Honeywell

Experion

HART I/O

Implementation Guide

EP-DCX234
R301.1
11/06

Notices and Trademarks

Copyright 2006 by Honeywell International Inc.
Release 301.1 **November 27, 2006**

While this information is presented in good faith and believed to be accurate, Honeywell disclaims the implied warranties of merchantability and fitness for a particular purpose and makes no express warranties except as may be stated in its written agreement with and for its customers.

In no event is Honeywell liable to anyone for any indirect, special or consequential damages. The information and specifications in this document are subject to change without notice.

Honeywell, PlantScape, Experion, and **TotalPlant** are registered trademarks of Honeywell International Inc.

Other brand or product names are trademarks of their respective owners.

Honeywell International

Process Solutions

2500 West Union Hills

Phoenix, AZ 85027

1-800 343-0228

About This Document

This document provides information for implementing HART I/O functionality in Experion. In this implementation guide, planning, installation, configuration and operation of HART-capable I/O modules and HART devices are covered.

Release Information

Document Name	Document ID	Release Number	Publication Date
HART I/O Implementation Guide - hartc	EP-DCX234	301.1	11/06

References

The following list identifies all documents that may be sources of reference for material discussed in this publication.

Document Title

Contacts

World Wide Web

The following Honeywell web sites may be of interest to Process Solutions customers.

Honeywell Organization	WWW Address (URL)
Corporate	*http://www.honeywell.com*
Honeywell Process Solutions	*http://hpsweb.honeywell.com*

Telephone

Contact us by telephone at the numbers listed below.

Location	Organization	Phone
United States and Canada	Honeywell IAC Solution Support Center	1-800-822-7673
Europe	Honeywell TAC-EMEA	+32-2-728-2704
Pacific	Honeywell Global TAC - Pacific	1300-300-4822 (toll free within Australia) +61-8-9362-9559 (outside Australia)
India	Honeywell Global TAC - India	+91-20-2682-2458
Korea	Honeywell Global TAC - Korea	+82-2-799-6317
People's Republic of China	Honeywell Global TAC - China	+86-10-8458-3280 ext. 361
Singapore	Honeywell Global TAC - South East Asia	+65-6580-3500
Taiwan	Honeywell Global TAC - Taiwan	+886-7-323-5900
Japan	Honeywell Global TAC - Japan	+81-3-5440-1303
Elsewhere	Call your nearest Honeywell office.	

Symbol Definitions

The following table lists those symbols used in this document to denote certain conditions.

Symbol	Definition
	ATTENTION: Identifies information that requires special consideration.
	TIP: Identifies advice or hints for the user, often in terms of performing a task.
	REFERENCE -EXTERNAL: Identifies an additional source of information outside of the bookset.
	REFERENCE - INTERNAL: Identifies an additional source of information within the bookset.
CAUTION	Indicates a situation which, if not avoided, may result in equipment or work (data) on the system being damaged or lost, or may result in the inability to properly operate the process.
	CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. **CAUTION** symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.
	WARNING: Indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or death. **WARNING** symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.

Symbol	Definition
	WARNING, Risk of electrical shock: Potential shock hazard where HAZARDOUS LIVE voltages greater than 30 Vrms, 42.4 Vpeak, or 60 VDC may be accessible.
	ESD HAZARD: Danger of an electro-static discharge to which equipment may be sensitive. Observe precautions for handling electrostatic sensitive devices.
	Protective Earth (PE) terminal: Provided for connection of the protective earth (green or green/yellow) supply system conductor.
	Functional earth terminal: Used for non-safety purposes such as noise immunity improvement. NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national local electrical code requirements.
	Earth Ground: **Functional earth connection.** NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.
	Chassis Ground: Identifies a connection to the chassis or frame of the equipment shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.

Contents

INTRODUCTION 1

Overview 1
About documentation 2
Series A HART I/O 2
Process Manager HART Input/Output Processors (IOPs) 3
Series C I/O AI and AO modules with HART 5
Control Builder 6
HART Device Description Manager 6
Honeywell Field Device Manager (FDM) 6
Experion HART Multiplexer 6
HART I/O Implementation 6

HART BASICS 9

HART Communications Protocol 9
Signal components 9
Device Description Language and DD files 11
HART Commands 11

SERIES A HART I/O INTEGRATION 13

Overview 13

Functional Description 14
Series A HART IO Modules 14
Analog signals and HART data 14
HART device data 15
Pass-through functions and IOM channel mode 15
Update rates of dynamic and device variables 16
Detail and alarm summary displays 17
HART Commands 18

Pre-installation Considerations 19
Series A I/O module planning 19
Starting conditions and assumptions 20
Installation declaration 20
Selecting wiring and cabling 20
Reviewing CE Mark requirements 20
EMC Directive 21
Low Voltage Directive 21
Observing good wiring practices 21

Reviewing Removal and Insertion Under Power (RIUP) function guidelines 23
Observing component handling guidelines 24

SERIES A HART I/O MODULE INSTALLATION AND WIRING 25

Preparing to Install Series A HART I/O Modules 25
Before you begin 25
Prepare for installation 25
Check module components 26
Check chassis configuration 27

Installing Series A HART I/O Modules 28
Insert modules into the chassis 28
Keying the Removable Terminal Blocks (RTBs) 30
About RTB Keying 30
Key RTB to module 31

Preparing to Connect Field Wiring 33
General wiring guidelines 33
Tools needed 33

Connecting Field Wiring to RTB 34
Wiring the RTB 34

Installing the RTB 39
Assemble the RTB and housing 39
Install RTB on module 40

Other Related Installation Considerations 42
Review Remote Termination Panel (RTP) use 42
Install other modules 42

Using Remote Termination Panels (RTPs) 43
About RTPs 43
RTP models 43

Removing Series A HART I/O Modules 44
Remove RTB from the module 44
Remove the module 46

Install Replacement Series A HART I/O Module 48
Procedure 48

SERIES A HART I/O CONFIGURATION 49

About control strategy configuration 49
Implementation considerations 50
Adding a Series A HART I/O block to Project 52

Series A HART Analog Input module TC-HAI081 Configuration 55
HART AI Module – Status/Data tab 59
TC-HAI081 alarm flags 60

Series A HART Analog Output module TC-HAO081 Configuration 61
HART AO Module – Status/Data tab 66
TC-HAO081 alarm flags 68

HART DEVICE Block Configuration 69
HART DEVICE alarm flags 73

OPERATION 75

Monitoring and Interacting with Process Data 75
Using Station displays 75
Detail and alarm summary displays 76
Update rate of HART variables for Series A HART I/O modules 76
Using Control Builder Monitoring tab 77
Using Network Tools 79

HART Module Output Behaviors 80
Inactivating a Series A HART I/O module 80
Output interaction with redundant Controller switchover 81
Output Behavior in Response to Deleting HART AO module block 81

Interpreting Series A HART I/O Module LED Indications 82
Series A HART analog input module LEDs 82
Series A HART analog output module LEDs 83

Series A HART I/O Module Replacement 85
Adding, removing and replacing Series A HART I/O system components 85
General guidelines 85

Series A HART IOM Calibration 86

PM I/O AND SERIES C I/O HART INTEGRATION 87

Overview 87

Functional Description 88
PM I/O HART IOPs 88
Series C IO modules 88
Analog signals and HART data 89
HART device data 90

PM I/O AND SERIES C I/O HART CHANNEL BLOCK CONFIGURATION 95

Summary 95
IOP/IOM Hardware Installation 95
HART IOPs and IOMs 97

About control strategy configuration 98
Implementation considerations 98
To configure PM HART AI or HART AO CHANNEL blocks: 101
Parameter access and custom displays 107
Server History and Server Display tab configuration 108
Device types 108
Adding HART device types 108
Scanning for HART Dynamic/Device Variables 109
Device and Dynamic Variables 112
Disable HART on an IOC block 113

HART Device Installation/Replacement 114
Device replacement 116
Correcting a device mismatch 117
Resetting Device ID mismatch flag 119

Auto Detection Feature 120
Description 120
HART Commands used for Auto Detection 121

MONITORING PM I/O AND SERIES C IO HART 125

Using Station displays 125
Detail and alarm summary displays 126

Using Control Builder Monitoring tab 126
HART IOP/IOM status 127
HART device status 128

HART I/O Alarm and Event Behaviors 131
HART Miscellaneous behaviors 133

PM I/O HART Alarm and Event Notifications 134
Field device status notifications 134
Additional device status (Command 48) notifications 136
IOP/IOM -Generated notifications 139

HART DEVICE CONFIGURATION 143

Device Configuration Methods 143

Honeywell and Experion HART management tools 143
Configuring HART devices connected to Series A HART I/O modules 144
Configuring HART devices connected to PM I/O HART IOPs (C200 controller topology)..147
Configuring HART devices connected to Series C IOMs (C300 controller topology) 150

I/O MAINTENANCE TOOL....153

Overview 153
I/O Maintenance Tool interface 153
{1} Navigator tab 154
Module calibration using IOTOOL 159
{2} Calibration tab....160

DEVICE DESCRIPTION MANAGER UTILITY....165

Overview 165
Identifying the correct DD file and revision number....166
Installation 166
Starting Device Description Manager....166
Using Device Description Manager 167

EXPERION HART MULTIPLEXER GUIDE....173

Overview 173
HART Software Multiplexer....173

Installation 174
HART Mux installation....174
Asset Management application (FDM) installation 175

HART Mux Functionality 175
HART Mux capacity 175
HART Mux Operation....175
HART Mux startup routine....176

HART Mux User Interface....178
Launching HART Mux....178
Configure the Communication Port settings....180
User interface window....181
The Tree pane....182
Using the tree pane....182
The List pane 183
Dropdown menus 185
HART Mux toolbar....189
Status bar indications....190
Error messages....190

HART COMMANDS..... 193

Overview.....193

Command 3 – Read Dynamic Variables 193
Device standard status..... 194
Commands 11, 12 and 13 - Device ID information..... 195
Command 14 – Read Sensor information 196
Command 15 – Read Device Range information 197
Command 33 – Read Device Variables 198
Command 48 – Read Device-Specific Status 199

Tables

Figures

Figure 1 Series A HART I/O system architecture integrated with the Experion system using ControlNet media. 3
Figure 2 Process Manager I/O control hardware integration within a C200 Controller topology....4
Figure 3 Process Manager HART IOPs and Series C I/O modules within a C300 Controller topology....5
Figure 4 Series A HART I/O Device Configuration Methods 144
Figure 5 PM I/O HART IOP Device Configuration Methods 147
Figure 6 Series C I/O HART Device Configuration Methods 150

Introduction

Overview

Experion can access, interpret and display HART communicatons protocol data and status in existing Station detail displays. HART device variables and status can also be used by Experion to develop control strategies. HART device configuration is accomplished by using Control Builder's device specific configuration forms to build control hardware function blocks and develop control strategies.

Integration of HART communications protocol into Experion is accomplished using a number hardware and software components:

- **HART-enabled control hardware –**
- Series A chassis-installed HART 8-channel Analog Input and 8-channel Analog Output plug-in modules, (Series A HART I/O)
- Process Manager HART I/O Processors (16-channel AI and 16-channel AO) for use in PM I/O control hardware installations, (PM I/O HART)
- Series C I/O Analog Input and Analog Output modules both provide 16 channels for connecting HART field devices and support HART communications protocol versions 5.x and 6.0. (Series C I/O)
- **Supporting Proprietary software –**
- Experion Control Builder provides configuration forms for building control hardware function blocks and control strategies for Series A HART I/O modules, PM I/O HART IOPs, Series C I/O modules and HART field devices.
- Honeywell HART Device Description Manager which is used to read and interpret HART Device Description files and then add device specific information to the system repository.
- Honeywell Field Device Manager (FDM) is a full-featured application that provides asset management of HART device data.
- Experion HART Software Multiplexer which emulates the equivalent of HART hardware multiplexers for retrieving HART device data.

About documentation

Please note that existing information in the online documentation database called Knowledge Builder still applies for the overall Experion system. This Guide is intended to provide information about the HART I/O components only as a supplement to the existing information.

If this is a new Experion system installation, we recommend that you familiarize yourself with the contents of these other Knowledge Builder publications before reading this Guide:

- Control Hardware Planning Guide
- ControlNet Installation Guide
- Control Hardware Installation Guide

These Guides provide general planning details and installation considerations for the Experion system in general. For the sake of brevity, this Guide does not repeat the applicable general guidelines, considerations, cautions, etc. that is covered in these other Guides.

The terms IOP (used chiefly to identify Process Manager I/O Processor) and IOM are used interchangeably in this document to denote an Input/Output Module.

Series A HART I/O

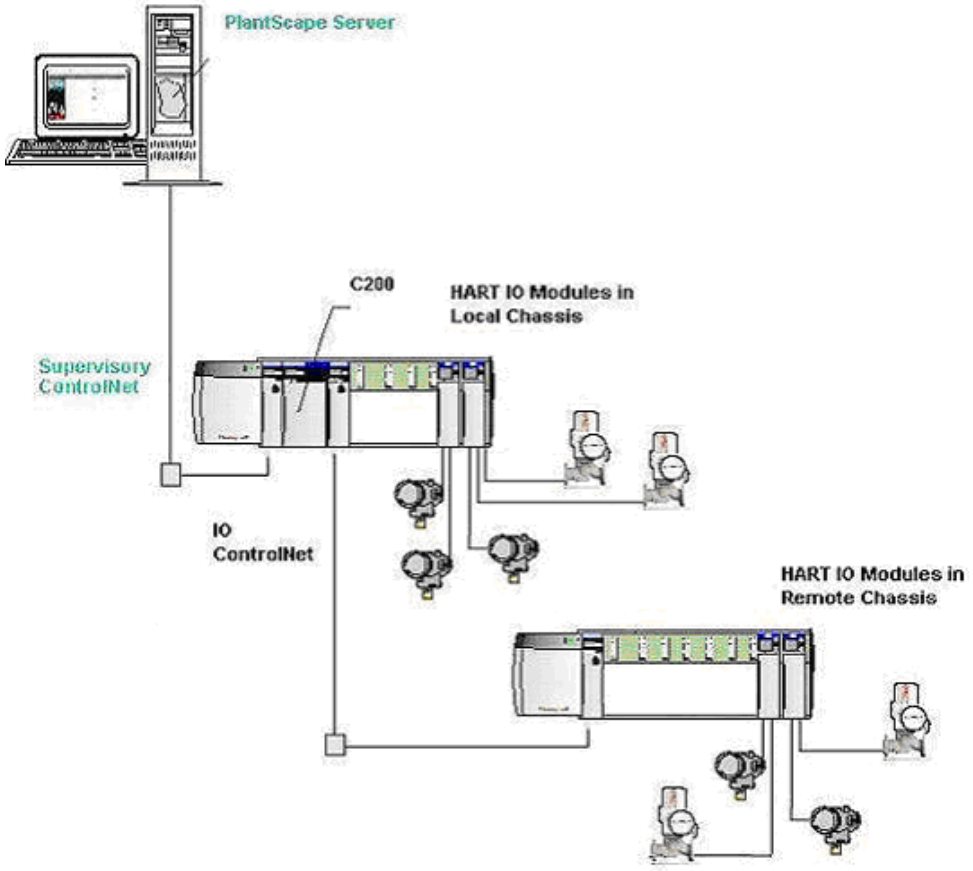
The Series A HART IOMs are designed for use in the same general-purpose locations as other Experion Control hardware components. They complement the existing Experion system Chassis I/O Modules – Series A (CIOM-A) and Rail I/O Modules – Series A (RIOM-A) and Series H (RIOM-H) components by providing a seamless integration with the ControlNet communications network.

Typical Series A HART I/O system architecture

Figure 1 shows a typical HART I/O installation that includes HART IO modules installed in a local as well as remote C200 controller chassis. ControlNet media serves as the communications link to a remote C200 controller chassis or I/O chassis.

Note: ControlNet, Ethernet and Fault Tolerant Etherent (FTE) can be used as the supervisory communications media between the server and local C200 controllers.

Figure 1 Series A HART I/O system architecture integrated with the Experion system using ControlNet media.

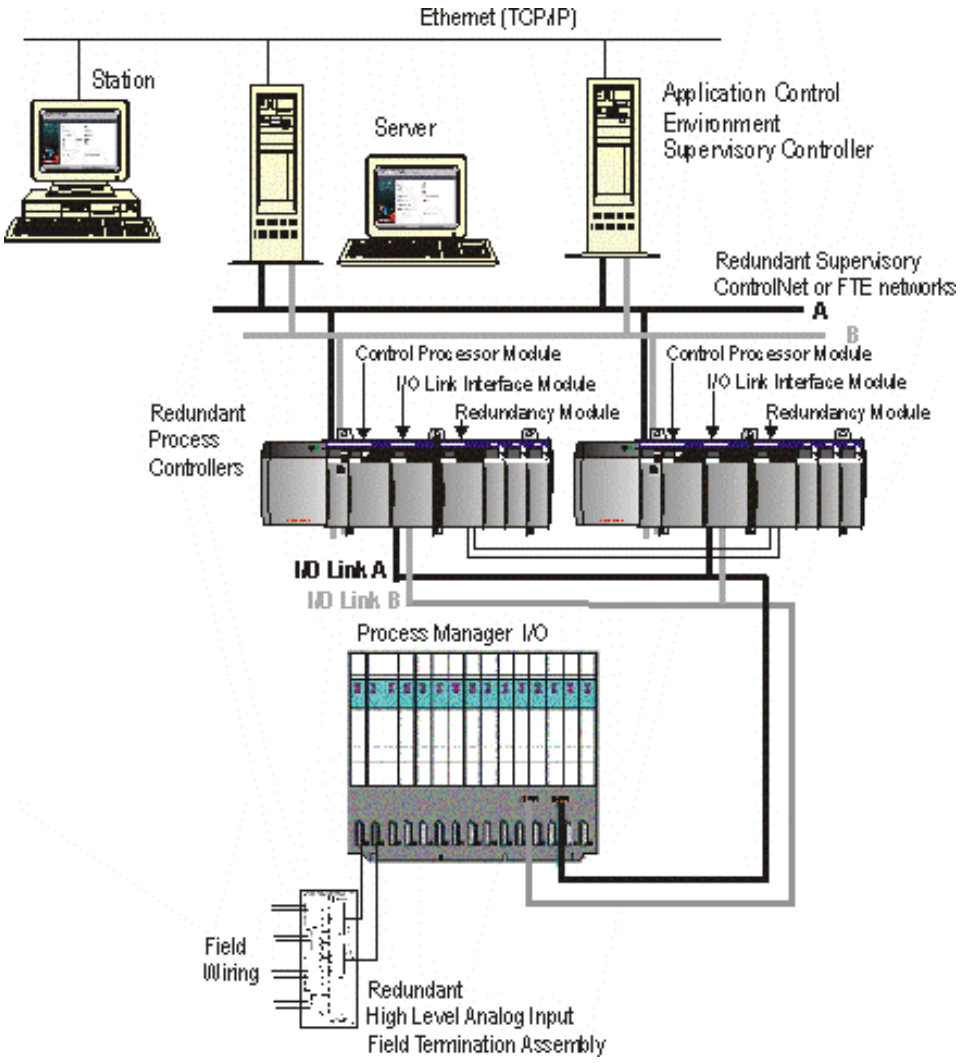


Process Manager HART Input/Output Processors (IOPs)

With Experion Release 200, two HART IOPs were introduced to the complement of Process Manager IOPs already available. A HART-enabled 16-channel analog input IOP and 16-channel analog output IOP provide redundant control operation. HART IOPs are installed in IOP card files and interface with the same hardware components (I/O Link Interface Modules and Field Termination Assemblies) as the other IOPs. Figure 2 shows the integration of Process Manager I/O control hardware in a typical Experion topology

using C200 process controllers. The I/O Link Interface Module installed in the C200 controller chassis provides the interface to the PM IO control hardware.

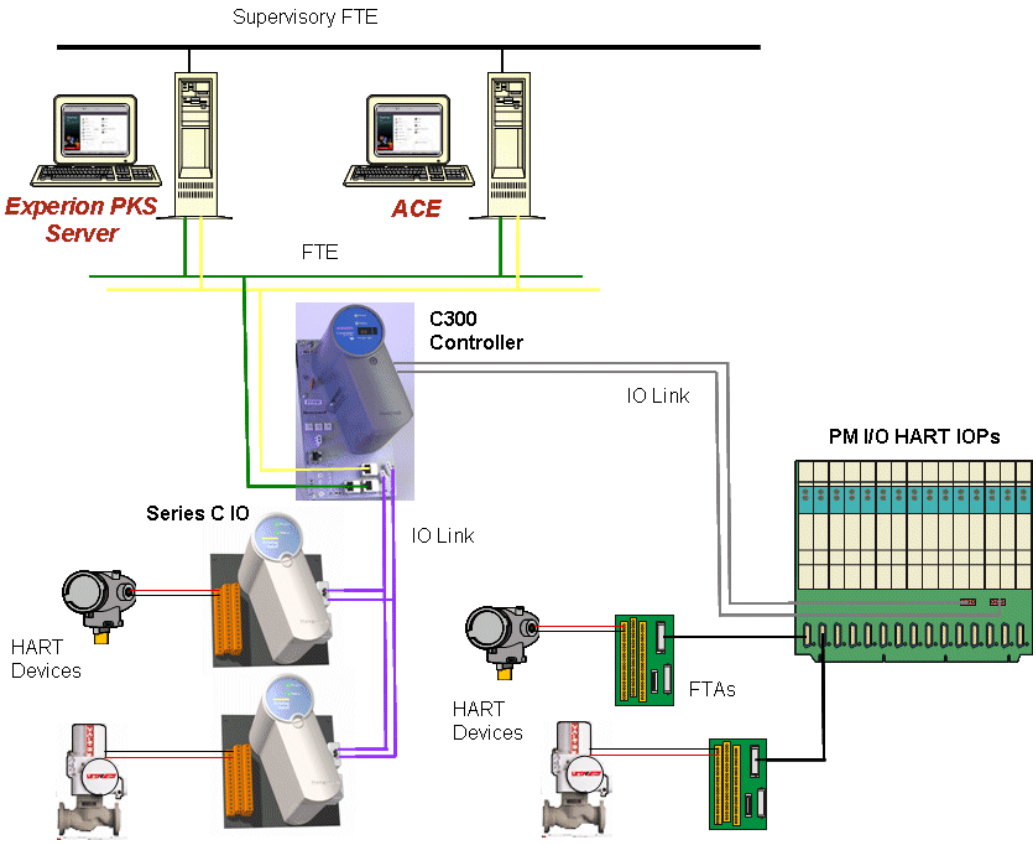
Figure 2 Process Manager I/O control hardware integration within a C200 Controller topology.



Series C I/O AI and AO modules with HART

Experion Release 300.1 introduced new Series C I/O modules that provide redundant control operation and support for HART devices. 16-channel analog input and 16-channel analog output modules can be enabled to support HART communications protocol versions 5.x and 6.0. Note also that PM I/O control hardware can be integrated into Experion when using C300 controllers. Figure 3 shows a typical Experion topology that uses C300 controllers linked to Series C IOMs and PM IOPs.

Figure 3 Process Manager HART IOPs and Series C I/O modules within a C300 Controller topology



Control Builder

Control Builder supports function block configuration for HART IO modules, HART IOPs, and HART devices. Device specific configuration forms can be added to Control Builder (via HART DD Manager) so that the system can take full advantage of HART device parameters and device status data.

HART Device Description Manager

HART Device Description Manager utility reads and interprets HART Device Description (DD) files furnished by device manufacturers so that customized configuration forms can be added to Control Builder. Additionally, Device Description Manager provides interpretation of the HART device's status bit strings and the text descriptions associated with the status bits.

Honeywell Field Device Manager (FDM)

A Honeywell standalone application that allows you to configure, manage and monitor HART devices in your system. The FDM provides device configuration management for one or a large database of of HART devices. The application can be used to detect installed HART device assets and automatically add them to the database. Information accessed from the actual connected HART device is used to establish the database record and assign the proper template.

The FDM uses the device vendor DD files to create a specific configuration template for a given HART device (by manufacturer, device type, and device revision) and supports the universal, common practice, device specific commands, and methods.

See the *Honeywell Field Device Manager User's Guide* for more information.

Experion HART Multiplexer

The HART Multiplexer utility provides the same connectivity of HART devices and retrieval of HART digital data as various other HART hardware multiplexers. The HART Mux can emulate up to 31 P+F or MTL type hardware multiplexers and interface with other HART asset management applications.

HART I/O Implementation

Various tasks are required to plan, install and commission HART IO devices in an Experion system and are outlined below.

- HART Basics – Provides a brief description of the HART communications protocol.

Series A HART Implementation

- Series A HART /IO Integration – Explains how HART communications has been integrated into the Experion control system using Series A HART I/O modules.
- Getting Started – Provides information on planning the installation of the Series A HART I/O control hardware.
- Series A HART I/O Module Installation and Wiring – Contains the procedures for installing Series A HART I/O modules and connecting the field wiring.
- Series A HART I/O Configuration – Outlines the creation and configuration of Series A HART I/O and HART DEVICE function blocks into a control strategy using Control Builder.
- Operation – Provides information on monitoring and interacting with process data, output behaviors and interpretation of the IO module LED indications.

PM I/O and Series C I/O HART Implementation

- PM I/O and Series C I/O HART Integration – Provides a functional description of the HART IO modules and how HART device data is accessed.
- PM I/O and Series C I/O HART Channel Block Configuration – Describes the creation and configuration of Process Manager I/O and Series C I/O HART Channel function blocks. Alarm and event notifications and I/O hardware behavior are also detailed in this section.

HART Implementation Utilities and Reference

- HART Device Configuration – Provides procedures for configuration of HART field devices connected to Series A HART I/O modules PM I/O HART processors and Series C IO modules.
- I/O Maintenance Tool – Describes the use of this utility to calibrate Series A HART AI and AO modules.
- HART Device Description Manager Utility – Description and use of the offline utility HART Device Description Manager in mapping DD file information into the system.
- HART Multiplexer Guide – Description and use of the Experion HART Multiplexer application.
- HART Commands – Description of several of the universal and common practice commands and how the HART IO modules use this data.

- Honeywell Field Device Manager – This application is described in and separate document contained in Knowledge Builder. See the *Honeywell Field Device Manager User's Guide* for more information.

HART Basics

HART Communications Protocol

There are nearly 500 devices from 95 different manufacturers that provide HART Foundation registered (or HART enabled) devices. These "smart" devices contain data that is specific to the identity, setup, configuration, process variables and status of the device. This data is accessed through use of the HART communications protocol.

HART protocol allows the simultaneous communication of the standard 4 to 20mA analog signal as well as a second digital communication path imposed on top of the analog signal. The digital information is communicated via Frequency Shift Keying (FSK) format that superimposes a digital signal on top of the analog signal.

See the HART Foundation's web site at hartcomm.org for more information on HART protocol, its applications and a complete listing of HART-enabled devices.

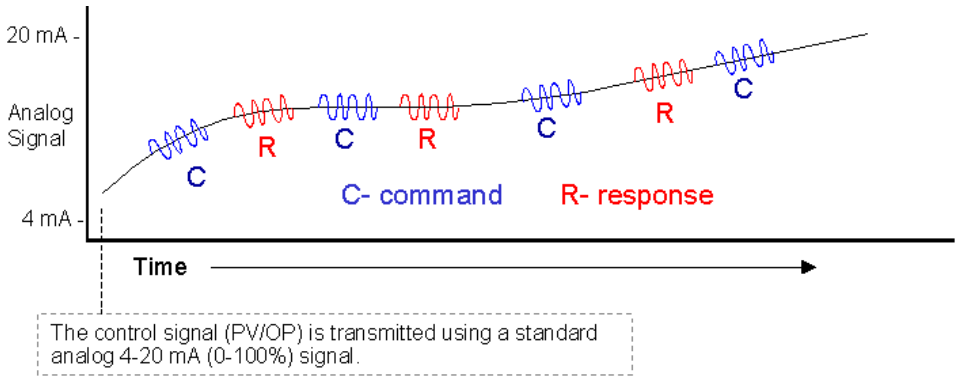
ATTENTION

All HART I/O control hardware which is part of the Experion system supports HART protocol version 5.x. Only Series C I/O supports HART protocol version 6.0

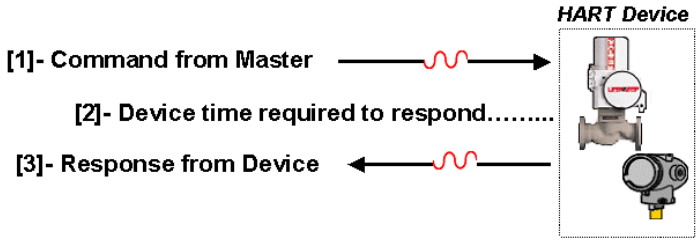
Signal components

There are two signal components to HART communications:

1. A 4 to 20 mA analog signal is the primary control signal for 0% to 100% range as shown in the following figure. For HART output devices, such as valve positioners, drives, etc., the 4 to 20 mA analog signal is generated by the control system and is used to drive the field device. For HART Input devices, such as a flow transmitters, temperature transmitters and analytical devices, the 4 to 20 mA analog signal is generated by the control system.
2. The HART digital signal that is superimposed on the 4 to 20 mA signal, (Command and Response shown in the following figure). All device data that resides in memory is accessed using HART protocol.



HART communications uses a command/response, half-duplex format to transmit commands and receive device data. Commands are issued by a master or host; the HART device is normally the slave that responds to host commands.



Device data that is received in response to commands:

- Device ID, serial number and Tag information,
- Software and Hardware revision levels
- Dynamic variables
- Device variables
- General and device-specific status information
- Range related information
- Full device setup and configuration information
- Trends and test analysis data

NOTE: You must check with each HART device manufacturer to determine what data is available in a given device type and revision.

Device Description Language and DD files

The HART protocol developed the concept called "Device Description Language" (DDL) that enables manufacturers of HART devices to define and document their products in a single consistent format. Each HART device manufacturer may create a Device Description file (DD file) for each model or type of HART device that they make. The DD file contains information about the device type, commands that are supported by the device, command 48 text descriptions and other device-specific data. The DD file is used by a host application to describe the device and to interpret messages and device status. This DD file format is readable by handheld communicators, PC's and other process interface devices that support DDL.

An off-line software utility, HART DD Manager, is supplied with Experion. This utility is used to read the DD files associated with specific HART devices and then map the information into the system repository for use by Experion. Once a DD file has been processed using HART DD Manager, a device template (configuration form) is generated to allow configuration of HART device function blocks in Control Builder. DD Manager utility also allows the system to interpret and display device status information accurately.

HART Commands

The command set for HART protocol defined by numbers and specifies three classes of commands: Universal, Common Practice and Device Specific. Some of these commands have a strictly defined structure and must be used in all HART devices. Other commands are optional and may or may not be implemented for the device. The following paragraphs briefly describe the three classes of commands used by HART.

Universal commands (0 – 30)

Universal commands represent the basic command set required by most HART devices. These commands must be supported by all HART devices and must be implemented exactly as specified by the HART foundation specification. DD interpretation is not required for universal commands.

Common Practice commands (32 – 121)

Common Practice commands are applicable to a wide range of devices. These commands provide functions implemented by many, but not all HART devices and should be supported whenever possible. Although the function of each command is well defined by the HART foundation specification, the actual meaning of the response data may require the interpretation of manufacturer's DD files.

Device Specific commands (128 – 253)

Device Specific commands are completely defined by the device manufacturer. Each command performs a function that is specific to the particular device type and model. The use of these commands requires full interpretation of the manufacturer's DD files.

Series A HART I/O Integration

Overview

Honeywell features the integration of the HART communications protocol into its Experion control system. HART digital messages now can be used in Experion to furnish expanded device status and information that HART-enabled smart devices provide. HART I/O integration into Experion includes the following components:

- Series A HART AI and HART AO chassis-installed modules that are HART Aware.

I/O Module	Model number	Description
Series A HART I/O		
Analog Input	TC-HAI081 or TK-HAI081	8-Channel HART input module
Analog Output	TC- HAO081 or TK-HAO081	8-Channel HART output module

- HART-enabled field devices that are wired directly to individual channels on the IO module.
- AI IOM and AO IOM Control Builder function blocks that support the new HART IOMs.
- A Control Builder HART Device function block. One block is required for each connected HART device.
- HART Device Description Manager utility that is used to map HART DD files and add the device information to the system repository. Templates then can be created for the configuration of HART Device function blocks.
- Experion HART Multiplexer application that emulates the functions of HART hardware multiplexerr and facilitates access to HART data.
- Honeywell Field Device Manager (FDM) asset management application that supports HART command protocol. Device configuration and commands can be generated to service HART devices.

Functional Description

Series A HART IO Modules

Two Series A HART-enabled IO modules have been developed as a primary interface to HART devices. They are designed to operate much like other existing Series A IO modules. Each HART module (AI or AO) contains eight IO channels and occupies one physical chassis slot position in a C200 controller chassis or remote IO chassis.

Additionally,

- Each IO module channel can be configured to operate as a standard analog only or HART-enabled channel
- IO Modules support only point-to-point connections, (no HART multi-drop connections).
- Each module counts as one IOM in the total allowable per C200 maximum.
- IO Modules can be used in a redundant C200 controller configuration.
- HART IO modules support all of the usual Series A certifications (FM, CE, etc.)

Analog signals and HART data

The HART AI and AO modules are optimized for control. All information needed for control is cached on the IO module and is always available to the system and the user. The IO modules handle analog signals and HART device data in the following way:

Analog Signals -

- The AI module – The 4 to 20 mA input (PV) is read, converted and published to the C200 controller, (250 ms update rate for all channels).
- The AO module – The 0 to 100% value is received from the C200 controller and then is converted to the equivalent 4 to 20 mA value, (OP), (25 ms update rate for all channels).

HART device digital data is cached on both the AI and AO modules and is available for use within the system. The data includes:

- Device ID information – such as Tag, Manufacturer, Model, Software/Hardware revision number, Serial number, Date, Descriptor, etc.
- Dynamic variables – Command 3 (PV, SV, TV, QV)
- Device variables – Command 33, Slot 0 through slot 3 (AO module only)

- Range information – Range high and range low
- Device standard status – General device condition, command and communication status
- Device-specific status – Command 48, Device specific status

NOTE: Device ID and Range information is read from the device upon startup and after a loss of communication has been restored.

HART device data

HART devices are scanned periodically for the following device data:

Dynamic variables - A Command 3 is always issued by the IO module for every channel that is HART enabled. The device values are then updated in the IO module. Update rate is approximately 6 to 8 seconds for all eight channels exclusive of HART device induced delays. Also device standard status is collected by the IO module every time a command 3 is issued to the device.

Device variables – Additional HART device variables are collected by an AO module only when slot variables are enabled. If Slot variables are enabled, a Command 33 is issued to a HART enabled device and introduces an additional update period for that channel. Slot variables are enabled on the HART Configuration tab for the AO module.

NOTE: IOM channels that are not HART enabled, and channels that are not enabled for device variables will allow HART enabled channels on the same IO module to read dynamic and device variables at a faster rate. See Update rates of dynamic and device variables for additional considerations.

Pass-through functions and IOM channel mode

All other HART data that is not cached on the IO modules is serviced through a pass-through function. HART commands and data can originate from a source other than the IO module, such as a host or HART asset management application. The IO module acts as a conduit to pass commands and data through to the HART device, or back to the host. Pass-through buffers on the IO module hold the HART data if normal scanning of IOM channels is in progress. This function allows the passing of HART commands, (whether they are universal, common practice or device-specific types), and configuration and calbration (write/read) commands through the IO module to the device.

An example of a pass-through operation may consist of the IO module to accept a HART command from the HART Software Mux and store the command in an open buffer. Then at the next opportunity, pass the command to the proper HART device. The module waits for the device to respond and then passes the response back to the originator.

An IOM channel may be placed in service; meaning that the module scans periodically for dynamic and device variables, (if enabled). Pass-through function is secondary to the collection of cached data.

When an IOM channel is placed out of service, the pass-through function is primary and cached data is no longer collected.

Update rates of dynamic and device variables

HART commands are issued to all HART enabled channels by the IO module. The IO module issues HART commands periodically, as well as upon startup and upon reconnection after a communications fault. The time that it takes to issue commands and receive the response can vary greatly.

A HART IO module issues a Command 3, Read dynamic variables, to each device on a HART enabled channel. The command/response time is approximately 800 ms per channel. So if all 8 channels of the IO module are HART enabled, the total update cycle time is about 6.4 seconds. This is the same for both the AI and AO modules.

AO modules also allow reading of up to four device variables from a HART device. So when a HART channel is enabled for device variables, the module issues an additional Command 33, Read device variables, to the device connected to the channel. Again, the command/response time is approximately 800 ms per channel. When device variables are enabled, there is a longer update cycle time for the module's HART data due to additional command/response times. The greater the number of enabled channels, the longer the update cycle time becomes for the HART data in the IO module.

Note that the update rates might need consideration in your control strategy if this data is critical to process control. The following table illustrates examples of the update rates for various configurations of HART IO modules.

HART IO Module Type	Number of Channels HART Enabled	Number of Channels Enabled for Devcie Variables	Update Rate per Module
Analog Input	2	-	1600 ms
	5	-	4 seconds
	8	-	6.4 seonds
Analog Output	2	0	1600 ms
	2	2	3.2 seconds
	4	2	4.8 seconds
	6	6	9.6 seconds
	8	4	9.6 seconds

Detail and alarm summary displays

HART device alarms and status are reported directly against the device Tag. Text descriptions of device alarms and status can be displayed through the use and interpretation of DD files. The HART DD Manager utility, supplied with Experion, provides a means for the system to interpret device-specific status information from HART devices. Device-specific information, which is derived from DD files, is mapped into the system repository and is available to the system

Each HART device block that is configured also has a dedicated detail display.

HART Commands

All HART universal type commands are supported by all HART devices and must be implemented exactly as defined by the HART foundation specification. The following are several of the universal and common practice commands with links to how the HART IO modules use this data.

Command 3 – Read dynamic variables

Command 11 – Read unique identifier associated with tag

Command 12 – Read message

Command 13 – Read tag, descriptor, date

Command 14 – Read Sensor Information

Command 15 – Read device range information

Command 33 – Read device variables

Command 48 – Read device-specific status

Pre-installation Considerations

Series A I/O module planning

There are few restrictions to Series A I/O module (IOM) placement. The restrictions (and recommendations) that do apply are as follows:

Restrictions

- Non-Redundant Controller Chassis — slots 0 through 2 are reserved for CNI modules and the Control Processor module. Additional slots beyond slot 2 may be reserved for optional CNIs, BEM, etc.
- Redundant Controller Chassis — no I/O is permitted.
- I/O Chassis — slot 0 is reserved for the CNI module.

Recommendations

- Group together IOMs of the same type such as Analog Output IOMs.
- Group IOMs with AC field wiring voltages separately from those with DC field wiring voltages.
- Group together IOMs with field wiring voltages of 30 Vdc or less.
- Group together IOMs with field wiring voltages greater than 30 Vdc.

REFERENCE - EXTERNAL

Refer to the Experion specifications for capacities and model numbers: The Experion specifications can be found on the Honeywell website: http://www.acs.honeywell.com/ . Just follow the Experion product links.

Starting conditions and assumptions

We assume that:

- You have reviewed and/or are familiar with the information provided for planning and installing a basic Experion system consisting of a Experion Server and Process Controller. This information provides general guidelines that are pertinent to overall system implementation.
- You have ordered and received your HART I/O components.

Installation declaration

ATTENTION

This equipment shall be installed in accordance with the requirements of the National Electrical Code (NEC), ANSI/NFPA 70, or the Canadian Electrical Code (CEC), C22.1. It is supplied as “open equipment” that is intended to be mounted on a sub-panel within an enclosure. The suitability of the enclosure and installed system shall be acceptable to the local “authority having jurisdiction,” as defined in the NEC, or “authorized person” as defined in the CEC.

Selecting wiring and cabling

You will need shielded, stranded 24 to 14 AWG wire for I/O connections, coaxial cable for ControlNet connections (if redundant or remotely located modules are used), and fiber optic cable type 62.5/125 micron with ST termination for fiber optic system connections.

You are responsible for selecting the wire and cable that is appropriate for your planned routing method and meets both national and local electrical and fire codes.

Since cable routes can vary from using plenum air returns to being buried underground, we suggest that you work with a cable manufacturer to select the wiring that meets your particular installation requirements. If you have access to the Internet, you can visit the Belden Wire and Cable Company web site at www.belden.com for helpful technical data on a wide variety of wire and cable types.

Reviewing CE Mark requirements

If a HART I/O component has a CE mark, it is approved for installation within the European Union and EEA regions. The HART I/O component has been designed and tested to meet the following directives.

EMC Directive

This component is tested to meet Council Directive 89//336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole or part, documented in a technical construction file:

- EN 50081-2 EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2 EMC – Generic Immunity Standard, Part 2 – Industrial Environment

This component is intended for use in an industrial environment.

Low Voltage Directive

This component is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

ATTENTION

The HART I/O equipment is classified as open equipment and must be mounted in an enclosure during operation to provide safety protection.

Observing good wiring practices

To promote electromagnetic compatibility, observe the following four general wiring practice guidelines.

Guideline 1: Be sure all inactive metal parts have a good ground connection.

- Connect all inactive metal parts, including their entire surface and with low impedance, to ground.
- Use special contact plates or remove the insulated protective layers on the contact points for screw connections on varnished or anodized metal parts.
- Avoid using aluminum parts whenever possible for grounding. Since aluminum oxidizes easily, it is not very suitable for grounding.
- Make a central connection between ground and the protective conductor.

Guideline 2: Be sure the wiring is properly run.

- Separate the wiring according to these four categories: high current, power supply, signal line and data line.
- Always run the high current wiring and signal/data line wiring in separate conduits or bundles.
- Run the signal/data line wiring in metal trays or as close as possible to bus bar, metal rails, and metal enclosure areas.

Guideline 3: Be sure the shielded wires are securely fastened.

- Use shielded cable for signal and data lines.
- Run the entire surface area of the shielded wire inside the enclosure on a shielded bus bar and fasten it with a cable clamp. Then, run the shielded signal line to the I/O module terminal connections. Remove the last 10 cm (4 in) of the shield from the signal line before connecting it to the terminal.
- Never use “pigtails” to connect the cable shield to the protective conductor.
- All shields should be grounded at one end only – preferably the I/O module end in the enclosure
- Never connect a shield to the common side of a logic circuit (this would introduce noise into the logic). Connect each shield directly to a chassis ground.
- When a distribution box is used for dividing a multicore cable into separate cables, be sure the potential of the cable shields is isolated from the metal housing of the distribution box. The distribution box must be made of metal. The metal housing can be connected to a protective conductor

Guideline 4: Make a uniform reference potential.

- If a module has individually isolated I/O or multiple isolated commons and multiple power sources are used, be sure that the difference in potential between any to power sources does not exceed the specified maximum continuous voltage that can be applied between the channels.
- Check the use of ground. It can serve as a measure of protection.
- Avoid ground loops by connecting the installations and enclosures with central and additional devices radically to the earth ground and protective conductor.

Reviewing Removal and Insertion Under Power (RIUP) function guidelines

The HART I/O modules have been designed to permit removal and insertion under power (RIUP) without damaging the module or interrupting chassis backplane communications. However, always remove field-side power, since the possibility of arcing or sparking is present anytime electrical connections are made or broken. For this reason, the use of the RIUP function is prohibited in Division 2 hazardous locations. In this case, power must be removed before removing and inserting a module.

WARNING

Always remove field-side power before removing or inserting a HART I/O module. Do not use the removal and insertion under power (RIUP) function for modules installed in a segment located in a Division 2 hazardous location.

Unless the location is known to be non-hazardous, as determined by a combustible gas detector, do not:

- connect or disconnect cables,
- remove or insert modules under power.

Other RIUP guidelines include:

- Be sure you consider the possible impact on the process before you RIUP any module.
- Minimize the number of RIUP cycles for a module or terminal base to prevent long-term damage to hardware.

Observing component handling guidelines

ESD

Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle a module:

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

Series A HART I/O Module Installation and Wiring

Preparing to Install Series A HART I/O Modules

Before you begin

Be sure you have reviewed the Pre-installation Considerations in this guide and confirmed that you have taken steps to minimize Electrostatic Discharge (ESD).

- Check that no power is applied to the chassis.
- Check that the chassis is not part of a Redundant Chassis Pair.

ATTENTION

The Series A HART Analog Input and HART Analog Output modules described in this guide are manufactured by Spectrum Controls and are labeled as such.

Prepare for installation

Verify that you have the appropriate Series A HART I/O Modules for your application as listed inTable 1.

ATTENTION

Model numbers beginning with the prefix "TK" are for a coated version of the I/O module.

Table 1 Series A HART I/O Modules Model Number Reference

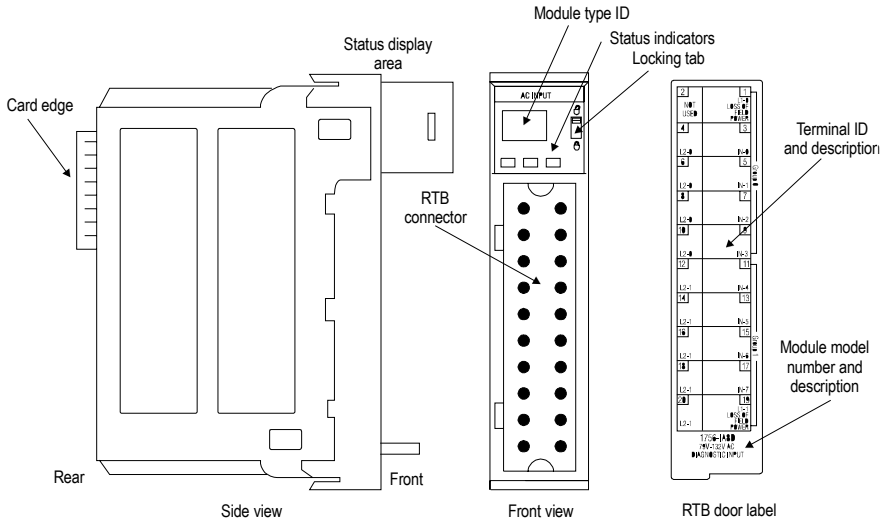
Module Type	Model Number	Description
Analog Input	TC-HAI081 or TK-HAI081	8 Channel HART, 10V / 4–20 mA Ranges: -10V to 10V, 0 to 10V, 0 to 5V, 4–20 mA
Analog Output	TC- HAO081 or TK-HAO081	8 Channel HART, 10V / 4–20 mA Ranges: -10V to 10V, 4–20 mA

Check module components

All Series A I/O modules share a similar set of common components as illustrated below. The basic module foot print is identical, as shown in the side view. Two variations of the Removable Terminal Block (RTB) connector (20- and 36-pin) provide the only significant difference in the front panel. RTB's are ordered separately and include an RTB door label (in 20 or 36 position format as appropriate) for terminal/field wiring identification. You can also order optional Remote Termination Panels including an RTB with a prewired cable. Please refer to *Using Remote Termination Panels (RTPs)* in this Guide for more information.

Common Components

All Series A HART I/O modules contain these basic components.

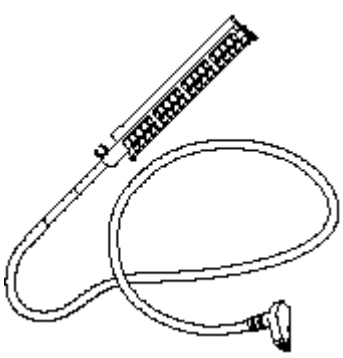


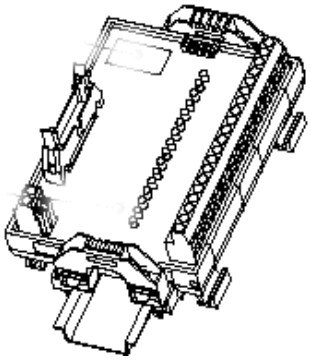
CAUTION

If using or installing a Remote Termination Panel (RTP), it is your responsibility to ensure the selected RTP meets all applicable specifications and requirements.

Optional Components

A Remote Termination Panel with pre-wired cable in standard length of 1 m (3 ft) or 2.5 m (8 ft) is available for the Series A HART I/O modules. Please see the section Using Remote Termination Panels (RTPs) for more information.





Check chassis configuration

Confirm the chassis configuration for your HART I/O module components. Be sure your planned chassis configuration complies with the configuration rules outlined in the Planning Your Chassis Configurations in the *Control Hardware Planning Guide*. And, check the I/O Module planning restrictions and recommendations outlined in the Planning Your I/O Modules and Remote Termination Panels in the *Control Hardware Planning Guide*.

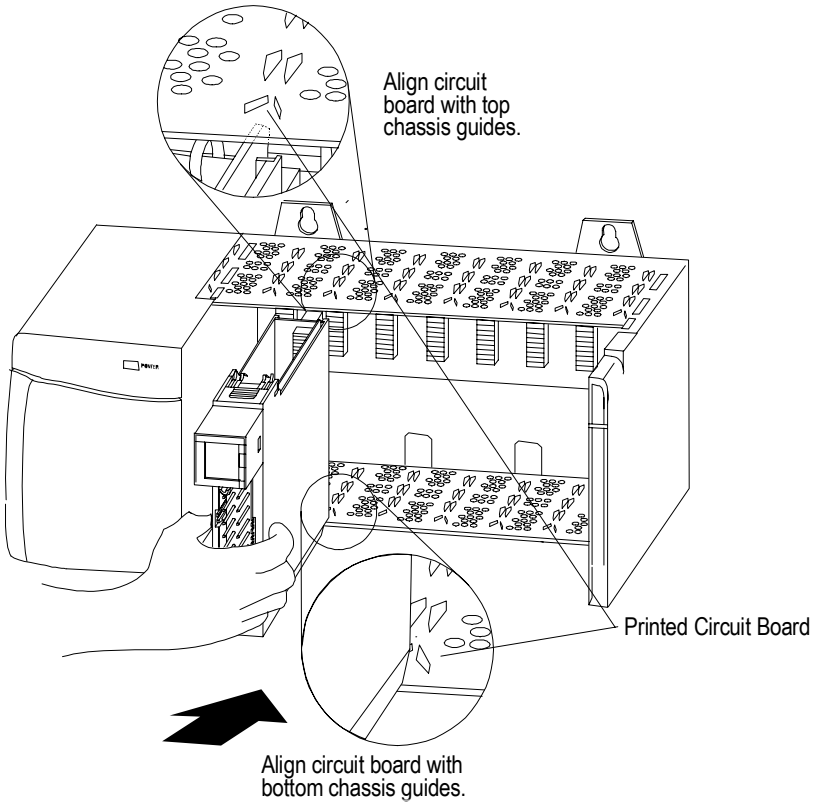
WARNING

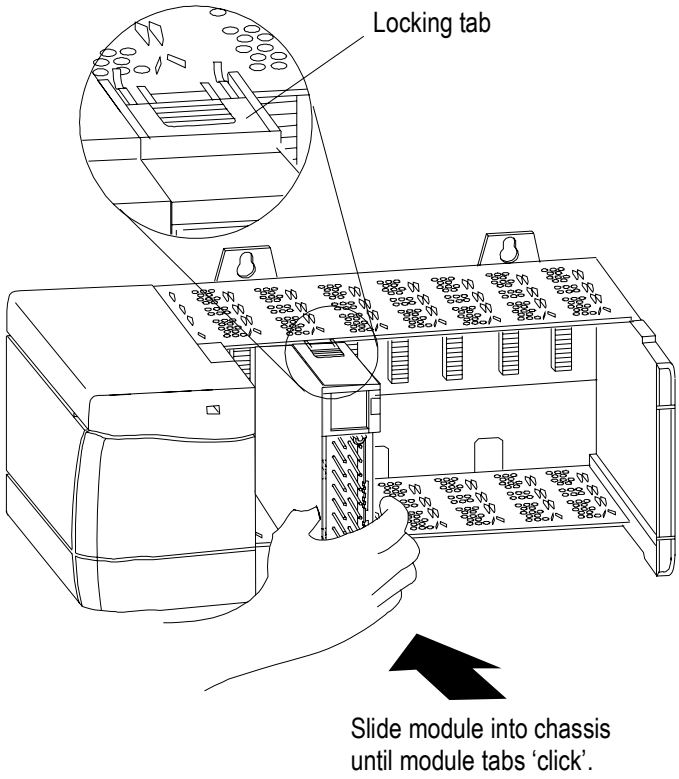
Do not install I/O modules in a redundant Controller chassis, since their data could be lost during a switchover to the backup Controller.

Installing Series A HART I/O Modules

Insert modules into the chassis

Use the following general procedure to install a Series A HART I/O module in the controller or remote I/O chassis.

Step	Action
1	Align the module's circuit board with the top and bottom chassis guide for the desired slot location. (Remember that slot numbering is zero-based and the left most slot is number "0", and it is reserved for the ControlNet Interface module.) 

Step	Action
2	Slide the module into the chassis until the module tabs “click” into position. 
3	Go to the next section **Keying the Removable Terminal Blocks (RTBs).**

Keying the Removable Terminal Blocks (RTBs)

CAUTION

Use a unique keying pattern for each module - RTB combination. This inhibits the RTB/field wiring from being connected to the wrong I/O module.

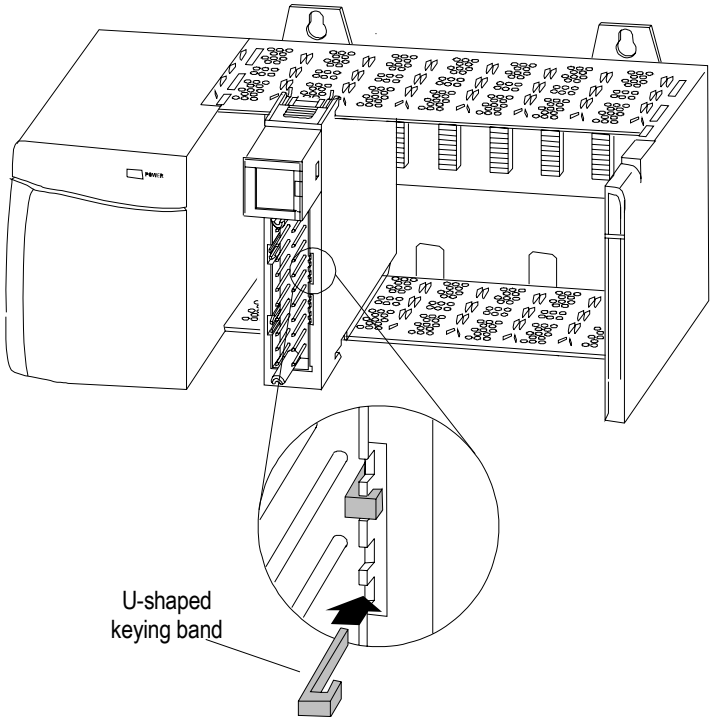
Refer to your site documentation for any predefined keying patterns or conventions.

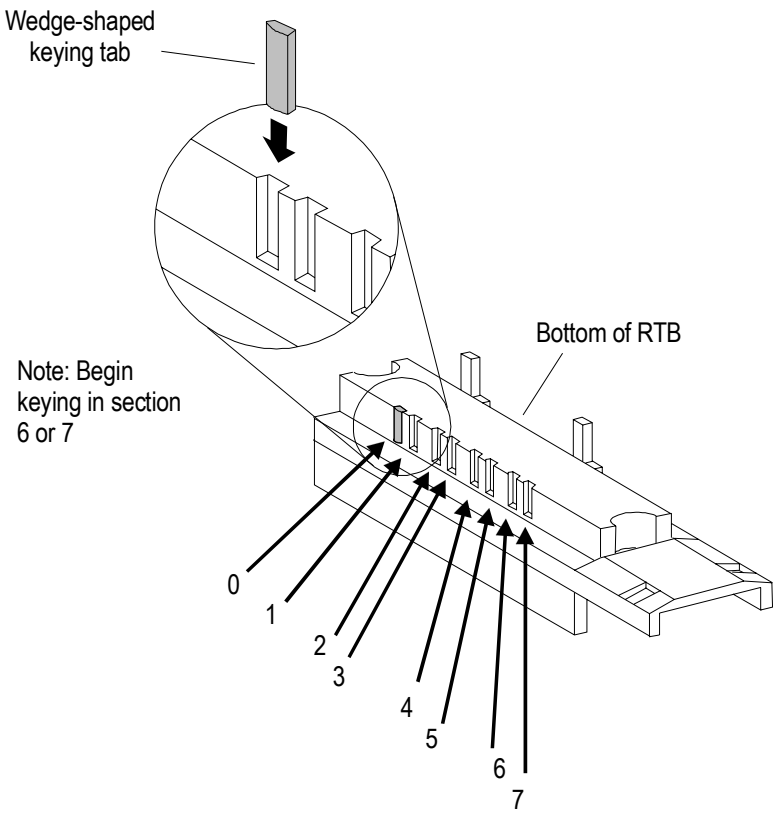
About RTB Keying

Every RTB/module combination should be keyed so that each RTB can only be installed on the module for which it was intended. This inhibits field wiring coming from one group of devices from being connected to the wrong I/O module.

RTB's include a series of slots that accept keying tabs. Similarly, I/O modules accept keying bands. As outlined in the following procedure, you insert a keying band(s) onto the module where no keying tab will be installed on the RTB. You then insert keying tabs onto the RTB in the unkeyed module positions. This then permits only the RTB that is intended for a given I/O module to be connected.

Key RTB to module

Step	Action
1	Insert the U-shaped keying band with the longer side near the terminals in the positions that correspond to the unkeyed RTB positions. Push the band onto the module until it snaps into place. 

Step	Action
2	Insert the wedge-shaped keying tab, rounded edge first, into the RTB positions that correspond to the “unkeyed” module positions. Push the tab into the RTB, until it stops. 

Preparing to Connect Field Wiring

TIP

It is easier to make field wiring connections to the RTB before it is installed on the front of the module.

General wiring guidelines

Observe the following guidelines for connecting field wiring to an RTB or optional RTP.

- Use 22 to 14 AWG shielded wire, such as Belden 8761, for field connections. You are responsible for selecting the wire that is appropriate for their application and that meets National Codes and local ordinances.
- Remove field side power before making connections to the RTB.
- Strip 8.0 to 8.3 mm (0.31 to 0.33 in) of insulation from the wire end to be connected to the RTB terminal.
- Begin wiring the RTB from the bottom terminals and move up.
- Use a tie-wrap to secure the wires in the strain relief area of the RTB.
- Connect shields to ground at the field side, whenever possible. If not possible, connect shield to the chassis functional ground.

Tools needed

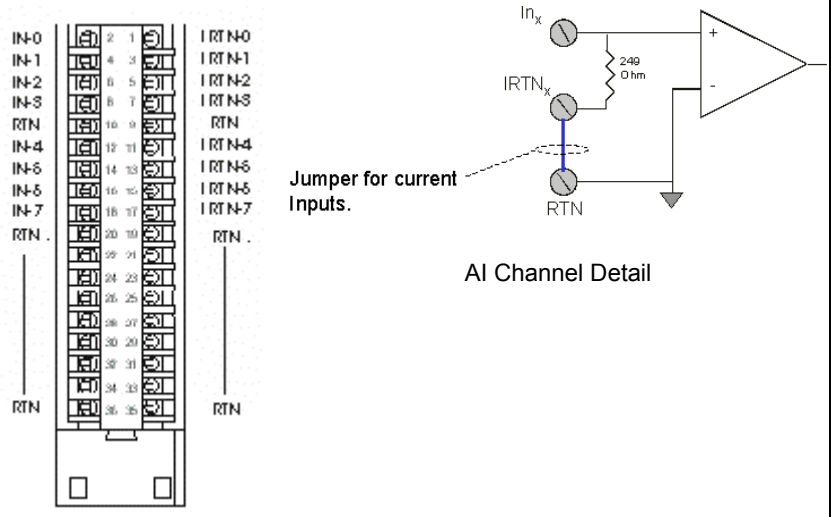
- Flat-blade screwdriver with maximum blade width of 3.2 mm (1/8 in.).
- Wire stripper/cutter.

Connecting Field Wiring to RTB

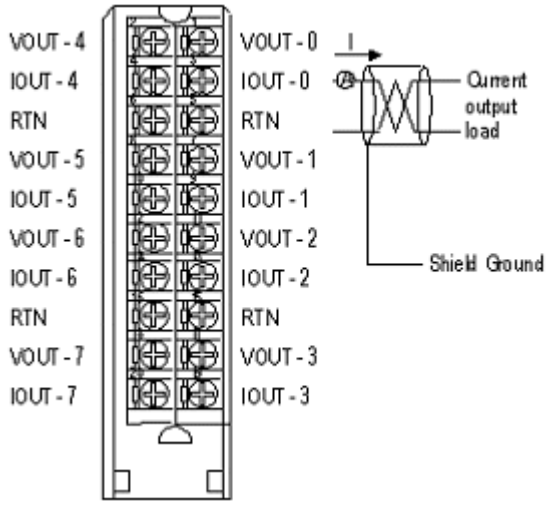
Wiring the RTB

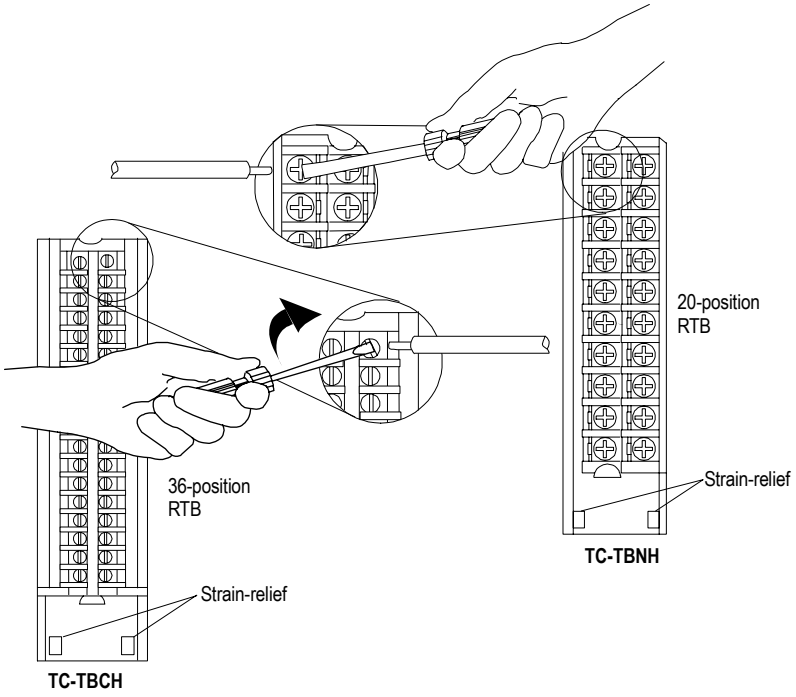
Use the following general procedure to connect field wiring to terminals on a 36-position RTB (model TC-TBCH, used on the HART AO module) or 20-position RTB (model TC-TBNH, used on the HART AO module) before installing it on the module.

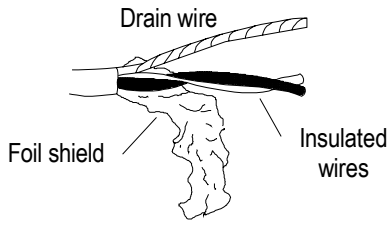
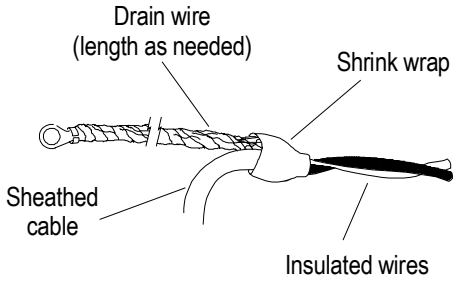
Step	Action
1	You are responsible for routing the wiring to the RTB, labeling the wiring for identification, and connecting the wiring to the correct RTB terminals. The following figures show the signal connections for the 36-pin RTB used on the Analog Input module and the 20-pin RTB used on the Analog Output module.

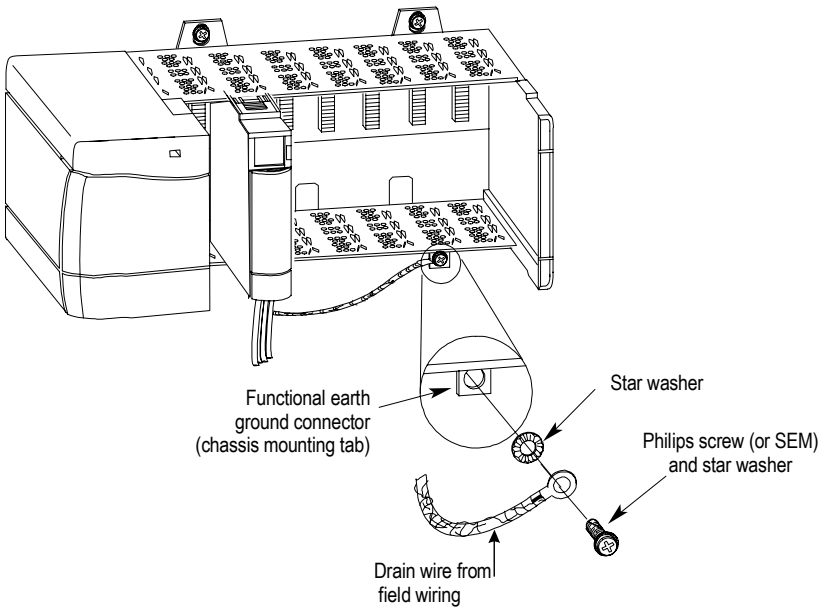


HART AI Module 36-pin RTB Connections

Step	Action
	 ***HART AO Module 20-pin RTB Connections***
2	Strip 8.0 to 8.3 mm (0.31 to 0.33 in) of insulation from the wire end to be inserted into an RTB terminal.
	ATTENTION There have been connector failures due to excessive removal of insulation from wires: • With excessive insulation removed it is possible to push the wire down into the cavity that the IO connector pin occupies. • This will cause the wire to press against the spring portion of the contact resulting in intermittent contacts.
3	Using a screwdriver, loosen the designated terminal screw for the given wire connection.

Step	Action
4	Insert the stripped wire end into the open terminal, and tighten the screw to secure the wire. 
5	Repeat Steps 2 to 4 until wiring for all field devices is connected to the correct terminals on the RTB.
6	Were you able to connect wire cable shields to ground at the field side? • If the answer is Yes, go to Step 12. • If the answer is No, go to Step 7 to connect shield to chassis functional ground.
7	If required, remove enough cable jacket to expose a sufficient length of the drain wire to reach the chassis functional ground.

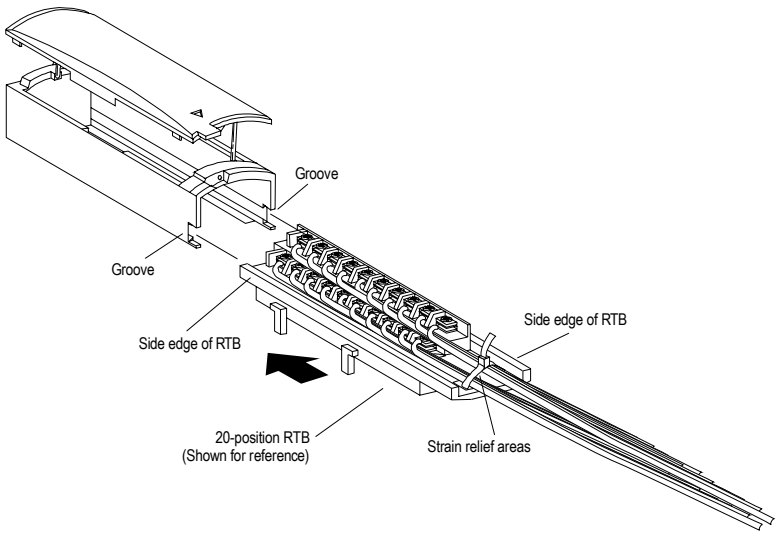
Step	Action
8	Separate the foil shield and bare drain wire from the insulated cable. 
9	Twist the foil shield and drain wire together to form a single strand.
10	Attach a wire lug, then apply heat shrink tubing to the exit area, when the drain wire is doubled-back along the insulated cable. 

Step	Action
11	Remove the screw from a bottom chassis mounting tab and connect the drain wire lug as shown below, after the RTB is installed on the module. (Note that this step assumes that the chassis is grounded. Refer to General Control Hardware Installation Requirements and Reference Figures 1 or 2 in the Control Hardware Installation Guide for chassis grounding information.) 
12	After field-side wiring is complete, secure the wires in the strain relief area with a cable tie.
13	Go to the next section **Installing the RTB**.

Installing the RTB

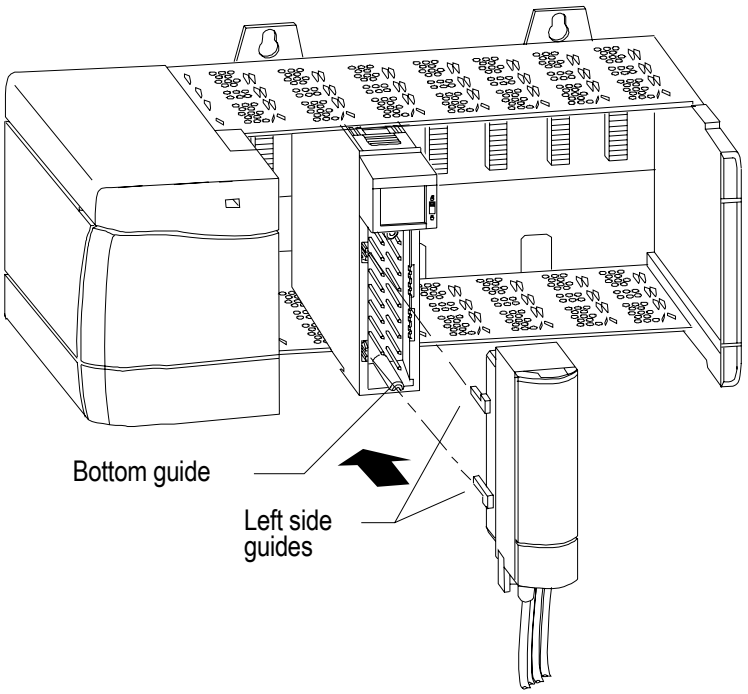
Assemble the RTB and housing

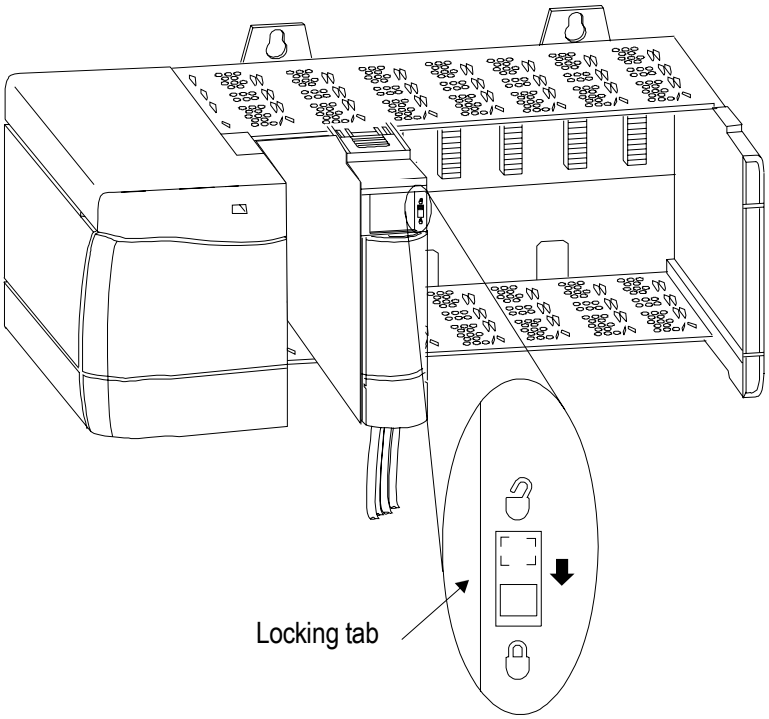
Use the following procedure to assemble the wired RTB in its housing.

Step	Action
1	Align the grooves at the bottom of each side of the housing with the side edges of the RTB.
2	Slide the RTB into the housing, until it snaps into place. 
3	Go to the next procedure **Install RTB on module**.

Install RTB on module

Use the following procedure to install the RTB on the front of the I/O module.

Step	Action
1	Align the top, bottom and left-side guides of the RTB with the guides on the module. 
2	Press quickly and evenly to seat the RTB on the module, until the latches snap into place.

Step	Action
3	Slide the locking tab down to lock the RTB onto the module. 

Other Related Installation Considerations

Review Remote Termination Panel (RTP) use

Since an optional RTP can be used in place of an RTB to connect field wiring to a HART I/O module, Refer to the Using Remote Termination Panels (RTPs) in this Guide for more information on using an RTP instead of an RTB.

Install other modules

Install the other modules planned for the chassis configuration as outlined in applicable sections of this Guide. Refer to Planning Your Chassis Configurations in the *Control Hardware Planning Guide* for more information about chassis configuration, including default module placement and redundant Controller considerations.

Using Remote Termination Panels (RTPs)

About RTPs

Remote Termination Panels (RTPs) allow you to connect I/O modules to termination strips by connecting one end of a cable to the front of the I/O module and the other end to a DIN rail mounted Interface Module (IFM). You can then connect your field wiring to the IFM terminal strip.

RTP models

The following table lists the available RTPs and associated RTP cable options for each HART I/O module. For complete information on installation and setup of an RTP, refer to the documentation that accompanies the RTP.

I/O Model #	RTP Model #	RTP Cable Options	Comment
Analog Input			
TC-HAI081 or TK-HAI081	1492-AIFM8-3 1492-AIFM8-F-5	1492-HWACAB010TB 1492-HWACAB025TB	Current
Analog Output			
TC-HAO081 or TK-HAO081	1492-AIFM8-3	1492-HWACAB010WB 1492-HWACAB025WB	Current

Removing Series A HART I/O Modules

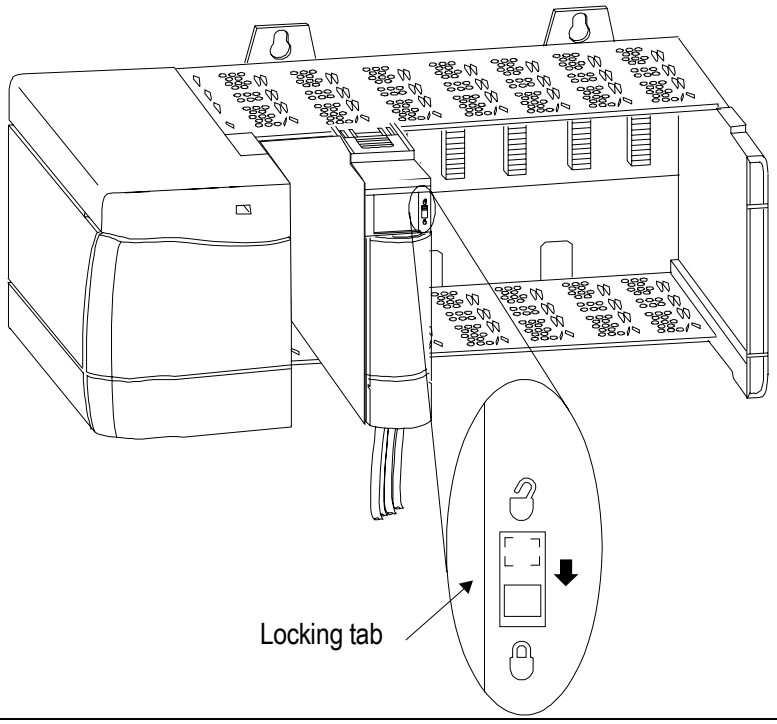
Remove RTB from the module

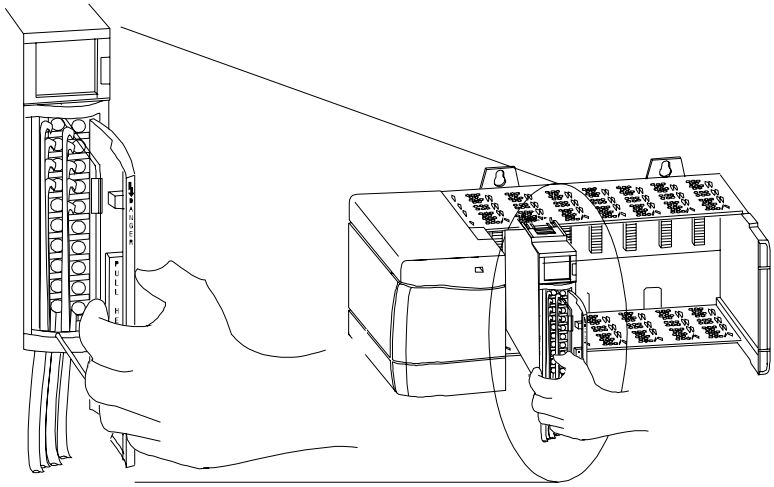
WARNING

We recommend that you remove field-side power before removing the RTB from the module. If you must remove or insert an RTB with field-side power applied, please note:

- The RTB will be electrically live. Do not touch the RTB's terminals.
- Unintended machine motion or loss of process control can occur.

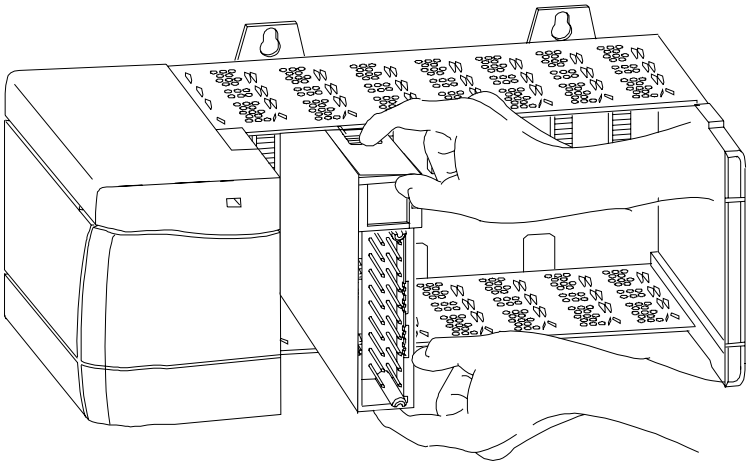
Use the following procedure to remove the RTB from an I/O module.

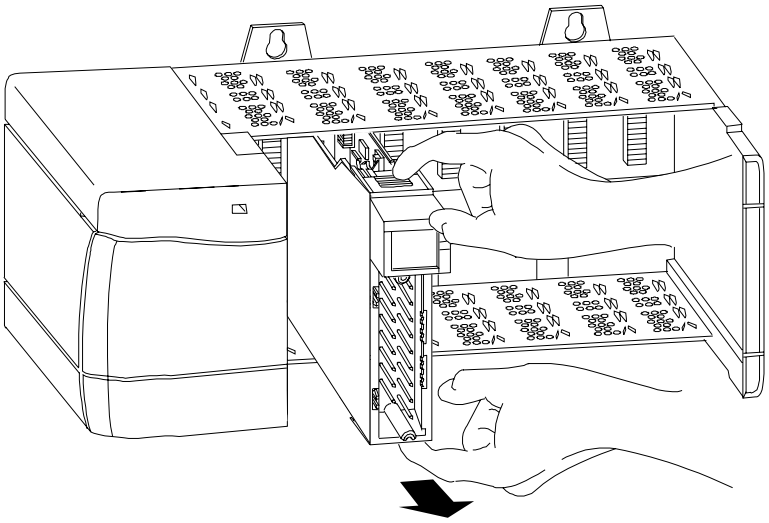
Step	Action
1	Unlock the locking tab at the top of the module. 

Step	Action
2	Open the RTB door, using the bottom tab.
3	If a shield for field wiring is connected to a bottom chassis mounting tab, disconnect it now.
4	Hold the spot marked **Pull Here**, and pull the RTB off the module. 
5	Go to the next procedure **Remove the module**.

Remove the module

Use the following procedure to remove the I/O module from the chassis, once the RTB is removed as outlined in the previous procedure.

Step	Action
1	Push in the top and bottom locking tabs. 

Step	Action
2	Pull the module out of the chassis. 

Install Replacement Series A HART I/O Module

Procedure

Refer to the previous Installing Series A HART I/O Modules procedure in this Guide to insert the replacement HART I/O module into the chassis.

Once the I/O module is installed, refer to Firmware Upgrades using NetworkTools in the *Control Hardware Troubleshooting and Maintenance Guide* to update the I/O module's firmware.

ATTENTION

You are responsible for checking that replacement modules have the appropriate firmware. This includes verifying that replacement modules pass their powerup diagnostics.

Series A HART I/O Configuration

About control strategy configuration

You use the Experion Control Builder application to configure a process control strategy using predefined function blocks. Control Builder includes Series A HART I/O module function blocks and HART Device function blocks in its Library database tab, which functionally integrate HART I/O components with Experion.

Each HART I/O function block has an associated configuration form for defining its configurable attributes. These attributes include naming and identifying the component's location within the network as well as setting module and channel specific parameters, as applicable. If you have used Control Builder to configure Series A chassis IOM blocks, you will use the same process to configure HART I/O blocks.

HART DEVICE blocks are also available as part of HART I/O integration. These function blocks represent HART devices that are connected to the individual IOM channels of Series A HART IO modules. Device-specific HART blocks can be created through the use of HART DD Manager utility.

REFERENCE - INTERNAL

Please refer to the Control Building Guide for overall information about using Control Builder to build a control strategy.

ATTENTION

The following information is only intended as a supplement to the Control Building Guide and does not repeat the basic functionality details for calling up, navigating, and interacting with the application. All the basic configuration tasks, such as assigning function blocks to a CEE and loading modules to a Controller, are the same for the HART I/O function blocks as they are for any other block.

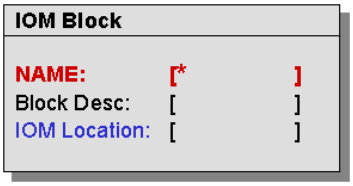
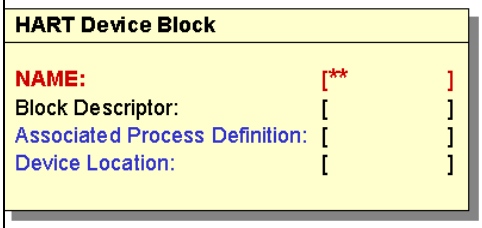
ATTENTION

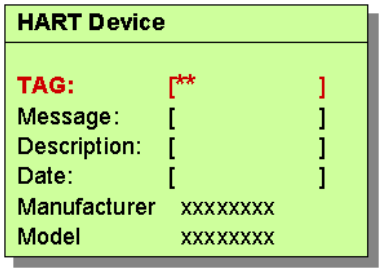
For procedures to configure HART Devices, see Series A HART Device Configuration in this guide.

Implementation considerations

A couple of things should be considered before you begin implementing HART IO into your control strategy. First, adopt a naming convention scheme will help in associating HART device and HART IOM blocks when creating a control strategy, and later when identifying HART devices in the plant. Second, Find out what HART commands are supported for the HART device that you are using in your process application. The device manufacturer should have the details.

1. Adopt some conventions for the use of block/tag names and descriptors. See examples below.

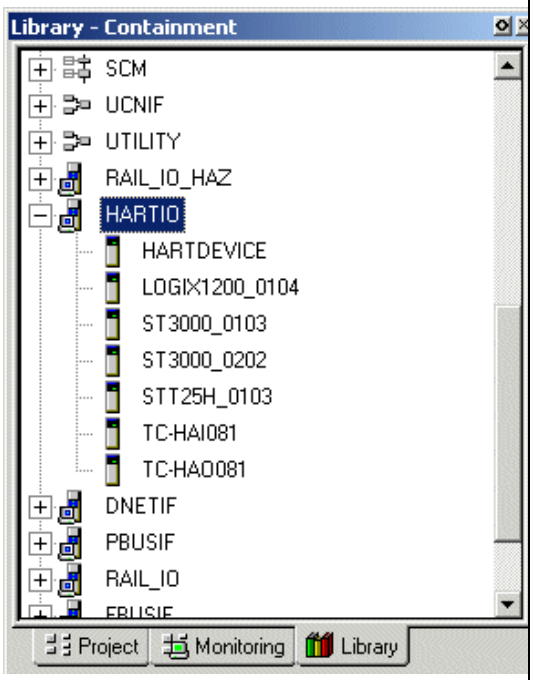
Naming Convention	HART Block and Location of Parameters
It might be helpful to include the word HART in the **IOM Block Name**. For example: HART, HRT, HAI, HAO, etc.	Main tab of HART DEVICE block configuration form 
The **HART Device Block Name** should have some relevance to the actual **Tag Name** assigned to the HART device in the field. NOTE: Device tag names are limited to 8 characters.	Main tab of HART DEVICE block configuration form 

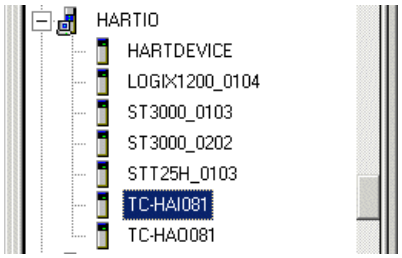
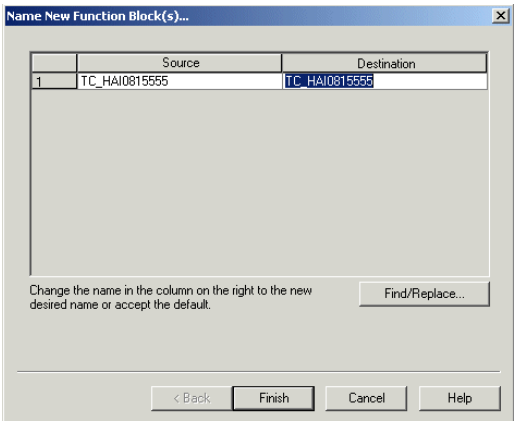
	Device Information tab of HART DEVICE block configuration form 

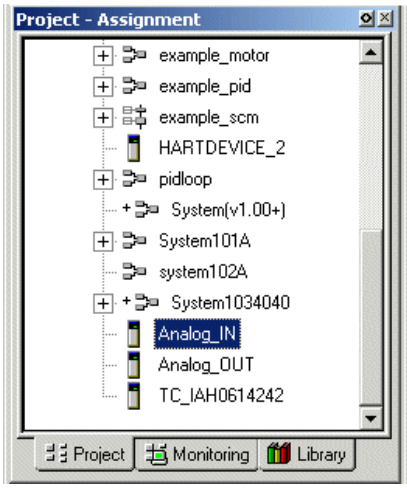
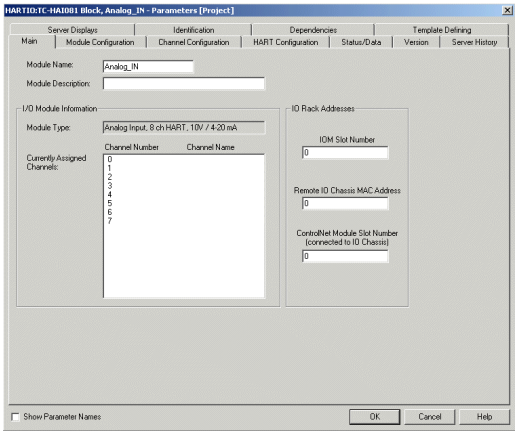
2. Find out what HART commands are supported for the HART device you are installing. Here are some questions that can be answered by the device manufacturer.

- What variables are mapped to the Dyanmic Variables (PV, SV, TV, and QV)?
- Are the Dyanmic Variables configurable?
- Does the HART device support command 33 (Device variables)?
- If so, what variables are available and where are they assigned (1 – 255)?
- Does the HART device support command 48 (Device-specific information)?
- If so, what are the definitions for the 136 ON/OFF status bits?

Adding a Series A HART I/O block to Project

Step	Action	Result
1	In the Library tab, click the + sign to the left of the HARTIO icon to expand the menu tree. Note that a number of devices under the HARTIO icon represent, • A generic HARTDEVICE, (a HART field device) • HART Analog Input Module, (TC-HAI081) • HART Analog Output Module, (TC-HAO081) Device templates can be added as desired with the HART DD Manager utility. The Flowserve LOGIX1200, Honeywell ST3000, and Honeywell STT25H listed in the menu tree are representative samples of templates for these HART devices.	

Step	Action	Result
2	Click the IOM icon for the model number of the module you want to add and drag it to the Project tab. 	The New Name Function dialog box opens. Control Builder automatically assigns a sequential IOM name to the added block, such as TC-HAI08189. 
3	Key in a new name and click the Finish button to assign it, or just click the Finish button to accept the assigned name.	Dialog box closes.

Step	Action	Result
4	Double-click the icon for the added IOM block in Project to call up the block's configuration form. 	The Main tab of the selected block configuration form opens. 
	Go to the appropriate sections that follow to configure the module and channel parameters for any of the three HART block types: – HART AI Module – HART AO Module – HART DEVICE	You can now select and enter values for the configurable parameters appearing in the block configuration forms.
5	When all configurable module and channel parameters have been entered, click OK on the configuration form to accept all configuration selections made on each configuration tab.	Return to the Project tree.

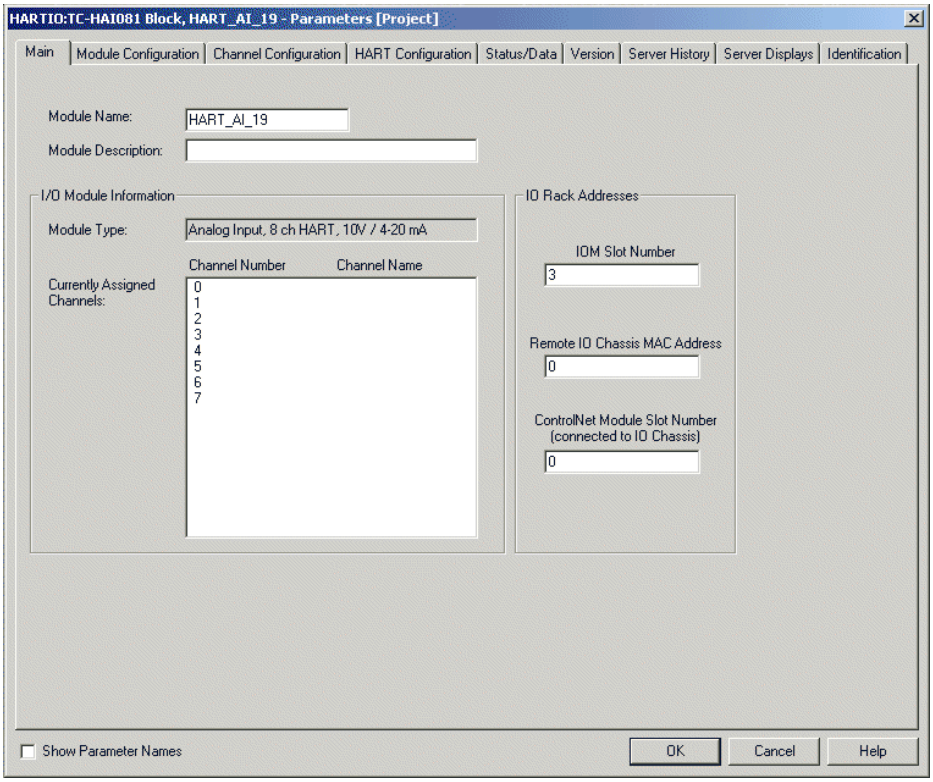
TIP

If you need additional information on any HART configuration parameter, see the *Control Builder Parameter Reference* manual that lists details about each parameter.

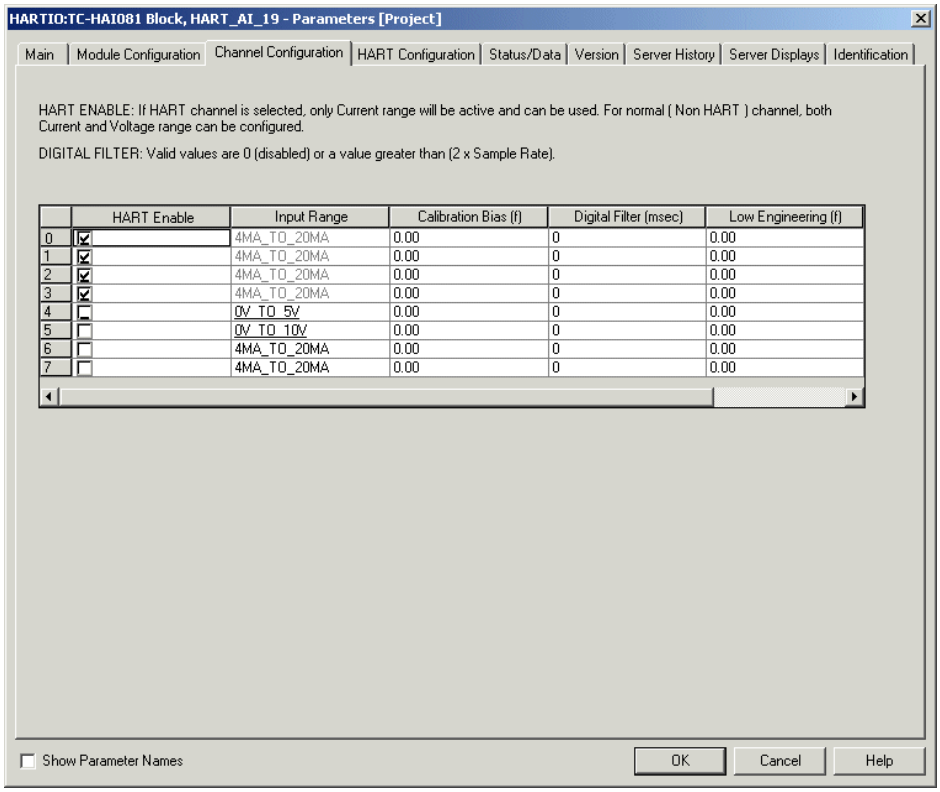
Series A HART Analog Input module TC-HAI081 Configuration

The following procedures outline the steps for configuring a Series A HART analog input module (Model TC-HAI081) and its associated channels. The following figures show configuration forms and the parameters used in configuring module/channel data for a Series A HART Analog Input module.

Step	Action
1	On the Main tab, as shown in the figure below, enter configuration parameters for the following data: • Module Name: A name that is meaningful for your process application. • Module Description (optional) to explain the IO module's function • IOM Slot Number: This corresponds to the position in the controller chassis containing the module. The slot numbers are zero-based from left to right. • Remote IO Chassis MAC Address: This corresponds to the address of the remote chassis that contains the module. • ControlNet Module Slot Number: This corresponds to the location of the downlink CNI in the I/O chassis or the controller chassis. The slot numbers are zero-based from left to right.
HART AI Module – Main tab	

Step	Action
	
2	Click on the Module Configuration tab to view the form. Check the Module Configuration tab for the following parameter data: • Alarming Enabled: Enable or disable the communications fault alarm for the module by checking or unchecking the Alarming Enabled check box. • Execution State and IO Connection Status: These fields are active only when the Analog Input module is accessed through the Monitoring tab after it has been downloaded as part of a control strategy to a controller. The Execution State lets you change the module state to INACTIVE or ACTIVE. The I/O Connection Status shows whether the module is connected or not to the ControlNet. • Sample Rate (msec): The module's sampling period is fixed at 250 milliseconds for the AI module. • 3DB Filter: The notch filter setting is fixed for a 20 Hz filter.

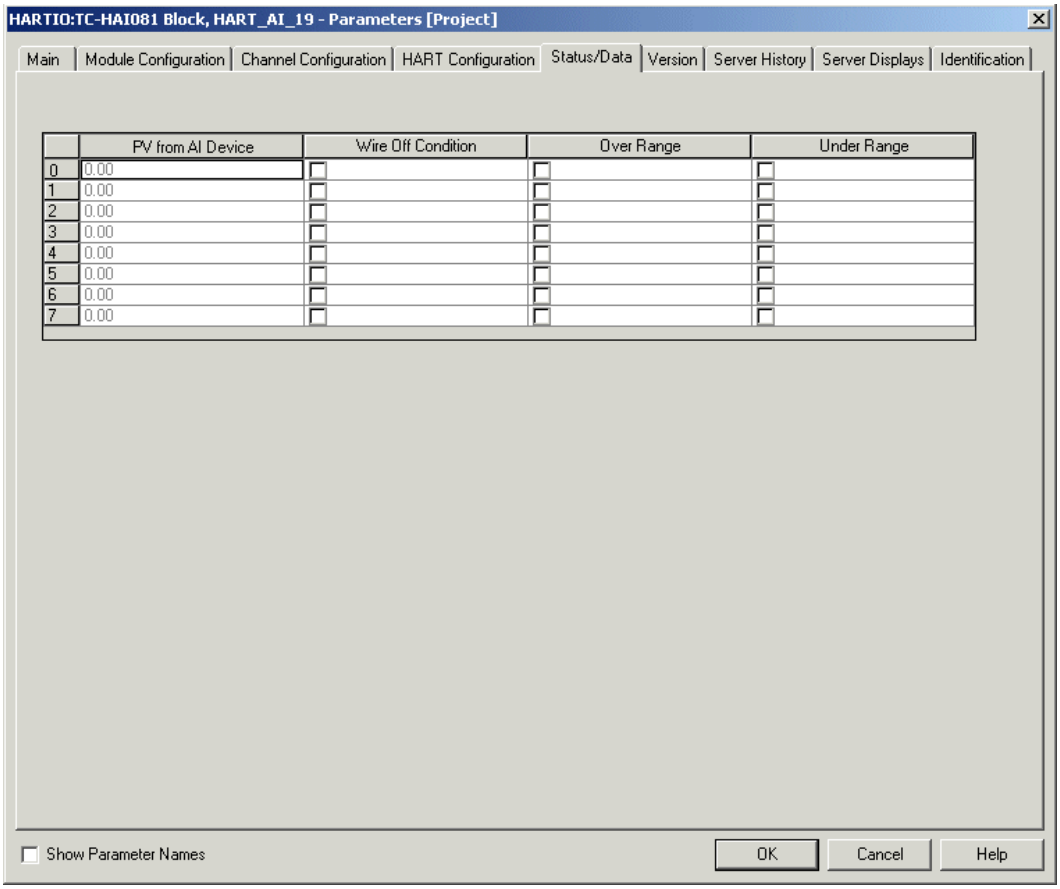
Step	Action
3	Select the Channel Configuration Tab, (shown in the following figure), and determine if any input channel of the module is connected to a HART field device. Check the HART Enable box to indicate that a HART device is connected to that channel. The IO module also supports non-HART devices, operating as an analog input module in a number of voltage ranges. Note that when a HART Enable box is checked, the Input Range values are fixed to the current range, 4MA_TO_20MA. Select one of the following Input Range parameters for any of the module's channels that does not connect to a HART field device. • -10V to +10V (Bipolar) • 0V to 5V • 0V to 10V • 4mA to 20 mA
HART AI Module – Channel Configuration tab	

Step	Action
	
	The configuration values for Calibration Bias, Digital Filter, Low Engineering and High Engineering parameters are made on a per channel basis.
4	Select the HART Configuration tab and enter values for the listed parameters: • Communication Threshold Limit: Enter a value that will trigger an alarm when communication errors equal or exceed the threshold value. Default value is 100. • Handle Timeout Value (sec.): Default timeout value is 4 seconds. • IOM Location: Enter a description of the IO module's location.
5	**Version tab** If you have a version control system license, the Version tab lets you view template properties for the selected block. Use the on-line help to see

Step	Action
	additional information on this tab.
6	**Server History and Server Displays tabs** The Server History tab is used to configure specific server parameters associated with history collection for the AI module block. The Server Displays tab is used to configure specific server parameters associated with Station displays for the AI module block. Use the on-line help as a guide to complete the configuration entries on these tabs.
7	**Identification tab** If you have a templates license, the Identification tab lets you view template properties for the selected block. Use the on-line help to see additional information on this tab. Click OK on the configuration form to accept all configuration selections made on each configuration tab and to return to the Project tree.

HART AI Module – Status/Data tab

Select the Status/Data tab, (shown in the following figure), to view the PV from each device connected to the module channel and the fault conditions associated with the PV. Note that the Status/Data form is functional only when the AI module is active in the monitoring tree of Control Builder. See *Monitoring and Interacting with Process Data* for additional information.



TC-HAI081 alarm flags

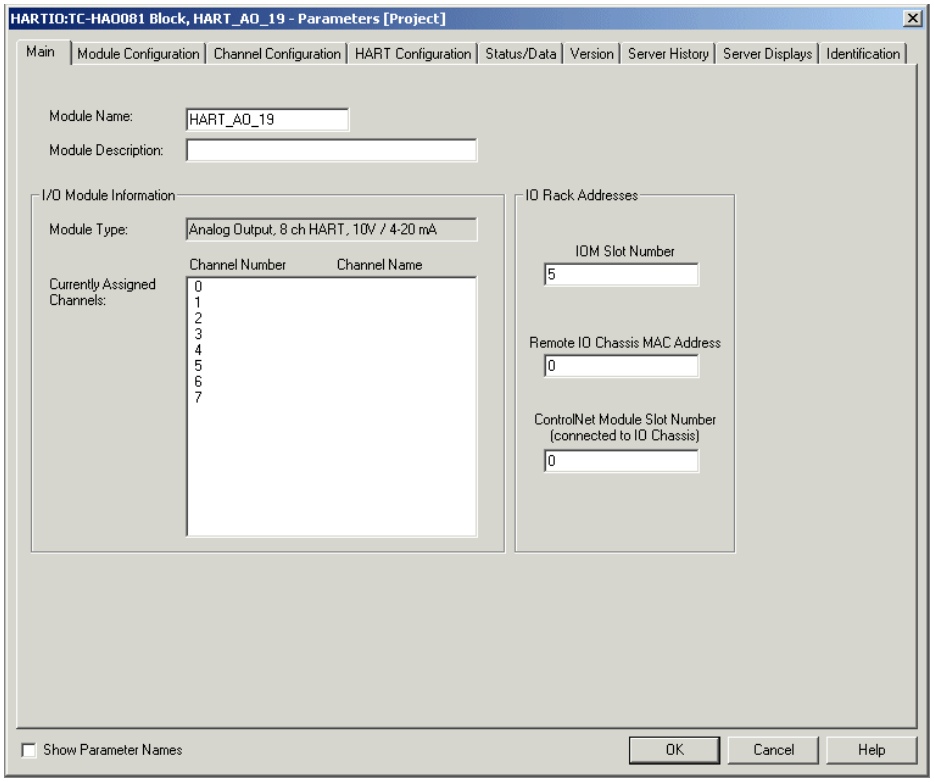
The HART Analog Input module can assert an internal flag for the following condition, when it is active. See the Module Configuration tab for the Alarm Enabled check box.

Condition	Description
Communications Fault	If enabled, indicates loss of ControlNet communications or removal of the module.

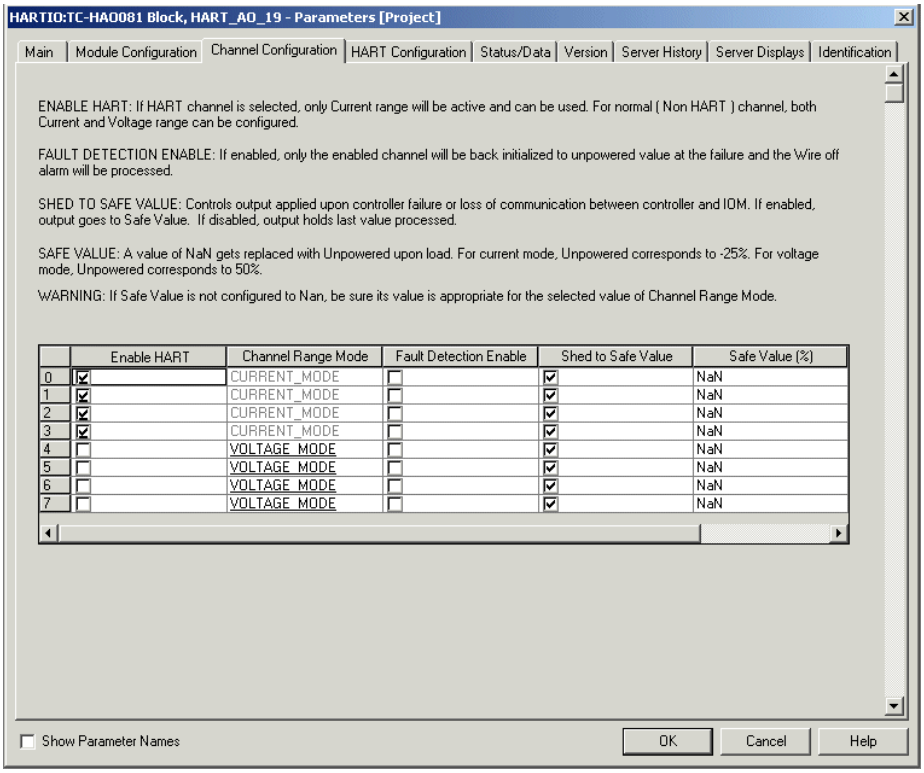
Series A HART Analog Output module TC-HAO081 Configuration

The following procedure outlines the steps for configuring a Series A HART analog output module (Model TC-HAO081) and its associated channels. The following figures show configuration forms and the parameters used in configuring module/channel data for a Series A HART Analog Output module.

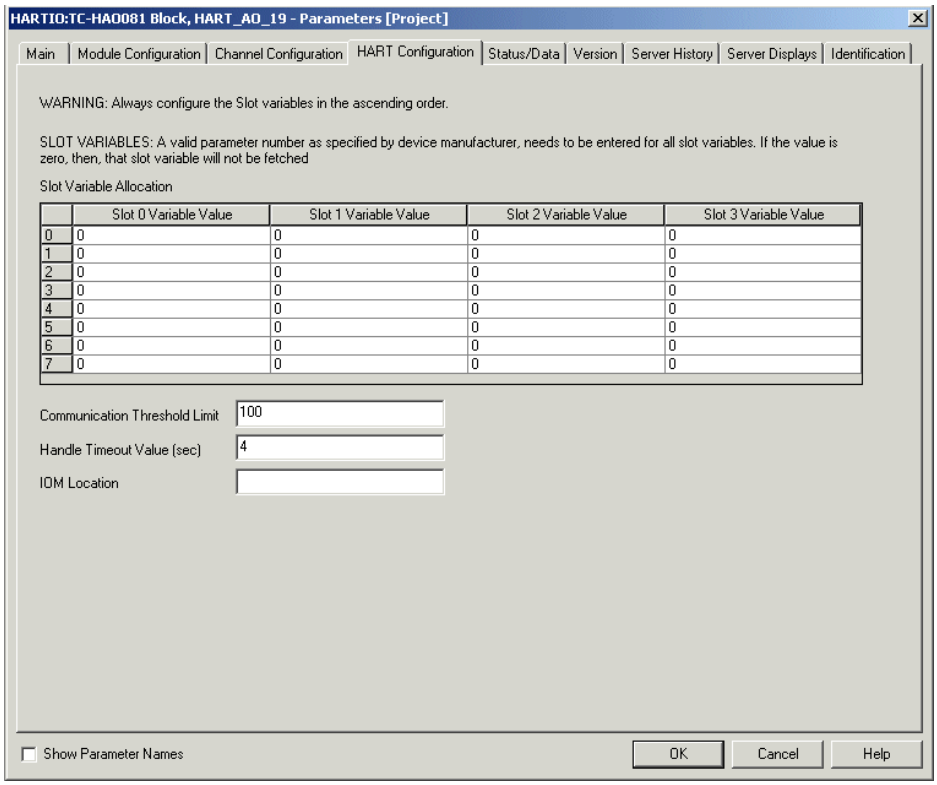
Step	Action
1	On the Main tab, as shown in the figure below, enter the configuration parameters for the following data: • Module Name: A name that is meaningful for your process application. • Module Description (optional) to explain the IO module's function • IOM Slot Number: This corresponds to the position in the controller chassis containing the module. The slot numbers are zero-based from left to right. • Remote IO Chassis MAC Address: This corresponds to the address of the remote chassis that contains this module. • ControlNet Module Slot Number: This corresponds to the location of the downlink CNI in the I/O chassis or the controller chassis. The slot numbers are zero-based from left to right
HART AO Module – Main tab	

Step	Action
	
2	Click on the Module Configuration tab to view the form. Check the Module Configuration form for the following parameter data: • Alarming Enabled: Enable or disable the communications fault or open wire alarms for the module by checking or unchecking the Alarming Enabled check box. • Execution State and IO Connection Status: These fields are active only when the Analog Input module is accessed through the Monitoring tab after it has been downloaded as part of a control strategy to a controller. The Execution State lets you change the module state to INACTIVE or ACTIVE. The I/O Connection Status shows whether the module is connected or not to the ControlNet.
3	Select the Channel Configuration tab, as shown in the folloing figure, to display parameters that are specific to each output channel of the HART AO

Step	Action
	module. Check the box to Enable HART for each channel that is connected to a HART field device. Note that when a HART Enable channel is checked, the Channel Range Mode is fixed to the CURRENT MODE. If HART Enable box is not checked, the Channel Range Mode can be either CURRENT or VOLTAGE Mode. NOTE: Some output devices that operate on two-wire loop require minimum current to communicate with the IO module. For example, the Logix (FlowServe) device requires at least 3.65 mA to communicate with the IO module. You must make sure that sufficient current is supplied to the output device so that the device can communicate with the IO module. The additional configuration parameters on this form, Fault Detection Enable, Shed to Safe Value, Safe Value, and Calibration Bias can be entered on a per channel basis.
HART AO Module – Channel Configuration tab	

Step	Action
	

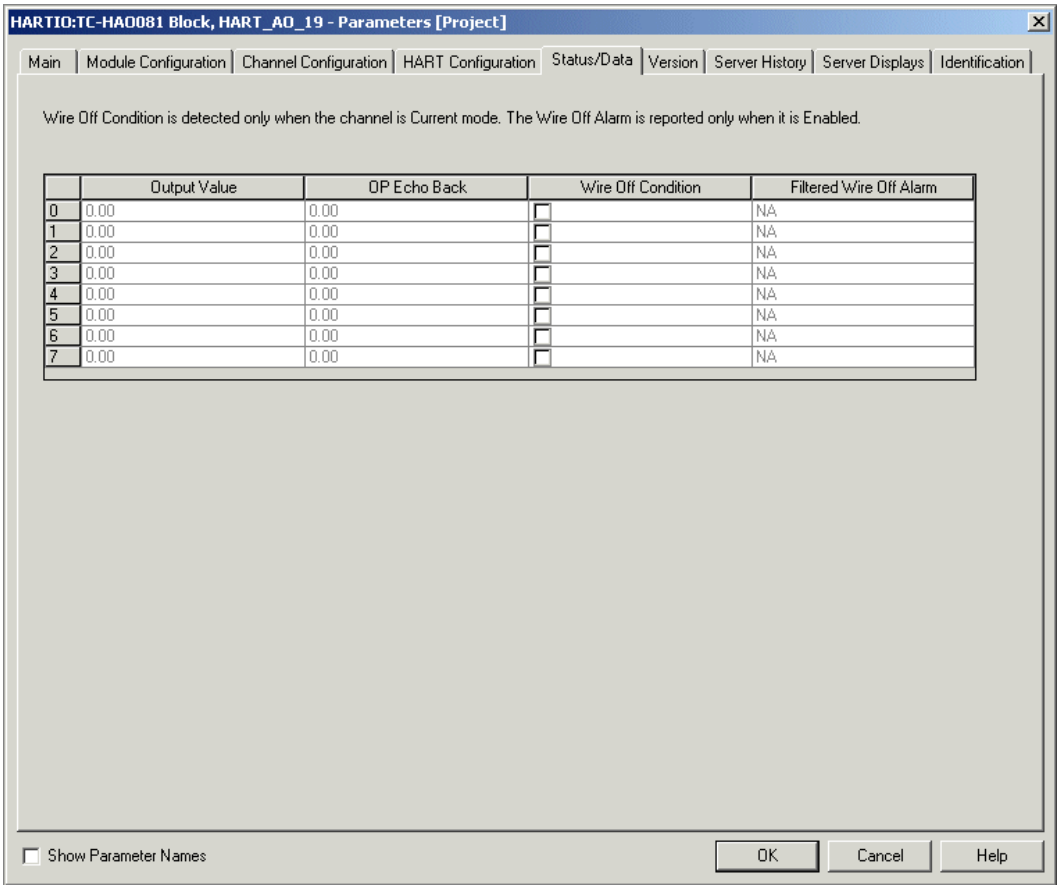
4	Select the HART Configuration tab, (shown in the following figure), to enter values for the listed parameters. • Slot Variable Value. HART device variables are read from the device when a valid value is entered in any of the slots (slot0 through slot3). Entering a valid number (1 through 255 as specified by the device manufactuer) in a slot enables the IO module to issue a command 33 and read device variables from the device. Entering zero on all slots of the channel disables the function and no command is issued. Slot Variable Values are configured on a per channel basis. NOTE: Enabling slot variables on any IOM channel increases the update cycle time of the HART data read from devices connected to that IO module. See Device update rates for additional information. • Communication Threshold Limit: Enter a value that will trigger an alarm when communication errors equal or exceed the threshold value. Default

Step	Action
	value is 100. • Handle Timeout Value (sec.): Default timeout value is 4 seconds • IOM Location: Enter a description of the IO module's physical plant location.
	HART AO Module – HART Configuration tab 
5	**Version tab** If you have a version control system license, the Version tab lets you view template properties for the selected block. Use the on-line help to see additional information on this tab.
6	**Server History and Server Displays tabs**

Step	Action
	The Server History tab is used to configure specific server parameters associated with history collection for the AO module block. The Server Displays tab is used to configure specific server parameters associated with Station displays for the AO module block. Use the on-line help as a guide to complete the configuration entries on these tabs.
7	**Identification tab** If you have a templates license, the Identification tab lets you view template properties for the selected block. Use the on-line help to see additional information on this tab. Click OK on the configuration form to accept all configuration selections made on each configuration tab and to return to the Project tree.

HART AO Module – Status/Data tab

Select the Status/Data tab, (shown in the following figure), to view the module channel's Output Values and the fault condition values associated with the outputs. Note that the Status/Data form is functional only when the AO module is active in the monitoring tree of Control Builder.


HARTIO:TC-HAO081 Block, HART_AO_19 - Parameters [Project]
Main
Module Configuration
Channel Configuration
HART Configuration
Status/Data
Version
Server History
Server Displays
Identification
Wire Off Condition is detected only when the channel is Current mode. The Wire Off Alarm is reported only when it is Enabled.
Output Value
OP Echo Back
Wire Off Condition
Filtered Wire Off Alarm
0 0.00 0.00 NA
1 0.00 0.00 NA
2 0.00 0.00 NA
3 0.00 0.00 NA
4 0.00 0.00 NA
5 0.00 0.00 NA
6 0.00 0.00 NA
7 0.00 0.00 NA
Show Parameter Names
OK
Cancel
Help

TC-HAO081 alarm flags

The HART Analog Output module can assert an internal flag for these conditions, when it is active. See the Module Configuration tab for the Alarm Enabled check box.

Condition	Description
Open Wire Fault *	For 4 to 20 mA output only, indicates whether a 'wire-off' condition exists.
Communications Fault	If enabled, indicates loss of ControlNet communications or removal of the module.
* HART AO modules do not detect a wire off condition when the outputs are at -25% (0mA). The outputs should be set to greater than 0.1mA for AO modules to detect a wire off condition.	

HART DEVICE Block Configuration

Configuration forms are available for entering module/channel data for a HART DEVICE function block. This block represents a HART device that is connected to an individual IOM channel of a Series A HART IO module and allows you to access digital HART data. One HART device block is configured for each HART device connected to the module channel terminal.

For HART devices that have Device Description (DD) files associated with them, you can create device templates that will contain device-specific HART data. Device-specific templates can be created and used by obtaining the correct DD file and using the HART Device Description Manager utility.

ATTENTION

If you are configuring a device block for a specific HART device, you must first obtain the correct Device Description (DD) file for the HART device (if available). Using the DD file and the HART DD Manager utility, DD file information will be added to the Engineering Repository Database (ERDB). Once the ERDB contains the device description information, configuration forms for that specific device will be available in Control Builder. Use the configuration forms to create device-specific HART Device blocks. This also will assure that HART device status information (Command 48) is identified and displayed accurately.

For HART devices that have no associated DD file, you can use the generic HART DEVICE template to create a HART device block. The generic HART DEVICE template can be used to define an output device which then can be associated with a HART AO module, or an input device which then can be associated with a HART AI module. The following procedure shows the configuration forms for a Generic HART DEVICE block.

NOTE: Each HART device block must be associated to a channel of a HART IO module. A device block cannot exist independently.

When associating a HART DEVICE block to an IOM channel, only one device block should be associated to one channel. Associating more than one device block to a channel will not create an error, but the data of the device blocks may be inconsistent.

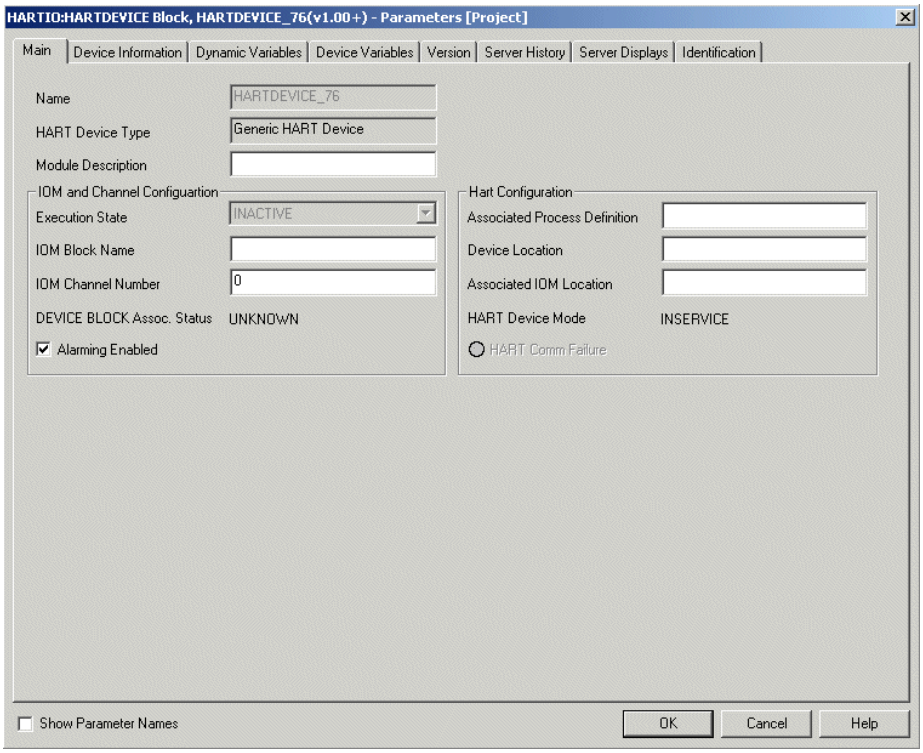
Using the Generic HART DEVICE block to identify a HART device will cause the HART DeviceType to be shown as "UNKNOWN" in the configuration forms. Also generic status information for the device will be displayed in response to a Command 48 status.

Refer to the *Control Builder Parameter Reference* manual for descriptions and valid entries of the parameters used in the configuration forms.

Step	Action
1	The Main tab of the HART DEVICE configuration form, as shown in the following figure, allows you to identify individual HART and non-HART field devices that are connected to HART IO modules. NOTE: The block name should have some relevance to the actual Tag name assigned to the HARTdevice in the field. The block name is used in all system displays and related functions. Enter appropriate values for the following parameters in the IOM and Channel Configuration and HART Configuration dialog boxes. Enter a name (Module Name) and description (Module Description) for the HART device on this form.

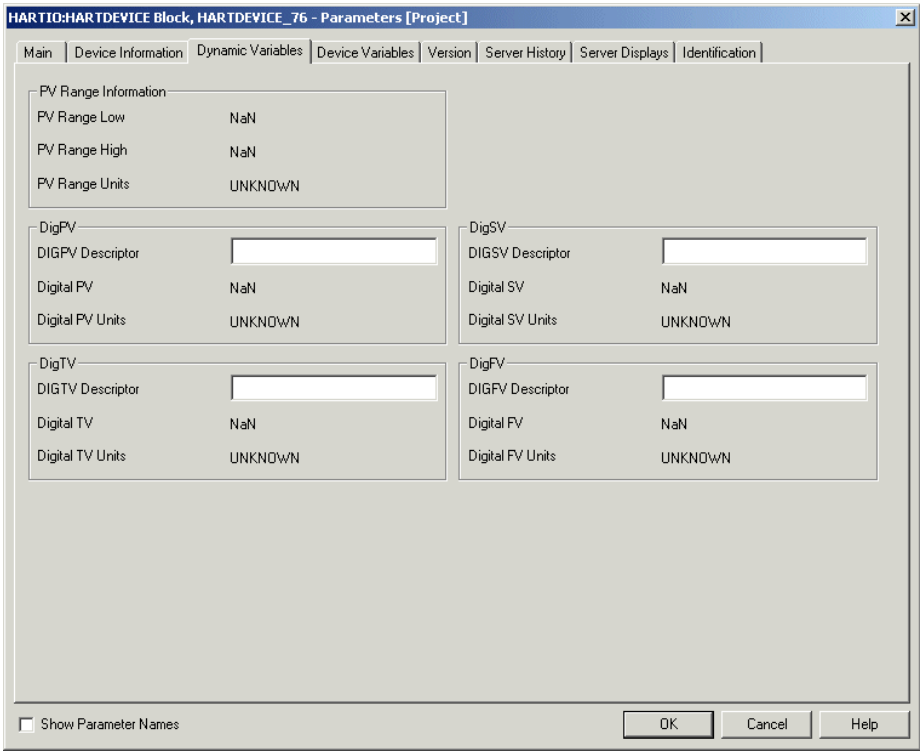
IMPORTANT !

The IOM Block Name and IOM Channel Number parameters are used to associate the HART Device block to the correct HART IO module. See Implementation considerations.

Step	Action
	HART Device – Main tab 
	• IOM Block Name – A name that will associate the device block with the HART IOM • IOM Channel Number – The channel number to which the HART device is connected • Associated Process Definition – A description of the process in which the HART device is used • Device location – A physical plant location of the HART device • Associated IOM location – A physical plant location of the associated IO module Enable or disable the communications fault and device specific alarms for the HART Device by checking or unchecking the Alarming Enabled check box. Note that the Execution State, DEVICE BLOCK Associated Status and HART Device Mode fields are active only when the HART Device is accessed

Step	Action
	through the Monitoring tab after it has been downloaded as part of a control strategy to a controller. HART Comm.Failure: Indicator shows if a communication fault has been detected.
2	Click on the Device Information tab to display device-specific information. Select the desired Date Format to be displayed for this device. All other parameters shown on this form are read only.
3	Select the Dynamic Variables tab as shown in the following figure to view device specific HART digital variables. Enter a description that identifies what each dyanmic variable represents for this device.

HART Device – Dynamic Variables tab



4	Select the Device Variables tab to display additional device specific

Step	Action
	information about the device variables. Enter a description that identifies what each device variable represents for this device. If supported by the HART device, four device (Slot) variables can be selected for monitoring. See Command 33 for more information.
5	**Version tab** If you have a version control system license, the Version tab lets you view template properties for the selected block. Use the on-line help to see additional information on this tab.
6	**Server History and Server Displays tabs** The Server History tab is used to configure specific server parameters associated with history collection for the HART Device block. The Server Displays tab is used to configure specific server parameters associated with Station displays for the HART Device block. Use the on-line help as a guide to complete the configuration entries on these tabs.
7	**Identification tab** If you have a templates license, the Identification tab lets you view template properties for the selected block. Use the on-line help to see additional information on this tab. Click OK on the configuration form to accept all configuration selections made on each configuration tab and to return to the Project tree.

HART DEVICE alarm flags

The HART DEVICE block can assert an internal flag for these conditions, when it is active. See the Main tab for the Alarm Enabled check box.

Condition	Description
Communications Fault	If enabled, indicates loss of communications with the device.
Device Specific Status *	The device block monitors the device status byte at every execution cycle. The device status byte contains error information about the device connected to a channel. See Device Standard Status for details.

Operation

Monitoring and Interacting with Process Data

Using Station displays

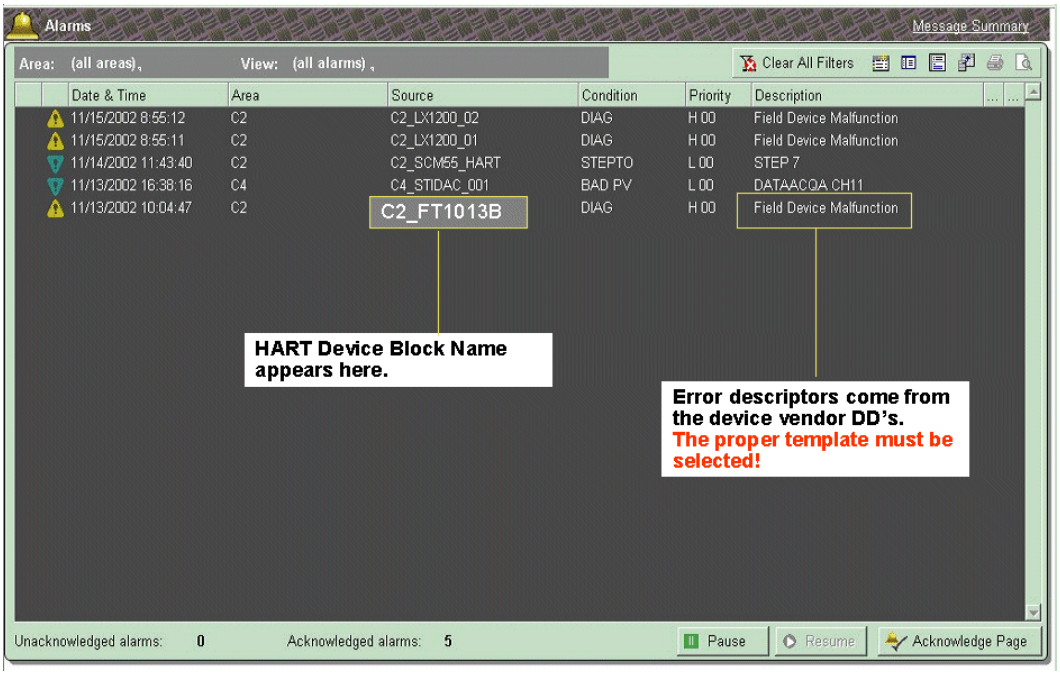
The Experion Server Station application includes pre-configured detail displays for each HART IOM block and each HART Device block. Once communications are established, you can begin monitoring the status of any HART block that has been loaded as part of a control strategy to a controller with points registered in the Experion server. The detail displays let you quickly view the module's current state, fault status, and pertinent configuration data.

REFERENCE - INTERNAL

Please refer to the Operator's Guide for detailed information about calling up, navigating, and viewing Station displays

Detail and alarm summary displays

Each HART device has a dedicated detail display. HART device alarms and status are reported directly against the device Tag, as shown in the following figure.



Alarm Summary Display

Update rate of HART variables for Series A HART I/O modules

The update rate of the HART variables for the Series A IO modules is a function of the number of IOM channels that are configured as HART devices, (and whether Slot Variables are enabled in the AO module).

For AI Modules. If all 8 channels of the Series A HART AI module are configured as HART, the HART variables are updated approximately every 6.4 seconds, (about 800 milliseconds per channel). If only 4 HART channels are configured the update rate is half that time, (approximately 3.2 seconds).

For AO Modules. The update rate for the Series A HART AO module is the same as for the AI module, if Slot Variables are not enabled. If any Slot Variable is enabled on the AO module the time doubles. When any Slot Variable is enabled, the module sends a Command 33, which requires an additional update cycle.

Using Control Builder Monitoring tab

Once you download a control strategy to a controller, you can use the Monitoring tab to interact with the function blocks in the control modules, sequential control modules, and IOMs assigned to the Control Execution Environment (CEE).

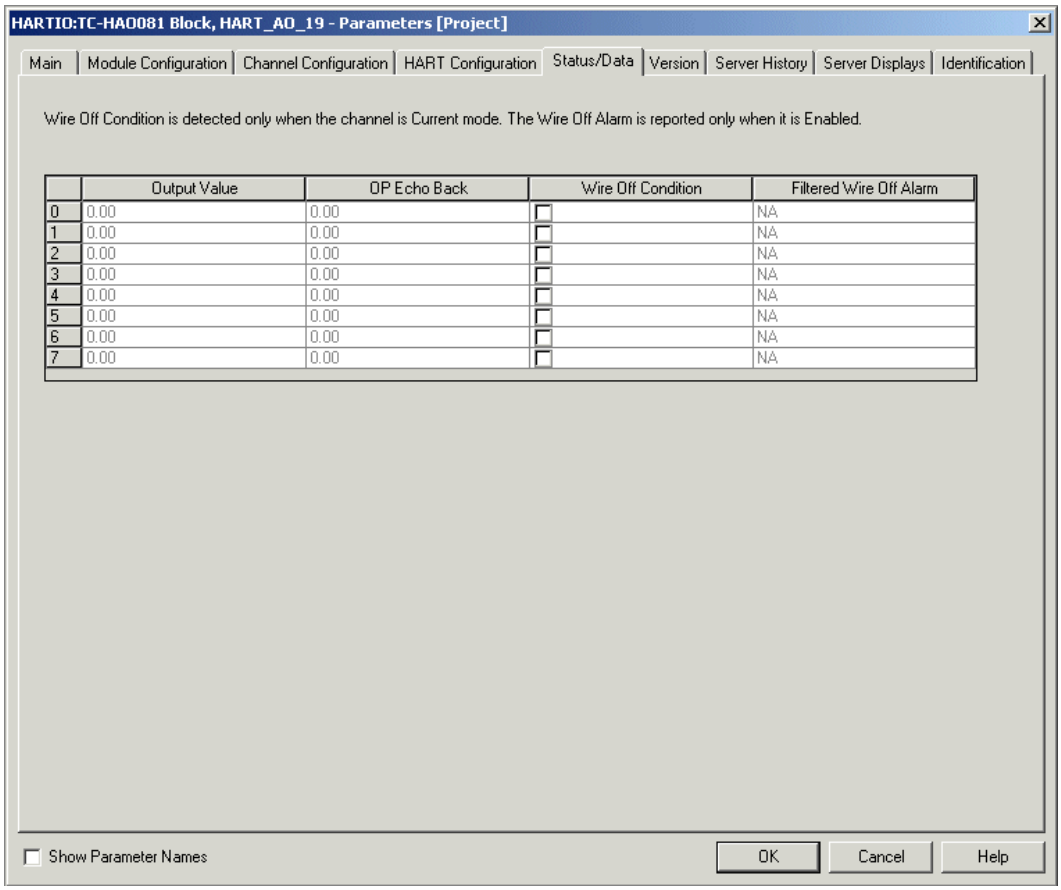
You simply double-click the desired IOM icon in the I/O tree menu under the CEE icon to call up the module's configuration form. Click the Status/Data tab on the AO module form to view the module's current status. Both the CEE and IOM function block must be active to view on-line data. The following table summarizes the data that you can monitor from a given AO module's Status/Data tab.

REFERENCE - INTERNAL

Please refer to the Control Building Guide sections in On-Line Monitoring Using Control Builder for detailed information:

- Setting the CEE Inactive
- Setting I/O Active
- Setting I/O Inactive
- Changing Parameters while Monitoring

Status/Data tab for a TC-HAO081 module



Parameter	Description
Output Value	(OPFINAL) Shows the final output value sent to the control element.
OP Echo Back	Process Value read back from the device in % full range.
Wire Off Condition	For the 4-20mA range only, ON (checked) means wire is no longer

	connected to the channel terminals.
Filtered Wire Off Alarm	Wire off alarm is reported only when it is enabled (Alarming Enabled box is checked on Module Configuration form).

Using Network Tools

You can use the Network Tools (NTOOLS) application supplied with Experion Engineering Tools to monitor and interact with the ControlNet Network. The HART IO system components are displayed in the same way as other Controller and Series A I/O components. The ControlNet always appears as the leftmost component in the HART IO segment graphic representation in the Detail pane of NTOOLS. **Not** all NTOOLS menu functions can be used with Series A HART IO system components and unusable functions will appear faded or "grayed out" in the menus. Only the ControlNet supports firmware loads through NTOOLS.

REFERENCE

- Please refer to the on-line Help provided with Network Tools for more information about the application.
- Please refer to the Process Software Installation and Upgrade Guide, if you need to update the firmware in the ControlNet.

HART Module Output Behaviors

The following sections summarize the HART IOM behaviors in response to various conditions.

Inactivating a Series A HART I/O module

The following table summarizes the effects on field outputs from directly or indirectly inactivating a Series A HART output module based on various operating conditions.

If you inactivate…	Then, expect these results…
A HART IO Analog Output module,	• Module holds the output value applied to the field terminals at the time of the inactivation. • The module's icon turns blue in Monitoring tab. • The module's detail display shows INACTIVE state with proper failsafe values for parameters. • No fault alarms appear on the Station's Alarm Summary (communication with the module is not disrupted).
A Control Module that has IO CHANNEL blocks,	• Module holds the output value applied to the field terminals at the time of the inactivation. • No fault alarms appear on the Station's Alarm Summary (communication with the module is not disrupted). • No change in the Gateway's Status LED.
A CEE that contains HART Analog Output module assignments,	• Module holds the output value applied to the field terminals at the time of the inactivation. • No fault alarms appear on the Station's Alarm Summary (communication with the module is not disrupted).

Output interaction with redundant Controller switchover

The following interaction with on-line HART Analog Output modules occurs in response to a redundant Controller switchover.

- No loss of connection to the HART output modules.
  - No communication fault alarms are generated for the module as a result of the switchover.
- The HART output module holds its value for the field terminal signal during switchover of the connection. The switchover lasts no more than 400 milliseconds and typically lasts only 150 to 200 milliseconds.

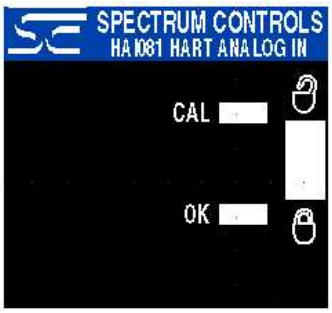
Output Behavior in Response to Deleting HART AO module block

If you delete a HART output module from the Monitoring tab in Control Builder, the HART I/O module will exhibit the following behavior.

- Outputs for analog output modules go to the unpowered state value at the field terminals.
- The IOM function block closes the connection to the HART output module.
- The icon for the HART output module is removed from the Monitoring Tab.

Interpreting Series A HART I/O Module LED Indications

Series A HART analog input module LEDs

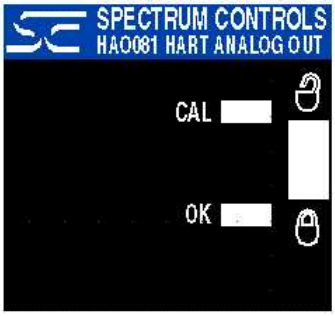


Two LEDs (CAL and OK) on the front panel of the analog input module indicate operational status. The following table summarizes the meanings of typical LED indications on the Series A HART AI module.

LED:	Displays:	Means:	Take this action:
OK/CAL	Off	No power to module.	Verify power to controller chassis.
OK	Steady green light	The inputs are being multicast and in normal operating state.	None.
OK	Flashing green light	The module has passed internal diagnostics but is not multicasting inputs or the module is inactive.	Download configuration.
OK	Flashing red light	Previously established communication has timed out. Minor fault.	Check controller and chassis communication.
OK	Steady red light	Power-on/Reset until self-test diagnostics complete. If red LED persists after power-on/Reset diagnostics, Major fault.	None. Replace module.
OK	Off	LED has failed or the module detects a major fault.	Replace module.

LED:	Displays:	Means:	Take this action:
CAL	Off	The module is not in calibration mode.	None.
CAL	Flashing green light	The module is in calibration mode.	Complete the calibration procedure.
CAL	Steady green light	New firmware is being downloaded to the module.	Allow download to complete.

Series A HART analog output module LEDs



Two LEDs (CAL and OK) on the front panel of the analog output module indicate operational status. The following table summarizes the meanings of typical LED indications on the Series A HART Analog Output Module.

LED:	Display:	Means:	Take this action:
OK/CAL	Off	No power to module.	Verify power to controller chassis.
OK	Steady green light	The outputs are actively controlled by a system processor and in normal operating state.	None.
OK	Flashing green light	The module has passed internal diagnostics but is not actively controlled; the module is inactive.	Download configuration.
OK	Flashing red light	Previously established communication has timed out. Minor fault.	Check controller and chassis communication.

LED:	Display:	Means:	Take this action:
OK	Steady red light	Power-on/Reset until self-test diagnostics complete. If red LED persists after Power-on/Reset diagnostics, it indicates a Major fault.	None. Replace module.
OK	Off	LED has failed or the module has detected a major fault.	Replace module.
CAL	Off	The module is not in calibration mode.	None.
CAL	Flashing green light	The module is in calibration mode.	Complete the calibration procedure.
CAL	Steady green light.	The module is not in calibration mode.	None.

Series A HART I/O Module Replacement

Adding, removing and replacing Series A HART I/O system components

WARNING

About removal and insertion under power

- When removing HART I/O modules, be sure no dangerous situations can arise due to unmonitored controlled processes.
- Always remove field-side power before removing or inserting a HART I/O module. Do not use the removal and insertion under power (RIUP) function for modules installed in a segment located in a Division 2 hazardous location.
- Unless the location is known to be non-hazardous, as determined by a combustible gas detector, do not:
  - connect or disconnect cables,
  - remove or insert modules under power.

ATTENTION

The removal or failure of one or more I/O modules does not affect the function of the remaining modules.

You can remove and insert the ControlNet and HART I/O Modules without removing power. The removal of the ControlNet module from a given HART I/O segment will result in the loss of communications with every HART I/O module in the segment. The removal of an individual HART I/O module only breaks communications with that module.

General guidelines

ATTENTION

The HART I/O components are not repairable in the field. Any attempt to repair a component will void the warranty. If repair is necessary, return the component to the factory.

- The direct replacement of a HART I/O component of the same kind is just a matter of removing the existing component and installing a new one in its place.

- If you are adding a HART I/O component, follow the installation instructions for the component and then configure it through Control Builder to integrate it with your control strategy.
- If you are removing and/or replacing a HART I/O component, proceed with extreme caution. You must delete, restore, and/or create all hardware connections and the control strategy database configuration through the Control Builder.

Series A HART IOM Calibration

Series A HART AI and AO modules are calibrated at the factory before they are shipped. Typically, the accuracy of an Analog Input module is typically 0.005%. The tolerance on an analog Output module is +/-0.4 mA, full span.

If calibration becomes necessary, you can use the I/O Maintenance Tool utility that is supplied with Experion. Description of the utility and the calibration procedures are found in the I/O Maintenance Tool section.

PM I/O and Series C I/O HART Integration

Overview

The Process Manager I/O and Series C I/O modules feature integration of HART communications protocol into the Experion control system. HART digital information can be used in Experion to furnish expanded device status and information that HART-enabled smart devices provide. HART I/O integration into Experion includes Process Manager IOPs and Series C IOMs that are HART aware. The following table provides the model numbers of the HART-enabled modules.

I/O Module	Model number	Description
PM I/O HART		
Analog Input processor	MU-PHAI01 or MC-PHAI01	16-Channel HART inputs
Analog Output processor	MU-PHAO01 or MC-PHAO01	16-Channel HART outputs
Series C I/O		
Analog Input	CU-PAIH01 or CC-PAIH01	16-Channel HART inputs
Analog Output	CU-PAOH01 or CC-PAOH01	16-Channel HART outputs

- HART-enabled field devices that are wired directly to either Field Termination Assemblies (FTAs) when connecting to PM IOPs, or to the Input Output Terminal Assemblies (IOTAs) when using Series C IOMs.
- IOP function blocks and AI and AO channel blocks support configuration of the PM I/O HART IOPs. Series C I/O modules are configured using IOM function blocks and AI and AO channel blocks.
- HART Device Description Manager utility is used to map HART DD files and add the device information to the system repository. Templates are then created for HART Device function block configuration.
- Experion HART Multiplexer application emulates the functions of HART hardware multiplexers and facilitates access to HART data.

- Honeywell Field Device Manager (FDM) asset management application supports the HART command protocol. Device configuration and commands can be generated to service HART devices.

Functional Description

HART-enabled Process Manager I/O and Series C IOMs have been developed as the primary interfaces to HART devices in Experion and are implemented similarly with a few differences. Both PM I/O and Series C IOMs support the same features for handling HART device data.

- Each IOP/IOM channel can be configured as a standard analog only or HART-enabled channel. When enabled for HART, the channel allows HART digital data to be communicated to the controller and Experion Server.
- IOPs/IOMs support only point-to-point connections, (no HART multi-drop connections).
- IOPs/IOMs can be used in a redundant or non-redundant configuration.
- HART-enabled IOPs/IOMs support a feature that automatically detects HART devices connected to the IOP/IOM channel terminals. See Auto Detect Feature for more information.
- Both PM IOPs and Series C IOMs support HART protocol Version 5.x. Series C also supports HART protocol version 6.0.
- HART IOPs/IOMs are compliant with the standard approvals and certifications (FM, CE, etc.) common to the PM I/O control hardware.

PM I/O HART IOPs

Plug-in Input/Output Processor card assemblies (IOPs) along with the associated FTAs perform input and output scanning and processing on various field I/O devices. HART IOPs are designed to operate much like other existing IOPs. Each HART IOP (AI or AO) supports sixteen IO channels and occupies one physical card slot position in a PM I/O card file or remote IO card file. See the *Control Hardware Planning Guide* and the *Control Hardware Installation Guide* for more information on PM I/O control hardware.

Series C IO modules

Series C IO modules can be enabled to support HART devices. The IOM and associated Input Output Termination Assembly, (IOTA) provides connection points, IO signal processing, and an interface for HART devices to Experion process control systems. See the *Series C IO User's Guide* for information on Series C IO module hardware.

Analog signals and HART data

Both PM I/O HART IOPs and Series C IOMs are optimized for control. All information needed for control is cached on the IOP/IOM and is always available to the control system and the user. The IOPs/IOMs handle analog signals and HART device data in the following way:

Analog Signals –

- The Analog Input IOP/IOM – The analog input (PV) is scanned and published to the C200 processor, (100 ms update rate for all channels). Operation is the same whether or not the channel is enabled for HART. When a channel is **not** configured for HART, the analog input can be set to any of the following ranges: 4-20 mA, 0.4-2.0 Vdc, 0-5 Vdc, 1-5 Vdc
- The Analog Ouptut IOP/IOM – The analog output (0 to 100% value) is updated to the IOP every 30 milliseconds for all channels. Operation is the same whether or not the channel is enabled for HART.

NOTE: The analog circuitry is independent of the digital (HART modem) circuitry and is not affected by the collection of HART digital data. Additionally, the analog signal is not affected by the collection of the HART digital data.

When an IOP channel is enabled for HART –

- The analog signal range is set to 4 to 20 mA.
- HART device digital data is cached on the IOP/IOM and is available for use within the control system. This data includes: Device ID information such as Tag, Manufacturer, Model, Software/Hardware revision number, Serial number, Date, Descriptor, PV range information, etc.
- After initial startup the channel begins to scan the on-line information, (for example, Dynamic and Device Variables). See On-line data access for details.
- The channel will service all pass-through commands. See Pass-through data access for details.

NOTE: Device ID and Range information is read from the device and updated in the IOP/IOM upon startup and after a loss of communication has been restored.

HART device data

HART device data is accessed by the IOP and control system using two distinct methods:

1. **On-line data access** – Information that is required by the control system to perform normal process control tasks is accessed periodically according to a user-selected device scan rate. The HART IOPs/IOMs are optimized for on-line performance.

2. **Pass-Through data access** – Information relating to device management and device configuration is handled as a background function in the IOPs/IOMs. Pass through access allows device commands and requests from other control system applications to be passed through the IOP/IOM to the device.

On-Line data access

HART device data is accessed by the IOP/IOM using HART protocol commands resident in the firmware of the IOP/IOM. The control system requires that this data is accessed and updated in as short a time period as possible. This data includes:

- Device ID information (Tag, manufacturer ID, device type, software and hardware revision levels, etc)
- Range information (such as LRV, URV, minimum span, damping, etc.)
- Device and Dynamic variables (secondary, real values)
- Device status and error conditions

When the IOP/IOM is powered up and makes a connection with a HART device, the IOP/IOM issues commands to aquire device ID and range related information. This information is cached in the IOP/IOM and is made available to the user through Experion system displays. This information is not aquired again unless the IOP/IOM loses communication with the HART device or the device indicates that the configuration has been changed (through a 2-byte device status message).

Once the device ID and range information have been aquired, the channel enters into a normal scan mode. During a normal scan the IOP/IOM issues HART commands to access the following device data:

- Dynamic variables – PV, SV, TV and QV (Command 3)
- Device variables – Up to four variables can be selected for display from a possible list of 255 (Command 33)
- Device status – A 2-byte status (16 bit) is returned by the device with every command response.

NOTE: Each HART enabled IOP/IOM channel can be configured to scan for for this device data. See Scanning for HART Dynamic/Device Variables for more detailed information.

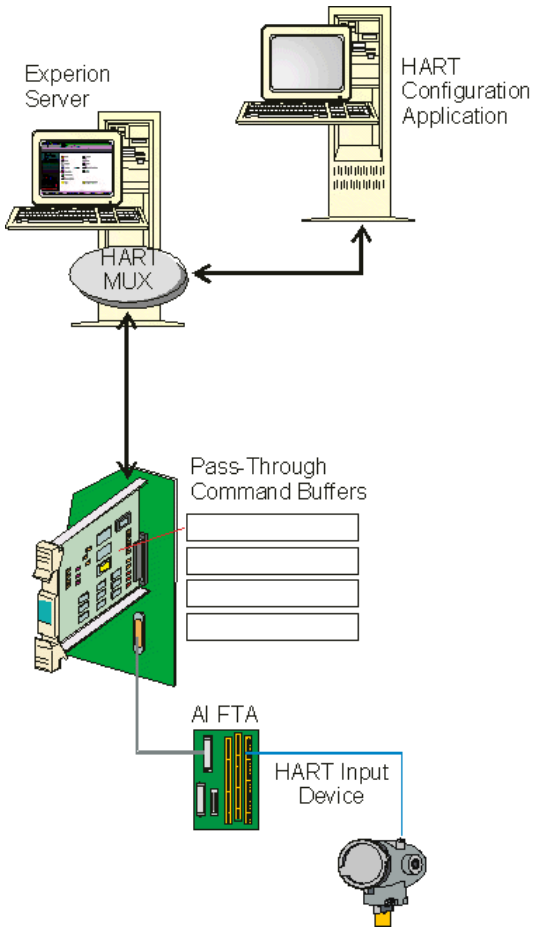
The IOP/IOM checks the 16 bits of the 2-byte device status to determine if there have been any changes to the device. The status can indicate a device malfunction or a change to the device configuration. If the IOP/IOM determines that the device is in an abnormal state it will enter an error handling mode.

The error handlng mode causes the IOP/IOM to issue a Command 48, which requests the device specific status and conditions. This status is reported to the alarm/event handler in the system. Depending on the type of fault, the analog value and/or the digital variables may be set to the bad state (unusable data). The channel remains in this mode until the fault is resolved.

Pass-through data access

The HART IOP/IOM contains memory buffers that provide a means to service commands which originate from sources other than the IOP/IOM, such as a host or a HART asset management application. When HART commands and data originate from other sources, the IOP/IOM acts as a conduit to pass the commands through to the HART device, or pass data back to the originator. Pass-through buffers on the IOP/IOM are used to hold the HART data when normal scanning of IO channels is in progress. Then at the next opportunity, the IOP/IOM passes commands or data through to its destination.

Honeywell's HART asset management application, Honeywell Field Device Manager, (FDM) is normally used for device configuration, calibration and general device setup. The FDM application completes these tasks by issuing particular commands to the HART device and then waiting for confirmation and validation through the device's command response. Honeywell's Software Multiplexer application (HART Mux) has been developed to provide an interface to the FDM. The HART Mux emulates a P+F hardware multiplexer which maps the FDM commands to specific PM I/O HART IOPs, Series C IOMs and their respective I/O channels. The following figure shows a block diagram of this arranagement using a PM IOP.



The HART Mux and the HART IOPs/IOMs operate in conjunction with the FDM. The HART Mux maps the hardware connections, so that commands and data from the FDM are directed to the appropriate IOP/IOM and IO channel. The IOP/IOM then passes these commands through to the device. The device responses are directed back to the source.

NOTE: The IOP/IOM and HART Mux act as a conduit between the HART device and the FDM application. Neither the IOPs/IOMs nor the HART Mux interprets these HART commands and data.

For example, a pass-through operation may consist of a HART command issued from the FDM. The HART Mux maps the path to the proper IOP/IOM and IO channel and passes the command through to the IOP/IOM. The IOP/IOM accepts the command and stores it

in an open buffer. Then at the next opportunity, the command is passed to the proper HART device. The IOP/IOM waits for the device to respond and then passes the response back through the HART Mux and to the FDM.

It is important to note that if a write command is sent to a device, the HART Mux will not send it to the IOP/IOM unless the IO channel is set to inactive state. A read command is allowed at any time.

When an IO channel is set to INACTIVE, the pass-through function is primary and normal device scanning for HART variables is suspended.

PM I/O and Series C I/O HART Channel Block Configuration

Summary

This section describes the configuration of a PM I/O HART and Series C I/O Channel blocks which represent HART devices connected to the Field Terminal Assembly (FTA) of a PM HART IOP, or the Input Output Terminal Assembly (IOTA) of a Series C IOM.

IOP/IOM Hardware Installation

Installation of the control hardware is **not** covered in this guide. For reference Figure 2 in this guide shows the hardware components necessary for integrating Process Manager I/O control hardware into a C200 controller topology. Figure 3 shows the Series C I/O and PM I/O control hardware connected in a C300 controller topology.

Installation of HART IOPs/IOMs follows the same procedures as all other IOP/IOM types. Model numbers for the Field Terminal Assemblies (FTAs) and Input Output Terminal Assemblies (IOTAs) that support connection of HART IOPs/IOMs to the field devices are listed here for reference.

I/O Type	Termination type	Terminal Assembly Model Number (See Note)
PM I/O uses FTAs		
	HART Analog Input	Mx-TAIH04, Mx-TAIH14, Mx-TAIH15, Mx-TAIH54
	HART Analog Output	Mx-TAOY24, Mx-TAOY25, Mx-TAOY54, Mx-TAOY55
	HART AI (Galvanically Isolated, Intrinsicaly Safe Interface)	Mx-GAIH13, Mx-GAIH14, Mx-GAIH22
	HART AO (Galvanically Isolated, Intrinsically Safe Interface)	Mx-GHAO21
Series C I/O uses IOTAs		
	HART Analog Input	Cx-TAIX01, Cx-TAIX11
	HART Analog Output	Cx-TAOX01, Cx-TAOX11

I/O Type	Termination type	Terminal Assembly Model Number (See Note)
Note: x- can be either a U-, which indicates the terminal assembly has a non-conformal coating, or C- which indicates the terminal assembly is conformal coated.		

The following paragraphs point to the relevant sections in Knowledge Builder that cover planning considerations, hardware installation and wiring for PM I/O and Series C control hardware. Go to these references for detailed hardware planning and installation information.

Planning considerations

The *Control Hardware Planning Guide* contains planning considerations for PM I/O and Series C I/O control hardware, which can be found in the following sections:

For PM I/O control hardware -

- Control Hardware Configuration – Provides planning considerations for PM I/O card files, IOPs, Link Extenders and Field Terminal Assemblies.
- Site Selection and Planning – Includes planning for PM I/O power requirements.
- Process Manager I/O Integration Planning – Contains system topology and performanace considerations for PM I/O control and and interface hardware.
- Appendix Cand Appendix D– Contain guidelines and instructions for control cabinet mounting of PM I/O hardware.

For Series C I/O control hardware –

- Series C Hardware Configuration – Contains planning information for implementing a Series C control system, such a selecting cabinet hardware and power supplies.
- Series C System cabling - Describes the various cables required for implementing Series C system hardware.
- Series C Hardware Grounding Considerations – Provides guidance on proper grounding when installing Series C system hardware or upgrading an exisiting system to include Series C components.

Installation instructions

For PM I/O control hardware -

Installation information of the I/O Link Interface Module and PM I/O control hardware is found in the following sections of the *Control Hardware Installation Guide*:

- I/OLink Interface Module Installation and Removal – Contains overview, planning and installation of the I/O Link Interface, the controller chassis module that interfaces to the PM I/O control hardware.
- Process Manager I/O Installation and Wiring – Contains descriptions of all PM I/O control hardware components, installation considerations in preparation for installation and wiring of control hardware assemblies.
- Appendix C – Contains the application and wiring references for PM I/O Field Terminal Assemblies (FTAs)
- Appendix D – Provides the application and wiring references for Galvanically Isolated FTAs which are used in hazardous operating environments.

For Series C I/O control hardware -

The Series C I/O User's Guide contains complete installation procedures, configuration, operation and troubleshooting information when implementing the Series C IOMs in Experion.

HART IOPs and IOMs

In general, the analog signal component of the I/O HART AI and AO channels (both Process Manager and Series C) behaves similarly to the analog signals of the non-HART AI and AO channels. Additionally, the HART IOP (MC-PHAO01) is similar in function to the AO16 IOP and the HART IOP (MC-PHAI01) is similar in function to the HLAI IOP. Series CIOMs use the same module for non-HART field devices and HART devices. A check box on one of the Channel block configuration forms enables HART functions on the IO module.

When a HART IO channel is enabled, the IOP/IOM issues HART commands to the connected device for device data and status. The HART digital data transmitted by a field device is unique to the HART device type. A device type is a particular model or revision level of HART field device that a device vendor manufactures. Device ID, device variable and device status data transmitted by a HART device is unique to that particular device type. Information that describes the HART data for a device type is contained in the Device Description file (DD file) furnished with the device. In Experion, descriptions of these HART device types can be added to the ERDB so that device blocks and station displays can accurately present the HART digital data and status which is unique for the device that it represents. See Adding HART Device Types for more information.

For more information see HART IOP operating functions and HART Basics.

ATTENTION

Note that HART device configuration can be performed using either a handheld HART communicator or Honeywell's Field Device Manager application. See Device Configuration Methods for details.

About control strategy configuration

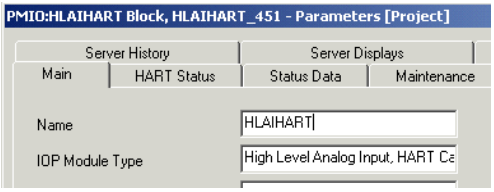
You use the Experion Control Builder application to configure a process control strategy using predefined function blocks. Control Builder includes in its Library database function blocks that represent both the I/O modules and I/O channels of Process Manager IOPs and Series C IOMs, which functionally integrates HART I/O components into Experion.

Each IOP/IOM function block has an associated configuration form for defining its configurable attributes. These attributes include naming and identifying the component's location within the network as well as setting the IOP/IOM and channel specific parameters, as applicable. If you have used Control Builder to configure other I/O function blocks, you will use the same process to configure HART I/O blocks.

Implementation considerations

You should consider a couple of things before implementing HART I/O into a control strategy. First, adopt a naming convention scheme that will help in associating HART IO Channel and HART IOP/IOM blocks when creating a control strategy, and later when identifying HART devices in the plant. Second, find out what HART commands are supported for the HART device that you are using in your process application. The device manufacturer should have the details.

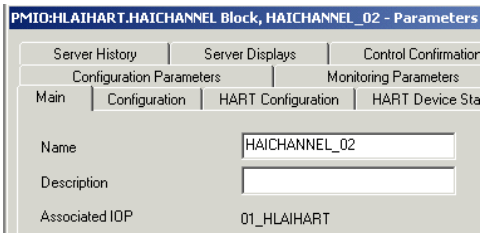
1. Adopt some conventions for the use of HART block/tag names and descriptors. See examples below.

Naming Convention	HART Block and Location of Parameters
It might be helpful to include the word HART in the **IOP/IOM Block Name**. For example: HART, HRT, HAI, HAO, etc.	Main tab of HART IOP block configuration form 

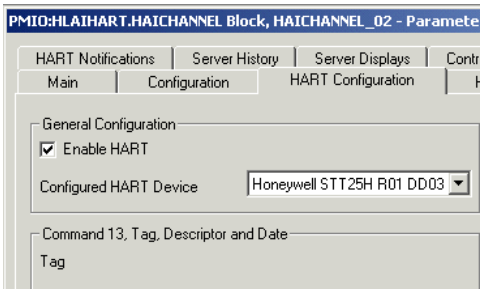
The **HART IO Channel Block Name** should have some relevance to the actual **Tag Name** assigned to the HART device in the field.

NOTE: Device Tag names are limited to 8 characters.

Main tab of HART IO Channel block configuration form



HART Configuration tab of HART IO Channel block configuration form



2. Find out what HART commands are supported for the HART device you are installing. Here are some questions that can be answered by the device manufacturer.

- What variables are mapped to the Dyanmic Variables (PV, SV, TV, and QV)?
- Are the Dyanmic Variables configurable?
- Does the HART device support command 33 (Device variables)?
- If so, what variables are available and where are they assigned (1 – 255)?
- Does the HART device support command 48 (Device-specific information)?
- If so, what are the definitions for the 200 ON/OFF status bits?

When implementing PM HART IOPs in a C200 controller topology (Figure 2):

If you are implementing PM HART IOPs connected to an IO Link Interface Module (IOLIM) in a C200 controller, first create function blocks in Control Builder which represent hardware instances of the IOLIM and the HART IOP. See *Control Building Guide* and follow the steps for Creating an IOLIM and IOLINK, and Creating PM I/O HART IOPs, if they have not yet been created.

When implementing PM HART IOPs and Series C IOMs in a C300 controller topology (Figure 3):

When implementing PM HART IOPs and/or Series C IOMs connected to a C300 controller, create function blocks in Control Builder that represent hardware instances of the IOPs/IOMs. See *Control Building Guide* and follow the steps for Creating PM I/O HART IOPs, if they have not yet been created.

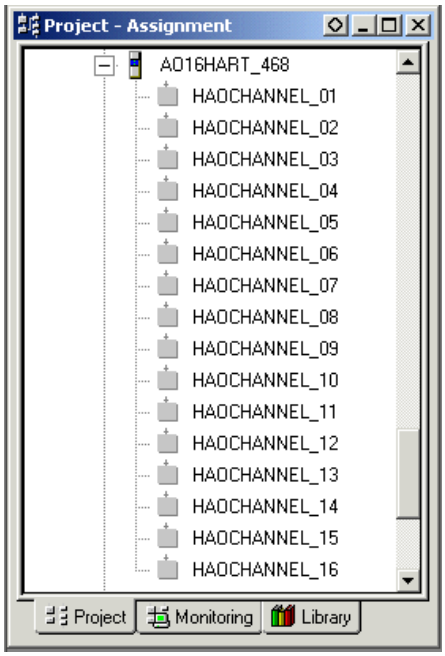
Device Auto Detection

After creating (configuring) IOP/IOM blocks in Control Builder, they can be loaded to the control hardware, provided that the hardware is installed. HART IOPs/IOMs contain an Auto Detect feature that allows the IOP/IOM to scan its channels for any devices connected to the IOP's/IOM's associated FTAor IOTA. For Analog Input HART IOPs/IOMs, the feature is always enabled and begins the device detection process when the IOP/IOM block is loaded to the hardware. For Analog Output HART IOPs/IOMs, the IOP/IOM block is loaded to the hardware and Auto Detection must then be enabled on a per channel basis for the IOP/IOM to scan the enabled channels for devices.

The HART IOPs/IOMs actually issue HART commands to the channels where devices are detected. The devices respond to the commands with various Device ID and range information which then is displayed in the IOP's/IOM's Status configuration forms. The information gathered on the connected devices is used to fill in the individual IO Channel configuration forms. Once the completed channel configuration is loaded to the control hardware, normal device scanning for HART variables and status will occur according to the configured scan rate. See Auto Detection Feature for additional information.

HART I/O Channel function blocks can be configured using Control Builder without the hardware being installed, although the control hardware should be present before the configured blocks are loaded.

For example, when a HART IOP block is created in the Project Tab of Control Builder (AO16HART_468 in the following figure), all of its associated I/O Channel (IOC) blocks are also created. Clicking the plus sign for the IOP expands the tree down to the IOC block level. Then, any channel block associated with the IOP can be selected for configuration.



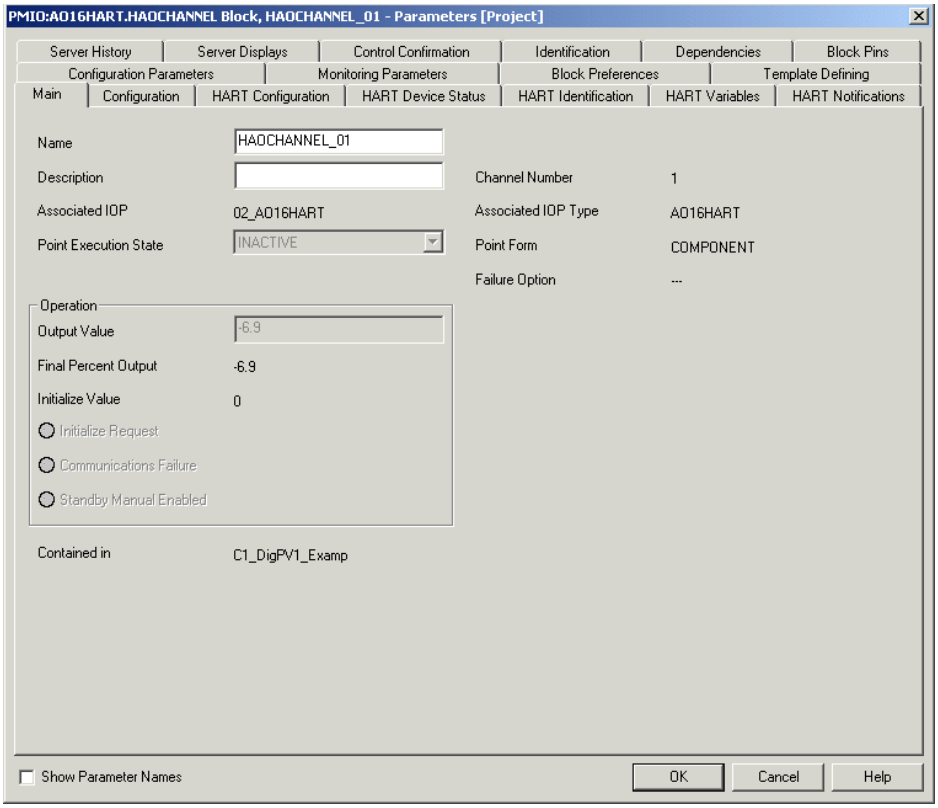
Use the steps in the following procedure to select and configure an IOC block on a HART IOP. In general, entering information in the data fields of the AI and AO CHANNEL blocks are nearly the same. The illustrations in this procedure are for example purposes only.

To configure PM HART AI or HART AO CHANNEL blocks:

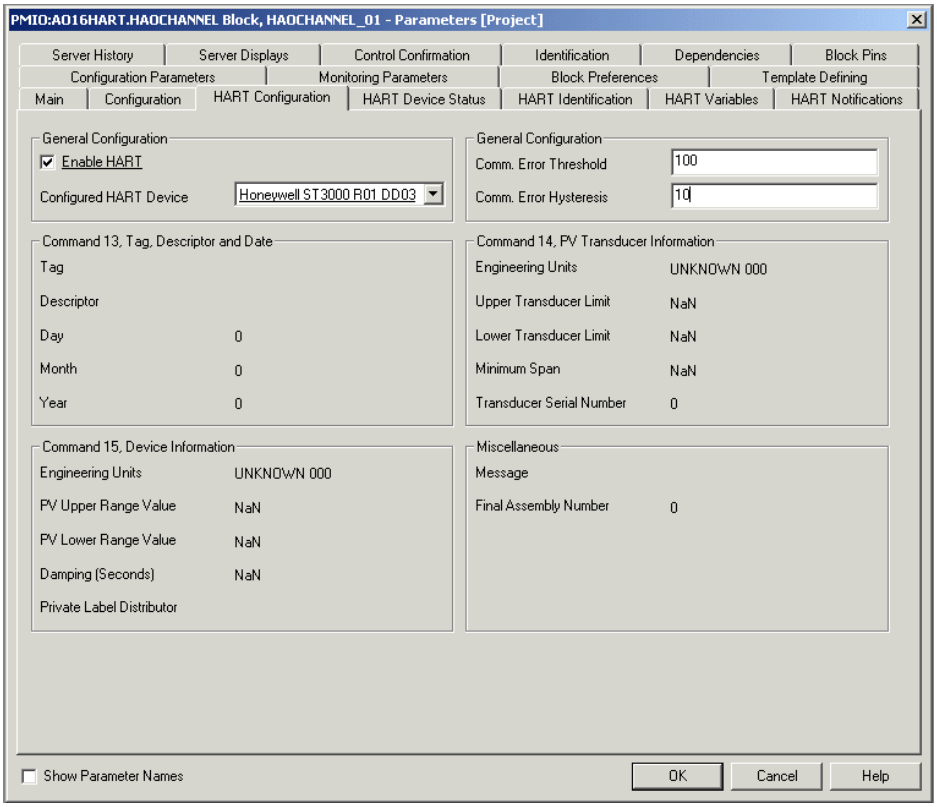
Step	Action
1	If you want the Auto Detection feature to identify any HART devices connected to HART IOPs, then: • Complete the configuration of the IOLIM and IOLINK blocks in Control Builder. (If implementing PM IOPs in a C200 controller topology.) • Complete the configuration of the PM HART IOP block • Make sure that the controller and control hardware which the configured blocks represent are installed. • Perfom a load of these blocks to the control hardware. • For HLAIHART IOPs, auto detect will scan the IOP channels for connected

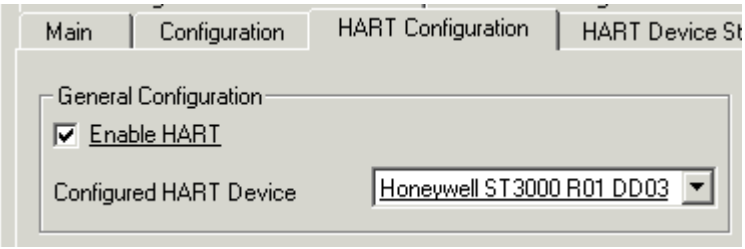
Step	Action
	HART devices and display the results in the IOP Status tabs. • For AO16HART IOPs, select the HART Status tab and check the Auto Detection box for every channel you want the IOP to scan for HART devices. Scanning begins immediately. The results are displayed in the IOP Status tabs.
2	Click on an IOC block (HAICHANNEL or HAOCHANNEL). Right click the block and select Configure Block Parameters…, that will open the IO Channel block configuration form.
	When using the Auto Detection feature, some of the fields in the channel block will be filled in due to the data recieved from the HART device.

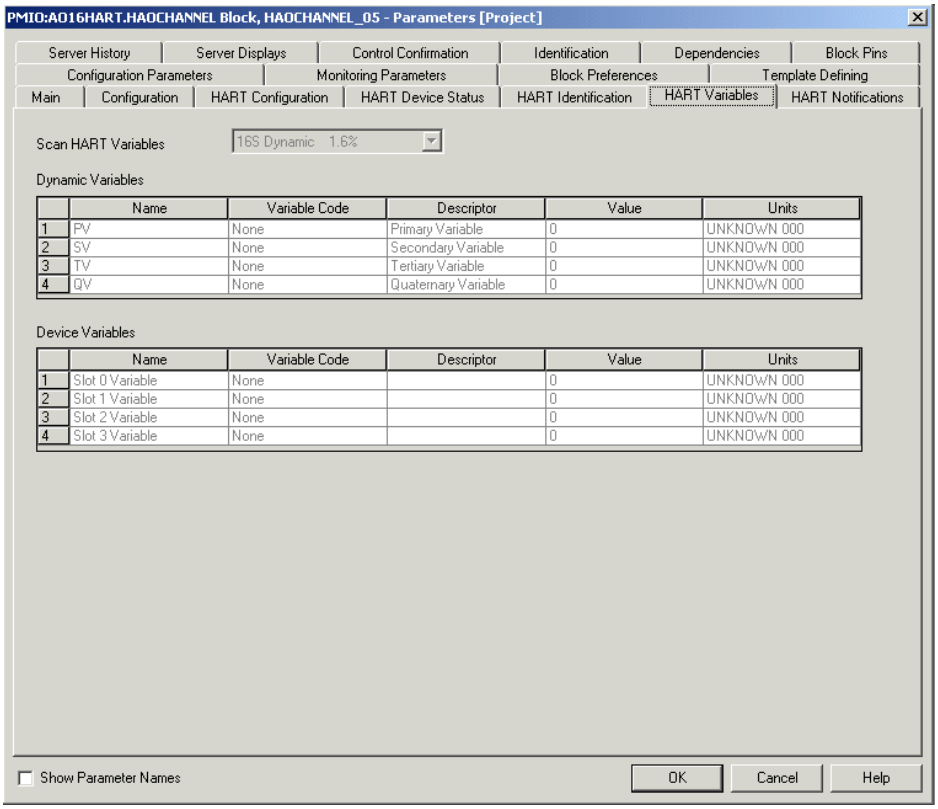
HART HAOCHANNEL Block – Main tab

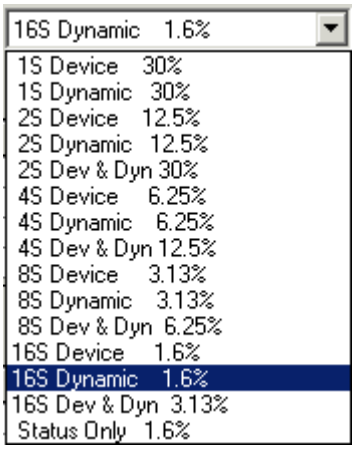


Step	Action
3	Key in a desired name (up to 16 characters) and a description of the device in the appropriate fields on the Main tab.
	Note: Experion does not require the block name to match the field device tag, and it does not provide an indication that the block name does not match the field device tag. Honeywell recommends matching the channel block name with the field device tag for easier identification and its maintenance and logistical advantages. See Implementation Considerations for suggested naming conventions.
4	Click on the Configuration tab. Select the appropriate options on the data fields of this form. Key in appropriate range values for the device and process application. These values may be filled in if auto detection was used to identify connected HART devices.
	A HART AI or HART AO Channel can be customized any one of the following ways: • A 4-20 mA channel with no HART Digital Data (HART functionality disabled), • A 4-20 mA channel with Generic HART Digital Data enabled (using a Generic HART Device template), • A 4-20 mA Channel with Device Specific Digital Data enabled (using a device-specific HART Device template).
5	Click on the HART Configuration tab.
HART HAOCHANNEL Block – HART Configuration tab	

Step	Action
	
6	If this channel is to be HART Enabled, first make sure that : a) The channel block is not loaded, and b) The channel block name is unique within the system. Then, enable HART function by adding a checkmark in the Enable HART box on the HART Configuration form.

Step	Action
	 The channel block now exists as a tagged object and provides access to HART parameters. Also, it allows for field device diagnostic alarms and events to be raised against the channel block. See Parameter Access and Custom Displays for additional information.
	Normal or non-HART enabled channels are displayed in Control Builder tree view as a colored square . When a channel's Enable HART check box is set, the channel icon changes to , which indicates that a HART device is associated with the channel block.
7	Choose the appropriate Device type from the list of available device types for the HART IOP type. • If generic HART data is desired, choose Generic HART Device type. • If device-specific HART data is desired, choose the appropriate device type. (The device type must match the device model and manufacturer connected to the appropriate FTA terminal for that channel.) If the device type is not visible, see Adding HART Device Types for a procedure to add the necessary type to the ERDB.
8	Accept default or key in any value for the Communication Error Threshold field.
9	Click on HART Variables tab.
HART HAOCHANNEL Block – HART Variables tab	

Step	Action
	
10	Select Scan HART Variables type. Accept the default or click the down arrow and select the desired rate from the list.

Step	Action
	 See Scanning for HART Dynamic/Device Variables and HSCANCFG for an explanation for using this parameter.
11	Key in the Name and/or Descriptor of the Dynamic Variables available for the HART device.
12	Accept the default (None) or click on the Variable Code box to select a Variable Code for the Slot Variable. See Device and Dynamic Variables for an explanation of these parameters. Key in a Descriptor for each of the Selected Slot Variables.
13	Make the necessary Input/Output connections to other blocks as needed.
14	Install HART device in the designated process location.

Parameter access and custom displays

HART enabled channel blocks are tagged objects; therefore parameters are accessed in the form BLOCK.PARAMETER. For non-tagged blocks, parameters are accessed in the form: CM.BLOCK.PARAMETER.

Note that changing an existing channel block from HART disabled to HART enabled, (or from HART enabled to HART disabled) changes the parameter access form, therefore any custom displays must be updated accordingly.

Server History and Server Display tab configuration

HART enabled channel blocks are tagged objects, therefore Server History and Server Display configuration parameters exist on the channel block itself, not on the containing Control Module block.

Enabling HART results in the following:

- The Server History and Server Display tabs become visible on the channel block's CB configuration form.
- Any channel block parameters that have been configured on the containing Control Module's Server History or Server Display tabs will be removed from the list.
- A Server Point Build occurs for the channel block as part of the CM load.

Device types

When creating IOC function blocks for HART devices, it is best to choose the device type (Manufacturer, Device model, revision and DD revision) for the particular device you want to configure. Experion contains the following HART device types installed in Control Builder:

Device Type as shown in Control Builder	Device Manufacturer	Device Model	Device Revision	DD File Revision
Generic HART DEVICE	Any	Any	Any	Any
FlowServe Logix1200 R01 DD00	FlowServe	Logix1200	R01	DD00
Honeywell ST3000 R01 DD03	Honeywell	ST3000	R01	DD03
Honeywell ST3000 R02 DD02	Honeywell	ST3000	R02	DD02
Honeywell STT25H R01 DD03	Honeywell	STT25H	R01	DD03

You can add device types to the ERDB so that the device type will be available in the menu selections in Control Builder. See Adding HART Device Types.

Note: Generic HART DEVICE type can be used to configure any HART device, but HART device status (Command 48) data will contain generic text descriptions for the specific device. See Command 48 for more details.

Adding HART device types

New HART Device types, (that is, additional HART-capable device models and device revision levels) can be added to the ERDB. Using HART DD Manager utility, the DD

file for a HART device is read and interpreted to create a device definition file (.def file) which can then be added to the system ERDB. The added device types will appear in the Configured HART Device selection on the HART Configuration form

Then, when you open Control Builder, the new device type will be available as a selection so you can customize IOC blocks for the device using the associated configuration forms. Additionally, once the HART device is operating and communicating with the control system, device status (Command 48 status) received from the device is interpreted by the system and presented with descriptive text specifically for that device type.

To add a new device type in the ERDB and Control Builder:

Step	Action
1	Close Control Builder.
2	Launch HART DD Manager.
3	Go to Using HART DD Manager in the *HART DD Manager Utility guide* and follow the procedure for adding HART device types to the ERDB.
4	Open Control Builder.
5	The newly added device type will appear in the list of HART devices of the HART IO menu and also in the Configured HART Device (HCFGDEV parameter) list for either PM AI or PM AO channel blocks
6	Select the correct device type for the HART device that you are configuring.
7	Go back to the procedure that led you to here.

Note: The CM containing the HAI or HAO Channel must be reloaded from project in order to affect this change.

Scanning for HART Dynamic/Device Variables

When a HART IO channel is activated, the IOP/IOM issues HART commands to the connected device for device ID and range information. This information is cached in the IOP/IOM and is made available to the control system. The IOP/IOM also can be set to scan devices periodically for dynamic and device variables, and device status.

During IOP/IOM channel block configuration, you can set each HART enabled IO channel to scan the device for dynamic variables, device variables and status data. The Scan HART Variables parameter on the HART Variables configuration form allows you set which device data you want to collect periodically from the device connected to an IO

channel. You must set the Scan HART Variables, (HSCANCFG parameter) to the appropriate selection in order to collect this HART data and status from the HART device.

ATTENTION

Dynamic and device variables are collected only when Point Execution State (PTEXECST) is set to ACTIVE and the IOP's/IOM's Execution State (IOMSTATE) is set to RUN.

Scan HART Variables parameter

The Scan HART Variables selection (HSCANCFG parameter) determines if you want to scan the device to collect:

- Device variables, or
- Dynamic variables, or
- Both dynamic and device variables, and
- Device status.

You also have the option to select how often you want the IOP/IOM to scan the device to collect this data (scan rate). The rate can range from one second to 16 seconds between scans. Every HART enabled IO channel can be set to scan for HART variable data, however there are restrictions to the frequency of device scanning per IOP/IOM. For each selection of the Scan HART Variables parameter there is a percentage value attached to it. The value represents the percentage of the total (100%) for a scan cycle of a HART IOP/IOM. The available selections are listed here.

Scan HART Variables Selection	Scanned Variables	Scan Rate (in Seconds)	Percentage of IOP/IOM Scan Cycle
1S Device 30%	Device	1	30%
1S Dynamic 30%	Dynamic	1	30%
2S Device 12.5%	Device	2	12.5%
2S Dynamic 12.5%	Dynamic	2	12.5%
2S Dev & Dyn 30%	Device and Dynamic	2	30%
4S Device 6.25%	Device	4	6.25%

Scan HART Variables Selection	Scanned Variables	Scan Rate (in Seconds)	Percentage of IOP/IOM Scan Cycle
4S Dynamic 6.25%	Dynamic	4	6.25%
4S Dev & Dyn 12.5%	Device and Dynamic	4	12.5%
8S Device 3.13%	Device	8	3.13%
8S Dynamic 3.13%	Dynamic	8	3.13%
8S Dev & Dyn 6.25%	Device and Dynamic	8	6.25%
16S Device 1.6%	Device	16	1.6%
16S Dynamic 1.6%	Dynamic	16	1.6%
16S Dev & Dyn 3.13%	Device and Dynamic	16	3.13%
Status Only 1.6%			1.6%

Some HART devices provide for secondary variables which may require a faster scan rate to update the control system, (HART protocol provides for up to four dynamic variables). Other devices may have variables that can be scanned at slower rates.

When selecting the Scan HART Variables field, you need to consider that selecting values that exceed 100% of the IOP/IOM scan cycle may cause errors. This requires that you balance the scan rate at which devices will be scanned. Although, Control Builder allows you to select values for the IOP/IOM channels that exceed 100% of the scan cycle, enabling the channels of an IOP/IOM that exceed the 100% restriction will result in a scanning overrun and may cause errors or a loss of data. Therefore, when selecting the Scan HART Variables parameter you need to take into account:

- The number of HART enabled channels on the IOP/IOM
- The types of variables you want to scan from the devices and
- The rate at which the devices will be scanned,

not to exceed 100% of the IOP/IOM scan cycle.

A channel can be activated even when the total value of the Scan HART Variables parameter for an IOP/IOM exceeds 100% of the scan cycle. However, an IOP/IOM Soft failure will occur when this condition is detected. Therefore, to avoid errors and a scan overrun, you should not activate channels that will cause an overrun of the IOP/IOM scan cycle or adjust the scan values so that an overrun does not occur when channels of an IOP/IOM are activated.

Device and Dynamic Variables

HART protocol provides for process variables which can be read from a device in response to device commands. The format and content of the commands and responses are fully defined by the HART protocol, although the device manufacturer determines the number and type of variables that are supported.

Dynamic Variables – HART protocol provides for up to four dynamic variables to be read from a device. A Command 3 is issued by the IOP/IOM to read the available dynamic variables of the HART device. (Note that some HART devices may not support four dynamic variables.) The device responds with a value and an engineering unit for up to four digital variables, labeled PV, SV, TV and QV.

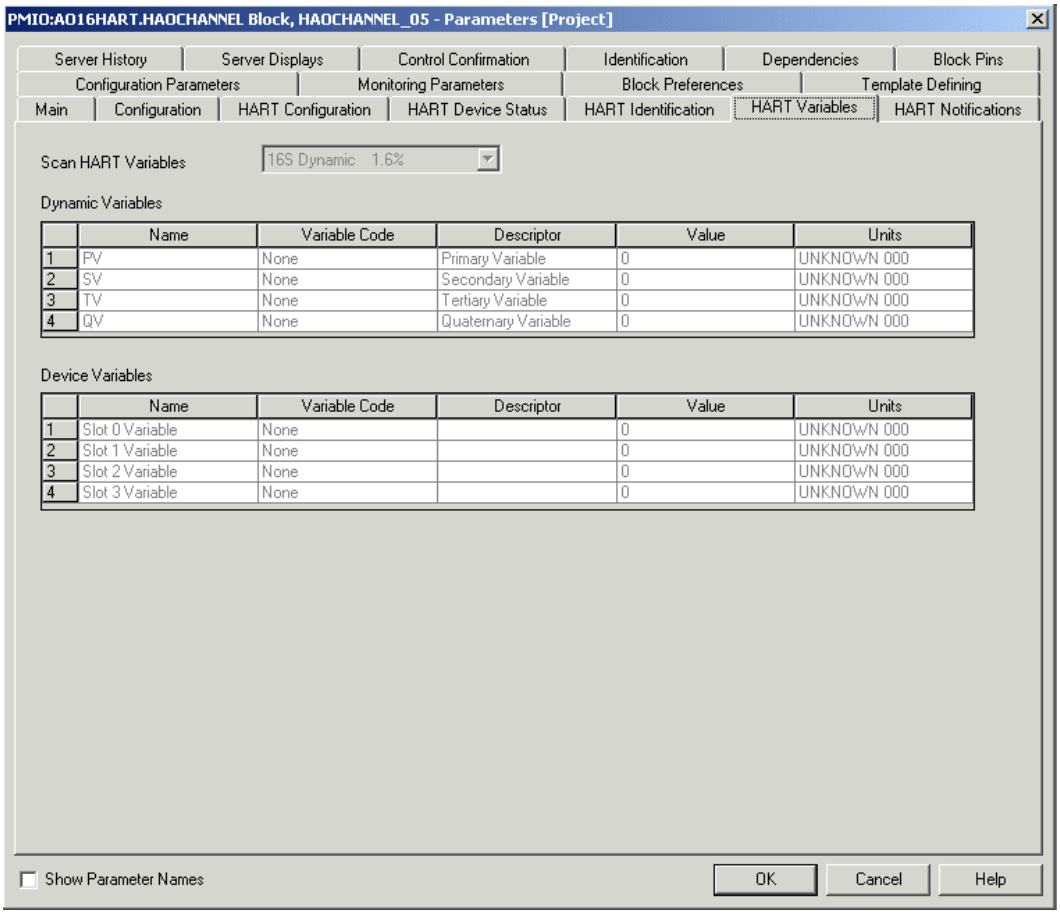
The device manufacturer determines what is returned for these four values and if all four variables are supported. For simple devices, only PV and SV are returned. If command 51 is supported, the user can select what four variables available in a given device will be returned as PV, SV, TV, and QV.

Device Variables – Up to four device variables (Slot0, Slot1, Slot2 and Slot3) can be requested from the HART device using Command 33, Read Device Variables. HART protocol specifies that a HART device can have up to 255 device variables for use with command 33. The device manufacturer determines if Command 33 is supported for the given device. If so, the manufacturer determines what variables are provided and assigns a numerical ID (from 1 to 255) to each particular variable. A variable code is entered in the HART Variables tab of the IOC function block. The value (1 – 255) in the Variable Code box corresponds to the numerical ID assigned to the device variable to be returned by the device. The default (None) indicates that no variable is to be returned. The following figure shows the HART Variables configuration form where the device variable information is entered.

ATTENTION

Command 33 is a common practice command that may or may not be support for a given device type. Check with the device manufacturer to verify if this command is implemented for the given HART device.

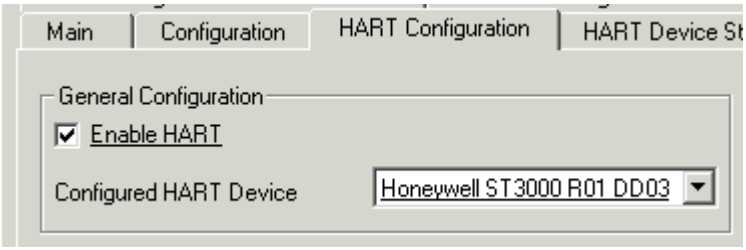
HART HAO CHANNEL – HART Variables tab



Disable HART on an IOC block

Disabling the HART function on an IO channel block causes the channel to operate with a standard 4 to 20 mA analog signal with no HART data being collected or reported.

To disable the HART function on an IO Channel:

Step	Action
1	First, make sure that – a) The channel block is not loaded. If the CM that contains the channel is currently loaded, it must be deleted. And, b) The channel block name must be unique within the system
2	Then, disable HART function by removing the checkmark in the HART Enable box on the HART Configuration form. 
	The IO Channel is now HART Disabled. Also, • The Server History and Server Display tabs are hidden from the channel block's CB configuration form. • A Server Point Build does not occur for the channel block as part of the CM load.
	Note that changing an existing channel block from HART disabled to HART enabled, (or from HART enabled to HART disabled) changes the parameter access form, therefore any custom displays must be updated accordingly
3	The CM containing the HAI or HAO channel must be reloaded from project in order to affect this change

HART Device Installation/Replacement

You should set the Configured HART Device (HCFGDEV parameter) on the HART Configuration form to match the device you intend to connect to the FTA screws. If the Configured HART device type is not available in the database, see Device Types. The

necessary HART parameter information is loaded through the IOLIM and to the IOP when the CM containing the IO channel is loaded. The IOP checks the configured device against the installed device for a difference in six parameters: the Device Manufacturer (HDEVMFG and HDVMFGCD), the Device Type (HDEVTYP and HDEVTYPCD) and Device Revision (HDVREV and HDVREVCD). If the installed device does not match the configured device, then the device mismatch flag (HDEVMISM) or device revision mismatch (HREVMISM parameter) is set and an alarm is raised indicating that an error exists in the block configuration. See Correcting a Device Mismatch for more information.

Use the steps in the following procedure to install a HART device.

Step	Action
1	Using Control Builder, Configure the appropriate HART enabled IO Channel within the IOP block.
2	Ensure proper connectivity to the IOP by loading the desired IOLIM (IOLINK block) and the IOP block.
3	Install the HART device in accordance with the directions provided by the device manufacturer. Be sure to note the HART device's manufacturer, device type, device revision and device ID.
4	Using a handheld HART communicator, set the HART address to 0 and configure the device for your process application.
5	Connect the HART device(s) to the terminal blocks of the appropriate channel of the FTA associated with the IOP.
6	From the Monitor View of Control Builder, you can view the HART device manufacturer, device type, device revision and device ID shown on the connected device(s) on the IOP "HART Status" for proper device connectivity.

Device replacement

To replace a HART device:

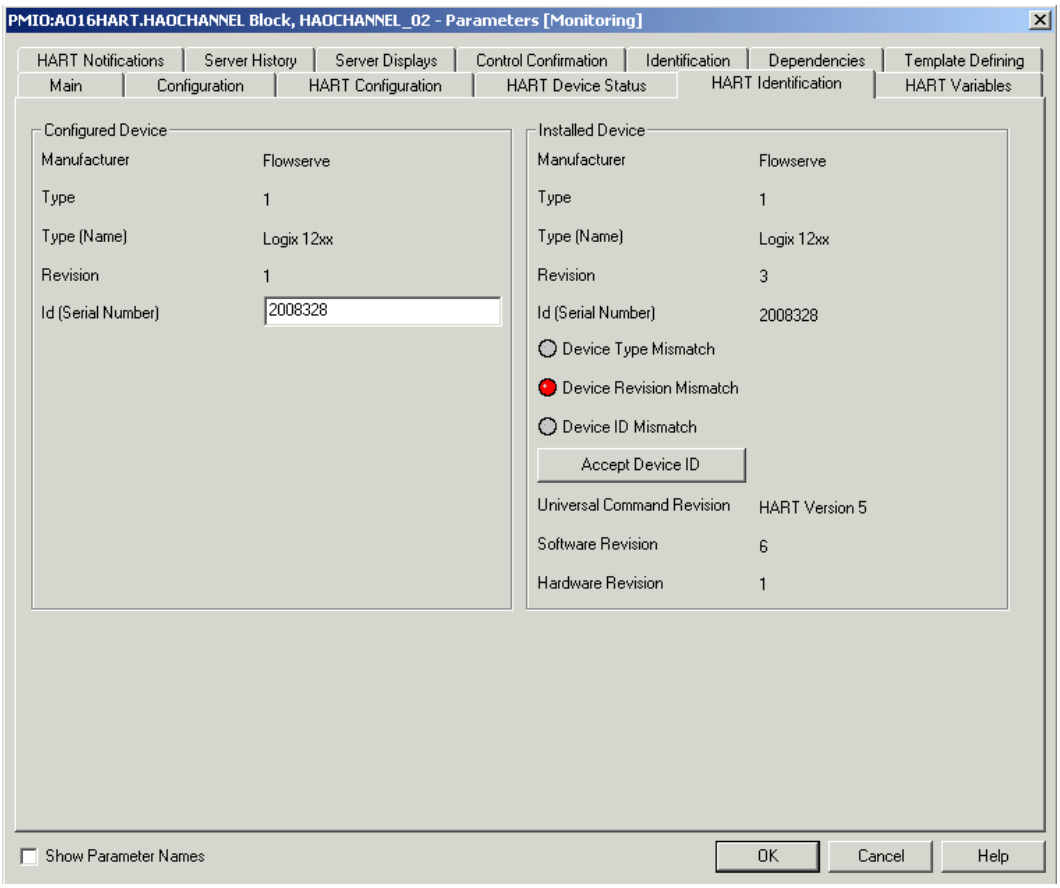
Step	Action
1	Inactivate the IO Channel block of the connected device that is to be replaced.
2	Remove the old device and install the replacement device according to the manufacturer's instructions.
3	Calbrate the replacement device, if necessary.
4	Connect the HART device(s) to the terminal blocks of the appropriate channel of the FTA associated with the IOP.
5	You will need to change the configuration of the IOChannel block if the replacement device is a different device type.
6	Load the CM containing the IO Channel block.
	Note that the device ID will be different than the replacement device ID. The HART device change flag (HDEVIDFL) will be raised. See Reset Device ID Mismatch Flag for details.
7	Click on "Accept Device ID" to clear the flag. Close the channel block. Close the CM.
8	Upload the channel to Monitor.
8	Update the IO Channel block information by selecting the "Update to Project" menu selection.
10	Activate the Channel block and the CM.

ATTENTION

If the new device is a different model, or has a different revision level, or is from a different manufacturer than the old device, the Device Type Mismatch flag or the Device Revision Mismatch flag will be set. The Device Mismatch flags appear on the HART Identification form in Control Builder.

The device mismatch can be resolved by identifying the condition and then performing one of the recommended actions in Correcting a Device Mismatch.

HART CHANNEL Block – HART Identification tab



Correcting a device mismatch

A device mismatch occurs whenever the channel is configured as HART Enabled, (Enable HART box is checked) and the installed device is different than the configured device block. HART parameter information is loaded to the IOP/IOM when the CM containing the channel is loaded. The IOP/IOM checks the configured device block against the installed device. If the installed device does not match the configured device block, then the Device Mismatch flag (HDEVMISM) and/or the Device Revision Mismatch flag (HREVMISM) is set and an alarm is raised indicating that an error exists in the system configuration. Both of these mismatch flags are shown on the HART Identification tab of a HART CHANNEL block.

HART device block parameter values, when using the generic HART device block, (HART DEVICE), will match any HART-capable device; although the values for the HART DEVICE block require that the Manufacturer, Device Type and Device Revision values match the connected device. Note that the Command 48 strings and device notifications generated from these HART devices will coorespondingly be generic. Examples of device mismatches and recommended actions on how to correct the mismatches are listed in the table below.

NOTE: HART devices are uniquely identified by four parameter values: Manufacturer, Device Type, Device Revision, DD Revision. Experion only checks if there is a difference for two of the four parameters, (the Device Type and Device Revision). Experion does not check for the DD revision level, therefore this may cause some inaccuracy in the Command 48 text strings since there is a possiblity that the Command 48 status bits and text strings may differ between two revisions of the DD file for the same device.

Condition	Recommended Action
The channel is configured as a Generic HART device and a “4-20 mA” device that is not HART capable is connected to the FTA/IOTA.	• Disable HART and reload the CM containing the channel, or • Connect any HART capable device to the FTA/IOTA.
The channel is configured as a specific HART device and a “4-20 mA” device that is not HART capable is connected to the FTA/IOTA.	• Disable HART and reload the CM containing the channel, or • Connect the appropriate HART capable device to the FTA/IOTA
The channel is configured as a Generic HART device and there is no device attached to the FTA/IOTA.	• Disable HART and reload the CM containing the channel, or • Connect any HART capable device to the FTA/IOTA.
The channel is configured as a specific HART device and there is no device attached to the FTA/IOTA.	• Disable HART and reload the CM containing the channel, or • Connect the appropriate HART capable device to the FTA/IOTA
The connected device has a different manufacturer, device type or device revision than the configured device.	• Disable HART and reload the CM containing the channel, or • Connect the appropriate HART capable device to the FTA/IOTA, or • Change Configured HART Device to

	match the installed device and reload the CM containing the channel, (See Note), or • Change Configured HART Device to the Generic HART Device setting and reload the CM containing the channel.
Note: If the device type for the replacement device is not available in the system, you may need to add the new device type to the ERDB. See Adding HART Device Types for more details and a procedure.	

Resetting Device ID mismatch flag

Whenever the configured HART Device ID (HDEVIDCD) is different from the installed device's Device ID (HDEVID), the Device ID Mismatch flag (HDEVIDFL) is set.

To reset this condition, you can:

- Delete the CM. Disable HART on the channel and reload the CM or IOP/IOM containing the channel. Or,
- In Project, change HDEVIDCD to match HDEVID and reload the CM or IOP/IOM containing the channel. Or,
- Press the "Accept Device ID" button on the HART Identification form, (shown below). Then upload the channel to Monitor and update the channel on Project.

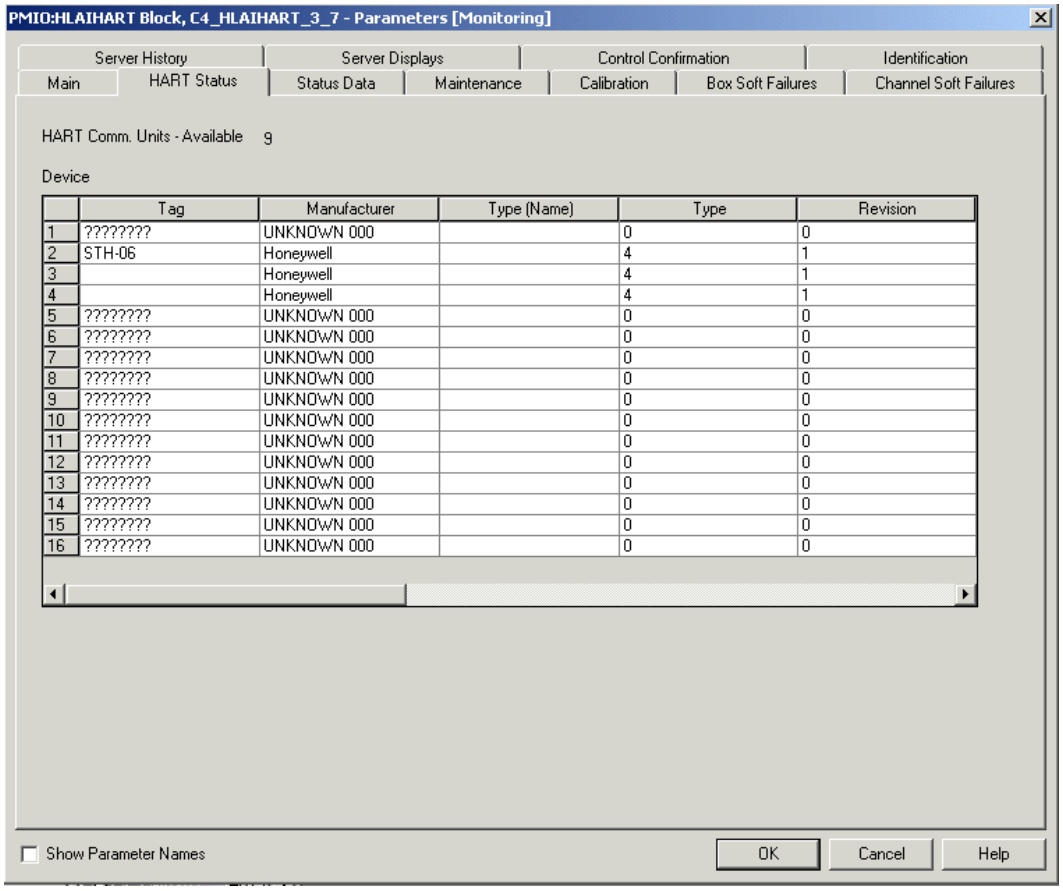
NOTE: Pressing the "Accept Device ID" button will signal a return to normal for the alarm associated with the Device ID Mismatch flag, (HDEVIDFL).

Auto Detection Feature

Description

The Auto Detection (Device Discovery) feature allows the IOP/IOM to scan its channels for any connected HART devices. Upon power up, (or upon the enabling of Auto Detection on analog output channels), the IOP/IOM issues a Command 0 to all HART-enabled channels. The IOP/IOM collects identity information from all HART devices that respond and displays that data on the Status tabs in the IOP/IOM block, as shown in the following figure.

HART Status tab – HART AI IOP Block



The data received from the devices then can be used to configure the HAICHANNEL and HAOCHANNEL blocks acssociated with the IOP/IOM.

HART Commands used for Auto Detection

A "successful" auto detection (or device discovery) is defined as the response from a connected HART device to the following commands:

- Command 0 – Read unique identifier
- Command 6 – Set polling address to 0 (if applicable)
- Command 38 – Reset configuration changed flag (if applicable)
- Command 12 – Read message
- Command 13 – Read tag, descriptor and date
- Command 14 – Read PV transducer information
- Command 15 – Read device information
- Command 16 – Read final assembly number

Two additional commands also are issued during a device discovery, but are not required for declaring a device discovery successful.

- Command 59 – Set response preamble bytes to 5
- Command 50 – Read dynamic variable association

Note that the IOP/IOM block must be loaded in order for auto detection to occur. Auto detection is always enabled on AI IOPs/IOMs; however the auto detection must be enabled on each channel of AO IOPs/IOMs.

The IOP/IOM issues commands for device discovery also when a HART communication failure occurs and when either the Cold Start or Configuration Changed status bits are set in the Device Standard Status message.

When no connected HART device is found after the IOP's/IOM's first attempt, the IOP/IOM will schedule additional scans, so in the event that devices are later added, they can be detected automatically. IOP/IOM issues a command 48 status periodically to all discovered devices for monitoring purposes. The rate at which the IOP/IOM schedules device discovery and command 48 scans is dependent upon a number of parameter states. The following table summarizes the IOP/IOM scanning rates for device discovery and command 48 when the auto detection feature is enabled.

Parameter and State			Scan for…	
PNTTYPE **Point Type**	**HENABLE** **HART Enabled**	**PTEXECST** **Point Execution State**	**Device Discovery**	**Command 48**
Not Configured (Channel block not loaded)	N/A	N/A	All channels once a minute.	Once every 64 seconds after the device is discovered. NOTE 1.
Configured (Channel block is loaded)	Disable	N/A	All HART communication including device discovery is disabled.	None.
Configured (Channel block is loaded)	Enable	PTEXECST is INACTIVE Or IOP/IOM State is IDLE	Device discovery, if needed, is attempted at the configured HART scan rates. Each instance uses a new polling address from 0 to 15 with two reties. The third retry scans for address 0. NOTE 2.	Once every 32 seconds after the device is discovered. NOTE 1.
Configured (Channel block is loaded)	Enable	PTEXECST is ACTIVE And IOP/IOM State is RUN	Device should be discovered before reaching this state. If not, discovery is attempted at the configured HART scan rates. Each instance uses a new polling address from 0 to 15 with two reties. The third retry scans for address 0. NOTE 2.	Every 16 seconds, when dynamic and device variable scanning is not selected. Every 64 seconds, when dynamic or device variable scanning is selected.
NOTE 1: This is to monitor the discovered device and also retrigger discovery of the device if communication is lost.				

Parameter and State	Scan for…
NOTE 2: This is to ensure that a device with address zero is discovered within the scan period.	

A command 48 scan is scheduled whenever the More Status is Available or Device Malfunction status bits are set in the Device Standard Status message. Not all field devices support command 48. The IOP/IOM will not generate a command error for these devices so long as the device responds with command not implemented.

Monitoring PM I/O and Series C IO HART

Using Station displays

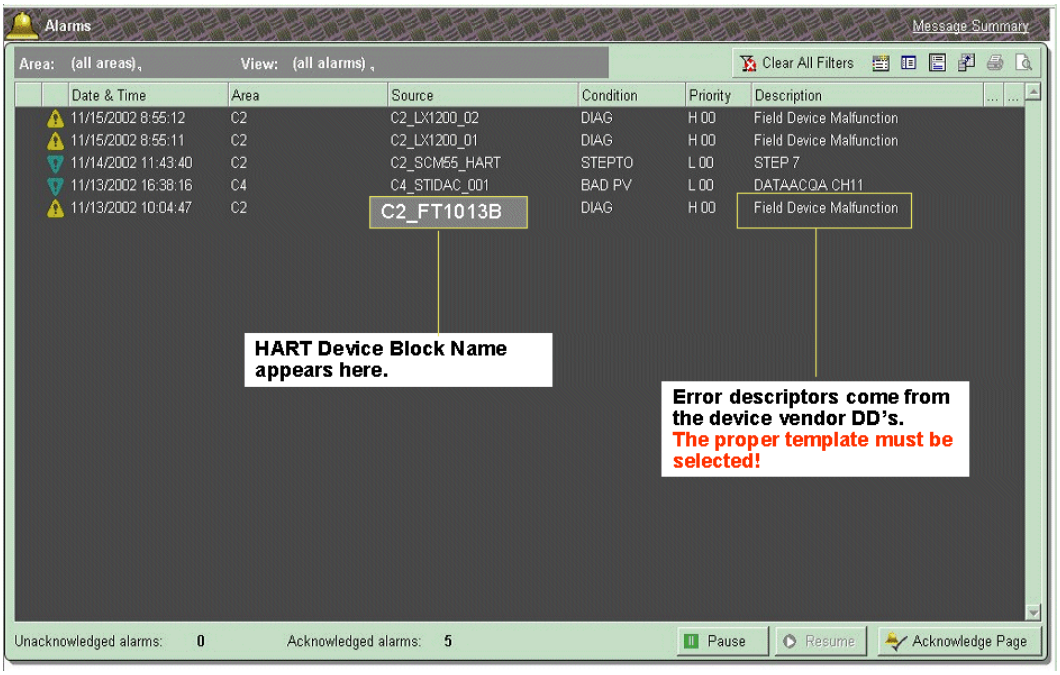
The Experion Server Station application includes pre-configured detail displays for each HART IOP/IOM block, and each HART IO Channel block. Once communications are established, you can begin monitoring the status of any HART block that has been loaded as part of a control strategy to a controller with points registered in the Experion server. The detail displays let you quickly view the module's current state, fault status, and pertinent configuration data.

REFERENCE - INTERNAL

Please refer to the Operator's Guide for detailed information about calling up, navigating, and viewing Station displays

Detail and alarm summary displays

Each HART device has a dedicated detail display. HART device alarms and status are reported directly against the device Tag, as shown in the following figure.



Alarm Summary Display

Using Control Builder Monitoring tab

Once you download a control strategy to a controller, you can use the Monitoring tab in Control Builder to interact with the function blocks in the control modules, sequential control modules, and IOPs/IOMs assigned to the Control Execution Environment (CEE).

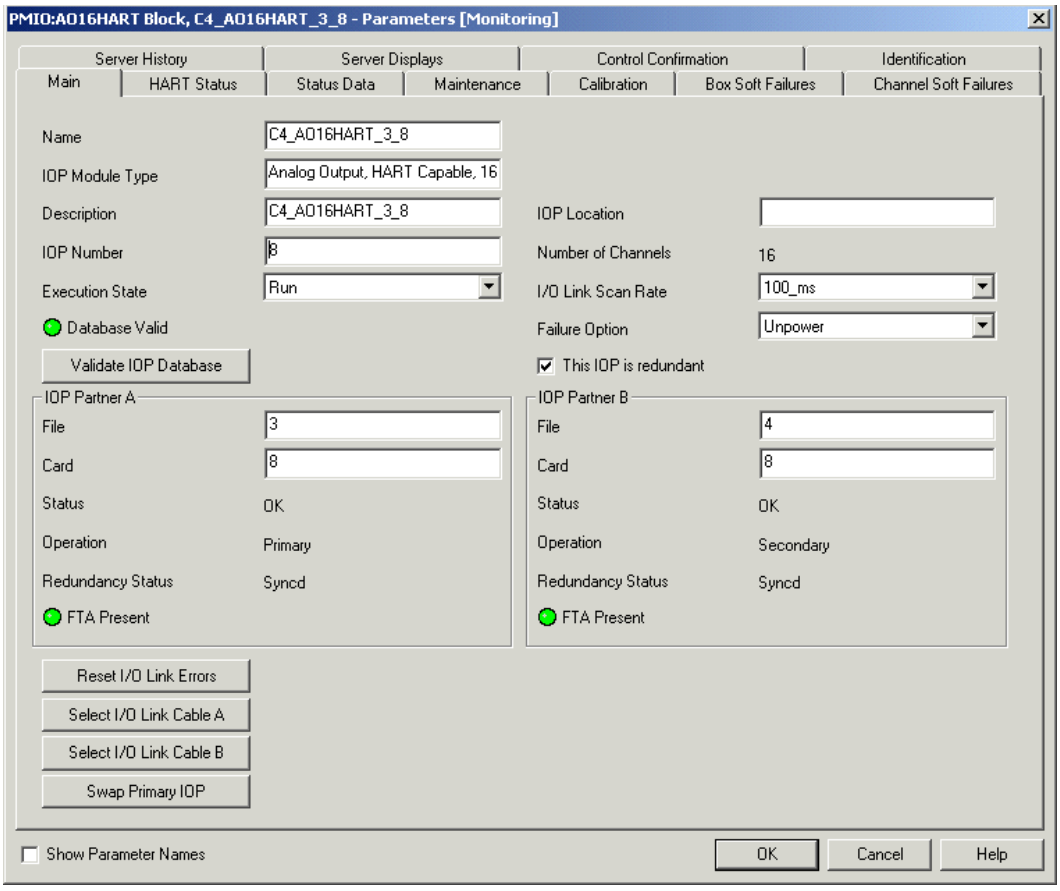
You simply double-click the desired IOP/IOM icon in the I/O tree menu under the CEE icon to call up the IOP's/IOM's configuration form. Click on the various tabs to view the IOP's/IOM's identification and current status. Both the CEE and IOP/IOM function blocks must be active to view on-line data.

HART IOP/IOM status

Clicking on the IOP/IOM icon in the Monitoring tree will open the configuration forms for the IOP/IOM.

- The Main tab, as shown in the following figure, describes the Name and IOP/IOM type (AI or AO HART), the Execution State of the IOP/IOM, and the physical location of the IOP/IOM. Additional information indicates whether the IOP/IOM has a redundant secondary IOP/IOM and the current status of both IOPs/IOMs. Buttons at the bottom of the form provide controls for resetting I/O link errors and selecting active control hardware.

Main tab – HART AO IOP Block



- The HART Status and Status Data tabs provide you with detailed information about connected field devices.
- The Maintenance tab provides hardware and firmware revision level information, plus additional configuration/status flags. If the IOP/IOM is redundant, the same information is shown for the secondary IOP/IOM.
- Box Soft Failures and Channel Soft Failures tabs will list any detected type failures for the IOP/IOM and if redundant, for the secondary IOP/IOM. Descriptions for these notifications are found in the *PM I/O Hardware Troubleshooting and Maintenance Guide* and the *Series C I/O User's Guide*.
- The Identification tab shows information on the IOP/IOM block.

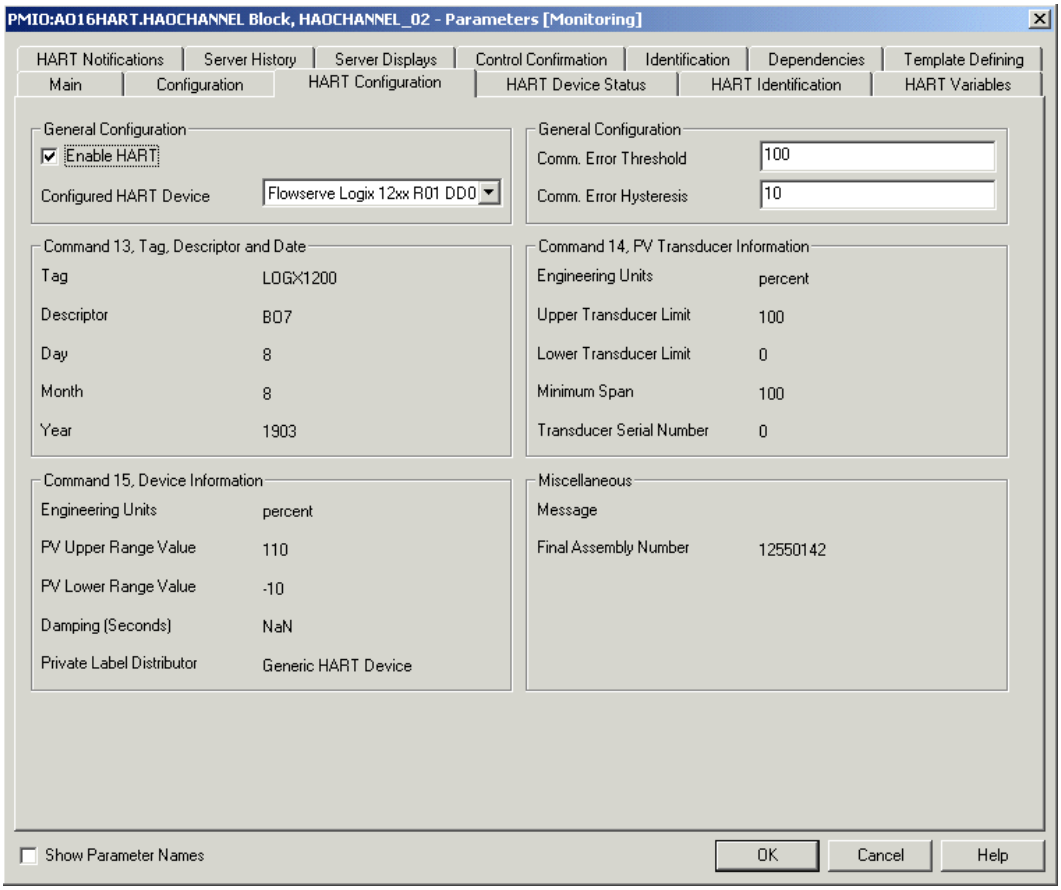
HART device status

You can also view HART device status information from the Control Builder monitoring tab. Double-click the desired Channel icon in the I/O tree menu under the IOP/IOM icon to call up the channel's configuration form. Click on the various tabs to view the device's identification and current status. Both the CEE and IOP/IOM function blocks must be active to view on-line data.

Clicking on the Channel icon in the Monitoring tree will open the configuration forms for the device channel.

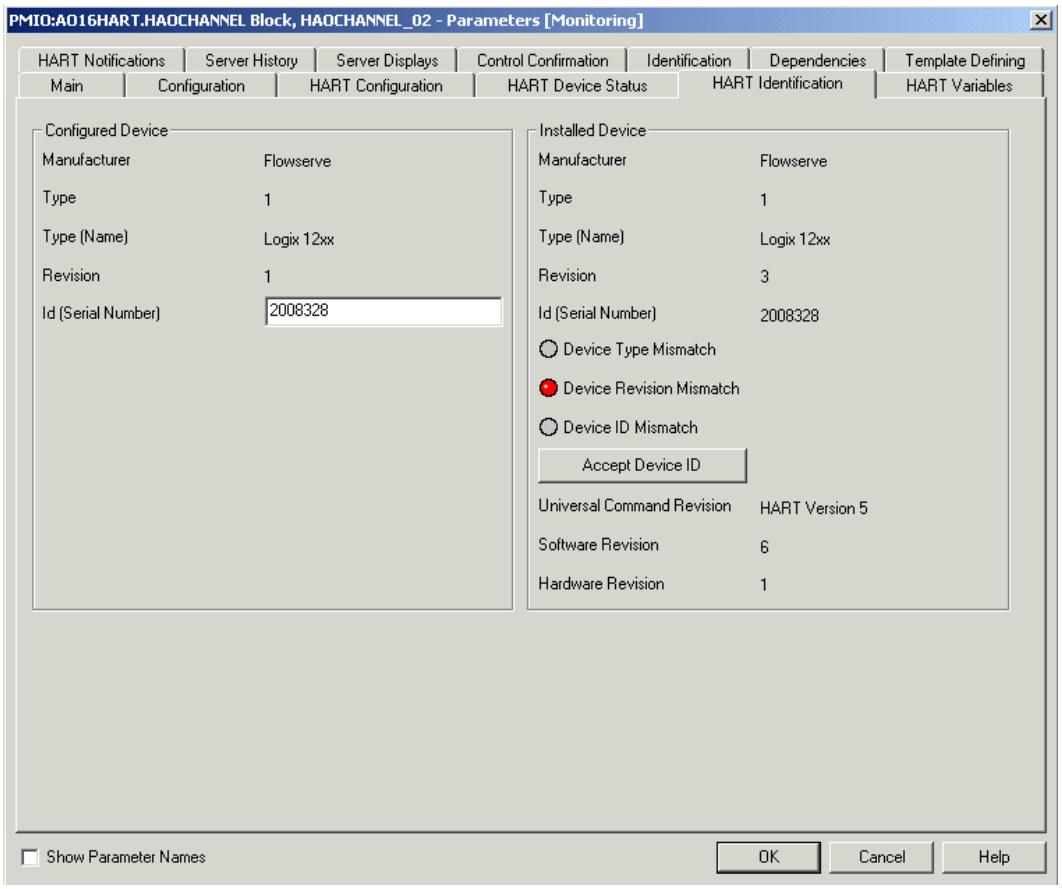
- The Main tab shows the Device Name, the associated IOP/IOM and the Point Execution State for the channel. The PV (or Output Value for AO) of the device is shown as well as the device location.
- The Configuration tab shows a summary of the device configuration, such as PV or output characterization and range values.
- HART Configuration tab provides identification information for the device and HART device data in response to commands issued from the IOP/IOM. An example is shown in the following figure.

HART Configuration tab – HART AO CHANNEL Block



- The HART Device Status lists any device status flags indicating an abnormal condition. Status is derived from the device standard status and command 48 responses from the device. Communication status between the IOP/IOM and the device is also indicated on the tab.
- The HART Identification tab shows the HART identification parameters of the connected device and compares them to the parameters of the configured device. Any mismatch of these parameters is indicated with a status flag as shown in the following figure.

HART Identification tab – HART AO CHANNEL Block



- HART Dynamic and Device Variable details are shown on the HART Variables tab.

HART Notifications Tab

The HART Notifications tab shows a listing of all the status bits returned from a device in response to a Command 48, Read Device-Specific Status. Note that this command may not be supported for the HART device so check with the device manufacturer.

Command 48 provides up to 200 bits of additional device status information. Adding the HART device type to the ERDB enables Experion to interpret the Command 48 status bits and provides descriptive text strings with the status bits. Since each device type may

differ in the meaning of each of its status bits, it is important that every HART device is configured using the associated configuration forms for that device. Device-specific configuration forms are derived by using the Device Description Manager to read and interpret the HART DD file associated with the device.

See Device Types and Adding HART Device Types for more information.

HART I/O Alarm and Event Behaviors

The following table describes the I/O hardware behavior in response to various conditions.

Condition	Description	Actions Taken
IOP transitions to IDLE	Communication between the IOLIM and the IOP is good, and IOP state changes from RUN to IDLE.	IOP generates a state change event and removes all active process alarms for all configured channels on that IOP.
IOP/IOM transitions to POWER ON (See Note 1.)	The IOLINK supervisor commands an IOP/IOM Recovery when the following conditions are detected: • Supervisor IOP/IOM state changes to Power On • IOP/IOM not responding • IOP/IOM has Communication Errors • Configuration Mismatch	• The IOLINK Block commands a recovery of the system diagnostic and process alarms events for the IOP/IOM. • Experion Server receives an IOP/IOM Recovery Begin bracket at which point it marks all alarms from that IOP/IOM and its channel blocks as questionable. • Alarms for the IOP/IOM and its channel blocks are reported as part of the recovery. If the alarm already exists, its questionable flag is cleared. Otherwise the alarm is added as a new alarm. • When the IOP/IOM Recovery End bracket is received, any alarms for the IOP/IOM or its channels whose questionable flags have not been cleared are removed.
IOP/IOM Switchover	A commanded or un-commanded	• The IOLINK block generates a switchover system diagnostic

Condition	Description	Actions Taken
	IOP/IOM switchover occurs.	event. • Event collection for the IOP/IOM pair is temporarily halted. • The IOLINK Block commands a Recovery of the system diagnostic and process alarms events for the IOP/IOM. • Experion Server receives an IOP/IOM Recovery Begin bracket at which point it marks all alarms from that IOP/IOM and its channel blocks as questionable. • Alarms for the IOP/IOM and its channel blocks are reported as part of the recovery. If the alarm already exists, its questionable flag is cleared. Otherwise the alarm is added as a new alarm. • When the IOP/IOM Recovery End bracket is received, any alarms for the IOP/IOM or its channels whose questionable flags have not been cleared are removed. • See Notes 2 and 3.
Channel State transitions: Active/Inactive		HART channel block alarms are not affected during a point execution state change
Loss of communications with the device	A loss of communications with the field device occurs if a HART transaction fails after three retries. Definition of a single HART transaction failure is: • No response from the device. • Errors detected by IOP/IOM -	• The HART channel block generates a Loss of Communications alarm to Experion Server. • The HART channel block invalidates the digital data and enters an initialization state in which device discovery is

Condition	Description	Actions Taken
	parity or checksum error in the reply. • Errors detected by device - communication status bit set in the device response. • Errors detected by both IOP/IOM and device.	scheduled at a reduced rate. Any active device status or extended device status alarms will remain active until the communications is reestablished with the device.
Re-establishment of communications with the device	Device communications are considered re-established when a HART transaction is successful.	• The HART channel block RTNs the Loss of Communications alarm to Experion Server. • The HART channel block scans HART digital data. As a result, any active device status or extended device status alarms that are no longer active will return to normal.
Note1: Both AI and AO IOPs/IOMs scan all channels for HART devices four seconds after power up. If HART devices are "found" connected to any channel, then the identity information is collected and a low frequency scan (once every 32 second) is scheduled to ensure the continued presence of the discovered devices. Channels for which no HART device is found, the IOP/IOM schedules a low frequency discovery (issuing a command 0 once every minute) so that any device connected in future will be discovered. This is done to show you what the IOP/IOM sees on its FTA/IOTA as soon as the IOP/IOM block is loaded, (and shown on the HART status tab.) This information helps you to configure the channel block rather than loading the channel and possibly creating a mismatch error.		
Note 2: The initial HART digital scanning of the new Primary IOP/IOM can take significantly longer than the IOP/IOM Event Recovery. As a result, some HART Device alarms may be marked as questionable and possibly discarded then re-reported after the IOP/IOM Recovery End bracket. These alarms/events will be re-reported and logged with a new time if their conditions still exist.		
Note 3: Since the Command 48 response is not tracked to the secondary IOP/IOM, any active Command 48 status bits that are configured for events will be re-sent as events on IOP/IOM switchover.		

HART Miscellaneous behaviors

HDEVST parameter contains specific HART device status bits that, when any of the status bits are set, the bit definition is visible on the HART Status tab in Control Builder. The status bits do not prevent you from activiating the channel to which the HART

device is connected. This is so because different HART devices identify the status bits differently.

See Correcting a Device Mismatch for more information.

The user may take any HART device status bit and make it an ouput of the IO channel block. Thus allowing the user to customize a control strategy based on that particular HART device status.

On import, the configured HART Device type (HCFGDEV) should already exist in the ERDB. Should this not be the case, configured HART Device will be set to the Generic HART Device. You will receive a warning message indicating this change.

PM I/O HART Alarm and Event Notifications

ATTENTION

When an IO channel is configured as HART enabled, the channel is set automatically to report alarms and events.

The HART channel blocks do not generate alarms and events if HART is disabled.

IO Channel blocks are treated as tagged blocks only if configured to be HART enabled. Each HART enabled channel block generates system diagnostic alarms and events that are specific to the corresponding HART field device. These alarms and events are reported in the Experion Server Alarm Summary display and the Experion Server Event Journal against the assigned HART channel tag name.

Alarms and events that are tagged against the HART channel block are categorized into three groups:

- Field Device Status Notifications
- Additional Device Status Notifications (Command 48)
- IOP-Generated Notifications

There are other HART related alarms and events that are tagged against the IOP/IOM block such as a HART Modem failure.

Field device status notifications

The Field Device Status is contained in the second data byte of a two-byte (16 bit) Device Standard status monitored by the IOP/IOM. It indicates the current operating

status of the field device as a whole and is not associated with the completion of any command.

The HART IO channel block generates an alarm or event when the associated bit in the Field Device Status transitions from value '0,' (for normal), to value '1,' (abnormal). For alarms, a transition from '1' to '0' will result in a RTN (Return to Normal). For events, a transition from '1' to '0' will result in an additional generated event indicating the status bit is Normal.

The following table summarizes the Field Device Status Notifications generated by the IO channel block.

Device Condition/ Status Byte 2 Bit	Type	Definition
Device Malfunction/ Bit 7	Alarm	The device detected a serious error or failure that compromises device operation.
Configuration Changed/ Bit 6	Event	An operation was performed that changed the device's configuration.
Cold Start/Bit 5	Alarm	A power failure or Device Reset has occurred.
More Status Available/ Bit 4	-	More status information is available via Command 48 - Read Additional Status Information.
Loop Current Fixed/ Bit 3	Alarm	The Loop Current is being held at a fixed value and is not responding to process variations.
Loop Current Saturated/ Bit 2	Alarm	The Loop Current has reached its upper (or lower) endpoint limit and cannot increase (or decrease) any further.
Non-Primary Variable Out Of Limits/Bit 1	Alarm	A Device Variable not mapped to the PV is beyond its operating limits.
Primary Variable Out of Limits/Bit 0	Alarm	The Digital PV is beyond its operating limit.
Note: More Status Available (Bit 4) is not processed as an Alarm or an Event. It does not represent an alarm condition. The HART specification states, "When More Status Available is set, the measurements may still be correct and suitable for use by control systems. More Status Available merely indicates that Command 48 contains diagnostic information that is useful to the host." The Command 48 response contains the additional device status bits. The HART DD Manager application allows users to configure which additional device status bits should be processed as alarms or events. See Command 48 for more information.		

Additional device status (Command 48) notifications

A Command 48 is issued periodically by the IOP/IOM to collect additional device status from the device. A Command 48 is issued also whenever the More Status Available bit (Bit 4 of Device Status Byte 1) is set or when the Device Malfunction bit (Bit 7 of Device Status Byte 2) is set. See Command 48 for additional information.

The HART channel block generates an Additional Device Status alarm or event when the following is true:

1. Bit 4 of the Status Byte 2 in the Device Standard Status transitions from '0' to '1',

   AND

2. The HART channel block's HNTFCFG[x] parameter = Alarm or Event, where 'x' is the associated bit number.

A transition from '1' to '0' will result in a RTN (Return to Normal) for the alarm or event. When multiple bits are set in the Command 48 response data, multiple alarms and events are generated; which will provide a clear one-to-one mapping to the RTNs.

Device specific status

For these notifications, the Experion Server's alarm summary and event journal displays will list:

Condition	Description	Explanation
HARTCMD48_ BYTExx_BITy	Descriptor string as defined in the manufacturer's DD file	For the Condition field, xx is the Byte offset number (0..24) and y is the Bit number (0..7) within the byte of the Command 48 response. The HART channel block's AUXDESC parameter is an arrayed string parameter that contains the bit descriptors as defined in the device manufacturer's DD file. The DD descriptor string may be truncated if it exceeds the Experion Server Description field length.

Extended device status

The following table summarizes the Extended Device Status Notifications.

Condition	Description	Explanation
HARTCMD48_ BYTE06_BIT1	Device Maintenance Required	While the device has not malfunctioned, the Field Device requires maintenance.
HARTCMD48_ BYTE06_BIT2	Device Variable Alert is set	This bit is set if any device variable is in an alarm or warning state. The host should identify the device variable(s) causing this to be set using the device status indicators.
NOTE: Both of these bits can be Configured during DD Manager Template Build step.		

Device operating mode

For these notifications, the Experion Server's alarm summary and event journal displays will list:

Condition	Description	
HARTCMD48	Operating Mode Bit X is set	

Analog channel saturated

For these notifications, the Experion Server's alarm summary and event journal displays will list:

Condition	Description	Explanation
HARTCMD48	Analog Channel Saturated	Bytes 8-10 of the Command 48 response contain information regarding Analog Channel 1 through Analog Channel 24. These bits are set when electrical limits established by the Field Device are exceeded for the corresponding Analog Channel.
Note: Only field devices that support more than one analog channel are required to return this status information		

Analog channel fixed

For these notifications, the Experion Server's alarm summary and event journal displays will list:

Condition	Description	Explanation
HARTCMD48	Analog Channel Fixed	Bytes 11-13 of the Command 48 response contain information regarding Analog Channel 1 through Analog Channel 24. These bits are set when the corresponding Analog Channel is being manually controlled.
Note: Only field devices that support more than one analog channel are required to return this status information.		

IOP/IOM -Generated notifications

The HART channel blocks generate System Diagnostic Alarms and Events based upon information within the IOP/IOM. These notifications are defined by the Experion system and are not part of the HART Protocol Specification. IOP/IOM notifications are presented on the Box Soft Failures and Channel Soft Failures tabs in the IOP/IOM block forms. A listing and description of the box and channel soft failures can be found in the *PM I/O Hardware Troubleshooting and Maintenance Guide* and the *Series C I/O User's Guide*.

IOP/IOM Generated Notifications for HART channels

Condition	Notification Type	Explanation
Device Configuration Mismatch *	Alarm	User-configured HART template type does not match the physical HART device type.
Device Revision Mismatch * *	Alarm	The user-configured HART template matches the physical HART device type, but the configured revision does not match the revision of the physical device.
Device ID Mismatch	Alarm	The configured HART Device ID is different from the installed device's Device ID.
Secondary Master Present	Alarm	A secondary HART master is present.
HART Communication Failure	Alarm	A HART transaction failed after three retries. Definition of a single HART transaction failure is: • No response from the device. • Errors detected by IOP/IOM - parity or checksum error in the reply. • Errors detected by device - communication status bit set in the device response. • Errors detected by both IOP/IOM and

Condition	Notification Type	Explanation
		device. The parameter HCOMFAIL indicates the reason for the transaction failure. This alarm will return to normal when a transaction is successful. Once the alarm returns to normal, the HCOMFAIL value will be copied to the HLCOMERR parameter to keep track of last failure reason. The parameter HNCOMERR will keep the count of the total HART communication failures per channel. See also Loss of communications with the device in Alarm and Event Behaviors.
Excessive Communication Errors	Alarm	The number of HART communication errors has exceeded a threshold level as defined by the HCOMTHRS parameter. This alarm will return to normal when error count goes below 90% of HCOMTHRS.
HART Command Failed	Event	A HART transaction failed with a command specific error code. • If the command failed is an initialization command (0, 6,59,109, 12, 13, 14 15, 16 or 50), the IOP/IOM will set the HART digital data to fail safe values and will try to rediscover the device at a reduced rate. • If the command failed is a scan command (3,9,33 or 48), then corresponding HART variables will be set to fail safe values, but the HART scan scheduling will not be changed. The HART channel block supports two parameters - HCMDFAIL and HCMDERR that provide failed commands and error codes. This event will return to normal when a good response is received for the

Condition	Notification Type	Explanation
		commands in error. If more than one command fails with a bad response code, the HART channel block will only report the first failed command event. This event is not posted if the device responds to a common practice command (that is, any command number greater than 32) with a response code 64, (Command not Implemented). However in this case, HCMDFAIL and HCMDRESP parameters are updated to show that the command is not implemented.
HART Scan Overruns	Alarm	The channel is not polling for HART dynamic and/or digital data in the configured time period. Note, the HART modems are operating beyond their capacity to collect data.
Range Mismatch	Alarm	User configured values for a set of PV characterization parameters does not match those found in the HART device. Can occur only when HPVCHAR is set to DeviceRange.
* HART Device Mismatch flag– (HDEVMISM parameter) is set when either the manufacturer or the device type of the configured device differs from the installed device.		
* * HART Device Revision Mismatch flag – (HREVMISM parameter) is set when the revision number of the configured device differs from the installed device.		

An alarm is raised when a mismatch is detected and it is cleared when the mismatch no longer exists. A supervisor or higher access user can activate a channel block when a mismatch exists. However the channel operates with the following conditions:

- The channel acts and performs all standard 4 -20 mA functions
- Returns NaN (Not a Number) for all digital Dynamic variables (PV, SV, TV and QV) and all device variables (slot values).
- Provides HART device status, alarms and events

- Does not provide command 48 status, alarms and events when the Device Mismatch flag is set.
- Provides command 48 status, alarms and events when Devcie Revision Mismatch flag is set.

HART Device Configuration

Device Configuration Methods

Experion provides two solutions for HART I/O that includes HART devices connected to Series A HART I/O modules (Series A HART I/O), Process Manager HART IOPs (PM I/O HART), or Series C IO modules (Series C IO).

The configuration of HART devices, or changing the device configuration, can be accomplished either of two ways.

3. **For a new device that has not been commissioned**. A bench configuration of the device can be performed using Honeywell's Smart Device Configurator (SDC 625) software that is running on a computer or a handheld PC. A third party handheld HART configurator can also be used.

4. **For a device that has been commissioned and is operating in a process application**. Use the Honeywell Field Device Manager, (FDM) application and connect to the device through the HART Software Multiplexer application.

The following sections outline procedures for accessing HART device configuration parameters for HART devices connected to Series A HART I/O, PM I/O HART and Series C IO control hardware.

Honeywell and Experion HART management tools

The Honeywell Field Device Manager, FDM, is an asset management application for HART field devices in your control system. The FDM allows you to configure, calibrate and monitor HART field devices as well as running HART device methods. The Smart Device Configurator (SDC 625) software is one of the applications included with the FDM.

The FDM is designed and developed to run on the client-server architecture which is basic to Experion. Experion Server includes the HART software multiplexer application, which emulates the functions of a HART hardware multiplexer, and enables the FDM to connect to and issue commands to HART devices.

See the *Honeywell Field Device Manager User's Guide* for more information.

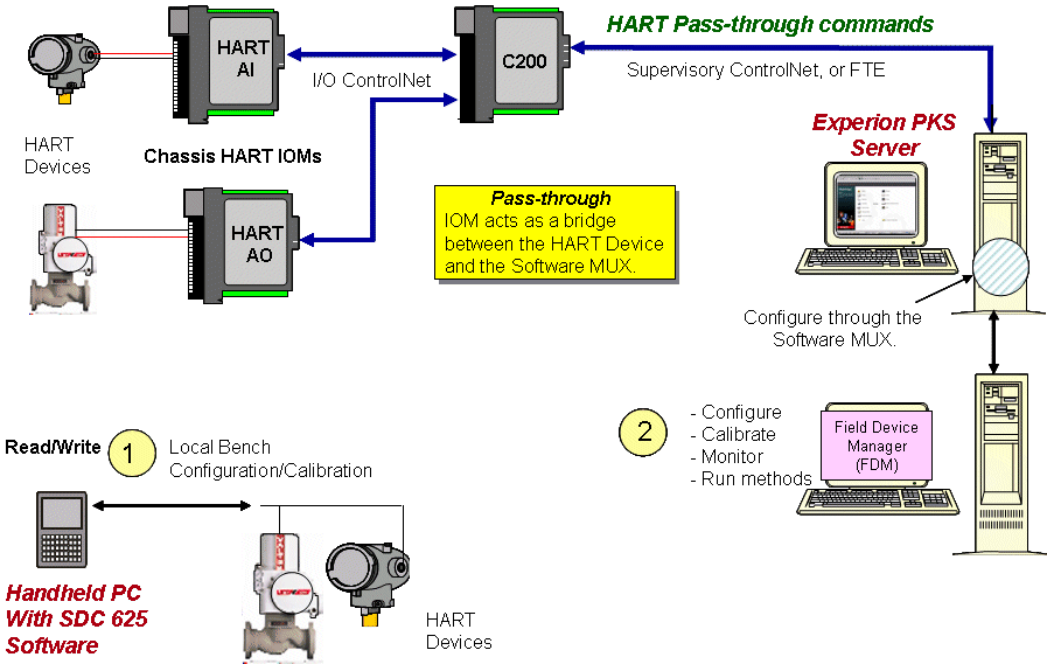
See HART Software Multiplexer for information on using the software mux application.

Configuring HART devices connected to Series A HART I/O modules

Figure 4 illustrates the two methods for accessing HART device configuration in a Series A HART I/O installation –

1. A local bench configuration and,
2. Using the FDM application to connect to devices already installed in a control system.

Figure 4 Series A HART I/O Device Configuration Methods



The following procedure outlines the steps for writing device configuration to a HART device that is connected to a Series A HART I/O Module (IOM).

Step	Action
1	Make sure the PC that contains the FDM application is connected to the Experion Server that contains the HART Software Multiplexer application. • The FDM should be running.

Step	Action
	• The HART Software Multiplexer Service should be running.
2	Set to Manual the control loop of the IOM channel to which the HART device is connected. • For AO module channels, the output should be driven to a safe value. • For AI module channels, the PV is set to Not a Number (NaN). Note that PVRAW continues to return the loop current value.

Make sure the control loop has been set to manual before proceeding! Once the HART Device block Channel Mode parameter is set to OFFCONTROL, (in step 3) the PV and output are not usable.

3	Set the Channel Mode parameter of the HART Device block display (Main tab) to OFFCONTROL. The HART Software Mux will write to the Passthrough Mode parameter and change it to "READ_AND_WRITE" when the configuration application initiates device communication. NOTE: The Channel Mode parameter on the HART Device Block indicates the current channel mode as either "NORMAL" or "OFFCONTROL."
4	Using the HART configuration application, make configuration changes to the HART device that is connected to the IOM channel. See ATTENTION Below.

ATTENTION

In OFFCONTROL mode, configuration or calibration/diagnostic commands from the HART Software Multiplexer have the highest priority for the channel.

When the device block's Channel Mode parameter is set to OFFCONTROL,

- Dynamic or device variables are set to NaN. Which can include DIGPV, DIGSV, DIGTV, DIGFV and SLOT0VALUE, SLOT1VALUE, SLOT2VALUE and SLOT3VALUE parameters.
- No alarms are reported for the IOM channel.
- For the HART AI channel - the PV is set to NaN, PVSTS is set to BAD, but the PVRAW continues to return the loop current value.
- For the HART AO channel - the output is held at the last calculated value and INIT mode is entered.

NOTE: If the channel mode parameter of the device block is in OFFCONTROL state and the device has not been issued a HART command from the MUX for three minutes, the Passthrough Mode parameter will automatically return to "READONLY."

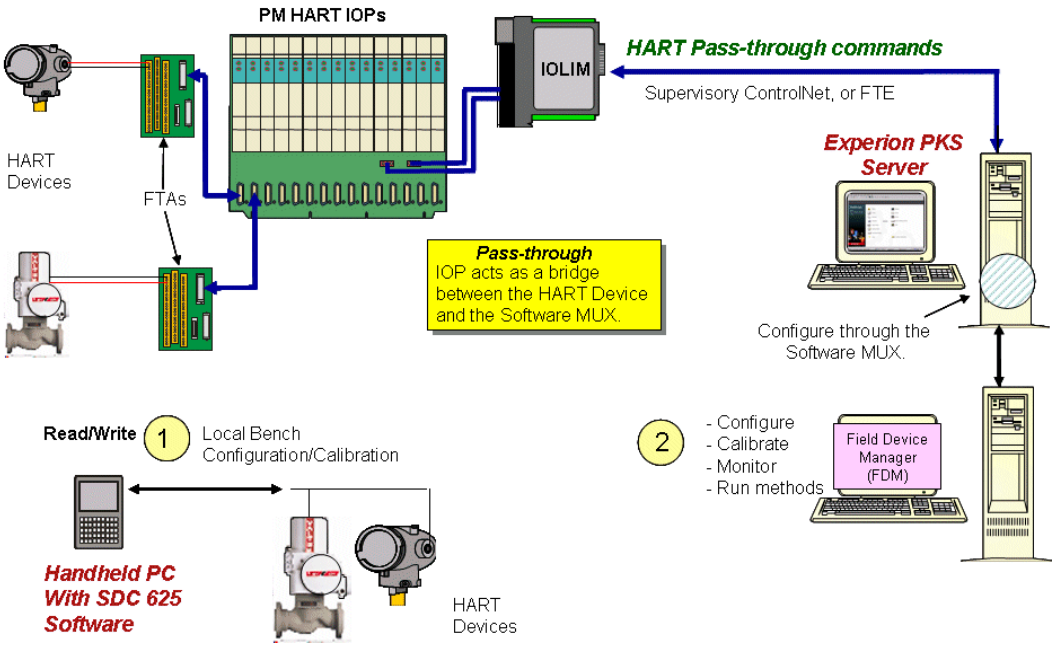
Step	Action
5	Once all configuration changes have been written to the device, be sure to set the Point Execution state to ACTIVE in the HART Device block. The HART Software Mux will return the HART Device Block to the "NORMAL" state automatically once the device block or associated IOM channel block is set to ACTIVE. Once the device block returns to the ACTIVE state: • The Device ID Information is updated from the HART Device, if changed during device configuration. • The Range information is updated from the HART Device • The IOM begins to scan and publish Dynamic/Device variables and Device Status.
6	Return the control loop to its normal operational mode.

Configuring HART devices connected to PM I/O HART IOPs (C200 controller topology)

Figure 5 illustrates the two methods for accessing HART device configuration in a PM I/O HART installation –

1. A local bench configuration and,
2. Using the FDM application to connect to devices already installed in a control system.

Figure 5 PM I/O HART IOP Device Configuration Methods



The following procedure outlines the steps for writing device configuration to a HART device that is connected to a Process Manager HART IOPs. Note that PM HART IOPs can be implemented in a C300 Controller topology, (see Figure 3). The configuration procedures are the same for both PM IO implementations (C200 and C300 topologies).

Step	Action
1	Make sure the PC that contains the FDM application is connected to the Experion Server that contains the HART Software Multiplexer application. • The FDM should be running. • The HART Software Multiplexer Service should be running.
2	Set to Manual the control loop of the IOP channel to which the HART device is connected. • For AO module channels, the output should be driven to a safe value. • For AI module channels, the PV is set to Not a Number (NaN). Note that PVRAW continues to return the loop current value.

Make sure the control loop has been set to manual before proceeding! Once the HART Channel block Execution State parameter is set to INACTIVE, (in step 3) the PV and output are not usable.

3	Set the Point Execution State parameter of the HART Channel block to the INACTIVE state. (Go to the Main tab of the channel block display and set the Execution State to "INACTIVE.")
4	Using the HART configuration tool, make configuration changes to the HART device that is connected to the IOP channel. See ATTENTION Below.

ATTENTION

When a HART IOP channel is in the INACTIVE state, the pass-through function is primary and normal device scanning for HART variables is suspended.

In addition, When the IOP Channel is set to INACTIVE,

- Point processing does not execute for the IOP channel.
- Dynamic and device variables are set to NaN. Which can include HDYNVAL1, HDYNVAL2, HDYNVAL3, HDYNVAL4 and HSLOTVAL0, HSLOTVAL1, HSLOTVAL2 and HSLOTVAL3 parameters.
- Alarms are unaffected for the IOP channel.
- For the HART AI channel - the PV is set to NaN, PVSTS is set to BAD, but the PVRAW continues to return the loop current value.
- For the HART AO channel - the output is held at the last calculated value and INIT mode is entered.

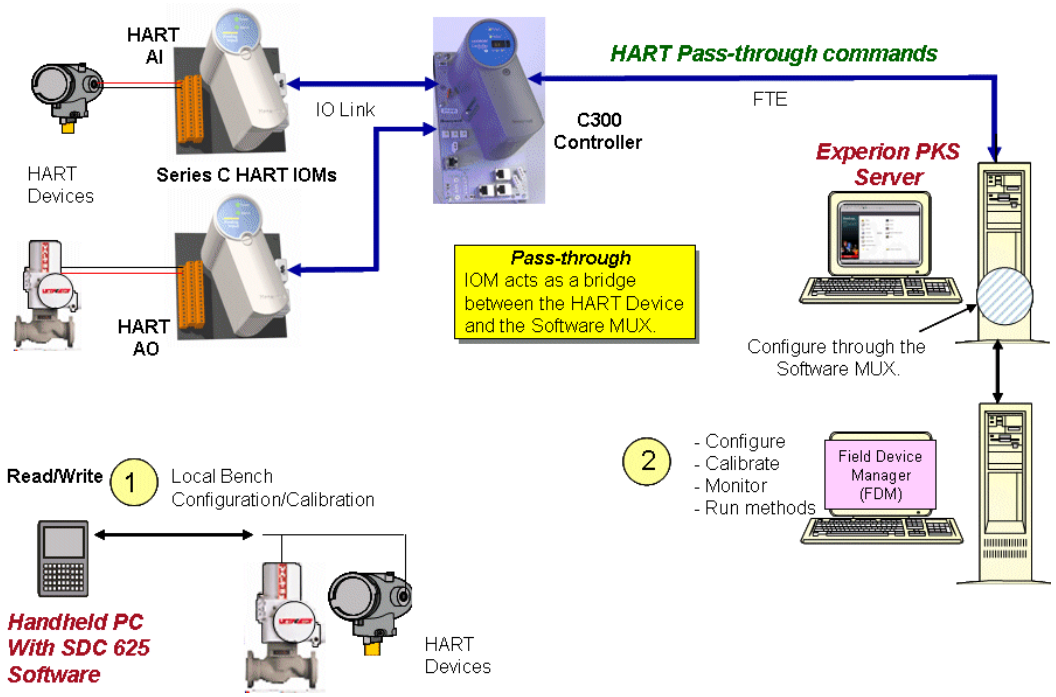
Step	Action
5	Verify all changed HART information in the channel detail display is correct. Once all configuration changes have been written to the device, return the Point Execution state to ACTIVE in the HART Channel block. Once the Channel block returns to the ACTIVE state: • The Device ID Information is updated from the HART Device, if changed during device configuration. • The Range information is updated from the HART Device • The IOP begins to scan and publish Dynamic/Device variables and Device Status.
6	Return the control loop to its normal operational mode.

Configuring HART devices connected to Series C IOMs (C300 controller topology)

Figure 5 illustrates the two methods for accessing HART device configuration in a Series C I/O HART installation –

1. A local bench configuration and,
2. Using the FDM application to connect to devices already installed in a control system.

Figure 6 Series C I/O HART Device Configuration Methods



The following procedure outlines the steps for writing device configuration to a HART device that is connected to a Series C HART IOMs.

Step	Action
1	Make sure the PC that contains the FDM application is connected to the Experion Server that contains the HART Software Multiplexer application. • The FDM should be running. • The HART Software Multiplexer Service should be running.

Step	Action
2	Set to Manual the control loop of the IOM channel to which the HART device is connected. • For AO module channels, the output should be driven to a safe value. • For AI module channels, the PV is set to Not a Number (NaN). Note that PVRAW continues to return the loop current value.

Make sure the control loop has been set to manual before proceeding! Once the HART Channel block Execution State parameter is set to INACTIVE, (in step 3) the PV and output are not usable.

3	Set the Point Execution State parameter of the HART Channel block to the INACTIVE state. (Go to the Main tab of the channel block display and set the Execution State to "INACTIVE.")
4	Using the HART configuration tool, make configuration changes to the HART device that is connected to the IOM channel. See ATTENTION Below.

ATTENTION

When a HART IOM channel is in the INACTIVE state, the pass-through function is primary and normal device scanning for HART variables is suspended.

In addition, When the IOM Channel is set to INACTIVE,

- Point processing does not execute for the IOM channel.
- Dynamic and device variables are set to NaN. Which can include HDYNVAL1, HDYNVAL2, HDYNVAL3, HDYNVAL4 and HSLOTVAL0, HSLOTVAL1, HSLOTVAL2 and HSLOTVAL3 parameters.
- Alarms are unaffected for the IOM channel.
- For the HART AI channel - the PV is set to NaN, PVSTS is set to BAD, but the PVRAW continues to return the loop current value.
- For the HART AO channel - the output is held at the last calculated value and INIT mode is entered.

Step	Action
5	Verify all changed HART information in the channel detail display is correct. Once all configuration changes have been written to the device, return the Point Execution state to ACTIVE in the HART Channel block. Once the Channel block returns to the ACTIVE state: • The Device ID Information is updated from the HART Device, if changed during device configuration. • The Range information is updated from the HART Device • The IOM begins to scan and publish Dynamic/Device variables and Device Status.
6	Return the control loop to its normal operational mode.

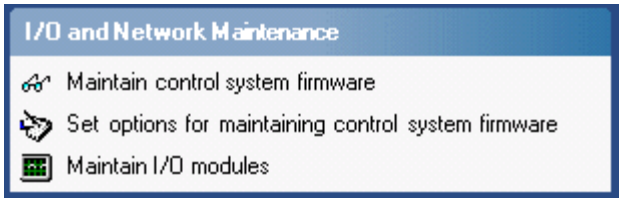
I/O Maintenance Tool

Overview

Note: The focus of this section is to describe the use of I/O Maintenance Tool utility as a means to calibrate the Series A HART AI and AO modules when needed.

The I/O Maintenance Tool is a diagnostic and calibration utility that obtains and displays device information and status for chassis- and/or rack-mounted I/O modules. The I/O Maintenance Tool utility is available through Configuration Studio interface.

Task

Step	Action
1	Launch Configuration Studio and connect to a system with a logon security level of Engineer or greater.
2	Select a Server and then choose **Control Strategy**. The **I/O and Network Maintenance** Tasks appear in the task pane
	
3	Click on **Maintain I/O modules**. The I/O Maintenance Tool interface will appear.

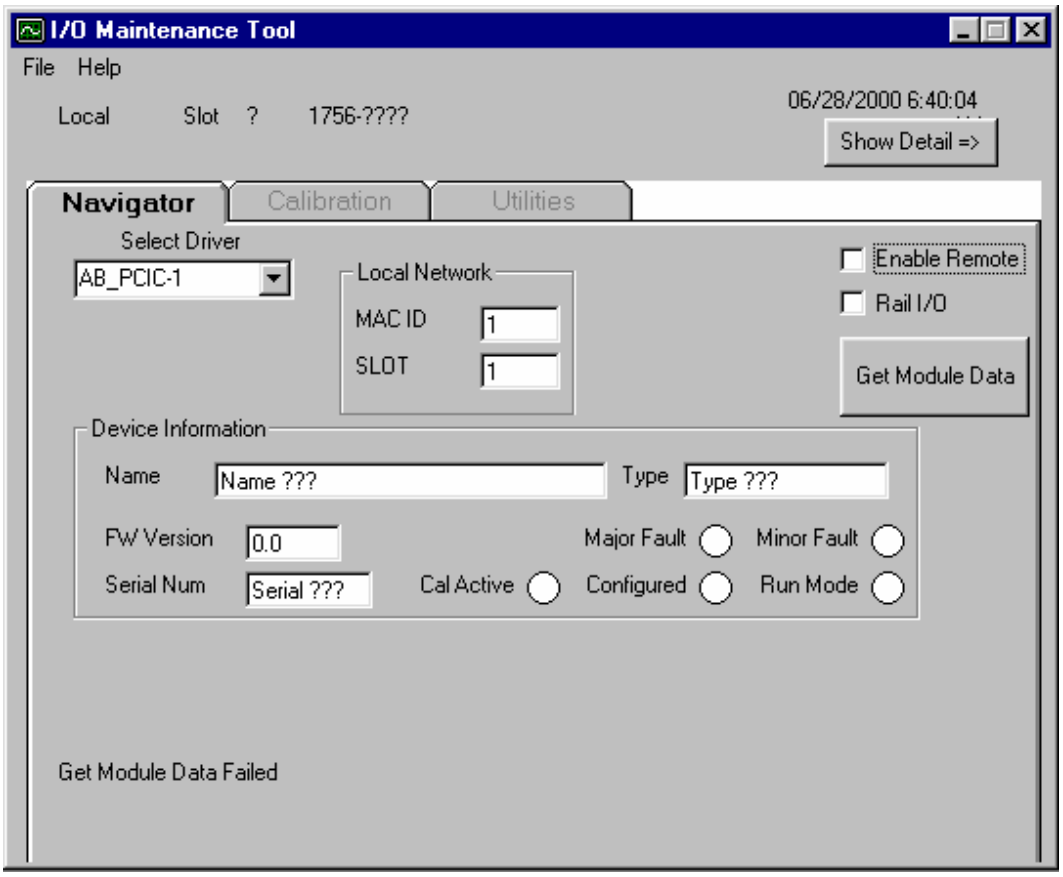
I/O Maintenance Tool interface

Operations are accessed by the 3 tabs on the main I/O Maintenance Tool interface: Navigator, Calibration, and Utilities. Selecting these tabs allow you to {1} navigate to a single I/O module and query the module for device identification information and status, {2} perform calibration for various analog modules, and {3} reset short/overload faults on diagnostic output modules.

Note that the Calibration and Utilities tabs are not accessible until you specify the appropriate target I/O module type on the Navigator tab.

{1} Navigator tab

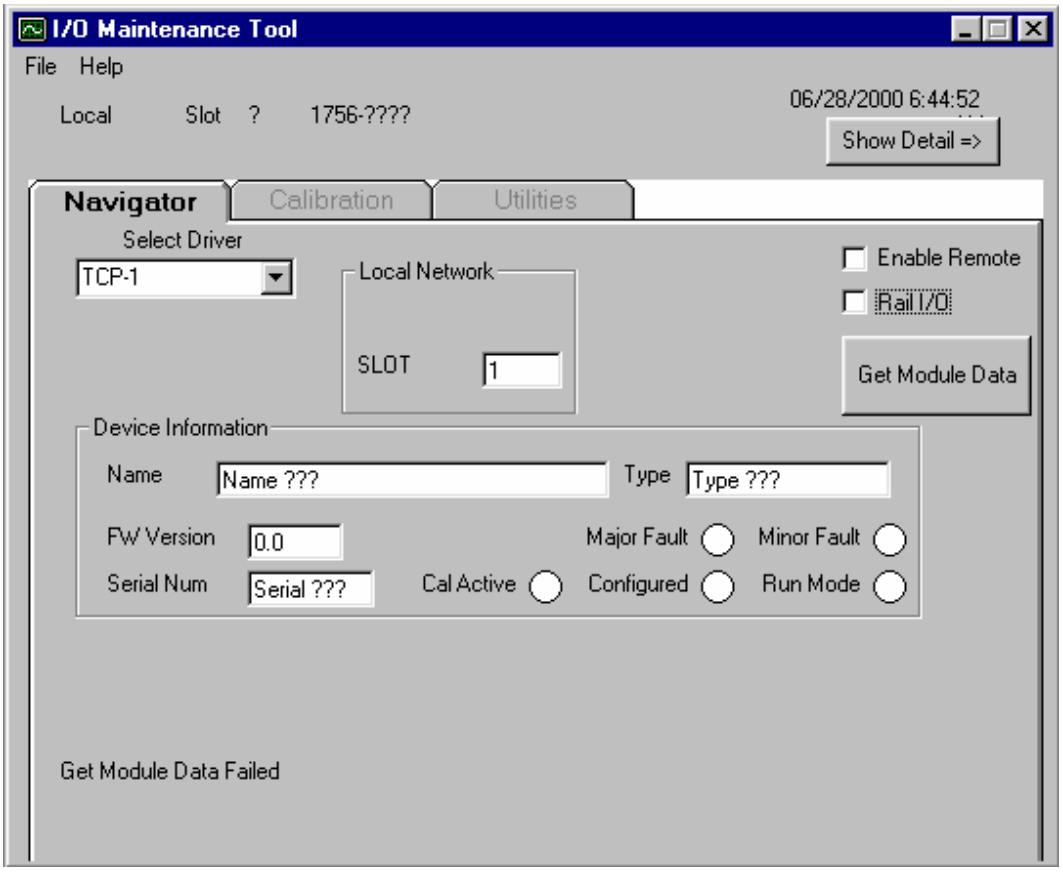
The Navigator Tab is used to specify the location of the I/O module that requires maintenance. The target I/O module can be either a chassis or rail mount module, and the destination chassis/rail can reside on either a local or remote network. The following illustration depicts the Navigator Tab configuration for a chassis I/O module residing on a local ControlNet network.



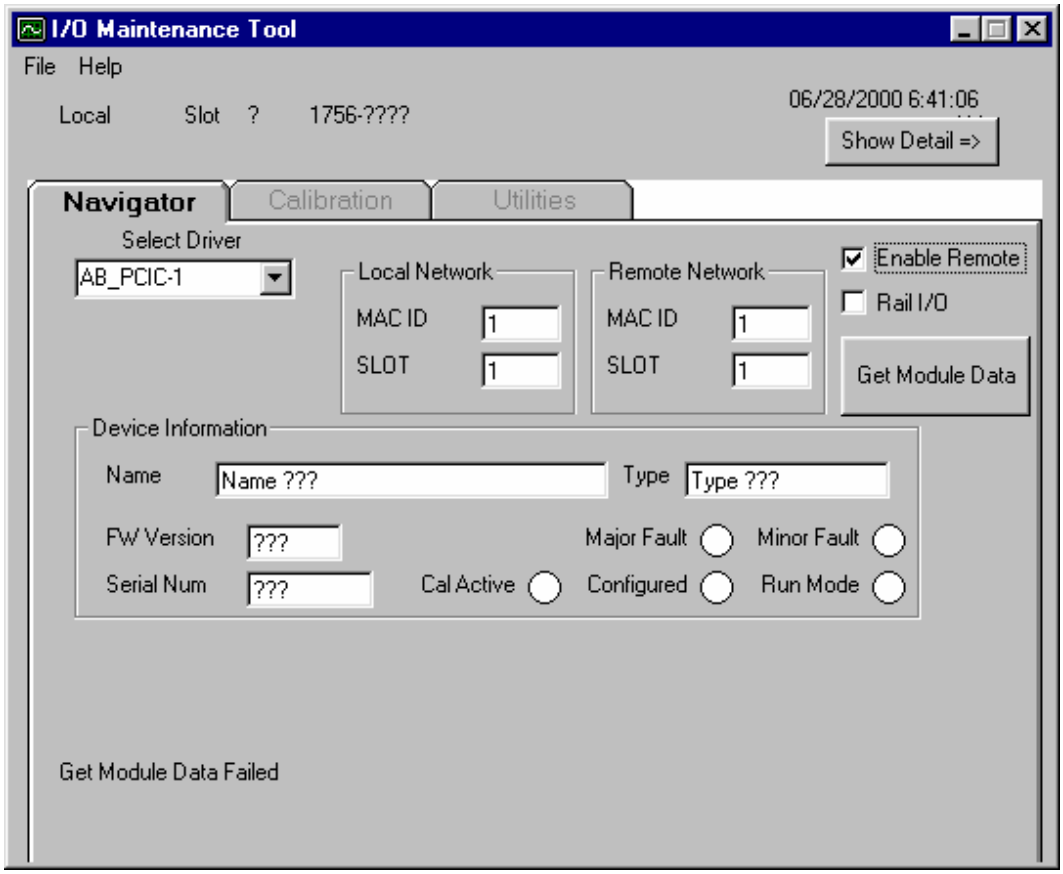
Feature	Description
Select Driver	Used to select an appropriate driver to communicate with the target I/O module. The I/O Maintenance Tool supports the

	maintenance of I/O modules via both Ethernet and ControlNet networks. With the possibility of having multiple RSLinx drivers, you must explicitly select the driver needed to communicate with the target I/O module. At startup, the I/O Maintenance Tool populates this combo box with a list of configured RSLinx drivers. Please note that RSLinx drivers must be configured before using the I/O Maintenance Tool.
Enable Remote	If the target I/O module resides on a remote network (i.e. not directly connected to the PC), check this box to expose the remote network fields.
Rail I/O	If selecting a rail I/O module, check this box to expose the Gateway and Device Information fields. NOTE: Make sure that Rail I/O is **not** checked when accessing HART IOMs.
Local Network	If the 'Enable Remote' check box is selected, the Local Network information specifies the communication hub used to reach the remote network. Otherwise, if the Enable Remote check box is not selected, the Local Network information specifies the target Rail/Chassis I/O module. Local Network information is comprised of up to 2 fields: 'MAC ID' and 'SLOT'. The 'MAC ID' field specifies the ControlNet address directly connected to this PC. Note that this selection is not required and hence not available when an Ethernet driver has been selected. The 'SLOT' field specifies the chassis position of either the I/O module (i.e. no remote network) or the communication interface module (i.e. I/O module on remote network).
Remote Network	The Remote Network entry fields are only exposed when the Enable Remote check box is selected. Remote Network information is comprised of 2 fields: {1} 'MAC ID' and {2} either 'SLOT' in the case of chassis I/O or 'MODULE #' in the case of rail I/O. The 'MAC ID' field specifies the ControlNet address of the remote chassis/rail. The 'SLOT' / 'MODULE #' field specifies the chassis/rail position of the I/O module. Note that the 'SLOT' field is only renamed to 'MODULE #' if the I/O module is a rail I/O module (i.e. 'Rail I/O' is selected).

The following illustration depicts the Navigator Tab configuration for a chassis I/O module residing on a local Ethernet network. Note that there is no MAC ID field in the Local Network box.



The following illustration depicts the Navigator Tab configuration for a chassis I/O module residing on a remote ControlNet network with a supervisory ControlNet network. Note that when the Enable Remote box is checked, two additional fields (MAC ID and SLOT) are visible in the Remote Network box.



Selection of the 'Get Module Data' button causes the I/O Maintenance Tool to query information and status for the targeted I/O module. The requested I/O module information is displayed in the fields within the Device Information box and the ControlNet Information fields (if remote).

Device Information Box Fields	Description
Name	The catalog name of the I/O module.
Type	The type of I/O module.
FW Version	The version number of the I/O module firmware currently loaded.
Serial Num	The I/O module's serial number.
LEDs	The I/O module Operation and Fault Status is displayed by the round "LED" symbols.

If this data reflects the desired I/O module, proceed to the Calibration tab.

NOTES:

1 Selection of an Analog Module enables the Calibration Tab.

2 If 'Get Module Data' fails, some of the fields display '???' and a Status message is displayed at the bottom of the Navigator Tab.

3 Possible Status Messages that may be returned in response to a query:

"Get Module Data Succeeded"

"Get Module Data Failed"

"Bad MAC ID for the Remote CNI"

"Bad SLOT # for the Local Chassis CNI"
"Selected Analog Module is READY to Calibrate"

"Selected Analog Module is RUNNING. You MUST INACTIVATE and DELETE this Module from the Control Builder Monitoring TAB before Calibrating."

"The ControlNet Gateway is Connected to one or more Rail I/O Devices. You MUST INACTIVATE and DELETE any such Device(s) from the Control Builder Monitoring TAB before Calibrating."

Module calibration using IOTOOL

REFERENCE

Please refer to the on-line help for the I/O Maintenance Tool for general information.

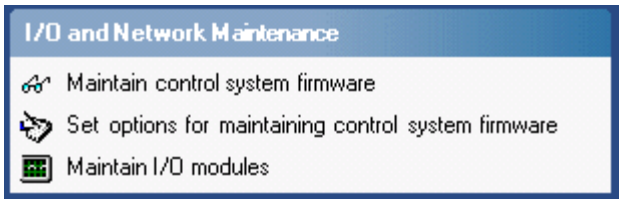
Modules you can calibrate

You can calibrate the Series A HART Analog Input module TC-/TK-HAI081 and the Series A HART Analog Output module TC-/TK-HAO081.

When to calibrate

Your module is shipped to you already calibrated. If calibration is required, follow the procedures in this section.

- Perform calibration periodically based on your application needs.
- Module calibration may also be required to remove error due to aging of components.
- Calibration may be required to eliminate long lead wire resistance to open circuit detection current.

Step	Action
1	Launch Configuration Studio and connect to a system with a logon security level of Engineer or greater.
2	Select a Server and then choose **Control Strategy**. The **I/O and Network Maintenance** Tasks appear in the task pane
	
3	Click on **Maintain I/O modules**. The I/O Maintenance Tool interface will appear showing the Navigator tab.

Step	Action
4	If the HART IO module is located in a local controller chassis, be sure the Enable Remote checkbox is not checked and in the appropriate Local Network fields: • Type the controller's MAC ID, • Type the SLOT number of the module to be calibrated. Remember that slot (or group) numbers are zero based (0 to 7) starting with the first module (Slot 0) to the right of the power supply. If the HART IO module is located in a remote chassis I/O or controller chassis, be sure the Enable Remote checkbox is checked and in the appropriate Local Network and Remote Network fields: • Type the MAC ID (Local) of controller chassis, • Type the SLOT number (Local) of the CNI module (Connects to I/O ControlNet) in the controller chassis, • Type the MAC ID (Remote), • Type the SLOT number (Remote) of the module to be calibrated.
5	Click the 'Show Detail =>' button.
6	Click the 'Get Module Data' button and verify that the listed CNI and Device information are correct and that no fault is signaled. .
7	Click the Calibration tab and go to the appropriate section that follows to calibrate the HART AI or HART AO module.

{2} Calibration tab

The Calibration tab is enabled once you specify an analog module on the Navigator tab. The following are procedures for performing a calibration sequence for HART analog modules. Substitute calibration values from the procedure-subordinate tables based on the particular I/O module type.

Series A HART analog input module calibration procedure

ATTENTION

This calibration procedure applies only to the Series A HART AI Module TC-/TK-HAI081.

Prerequisite

You have launched the IO Maintenance Tool utility and specified an analog module in the Navigator tab.

Step	Action
1	Click the Calibration tab to access the Calibration features.
2	Check the channel or channels to be calibrated with the "Select" check boxes next to each channel. The "Select Channel Group Box" is also used to navigate between the two (2) four-channel groups.
3	Click the 'Start Calibration Mode' button. Calibration is prohibited if the I/O module is in RUN mode. Please inactivate and unload (delete) the I/O Module from the controller before proceeding with Calibration.
4	Input exactly the Low Value from the calibration value table below to the screw terminals of the channel(s).
5	Click 'Perform Low Cal' Button. The input is then sampled and the 'L' LED should turn to yellow. If the Input is out of range the LED turns to red and the calibration is unsuccessful. Verify that the input is exactly the Low Value and press 'Perform Low Cal' again.
6	Once the 'L' LED is yellow, input exactly the High Value from the calibration value table below to the screw terminals of the channel(s).
7	Click 'Perform High Cal' Button. The input is then sampled and the 'H' LED should turn yellow. If the Input is out of range the LED turns red and the calibration is unsuccessful. Verify that the input is exactly the High Value and press 'Perform High Cal' again.
8	Now that the Low signal and High signal are sampled, the calibration should finish and the 'H' and 'L' LEDs turn to green. The Calibration Status LED on the left also turns to green. If either the low or high signal is not sampled correctly, the calibration is unsuccessful. In that case you can stop the calibration by clicking the 'Stop Calibration Mode' button. Note that the Calibration Status LED turns to red.
9	When calibration is successful, the calibration mode stops automatically. You do not need to click the 'Stop Calibration Mode' button.
10	If you need to continue calibration for other channels, repeat procedure from step 2 until all channels are calibrated correctly.

Series A HART AI calibration value table

Module	Low Value	Low Tolerance	High Value	High Tolerance
TC-/TK-HAI081	0V	+/-0.100V	+10.25V	-+/-0.100V

Notes:

- The tolerance means allowable difference counts from the Nominal Counts before the value is rejected with an error.
- The counts are converted to physical value based on the High Cal Nominal counts.
- The accuracy of a device is typically 0.005%.
- When the calibration has finished, the 'Last Cal Date' in the module is updated to Today's date.

Series A HART analog output module calibration procedure

ATTENTION

This calibration procedure applies only to the Series A HART AO Module TC-/TK-HAO081.

Prerequisite

You have launched the IO Maintenance Tool utility and specified an analog module in the Navigator tab.

Step	Action
1	Click the Calibration tab to access the Calibration features.
2	Check the channel or channels to be calibrated with the "select" check boxes next to each channel.
3	The "optional cal range" selection enables the channel(s) selected to output mA values to the current output pins, for Current Mode calibration.
4	Click the 'Start Calibration Mode' button.
5	Click 'Perform Low Cal' Button. The AO module outputs the Low Value. The 'L' LED turns to yellow.
6	Measure the value of the screw, and enter the value into the left

Step	Action
	'Measurements' text box.
7	Click 'Perform High Cal' Button. The AO module outputs the High Value, and the 'H' LED turns to yellow.
8	Measure the value of the screw, and enter the value into the right 'Measurements' text box. The value should be near the High Value.
9	Click 'Finish Calibration' button. The calibration should finish. If the entered values are out of range, the calibration is unsuccessful. In this case you can stop the calibration by clicking the 'Stop Calibration Mode' button. Note that the Calibration Status LED turns to red.
10	When calibration is successful, the calibration mode stops automatically. You do not need to click the 'Stop Calibration Mode' button.
11	If you need to continue calibration for other channels, repeat procedure from step 2).

HART AO calibration value table

Module	Low Value	Low Tolerance	High Value	High Tolerance
TC-/TK-HAO081				
Voltage	0V	+/-0.100V	+10V	+/-0.100V
Current	4.0 mA	+/-0.4 mA	20.0 mA	+/-0.4 mA

Note:

- When the calibration has finished, the 'Last Cal Date' in the module is updated to today's date.

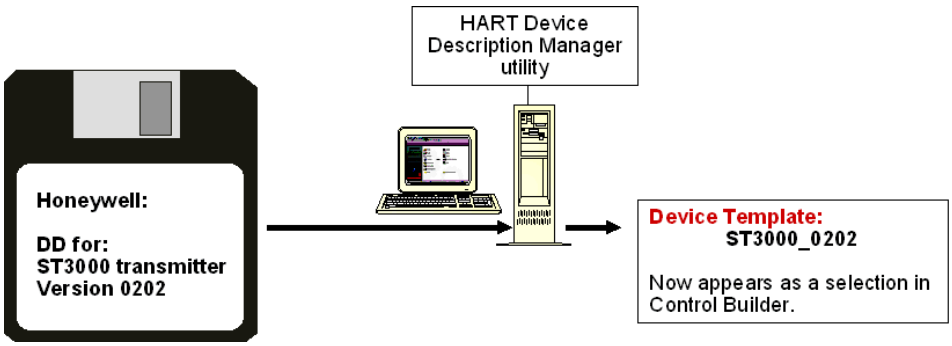
Device Description Manager Utility

Overview

The Device Description Manager (DD Manager) utility provides a means to read HART device information from the associated Device Description (DD) files and then map the device-specific information into a useable format for the host system.

Every manufacturer of HART devices creates a Device Description (DD) file for each model or type of HART device that they make. The DD file contains device-specific information that is used to interpret status and messages (command 48 enumeration strings) received from the device. In this case, a DD file for a HART device is read using the Device Description Manager utility, which then generates a map file. This map file is then used by the host system to interpret messages received from the HART device so that status information (Command 48 data), and alarms/events are generated and displayed accurately.

Using the Device Description Manager to process DD files also creates device templates (which are device specific) in Control Builder that are available to configure HART device function blocks.



DD Manager is a dialog-based application that you use off-line to interpret DD files and create map files of HART device information.

ATTENTION

Make sure that you use the correct DD file(s) for the HART device(s) that are being used in your process application.

Before you begin:

- Check the Manufacturer ID and Device IDs of the HART devices being used in the process application.
- Check that you have the correct DD file for the HART device.
- Check that you have the proper revision level of the DD file for the HART device.

Identifying the correct DD file and revision number

It is important that you use the correct DD files for the HART devices that you are going to use in your process application. The DD files are identified with a .fms extension to the file name. Note that there must be a match between the actual transmitter revision number and the first two digits of the DD revision number.

For example, If the transmitter revision is 02, (DEVREVNO parameter for Series A HART IO or HDVREVCD parameter for PM I/O HART) then this transmitter can be used with any DD file that begins with an 02 (DD 02xx, the xx number does not matter)

Installation

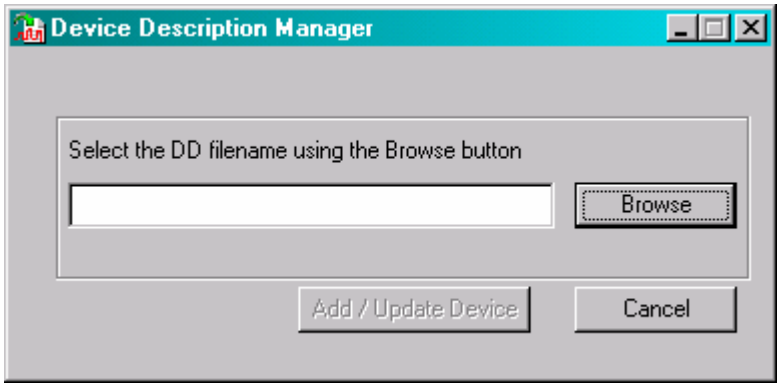
Once installed DD Manager resides along with the System Repository. You are given an option to install DD files along with Device Description Manager.

Starting Device Description Manager

To launch the DD Manager utility, select:

Programs > Honeywell Experion > Engineering Tools > Device Description Manager.

The main dialog appears on the screen as shown in the following figure.

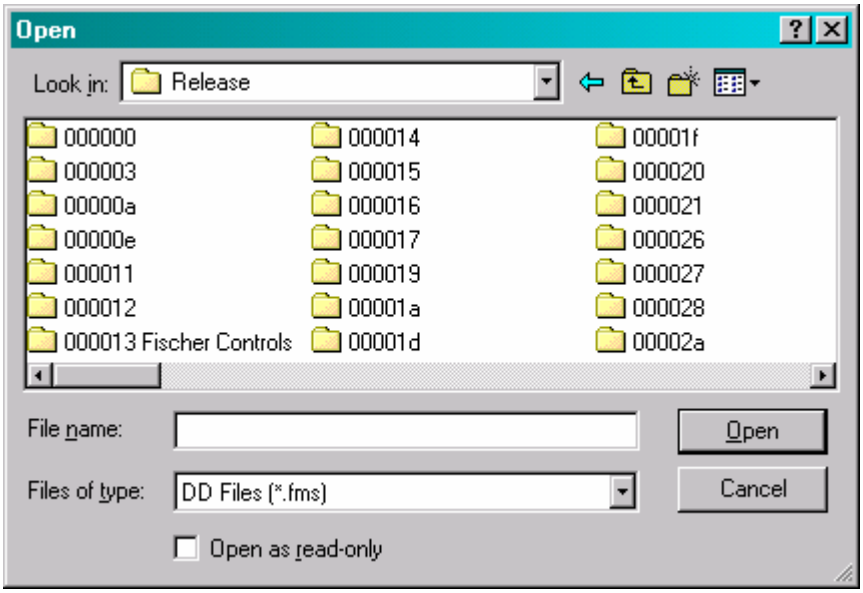


The features of the main dialog are descrbed in the following table.

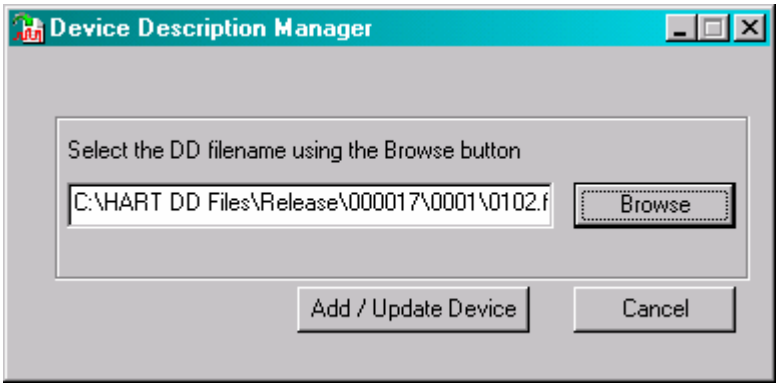
Feature	Description
'Browse' Button	Opens a window that allows you to browse your computer or network for the location of DD files.
'Add / Update Device' Button	Causes the Device Description Manager to read the selected DD file and generate a .def file. Note that this button is enabled when a valid DD file is selected and appears in the Filename box.
Cancel	Cancels the action and closes the DD Manager dialog.

Using Device Description Manager

- When you launch the DD Manager application the main dialog box appears.
- Click the 'Browse' button. A window opens to allow you select a directory where the DD file is located.

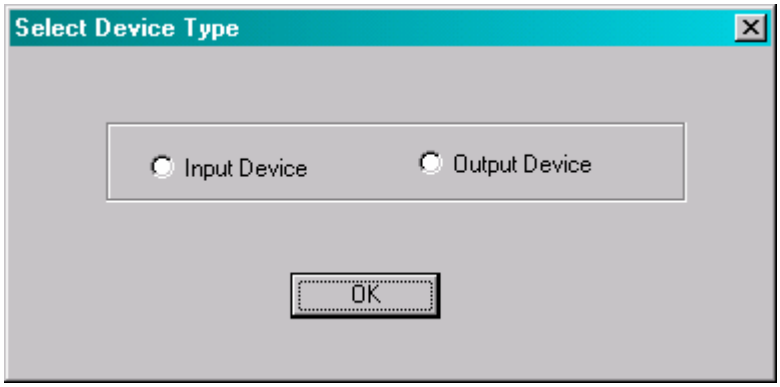


- Once you select a valid DD filename (.fms), the pathname will appear in the Filename box as shown in the following figure.



- Click the 'Add / Update Device' button. The DD Manager reads the contents of the DD file and generates a .def file containing device-specific information for the associated HART device. A dialog box will appear to show the progress of the file generation.

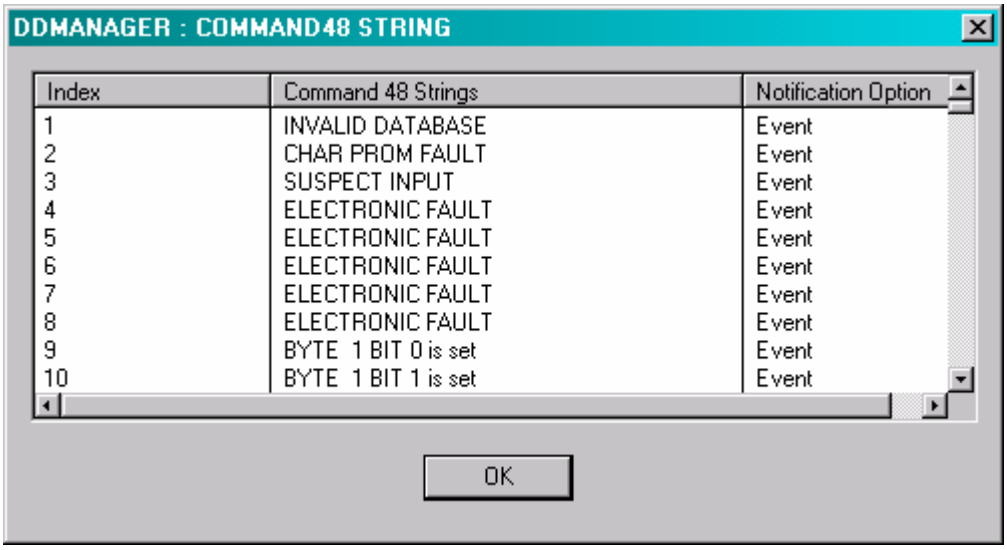
- Next, a dialog box will appear prompting you to select if the device being added is either an input device or an output device. The following figure shows the dialog box.



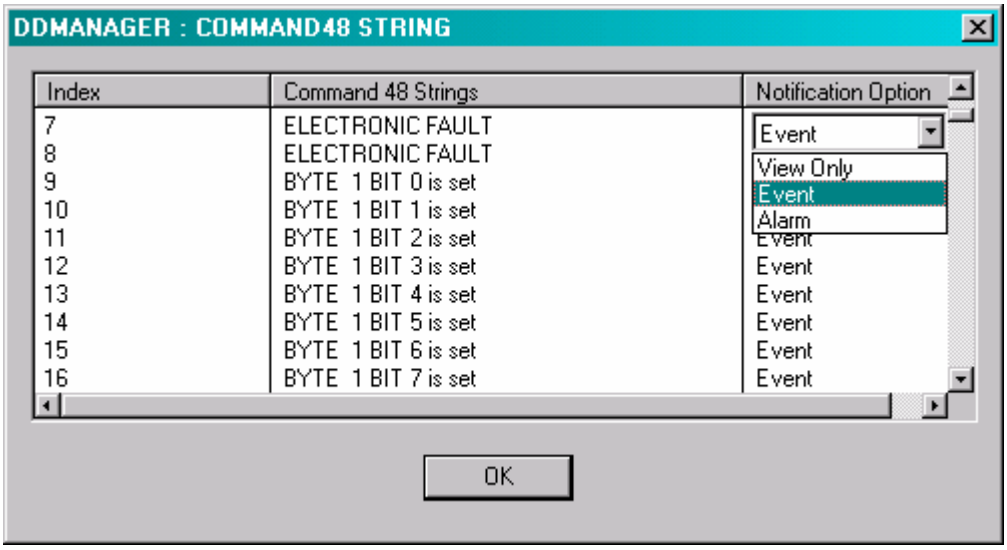
- Select either "Input Device" or "Output Device" and click OK.
- If the device already exists in the ERDB and is only being updated to the ERDB, a dialog box will appear indicating that the device is either an Analog Input or an Analog Output as shown in the following figure.

Select Notification Option

- HART command 48 can contain up to 200 bits of device status information. The device manufacturer's DD file provides text strings to describe the status bits meaning. Wherever the DD file does not provide a description for a status bit, a default string is displayed, "BYTE xx BIT Y is set." The following figure shows an index of the Command 48 text descriptions and default messages for a HART device.



- The Notification Option in this window allows you to set how the system will respond when a particular bit is set: Event (default), Alarm, or View Only.

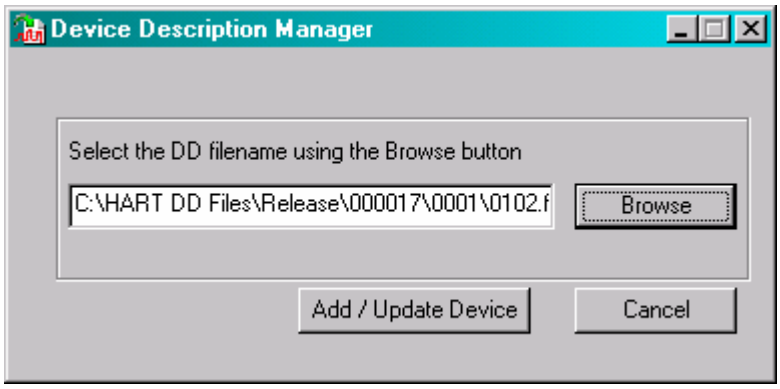


- By default, all notifications are set to Event, which will raise a notification in the event log showing the associated text description when that bit is set. Setting the

Notification Option to Alarm will raise an alarm in the Alarm log showing the associated text description for that bit when it is set. Selecting View Only will keep the system from generating an alarm or an event. Regardless of the notification setting, the status of all command 48 bits is available in the appropriate HART channel block or HART device block.

- Select the appropriate notification type for the status descriptions listed in the window. When all selections have been made, click "OK."

  The utility will show a progress bar and status messages indicating the processing of the DD file. When the process has completed, the main dialog will reappear.



- You can either select another DD file for processing by DD Manager, or click "Cancel" to close the dialog and exit the utility.

Experion HART Multiplexer Guide

Overview

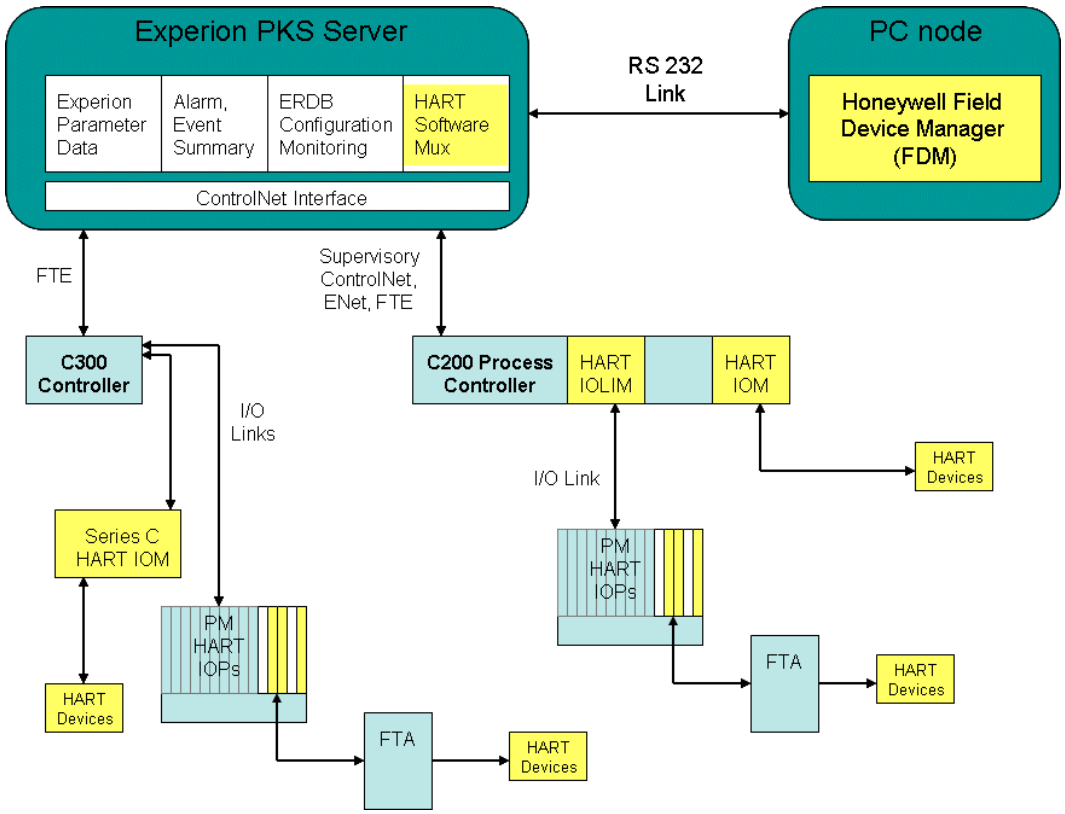
The Experion HART Software Multiplexer (HART Mux) is a Windows application that emulates the equivalent of HART hardware multiplexers. The HART Software Multiplexer application is installed on an Experion server and emulates a network of up to 31 P+F HART hardware multiplexers. Also, a link from the HART Mux to Honeywell Field Device Manager, (FDM) is established to provide access to HART data.

With Experion Release 200 and later, the HART Mux discovers devices connected to both Series A HART IO Modules (IOMs), PMIO HART IOPs and Series C IOMs. The HART Mux also enables the system to handle and process HART commands and responses between the HART field devices and the control system using the Honeywell Field Device Manager, (FDM). The FDM runs on a host PC and can be linked via COM ports to the HART Mux application running on the Experion server.

HART Software Multiplexer

The HART Mux application emulates a set of P+F HART hardware multiplexers on an RS-485 network and responds to commands from the FDM. The HART Mux passes HART commands originating from the FDM along the ControlNet/FTE to the IOMs (and IOPs) and then to the HART device connected to an individual IO channel. The HART Mux emulates the functions of a HART hardware multiplexer, so to make the FDM believe that it is communicating with HART hardware multiplexer.

The following figure shows integration of the various HART-enabled components into the Experion system.



HART Multiplexer and Asset Management Integration to Experion

Installation

HART Mux installation

The HART Mux is installed as an NT service on an Experion server. In a redundant server system, the HART Mux is installed on both the primary and secondary servers. However the HART Mux must be running only on the secondary server.

During Experion installation, the following HART Mux related files are copied into the Experion bin directory:

- **PScHARTMux.exe** – This file contains the HART Mux services application that starts up automatically and runs in the background during normal operations.

- **PscSwMuxUI.exe** – This file is the user interface that provides a window view of the control hardware connected to the HART Mux.
- **PlScHARTMuxps.dll**

When installed on an Experion server, the HART Mux icon is under **Programs > Honeywell Experion > Engineering Tools** on the **Start** menu. Note that if the HART Mux is installed on a computer other than an Experion server, RSLinx, CDA access software and a ControlNet interface card are necessary components that must be installed on that computer. During installation, messages will be displayed warning of installation problems or if a required component is missing for proper HART Mux operation.

Asset Management application (FDM) installation

We recommend that the asset management application reside on a separate host computer. Connection of the computer running the HART Mux and the computer running the FDM is made through RS-232 loopback cable attached to the COM ports.

HART Mux Functionality

HART Mux capacity

A typical P+F HART hardware multiplexer contains one HART multiplexer Master (multiplexer module) and up to 15 HART multiplexer Slave modules. The multiplexer master controls the slave multiplexer modules. Each master and slave multiplexer module is a 16-input mux allowing up to 16 HART devices to be connected to each module in a point-to-point arrangement. So each HART multiplexer can acommodate up to 256 HART devices (1 master mux + 15 slave muxs x 16 inputs = 256 inputs).

The HART Mux emulates up to 31 P+F HART hardware multiplexers, which will accommodate a total of 7936 devices (31 muxs x 256 devices = 7936 devices).

Note that only 255 devices can be addressed so that one channel of a HART IO module must be left open.

HART Mux Operation

The HART Mux runs in the background on an Experion server. The user interface for the HART Mux is a window that you can open to view multiplexer and device information, as well as view and monitor HART message activity.

The HART Mux is connected to a PC running the FDM via RS-232 link. It is recommended that the FDM reside on a PC separate from the Experion server.

The HART Mux acts as a conduit for passing HART messages, initiated by the FDM, to HART field devices connected to Series A and Series C HART IOMs, and PM IOPs.

HART devices send responses to the messages back to the FDM via the same path. The HART Mux furnishes device address data so that messages are sent to the proper HART device. Also the HART Mux logs HART messages and communication faults related to the links connecting the FDM with the controller or IO chassis that contain the HART IOMs.

Communcation faults between the FDM and the HART Mux, or between the HART Mux and the CNI modules in the controllers and IO chassis are logged by the HART Mux for troubleshooting purposes. Message activity between the FDM and the HART devices are also recorded in the HART Mux activity log.

HART Mux startup routine

The HART multiplexers are initialized with the communication port and database parameters when the HART Mux is launched. Default values for the communication port parameters are used when the HART is started for the first time and can be changed by using the HART Mux user interface.

Note that the multiplexer is said to be uninitialized if its database does not have information on the controllers, HART IOMs, IOPs and channels.

The HART Mux performs the following operations upon start up:

1. **Connects to ERDB**, retrieves the HART devices connected to Series A and Series C HART IOMs, and PM HART IOPs

2. **Maps a Master to 256 found HART devices**. The next 255 devices are mapped to master 2. Likewise, the 32 masters have the capacity of mapping to 7936 devices. A master is formed only when a HART device is found. Similarly, the master will get deleted when the devices mapped to that master are deleted from database.

3. **Constructs path information for the HART Mux to connect to individual IOMs and IOPs**. Once the hardware map is created, the HART Mux uses information available from the ERDB and constructs path information so that the HART Mux can connect to individual IOMs, IOPs and the CNI for supervisory ControlNet. The path information is then stored in HART Mux database. This information is used to generate addresses for the HART Mux to communicate with the IOMs and IOPs. The multiplexer then checks the IOM block for the IO module to see if it is active. Note that this logic is needed only for devices connected to Series A HART IOMs. The communication to HART devices connected to PM HART IOPs and Series C IOMs is handled with the help of Experion interfaces (CDA).

4. **Updates the hardware map in the HART mux database**. The hardware map in the HART Mux database is updated with the long frame address of the device

associated to each HART channel (manufacturer ID, device type, and device number). This allows HART messages to be addressed to a specific device.

5. **Checks the communication port connection**. The HART Mux checks the communication port connection and warns you if connection cannot be made (For example, if the port is being used by some other program or the port is not configured).

6. **Maintains an instrument (device) list**. The instrument list is a simply array of long frame addresses of the individual devices. The FDM references the device list index in directing device commands to correct multiplexer. This implementation has a pointer to the multiplexer structure for the channel to which the device is connected.

HART Mux User Interface

The HART Mux user interface is used only to:

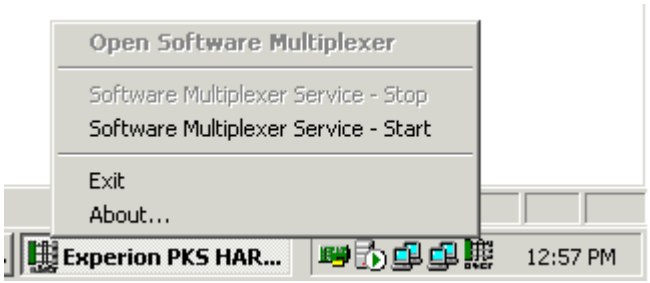
- Configure the COM port for communications between the FDM and the Experion control hardware.
- Display how the control hardware is mapped to a P+F multiplexer network
- Log HART message/error information.

For all control status/device information you must use Control Builder or Station displays.

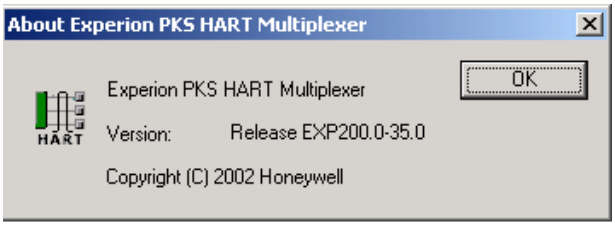
Launching HART Mux

The HART Mux application is launched from the Start menu.

Step	Action
1	From the Start menu, Select: **Programs > Honeywell Experion > Engineering Tools > HART Software Mux** The HART Software Mux user interface window is displayed on the screen
	A tray icon is displayed in the task bar status area at the bottom of the screen display.
2	Right click on the 'HART Multiplexer' tray icon to display a pop up menu as shown here.

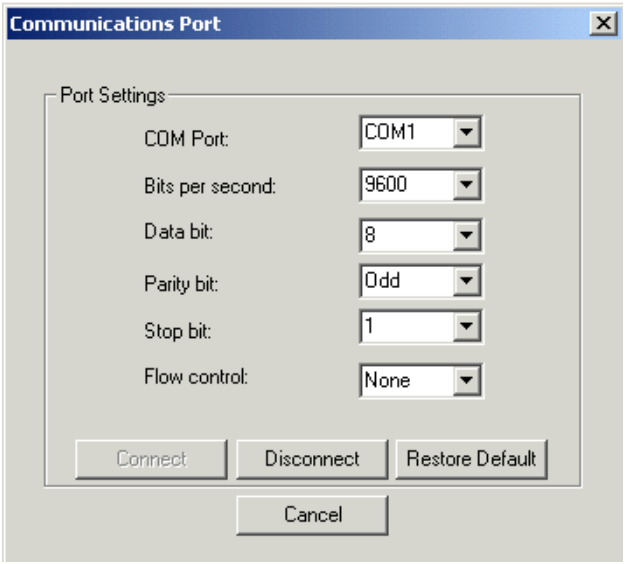
Step	Action
	
3	If the 'Software Multiplexer Service – Start' menu item is not grayed out, select it to start the multiplexer service. Description of the menu items are provided below. Note that once the multiplexer service is started it will run in the background on the server, whether the user interface window is visible or not.

The following selections appear on the popup menu.

Open Software Multiplexer	Opens up the HART Mux user interface window.
Software Multiplexer Service - Stop	Stops the HART Mux application if it is running.
Software Multiplexer Service - Start	Starts the HART Mux application if it is stopped. The application performs the startup routine.
Exit	Closes the HART Mux user interface window. The tray icon disappears also.
About. . .	The dialog about HART Mux with its version is displayed. 

Configure the Communication Port settings

Note: Communications Port settings must be made before attempting to connect the HART Mux to any asset management applications, (such as the Honeywell Field Device Manager).

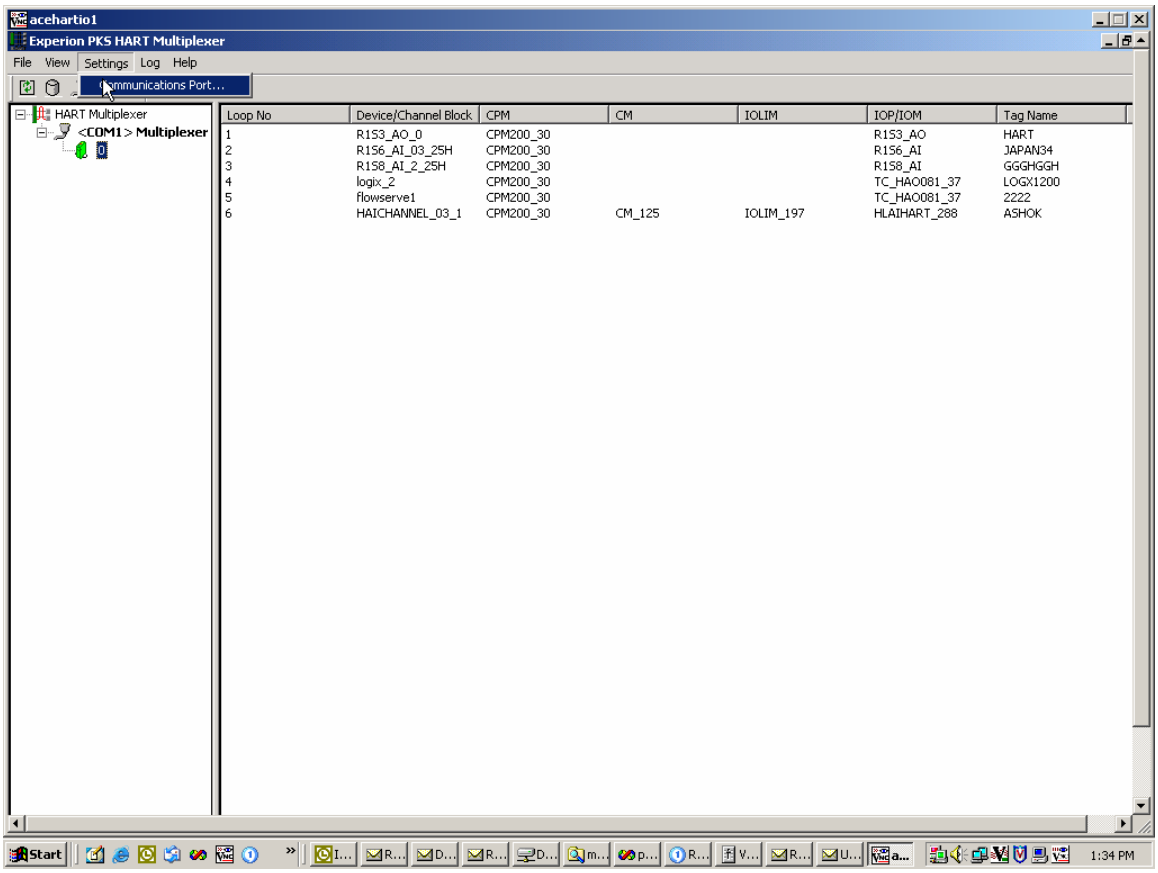
Menu Item	Description
Communications Port	Selecting Communications Port opens the Communications Port parameters dialog box. The dialog shows the current settings. 
	You can set the communication interface and parameters used by the multiplexer to connect to other software applications. This includes RS-232 connections that specify the Bits per second, Data bit, Parity bit, Stop bit, Flow control and the port to be used in the above dialog. NOTE: The communications port settings for the COM port for the Mux must be the same as the COM port settings for the asset management application.
Connect, Disconnect and Restore Default Buttons	Clicking one of these buttons will cause the HART Mux to attempt to either connect or disconnect the COM port. Clicking on Restore Default will restore the default parameters in the Communcation Port dialog box.

User interface window

The HART Mux user interface provides access to configuration and monitoring features in the main window.

The HART Mux user interface is a window created by HART Mux application. Information in the user interface window is presented in two panes – a Tree pane on the left side and the List pane on the right side. A tray icon named 'Experion HART Multiplexer' is included in the task bar status area.

The user interface window is initially in the hidden mode with its tray icon available in the task bar status area. Right click on the tray icon displays a popup menu so you can start and stop software Mux operations, or exit the HART Mux user interface.

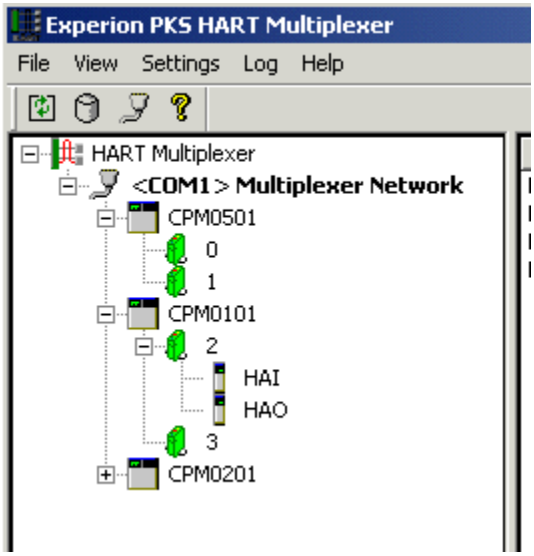


HART Mux User Interface

The Tree pane

The Tree pane shows the number of masters assigned. Clicking on the master displays the devices assigned to that master in the list pane.

When user interface is opened, the node Multiplexer Network is expanded and the selection is highlighted on the first master node. The List pane displays the devices assigned to the master.



Using the tree pane

Upon startup the HART Mux collects data; reading configuration information from ERDB on the:

- CPM, IOM and HART devices connected to Series A HART IOM, and
- IOLIM, HART IOPs and devices connected to PM HART IOPs.
- C300, IOM and devices connected to Series C HART IOMs

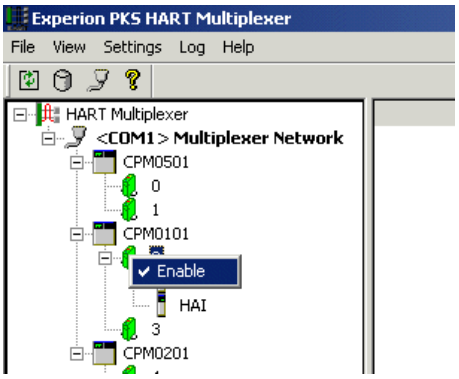
The HART Mux maps these devices to masters and displays then as icons in the Tree pane. Clicking on the "+" plus symbol expands the tree to show additional HART components in the network and clicking on the "-" minus symbol collapses the tree. The root item is named “HART Multiplexer.”

Enable/Disable master muxs

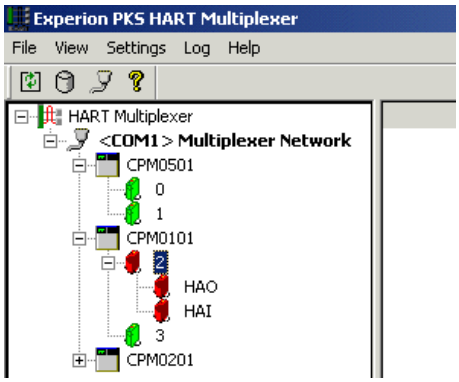
All master muxs are enabled by default upon startup, meaning that HART commands sent to HART devices will send back responses. Master muxs can be disabled so that HART commands are not sent to the HART devices and no responses are sent in return.

To disable a master mux, right mouse click on the master icon in the tree pane. Uncheck the pop up box that says "Enable." The master mux icon and devices connected to it are disabled and are not available to asset management applications. In the tree pane, the master mux icon and the modules connected to it turn red.

Master Mux Enabled



Master Mux Disabled

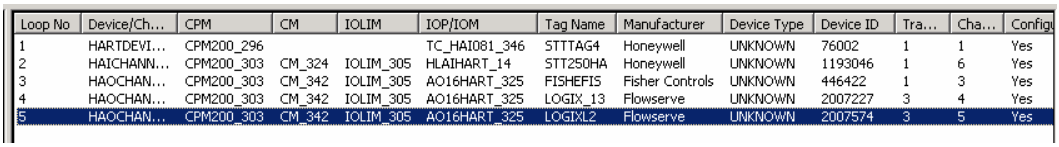


To enable the master mux, right mouse click on the red master icon and check the "Enable" box

The List pane

The List pane shown in the following figure lists the details of the HART devices configured under the HART module.

Highlighting a HART module in the tree pane by a mouse click populates HART devices that are associated with the selected module in the List pane.



Loop No	Device/Ch...	CPM	CM	IOLIM	IOP/IOM	Tag Name	Manufacturer	Device Type	Device ID	Tra...	Cha...	Config
1	HARTDEVI...	CPM200_296			TC_HAI081_346	STTTAG4	Honeywell	UNKNOWN	76002	1	1	Yes
2	HAICHANN...	CPM200_303	CM_324	IOLIM_305	HLAIHART_14	STT250HA	Honeywell	UNKNOWN	1193046	1	6	Yes
3	HAOCHAN...	CPM200_303	CM_342	IOLIM_305	AO16HART_325	FISHEFIS	Fisher Controls	UNKNOWN	446422	1	3	Yes
4	HAOCHAN...	CPM200_303	CM_342	IOLIM_305	AO16HART_325	LOGIX_13	Flowserve	UNKNOWN	2007227	3	4	Yes
5	HAOCHAN...	CPM200_303	CM_342	IOLIM_305	AO16HART_325	LOGIXL2	Flowserve	UNKNOWN	2007574	3	5	Yes

Heading in List Pane	Description
Loop No.	The loop number of the P+F Mux to which the device is connected.
Device/Channel Block	The designated device or channel block name.
CPM	The controller name of which the designated device belongs.
CM	The CM in which the PM HART I/O channel block is contained. This is applicable only to devices connected to HART IOPs.
IOLIM	The IOLIM block name to which the HART device connected. This is applicable only to devices connected to HART IOPs.
IOP/IOM	The HART IOP or HART IOM block name, to which the HART device is connected. • The HART IOP block name appears for the devices connected a HART IOP. • The HART IOM block name appears for the devices connected to a Series A or Series C HART IOM.
Tag name	The tag name of the device. If TAG name is not configured for a device, then the field is blank.
Manufacturer	The manufacturer of the HART device.
Device Type	A number that represents the device type. (Pressure transducer, temperature sensor, etc.)
Device ID	The HART Device ID.
Transmitter Rev. No	The revision number of the firmware that is currently loaded to the device.
Channel Number	The Channel number of the device connected to HART IOM or IOP.

Configurable	(Yes / No) Indicates whether the device can be configured by the asset management application.

Dropdown menus

There a number of dropdown menus available in the user interface window.

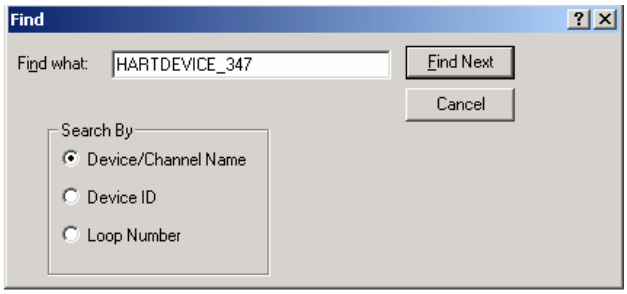
File – View – Settings - Log

'File' menu

Menu Item	Description
Exit	Exits the HART Mux application user interface window. Note: Selecting Exit will not shutdown the HART Mux Service. It will only minimize the user interface window.

'View' menu

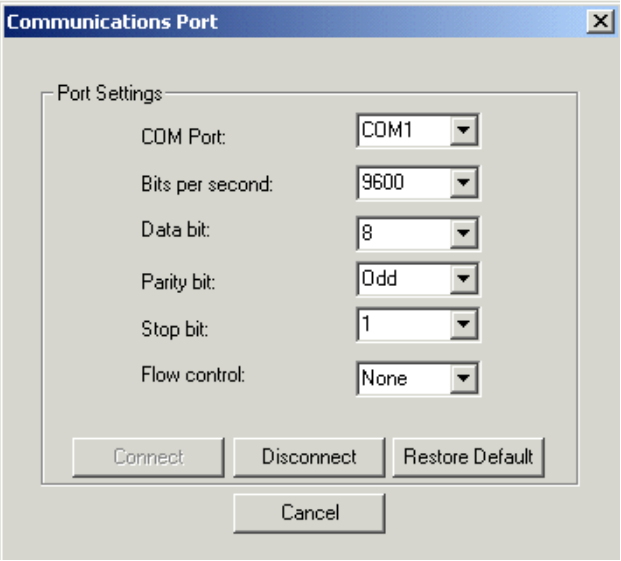
Menu Item	Description
Toolbar	A check means that the toolbar is visible in the user interface window. The toolbar contains icons for HART Mux functions.
Status Bar	A check means that the status bar is visible at the bottom of the user interface window.
Refresh	Selecting this item will refresh the objects in the tree and list panes. The refresh function also instructs the multiplexer to update the controller hardware map by reading the ERDB once again. Refresh is necessary when controllers, IOMs, IOPs and devices have been added, deleted, or changed in the ERDB.
Find	Selecting this item displays a dialog box, where you can search an item on the list pane.

	 You can search by: 1. Device or Channel Name 2. Device ID 3. Loop Number This feature is useful to locate information on a particular device, since a fully loaded mux may contain 256 devices assigned to it. The results of the search are highlighted in the List pane.

'Settings' menu

Note: Communications Port settings must be made before attempting to connect the HART Mux to any asset management or HART diagnostic applications, (such as Honeywell Field Device Manager).

Menu Item	Description
Communications Port	Selecting Communications Port opens the Communications Port parameters dialog box. The dialog shows the current settings.

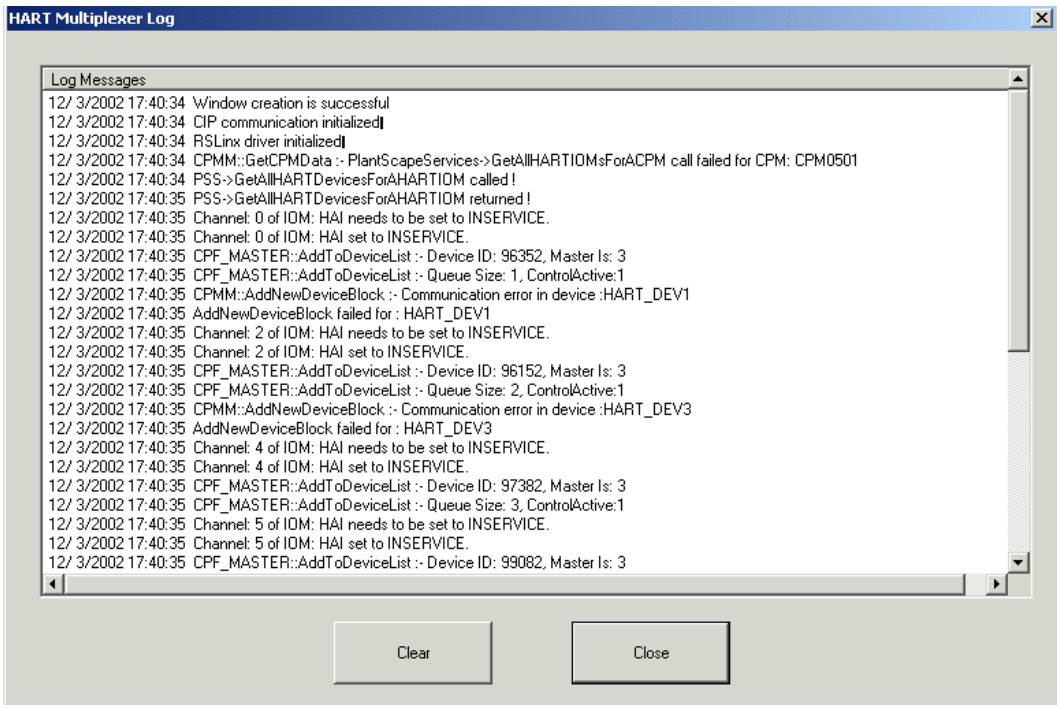
	
	You can set the communication interface and parameters used by the multiplexer to connect to other software applications. This includes RS-232 connections that specify the Bits per second, Data bit, Parity bit, Stop bit, Flow control and the port to be used in the above dialog. NOTE: The communications port settings for the COM port for the Mux must be the same as the COM port settings for the asset management application.
Connect, Disconnect and Restore Default Buttons	Clicking one of these buttons will cause the HART Mux to attempt to either connect or disconnect the COM port. Clicking on Restore Default will restore the default parameters in the Communcation Port dialog box.

'Log' menu

An activity log is maintained by the HART Mux to record any Mux activity and communication faults to or from the mux to the server or the ControlNet.

Menu Item	Description
View Log	When you select "View Log," a new window opens to show a continuously updating window that logs all multiplexer activity and error messages.

The HART Mutiplexer log window provides a listing of all message activity that occurs through the multiplexer with all active HART devices mapped in the multiplexer database. Messages include commands sent to HART devices, the responses returned from the devices, and all error messages associated with communication faults. The Multiplexer Log window is shown in the following figure.



Two buttons at the bottom of the window are used to Clear the log entries in the window and Close the HART Multiplexer Log window.

'Help' menu

This menu features one item:

Menu Item	Description
About Experion HART Multiplexer	Opens a dialog box describing the version, copyright and general information about application.

HART Mux toolbar

The toolbar, when visible in the main window, shows a number of icons associated with multiplexer functions. These are the same functions that are available from the dropdown menu items above.

Icon	Name of Function or Menu Item	Description
	Refresh	Updates the contoller hardware map and refreshes the items in tree and list panes.
	View Log	Opens the Multiplexer Log window so you can view the activity log entires.
	Communications Port Settings	Opens the Communciations Port dialog so you can configure the communications port.
	About	Opens a dialog box describing the version, copyright and general information about HART Mux application.
	Search	Opens a dialog box so you can search device information. See 'Find' function under the 'View' menu. The search can be made by Loop Number, Device ID and Device or Channel Block name.

NOTE: Moving the mouse pointer over an icon on the toolbar shows the name description of the icon.

Status bar indications

The Status Bar at the bottom of the HART multiplexer window indicates the multiplexer status. The following status message typically may appear during multiplexer operations.

- Refreshing HART multiplexer – Indicates multiplexer is refreshing the controller hardware map.

Error messages

The various error messages are logged by software multiplexer when various communicatons conditions are detected:

Communication Error	Description and Message Text
Serial Port communications	
Messages indicate that errors were detected during serial port communications.	• Failed to open the port during the multiplexer service startup
	• Failed to read messages from serial port buffer
	• Failed to read the host request messages from the host request queue
	• Failed to write response messages to serial port
	• Communications failure error when invalid port/port settings are set
ControlNet communications	
Messages indicate that errors were detected during control net communications.	• KTC card is not available
	• RS-Linx installation
	• Timed-out error while sending messages over control net
	• Timed-out error while receiving messages from control net
	• Invalid ASA path
	• RS linx cable not available

ERDB Interface	
Messages indicate that errors were detected when connecting to the Experion server.	• Failure in connecting to Experion server
	• Failure in reading Experion data (reading CPM/IOM/Device data)
	• Lost communication with CDA Server
	• Failure in reading device data
	• Failure in reading device configured data
	• Failure in subscribing device status notifications
	• Failure in not getting Device status notifications

HART Commands

Overview

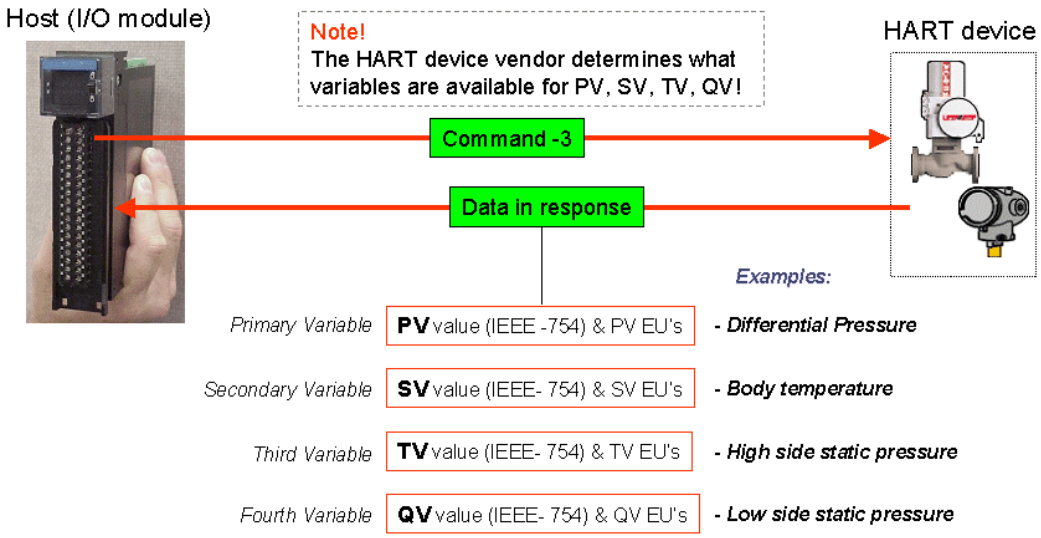
All HART universal type commands are supported by all HART devices and must be implemented exactly as defined by the HART Foundation specification. Common practice commands are optional and may or may not be supported for a given device type. The following are descriptions of several of the universal and common practice commands and how the HART IOMs and IOPs use this data. The format and content of the commands and responses are fully defined by the HART protocol.

Command 3 – Read Dynamic Variables

Command 3 is issued periodically by the HART IOM or IOP to read the available dynamic variables of the HART device. The device responds with a value and an engineering unit for up to four digital variables, PV, SV, TV and QV, as shown in the following illustration.
Note: QV may also be expressed as FV.

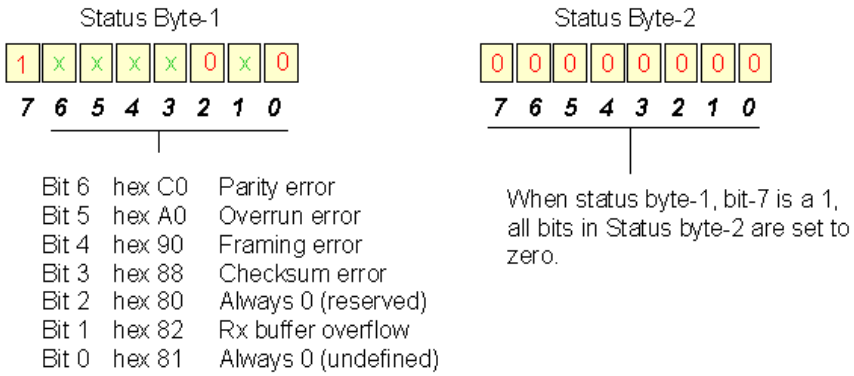
The device manufacturer determines what is returned for these four values and if all four variables are supported. For simple devices, only PV and SV are returned. If command 51 is supported, the user can select what four variables available in a given device will be returned as PV, SV, TV, and QV.

The 2-byte device status is also returned from the device.

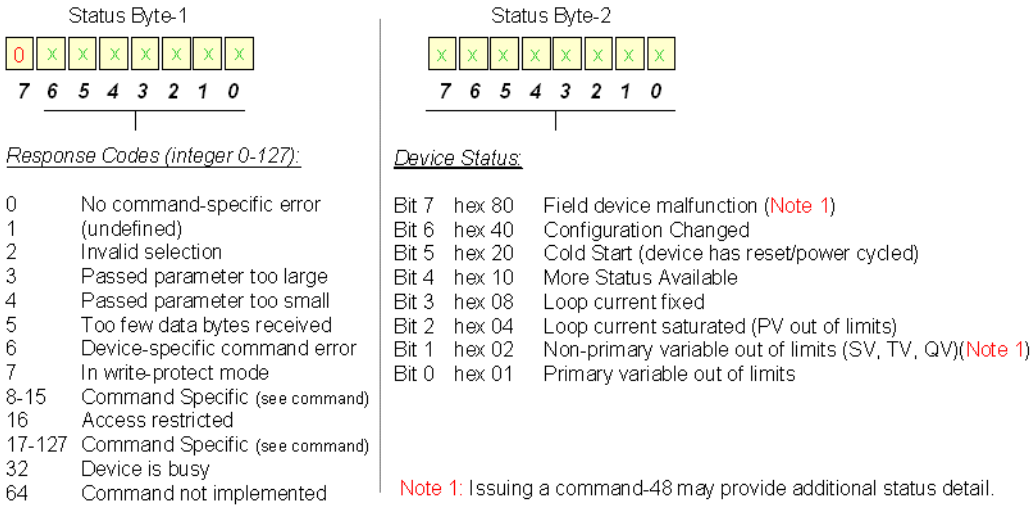


Device standard status

A two-byte (16 bit) status is monitored by the HART device block, IOP or IOM block on every execution cycle and also is returned from the device in response to Command 3. In the following figure, a communication failure status is reported if bit 7 of status byte 1 is set to 1. The details of the error are reported in the rest of the bits (bits 6 through 0). Status byte 2 is then all zeroes.

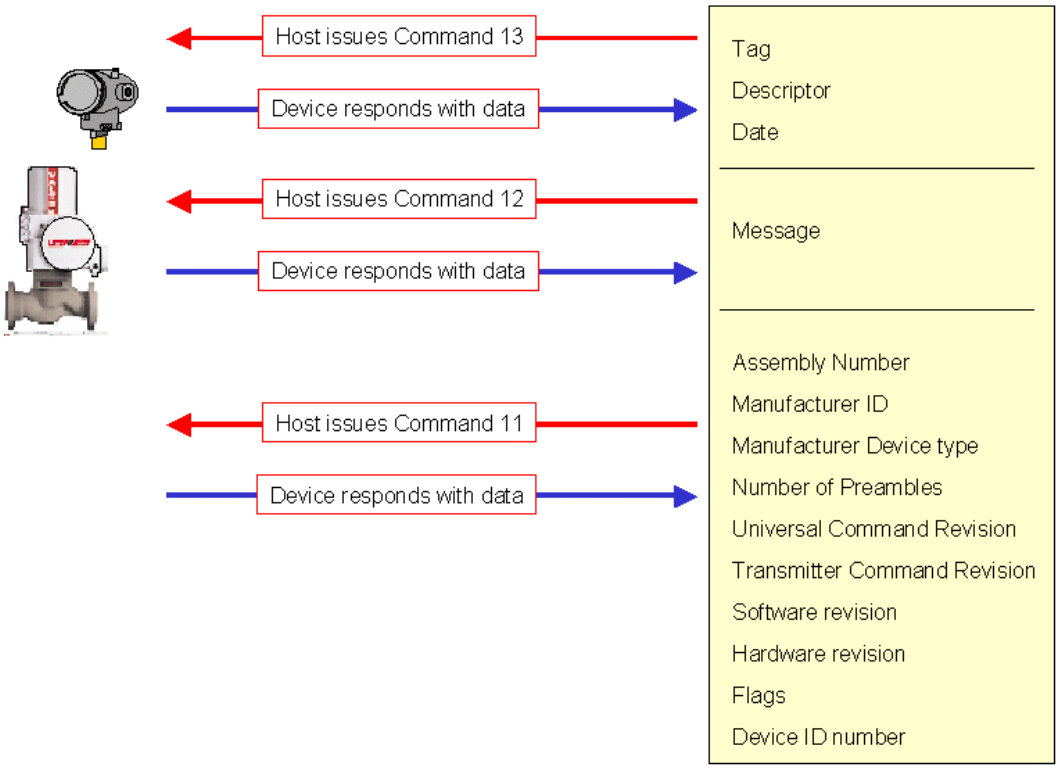


If no error is detected in the outgoing communication, the most significant bit (bit 7) of status byte 1 is set to zero and the command response is reported in the rest of the bits, (bits 6 through 0). Status byte 2 contains information as to the operational state of the HART device. The following figure illustrates this status response.



Commands 11, 12 and 13 - Device ID information

Device ID information is accessed from the HART device using HART commands 11, 12 and 13. The HART IOM or IOP issues these commands upon startup and after a communications failure. As shown in the following figure, the host issues the HART commands and the device returns the Device ID parameters.



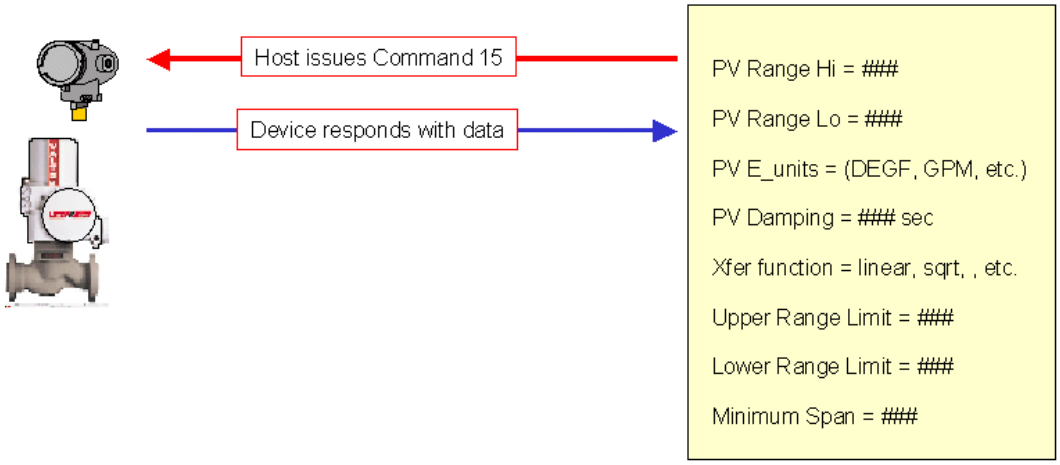
Command 14 – Read Sensor information

A HART command 14 issued to a device will return the following values:

- Sensor serial number
- Sensor engineering units
- Upper sensor limit
- Lower sensor limit
- Sensor limits and minimum span

Command 15 – Read Device Range information

Device Range information is returned from the device in response to a HART command 15. The HART IOM or IOP issues this command upon startup and after a communications failure has been restored. As shown in the following figure, the host issues the HART command and the device returns the Device Range parameters.



Command 33 – Read Device Variables

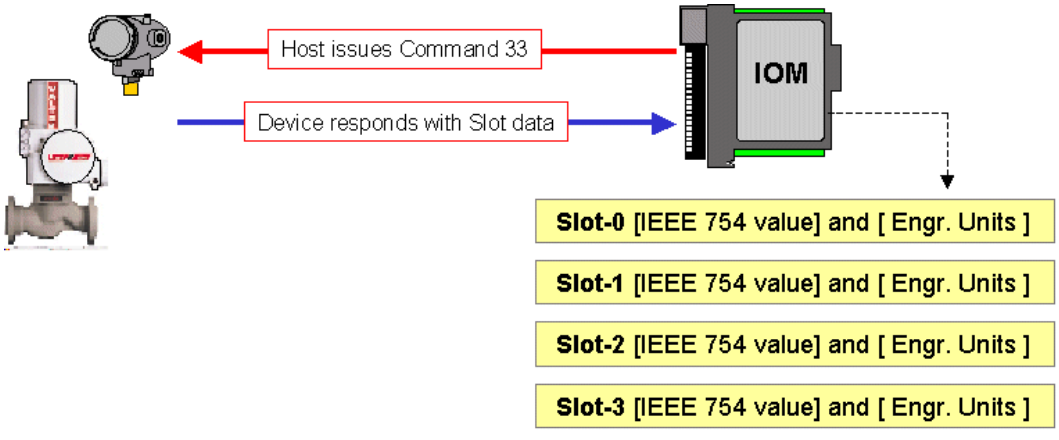
ATTENTION

This is a common practice command which may or may not be supported for a given device type. Check with the device manufacturer to verify if command 33 is implemented for the given HART device.

A Command 33 requests up to four device variables (Slot0, Slot1, Slot2 and Slot3) from a HART device as shown in the following illustration. HART protocol specifies that a HART device may provide up to 255 device variables, four of which can be requested with command 33. Each variable represents some information from the device, (for example, valve accumulated travel, electronics housing temperature, high side static pressure, valve deviation from set point, highest average temperature reading, etc.). The device manufacturer determines if command 33 is supported for the given device. If so, the manufacturer determines what variables will be provided and assigns a numerical ID (from 1 to 255) to each particular variable.

For Series A HART IO modules: A device variable value is entered on the HART Configuration tab of the HART AO function block. The value corresponds to the numerical ID assigned to the device variable to be returned by the device. An entry of zero indicates that no variable is to be returned for that slot position.

For PM HART IOPs and Series C IOMs: A variable code is entered in the HART Variables tab of the HART Channel block. The code corresponds to the numerical ID assigned to the device variable to be returned by the device. The default (None) indicates that no variable is to be returned.



Command 48 – Read Device-Specific Status

ATTENTION

This common practice command is optional and may or may not be supported for a given device type. Check with the device manufacturer to verify if command 48 is implemented for the given HART device.

Command 48 is a common practice command that requests the device-specific information from a HART device. The response to this command can contain up to 25 status bytes, (200 bits). The interpretation of these status bits is: Bit OFF = normal, Bit ON = abnormal condition or information available. The meaning or associated text description of each status bit can be derived **only** by using the manufacturer's device-specific Device Description file (DD file). For information on using HART DD files see the HART Device Description Manager Utility.

Note: Series A HART IO modules are capable of only using 17 bytes of status information that provide up to 136 ON/OFF status bits.

The IOM or IOP issues a command 48 to the device when:

- The More Status Available bit is set in the standard device status byte
- The Field Device Malfunction bit is set in the standard device status byte.

In order to report the latest status of the device, the command to the device is repeated if either of these bits are set for two minutes. The text strings associated with each status bit is available when the DD file is used.

The following paragraphs describe two examples showing the command 48 status when:
1. A device-specific DD file is used in configuring a HART device and
2. The generic HART DEVICE configuration form is used to configure a HART device.

Device Specific Example

This example shows the command 48 status byte description for a Honeywell STT25H smart temperature transmitter. Note that the device uses only three bytes in reporting status. Byte-0 describes critical status conditions, Byte-1 describes non-critical status and Byte-2 provides additional information.

Byte-0 Critical

Bit	DEVSPCBIT	DD-Descriptor
0	[0]	undefined
1	[1]	Hardware Failure
2	[2]	Input Open.
3	[3]	NVM Calib Failed
4	[4]	NVM Conf failed
5	[5]	undefined
6	[6]	undefined
7	[7]	undefined

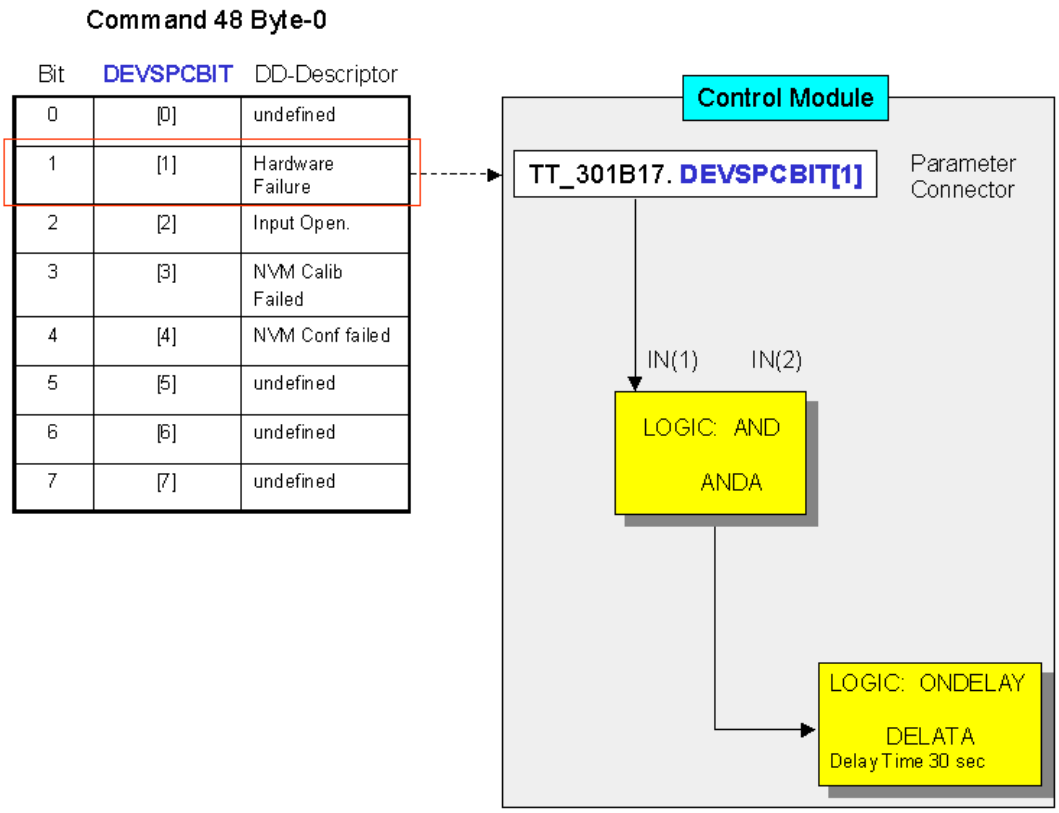
Byte-1 Non-Critical

Bit	DEVSPCBIT	DD-Descriptor
0	[8]	CJ Over Temp
1	[9]	undefined
2	[10]	Input out of Spec
3	[11]	Output Saturated
4	[12]	In Output Mode
5	[13]	undefined
6	[14]	undefined
7	[15]	User Correct Active

Byte-2 Information

Bit	DEVSPCBIT	DD-Descriptor
0	[16]	Suspect Input
1	[17]	undefined
2	[18]	undefined
3	[19]	undefined
4	[20]	undefined
5	[21]	undefined
6	[22]	undefined
7	[23]	4 wires Configuration

Note that each bit of the parameter DEVSPCBIT, (which is the device specific bits from the device), is numbered and can be used in Control Modules and graphics by using the format: Tag/Name.DEVSPCBIT[xx]. The following figure shows how status bit [1] can be used as part of a control strategy in a control module.



Also, the actual descriptor from the device manufacturer's DD file can appear in the Alarm Summary display for all command 48 status returned from a particular HART device. You must ensure the HART device revision number matches the template selected when building the HART device (or HART Channel) function block. See HART Device Description Manager for additional information in using device manufacturer's DD files and device templates to build HART function blocks.

Generic HART device example

Not all HART devices are supplied with a DD file. In this case, a generic HART DEVICE template is used to create a device block. The command 48 status descriptions will not be available and only generic descriptions of the status bits will be shown in alarm summaries and detail displays

The following table shows what the status bit descriptions would show for a Honeywell model STT25H temperature transmitter that uses a DD file, (and the device-specific template) and the same status bits reported from a device with no DD file, (and using the generic HART DEVICE template).

Command 48 Status Descriptions

Honeywell STT25H Temperature Transmitter	Generic HART DEVICE
Bit 1 : "Hardware Failure"	"Error Occurred at BIT 1"
Bit 2 : "Input Open"	"Error Occurred at BIT 2"
Bit 3 : "Nvm Calib failed"	"Error Occurred at BIT 3"

Honeywell

Honeywell International
Process Solutions
2500 West Union Hills
Phoenix, AZ 85027