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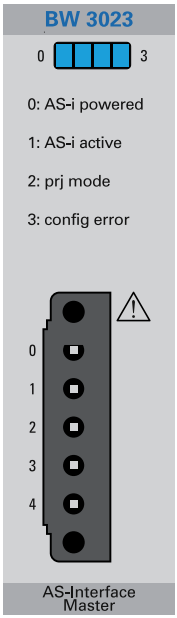
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C-Series AS-i Master Module

User manual



AS-i 3.0 specification

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Generally, this manual refers to products
without mentioning existing patents,
utility models, or trademarks.
The absence of any such references does
not indicate that a product is patent-free.

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Flosswoerthstr. 41
D-68199 Mannheim

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Declaration of Conformity

according to 2004/108/EC and 2011/65/EU

Bihl+Wiedemann GmbH, Mannheim, hereby declares under its sole responsibility that the products mentioned below are according to the listed harmonized standards or normative documents and (where neccessary) a competent body has been released.

Article No.	Description
BW3023	C-Series AS-i Master Module

Applied harmonized standards :	EN 62026-2:2013 EN 61000-6-2:2005/AC:2005 EN 61000-6-4:2007/A1:2011 EN 61131-2:2007/A1:2011 EN 50581:2012

The products are marked by the CE-sign in accordance with the EMC guideline.

Manufacturer:
Bihl+Wiedemann GmbH
Floßwörthstraße 41
68199 Mannheim
Deutschland

Date: 29. September 2014

Bernhard Wiedemann

Issue date: 16.4.2015

1. Symbol catalog



Information!

This symbol indicates important information.



Attention!

This symbol warns of a potential failure. Non-compliance may lead to interruptions of the device, the connected peripheral systems, or plant, potentially leading to total malfunctioning.



Warning!

This symbol warns of an imminent danger. Non-compliance may lead to personal injuries that could be fatal or result in material damages and destruction.

1.1 Abbreviations



Information!

Additional information can be found in section <Glossary>.

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2. General

2.1 Product information

This system manual applies to the following Bihl+Wiedemann GmbH equipment:

C-Series AS-i Master Module	**BW3023**
AS-i master module for compactRIO	

Tab. 2-1.

2.2 Product description and intended use

The BW3023 is an AS-interface master according to specification 3.0. It is also backward compatible because previous specifications (2.0 and 2.1) are supported as well.

It enables configuration, control and diagnosis of up to 31 single slaves or 62 A/B slaves via LabVIEW.

Fast changing data such as I/O data or execution control flags is directly located in the SPI frame while slower changing data and data which is only needed in special situations is located in the command interface.

The LEDs located on the module indicate the current module status, configuration errors or peripheral faults and the activity on AS-i. Diagnostics, which go far beyond the standard diagnostics facilitate the simple detection of the occasionally occurring configuration errors and further irritations towards the AS-i communication. So in case of an error the down time of machines can be minimized or you can initiate preventive maintenance.

The BW3023 is suitable for use in Class I, Div. 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4, and Ex nA IIC T4 hazardous locations; and nonhazardous locations only.

2.3 Conformity statement

The C-Series AS-i Master Module has been developed and manufactured in accordance with the applicable european standards and directives.

Information!

The corresponding conformity statement can be found at the very beginning of this system manual.

2.4 Certification according to EN ISO 9001:2008

The manufacturer of the product possesses a certified quality assurance system in accordance with ISO 9001.

Information!

The current certificate can be viewed in internet:
http://www.bihl-wiedemann.de

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2.5 Bihl+Wiedemann hotline

If problems or faults occur which you cannot rectify yourself and which are not described in this user‘s manual, please contact the Bihl+Wiedemann GmbH service hotline.

Phone:	+49 (0) 621-33 996-0 (Central)
Fax:	+49 (0) 621-33 92 22 39
mail:	info@bihl-wiedemann.com
web:	www.bihl-wiedemann.com

Please make a note (see lateral label) of the following details before calling Bihl+Wiedemann GmbH:

Device type:	
Art.-no.:	
Ident.-no.:	
Date of delivery:	

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3. Safety

3.1 Intended use



Warning!

This symbol warns of a possible danger. The protection of operating personnel and the system against possible danger is not guaranteed if the control interface unit is not operated in accordance to its intended use.



Warning!

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired!

3.2 No user-serviceable parts



Warning!

No user serviceable parts inside. Do not open!

3.3 General safety information



Warning!

Safety and correct functioning of the device cannot be guaranteed if any operation other than described in this operation manual is performed. Connecting the equipment and conducting any maintenance work under power must exclusively be performed by appropriately qualified personnel. In case a failure cannot be eliminated, the device must be taken out of operation and inadvertently operation must be prevented. Repair work must be performed by the manufacturer only. Additions or modifications to the equipment are not permitted and will void the warranty.



Information!

The operator is responsible for the observation of local safety standards.

3.4 Safety Guidelines for Hazardous Locations

The BW3023 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4, and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the BW3023 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.

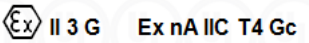
Issue date: 16.4.2015



Caution:

- Do not disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.
- Do not remove modules unless power has been switched off or the area is known to be nonhazardous.
- Substitution of components may impair suitability for Class I, Division 2.
- For Zone 2 applications, install the system in an enclosure rated to at least IP54 as defined by IEC 60529 and EN 60529.

3.4.1 Special Conditions for Hazardous Locations Use in Europe

This equipment has been evaluated as  equipment under DEMKO Certificate No. 14 ATEX 1413X and IECEx Certificate No. IECEx UL 14.0112X. Each module is marked II 3G and is suitable for use in Zone 2 hazardous locations. If you are using the BW3023 in Gas Group IIC hazardous locations or in ambient temperatures of $-40\ °C \leq Ta \leq 70\ °C$, you must use the device in a chassis that has been evaluated as EEx nA IIC T4, Ex nA IIC T4, or Ex nL IIC T4 equipment.

3.5 Disposal



Information!

Electronic waste is hazardous waste. Please comply with all local ordinances when disposing this product!

The device does not contain batteries that need to be removed before disposing it.

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4. Technical Specifications

4.1 Data sheet

Article No. BW3023: AS-i 3.0 Master for Compact RIO and Labview

Function

AS-i I/O data and status information is mapped into the PLC processor's I/O data.

AS-i Scope

Diagnostics, which go far beyond the standard diagnostics facilitate the simple detection of the occasionally occurring configuration errors and further irritations towards the AS-i communication.

So in case of an error the down time of machines can be minimized or you can initiate preventive maintenance.

Article No.	BW3023
AS-i	
Operating current	approx. 40 mA out of AS-i approx. 50 mA out of the backplane
Operating voltage	AS-i voltage 29,5 … 31,6 V_{DC}
AS-i cycle time	150 µs * (number of slaves + 2)
Total power dissipation	max. 1,5 W
Display	
LED **AS-i powered** (green)	on: AS-i voltage O.K.
LED **AS-i active** (green)	AS-i normal operation active
LED **prj mode** (yellow)	configuration mode active
LED **config error** (red)	on: at least 1 configured AS-i slave is missing, or at least 1 detected AS-i Slave is not configured, or for at least 1 configured and detected AS-i slave the actual configuration data does not match the nominal configuration data, or the master is in the startup process flashing: peripheral fault
Environment	
Applied standards	EN 61000-6-2 : 2005 EN 61000-6-4 : 2007 + A1:2011 IEC 60079-0, 6th edition IEC 60079-15, 4th edition EN 60079-0 : 2012 + A11:2013 EN 60079-15: 2010 ISA 12.12.01 : 2013 UL 60079-0 : 6th Edition UL 60079-15 : 4th Edition CSA C22.2, No 223 : 1987 (R2013)
Operating temperature	-40 °C … +70 °C
Storage temperature	-40 °C … +85°C
Intended environment	for indoor use only
Maximum altitude for use	5000 m
Maximum relative humidity	90%, non condensing
Pollution degree of the intended environment	II
Protection category acc. EN 60529	housing IP20 (only suitable for use in electrical operating rooms/cabinets with IP54 minimum protection rating)
Voltage of insulation	AS-i to compactRIO: ≥ 500 V
	60 V_{DC} CAT I Ch-to-Earth Isolation

Article No.	BW3023
Weight	420 g
Dimensions (W / H / D in mm)	23 / 71 / 89

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Attention!

Provision shall be made to prevent the rated voltage being exceeded by the transient disturbance of more than 140% of the peak rated voltage.

The system shall be mounted in an ATEX/IECEx certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC/EN60529 and used in an environment of not more than pollution degree 2.

The enclosure must have a door or cover accessible only by the use of a tool.

4.2 Instructions for cleaning

If you need to clean the module, wipe it with a dry towel.

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5. Description

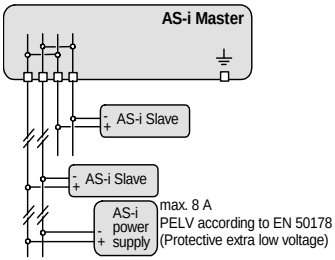
5.1 LED Indicators

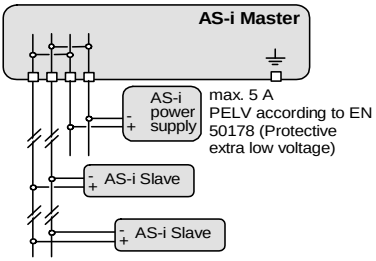
Indicator	Color		Description
AS-i powered	Green	☼	AS-i Master power
		☼	Peripheral fault
AS-i active	Green	☼	Normal operation active
prj mode	Yellow	☼	Configuration state
config error	Red	☼	Config error occurred

Tab. 5-2.

5.2 Connection of the AS-i Master

5.2.1 Connection samples for the AS-i power supply





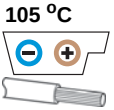
Attention!

In the wiring schemes above the current through the AS-i master must not exceed 5 A.

	0,2 ... 2,5 mm^2
	0,2 ... 2,5 mm^2
AWG	24 ... 12
Torque	0,5 ... 0,6 Nm

Temperature rating for cable

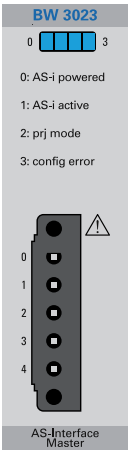
Use copper conductors only



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5.3 Display and Operating Elements



	PINs
0/1	**AS-i +/AS-i-** Connection AS-i circuit
2/3	**AS-i PWR +/AS-i PWR -** Supply voltage AS-i circuit
4	**FE** Functional earth

	LEDs
3	**config error** Configuration error At least one configured slave is missing, at least one detected slave is not projected or for at least one projected and detected slave the actual configuration data does not match the nominal configuration data.
0	**AS-i powered** The AS-i circuit is sufficiently powered.
1	**AS-i active** Normal operation active.
2	**prj mode** The AS-i master is in configuration mode.

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6. Configuration

6.1 I/O Data Interpretation

Fast changing data is directly located in the SPI frame while slower changing data and data which is only needed in special situations is located in the Command Interface.

Index	Length [Byte]	Direction Carrier to Module	Direction Carrier from Module
0	16	Reserved	Reserved
16	32	Output Data Image (ODI)	Input Data Image (IDI)
48	256	Analogue Output Data Image (AODI)	Analogue Input Data Image (AIDI)
304	2	Reserved	Execution Control Flags (EC-Flags)
306	2	Reserved	Reflected HI-Flags
308	8	Reserved	List of active slaves LAS
316	8	Reserved	List of detected slaves LDS
324	8	Reserved	List of projected slaves LPS
332	8	Reserved	List of peripheral faults LPF
340	40	Command Interface	Command Interface
380	4	Checksum	Checksum
	$\sum = 384$		

Tab. 6-3.

6.2 Output/Input Data Image

	ODI, IDI															
Adresse	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
+ 0x00	Slave 3				Slave 2				Slave 1				Slave 0			
+ 0x02	Slave 7				Slave 6				Slave 5				Slave 4			
:	:															
+ 0x10	Slave 3b				Slave 2b				Slave 1b				Slave 0b			
:	:															
+ 0x1E	Slave 31b				Slave 30b				Slave 29b				Slave 28b			

Tab. 6-4.

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6.3 Analog Output/Input Data Image

AODI, AIDI																
Adresse	**2^{15}**	**2^{14}**	**2^{13}**	**2^{12}**	**2^{11}**	**2^{10}**	**2^{9}**	**2^{8}**	**2^{7}**	**2^{6}**	**2^{5}**	**2^{4}**	**2^{3}**	**2^{2}**	**2^{1}**	**2^{0}**
+ 0x00	Slave 0 1st Channel															
+ 0x02	Slave 0 2nd Channel															
:	:															
+ 0x7E	Slave 15 4th Channel															
:	:															
+ 0xFE	Slave 31 4th Channel															

Tab. 6-5.

6.3.1 Execution Control Flags (EC-Flags)

EC - Flags																
Address	**2^{15}**	**2^{14}**	**2^{13}**	**2^{12}**	**2^{11}**	**2^{10}**	**2^{9}**	**2^{8}**	**2^{7}**	**2^{6}**	**2^{5}**	**2^{4}**	**2^{3}**	**2^{2}**	**2^{1}**	**2^{0}**
+ 0x0								Pok	OR	APF	NA	CA	AAv	AAs	S0	Cok

Tab. 6-6.

Cok: ConfigOk

S0: LDS.0

AAs: AutoAddressAssign

AAv: AutoAddressAvailable

CA: ConfigurationActive

NA: NormalOperationActive

APF: APF

OR: OfflineReady

Pok: PeriperyOk

6.3.2 Slave Lists

LAS, LDS, LPS, LPF																
Address	**2^{15}**	**2^{14}**	**2^{13}**	**2^{12}**	**2^{11}**	**2^{10}**	**2^{9}**	**2^{8}**	**2^{7}**	**2^{6}**	**2^{5}**	**2^{4}**	**2^{3}**	**2^{2}**	**2^{1}**	**2^{0}**
+ 0x0	s15	s14	s13	s12	s11	s10	s9	s8	s7	s6	s5	s4	s3	s2	s1	s0
+ 0x2	s31	s30	s29	s28	s27	s26	s25	s24	s23	s22	s21	s20	s19	s18	s17	s16
+ 0x4	s15b	s14b	s13b	s12b	s11b	s10b	s9b	s8b	s7b	s6b	s5b	s4b	s3b	s2b	s1b	s0b
+ 0x6	s31b	s30b	s29b	s28b	s27b	s26b	s25b	s24b	s23b	s22b	s21b	s20b	s19b	s18b	s17b	s16b

Tab. 6-7.

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7. Operating the AS-i

The **LabVIEW API** ships with two examples "AS-i RT Basic.lvproj" and "AS-i FPGA Basic.lvproj" referenced throughout the rest of this Manual. The examples can be located by the following steps:

1. Open **LabVIEW** if not already opened.
2. In LabVIEW click **Help** > **Find Examples** and then search for "AS-i".
3. Open the **AS-i RT Basic** or **AS-i FPGA Basic** project.
4. For addition help, click **Help** > **Bihl-Wiedemann** in LabVIEW to open the user manual.

7.1 Master Start-Up

- ☐ Connect the AS-i module as described in section <Connection samples for the AS-i power supply> and plug the AS-i module into one slot of your powered cRIO chassis. All LEDs of the module should be Off.
- ☐ Then if you run the example “BW-3023 AS-i Commissioning.vi” as described in section <Configuration Mode> some LED’s should turn ON, depending on the state of master.

1. If the AS-i network is not sufficiently powered.

AS-i powered	AS-i active	prj mode	config error
Off	Off	If configuration mode is active, LED is ’on’. Otherwise ’off’.	On

Tab. 7-8.

2. If the AS-i network is sufficiently powered.

AS-i powered	AS-i active	prj mode	config error
On	On	If configuration mode is active, LED is ’on’. Otherwise ’off’.	If there is config error, LED is ’on’. Otherwise, ’off’.

Tab. 7-9.

- ☐ On the VI Frontpanel press the the “Operation Mode” switch and notice your modules being marked in the address table, then press the “Store Actual Configuration” button, to turn OFF the Config Error LED.

7.2 Configuration Mode

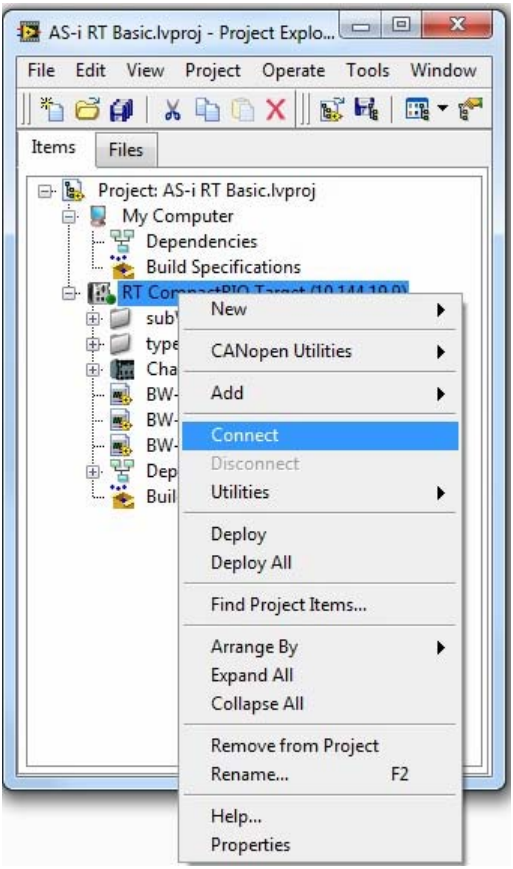
All slaves, except the slave with zero address, that are members of the list of detected slaves (LDS) shall be automatically detected and activated in the above mentioned way according to AS-i specification.

Configuration mode is demonstrated in both shipping examples referenced in section <Examples of address assignment>. The AS-i C-Series module can be placed into configuration mode by completing the following steps:

1. Connect the AS-i C-Series module as described in section <Connection of the AS-i Master>.
2. Open the “AS-i RT Basic.lvproj” example.

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3. Verify that your cRIO is connected properly by right clicking the target within your project and going to "Connect"
4. Open the front panel of the "BW3023 AS-i Commissioning.vi"



Assigning an AS-i Address in the Configuration Mode

Assigning a Slave Address

1. Connect a new slave in the AS-i network, the state of this slave is showed in the “Slave List” indicator.
2. Select the devices old address within the “Old Address” control.
3. Select the new address within the “New Address” control.
4. Click the button “Change Slave Address”.
5. If the indicator “Result Code” is 0, address assignment was successful.

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Programming the Address in Case of Configuration Errors

1. Click the button “Store Actual Configuration” to store the current AS-i network configuration for all connected slaves, then repeat step 2 – 5 from above.

Erasing the Slave Address

1. Remove a slave from the AS-i network
2. The status of this slave in “Slave List” indicator should change to P (Projected Only)
3. Click the button “Store Actual Configuration” to delete the address from the module.

Automatic Address Assignment (shall be processed only if):

1. the Master module execution control mode is the **protected mode**,
2. the "Auto_Address_Enable” mode is ON
3. the "Auto_Address_Assign" mode is set, and If one and only one configured slave is not detected.

7.3 Examples of address assignment

7.3.1 Example of automatic address assignment

1. Select an existing Slave (e.g Slave1) within the “Old Address” control.



2. Select Slave0 within the “New Address” control.
3. Click the button “Change Slave Address”. The status List should change like this.



4. Remove the slave from the AS-i network.
5. Click button “Operation Mode” to change to protected mode
6. Connect this slave back to the AS-i network
7. Address 1 is assigned to this slave automatically.



7.3.2 Example of manual address assignment

1. Connect a slave to the AS-i network.
2. If the slave address is zero, the status list should look like this.



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3. Select Slave0 within the "Old Address" control.
4. Select the new address (e.g. Slave2) within the "New Address" control.
5. Click the button "Change Slave Address".
6. If the indicator "Result Code" is 0, address assignment was successful.

7.4 Abbreviations used within the Status List Control

X (O.K.)	The configuration data for the detected AS-i slave matches the stored configuration data.
D (Detected Only)	An AS-i slave is detected at this address, but it was not stored before.
P (Projected Only)	An AS-i slave was stored at this address, but it was not detected.
C (Type Conflict)	The configuration data for the detected AS-i slave does not match the stored configuration data. The actual exiting configuration of the connected AS-i slave is displayed.
F (Periph. Fault)	The AS-i slave has a peripheral error.
A (Duplicate Addr.)	Two AS-i slaves use the same address.

7.5 Protected Operating Mode

Only those slaves shall be activated which are both members of the list of detected slaves (LDS) and members of the list of projected slaves (LPS), and whose configuration data image (CDI) value equals the permanent configuration data (PCD) value for that specific slave.

1. Follow steps 1-5 of section <Configuration Mode> to bring the AS-i network to Configuration mode
2. Click the "Operation Mode" control to change to "Protected Mode"



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8. Appendix: Codes indicated by the Display

Bihl+Wiedemann AS-i error codes and warnings are in the range: Range +/- 389000 to 389099. Errors explanations can be found with the NI LabVIEW environment by clicking Help "Explain Error". A list of error codes is shown below:

Code	Name	Description
-389000	asiErrorAnalogInvalidAddress	Slave address for the analog read or write is invalid. Solution: Specify an address in the range of 0 to 31.
-389001	asiErrorAnalogInvalidDataLength	The data length of four 16-bit analog channel is out of range. Solution: Make sure the data length is within 8 bytes.
-389002	asiErrorAnalogOperationTimeout	Analog read or analog write timed out. Solution: Increase timeout and ensure "AS-i Commit.vi" has been called.
-389003	asiErrorCommandInvalidRequestLength	Command request size is out of range. Solution: Make sure the length of command request is smaller than 39 bytes.
-389004	asiErrorCommandTimeout	Timeout occurred waiting for the command response. Solution: Increase timeout and check hardware connection.
-389005	asiErrorDigitalInvalidAddress	Slave address for digital read or digital write is invalid. Solution: Specify an address which is in the range of 0 to 63.
-389006	asiErrorDigitalInvalidData	Digital data value is invalid. Solution: Specify a value in the range of 0 to 15.
-389007	asiErrorDigitalInvalidDataImageLength	Digital data image size is out of range. Solution: Make sure the length of digital data image is smaller than 33 bytes.
-389008	asiErrorSpiFrameDataFault	CRC check failed between backplane and module. SPI communication may be corrupted by electrical noise. Solution: Reduce noise and contact National Instruments if the error persists.

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9. Your opinion is important to us!

Please give us an opportunity to hear your suggestions, wishes and criticisms regarding this Manual.

We read every note or comment, no matter how small, and incorporate them into the documentation whenever possible.

Fill out the form on the following page and fax it to us or send your remarks, suggestions for improvement etc. to the following address:

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Design	Yes	Partly	No
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Are the text explanations for the illustrations sufficient?	❒	❒	❒
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Are the formulations/technical terms understandable?	☐	☐	☐
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