HART SNAP I/O MODULES USER'S GUIDE

Form 2132-160418—April 2016

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HART SNAP I/O Modules User's Guide
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The information in this manual has been checked carefully and is believed to be accurate; however, Opto 22 assumes no responsibility for possible inaccuracies or omissions. Specifications are subject to change without notice.

Opto 22 warrants all of its products to be free from defects in material or workmanship for 30 months from the manufacturing date code. This warranty is limited to the original cost of the unit only and does not cover installation, labor, or any other contingent costs. Opto 22 I/O modules and solid-state relays with date codes of 1/96 or newer are guaranteed for life. This lifetime warranty excludes reed relay, SNAP serial communication modules, SNAP PID modules, and modules that contain mechanical contacts or switches. Opto 22 does not warrant any product, components, or parts not manufactured by Opto 22; for these items, the warranty from the original manufacturer applies. Refer to Opto 22 form 1042 for complete warranty information.

Opto 22
Automation Made Simple.

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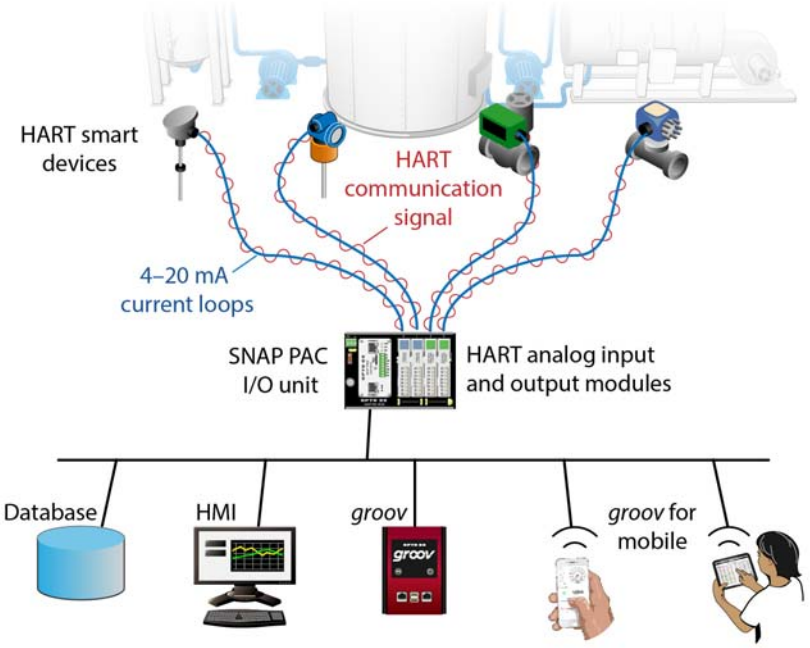
1: Introduction & Installation

Introduction

HART® SNAP I/O modules for analog current input and output provide communication with other Highway Addressable Remote Transducer (HART) current loop devices.



Two modules are available:

- The **SNAP-AIMA-iH** analog input module provides two channels of isolated current input with a range of 4–20 mA. External loop power supplies are required for current loops. This module is categorized by the HART protocol as a current input connection type, which means that the module is a low impedance device.
- The **SNAP-AOA-23-iH** analog output module provides two channels of isolated current output with a range of 4–20 mA. External loop power supplies are required for current loops. This module is categorized by the HART protocol as a current output device, which means that each channel controls the loop current and is a high impedance device.

HART SNAP I/O modules mount on SNAP PAC racks alongside other SNAP I/O modules (analog, digital, and serial), so you have the combination of I/O you need at any location. The rack requires a SNAP PAC brain or rack-mounted controller for I/O processing and communications.

Designed to be part of the SNAP PAC System, HART SNAP I/O is most easily used with a SNAP PAC controller and PAC Control software, which includes specific commands for use with the HART protocol. Sample subroutines and a flowchart can be downloaded free from our website to give you a head start on communicating with HART smart devices.

HART SNAP I/O can also be used without PAC Control in a custom program you develop using our free HART Developer Toolkit, also available on our website, www.opto22.com.

What's in this Guide?

This guide assumes that you are familiar with the HART protocol and Opto 22's SNAP PAC System. Online resources are available for learning about HART. A good place to start is here on the HART Communication Foundation website:
http://en.hartcomm.org/hcp/tech/aboutprotocol/aboutprotocol_what.html

To learn more about the SNAP PAC System, visit the Opto 22 website at www.opto22.com.

This guide includes the following chapters:

- **Chapter 1: Introduction & Installation**—How HART SNAP I/O works with HART devices; installation; specifications
- **Chapter 2: Using HART SNAP I/O with PAC Control**—Using PAC Control sample subroutines and HART commands in PAC Control
- **Chapter 3: Using HART SNAP I/O with a Custom Program**—Resources for configuring modules and communicating with them using a program built with our Developer's Toolkit

For Help

If you have problems installing or using SNAP serial communication modules and cannot find help in this guide or on our website, you can contact Opto 22 Product Support.

Phone:	800-TEK-OPTO (800-835-6786 toll-free in the U.S. and Canada) 951-695-3080 Monday through Friday, 7 a.m. to 5 p.m. Pacific Time	*NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.*
Fax:	951-695-3017	
Email:	support@opto22.com	
Opto 22 website:	www.opto22.com	

When calling for technical support, be prepared to provide the following information about your system to the Product Support engineer:

- Software and version being used
- Controller firmware version (if applicable)

- PC configuration
- A complete description of your hardware, including:
  - IP addresses and net masks for devices on the system
  - type of power supply (brand and model)
  - types of I/O units installed
  - third-party devices installed (for example, barcode readers)
  - jumper configuration, if applicable
  - accessories installed (such as expansion cards)
- Specific error messages seen.

About HART and HART SNAP I/O

The HART (Highway Addressable Remote Transducer) protocol is used for sending and receiving digital information across analog wires (4–20 mA loops). HART devices are a combination of a digital communication device and a 4–20 mA analog device.

A 4–20 mA loop can have one or more 4–20 mA receivers, but only one 4–20 mA transmitter (that is, only one device can drive the 4–20 mA current).

Transmitters vs. Actuators

HART field devices are generally categorized as *transmitters* or *actuators* (receivers):

- Transmitters transmit, or drive, the 4–20 mA current.
- Actuators (receivers) receive the 4–20 mA signal.

A receiver is called an actuator because most third-party HART devices are field devices that have HART capability built in, for example, a valve or motor with a HART interface. So the HART actuator is typically a field device that is actuated based on what it *receives* via the HART interface.

From an electrical standpoint:

- The SNAP-AOA-23-iH output module is a transmitter because it is transmitting the 4–20 mA signal. It should only be used in loops with HART actuators (receivers), since actuators do not try to set the analog loop current.
- The SNAP-AIMA-iH input module is an actuator because it receives the 4–20 mA signal. It can be used in a loop with a transmitter and other actuators.

NOTE: Our implementation is somewhat different from other HART devices that interface with field signals in that the "field" side of our HART modules is actually the SNAP PAC brain. The HART side is the 4–20 mA side.

HART on the Modules

Each channel on each module features an integrated HART modem that allows the channel to communicate digitally with a HART FSK (frequency-shift keying) signal superimposed onto the analog 4–20 mA current loop. The channel is a master device when used together with SNAP PAC

brains or controllers to communicate with other HART current loop devices in either point-to-point or multidrop configurations.

The SNAP-AOA-23-iH and SNAP-AIMA-iH differ only in their analog function (4–20 mA input or output). The HART component is the same for both modules. The parameters they can read and write using HART depend on the other HART devices they are communicating with.

- If the connected device is an actuator (receiver), you can write and read process variables (with Command 79 or a device-specific command) to control the field output of the device. Most HART actuators are like a converter taking in a HART signal and sending out an analog field signal.
- If the connected device is a transmitter, you can only read process variables, since the transmitter only reads in field values and does not output them. Most HART transmitters are like a converter taking in an analog field signal and sending out a HART signal.

For configuring, you can use HART to read and write configuration data for any HART device using Commands 0 and 13 or many of the Common Practice Commands.

For more information on the HART protocol, visit:
http://en.hartcomm.org/hcp/tech/aboutprotocol/aboutprotocol_what.html

Installation

HART SNAP I/O modules mount on SNAP PAC racks with other SNAP I/O modules (analog, digital, and serial). These modules require a SNAP PAC brain or rack-mounted controller. They are not compatible with legacy brains and controllers.

Install the Module

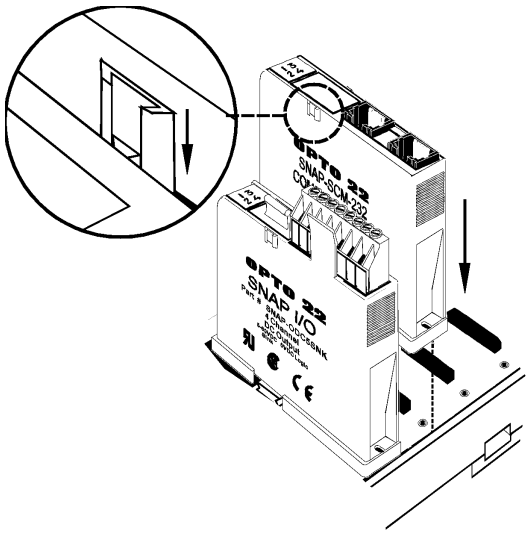
HART SNAP I/O modules can be installed in any position on an Opto 22 SNAP PAC mounting rack.

1. Turn off power to the rack.

   WARNING: Make sure power is off before continuing, or you will severely damage the module.

2. Remove the module from its packaging.
3. Position the module over the connector on the rack, aligning the small slot at the base of the module with the retention bar on the rack. If it is next to another module, make sure the male and female module keys are aligned, as shown at right.
4. Push straight down on the module to snap it into position.

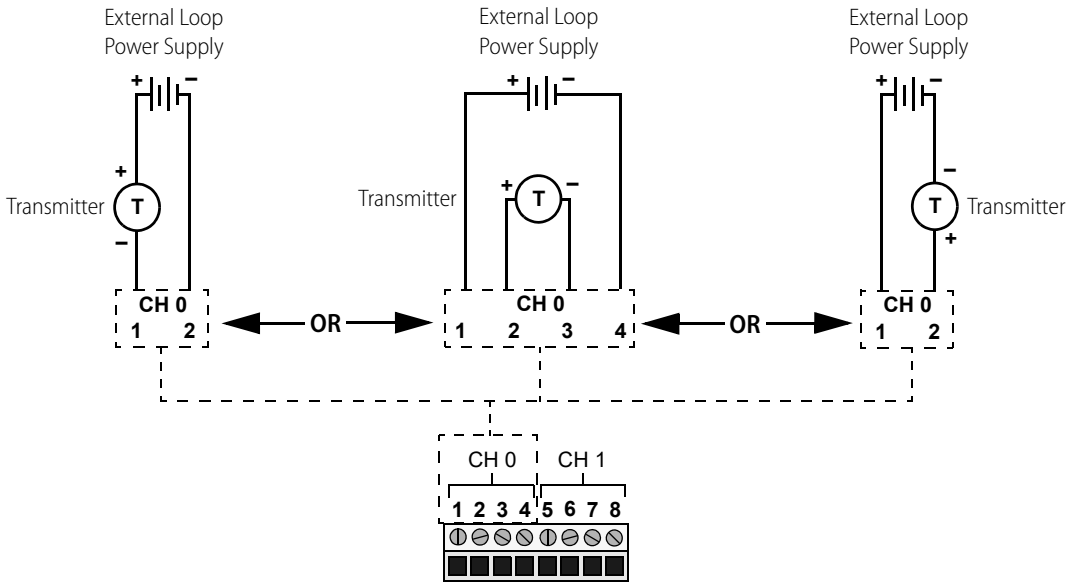
   If you need to remove the module, see page 7.



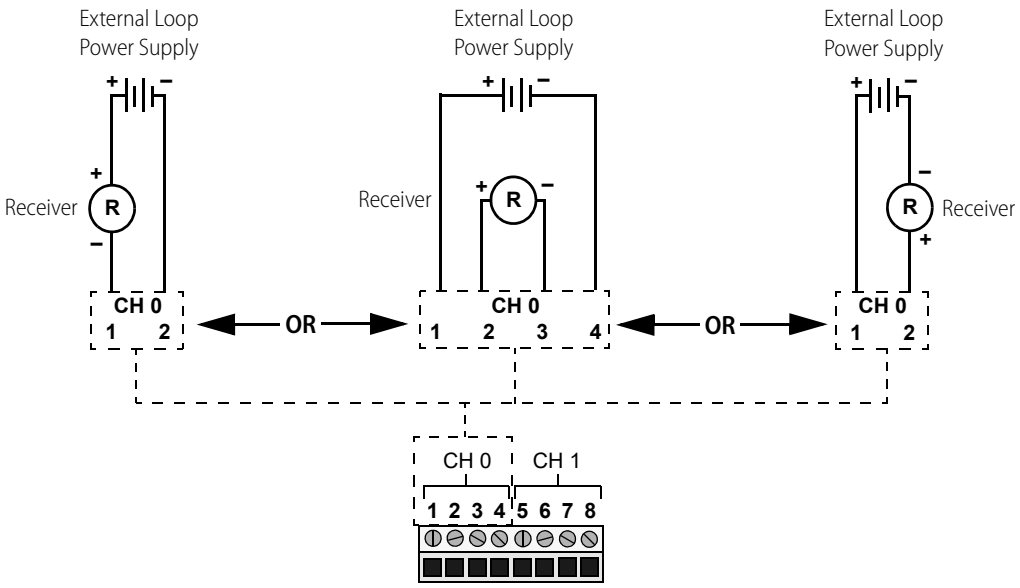
Wire the Module

Standard wiring for typical use is shown on this page.

SNAP-AIMA-iH



SNAP-AOA-23-iH



Alternate Wiring Diagram

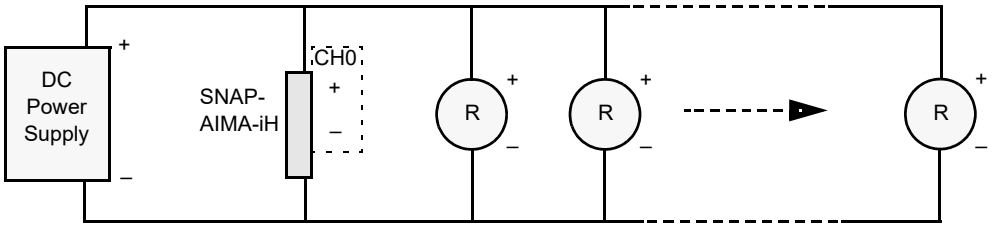
Wiring shown on the previous page is typical use.

The wiring on this page is nonstandard. **Use this page if:**

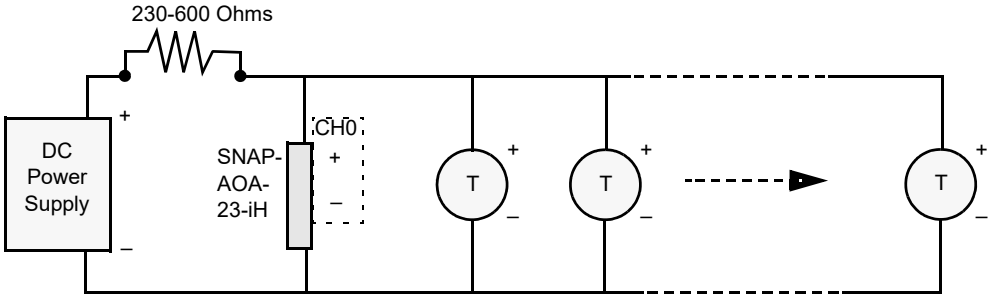
- You are using the HART protocol but not using the analog signal.
- Your HART network includes too many devices for a standard 4–20 mA loop.

This alternative wiring makes sure all HART devices on your network have adquate power.

Multidrop Wiring—SNAP-AIMA-iH



Multidrop Wiring—SNAP-AOA-23-iH



Apply Power to the Rack

Power can usually be supplied by an Opto 22 SNAP-PS5 power supply; however, check total power requirements for all modules and the processor.

What's Next

If you're using PAC Control, continue with Chapter 2: Using HART SNAP I/O with PAC Control.

If you're building a custom program, skip to Chapter 3: Using HART SNAP I/O with a Custom Program.

Removing a SNAP I/O Module

To remove a module, use the SNAP module tool that came with the module.

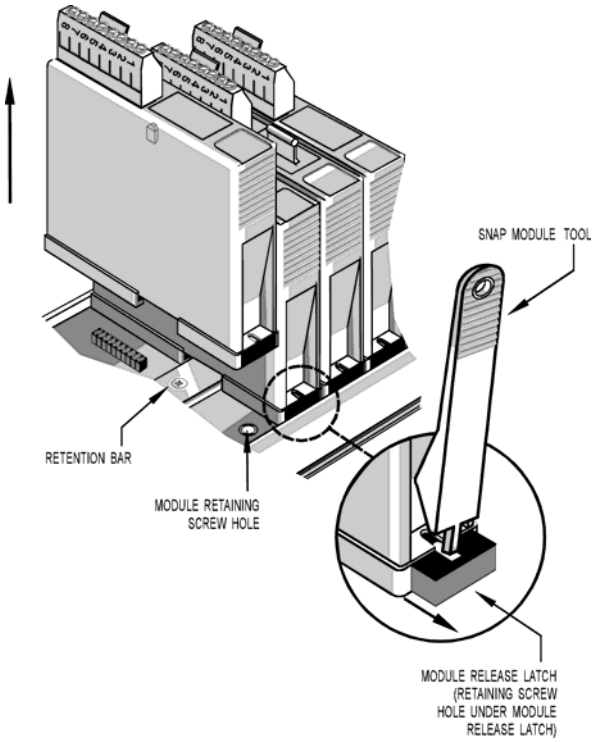
1. Turn off power to the rack.

   WARNING: Make sure power is off before continuing, or you will severely damage the module.

2. Holding the SNAP module tool as shown in the illustration at right, insert it into the notch at the base of the module.

   NOTE: If you are facing the rack with the processor on the left side, the notch is on the back of the module.

3. Squeeze the module tool against the module to open the release latch, and pull straight up on the module to remove it.



Specifications

SNAP-AIMA-iH Analog Input

Input Range Nominal Full	 4 to 20 mA 3.2 to 24 mA
Maximum Survivable Input	40 V or 160 mA
Impedance	230 Ohms nominal
Resolution	0.8 microamps
Accuracy	+/- 10 microamps
Response Time (% of span/delta I/delta time)	99.9%/20.7mA/10 ms
Gain Temperature Coefficient	30 ppm/ °C
Offset Temperature Coefficient	15 ppm/ °C
DC Common Mode Rejection	>-120 dB
AC Common Mode Rejection	>-120 dB @ 60 Hz
Maximum Operating Common Mode Voltage	250 V continuous 1500 V transient (1 s)
Isolation: Channel-Channel	250 V continuous 1500 V transient (1 s)
Power Requirements	5 VDC (+/- 0.15) @ 150 mA
Ambient Temperature: Operating Storage	 -20 °C to 70 °C -40 °C to 85 °C
Torque, hold-down screws	4 in-lb (0.45 N-m)
Torque, connector screws	5.26 in-lb (0.6 N-m)
Agency Approvals	UL, CE, RoHS, DFARS
Warranty	Lifetime

SNAP-AOA-23-iH Analog Output

Output Range Nominal Full	 4 to 20 mA 3.2 to 24 mA
External Loop Voltage Range Nominal	12-36 VDC 24 VDC
Maximum Load Resistance at Specified Loop Voltage 12 VDC 24 VDC 36 VDC	 300 Ohms 850 Ohms 1350 Ohms
Resolution	5 microamps
Accuracy	+/- 20 microamps
Response Time (% of span/delta I/delta time)	99.9%/20.7 mA/400 ms
Gain Temperature Coefficient	-50 ppm/ °C
Offset Temperature Coefficient	-25 ppm/ °C
DC Common Mode Rejection	>-120 dB
AC Common Mode Rejection	>-120 dB @ 60 Hz
Maximum Operating Common Mode Voltage	250 V continuous 1500 V transient (1 s)
Common Mode Resistance	>1000 megohms
Isolation: Channel-Channel	250 V continuous 1500 V transient (1 s)
Power Requirements	5 VDC (+/- 0.15) @ 150 mA
Ambient Temperature: Operating Storage	 -20 °C to 70 °C -40 °C to 85 °C
Torque, hold-down screws	4 in-lb (0.45 N-m)
Torque, connector screws	5.26 in-lb (0.6 N-m)
Agency Approvals	UL, CE, RoHS, DFARS
Warranty	Lifetime

LEDs

Each module includes four LED indicators on the top of the module. LEDs 1 and 3 refer to channel 0; LEDs 2 and 4 refer to channel 1.

LED 1 or 2 Status	LED 3 or 4 Activity	Description
Solid Green	Blinking Green	HART channel is operational; loop voltage and current are within limits.
Solid Red	Blinking Red	HART communication error: • On a SNAP-AOA-23-iH, check loop voltage. Excessive load resistance or an incorrect loop power supply may cause voltage to be too low. • On a SNAP-AIMA-iH, check loop current to make sure it is between 3.9 mA and 20.2 mA. NOTE: If loop voltage and current are correct, contact Product Support.
OFF	--	Current loop open or loop voltage is zero. Implies that the channel is not being used.

2: Using HART SNAP I/O with PAC Control

PAC Control Commands for HART SNAP I/O

HART SNAP I/O modules are designed for use with a SNAP PAC programmable automation controller and PAC Control automation software (version 9.4 and higher).

Several HART-specific PAC Control commands make it possible for these modules to communicate any HART command that adheres to the HART request-response model or the burst message model.

HART-specific PAC Control commands include:

- Get HART Unique Address
- Send/Receive HART Command
- Receive HART Response
- Receive HART Burst Response

In addition, you'll use the following string commands (also in PAC Control version 9.4 and higher) to build parameters in HART-specific commands:

- Pack Float into String
- Pack Integer 32 into String
- Pack Integer 64 into String
- Pack String into String
- Unpack String

For details and examples on all PAC Control commands, see the Command Help in PAC Control or form 1701, the *PAC Control Command Reference*, available at www.opto22.com.

Sample PAC Control Subroutines

In your PAC Control strategy you will need to assemble all request data sent to the module and to parse all response data returned by the module. Sample subroutines are available to help you see how to communicate with HART devices using PAC Control. They can be downloaded from our website here: HART Sample Subroutines for PAC Control. Or go to www.opto22.com and search on HART.

Here's what's included in the download:

- 14 PAC Control subroutines—one subroutine for each of 14 universal HART commands
- An Example Chart using the subroutines

Requirements

Before using the subroutines and example strategy, you will need:

- A PC running PAC Control software and the HART Sample Subroutines
- PAC Project (Basic or Pro) 9.4 or newer
- SNAP PAC controller with firmware version 9.4 or newer
- SNAP-AIMA-IH , HART communication analog 4-20 mA input module

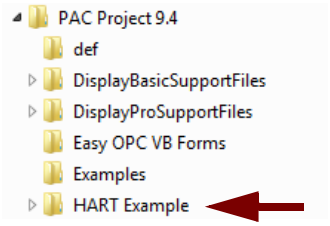
HART Commands Supported

The following universal HART commands are supported by the PAC Control subroutines included in the example strategy. For details on the PAC Control variables used in each subroutine, see "HART Commands and Subroutine Instructions and Variables" on page 17.

HART Command	Name	PAC Control Subroutine
0	Read Unique Identifier	HART_Command_0_ReadUniqueDeviceID
1	Read Primary Variable	HART_Command_1_ReadHartVariables
2	Read Loop Current and Percent of Range	HART_Command_2_ReadLoopCurrent_RangePercent
3	Read Dynamic Variables and Loop Current	HART_Command_3_ReadDynamicVAR_LoopCurrent
6	Write Polling Address	HART_Command_6_WritePollingAddress
7	Read Loop Configuration	HART_Command_7_ReadLoopConfiguration
8	Read Dynamic Variable Classifications	HART_Command_8_ReadDynamicVariableClassifications
12	Read Message	HART_Command_12_ReadMessage
13	Read Tag, Descriptor, Date	HART_Command_13_ReadTAGDescriptor_Date
14	Read Primary Variable Transducer Information	HART_Command_14_ReadPrimaryVariableTransducerInfo
15	Read Device information	HART_Command_15_ReadDeviceInfo
16	Read Final Assembly Number	HART_Command_16_ReadFinalAssemblyNumber
17	Write Message	HART_Command_17_WriteMessage

Installing the Example Strategy

To install the example strategy on your computer, extract the contents of the PACControlHARTSubroutines.zip file to a folder on your C: drive. A good location is to create a new folder in the PAC Project installation directory.



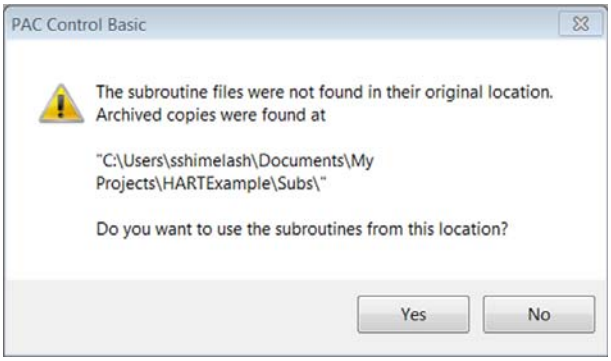
Using the Subroutines

Also see form 1700, the *PAC Control User's Guide* for detailed instructions on how to configure a controller, add an I/O unit, and use a subroutine.

Here are the basic steps to start reading data from your HART transmitter:

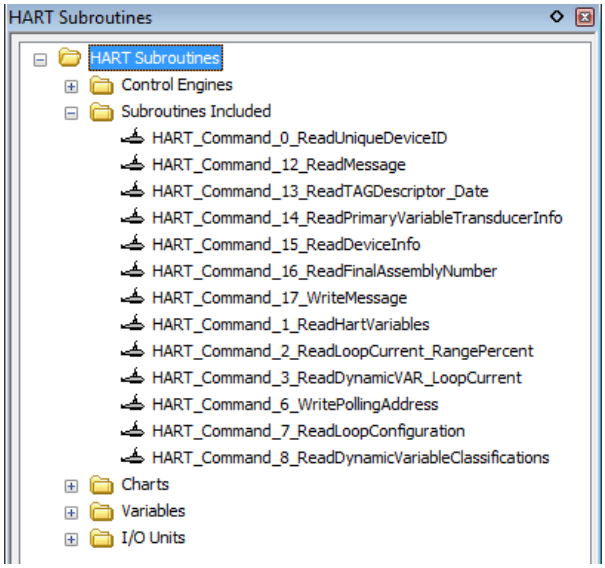
1. Open the strategy in PAC Control.

   The following message appears.

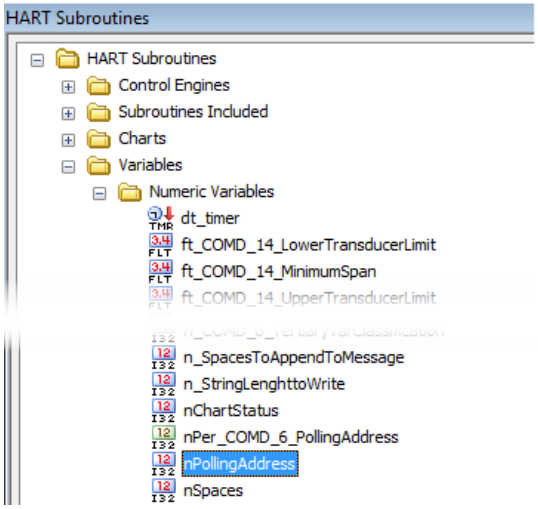


2. Click Yes to use the subroutines from the location shown on the dialog box. Or click No to specify a new location for each subroutine file.

Once the strategy is installed and open in PAC Control, the contents of the Subroutines Included folder should look like this:

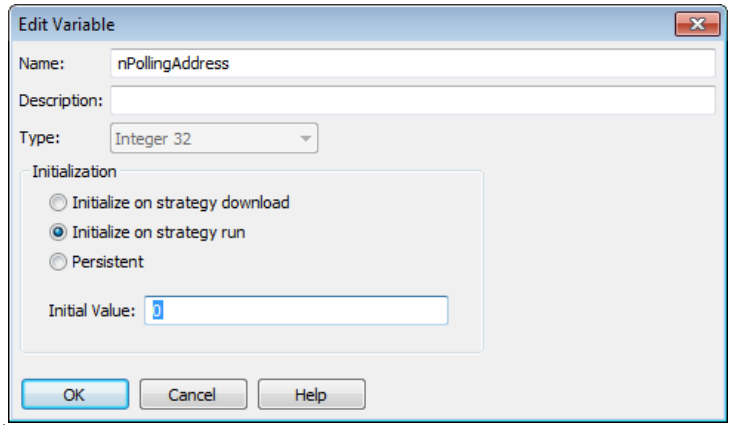


3. Right-click the I/O Units folder to add an I/O unit with an installed SNAP-AIMA-iH input module and configure the module's points. Also make sure the control engine is properly configured. For details, see form 1700, the *PAC Control User's Guide*.
4. In Config mode, expand the Variables folder and the Numeric Variables folder to find the nPollingAddress variable.

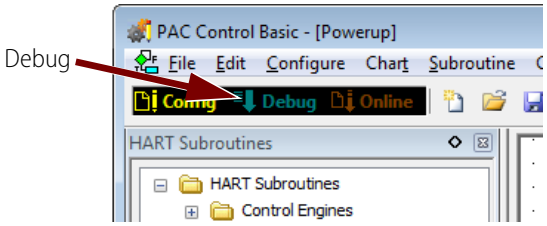


5. Double-click the nPollingAddress variable and change the initial value to the transmitter's polling address.

   You can find the polling address in the documents included with your transmitter.



6. Click OK to confirm and close the dialog box.
7. Click Debug.

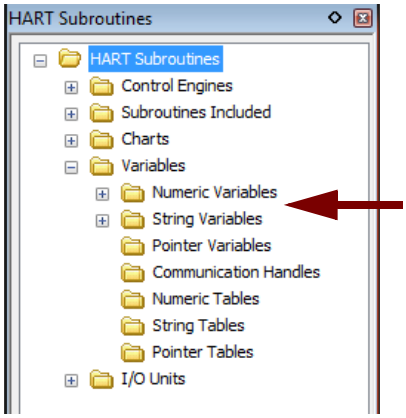


   The code is compiled and downloaded to your controller.

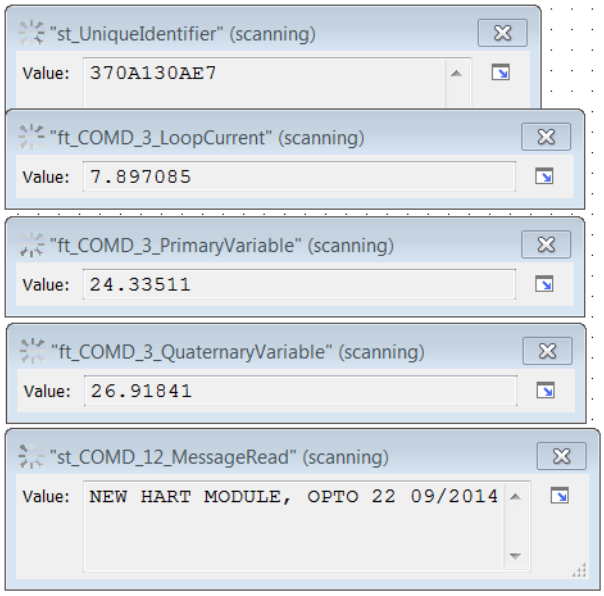
8. Once that's done, click Run Strategy.

   Now that the strategy is running, you will be able to read the unique identification of your device as well as the Primary and Secondary variables and other status information.

9. To read the value of a variable, double-click the variable in the Numeric Variables folder or the String Variables folder.



Here are some examples of the variables:

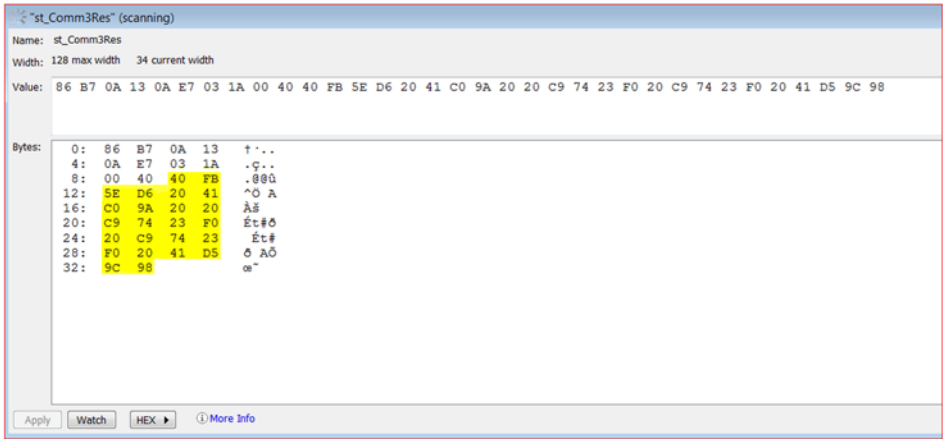


Unpacking Data Strings Received from HART Commands

In general, in order to unpack strings returned from the HART transmitter for specific HART commands, you will need to know which bytes to look at. However, if you are using the sample subroutines, this is done inside the subroutine; the specific HART command data is unpacked and copied to a variable in the example chart to ease the process of reading most common HART information. For details, refer to the HART documentation available on the HART Communication Foundation website, http://en.hartcomm.org

Command 3 Example

This graphic shows the subroutine response for Command 3.



The highlighted part is where the actual data begins (byte 10).

Command 3 fetches the following variables: Loop Current, Primary, Secondary, third and fourth Variable. These values can be temperature; pressure, etc. depending on the HART transmitter.

For the response (st_Comm3Res), bytes 0 - 9 are the HART header and status bytes. In the unpack command shown below (Command 3), it starts reading the Loop current from byte10. However, when looking at the HART command specification, the Loop current reads starting at byte 0 (the header is ignored). So there is an offset of 10 when unpacking the response in PAC Control. If the HART document states to start reading at byte 0, that's byte 10 in PAC Control. If the response data byte says to read byte 4, in PAC Control you start reading from byte 14 (for the Primary variable).

HART Commands and Subroutine Instructions and Variables

The command numbers are the same for all HART Transmitters. However, depending on what Dynamic Variables and commands a HART Device supports and the revision, the response might be slightly different from one device to another. Therefore, you will need to refer to the documentation for the specific HART transmitter being used and consider the information that is being read for that device.

Each HART command supported in the Sample Subroutines has an associated subroutine and PAC Control instruction. A table included with each command shows the variables used in the example chart to pass and receive HART information from the subroutine.

For additional information about the commands, see document numbers HCF_SPEC_127 and HCF_SPEC-151 on the HART Communication Protocol website, http://en.hartcomm.org/

Command 0: Read Unique Identifier

This is an Identity Command. Returns identity information about the field device (the HART Transmitter). When devising a strategy to communicate with a HART transmitter, always start with Command 0 (subroutine HART_Command_0_ReadUniqueDeviceID) before using any of the other subroutines. Command 0 returns the unique ID for that device. The unique ID is used when calling a subroutine or HART command.

The Command 0 subroutine requires that you know the *Polling Address* of your HART Transmitter. The Polling Address is found in the documents provided with your transmitter.

PAC Control Instruction: HART_Command_0_ReadUniqueDeviceID

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
nPollingAddress	INT 32	Polling Address of the device
st_UniqueAddress	String	This is where the Unique Address is going to be saved.
nChartStatus	INT 32	Chart Status

Command 1: Read Primary Variable

Reads the Primary Variable. This value is returned along with its Units Code.

PAC Control Instruction: HART_Command_1_ReadHartVariables

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
n_COMD_1_PrimVar_Unit	INT32	Unit of Primary Variable
ft_COMD_1_PrimVar	Float	Primary Variable
st_Comm1Res	String	Entire Response
nChartStatus	INT 32	Chart Status

Command 2: Read Loop Current and Percent of Range

Reads the Loop Current and its associated Percent of Range. The Loop Current always matches the current that can be measured by the SNAP-AIMA-IH module.

PAC Control Instruction: HART_Command_2_ReadLoopCurrent_RangePercent

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_empty	String	
ft_COMD_2_LoopCurrent	Float	Primary variable Loop Current: 4 - 20mA
ft_COMD_2_PrimVarPercent	Float	Primary variable Percent of Range (units of Percent)
st_Comm2Res	String	Entire Response
nChartStatus	INT 32	Chart Status

Command 3: Read Dynamic Variable and Loop Current

Reads the Loop Current and up to four predefined Dynamic Variables.

PAC Control Instruction: HART_Command_3_ReadDynamicVAR_LoopCurrent

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
ft_COMD_3_LoopCurrent	Float	Primary variable Loop Current: 4 - 20mA
n_COMD_3_PrimaryVariable_UnitCode	Int32	Primary Variable Unit Code
ft_COMD_3_PrimVar	Float	Primary variable
n_COMD_3_SecondaryVariable_UnitCode	Int32	Secondary Variable Unit Code
ft_COMD_3_SecVar	Float	Secondary variable
n_COMD_3_TertiaryVariableUnitCode	Int32	Tertiary variable Unit Code
ft_COMD_3_TertiaryVariable	Float	Tertiary variable
n_COMD_3_QuaternaryVariableUnitCode	Int32	Quaternary variable Unit Code
ft_COMD_3_QuaternaryVariable	Float	Quaternary variable
st_Comm3Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 6: Write Polling Address

Writes the polling address and the loop current mode to the field device.

PAC Control Instruction: HART_Command_6_WritePollingAddress

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
nPer_COMD_6_PollingAddress	Int32	Polling Address of Device
st_Comm6Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 7: Read Loop Configuration

Reads the polling address and the loop current mode.

PAC Control Instruction: HART_Command_7_ReadLoopConfiguration

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_empty	String	
n_COMD_7_PollingAddress	Int32	Polling Address
n_COMD_7_LoopCurrentMode	Int32	Loop Current Mode
st_Comm7Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 8: Read Dynamic Variable Classifications

Reads the Classification associated with the Dynamic Variables

PAC Control Instruction: HART_Command_8_ReadDynamicVariableClassifications

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
St_empty	String	-
n_COMD_8_PrimaryVarCalssification	Int32	Primary Variable Classification
n_COMD_8_SecondaryVarCalssification	Int32	Secondary Variable Classification
n_COMD_8_TertiaryVarClassification	Int32	Tertiary variable Classification
n_COMD_8_QuaternaryVarClassification	Int32	Quaternary variable Classification
st_Comm8Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 12: Read Message

Reads the Message contained within the device.

PAC Control Instruction: HART_Command_12_ReadMessage

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_empty	String	
st_COMD_12_MessageRead	String	Message Read
st_Comm7Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 13: Read Tag, Descriptor, Date

Read Tag, Descriptor, Date contained within the device. Only the Tag (6 Bytes or 8 Packed ASCII Characters) is processed by this subroutine.

PAC Control Instruction: HART_Command_13_ReadTAGDescriptor_Date

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_empty	String	-
st_COMD_13_TAG	String	Tag
st_COMD_13_Descriptor	String	Descriptor
st_COMD_13_Date	String	Date
st_Comm13Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 14: Read Primary Variable Transducer Information

Reads the Transducer Serial Number, Limits/Minimum Span Units Code, Upper Transducer Limit, Lower Transducer Limit and Minimum Span for the Primary Variable Transducer.

PAC Control Instruction: HART_Command_14_ReadPrimaryVariableTransducerInfo

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
St_empty	String	-
n_COMD_14_TransducerSerialNumber	Int32	Serial Number
n_COMD_14_TransducerLimits_SpanUnitCode	Int32	Limits and Minimum Span Unit Code
ft_COMD_14_UpperTransducerLimit	Float	Upper Limit
ft_COMD_14_LowerTransducerLimit	Float	Lower Limit
ft_COMD_14_MinimumSpan	Float	Minimum Span
st_Comm14Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 15: Read Device Information

Reads the alarm selection code, transfer function code, range values units code upper range value, Primary Variable lower range value, damping vale and write protect code.

PAC Control Instruction: HART_Command_15_ReadDeviceInfo

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
St_empty	String	-
n_COMD_15_AlarmSelectCode	Int32	PV Alarm Selection Code
n_COMD_15_TransferFunctionCode	Int32	PV Transfer Selection Code
n_COMD_15_UpperLowerRangeValuesUnitCode	Int32	PV Upper /Lower Range Values Unit Code
ft_COMD_15_UpperRangeValue	Float	PV Upper Range Value
ft_COMD_15_LowerRangeValue	Float	PV Lower Range Value
ft_COMD_15_DampingValueUnitSeconds	Float	PV Damping Value
n_COMD_15_WriteProtectCode	Int32	Write Protect Code
n_COMD_15_AnalogChannelFlags	Int32	PV Analog Channel Flags
st_Comm15Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 16: Read Final Assembly Number

Reads the final assembly number associated with the device.

PAC Control Instruction: HART_Command_16_ReadFinalAssemblyNumber

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_empty	String	-
n_COMD_16_FinalAssemblyNumber	Int32	Final Assembly Number
st_Comm16Res	String	Entire Response
nChartStatus	Int32	Chart Status

Command 17: Write Message

Writes the Message into the device. To write a message to the transmitter or use Command 17, you need to move the message to the variable (st_COMD_17_MessagetoWrite). Command 17 accepts messages that are exactly 32 characters to write to the transmitter.

PAC Control Instruction: HART_Command_17_WriteMessage

Passed Variable	Format	Description
HART I/O	AI	HART module on the rack
st_UniqueAddress	String	Unique Address of the device
st_COMD_17_MessagetoWrite*	String	Message to write.
st_Comm17Res	String	Entire Response
nChartStatus	Int32	Chart Status

* Note: The Message string must be exactly 32 string characters.

3: Using HART SNAP I/O with a Custom Program

Resources for Custom Programming

HART SNAP I/O modules are typically used with an Opto 22 PAC Control strategy running on a SNAP PAC programmable automation controller. If you're not using PAC Control, however, you can develop your own custom program. Here's what you'll need:

- One or more HART SNAP I/O modules on a SNAP PAC rack with a SNAP PAC I/O processor (brain or rack-mounted controller). See Chapter 1, "1: Introduction & Installation."
- The free SNAP PAC .NET HART developer toolkit. This toolkit lets you integrate HART SNAP I/O modules into an existing .NET/Mono application. This toolkit is available for download on www.opto22.com. It includes complete documentation.
- PAC Manager software. This free configuration and troubleshooting utility comes on a CD with all SNAP PAC brains and controllers and is also available for download on our website, www.opto22.com. Install PAC Manager on a Windows PC on the same Ethernet network as the I/O unit. The *PAC Manager User's Guide* (form 1704) is included.
- The *OptoMMP Protocol Guide* (form 1465, available on www.opto22.com). OptoMMP is the memory map protocol used by SNAP PAC I/O processors. This guide shows you how to address modules on the rack and includes the complete memory map, which provides the addresses you'll use to configure and communicate with HART SNAP I/O modules.

Getting Started

Get Acquainted

In Chapter 2 of the *OptoMMP Protocol Guide,* read "Overview of Programming,""Understanding the Memory Map," and "Referencing SNAP I/O Points."

Assign an IP Address

If the SNAP PAC I/O processor doesn't have a fixed IP address yet, follow steps in the *PAC Manager User's Guide* to assign it.

Configure I/O Points

You can configure the two points on the HART SNAP I/O module in your custom program or in PAC Manager software.

In your program

1. If you want to configure analog point features—watchdog, custom scaling, or output clamping—on HART SNAP I/O modules, follow instructions in "Using I/O Point Features" (in Chapter 2 of the *OptoMMP Protocol Guide*).

   If you're not using these features, you do not need to configure points. The I/O processor recognizes points automatically.

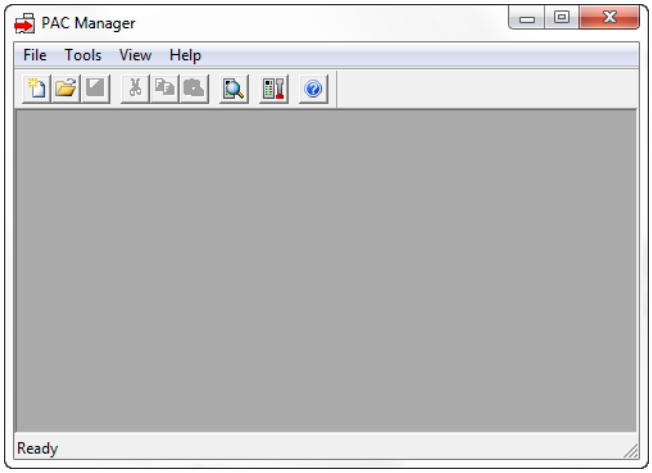
2. Configure HART settings using the memory map section, "HART Module Configuration—Read/Write" in the Memory Map Appendix.

NOTE: The only thing you cannot configure in your custom program is a change to the IP port number used by one of the module's points. If you need to change the IP port number, use PAC Manager and remember to save the configuration to flash memory. You must reboot the I/O processor for the change to take effect.

In PAC Manager—Inspect Window

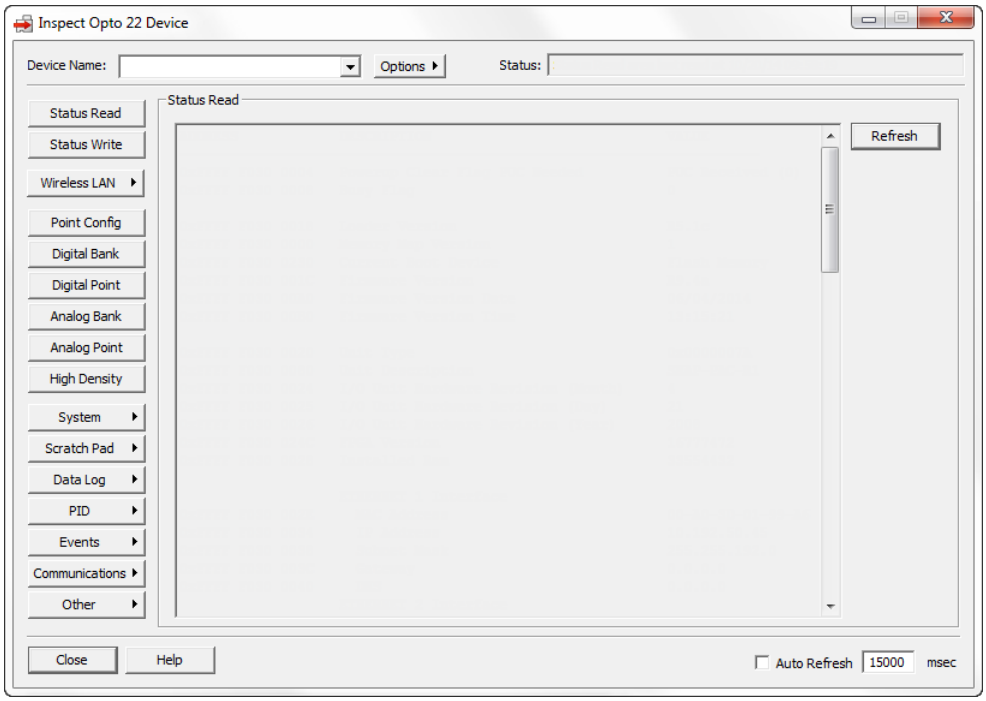
For individual I/O units, use the steps shown below. If you have several similar I/O units, you may prefer to create a configuration file and download it to several I/O units at once. For this option, see "In PAC Manager—Configuration File" on page 29.

1. On the PC, choose Start > Programs > Opto 22 > PAC Project > PAC Manager.

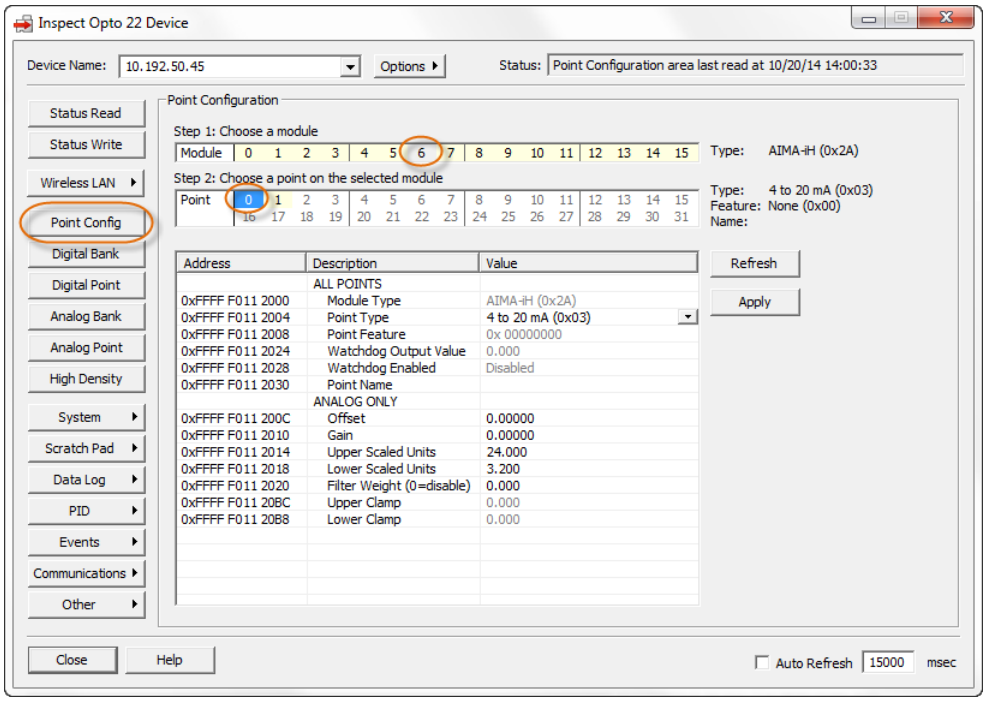


2. In the PAC Manager main window, click Tools > Inspect.

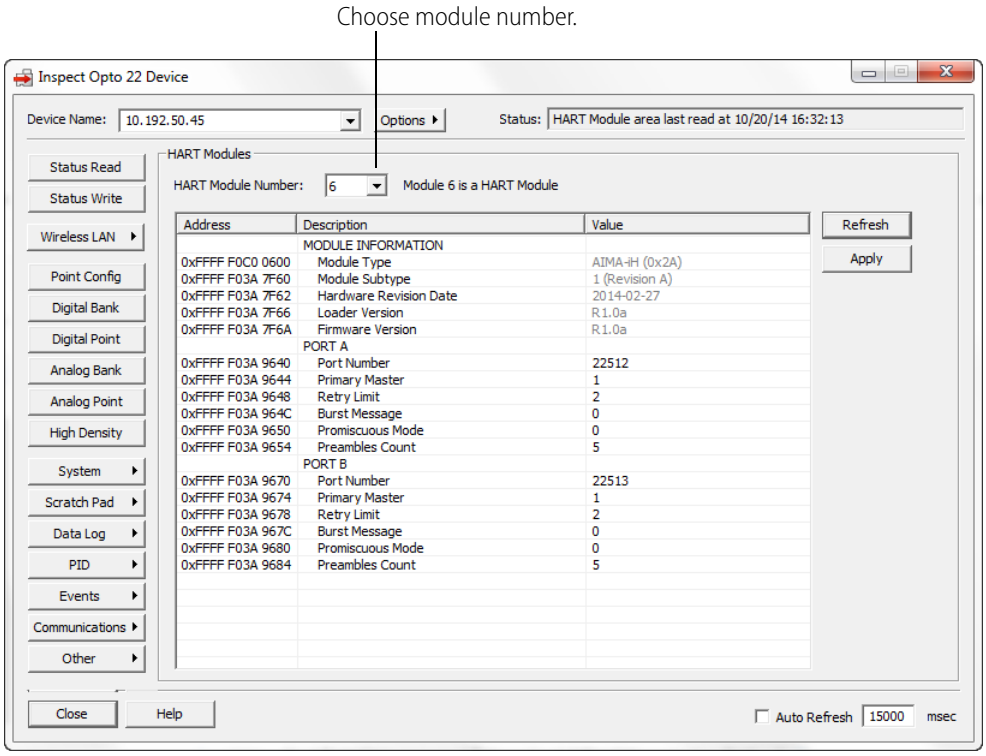
   If this is the first time you've used the Inspect window, it will be blank as shown below. If you've used it before, PAC Manager will try to connect to the last device you inspected and read its status.



3. In the Device Name field, enter the IP address you've assigned to the I/O unit with the HART module.
4. Click the Point Config button in the left column. Click the module number and then the point you want to configure.



5. If necessary, change Offset, Gain, Upper and Lower Scaled Units, and Filter Weight. When finished, click Apply.
6. In the left column, click Communications > HART Modules.
7. Choose the module number from the dropdown list. Remember that the first module on the rack is numbered 0.



8. Set parameters for each port to match the HART device it will communicate with:

Parameter	Description	Default
Port Number	TCP port number. NOTE: If you change the port number you must restart the I/O unit after you finish configuration.	See table on page 33
Primary Master	Master Address. 0 = Secondary Master, 1 = Primary Master Use 1 if you want the HART SNAP I/O module to be the permanent master; you can temporarily attach another master device for configuration or troubleshooting.	1
Retry Limit	Number of times to retry communication. Valid values: 0 to 5 If the module does not receive a valid response from the slave device after the maximum number of retries, it reports an error.	2
Burst Message	0 = Don't report burst messages, 1 = Report burst messages Burst messages occur when a slave device in a special mode sends data without a request from a master.	0
Promiscuous Mode	0 = Don't report other master requests/responses, 1 = Report other master requests/responses 1 means that the module will report transactions initiated by the other master, including requests and responses.	0

Parameter	Description	Default
Preambles Count	Valid values: 5 to 20 Older HART devices may requre more than 5 preamble characters. Verify using HART command 0.	5

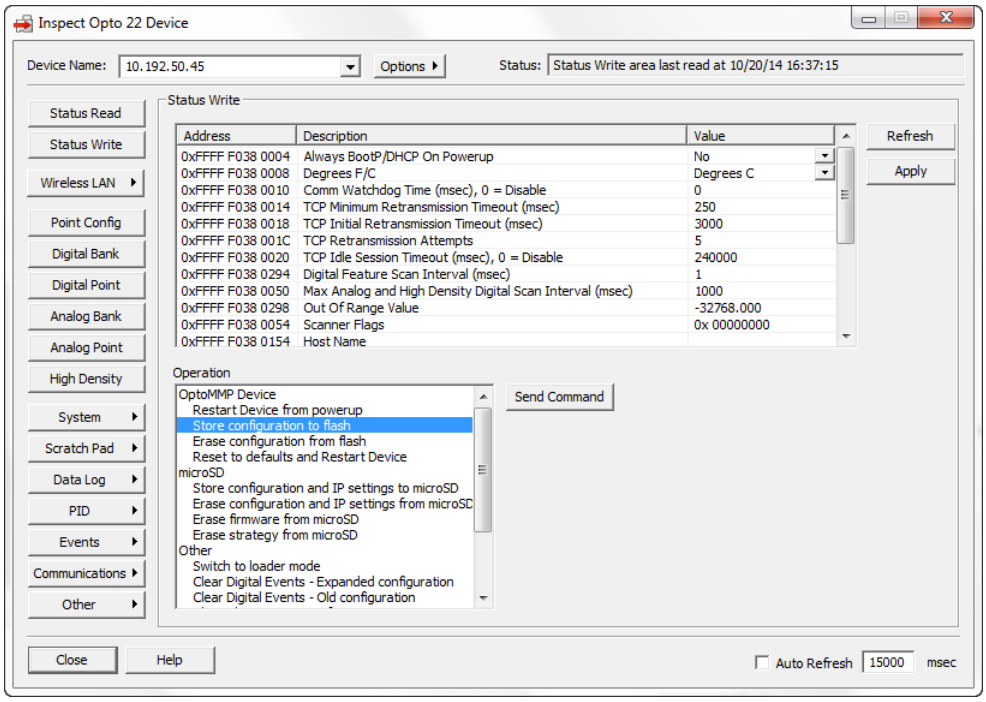
9. When everything is correct, click Apply.

The configuration is sent to the I/O unit BUT is not saved to flash memory. If the I/O unit loses power or is turned off, you will have to reconfigure the HART modules.

10. When you've finished configuring modules, save the configuration to flash:

a. Click Status Write in the left column.

b. In the Operation area halfway down the window, highlight Store configuration to flash.



c. Click Send Command.

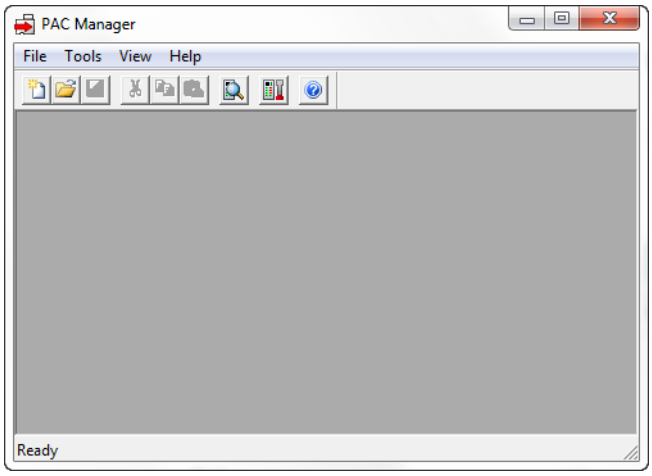
d. **IMPORTANT:** If you have changed the TCP port number, highlight the operation Restart Device from powerup, and click Send Command again.

The configuration is stored to the I/O unit's flash memory, and you're ready to use the module.

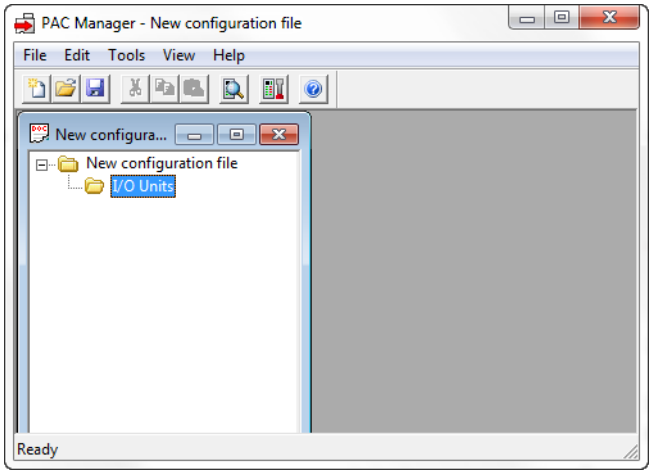
In PAC Manager—Configuration File

If you have several similar I/O units, you can create a configuration file (also called a tag database) and download it to several I/O units at once. A sample configuration file is included in the Developer's Toolkit, which you can modify as needed. Or follow these steps to create a new file.

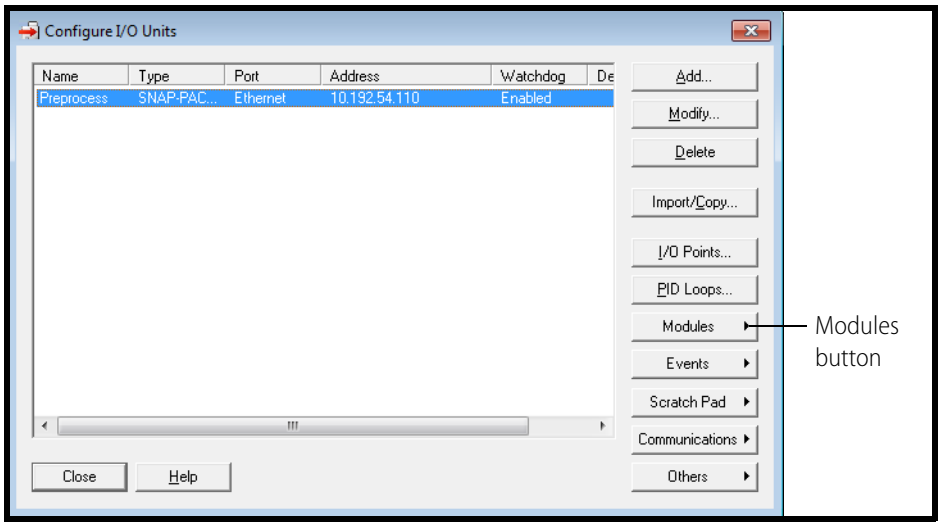
1. On the PC, choose Start > Programs > Opto 22 > PAC Project > PAC Manager.



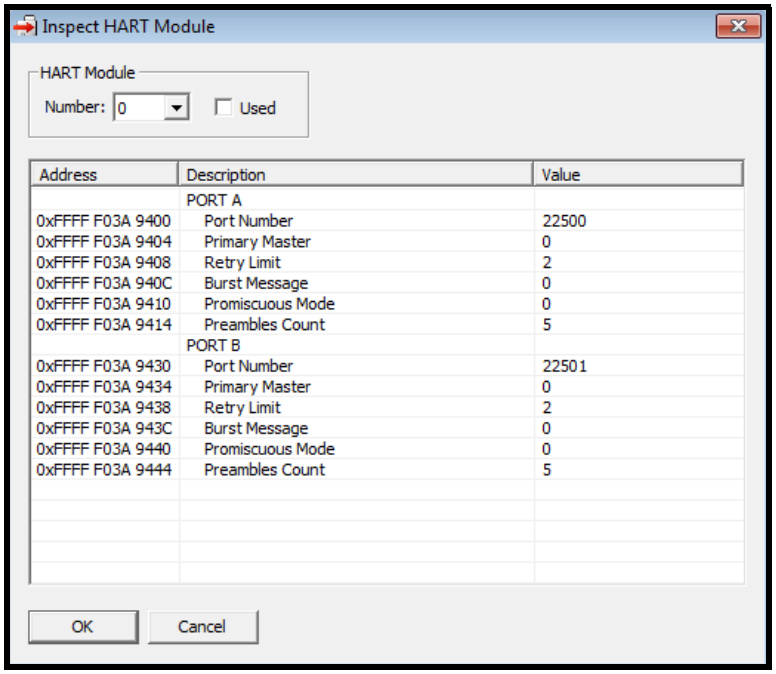
2. In the PAC Manager main window, click the New button or choose File > New and create a new tag database (configuration file).



3. In the tree, double-click the I/O Units folder. Follow steps in the *PAC Manager User's Guide* to add the I/O unit and configure its I/O modules and points. The SNAP-AIMA-iH is an analog input module; the SNAP-AOA-23-iH is an analog output module.
4. In the Configure I/O Units dialog box, highlight the I/O unit the HART module is on and click the Modules button.



5. Choose HART Modules from the pop-up menu.



6. In the Number field, choose the HART module's position from the drop-down list. Click to put a check mark in the Used box.

7. Configure all parameters for each port used.

- **Port Number**: If you need to change port numbers, enter a new number for each port in the Port Number field.
- **Primary Master**: 0 = Secondary Master, 1 = Primary Master

  A master is a device that is in control of the HART Bus. Either master (Primary or Secondary) can initiate a transaction with a slave field device attached to the bus.

If you want a permanent master connected to the HART bus, use Primary Master = 1. This allows you to temporarily attach another master device to configure a device or troubleshoot the HART bus.

- **Retry Limit**: 0, 1, 2, 3, 4, or 5

  If the module does not receive a valid message from the slave device it is talking to, it will automatically send up to the configured number of retries until it gets a valid response. If it does not get a valid response after the maximum number of retries, it will report back that an error occurred.

- **Burst Message**: 0 = Don't report burst messages, 1 = Report burst messages

  A burst message occurs in a special mode where one slave device on the HART Bus is periodically sending data without a request generated by a master device.

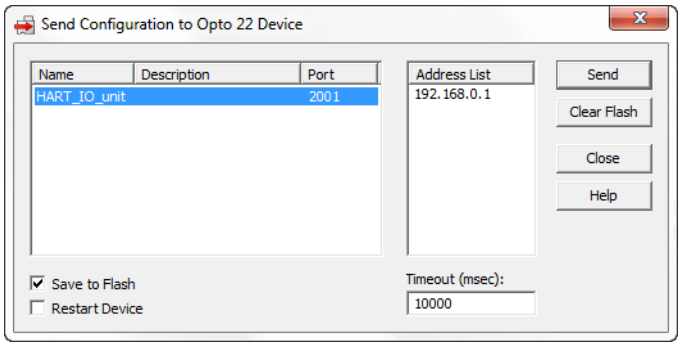
- **Promiscuous Mode**: 0 = Don't report other master requests/responses, 1 = Report other master requests/responses.

  When enabled (1), the module reports transactions initiated by the other master on the bus, including requests generated by the other master and responses to those requests by the addressed slave.

- **Preambles Count**: 5 to 20

  Preamble characters are sent with every message to indicate that data is about to be transmitted. The default of 5 should work in most situations. However, you might need to increase the number if the slave device requires more preamble characters, which is generally true of older HART devices and can be determined using HART command 0.

8. When all HART modules are configured, click OK to close the dialog box.
9. Choose File > Save to save the configuration file.
10. When configuration is complete, choose Tools > Send Configuration to I/O Unit.



The list on the left shows all the I/O units in this configuration file. When you click a unit, the Address List shows the IP addresses for all I/O units to receive the same configuration.

11. Highlight the I/O unit configuration(s) you want to send.
12. Highlight the IP addresses to receive the I/O unit configuration.

    If you don't highlight any addresses, the configuration will be sent to the entire list.

NOTE: If you highlighted more than one unit configuration, each unit configuration will automatically be sent to all the IP addresses associated with it.

13. If necessary, change the Timeout field.

    The timeout field shows how long, in milliseconds, PAC Manager will try to communicate with the I/O unit before returning a timeout error.

14. To save the configuration file to flash memory as well as to RAM, check Save to Flash. To also restart the unit, check Restart I/O Unit.

    IMPORTANT: If you have changed an IP Port number, you must save the change to flash and restart the I/O unit.

15. Click Send.

    The configuration data is sent to the I/O units.

HART Module and Port Numbers

For quick reference, the following table shows HART modules and ports, their default TCP port numbers, and their starting memory map addresses, beginning with FFFF F03A 9400. For more information about the memory map, see the *OptoMMP Protocol Guide*.

Module	Port	Default TCP port	Memory Map Address
0	A	22500	9400
0	B	22501	9430
1	A	22502	9460
1	B	22503	9490
2	A	22504	94C0
2	B	22505	94F0
3	A	22506	9520
3	B	22507	9550
4	A	22508	9580
4	B	22509	95B0
5	A	22510	95E0
5	B	22511	9610
6	A	22512	9640
6	B	22513	9670
7	A	22514	96A0
7	B	22515	96D0

Module	Port	Default TCP port	Memory Map Address
8	A	22516	9700
8	B	22517	9730
9	A	22518	9760
9	B	22519	9790
10	A	22520	97C0
10	B	22521	97F0
11	A	22522	9820
11	B	22523	9850
12	A	22524	9880
12	B	22525	98B0
13	A	22526	98E0
13	B	22527	9910
14	A	22528	9940
14	B	22529	9970
15	A	22530	99A0
15	B	22531	99D0