Point IO™
2/4 Channel Analog HART Module

Catalog Number: 1734sc-IE2CH / IE4CH

SPECTRUM
C O N T R O L S

Important Notes

1. Please read all the information in this owner's guide before installing the product.

2. The information in this owner's guide applies to hardware Series A and firmware version 1.00 or later.

3. This guide assumes that the reader has a full working knowledge of the relevant processor.

Notice

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Table of Contents

PREFACE

Read this preface to familiarize yourself with the rest of the manual. This preface covers the following topics:

- Who should use this manual
- How to use this manual
- Related publications
- Conventions used in this manual
- Rockwell Automation support

Who Should Use This Manual

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use Allen-Bradley I/O and/or compatible controllers, such as CompactLogix and ControlLogix.

How to Use This Manual

As much as possible, we organized this manual to explain, in a task-by-task manner, how to install, configure, program, operate and troubleshoot a control system using the 1734sc-IExCH.

Related Documentation

The table below provides a listing of publications that contain important information about Allen-Bradley PLC systems.

For	*Refer to this Document*	*Allen-Bradley Pub. No.*
A description and overview of the 1734 and 1734D series POINT I/O modules and compatible control platforms. Also includes an overview of how to specify a POINT I/O system.	POINT I/O Selection Guide	1734-SG001
Information about how to install the 1734-EP24DC, Series B POINT I/O 24V dc Expansion Power Supply.	Expansion Power Supply Installation Instructions	1734-IN058
Information about how to install 1734-TB and -TBS POINT I/O Wiring Base Assemblies	Wiring Base Assembly Installation Instructions	1734-IN511
Information about how to install 1734-TB3 and -TB3S POINT I/O Wiring Base Assemblies.	Wiring Base Assembly Installation Instructions	1734-IN013

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Conventions Used in This Manual

The following conventions are used throughout this manual:
- Bulleted lists (like this one) provide information not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.
- *Italic* type is used for emphasis
- **Bold** type identifies headings and sub-headings

- ⚠ Attention Are used to identify critical information to the reader

Chapter 1
Module Overview

The 1734sc-IE2CH module has two analog input channels with HART and the IE4CH has four. Each channel on either module can be configured for current only or current with HART. This chapter includes information about:

- General description
- Input types
- Data Formats
- Filter frequencies
- Hardware Features
- System overview and module operation

Section 1.1
General Description

The IExCH module digitally converts and stores analog data for each configured input. Each input channel can be individually configured via software for HART and provides over-range and under-range detection and indication.

Section 1.2
Input Types

The IExCH module supports a 4 to 20 mA (3.42 to 20.58mA) input type only.

Section 1.3
Data Formats

User defined scaling is provided by means of a high engineering and low engineering set point.

Section 1.4
Filter Frequencies

The module uses a notch filter to provide noise rejection for each input channel. The filter for each channel is programmable allowing you to select from 7 different filter options:

- 50/60 Hz (default)
- 50 Hz
- 60 Hz
- 100 Hz
- 120 Hz
- 240 Hz
- 480 Hz

Section 1.5 Hardware Features

Channels are wired as differential inputs.

Module configuration is done via the controller's programming software. The module configuration is stored in the memory of the controller. Refer to your controller's user manual for more information. The illustration below shows the module's hardware features.

Figure 1-1
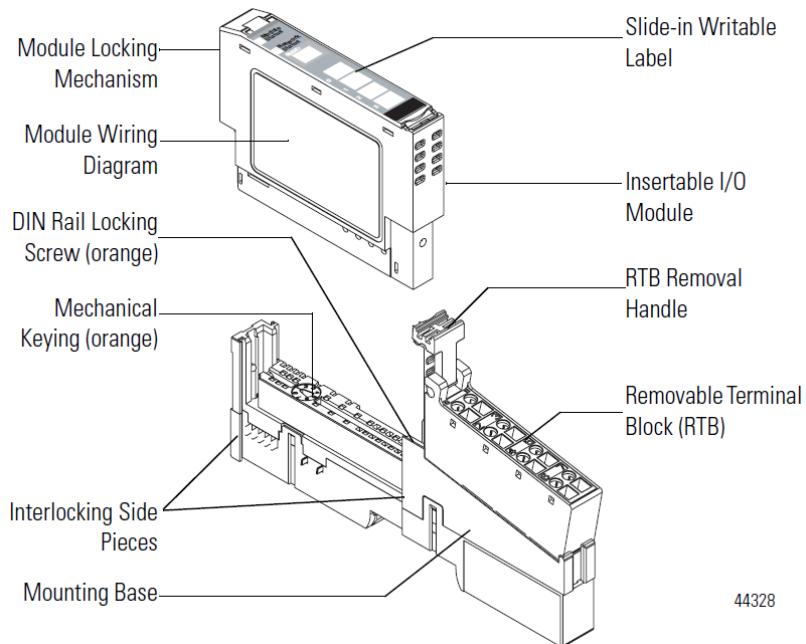
Figure 1-2
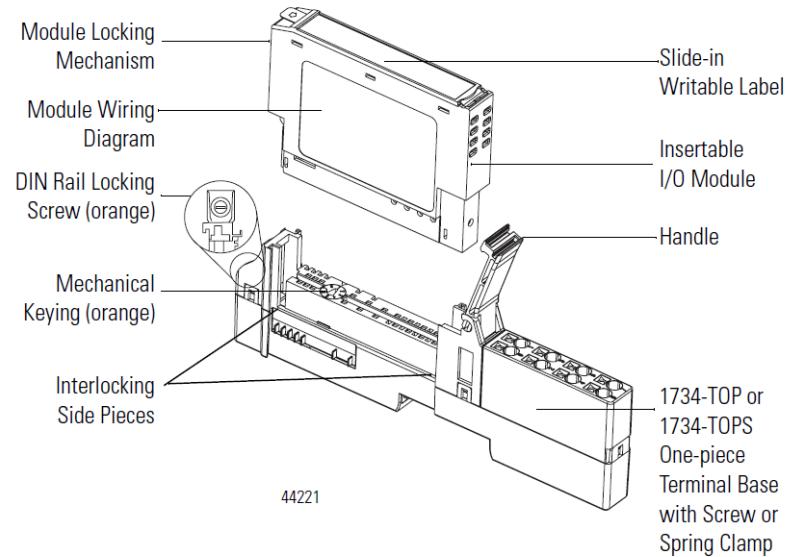
1.5.1 LED Indicators

The 1734 analog HART module uses several LEDs to show operational status. The status LEDs are defined below:

Table 1-1 (LED Status Indicators)

Indicator	State	Description
Module Status	Off	No power applied to device
	Green	Device operating normally
	Flashing Green	Device needs commissioning due to configuration missing, incomplete, or incorrect
	Flashing Red	Unrecoverable fault may require device replacement.
	Red	Recoverable fault.
	Flashing Red/Green	Device is in self-test mode.
Network status	Off	Device is not on-line - Device has not completed dup_MAC_id test. - Device not powered - check module status indicator
	Flashing Green	Device is on-line but has no connections in the established state.
	Green	Device on-line and has connections in the established state.
	Flashing Red	One or more I/O connections in timed-out state
	Red	Critical link failure - failed communication device. Device detected error that prevents it communicating on the network.
	Flashing Red/Green	Communication faulted device - the device has detected a network access error and is in communication faulted state.
Channel status	Off	Channel not in use
	Solid Green	Normal (channel scanning inputs)
	Flashing Green	Channel receiving HART data
	Solid Red	No power or major channel fault
	Flashing Red	Channel at end of range
	Flashing Red/Green	Hart device error on HART enabled channel

Section 1.6 System Overview

The module communicates to the controller via a 1734 Control Net, Device Net or Ethernet adapter. The module receives 5 and 24V dc power through the bus interface.

Note: No external power supply is required for 2-wire input transmitters.

1.6.1 Module Power-up

At power-up, the module performs a check of its internal circuits, memory, and basic

functions. If no faults are found during power-up diagnostics, the module status LED is turned on.

After power-up checks are complete, the module waits for valid channel configuration data. If an invalid configuration is detected, the module will generate a PLC fault. Once a channel is properly configured and enabled, it continuously converts the input data to a value within the range selected for that channel.

1.6.2 Module Operation

The 1734sc-IE2CH and IE4CH modules are single ended 4-20mA current sensing input modules with HART master capability. Analog current is measured by sensing voltage drop across an internal resistor. The nominal input resistance of individual channels is 250ohms. In the event of an over-current fault the module will protect the input circuitry by increasing the input resistance to limit input current. Analog to digital conversion is performed by a multiplexed Sigma-Delta ADC shared by all channels. A range of notch filters as well as an averaging filter can be applied to analog inputs. All channels share a common ground. Field power is provided on the terminal block to simplify wiring. The 1734sc-IE2CH and IE4CH have HART Primary Master capability. A dedicated HART modem is used for each channel for maximum throughput. When HART functionality is enabled on a channel the module will discover and establish communication with HART revision 5 and greater devices. Once communication has been established the module will automatically gather HART PV, SV, TV, FV data and monitor device status. The modules provide a communication bridge to HART devices for Asset Management Software and Ladder Programs via CIP messaging.

See the block diagram below.
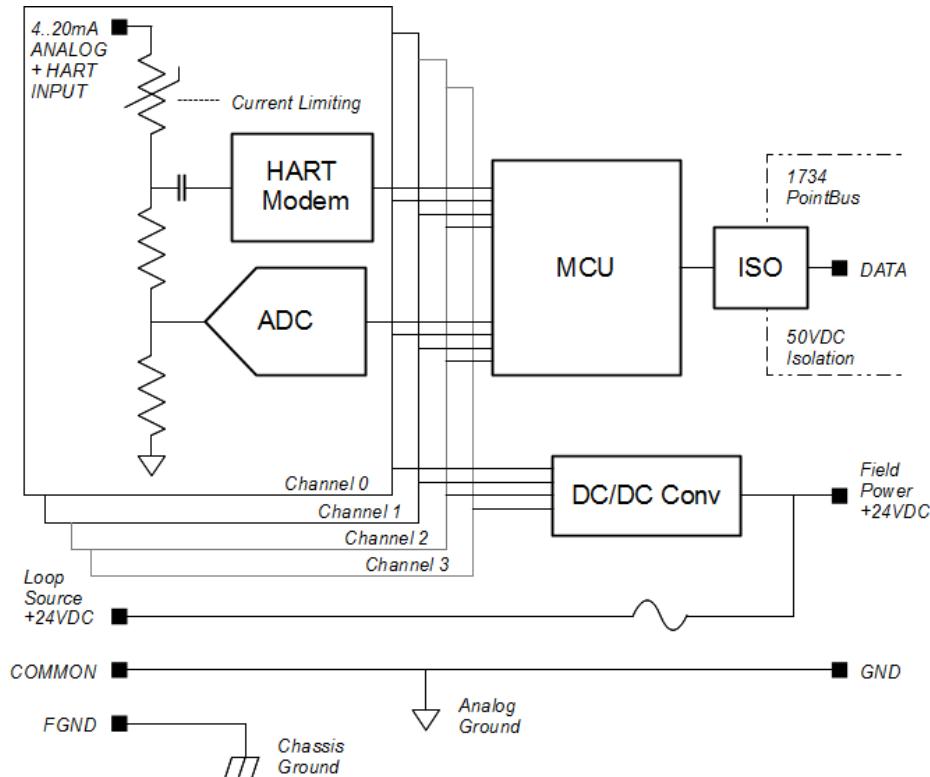
Chapter 2
Installation and Wiring

This chapter will cover:

- Compliance to European union directives
- Power requirements
- General considerations
- Mounting
- Field wiring connections

Section 2.1
Compliance to European Union Directives

This product is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

2.1.1 EMC Directive

The 1734sc-IExCH module is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or in part, documented in a technical construction file:

- IEC 61000-6-4 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
- IEC 61000-6-2 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments

This product is intended for use in an industrial environment.

2.1.2 Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131-2Programmable Controllers, Part 2 – Equipment Requirements and Tests. For specific information required by EN61131-2, see the appropriate sections in this publication, as well as the following Allen-Bradley publications:

- *Industrial Automation, Wiring and Grounding Guidelines for Noise Immunity*, publication 1770-4.1
- *Automation Systems Catalog*, publication B113

Section 2.2
Power Requirements

The module receives power through the bus interface from the +5V dc/+24V dc system power supply. The maximum current drawn by the module is shown in the table below.

5 VDC	24 VDC
15 mA	20 mA

Use the table below to determine the maximum number of IExCH modules that can be installed in a MicroLogix system.

**Section 2.3
General
Considerations**

1734 I/O is suitable for use in an industrial environment when installed in accordance with these instructions. Specifically, this equipment is intended for use in clean, dry environments Pollution degree 2[1] and to circuits not exceeding Over Voltage Category II[2](IEC 60664-1)[3].

2.3.1 Hazardous Location Considerations

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D or non-hazardous locations only. The following WARNING statement applies to use in hazardous locations.

!\
Attention

EXPLOSION HAZARD
- **Substitution of components may impair suitability for Class I, Division 2.**
- **Do not replace components or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.**
- **Do not connect or disconnect components unless power has been switched off or the area is known to be non-hazardous.**
- **This product must be installed in an IP54 rated enclosure.**
- **All wiring must comply with N.E.C. article 501-4(b).**

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[1] Pollution Degree 2 is an environment where, normally, only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation shall be expected.
[2] Over Voltage Category II is the load level section of the electrical distribution system. At this level transient voltages are controlled and do not exceed the impulse voltage capability of the product's insulation.
[3] Pollution Degree 2 and Over Voltage Category II are International Electrotechnical Commission (IEC) designations.

2.3.2 Prevent Electrostatic Discharge

⚠️ Attention	**Electrostatic discharge can damage integrated circuits or semiconductors if you touch analog I/O module bus connector pins or the terminal block on the input module. Follow these guidelines when you handle the module:**

- **Touch a grounded object to discharge static potential.**
- **Wear an approved wrist-strap grounding device.**
- **Do not touch the bus connector or connector pins.**
- **Do not touch circuit components inside the module.**
- **If available, use a static-safe work station.**
- **When it is not in use, keep the module in its static-shield bag.**

2.3.3 Remove Power

⚠️ Attention	**Remove power before removing or inserting this module. When you remove or insert a module with power applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:**

- **Sending an erroneous signal to your system's field devices, causing unintended machine motion**
- **Causing an explosion in a hazardous environment**

Electrical arcing causes excessive wear to contacts on both the module and its mating connector and may lead to premature failure.

2.3.4 Selecting a Location

Reducing Noise

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. Analog inputs are highly susceptible to electrical noise. Electrical noise coupled to the analog inputs will reduce the performance (accuracy) of the module. Group your modules to minimize adverse effects from radiated electrical noise and heat. Consider the following conditions when selecting a location for the analog module. Position the module:

- Away from sources of electrical noise such as hard-contact switches, relays, and AC motor drives
- Away from modules which generate significant radiated heat. Refer to the module's heat dissipation specification.

In addition, route shielded, twisted-pair analog input wiring away from any high voltage I/O wiring.

Section 2.4 Mounting

2.4.1 Before You Begin

Note that this series C product can be used with the following:

- ControlNet and EtherNet/IP adapters ONLY, using RSLogix 5000 software, version 11 or later

See the figures to familiarize yourself with major parts of the module, noting that the

wiring base assembly is one of the following:

- 1734-TB or 1734-TBS POINT I/O two-piece terminal base, which includes the 1734-RTB removable terminal block and 1734-MB mounting base
- 1734-TOP or 1734-TOPS POINT I/O one-piece terminal base
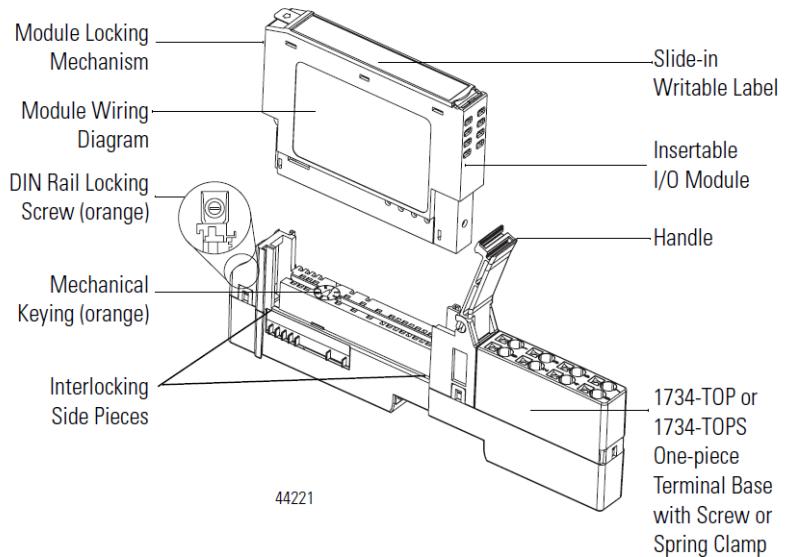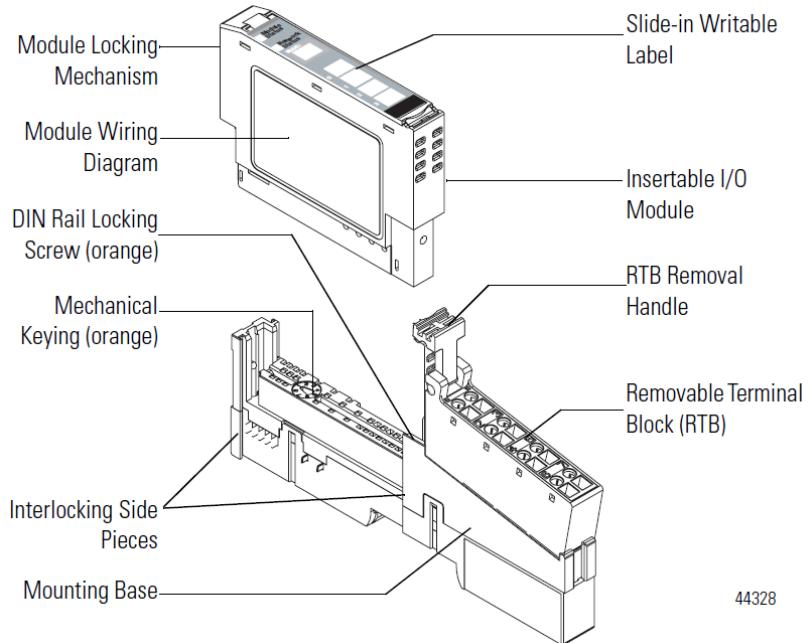
2.4.2 Install Mounting Base

> ⚠ **Attention**
>
> **During panel or DIN rail mounting of all devices, be sure that all debris (metal chips, wire strands, etc.) is kept from falling into the module. Debris that falls into the module could cause damage when power is applied to the module.**

To install the mounting base on the DIN rail, proceed as follows:

1.) Position the mounting base vertically above the installed units (adapter, power supply or existing module.

2.) Slide the mounting base down allowing the interlocking side pieces to engage the adjacent module or adapter.

3.) Press firmly to seat the mounting base on the DIN rail. The mounting base will snap into place.

4.) To remove the mounting base from the DIN rail, remove the module, and use a small bladed screwdriver to rotate the base locking screw to a vertical position. This releases the locking mechanism. Then lift straight up to remove.

2.4.3 Install the I/O Module

The module can be installed before, or after base installation. Make sure that the mounting base is correctly keyed before installing the module into the mounting base. In addition, make sure the mounting base locking screw is positioned horizontal referenced to the base.

1734-TB Base

Turn the keyswitch to align the number with the notch. Notch position 3 is shown.

44009

Be sure the DIN-rail locking screw is in the horizontal position.

44229
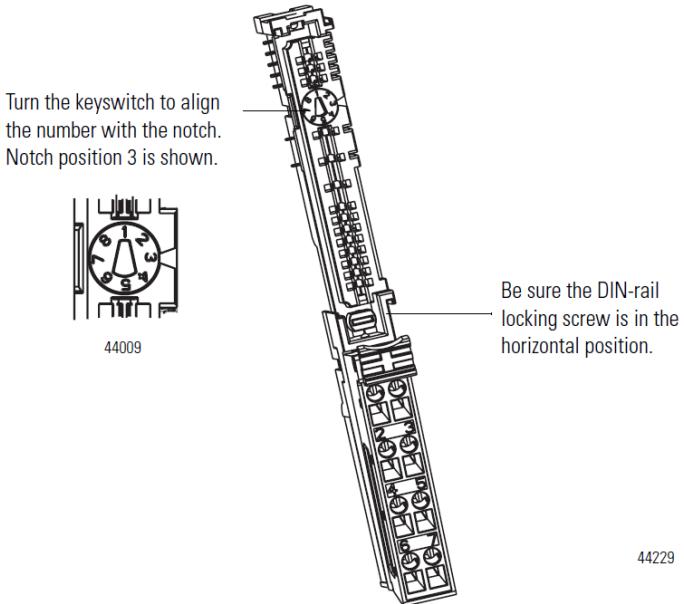
1734-TOP Base

Be sure the DIN-rail locking screw is in the horizontal position.

Turn the keyswitch to align the number with the notch. Notch position 1 is shown.
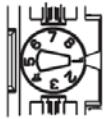
44325
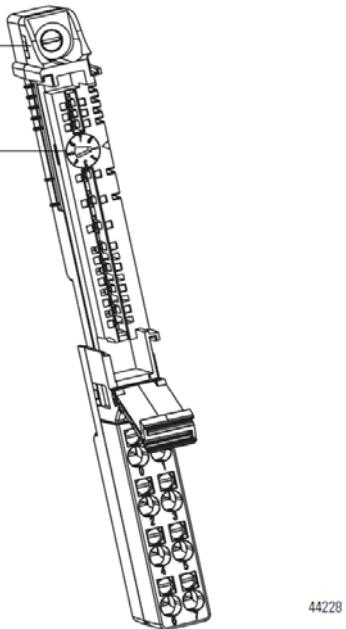
44228

1.) Using a bladed screwdriver, rotate the key switch on the mounting base clockwise until the number required for the type of module being installed aligns with the notch in the base.

2.) Make certain the DIN rail locking screw is in the horizontal position. (You cannot insert the module if the locking mechanism is unlocked.)

3.) Insert the module straight down into the mounting base and press to secure. The module will lock into place.

2.4.4 Install the Removable Terminal Block (RTB)

A removable terminal block is supplied with your wiring base assembly. To remove the terminal block, pull up on the RTB handle. This allows the mounting base to be removed and replaced as necessary without removing any of the wiring. To reinsert the removable terminal block, proceed as follows.

1.) Insert the end opposite the handle into the base unit. This end has a curved section that engages with the wiring base.

2.) Rotate the terminal block into the wiring base until it locks itself in place.

3.) If an I/O module is installed, snap the RTB handle into place on the module.

2.4.5 Remove a Mounting Base

To remove a mounting base, you must remove any installed module, and the module installed in the base to the right. Remove the removable terminal block (if wired).

1.) Unlatch the RTB handle on the I/O module.

2.) Pull on the RTB handle to remove the removable terminal block.

3.) Press on the module lock on the top of the module.

4.) Pull on the I/O module to remove from the base.

5.) Repeat steps 1, 2, 3 and 4 for the module to the right.

6.) Use a small bladed screwdriver to rotate the orange base locking screw to a

vertical position.

This releases the locking mechanism.

　　7.) Lift straight up to remove.

2.4.6 Install a 1734-TOPS Base

1.) Position the base vertically above the installed units, such as an adapter, power supply, or existing module.

2.) Slide the base down, allowing the interlocking side pieces to engage the adjacent installed unit.

3.) Press firmly to seat the base on the DIN rail until the base snaps into place.

4.) Verify that the DIN-rail locking screw is in a horizontal, locked position before inserting an I/O module.

2.4.7 Remove a 1734-TOPS Base

To remove a wiring base from the DIN rail, you must remove the module installed to the right of the base.

1.) Squeeze the module locking mechanism of the module to the right of the base, pulling up to remove the module.

2.) Turn the orange locking screw to a vertical position to unlock the base from the DIN rail.

3.) Slide the base up to release it from its mating units.

Section 2.5
Field Wiring
Connections

Consider the following when wiring your system:

General

- Power and input wiring must be in accordance with Class 1, Division 2 wiring methods, Article 501-4(b) of the National Electric Code, NFPA 70, and in accordance with the authority having jurisdiction.

- Use Belden™ 8761, or equivalent, shielded wire.

- To ensure optimum accuracy, limit overall cable impedance by keeping a cable as short as possible. Locate the module as close to input devices as the application permits.

- Digital and analog power must be supplied by an Isolated Secondary Limited Energy Low Voltage source.

Inputs

- The module provides loop power for analog inputs.

Grounding

⚠ ! Attention	**USE SUPPLY WIRES SUITALE FOR 10°C ABOVE SURROUNDING AMBIENT**

⚠ ! Attention	**UTILISER DES FILS D'ALIMENTATION QUI CONVIENNENT A UNE TEMPERATURE DE 10°C AU-DESSUS DE LA TEMPERATURE AMBIANTE**

- This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded.

- Under normal conditions, the drain wire (shield) should be connected to the metal mounting panel (earth ground). Keep shield connection to earth ground as short as possible.

- Ground the shield drain wire at one end only. The typical location is as follows:
    - For grounded thermocouples or millivolt sensors, this is at the sensor end.
    - For insulated/ungrounded thermocouples, this is at the module end. Contact your sensor manufacturer for additional details.

- Refer to Industrial Automation Wiring and Grounding Guidelines, Allen-Bradley publication 1770-4.1, for additional information.

Noise Prevention

- Route field wiring away from any other wiring and as far as possible from sources of electrical noise, such as motors, transformers, contactors, and ac devices. As a general rule, allow at least 15.2 cm (6 in.) of separation for every 120V of power.

- Routing field wiring in a grounded conduit can reduce electrical noise.

- If field wiring must cross ac or power cables, ensure that they cross at right angles.

- If noise persists for a device, try grounding the opposite end of the cable shield or ground both ends of the shield.

2.5.1 Wiring Diagram

Refer to the following wiring diagrams for field wiring connections.

Table 2-1 (4 Ch Terminal Block Pinout)

RTB Pin#	Usage	Usage	RTB Pin#
0	Input 0	Input 1	1
2	Input 2	Input 3	3
4	Common	Field Power	5
6	Chas GND	Chas GND	7

Table 2-2 (2 Ch Terminal Block Pinout)

RTB Pin#	Usage	Usage	RTB Pin#
0	Input 0	Input 1	1
2	Field Power	Field Power	3
4	Common	Common	5
6	Chas GND	Chas GND	7

Figure 2-1 (IE4CH Wiring Diagram)
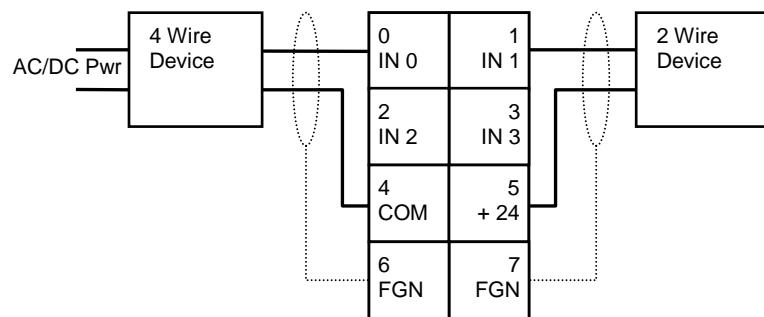
Figure 2-2 (IE2CH Wiring Diagram)
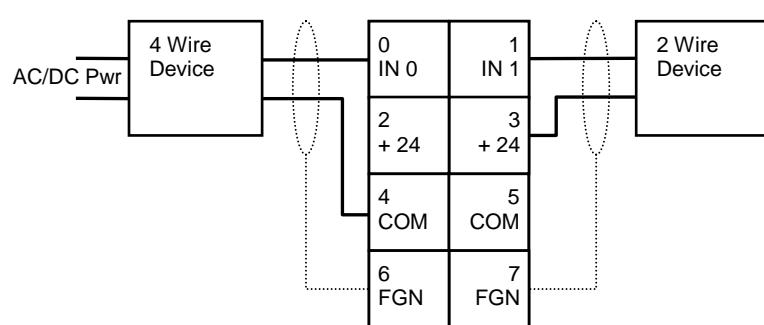
Chapter 3
Configuring the 1734sc-IExCH Using RSLogix 5000

This chapter covers the following subjects:

- Introduction
- About Communications
- Use Generic Profile
- Use AOP (Add On Profile)
- Module configuration
- Reading input data
- Module update time

Section 3.1
Introduction

The 1734sc-IE2CH and IE4CH allow, in addition to reading the 4 to 20 mA analog signal, the ability to read and write HART data to and from HART compatible devices. This chapter will describe how to configure the IExCH module using RSLogix 5000 programming software.

Section 3.2
About Communications

The module produces and consumes data as follows:

IE2CH Produce/Consume Data

Input Assembly Options	I/O Connection Type	Consumes	Produces
Analog + HART 0, 1	Change-of-State	0 Bytes	60 Bytes

IE4CH Produce/Consume Data

Input Assembly Options	I/O Connection Type	Consumes	Produces
Analog + HART 0, 1, 2, 3	Change-of-State	0 Bytes	112 Bytes

⚠ Attention	**The IExCH module is not compatible with the 1734-ADN, ADN(X), and PDN device net adapters and the 1734-APB profibus adapter.**

⚠ Attention	**It is not recommended to update module firmware if the module is installed behind a Control Net adapter (1734-ACNR). Only update firmware when the module is installed behind an Ethernet adapter (1734-AENT or 1734-AENTR).**

> ⚠️ **Attention**
>
> **The ControlNet adapter (1734-ACNR) has a maximum data transmit limit of 600 bytes. Therefore, the maximum number of 1734sc-IE4CH modules that can be installed behind a ControlNet adapter is four and the maximum number of 1734sc-IE2CH modules is eight.**

Section 3.3
Use Generic Profile

The generic point IO module profile can be used to represent the IExCH module within RSLogix 5000. The generic profile should be used for RSLogix 5000 versions 14 and older. Before the generic profile can be added to the IO configuration, the proper communication module needs to be added to the IO configuration first. Follow the procedure below to add a communication module to RSLogix 5000.

1.) Add the new local communication module to your project.

2.) Configure the local module, including:

      a. Naming the module

      b. Choosing a Communication Format

      c. Setting the Revision level

      d. Setting the module location as necessary such as the slot number for a 1756-CNB module

      e. Choosing an Electronic Keying method

3.) Add the new remote module to your project, such as a 1734 Control Net adapter or Ethernet Adapter (i.e. 1734-ACNR or 1734-AENT, respectively).

4.) Configure the remote module similarly to the local module

5.) Download the configuration to the controller

Note: If you are using Control Net, you must schedule the network using "RSNetworks for Control Net" after adding the local and remote communication modules.

Note: When you create a new RSLogix 5000 project with the CompactLogix 1769-L32C or L35CR controller, The Controller Organizer creates a Control Net port in the local chassis. In this case, you don't need to add a separate local communication module.

Note: When you create a new RSLogix 5000 project with the CompactLogix 1769-L23E, 1769-L32E or L35E controller, The Controller Organizer creates a Ethernet port in the local chassis. In this case, you don't need to add a separate local communication module.

3.3.1 Add a Local Ethernet Bridge Module

After you have started RSLogix 5000 software and created a controller project, you can add Ethernet communication modules. A local Ethernet communication module is a module that resides in the same chassis as the controller.

1.) Select a New Module for the I/O Configuration.

Data Types
  User-Defined
  Strings
  Add-On-Defined
  Predefined
  Module-Defined
Trends
I/O Configuration
  1756 Backplan

Right-click on I/O Configuration

New Module...

Cut   Ctrl+X
Copy   Ctrl+C
Paste   Ctrl+V

Select New Module
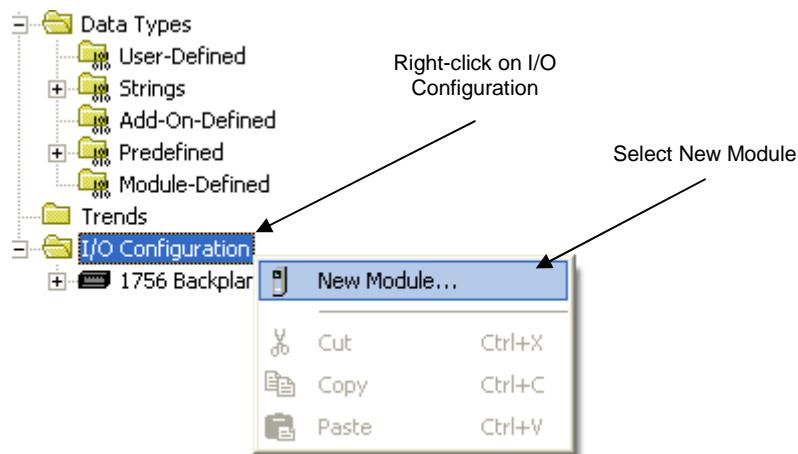
2.) Select the module type from the Select Module Type pop-up. The example
     below uses a 1756-ENBT module.

Select Module

Module	Description
1756-DMB30	1756 SB3000 Drive Interface
1756-DMD30	1756 SD3000 Drive Interface
1756-DMF30	1756 SF3000 Drive Interface
1756-DNB	1756 DeviceNet Scanner
1756-EN2F/A	1756 10/100 Mbps Ethernet Bridge, Fiber Media
1756-EN2T/A	1756 10/100 Mbps Ethernet Bridge, Twisted-Pair Media
1756-ENBF/A	1756 10/100 Mbps Ethernet Bridge, Fiber Media
1756-ENBT/A	1756 10/100 Mbps Ethernet Bridge, Twisted-Pair Media
1756-ENET/A	1756 Ethernet Communication Interface
1756-ENET/B	1756 Ethernet Communication Interface
1756-EWEB/A	1756 10/100 Mbps Ethernet Bridge w/Enhanced Web Services
1756-HSC	1756 High Speed Counter
1756-HYD02	2 Axis Hydraulic Servo

Find...   Add Favorite

By Category   By Vendor   Favorites

OK   Cancel   Help

Select the local Ethernet
bridge module

Click OK

3.) Configure the local Ethernet bridge module.

Name the module

Enter IP address of ENBT

Select the module's slot number

Select the module's revision level

Select electronic keying level

Click OK
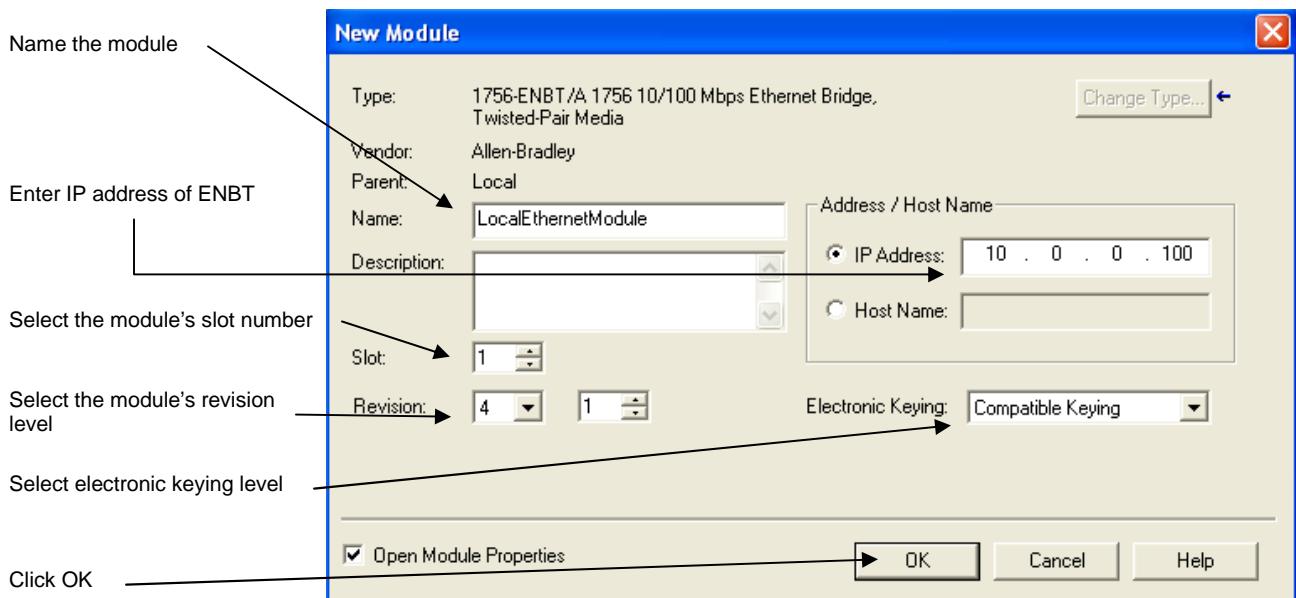
3.3.2 Add a Remote Ethernet Point IO Adapter

After you have added the local Ethernet communication module, you must add remote Ethernet communication modules. A remote Ethernet module is a module that resides in a separate chassis from the controller.

⚠ **Attention**

If you plan to use the 1734 Control Net adapter, you will need to install the 1734sc-IExCH EDS file before scheduling the network. The latest EDS files can be found at (www.spectrumcontrols.com).

1.) Select a New Module for the I/O Configuration.

Right-click on the local communication module

Select New Module

2.) Select the module type from the Select Module Type pop-up.

Select the remote Ethernet communication module.

Click OK
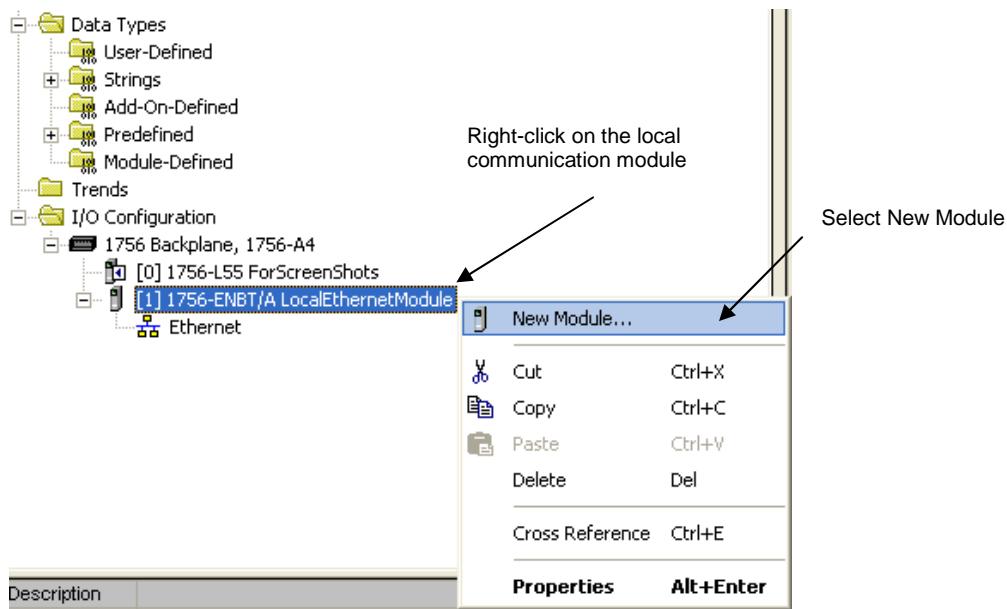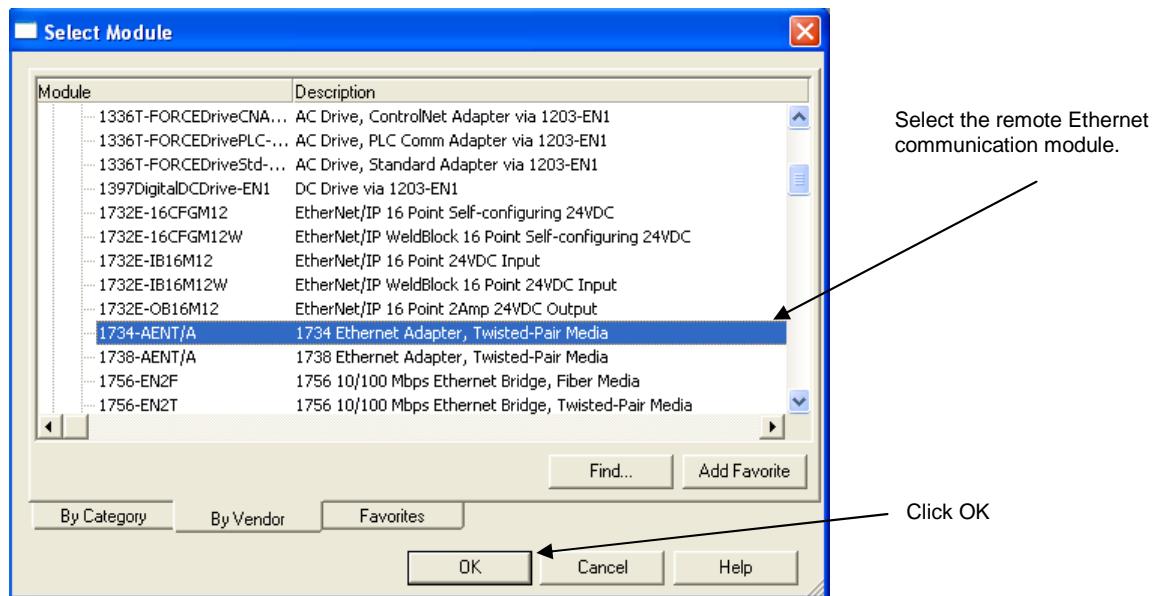
3.) Configure the remote Ethernet communication module.

Name the module

Enter IP address of ENBT

Select the comm. format

Select the module revision level

Select electronic keying level

Select the chassis size

Click OK
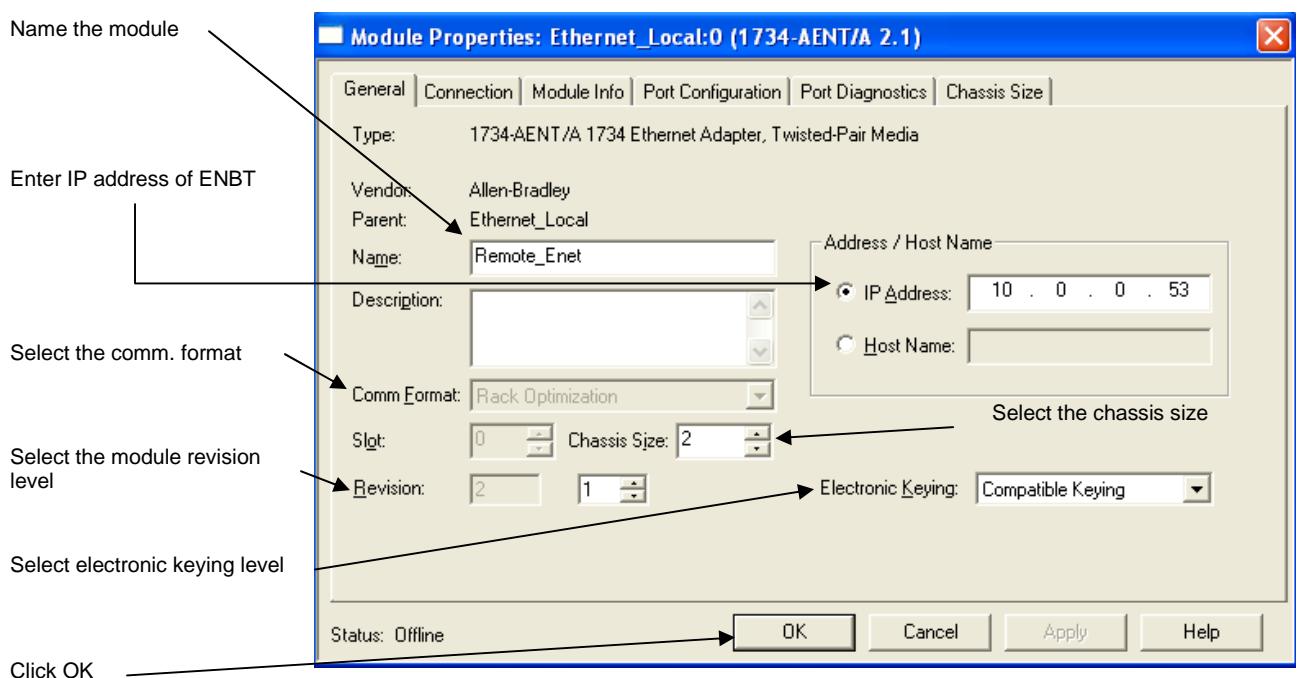
3.3.3 Add the Generic Point IO Module

After adding the remote Ethernet communication module, the 1734 Generic Module must be added. The following steps must be followed to add the 1734 Generic IO Module.

1.) Select a New Module for the I/O Configuration.

Right-click on the
remote communication

Select New Module

2.) Select the module type from the Select Module Type pop-up.

Select Generic Flex
Module

Click OK
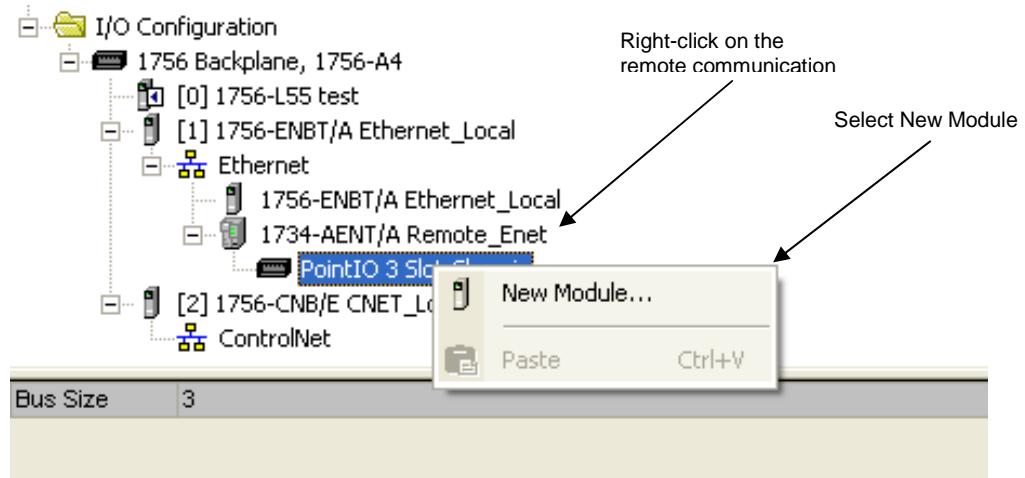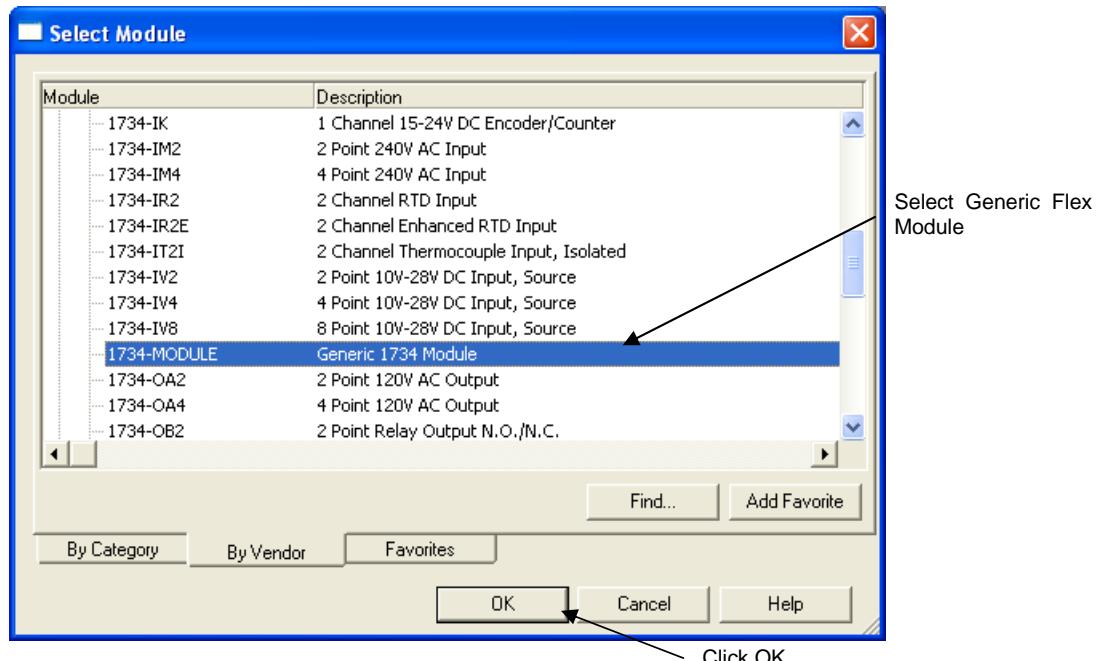
3.) Configure the Generic 1734 Module (i.e. 1734sc-IExCH)

Name the module

Enter "Input Data – SINT" for Comm. Format

Enter module slot #

Enter the input assembly instance and size.

Enter the output assembly (always 190) Click OK

Enter the configuration assembly instance and size.
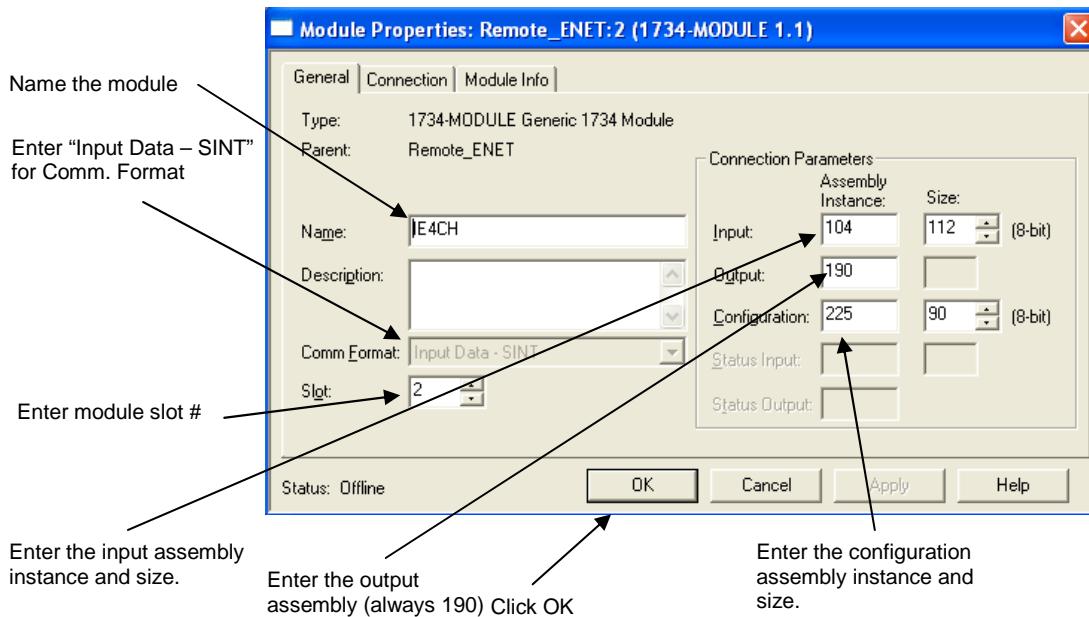
**Section 3.4
Use
Add-On-Profile**

For RSLogix 5000 version 15 and greater an Add-On module profile is available for download at (http://www.spectrumcontrols.com/downloads.htm). The Add-On profile allows the user to add the IExCH module to the RSLogix 5000 module pick list. The profile provides configuration and information screens to the user to simplify installation. Follow the procedure below to install and use the Add-On profile.

3.4.1 Installing the Add-On profile

1.) Download the zipped file from the Spectrum Controls website and unzip the file (http://www.spectrumcontrols.com/downloads.htm)

2.)
Open the created folder and double-click on the MPSetup.exe file.
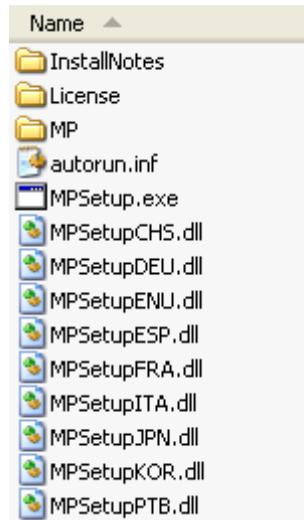
3.) Follow the online prompts.

3.4.2 Adding the IExCH Module To Your Logix Project

Once the profiles are installed you can access them through RSLogix 5000 via the I/O Configuration. Follow the procedure below to add a module:

1.) Before you can add the 1734sc-IExCH to your RSLogix 5000 project, you must first add a local communication module and a remote communication adapter. Complete sections 3.3.1 and 3.3.2 above, before proceeding to step 2 below.

2.) In the I/O Configuration, right mouse click on the Point IO backplane under the remote communication adapter that you added in step one above and select "New Module".
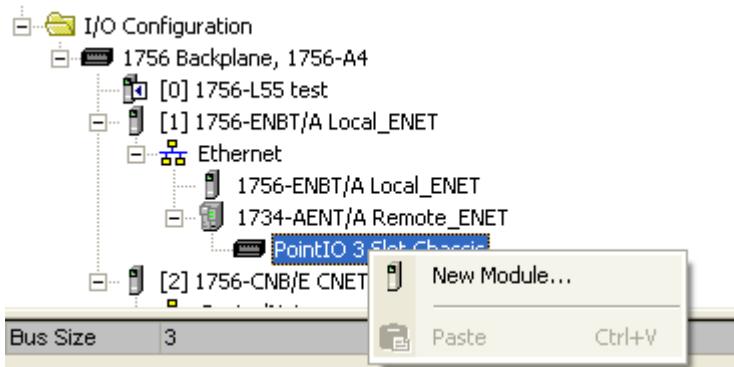
3.) When the dialog screen opens, select the "By Vender" tab and expand the Spectrum Controls folder.
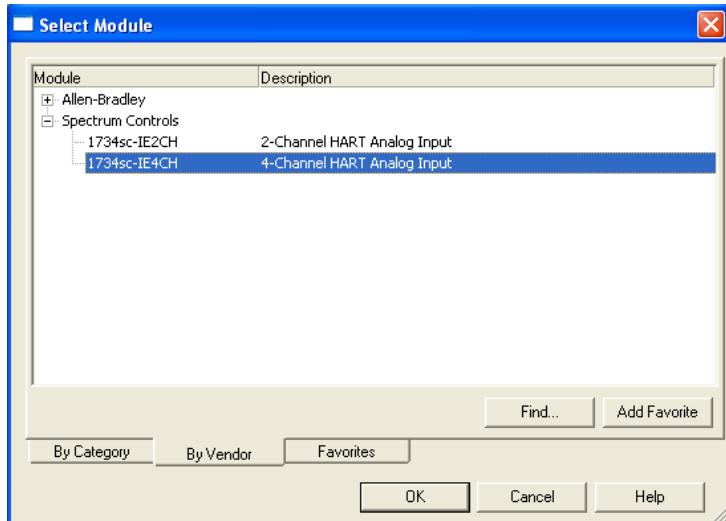
4.) Highlight the module and press the "OK" button.
5.) Give the module a unique name.

Name the module
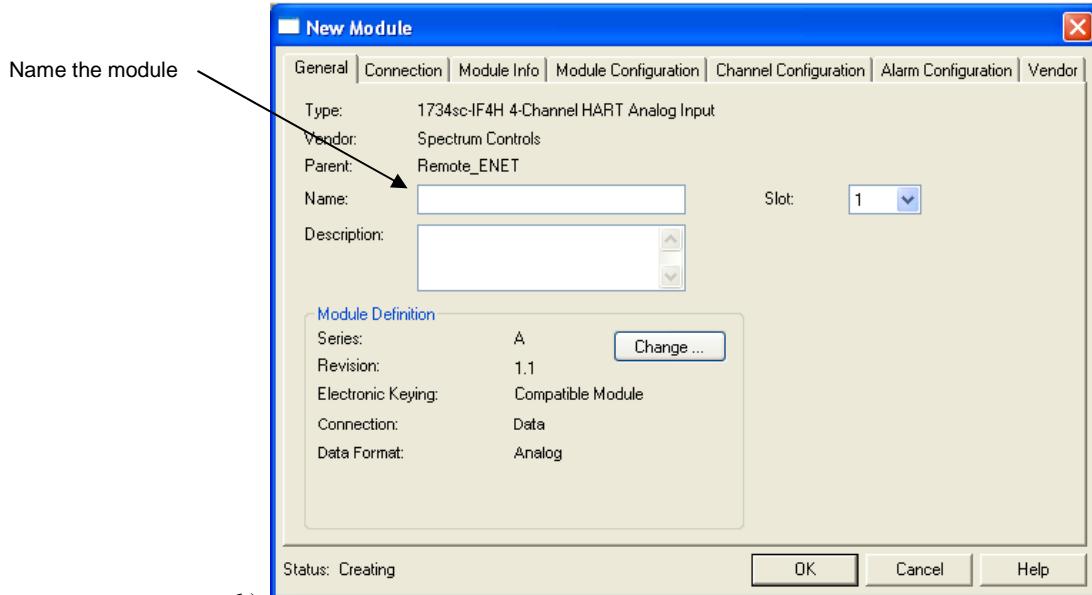
6.) Enter an RPI Rate

Set the RPI rate
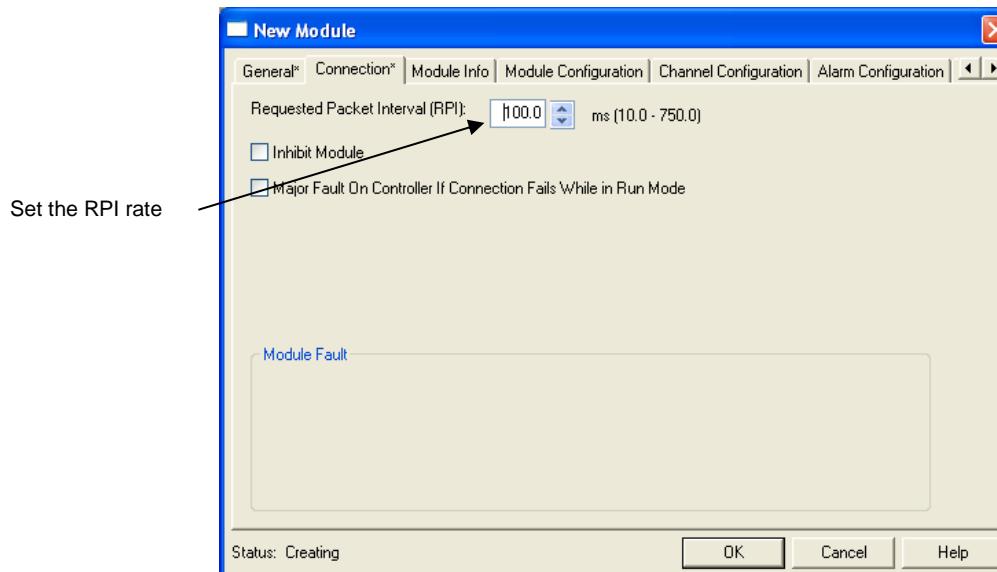
7.) Configure the rest of the module using the "Module Configuration" tab and the
"Channel Configuration" tab.

Section 3.5
Module
Configuration

The IExCH can be configured using the AOP (Add-On-Profile) or by using the 1734
generic module profile. The configuration tags for the IExCH are located under the
controller tags. The following examples describe the tag structure allocated by the
Generic Module profile and the AOP.

Generic Module Profile:

[Name of remote communication module]:e:x.Data[0 to 198]

e = IExCH slot number

x = Image Type (i.e. C, I, or O)

AOP (Add-On-Profile):

[Name of remote communication module]:e:x

e = IE4CH slot number

x = Image Type (i.e. C, I, or O)

Note: The AOP will provide a predefined tag structure for the configuration. See example below.
Figure 3-1 (AOP Config. Tags)

− Remote_Enet:2:C	{...}
+ Remote_Enet:2:C.Ch0LowEngineering	0
+ Remote_Enet:2:C.Ch0HighEngineering	0
+ Remote_Enet:2:C.Ch0DigitalFilter	0
+ Remote_Enet:2:C.Ch0LAlarmLimit	0
+ Remote_Enet:2:C.Ch0HAlarmLimit	0
+ Remote_Enet:2:C.Ch0LLAlarmLimit	0
+ Remote_Enet:2:C.Ch0HHAlarmLimit	0
+ Remote_Enet:2:C.Ch0RangeType	0

Table 3-1 (IE2CH Configuration Assembly)

Instance: 225   **Size:** 50 Bytes (DNET 46 Bytes)

OFFSET	FIELD	TYPE	BYTES
0x00 – 0x11	Channel 1 Configuration	STRUCT	20
+0x00	Low Engineering Channel 0	INT	2
+0x02	High Engineering Channel 0	INT	2
+0x04	Digital Filter Channel 0	INT	2
+0x06	Low Alarm Channel 0	INT	2
+0x08	High Alarm Channel 0	INT	2
+0x0A	Low Low Alarm Channel 0	INT	2
+0x0C	High High Alarm Channel 0	INT	2
+0x0E	Reserved pad alignment bytes	SINT	1
+0x0F	Alarm Latch Channel 0	SINT	1
+0x10	Enable Hart Channel 0	SINT	1
+0x11	Alarm Disable Channel 0	SINT	1
+0x12	Reserved pad alignment bytes	INT	2
0x14	Channel 1 Configuration	STRUCT	20

Instance: 225   **Size:** 50 Bytes (DNET 46 Bytes)

OFFSET	FIELD	TYPE	BYTES
	(same structure as Ch.0 above)		
0x28	Notch Filter (All Channels)	SINT	1
0x29	pad	SINT	1
0x2A	RTS (All Channels)	INT	2
0x2C	Hart Pass-Through Hold Time	UINT	2

Table 3-2 (IE4CH Configuration Assembly)

Instance: 225   **Size:** 90 Bytes (DNET 86 Bytes)

OFFSET	FIELD	TYPE	BYTES
0x00 – 0x11	Channel 1 Configuration	STRUCT	20
+0x00	Low Engineering Channel 0	INT	2
+0x02	High Engineering Channel 0	INT	2
+0x04	Digital Filter Channel 0	INT	2
+0x06	Low Alarm Channel 0	INT	2
+0x08	High Alarm Channel 0	INT	2
+0x0A	Low Low Alarm Channel 0	INT	2
+0x0C	High High Alarm Channel 0	INT	2
+0x0E	Reserved pad alignment bytes	SINT	1
+0x0F	Alarm Latch Channel 0	SINT	1
+0x10	Enable Hart Channel 0	SINT	1
+0x11	Alarm Disable Channel 0	SINT	1
+0x12	Reserved pad alignment bytes	INT	2
0x14	Channel 1 Configuration (same structure as Ch.0 above)	STRUCT	20
0x28	Channel 2 Configuration (same structure as Ch.0 above)	STRUCT	20
0x3C	Channel 3 Configuration (same structure as Ch.0 above)	STRUCT	20
0x50	Notch Filter (All Channels)	SINT	1
0x51	pad	SINT	1
0x52	RTS (All Channels)	INT	2
0x54	Hart Pass-Through Hold Time	UINT	2

3.5.1 Channel Configuration

Low Engineering

The minimum scaled value that will be displayed when the analog input signal is at 4 mA. This feature is applied on a per channel basis.

High Engineering

The maximum scaled value that will be displayed when the analog input signal is at 20 mA. This feature is applied on a per channel basis.

Digital Filter

The digital filter smoothes input data noise transients. This feature is applied on a per channel basis. The digital filter value specifies the time constant for a digital first order lag filter on the input data. A value of 0 disables the filter.

The digital filter equation is a classic first order lag equation.

Yn = Filtered Input Value

Yprevn = Previous Filtered Input Value

Tdelta = Change in time(msec)

TA = User supplied Time Constant(msec)

Xn = new unfiltered input value

$$Yn = Yprevn + (\ (Tdelta/\ (Tdelta + TA)) * (Xn - Yprevn)\ )$$

Value Units: Milliseconds

Value Limits: 0-20100, if not 0(feature disabled) then value must be greater than 2 * RTS Value else Configuration Error

Low Alarm

A low alarm will activate if the value of the scaled input is at or below this value. It will clear (if not latched) when the scaled input rises above this value.

High Alarm

A high alarm will activate if the value of the scaled input is at or above this value. It will clear (if not latched) when the scaled input drops below this value.

Low-Low Alarm

A low-low alarm will activate if the value of the scaled input is at or below this value. It will clear (if not latched) when the scaled input rises above this value.

High-High Alarm

A high-high alarm will activate if the value of the scaled input is at or above this value. It will clear (if not latched) when the scaled input drops below this value.

Reserved (set to zero)

Alarm Latch

0: Process alarms are not latched for associated channel.

1: Process alarms are latched for associated channel.

Alarm Disable

0: Process alarms enabled for associated channel.

1: Process alarms disabled for associated channel.

Enable HART Communication

0: Disable HART communication on associated channel.

1: Enable HART communication on associated channel.

3.5.2 Analog Notch Filter

The analog notch filter selection affects how the module attenuates the input signal at the specified frequency. It also affects the update time of the input data which is reflected in the minimum real time sample (RTS) rate that is available.

Table 3-3 (Analog Filter)

Notch Filter Selection	50/60Hz	50Hz	60Hz	100Hz	120Hz	240Hz	480Hz
Tag Value	1	2	3	4	5	6	7
Filter Setting	96	96	80	48	40	20	10
Settling Time (ms)	60	60	50	30	25	12.5	6.25
4 Channel Sample Time (RTS msec)	248	248	208	128	108	58	33
2 Channel Sample Time (RTS msec)	128	128	108	68	58	33	21

One setting applies to all channels in the module.

Value Units: NA

Value Limits: 1-7 (see Table 3-3 above)

3.5.3 RTS (Real Time Sample)

This parameter instructs the module how often to scan its input channels and obtain new sampled data. After the channels are scanned, the module broadcasts that data over the backplane.

Value Units: Milliseconds

Value Limits: 21-10,000 for IE2CH or 33 – 10,000 for IE4CH, actual minimum allowed is based upon Module Filter selection   Each module Filter selection will limit the minimum value allowed, see Table 3-3.

3.5.4 HART Pass-through Handle Timeout

The Handle time out value allows the user to set how long the module will hold the reply message for a HART Pass-through operation in its queue. If the time expires before the reply has been retrieved using the "Query" message, the reply is removed from the queue and the queue is now available for another Pass-through message.

Value Units: Seconds

Value Limits: 1 to 255 seconds.

Section 3.6 Read Input Data

The input data file contains module status information and analog input data for each of the input channels. Analog input data is read for each channel, converted to a scaled digital value, and stored in the input tags. The input tags for the IExCH are located under the controller tags. The following examples describe the tag structure allocated by the Generic Module profile and the AOP.

Generic Module Profile:

[Name of remote communication module]:e:x.Data[0 to 198]

e = IExCH slot number

x = Image Type (i.e. C, I, or O)

AOP (Add-On-Profile):

[Name of remote communication module]:e:x

e = IE4CH slot number

x = Image Type (i.e. C, I, or O)

Note: The AOP will provide a predefined tag structure for the input tags. See example below.

Figure 3-2 (AOP Input Tags)

+ Remote_Enet:1:C	{...}
– Remote_Enet:1:I	{...}
+ Remote_Enet:1:I.FltStatus	2#0000_0000_0000_0000_0000_0000_0000_0000
+ Remote_Enet:1:I.Ch0Data	0
+ Remote_Enet:1:I.Ch1Data	0
+ Remote_Enet:1:I.Ch2Data	0
+ Remote_Enet:1:I.Ch3Data	0
+ Remote_Enet:1:I.ModuleStatus	2#0000_0000_0000_0000_0000_0000_0000_0000
Remote_Enet:1:I.Ch1_CF	0
Remote_Enet:1:I.Ch1_CM	0
Remote_Enet:1:I.Ch1_LA	0
Remote_Enet:1:I.Ch1_HA	0

Table 3-4 (IE2CH Input Assembly)

Instance:	Description:	Total Size:
104	Analog + Hart 0,1	60 Bytes RSL5K (DNet 56 bytes)
100	Analog Only	12 Bytes RSL5K (Dnet 8 bytes)
101	Analog + Hart 0	36 Bytes RSL5K (Dnet 32 bytes)
102	Analog + Hart 0, 1	60 Bytes RSL5K (Dnet 56 bytes)
103	Analog + Hart 0, 1	60 Bytes RSL5K (Dnet 56 bytes)

(instance 104 is the default, instances 100-101 are subsets available to conserve bandwidth, instances 102,103 are redundant included for code compatibility between 2 and 4 ch)

Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Analog data	Channel 0 Data - INT															
8 bytes	Channel 1 Data - INT															
0x00-0x07	Status Byte for Channel 1								Status Byte for Channel 0							
	OR	UR	HHA	LLA	HA	LA	CM	CF	OR	UR	HHA	LLA	HA	LA	CM	CF
	Reserved alignment pad byte - SINT								Reserved alignment pad byte - SINT							
Ch. 0 Hart Data	Input Ch 0 Hart Device Status Byte 1								Input Ch0 Hart Device Status Byte 0							
24 bytes	*Response Code[1]*								FAULT	SUA	DDLGX	DDLDR	MSGRDY	MAFLT	FAIL	INIT
0x08-0x1F																
	Input Ch 0 Hart Device Status Byte 3 *Extended Device Status Byte[3]*								Input Ch 0 Hart Device Status Byte 2 *Field Device Status Byte[2]*							
	Input Channel 0 Hart PV - REAL (float)															
	Input Channel 0 Hart SV - REAL (float)															
	Input Channel 0 Hart TV - REAL (float)															
	Input Channel 0 Hart FV - REAL (float)															
	Input Channel 0 Hart SV Status								Input Channel 0 Hart PV Status							
	Input Channel 0 Hart FV Status								Input Channel 0 Hart TV Status							
Ch .1 Hart 0x20-0x38	(Data structure same as channel 0 above, 24 bytes)															

ANALOG STATUS BITS:
CF = Channel Fault status; 0 = no error, 1 = fault
CM = Calibration Mode; 0 = normal, 1 = calibration mode
LA = Low Alarm; 0 = no error, 1 = fault
HA = High Alarm; 0 = no error, 1 = fault
LLA = Low/Low Alarm; 0 = no error, 1 = fault
HHA = High/High Alarm; 0 = no error, 1 = fault
UR = Underrange; 0 = no error, 1 = fault
OR = Overrange; 0 = no error, 1 = fault

HART STATUS BITS:
INIT = HART device detected
FAIL = No device found or communication failed
MAFLT = HART does not match analog loop current
MSGRDY = Ladder pass-through message available
DDLDR = Device Data update Ladder
(New HART Device Information Available see page 4-6)
DDLGX = Device Data update Logix (Reserved – Not Used)
SUA = Status Update Available, Cmd48 data changed
FAULT= HART device reports a fault

[1] See page # B-2 for more information.
[2] See page # B-2 for more information.
[3] This is the first byte returned by HART command 9 when HART version 6 or 7 is used.
0x04 = Critical Power Failure, 0x02 = Device Variable Alert, 0x01 = Maintenance Required

Table 3-5 (IE4CH Input Assembly)

Instance:	Description:	Total Size:
104	Analog + Hart 0,1,2,3	112 Bytes RSL5K (DNet 108 bytes)
100	Analog Only	16 Bytes RSL5K (Dnet 12 bytes)
101	Analog + Hart 0	40 Bytes RSL5K (Dnet 36 bytes)
102	Analog + Hart 0,1	64 Bytes RSL5K (DNet 60 bytes)
103	Analog + Hart 0,1,2	88 Bytes RSL5K (DNet 84 bytes)

(instance 104 is the default, instances 100-103 are subsets available to conserve bandwidth)

Bit	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Analog data	Channel 0 Data - INT															
12 bytes	Channel 1 Data - INT															
0x00-0x0B	Channel 2 Data - INT															
	Channel 3 Data - INT															
	Status Byte for Channel 1								Status Byte for Channel 0							
	OR	UR	HHA	LLA	HA	LA	CM	CF	OR	UR	HHA	LLA	HA	LA	CM	CF
	Status Byte for Channel 3								Status Byte for Channel 2							
	OR	UR	HHA	LLA	HA	LA	CM	CF	OR	UR	HHA	LLA	HA	LA	CM	CF
Ch. 0 Hart Data	Input Ch 0 Hart Device Status Byte 1								Input Ch 0 Hart Device Status Byte 0							
24 bytes	Response Code[1]								FAULT	SUA	DDLGX	DDLDR	MSGRDY	MAFLT	FAIL	INIT
0x0C-0x23																
	Input Ch 0 Hart Device Status Byte 3 Extended Device Status Byte[3]								Input Ch 0 Hart Device Status Byte 2 Field Device Status Byte[2]							
	Input Channel 0 Hart PV - REAL (float)															
	Input Channel 0 Hart SV - REAL (float)															
	Input Channel 0 Hart TV - REAL (float)															
	Input Channel 0 Hart FV - REAL (float)															
	Input Channel 0 Hart SV Status								Input Channel 0 Hart PV Status							
	Input Channel 0 Hart FV Status								Input Channel 0 Hart TV Status							
Ch .1 Hart 0x24-0x3B	(Data structure same as channel 0 above, 24 bytes)															
Ch.2 Hart 0x3C-0x53	(Data structure same as channel 0 above, 24 bytes)															
Ch.3 Hart 0x54-0x6B	(Data structure same as channel 0 above, 24 bytes)															

ANALOG STATUS BITS:
CF = Channel Fault status; 0 = no error, 1 = fault
CM = Calibration Mode; 0 = normal, 1 = calibration mode
LA = Low Alarm; 0 = no error, 1 = fault
HA = High Alarm; 0 = no error, 1 = fault
LLA = Low/Low Alarm; 0 = no error, 1 = fault
HHA = High/High Alarm; 0 = no error, 1 = fault
UR = Underrange; 0 = no error, 1 = fault
OR = Overrange; 0 = no error, 1 = fault

HART STATUS BITS:
INIT = HART device detected
FAIL = No device found or communication failed
MAFLT = HART does not match analog loop current
MSGRDY = Ladder pass-through message available
DDLDR = Device Data update Ladder
(New HART Device Information Available see page 4-6)
DDLGX = Device Data update Logix (Reserved – Not Used)
SUA = Status Update Available, Cmd48 data changed
FAULT= HART device reports a fault

[1] See page # B-2 for more information.
[2] See page # B-2 for more information.
[3] This is the first byte returned by HART command 9 when HART version 6 or 7 is used.
0x04 = Critical Power Failure, 0x02 = Device Variable Alert, 0x01 = Maintenance Required

Section 3.7
Module
Update Time

The module update time is determined by the number of input channels enabled and by the filter frequency selected for each channel.

Table 3-6 (Module Update Time)

Filter Frequency	1734sc-IE2CH	1734sc-IE4CH
50/60 Hz (Default)	488 ms	248 ms
50 Hz	248 ms	128 ms
60 Hz	208 ms	108 ms
100 Hz	128 ms	68 ms
120 Hz	108 ms	58 ms
240 Hz	58 ms	33 ms
480 Hz	33 ms	21 ms

Chapter 4
IExCH and HART

This chapter describes how to read and write HART data using the IExCH module. This chapter includes the following sections:

- HART features
- Detecting HART devices
- Auto scanning of HART dynamic variables
- Supported HART CIP messages

Section 4.1
HART Features

The IExCH module will function as a HART master and will communicate with HART devices running HART revision 5 or greater. Ther IExCH module includes one HART modem per channel to provide maximum acquisition speed and flexibility. The block diagram in section 1.6.2 describes the internal architecture of the module including the placement of the HART modems. The module performs the following HART operations:

- Automatically reads the four dynamic HART variables PV,SV,TV, and FV
- Automatically retrieves and stores HART device information including, manufacturer's ID, device tag name, HART revision level, etc., and makes the information available via a CIP unconnected message
- The module automatically retrieves and stores extended device status, using HART command 48. The extended status can be retrieved using an unconnected CIP message.
- A HART pass-through interface using CIP unconnected messaging provides the ability for the user, or remote client, to send a HART command to a HART enabled device.

Section 4.2
Detecting HART Devices

HART communication can be enabled independently on each channel. For more information on configuring HART on a specific channel, refer to Chapter 3. When a channel is enabled for HART, the IExCH module will act as a primary HART master and the HART enabled field device will act as a HART slave. Any given channel may have a master (i.e. the IExCH), a secondary master (hand held configuration tool), and a slave device connected simultaneously. Please see figure below.

Figure 4-1
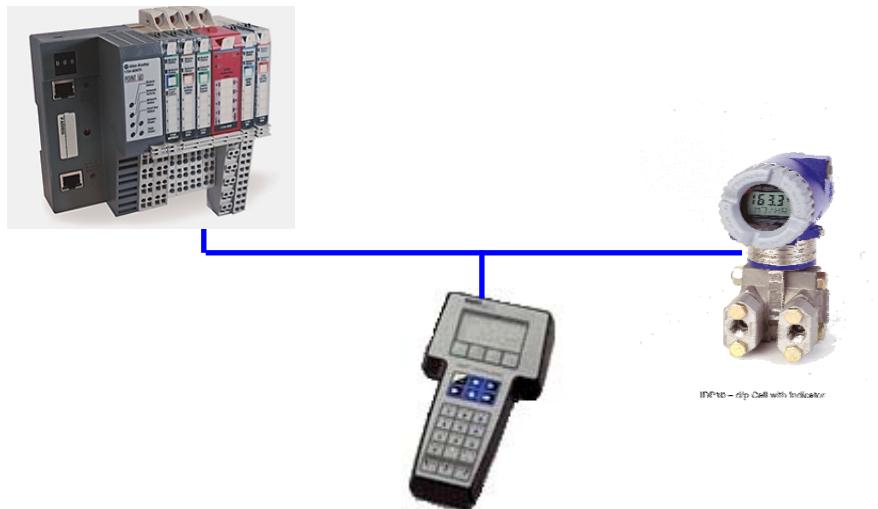
To determine if a HART device is present on a given channel the module will continuously send out HART command 0 if the channel is enabled for HART. Short frame addressing is used on command 0 and the polling address will be incremented in the following manner:

0,1-15,16-63, 0

Once the module receives a reply to command 0 it will start its connection sequence to populate its internal cache of device data for that channel and then proceed to scanning of the dynamic variables and processing pass-through requests. The data acquisition process is described in the flow chart shown on the following page.

Figure 4-2 (Connect Cycle)
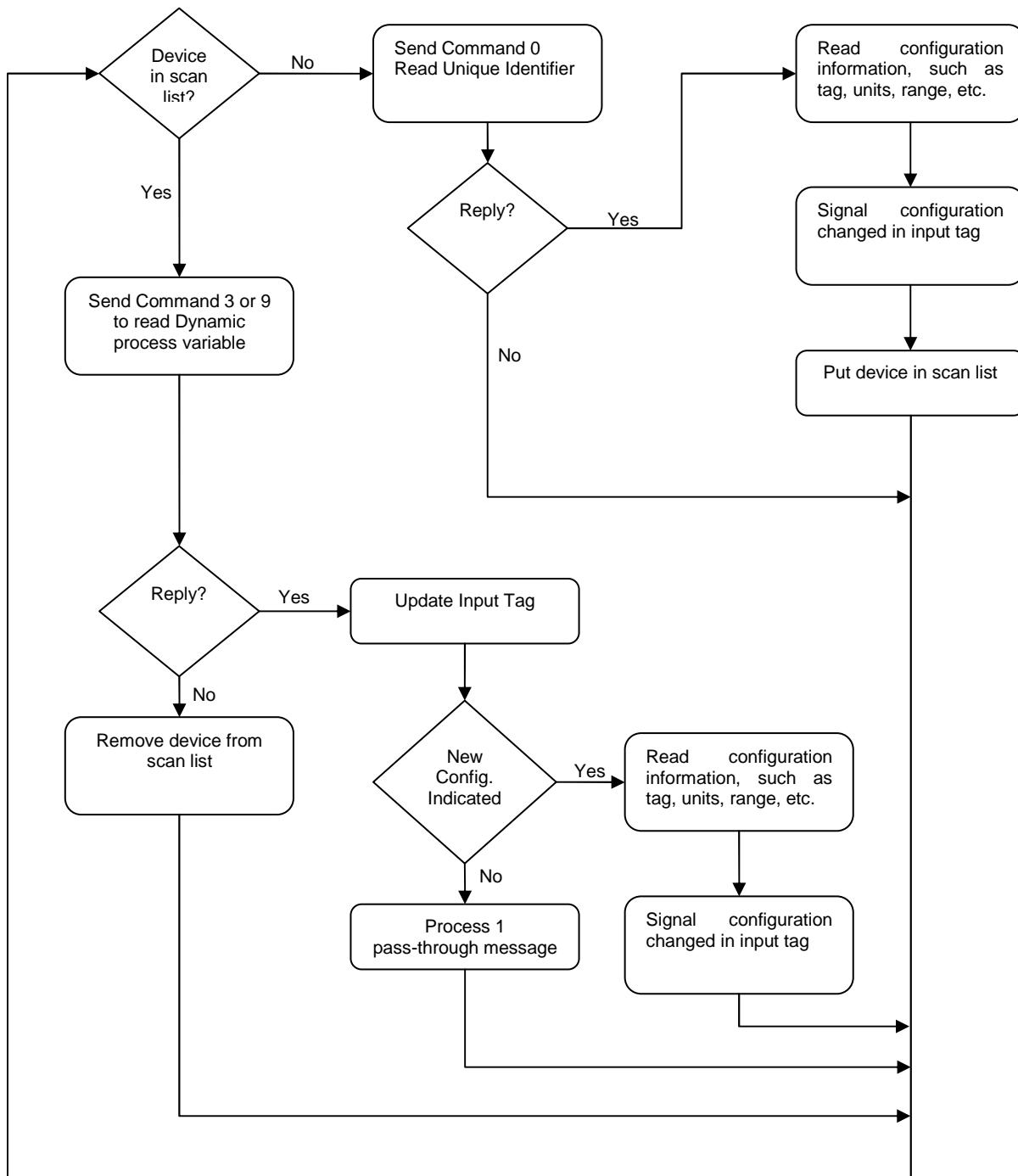
4.2.1 Auto-Scanning of Dynamic HART Variables (PV, SV, TV, FV)

The module will continuously send Cmd 3 or Cmd 9 to the HART device connected on a channel. Which command is sent is determined by the HART Universal revision number of the HART device. If the device has a revision of 6 or greater then Cmd 9 is used, otherwise for HART revision 5 devices Cmd 3 is used. The advantage of Cmd 9 is that it contains a "Health Status" byte for each of the 4 dynamic variables that it returns. The Dynamic variables and the status bytes are published in the module input tags. See Section 3.6 for more information.

Section 4.3
Supported HART
CIP Messages

CIP messages can be sent to the module using the MSG instruction to retrieve additional HART information that is not included in the module's input tags. This data may include, additional HART device information, HART device extended status, HART pass-through messaging, or the ability to temporarily suspend/resume HART communication on any given channel. The available HART CIP messages include:

4.3.1 Read Additional Device Status

Most devices support HART command 48 which allows the HART primary or secondary master to read additional device status information. HART command 48 is optional for devices running HART revision 5 & 6, but is required for devices running revision 7. Command 48 returns up to 25 bytes of status information. This group of 25 bytes includes both pre-defined status bytes and device specific status.

The IExCH will keep an internal cache of each channels Command 48 status data and make the data available via a CIP unconnected message. The IExCH keeps the data up to date by monitoring the MSA (More Status Available) bit (i.e. bit 4 in the Field Device Status Byte). See **Error! Reference source not found.** and **Error! Reference source not found.** for more information. When the MSA changes state (i.e. changes from 0 to 1 or 1 to 0), the module will resend command 48 on the associated channel. If the MSA bit remains set, the module will resend command 48 to the device every 2 minutes.

The SUA (Status Update Available) bit is used to notify the user that additional status for the channel has been refreshed by the module and the user should re-send the "Read Additional Device Status" CIP message to retrieve the cached data. After the CIP message is sent, the bit will clear.

Note: The data returned by the "Read Additional Device Status" message is in the original order as received from the HART device which means any multi-byte elements in the data will be reversed in the PLC. Hart format is MSB first and the PLC is LSB first for multi-byte variables. Since the location of the multi-byte elements can vary depending on the device, the module will not be able to reorder the bytes. Refer to the HART device's documentation for the location of each multi-byte element and reverse the order of the bytes in ladder to interpret.

The module will update its internal data cache for command 48 under the following conditions:

1. Initial device connection.

2. Detection of "more status available" bit change (0 to 1 or 1to 0).

3. Every 2 minutes if bit remains set.

The following table describes the class, service code and instances required to send the Read Additional Device Status message.

Table 4-1 (Read Additional Device Status)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x4C	Read Additional Status
Class Name	0x035D	HART Object
Instance	0 1-4	Selects All Channels Selects channel 0-3
Object Attribute	None, leave this field blank	
Request Size	0	No Request Data
Reply Size	2-112 bytes (2) Size when information not available (Instance 1-4) (28) Up to this Size when valid Information returned for a single channel (Instance 1-4) (56 if IE2CH) Fixed size returned for Instance 0 (112 if IE4CH) Fixed size returned for Instance 0	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-2 (Request Data)

HART Read Extended Status - Request packet structure			
Offset	**Field**	**Value**	**Definition**
			No Request Data

Table 4-3 (Request Failed)

HART Read Additional Status - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	34 = DR_RUNNING (No Device or connection process not completed or re-gathering device info is in progress) 35 = DR_DEAD (Channel is not HART enabled)	Command status
1	Pad	0	Pad byte

Table 4-4 (Request Succeeded)

HART Read Extended Status - Reply packet structure			
Offset	Field	Value	Definition
0	Status	00 = SUCCESS (1 byte)	Command status
1	Count	0-25(1 byte)	Number of Status bytes available
2-26	Additional Status Bytes		Additional Status bytes returned by CMD48 For Class Instance(Instance=0) if device doesn't return any or all 25 bytes then the remaining are set to 0.
27	Pad	0	Included if all 25 Additional Status bytes returned or returning all Channels at once for Instance 0

4.3.2 Get HART Device Information

When a HART device is first connected to the module, the module will send a series of HART commands to retrieve information about the device. This device information is held in the module's cache memory and can be retrieved by sending an unconnected CIP message. The following table lists the commands that are sent by the module when the device is first connected.

Table 4-5 (HART Initialization Sequence)

Commands sent at Initial device connection		
Command:	Definition:	Comment:
0	Read unique identifier.	Sent using "Short Address" to find device
6	Set Polling Address	Only sent if device responded at non 0 Addr
59	Write number of response preambles.	
12	Read Message	
13	Read tag, descriptor, and date.	
15	PV upper and lower range values	
16	Read final assembly Number.	
48	Read Additional Device Status	
50	Read dynamic variable assignments.	
3 or 9	Read Dynamic Variables	Cmd 3 if HART rev 5, else Cmd 9 used
2	Read Loop Current	Only sent if Cmd 9 is being used

If the connected HART device's configuration changes, the device will set the "configuration changed" bit (i.e. bit 6 of the Field Device Status byte). When the IExCH detects that the "configuration changed" bit is high, it will automatically re-send the appropriate HART commands to refresh the device information stored in its cache memory. See Table 4-6. The first command sent is command 38 which will reset the "configuration changed" bit in the device.

The CFG (device configuration changed) bit was added to the IExCH input assembly to

notify the user when to send the Get HART Device Information message to retrieve the cached data. See Table 3-4 and Table 3-5.

Table 4-6 (HART Refresh Sequence)

Commands sent to re-fresh Device Information on Configuration Change Detected

Command:	Definition:	Comment:
38	Reset Configuration Changed bit	
12	Read Message	
13	Read tag, descriptor, and date.	
15	PV upper and lower range values	
16	Read final assembly Number.	
48	Read Additional Device Status	
50	Read dynamic variable assignments.	

The following table describes the class, service code and instances required to send the Get HART Device Information message.

Table 4-7 (Get HART Device Information)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x4D	Get Device Information
Class Name	0x035D	HART Object
Instance Name	1-4	Selects channels 0 through 3
Object Attribute	None, leave this field blank	
Request Size	0	No Request Data
Reply Size	2-120 bytes (2) Size when Device information not available (120) Size when valid Device Information returned	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-8 (Request Data)

HART Get Device Information - Request packet structure			
Get currently cached Device Information for a given channel.			
Offset	**Field**	**Value**	**Definition**
			No Request Data

Table 4-9 (Request Failed)

HART Get Device Information - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	34 = DR_RUNNING 35 = DR_DEAD	Command status
1	Pad	0	Pad byte

Table 4-10 (Request Succeeded)

HART Get Device Information - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	00 = SUCCESS	Command status
1	Manufacture ID	(1 byte)	CMD#0, Byte 1
2	Device Type	(1 byte)	CMD#0, Byte 2
3	HART Preamble	(1 byte)	CMD#0, Byte 3
4	HART Univ Cmd Code	(1 byte)	CMD#0, Byte 4
5	HART Trans Spec Rev	(1 byte)	CMD#0, Byte 5
6	Software Revision	(1 byte)	CMD#0, Byte 6
7	Hardware Revision	(1 byte)	CMD#0, Byte 7
8	HART Flags	(1 byte)	CMD#0, Byte 8
9	Pad_1 for 32 bit alignment	(1 byte)	
10-11	HART Manufacturer ID16 Bit	(2 byte)	CMD#0,Byte 1 if HART rev < 7 CMD#0,Bytes 17-18 if HART rev >= 7
12-15	HART Device ID Number	(4 bytes – UINT)	CMD#0, Bytes 9-11 Bytes re-ordered into Intel Format(LSB 1st) from HART format(MSB 1st).
16-19	Tag Size	8 (4 bytes)	
20-27	Tag String	(8 bytes unpacked ASCII)	CMD#13, Bytes 0-5
28-31	Descriptor Size	16 (4 bytes)	
32-47	Descriptor String	(16 bytes unpacked ASCII)	CMD#13, Bytes 6-17
48	Date Day	(1 byte)	CMD#13, Byte 18
49	Date Month	(1 byte)	CMD#13, Byte 19
50-51	Date Year	(2 bytes)	CMD#13, Byte 20 (+ 1900)
52-55	Final Assembly Number	(4 bytes – UINT)	CMD#16, Bytes 0-2 Bytes re-ordered into Intel Format(LSB 1st) from HART Format(MSB 1st).
56-59	Message Size	32 (4 bytes)	
60-91	Message String	(32 bytes unpacked ASCII)	CMD#12, Bytes 0-23
92	PVCode	(1 byte)	CMD#50, Bytes 0, 0xff if not supported
93	SVCode	(1 byte)	CMD#50, Bytes 1, 0xff if not supported
94	TVCode	(1 byte)	CMD#50, Bytes 2, 0xff if not supported
95	FVCode	(1 byte)	CMD#50, Bytes 3, 0xff if not supported
96	PVUnits	(1 byte)	CMD#3, Byte 4
97	SVUnits	(1 byte)	CMD#3, Byte 9, 0 if not present
98	TVUnits	(1 byte)	CMD#3, Byte 14, 0 if not present
99	FVUnits	(1 byte)	CMD#3, Byte 19, 0 if not present
100	Transfer Function	(1 byte)	CMD#15, Byte 1
101	Range Units	(1 byte)	CMD#15, Byte 2

HART Get Device Information - Reply packet structure			
Offset	Field	Value	Definition
102-103	Expanded Device Type Code	(2 bytes)	CMD#0, Byte 2 if HART Rev < 7 CMD#0, Bytes 1-2 if HART Rev >= 7
104-107	HART PV Lower Range	(4 bytes – Floating Point Value)	CMD#15, Bytes 3-6
108-111	HART PV Upper Range	(4 bytes – Floating Point Value)	CMD#15, Bytes 7-10
112-115	Damping Value	(4 bytes – Floating Point Value)	CMD#15, Bytes 11-14
116	Write Protect Code	(1 byte)	CMD#15, Byte 15
117	Pad_2 for alignment	(1 byte)	
118 - 119	Private Label Mfg 16Bit	(2 bytes)	CMD#0, Byte 1 if HART Rev < 7 CMD#0, Bytes 19-20 if HART Rev >=7

Sending the Get HART Device Information Message

The following rung will send an unconnected message to read the HART device Information.
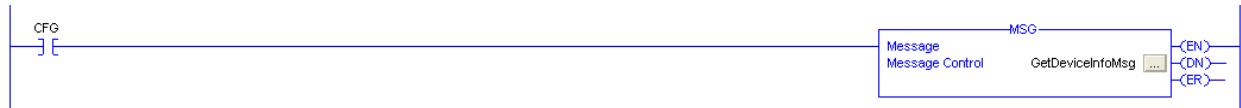
This is the message configuration dialog box
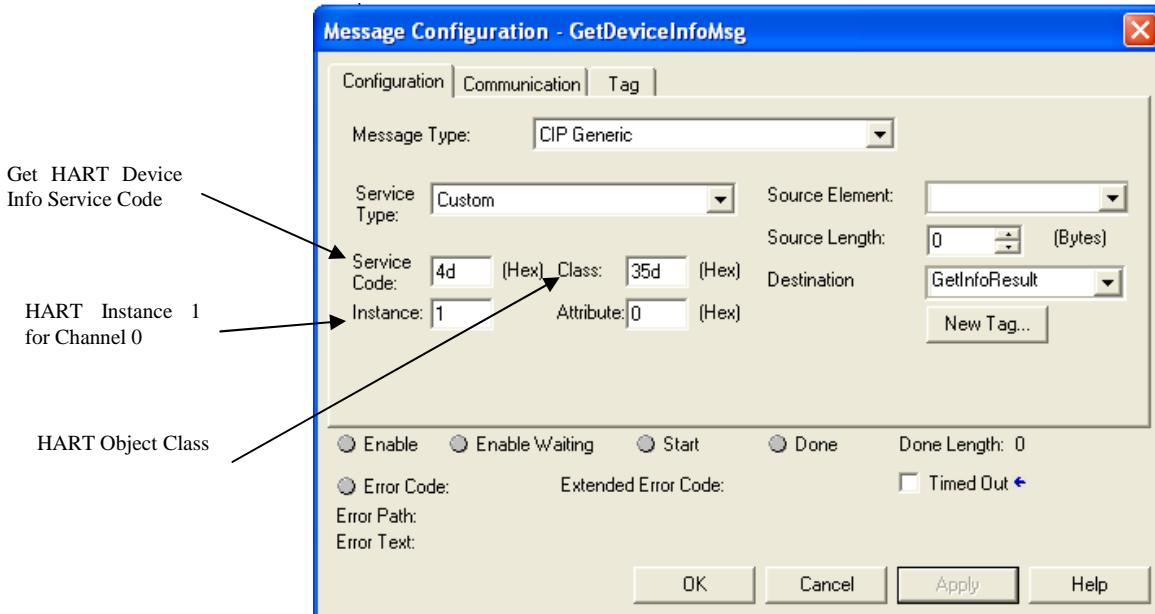
4.3.3 HART Pass-through Messaging

The HART Pass-Through Command can be used to send any HART command including universal, common practice or device specific, directly to a field device via ladder.

All HART pass-through commands require a series of messages to be exchanged. First, a pass-through init must be sent to the HART module to initiate the pass-through command. The HART module will respond to the request with a request reply that includes a handle that can be used to obtain the pass-through message response. Once the handle is received, the user may issue a pass-through query to obtain the status of the

pass-through command and the pass-through response data, if available.

There is a handle timeout associated with the final reply message. After the HART module obtains the requested information from the HART device, it will start a handle timeout timer. Refer to section 3.5.4for information regarding how to set the handle timeout. The reply message will be cached in memory during the handle timeout period. When the handle timeout timer expires the reply message will be discarded, and another pass through message will be serviced without being rejected. The user defined handle timeout is in the range of 1 to 255 seconds.

! **Attention**

If the HART message being sent or received using the pass-through command contains double-words or floating point values, the order of the bytes must be reversed.

Depending on the HART command, the data contained within the HART message may include floating point numbers or double integers. If a floating point or double integer is contained within the HART message, the user must be aware that the order of the bytes that make up the float or double will need to be reversed. The reason for this is related to how the bytes are stored in the PLC.

The PLC stores the bytes in memory in a format referred to as "little-endian". Little-endian is an order in which the "little end" (least significant value in the sequence) is stored first (at the lowest storage address). However, HART devices transmit the byte data in the reverse order or as you may have guessed "big-endian".

Pass-Through Init

The following table describes the class, service code and instances required to send the Pass-through Request message.

Table 4-11 (Pass-through Init)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x4E	Pass-through Request
Class Name	0x035D	HART Object
Instance	1-4	Selects channel 0-3
Object Attribute	None, leave this field blank	
Request Size	2-257 bytes	HART Data & Cmd
Reply Size	4 bytes	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-12 (Request Data)

HART Ladder Passthrough Init - Request packet structure			
Offset	**Field**	**Value**	**Definition**
0	HART Command	0-255 (1 byte)	HART Command Number
1	HART Data Size	0-255 (1 byte)	Number of Data bytes for selected HART command
2-256	HART Data bytes	0-255 (1 byte)	HART command data

Table 4-13 (Reply Data)

HART Ladder Passthrough Init - Reply packet structure
Offset	Field	Value	Definition
Unconnected Message Header
0	Status	32 = Busy (Queues full) 33 = DR_INITIATE (passthrough success) 35 = DR_DEAD	Command Status Note: HART Cmds 59,107,108, & 109 are not allowed and will always return DR_DEAD.
1	HART Command	0-255 (1 byte)	Echo of HART command
2	Handle	1-255 (1 byte)	Handle used in Query operation
3	Queue Space Remaining OR "Reason Code" if status = 35	(1 byte)	Number of queues still available for this channel. OR Reason Code is a diagnostic value returned when message fails(Status = 35)

Pass-through Query

The following table describes the class, service code and instances required to send the Pass-through Query message.

Table 4-14 (Pass-through Query)

Unconnected Message
Field	Value	Definition
Message Type	"CIP Generic"	
Service Code	0x4F	Passthrough Init
Class Name	0x035D	HART Object
Instance	1-4	Selects channel 0-3
Object Attribute	None, leave this field blank	
Request Size	1 byte	Handle for Query
Reply Size	6-260 bytes	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-15 (Request Data)

HART Ladder Passthrough Query - Request packet structure
Offset	Field	Value	Definition
0	Handle	1-255 (1 byte)	Handle for Query

Table 4-16 (Reply Data)

HART Ladder Passthrough Query - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	00 = Success 34 = DR_RUNNING 35 = DR_DEAD	Query Status
1	HART Command	0-255 (1 byte)	Echo of HART command
2	HART CommStatus	(1 byte)	HART Reply Status Byte #1
3	HART FieldDeviceStatus OR Reason Code if status = 35	(1 byte)	HART Reply Status Byte #2 Reason Code is a diagnostic value returned when message fails(Status = 35)
4	Data Size	0-255 (1 byte)	Number of Data bytes in reply for HART command
5-257	HART Reply Data …		Data bytes returned in data field of HART reply to requested command

HART Pass-through "Reason Code" definitions

The HART Pass-through "Reason Code" is a value that is reported when a Pass-through reply message returns the general "Status" value as 35 (DR_DEAD). It provides the user a diagnostic code, which is referenced in the table below, describing the possible cause of the failure. This code will be returned in offset 3 of the reply message for Pass-through Init or Query messages whenever the "Status" value at offset 0 is equal to 35 (DR_DEAD).

Table 4-17 (Reason Codes)

HART Pass-through Reason Code		
Value	**Definition**	**Notes:**
0x81	No response from HART device	
0x82	Invalid long frame address	
0x83	Invalid HART message checksum	
0x84	HART Command not allowed (blocked by module)	
0x85	Invalid Channel selected	
0x86	Channel is not HART Enabled	
0x87	Channel does not have a device connected	Module has not established HART communications on this channel
0x89	Size of CIP message too small to hold size of HART message	Module looks at HART Data size field in request and validates that the incoming CIP message size is large enough to send all the data
0x8A	Invalid Handle	Only applies to a Query message
0x8B	Invalid Start Delimiter	

Sending a Pass-through Message

The ladder on the following page demonstrates how to send a complete Pass-through message using ladder. This example sends universal HART command 1 (Read Primary Variable). For a listing of HART Universal and Common practice commands, see Appendix B.

Figure 4-3 (HART Pass-through)

The following rung sends the Pass-Through request message to the module.
Ie4chCmd1InitReq[0] = 1 (HART Command)   Ie4chCmd1InitRep[0] = 33 (Passthrough Success)
Ie4chCmd1InitReq[1] = 0 (Byte Count)   Ie4chCmd1InitRep[1] = 1 (Echo of HART Command)
Ie4chCmd1InitRep[2] = xx (Handle Number)
Ie4chCmd1InitRep[3] = 0 (Queue Space Remaining)
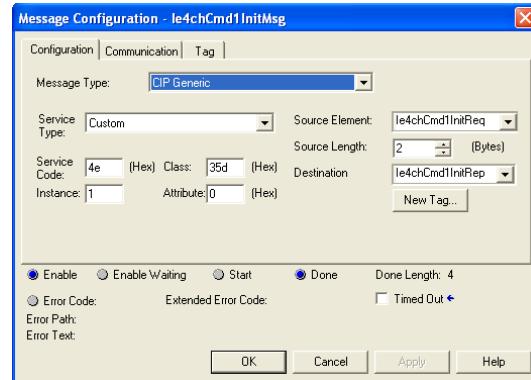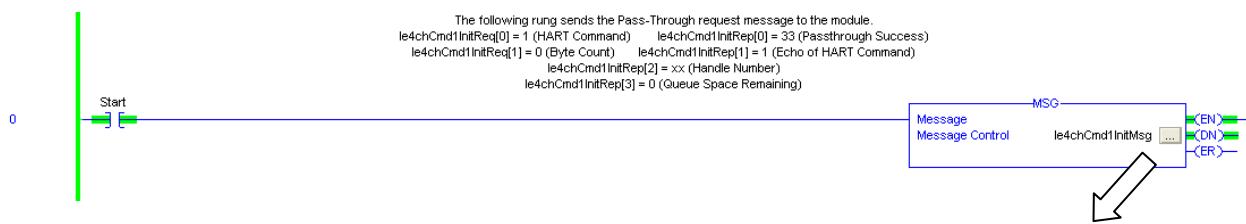
The following rung sends the Pass-Through query message to the module.
Ie4chCmd1QryReq = xx (Handle Number)
Ie4chCmd1QryRep[0] = 0 (Query Success)
Ie4chCmd1QryRep[1] = 1 (Echo of HART Command)
Ie4chCmd1QryRep[2] = 0 (HART Reply Status Byte #1)
Ie4chCmd1QryRep[3] = 0 (HART Reply Status Byte #2)
Ie4chCmd1QryRep[4] = 5 (Data Bytes In Reply)
Ie4chCmd1QryRep[5] = 33 (PV Unit Code for HART Command 1) Note: 33 = Degrees F
Ie4chCmd1QryRep[6-9] = HART Primary Variable
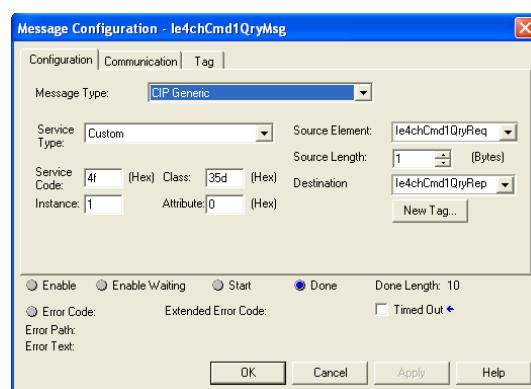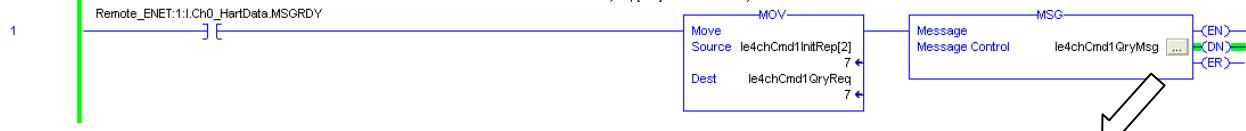
Because the PLC stores data in the little-endian form and the HART protocol transmits the data in big-endian form, the order of the bytes stored in the controller must be reversed. The following rung reverses the
order of the bytes and displays the HART PV in floating point format in the tag named "Ie4chCmd1Result".

4.3.4 Flush Queue

The Flush Queue message can be sent to have the IExCH module discard any pending HART replies awaiting a query command. These replies are automatically discarded once the handle timeout period has expired. The handle timeout period is defined in the module configuration. The default value assigned by the AOP is 20 seconds. Unless you need to discard the replies faster than 20 seconds, you won't need to use this Flush Queue command.

The following table describes the class, service code and instances required to send the Flush Queue message.

Table 4-18 (Flush Queue)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x50	Flush Queues
Class Name	0x035D	HART Object
Instance	0-3 0 = All Channels 1-4 = Single Channel (0-3)	All channels at once or a single channel
Object Attribute	None, leave this field blank	
Request Size	0	No Request Data
Reply Size	0	Number of Data bytes returned

4.3.5 Suspend HART Communication

The "suspend HART communication" message, will temporarily suspend all HART communication on one or more channels for up to 3 minutes. HART communication will resume automatically under the following conditions:

- After 3 minutes
- If the HART configuration changes during the three minute timeout period
- If the "resume HART communication" message is issued.

The following table describes the class, service code and instances required to send the Suspend HART Communication message.

Table 4-19 (Suspend HART Communication)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x51	Suspend HART
Class Name	0x035D	HART Object
Instance	0-3 0 = All Channels 1-4 = Single Channel	All channels suspended or a single channel
Object Attribute	None, leave this field blank	
Request Size	0	No Request Data
Reply Size	2	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-20 (Request Data)

Suspend Normal HART acquisitions - Request packet structure			
Offset	**Field**	**Value**	**Definition**
			No Request Data

Table 4-21 (Reply Data)

Suspend Normal HART acquisitions - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	(1 byte) 00 = SUCCESS 35 = DR_DEAD	
1	Pad	0	

4.3.6 Resume HART Communication

Used in conjunction with the HART suspend message, allows the user to resume HART communication on a channel or channels if HART communication is currently suspended.

The following table describes the class, service code and instances required to send the Resume HART Communication message.

Table 4-22 (Resume HART Communication)

Unconnected Message		
Field	**Value**	**Definition**
Message Type	"CIP Generic"	
Service Code	0x52	Resume HART
Class Name	0x035D	HART Object
Instance	0-3 0 = All Channels 1-4 = Single Channel	All channels resume or a single channel
Object Attribute	None, leave this field blank	
Request Size	0	No Request Data
Reply Size	2	Number of Data bytes returned

The following tables describe the possible message responses.

Table 4-23 (Request Data)

Resume Normal HART acquisitions - Request packet structure			
Offset	**Field**	**Value**	**Definition**
0			No Request Data

Table 4-24 (Reply Data)

Resume Normal HART acquisitions - Reply packet structure			
Offset	**Field**	**Value**	**Definition**
0	Status	(1 byte) 00 = SUCCESS 35 = DR_DEAD	
1	Pad	0	

Appendix A
Module Specifications

General Specifications

Parameter	1734sc-IE4CH Specification	1734sc-IE2CH Specification
Module location	1734-TBxx	
Pointbus current	15 mA	
Power dissipation	0.6 W maximum @ 28.8V dc	
Thermal dissipation	2.0 BTU/hr maximum @ 28.8V dc	
Isolation Voltage	50V (continuous), Basic Insulation Type, No isolation between channels	

External DC power
   Supply Voltage
   Voltage Range
   Supply Current
	24V DC nominal
	10..28.8V DC
	20 mA @24V DC
		24V DC nominal
		10..28.8V DC
		19 mA @24V DC

Dimensions (HxWxD), approx.	56 x 12 x 75.5 mm (2.21 x 0.47 x 2.97 in.)	
Keyswitch position	3	
Enclosure type rating	None (open-style)	
Wire size	Determined by installed terminal block	
Wiring category	2 – on signal ports	
Wire type	Shielded	
Terminal base screw torque	Determined by installed terminal block	
Weight, approx.	35g (1.235 oz)	

Input Specifications

Parameter	1734sc-IE4CH Specification	1734sc-IE2CH Specification
Number of Inputs	4 single ended, non-isolated	2 single ended, non-isolated
Resolution	16 bits	
Input current terminal	4..20 mA limit: 3.42-20.58mA	
Absolute accuracy	+/- 20 uA @ 25°C	
Repeatability	+/- 5 uA @ 25°C	
Accuracy drift w/temp.	50uA max -20..55°C, 30ppm / °C typical	

Input update rate (per module)	488 ms @ Notch=50/60Hz (def) 248 ms @ Notch=50Hz 208 ms @ Notch=60Hz 128 ms @ Notch=100Hz 108 ms @ Notch=120Hz 58 ms @ Notch=240Hz 33 ms @ Notch=480Hz	248 ms @ Notch=50/60Hz (def) 128 ms @ Notch=50Hz 108 ms @ Notch=60Hz 68 ms @ Notch=100Hz 58 ms @ Notch=120Hz 33 ms @ Notch=240Hz 21 ms @ Notch=480Hz
Input Impedance	250 ohms +/-1% (input 0-21 mA)	
ADC Type	Sigma Delta	
CMRR	>96dB Typical	
NMRR	- 60dB point of first notch 47 Hz @ Notch=50/60Hz (default) 45 Hz @ Notch=50Hz 54 Hz @ Notch=60Hz 91 Hz @ Notch=100Hz 109 Hz @ Notch=120Hz 221 Hz @ Notch=240Hz 446 Hz @ Notch=480Hz	
Data Format	Signed integer	
Maximum overload	Fault protected to 28.8V DC	
Calibration	Factory calibrated, user calibration supported	
Indicators	1 green/red module status LED 1 green/red network status LED 4 green/red input status LEDs	1 green/red module status LED 1 green/red network status LED 2 green/red input status LEDs

Environmental Specifications

Environmental Tests	Industry Standards	Test Level Limits
Temperature (Operating) (Performance Criteria A)	IEC60068-2-1: (Test Ad, Operating Cold), IEC60068-2-2: (Test Bd, Operating Dry Heat), IEC60068-2-14: (Test Nb, Operating Thermal Shock)	-20 to 55°C (-4 to 131°F) (natural convection cooling)
Temperature (Non-operating) (Performance Criteria B)	IEC60068-2-1: (Test Ab, Unpackaged Non-operating Cold), IEC60068-2-2: (Test Bb, Unpackaged Non-operating Dry Heat), IEC60068-2-14: (Test Na, Unpackaged Non-operating Thermal Shock)	-40 to 85°C (-40 to 185°F)
Humidity (Operating) (Performance Criteria A)	IEC60068-2-30: (Test Db, Unpackaged Damp Heat):	80 - 95% Condensing 20-60-20°C Temp Cycle
Vibration (Operating) (Performance Criteria A)	IEC60068-2-6: (Test Fc, Operating)	10 to 500Hz, 5g
Shock (Operating) (Performance Criteria A)	IEC60068-2-27: (Test Ea, Unpackaged Shock)	30 g,11ms half-sine (3 mutually perpendicular axes)
Shock (Non-operating) (Performance Criteria B)	IEC60068-2-27: (Test Ea, Unpackaged Shock)	50 g, 11ms half-sine (3 mutually perpendicular axes)
Packaged Vibration	ES# PC003, Revision A	5 to 20 Hz 1 g. 1 hour each axis. 4 min sweep.
Packaged Shock ("drop test")	ES# PC004, Revision A	Drop from 48 in. 10 times each in various orientations.
Radiated Emissions	CSIPR 11; Group 1, Class A	(Enclosure) Class A
Conducted Emissions	IEC 61000-6-4:2007	Group 1, Class A (AC Mains)
ESD immunity (Performance Criteria B)	IEC 61000-4-2 Rockwell Document QTP#X0327	6kV Indirect (Coupling Plate) 6kV Contact Discharge (to points of initial contact) 8kV Air Discharge (to points of initial contact)
Radiated RF immunity (Performance Criteria A)	IEC 61000-4-3: Level 3 Rockwell Document QTP#X0327	10 V/M with 1 kHz sine-wave 80%AM from 80…2000 MHz 10 V/M with 200 Hz sine-wave 50% Pulse 100%AM @900 MHz 10 V/M with 200 Hz sine-wave 50% Pulse 100%AM @1890 MHz 1 V/M with 1 kHz sine-wave 80%AM from 2000…2700 MHz
EFT/B immunity (Performance Criteria B)	IEC 61000-4-4* Rockwell Document QTP#X0327	± 3 kV @ 5 kHz for 5 minutes on communication ports and power ports ± 3 kV @ 5 kHz for 5 minutes on (PE) ground port
Surge transient immunity (Performance Criteria A)	IEC 61000-4-5 Rockwell Document QTP#X0327	±- 2 kV line-earth {CM}@ 2Ω on communications ports ± 2kV CM @ 42Ω, ±1kV DM @ 42Ω on unshielded ports
Conducted RF immunity (Performance Criteria A)	IEC 61000-4-6 Rockwell Document QTP#X0327	10V rms with 1 kHx sine wave 80%AM from 150 kHz…80 MHz on communications, power ports and (PE) ground
Magnetic Field		Not Applicable
AC Mains Voltage Dips, Interruptions and Variations		Not Applicable
DC Mains Voltage Dips, Interruptions and Variations		Not Applicable
Oscillatory Waves		Not Applicable
C-Tick (Australia)	AS/NZS CISPR 11 (Group 1, Class A)	Class A

Agency Certifications

The following certifications will be obtained at 1st production release.

UL 508

ISA 12.12.01

CUL

Operating Temperature Code T4

CE compliance to EN 61010-1 and EN 61131-2

Atex 4.4

ODVA DeviceNet Compliance

EX nA IIC Gc

⟨Ex⟩ **II 3G**

-20C < Ta < 55C
DEMKO 11 ATEX 1103434U

ATEX Special Conditions for Safe Use

- Provisions shall be made to prevent the rated voltage being exceeded by the transient disturbances of more than 140%.

- The system shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC60529 or EN60529 and used in an environment of not more than pollution degree 2.

- These modules must be used with the ATEX certified terminal module 1734-TB by Allen-Bradley.

Appendix B
Additional HART
Protocol Information

This appendix describes the HART protocol and provides references for additional information about the protocol. Consult the HART protocol specification and vendor provided documentation for specifics on HART commands.

This appendix provides the following:

- HART protocol background information
- Common practice command sets
- Extended command sets
- References to additional information

HART Field Communication Protocol is widely accepted in the industry as the standard for digitally enhanced 4…20mA communication with smart field instruments. The HART Protocol message structure, command set, and status are discussed in this appendix.

The HART command set is organized into these groups and provides read and write access to a wide array of information available in smart field instruments:

- Universal commands provide access to information that is useful in normal plant operation such as the instrument manufacturer, model, tag, serial number, descriptor, range limits, and process variables. All HART devices must implement universal commands.
- Common practice commands provide access to functions that can be carried out by many devices.
- Device specific commands provide access to functions that can be unique to a particular device.

Section B.1 Message Structure

Read this section for a description of transaction procedure, character coding, and message structure of the HART protocol. These correspond to layer 2 (datalink layer) of the OSI protocol reference model.

B.1.1 Master-slave Operation

HART is a master-slave protocol. This means that each message transaction is originated by the master; the slave (field) device replies when it receives a command message addressed to it. The reply from the slave device acknowledges that the command was received and can contain data requested by the master.

B.1.2 Multiple Master Operation

The HART protocol provides for two active masters in a system: one primary and one secondary. The two masters have different addresses. Each can positively identify replies

to its own command messages. The 1734sc-IE2CH or 1734sc-IE4CH module acts as primary master. A secondary master, such as a handheld configuration device, may also be connected.

B.1.3 Transaction Procedure

HART is a half-duplex protocol. After completion of each message, the FSK carrier signal must be switched off to let the other station transmit. The carrier control timing rules state that the carrier should be turned on not more than 5 bit times before the start of the message (that is, the preamble) and turned off not more than 5 bit times after the end of the last byte of the message (the checksum).

The master is responsible for controlling message transactions. If there is no reply to a command within the expected time, the master should retry the message. After a few retries, the master should abort the transaction, because presumably the slave device or the communication link has failed.

After each transaction is completed, the master should pause for a short time before sending another command, to provide an opportunity for the other master to break in if it wishes. This way, two masters (if they are present) take turns at communicating with the slave devices. Typical message lengths and delays allow two transactions per second.

B.1.4 Burst Mode

Burst mode is not supported.

Section B.2 Response Code and Field Device Status

Two bytes of status also called the response code and field device status are included in every reply message from a field or slave device. These two bytes convey communication errors, command response problems, and field device status. If an error is detected in the outgoing communication, the most significant bit (bit 7) of the first byte is set to 1 and the details of the error are reported in the rest of that byte. The second byte, in this case, is all zeros.

Communication errors are typically those that would be detected by a UART (parity overrun and framing errors). The field device also reports overflow of its receive buffer and any discrepancy between the message content and the checksum received.

In RSLogix 5000 software, if the leftmost bit of the ResponseCode is set, it displays a negative number. In this case, the ResponseCode represents a communication fault. Change the display format to hexadecimal to interpret communication status.

If the leftmost bit of the ResponseCode is 0 (value 0…127), then there was no communication error and the value is a ResponseCode from the HART field device. Response codes indicate if the device performed the command. 0 means no error. Other values are errors or warnings. To understand the ResponseCode, contact your HART field device manufacturer or the HART specification.

See Table B-1and Table B-2 for descriptions of the response code and the field device status.

Table B-1 (Response Codes – HART Device Status Byte 1)

Response Code		Description	
If Bit 7 is	**And Bits 6…0 are**		
1	16#40	Parity Error	Vertical parity error - The parity of one or more of the bytes received by the device was not odd

Response Code		Description	
If Bit 7 is	**And Bits 6…0 are**		
1	16#20	Overrun Error	Overrun error - At least one byte of data in the receive buffer of the UART was overwritten before it was read (for example, the slave did not process incoming byte fast enough)
1	16#10	Framing Error	Framing error - The Stop Bit of one or more bytes received by the device was not detected by the UART (for example, a mark or 1 was not detected when a Stop Bit should have occurred)
1	16#08	Checksum Error	Longitudinal parity error -The Longitudinal Parity calculated by the device did not match the Check Byte at the end of the message
1	16#04	(Reserved)	Reserved - Set to zero
1	16#02	RX Buffer Overflow	Buffer overflow -The message was too long for the receive buffer of the define
1	16#01	(undefined)	Reserved - Set to zero
0	0	No command specific error	
0	1	(undefined)	
0	3	Value too large	
0	4	Value too small	
0	5	Not enough bytes in command	
0	6	Transmitter-specific command error	
0	7	In Write-protect mode	
0	8	Update Failed - Update In Progress - Set to Nearest Possible Value	
0	9	Applied Process Too High - Lower Range Value Too High - Not In Fixed Current Mode	
0	10	Applied Process Too Low - Lower Range Value Too Low - MultiDrop Not Supported	
0	11	In MultiDrop Mode - Invalid Transmitter Variable Code - Upper Range Value Too High	
0	12	Invalid Unit Code -Upper Range Value Too Low	
0	13	Both Range Values Out of Limits	
0	14	Pushed Upper Range Value Over Limit - Span Too Small	
0	16	Access restricted	
0	32	Device busy	
0	64	Command not implemented	

If no error was detected in the outgoing communication, the second byte contains status information pertaining to the operational state of the field or slave device.

Table B-2 (Field Device Status – HART Device Status Byte 2)

Bit	Bit Mask	Definition
7	16#80	Device malfunction - The device detected a serious error or failure that compromises device operation
6	16#40	Configuration changed -An operation was performed that changed the device's configuration
5	16#20	Cold start - A power failure or device reset occurred
4	16#10	More status available - More status information is available via command 48, Read Additional Status Information
3	16#08	Loop current fixed - The loop current is being held at a fixed value and is not responding to process variations
2	16#04	Loop current saturated - The loop current has reached its upper or lower endpoint limit and cannot increase or decrease any further
1	16#02	Non-primary variable out of limits - A device variable not mapped to the PV is beyond its operating limits
0	16#01	Primary variable out of limits - The PV is beyond its operating limit

Note: 16# means this number is in Hex.

Table B-3 (HART Universal Commands)

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
0	Read Unique Identified		None		0	254 (expansion)			x
					1	Manufacturer identification code			x
					2	Manufacturer device type code Number of			x
					3	preambles required Universal command			x
					4	revision			x
					5	Device-specific command revision			x
					6	Software revision			x
					7	Hardware revision			x
					8	Device function flags[2]	(H)		x
					9…11	Device ID number	(B)		x
1	Read primary variable				0	PV units code Primary variable			x
					1…4		(F)	x	x
2	Read current and percent of range		None		0…3	Current (mA)	(F)	x	x
					4…7	Primary variable %	(F)	x	x
3	Read current and four (predefined) dynamic variables		None		0…3	Current (mA)			x
					4	PV units code			x
					5…8	Primary variable		x	x
					9	SV units code			x
					10…13	Secondary variable		x	x
					14	TV units code			x
					15…18	Third variable		x	x
					19	FV units code			x
					20…23	Fourth variable[3]		x	x
6	Write polling address	0	Polling address				As in command		
11	Read unique identifier associated with tag	0…5	Tag	(A)	0…11	As in command 0			
12	Read message		None		0…23	Message (32 characters)	(A)		x
13	Read tag, descriptor, date				0…5	Tag (8 characters)	(A)		x
					6…17	Descriptor (16 characters)	(A)		x
					18…20	Date	(D)		x
14	Read PV sensor information				0…2	Sensor serial number	(B)		
					3	Units code for sensor limits and min span			
					4…7	Upper sensor limit	(F)		
					8…11	Lower sensor limit	(F)		
					12…15	Min span	(F)		
15	Read output information				0	Alarm select code			
					1	Transfer function code			x
					2	PV/range units code			x
					3…6	Upper range value			x
					7…10	Lower range value			x
					11…14	Damping value (seconds)	(F)		x
					15	Write-protect code	(F)		x
					16	Private-label distributor code	(F)		
16	Read final assembly number		None		0…2	Final assembly number	(B)		x
17	Write message	0…23	Message (32 characters)	(A)		As in command			
18	Write tag, descriptor, date	0…5	Tag (8 characters)	(A)					
		6…17	Descriptor (16 characters)	(A)					
		18…20	Date	(D)					
19	Write final assembly	0…2	Final assembly number	(B)					

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[1]	Byte	Data	Type[1]	Input Tag	CIP MSG
	number								
48	Read additional device status		Starting in HART version 7, the data in the command could be the same as in the reply.		0…5	Device-specific status	S[5]		x
					6…7	Operational modes			x
					8	Standardized status 0			x
					9	Standardized status 1			x
					10	Analog channel saturated			x
					11	Standardized status 2			x
					12	Standardized status 3			x
					13	Analog channel fixed[4]			x
					14…24	Device-specific status			x

(1) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag
(2) Bit 6 = multisensor device. Bit 1 = EEPROM control required. Bit 2 = protocol bridge device.
(3) Truncated after last supported variable.
(4) 24 bits each LSB…MSB refers to A0 #1…24.
(5) Sint []

Table B-4 (Common Practice Commands)

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[6]	Byte	Data	Type[6]	Input Tag	CIP MSG
33	Read transmitter variables		None		0	Transmitter variable code, slot 0			
					1	Units code for slot 0			
					2…5	Variable for slot 0			
					6	Transmitter variable code, slot 1			
					7	Units code for slot 1			
					8…11	Variable for slot 1	(F)		
					12	Transmitter variable code, slot 2			
					13	Units code for slot 2			
					14…17	Variable for slot 2	(F)		
					18	Transmitter variable code, slot 3			
					19	Units code for slot 3			
					20…23	Variable for slot 3[7]	(F)		
34	Write damping value	0…3	Damping value (seconds)	(F)		As in command	(F)		
35	Write range values	0	Range units code			As in command			
		1…4	Upper-range value	(F)			(F)		
		5…8	Lower-range value	(F)			(F)		
36	Set upper-range value (= push SPAN button)		None			None			
37	Set lower-range value (= push ZERO button)								
38	Reset 'configuration changed' flag								
39	EEPROM control	0	EEPROM control code(3)			As in command			
40	Enter/exit Fixed Current mode	0…3 [1]	Current (mA)	(F)		As in command			
41	Perform device self-test		None			None			

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[6]	Byte	Data	Type[6]	Input Tag	CIP MSG
42	Perform master reset								
43	Set (trim) PV zero								
44	Write PV units	0	PV units code			As in command			
45	Trim DAC zero	0…3	Measured current (mA)						
46	Trim DAC gain	0…3		(F)					
47	Write transfer function	0	Transfer function code						
48	Read additional device status		Moved to Universal Commands in HART version 7.			See 48 in Universal Commands			
49	Write PV sensor serial number	0…2	Sensor serial number			As in command			
50	Read dynamic variable assignments		None	0 1 2 3		PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			x x x x
51	Write dynamic variable assignments	0 1 2 3	PV transmitter variable code SV transmitter variable code TV transmitter variable code FV transmitter variable code			As in command			
52	Set transmitter variable zero	0	Transmitter variable code						
53	Write transmitter variable units	0 1	Transmitter variable code Transmitter var. units code						
54	Read transmitter variable information	0	Transmitter variable code		0 1…3 4 5…8 9…12 13…16	Transmitter variable code Transmitter variable sensor serial Transmitter var. limits units code Transmitter variable upper limit Transmitter variable lower limit Transmitter var. damping value (sec)	 (F) (F) (F)		
55	Write transmitter variable damping value	0 1…4	Transmitter variable code Transmitter variable damping value (sec)	(F)		As in command			
56	Write transmitter variable sensor serial number	0 1…3	Transmitter variable code Transmitter variable sensor serial #			As in command			
57	Read unit tag, description, date		None		0…5 6…17 18…20	Unit tag Unit descriptor Unit date	(A) (A) (D)		x x x

| Command | | Data in Command | | | Data in Reply | | | Contained in | |
No.	Function	Byte	Data	Type[6]	Byte	Data	Type[6]	Input Tag	CIP MSG
58	Write unit tag, descriptor, date	0…5 6…17 18…20	Unit tag Unit descriptor Unit date	(A) (A) (D)		As in command			
59	Write number of response preambles	0	Number of response preambles						
60	Read analog output and percent of range	0	Analog output number code		0 1 2…5 6…9	Analog output number code Analog output units code Analog output level Analog output percent of range			
61	Read dynamic variables and PV analog output		None		0 1…4 5 6…9 10 11…14 15 16…19 20 21…24	PV analog output units code PV analog output level PV units code Primary variable SV units code Secondary variable TV units Tertiary variable FV units code Fourth variable	(F) (F) (F) (F) (F)	 x x x x	 x x x x x x x x
62	Read analog outputs	0 1 2 3[2]	Analog output number; code for slot 0 Analog output number; code for slot 1 Analog output number; code for slot 2 Analog output number; code for slot 3[4]	0 1 2…5 6 7 8…11 12 13 14…17 18 19 20…23		Slot 0 analog output number code Slot 0 Slot 0 level Slot 1 Slot 1 Slot 1 level Slot 2 Slot 2 Slot 2 level Slot 3 Slot 3 Slot 3 level[8]	 (F) (F) (F) (F)		
63	Read analog output information	0	Analog output number code		0 1 2 3 4…7 8…11 12…15	Analog output number code Analog output alarm select code Analog output transfer function code Analog output range units code Analog output upper-range value Analog output lower-range value Analog output additional damping value (seconds)	 (F) (F) (F)		
64	Write analog output	0 1…4	Analog output number code Analog output	 (F)		As in command			

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[6]	Byte	Data	Type[6]	Input Tag	CIP MSG
	additional damping value		additional damping value (seconds)						
65	Write analog output range value	0 1 2…5 6…9	Analog output number code Analog output range units code Analog output upper-range value Analog output lower-range value	 (F) (F)					
66	Enter/exit Fixed Analog Output mode	0 1 2…6	Analog output number code Analog output units code Analog output level[5]	(F)					
67	Trim analog output zero	0 1 2…6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
68	Trim analog output gain	0 1 2…6	Analog output number code Analog output units code Externally measured analog output level	 (F)					
69	Write analog output transfer function	0 1	Analog output number code Analog output transfer function code						
70	Read analog output endpoint values	0	Analog output number code		0 1 2…5 6…9	Analog output number code Analog output endpoint units code Analog output upper endpoint value Analog output lower endpoint value			
107	Write Burst mode transmitter variables (for command 33)	0 1 2 3	Transmitter variable code for slot 0 Transmitter variable code for slot 1 Transmitter variable code for slot 2 Transmitter variable code for slot 3			As in command			

Command		Data in Command			Data in Reply			Contained in	
No.	Function	Byte	Data	Type[6]	Byte	Data	Type[6]	Input Tag	CIP MSG
108	Write Burst mode command number	0	Burst mode command number			As in command			
109	Burst mode control	0	Burst mode control code (0 = exit, 1 = enter)						
110	Read all dynamic variables		None		0	PV units code			x
					1…4	PV value	(F)	x	x
					5	SV units code			x
					6…9	SV value	(F)	x	x
					10	TV units code			x
					11…14	TV value	(F)	x	x
					15	FV units code			x
					16…19	FV value	(F)	x	x

(1) 0 = exit Fixed Current mode.
(2) Truncated after last requested code.
(3) 0 = burn EEPROM, 1 = copy EEPROM to RAM.
(4) Truncated after last requested code.
(5) Not a number exits Fixed-output mode.
(6) (A) = Packed ASCII, (B) = 3-byte integer, (D) = Date, (F) = Floating Point (HART format), (H) = HART flag
(7) Truncated after last requested code.
(8) Truncated after last requested variable.

Section B.3 HART PV, SV, TV, and FV Status

HART PV, SV, TV, and FV are dynamic variables that contain the values of device variables, which are various direct or indirect process measurements performed by the HART field device.

Some devices let a set of their internal device variables be mapped to the PV, SV, TV, FV dynamic variables that are automatically collected in the 1734sc-IExCH Input Tag.

HART PVStatus, SVStatus, TVStatus, FVStatus are known as Device Variable Status values. These Status values are composed of groups of bits that indicate the quality of the associated device variable.


Process Data Status
11 Good
01 Poor Accuracy
10 Manual/Fixed
00 Bad

Limit Status
11 Constant
01 Low Limited
10 High Limited
00 Not Limited

Device Family Specific Status
More Device Variable Status Available
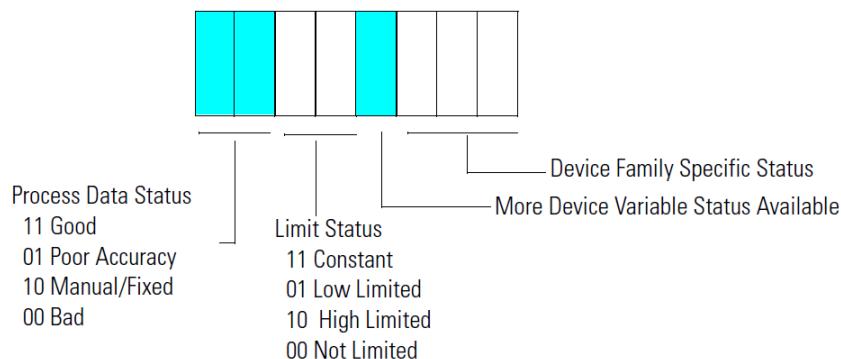
Table B-5 (HART PV, SV, TV, and FV Status Values)

HART PV, SV, TV FV Status Values			Quality		Limit		More Status Available?		Device Family Specific			
Decimal									Hex	Binary	Binary	Decimal
0	0	00000000	00	Bad	00	Not Limited	0	No	000		0	
1	1	00000001	00	Bad	00	Not Limited	0	No	001		1	
2	2	00000010	00	Bad	00	Not Limited	0	No	010		2	
3	3	00000011	00	Bad	00	Not Limited	0	No	011		3	
4	4	00000100	00	Bad	00	Not Limited	0	No	100		4	
5	5	00000101	00	Bad	00	Not Limited	0	No	101		5	
6	6	00000110	00	Bad	00	Not Limited	0	No	110		6	
7	7	00000111	00	Bad	00	Not Limited	0	No	111		7	
8	8	00001000	00	Bad	00	Not Limited	1	Yes	000		0	
9	9	00001001	00	Bad	00	Not Limited	1	Yes	001		1	
10	A	00001010	00	Bad	00	Not Limited	1	Yes	010		2	
11	B	00001011	00	Bad	00	Not Limited	1	Yes	011		3	
12	C	00001100	00	Bad	00	Not Limited	1	Yes	100		4	
13	D	00001101	00	Bad	00	Not Limited	1	Yes	101		5	
14	E	00001110	00	Bad	00	Not Limited	1	Yes	110		6	
15	F	00001111	00	Bad	00	Not Limited	1	Yes	111		7	
16	10	00010000	00	Bad	01	Low Limited	0	No	000		0	
17	11	00010001	00	Bad	01	Low Limited	0	No	001		1	
18	12	00010010	00	Bad	01	Low Limited	0	No	010		2	
19	13	00010011	00	Bad	01	Low Limited	0	No	011		3	
20	14	00010100	00	Bad	01	Low Limited	0	No	100		4	
21	15	00010101	00	Bad	01	Low Limited	0	No	101		5	
22	16	00010110	00	Bad	01	Low Limited	0	No	110		6	
23	17	00010111	00	Bad	01	Low Limited	0	No	111		7	
24	18	00011000	00	Bad	01	Low Limited	1	Yes	000		0	
25	19	00011001	00	Bad	01	Low Limited	1	Yes	001		1	
26	1A	00011010	00	Bad	01	Low Limited	1	Yes	010		2	
27	1B	00011011	00	Bad	01	Low Limited	1	Yes	011		3	
28	1C	00011100	00	Bad	01	Low Limited	1	Yes	100		4	
29	1D	00011101	00	Bad	01	Low Limited	1	Yes	101		5	
30	1E	00011110	00	Bad	01	Low Limited	1	Yes	110		6	
31	1F	00011111	00	Bad	01	Low Limited	1	Yes	111		7	
32	20	00100000	00	Bad	10	High Limited	0	No	000		0	
33	21	00100001	00	Bad	10	High Limited	0	No	001		1	
34	22	00100010	00	Bad	10	High Limited	0	No	010		2	
35	23	00100011	00	Bad	10	High Limited	0	No	011		3	
36	24	00100100	00	Bad	10	High Limited	0	No	100		4	
37	25	00100101	00	Bad	10	High Limited	0	No	101		5	
38	26	00100110	00	Bad	10	High Limited	0	No	110		6	
39	27	00100111	00	Bad	10	High Limited	0	No	111		7	
40	28	00101000	00	Bad	10	High Limited	1	Yes	000		0	
41	29	00101001	00	Bad	10	High Limited	1	Yes	001		1	
42	2A	00101010	00	Bad	10	High Limited	1	Yes	010		2	
43	2B	00101011	00	Bad	10	High Limited	1	Yes	011		3	
44	2C	00101100	00	Bad	10	High Limited	1	Yes	100		4	
45	2D	00101101	00	Bad	10	High Limited	1	Yes	101		5	

> *Note: that this Device Variable Status byte is a new HART feature in HART protocol revision 6 and many HART devices do not yet support it. For those devices, the module creates a status value based on the communication status of the device.*
>
> *If the PV, SV, TV, FV are being collected without communication errors, the value is set to 16#C0, indicating Good, Not Limited. Otherwise, the value is set to 0, indicating Bad, Not Limited, no specific information available.*

Appendix C
Manufacturer
Identification Codes

This appendix identifies the manufacturer by their assigned code.

Decimal	Hex	Company Name
1	01	Acromag
2	02	Allen-Bradley
3	03	Ametek
4	04	Analog Devices
5	05	ABB
6	06	Beckman
7	07	Bell Microsenser
8	08	Bourns
9	09	Bristol Babcock
10	0A	Brooks Instrument
11	0B	Chessell
12	0C	Combustion Engineering
13	0D	Daniel Industries
14	0E	Delta
15	0F	Dieterich Standard
16	10	Dohrmann
17	11	Endress+Hauser
18	12	ABB
19	13	Fisher Controls
20	14	Foxboro
21	15	Fuji
22	16	ABB
23	17	Honeywell
24	18	ITT Barton
25	19	Thermo MeasureTech
26	1A	ABB
27	1B	Leeds & Northup
28	1C	Leslie
29	1D	M-System Co.
30	1E	Measurex
31	1F	Micro Motion
32	20	Moore Industries
33	21	PRIME Measurement Products
34	22	Ohkura Electric
35	23	Paine
36	24	Rochester Instrument Systems
37	25	Ronan
38	26	Rosemount
39	27	Peek Measurement
40	28	Actaris Neptune

Decimal	Hex	Company Name
41	29	Sensall
42	2A	Siemens
43	2B	Weed
44	2C	Toshiba
45	2D	Transmation
46	2E	Rosemount Analytic
47	2F	Metso Automation
48	30	Flowserve
49	31	Varec
50	32	Viatran
51	33	Delta/Weed
52	34	Westinghouse
53	35	Xomox
54	36	Yamatake
55	37	Yokogawa
56	38	Nuovo Pignone
57	39	Promac
58	3A	Exac Corporation
59	3B	Mobrey
60	3C	Arcom Control System
61	3D	Princo
62	3E	Smar
63	3F	Foxboro Eckardt
64	40	Measurement Technology
65	41	Applied System Technologies
66	42	Samson
67	43	Sparling Instruments
68	44	Fireye
69	45	Krohne
70	46	Betz
71	47	Druck
72	48	SOR
73	49	Elcon Instruments
74	4A	EMCO
75	4B	Termiflex Corporation
76	4C	VAF Instruments
77	4D	Westlock Controls
78	4E	Drexelbrook
79	4F	Saab Tank Control
80	50	K-TEK
81	51	SENSIDYNE, INC
82	52	Draeger
83	53	Raytek
84	54	Siemens Milltronics PI
85	55	BTG
86	56	Magnetrol
87	58	Metso Automation
88	59	Siemens Milltronics PI
89	59	HELIOS
90	5A	Anderson Instrument Company
91	5B	INOR
92	5C	ROBERTSHAW
93	5D	PEPPERL+FUCHS

Decimal	Hex	Company Name
94	5E	ACCUTECH
95	5F	Flow Measurement
96	60	Courdon-Haenni
97	61	Knick
98	62	VEGA
99	63	MTS Systems Corp.
100	64	Oval
101	65	Masoneilan-Dresser
102	66	BESTA
103	67	Ohmart
104	68	Harold Beck and Sons
105	69	rittmeyer instrumentation
106	6A	Rossel Messtechnik
107	6B	WIKA
108	6C	Bopp & Reuther Heinrichs
109	6D	PR Electronics
110	6E	Jordan Controls
111	6F	Valcom s.r.l.
112	70	US ELECTRIC MOTORS
113	71	Apparatebau Hundsbach
114	72	Dynisco
115	73	Spriano
116	74	Direct Measurement
117	75	Klay Instruments
118	76	CiDRA CORP.
119	77	MMG AM DTR
120	78	Buerkert Fluid Control Systems
121	79	AALIANT Process Mgt
122	7A	PONDUS INSTRUMENTS
123	7B	ZAP S.A. Ostrow Wielkopolski
124	7C	GLI
125	7D	Fisher-Rosemount Performance Technologies
126	7E	Paper Machine Components
127	7F	LABOM
128	80	Danfoss
129	81	Turbo
130	82	TOKYO KEISO
131	83	SMC
132	84	Status Instruments
133	85	Huakong
134	86	Duon System
135	87	Vortek Instruments, LLC
136	88	AG Crosby
137	89	Action Instruments
138	8A	Keystone Controls
139	8B	Thermo Electronic Co.
140	8C	ISE Magtech
141	8D	Rueger
142	8E	Mettler Toledo
143	8F	Det-Tronics
144	90	Thermo MeasureTech
145	91	DeZURIK
146	92	Phase Dynamics

Decimal	Hex	Company Name
147	93	WELLTECH SHANGHAI
148	94	ENRAF
149	95	4tech ASA
150	96	Brandt Instruments
151	97	Nivelco
152	98	Camille Bauer
153	99	Metran
154	9A	Milton Roy Co.
155	9B	PMV
156	9C	Turck
157	9D	Panametrics
158	9E	R. Stahl
159	9F	Analytical Technologies Inc.
160	A0	FINT
161	A1	BERTHOLD
162	A2	InterCorr
163	A3	China BRICONTE Co Ltd
164	A4	Electron Machine
165	A5	Sierra Instruments
166	A6	Fluid Components Intl
167	A7	Solid AT
168	A8	Meriam Instrument
169	A9	Invensys
170	AA	S-Products
171	AB	Tyco Valves & Controls
172	AC	Micro Matic Instrument A/S
173	AD	J-Tec Associates
174	AE	TRACERCO
175	AF	AGAR
176	B0	Phoenix Contact
177	B1	Andean Instruments
178	B2	American Level Instrument
179	B3	Hawk
180	B4	YTC
181	B5	Pyromation Inc.
182	B6	Satron Instruments
183	B7	BIFFI
184	B8	SAIC
185	B9	BD Sensors
186	BA	Andean Instruments
187	BB	Kemotron
188	BC	APLISENS
189	BD	Badger Meter
190	BE	HIMA
191	BF	GP:50
192	C0	Kongsberg Maritime
193	C1	ASA S.p.A.
194	C2	Hengesbach
195	C3	Lanlian Instruments
196	C4	Spectrum Controls
197	C5	Kajaani Process Measurements
198	C6	FAFNIR
199	C7	SICK-MAIHAK

Decimal	Hex	Company Name
200	C8	JSP Nova Paka
201	C9	MESACON
202	CA	Spirax Sarco Italy
203	CB	L&J TECHNOLOGIES
204	CC	Tecfluid S.A.
205	CD	Sailsors Instruments
206	CE	Roost
207	CF	KOSO
208	D0	MJK
209	D1	GE Energy
210	D2	BW Technologies
211	D3	HEINRICHS
212	D4	SIC
213	D5	HACH LANGE
214	D6	Exalon Instruments
215	D7	FAURE HERMAN
216	D8	STI S.r.l.
217	D9	Manometr-Kharkiv
218	DA	Dalian-Instruments
219	DB	Spextrex
220	DC	SIPAI Instruments
221	DD	Advanced Flow
222	DE	Rexa. Koso America
223	DF	General Monitors, Inc.
224	E0	Manufacturer Expansion
249	F9	HART Communication Foundation
24576	6000	ExSaf
24577	6001	SEOJIN INSTECH
24578	6002	TASI FLOW
24579	6003	Daihan Control
24580	6004	APM
24581	6005	ORANGE INSTRUMENTS. UK
24582	6006	BARTEC
24583	6007	Detcon
24584	6008	MSA
24585	6009	METROVAL
24586	600A	Etalon Rus
24587	600B	JOGLER
24588	600C	KSB
24589	600D	Richter CT
24590	600E	NET SAFETY
24591	600F	SECanada
24592	6010	SUPCON
24593	6011	DKK - TOA
24594	6012	Dwyer Instruments
24595	6013	FineTek
24596	6014	Top Worx Inc.
24597	6015	Hoffer Flow Controls
24598	6016	Dust Networks
24599	6017	Forbes Marshall
24600	6018	All Measures, Ltd.
24601	6019	MACTek
24602	601A	CSI

Decimal	Hex	Company Name
24603	601B	TC Fluid Control
24604	601C	Rohrback Cosasco
24605	601D	AirSprite
24606	601E	Microcyber Inc.
24607	601F	TIG
24608	6020	ifm prover Gmbh
24609	6021	FLEXIM
24610	6022	TOKIMEC.INC
24611	6023	SBEM
24612	6023	SkoFlo Industries, Inc.
24613	6024	StoneL Corporation
24614	6026	EUREKA FLOW
24615	6027	BEKA associates
24616	6028	Capstar Automation
24617	6029	Pulsar
24618	602A	Elemer
24619	602B	Soft Tech Group

Appendix D
Engineering
Unit Codes

This table maps engineering unit code numbers to their meaning and abbreviations.

Unit Codes	Description from HART Specification	Abbreviated Units
1	inches of water at 20 °C (68 °F)	inH2O (20 °C or 68 °F)
2	inches of mercury at 0 °C (32 °F)	inHg (0 °C or 32 °F)
3	feet of water at 20 °C (68 °F)	ftH2O (20 °C or 68 °F)
4	millimeters of water at 20 °C (68 °F)	mmH2O (20 °C or 68 °F)
5	millimeters of mercury at 0 °C (32 °FC	mmHg (0 °C or 32 °F)
6	pounds per square inch	psi
7	bars	bar
8	millibars	mbar
9	grams per square centimeter	g/square cm
10	kilograms per square centimeter	kg/square cm
11	pascals	Pa
12	kilopascals	kPa
13	torr	torr
14	atmospheres	atm
15	cubic feet per minute	cubic ft/min
16	gallons per minute	usg/min
17	liters per minute	L/min
18	imperial gallons per minute	impgal/min
19	cubic meter per hour	cubic m/h
20	feet per second	ft/s
21	meters per second	m/s
22	gallons per second	usg/s
23	million gallons per day	million usg/d
24	liters per second	L/s
25	million liters per day	ML/day
26	cubic feet per second	cubic ft/s
27	cubic feet per day	cubic ft/d
28	cubic meters per second	cubic m/s
29	cubic meters per day	cubic m/d
30	imperial gallons per hour	impgal/h
31	imperial gallons per day	impgal/d
32	Degrees Celsius	°C
33	Degrees Fahrenheit	°F
34	Degrees Rankine	°R
35	Kelvin	°K
36	millivolts	mV
37	ohms	ohm
38	hertz	hz
39	milliamperes	mA
40	gallons	usg

Unit Codes	Description from HART Specification	Abbreviated Units
41	liters	L
42	imperial gallons	impgal
43	cubic meters	cubic m
44	feet	ft
45	meters	m
46	barrels	bbl
47	inches	in
48	centimeters	cm
49	millimeters	mm
50	minutes	min
51	seconds	s
52	hours	h
53	days	d
54	centistokes	centistokes
55	centipoise	cP
56	microsiemens	microsiemens
57	percent	%
58	volts	V
59	pH	pH
60	grams	g
61	kilograms	kg
62	metric tons	t
63	pounds	lb
64	short tons	short ton
65	long tons	long ton
66	milli siemens per centimeter	millisiemens/cm
67	micro siemens per centimeter	microsiemens/cm
68	newton	N
69	newton meter	N m
70	grams per second	g/s
71	grams per minute	g/min
72	grams per hour	g/h
73	kilograms per second	kg/s
74	kilograms per minute	kg/min
75	kilograms per hour	kg/h
76	kilograms per day	kg/d
77	metric tons per minute	t/min
78	metric tons per hour	t/h
79	metric tons per day	t/d
80	pounds per second	lb/s
81	pounds per minute	lb/min
82	pounds per hour	lb/h
83	pounds per day	lb/d
84	short tons per minute	short ton/min
85	short tons per hour	short ton/h
86	short tons per day	short ton/d
87	long tons per hour	long ton/h
88	long tons per day	long ton/d
89	deka therm	Dth
90	specific gravity units	specific gravity units
91	grams per cubic centimeter	g/cubic cm
92	kilograms per cubic meter	kg/cubic m
93	pounds per gallon	lb/usg

Unit Codes	Description from HART Specification	Abbreviated Units
94	pounds per cubic feet	lb/cubic ft
95	grams per milliliter	g/mL
96	kilograms per liter	kg/L
97	grams per liter	g/L
98	pounds per cubic inch	lb/cubic in
99	short tons per cubic yard	short ton/cubic yd
100	degrees twaddell	°Tw
101	degrees brix	°Bx
102	degrees baume heavy	BH
103	degrees baume light	BL
104	degrees API	°API
105	percent solids per weight	% solid/weight
106	percent solids per volume	% solid/volume
107	degrees balling	degrees balling
108	proof per volume	proof/volume
109	proof per mass	proof/mass
110	bushels	bushel
111	cubic yards	cubic yd
112	cubic feet	cubic ft
113	cubic inches	cubic in
114	inches per second	in/s
115	inches per minute	in/min
116	feet per minute	ft/min
117	degrees per second	°/s
118	revolutions per second	rev/s
119	revolutions per minute	rpm
120	meters per hour	m/hr
121	normal cubic meter per hour	normal cubic m/h
122	normal liter per hour	normal L/h
123	standard cubic feet per minute	standard cubic ft/min
124	bbl liq	bbl liq
125	ounce	oz
126	foot pound force	ft lb force
127	kilo watt	kW
128	kilo watt hour	kW h
129	horsepower	hp
130	cubic feet per hour	cubic ft/h
131	cubic meters per minute	cubic m/min
132	barrels per second	bbl/s
133	barrels per minute	bbl/min
134	barrels per hour	bbl/h
135	barrels per day	bbl/d
136	gallons per hour	usg/h
137	imperial gallons per second	impgal/s
138	liters per hour	L/h
139	parts per million	ppm
140	mega calorie per hour	Mcal/h
141	mega joule per hour	MJ/h
142	british thermal unit per hour	BTU/h
143	degrees	degrees
144	radian	rad
145	inches of water at 15.6 °C (60 °F)	inH2O (15.6 °C or 60 °F)
146	micrograms per liter	micrograms/L

Unit Codes	Description from HART Specification	Abbreviated Units
147	micrograms per cubic meter	micrograms/cubic m
148	percent consistency	% consistency
149	volume percent	volume %
150	percent steam quality	% steam quality
151	feet in sixteenths	ft in sixteenths
152	cubic feet per pound	cubic ft/lb
153	picofarads	pF
154	mililiters per liter	mL/L
155	microliters per liter	microliters/L
156	percent plato	% plato
157	percent lower explosion level	% lower explosion level
158	mega calorie	Mcal
159	Kohms	kohm
160	mega joule	MJ
161	british thermal unit	BTU
162	normal cubic meter	normal cubic m
163	normal liter	normal L
164	standard cubic feet	normal cubic ft
165	parts per billion	parts/billion
235	gallons per day	usg/d
236	hectoliters	hL
237	megapascals	MPa
238	inches of water at 4 °C (39.2 °F)	inH2O (4 °C or 39.2 °F)
239	millimeters of water at 4 °C (39.2 °F)	mmH2O (4 °C or 39.2 °F)

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Getting Technical Assistance

Note that your module contains electronic components which are susceptible to damage from electrostatic discharge (ESD). An electrostatic charge can accumulate on the surface of ordinary plastic wrapping or cushioning material. **In the unlikely event that the module should need to be returned to Spectrum Controls, please ensure that the unit is enclosed in approved ESD packaging (such as static-shielding / metalized bag or black conductive container).** Spectrum Controls reserves the right to void the warranty on any unit that is improperly packaged for shipment.

RMA (Return Merchandise Authorization) form required for all product returns.

For further information or assistance, please contact your local distributor, or call the Spectrum Controls technical Support at:

USA - 425-746-9481

Declaration of Conformity

Available upon request

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