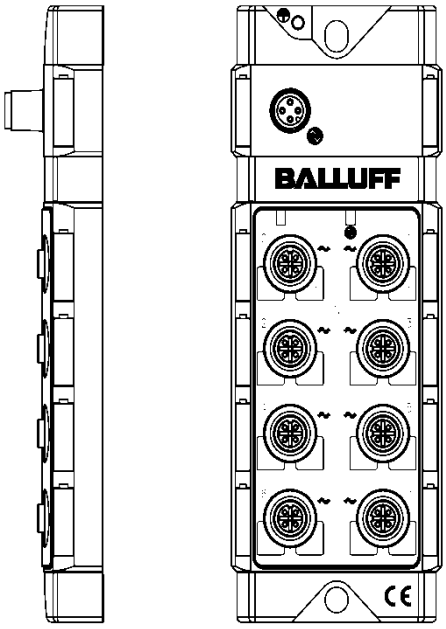
BALLUFF

BNI IOL-719-002-Z012

User´s Guide



Content

1 Notes for the user

1.1. Structure of the guide

The guide is organized so that the sections build on one another:
Section 2: Basic safety information.
Section 3: The main steps for installing the device.
……..

1.2. Typographical Conventions

The following typographical conventions are used in this guide.

Enumerations

Enumerations are shown in list form with bullet points.

- Entry 1,
- Entry 2.

Actions

Action instructions are indicated by a preceding triangle. The result of an action is indicated by an arrow.

- ➢ Action instruction 1.
  - ↳ Action result.
- ➢ Action instruction 2.

Syntax

Numbers:
Decimal numbers are shown without additional indicators (e.g. 123),
Hexadecimal numbers are shown with the additional indicator hex (e.g. 00hex).

Cross references

Cross references indicate where additional information on the topic can be found.

1.3. Symbols

Attention!
This symbol indicates a security notice which must be observed.

Note
This symbol indicates general notes.

1.4. Abbreviations

BNI	Balluff Network Interface
DPP	Direct Parameter Page
EMC	Electromagnetic Compatibility
FE	Function Earth
IOL	IO-Link
ISDU	Index Service Data Unit
MSB	Most significant bit

1.5. Differing views

Product views and images in this manual may differ from the product described. They are intended to serve only as illustrations.

1.6. Entsorgung

This product falls under the current EU Directive for WEEE, waste of electrical and electronic equipment for protecting you and the environment from possible hazards and responsible handling of natural resources.

Dispose of the product properly and not as part of the normal waste stream. Observe the regulations of the respective country. Information can be obtained from the national authorities. Or return the product to us for disposal.

2 Safety

2.1. Intended use

This guide describes the Balluff Network Interface BNI IOL-719-002-Z012 for the application as peripheral analog input module to establish connection of analog sensors, RTDs and thermocouple sensors. Hereby it is about an IO-Link device which communicates by means of IO-Link protocol with the superordinate IO-Link master assembly.

2.2. Installation and startup

Attention!
Installation and startup are to be performed only by trained specialists. Qualified personnel are persons who are familiar with the installation and operation of the product, and who fulfills the qualifications required for this activity. Any damage resulting from unauthorized manipulation or improper use voids the manufacturer's guarantee and warranty. The Operator is responsible for ensuring that applicable of safety and accident prevention regulations are complied with.

2.3. General safety notes

Commissioning and inspection
Before commissioning, carefully read the operating manual.
The system must not be used in applications in which the safety of persons is dependent on the function of the device.
Authorized Personnel
Installation and commissioning may only be performed by trained specialist personnel.
Intended use
Warranty and liability claims against the manufacturer are rendered void by:

- Unauthorized tampering
- Improper use
- Use, installation or handling contrary to the instructions provided in this operating manual

Obligations of the Operating Company
The device is a piece of equipment from EMC Class A. Such equipment may generate RF noise. The operator must take appropriate precautionary measures. The device may only be used with an approved power supply. Only approved cables may be used.
Malfunctions
In the event of defects and device malfunctions that cannot be rectified, the device must be taken out of operation and protected against unauthorized use.
Intended use is ensured only when the housing is fully installed.

2.4. Resistance to Aggressive Substances

Attention!
The BNI modules always have good chemical and oil resistance. When used in aggressive media (such as chemicals, oils, lubricants and coolants, each in a high concentration (i.e. too little water content)), the material must first be checked for resistance in the particular application. No defect claims may be asserted in the event of a failure or damage to the BNI modules caused by such aggressive media.

Hazardous voltage

Attention!
Disconnect all power before servicing equipment.

Note
In the interest of product improvement, the Balluff GmbH reserves the right to change the specifications of the product and the contents of this manual at any time without notice.

3 Getting Started

3.1. Connection overview

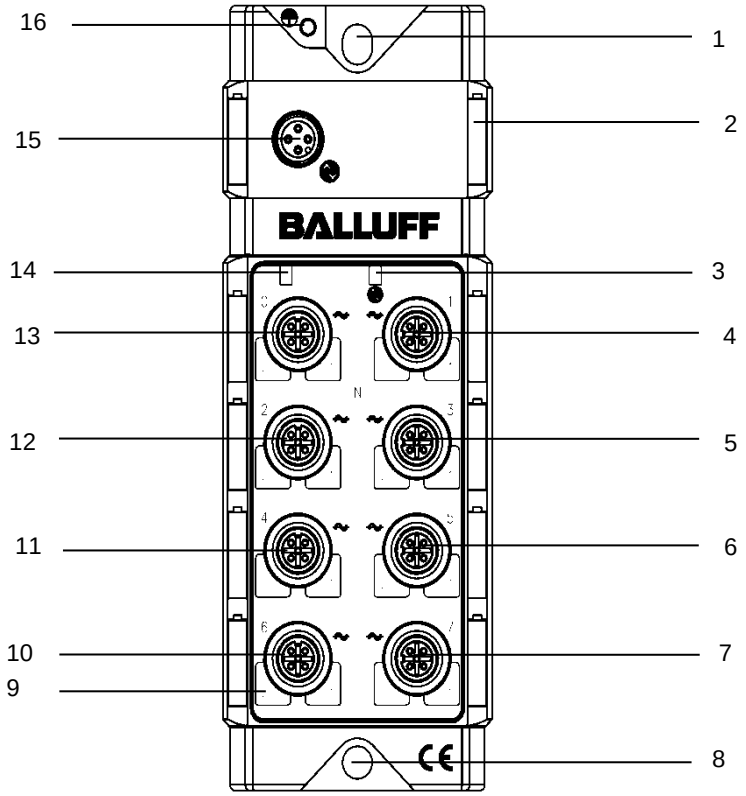


Fig. 3-1: BNI IOL-719-002-Z012

1 Mounting hole
2 Label
3 Status LED: Communication
4 Analog port 1
5 Analog port 3
6 Analog port 5
7 Analog port 7
8 Mounting hole
9 Pin/Port LED: Signalstatus
10 Analog port 6
11 Analog port 4
12 Analog port 2
13 Analog port 0
14 Status LED: Module supply
15 IO-Link Interface
16 FE connection

3 Getting Started

3.2. Mechanical connection

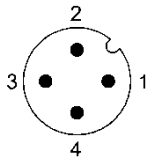
The BNI IOL-719-002-Z012 modules are attached by using 2 M6 screws and 2 spacers.

3.3. Electrical connection

The BNI IOL-719-002-Z012 modules require no separate supply voltage connection. Power is provided through the IO-Link interface by the host IO-Link Master.

IO-Link Interface

IO-Link (M12, A-coded, male)



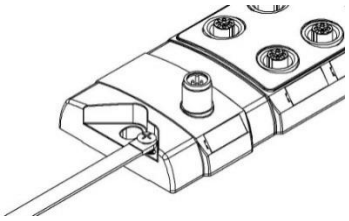
Pin	Function
1	Power supply controller, +24V, max 1.1A
2	-
3	GND, reference potential
4	C/Q, IO-Link data transmission channel

Connecting the Sensor Hub

- Connection protection ground to FE terminal, if present.
- Connect the incoming IO-Link line to the Sensor Hub.

Note
A standard 3 wire sensor cable is used for connection to the host IO-Link master.

Function earth



Note
The FE connection from the housing to the machine must be low-impedance and kept as short as possible.

Module versions

Sensor Hub Version	Analog function
BNI IOL-719-002-Z012	8 Analog input

3.4. Functionality

The BNI IOL-719-002-Z012 module has eight free configurable analog port. The ports can be configured independently to accept voltage signal, current signal, Pt sensor or thermocouples.

Input type	Nominal range
Voltage	0 V - 10 V
Voltage	5 V - 10 V
Voltage	-10 V - +10 V
Voltage	0 V – 5 V
Voltage	-5 V - +5 V
Current	4 – 20 mA
Current	0 – 20 mA
Pt100	-200 °C - +850 °C
Pt1000	-200 °C - +850 °C
Typ J	-100 °C - +1200 °C
Typ K	-180 °C - +1370 °C
Typ C*	0 °C - +2315 °C

*available from FW3.0

Note

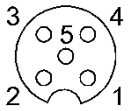
- One sensor can be connected to each port. In case of voltage/current type sensor the input pin of the analog port can be configured. The analog input signal can be connected either to pin2 or pin4. In this case the BNI IOL-719-002-Z012 has a +24V sensor supply. In case of voltage/current type sensors you can only use 3-wire method.
- In case of RTD sensor (Pt100, Pt1000), the sensor can be connected with 2 wire, 3 wire or 4 wire method.
- You can only connect Thermocouples of the Type J & K & C*.

* available from FW3.0

3 Getting Started

3.5. Sensor Interface

Standard I/O-port (M12, A-coded, female)



Pin	Voltage / Current input
1	+24 V, 150 mA (sensor supply)
2	Voltage / current input
3	GND (sensor supply, measurement)
4	Voltage / current input
5	-

Pin	Pt100, Pt1000 2 wire
1	Current Source 1 - / Analog In -
2	Current Source 1 - / Analog In -
3	Current Source 1 + / Analog In +
4	Current Source 1 + / Analog In +
5	-

Pin	Pt100, Pt1000 3 wire
1	Current Source -
2	Current Source 2 + / Analog In -
3	
4	Current Source 1 + / Analog In +
5	-

Pin	Pt100, Pt1000 4 wire
1	Current Source -
2	Analog In -
3	Analog In +
4	Current Source +
5	-

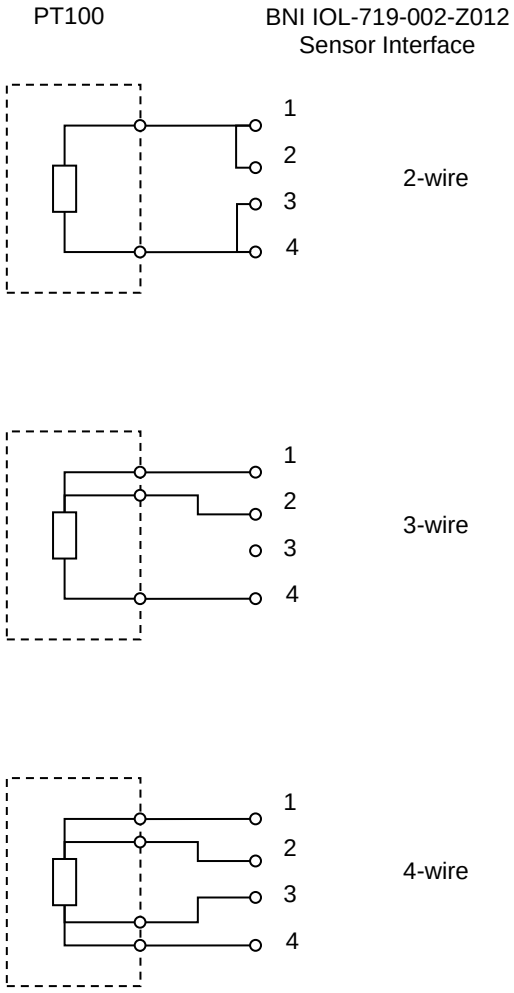
Pin	Thermocouple Typ J, Typ K, Typ C*
1	-
2	Thermocouple +
3	Thermocouple -
4	-
5	-

* available from FW3.0

Note
The +24V supply voltage is short circuit protected. The supply voltage will be switched off in case of short circuit, in order to reduce the power dissipation. The short circuit error is latched and it can be reset with the output process data.

Note
In case of current input, the BNI IOL-719-002-Z012 works only with 3-wire sensors.
2-wire-sensors are not supported with voltage or current input.

3 Getting Started



Attention!
A care must be taken during wiring. The inputs are protected against wrong wiring, but in some special cases damage can be occurred. Be sure to connect the wiring properly before turning power supply on.

Note
Unused I/O port socked must be fitted with cover caps to ensure IP67 protection rating.

Note
The analog signals shall be connected with a shielded cable to the BNI IOL-719-002-Z012

Note
In order to achieve better accuracy in case of thermocouple measurement, the thermocouple should be connected to the device with a special M12 connector for thermocouples (Typ J or Typ K, Typ C depending on the thermocouple.) .

3 Getting Started

3.6. Input signal range

The BNI IOL-719-002-Z012 supports many standard input signal ranges. In some cases an analog sensor has higher linear output range than the nominal output range. For example a sensor with a 0 – 10 V output can source voltages between -0.5V and 10.5V, and indicates error with a signal <-0.5V or >10.5V. Therefore the BNI IOL-719-002-Z012 has the following input ranges for the different analog modes.

Analog mode	V_{min} [V]	V_{max} [V]
0 V – 10 V	-0.5	10.5
5 V – 10 V	4.5	10.5
-10 V – 10 V	-10.5	10.5
0 V – 5 V	-0.5	5.5
-5 V – 5 V	-5.5	5.5

Analog mode	I_{min} [mA]	I_{max} [mA]
4 mA – 20 mA	3.8	20.5
0 mA – 20 mA	0	20.5

Analog mode	T_{min} [°C]	T_{max} [°C]
Pt100	-200	850
Pt1000	-200	850
Typ J (ungrounded)	-100	1200
Typ J (grounded)	-100	400
Typ K (ungrounded)	-180	1370
Typ K (grounded)	-100	400
Typ C (ungrounded)	0	2315
Typ C (grounded)	0	800

3.7. Data formats

The signal on the input port of the BNI IOL-719-002-Z012 will be digitalized and sent as a process data over IO-Link. There are 16 bits reserved in the process data for each port. The digitalized value can be represented in different formats (signed, unsigned or dimensioned), in different resolution (16, 14, 12 or 10 bit), with different alignment (left or right aligned).

3.8. Signed data format

In case of signed data format, the digitalized value is represented in a two's complement format (15 bit + sign, 13 bit + sign, 11 bit + sign, 9 bit + sign depending on the resolution.).

For different configurations, the analog signal (voltage, current, temperature) can be calculated with the following formulas.

Voltage input (0V-10V, -10V - +10V, 0V - 5V, -5V - +5V):

In case of positive numbers (MSB = 0):

$$\text{Input voltage [V]} = \text{PortValue} * \frac{\text{V}_{\text{max}}}{2^{(\text{N}-1)} - 1}$$

In case of negative numbers (MSB = 1):

$$\text{Input voltage [V]} = (\text{PortValue} - 2^{N}) * \frac{\text{V}_{\text{max}}}{2^{(\text{N}-1)} - 1}$$

Voltage input (5V – 10V):

$$\text{Input voltage [V]} = \text{PortValue} * \frac{\text{V}_{\text{max}} - V_{min}}{2^{(\text{N}-1)} - 1} + V_{min}$$

Current input (0-20mA, 4-20mA):

$$\text{Input current [mA]} = \text{PortValue} * \frac{\text{I}_{\text{max}} - \text{I}_{\text{min}}}{2^{(\text{N}-1)} - 1} + I_{min}$$

Pt100, Pt1000, Typ J, Typ K, Typ C:

In case of positive numbers (MSB = 0):

$$\text{Temperature [°C]} = \text{PortValue} * \frac{\text{T}_{\text{max}}}{2^{(\text{N}-1)} - 1}$$

In case of negative numbers (MSB = 1):

$$\text{Temperature [°C]} = (\text{PortValue} - 2^{N}) * \frac{\text{T}_{\text{max}}}{2^{(\text{N}-1)} - 1}$$

Where:
PortValue is the digitalized value of the input signal.
N is the resolution in bits.
V_{max}, I_{max}, T_{max} are the higher limits of the selected input range.
V_{min}, I_{min}, T_{min} are the lower limits of the selected input range.

Example 1:
The analog mode is set to 0-10V.
The resolution is 14 bit.
The process data is right aligned.
The digitalized value read over IO-Link is 1234_{hex} = 4660.

The most significant bit of 1234_{hex} is 0, so it is a positive number. In this case the voltage can be calculated with the following formula:

$$\text{Input voltage [V]} = \text{PortValue} * \frac{\text{V}_{\text{max}}}{2^{(\text{N}-1)} - 1} = 4660 * \frac{10.5V}{2^{(14-1)} - 1} = 5{,}974V$$

Example 2:
The analog mode is set to -10V - +10V
The resolution is 12 bit.
The process data is left aligned.
The digitalized value read over IO-Link is $ABC0_{hex}$

The 12 bit value is left aligned, so the 16 bit value read over IO-Link must be shifted right by four (the 12 bit value is ABC_{hex}). The most significant bit of the 12 bit value is 1, so it represents a negative number, therefore the voltage can be calculated with the following formula:

$$\text{Input voltage [V]} = (\text{PortValue} - 2^N) * \frac{\text{V}_{\text{max}}}{2^{(\text{N}-1)} - 1} = (\text{ABC}_{hex} - 2^{12}) * \frac{10.5V}{2^{(12-1)} - 1} = -6.915\,V$$

3.9. Unsigned data format

In case of unsigned data format, the selected input range will be represented as a number between 0000_{hex} and the full scale value according to the resolution ($FFFF_{hex}$ in case of 16 bit resolution). The input signal on the BNI IOL-719-002-Z012 can be calculated from the digital value with the following formulas:

Voltage input (0V-10V, 5V – 10V, -10V - +10V, 0V - 5V, -5V - +5V):

$$\text{Input voltage [V]} = \text{PortValue} * \frac{\text{V}_{\text{max}} - \text{V}_{\text{min}}}{2^{\text{N}} - 1} + V_{min}$$

Current input (0-20mA, 4-20mA):

$$\text{Input current [mA]} = \text{PortValue} * \frac{\text{I}_{\text{max}} - \text{I}_{\text{min}}}{2^{\text{N}} - 1} + I_{min}$$

Pt100, Pt1000, Typ J, Typ K, Typ C:

$$\text{Temperature [°C]} = \text{PortValue} * \frac{\text{T}_{\text{max}} - \text{T}_{\text{min}}}{2^{\text{N}} - 1} + \text{T}_{\text{min}}$$

Where:
PortValue is the digitalized value of the input signal.
N is the resolution in bits.
V_{max}, I_{max}, T_{max} are the higher limits of the selected input range.
V_{min}, I_{min}, T_{min} are the lower limits of the selected input range.

Example 1:
The analog mode is set to 0-10V.
The resolution is 14 bit.
The process data is right aligned.
The digitalized value read over IO-Link is 2345_{hex} = 9029.

In case of 0-10V, the analog input voltage range is between -0.5V and 10.5V.
Therefore V_{min} = -0.5V, V_{max}=10.5V.

$$\text{Input voltage [V]} = \text{PortValue} * \frac{\text{V}_{\text{max}} - \text{V}_{\text{min}}}{2^{\text{N}} - 1} + V_{min} = 9029 * \frac{10.5V - (-0.5\text{V})}{2^{14} - 1} + (-0.5V) = 5.562V$$

Example 2:
The analog mode is set to 4-20 mA
The resolution is 12 bit.
The process data is left aligned.
The digitalized value read over IO-Link is $ABC0_{hex}$

In case of 4-20 mA, the analog input current range is between 3.8 mA and 20.5 mA. The digitalized value is read over IO-Link as a 16 bit value, but the resolution is 12 bit and it is left aligned, so the 12 bit digitalized data is ABC_{hex} = 2748.

$$\text{Input current [mA]} = \text{PortValue} * \frac{\text{I}_{\max} - \text{I}_{\min}}{2^{\text{N}} - 1} + I_{min} = 2748 * \frac{20.5mA - 3.8mA}{2^{12} - 1} + 3.8mA = 15.007mA$$

Example 3:
The analog mode is set to TypJ Thermocouple.
The resolution is 16 bit
The digitalized value read over IO-Link is 4567hex = 17767

$$\text{Temperature [°C]} = \text{PortValue} * \frac{\text{T}_{\max} - \text{T}_{\min}}{2^{\text{N}} - 1} + \text{T}_{\min} = 17767 * \frac{1200°C - (-100°C)}{2^{16} - 1} + (-100°\text{C}) = 252.44\ °C$$

3 Getting Started

3.10. Dimensioned data format

In case of dimensioned format, the measured voltage, current or temperature will be converted to mV, uA or °C (in 0.1 °C step), and this value will be sent as a process data. In this case the resolution and process data alignment settings do not influence the data. It must be always handled as a right aligned data, and as a 16 bit value.

Voltage input (0V-10V, 5V – 10V, -10V - +10V, 0V - 5V, -5V - +5V):

In case of positive numbers (MSB = 0):

$$\text{Input voltage [V]} = \frac{\text{PortValue}}{1000}$$

In case of negative numbers (MSB = 1):

$$\text{Input voltage [V]} = \frac{\text{PortValue} - 65536}{1000}$$

Current input (0-20mA, 4-20mA):

$$\text{Input current [mA]} = \frac{\text{PortValue}}{1000}$$

Pt100, Pt1000, Typ J, Typ K, Typ C:

In case of positive numbers (MSB = 0):

$$\text{Temperature [°C]} = \frac{\text{PortValue}}{10}$$

In case of negative numbers (MSB = 1):

$$\text{Temperature [°C]} = \frac{\text{PortValue} - 65536}{10}$$

Where:
PortValue is the digitalized value of the input signal.

Example 1:
The analog mode is set to 0-10V.
The digitalized value read over IO-Link is $15BA_{hex}$ = 5562.

In case of voltage input, the dimensioned value has the dimension of mV.

$$\text{Input voltage [V]} = \frac{\text{PortValue}}{1000} = \frac{5562}{1000} = 5.562V$$

Example 2:
The analog mode is set to 0-10V.
The digitalized value read over IO-Link is $EC78_{hex}$ = 60536.

In case of voltage input, the dimensioned value has the dimension of mV.

$$\text{Input voltage [V]} = \frac{\text{PortValue} - 65536}{1000} = \frac{60536 - 65536}{1000} = -5.000V$$

Example 3:
The analog mode is set to 4-20 mA
The digitalized value read over IO-Link is $3A9F_{hex}$ = 15007.

In case of current input, the dimensioned value has the dimension of uA.

$$\text{Input current [mA]} = \frac{\text{PortValue}}{1000} = \frac{15007}{1000} = 15.007\ mA$$

Example 4:
The analog mode is set to TypJ Thermocouple.
The digitalized value read over IO-Link is 06F1hex = 1777

In case of Thermocouple input, the dimensioned value has the dimension of 0.1 °C

$$\text{Temperature [°C]} = \frac{\text{PortValue}}{10} = \frac{1777}{10} = 177.7\ °C$$

4 IO-Link Interface

4.1. IO-Link Data

BNI IOL-719-002-Z012		
Data transmission rate	COM2 (38,4 kBaud)	
Minimal cycle time	55 ms	
Process data lenght	22 Byte input, 1 Byte output	
IO-Link Revision	**1.1**	**1.0**
Frame typ	2.V	1
Process data cycle time*	55 ms	1320 ms

* by min. cycle time

Note
It is recommended to use the BNI IOL-719-002-Z012 with an IO-Link 1.1 master. In case of IO-Link 1.0 master, the process data cycle time will be extreme high.

4.2. Prozess data / Input data

BNI IOL-719-002-Z012

Byte	0								1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Switch point 1, Port 7	Switch point 1, Port 6	Switch point 1, Port 5	Switch point 1, Port 4	Switch point 1, Port 3	Switch point 1, Port 2	Switch point 1, Port 1	Switch point 1, Port 0	Switch point 2, Port 7	Switch point 2, Port 6	Switch point 2, Port 5	Switch point 2, Port 4	Switch point 2, Port 3	Switch point 2, Port 2	Switch point 2, Port 1	Switch point 2, Port 0

The switch point bits show a switch point overrun. The switch point can be configured by parameter. (see "Switch Point Enable", "Switch Point 1" and "Switch Point 2")

Byte	2								3							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 0															

Byte	4								5							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 1															

Byte	6								7							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 2															

Byte	8								9							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 3															

4 IO-Link Interface

Byte	10								11							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 4															

Byte	12								13							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 5															

Byte	14								15							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 6															

Byte	16								17							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Analog value Port 7															

Byte	18								19							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Pin 1 SC, Wire break Port 7	Pin 1 SC, Wire break Port 6	Pin 1 SC, Wire break Port 5	Pin 1 SC, Wire break Port 4	Pin 1 SC, Wire break Port 3	Pin 1 SC, Wire break Port 2	Pin 1 SC, Wire break Port 1	Pin 1 SC, Wire break Port 0	Underflow Port 7	Underflow Port 6	Underflow Port 5	Underflow Port 4	Underflow Port 3	Underflow Port 2	Underflow Port 1	Underflow Port 0

Pin1 SC, Wire break bit: This bit indicates a short circuit condition of the sensor supply in case of voltage or current input, or wire break condition in case of voltage input, Pt100, Pt1000 and thermocouple sensors on the corresponding port.
Underflow bit: This bit indicates when the measured signal is lower than the selected range.

Byte	20								21							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Description	Overflow Port 7	Overflow Port 6	Overflow Port 5	Overflow Port 4	Overflow Port 3	Overflow Port 2	Overflow Port 1	Overflow Port 0	-	-	-	-	-	-	-	Undervoltage Us

Overflow bit: This bit indicates when the measured signal is higher than the selected range.

4 IO-Link Interface

4.3. Process data / Output data

BNI IOL-719-002-Z012

Byte	0							
Bit	7	6	5	4	3	2	1	0
Description	Short circuit reset P7	Short circuit reset P6	Short circuit reset P5	Short circuit reset P4	Short circuit reset P3	Short circuit reset P2	Short circuit reset P1	Short circuit reset P0

When an input port is configured as a voltage or current input, +24V voltage will be switched between pin1 and pin3 of the input port. This supply voltage is short circuit protected. The supply voltage will be switched off in case of short circuit, in order to reduce the power dissipation. The short circuit error is latched and it can be reset with a 0 -> 1 transition on the corresponding bit in the output process data.

Note
If sensors with increased starting current are used, the short-circuit monitoring can be triggered when the sensor starts up.
If you observe the mentioned behavior, please contact the appropriate support department. They can support you to delay the triggered short-circuit message.

4.4. Parameter data / Request data

	DPP	ISDU		Object name	Length	Range	Default value
	Index	Index	Sub-Index				
Identification data	07_{hex}			Vendor ID	2 bytes	read only	0378_{hex}
	08_{hex}						
	09_{hex}			Device ID	3 bytes		050204_{hex}
	$0A_{hex}$						
		10_{hex}	0	Vendor name	7 bytes		BALLUFF
		11_{hex}	0	Vendor text	15 bytes		www.balluff.com
		12_{hex}	0	Product name	20 bytes		BNI IOL-719-002-Z012
		13_{hex}	0	Product ID	7 bytes		BNI00AJ
		14_{hex}	0	Product text	32 bytes		Sensorhub Analog, 8 Analog Input
		15_{hex}	0	Serial Nr	16 bytes		
		16_{hex}	0	Hardware Revision	1 byte		
		17_{hex}	0	Firmware Revision			
		18_{hex}	0	Application specific tag	32 bytes		
Parameter data		54_{hex}	0	Serial number	16 bytes		16x 00_{hex}
		59_{hex}	0	Process data alignment	1 byte	0..1	1
		$F0_{hex}$	0 1-8	Analog mode	8 bytes	0_{hex} FF_{hex}	FF_{hex}
		$F1_{hex}$	0 1-8	Resolution	8 bytes	0..3	0
		$F2_{hex}$	0 1-8	Pin assignment	8 bytes	0..3	1
		$F3_{hex}$	0 1-8	Pt100/ Pt1000 mode	8 bytes	0..3	3
		$F4_{hex}$	0	Wirebreak detection enable	1 byte	0..1	0
		$F5_{hex}$	0 1-8	Process data format	8 bytes	0..2	0
		$F6_{hex}$	0 1-8	Switch Point 1	16 bytes	0_{hex}- $FFFF_{hex}$	0
		$F7_{hex}$	0 1-8	Switch Point 2	16 bytes	0_{hex}- $FFFF_{hex}$	0
		$F8_{hex}$	0 1-16	Switch Point Enable	2 bytes	0_{hex}- $FFFF_{hex}$	0
		$F9_{hex}$	0 1-8	Thermocouple grounding	8 bytes	0_{hex}	
		FB_{hex}	0 1-8	Wirebreak detection	8 bytes	0..1	0

Note
To ensure the operation and detection of the sensor, the minimum current consumption should be at least 10 mA.

4 IO-Link Interface

Setting the serial number 54hex

The serial number has a default value of 16x 00_{hex}.
In order to use the "Identity" master validation mode, a serial number can be set using this parameter.
This prevents a device from connecting to the wrong master port

> **Note**
> It is recommended to set a unique serial number for each device, and use the “Indentity” master validation mode.

Process data alignment 59hex

The analog values are sent as a 16 bit values over the IO-Link in process data.
In case of 10, 12 or 14 bit resolution the analog value is padded with zeros in order to fill the 16 bit in the process data. The justification of the 10, 12 or 14 bit value can be set in Process data alignment ISDU register.

0 = Left justified
1 = Right justified

Analog values in process data in case of left justification for different resolutions.

Byte	n								n+1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	MSB	10 bit analog value								LSB						
	MSB	12 bit analog value										LSB				
	MSB	14 bit analog value												LSB		
	MSB	16 bit analog value														LSB

Analog values in process data in case of right justification for different resolutions.

Byte	n								n+1							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
							MSB	10 bit analog value								LSB
					MSB	12 bit analog value										LSB
			MSB	14 bit analog value												LSB
	MSB	16 bit analog value														LSB

Note
The process data alignment do not have effect in case of dimensioned data format

4 IO-Link Interface

Analog mode F0$_{hex}$

The mode of the input ports can be set with this ISDU register.
Accessing the ISDU register through the subindex 0, the settings for all ports can be read/written.
Accessing the ISDU register through subindex 1-8, the port mode for the corresponding port (P0-P7) can be read/written.

00_{hex} = Voltage input, 0V - 10V
01_{hex} = Current input, 4mA – 20 mA
02_{hex} = Voltage input, 5V – 10V
03_{hex} = Voltage input, -10V – 10V
04_{hex} = Voltage input, 0V – 5V
05_{hex} = Current input, 0mA – 20 mA
06_{hex} = Voltage input, -5V - +5V
07_{hex} = Pt100
08_{hex} = Pt1000
09_{hex} = Type J thermocouple
$0A_{hex}$ = Type K thermocouple
$0B_{hex}$ = Type C thermocouple*
FF_{hex} = Port is switched off

*available from FW3.0

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Mode Port 0	Mode Port 1	Mode Port 2	Mode Port 3	Mode Port 4	Mode Port 5	Mode Port 6	Mode Port 7

Attention!

- Changing the analog mode of the port to voltage or current input, +24V will be switched between pin1 and pin3, in order to supply the analog sensor.
- Please note that no temperature sensor (Pt100 or Pt1000) is connected to such a port.
- If a temperature sensor (Pt100 or Pt1000) is connected to an analog port that is not configured as Pt100 or Pt1000, the following current can cause the sensor to heat up and/or damage it. There may be a risk of burns.

Resolution F1hex

The resolution of the analog value can be set with this ISDU register.
Accessing the ISDU register through the subindex 0, the resolution for all ports can be read/written. Accessing the ISDU register through subindex 1-8, the resolution for the corresponding port (P0-P7) can be read/written,

0 = 16 bit resolution
1 = 14 bit resolution
2 = 12 bit resolution
3 = 10 bit resolution

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Resolution Port 0	Resolution Port 1	Resolution Port 2	Resolution Port 3	Resolution Port 4	Resolution Port 5	Resolution Port 6	Resolution Port 7

Note
The resolution do not have effect in case of dimensioned data format.

Pin assignment F2hex

In case of voltage or current input the source pin (pin 2 or pin 4) can be selected with an ISDU.
Accessing the ISDU register through the subindex 0, the resolution for all ports can be read/written. Accessing the ISDU register through subindex 1-8, the resolution for the corresponding port (P0-P7) can be read/written,

0 = Pin 2
1 = Pin 4

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Pin assignment Port 0	Pin assignment Port 1	Pin assignment Port 2	Pin assignment Port 3	Pin assignment Port 4	Pin assignment Port 5	Pin assignment Port 6	Pin assignment Port 7

4 IO-Link Interface

Pt100/Pt1000 mode F3hex

The measurement method for the Pt sensor can be set with this ISDU register. Accessing the ISDU register through the subindex 0, the resolution for all ports can be read/written. Accessing the ISDU register through subindex 1-8, the resolution for the corresponding port (P0-P7) can be read/written,

0 = 2 wire measurement
1 = 3 wire measurement
2 = 4 wire measurement

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Pt mode Port 0	Pt mode Port 1	Pt mode Port 2	Pt mode Port 3	Pt mode Port 4	Pt mode Port 5	Pt mode Port 6	Pt mode Port 7

Wire break disable F4hex

In case of Pt 100, Pt1000, Typ J, Typ K and Type C the BNI IOL-719-002-Z012-XXX can detect wire break condition. In some cases with a calibrator unit, the wire break detection will be activated. In order to be able to use calibrator to calibrate the module, the wire break detection can be disabled.
It is recommended to enable the wire break detection during normal operation.

0 = Enabled
1 = Disabled

Process data format F5hex

The analog value can be represented in different formats in the process data.
0 = Signed
1 = Unsigned
2 = Dimensioned (mV, uA, x0.1 °C)

Switch point 1, F6hex
Switch point 2, F7hex

Two switch points can be set for each port. When the analog value is greater than the value of the switch point, the corresponding bit in the process data will be set.
Each switch point ISDU register is 16 byte long. Accessing the ISDU register through the subindex 0, the switch point values for all ports can be read/written. Accessing the ISDU register through subindex 1 – 8, the switch point for the corresponding port (P0 – P7) can be read/written.

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Switch Point X Port 0		Switch Point X Port 1		Switch Point X Port 2		Switch Point X Port 3	

Byte	0	1	2	3	4	5	6	7
	Switch Point X Port 4		Switch Point X Port 5		Switch Point X Port 6		Switch Point X Port 7	

In order to avoid flickering of the switch point bit in process data, the switchpoint is evaluated with hysteresis. The hysteresis for different input types are listed in the table above.

Input type	Hysteresis
Voltage	5 mV
Current	10 µA
Temperature	1 °C

Note
The switch point value must be set according to the resolution and process data format. The switch point value is always right justified.

Switch point enable F8hex

Each switching point can be enabled or disabled. When a switch point is disabled, the corresponding bit in the process data will be set to 0. When a switch point is enabled, the analog value will be compared to the switch point value, and the corresponding bit will be set in the process data according to the result of the comparison.

4 IO-Link Interface

Thermo-couple grounding F9$_{hex}$

There are three types of thermocouples: ungrounded, grounded and exposed. The BNI IOL-719-002-Z012 is able to measure all of them, but in case of grounded thermocouple the measurement range is reduced. The thermocouple type must be set in the ISDU in order to measure the thermocouples correct.

0 = Ungrounded thermocouple
1 = Grounded thermocouple

Subindex 0:

Byte	0	1	2	3	4	5	6	7
	Grounding Port 0	Grounding Port 1	Grounding Port 2	Grounding Port 3	Grounding Port 4	Grounding Port 5	Grounding Port 6	Grounding Port 7

The ungrounded measurement mode should be selected in case of ungrounded and in case of exposed thermocouple. In case of exposed thermocouple the hot junction must not have galvanic connection to conductive surfaces.
In case of grounded thermocouple the sheath of the thermocouple must be connected to the ground.

Voltage sensor wire break detection FB$_{hex}$

Wire break detection can be switched on for the input ports, which are configured for voltage input, in order to detect broken wires or misconfigured sensor connections. This function is disabled by default.

0 = Disabled
1 = Enabled

Subindex 0:

Byte	0							
Bit	7	6	5	4	3	2	1	0
	Port 7	Port 6	Port 5	Port 4	Port 3	Port 2	Port 1	Port 0

4.5. Error

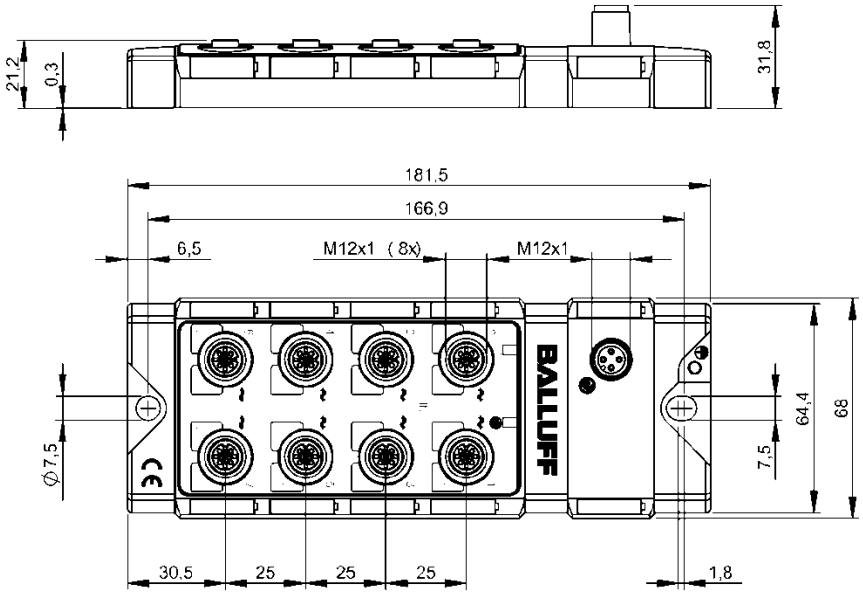
Error Code	Description
0x8011	Index not available
0x8012	Subindex not available
0x8023	Access Denied
0x8030	Parameter Value out of Range
0x8033	Parameter length overrun
0x8034	Parameter length underrun

4.6. Events

IO-Link Revision 1.0	
Event Code	**Description**
0x5112	Low supply voltage (US1)
0x5160	Short circuit on pin1 (on at least one of the ports)
0x8C20	Measurement value is out of range
0x8DF3	Wire break detected on some port
IO-Link Revision 1.1	
Event Code	**Description**
0x5111	Low supply voltage (US1)
0x7710	Short circuit on pin1 (on at least one of the ports)
0x8C20	Measurement value is out of range
0x7700	Wire break detected on some port

5 Technical Data

5.1. Dimensions



5.2. Mechanical Data

Housing material	Die-cast zinc housing
IO-Link-Port	M12, A-coded, male,
Analog Ports	M12, female, 5-poles
Enclosure rating per IEC 60529	IP67 (only when plugged in and threaded in)
Weight	ca. 500 g
Dimensions (W × H × D in mm)	68 x 181,5 x 31,8

5.3. Electrical Data

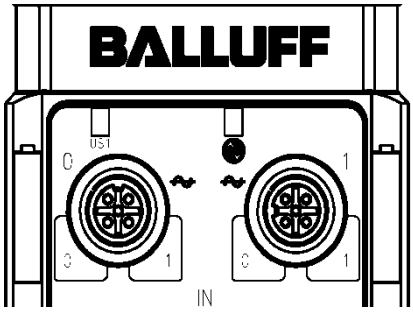
Operating conditions	18 ... 30,2 V DC, per EN 61131-2
Ripple	< 1 %
Current draw without load	≤ 80 mA
Voltage input measuring error	<±0.1% full-scale, <2 mV, which is greater
Current input measuring error	<±0.1% full-scale, <4 uA, which is greater
Pt100, Pt1000 input measuring error	<±0.2% full-scale, <0.2 °C, which is greater
TypJ thermocouple measuring error	-100 °C - +100 °C: <2.5˚C +100 °C - +1200 °C: <2 °C
TypK thermocouple measuring error	-180 °C - -100 °C: <3˚C -100 °C - +1370 °C: <2 °C
TypC thermocouple measuring error	0…2300°C:<2,5°C
Temperature coefficient	<±0.01% / °C

5.4. Operating conditions

Ambient temperature	-5 °C … +70 °C
Storage temperature	-25 °C … +70 °C

5 Technical Data

5.5. LED indicators



Status LEDs

LED	Indicator	Function
LED 1	Green / Red	Supply module ok / Undervoltage
LED 6	Green / Green flashing	Communcation error / communication ok

Port-Pin LEDs

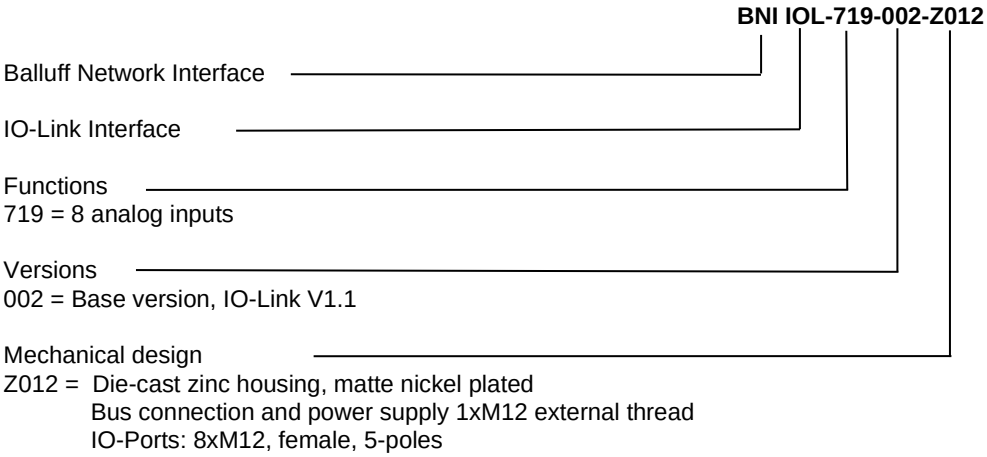
LED “0” – Port Pin 4
LED “1” – Port Pin 2

LED I-Ports Standard

Indicator	Function Port LED
Off	Port is switched off
Yellow static (LED0)	Port is switched on, input signal is in range
Red (LED0)	Input signal is out of range
Red (LED0, LED1)	Pin1 short circuit or wirebreak on port

6 Appendix

6.1. Product ordering code



6.2. Order information

Product ordering code	Order code
BNI IOL-719-002-Z012	BNI00AJ

Included material

BNI IOL… consists of the following components:

- IO-Module
- 4 Protection caps
- Ground connection-band
- Screw M4x6
- 20 Labels

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