cRIO PN – C SERIES PROFINET IO Slave Module

Getting started

V2.3/20.09.2017

Revision History

Version	Date	Description	Resp.
V2.3	20.09.2017	Kunbus Branding, Location of Example / GSD changed because of VIPM package	AME
V2.2	23.06.2015	Schreibfehler Seite 15 Slot von 0-16 auf 1-16 korrigiert	SKR
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1 Introduction

This document describes the set into operation procedure of the cRIO PN module as IO-Device.

1.1 Worldwide Support and Services

The National Instruments website is your complete resource for technical support. At *ni.com/support*, you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

1.2 Prerequisites:

- Download **KUNBUS** cRIO PN driver software from LabVIEW Tools Network
- National Instruments cRIO system with real time controller and chassis.
- The National Instruments LabVIEW Real time and FPGA Development System from Version 2012 installed on a Windows PC.
- A PROFINET IO-Controller System connected to the cRIO PN IO-Device module.

2 Installation

- Install the cRIO PN according the document ***cRIO PN – Installation Instructions***
- Switch on the CompactRIO system
- Install the **KUNBUS** cRIO PN driver software downloaded from Tools Network
- Check by the NI MAX (Measurement & Automation explorer) the proper installation of the cRIO system:

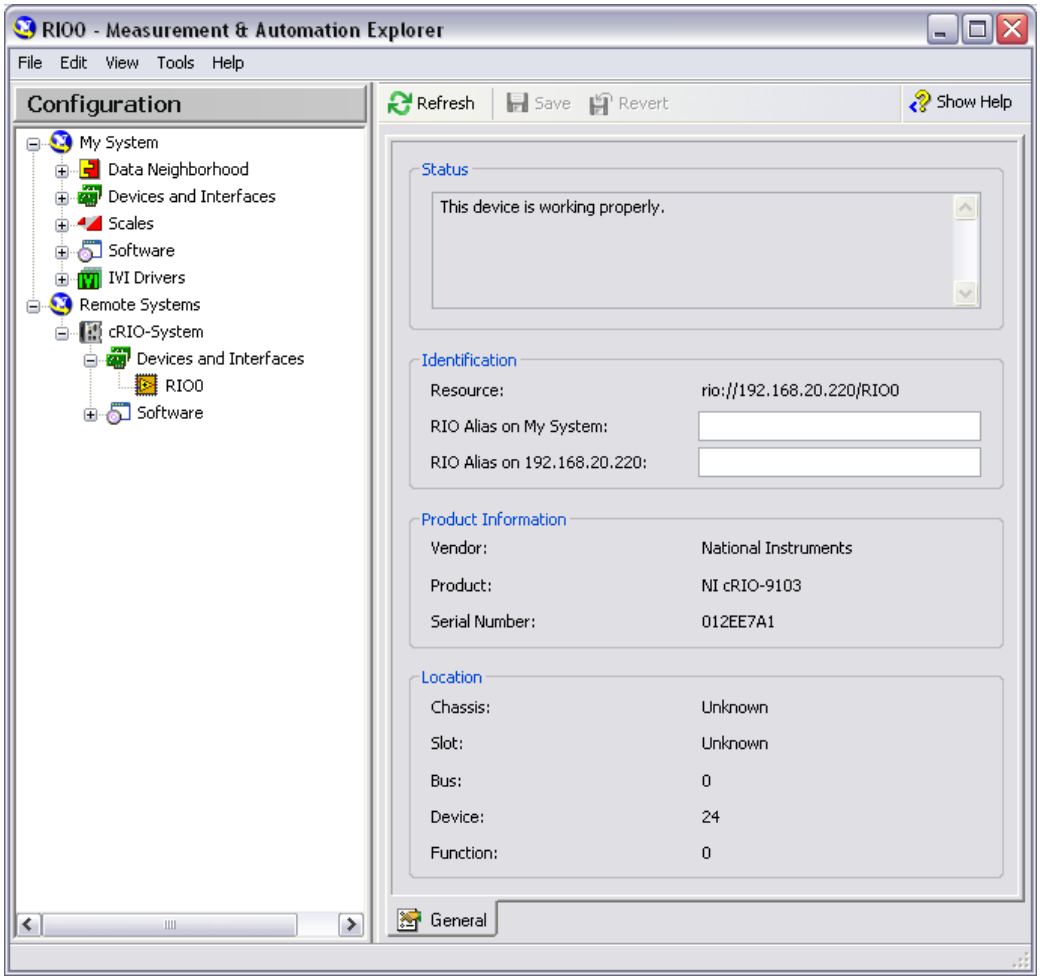

Figure 1: Measurement and Automation Explorer

Note: The cRIO PN module will be not displayed here.

3 Configuring the PN IO-Controller with the cRIO PN IO-Device module

To get the cRIO PN module into operation it must be configured on PN IO-Controller system to be in use. For this the cRIO PN module ships with a GSDML (GSD) file that can be imported on the PN IO-Controller configuration tool.

The cRIO PN GSDML file **GSDML-Vx.x- Kunbus-cRIO PN-yyyymmdd.xml** can be found in the folder "…\Public\Documents\Kunbus GmbH\GSDML". Additionally the GSDML file is included in the auto populating folder "GSDML" inside the PROFINET Device Example project.

4 FPGA Method Nodes

The lower level cRIO PN Module API consists of FPGA I/O Method and Property Nodes to be integrated into a FPGA based application. Additionally an easy to use high level RT API is available (see chapter 6).

3 different APIs are available:

1. IO Data:
   Read and Write IO data from/to the cRIO PN I/O-Device.

2. Alarm Data:
   Acyclic Alarm handling from/to the cRIO PN I/O-Device.

3. Record Data:
   Read and Write Record data from/to the cRIO PN I/O-Device.

Add your FPGA target to a LabVIEW project. LabVIEW will discover your module automatically if it is connected.

Complete the following steps to add the cRIO PN module to a LabVIEW project if the module is not connected:

1. Right-click your FPGA Target in the Project Explorer window and select **New » C Series Modules** from the shortcut menu to display the Add Targets and Devices dialog box.

2. Click the **New target or device** radio button, select **C Series Module**, and click **OK** button to display the New C Series Module dialog box.

3. Select the **CS_cRIO-PNAD** module from the **Module Type** pull-down menu and click the **OK** button.

After the CS_cRIO-PNAD module is added, the cRIO PN Module API is displayed in the project as shown in Figure 2.

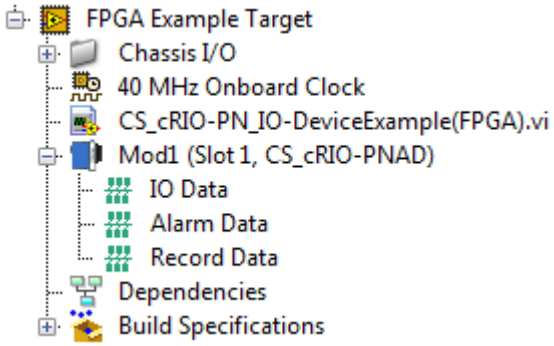

Figure 2: cRIO PN Module API

4.1 IO Data Methode Nodes

4.1.1 Read/Write IO Data Method

The Read/Write IO Data Method transmits input data to the IO Controller and receives output data from the IO Controller. The related I/O data are stored in the internal memory. Additionally the method sets the IOPS input status and returns the IOCS output status of the IO Device Slot. The internal memory can be accessed by the Get Output Data Method and the Set Input Data Method.

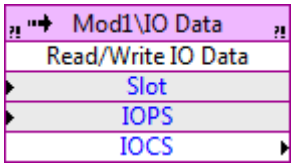

Figure 3: Read/Write IO Data Method Node

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot
IOPS Input status	0x00	Bad by Subslot → Input data not valid
	0x80	Good → Input data valid
IOCS Output status	0x00	Bad by Subslot → Input data not valid
	0x80	Good → Input data valid

Table 1: Read/Write IO Data Parameter

4.1.2 Get Output Data Method

The Get Output Data Method reads a single byte from the IO Controller's output data stream from the internal memory. Additionally the method returns the configured output data length of the IO Device. Use the Read/Write IO Data Method first to update the internal memory with the latest IO Controller data.

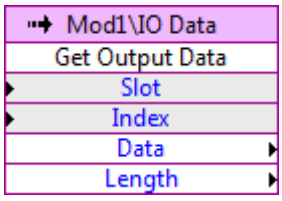

Figure 4: Get Output Data Method Node

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot
Index	0 – 253	Byte-Address of the IO Device output data stream Index 0 = Output Byte 0; Index 1 = Output Byte 1; …
Data	0 – 255	Output data byte
Length	0 – 254	Configured cRIO PN Output data size *Note: If the value may not return the real configured output data length, please contact the KUNBUS GmbH to get the latest firmware update of the cRIO PN.*

Table 2: Get Output Data Parameter

4.1.3 Set Input Data Method

The Set Input Data Method writes a single byte of an IO Device's input data stream to the internal memory. Use the Read/Write Data Method subsequently to transmit the input data stream from the internal memory to the IO Controller. Additionally the method returns the configured input data length of the IO Device.

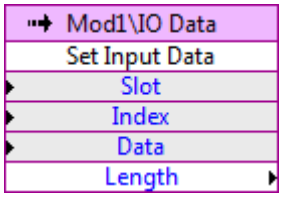

Figure 5: Set Input Data Method Node

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot
Index	0 – 253	Byte-Address of the IO Device input data stream Index 0 = Input Byte 0; Index 1 = Input Byte 1; …
Data	0 – 255	Input data byte
Length	0 – 254	Max cRIO PN Input data size *Note: If the value may not return the real configured output data length, please contact the KUNBUS GmbH to get the latest firmware update of the cRIO PN.*

Table 3: Get Input Data Parameter

4.2 Alarm Data Method Nodes

4.2.1 Read/Write Alarm Method

The Read/Write Alarm Method handles specific diagnostic- and alarm messages. The related diagnostic- and alarm data are stored in the internal memory. The internal memory can be accessed by the Set Diagnostic Data Method and the Set Process Data Method.

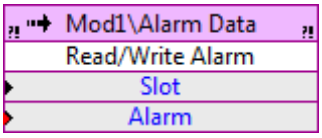

Figure 6: Read/Write Alarm Method Node

Note: All PN IO alarms are always slot specific.

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot
Alarm	0: Pull Alarm	Triggers a slot related pull alarm on the cRIO PN module
	1: Plug Alarm	Triggers a slot related plug alarm on the cRIO PN module
	2: Set Diagnostic Alarm	Activates a slot specific diagnostic alarm on the cRIO PN module
	3: Reset Diagnostic Alarm	Deactivates a slot specific diagnostic alarm on the cRIO PN module
	4: Set Process Alarm	Triggers a slot specific process alarm on the cRIO PN module

Table 4: Read/Write Alarm Parameter

4.2.2 Set Diagnostic Data Method

The Set Diagnostic Data Method writes a single byte of an IO Device's diagnostic data stream to the internal memory. Additionally the method returns the maximum diagnostic data length of the IO Device. Use the Read/Write Alarm Method subsequently to transmit the diagnostic data stream from the internal memory to the IO Controller.

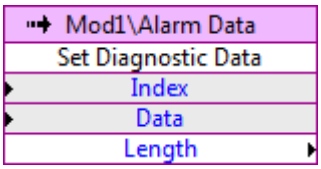

Figure 7: Set Diagnostic Data Method Node

Parameter	Value	Description
Index	0 – 253	Byte-Address of the IO Device diagnostic data stream Index 0 = Diag Byte 0; Index 1 = Diag Byte 1; …
Data	0 – 255	Diagnostic data byte
Length	254	Max cRIO PN Diagnostic data size

Table 5: Set Diagnostic Data Parameter

4.2.3 Set Process Data Method

The Set Process Data Method writes a single byte of an IO Device's process data stream to the internal memory. Additionally the method returns the maximum process data length of the IO Device. Use the Read/Write Alarm Method subsequently to transmit the process data stream from the internal memory to the IO Controller.

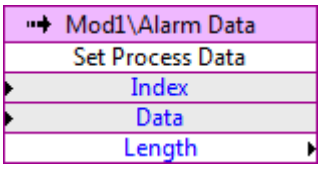

Figure 8: Set Process Data Method Node

Parameter	Value	Description
Index	0 – 253	Byte-Address of the IO Device process data stream Index 0 = Diag Byte 0; Index 1 = Diag Byte 1; …
Data	0 – 255	Process data byte
Length	254	Max cRIO PN Process data size

Table 6: Set Process Data Paramete

4.3 Record Data Method Nodes

cRIO PN supports acyclic data exchange in combination with the PN IO-Controller by PN IO ReadRec- and WriteRec services.

cRIO PN provides internal buffers for every configured PN IO slot storing read- and write specific acyclic data. These buffers are read and written by the PN IO-Controller using the PN IO ReadRec- and WriteRec services.

On FPGA level the cRIO PN slot specific acyclic buffers can also be read and written via the Read and Write Record Data Method Nodes.

Note: cRIO PN supports per slot only 1 acyclic Read/Write buffer.

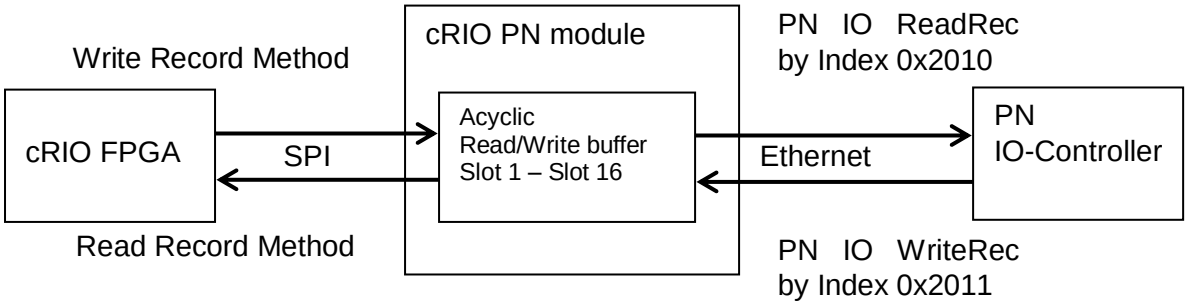

Figure 9: Handling of slot specific acyclic Read- and Write buffers

Acyclic Requests triggered by the Read Record -and Write Record Method are immediately acknowledged by the cRIO PN module.

Note: Incoming PN IO WriteRec service events on cRIO PN are not signalled automatically to the cRIO FPGA controller but must be polled.

Index	Access	Description
0x2010	Record data	This record returns the record data of the cRIO PN
0x2011	Record data	This record transmits the record data to the cRIO PN
0x8028	I/O handling	This record returns the current input data of the cRIO PN
0x8029	I/O handling	This record returns the current output data of the cRIO PN
0xAFF0	I&M data	This record returns I&M data of the cRIO PN

Table 7: Available records of the cRIO PN

4.3.1 Read Record Method

The Read Record Data Method receives read record data from the IO Controller. The read record data are stored in the internal memory. The internal memory can be accessed by the Get Record Data Method.

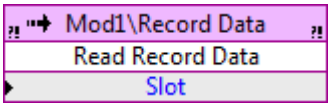

Figure 10: Read Record Method Node

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot

Table 8: Read Record Data Parameter

4.3.2 Get Record Data Method

The Get Record Data Method reads a single byte from the IO Controller's record data stream from the internal memory. Additionally the method returns the maximum record data length of the IO Device. Use the Read Record Data Method first to update the internal memory with the latest ReadRec data received from the PN IO controller.

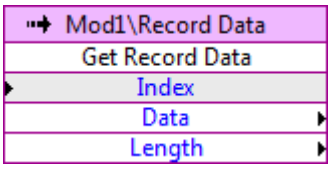

Figure 11: Get Record Data Method Node

Parameter	Value	Description
Index	0 – 253	Byte-Address of the IO Device record data stream Index 0 = Record Byte 0; Index 1 = Record Byte 1; …
Data	0 – 255	Record data byte
Length	254	Max cRIO PN Record data size

Table 9: Get Record Data Parameter

4.3.3 Write Record Method

The Write Record Data Method transmits record data to cRIO PN module which then can be read by the PN IO Controller. The record data are stored in the internal memory. The internal memory can be accessed by the Set Record Data Method.

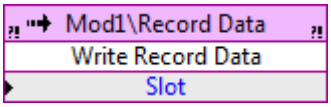

Figure 12: Write Record Method Node

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot

Table 10: Read Record Data Parameter

4.3.4 Set Record Data Method

The Set Record Data Method writes a single byte to record data the internal memory. Additionally the method returns the maximum record data length. Use the Write Record Data Method subsequently to update the cRIO PN module with the record data in the internal memory.

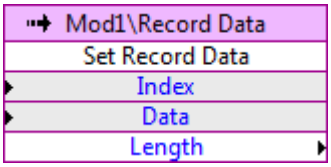

Figure 13: Set Record Data Method Node

Parameter	Value	Description
Index	0 – 253	Byte-Address of the IO Device record data stream Index 0 = Record Byte 0; Index 1 = Record Byte 1; …
Data	0 – 255	Record data byte
Length	254	Max cRIO PN Record data size

Table 11: Set Record Data Parameter

5 LabVIEW RT PROFINET IO Device VI

The RT IO Device VI provides access to the PROFINET on RT-Level via the already described low level FPGA VIs. Refer to the RT Device Example for a fully working implementation example. The VI specific context help menu describes in detail all VI specific parameters.

5.1 IO Device menu

Use the cRIO PN palette to access the RT IO Device VIs. Click Functions Palette » Kunbus GmbH » cRIO PN Device:

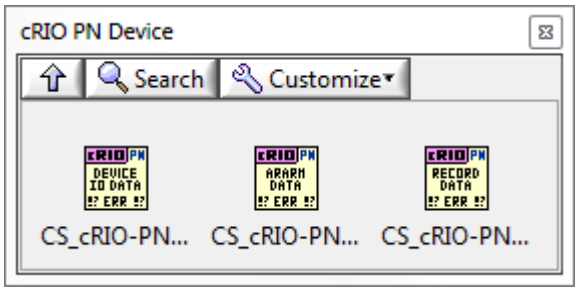

Figure 14: cRIO PN Device menu

5.1.1 Device I/O-Data

The CS_cRIO-PN_IO-Device_IOData.vi exchanges I/O-Data and status with the PN IO-Controller.

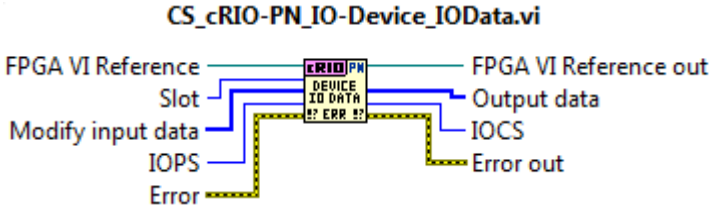

Figure 15: Device I/O-Data VI

Parameter	Value	Description
Slot	1 – 16	PROFINET IO Slot
Modify input data	[0 – 255]	IO-Device input data to be changed

IOPS Input status	0x00	Bad by Subslot
	0x80	Good
Input length	0 – 254	Size of cRIO PN IO-Device input data transmitted to the IO-Controller
Output length	0 – 254	Size of cRIO PN IO-Device output data received from the IO-Controller
Output data	[0 – 255]	IO-Device output data
IOCS Output status	0x80	Good
	0x00	Bad by Subslot

Table 12: Device I/O-Data Parameter

5.1.2 Device Alarm Data

The CS_cRIO-PN_IO-Device_AlarmData.vi exchanges Alarm-Data with the PN IO-Controller.

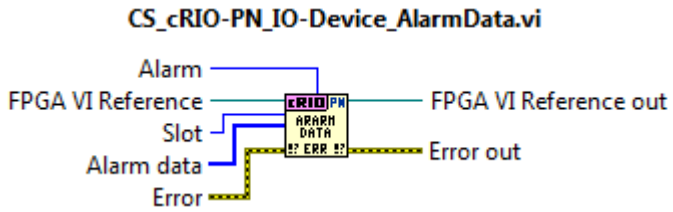

Figure 16: Device Alarm Data VI

Parameter	Value	Description
Alarm	0: Pull Alarm	Triggers a slot related pull alarm on the cRIO PN module
	1: Plug Alarm	Triggers a slot related plug alarm on the cRIO PN module
	2: Set Diagnostic Alarm	Activates a slot specific diagnostic alarm on the cRIO PN module
	3: Reset Diagnostic Alarm	Deactivates a slot specific diagnostic alarm on the cRIO PN module
	4: Set Process Alarm	Triggers a slot specific process alarm on the cRIO PN module

Slot	1 – 16	PROFINET IO Slot
Alarm data	[0 – 255]	IO-Device alarm data

Table 13: Device Alarm Parameter

5.1.3 Device Record Data

The CS_cRIO-PN_IO-Device_RecordData.vi exchanges Alarm-Data with the PN IO-Controller.

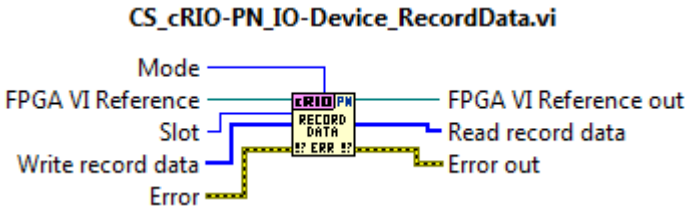

Figure 17: Device Record Data VI

Parameter	Value	Description
Mode	Read/Write	Reads or writes record data
Slot	1 – 16	PROFINET IO Slot
Write record data	[0 – 255]	IO-Device write record data
Read record data	[0 – 255]	IO-Device read record data

Table 14: Device Record Parameter

6 RT Device Example

The IO Device sample VI within scope of delivery demonstrates the following functions:

- Read and Write I/O data from/to the PN IO-Controller
- Read and Write alarm data from/to the PN IO-Controller
- Read and Write record data from/to the PN IO-Controller

On LabVIEW click Menu Help → Find Examples. The “NI Example Finder” opens.

Choose the directory Toolkits and Modules -> Third-Party Add-Ons -> KUNBUS GmbH -> PROFINET and open the LabVIEW project “CS_cRIO-PN_IO-DeviceExample.lvproj”.

Complete the following steps to use the CRIO PN module with your FPGA Target:

1. Add your FPGA target to the CS_cRIO-PN_IO-DeviceExample.lvproj.
2. Add the cRIO-PNAD module to your FPGA Target:
    - Right-click your FPGA Target in the Project Explorer window and select **New » C Series Modules** from the shortcut menu to display the Add Targets and Devices dialog box.
    - Click the **Discover an existing target(s) or device(s)** radio button, expand the **C Series Module** in the **Targets and Devices** list to discover existing C Series Modules.
    - Select **CS_cRIO-PNAD** module in the **Targets and Devices** list and click the **OK** button.
3. Copy the FPGA Device example to your FPGA Target:
    - Control + drag and drop the **CS_cRIO-PN_IO-DeviceExample(FPGA).vi** from the FPGA Example Target to your FPGA Target.
4. Create a new Compilation for your FPGA Target:
    - Right-click the **CS_cRIO-PN_IO-DeviceExample(FPGA).vi** in the FPGA Target and select **Create Build Specification** from the shortcut menu.
    - Under **Build Specifications**, right-click the new build specification for the **CS_cRIO-PN_IO-DeviceExample(FPGA)**, select **Build**, and wait for the build to complete.
5. Copy the RT Master example to your cRIO Chassis:
    - Control + drag and drop the **CS_cRIO-PN_IO-DeviceExample(Host).vi** from the FPGA Example Target to your FPGA Target.

6. Configure **Open FPGA VI Reference** to communicate between the Host VI and FPGA VI.

    - Double-click the RT Master example **CS_cRIO-PN_IO-DeviceExample(Host).vi** and select **Window»Show Block Diagram**.

    - Right-click the Open FPGA VI Reference function and select **Configure Open FPGA VI Reference** from the shortcut menu to display the **Configure Open FPGA VI Reference** dialog box.

    - Click the **VI** radio button, select **CS_cRIO-PN_IO-DeviceExample(FPGA).vi** in the **Select VI** dialog box and click the **OK** button.

Run the **CS_cRIO-PN_IO-DeviceExample(Host).vi** and following the Instructions in the IO-Device section.

7 Error codes

Status and Error codes returned by the cRIO PN module are handled via the Error Terminal of the Property and Method Node.

Right-click the Property or Method Node and select **Show Error Terminals** from the shortcut menu to enable the error handling.

Value	Description	Reason	Help
0x00	Success		-
0x19	Acyclic Service pending	The pending acyclic service must be completed first	cRIO PN module does not support simulteanous acyclic services.
0x1A	Acyclic Service pending	The pending acyclic service must be completed first	cRIO PN module does not support simulteanous acyclic services.
0x1B	Plug alarm not possible	A plug alarm can only be processed in combination with a preceding pull alarm.	
0x1C	Pull alarm is pending	No other service except a plug alarm can be processed.	
0x1D	Invalid Slot number	The slot number assigned with the service is not valid.	
0x1E	PN IO not activated	There is no PN IO-Controller connected with the cRIO PN module.	
0x1F	Diagnostic alarm pending	The pending diagnostic alarm must be completed first.	
0x20	Internal error		Contact support
0x10000	No module or invalid	Unable to communicate with the module.	Reinsert the module and check connections.
0x10001	Incorrect module	The module that was detected is different than the module that was expected.	Make sure the slot the module is configured for in software matches the physical location of the module.
0x4353457B	Rdy/Bsy Timeout	The module is not ready for communication.	Reinsert the module and check connections.
0x435345B0	Start Frame error	No or wrong or Start Frame received	Old Firmware version or Hardware defect.

Table 15: Error codes

377814A-01 Sep18