Application Note

FESTO

CPX-HART with Rockwell Logix and EtherNet/IP

How to make best use of the CPX-HART modulles when using EtherNet/IP in a Rockwell Logix environment. This includes a Festo AOI, FTD/DTM, plus visualization tools for PlantPAx.

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CPX-FB36

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1 Components/Software used

Type/Name	Version Software/Firmware	Date of manufacture
CPX-FB36	Rev14	--
CPX-P4AIO-HA	Rev1	--
Festo Maintenance Tool	Rev4.21.202	--
FDT software PACTware	PACTware V4.1 (V5 is incompatible)	--
Festo CPX_Terminal_HART_DTM	xxxx	--
Rockwell Studio 5K	V28	--
Rockwell Factory Talk View Studio ME	V9	--
Rockwell Process Library for PlantPAx	V3.5-09	--
Rockwell 1769-L30ERMS PLC	V28	--
Endress+Hauser TMT182 HART temperature sensor	1.02.11	--
Omega HPS-ICSS-18G-12-SMP-M thermocouple probe	--	2008/06

Table 1.1: 1 Components/Software used

2 Introduction

The CPX-FB36 and the CPX-P4AIO-HA modules now allow HART devices to be connected via EtherNet/IP to a Rockwell controller. This note uses an example with a temperature device via HART, but this can include any type of HART devices.

Festo provides documentation in a user manual to configure and use the HART modules. This application note is intended to provide details and hints for additional features possible when using a ControLogix or CompactLogix PLC from Rockwell over EtherNet/IP. Therefore, it is a prerequisite to this note that the user must use the Festo documentation of the HART modules to become especially familiar with the following:

- Use of the DIL switch settings of the HART modules, and resulting size of the I/O table
- Understanding of the CPX limitations with respect to I/O size allocation and module positioning
- Understanding of the HART variable types PV, SV, TV, QV, and the data conversion to these types via the heading of IEEE Routing.
- Understanding the difference of the analog data value and the corresponding HART PV value.

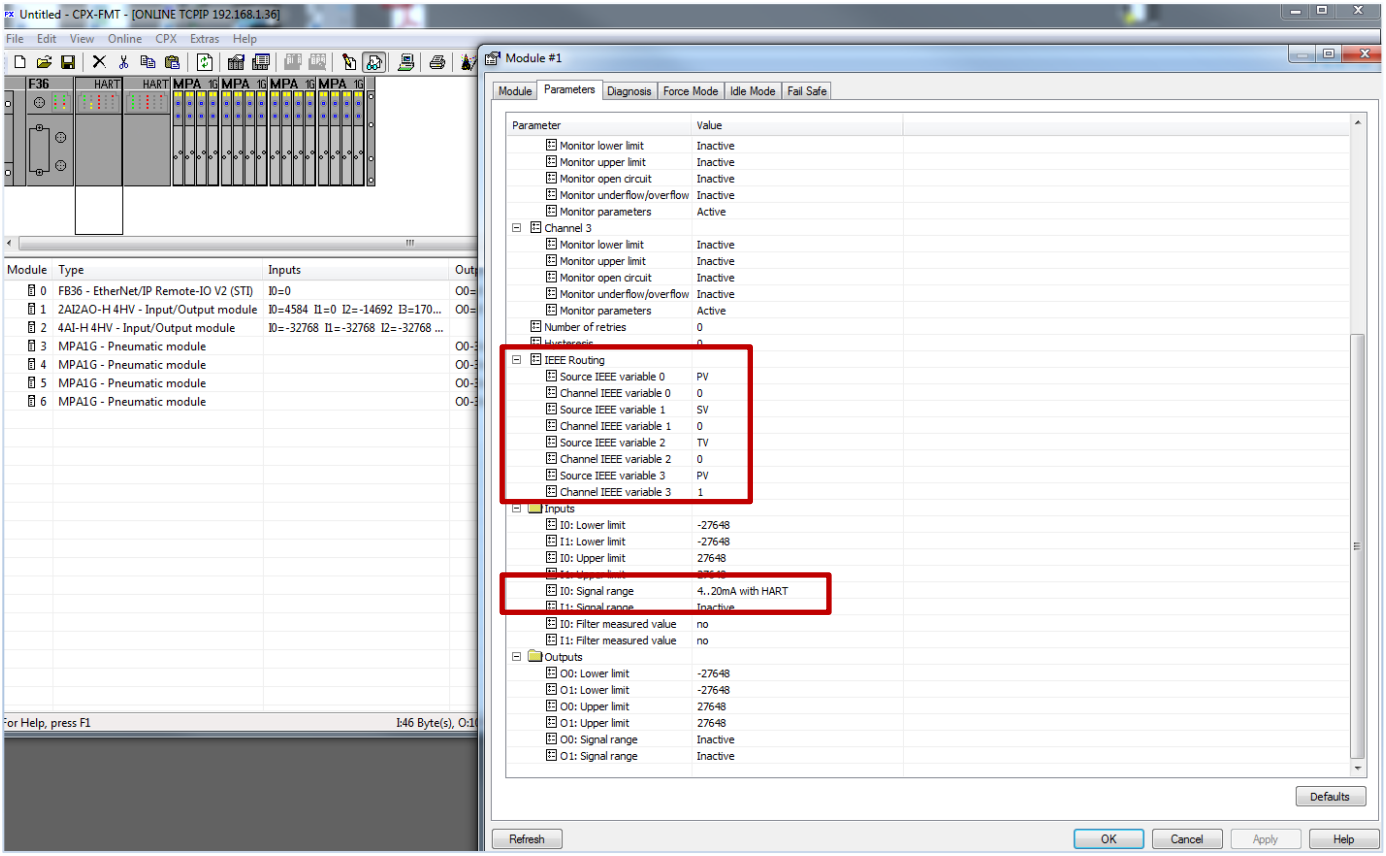
3 Rockwell Logix Configuration

3.1.1 L5K Export

It is easiest to configure the CPX with HART modules in the Festo Maintenance Tool (FMT) and to export this via L5K to the Logix project. This provides numerous benefits:

- Keeps configuration in the project for easy replacement of CPX system
- Provides an initial HART configuration in Logix during CPX start-up

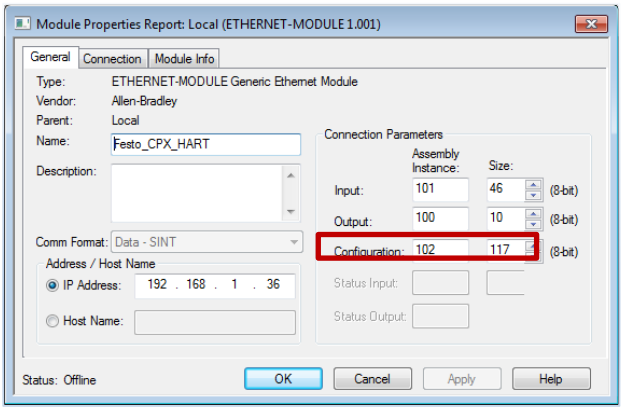
Create a configuration in FMT. It is possible to do this on line. Set the HART parameters. In this case, set the IEEE Routing and Signal Range:



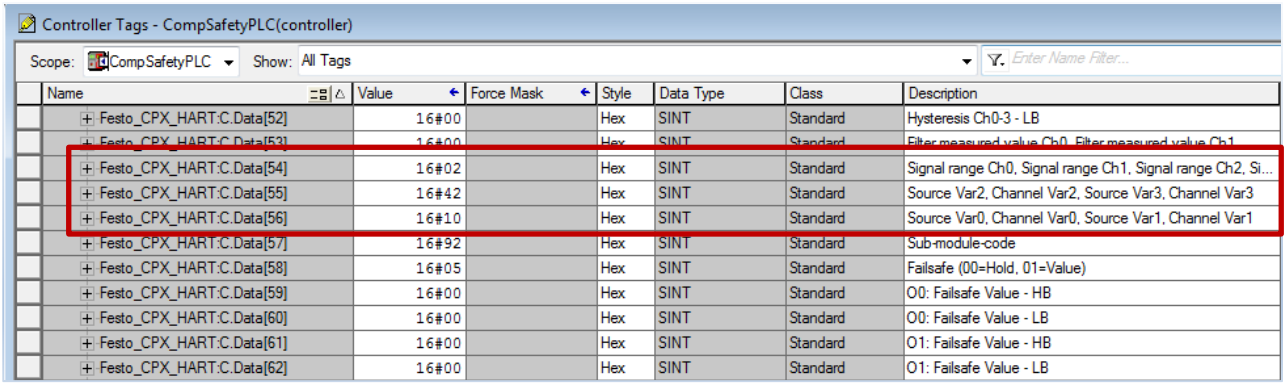
Follow the FMT-L5K export instructions to create a Logix project that can be used to copy the CPX configuration into the actual project.

3.1.2 L5K Import into Logix

Once the sample project is created in Logix from the L5K export, the CPX configuration can be imported into the actual user project. Simply copy the CPX generic configuration, and paste in the user project tree by right-clicking on Ethernet, and selecting paste. The following Ethernet Generic Module screen should be viewed:



The example here has a configuration size of 117 bytes. The config tag names are clearly annotated for convenience:



This data gets downloaded to the CPX in the Forward-Open message of CPX upon initial connection.

4 FTD/DTM for CPX

4.1.1 DTM Installation

DTM stands for Device Type Manager. It is a driver for a device. Festo provides a Communication DTM for the CPX. This can be downloaded from the support portal (link). This allows for the configuration of the HART device over the EtherNet/IP network. Simple let the Windows installer run 'Setup_CPX_Terminal HART DTM", the FDT application will find this when it is launched.

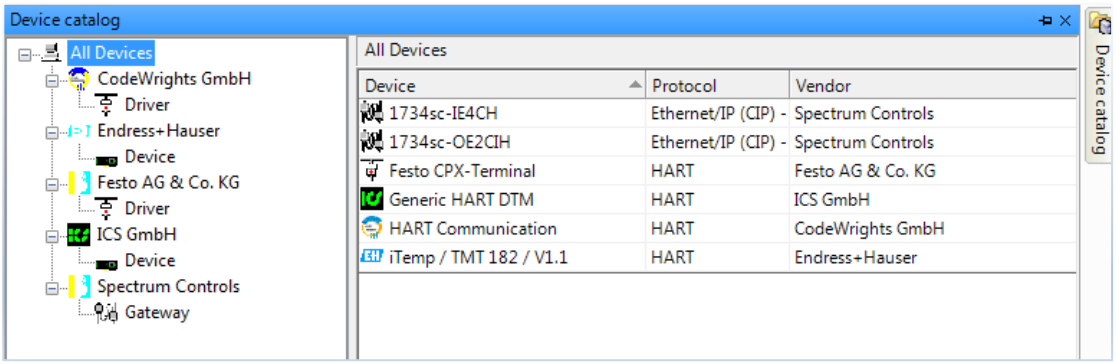
In addition, each supplier of a HART device should provide a standard DTM to configure the device. They get installed in a similar manner as the Festo CPX DTM. In this example, the Endress + Hauser iTEMP TMT182 temperature transmitter was used. The DTM "EH_iTemp_TMT_182_V1_1" was installed the same way as the CPX DTM.

4.1.2 FDT Frame Applications

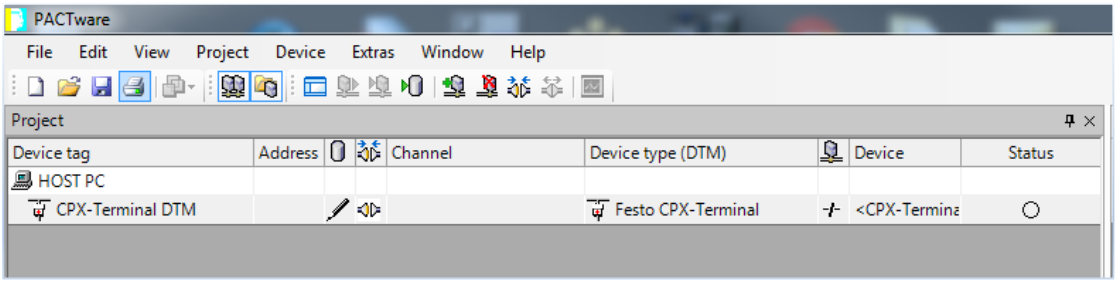
There are numerous FDT environments that can be used from a variety of suppliers. In this example, we used PACTware 4.1 from the Pepperl + Fuchs web site. This is a free download. Use version 4.1, since there is a known anomaly with version 5. Other FDT frame applications will work as well. Follow directions to install this software.

4.1.3 Create FDT Project

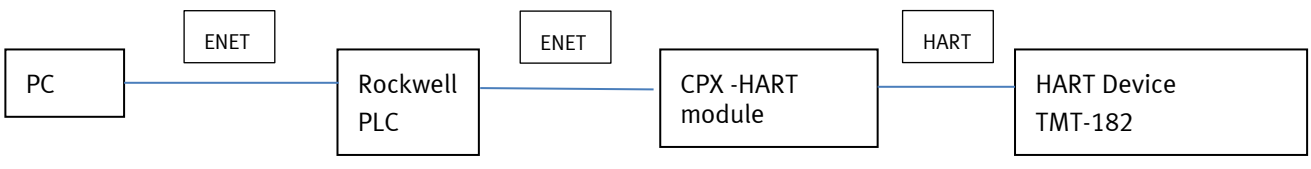
If the DTM's were installed properly, upon creation of a new project, the DTM's should be available in the Device Catalog. Notice below the Festo device is listed as a driver, and the E+H is listed as a device.



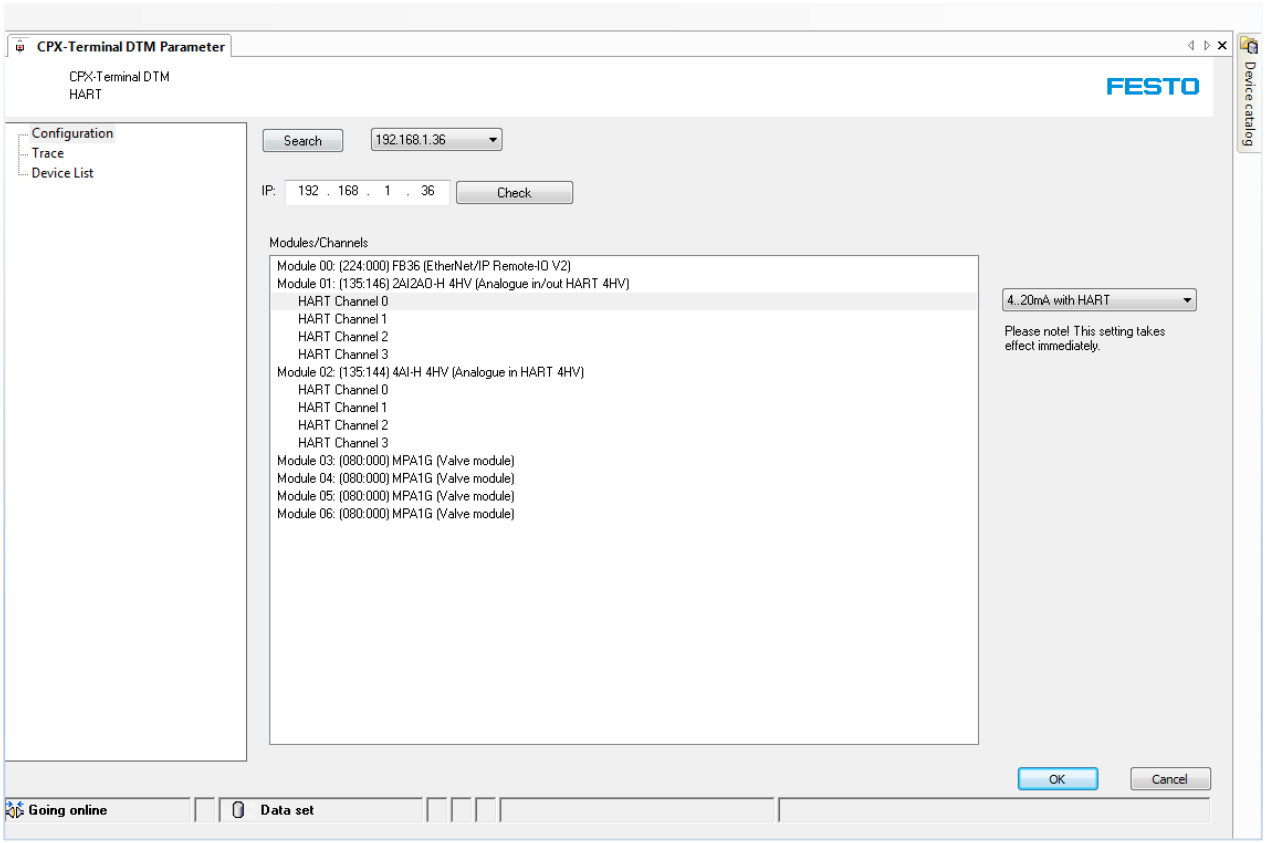
The Festo driver is immediately after the host in the network structure, and will be selected first when building the project. Double click or drag this under the HOST PC.



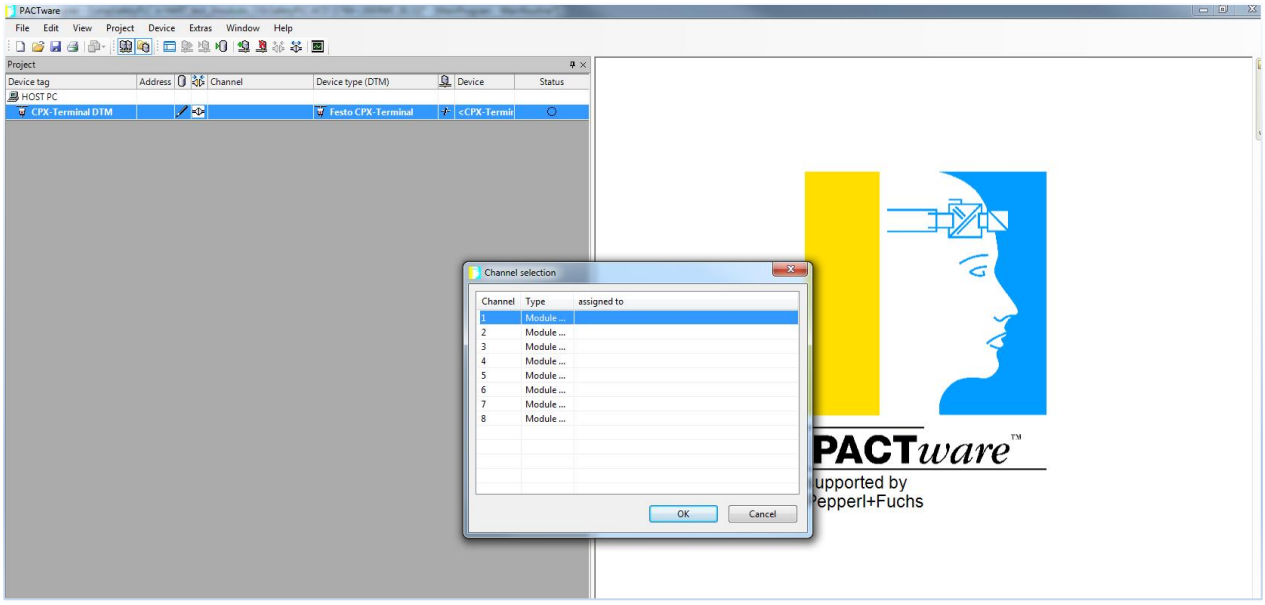
At this point, you need to be connected with the control system since we will configure the HART device for our application.



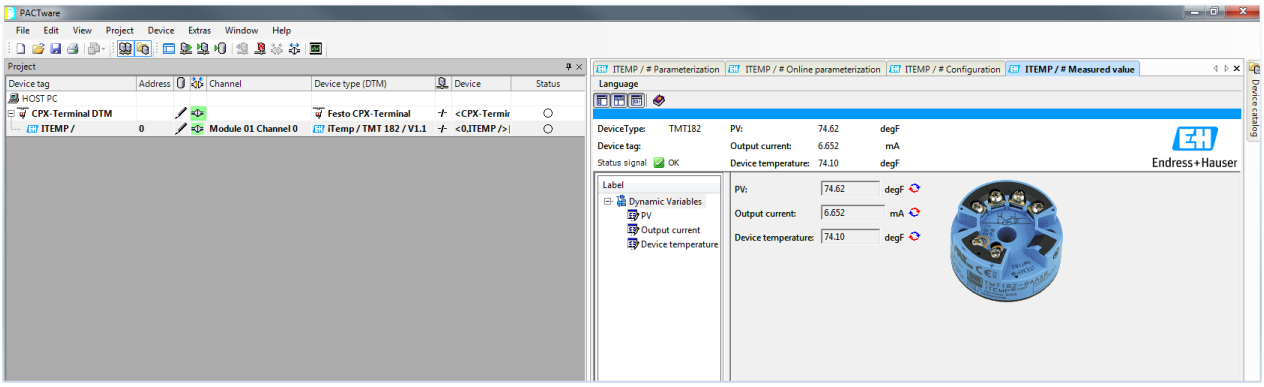
The PLC should be properly configured for the CPX terminal. The Forward Open message will configure the HART I/O on the CPX. When using the FDT/DTM, you should be able to find the IP address of the CPX terminal, and perform a Check. The configuration will be loaded from the terminal, and displayed in the DTM. In this case, channel 0 is configured as a HART channel.



The next step is to add the HART device. Based on the configuration of the CPX, there will be multiple HART channels available based on the CPX hardware installed. In this case, with 2 HART modules, there are 8 possible channels. We will select channel 1 for this example.



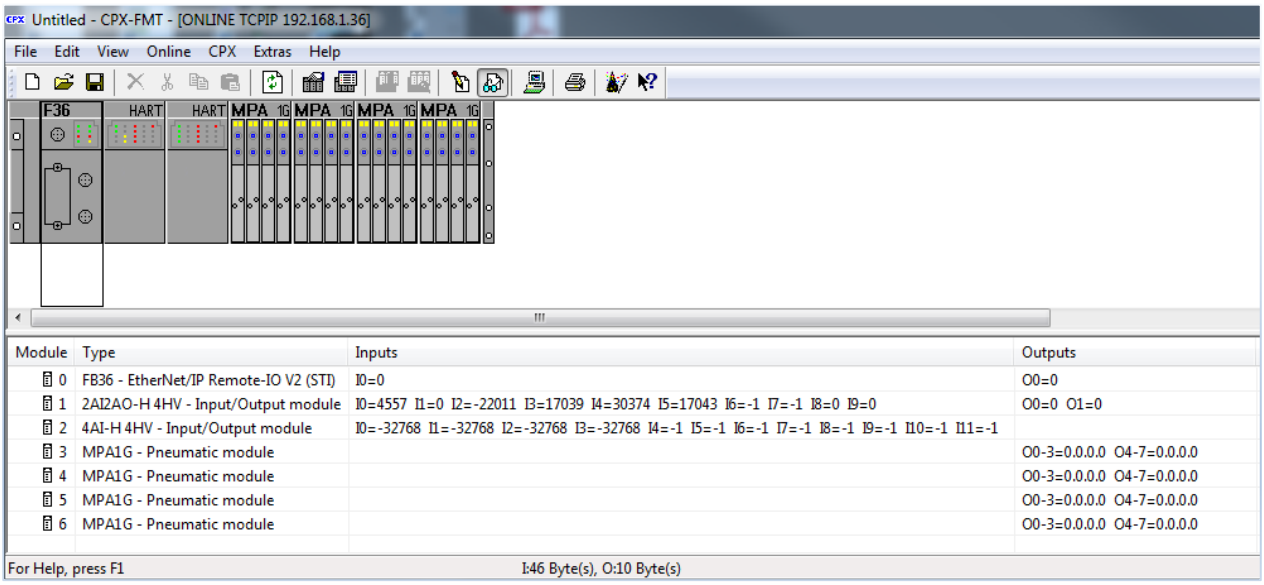
Select the E+H TMT182 device DTM from the catalog for this module. You can now go on-line by connecting each device. PACTware shows this as a “green” connection. While on-line, the user can examine the HART variables, make changes, download new settings, etc. In this case, the default temperature unit was changed to Fahrenheit, and stored in the device.



5 CPX_HART_AOI in Logix

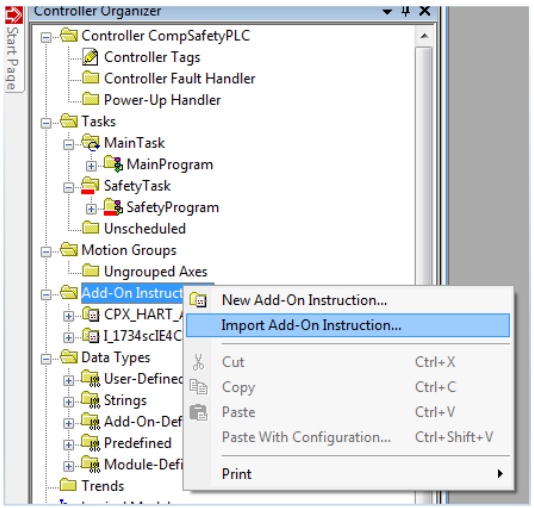
5.1.1 Introduction

Festo provides an AOI to allow the user to easily work with the HART data from each HART device. This AOI is to be used to read the HART data through the CPX HART module. The HART module has 4 channels, which can be configured multiple ways via the DIL switches. Only the DIL settings of 7, 9, 11, 13, 15 are relevant for HART. In each case, there are 16 bytes reserved for HART data (4 floating point variables). The user can select which channel and which variable type (PV, SV, TV, QV) is active by this AOI. This selection is done via explicit message using a MSG instruction. One AOI is needed per HART module. This example uses the following CPX configuration:

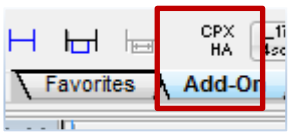


5.1.2 Import the AOI

Import the file CPX_HART_AOI.L5X into the user project by right-clicking on the Add-on Instruction folder in the organizer tree.

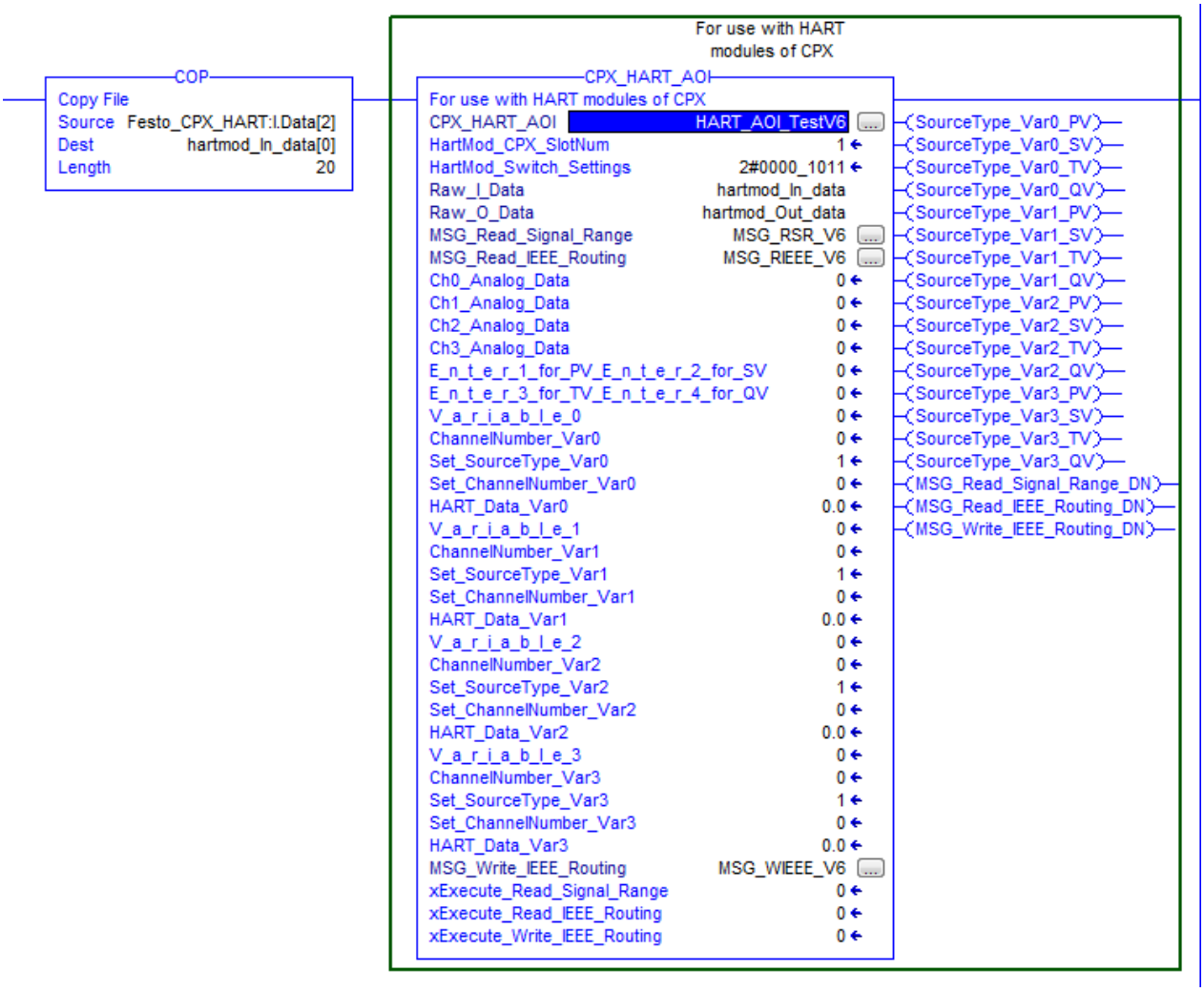


The instruction CPX HA appears in the Add-On tab of the Logix project.



5.1.3 Insert AOI into project

The AOI can be dragged into a new rung for programming. Use a COP instruction in same rung as AOI to load the Raw In data of the AOI. Use the starting SINT byte of the CPX array of the module. In this example, this is CPX_FB36:I.Data[2]. The destination array is defined by the AOI, so this needs to be set-up first. In this example, it is "hartmod_in_data[0]". Start at first byte of the array. Use a length equal to the amount of input data consumed by the DIL switch setting. Up to 24 bytes max for inputs. See example rung:



5.1.4 Complete the AOI instruction

Use the following steps to complete populating the AOI:

1. Create the CPX_HART_AOI tag name first. Other necessary variables are instances of this tag.
2. Enter CPX slot number of the module. The left most slot is 0.
3. Replicate the DIL switch settings of the HART module. The LSB is DIL 1.
4. Set-up MSG instructions.
    a. Use Get_Attr_Single for read messages.
    b. Use Set_Attr_Single for write.
    c. Enter 0 for Class, Instance, Attribute (the program selects these automatically).
    d. For Read commands, select the "DestinationElement" for the respective message (Signal range or IEEE routing). This must be an instance of the AOI.
    e. Select the "SourceElement" instance for the write command

If this rung is completed properly, the rung should show as a valid rung in Logix.

5.1.5 To use the AOI instruction

Reference the image below in this section 5.1.5 for steps:

The default value of the AOI is PV (PV=1) and Ch0 for each of the 4 HART variables. The IEEE routing of the CPX will always initialize to the CPX parameter configuration set by the FMT or saved parameters upon start-up.

1. The analog values of the HART sensors should immediately be available via the tag names:

   Ch0_Analog_Data
   Ch1_Analog_Data
   Ch2_Analog_Data
   Ch3_Analog_Data

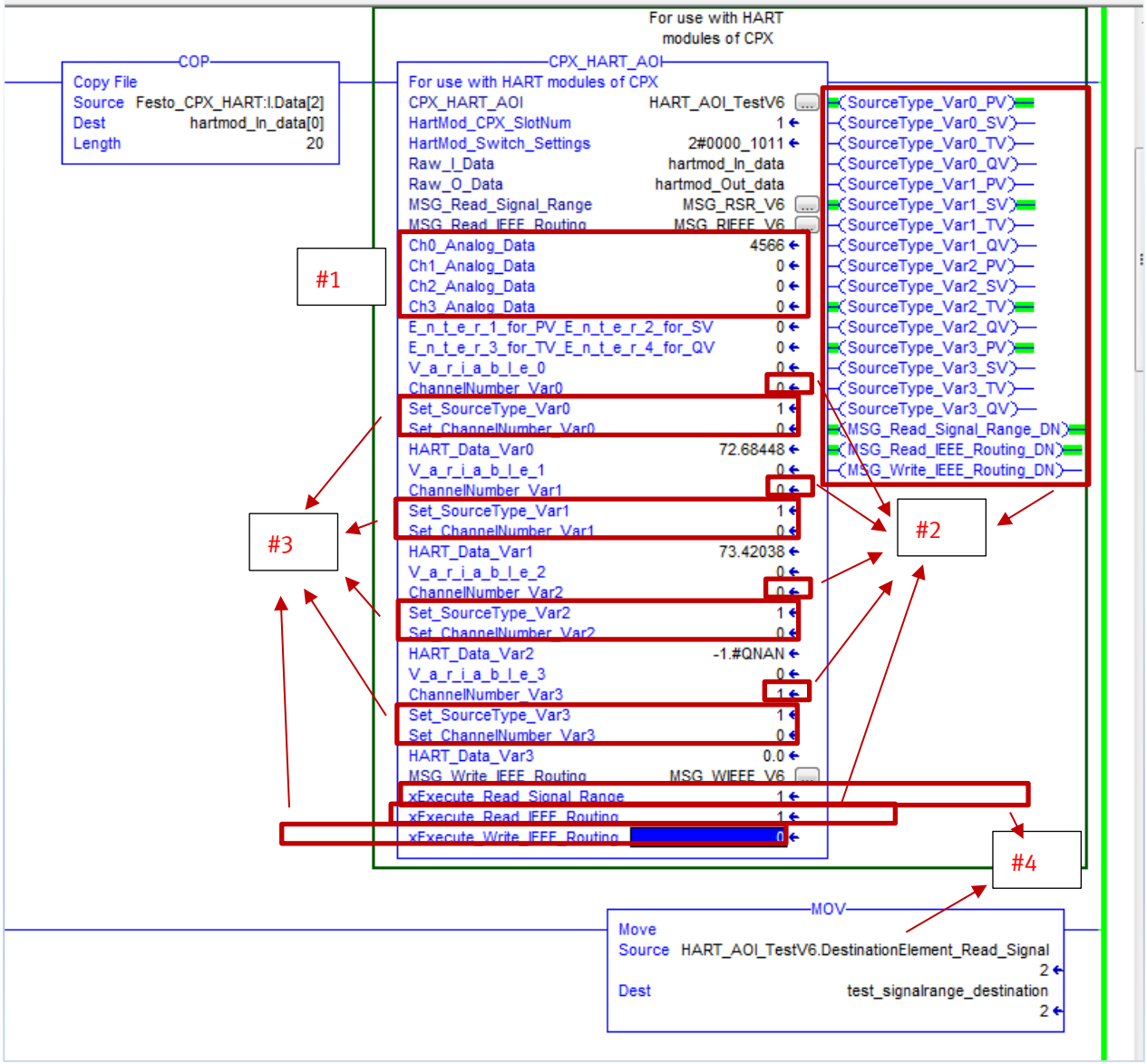
2. To update the AOI, execute the read IEEE routing. This will pull the CPX values via an explicit message. This can be done in an initialization routine using the first pass bit. In this example, after the read is executed, the following values are loaded:

Variable	Source Type	Channel Number
0	PV	0
1	SV	0
2	TV	0
3	PV	1

3. To change the variables of the IEEE Routing, load the Set_Source_Type and Set_ChannelNumber for all 4 variables.
   a. Source_Type: 1=PV, 2=SV, 3=TV, 4=QV. The AOI default is 1.
   b. ChannelNumber: 0, 1, 2, 3 respectively.

   Execute the write IEEE routing to load the configuration to the CPX. The new changes take effect immediately. Execute a read again to load the new configuration back to the AOI

4. Execute Read_Signal_Range if interested to read signal range settings. This variable is accessed from an AOI instance of the destination element.


For use with HART
modules of CPX
COP
Copy File
Source Festo_CPX_HART:I.Data[2]
Dest hartmod_In_data[0]
Length 20
CPX_HART_AOI
For use with HART modules of CPX
CPX_HART_AOI HART_AOI_TestV6
HartMod_CPX_SlotNum 1
HartMod_Switch_Settings 2#0000_1011
Raw_I_Data hartmod_In_data
Raw_O_Data hartmod_Out_data
MSG_Read_Signal_Range MSG_RSR_V6
MSG_Read_IEEE_Routing MSG_RIEEE_V6
Ch0_Analog_Data 4566
Ch1_Analog_Data 0
Ch2_Analog_Data 0
Ch3_Analog_Data 0
Enter_1_for_PV_Enter_2_for_SV 0
Enter_3_for_TV_Enter_4_for_QV 0
Variable_0 0
ChannelNumber_Var0 0
Set_SourceType_Var0 1
Set_ChannelNumber_Var0 0
HART_Data_Var0 72.68448
Variable_1 0
ChannelNumber_Var1 0
Set_SourceType_Var1 1
Set_ChannelNumber_Var1 0
HART_Data_Var1 73.42038
Variable_2 0
ChannelNumber_Var2 0
Set_SourceType_Var2 1
Set_ChannelNumber_Var2 0
HART_Data_Var2 -1.#QNAN
Variable_3 0
ChannelNumber_Var3 1
Set_SourceType_Var3 1
Set_ChannelNumber_Var3 0
HART_Data_Var3 0.0
MSG_Write_IEEE_Routing MSG_WIEEE_V6
xExecute_Read_Signal_Range 1
xExecute_Read_IEEE_Routing 1
xExecute_Write_IEEE_Routing 0
SourceType_Var0_PV
SourceType_Var0_SV
SourceType_Var0_TV
SourceType_Var0_QV
SourceType_Var1_PV
SourceType_Var1_SV
SourceType_Var1_TV
SourceType_Var1_QV
SourceType_Var2_PV
SourceType_Var2_SV
SourceType_Var2_TV
SourceType_Var2_QV
SourceType_Var3_PV
SourceType_Var3_SV
SourceType_Var3_TV
SourceType_Var3_QV
MSG_Read_Signal_Range_DN
MSG_Read_IEEE_Routing_DN
MSG_Write_IEEE_Routing_DN
#1
#2
#3
#4
MOV
Move
Source HART_AOI_TestV6.DestinationElement_Read_Signal
2
Dest test_signalrange_destination
2

6 Visualization with Rockwell FT View Studio and Process Libraries

6.1.1 Process Libraries Introduction

Rockwell includes libraries for visualizing process applications. These libraries include Add-On instructions for Logix controllers and graphics file for FT View Studio for panels or IPCs. These libraries are part of the PlantPAx® system. It is possible to use these libraries in part to visualize the HART data from the Festo CPX module. The process libraries can be downloaded from the Rockwell website free of charge for registered users. This example used version 3.5-09.

6.1.2 FactoryTalk View Studio

FactoryTalk View Supervisory Edition (SE)

FactoryTalk View Supervisory Edition (SE) is an HMI for supervisory-level monitoring and control applications. It has a distributed and scalable architecture that supports distributed-server/multi-user applications. This highly-scalable architecture can be applied to a stand-alone one-server/one-user application or to multiple users interfacing with multiple servers. FactoryTalk View Supervisory Edition is targeted at supervisory-level monitoring and control applications that need a distributed and scalable architecture. All of the process library features from Rockwell are designed to work with the (SE) edition.

FactoryTalk View Machine Edition (ME)

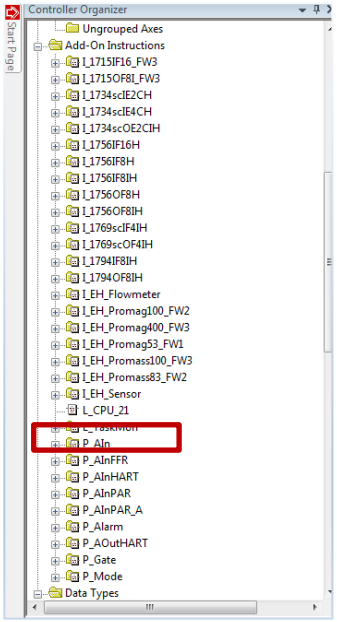
FactoryTalk View Machine Edition (ME) is a machine-level HMI that supports both open and embedded operator interface solutions for monitoring and controlling individual machines or small processes. FactoryTalk View ME allows for a consistent operator interface across multiple platforms. Components of this include a PC-based development tool called FactoryTalk® View Studio and a separate runtime system called FactoryTalk® View ME Station. FactoryTalk View ME Station runs projects developed with FactoryTalk View Studio for ME. Rockwell has a smaller suite of process libraries that are compatible with (ME) edition.

This example was done with the (ME) edition. It uses some generic analog input objects from the P_Ain Graphics Library made for (ME). Users can follow this example to other objects designed for (SE), including HART faceplates.

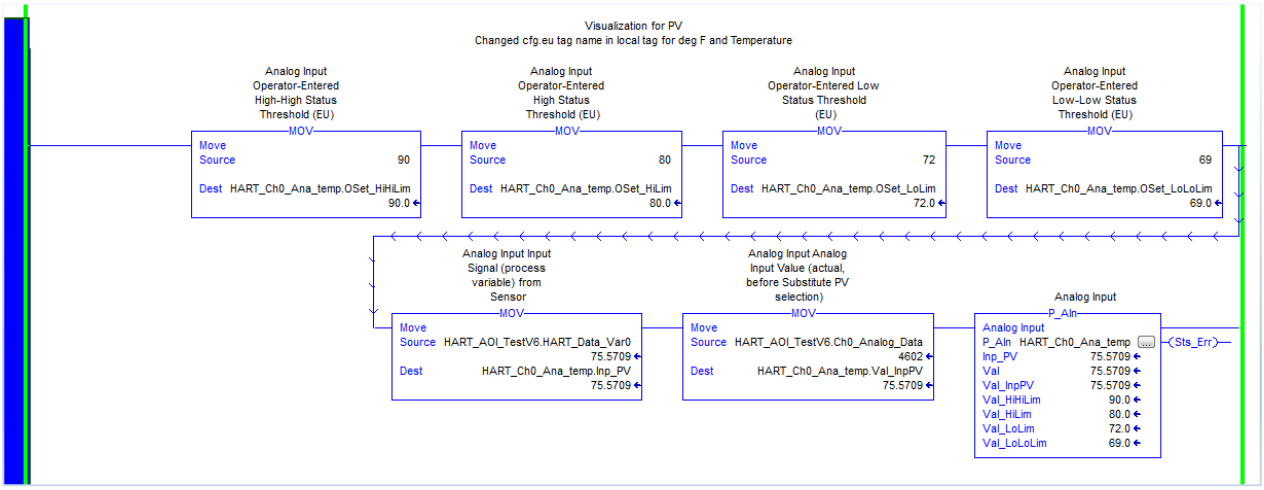
6.1.3 Install AOI for Process Library

In this example we use the P_Ain AOI. The steps are the same for installing any other AOI.

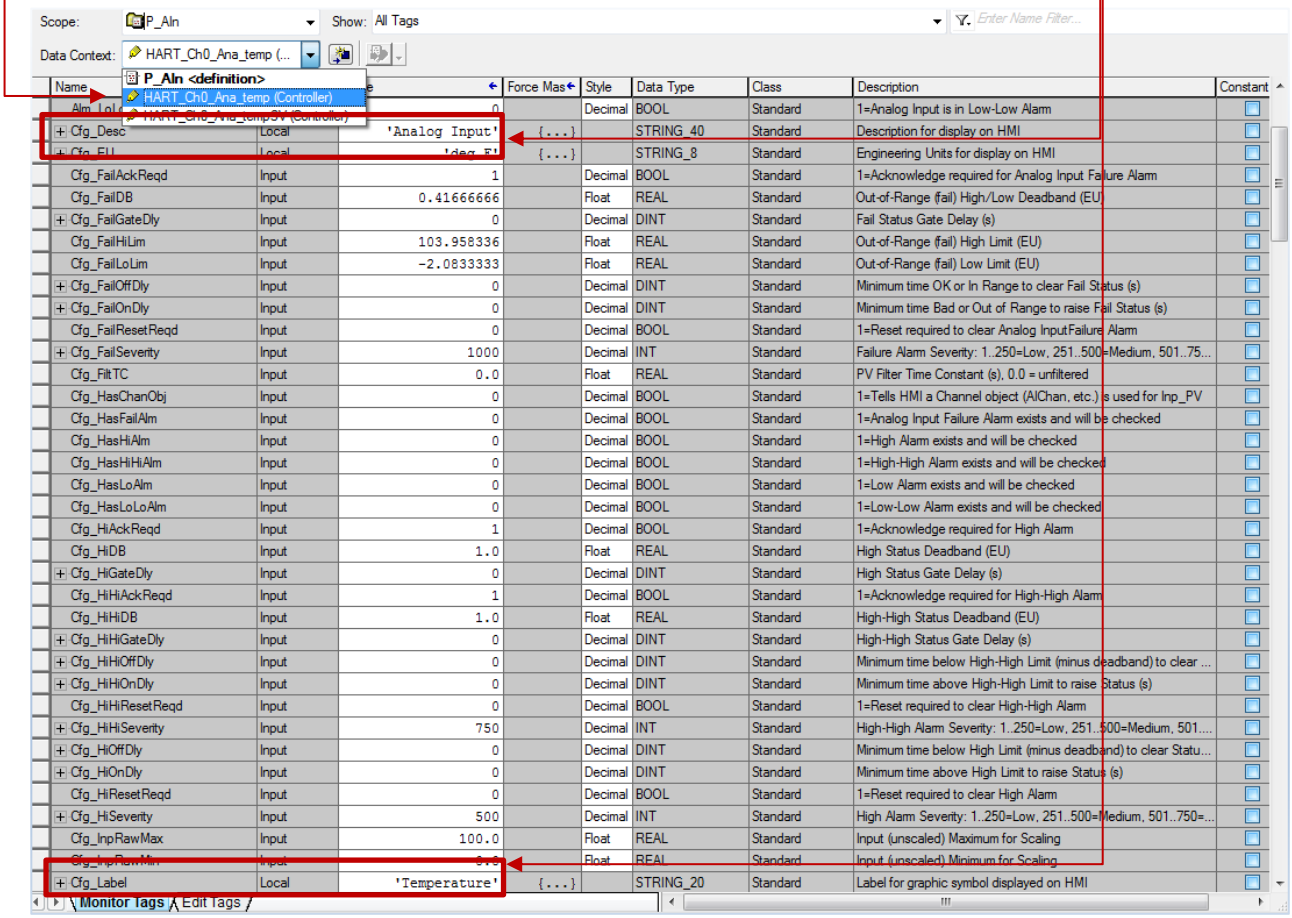
1. Download the sample code from Rockwell's website. You will find "Process_Library_v3.5-09.zip"
2. In the following folder you can launch the sample project:
   ....\Process Library v3.5-09\Files\Sample Projects\2_SamplesApp
3. Pick the project for your respective SW revision of Rockwell. There will be a full list of AOI's to export. Select P_Ain to export by right-click on this folder.



4. Import this AOI into your project. You may now install this into a routine as the following rung:



5. Insert the MOV instructions to load the 4 limit values desired; High High, High, Low, Low Low.
6. Insert a MOV instruction to load the analog data into the Val_InPV tag instance of the AOI
7. Insert a MOV instruction to load the REAL variable data into the Inp_PV tag instance.
8. Set-up the proper units for your application. In this case, it is “deg F” for “Temperature”.
   a. Do this by opening the AOI logic. (Double click on AOI, select logic)
   b. Open Parameters and Local Tags of the AOI
   c. Select the Instance to be used
   d. Edit Cfg_EU, Cfg_Desc, Cfg_Label if desired

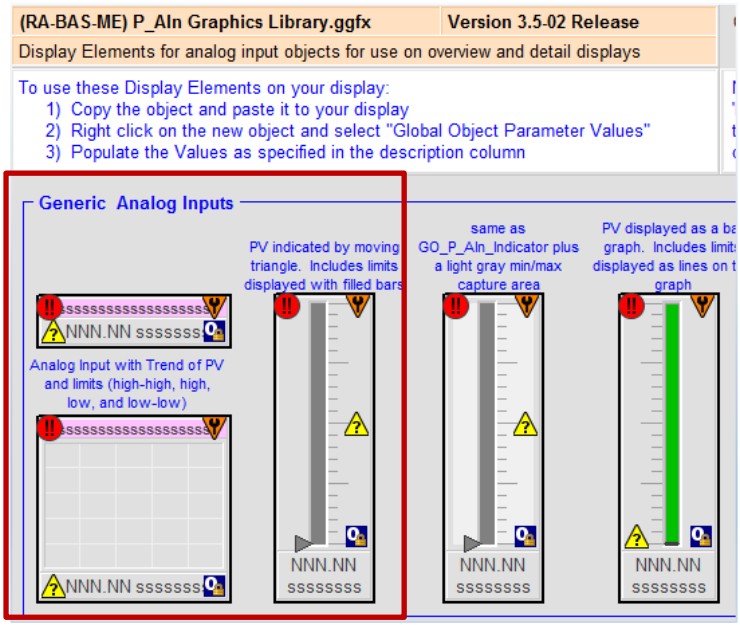


Refer to Rockwell “syslib-m001_-en-e.pdf” manual included in the Process Library download for more information.

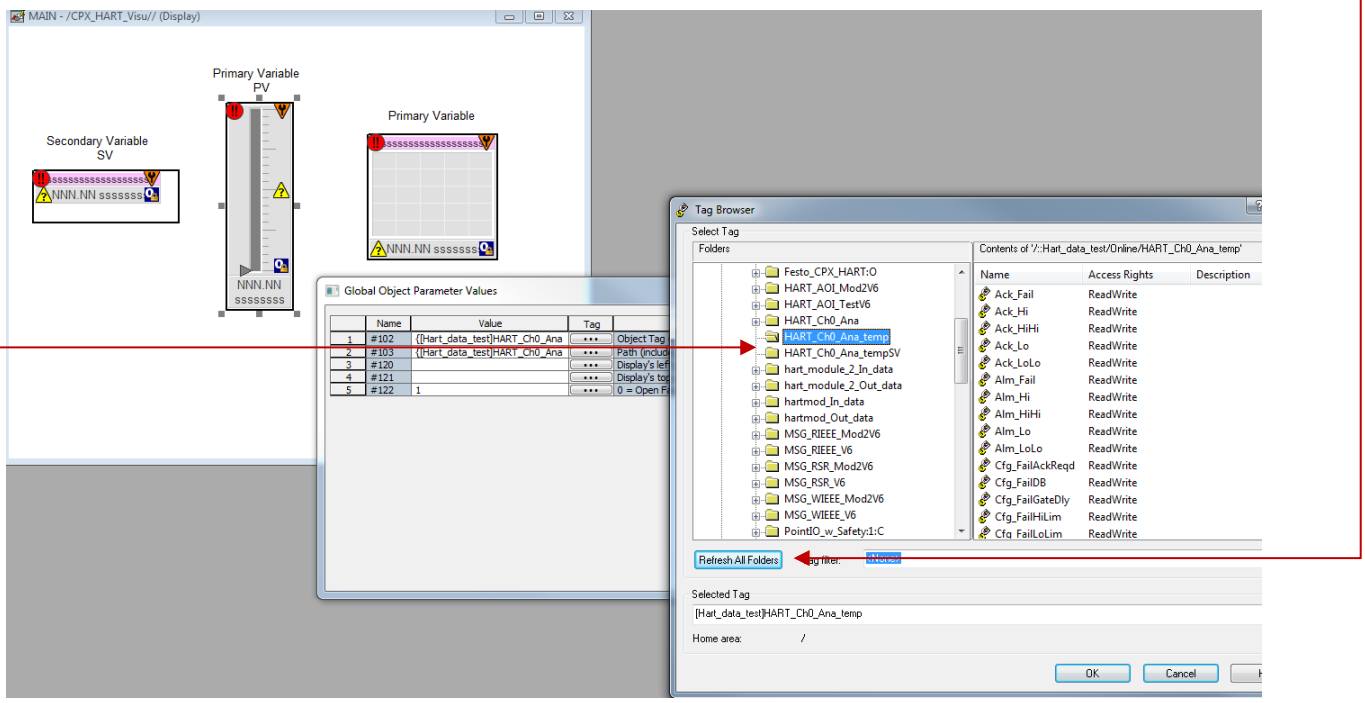
6.1.4 Install Objects from Process Library to Create a FT View Visualization

In this example we perform the following steps.

1. Open the file “ME_Samples_ProcessLib” found in the Process Library sample code.
2. Open the Global Object (RA-BAS-ME) P_Ain GraphicsLibrary.ggfx



3. For an example, copy the 3 objects in the red box to the “Main” page of a new FT View project.
4. In the new project, right-click on an object, and then select “Global Object Parameter Values”
5. Follow the description instructions of each item in the object. For Tag values, click on the ellipse, and the tag browser pops-up. Be sure to select “Refresh All Folders” while on-line to the PLC, to get the latest tag database.
6. Select the tag for this object. It is the tag name of the AOI in the Logix rung



Refer to Rockwell “syslib-m001_-en-e.pdf” manual included in the Process Library download for more information.

6.1.5 Run the FT View Visualization

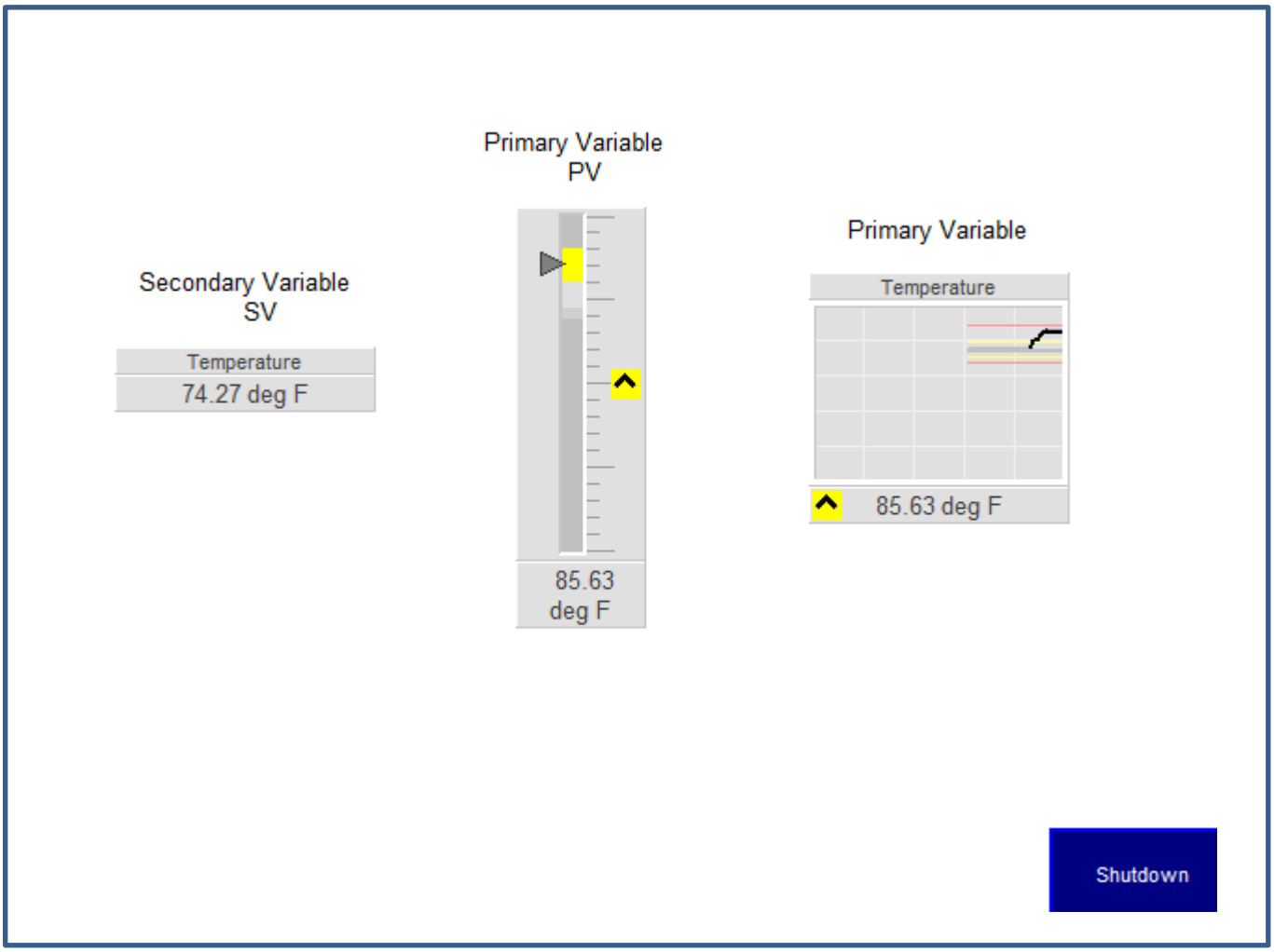
Run the visualization as any other FT View project.

1. In this example, labels were added for differentiating between the:
   - Primary Variable (PV) of the HART device. This is the temperature of the thermocouple probe from Omega
   - Secondary Variable (SV) of the HART device. This is the ambient temperature of the device

2. The PV graph shows a yellow indicator because the High limit was exceeded (› 80 deg F). See rung example from 6.1.3.

3. The function of the chart recorder shows the same since this is also the primary variable

4. The SV is the ambient of the device. This comes from a second rung with a different instance of the AOI (not shown in this app note).



5. The PV graph shows yellow/ red indicator because the High High limit was exceeded (› 90 deg F). See rung example from 6.1.3.