X67AT1311

1 General information

The module is a temperature module for PT100 resistance temperature sensors. The sensors can be connected using 2-wire or 4-wire connections.

- 4 inputs for resistance temperature measurement with 3 different resolutions
- Additional direct resistance measurement with 2 different resolutions
- Configuration can be set for each channel
- 2-wire and 4-wire measurement

2 Order data

Model number	Short description	Figure
	Temperature modules	
X67AT1311	X67 temperature input module, 4 inputs for resistance measurement, 2-wire or 4-wire measurement, PT100, resolution 0.01 K	

Table 1: X67AT1311 - Order data

Required accessories
For a general overview, see section "Accessories - General overview" of the X67 system user's manual.

3 Technical data

Model number	X67AT1311
Short description	
I/O module	4 inputs for PT100 or resistance measurement
General information	
B&R ID code	0xD21B
Status indicators	I/O function for each channel, supply voltage, bus function
Diagnostics	
Inputs	Yes, using status LED and software
I/O power supply	Yes, using status LED and software
Connection type	
X2X Link	M12, B-keyed
Inputs	4x M12, A-keyed
I/O power supply	M8, 4-pin
Power consumption	
Internal I/O	1.5 W
X2X Link power supply	0.75 W
Certifications	
CE	Yes
EAC	Yes
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
ATEX	Zone 2, II 3G Ex nA IIA T5 Gc IP67, Ta = 0 - Max. 60°C TÜV 05 ATEX 7201X
I/O power supply	
Nominal voltage	24 VDC
Voltage range	18 to 30 VDC
Integrated protection	Reverse polarity protection
Resistance measurement temperature inputs	
Input	Resistance measurement with constant current supply for 2-wire or 4-wire connections
Digital converter resolution	16-bit
Filter time	Configurable between 2 and 20 ms
Conversion time	
Same sensor types	75 ms per channel with 50 Hz filter
Conversion procedure	Sigma-delta
Output format	INT or UINT for resistance measurement
Sensor	
PT100	-200 to 270°C (at 0.01 K resolution) -200 to 645°C (at 0.02 K resolution) -200 to 850°C (at 0.04 K resolution)
PT100 temperature measurement range	Configurable per channel
Resistance measurement range	0.010 to 420 Ω / 0.005 to 210 Ω
Sensor standard	EN 60751
Common-mode range	±1 VDC
Isolation voltage between channel and bus	500 V_{eff}
Linearization method	Software
Measurement current	1.014 mA ±1.25%
Reference	422 Ω ±0.05%
Permissible input signal	Short-term max. ±30 V
Max. error at 25°C	
Gain	0.008% [1]
Offset	0.012% [2]
Max. gain drift	0.0008% / °C [1]
Max. offset drift	0.0006% / °C [2]
Nonlinearity	<0.002% [2]
Crosstalk between channels	-70 dB
Temperature sensor resolution [3]	
PT100	1 LSB = 0.01 K (up to 270°C) 1 LSB = 0.02 K (up to 645°C) 1 LSB = 0.04 K (up to 850°C)
Resistance measurement resolution	
Measurement range up to 420 Ω	1 LSB = 10 mΩ
Measurement range up to 210 Ω	1 LSB = 5 mΩ
Input filter	
Cutoff frequency	115 Hz / Filter 1st order
Slope	-20 dB

Table 2: X67AT1311 - Technical data

Model number	X67AT1311
Common-mode rejection	
50 Hz	>70 dB
DC	>70 dB
Temperature measurement monitoring	
Range undershoot	0x8001
Range overshoot	0x7FFF
Open circuit	0x7FFF
General error	0x8000
Open inputs	0x7FFF
Resistance measurement monitoring	
Range undershoot	0x0000
Range overshoot	0xFFFF
Open circuit	0xFFFF
General error	0xFFFF
Open inputs	0xFFFF
Electrical properties	
Electrical isolation	Channel isolated from bus Channel not isolated from channel
Operating conditions	
Mounting orientation	
Any	Yes
Installation elevation above sea level	
0 to 2000 m	No limitations
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP67
Ambient conditions	
Temperature	
Operation	-25 to 60°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Mechanical properties	
Dimensions	
Width	53 mm
Height	85 mm
Depth	42 mm
Weight	205 g
Torque for connections	
M8	Max. 0.4 Nm
M12	Max. 0.6 Nm

Table 2: X67AT1311 - Technical data

1) Based on the current resistance value.
2) Based on the entire resistance measurement range.
3) Based on the full converter resistance measurement resolution without correcting calculation

4 LED status indicators

Figure	LED	Description		
Status indicator 1: Left: Green, Right: Red  Status indicator 2: Left: Green, Right: Red	Status indicator 1	Status indicator - X2X Link.		
		Green	Red	Description
		Off	Off	No supply via X2X Link
		On	Off	X2X Link supplied, communication OK
		Off	On	X2X Link supplied, but X2X Link communication is not functioning
		On	On	PREOPERATIONAL: X2X Link supplied, module not initialized
	1 - 4	Status display of the corresponding analog input		
		LED	Status	Description
		Green	On	The A/D converter returns valid values.
			Blinking	Overflow, underflow or open circuit
			Off	The input is switched off
	Status indicator 2	Status indicator for module function.		
		LED	Status	Description
		Green	Off	No power to module
			Single flash	RESET mode
			Blinking	PREOPERATIONAL mode
			On	RUN mode
		Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning/Error on an I/O channel. Overflow or underflow of the analog inputs.
			Double flash	Supply voltage not in the valid range

5 Connection elements

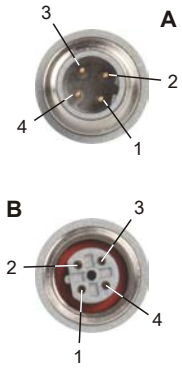
X2X Link
Connection A: Input
Connection B: Output

Analog inputs 1 to 4

24 VDC I/O power supply
Connection C: Supply
Connection D: Routing

6 X2X Link

This module is connected to X2X Link using pre-assembled cables. The connection is made using M12 circular connectors.

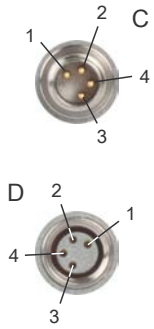
Connection	Pinout	
	**Pin**	**Description**
	1	X2X+
	2	X2X
	3	X2X⊥
	4	X2X\
	Shield connection made via threaded insert in the module. A → B-keyed (male), input B → B-keyed (female), output	

7 24 VDC I/O power supply

The I/O power supply is connected via M8 connectors C and D. The I/O power supply is connected via connector C (male). Connector D (female) is used to route the I/O power supply to other modules.

Information:

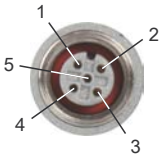
The maximum permissible current for the I/O power supply is 8 A (4 A per connection pin)!

Connection	Pinout	
	**Pin**	**Description**
	1	24 VDC
	2	24 VDC
	3	GND
	4	GND
	C → Connector (male) in module, feed for I/O power supply D → Connection (female) in module, routing of I/O power supply	

8 Pinout

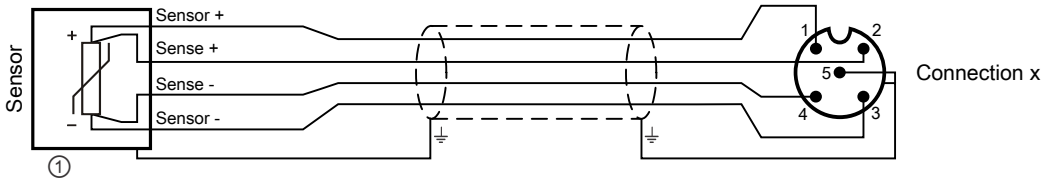
① X67CA0A41.xxxx: M12 sensor cable, straight
X67CA0A51.xxxx: M12 sensor cable, angled

8.1 Connections X1 to X4

M5, 5-pin	Pinout	
Connections 1/2	**Pin**	**Name**
	1	Sensor +
	2	Sense +
	3	Sensor -
	4	Sense -
	5	Shield[1)]
	1) Shielding also provided by threaded insert in the module.	
Connections 3/4	X1 to X4 → A-keyed (female), input	

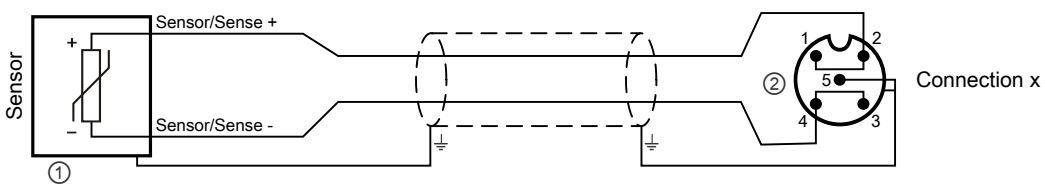
9 Connection examples

4-wire connections



① Braided shield, twisted wires

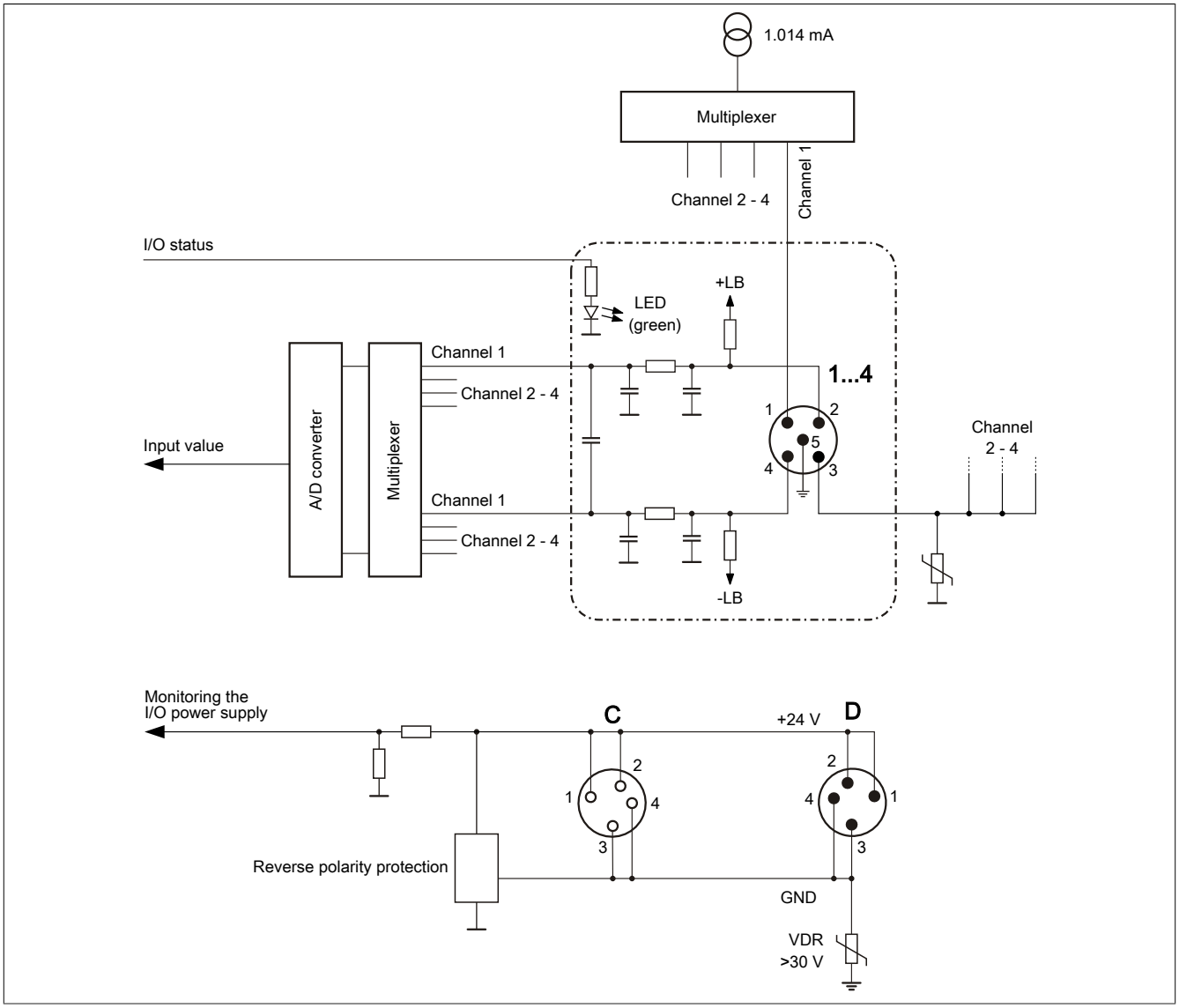
2-wire connections



① Braided shield, twisted wires

② **Pins 1 + 2 and 3 + 4 must be connected in the connector!**

10 Input circuit diagram



11 Register description

11.1 General data points

In addition to the registers listed in the register description, the module also has other more general data points. These registers are not specific to the module but contain general information such as serial number and hardware version.

These general data points are listed in section "Additional information - General data points" of the X67 system user's manual.

11.2 Function model 0 - Standard

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
16	ConfigOutput01 (input filter)	USINT				•
18	ConfigOutput02 (measurement range and channel selection)	UINT				•
Communication						
0	Temperature01	INT	•			
	Resistor01	UINT				
2	Temperature02	INT	•			
	Resistor02	UINT				
4	Temperature03	INT	•			
	Resistor03	UINT				
6	Temperature04	INT	•			
	Resistor04	UINT				
30	StatusInput01	USINT	•			
8192	asy_ModulID	UINT		•		
8196	asy_SupplyStatus	USINT		•		
8208	asy_SupplyInput	USINT		•		

11.3 Function model 254 - Bus controller

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
16	-	ConfigOutput01 (input filter)	USINT				•
18	-	ConfigOutput02 (measurement range and channel selection)	UINT				•
Communication							
0	0	Temperature01	INT	•			
		Resistor01	UINT				
2	2	Temperature02	INT	•			
		Resistor02	UINT				
4	4	Temperature03	INT	•			
		Resistor03	UINT				
6	6	Temperature04	INT	•			
		Resistor04	UINT				
30	-	StatusInput01	USINT		•		
8192	-	asy_ModulID	UINT		•		
8196	-	asy_SupplyStatus	USINT		•		
8208	-	asy_SupplyInput	USINT		•		

1) The offset specifies the position of the register within the CAN object.

11.3.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use additional registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" of the X67 user's manual (version 3.30 or later).

11.3.2 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

11.4 General information - Conversion cycle

All pending signals from enabled inputs are converted to digital values in every conversion cycle.

Unnecessary inputs can be disabled to reduce the I/O update time. Inputs can also be disabled temporarily if they are not needed for a certain amount of time.

The conversion time needed for an individual input is calculated using the following formula:

$$3 \times \frac{1}{filter\ frequency} + 15\ ms$$

The time saved per disabled input depends on the selected filter:

Filter frequency	Filter time	Time saved per input	Digital converter resolution
50 Hz	20 ms	75 ms	16-bit
60 Hz	16.67 ms	65 ms	16-bit
250 Hz	4 ms	27 ms	13-bit
500 Hz	2 ms	21 ms	10-bit

Example

Inputs are filtered using a 50 Hz filter.

	Example 1	Example 2
Switched on inputs	1 to 4	1 and 3
Conversion time	300 ms	150 ms

11.5 Configuration

11.5.1 Input filter

Name:
ConfigOutput01

Filtering for all analog inputs can be configured via this register.

Data type	Value	Filter frequency	Filter time	Digital converter resolution
USINT	0	50 Hz. Bus controller default setting	20 ms	16-bit
	1	60 Hz	16.67 ms	16-bit
	2	250 Hz	4 ms	13-bit
	3	500 Hz	2 ms	10-bit
	≥4	Values ≥4 are not permitted.		

11.5.2 Measurement range and channel selection

Name:
ConfigOutput02

This register can be used to configure the sensor type for individual channels.

This module is designed for temperature and resistance measurement. The measurement range must be specified because of the different calibration values for temperature and resistance.

The default setting for all channels is ON. To save time, individual channels can be switched off (see "conversion cycle" on page 8).

Data type	Values	Bus controller default setting
UINT	See bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 3	Analog input 1	**Measurement range for PT100 temperature measurement**	
		0000	-200 to 270°C, resolution 0.01 K/bit (bus controller default setting)
		0001	-200 to 645°C, resolution 0.02 K/bit
		0010	-200 to 850°C, resolution 0.04 K/bit
		0011 to 0100	Reserved
		Measurement range for resistance measurement	
		0101	0.01 to 420 Ω, resolution 0.01 Ω/bit
		0110	0.005 to 210 Ω, resolution 0.005 Ω/bit
		Disable input	
		0111	Input switched off
		1000 to 1111	Reserved.
4 - 7	Analog input 2	x	For possible values, see analog input 1
8 - 11	Analog input 3	x	For possible values, see analog input 1
12 - 15	Analog input 4	x	For possible values, see analog input 1

11.6 Communication

11.6.1 Analog inputs

Name:
Temperature01 to Temperature04
Resistor01 to Resistor04

This register is used to indicate the analog input values depending on the configured operating mode.

Data type	Value	Input signal
INT	-20000 to 27000 (for -200.0 to 270.0°C)	Sensor type PT100, resolution 0.01 K/bit
	-10000 to 32250 (for -200.0 to 645.0°C)	Sensor type PT100, resolution 0.02 K/bit
	-5000 to 21250 (for -200.0 to 850.0°C)	Sensor type PT100, resolution 0.04 K/bit
UINT	1 to 42000 (for 0.01 to 420 Ω	Resistance measurement
	1 to 42000 (for 0.005 to 210 Ω	Resistance measurement

In order for the user to always be supplied with a defined output value, the following must be taken into consideration:

- Up to the first conversion, 0x8000 is output.
- After switching the mode until the first conversion:
  - from "Resistance measurement" to "Sensor type PTxx": 0x8000
  - from "Sensor type PTxx" to "Resistance measurement": 0xFFFF
- If the input is not switched on, 0x8000 is output.

11.6.2 Status of the analog inputs

Name:
StatusInput01

The module's inputs are monitored. A change in the monitoring status generates an error message.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 1	Channel 1	00	No error
		01	Below lower limit value
		10	Above upper limit value
		11	Open circuit
...		...	
6 - 7	Channel 4	00	No error
		01	Below lower limit value
		10	Above upper limit value
		11	Open circuit
8 - 15	Number of conversion cycles performed	x	

Limiting the analog value

In addition to the status information, the analog value is set to the values listed below by default when an error occurs.

Error status	Temperature measurement Digital value for error	Resistance measurement Digital value for error
Open circuit or open input	32767 (0x7FFF)	65535 (0xFFFF)
Above upper limit value	32767 (0x7FFF)	65535 (0xFFFF)
Below lower limit value	-32767 (0x8001)	0 (0x0000)
General error	-32768 (0x8000)	65535 (0xFFFF)

11.6.3 Reading the module ID

Name:
asy_ModulID

This register offers the possibility to read the module ID.

Data type	Values
UINT	Module ID

11.6.4 Operating limit status registers

Name:
asy_SupplyStatus

This register can be used to read the status of the operating limits.

Data type	Values
USINT	See bit structure.

Bit structure:

Bit	Description	Value	Information
0	I/O power supply within/outside warning limits	0	Within the warning limits (18 to 30 V)
		1	Outside of the warning limits (<18 V or >30 V)
1 - 7	Reserved	0	

11.6.5 I/O supply voltage

Name:
asy_SupplyInput

This register contains the I/O supply voltage measured by the module.

Data type	Values	Information
USINT	0 to 255	Resolution 1 V

11.7 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time
200 µs

11.8 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

Minimum I/O update time	
Inputs	$(3 * \frac{1}{Filter\ frequency} + 15ms) * n_{Inputs}$