IEC60870-5 INTEGRATION KIT FOR PAC PROJECT GUIDE

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OPTO 22

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1: Introduction

The IEC60870-5 Integration Kit for PAC Project (Part #PAC-INT-IEC60870-5) allows Opto 22 SNAP PAC controllers using PAC Control to connect via an Ethernet network and serial port or serial module and communicate using the 60870-5-101 and 60870-5-104 protocol.

It supports 60870-5-101 outstation over serial and Ethernet and 60870-5-104 outstation over Ethernet.

The 60870-5 Outstation can connect to 1 – 4 masters using Ethernet and Serial ports.

The Integration Kit contains:

- An example 60870-5 strategy containing the 60870-5 charts that are imported into a strategy to enable an Opto 22 controller to communicate as a 60870-5 outstation.
- A set of PAC Control subroutines that are added to a strategy.

The 60870-5 strategy transmits message strings as specified in the 60870-5-101 Specification Version 2003 and 60870-5-104 Specification Version 2006.

This manual assumes that you understand fully how to use PAC Control, 60870-5, and the 60870-5 master.

What is Required

You will need:

- An Opto 22 SNAP PAC controller with firmware R9.3a or later
- A PC running PAC Control Professional 9.3a or later software and the 60870-5 Integration Kit for PAC Control
- (Optional) A SNAP PAC Learning Center (to run the example strategy)

Installing the Integration Kit

To install the integration kit on your computer, extract the zip file to your drive, usually C:\PAC870-5-Outstation.

IEC60870-5-101 & 104 Interoperability

Function or ASDU is used as standardized.

Network Configuration -101

Point to point

Multiple point to point

Multipoint partyline

Multipoint star

Transmission Speed -101

2400 bit/s

4800 bit/s

9600 bit/s

Controlled Station Definition

(slave)

Link Transmission Procedure -101

Unbalanced transmission

Address Field of the Link

Two octets

Frame Length -101

255, 255

Common Address of ASDU

Two octets

Information Object Address

Three octets

Cause of Transmission (COT)

One octets

Standard ASDUs Supported in Monitor Direction

ID	Description
1	Single-point information
3	Double-point information
5	Step position information
7	Bitstring of 32 bits
9	Measured value, normalized value
11	Measured value, scaled value
13	Measured value, short float value
15	Integrated totals
30	Single-point information with time tag CP56Time2a
31	Double-point information with time tag CP56Time2a
32	Step position information with time tag CP56Time2a
33	Bitstring of 32 bits with time tag CP56Time2a
34	Measured value, normalized value with time tag CP56Time2a
35	Measured value, scaled value with time tag CP56Time2a
36	Measured value, short float value with time tag CP56Time2a
37	Integrated totals with time tag CP56Time2a
38	Event of protected equipment with time tag CP56Time2a
39	Packed start events of protected equipment with time tag CP56Time2a
40	Packed outputs circuit information with time tag CP56Time2a

Process Information in Control Direction

ID	Description
45	Single command
46	Double command
47	Regulating step command
48	Set point command, normalized value
49	Set point command, scaled value

ID	Description
50	Set point command, short float value
51	Bitstring of 32 bits command

System information in Control Direction

ID	Description
100	Interrogation command
101	Counter Interrogation command
103	Clock Sync command

Parameter in Control Direction

ID	Description
110	Parameter of Measured value, normalized value
111	Parameter of Measured value, scaled value
112	Parameter of Measured value, short float value

Process Function in Control Direction

Function	Description
Function 0	Reset of remote link
Function 3	User Data
Function 4	User Data
Function 9	Request status of link
Function 10	Request user data class 1
Function 11	Request user data class 2

Function in Monitor Direction

Function	Description
Function 0	ACK
Function 1	NACK message not accepted

Function	Description
Function 8	User Data
Function 9	NACK request data not available
Function 11	Status of link

Type Identification and COT Assignments

Type ID	COT
1	20 – 36
3	20 – 36
5	20 – 36
7	20 – 36
9	20 – 36
11	20 – 36
13	20 – 36
15	37 – 41
20	20 – 36
21	20 – 36
30	3
31	3
32	3
33	3
34	3
35	3
36	3
37	3
45	6, 8, 9, 10, 45, 111
46	6, 8, 9, 10, 45, 111
47	6, 8, 9, 10, 45, 111
48	6, 8, 9, 10, 45, 111
49	6, 8, 9, 10, 45, 111
50	6, 8, 9, 10, 45, 111
51	6, 8, 9, 10, 45, 111
70	6, 8, 9, 10, 45, 111
101	6, 8, 9, 10, 45, 111
103	6, 8, 9, 10, 45, 111

Basic Application Function

Cyclic data transmission

Spontaneous transmission

Station Interrogation

global

Group 1 – Group 16

Clock Sync

Clock Sync

Command Transmission

Select and execute command

Select and execute set point command

Transmission of Integrated Totals

Counter Read

Counter reset

General request counter

Request counter group 1 – 4

2: Using the Example Strategy

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Running the Example Strategy

The example strategy uses the SNAP PAC Learning Center to demonstrate how to use the 60870-5 Outstation protocol.

To run the example strategy:

1. Set up the Learning Center so that you can access it from your PC. For more information, see form 1638, *SNAP PAC Learning Center User's Guide*.
2. Start PAC Control Pro.
3. Navigate to the integration kit's folder.
4. Open the strategy file, PAC 60870-5.idb.
5. Add your control engine and set it as the Active Engine.
6. Download and start the example strategy.

User Setup

User data is entered in block 199 and 341 of the chart named IEC60870_Outstation

Importing the 60870-5 Charts

Before importing the charts, include the 60870-5 subroutines.

Import the IEC60870-5 charts, IEC60870_Outstation, IEC60870_Events and IEC60870 _Cyclic and Command charts into your strategy. First export each chart in the example strategy as a PAC Control chart export file (.cxf file), and then import it into your strategy. For more information, see Chapter 8 of form 1700, the *PAC Control User's Guide*.

The **IEC60870_Outstation** chart receives chart frames and builds and transmits frames to master.

The **IEC60870_Events** chart is a support chart for IEC60870_Outstation. It monitors points and variables and loads event buffers

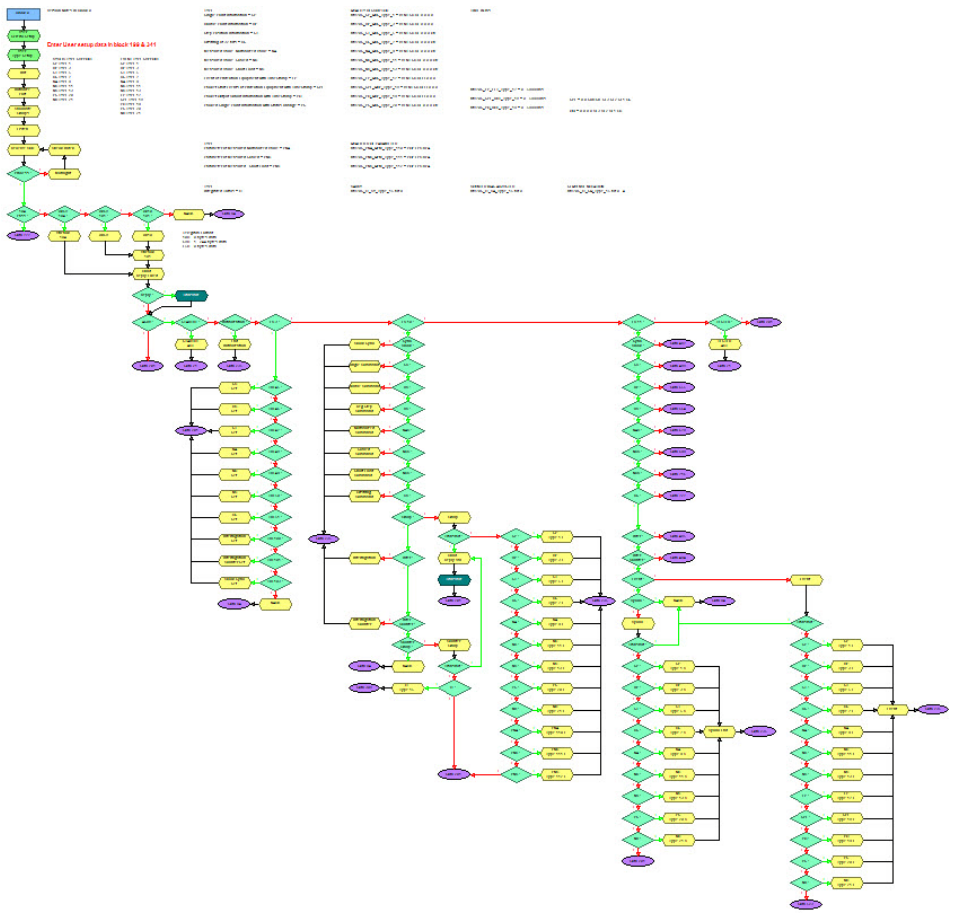
The **IEC60870 _Cyclic and Command** chart is a support chart for IEC60870_Outstation. It sets cyclic data transfer. It processes commands and sets points or variable.

Running the IEC60870-5 Charts

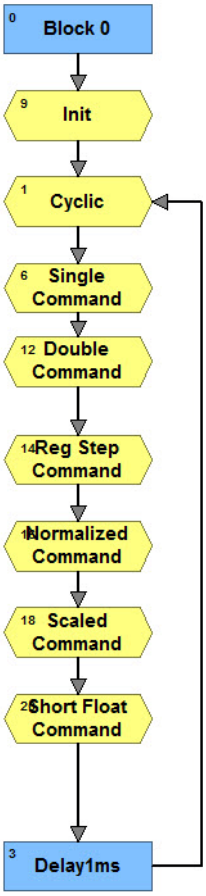
Start the IEC60870_Outstation chart in the Powerup chart of your strategy. The other charts are started by the IEC60870-5 charts as needed.

The Outstation Charts

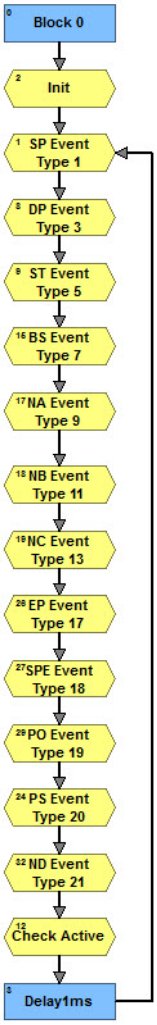
IEC60870_Outstation Chart



IEC60870_Cyclic and Command Chart

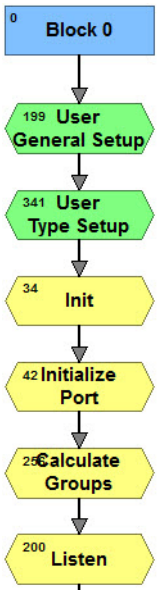


IEC60870_Events Chart



Configuring Outstation User Data

User data is entered in blocks 199 and 341.



Version Notes in Block 0

The configurable general user data is as follows:

- Number of supported masters (1– 4)
- Communication Mode
- Port setup
- Address of Outstation
- Receive buffer size
- Max number of I-Format before receiving confirmation
- Number of I-Format before sending S-Format
- Enable/Disable Unsolicited Response for each Master Station
- Confirm timeout for send in seconds
- Max time after receiving last I-Format before sending S-format confirm in seconds
- Timeout for sending test frames in seconds
- Set time in seconds for cyclic poll data
- Control point offset
- Single Command setpoints
- Double Command setpoints
- Regulating Step Command setpoints
- Set Point Command, Normalized Value setpoints
- Set Point Command, Scaled Value setpoints
- Set Point Command, Short Float setpoints

The configurable type user data is as follows:

- Single-Point Information = SP
- Double-Point Information = DP
- Step Position Information = ST
- Bitstring of 32 bits = BS
- Measured Value, Normalized value = NA
- Measured Value, Scaled = NB
- Measured Value, Short Float = NC
- Integrated Totals = IT
- Parameter of Measured Normalized value = PNA
- Parameter of Measured Scaled = PNB
- Parameter of Measured , Short Float = PNC
- Packed Single-Point Information with Status change = PS
- Measured Value, Normalized value without quality descriptor = ND
- Event of Protection Equipment with TimeStamp = EP
- Packet Start Events of Protection Equipment with TimeStamp = SPE
- Packet Output Circuit information with TimeStamp = PO

For each type used there are several tables that need to be setup.

These are the tables for Single-Point Type 1

pot870S_SP_Type_1 = load points and variable

nt870S_Variable_Type_SP_Flag = This table marks all the variable types for the strategy. (0 = digital Output 1 = integer 32 variable, 2 = integer 32 table 3 = digital input).

nt870S_Table_Index_SP_Flag = Index of virtual point in table (only used if 2 is set in (nt870S_Variable_Type_SP_Flag)

nt870S_SP_IOA = Single-Point Information Object Address

nt870S_SP_Interrogated_Group = Global and Group 1 – 16 or cyclic.

nt870S_Event_SP_Mode = SP Event Mode Setup. 0 = disabled, 1 = ON set class 2 data, 2 = OFF set class 2 data, 3 = STATE CHANGE set class 2 data

nt870S_Event_SP_Master_Buffer = Each supported master has an event buffer for each type. If there are multiple masters an event can be stored in one or all master buffers allowing the selected master to receive the events. 1 = enabled

Interrogated group assignment

The supported groups are:

Global = bit 0

Group 1 = bit 1 – Group 16 = bit 16

Example, to enable global, group 1 = 0x03 in type interrogated table for point

Counter Interrogated group assignment

The supported groups are:

Global = bit 0

Group 1 = bit 1 – Group 4 = bit 4

Example, to enable group 3 = 0x08 in type counter interrogated table for point

Cyclic group assignment

The supported groups are:

Cyclic = bit 28

Example, to enable cyclic = 0x10000000 in type interrogated table for point

Cyclic Support Types

SP TYPE 1

DP TYPE 3

ST TYPE 5

BS TYPE 7

NA TYPE 9

NB TYPE 11

NC TYPE 13

PS TYPE 20

ND TYPE 21

Event Support Types

SP TYPE 1

DP TYPE 3

ST TYPE 5

BS TYPE 7

NA TYPE 9

NB TYPE 11

NC TYPE 13

EP TYPE 17

SPE TYPE 18

PO TYPE 19

PS TYPE 20

ND TYPE 21

3: Troubleshooting

Use the following sections to discover troubleshooting information:

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Received Telegrams Using the 0x10 Start Character 16
Transmitted Telegrams 16
Master Events 17

Is the Controller Serial Port in Use?

When using the controller serial port, the controller serial port may be in use by the kernel for PPP or Nokia M2M (Machine to Machine wireless communications solution).

To check this in PAC Manager, do the following:

1. Open PAC Manager.
2. In the PAC Manager main window, click the Inspect button.
3. In the Device Name field, type the IP address for the SNAP PAC controller (or choose it from the drop-down list).
4. Click Communications and choose Communication Port Control.
5. Under Control Function for Communication Port, change the value to None, and then click Apply.
6. Click Status Write.
7. Under Operation, choose "Store configuration to flash." Click Send Command.
8. Under Operation again, choose "Restart Device from powerup." Click Send Command.

For more details on using PAC Manager, see the *PAC Manager User's Guide*, form 1704.

Master Communication Handles Status

The **ntNL_Comm_Handle_Accept_Status** table has the status for each master communication handle. For Ethernet ports the value will be negative until the master opens a session to the outstation. After the session is opened the index for the master should be 0. You will see this become a positive number as the telegrams are received. For a serial port the strategy will open the port when the strategy is started. The strategy removes these characters very quickly so you may not see a positive value because of the refresh rate in Debug mode.

You can also check the communication handle status to see if the handle is open.

Outstation Chart Activity

The **s870SStatus** string lists the activity of the outstation chart. It will indicate if the chart is waiting, or if there is a bad FCS, or it is processing a function. This is updated very quickly as the chart processes a telegram. Autostep can be used to troubleshoot a problem.

Here are some of the values listed:

- **Waiting** = waiting for telegram from master
- **0x68 Received101** = 60870-5-101 telegram received.
- **Bad FCS 0x68** = checksum failed.
- **0x10 Received101** = 60870-5-101 telegram received.
- **Bad FCS 0x10** = bad checksum.
- **0x68 Received104** = 60870-5-104 telegram received.
- **Timeout104** = timeout while waiting for confirmation.
- **Send TESTFR** = sending test telegram

Received Telegrams Using the 0x68 Start Character

The **nt870SRequest_68** table lists the received telegrams that use 0x68 start character. This should be viewed as hexadecimal.

Received Telegrams Using the 0x10 Start Character

The **nt870SRequest_10** table lists the received telegrams that use 0x10 start character. This should be viewed as hexadecimal.

Transmitted Telegrams

The **ntDLL_CHR_To_Send** table lists the transmitted telegrams. Index 0 is used to indicate the last index to transmit. This should be viewed as hexadecimal.

Master Events

The persistent string tables **pstEvent_Buffer_0 – 3** store the events for each master. The IEC60870_Events chart adds the events to the tables based on the user setup in the IEC60870_Outstation chart. The IEC_60870_Outstation chart transmits the events.