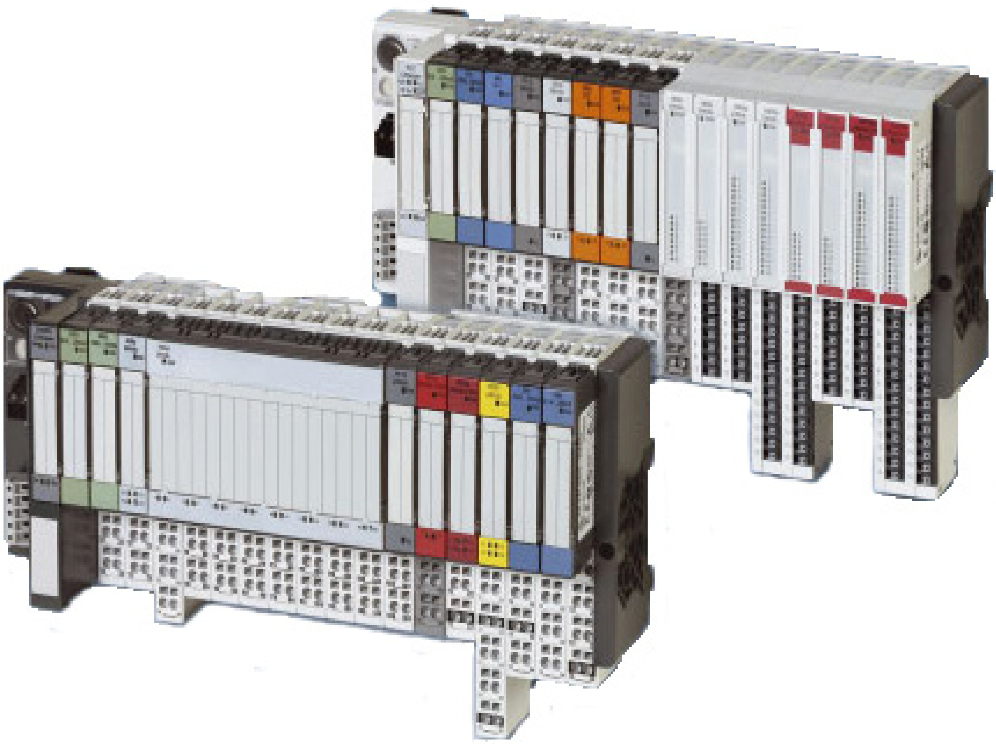
Flexium I/Os

XI/ON Analogue I/Os

Operator Manual

M00003EN

Edition 12.2008



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CNC HighEnd Applications

NUM Standard Material

Module	Commercial reference (NUM)	Consists of (number in this document) Type	Order No.
1 AI *2-wire circuitry*	**XION 084 030**	8550225178	XN-1AI-U(10/0 to 10V DC)
		8550225193	XN-S3T-SBB
2 AI *2-wire circuitry*	**XION 084 031**	8550230870	XN-2AI-U(10/0 to 10V DC)
		8550225193	XN-S3T-SBB
2 AI PT/NI *3-wire circuitry*	**XION 084 032**	8550225181	XN-2AI-PT/NI-2/3
		8550225197	XN-S4T-SBBS
2 AO *2-wire circuitry*	**XION 084 040**	8550225180	XN-2AO-U(10/0 to 10V DC)
		8550225193	XN-S3T-SBB

Document revisions

Date	Index	Reason for revision
12 - 2008	**00**	**Document creation**

Despite the care taken in the preparation of this document, NUM cannot guarantee the accuracy of the information it contains and cannot be held responsible for any errors therein, nor for any damage which might result from the use or application of the document.

The physical, technical and functional characteristics of the hardware and software products and the services described in this document are subject to modification and cannot under any circumstances be regarded as contractual.

The programming examples described in this manual are intended for guidance only. They must be specially adapted before they can be used in programs with an industrial application, according to the automated system used and the safety levels required.

Warning!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that the device cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions of the device concerned.
- Only suitably qualified personnel in accordance with EN 501101/-2 (VDE 0105 Part 100) may work on this device.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or tothe potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 Part 410).
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause uncontrolled operation or restart.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- The electrical installation must be carried out in accordance with the relevant regulations (e.g. with regard to cable cross sections, fuses, PE).
- All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel. (IEC 60364 and HD384 or DIN VDE 0100 and national work safety regulations).

Contents

About This Manual

Writing conventions

Abbreviations and symbols used in this manual have the following meanings:

Attention!
Warns of minor damage to property.

Caution!
Warns of major damage to property, and minor injuries.

Warning!
Warns of major damage to property, and death or major injuries.

→ Indicates interesting tips and additional information

1 The XI/ON Station

Dimensions

Dimensions of electronics modules

Dimensions in mm (W x L x H)

Slice design	12.6 x 74.1 x 55.4 / 0.49 x 2.92 x 2.18
Block design	100.8 x 74.1 x 55.4 / 3.97 x 2.92 x 2.18

Dimensions of base modules

Dimensions in mm (W x L x H)

Slice design	
2-/3-wire connection technology	12.6 x 117.6 x 49.9 / 0.49 x 4.63 x 1.96
4-wire connection technology	12.6 x 128.9 x 49.9 / 0.49 x 5.07 x 1.96
4 x 2-/3-wire connection technology	12.6 x 154.5 x 49.9 / 0.49 x 6.08 x 1.96
Block design	
2-/3-wire connection technology	100.8 x 117.6 x 49.9 / 3.97 x 4.63 x 1.96
4-wire connection technology	100.8 x 128.9 x 49.9 / 3.97 x 5.07 x 1.96

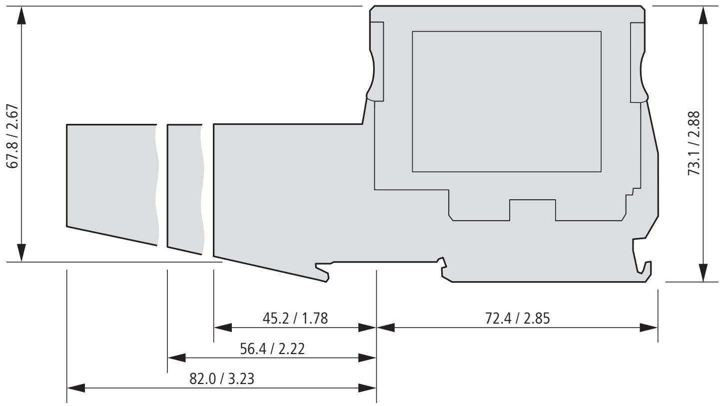


Figure 1: Side view of complete XI/ON module (with tension clamp connector)

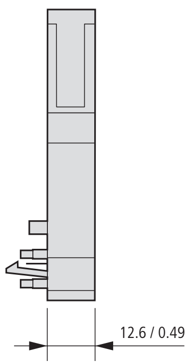


Figure 2: Rear view of complete XI/ON module, slice design

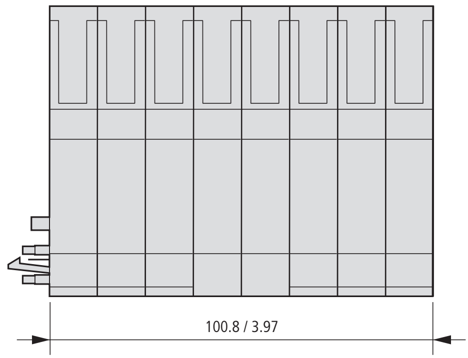


Figure 3: Rear view of complete XI/ON module, block design

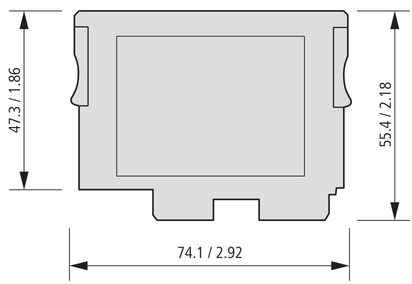


Figure 4: Side view of electronics module

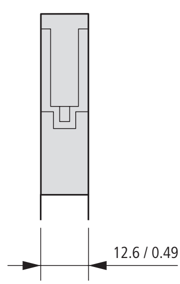


Figure 5: Rear view of electronics module, slice design

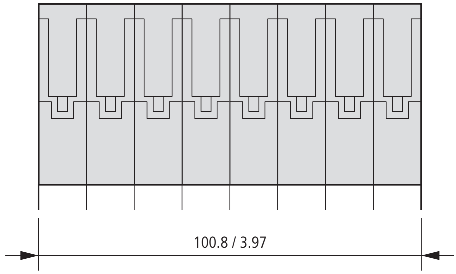


Figure 6: Rear view of electronics module, block design

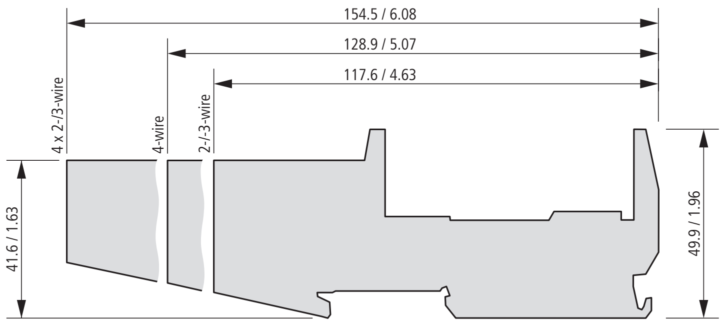


Figure 7: Base module with tension clamp connector

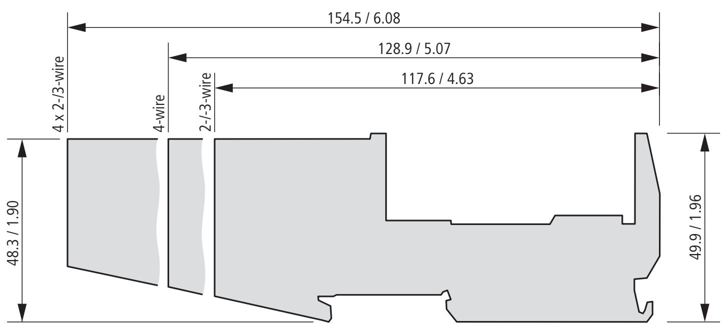


Figure 8: Base module with screw terminals

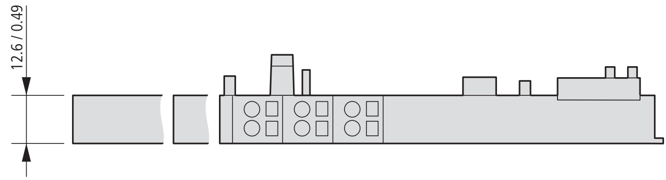


Figure 9: Plan view of base module, slice design

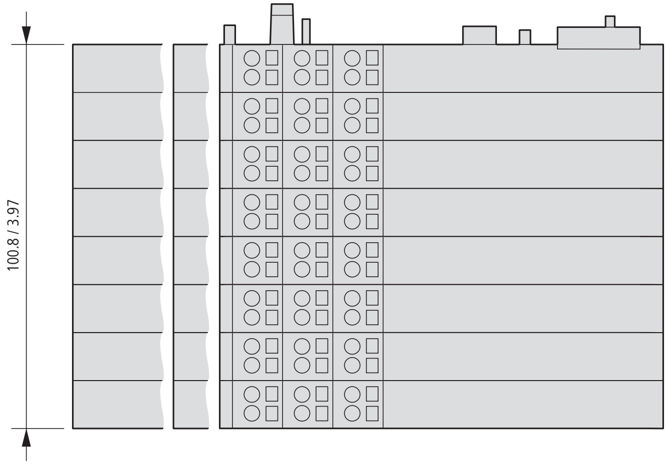


Figure 10: Plan view of base module, block design

Technical data for the XI/ON station

Attention!
The auxiliary supply must meet the requirements for SELV (= Safety Extra Low Voltage) as per IEC 60364-4-41.

Table 1: Technical data for the XI/ON station

Designation	Value
Supply voltage/auxiliary supply	
Nominal value (provided for other modules)	24 V DC
Residual ripple	to EN 61131-2
Electrical isolation (U_L to U_{SYS}/U_L to fieldbus/U_{SYS} to fieldbus)	yes, via optocoupler
Environment/temperature	
Operating temperature, mounted horizontally	0 – +55 °C
Operating temperature, mounted vertically	0 – +55 °C
Storage temperature	-25 – +85 °C
Relative humidity to EN 61131-2/EN 50178	5 – 95 % (indoor), Level RH-2, no condensation (storage at 45 °C, no functional test)
Housing rating for slice modules (possible heat dissipation)	1 W
Housing rating for block modules (possible heat dissipation)	4 W
Corrosive gases	
SO_2	10 ppm (rel. humidity < 75 %, no condensation)
H_2S	1.0 ppm (rel. humidity < 75 %, no condensation)
Vibration resistance	
10 – 57 Hz, constant amplitude 0.075 mm, 1 g	yes
57 – 150 Hz, constant acceleration 1 g	yes

Designation	Value
Vibration type	Variable frequency runs at a rate of change of 1 octave/min
Vibration duration	20 variable frequency runs per coordinate axis
Shock resistance as per IEC 68-2-27	18 shocks, half-sine 15 g peak value/11 ms, for both +/- directions per spatial coordinate
Repeated shock resistance as per IEC 68-2-29	1000 shocks, half sine 25 g peak value/6 ms, for both +/- directions per spatial coordinate
Drop and topple	
Fall height (weight < 10 kg)	1.0 m
Fall height (weight 10 – 40 kg)	0.5 m
Test runs	7
Instrument with packaging, electronics boards electrically tested	
Electromagnetic compatibility (EMC) as per EN 50082-2 (industrial)	
Static electricity as per EN 61000-4-2	
Air discharge (direct)	8 kV
Relay discharge (indirect)	4 kV
Electromagnetic HF fields as per EN 61000-4-3 and ENV 50204	10 V/m
Conducted interference, induced by HF fields as per EN 61000-4-6	10 V
Fast transients (burst) as per EN 61000-4-4	
Radiated interference as per EN 50081-2 (industrial)	to EN 55011 Class A[1], Group 1

1) The use in residential areas may lead to functional errors. Additional suppression measures are necessary!

Table 2: Approvals and tests for a XI/ON station

Designation	Value
Approvals	CE, CSA, UL
Tests (EN 61131-2)	
Cold	DIN IEC 60068-2-1, temperature -25 °C, duration 16 h; device not in operation
Dry heat	DIN IEC 60068-2-2, temperature +85 °C, duration 16 h; device not in operation
Damp heat, cyclical	DIN IEC 60068-2-30, temperature +55 °C, duration 2 cycles of 12 h
Temperature changes	DIN IEC 60068-2-14, temperature 5 – +55 °C, duration 2 cycles, 3 °C temperature change per minute; device in operation
Operating life MTBF	120 000 h[1)]
Removal/insertion cycles for electronics modules	20
Pollution level as per IEC 664 (EN 61131)	2
Degree of protection as per IEC 529	IP 20

1) The operational life of the relay modules is not given in hours. The relevant factor for the operational life of relay modules is the number of switching operations.

Technical data for the base modules

Table 3: Technical data for the base modules

Designation	Value
Degree of protection	IP 20
Stripped length	8 mm
Max. cross-section at terminal	0.5 – 2.5 mm^2
Suitable cables	
“e” solid H 07V-U	0.5 – 2.5 mm^2
“f” stranded H 07V-K	0.5 – 1.5 mm^2
“f” with core-end ferrules to DIN 46228/1 (ferrules are crimped gas-tight)	0.5 – 1.5 mm^2
Finger test to IEC 947-1/1988	A1
Rated data as per VDE 0611 Part 1/8.92/IEC 947-7-1/1989	
Rated voltage	250 V
Rated current	17.5 A
Rated cross-section	1.5 mm^2
Peak rated voltage	4 kV
Pollution degree	2
Connection method in TOP direction	Tension clamp connector or screw terminal

Designations of the base modules

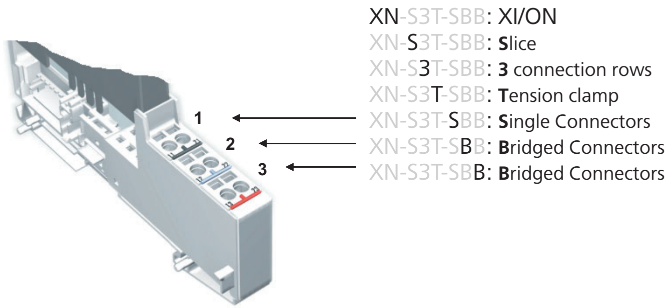


Figure 11: Example of a base module designation

Table 4: Abbreviations for base module designations

Code	Designation	Example
XN	Abbreviation for XI/ON	XN-**B**3S-SBB
B	Designation of base modules in block design (Block)	XN-**B**3S-SBB
S	Designation of base modules in slice design (Slice)	XN-**S**3T-SBB
P	Designation of base modules for feeding and bus refreshing modules (Power)	XN-**P**3T-SBB
3, 4, 6	Number of terminal rows.	XN-**P**3T-SBB
S	Designation of base modules with screw terminals (Screw)	XN-S3**S**-SBB
T	Designation of base modules with tension clamp connector (Tension Clamp)	XN-S3**T**-SBB
x	Optionally S or T in the designation of base modules with screw or tension clamp connections (Screw / Tension)	XN-S3**x**-SBB
S	Unbridged connections on the same connection level (level 1 in this case) in a base module, for connecting signals (Single Connector)	XN-S3T-**S**BB
B	Bridged connections on the same connection level in a base module, for voltage connections. (Bridged Connector)	XN-S3T-S**B**B

Code	Designation	Example
B	Supplement to the designation of base modules for bus refreshing modules that are used within a XI/ON station, but not for supplying the gateway. (Bus Refreshing)	XN-P4T-SBBC-**B**
C	Designation of a connection level that has a connection to a C-rail and can be used for a PE connection (only for specific base modules). (Cross Connection)	XN-S4T-SBB**C**
CJ	Base module for XN-2AI-THERMO-PI with integrated PT1000 for cold junction compensation. (Cold Junction Compensation)	XN-S4T-SBBS-**CJ**

Module designations and abbreviations

Table 5: Key to module designations

Code	Designation	Example
AI	Analog input module	XN-1**AI**-U(-10/0...+10VDC)
AO	Analog output module	XN-1**AO**-I(0/4...20MA)
BR	Bus refreshing module	XN-**BR**-24VDC-D
NI	Analog input module for connecting resistance thermometers with Ni100 and Ni1000 sensors with 2 and 3-wire measuring	XN-2AI-PT/**NI**-2/3
PF	Power feeding module	XN-**PF**-24VDC-D
PI	Potentially isolated (analog modules for thermocouples)	XN-2AI-THERMO-**PI**
PT	Analog input module for connecting resistance thermometers with PT100, PT200, PT500 and PT1000 sensors with 2 and 3-wire measuring	XN-2AI-**PT**/NI-2/3

The supply modules

The use of gateways

- XN-GWBR-PBDP for PROFIBUS
- XN-GWBR-CANOPEN for CANopen
- XN-GWBR-DNET for DeviceNet

replaces the use of a bus refreshing module (directly on the right of the gateway). These gateways have an integrated power supply module with the same dimensions. All other gateways require a bus refreshing module as the first module after it.

A detailed description of these power supply modules can be found in the manual:

- Product description XI/ON:
  Digital I/O modules, supply modules

Bus refreshing modules XN-BR-24VDC-D

The bus refreshing modules provide:

- 5 V DC for the internal XI/ON module bus and the neighbouring gateway.
- 24 V DC (permissible range as per EN 61 131-2) as the supply for the module electronics and the field. This 24 V DC supply voltage is distributed throughout the XI/ON station on a separate conductor.

This is electrically isolated from the neighbouring supply module on the left.

Attention!
The first bus refreshing module in a XI/ON station must be fitted directly to the right of a gateway without an integrated power supply. This provides the 5 V DC power supply to the gateway when connected to a special base module.

Attention!
Only the base modules XN-P3x-SBB or XN-P4x-SBBC (as the first module to the right of the gateway) can be used to supply the gateway.

Power feeding module XN-BR-24VDC-D

The power feeding modules are used to supply the various XI/ON modules with the field voltage of 24 V DC or 120/230 V AC. They are used when different potential groups need to be set up within a XI/ON station, or in the event that the supply would otherwise be inadequate for the rated current requirements of the XI/ON modules. They are electrically isolated from the adjacent supply group on the left.

Warning!
Power feeding modules cannot be used to provide the 5 V DC supply for the XI/ON gateway.

The ash-grey cover of the base modules for power feeding modules make them clearly distinguishable from the base modules for the XI/ON I/O modules.

Power feeding module XN-PF-120/230VAC-D

The following modules can be supplied from a preceding XN-PF-120/230VAC-D:

- XN-2DI-120/230VAC
- XN-2DO-120/230VAC-0,5A

Caution!
Relay modules must not be supplied from a preceding XN-PF-120/230VAC-D!
The nominal voltage at the supply terminals is 24 V DC!
The relay modules can be externally loaded by up to 230 V AC.

2 Analog Input Modules

General

Analog input modules (AI) process normalised electrical signals via the terminals of the base module, convert them to digital values and transmit the corresponding measured value to the gateway via the internal module bus.

The electronics on the module bus of the analog input modules is isolated from the field level via optocouplers and is protected against reverse polarity.

Analog input modules are built with a slice design. They are completed with base modules with tension clamp connectors or screw terminals.

Supported signal ranges
0 – 20 mA
4 – 20 mA
0 – 10 V DC
-10 – +10 V DC

Connectable sensors
Platinum sensors (PT100, PT200, PT500, PT1000)
Nickel sensors (Ni100, Ni1000)
Thermocouples (types B, E, J, K, N, R, S, T)

Representation of the analog values

16-bit or 12-bit representation

The analog values can be represented as either 16-bit or 12-bit values. The two's complement notation of the number allows both positive and negative values to be represented.

16-bit representation:
The 16-bit representation is implemented in **two's complement** notation. 2 bytes of process data are fully assigned.

12-bit representation:
The value is represented in **two's complement** notation for voltage measurement (output) and temperature measurement. The value is represented in **binary** format for current measurement (output) and resistance measurement. The 12-bit value is mapped **left-justified** in the process data so that it is compatible (e.g. with *WIN* bloc).
The diagnostics data is integrated in the process input data and is assigned to 4 bits (right-justified).
→ "Data structure with 12-bit representation" page 166

The two's complement in the number circle

This figure shows a 5-digit binary code in the outer circle. The inner number circle shows the corresponding decimal value if this binary code is interpreted as a binary (positive) value) and as a two's complement value:

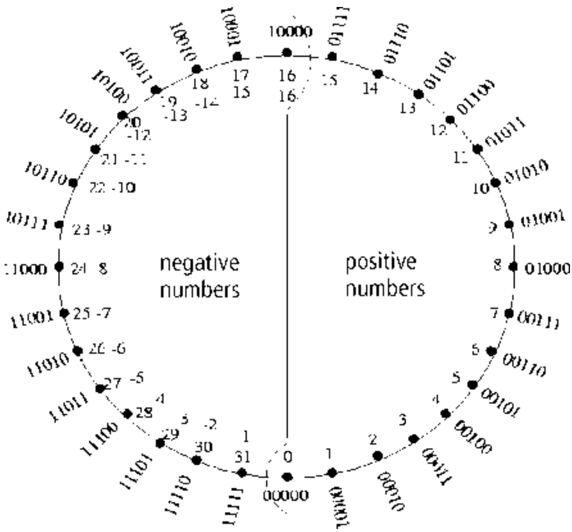


Figure 12: Binary code as binary number and as two's complement

Equations and graphs for 16-bit representation

Representation of current values in the range 0 mA – 20 mA

To use the equation below, the hexadecimal or binary value must be converted to a decimal value.

The value range:

0 – 20 mA

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

The hexadecimal/binary numerical value can be converted (using a pocket calculator) very easily to a decimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

Once the decimal value has been determined, the current values can be calculated with the following equation:

$$\text{current} = \frac{\text{dezimer value}}{1638.35}\,\text{mA} = 6.1 \times 10^{-4}\,\text{mA} \times \text{dezimer value}$$

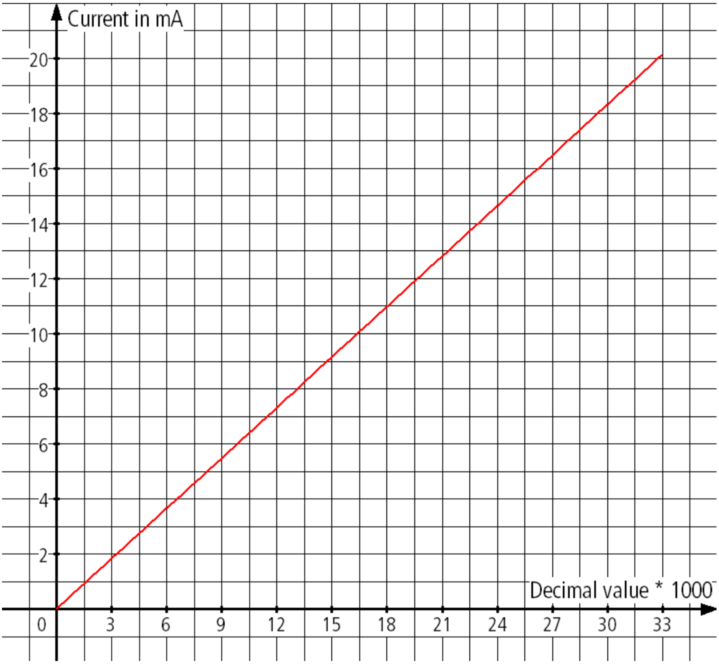


Figure 13: Representation of current values in relation to the decimal values in the coordinate system

Representation of current values in the range 4 mA – 20 mA

To use the equation below, the hexadecimal or binary value must be converted to a decimal value.

The value range:

4 – 20 mA

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

The hexadecimal/binary numerical value can be converted (using a pocket calculator) very simply to a decimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

Once the decimal value has been determined, the current values can be calculated with the following equation:

$$\boxed{\text{current} = 4.88 \times 10^{-4}\ \text{mA} \times \text{dezimal value} + 4\ \text{mA}}$$

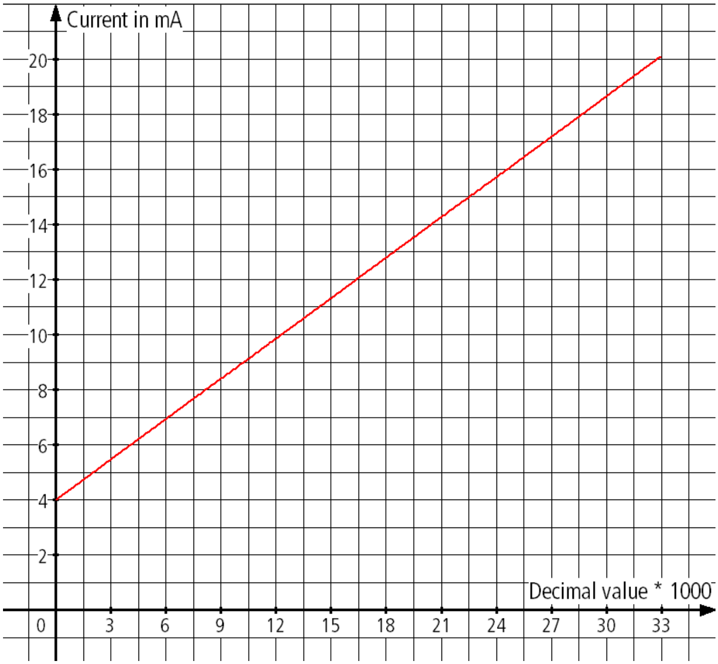


Figure 14: Representation of current values in relation to the decimal values in the coordinate system

Representation of temperature values and resistance values for the XN-2AI-PT/NI-2/3

To use the equations below, the hexadecimal or binary value must be converted to a decimal value.

The hexadecimal/binary numerical values for the negative number range cannot be converted (using a pocket calculator) easily to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 0000 – $7FFF_{hex}$ represent **positive** numerical values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 16).

All numerical values in the range 8000 – $FFFF_{hex}$ represent **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 16). The following examples shows the conversion to a decimal number:

→ “Example of the calculation of negative numerical values” page 50

Once the decimal value has been determined, the **temperature values** can be calculated according to the parameters defined (→ table 29 page 173).

The following applies to the parameter setting of

- "PT100, -200..850’C"
- "NI100, -60..250’C"
- "PT200, -200..850’C"
- "PT500, -200..850’C"
- "PT1000, -200..850’C"
- "NI1000, -60..250’C"

$$\boxed{\text{temperature} = 0.1\ °\text{C} \times \text{dezimal value}}$$

The value range:

-200 °C – -0.1 °C

is mapped to the number range:

F830 – $FFFF_{hex}$ (decimal: -2000 – -1).

The value range:

0 – 850 °C

is mapped to the number range:

0000 – 2134_{hex} (decimal: 0 – 8500).

The following applies to the parameter setting of

- "PT100, -200..150’C"
- "NI100, -60..150’C"
- "PT200, -200..150’C"
- "PT500, -200..150’C"
- "PT1000, -200..150’C"
- "NI1000, -60..150’C"

$$\boxed{\text{temperature} = 0.01\ °\text{C} \times \text{dezimal value}}$$

The value range:

-200 – -0.01 °C

is mapped to the number range:

B1E0 – FFFF$_{hex}$ (decimal: -20000 to -1).

The value range:

0 – 150 °C

is mapped to the number range:

0000 – 3A98$_{hex}$ (decimal: 0 – 15000).

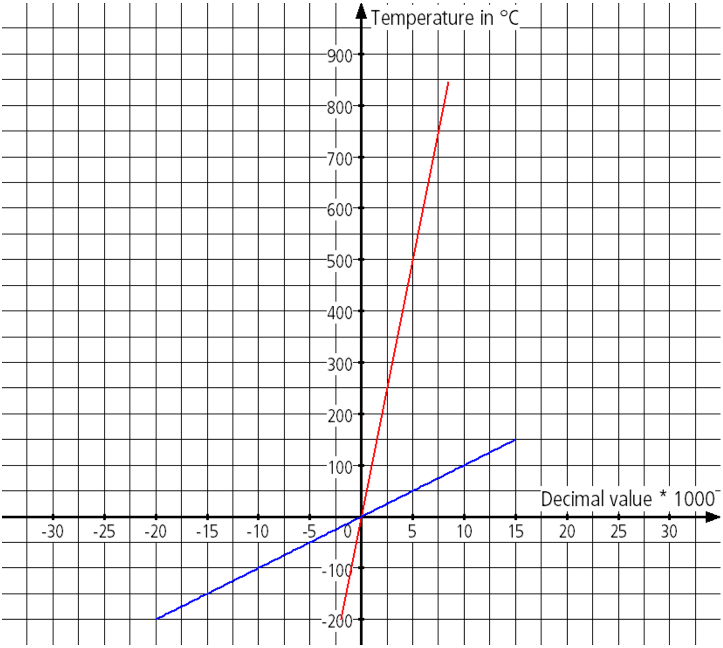


Figure 15: Representation of temperature values in relation to decimal values in the coordinate system
The **red** straight line (factor 0.1) applies with the following parameter setting:
"PT100, -200..850’C"
"NI100, -60..250’C"
"PT200, -200..850’C"
"PT500, -200..850’C"
"PT1000, -200..850’C"
"NI1000, -60..250’C"
The **blue** straight line (factor 0.01) applies with the following parameter setting:
"PT100, -200..150’C"
"NI100, -60..150’C"
"PT200, -200..150’C"
"PT500, -200..150’C"
"PT1000, -200..150’C"
"NI1000, -60..150’C"

The parameter setting for the measurement of **resistance values** only requires positive numerical values (hexadecimal/binary) for representation. The positive numerical values can be converted (with the pocket calculator) very easily to a decimal value.

The value range:

0 – 100 Ω; 0 – 200 Ω; 0 – 200 Ω; 0 – 1000 Ω

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

Once the decimal value has been determined, the resistance values can be calculated according to the parameters defined (→ table 29 page 173).

The following equations apply:

"Resistance, 0..100 Ohm" (yellow straight line):

$$\boxed{\text{resistance} = 0.00305\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..200 Ohm" (red straight line):

$$\boxed{\text{resistance} = 0.00610\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..400 Ohm" (blue straight line):

$$\boxed{\text{resistance} = 0.01221\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..1000 Ohm" (green straight line):

$$\boxed{\text{resistance} = 0.03052\ \Omega \times \text{dezimal value}}$$

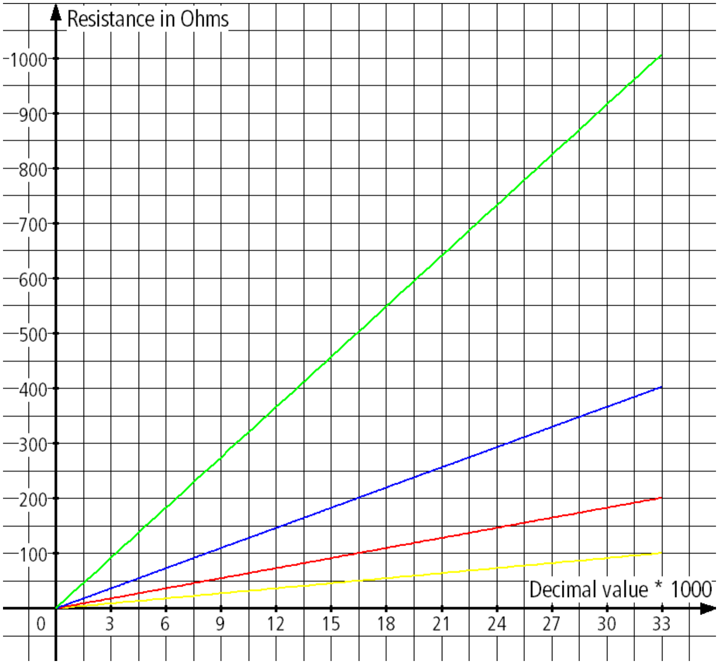


Figure 16: Representation of resistance values in relation to the decimal values in the coordinate system

Representation of temperature and voltage values for the XN-2AI-THERMO-PI

To use the equations below, the hexadecimal or binary value must be converted to a decimal value.

The hexadecimal/binary numerical values for the negative number range cannot be converted (using a pocket calculator) easily to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 0000 – $7FFF_{hex}$ represent **positive** numerical values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 16).

All numerical values in the range 8000 – $FFFF_{hex}$ represent **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 16). The conversion to a decimal value shows: → "Example of the calculation of negative numerical values" page 50

Once the decimal value has been determined, the **temperature values** and the **voltage values** can be calculated according to the parameters defined (→ table 29 page 173).

The following applies to the parameter setting of
"Type K, -270..1370'C"
"Type B, +100..1820'C"
"Type E, -270..1000'C"
"Type J, -210..1200'C"
"Type N, -270..1300'C"
"Type R, -50..1760'C"
"Type S, -50..1540'C"
"Type T, -270..400'C"

$$\boxed{\text{temperature} = 0.1\ °\text{C} \times \text{dezimal value}}$$

The value range:

-270 – -0.1 °C

is mapped to the number range:

F574 – FFFF$_{hex}$ (decimal: -2700 – -1)

The value range:

0 – 1820 °C

is mapped to the number range:

0000 – 4718$_{hex}$ (decimal: 0 – 18200)

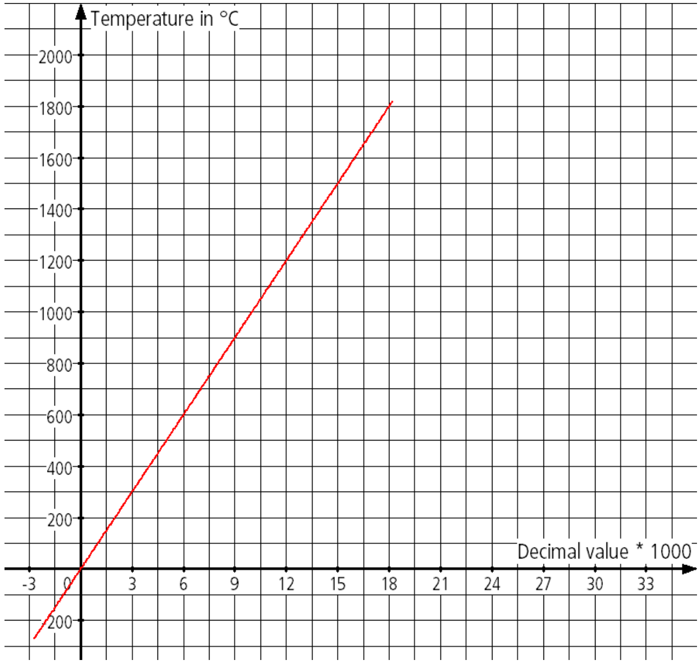


Figure 17: Representation of temperature values in relation to the decimal values in the coordinate system

The value range:

-50 – -0.002 mV;
-100 – -0.003 mV;
-500 – -0.015 mV;
-1000 – -0.031 mV

is mapped to the number range:

8000 – FFFF$_{hex}$ (decimal: -32768 – -1)

The value range:

0 – 50 mV;
0 – 100 mV;
0 – 500 mV;
0 – 1000 mV;

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

The following applies to the parameter setting **"+/– 50 mV"**:

$$\boxed{\text{voltage} = 0.001526 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting **"+/– 100 mV"**:

$$\boxed{\text{voltage} = 0.003052 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting **"+/– 500 mV"**:

$$\boxed{\text{voltage} = 0.015259 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting **"+/-1000 mV"**:

$$\boxed{\text{voltage} = 0.030519 \text{ mV} \times \text{dezimal value}}$$

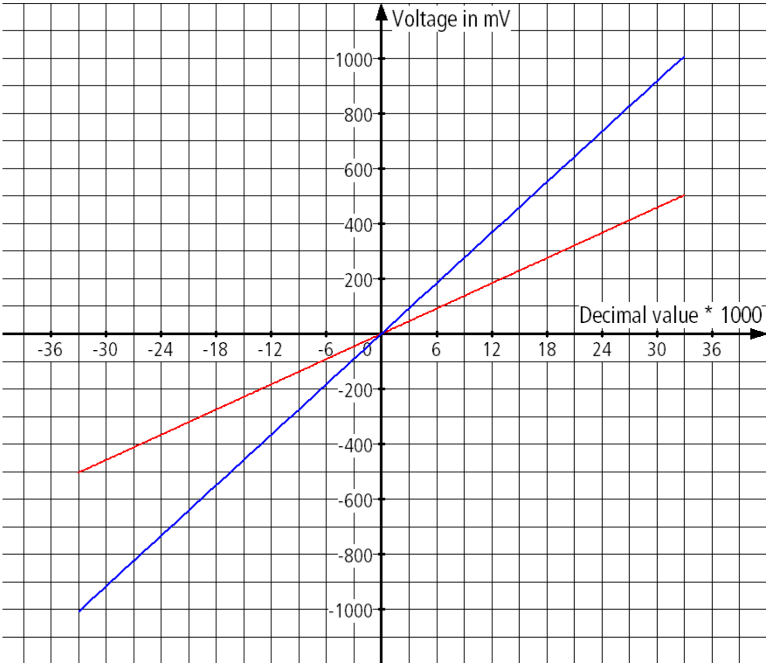


Figure 18: Representation of voltage values in relation to the decimal values in the coordinate system for the parameter setting "+/-500 mV" (red) and "+/-1000 mV" (blue)

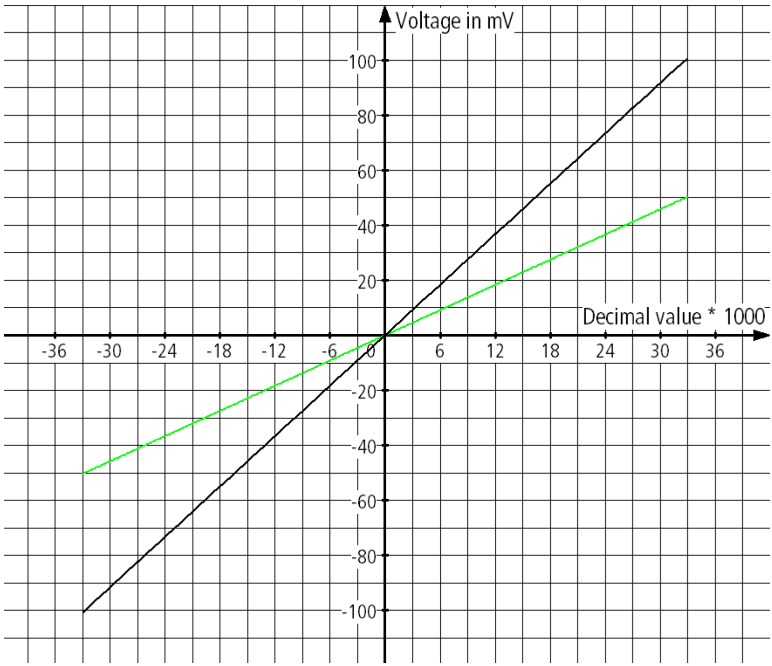


Figure 19: Representation of voltage values in relation to the decimal values in the coordinate system for the parameter setting "+/-50 mV" (green) and "+/-100 mV" (black)

Representation of the voltage values in the range 0 V DC – 10 V DC

To use the equation below, the hexadecimal or binary value must be converted to a decimal value.

The hexadecimal/binary numerical value can be converted (using a pocket calculator) very simply to a decimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

The value range:

0 – 10 V DC

is mapped to the number range:

0000 – $7FFF_{hex}$ (decimal: 0 – 32767)

Once the decimal value has been determined, the voltage values can be calculated with the following equation:

$$\boxed{\text{voltage} = 3.05185 \times 10^{-4}\ \text{V} \times \text{dezimal value}}$$

Figure 20: Representation of voltage values in relation to the decimal values in the coordinate system

Representation of the voltage values in the range –10 V DC – 10 V DC

To use the equation below, the hexadecimal or binary value must be converted to a decimal value.

The hexadecimal/binary numerical values for the negative number range cannot be simply converted (using a pocket calculator) to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 0000 – $7FFF_{hex}$ represent **positive** numerical values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 16).

All numerical values in the range 8000 – $FFFF_{hex}$ represent **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 16). The conversion to a decimal value shows: → "Example of the calculation of negative numerical values" page 50

The value range:

-10 – -3.052 10^{-4} V DC

is mapped to the number range:

8000_{hex} – $FFFF_{hex}$ (decimal:-32768 – -1)

The value range:

0 – 10 V DC

is mapped to the number range:

0000_{hex} – $7FFF_{hex}$ (decimal: 0 – 32767)

Once the decimal value has been determined, the voltage values can be calculated with the following equation:

$$\boxed{\text{voltage} = 3.052 \times 10^{-4}\ \text{V} \times \text{dezimal value}}$$

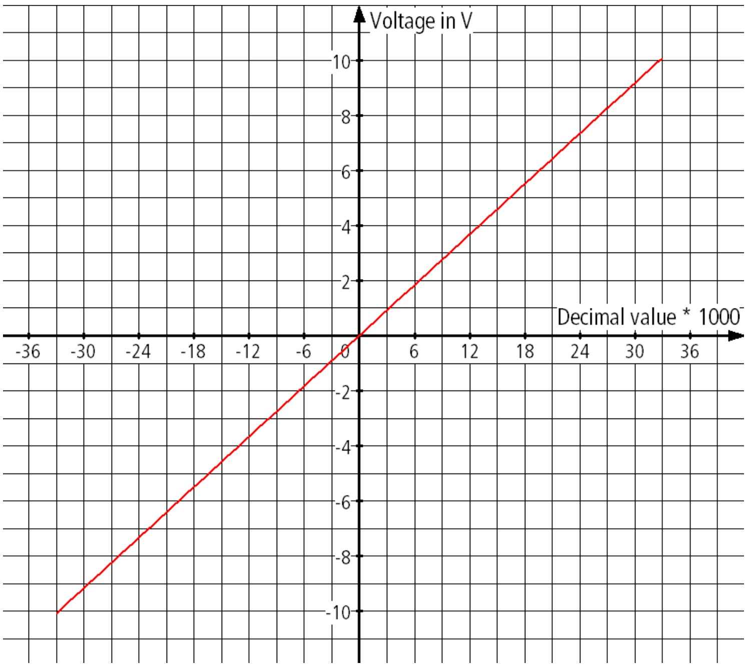


Figure 21: Representation of voltage values in relation to the decimal values in the coordinate system

Example of the calculation of negative numerical values

For the example the following parameter setting applies: "PT100, -200..150’C"

The temperature is thus calculated with the factor 0.01 (→ page 36).

The example shows the general procedure for calculating a negative decimal number from a hexadecimal or binary number coded as a two's complement value

The displayed hexadecimal value is **B344.**

The binary value for this is:

$$\boxed{B344 \Leftrightarrow 1011.0011.0100.0100}$$

Invert the binary number

$$\boxed{1011.0011.0100.0100 \Rightarrow 0100.1100.1011.1011}$$

Add a 1 to the inverted binary number:

$$\boxed{\begin{array}{l} 0100.1100.1011.1011 \\ \underline{0000.0000.0000.0001} \\ 0100.1100.1011.1100 \end{array}}$$

Calculate the corresponding decimal value (with the pocket calculator):

$$\boxed{0100.1100.1011.1100 \Leftrightarrow 19644}$$

You have now calculated the negative decimal value and the required result is:

$$\boxed{B344 \Leftrightarrow -19644}$$

The temperature value can be calculated as follows:

$$\boxed{\text{temperature} = 0.01\ °C \times \text{decimal value} = 0.01\ °C \times (-19644) = -196.44\ °C}$$

Equations and graphs for 12-bit representation

Attention!
The 12-bit representation is “left-justified”. The number is transmitted with 16 bits! Bit 0 – Bit 3 of the binary number, i.e. the last digit of the hexadecimal number, are the diagnostics bits.

Representation of the current values in the range 0 – 20 mA

To use the equation below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value.

The value range:

0 – 20 mA

is mapped to the number range:

000 – FFF$_{hex}$ (decimal: 0 – 4095)

The hexadecimal/binary value can be converted (with a pocket calculator) very easily to a decimal value.

Once the decimal value has been determined, the current values can be calculated with the following equation:

$$\boxed{\text{current} = 4.88 \times 10^{-3}\ \text{mA} \times \text{dezimal value}}$$

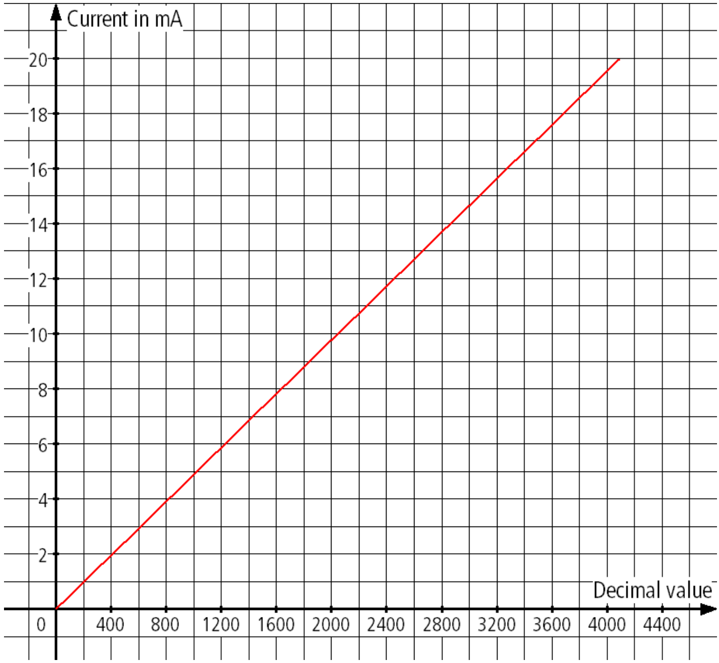


Figure 22: Representation of current values in relation to the decimal values in the coordinate system

Representation of the current values in the range 4 – 20 mA

To use the equation below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value.

The value range:

4 – 20 mA

is mapped to the number range:

000_{hex} – FFF_{hex} (decimal: 0 – 4095)

The hexadecimal/binary value can be converted (with a pocket calculator) very easily to a decimal value.

Once the decimal value has been determined, the current values can be calculated with the following equation:

$$\boxed{\text{current} = 3.91 \times 10^{-3}\ \text{mA} \times \text{dezimal value} + 4\ \text{mA}}$$

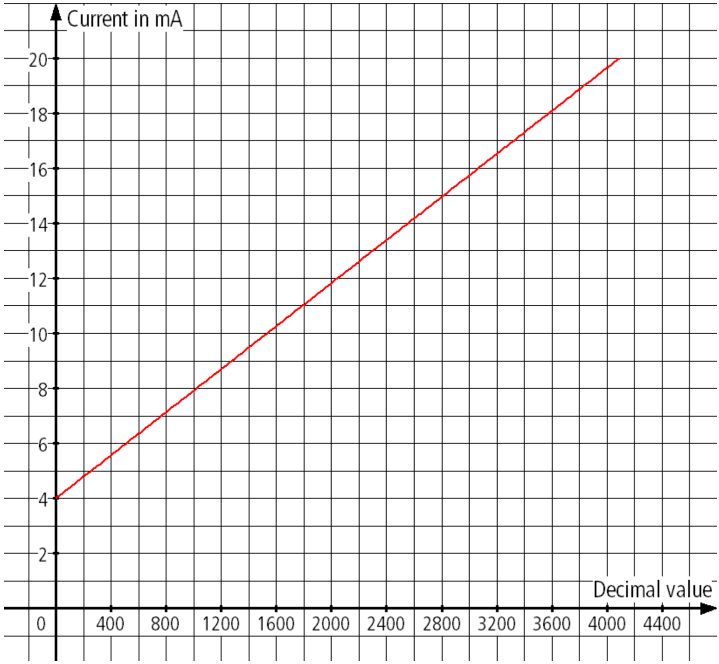


Figure 23: Representation of current values in relation to the decimal values in the coordinate system

Representation of temperature values and resistance values for the XN-2AI-PT/NI-2/3

To use the equations below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value (left-justified representation).

The hexadecimal/binary numerical values for the negative number range cannot be converted (using a pocket calculator) easily to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 000 – $7FF_{hex}$ are **positive** values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 16).

All numerical value in the range 800 – FFF_{hex} are **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 12).

The following example shows the conversion to a decimal number:→ "Example of the calculation of negative numerical values" page 50

Only the three most significant hexadecimal digits, i.e. the 12 most significant binary digits, are used for the calculation!

Once the decimal value has been determined, the **temperature values** can be calculated according to the parameters defined (⟶ table 29 page 173).

The first equation is for the parameter setting:

- "PT100, -200..850’C"
- "NI100, -60..250’C"
- "PT200, -200..850’C"
- "PT500, -200..850’C"
- "PT1000, -200..850’C"
- "NI1000, -60..250’C"

$$\boxed{\text{temperature} = 0.5\ °\text{C} \times \text{dezimal value}}$$

The value range:

-200 – -0.5 °C

is mapped to the number range:

E70 – FFF$_{hex}$ (decimal: -400 – -1)

The value range:

0 – 850 °C

is mapped to the number range:

000 – 6A4$_{hex}$ (decimal: 0 – 1700)

The second equation is for the parameter setting:

- "PT100, -200..150'C"
- "NI100, -60..150'C"
- "PT200, -200..150'C"
- "PT500, -200..150'C"
- "PT1000, -200..150'C"
- "NI1000, -60..150'C"

$$\boxed{\text{temperature} = 0.1\ °\text{C} \times \text{dezimal value}}$$

The value range:

-200 °C – -0.1 °C

is mapped to the number range:

830 – FFF$_{hex}$ (decimal: -2000 – -1)

The value range:

0 – 150 °C

is mapped to the number range:

000 – 5DC$_{hex}$ (decimal: 0 – 1500)

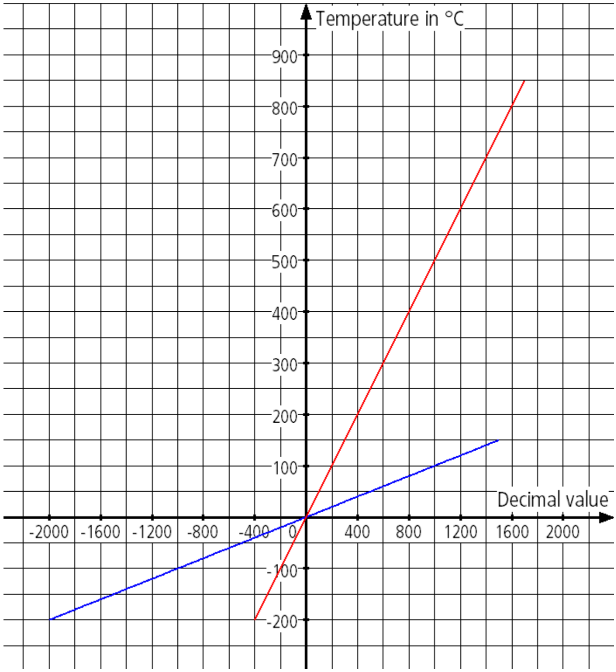


Figure 24: Representation of temperature values in relation to decimal values in the coordinate system
The **red** straight line applies with the following parameter setting:
"PT100, -200..850'C"
"NI100, -60..250'C"
"PT200, -200..850'C"
"PT500, -200..850'C"
"PT1000, -200..850'C"
"NI1000, -60..250'C"
The **blue** straight line applies with the following parameter setting:
"PT100, -200..150'C"
"NI100, -60..150'C"
"PT200, -200..150'C"
"PT500, -200..150'C"
"PT1000, -200..150'C"
"NI1000, -60..150'C"

The parameter setting for the measurement of **resistance values** only requires positive numerical values (hexadecimal/binary) for representation. The positive numerical values can be converted (with the pocket calculator) very easily to a decimal value.

Only the three most significant hexadecimal digits, i.e. 12 most significant binary digits, are used for the calculation!

Once the decimal value has been determined, the resistance values can be calculated according to the parameters defined (→ table 29 page 173).

The value range:

0 Ω – 100 Ω;
0 Ω – 200 Ω;
0 Ω – 400 Ω;
0 Ω – 1000 Ω;

is mapped to the number range:

000 – FFF$_{hex}$ (decimal: 0 – 4095)

The following equations apply:

"Resistance, 0..100 Ohm" (yellow straight line):

$$\boxed{\text{resistance} = 0.02442\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..200 Ohm" (red straight line):

$$\boxed{\text{resistance} = 0.04884\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..400 Ohm" (blue straight line):

$$\boxed{\text{resistance} = 0.09768\ \Omega \times \text{dezimal value}}$$

"Resistance, 0..1000 Ohm" (green straight line):

$$\boxed{\text{resistance} = 0.24420\ \Omega \times \text{dezimal value}}$$

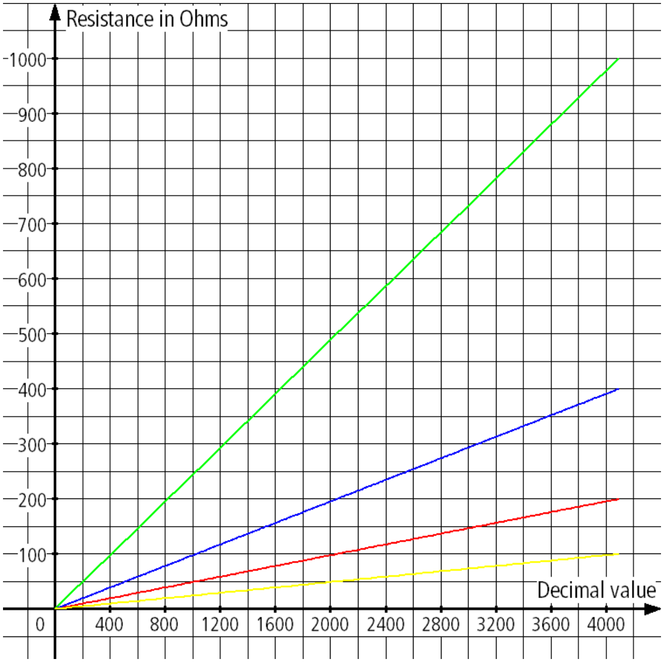


Figure 25: Representation of resistance values in relation to the decimal values in the coordinate system

Representation of temperature and voltage values for the XN-2AI-THERMO-PI

To use the equations below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value (left-justified representation).

The hexadecimal/binary numerical values for the negative number range cannot be converted (using a pocket calculator) easily to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 000 – $7FF_{hex}$ are **positive** values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 16).

All numerical value in the range 800 – FFF_{hex} are **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 12).

The following examples shows the conversion to a decimal number:→ "Example of the calculation of negative numerical values" page 50

Only the three most significant hexadecimal digits, i.e. the 12 most significant binary digits, are used for the calculation!

Once the decimal value has been determined, the **temperature values** and the **voltage values** can be calculated according to the parameters defined (→ table 29 page 173).

The following applies to the parameter setting of
"Type K, -270..1370'C"
"Type B, +100..1820'C"
"Type E, -270..1000'C"
"Type J, -210..1200'C"
"Type N, -270..1300'C"
"Type R, -50..1760'C"
"Type S, -50..1540'C"
"Type T, -270..400'C"

$$\boxed{\text{temperature} = 1\ {}^\circ\text{C} \times \text{dezimal value}}$$

The value range:

-270 – 1820 °C

is mapped to the number range:

EF2 – 71C$_{hex}$ (decimal: -270 – 1820)

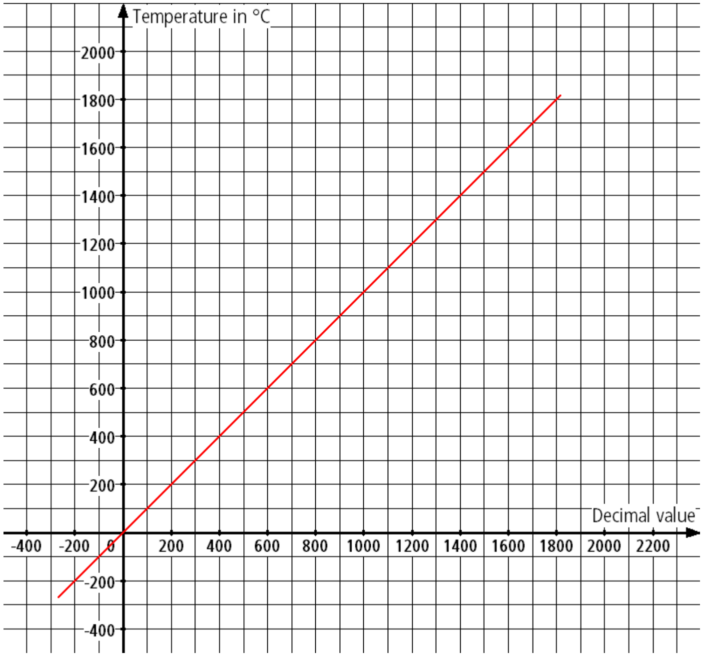


Figure 26: Representation of temperature values in relation to the decimal values in the coordinate system

The following applies to the parameter setting "+/-50 mV":

$$\boxed{\text{voltage} = 0.02443 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting "+/-100 mV"

$$\boxed{\text{voltage} = 0.04885 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting "+/-500 mV"

$$\boxed{\text{voltage} = 0.24426 \text{ mV} \times \text{dezimal value}}$$

The following applies to the parameter setting "+/-1000 mV"

$$\boxed{\text{voltage} = 0.48852 \text{ mV} \times \text{dezimal value}}$$

The value range:

-50 – -0.024 mV;
-100 – -0.049 mV;
-500 – -0.244 mV;
-1000 – -0.489 mV;

is mapped to the number range:

800 – $\mathbf{FFF_{hex}}$ (decimal: -2048 – -1)

The value range:

0 – 50 mV;
0 – 100 mV;
0 – 500 mV;
0 – 1000 mV;

is mapped to the number range:

000 – $\mathbf{7FF_{hex}}$ (decimal: 0 – 2047)

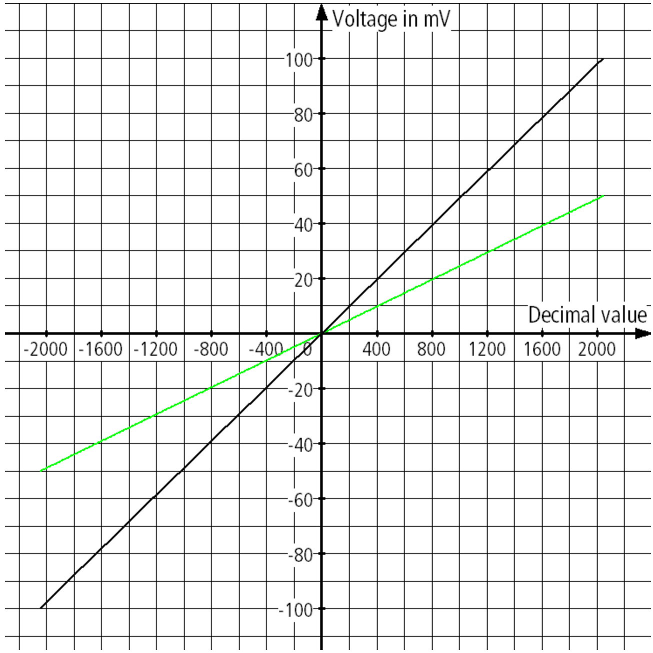


Figure 27: Representation of voltage values in relation to the decimal values in the coordinate system for the parameter setting "+/-50 mV" (green) and "+/-100 mV" (black)

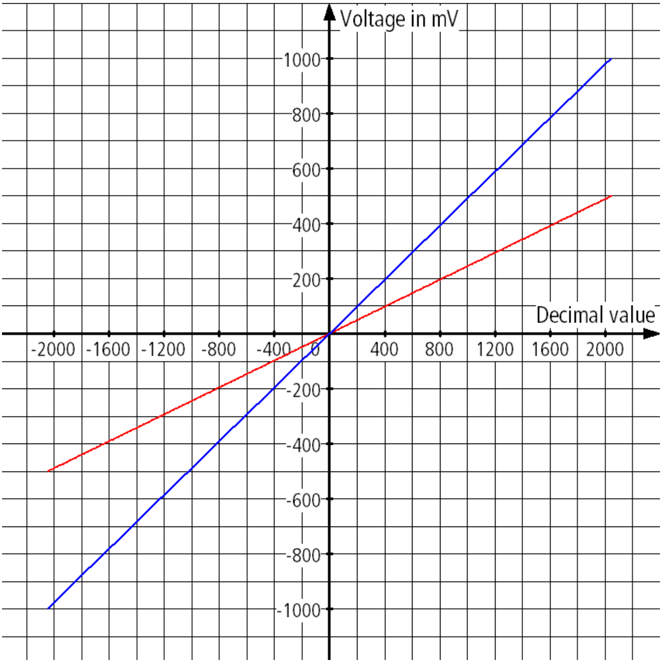


Figure 28: Representation of voltage values in relation to the decimal values in the coordinate system for the parameter setting "+/-500 mV" (red) and "+/-1000 mV" (blue)

Representation of the voltage values in the range 0 V DC – 10 V DC

To use the equation below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value (left-justified representation).

The hexadecimal/binary numerical value can be converted (using a pocket calculator) very easily to a decimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 12-bit values.

Once the decimal value has been determined, the voltage values can be calculated with the following equation:

$$\boxed{\text{voltage} = 0.002442\ \text{V} \times \text{dezimal value}}$$

The value range:

0 – 10 V DC

is mapped to the number range:

000 – FFF$_{hex}$ (decimal: 0 – 4095)

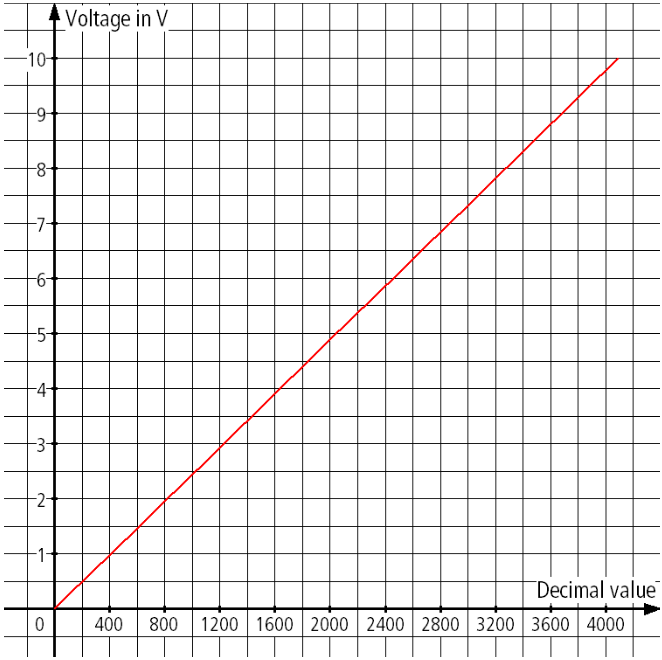


Figure 29: Representation of voltage values in relation to the decimal values in the coordinate system

Representation of the voltage values in the range –10 V DC – 10 V DC

To use the equation below, the hexadecimal or binary value must be converted to a decimal value. The numerical value is represented by the three most significant digits of the hexadecimal value, i.e. the 12 most significant bits of the binary value (left-justified representation).

The hexadecimal/binary numerical values for the negative number range cannot be converted (using a pocket calculator) easily to a decimal value since the numbers are coded in the two's complement notation (→ figure page 29).

All numerical values in the range 000 – $7FF_{hex}$ are **positive** values in two's complement notation. Numbers in this range can be converted to a decimal value with a pocket calculator. This applies also to binary numbers with 0 as the most significant bit (bit 12).

All numerical value in the range 800 – FFF_{hex} are **negative** values in two's complement notation. This applies also to binary numbers with 1 as the most significant bit (bit 12). The conversion to a decimal value shows: → "Example of the calculation of negative numerical values" page 50

Only the three most significant hexadecimal digits, i.e. the 12 most significant binary digits, are used for the calculation!

Once the decimal value has been determined, the voltage values can be calculated with the following equations:

Equations calculation:
For **positive** voltage values 0 V DC – 10 V DC:

$$\boxed{\text{voltage} = 0.004885\ \text{V} \times \text{dezimal value}}$$

The value range:

0 – 10 V DC

is mapped to the number range:

000 – 7FF$_{hex}$ (decimal: 0 – 2047)

For **negative** voltage values -10 V DC – 10 V DC:

$$\boxed{\text{voltage} = 0.004883\ \text{V} \times \text{dezimal value}}$$

The value range:

-10 – -0.0049 V DC

is mapped to the number range:

800 – FFF$_{hex}$ (decimal: -2048 – -1)

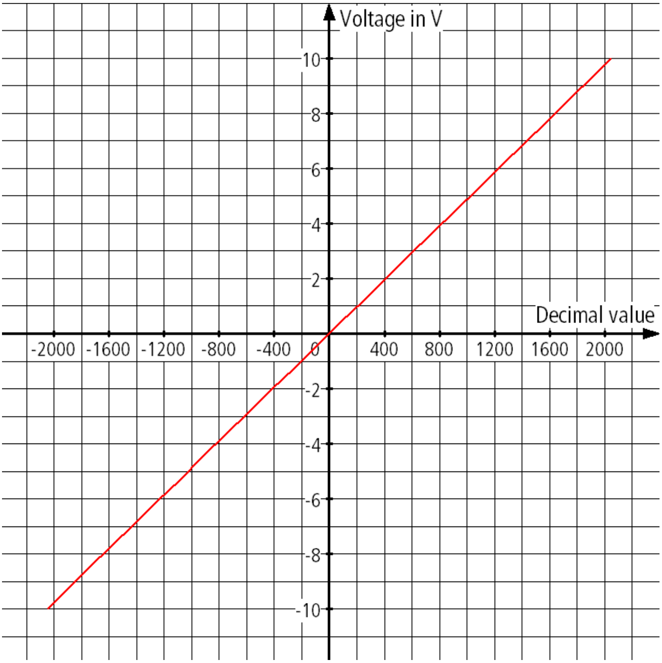


Figure 30: Representation of voltage values in relation to the decimal values in the coordinate system

LEDs

Errors from the I/O level are indicated on each module by means of the **DIA** collective LED. The corresponding diagnostics information is transmitted to the gateway as diagnostics bits.

If the **DIA** LED is permanently red, this indicates that the module bus communication for the analog input module has failed.

Shielding

Shielded signal cables are connected between the shield and base module via a two pole shield connector available as an accessory.

Module overview

	No. of channels
XN-1AI-I(0/4...20MA)	1
XN-2AI-I(0/4...20MA)	2
XN-1AI-U(-10/0...+10VDC)	1
XN-2AI-U(-10/0...+10VDC)	2
XN-2AI-PT/NI-2/3	2
XN-2AI-THERMO-PI	2
XN-4AI-U/I	4

XN-1AI-I(0/4...20MA)

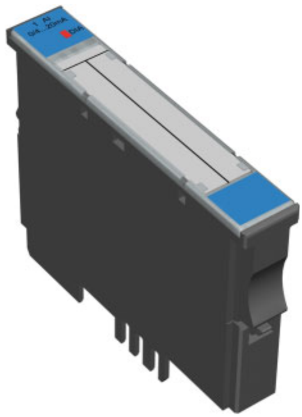


Figure 31: Analog input module, 1AI, 0/4 – 20 mA

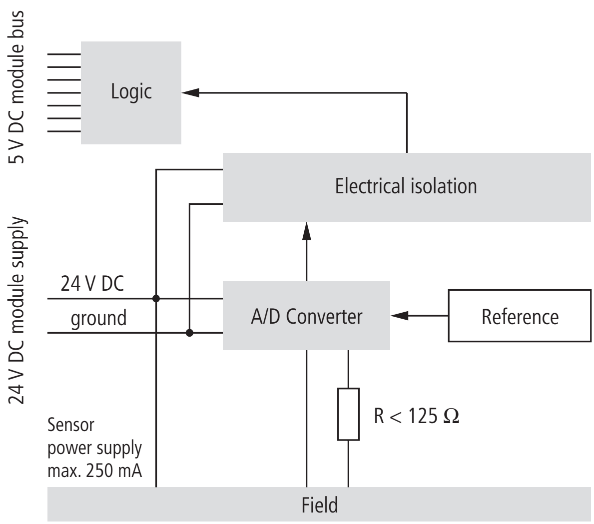


Figure 32: Block diagram

Technical data

Table 6: XN-1AI-I(0/4...20MA)

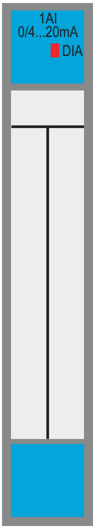
Designation	Value
Module supply[2)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	41 mA
Module supply via supply terminal[2)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	50 mA[1)]
No. of channels	1
Input	
Input resistance (load)	< 125 Ω
Input current (range that can be evaluated by the A/D converter)	0/4 – 20 mA
Input current (maximum - “measurement value range error” signalled already from 20.2 mA)	50 mA
Limit frequency (-3 dB)	200 Hz
Accuracy of input value	
Offset error	< 0.1 %
Linearity (0.1 – 19.9 mA)	0.03 %
Basic error at 23 °C	< 0.2 %
Repeatability	0.09 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Representation of input value	
Resolution of A/D converter	14 Bit Signed Integer
Measuring principle	Successive approximation

Designation	**Value**
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Binary uncoded (only positive binary values)
Sensor supply	Bridged with supply terminal U_L; not short-circuit-proof

1) The supply terminal (U_L) provides the current for the module electronics and for the analog sensor on the inputs.
The overall current that is required for each module is the sum of all the individual currents.

2) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Diagnostics messages



LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostics present	–
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostics	–

The module features the following diagnostics data:

- "Measurement value range error"
  Indication of overcurrent or undercurrent of 1 % of the set current range. Undercurrent is only detected on modules with a set current range of 4 to 20 mA.
  Overcurrent: I_{max} ($I > 20.2$ mA);
  Undercurrent: I_{min} ($I < 3.8$ mA)
- "Open circuit"
  Indication of an open circuit in the signal cable for operating mode 4 to 20 mA with a threshold of 3 mA.

Module parameters

Parameter name	Value
Diagnostic	release[1]
	block
Value representation	Integer (15-bit + sign)[1]
	12-bit (left-justified)
Current mode	0 – 20 mA[1]
	4 – 20 mA

1) Standard parameter values

Base modules

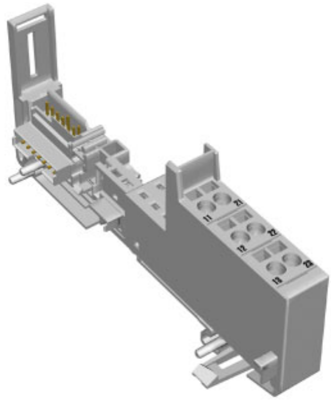


Figure 33: Base module XN-S3T-SBB

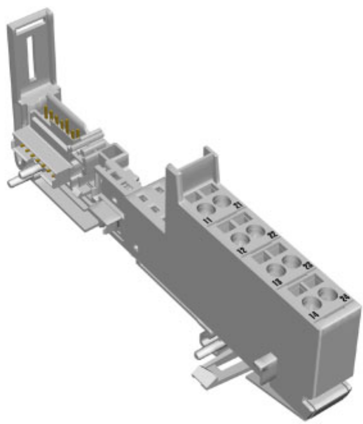


Figure 34: Base module XN-S4T-SBBS

Designation	
with tension clamp connectors	XN-S3T-SBB XN-S4T-SBBS
with screw terminals	XN-S3S-SBB XN-S4S-SBBS

Connection diagrams

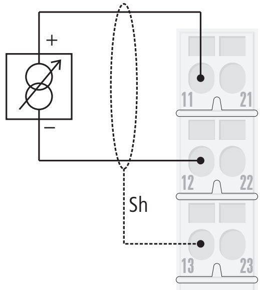


Figure 35: Connection diagram of XN-S3x-SBB analog sensor without sensor supply

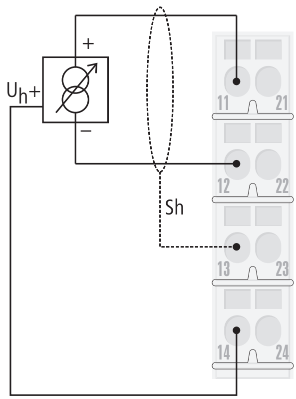


Figure 36: Connection diagram of XN-S4x-SBBS analog sensor with 1-wire sensor supply

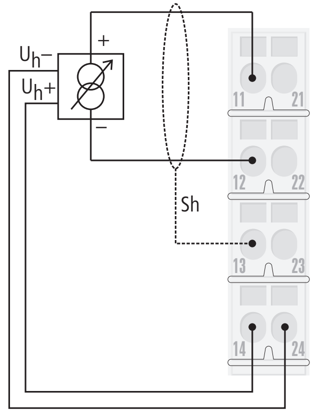


Figure 37: Connection diagram of XN-S4x-SBBS analog sensor with 2-wire sensor supply

→ “Technical data for the base modules” page 21

XN-2AI-I(0/4...20MA)

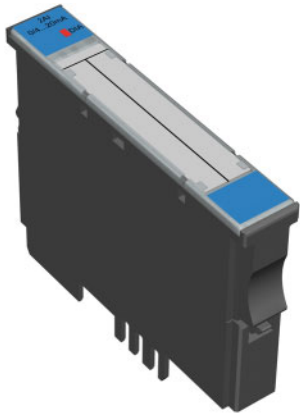


Figure 38: Analog input module, 2 AI, 0/4 – 20 mA

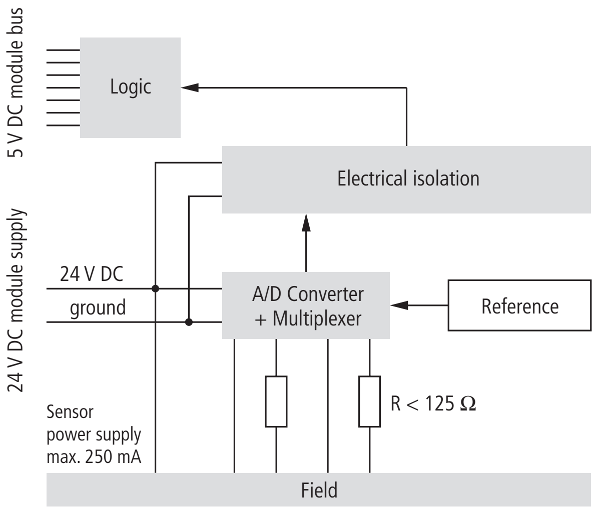


Figure 39: Block diagram

Technical data

Table 7: XN-2AI-I(0/4...20MA)

Designation	Value
Module supply2) through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	35 mA
Module supply via supply terminal2) (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	12 mA1)
No. of channels	2
Input	
Input resistance (load)	< 125 Ω
Input current (range that can be evaluated by the A/D converter)	0/4 – 20 mA
Input current (maximum - "measurement value range error" signalled already from 20.2 mA)	50 mA
Limit frequency (-3 dB)	50 Hz
Accuracy of input value	
Basic error at 23 °C	< 0.2 %
Repeatability	0.05 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Representation of input value	
Resolution of A/D converter	16-bit
Measuring principle	Successive approximation
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Binary uncoded (only positive binary values)

Designation	Value
Sensor supply	Bridged with supply terminal U_L; not short-circuit-proof

1) The supply terminal (U_L) provides the current for the module electronics and for the analog sensor on the inputs.
The overall current that is required for each module is the sum of all the individual currents.
2) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Diagnostics messages

LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	-
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	-

The module features the following diagnostics data per channel per channel:

- "Measurement value range error"
  Indication of overcurrent or undercurrent of 1 % of the set current range. Undercurrent is only detected on modules with a set current range of 4 to 20 mA.
  Overcurrent: I_{max} (I > 20.2 mA);
  Undercurrent: I_{min} (I < 3.8 mA)
- "Open circuit"
  Indication of an open circuit in the signal cable for operating mode 4 to 20 mA with a threshold of 3 mA.

→ With "12-bit left-justified" measured value representation, the diagnostics data is transmitted with bits 0 to 3 of the process data of the relevant channel.

Module parameters (per channel)

Parameter name	Value
Channel KX (X=1,2)	Activate [1]
	Deactivate
Diagnostic	release[1]
	block
Value representation	Integer (15-bit + sign)[1]
	12-bit (left-justified)
Current mode	0 – 20 mA [1]
	4 – 20 mA

1) ... Standard parameter value

Base modules

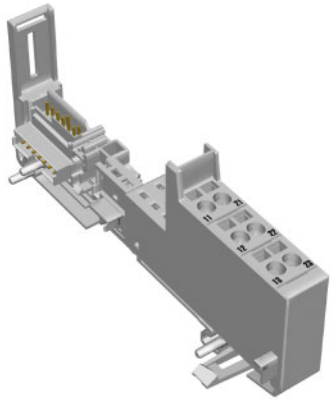


Figure 40: Base module XN-S3T-SBB

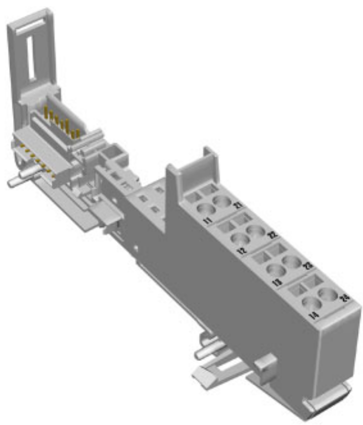


Figure 41: Base module XN-S4T-SBBS

Designation	
with tension clamp connectors	XN-S3T-SBB XN-S4T-SBBS
with screw terminals	XN-S3S-SBB XN-S4S-SBBS

Connection diagrams

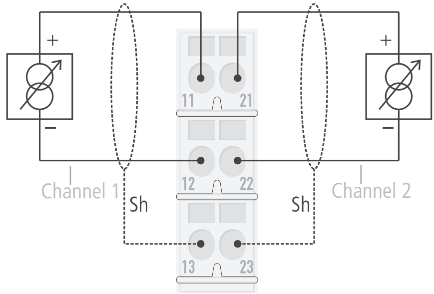


Figure 42: Connection diagram XN-S3x-SBB

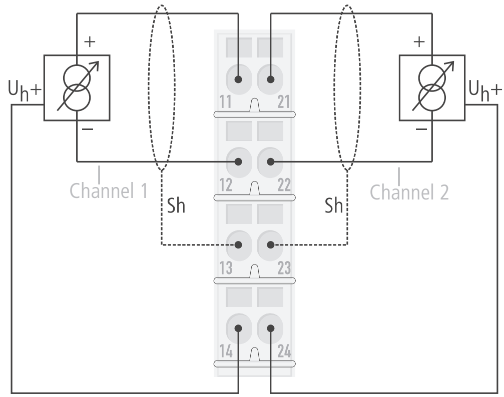


Figure 43: Connection diagram XN-S4x-SBBS

→ “Technical data for the base modules” page 21

XN-1AI-U(-10/0...+10VDC)

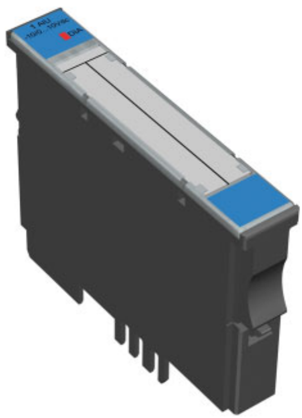


Figure 44: Analog input module, 1AI, -10/0 – +10V DC

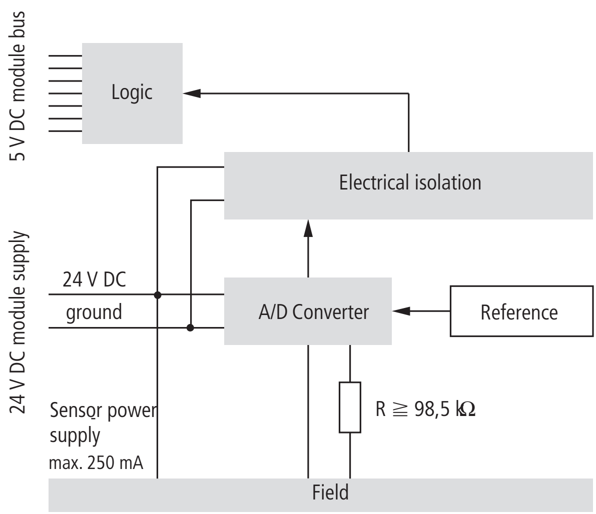


Figure 45: Block diagram

Technical data

Table 8: XN-1AI-U(-10/0...+10VDC)

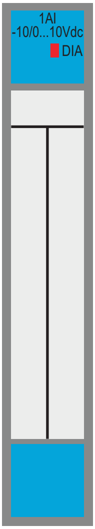
Designation	Value
Module supply[2)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	41 mA
Module supply via supply terminal[2)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	50 mA[1)]
No. of channels	1
Input	
Input resistance (load)	≧ 98.5 Ω
Input voltage (range that can be evaluated by the A/D converter)	-10/0 – +10 V DC
Input voltage (maximum/continuous - "measurement value range error" indicated already from 10.1 VDC)	35 V DC
Limit frequency (-3 dB)	200 Hz
Accuracy of input value	
Offset error	< 0.1 %
Linearity	0.03 %
Basic error at 23 °C	< 0.2 %
Repeatability	0.05 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Representation of input value	
Resolution of A/D converter	14 Bit Signed Integer
Measuring principle	Successive approximation

Designation	**Value**
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)
Sensor supply	Bridged with supply terminal U_L; not short-circuit-proof

1) The supply terminal (U_L) provides the current for the module electronics and for the analog sensor on the inputs.
The overall current that is required for each module is the sum of all the individual currents.

2) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Diagnostics messages



LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	–
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	–

The module features the following diagnostics data:

- "Measurement value range error"
  Indication of overvoltage or undervoltage of 1% of the set voltage range.
  Overvoltage: U_{max} (U > 10.1 V DC);
  Undervoltage : U_{min} (U < -10.1 V DC) for -10 – +10 V DC
  U_{min} (U < -0.1 V DC) for 0 – 10 V DC

Module parameters

Parameter name	Value
Diagnostic	release[1]
	block
Value representation	Integer (15-bit + sign)[1]
	12-bit (left-justified)
Voltage mode	-10 – +10V
	0 – 10V[1]

1) Standard parameter value

Base modules

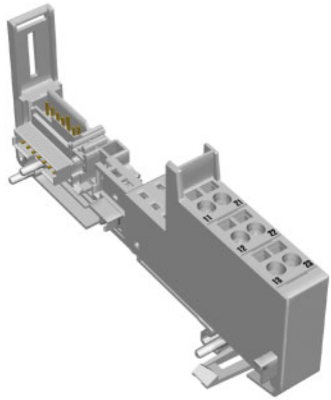


Figure 46: Base module XN-S3T-SBB

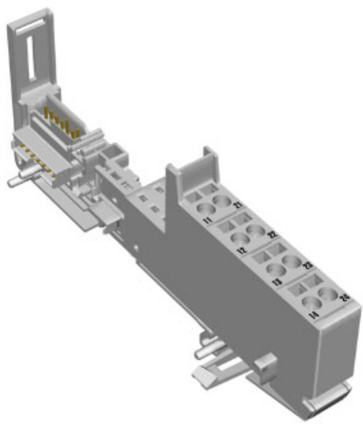


Figure 47: Base module XN-S4T-SBBS

Designation	
with tension clamp connectors	XN-S3T-SBB XN-S4T-SBBS
with screw terminals	XN-S3S-SBB XN-S4S-SBBS

Connection diagrams

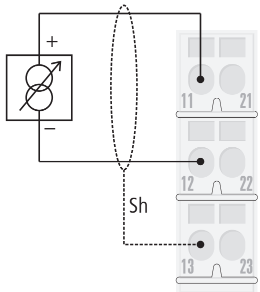


Figure 48: Connection diagram of XN-S3x-SBB analog sensor without sensor supply

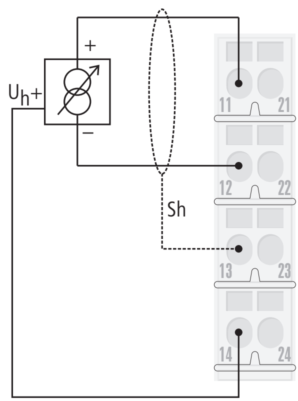


Figure 49: Connection diagram of XN-S4x-SBBS analog sensor with 1-wire sensor supply

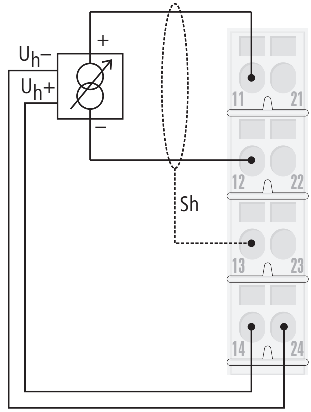


Figure 50: Connection diagram of XN-S4x-SBBS analog sensor with 2-wire sensor supply

→ "Technical data for the base modules" page 21

XN-2AI-U(-10/0...+10VDC)

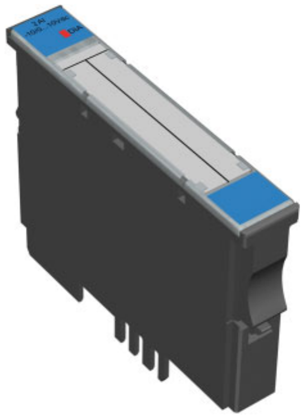


Figure 51: Analog input module, 2 AI, -10/0 – +10V DC

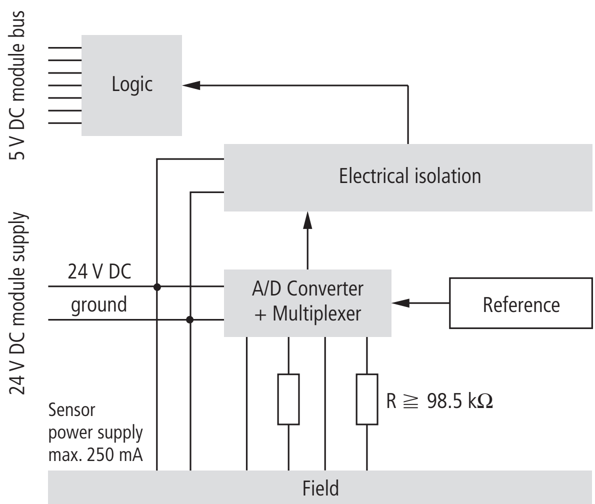


Figure 52: Block diagram

Technical data

Table 9: XN-2AI-U(-10/0...+10VDC)

Designation	Value
Module supply[2)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	35 mA
Module supply via supply terminal[2)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	12 mA[1)]
No. of channels	2
Input	
Input resistance (load)	≧ 98.5 Ω
Input voltage (range that can be evaluated by the A/D converter)	-10/0 – +10 V DC
Input voltage (maximum/continuous - “measurement value range error” indicated already from 10.1 VDC)	35 V DC
Limit frequency (-3 dB)	50 Hz
Accuracy of input value	
Basic error at 23 °C	< 0.2 %
Repeatability	0.05 %
Temperature coefficient	≦ 150 ppm/°C of limit value
Representation of input value	
Resolution of A/D converter	16-bit
Measuring principle	Delta Sigma

Designation	Value
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)
Sensor supply	Bridged with supply terminal U_L; not short-circuit-proof

1) The supply terminal (U_L) provides the current for the module electronics and for the analog sensor on the inputs.
The overall current that is required for each module is the sum of all the individual currents.

2) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Diagnostic messages

LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	-
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	-

The module features the following diagnostics data per channel
per channel:

- "Measurement value range error"
  Indication of overvoltage or undervoltage of 1% of the set voltage range.
  Overvoltage: U_{max} (U > 10.1 V DC)
  Undervoltage: U_{min} (U < -10.1 V DC)
  for -10 – +10 V DC
  U_{min} (U < -0.1 V DC)
  for 0 – +10 V DC

→ With "12-bit left-justified" measured value representation, the diagnostics data is transmitted with bits 0 to 3 of the process data of the relevant channel.

Module parameters (per channel)

Parameter name	Value
Channel KX (X=1,2)	Activate [1]
	Deactivate
Diagnostic	release[1]
	block
Value representation	Integer (15-bit + sign)[1]
	12-bit (left-justified)
Voltage mode	0...10 V[1]
	-10...+10 V

[1] ... Standard parameter value

Base modules

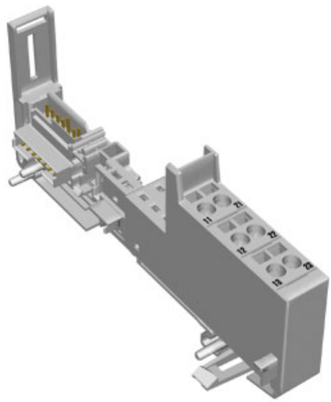


Figure 53: Base module XN-S3T-SBB

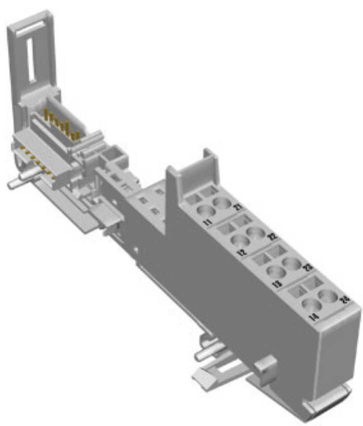


Figure 54: Base module XN-S4T-SBBS

Designation	
with tension clamp connectors	XN-S3T-SBB XN-S4T-SBBS
with screw terminals	XN-S3S-SBB XN-S4S-SBBS

Connection diagrams

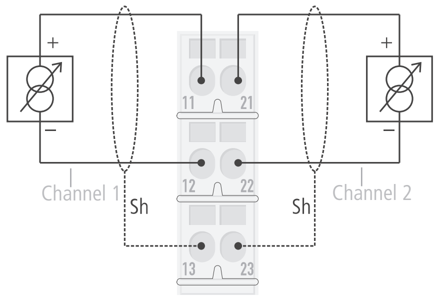


Figure 55: Connection diagram XN-S3x-SBB

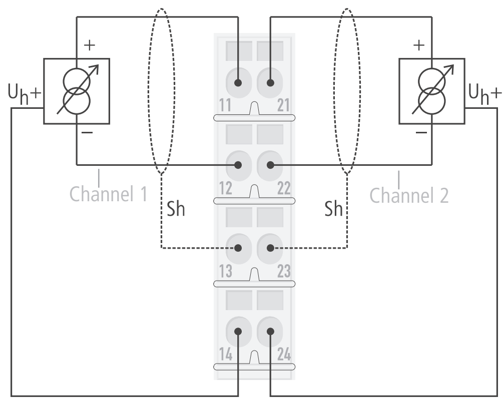


Figure 56: Connection diagram XN-S4x-SBBS

→ “Technical data for the base modules” page 21

XN-2AI-PT/NI-2/3

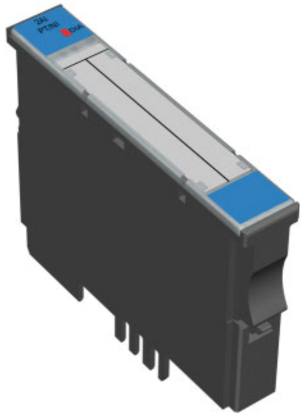


Figure 57: Analog input module, 2AI, PT/NI sensors

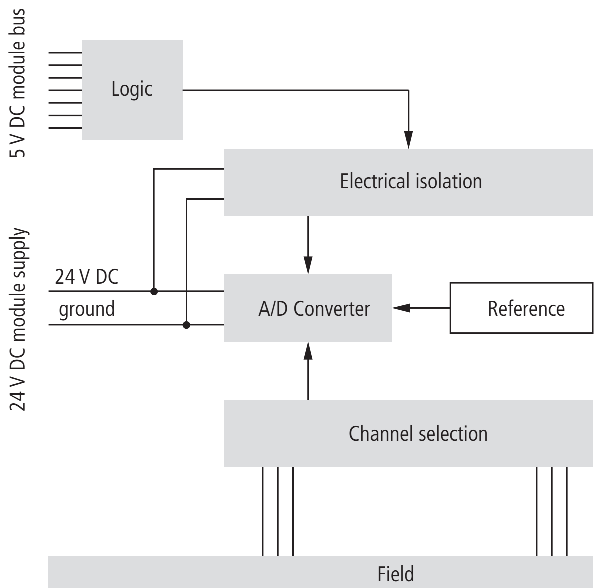


Figure 58: Block diagram

Technical data

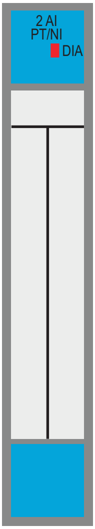
Table 10: XN-2AI-PT/NI-2/3

Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	45 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	30 mA
No. of channels	2
Input	
Measuring current	< 1 mA
Destruction limit (in the event of an operating error)	> 30 V DC
Accuracy of input value	
Offset error	≦ 0.1 %
Linearity	< 0.1 %
Basic error at 23 °C	< 0.2 %
Repeatability	0.05 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Representation of input value	
Resolution of A/D converter	16-bit
Measuring principle	Delta Sigma
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)

Designation	Value
Connectable sensor types	
Platinum sensors	PT100, PT200, PT500, PT1000 to DIN IEC 60751
Nickel sensors	Ni100, Ni1000 to DIN IEC 43760

1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Diagnostic messages



LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	–
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	–

The module features the following diagnostics data per channel:

- Measurement value range error 1)
  Underflow diagnostics only in the temperature range
- Open circuit
- Short-circuit
  (only for temperature measurement ranges)2)

1) Threshold: 1 % of the positive measurement range limit value
2) Threshold: 5 Ω (loop resistance)

With 3-wire measurements with PT100 sensors, no distinction is made between short-circuit and open circuit at a temperature below -177 °C. In this case, the “Short-circuit” diagnostic signal is generated.

Module parameters (per channel)

Parameter name	Value
Measuring mode KX (X=1,2)	2-wire[1)] 3-wire
Element KX (X=1,2)	PT100, -200 – 850 °C[1)] PT100, -200 – 150 °C Ni100, -60 – 250 °C Ni100, -60 – 150 °C PT200, -200 – 850 °C PT200, -200 – 150 °C PT500, -200 – 850 °C PT500, -200 – 150 °C PT1000, -200 – 850 °C PT1000, -200 – 150 °C Ni1000, -60 – 250 °C Ni1000, -60 – 150 °C Resistance, 0 – 100Ω Resistance, 0 – 200Ω Resistance, 0 – 400Ω Resistance, 0 – 1000Ω
Channel KX (X=1,2)	Activate[1)] Deactivate
Diagnostic KX (X=1,2)	release[1)] block
Value representation KX (X=1,2)	Integer (15-bit + sign)[1)] 12-bit (left-justified)
Mains suppression KX (X=1,2)	50 Hz[1)] 60 Hz

1) Standard parameter value

Base modules

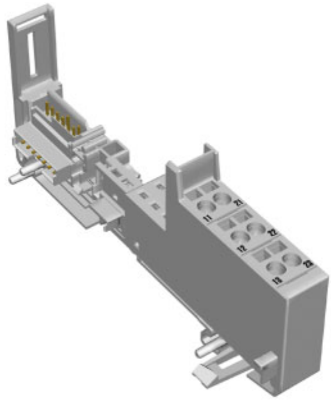


Figure 59: Base module XN-S3T-SBB (only 2-wire measuring possible)

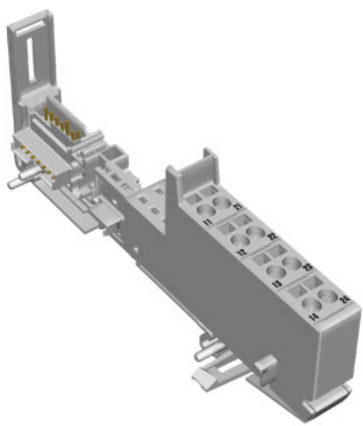


Figure 60: Base module XN-S4T-SBBS (also 3-wire measuring possible)

Designation	
with tension clamp connectors	XN-S3T-SBB (2-wire measuring) XN-S4T-SBBS (3-wire measuring)
with screw terminals	XN-S3S-SBB (2-wire measuring) XN-S4S-SBBS (3-wire measuring)

Connection diagrams

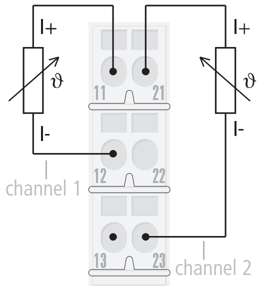


Figure 61: Wiring diagram XN-S3x-SBB (2-wire measuring)

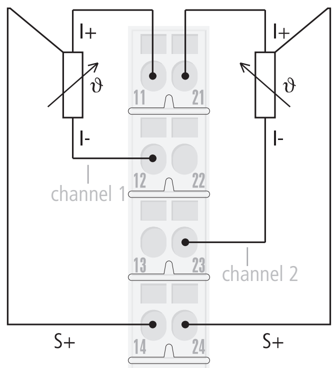


Figure 62: Wiring diagram XN-S4x-SBBS (3-wire measuring)

→ “Technical data for the base modules” page 21

XN-2AI-THERMO-PI

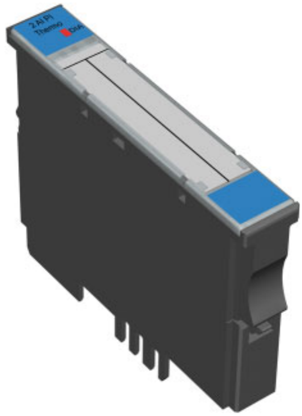


Figure 63: Analog input module, 2AI, thermocouple

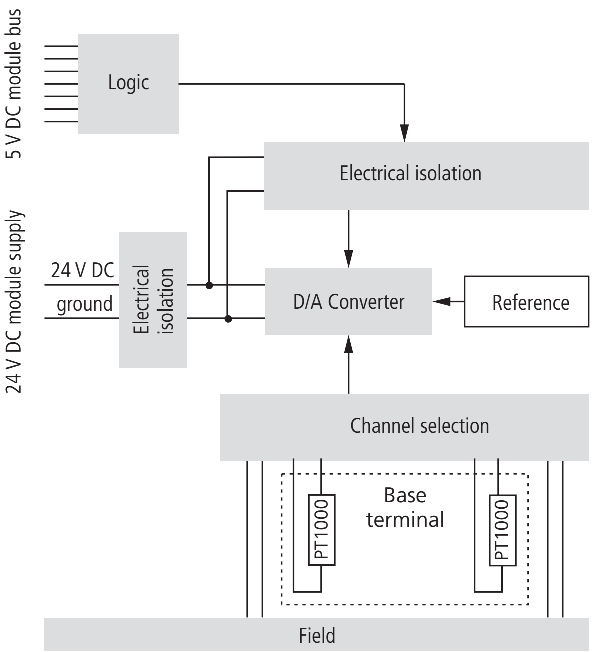


Figure 64: Block diagram

Technical data

Table 11: XN-2AI-THERMO-PI

Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	45 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current from supply terminal (maximum)	30 mA
No. of channels	2
Input	
Destruction limit	> 10 V DC
Accuracy of input value	
Basic error at 23 °C	The values are listed in the following table → table 12 page 114.
Repeatability	
Temperature coefficient	≦ 300 ppm/°C of limit value
Cross talk attenuation	≧ 80 dB
Representation of input value	
Resolution of A/D converter	16-bit
Measuring principle	Delta Sigma
Cycle time	Temperature measuring:130 ms Voltage measuring: 70 ms
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)

Designation	Value
Connectable thermocouples to IEC 60584 Class 1,2,3	
Type B	100 – 1820.0 °C
Type E	-270 – 1000.0 °C
Type J	-210 – 1200.0 °C
Type K	-270 – 1370.0 °C
Type N	-270 – 1300.0 °C
Type R	-50 – 1760.0 °C
Type S	-50 – 1540.0 °C
Type T	-270 – 400.0 °C

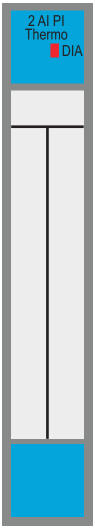
1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

Table 12: Basic error limits and repeatability

Thermo-couple	**Tempera-ture range / °C**	**Basic error limit at 23 °C / % of positive value**	**Repeatability / % of positive limit value**	**Error due to cold junction compen-sation / % of posi-tive limit value[1)]**
Type K	-200...1370	0.2	0.05	0.15
Type J	-210...1200	0.2	0.05	0.17
Type B	300...1820	0.2	0.05	0.11
Type N	-150...1300	0.2	0.05	0.16
Type E	-180...1000	0.2	0.05	0.20
Type R	-50...1760	0.2	0.05	0.12
Type S	-50...1540	0.2	0.05	0.13
Type T	-200...0 0...400	0.6 0.2	0.1 0.075	– 0.50
Voltage measuring	All meas-uring ranges	0.2	0.05	–

1) With negative measuring temperatures, a high deviation of the cold junction compensation should be expected.

Diagnostic messages



LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	–
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	–

The module features the following diagnostics data per channel:

- Measurement value range error[1)]
- Open circuit (only for temperature measurements)

1) Threshold: 1 % of the positive measurement range limit value

→ With type K, N and T sensors, the “Underflow” diagnostic signal is generated on temperatures below -271.6 °C.

Module parameters (per channel)

Parameter name	Value
Element KX (X=1,2)	Type K, -270..1370 °C[1)] Type B, +100...1820 °C Type E, -270..1000 °C Type J, -210..1200 °C Type N, -270..1300 °C Type R, -50..1760 °C Type S, -50..1540 °C Type T, -270..400 °C +/-50 mV +/-100 mV +/-500 mV +/-1000 mV
Channel KX (X=1,2)	Activate[1)] Deactivate
Diagnostic KX (X=1,2)	release[1)] block
Value representation KX (X=1,2)	Integer (15-bit + sign)[1)] 12-bit (left-justified)
Mains suppression KX (X=1,2)	50 Hz[1)] 60 Hz

1) Standard parameter value

Base modules

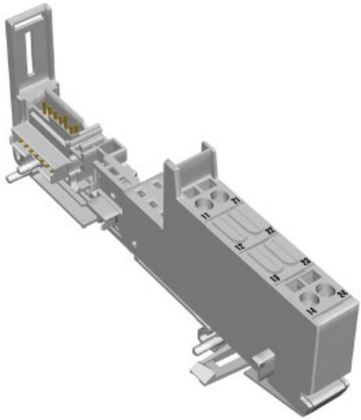


Figure 65: Base module XN-S4T-SBBS-CJ

Designation	
with tension clamp connectors	XN-S4T-SBBS-CJ
with screw terminals	XN-S4S-SBBS-CJ

Connection diagram

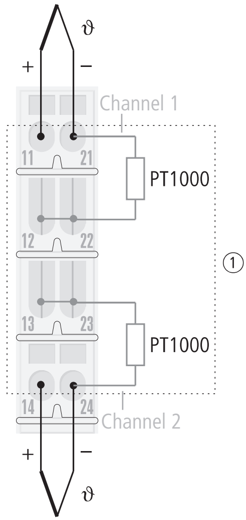


Figure 66: Connection diagram XN-S4x-SBBS-CJ

① Cold junction compensation in base module

→ "Technical data for the base modules" page 21

XN-4AI-U/I

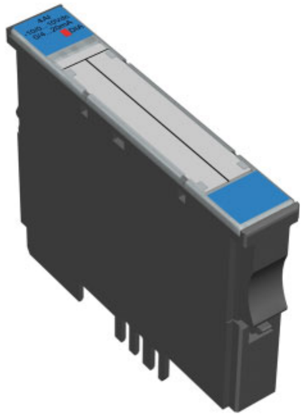


Figure 67: Analog input module, 4AI, 0/4 – 20mA, -10/0 – 10 V DC

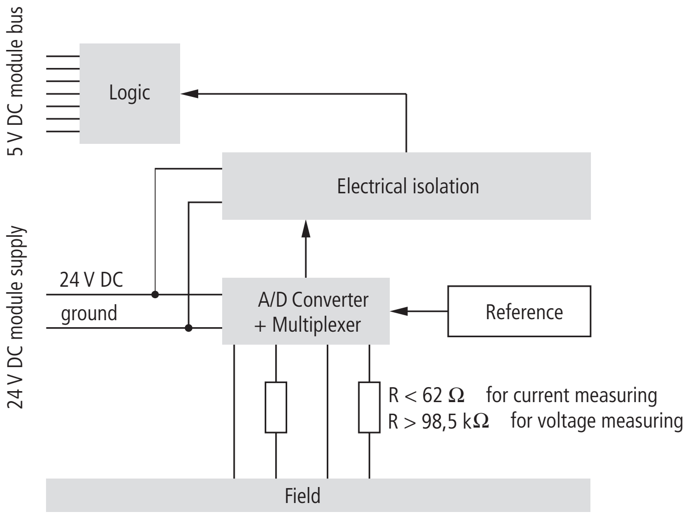


Figure 68: Block diagram

Technical data

Table 13: XN-4AI-U/I

Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	30 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current through supply terminal (for supply to the module electronics / max.)	40 mA
No. of channels	4
Input for current measuring [3)]	
Input resistance (load)	< 62 Ω[2)]
Input current (range that can be evaluated by the A/D converter)	0 – 20 mA 4 – 20 mA
Input current (maximum/temporary – “measurement value range error” output already from 20.2 mA)	50 mA [2)]
Limit frequency (-3 dB)	20 Hz
Input for voltage measuring	
Input resistance (load)	> 98.5 kΩ [2)]
Input voltage (range that can be evaluated by the A/D converter)	-10 – 10 V DC 0 – 10 V DC
Input voltage (maximum – “measurement value range error” is already output from 1% deviation from permissible range)	30 V DC
Limit frequency (-3 dB)	20 Hz
Accuracy of input value	
Basic error at 23 °C	< 0.3 %
Temperature coefficient	≦ 200 ppm/°C of limit value

Designation	Value
Representation of the converted input value	
Resolution of A/D converter	16-bit
Measuring principle	Delta Sigma
Measured value representation	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)

1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

2)

→ The input resistance of the channel is changed automatically if the module is parameterised in the measuring range and is loaded with an impermissibly high current. Diagnostic messages are retained. In this case, the module switches from the parameterised current measuring to voltage measuring.

This function mostly protects the input channel from destruction due to an overload!

3)

→ The conditions for the "Current measuring" mode are relevant when the channel is enabled!

The channel is enabled by means of the "ChannelX" parameter → "Module parameters (per channel)" page 123.

Diagnostic messages

LED	Display	Meaning	Remedy
DIA	Red, blinking, 0.5 Hz	Diagnostic present	-
	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed. Check the module supply via supply terminal U_L.
	OFF	No fault indication or diagnostic	-

The module features the following diagnostics data per channel:

- "Measurement value range error"
  Indication of overcurrent or undercurrent of 1 % of the set current range. Undercurrent is only detected on modules with a set current range of 4 to 20 mA.
  Overcurrent: I_{max} (I > 20.2 mA)
  Undercurrent: I_{min} (I < 3.8 mA)
  Indication of overvoltage or undervoltage of 1% of the set voltage range.
  Overvoltage: U_{max} (U > 10.1 V DC);
  Undervoltage : U_{min} (U < -10.1 V DC)
  for -10 – +10 V DC
  U_{min} (U < -0.1 V DC)
  for 0 – 10 V DC
- "Open circuit"
  Indication of an open circuit in the signal cable for operating mode 4 to 20 mA with a threshold of 3 mA.

→ With "12-bit left-justified" measured value representation, the diagnostics data is transmitted with bits 0 to 3 of the process data of the relevant channel.

Module parameters (per channel)

Parameter name	Value
Operating mode	Voltage[1)]
	Current
Channel KX (X= 1 – 4)	Activate [1)]
	Deactivate
Diagnostic	release[1)]
	block
Value representation	Integer (15-bit + sign)[1)]
	12-bit (left-justified)
Range	0..10V/0..20 mA [1)]
	-10..+10V/4..20 mA

1) ... Standard parameter value

Base module

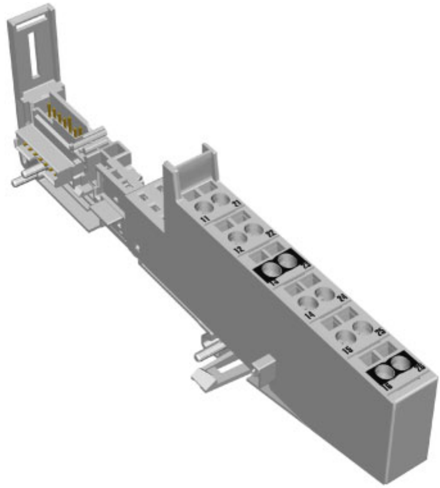


Figure 69: Base module XN-S6T-SBCSBC

Designation	
with tension clamp connectors	XN-S6T-SBCSBC
with screw terminals	XN-S6S-SBCSBC

Connection diagram

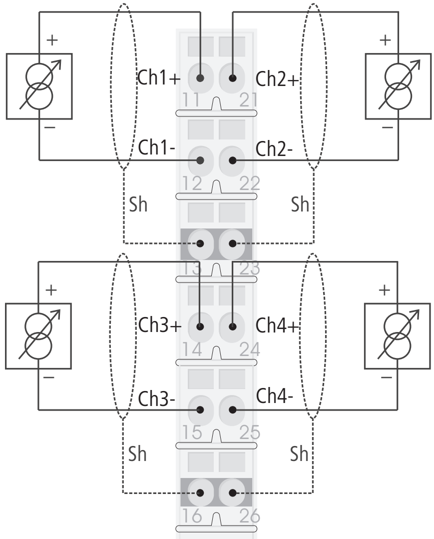


Figure 70: Connection diagram XN-S6x-SBCSBC

→ “Technical data for the base modules” page 21

3 Analog Output Modules

General

Analog output modules (AO) receive output values from the gateway via the internal module bus. The modules convert these values and transmit the appropriate signals per channel to the field level via the base module.

The electronics on the module bus of the analog output modules are isolated from the field level via optocouplers and are protected against reverse polarity.

The modules are short-circuit-proof.

Analog output modules are built in a slice design. They are completed with base modules with tension clamp connectors or screw terminals.

Supported signal ranges
0 – 20 mA,
4 – 20 mA,
0 – 10 V DC,
-10 – +10 V DC

Resolution of the analog value representation
The digitised analog values are represented in two's complement notation when both positive and negative values are processed. A parameter bit is used to set either 16-bit representation or left-justified 12-bit representation.

Equations and graphs for 16-bit representation

Representation of the current values in the range 0 – 20 mA

The decimal numerical values can be converted to the current values in the range 0 mA – 20 mA using the following equation:

$$\boxed{\text{decimal value} = 1638.35\,\frac{1}{\text{mA}} \times \text{current}}$$

The value range:

0 – 20 mA

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

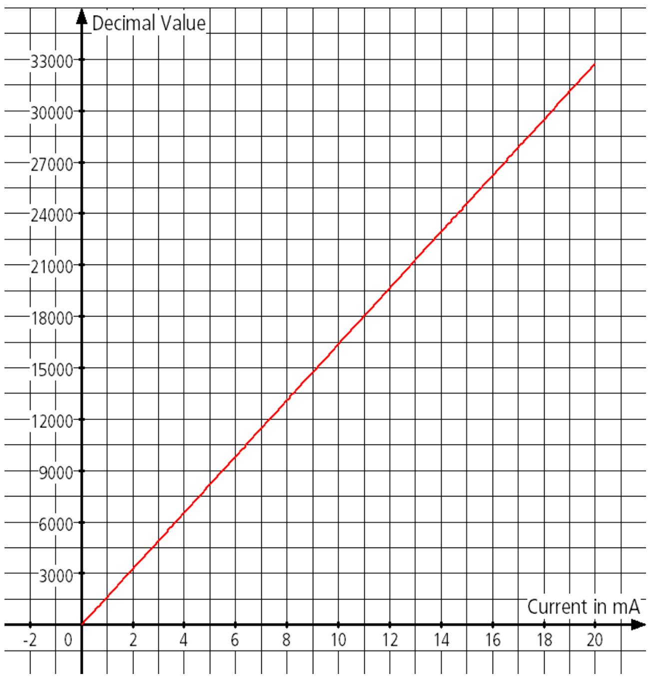


Figure 71: Representation of decimal values in relation to the current values in the coordinate system

The decimal numerical value can be converted (using a pocket calculator) very easily to a hexadecimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

Representation of the current values in the range 4 – 20 mA

The decimal numerical values can be converted to the current values in the range 4 mA – 20 mA using the following equation:

$$\boxed{\text{decimal value} = 2047.9375 \frac{1}{\text{mA}} \times \text{current} - 8191.75}$$

The value range:

4 – 20 mA

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

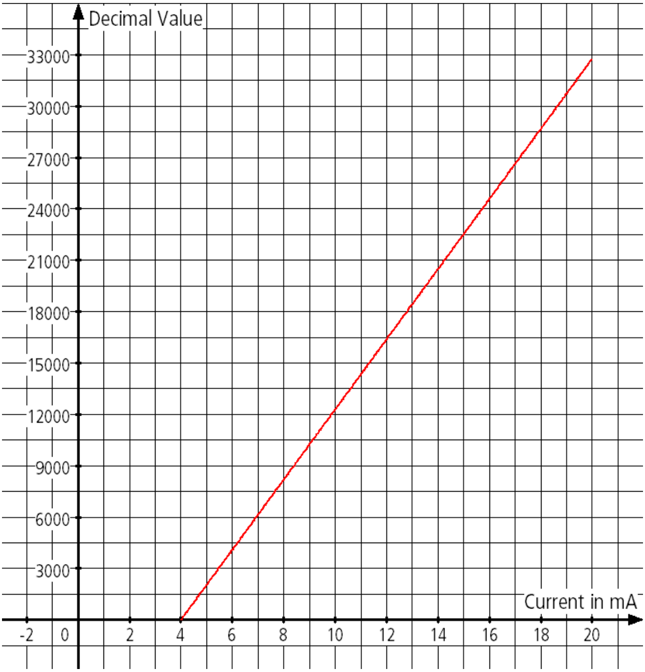


Figure 72: Representation of decimal values in relation to the current values in the coordinate system

The decimal numerical value can be converted (using a pocket calculator) very easily to a hexadecimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

Representation of the voltage values in the range 0 – 10 V DC

The decimal numerical values can be converted to voltage values in the range 0 V DC – 10 V DC using the following equation:

$$\boxed{\text{decimal value} = 3276.7\,\frac{1}{V} \times \text{voltage}}$$

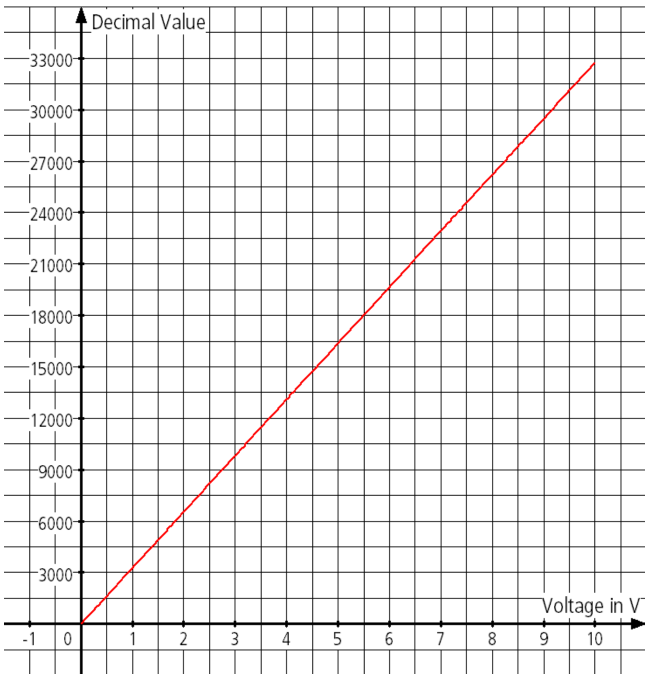


Figure 73: Representation of decimal values in relation to the voltage values in the coordinate system

The decimal numerical value can be converted (using a pocket calculator) very easily to a hexadecimal value since all the numbers are in the positive range of the two's complement (→ figure page 29) of 16-bit values.

Representation of the voltage values in the range -10 V DC – 10 V DC

The decimal numerical values can be converted to the voltage values in the range -10 V DC – 10 V DC using the following equations:
For **positive** voltage values 0 V DC – 10 V DC:

$$\boxed{\text{decimal value} = 3276.7\,\frac{1}{V} \times \text{voltage}}$$

The value range:

0 – 10 V DC

is mapped to the number range:

0000 – 7FFF$_{hex}$ (decimal: 0 – 32767)

For **negative** voltage values -10 V DC – 0 V DC:

$$\boxed{\text{decimal value} = 3276.8\,\frac{1}{V} \times \text{voltage}}$$

The value range:

-10 – -3.052 10^{-4} V DC

is mapped to the number range:

8000 – FFFF$_{hex}$ (decimal:-32768 – -1)

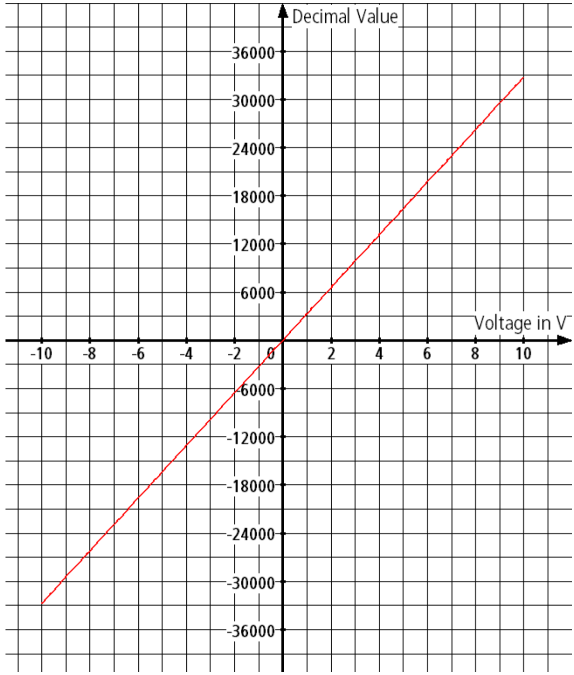


Figure 74: Representation of decimal values in relation to the voltage values in the coordinate system

Calculation of hexadecimal/binary values for negative decimal values

The decimal value can be converted (with a pocket calculator) very easily to a hexadecimal value for the positive range. The two's complement (→ figure page 29) of the 16-bit values is the same as the binary values in the positive range.

The hexadecimal value for the negative range is slightly more complicated to calculate as the value must be coded in two's complement notation. The following example illustrates the procedure:

The 4-digit hexadecimal value for the voltage value **-6 V DC** is to be calculated.

Using the previously mentioned formula, the calculation is as follows:

$$\boxed{\text{decimal value} = 3276.8\,\frac{1}{\text{V}} \times (-6\text{ V}) = -19660.8}$$

Some pocket calculators convert negative decimal values directly to a hexadecimal value in two's complement notation.

If this is not possible, proceed as follows:

Convert the negative decimal value to a binary value:

$$\boxed{|-19660.8| = 19660.8 \Leftrightarrow 100.1100.1100.1100}$$

Place the binary value in 16 bits by adding preceding zeros as required.

$$\boxed{100.1100.1100.1100 \Rightarrow 0100.1100.1100.1100}$$

Invert the 16-digit binary value:

$$\boxed{0100.1100.1100.1100 \Rightarrow 1011.0011.0011.0011}$$

Add a 1 to the inverted binary value:

$$\begin{array}{l} 1011.0011.0011.0011 \\ \underline{0000.0000.0000.0001} \\ 1011.0011.0011.0100 \end{array}$$

The number is now coded in two's complement notation and can be converted to a hexadecimal value. The conversion is very easy, as four digits of the binary value are always represented by one digit of the hexadecimal value.

$$\boxed{1011.0011.0011.0100 \Rightarrow B334}$$

The required result is:

$$\boxed{-19660.8 \Rightarrow B334}$$

Equations and graphs for 12-bit representation

Attention!
The 12-bit representation is “left-justified”. The number is transmitted with 16 bits! Bit 0 – Bit 3 of the binary number and the last digit of the hexadecimal number are always 0.

Representation of the current values in the range 0 – 20 mA

The decimal numerical values can be converted to the current values in the range 0 mA – 20 mA using the following equation:

$$\boxed{\text{decimal value} = 204.75\,\frac{1}{\text{mA}} \times \text{current}}$$

The value range:

0 – 20 mA

is mapped to the number range:

000 – FFF$_{\text{hex}}$ (decimal: 0 – 4095)

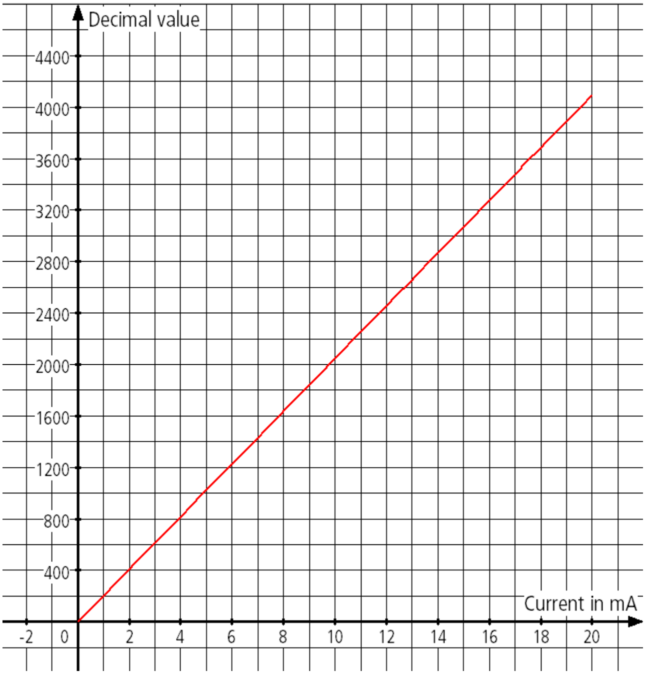


Figure 75: Representation of decimal values in relation to the current values in the coordinate system

The decimal value can be converted (with a pocket calculator) very easily to a hexadecimal value.

As the values have to be left-justified, do not forget to add a 0 to the three-digit hexadecimal value, i.e. to move the value by one digit to the left!

$\boxed{XXX_{hex} \Rightarrow XXX0_{hex}}$

In the same way, four zeros have to be added to the 12-digit binary value so that it is shifted four digits to the left.

$\boxed{XXXX.XXXX.XXXX \Rightarrow XXXX.XXXX.XXXX.0000}$

Representation of the current values in the range 4 mA – 20 mA

The decimal numerical values can be converted to the current values in the range 4 mA – 20 mA using the following equation:

$$\boxed{\text{decimal value} = 255.9375 \frac{1}{\text{mA}} \times \text{current} - 1023.75}$$

The value range:

4 – 20 mA

is mapped to the number range:

000 – FFF$_{hex}$ (decimal: 0 – 4095)

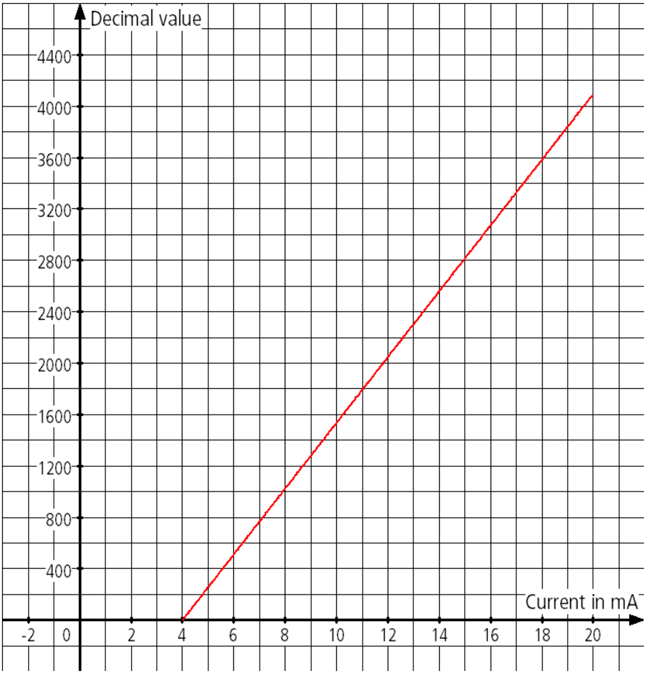


Figure 76: Representation of decimal values in relation to the current values in the coordinate system

The decimal value can be converted (with a pocket calculator) very easily to a hexadecimal value.

As the values have to be left-justified, do not forget to add a 0 to the three-digit hexadecimal value, i.e. to move the value by one digit to the left!

$$\boxed{XXX_{hex} \Rightarrow XXX0_{hex}}$$

In the same way, four zeros have to be added to the 12-digit binary value so that it is shifted four digits to the left.

$$\boxed{XXXX.XXXX.XXXX \Rightarrow XXXX.XXXX.XXXX.0000}$$

Representation of the voltage values in the range 0 – 10 V DC

The decimal numerical values can be converted to voltage values in the range 0 V DC – 10 V DC using the following equation:

$$\boxed{\text{decimal value} = 409.5\,\frac{1}{V} \times \text{voltage}}$$

The value range:

0 – 10 V DC

is mapped to the number range:

000 – FFF$_{hex}$ (decimal: 0 – 4095)

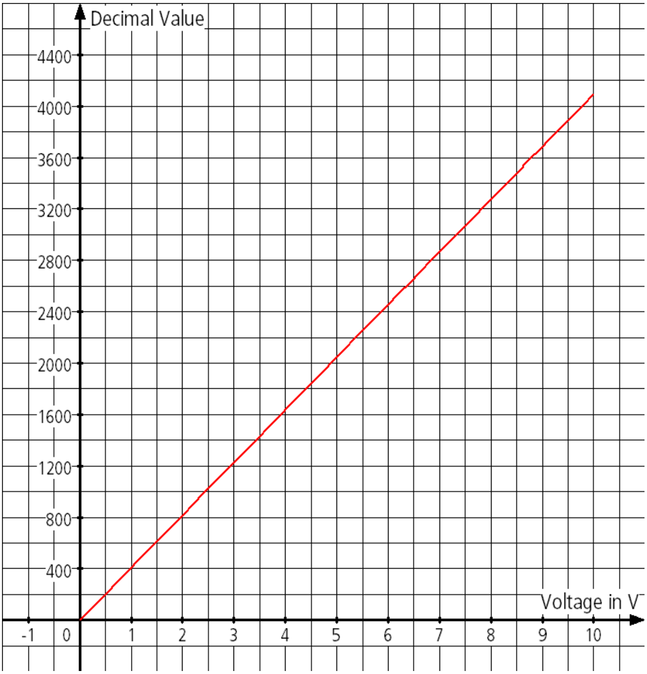


Figure 77: Representation of decimal values in relation to the voltage values in the coordinate system

The decimal value can be converted (with a pocket calculator) very easily to a hexadecimal value.

As the values have to be left-justified, do not forget to add a 0 to the three-digit hexadecimal value, i.e. to move the value by one digit to the left!

$$\boxed{XXX_{hex} \Rightarrow XXX0_{hex}}$$

In the same way, four zeros have to be added to the 12-digit binary value so that it is shifted four digits to the left.

$$\boxed{XXXX.XXXX.XXXX \Rightarrow XXXX.XXXX.XXXX.0000}$$

Representation of the voltage values in the range -10 V DC – 10 V DC

The decimal numerical values can be converted to the voltage values in the range -10 V DC – 10 V DC using the following equations:
For **positive** voltage values 0 V DC – 10 V DC:

$$\boxed{\text{decimal value} = 204.7\,\frac{1}{\text{V}} \times \text{voltage}}$$

The value range:

0 – 10 V DC

is mapped to the number range:

000 – 7FF$_{hex}$ (decimal: 0 – 2047)

For **negative** voltage values -10 V DC – 0 V DC:

$$\boxed{\text{decimal value} = 204.8\,\frac{1}{\text{V}} \times \text{voltage}}$$

The value range:

-10 – -0.0049 V DC

is mapped to the number range:

800 – FFF$_{hex}$ (decimal: -2048 – -1)

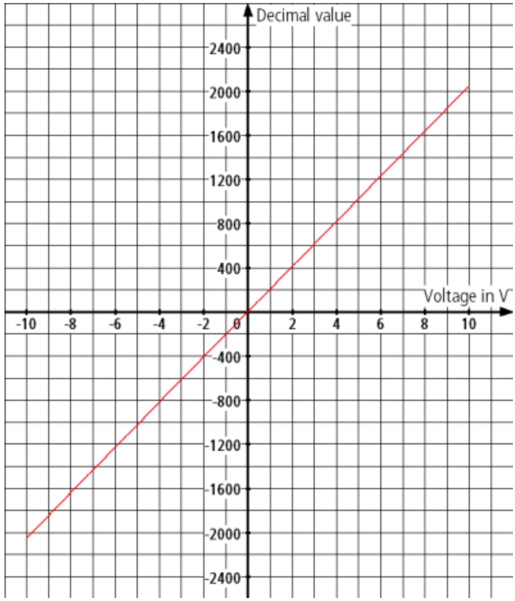


Figure 78: Representation of decimal values in relation to the voltage values in the coordinate system

The decimal value can be converted (with a pocket calculator) very easily to a hexadecimal value for the positive range. The two's complement (→ figure page 29) of the 12-bit values is the same as the binary values in the positive range.

As the values have to be left-justified, do not forget to add a 0 to the three-digit hexadecimal value, i.e. to move the value by one digit to the left!

$$\boxed{XXX_{hex} \Rightarrow XXX0_{hex}}$$

In the same way, four zeros have to be added to the 12-digit binary value so that it is shifted four digits to the left.

$$\boxed{XXXX.XXXX.XXXX \Rightarrow XXXX.XXXX.XXXX.0000}$$

Calculation of hexadecimal/binary values for negative decimal values

The hexadecimal value for the negative range is slightly more complicated to calculate as the value must be coded in two's complement notation. The following example illustrates the procedure:

The 4-digit hexadecimal value for the voltage value **-6 V DC** is to be calculated.

Using the previously mentioned formula, the calculation is as follows:

$$\boxed{\text{decimal value} = 204.8\,\frac{1}{V} \times (-6\text{ V}) = -1228.8}$$

Some pocket calculators convert negative decimal values directly to a hexadecimal value in two's complement notation.

If this is not possible, proceed as follows:

Convert the negative decimal value to a binary value:

$$\boxed{|-1228.8| = 1228.8 \Leftrightarrow 100.1100.1100}$$

Place the binary value in 12 bits by adding preceding zeros as required.

$$\boxed{100.1100.1100 \Rightarrow 0100.1100.1100}$$

Invert the 12-digit binary value:

$$\boxed{0100.1100.1100 \Rightarrow 1011.0011.0011}$$

Add a 1 to the inverted binary value:

1011.0011.0011
0000.0000.0001
1011.0011.0100

The number is now coded in two's complement notation and can be converted to a hexadecimal value. The conversion is very easy, as four digits of the binary value are always represented by one digit of the hexadecimal value.

$$1011.0011.0100 \Rightarrow B34$$

As the value is represented with 16 bits and is left-justified, a 0 has to be added to the hexadecimal value and four zeros to the binary value.

$$B34 \Rightarrow B340$$

$$1011.0011.0100 \Rightarrow 1011.0011.0100.0000$$

The required result is:

$$-1228.8 \Rightarrow B340$$

LEDs

Errors from the I/O level are indicated on each module by means of the **DIA** collective LED. The corresponding diagnostics information is transmitted to the gateway as diagnostics bits.

If the **DIA** LED is permanently red, this indicates that the module bus communication for the analog output module has failed.

Shielding

Shielded signal cables are connected between the shield and base module via a two pole shield connector available as an accessory.

Module overview

	No. of channels	Short-circuit proof
XN-1AO-I(0/4...20MA)	1	✓
XN-2AO-I(0/4...20MA)	1	✓
XN-2AO-U(-10/0...+10VDC)	2	✓

XN-1AO-I(0/4...20MA)

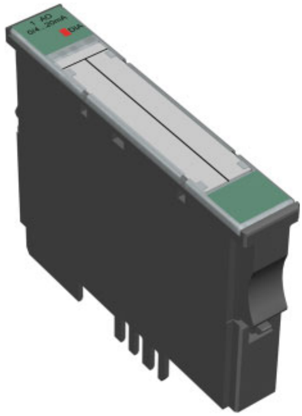


Figure 79: Analog output module, 1 AO, 0/4 – 20 mA

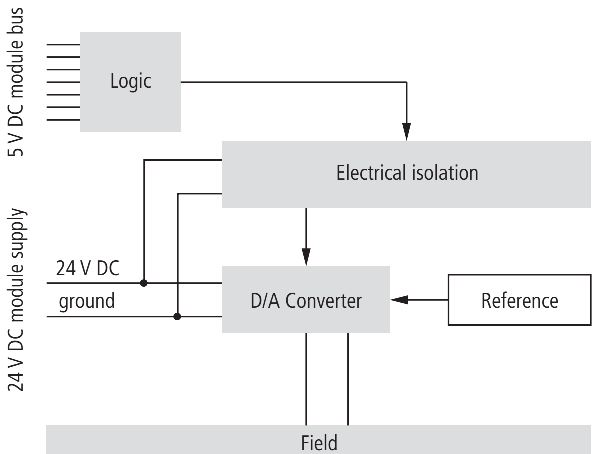


Figure 80: Block diagram

Technical data

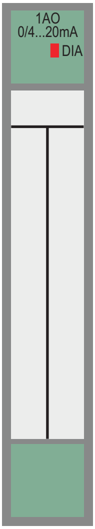
Table 14: XN-1AO-I(0/4...20mA)

Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	39 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current from supply terminal (maximum)	50 mA
No. of channels	1
Output	
Output current (range that can be evaluated by the A/D converter)	0/4 – 20 mA
Load resistance	
Resistive load R_{LO}	< 450 Ω
Inductive load R_{LI}	< 1 mH
Transmission frequency	< 200 Hz
Accuracy of output value	
Offset error	≦ 0.1 %
Linearity	0.02 %
Basic error at 23 °C	0.2 %
Repeatability	0.05 %
Output ripple	0.02 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Settling time (maximum)	
Resistive load	0.1 ms
Inductive load	0.5 ms
Capacitive load	0.5 ms

Designation	Value
Representation of output value	16-bit: two's complement notation or 12-bit left-justified: • Binary uncoded (only positive binary values)

1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

→ Negative values are output automatically as 0 mA or 4 mA depending on the range set.



Diagnostic messages

LED	Display	Meaning	Remedy
DIA	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No error message	–

Module parameters

Parameter name	Value
Value representation	Integer (15-bit + sign)[1)]
	12-bit (left-justified)
Current mode	0 – 20 mA[1)]
	4 – 20 mA
Substitute value A1	The substitute value defined for the module will be output if the parameter "Output substitute value" is set in the gateway.

1) Standard parameter values

Base modules

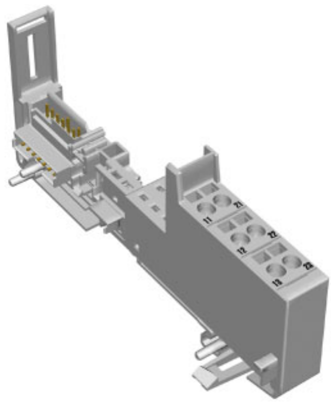


Figure 81: Base module XN-S3T-SBB

Designation	
with tension clamp connectors	XN-S3T-SBB
with screw terminals	XN-S3S-SBB

Connection diagram

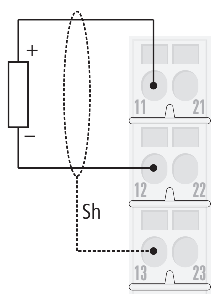


Figure 82: Connection diagram XN-S3x-SBB

→ “Technical data for the base modules” page 21

XN-2AO-I(0/4...20MA)

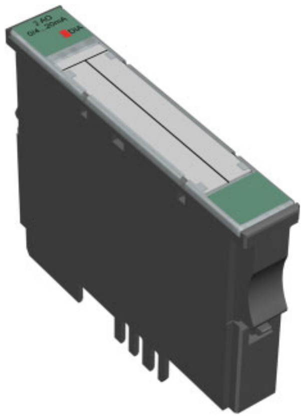


Figure 83: Analog output module, 2AO, 0/4...20 mA

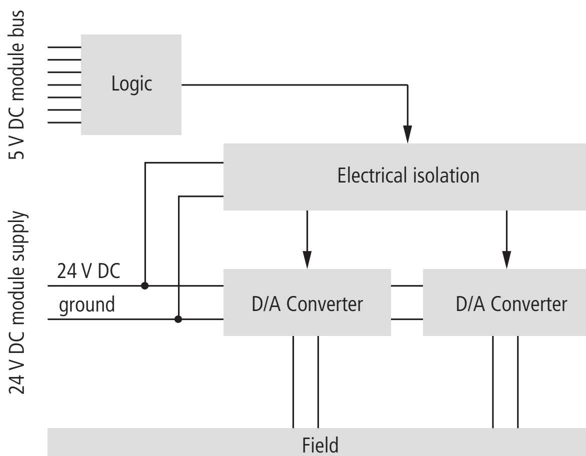


Figure 84: Block diagram

Technical data

Table 15: XN-2AO-I(0/4...20mA)

Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	40 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current from supply terminal (maximum)	50 mA
No. of channels	2
Output	
Output current (range that can be evaluated by the A/D converter)	0/4 – 20 mA
Load resistance	
Resistive load R_{LO}	< 450 Ω
Inductive load R_{LI}	< 1 mH
Transmission frequency	< 200 Hz
Accuracy of output value	
Basic error at 23 °C	< 0.2 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Settling time (maximum)	
Resistive load	2 ms
Inductive load	2 ms
Representation of output value	16-bit: two's complement notation or 12-bit left-justified: • Binary uncoded (only positive binary values)

1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

→ Negative values are output automatically as 0 mA or 4 mA depending on the range set.

Diagnostic messages

LED	Display	Meaning	Remedy
DIA	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No fault indication or diagnostic	-

The module does not feature any diagnostics data:

Module parameters (per channel)

Parameter name	Value
Channel KX (X=1,2)	Activate [1)]
	Deactivate
Value representation	Integer (15-bit + sign)[1)]
	12-bit (left-justified)
Current mode	0 – 20 mA [1)]
	4 – 20 mA
Substitute value AX (X=1,2)	The substitute value entered for the corresponding channel is output if the “Output substitute value” gateway parameter is set.

[1)] ... Standard parameter value

Base module

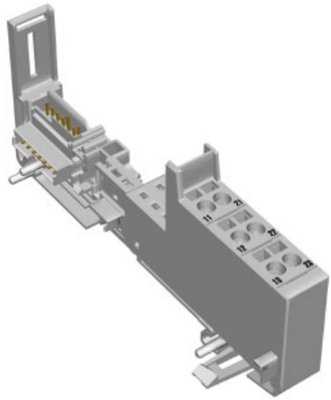


Figure 85: Base module XN-S3T-SBB

Designation	
with tension clamp connectors	XN-S3T-SBB
with screw terminals	XN-S3S-SBB

Connection diagram

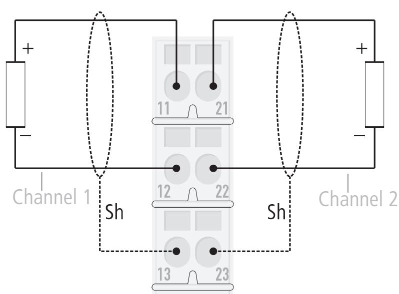


Figure 86: Connection diagram XN-S3x-SBB

→ "Technical data for the base modules" page 21

XN-2AO-U (-10/0...+10VDC)

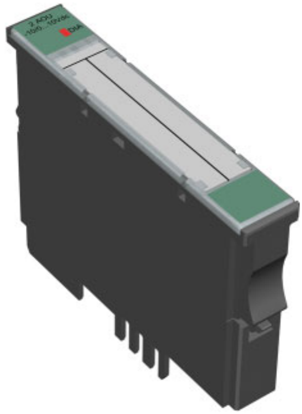


Figure 87: Analog output module, 2AO, -10/0...+10V DC

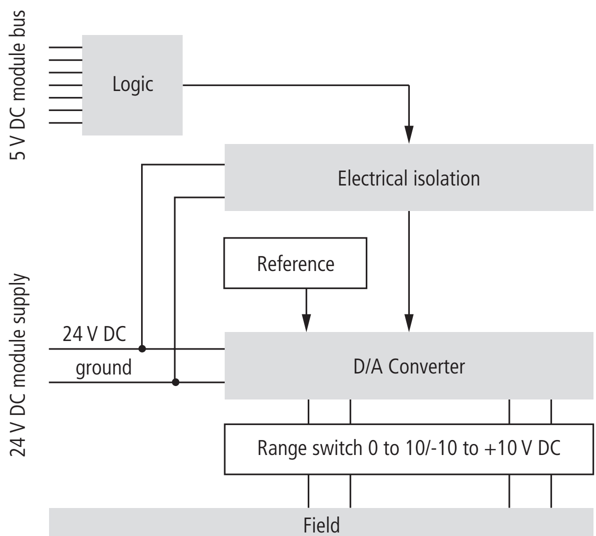


Figure 88: Block diagram

Technical data

Table 16: XN-2AO-U(-10/0...+10VDC)

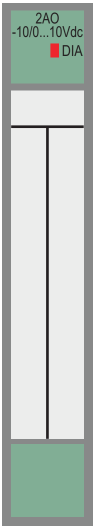
Designation	Value
Module supply[1)] through module bus voltage (5 V DC)	
Current from module bus IMB (for supply to module electronics / max.)	43 mA
Module supply via supply terminal[1)] (U_L)	
Nominal voltage through supply terminal U_L (range)	24 V DC (18 – 30 V DC)
Current from supply terminal (maximum)	50 mA
No. of channels	2
Output	
Output voltage (range that can be evaluated by the A/D converter)	-10/0 – +10 V DC
Load resistance	
Resistive load R_{LO}	> 1 kΩ
Capacitive load$_{LK}$	> 1 µF
Short-circuit current	≦ 40 mA
Transmission frequency	< 100 Hz
Accuracy of output value	
Offset error	≦ 0.1 %
Linearity	0.1 %
Basic error at 23 °C	< 0.2 %
Repeatability	0.05 %
Temperature coefficient	≦ 300 ppm/°C of limit value
Settling time (maximum)	
Resistive load	0.1 ms
Inductive load	0.5 ms
Capacitive load	0.5 ms

Designation	Value
Interference voltage suppression	
Common mode	> 90 dB
Normal mode	> 70 dB
Cross talk between channels	> -50 dB
Representation of output value	16-bit: two's complement notation/ or 12-bit left-justified: • Two's complement coded (also negative numerical values possible) • Binary uncoded (only positive binary values)

1) A part of the electronics of the XI/ON module is supplied from the module bus voltage (5 V DC), the rest from the supply terminal (U_L).

→ With a negative range from 0 – 10 V DC negative values are automatically output as 0 V DC.

Diagnostic messages



LED	Display	Meaning	Remedy
DIA	Red	Failure of module bus communication	Check whether more than 2 adjacent electronics modules have been removed.
	OFF	No error message	–

Module parameters

Parameter name	Value
Value representation	Integer (15-bit + sign)[1)]
	12-bit (left-justified)
Voltage mode	-10 – +10 V
	0 – 10 V[1)]
Substitute value A1	The substitute value defined for Channel 1 will be output if the parameter “Output substitute value” is set in the gateway.
Substitute value A2	The substitute value defined for Channel 2 will be output if the parameter “Output substitute value” is set in the gateway.

1) Standard parameter values

Base modules

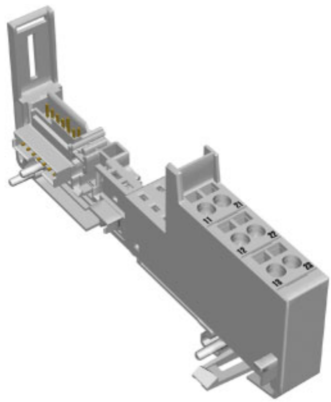


Figure 89: Base module XN-S3T-SBB

Designation	
with tension clamp connectors	XN-S3T-SBB
with screw terminals	XN-S3S-SBB

Connection diagram

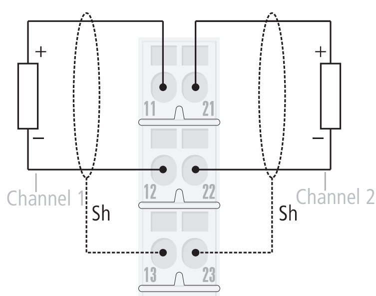


Figure 90: Connection diagram XN-S3x-SBB

4 Integration in PROFIBUS-DP

General

The process data is transmitted byte-wise (8-bit) via PROFIBUS. The analog module types have 2 bytes of process data for each channel. The two process data bytes contain the measured value of the channel and define the voltage or current value of the channel.

The analog input modules supply process input data and the diagnostics data if the appropriate parameter is set (12-bit representation).

The analog output modules and relay modules only receive process output data.

→ You can find the latest GSD files on our home page (http://www.microinnovation.com), under „DOWN-LOADS".

Process input data

Data structure with 16-bit representation

Table 17: Structure of the data bytes on the PROFIBUS-DP fieldbus

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Measured value							
Byte 1								

Table 18: Structure of the data bytes on the PROFIBUS-DP fieldbus, bitwise representation:

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
bByte 1	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8

Data structure with 12-bit representation

Table 19: Structure of the data bytes on the PROFIBUS-DP fieldbus

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Measured value 2)				Diagnostics data 1)			
Byte 1								

1) The diagnostics data varies according to module type and is represented by channel

2) The measured value is represented as a binary value if the set measured value range is positive. If the parameterised measured value range also allows negative values (-10 V DC – 10 V DC), the measured value is coded as a two's complement value.

Table 20: Structure of the data bytes in the PROFIBUS-DP fieldbus, bitwise display - Example of diagnostics for the XN-2AI-PT/NI-2/3

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Bit 3	Bit 2	Bit 1	Bit 0	X	"Short-circuit"	Open circuit	"Measurement value range error"
Byte 1	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4

X = reserved

Process output data

Data structure with 16-bit representation

Table 21: Structure of the data bytes in the PROFIBUS-DP fieldbus

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Output value							
Byte 1								

Table 22: Structure of the data bytes in the PROFIBUS-DP fieldbus, bitwise representation

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8

Data structure with 12-bit representation

Table 23: Structure of the data bytes in the PROFIBUS-DP fieldbus

PDInp	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Output value 1)				X	X	X	X
Byte 1								

X = reserved

1) The output value must be coded as a binary value if the parameterised output range is positive. If the parameterised output value range also allows negative values (-10 V DC – 10 V DC), the output value must be coded as a two's complement value.

Table 24: Structure of the data bytes in the PROFIBUS-DP fieldbus, bitwise representation

PDIn p	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Bit 3	Bit 2	Bit 1	Bit 0	X	X	X	X
Byte 1	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4

X = reserved

Parameter data structure

The structure of the parameter data of the analog I/O module depends on the module type. The structure of the parameter data for each module type is shown further on in this section.

It must be remembered that all the modules that appear in the
Standard module representation
(e.g. "S-XN-2AO-U(-10/0..+10VDC)")
will occupy one parameter byte when project engineering with a software tool.

This parameter byte contains the number of all other parameter bytes of the module.

The response of the analog outputs in the event of an error (change of module, wrong module replaced, fieldbus error) can be defined through gateway parameters.

The description of these gateway parameters can be found in the manual:

- Product description XI/ON:
  Gateways for PROFIBUS-DP

XN-1AI-I(0/4...20MA)

Table 25: Structure of the data byte (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	Diag-nostic	Value represen-tation	Current mode

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-I(0/4...20MA)

Table 26: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	Diag-nostic	Value represen-tation	Current mode
Byte 1	X	X	X	X	Channel K2	Diag-nostic	Value represen-tation	Current mode

X = reserved

→ "Meaning of the parameter data" page 177

XN-1AI-U(-10/0...+10VDC)

Table 27: Structure of the data byte (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	Diag-nostic	Value represen-tation	Voltage mode

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-U(-10/0...+10VDC)

Table 28: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	Diag-nostic	Value represen-tation	Voltage mode
Byte 1	X	X	X	X	Channel K2	Diag-nostic	Value represen-tation	Voltage mode

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-PT/NI-2/3

Table 29: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	X	Measure-ment mode K1
Byte 1	Element K1				Channel K1	Diag-nostic K1	Value represen-tation K1	Mains suppres-sion K1
Byte 2	X	X	X	X	X	X	X	Measure-ment mode K2
Byte 3	Element K2				Channel K2	Diag-nostic K2	Value represen-tation K2	Mains suppres-sion K2

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-THERMO-PI

Table 30: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Element K1				Channel K1	Diag-nostic K1	Value represen-tation K1	Mains suppres-sion K1
Byte 1	Element K2				Channel K2	Diag-nostic K2	Value represen-tation K2	Mains suppres-sion K2

X = reserved

→ "Meaning of the parameter data" page 177

XN-4AI-U/I

Table 31: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	Operating mode	Channel K1	Diag-nostic	Value repre-sentation	Range
Byte 1	X	X	X	Operating mode	Channel K2	Diag-nostic	Value repre-sentation	Range
Byte 2	X	X	X	Operating mode	Channel K3	Diag-nostic	Value repre-sentation	Range
Bytes 3	X	X	X	Operating mode	Channel K4	Diag-nostic	Value repre-sentation	Range

X = reserved

→ “Meaning of the parameter data” page 177

XN-1AO-I(0/4...20MA)

Table 32: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	Value represen-tation	Current mode
Byte 1	Substitute value A1							
Byte 2								

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AO-I(0/4...20MA)

Table 33: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	X	Value represen-tation	Current mode
Byte 1	Substitute value A1							
Byte 2								
Byte 3	X	X	X	X	Channel K2	X	Value represen-tation	Current mode
Byte 4	Substitute value A2							
Byte 5								

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AO-U(-10/0...+10VDC)

Table 34: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	Value represen-tation	Voltage mode
Byte 1	Substitute value A1							
Byte 2								
Byte 3	X	X	X	X	X	X	Value represen-tation	Voltage mode
Byte 4	Substitute value A2							
Byte 5								

X = reserved

→ “Meaning of the parameter data” page 177

Meaning of the parameter data

The structure of the parameter bytes depends on the module and is described from → page 170 onwards. The following table contains an overview of the parameter descriptions for all analog XI/ON modules. The table is arranged in alphabetical order according to the parameter name.

Table 35: Meaning of the data bits (parameters):

Designation	Value 1):Default	Designation of the values/ Value range	Description
"channel K1:"	0 1)	"activate"	This parameter enables individual channels to be deactivated and reactivated selectively.
	1	"deactivate"	
"channel K2:"	0 1)	"activate"	
	1	"deactivate"	
"channel K3:"	0 1)	"activate"	
	1	"deactivate"	
"channel K4:"	0 1)	"activate"	
	1	"deactivate"	
"current mode:"	0 1)	"0..20 mA"	The range for the current to be measured or the output current is limited to 0 mA – 20 mA.
	1	"4..20 mA"	The range for the current to be measured or the output current is limited to 0 mA – 20 mA.

Designation	Value 1):Default	Designation of the values/ Value range	Description
"diagnostic:"	0[1)]	"release"	The fieldbus related separate diagnostic message can be activated or deactivated. The messages are always available if the diagnostic message is integrated with the 12-bit representation in the process input data. Parameters can be assigned to each channel with multiple channel modules.
	1	"block"	
"diagnostic K1:"	0[1)]	"release"	With multiple channel modules, each channel is parameterised using identifiers K1 and K2. The function is the same as the "diagnostic:" parameter.
	1	"block"	
"diagnostic K2:"	0[1)]	"release"	
	1	"block"	
"element K1:"			
XN-2AI-PT/NI-2/3			
	0[1)]	"PT100, -200..850'C[1)]"	
	1	"PT100, -200..150'C"	
	2	"NI100, -60..250'C"	
	3	"NI100, -60..150'C"	
	4	"PT200, -200..850'C"	
	5	"PT200, -200..150'C"	
	6	"PT500, -200..850'C"	
	7	"PT500, -200..150'C"	
	8	"PT1000, -200..850'C"	
	9	"PT1000, -200..150'C"	
	10	"NI1000, -60..250'C"	

Designation	Value 1):Default	Designation of the values/ Value range	Description
	11	"NI1000, -60..150'C"	
	12	"Resistance, 0..100 Ohm"	
	13	"Resistance, 0..200 Ohm"	
	14	"Resistance, 0..400 Ohm"	
	15	"Resistance, 0..1000 Ohm"	
XN-2AI-THERMO-PI			
	0[1)]	"Type K, -270..1370'C"	
	1	"Type B, +100..1820'C"	
	2	"Type E, -270..1000'C"	
	3	"Type J, -210..1200'C"	
	4	"Type N, -270..1300'C"	
	5	"Type R, -50..1760'C"	
	6	"Type S, -50..1540'C"	
	7	"Type T, -270..400'C"	
	8	"+/-50 mV"	
	9	"+/-100 mV"	
	10	"+/-500 mV"	
	11	"+/-1000 mV"	
	12 – 15	reserved	
"element K2"	This parameter has the same values and designations as the parameter "Element K1". Channel 2 of the XN-2AI-PT/NI-2/3 module (→ "Connection diagrams" page 110) and the XN-2AI-THERMO-PI module (→ "Connection diagram" page 118) is assigned parameters.		

Designation	Value 1):Default	Designation of the values/ Value range	Description
"mains suppression K1:"	$0^{1)}$	"50 Hz"	Interference caused by the frequency of the supply voltage is suppressed. (in Germany the supply voltage is 50 Hz, in the USA 60 Hz).
	1	"60 Hz"	
"mains suppression K2:"	$0^{1)}$	"50 Hz"	The function is the same as the parameter "mains suppression K1:"
	1	"60 Hz"	
"measurement mode K1:"	$0^{1)}$	"2-wire"	→ "Connection diagrams" page 110
	1	"3-wire"	→ "Connection diagrams" page 110
"measurement mode K2:"	$0^{1)}$	"2-wire"	With multiple channel modules, each channel is parameterised using identifiers K1 and K2. The function is the same as the parameter "measurement mode K1"
	1	"3-wire"	
"operation mode:"	$0^{1)}$	"Voltage"	This parameter is used to set either voltage measuring or current measuring as operating mode on the XN-4AI-U/I module. This operating mode is set for each individual channel. → "Connection diagram" page 125
	1	"Current"	

Designation	Value 1):Default	Designation of the values/ Value range	Description
"range:"	0[1)]	"0..10V/0..20 mA"	This parameter is used on the XN-4AI-U/I module for setting the current or voltage range. This module allows both current and voltage measuring. The relevance of the voltage or current range depends on the "operation mode:" setting. This setting is carried out for each individual channel.
	1	"-10..+10V/4..20 mA"	
"substitute value A1:"	0[1)]	-32768 – +32767	Substitute value (for channel 1 with 2-channel modules). The response of the analog outputs in the event of a fault (change of module, wrong module replaced, fieldbus error) can be defined through gateway parameters. The substitute value stated here is only then used in the event of an error if the gateway parameter is set to "Output substitute value". The description of these gateway parameters can be found in the manual: Product description XI/ON: Gateways for PROFIBUS-DP
"substitute value A2:"	0[1]	-32768 – +32767	Substitute value for channel 2 with 2-channel modules. → "Connection diagram" page 157

Designation	Value 1):Default	Designation of the values/ Value range	Description
"value representation:"	0[1)]	"Integer (15-bit + sign)"	The value (current, voltage, resistance, temperature is represented with 16 bits. → "Representation of the analog values" page 28
	1	"12-bit (left-justified)"	The value (current, voltage, resistance, temperature is represented with 12 bits. → "Representation of the analog values" page 28
"value representation K1:"	0[1)]	"Integer (15-bit + sign)"	With multiple channel modules, each channel is parameterised using identifiers K1 and K2. The function is the same as the "Value representation" parameter.
	1	"12-bit (left-justified)"	
"value representation K2:"	0[1)]	"Integer (15-bit + sign)"	
	1	"12-bit (left-justified)"	
"voltage mode:"	0[1)]	"0..10V"	The range for the voltage to be measured or the output voltage is limited to 0 V DC – 10 V DC.
	1	"-10..+10V"	The range for the voltage to be measured or the output voltage is limited to -10 V DC – 10 V DC.

Diagnostic

The analog output modules do not provide diagnostics data.

The analog input modules provide 1 byte of diagnostics data per channel:

Module type	Diagnostic message	Position in diagnostic byte	Meaning
XN-1AI-I(0/4...20MA) XN-2AI-I(0/4...20MA) XN-2AI-THERMO-PI XN-4AI-U/I	"Measurement value range error"	0	The threshold for this error message is 1% above the upper measuring range value or 1 % below the lower measuring range value. Not all modules can detect an underflow. Refer to the sections “Diagnostic messages” from → page 73 onward for information on the diagnostics options for each module type .
	"Open circuit"	1	The input current is too low or the connections at the input are not connected. The analog input modules with a current input only supply this diagnostic signal for the measuring range 4 to 20 mA. The threshold in this case is 3 mA. The threshold is approx. 5 Ω for the temperature measuring ranges.
XN-1AI-U(-10/0...+10VDC) XN-2AI-U(-10/0...+10VDC)	"Measurement value range error"	0	See above

Module type	Diagnostic message	Position in diagnostic byte	Meaning
XN-2AI-PT/NI-2/3	"Measurement value range error"	0	See above
	Open circuit	1	See above
	"Short-circuit"	2	A short-circuit is only indicated here for the temperature measuring range. The threshold is 5 Ω (loop resistance)

5 Integration in CANopen

Process input data / process output data

The analog module types have 2 bytes of process data for each channel. These bytes contain the measured value of the channel (analog input) or the voltage or current value of the channel (analog output).

The analog input modules only provide process input data.

The analog output modules only receive process output data.

The process input and process output data is represented using the objects defined by the *Device Profile for I/O Devices CiA DS-401*.

→ You can find the latest EDS files on our home page (http://www.microinnovation.com), under „DOWNLOADS".

Objects for the process data

Overview

The objects represent the process input values for each analog input module and the process output values for each analog output channel of a XI/ON station.

Table 36: Objects for the process input and output data

Index (hex)	Page	Name
6401_{hex}		Read Analog Input 16 Bit
6411_{hex}		Write Analog Output 16 Bit

The **Index ($_{hex}$)** column describes the position of the entry in the object dictionary.

The following description of the objects uses the term "**Access**", indicating the possibility of accessing the entry.

These are as follows:

- rw (read/write):
  The writing and reading of the object via the service data is possible.
- ro (read only):
  The object can only be read.
- rwr (read/write/read):
  The writing and reading of the object via an SDO access is possible. A read PDO access is also possible if suitable PDO mapping has been configured for this object.
- rww (read/write/write):
  The writing and reading of the object via an SDO access is possible. A write PDO access is also possible if suitable PDO mapping has been configured for this object.

6401_{hex} Read Analog Input 16 Bit

The object represents the measured values for the analog input modules with 16 bits for each channel.

Attention!
The process data traffic for the analog input values is not started until the object 6423_{hex} is switched from the default setting FALSE to TRUE!

The representation of the different measured values as numerical values is described in detail from → page 28 onward for each value range.

Attention!
The possibility of 12-bit value representation (left-justified) is not useful for CANopen since all reference values (upper limit, lower limit) must be defined with 16 bits.

Table 37: Object 6401_{hex} Description

Features	Sub-index	Description / Value
Name		Read Analog Input 16 Bit
Object Code		ARRAY
PDO Mapping		Yes
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Integer16
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	ro
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	No

6411_{hex} Write Analog Output 16 Bit

The object represents the values for the analog output modules with 16 bits for each channel.

The representation of the current and voltage values as numerical values is described in detail from → page 128 onward for each value range.

Table 38: Object 6411_{hex} Description

Features	Sub-index	Description / Value
Name		Write Analog Output 16 Bit
Object Code		ARRAY
PDO Mapping		Yes
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Integer16
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rww
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00_{hex}

Objects for Interrupt behaviour

Objects 6421 – 6428$_{hex}$ can be used to control the event-triggered transmission of the process input data. As well as these event-triggered control objects, the transmission frequency of the process input data is also controlled by means of objects 1800$_{hex}$ to 181F$_{hex}$. These objects are described in the manual:

- Product Description XI/ON:
  Gateways for CANopen

→ Remember that the object → "6423hex Analog Input Global Interrupt Enable" page 193 must be used in order to enable the possibility of transmitting the process input data using an interrupt signal!

6421_{hex} Analog Input Interrupt Trigger Selection

The object defines which event is to trigger the transmitting of the analog input data (TPDOs) by means of an interrupt signal.

The triggering event is defined for each input channel using a corresponding sub-index of the object.

Table 39: Object 6421_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Trigger Selection
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned8
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	No

Table 40: Structure of sub-index 01_{hex} to $8E_{hex}$

Bit	Triggering event
0	1: **"Upper limit"**[1)] exceeded - the value at the input has exceeded the upper limit.
1	1: Input below **"lower limit"**[1)] - the value at the input is below the lower limit.
2	1: Input changed by more than **"delta"**[1)] - the value at the input has changed by a defined "Delta" value.
3	1: Input reduced by more than **"negative delta"**[1)] - the value at the input has reduced by a defined "Delta" value.
4	1: Input increased by more than **"positive delta"**[1)] - the value at the input has increased by a defined "Delta" value.
5 – 7	reserved

1) The upper/lower limit values and delta values are defined with the objects 6424_{hex}, 6425_{hex}, 6426_{hex}, 6427_{hex} and 6428_{hex}.

→ The transmitting of the analog input data (TPDOs) by means of an interrupt signal is triggered repeatedly with every change of the analog input value if the value stays above the upper limit or below the lower limit.

If another triggering event occurs at the same time (e.g. increase by "Delta value"), the repeated transmitting is aborted.

→ Several bits can be set simultaneously so that the transmitting of the input process data can be triggered by several events.

6422_{hex} Analog Input Interrupt Source

The object indicates if an analog input channel has fulfilled a condition for triggering an interrupt signal.

The conditions were defined with object 6421_{hex}.

If a condition for triggering an interrupt signal on a channel is fulfilled, the corresponding bit is set to 1. The corresponding bits for channels 0 to 31 are set in sub-index 01_{hex} and the bits for channels 32 to 63 in sub-index 02_{hex} etc.

The bits can be read using an SDO: The read operation causes the bits to be reset to 0.

Table 41: Object 6422_{hex} Description

Features	**Sub-index**	**Description / Value**
Name		Analog Input Interrupt Source
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – 08_{hex}	Unsigned32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – 08_{hex}	ro
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – 08_{hex}	00_{hex}

6423_{hex} Analog Input Global Interrupt Enable

This object enables the option for generating an interrupt signal. If the value of this object is set from the default setting FALSE to TRUE, the transmitting of the analog input data (TPDOs) can be triggered by means of an interrupt signal.

Table 42: Object 6423_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Global Interrupt Enable
Object Code		VAR
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Boolean
Access	Sub-index 00_{hex}	rw
XI/ON default value	Sub-index 00_{hex}	FALSE

6424_{hex} Analog Input Interrupt Upper Limit Integer

The object 6424_{hex} defines the value for an upper limit.

Values above this “upper limit” can be defined as the condition for generating an interrupt signal.

→ “6421hex Analog Input Interrupt Trigger Selection” page 190

Table 43: Object 6424_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Upper Limit Integer
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Integer32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

6425_{hex} Analog Input Interrupt Lower Limit Integer

The object 6425_{hex} defines the value for a lower limit.

Values below this “lower limit” can be defined as the condition for generating an interrupt signal.

→ “6421hex Analog Input Interrupt Trigger Selection” page 190

Table 44: Object 6425_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Lower Limit Integer
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Integer32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

6426_{hex} Analog Input Interrupt Delta Unsigned

The object 6426_{hex} defines a Delta value.

Values that deviate from the input value by this “Delta value” can be defined as the condition for generating an interrupt signal.

→ “6421hex Analog Input Interrupt Trigger Selection” page 190

Table 45: Object 6426_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Delta Unsigned
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

6427_{hex} Analog Input Interrupt Negative Delta Unsigned

The object 6427_{hex} defines a Delta value.

Values **lesser than** the input value by this "Delta value" can be defined as the condition for generating an interrupt signal.

→ "6421hex Analog Input Interrupt Trigger Selection" page 190

Table 46: Object 6427_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Negative Delta Unsigned
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

6428_{hex} Analog Input Interrupt Positive Delta Unsigned

The object 6428_{hex} defines a Delta value.

Values **greater than** the input value by this “Delta value” can be defined as the condition for generating an interrupt signal.

→ “6421hex Analog Input Interrupt Trigger Selection” page 190

Table 47: Object 6428_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Input Interrupt Positive Delta Unsigned
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

Objects for the substitute output value in the event of an error

Overview

The objects define the substitute value and the substitute-value mode for each individual analog output channel of a XI/ON station. The substitute value is used in the event of a communication error or other unrecoverable error.

These values are not saved by the analog output modules in the integrated memory. If the bus-master or the gateway is replaced, the values will have to be updated.

6443_{hex} Analog Output Error Mode

It defines for each digital output channel whether or not the output should take on a substitute value in the event of an error. The sub-indexes of 01 – $8E_{hex}$ define the mode of the analog output channels 1 to 142.
The following applies:

00_{hex} The output maintains its value if an error occurs.

01_{hex} The output is assigned a substitute value if an error occurs.

The substitute values for the analog output channels are defined with the object Analog Output Error State Object (6444_{hex}).

Table 48: Object 6443_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Output Error Mode
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned8
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	01_{hex}

6444_{hex} Analog Output Error State

The substitute value is defined for each analog output channel. The substitute values are only taken into account in the event of an error if a 01_{hex} was entered for the relevant output channel in object Analog Output Error Mode Object (6443_{hex}). The sub-indexes of 01 – $8E_{hex}$ define the value for the analog output channels 1 to 142.

Table 49: Object 6444_{hex} Description

Features	Sub-index	Description / Value
Name		Analog Output Error State
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Integer32
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	00000000_{hex}

→ The appropriate numerical values and number ranges for each input variable (current, voltage, temperature...) are given from → page 128.
The 12-bit representation is not available.

Objects for parameterisation

5420_{hex} Manu Spec Analog Input Range

The object Manu Spec Analogue Input Range defines the parameters of the analog input channels. Write accesses initiate a parameter update on the XI/ON module bus.

The parameter is stored retentively in the gateway and in the appropriate module, and is restored with every node reset.

The sub-indexes 01 – $8E_{hex}$ define the parameters for the analog input channel 1 to 142.

Table 50: Object 5420_{hex} Description

Features	Sub-index	Description / Value
Name		Manu Spec Analogue Input Range
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned16
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	No

1) The default values are defined for every single parameter. This information is provided under → “Meaning of the parameter data” page 177

The structure of the 2 bytes of parameter data depends on the module concerned. A sub-index is assigned for each channel. The following explains the structure for each module type:

XN-1AI-I(0/4...20MA)

Table 51: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	Diagnostic 2)	Value representation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

→ "Meaning of the parameter data" page 177

XN-2AI-I(0/4...20MA)

Table 52: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	Diagnostic 2)	Value representation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → “Emergencies” page 215

Table 53: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K2	Diagnostic 2)	Value representation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → “Emergencies” page 215

→ “Meaning of the parameter data” page 177

XN-1AI-U(-10/0...+10VDC)

Table 54: Structure of the data byte (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	Diagnostic 2)	Value represen-tation 1)	Voltage mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

2) The diagnostics data is transmitted in the form of an Emergency telegram → “Emergencies” page 215

→ “Meaning of the parameter data” page 177

XN-2AI-U(-10/0...+10VDC)

Table 55: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	Diagnostic 2)	Value representation 1)	Voltage mode
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 56: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K2	Diagnostic 2)	Value representation 1)	Voltage mode
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-PT/NI-2/3

Table 57: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Element K1				Channel K1	Diag-nostic K2[2)]	Value represen-tation K1[1)]	Mains suppres-sion K1
Byte 1	X	X	X	X	X	X	X	Measure-ment mode K1

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 58: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Element K2				Channel K2	Diag-nostic K2[2)]	Value represen-tation K2[1)]	Mains suppres-sion K2
Byte 1	X	X	X	X	X	X	X	Measure-ment mode K2

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

→ "Meaning of the parameter data" page 177

XN-2AI-THERMO-PI

Table 59: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Element K1				Channel K1	Diag-nostic K1 2)	Value represen-tation K1 1)	Mains suppres-sion K1
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.

2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 60: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	Element K2				Channel K2	Diag-nostic K2 2)	Value represen-tation K2 1)	Mains suppres-sion K2
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.

2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

→ "Meaning of the parameter data" page 177

XN-4AI-U/I

Table 61: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	Operating mode	Channel K1	Diagnostic 2)	Value representation 1)	Range
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 62: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	Operating mode	Channel K2	Diagnostic 2)	Value representation 1)	Range
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 63: Structure of the data bytes (parameters) for the third channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	Operating mode	Channel K3	Diagnostic 2)	Value representation 1)	Range
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.
2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

Table 64: Structure of the data bytes (parameters) for the fourth channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	Operating mode	Channel K4	Diagnostic 2)	Value representation 1)	Range
Byte 1	X	X	X	X	X	X	X	X

1) The 12-bit representation is not available for CANopen.

2) The diagnostics data is transmitted in the form of an Emergency telegram → "Emergencies" page 215

X = reserved

→ "Meaning of the parameter data" page 177

5440_{hex} Manu Spec Analog Output Range

The object Manu Spec Analogue Output Range defines the parameters of the analog output channels. Write accesses initiate a parameter update on the XI/ON module bus.

The parameter is stored retentively in the gateway and in the appropriate module, and is restored with every node reset.

The sub-indexes 01 – $8E_{hex}$ define the parameters for the analog input channel 1 to 142.

Table 65: Object 5440_{hex} Description

Features	Sub-index	Description / Value
Name		Manu Spec Analogue Output Range
Object Code		ARRAY
PDO Mapping		No
Data Type	Sub-index 00_{hex}	Unsigned8
	Sub-index 01 – $8E_{hex}$	Unsigned16
Access	Sub-index 00_{hex}	ro
	Sub-index 01 – $8E_{hex}$	rw
XI/ON default value	Sub-index 00_{hex}	No
	Sub-index 01 – $8E_{hex}$	No

The structure of the 2 bytes of parameter data depends on the module concerned. A sub-index is assigned for each channel. The following explains the structure for each module type:

XN-1AO-I(0/4...20MA)

Table 66: Structure of the data bytes (parameters)

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	Value represen-tation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

→ "Meaning of the parameter data" page 177

XN-2AO-I(0/4...20MA)

Table 67: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K1	X	Value represen-tation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

Table 68: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	Channel K2	X	Value represen-tation 1)	Current mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

→ "Meaning of the parameter data" page 177

XN-2AO-U(-10/0...+10VDC)

Table 69: Structure of the data bytes (parameters) for the first channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	Value representation 1)	Voltage mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

Table 70: Structure of the data bytes (parameters) for the second channel

	B7	B6	B5	B4	B3	B2	B1	B0
Byte 0	X	X	X	X	X	X	Value representation 1)	Voltage mode
Byte 1	X	X	X	X	X	X	X	X

X = reserved

1) The 12-bit representation is not available for CANopen.

→ "Meaning of the parameter data" page 177

Object for the Device Profile and the I/O types

67FF$_{hex}$ Device Type DS401

The object 67FFh returns the type of the first device profile supported.
The object is assigned the value 000x0191$_{hex}$.
The Low word (0191$_{hex}$) specifies the Device Profile (to CiA DS-401: I/O modules).
The High word (000x$_{hex}$) specifies the I/O type(s) (see CiA DS-401).

Table 71: Object 67FF$_{hex}$ Description

Features	**Sub-index**	**Description / Value**
Name		Device Type DS401
Object Code		VAR
PDO Mapping		No
Data Type	Sub-index 00$_{hex}$	Unsigned32
Access	Sub-index 00$_{hex}$	ro
XI/ON default value	Sub-index 00$_{hex}$	No

Emergencies

The following CANopen Emergencies can be triggered by a XI/ON module of type analog output module:

Designa-tion	Meaning	Byte 0/1 Error Code	Byte 2 Error Register	Byte 3 Extra info	Byte 4 Additional infor-mation
XN-1AI-I(0/4...20MA); XN-2AI-I(0/4...20MA)					
Input current too high	The input current is outside of the permis-sible range.[1)]	2110_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
Input current too low	Open circuit or input current (for the meas-uring range 4 to 20 mA) too low. The threshold is 3 mA.	2130_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
XN-1AI-U(-10/0...+10VDC); XN-2AI-U(-10/0...+10VDC)					
AI U voltage out of range	The input voltage is outside of the permis-sible range.[1)]	3003_{hex}	Bit 2 = 1 (voltage error)	Module number	Channel numbers for the 2-channel modules
XN-4AI-U/I					
Input current too high	The input current is outside of the permis-sible range.[1)]	2110_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
Input current too low	Open circuit or input current (for the meas-uring range 4 to 20 mA) too low. The threshold is 3 mA.	2130_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
AI U voltage out of range	The input voltage is outside of the permis-sible range.[1)]	3003_{hex}	Bit 2 = 1 (voltage error)	Module number	Channel numbers for the 2-channel modules
XN-2AI-PT/NI-2/3					
Output current out of range	The current is outside of the permissible range.[1)]	2323_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules

Designa-tion	Meaning	Byte 0/1 Error Code	Byte 2 Error Register	Byte 3 Extra info	Byte 4 Additional infor-mation
Load dumps at outputs	Open circuit or current too low (threshold: positive converter limit value)	2330_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
Output current too high	Current too high (threshold: approx. 5 Ω; only with tempera-ture measuring ranges)	2310_{hex}	Bit 1 = 1 (current error)	Module number	Channel numbers for the 2-channel modules
XN-2AI-THERMO-PI					
AI U voltage out of range	Open circuit or input voltage is outside of the permissible range.	3003_{hex}	Bit 2 = 1 (voltage error)	Module number	Channel numbers for the 2-channel modules

1) The threshold for this error message is 1% over the upper measuring range value or 1 % below the lower measuring range value.
Refer to the sections “Diagnostic messages” from → page 73 onward for information on the diagnostic options for each module type .

Bytes 5, 6, 7 of the Emergency Frame are not used, and therefore always 0.

6 Integration in DeviceNet

Analog Input Voltage Module Class (VSC106)

This class contains all the information and parameters of the analog input modules (voltage).

Table 72: Class Instance

Attribute No. dec.	hex	Attribute Name	Access	Type	Description
100	64_{hex}	CLASS REVISION	G	UINT	Contains the revision number for this class (Maj.-Rel. * 1000 + Min.-Rel.).
101	65_{hex}	MAX INSTANCE	G	USINT	Contains the number of the highest instance of an object created at this level in the class hierarchy.
102	66_{hex}	# OF INSTANCES	G	USINT	Contains the number of object instances created at this class level.
103	67_{hex}	MAX CLASS ATTR	G	USINT	Contains the number of the last class attribute that was implemented.

Table 73: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
100 (64_{hex})	MAX OBJECT ATTR	G	USINT	Contains the number of the last object attribute that was implemented.
101 (65_{hex})	MODULE PRESENT	G	BOOL	FALSE: XI/ON module is not inserted, vacant base module TRUE: XI/ON module is inserted

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
102 (66_{hex})	TERMINAL SLOT NUMBER	G	USINT	The slot number of the base module belonging to the module concerned (base module directly to the right of the gateway, = No. 1) corresponds to the instance number within the TERMINAL SLOT CLASS.
103 (67_{hex})	MODULE ID	G	DWORD	Contains the module ID.
104 (68_{hex})	MODULE ORDER NUMBER	G	UDINT	Contains the order number for the module, e.g. 225000.
105 (69_{hex})	MODULE ORDER NAME	G	SHORT_ STRING	Contains the module name, e.g. XN-1AI-U(-10/0..+10VDC).
106 ($6A_{hex}$)	MODULE REVISION	G	USINT	Contains the revision number of the module firmware.
107 ($6B_{hex}$)	MODULE TYPE ID	G	ENUM USINT	Provides information on the module type: 0 (00_{hex}) unknown module type 1 (01_{hex}) digital I/O module 17 (11_{hex}) analog module I/O voltage 18 (12_{hex}) analog module I/O current (current/voltage) 19 (13_{hex}) analog module PT temperature 20 (14_{hex}) analog module thermo temperature 33 (21_{hex}) 16-bit counter module 34 (22_{hex}) 32-bit counter module 40 (28_{hex}) SSI module 49 (31_{hex}) Motor starter module as DOL or reversing starter 50 (32_{hex}) electronic motor starter 65 (41_{hex}) RS232 module 66 (42_{hex}) RS485/422 module 67 (43_{hex}) TTY module

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
108 ($6C_{hex}$)	MODULE COMMAND INTERFACE	G/S	ARRAY	Control interface of the XI/ON module. ARRAY OF: BYTE: control byte sequence
109 ($6D_{hex}$)	MODULE RESPONSE INTERFACE	G	ARRAY	Message interface for the XI/ON module. ARRAY OF: BYTE: message byte sequence
110 ($6E_{hex}$)	MODULE REGIS-TERED INDEX	G	ENUM USINT	Contains the index number found in all module lists.
111 ($6F_{hex}$)	NUMBER OF SUPPORTED CHANNELS	G	USINT	Indicates the number of analog input channels supported by this module instance.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
112 – 119 (70 – 77_{hex}	PRODUCED DATA	G	INT	Contains the data of channels 1 – 8 transmitted from the analog input module. The calculation of the measured values for the numerical value of the analog voltage inputs has already been described fully: **16-bit representation** → “Representation of the voltage values in the range 0 V DC – 10 V DC” page 46 → “Representation of the voltage values in the range –10 V DC – 10 V DC” page 48 **12-bit representation:** → “Representation of the voltage values in the range 0 V DC – 10 V DC” page 67 → “Representation of the voltage values in the range –10 V DC – 10 V DC” page 69 The diagnostics data is integrated in the input data with 12-bit (left-justified) representation. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
120 – 127 (78 – $7F_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data for channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit0: 0 = ok, 1 = Measurement value range error Bit1 – 7:reserved
128 – 135 (80 – 87_{hex})	MODE PARAM-ETER DATA	G/S	BYTE	Contains the parameter data for channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Voltage mode: 0 = 0 ... 10 V 1 = -10 ... +10 V Bit1: Value representation: 0 = Integer (15-bit + sign) 1 = 12-bit (left-justified) → "Representation of the analog values" page 28 Bit2: Diagnostic: 0 = release 1 = block Bit3 – 7:reserved

Analog Output Voltage Module Class (VSC107)

This class contains all the information and parameters of the analog output modules (voltage).

Table 74: Class Instance

Attribute No. dec.	HEX	Attribute Name	Access	Type	Description
100	64_{hex}	CLASS REVISION	G	UINT	Contains the revision number for this class (Maj.-Rel. * 1000 + Min.-Rel.).
101	65_{hex}	MAX INSTANCE	G	USINT	Contains the number of the highest instance of an object created at this level in the class hierarchy.
102	66_{hex}	# OF INSTANCES	G	USINT	Contains the number of object instances created at this class level.
103	67_{hex}	MAX CLASS ATTR	G	USINT	Contains the number of the last class attribute that was implemented.

Table 75: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
100 (64_{hex})	MAX OBJECT ATTR	G	USINT	Contains the number of the last object attribute that was implemented.
101 (65_{hex})	MODULE PRESENT	G	BOOL	FALSE: XI/ON module is not inserted, vacant base module TRUE: XI/ON module is inserted
102 (66_{hex})	TERMINAL SLOT NUMBER	G	USINT	The slot number of the base module belonging to the module concerned (base module directly to the right of the gateway = No. 1). Corresponds to the particular instance number within the TERMINAL SLOT CLASS.
103 (67_{hex})	MODULE ID	G	DWORD	Contains the module ID.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
104 (68_{hex})	MODULE ORDER NUMBER	G	UDINT	Contains the order number for the module, e.g. 225000.
105 (69_{hex})	MODULE ORDER NAME	G	SHORT_ STRING	Contains the module name, e.g. XN-2AO-U(-10/0..+10VDC).
106 ($6A_{hex}$)	MODULE REVISION	G	USINT	Contains the revision number of the module firmware.
107 ($6B_{hex}$)	MODULE TYPE ID	G	ENUM USINT	Provides information on the module type: 0 (00_{hex}) unknown module type 1 (01_{hex}) digital I/O module 17 (11_{hex}) analog module I/O voltage 18 (12_{hex}) analog module I/O current (current/voltage) 19 (13_{hex}) analog module PT temperature 20 (14_{hex}) analog module thermo temperature 33 (21_{hex}) 16-bit counter module 34 (22_{hex}) 32-bit counter module 40 (28_{hex}) SSI module 49 (31_{hex}) Motor starter module as DOL or reversing starter 50 (32_{hex}) electronic motor starter 65 (41_{hex}) RS232 module 66 (42_{hex}) RS485/422 module 67 (43_{hex}) TTY module
108 ($6C_{hex}$)	MODULE COMMAND INTERFACE	G/S	ARRAY	Control interface of the XI/ON module. ARRAY OF: BYTE: control byte sequence
109 ($6D_{hex}$)	MODULE RESPONSE INTERFACE	G	ARRAY	Message interface for the XI/ON module. ARRAY OF: BYTE: message byte sequence

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
110 ($6E_{hex}$)	MODULE REGIS-TERED INDEX	G	ENUM USINT	Contains the index number found in all module lists.
111 ($6F_{hex}$)	NUMBER OF SUPPORTED CHANNELS	G	USINT	Indicates the number of analog output channels supported by this module instance.
112 – 119 ($70 – 77_{hex}$)	CONSUMED DATA	G/S	INT	Contains the data for the analog output channels no. 1 – 8. The calculation of the numerical values for the voltage values has already been described fully: **16-bit representation** → “Representation of the voltage values in the range 0 – 10 V DC” page 132 → “Representation of the voltage values in the range –10 V DC – 10 V DC” page 48 **12-bit representation:** → “Representation of the voltage values in the range 0 – 10 V DC” page 141 → “Representation of the voltage values in the range -10 V DC – 10 V DC” page 143 Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
120 – 127 (78 – $7F_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data of channel 1 – 8 of the analog output module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit 0 – 7:reserved
128 – 135 (80 – 87_{hex})	MODE PARAM-ETER DATA	G/S	BYTE	Contains the parameter data of channel 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Voltage mode: 0 = 0 ... 10 V 1 = -10 ... +10 V Bit1:Value representation: 0 = Integer (15-bit + sign) 1 = 12-bit (left-justified) Bit2 – 7:reserved
136 – 143 (88 – $8F_{hex}$)	FAULT VALUE PARAM-ETER DATA	G/S	INT	Contains the fault value definition of channels 1 to 8 of the analog output module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 136 contains the data for channel 1, attribute 143 for channel 8.

Analog Input Current Module Class (VSC108)

This class contains all the information and parameters of the analog input modules (current).

Class Instance

The class instance attributes of the analog input modules (current) are the same as those of the analog input modules (voltage).

Object Instances

The instances/attribute objects of the analog input modules (current) are the same as those of the analog input modules (voltage). Only the attributes concerning the measuring ranges of the module (current and voltage measurement) are different.

Table 76: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
112 – 119 (70_{hex} – 77_{hex})	PRODUCED DATA	G	INT	Contains the data of channels 1 to 8 transmitted from the analog input module. The calculation of the measured values for the numerical value of the analog current inputs has already been described fully: **16-bit representation** → "Representation of current values in the range 0 mA – 20 mA" page 30 → "Representation of current values in the range 4 mA – 20 mA" page 32 **12-bit representation** → "Representation of the current values in the range 0 – 20 mA" page 51 → "Representation of the current values in the range 4 – 20 mA" page 53 The diagnostics data is integrated in the input data with 12-bit (left-justified) representation. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
120 – 127 (78 – $7F_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data of channels 1 to 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit0: 0 = ok 1 = Measurement value range error Bit1: 0 = ok 1 = Open circuit; Only with measuring range: 4 – 20 mA Bit2 – 7:reserved
128 – 135 (80 – 87_{hex})	MODE PARAM-ETER DATA	G/S	BYTE	Contains the parameter data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Current mode: 0 = 0 – 20 mA 1 = 4 – 20 mA Bit1: Value representation: 0 = Integer (15-bit + sign) 1 = 12-bit (left-justified) Bit2: Diagnostic: 0 = release 1 = block Bit 3 – 7: reserved

Analog Output Current Module Class (VSC109)

This class contains all the information and parameters of the analog output modules (current).

Class Instance

The class instance attributes of the analog output modules (current) are the same as those of the analog output modules (voltage).

Object Instances

The instance/attribute object of the analog output modules (current) is the same as those of the analog output modules (voltage). Only the attributes to do with the measuring ranges of the module (current and voltage measurement) are different.

Table 77: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
112 – 119 (70 – 77$_{hex}$	CONSUMED DATA	G/S	INT	Contains the data for the analog output channels 1 – 8. The calculation of the numerical values for the current values has already been described fully: **16-bit representation** → “Representation of the current values in the range 0 – 20 mA” page 128 → “Representation of the current values in the range 4 – 20 mA” page 130 **12-bit representation** → “Representation of the current values in the range 0 – 20 mA” page 137 → “Representation of the current values in the range 4 mA – 20 mA” page 139 Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.
120 – 127 (78 – 7F$_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data of channels 1 – 8 of the analog output module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit0 – 7:reserved

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
128 – 135 (80 – 87_{hex})	MODE PARAM- ETER DATA	G/S	BYTE	Contains the parameter data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Current mode 0 = 0 – 20 mA 1 = 4 – 20 mA Bit1: Value representation 0 = Integer (15-bit + sign) 1 = 12-bit (left-justified) Bit2 – 7:reserved
112 – 119 (70 – 77_{hex}	FAULT VALUE PARAM- ETER DATA	G/S	INT	Contains the fault value definition of channels 1 – 8 of the analog output module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 136 contains the data for channel 1, attribute 143 for channel 8.

Analog Input PT100/NI Module Class (VSC110)

This class contains all the information and parameters of the analog input modules for PT100/NI sensors.

Class Instance

The class instance attributes of the analog input modules are the same as those of the analog input modules (voltage).

Table 78: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
100 (64_{hex})	MAX OBJECT ATTR	G	USINT	Contains the number of the last object attribute that was implemented.
101 (65_{hex})	MODULE PRESENT	G	BOOL	FALSE: XI/ON module is not inserted, vacant base module TRUE: XI/ON module is inserted
102 (66_{hex})	TERMINAL SLOT NUMBER	G	USINT	The slot number of the base module belonging to the module concerned (base module directly to the right of the gateway = No. 1). Corresponds to the particular instance number within the TERMINAL SLOT CLASS.
103 (67_{hex})	MODULE ID	G	DWORD	Contains the module ID.
104 (68_{hex})	MODULE ORDER NUMBER	G	UDINT	Contains the order number for the module, e.g. 225000.
105 (69_{hex})	MODULE ORDER NAME	G	SHORT_ STRING	Contains the module name, e.g. XN-2AI-PT/NI-2/3.
106 ($6A_{hex}$)	MODULE REVISION	G	USINT	Contains the revision number of the module firmware.
107 ($6B_{hex}$)	MODULE TYPE ID	G	ENUM USINT	Describes the module type (digital, analog, counter ...).

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
108 (6C$_{hex}$)	MODULE COMMAND INTERFACE	G/S	ARRAY	Control interface of the XI/ON module. ARRAY OF: BYTE: control byte sequence
109 (6D$_{hex}$)	MODULE RESPONSE INTERFACE	G	ARRAY	Message interface for the XI/ON module. ARRAY OF: BYTE: message byte sequence
110 (6E$_{hex}$)	MODULE REGIS-TERED INDEX	G	ENUM USINT	Contains the index number found in all module lists.
111 (6F$_{hex}$)	NUMBER OF SUPPORTED CHANNELS	G	USINT	Indicates the number of analog input channels supported by this module instance.
112 – 119 (70 – 77$_{hex}$)	PRODUCED DATA	G	INT	Contains the data of channels 1 – 8 transmitted from the analog input module. The calculation of the measured values for the numerical value of the analog PT100/NI sensor inputs has already been described fully: **16-bit representation** → "Representation of temperature values and resistance values for the XN-2AI-PT/NI-2/3" page 34 12-bit representation → "Representation of temperature values and resistance values for the XN-2AI-PT/NI-2/3" page 55 The diagnostics data is integrated in the input data with 12-bit (left-justified) representation. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
120 – 127 (78 – $7F_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit0: 0 = ok 1 = Measurement value range error Bit1: 0 = ok 1 = open circuit Bit2: 0 = ok 1 = short-circuit

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
128 – 135 (80 – 87_{hex})	MODE PARAM- ETER DATA	G/S	BYTE	Contains the parameter data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Mains suppression 0 = 50 Hz (50 Hz mains suppression) 1 = 60 Hz (60 Hz mains suppression) Bit1: Value representation: 0 = Integer (15-bit + sign) 1 = 12-bit (left-justified) Bit2: Diagnostic: 0 = release 1 = block Bit 3: Channel: 0 = activate channel 1 = deactivate channel Bit 4: Measuring mode: 0 = 2-wire 1 = 3-wire Bit 5 – 7:reserved

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
136 – 143 (88 – $8F_{hex}$)	SENSOR PARAM-ETER DATA	G/S	ENUM USINT	Contains the sensor parameter data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 136 contains the data for channel 1, attribute 143 for channel 8. ENUM USINT: Element: 0: PT100, -200..850 °C 1: PT100, -200..150 °C 2: NI100, -60..250 °C 3: NI100, -60..150 °C 4: PT200, -200..850 °C 5: PT200, -200..150 °C 6: PT500, -200..850 °C 7: PT500, -200..150 °C 8: PT1000, -200..850 °C 9: PT1000, -200..150 °C 10: NI1000, -60..250 °C 11: NI1000, -60..150 °C 12: resistance: 0..100Ω (resistance: 0..100Ω) 13: resistance: 0..200Ω 14: resistance: 0..400Ω 15: resistance: 0..1000Ω 16 – 255: reserved

Analog Input THERMO Module Class (VSC111)

This class contains all the information and parameters of the analog input modules for thermocouples.

Class Instance

The class instance attributes of the analog input modules are the same as those of the analog input modules (voltage).

Table 79: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
100 (64_{hex})	MAX OBJECT ATTR	G	USINT	Contains the number of the last object attribute that was implemented.
101 (65_{hex})	MODULE PRESENT	G	BOOL	FALSE: XI/ON module is not inserted, vacant base module TRUE: XI/ON module is plugged in
102 (66_{hex})	TERMINAL SLOT NUMBER	G	USINT	The slot number of the base module belonging to the module concerned (base module directly to the right of the gateway = No. 1). Corresponds to the particular instance number within the TERMINAL SLOT CLASS.
103 (67_{hex})	MODULE ID	G	DWORD	Contains the module ID.
104 (68_{hex})	MODULE ORDER NUMBER	G	UDINT	Contains the order number for the module, e.g. 225000.
105 (69_{hex})	MODULE ORDER NAME	G	SHORT_ STRING	Contains the module name, e.g. XN-2AI-THERMO-PI.
106 ($6A_{hex}$)	MODULE REVISION	G	USINT	Contains the revision number of the module firmware.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
107 ($6B_{hex}$)	TYPE ID	G	ENUM USINT	Provides information on the module type: 0 (00_{hex}) unknown module type 1 (01_{hex}) digital I/O module 17 (11_{hex}) analog module I/O voltage 18 (12_{hex}) analog module I/O current (current/voltage) 19 (13_{hex}) analog module PT temperature 20 (14_{hex}) analog module thermo temperature 33 (21_{hex}) 16-bit counter module 34 (22_{hex}) 32-bit counter module 40 (28_{hex}) SSI module 49 (31_{hex}) Motor starter module as DOL or reversing starter 50 (32_{hex}) electronic motor starter 65 (41_{hex}) RS232 module 66 (42_{hex}) RS485/422 module 67 (43_{hex}) TTY module
108 ($6C_{hex}$)	MODULE COMMAND INTERFACE	G/S	ARRAY	Control interface of the XI/ON module. ARRAY OF: BYTE: control byte sequence
109 ($6D_{hex}$)	MODULE RESPONSE INTERFACE	G	ARRAY	Message interface for the XI/ON module. ARRAY OF: BYTE: message byte sequence
110 ($6E_{hex}$)	MODULE REGIS-TERED INDEX	G	ENUM USINT	Contains the index number found in all module lists.
111 ($6F_{hex}$)	NUMBER OF SUPPORTED CHANNELS	G	USINT	Indicates the number of analog input channels supported by this module instance.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
112 – 119 (70 – 77_{hex})	PRODUCED DATA	G	INT	Contains the data of channels 1 – 8 transmitted from the analog input module. The calculation of the measured values for the numerical value of the analog inputs of the XN-2AI-THERMO-PI has already been described fully: **16-bit representation** → "Representation of temperature and voltage values for the XN-2AI-THERMO-PI" page 40 **12-bit representation** → "Representation of temperature and voltage values for the XN-2AI-THERMO-PI" page 61 The diagnostics data is integrated in the input data with 12-bit (left-justified) representation. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 112 contains the data for channel 1, attribute 119 for channel 8.
120 – 127 (78 – $7F_{hex}$)	DIAG DATA	G	BYTE	Contains the diagnostics data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 120 contains the data for channel 1, attribute 127 for channel 8. BYTE diag: Bit0: 0 = ok 1 = Measurement value rang error Bit1: 0 = ok 1 = open circuit

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
128 – 135 (80 – 87_{hex})	MODE PARAM-ETER DATA	G/S	BYTE	Contains the parameter data for channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 128 contains the data for channel 1, attribute 135 for channel 8. BYTE mode: Bit0: Mains suppression: 0 = 50 Hz (50 Hz mains suppression) 1 = 60 Hz (60 Hz mains suppression) Bit1: Value representation: 0 = Integer (15-bit + sign) 1 =12-bit (left-justified) Bit2: Diagnostic: 0 = release 1 = block Bit 3: Channel: 0 = activate channel 1 = deactivate channel Bit 4 – 7:reserved

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
136 – 143 (88 – $8F_{hex}$)	SENSOR PARAM-ETER DATA	G/S	ENUM USINT	Contains the sensor parameter data of channels 1 – 8 of the analog input module. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 136 contains the data for channel 1, attribute 143 for channel 8. ENUM USINT Element: 0: Type K -270...1370 °C 1: Type B 100...1820 °C 2: Type E -270...1000 °C 3: Type J -210...1200 °C 4: Type N -270...1300 °C 5: Type R -50...1760 °C 6: Type S -50...1540 °C 7: Type T -270...400 °C 8: +/-50 mV 9: +/-100 mV 10: +/-500 mV 11: +/-1000 mV 12 – 255: reserved

Analog VERSATILE Module Class (VSC118)

This class contains all the information and parameters of analog modules with inputs and outputs. The inputs can be set for both current and voltage measurement. The outputs can be set as a current output and voltage output.

The XN-4AI-U/I is currently being commissioned with this class.

Class Instance

The class instance attributes of the analog input modules are the same as those of the analog input modules (voltage).

Table 80: Object Instances

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
100 (64_{hex})	MAX OBJECT ATTR	G	USINT	Contains the number of the last object attribute that was implemented.
101 (65_{hex})	MODULE PRESENT	G	BOOL	FALSE: XI/ON module is not inserted, vacant base module TRUE: XI/ON module is inserted
102 (66_{hex})	TERMINAL SLOT NUMBER	G	USINT	The slot number of the base module belonging to the module concerned (base module directly to the right of the gateway = No. 1). Corresponds to the particular instance number within the TERMINAL SLOT CLASS.
103 (67_{hex})	MODULE ID	G	DWORD	Contains the module ID.
104 (68_{hex})	MODULE ORDER NUMBER	G	UDINT	Contains the order number for the module, e.g. 225000.
105 (69_{hex})	MODULE ORDER NAME	G	SHORT_ STRING	Contains the module name, e.g. XN-2AO-U(-10/0..+10VDC).
106 ($6A_{hex}$)	MODULE REVISION	G	USINT	Contains the revision number of the module firmware.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
107 ($6B_{hex}$)	MODULE TYPE ID	G	ENUM USINT	Provides information on the module type: 0 (00_{hex}) unknown module type 1 (01_{hex}) digital I/O module 17 (11_{hex}) analog module I/O voltage 18 (12_{hex}) analog module I/O current (current/voltage) 19 (13_{hex}) analog module PT temperature 20 (14_{hex}) analog module thermo temperature 33 (21_{hex}) 16-bit counter module 34 (22_{hex}) 32-bit counter module 40 (28_{hex}) SSI module 49 (31_{hex}) Motor starter module as DOL or reversing starter 50 (32_{hex}) electronic motor starter 65 (41_{hex}) RS232 module 66 (42_{hex}) RS485/422 module 67 (43_{hex}) TTY module
108 ($6C_{hex}$)	MODULE COMMAND INTERFACE	G/S	ARRAY	Control interface of the XI/ON module. ARRAY OF: BYTE: control byte sequence
109 ($6D_{hex}$)	MODULE RESPONSE INTERFACE	G	ARRAY	Message interface for the XI/ON module. ARRAY OF: BYTE: message byte sequence
110 ($6E_{hex}$)	MODULE REGISTERED INDEX	G	ENUM USINT	Contains the index number found in all module lists.
111 ($6F_{hex}$)	INPUT CHANNEL COUNT	G	USINT	Indicates the number of analog input channels supported by this module instance.
112 (70_{hex})	OUTPUT CHANNEL COUNT	G	USINT	Indicates the number of analog output channels supported by this module instance.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
113 – 128 (71_{hex} – 80_{hex})	INPUT UINT CHANNEL 1 to INPUT UINT CHANNEL 16	G/S	UINT	Contains the data of channel nos. 1 to 16 received by the analog input module. The calculation of the measured values for the numerical value of the analog voltage inputs and analog current inputs has already been described fully: **16-bit representation** → "Representation of the voltage values in the range 0 V DC – 10 V DC" page 46 → "Representation of the voltage values in the range –10 V DC – 10 V DC" page 48 → "Representation of current values in the range 0 mA – 20 mA" page 30 → "Representation of current values in the range 4 mA – 20 mA" page 32 **12-bit representation** → "Representation of the voltage values in the range 0 V DC – 10 V DC" page 67 → "Representation of the voltage values in the range –10 V DC – 10 V DC" page 69 → "Representation of the current values in the range 0 – 20 mA" page 51 → "Representation of the current values in the range 4 – 20 mA" page 53 The diagnostics data is integrated in the input data with 12-bit (left-justified) representation. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 129 contains the data for channel 1, 144 for channel 16.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
129 – 144 (81_{hex} – 90_{hex})	OUTPUT UINT CHANNEL 1 to OUTPUT UINT CHANNEL 16	G/S	UINT	Contains the data for the analog output channels no. 1 – no. 16. Only those channels are supported that are defined in attribute 111, NUMBER OF SUPPORTED CHANNELS. Attribute 113 contains the data for channel 1, attribute 118 for channel 16.
145 (91_{hex})	RANGE ERROR	G	WORD	Maps the diagnostics data for "measurement value range error" of channels 1 to 16 of the analog input module to bits 0 to 15 of the WORD data type. The diagnostics are generated for an overcurrent or undercurrent of 1% the set current range. The undercurrent can only be detected on modules with a set current range of 4 – 20 mA. Overcurrent:Imax (I > 20.2 mA) Undercurrent:Imin (I < 3.8 mA) Diagnostic of an overvoltage or undervoltage of 1% of the set voltage range. Overvoltage: Umax (U > 10.1 V DC); Undervoltage: Umin (U < -10.1 V DC) for -10 – +10 V DC Umin (U < -0.1 V DC) for 0 – 10 V DC Only those channels are supported that are defined in attributes 111 and 112, NUMBER OF SUPPORTED CHANNELS.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
146 (92_{hex})	OPEN CIRCUIT ERROR	G	WORD	Maps the diagnostics data for "open circuit" of channels 1 to 16 of the analog input module to bits 0 to 15 of the WORD data type. The indication of an open circuit of the connection cable for operating mode “4 to 20 mA”.
147 (93_{hex})	SHORT CIRCUIT ERROR	G	WORD	Maps the diagnostics data for "short-circuit" of channels 1 to 16 of the analog input module to bits 0 to 15 of the WORD data type. The XN-4AI-U/I does not generate this diagnostic type.
148 (94_{hex})	reserved			
149 – 164 (94 – $A4_{hex}$)	PARAM FAULT VALUE UINT CHANNEL 1 to PARAM FAULT VALUE UINT CHANNEL 16	G/S	UINT	Defines the substitute values for the analog output channels 1 – 16 of a station. The substitute value is used in the event of a communication error or other unrecoverable error. Analog input channels do not use this attribute.

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
165 – 180 (A5 – $B4_{hex}$)	PARAM OPERATING MODE CHANNEL 1 to PARAM OPERATING MODE CHANNEL 16	G/S	ENUM USINT	Each attribute of this group defines a parameter for a channel. Up to 16 channels can be parameterised. The rule is: 0: The channel is deactivated. 1: The channel is parameterised for the measuring range –10 V DC to 10 V DC. 2: The channel is parameterised for the measuring range 0 V DC to 10 V DC. 3: The channel is parameterised for the measuring range 0 mA to 20 mA. 4: The channel is parameterised for the measuring range 4 mA to 20 mA. 5 – 255: reserved

Attr. no. dec. (hex.)	Attribute Name	Access	Type	Description
181 – 196 (B5 – $C4_{hex}$)	PARAM DATA REPRESENTA-TION MODE CHANNEL 1 to PARAM DATA REPRESENTA-TION MODE CHANNEL 16	G/S	ENUM USINT	Each attribute of this group defines a parameter for a channel. Up to 16 channels can be parameterised. The rule is: 0: The default value is used for the representation of the channel values. 1: The channel values are represented with 16 bits in two's complement notation. 2: The channel values are represented with 12 bits. If the parameterised range of values also includes negative values, all values are represented in two's complement notation. If only positive values are set as permissible values, these are represented as uncoded binary values.
197 ($C5_{hex}$)	PARAM BLOCK DIAG-NOSTICS	G/S	WORD	Each bit of this WORD data type allows the individual activation/deactivation of diagnostics for each channel. Up to 16 channels can be parameter-ised: The messages are always available if the diagnostic message is integrated with the 12-bit representation in the process input data. 0: Diagnostic signalling is activated (default) 1:Diagnostic signalling is deactivated.