



# ESC Spectrum

## 8864 Data Controller User Guide

Firmware Version 4.11 through Version 6.02.r60  
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[Click here to view this document's Revision History.](#)

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# Revision History



**NOTE:** Beginning with v5.00, the numbering scheme of the 8864 firmware is identified in documentation using the format “vX.YY.rZZ”, such as v5.00.r24. The first part of the numbering scheme (v5.00) represents the version of the firmware, which defines the features included in the firmware. The second part of the numbering scheme (.r24) represents the build number. For example, all version v5.02 firmware has the same feature set and would be supported by the same User Guide. Revisions occur when a bug fix is required and a new build is generated. For example, v5.02.r25 would be updated to build v5.02.r26 if a bug were fixed, but would only be updated to version v5.03 if features are added or changed.

The following table identifies updates in the 8864 Data Controller User Guide. To obtain a copy of the latest software version and this user guide, as well as view an online help version of this document, visit the [8864 Data Controller Downloads](#) page in the [Customer Community](#) (requires login).

Data Controller Version	Revision Date	Revision Summary
Version 6.02.r60	02/15/2022	<p>Document updates for Version 6.02.r60 include:</p> <ul style="list-style-type: none"> <li>▪ <b>New Shortcut Keys / Modbus Client Config File:</b> New keyboard shortcuts added in the <a href="#">View Modbus Client Cfg File</a>. Also see <a href="#">Modbus Client Cfg File Shortcuts</a> in <a href="#">Keyboard Shortcuts</a>.</li> <li>▪ <b>8864 Modbus Table / Math Constant Real-time Values:</b> Updated the topic <a href="#">8864 Modbus Table</a> in the <a href="#">App Note - Modbus Server</a> section. Added new list item for math constant real-time values and updated the 8864 Modbus table.</li> <li>▪ <b>Serial Port 0 / Support for 2-wire RS-485:</b> Updated the <a href="#">Serial Ports</a> topic with information about Port 0 supporting 2-wire RS-485 implementations when Device Type is set as LLM-2W.</li> <li>▪ <b>Math Constants in Real-time Display:</b> Added new topic <a href="#">Display Math Constants</a> in</li> </ul>

Data Controller Version	Revision Date	Revision Summary
		<p>the section <a href="#">Real-Time Display Menu</a>.</p> <ul style="list-style-type: none"> <li>▪ <b>Configure Network Security / Ethernet Options:</b> Updated the topic <a href="#">Configure Network Security</a>.</li> <li>▪ <b>EtherNet/IP Communications Support:</b> Added new section <a href="#">Appendix K. EtherNet/IP Communications</a>.</li> <li>▪ <b>MODBUS “U” and “B” Flags:</b> Updated <a href="#">Display Readings w/Flags</a> with “U” flag description for MODBUS channels with communication error. Also updated the following topics to include “B” and “U” flags for MODBUS channels: <ul style="list-style-type: none"> <li>◦ <a href="#">Legacy 8832 Output Table</a> topic in the <a href="#">App Note - Modbus Server</a> section</li> <li>◦ <a href="#">Input Scan Interval</a> in the section <a href="#">Configure Channel Options</a></li> </ul> </li> <li>▪ <b>Build System Report:</b> Added new topic <a href="#">Build System Report</a> in <a href="#">Configure System Parameters</a>.</li> <li>▪ <b>Reboot 8864:</b> Updated <a href="#">Reboot</a> topic to include information about default Num Lock and Scroll Lock functionality.</li> <li>▪ <b>Overrange/NAN Channel Values:</b> Added new topic <a href="#">Math Operators and Overrange/NAN Channel Values</a> in <a href="#">Math Pack and Average Math Pack Channel</a> of <a href="#">Configure (Data) Channels</a>.</li> </ul>
Version 6.01.r53	06/28/2021	No document updates required for Version 6.01.r53.
Version 6.01.r52	06/22/2021	<p>Updates for firmware Version 6.01.r52 include:</p> <ul style="list-style-type: none"> <li>▪ Updated “Error Calculation Used” for “Difference” method as:  <math display="block">ABS (Actual \sim RP - Expected \sim RP) \sim RP</math> <p>Refer to the table in the topic <a href="#">Calibration</a></p> </li> </ul>

Data Controller Version	Revision Date	Revision Summary
		<p><a href="#">Error Calculation</a> for details.</p> <ul style="list-style-type: none"> <li>Global change: added new validation types 5, 6, and 7 to topic <a href="#">Validation Type (0-7)</a>.</li> <li>Add new topic <a href="#">Enable OOC Reset (Y/N)</a> in <a href="#">General Setup</a> of <a href="#">Configure System Parameters</a>.</li> <li>Added new topic <a href="#">Reset OOC (T Flag) and Grace</a> in <a href="#">Configure (Data) Channels</a>.</li> <li>Updated descriptions for merge math operator "?" and math merge channels in the topic <a href="#">Equation Configuration</a> for <a href="#">Math Pack</a> and <a href="#">Average Math Pack Channel</a> in <a href="#">Configure (Data) Channels</a></li> <li>Added new topic <a href="#">Check Ignore Flags?</a> in the <a href="#">Average (flags) Alarm</a> section of <a href="#">Configure Alarms</a>.</li> <li>Updated the topic <a href="#">Trigger DI Pattern</a> in the <a href="#">New DI-Triggered Dig. Event</a> section of <a href="#">Configure Digital Event Programs</a>.</li> <li>Added new topic <a href="#">Calibrate a Parameter in a Calibration</a> in the <a href="#">Configure Calibrations</a> section.</li> <li>Updated <a href="#">Automatic Logout (local)</a> and <a href="#">Automatic Logout (remote)</a> in the <a href="#">General Setup</a> section of <a href="#">Configure System Parameters</a>.</li> <li>Added note for new logout message to the end of topic <a href="#">8864 Graphical User Interface (GUI)</a>.</li> </ul>
Version 6.00.r48	12/21/2020	No document updates required for v6.00.r48 firmware release.
Version 6.00.r47	12/1/2020	No document updates required for v6.00.r47 firmware release.
Version 6.00.r44	10/6/2020	No document updates required for v6.00.r44 firmware release.



Data Controller Version	Revision Date	Revision Summary
Version 6.00.r43	9/22/2020	Updates include company/product re-branding. No other document updates required for v6.00.r43 firmware release.
Version 6.00.r42	7/28/2020	<p>Updates for firmware Version 6.00.r42 include:</p> <ul style="list-style-type: none"> <li>▪ <b>Firmware Upgrade Warning:</b> Added warning in <a href="#">Firmware Upgrades</a>, <a href="#">Download Code</a>, and <a href="#">Upgrade 8864 Firmware</a> about not being able to downgrade (revert) the firmware after installing firmware Version 6.00 or higher.</li> <li>▪ <b>USB Download:</b> Updated <a href="#">USB Download</a> to include searching only the USB root directory when downloading firmware upgrade file.</li> <li>▪ <b>Firmware Upgrade:</b> Updated instructions in System Maintenance <a href="#">Download Code</a> and <a href="#">Upgrade Using USB</a> in Appendix A. Installation Guide.</li> <li>▪ <b>Network Security:</b> Added new topic <a href="#">SSL Security Certificate Generation</a>.</li> <li>▪ <b>Modbus Client:</b> <ul style="list-style-type: none"> <li>• Updated the following topics for special addressing in the Modbus server.cfg file: <a href="#">Client n Section</a>, <a href="#">Port 0 Section</a>, and <a href="#">Data Map Section</a>.</li> <li>• Updated <a href="#">Client n Commands Section</a> with Minimum Command Delay and Enable Command Delay. Added Modbus example in <a href="#">Sample Server.cfg File</a>.</li> <li>• Added note in <a href="#">Client n Section</a>, <a href="#">Port 0 Section</a>, and <a href="#">Data Map Section</a> about entries no longer being case sensitive and, an entry of Yes, Y, or y will enable a feature, while No, N, or n will disable the feature.</li> </ul> </li> <li>▪ <b>General Setup Configuration:</b> Added new topic <a href="#">Enable Terminal Colors (Y/N)</a>.</li> </ul>

Data Controller Version	Revision Date	Revision Summary
		<ul style="list-style-type: none"> <li>▪ <b>System Configuration:</b> Added new topic <a href="#">Configure Ethernet Routes</a>.</li> <li>▪ <b>Status Menu:</b> Added description of color-coded status updates that display in the “Last” column of the <a href="#">Report Current Cal Status</a> screen.</li> <li>▪ <b>System Maintenance:</b> Updated description for “View Serial Port Data” in <a href="#">System Maintenance</a> and <a href="#">View Serial Port Data</a>.</li> <li>▪ <b>Real-Time Data Display:</b> Updated <a href="#">Display Last Base Average</a> and <a href="#">Display Readings with Units or Flags</a> with channel range displayed on current page and color-coded status conditions.</li> <li>▪ <b>Channel Configuration:</b> <ul style="list-style-type: none"> <li>• Added new option “MODBUS Unsigned Int (Y/N)” in <a href="#">MODBUS Channel</a> topic. Removed field labeled “MODBUS/SIO Register #” in Modbus Config Channel Options screen.</li> <li>• Updated <a href="#">Time On-Line Counter Channel</a> to include configuration fields “Require Full Base Int (On)” and “Require Full Base Int (Off)”. Added new topic <a href="#">How Require Full Base Int On/Off Functions</a>.</li> <li>• Updated <a href="#">Multi-Condition TOL Counter Channel</a> to include configuration fields “Require Full Base Int (On)” and “Require Full Base Int (Off)”. Added new topic <a href="#">How Require Full Base Int On/Off Functions</a>.</li> <li>• Added new topic <a href="#">Constituent Flag Options</a>.</li> <li>• Updated the fields “Pass Constituent BO Flags”, “Pass Constituent Flags”, and “Include Invalid Constituents” for <a href="#">Math Pack Channel Configuration</a>, <a href="#">Average Math Pack Channel Configuration</a>, and</li> </ul> </li> </ul>

Data Controller Version	Revision Date	Revision Summary
		<a href="#">Rolling Average Channel</a> .
Version 5.05.r54	4/14/2020	No document updates required for v5.05.r54 firmware release.
Version 5.05.r52	1/16/2020	<p>Updates in firmware release v5.05.r52 include:</p> <ul style="list-style-type: none"> <li>Updated the description for serial Port 0, 1, 2, and 3 in <a href="#">Configure Serial Ports</a>. Enabling or disabling a serial port now supports a user access level with “admin” or higher privileges when using the MDI to configure the 8864 Data Controller.</li> <li>Updated screenshots in <a href="#">Configure Ethernet Ports</a> to show two leading zeros in MAC address.</li> </ul>
Version 5.05.r41	7/31/2019	No document updates required for v5.05.r41 firmware release.
Version 5.05.r37	6/18/2019	<p>Updated for v5.05.r37 firmware release:</p> <ul style="list-style-type: none"> <li>Added “Delay After Retries” in <a href="#">Client n Section</a> and <a href="#">Port 0 Section</a> of Modbus configuration file (server.cfg).</li> <li>Updated section <a href="#">Configure Secure Communications</a> with description of new command <a href="#">Generate New 8864 Public/Private Keys</a> and addition of MD5 fingerprint in <a href="#">View 8864 Public Key</a>.</li> </ul>
Version 5.04.r15	9/28/18	No document updates required for v5.04.r15 firmware release.
Version 5.04.r13	8/6/18	<p>Updated for the General Release of v5.04.r13 firmware. Updates include:</p> <ul style="list-style-type: none"> <li>Added field description for <a href="#">Fast Serial Modbus Server</a> in <a href="#">Configure Modbus</a>.</li> <li>Added field descriptions for <a href="#">Data Type</a> and <a href="#">Injection Level</a> in <a href="#">Configure Expected</a></li> </ul>

Data Controller Version	Revision Date	Revision Summary
		<p><a href="#">Values</a>.</p> <ul style="list-style-type: none"> <li>Added field description for <a href="#">OOC Only (Y/N)</a> in <a href="#">Configure Complex Calibration</a>.</li> <li>Added field description for <a href="#">Hold Pattern</a> in <a href="#">Configure Phases of a Complex Calibration</a>.</li> <li>Updated <a href="#">Notes About Public Key Files</a> in <a href="#">Configure Secure Communications</a>.</li> <li>Added description for Modbus Command Monitor in table of <a href="#">View Modbus Master Status</a> section.</li> <li>Added section <a href="#">Modbus Command Monitor</a>.</li> <li>Added <a href="#">Appendix E. PS-9 Calibrations</a>.</li> </ul>
Version 5.03.r16	4/11/18	Corrected Graphs Screen description in the pop-up window on the home screen of online help.
Version 5.03.r16	2/1/18	<p>Updated for the General Release of v5.03.r16 firmware. Updates include:</p> <ul style="list-style-type: none"> <li>Rearranged menu items related to secure communications in the <a href="#">Configure Network Security</a> and <a href="#">Configure Secure Communications</a> menus.</li> <li>Updated <a href="#">Met card</a> support in <a href="#">Appendix G. Configuration Guidelines</a>.</li> </ul> <p>For a complete list of updates, refer to the <a href="#">8864 Release Notes</a> on the <a href="#">8864 Data Controller Downloads</a> page in the Customer Community (requires login).</p>
Version 5.02.r25	10/30/17	Updated for the General Release of v5.02.r25 firmware. For a complete list of updates, refer to <a href="#">8864 Release Notes</a> on the <a href="#">8864 Data Controller Downloads</a> page in the Customer Community (requires login).
Version 5.00.r24	3/10/17	Updated names of I/O cards in <a href="#">Appendix H. I/O Card Descriptions</a> . Added new page <a href="#">StackVision Support for the 8864 Data</a>

Data Controller Version	Revision Date	Revision Summary
		<a href="#">Controller</a> . Replaced references to CAP Solutions with corresponding articles in <a href="#">Customer Community</a> .
Version 5.00.r24 General Release	2/17/16	Updated for the General Release of v5.00.r24 firmware. For a list of updates, refer to the document <i>8864 Data Controller Release Notes</i> on the <a href="#">8864 Data Controller Downloads</a> page of the Customer Community (requires login).
Version 5.00.r24 Limited Release	2/2/16	Updated document with updates available in firmware release v5.00.r24. For a list of updates, refer to the document <i>8864 Data Controller Release Notes</i> on the <a href="#">8864 Data Controller Downloads</a> page of the Customer Community (requires login).
Version 4.56	9/14/15	Updated the functionality description in the section <a href="#">Cals Status Screen</a> . Added new section entitled "Upgrading to an 8864".
Version 4.50	6/11/15	Updated document with updates available in firmware release v4.50. For a list of updates, refer to the document <i>8864 Data Controller Release Notes</i> on the <a href="#">8864 Data Controller Downloads</a> page of the Customer Community (requires login).
Version 4.47	5/20/15	Updated document with new features and bug fixes available in firmware release v4.47 and v4.46. For a list of new features and bug fixes, refer to the document <i>8864 Data Controller Release Notes</i> on the <a href="#">8864 Data Controller Downloads</a> page of the Customer Community (login required).
Version 4.24	2/13/15	Inserted a new <a href="#">Product Installation</a> section, that contains a <a href="#">guide to upgrading from an 8832</a> with all instructions from CAP Solutions 99774 and 94346, as well as "lessons learned" from previous 8864 installations.  Updated user guide contents for the v4.24

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Data Controller Version	Revision Date	Revision Summary
		Firmware release, including the increased number of math ("K") constants, increased number of Ethernet console tasks, updated keyboard function keys, and the ability to enable/disable Ethernet ports at the integrator login level. Also documented MODBUS updates in the 8864, as well as modifications to the reboot and cold start processes.
Version 4.11	3/28/14	Documentation for the initial 8864 Data Controller release.



## Contact Information

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# Document Conventions

**Touchscreen “press” Instructions:** The primary user interface of the 8864 is a touchscreen GUI (graphical user interface). It is located on the front panel of the 8864. Because the screen responds to pressure, you can press icons and words on screen to interact with the 8864. The term “press” in this document means to use your finger or a stylus object to select an item on the touchscreen. The screen is very sensitive to touch input and only requires a light touch when selecting an item.

This document uses the following additional conventions:

Convention	Usage
<i>Italics</i>	<i>For emphasis, italic type is used.</i>
<b>User interface</b>	User interface items are <b>bolded</b> and include window names, screen terminology, dialog boxes, menus and commands, screen terminology, messages, key names, and other terms that appear on the screen.
<b>Menu commands</b>	Menu commands and commands to be typed or selected by the user are <b>bolded</b> .
Window Titles	Window titles, selections, and fields are capitalized.
<b>Folder and directory names</b>	Folder and directory names are <b>bolded</b> .
<b>Icon names</b>	Icon and button names are <b>bolded</b> .
Key names, key combinations, and key sequences	Key names, key combinations, and key sequences are UPPERCASE, e.g. CTRL+SHIFT.
> (right chevron)	Menu commands are separated by an arrow to indicate that items should be selected in order. For example, <b>File &gt; Exit</b> indicates that you should click <b>File</b> and then <b>Exit</b> .
	The <b>TIP</b> icon indicates a recommendation, shortcut, or other advice when working with a specific feature.
	The <b>NOTE</b> icon indicates an important reminder or additional information about a particular item (e.g., informational notes or definitions).
	The <b>IMPORTANT</b> icon indicates information about actions that may produce undesirable consequences (e.g., events that could cause the

Convention	Usage
	action to fail or to corrupt data). Users should acknowledge this information before proceeding.
	The <b>CAUTION</b> icon indicates information about actions that may damage or harm the product. Users should proceed with care when this icon is displayed.
	The <b>WARNING</b> icon warns about actions that may injure the person performing the action. Users should proceed with <i>extreme</i> caution when this icon is displayed and potentially not perform the action at all if the risk of injury is present.

# StackVision Support for the 8864

StackVision Version 4.0 is the first software version to support the 8864 Data Controller (8864). If you are replacing an 8832 Data Controller (8832) with an 8864, StackVision must be running Version 4.0 or greater. A configuration that runs in an 8832 will run completely unchanged in an 8864.



For information about how to upgrade from an 8832 to the 8864, view the article entitled [How to Upgrade from an 8832 to 8864 Data Controller](#) (requires login).

Any version of 8864 firmware is compatible with StackVision Version 4.0 and greater. Use the information in the table below to help determine which version of StackVision you need to take advantage of the features provided in a particular version of 8864 firmware.

8864 Firmware Version	Supported StackVision Software Version
Version 6.02.r60	Version 5.1.106
Version 6.01.r53	Version 5.1.106
Version 6.01.r52	Version 5.1.106
Version 6.00.r48	Version 5.1.106
Version 6.00.r47	Version 5.1.106
Version 6.00.r44	Version 5.1.106
Version 6.00.r43	Version 5.1.106
Version 6.00.r42	Version 5.1.106
Version 5.05.r54	Version 5.1.106
Version 5.05.r52	Version 5.1.106
Version 5.05.r41	Version 5.1.106
Version 5.05.r37	Version 5.1.106
Version 5.04.r15	Version 5.1.106
Version 5.03.r16	Version 5.1.106
Version 5.02.r25	Version 5.1.106
Version 5.00.r42	Version 4.9.108

8864 Firmware Version	Supported StackVision Software Version
Version 5.00.r24	Version 4.9.108
Version 4.56	Version 4.8.37
Version 4.50	Version 4.7.37
Version 4.47	Version 4.7.37
Version 4.24	Version 4.4.22
Version 4.11 (initial release)	Version 4.0.28

# Product Overview

The 8864 Data Controller (also referred to as 8864) is a microprocessor-based data acquisition system designed to acquire, process, store, report, and transmit data in a multi-tasking environment. The 8864 is designed around an expansion bus that gives the user great flexibility in configuring the unit with almost any combination of input and output types.

The base unit consists of:

- Motherboard with AMD Geode processor running at 500 MHz
- 256MB of RAM
- 4GB compact flash card slot for persistent storage
- Real-time clock
- Battery backup for the real-time clock and system BIOS
- One standard RS232 or RS485 port, and up to 3 additional serial ports that can be any combination of RS232 and RS485
- Full-color graphical touchscreen display
- Two Ethernet ports
- 3 USB 2.0 ports, including one on the front face of the unit
- Compatibility with PC style keyboard and mouse using the USB ports

## Related Topics:

- [8864 Features](#)
- [8864 Block Diagram](#)
- [8864 Front and Back Views](#)
- [8864 Specifications](#)
- [Comparison of 8864 with 8832](#)

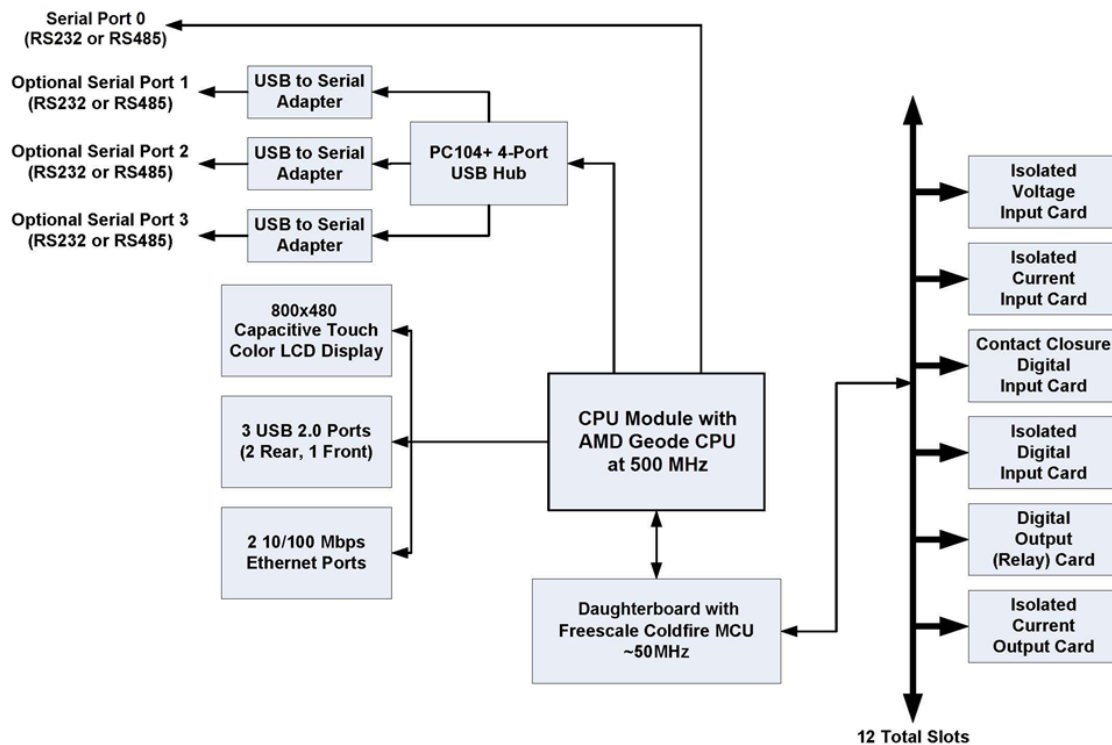
## 8864 Features

Features of the 8864 Data Controller include:

- Graphical display of data, both real-time and historical (using LCD or Ethernet).
- User-friendly menu-driven interface with “plain English” prompts.
- Data entry supports arrow and backspace keys and insert and overstrike modes.

- Supports several channel types, including math pack, stream-switching, time-on-line counters, rolling averages, and (optionally) meteorological parameters.
- Simple and complex calibration programs, providing both ease of use and flexibility.
- Full-screen real-time displays of data values.
- Flexible alarming system, no limit on number of alarms per channel.
- Six-level password protection with user-configured passwords.
- Data storage configurable for each channel and averaging interval, to allow optimum use of available data storage on the compact flash card.
- All configuration may be set using software (no DIP switch configurations required).
- With proper configuration, up to 999 parameters per 8864 Data Controller can be monitored.

## 8864 Block Diagram

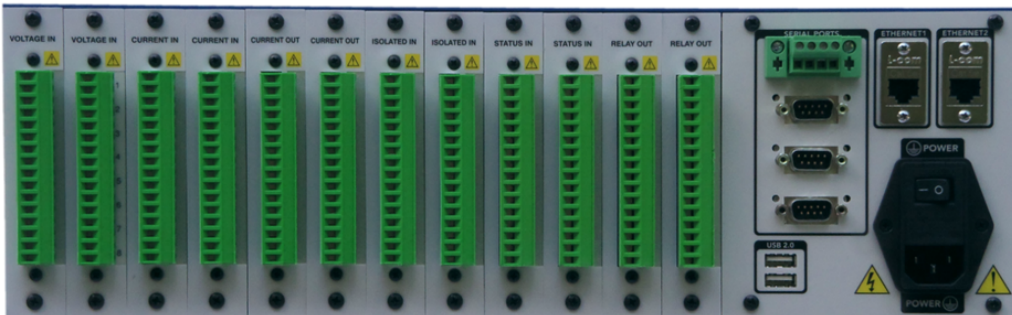


## 8864 Front and Back Views

**Front View:**



**Back View:**



## 8864 Specifications

Components	Specifications
Dimensions:	17.00w x 5.25h x 14.00d inches (43.2 x 13.4 x 35.6 cm)
Weight:	Less than 12 pounds (4.5 kg)
Mounting:	19-inch rack
Power:	Universal 120-240 VAC, 60-50 Hz, less than 60 Watts
Operating Temperature Range:	0° C to 40° C
Humidity:	0 to 95% (non-condensing)
Current Inputs:	Isolated, differential 4-20 mA current loops
Resolution:	14-bit
Front-To-Back Accuracy:	± 0.1% full scale at room temperature; ±0.15% full scale over full temperature range



Components	Specifications
Input Impedance:	~170 ohms
Scan Rate:	32 channels per second
Voltage Inputs:	Isolated, differential with programmable gain amplifier
Resolution:	14-bit
Front-To-Back Accuracy:	$\pm 0.05\%$ full scale at room temperature; $\pm 0.1\%$ full scale over full temperature range
Voltage Ranges:	$\pm 100$ mV, $\pm 1$ V, $\pm 5$ V, $\pm 10$ V full scale
Input Impedance:	$> 10$ M $\Omega$
Scan Rate:	32 channels per second
Digital Status Inputs:	Detects contact (relay) closures or voltage-to-ground transitions (to 24 V); configurable software debounce
Isolated Status Inputs:	Detects open-to-voltage transitions (24 V to 120 V, AC or DC); configurable software debounce
Relay Outputs:	Latching-coil relays; rated load: 5 A @ 150 VAC, 5 A @ 30 VDC
Analog Current Outputs:	Isolated 4-20 mA current loops with fully isolated +24V loop power
Resolution:	12-bit
Accuracy:	$\pm 0.5\%$ over operating temperature range
Compliance:	1,000 $\Omega$ per loop when 1 to 7 Analog Output cards are installed 500 $\Omega$ per loop if 8 to 12 Analog Output cards are installed
CPU:	AMD Geode, ~500MHz
Serial I/O Ports:	One RS232 or RS485 port standard and up to 3 additional serial ports in any combination of RS232 or RS485
Baud Rates:	300 baud to 115.2k baud on first three ports; 300 baud to 38.4k baud on fourth port, software selectable
Data Format:	8-bit word, even, odd or no parity, full duplex; 7-bit word, even or odd parity, full duplex

Components	Specifications
LCD:	Full-color touchscreen
Ethernet Port:	2 Ports, 10/100 Mbps

## Comparison of 8864 with 8832

8864 Data Controller	8832 Data Controller
<b>General Features</b> <ul style="list-style-type: none"> <li>▪ CPU – AMD Geode LX 800</li> <li>▪ Data Bus – 64 bits</li> <li>▪ Speed – 500 MHz</li> <li>▪ Dimensions – 17"W x 5.25"H x 14"D</li> <li>▪ Weight – 12 pounds</li> </ul>	<b>General Features</b> <ul style="list-style-type: none"> <li>▪ CPU – Motorola MPC860 Power QUICC</li> <li>▪ Data Bus – 32 bits</li> <li>▪ Speed – 50 MHz</li> <li>▪ Dimensions – 17"W x 5.25"H x 14"D</li> <li>▪ Weight – 15 pounds</li> </ul>
<b>Memory</b> <ul style="list-style-type: none"> <li>▪ 2048 MB Flash – firmware, configuration, and data</li> <li>▪ 256 MB DRAM – working memory</li> <li>▪ 64K L1 cache and 128K L2 cache</li> </ul>	<b>Memory</b> <ul style="list-style-type: none"> <li>▪ 6 MB total – firmware, configuration, and data</li> <li>▪ 32 MB DRAM – working memory</li> </ul>
<b>Communications</b> <ul style="list-style-type: none"> <li>▪ Dual 10/100Mbps Ethernet interfaces</li> <li>▪ USB – Three USB 2.0 (two rear, one front)</li> <li>▪ Serial Port 0 – optically isolated RS-232 or RS 485</li> <li>▪ Serial Port 1 – RS-232 or RS-485 (optional)</li> <li>▪ Serial Port 2 – RS-232 or RS-485 (optional)</li> <li>▪ Serial Port 3 – RS-232 or RS-485 (optional)</li> </ul>	<b>Communications</b> <ul style="list-style-type: none"> <li>▪ Single 10Mbps Ethernet interface</li> <li>▪ USB – (none)</li> <li>▪ Serial Port 0 – optically isolated RS-232 or RS-485</li> <li>▪ Serial Port 1 – optically isolated RS-232 or RS-485</li> <li>▪ Serial Port 2 – RS-232 (optional)</li> <li>▪ Serial Port 3 – RS-232 (optional)</li> </ul>
<b>Display</b> <ul style="list-style-type: none"> <li>▪ TFT active matrix LCD</li> </ul>	<b>Display</b> <ul style="list-style-type: none"> <li>▪ LCD</li> </ul>

8864 Data Controller	8832 Data Controller
<ul style="list-style-type: none"><li>▪ 16 Million Color</li><li>▪ 800x480</li><li>▪ Capacitive touch-screen</li></ul>	<ul style="list-style-type: none"><li>▪ 16 Color</li><li>▪ 640x240</li></ul>
<b>I/O Cards</b> <ul style="list-style-type: none"><li>▪ Modular – 8 points per card</li><li>▪ Card configuration – automatically detected</li><li>▪ Wiring connectors (same as 8832)</li></ul>	<b>I/O Cards</b> <ul style="list-style-type: none"><li>▪ Modular – 8 points per card</li><li>▪ Card configuration – must be manually set</li></ul>
<b>Configuration</b> <ul style="list-style-type: none"><li>▪ Channels – greater than 200</li><li>▪ Digital I/O points – 999 maximum</li><li>▪ Channel Names – 20 characters</li></ul>	<b>Configuration</b> <ul style="list-style-type: none"><li>▪ Channels – 99 maximum</li><li>▪ Digital I/O points – 88 maximum</li><li>▪ Channel Names – limited to 8 characters</li><li>▪ Configuration Upload to StackVision – (unavailable)</li></ul>

# Firmware Upgrades



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

From time to time, ESC Spectrum will publish new versions of the firmware for the 8864 Data Controller. Please check the [8864 Data Controller Downloads](#) page in the Customer Community (requires login) for firmware updates and updated release notes to determine if the new version needs to be installed on your system's controllers. Firmware upgrades and release notes are accessible to customers with an active ESC Spectrum Support agreement.

Detailed instructions for upgrading the 8864 firmware can be found in this document in [Appendix A. Installation Guide](#).



**NOTE:** Beginning with v5.00, the numbering scheme of the 8864 firmware is identified in documentation using the format “vX.YY.rZZ”, such as v5.00.r24. The first part of the numbering scheme (v5.00) represents the version of the firmware, which defines the features included in the firmware. The second part of the numbering scheme (.r24) represents the build number.

For example, all version v5.02 firmware has the same feature set and would be supported by the same User Guide. Revisions occur when a bug fix is required and a new build is generated. For example, v5.02.r25 would be updated to build v5.02.r26 if a bug were fixed, but would only be updated to version v5.03 if features are added or changed.



# Product Installation

The following sections will assist with 8864 product installations. ESC Spectrum recommends using the procedure in the topic [Upgrade from an 8832 to an 8864](#) in [Appendix A. Installation Guide](#) to lead you through an upgrade from the 8832 to an 8864. For support during the installation, also review the following sections:

- [Keyboard Installation](#)
- [IP Address Setup](#)
- [8864 Ports](#)
- [I/O Card Description and Installation](#)

## Keyboard Installation

To use the command line interface with the 8864, you must attach a keyboard. The 8864 supports a full-size PC-style keyboard with a USB connection. This feature is used in conjunction with the front-panel LCD display to provide a user-friendly local interface. The software will support the arrow keys and many of the other special keys available (insert, page up, page down).

**IMPORTANT:** The 8832 keyboard uses an older PS/2 style connector that will NOT work with the 8864.

To install the keyboard:

- Plug the keyboard cable in a USB port located on the back of the 8864 or on the front panel. See the following example.



**NOTE:** See [Keyboard Shortcuts](#) for information about using the keyboard with the 8864.

If you are referring to this section during product installation, use the following link to return to the section [Upgrade from an 8832 to an 8864](#).

## IP Address Setup

The 8864 supports two [Ethernet Ports](#) located on the back of the unit. Use either of these ports when connecting an Ethernet cable to the unit for an IP connection. If you plan to use an Ethernet port, you must first use the [Menu Driven Interface \(MDI\)](#) to set a fixed IP address for the connection, or set the IP address to DHCP and then let your network assign the IP address. The 8864 ships with default (non-routable) fixed IP addresses.

Use dotted decimal notation when entering an IP address, such as 10.7.43.194. For an example of this format, see the next example of the Configure Ethernet Ports screen. Additional characteristics of this screen include the following items:

- **IP Address:** This field identifies the IP address of the 8864.
- **Subnet Mask:** Use this field to define local network boundaries. If needed, contact your Network Administrator to obtain the Subnet Mask value.
- **Default Gateway:** This field identifies the gateway IP address that the 8864 uses to send packets that are destined for other IP addresses not on the local network (as defined by the Subnet Mask field). The IP address of the Default Gateway must be available on the local network. If needed, obtain the Default Gateway from your Network Administrator.

```

ESC 8864 v6.02r54 ID:01      Configure Ethernet Ports      01/16/22 11:02:25

Ethernet 1
  MAC Address      : 00:04:BF:B0:57:F7
  Ethernet Enable (Y/N) : ☒
  DHCP Enable (Y/N)  : N

  Static IP Address : 10.0.41.60
  Static Subnet Mask : 255.255.252.0
  Static Default Gateway : 10.0.40.1
  Static DNS Address : 0.0.0.0

  Request IP Address : 10.0.41.60
  Specify Client ID  :
  Domain Name       :

  IP Address (in use) : 10.0.41.60
  Subnet Mask (in use) : 255.255.252.0
  Default Gateway (in use): 10.0.40.1
  DNS Server (in use) : 0.0.0.0

Next Page = CTRL-N

```

You can set up Ethernet IP addresses for the 8864 from the Configure Ethernet Ports screen. To access this screen, complete the following steps

1. Press **More** in the touchscreen of the 8864 to display the MDI. Then log in using an administrative-level user account.
2. In the Home Menu of the MDI, select **C - Configuration Menu > S - Configure System Parameters > E Configure Ethernet Ports**.
3. Edit the information for the first Ethernet connection as required.

4. Press **CTRL-N** to display the second page. Set up the second Ethernet connection if required.
5. Select the field **FINISHED (Configure Now)** on the second page and then press **Enter**. When the message "Confirm Config Save" displays at the bottom of the screen, press **Y** to select Save Changes. (IP addresses change immediately.)

For detailed information with examples of setting a static IP Address and Subnet Mask, see [Configure Ethernet Ports](#).



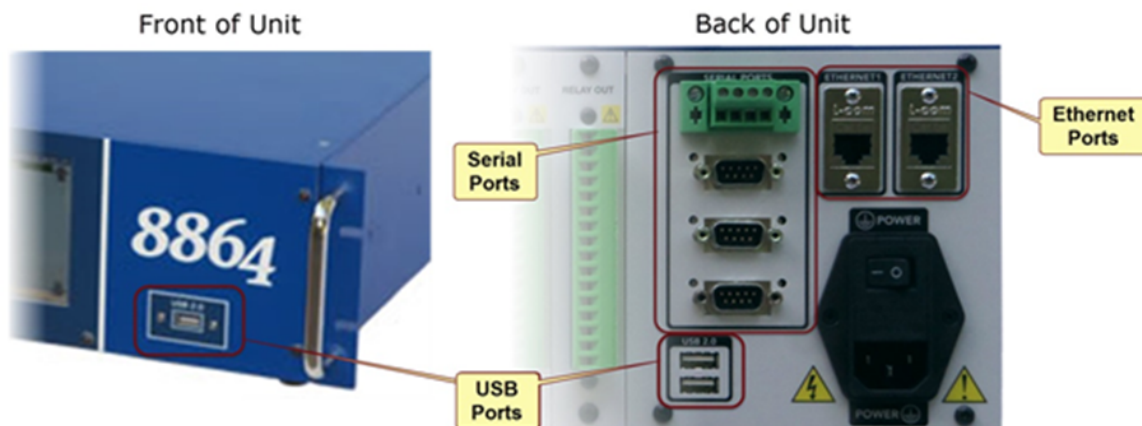
**NOTE:** The MDI includes a validation process that prevents manual configuration of Ethernet connections on the same subnet or gateway.

## 8864 Ports

The following types of ports are available on the 8864:

- [USB Ports](#)
- [Serial Ports](#)
- [Ethernet Ports](#)

Also refer to [TCP Port Usage](#) and [Security and Cipher Suites Used on Ethernet Ports](#).



### USB Ports

The 8864 supports three USB 2.0 ports as shown in the following example. One USB port is on the front panel of the unit and two are on the back of the unit. Use these ports with any USB-compatible equipment supported by the 8864, such as a keyboard, mouse, and flash drive.

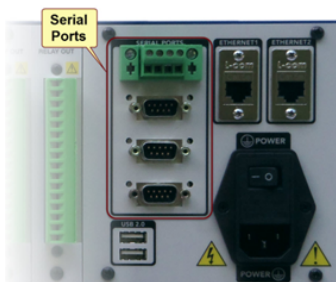




## Serial Ports

The 8864 provides four serial ports that can be any combination of RS-232 and RS-485. The connectors are standard RS-232 serial ports with DB-9 (male) connectors, like those found on a PC; however, they may optionally be configured as isolated RS-485 ports.

The serial ports are located on the back of the unit on the right-hand side.

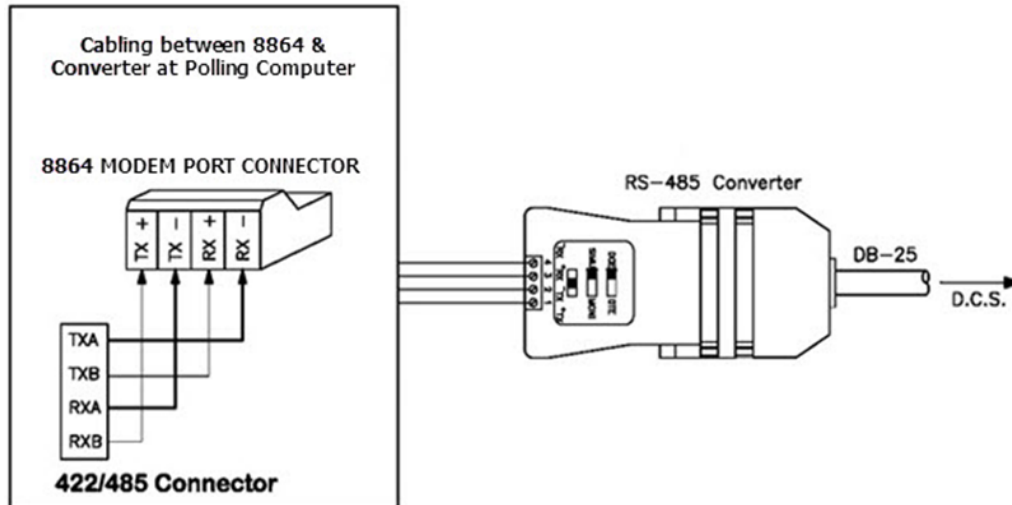


**To connect a modem to an RS-232 port**, use a DB-9 to DB-9 or a DB-9 to DB-25 modem cable provided by ESC Spectrum or purchased from a local computer store.

**To connect a terminal or PC directly to an RS-232 port**, use a DB-9 to DB-9 null modem cable provided by ESC Spectrum or purchased from a local computer store. Be sure to specify “null modem” when interfacing to a terminal or PC directly.

**To connect an RS-485 port**, use the custom connector or converter box provided by ESC Spectrum. The terminals are (in order from left to right): TX (transmit) +, TX -, RX (receive) +, and RX -. These terminals should be connected to the rest of the RS-485 network with the correct polarity (+ to +, - to -), but swapping the role of RX and TX. That is, connect the 8864's TX+ to the network's RX+, TX- to RX-, and so on.

The following diagram provides further detail.



**IMPORTANT:** When Serial Port 0 is configured for “RS485” operation with the “Device Type” set to “LLM-RTS”, a full “multi-drop” 4-wire RS-485 implementation is supported. On this port, the 8864 will “tri-state” the transmitter lines Tx+ and Tx- when the 8864 is not actively transmitting characters on this port (i.e., the lines are switched to a high-impedance state). This allows for “multi-drop” operation whereby the transmitter of Port 0 on the 8864 can be wired in parallel with the transmitters of other devices. This would typically be used if the 8864 were operating as a Modbus Server (slave). In this configuration, all other devices that are wired in parallel must also support “multi-drop” RS-485 operation.

When configured for “RS485”, Ports 1, 2, and 3 do not support a “Device Type” of “LLM-RTS”. For these ports, the “Device Type” should be set to “VT100”. This means that these ports will only support multi-drop operation if the 8864 is the only device that transmits on the Tx+ and Tx- lines, for example, then the port is configured to be the Modbus Client (master). On these ports, the Tx+ and Tx- lines are always driven and are never tri-state or high-impedance. The user should not connect the Tx+ and Tx- lines of Port 1, 2, or 3 to the Tx+ or Tx- lines of any other device. However, the TX+ and TX- lines can drive the receivers of up to 10 other devices. A more accurate description of these ports would be “4-wire RS-422”.

If a second RS485 port with multi-drop capability operating as a Modbus Server (slave) is required, then an RS232 port on the 8864 can be configured as LLM-RTS and connected to an external RS232 to RS485 converter. The RTS line on the RS232 port of the 8864 will signal when to enable the transmitter on the RS485 converter.

When Serial Port 0 is configured for “RS-485” operation with the “Device Type” set to “LLM-2W”, a 2-wire RS-485 implementation is supported.

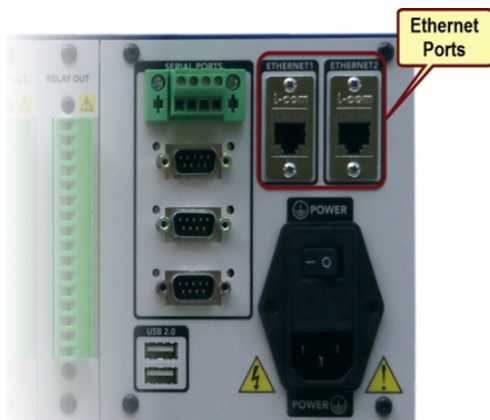
The 8864 does not support 2-wire RS-485 implementations on any port except for Port 0. Port 0 is the only port that supports 2-wire RS-485 implementations. Except for Port 0, do not connect the Tx+ and Tx- of any of the serial ports on the 8864 to its own Rx+ or Rx- lines.

All serial ports on the 8864 will support 4-wire point-to-point RS-422/RS-485 links.

## Ethernet Ports

The 8864 includes two 10/100 Mbps Ethernet ports that allow you to connect the unit to two separate TCP/IP networks at 10 Mbps (10Base-T) or 100 Mbps (100Base-Tx). The connection is made with a standard network cable through an RJ-45 connector.

The Ethernet ports are located on the back of the unit on the right-hand side. The left port is Ethernet #1, and the right port is Ethernet #2.



## TCP Port Usage

The 8864 Data Controller uses specific TCP ports for communication functions. The following table lists the TCP ports and corresponding functions.

TCP Port	Description
22	MDI (Menu Driven Interface) SSH Interface and SFTP file transfers
443	HTTPS Web Interface
502	MODBUS TCP Interface
9881	Central Command/Response Interface

## Security and Cipher Suites Used on Ethernet Ports

The following information identifies the security protocols used on port 22 (SSH), 443 (HTTPS), 502 (Modbus), and 9881 (ESC Spectrum polling).

### Port 22 (SSH)

The 8864 utilizes the following security protocols on port 22:

- OpenSSH: v7.1p1
- Key exchange: curve25519-sha256, diffie-hellman-group-exchange-sha256
- Encryption: chacha20-poly1305, aes128-gcm, aes128-ctr
- MAC: hmac-sha2-256-etm, hmac-sha2-256
- Public keys: RSA-2048 in OpenSSH format

Inbound port 22 can be closed and, instead an outbound reverse SSH tunnel with bi-directional RSA-2048 public-key authentication and AES-128 encryption can be established to an SSH server on the StackVision server to provide SSH terminal emulation and SFTP file-transfer functions.

### Port 443 (HTTPS)

The 8864 uses the following security protocols on port 443:

- OpenSSL: v1.0.2e
- Cryptographic protocol: TLS 1.2 only
- Key exchange: ECDHE-RSA
- Encryption: AES128 or AES256
- Hashing algorithms: SHA256, GCM-SHA256, SHA384, or GCM-SHA384

The self-signed X.509 certificate presented on port 443:

- Signature algorithm: sha256RSA
- Signature hash: sha256
- Public key: RSA-2048

Inbound port 443 can be closed and, instead an outbound reverse SSH tunnel with bi-directional RSA-2048 public-key authentication and AES-128 encryption can be established to an SSH server on the StackVision server to provide HTTPS functions.

### Port 502 (Modbus)

The 8864 provides no security or authentication on inbound port 502. Inbound port 502 can be closed and, instead an outbound reverse SSH tunnel with bi-directional RSA-2048 public-key authentication and AES-128 encryption can be established to an SSH server on the Modbus server to provide Modbus functions.

### Port 9881 (ESC Spectrum Polling)

Inbound port 9881 utilizes an ESC Spectrum proprietary protocol. The 8864 provides no security or authentication on inbound port 9881. Inbound port 9881 can be closed and, instead an outbound reverse SSH tunnel with bi-directional RSA-2048 public-key authentication and AES-128 encryption can be established to an SSH server on the StackVision server to provide HTTPS functions.

## I/O Card Description and Installation

The 8864 input/output (I/O) cards can be installed in any order. If I/O cards are removed or added, perform a cold start on the 8864, and the 8864 will auto-detect which card type is installed in each slot at boot.



**CAUTION:** Cold starting the 8864 will delete all configuration and data.

---

Each of the I/O card types contains removable screw-down connectors for easy access when making the wire terminations. The I/O card connectors accept 12-20 gauge solid or stranded wire stripped to 7.5 mm, but 20-gauge stranded wire with solder-tinned ends is recommended. The recommended torque for the connectors is 0.5 N-m (4.5 lbf-in.).



**CAUTION:** Be careful not to bend the pins on the card during installation.

---

Insert the I/O card into the vacant slot, and press the card down on the riser that is on the main board. The I/O card is correctly in place if the holes match up to the screws.

After removing or adding I/O cards, you must cold start the unit for the 8864 to auto-detect the updated card types.

#### Related Topics:

- [Keyboard Installation](#)
- [Analog Input Cards](#)
- [Analog Output Cards](#)
- [Digital Input Cards](#)

- [Digital Output Cards](#)
- [Serial Ports](#)
- [Ethernet Ports](#)
- [TCP Port Usage](#)

## Analog Input Cards

Each analog input card has connections for eight differential voltage inputs or 4-20 mA current-loop inputs (user must provide power for the loop). The software supports four voltage ranges for each channel (independent by channel) for voltage input cards. The ranges are:  $\pm 100$  mV,  $\pm 1$  V,  $\pm 5$  V, and  $\pm 10$  V full scale. These inputs are scanned at a rate of 32 channels per second.

The analog-to-digital converter then translates the voltage/current reading to digital data for manipulation and storage. The analog-to-digital converter has a resolution of greater than one part in 16,000 (14-bit). A full-scale front-to-back accuracy at room temperature is guaranteed at 0.05% for the Voltage Input Card and at 0.1% for the Current Input Card. A full-scale front-to-back accuracy over the full temperature range is guaranteed at 0.1% for the Voltage Input Card and at 0.15% for the Current Input Card.

### To install a voltage input:

1. Connect the ground terminal of the signal line to the negative (–) terminal of the numbered input.
2. Connect the signal terminal of the signal line to the positive (+) terminal on the input card.

### To install a current loop input:

1. Connect the “current in” of the signal line to the positive (+) terminal on the input card.
2. Connect the “current out” terminal of the signal line to the negative (–) terminal.

## Analog Output Cards

The analog output cards provide an individually isolated 4-20 mA signal output and have 12-bit resolution. An accuracy of 0.5% is guaranteed over the full temperature range. The 8864 provides +24V DC power for the loop. If 7 or fewer Analog Output Cards are installed, each current output of the 8864 can drive 20 mA into loop resistances of up to 1,000 ohms. If 8 or more Analog Output Cards are installed, each current output of the 8864 can drive 20 mA into loop resistances of up to 500 ohms.

The analog output cards are typically used to output the results of a calculation performed by the 8864 software such as pollutant emission rates. These outputs can be used to drive strip-chart devices or to provide information to a local distributed control system.

### To install an analog output:

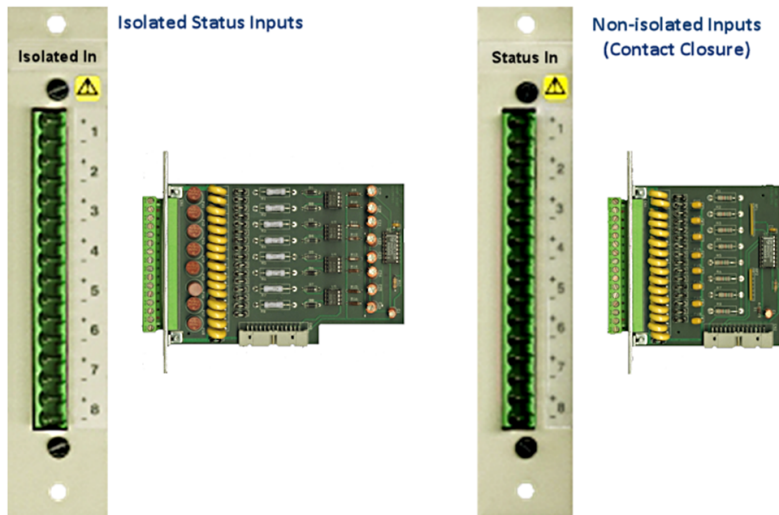
1. Connect the positive (+) and negative (–) terminals of the output to the positive (+) and negative(–) terminals of the required device. The initial output current will be zero mA.
2. Configure the digital-to-analog converter (DAC) in the software to provide a specific output. See [Configure Analog Outputs](#) in the Configuration Menu.

## Digital Input Cards

The 8864 supports the following types of digital input cards:

- [Contact Closure Inputs](#)
- [Isolated Status Inputs](#)

The example below shows the difference between isolated status inputs (Isolated In) and non-isolated inputs (Status In, contact closure).



### Related Topics:

- [Digital Output Cards](#)
- [Pseudo Digital Input/Output Lines](#)

### Contact Closure Inputs

Use the digital input lines to monitor the status of events external to the 8864 Data Controller, such as instrument-initiated calibrations, alarms, instrument failure, or the status of a stream-switched system. Each digital input card can read up to eight inputs which must be either dry contact closure (relay) or DC voltage-to-ground transition less than 24 VDC.



**CAUTION:** The negative (–) terminal must be at the AC ground potential of the 8864. Current of more than 50 mA flowing into this terminal may blow a built-in fuse or cause permanent damage to the 8864.



## Isolated Status Inputs

These inputs have the same functionality as contact closure inputs, but they must be “wetted” with a voltage of 24V DC to 120V DC. Current must flow through the inputs in order to activate them. AC voltages of 24V AC to 120V AC inputs may also be used.

### To install a digital input to an isolated-input card:

1. Connect the signals such that the current flows into the positive (+) terminal of the digital input.
2. Connect the negative (–) terminal of the isolated-input card to return the current flow out of the 8864.

## Digital Output Cards

Digital outputs allow the 8864 to control external events such as calibrations, switching of alarm lights, and notifying a distributed control system of an alarm or other event. Each digital output card contains eight relay outputs. Each relay is a latching-coil relay capable of switching up to 5A at 150 VAC or 5A at 30 VDC. The latching-coil feature allows all relays to maintain its on/off status during a power failure.

### To install a relay output:

1. Connect the two terminals of the positive (+) and negative (–) terminals in any order to the desired load.
2. If you need a switched voltage, you must supply the voltage using an external power source to one side of the relay.

### Related Topics:

- [Digital Input Cards](#)
- [Pseudo Digital Input/Output Lines](#)

## Pseudo Digital Input/Output Lines

The 8864 logically considers itself to have more digital inputs (DIs) and digital outputs (DOs) than it physically possesses. The number of these pseudo points is equal to the difference between the greater of the number of physical digital inputs and digital outputs and the maximum number of digital points allowed by the software (999). The 8864 software considers these additional lines to be jumpered to each other or looped back in the software.

For example, if an 8864 Data Controller has 24 DIs and 24 DOs, you can actually view and refer to digital inputs and digital outputs 01 through 999 (24 actual lines + up to 975 pseudo lines). Digital output #25 is considered to be connected to DI#25, DO#26 to DI#26, and so on.

If the number of DI and DO cards in the 8864 is not equal, the linked line numbers are skewed

from the end of the physical inputs up through line number 88.

If an 8864 Data Controller has 32 DIs but only 24 DOs, the user can actually view 56 (88 max–32 DI's) pseudo lines. The pseudo digital inputs are DI#33-DI#88, and the pseudo digital outputs are DO#25-DO#80. DO#25 is linked to DI#33, DO#26 to DI#34, and so on.

All digital lines above 88 (89 - 999) are always “aligned” so that the input number is the same as the output number. If the configuration setting for [Align Pseudos](#) is set in the [General Setup](#) configuration screen, then the pseudo lines will also be aligned from the end of the physical inputs through line 88 so that all pseudo lines are aligned.

**Related Topics:**

- [Digital Input Cards](#)
- [Digital Output Cards](#)



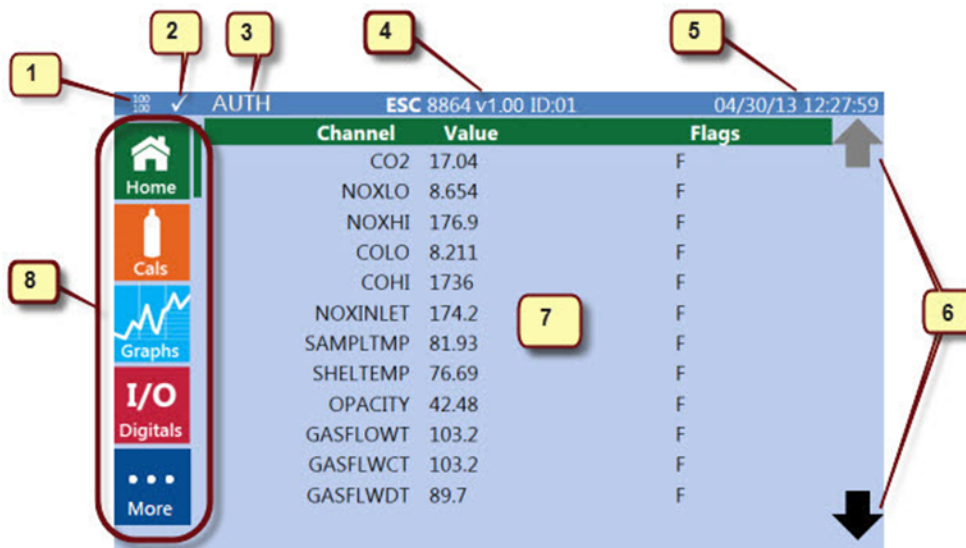
# 8864 Graphical User Interface (GUI)



The 8864 uses a touchscreen graphical user interface (GUI) to simplify access to the 8864 Data Controller's powerful and sometimes complex features. The software has been designed for ease of use by operators, with the most common tasks available on the touchscreen.



**NOTE:** More advanced configuration options can still be found on the MDI screen, which is accessed by pressing the [“More”](#) button. The More button is only available when a USB keyboard is connected.

The main parts of the touchscreen are identified in the following screen. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.



- **Link Lights for Ethernet Ports (1):** The top number is Port 1. The bottom number is Port 2. “10” indicates a 10 Mbps connection. “100” indicates a 100 Mbps connection. Blank indicates no connection. This information is displayed in the header on all screens.
- **Polling Status (2):** A polling status indicator displays on all screens. These include the following indicators:
  -  Indicates StackVision has polled the 8864 within the last 5 minutes.
  -  Indicates data was not polled within the last 5 minutes.

- **AUTH Indicator (3):** Attempting to perform any privileged action from the touchscreen (for example, starting or aborting a calibration, toggling a digital output, changing calibration expected values, etc.) will open a Pop-Up Number Pad on the screen. After you enter the correct PIN, the word AUTH is displayed at the top of the screen (to the right of the polling status icon) to indicate that you are logged in to the front panel. After this, you can perform privileged actions without logging in again. The authorized login will timeout after several minutes, or you can log out by pressing the AUTH indicator.
- **Firmware Version Number and Controller ID (4):** The firmware version number is displayed in “vx.xx” format. The “ID:01” portion defines the ID of the 8864 Data Controller. On other menu screens, this area displays the screen title, such as Active Cal Detail, Cal Status, etc.
- **Date and Time (5):** Current date and time. This information is updated once every 1–5 seconds and is displayed in the header on all screens.
- **Scrolling Buttons (6):** Press the black up and down arrows at the top and bottom right corners of the screen to scroll the main data area up and down. The arrows are grayed out when not available.
- **Main Data Area (7):** Displays data for the active screen.
- **Navigation Buttons (8):** Use these buttons to access different menu screens in the 8864 interface.

The active screen is identified by a colored bar just to the right of the corresponding navigation button. For example, the green bar to the right of the Home button in the screenshot to the right indicates that the home screen is the active screen. See the descriptions below for more information.

The touchscreen defaults to the Home screen, but you can access any of the other primary screens listed below by simply pressing their corresponding icon on the left side of the screen.



**NOTE:** The term “press” in this documentation means to use your finger or a stylus to select an item on the touchscreen. The screen has high sensitivity to touch input and only requires a light touch to select an item. When accessing the GUI interface using a browser across a network connection, the term “press” means to click an item with your mouse.

---



View configured channels in a scrollable list. Value and data flags are updated once every 1 to 5 seconds. Click [here](#) for more information.



View all calibration sequences, their current status, and the status of their last calibration. You can also abort an active calibration; manually initiate an automatic calibration; and change a calibration’s expected values. Click [here](#) for more information.



Provides quick access to current one-minute averages for a chosen channel. Click [here](#) for more information.



View digital input and outputs, including pseudo I/Os. You can also toggle the state of digital outputs. Reverse video shows closed inputs or outputs. Click [here](#) for more information.



Access the MDI interface in character mode to use advanced system configuration options, as well as the Help menu. Click [here](#) for more information.

**IMPORTANT:** The More button is available only when using a USB keyboard.

**NOTE:** A logout message displays in the front panel GUI (graphical user interface) and MDI (menu driven interface) when a user logs out. Settings configured for [Automatic Logout \(local\)](#) and [Automatic Logout \(remote\)](#) also apply to the front panel GUI and MDI. See [General Setup](#) in the [Configure System Parameters](#) section for more information.

## Home Screen



The **Home** screen displays when you start the 8864 (see example below). You can return to this screen at any time by pressing the Home button at the top left of the touchscreen.

The Home screen offers a quick glance at all configured channels. Channel values and data flags update every 1 to 5 seconds.



**NOTE:** To edit channels, switch to the MDI for channel configuration options. Press the **More** button to display the MDI screen. Enter login credentials and then select **C - Configuration Menu > D - Configure (Data) Channels**. See [Configure \(Data\) Channels](#) for further instructions.

The main parts of the Home screen are identified in the following example. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.

Channel	Value	Flags
CO2	0	F
CO2	-0.0007952	F
NOXLO	-0.0003976	F
NOXHI	-0.007952	F
COLO	-0.0003976	F
COHI	-0.07952	F
NOXINLET	-0.007952	F
SAMPLTMP	-25	F
SHELTEMP	-50.01	F
OPACITY	0.003975	FM
GASFLOWT	1	
GASFLWCT	1	
GASFLWDT	1	

- **Channel column (1):** List of configured channels. 12 channels are displayed per screen. If the channel list spans more than one screen, use the arrow icons on the right side of the screen to scroll up (↑) and down (↓)
- **Value column (2):** Current channel value. Updated every 1 to 5 seconds.
- **Flags column (3):** Channel status flag. Updated every 1 to 5 seconds. See [Data Validation and Flags](#) for detailed descriptions of each flag.

## Cals Status Screen



The **Cals Status** screen displays all calibration sequences, their current status, and the status of their last calibration (see example below). This screen can be accessed at any time by pressing the Cals button on the left side of the touchscreen.

The Cals Status screen allows you to:

- **View calibration details:** Press the name of any calibration to open a separate screen showing calibration details. If the calibration is currently running (active), the [Active Cal Detail Screen](#) displays. If the calibration is not currently active, the [Cal Sequence Screen](#) displays instead.
- **Abort an active calibration:** Press the name of any active calibration (indicated by 3 asterisks (\*\*\*) in the Status column) to open the [Active Cal Detail Screen](#), which provides an Abort button.
- **Start an idle calibration or change the start date/time:** Press the name of an idle calibration to open the [Cal Sequence Screen](#), which provides a Start Cal button.

- **Change the expected values for a calibration:** Press the name of an idle calibration to open the [Cal Sequence Screen](#). If the calibration is an “Auto”, Ext Init”, or “User” type calibration, then a Start Cal button is shown and can be pressed to start the calibration.

If the calibration list spans more than one screen, use the arrow buttons on the right side of the screen to scroll up (↑) and down (↓).



**NOTE:** For advanced calibration configuration options, you will need to switch to the MDI. Press the **More** button to display the MDI screen and then enter login credential. Select **C – Configuration Menu > C – Configure Calibrations**. See [Configure Calibrations](#) for further instructions.

The main parts of the Cal Status screen are shown in the next example. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.

The screenshot shows the 'Cal Status' screen. At the top, there is a status bar with '100' and a checkmark on the left, 'Cal Status' in the center, and '10/01/2012 09:23:29' on the right. Below this is a navigation menu on the left with icons for Home, Cals, Graphs, I/O Digitals, and More. The main area is a table with columns: Sequence, Type, Status, and Last. Callout numbers are placed as follows: 1 points to the 'Sequence' column header, 2 points to the 'Type' column header, 3 points to the 'Status' column header, and 4 points to the 'Last' column header.

Sequence	Type	Status	Last
GASCAL	Auto	*** SPAN	00:04:28 left Pass
FLOWCAL	Auto	Runs at 11/01/12 07:20	Pass
OPACCAL	Ext Init	PENDING	Pass
MANGAS	Inst Ctrl	PENDING	----
CALFLOW1	Auto	Runs at 11/01/12 07:50	Pass
FLWCAL1	Auto	Runs at 11/01/12 07:20	Fail
OPCAL1	Ext Init	PENDING	Pass
MANGAS12	Inst Ctrl	PENDING	Pass

- **Sequence column (1):** List of calibration names.
- **Type column (2):** Type of calibration sequence:
  - **Auto:** Automatic Calibration. Press the name of an Auto calibration to change the start date/time and manually initiate the calibration using the [Cal Sequence Screen](#).
  - **Inst Ctl:** Instrument Controlled Calibration.
  - **Ext Init:** Externally Initiated Calibration.
  - **User:** User Initiated Calibration.
  - **User DI:** User Initiated Calibration with Confirming Digital Input.

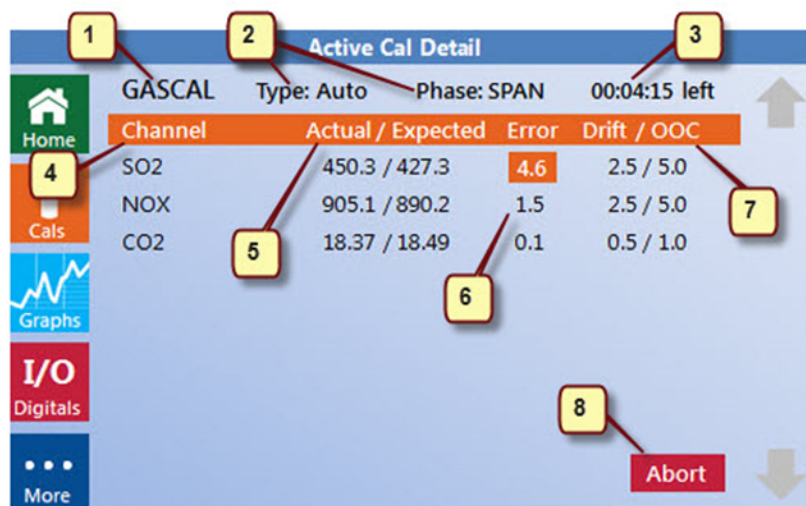


- **Menu:** Interactive (Menu) Calibration. See [Complex Calibrations](#) for more details about the previous calibration types.
- **Status column (3):** Current status of the calibration sequence:
  - Sequences that are currently running are displayed with a triple asterisk indicator (\*\*\*), the phase that the calibration is currently in, and the time remaining in the phase.
  - Sequences that are queued to start show a status of **PENDING**.
  - Scheduled sequences show a status of **Runs at mm/dd/yy hh:mm**.
- **Last column (4):** Status of the most recently completed calibration sequence:
  - For an actively running calibration, this column shows whether the calibration has passed all previous phases (**Pass**) or failed one of them (**Fail**).
  - For sequences that have never run, this column shows a dashed line ("-----").

## Active Cal Detail Screen

You can view the Active Cal Detail screen by pressing an active calibration from the [Cals Status Screen](#) (see example below). Active calibrations are labeled with 3 asterisks (\*\*\*) in the Status column on the Cal Status screen.

The Active Cal Detail screen shows the current status of the active calibration. Data refreshes on the screen every 1-5 seconds. The main parts of the screen are shown in the next example. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.



- **Calibration name (1):** Name of the channel selected from the Cals Status screen.
- **Calibration Type and Phase (2):** Type of calibration and the phase that it is currently in.

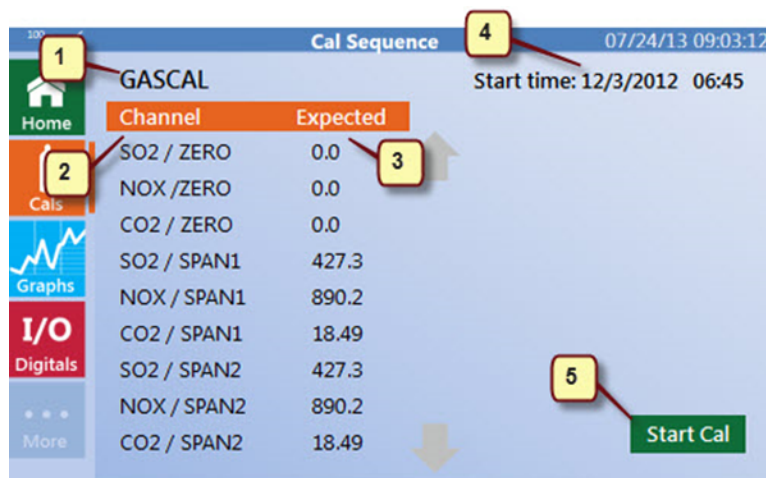
- **Time remaining (3):** Amount of time remaining in the phase, displayed in hh:mm:ss format.
- **Channel column (4):** List of the calibration's channel(s).
- **Actual/Expected column (5):** Actual and expected values for each calibration channel.
- **Error column (6):** Error value for each calibration channel. Any values that are in exceedance are highlighted.
- **Drift/OOC column (7):** Drift and OOC (out of control) values for each calibration channel.
- **Abort button (8):** Cancels the current calibration. This action requires a system login, and the system displays a confirmation message to proceed.

## Cal Sequence Screen

The Cal Sequence screen is displayed when you press the name of any idle calibration from the [Cals Status Screen](#). From this screen, you can:

- Change the calibration start date/time.
- Edit expected values.

The main parts of the screen are shown in the next example. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.



- **Calibration name (1):** Name of the channel selected from the Cals Status screen.
- **Channel column (2):** Channel and its current phase.
- **Expected values column (3):** Expected value for each calibration channel. Press a value in this column to open a pop-up editor that allows you to change the value. Guidelines described in the following list apply when using the pop-up editor:

- The system requires a PIN to make changes. Enter the PIN and press Done. Once the PIN is confirmed, you can then use the buttons on the pop-up to edit the values.



- The value currently being edited is highlighted, as is circled in red in the example screen to the right.

- The backspace button (  ) deletes previous character.

- The Done button confirms the PIN when first entered, and it ends the edit when done.

- **Start date/time (4):** Displayed only for “Auto” calibrations. You can edit this information by pressing the date/time, which opens a pop-up editor. When a valid date and time is entered, the start time is updated automatically, and the pop-up editor is closed. If the date or time is invalid, the start time reverts to its previous setting, and you may attempt to change it again.

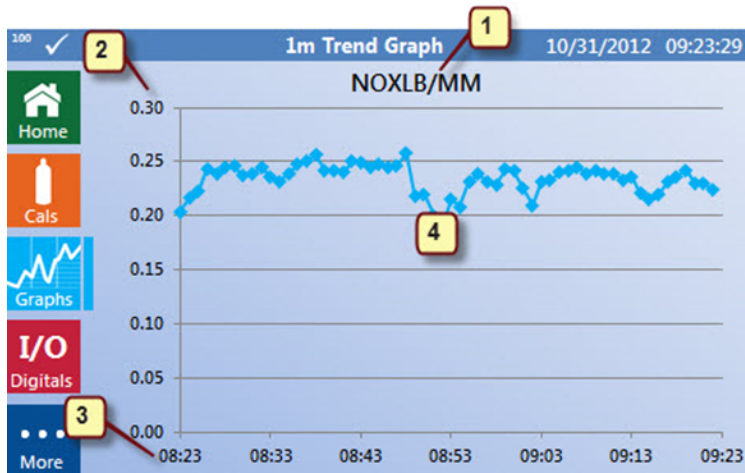
- **Start Cal button (5):** Use the **Start Cal** button to manually start the current calibration. This button displays only for “Auto” calibrations and requires login and confirmation prior to starting the calibration.

## Graphs Screen



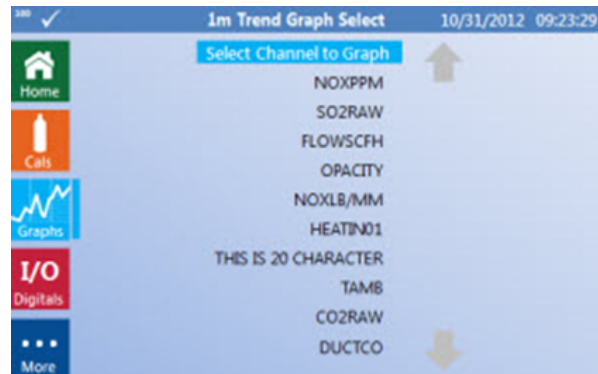
The **Graphs** screen can be accessed at any time by pressing the Graphs button on the left side of the touchscreen. This screen allows quick access to current one minute averages for a selected channel.

When you open the Graphs screen, it defaults to the parameter that was selected the last time the screen was shown. The main parts of the Graphs screen are shown in the next example. Callout numbers in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.



- **Channel name (1):** The name of the selected channel displays at the top of the graph. Press the channel name to open a new screen that lists all available channels as shown in the example to the right.

Simply scroll to the channel you want to graph and press it on the screen. The last 60 minutes of one-minute data displays on the main Graphs screen, with the new channel name displayed at the top of the screen.



- **Data values (2):** The vertical axis displays data values for the channel. It automatically scales to include 6 values.
- **Times (3):** The horizontal axis shows the time segments for the last hour in 10-minutes intervals. Times are displayed in hh:mm format.
- **Graphed data (4):** The graphed data provides a visual indication of peaks and drops for the channel's data values over the past hour. The graph is updated once every minute, with the most recent minute average at the far right side of the graph.

## I/O Digitals Screen



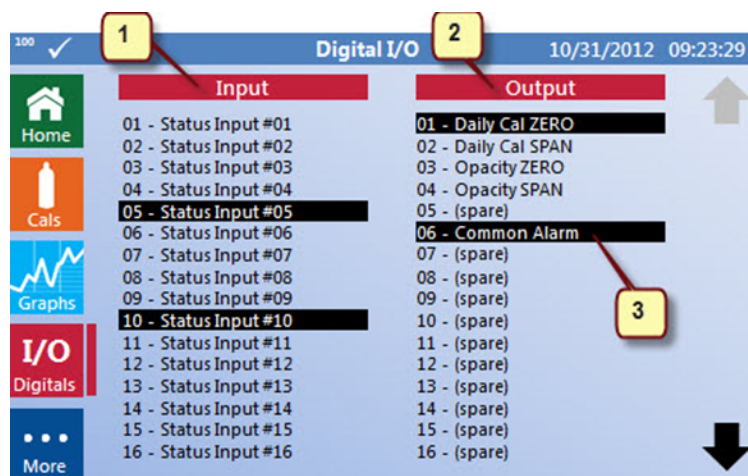
The **I/O Digitals** screen can be accessed at any time by pressing the I/O Digitals button on the left side of the touchscreen. This screen displays all digital input and outputs, including pseudo I/Os. From here, you can open and close inputs and outputs.

When you open the I/O Digitals screen, it lists all current digital inputs and outputs. Use the scroll arrows to scroll up and down to see all pages in the list.



**NOTE:** For advanced calibration configuration options, you will need to switch to the MDI. Press the **More** button to display the MDI screen, enter login credentials, and then select **C – Configuration Menu > R- Configure Digital I/O**. See [Configure Digital I/O](#) for further instructions.

The main parts of the I/O Digitals screen are shown in the next example. Callout numbers shown in the screen correspond to the numbers included in the name of the feature in the list that follows the screen.



- **List of digital inputs (1):** The input status is view-only from this screen.
- **List of digital outputs (2):** Press an output line to change state (requires login). See [Pop-Up Number Pad](#) for more information.
- **Reverse shading (3):** Reverse shading (black background with white letters) shows closed inputs or outputs.

## More Button



The **More** button allows you to access additional configuration options using a menu driven interface (MDI). To access the MDI, press the **More** button in the touchscreen on the front panel of the 8864.



**IMPORTANT:** The MDI is not touch-driven; a **keyboard must be connected to the 8864 to input MDI commands**. When a keyboard is not connected to the 8864, the More button is unavailable for use (disabled).

When you press the More button on the touchscreen, the display switches from the GUI touchscreen to a command line MDI as shown in the next example.



**NOTE:** The MDI now uses a larger font size that allows you to easily view text-based information when viewed from the front panel of the 8864.

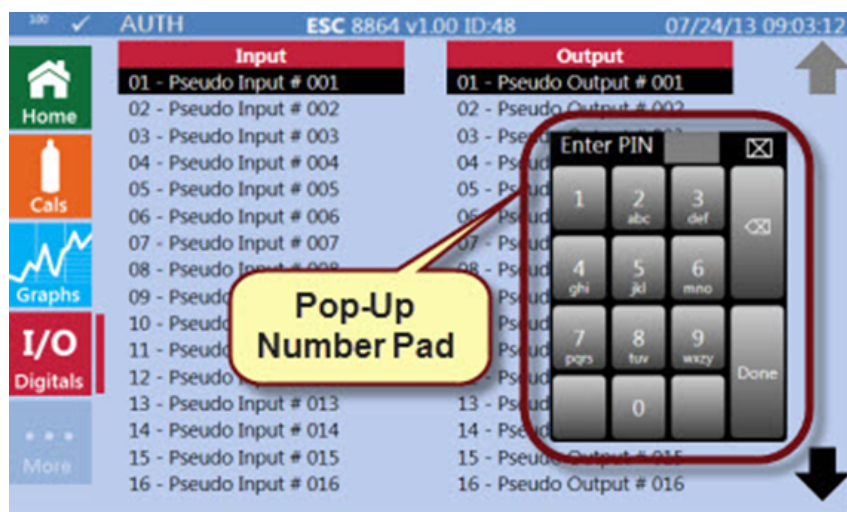
See [Menu Driven Interface \(MDI\)](#) for more information.

```
ESC 8864 v6.02r54 ID:01 Home Menu 01/16/22 10:44:28
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Comm to Port
```

## Pop-Up Number Pad

Performing certain actions on the touchscreen cause a pop-up number pad to display. For example, the pop-up number pad opens when starting or aborting a calibration; toggling a digital output; or changing calibration expected values.

The first time you attempt to make a change, you must enter a PIN and press **Done** for authorization. Once the PIN is approved, the indicator **AUTH** displays in the screen title. You can then use the pop-up number pad to edit data on the screen. The authorized login will timeout after several minutes. Pressing the **AUTH** indicator allows you to log out.





## Remote Connection to GUI Using Ethernet

To establish a remote Ethernet connection to the 8864 GUI, complete the following steps:

1. Access the 8864 interface by secure internet connection. To accomplish this, open an Internet browser page and then type **https://** and the **IP address** of the 8864 in the address bar. Your entry should look like the following example:

`https://11.22.3.44`



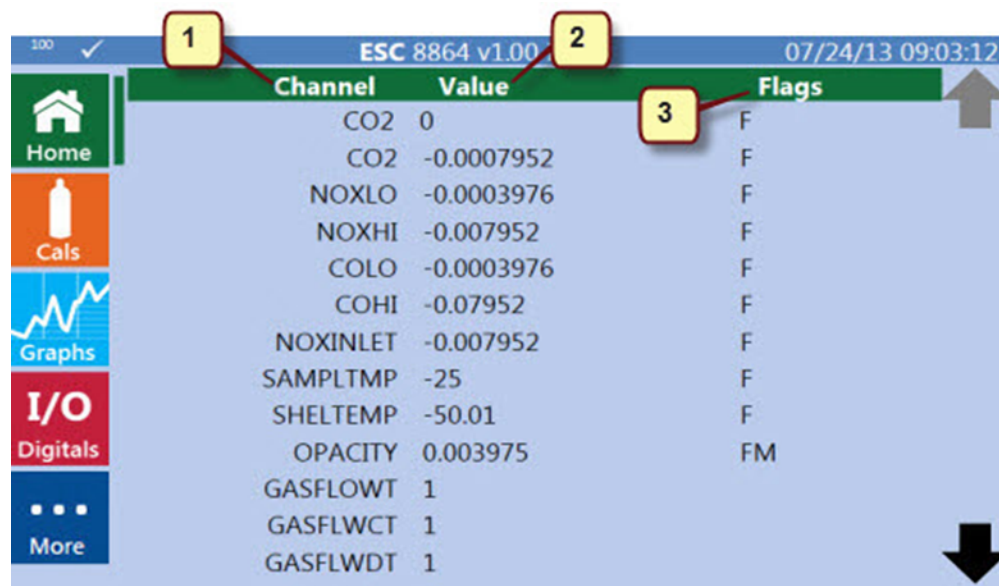
**NOTE:** For advanced calibration configuration options, you will need to switch to the MDI. Press the **More** button to display the MDI screen, enter login credentials, and then select **C – Configuration Menu > R- Configure Digital I/O**. See [Configure Digital I/O](#) for more information.

2. When the login screen displays, enter the **user name** and **password** set up by your system administrator.

Once the login credentials are accepted, the HTML version of the 8864 screen displays as shown in the next example. From here, you can use your mouse to navigate the system the same as you would the touchscreen on the console itself.



**IMPORTANT:** If the screen does not fully load all icons and data, check to see if Compatibility View is enabled for all websites in your browser. If so, try disabling Compatibility View and reloading the display.







# Menu Driven Interface (MDI)



You can access the menu driven interface (MDI) on the unit at any time by pressing the **More** button on the bottom left of the Home screen. You can use the MDI to operate the 8864 and perform advanced configuration.

**IMPORTANT:** The More button is only available if a USB keyboard is connected.



**NOTE:** For remote connections to the MDI, refer to [Remote Connection to the Character-Based MDI](#).

When you press the **More** button on the 8864 touchscreen, the graphical user interface (GUI) switches to a command line MDI screen (see next example).



**IMPORTANT:** The MDI screen is not touch-driven; a keyboard must be connected to the 8864 in order to input MDI commands.

- Press the <L> key to select **Login / Set User Level**, and then provide a user name and password in the **Enter User Name** and **Enter Password** fields, respectively. Press **Enter** when you finish to display the Home Menu screen shown below.

The system automatically selects the user level based on the user you provide. Users are configured to be one of six privilege levels. The access level determines which menus or menu selections are available. To configure user levels, see [User Security Groups](#) and [Menu Access](#).

When the system accepts login credentials, the Home Menu displays as shown in the next example.

```
ESC 8864 v6.02r54 ID:01 Home Menu 01/16/22 10:44:28
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

All menu selections in the MDI have single letters beside them. These letters are hot keys and can be used to navigate quickly through menus. For example, to display the Configuration Menu, press the **C** hot key.

Hot keys are designed so that popular sequences can be easily remembered as a few keystrokes that do not require using the <Enter> key. For example, to navigate to the Cal Configuration menu, the sequence of hot keys is **C–C**; the first **C** takes you to the Configuration menu and the second **C** selects the Cal Configuration menu.



**NOTE:** Use the <Esc> key to abort any screen, menu, or operation. The <Esc> key can be used to exit submenus to return to main menus and eventually back to the Home Menu.

The following table lists the hot keys you can use in the Home Menu. For all other hot keys, depending on which menu, see the respective sections in this manual.

Hot Key	Function/Menu	Purpose
H	<a href="#">Help Screen</a>	Information about navigating menus.
L	Login / Set User Level	Allows login to the 8864 Data Controller MDI and sets the user level based on the password provided. To configure user levels, see <a href="#">User Security Groups</a> and <a href="#">Menu Access</a> .
C	<a href="#">Configuration Menu</a>	Allows system configuration
D	<a href="#">Real-Time Display Menu</a>	Displays real-time data.
R	<a href="#">Report Generation Menu</a>	Displays and prints data.
S	<a href="#">Status Menu</a>	Displays system status, including historical logs.
O	<a href="#">Log Out/Exit</a>	Logs out the current user.
X	<a href="#">Serial Communication (Comm) to Port</a>	Links current interface to another port; typically used to contact analyzers with RS-232 options.

In addition to the hot keys described in the previous table, the following keys are also available for navigating the MDI interface:

- **Arrow Keys:** Use arrow keys to highlight a menu item.
- **ENTER:** Press ENTER to activate a highlighted menu item.
- **Hotkey:** Press “Hotkey” (displayed to left of item) to activate any menu item.

- **ESC:** Use the ESC key to perform any of the following actions:
  - Exit current menu and return to previous menu.
  - Exit display. Pressing **SPACE** when indicated also exits display.
  - Cancel an edit and restore previous data.
- **TAB** or **END:** Press TAB (**CTRL-I**) or END to go to the end of a list or menu.
- **CTRL-K** or **HOME:** Press CTRL-K or HOME to go to the beginning of a list or menu.
- **F2:** Press F2 to refresh the screen. Press any other key to exit.
- **CTRL-N:** If a configuration menu spans more than one screen, press CTRL-N to go to the next page and CTRL-P to go back to the previous one.
- **O:** To return to the GUI touchscreen, return to the MDI Home Menu and select the Log Out option (O).



**NOTE:** After startup, normal log out, or when the log out time has expired, the user must login before any other features (except the Help menu) can be accessed. **Menu items will only appear if the current login password allows access to that menu.**

---

Other topics in this section include:

- [Remote Connection to the Character-Based MDI](#)
- [User Security Groups](#)
- [Menu Access](#)
- [Help Screen](#)
- [Log Out/Exit](#)
- [Serial Communication \(Comm\) to Port](#)

## Remote Connection to the Character-Based MDI

You can access the 8864 using a character-based menu driven interface (MDI) that is similar to the MDI screen on former ESC Spectrum data controllers.

Connecting to the MDI interface over Ethernet uses the SSH (secure shell) protocol and requires an SSH protocol application such as PuTTY. To connect over Ethernet using PuTTY, follow the procedure in the section [Log in Using PuTTY Over Ethernet](#).

You can also connect to the MDI interface using a serial port. For instructions, see the topic [Log in Using PuTTY Over Serial Port](#).

## User Security Groups

The 8864 provides the following six user security groups:

- admin
- supervisor
- config
- priv
- login
- alarm

A user is assigned to one of these groups when a [new user](#) is created. A default user is created on factory reset for each user level. The default administrative user is “admin” and the default password for “admin” is the same as the integrator-level password in previous versions of firmware. Here are the default user names and passwords for the other access levels:

- supervisor / supervisor
- config / config
- priv / priv
- login / login
- alarm / alarm

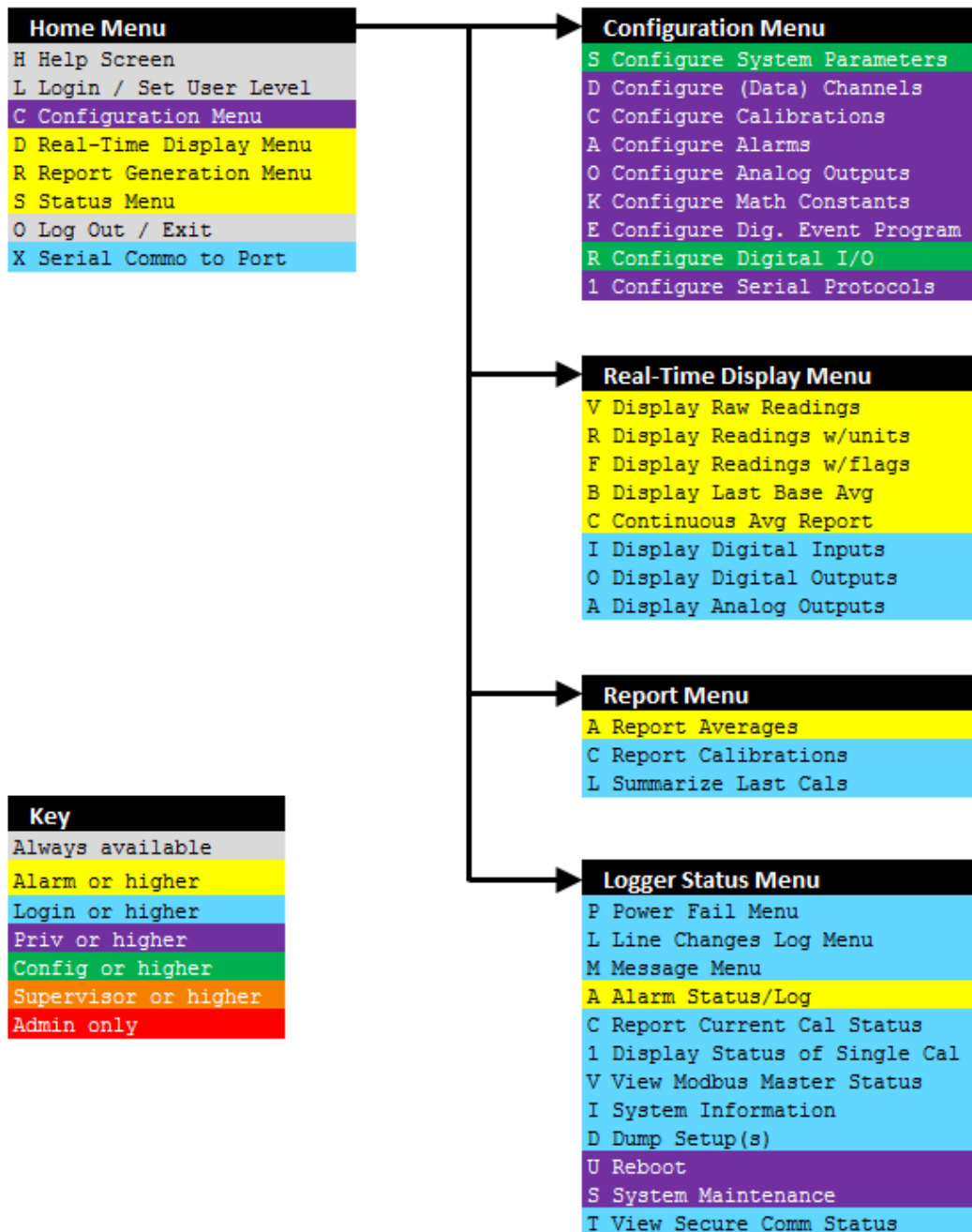
All user names and passwords can be changed to be different from the defaults, including “admin” and additional users can be added by an administrator to any access level.

## Menu Access

The main screens in the MDI are listed below. Click the links to view the options and user security groups that have access to each item on these menus:

- [Main Menu](#)
- [Configuration Menu](#)
- [Status Menu](#)
- [System Configuration Menu](#)

## Main Menu



## Configuration Menu

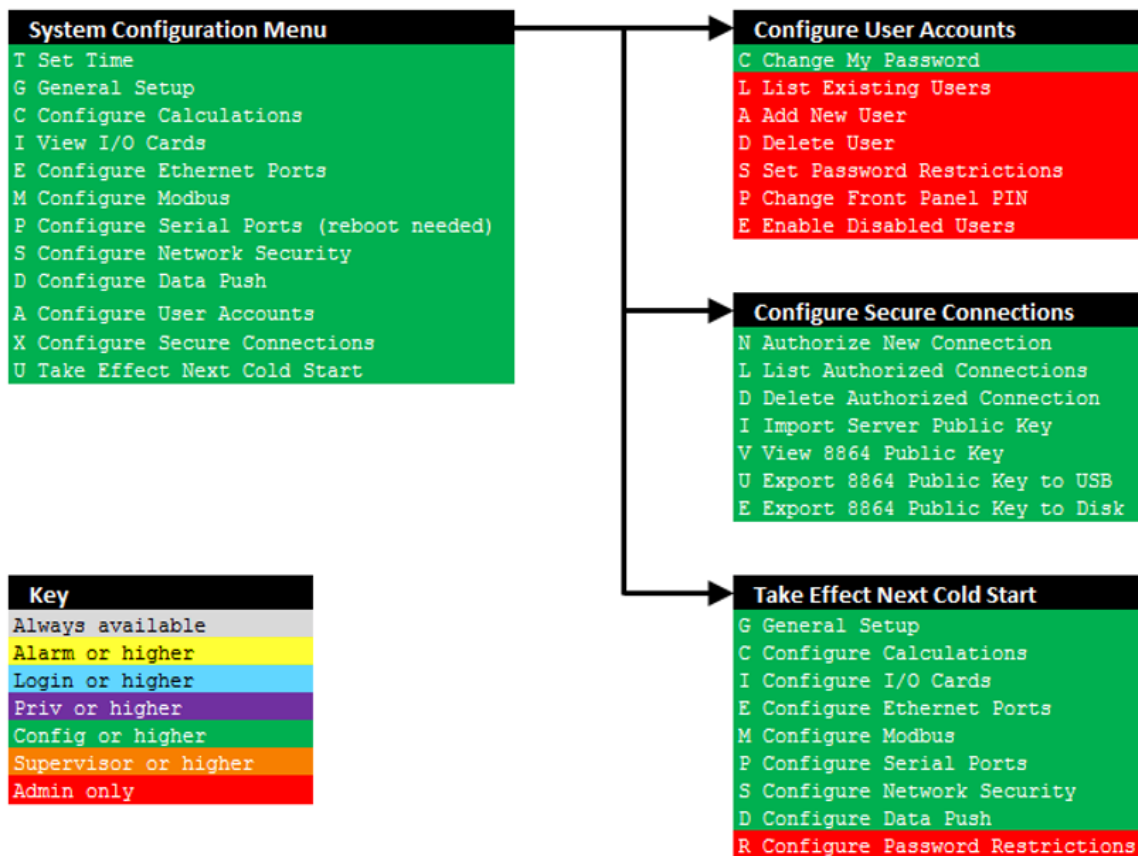


## Status Menu





## System Configuration Menu



## Help Screen

Use the Help Screen to display the Help Menu. The Help Menu provides information about how to navigate the MDI menu system.

To access the Help Menu:

1. Press the [More Button](#) on the 8864 touchscreen.

This switches the display to the MDI interface.

2. Press the <H> key to select **Help Menu**.
3. To exit the Help Menu and return to the Home Menu, press <Esc> or the spacebar.

## Log Out/Exit

When using the MDI, you can log out to restrict access to the 8864 system configuration options. After a user has logged in to the [Menu Driven Interface \(MDI\)](#) the access level can be reset to the logged out state by logging out.

To log out or exit:

1. Press the **More** button on the Home screen.

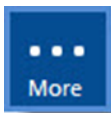
This switches the screen to the MDI interface.

2. Press the <O> key to select **Log Out / Exit**.

The display returns to the GUI Home Screen.

An automatic log out occurs when the MDI remains idle for a predetermined amount of time. After logging in at the proper level, you can set this time using the field "Automatic Logout" in the General Setup screen. To display the General Setup screen, press **C - Configuration Menu > S - Configure System Parameters > G - General Setup**.

## Serial Communication (Comm) to Port



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

The Serial Comm to Port selection from the MDI Home Menu is used to link the operator interface directly to another 8864 serial port.

To set up direct access to analyzers equipped with RS-232 port options using the 8864 operator interface:

1. Use the up and down arrows to select Serial Comm to Port (hot key X). Press **<Enter>**. A list of configured terminal ports will display.
2. Select one of the given ports. The screen will clear, and the operator interface will become a terminal to the device connected to the 8864 serial port.

The local echo is initially enabled (i.e., all characters typed at the operator interface are echoed back to the user's display). If the connected device (analyzer, etc.) echoes back characters it receives, this may result in double characters displayed on the operator interface terminal.

3. Use **<Ctrl><E>** to toggle the local echo state between disabled and enabled.

The alternate character entry is initially disabled (i.e., only characters that can be typed on the attached keypad or keyboard can be sent out to the serial port from the 8864 Data Controller).

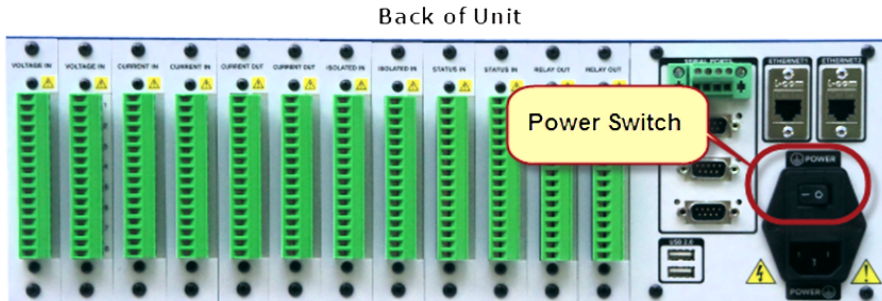
4. Use **<Ctrl><Y>** to toggle the alternate entry state between disabled and enabled.

When enabled, alternate characters can be entered in the format `\xnn` (where `nn` is a valid hexadecimal value, 00-FF). When a backslash character is entered, it, along with the next three characters entered, will not be sent out the serial port. If the format of the four characters is valid, the represented hexadecimal value is sent out the serial port instead.


5. To exit terminal mode and return to the menu interface, press **<Ctrl><X>**.

# System Operation

The 8864 is normally always powered on. However, if for some reason it is turned off, flip the power switch on the far right side of the back panel to turn it on.



Following the power-on sequence, the Home screen is displayed on the front-panel of the unit (see example below). The 8864 does not require a login at startup; system login is only required when you use the MDI (Menu-Driven Interface) for system configuration.

Press the **Home** button (  ) to return to the Home screen from any screen other than MDI real-time displays, configuration menus, and so on. If you are using the MDI, select the Log Out / Exit option to return to the GUI touchscreen.

To learn more about the touchscreen, refer to the section [8864 Graphical User Interface \(GUI\)](#). Also see [Related Topics](#) in this section.

The screenshot shows the Home screen of the 8864 GUI. At the top, it displays "100" with a checkmark, "AUTH", "ESC 8864 v5.02.r13 ID:88", and the date/time "01/19/17 16:16:17". On the left is a vertical menu with icons for Home, Cals, Graphs, I/O, and More. The main area contains a table with three columns: Channel, Value, and Flags. The table lists various sensor readings such as COALFLOW, GASFLOW, UNITLOAD, C, PM\_PS11C, PM, ORIFPRES, MASSFLOW, FLOW, FLOWTEMP, OPACITY, and FLOWVEL. A grey arrow points up and a black arrow points down on the right side of the table.

Channel	Value	Flags
COALFLOW	-250	F-
GASFLOW	-193.8	F-
UNITLOAD	-225	F-
C	0	
PM_PS11C	1	
PM	-12.5	F-
ORIFPRES	-7.5	F
MASSFLOW	-3.751	F
FLOW	-3.75E+04	F-
FLOWTEMP	-125	F-
OPACITY	-25	F-
FLOWVEL	-25	F

**Related Topics:**

- [Menu Driven Interface \(MDI\)](#)
- [Configuration Menu](#)

## Remote Connections to the 8864

The 8864 allows remote connections both to the GUI and the MDI. See the following sections for instructions:

- [Remote Connection to GUI Using Ethernet](#)
- [Remote Connection to the Character-Based MDI](#)

## Keyboard Shortcuts

Keyboard shortcuts can be used to navigate the MDI. See [Menu Driven Interface \(MDI\)](#) for instructions on using the hot keys for the Home Menu, and refer to the following sections for additional information:

- [Global Shortcuts](#)
- [Menu Shortcuts](#)
- [Shortcuts in Selection Lists](#)
- [Channel Configuration Screen Shortcuts](#)
- [Calibration Configuration Screen Shortcuts](#)
- [Modbus Client Cfg File Shortcuts](#)

### Global Shortcuts

Global Shortcuts	Action
<Esc> or left arrow key	Exits the current screen, returning to the previous screen. Left arrow can also be used if not in an active edit field.
<Tab>, <End>, or <Ctrl><I>	Goes to the bottom of a list; this can be a choose list, a configuration screen, or a menu list.
<Home> or <Ctrl><K>	Goes to the top of a list; this can be a choose list, a configuration screen, or a menu list.
Any hot key	Selects the corresponding feature.
<Ctrl><L>	Displays system log if access level is Configuration or higher, works from any menu screen. <ESC> exits the screen.

## Menu Shortcuts

Menu Shortcuts	Action
Down arrow key	Moves the highlighted selection box downward through a menu list.
Up arrow key	Moves the highlighted selection box upward through a menu list.
Right arrow key	Selects the highlighted menu item, except for field editing.

## Shortcuts in Selection Lists

In selection lists:	Action
Up, down, right, left arrow keys	Moves the selection highlight through the list (right and left arrows go across columns).
<Ctrl><N>	Goes to the next page if the choose list is longer than one screen.
<Ctrl><P>	Goes to the previous page if the choose list is longer than one screen.
Any unique characters	Type any unique characters of a name in the choose list and the selection highlight will move to that name. <Backspace> will erase the last typed character (highlight moves to name matching the remaining characters, if any). <Ctrl><R>erases all typed characters so you can start over.
<Ctrl><R>	Erases all characters typed.

## Channel Configuration Screen Shortcuts

Channel Configuration Screens	Action
<Ctrl><V>	Edit instantaneous or average validation information.
<Ctrl><D>	Edit decimal positioner, rounding precision, Modbus scale factor, Modbus/SIO register number, calibration span value, etc.
<Ctrl><C>	Toggles between two-point and three-point scaling in standard channel configurations.
<Ctrl><T>	Shows three-point scaling constants in three-point channel configurations.

## Calibration Configuration Screen Shortcuts

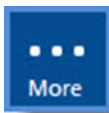
Calibration Configuration Screens	Action
<Ctrl><O>	Edit output normally open/normally closed settings.
<Ctrl><R>	Edit number of runs, interval between runs, startup delay, startup minute, and allow offline OOC checks.

## Modbus Client Cfg File Shortcuts

The following table identifies keyboard shortcuts you can use when navigating the display of the server.cfg file in the [View Modbus Client Cfg File](#) screen. (See S-Status Menu > V-View Modbus Master Status > C-View Modbus Client Cfg File. )

Key	Description
U	Move the display up one page at a time.
D	Move the display down one page at a time.
L	Move the display left one page at a time.
R	Move the display right one page at a time.
Left Arrow Key	Move the display to the left one character at a time.
Right Arrow Key	Move the display to the right one character at a time.
Up Arrow Key	Move the display up one line at a time.
Down Arrow Key	Move the display up one line at a time.

## Entering Data in Fields



**NOTE:** The options in this section apply only to the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

When the menu system is navigated to an information screen, such as a configuration screen, the information is arranged in fields. A field displays information and accepts typed input from users. When highlighted on the screen, it is the active selection; that is, whatever is typed displays in the highlighted field.

The following table lists the keys you can use when entering data into fields.

Key Command	Action
<Enter>	Accepts the information in the active field and moves the highlighted selection box downward to the next available field. If a change to a field is unnecessary, press <Enter> to highlight the next available field. Once editing of a data entry field has begun, <Esc> can be used at any time to abort the edit. The data value will remain unchanged from its value before editing.
<Esc>	Exits the edit mode in the active field without saving any changes that have been made.
Down arrow key	Moves the cursor down one line within a multi-line field. If a change to a field is unnecessary, the down arrow can be used to highlight the next available field.
Up arrow key	Moves the cursor up one line within a multi-line field.
Right arrow key	Moves the cursor to the right one character within a field.
Left arrow key	Moves the cursor to the left one character within a field.
Backspace key	Deletes the previous character in the active field.
<Ctrl><O>	Toggles between overstrike and insert modes in the active field. Typing in overstrike mode will overwrite any characters that may already be in the field. Insert mode allows typing without deleting any existing characters.

For example, the first data entry field in the “Config. Dig. Event Program” screen is the field “Dig. Event Program Name”. This field is highlighted when you first access the screen. To configure a new program name, type a new name and press **<Enter>**. The next field is then highlighted and available for entering information.



```
ESC 8864 v6.02r54 ID:01 Config. Dig. Event Program 01/16/22 11:15:55

Dig. Event Program Name : DEFPROG
Starting Time           : 01/17/22 00:00:00
Repeat Interval        : 12m
Output Line(s)         : 8
Output Duration        : 6m
Disable During Cal(s)  : (none)

FINISHED (Configure Now)

CTRL-O = Config Relay Outputs
```

## Common Field Definitions

There are several types of common fields that you will use from screen to screen. The most common types and their allowable formats and ranges are explained in the following field descriptions.

### Name

This is a user-configured label consisting of 1 to 20 characters. Names may consist of any numbers, letters, and the following special characters: % \* # + - \_ / ( ). This could be for alarms, calibrations, etc.

### Channel Name

This field is the same as the Name field above. An optional site name can be joined to the channel name with a colon (:), for a maximum of 29 characters (20-character channel name, 1 colon, and the 8-character site name).

The site name may be added to organize channels when one 8864 is monitoring the same parameter on multiple stacks (e.g., parameter SO2 may be monitored at two sites, BLR1 & BLR2, by using the following channel names: SO2:BLR1, SO2:BLR2).

### Report Channel Number

A number used for ordering channels in the real-time displays. It is also used in systems polled by central computers as a channel number designation. Report channel numbers may consist of 1 to 3 digits, 1 through 999.

## Date/Time

Dates are designated as MM/DD/YY. Times may be HH:MM or HH:MM:SS. All hourly time of day information should be entered in military format (e.g., 6:45 PM would be designated as 18:45).

## Units

The engineering units to which the input readings will be scaled (AP, #/MBTU, PPM, etc.). Units can be 1 to 8 characters.

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the base average. The two values must be entered separated by a comma. The average interval can be changed without affecting the number of storage blocks allocated by entering only the new interval value (e.g., 1m). The average storage can be changed without affecting the interval by entering only the new storage value preceded by a comma (e.g., 1h). Base average validation flag limits may be edited by typing <Ctrl><V> while the cursor is in this field.

Interval and storage values are 1 to 3 digits (0 to 999) with a one-letter designation for the time span: s = seconds, m = minutes, h = hours, d = days. For example, one-minute base averages would be configured as **1m**. All average intervals must either evenly divide into 24 hours (e.g., **5m** is acceptable) or be evenly divisible by 24 hours (e.g., 7d is acceptable).

## Average #1 Interval, Storage

The first half of the field specifies the average #1 interval. This interval must be some integer multiple of the base average interval. The second half of the field specifies the length of the long-term data storage buffer for the average #1. The two values must be entered separated by a comma.

The average interval can be changed without affecting the number of storage blocks allocated by entering only the new interval value (e.g., 1m). The average storage can be changed without affecting the interval by entering only the new storage value preceded by a comma (e.g., 1h). Average #1 validation flag limits may be edited by typing <Ctrl><V> while the cursor is in this field.

## Average #2 Interval, Storage

The first half of the field specifies the average #2 interval. This interval must be some integer multiple of the base average interval. The second half of the field specifies the length of the long-term data storage buffer for the average #2. The two values must be entered separated by

a comma.

The average interval can be changed without affecting the number of storage blocks allocated by entering only the new interval value (e.g., 1m). The average storage can be changed without affecting the interval by entering only the new storage value preceded by a comma (e.g., 1h). Average #2 validation flag limits may be edited by typing <Ctrl><V> while the cursor is in this field.



**NOTE:** With regard to the three fields above, the storage time displayed will be equal to or greater than the actual storage time entered. The data storage for an averaging interval is assigned in 1K blocks, so the actual storage will be rounded up to the next even block. The reported storage time will fill all blocks allocated.

## Validation Type (0-7)

A description of the field “Validation Type (0-7)” is provided in the following table. Also refer to the sections [Data Validation and Flags](#) and [Valid Average Determination \(Validation Type 0-7\)](#).

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 (“Y”), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 (“A”), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid](#)

### Average Determination.

## High Input

This is the maximum current, voltage, hertz or voltage ratio output from the instrument. You can type up to 10 characters.

## Mid Input

This is the mid-range current, voltage, hertz or voltage ratio output from the instrument. It is used for parabolic scaling. Press <Ctrl><C> to toggle between parabolic and linear scaling. You can type up to 10 characters.

## Low Input

This is the minimum current, voltage, hertz or voltage ratio output from the instrument. You can type up to 10 characters.

## High Output

This is the instrument reading in engineering units corresponding to the High Input. You can type up to 10 characters.

## Mid Output

This is the instrument reading in engineering units corresponding to the Mid Input. It is used for parabolic scaling. Press <Ctrl><C> to toggle between parabolic and linear scaling. You can type up to 10 characters.

## Low Output

This is the instrument reading in engineering units corresponding to the Low Input. You can type up to 10 characters.

## Analog Input Number

This specifies the actual, physical input line number. 01 to 99. When using a Meteorological Input Card, inputs **Tx** (YSI temperature input), **Dx** (wind direction input), **Sx** (wind speed input) or **Rx** (rainfall counter input) can be used, where **x** is the integer number of the Meteorological Input Card.

## Digital Outputs / Output Control Lines

This specifies the digital output line pattern; patterns can be up to 41 characters long. Both the line number and the status (1=activate, 0=deactivate) should be specified: n=1 or 0, where n is the line number. Each line number/status pair must be separated by a comma (e.g., 1=1,2=0,3,4). If the status is not designated, the ACTIVE state (=1) is assumed.

Digital outputs can be configured as normally open (active closed) or normally closed (active open).

## Digital Input Status Line Patterns

This specifies the digital input line pattern; patterns can be up to 41 characters long. Both the line number and the status (1=on, 0=off) should be specified: n=1 or 0, where n is the line number. If the status is not designated, the ON state (=1) is assumed.

Multiple input line/status pairs can be OR'ed together by separating them with the vertical bar character, |.

Multiple input line/status pairs can be AND'ed together by separating them with the ampersand character, &.

For example, a closed line number 2 would be designated as 2=1 or 2. An open line number 3 would be designated as 3=0. If either line 2 must be closed or line 3 must be open, designate the pattern as 2=1|3=0 or 2|3=0. If line 2 must be closed and line 3 must be open, designate the pattern as 2=1&3=0 or 2&3=0. If the AND/OR designators are mixed in one pattern, the entire pattern is forced to the same condition by converting to the first occurrence of & or |.



**NOTE:** A comma separator (e.g., **1,2=0**) will default to AND unless the entry is in one of the following fields: Instantaneous Channel Validation Status Lines (for B, M, F, V, W, X, Y and Z flags), Stream-Switched Channel On-Line, Merge/Join Channel On-Line, Alarm Input Lines for Ack or Math Pack Constants Alternate Status. In these cases, a comma separator will default as specified in the Default Dig. Inputs to OR ? field in the System Configuration screen.

## FINISHED (Configure Now)

In most configuration screens, this is the last field selection. Press <Enter> here to store the configuration into memory. This allows the configuration fields to be changed as many times as necessary until the setup is satisfactory.

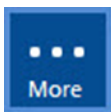


**NOTE:** Use the <Esc> key to abort the configuration process at any time before selecting FINISHED (Configure Now). Any changes that have been made to the configuration are ignored.

The date/time stamp after this field indicates the last time that the configuration was changed

and is only updated when <Enter> is pressed on this field or when the configuration is changed by a central download command.

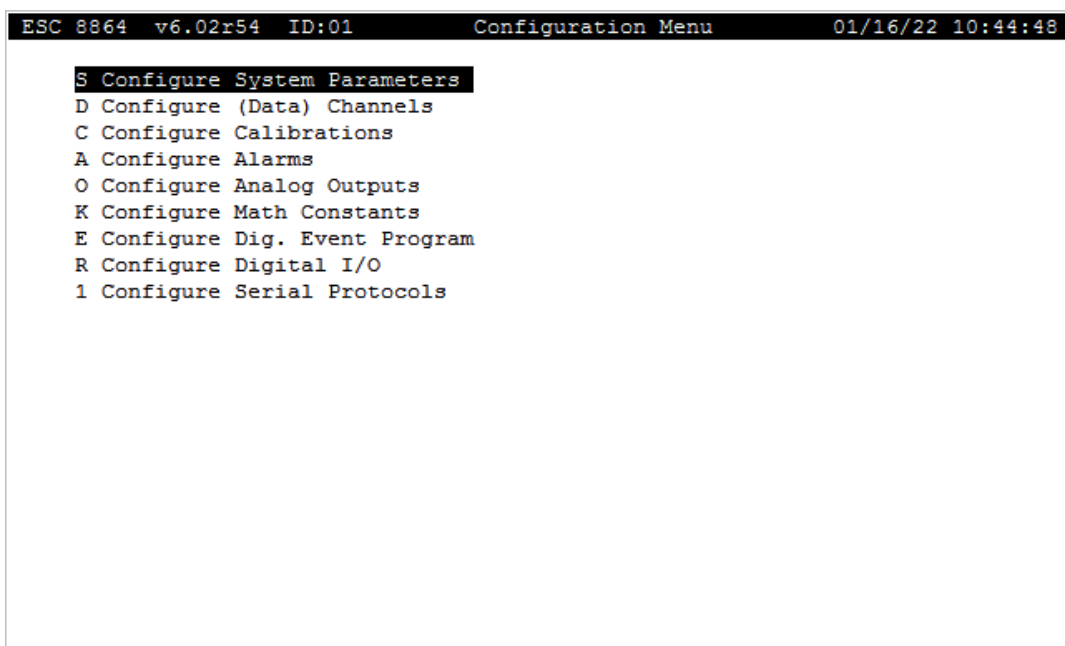
# Configuration Menu



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Configuration Menu accesses all sub-menus and screens necessary to configure the 8864 Data Controller and all inputs and outputs for operation. Changes and deletions to existing configurations are also accomplished using this menu.

From the Home Menu, use the arrow keys to select the Configuration Menu (hot key **C**) shown in the next example.



The path to a configuration screen (with data entry fields) may be direct (such as Configure System Parameters) or may proceed through one or more submenus with additional choices along the way (such as Configure (Data) Channels).

Hot Key	Function	Purpose
S	<a href="#">Configure System Parameters</a>	Modify the 8864 Data Controller's system parameters.
D	<a href="#">Configure (Data) Channels</a>	Enter, modify, and delete channel configurations. Channels are also enabled and disabled using this menu, and put into and taken out of maintenance mode.



Hot Key	Function	Purpose
C	<a href="#">Configure Calibrations</a>	Create, change, start, abort, or delete cal programs and single phase cals.
A	<a href="#">Configure Alarms</a>	Maintain up to 64 different alarm programs, including average alarms and calibration drift alarms.
O	<a href="#">Configure Analog Outputs</a>	Configure analog output cards to drive the result of a calculation internal to the 8864 Data Controller.
K	<a href="#">Configure Math Constants</a>	Create up to 99 math constants that can be used throughout the system.
E	<a href="#">Configure Digital Event Programs</a>	Define digital event programs that can be timed or triggered by a digital input.
R	<a href="#">Configure Digital I/O</a>	Edit digital input and output labels, and assign the default state for digital outputs.
1	<a href="#">Configure Serial Protocols</a>	Configure the following types of serial protocols: <ul style="list-style-type: none"> <li>▪ GSI Tables</li> <li>▪ GSI UCEM Client</li> <li>▪ GSI THERMO Client</li> <li>▪ GSI API Client</li> </ul>

## Configure System Parameters



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To configure system parameters:

1. Use the System Configuration Menu to modify the 8864 Data Controller's system parameters.
2. From the Configuration Menu, select **S - Configure System Parameters** to display the

following screen.

```
ESC 8864 v6.02r54 ID:01 System Configuration Menu 01/16/22 16:22:23
T Set Time
G General Setup
C Configure Calculations
I View I/O Cards
E Configure Ethernet Ports
R Configure Ethernet Routes
M Configure Modbus
P Configure Serial Ports
A Configure User Accounts
S Configure Network Security
X Configure Secure Communications
D Configure Data Push
V Configure Precision Voltages
U Take Effect Next Cold Start
B Build System Report
```

System parameters can be configured using a series of “System Configuration Menu” screens. The settings in these screens are saved even if the 8864 is cold-started (i.e., all other configuration and data are erased).

The 8864 maintains two copies of the items in the System Configuration Menu screens as follows:

- one copy for settings that are currently being used by the 8864
- another copy of settings that serve as a backup copy and will be loaded at the next cold start

When the logger is cold-started, values in the BACKUP copy are used, while values in the “current” settings are lost. You can access both copies of these configuration menus in the following manner:

1. To view and edit the “current” copy, select menu items from the System Configuration Menu.
2. To view and edit the backup copy (used after the next cold-start), select **U-Take Effect Next Cold Start** from the System Configuration Screen and then select items from the **Take Effect Next Cold Start Menu**.

Note the following characteristics of the System Configuration Menu screens:

- Press <Ctrl-N> to advance to additional screens or press <Ctrl-P> to return to previous screens.
- You can only access these screens if your login access is at Configuration or higher.
- Several items in the System Configuration Menu screens require login access of Supervisor or Integrator.
- Items will not appear if you are not logged in at the appropriate level.

Most items in the System Configuration Menu screens will take effect immediately when the changes are saved. However, some items will require a reboot of the 8864 to take effect. Items requiring a reboot are marked with an asterisk (\*). The reboot will occur when the configuration is saved.

Since you will almost always want system configuration items to survive a cold-start, any changes made in the “current” screens are automatically made to the backup screens so that the new values will be used after the next cold-start. Changes made to the “backup” screens are NOT copied to the “current” screens since they are not currently in use and will not take effect until the next cold-start.

There are, however, a few items in the System Configuration Menu screens that cannot be changed at all unless the 8864 is cold-started. These items can be viewed but not changed in the “current” screens. Instead, these items must be changed in the “Take Effect Next Cold Start” screens and then the 8864 must be cold-started for these changes to take effect.

In certain rare circumstances, it might be useful to make changes to configuration items in the backup screens that you do NOT want to take effect immediately, but only take effect when the 8864 is next cold-started. Those changes can be made in the backup screens and the unit cold-started at some later date. Be careful about making changes in the backup screens since a change could be made that will not take effect until sometime later when it may not be expected. In general, you should make all changes in the “current” screens unless you must change an item that can only be changed at the next cold-start.

To reduce the possibility of unexpected mismatches, the System Configuration Menu screens will show items in reverse video (black text on a white background) that are different between the “current” screens and the backup screens.

The following table provides a short description of selections in the System Configuration Menu. For more information about a certain item, click the related hyperlink listed in the table column “To Screen”.

Hot Key	To Screen	Configures
T	<a href="#">Set Time</a>	Sets the time
G	<a href="#">General Setup</a>	General, miscellaneous parameters
C	<a href="#">Configure Calculations</a>	Calculation parameters
I	<a href="#">View I/O Cards</a>	I/O cards
E	<a href="#">Configure Ethernet Ports</a>	Ethernet ports
M	<a href="#">Configure Modbus</a>	Modbus parameters
P	<a href="#">Configure Serial Ports</a>	Serial ports

Hot Key	To Screen	Configures
A	<a href="#">Configure User Accounts</a>	User accounts
S	<a href="#">Configure Network Security</a>	Network security
X	<a href="#">Configure Secure Communications</a>	Secure connections
D	<a href="#">Configure Data Push</a>	Data push (push polling)
U	<a href="#">Take Effect Next Cold Start Menu</a>	Parameters that do not take effect until the next cold start
B	<a href="#">Build System Report</a>	Bundle, zip, and transfer system files to SFTP or a USB thumb drive.

## Set Time

To display the Set Time screen:

- From the MDI home screen, select **C-Configuration Menu > S-Configure System Parameters > T-Set Time**.

ESC 8864 v5.02.r25 ID:1M	Set Time	10/24/17 13:37:15
Set Date	:	10/24/17
Set Time	:	13:37:11

## Set Date

The system date; entry is active as soon as <Enter> is pressed. MM/DD/YY.

## Set Time

The system time; entry is active as soon as <Enter> is pressed. HH:MM:SS (in military format).

## General Setup

The General Setup Screen contains high-level system configuration options, several of which can be customized.

To display the General Setup Screen:

- From the MDI home screen, select **C-Configuration Menu > S-Configure System Parameters > G-General Setup**.

The information below provides a description of the fields in the General Setup.

ESC 8864 v6.00r39 ID:01		General Setup	06/07/20 22:29:42
Logger ID Code	:	01	
Serial Number	:	6920	
Logger Description	:	ESC 8864	
	:		
Feature Mask	:	0x0929	
Security Features Enabled	:	Y	
AC Line Freq. (Hz)	:	60	
Development System (Y/N)	:	N	
Time Zone	:		
Station ID Code	:		
	:		
Automatic Logout (local)	:	10m	
Automatic Logout (remote)	:	10m	
Remote Time Update (Y/N)	:	Y	
Enable Terminal Colors (Y/N)	:	Y	
	:		
Align Pseudos? (Y/N)	:	N	
Debounce Digital Inputs ?	:	N	
Default Dig. Inputs to OR ?	:	N	
	:		
FINISHED (Configure Now)		06/05/20 21:16:11	

### Logger ID Code

Unique two-character identification code for the 8864 Data Controller. This will assign the Logger ID after a cold start. This field can be changed at configuration user access level and above. The actual ID code can be changed in the System Configuration screen.

### Serial Number

This field is view only at Configuration and Supervisor user access level. This is the unique number identification code for the 8864 Data Controller initially set by ESC Spectrum.

### Logger Description

The description of this 8864 Data Controller for user convenience; 26 characters maximum.

## Feature Mask

This field is view-only regardless of user access level. Software feature activation code set by ESC Spectrum.

Hex	Feature
0x0001	Core Features
0x0002	...
0x0004	WIND Channels
0x0008	Modbus Channel and Protocol
0x0010	---
0x0020	Generic Serial Channel
0x0040	---
0x0080	Daily Reports
0x0100	Digital Channel
0x0200	Tape Sampler Channel
0x0400	Central Alarm Task
0x0800	CEM
0x1000	Ambient
0x2000	---
0x4000	---
0x8000	---

## AC Line Freq. (Hz)

This field is view-only regardless of user access level. The AC frequency of the voltage supplied to the 8864 Data Controller.

## Development System (Y/N)

This field is view-only regardless of user access level. Y(es) or N(o). Y indicates that development features are activated. N indicates normal 8864 Data Controller operation.

## Time Zone

The time zone (EST, PST, etc.) that is displayed on the Daily Averages Report and the Daily Calibrations Report; 3 characters maximum.

## Station ID Code

Unique three-character station identification code for this 8864 Data Controller that is displayed on the Daily Averages Report and the Daily Calibrations Report.

## Automatic Logout (local)

The timeout interval of no key input before automatically being logged out when on the local front-panel LCD. 1m to 49710d.

Automatic Logout local time only affects the front panel MDI logout and the front panel GUI logout. Prior to firmware v6.01.r52, the front panel GUI logout had been hard-coded to five minutes.

**NOTE:** Configured settings for Automatic Logout (local) are unchanged after upgrading the firmware to v6.01.r52. This setting now persists across firmware upgrades and cold starts.

## Automatic Logout (remote)

Beginning in firmware v6.01.r52, automatic logout remote time is global for all remote connections. Timeouts are no longer based on which "MDI task" the user connected with. All remote connections now share the same remote logout time. Changing the logout time from any remote connection will change the logout time for all remote connections. This setting affects both remote MDI and remote GUI connections.

**NOTE:** Configured settings for Automatic Logout (remote) are unchanged after upgrading the firmware to v6.01.r52. This setting now persists across firmware upgrades and cold starts.

## Remote Time Update (Y/N)

This field, if set to N(o) will suppress the updating of the logger time field in the header of the logger menus during remote logger sessions. This is sometimes useful in telemetry systems. The default for this field is Y(es).

## Enable Terminal Colors (Y/N)

Terminal colors make it easier to visualize the status of certain data displayed in the MDI menus. When this option is enabled, colors display on any terminal that accepts terminal escape sequences (such as PuTTY), including the front panel MDI interface. The default for this option is Yes (enabled). See the next examples.

Colors on Instantaneous and Average Data are described in these tables in order of applied priority:

Instantaneous and Average Data	
Color	Description
<b>Red</b>	<p>Red = INVALID data</p> <p><u>Instantaneous data</u>: if an invalidating flag [PDTFBCMOUA+-RG] is present then the data point will have this color applied. The resulting average may be valid based on the validity applied to the average.</p> <p><u>Average Data</u>: if an average has the "&lt;" invalid flag then the data point will have this color applied. Invalidating flags [PDTFBCMOUA+-RG] do not affect the application of color on an average, only the invalid flag "&lt;".</p>
<b>Yellow</b>	<p>Yellow = Flags present on data</p> <p>If flags are present on the data that are not invalidating, such as alarm [HhLIJ] or information [VWXYZfc] flags then the data point will have this color applied.</p>
<b>Green</b>	Green = No flags present

Calibration Data	
Color	Description
<b>White</b>	<p>White = no data</p> <p>No record of completed or active phase for this calibration or parameter.</p>
<b>Red</b>	<p>Red = OOC limit</p> <p>Last phase completed on this calibration or parameter had a parameter above the OOC limit or if real time the parameter value is above the OOC limit. Note that OOC limits of "0" (zero) are not applied as this is the default.</p>
<b>Magenta</b>	<p>Magenta = Aborted</p> <p>Calibration aborted. If a the parameter or calibration has an OOC parameter then the OOC color application will override the application of this color.</p>
<b>Yellow</b>	<p>Yellow = Drift limit</p> <p>Last phase completed on this calibration or parameter had a parameter above the Drift limit or if real time the parameter value is above the Drift limit. Note that Drift limits of "0" (zero) are not applied as this is the default.</p>
<b>Green</b>	<p>Green = No Drift or OOC limit</p> <p>Last phase completed on this calibration or parameter had no parameter above the Drift or OOC limit or if real time the parameter value is not above the Drift or OOC limit.</p>



Alarm Data	
Color	Description
White	White = Pending (expired)
Red	Red = Active
Yellow	Yellow = Ack'd (acknowledged but not yet expired).

See the following screen examples for [Instantaneous Data](#), [Average Data](#), [Calibration Data](#), and [Alarm Data](#).

#### Real-Time Readings with Flags - Instantaneous Data (Hot Key: D > F):

```

ESC 8864 v6.00r41 ID:QE Real-Time Engineering Units 06/12/20 19:54:53

UNITOPHR= 0 (MINS ) SO2#/HRU= 0 (LB/HR )
LOADMW= 0 (MW ) SO2#/MM= 0.02988 (LB/MMBTU)
PM_OFFSET= 1 (mg/M3 ) NOX#/MM= 0.02149 (LB/MMBTU)
PM_MULTP= 1 (mg/M3 ) CO2T/HRU= 0 (TONS/HR )
PM= 1 (mg/M3 ) HEATINU= 0 (MMBTU/HR)
PM#M_3H= 1 (LB/MMBTU) FUELFACT= 1800 (FUELFACT)
PM_C= 1 (mg/M3 ) SO2#/M3H= 0.005976 (LB/MMBTU)
FGDSLFLA= 0 (GPM ) INTCHK= 1 (NONE )
FGDSLFLB= 0 (GPM ) HEATERR= 2.217 (PERCENT )
FGDSLFLC= 0 (GPM ) PM#/MM= 0.01123 (LB/MMBTU)
HG_CM= 0 (UG/M3 ) MATSOPHR= 0 (MINS )
H2SO4COR= 0 (PPM )
SO2PPM= 1 (PPM )
NOXPPM= 1 (PPM )
FLOWSCFH= 1 (SCFH ) NOX#60= 0.004298 (LB/MMBTU)

ESC/SPACE: exit CTRL-N: next CTRL-P: prev (033->064)

```

#### Display Last Base Average - Average Data (Hot Key: D > B):

```

ESC 8864 v6.00r41 ID:01 Display Last Base Average 06/19/20 12:08:09

RSO2LO= 0 (<Bf ) ETHYLENC= 0.01512 ( )
RSO2HI= 0 (<Bf ) HG#/GWH= 0 (<FBaf )
RNOXLO= 0 (<Bf ) HGLB/T= 1 ( )
RNOXHI= 0 (<Bf ) HGLB/HR= 1 ( )
SAMPVAC= 0 (lf ) HGR1DB= 333.5 (<DFBAHhp)
RCO2= 0 (<Bf ) HG/CONV1= 1 ( )
SMPFLOW= 0 (f ) LOADMW= 0 (<Blf )
DILPRESS= 0 (f ) UNITON= 1 ( )
PROBEVAC= 44.88 ( ) SO2LO= 0 (<B )
FILTEMP= 0 (Lf ) SO2HI= 0 (<B )
PRBTEMP= 0 (Lf ) NOXLO= 0 (<B )
SHELTEMP= 0 (<Blf ) NOXHI= 0 (<B )
BARPRESS= 0 (<-f ) SO2PPM= 0 (<Bf )
FLOW_DP= 0 (<Bf ) NOXPPM= 0 (<Bf )
STKPRESS=-4.5 (<- ) CO2= 0 (<B )
STKTEMP= 0 (<-f ) FLOWSCFH= 0 (<B- )

ESC/SPACE: exit CTRL-A: type CTRL-N: next CTRL-P: prev (001->032)

```

## Report Averages - Average Data (Hot Key: R &gt; A):

TIME	COPPMC	ESPICURR	ESPIKW
06/19 05:00	0<Bf	0f	3.125
06/19 06:00	0<Bf	0f	3.125
06/19 07:00	0<Bf	0f	3.125
06/19 08:00	0<Bf	0f	3.125
06/19 09:00	0<Bf	0f	3.125
06/19 10:00	0<Bf	0f	3.125
06/19 11:00	0<Bf	0f	3.125
06/19 12:00	0<Bf	0f	3.125
06/19 13:00	0<Bf	0f	3.125
06/19 14:00	0<Bf	0f	3.125
06/19 15:00	0<Bf	0f	3.125
06/19 16:00	0<Bf	0f	3.125
06/19 17:00	0<Bf	0f	3.125
06/19 18:00	0<Bf	0f	3.125
06/19 19:00	0<Bf	0f	3.125
06/19 20:00	0<Bf	0f	3.125
06/19 21:00	0<Bf	0f	3.125
06/19 22:00	0<Bf	0f	3.125
06/19 23:00	0<Bf	0f	3.125
06/20 00:00	0<Bf	0f	3.125
06/20 01:00	0<Bf	0f	3.125

## Display Status of Single Cal - Calibration Data (Hot Key: S &gt; 1):

CGA_LOW	User	LOW	(4m 42s left)	Pass	Run#	1 of 3
Channel	Expected	Actual	Error	M	Drift	Units
NOXPPM	248.8	-0.07057	100 L	5	0	%
SO2PPM	--N/A--	-625	--N/A--	--N/A--	--N/A--	PPM
COPPM	--N/A--	-625	--N/A--	--N/A--	--N/A--	PPM
COHI	--N/A--	-625	--N/A--	--N/A--	--N/A--	PPM
COLO	124.6	-0.04253	100 L	10	0	%
SO2HI	--N/A--	-625	--N/A--	--N/A--	--N/A--	PPM
SO2LO	125.2	-0.09658	100.1 L	5	0	%

Page 1 of 1, CTRL-N=Next Page, CTRL-P=Previous Page, ESC or SPACE=exit

**Current Calibration Status - Calibration Data (Hot Key: S > C):**

ESC 8864 v6.00r41 ID:01 Current Calibration Status (4/12) 06/19/20 12:59:59				
Sequence	Type	Status	Last	
-----	-----	-----	-----	
CAL_SPAN	User	INACTIVE	-----	
CAL_ZERO	User	INACTIVE	-----	
CGA	User	INACTIVE	----- 3 of 3 left	
CGA_HI	User	INACTIVE	Drift	3 of 3 left
CGA_LOW	User	LOW (4m 57s left)	Pass	Run# 1 of 3
FLOWCAL	Ext Init	PENDING	-----	
GASCAL	Auto	Runs at 05/13/20 05:30:00	-----	
GO_FLOW	Auto	Runs at 05/13/20 06:34:00	-----	
ICALSPAN	User	INACTIVE	-----	
ICALZERO	User	INACTIVE	-----	
IGASCAL	Auto	Runs at 05/13/20 06:15:00	-----	
O2_SPAN	User	INACTIVE	-----	
O2_ZERO	User	INACTIVE	-----	
O2CAL	Auto	Runs at 05/13/20 07:15:00	-----	
O2CGA	User	INACTIVE	----- 3 of 3 left	
OPACCAL	Auto	Runs at 05/13/20 06:30:00	-----	
--- ESC or SPACE to exit, CTRL-N Next, CTRL-P Previous ---				

**Alarm Journal Log - Alarm Data (Hot Key: S > A > V):**

ESC 8864 v5.06r35 ID:05 Alarm Journal Log: Page 1 01/16/01 11:10:23				
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=ACTIVE
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:10	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
ALARM:SECMN	Start:01/16	11:09	Source:SECMN	Flags=h Status=EXPIRED
--- ESC or SPACE to exit, CTRL-N = next page ---				

**Current Alarm Status - Alarm Data (Hot Key: S > A > S):**

```

ESC 8864 v6.00r4l ID:01 Current Alarm Status 06/19/20 12:07:57
ALARM:AMBTMP01 Start:06/19 11:59 Source:AMBTMP Flags=1 Status=ACTIVE
ALARM:LOOPAL01 Start:06/19 11:59 Source:SKTEMP Flags=- Status=ACTIVE
ALARM:LOWMW01 Start:06/19 11:59 Source:LOADMW Flags=1 Status=ACTIVE
ALARM:SMPVAC01 Start:06/19 11:59 Source:SAMPVAC Flags=1 Status=ACTIVE
ALARM:TMPFLT01 Start:06/19 11:59 Source:PRBTEMP Flags=L Status=ACTIVE

```

---

```

ESC or SPACE to exit

```

**Enable OOC Reset (Y/N)**

Introduced in firmware v6.01, this menu option is intended to be used to reset the OOC and grace counter for calibrations. The default setting is Yes. If the setting is changed to No, changing it back to Yes requires assistance by [ESC Spectrum Support](#). This functionality is intended to help prevent access to this feature for sites that wish to disable the menu option [Reset OOC \(T Flag\) and Grace](#) in [Configure \(Data\) Channels](#) of the [Configuration Menu](#).

**Align Pseudos? (Y/N)**

Aligns the pseudo from the end of the physical inputs through line 88 so that all pseudo lines are aligned.

**Debounce Digital Inputs**

Y(es) or N(o). If Y, digital inputs must remain in a new state for at least one second before the new state is recognized. If N, digital transitions take effect as soon as they are detected.

**Default Dig. Inputs to OR**

Y(es) or N(o). This flag applies only to digital input fields where an explicit AND or OR pattern has not been entered, i.e., fields where the input line numbers are separated by commas (1,2=0,3). If N (the default), the digital inputs are AND'ed to determine status. If Y, the digital inputs are OR'ed to determine status. This flag does NOT apply to digital input patterns for calibrations, DI-triggered digital event programs, time on-line counter channels or multi-condition TOL (MTOL) counter channels.

## Configure Calculations

The Configure Calculations Screen contains options that control how calculations are performed.

To display the Configure Calculations Screen:

- From the MDI home screen, select **C-Configuration Menu > S-Configure System Parameters > C-Configure Calculations**.

The information below provides a description of the fields in the Configure Calculations screen.

ESC 8864 v5.02.r25	ID:1M	Configure Calculations	10/24/17 13:46:06
Math Eqn Update Rate	:	1	
Min % for Valid Base Avg	:	100	
Min % for Valid Ext Avg	:	75	
If Cal is in Maint (D/S/N)	:	NORMAL	
Offline Drift Alarms (Y/N)	:	N	
Alarm Deadband (% of limit)	:	0.0	
Allow Auto Corr if Config'd?	:	N	
FINISHED (Configure Now)		10/23/17 09:58:51	

### Math Eqn Update Rate

This field is view only at Configuration and Supervisor user access level. The default rate at which math equations are evaluated after a cold start from once per second to once per 10 seconds. The actual update rate can also be changed in the System Configuration screen.

### Min % for Valid Base Avg

This field is view only at Configuration and Supervisor user access level. The default required percentage (1 to 100) of valid data points during averaging interval for a base average to be marked as valid after a cold start. The actual default percentage may also be changed in the System Configuration screen.

### Min % for Valid Ext Avg

This field is view only at Configuration and Supervisor user access level. For non-Part 75 only. The default required percentage (1 to 100) of valid points during averaging interval for an extended average to be marked as valid after a cold start. The actual default percentage may also be changed in the System Configuration screen.

### If Cal is in Maint (D/S/N)

This field is view only at Configuration and Supervisor user access level. D, S, or N.

If **D** (DONTSEND), perform OOC checks, but do not change OOC status of any OOC configured parameter if in maintenance when checked for OOC during any phase, or in maintenance at the end of the sequence. Also, store cal results, but do not send results (for parameters that were in maintenance when checked for OOC) to central when polled.

If **S** (SEND), perform OOC checks, but do not change OOC status of any OOC configured parameter if in maintenance when checked for OOC during any phase, or in maintenance at the end of the sequence. Store all cal results, and send all results to central when polled.

If **N** (NORMAL), process calibrations as in normal operation.

### Offline Drift Alarms (Y/N)

When configured as Y(es), all configured calibration drift alarms will be generated or cleared regardless of the online status of the channels. When configured as N(o), calibration drift alarms function as in previous versions. Alarms are generated only when the channels are in an online state, unless the channel's Allow Offline Calibrations? field is configured as Y(es) or the calibration's Allow OFFLINE OOC Check? field is configured as Y(es).

## Alarm Deadband (% of limit)

Indicates deadband used by high, high-high, low and low-low alarm limits in all channels. Alarm must drop below/above original limit plus deadband for alarm condition to go inactive. Alarm deadband is calculated as a percentage of the limit. Up to 10 characters; 0.0 to 99.9%.

Example: High limit for SO2#/MBTU is 1.2. If alarm deadband is 10%, SO2#/MBTU must fall below 1.08 for High alarm condition to go inactive.

## Allow Auto Corr if Config'd

Refer to Configuring Expected Values Default=Y.

## View I/O Cards

The View I/O Cards screen allows the user to determine which I/O cards are currently in effect and which have been overridden to function like other cards. This screen shows slightly different information than the corresponding “backup” screen that allows the user to configure the overrides. To view and change how the cards will be configured after the next cold start, access the [Configure I/O Cards](#) screen from the [Take Effect Next Cold Start Menu](#).

To display the View I/O Cards screen:

- From the MDI home screen, select **C-Configuration Menu > S-Configure System Parameters > I-View I/O Cards**.

The information below provides a description of the fields in the View I/O Cards screen.

ESC 8864 v5.02.r25 ID:1M View I/O Cards 10/24/17 14:04:03				
Slot	Physical Card Detected Last Cold Start	Override at the Last Cold Start	Card Configuration In Effect Now	Slot
1	Voltage In		Voltage In	1
2	Voltage In		Voltage In	2
3	Current In		Current In	3
4	Current In		Current In	4
5	Current Out		Current Out	5
6	Current Out		Current Out	6
7	Isolated In	(none)	(none)	7
8	Met Card		Met Card	8
9	(none)		(none)	9
10	(none)		(none)	10
11	Relay Out	(none)	(none)	11
12	Relay Out	(none)	(none)	12

Notes: Make changes to overrides in 'Take Effect Next Cold Start' screen  
Overrides and new card configurations take effect on cold start

## Slot

The card slot number in the I/O bus for the Card Detected. This information cannot be edited.

## Physical Card Detected at the Last Cold Start

The type of I/O card physically installed in the corresponding Slot of the I/O bus as detected at the last cold start. The system automatically detects the card type, so this information cannot be edited. Possible card types are Current In, Voltage In, Status In, Isolated In, Relay Out, Current Out, or (none).

The card type shown in the screen is the type of card detected when the 8864 was last cold-started. This may or may not be the actual physical card configuration that is currently installed. The cards may have been changed since the last time the unit was cold-started. To see the actual cards installed as detected at the last time the unit was re-booted, access the Configure I/O Cards Screen from the Take Effect Next Cold Start Menu as seen in the section Configure I/O Cards. If the physical I/O cards have been changed, the 8864 must be cold-started to have the new card configuration take effect.

## Override at the Last Cold Start?

If this field is blank, then the physical card that is detected at the last cold start is used for this slot. However, if you want to force the 8864 firmware to use a card for this slot that is DIFFERENT from the card that is physically detected in the slot, then an “override” can be used. For example, if you want to add a new card to an empty slot, but the card is not yet available to install, then you can override the empty slot and force the 8864 to “think” that the new card is already installed. Alternatively, you may not want an installed card to be available yet, so the slot can be overridden to be “none.”

Valid values for this field are:

- (blank) - use the physically detected I/O card
- Voltage In - (shortcut = “VI”)
- Current In - (shortcut = “CI”)
- Isolated In - (shortcut = “II”)
- Status In - (shortcut = “SI”)
- Relay Out - (shortcut = “RO”)
- Current Out - (shortcut = “CO”)
- None - do not use a card for this slot, even if one is detected

This value cannot be changed in the View I/O Card screen. To change the override, it must be configured in the Configure I/O Cards Screen from the Take Effect Next Cold Start Menu as seen in the section Configure I/O Cards. The unit must be cold started for the new override to take effect.



## Card Configuration In Effect Now

This field shows the user what card is actually being used by the 8864 for this slot. If the override field is blank, then the card physically detected at the last cold start will be used. If an override is configured, then the override in effect at the last cold start will be used.

## Slot

The card slot number for the card defined as Card Used.

## Configure Ethernet Ports

The Configure Ethernet Ports screen lists configuration options for the two 8864 Ethernet connections. This is a 2-page screen with Ethernet Port 1 configured on the first page and Ethernet Port 2 configured on the second page. You must go to the second page using <Ctrl-N> to get to the “FINISHED (Configure Now)” selection for this screen.

To display the Configure Ethernet Ports screen:

- From the MDI home screen, select **C-Configuration Menu > S -Configure System Parameters > E-Configure Ethernet Ports**.

```

ESC 8864  v5.06r21  ID:01  Configure Ethernet Ports  08/20/19 17:58:10

Ethernet 1
  MAC Address      : 00:04:BF:B0:57:F7
  Ethernet Enable (Y/N) : Y
  DHCP Enable (Y/N)  : N

  Static IP Address : 10.0.41.60
  Static Subnet Mask : 255.255.252.0
  Static Default Gateway : 10.0.40.1
  Static DNS Address : 0.0.0.0

  Request IP Address : 0.0.0.0
  Specify Client ID  :
  Domain Name       :

  IP Address (in use) : 10.0.41.60
  Subnet Mask (in use) : 255.255.252.0
  Default Gateway (in use): 10.0.40.1
  DNS Server (in use) : 0.0.0.0

Next Page = CTRL-N

```

## Ethernet 1

The following information below provides a description of the fields in the Configure Ethernet Ports screen for Ethernet 1. For field descriptions in the second page, see [Ethernet 2](#) below.

### MAC Address

View only. The unique 48-bit Ethernet address is assigned to the controller's Ethernet ports by

the manufacturer.

### Ethernet Enable (Y/N)

Y(es) or N(o). Indicates whether the Ethernet is enabled. Can be set to “N” to disable the Ethernet port completely.

### DHCP Enable (Y/N)

DHCP Enable is a Y(es)/N(o) field that enables (Y) or disables (N) the DHCP protocol. If DHCP is disabled, the Data Controller will boot with the fixed parameters listed on the same menu.

### Static IP Address

If you wish to assign a static IP address for Ethernet 1, enter it using the Static IP Address field.

### Static Subnet Mask

If you are using a static IP address for Ethernet 1, enter the static Subnet Mask in this field. Review the following information prior to defining this field:

- The two Ethernet ports cannot be on the same Ethernet Subnet.
- Do not be confused between the terms “Subnet Mask” and “Subnet.”

To determine the Subnet of an Ethernet Port:

1. First identify both the IP address and the Subnet Mask for the Ethernet Port.
  - The IP address will look similar to 192.168.1.34.
  - The Subnet Mask will look similar to 255.255.255.0.
2. Use the IP address and the Subnet Mask to then determine the Subnet:
  - For every number that is a “255” in the Subnet Mask, replace that number with the corresponding value in the IP address for the Subnet.
  - Then for every “0” in the Subnet Mask, replace it with a “0” for the Subnet.
  - The resulting value is the Subnet.
  - Example:
    - If the IP address of Ethernet Port #2 is 192.168.1.34,
    - And the Subnet Mask of Ethernet Port #2 is 255.255.255.0,
    - Then the Ethernet Subnet for Ethernet Port #2 is 192.168.1.0

Keep in mind that the Subnet Mask filters the IP address to create the Subnet.

For example, if the Static IP address is 192.168.12.34 and the Subnet Mask is 255.255.255.0, then the resulting Subnet is 192.168.12.0. If, instead, the Subnet Mask is 255.255.0.0, then the resulting Subnet would be 192.168.0.0.

Remember also that it is the Subnet—not the Subnet Mask—that cannot be the same between the two ports. For example, if the IP address of Port #1 is 192.168.1.34 with a Subnet Mask of 255.255.255.0, then its Subnet is 192.168.1.0. If the IP address of Port #2 is 192.168.2.34 with a Subnet Mask of 255.255.255.0, then its subnet is 192.168.2.0 and there is no conflict, even though the Subnet Masks are the same.

### Static Default Gateway

If you are using a static IP address for Ethernet 1, enter the static default gateway here.

### Static DNS Address

If you configure a valid DNS server here, then you can substitute server names for IP addresses in fields where both an IP address and a TCP port are configured. For example, in the other configuration fields, you may use “CEMSserver3:2222” instead of “10.4.7.200:2222”.

### Request IP Address

The DHCP protocol allows the client to request an IP address.

### Specify Client ID

The Client ID is a unique identifier that the server uses to identify DHCP requests. This option allows the client to specify its own identifier. If this option is left blank, the client will generate its own unique identifier based on its MAC address.

### Domain Name

If DHCP is enabled, this field is passed to the DHCP server as the fully-qualified domain name to update DNS. If DHCP is not used, this field is added to the beginning of the server name when querying the Domain Name System (DNS) to resolve a server name to an IP address.

### IP Address (in use)

The unique 32-bit internet address assigned to the controller that is used in all of its network communications for Ethernet 1.

## Subnet Mask (in use)

The subnet mask currently in use for Ethernet 1.

## Default Gateway (in use)

The default gateway currently in use for Ethernet 1.

## Ethernet 2

Press the Page Down key from the keyboard interface or <Ctrl><N> from any other interface to move to the second page of the Configure Ethernet Ports screen shown in the next example.

The following information below provides a description of the fields in the Configure Ethernet Ports screen for Ethernet 2. For field descriptions in the first page, see [Ethernet 1](#).

```

ESC 8864 v5.06r21 ID:01      Configure Ethernet Ports      08/21/19 17:25:42

Ethernet 2
  MAC Address       : 00:04:BF:B0:57:F6
  Ethernet Enable (Y/N) : N
  DHCP Enable (Y/N)  : N

  Static IP Address  : 169.254.2.2
  Static Subnet Mask : 255.255.255.0
  Static Default Gateway : 169.254.0.254
  Static DNS Address : 0.0.0.0

  Request IP Address : 0.0.0.0
  Specify Client ID  :
  Domain Name        :

  IP Address (in use) : 169.254.2.2
  Subnet Mask (in use) : 255.255.255.0
  Default Gateway (in use): 0.0.0.0
  DNS Server (in use) : 0.0.0.0
  :
  FINISHED (Configure Now)      08/19/19 14:13:36

Prev Page = CTRL-P

```

The following information below provides a description of the fields in the Configure Ethernet Ports screen for Ethernet 2.

## MAC Address (Ethernet 2)

View only. The unique 48-bit Ethernet address is assigned to the controller's port by the manufacturer.

## Ethernet Enable Y/N (Ethernet 2)

Y(es) or N(o). Indicates whether the Ethernet is enabled. Can be set to "N" to disable the Ethernet port completely.

## DHCP Enable Y/N (Ethernet 2)

DHCP Enable is a Y(es)/N(o) field that enables (Y) or disables (N) the DHCP protocol. If DHCP is disabled, the Data Controller will boot with the fixed parameters listed on the same menu.

## Static IP Address

If you wish to assign a static IP address for Ethernet 2, enter it here.

## Static Subnet Mask

If you are using a static IP address for Ethernet 2, enter the static Subnet Mask here.

Review the following information prior to defining this field:

- The two Ethernet ports cannot be on the same Ethernet Subnet.
- Do not be confused between the terms “Subnet Mask” and “Subnet.”

To determine the Subnet of an Ethernet Port:

1. First identify both the IP address and the Subnet Mask for the Ethernet Port.
  - The IP address will look similar to 192.168.2.34.
  - The Subnet Mask will look similar to 255.255.255.0.
2. Use the IP address and the Subnet Mask to then determine the Subnet:
  - For every number that is a “255” in the Subnet Mask, replace that number with the corresponding value in the IP address for the Subnet.
  - Then for every “0” in the Subnet Mask, replace it with a “0” for the Subnet.
  - The resulting value is the Subnet.
  - Example:
    - If the IP address of Ethernet Port #2 is 192.168.2.34,
    - And the Subnet Mask of Ethernet Port #2 is 255.255.255.0,
    - Then the Ethernet Subnet for Ethernet Port #2 is 192.168.2.0

Keep in mind that the Subnet Mask filters the IP address to create the Subnet. For example, if the Static IP address is 192.168.12.34 and the Subnet Mask is 255.255.255.0, then the resulting Subnet is 192.168.12.0. If, instead, the Subnet Mask is 255.255.0.0, then the resulting Subnet would be 192.168.0.0.

Remember also that it is the Subnet—not the Subnet Mask—that cannot be the same between the two ports. For example, if the IP address of Port #1 is 192.168.1.34 with a Subnet Mask of 255.255.255.0, then its Subnet is

192.168.1.0. If the IP address of Port #2 is 192.168.2.34 with a Subnet Mask of 255.255.255.0, then its subnet is 192.168.2.0 and there is no conflict, even though the Subnet Masks are the same.

### Static Default Gateway

If you are using a static IP address for Ethernet 2, enter the static default gateway here.

### Static DNS Address

If you configure a valid DNS server here, then you can substitute server names for IP addresses in fields where both an IP address and a TCP port are configured. For example, in the other configuration fields, you may use "CEMSserver3:2222" instead of "10.4.7.200:2222".

### Request IP Address

The DHCP protocol allows the client to request an IP address.

### Specify Client ID

The Client ID is a unique identifier that the server uses to identify DHCP requests. This option allows the client to specify its own identifier. If this option is left blank, the client will generate its own unique identifier based on its MAC address.

### Domain Name

If DHCP is enabled, this field is passed to the DHCP server as the fully-qualified domain name to update DNS. If DHCP is not used, this field is added to the beginning of the server name when querying the Domain Name System (DNS) to resolve a server name to an IP address.

### IP Address (in use)

The unique 32-bit internet address assigned to the controller that is used in all of its network communications for Ethernet 2.

### Subnet Mask (in use)

The subnet mask currently in use for Ethernet 2.

### Default Gateway (in use)

The default gateway currently in use for Ethernet 2.

## Configure Ethernet Routes

Ethernet networking in the 8864 is typically configured to use static IP addresses on both Ethernet ports. Each Ethernet port allows you to configure an IP address, network mask, and a default gateway address. For example:

### Ethernet 1

MAC Address : 0:4:BF:B1:BF:CE  
Ethernet Enable (Y/N) : Y  
DHCP Enable (Y?N) : N  
Static IP Address : 192.168.1.111  
Static Subnet Mask : 255.255.255.0  
Static Default Gateway : 192.168.1.1

### Ethernet 2

MAC Address : 0:4:BF:B1:BF:CD  
Ethernet Enable (Y/N) : Y  
DHCP Enable (Y/N) : N  
Static IP Address : 10.10.4.200  
Static Subnet Mask : 255.255.255.0  
Static Default Gateway : 10.10.4.1

This results in a main route table that looks like this:

Destination	Gateway	Genmask	Flags	Metric	Ref	Use Iface
default	192.168.1.1	0.0.0.0	UG	0	0	eth1
default	10.10.4.1)	0.0.0.0	UG	0	0	eth0
10.10.4.0	*	255.255.255.0	U	0	0	eth0
192.168.1.0	*	255.255.255.0	U	0	0	eth1

In addition, the 8864 adds rules to the routing table database (RTDB) in order to create additional routing tables. For example:

```
default via 10.10.4.1 dev eth0
10.10.4.0/24 dev eth0 src 10.10.4.200
```

```
default via 192.168.1.1 dev eth1
192.168.1.0/24 dev eth1 src 192.168.1.111
```

These rules ensure that the responses to packets that originate on each of the Ethernet ports are guaranteed to be sent **ONLY** on the interface where the original packet was received. In other words, any packets that are responses to packets received on eth0 will be restricted to going back out on eth0, and packets received on eth1 can only generate packets on eth1. This is to prevent any network traffic from “crossing over” from one network to the other.

All of this works for packets that originate externally to the logger from either of the local subnets (192.168.1.xx and 10.10.4.xx, in the example). It also works for packets that are received from either of the two default gateways -- the response packets are always routed back to their respective gateways via the eth0 or eth1 route tables.

## Configure Static Routes

Applications to consider are packets that **\*originate\*** on the 8864 (and are **\*not\*** packets that are generated in **\*response\*** to received packets). Packets can originate from Data Push, secure communications, or Modbus Client connections. When an initial packet is sent out from the 8864 to a device that is not on one of the two local subnets (192.168.1.xx and 10.10.4.xx, in the example), there is ambiguity as to which of the two gateways should be used. In other words, there are two default gateways, and “technically” either should be able to route the packet to its destination. The 8864 Data Controller is often deployed in network topologies where gateways do **\*not\*** have universal access – we must direct certain addresses to particular gateways. This can be done by adding a static route to the routing table:

```
ip route add 172.16.0.0/16 via 192.168.1.1
```

This forces packets that originate in the 8864 and destined for addresses in the range 172.16.0.0/16 to always be sent to the gateway at 192.168.1.1.

Admin users can now enter static routes via the MDI. From the Home screen navigate to **C-Configuration Menu > S-Configure System Parameters > R-Configure Ethernet Routes** to display this MDI Static Routes Menu:



```

ESC 8864 v5.06r35 ID:05 Configure Static Routes 01/16/01 09:56:11

Static Routes:
"IP[/MASK] via IP" OR "IP dev eth0"

1: 172.16.0.0/16 via 192.168.1.1
2:
3:
4:
5:
6:
7:
8:
9:
10:
11:
12:
13:
14:
15:
16:
FINISHED (Configure Now) 01/13/01 16:33:20

```

From here a static route can be configured in one of two valid formats. If an invalid format is specified, the error messages shown here will display formats that are valid.

```

ESC 8864 v5.06r35 ID:05 Configure Static Routes 01/16/01 09:57:29

Static Routes:
"IP[/MASK] via IP" OR "IP dev eth0"

1: INVALID
2:
3:
4:
5:
6:
7:
8:
9:
10:
11:
12:
13:
14:
15:
16:
FINISHED (Configure Now) 01/13/01 16:33:20

Invalid Format. Expected: <ip addr>[/<mask>] [ via <ip addr> | dev eth[01] ]

```

If the user presses any key other than ESC when this message is displayed then the current line can continue to be edited without losing changes to the current line. The ESC key clears the current line when it is invalid and returns it to the previous entry if one was configured.

Using the IP addresses and routes shown in the tables above the first of the two valid formats allows a user to configure a static route by IP address with an optional subnet mask applied using CIDR (Classless Inter-Domain Routing) notation routed to a destination gateway IP address. Here are two examples of valid static routes using this notation. The first command routes a range of IP address based on subnet mask while the second one only routes a single IP address.

172.16.0.0/16 via 192.168.1.1

172.16.10.10 via 192.168.1.1

Using the IP addresses and routes shown in the tables above the second valid notation allows a user to configure a static route by IP address with an optional subnet mask applied using CIDR (Classless Inter-Domain Routing) notation routed to one of the two ethernet ports available in the 8864. Note that "Ethernet 1" in the MDI system menus corresponds to eth1 in the static routes and "Ethernet 2" in the system MDI menus corresponds to eth0 in the static routes. The first command routes a range of IP address based on subnet mask while the second one only routes a single IP address.

172.16.0.0/16 dev eth1

172.16.10.10 dev eth1

Most typical network topologies would only require configuring one or two static routes. For demonstration only the following screenshot shows the examples described above.

```

ESC 8864 v5.06r35 ID:05 Configure Static Routes 01/16/01 10:01:54

Static Routes:
"IP[/MASK] via IP" OR "IP dev eth0"

1: 172.16.0.0/16 via 192.168.1.1
2: 172.16.10.10 via 192.168.1.1
3: 172.16.10.10/16 dev eth1
4: 172.16.10.10 dev eth1
5: 
6: 
7: 
8: 
9: 
10: 
11: 
12: 
13: 
14: 
15: 
16: 
FINISHED (Configure Now) 01/13/01 16:33:20

```

Anytime the static routes are changed only configured static routes in the MDI remain in the active configuration. The network in the 8864 is reset anytime changes to static routes are made and connectivity may be lost temporarily during the reset. If a static route is changed then the old static route before the change will not continue to be active in the system configuration.

Once a static route is configured it will survive reboot, COLDSTART, and version upgrades. Static routes can only be removed by editing the static route in the MDI. To remove a static route delete all the characters on the line that contains the static route to be removed then used **FINISHED (Configure Now)** to save the changes.

## Configure Modbus

The Configure Modbus screen allows the user to edit the Modbus configuration options. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > M - Configure Modbus**.

```

ESC 8864 v5.04r12 ID:01          Configure Modbus          06/21/18 17:01:07

Modbus ID Code                   : 115
8832 Modbus AddrTbl Start       : 40004
8832 Modbus InputTbl Start     : 40010
8832 Modbus OutputTbl Start    : 41006
ModbusQuietIfNoRegMatch        : N
ModbusAddrTbl[0] =              : 2
ModbusAddrTbl[1] =             : 2001
Modbus Channel Int Start       : 3
Modbus Channel Int End        : 64
Modbus Channel Float Start     : 0
Modbus Channel Float End      : 0

Enable 8864 MODBUS Tables      : Y
8864 MODBUS Table Start        : 43001
Enable Double-Wide Tables     : N
Double-Wide Table Start       : 43005
Fast Serial Modbus Server     : Y

FINISHED (Configure Now)      06/20/18 10:18:53

```

The following information provides a description of the fields in the Configure Modbus screen.

### Modbus ID Code

The default unique three-digit Modbus identification code, 001-246 only. This will assign the Modbus ID after a cold start. The actual Modbus ID code can be changed in the System Configuration Screen.

### 8832 Modbus AddrTbl Start

The Modbus Address Table start location.

### 8832 Modbus InputTbl Start

The Modbus Input Table start location.

### 8832 Modbus OutputTbl Start

The Modbus Output Table start location.

### ModbusQuietIfNoReg Match

Y(es) or N(o). N = Return error message if requested register cannot be found. Y = No

response if requested register cannot be found.

#### ModbusAddrTabl[0]=

User Information field. Value entered is returned as the value of the first register in the Modbus Address Table.

#### ModbusAddrTabl[1]=

User Information field. Value entered is returned as the value of the second register in the Modbus Address Table.

#### Modbus Channel Int Start

The starting channel number for the block of integer channels for use by the Modbus Client. Valid values are 00 to 99.

#### Modbus Channel Int End

The ending channel number for the block of integer channels for use by the Modbus Client. Valid values are 00 to 99.

#### Modbus Channel Float Start

The starting channel number for the block of floating-point channels for use by the Modbus Client. Valid values are 00 to 99.

#### Modbus Channel Float End

The ending channel number for the block of floating-point channels for use by the Modbus Client. Valid values are 00 to 99.

#### Enable 8864 MODBUS Tables

If this field is set to "N", then the new 8864 MODBUS server registers will not appear in the map at all; only the legacy 8832 MODBUS server registers will be available.

#### 8864 MODBUS Table Start

The 8864 MODBUS server register mapping is available in the document entitled *8864 Modbus Map Spreadsheet*. The document is available for download on the [8864 Data Controller Downloads](#) page in the [Customer Community](#) (requires login). The server registers start at the

default value 42001. If the “8864 MODBUS Table Start” field is set to a value that is not 42001, then the 8864 MODBUS server registers will ALL be offset by the same amount.

The table start value in this field cannot be less than the end of the legacy 8832 server registers (that is, the value defined for the Modbus Channel Float End). Likewise, the table end value for the new 8864 MODBUS server registers cannot extend beyond register 99999. If the 8864 MODBUS server registers cannot fit between the end of the legacy 8832 server registers and 99999, then the configuration will not be saved until these requirements are met.

### Enable Double-Wide Tables

If this field is set to “Y”, then a set of “double-wide” Modbus server registers will appear in the Modbus map. These registers offer double the precision of the values in the 8864 Modbus registers. Integers are 2 registers each (32-bits) and floating-point numbers are 4 registers each (64-bits). The floating-point numbers follow IEEE 754 standards for double precision floating-point numbers, with the least-significant register at the lowest register address (i.e., LSW first).

### Double-Wide Table Start

The double-wide registers start at this address in the holding register address space. The 8864 MODBUS server register mapping is available in the document entitled 8864 Modbus Map Spreadsheet. The document is available for download on the [8864 Data Controller Downloads](#) page in the [Customer Community](#) (requires login).

### Fast Serial Modbus Server

The default setting for this field is “N” (no). When set as “N”, the 8864 Data Controller operates normally. If a serial port is configured as “MB-RTU” (such as a serial Modbus server), the end of the Modbus command is defined as “no characters received for 100ms”.

When this field is set to “Y” (yes), the 8864 Data Controller ends the command after a delay of 50 ms. The “detect-the-end-of-the-Modbus-command” timeout time should only apply to receiving commands for the Modbus server and should not affect the “Response Timeout” that controls the timeout on the Modbus Client commands in the server.cfg.

## Configure Serial Ports

The Configure Serial Ports screen lists configuration options for the (up to) four 8864 Serial Port connections. This is a 2-page screen with Serial Ports 0 and 1 configured on the first page and Serial Ports 3 and 4 configured on the second page. You must go to the second page using <Ctrl-N> to get to the “FINISHED (Configure Now)” selection for this screen.

To display the Configure Serial Ports screen:

- From the MDI home screen, select **C - Configuration Menu > S - Configure System Parameters > P - Configure Serial Ports**.



**IMPORTANT:** All options marked with an asterisk (\*) will force a system reboot when the configuration is saved.

```

ESC 8864 v5.02.r25 ID:1M          Configure Serial Ports          10/24/17 14:42:00

Port0(COM0) Enable (Y/N)*      : Y
Port0(COM0) Baud/Bits/Parity: 9600/8/E
Port0(COM0) Delay (ticks)      : 0
Port0(COM0) 232/485            : 232
Port0(COM0) Device Type        : VT100
Port0(COM0) Interface*         : MB-RTU
                               :
Port1(COM1) Enable (Y/N)*      : Y
Port1(COM1) Baud/Bits/Parity: 9600/8/N
Port1(COM1) Delay (ticks)      : 0
Port1(COM1) 232/485            : 232
Port1(COM1) Device Type        : VT100
Port1(COM1) Interface*         : MB-RTU

Next Page = CTRL-N

```

The following information provides a description of the fields in page 1 and [page 2](#) of the Configure Serial Ports screen.

### Port0(COM0) Enable (Y/N) \*

Indicates if the port is enabled or disabled. Type Y(es) for enabled or N(o) for disabled. Enabling or disabling a serial port supports a user access level with “admin” or higher privileges when using the MDI to configure the 8864 Data Controller.

### Port0(COM0) Baud/Bits/Parity

The default baud rate for the external modem Serial Port 0. 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Number of data bits and parity are also displayed. A 7-bit data length can be combined with odd or even parity. An 8-bit data length can be combined with odd, even or no parity.

### Port0(COM0) Delay (ticks)

The number of delay ticks that the 8864 Data Controller waits before transmitting characters. Each tick is 1/100th of a second.

### Port0(COM0) 232/485

The type of serial communication port for Serial Port 0.

### Port0(COM0) Device Type

The type of communication device connected to Serial Port 0. Supported device types are:

- VT100 (Video terminal – fixed modem control)
- DIALUP (Dial-up modem)
- LLM (Leased-line modem with no modem control)
- LLM-RTS (Leased-line modem with modem control)
- DU!TIME (Video terminal-does not send time updates while in MDI mode)

### Port0(COM0) Interface \*

The type of communication interface that Serial Port 0 should follow. Supported interface types are:

- MDI (Menu driven interface)
- CEN (Central interface)
- TERM (Dumb terminal – VT100), MB-RTU (Modbus RTU)
- GSI1 (Generic Serial Interface)
- GSI2 (Extended Generic Serial Interface)
- MODBUSM (Modbus Client)
- NJERSEY (New Jersey polling protocol)
- Leads (LEADS polling protocol)
- GSITEI (Generic Serial Interface supporting networked TEI software)

### Port1(COM1) Enable (Y/N)

Indicates if the port is enabled or disabled. Type Y(es) for enabled or N(o) for disabled.

Enabling or disabling a serial port supports a user access level with “admin” or higher privileges when using the MDI to configure the 8864 Data Controller.

### Port1(COM1) Baud/Bits/Parity

The default baud rate for Serial Port 1. 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Number of data bits and parity are also displayed. A 7-bit data length can be

combined with odd or even parity. An 8-bit data length can be combined with odd, even or no parity.

### Port1(COM1) Delay (ticks)

This is the number of delay ticks that the 8864 Data Controller waits before transmitting characters. Each tick is 1/100th of a second.

### Port1(COM1) 232/485

The type of serial communication port for Serial Port 1.

### Port1(COM1) Device Type

The type of communication device connected to Serial Port 1. Supported device types are:

- VT100 (Video terminal – fixed modem control)
- DIALUP (Dial-up modem)
- LLM (Leased-line modem with no modem control)
- LLM-RTS (Leased-line modem with modem control)
- DU!TIME (Video terminal-does not send time updates while in MDI mode)

### Port1(COM1) Interface \*

The type of communication interface that Serial Port 1 should follow. Supported interface types are:

- MDI (Menu driven interface)
- CEN (Central interface)
- TERM (Dumb terminal – VT100), MB-RTU (Modbus RTU)
- GSI1 (GSI interface)
- GSI2 (Extended GSI interface)
- SANBAR (Santa Barbara Protocol)
- MODBUSM (Modbus Client)
- NJERSEY (New Jersey polling protocol)
- LEADS (LEADS polling protocol)
- GSITEI (Generic Serial Interface supporting networked TEI software)

Press the Page Down key from the keyboard interface or <Ctrl><N> from any other interface to



move to the second page of the Configure Serial Ports screen shown in the next example.



**IMPORTANT:** All options marked with an asterisk (\*) will force a system reboot when the configuration is saved.

```

ESC 8864 v5.02.r25 ID:1M          Configure Serial Ports          10/24/17 14:45:01

Port2(COM2) Enable (Y/N)*       : N
Port2(COM2) Baud/Bits/Parity:    9600/8/N
Port2(COM2) Delay (ticks)       : 0
Port2(COM2) 232/485              : 485
Port2(COM2) Device Type         : VT100
Port2(COM2) Interface*          : CEN
                               :
Port3(COM3) Enable (Y/N)*       : N
Port3(COM3) Baud/Bits/Parity:    9600/8/N
Port3(COM3) Delay (ticks)       : 0
Port3(COM3) 232/485              : 232
Port3(COM3) Device Type         : VT100
Port3(COM3) Interface*          : CEN
                               :
Alarm Printer Port              : Disabled
                               :
FINISHED (Configure Now)        10/23/17 09:58:51

Prev Page = CTRL-P

```

The following information provides a description of the fields on page 2 of the Configure Serial Ports screen.

### Port2(COM2) Enable (Y/N) \*

Indicates if the port is enabled or disabled. Type Y(es) for enabled or N(o) for disabled.

Enabling or disabling a serial port supports a user access level with “admin” or higher privileges when using the MDI to configure the 8864 Data Controller.

### Port2(COM2) Baud/Bits/Parity

The default baud rate for Serial Port 2. 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200. Number of data bits and parity are also displayed. A 7-bit data length can be combined with odd or even parity. An 8-bit data length can be combined with odd, even or no parity.

### Port2(COM2) Delay (ticks)

The number of delay ticks that the 8864 Data Controller waits before transmitting characters. Each tick is 1/100th of a second.

### Port2(COM2) 232/485

The type of serial communication port for Serial Port 2.

### Port2(COM2) Device Type

The type of communication device connected to Serial Port 2. Supported device types are:

- VT100 (Video terminal – fixed modem control)
- DIALUP (Dial-up modem)
- LLM (Leased-line modem with no modem control)
- LLM-RTS (Leased-line modem with modem control)
- DU!TIME (Video terminal-does not send time updates while in MDI mode)

### Port2(COM2) Interface \*

The type of communication interface that Serial Port 2 should follow. Supported interface types are:

- MDI (Menu driven interface)
- CEN (Central interface)
- TERM (Dumb terminal – VT100)
- MB-RTU (Modbus RTU)
- GSI1 (GSI interface)
- GSI2 (Extended GSI interface)
- KORAMB1 (Korean Ambient Protocol - in 8800)
- SANBAR (Santa Barbara Protocol)
- MODBUSM (Modbus Client)
- NJERSEY (New Jersey polling protocol)
- Leads (LEADS polling protocol)
- GSITEI (Generic Serial Interface supporting networked TEI software)

### Port3(COM3) Enable (Y/N) \*

Indicates if the port is enabled or disabled. Type Y(es) for enabled or N(o) for disabled.

Enabling or disabling a serial port supports a user access level with “admin” or higher privileges when using the MDI to configure the 8864 Data Controller.

### Port3(COM3) Baud/Bits/Parity

The default baud rate for Serial Port 3. 300, 600, 1200, 2400, 4800, 9600, 19200, 38400. Number of data bits and parity are also displayed. A 7-bit data length can be combined with odd or even parity. An 8-bit data length can be combined with odd, even or no parity.

### Port3(COM3) Delay (ticks)

The number of delay ticks that the 8864 Data Controller waits before transmitting characters. Each tick is 1/100th of a second.

### Port3(COM3) 232/485

The type of serial communication port for Serial Port 3.

### Port3(COM3) Device Type

The type of communication device connected to Serial Port 3. Supported device types are:

- VT100 (Video terminal – fixed modem control)
- DIALUP (Dial-up modem)
- LLM (Leased-line modem with no modem control)
- LLM-RTS (Leased-line modem with modem control)
- DU!TIME (Video terminal-does not send time updates while in MDI mode)

### Port3(COM3) Interface \*

The type of communication interface that Serial Port 3 should follow. Supported interface types are:

- MDI (Menu driven interface)
- CEN (Central interface)
- TERM (Dumb terminal – VT100)
- MB-RTU (Modbus RTU)
- GSI1 (GSI interface)
- GSI2 (Extended GSI interface)
- SANBAR (Santa Barbara Protocol)
- MODBUSM (Modbus Client)
- NJERSEY (New Jersey polling protocol)

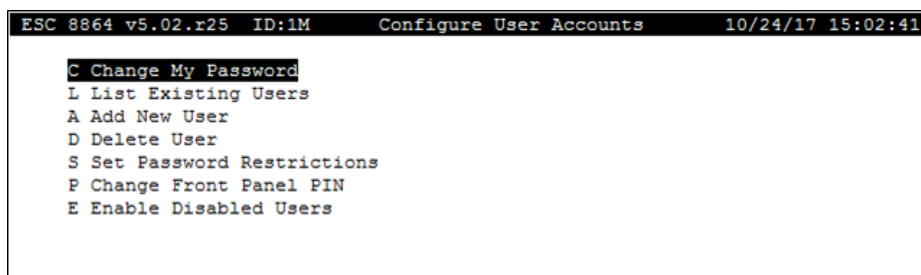
- LEADS (LEADS polling protocol)
- GSITEI (Generic Serial Interface supporting networked TEI software)

## Alarm Printer Port

Use this field to assign a default serial port for all alarm to printer notifications. Valid entries include 0, 1, 2, or 3. Typing disabled in the field disables the alarm printer port.

## Configure User Accounts

The Configure User Accounts Menu allows the user to add, delete and change user accounts on the 8864. To get to this menu, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts**.



The following table provides a short description of selections in the Configure User Accounts Menu. For more information about a certain item, click the related hyperlink listed in the table column "To Screen".

Hot Key	To Screen	Configures
C	<a href="#">Change My Password</a>	Allows the user to change their own password.
L	<a href="#">List Existing Users</a>	Allows an admin to list all existing user accounts.
A	<a href="#">Add New User</a>	Allows an admin to add a new user account.
D	<a href="#">Delete User</a>	Allows an admin to delete a user account.
S	<a href="#">Set Password Restrictions</a>	Allows an admin to set the password restrictions.
P	<a href="#">Change Front Panel PIN</a>	Allows an admin to change the login PIN for the front panel GUI.
E	<a href="#">Enable Disabled Users</a>	Allows an admin to re-enable a user account that has been disabled due to inactivity.

## Change My Password

The Change My Password screen allows the user to change their own password. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > C - Change My Password**.

```
ESC 8864 v5.02.r25 ID:1M Configure User Accounts 10/24/17 15:02:41
C Change My Password
L List Existing Users
A Add New User
D Delete User
S Set Password Restrictions
P Change Front Panel PIN
E Enable Disabled Users
```

The following information provides a description of the fields in the Change My Password screen.

### Enter Current Password

Enter your current password to authorize changing your password.

### Enter New Password

Enter a new password. The new password will be checked against the password restrictions currently configured.

### Confirm New Password

Retype the same password to ensure that the password was entered accurately.

## List Existing Users

The List Existing Users screen allows the user to display information for a list of existing users. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > L - List Existing Users**.

```
ESC 8864 v5.02.r25 ID:1M 8864 Users (Page 1 of 6) 10/24/17 16:53:50
Alarm Level Users (1 total, page 1 of 1):
alarm
  PW Expires: PW Expiration Disabled for this Account
  Last PW Change: N/A
```

The previous screen (List Existing Users) shows all users that are configured at each of the six authorization levels:

- Alarm
- Login
- Privilege (Priv)
- Config
- Supervisor
- Admin

Use <Ctrl-N> and <Ctrl-P> to move through the screens and <ESC> to exit.

The following information provides a description of the fields in the List Existing Users screen.

### PW Expires

Date and time when the user's password will expire according to the currently configured password rules.

### Last PW Change

Date and Time when the user last changed their password.

### Add New User

The Add New User screen allows the user to xxx. To get to this screen, start from the MDI home screen and select C - Configuration Menu > S Configure System Parameters > A - Configure User Accounts > A - Add New User.

ESC 8864 v5.02.r25 ID:1M		Add New User	10/24/17 17:02:33
User Name (no uppercase)	:	<input type="text"/>	
Password	:	<input type="password"/>	
Confirm Password	:	<input type="password"/>	
PW change on first login?	:	N	
Group	:	<input type="text"/>	
FINISHED (Configure Now)			

The following information provides a description of the fields in the Add New User screen.

### User Name

The name of the new user. The name must be less than or equal to 32 characters and must be all lower-case letters, numerals, or the following special characters:

!#\$%&'()- . ^ \_ ` { } ~

### Password

The initial password for the new user. The new password will be checked against the password

restrictions currently configured.

### Confirm Password

Retype the same password to ensure that the password was entered accurately.

### PW change on first login?

If set to “Y” then the user is forced to change their password on first login. If “N”, then the user may continue to use the password entered on this screen until it expires (according to the expiration timer that is configured).

### Group

The security group assigned to this user. The possible entries are:

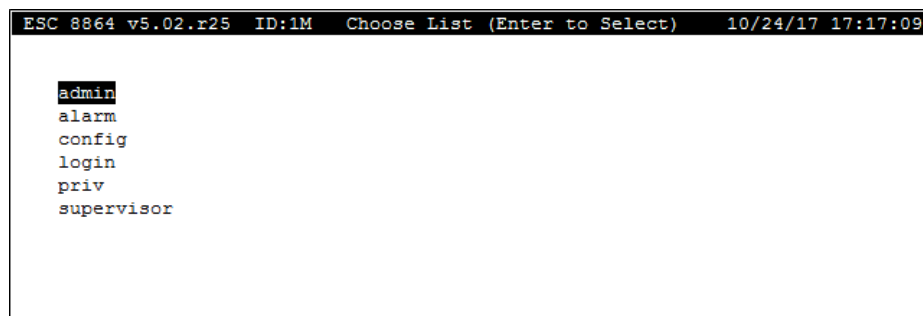
- alarm
- login
- priv
- config
- supervisor
- admin

See [Menu Access](#) in [Menu Driven Interface \(MDI\)](#) to see which security group has access to which MDI menus.

### Delete User

The Delete User screen allows the user to delete existing users. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > D - Delete User**.

This screen lists all configured users. Select one to delete and press <Enter>. You will be asked to verify the deletion. Use the <ESC> key to exit without deleting. You cannot delete the account that you are currently logged in as.



```
ESC 8864 v5.02.r25 ID:1M Choose List (Enter to Select) 10/24/17 17:17:09
admin
alarm
config
login
priv
supervisor
```

## Set Password Restrictions

The Set Password Restrictions screen allows the user to xxx. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > S - Set Password Restrictions**.

```

ESC 8864 v5.02.r25 ID:1M Set Password Restrictions 10/24/17 17:20:20

Minimum Number of Chars      : 8
Minimum Number of Capitals   : 0
Minimum Number of Numeric    : 0
Minimum Number of Specials   : 0
Allow 3 Ident Chars in a Row?: N
Allow PW to Match User Name? : N
Passwords Expire (days)     : 99999
Allow Old Passwords?         : N
Passwords Disabled (days)    : None

FINISHED (Configure Now)

```

The following information provides a description of the fields in the Set Password Restrictions screen.

### Minimum Number of Chars

Minimum number of total characters in the password. Default is 8.

### Minimum Number of Capitals

Minimum number of capital letters required in the password. Default is 0.

### Minimum Number of Numeric

Minimum number of numerals required in the password. Default is 0.

### Minimum Number of Specials

Minimum number of special characters required in the password. Default is 0.

### Allow 3 Ident Chars in a Row?

Is the password allowed to have three of the same characters in a row? Default is N.

### Allow PW to Match User Name?

Is the password allowed to match the user name? Default is N.

### Passwords Expire (days)

How often do users have to change their passwords? Default is 99,999 days (273 years). Once a password has expired, the user must log in using their expired password, then they will be forced to change the password before they are allowed access to anything else in the 8864



MDI.

### Allow Old Passwords?

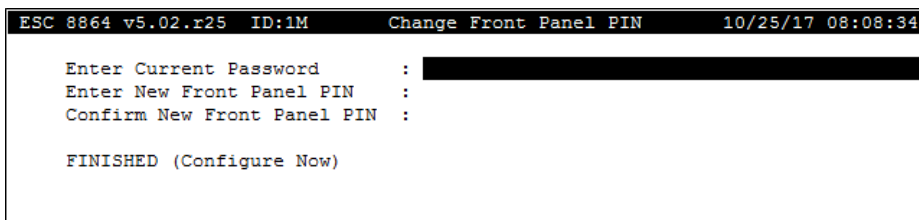
Is the user allowed to reuse old passwords? Default is N.

### Passwords Disabled (days)

How long before an inactive user account is automatically disabled. Once the account is disabled, an admin can log in and re-enable the user. Default is "None" (users are never disabled).

### Change Front Panel PIN

The Change Front Panel PIN screen allows an admin user to change the PIN used to access the GUI features. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > P - Change Front Panel PIN**.



```
ESC 8864 v5.02.r25 ID:1M Change Front Panel PIN 10/25/17 08:08:34
Enter Current Password : 
Enter New Front Panel PIN : 
Confirm New Front Panel PIN : 

FINISHED (Configure Now)
```

The following information provides a description of the fields in the Change Front Panel PIN screen.

#### Enter Current Password

Enter your current password to authorize changing the PIN.

#### Enter New Front Panel PIN

Enter the new PIN. The PIN must be all numeric and contain between 4 and 8 numbers.

#### Confirm New Front Panel PIN

Enter the new PIN again to confirm that no mistakes have been made when entering the PIN.

## Enable Disabled Users

The Enable Disabled Users screen allows the user to re-enable any user that has been disabled due to inactivity on the user account as configured in the Set Password Restrictions screen. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > A - Configure User Accounts > E - Enable Disabled Users**.

This screen lists all disabled users. Select one to re-enable and press **<Enter>**. Use the **<ESC>** key to exit without re-enabling any users.

```
ESC 8864 v5.02.r25 ID:1M Choose List (Enter to Select) 10/25/17 08:15:09

priv
cemstech
smith2017
```

## Configure Network Security

The Configure Network Security screen allows you to edit the configuration for the secure communications link to StackVision and to disable any unused TCP/IP ports. To display this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > S - Configure Network Security**. See next example.

```

ESC 8864 v6.02r54 ID:01 Configure Network Security 01/13/22 10:32:44

Disable SSH port (22)      : N
Disable https port (443)   : N
Disable polling port (9881) : N
Disable modbus port (502)  : N

FINISHED (Configure Now)   01/12/22 19:28:59
NOTE: This May Take Several
Seconds to Complete

Y=Both, N=Neither, 1=Ethernet 1, 2=Ethernet 2

```

Options in the next table are available when configuring the following fields in the Configure Network Security screen:

- Disable SSH port (22)
- Disable https port (443)
- Disable polling port (9981)
- Disable modbus port (502)

Option	Description
Y=Both	Ethernet 1 and 2 are disabled. No packets are received on the port.
N=Neither	Ethernet 1 and 2 are not disabled. Ethernet 1 and 2 are open and listening for external packets on the port.
1=Ethernet 1	Only Ethernet 1 is disabled and no packets are received on the port.
2=Ethernet 2	Only Ethernet 2 is disabled and no packets are received on the port.

## Configure Secure Communications

The Configure Secure Connections Menu allows the user to:

- Set up an optional secure communications link to StackVision.
- Manage the public keys that authenticate the 8864 to StackVision.
- Authenticate StackVision to the 8864 via the secure communications link.

To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections**.

```
ESC 8864 v5.05r9 ID:01 Configure Secure Connections 12/13/18 16:43:15

S Setup Secure Communications
N Authorize New Connection
L List Authorized Connections
D Delete Authorized Connection
I Import Server Public Key

V View 8864 Public Key
U Export 8864 Public Key to USB
E Export 8864 Public Key to Disk
R Generate New 8864 Public/Private Keys
```

The following table provides a short description of selections in the Configure Secure Connections Menu. For more information about a certain item, click the related hyperlink listed in the table column "To Screen".

Hot Key	To Screen	Configures
S	<a href="#">Setup Secure Communications</a>	Edit the configuration for the secure communications link to StackVision.
N	<a href="#">Authorize New Connection</a>	Authorizes a new connection over the network (less secure).
L	<a href="#">List Authorized Connections</a>	Provides a list of authorized connections (trusted public keys).
D	<a href="#">Delete Authorized Connection</a>	Allows an admin user to delete authorized connections (trusted public keys).
I	<a href="#">Import Server Public Key</a>	Allows an admin user to import a trusted public key from USB drive or over the network to

Hot Key	To Screen	Configures
		establish an authorized connection.
V	<a href="#">View 8864 Public Key</a>	View the 8864's public key so that it can be copied and pasted into the StackVision server.
U	<a href="#">Export 8864 Public Key to USB</a>	Export the 8864's public key to the USB drive.
E	<a href="#">Export 8864 Public Key to Disk</a>	Export the 8864's public key to a location on the disk so that it can be retrieved via SFTP.
R	<a href="#">Generate New 8864 Public/Private Keys</a>	Allows an admin user to randomly generate a new public/private key pair that is then used to replace the existing key pair.

## SSL Security Certificate Generation

The 8864 generates a new self-signed SSL certificate for server authentication at boot-up if any of the following changes occur:

- MAC address of the first Ethernet port has changed.
- Two-digit ID of the 8864 has changed.
- IP address of either Ethernet ports has changed.

**NOTE:** SSL is an acronym for Secure Sockets Layer. SSL is a secure protocol used for sending information securely by encrypting transmitted data.

It may take more than two minutes to generate the SSL certificate. A message displays to indicate the current process (see next example).

```

ESC 8864 v6.00r41 ID:02          General Setup          07/01/20 16:08:25

Logger ID Code      : 01
Serial Number       : 6920
Logger Description   : ESC 8864
                    :
Feature Mask        : 0x0929
Security Features Enabled : Y
AC Line Freq. (Hz)  : 60
Development System (Y/N) : N
Time Zone           :
Station ID Code     :
                    :
Automatic Logout (local) : 10m
Automatic Logout (remote) : 10m
Remote Time Update (Y/N) : Y
Enable Terminal Colors (Y/N): N

Align Pseudos? (Y/N) : N
Debounce Digital Inputs ? : N
Default Dig. Inputs to OR ? : N
                    :

FINISHED (Configure Now) 07/01/20 16:07:48
This may take a few minutes. . .please wait. . .system is saving changes

```

Message

## Setup Secure Communications

The Setup Secure Communications screen allows the user to edit the configuration for the secure communications link to StackVision. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Communications > S - Setup Secure Communications**.

```

ESC 8864 v5.03r16 ID:88 Setup Secure Communications 01/11/18 13:59:38

Secure StackVision Comm (Y/N): N
SV SSH Server IP:port      : 0.0.0.0:2222
SV polling IP:port        : 127.8.8.99:9881
SV emulation IP:port      : 127.8.8.99:22
SV https IP:port          : 127.8.8.99:443

Secure Modbus Comm (Y/N)  : N
Modbus SSH Server IP:port : 0.0.0.0:2222
Modbus client IP:port     : 127.8.8.99:502

FINISHED (Configure Now)  01/11/18 12:47:02
NOTE: This May Take Several
Seconds to Complete

```

The following information provides a description of the fields in the Setup Secure Communications screen.

### Secure StackVision Comm (Y/N)

Enable or disable the secure communications reverse SSH tunnel. If “N”, then the 8864 will not attempt to establish a reverse SSH tunnel to StackVision. If “Y”, then the 8864 will attempt to connect to an SSH server on the StackVision system as configured in the fields, below. The attempt will be made on boot and checked periodically afterwards.

### SV SSH Server IP:port

The IP address and TCP port that the secure communications reverse SSH tunnel will attempt to connect to on the StackVision server. An SSH server package such as BitVise must be running on the StackVision server.

### SV polling IP:port

The localhost IP address and port on the StackVision server that will be redirected by the SSH server (BitVise) to the 8864’s polling listener task. To maintain security, the address should be in the range 127.xxx.xxx.xxx so that no polling packets are routed outside of the StackVision server and are instead directed to the SSH Server (BitVise) so that they can be encrypted and sent to the 8864. This is the IP address that the StackVision polling task should be configured

to poll (usually in the StackVision server's "host" file). By default, the address will be of the form: 127.xxx.yyy.99:9881 where "xxx" represents the first digit of the 8864's two-digit Logger ID and "yyy" represents the second digit of the Logger ID. If the digit of the logger ID is 0-9, then xxx or yyy will be 0-9. If the digit is A-Z, then xxx or yyy will be 101-126. StackVision polling will then be directed through this reverse tunnel to the 8864.

Examples of default IP addresses:

Logger ID	IP Address
11	127.001.001.99
03	127.000.003.99
C1	127.103.001.99
Z9	127.126.009.99
9E	127.009.105.99
23	127.002.003.99
ZZ	127.126.126.99

### SV emulation IP:port

The localhost IP address and port on the StackVision server that will be redirected by the SSH server (BitVise) to the 8864's SSH server (listener) task. To maintain security, the address should be in the range 127.xxx.xxx.xxx so that no emulation packets are routed outside of the StackVision server and are instead directed to the SSH Server (BitVise) so that they can be encrypted and sent to the 8864. This is the IP address that the StackVision polling task should be configured to poll (usually in the StackVision server's "host" file). By default, the address will be of the form: 127.xxx.yyy.99:22 where "xxx" represents the first digit of the 8864's two-digit Logger ID and "yyy" represents the second digit of the Logger ID. If the digit of the logger ID is 0-9, then xxx or yyy will be 0-9. If the digit is A-Z, then xxx or yyy will be 101-126. StackVision emulation will then be directed through this reverse tunnel to the 8864.

Examples of default IP addresses:

Logger ID	IP Address
11	127.001.001.99
03	127.000.003.99
C1	127.103.001.99
Z9	127.126.009.99

Logger ID	IP Address
9E	127.009.105.99
23	127.002.003.99
ZZ	127.126.126.99

### SV https IP:port

The localhost IP address and port on the StackVision server that will be redirected by the SSH server (BitVise) to the 8864's web server task. To maintain security, the address should be in the range 127.xxx.xxx.xxx so that no http packets are routed outside of the StackVision server and are instead directed to the SSH Server (BitVise) so that they can be encrypted and sent to the 8864. This is the IP address that the StackVision polling task should be configured to poll (usually in the StackVision server's "host" file). By default, the address will be of the form: 127.xxx.yyy.99:443 where "xxx" represents the first digit of the 8864's two-digit Logger ID and "yyy" represents the second digit of the Logger ID. If the digit of the logger ID is 0-9, then xxx or yyy will be 0-9. If the digit is A-Z, then xxx or yyy will be 101-126. StackVision Config Compare will then be directed through this reverse tunnel to the 8864. A web browser on the StackVision server can also securely connect to the web interface (GUI) on the 8864 through this port.

Examples of default IP addresses:

Logger ID	IP Address
11	127.001.001.99
03	127.000.003.99
C1	127.103.001.99
Z9	127.126.009.99
9E	127.009.105.99
23	127.002.003.99
ZZ	127.126.126.99

### Secure Modbus Comm (Y/N)

Enable or disable secure Modbus communications via a reverse SSH tunnel. If "N", then the 8864 will not attempt to establish a reverse SSH tunnel for Modbus. If "Y", then the 8864 will attempt to connect to an SSH server on a Modbus client system as configured in the fields, below. The attempt will be made on boot and checked periodically afterwards.

### Modbus SSH Server IP:port

The IP address and TCP port that the Modbus reverse SSH tunnel will attempt to connect to on



a Modbus client. An SSH server package such as BitVise must be running on the Modbus client.

### Modbus client IP:port

The localhost IP address and port on the Modbus client that will be redirected by the SSH server (BitVise) to the 8864's Modbus server task. To maintain security, the address should be in the range 127.xxx.xxx.xxx so that no Modbus packets are routed outside of the Modbus client and are instead directed to the SSH Server (BitVise) on the Modbus client so that they can be encrypted and sent to the 8864. By default, the address will be of the form: 127.xxx.yyy.99:502 where "xxx" represents the first digit of the 8864's two-digit Logger ID and "yyy" represents the second digit of the Logger ID. If the digit of the logger ID is 0-9, then xxx or yyy will be 0-9. If the digit is A-Z, then xxx or yyy will be 101-126. Modbus command packets will then be directed through this reverse tunnel to the 8864.

Examples of default IP addresses:

Logger ID	IP Address
11	127.001.001.99
03	127.000.003.99
C1	127.103.001.99
Z9	127.126.009.99
9E	127.009.105.99
23	127.002.003.99
ZZ	127.126.126.99

### Authorize New Connection

The Authorize New Connection screen allows the user to authorize a new server connection. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > N - Authorize New Connection**.

```

ESC 8864 v5.02.r25 ID:1M      Authorize New Connection      10/25/17 09:21:18
IP/Name of Server:port      : 10.5.5.105:2222
Authorize Server
  
```

The following information provides a description of the fields in the Authorize New Connection

screen.

### IP/Name of Server:port

Enter the IP address (or server name if DNS is configured) and the TCP port of the SSH server (BitVise) on the StackVision server computer.

### Authorize Server

After entering the IP address and port in the field, selecting this entry will contact the SSH server at the entered IP address and port and retrieve the public keys for that server and store them in the 8864 as an authorized (trusted) connection.

Although this is very convenient, this method of retrieving and trusting the public keys is subject to a man-in-the-middle cyber-attack. It is conceivable that a third-party could intercept the request for the public keys and substitute their own public key. This would result in the 8864 having an authorized connection to an untrusted party. Of course, this vulnerability only exists for the initial authorization attempt. If the initial authorization results in a successful retrieval of the public keys from the actual StackVision server, then subsequent connections and communications are not subject to a man-in-the-middle attack.

### List Authorized Connections

The List Authorized Connections screen allows the user to display a list of all authorized connections (trusted public keys) saved on the 8864. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > L - List Authorized Connections**. Press <ESC> to exit the screen.

ESC 8864 v5.02.r25 ID:1M		Authorized SSH Servers	10/25/17 09:29:28
1	:	[10.5.5.100]:2222	
2	:	[kcallihantest]:2222	
3	:	[10.5.5.105]:2222	

### Delete Authorized Connection

The Delete Authorized Connection screen allows the user to delete any authorized connections (trusted public keys) that are stored in the 8864. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > D - Delete Authorized Connection**.

Select the authorized connection (trusted public key) that you wish to delete. Press <ESC> to exit without deleting an authorized connection.

```
ESC 8864 v5.02.r25 ID:1M Choose List (Enter to Select) 10/25/17 09:32:18

[10.5.5.100]:2222
[kcallihantest]:2222
[10.5.5.105]:2222
```

## Import Server Public Key

The Import Server Public Key screen allows the user to import a trusted public key from either a USB drive or from a file transferred to the 8864's disk drive via SFTP. The imported public key authorizes secure communications with StackVision. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > I - Import Server Public Key**.

```
ESC 8864 v5.02.r25 ID:1M Import Server Public Key 10/25/17 09:36:28

IP/Name of Server:port : 10.5.5.105:2222

Import from USB drive
Import from disk
```

The following information provides a description of the fields in the Import Server Public Key screen.

### IP/Name of Server:port

Enter the IP address (or server name if DNS is configured) and the TCP port of the SSH server (BitVise) on the StackVision server computer that is associated with the public key file to be imported.

### Import from USB drive

After entering the IP address and port in the field above, selecting this entry will attempt to read a public key file from the USB drive and save it in the 8864 as an authorized connection. Make sure to install the USB drive before selecting this item.

### Import from disk

After entering the IP address and port in the field above, selecting this entry will attempt to read a public key file from the 8864's "sftp-data" folder on its flash hard drive and save it as an authorized connection. Make sure to transfer the public key file to the "sftp-data" folder using SFTP before selecting this item. Use the Procedure in the section File Transfer Using SFTP.

## Notes About Public Key Files

Public Key files to be imported must be named **stackvision.pub**. Note that the file name must

be all lower-case characters.

Public Key files must be RSA-2048 and must be in OpenSSH format. Public Key files in the correct OpenSSH format will have the following characteristics:

- The file will begin with the characters “ssh-rsa”.
- The file will be between 380 and 450 characters long.

The following is an example public key file in the correct format (an optional comment may be appended at the end of the key text):

```
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQDYo+uR34Xpo5pEyBfFwKcMmoXNi3U6vJtS+H
R5C6SzxivrTLaVYJcaPlvULOWDQC+gQOSaDgWHHYcfv4abnluz5atQh5dEQaI9v2MzqHGm/Ald
sVLSDhreGZLdLuuxedPQi7HZKjlyDSx4q6nXBGKEDSCzmdeoGuY4epFLfJXmJqE0BK5kNNYX4z
FbJNHITBHaeJB4fMsBMSvdSpvCzX/cRZpBlV6ib8rUrzzscHWqKlmZYKwY8UTr6F7VjMQk8ssq
txu/2er5BrTY/MCXjYqFjTWoYAvOnF7XOEVueIO7SQRaawMJ9db03jyJvo2orXinhs09aelKPj
ZbVBjjYR8p Optional comment here
```

## View 8864 Public Key

The View 8864 Public Key screen allows the user to view the 8864's public key. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > V - View 8864 Public Key**.

```
ESC 8864 v5.05r9 ID:01 8864 Public Key 12/13/18 18:15:39

MD5 fingerprint: eb:c0:1e:5a:13:8b:5e:32:64:b1:07:b7:20:73:8b:01

Copy the following lines and paste them into a text file
This file can be used to import the 8864 public key into an SSH server

ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQDL0eJNBQeJ0JuBVLZNwU8NSUc0IkE4Dk6cQj27JpA
EisWd5e1N49P5dCvDs9ai9VpcYEDZP+i47LhInKk6IXGN+ofo+ReszATdIFbelsyyzIpRct1Eia/iEx7
KSJ6mdMZf269bZe26nF24uzjzI7DUlhZ/3nVg1yIem4fGGhJTfh9ZdimBTuvD3fOU4LK1LVjrc1cK9P
OfoEHw1Of1aKvlgXEJ9w0ny6SddomvESixk6JuYm9a/gfRPQHLdO1EqkTLtIJvW3RHMS8WoykCSC5e16
q0lzF9w1KiL3sG+6hXwV8cLrsxe2xxPd5et2Fy5GmlpVHSfF9K+I519wW31T 8864_01

ESC = exit
```

The user can copy the 8864's public key from this screen and paste it into a file on the StackVision server so that it may be imported in to an SSH server such as BitVise. The user should copy the characters starting with the “ssh-rsa” and continue through the last character shown on the screen (usually the 2-character Logger ID).

This public key is an RSA-2048 public key in OpenSSH format. The screen also includes information for the MD5 fingerprint.

Press the <ESC> key to exit the screen.

## Export 8864 Public Key to USB

The Export 8864 Public Key to USB selection allows the user to export the 8864's public key to a thumb drive plugged into the 8864's USB port. To perform this function, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > U - Export 8864 Public Key to USB**.

Make sure that a USB thumb drive is plugged into a USB port on the 8864 before making this selection. If successful, the 8864's public key will be written to the root directory of the USB drive. The file name will be "8864\_XX.pub" where the "XX" is replaced with the 2-character Logger ID.

The file is an RSA-2048 public key in OpenSSH format that can be directly imported into an SSH server (BitVise) on the StackVision Server.

## Export 8864 Public Key to Disk

The Export 8864 Public Key to Disk selection allows the user to export the 8864's public key to the "sftp-data" folder on the 8864's flash hard drive. This file can then be transferred to another computer via SFTP. To perform this function, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > X - Configure Secure Connections > E - Export 8864 Public Key to Disk**.

If successful, the 8864's public key will be written to the "sftp-data" folder on the 8864's flash hard drive. This file can then be transferred to another computer via SFTP using the same procedure as retrieving a server.cfg file. The file name will be "8864\_XX.pub" where the "XX" is replaced with the 2-character Logger ID.

The file is an RSA-2048 public key in OpenSSH format that can be directly imported into an SSH server (BitVise) on the StackVision Server.

## Generate New 8864 Public/Private Keys

This command requires "admin" level to regenerate the public/private keys. Use this command to randomly generate a new key pair (public/private keys) that is then used to replace the existing key pair.

After selecting **R-Generate New 8864 Public/Private Keys** in the menu, press **Y** (yes) or **N** (no) at the prompt "Are You Sure (Y/N)?".

---

```
ESC 8864  v5.05r9  ID:01  Configure Secure Connections  12/13/18 16:43:15
```

```
S Setup Secure Communications
```

```
N Authorize New Connection
```

```
L List Authorized Connections
```

```
D Delete Authorized Connection
```

```
I Import Server Public Key
```

```
V View 8864 Public Key
```

```
U Export 8864 Public Key to USB
```

```
E Export 8864 Public Key to Disk
```

```
R Generate New 8864 Public/Private Keys
```

## Configure Data Push

The Configure Data Push screen allows the user to enable pushing instantaneous (once-per-second) data to StackVision (also referred to as “Push Polling”). To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > D - Data Push**.

ESC 8864 v5.02.r25 ID:1M		Configure Data Push	10/24/17 14:59:15
Enable Data Push (Y/N)	:	Y	
Use SSH Tunnel (Y/N)	:	N	
SV SSH Server IP:port	:	kcallihantest:2222	
SV Listener IP:port	:	10.5.5.105:46000	
FINISHED (Configure Now)	:	10/23/17 09:58:51	

The following information provides a description of the fields in the Configure Data Push screen.

### Enable Data Push (Y/N)

If this field is “N” then instantaneous (once-per-second) data is not sent to StackVision (also referred to as “Push Polling” is turned off). If this field is “Y” then the instantaneous readings from all configured channels and the current state of all digital input lines are sent to a listener task on StackVision once per second. In addition, each base or extended average calculated is immediately sent to the listener task on StackVision as soon as they are calculated. The results of calibrations are sent as soon as they complete. The default is “N”.

### Use SSH Tunnel (Y/N)

If this field is “Y” and Data Push is enabled (see above), then a forward SSH tunnel is established to an SSH server (such as BitVise) that is running on the StackVision server. This allows the pushed data to be authenticated and encrypted. If this field is “N” and Data Push is enabled, then the 8864 will attempt to push the data directly to an unencrypted, unauthenticated listener port on the StackVision server. If Data Push is not enabled, this field has no effect. If “Use SSH Tunnel” is “N” then there is no assurance that pushed data packets are secure across the network.

### SV SSH Server IP:port

The IP address and TCP port of the SSH server (BitVise) on the StackVision server. This is the port that the 8864 will attempt to connect to in order to establish a forward SSH tunnel if “Use SSH Tunnel” is set to “Y” and Data Push is enabled. If either “Use SSH Tunnel” or “Data Push” is set to “N”, then this field has no effect.

## SV Listener IP:port

The IP address and TCP port on the StackVision server where the Push Poll listener task is listening. If “Use SSH Tunnel” is “Y” then this should be set to “localhost:pppp” where pppp is the listening port on the StackVision server in order to maintain security (packets to localhost are never routed onto the network). If “Use SSH Tunnel” is “N” then this should be the IP address of the StackVision server with the port where the StackVision Push Polling listener is configured. If “Use SSH Tunnel” is “N” then there is no assurance that pushed data packets are secure across the network.

## Take Effect Next Cold Start Menu

The Take Effect Next Cold Start Menu allows the user to make configuration changes to system parameters that can only be changed at the time of a cold start, or to make other system configuration parameters that the user wants to only take effect on the next cold start. To get to this screen, start from the MDI home screen and select **C - Configuration Menu > S - Configure System Parameters > U - Take Effect Next Cold Start**.

```
ESC 8864 v5.02.r25 ID:1M Take Effect Next Cold Start Menu 10/24/17 15:16:11
G General Setup
C Configure Calculations
I Configure I/O Cards
E Configure Ethernet Ports
M Configure Modbus
P Configure Serial Ports
S Configure Network Security
D Configure Data Push
R Configure Password Restrictions

NOTE: Config changes in these screens
will take effect at the next cold start
```

System parameters can be configured using a series of “Configuration Menu” screens. The settings in these screens are saved even if the 8864 is cold-started (i.e., all other configuration and data are erased).

The 8864 maintains two copies of the items in the Configuration Menu screens as follows:

- one copy for settings that are currently being used by the 8864
- another copy of settings that serve as a backup copy and will be loaded at the next cold start

When the logger is cold-started, values in the BACKUP copy are used, while values in the “current” settings are lost. You can access both copies of these configuration menus in the following manner:

1. To view and edit the “current” copy, select menu items from the System Configuration Menu.



2. To view and edit the backup copy (used after the next cold-start), select U Take Effect Next Cold Start from the System Configuration Screen and then select items from the Take Effect Next Cold Start Menu.

Most items in the System Configuration Menu screens take effect immediately when the changes are saved. However, some items will require a reboot of the 8864 to take effect. Items requiring a reboot are marked with an asterisk (\*). The reboot will occur when the configuration is saved.

Since you will almost always want system configuration items to survive a cold-start, any changes made in the “current” screens are automatically made to the backup screens so that the new values will be used after the next cold-start. Changes made to the “backup” screens are NOT copied to the “current” screens since they are not currently in use and will not take effect until the next cold-start.

There are, however, a few items in the System Configuration Menu screens that cannot be changed at all unless the 8864 is cold-started. These items can be viewed but not changed in the “current” screens. Instead, these items must be changed in the “Take Effect Next Cold Start” screens and then the 8864 must be cold-started for these changes to take effect.

In certain rare circumstances, it might be useful to make changes to configuration items in the backup screens that you do NOT want to take effect immediately, but only take effect when the 8864 is next cold-started. Those changes can be made in the backup screens and the unit cold-started at some later date. Be careful about making changes in the backup screens since a change could be made that will not take effect until sometime later when it may not be expected. In general, you should make all changes in the “current” screens unless you must change an item that can only be changed at the next cold-start.

To reduce the possibly of unexpected mismatches, the System Configuration Menu screens will show items in reverse video (black text on a white background) that are different between the “current” screens and the backup screens.

The following table provides a short description of selections in the Take Effect Next Cold Start Menu. For more information about a certain item, click the related hyperlink listed in the table column “To Screen”. Most of the items are identical to the screens in the “current” configuration screens.

Hot Key	To Screen	Configures
G	<a href="#">General Setup</a>	General, miscellaneous parameters
C	<a href="#">Configure Calculations</a>	Calculation parameters
I	<a href="#">View I/O Cards</a>	I/O cards

Hot Key	To Screen	Configures
E	<a href="#">Configure Ethernet Ports</a>	Ethernet Ports
M	<a href="#">Configure Modbus</a>	Modbus parameters
P	<a href="#">Configure Serial Ports</a>	Serial Ports
S	<a href="#">Configure Network Security</a>	Network Security
D	<a href="#">Configure Data Push</a>	Data Push (Push Polling)
S	<a href="#">Configure User Accounts</a>	Allows an admin to set the password restrictions

## Configure I/O Cards

The Configure I/O Cards screen is used to view and change how cards are identified after the next cold start. Field descriptions are slightly different from those described in the section [View I/O Cards](#) where the user can view which I/O cards are currently in use.

To display the Configure I/O Cards screen:

- From the MDI home screen, select **C - Configuration Menu > S - Configure System Parameters > U - Take Effect Next Cold Start > Configure I/O Cards**.

ESC 8864 v5.02.r25 ID:1M Configure I/O Cards (backup) 10/25/17 14:03:18					
Slot	Physical Card Detected at Last Boot	Override at the Next Cold Start		Card Config In Effect After Next Cold Start	Slot
1	Voltage In			Voltage In	1
2	Voltage In			Voltage In	2
3	Current In			Current In	3
4	Current In			Current In	4
5	Current Out			Current Out	5
6	Current Out			Current Out	6
7	Isolated In	(none)	<=diff	(none)	7
8	Met Card			Met Card	8
9	(none)			(none)	9
10	(none)			(none)	10
11	Relay Out	(none)	<=diff	(none)	11
12	Relay Out	(none)	<=diff	(none)	12
Note: Overrides and new card configurations take effect on cold start					
FINISHED (Configure Now)					

All fields are view-only with Configuration and Supervisor user access levels.

The following information provides a description of the fields in the Configure I/O Cards screen.

### Slot

The card slot number in the I/O bus for the Card Detected. This information cannot be edited.

### Physical Card Detected at Last Boot

The type of I/O card physically installed in the corresponding Slot of the I/O bus as detected at the time that the 8864 was last booted. The system automatically detects the card type, so this information cannot be edited. Possible card types are Current In, Voltage In, Status In, Isolated In, Relay Out, Current Out, or No Card. The card type shown in this screen is the type of card detected when the 8864 was last rebooted. Assuming that the physical card configuration is not changed, then this card type would be used along with the "Override at the Next Cold Start" to determine the card configuration that will be used after the next cold start. The card configuration that is actually used can only be changed if the unit is cold started.

### Override at the Next Cold Start?

If this field is blank, then the physical card that is detected at the next cold start will be used for this slot. However, if you want to force the 8864 firmware to use a card for this slot that is DIFFERENT from the card that is physically detected in the slot at the next cold start, then an "override" can be used. For example, if you want to add a new card to an empty slot, but the card is not yet available to install, then you can override the empty slot and force the 8864 to "think" that the new card is already installed. Alternatively, you may not want an installed card to be available yet, so the slot can be overridden to be "none."

Valid values for this field are:

- (blank) - use the physically detected I/O card
- Voltage In - (shortcut = "VI")
- Current In - (shortcut = "CI")
- Isolated In - (shortcut = "II")
- Status In - (shortcut = "SI")
- Relay Out - (shortcut = "RO")
- Current Out - (shortcut = "CO")
- None - do not use a card for this slot, even if one is detected

### Card Configuration in Effect After Next Cold Start

This field shows the user what card will actually be used by the 8864 for this slot after the next cold start, assuming that the card installed in this slot is the same at the time of the next cold start as the card detected at the last boot. If the override field is blank, then the card physically detected card at the next cold start will be used. If an override is configured, then the override in

effect at the next cold start will be used.

## Slot

The card slot number for the card defined as Card Used.

## Build System Report

The Build System Report screen allows you to bundle, zip, and transfer the following files to a specified FTP or USB location for debug purposes:

- most recent core dump (if it exists)
- current ESC8864 executable file
- most recent messages file

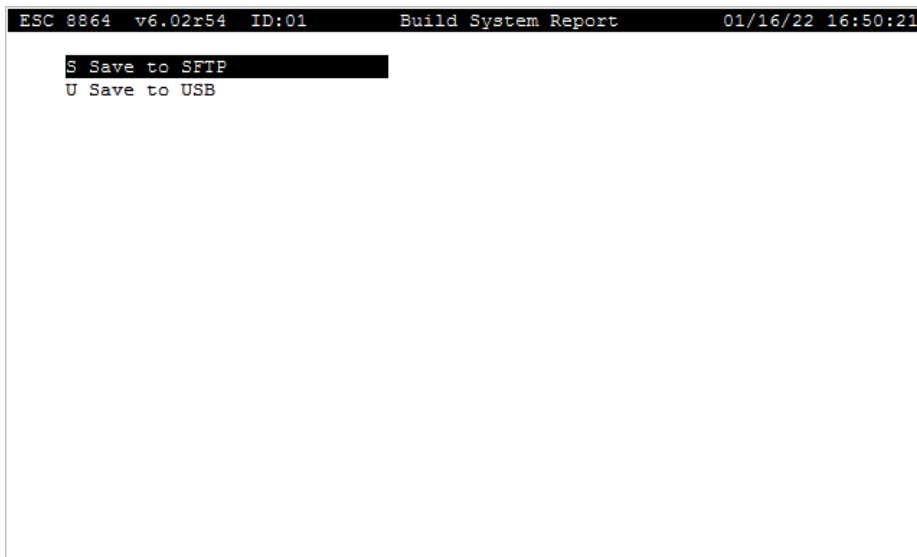
**NOTE:** A USB thumb drive must be connected to a USB port on the 8864 if you plan to transfer the zipped file to a USB thumb drive.

The zip file includes “SystemReport” and the date the file was created in the filename as seen in the following example:

```
SystemReport_011622_173826.zip
```

To display the Build System Report screen, press **C-Configuration Menu > S-Configure System Parameters > B-Build System Report** (see next example).

- Select **S-Save to SFTP** or **U-Save to USB**.



## Configure (Data) Channels



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Channel Configuration Menu allows you to enter, modify, and delete channel configurations. Channels are also enabled and disabled using this menu, as well as put into and taken out of maintenance mode.

To display the Channel Configuration menu:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels**.

```
ESC 8864 v5.02.r25 ID:88 Channel Configuration Menu 12/04/17 12:15:20
N Enter New Configuration
C Change Old Configuration
D Delete Old Configuration
M Disable/Mark Channel Offline
E Enable/Mark Channel Online
I Put Channel In Maint.
O Take Channel Out of Maint.
```

The following two tables identify the hot keys and control keys you can use when working with the Channel Configuration Menu.

### Hot Keys:

Channel Configuration Menu Hot Keys		
Hot Key	To Option	Purpose
N	<a href="#">Enter New Configuration</a>	Enters a new channel configuration. See Entering a New Channel Configuration.
C	<a href="#">Change Old Configuration</a>	Modifies an existing channel configuration. See Changing a Channel Configuration.
D	<a href="#">Delete Old</a>	Deletes an existing channel configuration. See

Channel Configuration Menu Hot Keys		
Hot Key	To Option	Purpose
	<a href="#">Configuration</a>	Deleting a Channel Configuration.
M	<a href="#">Disable/Mark Channel Offline</a>	Disables an existing channel. See Disabling Channels.
E	<a href="#">Enable/Mark Channel Online</a>	Enables an existing channel. See Enabling Channels.
I	<a href="#">Put Channel In Maintenance</a>	Puts a channel into maintenance mode. See Putting Channels Into Maintenance.
O	<a href="#">Take Channel Out of Maintenance</a>	Takes a channel out of maintenance mode. See Taking Channels Out of Maintenance.

**Control Keys:**

Channel Configuration Menu Control Keys	
Control Keys	Purpose
<Ctrl><V>	Edit instantaneous or average validation information and percent validity per average
<Ctrl><D>	Configure channel options, such as decimal positioner, round precision, and calibration span value.
<Ctrl><C>	Toggles between two-point and three-point scaling in standard channel configurations
<Ctrl><T>	Shows three-point scaling constants in three-point channel configurations (standard channels)
<Ctrl><A>	Select all channel names in a choose list when enabling/disabling a channel or placing a channel into/out of maintenance.
<Ctrl><D>	Deselect all channel names in a choose list when enabling/disabling a channel or placing a channel into/out of maintenance.

**Related Topics:**

[Constituent Flag Options](#)

[Standard Averaging Channel](#)

[Math Pack and Average Math Pack Channel](#)

[Rolling Average Channel](#)

[Stream-Switched Averaging Channel](#)

[Merge \(Join Streams\) Channel](#) and [Average Merge Channel](#)

[Time On-Line Counter Channel](#) and [Multi-Condition TOL Counter Channel](#)

[Linear Interpolation Channel](#)

[MODBUS Channel](#)

[Digital State Channel \(Optional\)](#)

[Generic Serial Interface \(GSI\) Channel \(Optional\)](#)

[Tape Sampler Channel \(Optional\)](#)

[General Channel \(Optional\)](#)

[Data Validation and Flags](#)

[Configure Channel Options](#)

## Enter New Configuration

To enter a new channel configuration:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.

The following screen displays. Eleven channel types are standard. The remainder (shown in italic type) are optional channel types that may or may not have been purchased with the 8864 Data Controller.

Typing <CTRL-N> displays the second page of channel types. Once on the second page, type <CTRL-P> to return to the first page.

*Select Channel Type (Page 1)*

```

ESC 8864 v5.02.r25 ID:1M Select Channel Type (Page 1) 10/26/17 09:59:59

A Standard Averaging
M Math Pack
P Average Math Pack
R Rolling Averaging
X Stream-Switched Averaging
J Merge (Join Streams)
K Average Merge
T Time On-Line Counter
U Multi-Condition TOL Counter
L Linear Interpolation
1 Vector Wind Speed
2 Vector Wind Direction
3 Wind Speed Channel
4 Wind Direction Channel
5 Sigma-Theta Channel
6 Linear Sigma Channel
Z Rainfall Channel
9 MET Rainfall Channel
Q Modbus Channel
C General Channel
N Counter Channel
Next Page = CTRL-N

```

### Select Channel Type (Page 2)

```

ESC 8864 v5.02.r25 ID:1M Select Channel Type (Page 2) 10/26/17 10:00:50

I GSI Channel
V Vector Wind Speed (CH)
W Vector Wind Direction (CH)
7 Wind Speed Channel (CH)
8 Wind Direction Channel (CH)
D Digital State Channel

Prev Page = CTRL-P

```

The following information provides a description of the various channel types:

Hot Key	To Option	Purpose
A	Standard Averaging	Standard averaging channel
M	Math Pack	Math pack channel
P	Average Math Pack	Average math pack channel
R	Rolling Averaging	Rolling averaging channel
X	Stream-Switched Averaging	Stream-switched channel
J	Merge (Join Streams)	Joining of two channels' real-time data
K	Average Merge	Merges results at average interval time



Hot Key	To Option	Purpose
T	Time On-Line Counter	Time on-line counter channel
U	Multi-Condition TOL Counter	Multi-condition time on-line counter channel
L	Linear Interpolation	Linear interpolation channel
1	Vector Wind Speed	Optional vector wind speed channel
2	Vector Wind Direction	Optional vector wind direction channel
3	Wind Speed Channel	Optional (scalar) wind speed channel
4	Wind Direction Channel	Optional (scalar) wind direction channel
5	Sigma-Theta Channel	Optional sigma-theta channel
6	Linear Sigma Channel	Optional linear sigma channel
Z	Rainfall Channel	Optional rainfall channel
Q	Modbus Channel	Optional Modbus server channel
I	GSI Channel	Optional generic serial interface channel
C	General Channel	Multi-purpose channel
N	Counter Channel	Counter, accumulator, and interval averaging channel
W	Vector Wind Speed (CH)	Optional channel based vector wind speed channel
X	Vector Wind Direction (CH)	Optional channel based vector wind direction channel
7	Wind Speed Channel (CH)	Optional channel based (scalar) wind speed channel
8	Wind Direction Channel (CH)	Optional channel based (scalar) wind direction channel
D	Digital State Channel	Optional digital state channel
G	Tape Sampler Channel	Optional tape sampler channel

## Change Old Configuration

To change an old channel configuration:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > C - Change Old Configuration**.
2. Use the up/down arrows to navigate the list of channels. Press **<Enter>** for a highlighted channel to open a configuration screen. The selected channel is copied into memory for editing. See the next screen example.

```
ESC 8864 v5.02.r25 ID:88 Choose List (Enter to Select) 12/04/17 13:51:36

EXAMPLE-1 [01]
EXAMPLE-2 [02]
EXAMPLE-3 [03]
EXAMPLE-4 [04]
EXAMPLE-5 [05]

F2      <ESC>  TAB  CTRL-K  CTRL-R  Arrows
Refresh Exit  GOTO END GOTO TOP Clr Keys Select
```

3. Make changes as needed and then select **FINISHED (Configure Now)** for changes to take effect. See the next screen example.

Pressing **<Esc>** before finishing and accepting changes allows you to exit without any changes taking effect.



**NOTE:** Each channel and each average in each channel has its own circular storage. The value in the storage field for each average determines how long data are kept before rolling over. These storage buffers are allocated in discrete 1Kbyte blocks, so even though a storage time of 4d (4 days) may be entered, the 8864 rounds up to the next block size. The actual storage time may be reported as 5d, 4h (5 days, 4 hours). In any case, the 8864 stores data at least as long as the value configured for storage time.

```

ESC 8864 v5.02.r25 ID:88 Standard Channel Config. 12/04/17 13:54:36

Instrument Name      : EXAMPLE-1
Analog Input Number  : 01
Report Channel Number : 01
Volts Full Scale     : N/A
High Input           : 20 mA
Low Input             : 0 mA
High Output (E.U.s)  : 100
Low Output (E.U.s)   : 0
Units                : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-4) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now) 12/04/17 13:49:49

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

## Delete Old Configuration

To delete an old channel configuration:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > D - Delete Old Configuration**.
2. Use the up/down arrows on your computer keyboard to navigate the list of channels. Press **<Enter>** for the selected (highlighted) channel you want to delete.
3. When the message "Are you Sure (Y/N)?" displays, press **Y** on your keyboard to delete the selected channel. See the next example.

Pressing **N** or the **<Esc>** keys allows you to exit the configuration screen without deleting the channel.

```

ESC 8864 v5.02.r25 ID:88 Choose List (Enter to Select) 12/04/17 14:00:53

EXAMPLE-1 [01]
EXAMPLE-2 [02]
EXAMPLE-3 [03]
EXAMPLE-4 [04]
EXAMPLE-5 [05]

F2  <ESC>  TAB  CTRL-K  CTRL-R  Arrows
Are You Sure (Y/N)?

```

## Disable/Mark Channel Offline

When you disable a channel, instantaneous readings are invalidated. This includes any instantaneous data readings taken during the time that data are flagged - these are excluded from the averages.

To disable a channel:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > M - Disable/Mark Channel Offline**.
2. The first channel in the list is automatically selected/highlighted. Select or deselect individual channels by highlighting the desired channel name, and then pressing the **Spacebar**.

An indicator (>) displays next to a selected channel name as shown in the next screen with "EXAMPLE\_2". If you need to select all channel names, press **<Ctrl> <A>**. If you need to deselect all channel names, press **<Ctrl> <D>**.

3. Press **<Enter>** to disable selected channels. Data readings for these channels are marked with a "D" validation flag.

If you want to exit the screen without disabling any channels, press **<Esc>** to exit.



**IMPORTANT:** Do not press the **<Enter>** key when exiting; doing so causes the first highlighted channel in the list to become disabled.

```
ESC 8864 v5.02.r25 ID:88 Choose (Space Toggle/Enter Select) 12/04/17 14:10:26

EXAMPLE-1 [01]
> EXAMPLE-2 [02]
EXAMPLE-3 [03]
EXAMPLE-4 [04]
EXAMPLE-5 [05]

F2      <ESC>  TAB    CTRL-K  CTRL-R  Arrows
Refresh Exit   GOTO END GOTO TOP Clr Keys Select
```

4. To verify a channel has been disabled:
  - From the Home Menu select **D - Real-Time Display Menu > F - Display Readings w/flags**. A disabled channel displays a "D" flag as shown in the next

screen for “EXAMPLE-2”.

```
ESC 8864 v5.02.r25 ID:88 Real-Time Engineering Flags 12/04/17 14:15:47

EXAMPLE-1= 0.003928 (      )
EXAMPLE-2= 0          (D    )
EXAMPLE-3= 0          (      )
EXAMPLE-4= 0.003928 (      )
EXAMPLE-5= 0.003928 (      )

ESC or SPACE to exit
```

## Enable/Mark Channel Online

Data for enabled channel(s) are included in averages if other invalidating conditions do not apply.

To enable a channel:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > E - Enable/Mark Channel Online**

A list of disabled channels display. If no channels are disabled, a message displays instead.

2. The first channel in the list is automatically selected/highlighted. Select or deselect individual channels by highlighting the desired channel name, and then pressing the **Spacebar**.

An indicator (>) displays next to a selected channel name as shown in the next screen with “EXAMPLE-2” and “EXAMPLE-4”. If you need to select all channel names, press <Ctrl> <A>. If you need to deselect all channel names, press <Ctrl> <D>.

3. Press <Enter> to enable selected channels. Data readings for these channels are no longer marked with a “D” validation flag.

If you want to exit the screen without enabling any channels, press <Esc> to exit.



**IMPORTANT:** Do not press the <Enter> key when exiting; doing so causes the first highlighted channel in the list to become enabled.

---

```

ESC 8864 v5.02.r25 ID:88 Choose List (Enter to Select) 12/04/17 14:26:14

> EXAMPLE-2 [02]
> EXAMPLE-4 [04]

F2      <ESC>  TAB  CTRL-K  CTRL-R  Arrows
Refresh Exit  GOTO END GOTO TOP Clr Keys Select

```

4. To verify a channel has been enabled:

- From the Home Menu select **D - Real-Time Display Menu > F - Display Readings w/flags**.

An enabled channel no longer displays a “D” flag inside the parenthesis.

```

ESC 8864 v5.02.r25 ID:88 Real-Time Engineering Flags 12/04/17 14:31:48

EXAMPLE-1=-0.003928 (    )
EXAMPLE-2=-0.003928 (    )
EXAMPLE-3=-0.003928 (    )
EXAMPLE-4=-0.003928 (    )
EXAMPLE-5=-0.003928 (    )

ESC or SPACE to exit

```

## Put Channel In Maintenance

When you place a channel in maintenance, instantaneous readings are invalidated. For example, any instantaneous data readings taken during the time that data are flagged are excluded from the averages.

To put a channel into maintenance:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > I - Put Channel In Maint**.

- The first channel in the list is automatically selected/highlighted. Select or deselect individual channels by highlighting the desired channel name, and then pressing the **Spacebar**.

An indicator (>) displays next to a selected channel name as shown in the next screen with “EXAMPLE-3”. If you need to select all channel names, press <Ctrl> <A>. If you need to deselect all channel names, press <Ctrl> <D>.

- Press <Enter> to put selected channels into maintenance. Data readings for these channels are marked with an “M” validation flag.

If you want to exit the screen without putting any channels into maintenance, press <Esc> to exit.



**IMPORTANT:** Do not press the <Enter> key when exiting; doing so causes the first highlighted channel in the list to be put into maintenance.

```
ESC 8864 v5.02.r25 ID:88 Choose (Space Toggle/Enter Select) 12/04/17 14:40:34

EXAMPLE-1 [01]
EXAMPLE-2 [02]
> EXAMPLE-3 [03]
EXAMPLE-4 [04]
EXAMPLE-5 [05]

F2      <ESC>  TAB      CTRL-K    CTRL-R    Arrows
Refresh Exit   GOTO END GOTO TOP Clr Keys  Select
```

- To verify a channel has been put into maintenance:
  - From the Home Menu select **D - Real-Time Display Menu > F - Display Readings w/flags**.

A channel that has been put into maintenance displays an “M” flag inside parenthesis as shown in the next screen with “EXAMPLE-3”.

```

ESC 8864 v5.02.r25 ID:88 Real-Time Engineering Flags 12/04/17 14:43:51

EXAMPLE-1=-0.003928 (      )
EXAMPLE-2=-0.003928 (      )
EXAMPLE-3=-0.003928 (M     )
EXAMPLE-4=-0.003928 (      )
EXAMPLE-5=-0.003928 (      )

ESC or SPACE to exit

```

## Take Channel Out of Maintenance

When you take a channel out of maintenance, data for the channel(s) are included in averages if other invalidating conditions do not apply.

To take a channel out of maintenance:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > O - Take Channel Out of Maint.**
2. The first channel in the list is automatically selected/highlighted. Select or deselect individual channels by highlighting the desired channel name, and then pressing the **Spacebar**.

An indicator (>) displays next to a selected channel name as shown in the next screen with "EXAMPLE-3". If you need to select all channel names, press <Ctrl> <A>. If you need to deselect all channel names, press <Ctrl> <D>.

3. Press <Enter> to take selected channels out of maintenance. Data readings for these channels are no longer marked with an "M" validation flag.

If you want to exit the screen without taking any channels out of maintenance, press <Esc> to exit.



**IMPORTANT:** Do not press the <Enter> key when exiting; doing so causes the first highlighted channel in the list to be taken out of maintenance.



```
ESC 8864 v5.02.r25 ID:88 Choose (Space Toggle/Enter Select) 12/04/17 15:02:36

> EXAMPLE-3 [03]

F2 Refresh <ESC> Exit
```

4. To verify a channel has been taken out of maintenance:

- From the Home Menu select **D - Real-Time Display Menu > F - Display Readings w/flags** (hot key **F**).

A channel that has been taken out of maintenance no longer displays an “M” flag inside parenthesis as shown in the next screen for channel “EXAMPLE-3”.

```
ESC 8864 v5.02.r25 ID:88 Real-Time Engineering Flags 12/04/17 15:07:12

EXAMPLE-1= 0.003927 ( )
EXAMPLE-2= 0 ( )
EXAMPLE-3= 0.003927 ( )
EXAMPLE-4= 0.003927 ( )
EXAMPLE-5= 0.003927 ( )

ESC or SPACE to exit
```

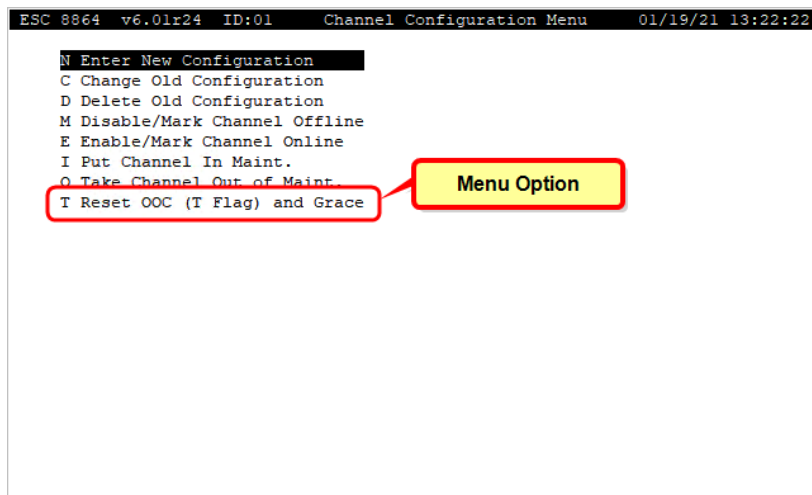
## Reset OOC (T Flag) and Grace

Using the menu option “Reset OOC (T Flag) and Grace” requires [admin access rights](#). This feature allows you to manually reset the "T" flag and 8-hour grace counter for channels that are associated with a calibration. After making updates, press <Enter> to commit changes. After committing changes, a "D" flag is added to denote a manual reset of the "T" flag and grace counter.

**NOTE:** For related information, see [Enable OOC Reset \(Y/N\)](#) in [General Setup](#).

To access the “Reset OOC (T Flag) and Grace” feature:

- From the Home menu, select **C - Configuration Menu > D - Configure (Data) Channels > T - Reset OOC (T Flag) and Grace**.



## Constituent Flag Options

The following information applies to the following channel types (*C-Configuration Menu > D-Configure (Data) Channels*):

- [M-Math Pack](#)
- [P-Average Math Pack](#)
- [R-Rolling Average](#)

Beginning in firmware Version 6.00, the following fields are available for passing constituent flags. Default settings that match legacy flag passing logic are shown here:

- Pass Constituent Flags = Y
- Pass Constituent BO Flags = Y
- Include Invalid Constituents = N

Configuring the previously listed fields with a different combination of settings produces

different effects. Each of these are described in this topic. An incorrect combination of settings that are downloaded to the controller cause error -351 in the 8864 Data Controller. Even though a download error occurs, the channel configuration is still saved, but the three settings are set to the legacy defaults identified earlier in the previous list.

## Combination Settings for Constituent Flag Options

When configuring settings for the fields *Pass Constituent Flags*, *Pass Constituent BO Flags*, and *Include Invalid Constituents*, setting certain options can cause another field's settings to auto-change (automatically change). This functionality is intended to help with configuring constituent flag options correctly. You can however change any of these settings, including settings for auto-change fields. An incorrect combination of settings will automatically change other settings to a valid combination.

The following examples illustrate changes made among the three settings identified in the [previous list](#):

### Pass Constituent Flags

- Change **Pass Constituent Flags = Y** (see next example):

Does not change other settings.

```
ESC 8864 v6.00r41 ID:01Math Channel Configuration (Page 2) 06/18/20 18:18:27

Name (not editable)      : TEST
Ch1 Number (not editable) : 62
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N) : N
Pass Constituent Flags   : Y
Pass Constituent BO Flags : N
Include Invalid Constituents: Y
Validation Type (0-4)    : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options
```

- Change **Pass Constituent Flags = N** (see next example):

Auto-change fields update as follows:

- Pass Constituent BO Flags = N
- Include Invalid Constituents = Y

**NOTE:** After changing “Pass Constituents Flags” to N(o) and pressing Enter, the following message displays near the bottom of the configuration screen: Set Pass Constituent BO Flags [N], Include Invalid Constituent Flags [Y].

```

ESC 8864 v6.00r41 ID:01Math Channel Configuration (Page 2)06/18/20 19:20:00

Name (not editable)      : TEST
Ch1 Number (not editable) : 01
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : N
Pass Constituent BO Flags : N
Include Invalid Constituents: Y
Validation Type (0-4)     : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

Message Display

Set Pass Constituent BO Flags [N], Include Invalid Constituent Flags [Y]

```

### Pass Constituent BO Flags

- Change **Pass Constituent BO Flags = Y** (see next example):
  - Pass Constituent Flags = Y

**NOTE:** After changing “Pass Constituent BO Flags” to Y(es) and pressing Enter, the following message displays near the bottom of the configuration screen: Set Pass Constituent Flags [Y].

```

ESC 8864  v6.00r41  ID:01Math Channel Configuration (Page 2)06/18/20 19:48:01

Name (not editable)      : TEST
Ch1 Number (not editable) : 01
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : Y
Pass Constituent BO Flags : Y
Include Invalid Constituents: Y
Validation Type (0-4)     : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)  06/18/20 19:44:48

Message Display

Set Pass Constituent Flags [Y]

```

- Change **Pass Constituent BO Flags = N** (see next example):

Does not change other settings.

```

ESC 8864  v6.00r41  ID:01Math Channel Configuration (Page 2)06/19/20 10:11:47

Name (not editable)      : TEST
Ch1 Number (not editable) : 02
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : Y
Pass Constituent BO Flags : N
Include Invalid Constituents: Y
Validation Type (0-4)     : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

### Include Invalid Constituent

- Change **Include Invalid Constituents = Y**

Does not change other settings.

```

ESC 8864 v6.00r41 ID:01Math Channel Configuration (Page 2)06/19/20 09:16:55

Name (not editable)      : TEST
Ch1 Number (not editable) : 01
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : Y
Pass Constituent BO Flags : N
Include Invalid Constituents: Y
Validation Type (0-4)     : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

■ Change Include Invalid Constituents = N

Auto-change fields update as follows:

- Pass Constituent Flags = Y

```

ESC 8864 v6.00r41 ID:01Math Channel Configuration (Page 2)06/19/20 11:16:30

Name (not editable)      : TEST
Ch1 Number (not editable) : 01
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : Y
Pass Constituent BO Flags : N
Include Invalid Constituents: N
Validation Type (0-4)     : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

## Constituent Flag Truth Table

The constituents flag fields *Pass Constituent Flags*, *Pass Constituent BO Flags*, and *Include Invalid Constituents* are provided in firmware Version 6.00 and higher to handle apportionment equations when one side of the equation is offline and invalid (for some other reason like a “B” flag), and to be able to include invalid data for counting logic or non-compliance logic. Because the constituents flag fields can be configured several different ways for various effects, review the truth table in this section for related information when configuring the constituents flag fields.

Most channels should be set up to use option 3 in the truth table when the “F” flag of the constituent matches your parameter. Examples include converting from PPB to PPM, SCFM to HSCFH, LB/MMBTU equations etc. For any channel that has a different “F” flag than its constituents, then options 2 or 4 in the truth table should be used. Examples would be dual-fuel HEATIN where gas (GHEATIN) and oil (OHEATIN) have different “F” flags than combined heat (HEATIN), or channel has startup/shutdown “F” flags for excluding SU/SD (startup/shutdown) minutes. When using option 4 in the truth table, because it includes data when the “F” flag is present on the constituent, ensure that the data is zero by multiplying by the time online.

Example below:

$$(GVOC\_LBS * GASOPHR\#1) + (OVOC\_LBS * OILOPHR\#1) =$$

When either GVOC\_LBS or OVOC\_LBS has an “F” flag, no flags are passed in, but the data is included. By including the GASOPHR and OILOPHR in the equation, any offline data that would be included is zeroed by the time online.

Constituent Flags		Flags Passed	Invalid Data Included?	Results / Situation Used
1	<ul style="list-style-type: none"> <li>Pass Constituent Flags = No</li> <li>Pass Constituent BO Flags = No</li> <li>Include Invalid Constituents = Yes</li> </ul>	None	Yes	<p><b>Results:</b> No flags are passed and data is always included in the equation. “P” channel is always valid. Can make “M” channel invalid directly on channel.</p> <p><b>Situation Used:</b> Non-compliance or logic channels.</p>
2	<ul style="list-style-type: none"> <li>Pass Constituent Flags = Yes</li> <li>Pass Constituent BO Flags = No</li> </ul>	Not “F”	No	<p><b>Results:</b> Legacy – all flags passed except “F”. When invalid for any other reason “F” flag is passed.</p>

Constituent Flags		Flags Passed	Invalid Data Included?	Results / Situation Used
	<ul style="list-style-type: none"> <li>Include Invalid Constituents = No</li> </ul>			<p><b>Situation Used:</b> Used when channel has a different “F” flag than constituents, like a dual-fuel HEATIN.</p>
3	<ul style="list-style-type: none"> <li>Pass Constituent Flags = Yes</li> <li>Pass Constituent BO Flags = Yes</li> <li>Include Invalid Constituents = No</li> </ul>	All	No	<p><b>Results:</b> Legacy – all flags passed (most channels are set up this way)</p> <p><b>Situation Used:</b> Most math equations other than apportionment, multi-fuel, and totaled equations.</p>
4	<ul style="list-style-type: none"> <li>Pass Constituent Flags = Yes</li> <li>Pass Constituent BO Flags = Yes</li> <li>Include Invalid Constituents = Yes</li> </ul>	Special	Maybe	<p><b>Results:</b> This is a special case that does not follow settings exactly. In this setup, when the “F” flag is present, no other flags are passed. For example, if you have 100 &lt;FB, the value 100 is used and the &lt;FB flags do not pass in. If the “F” flag is not present, it operates like line above - all flags passed.</p> <p><b>Situation Used:</b> Apportionment, multi-fuel HEATIN/FC/FD, summation equations, and so on. Because the value is passed when offline, ensure value of zero when offline.</p>
5	<ul style="list-style-type: none"> <li>Pass Constituent Flags = Yes</li> <li>Pass Constituent BO Flags = No</li> </ul>	VWXYZ	Yes	<p><b>Results:</b> Only custom flags are passed and all data is included. “P” channel is always valid.</p>



Constituent Flags		Flags Passed	Invalid Data Included?	Results / Situation Used
	<ul style="list-style-type: none"> <li>Include Invalid Constituents = Yes</li> </ul>			<p>Can make "M" channel invalid directly on channel via B, F, M, +, etc. flags.</p> <p><b>Situation Used:</b> Non-compliance or logic channels.</p>
6	<ul style="list-style-type: none"> <li>Pass Constituent Flags = No</li> <li>Pass Constituent BO Flags = No</li> <li>Include Invalid Constituents = No</li> </ul>			Invalid settings. Causes download error -351 and settings are set to default of: Pass Constituent Flags = Yes, Pass Constituent BO Flags = Yes, and Include Invalid Constituents = No.
7	<ul style="list-style-type: none"> <li>Pass Constituent Flags = No</li> <li>Pass Constituent BO Flags = Yes</li> <li>Include Invalid Constituents = No</li> </ul>			Invalid settings. Causes download error -351 and settings are set to default of: Pass Constituent Flags = Yes, Pass Constituent BO Flags = Yes, and Include Invalid Constituents = No.
8	<ul style="list-style-type: none"> <li>Pass Constituent Flags = No</li> <li>Pass Constituent BO Flags = Yes</li> <li>Include Invalid Constituents = Yes</li> </ul>			Invalid settings. Causes download error -351 and settings are set to default of: Pass Constituent Flags = Yes, Pass Constituent BO Flags = Yes, and Include Invalid Constituents = No.

## Standard Averaging Channel



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Standard averaging channels calculate averages from voltage or current inputs for up to three

unique averaging intervals.

As each voltage or current input is scanned, it is scaled to the appropriate engineering units (EU) (PPM, %, etc.) according to the user's specifications. Analog inputs may be scaled using either a linear (first-order) or parabolic (second-order) curve-fit to yield the desired engineering units.

The first average, called the **base average**, is then calculated as the average of all scans (in EU values) for the prescribed interval. If configured, one or two extended averages are then calculated as the average of several base averages, according to each of the other averages' prescribed intervals. If the base average is considered to be invalid due to calibration or some error, that average is not included in the calculation of the other one or two dependent averages. See [Appendix C. Clean Air Act Validation](#) in this manual for extended average calculation details when Validation Type (0-7) is set to 1.

Also see [Scaling](#).

To display the Standard Averaging configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > A - Standard Averaging**.

The following screen displays.

```

ESC 8864 v6.01r24 ID:01 Standard Channel Config. 01/19/21 20:44:37

Instrument Name      : TEMP
Analog Input Number : 01
Report Channel Number : 62
Volts Full Scale    : N/A
High Input          : 20 mA
Low Input           : 0 mA
High Output (E.U.s) : 100
Low Output (E.U.s)  : 0
Units               : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-7) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the Standard Averaging channel configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Analog Input Number

Specifies the actual, physical input line number. **01** to **99**. When using a Meteorological Input Card, inputs **Tx**, **Dx**, **Sx** or **Rx** can be used (**x** is the integer number of the Meteorological Input Card).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Volts Full Scale

The volts full scale range for the channel. **0.1**, **1.0**, **5.0** or **10.0** volts. Applicable only when the Analog Input Number references a voltage input.

### High Input

The maximum current, voltage, hertz or voltage ratio output from the instrument.

### Mid Input

The mid-range current, voltage, hertz or voltage ratio output from the instrument; used for parabolic scaling. (<Ctrl><C> toggles between parabolic and linear scaling.)

### Low Input

The minimum current, voltage, hertz or voltage ratio output from the instrument.

### High Output

The instrument reading in engineering units corresponding to the High Input.

## Mid Output

The instrument reading in engineering units corresponding to the Mid Input; used for parabolic scaling. (<Ctrl><C> toggles between parabolic and linear scaling.)

## Low Output

The instrument reading in engineering units corresponding to the Low Input.

## Units

The engineering units to which the input readings will be scaled (AP, #/MBTU, PPM, etc.).

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					Ext2 validation	
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 (“Y”), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 (“A”), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					Base average (arithmetic averaging)	
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

### Scaling

Standard channels have the optional capability of parabolic (second-order) scaling. Three points can be entered (low, mid, and high inputs and outputs) that the 8864 uses to construct a second-order curve fit.

Pressing **Ctrl + C** in the Standard Channel Config screen toggles between linear and parabolic scaling. Parabolic scaling includes the fields Mid Input and Mid Output. See the following screen examples.

#### **Linear Scaling:**

```

ESC 8864 v5.00.r15 ID:88      Standard Channel Config.      07/30/15 16:09:31

Instrument Name       : SO2
Analog Input Number  : 07
Report Channel Number : 07
Volts Full Scale     : N/A
High Input           : 20 mA
Low Input            : 0 mA
High Output (E.U.s)  : 100
Low Output (E.U.s)   : 0
Units                : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-4) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now) 07/30/15 15:59:51

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

### Parabolic Scaling:

```

ESC 8864 v5.00.r15 ID:88      Non-Linear Channel Config.    09/30/15 13:04:54

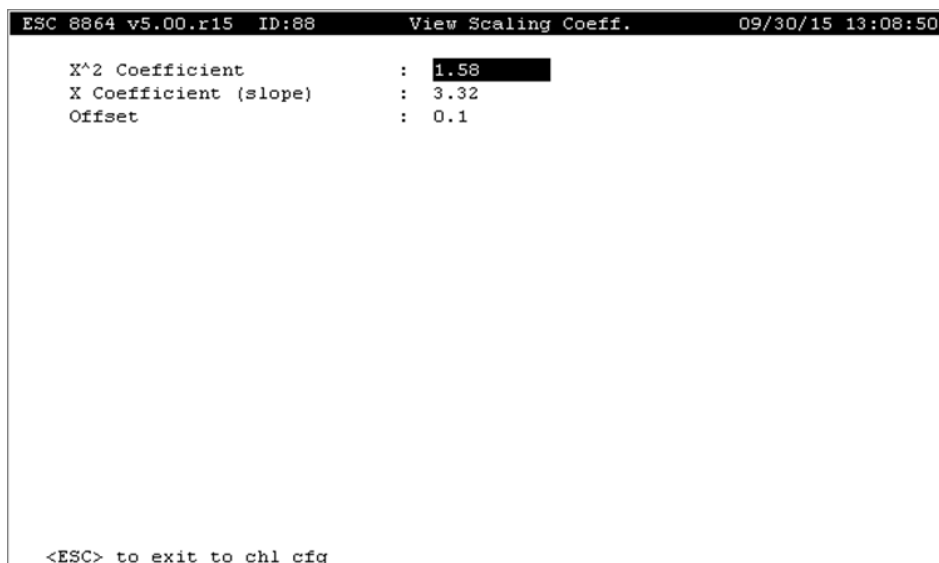
Instrument Name       : SO2
Analog Input Number  : 07
Report Channel Number : 07
Volts Full Scale     : N/A
High Input           : 20 mA
Mid Input            : 10 mA
Low Input            : 0 mA
High Output (E.U.s)  : 100
Mid Output (E.U.s)   : 43.1
Low Output (E.U.s)   : 2
Units                : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-4) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

After toggling to parabolic scaling (Ctrl + C), pressing **Ctrl + T** displays the three-point scaling constants. These are based on the regular channel configuration of low/mid/high inputs and outputs. See the following screen example.

### View Scaling Coeff:



## Math Pack and Average Math Pack Channel



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Math channels calculate results according to a user-defined equation. The configured equation can use the results of other channels as operators. This channel type is most often used to correct stack gas readings from dilution probes for the diluent or to calculate emission rates for pollutants in lbs/hour or lbs/mmBtu. Like the standard averaging channel, a math pack channel has a base average and up to two dependent averages.

There are two distinct types of math channels:

- **Math Channels (type “M”):** The equation is evaluated on the instantaneous (once-per-second) values and then the result of the equation is averaged to form the base average. The base average is used to compute the extended averages.
- **Average Math (type “P”):** In this channel type, the equation is only evaluated on the averages of the input channels. The base average of the Average Math (type “P”) channel is computed using the equation from the base average of the constituent channels. Similarly, the extended averages of the Average Math channel are computed using the equation from the corresponding averages in the constituent channels.

It is important to note that the two types of math channels will likely result in similar but different results. You should carefully consider which type of averaging to use. More detail and an example can be found in the section “M” type vs. “P” type Math Channels.





**IMPORTANT:** A system parameter called Math Update Rate allows the rate at which equations are evaluated to be configured, from once per second to once per 10 seconds.

#### Related Topics:

- [Math Pack Channel Configuration](#)
- [Average Math Pack Channel Configuration](#)
- [Equation Configuration](#)
- [Explicit Rounding in Equations](#)
- [Round to Significant Digit Functions in Equations](#)
- [Configure Data Validation Flags in Math Channels](#)
- [Configure Math Constants](#)

## Math Pack Channel Configuration

To display the Math Pack channel configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > M - Math Pack**.

```
ESC 8864 v5.02.r25 ID:88Math Channel Configuration (Page 1) 12/04/17 16:37:33

Instrument Name      : TEMP
Report Channel Number : 06
Equation             : 0=

Units                : #/MBTU

CTRL-N=Next Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options
```

Pressing **Ctrl+N** displays the second page as shown in the next example. Once on the second page, pressing **Ctrl+P** returns to the first page.

```

ESC 8864 v6.01r24 ID:01 Avg. Math Channel Config (Page 2) 01/19/21 20:33:04

Name (not editable)      : TEMP
Ch1 Number (not editable) : 62
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)  : N
Pass Constituent Flags    : Y
Pass Constituent BO Flags : Y
Include Invalid Constituents: N
OOC Validation Type (0-7) : 0
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

The following information provides a description of the Math Channel Configuration screens (Page 1 and Page 2). Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Equation

The equation to be used to calculate data from this channel; see [Equation Configuration](#) for details. Up to 255 characters.

If using math constants, see [Configure Math Constants](#).

### Units

The engineering units to which the equation results will be scaled (AP, #/MBTU, PPM, etc.).

### Name (not editable)

Instrument name entered on Page 1 configuration screen. The Name field is not editable in the Page 2 configuration screen.

### ChI Number (not editable)

Report Channel Number entered on Page 1 configuration screen. The ChI Number field is not editable in the Page 2 configuration screen.

### Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

### Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

### Round Constituents (Y/N)

Y(es) or N(o) to indicate if the constituents for this calculated average are to be rounded before calculating the average. If Y, the constituents in the equation will be rounded according to the precision configured in the channel options screen for the constituent(s). If this math channel parameter is to be used in another math channel equation (i.e., it is itself a constituent) and that math channel is to be rounded, use <Ctrl><D> to configure the rounding precision. See also [Implicit Rounding of Values](#).

### Pass Constituent Flags (Y/N)



**IMPORTANT:** See [Constituent Flag Options](#) for related information when configuring the following fields: *Pass Constituent Flags*, *Pass Constituent BO Flags*, and *Include Invalid Constituents*. Also note that configuring an incorrect combination of settings for these fields will cause error -351 in the 8864 Data Controller. The error message includes default settings for the three constituent fields identified in this note.

Y(es) or N(o) to indicate when flags are passed. See the next table for functionality.

Pass Constituent Flags	Pass Constituent BO Flags	Function
N	N	Exclude all constituent flags (only "local" flags are

Pass Constituent Flags	Pass Constituent BO Flags	Function
		passed)
N	Y	Exclude all constituent flags (only “local” flags are passed)
Y	N	Exclude all “F” and informational flags unless a <a href="#">validity flag</a> is present, in which case all flags are passed. (This is the same operation as the old field “Constituent BO Flags (Y/N)” = “N” prior to firmware version 5.06.)
Y	Y	Include all flags. (This is the same operation as the old field “Constituent BO Flags (Y/N)” = “Y” prior to firmware version 5.06.)

### Pass Constituent BO Flags (Y/N)

Y(es) or N(o) to indicate if the offline condition of constituent channels should be included. If Y(es), the constituent offline flags are propagated to the math channel. If N(o), the constituent offline flags are not propagated. (This field was previously named “Constituent BO Flags” in firmware versions prior to v5.06. Functionality did not change however.)

### Include Invalid Constituents (Y/N)

Y(es) or N(o) to indicate whether or not invalid constituents with a “<” flag ([validity flag](#)) are included in the average result:

- N (No) = invalid values are excluded in average results and invalid constituents will propagate INVALID status flags to the target channel.
- Y (Yes) = invalid values are included in average results and invalid constituents will be treated as VALID for the target channel and will NOT propagate INVALID status flags to the target channel.

### Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					Base averages determining the Ext2 validation	
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 (“Y”), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 (“A”), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10	Yes	No	Identical to Validation Type 2 except that the	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
		(d)			Ext2 average is built from the Base average (arithmetic averaging)	
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

### Average Math Pack Channel Configuration

To display the Average Math Pack configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > P - Average Math Pack**.

```

ESC 8864 v5.02.r25 ID:88Average Math Channel Config. (Page 112/04/17 16:50:44)

Instrument Name      : TEMP
Report Channel Number : 06
Equation            : 0=

Units               : #/MBTU

CTRL-N=Next Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

Pressing **Ctrl+N** displays the second page as shown in the next example. Once on the second page, pressing **Ctrl+P** returns to the first page.

```

ESC 8864 v6.01r24 ID:01 Avg. Math Channel Config (Page 2) 01/19/21 20:37:36

Name (not editable) : TEMP
Chl Number (not editable) : 62
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N) : N
Pass Constituent Flags : Y
Pass Constituent BO Flags : Y
Include Invalid Constituents: N
OOC Validation Type (0-7) : 0
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

The following information provides a description of the Math Channel Configuration screens (Page 1 and Page 2).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

## Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

## Equation

The equation to be used to calculate data from this channel; see [Equation Configuration](#) for details. Up to 255 characters.

If using math constants, see [Configure Math Constants](#).

## Units

The engineering units to which the equation results will be scaled (AP, #/MBTU, PPM, etc.).

## Base Avg. Interval, Storage

The first half of the field specifies the first interval time at which the 8864 will evaluate the Equation. This interval must match the Base Average Interval of any constituent channels in the Equation. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the second interval time at which the 8864 will evaluate the Equation. This interval must match the Average #1 Interval of any constituent channels in the Equation. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the third interval time at which the 8864 will evaluate the Equation. This interval must match the Average #2 Interval of any constituent channels in the Equation. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## Round Constituents (Y/N)

Y(es) or N(o) to indicate if the constituents for this calculated average are to be rounded before calculating the average. If Y, the constituents in the equation will be rounded according to the precision configured in the channel options screen for the constituent(s). If this math channel parameter is to be used in another math channel equation (i.e., it is itself a constituent) and that math channel is to be rounded, use <Ctrl><D> to configure the rounding precision. See also [Implicit Rounding of Values](#).



## Pass Constituent Flags (Y/N)



**IMPORTANT:** See [Constituent Flag Options](#) for related information when configuring the following fields: *Pass Constituent Flags*, *Pass Constituent BO Flags*, and *Include Invalid Constituents*. Also note that configuring an incorrect combination of settings for these fields will cause error -351 in the 8864 Data Controller. The error message includes default settings for the three constituent fields identified in this note.

Y(es) or N(o) to indicate when flags are passed. See the next table for functionality.

Pass Constituent Flags	Pass Constituent BO Flags	Function
N	N	Exclude all constituent flags (only “local” flags are passed)
N	Y	Exclude all constituent flags (only “local” flags are passed)
Y	N	Exclude all “F” and informational flags unless a <a href="#">validity flag</a> is present, in which case all flags are passed. (This is the same operation as the old field “Constituent BO Flags (Y/N)” = “N” prior to firmware version 5.06.)
Y	Y	Include all flags. (This is the same operation as the old field “Constituent BO Flags (Y/N)” = “Y” prior to firmware version 5.06.)

## Pass Constituent BO Flags (Y/N)

Y(es) or N(o) to indicate if the offline condition of constituent channels should be included. If Y(es), the constituent offline flags are propagated to the math channel. If N(o), the constituent offline flags are not propagated. (This field was previously named “Constituent BO Flags” in firmware versions prior to v5.06. Functionality did not change however.)

## Include Invalid Constituents (Y/N)

Y(es) or N(o) to indicate whether or not invalid constituents with a “<” flag ([validity flag](#)) are included in the average result:

- N (No) = invalid values are excluded in average results and invalid constituents will propagate INVALID status flags to the target channel.
- Y (Yes) = invalid values are included in average results and invalid constituents will be treated as VALID for the target channel and will NOT propagate INVALID status flags to the target channel.

## OOO Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 ("Y"), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					averaging)	
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

### Equation Configuration

To define the equation that a math pack channel uses as its input, the equation must be entered just as it would be on a calculator. The maximum length of a math equation is 512 characters. The maximum number of operators in a math equation has been increased by a factor of 10.

Beginning in firmware Version 6.01.r52, equations that use the merge math operator "?" with operands that are surrounded by parenthesis, such as  $(\text{parm1} + \text{parm2}) ? \text{parm3} =$ , are

supported when downloaded or typed into the 8864. The 8864 also supports equations with a constant or numeric value on the right side of the merge math operator "?" as shown in the next example:

```
channel1?K02= OR channel1?K2= OR channel1?12.34=
```

Support for the previously described functionality also applies to embedded merge, such as  $(S1?S2)?S3=$ .

For related information, see the following topics. Also refer to the [Equation Example](#) later in this topic.

- [Operators](#)
- [Functions](#)

## Operators

In addition to numerals, the operators identified in the following table can be used to define an equation.

Equation Symbol	Explanation
<channel name>	Value of channel
*	Multiply
/	Divide
+	Add
-	Subtract
^	Raise to the power
K1...K99	Use math pack constant in equation
SQRT()	Take square root
%	Modulo "A % B" returns the remainder when A is divided by B. Implemented as: $A - \text{floor}(A/B) * B$ Where "floor()" returns the next smaller integer.
~	Round
TRUNC()	Truncate

Equation Symbol	Explanation
SECMN(SECS)	Number of seconds into the current SECS second interval. If SECS is omitted, the default is 60 seconds (1 min).
HRDAY(HRS)	Number of hours into the current HRS hour interval. If HRS is omitted, the default is 24 hours (1 day).
<	Math less than: Format is $A < B$ . If A is less than B, then the value and flags from A are used and the flags from B are not passed to the target channel. Else the values and flags from B are used and the flags from A are not passed to the target channel. A and B can be channel names, math constants, etc.
?	<p>Math merge channels: Format is (<math>\text{&lt;expression1&gt; ? &lt;expression2&gt;</math>).</p> <p><math>\text{&lt;expression1&gt;}</math> is considered the primary expression and <math>\text{&lt;expression2&gt;}</math> is considered the secondary expression.</p> <p>Additional functionality includes:</p> <ul style="list-style-type: none"> <li>■ If an expression is enclosed in parenthesis, the entire expression is evaluated before being used in the math merge operation. An expression can be the result of other operations, a single channel, or nested operation results.</li> <li>■ If the primary expression is valid, then the result is the primary expression flags and value.</li> <li>■ If the primary expression is invalid and the secondary expression is NOT invalid, then the result is the secondary expression flags and value.</li> <li>■ If the primary and secondary expressions are both invalid, then the result is the primary expression flags and value.</li> </ul>
SIG1(), SIG2(), SIG3(), ... , SIG9()	Round to Significant Digit: round the value to the specified number of significant digits. Leading zeros that are to the right of the decimal point are not significant.
SIN()	Sine
ASIN()	Arc sine
COS()	Cosine
ACOS()	Arc cosine
TAN()	Tangent

Equation Symbol	Explanation
ATAN()	Arc tangent
LOG()	Logarithm, base 10
LN()	Natural logarithm
ABS()	Absolute value
EXP()	Natural exponent
QTRHR()	Quarter hour in fractional units
MINHR(MINS)	Number of minutes into the current MINS minute interval. If MINS is omitted, the default is 60 minutes (1 hr).
JDAY(DAYS)	Number of days into the current DAYS interval. If DAYS is omitted, the default is the total number of days in the current year.
>	Math greater than: Format is $A > B$ . If A is greater than B, then A is used. Else B is used. A and B can be channel names, math constants, etc.
#	Math optime: Format is $A \# B$ . A is the value to normalize. B is the number of divisions in which hour is to be divided (precision). A and B can be channel names, math constants, etc.

## Functions

In addition to numerals, as well as the operators identified in the previous table, the following functions can be used to define an equation.

Function	Returns
NEXTCAL(calibration)	Number of seconds until the next scheduled start time for the specified auto-calibration sequence. Only valid for calibration types "A" and "1", others return zero.
LASTCAL(calibration)	Number of seconds since the last time that the named calibration sequence was started. If never started, return zero.
STARTUP(calibration)	Seconds left in the startup delay for the named calibration sequence. Zero if not in a startup delay. The STARTUP() function does not begin until an entire clock minute (:00 to :59) has elapsed after a channel goes "online". For example, if a channel goes online at

Function	Returns
	05:23:15 then the STARTUP function will return 0 until 05:25:00 (i.e., the channel is online from 04:24:00 to 05:24:59).
PHASE(calibration)	Seconds left in the currently active calibration phase. Returns zero if the calibration is not active, or if the remaining time in the phase is indeterminate (like in an instrument-controlled calibration).
NEXTEVENT(event)	Number of seconds until the next scheduled run for the specified timed digital event.
LASTEVENT(event)	Number of seconds since the last time that the named timed digital event was started. If never started, return zero.
26HOUR(channel)	Seconds remaining in the 26-clock-hour timer for the named channel. The 26-clock-hour period starts at the beginning of the clock hour in which the last passed calibration was completed. If the "Allow offline cals" is "N" in the channel configuration, then the last passed calibration is the last passed online calibration. If the "Allow offline cals" is "Y" in the channel configuration or if "Allow OFFLINE OOC Check" is "Y" in the calibration configuration, then the last passed calibration is the last passed online or offline calibration. Zero if the timer has expired or a calibration has never run for that channel.
26OPHR(channel)	Seconds remaining in the 26-operating-hour timer for the named channel. The 26-operating-hour period starts at the beginning of the clock hour in which the last passed online calibration was completed and only counts hours during which the channel was online at any time during that hour. If "Allow offline cals" is "N" in the channel configuration, then this counter does not affect the OOC status of the channel; therefore, the counter remains at zero. Zero if the timer has expired or a calibration has never run for that channel.
GRACE(channel)	Seconds remaining in the 8-hour grace period after startup for the named channel. Zero if not in a valid 40CFR75 grace period or if a grace period doesn't

Function	Returns
	apply for that channel. The channel must be online for one entire clock minute (:00 to :59) at the start of the grace period before this counter begins to count. For example, if a channel goes online at 05:23:15 then the GRACE function will return 0 until 05:25:00.
SEC2OOC(channel)	Seconds until the channel is automatically marked as OOC, assuming no calibration check is run in the meantime and the channel is online in every subsequent hour. If "Allow offline cals" is "N" in the channel configuration, then this value is the maximum value between GRACE() and 26HOUR(). If "Allow offline cals" is "Y" in the channel configuration, this value is the maximum value between GRACE() and the minimum value of 26HOUR() and 26OPHR(). The channel will not go OOC if the unit is offline when SEC2OOC() reaches zero.

### Equation Example

**EXAMPLE:** If a user wants to average the concentration of SO<sub>2</sub> for three ducts into one "stack value" weighed by three flow measurements, the equation would be:

$$(SO2A * FLOWA + SO2B * FLOWB + SO2C * FLOWC) / 3.0 =$$



When a channel name is used in an equation, that channel must already exist or the 8864 will invalidate the equation entry.

### Explicit Rounding in Equations

The format for explicitly rounding values in a math equation is:

<expression>~<round\_precision>, where <expression> is any valid math pack sequence of values, operators, or operands

The <expression> is rounded to the number of decimal places indicated by <round\_precision>. The value of <round\_precision> is interpreted as:

1 = round to the nearest tenth

-1 = round to the nearest ten

2 = round to the nearest hundredth



- 2 = round to the nearest hundred
- 3 = round to the nearest thousandth
- 3 = round to the nearest thousand, etc.

The implicit rounding of values is described in the section [Implicit Rounding of Values](#).

## Round to Significant Digit Functions in Equations

You can configure math equations with “round to significant digit” functions SIG1, SIG2, SIG3, through SIG9. Rounding occurs as follows:

- The function “SIG1( )” rounds to 1 significant digit.
- The function “SIG2( )” rounds to 2 significant digits
- The function “SIG3( )” rounds to 3 significant digits
- The function “SIG4( )” rounds to 4 significant digits
- The function “SIG5( )” rounds to 5 significant digits
- The function “SIG6( )” rounds to 6 significant digits
- The function “SIG7( )” rounds to 7 significant digits
- The function “SIG8( )” rounds to 8 significant digits
- The function “SIG9( )” rounds to 9 significant digits

This is different than explicit rounding already used in math equations where we use the tilde symbol (~) for explicit rounding. Explicit rounding rounds to the number of digits to the right of the decimal point. For example, if a channel named NOXLBS has the value 0.00123456 and it is rounded to 3 places to the right of the decimal point (configured in an equation as NOXLBS~3), then it would round to 0.001.

However, with significant digit rounding, leading zeros to the right of the decimal point are not considered significant, and as a result are not counted as significant digits. Using the same example as earlier, the first 3 significant digits are 123. So the value 0.00123456 rounded to 3 significant digits (configured as SIG3(NOXLBS) in the equation), would calculate to be 0.00123.

## Math Operators and Overrange/NAN Channel Values

Use the legend information in the following list with the next table:

- ANALOGA = Overrange/NAN
- ANALOGB = ~64.16
- ANALOGC = Overrange/NAN
- Flag Table Column: none = no flag

Operator	Operator Description	Equation	Value	Flag
>	Greater than	ANALOGA>0=	0	none
>	Greater than	ANALOGA>1	1	none
<	Less than	ANALOGA<0=	0	none
<	Less than	ANALOGA<1=	1	none
>	Greater than	ANALOGA>ANALOGC=	Overrange	OA
>	Greater than	ANALOGC>ANALOGA=	Overrange	OA
<	Less than	ANALOGA<ANALOGC=	Overrange	OA
<	Less than	ANALOGC<ANALOGA=	Overrange	OA
+	Add	ANALOGA+2=	Overrange	OA
+	Add	2+ANALOGA=	Overrange	OA
-	Subtract	ANALOGA-2=	Overrange	OA
-	Subtract	2-ANALOGA=	Overrange	OA
*	Multiply	ANALOGA*2=	Overrange	OA
*	Multiply	2*ANALOGA=	Overrange	OA
/	Divide	ANALOGA/2=	Overrange	OA
/	Divide	2/ANALOGA=	Overrange	OA
?	Math merge channels: Format is (<expression1> ? <expression2>). <expression1> is considered the primary expression and <expression2> is considered the	ANALOGA?ANALOGB=	64.16	none

Operator	Operator Description	Equation	Value	Flag
	<p>secondary expression.</p> <p>Additional functionality includes:</p> <ul style="list-style-type: none"> <li>■ If an expression is enclosed in parenthesis, the entire expression is evaluated before being used in the math merge operation. An expression can be the result of other operations, a single channel, or nested operation results.</li> <li>■ If the primary expression is valid, then the result is the primary expression flags and value.</li> <li>■ If the primary expression is invalid and the secondary expression is NOT invalid, then the result is the secondary expression flags and value.</li> <li>■ If the primary and secondary expressions are both invalid, then the result is the primary expression flags and value.</li> </ul>			
?	Math merge channel – see previous	ANALOGB?ANALOGA=	64.16	none

Operator	Operator Description	Equation	Value	Flag
	description.			
?	Math merge channel – see previous description.	ANALOGA?ANALOGA=	Overrange	OA
^	Raise to the power	ANALOGA^2=	Overrange	OA
^	Raise to the power	2^ANALOGA=	Overrange	OA
K1...K99	Use math pack constant in equation	K1=	1	none
SQRT(0)	Take square root	SQRT(0)=	0	none
SQRT(ANALOGA)	Take square root	SQRT(ANALOGA)=	Overrange	OA
%	Modulo  “A % B” returns the remainder when A is divided by B. Implemented as: A - floor(A/B) * B  Where “floor()” returns the next smaller integer.	ANALOGA%2=	Overrange	OA
%	Modulo – see previous description	2%ANALOGA=	Overrange	OA
~	Round	ANALOGA~2=	Overrange	OA
~	Round	2~ANALOGA=	Overrange	OA
TRUNC()	Truncate	TRUNC(0)=	0	none
TRUNC(ANALOGA)	Truncate	TRUNC(ANALOGA)=	Overrange	OA
SECMN(SECS)	Number of seconds into the current SECS second interval. If SECS is omitted, the default is 60 seconds (1 min).	SECMN(0)=	Overrange	A
SECMN(ANALOGA)	Number of seconds into the current SECS second interval. If SECS	SECMN(ANALOGA)=	Overrange	OA

Operator	Operator Description	Equation	Value	Flag
	is omitted, the default is 60 seconds (1 min).			
HRDAY(0)	Number of hours into the current HRS hour interval. If HRS is omitted, the default is 24 hours (1 day).	HRDAY(0)=	Overrange	A
	Number of hours into the current HRS hour interval – see previous description.	HRDAY(ANALOGA)=	Overrange	OA
SIN(0)	Sine	SIN(0)=	0	none
SIN(ANALOGA)	Sine	SIN(ANALOGA)=	Overrange	OA
ASIN(0)	Arc sine	ASIN(0)=	0	none
ASIN(ANALOGA)	Arc sine	ASIN(ANALOGA)=	Overrange	OA
COS(0)	Cosine	COS(0)=	1	none
COS(ANALOGA)	Cosine	COS(ANALOGA)=	Overrange	OA
TAN(0)	Tangent	TAN(0)=	0	none
TAN(ANALOGA)	Tangent	TAN(ANALOGA)=	Overrange	OA
ATAN(0)	Arc tangent	ATAN(0)=	0	none
ATAN(ANALOGA)	Arc tangent	ATAN(ANALOGA)=	Overrange	OA
LOG(0)	Logarithm, base 10	LOG(0)=	0	A
LOG(ANALOGA)	Logarithm, base 10	LOG(ANALOGA)=	Overrange	OA
LN(0)	Natural logarithm	LN(0)=	0	A
LN(ANALOGA)	Natural logarithm	LN(ANALOGA)=	Overrange	OA
ABS(0)	Absolute value	ABS(0)=	0	none
ABS(ANALOGA)	Absolute value	ABS(ANALOGA)=	Overrange	OA
EXP(0)	Natural exponent	EXP(0)=	1	none
EXP(ANALOGA)	Natural exponent	EXP(ANALOGA)=	Overrange	OA
QTRHR(0)	Quarter hour in fractional units	QTRHR(0)=	0	none

Operator	Operator Description	Equation	Value	Flag
QTRHR (ANALOGA)	Quarter hour in fractional units	QTRHR(ANALOGA)=	Overrange	OA
MINHR(0)	Number of minutes into the currents MINS minute interval. If MINS is omitted, the default is 60 minutes (1 hr).	MINHR(0)=	Overrange	A
MINHR (ANALOGA)	Number of minutes into the currents MINS minute interval – see previous description.	MINHR(ANALOGA)=	Overrange	OA
JDAY(0)=	Number of days into the current DAYS interval. If DAYS is omitted, the default is the total number of days in the current year.	JDAY(0)=	Overrange	A
JDAY(ANALOGA)	Number of days into the current DAYS interval – see previous description.	JDAY(ANALOGA)=	Overrange	OA
ANALOGA#100	Math optime: Format is A # B. A is the value to normalize. B is the number of divisions in which hour is to be divided (precision). A and B can be channel names, math constants, etc.	ANALOGA#100=	Overrange	OA
100#ANALOGA	Math optime – see previous description.	100#ANALOGA=	Overrange	OA

### Configure Math Constants

The Configure Math Constants screen allows you to create up to 99 math constants (K1...K99) that can be used throughout the system. These math constants may be used in equations for math pack channels. The intention of math constants is to represent parameters in the system that only periodically change. This screen is an easy way to update those constants without

reconfiguring several math channels.



**NOTE:** An option will allow a calibration expected value or result to be written to a math constant; see [Configure Expected Values](#). Any of the three averages of a channel (base, average #1, average #2) can also be written to a constant; see [Configure Average Validation Limits](#).

Secondary or tertiary values based on digital inputs can also be defined for math constants. These were designed for fuel-switching systems, which must constantly adjust the fuel factor and can provide digital inputs representing the exact fuel loaded.

To change a channel configuration:

1. From the Home Menu, select **C - Configuration Menu > K - Configure Math Constants**.

The following screen displays.

2. Place the cursor on the desired math constant and then press **<Ctrl><A>**.

```

ESC 8864 v5.02.r25 ID:88 Set Math Pack Constants 12/04/17 18:52:54

Constant K1 = 1
Constant K2 = 1
Constant K3 = 1
Constant K4 = 1
Constant K5 = 1
Constant K6 = 1
Constant K7 = 1
Constant K8 = 1
Constant K9 = 1
Constant K10 = 1
Constant K11 = 1
Constant K12 = 1
Constant K13 = 1
Constant K14 = 1
Constant K15 = 1
Constant K16 = 1

ESC=Exit, CTRL-A=Alternate Values, CTRL-N=Next Page

```

A screen displays with fields for entering the numerical value and digital input status for the secondary and tertiary states. See the next example.

Pressing **<Ctrl><N>** displays the next page of math constants. Pressing **<Ctrl><P>** displays the previous page of math constants.

When the digital input state does not match the secondary or tertiary status, the primary value (edited on the first screen) is used.

ESC 8864 v5.02.r25 ID:88		Set Constants/Secondary	12/04/17 19:17:06
Constant # (not editable) :	1		
Primary Value = :	1.000000		
Alternate Value#1 = :	0.000000		
Alternate Status#1 :	(none)		
Alternate Value#2 = :	0.000000		
Alternate Status#2 :	(none)		

ESC=Exit, CTRL-A=Primary Values

### Configure Data Validation Flags in Math Channels

The tables in this section identify how data validation flags are propagated in math pack and average math channels.

In the following tables:

- **(Y)**: indicates “yes” but flag is not propagated. Only average information configured for that average is seen.
- **((Y))**: indicates “yes” but flag is only generated on base average and propagated to extended averages.
- **\*Flag**: indicates a flag appears but data are not invalidated.

Flag Type in Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
All instant. validation flags on math parameter	Y	Y	Y	Y
V-Z instant. information flags on math parameter	Y	Y	Y	Y
All average validation flags on math parameter (H, h, L, l, J, j, f, c) except G	N	(Y)	(Y)	(Y)
G average validation flag on math parameter	N	Y	((Y))	((Y))



Flag Type in Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
All instantaneous validation flags on constituent	Y	Y	Y	Y
Out-of-control tolerance flag on constituent	Y	Y	Y	Y
V-Z instant. information flags on constituent	Y	Y	Y	Y
All average validation flags on constituent (H, h, L, I, J, j, f, c, G)	N	N	N	N

Flag Type in Average Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
All instant. validation flags on math parameter	Y	Y*	Y*	Y*
V-Z instant. information flags on math parameter	Y	Y	Y	Y
All average validation flags on math parameter (H, h, L, I, J, j, f, c) except G	N	(Y)	(Y)	(Y)
G average validation flag on math parameter	N	Y	((Y))	((Y))
All instantaneous validation flags on constituent	Y	Y	Y	Y
Out-of-control tolerance flag on constituent	Y	Y	Y	Y
V-Z instant. information flags on constituent	Y	N	N	N
All average validation flags on constituent (H, h, L, I, J, j, f, c, G)	N	N	N	N

### “M” Type Versus “P” Type Math Channels

There are two distinct types of math channels:

- **Math Channels (type “M”):** The math equation is evaluated on the instantaneous (once-per-second) values and then the result of the equation is averaged to form the base average. The base average is used to compute the extended averages.
- **Average Math (type “P”):** In this channel type, the equation is only evaluated on the averages of the input channels. The base average of the Average Math (type “P”) channel is computed using the equation from the base average of the constituent channels. Similarly, the extended averages of the Average Math channel are computed using the equation from the corresponding averages in the constituent channels.

It is important to note that the two types of math channels will likely result in similar but different

results. You should carefully consider which type of averaging to use.

To illustrate the difference between “M” type and “P” type math channels, consider the following example:

- Assume there are two analog input channels “NOX” and “FLOW” that we need to combine to get a mass-flow rate “MASS”.
- The equation is  $MASS = NOX * FLOW$
- To make things easier, instead of sampling every 1 second (like in the 8864), we are assuming that we are sampling every 10 seconds. We will also assume that the input channels have the following “instantaneous” values:

	NOX	FLOW
00:00:00	1.0	100
00:00:10	1.1	200
00:00:20	1.2	300
00:00:30	1.3	400
00:00:40	1.4	500
00:00:50	1.5	600

- To compute a 1-minute base average for each channel, add them together and then divide by the number of averages (6, in this case):

	NOX	FLOW
00:00:00	1.0	100
00:00:10	1.1	200
00:00:20	1.2	300
00:00:30	1.3	400
00:00:40	1.4	500
00:00:50	1.5	600
<b>1-min avg:</b>	<b>1.25</b>	<b>350</b>

- Also, the once-per-10-second “instantaneous” value for MASS is the value of the input channels (NOX and FLOW) evaluated with the equation  $MASS = NOX * FLOW$ :

	NOX	FLOW	MASS
00:00:00	1.0	100	100
00:00:10	1.1	200	220
00:00:20	1.2	300	360
00:00:30	1.3	400	520
00:00:40	1.4	500	700
00:00:50	1.5	600	900
<b>1-min avg:</b>	<b>1.25</b>	<b>350</b>	

- Now, consider how the 8864 should calculate the 1-minute base average for the MASS channel:

	NOX	FLOW	MASS
00:00:00	1.0	100	100
00:00:10	1.1	200	220
00:00:20	1.2	300	360
00:00:30	1.3	400	520
00:00:40	1.4	500	700
00:00:50	1.5	600	900
<b>1-min avg:</b>	<b>1.25</b>	<b>350</b>	<b>???</b>

- One way would be to average together the instantaneous (one-per-10-second) values of MASS. This is what the 8864 does for “M” type math channels:

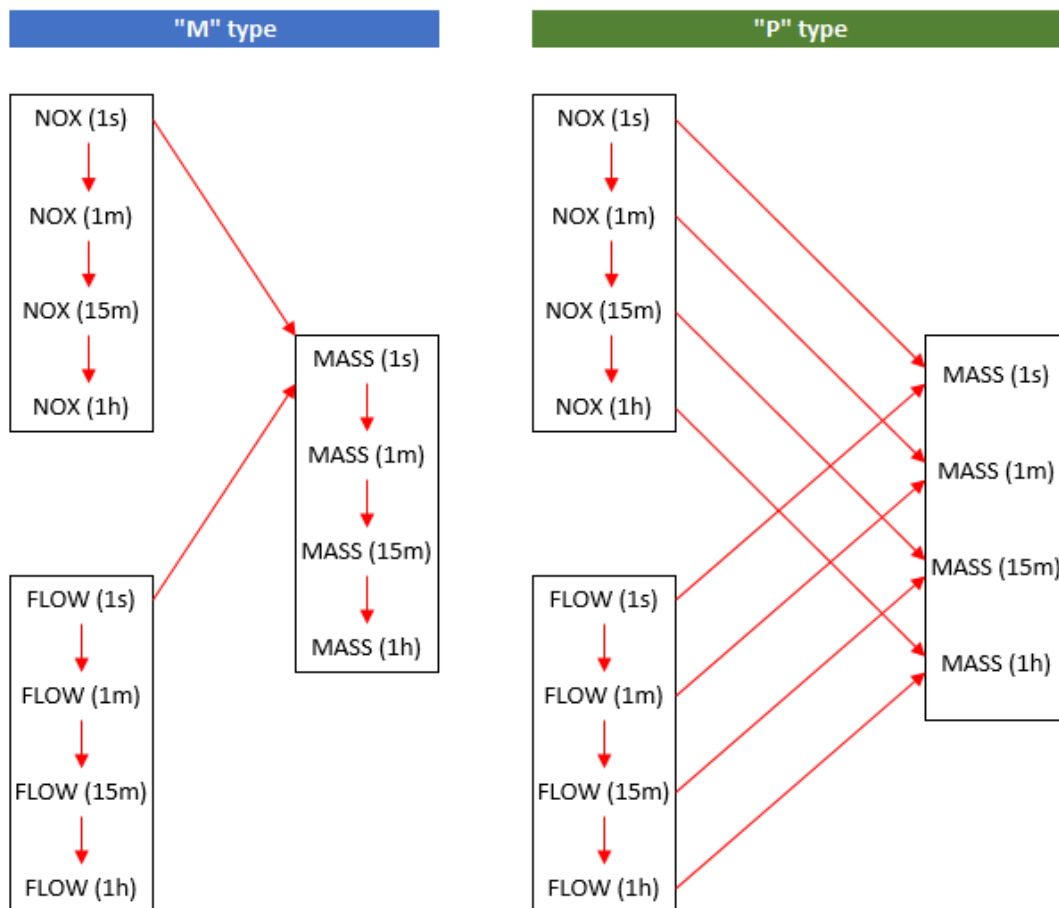
	NOX	FLOW	MASS
00:00:00	1.0	100	100
00:00:10	1.1	200	220
00:00:20	1.2	300	360
00:00:30	1.3	400	520
00:00:40	1.4	500	700
00:00:50	1.5	600	900
<b>1-min avg:</b>	<b>1.25</b>	<b>350</b>	<b>466.7</b>

- The second way is for the 8864 to apply the equation to the 1-minute base averages of NOX and FLOW to get the 1-minute base average for MASS:

	NOX	FLOW	MASS
00:00:00	1.0	100	100
00:00:10	1.1	200	220
00:00:20	1.2	300	360
00:00:30	1.3	400	520
00:00:40	1.4	500	700
00:00:50	1.5	600	900
<b>1-min avg:</b>	<b>1.25</b>	<b>350</b>	<b>437.5</b>

- You should note that in this example, as is often the case for most types of equations, the values for the “M” type and “P” type methods yield similar but different results (466.7 vs. 437.5).

To summarize, the “M” type channel applies the equation to the instantaneous values of the input channels and averages the result. The “P” type channel applies the equation to the averaged values of the input channels. Visually, the difference can be seen in the following data flow diagram:



The tables in this section identify how data validation flags are propagated in math pack and

average math channels.

In the following tables:

- **(Y)**: indicates “yes” but flag is not propagated. Only average information configured for that average is seen.
- **((Y))**: indicates “yes” but flag is only generated on base average and propagated to extended averages.
- **\*Flag**: indicates a flag appears but data are not invalidated.

Flag Type in Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
All instant. validation flags on math parameter	Y	Y	Y	Y
V-Z instant. information flags on math parameter	Y	Y	Y	Y
All average validation flags on math parameter (H, h, L, I, J, j, f, c) except G	N	(Y)	(Y)	(Y)
G average validation flag on math parameter	N	Y	((Y))	((Y))
All instantaneous validation flags on constituent	Y	Y	Y	Y
Out-of-control tolerance flag on constituent	Y	Y	Y	Y
V-Z instant. information flags on constituent	Y	Y	Y	Y
All average validation flags on constituent (H, h, L, I, J, j, f, c, G)	N	N	N	N

Flag Type in Average Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
All instant. validation flags on math parameter	Y	Y*	Y*	Y*
V-Z instant. information flags on math parameter	Y	Y	Y	Y
All average validation flags on math parameter (H, h, L, I, J, j, f, c) except G	N	(Y)	(Y)	(Y)
G average validation flag on math parameter	N	Y	((Y))	((Y))
All instantaneous validation flags on constituent	Y	Y	Y	Y
Out-of-control tolerance flag on constituent	Y	Y	Y	Y

Flag Type in Average Math Pack Channels	Instantaneous Reading	Base Avg	Avg#1	Avg#2
V-Z instant. information flags on constituent	Y	N	N	N
All average validation flags on constituent (H, h, L, I, J, j, f, c, G)	N	N	N	N

## Rolling Average Channel



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Rolling average channels take average values determined by other channels as input, and then calculate rolling averages from them. A rolling average is updated at the same interval as the input average, but is calculated over a length of time equal to the rolling average duration. If, for example, the input average interval is one minute, and the rolling average duration is one hour, the rolling average channel will store a new data point every minute.

To display the Rolling Average Config screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > R - Rolling Averaging**.

The following screen displays.

```

ESC 8864 v6.00r39 ID:01      Rolling Average Config      06/09/20 20:15:49

Instrument Name      : TEMP
Report Channel Number : 62
Input Channel       : (none)
Input Avg Interval,Storage : 1m , 0s
Units              : #/HR
Rolling Average Duration : 1h
Clear at Rolling Interval? : N
Exclude Offline Data? : N
Pass Constituent Flags : Y
Pass Constituent BO Flags : Y
Include Invalid Constituents: N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the Rolling Average Config screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Input Channel

The name of the channel to be used as input. Must be a configured channel name.

### Input Avg Interval, Storage

The first half of the field specifies the input channel's average interval from which rolling averages will be calculated. The second half of the field specifies the length of the long-term data storage buffer for the Input Average Interval.

### Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

### Rolling Average Duration

Specifies the total length of the rolling average. (Rolling averages are calculated and stored each time a new input average becomes available.) The maximum length of the rolling average stack ( $\text{Rolling Average Duration} \div \text{Input Average Interval}$ ) is limited only by the bounds of available memory.

### Clear at Rolling Interval?

Y(es) or N(o) to specify whether the rolling average buffer should be cleared at the beginning of each Rolling Average Duration. Default=N.

### Exclude Offline Data?

Y(es) or N(o) to specify whether offline input data should be excluded from the rolling average

calculation. If this is set to Y and the input data is offline, the held rolling average value is marked with the offline flag **F**. Default=N.

### Pass Constituent Flags (Y/N)



**IMPORTANT:** See [Constituent Flag Options](#) for related information when configuring the following fields: *Pass Constituent Flags*, *Pass Constituent BO Flags*, and *Include Invalid Constituents*. Also note that configuring an incorrect combination of settings for these fields will cause error -351 in the 8864 Data Controller. The error message includes default settings for the three constituent fields identified in this note.

Y(es) or N(o) to indicate when flags are passed. See the next table for functionality.

Pass Constituent Flags	Pass Constituent BO Flags	Function
N	N	Exclude all constituent flags (only “local” flags are passed)
N	Y	Exclude all constituent flags (only “local” flags are passed)
Y	N	Exclude all “F” and informational flags unless a <a href="#">validity flag</a> is present, in which case all flags are passed.
Y	Y	Include all flags. (This is the same operation as the old field “Constituent BO Flags (Y/N)” = “Y” prior to firmware version 5.06.)
<b>Note for “R” Type Channels:</b> The same rules apply for passing constituent channel flags in “R” channels (R-Rolling Averaging) as exists in “P” channels (P-Average Math Pack). For “R” channels, there is only one constituent channel and no equation.		

### Pass Constituent BO Flags (Y/N)

Y(es) or N(o) to indicate if the offline condition of constituent channels should be included. If Y(es), the constituent offline flags are propagated to the channel. If N(o), the constituent offline flags are not propagated.



### Include Invalid Constituents (Y/N)

Y(es) or N(o) to indicate whether or not invalid constituents with a "<" flag ([validity flag](#)) are included in the average result:

- N (No) = invalid values are excluded in average results and invalid constituents will propagate INVALID status flags to the target channel.
- Y (Yes) = invalid values are included in average results and invalid constituents will be treated as VALID for the target channel and will NOT propagate INVALID status flags to the target channel.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Stream-Switched Averaging Channel



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Stream-switched channels allow the 8864 to monitor one analyzer that is time-shared between two sampling trains. It forms a base average and two extended averages from another channel, accepting data from that input channel only when an online digital input status is met. If this condition is not met, data may be designated as invalid, or the last good reading, base average, extended average, or average over the previous online period may be "held" until the online status condition is met again.

An example of configuring a stream-switched (or time-shared) system between three boilers is given in [App Note - Stream-Switched Channel](#).



**NOTE:** When stream-switched channels are controlled by digital event programs or calibrated using the automatic calibration programs, the digital program or calibration timing may not line up exactly with the stream-switched channels averaging periods. It is recommended that calibrations and event programs be configured so that they end a few seconds before the start of the next base average.

To display the Stream-Switched Config screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > X - Stream-Switched Averaging**.

The following screen displays.

```

ESC 8864 v6.01r24 ID:01 Stream-Switched Config. 01/19/21 20:28:44

Instrument Name      : TEMP
Report Channel Number : 62
Input Channel       : (none)
On-Line Input Status : (none)
Purge Time         : 0s
Offline Action (I,R,O,B,I,2): I
Units              : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-7) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the Stream-Switched Config screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Input Channel

The name of the channel to be used as input. Must be a configured channel name.

### On-Line Input Status

Specifies the online digital input pattern. Both the line number and the state should be specified (**1**=on, **0**=off); e.g., **2=1**.

### Purge Time

Amount of time to wait after switching from offline to online before taking data again.

## Offline Action

If the online digital input pattern is not met, this designates whether data should be invalidated (**I**) or the last good reading (**R**), the average of the last online period (**O**), the last base average (**B**), the last average #1(**1**), the last average #2 (**2**), or a value of 0 (**Z**) should be “held” until the online status condition is met again.

## Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 (“Y”), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 (“A”), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					(arithmetic averaging)	
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Merge (Join Streams) Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Merge (Join Streams) channel type allows two channels to be merged into one channel (almost the opposite of a stream-switched channel). The real-time data from two channels are merged and then averaged. This type of channel uses the value of one of two input channels, based on a digital input line status. The On-Line Input Status pattern indicates when the

primary channel should be used; if the pattern is not observed, the secondary channel's data are used.

To display the Merge/Join Chl Config screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > J - Merge (Join Streams)**.

The following screen displays.

```

ESC 8864  v6.01r24  ID:01      Merge/Join Chl Config.      01/19/21 20:21:21

Instrument Name      : TEMP
Report Channel Number : 62
Primary Input Channel : (none)
Secondary Input Channel : (none)
On-Line Input Status : (none)
Switch on Invalid?   : Y
Switch on Flags      : (none)
Purge Time           : 0s
Flags from Off-Line Channel : (none)
Dual Range Single Analyzer? : N
Units                : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-7)   : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the Stream-Switched Config screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Primary Input Channel

The name of the channel to be used as the primary source of data for the merged channel. Must be a configured channel name.

## Secondary Input Channel

The name of the channel to be used as the secondary source of data for the merged channel. Must be a configured channel name.

## On-Line Input Status

(Merge/Join channel only) Specifies the online digital input pattern. Both the line number and the state should be specified (**1**=on, **0**=off); e.g., **2=1**.

## Switch on Invalid?

Y(es) or N(o). If Y, the merged channel will also revert to taking data from the secondary input channel if readings from the primary input channel become invalid due to a bad status, calibration, etc. (anything that results in the < flag being appended to data).

## Switch on Flags

The list of data flags that selects the secondary channel's data.

## Purge Time

(Merge/Join channel only) Amount of time to wait after switching from offline to online before taking data again.

## Flags from Off-Line Channel

(Merge/Join channel only) The flags that should be passed up to the merged channel from offline channels; data from offline channels will not be used but flags will (e.g., dual range analyzers that pass on the out-of-control flag).

## Dual Range Single Analyzer

When this field is configured as Y(es), if either input channel has failed the most recent calibration check, then the Merge channel output should be marked as OOC (T flag).

If the currently active input channel passed the most recent calibration check, but it has since expired (>26 hours), then the Merge channel output should be marked as OOC (T flag). Otherwise, the Merge channel output should not be marked as OOC (T flag). If the T flag is included in the list of Flags from Off-line Channel, it is ignored. When configured as N(o), the Merge channel functions as in previous versions. This field defaults to N(o).

## Units

The engineering units to which the readings will be scaled (e.g., **PPM**).

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and	Yes	No	Identical to Validation Type 1	Yes



Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
		40CFR75.10 (d)			("Y"), except that the 8-hour grace period is disabled	
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Average Merge Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Average Merge channel merges the results of two input channels at the average time, rather than merging real-time data, similar to the Average Math channel.

To display the Avg Merge Chl Config screen:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > K - Average Merge** (hot key **K**).

The following screen displays.

```

ESC 8864  v6.01r24  ID:01      Avg Merge Ch1 Config.      01/19/21 21:27:47

Instrument Name      : TEMP
Report Channel Number : 62
Primary Input Channel : (none)
Secondary Input Channel : (none)
Switch on Invalid?   : Y
Switch on Flags      : (none)
Units                : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
OOC Validation Type (0-7) : 0
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the Stream-Switched Config screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Primary Input Channel

The name of the channel to be used as the primary source of data for the merged channel. Must be a configured channel name.

### Secondary Input Channel

The name of the channel to be used as the secondary source of data for the merged channel. Must be a configured channel name.

### Switch on Invalid?

Y(es) or N(o). If Y, the merged channel will also revert to taking data from the secondary input channel if readings from the primary input channel become invalid due to a bad status, calibration, etc. (anything that results in the < flag being appended to data).

### Switch on Flags

The list of data flags that selects the secondary channel's data.

### Units

The engineering units to which the readings will be scaled (e.g., **PPM**).

### Base Avg. Interval, Storage

The first half of the field specifies the first interval time at which the 8864 will record data from an Input Channel. This interval must match the Base Average Interval of both the Primary Input Channel and the Secondary Input Channel. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the second interval time at which the 8864 will record data from an Input Channel. This interval must match the Average #1 Interval of both the Primary Input Channel and the Secondary Input Channel. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

### Average #2 Interval, Storage

The first half of the field specifies the third interval time at which the 8864 will record data from an Input Channel. This interval must match the Average #2 Interval of both the Primary Input Channel and the Secondary Input Channel. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

### OOO Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent	No	No	Standard	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
		Validation			Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 ("Y"), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Time On-Line Counter Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Time On-Line Counter channel and [Multi-Condition TOL Counter Channel](#) provide a method for counting intervals. Time online (TOL) channels are typically used to monitor boiler or scrubber online times. They count the number of base average intervals in which a user-

configured digital input online status is met. The total number of base averages that meet this condition is reported in an extended average.

**EXAMPLE:** If the base average is one minute and the extended average is one hour, the hourly average would report the number of minutes that the online status was observed.

To display the Time On-Line Counter channel configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > T - Time On-line Counter**.

The following screen displays.

```

ESC 8864  v6.00r39  ID:01      Time On-Line Config.      06/09/20 14:19:57

Instrument Name      : TEMP
Report Channel Number : 03
On-Line Input Status : (none)
TOL Output Control Line : (none)
Require Full Base Int (On) : N
Require Full Base Int (Off) : N
Units               : MINS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 1h , 0s
Average #2 Interval, Storage: 15m , 0s
FINISHED (Configure Now)

CTRL-V=Edit Avg. Validation, CTRL-D=Config. Channel Options
  
```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

## On-Line Input Status

Specifies the online digital input pattern. Both the line number and the state should be specified (**1**=on, **0**=off); e.g., **2=1**.

## TOL Output Control Line

Optional specification of an output line pattern to be activated or deactivated when the On-Line Input Status is met.

Note: If this pattern is changed while the TOL channel is active, the “old” pattern does not reset.

## Require Full Base Int (On)

Y(es) or N(o) to require that, to be considered online, the online input status must be met for the full Base Average Interval. Default=N. See [How Require Full Base Int On/Off Functions](#) in this topic for related information.

## Require Full Base Int (Off)

Y(es) or N(o) to require that, to be considered offline, the offline input status must **NOT** be met for the full Base Average Interval. Default=N. See [How Require Full Base Int On/Off Functions](#) in this topic for related information.

## How Require Full Base Int On/Off Functions

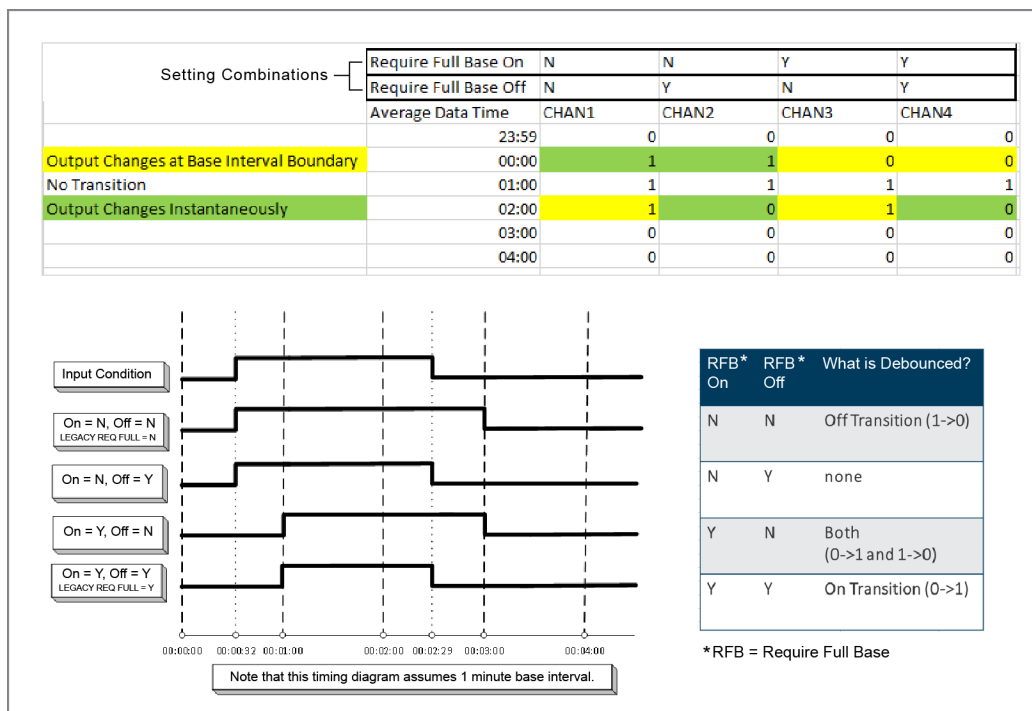
The following information applies to the Time On-Line Counter Channel (TOL) and Multi-Condition Time On-line Counter Channel (MTOL). Settings for “Require Full Base Interval (On)” and “Require Full Base Interval (Off)” determine whether or not the TOL output condition and value can change instantaneously (are not debounced) or, change at the boundary of the base interval (are debounced).

- **Require Full Base Interval (On):** When set to Yes, on transitions are debounced. When set to No, on transitions are not debounced. See next note for more information.
- **Require Full Base Interval (Off):** When set to Yes, off transitions are not debounced. When set to No, off transitions are debounced. See next note for more information.

**NOTE:** The logic for “Require Full Base Interval (On)” is opposite the logic of “Require Full Base Interval (Off)” in order to provide compatibility with previous versions of firmware.

The following example shows how digital on/off transitions are debounced based on settings the “Require Full Base Interval (On)” and “Required Full Base Interval (Off)” settings.





## Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will instantaneously check for a digital input pattern matching the On-Line Input Status. The result stored for this interval will always be either 0 or 1. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the totaling interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the totaling interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Multi-Condition TOL Counter Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

The Multi-Condition TOL Counter channel and [Time On-Line Counter Channel](#) provide a method for counting intervals. Time online (TOL) channels are typically used to monitor boiler or scrubber online times. They count the number of base average intervals in which a user-configured digital input online status is met.

Multi-condition TOL (MTOL) channels allow up to three conditions to be specified that must be considered when determining online intervals. The three conditions can be considered together (AND link), so that all conditions must be true to determine an online interval, or they can be considered separately (OR link), so that only one must be true for an online interval to be counted.

A condition can be configured as a digital input line status, a channel/threshold value or a combination of the two. If both are configured, the states of each are OR'ed together to determine the condition status.

The configuration of a multi-condition TOL channel is the same as for a time online channel, with the addition of some fields in place of the one On-Line Input Status field. Note that if a condition is not specified, it is considered false. In this case (when a condition is **not** used), it should be linked to the other states with **OR**.

To display the Multi-Condition TOL Channel Config screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > U - Multi-Condition TOL Counter**.

The following screen displays.

```

ESC 8864 v6.00r39 ID:01 Multi-Conditional TOL Config. 06/09/20 14:24:16

Instrument Name      : TEMP
Report Channel Number : 62
COND-A Input Status  : (none)
COND-A Input Channel : (none)
COND-A Threshold Type/Value : (none)
COND-A/B Link (AND/OR) : OR
COND-B Input Status  : (none)
COND-B Input Channel : (none)
COND-B Threshold Type/Value : (none)
COND-B/C Link (AND/OR) : OR
COND-C Input Status  : (none)
COND-C Input Channel : (none)
COND-C Threshold Type/Value : (none)
TOL Output Control Line : (none)
Require Full Base Int (On) : N
Require Full Base Int (Off) : N
Units                : MINS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 1h , 0s
Average #2 Interval, Storage: 15m , 0s
FINISHED (Configure Now)
CTRL-V=Edit Avg. Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### COND-A Input Status

Specifies the online digital input pattern for the first condition. Both the line number and the state should be specified (**1**=on, **0**=off); e.g., **2=1**.

### COND-A Input Channel

The name of the channel to be checked for the first condition. Must be a configured channel name. This field is cleared by entering "none."

### COND-A Threshold Type/Value

Specifies the COND-A Input Channel's threshold in the format **>Value**, **<Value**, or **=Value**,

where Value is numeric data.

### COND A/B Link (AND/OR)

Indicates whether the first and second conditions should be considered together (AND) or separately (OR) to determine online intervals. Default=**OR**: one of conditions A or B must meet the specified status.

### COND-B Input Status

Specifies the online digital input pattern for the second condition. Both the two-digit line number and the state should be specified (**1**=on, **0**=off); e.g., **02=1**.

### COND-B Input Channel

The name of the channel to be checked for the second condition. Must be a configured channel name. This field is cleared by entering "none."

### COND-B Threshold Type/Value

Specifies the COND-B Input Channel's threshold in the format **>Value**, **<Value**, or **=Value**, where Value is numeric data.

### COND B/C Link (AND/OR)

Indicates whether the second and third conditions should be considered together (AND) or separately (OR) to determine online intervals. Default=**OR**: one of conditions B or C must meet the specified status.

### COND-C Input Status

Specifies the online digital input pattern for the third condition. Both the two-digit line number and the state should be specified (**1**=on, **0**=off); e.g., **02=1**.

### COND-C Input Channel

The name of the channel to be checked for the third condition. Must be a configured channel name. This field is cleared by entering "none."

### COND-C Threshold Type/Value

Specifies the COND-C Input Channel's threshold in the format **>Value**, **<Value**, or **=Value**,

where Value is numeric data.

### TOL Output Control Line

Optional specification of an output line pattern to be activated or deactivated when the On-Line Input Status is met.



**NOTE:** If this pattern is changed while the TOL channel is active, the “old” pattern does not reset.

---

### Require Full Base Int (On)

Y(es) or N(o) to require that, to be considered online, the on-line input status must be met for the full Base Average Interval. Default=N. See [How Require Full Base Int On/Off Functions](#) in this topic for related information.

### Require Full Base Int (Off)

Y(es) or N(o) to require that, to be considered offline, the offline input status must **NOT** be met for the full Base Average Interval. Default=N. See [How Require Full Base Int On/Off Functions](#) in this topic for related information.

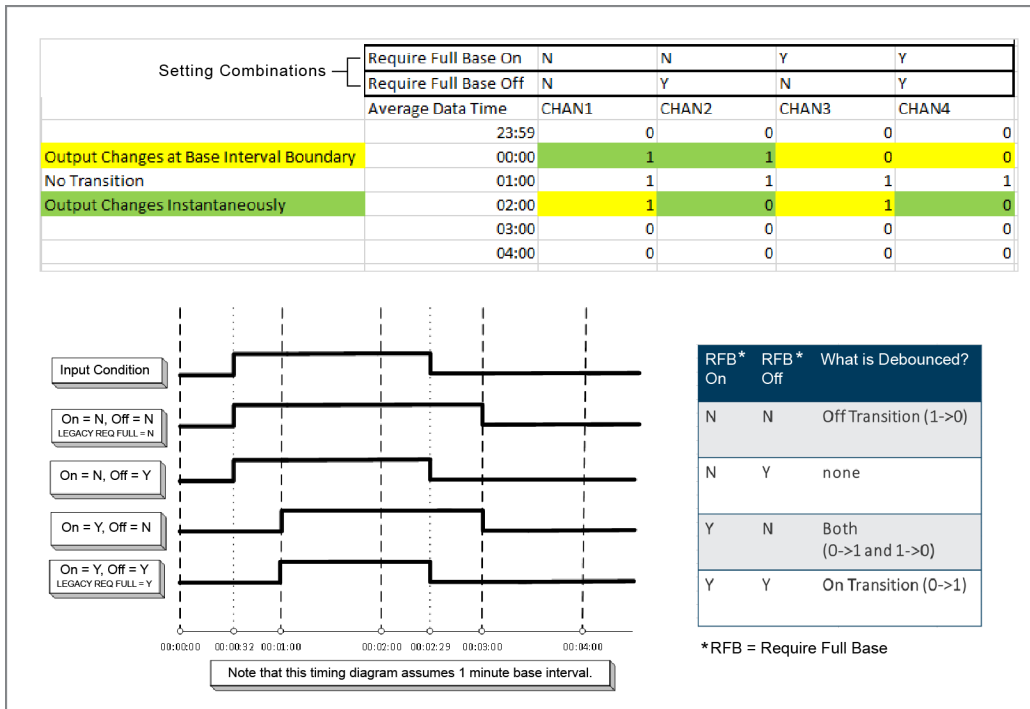
### How Require Full Base Int On/Off Functions

The following information applies to the Time On-Line Counter Channel (TOL) and Multi-Condition Time On-line Counter Channel (MTOL). Settings for “Require Full Base Interval (On)” and “Require Full Base Interval (Off)” determine whether or not the TOL output condition and value can change instantaneously (are not debounced) or, change at the boundary of the base interval (are debounced).

- **Require Full Base Interval (On):** When set to Yes, on transitions are debounced. When set to No, on transitions are not debounced. See next note for more information.
- **Require Full Base Interval (Off):** When set to Yes, off transitions are not debounced. When set to No, off transitions are debounced. See next note for more information.

**NOTE:** The logic for “Require Full Base Interval (On)” is opposite the logic of “Require Full Base Interval (Off)” in order to provide compatibility with previous versions of firmware.

The following example shows how digital on/off transitions are debounced based on settings the “Require Full Base Interval (On)” and “Required Full Base Interval (Off)” settings.



## Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

## Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will instantaneously check for a digital input pattern matching the On-Line Input Status. The result stored for this interval will always be either 0 or 1. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

## Average #1 Interval, Storage

The first half of the field specifies the totaling interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the totaling interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Linear Interpolation Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The linear interpolation channel is designed to meet the alarming requirements of *Appendix E to 40CFR75*. Appendix E systems require that the measured value of certain parameters (e.g., O<sub>2</sub>) be within a certain range of test values. The estimated value is calculated by linear interpolation between test points, correlating it to an input parameter (typically heat input).

The number of correlation input-vs-output points is limited to six (6), which is suitable for most applications.

To display the Linear Interpolation configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > L - Linear Interpolation**.

The following screen displays.

```

ESC 8864 v6.01r24 ID:01      Linear Interp. Config.      01/19/21 20:16:35

Instrument Name      : TEMP
Report Channel Number : 62
Input Channel       : (none)
# of Points/Runs    : 2
Input,Output[0]     : 0 ,0
Input,Output[1]     : 1000 ,1000
Input,Output[2]     : 0 ,0
Input,Output[3]     : 0 ,0
Input,Output[4]     : 0 ,0
Input,Output[5]     : 0 ,0
Units               : %FS
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-7) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#) .

### Channel Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Input Channel

The name of the channel to be used as input. Must be a configured channel name.

### Number of Points/Runs

The number of points or runs to apply to the interpolation; the number of input/output ("x,y coordinates") to calculate.

### Input, Output[0]

First input value ("x coordinate") to be correlated versus the output value ("y coordinate"); usually **0,0**. Math constants (**K1-K99**) are allowed for either value.

### Input, Output[1]

Second input value ("x coordinate") to be correlated versus the output value ("y coordinate"). Math constants (**K1-K99**) are allowed for either value.

### Input, Output[2]

Third input value ("x coordinate") to be correlated versus the output value ("y coordinate"). Math constants (**K1-K99**) are allowed for either value.

### Input, Output[3]

Fourth input value ("x coordinate") to be correlated versus the output value ("y coordinate"). Math constants (**K1-K99**) are allowed for either value.



### Input, Output[4]

Fifth input value ("x coordinate") to be correlated versus the output value ("y coordinate"). Math constants (**K1-K99**) are allowed for either value.

### Input, Output[5]

Sixth input value ("x coordinate") to be correlated versus the output value ("y coordinate"). Math constants (**K1-K99**) are allowed for either value.

### Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

### Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

### Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

### Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					Base averages determining the Ext2 validation	
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 ("Y"), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10	Yes	No	Identical to Validation Type 2 except that the	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
		(d)			Ext2 average is built from the Base average (arithmetic averaging)	
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## MODBUS Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To display the Modbus Channel configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > Q - Modbus Channel**.

```

ESC 8864  v6.01r24  ID:01      MODBUS Channel Config.      01/19/21 20:11:52

Instrument Name      : TEMP
Report Channel Number : 62
Hold Data Between Updates : N
Units               : PPM
Unsigned Integers (Y/N) : N
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-7)   : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

Pressing **CTRL-D** displays a second page of configuration settings. See the next screen.

ESC 8864 v6.00r39 ID:01		Config. Channel Options	06/09/20 14:51:33
Name (not editable)	:	TEMP	
Chl Number (not editable)	:	62	
Decimal Positioner	:	00	
MODBUS Scale Factor	:	0.0100	
MODBUS MSW First(Y/N)	:	N	
Span for Cal Err	:	(not set)	
Round Precision	:	(none)	
Allow Offline Calibrations?	:	N	
Online Cal. Hour (0-26)	:	(none)	
Input Scan Interval	:	0s	
ESC to return to chl config			

The following information provides a description of the MODBUS Channel Config screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01** to **99**.

### Hold Data Between Updates

Y(es) or N(o). If you want to use the last value received until the next one arrives, configure Y.

### Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

### Unsigned Integers (Y/N)

If integers should be represented as unsigned integers (0 to 65536), select Y (yes) for this option. If integers should be represented as signed integers (-32768 to 32767), select N (no).

The default setting for this option is N (no).

### Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

### Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

### Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 ("Y"), except that the 8-hour grace	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					period is disabled	
3	Arithmetic	40CFR 60.13 (h) and 40CFR 75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR 60.13 (h) and 40CFR 75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR 60.13 (h) and 40CFR 75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR 60.13 (h) and 40CFR 75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					(integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## General Channel (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The General Channel is used for evaluation of data in six different channel types. The Maximum, Minimum, and Accumulative types will evaluate maximum, minimum, and accumulative (summation) values respectively from the Input Channel over the General Value Duration. Other characteristics include:

- **Percent Complete type:** reports the amount of data from the Input Channel that is valid over the duration specified.
- **Number of Runs type:** specifies the number of input values from the Input Channel over the duration specified.
- **Number of Valid Runs type:** specifies the number of valid input values from the Input Channel over the duration specified.



To display the General Channel Config screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > C - General Channel**.

The following screen displays.

```

ESC 8864 v5.02.r25 ID:88      General Channel Config      12/05/17 15:39:04

Instrument Name      : TEMP
Report Channel Number : 06
Input Channel       : (none)
Input Average Interval : 1m
Units              : %FS
Data Channel Type   : MAXIMUM
Reset Input Status Pattern : (none)
General Val Duration,Storage: 1h , 0s
Ignore Input Channel Flag(s): (none)
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Input Channel

The name of the channel to be used as the source of data. Must be a configured channel name.

### Input Average Interval

One of the Input Channel's averaging intervals or 0s for instantaneous data.

## Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

## Data Channel Type

- MAXIMUM, MINIMUM, ACCUM for **Accumulation**
- PCNTCMP for **Percent Complete**
- NRUNS for **Number of Runs**
- or NVRUNS for **Number of Valid Runs**

## Reset Input Pattern Status

The input status which will generate a reset to the General Channel based on the Data Channel Type at the next Input Average Interval.

## General Val Duration, Storage

The first half of the field specifies the duration to collect the data over the Input Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the General Value Duration.

## Ignore Input Channel Flag(s)

The flags to ignore when verifying the validity of the current data point. This field is only valid for the MINIMUM, MAXIMUM and ACCUM Data Channel Type. For any other Data Channel Type, this field will remain (none) and cannot be changed.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Counter Channel



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Type “N” counter channel is a flexible channel type that functions as a counter or accumulator to count events, totalize values from other channels, or average values from other channels. The channel can count, average, or total values based on a configurable start and

stop signal. For example, you can configure the counter channel to totalize emissions during a startup event; average emissions during startup; or count the number of startup events over a configurable time period.

An important feature of the counter channel is its ability to be in one of two states, SET (counting, totalizing, averaging) or RESET, and be able to toggle between these states based on digital input patterns.

ESC 8864 v5.00.r10 ID:88 Counter Channel Config (Page 1) 07/08/15 08:43:08	
Instrument Name	: ZCOUNT
Report Channel Number	: 04
Equation	: 1=
Units	: #/MBTU
Set Pattern	: 1&2 123
Reset Pattern	: 25&{30 !324}
Output Lines	: 1,2=0
CTRL-N=Next Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options	

#### Related Topics:

- [Configure Counter Channel](#)
- [Basic Counter Operation](#)
- [Counter Flip-Flop Operation](#)
- [8864 System Reset](#)

### Configure Counter Channel

To display the Counter Channel configuration screen:

- From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > N - Counter Channel**.

The following screen displays.

```

ESC 8864 v5.02.r25 ID:88 Counter Channel Config (Page 1) 12/04/17 19:30:26

Instrument Name      : TEMP
Report Channel Number : 06
Equation            : 0=

Units               : #/MBTU
Set Pattern         : (none)

Reset Pattern       : (none)

Output Lines        : (none)

CTRL-N=Next Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

Pressing **Ctrl+N** displays the second page as shown in the next example. Once on the second page, pressing **Ctrl+P** returns to the first page.

```

ESC 8864 v5.02.r25 ID:88 Counter Channel Config (Page 2) 12/04/17 19:30:44

Name (not editable) : TEMP
Chl Number (not editable) : 06
Require Full Base Interval : N
Start Value          : (none)
End Value            : (none)
Hold Flags           : (none)

Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)   : N
Count or Average (C/A)     : Count
Action on Invalid (H,I)    : Hold
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

The following information provides a description of the fields in the Counter Channel Config (Page 1) screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify the channel.

### Report Channel Number

A number used for ordering channels in the real-time displays. Also used in systems polled by central computers as a channel number designation (01 to 99).

### Equation

The equation to be used to calculate data from this channel. See [Equation Configuration](#) for details. This field accepts up to 255 characters.

### Units

The engineering units to which the equation results will be scaled (AP, #/MBTU, PPM, etc.).

### Basic Counter Operation

When the counter is in the SET state, the counter channel computes the value of a user-defined equation at the end of each base average, and then adds the result of the equation to the previous value of the counter channel. This new value is stored as the base average in the counter channel's long-term storage.

For example, when the equation is "1=", the channel counts up by one for each base interval as shown in the following table.

Time	Result of Equation	1 min Base Avg
12:33	1	1
12:34	1	2
12:35	1	3
12:36	1	4
12:37	1	5

If the equation is "5=", the channel counts up by 5s as shown in the next table.

Time	Result of Equation	1 min Base Avg
12:33	5	5
12:34	5	10
12:35	5	15
12:36	5	20
12:37	5	25

When the equation is the result of another channel in the system, such as “OPACITY=”, in this case the channel functions like an accumulator by summing up the value of the other channel. See the next table for an example.

Time	OPACITY Channel	Result of Equation	1 min Base Avg
12:33	18	18	18
12:34	25	25	43
12:35	23	23	66
12:36	16	16	82
12:37	24	24	106

If the result of the equation is negative, the counter channel value decreases.

Channels referenced in the counter channel's equation must have averaging intervals configured that match the counter channel's base average.

For example, if the counter channel's base average is 1 minute, then all channels referenced in its equation must also have 1 minute averages configured as either their base average or one of their extended averages. If not, then an error message displays when the counter channel is configured indicating that “All channels in the equation must have 001m averages” (where 001m is replaced with the configured base interval of the counter channel).

The equation has the same syntax and is able to use the same operators and complexity as an equation in an “M” type or “P” type channel (including the expanded size of 512 characters).

For example, in the equation “TRUNC((OPACITY/20.09)^.001)=”, the counter channel counts the number of base intervals where the OPACITY channel exceeds the value 20.9 as shown in the following table.

Time	OPACITY Channel	Result of Equation	1 min Base Avg
12:33	18	0	0
12:34	25	1	1
12:35	23	1	2
12:36	16	0	2
12:37	24	1	3
12:38	17	0	3
12:39	22	1	4
12:40	11	0	4
12:41	15	0	4

**Related Topics:**

- [Counter Channel Configuration](#)

**Values Written to Extended Averages**

At the end of each **Extended 1** and **Extended 2** averaging interval, the just-computed value of the counter channel is written to long-term storage for that interval. See the next table for an example.

Clock Time	OPACITY Channel	Result of Equation	1 min Base Avg Time Tag	6 min Ext 1 Avg Time Tag	6 min Ext 1 Avg Value	1 hour Ext 2 Avg Time Tag	1 hour Ext 2 Avg Value
12:52:59.9	23	1	12:52:00	1			
12:53:59.9	19	0	12:53:00	1	12:48:00	1	
12:54:59.9	29	1	12:54:00	2			
12:55:59.9	30	1	12:55:00	3			
12:56:59.9	26	1	12:56:00	4			
12:57:59.9	26	1	12:57:00	5			
12:58:59.9	30	1	12:58:00	6			
12:59:59.9	27	1	12:59:00	7	12:54:00	7	12:00:00
13:00:59.9	23	1	13:00:00	8			
13:01:59.9	11	0	13:01:00	8			
13:02:59.9	31	1	13:02:00	9			
13:03:59.9	17	0	13:03:00	9			
13:04:59.9	15	0	13:04:00	9			
13:05:59.9	25	1	13:05:00	10	13:00:00	10	

**Related Topics:**

- [Configure Counter Channel](#)

**Counter Flip-Flop Operation**

The counter channel includes the two states described in the following list. These states work

like a “set/reset” flip-flop where the counter stays in one state until it detects a digital input pattern that causes it to change state. When first configured, the counter channel is in the RESET state.

- **SET** (counting): The counter continues to add the equation value at the end of each base interval. The counter stays in the SET state until a “reset pattern” is detected, at which time the counter enters the RESET state.
- The counter is reset to an initial “start value” and stays at this value as long as the counter is in the RESET state. The counter exits this state and goes to the SET state whenever the “set pattern” is detected.

#### Related Topics:

- [SET and RESET Patterns](#)
- [Require Full Base Interval](#)
- [Configure Counter Channel](#)

### SET and RESET Patterns

The counter channel supports **SET** and **RESET** patterns. Characteristics of these patterns include the following list.

Also see the next screen example (from the Home Menu, select C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > N - Counter Channel).

- Patterns are digital input patterns that allow both “ANDs” and “ORs” in the digital pattern and allow multiple levels of parenthesis.
- Logical operators of the SET and RESET patterns are “&” (AND) and “|” (OR).
- To indicate that an input line should be evaluated as TRUE when the input line is deactivated (i.e., “active low”), then follow the line number with “=0”. For example, the expression “23=0&24” would be TRUE when input line #23 is deactivated and input line #24 is active.
- The counter channel supports multiple levels of nesting of the logical expression.
- Maximum digital pattern length is 80 characters.
- Patterns are evaluated approximately once per second. When both patterns are detected at the same time, the counter enters the RESET state.
- Patterns are “level-triggered” and not “edge-triggered”.

This means patterns do not have to make a transition for the counter state to change. For example, assume the set pattern condition is always true. If a reset condition occurs and sets the state to RESET (resetting the counter to the start value), then once the reset condition is again false, the counter immediately enters the SET state since the set state



is true.

- The default SET condition is a blank string. A blank set string is interpreted as TRUE.
- The default RESET condition is a blank string. A blank reset string is interpreted as FALSE.

```

ESC 8864 v5.02.r25 ID:88 Counter Channel Config (Page 1) 12/05/17 09:11:01

Instrument Name      : ZCOUNT
Report Channel Number : 06
Equation            : 1

Units               : #/MBTU
Set Pattern         : 1&2|123

Reset Pattern       : 25&(30|!324)

Output Lines        : 1,2=0

CTRL-N=Next Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

### Related Topics:

- [Configure Counter Channel](#)

## Require Full Base Interval

There may be situations when a short (1 or 2 sec) pulse on the SET or RESET pattern is considered a glitch and subsequently **should not** cause the counter's flip-flop to change state. For these situations, you can configure the counter channel to require that the SET or RESET pattern be active for an entire base interval period before the SET or RESET actually occurs. The flip-flop changes state only when the pattern is detected for each sample in the base interval. When configured with the setting **Require Full Base Interval**, testing to see if the SET or RESET patterns have been active for the entire period will occur before the counter increments.

Valid entries for the field **Require Full Base Interval** include those in the following list. The default setting is "N" (require full base interval on neither).

Also see the next screen example (from the Home Menu, select C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > N - Counter Channel > Ctrl-N for

next page).

- **S** - Require full base interval on SET only
- **R** - Require full base interval on RESET only
- **Y** - Require full base interval on both
- **N** - Require full base interval on neither

The 8864 evaluates the input lines approximately once every second to see if the SET and RESET conditions (or both) are true. When both conditions are true at that same sampling time, the state machine acts as if only the RESET condition occurred for that sample (second).



**NOTE:** A general definition of a state machine is any device that stores the status of something at a given time and can operate on inputs to change the status or cause an action or output to take place for any given change.

```

ESC 8864 v5.02.r25 ID:88 Counter Channel Config (Page 2) 12/05/17 09:23:16

Name (not editable)      : TEMP
Ch1 Number (not editable) : 06
Require Full Base Interval : N
Start Value               : (none)
End Value                 : (none)
Hold Flags                : (none)

Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Round Constituents (Y/N)   : N
Count or Average (C/A)     : Count
Action on Invalid (H,I)    : Hold
FINISHED (Configure Now)

CTRL-P=Prev Page, CTRL-V=Edit Validation, CTRL-D=Config Ch Options

```

### Require Full Base Interval = Y

If **Require Full Base Interval** is set to **Y** then both SET and RESET will have to be TRUE for every once-per-second sample in the base interval for the conditions to affect the state of the counter. That determination will happen at the end of the base interval. If both conditions were met for the entire base interval, then the counter will be reset.

As an example, assume the field **Require Full Interval** is set to **Y** and includes the following settings:

- SET pattern is an empty string.
- RESET pattern is "28=1".
- Base average interval is set to 1m.
- Counter value is 57 coming into the minute.
- Equation is 1=.
- Also assume that at second 22 of the minute input, #28 is high and then goes low and remains low at second 23.

Using settings in the previous example, the following occurs:

- The counter is in the SET state from **xx:xx:00** through **xx:xx:21** (since the set pattern is blank and is considered TRUE, and the RESET pattern is FALSE) and the counter value continues to be 57. The instantaneous value for the channel reads 57 from the top of the minute through **xx:xx:21**. You can use the MDI user interface on the 8864 Data Controller to view real-time information in "Display Readings w/Flags" (Home Menu > D - Real-Time Display Menu > F - Display Readings w/flags).
- When the inputs are sampled at **xx:xx:22**, both input patterns are TRUE (both SET and RESET); the state is considered to be RESET; and the counter is set to the start value, which is assumed to be "0" for this example. At this point the instantaneous value for the counter channel begins displaying "0" in the UI.
- At **xx:xx:23**, input patterns are evaluated again. This time SET is TRUE and RESET is FALSE, and the counter state is set to SET. This continues to be the case through the end of the minute. The counter value continues to be 0 through the balance of the minute.
- At the end of the **minute**, just as channel values are being calculated and before they are stored, the 8864 Data Controller evaluates the counter channel checking to see if the channel needs to count (that is, add the result of the equation). Since the counter is in the SET state at that time, then the result of the equation ("1") will be added to the current counter value ("0") to get a new counter value ("1"). The new counter value ("1") is stored as the base average for the interval just completed. The instantaneous value in the UI and the Modbus register will also change to "1" at this time.

### Require Full Base Interval = R

In the case where **Require Full Interval** is set to **R**, the state machine (SET or RESET) can only be reset at the end of the base interval. The RESET condition is monitored every second but the RESET can only happen at the end of the base interval and only if the RESET condition was true for each and every once-per-second sample during the base interval. The state machine can move to the SET condition at any once-per-second sample if the SET condition is true, but can only move to RESET at the end of the base interval. If the RESET condition has

been TRUE for the entire base interval and the SET is TRUE (as of the most recent once-per-second sample) at the end of the base interval, then the RESET takes precedence and the counter is RESET.

### Require Full Base Interval = S

Complementary events happen if **Require Full Interval** is set to **S**. A RESET can happen at any once-per-second sample, but the state machine can only be SET at the end of a base interval. At the end of a base interval, the status of SET will be evaluated first before the decision is made to increment the counter and store the result. Again, if at the end of the base interval the SET has been TRUE for the entire interval but the RESET is TRUE as of the last once-per-second sample, then the RESET “wins”.

#### Related Topics:

- [Configure Counter Channel](#)

### Start Value

Once in the RESET state, the counter channel resets immediately to the value configured as the **Start Value**. The **Start Value** can be any of the following:

- A constant value, such as “0.0”.
- A math constant, such as “K01”.
- The name of another channel, for example “OPACREST”.

In the case that the **Start Value** is set to a channel name, the value that is used is the most-recently determined value of the named channel’s average interval that is the same as the base average interval of the counter channel. For example, if the counter channel is set to 1m base averages, but the “OPACREST” channel has 10s base averages; 1m extended #1 averages; and 1h extended #2 averages; then the most-recently determined 1m average from the “OPACREST” channel is used when the counter channel resets.

If the reset pattern is detected at any time during the base interval, the counter value is immediately set to the **Start Value**. If the counter goes to the SET state before the end of the base averaging interval, then the counter will count (as usual) and the new value will be stored. If the counter is still in the RESET state at the end of the base average interval, the start value will be stored for the base average.

The default **Start Value** is 0 (zero). A blank **Start Value** is interpreted as 0 (zero). For a screen example, see the topic [Require Full Base Interval](#).

The following table shows an example when **Start Value** is 0 (zero).

Time	OPACITY Channel	Result of Equation	State	1 min Base Avg
12:53	23	1	SET	1
12:54	19	0	SET	1
12:55	29	1	SET	2
12:56	30	1	SET	3
12:57	26	1	SET	4
12:58	26	1	RESET	0
12:59	30	1	RESET	0
13:00	27	1	SET	1
13:01	23	1	SET	2
13:02	11	0	SET	2
13:03	31	1	SET	3
13:04	17	0	SET	3

#### Related Topics:

- [Configure Counter Channel](#)

### End Value and End Value Operand

This section includes information for the following items:

- [End Value](#)
- [End Value Operand](#)

### End Value

The counter channel value (but not the STATE of the counter) can also be reset when the counter value exceeds a configured **End Value**. You can configure **End Value** as a fixed constant, math constant, or channel name.

If, at the end of the base average and after the new value of the counter channel has been

computed (by adding the result of the equation to the old value), the value of the counter channel exceeds the **End Value**, the counter channel value is set to the Start Value and then stored. The STATE of the counter is not changed (that is, it continues to stay in the SET state until reset by the reset pattern). This allows you to configure a counter that increments up and then resets once a pre-configured value is reached.

The default **End Value** is blank. When **End Value** is blank, the check for an **End Value** is ignored.

The following table shows an example when the **End Value** is 5 and the Start Value is 0 (zero).

Time	Result of Equation	1 min Base Avg
12:53	1	1
12:54	0	1
12:55	1	2
12:56	1	3
12:57	1	4
12:58	1	5
12:59	1	0
13:00	1	1
13:01	1	2
13:02	0	2
13:03	1	3

### End Value Operand

Because the counter can be configured to count either up or down, the **End Value** should have an optional operand. Valid operators include: ">", ">=", "<", and "<=". The default is ">" (no operand).

An example of a valid End Value with operands includes: "<0" or ">=OPAC\_LIMIT".

### Related Topics:

- [Configure Counter Channel](#)

### Flags

The counter channel supports a complete group of instantaneous, base, Ext1, and Ext2 flags,

as defined on a P-type (Average Math) type channel. See the following screen examples.

*Instantaneous Validation Config Screen:*

```

ESC 8864 v5.02.r25 ID:88      Inst. Validation Config.      12/05/17 09:56:09

Bad Status Lines (B)      : (none)
Maintenance Status Lines (M) : (none)
Boiler Offline Status (F)  : (none)
Maximum Reading Limit (+)  : 1E+10
Minimum Reading Limit (-)  : -1E+10
Rate of Change Limit (R)   : 1E+10
Digital Info Status #1 (V) : (none)
Digital Info Status #2 (W) : (none)
Digital Info Status #3 (X) : (none)
Digital Info Status #4 (Y) : (none)
Digital Info Status #5 (Z) : (none)

<ESC> to return to chl config

```

*Average Validation Config Screen:*

```

ESC 8864 v5.00.r10 ID:88      Average Validation Config.      07/08/15 08:42:43

High-High Alarm Limit (H)  : 1E+10
High Alarm Limit (h)      : 1E+10
Low Alarm Limit (l)       : -1E+10
Low-Low Alarm Limit (L)   : -1E+10
High ROC Alarm Limit (J)  : 1E+10
Low ROC Alarm Limit (j)   : 1E+10
Floor Limit (f)           : -1E+10
Floor Value               : 0
Ceiling Limit (c)         : 1E+10
Ceiling Value             : 0

Percent for valid average  : Default ( 75)
Average to Math Constant  : (none)

<ESC> to return to chl config

```

The instantaneous flags for the counter channel are cleared at the beginning of every base interval and accumulate until the end of the base interval. These accumulated instantaneous flags display in the screen labeled Real-Time Engineering Flags when using the MDI user interface on the 8864 Data Controller (Home Menu > D - Real-Time Display Menu > F - Display

Readings w/flags).

The instantaneous flags are **B M F + - R V W X Y Z**. They are configured in the channel screen labeled *Inst. Validation Config* shown in the next example (Home Menu > C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration > N - Counter Channel > CTRL-V=Edit Validation).

The validity flags ">" and "<" do not apply to instantaneous values. Additional information about validity flags is provided later in the section [Validity Flags \(> and <\)](#).

```
ESC 8864 v5.02.r25 ID:88      Inst. Validation Config.      12/05/17 09:56:09

Bad Status Lines (B)      : (none)
Maintenance Status Lines (M): (none)
Boiler Offline Status (F)  : (none)
Maximum Reading Limit (+)  : 1E+10
Minimum Reading Limit (-)  : -1E+10
Rate of Change Limit (R)   : 1E+10
Digital Info Status #1 (V) : (none)
Digital Info Status #2 (W) : (none)
Digital Info Status #3 (X) : (none)
Digital Info Status #4 (Y) : (none)
Digital Info Status #5 (Z) : (none)

<ESC> to return to chl config
```

At the end of the base interval, base interval flags are determined by taking the logical "OR" of all of the flags from any constituent channels referenced in the equation. They are then OR'ed in with the instantaneous flags accumulated during the base interval, and then OR'ed again with any local flags configured on the base interval of the channel itself (H, h, L, l, J, j, f, or c). The resulting flags are stored with the base interval count/average (except for the validity flags "<", ">" as described later in the section [Validity Flags \(> and <\)](#). The resulting flags are also shown in the screen labeled Display Last Base Average (Home Menu > D - Real-Time Display Menu > B - Display Last Base Avg).

If at the end of the interval the counter is holding, the flags in the equation are included along with the accumulated instantaneous flags and any local flags on the base interval. However, the counter does not count. If the counter is in the RESET state (whether the RESET pattern is active or not), then the flags from the constituent channels referenced in the equation are not included in the overall flags, but the accumulated instantaneous flags and the base interval flags are included.

The flags Ext1 and Ext2 are the OR of the BASE constituent channels (except when in RESET)



with the instantaneous flags accumulated over the BASE interval and OR'ed with the local interval flags as configured for the Ext1 or Ext2 average. Although the values are the same for a base and Ext average stored at the same time, the flags may be different. The Hold Flags pattern is evaluated against the resulting base average flags and not the Ext1 or Ext2 flags.

**Related Topics:**

- [Configure \(Data\) Channels](#)

### Validity Flags (> and <)

**When the counter channel is configured as “Count or Average” = Count:**

If any of the constituent channels have an “<” flag, the counter result is “<”. If none of the constituent channels have an “<” but at least one has a “>”, the counter result is “>”. Otherwise the result is neither “<” or “>”.

The validity flag for the Ext1 and Ext2 averages is the current validity flag for the base average at the time the Ext1 or Ext2 average is stored.

**When the counter channel is configured as “Count or Average” = Average:**

The 8864 keeps track of how many intervals were valid and how many total intervals have occurred since the counter entered the SET state. It then compares the % valid (valid/total) with the Percent for valid average threshold configured on the base average. If there are no invalid intervals, the average does not get either the “<” or the “>” flag. If the % valid  $\geq$  limit (but less than 100%), the flags include “>”. If the % valid is less than the threshold, then the flags include “<”.

The validity flags for the Ext1 and Ext2 averages are the current validity flag for the base average at the time the Ext1 or Ext2 average is stored. The Percent for valid average is not used for Ext1 or Ext2 averages.

**Related Topics:**

- [Configure \(Data\) Channels](#)

### Hold Flags

The counter channel supports a flagging condition that, when true at the time an equation is evaluated, prevents the counter channel from counting or being evaluating against the End Value. The count simply holds until the next base interval. This condition being true does not affect the STATE of the counter channel (in particular, it does not cause it to go to the RESET state).

The logical operators “&” (AND), “|” (OR), and “!” (NOT) are supported. The hold flag condition is evaluated the same way as the “action flag” string on the DAC channels (for DACs that

reference intervals that are not 0s). For example if the hold flag string is set to “!F|X&W”, then the counter is held at its previous value if the F flag is not set, or if both the X and W flags are set.

The counter channel supports the normal logical order of operations (NOT before AND, and AND before OR) and multiple levels of parenthesis nesting. The default **Hold Flags** value is blank. A blank **Hold Flags** value is interpreted as “never hold”. If no “&” or “|” operator exists between flags, then “&” is assumed.

#### Related Topics:

- [Configure \(Data\) Channels](#)

### Write to Math Constant

All averaging intervals of the counter channel support the option **Write to Math Constant**. This allows the count to be written to a math constant at the time the count is stored. The default is (none).

#### Related Topics:

- [Configure \(Data\) Channels](#)

### Count or Average

There may be situations when, instead of counting or accumulating a value, you need to generate a running average of an input over an unknown time period. For example, you may need to determine the average of an analog input during a time period when a particular digital input is active. To accomplish this, the counter channel keeps a running total of equation results and also keeps a running count of the number of times the counter increments. When the average is stored, instead of saving the accumulated counter value, the counter channel divides the accumulator by the number of times the equation has been added to the total and then stores the ratio (average over the period).

As an example, if the equation is “OPACITY=” and “Count or Average” = “Average”, the counter channel functions as shown in the next table.

Time	OPACITY Channel	Result of Equation	Accumulator	Counts	1 min Base Avg
12:33	18	18	18	1	18
12:34	25	25	43	2	21.5
12:35	23	23	66	3	22
12:16	16	16	82	4	20.5

Time	OPACITY Channel	Result of Equation	Accumulator	Counts	1 min Base Avg
12:37	24	24	106	5	21.5

If Hold Flags prevents the counter channel from updating, the accumulator does not update and the counts do not increment. In this case, the same value is stored as for the previous base average.

If the counter is in the RESET state, the 8864 Data Controller stores the Start Value. The default is Count.

If an End Value is configured while in Average mode, the average at the end of the base average is compared with the End Value (and End Operator) and the counter is RESET if the End condition is met.

#### Related Topics:

- [Configure \(Data\) Channels](#)

#### Action on Invalid (Hold or Ignore)

The counter channel includes an option that determines the action when any of the channels in the equation are invalid. Possible entries include **Hold** and **Ignore**.

##### Action on Invalid = Hold

When the **Action on Invalid** field is configured with the option **Hold**, and one of the constituent channels referenced in the equation is invalid, the counter channel functions the same as if the Hold Flags condition is met.

##### Action on Invalid = Ignore

When **Action on Invalid** is configured with the **Ignore** option, the values of the constituent channels are used in the equation even if they are invalid. If the result of the equation is NaN, the channel functions as if the Hold Flags condition is met.

#### Related Topics:

- [Configure \(Data\) Channels](#)

#### Output Line Digital Pattern

The counter channel supports an output line digital pattern that activates when the counter channel is in the SET or RESET condition. For example, when the counter channel is in the SET condition, "1,2,3=0" turns on lines 1 and 2 and turns off line 3. If the counter channel is in

the RESET condition, the opposite pattern is set which turns off lines 1 and 2 and turns on line 3. This functionality is the same type of pattern as found in calibrations or timed digital event programs.

The line pattern is set on the transition between RESET and SET and on the transition from SET to RESET. The lines are not reasserted during the duration of the SET or RESET period, only during the transition from one to the other.

The default line pattern is a blank string. A blank string is interpreted as not turning on or off any flag.

**Related Topics:**

- [Configure \(Data\) Channels](#)

## 8864 System Reset

If the 8864 resets, the counter channel remembers its accumulator value, count value, and state. The digital pattern for either the SET or RESET state is asserted once after the reboot completes. The counter channel then resumes normal operation.

**Related Topics:**

- [Counter Channel Configuration](#)

## Generic Serial Interface (GSI) Channel (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The GSI channel type is used to store data collected using the Generic Serial Interface. The Generic Serial Interface (GSI) is a serial communications interface used by the 8864 Data Controller. This interface is used to retrieve data from analyzers, digital control systems, or some other device using one of the RS-232 or RS-485 serial communications ports.

The input functions of this interface include receiving data strings to store values into GSI Channels for data collection. (See [Configure Serial Protocols](#) - [Configure GSI Tables](#) for more information.)

To display the GSI Channel Config screen:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press **CTRL-N** to display the second page of channel types.

3. Select **I - GSI Channel**. The following screen displays.

```
ESC 8864 v5.02.r25 ID:88      GSI Channel Config.      12/05/17 15:59:14

Instrument Name      : TEMP
Report Channel Number : 06
Hold Data Between Updates : N
Units               : PPM
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Validation Type (0-4) : 0
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options
```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Hold Data Between Updates

Y(es) or N(o). If you want to use the last value received until the next one arrives, configure Y.

### Units

The engineering units to which the readings will be scaled (AP, #/MBTU, PPM, etc.).

### Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will average instantaneous readings.

**NOTE:** The Generic Serial Interface attempts to update readings based on the Input Scan Interval. If data streams will not be received at this rate, the **Percent for valid average** value must be adjusted to validate the base average. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

### Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

### Validation Type (0-7)

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10	Yes	No	Identical to Validation Type 1 ("Y"), except that	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
		(d)			the 8-hour grace period is disabled	
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 (“A”), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1 average (integrated averaging)	Yes
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1	No

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

### Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Tape Sampler Channel (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Tape Sampler channel takes two one-minute averages every two hours and stores the difference or the COH (coefficient of haze) between each minute average. (See the [COH Factor](#) calculation in this section.)

In the next screen example, for each even clock hour, the configured output control line is activated for the selected period of time (Output Duration). The 8864 Data Controller takes a one-minute average (the second minute of the hour) and stores the minute average as the hourly average on the even-numbered hour. After 119 minutes, the 8864 Data Controller again takes a one-minute average and stores the difference (or the COH) of the two one-minute averages at the odd hour.



To display the Tape Sampler Channel Cfg screen:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press **CTRL-N** to display the next page of channel types.
3. Select **GT Channel** and then press **Enter** on the keyboard to open the following screen.

ESC 8864 v4.xx ID:49		Tape Sampler Channel Cfg.	mm/dd/yy hh:mm:ss
Instrument Name	:	TEST1	
Analog Input Number	:	01	
Report Channel Number	:	01	
Volts Full Scale	:	N/A	
High Input	:	20 mA	
Low Input	:	0 mA	
High Output (E.U.s)	:	100	
Low Output (E.U.s)	:	0	
Units	:	COH	
Storage Time	:	0s	
Output Line	:	(none)	
Starting Time	:	mm/dd/yy hh:mm:ss	
Output Duration	:	4s	
COH Factor	:	20.55945809	
Use Time-on-line Valid (Y/N)	:	N	
FINISHED (Configure Now)			
CTRL-V=Edit Validation, CTRL-D=Config. Channel Options			

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Analog Input Number

Specifies the actual, physical input line number. **01 to 99**. When using a Meteorological Input Card, inputs **Tx**, **Dx**, **Sx** or **Rx** can be used (**x** is the integer number of the Meteorological Input Card).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Volts Full Scale

The volts full scale range for the channel. **0.1**, **1.0**, **5.0**, or **10.0** volts. Applicable only when the Analog Input Number references a voltage input.

### High Input

The maximum current, voltage, hertz or voltage ratio output from the instrument.

### Low Input

The minimum current, voltage, hertz or voltage ratio output from the instrument.

### High Output

The instrument reading in engineering units corresponding to the High Input.

### Low Output

The instrument reading in engineering units corresponding to the Low Input.

### Units

The engineering units to which the input readings will be scaled (AP, #/MBTU, PPM, etc.).

### Storage Time

The length of the long-term data storage buffer for averages.

### Output Line

The digital output line which will be activated each even clock hour.

### Starting Time

The date and time to start the tape sampling; will always move to the next even-numbered hour. dd/mm/yy hh:mm:ss.

### Output Duration

The amount of time to keep the Output Line activated.

## COH Factor

Coefficient of haze factor: enter **0.0** to store the difference (first minute average minus second minute average); enter any other positive value to calculate the difference according to the formula shown in the next example.

$$\text{COH}/1000\text{ft} = 540 / (\Delta T) C * \text{LOG} (\text{Avg1}/\text{Avg2})$$

**where:**

$\Delta T$ =119 minutes,  
C=6.25 L/min or 0.22071666667009ft<sup>3</sup>/minute,  
Avg1=first average reading, and  
Avg2=second average reading

**this yields:**

$$\text{COH}/1000\text{ft} = 540 / (119) 0.22071666667009 * \text{LOG} (\text{Avg1}/\text{Avg2})$$

$$\text{COH}/1000\text{ft} = 20.55945809 * \text{LOG} (\text{Avg1}/\text{Avg2})$$

where COH constant = 20.55945809

## Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Digital State Channel (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

A digital state channel monitors four digital input lines and their online status over the base average, much like the time online channel. However, rather than counting instances of online or offline status, the four channels' status is grouped together and represented as numeric data.

At each averaging interval, a four-digit number is stored, each digit being 0 (for offline) or 1 (for

online), with the first digital input line status in the 1's place, the second digital input line status in the 10's place, and so on. Once the data are stored in numerical format, they can be used to drive analog outputs, trigger alarms, and so forth.

To display the Digital Channel Config screen:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press **CTRL-N** to display the next page of channel types.
3. Select **D - Digital State Channel** to open the configuration screen shown in the next example.

```

ESC 8864 v5.02.r25 ID:88      Digital Channel Config.      12/05/17 17:06:26

Instrument Name      : TEMP
Report Channel Number : 06
Line #1             : 00
Line #2             : 00
Line #3             : 00
Line #4             : 00
Require Full Int (Y/N)? : N
Units               : STATE
Base Avg. Interval, Storage : 1m , 0s
Average #1 Interval, Storage: 15m , 0s
Average #2 Interval, Storage: 1h , 0s
Use Time-on-line Valid (Y/N): N
FINISHED (Configure Now)

CTRL-V=Edit Validation, CTRL-D=Config. Channel Options

```

The following information provides a description of the configuration screen. Also refer to [Configure Channel Options](#) and [Configure Instantaneous Validation](#).

### Instrument Name

The label used to identify this channel. May consist of a parameter name and site name separated with a colon (:).

### Report Channel Number

A number used for ordering channels in the real-time displays; also used in systems polled by central computers as a channel number designation. **01 to 99**.

### Line #1

The digital input number for the first digital input line (whose results are displayed in the 1's place). **00** to **99**.

### Line #2

The digital input number for the second digital input line (whose results are displayed in the 10's place). **00** to **99**.

### Line #3

The digital input number for the third digital input line (whose results are displayed in the 100's place). **00** to **99**.

### Line #4

The digital input number for the fourth digital input line (whose results are displayed in the 1000's place). **00** to **99**.

### Require Full Int (Y/N)?

Y(es) or N(o) to require that, to be counted as online (=1), the digital input line must be on for the full Base Average Interval.

### Units

The engineering units to which the data will be scaled (AP, #/MBTU, PPM, etc.).

### Base Avg. Interval, Storage

The first half of the field specifies the interval over which the 8864 will instantaneously check each specified digital input. The result stored for this interval will always be either 0 or 1 for each field of the pattern. The second half of the field specifies the length of the long-term data storage buffer for the Base Average.

### Average #1 Interval, Storage

The first half of the field specifies the averaging interval for the Average #1. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #1.

## Average #2 Interval, Storage

The first half of the field specifies the averaging interval for the Average #2. This interval must be some integer multiple of the Base Average Interval. The second half of the field specifies the length of the long-term data storage buffer for the Average #2.

## Use Time-on-line Valid (Y/N)

Y(es) or N(o) to indicate how validity should be calculated. If Y(es), validity is calculated only on online time during the interval. If N(o), the validity calculation is not modified. This applies only to CFR60 channels.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Data Validation and Flags

Data validation refers to the following concepts:

- A determination of whether an hourly average is a valid average; this is determined by regulations or by a percentage.
- Certain conditions and value limits that can invalidate data (i.e., the data will not be included in averages). This validation information is configured and checked on an instantaneous basis and on each averaging interval. (Each base and extended average interval can have validation limits specified, although these are generally attached only to the base average.)

### Related Topics:

- [Valid Average Determination \(Validation Type 0-7\)](#)
- [Configure Instantaneous Validation](#)
- [Configure Average Validation Limits](#)
- [Data Flags](#)
- [Configure Channel Options](#)

## Valid Average Determination (Validation Type 0-7)

In the Channel Config screen, the field Validation Type (0-7) allows a choice between a simple percent validity test or the validation required by Part 60 40CFR60.13(h) and Part 75 40CFR75.10(d), the Federal Clean Air Act regulations. This field determines how an average is

calculated and whether an hourly average is a valid hourly average according to the information in the following table.

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
0	Arithmetic	Percent Validation	No	No	Standard Arithmetic Averaging with valid percent of Base averages determining the Ext2 validation	No
1	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Integrated Averaging	Yes
2	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 1 ("Y"), except that the 8-hour grace period is disabled	Yes
3	Arithmetic	40CFR 60.13 (h) and 40CFR75.10 (d)	Yes	Yes	Validation using Arithmetic Averaging	Yes
4	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 3 ("A"), except that the 8-hour grace period and 26-hour calibration OOC period is disabled	Yes
5	Integrated	40CFR60.13 (h) and 40CFR75.10 (d)	No	No	Identical to Validation Type 4 except that the Ext2 average is built from the Ext1	Yes

Validation Type	Averaging Type	Validation Rule	26 Hour Clock	8 Hour Grace Clock	Description	Startup Calibration
					average (integrated averaging)	
6	Arithmetic	40CFR60.13 (h) and 40CFR75.10 (d)	Yes	No	Identical to Validation Type 2 except that the Ext2 average is built from the Base average (arithmetic averaging)	Yes
7	Integrated	Percent Validation	No	No	Identical to Validation Type 0 except that the Ext2 average is built from the Ext1 average (integrated averaging) with valid percent of Ext1 averages determining the Ext2 validation	No

**NOTE:** For more information about Validation Type, see [Data Validation and Flags](#) and [Valid Average Determination](#).

The following information provides a description for items in the columns labeled Averaging Type and Validation Rule:

- **Arithmetic Averaging:** Calculates averages with equal weighting given to all data points recorded during the averaging period.
- **Integrated Averaging:** Calculates hourly averages from data points representative of equal divisions of the hour, the smallest of which must be at least 15 minutes. No division is weighted more than any other. Therefore, a “data point” is defined as a 15-minute average (Ext1 average) that is calculated from one or more 1-minute averages (Base average).

These 15-minute averages are weighted equally in calculating the hourly average (Ext2



average), regardless of how many 1-minute averages are contained in each 15 minute average. The base average must be configured as 1 minute, the Ext1 average must be configured as 15 minute and the Ext2 average must be configured as 1 hour.

- **Part 60 Validation:** The percentage validity test divides the number of valid readings by the number of possible readings in the averaging period and multiplies that result by 100; the default validity percent is 75. Any average that is less than the validity percentage is deemed invalid (flagged with <).

For example, if there were 42 one-minute averages valid during a one hour averaging period, the resulting percent valid would be 70% ( $42 \div 60 \times 100$ ). Since this is less than 75%, the average would be invalid.

- To apply the percent validation globally (to every average), the Percent for Valid Base Avg and Percent for Valid Ext. Avg fields are configured in the System Configuration screen (see [Configure System Parameters](#)).
  - To configure percent validation on a per-channel, per-average basis, place the cursor in the desired average field, and press <Ctrl><V>. The Percent for *Valid Base Avg* field is configured. This overrides the global percent validation for that channel's average interval.
- **Part 75 Validation:** The average is validated according to the following rules:
    - For a full operating hour (a clock hour with 60 minutes of unit operation), at least one data point in each of the 15-minute quadrants of the hour is required to calculate the hourly average.
    - For a partial operating hour (a clock hour with less than 60 minutes of unit operation), at least one data point in each 15-minute quadrant of the hour in which the unit operated is required to calculate the hourly average.
    - For an operating hour in which required maintenance or quality-assurance activities were performed:
      - If the unit operated in two or more 15-minute quadrants of the hour, a minimum of two valid data points, separated by at least 15-minutes, is required to calculate the hourly average.
      - If the unit operated in only one 15-minute quadrant of the hour, at least one valid data point is required to calculate the hourly average.
    - The base average must be configured as 1 minute, the Ext1 average must be configured as 15 minute and the Ext2 average must be configured as 1 hour.

### Configure Instantaneous Validation



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To configure instantaneous validation information:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press the hot key for the channel you want to configure.
3. Place the cursor in any field, except an interval or storage field, and then press **CTRL-V = Edit Validation** to display the following configuration screen.

Only conditions related to digital inputs and limits that invalidate data are configured and checked on an instantaneous basis.

```

ESC 8864 v5.02.r25 ID:88      Inst. Validation Config.      12/05/17 17:20:39

Bad Status Lines (B)      : (none)
Maintenance Status Lines (M): (none)
Boiler Offline Status (F) : (none)
Maximum Reading Limit (+) : 1E+10
Minimum Reading Limit (-) : -1E+10
Rate of Change Limit (R)  : 1E+10
Digital Info Status #1 (V) : (none)
Digital Info Status #2 (W) : (none)
Digital Info Status #3 (X) : (none)
Digital Info Status #4 (Y) : (none)
Digital Info Status #5 (Z) : (none)

<ESC> to return to chl config

```

The following information provides a description of the configuration screen.

### Bad Status Lines (B)

Digital Input Pattern which indicates Bad Status for the parameter. The **B** flag will be present with the data when the pattern in this field is true.

### Maintenance Status Lines (M)

Digital Input Pattern which indicates that the parameter is in Maintenance. The **M** flag will be present with the data when this field is true.

### Boiler Offline Status (F)

Digital Input Pattern which indicates that the Boiler that this parameter is associated with is

Offline. The **F** flag will be present with the data when this field is true.

#### Maximum Reading Limit (+)

Numerical value; if reading is equal to or exceeds this value, the “+” flag will be present with the data.

#### Minimum Reading Limit (–)

Numerical value; if reading is equal to or less than this value, the “–” flag will be present with the data.

#### Rate of Change Limit (R)

Numerical value; if difference between the previous reading and the current reading is equal to or exceeds this value, the **R** flag will be present with the data.

#### Digital Info Status #1 (V)

Digital Input Pattern which indicates that Status#1 is true. The **V** flag will be present with the data when the pattern in this field is true.

#### Digital Info Status #2 (W)

Digital Input Pattern which indicates that Status#2 is true. The **W** flag will be present with the data when the pattern in this field is true.

#### Digital Info Status #3 (X)

Digital Input Pattern which indicates that Status#3 is true. The **X** flag will be present with the data when the pattern in this field is true.

#### Digital Info Status #4 (Y)

Digital Input Pattern which indicates that Status#4 is true. The **Y** flag will be present with the data when the pattern in this field is true.

#### Digital Info Status #5 (Z)

Digital Input Pattern which indicates that Status#5 is true. The **Z** flag will be present with the data when the pattern in this field is true.

### Configure Average Validation Limits



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To configure average validation limits:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press the hot key for the channel you want to configure.
3. Place the cursor in an interval or storage field and then press **CTRL-V = Edit Validation** to display the following configuration screen.

All validations related to averages are configured and checked on each averaging interval.

```

ESC 8864 v5.02.r25 ID:88      Average Validation Config.      12/06/17 09:23:22

High-High Alarm Limit (H) : 1E+10
High Alarm Limit (h) : 1E+10
Low Alarm Limit (l) : -1E+10
Low-Low Alarm Limit (L) : -1E+10
High ROC Alarm Limit (J) : 1E+10
Low ROC Alarm Limit (j) : 1E+10
Floor Limit (f) : -1E+10
Floor Value : 0
Ceiling Limit (c) : 1E+10
Ceiling Value : 0

Percent for valid average : Default (100)
Average to Math Constant : (none)

<ESC> to return to chl config

```

The following information provides a description of the configuration screen.

### High-High Alarm Limit (H)

Numerical value; if average is equal to or exceeds this value, the **H** flag will be present with the data.

### High Alarm Limit (h)

Numerical value; if average is equal to or exceeds this value, the **h** flag will be present with the data.

### Low Alarm Limit (l)

Numerical value; if average is equal to or less than this value, the “l” flag (lowercase L flag) will

be present with the data.

### Low-Low Alarm Limit (L)

Numerical value; if average is equal to or less than this value, the **L** flag will be present with the data.

### High ROC Alarm Limit (J)

Numerical value; if the absolute value of the difference between the previous average and the current average is equal to or exceeds this value, the **J** flag will be present with the data.



**NOTE:** ROC is an acronym for Rate of Change.

---

### Low ROC Alarm Limit (j)

Numerical value; if the absolute value of the difference between the previous average and the current average is equal to or exceeds this value, the **j** flag will be present with the data.

### Floor Limit (f)

Numerical value; if average is equal to or less than this value, the **f** flag will be present with the data.

### Floor Value

Numerical value; if average is equal to or less than the Floor Limit value, the average will be replaced by this value.

### Ceiling Limit (c)

Numerical value; if average is equal to or exceeds this value, the **c** flag will be present with the data. The Passed Ceiling Limit flag "**G**" will also be present with the data (unless the Invalid Data flag "<" is present) and, unlike the "**c**" flag, will be passed on to the extended averages. If this limit is configured and the Analog Overrange flag "**O**" is present with no other invalidating flags, the Invalid Data flag "<" is cleared (if it is present), and the "**c**" and "**G**" and ">" (Incomplete Data) flags will be present with the data.

### Ceiling Value

Numerical value; if average is equal to or exceeds the Ceiling Limit value, the average will be replaced by this value.

### Percent for valid average

Required percentage (1 to 100) of valid data points during averaging interval for this average to

be marked as valid. An average that falls below this percentage will be flagged with < to indicate that it is invalid. This field will override the setting in the System Configuration.

### Average to Math Constant

The Math Constant (**K1-K99**) in which to write this average at the completion of each averaging interval. Entering “none” in this field will clear the Math Constant.



**NOTE:** The average must be valid before it is written to the specified math constant.

### Data Flags

The 8864 stores data flags along with the numerical average in long-term storage. These data flags describe error conditions or alarms that took place during the averaging interval. The validation process described in the section [Data Validation and Flags](#) allows you to set up certain limits and conditions under which data can be flagged for informational purposes, invalidated, or both.

Control Keys for any Channel Configuration Screen	
<Ctrl><V>	In interval or storage fields to enter/edit validation limits on averages.
<Ctrl><V>	In any other field to enter/edit validation limits on instantaneous readings.

Validation-type flags indicate data that were not included in averaging (invalidated). Validation flags are sent with averages when a central computer system polls the 8864 Data Controller. Alarm and information flags indicate data that were used in averaging; these flags can be used for alarm purposes and reporting at the 8864 Data Controller.

The flags and conditions in the following tables are listed in order of priority:

- [Data Not Included in Average](#)
- [Data Included in Average](#)

Additional information about the different types of flags is provided in the following topics:

- [Out-of-Control Flags](#)
- [Boiler Offline Flags](#)
- [Floor Limit Flag](#)
- [Ceiling Limit Flag](#)

### Data Not Included in Average

Validation Flag	Condition	Type
P	Power Failure	Validation
D	Channel Disabled (marked off-line)	Validation
T, t	Out-of-Control Tolerance Exceeded (calibration data)	Validation
F, p	Boiler Offline	Validation
B	Bad Status Detected	Validation
C	Calibration	Validation
M	Maintenance	Validation
O	Analog Overrange	Validation
U	Analog Underrange	Validation
A	Arithmetic Error (math calculation error)	Validation
+	Maximum Exceeded	Validation
–	Minimum Exceeded	Validation
R	Rate of Change Limit Exceeded	Validation

### Data Included in Average

Alarm & Info Flags	Condition	Type
H	High-High Alarm Limit Exceeded	Alarm
h	High Alarm Limit Exceeded	Alarm
L	Low-Low Alarm Limit Exceeded	Alarm
l	Low Alarm Limit Exceeded	Alarm
J	High Rate of Change Alarm Limit Exceeded	Alarm
j	Low Rate of Change Alarm Limit Exceeded	Alarm
f	Floor Limit Exceeded	Information
c	Ceiling Limit Exceeded	Information
G	Passed Ceiling Limit	Information

Alarm & Info Flags	Condition	Type
V	Digital Information Status #1 Detected	Information
W	Digital Information Status #2 Detected	Information
X	Digital Information Status #3 Detected	Information
Y	Digital Information Status #4 Detected	Information
Z	Digital Information Status #5 Detected	Information
>	Some missing data, but meets requirement for valid average	Data Capture
<	Does not meet requirement for valid average	Data Capture
<blank>	No missing data	Data Capture

### Out-of-Control Flags

The out-of-control tolerance flags will be appended to any data whose calibration exceeded the configured out-of-control limit. The uppercase “**T**” flag indicates that data were out-of-control during the interval, and the interval was invalid. The lowercase “**t**” flag indicates that data were out-of-control, but the interval was still valid. Subsequent data for that channel is marked with a **T** until a calibration is performed that falls within the out-of-control limits. The out-of-control tolerance is configured in the Expected Value Configuration screen of a Calibration Configuration. For more information about how the 8864 Data Controller handles OOC conditions, see [Handling Out-of-Control Calibrations](#).

### Boiler Offline Flags

The boiler offline flags can be used to invalidate data during non-operating hours. These flags will prevent the 8864 from averaging in zeroes during non-operating periods; their use is crucial to correctly calculate emission rates during partial operating hours for 40 CFR Part 75.

The capital “**F**” indicates a whole hour offline; the lowercase “**p**” indicates a partial hour offline. The lowercase “**p**” flag only applies to Extended #1 and Extended #1 averages (typically configured as 15-minute and 1-hour intervals) and does **NOT** apply to Base intervals (typically configured as 1-minute averages). The Base interval will have only the capital “**F**” flag.

The digital input pattern that triggers the boiler offline flag is entered at the *Instantaneous Validation Configuration* screen. This DI pattern is usually the opposite of the time-on-line channel’s digital input pattern (entered at the On-Line Input Status field), especially if the time-on-line signal is a single digital input line. If the time-on-line signal is multiple lines, consider whether the lines are AND’ed or OR’ed together; note that the boiler offline flag uses the global Default Dig. Inputs to OR? switch configured in the *System Configuration* screen (unless the |



or & designators are used).

The validity flags (“<” and “>”) are applied to the Base interval according to the normal rules for the validity of Base intervals. However, the Extended #1 averages and Extended #2 averages follow slightly different rules. If an Extended #1 or Extended #2 average is offline for only part of the averaging interval, then the lowercase “p” flag is applied to the data. In this case, the normal rules for setting the validity flags (“<” and “>”) are also followed, depending on how the “Validation Type” parameter is configured. In the special case of the offline condition applying for the ENTIRE averaging period, however, then the flags are shown as “<F”. This is summarized in the following table:

Condition	Validity	Flags on Base	Flags on Ext1 or Ext2
Not offline during interval	Valid	(none)	(none)
Offline for some, but not all of the interval	Valid	F>	p>
Offline for some, but not all of the interval	Invalid	F<	P<
Offline for entire interval	Invalid	F<	F>

### Floor Limit Flag

The Floor Limit/Value feature addresses the situation of averages lower than allowed. It allows a value to be set for each averaging interval (minute, hour, etc.). If the average falls below the Floor Limit, the average is flagged with an “f,” and the average is replaced with the Floor Value. The defaults for this feature render it inactive.

The Floor Value propagates to average math and average merge channels and to further extended averages in regular math channels, stream-switched channels, merged channels, and so on. However, the Floor Limit flag “f” is only present on the average on which it is generated. The Floor Limit is evaluated before any other average validation check, so that if the Floor Value is used, all other validation checks are made against the stored data (floor) value.

### Ceiling Limit Flag

The Ceiling Limit/Value feature addresses the situation of averages higher than allowed. It allows a value to be set for each averaging interval (minute, hour, etc.). If the average rises above the Ceiling Limit, the average is flagged with a “c,” and the average is replaced with the Ceiling Value. If this is a base average and the Invalid Data flag “<” is not present, the average is also flagged with the Passed Ceiling Limit flag “G.” The defaults for this feature render it inactive.

If this limit is configured and the Analog Overrange flag “O” is present on the data with no other invalidating flags, the Invalid Data flag “<” is cleared (if it is present), and the “c” and “G” and “>” (Incomplete Data) flags will be present with the data. The Ceiling Value propagates to average

math and average merge channels and to further extended averages in regular math channels, stream-switched channels, merged channels, and so on. However, the Ceiling Limit flag “c” is only present on the average on which it is generated. The Passed Ceiling Limit flag “G” is propagated on to the extended averages of the channel. The Ceiling Limit is evaluated before any other average validation check, except the Floor Limit, so that if the Ceiling Value is used, all other validation checks are made against the stored data (ceiling) value.

## Configure Channel Options



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To use the decimal positioner, Modbus information, rounding precision, and the span value in calibration error calculations that will be configured:

1. From the Home Menu, select **C - Configuration Menu > D - Configure (Data) Channels > N - Enter New Configuration**.
2. Press the hot key for the channel you want to configure.
3. Press **CTRL-D=Config Channel Options** to open the configuration screen shown in the next example.

ESC 8864 v5.02.r25 ID:1M		Config. Channel Options	10/26/17 10:13:48
Name (not editable)	:	MBI_2041:NOX	
Ch1 Number (not editable)	:	33	
Decimal Positioner	:	00	
MODBUS Scale Factor	:	0.0100	
MODBUS/SIO Register #	:	033	
MODBUS MSW First(Y/N)	:	N	
Span for Cal Err	:	(not set)	
Round Precision	:	+1	
Allow Offline Calibrations?	:	N	
Online Cal. Hour (0-26)	:	(none)	
Input Scan Interval	:	10s_	
ESC to return to chl config			

The following information provides a description of the configuration screen.

### Name (not editable)

A non-interactive field used to identify the name of the channel currently displayed in the editor.

### ChI Number (not editable)

A non-interactive field used to identify the channel number of the channel currently displayed in the editor.

### Decimal Positioner

The decimal positioner is used to convert floating point numbers to integers for communications compatibility with 8800 data loggers. Press <Ctrl><D> in any channel configuration screen to designate the number of places to the right of the decimal. Valid entries are any value from **0** to **7**.

### MODBUS Scale Factor

The Modbus scaling factor is used to convert numeric data to integers for placement in Modbus input/output registers. The default scaling factor is **0.01**.

Each channel may be assigned a scaling factor for this conversion; typing <Ctrl><D> at the channel configuration screen allows the factor that will be used to scale data to be entered as follows:

Modbus register integer = Value in engineering units × scaling factor.

### MODBUS/SIO Register #

Press <Ctrl><D> to map data from this channel to the Modbus register number entered here; this is the starting register number. The Modbus register number will default to the channel number.



**IMPORTANT:** Use caution. The 8864 will not check to see if an index is already being used.

---

For more information about the 8864 Modbus interface and Modbus channels, see [App Note - Modbus Server](#) and [App Note - Modbus Client](#).

### MODBUS MSW First (Y/N)

The Modbus MSW First field is used to set which register (the least-significant or the most-significant) comes first (i.e., at the lowest Modbus register address) for those numeric values that span multiple registers. The default is “N” (i.e. LSW first). For example, the decimal number 1,234. is represented in the Modbus registers as follows (register values are shown as hexadecimal):

MSW First = "N" (default)				
	smallest address		largest address	
Single integer	04D2			
Single float	4000	449A		
Double Integer	04D2	0000		
Double float	0000	0000	4800	4093

MSW First = "Y"				
	smallest address		largest address	
Single integer	04D2			
Single float	449A	4000		
Double Integer	0000	04D2		
Double float	4093	4800	0000	0000

### Span for Cal Err (Span Value for Calibration Error)

Use this field to configure the span value to be used in calibration error calculations. For information about how the span value would be used with and without rounding, see the table in the section [Calibration Error Calculation](#).

### Round Precision

Rounding of values can be accomplished in two ways—explicitly by using the rounding operand in a math pack equation (see [Equation Configuration](#)), or implicitly as described in the following paragraphs:

- In the *Round Constituents* (Y/N) field of the Math Channel Configuration (Page 2) screen, select Y(Yes) for any constituent parameters in the math channel equation to be rounded to the precision configured in the Config. Channel Options screen for the constituent(s).
- Check the Config. Channel Options screen for the *Round Precision* field. This field accepts values from 9 to –9, such that a positive **n** entry rounds **n** number of places to the right of the decimal and a negative **n** entry rounds **n** number of places to the left of the decimal. For example:
  - –1 = round to the nearest ten
  - –2 = round to the nearest hundred
  - 1 = round to the nearest tenth
  - 2 = round to the nearest hundredth

The rounded constituent values are then used in the equation to arrive at the math

channel's values. If the math channel is itself a constituent to another math channel, and *Round Constituents* is enabled in the second math channel, a Round Precision must be configured at the first Config. Channel Options screen.

### Allow Offline Calibrations?

This field determines whether the channel is validated per the 40CFR75 offline calibration regulations. If the field is set to Y(es), then the channel output is marked as OOC (T flag) at the initial online point of the 26<sup>th</sup> hour since the operation of the last successful online calibration. A successful calibration (offline or online) must continue to take place each 26 clock hours as well or the channel output is marked OOC (T flag).

### Online Cal. Hour (0-26)

If Allow Offline Calibrations? is configured to Y(es) and Validation Type (0-7) is configured as 1, 2, or 3, then the calibration will occur in the number of online hours since the last online calibration. A value of 0 disables the calibration. A Startup Delay or a Startup Minute must also be configured on the calibration. The calibration begins at the top of the hour after the amount of time defined by the Startup Delay.

**NOTE:** See the topic [Validation Type \(0-7\)](#) for related information.

If a Startup Minute is configured, then the calibration is scheduled for that minute of the hour after the Startup Delay time has expired. If the channel is offline at the scheduled calibration time, then the calibration is rescheduled for the same minute of the next hour. If an online calibration is initiated from another source, then the automatic calibration is canceled. Otherwise, the calibration continues to be rescheduled each hour until an online calibration is performed. This feature is available for configuration in both the [menu-driven interface](#) and when accessing the GUI interface using a [browser](#) across a network connection (HTML interface).

### Input Scan Interval

This field is valid only for MODBUS and GSI type channels. It defines the sampling rate for receiving input data for inclusion in the base average.

The default value for a MODBUS channel is the base average interval. The default value for a GSI type channel is 5s. By setting this value to 0s, the base average interval of the channel is used. Only the last valid reading received during the scan interval is included in the base average.

If the scan interval is 0s (use base average interval), then the base average interval is equal to the last valid reading received during that interval regardless of the number of readings received. If the scan interval is, for example 5s and the base average is 1m, and all the scan interval readings are valid, the base (1m) average will consist of 12 readings.

The registers that are used for Modbus-type channels must be updated at least once per Input Scan Interval (as set in the Modbus channel configuration). If they are not updated at least once per scan interval, the average will be marked with the “B” and “U” flags, 100% data capture will not be achieved, and the validity of the average interval will be determined by the “Percent for valid average” setting.

## Configure Calibrations



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Up to 64 calibration sequences can be maintained in the 8864 (if adequate configuration memory is available). The types of calibrations, simple and complex, are broken down by how the programs are initiated and controlled.

The simplified calibrations, automatic and externally controlled zero/span, are intended to handle a majority of zero/span calibration sequences. The complex calibrations provide the user with a great deal of flexibility to handle unusual or long (more than two points) calibration sequences.



**NOTE: Storing Calibrations** – The storage system for calibrations acts like the long-term data storage for average data. Each calibration has its own storage area and can be a variable size. The number of calibration records to be stored for each calibration sequence is configurable (see Calibration Records Stored in calibration configuration screens).

To display the Cal Configuration Menu screen:

- From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.

```
ESC 8864 v6.01r24 ID:01 Cal Configuration Menu 01/20/21 13:40:28
N Enter New Cal Program
C Change Old Cal Program
D Delete Old Cal Program
S Start a Calibration Program
1 Start a Single Phase Cal
Z Select Channel(s) for Cal
A Abort a Calibration Program
Q Quick Expected Value Editor
I Return to Interactive Cal
K Abort Cal (NO:OOC,STORE)
W Abort Cal (NO:OOC,REC,STORE)
```

The following table provides a brief description for each menu item in the Cal Configuration Menu screen. For a detailed description, click any of the hyperlinks in the column labeled *Menu Item*.

Hot Key	Menu Item	Description
N	<a href="#">Add a Calibration Program</a>	Enter a new calibration sequence.
C	<a href="#">Change a Calibration Program</a>	Changes an existing calibration sequence.
D	<a href="#">Delete a Calibration Program</a>	Deletes an existing calibration sequence.
S	<a href="#">Start a Calibration Program</a>	Starts a calibration sequence manually.
1	<a href="#">Start a Single Phase Cal</a>	Manually runs one phase of a calibration.
Z	<a href="#">Calibrate a Parameter in a Calibration</a>	Manually calibrates a parameter in a calibration.
A	<a href="#">Abort a Calibration Program</a>	Ends a calibration sequence manually.
Q	<a href="#">Quick Expected Value Editor</a>	Edits expected values for existing calibrations. See also <a href="#">Configure Expected Values</a> .
I	<a href="#">Return to Interactive Cal</a>	Accesses the interactive calibration screen.

Hot Key	Menu Item	Description
K	<a href="#">Abort Cal (NO:OOC, Store)</a>	Ends a calibration sequence with control.
W	<a href="#">Abort Cal (NO:OOC, REC, STORE)</a>	Ends a calibration sequence with control.

Based on the type of calibration you are currently working with, one or both of the following control key commands are available for selection in the calibration configuration screen:

- **CTRL-R = Advanced Options:** Edit number of runs and interval between each run for a phase and other information.
- **CTRL-O = Config Relay Outputs:** Edit output normally open/normally closed settings.



**NOTE:** A system settings switch affects whether calibrations are stored and how they affect the out-of-control status if a parameter is in maintenance. For more information see [Configure System Parameters](#).

#### Related Topics:

- [Complex Calibrations](#)
- [Configure Complex Calibration](#)
- [Automatic Zero/Span](#)
- [Instrument Controlled Zero/Span](#)
- [Calibration Flags](#)
- [PS-9 Calibrations](#)

## Add a Calibration Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To configure a calibration program:

- From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations > N - Enter New Cal Program** (see next example).

The first two selections in the menu (*Automatic Zero-Span* and *Instrument Controlled Z-S*) handle a majority of zero/span calibration sequences. The remaining selections are complex calibrations that provide significant flexibility in handling unusual or long (more than two points) calibration sequences.



```
ESC 8864 v5.02.r25 ID:88 Config. Cal - Choose Type 12/06/17 15:00:11
1 Automatic Zero-Span
2 Instrument Controlled Z-S
A Automatic Cal
I Instrument Controlled Cal
E Externally Initiated Cal
U User Initiated Cal
L User Init w/Confirming DI
M Interactive (Menu) Cal
```

**Related Topics:**

- [Simple Calibration Types](#)
- [Complex Calibration Types](#)
- [Affected Channels](#)
- [Expected Values](#)
- [Calibration Error Calculation](#)
- [Handling Out-of-Control Calibrations](#)
- [Advanced Options for Automatic Cals](#)
- [Startup Delay/Startup Minute for Calibrations](#)

## Simple Calibration Types

Simple calibration types include:

- Automatic Zero-Span (hot key **1**). See [Automatic Zero/Span](#).
- Instrument Controlled Z-S (hot key **2**). See [Instrument Controlled Zero/Span](#).

**Related Topics:**

- [Configure Calibrations](#)
- [Add a Calibration Program](#)
- [Start a Calibration Program](#)

## Complex Calibrations

See the following sections for a description of complex calibration settings:

- [Automatic Calibration](#)
- [Instrument Controlled Calibration](#)
- [Externally Initiated Calibration](#)
- [User-Initiated Calibration](#)
- [User-Initiated Calibration with Confirming Digital Input](#)
- [Interactive \(Menu\) Calibration](#)

Also refer to [Configure Complex Calibration](#) and [Configure Phases of a Complex Calibration](#).

## Affected Channels

Each calibration has affected channels. Data from these channels are flagged with a “C” and are not used for averages while the calibration sequence is running.

In complex calibrations, each calibration phase has one or more data channels specified, a subset of the affected channels. When a phase runs, a data point is taken for each parameter in the manner prescribed by the phase information.

## Expected Values

An expected value can be entered for each parameter (channel) and phase. This value is typically a calibration gas bottle value, known as gas permtube (GPT) output.

Expected values can be configured in two ways:

- By selecting the field **Edit Expected Value** in the calibration configuration screen.
- Or by selecting **Quick Expected Value Editor** (hot key **Q**) from the Cal Configuration Menu.



**NOTE:** Expected values must be updated every time a calibration gas bottle is changed.

---

## Calibration Error Calculation

Three methods are available to determine a parameter's calibration error. The option of rounding results when calculating calibration error is also available. The three methods, with and without rounding, are shown in the following table:

Method	Rounding	Error Calculation Used
Standard	Off	$(\text{ABS}(\text{Actual} - \text{Expected}) * 100) / \text{Span}$
Difference	Off	$\text{ABS}(\text{Actual} - \text{Expected})$
Linearity	Off	$(\text{ABS}(\text{Actual} - \text{Expected}) * 100) / \text{Expected}$
Standard	On	$((\text{ABS}(\text{Actual} \sim \text{RP} - \text{Expected} \sim \text{RP}) * 100) / \text{Span} \sim 3) \sim 1$
Difference	On	$\text{ABS}(\text{Actual} \sim \text{RP} - \text{Expected} \sim \text{RP}) \sim \text{RP}$
Linearity	On	$((\text{ABS}(\text{Actual} \sim \text{RP} - \text{Expected} \sim \text{RP}) * 100) / \text{Expected} \sim \text{RP}) \sim 1$

Elements in the error calculation are defined as:

- **ABS:** absolute value
- **Actual:** actual calibration result for the parameter
- **Expected:** configured expected value for the parameter
- **Span:** configured calibration span value for the parameter
- **~:** rounding operand ( $a \sim b$  means  $a$  rounded to  $b$  places)
- **RP:** configured rounding precision for the parameter

Configuring calibration error information involves the following:

Expected Value	Description
Span	Span for Cal Err in the Config. Channel Options screen. (<Ctrl><D> in channel configuration screen.)
RP	Round Precision in the Config. Channel Options screen. (<Ctrl><D> in channel configuration screen.)

## Handling Out-of-Control Calibrations

Every calibration sequence can be configured to check for out-of-control (OOC) calibration data. (See [Startup Delay/Startup Minute for Calibrations](#)). If any calibration data point exceeds the configured out-of-control limit, it and all subsequent data points are flagged with a “T” (or “t” if valid hour OOC) validation flag.

For more details on OOC flags, see [Data Flags](#). When out-of-control, all subsequent

calibrations are checked for out-of-control status until receipt of the next good calibration, one that falls within the OOC tolerance limits.

Configuration of OOC checking at the 8864 Data Controller involves the following:

- **Out-of-control tolerance limits:** In the Phase Configuration screen, access the Expected Value Configuration screen by selecting the Edit Expected Values field. The OOC Drift Tolerance field can be configured here.



**NOTE:** If this OOC limit is not set or is removed, the calibration sequence cannot put a parameter back in control.

- **Recovery when OOC:** No Recovery if OOC Drift? = N(o) in the Expected Value Configuration screen (using Phase Configuration screen). If Y(es), the calibration sequence will stop without recovery controls (switching relays off) when a parameter goes OOC.
- **OOO checks on offline parameters:** Allow OFFLINE OOC Check? = Y(es) in the Advanced Cal Options screen of the calibration configuration.
- **Generate alarm when OOC:** Alarm on Out of Control? = Y(es) in the Alarm Configuration screen.

A calibration sequence that does not have OOC limits set cannot affect the OOC status of a channel. For instance, if a channel is OOC and then the OOC limits are removed, the calibration sequence cannot put the parameter back in control.

Calibrations that occur during a boiler offline period ("F" flag) cannot affect the OOC status of a channel (unless the Allow OFFLINE OOC Check? option is Y(es) or the Allow Offline Calibrations? option on the channel is Y(es)).

## Related Topics

- [Normal Operations](#)
- [Automatic Out-of-Control](#)

## Normal Operations

At the end of each phase, each parameter that is configured with an OOC limit for at least one phase and that is not currently offline is checked for OOC status by comparing the calibration error against the OOC limit. If the result exceeds the configured OOC limit, the parameter is marked OOC and the OOC alarm calibration flag is set.

Note that the options Allow OFFLINE OOC Check? in the Advanced Cal Options screen of the calibration configuration and Allow Offline Calibrations? in the Config. Channel Options screen of the channel configuration can allow for OOC checks even if the parameter is offline.

At the end of the entire calibration sequence, the calibration results are stored (unless Store

Result in Cal Record? in the Expected Value Configuration screen is N(o)).

**Related Topics:**

- [Handling Out-of-Control Calibrations](#)
- [Automatic Out-of-Control](#)

### Automatic Out-of-Control

All parameters that are configured with an OOC limit for at least one calibration phase will be automatically marked out-of-control if (a) they are online and (b) they have not passed an online calibration in 26 hours and the Validation Type (0-7) flag in the channel configuration is set to 1, 2, or 3.

**NOTE:** See the topic [Validation Type \(0-7\)](#) for related information.

The only exception to this rule is the 8-hour “grace period” following startup of a parameter. The startup grace period occurs when a parameter transitions from being totally offline during one hour to being online for any time in the next hour. If the 26-hour window expires during the 8-hour grace period, the parameter is not marked OOC until the end of the grace period. This allows users additional time to perform an online calibration and avoid going automatically OOC. Note, however, that additional startups that occur during an 8-hour grace period do not rescind or extend the grace period. For related information about automatically triggering calibrations following a startup, see the next section about Advanced Cal Options.

If the **Allow Offline Calibrations?** flag in the channel configuration is set to Y(es), then channel output is marked as OOC (T flag) at the initial point of the 26<sup>th</sup> online hour since the hour of the last successful online calibration. A successful calibration (offline or online) must continue to take place each 26 clock hours as well or the channel output is marked OOC (T flag).

By setting the Validation Type (0-7) flag to 2, a channel operates identically to a channel with the Validation Type (0-7) flag set to 1 except that the grace period is disabled. If an off-line condition begins less than 26 hours after a good calibration and extends past the 26-hour calibration window, the channel is marked with a “T” flag (OOO) immediately after the next on-line condition begins.

## Advanced Options for Automatic Cals

Configuring advanced calibration options (except for Keep Other Cals in Startup? and Allow OFFLINE OOC Check?) are available for automatic, user-initiated, and externally initiated calibrations.

To configure a calibration with advanced features:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations > N - Enter New Cal Program**.
2. Select a calibration type to open a calibration configuration screen. Then press **CTRL-R = Advanced Options** to display the configuration screen shown in the next example.

```

ESC 8864 v5.02.r25 ID:88      Advanced Cal Options      12/06/17 16:58:52

Name of Cal      (can't edit): TEMP
Startup Delay    : 0s
Startup Minute (00-59) : (none)
Keep Other Cals in Startup? : N
Allow OFFLINE OOC Check? : N
Number of Runs   : 0
Interval Between Runs : 0s

Type <ESC> to exit

```

The following information provides a description of the fields in the Advanced Cal Options screen.

### Startup Delay

An interval of time to delay calibrations after the boiler starts up (e.g., 004h, 030m). The Startup Delay and Startup Minute must be configured for any calibration sequences that should run automatically during the “grace period” after unit start-ups. A Startup Delay of 0s disables the startup calibration. This interval is also used to schedule an online calibration. See [Startup Delay/Startup Minute for Calibrations](#) for more information.

### Startup Minute (00-59)

The clock minute to begin calibrations after the startup delay time period has elapsed. Entering a minute of 99 sets the Startup Minute to (none), and the startup calibration begins immediately

after the Startup Delay time. This setting is also used to schedule an online calibration.

### Keep Other Cals in Startup?

Y(es) or N(o). If Y, any other calibration scheduled to run during startup with one or more of the same affected parameters runs as scheduled even after this calibration is completed. If N, any other calibration scheduled to run during startup with one or more of the same affected parameters is canceled.

### Allow OFFLINE OOC Check?

Y(es) or N(o). Normally, if a parameter is offline, it is marked as such at the end of each calibration phase and at the end of each sequence. Each parameter that is configured with an out-of-control limit is checked for OOC status at the end of each phase unless it has been marked offline. To allow OOC checks while the parameter is offline, this field must be configured as Y; the offline status is ignored and the parameter is checked for OOC status.

Note: Configuring this field to Y(es) does not meet the 40CFR75 regulations concerning offline calibrations.

### Number of Runs

The number of runs of each calibration that should be made.

### Interval Between Runs

The amount of time that should elapse between the start time of each run of a calibration.

### Startup Delay/Startup Minute for Calibrations

Automatic calibrations, user-initiated calibrations, and externally initiated calibrations can be configured to automatically trigger after a calibration startup condition.

A calibration startup condition occurs when one or more parameters, configured with OOC limits for at least one phase of the calibration, transition from being totally offline during one hour to being online at any (averaging) time in the next hour. (This is similar, but not identical, to the 8-hour grace period following start-ups described above.)

In the Advanced Cal Options screen, the Startup Delay is the amount of time that must expire following a startup before the calibration is triggered. A Startup Delay of 0s disables the startup calibration. The Startup Minute (00-59) is the exact minute of the hour to begin the calibration. The calibration automatically begins at the first occurrence of the startup minute following the expiration of the startup delay. If a 40CFR75 type channel also has both the Allow Offline Calibrations? and the Online Cal. Hour (0-26) fields configured, then the calibration is performed as an online calibration instead of a startup calibration. (See [Allow Offline Calibrations.](#))

A calibration is scheduled to automatically trigger when at least one of its OOC-configured

parameters transitions into the startup state. This only occurs, however, if the calibration has not already been scheduled for triggering. Also, a calibration is triggered at its startup time only if all OOC-configured parameters that are in the calibration startup state are online. Otherwise, the calibration is scheduled to trigger at the startup minute of the next hour. For a 40CFR75 type parameter, a configured startup calibration is always scheduled at the first online condition after a completely offline clock-hour. If the calibration completes successfully, however, no additional startup calibrations are scheduled during the 8-hour startup period. Although this method does not use the 26-hour calibration window to the fullest, it does prevent unexpected data loss under conditions that are common to combustion turbines. It also reduces the number of calibrations performed for a unit that comes up and down multiple times during a day.

If a calibration has not executed by the time the startup condition expires on all of its OOC-configured parameters, the calibration is canceled and rescheduled for normal operation. Note also that if such a calibration executes for any other reason (e.g., started from the menu or externally initiated), its startup condition is canceled. Automatic calibrations are blocked from execution as long as they are scheduled as a startup calibration; they can, however, be started from the menu.

### Related Topics

- [Advanced Options for Automatic Cals](#)
- [Configure Complex Calibration](#)

## Change a Calibration Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To change a calibration program:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **C - Change Old Cal Program** (hot key **C**) to open the configuration screen. A list of all configured calibration programs will display.
3. Select a calibration program and then press **<Enter>** to copy the calibration program into memory for editing. The program's configuration screen will display.

If needed, see [Add a Calibration Program](#).

4. After making all changes, select **FINISHED (Configure Now)** for the new changes to take effect.

If you exit the configuration screen using the **<Esc>** key before saving changes, new changes will not take effect.



## Delete a Calibration Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To delete a calibration program:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **D - Delete Old Cal Program** (hot key **D**) to open the configuration screen. A list of all configured calibration programs will display.
3. Select a calibration program and then press **<Enter>** to delete. Or press **<Esc>** to exit without deleting.

## Start a Calibration Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To start a calibration program:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations > S - Start a Calibration Program**.

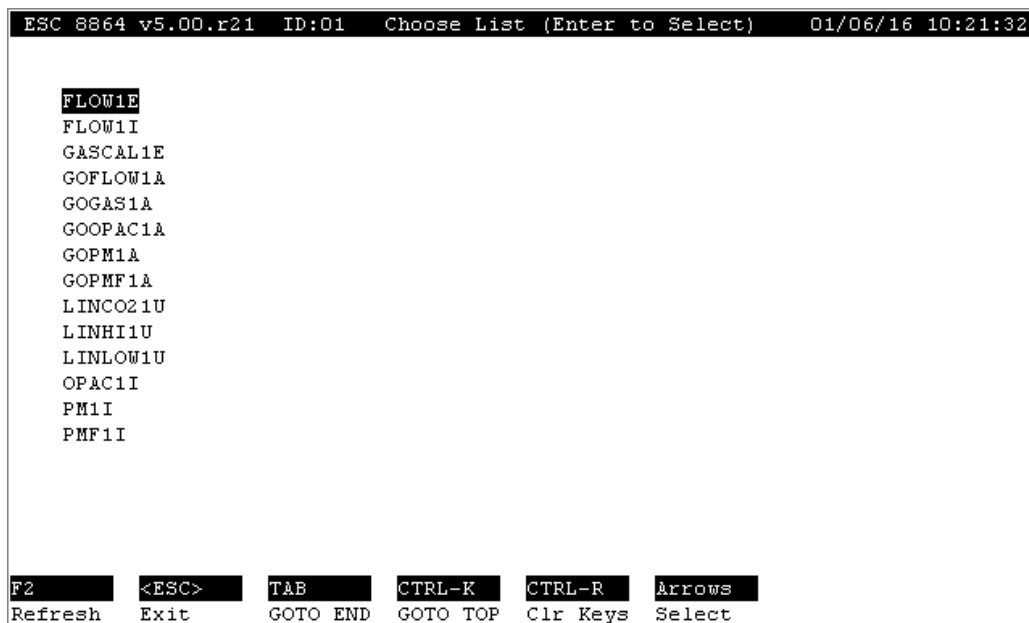
A list of all configured calibration programs display as shown in the next example.

2. Select a calibration program and then press **<Enter>** to start the calibration. Or press **<Esc>** to exit without starting the calibration program. Also note that instrument-controlled calibrations cannot be started with this menu selection.



**NOTE:** Manually starting a calibration will not affect any scheduled calibrations. Also, if a calibration was scheduled to run during the manual start, it will be rescheduled to the next even-numbered interval.

---



### Related Topics:

- [Start a Single Phase Cal](#)

## Start a Single Phase Cal

To run a single phase of a calibration:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **Start a Single Phase Cal** (hot key 1) to open the configuration screen. A list of all configured calibration programs displays.
3. Select a calibration program. Then press **<Enter>** to display a list of phases for the selected calibration program.
4. Select a phase and then press **<Enter>** to display the Single Phase Setup screen for the selected phase.
5. If needed, update the field **Phase Duration**. Then select **Start Single Cal (NOW)** to begin running the phase.

When the phase completes, the recovery period occurs before normal data acquisition resumes.

## Calibrate a Parameter in a Calibration

To calibrate a single parameter in a calibration:

1. From the Home menu, select **C - Configuration Menu** > **C - Configure Calibrations** to open the [Cal Configuration Menu](#).
2. Select **Z - Select Channel(s) for Cal** (hot key **Z**). A screen opens that includes a list of all calibration programs (see next example).
3. Select a calibration program in the list and then press <Enter>.

```
ESC 8864 v6.01r24 ID:01 Choose List (Enter to Select) 01/20/21 16:15:35

GASCAL01
GASLIN01

F2      <ESC>  TAB  CTRL-K  CTRL-R  Arrows
Refresh Exit  GOTO END GOTO TOP Clr Keys Select
```

4. When a screen opens that includes a list of all parameters for the selected calibration program, navigate to the parameter you want to calibrate and then press <Enter>. See next example.

```
ESC 8864 v6.01r24 ID:01 Choose (Space Toggle/Enter Select) 01/20/21 16:16:24

SO2LO [25]
SO2HI [26]
NOXLO [27]
NOXHI [28]
CO2 [31]


F2      <ESC>  TAB  CTRL-K  CTRL-R  Arrows
Refresh Exit  GOTO END GOTO TOP Clr Keys Select
```

The system returns to the Cal Configuration Menu and displays a message at the bottom of the screen (see next example) similar to the following example: *Started Calibration GASLIN01 with NOXLO*.

```
ESC 8864 v6.01r24 ID:01 Cal Configuration Menu 01/20/21 15:11:37

N Enter New Cal Program
C Change Old Cal Program
D Delete Old Cal Program
S Start a Calibration Program
1 Start a Single Phase Cal
Z Select Channel(s) for Cal
A Abort a Calibration Program
Q Quick Expected Value Editor
I Return to Interactive Cal
K Abort Cal (NO:OOC,STORE)
W Abort Cal (NO:OOC,REC,STORE)

Started Calibration GASLIN01 with NOXLO
```



## About a Calibration Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---



**IMPORTANT:** Aborting a calibration program requires that your login access be set up with the **Privileged** level or higher. Also note that instrument-controlled calibrations cannot be stopped using the procedure in this section.

---

To abort a calibration program that is currently running:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **Abort a Calibration Program** (hot key **A**) to open the configuration screen. A list of all configured calibration programs will display.

Instrument-controlled calibrations cannot be stopped with this menu selection.

3. Select a calibration program that is currently running and then press **<Enter>** to stop the selected calibration program. Or press **<Esc>** to exit without stopping the calibration program.

The complete recovery phase is executed and the results are stored. Partially completed parameters that have OOC limits configured for at least one phase are marked as OOC.

### Related Topics:

- [Controlling Abort Actions \(NO:OOC, STORE\)](#)
- [Controlling Abort Actions \(NO:OOC, REC, STORE\)](#)

## Abort Cal (NO:OOC, Store)



**IMPORTANT:** Aborting a calibration program using the menu item “K-Abort Cal (NO:OOC, STORE)” requires that your login access be set up with the **Integrator** level. Also note that instrument-controlled calibrations cannot be stopped using the procedure in this section.

---

To abort a calibration program that is currently running:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **K - Abort a Cal (NO:OOC, STORE)** (hot key **K**) to open the configuration screen. A list of all configured calibration programs will display.

Instrument-controlled calibrations cannot be stopped with this menu selection.

3. Select a calibration program that is currently running and then press **<Enter>** to stop the selected calibration program. Or press **<Esc>** to exit without stopping the calibration

program.

The complete recovery phase is executed but the results are **not** stored. Partially completed parameters that have OOC limits configured for at least one phase are **not** marked as OOC.

### Abort Cal (NO:OOC, REC, STORE)



**IMPORTANT:** Aborting a calibration program using the menu item “K-Abort Cal (NO:OOC, REC, STORE)” requires that your login access be set up with the **Integrator** level. Also note that instrument-controlled calibrations cannot be stopped using the procedure in this section.

To abort a calibration program that is currently running:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **W - Abort a Cal (NO:OOC, REC, STORE)** (hot key **W**) to open the configuration screen. A list of all configured calibration programs will display.

Instrument-controlled calibrations cannot be stopped with this menu selection.

3. Select a calibration program that is currently running and then press **<Enter>** to stop the selected calibration program. Or press **<Esc>** to exit without stopping the calibration program.

The complete recovery phase is **not** executed and the results are **not** stored. Partially completed parameters that have OOC limits configured for at least one phase are **not** marked as OOC.

### Quick Expected Value Editor



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This utility allows only the expected values to be quickly edited using up to 40 parameter/phase combinations for a single calibration. Calibration expected values can be updated while calibrations are in progress.

To edit expected values:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **S - Start a Calibration Program** (hot key **S**).
3. Use the up/down arrow keys to navigate the list of calibrations in the configuration screen.

4. Highlight a calibration to select it and then press **<Enter>**. A list of calibration phases and associated data parameters display for the selected calibration.

The first screen contains up to 20 expected values. A second screen of the same size is available if necessary. The total number of data parameters in all phases must be less than or equal to 40 or not all parameters will be accessible by the editor (for example, up to 20 parameters in a zero/span calibration, 13 parameters in a three-point calibration and so on).

5. Press **<Ctrl><N>** to select next page or **<Ctrl><P>** to select previous page. Use the up/down arrows to select a calibration phase. Press **<Esc>** to abort.

ESC 8864 v5.00.r21 ID:01		Edit Expected Values	01/06/16 10:30:56
PHASE1/CO2	:	17.84	
PHASE1/COLOW	:	0	
PHASE1/COHIGH	:	0	
PHASE1/NOXLOW	:	0	
PHASE1/NOXHIGH	:	0	
PHASE1/SO2LOW	:	0	
PHASE1/SO2HIGH	:	0	
PHASE2/CO2	:	0	
PHASE2/COLOW	:	181.8	
PHASE2/NOXLOW	:	90.97	
PHASE2/SO2LOW	:	89.87	
PHASE3/COHIGH	:	889.2	
PHASE3/NOXHIGH	:	731.6	
PHASE3/SO2HIGH	:	5346	

**EXIT (Configure Now)**  
Type <ESC> to abort

## Configure Expected Values



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The expected values in a calibration configuration can be edited by selecting the **Edit Expected Values** field. After the list of configured channels is displayed, press **<Enter>** for the following screen to appear for the selected channel.

Press **<Esc>** to return to the list of channels to edit additional expected values. Press **<Esc>** again to return to the Calibration Configuration screen.

ESC 8864 v5.02.r25	ID:1M	Expected Value Configuration	10/26/17 11:02:40
Name of Cal (not editable)	:	DAY-NOX2	
Name of Phase (not editable)	:	ZERO	
Channel Name (not editable)	:	NOX H204:NOX	
Expected Value	:	0	
Tracer/ID Code (0000-9999)	:	0000	
Use EV For Automatic Correct?	:	N	
Write EV to Math Constant	:	(none)	
Write Result to Math Constant	:	(none)	
Write Consts at End of Phase	:	N	
Warning Drift Tolerance	:	5	
OOB Drift Tolerance	:	10	
No Recovery If Warning Drift?	:	N	
No Recovery If OOB Drift?	:	N	
Store Result in Cal Record?	:	Y	
Use Rounded Results?	:	Y	
Method of Error Calc. (S,D,L)	:	S	
ESC to return to Phase Config			

The following information provides a description of the fields in the Expected Value Configuration screen.

### Name of Cal

A non-interactive field displaying the calibration sequence name.

### Name of Phase

A non-interactive field identifying this phase of the calibration program.

### Channel Name

A non-interactive field used to display which channel the expected value editor is working on.

### Expected Value

The expected value of the calibration channel for the selected phase, in engineering units. Up to 10 characters. The expected value can be one of the following:

- the actual numerical value (bottle value),
- a Math Constant (**K1-K99**),



- the result of a previous phase (phase name), or
- the product of a numerical value or a Math Constant and the result of a previous phase.

As an example, the expected value can be specified as **45.0**, **K1**, **ZERO**, **ZERO\*45**, or **ZERO\*K1**. For multiplication entries, the phase name must be the first operand.

### Tracer ID Code (0000-9999)

The identification code attached to each data point, usually corresponding to serial numbers on calibration gas bottles or filters.

### Use EV For Automatic Correct?

A flag (Y(es) or N(o)) indicating whether the 8864 should **automatically** recalculate scaling constants for this channel based on calibration results. The following conditions apply:

- If the flag is enabled for the parameter for one phase, a zero adjust is performed.
- If the flag is enabled for two phases, a linear rescaling is performed.
- If the flag is enabled (Y) for three phases, a three-point parabolic curve fit is performed.

Only standard and rolling average channels can be rescaled. The **Allow Auto Corr if Config'd?** flag must also be set to (Y)es in the System Configuration screen (see [Configure System Parameters](#)).



**NOTE:** Few checks for “reasonability” are done on the data, so a bad calibration (such as running out of span gas) could cause irrevocable loss of accuracy.

---

### Write EV to Math Constant

The user may specify that the expected value for this channel and phase be recorded as one of the thirty-two math constants (**K1-K99**).

### Write Result to Math Constant

The user may specify that the results for this channel and phase be recorded as one of the thirty-two math constants (**K1-K99**).

### Write Const at End of Phase

The user may specify that the math constants are written at the end of this phase by setting this field to “Y”. If this field is set to “N” (default) then the math constants are written at the beginning of the recovery phase.

## Warning Drift Tolerance

The maximum amount that each calibration result is allowed to differ from the expected value (in engineering units if the *Method of Error Calc. (S,D,L)* flag is set to **D** or in percentage if the flag is set to **S** or **L**). This field accepts up to 19 characters.

As an example, if the field *Method of Error Calc. (S,D,L)* is set to **D** and the expected value = 900 and this limit = 50, the calibration drift can span 850-950 before a calibration alarm is triggered (see [Average \(flags\) Alarm](#)).

Drift tolerances can be any of the following:

- numerical value
- Math Constant
- result of a previous phase
- product of a numerical value or Math Constant and the result of a previous phase
- expected value (**EXPVALUE**), or the product of the expected value and a Math Constant (**EXPVALUE\*Kn**)

See [Expected Values](#) in this section.

Can also use the **<** character to indicate that a variance less than or equal to the tolerance is an alarm condition.

## OOO Drift Tolerance

The maximum value of a calibration result (in engineering units if the **Method of Error Calc. (S,D,L)** flag is set to **D** or in percentage if the flag is set to **S** or **L**) for determining out-of-control status. If a calibration exceeds this value, the data will be flagged with a **T** to indicate it is out-of-control. This field accepts up to 19 characters.

Drift tolerances can be any of the following:

- numerical value
- Math Constant
- result of a previous phase
- product of a numerical value or Math Constant and the result of a previous phase
- expected value (**EXPVALUE**), or the product of the expected value and a Math Constant (**EXPVALUE\*Kn**)

See [Expected Values](#) in this section.

Can also use the **<** character to indicate that a variance less than or equal to the tolerance is an out-of-control condition.

### No Recovery If Warning Drift?

Y(es) or N(o) to indicate if the calibration sequence should stop without the recovery control (switching relays off) if the Cal Alarm Drift Tolerance limits are exceeded.

### No Recovery If OOC Drift?

Y(es) or N(o) to indicate if the calibration sequence should stop without the recovery control (switching relays off) if the Out-of-Control Drift Tolerance limits are exceeded.

### Store Result in Cal Record?

Y(es) or N(o) to store the data point in the calibration record. Normally Y, the user may choose that this data point not be stored in the calibration record. This feature may be used when a parameter is in the calibration for correction or write to math pack purposes, but should not be included in calibration records (i.e., if the parameter is not required by regulations to be calibrated).

### Use Rounded Results

Y(es) or N(o) to round the calibration results when calculating calibration error. If Y, values will be rounded to the precision configured in the advanced options screen of the parameter's channel configuration. Results will not be stored as rounded numbers. See [Calibration Error Calculation](#).

### Method of Error Calc. (S,D,L)

The method to be used for calculating calibration error: **S**=standard, **D**=difference, and **L**=linearity. The table in [Calibration Error Calculation](#) shows the methods with and without rounding.

### Data Type

The "Data Type" field is configured at the "expected value" level. This field determines the source of the "actual value" result for this phase/channel in the following manner:

- If the Data Type is "I" or blank, data is averaged from the channel readings.
- If the Data Type is "A", the actual value for this phase is the average of the actual values of previous phases that have their Data Type set to "I" and are the same Injection Level as this phase.
- If the Data Type is "R", the actual value is computed as the  $R^2$  of the previous phases that are marked as Data Type = "A".

## Injection Level

The “Injection Level” field is configured at the “expected value” level. This field sets the injection level (L, M, H, or none) for this phase. It is used if the Data Type for this phase/channel is set to “A” to indicate which previous phases should be averaged.

## Return to Interactive Cal



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This calibration type uses a menu interface to control data acquisition and to move from one calibration phase to another.

To perform an interactive calibration:

1. From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations**.
2. Select **S - Start a Calibration Program** (hot key **S**) to open the configuration screen.
3. Use the up/down arrow keys to navigate the list. Select the name of the interactive calibration program. Only one interactive calibration can be active at a time.

A special menu displays with the active calibration and phase, and whether data acquisition is active or inactive. The special menu selections are used to start and stop data acquisition.

After stepping through all the phases, the calibration program enters a preset recovery period, then returns to normal sampling. While in recovery, the Interactive Calibration screen cannot be displayed.

```

ESC 8864 v5.xx ID:49      Interactive Calibration      mm/dd/yy hh:mm:ss

Cal Sequence              : MENCAL
Currently Active Phase    : ZERO
Data Acquisition is       : OFF
START Data Acquisition
Display Readings
Display Cal Status
STOP Data, Go To Next Phase
Edit Expected Values
Abort Cal Entirely
  
```

The following information provides a description of the fields in the Interactive Calibration screen.

### Cal Sequence

A non-interactive field displaying the name of the interactive calibration sequence being performed.

### Currently Active Phase

A non-interactive field identifying the phase of the interactive calibration program that is currently executing. Any Output Control Lines defined for this phase will be in the activate state at this time.

### Data Acquisition is

OFF or ON. A non-interactive field that indicates whether the 8864 Data Controller is collecting calibration data for the above-referenced calibration phase.

### START Data Acquisition

Press <Enter> at this field to begin collecting data for the Currently Active Phase of the calibration.

### Display Readings

Press <Enter> at this field to view the Real-Time Engineering Units display.

### STOP Data, Go To Next Phase

Press <Enter> at this field to stop data collection for the Currently Active Phase and to make the next configured phase of the interactive calibration sequence the Currently Active Phase.

### Display Cal Status

Press <Enter> at this field to view the Display Status of Single Cal screen (See [Display Status of Single Cal](#)).

### Edit Expected Values

Press <Enter> at this field to edit the expected values for the Currently Active Phase of the interactive calibration program.

## Abort Cal Entirely

Press **<Enter>** at this field to abort the interactive calibration sequence. The recovery portion of the calibration will be initiated, and the display will return to the Cal Configuration Menu.

## Automatic Calibration

This calibration, like the Automatic Zero/Span, is initiated by the internal clock of the 8864 Data Controller and is repeated on a preset interval. The starting time and interval (repeat) time must be configured.

For each phase, the user must designate which control lines are to be turned on or off; the duration of the switch; and the response time.

## Instrument Controlled Calibration

This calibration, like the Instrument Controlled Zero/Span, is initiated and controlled by external equipment. The current state is detected using digital inputs. (An instrument-controlled calibration cannot be manually started or stopped.) The user enters a list of phases; these phases can occur in any order.

For each phase, the user must designate the pattern of digital input lines that defines the state and the response time for each phase (seconds, minutes, or hours).

## Externally Initiated Calibration

This calibration is similar to the [Automatic Calibration](#). Instead of specifying a start time, the digital inputs (one or more) used to notify the 8864 that the calibration should begin are specified. The digital input status (1=on, 0=off) is also specified. The calibration timing, control, and phase configuration is the same as an [Automatic Calibration](#).

## User-Initiated Calibration

This calibration is similar to the [Automatic Calibration](#), but there is no automatic start time or repeat time. The calibration begins when **Start a Calibration Program** (hot key **S**) is selected from the Cal Configuration Menu. The timing, control, and phase configuration is the same as for an [Automatic Calibration](#).

## User-Initiated Calibration with Confirming Digital Input

This user-initiated calibration type looks for digital inputs to confirm the end of a phase. The calibration is aborted if the configured digital input line pattern is not observed.

## Interactive (Menu) Calibration

In this calibration type, the user controls calibration data acquisition using a menu interface. This calibration type is often used for highly manual procedures such as testing opacity instruments against standard filters (see [Return to Interactive Cal](#)).

## Configure Complex Calibration



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Complex calibrations require the same configuration information, with some extra fields for automatic and externally initiated calibration types.

```

ESC 8864 v5.02.r25 ID:1M Externally Init. (E) Cal Cfg. 10/27/17 09:55:38

Name of Cal Sequence      : DAY-NOX2
EDIT AFFECTED CHANNELS   :
Calibration Records Stored : 20
Start Pattern Status Lines : 33=0&39
MODIFY PHASE              :
ADD PHASE                 :
DELETE PHASE              :
Recovery Time             : 5s
FINISHED (Configure Now)  : 10/27/17 09:47:56

CTRL-R = Advanced Options

```

The following information provides a description of the fields in the configuration screen.

### Name of Cal Sequence

The label used to identify this calibration program.

### Starting Time

[Automatic only] The month, day, and time that the 8864 Data Controller should begin this calibration sequence. MM/DD/YY HH:MM:SS

## Interval

[Automatic only] How often this calibration sequence should repeat; usually every 24 hours (1d). Smaller intervals must evenly divide into 24 hours. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively).

## Edit Affected Channels

Select this entry to enter the names of the channels that will be affected by the introduction of calibration gas; these will be flagged during calibration. Up to 64 channels can be configured. Press **<Ctrl-N>** to go to the next page and **<ESC>** when done editing.

```
ESC 8864 v5.02.r25 ID:1M Edit Affected Parameters (Page 1) 10/27/17 09:57:45

01: SECMN 17: H2O4OPHR:FUEL
02: HBEATAX3:FUEL 18: H2O4OPHR:NOX
03: MBI_2041:NOX 19: H2O4OPHR:O2
04: MBI_2042:NOX 20: H501OPHR:FUEL
05: MBI_H204:O2 21: H501OPHR:NOX
06: MBI_5011:NOX 22: H501OPHR:O2
07: MBI_5012:NOX 23:
08: MBI_H501:O2 24:
09: MBI_H204:FUEL 25:
10: MBI_H501:FUEL 26:
11: FF_H204:FUEL 27:
12: NOX_H204:NOX 28:
13: O2_H204:O2 29:
14: FF_H501:FUEL 30:
15: NOX_H501:NOX 31:
16: O2_H501:O2 32:

Exit and Save=ESC, Next Page=CTRL-N, Prev Page=CTRL-P, Type to Edit
```

## Affected Channels

The channels that will be affected by the introduction of calibration gas; these will be flagged during calibration. Any configured channel name or ALL for all configured channels.

## Calibration Records Stored

The minimum number of calibration records that can be stored for this particular calibration sequence. The default depends on the number of parameters affected. See the note labeled "Storing Calibrations" in the [Configure Calibrations](#) section.

## Start Pattern Status Lines

[Externally Initiated only] A list of the input lines and their on/off states that signal the beginning of calibration. Both the line number and the state should be specified (1=on, 0=off); e.g., 2=1.



## Modify Phase

Pressing **<Enter>** at this field brings up a choose list from which the phase to modify is selected. See [Configure Phases of a Complex Calibration](#) for an explanation of how phases are configured.

## Add Phase

Pressing **<Enter>** at this field brings up a choose list of existing phases along with the option END. Pressing the **<Enter>** key with a phase name highlighted causes the new phase to be placed before the selected phase and accesses the Phase Configuration screen. Pressing the **<Enter>** key with the END selection highlighted causes the new phase to be the final phase of the calibration and accesses the Phase Configuration screen. See [Configure Phases of a Complex Calibration](#) for an explanation of how phases are configured.

## Delete Phase

Pressing **<Enter>** at this field brings up a choose list from which the phase to delete is selected. Press **<Enter>** to confirm deletion or **<Esc>** to exit without deleting.

## Recovery Time

The time required to purge the calibration gases; a delay before normal sampling and averaging begins again. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). Setting the recovery time to zero (0s) will skip recovery control (switching relays off) and time delay before normal operation resumes.

## OOO Only (Y/N)

The “OOO Only” field is configured at the calibration level. If checked, this calibration sequence can mark a channel as OOC (add the “T” flag in the controller), but it cannot remove the OOC (“T” flag).

The field “OOO Only” is available when configuring the following types of calibrations (*C-Configuration Menu > C-Configure Calibrations > N-Enter New Cal Program*):

- Automatic Cal (hot key A)
- Instrument Cal (hot key I)
- Externally Initiated Cal (hot key E)
- User Initiated Cal (hot key U)
- L-User Init w/Confirming DI (hot key L)
- Interactive (Menu) Cal. (hot key M)

## FINISHED (Configure Now)

### Configure Phases of a Complex Calibration

Depending on the type of complex calibration, the phase configuration screen will contain the fields shown in the next screen and described below. Some calibration types will not display all of these fields in their phase configuration.

```

ESC 8864 v5.00.r21 ID:01 Phase Configuration Screen 01/06/16 10:52:19

Name of Cal (not editable) : TEMP
Name of Phase              : END
Data Channels              : (none)


Output Control Lines       : 1=0,2=0,3=0
Phase Data Time           : 0s
Phase Duration            : 5s
Edit Expected Values      :

<ESC> to return to cal config

```

The following information describes the fields in the configuration screen.

#### Name of Cal

The calibration sequence name of which this phase is a part.

#### Name of Phase

The label used to identify this phase of the calibration program.

#### Data Channels

A subset of the affected channels; when this phase runs, a data point will be taken for each parameter. Defaults to the same channels as designated in the Affected/Data Channels field in the Calibration Configuration screen. Up to 255 characters.

#### Output Control Lines

[All except Instrument Controlled] A list of the 2-digit output line numbers and their states that

will control this phase of calibration.

### Hold Pattern

The “Hold Pattern” field is configured at the phase level. When configured, the phase will not end until both the digital inputs match the hold pattern (i.e., the pattern is TRUE) and the phase duration time has expired. If the Hold Pattern is not configured, then the phase ends when the timer expires.

### Phase Data Time

How long data are to be averaged at the end of this phase to form the data. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). A data time of “0s” indicates that no data should be stored for this interval. A data time of “1s” indicates to take the most recent instantaneous scan for “Instrument Controlled” and “Interactive” calibrations, and the next-to-last instantaneous scan for “Automatic”, “Externally Initiated”, and “User Initiated” calibrations.

### Phase Duration

[All except Instrument Controlled] How long the lines are to be switched on for this phase of calibration; must be greater than or equal to the Phase Data Time. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively).

### Edit Expected Values

Press <Enter> at this field to edit expected values for the zero phase of this calibration program.

### Input Status Lines

[Instrument Controlled only] A list of the input lines and their on/off states that signal the beginning of this phase of an instrument controlled calibration. Both the line number and the state should be specified (1=on, 0=off); e.g., 2=1.

### Confirming Status Inputs

[User Init w/Confirming DI only] For user-initiated calibrations with confirming digital inputs, list the digital input line pattern that confirms the end of this phase (may or may not be configured for each phase). Both the line number and the on/off state should be specified (1=on, 0=off); e.g., **2=1**. If the confirming pattern is configured for a phase, the phase ends when the pattern is observed or after the Phase Duration time has expired. If the configured digital inputs are not observed by the end of the phase duration, the calibration is aborted.

## Automatic Zero/Span



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Automatic Zero/Span calibration is initiated by the internal clock of the 8864 Data Controller. It typically repeats every 24 hours. Two data points are taken: a zero point and a span point. Each phase controls a calibrator or solenoids using digital output lines. Each phase can switch several output lines. Each phase has a prescribed duration that specifies how long the lines are to be switched on, and a response time that specifies how long data are to be averaged at the end of each phase to form the data for that phase.

To configure an Automatic Zero/Span calibration:

- From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations > N - Enter New Cal Program > 1 - Automatic Zero-Span**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88      Auto Zero/Span Cal Cfg      12/06/17 18:35:44

Name of Cal Sequence       : TEMP
Starting Time              : 12/06/17 19:00:00
Interval                   : 1d
EDIT AFFECTED CHANNELS    :
Calibration Records Stored : 1
Zero Output Control Lines  : 1,2=0
Zero Phase Data Time       : 0s
Zero Phase Duration        : 5s
Edit Zero Expected Values  :
Span Output Control Lines  : 1=0,2
Span Phase Data Time       : 0s
Span Phase Duration        : 5s
Edit Span Expected Values  :
Recovery Time              : 5m
FINISHED (Configure Now)

CTRL-R = Advanced Options, CTRL-O = Config Relay Outputs
```

The following information provides a description of the fields in the configuration screen.

### Name of Cal Sequence

The label used to identify this calibration program.

## Starting Time

The month, day, and time that the 8864 Data Controller should begin this calibration sequence. MM/DD/YY HH:MM:SS.

## Interval

How often this calibration sequence should repeat; usually every 24 hours (1d). Interval must evenly divide into 24 hours. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively).

## Edit Affected Channels

The channels that will be affected by the introduction of calibration gas; these will be flagged during calibration. Any configured channel name or ALL for all configured channels. Select the field and then press **<Enter>** to open the *Edit Affected Parameters* configuration screen. Up to 64 channels can be configured. Pressing **<Esc>** returns to the Auto Zero/Span Cal Cfg screen.

## Calibration Records Stored

The minimum number of calibration records that can be stored for this particular calibration sequence. The default depends on the number of parameters affected. See A Note About Storing Calibrations in the [Complex Calibrations](#) section.

## Zero Output Control Lines

A list of the 2-digit output line numbers and their states that will control the zero phase of calibration.

## Zero Phase Data Time

How long data are to be averaged at the end of the zero phase to form the data for zero calibration. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively). Must be equal to or greater than 5 seconds. A data time of “0s” indicates that no data should be stored for this interval. A data time of “1s” indicates to take the most recent instantaneous scan for “Instrument Controlled” and “Interactive” calibrations, and the next-to-last instantaneous scan for “Automatic”, “Externally Initiated”, and “User Initiated” calibrations.

## Zero Phase Duration

How long the lines are to be switched on for the zero phase of calibration; must be greater than or equal to the Zero Phase Data Time. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively). Must be equal to or greater than 5 seconds.

### Edit Zero Expected Values

Press <Enter> at this field to edit expected values for the zero phase of this calibration program. (Use the down arrow to skip the expected values editor.)

### Span Output Control Lines

A list of the 2-digit output line numbers and their states that will control the span phase of calibration.

### Span Phase Data Time

How long data are to be averaged at the end of the span phase to form the data for span calibration. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively). Must be equal to or greater than 5 seconds. A data time of "0s" indicates that no data should be stored for this interval. A data time of "1s" indicates to take the most recent instantaneous scan for "Instrument Controlled" and "Interactive" calibrations, and the next-to-last instantaneous scan for "Automatic", "Externally Initiated", and "User Initiated" calibrations.

### Span Phase Duration

How long the lines are to be switched on for the span phase of calibration; must be greater than or equal to the Span Phase Data Time. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively). Must be equal to or greater than 5 seconds.

### Edit Span Expected Values

Press <Enter> at this field to edit expected values for the span phase of this calibration program.

### Recovery Time

The time required to purge the calibration gases; a delay before normal sampling and averaging begins again. **0** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively). Setting the recovery time to zero (**0s**) will skip any recovery control (switching relays off) and time delay before normal operation resumes.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Instrument Controlled Zero/Span



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This calibration is initiated by events external to the 8864 Data Controller (typically an automatic calibrator). An instrument-controlled calibration cannot be manually started or stopped.

The 8864 Data Controller senses the zero and span states through its digital input lines. Two data points are taken: a zero point and a span point. For each phase, the 8864 Data Controller must be told which inputs are to be watched and whether an on or off state for each input defines the beginning of the phase. When the 8864 Data Controller senses the exact specified input pattern, it recognizes the zero or span state.

Each phase has a response time that specifies how long data are to be averaged at the end of each phase to form the data for that phase. A recovery time specifies the time required to purge out the calibration gases after the zero and span phases have switched off, providing a delay before normal sampling and averaging begins.

To configure an instrument controlled zero/span calibration program:

- From the Home Menu, select **C - Configuration Menu > C - Configure Calibrations > N - Enter New Cal Program > 2 - Instrument Controlled**.

The following screen displays.

```

ESC 8864 v5.02.r25  ID:88  Instr Ctrl Zero/Span Config  12/08/17 10:44:39

Name of Cal Sequence      : TEMP
EDIT AFFECTED CHANNELS   :
Calibration Records Stored : 1
Zero Input Status Lines  : 1&2=0
Zero Phase Data Time     : 5m
Edit Zero Expected Values :
Span Input Status Lines  : 1=0&2
Span Phase Data Time     : 5m
Edit Span Expected Values :
Recovery Time            : 5m
FINISHED (Configure Now)

CTRL-R = Advanced Options
  
```

The following information provides a description of the fields in the configuration screen.

### Name of Cal Sequence

The label used to identify this calibration program.

### Edit Affected Channels

The channels that will be affected by the introduction of calibration gas; these will be flagged during calibration. Any configured channel name or ALL for all configured channels. Up to 255 characters. Select the field and then press **<Enter>** to open the *Edit Affected Parameters* configuration screen. Up to 64 channels can be configured on two pages. Pressing **<Esc>** returns to the Instr Ctrl Zero/Span Config screen.

```
ESC 8864 v5.02.r25 ID:1M Edit Affected Parameters (Page 1) 10/27/17 09:57:45

01: SECMN 17: H2O4OPHR:FUEL
02: HBEATAX3:FUEL 18: H2O4OPHR:NOX
03: MBI_2041:NOX 19: H2O4OPHR:O2
04: MBI_2042:NOX 20: H501OPHR:FUEL
05: MBI_H204:O2 21: H501OPHR:NOX
06: MBI_5011:NOX 22: H501OPHR:O2
07: MBI_5012:NOX 23:
08: MBI_H501:O2 24:
09: MBI_H204:FUEL 25:
10: MBI_H501:FUEL 26:
11: FF_H204:FUEL 27:
12: NOX_H204:NOX 28:
13: O2_H204:O2 29:
14: FF_H501:FUEL 30:
15: NOX_H501:NOX 31:
16: O2_H501:O2 32:

Exit and Save=ESC, Next Page=CTRL-N, Prev Page=CTRL-P, Type to Edit
```

### Calibration Records Stored

The minimum number of calibration records that can be stored for this particular calibration sequence. The default depends on the number of parameters affected. See [A Note About Storing Calibrations](#) in the [Configure Calibrations](#) section.

### Zero Input Status Lines

A list of the input lines and their on/off states that signal the beginning of the zero phase of calibration. Both the line number and the state should be specified (1=on, 0=off); the "1" is



assumed and will not be shown (e.g., if you enter **1=1&2=0**, it will display as **1&2=0**).

### Zero Phase Data Time

How long data are to be averaged at the end of the zero phase to form the data for zero calibration. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). A data time of "0s" indicates that no data should be stored for this interval. A data time of "1s" indicates to take the most recent instantaneous scan for "Instrument Controlled" and "Interactive" calibrations, and the next-to-last instantaneous scan for "Automatic", "Externally Initiated", and "User Initiated" calibrations.

### Edit Zero Expected Values

Press <Enter> at this field to edit expected values for the zero phase of this calibration program.

### Span Input Status Lines

A list of the input lines and their on/off states that signal the beginning of the span phase of calibration. Both the line number and the state should be specified (1=on, 0=off); the "=1" is assumed and will not be shown (e.g., 1=0&2 for 1=0 and 2=1). A data time of "0s" indicates that no data should be stored for this interval. A data time of "1s" indicates to take the most recent instantaneous scan for "Instrument Controlled" and "Interactive" calibrations, and the next-to-last instantaneous scan for "Automatic", "Externally Initiated", and "User Initiated" calibrations.

### Span Phase Data Time

How long data are to be averaged at the end of the span phase to form the data for span calibration. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively).

### Edit Span Expected Values

Press <Enter> at this field to edit expected values for the span phase of this calibration program.

### Recovery Time

The time required to purge the calibration gases; a delay before normal sampling and averaging begins again. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). Setting the recovery time to zero (0s) will skip any recovery control (switching relays off) and time delay before normal operation resumes.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Calibration Flags

The 8864 stores the following calibration flags along with the data in long-term storage. These calibration flags describe error conditions or events that took place during the calibration.

Flag	Condition
a	Cal Restore Caused Abort
E	Cal Error Caused Abort
C	Can't Find Cal Channel
P	Can't Find Parm Channel
<	All OOC Phases Not Done
m	OOC While In Maintenance
M	Cal Phase Ended While In Maintenance
F	Cal Phase Ended While Offline
A	Cal Aborted (lowest priority)
R	Error Rescaling
D	Instrument Drifted
O	Instrument OOC (highest priority)

## Configure Alarms



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

If sufficient configuration memory is available, the 8864 can maintain up to 64 different alarm programs for reporting alarm conditions to the screen or to a host computer. These types of alarms can be configured:

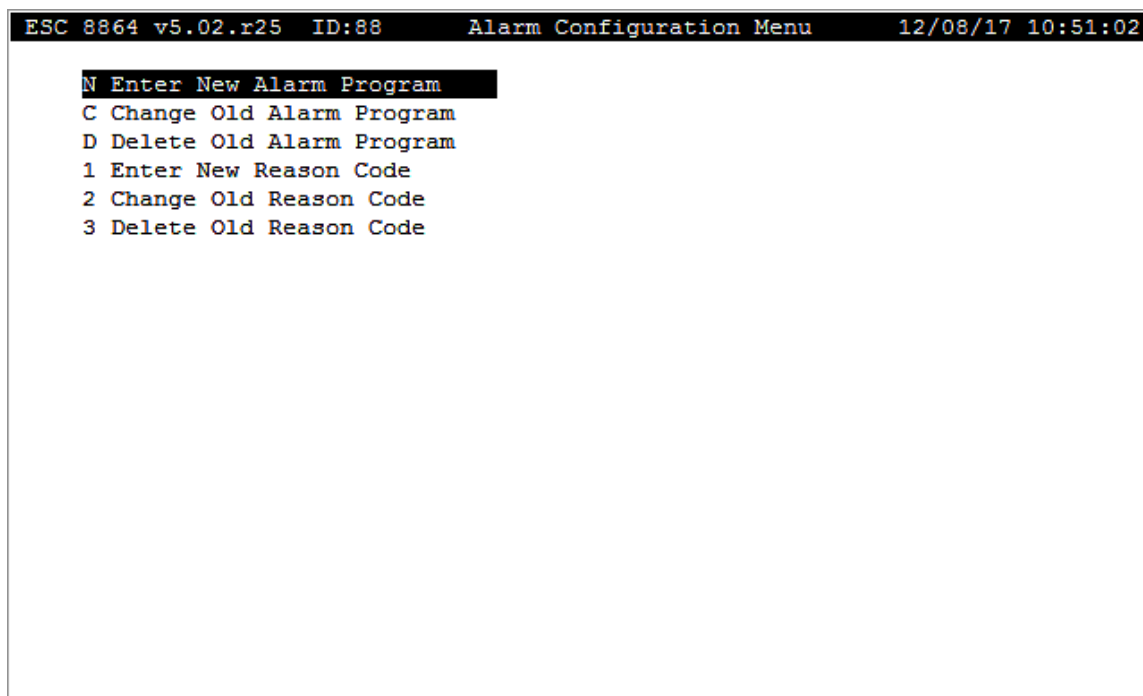
- **Average Alarm:** Triggered by the presence of a validation or information flag on a data average.
- **Calibration Drift Alarm:** Triggered under the following conditions:
  - When a calibration result differs from the expected value by more than the configured Warning Drift Tolerance.
  - When a calibration result differs from the expected value by more than the configured OOC Drift Tolerance.
  - When the calibration is aborted before completion.
  - When the auto-scale of any calibration channel fails.
  - By any combination of the previous four conditions.

All alarms can be used to turn on control (relay) output lines, send messages to serial ports, and create an entry in an alarm journal buffer, along with time tags and information about who and what triggered the alarm.

An alarm can also be used to execute a user-defined dial-out program that initiates communication through a modem and outputs user-defined data in the form of text strings. An additional software option can be used to provide automatic and instant notification to a polling computer, even during polling.

To display the Alarms Configuration Menu screen:

- From the Home Menu, select **C - Configuration Menu** > **A - Configure Alarms**.



A brief description of each item in the Alarm Configuration menu is provided in the next table. For a detailed description, click the hyperlink in the *To Option* column.

Hot Key	To Option	Purpose
N	<a href="#">Enter New Alarm Program</a>	Configures a new alarm program.
C	<a href="#">Change Old Alarm Program</a>	Modifies an existing alarm program.
D	<a href="#">Delete Old Alarm Program</a>	Deletes an existing alarm program.
1	<a href="#">Enter New Reason Code</a>	Configures a reason code.
2	<a href="#">Change Old Reason Code</a>	Modifies an existing reason code.
3	<a href="#">Delete Old Reason Code</a>	Deletes an existing reason code.
4	<a href="#">Enter New Dial-out Program</a>	Configures a dial-out program.
5	<a href="#">Change Old Dial-out Program</a>	Modifies a dial-out program.
6	<a href="#">Delete Old Dial-out Program</a>	Deletes a dial-out program.

Other features available when working with Alarms include those in the Status Menu. From the Home Screen, select **S - Status Menu** (hot key **S**) > **A - Alarm Status/Log** (hot key **A**). The

following actions can be performed in the Alarm Status/Log Menu:

- V - View Alarm Log (hot key V)
- C - Clear Alarm Log (hot key C)
- S - Report Current Alarm Status (hot key S)
- A - Acknowledge Active Alarm (hot key A). See [Acknowledge Alarms](#).

## Acknowledge Alarms

Each alarm program can have a particular method or combination of methods for acknowledging alarms. Acknowledgment methods include:

- The transition of an input status line, perhaps from an acknowledgment switch, (Input Lines for Ack and Encode DI as Reason Code fields).
- An automatic acknowledgment after a specified time-out period (Acknowledgment Timeout field)
- Manual acknowledgment by the user

Any combination of these methods can be used to acknowledge alarms. If none of these methods are used, the alarm is reset when the alarm condition disappears – provided the field *End Alarm When No Flag?* is set to (Y)es.

## Enter New Alarm Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

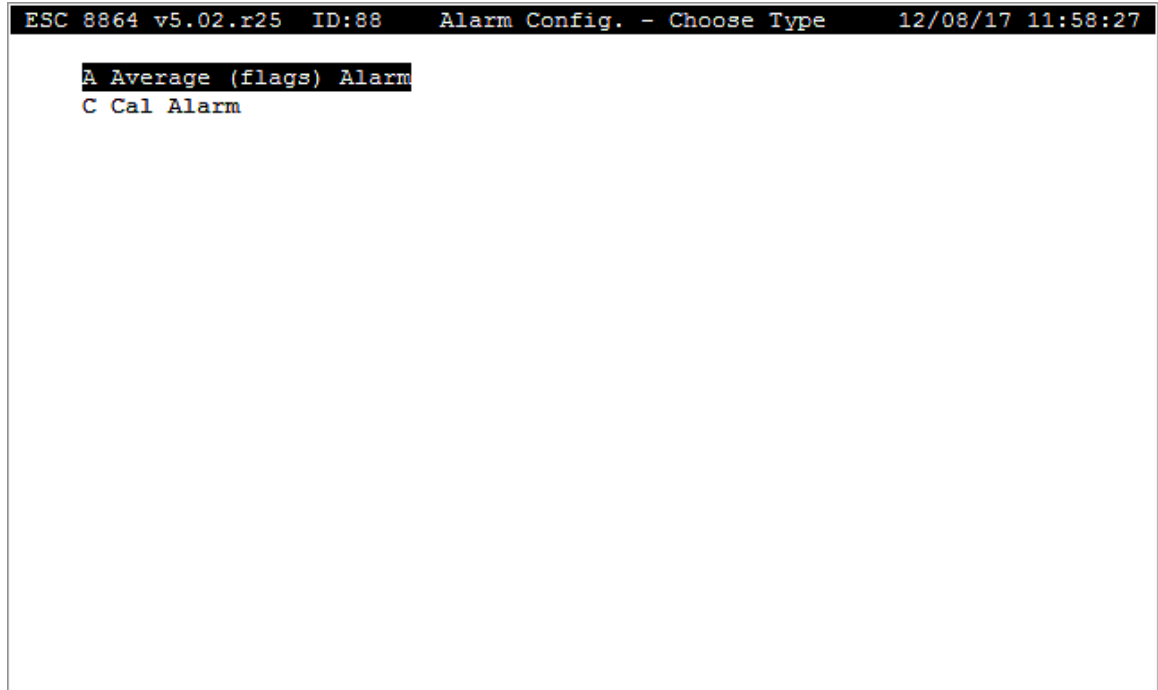
---

To display the Alarm Programs configuration screen:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **N - Enter New Alarm Program** (hot key **N**) to open the Alarm Config - Choose Type screen shown in the next example.

Items available for selection in the configuration screen include:

- **A - Average (flags) Alarm:** An alarm to occur when an average has a particular data flag appended.
- **C - Cal Alarm:** An alarm to occur when calibration data meet certain criteria.

**Related Topics:**

- [Average \(flags\) Alarm](#)
- [Cal Alarm](#)
- [Change Old Alarm Program](#)
- [Delete Old Alarm Program](#)
- [Acknowledge Alarms](#)

### Average (flags) Alarm

Average alarms are triggered by the presence of a data flag on an average. This alarm methodology provides a flexible system for notifying operators about multiple conditions on a single channel. For example, one alarm can be configured for high limits, another alarm for required maintenance, and a third alarm for an invalid hour of data. See [Data Flags](#) for a description about data flags that can trigger alarms.

The following parameters must be defined to configure an average alarm:

- Monitored Parameter(s) list.
- Averaging Interval to be observed.
- Flag(s) for Alarm Condition.

The first occurrence of the alarm is the triggering event. The appropriate channel and flag are

noted in the alarm log. If several alarm conditions occur simultaneously, only the first condition found is logged in the alarm journal.

An average alarm can also be configured not to change state when certain flags are present. Generally, these conditions indicate system failure or calibration, such as the power failure flag (P), bad status flag (B), channel disabled flag (D), calibration flag (C), or maintenance flag (M).

As an option, a dial-out program can be executed upon the instance of an active alarm. The dial-out program must be configured prior to configuring the initiating average alarm.

To display the Average Alarms Configuration screen:

- From the Home Menu, select **C - Configuration Menu > A - Configure Alarms > N - Enter New Alarm Program > A - Average (flags) Alarms.**

The following screen displays.

ESC 8864 v6.01r24 ID:01 Avg. Alarm Configuration 01/19/21 22:16:35	
Alarm Program Name	: TEMP
Average Interval	: 1m
Monitored Parameter(s)	: (none)
Flag(s) for Alarm Condition	: (none)
Ignore State Changes Flag(s)	: (none)
Check Ignore Flags?	: Y
Output Lines During Alarm	: (none)
Output to Alarm Port?	: N
Input Lines for Ack	: (none)
Encode DI as Reason Code?	: N
Acknowledgment Timeout	: 0s
Retrigger Alarm?	: N
End Alarm When No Flag?	: Y
FINISHED (Configure Now)	
CTRL-O = Config Relay Outputs	

The following information provides a description of the fields in the configuration screen.

### Alarm Program Name

Label that uniquely identifies this alarm program.

### Monitored Parameter(s)

Indicates which channel(s) the alarm program should monitor. Any configured channel name (s), up to 255 characters, or ALL for all configured channels.

## Average Interval

Selects which average interval the alarm program should monitor. Default=1m (minute).

## Flag(s) for Alarm Condition

Specifies which flags will trigger the alarm. Choose from any of the validation flags listed in the section entitled [Data Flags](#). Up to 32 characters or ALL for all validation flags.

## Ignore State Changes Flag(s)

Specifies which flags will prevent alarm state changes. If any of these flags are present, an active alarm will remain active, and an inactive alarm will remain inactive. Choose from any of the flags listed in the section entitled [Data Flags](#). Up to 32 characters. This field works in conjunction with the field labeled [Check Ignore Flags?](#).



**NOTE:** If multiple Monitored Parameter(s) are configured, the alarm will not activate if any of these flags are present ONLY on all of the parameters that also have the Flag(s) for Alarm Condition. Alternately, the alarm will not clear if any of these flags are present on ANY of the Monitored Parameter(s).

## Check Ignore Flags?

This field works in conjunction with the field labeled "Ignore State Change Flag(s)". Available settings include Y, S, and R and work in conjunction with the field "Ignore State Change Flag(s)" as described in the following list:

- **Y:** Yes, ignores on set and reset of alarm. This is the default and matches legacy behavior in the 8864 Data Controller before introduction of this setting in firmware v6.01.r52. It does not activate or acknowledge an alarm if "Ignore State Changes Flag(s)" flags are present. Alarm will check "Ignore State Changes Flag(s)" for activation or acknowledgment.
- **S:** Set, ignores only on set of alarm. It does not activate alarm if "Ignore State Changes Flag(s)" flags are present. Alarm will not check "Ignore State Changes Flag(s)" for acknowledgment.
- **R:** Reset, ignores only on reset of alarm. It does not acknowledge alarm if "Ignore State Changes Flag(s)" flags are present. Alarm will not check "Ignore State Changes Flag(s)" for activation.

**NOTE:** An "N" setting is not implemented as this is the same as leaving the field "Ignore State Change Flag(s)" blank.

## Output Lines During Alarm

Specifies the 2-digit output line number to activate while in alarm (until acknowledged). Up to 40 characters.



### Output to Alarm Port?

Y(es) or N(o) to print alarm to the Alarm Printer Port as defined in the EEPROM Configuration Menu (see [Configure System Parameters](#)).

### Dial-out Program Name

The name of the previously configured dial-out program that is to be initiated when this alarm becomes active.

### Input Lines for Ack

Specifies the 2-digit digital input line number(s) for an acknowledgment signal. Up to 40 characters. The 8864 will look for any of the specified lines to go active after an alarm has commenced. The active lines will then be binary-encoded as the reason code for that alarm. If the Encode DI as Reason Code? field is set to Y(es), the lowest line number is treated as the 1's place, the second lowest line number is treated as the 2's place, and so on. Also enable the Encode DI as Reason Code field. See [Delete Old Reason Code](#).

### Encode DI as Reason Code?

Y(es) or N(o) to use the above-referenced digital input acknowledgment line(s) to enter reason codes. See [Delete Old Reason Code](#).

### Acknowledgment Timeout

Automatic acknowledgment of alarms. Specifies the time-out period before automatic acknowledgment of an alarm. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). Use 0s to configure the alarm program without an automatic acknowledgment.

### Retrigger Alarm?

Y(es) or N(o). Answer Y to cause alarm to be retrIGGERED on each averaging interval where the alarm condition still exists. The alarm is checked at each alarm average interval. If the alarm is active from the previous interval but unacknowledged, the alarm remains in the active state. If the alarm is active from the previous interval but acknowledged, the alarm is changed to the active state. In either case, any configured output lines, alarm port messages and dial-out programs are activated, and the acknowledgment timeout counter is reset. The existing alarm journal entry is closed, and a new entry is created. Default=N.

### End Alarm When No Flag?

Y(es) or N(o). Answer N to force manual acknowledgment of alarms by users; alarm will stay in effect until acknowledged, providing a "sticky" alarm. Sticky alarms terminate only upon acknowledgment. Default=Y.

**NOTE:** Press <Ctrl><O> to configure relay outputs.

## FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Cal Alarm

Calibration alarms monitor one or more data parameters in a specific calibration sequence. The calibration sequence must already be configured, including expected values. By setting a series of flags, an alarm can be configured to occur when:

- The calibration average differs from the expected value by more than the configured Warning Drift Tolerance.
- The calibration average differs from the expected value by more than the configured OOC Drift Tolerance.
- The calibration is aborted before completion.
- The automatic rescaling fails.

To display the Calibration Alarms configuration screen:

- From the Home Menu, select **C - Configuration Menu > A - Configure Alarms > N - Enter New Alarm Program > C - Cal Alarm.**

The following screen displays.

```

ESC 8864 v5.02.r25 ID:88 Cal. Alarm Configuration 12/08/17 12:18:46

Alarm Program Name      : TEMP
Monitored Cal Program   : (none)
Monitored Parameter(s)  : (none)

Alarm on Cal Drift?      : Y
Alarm on Out of Control? : N
Alarm on Cal Aborted?    : N
Alarm on Autoscale Fail? : N
Output Lines During Alarm : (none)
Output to Alarm Port?    : N

Input Lines for Ack      : (none)
Encode DI as Reason Code? : N
Acknowledgment Timeout   : 0s
Retrigger Alarm?         : N
End Alarm When No Flag?  : Y
FINISHED (Configure Now)
CTRL-O = Configure Relay Outputs

```

The following information provides a description of the fields in the configuration screen.

### Alarm Program Name

Label that uniquely identifies this alarm program.

### Monitored Cal Program

Name of calibration sequence for this alarm program to monitor.

### Monitored Parameter(s)

Indicates which channel(s) the alarm program should monitor. Any configured channel name (s), up to 255 characters, or ALL for all configured channels.

### Alarm on Cal Drift?

Y(es) or N(o) to indicate if the alarm should be generated when the calibration error exceeds the configured Warning Drift Tolerance.

### Alarm on Out of Control?

Y(es) or N(o) to indicate if the alarm should be generated when the calibration error exceeds the configured OOC Drift Tolerance.

### Alarm on Cal Aborted?

Y(es) or N(o) to indicate if an alarm should be generated when the calibration sequence is aborted before completion.

### Alarm on Autoscale Fail?

Y(es) or N(o) to indicate if an alarm should be generated when the automatic rescaling fails for any reason.

### Output Lines During Alarm

Specifies the 2-digit output line number to activate while in alarm (until acknowledged). Up to 40 characters.

### Dial-out Program Name

The name of the previously configured dial-out program that is to be initiated when this alarm becomes active.

### Output to Alarm Port?

Y(es) or N(o) to print alarm to the Alarm Printer Port as defined in the EEPROM Configuration

Menu (see [Configure System Parameters](#)).

### Input Lines for Ack

Specifies the 2-digit digital input line number(s) for an acknowledgment signal. Up to 40 characters. The 8864 will look for any of the specified lines to go active after an alarm has commenced. The active lines will then be binary-encoded as the reason code for that alarm. If Encode DI as Reason Code? field is set to Y(es), the lowest line number is treated as the 1's place, the second lowest line number is treated as the 2's place, and so on. Also enable the Encode DI as Reason Code field. See [Delete Old Reason Code](#).

### Encode DI as Reason Code?

Y(es) or N(o) to use the above-referenced digital input acknowledgment line(s) to enter reason codes. See [Delete Old Reason Code](#).

### Acknowledgment Timeout

Automatic acknowledgment of alarms. Specifies the time-out period before automatic acknowledgment of an alarm. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). Use 0s to configure the alarm program without an automatic acknowledgment.

### Retrigger Alarm?

Y(es) or N(o) Answer Y to cause alarm to be retriggered on each calibration where the alarm condition still exists. The alarm is checked at each calibration phase. If the alarm is active from the previous interval but unacknowledged, the alarm remains in the active state. If the alarm is active from the previous interval but acknowledged, the alarm is changed to the active state. In either case, any configured output lines, alarm port messages and dial-out programs are activated, and the acknowledgment timeout counter is reset. The existing alarm journal entry is closed, and a new entry is created. The alarm is retriggered only once during a single calibration sequence. Default=N.

### End Alarm When No Flag?

Y(es) or N(o). Answer N to force manual acknowledgment of alarms by users; alarm will stay in effect until acknowledged, providing a "sticky" alarm. Sticky alarms terminate only upon acknowledgment. Default=Y.

**NOTE:** Press <Ctrl><O> to configure relay outputs.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

## Change Old Alarm Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To change an alarm program:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **C - Change Old Alarm Program** (hot key **C**) to display a list of alarm programs as shown in the next example.
3. Use the up/down arrow keys to navigate the list of alarm programs.
4. Select an alarm program by highlighting the selection and then pressing **<Enter>**.

The configuration screen displays for the selected alarm program. The alarm program is also copied into memory for editing.

5. Configure the alarm program as required. For information about configuration fields, see [Enter New Alarm Program](#).
6. After making all changes, select **FINISHED (Configure Now)** for new changes to take effect. Or, press **<Esc>** to cancel (changes will not take effect).

```

ESC 8864 v5.02.r25  ID:88  Choose List (Enter to Select)  12/08/17 13:14:51

COHI
EXC
NOXHI
OOC
SO2HI
SO2HION
SO2LOFLT
FLWDRFT1
GASDRFT1
OPCDRFT1
PMDRIFT1
PMFDRFT1

F2      <ESC>  TAB      CTRL-K  CTRL-R  Arrows
Refresh  Exit   GOTO END GOTO TOP Clr Keys Select

```

## Delete Old Alarm Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To delete an alarm program:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **D - Delete Old Alarm Program** (hot key **D**) to display a list of alarm programs.
3. Use the up/down arrow keys to navigate the list of alarm programs.
4. Select an alarm program by highlighting the selection. Press **<Enter>** for the selected alarm program to be deleted.
5. Press **Y** (Yes) to delete or **N** (No) to cancel the deletion and return to the Alarm Configuration Menu. Pressing **<ESC>** also cancels the deletion.

```

ESC 8864 v5.02.r25 ID:88 Choose List (Enter to Select) 12/08/17 13:14:51

COHI
EXC
NOXHI
OOC
SO2HI
SO2HION
SO2LOFLT
FLWDRFT1
GASDRFT1
OPCDRFT1
PMDRIFT1
PMFDRFT1

F2      <ESC>  TAB      CTRL-K    CTRL-R    Arrows
Refresh Exit   GOTO END GOTO TOP  Clr Keys  Select

```

## Enter New Reason Code



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To display the reason code configuration screen:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **1 - Enter New Reason Code** to display the Edit Reason Code Buffer configuration screen shown in the next example.

The following information provides a description of the fields in the configuration screen:

- **Code Number:** The two-digit number for this reason code. Valid entries are 00-99.
- **Code Text:** The accompanying text for the reason code; the explanation for the “alarming” data. Up to 40 characters.
- **Finished (Exit Menu):** Exits the configuration screen. Configuration data is saved.

```
ESC 8864 v5.02.r25 ID:88      Edit Reason Code Buffer      12/08/17 13:26:34

Code Number                   : 01
Code Text                     :
FINISHED (Exit Menu)
```

#### Related Topics:

- [Change Old Reason Code](#)
- [Delete Old Reason Code](#)
- [Enter Reason Codes Using Digital Inputs](#)

#### Enter Reason Codes Using Digital Inputs



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

The 8864 can be configured to accept reason codes from a switch panel or distributed control system using its digital inputs. By listing digital input line numbers in the Input Lines for Ack field and enabling the Encode DI as Reason Code? switch (Y), the 8864 will look for any of the specified lines to go active after an alarm has commenced.

The active lines will then be binary-encoded as the reason code for that alarm. The lowest line number is treated as the 1's place, the second lowest line number is treated as the 2's place, etc.

**EXAMPLE:** The Input Lines for Ack are set to 8=1, 9=1, 10=1, 11=0, and the Encode DI as Reason Code? option is enabled. An alarm becomes active, and the DCS switches digital input 9 ON and lines 10 through 11 OFF. The reason code is encoded as follows:

DI#08= 1's place does not match = 0

DI#09= 2's placematches = 2

DI#10= 4's placedoes not match = 0

DI#11= 8's placematches = 8

The alarm is acknowledged with reason code 10.

## Change Old Reason Code



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To change a reason code:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **2 - Change Old Reason Code** to open the configuration screen shown in the next example.
3. Use the up/down arrow keys to navigate the list of reason codes.
4. Highlight a reason code to make a selection and then press **<Enter>** to open a configuration screen. Make changes as required.
5. Select **FINISHED (Exit Menu)** and then press **<Enter>** to apply changes and return to



the Alarm Configuration screen. Or, press **<Esc>** to exit without applying changes.



## Delete Old Reason Code



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To delete a reason code:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **3 - Delete Old Reason Code** to open the configuration screen shown in the next example.
3. Use the up/down arrow keys to navigate the list of reason codes.
4. Highlight a reason code to make a selection and then press **<Enter>**.
5. When the message “Are You Sure Y/N?” displays, press **Y** (yes) to delete the selected reason code or **N** (no) to not delete your selection.

After pressing Y or N the Alarm Configuration Menu displays.



## Enter New Dial-out Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The dial-out on alarm feature provides the capability for the 8864 Data Controller to execute a user-defined dial-out program upon the instance of an active alarm. The 8864 Data Controller initiates communication through a modem and outputs user-defined data in the form of text strings. A printer or some other device capable of receiving text is required to be connected to the modem receiving the dial-out call. Each program can contain up to three user-defined phone number strings which can incorporate most standard modem dial characters. The number of retries, the carrier wait time and the 8864 Data Controller communications port are also configurable.

Several options for 8864 Data Controller behavior after the connection is established are provided. Three selectable types of information can be output including an eighty-character user-defined message, an alarm report containing the active alarm information and a comprehensive data report consisting of the latest base, extended 1 and extended 2 average information for each configured channel.

To execute a dial-out program, an associated alarm program must be configured. When the alarm is activated, a connection is attempted using the first valid phone string and is retried up to the configured retry count. If a connection is not established, the second number and, if necessary, the third number is attempted. After a connection is established, the user-configured data strings are output.

To display the Dial-out Program configuration screen:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **4 - Enter New Dial-out Program** to display the screen shown in the next example.

Also see [Change Old Dial-out Program](#) and [Delete Old Dial-out Program](#).

ESC 8864 v5.xx ID:49	Dial-out Program	mm/dd/yy hh:mm:ss
Dial-out Program name	: none	
First Phone Number	: none	
Second Phone Number	: none	
Third Phone Number	: none	
Number of retries	: 0	
Carrier Wait Time	: 1m	
Communications Port	: 0	
Output all data ?	: N	
Use decimal positioner ?	: Y	
Output alarm message ?	: N	
User defined string	:	
FINISHED (Exit Menu)		
<ESC> to exit		

The following information provides a description of the fields in the configuration screen.

### Dial-out Program Name

Label that uniquely identifies this dial-out program.

### First Phone Number

First phone number to be attempted by the dial-out program. Valid phone number characters include the following: 0123456789\*,-,!/”

### Second Phone Number

Phone number to be attempted by the dial-out program after the First Phone Number has been unsuccessfully attempted the configured Number of retries. Valid phone number characters include the following: 0123456789\*,-,!/”

### Third Phone Number

Phone number to be attempted by the dial-out program after both the First Phone Number and the Second Phone Number have been unsuccessfully attempted the configured Number of retries. Valid phone number characters include the following: 0123456789\*,-,!/”

### Number of retries

Number of times the dial-out program attempts to retry a phone number before ceasing to dial that number and attempting the next number or exiting. Valid entries are 0-9.

### Carrier Wait Time

Interval which the dial-out program waits for the modem to receive and report a character. Valid entries are 0 to 99 s, m, h, or d (for seconds, minutes, hours, or days, respectively).

### Communications Port

Serial port number that is attached to the modem desired to receive the dial-out information. Valid entries are 0-3.

### Output all data?

If Y(es), the data and flags for all configured channels are included in the transmitted text strings. If N(o), only the data and flags for the alarming channel are included in the transmitted text strings.

### Use decimal positioner?

If Y(es), the data for each channel included in the transmitted text strings are adjusted by the configured decimal positioners. If N(o), the data included in the transmitted text strings are not adjusted by the configured decimal positioners.

### Output alarm message?

If Y(es), the 8864 Data Controller alarm message associated with the alarm activating the dial-out program is included in the transmitted text strings. If N(o), the 8864 Data Controller alarm message is not included in the transmitted text strings.

### User defined string

User-defined text string that is included in the text strings transmitted by the dial-out program. 80 characters maximum length.

### FINISHED (Configure Now)

Selecting FINISHED (Configure Now) allows new changes to take effect. If the configuration screen is exited using the <Esc> key, changes do not take effect.

**Related Topics:**

- [Change Old Dial-out Program](#)
- [Delete Old Dial-out Program](#)

## Change Old Dial-out Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To change a dial-out program:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **5 - Change Old Dial-out Program** to display the screen shown in the next example.
3. Use the up/down arrow keys to navigate the list of dial-out programs.
4. Highlight a dial-out program to make a selection and then press **<Enter>** to open a configuration screen. The selected dial-out program is copied into memory for editing.
5. Make changes as required. For a description of configuration fields, see [Enter New Dial-out Program](#).
6. Select **FINISHED (Exit Menu)** and then press **<Enter>** to apply changes. Or, press **<Esc>** to cancel without applying changes.

```
ESC 8864 v5.xx ID:49          Choose List (Enter to Select)          mm/dd/yy hh:mm:ss

SENDOPAC
SENDNOX

F2----- <ESC> TAB CTRL-K CTRL-R Arrows--
Refresh Exit  GOTO END GOTO TOP Clr Keys Select
```

## Delete Old Dial-out Program



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

To delete a dial-out program:

1. From the Home Menu, select **C - Configuration Menu > A - Configure Alarms**.
2. Select **6 - Delete Old Dial-out Program**. A list of all configured dial-out programs display.
3. Use the up/down arrow keys to navigate the list of dial-out programs.
4. Highlight a dial-out program to make a selection and then press **<Enter>** to delete or press **<Esc>** to cancel the deletion.

After pressing **<Enter>** the selection is deleted unless it is in use by an alarm program.

**Related Topics:**

- [Enter New Dial-out Program](#)
- [Change Old Dial-out Program](#)

## Configure Analog Outputs

If the 8864 Data Controller is supplied with analog output cards, you can configure these outputs to drive the result of a calculation internal to the 8864 Data Controller. You can use any channel to drive the outputs, which allows the unit to be used as a simple voltage to current loop converter if desired – such as a current loop output driving the result of a single analog input.



**NOTE:** If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Up to 96 DACs can also be configured to allow pseudo DACs that have the ability to hold values for Modbus . From the Configuration Menu, use the up and down arrows to select Configure Analog Outputs (hot key O). Select a DAC number when a list of the DAC numbers appear to display the next screen.



**NOTE:** **<Ctrl> <Z>** resets the analog outputs to the default settings shown here.

```
ESC 8864 v5.02.r25 ID:88      Configure DAC Outputs      12/01/17 09:46:21

DAC Number (not editable)   : 01
Input Parameter Name       : (none)
Averaging Interval         : 0s
High Input (E.U.s)         : 100
Low Input (E.U.s)          : 0
High Output                 : 20 mA
Low Output                  : 4 mA
Action When Flagged(I,Z,H,0): HOLD
Action Flags                : R|-|+|A|U|O|M|C|B|F|T|D|P

FINISHED (Configure Now)

CTRL-Z = Clear Settings
```

The following information provides a description of the fields in the Configure DAC Outputs screen.

## Input Parameter Name

The parameter name whose results are to be used to drive the output.

## Averaging Interval

The average to be used, as well as the analog output's update speed. Interval must match an interval configured in the input parameter. However, 0s can be used for instantaneous readings. 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively).

## High Input

The high reading in engineering units of the driving input.

## Low Input

The low reading in engineering units of the driving input.

## High Output

The high value of the analog output corresponding to the High Input in mA.

## Low Output

The low value of the analog output corresponding to the Low Input in mA.

The current output can be set to a constant value by setting both the Low Output and High Output fields to the desired value.

## Action When Flagged

Action to take when the flags on the input parameter matches the “Action Flags” field below. **(I)** - **IGNORE** (continue to output values normally), **(Z)** - **ZERO** (hold output at 0mA), **(H)** - **HOLD** (hold output at the last good output setting), or **(0)** - **LAVAL** (hold output equal to 0.0 EU).

## Action Flags

Take the action listed in the “Action When Flagged” field, above, when the flags on the input parameter meets the criteria listed in this field.

This field can contain a logical expression containing one or more data flags separated by the logical operators “&” (AND) and “|” (OR). For example, a valid field would be “C|M” which would indicate to take the action listed in the “Action When Flagged” field if the input parameter has a “C” or an “M” flag.

If no operator is present between flags, then it is assumed to be “|” (OR).

For instantaneous data, this field defaults to: “R|-|+|A|U|O|M|C|B|F|T|D|P”. For an average interval, this field defaults to the < flag.

## Configure Math Constants

The Configure Math Constants screen allows you to create up to 99 math constants (K1...K99) that can be used throughout the system. These math constants may be used in equations for math pack channels. The intention of math constants is to represent parameters in the system that only periodically change. This screen is an easy way to update those constants without reconfiguring several math channels.



**NOTE:** An option will allow a calibration expected value or result to be written to a math constant; see [Configure Expected Values](#). Any of the three averages of a channel (base, average #1, average #2) can also be written to a constant; see [Configure Average Validation Limits](#).

Secondary or tertiary values based on digital inputs can also be defined for math constants. These were designed for fuel-switching systems, which must constantly adjust the fuel factor and can provide digital inputs representing the exact fuel loaded.



To change a channel configuration:

1. From the Home Menu, select **C - Configuration Menu > K - Configure Math Constants**.

The following screen displays.

2. Place the cursor on the desired math constant and then press **<Ctrl><A>**.

ESC 8864 v5.02.r25		ID:88	Set Math Pack Constants	12/04/17 18:52:54
Constant K1	=		1	
Constant K2	=		1	
Constant K3	=		1	
Constant K4	=		1	
Constant K5	=		1	
Constant K6	=		1	
Constant K7	=		1	
Constant K8	=		1	
Constant K9	=		1	
Constant K10	=		1	
Constant K11	=		1	
Constant K12	=		1	
Constant K13	=		1	
Constant K14	=		1	
Constant K15	=		1	
Constant K16	=		1	

ESC=Exit, CTRL-A=Alternate Values, CTRL-N=Next Page

A screen displays with fields for entering the numerical value and digital input status for the secondary and tertiary states. See the next example.

Pressing **<Ctrl><N>** displays the next page of math constants. Pressing **<Ctrl><P>** displays the previous page of math constants.

When the digital input state does not match the secondary or tertiary status, the primary value (edited on the first screen) is used.

ESC 8864 v5.02.r25 ID:88		Set Constants/Secondary		12/04/17 19:17:06	
Constant # (not editable) :	1				
Primary Value = :	1.000000				
Alternate Value#1 = :	0.000000				
Alternate Status#1 :	(none)				
Alternate Value#2 = :	0.000000				
Alternate Status#2 :	(none)				

ESC=Exit, CTRL-A=Primary Values

## Configure Digital Event Programs



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

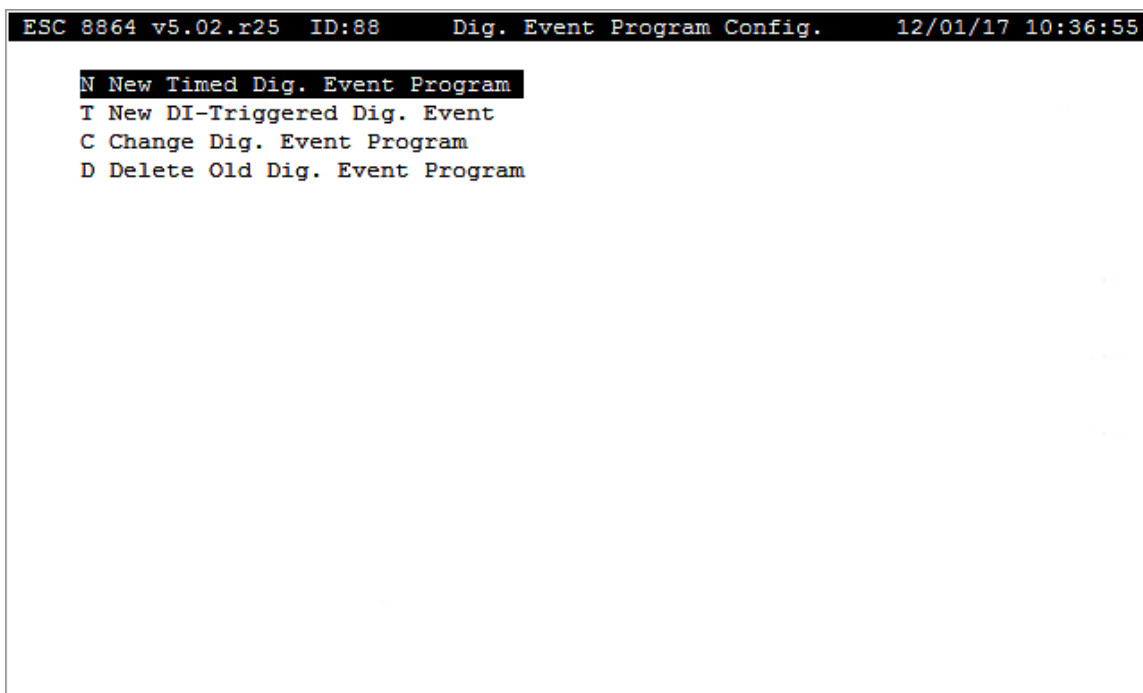
This feature allows you to set up a digital control output event. A digital event program can either be timed or triggered by a digital input.

As an example, a digital event program can be described as:

- Starting at 3 PM on July 6, turn digital outputs 07 and 08 ON.
- Leave digital outputs 07 and 08 ON for 14 minutes.
- Repeat this sequence every other day.



**IMPORTANT:** Stream-switching (or time-sharing) is normally controlled by digital event programs which switch a specified output or outputs on a timed basis or using digital input triggers. One approach to configuring a stream-switched system is described in [App Note - Stream-Switched Channel](#).



From the Configuration Menu, select **E - Configure Dig. Event Program**. The following table provides a description for selections in the Dig. Event Program Config screen.

Hot Key	Selection	Purpose
N	New Timed Dig. Event Program	Choose this option to enter a new timed digital event program.
T	New DI-Triggered Dig. Event	Choose this option to enter a new digital event program that is triggered by digital inputs.
C	Change Dig. Event Program	Choose this option to modify an existing digital event program.
D	Delete Old Dig. Event Program	Choose this option to delete an existing digital event program.

#### Related Topics:

- [New Timed Dig. Event Program](#)
- [New DI-Triggered Dig. Event](#)

## New Timed Dig. Event Program

To add a new timed digital event program:

- From the Home Menu select **C - Configuration Menu > E - Configure Dig. Event Program > N - New Timed Dig. Event Program**.

For a timed digital event program, the start time and repeat interval for the digital output (s) event are specified. The configuration screen for a timed digital event program is shown in the next example



**NOTE:** Press CTRL-O to configure digital outputs.

```

ESC 8864 v5.02.r25 ID:88 Config. Dig. Event Program 12/01/17 10:53:42

Dig. Event Program Name : DEFPROG
Starting Time           : 12/02/17 00:00:00
Repeat Interval         : 12m
Output Line(s)          : 8
Output Duration         : 6m
Disable During Cal(s)   : (none)

FINISHED (Configure Now)

CTRL-O = Config Relay Outputs

```

The following information provides a description of the Config. Dig. Event Program screen.

### Program Name

The name that uniquely identifies this digital event program.

### Starting Time

The scheduled execution time of the program. MM/DD/YY HH:MM:SS (in military format).

### Repeat Interval

The time between program executions. **10s** to **999 s**, **m**, **h**, or **d** (for seconds, minutes, hours, or days, respectively).

### Output Control Line(s)

The list of the two-digit output control line numbers that should be activated at execution time.

### Output Duration

The length of time that the Output Control Line(s) will be activated. After this time, the lines will return to their inactive state. **5s** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively).

### Disable During Calibration(s)

The list of calibration program names during which the digital program will update its Starting Time but will not activate output lines. This option allows calibrations to override normally programmed probe-switching sequences.

## New DI-Triggered Dig. Event

For this type of digital event program, a digital input pattern is specified that will initiate the digital output(s) event. The output lines will remain ON in their active state for the specified duration. At the end of this time, the output lines will be deactivated unless the triggering digital input pattern is still true.

To add a new DI-Triggered digital event:

- From the Home Menu select **C - Configuration Menu > E - Configure Dig. Event Program > T - New DI-Triggered Event Program**.

The following screen displays.



**NOTE:** Press CTRL-O to configure digital outputs.

---

ESC 8864 v6.01r24 ID:01 Config. Dig.Event Program 01/20/21 11:00:06	
Dig. Event Program Name	: DEFPROG
Trigger DI Pattern	: (none)
Output Line(s)	: 8
Output Duration	: 6m
Debounce Period (seconds)	: 0s
Delay Before Output Trigger	: 0s
Disable During Cal(s)	: (none)
FINISHED (Configure Now)	
CTRL-O = Config Relay Outputs	

The following information provides a description of the fields in the Config Dig Event Program configuration screen.

### Dig. Event Program Name

The name that uniquely identifies this digital event program.

### Trigger DI Pattern

The digital input line pattern that will trigger the execution of this digital event program. Specify the line number followed by the state (1=on, 0=off); e.g., **1=1|2=0|3=1**. If more than one line pattern is entered, the inputs will be "OR" if the patterns are separated by "|" or will be "AND" if the patterns are separated by "&" or ",".

Beginning in firmware Version 6.01.r52, the "Trigger DI Pattern" field supports complex patterns for DI-triggered digital events (similar to Counter channel). The field now supports a pattern with a 255 character limit and the following:

- Numeric, & = AND, | = OR, ! = NOT
- ( = opening parenthesis
- ) = closing parenthesis

### Output Line(s)

The list of the two-digit output control line numbers that should be activated at execution time.

## Output Duration

The length of time that the Output Control Line(s) will be activated. After this time, the Trigger DI Pattern will again be compared against the state of the digital inputs. If the pattern matches, the lines will remain activated for this duration. If the pattern no longer matches, the lines will return to their inactive state. **5s** to **999 s, m, h, or d** (for seconds, minutes, hours, or days, respectively).

## Debounce Period (seconds)

This field configures a debounce period that must be satisfied before the input pattern is recognized. Valid values are 0s to 999s.

## Delay Before Output Trigger

This field allows you to configure a delay period to occur after a digital event program has triggered and before the output conditions are set.

The delay period is the length of time the 8864 Data Controller waits after the Trigger DI Pattern is true before triggering the Output Control Lines. 0s to 999s, m, h, or d (for seconds, minutes, hours, or days, respectively). The default is 0s to maintain backwards compatibility with the 8832 Data Controller.

## Disable During Calibration(s)

The list of calibration program names during which the digital program will update its Starting Time but will not activate output lines. This option allows calibrations to override normally programmed probe-switching sequences.

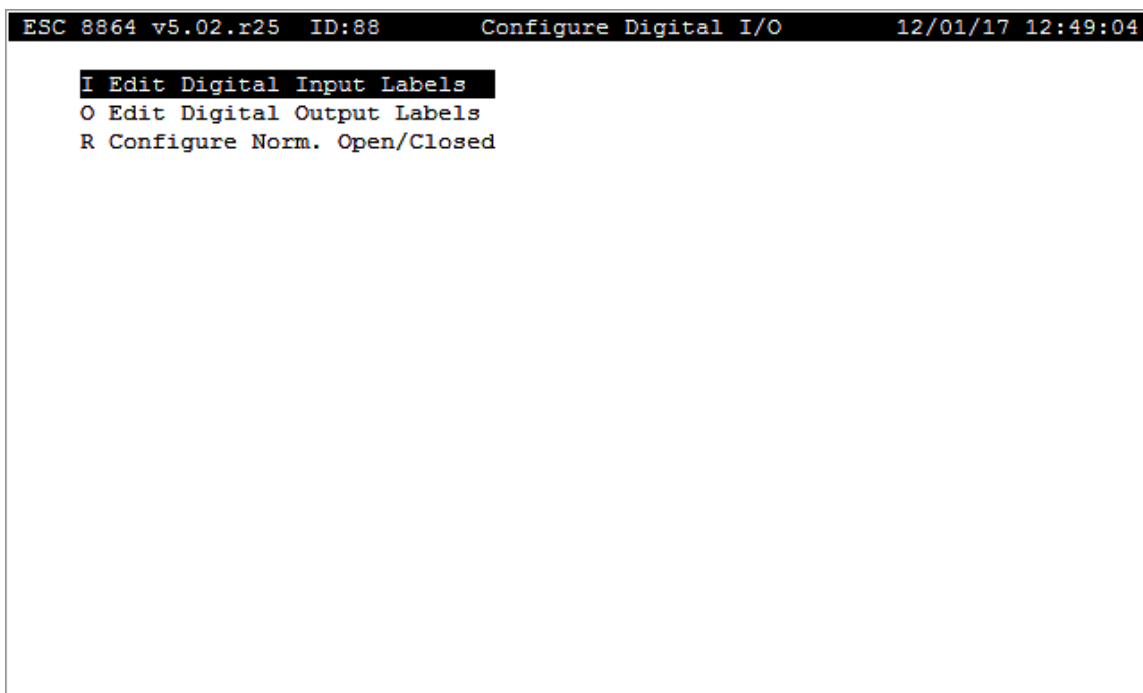
# Configure Digital I/O



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

From the Home Menu, select **C - Configuration Menu > R - Configure Digital I/O**.



The following table identifies menu selections in the Configure Digital I/O screen.

Hot Key	Function	Purpose
I	<a href="#">Edit Digital Input Labels</a>	Choose to assign a label to a digital input line.
O	<a href="#">Edit Digital Output Labels</a>	Choose to assign a label to a digital output line.
R	<a href="#">Configure Norm. Open/Closed</a>	Choose to assign the default state for the digital outputs.



The 8864 can logically possess more digital inputs and digital outputs than it physically possesses (up to a maximum of 88).

#### Menus for other Digital I/O features in the 8864 include:

- [Real-Time Display Menu](#) - Display Digital Inputs, Display Digital Outputs
- [Status Menu](#) - Line Changes Log Menu

#### Related Topics:

- [Edit Digital Input or Output Labels](#)
- [Configure Norm. Open/Closed](#)

## Edit Digital Input or Output Labels

The menus labeled Edit Digital Input Labels and Edit Digital Output Labels allow the



configuration of any digital input or output line with a common, recognizable name.

Complete the following steps:

1. From the Home Menu, select **C - Configuration Menu > R - Configure Digital I/O**.

2. Select either:

- **I - Edit Digital Input Labels**

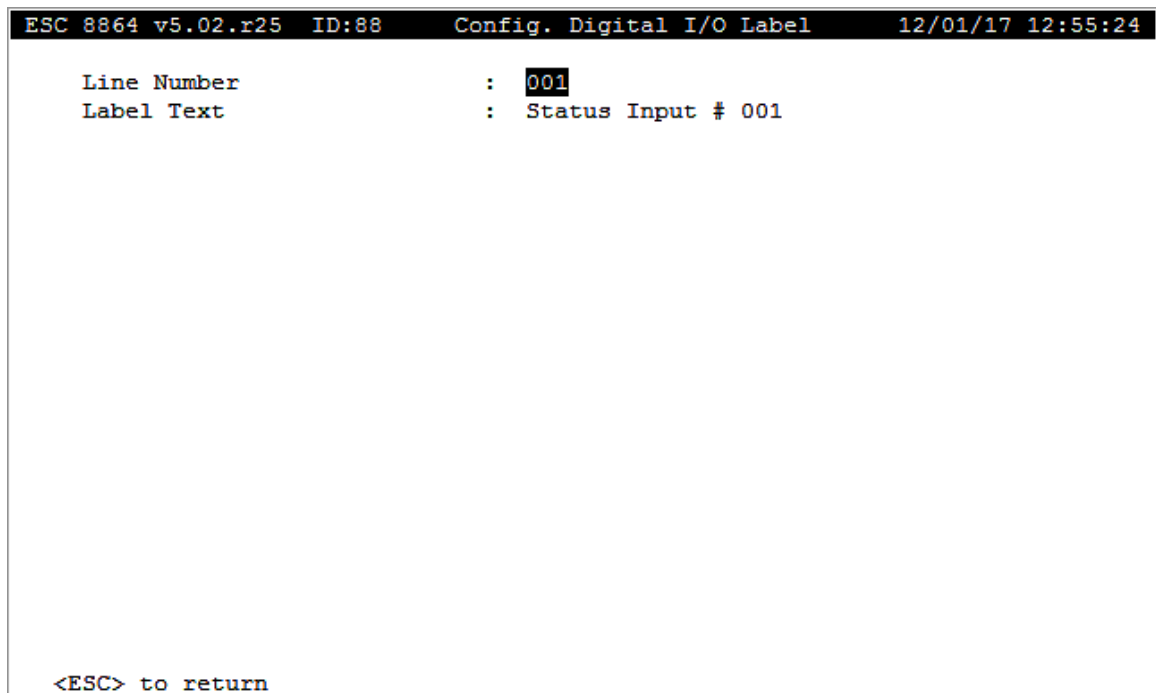
- or -

- **O - Edit Digital Output Labels**

A list of the digital lines display.

3. Use the up/down and left/right arrows to highlight the desired digital line and then press **<Enter>**.

4. In the screen that opens, type a description for the line in the **Label Text** field as required. The field accepts up to 21 alpha characters including spaces and special characters such as #, &, and \*.



```
ESC 8864 v5.02.r25 ID:88 Config. Digital I/O Label 12/01/17 12:55:24

Line Number      : 001
Label Text       : Status Input # 001

<ESC> to return
```

## Configure Norm. Open/Closed

All channels default to Normally Open on cold start. In this state, the relay is open until activated by a calibration, digital event program, or an alarm.

Line states can only be reassigned when the output is inactive. If the output is activated, the

calibration, digital event program, or alarm must be canceled before its assignment can be changed.

When a digital output's assignment is changed, the relay switches to the new default (inactive) state. That is, when a relay is changed to Normally Closed, the 8864 closes the relay to keep it in the default, inactive state.

Use the selections in the Configure Digital Outputs screen to select the default state of digital outputs.

To display the Configure Norm. Open/Closed screen:

1. From the Home Menu, select **C - Configuration Menu > R - Configure Digital I/O > R - Configure Norm. Open/Closed**.
2. To move the cursor, use the up/down and right/left arrow keys or type the two-digit relay number.
3. To change a digital output to Normally Closed (i.e., the relay will remain closed until it is activated, at which point it will open), type **C** when the cursor is pointing to the appropriate output. To switch a line back to Normally Open, type **O**.

```

ESC 8864 v5.02.r25 ID:1M      Configure Digital Outputs      10/25/17 15:52:37

=>H204-NOX-DAILY ZERO = NormOpen      H204 FUEL > 3000      = NormOpen
   H204-NOX-DAILY SPAN = NormOpen      H501 FUEL > 8000      = NormOpen
   H204-NOX-CGA LOW    = NormOpen      HEARTBEAT to server   = NormOpen
   H204-NOX-CGA HIGH   = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
   H501-NOX-DAILY ZERO = NormOpen
   H501-NOX-DAILY SPAN = NormOpen
   H501-NOX-CGA LOW    = NormOpen
   H501-NOX-CGA HIGH   = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen
                               = NormOpen

EXIT=ESC or SPACE, O = NormOpen, C = NormClosed

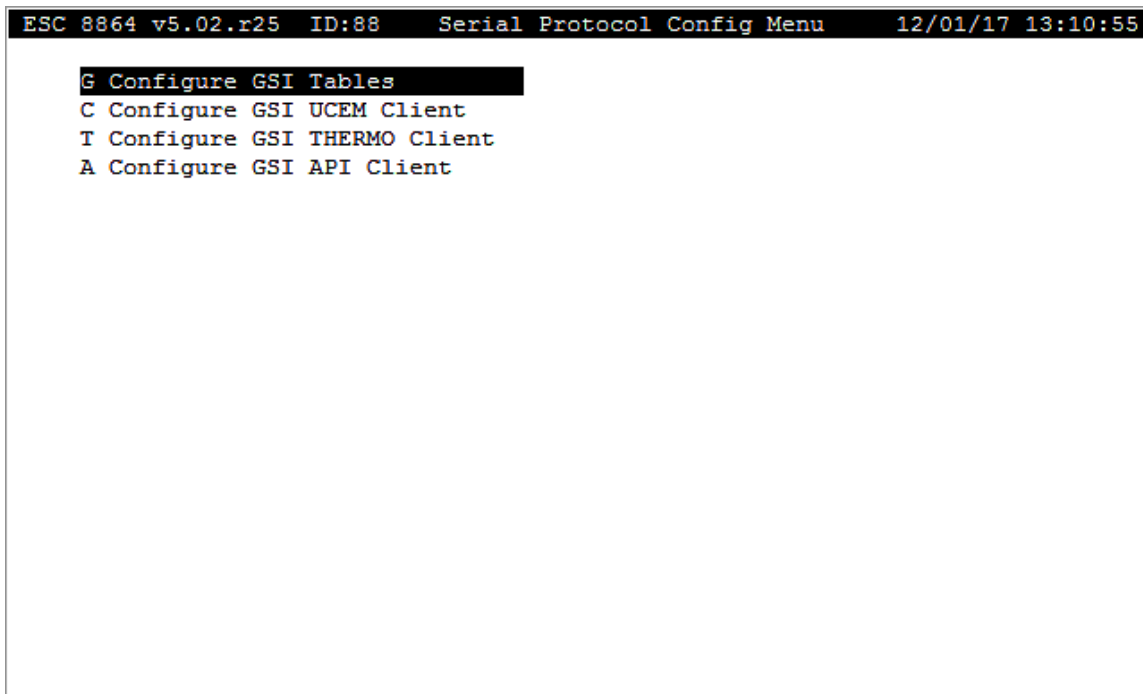
```

## Configure Serial Protocols



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols** to display the Serial Protocol Config Menu shown in the next example.



The following table provides a description of the selections available in the Serial Protocol Config Menu. Use the links in the table to learn more about configuring a particular type of serial protocol.

Hot Key	Function	Purpose
G	<a href="#">Configure GSI Tables</a>	Allows configuration of the Generic Serial Interface. Instructions for this option are included in this section.
C	<a href="#">Configure GSI UCEM Client</a>	Allows configuration of GSI UCEM Client (Ethernet) entries. Click the link to the left for more information.
T	<a href="#">Configure GSI THERMO Client</a>	Allows configuration of GSI THERMO Client (Ethernet) entries. Click the link to the left for more information.
A	<a href="#">Configure GSI API Client</a>	Allows configuration of GSI API Client (Ethernet) entries. Click the link to the left for more information.

#### Related Topics:

- [Configure GSI Tables](#)
- [Configure GSI UCEM Client](#)
- [Configure GSI THERMO Client](#)
- [Configure GSI API Client](#)

---

## Configure GSI Tables



**NOTE:** Configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#).

---

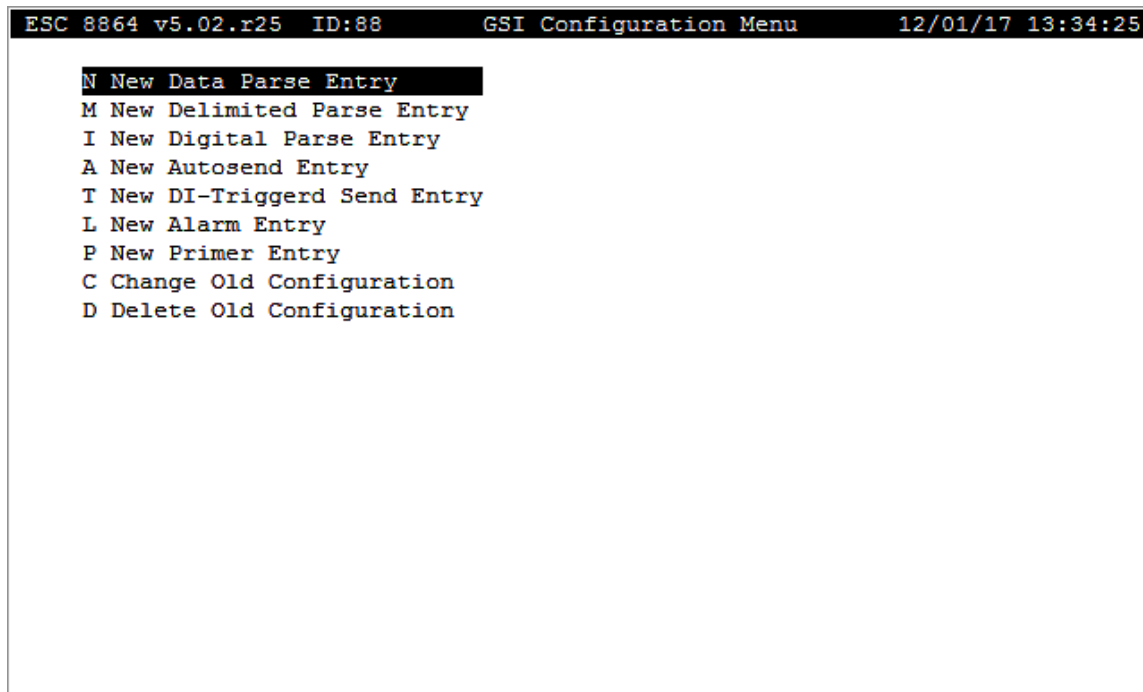
The Generic Serial Interface (GSI) is a serial communications interface used by the 8864 Data Controller. This interface is used to retrieve data from analyzers, digital control systems, or some other device using one of the RS-232 or RS-485 serial communications ports.

The input functions of this interface include receiving data strings to store values into GSI Channels for data collection and receiving alarm strings to close the 8864 relay or pseudo outputs. The output functions of this interface include sending strings from the 8864 to an analyzer to execute certain functions, such as gather data or start calibrations, either on a repeating time-basis or based on a given status input pattern.

Before using the GSI, the Interface type for the serial port to be used for GSI communications must be set to GSI1 or GSI2 in the EEPROM Configuration Menu. The GSI1 interface type is the original implementation of the GSI and allows for the configuration of Data Parse and Autosend entries. The GSI2 interface type allows for the configuration of all types of GSI entries, which include Data Parse, Autosend, DI-Triggered Send, Alarm and Primer entries. The GSI Client feature allows a networked device to be polled by an application-specific method. The device's response strings are then placed into the GSI table where they can be parsed by the standard GSI entry types.

To configure GSI Tables:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables** to open the GSI Configuration Menu shown in the next example.



The following table provides a description of the selections available in the GSI Configuration Menu. Also refer to [Format Strings](#).

Hot Key	Function	Purpose
N	<a href="#">New Data Parse Entry</a>	Defines a parsing program to extract data from a received string of a predefined format.
M	<a href="#">New Delimited Parse Entry</a>	Defines a parsing program to extract data from a received string with data separated by a delimiting character.
I	<a href="#">New Digital Parse Entry</a>	Defines a parsing program to extract data from a received string of a predefined format and control a digital output based on the state.
A	<a href="#">New Autosend Entry</a>	Transmits a predefined string at regular intervals.
T	<a href="#">New DI-Triggered Send Entry</a>	Transmits a predefined string based on a digital input.
L	<a href="#">New Alarm Entry</a>	Closes an output after receiving a predefined string.
P	<a href="#">New Primer Entry</a>	Defines a string that must be received before data is validated in a GSI Channel.

Hot Key	Function	Purpose
C	<a href="#">Change Old Configuration</a>	Modifies an existing GSI table entry.
D	<a href="#">Delete Old Configuration</a>	Deletes an existing GSI table entry.

## New Data Parse Entry

A New Data Parse Entry ( hot key **N**) defines a parsing program to extract data from a received text string. The string must have a predefined format consisting of a start (sync) section, an optional channel number or identifier section, and a transferred data section.

To configure a new data parse entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Table > N - New Data Parse Entry**.

The following screen displays.

```

ESC 8864 v5.02.r25 ID:88          Config GSI Entry          12/01/17 14:30:35

Entry Tag Name      : TEMP
Port#               : 6
Start (sync) String :
(# of Chars to Channel ID) : 0
(Channel ID Field Width) : X
Affected Channel    : (none)
# of Chars to Channel Data : 0
Channel Data Field Width : 0
Data Field Type     : FLOAT
(# of Chars in String) : XXX
FINISHED (Configure Now)

<ESC> to Cancel

```

The following information provides a description of the fields in the Config GSI Entry screen.

## Entry Tag Name

The label used to identify this GSI Parse Entry.

## Port #

The port being used for GSI communications. Valid entries are 0 to 3 and 6 to 9.

## Start (sync) String

One or more characters that signal the beginning of the data stream to be parsed.

## (# of Chars to Channel ID)

(Optional) The number of characters between the end of the Start (sync) String and the beginning of the Channel Identification field. 0 indicates that the first byte after the Start (sync) String is the first character of the Channel ID. Valid entries are 0 to 512.

## (Channel ID Field Width)

(Optional) The number of characters that compose the channel identification (number or name) in the incoming stream. If no Channel ID is expected, the Channel ID Field Width must be entered as 0. (A value of 0 displays as X.) Valid entries are 0 to 8.

## Affected Channel

The name of the GSI Channel used to store the data received. If a Channel ID Field Width is specified, the Channel ID received must either match the channel number or the channel name of the **Affected Channel** before data is stored. Entering **none** clears the field.

## # of Chars to Channel Data

The number of characters between the end of the Start (sync) String and the beginning of the Channel Data field. 0 indicates that the first byte after the Start (sync) String is the first character of the channel data. Valid entries are 0 to 512.

## Channel Data Field Width

The number of characters that compose the Channel Data field in the incoming stream. Valid entries are 0 to 32.

## Data Field Type

Available data types are FLOAT, HEX, and BINARY WORD:

- **FLOAT:** This type takes the ASCII text received for the Channel Data and converts it to a number. Valid ASCII characters used in converting to a FLOAT are **+**, **-**, **0** through **9**, and **e** or **E** for exponential notation. If any characters other than white spaces or a trailing ETX (<Ctrl><C>) are present in the field, the value is considered invalid.
- **HEX:** This type takes the ASCII text received for the Channel Data and converts it to a hexadecimal number. Valid ASCII characters used in converting to a HEX are **0** through **9**, **A** through **F**, or **a** through **f**.
- **BINARY WORD:** This takes two bytes of data and uses them to represent a 16-bit signed integer allowing values from -32768 to +32768. The Channel Data field width must be **2** for the Binary Word type.

### (# of Chars in String)

(Optional) The number of characters that must be received after the last byte of the Start (sync) String before the string is parsed. The configuration of this field allows for more than one GSI Data Parse Entry to contain the same Start (sync) String and for data to be received for multiple channels from a single GSI string.



**NOTE:** One parsing program should be configured for each channel to which data is to be transferred.

#### **EXAMPLE** - Autosending Analyzer

Assume an instrument that automatically sends minute averages to the 8864 in the following format:

AVERAGE=001m 14:50:03 345.5 14.200

The first value (345.5) is the NO2 reading and it is desired to send it to the NO2 channel in the 8864 Data Controller. The description for the GSI data parse entry would read as follows:

Look for the start string "AVERAGE=." Skip to the next 14 characters "001m 14:50:03" and then parse the next 5 characters and use the result in the NO2 channel.

### New Delimited Parse Entry

A Delimited Parse Entry defines a parsing program to extract data from a received text string. The string must have a predefined format consisting of a start (sync) section, an optional channel number or identifier section, and a transferred data section. Each section of the string must be separated by a delimiting character.

To configure a new delimited parse entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > M - New Delimited Parse Entry**.

The following screen displays.



ESC 8864 v5.02.r25 ID:88		Config GSI Delimited Entry	12/01/17 15:11:31
Entry Tag Name	:	TEMP	
Port#	:	6	
Start (sync) String	:		
Delimiter Character(s)	:	,	
(Delimiters to Channel ID)	:	XX	
Affected Channel	:	(none)	
Delimiters to Channel Data	:	1	
Data Field Type	:	FLOAT	
(Delimiters to Validation)	:	XX	
Validation String	:		
(Delimiters in String)	:	XX	
FINISHED (Configure Now)			
<ESC> to Cancel			

The following information provides a description of the fields in the Config GSI Delimited Entry screen.

### Entry Tag Name

The label used to identify this GSI Delimited Parse Entry.

### Port #

The port used for GSI communications. Valid entries are 0 to 3 and 6 to 9.

### Start (sync) String

One or more characters that signal the beginning of the data stream to be parsed.

### Delimiter Character(s)

The characters that define the beginning of each new field in the data stream. Up to 32 characters may be entered. If any of the delimiter characters are found, a new field begins with the following character and ends with the character preceding the next delimiter character.

### Affected Channel

The name of the GSI Channel used to store the data received. If the **(Delimiters to Channel ID)** is configured, the Channel ID received must either match the channel number or the channel name of the **Affected Channel** before data is stored. Entering none clears the field.

## Delimiters to Channel Data

The number of **Delimiter Character(s)** between the end of the **Start (sync) String** and the beginning of the Channel Data field. **0** to **99**.

## Data Field Type

Available data types are FLOAT, HEX, and BINARY WORD:

- **FLOAT:** The FLOAT type takes the ASCII text received for the Channel Data and converts it to a number. Valid ASCII characters used in converting to a FLOAT are **+**, **-**, **0** through **9**, and **e** or **E** for exponential notation. If any characters other than white spaces or a trailing ETX <Ctrl><C> are present in the field, the value is considered invalid. The HEX type takes the ASCII text received for the Channel Data and converts it to a hexadecimal number.
- **HEX:** Valid ASCII characters used in converting to a HEX are **0** through **9**, **A** through **F**, or **a** through **f**.
- **BINARY WORD:** The BINARY WORD type takes two bytes of data and uses them to represent a 16-bit signed integer allowing values from -32768 to +32768. Only the first two characters of the field are read for the Binary Word type.

## (Delimiters to Validation)

(Optional) The number of **Delimiter Character(s)** between the end of the **Start (sync) String** and the beginning of the Validation String field. **0** to **99**.

## Validation String

If the **(Delimiters to Validation)** is configured, the string that must be matched in order for the Channel Data to be marked as valid data.

## (Delimiters in String)

(Optional) The number of delimiters that must be received after the last byte of the **Start (sync) String** before the string is parsed. The configuration of this field allows for more than one GSI Data Parse Entry to contain the same **Start (sync) String** and for data to be received for multiple channels from a single GSI string.



**NOTE:** One parsing program should be configured for each channel to which data is to be transferred.

## New Digital Parse Entry

A Digital Parse Entry is used to control relay outputs based on digital values present in a delimited string received on the GI Port. The first character in the Digital State field is checked

to be either a 1 or a 0. If the field contains a 1, the configured Output Line(s) are activated. If the field contains a 0, the configured Output Line(s) are deactivated.

To configure a digital parse entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > I - New Digital Parse Entry**.

The following screen displays.

ESC 8864 v5.02.r25 ID:88		Config GSI Entry	12/01/17 15:25:29
Entry Tag Name	:	TEMP	
Port#	:	6	
Start (sync) String	:		
Delimiter Character(s)	:	,	
Delimiters to Digital State	:	1	
Output Line(s)	:	(none)	
(Delimiters in String)	:	XX	
FINISHED (Configure Now)			
<ESC> to Cancel			

The following information provides a description of the fields in the Config GSI Entry screen.

### Entry Tag Name

The label used to identify this GSI Digital Parse Entry.

### Port #

The port being used for GSI communications. **0 to 3, 6 to 9**.

### Start (sync) String

One or more characters that signal the beginning of the data stream to be parsed.

### Delimiter Character(s)

The characters that define the beginning of each new field in the data stream. Up to 32 characters may be entered. If any of the delimiter characters are found, a new field begins with

the following character and ends with the character preceding the next delimiter character.

### Delimiters to Digital State

The number of **Delimiter Character(s)** between the end of the **Start (sync) String** and the beginning of the digital state data. **0** to **99**.

### Output Lines

The pattern of digital outputs to be activated and/or deactivated upon reception of the digital state data.

### (Delimiters in String)

(Optional) The number of delimiters that must be received after the last byte of the **Start (sync) String** before the string is parsed. The configuration of this field allows for more than one GSI Data Parse Entry to contain the same **Start (sync) String** and for multiple digital data states to be received from a single GSI string.

### New Autosend Entry

An Autosend Entry is used to send a string from the GSI Serial Port at a repeated interval.

To configure an autosend entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > A - New Autosend Entry**.

The following screen displays.

ESC 8864 v5.02.r25 ID:88		Config GSI Send	12/01/17 15:48:46
Entry Tag Name	:	TEMP	
Port#	:	6	
Output String	:		
Interval	:	1m	
Send Time Skew	:	0s	
FINISHED (Configure Now)			
<ESC> to Cancel			

The following information provides a description of the fields in the Config GSI Entry screen.

### Entry Tag Name

The label used to identify this GSI Autosend Entry.

### Serial Port #

The serial port used for GSI communications. **0** to **3**, **6** to **9**.

### Output String

The string sent to the GSI port. This string can contain time formatting and time offset characters.

### Interval

The repeat interval of the autosend entry.

### Send Skew Time

The time offset this entry should be transmitted. A Send Skew Time of **0s** causes the Output String to transmit at the beginning of each Interval. A Send Skew Time of **10m**, for example, causes the Output String to transmit 10 minutes after the beginning of each Interval. The Send Skew Time must be less than the Interval.

## New DI-Triggered Send Entry

A DI-Triggered Send Entry is used to send a string out the GSI Serial Port when a specified set of status input lines matches a specified pattern. The GSI only sends the string once per pattern match. The pattern match must become false and then true once again before the string is resent. This feature prevents the string from being sent multiple times while the input pattern is matched.

To configure an autosend entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > T - New DI-Triggered Send Entry**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88 Config GSI2 DI-Triggered Send 12/01/17 15:57:05

Entry Tag Name      : TEMP
Port#               : 6
Start Pattern Status Lines : (none)
Output String       :

FINISHED (Configure Now)

<ESC> to Cancel
```

The following information provides a description of the fields in the Config GSI2 DI-Triggered Send screen.

### Entry Tag Name

The label used to identify the GSI DI-Triggered Send Entry.

### Serial Port #

The serial port for GSI communications. **0** to **3**, **6** to **9**.

## Start Pattern Status Lines

The digital input pattern that must be matched before transmitting the Output String.

## Output String

The string sent to the GSI port. This string can contain time formatting and time offset characters.

## New Alarm Entry

An Alarm Entry is used to control relay outputs upon the reception of a specified string on the GSI Serial Port.

To configure an alarm entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > L - New Alarm Entry**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88 Config GSI2 Alarm Entry 12/01/17 16:03:18

Entry Tag Name      : TEMP
Port#               : 6
Alarm String        :
Output Line(s)      : (none)
FINISHED (Configure Now)

<ESC> to Cancel
```

The following information provides a description of the fields in the Config GSI2 Alarm Entry screen.

## Entry Tag Name

The label used to identify this GSI Alarm Entry.

## Serial Port #

The serial port being used for GSI communications. **0** to **3**, **6** to **9**.

## Alarm String

The activation string for this entry.

## Output Lines

The pattern of digital outputs to be activated and/or deactivated when the Alarm String is received.

## New Primer Entry

A Primer Entry is used to validate or invalidate data based upon the reception of a specified string on the GSI Serial Port. At the beginning of each **Primer Duration** interval, all of the **Affected Data Parse Entries** are disabled from accepting valid data. Until the Primer String is received, Affected Data Parse Entries that receive and parse data must mark the received data as invalid.

After the Primer String is received, any Affected Data Parse Entries that receive and parse data operate normally, and the received data is valid for averages. For any Affected Data Parse Entries that receive and parse data two or more times after the Primer String is received, all but the first data received is ignored (no data conversion and no effect on validity).

To configure a primer entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > P - New Primer Entry**.

The following screen displays.



```
ESC 8864 v5.02.r25 ID:88 Config GSI2 Primer Entry 12/01/17 16:10:21

Primer Tag Name      : TEMP
Port#                : 6
Primer String        :

Primer Duration      : 1m
Hold Data Between Updates : N
Affected Data Parse Entries : (none)

FINISHED (Configure Now)

<ESC> to Cancel
```

The following information provides a description of the fields in the Config GSI2 Primer Entry screen.

### Primer Tag Name

The label used to identify the GSI Primer Entry.

### Port #

The serial port for GSI communications. Valid entries are **0** to **3** and **6** to **9**.

### Primer String

The string that signals to the Affected Data Parse Entries that the following data strings can be parsed for valid data. This string can contain time formatting and time offset characters.

### Primer Duration

The amount of time after receiving the Primer String allowed for Affected Data Parse Entries to receive and parse strings containing valid data.

### Hold Data Between Updates

Feature not implemented at this time.

### Affected Data Parse Entries

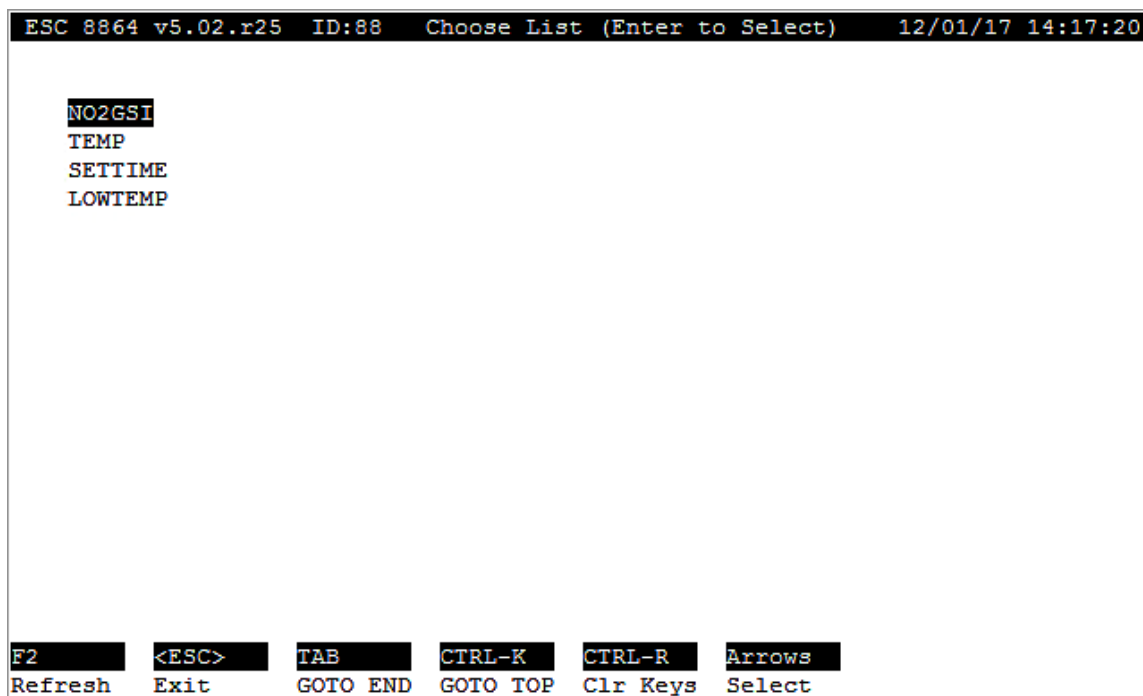
The list of data parse entry tag names that require the reception of the Primer String before

receiving and parsing valid data.

## Change Old Configuration

To change a GSI table entry:

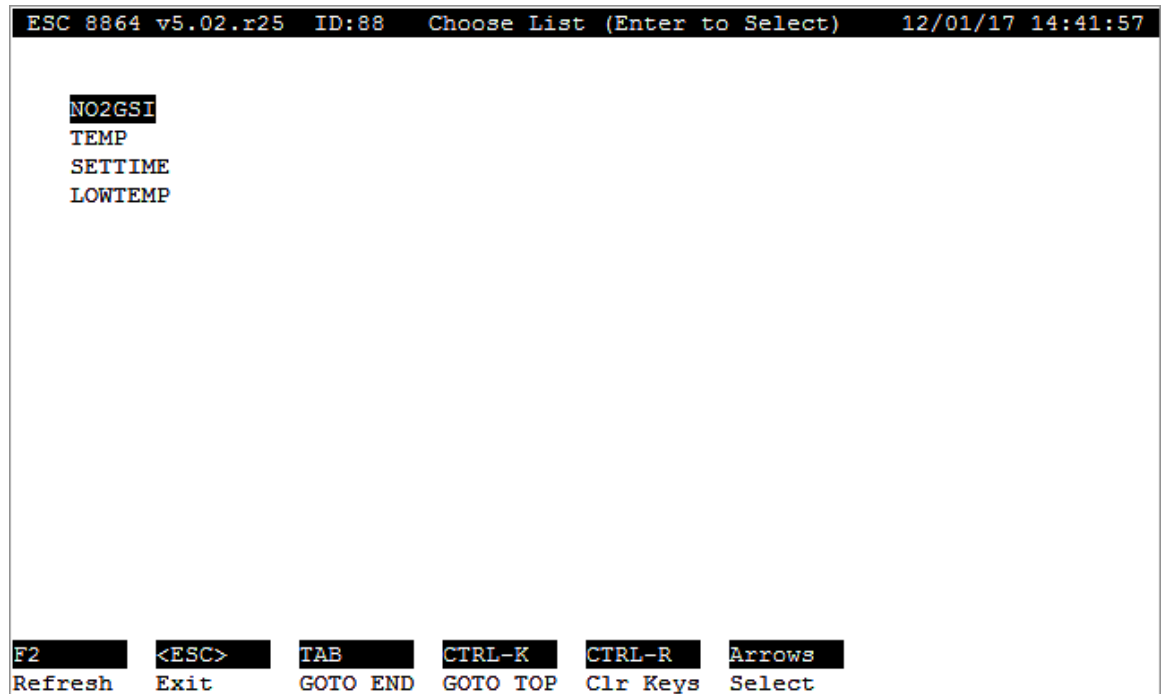
1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols**.
2. Select **G - Configure GSI Tables** (hot key **G**) in the Serial Protocol Config Menu to open the GSI Configuration Menu.
3. Select **C - Change Old Configuration** in the GSI Configuration Menu screen to display a list of all configured GSI table entries. See the next screen for an example.
4. Use the up/down arrows to navigate table entries. Press **<Enter>** for a highlighted GSI table entry to open a configuration screen. The selected GSI table entry is copied into memory for editing.
5. Make changes as needed. Also see [New Data Parse Entry](#) for information about configuration fields.
6. Select **FINISHED (Configure Now)** for changes to take effect. If you exit using the **<Esc>** key, the GSI table entry will not be deleted.



## Delete Old Configuration

To delete a GSI table entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > G - Configure GSI Tables > D - Delete Old Configuration**.
2. Use the up/down arrows to navigate table entries. Press **<Enter>** for the highlighted GSI table entry you want to delete. If you press the **<Esc>** key to exit, the entry is not deleted.
3. When the message “Are you Sure (Y/N)?” displays, press **Y** on your keyboard.



## Format Strings

All GSI strings allow the use of **\xhh**, where **hh** is a hexadecimal number from **00** to **FF** representing an ASCII character.

The Output String for the Autosend and DI-Triggered Send Entries and the Primer String for the Primer Entry also allow the data and time to be included in the string. The table below identifies special characters that are allowed.

For the two-digit second, minute, hour (24-hour), and day, or %S, %M, %H and %d, respectively, a three-digit integer can be added or subtracted from the current date and time. For example, if the current date and time is 1/1/92 12:00pm, and an Autosend Entry is configured to output the formatted string “%H:%M+001:%S+030\x0D\x0A,” the resulting output is “12:01:30” followed by a line feed and a carriage return.

Character	Description
%%	Character %
%a	Abbreviated weekday name
%A	Full weekday name
%b	Abbreviated month name
%B	Full month name
%c	Date and time
%d[+nnn]	Two-digit day of month ( <b>01-31</b> )
%H[+nnn]	Two-digit hour ( <b>00-23</b> )
%l	Two-digit hour ( <b>01-12</b> )
%j	Three-digit day of year ( <b>001-366</b> )
%m	Two-digit month as a decimal number ( <b>1-12</b> )
%M[+nnn]	Two-digit minute ( <b>00-59</b> )
%p	AM or PM
%S[+nnn]	Two-digit second ( <b>00-59</b> )
%U	Two-digit week number where Sunday is the first day of the week ( <b>00-53</b> )
%w	Weekday where <b>0</b> is Sunday ( <b>0-6</b> )
%W	Two-digit week number where Monday is the first day of the week ( <b>00-53</b> )
%x	Date
%X	Time
%y	Two-digit year without century ( <b>00-99</b> )

Character	Description
%Y	Year with century
%Z	Time zone name, or no characters if no time zone

## Configure GSI UCEM Client



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The GSI UCEM Client is used to establish polling of a networked Rosemount® MicroCEM™ analyzer from an 8864 Data Controller. An entry is configured to control polling of data in a text format from an analyzer. When the controller receives a response, it is parsed against the normal GSI tables. The Port field is used to relate poll and parse entries. The GSI UCEM Client polls for textual result strings from an analyzer over the Ethernet.

To display GSI UCEM Client selections:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > C - Configure GSI UCEM Client**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88 Config GSI UCEM Client 12/01/17 16:39:48
N New GSI Client Entry
C Change GSI Client Entry
D Delete Old GSI Client Entry

<ESC> to Cancel
```

### Related Topics:

- [New GSI Client Entry](#)
- [Change GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

## New GSI Client Entry

A new UCEM GSI Client Entry defines a label for the client, its Ethernet network address, how often it should be polled, and the command to be issued. The response string received from the client is then available for processing with the standard GSI tables.

To configure a new GSI UCEM Client entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > C - Configure GSI UCEM Client > N - New GSI Client Entry**.

The following screen displays.

```

ESC 8864 v5.02.r25 ID:88      Config GSI UCEM Client      12/01/17 16:48:01

Entry Name                    : TEMP
Instrument IP Address          :
Port ( 6 <= port <= 9 )      : 6
Repeat Interval ( secs )      : 1
Timeout ( secs )              : 1
Command string                 : fetchData.asp

FINISHED (Configure Now)

<ESC> to Cancel

```

The following information provides a description of the Config GSI UCEM Client screen.

### Entry Name

The label used to identify the GSI Client Entry.

### Instrument IP Address

The network IP address of the client instrument using the format 0.0.0.0.

### Port ( 6 <= port <= 9 )

The Ethernet port for GSI communications. A unique port number must be used for each client instrument. Valid entries are **6** to **9**.

### Repeat Interval ( secs )

The interval rate in seconds for polling the client instrument. Valid entries are **0** to **3600**.

### Timeout ( secs )

The amount of time in seconds to wait for a response from the client instrument. Valid entries are **0** to **300**.

### Command string

The default command string for the UCEM client is **fetchData.asp**. Other commands typically used are **fetchData1.asp** and **fetchData2.asp**.

#### Related Topics:

- [Configure GSI UCEM Client](#)
- [Change GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

### Change GSI Client Entry

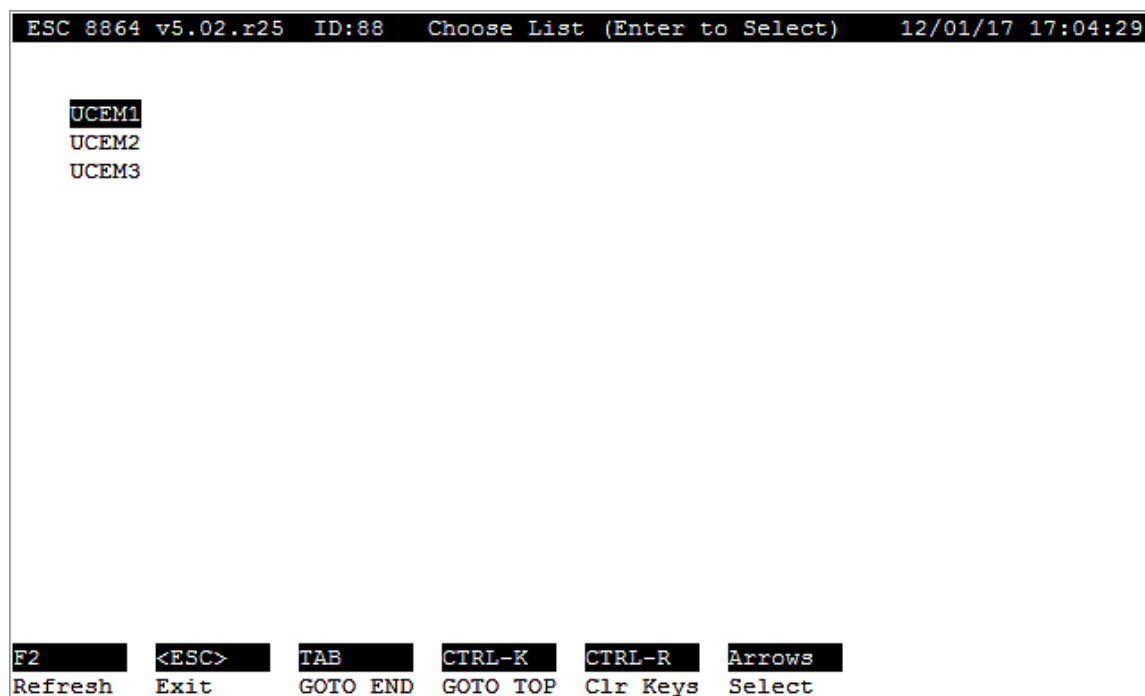
To change a GSI UCEM Client Entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > C - Configure GSI UCEM Client > C - Change GSI Client Entry**.

A list of all configured GSI client entries display. See the next screen for an example.

2. Use the up/down arrows to navigate client entries. Press **<Enter>** for a highlighted client entry to open a configuration screen. The selected entry is copied into memory for editing.
3. Make changes as needed. Also see [New GSI Client Entry](#) for information about configuration fields.
4. Select **FINISHED (Configure Now)** for changes to take effect. If you exit using the

<Esc> key, the GSI client entry will not be deleted.



#### Related Topics:

- [Configure GSI UCEM Client](#)
- [New GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

#### Delete Old GSI Client Entry

To delete a GSI UCEM Client Entry:

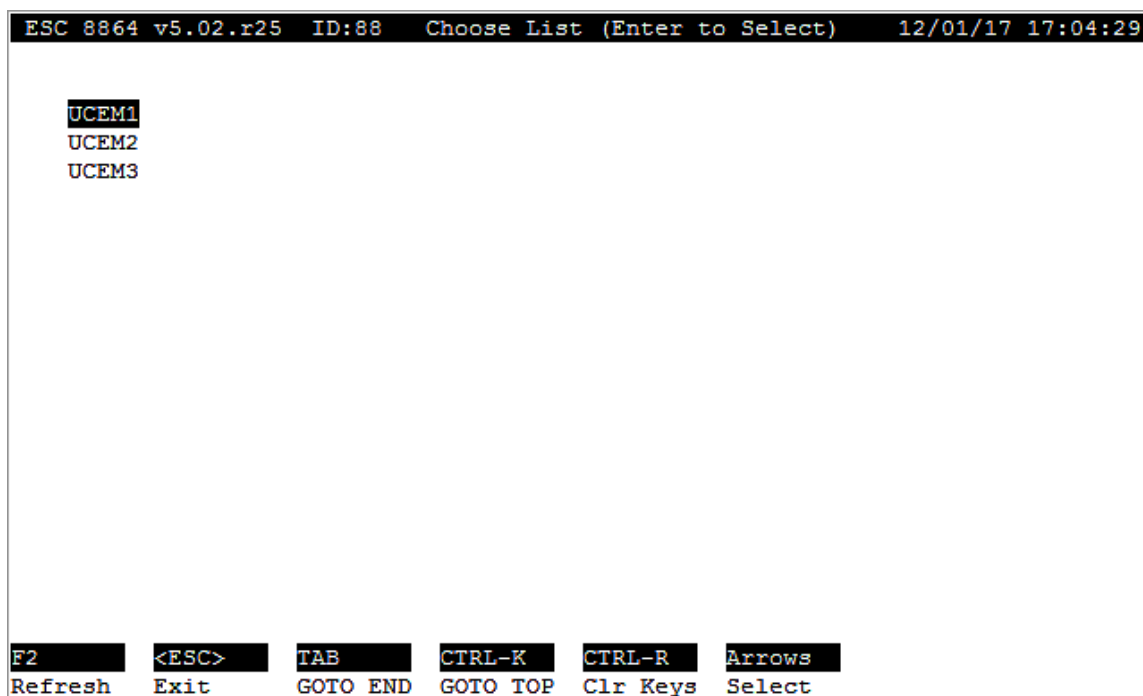
1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > C - Configure GSI UCEM Client > C - Change GSI Client Entry**.

A list of all configured GSI client entries display. See the next screen for an example.

2. Use the up/down arrows to navigate client entries. Press **<Enter>** for the highlighted entry you want to delete. If you press the **<Esc>** key to exit, the entry is not deleted.



3. When the message “Are you Sure (Y/N)?” displays, press **Y** on your keyboard.



#### Related Topics:

- [Configure GSI UCEM Client](#)
- [New GSI Client Entry](#)
- [Change GSI Client Entry](#)

## Configure GSI THERMO Client



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The GSI THERMO Client is used to establish polling of a network enabled Thermo Environmental® Thermo™ analyzer (typically “I” series) from an 8864 Data Controller. An entry is configured to control polling of data in a text format from an analyzer. When the controller receives a response, it is parsed against the normal GSI tables. The Port field is used to relate poll and parse entries. The GSI THERMO Client polls for textual result strings from the analyzer over the Ethernet.

To display GIS THERMO selections:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > T- Configure GSI THERMO Client**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88 Serial Protocol Config Menu 12/04/17 09:39:55

G Configure GSI Tables
C Configure GSI UCEM Client
T Configure GSI THERMO Client
A Configure GSI API Client
```

The following information provides a description of the Config GSI THERMO Client screen.

### New GSI Client Entry

Defines a networked client from which to receive a data string in a predefined format. See the topic [New GSI Client Entry](#) for more information.

### Change GSI Client Entry

Modifies an existing GSI client entry. See the topic [Change GSI Client Entry](#) for more information.

### Delete Old GSI Client Entry

Deletes an existing GSI client entry. See the topic [Delete Old GSI Client Entry](#) for more information.

#### Related Topics:

- [New GSI Client Entry](#)
- [Change GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

## New GSI Client Entry

The configuration screen for a New THERMO GSI Client Entry defines:

- a label for the client,
- its Ethernet network address,
- how often it should be polled,
- and the command to be issued.

The response string received from the client is then available for processing with the standard GSI tables.

To configure a new GSI THERMO client entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > T - Configure GSI THERMO Client > N - New GSI Client Entry**.

The following screen displays.

```
ESC 8864 v5.02.r25  ID:88      Config GSI Thermo Client      12/04/17 09:51:02

Entry Name           : TEMP
Instrument IP Address :
Instrument ID         : 0
Port ( 6 <= port <= 9 ) : 6
Repeat Interval ( secs ) : 1
Timeout ( secs )      : 1
Command string        :

FINISHED (Configure Now)

<ESC> to Cancel
```

The following information provides a description of the Config GSI Thermo Client screen.

### Entry Name

The label used to identify this GSI Client Entry.

### Instrument IP Address

The network IP address of the client instrument.

### Instrument ID

The network IP address of the client instrument.

### Port ( 6 <= port <= 9)

The Ethernet port being used for GSI communications. A unique port number must be used for each client instrument. **6** to **9**.

### Repeat Interval ( secs )

The interval rate in seconds at which to poll this client instrument. **0** to **3600**.

### Timeout ( secs )

The amount of time in seconds to wait for a response from the client instrument. **0** to **300**.

### Command string

The command string for the THERMO client entry consists of a string of up to 80 characters which may include non-printable and control characters as described the section [Formatting Strings](#).

#### Related Topics:

- [Configure GSI THERMO Client](#)
- [Change GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

### Change GSI Client Entry

To change a GSI THERMO Client Entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > T - Configure GSI THERMO Client > C - Change GSI Client Entry**.
2. Use the up/down arrows to navigate client entries. Press **<Enter>** for a highlighted client entry to open a configuration screen. The selected entry is copied into memory for editing.
3. Make changes as needed. Also see [New GSI Client Entry](#) for information about configuration fields.
4. Select **FINISHED (Configure Now)** for changes to take effect. If you exit using the

<Esc> key, the GSI client entry will not be deleted.



#### Related Topics:

- [Configure GSI THERMO Client](#)
- [New GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

#### Delete Old GSI Client Entry

To delete a GSI UCEM Client Entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > T - Configure GSI THERMO Client > D - Delete Old GSI Client Entry**.
2. Use the up/down arrows to navigate client entries. Press **<Enter>** for the highlighted entry you want to delete. If you press the **<Esc>** key to exit, the entry is not deleted.
3. When the message "Are you Sure (Y/N)?" displays, press **Y** on your keyboard.

#### Related Topics:

- [Configure GSI THERMO Client](#)
- [New GSI Client Entry](#)
- [Change GSI Client Entry](#)

## Configure GSI API Client



**NOTE:** The configuration options in this section are available only through the MDI. If the 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The GSI API Client is used to establish polling of a network enabled Advanced Pollution Instrumentation analyzer from an 8864 Data Controller. An entry is configured to control polling of data in a text format from an analyzer. When the controller receives a response, it is parsed against the normal GSI tables. The Port field is used to relate poll and parse entries. The GSI API Client polls for textual result strings from an analyzer over the Ethernet.

To display GSI API Client selections:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > A - Configure GSI API Client**.

The following screen displays.

```
ESC 8864 v5.02.r25 ID:88 Config GSI API Client 12/04/17 11:52:37
N New GSI Client Entry
C Change GSI Client Entry
D Delete Old GSI Client Entry

<ESC> to Cancel
```

The following information provides a description of the Config GSI API Client screen.

### New GSI Client Entry

Defines a networked client from which to receive a data string in a predefined format. Also refer to [New GSI Client Entry](#).

## Change GSI Client Entry

Modifies an existing GSI client entry. Also refer to [Change GSI Client Entry](#).

## Delete Old GSI Client Entry

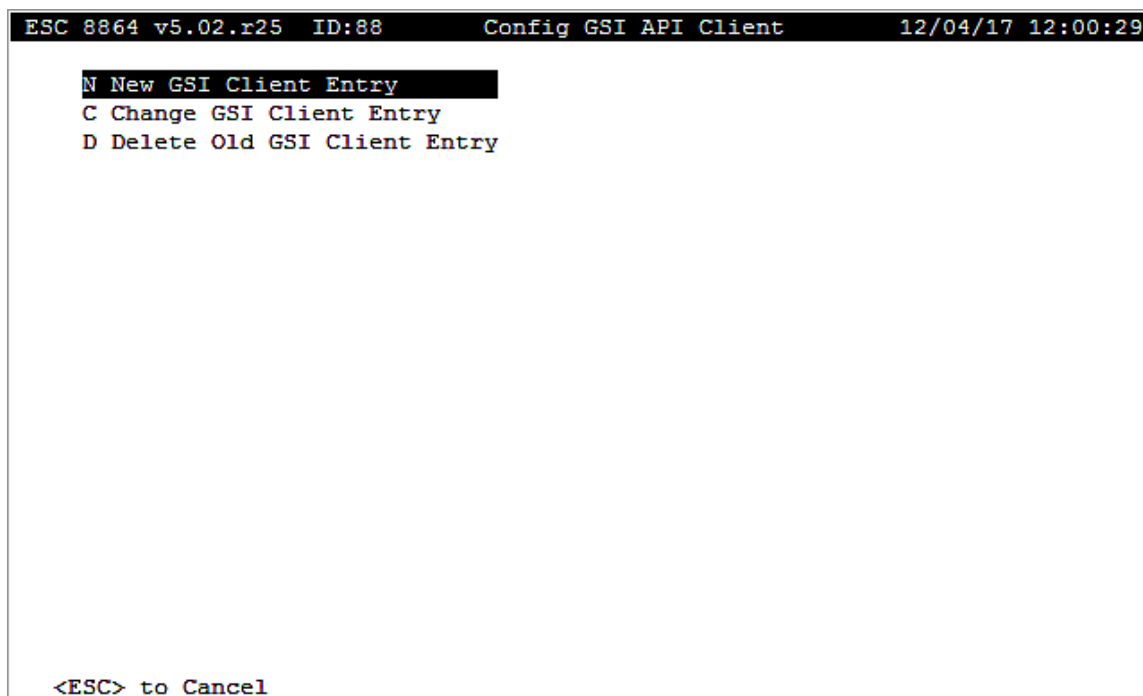
Deletes an existing GSI client entry. Also refer to [Delete Old GSI Client Entry](#).

## New GSI Client Entry

A new GSI API Client Entry defines a label for the client, its Ethernet network address, how often it should be polled, and the command to be issued. The response string received from the client is then available for processing with the standard GSI tables.

To configure a new GSI API client entry:

- From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > A - Configure GSI API Client > N - New GSI Client Entry**.



```
ESC 8864 v5.02.r25 ID:88      Config GSI API Client      12/04/17 12:00:29

N New GSI Client Entry
C Change GSI Client Entry
D Delete Old GSI Client Entry

<ESC> to Cancel
```

The following information provides a description of the Config GSI Thermo Client screen.

## Entry Name

The label used to identify the GSI Client Entry.

### Instrument IP Address

The network IP address of the client instrument.

### Port ( 6 <= port <= 9)

The Ethernet port being for GSI communications. A unique port number must be used for each client instrument. Valid port entries are 6 to 9.

### Repeat Interval ( secs )

The interval rate in seconds at which to poll this client instrument. Valid entries are 0 to 3600.

### Timeout ( secs )

The amount of time in seconds to wait for a response from the client instrument. Valid entries are 0 to 300.

### Command String

The command string for the API client entry consists of a string of up to 80 characters. It can include non-printable and control characters as described in the section [Format Strings](#).

#### Related Topics:

- [Configure GSI API Client](#)
- [Change GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

### Change GSI Client Entry

To change a GSI API Client Entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > A - Configure GSI API Client > C - Change GSI Client Entry**.
2. Use the up/down arrows to navigate client entries. Press **<Enter>** for a highlighted client entry to open a configuration screen. The selected entry is copied into memory for editing.
3. Make changes as needed. Also see [New GSI Client Entry](#) for information about configuration fields.
4. Select **FINISHED (Configure Now)** for changes to take effect. If you exit using the



<Esc> key, the GSI client entry will not be deleted.

```
ESC 8864 v5.02.r25 ID:88 Config GSI Api Client 12/04/17 11:58:01

Entry Name      : TEMP
Instrument IP Address :
Port ( 6 <= port <= 9 ) : 6
Repeat Interval ( secs ) : 1
Timeout ( secs ) : 1
Command string   :

FINISHED (Configure Now)

<ESC> to Cancel
```

#### Related Topics:

- [Configure GSI API Client](#)
- [New GSI Client Entry](#)
- [Delete Old GSI Client Entry](#)

#### Delete Old GSI Client Entry

To delete a GSI API Client Entry:

1. From the Home Menu, select **C - Configuration Menu > 1 - Configure Serial Protocols > A - Configure GSI API Client > D - Delete Old GSI Client Entry**.
2. Use the up/down arrows to navigate client entries. Press <Enter> for the highlighted entry you want to delete. If you press the <Esc> key to exit, the entry is not deleted.
3. When the message "Are you Sure (Y/N)?" displays, press **Y** on your keyboard.

#### Related Topics:

- [Configure GSI API Client](#)
- [New GSI Client Entry](#)
- [Configure GSI API Client](#)

# Real-Time Display Menu

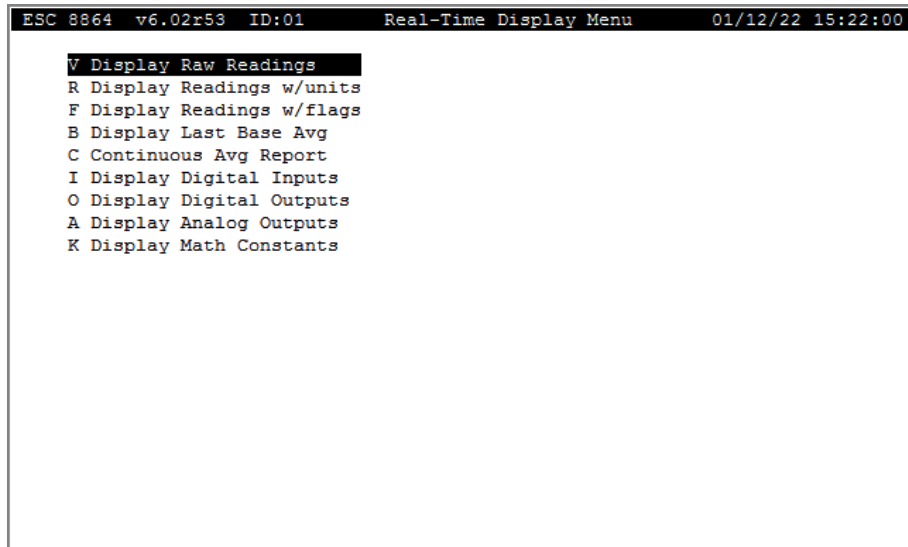


**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Real-time data display takes advantage of a high-speed interface to report data in real-time. This includes real-time display of data for current voltage readings; scaled engineering values with units or flags; digital inputs; and math constant values.

To open the Real-Time Display Menu:

- From the Home Menu, select **D - Real-Time Display Menu**.



A brief description of each item in the Real-Time Display Menu is provided in the next table. For a detailed description, click the hyperlink in the *To Option* column.

Selections in the Real-Time Display menu provide output only to the front-panel LCD display and serially connected terminals (except for the LARGE TEXT Display). The real-time display's update rate depends on the local baud rate. For updates every second, the terminal should be running at 9600 baud or faster.

Hot Key	To Option	Purpose
V	<a href="#">Display Raw Readings</a>	Displays the analog inputs
R	<a href="#">Display Readings with Units or Flags</a>	Displays Channel readings with Engineering units

Hot Key	To Option	Purpose
F	<a href="#">Display Readings with Units or Flags</a>	Displays Channel readings with data flag(s)
B	<a href="#">Display Last Base Average</a>	Displays Channel averages with data flag(s)
C	<a href="#">Continuous Avg Report</a>	Continuously displays Channel readings or averages with flag(s)
I	<a href="#">Display Digital Inputs</a>	Displays the status of all digital inputs
O	<a href="#">Display Digital Outputs</a>	Displays the status of all digital outputs
A	<a href="#">Display Analog Outputs</a>	Displays the current delivered by the analog outputs
K	<a href="#">Display Math Constants</a>	Displays real-time values of math constants as they are used in any equation calculation.

## Display Raw Readings



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Display Raw Readings allows you to view instantaneous input voltage or current values (whether they have been initialized as a data parameter or not). The configured instrument name and the three-digit analog input number are displayed along with the input voltage or current value. If more than one channel uses an analog input, the name of the first configured channel is displayed in reverse video (see SO2 in the following example).

To open the Display Raw Readings screen:

- From the Home Menu, select **D - Real-Time Display Menu > V - Display Raw Readings**.

ESC 8864 v5.xx ID:49		Real-Time Raw Readings		mm/dd/yy hh:mm:ss	
SO2	(A01) = 8.4847 mA	TAMB	(A17) = 3.9910 V		
NOX	(A02) = 4.7680 mA	PAMB	(A18) = 4.3278 V		
CO2	(A03) = 15.0814 mA		(A19) = 0.0006 V		
OPACITY	(A04) = 12.0991 mA		(A20) = -0.0006 V		
FLOW	(A05) = 0.0079 mA		(A21) = 0.0006 V		
	(A06) = 0.0115 mA		(A22) = 0.0006 V		
	(A07) = 0.0000 mA		(A23) = -0.0006 V		
	(A08) = -0.0006 mA		(A24) = 0.0006 V		
	(A09) = 0.0000 mA	<Met Reference 1>	(M25) = 5.0092 V		
	(A10) = 0.0000 mA	<Met WDR Input 1>	(M26) = 3.6348 V		
	(A11) = -0.0006 mA	<Met TMP Input 1>	(M27) = 1.9954 V		
	(A12) = 0.0000 mA		( D1) = 0.7256 V/V		
	(A13) = 0.0006 mA		( T1) = 0.3983 V/V		
	(A14) = 0.0006 mA		( S1) = 1227 Hz		
	(A15) = 0.0006 mA		( R1) = 0 CNTS		
	(A16) = 0.0000 mA				

ESC or SPACE to exit

## Display Readings with Units or Flags



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

---

These displays allow you to view scaled readings from all data channels that have been initialized. Parentheses enclose the engineering units when using Display Readings w/units. When using Display Readings w/flags, parentheses enclose the validation flags.

Some flags occur only on averages and will not appear on the readings with units display. These flags include the **c**, **f**, **H**, **h**, **L**, **I**, **J**, and **j** flags. To view occurrences of these flags, select **Display Last Base Avg** (hot key **B**) from the Real-Time Display Menu.



**NOTE:** Certain MDI menus display data in color when the option "Enable Terminal Colors" has been enabled. When this option is disabled, MDI menus display white text on a black background. See [Enable Terminal Colors \(Y/N\)](#) for more information.

To open the **Display Readings w/units** screen:

- From the Home Menu, select **D - Real-Time Display Menu > R - Display Readings w/units**. A screen similar to the following displays.

The range of channel numbers being displayed on the current page display in the bottom right corner of the page using the format (###->###). Blank pages without a configured channel are skipped – blank pages are not shown.

```

ESC 8864 v6.00r41 ID:01 Real-Time Engineering Units 06/22/20 17:48:25

      RSO2LO= 0      (PPM      )      ETHYLENC= 0.01512 (UG/M3      )
      RSO2HI= 0      (PPM      )      HG#/GWH= 0      (LB/GWH      )
      RNOXLO= 0      (PPM      )      HGLB/T= 1      (LB/TBTU      )
      RNOXHI= 0      (PPM      )      HGLB/HR= 1      (LB/HR      )
      SAMPVAC=-7.5    (Hg      )      HGR1DB= 0      (LB/GWH      )
      RCO2= 0      (PERCENT )      HG/CONV1= 1      (UG/M3      )
      SMPFLOW=-2.5    (LIT/MIN )      LOADMW= 0      (MW      )
      DILPRESS=-36.25 (PSI      )      UNITON= 1      (MINS      )
      PROBEVAC= 44.88 (HG VAC  )      SO2LO= 0      (PPM      )
      FILTEMP=-100    (DEG_F   )      SO2HI= 0      (PPM      )
      PRBTEMP=-100    (DEG_F   )      NOXLO= 0      (PPM      )
      SHELTEMP= 0      (DEG_F   )      NOXHI= 0      (PPM      )
      BARPRESS=-7.5    (PSIA     )      SO2PPM= 0      (PPM      )
      FLOW_DP= 0      (in_wc    )      NOXPPM= 0      (PPM      )
      STKPRESS=-4.5    (in_wc    )      CO2= 0      (PERCENT )
      STKTEMP=-125     (DEG_F   )      FLOWSCFH= 0      (SCFH      )

ESC/SPACE: exit CTRL-N: next CTRL-P: prev (001->032)

```

To open the **Display Readings w/flags** screen:

- From the Home Menu, select **D - Real-Time Display Menu > F - Display Readings w/flags**. A screen similar to the following displays.

The range of channel numbers being displayed on the current page display in the bottom right corner of the page using the format (###->###). Blank pages without a configured channel are skipped – blank pages are not shown.

Beginning in firmware Version 6.02.r60, if a communication error occurs on a MODBUS channel, the 8864 now adds a U flag to the MODBUS channel and displays the information in the Real-Time Engineering Flags screen. Both the "B" and "U" flags will be present on MODBUS data that is not updated once a scan interval (see next example).

ESC 8864 v6.02r54 ID:01 Real-Time Engineering Flags 01/14/22 14:43:38					
MOD1= 1	(	)	ETHYLENC= 0.01512	(	)
MOD2= 0	(BU	)	HG#/GWH= 0	(FBUA	)
MOD3= 1	(	)	HGLB/T= 1	(F	)
MOD4= 0	(BU	)	HGLB/HR= 1	(F	)
SAMPVAC=-7.5	(	)	HGR1DB= 0	(FBUA	)
RCO2= 0	(BCU	)	HG/CONV1= 1	(	)
SMPFLOW=-2.5	(	)	LOADMW= 0	(BU	)
DILPRESS=-36.26	(	)	UNITON= 1	(	)
PROBEVAC= 44.88	(	)	SO2LO= 0	(BCU	)
FILTEMP=-100	(	)	SO2HI= 0	(BCU	)
PRBTEMP=-100	(	)	NOXLO= 0	(BCU	)
SHELTEMP= 0	(BU	)	NOXHI= 0	(BCU	)
BARPRESS=-7.501	(-	)	SO2PPM= 0	(BCU	)
FLOW_DP= 0	(TBU	)	NOXPPM= 0	(BCU	)
STKPRESS=-4.5	(-	)	CO2= 0	(BCU	)
STKTEMP=-125	(-	)	FLOWSCFH=Overrange!	(TBUA-	)
ESC/SPACE: exit CTRL-N: next CTRL-P: prev (001->032)					

## Display Last Base Average



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This real-time display allows you to view the latest base averages from all data channels that have been initialized, including their flags.



**NOTE:** Certain MDI menus display data in color when the option "Enable Terminal Colors" has been enabled. When this option is disabled, MDI menus display white text on a black background. See [Enable Terminal Colors \(Y/N\)](#) for more information.

To open the Display Last Base Average screen:

1. From the Home Menu, select **D - Real-Time Display Menu > B - Display Last Base Avg.**
2. Press **<Ctrl><A>** to switch between Display Last Base Average, Display Last Avg#1 Average, and Display Last Avg#2 Average screens.

The range of channel numbers being displayed on the current page display in the bottom right corner of the page using the format (###->###). Blank pages without a configured channel are skipped – blank pages are not shown.

ESC 8864	v6.00r41	ID:01	Display Last Base Average	06/19/20 12:08:09
RSO2LO= 0	(<Bf )	ETHYLENC= 0.01512	( )	
RSO2HI= 0	(<Bf )	HG#/GWH= 0	(<FBAf )	
RNOXLO= 0	(<Bf )	HGLB/T= 1	( )	
RNOXHI= 0	(<Bf )	HGLB/HR= 1	( )	
SAMPVAC= 0	(lf )	HGR1DB= 333.5	(<DFBAHhp)	
RCO2= 0	(<Bf )	HG/CONV1= 1	( )	
SMPFLOW= 0	(f )	LOADMW= 0	(<B1f )	
DILPRESS= 0	(f )	UNITON= 1	( )	
PROBEVAC= 44.88	( )	SO2LO= 0	(<B )	
FILTEMP= 0	(Lf )	SO2HI= 0	(<B )	
PRBTEMP= 0	(Lf )	NOXLO= 0	(<B )	
SHELTEMP= 0	(<B1f )	NOXHI= 0	(<B )	
BARPRESS= 0	(<-f )	SO2PPM= 0	(<Bf )	
FLOW_DP= 0	(<Bf )	NOXPPM= 0	(<Bf )	
STKPRESS=-4.5	(<- )	CO2= 0	(<B )	
STKTEMP= 0	(<-f )	FLOWSCFH= 0	(<B- )	
ESC/SPACE: exit CTRL-A: type CTRL-N: next CTRL-P: prev (001->032)				

## Continuous Avg Report



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Continuous Avg Report allows you to continuously view instantaneous or average data values for selected channels as they are calculated while also viewing as many as twenty of the most recently calculated values. The display screen automatically updates as new data become available. Up to 32 flags may be reported for each channel. The decimal positioner configured for each channel can optionally be used to format the data in the display.

To display the Continuous Avg Report screen:

- From the Home Menu, select **D - Real-Time Display Menu > C - Continuous Avg Report**.



```
ESC 8864 v5.00.r21 ID:01 Continuous Avg Report Setup 01/06/16 15:08:04

Average Interval      : 1m
Show Channels         : COALFLOW,GASFLOW,UNITLOAD,C,PM,PM_RIGHT,PM_D
                      : ILFL,PM_WETFL,PM_PS11C,ORIFPRES,MASSFLOW,FLO
                      : W,FLOWTEMP,OPACITY,FLOWVEL,INTCHK,UNITOPHR,P
                      : M#/MW,DR_CORR,PRCO2,PRCOLO,PRCOHI,PRNOXLO,PR
                      : NOXHI,PRSO2LO,PRSO2HI,CO2,COLOW,COHIGH,NOXLO
                      : W,NOXHIGH,SO2LOW,SO2HIGH,
# of Flags to Report  : 02
Use Decimal Positioner? : Y
Start Continuous Report
```

The following information provides a description of the fields in the Continuous Avg Report Setup screen.

## Average Interval

The averaging interval to be reported. For rolling average channels, the Input Avg Interval should be entered (the rate at which rolling averages are stored). 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively). 0s displays instantaneous data.

## Show Channels

The channel(s) to be displayed. Any configured channel name(s), up to 255 characters. ALL selects all channels configured with the Average Interval selected above. A maximum of 5 channels can be displayed at one time, depending on the value entered for the # of Flags to Report.

## # of Flags to Report

The maximum number of data validation flags that will be displayed with each average value. 00 to 32. Default=02.

## Use Decimal Positioner?

Y(es) or N(o). If Y, the decimal positioner configured for the channel will be used to format the displayed data. If N, the full precision of the data will be displayed. Default=Y.

## Start Continuous Report

Press <Enter> at this field to view the Continuous Average Report.

## Example of Continuous Average Report

TIME	SO2	NOX	CO2	OPACITY	FLOW
08/29 10:14:14	127.99CM	220.32CM	8.35CM	12.35	255.3
08/29 10:14:15	126.99CM	223.32CM	9.32CM	13.24	254.7
08/29 10:14:16	127.98CM	220.32CM	8.82CM	13.53	253.6
08/29 10:14:17	128.98CM	219.32CM	9.24CM	13.55	253.8
08/29 10:14:18	127.98CM	221.32CM	10.23CM	13.34	252.4
08/29 10:14:19	127CM	220.32CM	10.72CM	12.92	251.7
08/29 10:14:20	128.99	223.31	9.54	12.87	252.3
08/29 10:14:21	125.98	220.31	7.36	13.11	252.9
08/29 10:14:22	128.97	225.31	8.04	13.33	254.1D
08/29 10:14:23	127.96	220.31	8.59	13.49	254.3D
08/29 10:14:24	127.95	222.31	10.92	13.62	255.0
08/29 10:14:25	128.95	220.3	9.81	13.73	255.1
08/29 10:14:26	127.94	221.3	9.8	14.1	249.7
08/29 10:14:27	127.99	220.32	8.35	12.35	255.3
08/29 10:14:28	126.99	223.32	9.32	13.24	254.7
08/29 10:14:29	127.98	220.32	8.82	13.53	253.6
08/29 10:14:30	128.98	219.32	9.24	13.55	253.8
08/29 10:14:31	127.98	221.32	10.23	13.34	252.4
08/29 10:14:32	127	220.32	10.72	12.92	251.7
08/29 10:14:33	128.99	223.31	9.54	12.87	252.3
08/29 10:14:34	125.98	220.31	7.36	13.11	252.9
ESC or SPACE to exit					

## Display Digital Inputs

Use this screen to view the current open/closed status of all digital inputs. The information also displays in the touchscreen. See [I/O Digital Screen](#) for more information.

To open the Real-Time Digital Inputs screen:

- From the Home Menu, select **D - Real-Time Display Menu > I - Display Digital Inputs**.



**NOTE:** Descriptive labels can be assigned to digital inputs using the Configure Digital I/O menu in the Configuration Menu (see [Edit Digital Input or Output Labels](#)). A log of input line status changes can be found in the Status Menu (see [Line Change Log Menu](#)).

ESC 8864 v5.00.r21 ID:01		Real-Time Digital Inputs		01/06/16 15:22:18
UNIT ONLINE	(01) = OPEN	PM IN FAULT	(17) = CLOSED	
LO EDUCATOR VAC (NC)	(02) = OPEN	PM IN STANDBY	(18) = OPEN	
LO INST AIR PRES(NC)	(03) = OPEN	PM INVALID DATA	(19) = OPEN	
LO HSL TEMP (NC)	(04) = OPEN	PM IN MAINTENANCE	(20) = OPEN	
LO PROBE TEMP (NC)	(05) = OPEN	PM LOW FILTER TAPE	(21) = OPEN	
LO STRAW TEMP (NC)	(06) = OPEN	PM IN CALIBRATION	(22) = OPEN	
spare	(07) = OPEN	PM IN L BETA ZERO CAL	(23) = OPEN	
ID FAN ON	(08) = OPEN	PM IN R BETA ZERO CAL	(24) = OPEN	
spare	(09) = OPEN	PM IN L HEAD SPAN CAL	(25) = OPEN	
INT CHECK FAIL	(10) = OPEN	PM IN R HEAD SPAN CAL	(26) = OPEN	
FLOW IN ZERO	(11) = OPEN	PM IN DIL FLW LOSPAN	(27) = OPEN	
FLOW IN SPAN	(12) = OPEN	PM IN WET FLW LOSPAN	(28) = OPEN	
FLOW IN FAULT (NC)	(13) = OPEN	PM IN DIL FLW HISPAN	(29) = OPEN	
OPACITY ZERO	(14) = OPEN	PM IN WET FLW HISPAN	(30) = OPEN	
OPACITY SPAN	(15) = OPEN	SPARE	(31) = OPEN	
OPACITY FAULT (NC)	(16) = OPEN	SPARE	(32) = OPEN	

Exit=ESC or SPACE, Next page=PgDn or CTRL-N, Prev page=PgUp or CTRL-P

## Display Digital Outputs

This report allows the current status of all digital outputs to be viewed. The report is similar in form to the real-time [Display Digital Inputs](#), except the digital outputs display also allows the user to manually switch lines ON and OFF. Information can also be viewed from the touchscreen. See [I/O Digitals Screen](#) for more information.

To open the Real-Time Digital Outputs screen:

- From the Home Menu, select **D - Real-Time Display Menu > O - Display Digital Outputs**.

ESC 8864 v5.00.r21 ID:01		Real-Time Digital Outputs		01/06/16 15:32:39
=>CV1	(01) = OPEN	CEMS EXCES EMISS(NC)	(17) = CLOSED	
CV2	(02) = OPEN	NOX HI SELECTED	(18) = OPEN	
CV3	(03) = OPEN	SO2 HI SELECTED	(19) = OPEN	
CV4	(04) = OPEN	CO HI SELECTED	(20) = OPEN	
CV5	(05) = OPEN	START PM BETA CAL	(21) = OPEN	
CV6	(06) = OPEN	START PM FLOW CAL	(22) = OPEN	
CV7	(07) = OPEN	SO2 LO CAL BYPASS	(23) = OPEN	
CV8	(08) = OPEN	CV10 CAL LINE PURGE	(24) = OPEN	
CV9	(09) = OPEN	SPARE	(25) = OPEN	
SDV - SAMPLE DIVERT	(10) = CLOSED	SPARE	(26) = OPEN	
BFV - BACK FLUSH	(11) = CLOSED	SPARE	(27) = OPEN	
CEMS FAULT (NC)	(12) = OPEN	SPARE	(28) = OPEN	
CEMS IN CAL (NC)	(13) = CLOSED	SPARE	(29) = OPEN	
CEMS CAL FAIL (NC)	(14) = OPEN	SPARE	(30) = OPEN	
START FLOW CAL	(15) = OPEN	SPARE	(31) = OPEN	
START OPACITY CAL	(16) = OPEN	SPARE	(32) = OPEN	

Exit=ESC or SPACE, C=Close, O=Open, Next Page=CTRL-N, Prev Page=CTRL-P

To open or close an output:

- Place the arrow => next to the desired control output line number using the arrow keys or by typing the two-digit relay number.
- Press the <O> key to open the selected relay, or press the <C> key to close the selected relay, regardless of whether that output has been configured normally open or normally closed.
- Press <Enter> to toggle the state of the selected relay. Closed relays remain highlighted until opened again.



**NOTE:** Descriptive labels can be assigned to digital outputs using the Configure Digital I/O Menu in the Configuration Menu (see [Edit Digital Input or Output Labels](#)). The default state of digital outputs, normally open or normally closed, can also be configured there.

## Display Analog Outputs



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This display shows the status of all analog current outputs. The name of the channel whose value is being driven out of the analog output is displayed to the left of the analog output number.

To open the Analog Outputs Settings screen:

- From the Home Menu, select **D - Real-Time Display Menu > A - Analog Outputs**.

ESC 8864 v5.02.r25 ID:88		Analog Outputs Settings		12/11/17 09:44:40	
(AO01)=	0.0000 mA	(PO17)=	0.0000 mA		
(AO02)=	0.0000 mA	(PO18)=	0.0000 mA		
(AO03)=	0.0000 mA	(PO19)=	0.0000 mA		
(AO04)=	0.0000 mA	(PO20)=	0.0000 mA		
(AO05)=	0.0000 mA	(PO21)=	0.0000 mA		
(AO06)=	0.0000 mA	(PO22)=	0.0000 mA		
(AO07)=	0.0000 mA	(PO23)=	0.0000 mA		
(AO08)=	0.0000 mA	(PO24)=	0.0000 mA		
(PO09)=	0.0000 mA	(PO25)=	0.0000 mA		
(PO10)=	0.0000 mA	(PO26)=	0.0000 mA		
(PO11)=	0.0000 mA	(PO27)=	0.0000 mA		
(PO12)=	0.0000 mA	(PO28)=	0.0000 mA		
(PO13)=	0.0000 mA	(PO29)=	0.0000 mA		
(PO14)=	0.0000 mA	(PO30)=	0.0000 mA		
(PO15)=	0.0000 mA	(PO31)=	0.0000 mA		
(PO16)=	0.0000 mA	(PO32)=	0.0000 mA		
--- ESC or SPACE to exit, CTRL-N for Next Page, CTRL-P for Prev ---					

## Display Math Constants

Selecting the option Display Math Constants in the [Real-Time Display Menu](#) screen displays the Real-Time Math Constants screen shown below. Use this new screen to view real-time values of math constants as they are used in any equation calculation. The screen updates the display of real-time math constant values once every second.

To display the following screen, select **D-Real-Time Display Menu > K-Display Math Constants**.

ESC 8864 v6.02r53 ID:01		Real-Time Math Constants		01/12/22 15:24:11	
Constant K1 =	0	Constant K17 =	0		
Constant K2 =	0.01512	Constant K18 =	0		
Constant K3 =	1800	Constant K19 =	0		
Constant K4 =	2.6	Constant K20 =	0		
Constant K5 =	70.034	Constant K21 =	0		
Constant K6 =	5.23	Constant K22 =	82.56		
Constant K7 =	1.24	Constant K23 =	0		
Constant K8 =	6.2	Constant K24 =	1681.3		
Constant K9 =	3.2	Constant K25 =	0		
Constant K10 =	0	Constant K26 =	86.5		
Constant K11 =	0.9749	Constant K27 =	87.482		
Constant K12 =	0	Constant K28 =	525.64		
Constant K13 =	0.3156	Constant K29 =	0		
Constant K14 =	1	Constant K30 =	19.2		
Constant K15 =	1	Constant K31 =	0		
Constant K16 =	1	Constant K32 =	0.8564		
ESC=Exit, CTRL-N=Next Page, CTRL-P=Prev Page					



# Report Generation Menu

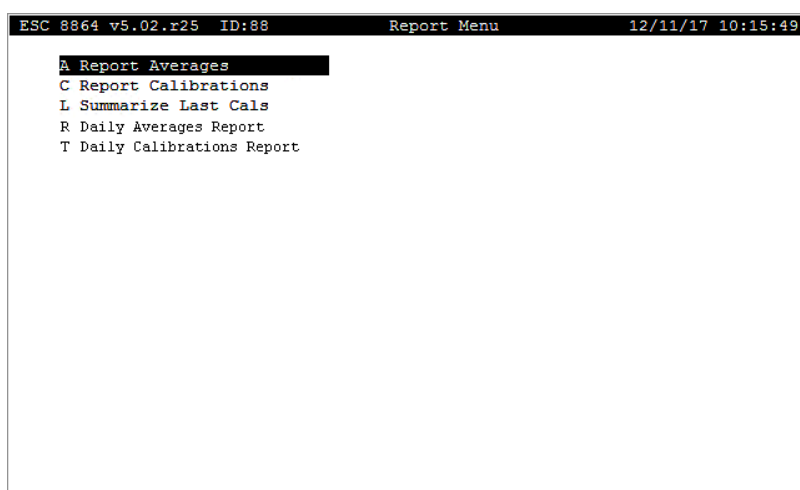


**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Report Menu is used to generate reports of historical (stored) data.

To display the Report Menu:

- From the Home Menu, select **R - Report Generation Menu**.



A brief description of each item in the Real-Time Display Menu is provided in the next table. For a detailed description, click the hyperlink in the *To Option* column.

Hot Key	To Option	Purpose
A	<a href="#">Report Averages</a>	Report averages for one or more selected channels
C	<a href="#">Report Calibrations</a>	Report results of a selected calibration program for one channel
L	<a href="#">Summarize Last Calibrations</a>	Display results of the most recent run of all calibration programs for all channels
R	<a href="#">Daily Averages Report (Optional)</a>	(Optional) Report hourly average data and summary data for the previous day
T	<a href="#">Daily Calibrations Report (Optional)</a>	(Optional) Report calibration data for the previous day



Reports can be viewed on screen or printed. If an attempt is made to print a report when there is no printer attached to the 8864 Data Controller, an error message is generated.

Key commands available for use when viewing reports on screen are described in the following table.

Key Command	Action
Right Arrow Key	Shifts report to the right, removing the first parameter or calibration phase and bringing the next parameter or phase into view.
Left Arrow Key	Shifts report to the left, removing the last parameter or calibration phase and bringing the previous parameter or phase into view.
Shift-Right Arrow or <R>	Shifts report to the right one page, removing the displayed parameters or calibration phases and bringing the next group of parameters or phases into view.
Shift-Left Arrow or <L>	Shifts report to the left one page, removing the displayed parameters or calibration phases and bringing the previous group of parameters or phases into view.
Down Arrow Key	Scrolls report vertically forward one record.
Up Arrow Key	Scrolls report vertically backward one record.
Shift-Down Arrow or <D>	Scrolls report vertically forward one page (24 data points or calibration records).
Shift-Up Arrow or <U>	Scrolls report vertically backward one page (24 data points or calibration records).

## Report Averages



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This selection is used to report blocks of averages for several parameters. All averages in a single report must have the same averaging interval (e.g., 5-minute data for SO<sub>2</sub> and hourly data for NO<sub>x</sub> cannot be displayed on the same report).

To open the Report Averages screen:

- From the Home Menu, select **R - Report Generation Menu > A - Report Averages**.

```

ESC 8864 v5.00.r21 ID:01      Report Averages Screen      01/06/16 16:17:39

Average Interval      : 1h
Show Channels         : COALFLOW,GASFLOW,UNITLOAD,PM,PM_RIGHT,PM_DIL
                      : FL,PM_WETFL,PM_PS11C,ORIFPRES,MASSFLOW,FLOW,
                      : FLOWTEMP,FLOWVEL,INTCHK,UNITOPHR,PM#/MW,DR_C
                      : ORR,PRCO2,PRCOLO,PRCOHI,PRNOXLO,PRNOXHI,PRSO
                      : 2LO,PRSO2HI,CO2,COLOW,COHIGH,NOXLOW,NOXHIGH,
                      : SO2LOW,SO2HIGH,FLOWSCFH,FFACTOR,
Start Time            : 01/06/16 00:00:00
# of Flags to Report  : 02
Use Decimal Positioner? : N
View On Screen

```

The following information provides a description of the fields in the Report Averages screen.

## Average Interval

The averaging interval to be reported. For rolling average channels, the Input Avg Interval should be entered (the rate at which rolling averages are stored). 0 to 999 s, m, h, or d (for seconds, minutes, hours, or days, respectively).

## Show Channels

The channel(s) to be displayed. Any configured channel name(s), up to 255 characters. ALL selects all channels configured with the Average Interval selected above. A maximum of 5 channels can be displayed at one time, depending on the value entered for the # of Flags to Report.

## Start Time

Date and time of the first data point to report; MM/DD/YY HH:MM:SS (in military format).

## # of Flags to Report

The maximum number of data validation flags that will be displayed with each average value.

00 to 32. Default=02.

## Use Decimal Positioner?

Y(es) or N(o). If Y, the decimal positioner configured for the channel will be used to format the displayed data. If N, the full precision of the data will be displayed. Default=N.

## View on Screen

Press **<Enter>** at this field to view the report on screen.

<b>Example of Average Report</b>					
TIME	SO2	NOX	CO2	OPACITY	FLOW
08/14 00:00	127.99	220.32	8.35	12.35	255.3
08/14 01:00	126.99	223.32	9.32	13.24	254.7
08/14 02:00	127.98	220.32	8.82	13.53	253.6
08/14 03:00	128.98	219.32	9.24	13.55	253.8
08/14 04:00	127.98	221.32	10.23	13.34	252.4
08/14 05:00	127	220.32	10.72	12.92	251.7
08/14 06:00	128.99	223.31	9.54	12.87	252.3
08/14 07:00	125.98	220.31	7.36	13.11>C	252.9>C
08/14 08:00	128.97>C	225.31>C	8.04>C	13.33	254.1
08/14 09:00	127.96	220.31	8.59	13.49	254.3
08/14 10:00	127.95	222.31	10.92	13.62	255.0
08/14 11:00	128.95	220.3	9.81	13.73	255.1
08/14 12:00	127.94	221.3	9.8	14.1	249.7
08/14 13:00	127.99	220.32	8.35	14.35	255.3
08/14 14:00	126.99	223.32	9.32	15.24	254.7
08/14 15:00	127.98<M	220.35<M	8.82<M	17.53	253.6
08/14 16:00	128.98	219.32	9.24	18.55	253.8
08/14 17:00	127.98	221.32	10.23	20.34H	252.4
08/14 18:00	127	220.32	10.72	20.92H	251.7
08/14 19:00	128.99	223.31	9.54	19.87	252.3
08/14 20:00	125.98	220.31	7.36	15.11	252.9
08/14 21:00	-9999.<N	-9999.<N	-9999.<N	-9999.<N	-9999.<N

Data reports use the following flags and symbols to indicate information about data points:

- **>C** - Indicates the value is a valid average, but at least one reading that should have been used in the calculation of the average was invalid for some reason; the reason is indicated by the validation flag following the > (in this case, **C** for calibration).
- **<M** - Indicates the value failed the test for valid data because too many readings that should have been used in the calculation were invalid for some reason; the reason is indicated by the flag following the < (in this case, **M** for maintenance). The validity test is either the simple percentage test or the EPA Clean Air Act validation (see [Valid Average Determination](#)).
- **-9999.<N** - Indicates the data point has not been calculated. In this case, the report time is past the current time.

## Report Calibrations



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To open the Report Calibrations screen:

- From the Home Menu, select **R - Report Generation Menu > C - Report Calibrations**.

```

ESC 8864 v5.00.r21 ID:01 Report Calibrations Screen 01/05/16 17:05:34
Cal Sequence Name      : FLOW1E
Data Channel           : (none)
Start Time             : 01/04/16 17:00:00
View On Screen
  
```

The following information provides a description of the fields in the Report Calibrations screen.

### Cal Sequence Name

The name of the calibration sequence to be reported. (Only one calibration sequence can be reported at a time.)

### Data Channel

The data channel to be reported. Any configured channel name, up to 17 characters total.

### Starting Time

Date and time of the first calibration results to report. MM/DD/YY HH:MM:SS (in military format).

### View on Screen

Press **<Enter>** at this field to view the report on screen.

## Example of Calibration Report

```

GASCAL, NOX
---ZERO--- ---SPAN--- ---FLAGS-----
mm/dd/yy hh:mm:ss -0.7572 872.3 D
mm/dd/yy hh:mm:ss -0.7601 897.3
mm/dd/yy hh:mm:ss -0.7738 916.8 F<
mm/dd/yy hh:mm:ss -0.738 894.9 F<
mm/dd/yy hh:mm:ss 0.3361 922.6
mm/dd/yy hh:mm:ss 0.3452 916.5
mm/dd/yy hh:mm:ss 0.3351 958.6 DO
mm/dd/yy hh:mm:ss 0.2887 922
mm/dd/yy hh:mm:ss -0.784 900.1
mm/dd/yy hh:mm:ss 0.3195 890

SCROLL: Arrows. Page: U/D/R/L Keys/Shift-Arrows. Refresh: F2. Exit:<SPACE>/<ESC>

```

## Summarize Last Calibrations



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This selection displays the results of the most recent run of each calibration program. Use the up and down arrow keys to scroll the screen and view additional phases. This report cannot be printed and does not require any setup information.

To display the Summarize Last Cals report:

- From the Home Menu, select **R - Report Generation Menu > L - Summarize Last Cals**.

The next figure shows an example of the Summarize Last Cals report.

```

GASCAL1E 01/06 11:41 -EXPECTED- --ACTUAL-- --ERROR-- -UNITS-- -----FLAGS-----
CO2
    PHASE1      17.84      0      17.8 PERCENT F<
    PHASE2       0        0      0 PERCENT
COLOW
    PHASE1       0        0      0 % F<
    PHASE2     181.8      0     90.9 %
COHIGH
    PHASE1       0        0      0 % F<
    PHASE3     889.2      0     88.9 %
NOXLOW
    PHASE1       0        0      0 PPM F<
    PHASE2     90.97      0     91 PPM
NOXHIGH
    PHASE1       0        0      0 % F<
    PHASE3     731.6      0     91.5 %
SO2LOW
    PHASE1       0        0      0 PPM F<
    PHASE2     89.87      0     89.9 PPM
SO2HIGH
    PHASE1       0        0      0 % F<
    PHASE3     5346      0     89.1 %

```

## Daily Averages Report (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Daily Averages Report is used to generate a 24 hour record of 1 hour averages to the screen.

To open the Daily Averages Report screen:

- From the Home Menu, select **R - Report Generation Menu > R - Daily Averages Report**.

```

ESC 8864 v5.xx ID:49   Daily Report Screen   mm/dd/yy hh:mm:ss

Show Channels          :   SO2,NOX,CO2

Start Time             :   mm/dd/yy hh:mm:ss
# of Flags to Report   :   02
Daily Report to screen :
  
```

The following information provides a description of the fields in the Daily Averages Report screen.

### Show Channel(s)

The channel(s) to be reported. Any configured channel name(s), with an average interval of 1h with storage (up to 255 characters). ALL selects all configured channels meeting this criteria.

### Start Time

Date and time of the start of the report. MM/DD/YY HH:MM:SS (in military format).

### # of Flags to Report

The maximum number of data validation flags that will be displayed with each average value. 00 to 32. Default=02.

### Daily Report on Screen

Press <Enter> at this field to view the report on screen.

## Example of Daily Average Report (displayed)

Daily Average Report	mm/dd/yy hh:mm:ss	EST JDay: 226	Logger ID: 49
	ESC 8864	Station ID: A01	
Name:	SO2	NOX	CO2
Channel Num:	1	2	3
Analog Input:	1	2	3
Units:	PPM	PPM	PERCENT
Full Scale:	N/A	N/A	N/A
High Output:	500.0	1000.0	20.0
Low Output:	0.0	0.0	0.0
08/14 00:00	128.0	220.7	8.4
08/14 01:00	127.2	223.3	9.3
08/14 02:00	128.3	220.1	8.8
08/14 03:00	127.7	219.3	9.2
08/14 04:00	128.1	221.5	10.2
08/14 05:00	126.5	219.3	10.7
08/14 06:00	129.2	217.4	9.5
08/14 07:00	124.6	215.6	7.4
Minimum:	121.1	214.4	7.4
Maximum:	197.6<M	305.6<M	13.8<M
Average:	131.2<M	224.9<M	9.5<M

## Daily Calibrations Report (Optional)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Daily Calibrations Report is used to generate a report of the most recent run of each selected calibration for the date specified. The report displays on screen.

To open the Daily Cal Report screen:

- From the Home Menu, select **R - Report Generation Menu > T - Daily Calibrations Report**.

ESC 8864 v5.xx ID:49		Daily Cal Report Screen		mm/dd/yy hh:mm:ss
Show Cal(s)	:	GASCAL, FLOWCAL		
Start Date	:	mm/dd/yy		
View On Screen				

The following information provides a description of the fields in the Daily Averages Report screen.

### Show Cal(s)

The calibration(s) to be reported. Any configured calibration name(s), (up to 255 characters).

ALL selects all configured calibrations.

## Start Date

Starting date of the report. MM/DD/YY.

## View on Screen

Pressing <Enter> at this field displays the report on the screen.

## Example of Daily Calibration Report

Daily Calibration Report		mm/dd/yy	hh:mm:ss	EST	JDay: 226	Logger ID: 49
		ESC 8864			Station ID: A01	
-----						
Cal Sequence: GASCAL		Start Time: 08/14 08:00				
Ch	Name		ZERO	SPAN	FLAGS	
-----						
1	SO2	Act	-0.2	427.3	D	
		Exp	0	450.3		
		Err	0	4.6		
2	NOX	Act	0.3	890		
		Exp	0	905.1		
		Err	0	1.5		
3	CO2	Act	0	18.5		
		Exp	0	18.4		
		Err	0	0.1		
-----						
Cal Sequence: FLOWCAL		Start Time: 08/14 07:20				
Ch	Name		ZERO	SPAN	FLAGS	
-----						
5	FLOW	Act	3.7	249.7		
		Exp	0	255.2		
		Err	1.2	1.8		





# Status Menu



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Status Menu provides historical logs of various system occurrences, a report of current calibrations, and other system information and diagnostics.

To display the Status Menu:

- From the Home Menu, select **S - Status Menu** (hot key **S**) to display the following screen.

```
ESC 8864 v6.02r54 ID:01      Logger Status Menu      01/16/22 10:45:13

P Power Fail Menu
L Line Changes Log Menu
M Message Menu
A Alarm Status/Log
C Report Current Cal Status
1 Display Status of Single Cal
V View Modbus Master Status
I System Information
D Dump Setup(s)
U Reboot
S System Maintenance
T View Secure Comm Status
```

## Related Topics:

- [Power Fail Menu](#)
- [Line Change Log Menu](#)
- [Message Menu](#)
- [Alarm Status / Log](#)
- [Report Current Cal Status](#)
- [Display Status of Single Cal](#)
- [View Modbus Master Status](#)
- [System Information](#)
- [Dump Setup\(s\)](#)

- [Reboot](#)
- [System Maintenance](#)

## Power Fail Menu

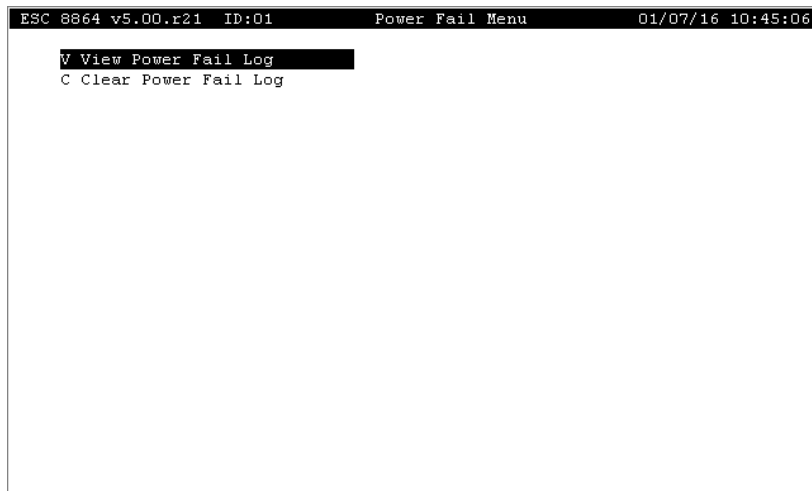


**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Power Fail Menu allows you to display, print, and erase the log of power failures recorded by the 8864.

To display the Power Fail Menu:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **P - Power Fail Menu** (hot key **P**).



The following information provides a description of the selection in the Power Fail Menu:

- **V - View Power Fail Log** (hot key **V**): Displays a log of power failures.
- **C - Clear Power Fail Log** (hot key **C**): Erases all power failure entries from the log. (Power failures are stored in a circular buffer and will automatically roll over after storing 48 power failures.)

Selecting **V - View Power Fail Log** (hot key **V**) displays a screen similar to the next example.

For each line of data, the first time shown is the time that power was lost, such as 01/06/16 11:21:14 in the example below. The second time shown after the arrow (=>) is the time that power was restored to the 8864 Data Controller, such as 01/06/16 11:21:26.

The date/time of a power failure is taken from the internal clock. If the date/time has not been

set or if the battery has failed, the date/time information may be incorrect.

```
ESC 8864 v5.00.r21 ID:01 Power Failures Log: Page 1 01/07/16 10:46:57

01/06/16 11:21:14=> 01/06/16 11:21:26
01/03/16 06:58:40=> 01/03/16 06:58:46
01/02/16 21:22:40=> 01/02/16 21:22:46
01/01/16 07:31:09=> 01/01/16 07:31:17
01/01/16 03:30:22=> 01/01/16 03:30:30
12/31/15 01:05:58=> 12/31/15 01:06:04
12/29/15 10:13:38=> 12/29/15 10:13:43
12/23/15 20:42:07=> 12/23/15 20:42:20
12/21/15 18:36:49=> 12/21/15 18:36:54
12/21/15 17:39:40=> 12/21/15 17:39:46
12/20/15 05:22:46=> 12/20/15 05:22:52
12/15/15 13:19:40=> 12/15/15 13:19:46
12/14/15 23:03:30=> 12/14/15 23:03:35
12/14/15 21:44:31=> 12/14/15 21:44:37
12/11/15 16:51:21=> 12/11/15 16:52:20
12/09/15 17:18:21=> 12/09/15 17:18:26
12/09/15 13:54:28=> 12/09/15 14:08:57

--- ESC or SPACE to exit, CTRL-N = next page ---
```

## Line Change Log Menu



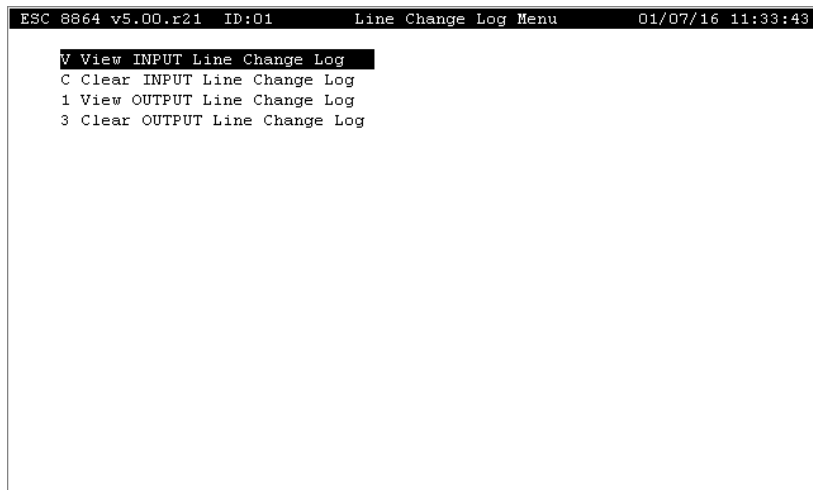
**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The 8864 adds an entry in the log each time a transition occurs in an input status or output control line. The log supports up to 10 times as many entries as in previous firmware versions of the 8864.

Selections in the Line Change Log Menu allow you to display, print, and erase the log of digital input transitions recorded by the 8864. Information in the log includes the date and time of the transition and whether the transition was on-to-off or off-to-on.

To display the Line Change Log Menu:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **L - Line Changes Log Menu** (hot key **L**).



Selections in the Line Change Log Menu include those in the following table.

Hot Key	Selection	Action
V	View INPUT Line Change Log	Displays a log of all digital input transitions with 1 indicating an active input state (on-to-off) and 0 indicating an inactive input state (off-to-on).  If you want to filter the display of log entries by a particular line number, press CTRL-E and then type a 3-digit line number.
C	Clear INPUT Line Change Log	Erases all input line transition entries from the log.  Input line changes are stored in a circular buffer and will automatically roll over after storing 120 transitions.
1	View OUTPUT Line Change Log	Displays the log of output line status changes, where 1 indicates a contact-closed output state and 0 indicates a contact-open output state.
3	Clear OUTPUT Line Change Log	Erases all output line transition entries from the log.  Output line changes are stored in a circular buffer and will automatically roll over after storing 120 transitions.

Selecting **V - View INPUT Line Change Log** (hot key **V**) or **1 - View OUTPUT Line Change Log** (hot key **1**) displays a screen similar to the next example. The time of the transition is listed first. Beside the time is the input/output number and a description of the transition that took place (old state => new state).

The screen automatically updates as new line changes are logged.

- Press <Ctrl-N> or <Ctrl-P> to go to the next and previous pages.
- Press <Ctrl-E> to filter the lines and only show a specific line of interest.
- Press <Ctrl-A> to return to showing all line changes.
- Press <Ctrl-U> to toggle the automatic update on and off.

ESC 8864 v5.02.r25 ID:1M Input Line Status Changes: Page 1 10/26/17 10:51:39											
10/26 08:01:06 #019 1=>0	10/25 08:06:40 #006 1=>0	10/24 08:01:06 #019 1=>0									
10/26 08:01:01 #019 0=>1	10/25 08:06:36 #006 0=>1	10/24 08:01:01 #019 0=>1									
10/26 04:01:06 #019 1=>0	10/25 08:06:18 #006 1=>0	10/24 04:01:06 #019 1=>0									
10/26 04:01:01 #019 0=>1	10/25 08:06:12 #006 0=>1	10/24 04:01:01 #019 0=>1									
10/26 00:01:06 #019 1=>0	10/25 08:01:06 #019 1=>0	10/24 00:01:06 #019 1=>0									
10/26 00:01:01 #019 0=>1	10/25 08:01:01 #019 0=>1	10/24 00:01:01 #019 0=>1									
10/25 20:01:06 #019 1=>0	10/25 04:01:06 #019 1=>0	10/23 20:01:06 #019 1=>0									
10/25 20:01:01 #019 0=>1	10/25 04:01:01 #019 0=>1	10/23 20:01:01 #019 0=>1									
10/25 19:00:11 #002 1=>0	10/25 00:01:06 #019 1=>0	10/23 19:00:11 #002 1=>0									
10/25 19:00:06 #002 0=>1	10/25 00:01:01 #019 0=>1	10/23 19:00:06 #002 0=>1									
10/25 19:00:06 #001 1=>0	10/24 20:01:06 #019 1=>0	10/23 19:00:06 #001 1=>0									
10/25 19:00:01 #001 0=>1	10/24 20:01:01 #019 0=>1	10/23 19:00:01 #001 0=>1									
10/25 16:01:06 #019 1=>0	10/24 19:00:11 #002 1=>0	10/23 16:01:06 #019 1=>0									
10/25 16:01:01 #019 0=>1	10/24 19:00:06 #002 0=>1	10/23 16:01:01 #019 0=>1									
10/25 12:01:06 #019 1=>0	10/24 19:00:06 #001 1=>0	10/23 12:01:06 #019 1=>0									
10/25 12:01:01 #019 0=>1	10/24 19:00:01 #001 0=>1	10/23 12:01:01 #019 0=>1									
10/25 08:07:49 #008 1=>0	10/24 16:01:06 #019 1=>0	10/23 08:01:06 #019 1=>0									
10/25 08:07:45 #008 0=>1	10/24 16:01:01 #019 0=>1	10/23 08:01:01 #019 0=>1									
10/25 08:06:45 #006 1=>0	10/24 12:01:06 #019 1=>0	10/23 04:01:06 #019 1=>0									
10/25 08:06:43 #006 0=>1	10/24 12:01:01 #019 0=>1	10/23 04:01:01 #019 0=>1									

CTRL-N next, CTRL-P prev, CTRL-A all, CTRL-E Line#, CTRL-U update on

## Message Menu



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

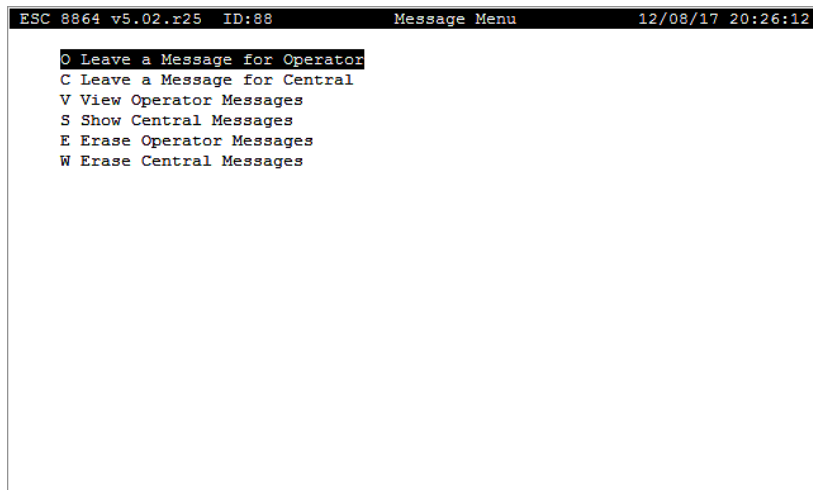
The 8864 keeps track of two different message buffers - one for messages to the operator, the other for messages to be polled by the central computer.

Each buffer can hold up to five messages (eight on an Ambient data logger) of up to 128 characters each, not counting the date/time tag. With this menu, you can leave messages, view messages, and erase the message log(s).

Also see [Typing Operator and Central Messages](#).

To display the Message Menu:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **M - Message Menu** (hot key **M**).



Selections available in the Message Menu include those in the following table.

Hot Key	Selection	Action
O	Leave a Message for Operator	Accesses the Operator Message screen where the message is typed.
C	Leave a Message for Central	Accesses the Central Message screen where the message is typed.
V	View Operator Messages	Displays messages sent to operators; only displays as many messages as will fit on one screen. Press any key to exit the display.
S	Show Central Messages	Displays messages sent to the central computer; only displays as many messages as will fit on one screen. Press any key to exit the display.
E	Erase Operator Messages	Erases all operator messages.
W	Erase Central Messages	Erases all central messages (if Supervisor access or higher).

## Typing Operator and Central Messages



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To type an operator or central message:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **M - Message Menu** (hot key **M**) to display the Message Menu.
2. Select **O - Leave a Message for Operator** (hot key **O**) or select **C - Leave a Message for Central** (hot key **C**).

```
ESC 8864 v5.02.r25 ID:88      Message Menu      12/08/17 20:26:12
O Leave a Message for Operator
C Leave a Message for Central
V View Operator Messages
S Show Central Messages
E Erase Operator Messages
W Erase Central Messages
```

3. Type the text to enter a message (use the backspace key to correct typing errors). Messages can be up to 128 characters long.
4. Press **<Enter>** to save the message and return to the Message Menu.

A time stamp is automatically appended to the message to indicate the date and time the message was created.

Messages are stripped of any special characters (such as @,!,& or \$) before messages are sent to the central computer. These characters are part of the polling protocol and cannot be sent as part of a message.

```
ESC 8864 v5.00.r21 ID:01      Operator Message Entry      01/07/16 11:45:32
Enter Operator Message      :
<ESCAPE> aborts message entry
```



## Alarm Status / Log

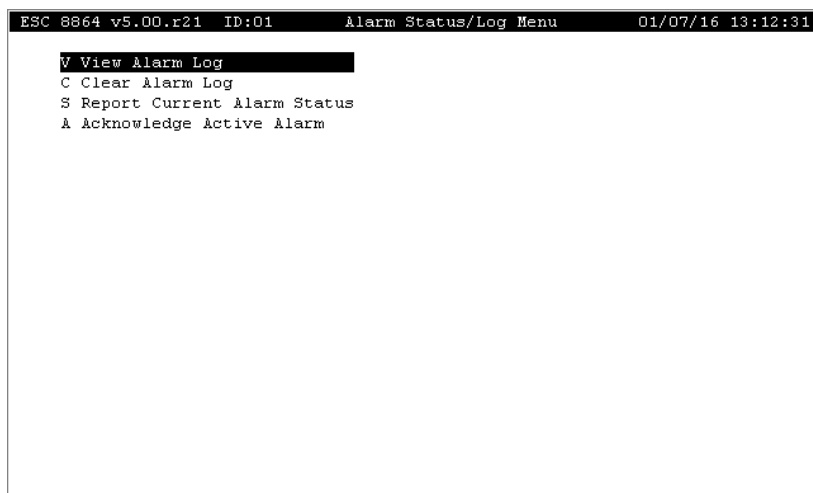


**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Alarm Status/Log Menu allows you to display, print, and erase the alarms log. The alarm log records the starting and ending times of an alarm as well as the reason code entered by the user. Active alarms are currently viewed and acknowledged using this menu.

To display the Alarm Status/Log screen:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **A - Alarm Status/Log Menu** (hot key **A**).



A brief description of each item in the Alarm Status/Log Menu is provided in the next table. For a detailed description, click the hyperlink in the *To Option* column.

Hot Key	To Option	Action
V	<a href="#">View Alarm Log</a>	Displays the alarm log.
C	Clear Alarm Log	Erases the entire alarm log.
S	<a href="#">Report Current Alarm Status</a>	Displays only currently active alarms.
A	<a href="#">Acknowledge Active Alarm</a>	Accesses the alarm acknowledgment utility.

### View Alarm Log

The Alarm Journal Log displays a log of up to three pages of the most recent alarms, both

active and expired. The log identifies the alarm program name, the date/time the alarm started, the channel and flag code(s) that triggered the alarm, and the current status of the alarm.

If there are multiple occurrences of the same alarm on different channels, only the first alarm is reported. If this is unsatisfactory, the alarm configuration must be modified (see [Enter New Alarm Program](#)).

To view the Alarm Journal Log:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **A - Alarm Status/Log** (hot key **A**).
2. Select **V - View Alarm Log** (hot key **V**).

## Report Current Alarm Status

Current alarms are active alarms where the alarm condition still exists and may or may not have been acknowledged. The Current Alarm Status screen shows the alarm program name, the date/time the alarm started, the channel and flag code(s) that triggered the alarm, and the current status of the alarm.

If there are multiple occurrences of the same alarm on different channels, only the first alarm is reported. If this is unsatisfactory, the alarm configuration must be modified (see [Enter New Alarm Program](#)).

To view the Current Alarm Status screen:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **A - Alarm Status/Log** (hot key **A**).
2. Select **S - Report Current Alarm Status** (hot key **S**).

```
ESC 8864 v5.xx ID:49 Current Alarm Status mm/dd/yy hh:mm:ss
ALARM:SO2HIGH Start:08/14 10:00 Source:SO2 Flags=H Status=ACTIVE
CAL ALARM:FLWDRIPT Start:08/14 07:25 Source:FLOW Status=ACKED(01)

--- ESC or SPACE to exit, CTRL-N = next page ---
```

## Acknowledge Active Alarm

Use this feature to manually acknowledge alarms. This is not to be confused with the “active” status of alarms; “active” means the condition that caused the alarm still exists.



**NOTE:** If multiple instances of an alarm exist and the logged alarm is acknowledged, all of the multiple instances are also acknowledged.

Acknowledgment of an alarm results in the configured digital output line(s) being deactivated (see [Enter New Alarm Program](#)).

To acknowledge an alarm:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **A - Alarm Status/Log** (hot key **A**).
2. Select **A - Acknowledge Active Alarm** (hot key **A**).
3. From Choose List of Active Alarms, select the alarm to acknowledge and then press **<Enter>**.
4. From Choose List of Reason Codes, select the reason code for the chosen alarm.

When **<Enter>** is pressed, the alarm status changes from “ACTIVE” to “ACKED(nn)” to indicate the alarm has been acknowledged. The reason code is shown in parentheses. (Reason codes are defined in the [Configure Alarms](#).)

## Report Current Cal Status



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The Current Calibration Status screen provides the following information:

- Displays the real-time status of all configured calibration programs. For any calibration that is currently running, the phase of the calibration that is active is shown along with the amount of time remaining in the phase (when known by the 8864). Automatic calibrations that are not currently running are shown with the next scheduled start-time listed. Other calibration types that are initiated by some external event are shown only as pending until they are actually in the process of running.
- The column labeled “Last” identifies valid, color-coded status conditions in order of precedence (see next screen example). The calibration status updates in real-time as each phase completes before the calibration finishes. See the next table and the related note about [color-coded status conditions](#).

“Last” Status Column Description	
Status / Color	Description
<b>Drift</b>	Drift / Yellow = last calibration phase completed with drift
<b>Abort</b>	Abort / Magenta = last calibration phase was aborted
<b>OOC</b>	OOC / Red = last calibration phase completed out-of-control

“Last” Status Column Description	
Status / Color	Description
	(OOC)
Pass	Pass / Green = last calibration phase completed with no OOC or drift
----	---- / White = no data recorded for calibration
<b>NOTES:</b> <ul style="list-style-type: none"> <li>• Abort overrides Drift. OOC overrides Abort.</li> <li>• Status conditions are color-coded when the option <a href="#">Enable Terminal Colors</a> is enabled in the <a href="#">General Setup</a> menu. When the option is disabled, status conditions display using white text on a black background. See <i>C-Configuration Menu &gt; S-Configure System Parameters &gt; G-General Setup</i>.</li> </ul>	

To display the Current Calibration Status screen:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **C - Report Current Cal Status** (hot key **C**).

```

ESC 8864 v6.00r40 ID:01 Current Calibration Status (1/12) 06/11/20 23:28:02
Sequence  Type      Status                                     Last
-----
DPCAL01   Auto      RECOVERY \ Aborted                         Fail
DPINT01   Auto      Runs at 06/12/20 04:31:00                  ----
DPARG01   Auto      Runs at 06/11/20 18:15:00                  ----
GASCAL01   Auto      ZERO (2m 50s left)                         Pass
GASLIN01   User      INACTIVE                                     3 of 3 left
GASPRG01   Auto      Runs at 06/11/20 19:31:00                  ----
HLLINCHK  User      INACTIVE                                     3 of 3 left
HGDAYCAL  Auto      Runs at 06/12/20 04:10:00                  ----
HGWKCHK   Auto      Runs at 06/18/20 04:12:00                  ----
PMCAL1    Auto      Runs at 06/12/20 06:03:00                  ----

--- ESC or SPACE to exit, CTRL-N Next, CTRL-P Previous ---

```

## Display Status of Single Cal



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Selecting Single Calibration Status displays the real-time status of one configured calibration program.

A real-time screen of information about the current calibration state displays when you select a calibration that is currently running. The phase of the calibration that is active is shown along with the amount of time remaining in the phase (when known by the 8864).

All affected parameters of the calibration also display along with the expected values for the current phase; the real-time readings; the real-time error from the expected values; the method of error calculation; the drift and OOC limits for the current phase; and the units for the error from the expected values. If the error from the expected values is greater than either the drift or OOC limits, the value displays in reverse video mode.

The next scheduled start time for automatic calibration types display when you select a calibration that is not currently running (or a pending message for other calibration types will display).

To display the status of a single calibration:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **1 - Display Status of Single Cal** (hot key **1**) and then select a particular cal to view.

GASCAL Auto SPAN (4m 19s left)								
Channel	Expected	Actual	Error	M	Drift	OOC	Units	
SO2	450.3	427.3	4.6	S	2.5	5	%	
NOX	905.1	890	1.5	S	2.5	5	%	
CO2	18.37	18.49	0.1	D	0.5	1	PERCENT	

## View Modbus Master Status



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This selection allows you to view the Modbus Client Table, Server Table, Modbus Client Cfg (configuration) file, and enable or disable Modbus Client Devices.

To display the Modbus Master Status Menu:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).

```

ESC 8864  v5.04r12  ID:01  Modbus Master Status Menu  06/21/18 17:34:24

T View Modbus Client Table
C View Modbus Client Cfg File
S View Modbus Server Table
E Enable Modbus Client Devices
D Disable Modbus Client Devices
M Modbus TCPdump
V Modbus Command Monitor

```

A brief description of each item in the Alarm Status/Log Menu is provided in the next table. For a detailed description, click the hyperlink in the *To Option* column.

Hot Key	To Option	Action
T	<a href="#">View Modbus Client Table</a>	Displays the table selection form.
C	<a href="#">View Modbus Client Cfg File</a>	Displays the file selection form.
S	<a href="#">View Modbus Server Table</a>	Displays the table selection form.
E	<a href="#">Enable Modbus Client Devices</a>	Re-enables Ethernet and/or serial devices that were previously disabled.
D	<a href="#">Disable Modbus Client Devices</a>	Disables Ethernet and/or serial devices.
M	<a href="#">Modbus TCPdump</a>	Displays the Modbus commands and responses that are occurring on the Ethernet ports.
V	<a href="#">Modbus Command Monitor</a>	Displays incoming commands received from a user-selected MB-RTU serial port or Ethernet Modbus Server port.

## View Modbus Client Table

To view registers in the Modbus Client Table:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).
2. Select **T - View Modbus Client Table** (hot key **T**) to display the Modbus Master Table Menu.

```

ESC 8864 v5.02.r9 ID:88 Modbus Master Table Menu 10/17/16 16:16:29

Register          : 100
View Table
  
```

3. Type a register number in the **Register** field and then press <Enter> two times. A screen with the resulting address displays similar to one shown in the next example.

```

ESC 8864 v5.02.r9 ID:88 Modbus Client Table 10/17/16 16:16:04

00100: 0000 0000 0000 0000 0000 0000 0000 0000
00108: 0000 0000 0000 0000 0000 0000 0000 0000
00116: 0000 0000 0000 0000 0000 0000 0000 0000
00124: 0000 0000 0000 0000 0000 0000 0000 0000
00132: 0000 0000 0000 0000 0000 0000 0000 0000
00140: 0000 0000 0000 0000 0000 0000 0000 0000
00148: 0000 0000 0000 0000 0000 0000 0000 0000
00156: 0000 0000 0000 0000 0000 0000 0000 0000
00164: 0000 0000 0000 0000 0000 0000 0000 0000
00172: 0000 0000 0000 0000 0000 0000 0000 0000
00180: 0000 0000 0000 0000 0000 0000 0000 0000
00188: 0000 0000 0000 0000 0000 0000 0000 0000
00196: 0000 0000 0000 0000 0000 0000 0000 0000
00204: 0000 0000 0000 0000 0000 0000 0000 0000
00212: 0000 0000 0000 0000 0000 0000 0000 0000
00220: 0000 0000 0000 0000 0000 0000 0000 0000

Press any key to continue.
  
```

## View Modbus Client Cfg File

To view the Modbus client configuration file:

1. From the Home Menu, select **S-Status Menu > V-View Modbus Master Status > C-View Modbus Client Cfg File**.
2. Use the following shortcut keys to browse/scroll the displayed file. These are also listed in the legend at the bottom of the screen:
  - **U**: Move the display up one page at a time.
  - **D**: Move the display down one page at a time.
  - **L**: Move the display left one page at a time.
  - **R**: Move the display right one page at a time.
  - **Left Arrow Key**: Move the display to the left one character at a time.
  - **Right Arrow Key**: Move the display to the right one character at a time.
  - **Up Arrow Key**: Move the display up one line at a time.
  - **Down Arrow Key**: Move the display up one line at a time.
3. Press the <ESC> key to exit the screen and return to the [Modbus Master Status Menu](#).

**NOTE:** Shortcut keys are also listed in the topic [Modbus Client Cfg File Shortcuts](#).

```

ESC 8864 v6.02r53 ID:01 Modbus Client Config File 01/11/22 16:50:37

# SERVER.CFG
#
# This is an example configuration file for the 8864 Modbus Master.
#
# COMPANY : ESC
# DATE : 2017-03-15
# CONTROLLER: LOG01 - SPTSERV34
[Module]
Module Name : 8832-Modbus-Master
# This section is used to define the configuration for the master.
#
[8864 Client 0]
Minimum Command Delay : 100 #Minimum number of msec's between commands
Response Timeout : 2000 #Response message timeout (0-65535 mSec)
Retry Count : 0 #Response failure retry count
Float Flag : No #Use floating-point data type Y=Yes, N=No
Float Start : 7000 #Register offset in message for floats
Float Offset : 2000 #Internal Address for floats
Run in parallel : Y
[8864 Client 0 Commands]

ESC=Exit, U=Scroll Up, D=Scroll Down, L=Scroll Left, R=Scroll Right

```

## View Modbus Server Table

To display the Modbus Server Table Menu:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).



2. Select **S - View Modbus Server Table** (hot key **S**).

```

ESC 8864 v5.00.r21 ID:01 Modbus Server Table Menu 01/07/16 14:29:02
Address : 200
View Table

```

3. Type a register number in the **Address** field and then press **<Enter>** two times. A screen displays similar to one shown in the next example.

```

ESC 8864 v5.00.r21 ID:01 Modbus Server Table 01/07/16 14:29:22

40201: 00000 08208 08208 08208 00000 08208 08208 08192
40209: 08192 08208 08208 08208 08192 08208 00000 08208
40217: 08192 12290 12290 12290 12290 12290 12290 12290
40225: 12290 12290 12290 12290 12290 12290 00000 12290
40233: 12290 12290 12290 12290 12290 00000 00000 00000
40241: 12306 00000 12322 12322 12322 12338 12338 08208
40249: 12306 12306 12338 12338 00000 00000 12322 12338
40257: 12338 12290 12306 12322 12338 12338 12338 12290
40265: 12290 00000 00000 00000 00000 00000 00000 00000
40273: 00000 00000 00000 00000 00000 63036 00000 00000
40281: 00000 00000 00000 00000 00000 00000 00000 00000
40289: 00000 00000 00000 00000 00000 00000 00000 00000
40297: 00000 00000 00000 00000 00000 00000 00000 00000
40305: 00000 00000 00000 00000 00000 00000 00000 00000
40313: 00000 00000 00000 00000 00000 00100 00000 00000
40321: 00000 00000 00000 00000 00000 00000 00000 00000

Press any key to continue.

```

## Enable Modbus Client Devices

To enable an Ethernet or serial Modbus client device:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).
2. Select **E - Enable Modbus Client Devices** (hot key **E**) to display the Modbus Devices Menu.

```
ESC 8864 v5.00.r21 ID:01 Modbus Enable Devices Menu 01/07/16 15:05:29
E Enable Ethernet Devices
S Enable Serial Devices
```

3. Select either **E - Enable Ethernet Devices** (hot key **E**) or **S - Enable Serial Devices** (hot key **S**).

A list of available client devices will display as shown in the next examples.

*Example of Ethernet Client Devices:*

```
ESC 8864 v5.xx ID:49 Choose <Space Toggle/Enter Select> mm/dd/yy hh:mm:ss
192.168.7.161
192.168.7.162
```

*Example of Serial Client Devices:*

```
ESC 8864 v5.xx ID:49 Choose <Space Toggle/Enter Select> mm/dd/yy hh:mm:ss
108
128
```

4. Use the up/down arrow keys on your keyboard to navigate the list. To select or deselect a device, highlight the device name and then press the **spacebar**.

An indicator (>) displays next to a selected device name. You can also press <Ctrl><A> to select all device names in the list or <Ctrl><D> to deselect any selected device names.

5. Press <Enter> to enable selected devices. They are removed from the list once they are enabled. If you want to exit without enabling any devices, press <Esc>.



**IMPORTANT:** Take caution not to press the <Enter> key when exiting, or the first device highlighted in the list will be enabled. See [Disable Modbus Client Devices](#) for a list of devices that are currently enabled.

## Disable Modbus Client Devices

To disable an Ethernet or serial Modbus client device:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).
2. Select **D - Disable Modbus Client Devices** (hot key **D**) to display the Modbus Devices Menu.

```
ESC 8864 v5.00.r21 ID:01 Modbus Disable Devices Menu 01/07/16 15:18:53
E Disable Ethernet Devices
S Disable Serial Devices
```

3. Select either **E - Disable Ethernet Devices** (hot key **E**) or **S - Disable Serial Devices** (hot key **S**).

A list of enabled devices will display as shown in the next examples.

*Example of Ethernet Client Devices:*

```
ESC 8864 v5.xx ID:49 Choose <Space Toggle/Enter Select> mm/dd/yy hh:mm:ss
192.168.7.161
192.168.7.162
```

*Example of Serial Client Devices:*

```
ESC 8864 v5.xx ID:49 Choose <Space Toggle/Enter Select> mm/dd/yy hh:mm:ss
108
128
```

4. Use the up/down arrow keys on your keyboard to navigate the list. To select or deselect a device, highlight the device name and then press the **spacebar**.

An indicator (>) displays next to a selected device name. You can also press <Ctrl><A>

to select all device names in the list or <Ctrl><D> to deselect any selected device names.

5. Press <Enter> to disable selected devices. When a device is disabled, it no longer appear in the list. If you want to exit without disabling any devices, press <Esc>.



**IMPORTANT:** Take caution not to press the <Enter> key when exiting, or the first device highlighted in the list will be disabled. See [Enable Modbus Client Devices](#) for a list of devices that are currently enabled.

## Modbus TCPdump

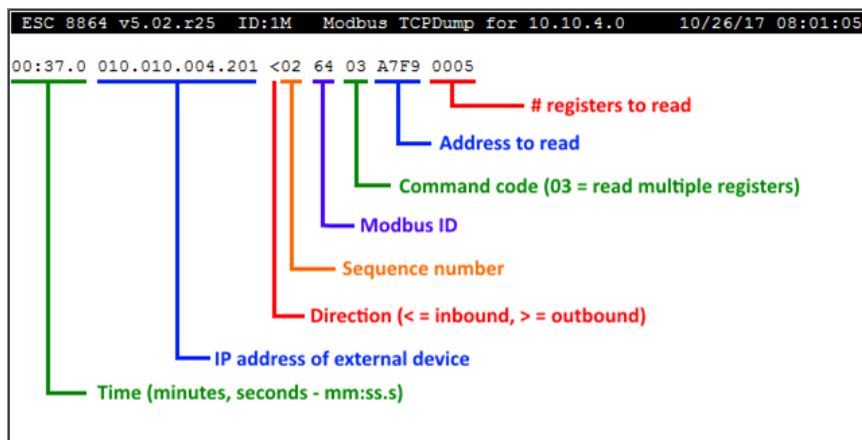
To display the Modbus commands and responses on the Ethernet ports:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).
2. Select **M - Modbus TCPdump** (hot key **M**) to display the Modbus Devices Menu.

```
ESC 8864 v5.02.r25 ID:1M Modbus TCPDump for 10.10.4.0 10/26/17 09:50:17
50:16.9 192.168.023.001 <04 64 03 0000 0000 0000 0000 0000 0000 0000 0000 0000 >
50:16.9 192.168.023.001 <05 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.3 192.168.023.001 <44 01 03 0000 0009
50:17.3 192.168.023.001 >44 01 03 0001 03E9 7FFF 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >06 64 03 1195 0064
50:17.4 192.168.023.001 <06 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >07 64 03 11F9 0064
50:17.4 192.168.023.001 <07 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >08 64 03 125D 0064
50:17.4 192.168.023.001 <08 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >09 64 03 12C1 0064
50:17.4 192.168.023.001 >01 64 03 0FA1 0064
50:17.4 192.168.023.001 <09 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 <01 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >0A 64 03 1325 0064
50:17.4 192.168.023.001 <0A 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >02 64 03 1005 0064
50:17.4 192.168.023.001 <02 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >
50:17.4 192.168.023.001 >03 64 03 1069 0064
50:17.4 192.168.023.001 <03 64 03 0000 0000 0000 0000 0000 0000 0000 0000 >

Press ESC to exit, p: unpause f: file cap, u: USB cap e: Switch Ethernet
```

The screen shows one row per Modbus command or response and will scroll up as more commands are received. The title bar shows the IP address of the Ethernet port that is being monitored – press “e” to switch to the other Ethernet port or “p” to pause or unpause the screen. The fields displayed are:



All fields to the right of the direction indicator (“<” or “>”) are in hexadecimal. The meaning and the number of bytes after the command code depend on the actual Modbus command sent or received. The sequence number is the numeric order of the command in the [Client] section of the 8864’s server.cfg file and is truncated to 255. The first command in the section has a sequence number of 1, the second command is 2, and so forth. Sequence numbers may not be supported by other Modbus clients.

Use the arrow keys to scroll the screen left and right, and when paused, up and down. A “>” character at the far right of the screen means that this line extends off the right of the screen.

To capture the full command and response packets to a file, press “f” to save to the “sftp-data” folder on the 8864’s flash hard drive or “u” to capture to an installed USB thumb drive. The files on the 8864’s flash drive can be retrieved with SFTP. Press “s” to stop the capture. Pausing the display with “p” does not stop a capture, only the screen display.

Captured files are in “pcap” format and can be read with the free program Wireshark ([www.wireshark.org](http://www.wireshark.org)).

## Modbus Command Monitor

Use the Modbus Command Monitor screen to monitor incoming commands received from a user-selected MB-RTU serial port or Ethernet Modbus Server port, as well as monitor the rate at which the commands are received.

To display the Modbus Command Monitor screen:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**) > **V - Modbus Command Monitor** (hot key **V**).

	Modbus Command Received		Count	Period	IP address
Write	1 coils to address	0	699	1.997	10.10.4.200
Write	1 coils to address	24	349	0.997	10.10.4.200

Other features of the Modbus Command Monitor screen include:

- Updates once every second.
- Starts over when the screen is exited and re-entered.
- Displays 18 incoming commands per screen. Commands are identified in the **Modbus Command Received** column. Use Ctrl-N and Ctrl-P to navigate between monitor screens.
- If the same command is received more than once, a total count of the received command displays in the **Count** column.
- Displays a list of the number of invalid commands received (such as bad number of characters or bad CRC).
- If the user-selected interface is a serial port, displays a list of the number of valid commands addressed to a different Modbus address.
- Shows the average time between commands in the **Period** column.
- Identifies the originating IP address of commands in the **IP address** column.
- Displays the following information at the bottom of the screen:
  - serial port or Ethernet interface being monitored
  - total number of received commands while the monitor is running
  - length of time the monitor has been running (hours, minutes, seconds as hh:mm:ss)

## System Information



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The System Information screen displays the current memory utilization, software version, and optional features of the 8864.

To display the System Information screen:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **I - System Information** (hot key **I**).

```
ESC 8864 v5.02.r25 ID:88      System Information      12/11/17 10:32:15

ESC 8864 Software v5.02.r25 dated 07/07/2017

Used Data Space (1K-Blocks)   : 0
Free Data Space (1K-Blocks)   : 2,345,080
Data Space Utilization        : 0%

Used Config Space (1K-Blocks) : 26,584
Free Config Space (1K-Blocks) : 463,244
Config Space Utilization      : 5%

Memory Utilization            : Total: 213MB  Used: 76MB  Utilization: 35%

CPU Busy (1 Minute Average)   = 15%

ESC or SPACE=EXIT, F2=Refresh, CTRL-N or PgDn = Next Page
```

2. Press <Ctrl><N> to display the next page.

```

ESC 8864 v5.02.r25 ID:88      System Feature Status      12/11/17 10:34:08

ESC 8864 Software v5.02.r25 dated 07/07/2017

Core Features           : ON
WIND Channels           : OFF
Modbus Channel & Protocol: ON
Generic Serial Channel  : ON
Daily Reports           : OFF
Digital Channel         : ON
Tape Sampler Channel    : OFF
Central Alarm Task      : OFF
CEM                     : ON
Ambient                 : OFF
Secure Login            : OFF

ESC or SPACE=EXIT, F2=Refresh, CTRL-P or PgUp = Previous Page

```

## Dump Setup(s)



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

The recommended use of this feature is to access the MDI remotely (see [Appendix H. Retrieve a Data Controller Dump](#)), and then set the terminal connection to record all dump contents to a file.

When *Dump All to Curr Port* is selected, all configuration for all channels, calibrations, digital programs, alarm programs, DACs (analog output), digital input and output labels, and reason codes are dumped to the terminal file.



To dump the 8864 setup to a terminal file:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **Dump Setup(s)** (hot key **D**).
2. Select **P - Dump All to Curr Port** (hot key **P**).



## Reboot



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This selection is used to reboot the 8864 Data Controller. The reboot process typically completes within a few seconds.

To reboot the 8864:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **U - Reboot** (hot key **U**).
2. When the message “Are You Sure? (Y/N)” displays, select **Y** (yes to reboot) or **N** (cancel reboot).



**NOTE:** Beginning in firmware Version 6.02.54, when a keyboard is connected to the USB port on the 8864:

- The Scroll Lock key on the keyboard is inactive (disabled).
- The Num Lock Key is enabled (on) by default after rebooting the 8864. Pressing the More button on the MDI front panel allows you to use the number keypad for numbers instead of arrows. Pressing the Num Lock key again will disable this functionality and then re-enable the arrow buttons on the number keypad.

## System Maintenance



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This selection provides a series of system diagnostic tests that can help identify the source of a problem.

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).

```
ESC 8864 v5.02.r25 ID:88      System Maintenance      12/11/17 10:37:04

V View Serial Port Data
D Download Code
P Connectivity Tests
A Create Debug Archive

S Download Server.cfg
C Cold Start
```

The following table provides a brief description for each menu item in the System Maintenance screen. For a detailed description, click any of the hyperlinks in the column labeled *To Option*.

Hot Key	To Option	Action
V	<a href="#">View Serial Port Data</a>	Displays all serial port data coming in and going out of the controller. Data in the top half of the screen is data coming into the 8864 Data Controller. Data in the bottom half of the screen is data going out of the 8864 Data Controller.
D	<a href="#">Download Code</a>	Download new firmware using <a href="#">USB Download</a> or <a href="#">Ethernet Download</a> .
P	<a href="#">Connectivity Tests</a>	Diagnostic tests involving Ethernet correction.
S	<a href="#">Download Server.cfg</a>	Loads the server.cfg file from an attached USB thumb drive.
C	<a href="#">Cold Start</a>	Cold start the 8864. This deletes all configuration and data.

## View Serial Port Data

The primary purpose of this feature is to allow direct access to an attached device equipped with RS-232 port options using the 8864 operator interface. Use the “View Serial Port Data” screen to view all serial port data coming in and going out of the controller. Data in the top half of the screen is data coming into the 8864 Data Controller. Data in the bottom half of the screen is data going out of the 8864 Data Controller (see example in [step 3](#)).

To view serial port data:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).
2. Select **V - View Serial Port Data** (hot key **V**) to link the operator interface directly to another serial port. A list of configured terminal ports will display.

```

ESC 8864 v5.02.r9 ID:88 Choose List (Enter to Select) 10/17/16 18:52:18

PORT#0:VT100
PORT#1:VT100
PORT#2:VT100

F2      <ESC>  TAB      CTRL-K    CTRL-R    Arrows
Refresh Exit   GOTO END GOTO TOP  Clr Keys  Select

```

3. Use the up/down arrows on your keyboard to navigate the list of ports. Highlight a port to select it and then press **<Enter>**.

The screen will display characters sent to and received from the device connected to the 8864 serial port. The characters are displayed in both ASCII and hexadecimal format as shown in the next example.

If local echo is enabled, the top half of the screen shows characters that are typed at the 8864 Data Controller, and the bottom half of the screen shows characters that are received by the 8864 Data Controller on the selected port. Note that local echo is initially enabled. That is, all characters typed at the operator interface are echoed back to the display. Press **<Ctrl><E>** to toggle the local echo state between disabled and enabled.

Note that alternate character entry is initially disabled. That is, only characters that can be typed on the attached keypad or keyboard can be sent out to the serial port from the 8864

Data Controller. Press <Ctrl><Y> to toggle the alternate entry state between disabled and enabled. When enabled, alternate characters can be entered in the format \xnn (where nn is a valid hexadecimal value, 00-ff) When a “\” character is entered, it, along with the next three characters entered, will not be sent out the serial port. If the format of the four characters is valid, the represented hexadecimal value is sent out the serial port instead.

54 68 69 73 20 69 73 20 61 20 74 65 73 74 20 6f	This is a test of
66 20 74 68 65 20 73 65 72 69 61 6c 20 70 6f 72	the serial port
74 20 6f 75 74 70 75 74 20 64 61 74 61 20 73 63	output data screen.
72 65 65 6e 2e	
<hr/>	
54 68 69 73 20 69 73 20 61 20 74 65 73 74 20 6f	This is a test of
66 20 74 68 65 20 73 65 72 69 61 6c 20 70 6f 72	the serial port
74 20 69 6e 70 75 74 20 64 61 74 61 20 73 63 72	input data screen.
65 65 6e 2e	
 CTRL-X to exit	

4. To exit terminal mode and return to the menu, press <Ctrl><X>.

## Download Code



**IMPORTANT:** Follow the “Upgrade 8864 Firmware” procedure in the *8864 Data Controller Installation Guide* to correctly upgrade the 8864 firmware. This document is available for download in the Customer Community on the [8864 Data Controller Downloads](#) downloads page (requires login).



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

The download can be performed from a USB drive or using an Ethernet port. Please note that downloading new firmware requires a cold start of the logger. Configuration and data will be lost. When either option is selected, the user is prompted before continuing. Press N(o) to stay in the Download Code Menu. Press Y(es) to continue with the download. Once Y(es) has been selected, configuration and data are lost.

To display the Download Code Menu:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).
2. Select **D - Download Code** (hot key **D**).



The following information provides a description of the options [USB Download](#) and [Ethernet Download](#).

## USB Download



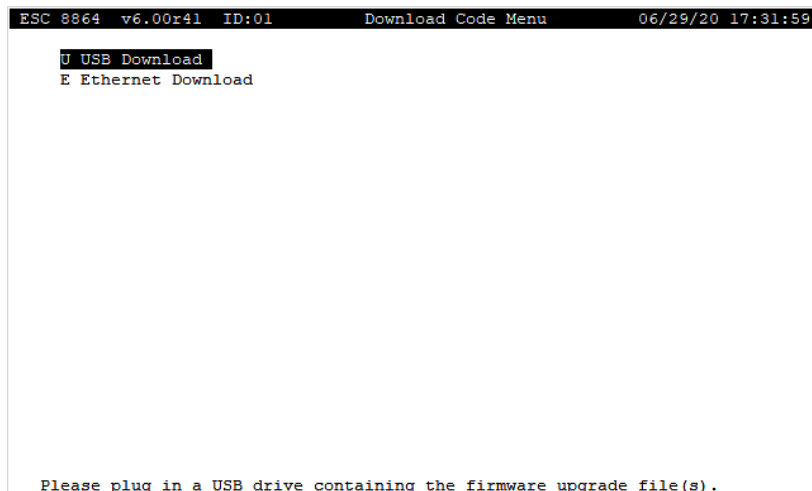
**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

Selecting the USB Download option allows you to install an upgraded version of the firmware on the 8864 using a USB flash drive. Only the USB root directory is searched when locating the firmware upgrade file for download. If the USB includes sub-directories, these folders are not searched for the firmware upgrade file.

**NOTE:** See [Upgrade Using USB](#) in this document for detailed instructions.

To download new firmware to the 8864 using a USB drive:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**) > **D - Download Code** (hot key **D**).
2. Select **U - USB Download** and then select **Y** (Yes) when the message “Are You Sure? (Y/N)” displays.
3. Plug the USB flash drive in a USB port on the 8864 when prompted. Then press <Enter> to begin the upgrade. On-screen messages show the progress of the installation.



## Ethernet Download



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

Selecting the Ethernet Download option displays the Ethernet download page. Please note that once Y(es) has been selected, configuration and data are lost. The download is conducted using FTP.

**NOTE:** See [Upgrade Using Ethernet](#) in this document for detailed instructions.

To download new firmware to the 8864 using Ethernet:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**) > **D - Download Code** (hot key **D**).

---

2. Select **E - Ethernet Download**.



3. Transfer the firmware upgrade file to the 8864 using SFTP. The procedure to transfer a file using SFTP can be found in this section.
4. Press **<Enter>** to continue the upgrade process.

## Connectivity Tests

Use this menu to run diagnostic tests for the Ethernet connection to the 8864 Data Controller. The “Ping” connectivity test determines if the 8864 can communicate with another device on the network with a known IP address.

To run a Ping connectivity test:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).
2. Select **P - Connectivity Tests** (hot key **P**) and then press **<Enter>**.



3. Type the IP address of the networked device in the **IP Address** field.

ESC 8864 v5.00.r21	ID:01	Ping Test Menu	01/08/16 09:30:52
IP Address : <input type="text"/>			
Start Ping			

4. Press **<Enter>** two times to start the test. When the test completes a screen similar to the next example displays.

ESC 8864 v5.00.r21	ID:01	Ping Test	01/08/16 09:37:25
Starting Ping Test...			
PING 10.5.2.37 (17.5.2.27): 56 data bytes			
64 bytes from 17.5.2.27: seq=0 ttl=64 time=0.289 ms			
64 bytes from 17.5.2.27: seq=1 ttl=64 time=0.124 ms			
64 bytes from 17.5.2.27: seq=2 ttl=64 time=0.126 ms			
64 bytes from 17.5.2.27: seq=3 ttl=64 time=0.120 ms			
--- 17.5.2.27 ping statistics ---			
4 packets transmitted, 4 packets received, 0% packet loss			
round-trip min/avg/max = 0.120/0.164/0.289 ms			
Press any key to continue.			

## Download Server.cfg



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

Use this selection to load a new server.cfg file from a thumb drive attached to the 8864's USB port. To access this function:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).
2. Select **S - Download Server.cfg** (hot key **S**) and then press <Enter>.
3. Type **Y** to continue.

The server.cfg file must be located in the root directory of the USB drive. The file name must be all lower case.



## Cold Start



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

To cold start the 8864 and delete all configuration and data:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **S - System Maintenance** (hot key **S**).
2. Select **C - Cold Start** (hot key **C**) and then press <Enter>.
3. Type the password of the currently logged in account to continue.

**All data and configuration will be deleted when this command is confirmed.**

ESC 8864 v5.02.r25 ID:1M Enter Password For Cold Start 10/26/17 09:31:11	
Current User Name	: admin
Enter Password	: <input type="password"/>

# App Note - Calculating Data Storage

In firmware version 5.00 and later, the 8864 increases data storage efficiency by storing data averages and flags in a file-based, group-storage structure. With this method you can see unfamiliar results when determining the amount of data that can be stored for individual channels.

Information in this section explains the data storage method used by the 8864. It also describes how to calculate the amount of data storage required for a particular configuration. Topics include those in the following list:

- [Data Storage Overview](#)
- [Structure of Data Storage Files](#)
- [Different Averaging Intervals are Stored in Different Files](#)
- [Channels in Different Groups are Stored in Different Files](#)
- [Files Created for Channel Group/Interval Combinations](#)
- [New File Created Every 115 Data Points](#)
- [Results of Grouping Channels Into Files](#)
- [Rollover Occurs on Even Data Point Boundaries](#)
- [Minimum and Maximum Rollover Durations](#)
- [File Rollovers Occur at Even Number of Intervals](#)
- [Calculating Data Storage](#)

## Data Storage Overview

With firmware version 5.00 and later, the 8864 stores data averages and flags in a file-based, group storage structure in order to increase data storage efficiency. This method can sometimes lead to surprising results when determining the amount of data that can be stored for individual channels.

Each channel in the 8864 can store up to three averaging intervals. These are:

- base average
- extended #1 average
- extended #2 average

For a typical Part 75 channel, averaging intervals are configured as 1-minute base averages, 15-minute extended #1 averages, and 1-hour extended #2 averages. The minimum length of time you want to retain for each averaging interval is also configurable. The 8864 will always

retain at least the length of time that is configured.

For example, if you set up 1-minute averages to be retained for 7 days, 15-minute averages for 30 days, and 1-hour averages for 90 days, the 8864 retains data for at least the specified length of time before the data averages “roll over”. Once the maximum data storage time has passed for a particular averaging interval, then the oldest data is deleted to make room for the newest data averages. However, due to the group-based storage method in firmware version 5.00 and later, data may be kept for more than the minimum requested storage time. The amount stored is never less than the amount configured.

## Structure of Data Storage Files

The 8864 uses files to store data averages. Each file consists of the following information:

- up to 126 channels of data
- one (and only one) averaging interval
- up to 115 consecutive data points

Channels are grouped together so that data from all of the channels in that group (with the same averaging interval) are all stored in the same file. Channel groups are listed in the following table.

Channel Groups
001 to 125
126 to 251
252 to 377
378 to 503
504 to 629
630 to 755
756 to 881
882 to 999

## Different Averaging Intervals are Stored in Different Files

The following example explains how the 8864 stores different averaging intervals in different data storage files:

- **1-Min Averages**

If a data storage file has a start time of midnight and contains 1-minute data for the first channel group (channels 001 to 125), the data storage file contains **all** of the 1-minute average data (and flags) for **all** channels in the range of 001 to 125 that have 1-minute data configured for storage. This includes 1-minute averages configured as base averages, extended #1 averages, and extended #2 averages.

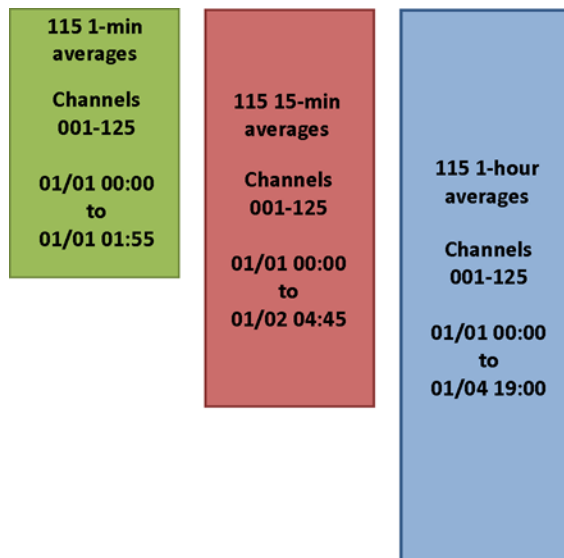
Using the green box in the following diagram as an illustration, the data storage file stores all 1-minute data from midnight through 01:55:00, which is a total of 115 1-minute averages.

- **15-Min Averages**

A second data storage file is used to store all 15-minute averages for all channels in the channel range of 001 to 125 that are configured to store 15-minute averages. This is illustrated using the red box in the following diagram. However, the second data storage file contains data from midnight on January 1 to 04:45:00 on January 2, for a total of 115 15-minute averages.

- **1-Hour Averages**

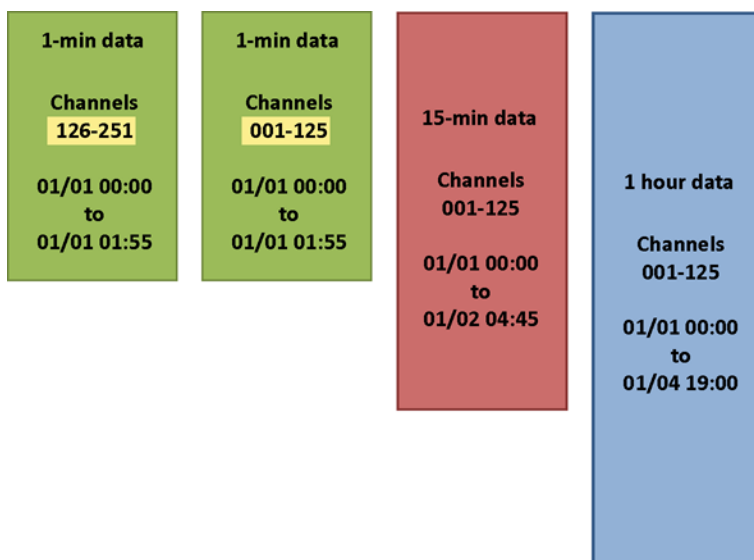
A third data storage file is used to store 1-hour averages for any channels in the channel range of 001 to 125 that are configured to store 1-hour averages. If the 1-hour data storage file also begins at midnight on January 1, it will then store data for 1-hour averages through January 4 at 19:00, for a total of 115 1-hour averages. See the blue box in the following diagram.



## Channels in Different Groups are Stored in Different Files

The following information provides an example of how the 8864 uses different files to store data for channels in different groups.

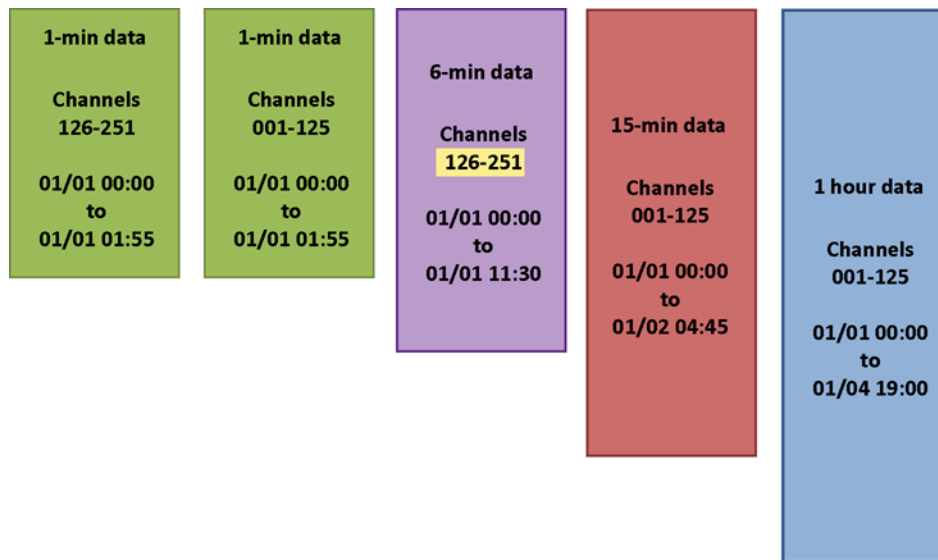
**EXAMPLE:** If a new channel that calls for the storage of 1-minute data is added to the example shown in the section [Different Averaging Intervals are Stored in Different Files](#) and it is configured outside the range of channels 001-125, then a second 1-minute data storage file would be created for that same data start time. If channel 130 is configured for 1-minute averages, for example, then a second 1-minute storage file would contain data averages for each and every 1-minute average configured in the second block of channels (i.e., channels 126 through channel 251). See the second green box in the following diagram.



## Files Created for Channel Group/Interval Combinations

The following information provides an example of how the 8864 creates files only for new channel group/interval combinations.

**EXAMPLE:** If a 6-minute average is added to the example configuration and is configured for channel 130 (as its extended #1 average for example), then a new file is created for the 6-minute averages in the group of channels 126 to 251, as shown in the purple box in the next diagram. A 6-minute file is not created for the channel range 001 to 125 if no 6-minutes averages have been configured for any channel in that range.

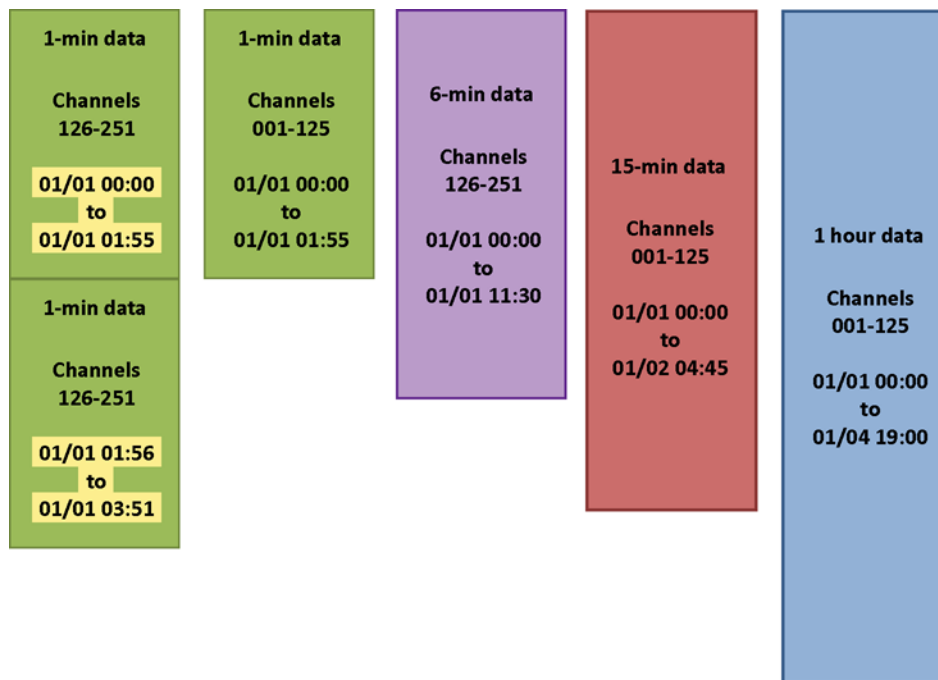


## New File Created Every 115 Data Points

The 8864 creates a new data storage file for every 115 data points. When the configured minimum storage time exceeds the duration of time that can be stored in one file (115 data points), then a second file is created after the first file has been filled.

Building on the [previous example](#), if 1-minute averages in channel 130 are configured to store at least three hours of data, this would require 180 data points. Two data storage files are then used for this range of channels as shown in the following diagram.





## Results of Grouping Channels Into Files

Grouping channels into files produces the following results:

- Adding a new channel into a group of channels that already exists will **not** increase the amount of data storage used if no new averaging intervals are configured and if the duration of storage for the new channel is not any more than the maximum amount already configured for the channels in that group.

Using the example in the previous section [New File Created Every 115 Data Points](#), adding a new channel in the range 001 to 125 with 1-minute, 15-minute, and 1-hour averages (and not any longer storage times) will not increase the amount of storage required since the files already exist for that group of channels for those averaging intervals. However, if a channel is configured in a new channel group (for example, channel 300) or if the new channel requests a longer storage duration than the existing channels, then new files will be allocated and require additional data storage space.

- The number of files needed for a particular range of channels for a particular averaging interval is determined by the maximum duration of data storage requested for **any** channel in the range.

For example, if channel 001 has 1-hour averages configured for 30 days of storage and channel 002 has 60 days of storage configured for 1-hour averages, then enough files will be allocated to store 60-days of 1-hour averages for the channel group 001 to 125. Consequently, the 1-hour averages for both channels 001 and 002 will rollover after 60

days (as will any other 1-hour averages configured on all channels in the range 001 to 125).

- If the channel that has the maximum storage requirements for an averaging interval in a group of channels is deleted, the rollover time of other channels in the same group will go down. It will go down to the maximum rollover time for that interval that has been configured for the remaining channels in that group. It does not however go below the configured amount for any channel.

## Rollover Occurs on Even Data Point Boundaries

Because files always contain 115 consecutive averages, the minimum rollover time of a group of channels is always an even multiple of 115 intervals. For example, 1-minute averages roll over after 115 minutes, 230 minutes, or 345 minutes.

The minimum rollover time of a channel group for a particular averaging interval is the maximum requested storage time for that interval for all channels in the group, rounded up to the next even 115 intervals. For example, if the maximum requested storage time for 1-minute averages in the channel group 001-125 is 300 minutes (5 hours), all channels in the group 001-125 that have 1-minute averages configured will store at least 345 minutes (5 hours, 45 minutes) of 1-minute averages, regardless if less storage time has been configured for other channels in the group.

## Minimum and Maximum Rollover Durations

Files are created as they are needed. When one file is filled, another file is created to store the next set of data. Files older than the minimum rollover time are deleted. The number of files equal to the minimum rollover time for the channel group are kept, plus the one file that is currently being filled. This results in the rollover time being up to 115 intervals more than the minimum rollover time, depending on the time that the last file was filled.

For example, with a maximum requested storage time of 300 1-minute averages, 3 files will be allocated (for a total of 345 1-minute values), plus one more file that is partially filled (up to 115 more averages). Therefore at any particular time, somewhere between 345 and 460 1-minute averages will be stored. Once 460 1-minute averages are stored, the 8864 will roll over so that 345 1-minute averages are stored. As time progresses, the stored 1-minute averages will again build up to 460 before dropping again to 345.

## File Rollovers Occur at Even Number of Intervals

Files always begin at a time that is an even number of their storage amounts, starting at 1/1/1970 00:00:00. Because files always contain 115 consecutive averages, the files always begin on an even number of 115 averaging intervals since 1/1/1970 at 00:00:00.

For example, 1-hour average files always begin at a time that is an even multiple of 115 1-hour

periods from 1/1/1970 at 00:00:00. A new hourly file is created at 7/1/2015 at 12:00:00, and all 1-hour files rollover at that time because it is exactly 3,468 multiplied by 115 hours since 1/1/1970 00:00:00.

Rollovers occur at an even number of 115 intervals for each storage interval, independent of other intervals. Using the same example from earlier in this section, a new 1-minute file is created at 7/1/2015 at 00:30:00. 1-minute files rollover at that time because it is exactly 208,074 multiplied by 115 minutes since 1/1/1970 at 00:00:00.

## Calculating Data Storage

To determine the data storage space required for a particular configuration, follow these steps:

1. Determine the number of files used by each unique averaging interval for each group of channels. To do this:
  - a. Take the maximum requested storage time for all channels in the group that have a particular averaging interval configured.
  - b. Compute the number of files needed by first taking the requested storage time, dividing by the averaging interval to determine the number of data points requested, then dividing the result by 115 (the number of data points per file).
  - c. Round the result UP to the next integer value (unless it happens to be an exact even multiple) and add two (one for the file that is partially filled, one more for file overhead) to determine the number of files required for each averaging interval in the storage group.
2. Sum the number of files required for each averaging interval in each channel group, and then total the number of files required for each averaging interval over all channel groups. This is the total number of files required.
3. Each file is allocated 120 of the 1K data storage blocks. Multiply 120 by the total number of files required. This is the total number of 1K storage blocks that are required for data storage for that configuration.
4. Subtract the number of 1K data storage blocks from the total available of 2,345,080 storage blocks available to determine the amount of data storage that will be free after the configuration is loaded into an 8864. No additional channels can be configured once 2,345,080 storage blocks have been allocated.

### Related Topic:

- [Example of Data Storage Calculation Method](#)

## Example of Data Storage Calculation Method

Information in this section provides an example of how the 8864 data storage calculation method functions. In this example, the averaging intervals in the following table have been

configured and the indicated length of time is the maximum configured storage time for that interval within that storage block.

#### Maximum Storage Time Configured in Each Data Block:

Channel Block	Averaging Interval				
	10s	1m	6m	15m	1h
001-125		300d		300d	300d
126-251	30d	60d		120d	120d
252-377		90d	90d		90d
378-503					
504-629					
630-755					
756-881					
882-999					

The next table identifies the number of files used for each averaging interval that has been configured in each storage block.

A total of 8,558 files are used. These files require 8,558 multiplied by 120 = 1,026,960 of the 1K storage blocks out of a total of 2,345,080 storage blocks available (44% used), leaving 1,318,120 free (56% free).

#### Files Used:

Channel Block	Averaging Interval				
	10s	1m	6m	15m	1h
001-125		3,759		253	65
126-251	2,256	754		103	28
252-377		1,129	190		21
378-503					
504-629					
630-755					
756-881					
882-999					

Minimum and maximum rollover durations are found in the next table. The table shows that although the 10-second averages in channel block 126-251 have been configured to be stored

for 30 days, the 10-second averages will be stored for a minimum of 30 days, 1 hour, and 40 minutes. As time passes, the 10-second averages build up to a total of 30 days, 20 minutes, and 50 seconds before rolling over to store 30 days, 1 hour, and 40 minutes.

#### Minimum and Maximum Rollover Durations:

Channel Block	Averaging Interval				
	10s	1m	6m	15m	1h
001-125		300d 00:55:00 300d 02:50:00		300d 16:15:00 301d 21:00:00	301d 21:00:00 306d 16:00:00
126-251	30d 00:01:40 30d 00:20:50	60d 01:20:00 60d 03:15:00		120d 23:45:00 122d 04:30:00	124d 14:00:00 129d 09:00:00
252-377		90d 00:05:00 90d 02:00:00	90d 02:00:00 90d 13:30:00		91d 01:00:00 95d 20:00:00
378-503					
504-629					
630-755					
756-881					
882-999					

## Deleting Data

Because of the file-based, group-storage structure, deleting channels can have unexpected consequences:

- If a channel is deleted, the amount of storage for other channels in the same group for a particular averaging interval may or may not be affected. If the deleted channel has the longest amount of storage time configured among all channels in the same channel group for that averaging interval, then the total amount of storage of the remaining channels may be reduced.

The new maximum storage time of the remaining channels in the group will depend on the remaining channel that has the longest storage time configured for the averaging interval. As always, the storage time for a channel will never be less than the minimum amount configured for that averaging interval.

- If a channel is deleted, its data is not immediately deleted since it is stored in the same file as other channels in its group. If a deleted channel is reconfigured, any historical data that has not rolled off will again be available for the channel. The data is stored by channel number, so the historical data will still be accessible even if the name and/or purpose of the channel has changed.

For example, if data has been collected for channel 017 for a parameter SO2RAW and then subsequently deleted. If a new channel 017 is configured, even if it is named OPACITY, the historical data for SO2RAW will still be available and accessible on the OPACITY channel until that old data has rolled off.



# App Note - Calibrations



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This section provides the following helpful notes about calibrations:

- [Typical Calibration Setup/Probe Controllers](#)
- [Daily Calibrations and Boiler Operation](#)
- [Handling Pilot Tube/Differential Pressure Flow Interference Checks](#)
- [Calibration Correction on Analog Inputs](#)

## Typical Calibration Setup/Probe Controllers

A typical gas calibration sequence would be configured as shown in the screens below.

```

ESC 8864 v5.xx ID:49      Auto Zero/Span Cal Cfg      mm/dd/yy hh:mm:ss

Name of Cal Sequence      : GASCAL1
Starting Time             : mm/dd/yy hh:mm:ss
Interval                  : 1d
Affected/Data Channels     : SO2PPM, CO2, NOXPPPM, SO2PPMC, CO2C, NOXPPMC

Calibration Records Stored : 1
Zero Output Control Lines : 25,30,
Zero Phase Data Time      : 1m
Zero Phase Duration       : 8m
Edit Zero Expected Values :
Span Output Control Lines : 25,27,
Span Phase Data Time      : 1m
Span Phase Duration       : 8m
Edit Span Expected Values :
Recovery Time             : 5m
FINISHED (Configure Now)

CTRL-R = Advanced Options, CTRL-O = Config Relay Outputs
  
```

### Edit Zero Expected Values for GASCAL1, SO2PPM affected data channel:

The expected value configuration would be done for each of the six affected data channels in the GASCAL1 calibration sequence for both zero and span phases, for a total of 12 expected value configurations. See the following example.



ESC 8864 v5.xx ID:49	Expected Value Configuration	mm/dd/yy hh:mm:ss
Name of Cal (not editable)	: GASCAL1	
Name of Phase (not editable)	: ZERO	
Channel Name (not editable)	: SO2PPM	
Expected Value	: 2116	
Tracer/ID Code (0000-9999)	: 0000	
Use EV For Automatic Correct?	: N	
Write EV to Math Constant	: (none)	
Write Result to Math Constant	: (none)	
Warning Drift Tolerance	: (not set)	
OOB Drift Tolerance	: (not set)	
No Recovery If Warning Drift?	: N	
No Recovery If OOB Drift?	: N	
Store Result in Cal Record?	: Y	
Use Rounded Results?	: N	
Method of Error Calc. (S,D,L)	: D	
ESC to return to Phase Config		

## Daily Calibrations and Boiler Operation

A daily calibration error check is not required if the boiler is offline for the entire day. If a boiler operates for part of a day, the daily calibration error check must be performed in most cases. Generally, to avoid failing the calibration due to temperature differences, it is desirable to perform the calibration after the system has reached a stable operating temperature. The following are the desired goals:

- In normal operation, run a daily calibration at the same time every day.
- If the boiler is offline, do not run the daily calibration.
- Once a boiler goes from offline to online, run a daily calibration after a delay.

See the following sections for more detail:

- [Daily Calibration Program](#)
- [Boiler Startup](#)

### Daily Calibration Program

Most daily calibration error programs are automatic (type A) calibrations.

A more complicated, but still valid, approach to starting the calibration is to change the calibration type to externally initiated (cal type E), specify a pseudo digital input/output pair as the starting digital input pattern, and have a timed digital event program toggle the pseudo digital output line once per day.

The advantage to the latter approach is that conditions can be added to the starting input pattern for the type E calibration, such as the boiler online conditions. The digital start pattern can be configured so that the calibration only starts when the timed digital event program runs AND the boiler is operating. This meets the first two goals.

## Boiler Startup

To accomplish the third goal, a simple method is to configure the Startup Delay and Startup Minute (00-59) fields in the Advanced Cal Options screen of the calibration configuration (see [Handling Out-of-Control Calibrations](#)). This method is valid when the amount of operating time needed after the boiler comes online before a calibration can successfully run is a known constant. If this time is not known or varies based on certain conditions during startup, a more complicated method can be implemented using a “ready to cal” digital input pulse. The easiest way to generate this pulse is to create an average alarm program that represents the desired conditions and momentarily turns on a pseudo digital input/output pair.

To make an alarm program generate a pulse, the automatic Acknowledgment Timeout field should be configured to 005s (or however long the pulse is desired to be) and the End Alarm When No Flag? field should be set to Y(es).

**EXAMPLE:** The system’s digital input #01 is on when the boiler is online.

The system should calibrate when the stack temperature rises above 300°F after the boiler comes online. Therefore, on the STKTEMP channel, the High Alarm Limit (“h” flag) is configured as 300.0 on the minute average (1m), and the instantaneous validation Boiler Offline Status is configured as 1.

A **STARTUP** alarm is configured with the Average Interval configured as 1m, the Flag(s) for Alarm Condition configured as h, the Ignore State Changes Flag(s) configured as F and the Output Lines During Alarm configured as 33 (pseudo digital input/output #33). The Acknowledgment Timeout is configured as 5s to generate a 5-second pulse on DI#33 when the alarm activates.

A **TEMPOK** alarm should also be created that is identical to the STARTUP alarm except that the Acknowledgment Timeout is configured as 0s. The Output Lines During Alarm is configured as 34 (pseudo digital input/output #34). This alarm is used to keep the normal daily calibration from running in cases where the normal daily calibration start time happens to fall during the startup period before the stack temperature reaches 300°F.

A **CALTIME** timed digital event program is created with the Starting Time configured as the normal calibration start time, the Output Line(s) configured as 35 (pseudo digital input/output #35) and the Output Duration configured as 5s.

Considering all inputs, the system should start a calibration when:

(DI#01=1 AND DI#34=1 AND DI#35=1) OR (DI#33=1).

This can be done by creating a **CALSTART** digitally triggered digital event program with the Trigger DI Pattern configured as 1&34&35 and the Output Line(s) configured as 36 (pseudo digital input/output #36).

The **DAILYGAS** automatic calibration program is then changed from a type A calibration to a type E with the Start Pattern Status Lines configured as 33|36.

## Handling Pilot Tube/Differential Pressure Flow Interference Checks

The EMRC probe must detect an out-of-control condition by comparing  $\Delta P$  in the stack before and after the purge. If the difference in the P reading ( $\% \text{ difference} = ((\text{before} - \text{after}) \div \text{before}) \times 100$ ) is greater than 3%, the instrument is considered out-of-control.

Setting up the 8864 to threshold on a 3% difference is accomplished as follows:

1. Set up one phase called BASELINE (or whatever name is desired). Make  $\Delta P$  a data parameter for that phase.
2. Set up a second phase called PURGE. This phase should activate the purge air line.
3. Set up a third phase called CHECK. This phase will take another reading on the  $\Delta P$  channel.
4. In the Expected Value Configuration screen for  $\Delta P$  during the CHECK phase:
  - Expected Value: **BASELINE**
  - OOC Drift Tolerance: **0.03\*BASELINE or 0.03\*CHECK**

At the end of the CHECK phase, the 8864 will test the CHECK reading against the BASELINE reading, and test against a drift limit equal to  $0.03 \times \text{BASELINE}$  (or CHECK). If the difference is greater than this threshold, the  $\Delta P$  channel will go out-of-control and be flagged with a T.

The central system can be configured to set the out-of-control flag based on this flag. A calibration drift alarm can also be configured at the 8864 to alarm on OOC drift and turn on a digital output, possibly a pseudo-digital input/output, which the central software would detect.

If the purge pressure is measured on a channel other than  $\Delta P$ , the OOC flag must be propagated to the FLOW channel. To propagate flags, “+ (0\*PURGPRES)” can be added to the flow equation. This makes PURGPRES a constituent channel without affecting the result of the equation.

## Calibration Correction on Analog Inputs

The 8864 can be configured to perform automatic adjustments to the scaling parameters of analog inputs based on calibration results.

It should be noted, however, that these corrections are incremental. For example, assume that the 8864 is currently using a set of scaling parameters “A” (high/low inputs, high/low outputs) based on the analyzer’s factory settings. The system goes through a calibration correction and is now using scaling parameters “B.” On the next day, the system goes through another calibration using scaling parameters “B” (not the factory settings). The results are then used to set scaling parameters “C,” and so on.

The system will alarm on excess calibration drift and OOC limits, but these checks are on a

day-to-day drift, not the drift from the original factory settings. If the analyzer has a slow degradation, the user may never be aware of the drift until the scaling curve becomes very flat (or vertical).

One approach to warn the user of excess drift from factory settings is to wire the analog input in parallel with another analog input (in series if a current loop), and to configure an uncorrected version of the channel. This channel is also used as a data parameter in the calibration, but the automatic correction is not enabled for that channel. Thus, this channel will always represent the calibration results in terms of factory settings. The user then sets up a calibration alarm to look at the uncorrected parameters and check them for excess drift.



# App Note - Modbus Server



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

## Communications:

- **Modbus RTU (Serial):** 8 data bits, no parity, 1 stop bit, 300-115200 baud (9600 default).
- **Modbus TCP (Ethernet):** Standard Modbus TCP protocol. Listens on port 502.

The 8864 can emulate a Modicon PLC using the Modbus RTU or Modbus TCP interface. A Modbus Client can read data values and status bits from the 8864 and can provide data input to the 8864 by writing to designated coils and registers.

The 8864 currently supports ONLY the commands in Modbus server mode identified in the following table.

Command		Description
Read Coil Status	(01)	(Reads digital inputs, not coil outputs)
Read Holding Registers	(03)	(Max # of registers read per access is 124)
Force Single Coil	(05)	
Print Single Register	(06)	
Diagnostics	(08)	
Force Multiple Coils	(15)	
Write Multiple Registers	(16)	(Max # of registers written per access is 124)
Report Server ID	(17)	

## Related Topics:

- [Modbus ID Code](#)
- [Register Mapping](#)
- [Legacy 8832 Address Table](#)
- [Legacy 8832 Input Table](#)
- [Legacy 8832 Output Table](#)

- [8864 Modbus Table](#)
- [Double-wide Modbus Tables](#)
- [Numerical Values in Modbus Registers](#)
- [Legacy 8832 Status Words](#)
- [8864 Modbus Table Status Words](#)
- [Command Descriptions](#)

## Modbus ID Code

You must assign a Modbus ID Code of 001-246 in the [Configure System Parameters](#), which may be different from the Logger ID Code used by the polling computer. This identifies the device in server mode.

## Register Mapping

The 8864 Modbus interface consists of the following five separate tables:

- Legacy 8832 Address Table
- Legacy 8832 Input Table
- Legacy 8832 Output Table
- 8864 Modbus Table
- Double-wide Table

The Modbus Client can read from any of the four tables but can only write to the legacy 8832 Output Table and the 8864 Modbus table. The starting addresses of the tables are editable by the user, and the defaults are listed below:

- 8832 Address Table=40001
- 8832 Input Table =40005
- 8832 Output Table=41005
- 8864 Modbus Table=42001
- Double-wide table = (not enabled)

The Legacy 8832 Modbus server tables can include up to two blocks of channels for use by a Modbus client. One block of channels may be configured as “integer” (1 register each) and the other block as “float.” This is accomplished in [Configure Modbus](#), as shown below (default values shown).

A valid value for the following fields is any value from 00 to 99:

- Modbus Channel Int Start\*
- Modbus Channel Int End\*
- Modbus Channel Float Start\*
- Modbus Channel Float End\*

```
ESC 8864 v5.02.r25 ID:1M          Configure Modbus          10/24/17 14:27:29

Modbus ID Code                   : 103
8832 Modbus AddrTbl Start        : 40001
8832 Modbus InputTbl Start       : 40005
8832 Modbus OutputTbl Start      : 41005
ModbusQuietIfNoRegMatch          : N
ModbusAddrTbl[0] =                : 1
ModbusAddrTbl[1] =                : 1001
Modbus Channel Int Start         : 0
Modbus Channel Int End           : 0
Modbus Channel Float Start       : 1
Modbus Channel Float End         : 99

Enable 8864 MODBUS Tables        : Y
8864 MODBUS Table Start          : 42001
Enable Double-Wide Tables        : N
Double-Wide Table Start          : 23002

FINISHED (Configure Now)         10/23/17 09:58:51
```



**TIP:** 8832 Change-out Tip - The settings shown in the previous example (except for the ID) will enable the 8864 Modbus Address Tables to be compatible with most existing 8832 Modbus Integer Address Tables. To make the 8864 table compatible with most existing 8832 Float tables, set the Integer Start and Integer End both to “0” then set the Float Start to “1” and the Float End to “64”.

The 8864 Modbus table is disabled by default and must be enabled before use.

Once these changes have been saved, the 8864 will have to be “cold- started” for the new settings to take effect.

The values entered are 8864 channel numbers. Each block must be contiguous channels, and may be placed anywhere in the 1 – 99 channel-space. The blocks should NOT overlap. In the following discussions, the first block of channels corresponds to the integer or float block with the lowest starting channel number. The second block of channels corresponds to the remaining block. Set both the start and end channels to 0 for a block that is not to be used.

Commands can reference the register addresses directly or by relative addressing. If the specified starting register address is less than the starting address of the Address Table, the address is assumed to be an index from the starting address of the Address Table. For example, if the Address Table begins at the default of 40001, a Starting Register Address of



101 is used as an index to the actual address of 40001+101, or 40102. Addressing for reading individual status inputs and writing individual coil outputs is always relative, and always starts with an offset of 0 (i.e. input/output #1 is at address 0, #2 is at address 1, etc.).

## Legacy 8832 Address Table

The Legacy 8832 Address Table consists of four 16-bit read-only registers. When the first two registers are read, the values configured for the Modbus Address Table[0] and Modbus Address Table[1] in the [Configure Modbus](#) screen are returned respectively. When the second two registers are read, the maximum and minimum values that can be returned as Modbus register values are returned respectively.

See the following table when using the default values for the starting addresses:

Contents	Length	Absolute Address	Relative Address
Modbus Address Table[0]	1	40,001	0
Modbus Address Table[1]	1	40,002	1
Modbus Address Table, Maximum	1	40,003	2
Modbus Address Table, Minimum	1	40,004	3

## Legacy 8832 Input Table

The Legacy 8832 Input Table consists of a variable number of 16-bit, read-only registers. The first five registers contain the current state of the first 80 digital status inputs (both real and pseudo inputs). The first status input corresponds to bit 0 of the first register, and the 80th status input corresponds to bit 15 of the fifth register, with the bits in each register arranged as follows:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

Addressing for reading individual status inputs is relative, and always starts with an offset of 0 (i.e. input #1 is at address 0, #2 is at address 1, etc.).

The remaining Input Registers are separated into three (3) main groups, each group consisting of at least one block of registers containing average data (two blocks if both integer and float blocks are configured) and one block of registers containing a binary representation of data flags for each of the corresponding channels average. Group 1 contains the values and flags for the Base Averages (usually 1-minute averages), group 2 contains the values and flags for the Ext2 Averages (usually 1-hour averages), and group 3 contains the values and flags for the

Ext2 Averages (usually 6 or 15 minute averages).

The table below illustrates the layout of these registers.

**Input Table Layout:**

Status/Pseudo Inputs	5 Registers, Status/Pseudo Inputs 1-80
<b>Group 1</b>	
Base Averages – Block 1	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Base Averages – Block 2 (if needed)	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Base Average Flags	1 register for each channel of both blocks
<b>Group 2</b>	
Ext2 Averages – Block 1	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Ext2 Averages – Block 2 (if needed)	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Ext2 Average Flags	1 register for each channel of both blocks
<b>Group 3</b>	
Ext1 Averages – Block 1	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Ext1 Averages – Block 2 (if needed)	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Blocks 1 & 2 mutually exclusive.
Ext1 Average Flags	1 register for each channel of both blocks

For example, if the Modbus Channel Integer Start is 1, the Modbus Integer End is 64, the Modbus Channel Float Start is 65 and the Modbus Channel Float end is 99, then the Legacy 8832 Input Table would be:

Contents	Length	Address	Address
Digital Inputs (01-80)	5	40,005	4
Base averages integer (01-64)	64	40,010	9
Base averages float (65-99)	70	40,074	73
Base flags	99	40,144	143
Ext2 averages integer (01-64)	64	40,243	242
Ext2 averages float (65-99)	70	40,307	306
Ext2 flags	99	40,377	376
Ext1 averages integer (01-64)	64	40,476	475
Ext1 averages float (65-99)	70	40,540	539
Ext1 flags	99	40,610	609

## Legacy 8832 Output Table

The Legacy 8832 Output Table consists of a variable number of 16-bit registers which can be read or written. The first five contain the current state of the first 80 digital outputs (both real and pseudo). The first output corresponds to bit 0 of the first register, and the 80<sup>th</sup> output corresponds to bit 15 of the fifth register with the bits in each register arranged as follows:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
----	----	----	----	----	----	---	---	---	---	---	---	---	---	---	---

Addressing for writing individual coil outputs is relative, and always starts with an offset of 0 (i.e. output #1 is at address 0, output #2 is at address 1, etc.). The status of an individual coil cannot be read. Care must be used when writing to these registers since doing so updates the state of the corresponding relay outputs, regardless of any other control being performed by the 8864. Typically, the Modbus Client is assigned registers corresponding to pseudo-digital (non-physical) I/O lines and does not write to any of the physical outputs.

The remaining Output Table Registers consists of at least one block of registers for updating 8864 base averages (usually 1-minute averages) for any of the channels that are configured as Modbus ("Q")-type channels (two blocks if both integer and float blocks are configured). The registers that are used for Modbus-type channels must be updated at least once per Input Scan Interval (as set in the Modbus channel configuration). If they are not updated at least once per scan interval, the average will be marked with the "B" and "U" flags, 100% data capture will not

be achieved, and the validity of the average interval will be determined by the “Percent for valid average” setting.

The table below illustrates the layout of these registers.

**Output Table Layout:**

Relay/Pseudo Outputs	5 Registers, Relay/Pseudo Outputs 1-80
Base Average Inputs – Block 1	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Channels for blocks 1 & 2 are mutually exclusive.
Base Average Inputs – Block 2 (if needed)	1 register each channel if Integer Block, 2 each if Float Block (LSW, MSW). Channels for blocks 1 & 2 are mutually exclusive.

For example, if the Modbus Channel Integer Start is 1, the Modbus Integer End is 64, the Modbus Channel Float Start is 65 and the Modbus Channel Float end is 99, then the Legacy 8832 Output Table would be:

Contents	Length	Absolute Address	Relative Address
Digital Outputs (01-80)	5	41,005	1,004
Inputs to “Q” channels integer (01-64)	64	41,010	1,009
Inputs to “Q” channels float (65-99)	70	41,074	1,073

## 8864 Modbus Table

The 8864 has an optional 8864 Modbus Table that can be enabled in [Configure Modbus](#).

ESC 8864 v6.02r53 ID:01		Configure Modbus	01/12/22 10:36:48
Modbus ID Code	:	100	
8832 Modbus AddrTbl Start	:	40001	
8832 Modbus InputTbl Start	:	40005	
8832 Modbus OutputTbl Start	:	41005	
ModbusQuietIfNoRegMatch	:	N	
ModbusAddrTbl[0] =	:	1	
ModbusAddrTbl[1] =	:	1001	
Modbus Channel Int Start	:	1	
Modbus Channel Int End	:	64	
Modbus Channel Float Start	:	0	
Modbus Channel Float End	:	0	
Enable 8864 MODBUS Tables	:	N	
8864 MODBUS Table Start	:	42001	
Enable Double-Wide Tables	:	N	
Double-Wide Table Start	:	23002	
Fast Serial Modbus Server	:	N	
FINISHED (Configure Now)		01/10/22 15:33:48	

The 8864 Modbus table has separate floating point registers and integer registers assigned for all 999 possible 8864 channels and all configured base and extended averages. In addition, there are separate registers for:

- The instantaneous values for all channels in integer and floating formats
- All 64 possible status flags for each channel and each interval (including instantaneous)
- All 999 possible digital inputs and outputs
- The time of day (year, month, day, hour, minute, second) in both integer and floating formats
- All DAC (Analog Outputs) in both integer and floating formats
- All math constant real-time values in both integer and floating points (these values are read-only)



**NOTE:** Included with the 8864 Version 6.02 firmware release is the updated Microsoft Excel file "8864 Data Controller Modbus Map Spreadsheet" ([8864-MODBUS-Map-092921.zip](#)). Visit the [8864 Data Controller Downloads](#) page in the Customer Community to download the Excel file (requires login)

As shown in the next table, Time of Day is available in six registers in the Modbus space in integer format. These registers can be used by a DCS to verify the clock on the 8864 is correct. They can also be used by a DCS to verify the 8864 is active and responding to Modbus commands. Some systems may want to use this function as a "heartbeat" by reading the "seconds" register periodically (either the integer or floating point) to verify the 8864 is

operating and communication is established. Also note that you cannot set the time by writing to these registers; they are read-only.

The registers shown in the following table use default register addresses. They can move however if the value for “8864 Modbus Table Start” is changed.

If the 8864 Modbus Table is enabled and the 8864 Modbus Table Start is set to its default value of 40001, then the 8864 Modbus map would be as indicated in the next table:

Contents	Length	Absolute Address	Relative Address
<reserved for 8864 Address Table>	4	42,001	2,000
Digital Inputs (001-999)	63	42,005	2,004
<unused>	37	42,068	2,067
Digital Outputs (001-999)	63	42,105	2,104
<unused>	33	42,168	2,167
Time of Day, integer Year	1	42,201	2,200
Time of Day, integer Month	1	42,202	2,201
Time of Day, integer Day	1	42,203	2,202
Time of Day, integer Hour	1	42,204	2,203
Time of Day, integer Minute	1	42,205	2,204
Time of Day, integer Second	1	42,206	2,205
<unused>	1	42,207	2,206
Time of Day, float Year	2	42,208	2,207
Time of Day, float Month	2	42,210	2,209
Time of Day, float Day	2	42,212	2,211
Time of Day, float Hour	2	42,214	2,213
Time of Day, float Minute	2	42,216	2,215
Time of Day, float Second	2	42,218	2,217
<unused>	81	42,220	2,219
DAC integer (001-096)	96	42,301	2,300
<unused>	5	42,397	2,396
DAC float (001-096)	192	42,402	2,401
<unused>	7	42,594	2,593
Math Constants integer (001-099)	99	42,601	2600

Contents	Length	Absolute Address	Relative Address
<unused>	1	42,700	2699
Math Constants float (001-099)	198	42,701	2700
<unused>	102	42,899	2898
Instantaneous integer (001-999)	999	43,001	3,000
<unused>	2	44,000	3,999
Instantaneous float (001-999)	1998	44,002	4,001
<unused>	2	46,000	5,999
Instantaneous flags (001-999)	1998	46,002	6,001
<unused>	1	48,000	7,999
Base averages integer (001-999)	999	48,001	8,000
<unused>	2	49,000	8,999
Base averages float (001-999)	1998	49,002	9,001
<unused>	2	51,000	10,999
Base flags (001-999)	1998	51,002	11,001
<unused>	1	53,000	12,999
Ext2 averages integer (001-999)	999	53,001	13,000
<unused>	2	54,000	13,999
Ext2 averages float (001-999)	1998	54,002	14,001
<unused>	2	56,000	15,999
Ext2 flags (001-999)	1998	56,002	16,001
<unused>	1	58,000	17,999
Ext1 averages integer (001-999)	999	58,001	18,000
<unused>	2	59,000	18,999
Ext1 averages float (001-999)	1998	59,002	19,001
<unused>	2	61,000	20,999
Ext1 flags (001-999)	1998	61,002	21,001

## Double-wide Modbus Tables

The “Double-wide” Modbus table is a range of Modbus registers that can be enabled in the 8864. It is a complete set of all 999 channels, with each channel available as both double-wide integers (2 registers each) and as double-wide floats (4 registers each). All averaging intervals (instantaneous, base, extended #1 and extended #2) are available also. The arrangement of the double-wide table is fixed – in other words, all channels are always in the double-wide table, all intervals are always represented, and both double-wide floats and double-wide integers are always present (just like in the “normal” 8864 Modbus table). The double-wide table is either enabled or not. When enabled, the double-wide table always takes up 23,998 consecutive registers.

The arrangement is always as follows:

**8864 Double-Wide Modbus Table**

Type of Registers	# of registers (each channel)	Total registers for this type
Instantaneous double integer (001-999)	2	1,998
<unused>		2
Base averages double integer (001-999)	2	1,998
<unused>		2
Ext2 averages double integer (001-999)	2	1,998
<unused>		2
Ext1 averages double integer (001-999)	2	1,998
<unused>		4
Instantaneous double float (001-999)	4	3,996
<unused>		4
Base averages double float (001-999)	4	3,996
<unused>		4
Ext2 averages double float (001-999)	4	3,996
<unused>		4
Ext1 averages double float (001-999)	4	3,996
		23,998

The double-wide table can be enabled by configuring the “Enable Double-wide Tables” setting to “Y” in the “Configure Modbus” system configuration screen. The starting (absolute) address of the double-wide table can be configured by entering the “Double-wide Table Start” value in the “Configure Modbus” system configuration screen.

A significant issue is that there is not room in the default 8832/8864 Modbus map to fit the new double-wide table. For example, the default arrangement of the 8864 Modbus map is:

8832 Modbus AddrTbl Start : 40001

8832 Modbus InputTbl Start : 40005



8832 Modbus OutputTbl Start : 41005

Enable 8864 MODBUS Tables : Y

8864 MODBUS Table Start : 42001

#### Default 8864 Modbus Map

Modbus table	Number of Registers	Start Address (absolute)	End Address (absolute)	Start Address (relative)	End Address (relative)
Legacy 8832 Modbus Address Table	4	40,001	40,004	0	3
Legacy 8832 Modbus Input Table	1,000	40,005	41,004	4	1,003
Legacy 8832 Modbus Output Table	203	41,005	41,207	1,004	1,206
<unused>	793	41,208	42,000	1,207	1,999
8864 Single-wide Modbus table	20,999	42,001	62,999	2,000	22,998
<unused>	2,536	63,000	65,535	22,999	25,534
<unused>	14,466			25,535	40,000

Since there is no block of “unused” registers big enough for the new double-wide table (23,998 registers are needed), the double-wide table cannot simply be enabled without first making room for it in the Modbus address space.

The consequence of moving the legacy 8832 tables and/or the 8864 single-wide tables is that either the relative addresses or the absolute address (or both) will change, which may cause existing Modbus interfaces to no longer work properly! **Enabling the double-wide Modbus table must be done carefully.**

There are two logical ways to fit in the double-wide table. The first way is to move the Legacy 8832 Modbus Address table down in the address space and put the double-wide table before the 8832 input and output tables, leaving the 8832 tables and 8864 tables unchanged as follows:

8832 Modbus AddrTbl Start : 0

8832 Modbus InputTbl Start : 40005

8832 Modbus OutputTbl Start : 41005

Enable 8864 MODBUS Tables : Y

8864 MODBUS Table Start : 42001

Enable Double-Wide Tables : Y

Double-Wide Table Start : 10002

**Preserve Absolute Addresses**

Modbus table	Number of Registers	Start Address (absolute)	End Address (absolute)	Start Address (relative)	End Address (relative)
Legacy 8832 Modbus Address Table	4	0	4	0	4
<unused>					
New 8864 double-wide Table	23,998	10,002	34,000	10,002	34,000
<unused>					
Legacy 8832 Modbus Input Table	1,000	40,005	41,004	40,005	41,004
Legacy 8832 Modbus Output Table	203	41,005	41,207	41,005	41,207
<unused>	793	41,208	42,000	41,208	42,000
8864 Single-wide Modbus table	20,999	42,001	62,999	42,001	62,999
<unused>	2,536	63,000	65,535	63,000	65,535

The significant advantage of this arrangement is that the absolute addresses of the 8832 and single-wide 8864 tables are unchanged. Note that the relative addresses are changed!

Also note that with the “8832 Modbus AddrTbl Start” field set to “0” there is no longer a difference between “relative” and “absolute” addresses.

The second way is to move the 8832 and 8864 single-wide tables down in the Modbus address space so that the new double-wide tables can now fit at the end of the Modbus map:

8832 Modbus AddrTbl Start : 0  
 8832 Modbus InputTbl Start : 4  
 8832 Modbus OutputTbl Start : 1004

Enable 8864 MODBUS Tables : Y  
 8864 MODBUS Table Start : 2000

Enable Double-Wide Tables : Y  
 Double-Wide Table Start : 23002

Modbus table	Number of Registers	Start Address (absolute)	End Address (absolute)	Start Address (relative)	End Address (relative)
Legacy 8832 Modbus Address Table	4	0	3	0	3
Legacy 8832 Modbus Input Table	1,000	4	1,003	4	1,003
Legacy 8832 Modbus Output Table	203	1,004	1,206	1,004	1,206
<unused>	793	1,207	1,999	1,207	1,999
8864 Single-wide Modbus table	20,999	2,000	22,998	2,000	22,998
<unused>	3	22,999	23,001	22,999	23,001
New 8864 double-wide Table	23,998	23,002	46,999	23,002	46,999
<unused>	18,536	47,000	65,535	47,000	65,535

The significant advantage of this arrangement is that the relative addresses of the 8832 and single-wide 8864 tables are unchanged. Note that the absolute addresses are changed!

Also note that with the “8832 Modbus AddrTbl Start” field set to “0” there is no longer a difference between “relative” and “absolute” addresses.

A third possible approach is to not enable the 8864 single-wide Modbus table at all, and instead enable only the double-wide table:

8832 Modbus AddrTbl Start : 40001  
 8832 Modbus InputTbl Start : 40005  
 8832 Modbus OutputTbl Start : 41005

Enable 8864 MODBUS Tables : N  
 8864 MODBUS Table Start : 42001

Enable Double-Wide Tables : Y  
 Double-Wide Table Start : 41301

#### Default 8864 Modbus Map

Modbus table	Number of Registers	Start Address (absolute)	End Address (absolute)	Start Address (relative)	End Address (relative)
Legacy 8832 Modbus Address Table	4	40,001	40,004	0	3
Legacy 8832 Modbus Input Table	1,000	40,005	41,004	4	1,003
Legacy 8832 Modbus Output Table	203	41,005	41,207	1,004	1,206
<unused>	93	41,208	41,300	41,208	41,300
New 8864 double-wide Table	23,998	41,301	65,298	41,301	65,298
<unused>	237	65,299	65,535	65,299	65,535

The advantage of this approach is that all 8832 legacy register addresses (both absolute and relative) are preserved. The disadvantages are:

- The single-wide registers are not available, and
- Most importantly, the 8864 flag registers are not available.

## Numerical Values in Modbus Registers

Topics in this section include the following:

- [Scaling Factors](#)
- [Integers](#)
- [Floating Point Numbers](#)
- [LSW or MSW First](#)

### Scaling Factors

Because the Modbus interface uses 16-bit registers for integer numeric values, which are interpreted as signed integers (2's complement), some manipulation must be performed to map floating point numbers in and out of these registers. Each channel may be assigned a scaling factor for this conversion; the default scaling factor is 0.01. The relevant formulas are:

- Input Table Value (read by Client) = value in 8864 ÷ scaling factor
- Output Table Value (written by Client) = value written × scaling factor

Using the default scaling factor, an SO<sub>2</sub> channel with a value of 34.56 ppm would be read by the Modbus Client as 3,456.

A TEMPF channel with a value of -5.25 degF would be read by the Modbus Client as -525 (or 65,011 if the Client views the register as an unsigned integer). If the Modbus Client wrote a value of 1,890 to the register for the LOAD Modbus channel, the 8864 would report a value of 18.9 MW.



**NOTE:** Modbus scaling factors are configured by pressing <Ctrl><D> at the channel configuration screen.

---

### Integers

Single-precision integers are represented in one 16-bit register. They are 2's complement numbers and range from -32768 to +32767. The number -32768 (0x8000 in hexadecimal) is used as a special "invalid" number.

Double-precision integers are represented in two registers (32 bits) and are also 2's complement ranging from -2,147,483,648 to +2,147,483,647. The number -2,147,483,648 (0x8000 0000 hexadecimal) is considered invalid. By default, the least-significant word

(register) of the number is at the lowest Modbus register address.

## Floating Point Numbers

Single-precision floating point numbers occupy two 16-bit registers (32 bits) and represent values to approximately 7-decimal-digits of precision in a format conforming to the IEEE Standard 754. By default, the least-significant word (register) of the number is at the lowest Modbus register address.

Double-precision floating point numbers are represented as 4-register, 64-bit numbers in IEEE 754 format, with the LSW first (by default). Double-floats can maintain approximately 15-decimal-digits of precision.

No scaling factor is used for the floating-point numbers as decimals and exponentials are already handled by the format. If a scaling factor is configured, it is ignored. Because each floating-point value is represented by multiple 16-bit registers, a single Write Register command 06 cannot be used to transfer a point of data to a channel in the 8864 Data Controller.

## LSW or MSW First

The Modbus MSW First field in the channel configuration is used to set which register (the least-significant or the most-significant) comes first (i.e., at the lowest Modbus register address) for those numeric values that span multiple registers. The default is LSW first. For example, the decimal number 1,234. is represented in the Modbus registers as follows (register values are shown as hexadecimal):

LSW First (default)				
	smallest address		largest address	
Single integer	04D2			
Single float	4000	449A		
Double Integer	04D2	0000		
Double float	0000	0000	4800	4093

MSW First				
	smallest address		largest address	
Single integer	04D2			
Single float	449A	4000		
Double Integer	0000	04D2		
Double float	4093	4800	0000	0000

## Legacy 8832 Status Words

Each of the 16-bit status words in the Legacy 8832 Input Table for minute and extended averages are mapped to the normal 8864 flags as follows:

Bit	Flag
bit 15 (MSB)	< (data invalid)
bit 14	T (out-of-control)
bit 13	F (boiler offline)
bit 12	B (bad status)
bit 11	C (in calibration)
bit 10	M (in maintenance)
bit 9	H (high-high alarm)
bit 8	L (low-low alarm)
bit 7	P (power failure)
bit 6	D (channel disabled)
bit 5	O   U   A (overrange/underrange)
bit 4	-   +   R (limit exceeded)
bit 3	h (high alarm)
bit 2	l (low alarm)
bit 1	V (digital information #1)
bit 0 (LSB)	(unused)

## 8864 Modbus Table Status Words

In the 8864 Modbus Table, 64 bits are allocated across two registers for each of the instantaneous, base, extended 1, and extended 2 averages as follows:

Lower address register		Higher address register	
Bit	Flag	Bit	Flag
bit 15 (MSB)	< (data invalid)	bit 15 (MSB)	> (valid, but some missing)

Lower address register		Higher address register	
Bit	Flag	Bit	Flag
bit 14	T (out-of-control)	bit 14	t (out-of-control)
bit 13	F (boiler offline)	bit 13	p (boiler offline)
bit 12	B (bad status)	bit 12	O (analog overrange)
bit 11	C (in calibration)	bit 11	U (analog underrange)
bit 10	M (in maintenance)	bit 10	- (minimum limit)
bit 9	H (high-high alarm)	bit 9	+ (maximum limit)
bit 8	L (low-low alarm)	bit 8	J (high rate-of-change limit)
bit 7	P (power failure)	bit 7	j (low rate-of-change limit)
bit 6	D (channel disabled)	bit 6	f (floor limit)
bit 5	A (arithmetic error)	bit 5	c (ceiling limit)
bit 4	R (rate-of-change limit)	bit 4	G (passed ceiling limit)
bit 3	h (high alarm)	bit 3	W (digital information #2)
bit 2	l (low alarm)	bit 2	X (digital information #3)
bit 1	V (digital information #1)	bit 1	Y (digital information #4)
bit 0 (LSB)	(unused)	bit 0 (LSB)	Z (digital information #5)

## Command Descriptions

The following sections contain a detailed description of the supported Modbus commands and the corresponding responses. Note that each field is designated by using the “<” and “>” characters, **but these characters are NOT part of the actual command.**

- [Read Coil Status \(01\)](#)
- [Read Holding Registers \(03\)](#)
- [Force Single Coil \(05\)](#)
- [Diagnostics \(08\)](#)
- [Force Multiple Coils \(15\)](#)
- [Write Multiple Registers \(16\)](#)
- [Report Server ID \(17\)](#)

### Read Coil Status (01)

The Read Coil Status command is used to read the status of the 8864 Digital Inputs.

**Command:****<ID><01><Starting Coil #><# Coils to Read><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte - hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
01	Modbus Read Coil Status command code (1 byte – hex).
Starting Coil #	The # of the first coil (digital input) to read (2 bytes – hex, high byte followed by low byte).
# Coils to Read	The # of coils (digital inputs) to read (2 bytes – hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

**Response:****<ID><01><# Bytes of Coil Data><Coils Data><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
01	Modbus Read Coil Status command code (1 byte – hex).
# Bytes of Coil Data	The # of bytes of Coils Data returned (1 byte – hex). This value is computed by dividing the # Coils to Read by 8 and adding 1 if the # Coils to Read is not evenly divisible by 8.
Coils Data	Coil states where each bit represents a coil (total bytes = # Bytes of Coil Data). The Starting Coil # state is returned in bit 0 of the first byte of the response.
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

## Read Holding Registers (03)

The Read Holding Registers command is used to read registers in any of the three Modbus tables. Register reads across table boundaries (e.g., Address Table into Input Table or Input



Table into Output Table) are allowed provided that the tables are contiguous in the Modbus memory map.

#### Command:

**<ID><03><Starting Register Address><# Registers to Read><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
03	Modbus Read Multiple Registers command code (1 byte – hex).
Starting Register Address	The address of the first register to read (2 bytes – hex, high byte followed by low byte). If this address is less than the starting address of the Address Table, it is assumed to be an index from the starting address of the Address Table.
# Registers to Read	The # of registers to read beginning at the address referenced by the Starting Register Address (2 bytes – hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

#### Response:

**<ID><03><# Bytes of Data><Registers Data><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
03	Modbus Read Multiple Registers command code (1 byte – hex).
# Bytes of Data	The # of bytes of Register Data returned (1 byte – hex). This value is computed by multiplying the # Registers to Read by 2.
Register Data	Data for the # of Registers to Read beginning at the address referenced by the Starting Register Address (total bytes = # Bytes of Data, high byte followed by low byte for

Response	Explanation
	each register).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

## Force Single Coil (05)

The Force Single Coil command is used to activate or deactivate a single 8864 Digital Output. Care must be used when issuing this command since doing so updates the state of the corresponding relay output, **regardless of any other control being performed by the 8864.**

### Command:

<ID><05><Coil#><Coils State><CRC16>

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte, e.g., a Modbus ID of 100 is transmitted as hex 64).
05	Modbus Force Single Coil command code (1 byte – hex).
Coil #	The # of the coil (digital output) to force (2 bytes – hex, high byte followed by low byte).
Coils State	The requested state of the coil (digital output) to force (2 bytes – hex, high byte followed by low byte). A value of 0xFF00 requests that the coil be activated. A value of 0x0000 requests that the coil be deactivated.
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

### Response:

<ID><05><Coil #><Coil State><CRC16>

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).

Response	Explanation
05	Modbus Force Single Coil command code (1 byte – hex).
Coil #	The # of the coil (digital output) to force (2 bytes – hex, high byte followed by low byte).
Coil State	The requested state of the coil (digital output) to force (2 bytes – hex, high byte followed by low byte). A value of 0xFF00 requests that the coil be activated. A value of 0x0000 requests that the coil be deactivated.
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

### Write Single Register (06)

The Write Single Register command is used to write data to a single register in the Output Table.

#### Command:

**<ID><06><Register Address><Register Data><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
06	Modbus Preset Single Register command code (1 byte – hex).
Register Address	The address of the register to write (2 bytes – hex, high byte followed by low byte). If this address is less than the starting address of the Address Table, it is assumed to be an index from the starting address of the Address Table.
Register Data	Data to write at the Register Address (2 bytes – hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

#### Response:

**<ID><06><Register Address><Register Data><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
06	Modbus Preset Single Register command code (1 byte – hex).
Register Address	The address of the register to write (2 bytes – hex, high byte followed by low byte).
Register Data	Data to write at the Register Address (2 bytes – hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

## Diagnostics (08)

The Diagnostics command is used to echo a command and to set or reset “listen only mode.”

### Command:

**<ID><08><Code><Data><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
08	Modbus Diagnostics command code (1 byte – hex).
Code	Diagnostics code (2 bytes – hex, high byte followed by low byte). Valid codes are 0, 1, and 2 where the following actions are taken: 0 – Echoes entire string as response 1 – Resets “listen only mode” if Data is 0x00 or 0xFF00 2 – Sets “listen only mode” if Data is 0x00.
Data	Data for the Code (2 bytes, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes, high byte followed by low byte).

**Response (for Codes 0 and 1):****<ID><08><Code><Data><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
08	Modbus Diagnostics command code (1 byte – hex).
Code	Diagnostics code (2 bytes – hex, high byte followed by low byte).
Data	Data for the Code (2 bytes – hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

**Response (for Code 2):****<ID><08><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
08	Modbus Diagnostics command code (1 byte – hex).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

## Force Multiple Coils (15)

The Force Multiple Coils command is used to activate or deactivate multiple consecutive 8864 Digital Outputs with a single command. Care must be used when issuing this command since doing so updates the state of the corresponding relay outputs, **regardless of any other control being performed by the 8864.**

**Command:**

**<ID><0F><Starting Address><Num of Outputs><Byte Count><Outputs Value><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
0F	Modbus Force Multiple Coil command code (1 byte - hex).
Starting Address	The number (address) of the 1 <sup>st</sup> coil in the sequence (2 bytes – hex)
Num of Outputs	The requested number of coils to be activated or deactivated. (2 bytes – hex)
Byte Count	Number of bytes containing Outputs Value (N* – hex) (*N = Num of Outputs / 8 → if the remainder is not 0 then N = N+1.)
Outputs Value	N* x 1 bytes. (Bits not used set to 0) Example setting 10 coils starting at coil 20 (2 bytes 0xCD01) (1100 1101 0000 0001 bin) Bit: 1100110100000001 Coil: 2726252423222120-----2928
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

#### Response:

**<ID><0F><Starting Address><Num of Outputs><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
0F	Modbus Force Multiple Coil (15) command code in hex format (1 byte - hex).
Starting Address	The number (address) of the 1 <sup>st</sup> coil in the sequence (2 bytes – hex)
Num of Outputs	The requested number of coils to be activated or deactivated. (2 bytes – hex)
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

## Write Multiple Registers (16)

The Write Multiple Registers command is used to write data to multiple registers in the Output Table.

### Command:

**<ID><10><Starting Register Address><# of Registers to Write><Byte Count of Data><Register Data><CRC16>**

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
10	Modbus Write Multiple Registers command code (1 byte - hex).
Starting Register Address	The address of the first register to write (2 bytes – hex, high byte followed by low byte - hex). If this address is less than the starting address of the Address Table, it is assumed to be an index from the starting address of the Address Table.
# of Registers to Write	The # of registers to write data beginning at the address referenced by the Starting Register Address (2 bytes – hex, high byte followed by low byte - hex).
Byte Count of Data	The # of data bytes to write (1 byte - hex).
Register Data	Data to write beginning at the address referenced by the Starting Register Address (total bytes = Byte Count of Data, high byte followed by low byte for each register - hex).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

### Response:

**<ID><10><Starting Register Address><# of Registers to Write><CRC16>**

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte - hex, e.g., a Modbus ID of 100 is transmitted as hex 64).

Response	Explanation
10	Modbus Write Multiple Registers command code (1 byte - hex).
Starting Register Address	The address of the first register to write (2 bytes - hex, high byte followed by low byte).
# of Registers to Write	The # of registers to write data beginning at the address referenced by the Starting Register Address (2 bytes - hex, high byte followed by low byte).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes - hex, high byte followed by low byte).

## Report Server ID (17)

The Report Server ID command returns a description of the type of 8864 Data Controller present at the server address, the current status of the server Run indicator, and other information specific to the server device.

### Command:

<ID><11><CRC16>

Command	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
11	Modbus Report Server ID command code (1 byte – hex).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

### Response:

<ID><11><Byte Count><Server ID Device><Run Indicator Status><Additional Data><CRC16>

Response	Explanation
ID	Modbus ID of the 8864 Data Controller (1 byte – hex, e.g., a Modbus ID of 100 is transmitted as hex 64).
11	Modbus Report Server ID command code (17) in hex



Response	Explanation
	format (1 byte – hex).
Byte Count	The number of data bytes to follow (1 byte – hex, always 09 for this command).
Server ID Device	The server ID device code (1 byte – hex, always 03 for this command corresponding to a Modicon 584 Controller).
Run Indicator Status	Current status of the server Run indicator (1 byte – hex, always 0xFF for this command indicating ON).
Additional Data	Additional information specific to the server device (7 bytes – hex, all data 0x00 for this command).
CRC16	Cyclic Redundancy Check based on all preceding bytes beginning with the Modbus ID (2 bytes – hex, high byte followed by low byte).

# App Note - Modbus Client

The 8864 Data Controller can function as a Modbus Client over the Ethernet port and/or the serial ports. The Modbus Client functionality is configured with a text file that is transferred or downloaded to the 8864 Data Controller. The data is stored to or sent from a separate internal client table that is accessed with normal Modbus commands. The 8864 Client supports Modbus commands 1 through 6, 15, and 16.

See the following sections for more information:

- [Modbus Client Over Ethernet Ports](#)
- [Modbus Client Over Serial Ports](#)
- [Modbus Commands](#)
- [Modbus Client Data Table](#)
- [Modbus Client Status Information](#)
- [Modbus Configuration File](#)

## Modbus Client Over Ethernet Ports

Commands can be sent over Ethernet when a TCP/IP connection is established with the configured IP address and Port 502. Multiple connections may be established with multiple IP addresses.

The given port number, 502, may be changed in the configuration file. However, Port 502 has been established as the industry standard Modbus port and some Modbus servers, including the 8864, will only accept connections on this port.

## Modbus Client Over Serial Ports

Commands can be sent over the serial ports. Each port can be configured individually with a separate list of commands. The baud rate and interface type of each serial port is set in the system configuration menus. The interface type of a serial port that the Modbus Client is to use is "MODBUSM."

## Modbus Commands

The Modbus client supports commands 1 through 6, 15, and 16. Of these commands, only commands 3 and 16 support floating point operations. The primary action of the command is performed on the server. For instance, a "read coil status" command reads the specified coils from the server. A "write single register" command writes a value to the specified register in

the server.



**NOTE:** It is the responsibility of the user to take into account that floating-point registers occupy two regular Modbus registers.

Command ID	Description
1	Read Coil Status
2	Read Input Status
3	Read Holding Registers (Supports Floating Point)
4	Read Input Registers
5	Force Single Coil
6	Write Single Register (Supports Floating Point)
15	Force Multiple Coils
16	Write Multiple Registers (Supports Floating Point )

## Modbus Client Data Table

The Modbus Client uses a 100,000-register table (Address 0-99999) for storing data values. This table is separate and in addition to the 8864 Modbus server table. A loss of power or a reboot will cause any existing data in this table to be lost.

Read commands (1, 2, 3, 4) read the specified values from the server and store them in the specified locations in the Modbus Client data table. Write commands (5, 6, 15, and 16) take values from the specified locations in the Modbus Client data table and write them to the specified locations in the server.

Client and Server data table addresses specified in coil commands (1, 2, 5, 15) are treated as coil addresses, i.e., bit addresses. Client and Server data table addresses specified in register commands (3, 4, 6, 16) are treated as register addresses. Client data table addresses are treated as absolute. An offset is never applied to a Client data table address.

## Modbus Client Status Information

Status information is available for the Modbus Client when you select:

- From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**) > **T - View Modbus Client Table** (hot key **T**).

From the Modbus Master Table Menu, you can enter any valid register number (0-99999) and view that portion of the table by selecting **View Table**.

A sample screen starting at address 0 is shown in the next example. Register values display as

hex numbers. Information in the screen updates once per second.

ESC 8864 v5.02.r25 ID:88 Modbus Client Table 12/11/17 15:07:23									
00000:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00008:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00016:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00024:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00032:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00040:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00048:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00056:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00064:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00072:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00080:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00088:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00096:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00104:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00112:	0000	0000	0000	0000	0000	0000	0000	0000	0000
00120:	0000	0000	0000	0000	0000	0000	0000	0000	0000
Press any key to continue.									

## Modbus Configuration File

A text configuration file is used to configure the Modbus Client on the 8864 Data Controller. The file MUST BE named server.cfg (all lower case); any other file name will not be accepted. The downloaded file is then stored in configuration space, which will be maintained over power outages and reboots.

To view a downloaded configuration file:

1. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).
2. Select **C - View Modbus Client Cfg File** (hot key **C**) to open the Modbus Master Cfg File Menu screen.

Modbus server devices present in the server.cfg file can be enabled or disabled. When disabled, poll attempts are no longer made from the client to the server. When enabled, poll attempts from the client to the server are attempted as usual.

Separate status tables are created for Ethernet devices by IP address and for serial devices by node address. Tables are created on reboot and when a new server.cfg file is downloaded, and contain a maximum of 16 entries per table.

See the following sections for more information:

- [Load server.cfg](#)
- [File Configuration](#)
- [Module Section](#)
- [Client n Section](#)
- [Port 0 Section](#)
- [Ports 1, 2 & 3 Section](#)
- [Data Map Section](#)
- [Modbus Client Error/Status Information](#)
- [Sample Server.cfg File](#)
- [Modbus Client Timing](#)
- [Parallel Modbus Example](#)

## Load server.cfg

To transfer a server.cfg file to the 8864, follow the procedure in the installation guide “[Load server.cfg](#)”.

## File Configuration

The table below shows an example of a configuration file. The configuration file is divided in up to 21 sections demarked by [text]. Do not modify any line containing these headings.



**IMPORTANT:** Minor changes to the file can have significant effects on the proper operation of the 8864. Modify only the areas clearly marked and discussed as available for modification. Other changes will have unpredictable results.



**NOTE:** To maintain backwards compatibility, section headers in the server.cfg file can be named either with 8832 in the header or with 8864.

All lines beginning with “#” are comment lines. Commands should be added and deleted between the “START” and “END” lines. The “START” and “END” lines **MUST** be present, and all commands should be located on single lines between them. Blank lines are permissible.

Section Heading*	Description
[Module]	Identifying name for the file.
[Client 0]	TCP/IP configuration

Section Heading*	Description
[Client 0 Commands]	Commands executed on TCP/IP port.
[Client 1]	TCP/IP configuration
[Client 1 Commands]	Commands executed on TCP/IP port.
... (through)	
[Client 9]	TCP/IP configuration
[Client 9 Commands]	Commands executed on TCP/IP port.
[Port 0]	Serial port 0 configuration.
[Port 0 Commands]	Commands executed on serial port 0.
[Port 1]	Serial Port 1 configuration.
[Port 1 Commands]	Commands executed on serial port 1.
[Port 2]	Serial Port 2 configuration.
[Port 2 Commands]	Commands executed on serial port 2.
[Port 3]	Serial Port 3 configuration.
[Port 3 Commands]	Commands executed on serial port 3.
[Data Map]	Data map commands.
* To maintain backwards compatibility, section headers in the server.cfg file can be named either with "8832" in the header or with "8864", or with no indicator at all. For example, "[8832 Client 0]", "[8864 Client 0]", or simply "[Client 0]" are all acceptable.	

## Module Section

The Module section has one entry, the module name. Do not modify anything preceding the ":". Any text after the ":" can be modified. This name should not span more than one line.

Entry	Description
Module Name: 8864-Modbus-Master	Description of Module

## Client n Section

Up to 10 "Client n" sections can be configured. These should be named "Client 0" up to "Client 9". These sections define the configuration of the TCP/IP portion of the Modbus Client.

Entry	Description
Minimum Command Delay :100	Minimum number of milliseconds (msec) between

Entry		Description
		commands.
Enable/ Command Delay	:Y	Enable or disable Minimum Command Delay.
Response Timeout	:1000	Response timeout in milliseconds.
Retry Count	:5	Number of times to retry a failed command.
Status Registers	:8000	Starting address of status registers
Run in parallel	:N	Run this section in parallel
Delay After Retries	:50	#Time to wait after retries before trying again (0.1 sec, 0 = use poll interval)
Float Flag	:No	Indicates floating point data.
Float Start	:7000	Register offset in message for floats.
Float Offset	:2000	Internal address for floats.



**NOTE:** Each of the above entries may be present or not, except that the “Float Offset” entry must be present and must be last in the list. Also note that beginning with firmware Version 6.0 and higher, entries with Y/N selections are not case sensitive. Any string after the colon “:” that starts with **Yes**, **Y**, or **y** is valid for enabling a feature, as is **No**, **N**, or **n** for disabling the feature.

The following list provides a description of the items in the previous table:

- **Minimum Command Delay:** Minimum number of milliseconds (msec) between sending two sequential commands in the same server.cfg section. When a command is sent, the next subsequent command in the same section is not sent until the “Minimum Command Delay” has elapsed for the preceding sent command. When enabled, the “Minimum Command Delay” will always be applied, which means the time between commands being sent may be greater than the “Minimum Command Delay” due to turn-around-time of the first command. When using “Minimum Command Delay,” make sure to configure [Enable Command Delay](#) as “yes”. When [Enable Command Delay](#) is configured as “no,” a command delay is not applied.
- **Enable Command Delay:** Enable or disable [Minimum Command Delay](#). The command is disabled by default. To enable [Minimum Command Delay](#), type Yes, Y, or y. To disable the feature, type No, N, or n. This field is not case sensitive. If “Minimum Command Delay” is configured with a delay time, but [Enable Command Delay](#) is configured as “no”, a command delay is not applied. Make sure “Enable Command Delay” is configured as Y (es) when using the “Minimum Command Delay” option.

- **Response Timeout:** Specifies the amount of time, in milliseconds, to wait for a response. For instance, to wait for one second, enter 1000.
- **Retry Count:** Specifies the number of times that a failed command is retried. The command is not retried immediately and processing continues to the next command in the same command section. The failed command is retried after the poll interval time has elapsed on the next pass through the command section this command is in. If a command fails the same number of times as specified by the retry count, the amount of time until it is attempted again is either the poll delay or the "Delay After Retries" if configured. See [Delay After Retries](#) in this topic for more information. The 8864 supports a maximum of 5 retries.
- **Status Registers:** Specifies the register in the client table where the status registers start. See the section [Modbus Client Error/Status Information](#).
- **Run in parallel:** Specifies if the commands in the current "Client n" section are processed in parallel with the commands in other sections. If "N" then this section will be processed serially with other sections that have "Run in parallel" = "N". If this line does not exist, then the 8864 defaults to "N". If all the sections are set to "N", then the 8864 works the same as the 8832 (and the 8864 prior to version v5.01). Even if this option is set to "Y", all commands in this section are processed serially (one after the other) – but multiple sections are all processed in parallel. For non-parallel operation, the order that the sections are processed is: Client 0-9, Port 0-3, then Data Map.
- **Delay After Retries:** Sets how long the Modbus client will wait after a Modbus command fails (and the number of retries have been exhausted) before it tries again. Specified in tenths of a second (for example, 100 = 10.0 seconds). If this value is 0, then the delay after retries will be set to the "Poll Interval" of the command that failed. The value will default to 50 (5.0 seconds) if the option is omitted
- **Float Flag:** Not currently used.
- **Float Start:** Not currently used.
- **Float Offset:** Not currently used but **must** be present and **must** be last in the list.

It is the user's responsibility to keep integer registers and floating-point registers separated in the server and client tables. The Modbus Client supports floating point registers, but does not treat them differently from integer registers. To read one floating point register, the Client must be configured to read two integer registers with the appropriate starting address. The two register values will then be saved at the specified locations in the Client table.

Also see [Client n Commands Section](#).



## Client n Commands Section

This section describes the format for the command entries for Client 0 to Client 9. Each entry is a single line with the fields described below separated by spaces. To maintain readability, the fields should be kept at fixed widths for each command line.

First Command		
Entry		Text
Enab	1	Enable command
Intern Addr	1000	Internal 8864 Client table register or bit address. If this address is bracketed "[43001]" then the address will reference the Internal Modbus Server Table register or bit address.
Poll Delay	10	Desired Delay between issuance of this command.
Reg Count	16	Register or bit count.
Swap Code	0 or 1	Applies to instruments that have a non-standard arrangement of floating point registers. For more information, see the description for Swap Code on the next page.
Node IP Addr	10.4.4.10	Server IP address.
Serv Port	502	TCP port to use to communicate with Remote Server.
Node Addr	100	Remote Modbus Server ID code.
Func Code	3	Modbus Command ID.
Addr In Dev	9	Register or bit address in Remote Modbus Server.
Hold On Timeout	0 or 1 (optional)	0 = If the command times out, write "8000" (hexadecimal) to the Client Table register. 1 = If the command times out, do not write anything to the Client Table register. This entry is optional and defaults to "0".

Second Command		
Entry		Text
Enab	1	Enable command
Intern Addr	[43001]	Internal 8864 Server table register or bit address. If this address is bracketed "[43001]" then the address will reference the Internal Modbus Server Table register or bit address.
Poll Delay	10	Desired Delay between issuance of this command.
Reg Count	1	Register or bit count.
Swap Code	0 or 1	Applies to instruments that have a non-standard arrangement of floating point registers. For more information, see the description for Swap Code on the next page.
Node IP Addr	10.4.4.10	Server IP address.
Serv Port	502	TCP port to use to communicate with Remote Server.
Node Addr	100	Remote Modbus Server ID code.
Func Code	3	Modbus Command ID.
Addr In Dev	9	Register or bit address in Remote Modbus Server.
Hold On Timeout	0 or 1 (optional)	0 = If the command times out, write "8000" (hexadecimal) to the Client Table register. 1 = If the command times out, do not write anything to the Client Table register. This entry is optional and defaults to "0".

Example of the two command lines as previously described above (see next example):

**First Command:** Read 16 registers starting at register address 9 from Modbus Server (10.4.4.10:port 502, ID=100) and store them at address 1000 in the 8864 Client table.

**Second Command:** Read 1 register starting at register 9 from Modbus server (10.4.4.10:port 502, ID=100) and store them directly in channel #1 instantaneous data value in the 8864 Server table without using the Data Map.

[8864 Client 0 Commands]										
START										
#	1	2	3	4	5	6	7	8	9	10
#		DB	Poll	Reg	Swap		Serv	Slave	Func	Address
#Enab	Addr	Delay	Count	Code	Node	IP Address	Port	Addr	Code	In Dev
1	1000	10	16	0		10.4.4.10	502	100	3	9
1	[43001]	10	1	0		10.4.4.10	502	100	3	9
END										

- **Enab** indicates whether the command is enabled. To enable the command, enter “1.” To disable the command, enter “0.”
- **Intern Addr** is the 8864 Client table register or bit address to be used in this command. For a register command (3, 4, 6, 16), this is a register address. For a coil command (1, 2, 5, 15), this is a coil or bit address. For a read command, 1, 2, 3, 4, this is where the value from the Server is stored. For a write command (5, 6, 15, 16), the value written to the Remote Modbus Server is obtained from this address. If this address is bracketed “[43001]” then the address will reference the Internal Modbus Server Table register or bit address.
- **Poll Delay** is the desired delay, in tenths of seconds, between issuance of this command. To send the command once a second, enter 10. The command will not be sent more often than once every 500 milliseconds (a value of 5). Variances in response times from other commands in the server.cfg file will probably increase the actual delay.
- **Reg Count** is the number of registers or coils to be written or read in this command. For a coil command (1, 2, 5, 15), this refers to the number of coils or bits. For a register command (3, 4, 6, 16), this refers to the number of registers. For the 5 and 6 command, this field is not used but should be set to 1.
- **Swap Code** MUST be present. The Modbus configuration file server.cfg supports Swap Code for instruments that use a non-standard arrangement of floating point registers.

Valid values for Swap Code are either 0 or 1. Setting the Swap Code value as 1 for any data map command in the Modbus server config file (only for Modbus functions 3 and 16) reverses the mapping for any registers mapped by that particular command with the most significant 16-bit word in an even numbered register and the least significant 16-bit word in the next highest odd numbered register.

Swap Code Value	Definition	Example
0	Bytes left in original order	(0xABCD -> 0xABCD)
1	16-bit words are swapped	(0xABCD -> 0xCDAB)

- **Node IP Addr** is the IP address of the Server (must be an IP address and not a name to be resolved to an IP address). This implies that the Server has a fixed IP address.
- **Serv Port** is the TCP port used to communicate with the Server. In most cases, this should be left as 502.
- **Node Addr** is the Modbus ID code of the Remote Modbus Server.

- **Func Code** is the Modbus command ID. The 8864 Modbus Client supports commands 1, 2, 3, 4, 5, 6, 15, and 16.
- **Addr in Dev** is the register or bit address in the Remote Modbus Server. For a register command (3, 4, 6, 16), this is a register address. For a coil command (1, 2, 5, 15), this is a coil or bit address.
- **Hold on Timeout** (optional) determines what to do if the command times out. If this entry is 0 (or is not present) and if the command times out, then a value of "8000" (hexadecimal, -32768 decimal) is written to the Client Table register to indicate that an error occurred. If this entry is 1 and the command times out, then do not write anything to the Client Table register. This entry is optional and defaults to "0" to maintain backwards compatibility with the 8832.

## Port 0 Section

This section defines the configuration for Serial Port 0 portion of the Modbus Client. To maintain readability, the fields should be kept at fixed widths for each command line.

Entry		Text
Enabled	:Y	Port enable flag.
Response Timeout	:1000	Response timeout in milliseconds.
Status Registers	:8000	Starting address of status registers.
Run in parallel	:N	Run this section in parallel.
Delay After Retries	:50	#Time to wait after retries before trying again (0.1 sec, 0 = use poll interval)
Protocol	:RTU	Modbus protocol.
Float Flag	:No	Indicates floating point data.
Float Start	:7000	Register offset in message for floats.
Float Offset	:2000	Internal address for floats.
Protocol	:RTU	Modbus protocol.



**NOTE:** Each of the above entries may be present or not, except that the "Float Offset" entry must be present and must be last in the list. Also note that beginning with firmware Version 6.0 and higher, entries with Y/N selections are not case sensitive. Any string after the colon ":" that starts with **Yes**, **Y**, or **y** is valid for enabling a feature, as is **No**, **N**, or **n** for disabling the feature.

The following list provides a description of the items in the previous table:

- **Enabled** enables or disables the port for use. To send commands out the serial port, set the entry to Y(es). To not use the serial port, set the entry to N(o). The port cannot be enabled to send Modbus Commands if the port “Interface type” is not configured as MODBUSM (see System Configuration Setup).
- **Response Timeout** specifies the amount of time, in milliseconds to wait for a response. For example, to wait for one second, enter 1000.
- **Status Registers** specify the register in the client table where the status registers start. See [Modbus Client Error/Status Information](#).
- **Run in parallel** with the commands in other sections. If “N” then this section will be processed serially with other sections that have “Run in parallel” = “N”. If this line does not exist then the 8864 defaults to “N”. If all of the sections are set to “N”, then the 8864 works the same as the 8832 (and the 8864 prior to version v5.01). Even if this option is set to “Y”, all commands in this section are processed serially (one after the other) – but multiple sections are all processed in parallel. For non-parallel operation, the order that the sections are processed is: Client 0-9, Port 0-3, then Data Map.
- **Delay After Retries:** Sets how long the Modbus client will wait after a Modbus command fails (and the number of retries have been exhausted) before it tries again. Specified in tenths of a second (for example, 100 = 10.0 seconds). If this value is 0, then the delay after retries will be set to the “Poll Interval” of the command that failed. The value will default to 50 (5.0 seconds) if the option is omitted
- **Protocol** determines the Modbus protocol to be used on this serial port. To set the port to RTU, enter “R” or “RTU.” Currently Modbus RTU is the only Serial Modbus protocol supported on the 8864 Data Controller.
- **Float Flag** is not currently used.
- **Float Start** is currently not used.
- **Float Offset** is currently not used, but **must** be present and **must** be last in the list.

Also see [Port 0 Commands Section](#).

## Port 0 Commands Section

This section defines the commands that are sent over serial port 0. To maintain readability, the fields should be kept at fixed widths for each line.

First Command	
Entry	Text
<b>Enab: 1</b>	Enable command
<b>Internal Addr: 1000</b>	Internal 8864 Client table register or bit address. If this address

First Command	
Entry	Text
	is bracketed "[43001]" then the address will reference the Internal Modbus Server Table register or bit address.
<b>Poll Interval : 10</b>	Delay between sets of commands.
<b>Reg Count : 16</b>	Register or bit count.
<b>Swap Code : 0</b>	Not used.
<b>Node Addr: 100</b>	Modbus ID of Server.
<b>Modbus Func : 3</b>	Command ID.
<b>Addr In Dev: 9</b>	Register or bit address in Server.

Second Command	
Entry	Text
<b>Enab: 1</b>	Enable command
<b>Internal Addr: 1000</b>	Internal 8864 Client table register or bit address. If this address is bracketed "[43001]" then the address will reference the Internal Modbus Server Table register or bit address.
<b>Poll Interval : 10</b>	Delay between sets of commands.
<b>Reg Count : 16</b>	Register or bit count.
<b>Swap Code : 0</b>	Not used.
<b>Node Addr: 100</b>	Modbus ID of Server.
<b>Modbus Func : 3</b>	Command ID.
<b>Addr In Dev: 9</b>	Register or bit address in Server.

Below is an example of the command lines as previously described above (with comment headers):

**First Command:** Read 16 registers starting at register address 9 from the Modbus Server (ID=100) connected to serial port 0 and store them at address 1000 in the 8864 Client table.

**Second Command:** Read 1 register starting at register address 9 from the Modbus Server (ID=100) connected to serial port 0 and store them directly in channel #1 instantaneous data value in the 8864 Server table without using the Data Map.

[8864 Port 0 Commands]								
#	1	2	3	4	5	6	7	8
#	Internal	Poll	Reg	Swap	Node	Modbus	MB Address	
#Enab	Address	Interval	Count	Code	Address	Func	in Device	
1	1000	10	16	0	100	3	9	
1	[43001]	10	1	0	100	3	9	

The following list provides a description of the command line previously noted in the table above:

- **Enab** indicates whether the command is enabled. To enable the command, enter “1.” To disable the command, enter “0.”
- **Internal Addr** is the Client table register or bit address to be used in this command. For a register command (3, 4, 6, 16), this is a register address. For a coil command (1, 2, 5, 15), this is a coil or bit address. For a read command (1, 2, 3, 4), this is where the value from the Server is stored. For a write command (5, 6, 15, 16), the value written to the Server is obtained from this address. If this address is bracketed “[43001]” then the address will reference the Internal Modbus Server Table register or bit address.
- **Poll Interval** is the desired delay, in tenths of seconds, between issuances of this command. To send the command once a second, enter 10. The command will not be sent more often than once every 500 milliseconds (a value of 5). Variances in response times from other commands in the server.cfg file will probably increase the actual delay.
- **Reg Count** is the number of registers or coils to be written or read in this command. For a coil command (1, 2, 5, 15), this refers to the number of coils or bits. For a register command (3, 4, 6, 16), this refers to the number of registers. For the 5 and 6 command, this field is not used.
- **Swap Code** is not currently used, but MUST be present.
- **Node Address** is the Modbus ID code of the Server.
- **Modbus Func** is the Modbus command ID. The 8864 Modbus Client supports commands 1, 2, 3, 4, 5, 6, 15, and 16.
- **Address In Dev** is the register or bit address in the Server. For a register command (3, 4, 6, 16), this is a register address. For a coil command (1, 2, 5, 15), this is a coil or bit address.

## Ports 1, 2 & 3 Section

The sections for Serial Ports 1, 2 and 3 are identical to the section for Serial Port 0 except for the serial port number. See [Port 0 Section](#) for more information.

## Data Map Section

This section lists commands that are used to move data between the Modbus Client and Server

Tables located in the same data logger. For this reason, only the 1, 3, 5, 6, 15 and 16 commands are supported in this section.

Entry	Text
Run in parallel :N	Run this section in parallel



**NOTE:** The above entry may be present or not. Also note that beginning with firmware Version 6.0 and higher, entries with Y/N selections are not case sensitive. Any string after the colon “:” that starts with **Yes**, **Y**, or **y** is valid for enabling a feature, as is **No**, **N**, or **n** for disabling the feature.

**Run in parallel** specifies if the commands in the Data Map section are processed in parallel with the commands in other sections. If “N” then this section will be processed serially with other sections that have “Run in parallel” = “N”. If this line does not exist then the 8864 defaults to “N”. If all of the sections are set to “N”, then the 8864 works the same as the 8832 (and the 8864 prior to version v5.01). Even if this option is set to “Y”, all commands in this section are processed serially (one after the other) – but multiple sections are all processed in parallel. For non-parallel operation, the order that the sections are processed is: Client 0-9, Port 0-3, then Data Map.

### Data Map Commands Section

This section describes the format for the command entries for the Data Map section. Each entry is a single line with the fields described below separated by spaces. To maintain readability, the fields should be kept at fixed widths for each command line.

Entry	Text
<b>Enab: 1</b>	Enable command
<b>Int Client Addr: 1000</b>	Internal Modbus Client table register or bit address.
<b>Poll Interval : 10</b>	Desired Delay between sets of commands.
<b>Reg Count : 16</b>	Register or bit count.
<b>Swap Code : 0 or 1</b>	Must be present. See description below for further information.
<b>Modbus Func : 3</b>	Command ID.
<b>Int Server Addr: 9</b>	Internal Modbus Server Table register or bit address. If this address is bracketed “[1001]” and the “Modbus Func” is “1” then the address will reference the Internal Modbus Client Table register or bit address. This bracket addressing in the Data Map only works with Modbus Func “1”.



Below is an example of the command line as described above (with comment headers) – Read 16 registers from the Internal Server Table starting at register address 9 connected to serial port 0 and store them at address 1000 in the Internal Client Table.

#		Client	Poll	Reg	Swap	Func	Server
#	Enab	Addr	Delay	Count	Code	Code	Addr
	1	1000	10	16	0	3	9

The following list provides a description of the command line previously noted in the table above:

- **Enab** indicates whether the command is enabled. To enable the command, enter “1.” To disable the command, enter “0.”
- **Internal Client Address** is the Client table register or bit address to be used in this command. For a register command (3, 6, 16), this is a register address. For a coil command (1, 5), this is a coil or bit address. For a read command (1, 3), this is where the value from the Server is stored. For a write command (5, 6, 16), the value written to the server is obtained from this address.
- **Poll Interval** is the desired delay, in tenths of seconds, between issuances of this command. To send the command once a second, enter 10. The command will not be sent more often than once every 500 milliseconds (a value of 5). Variances in response times from other commands in the server.cfg file will probably increase the actual delay.
- **Reg Count** is the number of registers or coils to be written or read in this command. For a coil command (1, 5) this refers to the number of coils or bits. For a register command (3, 6, 16), this refers to the number of registers. For the 5 and 6 command, this field is not used but should be set to 1.
- **Swap Code** is used to determine if adjacent 16-bit registers should be swapped during the transfer. Valid values for Swap Code are either 0 or 1. Setting the Swap Code value as 1 for commands 3 and 16 reverses the mapping for any registers mapped, swapping the even registers with the adjacent odd registers. This is most useful when swapping the word order of floating-point numbers so that the least-significant register is swapped with the most-significant word in a 32-bit floating-point number. Command “1” in data map supports “Swap Code” if bracket addressing is being used. Setting the Swap Code value as 1 with Command “1” will cause the bits that are read from Client table address in column 7 to be written into the destination Client table address in column 2 in reverse order but only if bracket addressing is being used. If the Reg Count is “1”, then no change occurs and Swap Code value has no effect. In order to maintain backward compatibility, if the Command is “1”, and is not using bracket addressing (is reading from the Server table), then the swap code is ignored.

**Examples:**

- **Swap Code Value: 0**

Definition: Registers left in original order

Example (values in Hexadecimal): 5A73, 37DE, 457F, 1321 -> 5A73, 37DE, 457F, 1321

- **Swap Code Value: 1**

Definition: Successive registers are swapped

Example (values in Hexadecimal): 5A73, 37DE, 457F, 1321 -> 37DE, 5A73, 1321, 457F

- **Modbus Func Code** is the Modbus command ID. The 8864 Modbus Client supports commands 1, 3, 5, 6, 15 and 16 described as:
  - Command 1 reads the specified discrete inputs from the internal Server table and write them to the internal Client table. If bracket addressing [1001] is being used then Command 1 reads the specified discrete inputs from the internal Client table specified in column 7 (labeled below as Int Server Addr) and writes them to the internal Client table specified in column 2 (labeled above as Internal Client Address).
  - Command 3 reads the specified registers from the internal Server table and write them to the internal Client table.
  - Command 5 reads a single coil from the internal Client table and writes it to the internal Server table.
  - Command 6 reads a single register from the internal Client table and writes it to the internal Server table.
  - Command 15 reads multiple coils from the internal Client table and writes them to the internal Server table.
  - Command 16 reads the registers from the internal Client table and write them to the internal Server table.
- **Int Server Addr** is the internal register or bit address in the Server table. For a register command (3, 6, 16), this is a register address. For a coil command (1, 5), this is a coil or bit address. If this address is bracketed "[1001]" and the "Modbus Func" is "1" then the address will reference the Internal Modbus Client Table bit address. This bracket addressing in the Data Map only works with Modbus Func "1" and only in this column.

## Modbus Client Error/Status Information

To view status information for a Modbus client:

1. Log in to the 8864 using the integrator-level user name and password.
2. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**).

## 3. Complete one of the following steps:

- a. To view by register number, select **T - View Modbus Client Table** (hot key **T**).

The table updates once per second.

**- or -**

- b. To view the server.cfg file, select **C - View Modbus Client Cfg File** (hot key **C**).  
Type the file name (server.cfg) and then press <Enter>.

The server.cfg file cannot be edited on the 8864.

The Modbus Client module also tracks errors and inserts them into the Modbus Client table. A block of errors is stored for each port and for each command enabled on that port.

The following table includes the default starting addresses of these error/status registers. Use the configuration file to change the locations. Refer to the “Status Registers” option in the [Client] and [Port] sections of this document (see [Client n Section](#) and [Port 0 Section](#)).

Port	Default Error/Status Registers Starting Address
Ethernet Port Client 0	6000
8864 Serial Port 0	6200
8864 Serial Port 1	6400
8864 Serial Port 2	6600
8864 Serial Port 3	6800
Ethernet Port Client 1	7000
Ethernet Port Client 2	7200
Ethernet Port Client 3	7400
Ethernet Port Client 4	7600
Ethernet Port Client 5	7800
Ethernet Port Client 6	8000
Ethernet Port Client 7	8200
Ethernet Port Client 8	8400
Ethernet Port Client 9	8600

To view the error/status registers for a given port:

1. Log in to the 8864 using the integrator-level user name and password.
2. From the Home Menu, select **S - Status Menu** (hot key **S**) > **V - View Modbus Master Status** (hot key **V**) .
3. Select **T - View Modbus Client Table** (hot key **T**) to display the Modbus Master Table Menu.
4. Enter the register value as listed above for the port of interest. Then press **<Enter>**.

See the next table for a description of the error/status registers.

Offset	Error/Status Description
0	Number of commands sent.
1	Number of responses received.
2	Number of command errors.
3	Not used.
4	Not used.
5	Not used.
6	Not used.
7	Not used.
8	Current error code ( <a href="#">see next table</a> )
9	Last error code ( <a href="#">see next table</a> )
10	Latest error/status code for command 1
11	Latest error/status code for command 2
:	:
N	Latest error/status code for command N

The “Number of commands sent” register is an accumulation of the number of commands that have been sent on the port since the last 8864 re-boot. The “Number of responses received” register is an accumulation of the number of responses that have been received. The “Number of command errors” register is the difference between the number of commands sent and the number of responses received.

The “Current error code” register reflects the latest error/status code for the last command executed on the port. If all is working properly, this value should be zero (0). The “Last error code” Register reflects the last error code recorded for any command executed on the port. Serial port error codes are currently limited to a response timeout value of -11. Ethernet ports currently have two error codes, -33 for no connection and -36 for response timeout.

After the first ten error/status registers, there are error/status codes for each command enabled on the port. A single register is used for each command status. In addition to the error codes of -11, -33, and -36, the standard Modbus protocol errors, 1, 2, 3, 4, 5, 6, may appear in a given command status register as well.

Error Code	Error/Status Description
0	No error.
1	Standard Modbus protocol error – Invalid function code
2	Standard Modbus protocol error – Address validation error
3	Standard Modbus protocol error – Data validation error
4,5,6	Standard Modbus protocol error – Command specific errors
-11 (0xFFFF5)	Serial port – response timeout.
-33 (0xFFDF)	Ethernet port – no connection established.
-36 (0xFFDC)	Ethernet port – response timeout.

The following information provides an example Modbus Client Table with status registers for Client 0 (default location). The example shows that out of 1000 (0x03E8 – register 6000) commands sent, 999 (0x03E7 – register 6001) responses were received, and only 1 (register 6002) command error has occurred and the “Last error code” (Register 6010) indicates that the last error was a command response timeout. This display updates once a second.

ESC 8864 v5.00.r15 ID:88 Modbus Client Table 09/17/15 12:46:56									
06000:	03E8	03E7	0001	0000	0000	0000	0000	0000	0000
06008:	0000	0000	FFDC	0000	0000	0000	0000	0000	0000
06016:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06024:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06032:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06040:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06048:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06056:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06064:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06072:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06080:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06088:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06096:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06104:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06112:	0000	0000	0000	0000	0000	0000	0000	0000	0000
06120:	0000	0000	0000	0000	0000	0000	0000	0000	0000
Press any key to continue.									

## Sample Server.cfg File

In the next two examples, the first example shows a simple server.cfg file. The second example shows MODBUS settings configured in the server.cfg file.

### Example 1 - simple server.cfg file:

```
# SERVER.CFG
#
# This is a simple example of a 8864 Modbus Client server.cfg file.
#
# COMPANY : ESC
# DATE   :
#

[Module]
Module Name : 8864-Modbus-Client

# This section is used to define the configuration for the Client.
#
[8864 Client 0]
Enabled          : N #Port enable flag Y=Yes, N=No
Minimum Command Delay : 10 #Minimum number of msec's between commands
Response Timeout   : 1000 #Response message timeout (0-65535 mSec)
Retry Count       : 0 #Response failure retry count
Float Flag        : No #Use floating-point data type Y=Yes, N=No
Float Start       : 7000 #Register offset in message for floats
Float Offset      : 2000 #Internal Address for floats
Protocol          : RTU #Modbus Protocol R=RTU

[8864 Client 0 Commands]
#E Client Poll Reg Swap Serv Srv MB Serv
#N Addr Delay Cnt Code Node IP Addr. Port ID CMD Addr. Comment
#- -----
START
1 200 20 1 0 10.4.4.7 502 107 3 9 #Read SO2 from ID 107
END

[8864 Port 0]
Enabled          : N #Port enable flag Y=Yes, N=No
Response Timeout : 500 #Response message timeout (0-65535 mSec)
Float Flag       : No #Use floating data type Y=Yes, N=No
Float Start      : 7000 #Register offset in message for floats
Float Offset     : 2000 #Internal Address for floats
Protocol         : RTU #Modbus Protocol R=RTU

[8864 Port 0 Commands]
#E Client Poll Reg Swap Srv MB Serv
#N Addr Delay Cnt Code ID CMD Addr. Comment
#- -----
START
1 201 20 1 0 108 3 9 #Read CO2 from ID 108
END

[8864 Data Map]
#E Client Poll Reg Swap MB Serv
#N Addr Delay Cnt Code CMD Addr Comment
#- -----
START
1 200 20 1 0 6 1009 #Write SO2 to chan1 reg
1 201 20 1 0 6 1010 #Write NOX to chan2 reg
END
```

**Example 2 - MODBUS settings configured in server.cfg file:**

```
# SERVER.CFG
#
# This is an example configuration file for the 8864 Modbus Master.
#
# COMPANY   : ESC
# DATE      : 2020-06-11
# CONTROLLER: LOG99
#
#
#
#
# [Module]
Module Name : 8864-Modbus-Master
# This section is used to define the configuration for the master.
#
[8864 Client 0]
Minimum Command Delay : 100 #Minimum number of msec's between commands
Enable Command Delay  : Y #Enable/Disable the Delay configured above
Response Timeout      : 2000 #Response message timeout (0-65535 mSec)
Retry Count           : 2 #Response failure retry count
Run in parallel       : Y
Float Flag            : No #Use floating-point data type Y=Yes, N=No
Float Start           : 7000 #Register offset in message for floats
Float Offset          : 2000 #Internal Address for floats
[8864 Client 0 Commands]
#
# The file contains examples for a Modbus TCP/IP control using port 502.
#
START
#=====
# READ PARAMETERS FROM LOG99 Data Controller
# READ ONE REGISTER FROM EXT.SLAVE TABLE TO REGISTER IN MASTER TABLE (8864)
#=====
# Internal Poll Reg Swap IP Serv Slave Func MB Address
# Enable Address Interval Count Code Address Port Address Code In Device
# 1 101 5 1 0 10.0.1.99 502 100 16 3000 #
# 1 102 5 1 0 10.0.1.99 502 100 16 3001 #
# 1 103 5 1 0 10.0.1.99 502 100 16 3002 #
# 1 1664 5 1 0 10.0.1.99 502 100 15 99 #
# 1 1665 5 1 0 10.0.1.99 502 100 15 100 #
# IP of logger Read From Slave or- Modscan Address of Master or-
# Master or Slave Write from Master- AcrossTheWire of Slave
END
[8864 Client 1]
Minimum Command Delay : 100 #Minimum number of msec's between commands
Enable Command Delay  : N #Enable/Disable the Delay configured above
Response Timeout      : 2000 #Response message timeout (0-65535 mSec)
Retry Count           : 0 #Response failure retry count
Run in parallel       : Y
Float Flag            : No #Use floating-point data type Y=Yes, N=No
Float Start           : 7000 #Register offset in message for floats
Float Offset          : 2000 #Internal Address for floats
[8864 Client 1 Commands]
#
# The file contains examples for a Modbus TCP/IP control using port 502.
#
START
#=====
# READ PARAMETERS FROM LOG99 Data Controller
# READ ONE REGISTER FROM EXT.SLAVE TABLE TO REGISTER IN MASTER TABLE (8864)
#=====
# Internal Poll Reg Swap IP Serv Slave Func MB Address
```

## Modbus Client Timing

The following list describes the timing of the Modbus client and how the 8864 evaluates the server.cfg file. Also see [More Details](#) for additional information.

- Commands in the server.cfg file are evaluated one at a time, one after the other. However, each command may not be ready to execute when it is evaluated and may be skipped over in the list.
- The server.cfg file is evaluated approximately once every 0.5 seconds. If the execution of the server.cfg file takes less than 0.5 seconds, then it will be evaluated again starting at the next even 0.5 second mark. If the execution of the server.cfg file takes more than 0.5 seconds, then it will be evaluated again immediately. One cycle through all of the commands in the server.cfg file is called a “loop”.
- Each command executes periodically, but no more often than the rate configured in the “Poll Delay” column for that command in the server.cfg file. If the “Poll Delay” hasn’t elapsed since the last time the command has run, the command is skipped and the next command in the loop is evaluated.
- A subsequent command will not be evaluated and cannot execute until after the previous command completes. A command is complete when a response is received, the command times out, or it is skipped because the “Poll Delay” hasn’t expired.
- If the loop takes less than 0.5 seconds to execute, then a particular command will execute on intervals that are approximate multiples of 0.5 seconds. A configured “Poll Delay” of 0 will therefore result in the command being executed once every 0.5 seconds. If the “Poll Delay” is configured for 7 (0.7 seconds) for example, then the command will be executed every other time through the loop, or once every 1.0 seconds.
- If the loop takes more than 0.5 seconds to complete, and since a particular command can only execute on multiples of the loop execution time, then the frequency that the command will execute will be the configured “Poll Delay” effectively rounded up to the next multiple of the loop execution time. For example, if the loop takes 0.8 seconds to execute and the “Poll Delay” is configured for 20 (2.0 seconds), then the command will be executed every third time through the loop, or every 2.4 seconds.
- If a command does not receive a response for the amount of time configured in the “Response Timeout” field in the corresponding section of the server.cfg, it will be retried every time through the loop (approximately every 0.5 seconds, or longer if there are delays) up to the number of times configured in the “Retry Count” field in the corresponding section of the server.cfg.
- If a command has not responded once the “Retry Count” has expired, then it is retried approximately once every 5 seconds from that point on until a response is received. The retry occurs during the next loop evaluation after 5 seconds has expired.



- You cannot be assured that commands will execute in the order that they are listed in the server.cfg file. Commands may get out of order if some commands have delayed responses while other commands are not delayed.

### More Details

The following list describes additional characteristics for the timing of the Modbus client and how the 8864 evaluates the server.cfg file:

- The 8864 maintains a countdown timer for each individual command in the server.cfg file. Each of these timers keeps track of how long is left to wait until the associated command is scheduled to run.
- The 8864 evaluates each section of the server.cfg in the following order, independent of the order that the sections are listed in the server.cfg file itself:
  - Client 0
  - Port 0
  - Port 1
  - Port 2
  - Port 3
  - Data Map
- Each command in a particular section is evaluated in the order that they are found in the server.cfg file, but a command is not executed until its countdown timer expires.
- Once the timer on a command has expired (reached zero), then the command is actually executed. At that time, its timer is set to the length of time configured in the “Poll Delay” field in that command of the server.cfg file.
- When a new server.cfg file is loaded, the timers on all of the commands are set to their configured “Poll Delay” and normal processing of the server.cfg file proceeds.
- Each time that the loop in the server.cfg file is started, the length of time since the last time that the loop was started is calculated. As each command in the loop is evaluated, its timer is decremented by that amount of time and checked to see if it has expired. If the timer has expired, then the command is executed.
- Each command is evaluated and (if its timer has expired) executed one at a time. The next command is not evaluated until a response has been received from the previous command, the previous command has timed out, or the previous command has been skipped because its timer has not yet expired.
- Once all of the commands have been evaluated, the loop will restart immediately if more than 0.5 seconds has elapsed since the last time the loop was started. If 0.5 seconds has not yet expired, then the loop is restarted on the next even 0.5 seconds mark.

- After a command is sent, the Client waits up to the amount of time configured in the “Response Timeout” field in the corresponding section for a response. If the command times out and the “Retry Count” for that section is configured and greater than zero, then normal command processing will resume and the command will be executed again the next time through the loop. This is repeated every time through the loop until the number of configured retries has occurred.

If a valid response has not been received after the last retry, then the command will not be tried again for a fixed 5 seconds. The retry will occur when the command is evaluated during the next scan of the loop after the 5 seconds has elapsed (i.e., the command’s countdown timer is set to 5 seconds). These “long delay” retries will reoccur every 5 seconds (or possibly longer, depending on how long the loop takes to execute) indefinitely. The long delay time in the 8832 and in 8864 firmware before v5.00 is 10 seconds. Once a valid command is received, then normal loop processing resumes and the configured number of retries will again occur if a command subsequently times out. There are no retries in the 8832 or in the 8864 before firmware version v4.30.

- For Ethernet commands (Port 0), if the 8864 determines that it cannot find the IP address on the network or cannot establish a link (socket) to the remote device, then the command will be considered “timed out”. The 8864 will attempt to make this connection for up to the amount of time configured in the “Response Timeout”, but may determine that the IP address cannot be found or that the connection cannot be completed before the end of the “Response Timeout” period. The 8832 always waits the full “Response Timeout” time before timing out.
- If a command’s “Poll Delay” is less than the loop execution time, then this particular command will not execute again until all of the other commands have been completed and the loop restarted. In other words, a command can only execute once per loop regardless of the poll delay length and loop execution time.
- Commands will not execute faster than their configured “Poll Delay”, but may be delayed longer if the other commands in server.cfg take too long to execute.
- In the 8832 and in the 8864 through at least version v5.00, there is no enforced delay between the end of one command and the beginning of the execution of the next command that is ready to run. The “Minimum Command Delay” is ignored. The delay between the response of one command and the execution of the next command for the 8864 is typically less than 2 milliseconds.
- Since the commands execute only when their timers expire and some may be delayed more than others, you cannot be assured that commands will execute in the order that they are listed in the server.cfg file.
- Commands will always retry at least once (total of 2 tries) before waiting the fixed “long delay” of 5 sec, even if the number of retries is configured to be zero. The maximum number of retries is 5. See the following table.

Configured Retries	Actual Total Number of Tries Before Waiting 5 sec
0	1 try + 1 retry = 2 total
1	1 try + 1 retry = 2 total
2	1 try + 2 retries = 3 total
3	1 try + 3 retries = 4 total
4	1 try + 4 retries = 5 total
5 or more	1 try + 5 retries = 6 total

## Parallel Modbus Example

The following examples illustrate the “Run in Parallel” option that can be included in the header of each section of the server.cfg file.

If the “Run in parallel” option is missing or is set to “N” for all sections, then the server.cfg file is processed sequentially in the following order: Client 0-9, Port 0-3, then Data Map.

This is identical operation to the 8832 and the 8864 prior to v5.01 where the processing of the commands of one section starts right after the last command is processed from the previous section. However, if you set a section to “Run in parallel :Y”, then that section starts to process commands simultaneous with all of the sections that are still set to “N”.

### Example #1

[Client 0]  
Run in parallel: N

[Client 1]  
Run in parallel: N

[Client 2]  
Run in parallel: Y

[Client 3]  
Run in parallel: N

[Data Map]  
Run in parallel: N

With this configuration, the 8864 will run two parallel chains:

- Chain 1: Client 0 => Client 1 => Client 3 => Data Map
- Chain 2: Client 2

The two chains start out together, processing all of the commands in a section sequentially and

then moving on to the commands in the next section in the same chain. Chain 1 processes all the commands in Client 0, then those in Client 1, then those in Client 3, then runs the Data Map section. Processing then returns to the first command of Client 0 again.

Simultaneously, the commands in the Client 2 section start to be processed one after the other. When all Client 2 commands have been processed, then the commands in Client 2 start over again.

An advantage of the Parallel Modbus feature is that if one of the chains gets stalled by a bad instrument, then the other chains would continue to run.

### **Example #2**

[Client 0]  
Run in parallel: N

[Client 1]  
Run in parallel: Y

[Client 2]  
Run in parallel: Y

[Client 3]  
Run in parallel: N

[Data Map]  
Run in parallel: Y

With this configuration the commands in Client 0 and Client 3 run serially in the “classic” way, but the commands in Client 1, Client 2, and the Data Map all run in separate chains, all running in parallel:

- Chain 1: Client 0 => Client 3
- Chain 2: Client 1
- Chain 3: Client 3
- Chain 4: Data Map

In this example, the Data Map runs over and over – as soon as it processes its last command, it starts again.

If all the sections are marked as “Run in parallel” then each section starts processing commands and then repeats when it gets to the end of its commands.



# App Note - Stream-Switched Channel



**NOTE:** Configuration options in this section are available only through the MDI. If the ESC 8864 is currently displaying the touchscreen, press the **More** button to switch to the MDI. See [Menu Driven Interface \(MDI\)](#) for more information.

This approach to configuring a stream-switching system supports both switching and non-switching modes, selected using an external switch contact. Stream-switching (or time-sharing) is normally controlled by digital event programs. These programs switch a specified output or outputs starting at a specified time and repeating at a specified time interval. The 8864 also supports digital programs that are triggered by digital inputs, rather than on a timed basis. The system example in this section uses a combination of these.



**NOTE:** It is important to note that the 8864 supports pseudo-digital outputs and inputs. These are input/output line numbers that extend beyond what the 8864 Data Controller physically possesses. These pseudo-inputs/outputs are considered to be wired back to each other using software. That is, if an 8864 has 24 digital inputs and 24 digital outputs, digital outputs 25-88 and digital inputs 25-88 are pseudo digital points. Digital output #25 is considered to be wired back to digital input #25, and so on.

## Assumptions

This example assumes three boilers with the system normally monitoring one boiler at a time. During startup and shutdown periods, the system may have to switch between two boilers. The system is not required to switch between all three systems at the same time. In this scenario, there are six cases to consider:

- Only Boiler #1 is monitored.
- Only Boiler #2 is monitored.
- Only Boiler #3 is monitored.
- Boilers 1 & 2 are monitored.
- Boilers 2 & 3 are monitored.
- Boilers 3 & 1 are monitored.

Also assumed is that three digital inputs (01, 02, 03) are used to indicate that the system should be monitoring Boiler #1, #2, or #3, respectively. The system has an additional input (04) to indicate that stream-switching should take place. When digital input 04 is closed, digital inputs 01 through 03 have the following meaning:

- DI 01=Switch between Boiler #1 and Boiler #2
- DI 02=Switch between Boiler #2 and Boiler #3
- DI 03=Switch between Boiler #3 and Boiler #1

## Configuration

The system is configured with the digital event programs shown below:

- **TIMEDEP:** Timed digital event program that turns on pseudo-digital output/input #25.

The next three programs, all digital-input triggered, handle the case where time-sharing (signified by DI #04) is off.

- **SAMPLE1:** When DI #01 is on and DI #04 is off, switch the lines appropriate to sampling Boiler #1.
- **SAMPLE2:** When DI #02 is on and DI #04 is off, switch the lines appropriate to sampling Boiler #2.
- **SAMPLE3:** When DI #03 is on and DI #04 is off, switch the lines appropriate to sampling Boiler #3.

Example of configuration screen for SAMPLE3 case:

```

ESC 8864 v5.00.r21 ID:01 Config. Dig.Event Program 01/08/16 10:51:40

Dig. Event Program Name      : SAMPLE3
Trigger DI Pattern           : 3&4=0
Output Line(s)               : 8,12,14
Output Duration              : 6m
Delay Before Output Trigger  : 5s
Disable During Cal(s)        : (none)

FINISHED (Configure Now)

CTRL-O = Config Relay Outputs

```

The next six digital event programs, all digital-input triggered, handle the case where time-sharing is active (DI #04 is on) and the system is sampling either the first boiler listed (DI #25 is off) or the second boiler listed (DI #25 is on):

- **SWITCH1A:** When DI #01 and #04 are on, and DI #25 is off, switch the lines appropriate to sampling Boiler #1.
- **SWITCH2A:** When DI #02 and #04 are on, and DI #25 is off, switch the lines appropriate to sampling Boiler #2.
- **SWITCH3A:** When DI #03 and #04 are on, and DI #25 is off, switch the lines appropriate to sampling Boiler #3.
- **SWITCH2B:** When DI #01 and #04 and #25 are all on, switch the lines appropriate to sampling Boiler #2.
- **SWITCH3B:** When DI #02 and #04 and #25 are all on, switch the lines appropriate to sampling Boiler #3.
- **SWITCH1B:** When DI #03 and #04 and #25 are all on, switch the lines appropriate to



sampling Boiler #1.

```
ESC 8864 v5.00.r21 ID:01 Config. Dig.Event Program 01/08/16 10:59:38

Dig. Event Program Name      : SWITCH3B
Trigger DI Pattern           : 2&4&25
Output Line(s)               : 8,12,14
Output Duration              : 6m
Delay Before Output Trigger   : 5s
Disable During Cal(s)        : (none)

FINISHED (Configure Now)

CTRL-O = Config Relay Outputs
```

Thus, nine digital event programs define the nine possible states in the system. These programs can switch on additional pseudo-points to inform the acquisition programs which channels are active, or physical limit switches from the valves can be used.

## App Note - Standby Mode

Some configurations require the system to monitor for failure conditions (digital inputs, analog value alarms) and enter a standby mode when a failure is detected. This standby mode typically requires several digital outputs to be turned on or off, and for all other normal operations, such as calibrations and purges, to cease.

For this example, a rather complex system of stream-switching is used, one which monitors two sample points with one set of instruments. The failure conditions can be tied to a particular probe or to the instruments themselves. However, the assumption is that a failure on one probe puts the entire system into standby mode, shutting down sampling of both streams.

See the following sections for more information:

- [I/O Specifics](#)
- [Failure Conditions](#)
- [Approach](#)
- [Timed Digital Event Programs](#)
- [Calibrations](#)
- [Standby Mode](#)
- [Lockout](#)

### I/O Specifics

The following table lists the digital outputs in the system and their expected state in various operating modes.

Functions	DL Relays	Pt. A Measure	Pt. B Measure	Probe Cal	Purge	Standby
Ext Pump #2	1	1	1	1	0	0
Control Air #1 (SV3)	2	X	X	1	1	1
Purge Probe #1 (SV4)	3	X	X	X	1 (0-15s)	X
Control Air #2 (SV5)	4	X	X	1	1	1
Purge Probe #2 (SV6)	5	X	X	X	1 (15-30s)	X
Heated Valve #1 (SV8)	6	1	0	1	0	0
Heated Valve #2 (SV9)	7	0	1	1	0	0

Functions	DL Relays	Pt. A Measure	Pt. B Measure	Probe Cal	Purge	Standby
Span Gas #3 (SV10)	8	X	X	1 (10-15m)	X	X
CSS +15VDC	9	1	1	1	1	1
CSS Measure Mode / CSS Control External	10	0	0	0	1	1
Span Gas #1 (SV1)	11	X	X	1 (0-5m)	X	X
	12	X	X	X	1	X
	13	0	0	0	0	1
CSS Pump #1	14	1	1	1	0	0
Span Gas #2	15	X	X	1 (5-10m)	X	X
	16	0	1	X	X	X

## Failure Conditions

The failure inputs are defined as follows:

- At any time: DI#10, #12
- While sampling A: DI#04, #01
- While sampling B: DI#05, #02

## Approach

Assume a pseudo digital output/input pair called P1 identifies which stream is being sampled. P1=0 when sampling stream A and p1=1 when sampling stream B.

The default state of the system is to monitor stream A. Sampling on stream B is controlled by a digital program called SAMPLEB, which switches P1 on, as well as any physical relays necessary to control stream-switching.

The probe calibration is controlled by a calibration program called PROBECAL. The purge is controlled by a digital event program called PURGE.

To define which relay outputs are normally open (NO) and which contacts are normally closed (NC): For the most part, the state of the relay during the stream A measurement (the default state) defines whether the contact is NO or NC. For those points listed as “X,” the default setting is generally the opposite of the state specified in any calibration, purge, or standby mode. See the next table.



**NOTE:** The 8864 simply “activates” digital outputs referenced in calibrations. Whether the relay opens or closes depends on the NO/NC setting. For example, the pump lines are NC. They are activated by the PURGE and STANDBY programs, which open the relays.

Digital Output	Physical Relay	Status
DO#01	Ext Pump 2	NC
DO#02	Control Air 1	NO (could go either way)
DO#03	Purge Probe 1	NO (could go either way, but name implies NO)
DO#04	Control Air 2	NO (could go either way)
DO#05	Purge Probe 2	NO (could go either way, but name implies NO)
DO#06	Heated Valve 1	C (on when stream A)
DO#07	Heated Valve 2	O (off when stream A)
DO#08	Span Gas 3	NC (could go either way, but name implies NO)
DO#09	CSS +15VDC	NC
DO#10	CSS Measure Mode	NO
DO#11	Span Gas 1	NC (could go either way, but name implies NO)
DO#12	???	NO
DO#13	???	NO
DO#14	CSS Pump 2	NC
DO#15	Span Gas 2	NC (could go either way, but name implies NO)
DO#16	???	NO

## Timed Digital Event Programs

The SAMPLEB and PURGE digital event programs activate the following lines:

- **SAMPLEB:** DO#06, 07, 16 (start, duration, interval depend on user's requirements)
- **PURGE1:** DO#01, 03, 06, 10, 13, 14 (duration = 15s)
- **PURGE2:** DO#01, 05, 06, 10, 13, 14 (starts 15s after PURGE1 starts, duration = 15s)

These can be simple timed digital event programs.

## Calibrations

The PROBE CAL calibration program must have DO#04 and #07 referenced in each phase, and the span gas lines (08, 11, 15) referenced in the appropriate phases of the calibration.

## Standby Mode

The standby mode must activate the following output lines: DO#01, 02, 04, 06, 10, 13, 14. The trigger for the standby mode is one of several digital inputs (see above).

There are two approaches to this:

- The first is to let the failure digital inputs flag the data and let an alarm look for these flags and flag the data. The Ignore State Changes feature of the average alarm configuration could be used to inhibit going into standby on a probe 1 failure while sampling on probe 2. Alarm programs only perform their checks at the smallest averaging interval (generally one minute) which may not be fast enough.
- A second approach is to use digitally triggered digital event programs, which allows near instantaneous triggering of the standby mode. However, this approach is a little more complex because one event program must be configured for every possible digital input trigger condition. The output duration should be set to the shortest possible time (5s).

Name	Trigger DI	Output Lines	Duration
STBY10	10=1	01,02,04,06,10,13,14	5s
STBY12	12=1	01,02,04,06,10,13,14	5s

For failure inputs that should only be examined when the appropriate probe is in use, take advantage of the AND'ing performed when multiple digital inputs are defined as the triggering condition. (Recall that pseudo digital input P1 signals which stream is being sampled.)



**NOTE:** The reference to P1 in the next table should not be directly typed into the configuration as “P1.” An actual number must be typed in. See [Pseudo Digital Input/Output Lines](#).

Name	Trigger DI	Output Lines	Duration
STBY01	01=1,P1=0	01,02,04,06,10,13,14	5s
STBY02	02=1,P1=1	01,02,04,06,10,13,14	5s
STBY04	04=1,P1=0	01,02,04,06,10,13,14	5s
STBY05	05=1,P1=1	01,02,04,06,10,13,14	5s

## Lockout

A lockout method is needed to ensure that the system does not try to perform a stream-switch, purge, or calibration while in standby mode. In addition, the system should not switch or purge while in calibration.

The latter requirement is easy to achieve. All digital event programs have a Disable During Calibration(s) feature that prevents the program from running while specified calibrations are in progress. By setting the MEASUREB and PURGE programs to be disabled during PROBE CAL, the latter lockout is in place.

The former requirement is more difficult. The MEASUREB and PURGE event programs and the PROBE CAL calibration must be locked out while in standby mode. Only another calibration could lockout both event programs and calibrations.

Therefore, another calibration program, STBYCAL, must be configured. This calibration is a single-phase, instrument-controlled calibration program, and it must share at least one affected parameter with PROBE CAL. That ensures that PROBE CAL and STBYCAL lock each other out. By also adding STBYCAL to the Disable During Calibration(s) list of MEASUREB and PROBE CAL, those programs are locked out while in standby mode.

The last step is to link STBYCAL with the standby mode. This is done by adding one more digital output (pseudo) to all the STBYxx digitally triggered digital event programs. This pseudo DO is linked to a pseudo digital input. This pseudo DI is the input line pattern for the STBYCAL calibration program.

To review the final configuration:

■ **Timed Digital Event Programs:**

Name	Start Time	Output Lines
SAMPLEB	???	06,07,16
PURGE1	???	01,03,06,10,13,14
PURGE2	Purge1+15s	01,05,06,10,13,14

(All three are disabled during PROBECAL, STBYCAL.)

■ **DI-Triggered Digital Event Programs:**

Name	Trigger DI Pattern	Output Lines	Output Duration
STBY10	10=1	01,02,04,06,10,13,14,P2	5s
STBY12	12=1	01,02,04,06,10,13,14,P2	5s
STBY01	01=1,P1=0	01,02,04,06,10,13,14,P2	5s
STBY02	02=1,P1=1	01,02,04,06,10,13,14,P2	5s
STBY04	04=1,P1=0	01,02,04,06,10,13,14,P2	5s
STBY05	05=1,P1=1	01,02,04,06,10,13,14,P2	5s

■ **Calibrations:**

Name	Description
PROBECAL:	Normal automatic calibration program.
STBYCAL:	Instrument-controlled, one-phase, shares at least one affected parameter with PROBECAL, input pattern is P2=1.

# Troubleshooting

The table below contains general troubleshooting guidelines. For more detailed instructions with starts and restarts, or to contact Support for assistance, see the following topics:

- [Warm Restart](#)
- [Cold Start](#)
- [Contacting Support](#)

Problem	Solution
Display does not light up.	Check 120 VAC power, power cord connection, fuse.
Speckle pattern or bars on LCD.	Bad LCD controller. Call Support.
Main menu does not appear; text messages on LCD.	Record text messages and call Support.
Main menu appears; no response from external keyboard.	Check keyboard connection. Does NUM LOCK/CAPS LOCK light up on keyboard? Swap with spare keyboard. If second keyboard fails, call Support.
Keypad on front panel does not work.	Call Support.
Main menu appears and keyboard works but “out of memory” message appears.	Check System Information in Status Menu. If heap memory is low, perform a warm restart (described below). If the storage space is low, delete unnecessary channels or calibrations.
8864 appears “hung.”	Cycle power to the 8864.

## Warm Restart

While running or during power-up:

- Cycle the power or, from the Home Menu, select **S - Status Menu** (hot key **S**) > **U - Reboot** (hot key **U**). (See [Reboot](#) for more information.)

A warm restart forces a complete restart of the tasks and de-allocation of any unused heap space. All configurations are destroyed, but they are rebuilt from the permanent copies in storage RAM. Any long-term data that has been stored are reattached to the channels that generated them.

The 8864 updates its internal clock from the battery-backed clock, aborts all calibrations



and digital event programs, and reschedules all calibrations and event programs.

## Cold Start

A “cold start” erases **all** configuration information (except the items stored in the System Configuration Menus) as well as **all** stored data in the 8864. Thus, the 8864 Data Controller must be downloaded again after a cold start.

To cold start the 8864:

1. Log in to the 8864 at the **Integrator level**.
2. Log in again, using the password **COLD START** (note that this is all caps and includes the space between the words).
3. Configure the 8864 Data Controller for the correct 2-digit ID code and the correct baud rate or IP address on the port to be used to download tables, if these are not set in the system configuration.

## Contacting Support

You can contact [Support](#) at 512-250-7901 or [support@envirosys.com](mailto:support@envirosys.com).

Please have the following information on hand:

- For a hardware problem or failure, please have the unit serial number available. When calling, ask for Data Controller Hardware Repair.
- For a software problem, please record the information shown in the System Information screen (see [System Information](#)), particularly the software version number and memory levels. Also, if the Supervisor password is known, log into the 8864 Data Controller at Supervisor level and type <Ctrl><L>. This will display a log of potentially suspicious events and may be of help to the ESC Spectrum staff in identifying the problem. When calling, ask for Data Controller Software Support.

# Appendix A. Installation Guide

This installation guide includes the following procedures:

- [Upgrade 8864 Firmware](#)
- [Upgrade from an 8832 to an 8864](#)

## Upgrade 8864 Firmware



**NOTE:** Beginning with v5.00, the numbering scheme of the 8864 firmware is identified in documentation using the format “vX.YY.rZZ”, such as v5.00.r24. The first part of the numbering scheme (v5.00) represents the version of the firmware, which defines the features included in the firmware. The second part of the numbering scheme (.r24) represents the build number.

For example, all version v5.02 firmware has the same feature set and would be supported by the same User Guide. Revisions occur when a bug fix is required and a new build is generated. For example, v5.02.r25 would be updated to build v5.02.r26 if a bug were fixed, but would only be updated to version v5.03 if features are added or changed.

ESC Spectrum regularly publishes new versions of firmware for the 8864 Data Controller. Announcements about new firmware versions are posted in the [Customer Community](#) and are available for download on the [8864 Data Controller Downloads](#) page (requires login). Information about new features and improvements can also be found in the [8864 Data Controller Release Notes](#). These files are available to customers with an active ESC Spectrum Support agreement. Use the information in the Release Notes to help determine if a new firmware version should be installed on your system’s data controllers.

You can also contact [Customer Support](#) with any questions you may have about the procedures described in this document. If you prefer to have ESC Spectrum perform the upgrade as a turnkey service, please contact [Customer Support](#).



**WARNING:** Upgrading the firmware in the 8864 Data Controller will “cold start” the data controller, which causes all configuration and stored data to be erased. Before starting an upgrade, it’s important to make sure you have the current configuration saved in StackVision and that all data has been collected from the 8864. Failure to follow these instructions could result in the loss of compliance data.



**IMPORTANT:** ESC Spectrum recommends that upgrades be performed offline or during a scheduled outage to prevent any data loss. If these steps are performed while operating, it may result in the loss of compliance data.

To save space and transfer time, firmware upgrades are stored in an archived .zip file labeled with the firmware and release number, such as **8864\_Upgrade\_v6.00r42.zip**. The “zip” file must be unzipped to extract the actual upgrade file.

The upgrade file is labeled using a numbering scheme in the format *8864\_Upgrade\_vX.YY.rZZ.bin*. An example of an actual upgrade file is **8864\_Upgrade\_v6.00r42.bin**. For more information about this numbering scheme, see the note at the beginning of this topic.

Use either of the following methods to upgrade the firmware of the 8864:

- [Upgrade Using Ethernet](#): Use this method to transfer the new firmware across a remote Ethernet connection.
- [Upgrade Using USB](#): Use this method to load the new firmware version from a USB flash drive that connects locally to one of the USB ports on the 8864. (A USB flash drive is also referred to as a USB thumb drive.)



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

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**IMPORTANT:** 8864 Data Controllers that are running firmware versions before v5.00, including all v4.xx firmware, should first upgrade to v5.00.r42 before upgrading to any v6.00 firmware. Any v5.xx firmware can upgrade to any v6.xx version. Firmware versions before v5.00 risk missing calibration sequences due to a “time skip” bug.

---



**IMPORTANT:** **With firmware version 5.05.r37 and later, if the 8864 Data Controller is configured for secure StackVision communications**, certain preparations must be completed before and after upgrading the firmware. These include the items listed below. For detailed instructions, refer to the topics “Transfer the 8864 Public Keys to the StackVision SSH Server” and “Transfer the StackVision Public Key to the 8864” in the [StackVision Installation Guide](#).

**Before upgrading the firmware (v5.05.r37 or later):**

- Run PuTTY (or similar tool) and then record the data controller “Static IP Address” listed on the “Configure Ethernet Ports” configuration screen (C > S > E).

**After upgrading the firmware (v5.05.r37 or later):**

---

- 
- In the “Setup Secure Communications” configuration screen (C > S > X > S), enter the “Static IP Address” recorded earlier. Verify other settings are correct and, if needed, update settings as required.
  - Generate a new 8864 public key and then transfer it to the StackVision SSH server (C > S > X > R; C > S > X > U or E).
  - Use BitVise (or similar tool) to transfer the StackVision SSH server public key to the 8864 Data Controller.
-

## Upgrade Using Ethernet



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

Follow the steps below to upgrade the 8864 firmware remotely via an Ethernet connection:

1. Take an “as found” snapshot of the 8864 configuration.

**Failure to obtain an as-found dump of the configuration may result in your CEM system not operating properly or collecting incorrect data.**

2. Download the 8864 firmware upgrade file from the [8864 Data Controller Downloads](#) page in the Customer Community (requires login).
3. Unzip the upgrade file and transfer it to the root folder of the PC that will be used to upgrade the firmware.
4. Log in to the 8864 using the integrator-level password (firmware versions before v5.02) or an admin-level user name and password (firmware v5.02 and beyond)..
5. “Cold start” the 8864. (Cold starting the 8864 deletes all configuration and data.) After cold starting the 8864 Data Controller, the data controller reboots to the graphical menu.
6. Log in to the 8864 again using the integrator-level password (firmware versions before v5.02) or an admin-level user name and password (firmware v5.02 and beyond).
7. Select **S - Status Menu** to open the Logger Status Menu.

```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

8. Select **S - System Maintenance** to open the System Maintenance menu.

```
ESC 8864 v6.00r41 ID:01      Logger Status Menu      06/29/20 16:57:41

P Power Fail Menu
L Line Changes Log Menu
M Message Menu
A Alarm Status/Log
C Report Current Cal Status
I Display Status of Single Cal
V View Modbus Master Status
I System Information
D Dump Setup(s)
U Reboot
S System Maintenance

T View Secure Comm Status
```

9. Select **D - Download Code** to open the Download Code Menu.

```
ESC 8864 v6.00r41 ID:01      System Maintenance      06/29/20 17:00:47

V View Serial Port Data
L Log Serial Port Data
D Download Code
P Connectivity Tests
A Create Debug Archive

S Download Server.cfg
C Cold Start
```

10. Select **E - Ethernet Download** and then select **Y** when prompted Are You Sure (Y/N)?

```
ESC 8864 v5.02.r25 ID:88 Download Code Menu 12/12/17 13:52:31
U USB Download
E Ethernet Download

Are You Sure (Y/N)?
```

C

11. Verify the firmware upgrade file has successfully transferred, then press **Enter** on the keyboard.

```
ESC 8864 v6.00r41 ID:01 Download Code Menu 06/29/20 17:05:05

Please transfer file via SFTP.

Press ENTER after transfer completes.
```

The 8864 will decrypt, extract, un-compress, and verify the upgrade file before installing it on the 8864 as shown in the following example. The process takes 2 to 3 minutes to complete.

```
ESC 8864 v6.00r41 ID:01 Download Code Menu 06/26/20 11:36:02

Please transfer file via SFTP.

Press ENTER after transfer completes.

Clearing system config...
Attempting SFTP Upgrade
Attempting Upgrade with /data/SSHChroot/sftp-data/8864_Upgrade_v6.00r41.bin
Decrypt Archive
84.7MiB 0:00:37 [2.29MiB/s] [=====>] 100%
Extract Upgrade Archive
84.7MiB 0:00:38 [2.23MiB/s] [=====>] 100%
Uncompress Filesystem Archive
82.2MiB 0:00:54 [ 1.5MiB/s] [=====>] 100%
Verify filesystem archive
206MiB 0:00:06 [33.1MiB/s] [=====>] 100%
Root Device /dev/sda5
Format and Install on /dev/sda6
206MiB 0:00:52 [3.89MiB/s] [=====>] 100%
Copying Kernel
Copying Grub Menu
Press Any Key to Cold Start and Complete the Upgrade Process...
```

12. Press any key to reboot the 8864 and complete the upgrade. (Starting with firmware v5.02, this step will occur automatically after 2 minutes if the user does not press Enter.)
13. Download the full 8864 configuration from StackVision. If required, also make sure to reload the Modbus Client “server.cfg” file. See the instructions **Download Configuration Changes** in the [StackVision User Guide](#) if needed (*Controller Tools > Download Configuration Changes*).
14. Obtain an “as-left” snapshot of the newly downloaded 8864 configuration. This will provide a comparison to the “as-found” snapshot that you created in step 1 of this procedure, which will help troubleshoot problems if, for some reason, the as-found configuration in the 8864 is not the same as the configuration in StackVision.
15. Verify polling/communication has been re-established with StackVision by selecting **Controller Tools** in the StackVision Client and making sure you have a “green” status. The procedure can be found in the topic **Verify Data Has Been Collected** in the [StackVision User Guide](#).



## Upgrade Using USB



**WARNING:** Because of security updates such as long-term kernel support, OpenSSH, and OpenSSL, 8864 firmware v6.00 and later **cannot** be downgraded (reverted) to a firmware version earlier than v6.00. All 8864 firmware v6.XX are interchangeable and can be upgraded or downgraded in either direction.

---

Follow the steps below to use a USB flash drive to upgrade the 8864 firmware:

1. Take an “as found” snapshot of the 8864 configuration. **Failure to obtain an as-found dump of the configuration may result in your CEM system not operating properly or collecting incorrect data.**
2. Download the 8864 firmware upgrade file from the [8864 Data Controller Downloads](#) page in the Customer Community (requires login).
3. Unzip the upgrade file and then transfer it to **root directory of a USB flash drive**. Verify the firmware upgrade file meets the following requirements:
  - File type is = **.bin**
  - File name formatted as = **8864\_Upgrade\_v#.##r##.bin**

**IMPORTANT:** A firmware upgrade file with an invalid file name will not upgrade. A valid file name must be formatted as *8864\_Upgrade\_v#.##r##.bin*.
4. Insert the USB flash drive in an available USB port on the 8864.
5. Log in to the 8864 using the integrator-level password (firmware versions before v5.02) or an admin-level user name and password (firmware v5.02 and later).
6. “Cold start” the 8864. (Cold starting the 8864 deletes all configuration and data.) After cold starting the 8864, the data controller reboots to the graphical menu.
7. Log in to the 8864 using the integrator-level password (firmware versions before v5.02) or an admin-level user name and password (firmware v5.02 and later).

8. Select **S - Status Menu** to open the Status Menu.

```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Comm to Port
```

9. Select **S - System Maintenance** to open the System Maintenance menu.

```
ESC 8864 v5.02.r25 ID:88 Logger Status Menu 12/11/17 10:19:52
P Power Fail Menu
L Line Changes Log Menu
M Message Menu
A Alarm Status/Log
C Report Current Cal Status
1 Display Status of Single Cal
V View Modbus Master Status
I System Information
D Dump Setup(s)
U Reboot
S System Maintenance
T View Secure Comm Status
```

10. Select **D - Download Code** to open the Download Code Menu.

```
ESC 8864 v5.02.r25 ID:88      System Maintenance      12/11/17 10:37:04

V View Serial Port Data
D Download Code
P Connectivity Tests
A Create Debug Archive

S Download Server.cfg
C Cold Start
```

11. Select **U - USB Download**.

```
ESC 8864 v5.02.r25 ID:88      Download Code Menu      12/12/17 13:52:31

U USB Download
E Ethernet Download

Are You Sure (Y/N)?
```

The next screen displays a list of up to 10 “.bin” files stored in the root directory of the USB flash drive. The files are numbered using hot keys labeled 0 through 9. The next example shows two “.bin” files stored in the root directory.

12. Use the arrow keys on the keyboard to move the cursor up and down the list of files. To select a file for installation, type the hot key number associated with the file. Or move the cursor to the file and press **Enter**.
13. When the message **Are You Sure (Y/N)?** displays, press **Y** (yes) to begin the

installation.

```

ESC 8864 v6.00r22 ID:05 Download Code Menu 06/26/20 12:11:49

0 8864 Upgrade v6.00r11.bin
1 8864 Upgrade v6.00r25.bin

Are You Sure (Y/N)?

```

Status information displays on the screen throughout the firmware upgrade. The 8864 will decrypt, extract, uncompress, and verify the upgrade file before installing it. The process takes 2 to 3 minutes to complete.

**NOTE:** If the firmware upgrade is unsuccessful, the System Maintenance screen displays with the message “Error occurred. Firmware update not successful”. You can either try the firmware upgrade again or contact [Support](#) for assistance.

14. When the following message displays, press any key to reboot the 8864 and continue the upgrade. (Starting in firmware v5.02, this step occurs automatically after 2 minutes if the user does not press a key to continue.)
  - *Press Any Key to Cold Start and Complete the Upgrade Process.*
15. Download the full 8864 configuration from StackVision. If required, also make sure to reload the Modbus Client “server.cfg” file. See the instructions **Download Configuration Changes** in the [StackVision User Guide](#) if needed (*Controller Tools > Download Configuration Changes*).
16. Obtain an “as-left” snapshot of the newly downloaded 8864 configuration. This will provide a comparison to the “as-found” snapshot that you created in step 1 of this procedure, which will help troubleshoot problems if the as-found configuration in the 8864 is not the same as the configuration in StackVision.
17. Verify polling/communication has been re-established with StackVision by selecting **Controller Tools** in the StackVision Client and making sure you have a “green” status. The procedure can be found in the topic **Verify Data Has Been Collected** in the [StackVision User Guide](#).




## Upgrade from an 8832 to an 8864



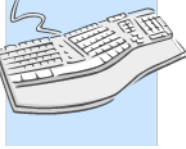


Perform the steps in the order listed below to ensure a smooth upgrade from an 8832 to an 8864 Data Controller. The progression of these steps ensures a proper backup of the existing data controller configuration, prerequisite hardware setup on the new 8864 Data Controller, and proper preparation on the StackVision system to support the data controller change-over.

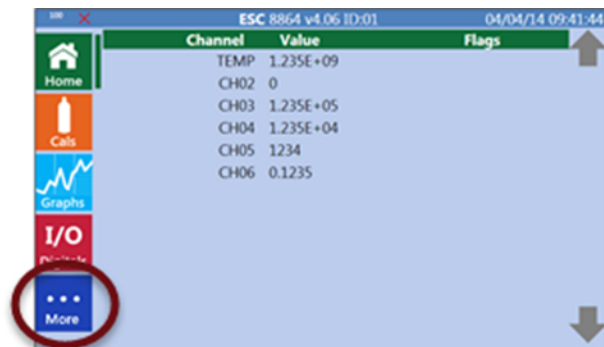
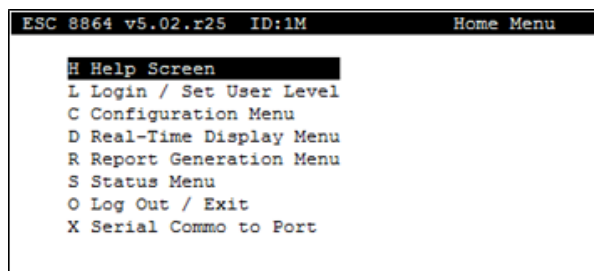
Contact [Customer Support](#) with any questions you have about the process. If you prefer that ESC Spectrum perform the upgrade as a turnkey service, please contact [ESC Spectrum Sales](#).



**CAUTION:** Failure to follow these steps could result in the loss of compliance data. If these steps are performed while the controller is operating, it may still result in the loss of a limited amount of compliance data. To prevent any data loss, **the steps below should be performed offline or during a scheduled outage**. Failure to follow these instructions could result in the loss of compliance data.

Step		Instructions
1		It is helpful to have the new 8864 set up near the old 8832 and have both units operational to transfer all settings from the old unit to the new unit.
2		<p><b>Snapshot the 8832 “as found”</b></p> <p><b>The snapshot is a mandatory step when replacing an 8832 with an 8864.</b> Make sure to take the snapshot before disconnecting the 8832. Taking a snapshot helps to ensure that no manual configuration changes made in the 8832 are lost. Only skip this step if you are certain the configuration in StackVision matches the configuration in the existing 8832. For instructions, refer to <a href="#">Snapshot a Configuration</a>.</p> <p><b>WARNING:</b> Failure to obtain an “as found” dump of the configuration may result in your CEM system not operating properly or collecting incorrect data.</p>
3		<p><b>Make sure the physical I/O card configuration is the same in the 8864 as it was in the 8832</b></p> <p>Verify the I/O cards in the 8864 match the type of I/O cards in the 8832. If the I/O cards do not match, your system will not function correctly when replacing the 8832 with an 8864. If you are unfamiliar with the types of I/O cards supported by the 8864, see <a href="#">I/O Card Description and Installation</a> before continuing with the steps in this procedure.</p>


Step		Instructions
4		<p><b>Prepare the StackVision server</b></p> <p>Upgrade the StackVision server to Version 4.2 or later. Version 4.2 (and later) includes all necessary configuration support for the 8864.</p> <p>For upgrade instructions, see the <i>StackVision Installation Guide</i> found on the <a href="#">StackVision Downloads</a> page (requires login) or <a href="#">StackVision Installation Online Help</a>.</p>
5		<p><b>Physically install and power on the 8864</b></p> <p>If you are replacing an existing 8832, ESC Spectrum recommends setting up the 8864 in the shelter in parallel with the 8832. Later in this procedure, you will set up a separate IP address for the 8864 before removing the 8832.</p>
6		<p><b>Attach a keyboard</b></p> <p>Plug a USB keyboard into any of the available USB ports on the 8864.</p> <p>The 8864 supports one USB port on the front panel of the unit and two on the back of the unit. Keyboards of 19 inches or less will fit in the rack with the unit. <b>The keyboard must be attached to the 8864 before you can enter IP addresses later in this procedure.</b> For detailed information, refer to <a href="#">Keyboard Installation</a>.</p> <p><b>IMPORTANT:</b> An 8832 keyboard will NOT work with an 8864.</p> <div data-bbox="657 1266 1230 1501">  </div>
7		<p><b>Confirm 8864 settings match 8832 settings</b></p> <ol style="list-style-type: none"> <li>1. Press the <a href="#">More Button</a> on the front panel of the 8864 to display the character-based MDI interface. The More button becomes active for use after connecting a USB keyboard to the 8864.</li> </ol>

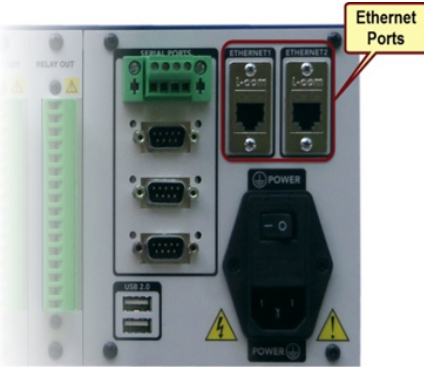

Step	Instructions
	<div></div> <p>2. On the 8832, log in to the MDI interface using the integrator-level password. On the 8864, log in using an administrator user and password. If you do not know the integrator-level password on the 8832 or an admin-level user account on the 8864, contact your CEMS Administrator or ESC Spectrum <a href="#">Support</a>.</p> <div></div> <p>3. On the 8832, select <b>C - Configuration Menu</b> &gt; <b>S - Configure System Parameters</b>. Press <b>Ctrl-U</b> to display System Backup Configuration Menu #1. Then press <b>Ctrl-N</b> to display the System Backup Configuration Menu #2.</p>




Step	Instructions																																							
	<div><div>ESC 8832 v3.02 ID:1M System Configuration Menu#2</div><div>Max External 4-20 mA Inputs : 0 Max External Voltage Inputs : 0 Max External Status Inputs : 0 Max External Relay Outputs : 0 Max External Current Outputs: 0 Max External 16-bit Counters: 0 : Card Slot 1 : CURRENT IN CARD Card Slot 2 : CURRENT IN CARD Card Slot 3 : STATUS IN CARD Card Slot 4 : STATUS IN CARD Card Slot 5 : STATUS IN CARD Card Slot 6 : STATUS IN CARD Card Slot 7 : RELAY OUT CARD Card Slot 8 : RELAY OUT CARD Card Slot 9 : RELAY OUT CARD Card Slot 10 : RELAY OUT CARD Card Slot 11 : CURRENT OUT CARD Card Slot 12 : CURRENT OUT CARD  Next Page = CTRL-N or PGDN, Prev Page = CTRL-P or PGUP</div></div> <p>4. On the 8864, select <b>C - Configuration Menu &gt; S - Configure System Parameters &gt; U - Take Effect Next Cold Start &gt; I - Configure I/O Cards</b> to display the Configure I/O Cards (backup) screen.</p> <div><div>ESC 8864 v5.02.r25 ID:1M Configure I/O Cards (backup)</div><div><table><thead><tr><th>Slot</th><th>Physical Card Detected at Last Boot</th><th>Override at the Next Cold Start</th></tr></thead><tbody><tr><td>1</td><td>Voltage In</td><td></td></tr><tr><td>2</td><td>Voltage In</td><td></td></tr><tr><td>3</td><td>Current In</td><td></td></tr><tr><td>4</td><td>Current In</td><td></td></tr><tr><td>5</td><td>Current Out</td><td></td></tr><tr><td>6</td><td>Current Out</td><td></td></tr><tr><td>7</td><td>Isolated In</td><td></td></tr><tr><td>8</td><td>Met Card</td><td></td></tr><tr><td>9</td><td>(none)</td><td></td></tr><tr><td>10</td><td>(none)</td><td></td></tr><tr><td>11</td><td>Relay Out</td><td></td></tr><tr><td>12</td><td>Relay Out</td><td></td></tr></tbody></table><p>Note: Overrides and new card configurations take effect at the next cold start.</p><p>FINISHED (Configure Now)</p></div></div> <p>5. Verify the <b>Physical Card Detected at Last Boot</b> column of the 8864 has the same I/O card configuration as the 8832. If the 8864 is different than the 8832, obtain and install the correct I/O cards in the 8864. Note the following items when setting up I/O cards:</p>	Slot	Physical Card Detected at Last Boot	Override at the Next Cold Start	1	Voltage In		2	Voltage In		3	Current In		4	Current In		5	Current Out		6	Current Out		7	Isolated In		8	Met Card		9	(none)		10	(none)		11	Relay Out		12	Relay Out	
Slot	Physical Card Detected at Last Boot	Override at the Next Cold Start																																						
1	Voltage In																																							
2	Voltage In																																							
3	Current In																																							
4	Current In																																							
5	Current Out																																							
6	Current Out																																							
7	Isolated In																																							
8	Met Card																																							
9	(none)																																							
10	(none)																																							
11	Relay Out																																							
12	Relay Out																																							



Step	Instructions
	<p>a. The 8864 detects new cards when cold-started.</p> <p>b. The <i>Override</i> column can be used in the 8864 to override the automatically detected card settings. This is sometimes used if an 8832 has a different physical I/O configuration from the configuration defined on this screen.</p> <p>c. <b>Cold-start</b> the 8864 for the new I/O card overrides to take effect.</p> <p>6. Press <b>Ctrl-N</b> on the 8832 to display the System Backup Configuration Menu #3. On the 8864, press <b>Esc</b> and then <b>E - Configure Ethernet Ports</b>. Set the following fields in the 8864 to match the 8832 configuration</p> <p>a. Static IP Address</p> <p>b. Static Subnet Mask</p> <p>c. Static Default Gateway</p> <p>7. See <a href="#">IP Address Setup</a> in this document for more information about setting the data controller IP address.</p> <p>On the 8864, press <b>Ctrl-N</b> to go to the next page, then select <b>FINISHED (Configure Now)</b> to save the settings.</p> <div data-bbox="711 1087 1333 1528" data-label="Code-Block"> <pre> ESC 8864 v5.02.r25 ID:1M Configure Ethernet Ports (backup)  Ethernet 1   MAC Address      : 0:4:BF:B0:19:7D   Ethernet Enable (Y/N) : Y   DHCP Enable (Y/N)  : N   :   Static IP Address : 192.168.1.111   Static Subnet Mask : 255.255.0.0   Static Default Gateway : 0.0.0.0   Static DNS Address : 0.0.0.0   :   Request IP Address : 192.168.1.111   Specify Client ID  :   Domain Name       :   :   IP Address (in use) : 192.168.1.111   Subnet Mask (in use) : 255.255.0.0   Default Gateway (in use): 0.0.0.0   DNS Server (in use) : 0.0.0.0 </pre> </div> <p>8. Press <b>Ctrl-N</b> once on the 8832 to display System Backup Configuration Menu #5 (Modbus configuration). On the 8864, press <b>M-Configure Modbus</b> to display the Configure Modbus (backup) screen. Verify all values for the 8864 match those of the 8832.</p>

Step		Instructions
		<div data-bbox="711 285 1321 722"> <pre> ESC 8864 v5.02.r25 ID:1M Configure Modbus (backup)  Modbus ID Code           : 103 8832 Modbus AddrTbl Start : 40001 8832 Modbus InputTbl Start : 40005 8832 Modbus OutputTbl Start : 41005 ModbusQuietIfNoRegMatch   : N ModbusAddrTbl[0]=         : 1 ModbusAddrTbl[1]=         : 1001 Modbus Channel Integer Start: 0 Modbus Channel Integer End : 0 Modbus Channel Float Start : 1 Modbus Channel Float End   : 99  Enable 8864 MODBUS Tables : Y 8864 MODBUS Table Start    : 42001 Enable Double-Wide Tables  : N Double-Wide Table Start    : 23002  FINISHED (Configure Now)   10/23/17 09:58:51 </pre> </div> <p>9. Press <b>Ctrl-N</b> to advance to the next screens in the 8832 and select the other sub-menus of the <b>Take Effect Next Cold Start Menu</b> on the 8864. Configure settings for 8864 to match those of the 8832. Repeat this step for all remaining configuration screens. When you finish configuring the last screen on the 8864 go to the <b>S - Status Menu &gt; S - System Maintenance &gt; C - Cold Start</b> screen and type in your user name and password to cold start the 8864.</p> <div data-bbox="711 1150 1403 1297"> <pre> ESC 8864 v5.02.r25 ID:1M Enter Password For Cold Start  Current User Name       : admin Enter Password          : ***** </pre> </div>
8		<p><b>Finish hooking up the 8864 and unhook the 8832</b></p> <ol style="list-style-type: none"> <li>1. Configuration is not done until you reboot the 8864. A reboot is needed because the network may not recognize that the IP address previously used by the 8832 is now used by a different device (i.e., the 8864). A reboot also ensures that the correct MAC address is assigned in the network router table. .</li> </ol> <p><b>NOTE:</b> The left port is Ethernet #1, and the right port is Ethernet #2. You should connect to Ethernet #1 (left port)</p>

Step		Instructions
		<p>when changing out an 8832 to an 8864.</p>  <ol style="list-style-type: none"> <li><b>IMPORTANT:</b> For security reasons the 8864 uses the SSH protocol for remote connections instead of the TELNET protocol used by the 8832. SSH uses IP port 22. To be able to connect to the MDI interface across the network, port 22 must be open through any firewalls. Normal polling of data occurs over port 9881 and is unaffected by this change. Verify with your IT department that port 22 is open to the 8864. Also note that “ping” may work across a firewall even though SSH over port 22 is blocked.</li> </ol>
9		<p><b>In StackStudio, change the Data Controller model to 8864</b></p> <ol style="list-style-type: none"> <li>Log in to the StackVision server, making sure version 4.2 or later is installed.</li> <li>Launch StackStudio and go to Data Controllers.</li> <li>Find the controller you are replacing and set the <b>Model</b> to <b>ESC8864Cv4</b>.</li> <li>Save and upload changes to the server before exiting StackStudio.</li> <li>In StackVision, go to <b>Tools &gt; Controller Emulation</b>. Make sure you can emulate to the new controller from StackVision.</li> <li>Still in StackVision, download the configuration to the 8864 using <b>Controller Tools &gt; Download</b> tab at the</li> </ol>

Step		Instructions
		<p>bottom of the screen. The 8864 also supports downloading of the configuration file using a <a href="#">USB flash drive</a>.</p> <p><b>NOTE:</b> You can use the older version of StackVision (pre 4.0) if you wish. In that case, leave the controller Model at v3.xx in StackStudio, but please be aware that data controller emulation will not work from StackVision to the 8864 and you cannot utilize the expanded capabilities of the 8864.</p>
<b>10</b>		<p><b>Controller Emulation</b></p> <p>Establishing successful controller emulation is important because a ping may work even when SSH is blocked by a firewall.</p> <p>First try a ping, and then attempt to login to the 8864 from the StackVision server using PuTTY over Ethernet. Be sure that the IP address in the 8864 is the same as the IP address from the 8832 as configured previously in step 6. If you encounter any problems, contact your IT department for assistance.</p>
<b>11</b>		<p><b>Download StackVision configuration to the 8864</b></p> <p>See <i>Download Configuration Changes to Controller</i> in the <a href="#">StackVision User Guide</a> (requires login).</p> <p><b>IMPORTANT:</b> If your system uses Modbus Client, also reload the server.cfg file.</p>
<b>12</b>		<p><b>Snapshot the 8864 “as left” and verify polling/communication</b></p> <ol style="list-style-type: none"> <li>1. Obtain an “as-left” snapshot of the newly downloaded 8864 configuration. This will provide a comparison to the “as-found” snapshot that you created earlier in this procedure, which will help troubleshoot problems if, for some reason, the as-found configuration in the 8832 is not the same as the configuration in StackVision.</li> </ol>

Step	Instructions
	<ol style="list-style-type: none"> <li>Once the 8864 is up and running, refer to 8864 Graphical User Interface (GUI) to get started with using the new data controller.</li> <li>Verify polling/communication has been re-established with StackVision by selecting <b>Controller Tools</b> in the StackVision Client and making sure you have a “green” status. The procedure can be found in the topic <i>Verify Data Has Been Collected</i> in the <a href="#">StackVision User Guide</a> (requires login).</li> </ol>

## Snapshot a Configuration

Sometimes manual configuration updates are made in the data controller and may not be downloaded to the StackVision server. For this reason, it is important to take a snapshot of the current 8864 configuration before replacing or upgrading an 8864.



**IMPORTANT:** If someone has made a configuration change in the 8864 but has not also made the same change in StackVision (StackStudio), there will be differences between the configuration in the 8864 and StackVision (StackStudio).

The controller snapshot consists of one, and possibly two, text files. These are described in the following table.

Text Files	Description	Instructions
Data Controller Dump file	This file contains all channel configurations, calibration configurations, etc. that has been loaded from StackVision (but possibly changed in the data controller after the last download). There will always be a “Data Controller Dump” file in the snapshot.	<a href="#">Obtain an 8864 Data Controller Dump</a>
Server.cfg file	The server.cfg file is only installed in data controllers that are being used as a Modbus Master (client). This file is used to control the Modbus Client feature of the data controller. The server.cfg file can only be retrieved from the data controller across an Ethernet network.	<a href="#">Retrieve server.cfg</a>

## Obtain an 8864 Data Controller Dump


Use the following procedure to dump all of the 8864 Data Controller's configuration to a text file. This file will contain all channel configurations, calibration configurations, etc. as stored in the Data Controller.

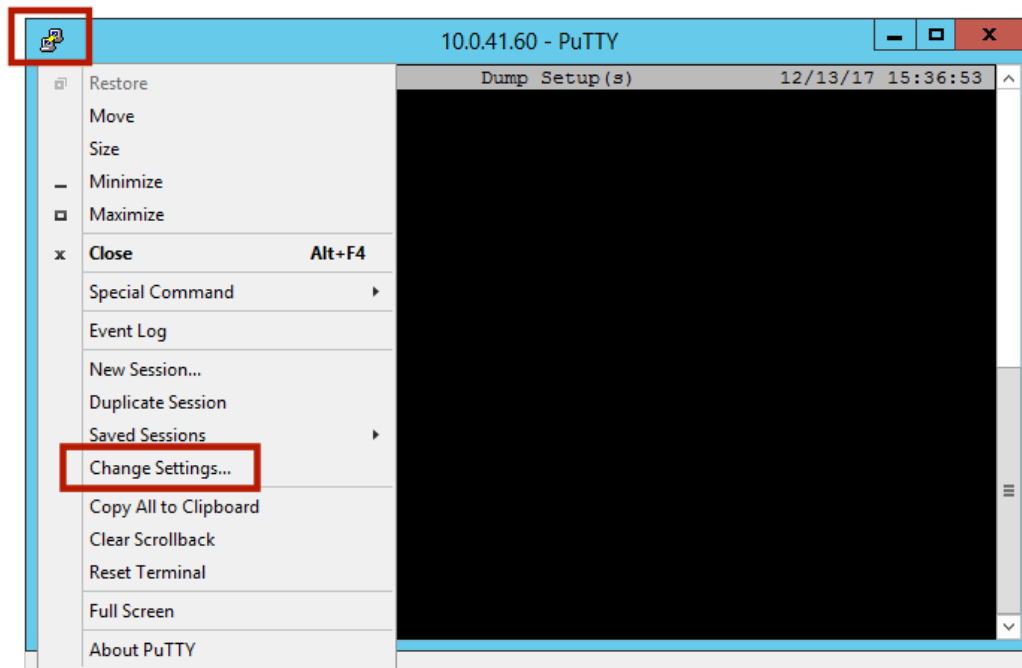
1. Use PuTTY to log in to the 8864 Data Controller remotely via Ethernet or a serial port connection.

```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

2. Navigate to **S - Status Menu > D - Dump Setup(s)**. This gets you ready to dump the configuration.

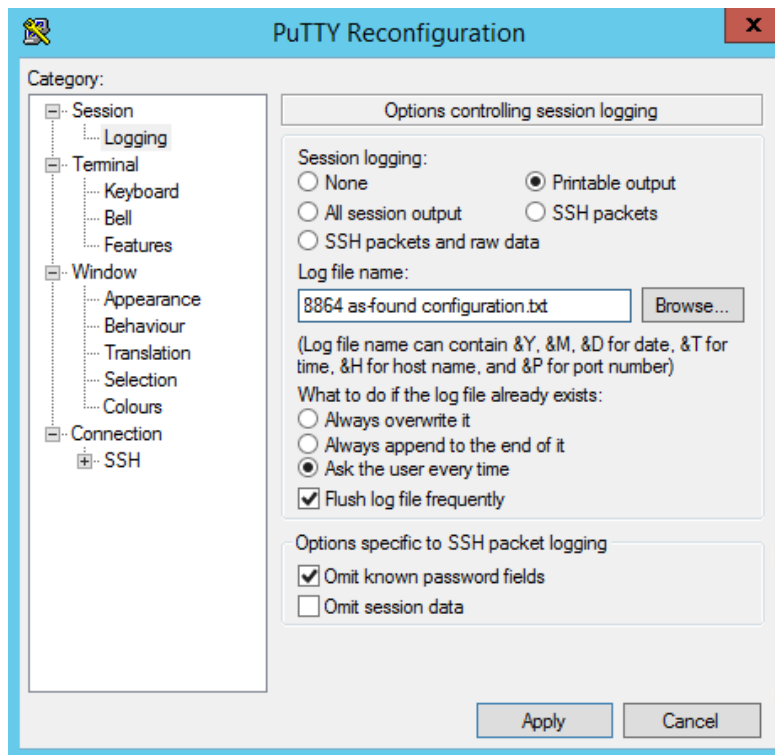
```
ESC 8864 v5.02.r25 ID:88 Dump Setup(s) 12/13/17 15:32:24
P Dump All to Curr Port
```

3. To turn on the capture of the configuration in PuTTY, click the system menu icon (  ) located in the upper left of the PuTTY window (on the left side of the title bar). Then click **Change Settings**.



4. Select **Logging** in the “Category” navigation pane and then complete the following steps:
  - a. Click the option **Printable output** in “Session logging”.
  - b. Type a name for the file in the field **Log file name**, such as “8864 as-found configuration.txt”.

- c. When you're ready to start the file capture, click **Apply**.



5. On the MDI of the 8864 Data Controller, select **P - Dump All to Curr Port**. The MDI screen will scroll the configuration as it is captured to the log file. When it is complete, the MDI will return.
6. Close the PuTTY window. The configuration dump file will be in the directory of the putty.exe file.
7. If you stopped the StackVision services or disabled the data controller during this procedure, remember to re-enable the data controller and restart the services, then verify that polling has been restored.

## Retrieve server.cfg

Complete the steps in the following procedures to determine if the 8864 Data Controller has a server.cfg file, and then retrieve the server.cfg file if present:

1. Log in to the 8864 Data Controller as "Integrator" if you are connected to an 8832 or to an 8864 with firmware before v5.02. For 8864 firmware v5.02 and later, log in using an admin level user name and password.
2. Navigate to **S - Status Menu > V - View Modbus Master Status**. If the **V** option is unavailable, MODBUS is not enabled and there is no server.cfg file.
3. Select **C - View Modbus Client CFG File**.



4. Type the file name **SERVER.CFG** (all caps) and then press **Enter**. This step is not necessary for firmware version v5.02 and later.
5. To scroll through the Configuration File, press **Enter**.
6. When you finish viewing the file, press the **ESC** key to exit. If the SERVER.CFG file is not present, the error message “File not available” displays.
7. To retrieve the Modbus Client configuration file “server.cfg” from the Data Controller, if present, follow the procedures in the topic [Transfer Files From/To the Data Controller](#).

## Load server.cfg

The following procedure explains how to load a Modbus Client configuration file “server.cfg” from a USB flash drive to the 8864 Data Controller. To load a Modbus Client configuration file “server.cfg” from a PC to the Data Controller over an Ethernet connection, follow the procedures in the topic [Transfer Files From/To the Data Controller](#).

Complete the following steps:

1. From the Home Menu, select **S - Status Menu** (hot key S) > **S - System Maintenance** (hot key S).
2. Select **S - Download Server.cfg** (hot key S) and then press <Enter>.
3. Type **Y** to continue.

The server.cfg file **must** be located in the root directory of the USB drive. The file name **must** be all lower case.



## Log in to the 8864 Data Controller

The following methods are available for logging into the 8864 Data Controller. Choose the method you want to use from the list below and then click the link to view instructions for the selected method:

- [Log in Using the Front Panel](#)
- [Log in Using StackVision](#)
- [Log in Using PuTTY Over Ethernet](#)
- [Log in Using PuTTY Over Serial Port](#)

### Log in Using the Front Panel

On the 8864, access the character-mode MDI interface by pressing the “More” button on the front-panel, graphical screen. (For the 8832, the character-mode MDI interface is always available on the front-panel.)



**IMPORTANT:** The MDI is not touch-driven; **a keyboard must be connected to the 8864 to input MDI commands**. When a keyboard is not connected to the 8864, the More button is unavailable for use (disabled).

```
ESC 8864 v5.02.r25 ID:1M Home Menu 10/29/17 19:54:30

H Help Screen
L Login / Set User Level

O Log Out / Exit
```

For firmware versions later than v5.02, log in by selecting **L - Login / Set User Level** and then typing in a valid user name and password. For firmware versions earlier than v5.02, type a valid password to login and set the security level.

```
ESC 8864 v5.02.r25 ID:1M Home Menu 10/29/17 19:54:30
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

## Log in Using StackVision

To login using StackVision,

- Select **Tools > Controller Emulation**. Then provide your login credentials.

The login procedure can also be found in the *Emulate a Controller* section of the [StackVision User Guide](#).

## Log in Using PuTTY Over Ethernet

PuTTY is a free and open-sourced terminal emulator program that can be used to communicate with and capture files from the 8864 Data Controller. PuTTY supports the encrypted communications format “SSH” that is used in the 8864. For more information, see <http://en.wikipedia.org/wiki/PuTTY> and [http://en.wikipedia.org/wiki/Secure\\_Shell](http://en.wikipedia.org/wiki/Secure_Shell).

PuTTY can be downloaded from [www.putty.org](http://www.putty.org). It is a stand-alone executable file (putty.exe) that does not have to be installed. Place the executable file anywhere on a client computer and then double-click the file to open PuTTY.

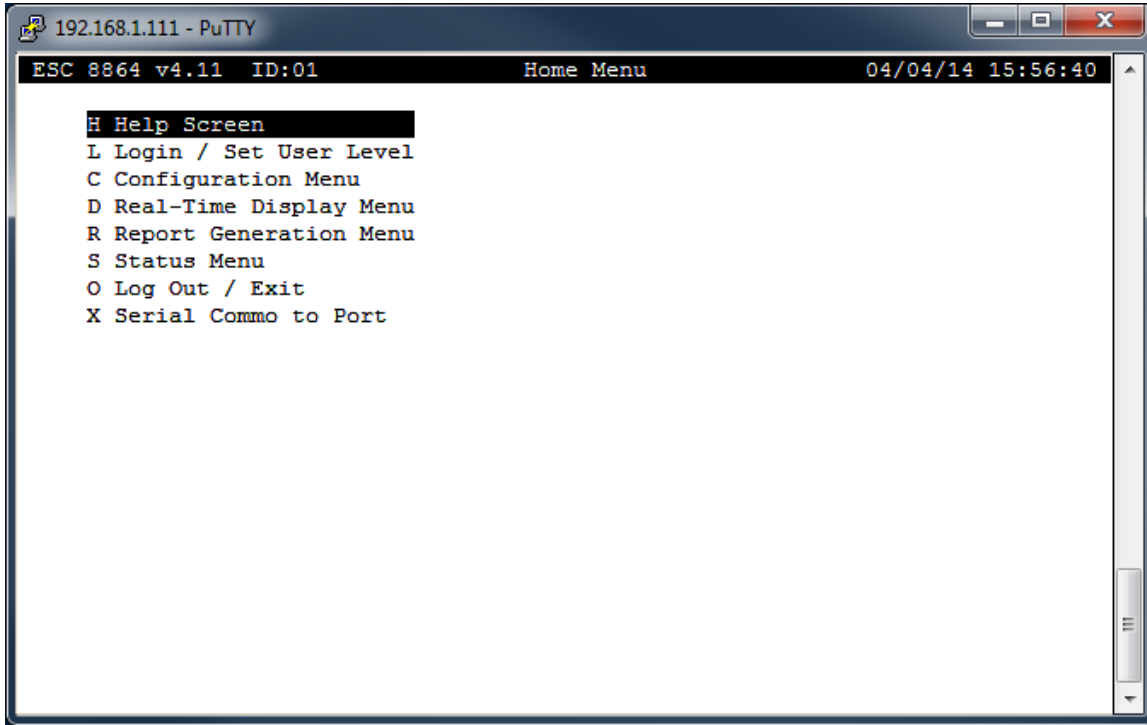


**NOTE:** Please note that although ESC Spectrum recommends using the PuTTY software, PuTTY is made available from a third party that is not affiliated with ESC Spectrum. ESC Spectrum takes no responsibility for the information, content, presentation, or accuracy of the software made available from this third-party vendor. Be aware that the privacy and security policy of the <http://www.putty.org/> website is not

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that of ESC Spectrum. ESC Spectrum makes no specific endorsement of PuTTY. Other third-party applications may work equally well for this task. For more information, see <http://en.wikipedia.org/wiki/PuTTY> and [http://en.wikipedia.org/wiki/Secure\\_Shell](http://en.wikipedia.org/wiki/Secure_Shell).

PuTTY can be used to interface with the 8864 Data Controller via the character-based MDI interface shown in the next example.



It can also be used to capture 8864 configuration dump files.

PuTTY can communicate either via a network (Ethernet) connection or via a serial port connection. When communicating over Ethernet, it can use either the "telnet" protocol (as used in the 8832) or the "SSH" protocol (as used in the 8864).

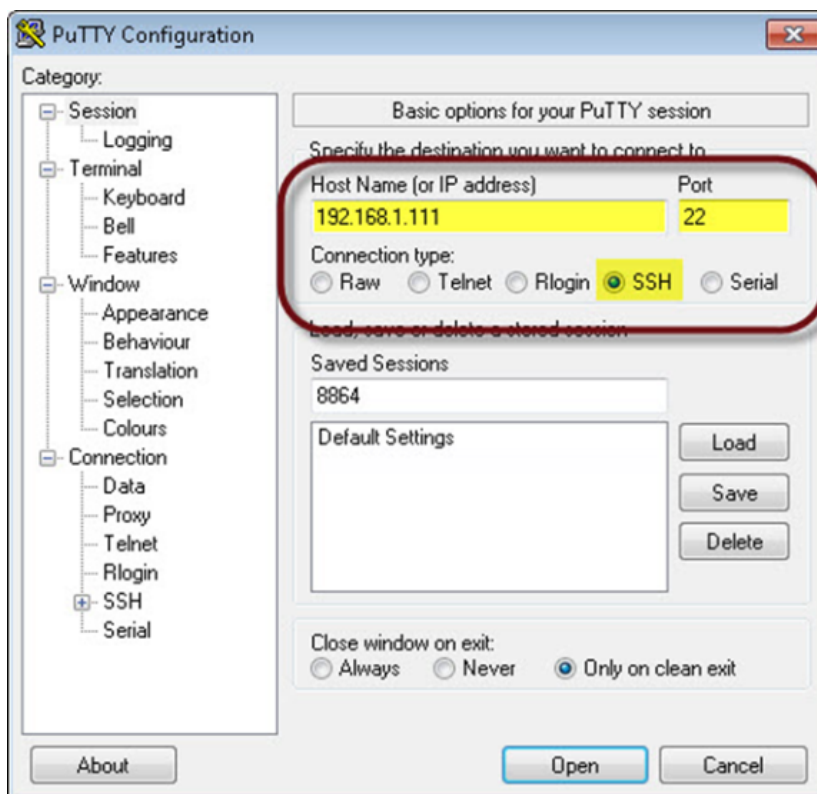
Follow these links for additional information:

- [Log in Using the Front Panel](#)
- [Log in Using StackVision](#)
- [Log in Using PuTTY Over Ethernet](#)
- [Log in Using PuTTY Over Serial Port](#)

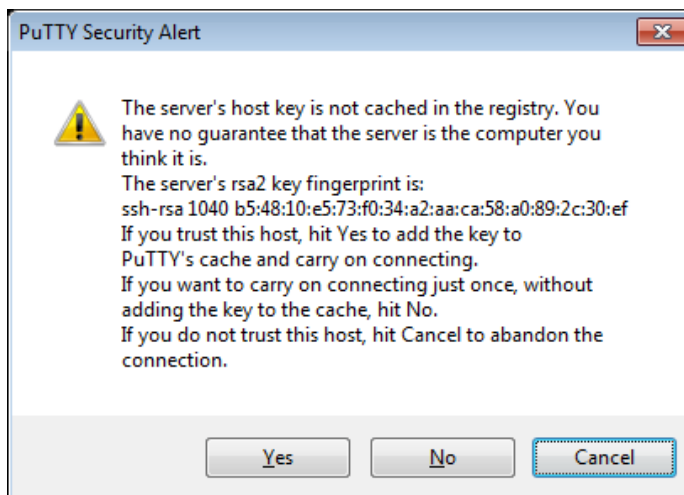
### Log in to an 8864 Over Ethernet

Complete the following steps using PuTTY to log in to the 8864 over the Ethernet:

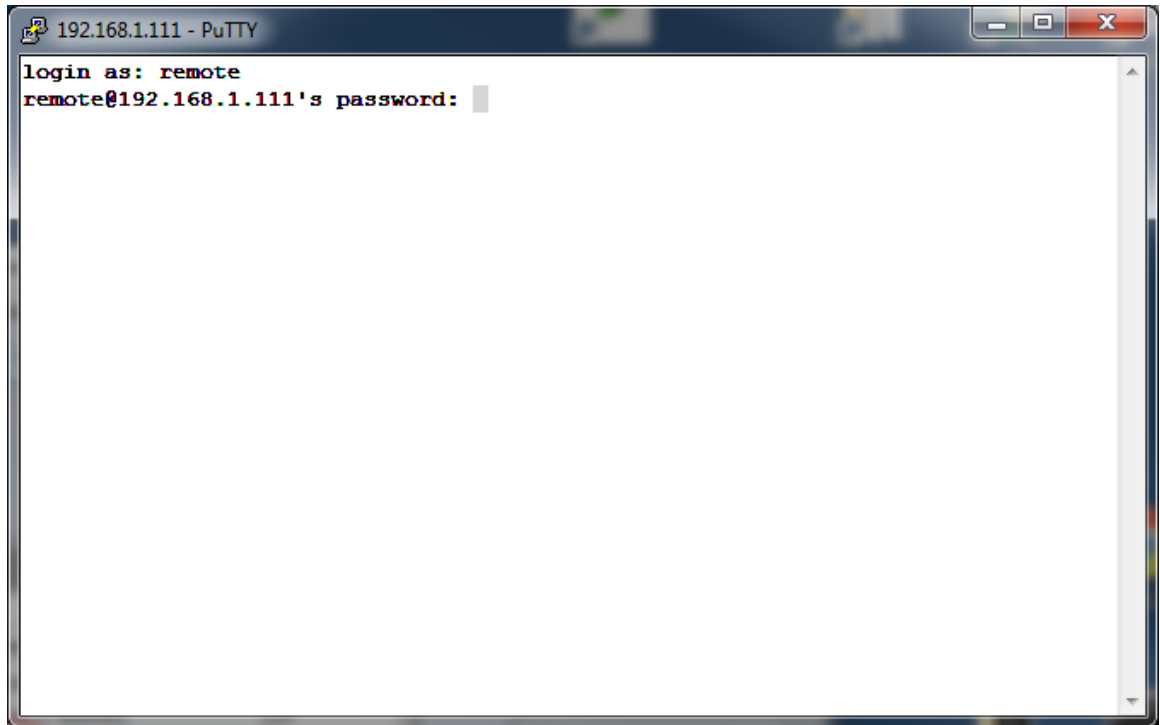
1. Launch PuTTY.
2. Set the IP address of the 8864. Verify that the **Port** is set to **22** and the **Connection Type** is **SSH**.



3. Click **Open** in the lower right to establish the connection.
4. If you are prompted about a security certificate, respond by clicking **Yes**.



5. For firmware versions before v5.02, when the 8864 responds with **login as:**, type **remote** and then press **ENTER**. If you do not know the “remote” password, ask your CEMS administrator or contact [Support](#) for assistance. If the 8864 is running v5.02 and later, type a valid 8864 user name and password.



6. You should see the following MDI menu if the connection is successful.

```
ESC 8864 v5.02.r25 ID:1M Home Menu 10/29/17 19:54:30
H Help Screen
L Login / Set User Level

O Log Out / Exit
```

7. If the 8864 is running firmware v5.02 or later, you will already be logged on. If the 8864 is running firmware before v5.02, then you will have to log in again by selecting the **L - Login / Set User Level** menu selection and typing in a valid password.

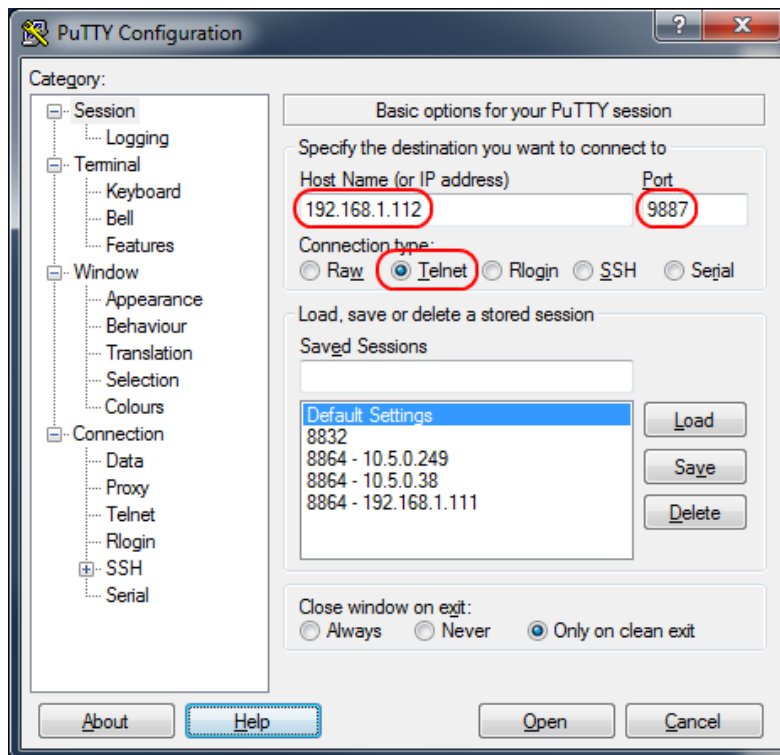
```
ESC 8864 v5.02.r25 ID:1M Home Menu 10/29/17 19:54:30
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Comm to Port
```

8. If you do not get a connection to the 8864 immediately, wait 10 minutes and then try again. Some networks have a security timeout for secure connections.

### Log in to an 8832 Over Ethernet

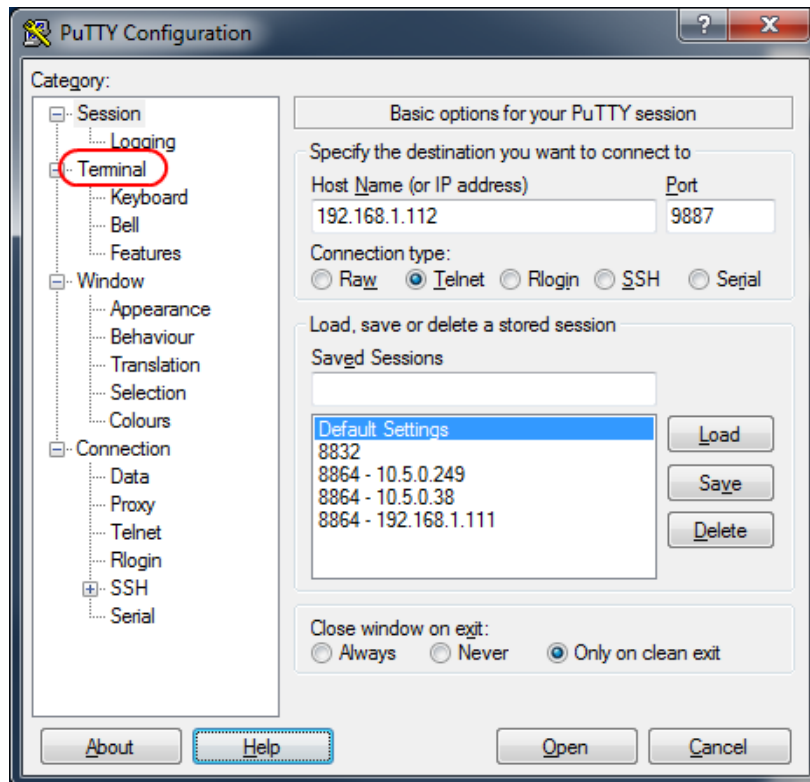
Complete the following steps using PuTTY to log in to the 8832 over Ethernet:

1. Start PuTTY.
2. Set the following fields in the PuTTY Configuration screen as shown in the next example:
  - a. Set the **IP address** of the 8832.
  - b. Set **Port** to **9887**.
  - c. Set **Connection type** to **Telnet**.

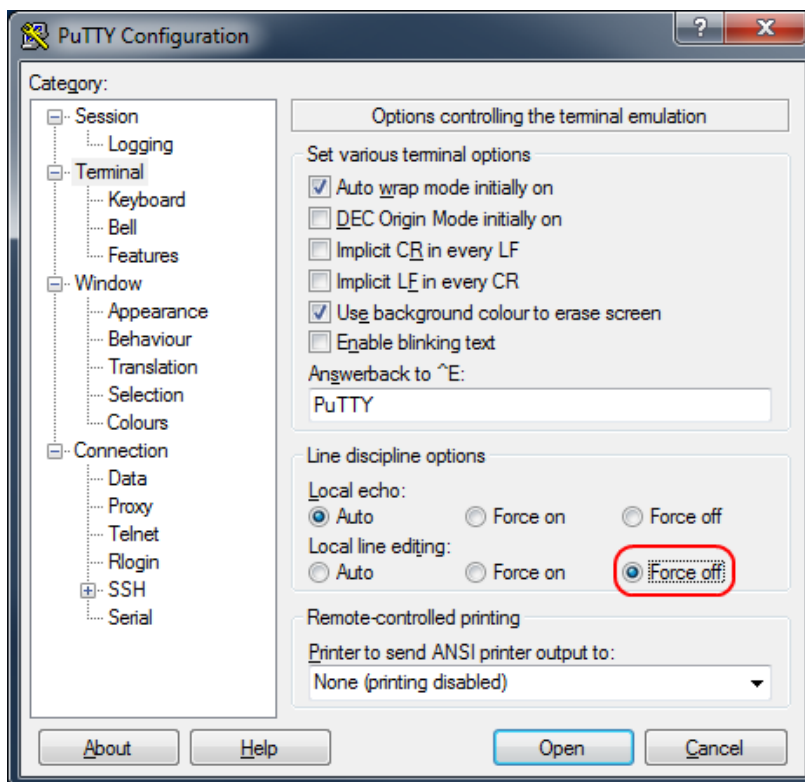




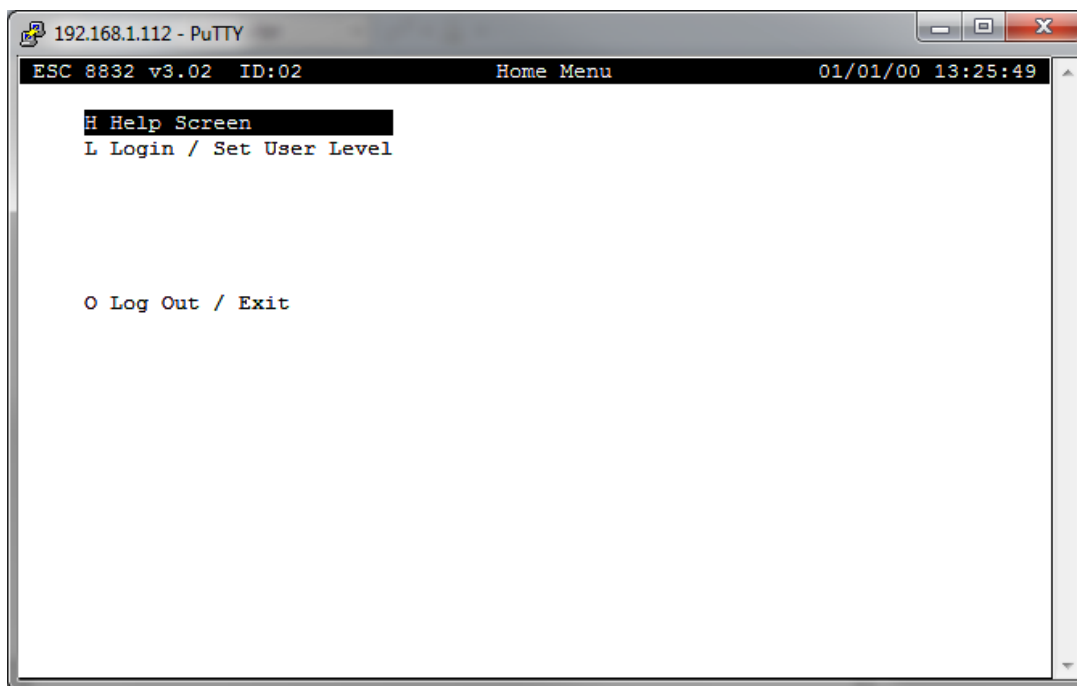
3. Click **Terminal** in the Category navigation pane located on the left side of the screen.



4. Select the option **Force off** for “Local line editing”.



5. Click **Open** to establish the connection.



6. Login by selecting **L - Login / Set User Level** menu selection and then typing a valid password.

```
ESC 8864 v5.02.r25   ID:1M           Home Menu           10/29/17 19:54:30

H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

## Log in Using PuTTY Over Serial Port

PuTTY is a free and open-sourced terminal emulator program that can be used to communicate with and capture files from the 8864 Data Controller. PuTTY supports the encrypted communications format “SSH” that is used in the 8864. For more information, see <http://en.wikipedia.org/wiki/PuTTY> and [http://en.wikipedia.org/wiki/Secure\\_Shell](http://en.wikipedia.org/wiki/Secure_Shell).

PuTTY can be downloaded from [www.putty.org](http://www.putty.org). It is a stand-alone executable file (putty.exe) that does not have to be installed. Place the executable file anywhere on a client computer and then double-click the file to open PuTTY.



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PuTTY can be used to interface with the 8832 or 8864 Data Controller via the character-based MDI interface shown in the next example. PuTTY can also be used to capture data controller

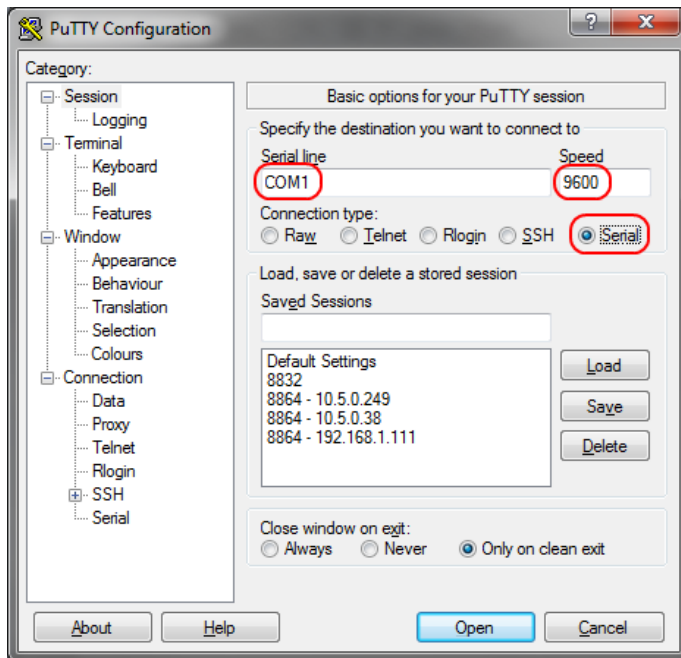
configuration dump files.

```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

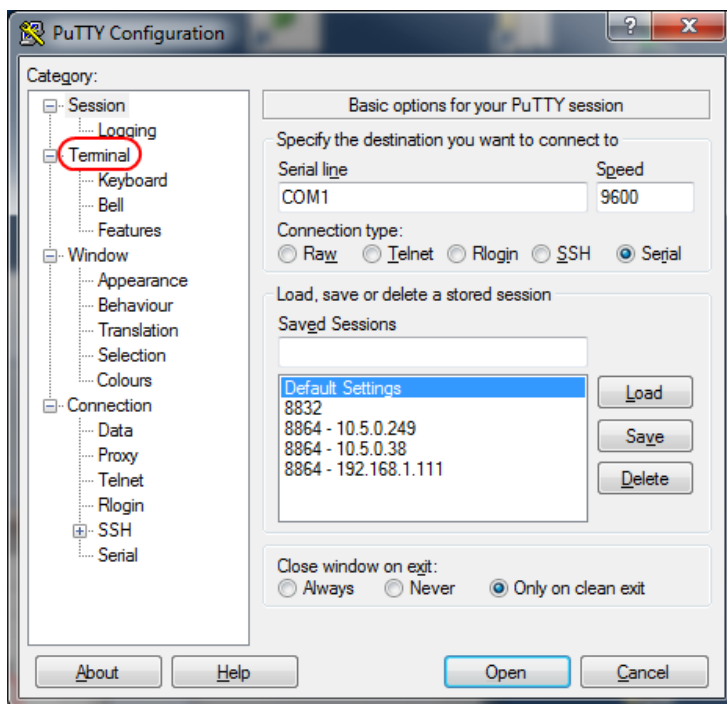
Use the following procedure to log in to a 8864 Data Controller using PuTTY over a serial port:

1. Determine if you will be connecting to the 8864 Data Controller from a StackVision server:
  - a. If you are attempting to connect from a StackVision server using a serial port that StackVision is using to poll the 8864, you must first stop the StackVision services. Alternatively, you may disable the 8864 in StackVision, and then stop/start the StackVision services (this allows other data controllers to be polled).
  - b. If you are directly connecting from a computer that is not a StackVision server, then ensure that a 9-pin to 9-pin “null modem” cable is connected from the PC to a serial port on the data controller that has an Interface type of “MDI” or “CEN”.
2. Start PuTTY.
3. Complete the following steps:
  - a. Click **Serial** for the **Connection type**.
  - b. Set the **Serial line** to **COM1** (or other COM port on the PC).

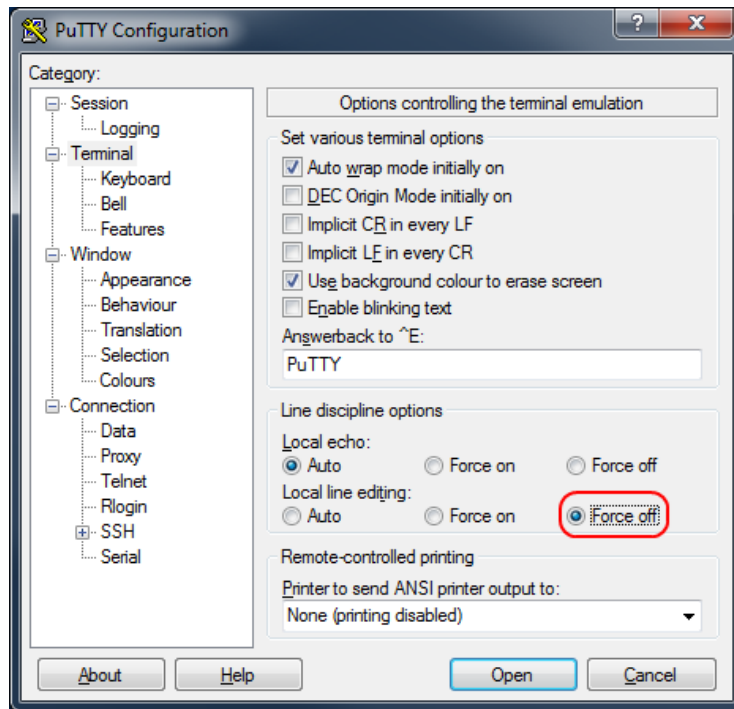
- c. Set **Speed** to the speed (baud rate) of the data controller serial port.



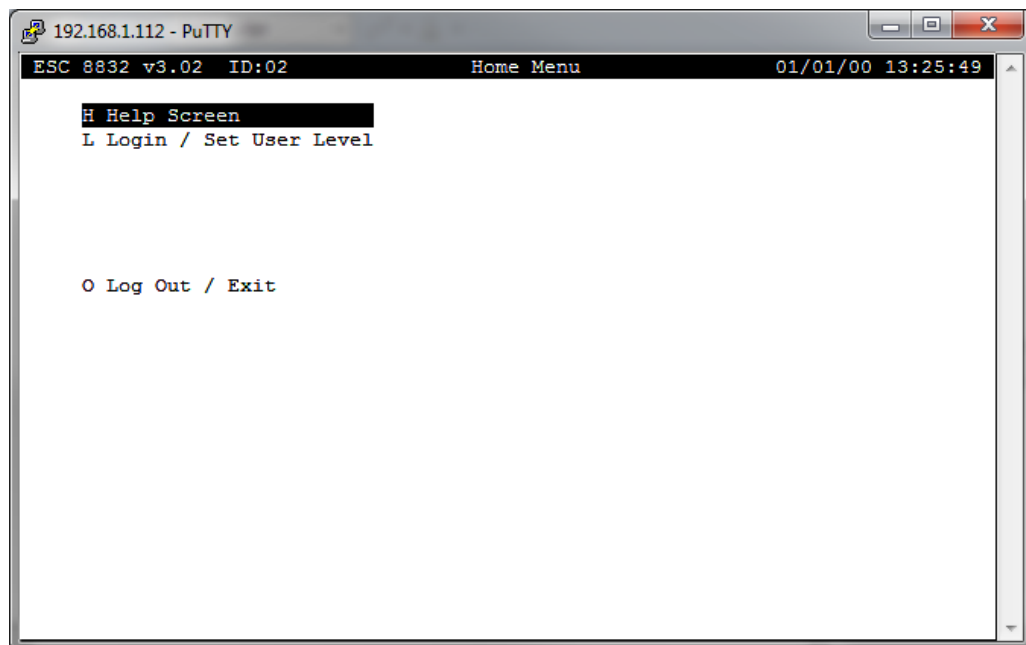
4. Click **Terminal** in the Category navigation pane on the left side of the screen.



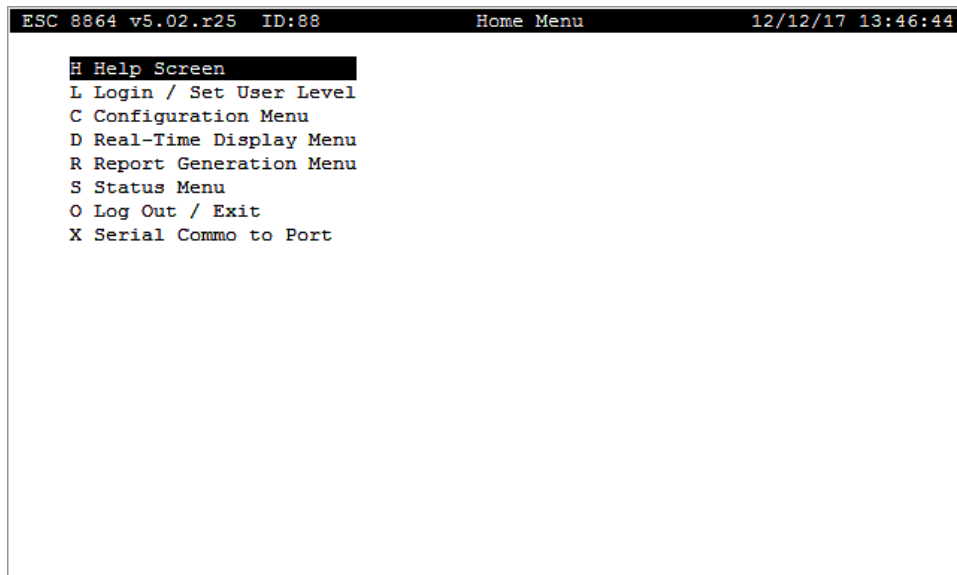
5. Click **Force off** to set **Local line editing**.



6. Click **Open** to establish the connection.



7. Login by selecting the **L - Login / Set User Level** menu selection and then typing a valid password.



```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

## Cold Start the 8864 Data Controller

Complete either step 1 or 2 to cold start the 8864:

1. If the 8864 is running a firmware version before v5.02:
  - a. Log in to the 8864 at the Integrator level.
  - b. Select **L - Login / Set User Level** and then type **COLD START**.  
**All data and configuration will be deleted when this command is confirmed.**
2. If the 8864 is running firmware v5.02 or later:
  - a. Log in to the 8864 using an admin user name and password.
  - b. From the Home Menu, select **S - Status Menu** (hot key S) > **S - System Maintenance** (hot key S).
  - c. Select **C - Cold Start** (hot key C) and then press <Enter>.
  - d. Type the password of the currently logged in account to continue.

**All data and configuration will be deleted when this command is confirmed.**

ESC 8864 v5.02.r25 ID:1M Enter Password For Cold Start 10/26/17 09:31:11	
Current User Name	: admin
Enter Password	: <span style="background-color: black; color: black;">XXXXXXXXXX</span>

## Transfer Files From/To the Data Controller

Use the procedure in the following topics to transfer files from or to the 8864 Data Controller or 8832:

- [Transfer Files Using FTP](#)
- [Transfer Files Using SFTP](#)

### Transfer Files Using FTP

The following information applies to an 8832 or 8864 Data Controller that is running firmware prior to v5.02.

To transfer files from or to the data controller using FTP (file transfer protocol):

1. Click the Windows **Start** button and select **Run**. Type **cmd** in the Open field of the Run dialog box, then press **OK**. This opens the Windows command window (cmd.exe).
2. At the command prompt, type the IP address of the data controller using the following format, and then press **Enter** on the keyboard:

```
ftp xxx.xxx.xxx.xxx
```

3. When prompted for a user name and password, type **das** as the user name and the **integrator-level password** of the logger. If you do not know the integrator-level password, contact your CEMS Administrator or ESC Spectrum [Support](#). After entering the password, the system displays an ftp> prompt as shown in the next example.

```
C:\>ftp 192.168.1.111
Connected to 192.168.1.111.
220 Service ready for new user.
User (192.168.1.111:(none)): das
331 User name okay, need password.
Password:
230 User logged in proceed.
ftp>
```

4. At the ftp> prompt, type **lcd \** and then press **Enter** on the keyboard. If the folder to be accessed on the PC is not located in the root folder on C: drive, replace the backward slash (\) with the full Windows path to the firmware upgrade file.



```
ftp> lcd \  
Local directory now C:\.  
ftp>
```

5. To transfer files from the PC to the data controller, at the ftp> prompt type **put xxxxx** making sure to replace **xxxxx** with the file name of the file to transfer to the data controller. Then press **Enter** on the keyboard. The transfer process may take a few minutes to complete depending on the speed of the network connection.

```
ftp> put 8864_Upgrade_V4.11.bin  
200 Command okay.  
150 File status okay; about to open data connection.  
226 Closing data connection. Requested file action successful.  
ftp: 56774528 bytes sent in 18.70Seconds 3036.23Kbytes/sec.  
ftp>
```

6. To transfer files from the data controller to the PC, use the command **get xxxxxx<enter>**, where **xxxxxx** is the file name.
7. After the transfer process completes, type **bye** at the ftp> prompt and then press **Enter** on the keyboard. This closes the connection to the data controller.

```
ftp> bye  
221 Service closing control connection.  
C:\>
```

8. Click the close button (X) to close the Windows command window (cmd.exe).

When retrieving the server.cfg or other file using FTP, always make sure an existing file of the same name is not in the active directory. If an existing file is in the active directory, rename the file so it isn't overwritten.

## Transfer Files Using SFTP

The information in this topic applies to an 8832 or 8864 Data Controller that is running firmware prior to v5.02.

To transfer files from or to the data controller using SFTP (secure file transfer protocol):

1. Obtain a copy of a file transfer program that can communicate using SFTP (Secure FTP). ESC Spectrum recommends the open-source, free program WinSCP (<https://winscp.net>). WinSCP can also be found on any StackVision server running StackVision v6.0 or later in the "C:\StackVision\Application\Core\Misc" folder.

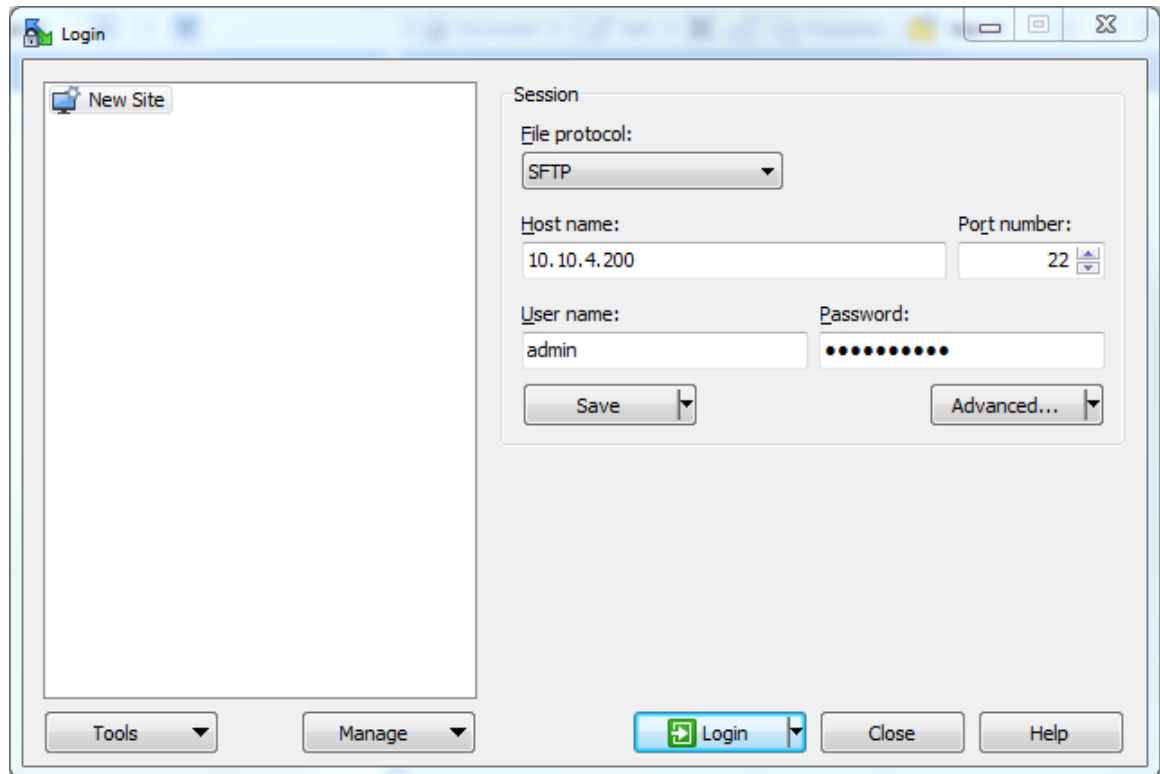


**NOTE:** Please note that although ESC Spectrum recommends using the WinSCP software, WinSCP is made available from a third party that is not affiliated with ESC Spectrum. ESC Spectrum takes no responsibility for the information, content, presentation, or accuracy of the software made

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available from this third-party vendor. Be aware that the privacy and security policy of the <https://winscp.net> website is not that of ESC Spectrum. ESC Spectrum makes no specific endorsement of WinSCP. Other third-party applications may work equally well for this task.

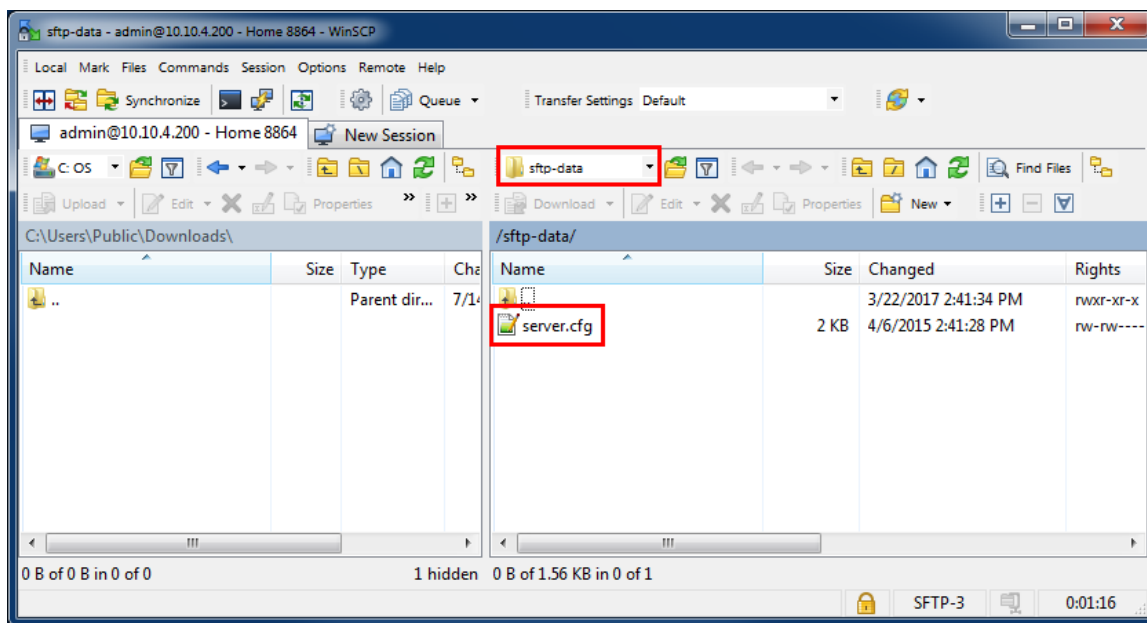
2. Open WinSCP to display the Login screen shown in the next example.



3. Provide the following information in the Login screen:
  - a. Type the IP address of the 8864 in the **Host name** field.
  - b. Type an administrator-level user name in the **User name** field.
  - c. Type the administrator-level password in the **Password** field.
4. Click **Login**.
5. If you have never connected to this 8864 with WinSCP, the following security warning displays. Click **Update**.



6. Make sure the folder selected on the right is labeled **sftp-data**. The server.cfg file (if present) will be shown in the file area on the right side of the window. Drag and drop to or from the Windows desktop to transfer files between the 8864 and the PC.



# Appendix B. Regulatory Notices and Warnings

- [FCC Notices](#)
- [Battery Disposal](#)
- [Important Safety Notices](#)

## FCC Notices

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instruction manual, may cause harmful interference with radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case you will be required to correct the interference at your own expense.

The following information is provided on the device covered in this document, in compliance with the FCC Regulations.

- **Model Number:** S-164-0001
- **Rating:** ~110-240V – 60/50 Hz – .74/.24 I
- **Company Name:**  
ESC Spectrum  
Engineering Department  
10801 N. Mopac Bldg 1-200  
Austin, TX 78759 USA

## Battery Disposal



Your model S-164-0001 Data Controller uses a lithium-ion battery. The lithium-ion battery is a long-life battery, and it is very possible that you will never need to replace it. However, should you need it replaced, have it replaced by qualified service personnel. Contact the nearest authorized service facility for examination, repair, or adjustment.

**Do not dispose of the battery along with normal waste.** Contact your local waste disposal agency for the address of the nearest battery deposit site.

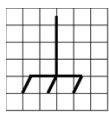
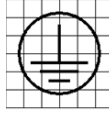
## Important Safety Notices

- [Definition of Safety Symbols](#)
- [Warning: Risks](#)
- [Additional Warnings](#)

### Definition of Safety Symbols

When using this electrical appliance, basic safety precautions should be followed, including the following:

Symbol	Definition
	Caution (Refer to accompanying documentation)
	Caution (Risk of electric shock)
	Alternating current
	Earth (ground) terminal

Symbol	Definition
	Frame (ground) terminal
	Protective (ground) terminal

## Warning: Risks

To reduce the risk of burns, electric shock, fire or injury to persons, observe the following precautions:

- Read all instructions before using this appliance.
- This product must be grounded. Connect only to properly grounded outlet.
- Voltages above 60VDC and 25V AC RMS may create a serious shock hazard.
- Unplug this product from the power source before cleaning, and use a dry cloth, without liquid or aerosol cleaners.
- Disconnect all power to this product and the attached peripherals during the installation or uninstalling process.
- Install or locate this product only in accordance with the provided installation instructions.
- This product should be operated only from the type and rated power source indicated on the marking label. If you are unsure of the type of power supply in your facility, consult your maintenance department or local Power Company.
- To reduce the risk of electric shock, do not disassemble this product. Take it to qualified service personnel when service or repair work is required. Opening or removing covers may expose you to dangerous voltages or other risks. Incorrect re-assembly can cause electric shock when the product is subsequently used.
- Disconnect this device from the power source and refer servicing to qualified service personnel under any of the following conditions:
  - When the power supply cord is damaged or frayed.
  - If liquid has been spilled on or into the product.
  - If the product has been exposed to rain or water.
  - If the product has been dropped or the cabinet has been damaged.
  - If the product does not operate normally when following the operating instructions. (Adjust only those controls that are covered by the operating instructions. Improper

adjustment of other controls may result in damage and will often require extensive repair work by a qualified technician.)

- Use this product only for its intended use as described in this manual.
- Do not overload wall outlets and extension cords, as this can result in the risk of fire or electric shock.
- Replace AC Input fuses only with manufacturer's replacement part. Contact the nearest authorized service personnel for part replacement.

## Additional Warnings

Unit is to be used under the following environmental conditions:

- Indoor use only.
- Altitude up to 2000 m.
- Maximum relative humidity of 80% for temperatures up to 31 degrees C, decreasing linearly up to 50% relative humidity at 40 degrees C.
- Mains supply voltage fluctuations not to exceed +/- 10 percent of the nominal voltage.
- Transient over-voltages according to Installation Categories (Over-voltage categories) I, II, and III.
- Pollution Degree 1 or 2.

## Appendix C. Clean Air Act Validation

This appendix documents the algorithms used by the 8864 Data Controller to determine valid hourly averages for gaseous/flow parameters in 40CFR75 systems. See the following sections for more information:

- [Valid Hourly Average for Gaseous/Flow Parameters](#)
- [Algorithm Summary](#)
- [Configure 40CFR75 Channels](#)

### Valid Hourly Average for Gaseous/Flow Parameters

Modern data acquisition systems can easily scan all inputs at least once every 10 seconds. The 8864 scans all inputs every second and uses those scans to build 1-minute averages. From these base average points, two methods are available to calculate hourly averages:

- First method: Integrated Averaging - Calculates hourly averages from data points representative of equal divisions of the hour, the smallest of which must be at least 15 minutes. No division is weighted more than any other. Thus, a “data point” is defined as a 15-minute average that is calculated from one or more 1-minute averages. These 15-minute averages are weighted equally in calculating the hourly average, regardless of how many 1-minute averages are contained in each.
- Second method: Arithmetic Averaging - Calculates hourly averages with equal weighting given to all data points recorded during the hour. In this method, a “data point” is defined as a 1-minute average.

The [Algorithm Summary](#) section contains the calculations used in both the Integrated Averaging and Arithmetic Averaging methods.

Regardless of the averaging method, each hour is validated by the guidelines described in the regulations as follows:

- For a full operating hour (a clock hour with 60 minutes of unit operation), at least one data point in each of the 15-minute quadrants of the hour is required to calculate the hourly average.
- For a partial operating hour (a clock hour with less than 60 minutes of unit operation), at least one data point in each 15-minute quadrant of the hour in which the unit operated is required to calculate the hourly average.
- For an operating hour in which required maintenance or quality-assurance activities were performed:



- If the unit operated in two or more 15-minute quadrants of the hour, a minimum of two valid data points, separated by at least 15-minutes, is required to calculate the hourly average.
- If the unit operated in only one 15-minute quadrant of the hour, at least one valid data point is required to calculate the hourly average.
- If a daily calibration error check is failed during an operating hour, all data for that hour are invalidated, unless a subsequent calibration error test is passed in the same hour and the data validation requirements described above are met, based on data recorded after the successful calibration.
- For a full or partial operating hour, all valid data points are used to calculate the hourly average.

### Related Topics

- [Algorithm Summary](#)
- [Configure 40CFR75 Channels](#)

## Algorithm Summary

### Calculation of Hourly Average using the Integrated Averaging Method

$$A_H = (1/N) \times (D_0 + D_{15} + D_{30} + D_{45})$$

where

$N$  = the number of valid 15-minute data points, and

$D_n$  = a valid 15-minute data point calculated by

$$D_n = (1/N) \times [ M_{(n+0)} + M_{(n+1)} + \dots M_{(n+14)} ]$$

where

$N$  = number of valid 1-minute averages in the 15-minute period,  
and

$M_n$  = a valid 1-minute average ( $n$  = 'index' into 15-minute period).

Invalid 1-minute averages are not included in the 15-minute data point calculation, and invalid 15-minute data points are not included in hourly averages.

### Calculation of Hourly Average using the Arithmetic Averaging Method

$$A_H = (1/N) \times (D_0 + D_1 + \dots + D_{58} + D_{59})$$

where

$N$  = the number of valid 1-minute data points, and

$D_n$  = a valid 1-minute data point

Invalid 1-minute averages are not included in the hourly averages.

#### Related Topics:

- [Valid Hourly Average for Gaseous/Flow Parameters](#)
- [Configure 40CFR75 Channels](#)

## Configure 40CFR75 Channels

The following averaging intervals must be set in the 8864 channel configuration to allow the 40CFR75 option to be turned “on:”

	Base Avg	Avg #1	Avg #2
Gaseous/Flow Channel	1 min	15 min	1 hour

The following availability criteria are then used in each average to determine if that average is a “valid” average:

	Base Avg	Avg #1	Avg #2
Gaseous/Flow Channel	100%	> 0%	EPA

For a gaseous/flow channel, a single bad scan makes the minute average bad, but anywhere from 1 to 15 good minute averages makes the 15-minute data point valid. The hourly average validity is based on the criteria defined in [Valid Hourly Average for Gaseous/Flow Parameters](#).



**NOTE:** The 100-percent criteria for the base average is not required by EPA, but is used to give the system time to recover from error conditions such as power failures. The 8864 may be configured to accept a lower threshold, using the “% Valid for Base Avg” setting in the System Configuration > Configuring System Parameters menu.

#### Related Topics:

- [Valid Hourly Average for Gaseous/Flow Parameters](#)
- [Algorithm Summary](#)



# Appendix D. Calibration Parameter N Point Autoscaling Method

This appendix contains instructions for autoscaling calibration parameters. See the following sections for more information:

- [Autoscaling Procedure](#)
- [Autoscaling Execution Check](#)
- [Autoscaling Algorithm](#)

## Autoscaling Procedure

The basic procedure for n-point rescaling of any calibration parameter is as follows:

Use the actual calibration result and the current scaling parameters to determine the actual input voltage (or current) for each of the “n” points where valid calibration results are available.

- Use the actual input voltage (or current) and the expected output for each of the “n” points to determine the scaling parameters.
- The calibration parameter three-point autoscaling must guarantee that the result of the rescaling yields a curve that has unique output values over the range of possible input voltages (or currents).

The valid input range over which the scaled output must be unique is from the Negative Overrange Limit (i.e., -100% Full Scale - Permissible Negative Overrange) through the Positive Overrange Limit (i.e., 100% Full Scale + Permissible Positive Overrange). Note that the current permissible overrange is currently 10% of full scale for both positive and negative input values.

### Related Topics:

- [Autoscaling Execution Check](#)
- [Autoscaling Algorithm](#)

## Autoscaling Execution Check

Upon completion of a calibration sequence (but before the recovery phase), each affected parameter is checked to see if autoscaling needs to be performed for that parameter.

Autoscaling will be performed only if:

- The affected parameter is configured as a data parameter with autoscaling enabled (henceforth referred to as the autoscaled parameter) in one or more calibration phases.
- The calibration result for each phase that contains the autoscaled parameter is valid. (Note this only applies up to the maximum number of data points permitted for autoscaling, which currently is three points. Therefore, if the autoscaled parameter is configured for autoscaling on more than three phases, then only the first three phases containing the autoscaled parameter with valid results will be used, and subsequent phases will be ignored both in regard to validity as well as autoscaling.)

Note that, if the number of phases configured with the autoscaled parameter, up to the maximum of three points, does not match the number of phases with valid results, then the autoscaling will not be performed and a message will be placed in the system log which states "AutoScalNotEnoughPts." The system log codes will contain the calibration sequence number, the number of phases with valid results for the autoscaled parameter, and the number of phases configured with the autoscaled parameter, respectively. The log does not indicate which parameter failed; however, it will contain an entry for each parameter that does fail.

To satisfy the second condition, in both the calibration hour and non-calibration hour scenarios, apply the criteria stated in the EPA policy guideline notes of Fall 1993, indicating that a valid hour exists if there is at least one data point in each 15-minute quadrant. For hours during which calibration or scheduled maintenance occur, only two 15-minute quadrants must be present.

### Related Topics:

- [Autoscaling Procedure](#)
- [Autoscaling Algorithm](#)

## Autoscaling Algorithm

The algorithm to actually autoscale a given autoscaled parameter is outlined below.

### Step 1:

A check of the existing scaling coefficients for the autoscaled parameter is first made to ensure that existing scaling does not actually define a line instead of a parabola (i.e., if the second-order coefficient is 0, then the scaling defines a straight line and not a parabola). If the existing scaling does define a straight line, then the scaling will be modified to a two-point scale (i.e., a straight line) before rescaling.

For each valid calibration result data point, the actual voltage (or current) is determined based on the actual output in the following manner:

If the current scaling is a three-point scale, then the actual output is determined by the following equation:

$$AVG_n = C2INPUT_n^2 + C1INPUT_n + C0$$

where:

$AVG_n$  = actual output "n", for  $n = 1$  to 3 calibration data points;

$INPUT_n$  = actual input "n", for  $n = 1$  to 3 calibration data points;

and  $C2, C1, C0$  = current scaling coefficients

Therefore, the actual input is determined by solving for the 2 roots of the following equation:

$$C2INPUT_n^2 + C1INPUT_n + (C0 - AVG_n) = 0$$

The roots are the values of  $INPUT_n$  which cause the above equation to equal 0 and therefore represent the actual input which would result in an actual output of  $AVG_n$ . Note that because this is a second order polynomial, there are always two possible values of  $INPUT_n$  which would give a result of 0 in the above equation. Solving the above equation (based on the well-known quadratic formula) yields the following equations that may be used to calculate the values of  $INPUT_n$  corresponding to an output value of  $AVG_n$ :

$$INPUT_nRoot0 = (-C1 + (C1^2 - 4 * C2 * (C0 - AVG_n))^{1/2}) / (2 * C2)$$

**-or-**

$$INPUT_nRoot1 = (-C1 - (C1^2 - 4 * C2 * (C0 - AVG_n))^{1/2}) / (2 * C2)$$

Note that the raising of an expression to the "1/2" power is equivalent to computing the square root of the expression. Consequently, if the expression were a negative number, the square root of the expression would be imaginary (because you cannot multiply any positive number by itself and get a negative result). Please note that the expressions for which the square root is being computed in the above equations are identical.

If both  $INPUT_nRoot0$  and  $INPUT_nRoot1$  are imaginary, then a message will be placed in the system log which states "AC:ImaginaryRoots" with the first system log code containing the report channel number (the other two codes will be 0) and the rescaling attempt will then be aborted. Note that this case should never occur, because the current scaling coefficients ( $C2$ ,  $C1$ , and  $C0$ ) should be correct and the values  $AVG_n$  are already based on the current scaling coefficients.

If both roots (INPUTnRoot0 and INPUTnRoot1) are not imaginary, if the roots are not equal, AND both roots fall within the valid input range or both roots fall outside the valid input range, then the actual input (INPUTn) corresponding to the actual output (AVGn) cannot be determined. Consequently, a message will be placed in the system log which states “AC:TwoRoots” with the first system log code containing the report channel number (the other two codes will be 0) and the rescaling attempt will be aborted.

If both roots (INPUTnRoot0 and INPUTnRoot1) are not imaginary, if the roots are equal OR both roots do not fall within the valid input range or both roots do not fall outside the valid input range, then the actual input (INPUTn) corresponding to the actual output (AVGn) is determined as follows:

If INPUTnRoot0 is within the valid input range it will be used as the actual input value corresponding to the actual output AVGn. Else, if INPUTnRoot0 is outside the valid input range, then INPUTnRoot1 will be used as the actual input value corresponding to the actual output AVGn.

If the current scaling is a two-point scale, then the actual output is determined by the following equation:

$$AVG_n = C1INPUT_n + C0$$

where:

AVGn = actual output “n”, for n = 1 to 2 calibration data points;

INPUTn = actual input “n”, for n = 1 to 2 calibration data points;

and C1,C0 = current scaling coefficients.

Therefore, the actual input is determined by the following equation:

$$INPUT_n = (AVG_n - C0) / C1$$

## Step 2:

The new scaling coefficients are determined based on the actual input values determined in step 2 and the expected output values (expressed as % of full scale) specified by the user:

For three-point rescaling, the new coefficients are determined by solving the following three simultaneous equations for the new coefficients:

$$C2_{new} * INPUT_{12} + C1_{new} * INPUT_1 + C0_{new} = EXPECTED_1$$

$$C2_{new} * INPUT_{22} + C1_{new} * INPUT_2 + C0_{new} = EXPECTED_2$$

$$C2_{new} * INPUT_{32} + C1_{new} * INPUT_3 + C0_{new} = EXPECTED_3$$

where:

$C_{2new}, C_{1new}, C_{0new}$  = new 3-point scaling coefficients;

$INPUT_n$  = actual input "n" for  $n = 1$  to 3 points; and

$EXPECTED_n$  = expected output "n" for  $n = 1$  to 3 points.

The method used by ESC Spectrum for solving the above simultaneous equations is known as **Cramer's Rule**. Cramer's Rule is based on the use of matrix algebra to represent the above equation as a system of matrices. A detailed explanation of Cramer's Rule is not within the scope of this document (for more information on Cramer's Rule, please refer to a standard mathematics textbook on the subject). However, the final equations used to determine the new scaling coefficients, based on Cramer's Rule, are as follows:

(Note that the result of the following equation is used by the subsequent equations. It is calculated first in order to simplify and expedite the subsequent calculations.)

$$\begin{aligned}
 \text{DETERMINATE} &= INPUT_1^2 * (INPUT_2 - INPUT_3) + \\
 &\quad INPUT_2^2 * (INPUT_3 - INPUT_1) + \\
 &\quad INPUT_3^2 * (INPUT_1 - INPUT_2) \\
 C_{2new} &= (EXPECTED_1 * (INPUT_2 - INPUT_3) + \\
 &\quad EXPECTED_2 * (INPUT_3 - INPUT_1) + \\
 &\quad EXPECTED_3 * (INPUT_1 - INPUT_2)) / \text{DETERMINATE} \\
 C_{1new} &= (EXPECTED_1 * (INPUT_3^2 - INPUT_2^2) + \\
 &\quad EXPECTED_2 * (INPUT_1^2 - INPUT_3^2) + \\
 &\quad EXPECTED_3 * (INPUT_2^2 - INPUT_1^2)) / \text{DETERMINATE} \\
 C_{0new} &= (EXPECTED_1 * (INPUT_2^2 * INPUT_3 - INPUT_3^2 * INPUT_2) + \\
 &\quad EXPECTED_2 * (INPUT_3^2 * INPUT_1 - INPUT_1^2 * INPUT_3) + \\
 &\quad EXPECTED_3 * (INPUT_1^2 * INPUT_2 - INPUT_2^2 * INPUT_1)) \\
 &\quad / \text{DETERMINATE}
 \end{aligned}$$

Once the new scaling coefficients have been determined (assuming no error occurred), the new scaling equation will be:

$$AVG = C_{2new}INPUT^2 + C_{1new}INPUT + C_{0new}$$

If the roots of the new scaling equation (i.e., the values of  $INPUT$  which yield  $C_{2new}INPUT^2 + C_{1new}INPUT + C_{0new} = 0$ ) are imaginary (see above for an explanation of solving a second-order polynomial for the roots and the meaning of imaginary roots), then a message will be



placed in the system log which states “AC:GetRootsFailed” with the first system log code containing the report channel number (the other two codes will be 0) and the rescaling attempt will then be aborted.

Else, if the roots of the new scaling equation are **not** imaginary, then if a minimum or maximum of the new rescaling occurs within the valid input range, then a message will be placed in the system log which states “AC:LocalMinMaxFound” with the system log codes containing the report channel number, the integer value of  $C_2$ , and the integer value of  $C_1$ , respectively, and the rescaling attempt will then be aborted. (Note that the test for a minimum or maximum is made by finding the input value at which the slope of the new rescaling equation is equal to 0, and then verifying that the input value is within the valid input range. If such is the case, then a minimum or maximum falls within the valid input range and the new scaling will not be used. Currently, the test for a minimum or maximum is based on an input range of  $-100$  to  $+100$  % full scale.

For two-point rescaling, the new coefficients are determined by solving the following two simultaneous equations for the new coefficients:

$$C_{1\text{new}} * \text{INPUT}_1 + C_{0\text{new}} = \text{EXPECTED}_1$$

$$C_{1\text{new}} * \text{INPUT}_2 + C_{0\text{new}} = \text{EXPECTED}_2$$

where:

$C_{1\text{new}}, C_{0\text{new}}$  = new two-point scaling coefficients;

$\text{INPUT}_n$  = actual input “n” for  $n = 1$  to 2 points; and

$\text{EXPECTED}_n$  = expected output “n” for  $n = 1$  to 2 points.

The method used by ESC Spectrum for solving the above simultaneous equations is known as Cramer’s Rule. Cramer’s Rule is based on the use of matrix algebra to represent the above equation as a system of matrices. A detailed explanation of Cramer’s Rule is not within the scope of this document (for more information on Cramer’s Rule, please refer to a standard mathematics textbook on the subject). However, the final equations used to determine the new scaling coefficients, based on Cramer’s Rule, are as follows:

(Note that the result of the following equation is used by the subsequent equations. It is calculated first in order to simplify and expedite the subsequent calculations.)

$$\text{DETERMINATE} = \text{INPUT}_1 - \text{INPUT}_2$$

$$C_{1\text{new}} = (\text{EXPECTED}_1 - \text{EXPECTED}_2) / \text{DETERMINATE}$$

$$C_{0\text{new}} = (\text{EXPECTED}_2 * \text{INPUT}_1 - \text{EXPECTED}_1 * \text{INPUT}_2) / \text{DETERMINATE}$$

Once the new scaling coefficients have been determined (assuming no error occurred), the new scaling equation will be:

$$\text{AVG} = C_{1\text{new}}\text{INPUT} + C_{0\text{new}}$$

For one-point rescaling (i.e., zero correction), the new constant coefficient is determined by the following equation:

$$C_{0\text{new}} = (\text{EXPECTED}_1 - \text{AVG}_1) + C_{0\text{old}}$$

where:

$C_{0\text{new}}$  = new constant coefficient,

$\text{EXPECTED}_1$  = expected output for point 1,

$\text{AVG}_1$  = actual output for point 1, and

$C_{0\text{old}}$  = old constant coefficient.

This calculation is made from the fact that the difference in the expected output and the actual output at a given input value is equivalent to the difference in the constant coefficients.

**Related Topics:**

- [Autoscaling Procedure](#)
- [Autoscaling Execution Check](#)



## Appendix E. PS-9 Calibrations

PS-9 (Performance Specification 9) is an EPA regulation that identifies requirements for oil refineries, which includes a 3-level, multi-injection calibration audit for Gas Chromatographs (GCs). GC calibration records are created from polled data in the 8864 Data Controller, as well as PS-9 calibration sequences configured in StackStudio.

The following types of calibration validations are required per EPA 40CFR60 Performance Specification 9:

- [Daily PS-9 Calibration Error Check](#)
- [Monthly PS-9 Multi-Point Check](#)
- [Quarterly PS-9 Performance Audit](#)

### Daily PS-9 Calibration Error Check

The *Daily Calibration Error Check* is performed once a day. It is a three-injection, single-gas-level calibration.

The single calibration gas is mid-level and must be within the range of 90-110% of the measured concentration. This known-value gas is injected three separate times into the GC (Gas Chromatograph). The result of each injection is captured. The three measured injection values are then averaged together and compared with the known-value gas. A variance of greater than 10% between the averaged measured value and the known gas value results in a failure of the daily validation and starts to mark the instrument data as out-of-control (OOC). If the instrument is already OOC, then passing this calibration does not however result in the instrument being marked back in control.

#### Daily PS-9 Calibration Error Check

- $(\text{AVG}(\text{MID injections}) - \text{Known MID}) / (\text{Known MID}) \leq 10\%$

The following procedure explain how to configure a daily PS-9 calibration. If needed, see the field descriptions provided earlier in the topics [Configure Complex Calibration](#) and [Configure Phases of a Complex Calibration](#).

Complete the following steps:

1. Press **More** in the 8864 touchscreen to display the [Menu Driven Interface \(MDI\)](#).
2. Log in using an administrative-level user account.
3. In the Home Menu, select **C-Configuration Menu > C-Configure Calibrations > N-Enter New Cal Program > A-Automatic Cal** to open the following configuration screen.

4. Configure the following fields in the “Automatic (A) Cal Cfg” screen shown in the next screen example. See [Configure Complex Calibration](#) for field descriptions.
  - a. **Name of Cal Sequence:** Type a name for the calibration.
  - b. **Starting Time:** Type the month, day, and time that the 8864 Data Controller should begin the calibration sequence. Use the format MM/DD/YY HH:MM:SS to indicate the month, day, year, hour, minutes, and seconds.
  - c. **Interval:** Type **1d** to indicate a daily calibration.

```
ESC 8864 v5.04r13 ID:01 Automatic (A) Cal Cfg. 07/11/18 13:10:12

Name of Cal Sequence      : PS9D
Starting Time             : 07/12/18 00:00:00
Interval                  : 1d
EDIT AFFECTED CHANNELS    :
Calibration Records Stored : 1
MODIFY PHASE              :
ADD PHASE                  :
DELETE PHASE              :
Recovery Time             : 30s
OOC Only (Y/N)           : N
FINISHED (Configure Now)  : 07/06/18 09:17:55

CTRL-R = Advanced Options
```

- d. **Edit Affected Channels:** Select this field and then press **Enter** to display the “Edit Affected Parameters” screen. Type the name(s) of the channel(s) that will be affected by the introduction of the calibration gas, as shown in the next example.

Press **ESC** to save settings and return to the “Automatic (A) Cal Cfg” screen.

```
ESC 8864 v5.04r13 ID:01 Edit Affected Parameters (Page 1) 07/11/18 13:31:20
```

01:	HGT	17:
02:		18:
03:		19:
04:		20:
05:		21:
06:		22:
07:		23:
08:		24:
09:		25:
10:		26:
11:		27:
12:		28:
13:		29:
14:		30:
15:		31:
16:		32:

Exit and Save=ESC, Next Page=CTRL-N, Prev Page=CTRL-P, Type to Edit

- e. **Calibration Records Stored:** Type a value in the field to indicate the minimum number of calibration records to be stored for the calibration sequence.
5. Select the **Modify Phase** field and then press **Enter** to open the “Choose List” screen shown in the next example.

6. Press **Enter** in the “TEMP01” field to open the “Phase Configuration Screen”.

```
ESC 8864 v5.04r13 ID:01 Choose List (Enter to Select) 07/11/18 16:32:08

TEMP01
TEMP02
TEMP03

F2 Refresh <ESC> Exit TAB GOTO END CTRL-K GOTO TOP CTRL-R Clr Keys Arrows Select
```

7. Configure the following fields in the “Phase Configuration Screen” shown in the next example. A daily PS-9 calibration requires 3 mid-level and 1 average phase sequence - for a total of 4 phase sequences. For field descriptions, see [Configure Phases of a Complex Calibration](#).
  - a. **Name of Phase:** Rename “TEMP01” with the name of the first phase sequence.
  - b. **Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - c. **Phase Data Time:** Type **10s** in this field to indicate 10 seconds.
  - d. **Phase Duration:** Type **1m** in this field to indicate 1 minute.
  - e. **Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration” screen.
8. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
  - a. **Expected Value:** Type the expected value of this phase in the field.
  - b. **OOB Drift Tolerance:** Type **10** in this field.
  - c. **Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - d. **Use Rounded Results?:** Type **Y** to indicate “yes”.

- e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
- f. **Data Type (I, A, R):** Type **I** to indicate “Injection”.
- g. **Injection Level (H, M, L):** Type **M** to indicate “Mid”.

```

ESC 8864  v5.04r13  ID:01  Expected Value Configuration  07/11/18 14:55:09

Name of Cal (not editable) : PS9D
Name of Phase (not editable): MID-1
Channel Name (not editable) : HGT
Expected Value : 100
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance : (not set)
OOC Drift Tolerance : 10
No Recovery If Warning Drift? N
No Recovery If OOC Drift? : N
Store Result in Cal Record? : Y
Use Rounded Results? : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R) : I
Injection Level (H,M,L) : M

ESC to return to Phase Config

```

- 9. Press **ESC** three (3) times to return to the “Automatic (A) Cal Cfg” configuration screen.
- 10. Repeat steps [5](#) through [7-d](#) to configure two more mid-level phases. Refer to the following table for configuration settings.

Field Name	2nd Mid-Level Phase	3rd Mid-Level Phase
<b>Name of Phase</b>	Rename TEMP02	Rename TEMP03
<b>Output Control Lines</b>	(as required)	(as required)
<b>Phase Data Time</b>	15s (15 seconds)	20s (20 seconds)
<b>Phase Duration</b>	1m (1 minute)	1m (1 minute)

- 11. Select **Add Phase** in the “Automatic (A) Cal Cfg” configuration screen and then press **Enter** to open the “Choose List” configuration screen.
- 12. Select **End** in the “Choose List” configuration screen and then press **Enter** to open the “Phase Configuration Screen”.
- 13. Configure the following fields for an “average” phase sequence in the “Phase Configuration Screen”. See the next screen example.
  - a. **Name of Phase:** Rename “END” with the name of the “average” phase sequence.



- b. **Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - c. **Phase Data Time:** Type **15s** in this field to indicate 15 seconds.
  - d. **Phase Duration:** Type **1m** in this field to indicate 1 minute.
  - e. **Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration”.
14. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
- a. **Expected Value:** Type the expected value of the “average” phase in this field.
  - b. **OOB Drift Tolerance:** Type **10** in this field.
  - c. **Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - d. **Use Rounded Results?:** Type **Y** to indicate “yes”.
  - e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
  - f. **Data Type (I, A, R):** Type **A** to indicate “Average”.
  - g. **Injection Level (H, M, L):** Type **L** to indicate “Low”.

```

ESC 8864  v5.04r13  ID:01  Expected Value Configuration  07/11/18 18:05:36

Name of Cal (not editable) : PS9D
Name of Phase (not editable): AVG
Channel Name (not editable): HGT
Expected Value              : 1
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant   : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance     : (not set)
OOB Drift Tolerance         : 10
No Recovery If Warning Drift? N
No Recovery If OOB Drift?   : N
Store Result in Cal Record? : Y
Use Rounded Results?        : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R)           : A
Injection Level (H,M,L)      : M

ESC to return to Phase Config

```

- 15. Press **ESC** three (3) times to return to the “Automatic (A) Cal Cfg” configuration screen.
- 16. Configure the following remaining fields in the “Automatic (A) Cal Cfg” configuration screen:

- a. **Recovery Time:** Type **30s** to indicate 30 seconds.
- b. **OOO Only (Y/N):** Type **N** to indicate “no”.
- c. **Finished (Configure Now):** Press **Enter** to complete the configuration.



**NOTE:** No configuration changes are required in the “Advanced Options” configuration screen. Default settings are used for “average” phase.

The daily PS-9 calibration is now configured. Continue with the next section [Monthly PS-9 Multi-Point Check](#).

## Monthly PS-9 Multi-Point Check

The *Monthly Multi-Point Check* is performed once a month. It is a three-injection test that averages the results of three injections at three different gas concentrations (low, mid, and high), and then compares the results to the known gas concentration value, as in the [Daily PS-9 Calibration Error Check](#).

In the monthly check, the test must be performed at three different gas concentrations (low-, mid-, and high- level). With three injections at each of three gas levels, a total of 9 injections must be performed. Each gas-level average is checked independently against the three known gas concentrations. If any vary by more than 10%, the test fails and the channel is marked OOC. If all checks pass and the channel was previously OOC, the channel is marked back in control.

Monthly PS-9 Multi-Point Check	
▪	$(\text{AVG}(\text{LOW injections}) - \text{Known LOW}) / (\text{Known LOW}) \leq 10\%$
▪	$(\text{AVG}(\text{MID injections}) - \text{Known MID}) / (\text{Known MID}) \leq 10\%$
▪	$(\text{AVG}(\text{HI injections}) - \text{Known HI}) / (\text{Known HI}) \leq 10\%$

The following procedure explains how to configure a monthly, multi-point PS-9 calibration. If needed, see the field descriptions provided earlier in the topics [Configure Complex Calibration](#) and [Configure Phases of a Complex Calibration](#).

Complete the following steps:

1. Press **More** in the 8864 touchscreen to display the [Menu Driven Interface \(MDI\)](#).
2. Log in using an administrative-level user account.
3. In the Home Menu, select **C-Configuration Menu > C-Configure Calibrations > N-Enter New Cal Program > A-Automatic Cal** to open the following configuration screen.

4. Configure the following fields in the “Automatic (A) Cal Cfg” screen shown in the next screen example. See [Configure Complex Calibration](#) for field descriptions.
  - a. **Name of Cal Sequence:** Type a name for the calibration.
  - b. **Starting Time:** Type the month, day, and time that the 8864 Data Controller should begin the calibration sequence. Use the format MM/DD/YY HH:MM:SS to indicate the month, day, year, hour, minutes, and seconds.
  - c. **Interval:** Type **30d** to indicate a monthly calibration.

```
ESC 8864 v5.04r13 ID:01 Automatic (A) Cal Cfg. 07/16/18 07:18:11

Name of Cal Sequence      : PS9M
Starting Time             : 08/01/18 00:00:00
Interval                  : 30d
EDIT AFFECTED CHANNELS    :
Calibration Records Stored : 1
MODIFY PHASE              :
ADD PHASE                 :
DELETE PHASE              :
Recovery Time             : 6m
OOC Only (Y/N)           : N
FINISHED (Configure Now)  : 07/12/18 12:31:50

CTRL-R = Advanced Options
```

- d. **Edit Affected Channels:** Select this field and then press **Enter** to display the “Edit Affected Parameters” screen. Type the name(s) of the channel(s) that will be affected by the introduction of the calibration gas, as shown in the next example.

Press **ESC** to save settings and return to the “Automatic (A) Cal Cfg” screen.

```
ESC 8864 v5.04r13 ID:01 Edit Affected Parameters (Page 1) 07/11/18 13:31:20
```

01:	HGT	17:
02:		18:
03:		19:
04:		20:
05:		21:
06:		22:
07:		23:
08:		24:
09:		25:
10:		26:
11:		27:
12:		28:
13:		29:
14:		30:
15:		31:
16:		32:

Exit and Save=ESC, Next Page=CTRL-N, Prev Page=CTRL-P, Type to Edit

- e. **Calibration Records Stored:** Type a value in the field to indicate the minimum number of calibration records to be stored for the calibration sequence.
5. Select the **Modify Phase** field and then press **Enter** to open the “Choose List” screen shown in the next example.

6. Press **Enter** in the “TEMP01” field to open the “Phase Configuration Screen”.

```
ESC 8864 v5.04r13 ID:01 Choose List (Enter to Select) 07/11/18 16:32:08

TEMP01
TEMP02
TEMP03

F2 Refresh <ESC> Exit TAB GOTO END CTRL-K GOTO TOP CTRL-R Clr Keys Arrows Select
```

7. Configure the following fields in the “Phase Configuration Screen” shown in the next example. A monthly PS-9 calibration requires 3 low-level and 1 average phase sequence; 3 mid-level and 1 average phase sequence; and 3 high-level and 1 average phase sequence - for a total of 12 phase sequences. For field descriptions, see [Configure Phases of a Complex Calibration](#).
  - a. **Name of Phase:** Rename “TEMP01” with the name of the first phase sequence.
  - b. **Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - c. **Phase Data Time:** Type **2s** in this field to indicate 2 seconds.
  - d. **Phase Duration:** Type **20s** in this field to indicate 20 seconds.
  - e. **Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration”.
8. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
  - a. **Expected Value:** Type the expected value of this phase in the field.
  - b. **OOB Drift Tolerance:** Type **10** in this field.
  - c. **Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - d. **Use Rounded Results?:** Type **Y** to indicate “yes”.

- e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
- f. **Data Type (I, A, R):** Type **I** to indicate “Injection”.
- g. **Injection Level (H, M, L):** Type **L** to indicate “Low”.

```

ESC 8864  v5.04r13  ID:01  Expected Value Configuration  07/16/18  07:37:09

Name of Cal (not editable) : PS9M
Name of Phase (not editable): LO-1
Channel Name (not editable) : HGT
Expected Value             : 50.1
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant  : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance    : (not set)
OOC Drift Tolerance        : 10
No Recovery If Warning Drift? N
No Recovery If OOC Drift?  : N
Store Result in Cal Record? : Y
Use Rounded Results?       : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R)          : I
Injection Level (H,M,L)     : L

ESC to return to Phase Config

```

- 9. Press **ESC** three (3) times to return to the “Automatic (A) Cal Cfg” configuration screen.
- 10. Repeat steps [5](#) through [7-d](#) two times to configure two more low-level phases. Refer to the following table for configuration settings.

Field Name	2nd Low-Level Phase	3rd Low-Level Phase
<b>Name of Phase</b>	Rename TEMP02 - must be unique	Rename TEMP03 - must be unique
<b>Output Control Lines</b>	(as required)	(as required)
<b>Phase Data Time</b>	5s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)

- 11. Select **Add Phase** in the “Automatic (A) Cal Cfg” configuration screen and then press **Enter** to open the “Choose List” configuration screen.
- 12. Select **End** in the “Choose List” configuration screen and then press **Enter** to open the “Phase Configuration Screen”.
- 13. Configure the following fields for a “low average” phase sequence in the “Phase Configuration Screen”. See the next example.

- a. **Name of Phase:** Rename “END” with the name of the “low average” phase sequence (must be unique name).
  - b. **Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - c. **Phase Data Time:** Type **15s** in this field to indicate 15 seconds.
  - d. **Phase Duration:** Type **30s** in this field to indicate 30 seconds.
  - e. **Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration”.
14. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
- a. **Expected Value:** Type the expected value of the “low average” phase in this field.
  - b. **OOO Drift Tolerance:** Type **10** in this field.
  - c. **Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - d. **Use Rounded Results?:** Type **Y** to indicate “yes”.
  - e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
  - f. **Data Type (I, A, R):** Type **A** to indicate “Average”.
  - g. **Injection Level (H, M, L):** Type **L** to indicate “Low”.

```

ESC 8864 v5.04r13 ID:01 Expected Value Configuration 07/16/18 08:17:54

Name of Cal (not editable) : PS9M
Name of Phase (not editable): LO-AVG
Channel Name (not editable) : HGT
Expected Value              : 50.1
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant   : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance     : (not set)
OOO Drift Tolerance         : 10
No Recovery If Warning Drift? N
No Recovery If OOO Drift?   : N
Store Result in Cal Record? : Y
Use Rounded Results?        : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R)           : A
Injection Level (H,M,L)     : L

ESC to return to Phase Config

```

15. Repeat steps [11](#) through [14](#) three times to add three (3) mid-level phases and one (1)

mid-level average phase. See the following table for specific settings.

Field Name	1st Mid-Level Phase	2nd Mid-Level Phase	3rd Mid-Level Phase	Mid Average Phase
<b>Name of Phase</b>	(1st name - must be unique)	(2nd name - must be unique)	(3rd name - must be unique)	("average" name - must be unique)
<b>Output Control Lines</b>	(as required)	(as required)	(as required)	(as required)
<b>Phase Data Time</b>	30s (30 seconds)	15s (15 seconds)	15s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)
<b>Data Type</b>	I (injection)	I (injection)	I (injection)	A (average)
<b>Injection Level</b>	M (mid)	M (mid)	M (mid)	M (mid)

16. Repeat steps [11](#) through [14](#) three times to add three (3) high-level phases and one (1) high-level average phase. See the following table for specific settings.

Field Name	1st High-Level Phase	2nd High-Level Phase	3rd High-Level Phase	High Average Phase
<b>Name of Phase</b>	(1st name - must be unique)	(2nd name - must be unique)	(3rd name - must be unique)	("average" name - must be unique)
<b>Output Control Lines</b>	(as required)	(as required)	(as required)	(as required)
<b>Phase Data Time</b>	30s (30 seconds)	15s (15 seconds)	15s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)
<b>Data Type</b>	I (injection)	I (injection)	I (injection)	A (average)
<b>Injection Level</b>	H (high)	H (high)	H (high)	H (high)

17. Press **ESC** three (3) times to return to the "Automatic (A) Cal Cfg" configuration screen.
18. Select **Finished (Configure Now)** and then press **Enter** to complete the configuration.

The monthly PS-9 calibration is now configured. Continue with the next section [Quarterly](#)



[PS-9 Performance Audit.](#)

## Quarterly PS-9 Performance Audit

The *Quarterly Performance Audit* is performed at any point during the quarter. It is a three-injection test at three different gas concentrations (low, mid, and high). In the Quarterly check, the 9 injections required by the Monthly check are performed. In addition to the three calibration error checks required by the monthly checks (i.e., the average of the injections must be within 10% of the known concentration), the following additional checks are required:

- Each injection must be within 5% of the average of the three injections (a precision check).
- The statistical “coefficient of determination” R-squared ( $r^2$ ) must be greater than or equal to ( $\geq$ ) 0.995 to confirm linearity of the response.

If any of the individual checks fail, the test fails and the channel is marked OOC. If all checks pass and the channel was previously OOC, the channel is marked back in control.

Quarterly PS-9 Performance Audit
<ul style="list-style-type: none"> <li>▪ <math>(\text{AVG}(\text{LOW injections}) - \text{Known LOW}) / (\text{Known LOW}) \leq 10\%</math></li> <li>▪ <math>(\text{AVG}(\text{MID injections}) - \text{Known MID}) / (\text{Known MID}) \leq 10\%</math></li> <li>▪ <math>(\text{AVG}(\text{HI injections}) - \text{Known HI}) / (\text{Known HI}) \leq 10\%</math></li> </ul>
<ul style="list-style-type: none"> <li>▪ <math>(\text{LOW injection1} - \text{AVG}(\text{LOW injections})) / \text{AVG}(\text{LOW injections}) \leq 5\%</math></li> <li>▪ <math>(\text{LOW injection2} - \text{AVG}(\text{LOW injections})) / \text{AVG}(\text{LOW injections}) \leq 5\%</math></li> <li>▪ <math>(\text{LOW injection3} - \text{AVG}(\text{LOW injections})) / \text{AVG}(\text{LOW injections}) \leq 5\%</math></li> </ul>
<ul style="list-style-type: none"> <li>▪ <math>(\text{MID injection1} - \text{AVG}(\text{MID injections})) / \text{AVG}(\text{MID injections}) \leq 5\%</math></li> <li>▪ <math>(\text{MID injection2} - \text{AVG}(\text{MID injections})) / \text{AVG}(\text{MID injections}) \leq 5\%</math></li> <li>▪ <math>(\text{MID injection3} - \text{AVG}(\text{MID injections})) / \text{AVG}(\text{MID injections}) \leq 5\%</math></li> </ul>
<ul style="list-style-type: none"> <li>▪ <math>(\text{HI injection1} - \text{AVG}(\text{HI injections})) / \text{AVG}(\text{HI injections}) \leq 5\%</math></li> <li>▪ <math>(\text{HI injection2} - \text{AVG}(\text{HI injections})) / \text{AVG}(\text{HI injections}) \leq 5\%</math></li> <li>▪ <math>(\text{HI injection3} - \text{AVG}(\text{HI injections})) / \text{AVG}(\text{HI injections}) \leq 5\%</math></li> </ul>
<ul style="list-style-type: none"> <li>▪ <math>r^2 \geq 0.995</math></li> </ul>

The following procedure explains how to configure a quarterly PS-9 performance audit calibration. If needed, see the field descriptions provided earlier in the topics [Configure Complex Calibration](#) and [Configure Phases of a Complex Calibration](#).

Complete the following steps:

1. Press **More** in the 8864 touchscreen to display the [Menu Driven Interface \(MDI\)](#).
2. Log in using an administrative-level user account.
3. In the Home Menu, select **C-Configuration Menu > C-Configure Calibrations > N-Enter New Cal Program > A-Automatic Cal** to open the following configuration screen.
4. Configure the following fields in the “Automatic (A) Cal Cfg” screen shown in the next screen example. See [Configure Complex Calibration](#) for field descriptions.
  - a. **Name of Cal Sequence:** Type a name for the calibration.
  - b. **Starting Time:** Type the month, day, and time that the 8864 Data Controller should begin the calibration sequence. Use the format MM/DD/YY HH:MM:SS to indicate the month, day, year, hour, minutes, and seconds.
  - c. **Interval:** Type **30d** to indicate a monthly calibration.

ESC 8864	v5.04r13	ID:01	Automatic (A) Cal Cfg.	07/16/18 14:28:52
Name of Cal Sequence	:	PS9Q		
Starting Time	:	08/01/18 00:00:00		
Interval	:	30d		
EDIT AFFECTED CHANNELS	:			
Calibration Records Stored	:	1		
MODIFY PHASE	:			
ADD PHASE	:			
DELETE PHASE	:			
Recovery Time	:	30s		
OOB Only (Y/N)	:	N		
FINISHED (Configure Now)	:	07/12/18 12:31:57		

CTRL-R = Advanced Options

- d. **Edit Affected Channels:** Select this field and then press **Enter** to display the “Edit Affected Parameters” screen. Type the name(s) of the channel(s) that will be affected by the introduction of the calibration gas, as shown in the next example.

Press **ESC** to save settings and return to the “Automatic (A) Cal Cfg” screen.

```
ESC 8864 v5.04r13 ID:01 Edit Affected Parameters (Page 1) 07/11/18 13:31:20
```

01:	HGT	17:
02:		18:
03:		19:
04:		20:
05:		21:
06:		22:
07:		23:
08:		24:
09:		25:
10:		26:
11:		27:
12:		28:
13:		29:
14:		30:
15:		31:
16:		32:

Exit and Save=ESC, Next Page=CTRL-N, Prev Page=CTRL-P, Type to Edit

- e. **Calibration Records Stored:** Type a value in the field to indicate the minimum number of calibration records to be stored for the calibration sequence.
5. Select the **Modify Phase** field and then press **Enter** to open the “Choose List” screen shown in the next example.

6. Press **Enter** in the “TEMP01” field to open the “Phase Configuration Screen”.

7. Configure the following fields in the “Phase Configuration Screen” shown in the next example. A quarterly PS-9 calibration requires 3 low-level and 1 average phase sequence; 3 mid-level and 1 average phase sequence; 3 high-level and 1 average phase sequence; and 1 R-squared ( $r^2$ ) phase sequence - for a total of 13 phase sequences. For field descriptions, see [Configure Phases of a Complex Calibration](#).
- Name of Phase:** Rename “TEMP01” with the name of the first phase sequence.
  - Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - Phase Data Time:** Type **2s** in this field to indicate 2 seconds.
  - Phase Duration:** Type **20s** in this field to indicate 20 seconds.
  - Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration”.
8. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
- Expected Value:** Type the expected value of this phase in the field.
  - OOB Drift Tolerance:** Type **10** in this field.
  - Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - Use Rounded Results?:** Type **Y** to indicate “yes”.

- e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
- f. **Data Type (I, A, R):** Type **I** to indicate “Injection”.
- g. **Injection Level (H, M, L):** Type **L** to indicate “Low”.

```

ESC 8864  v5.04r13  ID:01  Expected Value Configuration  07/16/18  07:37:09

Name of Cal (not editable) : PS9M
Name of Phase (not editable): LO-1
Channel Name (not editable) : HGT
Expected Value             : 50.1
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant  : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance    : (not set)
OOC Drift Tolerance        : 10
No Recovery If Warning Drift? N
No Recovery If OOC Drift?  : N
Store Result in Cal Record? : Y
Use Rounded Results?       : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R)          : I
Injection Level (H,M,L)     : L

ESC to return to Phase Config

```

- 9. Press **ESC** three (3) times to return to the “Automatic (A) Cal Cfg” configuration screen.
- 10. Repeat steps [5](#) through [7-d](#) to configure two more low-level phases. Refer to the following table for configuration settings.

Field Name	2nd Low-Level Phase	3rd Low-Level Phase
<b>Name of Phase</b>	Rename TEMP02 - must be unique	Rename TEMP03 - must be unique
<b>Output Control Lines</b>	(as required)	(as required)
<b>Phase Data Time</b>	5s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)

- 11. Select **Add Phase** in the “Automatic (A) Cal Cfg” configuration screen and then press **Enter** to open the “Choose List” configuration screen.
- 12. Select **End** in the “Choose List” configuration screen and then press **Enter** to open the “Phase Configuration Screen”.
- 13. Configure the following fields for a “low average” phase sequence in the “Phase Configuration Screen”. See the next example.

- a. **Name of Phase:** Rename “END” with the name of the “low average” phase sequence (must be unique name).
  - b. **Output Control Lines:** Type the output line number(s) and the state(s) that will control this phase of the calibration.
  - c. **Phase Data Time:** Type **15s** in this field to indicate 15 seconds.
  - d. **Phase Duration:** Type **30s** in this field to indicate 30 seconds.
  - e. **Edit Expected Value:** Select this field and then press **Enter** to open the “Choose List” screen. Select the channel/parameter you want to use for the phase sequence and then press **Enter** to open the “Expected Value Configuration”.
14. Configure the following fields in the “Expected Value Configuration” screen shown in the next example. For field descriptions, see [Configure Expected Values](#).
- a. **Expected Value:** Type the expected value of the “low average” phase in this field.
  - b. **OOB Drift Tolerance:** Type **10** in this field.
  - c. **Store Result in Cal Record:** Type **Y** to indicate “yes”.
  - d. **Use Rounded Results?:** Type **Y** to indicate “yes”.
  - e. **Method of Error Calc (S, D, L):** Type **L** to indicate “Linearity Method”.
  - f. **Data Type (I, A, R):** Type **A** to indicate “Average”.
  - g. **Injection Level (H, M, L):** Type **L** to indicate “Low”.

```

ESC 8864 v5.04r13 ID:01 Expected Value Configuration 07/16/18 08:17:54

Name of Cal (not editable) : PS9M
Name of Phase (not editable): LO-AVG
Channel Name (not editable): HGT
Expected Value              : 50.1
Tracer/ID Code (0000-9999) : 0000
Use EV For Automatic Correct? N
Write EV to Math Constant   : (none)
Write Result to Math Constant (none)
Write Consts at End of Phase N
Warning Drift Tolerance     : (not set)
OOB Drift Tolerance         : 10
No Recovery If Warning Drift? N
No Recovery If OOB Drift?   : N
Store Result in Cal Record? : Y
Use Rounded Results?        : Y
Method of Error Calc. (S,D,L): L
Data Type (I,A,R)           : A
Injection Level (H,M,L)     : L

ESC to return to Phase Config

```

15. Repeat steps [11](#) through [14](#) three times to add three (3) mid-level phases and one (1)

mid-level average phase. See the following table for specific settings.

Field Name	1st Mid-Level Phase	2nd Mid-Level Phase	3rd Mid-Level Phase	Mid Average Phase
<b>Name of Phase</b>	(1st name - must be unique)	(2nd name - must be unique)	(3rd name - must be unique)	("average" name - must be unique)
<b>Output Control Lines</b>	(as required)	(as required)	(as required)	(as required)
<b>Phase Data Time</b>	30s (30 seconds)	15s (15 seconds)	15s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)
<b>Data Type</b>	I (injection)	I (injection)	I (injection)	A (average)
<b>Injection Level</b>	M (mid)	M (mid)	M (mid)	M (mid)

16. Repeat steps [11](#) through [14](#) three times to add three (3) high-level phases and one (1) high-level average phase. See the following table for specific settings.

Field Name	1st High-Level Phase	2nd High-Level Phase	3rd High-Level Phase	High Average Phase
<b>Name of Phase</b>	(1st name - must be unique)	(2nd name - must be unique)	(3rd name - must be unique)	("average" name - must be unique)
<b>Output Control Lines</b>	(as required)	(as required)	(as required)	(as required)
<b>Phase Data Time</b>	30s (30 seconds)	15s (15 seconds)	15s (15 seconds)	15s (15 seconds)
<b>Phase Duration</b>	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)	30s (30 seconds)
<b>Data Type</b>	I (injection)	I (injection)	I (injection)	A (average)
<b>Injection Level</b>	H (high)	H (high)	H (high)	H (high)

17. Repeat steps [11](#) through [14](#) to add one R-Squared phase. See the following table for specific settings.

Field Name	R-Squared Phase
Name of Phase	(add unique name)
Output Control Lines	(as required)
Phase Data Time	1m (1 minute)
Phase Duration	1m (1 minute)
Method of Error Calc (S, D, L)	D (Difference Method)
Data Type	R (R-Squared)
Injection Level	(none)

18. Press **ESC** three (3) times to return to the “Automatic (A) Cal Cfg” configuration screen.
19. Select **Finished (Configure Now)** and then press **Enter** to complete the configuration.

The quarterly PS-9 calibration is now configured.





# Appendix F. Terminal Communications Setup

This appendix includes instructions for setting up communications between the 8864 Data Controller and a PC terminal when the terminal is connected directly to the 8864 using a COM port. See the following sections for more information:

- [Connect to a PC Terminal](#)
- [Terminal Setup for Windows 7](#)
- [Terminal Setup for Windows XP](#)
- [Using the 8864 Serial Interface with Windows XP](#)

## Connect to a PC Terminal



**NOTE:** The 8864 is provided with four serial ports that can be of any combination of RS-232 and RS-485. The connectors are standard RS-232 serial ports with DB-9 (male) connectors, similar to those found on a PC; however, they may optionally be configured as isolated RS-485 ports.

To connect a terminal or PC directly to an RS-232 port:

1. Use a DB-9 to DB-9 null modem cable provided by ESC Spectrum or purchased from a local computer store.
2. Be sure to specify “null modem” when interfacing to a terminal or PC directly.
3. See [8864 Ports](#) and [Serial Ports](#) in this document for terminal connection to the 8864.

## Terminal Setup for Windows 7

When a Windows 7 PC is directly connected to the 8864, you can access the menu driven interface (MDI) using a serial COM port connection. ESC Spectrum recommends using the free industry-standard application PuTTY to establish the serial connection.



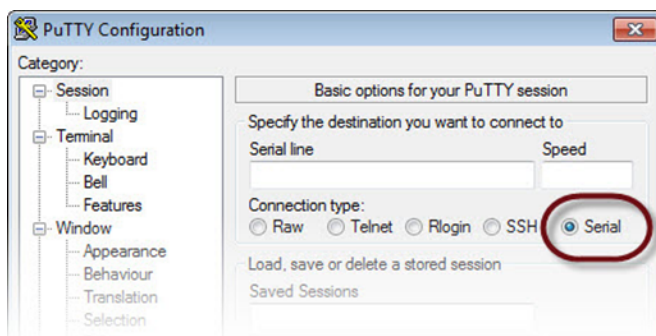
**NOTE:** ESC Spectrum makes no specific endorsement of PuTTY. Other third-party applications may work equally well for this task. For more information about PuTTY, visit <http://www.putty.org>.

Complete the following steps:

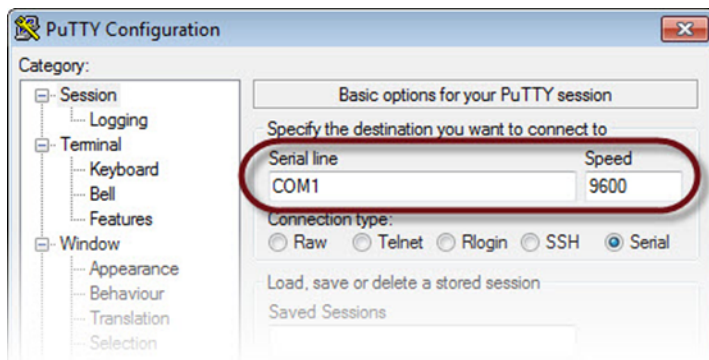
1. Visit the PuTTY website at the following address to download the PuTTY software:  
<http://www.putty.org>.

Note that this is a standalone executable file (putty.exe) that does not have to be installed. Place the executable file anywhere on a client computer and then double-click to run the software.

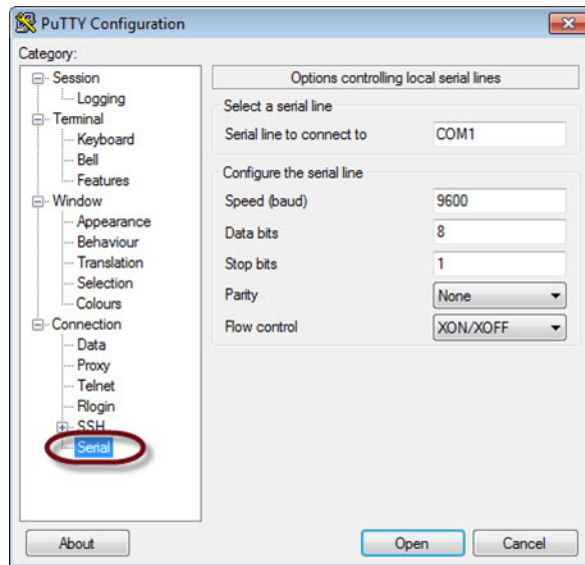
2. To use PuTTY with a COM port, first launch PuTTY, then select **Serial** as the **Connection Type**.



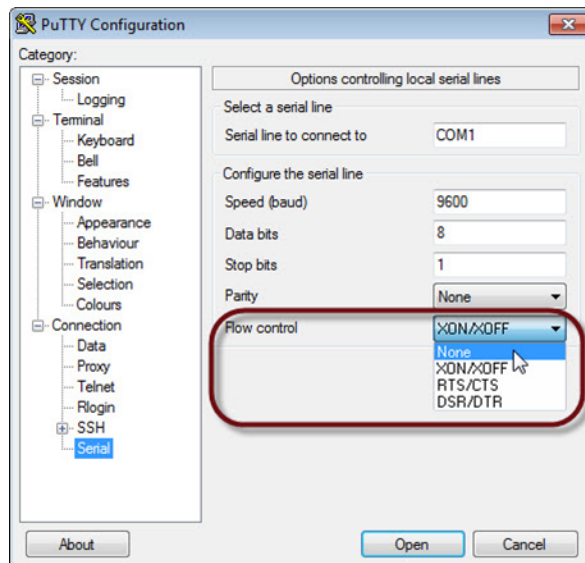
3. Enter your computer's COM port and the connection speed you want to use. These are typically default settings, such as those shown in the following example.



4. In the Category pane on the left side of window, click **Serial** near the bottom of the list.



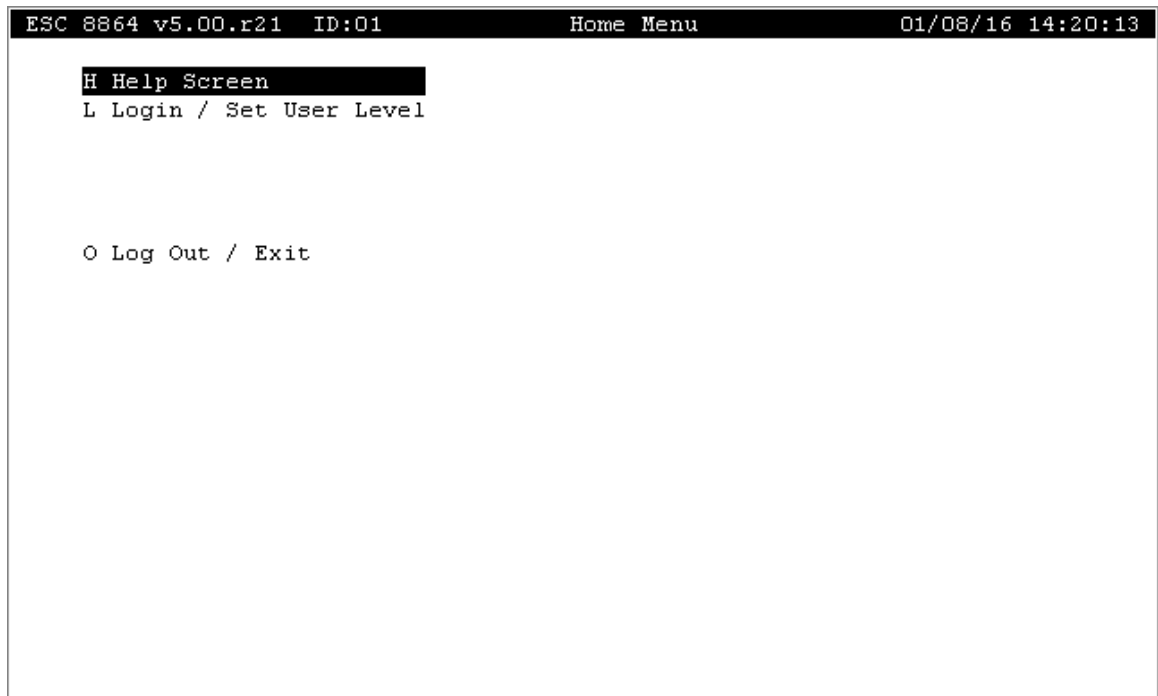
5. On the right side of the window, click the down arrow in the **Flow control** field and select **None**.
6. Leave remaining Serial settings as is. Then click **Open**.



After performing these steps, the 8864 MDI screen will be displayed in the PuTTY window.

For remote connections from a terminal not directly connected to the 8864, see [Remote Connection to MDI Using SSH](#) in this document.

7. Select **L - Login / Set User Level** and enter the password to log in to the 8864. Then press **Enter**.



The 8864 menu provides the same menu selections as those in the GUI menu on the console. See the example below.

When first accessing any menu, the first menu selection is highlighted. It displays in reverse video with black text and a white background to indicate an active selection.

Follow the navigation instructions in [Remote Connection to the Character-Based MDI](#) in this document to continue.

```

ESC 8864 v5.00.r21  ID:01           Home Menu           01/08/16 14:22:35

H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port

LOGGED IN!

```

If the menu is not displayed, check for one of the following possible causes:

- The interface might be set as a connection to StackVision. If this is the case, then you can type "<ESC>IDAQM" to get to the menu, where ID is the 2-digit controller ID number (displayed in the MDI menu bar). For example, if the ID number is 01, type "<ESC>01AQM".
- Another common reason for the menu not displaying is that the connection speed might not be set to the same speed on both ends. Check to make sure that the connection speed is **9600**.

## Terminal Setup for Windows XP

To see if the HyperTerminal is already installed on your PC, complete the following steps:

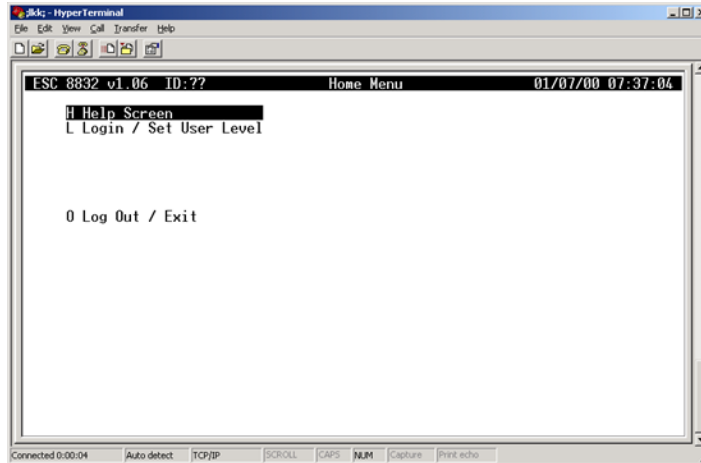
1. Click the Windows **Start** button to open the Start menu. Navigate to **All Programs > Accessories** and then click **Communications**.

2. If a HyperTerminal folder is in the Accessories menu, the communications software is installed, and you can skip to [Using the 8864 Serial Interface with Windows XP](#). Otherwise, continue with the next step.
3. To install HyperTerminal, click the Windows **Start** button to open the Start menu. Then click **Control Panel**.
4. In Windows Control Panel, click **Add or Remove Windows Components** and then click the **Windows Setup** tab.
5. Select the **Communications** option and then click the **Details** button to display the Communications dialog box.
6. In the Communications dialog box, click the **HyperTerminal** check box to select it for installation. Then click **OK**.
7. Insert your Windows XP CD into the CD-Rom Drive when prompted. To complete the installation, click **Apply**.

## Using the 8864 Serial Interface with Windows XP

Complete the following steps to use the 8864 serial interface with Windows XP:

1. To run the HyperTerminal configuration, choose the HyperTerminal option from the Start menu (e.g., for Windows XP access using Start > All Programs > Accessories > Communications > HyperTerminal. In the HyperTerminal screen, select File > Open. Double-click the 8864 ComX.ht file in the HyperTerminal screen.
2. In the HyperTerminal screen, press the <ESC> key, then type “.. AQM” (do not type the quotation marks) to obtain the default Controller ID. The response from the Controller will be displayed in the HyperTerminal window. You should see “!ID&”, where ID is the 2-character alphanumeric Controller ID (e.g., !22&). If more than one response is received, more than one controller is attached to the communications channel.
3. To access the 8864 menu-driven Interface (MDI), press the <ESC> key again, and enter “IDAQM”, where ID is the same 2-character controller ID (e.g., 22AQM). The 8864’s Home Menu will appear in the HyperTerminal window.



4. To log in to the 8864:
  - a. Type "**L**" in the Home Menu to open the Login Screen.
  - b. To set the User Level, type **escpriv** in the Login Screen. Then press **Enter** to return to the Home Menu.
5. To change the Controller ID:
  - a. Type **C** in the Home Menu to open the Configuration Menu.
  - b. Type **S** in the Configuration Menu to open the System Configuration Screen.
  - c. Press the **down arrow** key in the System Configuration Screen until the **Controller ID Code** field is highlighted.
  - d. Type a two-character **Controller ID**, then press **Enter**.
6. To enter this Controller ID into EEPROM (which allows the ID to remain unchanged when a cold start or reset occurs), complete the following steps:
  - a. Press **Ctrl - U** on the keyboard to open EEPROM Configuration Menu#1.
  - b. The field Controller ID Code is active. Type the new Controller ID and then press **Enter**.
  - c. Press **Ctrl - N** three times on the keyboard.
  - d. The selection Finished (Configure Now) is highlighted in the third screen. Press **Enter** to save the new Controller ID.
  - e. To exit the 8864 Serial Interface, press the **ESC** key until you return to the Home Menu. Then type **O** to log out.

You can now cold-start the 8864 without losing the Controller ID setting.





# Appendix G. Configuration Guidelines

Information in this section provides guidelines for configuring the 8864 Data Controller. The 8864 Data Controller will allow the configuration of more items than are included in these guidelines and will also allow configuration trade-offs, assuming that configuration memory is available. For example, if fewer channels are configured, more memory and performance will be available for other items such as calibrations and alarms. By following these guidelines, the 8864 Data Controller should provide optimal performance and reliability.

See the following sections for more information:

- [I/O Cards](#)
- [Channels](#)
- [Calibrations](#)
- [Alarms](#)
- [Digital Event Programs](#)
- [Modbus](#)
- [Miscellaneous](#)
- [Special Systems](#)

## I/O Cards

Up to six (6) total cards of the following types are supported: Current In, Voltage In, and Met Card. The I/O cards that can be installed in an 8864 are limited as follows:

- 2 total I/O cards
- 11 total Relay Output cards
- 11 total Status Input or Isolated Input cards
- 5 total Voltage Input, Current Input or Met cards
- 1 Met card

## Channels

The total number of channels configured should be no more than 999. Instantaneous and average channel validation should not be configured unless required.

## Calibrations

The total number of calibrations configured should be no more than 100. The total number of calibration phase data points configured should be no more than 200. For example, a linearity calibration that stores low-, mid- and high-level data for three different gas channels contains 9 phase data points (3 channels x 3 data phases). The total number of calibration phases should also be no more than 200.

## Alarms

The total number of alarms configured should be no more than 64. This number represents both average and calibration alarms combined. Configuring an average alarm with an average interval of less than 5 seconds is not recommended because of the processing time required.

## Digital Event Programs

The total number of digital event programs configured should be no more than 100. This number represents both timed and digitally-triggered event programs.

## Modbus

The Modicon Modbus Protocol details stringent timing specifications. The first Modbus port that is configured in the 8864 Data Controller is guaranteed to meet these specifications and is, therefore, one of the highest priority tasks. If a second Modbus port is configured, the responses from the second port are not guaranteed to meet the protocol timing specifications.

However, it has been our experience that several of the Distributed Control Systems (DCS) to which we have interfaced also do not adhere to the specification.

In order to prevent adversely affecting the performance of the 8864 Data Controller, the Modbus master should communicate with the 8864 Data Controller at the minimum possible update rate possible for the application. Digital inputs/outputs should be read/written no more than once every 10 seconds. The update rate for calculated channels should be no faster than the shortest base average interval of interest. Modbus channels in the 8864 Data Controller use only the last value communicated during the base average interval in the calculation, so a faster update rate does not provide any benefit. Modbus output values from the 8864 Data Controller are only updated at the end of the averaging intervals.

## Miscellaneous

Do not configure serial ports as menu driven interface (MDI) ports unless required. The user can access the logger through remote console mode with the interface type set up as central (CEN).

Do not configure the 8864 Data Controller with more I/O cards than are actually required. Additional I/O points require more processing power and memory space even if they are not used in channel configurations.

## Special Systems

The 8864 Data Controller is not designed for use in process control or in safety system applications. Under no circumstances should the 8864 Data Controller be used where the safety of human life or property depends on its proper operation.

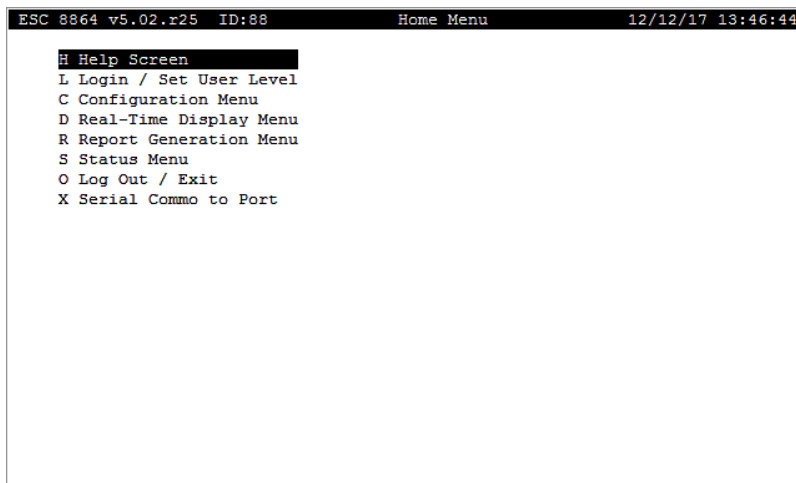


## Appendix H. Retrieve a Data Controller Dump

You can retrieve an 8864 Data Controller dump by using a remote connection to the menu-driven interface (MDI)

To retrieve a data controller dump:

1. Follow the instructions in one of the following sections to establish a remote connection to the MDI. For more information, refer to [Log in to the 8864 Data Controller](#)
  - [Log in Using PuTTY Over Ethernet](#)
  - [Log in Using PuTTY Over Serial Port](#)
2. Log into the MDI interface at the Integrator level. If you do not know the Integrator password, contact your CEMS Administrator or ESC Spectrum [Support](#).

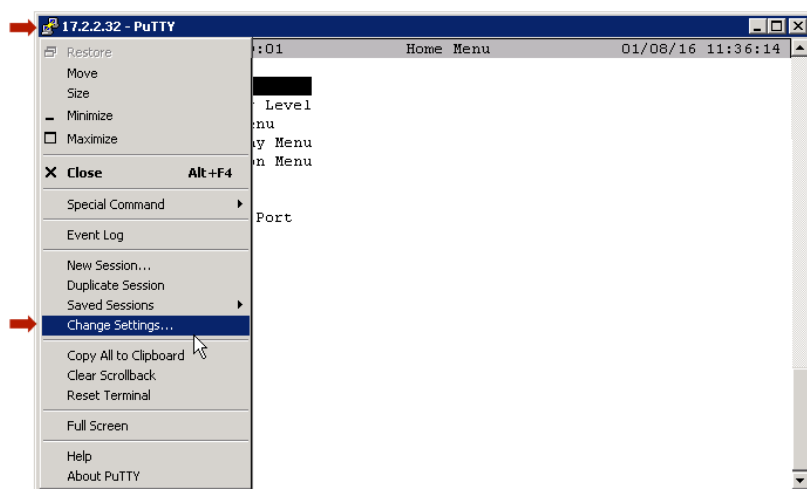


```
ESC 8864 v5.02.r25 ID:88 Home Menu 12/12/17 13:46:44
H Help Screen
L Login / Set User Level
C Configuration Menu
D Real-Time Display Menu
R Report Generation Menu
S Status Menu
O Log Out / Exit
X Serial Commo to Port
```

3. From the Home Menu, select **S - Status Menu** (hot key **S**) > **D - Dump Setup(s)** (hot key **D**).

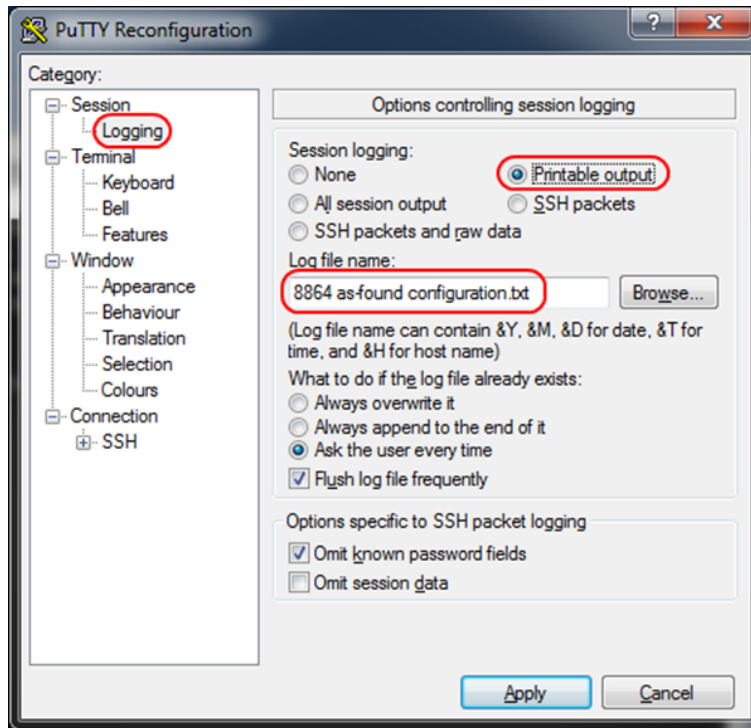


4. To turn on the capture of the configuration in PuTTY, first click on the system menu icon in the upper left of the PuTTY window (on the left side of the title bar), and then select **Change Settings** to open the PuTTY Reconfiguration window.



5. In the PuTTY Reconfiguration window, select the following settings (see example screen below):
  - a. In the Category field on the left side of the window, elect **Session > Logging**.
  - b. In the Session logging field on the right side of the window, select **Printable output**.

- c. In the Log file name field, enter a file name for the configuration dump file.



6. Click **Apply** to start the capture. This closes the PuTTY Reconfiguration window and returns you to the MDI screen.
7. On the 8864 Data Controller MDI screen, select **P - Dump All to Curr Port**. The MDI screen will scroll the configuration as it is captured to the log file. When it is complete, the MDI menu will return.
8. Close the PuTTY window, and locate the configuration dump file. It will be in the same directory as the putty.exe file.
9. If you stopped the StackVision services or disabled the 8864 Data Controller during this procedure, remember to re-enable the 8864 Data Controller and restart the services, then verify that polling has been restored.





# Appendix J. I/O Card Descriptions

The following card types are available for the 8864 Data Controller:

- [64VOLT-I \(Model 3010\) - Voltage Input Card](#)
- [64CUR-I \(Model 3110\) - Current Input Card](#)
- [64CDS-I \(Model 3210\) - Digital Status Input Card](#)
- [64D-O \(Model 3310\) - Relay Output Card](#)
- [64CUR-O \(Model 3510\) - Analog Current Output Card](#)
- [64MET \(Model 3610\) - Meteorological Input Card](#)
- [64IDS-I \(Model 3710\) - Isolated Status Input Card](#)



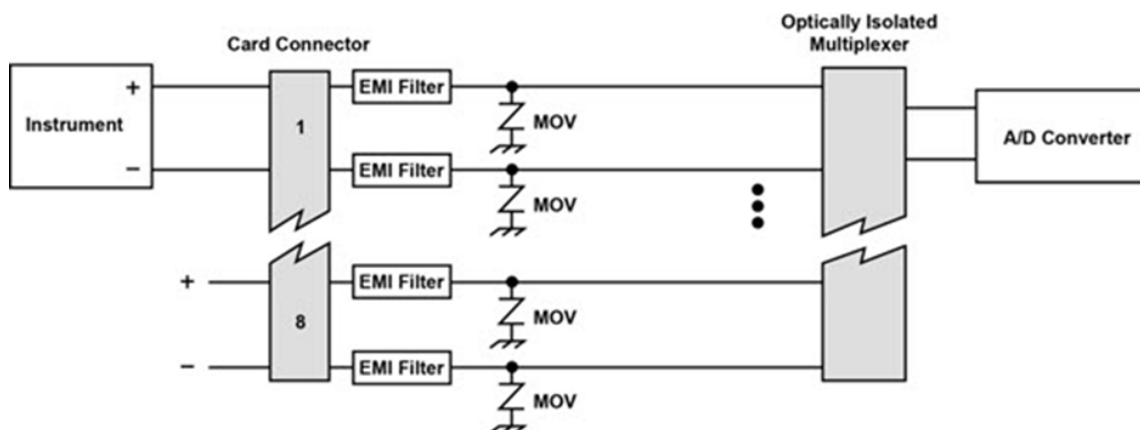
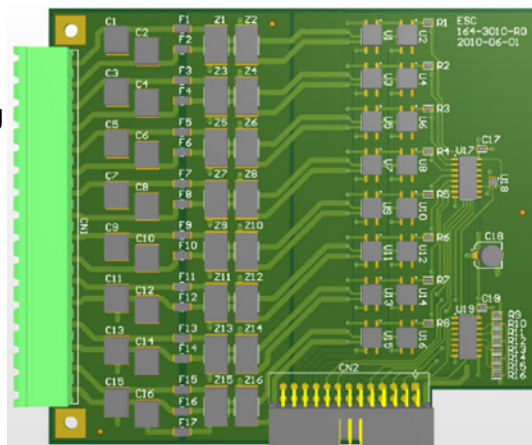
**IMPORTANT:** The specifications defined in this section are subject to change without notice.

---

## 64VOLT-I (Model 3010) - Voltage Input Card

### Specifications:

- **Inputs:** Eight (8) isolated, differential, with programmable gain amplifier
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Resolution:** 14-bit
- **Accuracy:**  $\pm 0.05\%$  full scale front-to-back accuracy at room temperature,  $\pm 0.1\%$  full scale over full temperature range
- **Voltage Ranges:**  $\pm 100$  mV,  $\pm 1$  V,  $\pm 5$  V, and  $\pm 10$  V full scale
- **Input Impedance:**  $>10$  megaohms
- **Scan Rate:**  $\sim 32$  channels per second
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3010



### Operation:

The Voltage Input Card consists of 8 isolated differential inputs. During the measurements process, the controller CPU connects the first input channel to the Analog-to-Digital converter through an optically isolated multiplexer. At the same time, the controller adjusts the full scale range of the Analog-to-Digital converter to the full scale configured for the first channel. The controller CPU then collects and stores this value for further manipulation and calculations, disconnects that input, and proceeds to the next input. This process is repeated as long as power is supplied to the controller.

**Card Description:**

Each Voltage Input Card has connections for eight (8) differential voltage inputs. The software supports four (4) voltage ranges for each channel (independent by channel). The ranges are:  $\pm 100$  mV,  $\pm 1$  V,  $\pm 5$  V and  $\pm 10$  V full scale. The inputs are scanned at a rate of about 32 channels per second. The analog to digital converter then translates the voltage reading to digital data for manipulation and storage. The analog-to-digital converter has a resolution of greater than one part in 16,000 (14 bit) and a guaranteed accuracy (voltage input to digital data reading) of 0.05% of full scale at room temperature or normal shelter temperatures. Accuracy of 0.1% of full scale is guaranteed over the entire operating temperature range of the unit.

**Connection Notes:**

Connect the positive voltage output of the instrument to the (+) input of the 8864 Data Controller, and the negative (or ground) output to the (–) input of the 8864 Data Controller. Inputs to the Voltage Input Card are quite robust. All inputs are true differential inputs. Negative terminals of different instruments should not be connected together at the 8864 Data Controller, because ground loop problems between the instruments could affect the accuracy of the readings.



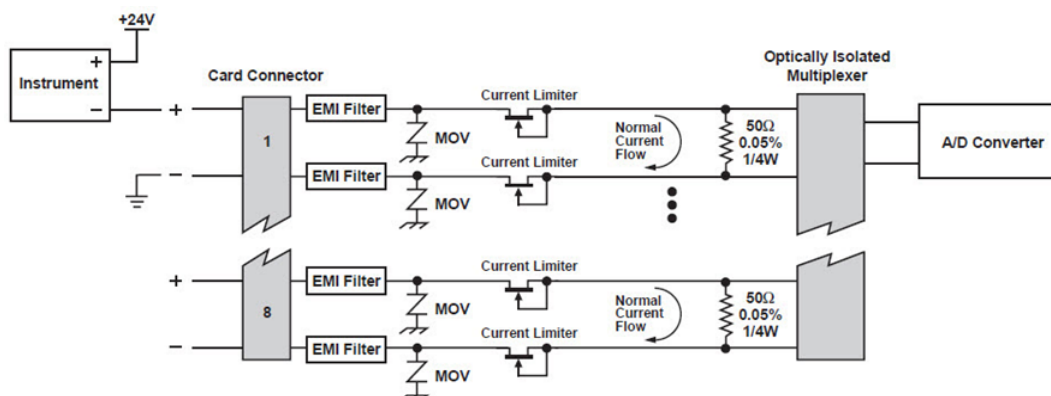
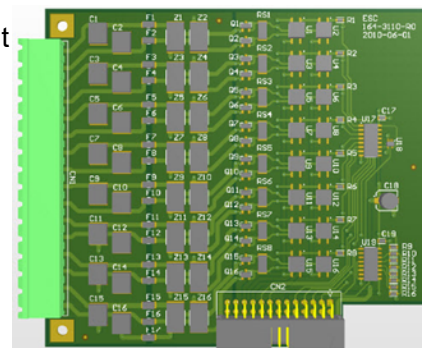
**NOTE:** The 64VOLT-I (Model 3010) card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

---

## 64CUR-I (Model 3110) - Current Input Card

### Specifications:

- **Inputs:** Eight (8) isolated, differential, 4-20 mA current inputs
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Resolution:** 14-bit
- **Accuracy:**  $\pm 0.1\%$  full scale front-to-back at room temperature,  $\pm 0.15\%$  full scale over full temperature range
- **Sense Resistor:** 50 ohm, 0.05%
- **Normal Input Impedance:**  $\sim 170$  ohms
- **Scan Rate:**  $\sim 32$  channels per second
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3110



### Operation:

The Current Input Card consists of 8 isolated differential inputs with 50 ohm dropping resistors on each input. The current into each input develops a voltage across the resistors (20 mA = 1 volt).

During the measurements process, the controller CPU connects the first input channel to the Analog-to-Digital converter through an optically isolated multiplexer. At the same time, the controller adjusts the Analog-to-Digital converter to 1 volt full scale. The controller CPU then collects and stores this value for further manipulation and calculations, disconnects that input, and proceeds to the next input. This process is repeated as long as power is supplied to the

controller.

#### Card Description:

Each Current Input Card has connections for eight (8) 4-20mA current-loop inputs. The current inputs are scanned at a rate of about 32 channels per second. The analog to digital converter then translates the current reading to digital data for manipulation and storage. The analog-to-digital converter has a resolution of greater than one part in 16,000 (14 bit) and a guaranteed accuracy (current input to digital data reading) of 0.1% of full scale at room temperature or normal shelter temperatures. An accuracy of 0.15% of full scale is guaranteed over the entire operating temperature range of the unit.

#### Connection Notes:

Normally, connections are made so that the current flows into the positive terminal of the input and out the negative input. Accidentally reversing the polarity of the inputs at the Current Input Card should not cause damage to the card. The readings taken; however, will be negative. Current limiting devices protect the 50 ohm precision resistor in case of improper wiring. These devices provide protection from a direct power supply connection of up to 24V.



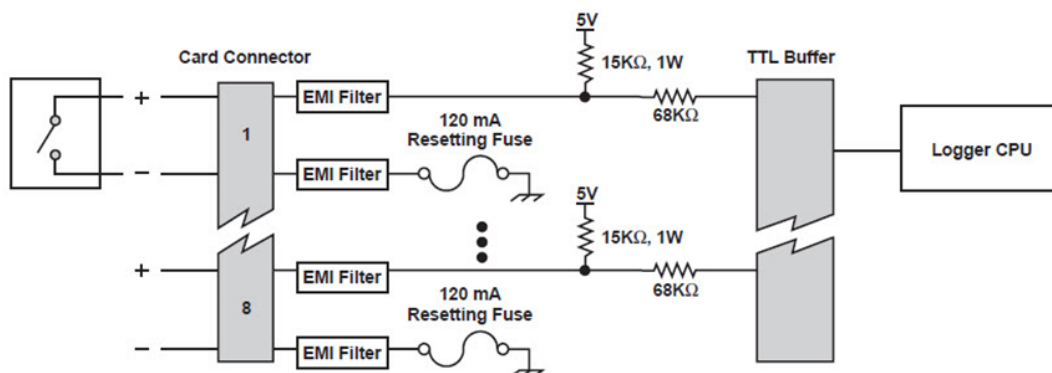
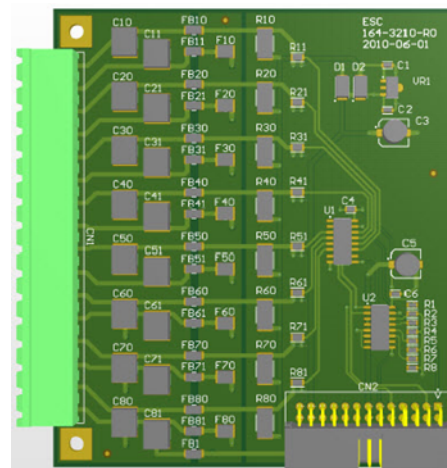
**NOTE:** The 64CUR-I (Model 3110) card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

---

## 64CDS-I (Model 3210) - Digital Status Input Card

### Specifications:

- **Inputs:** Eight (8) inputs, detect contact (relay) closures or voltage-to-ground transitions (including 0-24 V and TTL); optional software debounce available
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Scan Rate:** Once per second
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3210



### Operation:

For dry contact closure inputs, the input line is held at a 5 V level by the 15KΩ resistor as long as the contact is open. This is considered a logic “0” at the controller.

When the dry contact (relay) closes, the input is driven to the ground level of the 8864 Data Controller through the negative terminal. This is considered a logic “1” at the 8864 Data Controller.

For voltage transition inputs, a high voltage (5 to 24 VDC) across the input terminals would be interpreted as a logic “0” at the 8864 Data Controller, whereas a voltage potential of less than 0.8 V across the input terminals would be interpreted as logic “1”. The inputs are scanned approximately once per second. If the software debounce option is enabled, a transition must be stable for at least 1 second before the transition is acknowledged. These logic levels can then be used in the 8864 Data Controller configuration to validate data, detect online conditions, monitor calibrations, and detect alarms and equipment failures.

**Card Description:**

Status input lines can be used to monitor the status of events external to the 8864 Data Controller, such as instrument-initiated calibrations, alarms, instrument failure, or the status of a stream-switched system. Each Status Input card can read up to eight inputs, which must be either dry contact closures (relays), or DC voltage-to-ground transitions (including 0 to 24 V and TTL).

The status inputs are scanned, on the average, once per second. Software debouncing can be activated through the 8864 Data Controller configuration. Please note that this input card is used to monitor relay contacts or the presence or absence of voltages (e.g., TTL). It is not to be used in systems where the completion of a circuit (i.e., current flow) is to be monitored. For these type systems, refer to the [Model 3710 - Isolated Status Input Card](#).

**Connection Notes:**

To install a dry contact input, the plus (+) and minus (–) terminals of a status input can be connected to the contact in any order. To install a voltage-transition input, however, the voltage transition line must be connected to the plus (+) terminal of the status input, and the ground reference must be connected to the minus (–) terminal. The minus (–) terminal must be at the controller's AC ground potential. Current of more than 120 mA flowing into (or out of ) this terminal will cause the fuse to trip until the fault condition is removed. Care should be taken to ensure that a voltage-transition input is not connected with the polarities reversed.



**NOTE:** The 64CDS-I Model 3210 card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

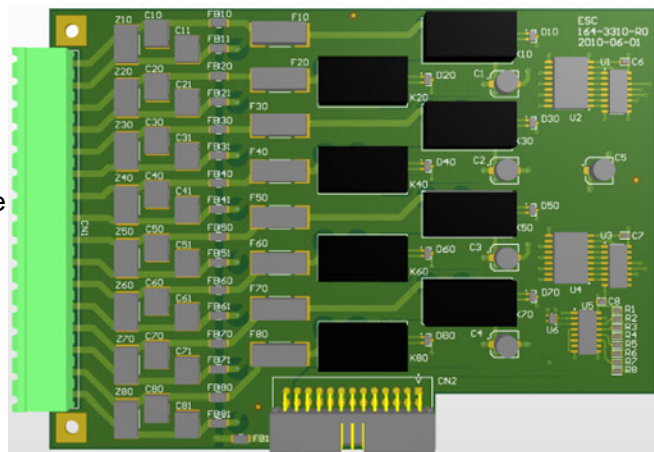
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## 64D-O (Model 3310) - Relay Output Card

### Specifications:

- **Inputs:** Eight (8) latching relay outputs
- **Ratings:** 5A at 250 VAC or 5A at 30 VAC (resistive load) 2A at 250VAC or 2A at 30 VDC (inductive load)
- **Inductive Load:** L/R  $\leq$  7ms maximum
- **Power Factor:** 0.4 minimum
- **Operating Voltage:** 250 VAC, 30 VDC maximum
- **Switching Load:** 1250 VA or 125 W (maximum resistive load) 500 VA or 60 W (maximum inductive load)
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Update Rate:** Once per second (each output)
- **Bounce Time:** < 5 ms
- **Contact Resistance:** < 30 mW
- **Service Life:** 500,000 operations at 1A DC, resistive load
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3310



Digital (relay) outputs are used to control events external to the 8864 Data Controller such as instrument calibrations and stream switching or to signal alarm or other conditions. Calibration programs can be configured in the 8864 Data Controller to activate specific outputs to flow calibration gases, purge lines, etc. Alarm programs can be configured to activate outputs when certain alarm conditions are met (i.e., exceedances, out-of-control conditions, equipment failure, etc.). To close a relay output, the 8864 Data Controller briefly energizes the “Set” coil in the relay. To open the relay, the controller briefly energizes the “Reset” coil.

#### Card Description:

Digital (relay) outputs allow the 8864 Data Controller to control external events such as calibrations, switching of alarm lights/audible alarms, and notifying an external device (e.g., DCS or annunciator panel) of an alarm or other event. Each card contains eight relay outputs.

Each relay is a latching-coil relay capable of switching up to 5A at 250 VAC or 5A at 30 VDC. The latching-coil feature allows the relay to maintain its on/off status during a power failure. Each relay is a single set of mechanical contacts and is isolated from other relays and from the 8864 Data Controller’s AC ground.

#### Connection Notes:

To install a relay output, connect the two terminals labeled plus (+) and minus (–) in any order to the desired load. If the user requires a switched voltage, the voltage must be supplied using an external power source to one side of the relay.



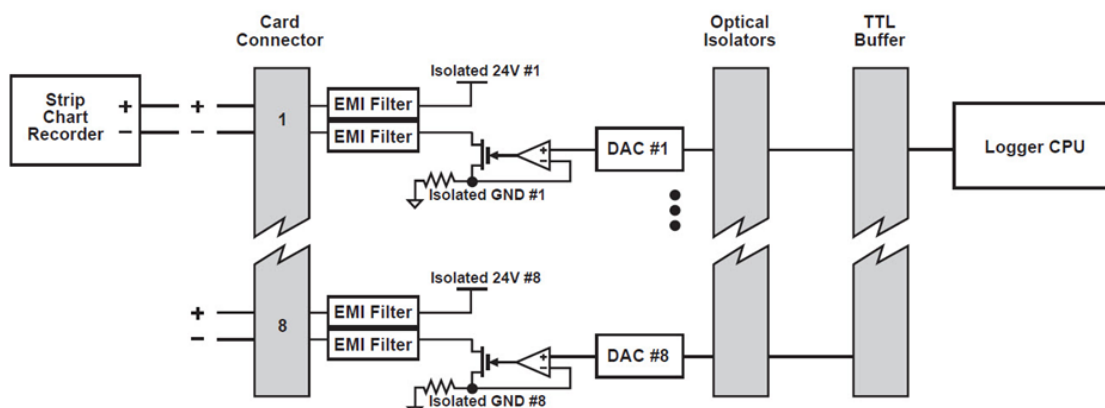
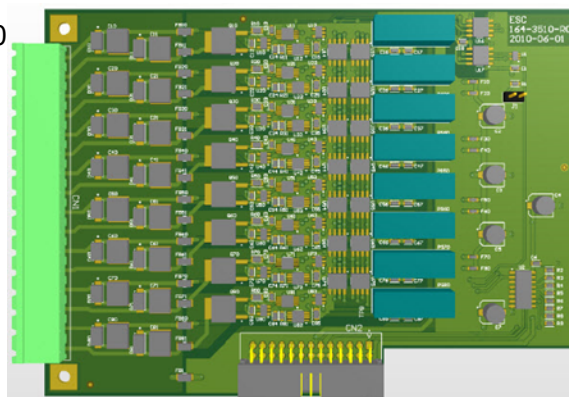
**NOTE:** The 64D-O (Model 3310) card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

---

## 64CUR-O (Model 3510) - Analog Current Output Card

### Specifications

- **Inputs:** Eight (8) individually isolated 4-20 mA signal outputs
- **Load:** 1KW @ 20 mA maximum
- **Resolution:** 12-bit
- **Accuracy:** 0.5% over operating temperature range
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Update Rate:** Up to once per second for each output
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3510



### Operation

The analog (current) outputs are typically used to output the results of calculations performed by the 8864 Data Controller's software, such as pollution emission rates. Initially, the output currents will be zero mA. Each digital-to-analog converter (DAC) can then be configured in the software to provide a specific output for a given value of a calculation. A DAC output could be programmed to output a 4-20 mA signal corresponding to an emission rate of 0-2 lb/mm Btu. To control the current flow, the 8864 Data Controller sends a digital value to the digital-to-analog converter of the corresponding output at a rate configured by the user. This rate can be anything from "instantaneous" (as soon as a new value is calculated, typically once a second) to once every 24 hours.

## Card Descriptions

The Analog (current) Output Card provides eight (8) individually isolated 4-20 mA signal outputs with 12 bit resolution. These current outputs are typically used to output the results of calculations performed by the 8864 Data Controller software, such as pollutant emission rates. These outputs can be used to drive strip-chart devices or to provide information to a local distributed control system.

The loop power for each output is provided by the 8864 Data Controller and can drive loads of up to 1,000 ohms.

## Connection Notes

To install a current output, connect the two terminals labeled plus (+) and minus (–) to the plus (+) and minus (–) terminals of the measurement device. Current flow is from the plus (+) terminal of the current output to the minus (–) terminal. If the polarity is reversed, no damage should occur to the analog output card; however, the current measured by the device will be negative. To ensure that the analog output can drive the full 4-20 mA range, connect no more than a 1K $\Omega$  load, including line resistance.



**NOTE:** The 64CUR-O (Model 3510) card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

---

# 64MET (Model 3610) - Meteorological Input Card

## SPECIFICATIONS

**Inputs/Outputs:** Rainfall Input, Wind Speed Input, Wind Direction Input, Temperature Input, Excitation Voltage Outputs

**Temperature Range:** 0° C to 40° C operating

**Humidity:** 0 to 95% (noncondensing)

**Wire Size:** 12 to 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)

**Scan Rate:** Up to once per second for each input

## CARD DESCRIPTION

The 64MET Meteorological Input Card provides direct signal conditioning for the following types of instruments:

### Wind Speed Input

Input Voltage transition 50mV to 15V peak-to-peak, square or sine wave (AC coupled)  
Maximum Count Rate: 2000 Hz  
Input Impedance: 10 Kohm (<3V input), 1 Kohm (>3V input)

### Wind Direction Input

Excitation Voltage: 5VDC  
Allowed Instrument Resistance: 1 Kohm to 100 Kohm

### Tipping Bucket Rain Gauge

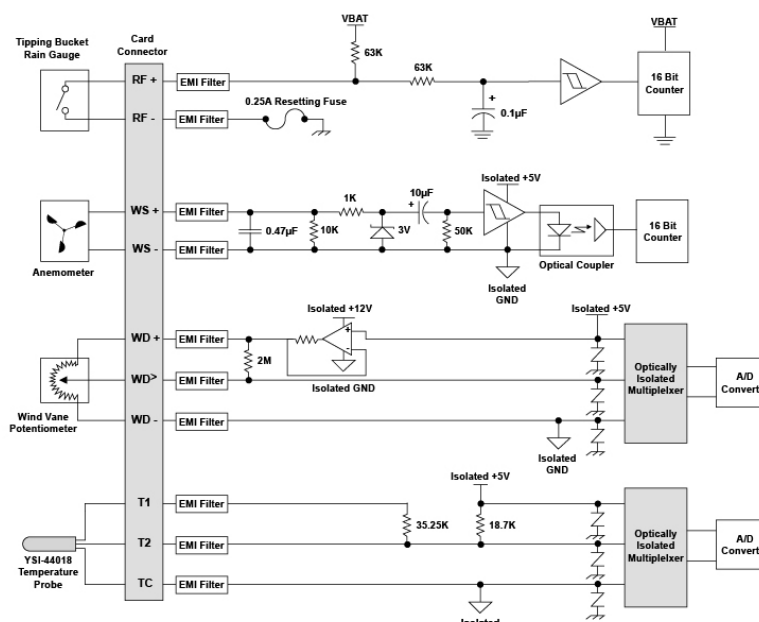
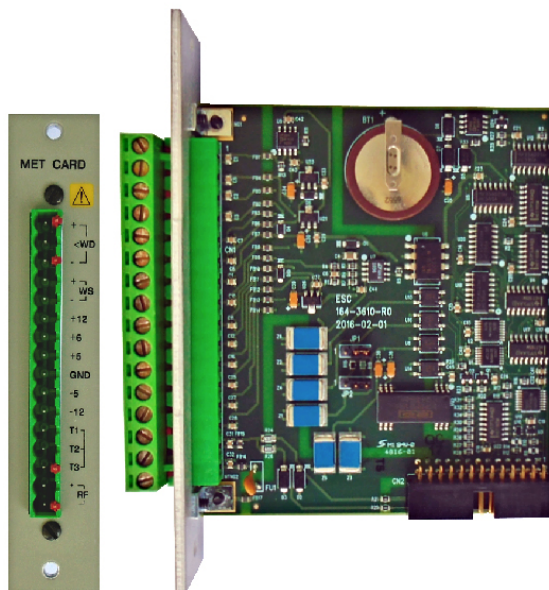
Input Contact closure or voltage transition from 0V to 3VDC through 0V to 24VDC (includes TTL levels)  
Debounce Circuit: Yes  
Maximum Count Rate: 5 Hz  
Battery Backup: Yes  
Rainfall count continues to accumulate even if power fails (e.g., during a thunderstorm)

### Temperature Input

Probe: YSI Model 44018  
Range: -30°C to 50°C  
Accuracy:  $\pm 0.5^\circ\text{C}$

### Excitation Voltage Outputs

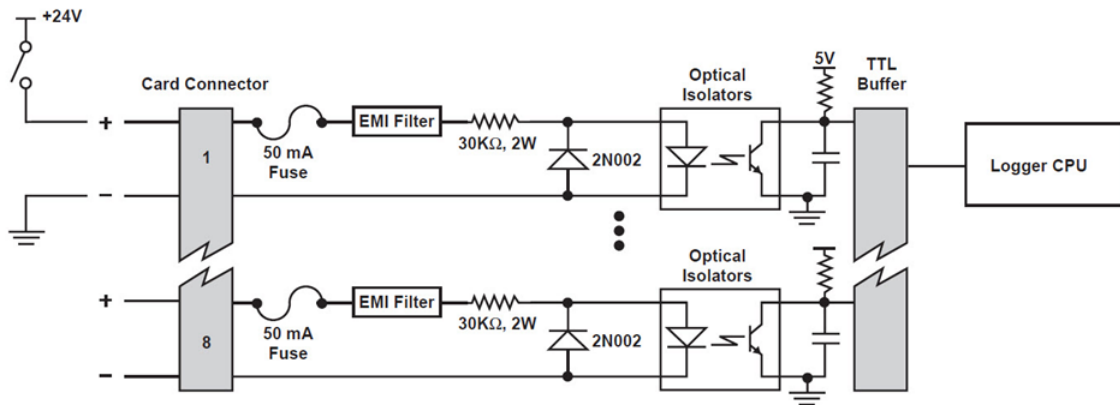
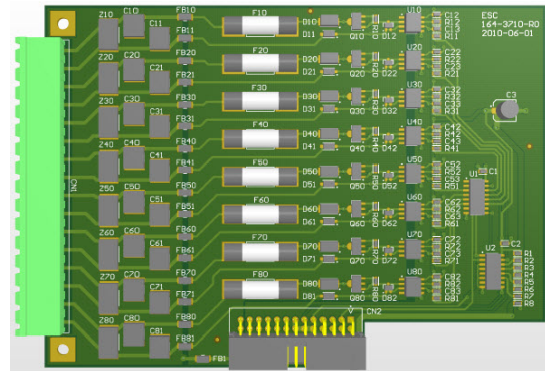
Available Voltages (DC)  
+5V, +6V, +12V, -5V, -12V  
Maximum Current Out  
70 mA (total for all outputs)



## 64IDS-I (Model 3710) - Isolated Status Input Card

### Specifications:

- **Inputs:** Eight (8) isolated status inputs; optional software debounce
- **Guaranteed “ON” Condition:** DC, 14-220 VDC across (+) and (–) terminals(>0.5 mA) AC, 60-220 VAC (50 or 60 Hz)
- **Guaranteed “OFF” Condition:** DC, less than 3 VDC across (+) and (–) terminals or open circuit (<0.1 mA) AC, less than 5 VAC (50 or 60 Hz) or open circuit
- **Temperature Range:** 0°C to 40°C operating
- **Humidity:** 0 to 95% (non-condensing)
- **Scan Rate:** Once per second
- **Wire Gauge:** 12 - 20 gauge solid or stranded (20 gauge stranded with solder-tinned ends recommended)
- **8864 Part Number:** S164-3710



### Operations:

For isolated status inputs, an input is considered “off” (a logic “0”) if the input’s plus (+) and minus (–) terminals are an open circuit, or if the voltage potential between the terminals is less than 3 VDC or 5 VAC (i.e., less than 0.1 mA is flowing into the (+) terminal). An input is considered to be “on” (a logic “1”) if the voltage is greater than 14 VDC or 60 VAC (i.e., greater than 0.5 mA) is applied across the plus (+) and minus (–) terminals at that input.

The inputs are scanned approximately once per second. If the software debounce option is enabled, a transition must be stable for at least 1 second before the transition is acknowledged. These logic levels can then be used in the 8864 Data Controller configurations to validate data,

detect online conditions, monitor calibrations, and detect alarms and equipment failures.

#### Card Description:

Isolated status input lines can be used to monitor the status of events external to the 8864 Data Controller, such as instrument-initiated calibrations, alarms, instrument failure, or the status of a stream-switched system. Each Model 3710 Isolated Status Input Card can read up to eight (8) inputs, which must be a voltage transition (AC or DC). Monitoring “dry” contacts requires either an external excitation voltage or the use of the [Model 3210 - Digital Status Input Card](#). The status inputs are scanned, on the average, once per second. Software debouncing can be activated through the 8864 Data Controller configuration.

#### Connection Notes:

Connecting an isolated status input to detect a DC voltage requires that the polarity match that of the input. The positive side of the voltage must be connected to the plus (+) terminal of the input and the common must be connected to the minus (-) terminal. No damage will occur if the polarity is reversed; however, the input will always read as “off”. Connecting an isolated status input to detect AC voltage allows the terminals to be connected in any order. The voltages applied to these inputs should be limited to less than 220 V (AC or DC) to prevent permanent damage to the card.



**NOTE:** The 64IDS-I (Model 3710) card has been evaluated and meets UL requirements when used with Model 8864 Data System Controller systems.

---



# Appendix K. EtherNet/IP Communications

EtherNet/IP (EIP) is an industrial protocol common in newer Allen Bradley PLCs in use across a wide range of applications. Examples include the following devices. ( PLC refers to Programmable Logic Controller.)

- **ControlLogix**



- **CompactLogix**



- **Standalone Remote I/O Modules**



Basic concepts of EtherNet/IP include:

- It is another type of communication protocol – think of it like Modbus.
- It has a governing standards board to drive standardization across all vendors making it simple for different devices to communicate with one another.
- Anything from raw I/O to calculations to custom data types would be available – if it's in the PLC, you can read it over Ethernet I/O.

Note that all StackStudio configuration references and settings are intentionally omitted. All channels (whether Modbus or EtherNet/IP) are configured as Modbus in StackStudio. All Modbus update intervals and Modbus scaling factors apply.

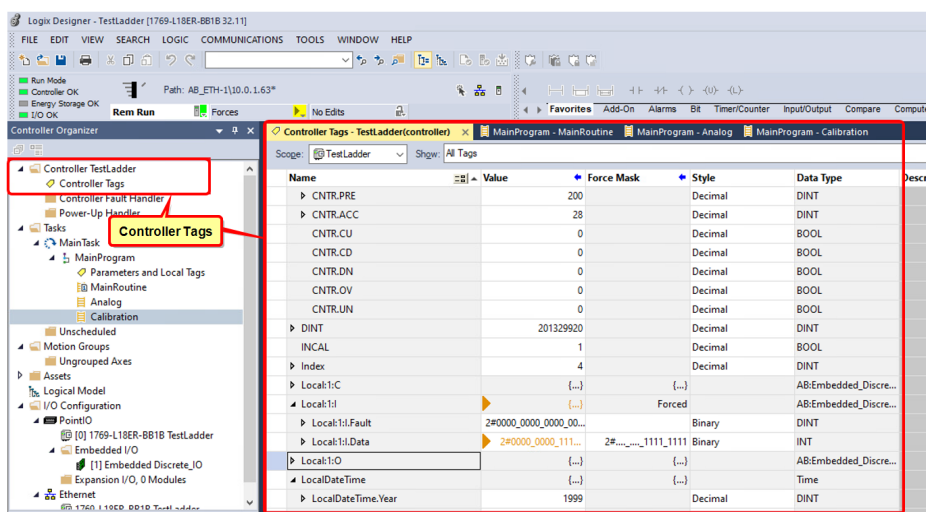


For more information, continue with the following topics in this section:

- [CompactLogix and ControlLogix Tags](#)
- [server.cfg Configuration](#)
- [Sample server.cfg](#)

## CompactLogix and ControlLogix Tags

Tags in these devices are similar to channels in the 8864 Data Controller or parameters in the StackVision software. Generally, except for specific situations, all tags are found in the Controller Tags section when using Rockwell Software RSLogix 5000, the programming software for AB PLCs. See next example.

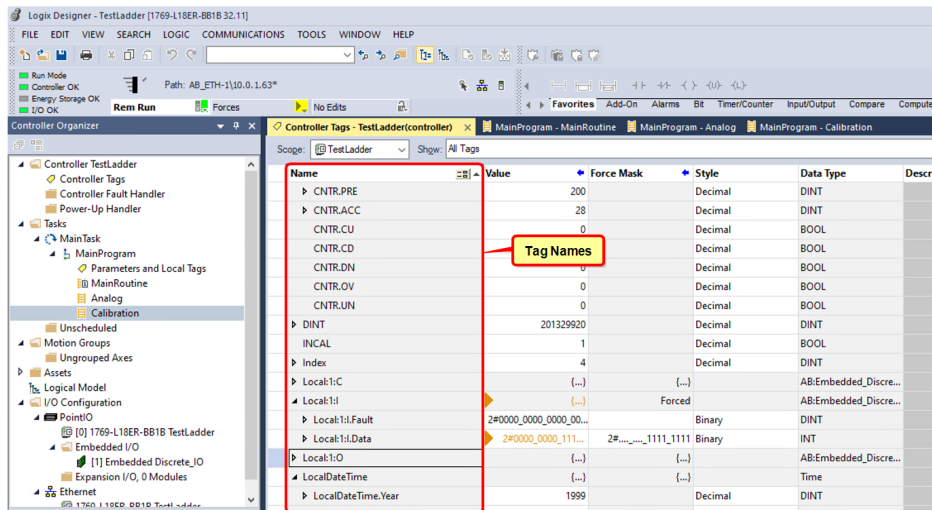


For related information, continue with the following topics:

- [Tag Information](#)
- [Tag Data Types](#)
- [Tag Structures](#)
- [Exporting the Tag Database](#)

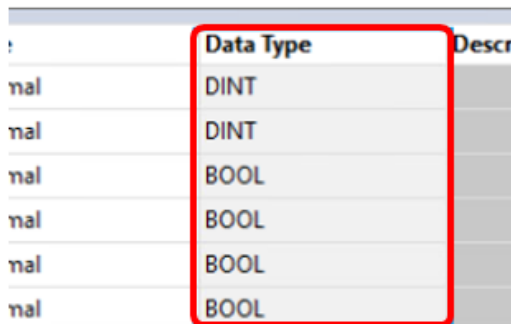
## Tag Information

Tag names are the address the 8864 reads data from. They are specified in the **Name** column (see next example).



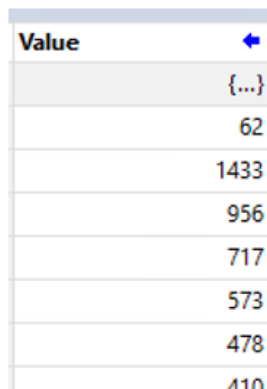
Name	Value	Force Mask	Style	Data Type	Descri
CNTR.PRE	200		Decimal	DINT	
CNTR.ACC	28		Decimal	DINT	
CNTR.CU	0		Decimal	BOOL	
CNTR.CD			Decimal	BOOL	
CNTR.DN	0		Decimal	BOOL	
CNTR.OV	0		Decimal	BOOL	
CNTR.UN	0		Decimal	BOOL	
DINT	201329920		Decimal	DINT	
INICAL	1		Decimal	BOOL	
Index	4		Decimal	DINT	
Local:I:C	(...)			AB:Embedded_Discr...	
Local:I:I	(...)	Forced		AB:Embedded_Discr...	
Local:I:I.Fault	2#0000_0000_0000_00...		Binary	DINT	
Local:I:I.Data	2#0000_0000_1111...	2#..._1111_1111	Binary	INT	
Local:I:O	(...)			AB:Embedded_Discr...	
Local:DateTime	(...)			Time	
Local:DateTime.Year	1999		Decimal	DINT	

The tag database also provides information for specific data types (see next example).



Data Type	Descri
DINT	
DINT	
BOOL	
BOOL	
BOOL	
BOOL	

When connected to a PLC (Online), the current value of the tag displays in the Value column (see next example).



Value
{...}
62
1433
956
717
573
478
410

## Tag Data Types

Common tag data types to be familiar with include:

- **INT**: Integer, consisting of a single, 16 bit word.
- **DINT**: Double integer, consisting of two 16 bit words.
- **REAL**: Floating point, consisting of two 16 bit words.
- **BOOL**: Boolean, or digital point, which is a single bit.

You can group the data types in the previous list in an array structure. In the next screen example, an array tag has been created that consists of 16 integers. The name of the array structure **Analog\_Out**. Specific tags are referenced in the array — such as **Analog\_Out[4]**, which is the 5th integer in the Analog\_Out array.

Name	Value	Force Mask	Style	Data Type
▶ Analog	{...}	{...}	Float	REAL[16]
▲ Analog_Out	{...}	{...}	Decimal	INT[16]
▶ Analog_Out[0]	0		Decimal	INT
▶ Analog_Out[1]	0		Decimal	INT
▶ Analog_Out[2]	0		Decimal	INT
▶ Analog_Out[3]	0		Decimal	INT
▶ Analog_Out[4]	0		Decimal	INT
▶ Analog_Out[5]	0		Decimal	INT
▶ Analog_Out[6]	0		Decimal	INT
▶ Analog_Out[7]	0		Decimal	INT
▶ Analog_Out[8]	0		Decimal	INT
▶ Analog_Out[9]	0		Decimal	INT
▶ Analog_Out[10]	0		Decimal	INT
▶ Analog_Out[11]	0		Decimal	INT
▶ Analog_Out[12]	0		Decimal	INT
▶ Analog_Out[13]	0		Decimal	INT
▶ Analog_Out[14]	0		Decimal	INT
▶ Analog_Out[15]	0		Decimal	INT

## Tag Structures

You can group tags in specific structures. The most common tag structures include:

- [Physical I/O](#)
- [Timers](#)
- [Counters](#)
- [User Defined](#)

### Physical I/O Tag Structure

Name	Value	Force Mask	Style	Data Type
Local:1:I				AB:Embedded_DiscreteIO:0
Local:1:I.Fault	2#0000_0000_0000_00...		Binary	DINT
Local:1:I.Data	2#0000_0000_1111...	2#..._1111_1111	Binary	INT
Local:1:I.Data.0	1	1	1 Decimal	BOOL
Local:1:I.Data.1	1	1	1 Decimal	BOOL
Local:1:I.Data.2	1	1	1 Decimal	BOOL
Local:1:I.Data.3	1	1	1 Decimal	BOOL
Local:1:I.Data.4	1	1	1 Decimal	BOOL
Local:1:I.Data.5	1	1	1 Decimal	BOOL
Local:1:I.Data.6	1	1	1 Decimal	BOOL
Local:1:I.Data.7	1	1	1 Decimal	BOOL
Local:1:I.Data.8	0		Decimal	BOOL
Local:1:I.Data.9	0		Decimal	BOOL
Local:1:I.Data.10	0		Decimal	BOOL
Local:1:I.Data.11	0		Decimal	BOOL
Local:1:I.Data.12	0		Decimal	BOOL
Local:1:I.Data.13	0		Decimal	BOOL
Local:1:I.Data.14	0		Decimal	BOOL
Local:1:I.Data.15	0		Decimal	BOOL

In the previous screen example, the **data type** is `AB:Embedded_DiscreteIO:I:0`. For this CompactLogix device, controller translates out to the embedded digitals located on the:

- actual controller (named `Embedded_DiscreteIO`)
- digital field inputs (named `:I`)
- first set of available inputs (named `:0`)

For **Outputs**, the digital field would be `:O` and the first set of available outputs (named `:0`).

The specific tag name to read also contains this similar information `Local:1:I.Data.0` for example would be the Local, physical I/O in position or slot 1 with the `I` indicating it is an input, not an output, which would be `O`. The `Data.0` indicates digital input 0, or the first digital input available.

Note that you can read in the entire digital input card as an `INT`, or you can read the specific points as a `BOOL`.

## Timers Tag Structure

Name	Value	Force Mask	Style	Data Type
▲ CALTOL	{...}	{...}		TIMER[3]
▲ CALTOL[0]	{...}	{...}		TIMER
▶ CALTOL[0].PRE	180000		Decimal	DINT
▶ CALTOL[0].ACC	0		Decimal	DINT
CALTOL[0].EN	0		Decimal	BOOL
CALTOL[0].TT	0		Decimal	BOOL
CALTOL[0].DN	0		Decimal	BOOL

Timers always consist of two DINTs and three BOOLS:

- **.PRE** is the timer preset. The preset is always in milliseconds. In the previous screen example it is: 180,000 milliseconds or 180 seconds.
- **.ACC** is the timer accumulated value. This is also stored in milliseconds.
- **.EN** is a digital indication of an enabled timer. Depending on the PLC program, you can control when a timer is active or not.
- **.TT** is a digital indication that the timer is operating (also referred to as “timing”) and the accumulated value (ACC) is incrementing.
- **.DN** is a digital indication that the timer is done and has reached its preset. It is common for the DN bool to only be in for a short amount of time as most programs will use this indication to proceed to a “next step” and reset the status of the preceding timer. Do not expect the DN bool to stay active the entire time after a timer completes.

**NOTE:** If you use 0.001 as the scaling factor on a channel, the Modbus Scaling factor used by the StackVision/StackStudio software does work for automatically handling the reduction of milliseconds to seconds.

## Counters Tag Structure

Name	Value	Force Mask	Style	Data Type
▲ CNTR	{...}	{...}		COUNTER
▸ CNTR.PRE	200		Decimal	DINT
▸ CNTR.ACC	62		Decimal	DINT
▸ CNTR.CU	0		Decimal	BOOL
▸ CNTR.CD	0		Decimal	BOOL
▸ CNTR.DN	0		Decimal	BOOL
▸ CNTR.OV	0		Decimal	BOOL
▸ CNTR.UN	0		Decimal	BOOL

Counters are similar to Timers but include support for more Booleans:

- **.PRE** is the counter preset. The preset is a number and is independent of time. Conversion is not necessary.
- **.ACC** is the counter accumulated value. The value is also stored as a plain number.
- **.CU** is a digital command to the counter to count “up” or increment.
- **.CD** is a digital command to the counter to count “down” or decrement.
- **.DN** is a digital indication that the counter is done and has reached its preset. It is common for the DN bool to only be in for a short amount of time as most programs will use this indication to proceed to a “next step” and reset the status of the preceding counter. Do not expect the DN bool to stay active the entire time after a counter completes.
- **.OV** and **.UN** are over and under status error messages for incorrect counter operation.

## User Defined Tag Structure

**Name:** Analog\_Output

**Description:**

**Members:**

Name	Data Type
Output	INT
Hi_Egu	REAL
Lo_Egu	REAL
Hi_Count	DINT
Lo_Count	DINT

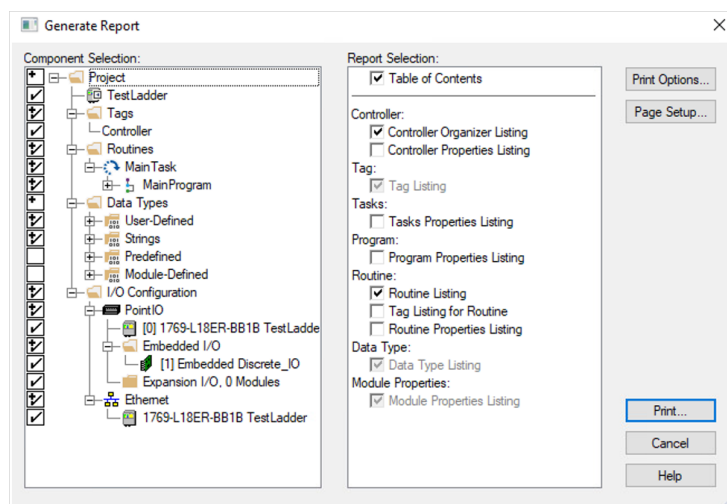
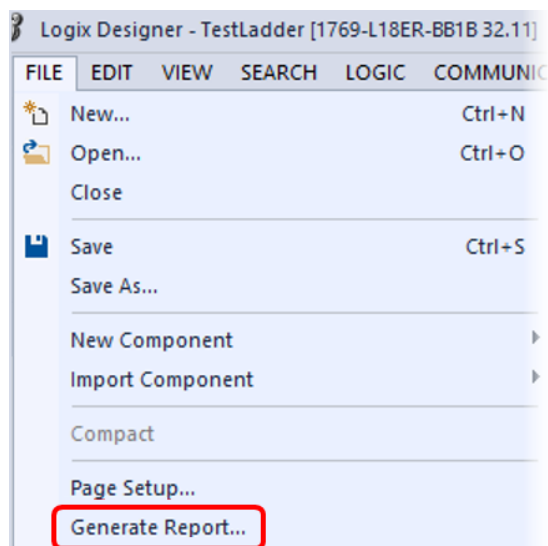
Name	Value	Force Mask	Style	Data Type
▲ AO	{...}	{...}		Analog_Output
▸ AO.Output	16		Decimal	INT
▸ AO.Hi_Egu	9190.0		Float	REAL
▸ AO.Lo_Egu	0.0		Float	REAL
▸ AO.Hi_Count	4095		Decimal	DINT
▸ AO.Lo_Count	0		Decimal	DINT

Tags can also be User Defined and consist of any number or combination for other available data types or structures.

In the previous screen example, a custom type `Analog_Output` is created that consists of a group of other data types. The tag name to reference when an output in counts is desired is `AO.Output`.

## Exporting the Tag Database

For AB PLCs, the version of the programming software is matched with the version of the PLC. If you do not have the exact version of software to match the version number of the PLC, the software will not read the PLC saved file. In these cases, you can extract the tag database from the software using the **Generate Report** function to save the list as a PDF file (Adobe's portable document file format). See the next examples.



## server.cfg Configuration

EtherNet/IP (EIP) has its own area in the server.cfg file. Important notes about the new sections include those in the following list and are described more in subsequent topics:

- Nine (9) Clients are available and can be configured to run in Parallel.
- Bracket addressing or holding register addressing are both supported.
- Status registers begin at address 10,000 and increment by 200 for each successive configured Client.
- Columns are different from Modbus sections.

See the following topics for more information.

- [Client Headers](#)
- [Column Headers](#)
- [Examples](#)

### Client Headers

```
[EIP Class 3 Client 0]
Minimum Command Delay      : 50
Response Timeout           : 1000
Retry Count                 : 3
Run in parallel             : Y
# Status registers begin at 10,000
[EIP Class 3 Client 0 Commands]
START
.
.
.
END
```



## Column Headers

#	Enable	Reg (0)	Internal	Poll	Elem	Swap	IP	Slot	Func Code	Tag Name	Offset	Comment
#		Coil(1)	Address	Interval	Count	Code	Address					

Columns of note are identified in the following list. Other columns are identical to Modbus configurations.

- **Reg(0) / Coil(1) Column:** This column identifies Coils (BOOL) versus all other register types. Data types REAL, INT and DINT are all Registers.
- **Element Count Column:** This column is a major difference between Modbus and Ethernet I/P. The Element Count column specifies the number of tags to bring over. Specification of number of words is not required.
- **Swap Code Column:** The swap code column has been enhanced to include the following items:
  - 0 – None (abcd), where the bytes of the 16 bit word are represented as a, b, c, and d
  - 1 – Word Swap (cdab)
  - 2 – Word and Byte Swap (dcba)
  - 3 – Byte Swap (badc)
- **Slot Column:** This refers to the location of the PLC CPU within the physical rack:
  - CompactLogix always has the slot set to 0.
  - ControlLogix PLCs can have the CPU installed in any slot in the rack. For proper communication across the chassis backplane, the CPU slot must be specified.
- **Func Code Column:** The functions of READ and WRITE are supported and must be typed out but are not case sensitive.
- **Tag Name Column:** The tag being requested or written to.

## Examples

Note the following for examples in this topic:

- In all of the following examples, 8864 Double Wide was configured to support DINT data types. Double Wide data tables are required for this data type.
- Swap Code 3 is required when reading in Register values due to the specific implementation library the 8864 has adopted.
- The Poll Interval is the same as Modbus, 10 = 1.0 seconds.

### Example 1:

Read in an entire **Digital Input** or **Output** slot and write it to an integer Channel:

# Enable #	Reg (0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	0	[3099]	10	1	3	10.0.1.63	0	Read	Local:1:I.Data	#
1	0	[3100]	10	1	3	10.0.1.63	0	Read	Local:1:O.Data	#

### Example 2:

Read an **array of 8 Elements**. The tag **Analog\_Out** is an INT data type and must be written to the standard integer Modbus register space:

# Enable #	Reg(0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	0	[3101]	10	8	3	10.0.1.63	0	Read	Analog_Out	#

### Example 3:

Read a **REAL or floating point Element** and write it to a floating point Channel:

# Enable #	Reg (0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	0	[4223]	10	1	3	10.0.1.63	0	Read	TEMPA	#

### Example 4:

Read a **DINT or double integer Element** and write it to a Double Wide Integer Channel:

# Enable #	Reg (0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	0	[23258]	10	1	3	10.0.1.63	0	Read	CNTR.ACC	#

**Example 5:**

Read **BOOL** data types:

- **Line #1** reads in a single BOOL and stores it in a Coil to be mapped later by the [8864 Data Map] section.
- **Line #2** reads in a single BOOL and stores it in Pseudo 101.
- **Line #3** reads in an entire Digital Input slot, all 16 bits, and stores it in the Pseudo space at the corresponding word location (16 consecutive pseudos).

# Enable #	Reg (0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	1	16160	10	1	0	10.0.1.63	0	Read	INCAL	#
1	1	[100]	10	1	0	10.0.1.63	0	Read	INCAL	#
1	0	[2112]	10	1	3	10.0.1.63	0	Read	Local:1:I.Data	#

**Example 6:**

To save on commands, the entire Structure of a **Timer** or a **Counter** can be read in instead of independently reading each tag within the structure. This operation requires writing to the holding register space and parsing out the specific data in the [8864 Data Map] section:

# Enable #	Reg(0) Coil(1)	Internal Address	Poll Interval	Elem Count	Swap Code	IP Address	Slot	Func Code	Tag Name	Comment
1	0	1100	10	1	3	10.0.1.63	0	Read	CALTOL[0]	# Get Entire CALTOL Tag
1	0	1200	10	1	3	10.0.1.63	0	Read	CNTR	# Get Entire CNTR Tag

Next is the corresponding data map for the previous command when reading the **CALTOL[0] Timer Structure**. Note that 17,629 through 17,631 correspond to bits 13-15 of holding register 1101 (highlighted in yellow).

The next example stores the three digitals associated with a timer to pseudos and writes the timer preset to a double-wide integer Channel. Although only 1 Element has been read in, what has been read is a structure containing multiple elements is understood and written across six words. Also note that the first word of this structure can be ignored. It is a control word used for timer operational status in the PLC.

[8864 Data Map]						
Run in parallel		: Y				
START						
#	Internal	Poll	Reg	Swap	Modbus	MB Address
# Enable	Address	Interval	Count	Code	Func	in Slave
#CAL TOL 0 Timer						
#0	1100	10	1	0	16	# WRITE registers Timer CTRL Value
1	17631	10	1	0	15	108 # WRITE registers Word 1101: Bit 15: Timer Enabled
1	17630	10	1	0	15	109 # WRITE registers Word 1101: Bit 14: Timer Timing
1	17629	10	1	0	15	110 # WRITE registers Word 1101: Bit 13: Timer Done
1	1102	10	2	0	16	23278 # WRITE registers Timer PRE Value
#0	1104	10	2	0	16	# WRITE registers Timer ACC Value

Next is the corresponding data map for the above command when reading the CNTR Counter Structure. Note that 19,227 through 19,231 correspond to bits 11-15 of holding register 1201 (highlighted in yellow).

The next example stores the five digitals associated with a timer to pseudos and writes the timer preset to a double-wide integer Channel, though a double wide channel type is not required for the counter structure – a standard Integer Modbus register should be adequate. Also note that the first word of this structure can be ignored. It is a control word used for counter operational status within the PLC.

[8864 Data Map]						
Run in parallel : Y						
START						
#	Internal	Poll	Reg	Swap	Modbus	MB Address
# Enable	Address	Interval	Count	Code	Func	in Slave
#CNTR Counter						
#0	1200	10	1	0	16	# WRITE registers Timer CTRL Value
1	19231	10	1	0	15	119 # WRITE registers Word 1201: Bit 15: Counter Count Up
1	19230	10	1	0	15	120 # WRITE registers Word 1201: Bit 14: Counter Count Down
1	19229	10	1	0	15	121 # WRITE registers Word 1201: Bit 13: Counter Done
1	19228	10	1	0	15	122 # WRITE registers Word 1201: Bit 12: Counter Over
1	19227	10	1	0	15	123 # WRITE registers Word 1201: Bit 11: Counter Under
1	1202	10	2	0	16	23294 # WRITE registers Timer PRE Value
#0	1204	10	2	0	16	# WRITE registers Timer ACC Value

In the next example, write commands are controlled by the Function Code “Write”. All other columns are configured similarly as in the previous example:

- **Line #1** in the next example provides a sample of writing a floating point Channel to a corresponding REAL data type tag name.
- **Line #2** is writing a double-wide Integer Channel to a corresponding DINT data type tag.
- **Line #3** writes a single pseudo (pseudo 100) to a digital output 16 on the PLC module. This is where each output card contains 16 bits and begins at 0 addressing, 0-15 points.

# Enable	Reg (0)	Internal	Poll	Elem	Swap	IP	Slot	Func Code	Tag Name	Comment
#	Coil(1)	Address	Interval	Count	Code	Address				
1	0	[4289]	10	1	3	10.0.1.63	0	Write	AnalogOut[0].Hi_Egu	#
1	0	[23292]	10	1	3	10.0.1.63	0	Write	AnalogOut[0].Hi_Count	#
1	1	[99]	10	1	0	10.0.1.63	0	Write	Local:1:O.Data.15	#

## Sample server.cfg

The following sample server.cfg file is also available in the online help version of the *8864 User Guide* and may be easier to read than the PDF version. Use the following link to view the online help version, and then navigate to the topic “*Sample server.cfg*” in the section “*Appendix K. EtherNet/IP Communications*”:

<https://www.escspectrum.com/wp-content/online-docs/dc-docs/WebHelp/Default.htm>

```
# COMPANY   : ESC
# DATE      :
# CREATED BY: ESC ENGINEERING
# EDIT DATE :
# EDITED BY :
#
[Module]
Module Name : 8864-Modbus-Master
[8864 Client 0]
Minimum Command Delay : 10 #Minimum number of msec's between commands
Response Timeout      : 2000 #Response message timeout (0-65535 mSec)
Retry Count           : 0 #Response failure retry count
Float Flag            : Yes #Use floating-point data type Y=Yes, N=No
Float Start           : 7000 #Register offset in message for floats
Run in parallel       : Y
Float Offset          : 2000 #Internal Address for floats
[8864 Client 0 Commands]
START
# Enable Internal Poll Reg Swap IP Serv Slave Func MB Address
# Address Interval Count Code Address Port Address Code In Device
#-----
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 1 XX #READ coil
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 2 XX #READ discrete input
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 3 XX #READ registers - (4XXXXX)
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 4 XX #READ input registers - (3XXXXX)
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 5 XX #WRITE coil
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 6 XX #WRITE register -- (single)
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 15 XX #WRITE coil ----- (multiple)
# 1 XXX 10 1 0 XX.XX.XX.XXX 502 1 16 XX #WRITE registers - (multiple)
#-----
# 8832 10.0.40.39
# Enable Internal Poll Reg Swap IP Serv Slave Func MB Address
# Address Interval Count Code Address Port Address Code In Device
#-----
1 0 10 2 0 10.0.40.39 502 1 3 1009 #READ Analog Inputs
1 2 10 2 0 10.0.40.39 502 1 3 1011 #READ Analog Inputs
1 4 10 2 0 10.0.40.39 502 1 3 1013 #READ Analog Inputs
1 6 10 2 0 10.0.40.39 502 1 3 1015 #READ Analog Inputs
1 8 10 2 0 10.0.40.39 502 1 3 1017 #READ Analog Inputs
1 10 10 2 0 10.0.40.39 502 1 3 1019 #READ Analog Inputs
1 12 10 2 0 10.0.40.39 502 1 3 1021 #READ Analog Inputs
1 14 10 2 0 10.0.40.39 502 1 3 1023 #READ Analog Inputs
1 320 10 3 0 10.0.40.39 502 1 1 66 #READ Digital Status
#-----
# Write data to Channel Registers
1 0 10 16 0 127.0.0.1 502 1 16 4001 #WRITE Analog Inputs
1 320 10 3 0 127.0.0.1 502 1 15 66 #READ Digital Status
#-----
END
```

(continued on next page)

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[8864 Client 1]
Minimum Command Delay : 10 #Minimum number of msec's between commands
Response Timeout : 2000 #Response message timeout (0-65535 mSec)
Retry Count : 0 #Response failure retry count
Float Flag : Yes #Use floating-point data type Y=Yes, N=No
Float Start : 7000 #Register offset in message for floats
Run in parallel : Y
Float Offset : 2000 #Internal Address for floats
[8864 Client 1 Commands]
START
# PLX32-EIP-MBICP-UA
# Enable Internal Poll Reg Swap IP Serv Slave Func MB Address
# Address Count Code Address Port Address Code In Device
#-----
1 400 10 1 0 10.0.0.120 502 1 3 0 #READ Analog Inputs
END

[EIP Class 3 Client 0]
Minimum Command Delay : 50
Response Timeout : 1000
Retry Count : 3
Run in parallel : Y
# Status registers begin at 10,000
[EIP Class 3 Client 0 Commands]
START
# Enable Reg (0) Internal Poll Elem Swap IP Slot Func Code Tag Name Comment
# Coil(1) Address Interval Count Code Address
1 0 [3099] 10 1 3 10.0.1.63 0 Read Local:1:I.Data #
1 0 [3100] 10 1 3 10.0.1.63 0 Read Local:1:O.Data #
1 0 [3101] 10 8 3 10.0.1.63 0 Read Analog_Out #
1 0 [3110] 10 1 3 10.0.1.63 0 Read INDEX #
1 0 [4223] 10 1 3 10.0.1.63 0 Read TEMPA #
1 0 [4285] 10 1 3 10.0.1.63 0 Read NOXPPM #
1 0 [4287] 10 1 3 10.0.1.63 0 Read O2 #
1 0 [4225] 10 16 3 10.0.1.63 0 Read Analog #
1 0 [23258] 10 1 3 10.0.1.63 0 Read CNTR.ACC #
1 0 [23260] 10 1 3 10.0.1.63 0 Read TIMER.ACC #
1 0 [23262] 10 1 3 10.0.1.63 0 Read CALTOL[0].PRE #
1 0 [23264] 10 1 3 10.0.1.63 0 Read CALTOL[0].ACC #
1 0 [23266] 10 1 3 10.0.1.63 0 Read CALTOL[1].PRE #
1 0 [23268] 10 1 3 10.0.1.63 0 Read CALTOL[1].ACC #
1 0 [23270] 10 1 3 10.0.1.63 0 Read CALTOL[2].PRE #
1 0 [23272] 10 1 3 10.0.1.63 0 Read CALTOL[2].ACC #
1 0 [23274] 10 1 3 10.0.1.63 0 Read DINT #
1 1 16160 10 1 0 10.0.1.63 0 Read INCAL #
1 1 [100] 10 1 0 10.0.1.63 0 Read INCAL #
1 0 [2112] 10 1 3 10.0.1.63 0 Read Local:1:I.Data #
END

[EIP Class 3 Client 1]
Minimum Command Delay : 50
Response Timeout : 1000
Retry Count : 3
Run in parallel : Y
[EIP Class 3 Client 1 Commands]
START
# Enable Reg (0) Internal Poll Elem Swap IP Slot Func Code Tag Name Comment
# Coil(1) Address Interval Count Code Address
1 0 [23276] 10 1 3 10.0.1.63 0 Read LocalDateTime.Second #
#0 0 [23278] 10 1 3 10.0.1.63 0 Read CALTOL0_PRE #
#0 0 [4279] 10 1 3 10.0.1.63 0 Read CALTOL1_PRE #
#0 0 [23282] 10 1 3 10.0.1.63 0 Read CALTOL2_PRE #
1 0 [3141] 10 1 3 10.0.1.63 0 Read AO_output #
1 0 [4289] 10 1 3 10.0.1.63 0 Write AnalogOut[0].Hi_Egu #
1 0 [23292] 10 1 3 10.0.1.63 0 Write AnalogOut[0].Hi_Count #
1 1 [99] 10 1 0 10.0.1.63 0 Write Local:1:O.Data.I5 #
1 1 [104] 10 1 0 10.0.1.63 0 Write Local:1:O.Data.I4 #
1 0 1100 10 3 3 10.0.1.63 0 Read CALTOL # Get Entire CALTOL Array
1 0 1200 10 1 3 10.0.1.63 0 Read CNTR # Get Entire CALTOL Array
1 0 1250 10 1 3 10.0.1.63 0 Read Analog_Out #
END

```

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[8864 Data Map]
Run in parallel
START
:      Y
#      Internal Poll Reg Swap Modbus MB Address
# Enable Address Interval Count Code Func in Slave
# 1 XXX 10 1 0 1 XX # READ coil
# 1 XXX 10 1 0 2 XX # READ discrete input
# 1 XXX 10 1 0 3 XX # READ registers - (4XXXX)
# 1 XXX 10 1 0 4 XX # READ input registers - (3XXXX)
# 1 XXX 10 1 0 5 XX # WRITE coil
# 1 XXX 10 1 0 6 XX # WRITE register -- (single)
# 1 XXX 10 1 0 15 XX # WRITE coil ----- (multiple)
# 1 XXX 10 1 0 16 XX # WRITE registers - (multiple)
#-----
1 16160 10 1 0 15 99 # WRITE registers
1 1010 10 1 0 16 3109 # WRITE registers
#CAL TOL 0 Timer
#0 1100 10 1 0 16 # WRITE registers Timer CTRL Value
1 17631 10 1 0 15 108 # WRITE registers Word 1101: Bit 15: Timer Enabled
1 17630 10 1 0 15 109 # WRITE registers Word 1101: Bit 14: Timer Timing
1 17629 10 1 0 15 110 # WRITE registers Word 1101: Bit 13: Timer Done
1 1102 10 2 0 16 23278 # WRITE registers Timer PRE Value
#0 1104 10 2 0 16 # WRITE registers Timer ACC Value
#CAL TOL 1 Timer
#0 1106 10 1 0 16 # WRITE registers Timer CTRL Value
1 17727 10 1 0 15 111 # WRITE registers Word 1107: Bit 15: Timer Enabled
1 17726 10 1 0 15 112 # WRITE registers Word 1107: Bit 14: Timer Timing
1 17725 10 1 0 15 113 # WRITE registers Word 1107: Bit 13: Timer Done
1 1108 10 2 0 16 23280 # WRITE registers Timer PRE Value
#0 1110 10 2 0 16 # WRITE registers Timer ACC Value
#CAL TOL 2 Timer
#0 1112 10 1 0 16 # WRITE registers Timer CTRL Value
1 17823 10 1 0 15 114 # WRITE registers Word 1113: Bit 15: Timer Enabled
1 17822 10 1 0 15 115 # WRITE registers Word 1113: Bit 14: Timer Timing
1 17821 10 1 0 15 116 # WRITE registers Word 1113: Bit 13: Timer Done
1 1114 10 2 0 16 23282 # WRITE registers Timer PRE Value
#0 1116 10 2 0 16 # WRITE registers Timer ACC Value
#
#CNIR Counter
#0 1200 10 1 0 16 # WRITE registers Timer CTRL Value
1 19231 10 1 0 15 119 # WRITE registers Word 1201: Bit 15: Counter Count Up
1 19230 10 1 0 15 120 # WRITE registers Word 1201: Bit 14: Counter Count Down
1 19229 10 1 0 15 121 # WRITE registers Word 1201: Bit 13: Counter Done
1 19228 10 1 0 15 122 # WRITE registers Word 1201: Bit 12: Counter Over
1 19227 10 1 0 15 123 # WRITE registers Word 1201: Bit 11: Counter Under
1 1202 10 2 0 16 23294 # WRITE registers Timer PRE Value
#0 1204 10 2 0 16 # WRITE registers Timer ACC Value
END

```