

PACSystems™ RX3i Sequence of Events

USER MANUAL

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Section 1 Introduction

Capturing a sequence of events is important in a variety of automation applications. The goal is to configure the target system to continuously capture any change in the state of selected I/O points throughout the application, store the resultant records into a managed depository, then be in a position to analyze the sequence of events that led up to a trigger situation, such as the inadvertent opening of a valve, or some other unintended operation of the overall system.

The key to capturing intelligible data is synchronizing all devices throughout the system to a common time-base and using a time-base with a degree of resolution that is meaningful for the application. The time-base is used to time-stamp each event recorded. By analyzing the captured sequence of events, the automation designer or system operator can reconstruct the activities that led up to the trigger event, and thereby correct or adjust the operation to achieve a more desirable outcome.

With the RX3i Sequence of Events (SoE) architecture shown in Figure 1 and , all the elements described above are made available.

Figure 1: High-Level SoE Architecture with PLC Racks

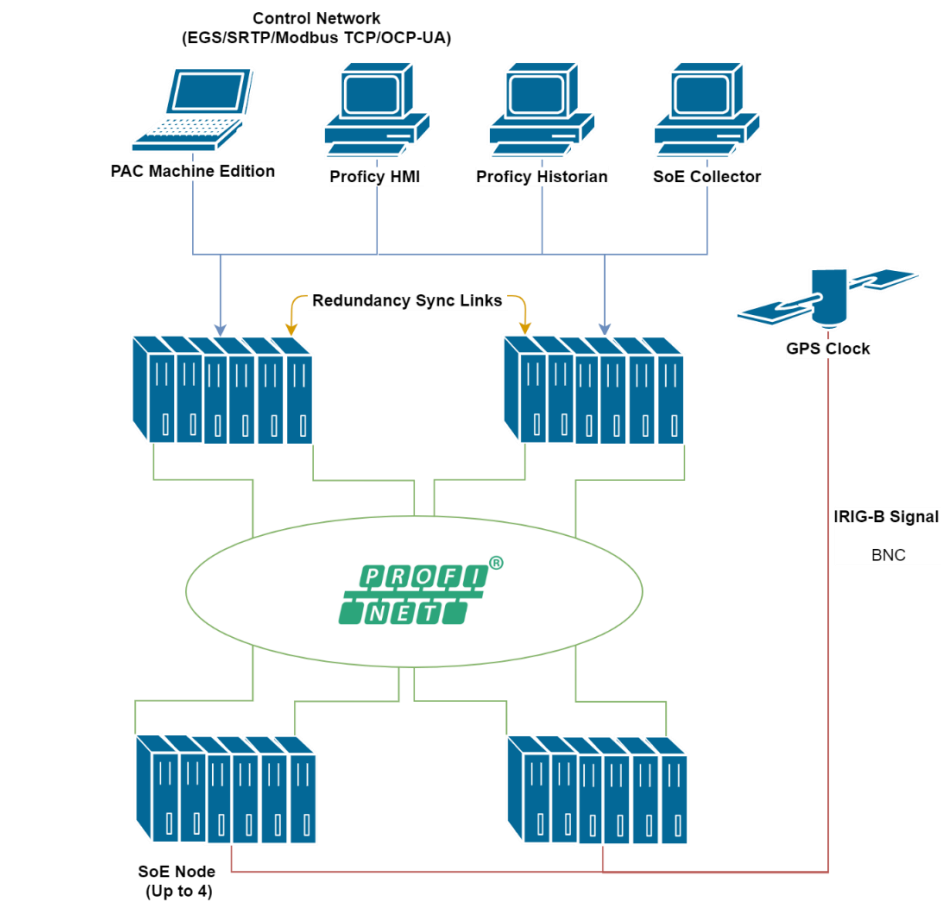
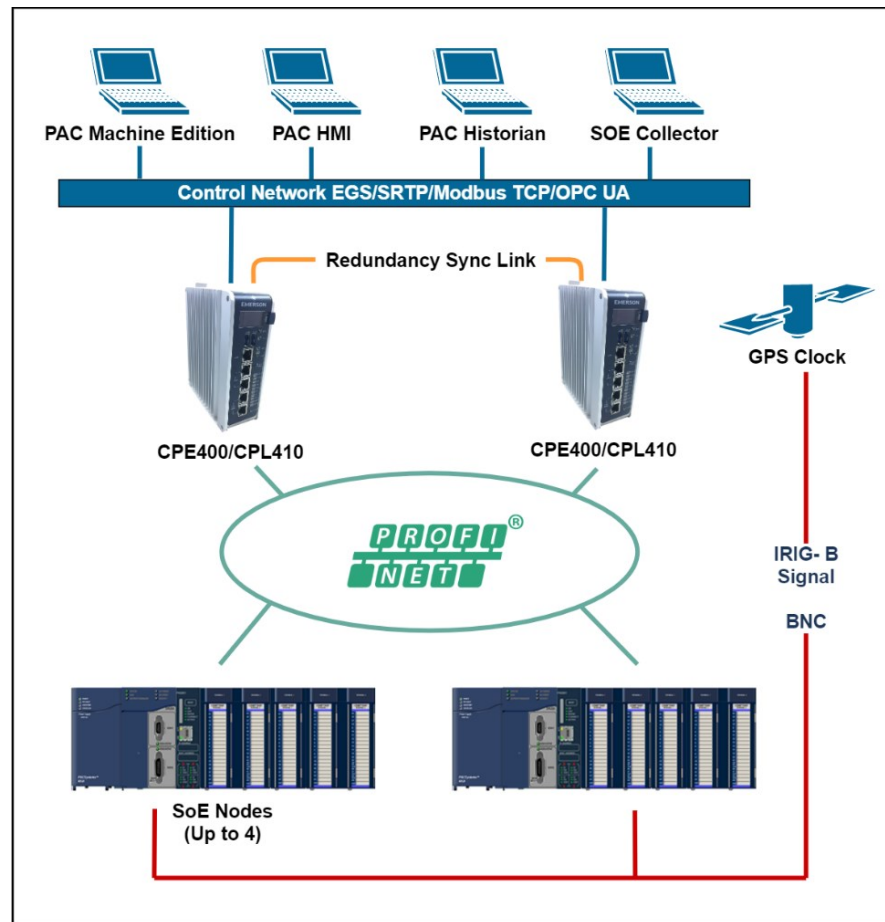


Figure 2: High-Level SoE Architecture with CPE400/CPL410s



1.1 Key Features

1.1.1 High System Availability

The RX3i solution relies on a system configuration that provides high reliability and is compatible with both redundant and simplex applications. The I/O is connected via the industry-standard PROFINET. The CPUs are interconnected via high-speed links that synchronize the redundant CPUs, if redundancy is used. The computer used to collect the sequence of events records is attached via a high-speed, high-availability Ethernet link.

1.1.2 Time-stamps to ± 1 ms Accuracy

The IRIG-B time reference signal, used to establish a system-wide time-base, is directly connected to High-Speed Counter modules distributed throughout the network via a dedicated signal network.

This solution provides time synchronization of I/O events accurate to $\pm 1 \text{ ms}^1$ using unmodulated IRIG-B formatted signals.

1.1.3 Components

The CPUs which support the SoE implementation are IC695CPE330, IC695CPE400, and IC695CPL410.

To implement SoE, the compatible controller project folder (in PAC Machine Edition) must contain a pair of dedicated C program blocks designed to configure and collect SoE records and provide diagnostic features.

The user defines which I/O points are to be monitored as part of the SoE data collection using the CPU registers used to interface with the C Block, and by configuring those points on the input module.

Each CPU is configured to use its embedded PROFINET Controller (PNC). Rack-mounted PROFINET Controllers may not be used to collect SoE records.

The CPE330 may be configured for simplex operation or PROFINET redundancy. If PROFINET redundancy is configured, the high-speed redundancy links are provided by a pair of RMX modules (IC695RMX128 or IC695RMX228), two installed in each CPU rack of the redundant pair. The CPE400/CPL410 may be configured for simplex or PROFINET redundancy without additional hardware: the two ports on the LAN3 provide high-speed data synchronization between the two CPUs.

Each PNC may control up to four PROFINET nodes collecting SoE data. These are designated SoE Nodes in this document. Each SoE node is equipped with an RX3i Advanced PROFINET Scanner Module (PNS101). The PNS101 contains features required in the SoE Application. The PNC is networked to its PNS modules over PROFINET, which may itself be configured for Media Redundancy (MRP mode). The PNC may control additional PROFINET IO Devices (not collecting SoE Data) based on its documented capabilities.

Up to four Discrete Input modules may be installed in any given PNS node. An SoE event is defined as a transition (low-to-high or high-to-low) on any of these inputs, provided they have been configured as an SoE channel to be monitored.

Each PNS can buffer up to 4,000 events in its event queue at a maximum rate of 400 events per second.

The I/O events are time-stamped by the PNS as they are scanned.

The PNS time-stamps are synchronized to the IRIG-B time-base via a High-Speed Counter (HSC) located within the same rack, thus all time-stamps are referenced to a common clock. The IRIG-B/HSC interface is described in Section 1

¹ Calculated with 90% confidence interval.

Each SoE event is compiled into an SoE Record by the supervising PNS module. The SoE Record pinpoints the location of the input channel, the nature of the transition, and a time-stamp.

The SoE records from each of the PNS modules are passed to its networked CPU Embedded PNC and are then consolidated by the host CPU. The consolidated recordset is placed in CPU reference memory as configured by the user (refer to Section 4).

The Historian/SoE Collector (Cimplicity Historian/SQL database) can read the CPU's SoE Records Buffer using a variety of techniques: SRTP, EGD, etc. The CPU indicates how many records are present in that buffer. The Historian/SoE Collector, after reading these records, indicates to the CPU that they have been read. For details, refer to Section 5.7.

Component Checklist

Item	Catalog #	Description	Qty	Remarks
CPU	IC695CPE330 or IC695CPE400 or IC695CPL410	RX3i CPU with embedded Ethernet	1 or 2	1 for Simplex 2 for Redundancy
RMX	IC695RMX128 or IC695RMX228	Reflexive Memory Module	2 per CPU	Redundancy only: Pair RMX128 with RMX128 or RMX228 with RMX228 Note: RMX modules are only required for CPE330 Redundancy
PNC	N/A	PROFINET Controller	1 per CPU	Embedded in CPE330, CPE400, and CPL410
PNS	IC695PNS101	Advanced PROFINET Scanner Module	Up to 4 per PNC	Each PNS controls a node of I/O Modules
HSC	IC695HSC304 or IC695HSC308	RX3i High-Speed Counter Module	1 per PNS	IRIG-B signal is connected to all HSC modules.
I/O Modules	IC694MDL660 or IC694MDL655	RX3i 32-Point 24Vdc Grouped Input Module	Up to 4 per PNS	Input-only module Only the IC694MDL660 and IC694MDL655 support the capture of SoE Events.
I/O Rack	IC695CHSxxx	7-, 12-, 16-Slot RX3i Universal Backplane	1 per SoE Node	

Item	Catalog #	Description	Qty	Remarks
Power Supply	IC695PWRxxx or IC695PSAxxx or IC695PSDxxx	RX3i Power Supply Modules	1 or 2 per rack	Size PS to meet rack current draw requirements
PAC Machine Edition	ME95MBP001	PACSystems Programming & Configuration Tool	1	PAC Machine Edition v9.50 SIM 7 or later ² . Download from website.
HMI /Historian	Customer's choice		1	Historian/SoE Collector
IRIG-B Clock	Arbiter 1084	GPS Satellite Controlled Clock	1	Third-party item.

For PACSystems CPU information, refer to the PACSystems RX3i and RSTi-EP CPU Reference Manual, GFK-2222.

To program a PACSystems CPU, refer to the PACSystems RX3i and RSTi-EP CPU Programmer's Reference Manual, GFK-2950.

For Ethernet information, refer to the PACSystems RX3i and RSTi-EP TCP/IP Ethernet Communications User Manual, GFK-2224.

For PROFINET information, refer to the PACSystems RX3i & RSTi-EP PROFINET I/O Controller Manual, GFK-2571, and to the PACSystems RX3i PROFINET Scanner Manual, GFK-2737.

For I/O Modules, High-Speed Counters, Power Supplies, I/O Racks, and installation details, refer to the PACSystems RX3i System Manual, GFK-2314.

All manuals and software may be downloaded from the suppose link provided at the end of the document.

² Download & install the GSDML from the firmware update kit for the Advanced PROFINET Scanner (IC695PNS101) (GSDML-V2.3-GEIP-RX3iPNS-20180724.xml or later for MDL660 support, GSDML-V2.3-IntelligentPlatformsLLC-RX3iPNS-20191010.xml or later is required for MDL655 support). The GSDML file impacts the configuration of the PNS101 and of the MDL660/MDL655 and HSC modules associated with the PNS101.

1.2 Glossary of Terms

Term	Explanation
CPU	In the context of this manual, a PACSystems RX3i CPU (specifically model IC695CPE330, IC695CPE400, IC695CPL410).
HMI	Human Machine Interface
HSC	High-Speed Counter
IRIG-B	Inter-range instrumentation group time codes, commonly known as IRIG time codes, are standard formats for transferring timing information. Atomic frequency standards and GPS receivers designed for precision timing are often equipped with an IRIG output.
MRP	Media Redundancy Protocol (used in PROFINET communications).
PLC	Programmable Logic Controller (CPE330/CPE400/CPL410 provides PLC functionality).
PAC Machine Edition	PAC Machine Edition: A configuration tool used to configure and program PACSystems CPUs.
PNC	PROFINET IO Controller (in the SoE Application, the CPE330/CPE400/CPL410 Embedded PROFINET Controller is used).
PNS	PROFINET IO Scanner: a module that scans I/O modules in an I/O Rack and exchanges I/O data over PROFINET with a PROFINET IO Controller.
PROFINET	Acronym for Process Field Net: an industry technical standard for data communication over Industrial Ethernet.
RMX	Redundancy Memory Xchange module
SoE	Sequence of Events
SoE Node	A remote rack controlled by an IC695PNS101 Advanced PROFINET Scanner and containing the RX3i modules required to support SoE, as defined in Section 2.2.

1.3 Revisions in this Manual

Rev	Date	Description
D	Jan-2021	Extends support for Sequence of Events capture from IC694MDL660 or IC694MDL655 modules in the PNS101 rack for CPE400/CPL410
C	Mar-2020	Adds support for Sequence of Events capture from IC694MDL655 modules in the PNS101 rack.
B	Sep-2018	Following Emerson's acquisition of this product, changes have been made to apply appropriate branding and registration of the product with required certification agencies. No changes to the material, process, form, fit, or functionality.
A	Aug - 2018	Release update. Advanced PROFINET Scanner with SoE was released as IC695PNS101.
-	Apr-2018	Initial publication (for Beta).

1.4 PACSystems Documentation

A complete Sequence of Events application system incorporates a variety of hardware and software components.

A simple SoE ladder application template, along with C Blocks, and the Diagnostic UDTs referenced later in this document are available for download at the Emerson support website. The latest information can be obtained by searching for the PNS101 Landing Page and following SoE references there.

PACSystems Manuals

PACSystems RX3i and RSTi-EP CPU Reference Manual	GFK-2222
PACSystems RX3i and RSTi-EP CPU Programmer's Reference Manual	GFK-2950
PACSystems RX3i and RSTi-EP TCP/IP Ethernet Communications User Manual	GFK-2224
PACSystems TCP/IP Ethernet Communications Station Manager User Manual	GFK-2225
C Programmer's Toolkit for PACSystems	GFK-2259
PACSystems Memory Xchange Modules User's Manual	GFK-2300
PACSystems Hot Standby CPU Redundancy User Manual	GFK-2308
PACSystems Battery and Energy Pack Manual	GFK-2741
PAC Machine Edition Logic Developer Getting Started	GFK-1918
PACSystems RXi, RX3i and RSTi-EP Controller Secure Deployment Guide	GFK-2830
PACSystems RX3i & RSTi-EP PROFINET I/O Controller Manual	GFK-2571

RX3i Manuals

PACSystems RX3i System Manual	GFK-2314
PACSystems RX3i Ethernet Network Interface Unit User's Manual	GFK-2439
PACSystems RX3i PROFINET Scanner Manual	GFK-2737
PACSystems RX3i Serial Communications Modules User's Manual	GFK-2460
PACSystems RX3i High-Speed Counter Modules User's Manual	GFK-2441

In addition to these manuals, datasheets and product update documents describe individual modules and product revisions. The most recent PACSystems documentation is available on the Emerson support website <https://www.emerson.com/Industrial-Automation-Controls/support>

Section 2 RX3i Hardware Configuration

A Sequence of Events configuration is comprised of two parts: the setup of a Hardware Configuration profile in PAC Machine Edition and SoE/IRIG-B User Memory Map data read by the SoE Application C Block. This section describes the Hardware Configuration profile in PAC Machine Edition. For information on the SoE/IRIG-B User Memory Map, see Section 4.

2.1 CPU Configuration

The SoE functionality is supported by the CPE330, CPE400, and CPL410. The following firmware versions are required to support the SoE C Block.

Controller	Firmware Versions Supporting SoE C Block
CPE330	9.60 or later
CPE400/CPL410	10.10

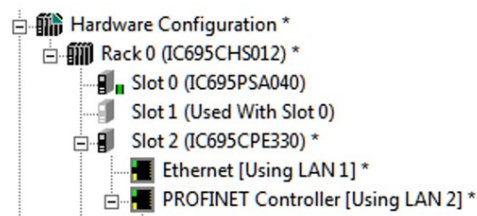
To ensure the CPU firmware version supports the SoE C Block, the CPE330 requires firmware version 9.60 or later. The CPE400 and CPL410 require firmware versions 10.10 or later.

The following instructions will illustrate the configuration of an SoE configuration on a CPE330, but the instructions are identical for the CPE400 or CPL410.

Note: These instructions are specific to simplex configuration. Section 2.1.1 *Redundant Systems*, provides instruction on specific hardware configuration changes and considerations for the setup of a redundant system.

In PAC Machine Edition's Navigator pane, configure LAN2 of the CPE330 as a PROFINET Controller (Figure 3).

Figure 3: CPE330 with Embedded PROFINET Controller



The Settings tab shows **LAN 2 Mode** is configured for PROFINET, which is required for this application (Figure 4).

Figure 4: CPE330 Settings Showing LAN2 Mode = PROFINET

InfoViewer (P.O.2) IC695CPE330	
Settings Scan Memory Redundancy Transfer List Faults Scan Sets Power Consumption Access Control Time OPCUA	
Parameters	Values
Passwords	Enabled
Stop-Mode I/O Scanning	Disabled
Watchdog Timer (ms)	220
Logic/Configuration Power-up Source	Always RAM
Data Power-up Source	Always RAM
Run/Stop Switch	Enabled
Memory Protection Switch	Disabled
Power-up Mode	Last
Modbus Address Space Mapping Type	Disabled
Universal Serial Bus	Enabled
LAN 1 Mode	Ethernet
LAN 2 Mode	PROFINET
Network Time Sync	None
Enable UTC Offset	Disabled
Day Light Savings Time(DST)	Disabled

Once the PROFINET controller has been configured, add nodes to the PROFINET network. For an SoE operation, an IC695PNS101 is selected as a module to be added. In Figure 3, it is displayed in PAC Machine Edition as an Advanced PROFINET Scanner. Each PNS101 added will function as the head-end of the RX3i rack containing all the hardware required to support SoE. (For further discussions consult Section 2.2, SoE Node Configuration.) Up to four PNS101 modules may be added in this fashion.

SoE functionality requires locating and reserving two blocks of memory; a 151-word User Memory Map area that is specified as one of the input parameters to the SoE Application C Block; and an SoE Records Buffer whose size and location is configured within the User Memory Map. (The SoE Records Buffer size is defined by the number of records specified in element 17 of the SoE Memory Map multiplied by 10 words per record for a size of up to 320,000 words.) Each block may be in any of the Word-type Reference memory areas; i.e. %W, %R, %AI, or %AQ. Reference Memory area sizes are user-configured on the CPU's **Memory** tab and must allocate enough memory for the highest memory reference used. Figure 5 shows a configuration that is utilizing %W memory for both the Memory Map and SoE Records Buffer.

Figure 5 CPE330 Memory Configuration

InfoViewer (P.O.2) IC695CPE330	
Settings	Scan
Memory	Redundancy
Transfer List	Faults
Parameters	
--- Reference Points ---	
%I Discrete Input	32768
%Q Discrete Output	32768
%M Internal Discrete	32768
%S System	128
%SA System	128
%SB System	128
%SC System	128
%T Temporary Status	1024
%G Genius Global	7680
Total Reference Points	107520
--- Reference Words ---	
%AI Analog Input	64
%AQ Analog Output	64
%R Register Memory	1024
%W Bulk Memory	2000896
Total Reference Words	2002048

In planning, care should be taken that the Memory Map and SoE Records Buffer do not conflict with memory used by anything else, and if located in the same memory region, do not overlap each other.

2.1.1 Redundant Systems

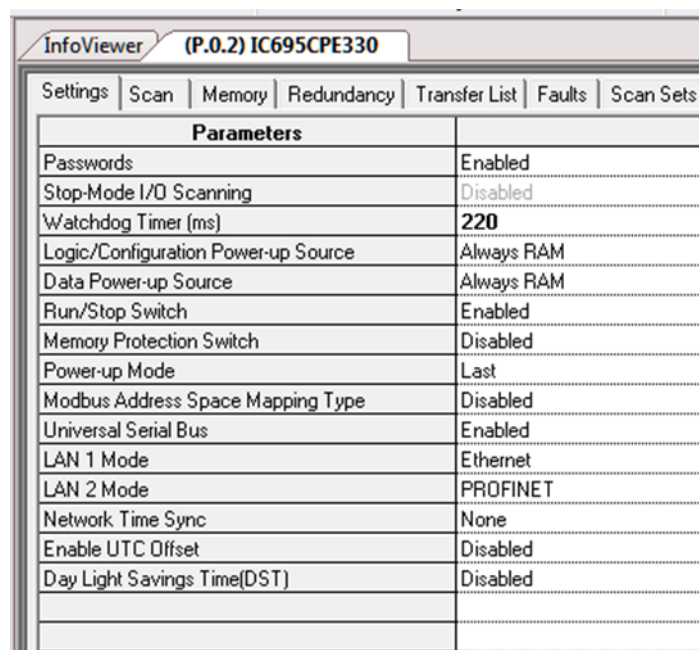
In a system configured for Hot Standby Redundancy, the active controller must synchronize its SoE Records Buffer with the backup controller on every sweep. This can significantly increase sweep time if the external Historian/SoE Collector is not keeping up with the SoE events being generated; therefore, the CPU Watchdog Timer parameter will need to be increased.

The Watchdog Timeout should be equal to the normal sweep time plus the worst-case sweep impact values seen in table. For example, if the sweep is normally 100 ms with no SoE records buffered internally, then the Watchdog Timeout should be set to at least 220 ms ($100 + 120 = 220$ ms).

Table 1: Worst-Case Sweep Impact Values

Controller	Worst-Case Sweep Impact (ms)	Watchdog Timeout (ms)
CPE330	120	$100 + 120 = 220$
CPE400/CPL410	200	$100 + 200 = 300$

Figure 6: Watchdog Timer Configuration



The SoE Records Buffer should be added to the Output Transfer List of the system. The Memory Map area should not be in either of the transfer lists. The SoE_App and CPU firmware will transfer the portions of the Memory Map area that should be synchronized. Specifically, the CPU firmware will maintain the SoE Record Communication Buffer Handshake and SoE Records Buffer update counter. These two registers must not be in either transfer list. If the SoE Records Buffer is incorrectly added to the Input Transfer List, the SoE Events that are placed in the SoE Records Buffer on the sweep before a CPU switchover are lost.

Remote Station Overflow bits are not maintained redundantly. They are set on the active unit on the first read of records after an overflow has occurred. If it is desired to maintain these accurately on a redundant system, they should be operator OR'd into a variable from User Logic and that variable should be placed on the Output Transfer List.

Similarly, the Overflow bit (bit 1) of the SoE Status register is set when new data is received on the active unit that would overflow the buffer. When SoE data is transferred to the backup unit, the overflow condition is not sent. When the backup unit transitions to the active unit, it has all the internal events transferred, and the ½ full and ¾ full bits will be correctly set based on that internal data, but an overflow bit will not be maintained. If it is necessary to maintain the overflow condition between redundant CPUs, the SoE Status register should be placed on the Output Transfer List.

2.2 SoE Node Configuration

2.2.1 Physical Constraints for Devices in an SoE Node

Each of the RX3i SoE Nodes shown in Figure 1 must conform to the following module placement:

Figure 7: SoE Node (Remote Rack) Module Placement

	Power Supply Module	PNS Module	Input Module 1	Input Module 2 (optional)	Input Module 3 (optional)	Input Module 4 (optional)	HSC Module
Slot #	See rules	N	N+1	N+2	N+3	N+4	any

Once a slot is selected for the PNS module, the input modules used in SoE must be placed contiguously to the right of the PNS Module, as shown in Figure 7. Up to four input modules are permitted per Node. The slot location of the PNS module is passed to the C Block via the Memory map discussed in Section 4.

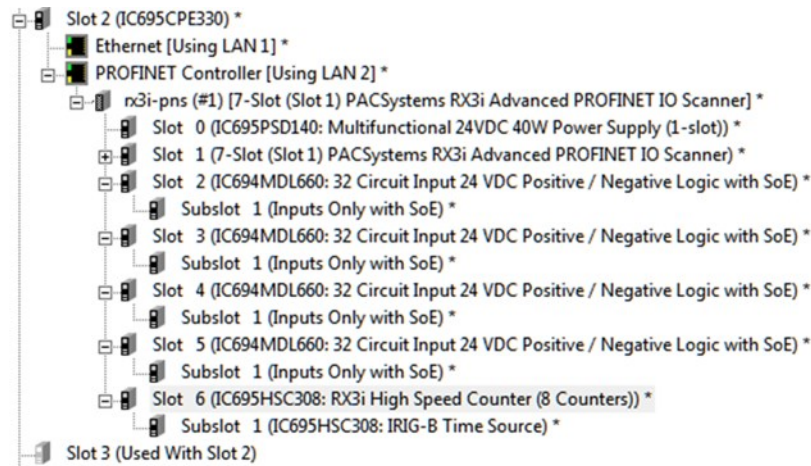
The Power Supply follows rules for its placement per the PACSystems RX3i System Manual, GFK-2314.

The High-Speed Counter is free to use in any unoccupied slot. However, it may not be placed between the PNS module or any of the designated SoE Input Modules. The IRIG-B signal is connected to the HSC, as discussed in Section 3 *IRIG-B Set-up & Interface*.

Figure 8 shows a fully-configured SoE Node, corresponding to that diagrammed in Figure 7. The PNS101 occupies Slot 1. This constrains the MDL660/MDL655 modules to Slot 2 and

higher (contiguously). The Power Supply occupies Slot 0 and the HSC occupies Slot 6. The whole arrangement fits in a 7-slot RX3i backplane.

Figure 8: Fully-Configured SoE Node (Remote Rack)



For full details on configuring a PROFINET Controller, refer to the PACSystems RX3i & RSTi-EP PROFINET I/O Controller Manual, GFK-2571.

For full details on configuring a PROFINET Scanner, refer to the PACSystems RX3i PROFINET Scanner Manual, GFK-2737.

2.2.2 I/O Mapping for Devices in an SoE Node

As shown in Figure 7, the Input Modules and PNS are constrained to a fixed physical arrangement. Similarly, within each SoE Node, the mapping of those inputs into the host CPU reference memory is fixed relative to one another, as described in this section. If PAC Machine Edition has any problems accepting the planned reference assignments, the user must either change some external reference assignments or alter the planned reference assignments in PAC Machine Edition.

The base index for each SoE Node is defined in Section 4, SoE/IRIG-B User Memory-Map. These assignments are passed to the C-Block.

Note: Since multiple PNS modules may be present in the SoE structure, this document is using PNS(x) to denote the PNS module located in SoE Node x in the Memory Map. Thus PNS(1) represents the PNS in Node 1, PNS(2) represents the PNS located in SoE Node 2, etc. Each PNS(x) has a unique range of map elements associated with it, per Section 4.

For PNS(1), the definition is presented in Element (26) and Element (27). Thus,

- if Element (26) is set to 16(dec), the CPU reference memory type is defined as %I;
- if Element (27) = 1001, the starting reference for this SoE Node is %I1001.

Device	Required/ Optional	Reference Assigned	Number of Bits	Example
PNS(1)	Required	Per Element (26) and Element (27)	32	%I1001 - %I1032
Input Module 1	Required	Next contiguous	32	%I1033-%I1064
Input Module 2	Optional	Next contiguous, if used	32	%I1065-%I1096
Input Module 3	Optional	Next contiguous, if used	32	%I1097-%I1128
Input Module 4	Optional	Next contiguous, if used	32	%I1129-%I1160
HSC (IRIG-B)	Required	None		

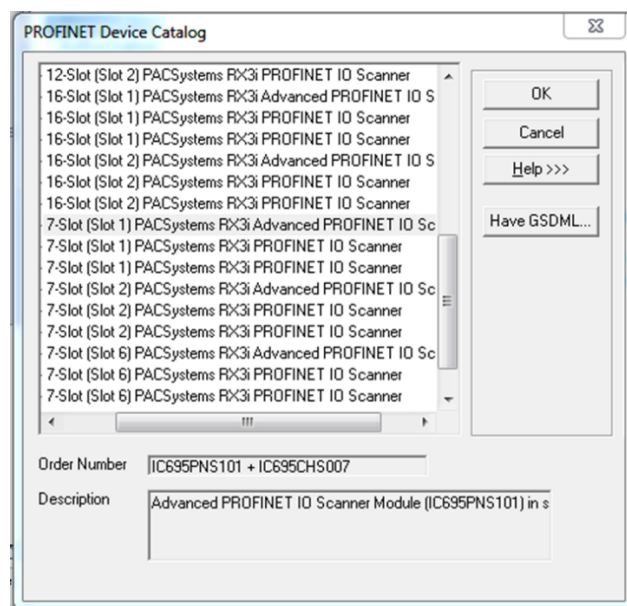
The PROFINET Scanner Module also consumes 32 bits of output data. Refer to the PACSystems RX3i PROFINET Scanner Manual, GFK-2737.

2.3 PNS Selection

A PNS is added by right-clicking the CPE330 PROFINET Controller (Figure 8) and selecting **Add IO-Device**. This opens the PROFINET Device Catalog. Expand the **RX3i-PNS** entry to expose the RX3iPNS101 configuration selections (Figure 9). The revision date is encoded as part of the RX3i-PNS entry name. If there are multiple RX3i-PNS entries, select the latest.

When adding a device to the PROFINET network (Figure 9), choose one of the devices with the description Advanced PROFINET IO Scanner. The selection represents the PNS101 module itself, the type of rack in which it will reside, and the slot it will occupy in that SoE Node:

Figure 9: Select Advanced PROFINET IO Scanner from PROFINET Device Catalog



If the particular version of Advanced PROFINET IO Scanner is not available, or an updated GSDML file has been made available, click on the **Have GSDML button** (Figure 9) and browse to the folder containing the new GSDML file, then import that file to the PROFINET Device Catalog. Detailed instructions are provided in the PACSystems RX3i & RSTi-EP PROFINET I/O Controller Manual, GFK-2571.

GSDML files are available for download (as part of the PNS101 firmware update kits) at the support links located at the end of this document.

2.4 PNS Configuration

The Update Rate of the PNS scan should be set to either the fastest supported for the overall system (see PROFINET IO controller documentation for the fastest rate supported for the number of nodes in the system) or considering the rate of SoE Records generated. The CPU uses the PNS status bits to know if there are any records available to be retrieved. If too many records occur before the update of the PNS status bits, an overflow can occur within the PNS internal queue and events will be lost.

2.4.1 Module Parameters

Figure 10 PNS Module Settings Tab

InfoViewer (P.0.4.1.1.2) 12-Slot (Slot 2) PACSystems RX3i PROFINET IO Scanner	
Redundancy IO-Device Access Point Media Redundancy Settings Module Parameters	
Max IO Scan of 1ms:	Enabled
Front Panel IP Address Byte 1:	192
Front Panel IP Address Byte 2:	168
Front Panel IP Address Byte 3:	0
Front Panel IP Address Byte 4:	19
Front Panel Subnet Mask Byte 1:	255
Front Panel Subnet Mask Byte 2:	255
Front Panel Subnet Mask Byte 3:	255
Front Panel Subnet Mask Byte 4:	0
Front Panel Gateway IP Address Byte 1:	0
Front Panel Gateway IP Address Byte 2:	0
Front Panel Gateway IP Address Byte 3:	0
Front Panel Gateway IP Address Byte 4:	0

The Advanced PROFINET Scanner (IC695PNS101) has a parameter in its Module Parameters Tab labeled Max IO Scan of 1 ms which defaults to Enabled. When enabled, the Scanner prioritizes the collection of input transitions at a 1 ms rate, and internal schedules and settings are adjusted to prioritize the I/O scanning. To support 1ms SoE collection, all limitations must be adhered to and this parameter set to Enabled.

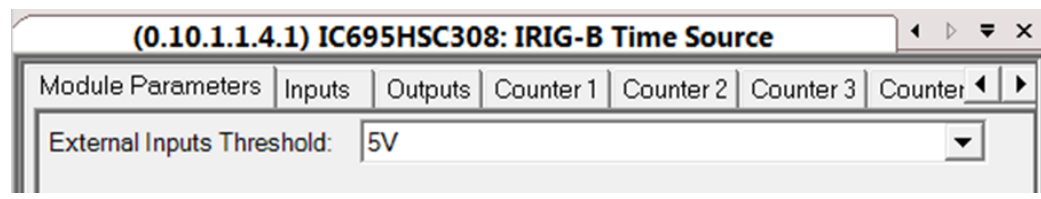
The PNS101 is optimized to support 1 ms SoE collection when used with up to four IC694MDL660, IC694MDL655 input modules and one IC695HSC304/308 for IRIG-B time synchronization and the Max IO Scan of 1 ms parameter Enabled. Additional general-purpose I/O may be incorporated into the PNS101 rack; however, adding general-purpose I/O increases the PNS101 IO scan time and the PNS101 may not be able to maintain a 1 ms

SoE collection rate. For the best performance, general-purpose I/O should be in a separate PROFINET Scanner rack and not added to a dedicated PNS101 SoE Node. If general-purpose I/O modules are present in the PNS101 SoE node, best-effort SoE collection can be used. In that case, the Max IO Scan of 1 ms parameter should be set to Disabled to allow for I/O scans potentially longer than 1 ms and correct servicing of the SoE and general purpose of I/O modules in a given PNS101 SoE node. SoE collection will occur at the I/O scan rate of the PNS101 which may be longer than 1ms. In this case, events occurring faster than the PNS101 I/O scan rate may be missed.

2.5 High-Speed Counter (HSC) Configuration

Most of the HSC configuration is performed by the SoE C Block. Only one parameter is available when the HSC is chosen to be an IRIG-B Time Source. On the Module Parameters tab, the HSC External Input Voltage threshold is defaulted to 5 V to match the voltage range of the IRIG-B clock source output as shown in Figure 11. This may be changed to 12/24 V if the IRIG-B clock source provides signaling in that range.

Figure 11: HSC Input Voltage Threshold Configuration



2.6 MDL660 Configuration

Each IC694MDL660 Input Module needs to be configured.

- To determine which inputs on the module are being used in the SoE application. Any inputs with SoE enabled (Figure 13) will be monitored for input state transitions. Any such transitions will be logged as an SoE Record. This aspect is discussed in this section.
- Note that the status bits normally associated with MDL660 are not allowed in combination with the SoE feature.

Figure 12: PAC Machine Edition Navigator Tree View of MDL660 in SoE Node (Remote Rack)

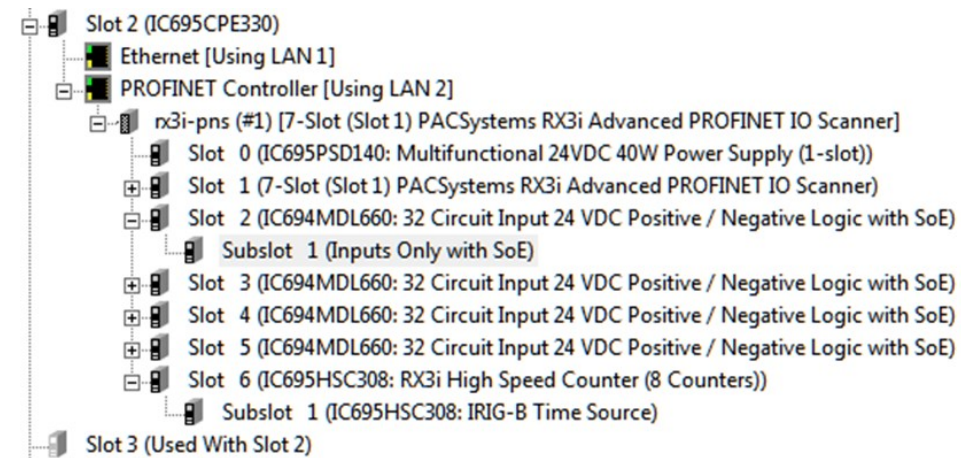


Figure 13: Enable MDL660 Inputs as SoE Channels

InfoViewer (0.2.1.1.2.1) Inputs Only with SoE		
Settings	Module Parameters	GSDML Details
Enable SoE on Channel 1:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 2:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 3:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 4:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 5:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 6:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 7:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 8:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 9:	<input type="checkbox"/>	
Enable SoE on Channel 10:	<input type="checkbox"/>	
Enable SoE on Channel 11:	<input type="checkbox"/>	
Enable SoE on Channel 12:	<input type="checkbox"/>	

The MDL660 has 32 input channels. Any combination may be used as SoE Input Channels, as determined by the selections made on the MDL660 Module Parameters tab (Figure 13).

2.7 MDL655 Configuration

Each IC694MDL655 Input Module needs to be configured.

To determine which inputs on the module are being used in the SoE application. Any inputs with SoE enabled (Figure 14) will be monitored for input state transitions. Any such transitions will be logged as an SoE Record. This aspect is discussed in this section.

Figure 14: PAC Machine Edition Navigator Tree View of MDL655 in SoE Node (Remote Rack)

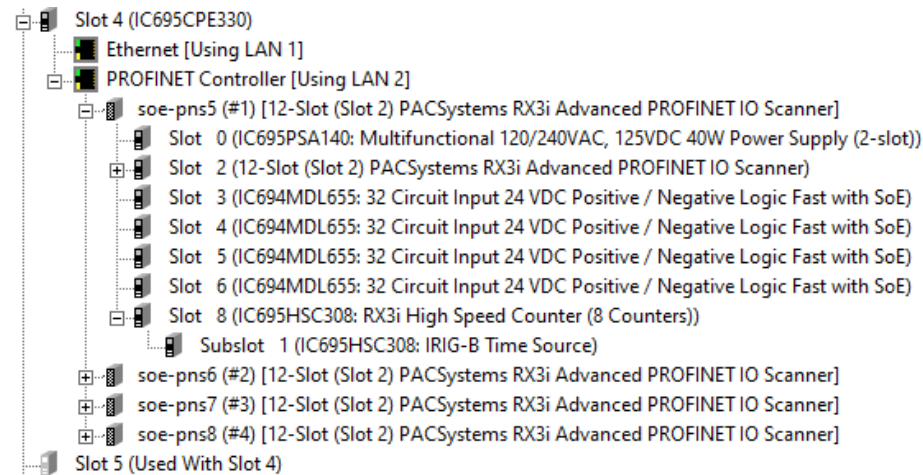


Figure 15: Enable MDL655 Inputs as SoE Channels

(0.4.1.1.3) IC694MDL655: 32 Circuit Input 24 VDC Po

Settings	Module Parameters	GSDML Details
Enable SoE on Channel 1:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 2:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 3:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 4:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 5:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 6:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 7:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 8:	<input checked="" type="checkbox"/>	
Enable SoE on Channel 9:	<input type="checkbox"/>	
Enable SoE on Channel 10:	<input type="checkbox"/>	
Enable SoE on Channel 11:	<input type="checkbox"/>	
Enable SoE on Channel 12:	<input type="checkbox"/>	

The MDL655 has 32 input channels. Any combination may be used as SoE Input Channels, as determined by the selections made on the MDL655 Module Parameters tab (Figure 17).

Section 3 IRIG-B Set-up & Interface

IRIG-B is a protocol used to encode Global Positioning System (GPS) time into a serial bitstream. The RX3i architecture uses the IRIG-B data stream to synchronize its local clock to that GPS Time. It then uses its locally synchronized clock as the time-source when an SoE event is detected in the RX3i system.

The IRIG-B signal is physically interfaced to the RX3i SoE system via a BNC cable. The BNC signal is connected to a series of High-Speed Counter (HSC) Modules, one located in each SoE Node (Figure 1). Either an IC695HSC304 or an IC695HSC308 may be used.

The HSC module converts the IRIG-B signal to a digital bitstream that is delivered to the PNS over the backplane. The PNS module interprets the bitstream to resynchronize its internal timebase once per second, which it subsequently uses to time-stamp all SoE events in the same rack.

The time-stamped SoE records are stored by the PNS. The PNS then sets an SoE Data Available status bit indication to the CPU. The CPU automatically retrieves the associated SoE records over PROFINET and deposits those records into the memory location previously configured for SoE Records (refer to Section 1)

The limiting factor for the overall accuracy of the time-stamp is the 1ms update rate of the inputs on IC694MDL660/IC694MDL655 and the input filter delay of the IC694MDL655. Refer to the PACSystems RX3i System Manual, GFK-2314 for information on how to set the input filter to its lowest value on MDL660. This setting (0) corresponds to the hardware filter of 0.5ms. The purpose of the input filter is to prevent unwanted transitions from external electrical noise that may be present at the SoE Node,

The supported formats of the IRIG 200-04 standard are: B000, B004, B005, B006, and B007. Instruments that use the older IRIG 200-98 standard are also supported in format B000 with IEEE 1344-1995 control function extensions.

The solution can be configured to accept Unmodulated (DC Level) IRIG-B signals. Modulated (1 kHz Carrier) signaling is not supported.

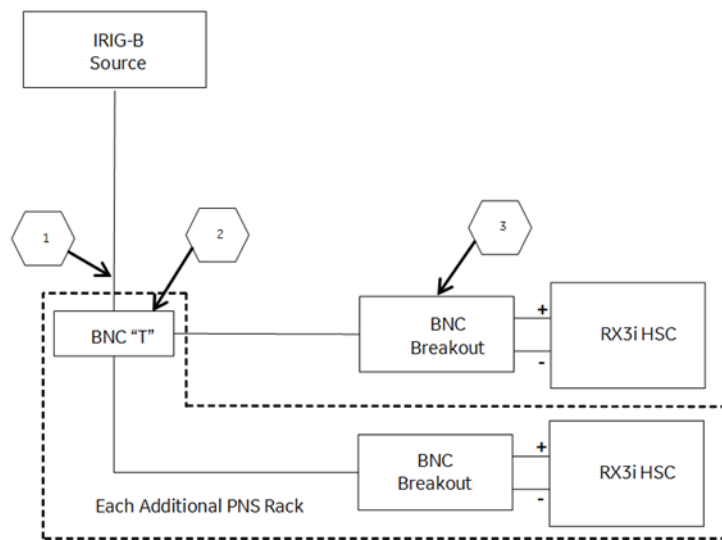
3.1 Connecting the IRIG-B to HSC Input

Attach the BNC connector to the Unmodulated (DC Level) output connector on the IRIG-B hardware, per your application design.

The IRIG-B Signal is connected to the HSC in each SoE Node on the network via BNC breakout boxes, as indicated in Figure 15 One BNC breakout box is required for each SoE Node in your application.

- Connect the positive signal from the BNC breakout box to Input 1 (Terminal 1) of the HSC.
- Connect the BNC breakout box negative signal to the HSC Common terminal (Terminal 9).
- Do not use any other HSC input for this purpose.

Figure 16: IRIG-B Signal Distribution



The following table documents the callouts shown in Figure 16. The indicated components are available from multiple sources. The indicated vendor and corresponding components are provided as a reference.

Item	Part Number	Description	Vendor
1	2249-C-XX	RG58 Patch Cable: (XX = length in inches)	Pomona
2	3284	BNC Tee	Pomona
3	4969	BNC Breakout	Pomona

Figure 17: Field Wiring HSC304

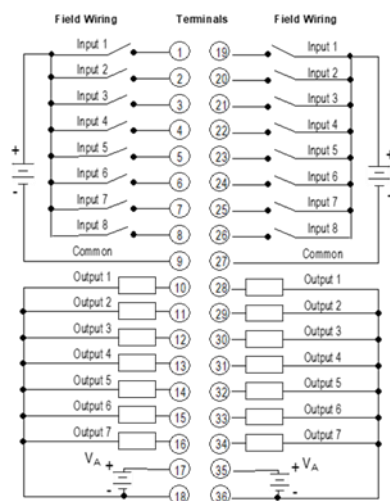
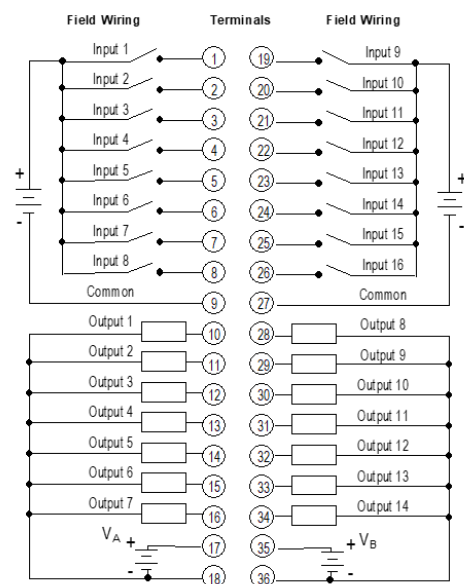


Figure 18: Field Wiring HSC308



The HSC module used for interfacing with the IRIG-B signal cannot perform any other functions

Refer to the PACSystems RX3i System Manual, GFK-2314, Chapter 8, for information on HSC304 & HSC308.

3.2 Synchronization of the CPU System Clock

The CPU system clock is not synchronized to the IRIG-B signal.

Section 4 SoE/IRIG-B User Memory-Map

The second part of setup for an SoE operation is the SoE/IRIG-B User Memory-Map that the SoE Application C Block will read.

The structure discussed in this section is set up in the PLC CPU Memory. It is manipulated by the user to interface with the SoE application.

The SoE C-Block accepts an input that defines the base memory location for the structure. Once the base location is set, all elements are relatively located, as shown below.

The SoE User Memory Map consists of three main areas; the *Handshake Word* (element 1), *Status* (elements 2 through 11), and *Configuration* (elements 17 and beyond). The Configuration area defines the size and location of the SoE Records Buffer, and the PNS node(s) providing the event data.

Note that elements (18) and (19) combine to determine where the SoE Records Buffer is to be located. The Memory Map and SoE Records Buffer may be in %W, %R, %AI, or %AQ memory. Adequate memory must be specified in the PAC Machine Edition CPU Memory configuration (refer to 2.1 CPU Configuration). Care should be taken that the Memory Map and SoE Records Buffer do not conflict with memory used by anything else and, if located in the same memory region, do not overlap.

Element (Word Offset)	Type	Access	Sub- Structure	Function
(1)	WORD	R/W		SoE Record Communication Buffer Handshake
(2)	WORD	R		Overflow Missed Events Counter
(3)	WORD	R		SoE Records Buffer update counter
(4)	WORD	R		SoE Status Flags
(5)	DWORD	R		Informational: Minimum PLC Scan Time (μS)
(7)	DWORD	R		Informational: Current PLC Scan Time (μS)
(9)	DWORD	R		Informational: Maximum PLC Scan Time (μS)
(11)	DWORD	R		Remote Station Overflow bits
(13)	DWORD	R		Reserved
(15)	DWORD	R		Reserved
(17)	WORD	W		Maximum Number of SoE Records Buffered in CPU SoE Records Buffer (Simplex: 1-32,000, Hot Standby Redundancy: 1000-32,000)
(18)	WORD	W		SoE Records Buffer Memory Type (e.g., %W = 196)

Element (Word Offset)	Type	Access	Sub- Structure	Function
(19)	DWORD	W		SoE Records Buffer Memory Index (e.g., Index into %W: use 1001 to represent %W1001)
(21)	WORD	W		Reserved
(22)	WORD	W		SoE Record Export Format (Always 0)
(23)	WORD	W		Number of SoE Nodes (i.e., Number of PNS devices, maximum of 4)
(24)	WORD	W	PNS(1)	PROFINET Device Number ³ of PNS(1)
(25)	WORD	W	PNS(1)	PNS(1) Slot location in SoE Node
(26)	WORD	W	PNS(1)	PNS(1) Status Memory Type (e.g., %I = 16 dec)
(27)	WORD	W	PNS(1)	PNS(1) Status Memory Index (e.g., index into %I)
	Repeat Elements (24) through (27) for each PNS-controlled SoE Node in the system. (max 4 PNS's).			
(36)	WORD	W	PNS(4)	PROFINET Device Number ² of PNS(4)
(37)	WORD	W	PNS(4)	PNS(4) Slot location in SoE Node
(38)	WORD	W	PNS(4)	PNS(4) Status Memory Type (e.g., %I = 16 dec)
(39)	WORD	W	PNS(4)	PNS(4) Status Memory Index (e.g., index into %I: use 1 to represent %I0001)

The map above is laid out for the maximum of four SoE Nodes.

The user also populates some aspects via normal configuration parameters in PAC Machine Edition.

The C-Block validates some of this data and validation is returned in the Configuration/Set-up status (refer to Section 4.2).

Use a DATA INIT Block to configure the SoE application with an FST_EXE contact. Such a DATA INIT block would start at element 17 (Maximum Number of SoE Records Buffered in CPU).

Note: The SoE Node configuration assumes the input modules (max 4) are installed immediately to the right of the PNS module. For instance, if the PNS module is installed in Slot #1, then the input modules must be installed in Slots #2 through #5, contiguously. Fewer than four input modules are permitted, but they still must be installed in contiguous slots. Index 25 above defines the slot number of the PNS Module, and by extension, the locations of the input modules which it services.

³ PROFINET Device Number cannot be 0. SoE Record requires 1-127 (7-bit constraint – refer to Appendix A).

4.1 Memory-Map Definitions

Element	Sub-Structure	Function	Definition	Range
(1)		SoE Record Communication Buffer Handshake	Read: The number of events that are available in the SoE Records Buffer. Write: The Historian/SoE Collector reciprocates by setting this word to zero each time all content has been copied to the Historian itself.	
(2)		Overflow Missed Events Counter	Number of times the internal buffer overflowed and events are lost	
(3)		SoE Records Buffer update counter	Incremented by 1 when one or more new events have become available in the SoE Records Buffer since the SoE Record Communication Buffer Handshake word was last cleared. Cleared to 0 on stop to run transition.	
(4)		SoE Status	Bit 1: 1= Internal events buffer overflowed. Cleared on stop to run transition. Bit 1: 0= PLC Reset or new configuration downloaded. Bit 2: PLC restarted (CPU sets the bit to 1 following a Stop to Run transition) The HMI/SCADA/Controls system can set Bit 2 to zero to monitor when the PLC is restarted. Bit 3: Reserved Bit 4: 1 = Internal event buffer is ½ full. Cleared when the event count drops below ½ full or stop to run transition. Bit 5: 1 = Internal event buffer is ¾ full. Cleared when the event count drops below ¾ full or stop to run transition. Bit 6 - 16: Reserved	
(5)		Minimum PLC Scan Time (μS)	Informational	
(7)		Current PLC Scan Time (μS)	Informational	
(9)		Maximum PLC Scan Time (μS)	Informational	
(11)		Remote Station Overflow bits	Each bit is set to 1 when there is an overflow (and records are lost) at the remote (PNS) station. The bit remains set until a zero is written to that position. Each bit represents the corresponding PNS configured at Element 24 or later. Bit 0 is the PNS at Element 24, Bit 1, the PNS at Element 28, etc.	
(13)		Reserved		
(15)		Reserved		

Element	Sub-Structure	Function	Definition	Range
(17)		Maximum Number of SoE Records Buffered in CPU	The communication buffer in the CPU is configurable to store up to 32,000 SoE Records. This word indicates the maximum number of SoE Records the host HMI/SCADA/Controls Application Program can poll and collect. By checking the information in the SoE Record Communications Buffer Handshake word (1), the SoE C-Block application in the CPU moves the SoE Records from the internal buffer to the SoE Records Buffer. Be aware that the larger the number of SoE Records specified, the larger the impact on the PLC scan time. Each SoE Record is 10 words in size.	1--32,000 For Redundancy, the range is 1,000 – 32,000.
(18)		SoE Records Buffer Memory Type (%W, %R, %AI, or %AQ)	%W = 196 (dec), %R = 8, %AI = 10 (dec), %AQ = 12 (dec)	Using %W is recommended.
(19)		SoE Records Buffer Memory Index (i.e., Index into Memory Type)	Enter 1001 to indicate %W1001, for example.	The range is dependent on memory type and configuration maxima (selected at Index (18) above).
(21)		Reserved		0
(22)		Export Format	This parameter is used to select the SoE Record Format that will be used in the SoE Records Buffer.	Always 0
(23)		Number of SoE Nodes (i.e., Number of PNS devices)		1-4
(24)	PNS(1)	PROFINET Device Number	The range is limited by Export Format	1 - 127
(25)	PNS(1)	Slot occupied by PNS in remote rack (SoE Node)	slot #: 0 = slot 0... up to 0FH=Slot 15	0 - 15
(26)	PNS(1)	PNS Status Memory Type (%I, %Q, %G, %M, %T)	For this memory type	decimal value
			%I Discrete input table (Byte mode)	16
			%Q Discrete output table (Byte mode)	18
			%G Discrete G table	86
			%M Discrete M table	76
			%T Discrete T table	74
(27)	PNS(1)	PNS Status Memory Index (e.g. index into %I)	1 represents %I0001	
Repeat elements (24) through (27) for each PNS-controlled SoE Node in the system. Refer to page 22.				

4.2 Configuration/Set-up Status

The status reflected here is generated by the SoE C-Block. It is one word wide. Its location in reference memory is determined by the CPU application program. See Rung 5 in the ladder logic below (Figure 29).

Status	Description
0	OK
-1	The SoE User Memory Location, supplied as a parameter to the C-Block is null, which is not permitted. (This does not apply to the SoE Status parameter, which may be null).
-2	The memory type used for the SoE Memory-Map is not supported. Supported types are %W, %R, %AI, and %AQ.
-3	The SoE User Memory Location supplied as a parameter to the C Block is set to a Memory Type configured for a memory size of 0.
-4	SoE Memory-Map will not fit in the available memory. Either there is insufficient memory configured or the 151-word map is not within the available memory range.
-5	Unsupported SoE record format. Check the contents of the Export Format element in the Memory Map.
-6	The memory index used for the SoE Records Buffer is zero. All CPU memory is 1-based, e.g. %W0001, etc.
-7	Memory Type used for the SoE Records Buffer is not supported. Supported types are %W, %R, %AI, and %AQ.
-8	SoE Records Buffer, as configured, will not fit in the available memory. There is insufficient memory configured for the specified memory, or it is located such that it does not fit in the range of available memory.
-9	SoE Records Buffer size has been set to default. This happens when the user inputs a size of zero or a value greater than the maximum (32,000). The default value is 50 events. This error code may be ignored; the code is displayed but the C Block call will pass power.
-10	SoE Records Buffer update delay value is not supported and must be set to zero.
-11	SoE Records Buffer starts within the SoE Memory-Map area.
-12	SoE Records Buffer overlaps the SoE Memory-Map area.
-13	Invalid number of Remote Nodes. Valid values are 1 through 32.
-14	Applying the SoE configuration has failed. Ensure the CPU firmware version supports the SoE C Block. (Requires CPE330 version 9.60 or later. Requires CPE400/CPL410 version 10.10 or later.)
-15	Failed to collect SoE Records from the CPU.
-16	User configured Comm Buffer Event Size is less than minimum required for redundant mode (1000 events)
-1xx	Invalid Device Number. Error numbers are in the range -101 to -132. An unsupported Device Number was specified in the indicated PNS record (1-32). The PNS Device Number must be in the range of 1 – 127.

Status	Description
-2xx	Invalid Remote Node Status Memory Type. Error numbers are in the range -201 to -232. An unsupported reference address memory type was specified in the indicated PNS record (1-32).
-3xx	Invalid Remote Node Status Memory Index. Error numbers are in the range -301 to -332. An invalid reference address was specified in the indicated PNS record (1-32).

4.3 Configuration Errors

Some setup or configuration errors in an SoE system are only detected when the SoE application has been stored and the CPU is put in run mode. These errors are reported in the CPU Fault Table. The presence of any of these faults indicates the SoE system is not configured correctly and the system will not collect and report all Events.

These errors are caused by incorrect data in one or more of the four-word SoE Node descriptors, starting at element 24 in the User Memory-Map (section 4.1 Memory-Map Definitions). If one of these errors occurs, review the SoE Node PNS descriptors and correct them as necessary. Changes are applied by storing the updated logic and putting the CPU in Run mode.

Note that all Fault Extra Data is in hexadecimal format.

4.3.1 Invalid Device Number (Error Code 662)

The fault shown below is the result of providing an SoE Node Profinet Device Number that does not exist in the hardware configuration of the PAC Machine Edition project.

Figure 19: PLC Fault Table

Controller Fault Table (Displaying 2 of 2 faults, 0 Overflowed)			
Loc	Fault Description		
0.2	Non-critical CPU software event		
	Error Code	Group	Action
	662	140	1:Informational
	Fault Extra Data: 06 13 01 41 80 42 00 67 03 00 00 00 00 00 00 00 00 00 00 00		

Figure 20: PACSAnalyzer Output

```

##### PLC FAULT TABLE #####
Last cleared: 08-08-2018 10:49:43
Displaying 1 of 1 faults (0 overflowed), in time ascending order.
1. Location: 0.1 Date/Time: 08-08-2018 10:51:22.389
   Group:140 INFO_CPU_SOFTWR - CPU software event
   Error Code:662 Action:1 Task Num:3
   Extra Data: 06 13 01 40 80 42 00 67 03 00 00 00 00 00 00 00 00 00 00 00
   ASCII: . . . @ . B . g . . . . . . . . . . . . . . . . . . . . . .

```

In the above example, PROFINET Device Number 3 as indicated in the fault extra data (9th byte) has been specified for an SoE Node but does not exist in the hardware configuration

4.3.2 Collector Access Denied (Error Code 663)

Figure 21: PLC Fault Table

Controller Fault Table (Displaying 1 of 1 faults, 0 Overflowed)			
Loc	Fault Description		
0.2	Non-critical CPU software event		
.....	Error Code	Group	Action
	663	140	1:Informational
	Fault Extra Data:	06 13 04 a3 81 4e 00 13 00 00 00 00 00 00 00 00	

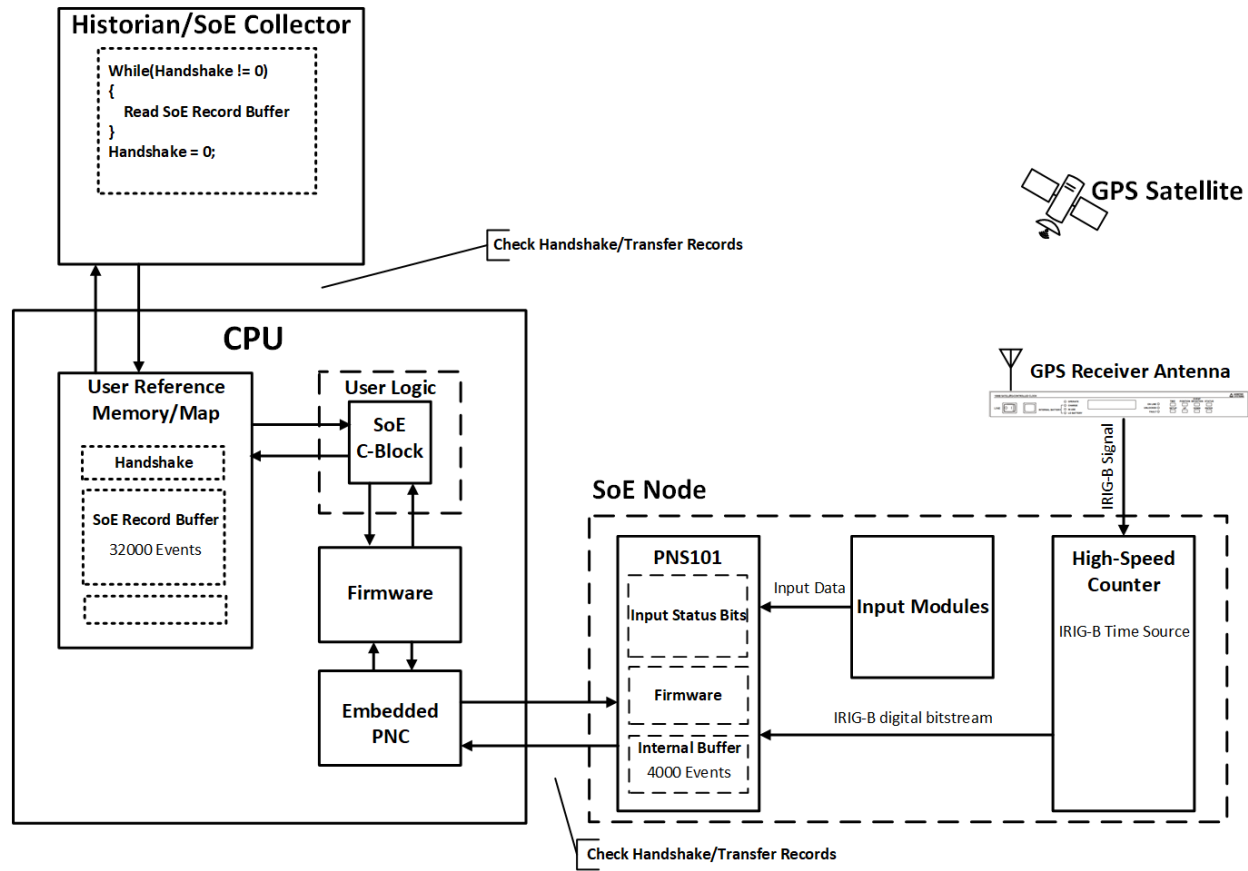
[illegible]

Section 5 Operation

Once the setup of the Hardware Configuration profile and the SoE/IRIG-B User Memory Map is complete, the user can begin to retrieve SoE records from the controller and make them available to the application.

Below is a block diagram of a sample use-case, in which the SoE Node passes information to the CPU, which is then recorded by the Historian. Section 5 will review the functions of each of the nodes in the diagram.

Figure 23: Operational Overview Diagram



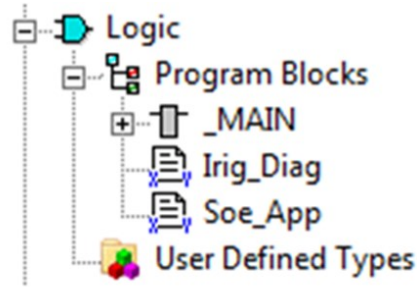
5.1 Functions of the C Program Blocks

Two C Block programs are supplied with the SoE application: SoE_App and IRIG_Diag. Both are non-modifiable programs developed by Emerson. The main functions of the C Blocks are:

- To initialize and configure SoE operation based on the user's input as set out in the User Memory-Map (Section 1)
- To pass that configuration to the CPU firmware.
- To trigger the collection of an SoE record from a Remote Node.
- To provide diagnostics for the overall SoE Application.

Locate and select the C Program Block in PAC Machine Edition's Navigator pane:

Figure 24: SoE C Program Block Viewed in PAC Machine Edition Navigator



In the PAC Machine Edition Inspector, right-click in the empty box to the right of the Parameters entry, then click on the ellipses (...) to access the parameters for the C Program Block:

Figure 25: Access the Parameters for C Program Block

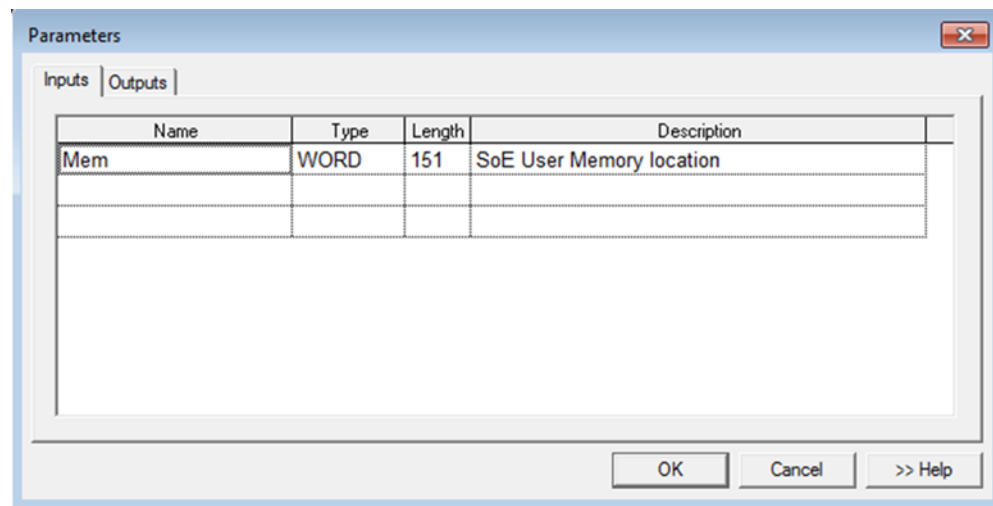


5.1.1 Set up the Input and Output Parameters for the C Program Block

The SoE_App C Program Block requires one input parameter and supplies two output parameters:

1. INPUT - SoE User Memory Location (WORD). This parameter is pointing to the base of the SoE User Memory Map discussed in Section 1. Enter a memory reference such as %W0001. Note that the corresponding memory area cannot be used for any other purpose once assigned to the SoE Application.
2. OUTPUT - Configuration Status (INT). The C-Block uses this parameter to indicate the status of the SoE application operations, per section 4.2. Zero indicates OK. Negative values indicate various error conditions. This parameter may be null, but null is not recommended, as status information would not then be relayed to the user.
3. OUTPUT – SoE C-Block Version (WORD): for information only. Should any interfaces change over time, they may be traced to this item.

Figure 26: C Program Block Input Parameters



The screenshot shows a 'Parameters' dialog box with two tabs: 'Inputs' and 'Outputs'. The 'Inputs' tab is active, displaying a table with the following data:

Name	Type	Length	Description
Mem	WORD	151	SoE User Memory location

The 'Outputs' tab is also visible but contains no data. At the bottom of the dialog are buttons for 'OK', 'Cancel', and '>> Help'.

Figure 27: C Program Block Output Parameters

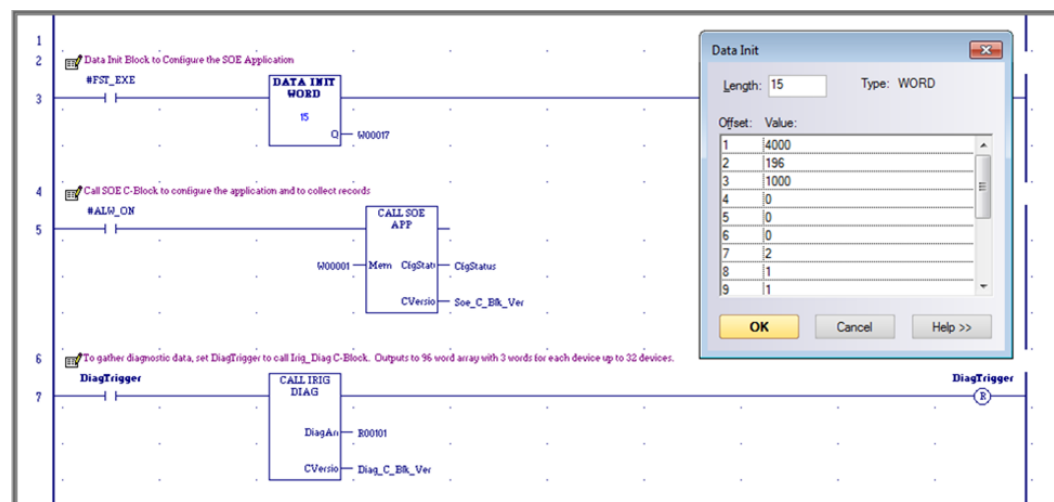
Name	Type	Length	Description
CfgStatus	INT	1	SoE Configuration Status (0==Success)
CVersion	WORD	1	C-Block Version (0x0100 -> 1.00)

5.1.2 Install Ladder Logic in Support of C-Block

Once the User Memory-Map (refer to Section 4) and the Input and Output Parameters discussed above have been set up, install ladder logic (or equivalent) to initialize the SoE execution, using a Data Init Function Block, as shown in

Figure 28 (rung 3). The Data Init function is used to populate user configuration data in the SoE Memory Map that begins at Element 17. This should be executed only once.

Figure 28: Data Init Function Block for SoE_App Set-up (Rung 3)



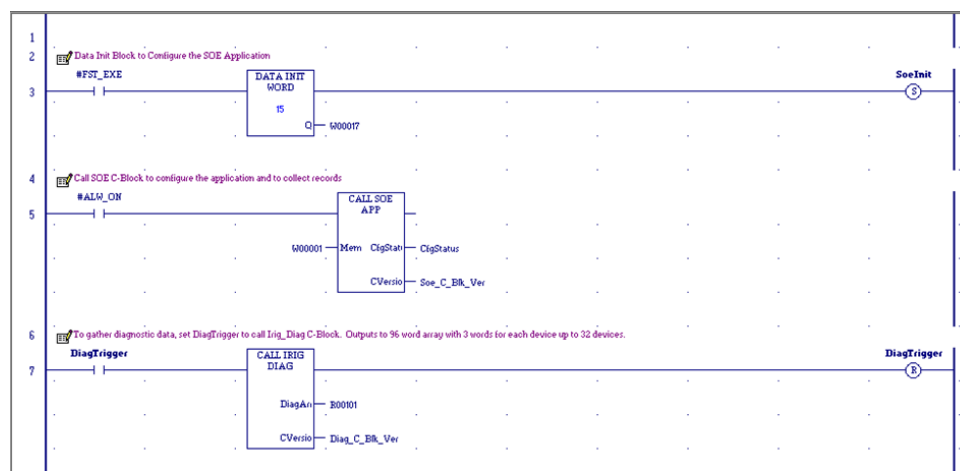
The first word of the SoE User Memory-Map is the SoE Record Communications Buffer Handshake word. The C Block updates this word with the number of events that have been copied to the SoE Records Buffer. When the buffer is populated, no more events are written. Writing zero to this word causes the Controller to start re-filling the capture buffer from the start.

The next 6 parameters provide SoE status information and are updated continuously while the C Block is being executed.

The parameters starting at word 17 provide SoE configuration data to the Controller. These are read by the SoE C Block and updated to the CPU on stop-to-run transitions only.

Following initialization, the C Program Block is called on every subsequent Logic Scan.

Figure 29: Calling SoE_App C Program Block from Main Program (Rung 5)



5.2 Functions of the Input Modules (MDL660/MDL655)

The input module MDL660 or MDL655 is scanned in the normal way by the PROFINET Scanner (PNS) located in the same rack. For those inputs which have been designated as SoE Channels (refer to Section 2.6, MDL660 Configuration or Section 2.7 MDL655 Configuration), an SoE event is logged whenever a transition is detected on a corresponding input.

5.3 Functions of the High-Speed Counter (HSC)

Each High-Speed Counter Module converts the GPSTime IRIG-B data stream to a digital data stream to be interpreted by the PNS.

Note that the functionality of the HSC is constrained by the GSMDL file used in this application. Only the IRIG-B input is operational.

5.4 Functions of the Advanced PROFINET Scanner (PNS101)

The PROFINET Scanner executes several functions:

- a. Interprets the data stream from the HSC to synchronize the SoE Node time-base once per second.
- b. Read inputs from the IC694MDL660's or IC694MDL655's in the rack. If the PNS is configured for a Max IO Scan of 1ms, then priority is given to reading the MDL660/MDL655's every 1ms so events can be recognized every ms.
- c. Based on the configuration received during initialization, it analyzes the inputs from the SoE-enabled channels of the MDL660/MDL655 modules located in the same rack and generates an SoE time-stamped record whenever a transition is detected on one of those channels.
- d. Once PNS101 is initialized, config received, and is ready to record events, any input that is already in a high state will be recorded as a new event.
- e. It generates an IRIG-B time processing status.
- f. In response to periodic requests from its host CPU, the PNS passes the SoE records to its host over the PROFINET bus.

5.4.1 Input Status Bits

The PROFINET Scanner's 32 bits of input status provides information about the scanner. All status bits are active high. Bit 1 is the least significant bit.

Status Bits	Name	Description
1	Module OK	Indicates the health of the module. A value of 0 indicates the module is powering up or has failed. A value of 1 indicates the module is functioning properly
2	Reserved	Set to 0
3	Port1 Link Up	1 = port is connected to another device and is communicating. 0 = port is not connected to another device, or the port has some sort of error preventing communications.
4	Port2 Link Up	
5	Port3 Link Up	
6	Port4 Link Up	
7-10	Reserved	Set to 0
11	MRP Enabled	Indicates whether MRP has been enabled or not. A value of 0 indicates that MRP is not enabled. A value of 1 indicates that MRP is enabled.
12	MRP Role	Always 0. PNS only supports MRP Client.
13	PNS Synchronized	PNS101 is synchronized to the GPS global time.
14	SoE Events Available	SoE Events available
15-32	Reserved	Set to 0

The PNS Synchronized status indicates that the PNS has synchronized its clock to the GPS global time. Clock synchronization may require if 90 seconds after power-up. Any records captured before synchronization will have 1970 as the year and other timestamp values will not be referenced to the GPS global time. This status is echoed in the corresponding output data of the SoE Diagnostic Block. The SoE Events Available status indicates that the PNS has captured events available to be read by the PLC. This is an indication to the SoE Application to request event data from the PNS.

5.5 Functions of the PROFINET Controller (PNC)

In addition to its role as a normal PROFINET Bus Controller, the CPU Embedded PNC retrieves SoE data from all the configured SoE Nodes and interfaces with its host PACSystems Controller (CPE330/CPE400/CPL410).

During initialization, it passes configuration information to each PROFINET Scanner, as appropriate for that PNS101.

5.6 Functions of the CPU

The CPU interfaces with the C Program Block and with the Embedded PROFINET Controller (PNC).

- a. It processes the Configuration represented in the User Memory-Map (Section 1) and passes that configuration information to the PNC, which in turn, passes segments to each PNS, as appropriate.
- b. Based on PNS Status information, it initiates the collection of SoE records from each SoE Node via the PNC and accumulates them for retrieval by the Historian/SoE Collector.
- c. Whenever the SoE Communication Buffer Handshake Word is zero, the CPU transfers SoE Records from the internal SoE Records Buffer to the Communication Buffer per the user-supplied configuration (Section 1).
- d. The CPU monitors whether the internal SoE Records Buffer is full. In response to a full condition, the more recent SoE records are lost and a diagnostic is produced (Section 6).

5.7 Functions of a Historian/SoE Collector

A Historian/SoE Collector interfaces with the CPU using an agreed protocol, such as SRTP, EGD.

- a. Whenever the SoE Record Communications Buffer Handshake Word is non-zero, the Historian/SoE Collector reads the contents of the SoE Records Buffer from the CPU for that number of records.
- b. Once all records have been transferred from the SoE Records Buffer, the Historian/SoE Collector needs to set the SoE Record Communications Handshake Word to zero, as that action tells the CPU that the buffer is available for the update again.
- c. The Historian/SoE Collector retains all SoE records collected in this fashion, in conformance with rules established by its operator.
- d. The Historian/SoE Collector then performs further SoE record analysis, as programmed by its operator.

5.8 Performance Considerations

For both Simplex and Redundant operation, each RX3i PNS101 device and each MDL module in the PNS rack will contribute time to the IO Scan sweep impact. The IO scan sweep impact is the same as non-SOE RX3i PNS001 devices and modules.

For Simplex (non-redundant) SOE operation, the SOE Application C-block has a logic execution time that impacts CPU sweep time.

The SOE_Application logic execution time can be estimated as follows:

SOE_Application Idle call: 0.02ms

SOE_Application Update call: 0.75ms per 1000 events added to SoE Records Buffer

An Idle call occurs when the app is either waiting for the next SoE Record Communication Buffer Handshake or there are no events in the internal buffer to move to the SoE Records Buffer. An Update call occurs when the SOE Application updates the SoE Records Buffer with new events.

The following formula estimates the SOE Application logic execution time for SoE Records Buffer Update calls of at least 1000 events or more:

$\text{SoeAppExeTimeMilliseconds} = (\text{eventCnt} * 0.00075)$

Since the maximum SoE Records Buffer event size is 32000, the worst-case SOE Application logic execution time is approximately 24ms. The worst-case logic execution impact can be reduced by configuring the SoE Records Buffer for a smaller size. In most cases, the SOE Application will be called in the Idle state so a minimal execution time will occur, but periodically the SoE Records Buffer will be updated and that will result in a larger execution time for that sweep.

For redundant SOE operation, the synchronization of buffered events from Active to Backup is the primary contributor to sweep time. This sweep impact is dynamic and can change from sweep-to-sweep depending on the number of events in the Internal buffer (not the SoE Records Buffer in user memory). To keep the sweep impact to a minimum, the external Historian/SOE Collector should empty the SoE Records Buffer at regular intervals and at a rate that keeps up with the SOE event generation rate.

There can be additional sweep time impact due to the SoE Records Buffer data in the Transfer List and the SOE_Application C-Block execution time. For the SoE Records Buffer data in the Transfer List, the sweep impact is constant each sweep. The sweep impact can be minimized by using a smaller SoE RecordsBuffer. Allowed redundant SoE Records Buffer sizes are between 1000 and 32000, so a size closer to 1000 will reduce the Transfer List sync time. For the SOE_Application C-Block, the logic execution times are equal to the simplex/non-redundant times. However, when the SOE_Application moves events from the internal buffer to the SoE Records Buffer the sweep time will likely be reduced because the impact due to synchronizing events in the internal buffer is greater than the SOE_Application logic execution time to move events to the SoE Records Buffer.

Below are typical sweep time impacts for SOE events in the internal buffer:

For 1 event queued -> 0.5ms

For first 1000 events -> 2.0ms

For each additional 1000 events -> 0.85ms per 1000.

The internal buffer's redundant synchronization is more efficient for larger event sizes. Below is an equation to estimate the sweep impact for internal buffer event counts over 1000.

CPE330	$\text{BufferSyncMilliseconds} = ((\text{eventCnt} - 1000) * 0.00085) + 2.0$
CPE400/CPL410	$\text{BufferSyncMilliseconds} = ((\text{eventCnt} - 1000) * 0.00150) + 2.0$

If the SOE internal buffer fills to its max size of 128000, then the sweep impact is approximately 110ms. Note, this formula is only approximate. There is variation in the sweep impact depending on how the events are queued and how many are queued. For example, if one PNS queues 8 events this may have less impact than 8 different PNS devices each queuing 1 event to the internal buffer. This calculation is an estimate only.

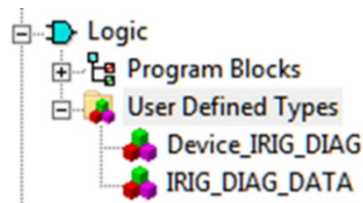
Section 6 Diagnostics

The SoE system drops the more recent events once the Internal Events Buffer overflows. There are indications that the buffer has overflowed in the memory map. Refer to the SoE Status Byte, bit 1 (Section 4.1, Memory-Map Definitions). Each SoE Node also has an Overflow bit in the Remote Station Overflow bits status register.

The IRIG_Diag C-Block is used to collect diagnostic info from the configured SoE devices.

The SoE Application provides a User Defined Type (UDT) for monitoring the diagnostic data collected by the Diagnostic block. The IRIG Diag Data UDT can be applied to the Diagnostic C Block by expanding the UDT node in the PAC Machine Edition Navigator pane and dragging the IRIG_DIAG_DATA element to the first output of Diagnostic C Block.

Figure 30: Logic Tree



6.1 Configuring the SoE Diagnostic Block

There are no input parameters for this C-Block.

The screenshots below show two methods of setting up the Irig_Diag C-Block Output parameters:

- Figure 31 shows a configuration using a UDT for the DiagArray output.
- Figure 32 shows a configuration using a WORD array output.

Figure 31: IRIG-B Diagnostics Output Parameters (UDT)

Parameters

Inputs Outputs

Name	Type	Length	Description
DiagArray	ANY UDT	1	3 diagnostic words per 32 devices
CVersion	WORD	1	Version of C Block (0x0100 -> 1.00)

OK Cancel >> Help

Figure 32: IRIG-B Diagnostics Output Parameters (Words)

Parameters

Inputs Outputs

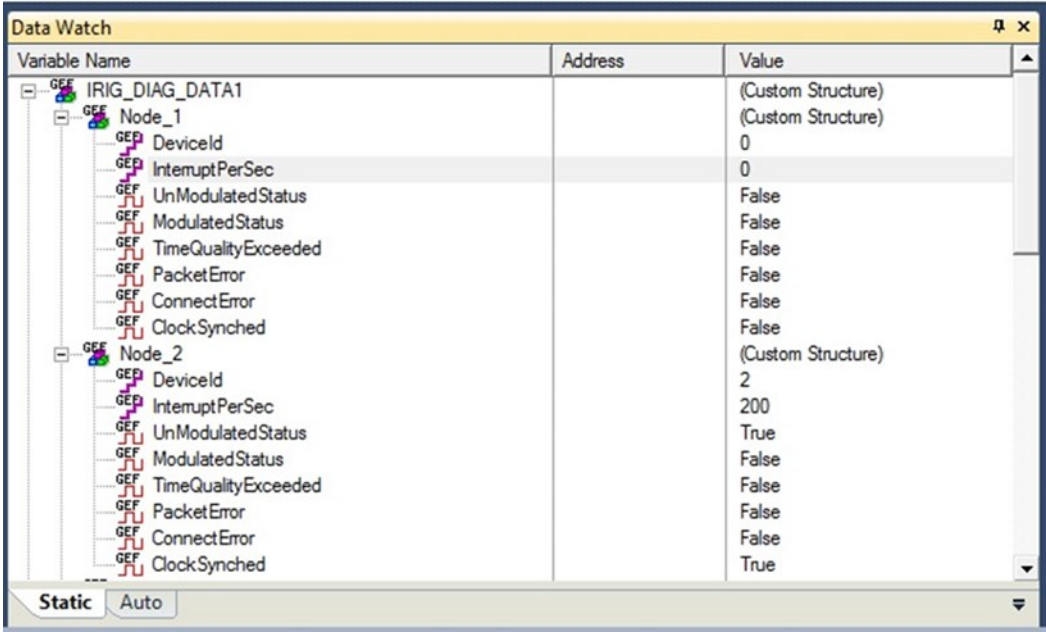
Name	Type	Length	Description
DiagArray	WORD	96	3 diagnostic words per 32 devices
CVersion	WORD	1	Version of C Block (0x0100 -> 1.00)

OK Cancel >> Help

6.2 Monitoring SoE Diagnostics

The IRIG-B diagnostics cannot be run on the first PLC scan, since the first scan is used to configure the SoE system. The diagnostics application requires that the SoE system be configured before it can query the PNS for diagnostic data. Any subsequent execution can run the diagnostics, as shown in Figure 33.

Figure 33: SoE Diagnostic Monitoring



The screenshot shows a 'Data Watch' window with a tree view on the left and a table on the right. The tree view shows a hierarchy starting with 'IRIG_DIAG_DATA1', followed by 'Node_1' and 'Node_2'. Each node contains a list of diagnostic variables. The table on the right displays the current values for these variables. The 'Static' tab is selected at the bottom.

Variable Name	Address	Value
IRIG_DIAG_DATA1		(Custom Structure)
Node_1		(Custom Structure)
DeviceId		0
InterruptPerSec		0
UnModulatedStatus		False
ModulatedStatus		False
TimeQualityExceeded		False
PacketError		False
ConnectError		False
ClockSynched		False
Node_2		(Custom Structure)
DeviceId		2
InterruptPerSec		200
UnModulatedStatus		True
ModulatedStatus		False
TimeQualityExceeded		False
PacketError		False
ConnectError		False
ClockSynched		True

6.2.1 SoE Diagnostic Definitions

Device Id	PNS device ID
Interrupt Per Sec	Set to the number of IRIG-B interrupts the PNS is detecting
Un Modulated Status	Set to true if the correct number of interrupts are seen for an unmodulated IRIG-B signal
Modulated Status	Set to true if the correct number of interrupts is seen for a modulated IRIG-B signal
Time Quality Exceeded	Set to true if IRIG-B packet IEEE-1344 extension time quality value is above 6
Packet Error	Set to true if last IRIG-B packet had an error of some kind
Connect Error	Set to true if no IRIG-B interrupts seen in the last second
Clock Synced	Set to true if the PNS has synchronized its internal clock to match the IRIG-B clock

Appendix A: SoE Record Format

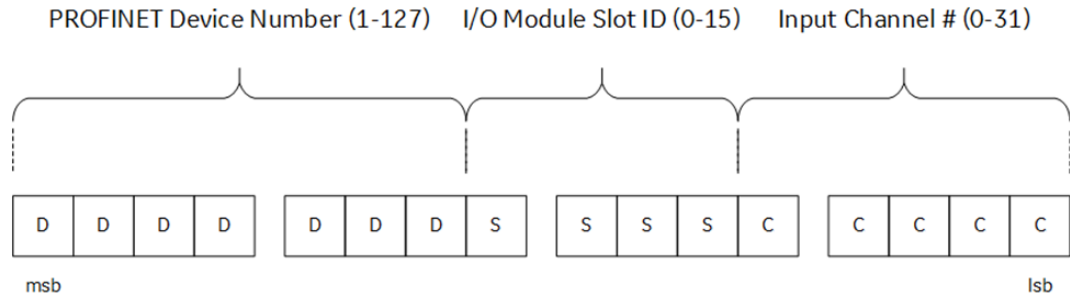
The SoE record structure provides very specific information about the physical location of the SoE event and the nature of the event (i.e., which channel in what SoE Node detected the event, whether the channel transitioned from low-to-high or from high-to-low, and the associated time-stamp and its validity). The SoE record provides complete details for the SoE collection tools.

Word 1 is the most significant word. Word 10 is the least significant word.

Word#	Field	Description	Range
1	YYYY	Year	2000 - 2099
2	MM	Month	1 - 12
3	DD	Day	1 - 31
4	HH	Hour	0 - 23
5	MM	Minute	0 - 59
6	MS	Millisecond	0 - 59999
7	Event Location	Event Location formatted as DDDD DDDS SSSC CCCC (see Figure 34 below).	0 - 65535
8	Channel Event Count	The number of SoE events for this channel since the PACSystems controller powered up. Note: <i>PNS does not stop collecting. This count resets only upon overflow, whenever the downloaded PNS configuration is updated with a different configuration, or when the PNS is power-cycled.</i>	0 - 65535
9	Station Event Count	The number of SoE events for ALL configured channels since the PACSystems Controller powered up.	0 - 65535
10	Event Status/ Channel Transition	Event Status formatted as xxxx xxxV xxxT (see Figure 35 below)	V = 0/1 T = 0/1

A.1 Decoding Event Location

Figure 34: Decoding Event Location



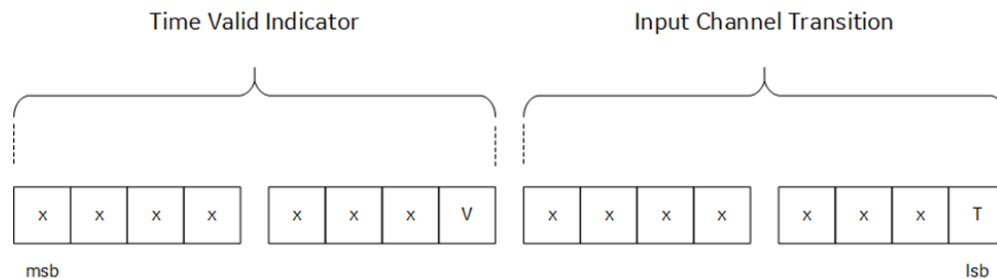
The most significant seven bits, denoted by DDDDDDD above represent the PROFINET Device Number of the PNS Module from which the event was generated. Note that zero is not a permitted value and that Device Numbers over 127 are not supported by the 7-bit format. Thus, all PNS modules used in this SoE application need to use a unique PROFINET Device Number in the range 1-127.

The next four bits, denoted by SSSS above, represent the slot number occupied by the I/O Module which detected the SoE event. Refer to Section 2.2, SoE Node Configuration for the constraints placed on the relative location of the PNS Module and the Input modules which support SoE. Both the PNS with the Device ID indicated in the seven most significant bits and the I/O module represented here by SSSS reside in the same RX3i I/O Rack.

The lowest five bits, denoted by CCCCC above, represent the specific I/O Channel which detected the SoE event. The Channel Number is associated with the input module located at slot SSSS.

A.2 Decoding Event Status

Figure 35: Decoding Event Status



Only two bits in the Events Status Word are used:

V, when returning 1, indicates that the IRIG-B based time-stamp is valid. 0 indicates not valid.

T indicates the direction of transition for the indicated SoE channel (refer to Figure 34).

T = 0 indicates 1 → 0 transition for that channel;

T = 1 indicates 0 → 1 transition.

Note: those bits indicated as "x" are reserved for future use and should not be assumed to be zero.

Appendix B: Duplication of Events

The SoE implementation attempts to minimize or eliminate the possibility of duplicated events, but there are some situations where duplication of events may still occur.

If a PNS sends SoE records to the CPU, but the PNS becomes disconnected before the CPU acknowledges the events. Then the events will remain in the PNS device's event queue. When the PNS device connection is later reestablished, the events previously sent to the CPU may be repeated.

In a redundant system with SoE, Active status may switch between Primary and Secondary units along with the Redundant IP assignment. If the external Historian/SoE Collector sets the SoE Record Communication Buffer Handshake word to 0 just before a switch of Active units, then the updated SoE Record Communication Buffer Handshake value may not get transferred to the new Active unit. When the Redundant IP moves to the new Active unit, the Historian/SoE Collector will see the SoE Record Communication Buffer Handshake at its previous value and not cleared to 0. Thus, the Historian/SoE Collector may interpret this as new events, but these records are the same events it previously consumed. This situation can be avoided if the Historian/SoE Collector takes the extra step of also checking the SoE Records Buffer update counter. If the update counter is the same value as the previously consumed events, then the Historian/SoE Collector could write the SoE Record Communication Buffer Handshake to 0 again and wait for a non-zero value.

Appendix C: SoE Data Retrieval Example

The following example demonstrates the operation of a simplex SoE configuration with a single PNS node. This sections uses an example application for PAC Machine Edition application that is available in the *Workshop_SoE.zip*, which is included in the *SoE Application Software Bundle* (Figure 36). This software bundle can be found on Emerson's support site (links are provided at the end of this document.) The HMI (QuickPanel+) demonstrates a *Run in Simulation* mode on PAC Machine Edition View.

Figure 36: PROFINET SoE Application Software

PROFINET SoE Application Software

Customer Page URL: https://digitalsupport.ge.com/communities/en_US/Download/PROFINET-SoE-Application-Software
 Partner Page URL: https://ge-ip.force.com/communities/en_US/Download/PROFINET-SoE-Application-Software?Type=Download__kav&id=ka40h000000LWmj
 Internal Page URL: https://ge-ip--c.na28.visual.force.com/apex/KnowledgeDetailWithoutHeaderFooter?id=ka40h000000LWmj&Type=Download__kav&lang=en_US
 Id: 000021292
 Average User Rating: ★★★★★ Your Rating: ★★★★★ Last Updated: 08/30/2018 Date Created: 08/29/2018
 Products: PACSystems RX3i Categories: Software Add-On
 Channels: Internal App, Partner, Customer, Public Knowledge Base
 Status: Not Validated

Attached Files

SoE_App_Bundle_v1.zip 15 MB
 Posted: 8/30/2018
 Sequence of Events (SoE) application bundle Version 1

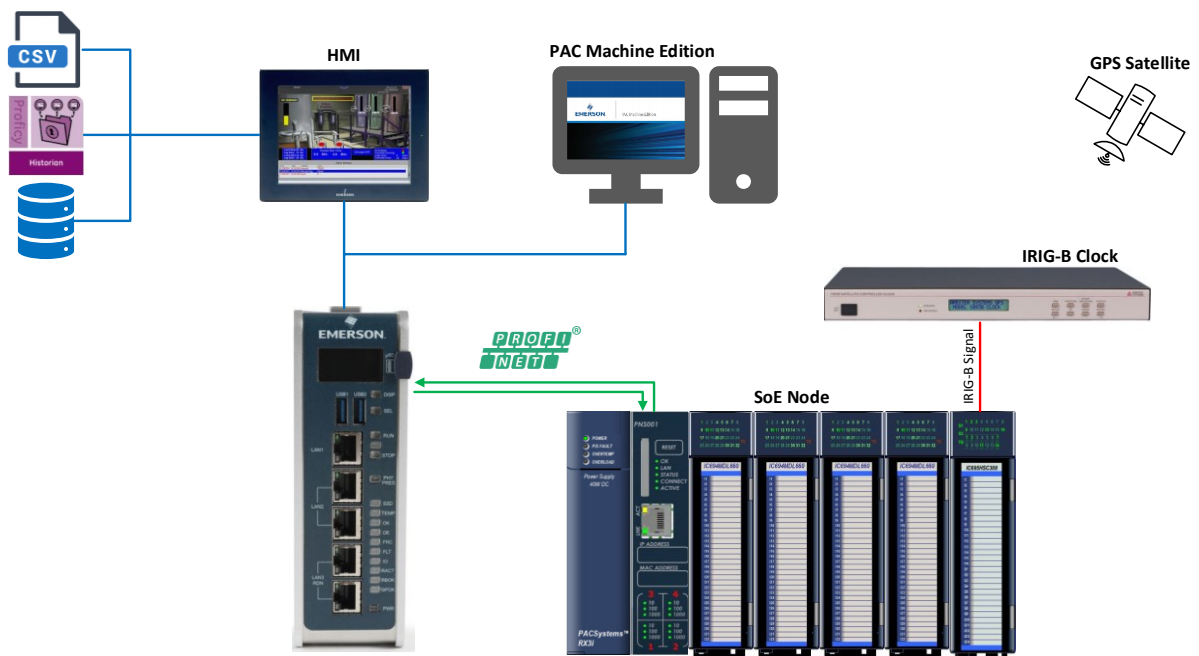
Select Language: English

Sequence of Events (SoE) application bundle zip.
 Includes the following in the zip:
 EULA - End User License Agreement
 SoE_App.gefEif - SoE Application C-Block
 Irig_Diag.gefEif - IRIG-B Diagnostic C-Block
 IRIG_DIAG_DATA.UDT - PME User Defined Type (UDT) for optionally interpreting
 Irig_Diag C-Block output
 SOE_Example_Project.zip - PME project with SoE application example

Additional details about Sequence of Event operation can be found in the [PACSystems RX3i Sequence of Events User Manual, GFK-3050](#)

Note: SIM 13 for Machine Edition 9.5 might be required for this to install properly.

Figure 37: Sample Block Diagram of a SOE Data Retrieval Solution



C.1 Preparing the RX3i Controller

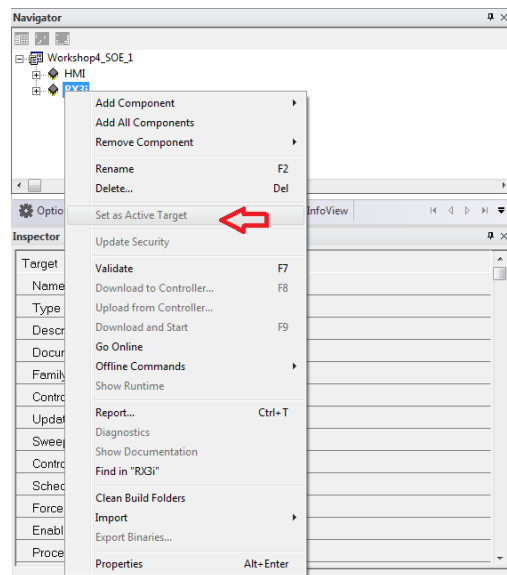
Before the controller can retrieve SoE records, the target controller must be prepared to maintain SoE information locally for applications requiring real-time decisions based on the logged data.

Setting the RX3i Controller as an Active Target

1. After opening the project, right-click the RX3i controller and set it as the Active Target.

Note: If the RX3i is Active Target then the selection will be greyed out. If not, select it. We want the RX3i to be the Active target in order to ensure proper flow of this application.

Figure 38: Set as Active Target



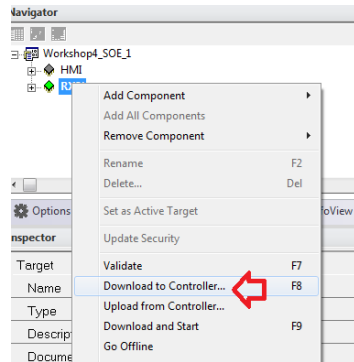
2. Right-click the RX3i target and choose **Go Online**. When Online, the node beside the RX3i target will change to green. The bottom-right hand corner of PME will also show the controller's status details.

Downloading to the Target Controller

Now that the controller has been prepared, download the logic, hardware configuration and variables to the controller.

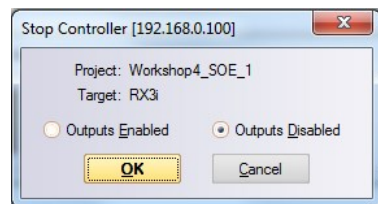
1. Right-click on the RX3i target and click **Download to Controller**.

Figure 39: Download to Controller



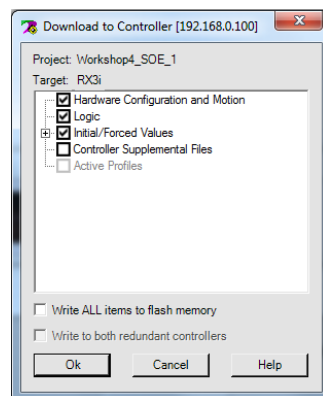
2. Choose **Outputs Disabled** and then **OK**.

Figure 40: Outputs Disabled



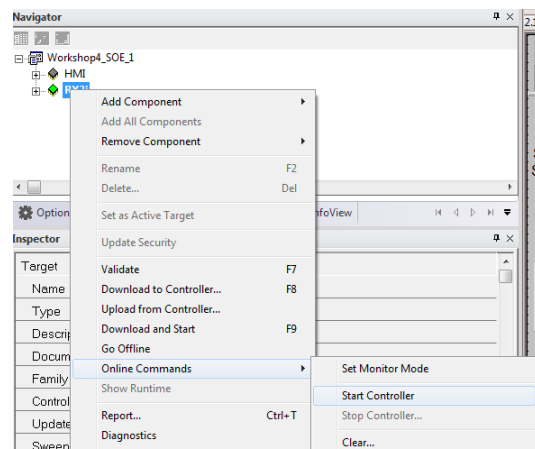
3. The Download to Controller window will appear. Check the checkboxes for **Hardware Configuration and Motion**, **Logic**, and **Initial/Forced Values** (Figure 41). Select **OK**.

Figure 41: Download to Controller Options



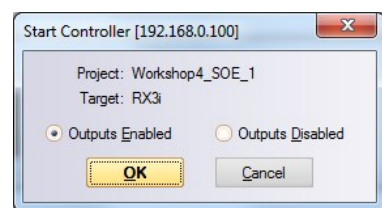
4. Right-click the target RX3i controller, navigate to **Online Commands**, and start the controller (Figure 42).

Figure 42: Restart the Controller



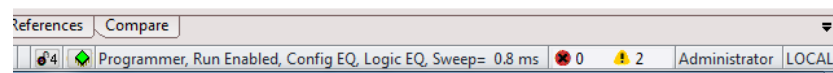
5. Select **Outputs Enabled** and OK.

Figure 43: Outputs Enabled



6. Ensure the status in the bottom-right looks like Figure 44.

Figure 44: Controller is running



C.2 Reviewing Downloaded Logic, Hardware Configuration, and Initial/Forced Values

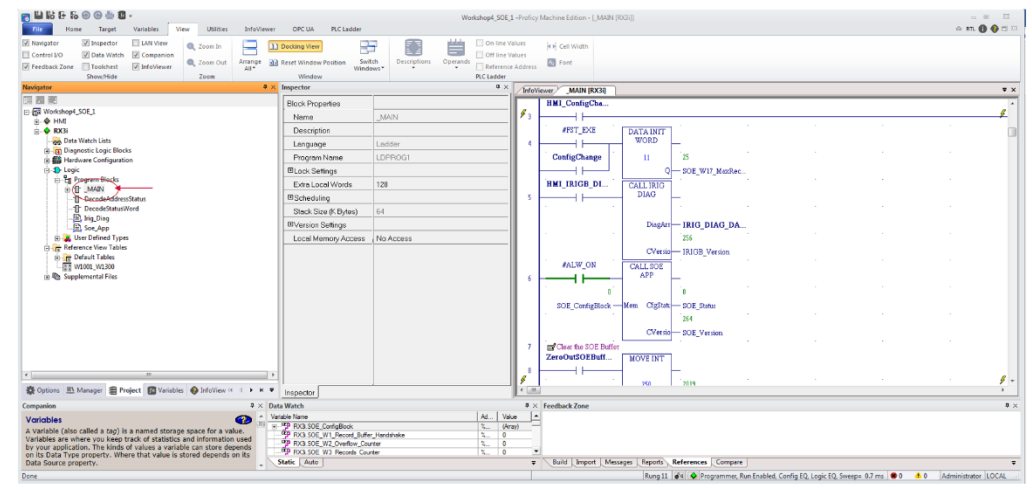
This section shows the user how to review and edit the three download outputs from the previous section. While the sample application in the ZIP file is functional, it is only meant to serve for illustrative purposes and users will need to customize the logic, hardware configuration (HWC), and variables to suit their needs.

To begin, we need to view the logic that was downloaded to the controller in the previous section.

Viewing the Logic

1. Open the **Program Blocks** node to reveal **_MAIN**.
2. Double-click the **_MAIN** Ladder Diagram node so that the InfoViewer looks like Figure 45.

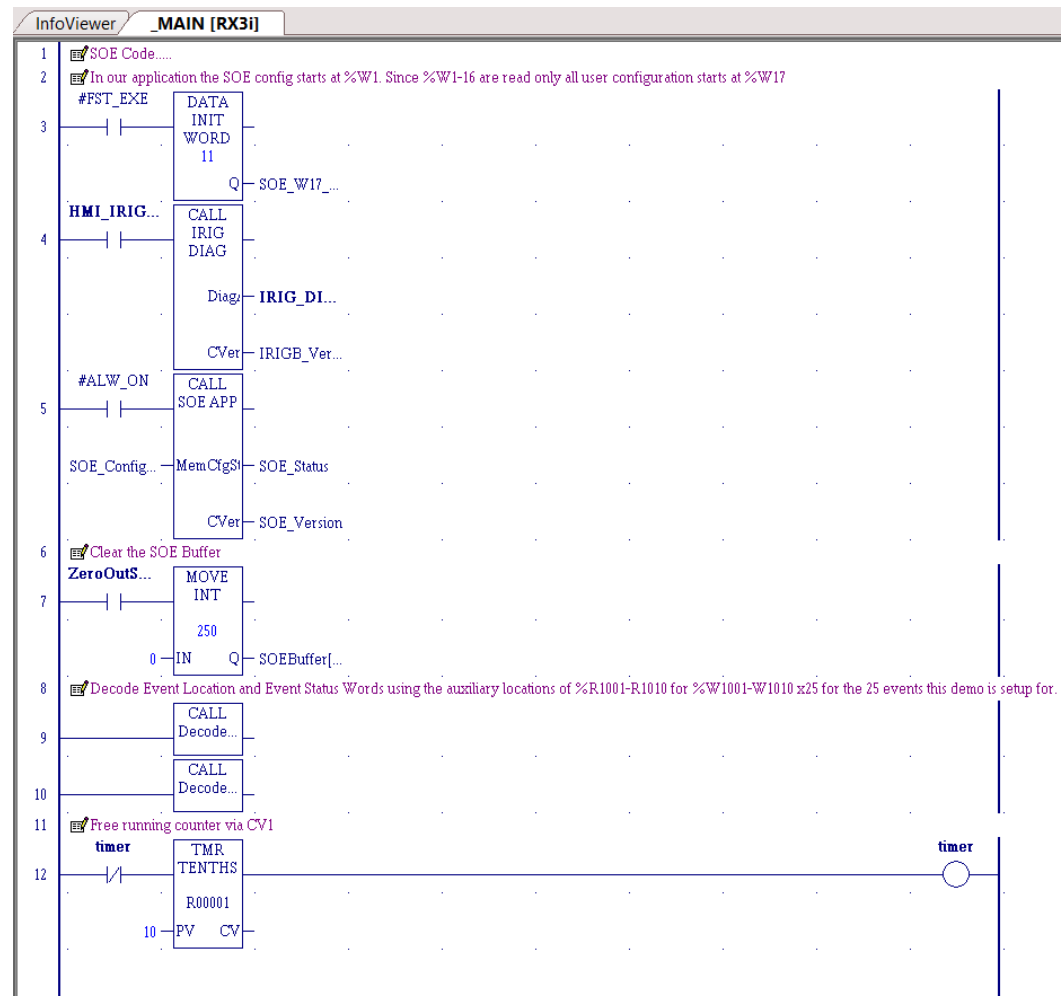
Figure 45: **_MAIN** Ladder Diagram



Analyzing the Logic

The InfoViewer will reflect the ladder diagram below. The definitions following Figure 46, will describe each component.

Figure 46: RX3i Target



Ladder Diagram Overview

- Rungs 1 & 2 are comments.
- Rung 3 is driven by the first scan bit to configure the SoE Application. For this application, SoE records are starting at memory location %W1000. Since %W1-W16 are read-only, user configuration starts at %W17 which is the Maximum Number of SOE Records buffered in CPU. The Data Init length is 11 because this application only has one PNS drop therefore we do not have to configure the other 3 PNS drops from %W28-W39.

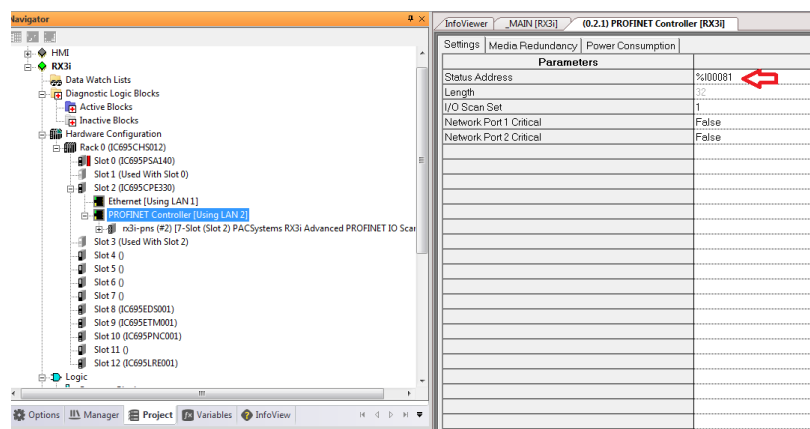
Note: To configure additional PNSs, set the number in %W23 (Number of SoE Nodes) and repeat the information in %W24-W27 for each PNS.

- Rung 4 is toggling the IRIG_Diag C-Block used to collect diagnostic info from the configured SoE devices.
- Rung 5 is a call to SoE_App C-block. The block takes an input pointing to the base location of the SoE User Memory Configured at Rung 4 and provides two words of feedback: SOE_Status and SOE_Version.
- Rungs 6 & 7 show a simple way to Zero out 250 consecutive words. This function is tied to a Momentary On button on the Quickpanel+ application allowing us to zero out the SoE buffer while experimenting with the features.
- Rungs 8 & 9 call DecodeAddressStatus block that creates an additional table that breaks out any SoE words that contain more than one piece of information and save records and their respective information into SoEBuffer[] array.
- Rung 10 call to DecodeStatusWord block that decodes the SoE Status Flag at memory location %W0004 and the Remote Station Overflow bit 1 at memory location %W00011. Since this application has one PNS101, only one bit of the Remote Station Overflow register at %W00011 is decoded to generate a remote station overflow bit. The following Boolean variables are set to ON as follows:
 - PNS101_BufferOverflow: SoE Status Flag bit 1 is ON
 - PLC_RestartedFlag: SoE Status Flag bit 2 is ON
 - PNS101_Buffer_50PrecentFull: SoE Status Flag bit 4 is ON
 - PNS101_Buffer_75PrecentFull: SoE Status Flag bit 5 is ON
 - PNS101_1_Overflow: Remote Station Overflow bit 1 is ON
- Rung 11 and beyond are for testing purposes.

Viewing the Hardware Configuration

1. Expand the **Hardware Configuration** node under the target RX3i controller.
2. Inspect the built-in LAN2 PROFINET Controller and take note of the status address.

Figure 47: LAN2 PROFINET Controller



- ### Figure 48: SoE Configuration



Figure 49: IRIG-B Time Source

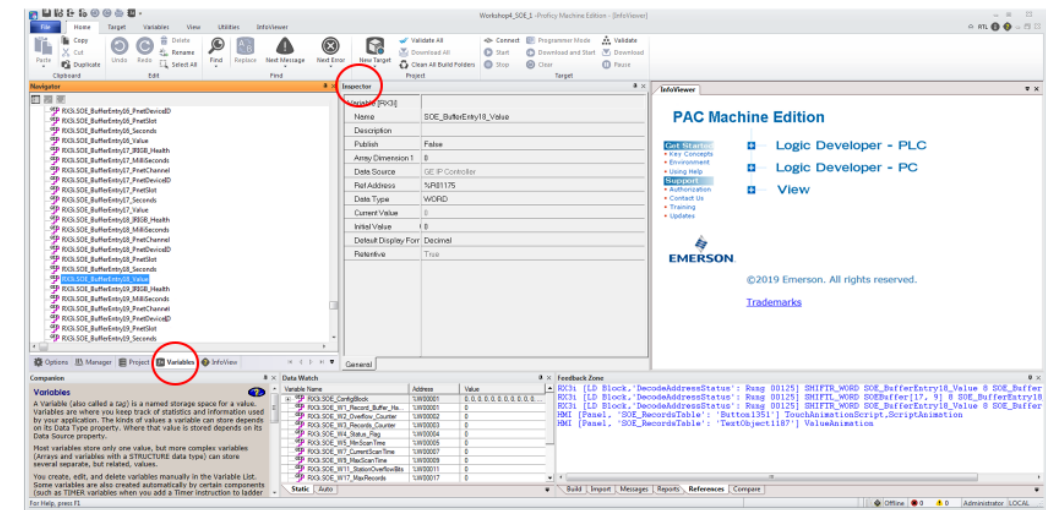


Viewing the Variables

The variables reviewed in this subsection are specific to the demo application. This section serves as an aid only.

1. In the **Navigator Window**, choose the **Variables** tab.
2. In conjunction with the **Inspector Window**, inspect the various variables associated with the application.

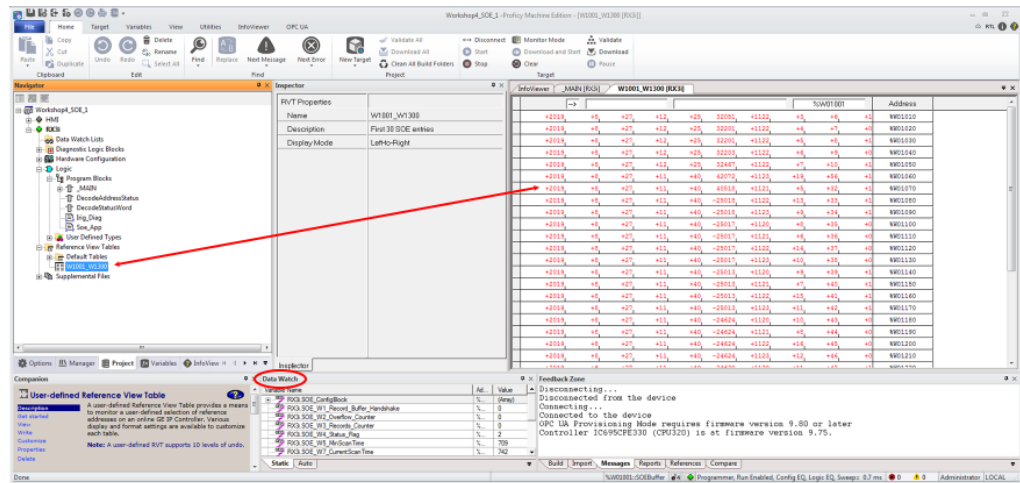
Figure 50: Variables to Watch



Leveraging the Watch Windows

Pre-configured groups of variables are set up in order to help see all of the variables in several areas.

Figure 51: Gouped Variables



The raw %W table has most of the data. You can create events on the IO simulator and watch their effect on the %W tables.

The Data Watch window is another way to see data focusing on descriptors instead of raw data. The entire system is functional at the logic level. However the HMI makes it so much easier to see how to interact with the system. If you want to try something at this level, zero out the first variable in the data watch list, SOE_W1_Record_Buffer_Handshake. If a number is returned, that is how many new events you just received. Keep zeroing until it stays at zero. At this point, we are awaiting a new event.

C.3 HMI Target

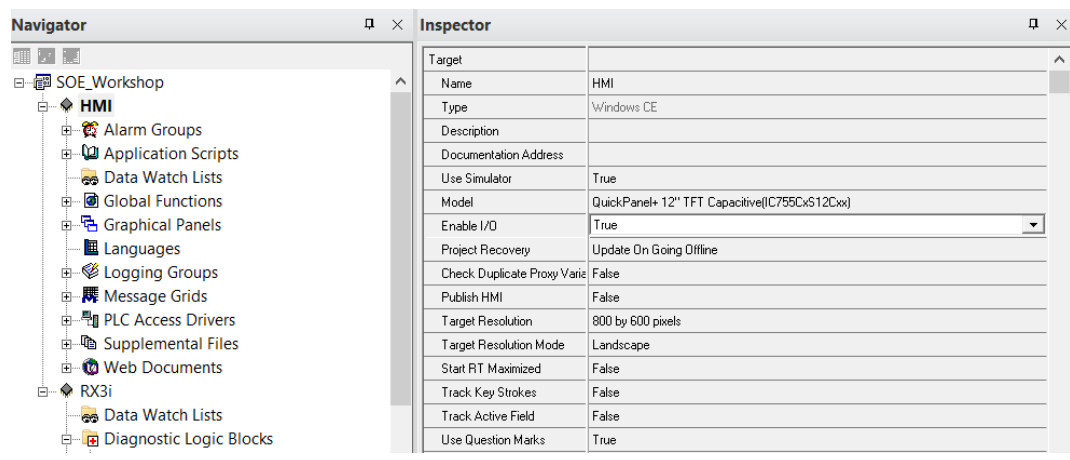
This section is on how to utilize a local HMI to visualize and log the SOE data on a local storage media. This allows for a robust long term and low-cost logging solution.

One of the advantages of using the Quickpanel+ application is it can run in Simulation Mode on a PC. Before running in Simulation Mode, verify that the application is fully functional by turning the **Enable IO** parameter to True. We can then Download and Start the Quickpanel+ application on the PC.

To run the target in simulation mode:

1. Select the target and turn the Enable I/O to **True** in the inspector pane.
2. Download and Run the Quickpanel+ application.
3. ThenDownload and Start the Quickpanel+ application on the PC.

Figure 52: Enable I/O Parameter Set to True

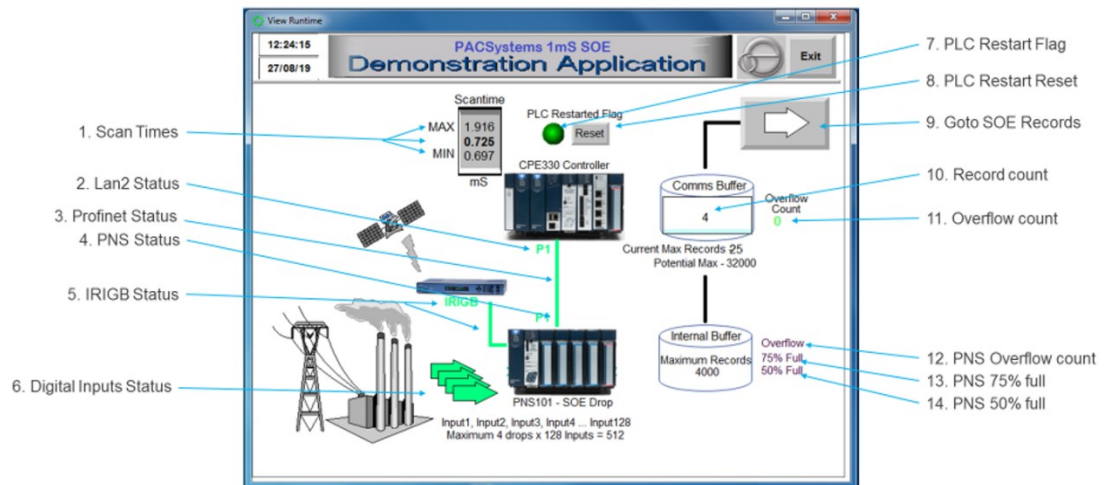


QuickPanel+ Application (HMI)

The QuickPanel+ application simulates runtime values of the system. The user can review components statuses of the system in real time.

The following definitions describe the key features of the demo application and how to interact with the HMI.

Figure 53: Demonstration Application



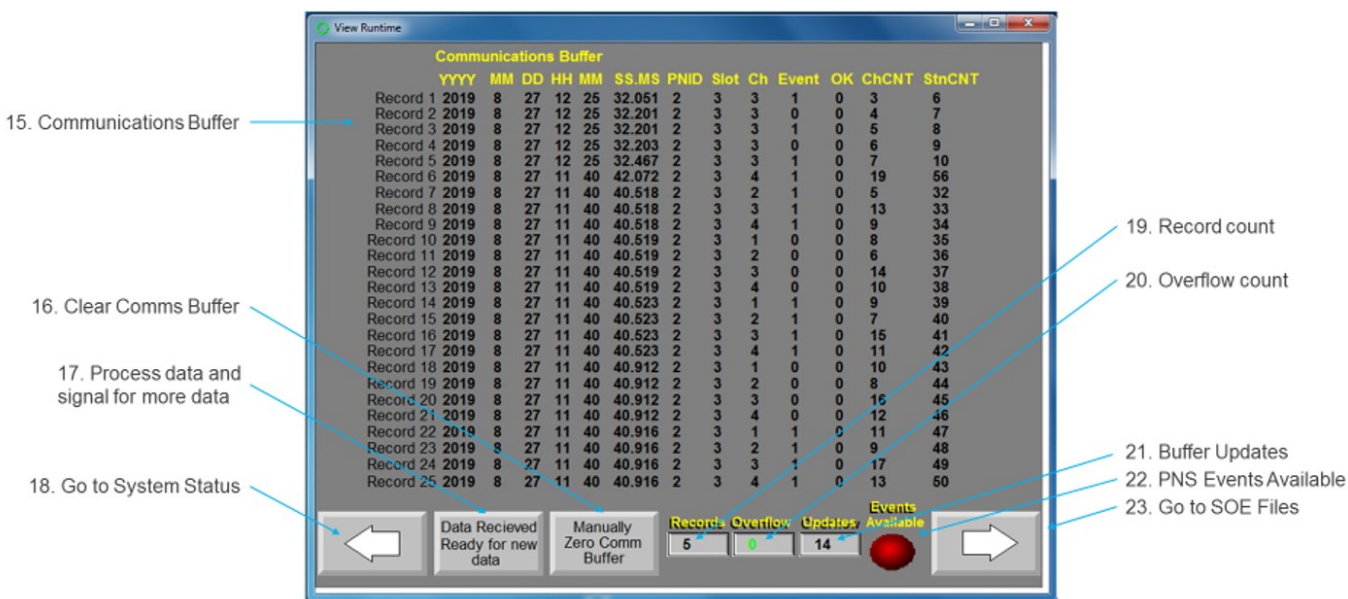
1. Scan Times: this item displays minimum, current, and maximum PLC scan times converted to mS for display. These are words (5), (7), and (9) of the SoE User Memory Map.
2. LAN2 Status: monitors which ports are connected to other devices using LAN2 Profinet Status Bits on the CPU.
3. PROFINET Device #1 Status: monitors the PNS OK status bit. Green indicates the module is functioning properly, and red indicates the module is powering up or has failed.
4. PNS Device #1 Status: monitors which port is connected and whether or not it's communicating using the PNS101 status bits.
5. IRIG-B Status: this reflects the PNS Synchronized to the GPS global time status bit
6. Digital Inputs Status: monitors the status of inputs 1 through 4 on the MDL module.
7. PLC Restart Flag: indicates if a power cycle occurred. Helpful in pointing to a possible loss of data. Obtained by reading SoE Status (word 4) bit 2 of the SoE User Memory Map.
8. PLC Restart Reset: writing zero to the PLC Restart flag (SoE Status Bit 2 of the SoE User Memory Map).
9. Go to SoE Records Table
10. Record Count: shows the number of events that are available in the SoE Records Buffer. This is obtained by reading the SoE Record Communication Buffer Handshake word (first word of the SoE User Memory Map).
11. Overflow Count: indicates the number of times the internal buffer overflowed. This is obtained by reading the second word of the SoE User Memory Map.

12. PNS Overflow Count: indicates the internal events buffer has overflowed.
Obtained by reading SoE Status word (4) Bit 1 of the SoE User Memory Map.
13. PNS 75% Full: obtained by reading SoE Status word (4) bit 5 of the SoE User Memory Map.
14. PNS 50% Full: obtained by reading SoE Status word (4) bit 4 of the SoE User Memory Map.

SoE Records

Clicking on the large arrow (item #9) in the previous section will direct the user to the SoE Records Table. This screen will show all 25 SoE Records and their decoded locations and event statuses.

Figure 54: SOE Records Table

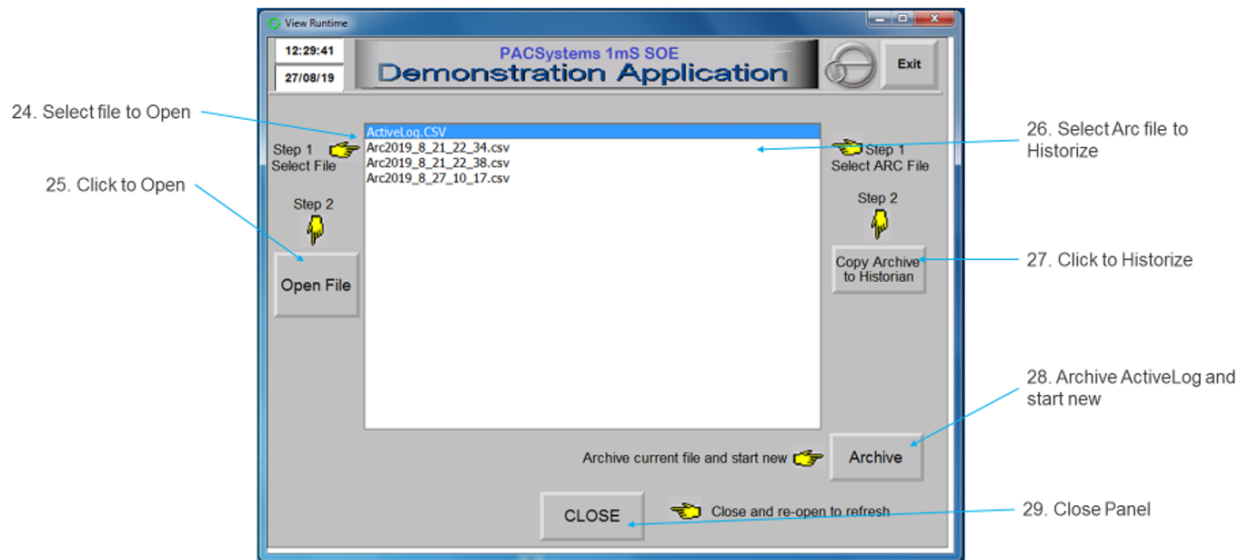


15. Communications Buffer: this table lists all 25 SoE records
16. Clear Communications Buffer: this button is linked to the variable ZeroOutSOEBuffer (%M01003) in **_MAIN** block to clear the SoE buffer. This writes zero to 250 consecutive words starting at memory location %W01001.
17. Process data and Signal for more data: this button executes a ViewScript that essentially does the following:
 - a. This button logs the current batch of events to a CSV file
 - b. Writes zero to SOE_W1_Record_Buffer_Handshake (first word of the SoE User Memory Map) to signal availability for more SoE records
18. Go to System Status
19. Record Count: this is reading the current SOE_W1_Record_Buffer_Handshake (first word of the SoE User Memory Map).
20. Overflow Count: indicates the number of times the internal buffer overflowed. This is obtained by reading the second word of the SoE User Memory Map.
21. Buffer Updates: shows how many batches of events we have received since startup. This is obtained by reading SoE Records Buffer Update Counter (word (3) of the SoE User Memory Map).
22. PNS Events Available: pulses to show there are new events awaiting requesting. This indicator reads SoE Events Available bit of the PNS101 status bits.
23. Go to SOE files

SoE File Manipulation

Clicking the Right Arrow in the previous section takes you to the SoE File Manipulation screen. The following definitions describe the actions available.

Figure 55: SoE File Manipulation



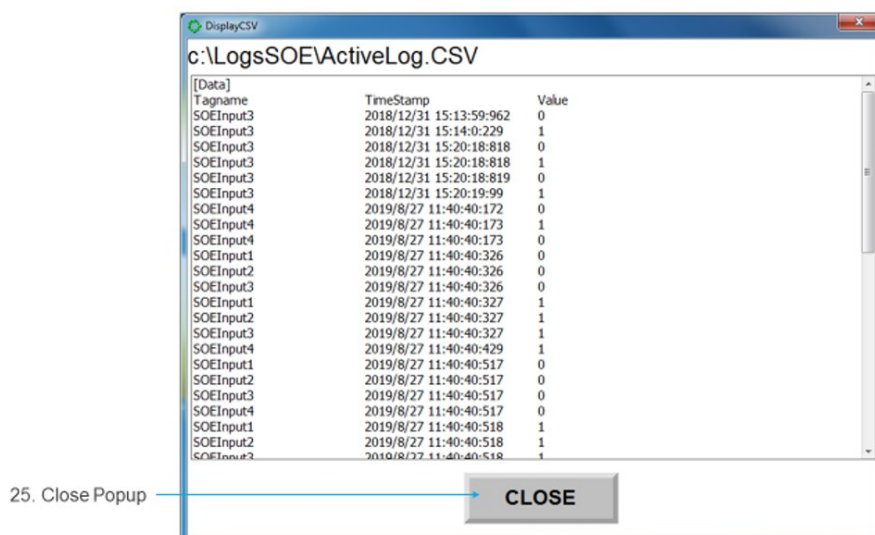
24. Select file to Open: this window shows all the archive files available. All current events are logged to ActiveLog.csv after pushing button 17.
25. Click to Open: once a file is selected, we can open for viewing using this button.
26. Select Arc file to Historize: select any file other than ActiveLog.csv. This file is used for any new events to be logged.
27. Copy Archive to Historian: the CSV files in this example are already formatted for the GE Historian File Collector. Simply move this file to the File Collector Incoming directory for ingestion into Historian.
28. Archive ActiveLog and start new: this button will use the current time and date to create an archive file using the current ActiveLog.csv file and create a new one.
29. Close Panel

This popup is triggered by the Open File Push button on the SoE File Manipulation screen.

In here you should see all of your events captured with 1mS accuracy.

The HMI application employs some interesting features. An advanced user could find interest in some of the techniques employed. As an example a startup script exists that can tell if the project is running on an actual Quickpanel+ which would mean the data would be logged to an SD Card or whether it is running on a PC at which point the data is logged to C:\SOELogs.

Figure 56:Logs



This popup is triggered by the Open File button (25). Displayed here is all the events captured with 1mS accuracy.

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