AXL F RTD4 XC 1H

Axioline F, temperature recording module, analog inputs: 4 (for resistance temperature detectors), extreme conditions version

Data sheet
108357_en_05

 2026-06-01

1 Description

The module is designed for use within an Axioline F station.
It is used to acquire signals from resistive temperature sensors.
The module supports all common platinum and nickel sensors in accordance with DIN EN 60751 and SAMA. Cu10, Cu50, Cu53 sensors as well as various KTY8x sensor types are also supported.

Features

– 4 analog input channels for connecting resistance temperature detectors (RTDs)
– 500 Ω and 5 kΩ linear inputs
– Connection of sensors in 2-, 3-, and 4-conductor technology
– Integrated, digital sensor linearization
– Standardized measured value representation directly in °C, °F or Ω
– Measured value display in 16-bit format or floating point format
– Programmable filters
– Short-circuit protected inputs
– Temperature stability
– Very high level of noise immunity
– Low noise emission
– Installation monitoring by means of “Channel scout” function
– Can be used under extreme ambient conditions
– Extended temperature range of -40 °C ... +70 °C (see “Tested successfully: use under extreme ambient conditions” in the data sheet)
– Partially coated PCBs
– Device rating plate stored

Observe these notes

WARNING: Explosion hazard when used in potentially explosive areas
When using the module in potentially explosive areas, observe the corresponding notes.

This data sheet is only valid in association with the UM EN AXL F SYS INST user manual.

Make sure you always use the latest documentation.
It can be downloaded at: phoenixcontact.com/product/1035430

2 Table of contents

3 Ordering data

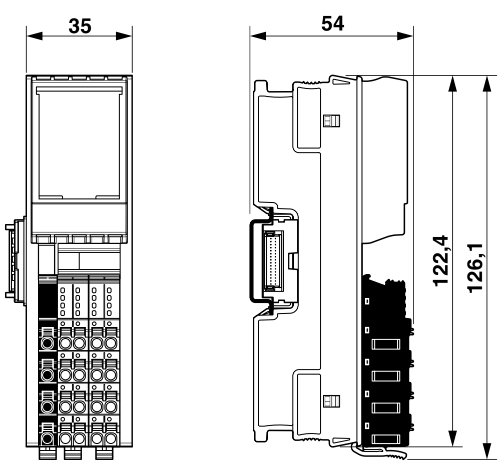
Description	Type	Item no.	Pcs./Pkt.
Axioline F, Temperature recording module, Analog inputs: 4 (for resistance temperature detectors), connection technology: 2-, 3-, 4-conductor (shielded), transmission speed in the local bus: 100 Mbps, Extreme conditions version, degree of protection: IP20, including bus base module and Axioline F connectors	AXL F RTD4 XC 1H	1035430	1

Documentation	Type	Item no.	Pcs./Pkt.
User manual, English, Axioline F: System and installation	UM EN AXL F SYS INST	-	-
User manual, English, Axioline F: Diagnostic registers, and error messages	UM EN AXL F SYS DIAG	-	-

Additional ordering data	
For additional ordering data (accessories), go to:	www.phoenixcontact.com/product/1035430

4 Technical data

Dimensions (nominal sizes in mm)



Width	35 mm
Height	126.1 mm
Depth	54 mm
Note on dimensions	The depth applies when a TH 35-7.5 DIN rail is used (in accordance with EN 60715).

General data	
Color	Housing: traffic gray A (RAL 7042)
Weight	144 g (with connectors and bus base module)
Ambient temperature (operation)	-25 °C ... 60 °C (Standard, applications with UL approval, use in zone 2 potentially explosive area) -40 °C ... 70 °C (Extended, see section “Tested successfully: use under extreme ambient conditions” in the data sheet.)
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	5 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	5 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III (IEC 61140, EN 61140, VDE 0140-1)
Overvoltage category	II (IEC 60664-1, EN 60664-1)
Degree of pollution	2 (IEC 60664-1, EN 60664-1)
Mounting type	DIN rail mounting
Mounting position	any (no temperature derating)

Connection data: Axioline F connector	
Connection method	Push-in connection
Conductor cross-section, rigid	0.2 mm² ... 1.5 mm²
Conductor cross-section, flexible	0.2 mm² ... 1.5 mm²
Conductor cross-section [AWG]	24 ... 16
Stripping length	8 mm

Please observe the information provided on conductor cross-sections in the “Axioline F: system and installation” user manual.

Interface: Axioline F local bus	
Number of interfaces	2
Connection method	Bus base module
Transmission speed	100 Mbps

Axioline F local bus supply (U_{Bus})	
Supply voltage	5 V DC (via bus base module)
Current consumption	max. 140 mA

Supply for analog modules (U_A)	
Supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current consumption	max. 17 mA
Surge protection	electronic (35 V, 0.5 s)
Reverse polarity protection	Polarity protection diode
Transient protection	Suppressor diode

Power dissipation	
Maximum power dissipation for nominal condition	1.1 W

Analog inputs	
Number of inputs	4 (for resistance temperature detectors)
Connection method	Push-in connection
Connection technology	2-, 3-, 4-conductor (shielded)
Sensor types (RTD) that can be used	Pt, Ni, KTY, Cu sensors
Linear resistance measuring range	0 Ω ... 500 Ω, 0 kΩ ... 5 kΩ
A/D converter resolution	24 bit
Measured value representation	16 bits (15 bits + sign bit)
Data formats	IB IL, S7-compatible
Input filter time	40 ms, 60 ms, 100 ms, 120 ms (adjustable)
Tolerance, relative	see tables for tolerance values
Tolerance, absolute	typ. ± 0.1 K (Pt 100 with 3-wire connection) see tables for tolerance values
Short-circuit protection, overload protection of the inputs	yes
Transient protection of inputs	yes
Transient protection of sensor supplies	yes
Nominal value of the current sources	1 mA (Pt 100, Ni 100, R_{Lin} 500 Ω; pulse current, the specification is valid during the sampling phase) 210 µA (Pt 1000, Ni 1000, R_{Lin} 5000 Ω; pulse current, the specification is valid during the sampling phase)
Differential non-linearity	typ. 1 ppm / ±0.0001 % (in all ranges)
Integral non-linearity	typ. 30 ppm / ±0.003 % (Pt 100) typ. 20 ppm / ±0.002 % (R_{Lin} 500 Ω) typ. 200 ppm / ±0.02 % (R_{Lin} 5000 Ω)

Input and output address area	
Input address area	8 Byte
Output address area	0 Byte

Configuration and parameter data in a PROFIBUS system	
Required parameter data	12 Byte
Required configuration data	6 Byte

Electrical isolation/isolation of the voltage areas	
Test section	**Test voltage**
5 V supply of the local bus (U_{Bus}) / 24 V supply (I/Os)	500 V AC, 50 Hz, 1 min
5 V supply of the local bus (U_{Bus}) / analog inputs	500 V AC, 50 Hz, 1 min
5 V supply of the local bus (U_{Bus}) / functional ground	500 V AC, 50 Hz, 1 min
24 V supply (I/O) / analog inputs	500 V AC, 50 Hz, 1 min
24 V supply (I/O) / functional ground	500 V AC, 50 Hz, 1 min
Analog inputs / functional ground	500 V AC, 50 Hz, 1 min

Test (noxious gas)	
Test standard	ISA-71.04-2013 G3 Harsh Group A IEC 60068-2-60:2015 Method 4
Temperature	25 °C ±1 K
Humidity (relative)	75 % ±3 %
Test duration	21 Days
Volume concentration H_2S (Hydrogen sulfide)	50 ppb
Volume concentration NO_2 (Nitrogen dioxide)	1250 ppb
Volume concentration Cl_2 (Chlorine)	10 ppb
Volume concentration SO_2 (Sulfur dioxide)	300 ppb

Mechanical tests	
Vibration resistance in accordance with EN 60068-2-6/IEC 60068-2-6	5g
Shock in accordance with EN 60068-2-27/IEC 60068-2-27	30g
Continuous shock in accordance with EN 60068-2-27/IEC 60068-2-27	10g

Conformance with EMC Directive 2014/30/EU	
Immunity test in accordance with EN IEC 61000-6-2	
Electrostatic discharge (ESD) IEC 61000-4-2	Criterion B, ±6 kV contact discharge, ±8 kV air discharge
Electromagnetic fields IEC 61000-4-3	Criterion A, Field intensity: 10 V/m
Fast transients (burst) IEC 61000-4-4	Criterion B, ±2 kV
Transient overvoltage (surge) IEC 61000-4-5	Criterion B, DC supply lines: ±0.5 kV/±1.0 kV (symmetrical/unsymmetrical), ±1.0 kV to shielded I/O cables
Conducted interference IEC 61000-4-6	Criterion A, Test voltage 10 V
Noise emission test in accordance with EN IEC 61000-6-3	Class B

Approvals	
For the current approvals, go to:	www.phoenixcontact.com/product/1035430
ATEX (UL 20 ATEX 2441X)	Ex II 3 G Ex ec IIC T4 Gc EN IEC 60079-0, EN IEC 60079-7
IECEx (IECEx ULD 20.0026X)	Ex ec IIC T4 Gc IEC 60079-0 Ed. 7, IEC 60079-7 Ed. 5.1
UL, USA/Canada (E238705)	cULus
UL Ex, USA / Canada (E366272)	Class I, Zone 2, AEx ec IIC T4 Class I, Division 2, Groups A, B, C, D, T4 Ex ec IIC T4 Gc X UL 60079-0, Ed. 7 / CSA C22.2 NO. 60079-0, Ed. 4 UL 60079-7, Ed. 5 / CSA C22.2 NO. 60079-7, Ed. 2
CCC / China-Ex (CCC, 2021122309114456)	Ex ec IIC T4 Gc GB/T 3836.1-2021, GB/T 3836.3-2021

Manufacturer's declarations	
For the current manufacturer’s declarations, go to:	www.phoenixcontact.com/product/1035430

5 Additional technical data

Sampling times for different filter times		
Filter time	**Typical scan repeat time for all four measuring channels**	**Typical scan time for each measuring channel**
120 ms	1.64 s	410 ms
100 ms	1.5 s	375 ms
60 ms	1.16 s	290 ms
40 ms	1.0 s	250 ms

Common mode rejection with different filter times		
Filter time	**Optimization of common mode rejection for the interference frequency**	**Typical common mode rejection for measuring inputs of analog/digital converters (CMRR)**
120 ms	50 Hz	80 dB (at 50 Hz)
100 ms	60 Hz	90 dB (at 60 Hz)
60 ms	-	-
40 ms	-	-

Connecting cable and maximum cable length specifications		
Connection technology	**Maximum permissible cable length**	**Sensor type**
4-conductor	250 m	All
3-conductor	100 m	All
2-conductor	20 m	Pt 1000, Ni 1000, R_{Lin} 5000 Ω
2-conductor	3 m	Pt 100, Ni 100, R_{Lin} 500 Ω

The maximum cable length specification is valid from the sensor to the connection terminal block and includes the maximum specified tolerances.

With 2-conductor connection, longer cable lengths can lead to increased measuring tolerances.

The specifications are valid when using the reference cable type LiYCY (TP) 2*2*0.5 mm² and observing the Axioline F installation guidelines.

6 Temperature and resistance measuring ranges

Supported measuring ranges			
Sensor type	**Standard and manufacturer specification**	**Measuring range**	
		Lower limit	**Upper limit**
Pt sensors (e.g., Pt 100, Pt 500, Pt 1000)	DIN IEC 60751 or SAMA RC 21-4-1966	-200 °C	+850 °C
Ni sensors (e.g., Ni 100, Ni 1000)	DIN 43760	-60 °C	+180 °C
Ni 500 (Viessmann)	(Viessmann)	-60 °C	+250 °C
Ni 1000 (Landis & Gyr)	(Landis & Gyr)	-50 °C	+160 °C
KTY 81-110	(Philips)	-55 °C	+150 °C
KTY 81-210	(Philips)	-55 °C	+150 °C
KTY 84	(Philips)	-40 °C	+300 °C
Cu 10	SAMA RC 21-4-1966	-70 °C	+500 °C
Cu 50	SAMA RC 21-4-1966	-50 °C	+200 °C
Cu 53	SAMA RC 21-4-1966	-50 °C	+180 °C
Linear resistor R_{Lin} 500 Ω (linear range 1)		0 Ω	500 Ω
Linear resistor R_{Lin} 5000 Ω (linear range 2)		0 Ω	5000 Ω

The linear input ranges have an additional overflow range of 5% of the measuring range final value. For linear input ranges, the measuring range around the zero point may be limited by ±0.03%. If a short-circuit occurs or there is a resistance value of R = 0.0 Ω, the "Underrange" message (8080_{hex}/32896_{dec}) may appear in the process data.

7 Tolerance data

MRFV= Measuring range final value

The data contains the offset error, gain error, and linearity error in its respective setting.

To determine the overall tolerance, please also take into consideration the values for temperature drift (see tables in section “Temperature and drift response”).

Typical tolerance values are measured application values that are based on the maximum variance of all test objects.

The **maximum tolerance values** represent the worst-case measurement inaccuracy. They contain the theoretical maximum possible tolerances in the corresponding measuring ranges as well as the theoretical maximum possible tolerances of the calibration and test equipment. The data is valid for at least 24 months from delivery of the module. Thereafter the modules can be recalibrated by the manufacturer at any time.

7.1 Tolerances in 3-conductor technology at 25°C

Measuring conditions:

– Nominal operation U_A = 24 V
– Connection of sensors in 3-conductor technology
– Filter of RTD inputs 120 ms
– All channels are connected
– Installation on horizontal DIN rail on the wall
– Reference cable type LiYCY (TP) 2*2*0.5 mm² with a connection length of < 1 m

No.	Sensor type	Measuring range		Absolute tolerance		Relative tolerance (with reference to MRFV)	
		Lower limit	Upper limit	Typical	Maximum	Typical	Maximum
1	Pt 100 DIN and SAMA	-200 °C	+200 °C	±0.10 K	±0.38 K	±0.05 %	±0.19 %
2	Pt 100 DIN and SAMA	-200 °C	+850 °C	±0.13 K	±0.55 K	±0.02 %	±0.06 %
3	Pt 1000 DIN and SAMA	-200 °C	+850 °C	±0.15 K	±0.68 K	±0.02 %	±0.08 %
4	Ni 100	-60 °C	+180 °C	±0.05 K	±0.12 K	±0.03%	±0.07%
5	Ni 1000	-60 °C	+180 °C	±0.09 K	±0.46 K	±0.05 %	±0.26 %
6	Ni 1000 (Landis & Gyr)	-50 °C	+160 °C	±0.09 K	±0.49 K	±0.06 %	±0.31 %
7	KTY 81-110	-55 °C	+150 °C	±0.08 K	±0.41 K	±0.05 %	±0.27 %
8	KTY 84 (KTY 84-130, KTY 84-150)	-55 °C	+150 °C	±1.20 K		±0.80 %	
9	KTY 81-210	-55 °C	+150 °C	±0.05 K		±0.03%	
10	Cu 10	-70 °C	+500 °C				
11	Cu 50	-50 °C	+200 °C				
12	Cu 53	-50 °C	+180 °C				
13	Linear resistor R_{Lin} 500 Ω (linear range 1)	0 Ω	500 Ω	±0.12 Ω	±2.35 Ω	±0.02 %	±0.47 %
14	Linear resistor R_{Lin} 5000 Ω (linear range 2)	0.1 Ω	5000 Ω	±0.50 Ω	±6.5 Ω	±0.01 %	±0.13 %

7.2 Tolerances in 4-conductor technology at 25°C

Measuring conditions:

– Nominal operation U_A = 24 V
– Connection of sensors in 4-conductor technology
– Filter of RTD inputs 120 ms
– All channels are connected
– Installation on horizontal DIN rail on the wall
– Reference cable type LiYCY (TP) 2*2*0.5 mm² with a connection length of < 1 m

No.	Sensor type	Measuring range		Absolute tolerance		Relative tolerance (with reference to MRFV)	
		Lower limit	Upper limit	Typical	Maximum	Typical	Maximum
1	Pt 100 DIN and SAMA	-200 °C	+200 °C	±0.05 K	±0.25 K	±0.03%	±0.13 %
2	Pt 100 DIN and SAMA	-200 °C	+850 °C	±0.10 K	±0.42 K	±0.01 %	±0.05 %
3	Pt 1000 DIN and SAMA	-200 °C	+850 °C	±0.13 K	±0.60 K	±0.03%	±0.10 %
4	Ni 100	-60 °C	+180 °C	±0.04 K	±0.12 K	±0.02 %	±0.07%
5	Ni 1000	-60 °C	+180 °C	±0.09 K	±0.43 K	±0.05 %	±0.24 %
6	Ni 1000 (Landis & Gyr)	-50 °C	+160 °C	±0.09 K	±0.47 K	±0.06 %	±0.29%
7	KTY 81-110	-55 °C	+150 °C	±0.08 K	±0.38 K	±0.03%	±0.10 %
8	KTY 84 (KTY 84-130, KTY 84-150)	-55 °C	+150 °C	±1.20 K		±0.80 %	
9	KTY 81-210	-55 °C	+150 °C	±0.05 K		±0.03%	
10	Cu 10	-70 °C	+500 °C				
11	Cu 50	-50 °C	+200 °C				
12	Cu 53	-50 °C	+180 °C				
13	Linear resistor R_{Lin} 500 Ω (linear range 1)	0 Ω	500 Ω	±0.12 Ω	±2.35 Ω	±0.02 %	±0.47 %
14	Linear resistor R_{Lin} 5000 Ω (linear range 2)	0.1 Ω	5000 Ω	±0.50 Ω	±6.5 Ω	±0.03%	±0.13 %

7.3 Tolerances influenced by electromagnetic interference

Type of electromagnetic interference	Standard	Level	Additional tolerances of measuring range final value	Criterion
Electromagnetic fields	IEC 61000-4-3	10 V/m	None	A
Fast transients (burst)	IEC 61000-4-4	1.1 kV	None	A
Conducted interference	IEC 61000-4-6	150 kHz ... 80 MHz, 10 V, 80 % (1 kHz)	None	A

The data was determined under nominal conditions with the following parameterization:
R_{Lin}: 500 Ω, resolution: 0.01 K, 4-conductor connection, filter: 120 ms.

The set-up was implemented in accordance with the installation guidelines (with shielded I/O cables).

No additional tolerances occur due to the influence of high-frequency interference caused by wireless transmission systems in the near vicinity.

The specifications refer to nominal operation. The modules are directly exposed to interference without the use of additional shielding measures (e.g., steel cabinet).

8 Temperature and drift response

Please also observe the calculation examples at the end of the document.

8.1 Tolerance and temperature response (drift behavior) for 3-conductor connection

Tolerance and temperature response at T_A = -25 °C ... +60 °C				
Sensor type	**Measuring range**		**Drift**	
	Lower limit	**Upper limit**	**Typical**	**Maximum**
Pt 100 DIN and SAMA	-200 °C	+200 °C	±3 ppm/K	±18 ppm/K
Pt 100 DIN and SAMA	-200 °C	+850 °C	±5 ppm/K	±18 ppm/K
Pt 1000 DIN and SAMA	-200 °C	+850 °C	±20 ppm/K	±65 ppm/K
Ni 100 DIN and SAMA	-60 °C	+180 °C	±4 ppm/K	±20 ppm/K
Ni 1000 DIN and SAMA	-60 °C	+180 °C	±23 ppm/K	±75 ppm/K
Linear resistor R_{Lin} 500 Ω (linear range 1)	0 Ω	500 Ω	±5 ppm/K	±20 ppm/K
Linear resistor R_{Lin} 5000 Ω (linear range 2)	0 Ω	5000 Ω	±34 ppm/K	±95 ppm/K

8.2 Tolerance and temperature response (drift behavior) for 4-conductor connection

Tolerance and temperature response at T_A = -25 °C ... +60 °C				
Sensor type	**Measuring range**		**Drift**	
	Lower limit	**Upper limit**	**Typical**	**Maximum**
Pt 100 DIN and SAMA	-200 °C	+200 °C	±3 ppm/K	±18 ppm/K
Pt 100 DIN and SAMA	-200 °C	+850 °C	±3 ppm/K	±18 ppm/K
Pt 1000 DIN and SAMA	-200 °C	+850 °C	±18 ppm/K	±65 ppm/K
Ni 100 DIN and SAMA	-60 °C	+180 °C	±2 ppm/K	±20 ppm/K
Ni 1000 DIN and SAMA	-60 °C	+180 °C	±24 ppm/K	±75 ppm/K
Linear resistor R_{Lin} 500 Ω (linear range 1)	0 Ω	500 Ω	±4 ppm/K	±20 ppm/K
Linear resistor R_{Lin} 5000 Ω (linear range 2)	0 Ω	5000 Ω	±25 ppm/K	±80 ppm/K

Typical drift values have been determined under nominal conditions with a filter of 120 ms. All channels were connected and parameterized in the same way.

Typical tolerance values are measured application values that are based on the maximum variance of all test objects.

Hardly any typical drift influences can be determined in the temperature range from T_A = +25°C to +60°C. The documented typical drift values basically occur in the temperature range from T_A = -25°C to +25°C.

The **maximum values** represent the worst case measurement inaccuracy.

8.3 Absolute tolerances with a Pt 100 sensor at T_A = -25°C ... +60°C

Measuring conditions:

- Nominal operation U_A = 24 V
- Filter of RTD inputs 120 ms
- Installation on horizontal DIN rail on the wall
- Reference cable type LiYCY (TP) 2 x 2 x 0.5 mm² with a connection length <100 m (with 3-conductor technology)
- Reference cable type LiYCY (TP) 2 x 2 x 0.5 mm² with a connection length <250 m (with 4-conductor technology)

Tolerances at T_A = -25°C ... +60°C					
Sensor type (4-conductor connection)	Measuring range (nominal range)		Connection technology	Absolute tolerance	
	Lower limit	Upper limit		Typical	Maximum
Pt 100 DIN and SAMA	-200 °C	+200 °C	4-conductor	±0.08 K	±0.43 K
Pt 100 DIN and SAMA	-200 °C	+200 °C	3-conductor	±0.15 K	±0.56 K

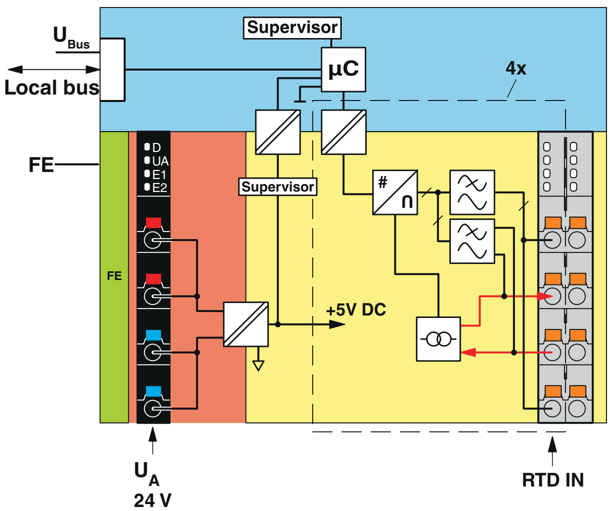
The data contains the offset error, gain error, and linearity error in its respective setting.

Typical tolerance values are measured application values that are based on the maximum variance of all test objects.

The **maximum tolerance values** represent the theoretical worst case measurement inaccuracy. Besides the maximum offset error and gain error, the maximum tolerance values also comprise the longtime drift as well as the maximum tolerances of the test and calibration equipment.

9 Internal circuit diagram

Figure 1 Internal wiring of the terminal points

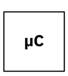


Key:

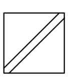
Local bus — Axioline F local bus (hereinafter referred to as local bus)

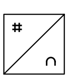
FE — Functional ground

Hardware monitoring

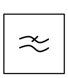


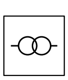
Microcontroller

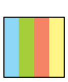

Electrical isolation for data or power supply



Analog/digital converter


Low pass filter


Constant current source


Electrically isolated areas

10 Tested successfully: Use under extreme ambient conditions

WARNING:
In the following applications, the module is only approved for use in the temperature range from -25°C to 60°C:

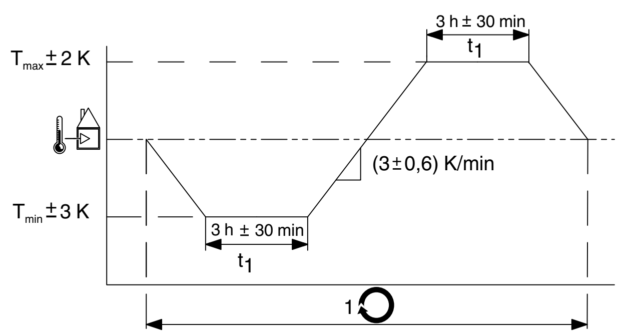
– Applications with UL approval
– Use in zone 2 potentially explosive areas

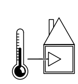
XC modules have been tested successfully over 250 temperature change cycles according to IEC 61131-2 in the range from -40°C to +70°C.

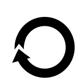
The following conditions were observed:

– The Axioline F devices for all connecting cables were connected with a minimum conductor cross-section of 0.5 mm²
– The Axioline F station was installed on a wall-mounted horizontal DIN rail
– Fans were used to ensure continuous movement of air in the control cabinet
– The Axioline F station was not exposed to vibration or shock
– The Axioline F station was operated with a maximum of 24.5 V (ensured by using electronically regulated power supply units)

Figure 2 Temperature change cycle




Temperature in the control cabinet/ambient temperature


Cycle

11 For your safety

11.1 Intended use

Use the Axioline F modules exclusively in accordance with the specifications in the accompanying data sheet and the “Axioline F: System and Installation” user manual.

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

11.2 Qualification of users

The use of products described in this data sheet is oriented exclusively to electrically skilled persons or persons instructed by them. The users must be familiar with the relevant safety concepts of automation technology as well as applicable standards and other regulations.

11.3 Electrical safety

WARNING: Loss of electrical safety

If used incorrectly, device safety may be impaired.

The instructions given in this data sheet as well as the UM EN AXL F SYS INST user manual must be observed during installation, startup, and operation.

11.4 Installation

Only install the Axioline F modules in a control cabinet or junction box.

NOTE: Fire hazard

– The device must be installed in the final protective housing, which provides sufficient resistance to mechanical strain and protection against the spreading of fire in accordance with the standards UL/IEC/EN 61010-1 and UL/IEC/EN 61010-2-201.
– The supply and external circuits intended to be connected to this device shall be galvanically separated from the mains supply or hazardous live voltage by reinforced or double insulation and meet the requirements of SELV/PELV (Class III) circuits of UL/CSA/IEC/EN 61010-1, UL/CSA/IEC/EN 61010-2-201.

NOTE: Damage to the contacts

Physical overloads can result in damage to the terminal points.

- Relieve strain in the connected cables.

12 Installation in potentially explosive area

WARNING: Explosion hazard

Before using the device in a potentially explosive area, make sure that your device has the required approval.

The approvals are printed on the device.

WARNING: Explosion hazard

Please make sure that the following notes and instructions are observed.

- The category 3 device is designed for installation in zone 2 potentially explosive areas.
- The device satisfies the requirements of the following standards:

  EN/IEC 60079-0, EN/IEC 60079-7

  For detailed information, refer to the declarations of conformity that accompany the product. For the latest version, go to the item page at www.phoenixcontact.com/products.
- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described. When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as general technical regulations, must be observed. The safety data is listed in this document and in the certificates.
- Observe the specified conditions for use in potentially explosive areas. Also observe the requirements of IEC/EN 60079-14.
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- Do not subject the product to mechanical and/or thermal stress that exceeds the specified limits.
- The device must be stopped and immediately removed from the Ex area if it is damaged, was subject to an impermissible load, stored incorrectly or if it malfunctions.
- Electrical isolation, rated insulation voltage: 85 V DC in accordance with EN/IEC 600079-7 Annex H.

Specific conditions of use

- Install the device in such a way that a degree of protection of at least IP54 is achieved in accordance with EN/IEC 60529. To this end, a suitable, approved housing that meets the requirements of EN/IEC 60079-0, GB/T 3836.1 must be used.
- Only devices that are designed for operation in Ex Zone 2 and the conditions at the installation location may be connected to the circuits in Zone 2.
- In potentially explosive areas, only connect and disconnect cables and plug-in connections (e.g., connector, bus base module, SD card, etc.) when the power is disconnected.
- For safe operation, lockable plug-in connections must be fully inserted and have a functional interlock (e.g., locking clips, screw connection, etc.). Insert the interlock. Repair any damaged plug-in connections immediately.
- Only connect one cable per terminal point.
- Use only cables that are suitable for a temperature of at least 80°C.
- The air pressure during operation is limited to 106 kPa.
- Use the device in an environment that does not exceed pollution degree 2 in accordance with EN/IEC 60664-1, GB/T 16935.1.
- Use transient protection so that short-term surge voltages do not exceed 119 V.

Areas with a danger of dust explosions

- The device is not designed for use in atmospheres with a danger of dust explosions.

13 UL notes

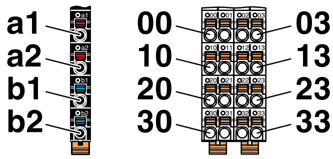
- Use copper conductors only.

UL Hazardous Location

- This device must be mounted in an enclosure certified for use in Class I, Zone 2, minimum, and rated IP54, minimum, in accordance with UL/CSA 60079-0 when used in a Class I, Zone 2 environment.
- This device is to be installed within an area of not more than pollution degree 2, as defined in IEC 60664-1.
- Only connect one cable per terminal point.
- Use only cables that are suitable for a temperature of at least 80°C.
- WARNING - Do not separate terminal blocks when energized!

14 Terminal point assignment

Figure 3 Terminal point assignment

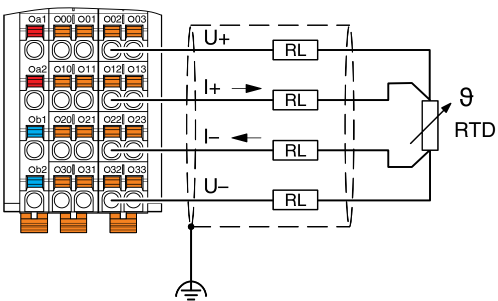


Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_A)	Supply for analog modules (bridged internally)
b1, b2	Blue	GND	Reference potential of the supply voltage (bridged internally)
Analog inputs			
00 ... 03	Orange	U01+ ... U04+	RTD sensor + channel 1 ... 4
10 ... 13	Orange	I01+ ... I04+	Constant current supply + channel 1 ... 4
20 ... 23	Orange	I01- ... I04-	Constant current supply - channel 1 ... 4
30 ... 33	Orange	U01- ... U04-	RTD sensor - channel 1 ... 4

15 Connection examples

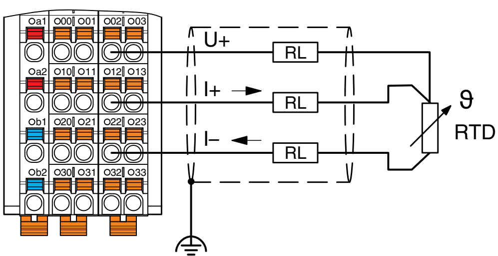
15.1 4-conductor connection

Figure 4 Connection example: 4-conductor connection



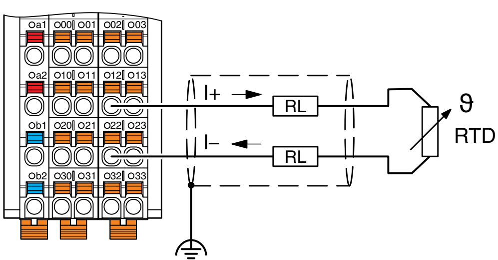
15.2 3-conductor connection

Figure 5 Connection example: 3-conductor connection



15.3 2-conductor connection

Figure 6 Connection example: 2-conductor connection



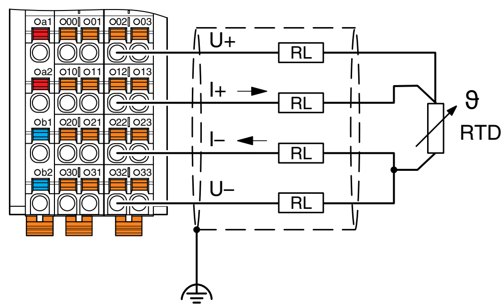
15.4 4-conductor connection using a sensor in 3-conductor technology

In order to also measure 3-conductor sensors with very long supply lines without additional tolerances, we also recommend 4-conductor connection technology here.

To do so, configure the channel as a 4-conductor channel and bridge the connections Ix- and Ux- on the sensor side.

In this application you can connect sensors with a cable length up to 250 m.

Figure 7 Connection example: 4-conductor connection for 3-conductor sensor with very long supply lines (> 100 m)



16 Connection notes

Observe the connection notes by the sensor manufacturer.

Shielding

Always connect the analog sensors using shielded, twisted pair cables.

In environments with high levels of interference, unshielded cables may cause values to be outside the specified tolerance limits.

Use of shielded, twisted connecting cables (e.g. LiYCY (TP) 2 x 2 x 0.5 mm²) is required in environments prone to interference as well as for sensor cables which are longer than 1 m.

For installation in a control cabinet: Connect the cable shield to the functional ground at a suitable point immediately after entry into the control cabinet. Route the cable in the control cabinet in a shielded manner.

If a closed control cabinet is not available, connect the shield to a shield bus.

Use the AXL SHIELD SET Axioline shield connection set for an optimized connection directly in front of the module.

In general, you can use Phoenix Contact products for shielding, see www.phoenixcontact.com/webcode/#0845.

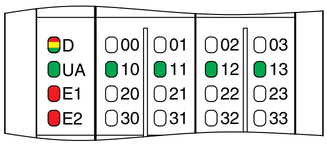
For further information on shielding, please refer to the user manual UM EN AXL F SYS INST.

Strain relief

Do not use the shield contact as a strain relief. Carry out the shielding and the strain relief separately.

17 Local diagnostic and status indicators

Figure 8 Local diagnostic and status indicators



Channel errors are errors that can be associated with a channel.
I/O errors are errors that affect the entire module.

Designation	Color	Meaning	State	Description
D	Red/ yellow/ green	Diagnostics of local bus communication		
		Run	Green on	The device is ready for operation, communication within the station is OK. All data is valid. An error has not occurred.
		Active	Flashing green	The device is ready to operate, communication within the station is OK. The data is **not** valid. The controller or higher-level network is not delivering valid data. There is no error on the module.
		Device application not active	Flashing green/ yellow	The device is ready for operation, communication within the station is OK. Output data **cannot** be outputted and/or input data **cannot** be read. There is a fault on the periphery side of the module.
		Ready	Yellow on	The device is ready for operation but did not detect a valid cycle after power-up.
		Connected	Flashing yellow	The device is not (yet) part of the active configuration.
		Reset	Red on	The device is ready for operation but has lost the connection to the bus head.
		Not connected	Red flashing	The device is ready for operation but there is no connection to the previously existing device.
		Power down	Off	Device is in (power) reset.
UA	Green	U_{Analog}	On	Supply for analog modules (U_A) present.
			Off	Supply for analog modules (U_A) not present.
E1	Red	Supply voltage error	On	Supply for analog modules (U_A) is faulty.
			Off	Supply for analog modules (U_A) is OK.
E2	Red	Error	On	I/O or channel error has occurred.
			Off	No error
10 ... 13	Red/ orange/ green	Channel Scout/error message		
		Channel Scout	Flashing orange	Channel searched for
		Error message	Red on	Wire break, overrange or underrange
				Errors which affect the entire device (e.g., parameter table invalid); Such errors are only displayed on active channels.
		OK	Green on	Normal operation
		Inactive	Off	Channel is parameterized as inactive.

Error code and status of the E1 and E2 LEDs

Error	LED E1	LED E2
No error	off	off
Underrange	off	on
Overrange	off	on
Wire break	off	on
Supply voltage faulty (supply for analog modules (U_A))	on	on
Parameter table invalid	off	on
Device error	off	on
Flash format error	off	on

18 Diagnostic behavior in the event of an error

The following error states are diagnosed and indicated by the module. They are indicated in the diagnostic object (PDI object 0018_{hex}), at the corresponding local diagnostic indicators, and, when IB IL format is set, in the input process data.

Error	Indication in the process data		Messages via the "Diagnostics" object			Local diagnostic indicators
U_L missing	None (local bus without supply)		None			All LEDs are off. (Exception: UA LED)
Measured value is above the valid measuring range (e.g., 500 Ω at Pt 100 input)	8001_{hex}	Measuring range violated (overrange)	8910_{hex}	Overrange	Warning, priority 2	LED of the affected channel (10 ... 13) lights up red E2 LED lights up red
Sensor connector is not connectorged in, the sensor cable is completely interrupted						LED of the affected channel (10 ... 13) lights up red E2 LED lights up red
- “Wire-break detection” bit = 0 (default)*	8002_{hex}	Wire break	7710_{hex}	Open circuit	Error, priority 1	
- “Wire-break detection” bit = 1*	8001_{hex}	Measuring range violated (overrange)	8910_{hex}	Overrange	Warning, priority 2	
Measured value invalid (e.g., if channel is inactive)	8004_{hex}	Measured value invalid	No			None
U_A (24 V) is missing or failure of internal I/O voltages	8020_{hex}	Faulty supply voltage	5160_{hex}	Supply fail	Error, priority 1	The E1 and E2 LEDs light up red LEDs 10 ... 17 of the active channels light up red
Internal component faulty	8040_{hex}	Device faulty	6301_{hex}	CS FLASH	Error, priority 1	LED E2 lights up red LEDs 10 ... 17 of the active channels light up red
			6302_{hex}	FO FLASH		
Measured value is below the valid measuring range (e.g., 5 Ω at Pt 100 input)	8080_{hex}	Measuring range violated (underrange)	8920_{hex}	Underrange	Warning, priority 2	LED of the affected channel (10 ... 13) lights up red E2 LED lights up red

* See section “Parameter table (0080hex: ParaTable)”, “Data format, system bits”.

19 Process data

The module uses four words of IN process data.

The measured values are transmitted to the controller board or the computer using process data input words.

Each channel is mapped to a word.

The process data is mapped in Motorola format (Big Endian).

IN process data

	Connection technology	Input word			
		0	1	2	3
Assignment		Measured value channel 1	Measured value channel 2	Measured value channel 3	Measured value channel 4
Name	3-, 4-conductor	IN01	IN02	IN03	IN04
	2-conductor	IN01_2wire	IN02_2wire	IN03_2wire	IN04_2wire

In PC Worx, two different signal names are used for one channel (depending on the connection technology).

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value														

V Sign bit

In the IB IL format a diagnostic code is mapped to the input data in the event of an error.

Code (hex)	Cause
8001	Measuring range exceeded (overrange)
8002	Wire break
8004	Measured value invalid or no valid measured value available
8010	Parameter table invalid
8020	Faulty supply voltage
8040	Device faulty
8080	Below measuring range (underrange)

As long as a used channel is not parameterized, the relevant status LED is OFF and the code 8004_{hex} is transmitted in the process data.

20 Significant values in various formats

20.1 Significant values in IB IL format

Input data		**R 0 Ω ... 500 Ω**		**R 0 Ω ... 5 kΩ**		**Temperature sensors**	
Resolution		**0.1 Ω**	**0.01 Ω**	**1 Ω**	**0.1 Ω**	**0.1 °C or 0.1 °F**	**0.01 °C or 0.01 °F**
hex	**dec**	**Ω**	**Ω**	**Ω**	**Ω**	**°C or °F**	**°C or °F**
8001	Overrange	> 525	> 325.12	> 5250	> 3251.2	> Limit value	> Limit value
03E8	1000	+100.0	+10.0	+1000.0	+100.0	+100.0	+10.0
0001	1	+0.1	+0.01	+1.0	+0.1	+0.1	+0.01
0000	0	≤ 0	≤ 0	≤ 0	≤ 0	0	0
FFFF	-1					-0.1	-0.01
FC18	-1000					-100.000	-10.0
8080	Underrange					< Limit value	< Limit value

20.2 Significant values in S7-compatible format

Input data		**R 0 Ω ... 500 Ω**		**R 0 Ω ... 5 kΩ**		**Temperature sensors**	
Resolution		**0.1 Ω**	**0.01 Ω**	**1 Ω**	**0.1 Ω**	**0.1 °C or 0.1 °F**	**0.01 °C or 0.01 °F**
hex	**dec**	**Ω**	**Ω**	**Ω**	**Ω**	**°C or °F**	**°C or °F**
7FFF	Overrange	> 525	> 325.12	> 5250	> 3251.2	> Limit value	> Limit value
03E8	1000	+100.0	+10.0	+1000.0	+100.0	+100.0	+10.0
0001	1	+0.1	+0.01	+1.0	+0.1	+0.1	+0.01
0000	0	≤ 0	≤ 0	≤ 0	≤ 0	0	0
FFFF	-1					-0.1	-0.01
FC18	-1000					-100.000	-10.0
8000	Underrange					< Limit value	< Limit value

21 Parameter, diagnostics and information (PDI)

21.1 PDI objects

The module has PDI objects. They are used to map parameters, diagnostic data, and information about the module. The PDI objects can be read and/or written acyclically.

You can find out how to access the PDI objects in the documentation for the bus coupler or the controller used.

The PDI objects created in the module are described in the following sections.

You will find an explanation of the data types in the user manual UM EN AXL F SYS INST.

The following applies to all tables below:

Abbreviation	Meaning
Length in bytes	Maximum length of the elements in bytes
R	Read
W	Write
[x]	Number of elements in an array or record

Each visible string is terminated with a null terminator (00_{hex}). The length of a visible-string-type element is therefore at least one byte larger than the number of user data items.
If the number of user data items plus null terminator is smaller than the specified length of the element, the visible string will be populated with a null character (00_{hex}).

You will find detailed information on the PDI objects in the user manual UM EN AXL F SYS INST.

21.2 Retentive storage

Axioline F modules can have retentively (non-volatilely) and volatilely stored parameters.

Retentively stored parameters retain their values even after the module voltage is reset.

For writeable parameters, the following tables indicate whether they are stored retentively or volatilely.

A write operation to the module memory is only triggered if the value of at least one retentive parameter has been changed.

Due to the storage technology used, parameters that are stored retentively only allow a certain number of write access operations (typ. 100,000 to 1,000,000 times). **They are not suitable for being changed cyclically.**

NOTE: Damage to the Flash memory during cyclic write access

The flash memory is only designed for a limited number of write access operations.

- Make sure that write access operations are not performed too often and, in particular, are not performed cyclically.
- Note this behavior when programming function blocks.
- For systems with initial parameterization (e.g., PROFINET), avoid parameterization from the application program.

22 Standard objects

You can only access these objects via subindex 00, i.e., you access the entire object in each case.

Index (hex)	Object name	Data type	Length in bytes	Rights	Meaning/contents		Retentive storage	
0005	Capabilities	Visible String	8	R	Capabili-ties	Energ_0		
0037	DeviceType	Octet string	8	R	Device type	0020 0008 0000 00A4$_{hex}$		
Diagnostics objects								
0018	DiagState	Record [6]	21	R	Diagnostic state			*
0019	ResetDiag	UINT8	1	R/W	Handling diagnostic messages		No	*
Objects for process data management								
0025	PDIN	Octet string	8	R	Input process data The structure corresponds to the representation in the "Process data" section.			
0026	PDOUT	Octet string	8	R	OUT process data, not applicable			

The objects identified with * in the last column are described in more detail in the following sections.

The description of the other objects is to be found in the user manual UM EN AXL F SYS INST.

22.1 Diagnostics state (0018_{hex}: DiagState)

This object is used for a structured message of an error.

Read off all information via subindex 00 to receive all information on an error number. Access to individual elements of the object is not permitted.

A detailed description of the object is provided in user manual UM EN AXL F SYS INST.

Error and status of the local diagnostics and status indicators

Element	**2**	**3**	**4**	**6**					
Error	**Priority**	**Channel/ group/ module**	**Error code**	**Text**	**LED**				
	hex	**hex**	**hex**		**D**	**UA**	**E1**	**E2**	**10 ... 13**
No error	00	00	0000	Status OK	◐	●	○	○	X
Supply voltage faulty (supply for analog modules (U_A))	01	FF	5160	Supply fail	☼	○	●	●	◑
Device error	01	FF	6301	CS FLASH	◐	●	○	●	◑
Flash format error	01	FF	6302	FO FLASH	◐	●	○	●	◑
Parameter table invalid	01	FF	6320	Invalid para	◐	●	○	●	◑
Wire break (default)	01	01 ... 04	7710	Open circuit	◐	●	○	●	◑
Wire break (“Wire-break detection” bit = 1*)	02	01 ... 04	8910	Overrange	◐	●	○	●	◑
Overrange	02	01 ... 04	8910	Overrange	◐	●	○	●	◑
Underrange	02	01 ... 04	8920	Underrange	◐	●	○	●	◑
* See section “Parameter table (0080hex: ParaTable)”, “Data format, system bits”.									

Key

Priority	00_{hex}	No error
	01_{hex}	Error
	02_{hex}	Warning
Channel	00_{hex}	No error
	01_{hex}	Channel 1
	:	:
	04_{hex}	Channel 4
	FF_{hex}	Entire device
LED	X	The LED is not affected by this error.
	○	Off
	●	On
	◐	Green on
	◑	Red on
	☼	Flashing green/yellow

An error at a channel (channel = 01 ... 04) is indicated via the corresponding LED (LED 10 ... 13). An error which affects the entire device (channel = FF), is only indicated on active channels via LEDs 10 ... 13. The corresponding LED is off for inactive channels.

Once the cause of the fault has been removed, the message is automatically reset.

22.2 Handling diagnostic messages (0019_{hex}: ResetDiag)

You can use this object to specify how the module should handle diagnostic messages.

Handling diagnostic messages	
Code (hex)	**Meaning**
00	**Permit all diagnostic messages (default)**
02	Delete all diagnostic messages that are still pending
06	Delete all diagnostic messages and do not permit new ones
Other	Reserved

23 Application objects

Index (hex)	Object name	Data type	Length in bytes	Rights	Meaning/contents	Retentive storage
0080	ParaTable	Array [6] of UINT16	12	R/W	Parameter table	Yes
0082	Measured Value Float	Array [4] of Records	24	R	Measured values in the extended float format	
0083	PD Min	Array [4] of INT16	8	R	Minimum process data value	
0084	PD Max	Array [4] of INT16	8	R	Maximum process data value	
0090	Channel Scout	Var	1	R/W	Channel Scout	

23.1 Parameter table (0080$_{hex}$: ParaTable)

Parameterize the module using this object.

In the case of valid parameters, the parameterization is stored retentively in the module.

After a reset, the module operates with the last retentively stored data. In the delivery state, the module works with the default data (default setting).

0080$_{hex}$: Parameter table (read, write)				
Subindex	**Data type**	**Length in bytes**	**Meaning**	**Default value**
0	Array [6] of UINT16	12	Read/write all elements	See subindices
1	UINT16	2	Parameterization of channel 1	000F$_{hex}$
:	UINT16	2	:	000F$_{hex}$
4	UINT16	2	Parameterization of channel 4	000F$_{hex}$
5	UINT16	2	Data format, system bits	0000$_{hex}$
6	UINT16	2	Reserved	0000$_{hex}$

Parameterization channel 1 ... channel 4

Parameterization word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Conductor		Filter		R0				Resolution		0	0	Sensor type			

Connection method (wire)	Code (bin)	Code (hex)
3-conductor (default)	**00**	**0**
2-conductor	01	1
4-conductor	10	2
Reserved	11	3

Filter		Code (bin)	Code (hex)
120 ms (default)	**8.3 Hz**	**00**	**0**
100 ms	10 Hz	01	1
60 ms	16.6 Hz	10	2
40 ms	25 Hz	11	3

R0 (Ω)	Code (bin)	Code (hex)
100 (default)	**0000**	**0**
10	0001	1
20	0010	2
30	0011	3
50	0100	4
120	0101	5
150	0110	6
200	0111	7
240	1000	8
300	1001	9
400	1010	A
500	1011	B
1000	1100	C
1500	1101	D
2000	1110	E
Reserved	1111	F

Parameterization of the resistance type is only useful for Pt and Ni sensors (DIN and SAMA). For other sensors the resistance type does not have to be parameterized.

Resolution	Code (bin)	Code (hex)
0.1 °C (default)	**00**	**0**
0.01 °C	01	1
0.1 °F	10	2
0.01 °F	11	3

Sensor type	Code (bin)	Code (hex)
Pt DIN	0000	0
Pt SAMA	0001	1
Ni DIN	0010	2
Ni SAMA	0011	3
Cu 10	0100	4
Cu 50	0101	5
Cu 53	0110	6
Ni 1000 (Landis & Gyr)	0111	7
Ni 500 (Viessmann)	1000	8
KTY 81-110	1001	9
KTY 84 (KTY 84-130, KTY 84-150)	1010	A
KTY 81-210	1011	B
Reserved	1100	C
Linear R 0 Ω ... 500 Ω	1101	D
Linear R 0 Ω ... 5 kΩ	1110	E
Channel inactive (default)	**1111**	**F**

For the sensor types 0_{hex} to 3_{hex} parameterize the resistance type as well.

Unused channels indicate a wire break diagnosis. To not receive a diagnostic message, set unused channels to “Channel inactive”.

Possible resolutions for the individual sensor types

Resolution for sensor type				
Temperature sensors	**Linear R 0 Ω ... 500 Ω**	**Linear R 0 Ω ... 5 kΩ**	**Code (bin)**	**Code (hex)**
0.1 °C	0.1 Ω	1 Ω	00	0
0.01 °C	0.01 Ω	0.1 Ω	01	1
0.1 °F	0.1 Ω	1 Ω	10	2
0.01 °F	0.01 Ω	0.1 Ω	11	3

Set all unused bits to 0.

Data format, system bits

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	B	Data format		0	0	0	0	0	0	0	K

B: wire-break detection	Code (bin)	Code (hex)
Enabled (default)	**0**	**0**
Disabled	1	1

Wire-break monitoring is always active. You can specify whether and how the wire break should be indicated via the bit.

- **Bit 10 = 0 (default):**
  In the delivery state, an error message is generated in the event of a wire break.
- **Bit 10 = 1:**
  In the case of extreme EMC requirements, i.e., in the event of interference far above the industry standard, you can set the bit to specify that a warning should be indicated instead of an error.
- The bit does not influence the behavior of the LEDs.
- See section “Diagnostic behavior in the event of an error”.

Data format	Code (bin)	Code (hex)
IB IL (default)	**00**	**0**
Reserved	01	1
S7-compatible	10	2
Reserved	11	3

K: Temperature drift compensation	Code (bin)	Code (hex)
Compensation active (default)	**0**	**0**
Compensation inactive	1	1

23.2 Measured value in extended float format (0082_{hex}: Measured Value Float)

You can read the IN process data in IB IL or S7-compatible format with the 0025_{hex} object.

The 0082_{hex} object is also available.

This object provides the measured value in the highest internal accuracy of the terminal in the float format.

0082_{hex}: Measured value in extended float format (read)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Array [4] of Records	24	Read all elements
1	Record	6	Measured value for channel 1
:	:	:	:
4	Record	6	Measured value channel 4

Measured value channel 1 ... channel 4

Element	Data type	Length in bytes	Meaning
1	FLOAT32	4	Measured value in float format according to IEEE 754
2	UINT8	1	Status
3	UINT8	1	Unit

Structure of the float format according to IEEE 754 in the bit representation:

VEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM

V	1 sign bit, 0: positive, 1: negative
E	8 bits exponent with offset $7F_{hex}$
M	23 bits mantissa

Example values for conversion from floating point to hexadecimal representation:

Floating point	Hexadecimal representation
1.0	3F 80 00 00
10.0	41 20 00 00
1.03965528	3F 85 13 6D
-1.0	BF 80 00 00

Extended Float Format

Extended Float Format is a specially defined format. It consists of the measured value in float format, a status, and a unit.

Status is necessary because the float format defines no patterns providing information on the status of the numerical value.

The status corresponds to the LSB of the diagnostic code in IB IL format (e.g., overrange: status = 01, diagnostic code = 8001_{hex}). If status = 0, the measured value is valid.

Unit	Code
°C	32 (20_{hex})
°F	33 (21_{hex})
Ohms (Ω)	37 (25_{hex})

Status	Code
Measured value is valid	00_{hex}
Measured value invalid	Other

23.3 Minimum process data value (0083_{hex}: PD Min)

Object 0083_{hex} can be used to read the minimum IN process data values.

The values are initialized after each parameterization. The highest value is assigned for the minimum process data value.

PD Min = $7FFF\ 7FFF\ 7FFF\ 7FFF_{hex}$

On every analog conversion, the PD Min value is compared with the current measured values and overwritten if necessary.

0083_{hex}: Minimum process data value (read)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Array [4] of INT16	8	Read all elements
1	INT16	2	Minimum process data value channel 1
:	:	:	:
4	INT16	2	Minimum process data value channel 4

23.4 Maximum process data value (0084_{hex}: PD Max)

Object 0084_{hex} can be used to read the maximum IN process data values.

The values are initialized after each parameterization. The lowest value is assigned for the maximum process data value.

PD Max = $8000\ 8000\ 8000\ 8000_{hex}$

On every analog conversion, the PD Max value is compared with the current measured values and overwritten if necessary.

0084_{hex}: Maximum process data value (read)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Array [4] of INT16	8	Read all elements
1	INT16	2	Maximum process data value channel 1
:	:	:	:
4	INT16	2	Maximum process data value channel 4

23.5 Channel Scout (0090_{hex})

This object is used to quickly find a channel.

0090_{hex}: Channel Scout (read, write)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Var	1	Channel Scout

Value	**Meaning**
0	Disable all channel scout processes
1 ... 4	Green LED of the channel is flashing at 0.5 Hz (1 second ON, 1 second OFF)

The function is terminated automatically after five minutes if you do not deactivate the Channel Scout processes. The flashing overrides all diagnostic messages of the selected channel. When a channel is parameterized, the Channel Scout function is aborted.

24 Parameterization example

A different parameterization is selected for every channel. The data format is the IB IL format.

Channel	Connection method (wire)	Filter	R0	Resolution	Sensor type
1	3-conductor	120 ms	100 Ω	0.1 °C	Pt 100 DIN
2	2-conductor	40 ms	not relevant	1 Ω	Linear R 0 Ω ... 5 kΩ
3	4-conductor	120 ms	1000 Ω	0.1 °C	Ni 1000 DIN (= Ni DIN)
4	2-conductor	120 ms	not relevant	0.1 °C	Cu 10

The individual parameterization words are combined in accordance with the modular principle.

Channel	Parameter word (hex)	Parameter word (bin)															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Conductor		Filter		R0				Resolution		0	0	Sensor type			
1	0000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	700E	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0
3	8C02	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
4	4044	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0

This results in the following parameter table:

Element	Meaning	Value (hex)
1	Parameterization of channel 1	0000
2	Parameterization of channel 2	700E
3	Parameterization of channel 3	8C02
4	Parameterization of channel 4	4044
5	Data format, system bits	0000
6	Reserved	0000

25 Device descriptions

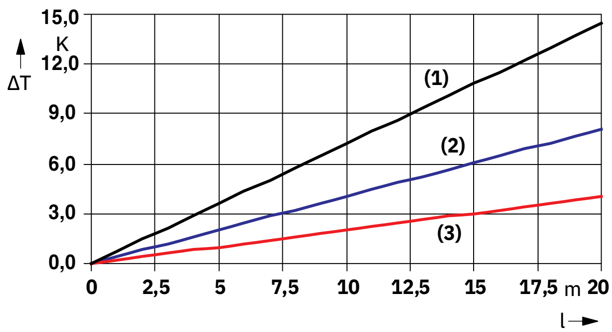
The device is described in the device description files. The device descriptions for controllers from Phoenix Contact are included in PC Worx and PLCnext Engineer, as well as in the corresponding service packs.

The device description files for other systems are available for download in the download area of the installed bus coupler at the following address: www.phoenixcontact.com/products.

26 Measuring errors caused by connecting cables for sensors with 2-conductor connection

Diagram 1

Figure 9 Systematic temperature measuring error ΔT depending on the cable length l



Curves depending on cable cross section A

1 Temperature measuring error for A = 0.14 mm²

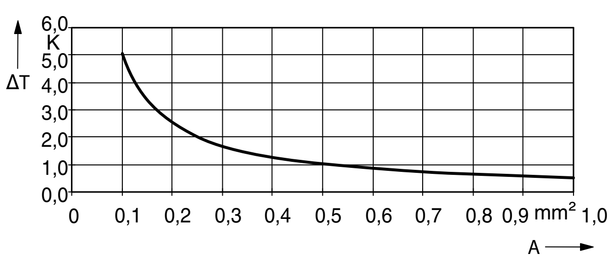
2 Temperature measuring error for A = 0.25 mm²

3 Temperature measuring error for A = 0.50 mm²

(Measuring error valid for: copper cable χ = 57 m/Ωmm², T_A = 25 °C and Pt 100 sensor)

Diagram 2

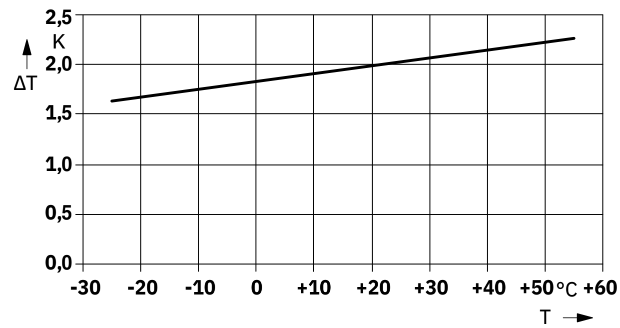
Figure 10 Systematic temperature measuring error ΔT depending on the cable cross section A



(Measuring error valid for: copper cable χ = 57 m/Ωmm², T_A = 25°C, l = 5 m, and Pt 100 sensor)

Diagram 3

Figure 11 Systematic temperature measuring error ΔT depending on the cable temperature T



(Measuring error valid for: copper cable χ = 57 m/Ωmm², T_A = 25°C, l = 5 m, A = 0.25 mm², and Pt 100 sensor)

Conclusion

All diagrams show that the increase in cable resistance causes the measuring error.

A considerable improvement is made when Pt 1000 sensors are used. Due to the 10-fold higher temperature coefficient α (α = 0.385 Ω/K for Pt 100 to α = 3.85 Ω/K for Pt 1000) the effect of the cable resistance on the measurement is decreased by factor 10. All errors in the diagrams above would be reduced by factor 10.

Diagram 1 clearly shows the effect of the cable length on the cable resistance and therefore on the measuring error. The solution is to use the shortest possible sensor cables.

Diagram 2 shows the influence of the cable diameter on the cable resistance. It can be seen that cables with a diameter of less than 0.5 mm² cause the error to increase exponentially.

Diagram 3 shows the influence of the ambient temperature on the cable resistance. This parameter is of minor importance and can hardly be influenced. It is mentioned here only for the sake of completeness.

The formula for calculating the cable resistance is as follows:

$$R_L = R_{L20} \times (1 + 0{,}0039 \frac{1}{K} \times (T - 20°C))$$

$$R_L = \frac{l}{\chi \times A} \times (1 + 0{,}0039 \frac{1}{K} \times (T - 20°C))$$

Where:

R_L	Cable resistance in Ω
R_{L20}	Cable resistance at 20°C in Ω
l	Cable length in m
χ	Specific electrical resistance of copper in m/Ωmm²
A	Cable cross section in mm²
0.0039 1/K	Temperature coefficient for copper (percentage purity of 99.9%)
T	Ambient temperature (cable temperature) in °C

Since there are two cable resistances in the measuring system (forward and return), the value must be doubled. The absolute measuring error in Kelvin [K] is provided for platinum detectors according to DIN using the average temperature coefficient χ (χ = 0.385 Ω/K for Pt 100; χ = 3.85 Ω/K for Pt 1000).

27 Calculation examples

27.1 Calculation base for the following examples

For the measuring temperature in question, use the measuring range -200°C ... +200°C.

For the tolerances, go to section “Tolerances in 4-conductor technology at 25°C”.

Extract from the table:

No.	Sensor type	Measuring range		Absolute tolerance		Relative tolerance (with reference to MRFV)	
		Lower limit	Upper limit	Typical	Maximum	Typical	Maximum
1	Pt 100 DIN and SAMA	-200 °C	+200 °C	±0.05 K	±0.25 K	±0.03%	±0.13 %

For the drift, go to section “Tolerance and temperature response (drift behavior) for 4-conductor connection”.

Extract from the table:

Tolerance and temperature response at T_A = -25 °C ... +60 °C				
Sensor type	Measuring range		Drift	
	Lower limit	Upper limit	Typical	Maximum
Pt 100 DIN and SAMA	-200 °C	+200 °C	±3 ppm/K	±18 ppm/K

27.2 Typical temperature behavior

Task setting:

Temperatures of up to +45°C are achieved in the control cabinet.

1. What typical drift values of the measuring inputs are to be expected for temperature measurement with a Pt100 sensor using 4-conductor technology at a measuring temperature of+180°C for this device?
2. What typical measuring tolerance is to be expected at +45°C?

Calculation:

The temperature difference is calculated using the formula (1):

$$\Delta T_U = T_S - 25\ °C \qquad (1)$$

Where:

ΔT_U	Temperature difference (difference between current switch cabinet temperature and reference temperature of +25°C)
T_S	Current temperature in the switch cabinet

Value for this example:

T_S	= 45 °C

According to formula (1)

$$\Delta T_U = T_S - 25\ °C$$
$$= 45\ °C - 25\ °C$$
$$= 20\ K$$

The temperature drift of the Pt 100 sensor is calculated according to formula (2):

$$T_{Drift} = \Delta T_A \times T_K \times T_M \qquad (2)$$

Where:

T_{Drift}	Temperature drift of the Pt 100 measuring input
ΔT_U	Temperature difference; from formula (1)
T_K	Temperature coefficient
T_M	Measuring range final value

Values for this example:

ΔT_U	= 20 K
T_K	= ±3 ppm/K (typical drift)
T_M	= 200 °C

According to formula (2)

$$T_{Drift} = \Delta T_U \times T_K \times T_M$$
$$= 20\ K \times \pm 3\ ppm/K \times 200\ °C$$
$$= 20 \times \pm 3 \times 10^{-6} \times 200\ °C$$
$$= \pm 0.012\ K$$
$$T_{Drift} = \pm 0.01\ K$$

Solution:

Under these marginal conditions, a typical temperature drift of ±0.01 K is to be expected.

Calculation of the typical measuring tolerance:

The measuring tolerance is calculated using the formula (3):

$$\Delta T_{Tot} = \Delta T_{25} + T_{Drift} \qquad (3)$$

Where:

ΔT_{Tot}	Total tolerance
ΔT_{25}	Typical tolerance at 25°C
T_{Drift}	Drift at 45°C; from formula (2)

Values for this example:

ΔT_{25}	= ±0.05 K (typical absolute tolerance)
T_{Drift}	= ±0.01 K

According to formula (3)

$$\Delta T_{Tot} = \Delta T_{25} + T_{Drift}$$
$$= \pm 0.05\ K + \pm 0.01\ K$$
$$\Delta T_{Tot} = \pm 0.06\ K$$

Solution:

At an ambient temperature of +45°C, a typical measuring tolerance of ±0.06 K is to be expected.

27.3 Maximum temperature behavior (worst case)

Task setting:

Temperatures of up to +40°C are achieved in the control cabinet.

What typical drift values of the measuring inputs are to be expected for temperature measurement with a Pt100 sensor using 4-conductor technology at a measuring temperature of +200°C for this device?

Calculation:

The measuring tolerance is calculated using the formula (3):

$$\Delta T_{Tot} = \Delta T_{25} + T_{Drift} \qquad (3)$$

Values for this example:

ΔT_{25}	= ±0.25 K (maximum absolute tolerance)
T_{Drift}	Must be calculated

To calculate the drift, proceed as described in the example for the typical temperature response.

The temperature difference is calculated using the formula (1):

$$\Delta T_U = T_S - 25\ °C \qquad (1)$$

Value for this example:

T_S	= 40 °C

According to formula (1)

$$\begin{aligned} \Delta T_U &= T_S - 25\ °C \\ &= 40\ °C - 25\ °C \\ &= 15\ K \end{aligned}$$

The maximum temperature drift of the Pt 100 sensor is calculated according to formula (2):

$$T_{Drift} = \Delta T_A \times T_K \times T_M \qquad (2)$$

Values for this example:

ΔT_U	= 15 K
T_K	= ±18 ppm/K (maximum drift)
T_M	= 200 °C

According to formula (2)

$$\begin{aligned} T_{Drift} &= \Delta T_U \times T_K \times T_M \\ &= 15\ K \times \pm 18\ ppm/K \times 200\ °C \\ &= 15 \times \pm 18 \times 10^{-6} \times 200\ °C \\ &= \pm 0.054\ K \\ T_{Drift} &= \pm 0.05\ K \end{aligned}$$

The measuring tolerance is calculated using the formula (3):

According to formula (3)

$$\begin{aligned} \Delta T_{Tot} &= \Delta T_{25} + T_{Drift} \\ &= \pm 0.25\ K + \pm 0.05\ K \\ \Delta T_{Tot} &= \pm 0.30\ K \end{aligned}$$

Solution:

At an ambient temperature of +40°C, a maximum worst-case measuring tolerance of ±0.3 K is to be expected.