HART Sample Subroutines for PAC Control

INTRODUCTION

The HART (Highway Addressable Remote Transducer) Sample Subroutines for PAC Control allow Opto 22 controllers, using PAC Control to communicate with a HART transmitter via an Opto 22 HART input module (SNAP-AIMA-iH).

What's included:

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

After wiring the HART transmitter to the input module[1] and then running the example strategy, you can read HART data right away.

This technical note includes the following topics:

UNDERSTANDING THE HART PROTOCOL

The information in this technical note assumes that you are knowledgeable about using the HART protocol. Even for those who are experienced, we highly recommend reviewing the information on the HART Communication Foundation website:

http://en.hartcomm.org/

1. You can substitute a SNAP-AOA-23-iH HART output module and a HART receiver

WHAT'S REQUIRED

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

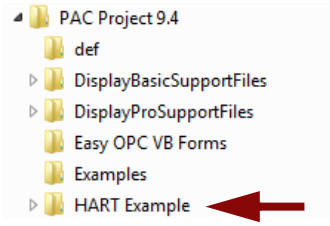
HART COMMANDS SUPPORTED

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 8.

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 Classification	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 Assemble 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.

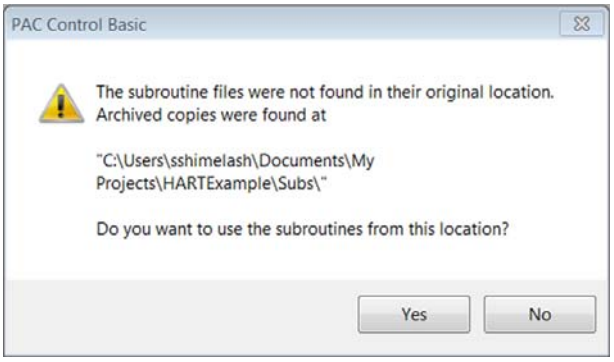


USING THE SUBROUTINES

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.

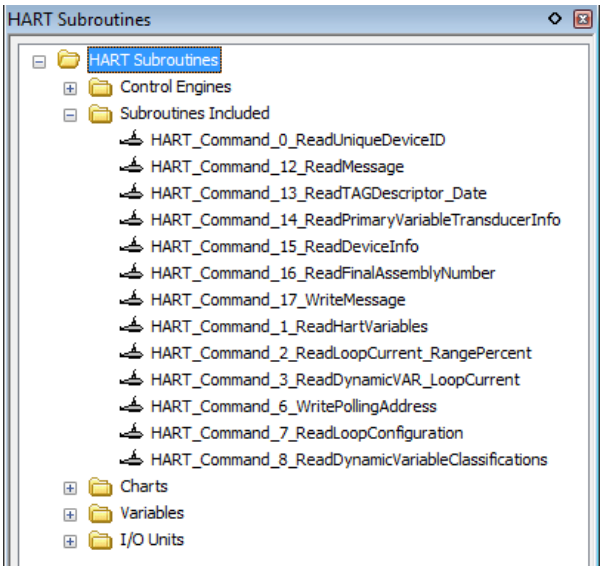
Here are the basic steps to start reading data from your HART transmitter:

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 subroutines file.

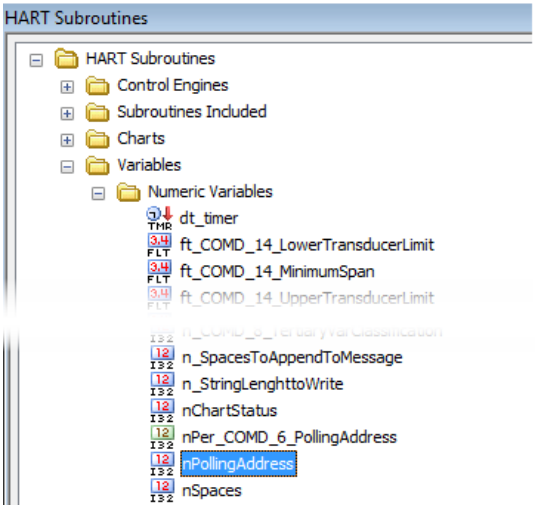
   Once the strategy is installed and open in PAC Control, the contents of the Subroutines Included folder should look like this:



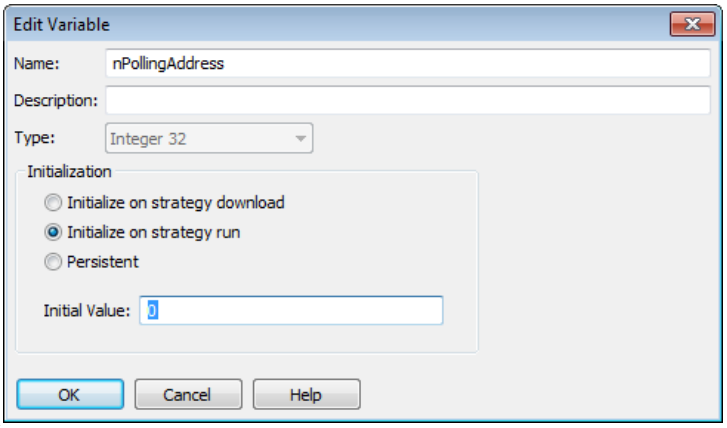
3. Right-click the I/O Units to add an I/O unit with an installed SNAP-AIMA-iH input module and configure the module's points. Also make sure the control engine is properly configured.

   For details, see form 1700, *PAC Control User's Guide*.

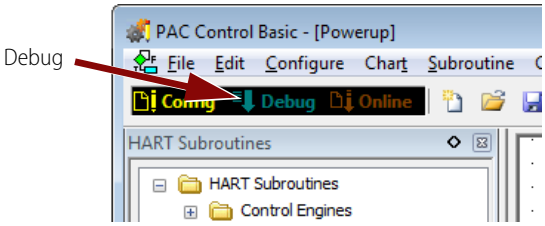
4. In Config mode, expand the Variables folder and the Numeric Variables folder to find the nPollingAddress variable.



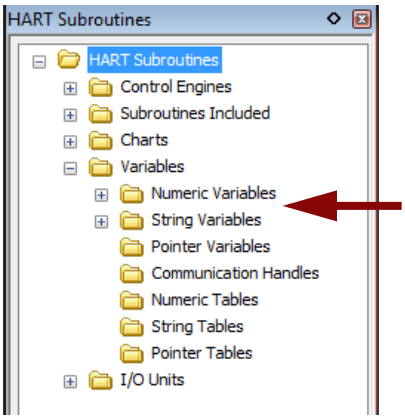
5. Double-click the nPollingAddress variable and change the initial value to the transmitter's polling address.
   You can find the polling address in the documents included with your transmitter.



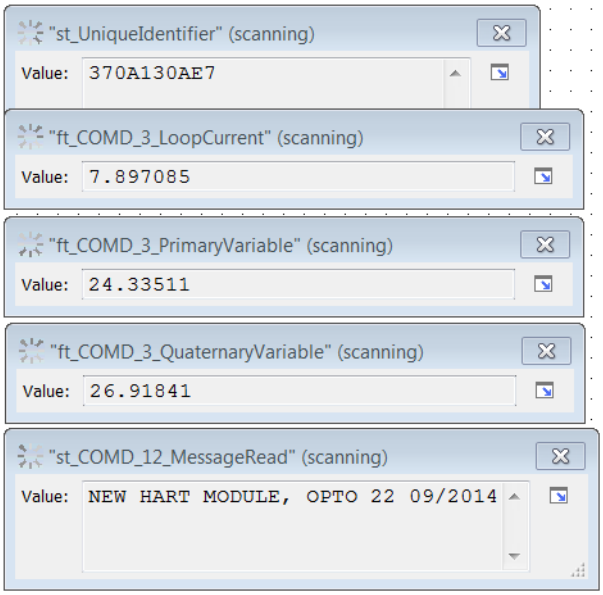
6. Click OK to confirm and close the dialog box.
7. Click Debug.



   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:

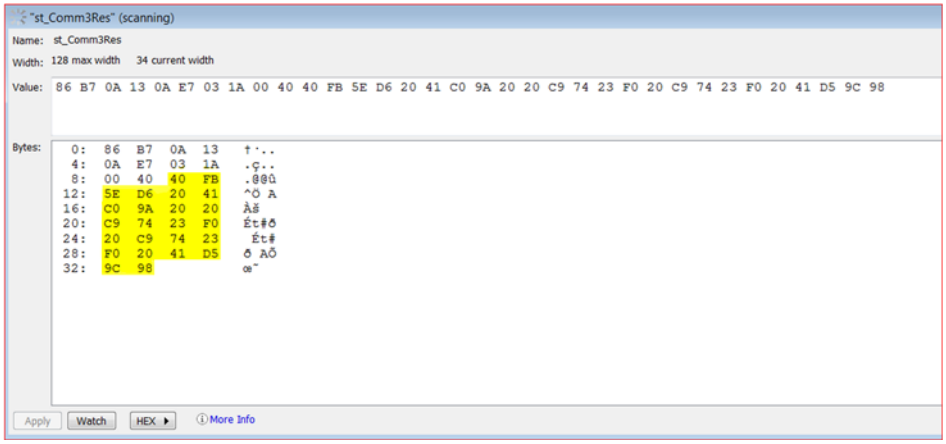


UNPACKING DATA STRINGS RECEIVED FROM HART COMMANDS

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 Foundation 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 (10th byte).

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 headers. In the unpack command shown below (Command 3), it starts reading the Loopcurrent from 10th byte. However, when looking at the HART command specification, the Loopcurrent 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 the 10th byte in PAC Control. If the response data byte says to read the 4th byte, in PAC Control you start reading from the 14th byte (for the Primary variable).

This applies to all commands except the write commands and Command 0.

For Command 0 you would look at the entire response.

HART COMMANDS AND SUBROUTINE INSTRUCTIONS AND VARIABLES

The command numbers are the same for all HART Transmitters. However, depending on what 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 supported HART command 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 number HCF_SPEC_127 on the HART Communication Foundation 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 Loops 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 read here.

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.		