AXL F UTH4 1H

Axioline F, temperature recording module, analog inputs: 4



Data sheet
8672_en_04

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1 Description

The module is designed for use within an Axioline F station.
It is used to acquire signals from standard thermocouples in industrial applications.
The module supports various types of thermocouple conforming to DIN EN 60584-1 and DIN 46710 as well as linear voltages from -100 mV to +100 mV.
It also offers a voltage input from -5 V to +5 V.
Heating currents can be monitored here, for example, using a measuring transducer.
Both Pt 100 inputs (CJ1 and CJ2) can each be used as a sensor input or as an external cold junction.

Features

- 4 analog input channels to connect thermocouples or linear voltages from -100 mV to +100 mV
- 1 analog input channel for the connection of voltages from -5 V to +5 V
- Connection of sensors in 2-conductor technology
- Internal detection and compensation of cold junction temperature (can be parameterized)
- External connection of Pt 100 cold junction sensors possible
- Low tolerances (typically ±0.01% for sensor type K)
- Very low measuring tolerances, even in various mounting positions, due to built-in space compensation of the internal cold junction
- High temperature stability (typically 8 ppm/K)
- High resistance to electromagnetic interference (Class A)
- "Channel Scout" function
- Device rating plate stored
- Installation monitoring with indication via diagnostic LED for each channel

Observe these 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/2688598

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3 Ordering data

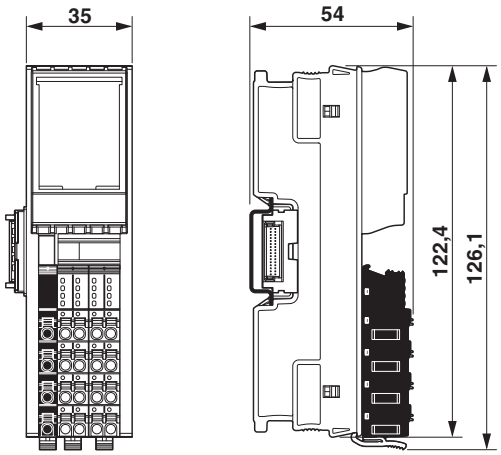
Description	Type	Item no.	Pcs./Pkt.
Axioline F, Temperature recording module, Analog inputs: 4 (4 inputs for thermocouples or linear voltage, plus 1 input -5 V to +5 V), connection technology: 2-conductor (shielded, twisted pair), transmission speed in the local bus: 100 Mbps, degree of protection: IP20, including bus base module and Axioline F connectors	AXL F UTH4 1H	2688598	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/2688598

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 grey A (RAL 7042)
Weight	144 g (with connectors and bus base module)
Ambient temperature (operation)	-25 °C ... 60 °C
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; Parameterize the mounting position using the object 0080_{hex} ParaTable!)

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	typ. 112 mA max. 160 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	typ. 23 mA max. 40 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	1.75 W
Analog inputs	
Number of inputs	4 + 1 (4 inputs for thermocouples or linear voltage, plus 1 input -5 V to +5 V)
Connection method	Push-in connection
Connection technology	2-conductor (shielded, twisted pair)
Sensor types that can be used (TC)	U, T, L, J, E, K, N, S, R, B, C, W, HK
Sensor types (RTD) that can be used	Pt 100 (2 external cold junctions, can also be used as a sensor input)
A/D converter resolution	24 bit
Measuring principle	Sigma/Delta process
Measured value representation	16 bits (15 bits + sign bit)
Input filter time	40 ms, 60 ms, 100 ms, 120 ms (adjustable)
Tolerance, relative	typ. 0.01 % (Thermocouple type K, NiCr-Ni) see tables for tolerance values
Tolerance, absolute	typ. ± 0.19 K (Thermocouple type K, plus tolerance of cold junction) see tables for tolerance values
Short-circuit protection, overload protection of the inputs	yes
Transient protection of inputs	yes
Crosstalk attenuation	typ. 113 dB (Channel/channel, sensor type K) typ. 114 dB (Channel/channel, sensor type linear voltage ±100 mV) typ. 107 dB (Channel/channel, external Pt 100 connection)
Common mode rejection (CMR): TC inputs/linear voltage	min. 100 dB (Channel/functional ground; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Common mode rejection (CMR): TC inputs/linear voltage	typ. 140 dB (Channel/functional ground; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Common mode rejection (CMR): TC inputs/linear voltage	min. 100 dB (Channel/AGND; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Common mode rejection (CMR): TC inputs/linear voltage	typ. 131 dB (Channel/AGND; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Common mode rejection (CMR): Voltage input -5 V ... +5 V	min. 95 dB (Channel/functional ground; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Common mode rejection (CMR): Voltage input -5 V ... +5 V	typ. 105 dB (Channel/functional ground; for DC up to 100 kHz, V_{cm} = -10 V ... +10 V)
Input resistance: TC inputs/linear voltage	typ. 20 MΩ (With 24 V I/O supply voltage present)
Input resistance: Voltage input -5 V ... +5 V	typ. 5 MΩ (With 24 V I/O supply voltage present)
Voltage at the TC input	max. 40 V DC (1 min.)

Input and output address area	
Input address area	10 Byte
Output address area	10 Byte

Configuration and parameter data in a PROFIBUS system	
Required parameter data	12 Byte
Required configuration data	7 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}) / functional ground	500 V AC, 50 Hz, 1 min
24 V supply (I/O) / functional ground	500 V AC, 50 Hz, 1 min

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 A for shielded cables, 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 and manufacturer's declarations	
The latest documents can be found at:	www.phoenixcontact.com/product/2688598

5 Additional technical data

5.1 Maximum permissible cable lengths

Connecting cable and maximum cable length specifications				
Maximum permissible cable length	**Sensor type**	**Connection technology**	**Sensor cable**	**Cable type**
10 m	TC inputs channel 1 ... 4	2-conductor	Unshielded, twisted	TC sensor cable or equalizing conductor (according to DIN EN 60584-3, IEC 60584-3, DIN 43722)
250 m	TC inputs channel 1 ... 4	2-conductor	Shielded, twisted	TC sensor cable or equalizing conductor (according to DIN EN 60584-3, IEC 60584-3, DIN 43722)
10 m	Inputs channel 1 ... 4, -100 mV ... +100 mV	2-conductor	Unshielded, twisted	Reference cable type LiYY (TP) 2 x 2 x 0.5 mm²
250 m	Inputs channel 1 ... 4, -100 mV ... +100 mV	2-conductor	Shielded, twisted	Reference cable type LiYCY (TP) 2 x 2 x 0.5 mm²
2 m	Pt 100 external cold junction sensor	2-conductor	Unshielded, twisted	Reference cable type LiYY (TP) 2 x 2 x 0.5 mm²
10 m	Pt 100 external cold junction sensor	2-conductor	Shielded, twisted	Reference cable type LiYCY (TP) 2 x 2 x 0.5 mm²
5 m	-5 V ... +5 V input	2-conductor	Shielded, twisted	Reference cable type LiYCY (TP) 2 x 2 x 0.5 mm²

TC inputs: select the appropriate TC equalizing conductors for TC sensors (according to DIN EN 60584-3, IEC 60584-3, and DIN 43722).

Other inputs: the values are valid when reference cable type LiYCY (TP) 2 x 2 x 0.5 mm² is used in accordance with the Axioline F installation instructions.

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

Observe the cable resistance values when operating the externalPt 100 cold junction. Long cables and/or small cable cross sections increase measuring tolerances.

The measuring tolerances of all channels will only be observed if the permissible cable types are used.

Using the Axioline shield connection set (AXL SHIELD SET), connect the braided shield at one end of the long sensor cables to the functional ground potential upstream of the F UTH4 1H module.

5.2 Measuring ranges of the TC inputs

Input	Sensor type	Standard	Measuring range		Average basic value for sensitivity	Voltage level at measuring range final value
			Lower limit	Upper limit		
Thermocouples	B	DIN EN 60584	+50 °C	+1820 °C	6 µV/K	13.820 mV
	E	DIN EN 60584	-270 °C	+1000 °C	65 µV/K	76.373 mV
	J	DIN EN 60584	-210 °C	+1200 °C	54 µV/K	69.553 mV
	K	DIN EN 60584	-270 °C	+1372 °C	42 µV/K	54.886 mV
	N	DIN EN 60584	-270 °C	+1300 °C	27 µV/K	47.513 mV
	R	DIN EN 60584	-50 °C	+1768 °C	10 µV/K	21.101 mV
	S	DIN EN 60584	-50 °C	+1768 °C	10 µV/K	18.693 mV
	T	DIN EN 60584	-270 °C	+400 °C	40 µV/K	20.872 mV
	C		-18 °C	+2316 °C	15 µV/K	37.07 mV
	W		-18 °C	+2316 °C	12 µV/K	38.56 mV
	HK		-200 °C	+800 °C	69 µV/K	66.42 mV
	L	DIN 43710	-200 °C	+900 °C	54 µV/K	53.14 mV
	U	DIN 43710	-200 °C	+600 °C	40 µV/K	34.31 mV

5.3 Tolerances of the measuring inputs at T_A = +25°C

Input	Sensor type	Measuring range		Absolute tolerance		Relative tolerance (with reference to MRFV)	
		Lower limit	Upper limit	Typical	Maximum	Typical	Maximum
Thermocouples	B	+500 °C	+1820 °C	±0.5 K	±4.17 K	±0.03%	±0.23 %
	E	-226 °C	+1000 °C	±0.15 K	±1.38 K	±0.02 %	±0.19 %
	J	-210 °C	+1200 °C	±0.19 K	±1.67 K	±0.02 %	±0.14 %
	K	-200 °C	+1372 °C	±0.19 K	±0.71 K	±0.01 %	±0.05 %
	N	-200 °C	+1300 °C	±0.39 K	±3.15 K	±0.03%	±0.23 %
	R	-50 °C	+1768 °C	±0.8 K	±2.5 K	±0.05 %	±0.14 %
	S	-50 °C	+1768 °C	±0.8 K	±2.5 K	±0.05 %	±0.14 %
	T	-270 °C	+400 °C	±0.18 K	±0.63 K	±0.04 %	±0.16 %
	C	-18 °C	+2316 °C	±0.53 K	±0.81 K	±0.02 %	±0.03%
	W	+250 °C	+2316 °C	±1.33 K	±2.5 K	±0.06 %	±0.11 %
	HK	-200 °C	+800 °C	±0.16 K	±1.3 K	±0.02 %	±0.16 %
	L	-200 °C	+900 °C	±0.15 K	±1.67 K	±0.02 %	±0.19 %
	U	-200 °C	+600 °C	±0.15 K	±0.75 K	±0.03%	±0.13 %
Internal cold junction	Pt DIN	-70 °C	+150 °C	±0.25 K	±1.6 K	±0.17 %	±1.07 %
External external cold junction sensor	Pt DIN	-100 °C	+400 °C	±0.3 K	±0.8 K	±0.08 %	±0.20 %
		-100 °C	+100 °C	±0.10 K	±0.60 K	±0.03%	±0.15 %
Voltage input	Linear voltage	-100 mV	+100 mV	±10 µV	±100 µV	±0.01 %	±0.10 %
		-30 mV	+30 mV	±7 µV	±30 µV	±0.007 %	±0.03%
		-10 mV	+10 mV	±5 µV	±25 µV	±0.005 %	±0.03%
5 V DC voltage input channel	Linear voltage	-5 V	+5 V	±1.5 mV	±10 mV	±0.03%	±0.10 %

MRFV= Measuring range final value

The tolerances of the thermocouple inputs (TC sensors) are based on differential temperature recording plus the tolerances due to cold junction compensation during nominal operation in the preferred mounting position.

Please observe the notes in the "Notes on the tolerance tables" section.

5.4 Temperature and drift response

	Measuring range	Drift	
		Typ.	Max.
External Pt 100	-100 °C ... +400 °C	±15 ppm/K	±30 ppm/K
	-100 °C ... +100 °C	±10 ppm/K	±25 ppm/K
Linear voltage	-10 mV ... +10 mV	±3 ppm/K	±12 ppm/K
	-30 mV ... +30 mV	±6 ppm/K	±15 ppm/K
	-100 mV ... +100 mV	±11 ppm/K	±20 ppm/K
Voltage input	-5 V ... +5 V	±13 ppm/K	±25 ppm/K
TC inputs	Type K	±8 ppm/K	±20 ppm/K

1. The data refers to nominal operation (U_A = 24 V) in the preferred mounting position (horizontal).
2. The measurement is performed within an Axioline F station in which another AXL F UTH4 1H module is located to the right and left of the module in question.
3. The drift values refer to the full measuring range final value, i.e., 1372°C in the case of TC sensor type K, +400°C in the case of the external Pt 100, and +100 mV in the case of the linear voltage.

5.5 Tolerances for TC sensor type K with internal cold junction compensation

Temperature	Absolute tolerance		Relative tolerance (with reference to MRFV)	
	Typ.	Max.	Typ.	Max.
+25 °C	±0.20 K	±2.4 K	±0.01 %	±0.17 %
-25 °C ... +60 °C	±0.71 K	±3.9 K	±0.05 %	±0.28 %

MRFV= Measuring range final value

The tolerances of the thermocouple inputs (TC sensors) are based on absolute temperature recording during nominal operation in the preferred mounting position.

Please observe the notes in the "Notes on the tolerance tables" section.

5.6 Notes on the tolerance tables

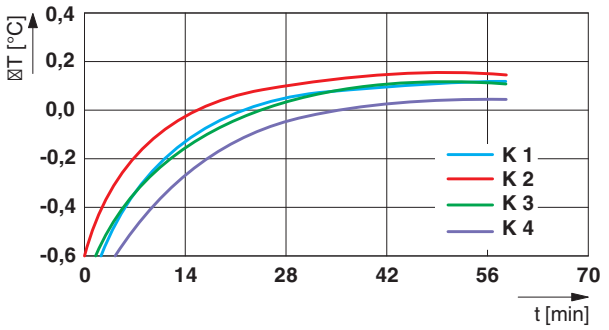
The following notes apply for the tables:

– Tolerances of the measuring inputs at T_A = +25°C
– Tolerances for TC sensor type K with internal cold junction compensation

1. The measurement is performed within an Axioline F station in which another AXL F UTH4 1H module is located to the right and left of the module in question.
2. In order to achieve optimum accuracy in the various mounting positions of the station, different installation positions can be configured.
3. The tolerance values for the TC inputs are based on the average basic values for sensitivity (see table for measuring ranges of the TC inputs).
4. The typical values were determined from the maximum tolerances of the measured practical values.
5. The maximum tolerances represent the worst-case measurement inaccuracy. They contain the theoretical maximum possible tolerances in the measuring ranges as well as the theoretical maximum possible tolerances of the test and calibration 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.
6. An additional path calibration function for maximum accuracy is possible at any time in the application (see object 008F_{hex} path calibration values). Using the temperature offset, you can finely tune the tolerances for each channel by means of the connecting cables and the sensors. The specified tolerances are then reduced accordingly.
7. The tolerances increase slightly for a short time immediately after power up (see switch-on behavior section).
8. In the -100 mV ... +100 mV linear voltage input range, smaller measuring windows with closer tolerances were also specified. The reference value of the relative tolerance value is always based on +100 mV.
9. Please note when using linear voltage signals: for voltages above +32.7 mV and below -32.7 mV, parameterize the process data resolution as 10 µV/LSB (instead of 1 µV/LSB) in order to prevent overrange or underrange messages from occurring.
10. Always position temperature modules at the end of the station. For modules that must be positioned next to a bus coupler, the typical measuring tolerance can be increased by up to 0.9 K.
11. The maximum tolerances are observed even in the event of electromagnetic interference (see also Table "Tolerances influenced by electromagnetic interference"). They apply for both shielded and unshielded I/O cables.

5.7 Switch-on behavior of TC inputs with internal cold junction compensation

Figure 1 Typical switch-on behavior of type K TC sensors with internal cold junction compensation



K1 ... K4 Channel 1 ... channel 4

Transient period	Typical tolerance
5 minutes	-0.7 K
10 minutes	-0.3 K
35 minutes	±0.2 K
45 minutes	±0.2 K

1. The switch-on behavior must only be taken into consideration for TC measurements with internal cold junction temperature, it does not apply for differential measurements or measurements with external compensation.
2. The typical characteristic curves of the TC inputs after power up were recorded in the preferred mounting position (horizontal), in nominal operation (U_A = 24 V, T_A = 25°C), and with unobstructed ventilation ducts (free air flow).
3. The measurement is performed within an Axioline F station in which another AXL F UTH4 1H module is located to the right and left of the module in question.
4. Different installation positions or arrangements where the module is affected by external sources of heat can result in a different thermal switch-on behavior.
5. The measuring probes of the type K TC sensors were kept at a constant temperature.

In the event of sudden changes in the ambient temperature of the temperature module (e.g., from T_A = +25°C to T_A = +60°C), the time curve for the transient response is comparable with that of the switch-on behavior.

5.8 Switch-on behavior of TC inputs with external cold junction compensation

The module supports the connection of up to two external Pt 100 cold junction sensors.

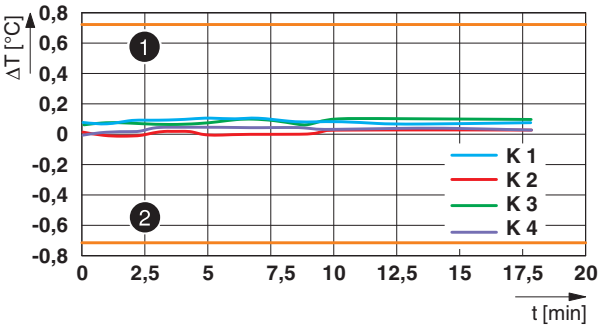
Connection example: Figure 8

If you use this function, use copper cables from the isothermal cold junction up to the module connector.

The advantage of this is the very fast warm-up behavior of just a few seconds.

Even in the event of extreme temperature fluctuations in the environment where the Axioline F station is located, the system operates very quickly and precisely. There is also the option of adjusting all sensor and cable tolerances in the application via an additional path calibration function.

Figure 2 Typical switch-on behavior of type K TC sensors with external Pt 100 cold junction compensation and path calibration function for the cold junction at connector 1 at an ambient temperature of +25°C



1 Maximum tolerance limit

2 Minimum tolerance limit

K1 ... K4 Channel 1 ... channel 4

5.9 Technical data for cold junctions

Internal cold junctions

Simple cold junction compensation can be implemented for the thermocouple inputs using the internal cold junctions.

To read the temperature of each internal cold junction for TC channels, parameterize the sensor type as "Cold Junction".

The tolerance values are listed in the corresponding tables.

Internal cold junction	
Connection technology	2-conductor connection
Sensor type	Pt 100 DIN
R_0 (sensor resistance at T_A = 0 °C)	100 Ω
Measuring range	-55 °C ... +125 °C
Resolution (process data)	0.1 K/LSB
Resolution (floating point object)	< 0.001 K
Filter time	120 ms

Compensation of the mounting position of the internal cold junction

In order that the lowest measurement tolerance is also achieved when installed in various different mounting positions, it is possible to compensate the mounting position of the internal cold junction.

Parameterize this compensation using the ParaTable object, data format, mounting position.

Tolerances of the internal cold junction

Tolerance structure	Temperature	Tolerances	
		Typ.	Max.
Cold junction temperature drift	-25 °C ... +60 °C	10 ppm/K	25 ppm/K
Total tolerance of the internal cold junction	+25 °C	±0.15 K	±1.76 K
Total tolerance of the internal cold junction	-25 °C ... +60 °C	±0.85 K	±2.4 K

* Thermally steady system without external heat influence

1. The data refers to nominal operation (U_A = 24 V) in the preferred mounting position (horizontal).
2. The measurement is performed within an Axioline F station in which another AXL F UTH4 1H module is located to the right and left of the module in question.

ExternalPt 100 cold junctions

When using external isothermal blocks or distributed terminal boxes, an external cold junction is recommended. The advantage of this is an improved switch-on behavior and the very fast thermal transient period in the event of sudden changes to the ambient temperature of the measuring station.

You can connect up to two Pt 100 sensors to the AXL F UTH4 1H module.

You can also use the inputs for the external cold junction sensors as sensor inputs for any applications involving Pt 100 and connection in 2-conductor technology. To do this, parameterize the sensor type as “Cold junction” and the cold junction type as “External Pt 100” on the corresponding connector.

ExternalPt 100 cold junctions	
Connection technology	2-conductor connection
Sensor type	Pt 100 DIN
R_0 (sensor resistance at T_A = 0 °C)	100 Ω
Measuring range	-100 °C ... +400 °C
Resolution (process data)	0.1 K/LSB
Resolution (floating point object)	< 0.001 K
Filter time	120 ms

Tolerances of the external Pt 100 cold junction inputs

	Ambient temperature	Tolerances	
		Typ.	Max.
Tolerances	+25 °C	±0.3 K	±0.8 K
Drift	-25 °C ... +60 °C	±10 ppm/K	±25 ppm/K

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

The data is valid for nominal operation (preferred mounting position, U_A = 24 V).

The documented typical tolerances were determined for reference cable type LiYCY (TP) 2 x 2 x 0.5 mm² with a connection length < 1 m.

The drift data and percentage tolerance values refer to the measuring range final value of +400°C.

The typical data has been determined in an example Axioline F station.

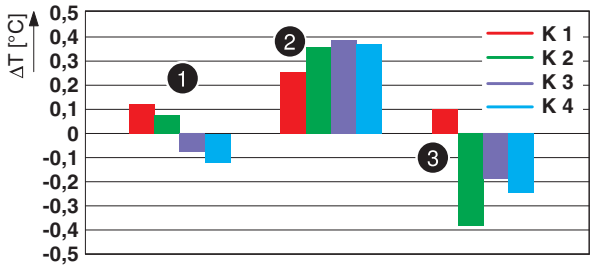
Typical tolerance values are measured application values that are based on the maximum variance of all test objects.

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.

To achieve maximum accuracy (< ±0.1 K, it is possible to calibrate a measuring section.
To do so, carry out fine adjustment of the tolerances of the connecting cables and the external Pt 100 sensor with object $008F_{hex}$: local adjust values.

Drift response of the TC inputs with external cold junction compensation

Figure 3 Typical tolerance distribution of type K TC detection with external cold junction compensation and path calibration function for the cold junction



1	Ambient temperature +25°C
2	Ambient temperature +60°C
3	Ambient temperature -25 °C
K1 ... K4	Channel 1 ... channel 4

The diagram shows the typical tolerance distribution in the entire ambient temperature range of the module with external Pt 100 compensation and path calibration of the cold junction in the entire ambient temperature range of T_U = -25°C ... +60°C.

The advantages of external cold junction compensation are, on the one hand, immediate measuring accuracy without thermal switch-on behavior and, on the other hand, high temperature stability.

For maximum accuracy, path calibration is possible. This can be carried out channel-specific using object $008F_{hex}$. You can therefore calibrate the tolerances of the entire measuring section including the sensor and connecting cable.

5.10 Technical data for the ±5 V DC voltage input

This input is used to acquire additional voltage signals.

Connect a signal converter to the input. This can be used to acquire any AC or DC currents which are converted by the converter into an electrically isolated ±5 V signal. This ±5 V signal is processed by the module.

Connection example: Figure 13

±5 V voltage input	
Connection technology	2-conductor connection
Measuring range	-5 V ... +5 V
Format	IB IL
Resolution	16 bits
Quantization	166.7 µV/LSB
Filter time	120 ms
Input resistance	typ. 5 MΩ

Tolerances of the voltage input

	Temperature	Absolute		Relative	
		Typ.	Max.	Typ.	Max.
Tolerance	+25 °C	±1 mV	±10 mV	±0.02 %	±0.20 %
Tolerance	-25 °C ... +60 °C	±2.3 mV	±15 mV	±0.05 %	±0.30 %
Drift	-25 °C ... +60 °C	±8 ppm/K	±20 ppm/K		

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.

Use an isolating amplifier to decouple from the field the sensor signals which go to the sensor input. The MCR range from Phoenix Contact offers various solutions (see also connection example "Universal AC and DC current acquisition by means of combination with a current transducer").

5.11 Cycle times

Filter time	Channel conversion time for TC operation with internal compensation
120 ms	120 ms
100 ms	100 ms
60 ms	60 ms
40 ms	40 ms

Filter time	Typical scan repeat time for all four measuring channels
	TC operation with internal cold junction compensation
120 ms	962 ms
100 ms	880 ms
60 ms	720 ms
40 ms	640 ms

Filter time	Typical scan repeat time for a measuring channel
	TC operation with internal cold junction compensation; channels 2 ... 4 deactivated
120 ms	600 ms
100 ms	580 ms
60 ms	540 ms
40 ms	520 ms

5.12 Additional 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 values determined apply for both shielded and unshielded twisted sensor cables. The maximum cable lengths should be taken into consideration.

For all tested electromagnetic interferences (see table), the measured values were within the maximum tolerances.

The values were determined under nominal conditions with the following sensor settings and sensor circuits:

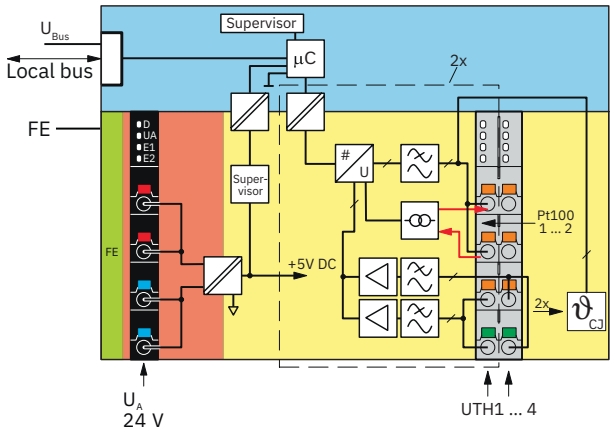
– Thermocouple type K (NiCr-Ni) with internal cold junction compensation, filter = 120 ms
– External RTD sensor type Pt 100 as sensor input, filter = 120 ms
– -100 mV ... +100 mV linear voltage signals, 1 µV/LSB resolution, filter = 120 ms

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).

6 Internal circuit diagram

Figure 4 Internal wiring of the terminal points



Key:

Local bus	Axioline F local bus (hereinafter referred to as local bus)
FE	Functional ground
µC	Microcontroller
Supervisor	Hardware monitoring
	Electrical isolation for data or power supply
#	Analog/digital converter
	Low pass filter
	Constant current source
	Difference amplifier
	Reference ground of I/O devices
CJ	Cold junction (CJ)
	Electrically isolated areas

7 For your safety

7.1 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.

7.2 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.

7.3 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.

7.4 Installation

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

Mount and install the device in such a way that the disconnecting device can be operated without restriction.

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.

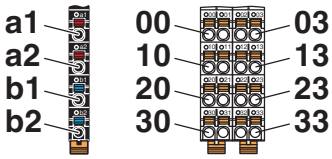
NOTE: Damage to the contacts

Physical overloads can result in damage to the terminal points.

- Relieve strain in the connected cables.

8 Terminal point assignment

Figure 5 Terminal point assignment

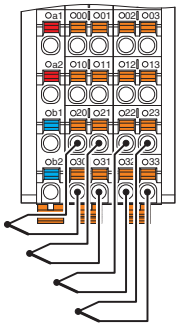


Terminal point	Color	Assignment	
Supply voltage input			
a1, a2	Red	24 V DC (U_A)	Supply for analog modules (bridged internally)
b1, b2	Blue	GND	Reference potential of the supply voltage (bridged internally)
Analog inputs			
00, 02	Orange	CJ1+, CJ2+	External external cold junction sensor (+)
01	Orange	-	Not used
10, 12	Orange	CJ1-, CJ2-	External external cold junction sensor (-)
11	Orange	-	Not used
03	Orange	U+	Voltage input 5 V (+)
13	Orange	U-	Voltage input 5 V (-)
20 ... 23	Orange	TC1+ ... TC4+	Thermocouple (+)
30 ... 33	Orange	TC1- ... TC4-	Thermocouple (-)

9 Connection examples

9.1 Absolute temperature measurement with internal cold junction compensation

Figure 6 Connection example: absolute temperature measurement



A thermocouple sensor is connected to each of the four channels.

For example, sensor type J (TC1) and sensor type K (TC2) are used at channels 1 and 2.

The measuring temperature of TC1 and TC2 is automatically determined by the module by means of internal cold junction compensation.

Parameterize the cold junction type as "Internal" (preset by default).

This application is the simple standard application for temperature recording with thermocouples.

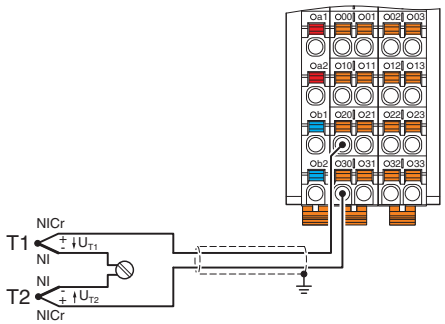
9.2 Differential temperature measurement

Precise differential temperature recording is a special application, e.g., in process engineering and process technology. You can determine the exact differential temperature, e.g., between an inlet and return temperature, by connecting two thermocouples in series to one channel of the module.

Parameterize the cold junction type as "Disabled".

The pure differential temperature between the measuring points will therefore be recorded.

Figure 7 Differential temperature measurement



By linking the two thermocouples (here type K, NiCr-Ni), the temperature difference between both thermoelectric voltages is determined.

$$T_D = T1 - T2$$
$$U_M = UT1 - UT2$$

Where:

T_D	Temperature difference
T1/T2	Temperature at sensor 1/2
U_M	Differential thermoelectric voltage
U_{T1}/U_{T2}	Thermoelectric voltage sensor 1/2

The advantage of this application is the high degree of precision without a waiting time to warm up.

9.3 Thermocouple detection with external cold junction compensation

For applications with a high degree of precision, the module offers the option of compensation using an external cold junction.

Each connector has a connection for an external Pt 100 cold junction sensor.

External cold junction compensation is implemented for each channel.

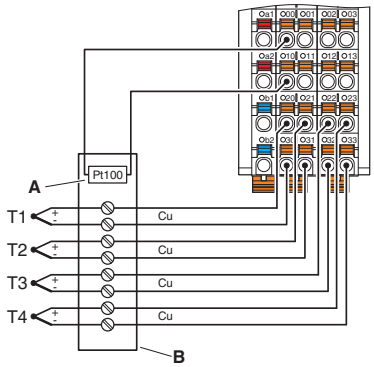
Proceed as follows:

- Route the sensor cables of the thermocouple to an isothermal block.
- For each channel, wire a copper (Cu) connecting cable from the isothermal block to the input terminals of the module.
- Connect the external Pt 100 cold junction sensor to the isothermal block using a Pt 100 input of connector 1 or 2 (connector 1 in the example).
- Parameterize the cold junction type of the desired input channel as “External, Pt 100, connector x” (x = 1 or 2; channel 1 in the example)

The advantage of this application is the improved warm-up behavior in the first few minutes after the module is switched on.

As an input is available at each connector for an external Pt 100 cold junction sensor, you can operate up to two external cold junction sensors. If you have connected two cold junction sensors, you can then select any cold junction type, i.e., you can use the Pt 100 of connector 1 or 2.

Figure 8 Thermocouple detection with external cold junction compensation at channel 1



A Pt 100 external cold junction sensor

B Isothermal block

9.4 Thermocouple detection with cold junction temperature specification via process data

Another option for compensating the cold junction temperature externally is to specify the cold junction temperature via process data.

In this way, the temperature of the external cold junction can be recorded at the isothermal block via any system and used for compensation.

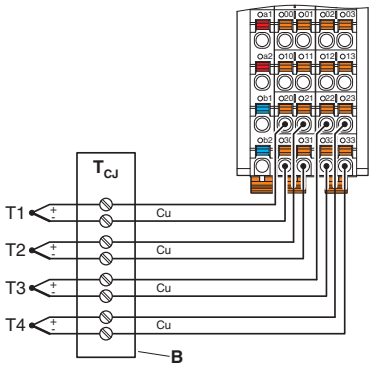
Proceed as follows:

- Route the sensor cables of the thermocouple to an isothermal block.
- For each channel, wire a copper (Cu) connecting cable from the isothermal block to the input terminals of the module.
- Write the cold junction temperature recorded externally by the isothermal block to the first process data output word of the module in your application (IB IL format).
- Parameterize the cold junction type of the desired input channel as "Process data".

For each module, you can use a digital external process data value for cold junction compensation.

OUT0 = T_{CJ}	0	0	0	0

Figure 9 Thermocouple detection with cold junction temperature specification via process data



T_{CJ} Cold junction temperature

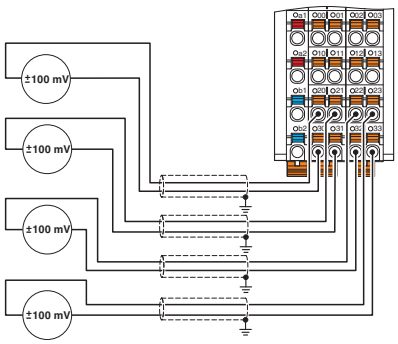
B Isothermal block

9.5 Measurement of linear mV voltage signals

You can connect sensors to each channel which supply a linear voltage in the mV range, e.g., pressure or Hall sensors.

- Parameterize the corresponding channel as sensor type “Linear voltage ±100 mV”.

Figure 10 Measurement of linear voltages ±100 mV



A cable break on the sensor cables is monitored and detected.

The ±10 mV and ±30 mV ranges are more accurate than the entire ±100 mV range and have therefore also been specified.

For mV sensors, cable lengths of up to 250 m are possible. Please note the cable length specifications and suitable sensor cable types.

For voltages above +32.7 mV and below -32.7 mV, parameterize the process data resolution as 10 µV/LSB (instead of 1 µV/LSB) in order to prevent overrange or underrange messages from occurring.

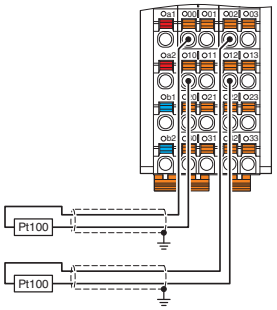
9.6 Pt 100 detection

You can also use the inputs for external Pt 100 cold junction sensors as Pt 100 sensor inputs.

To do this, proceed as follows:

- Connect the Pt 100 sensor in 2-conductor technology to connector 1 or 2.
- Parameterize a desired channel as sensor type “Cold junction (CJ)” and parameterize the cold junction type as “External, Pt 100, connector x” (x = 1 or 2).
- Record the temperature value of the external Pt 100 sensor at the parameterized channel with a resolution of 0.1 K/LSB.

Figure 11 Pt 100 detection



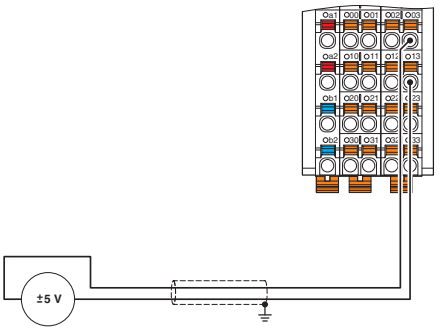
Make sure that the sensor cable is no more than 10 m in length.

To achieve maximum accuracy (< ±0.1 K, it is possible to calibrate a measuring section.
To do so, carry out fine adjustment of the tolerances of the connecting cables and the external Pt 100 sensor with object 008F$_{hex}$: local adjust values.

9.7 Measurement of a ±5 V signal

A -5 V ... +5 V input is available for acquisition from a wide range of signal sources.

Figure 12 Measurement of a linear voltage ±5 V DC



Make sure that the shielded twisted sensor cable is no more than 5 m in length at the ±5 V input.

If longer cable lengths are required, connect appropriate converters or signal conditioners upstream.

The MCR range from Phoenix Contact offers a comprehensive range of products for this.

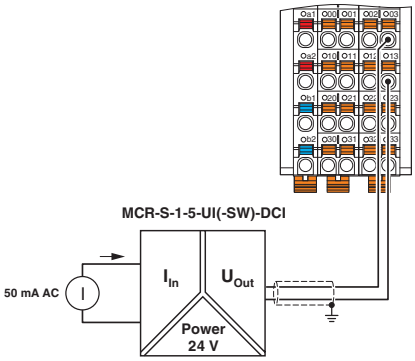
In this way, you can acquire isolated Pt100 signals, for example, from very remote areas (>100 m), with a temperature transducer (e.g., MCR-T-UI-E) in 4-conductor technology and read them in via the -5 V ... +5 V input. You can use this for external cold junction compensation of very remote control boxes, if copper TC sensor cables need to be used.

9.8 Universal AC and DC current acquisition in combination with a current transducer

Any AC or DC currents with 300 V AC safe isolation in accordance with EN 50178, EN 61010, such as heating currents, can be acquired via the 5 V voltage input (terminal points 03 and 13) using a current transducer.

For signal conditioning, use the MCR-S-1-5-UI(-SW)-DCI current transducer from Phoenix Contact, for example.

Figure 13 Measurement of an AC or DC current signal at the -5 V voltage input ... +5 V DC in combination with a current transducer (heating current acquisition)



I_{In}	AC/DC input current, 0 mA ... 200 mA up to 0 A ... 11 A, 15 Hz ... 400 Hz
U_{Out}	-5 V DC ... +5 V DC output voltage
MCR-S-1-5-UI(-SW)-DCI	Current measuring transducer

Make sure that the shielded twisted sensor cable is no more than 5 m in length from the current transducer to the temperature module.

If longer cable lengths are required, connect appropriate converters or signal conditioners upstream.

The MCR range from Phoenix Contact offers a comprehensive range of products for this.

10 Connection notes

Observe the connection notes by the thermocouple manufacturer.

Use encapsulated thermocouples.

Always connect the thermocouples using twisted pair equalizing conductors.

Use shielded twisted pair equalizing conductors for a cable length from 10 m.

Use shielded, twisted connecting cables (e.g., LiYCY (TP) 2 x 2 x 0.5 mm²) for mV sensors in environments subject to interference as well as for sensor cables which are longer than 10 m.

For TC sensors, use the corresponding shielded TC connecting cable according to DIN EN 60584-3/ISO 60584-3.

Shielding

For installation in a control cabinet: Connect the cable shield to the functional ground immediately after the cables enter the control cabinet. Route the shield as far as the Axioline F temperature module without interruption.

For optimum shield connection directly before the module, use the AXL SHIELD SET Axioline shield connection set (see ordering data).
Please refer to the UM EN AXL SYS INST user manual for information on how to install the set and connect the shield.

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.

11 Configuration notes

Always position temperature modules at the end of the station. For modules that must be positioned next to a bus coupler, the typical measuring tolerance can be increased by up to 0.9 K.

12 Local diagnostic and status indicators

Figure 14 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

Designation	Color	Meaning	State	Description
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, or supply for analog modules (U_A) not present
				Errors which affect the entire device (e.g., parameter table invalid); Such errors are only displayed on active channels.
		OK	Green on	Normal operation, installation OK
		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

13 Process data

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

The module uses five words of IN process data and five words of OUT process data.

13.1 Input words IN0 to IN4

The measured values of the TC channels are transmitted to the higher-level system via the process data input words IN0 to IN3.

IN4 is used to transmit the measured value for the voltage input.

The measured values are depicted in IB IL or S7-compatible format. In both cases, the measured value is displayed in 16 bit format.

IN0: measured value channel 1
:
IN3: measured value channel 4
IN4: measured value voltage input

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

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
8008	Cold junction defective
8010	Parameter table invalid
8020	Supply voltage faulty (supply for analog modules (U_A))
8040	Device faulty
8080	Below measuring range (underrange)

Note regarding code 8008_{hex}:in the event of a cold junction error, code 8008_{hex} is indicated for the channel to which the affected cold junction is assigned.
In order to determine the exact cause of the error, select the "Cold junction" sensor type via the parameterization. The detailed error message is then output for this channel (8080_{hex}, 8001_{hex} or 8002_{hex}).

13.2 Output words OUT0 to OUT4

OUT0: cold junction temperature specification
OUT1: -
:
OUT4: -

14 Wire break

14.1 Channels 1 to 4 (TC/linear voltage)

Channels 1 to 4 are monitored for wire breaks.

As soon as a wire break occurs, this is indicated in the process data and in PDI object 0018_{hex}.

In addition, the corresponding diagnostic LED for the channel lights up red.

14.2 Voltage input ±5 V

In the event of an error, the voltage input value goes to 0.

A diagnostic message is not generated, this error is not indicated at the diagnostic LEDs either.

15 Significant values in various formats

15.1 Significant values in IB IL format

Input data		Temperature sensors		Linear voltage ±100 mV	
Resolution		1 °C or 1 °F	0.1 °C or 0.1 °F	1 µV	10 µV
hex	dec	°C or °F	°C or °F		
8001	Overrange	> Limit value	> Limit value	> 32.512 mV	> 100 mV
03E8	1000	+1000.0	+100.0	+1 mV	+10 mV
0001	1	+1.0	+0.1	+1 µV	+10 µV
0000	0	0	0	0 µV	0 µV
FFFF	-1	-1	-0.1	-1 µV	-10 µV
FC18	-1000	-1000.0	-100.0	-1 mV	-10 mV
8080	Underrange	< Limit value	< Limit value	< -32.512 mV	< -100 mV

15.2 Significant values in S7-compatible format

Input data		Temperature sensors		Linear voltage ±100 mV	
Resolution		1 °C or 1 °F	0.1 °C or 0.1 °F	1 µV	10 µV
hex	dec	°C or °F	°C or °F		
8000	Overrange	> Limit value	> Limit value	> 32.512 mV	> 100 mV
03E8	1000	+1000.0	+100.0	+1 mV	+10 mV
0001	1	+1.0	+0.1	+1 µV	+10 µV
0000	0	0	0	0	0
FFFF	-1	-1	-0.1	-1 µV	-10 µV
FC18	-1000	-1000.0	-100.0	-1 mV	-10 mV
7FFF	Underrange	< Limit value	< Limit value	< -32.512 mV	< -100 mV

16 Parameter, diagnostics and information (PDI)

16.1 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.

16.2 Retentive storage

The module has 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.

17 Standard objects

17.1 Objects for identification (device rating plate)

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

If an object contains several elements, the content is listed in the table in a structured way, e.g. hardware version divided into date and version.

Index (hex)	Object name	Data type	Length in bytes	Rights	Meaning	Contents
Manufacturer						
0001	VendorName	Visible String	16	R	Vendor name	Phoenix Contact
0002	VendorID	Visible String	7	R	Vendor ID	00A045
0003	VendorText	Visible String	49	R	Vendor text	Components and systems for industrial automation
0012	VendorURL	Visible String	23	R	Vendor URL	www.phoenixcontact.com
Module - general						
0004	DeviceFamily	Visible String	14	R	Device family	I/O analog IN
0006	ProductFamily	Visible String	6	R	Product family	AXL F
000E	CommProfile	Visible String	4	R	Communication profile	633
000F	DeviceProfile	Visible String	5	R	Device profile	0010
0011	ProfileVersion	Record [2] of Visible Strings	31	R	Profile version	2011-12-07; Basis - Profil V2.0
0017	Language	Record [2] of Visible Strings	14	R	Language	en-us; English
Module - special						
0005	Capabilities	Visible String	8	R	Capabilities	Nothing
0007	ProductName	Visible String	14	R	Product name	AXL F UTH4 1H
0008	SerialNo	Visible String	11	R	Serial number	e. g., 1234512345
0009	ProductText	Visible String	24	R	Product text	4 analog input channels
000A	OrderNumber	Visible String	8	R	Item No.	2688598
000B	HardwareVersion	Record [2] of Visible Strings	14	R	Hardware version	e. g., 2010-06-21; 01
000C	FirmwareVersion	Record [2] of Visible Strings	17	R	Firmware version	e. g., 2010-06-21; V1.10
000D	PChVersion	Record [2] of Visible Strings	17	R	PDI version	2010-01-08; V1.00
0037	DeviceType	Octet string	8	R	Device type	00 20 00 08 00 00 00 $A8_{hex}$
003A	VersionCount	Array [4] of UINT16	8	R	Version counter	e. g., 0007 0001 0001 0001_{hex}
Use of the device						
These parameters are stored retentively. They are retained when the voltage is reset.						
0014	Location	Visible String	58	R/W	Location	Can be completed by the user.
0015	EquipmentIdent	Visible String	58	R/W	Equipment identifier	Can be completed by the user.
0016	ApplDeviceAddr	UINT16	2	R/W	Application-specific device address	Can be completed by the user.

17.2 Miscellaneous standard objects

Index (hex)	Object name	Data type	Length in bytes	Rights	Meaning/contents	Retentive storage	
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	10	R	Input process data The structure corresponds to the representation in the "Process data" section.		
0026	PDOUT	Octet string	10	R/W	OUT process data The structure corresponds to the representation in the “Process data” section.	No	*
0027	GetExRight	UINT8	1	R/W	Get exclusive process data write rights	No	*
Objects for device management							
001D	Password	Octet string	9	W	Password		*

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.

17.3 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.

0018_{hex}: Diagnostics state (read)					
Subindex/ element	**Data type**	**Length in bytes**	**Meaning**	**Contents**	
0	Record [6]	21	Diagnostic state	Complete diagnostics information	
1	UINT16	2	Error number	0 ... 65535_{dec}	
2	UINT8	1	Priority	00_{hex}	No error
				01_{hex}	Error
				02_{hex}	Warning
				81_{hex}	Error removed
				82_{hex}	Warning eliminated
3	UINT8	1	Channel/group/module	00_{hex}	No error
				01_{hex}	Channel 1
				:	:
				04_{hex}	Channel 4
				05_{hex}	±5 V voltage input
				FF_{hex}	Entire device
4	UINT16	2	Error code	See table below	
5	UINT8	1	Additional information	00_{hex}	
6	Visible String	14	Text	See table below	

The message with priority 81_{hex} or 82_{hex} is a one-off, internal message to the bus coupler. The bus coupler transfers this error message to the error mechanisms of the higher-level system.

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

Error and status of the local diagnostics and status indicators

Element	2	3	4	6						
Error	Priority	Channel/ group/ module	Error code	Text	Process data	LED				
	hex	hex	hex			D	UA	E1	E2	10 ... 13
No error	00	00	0000	Status OK	xxxx	◐	●	○	○	X
Cold junction invalid	01	01 ... 04	5120	Cold junction (CJ)	8008	◐	●	○	●	◑
Supply voltage faulty (supply for analog modules (U_A))	01	FF	5160	Supply fail	8020	☼	○	●	●	◑
Device error	01	FF	6301	CS FLASH	8040	◐	●	○	●	◑
Flash format error	01	FF	6302	FO FLASH	8040	◐	●	○	●	◑
Parameter table invalid	01	FF	6320	Invalid para	8010	◐	●	○	●	◑
Wire break	01	01 ... 04	7710	Open circuit	8002	◐	●	○	●	◑
Overrange	02	01 ... 05	8910	Overrange	8001	◐	●	○	●	◑
Underrange	02	01 ... 05	8920	Underrange	8080	◐	●	○	●	◑

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.

An overrange or underrange at the ±5 V voltage input (channel = 05) is not indicated by an LED.

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

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

Handling diagnostic messages	
Value (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

17.5 Output process data (0026_{hex}: PDOUT)

You can read and write the OUT process data of the module with this object.

The structure corresponds to the representation in the "Process data" section.

Output data can be written in order to specify the temperature as an external cold junction, in you do not want to use the process data for this.
If you use the first word (specification of the cold junction temperature), reset the remaining words to 0.

Observe the notes in the section "Writing the analog values via the PDI channel".

17.6 Request exclusive write access (0027_{hex}: GetExRight)

This object allows you to determine which channel (process data channel or PDI channel) gets the rights for writing the outputs.

Get exclusive process data write rights	
Value (hex)	**Meaning**
00	Rights for writing output data over the PD channel (process data channel)
01	Rights for writing output data via the PDI channel

All other values are invalid and will be acknowledged with an error.

Please note the following for your process:
The parameterization in object 0027_{hex} “Rights for writing the output data via the PDI channel” overwrites the output process data transmitted via the process data channel with the values from object 0026_{hex} PDOUT.
From now on, changes to the output process data can only be made via the PDI object. Changes on the process data channel will have no effect.
If the value from the process data channel is to be used again, write access must be changed to “Rights for writing the output data via the PD channel (process data channel)” via the GetExRight object.
After a power reset, the values transmitted via the process data channel are always valid.

17.7 Password ($001D_{hex}$: Password)

By entering the "Superuser" password you permit writing to the "Exclusiv right received" object. These rights are required to transmit process data over the PDI channel.

18 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 Octet Strings	24	R	Measured values in the extended float format	
0083	PD Min	Array [5] of INT16	10	R	Minimum process data value	
0084	PD Max	Array [5] of INT16	10	R	Maximum process data value	
008F	Local adjust value	Octet string	8	R/W	Local adjust values	Yes
0090	Channel Scout	UINT8	1	R/W	Channel Scout	No

18.1 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	$001F_{hex}$
:	UINT16	2	:	
4	UINT16	2	Parameterization of channel 4	$001F_{hex}$
5	UINT16	2	Data format, mounting position	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
0	0	Filter		Cold junction type				Resolution		0	Sensor type				

The values displayed in bold are pre-settings.

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

Cold junction type			Code (bin)	Code (hex)
Internal (default)			**0000**	**0**
Switched off			0001	1
External	Pt 100	Connector 1	0010	2
External	Pt 100	Connector 2	0011	3
Reserved			0100	4
Reserved			0101	5
Process data			0110	6
Reserved			Other	

Internal	There are several internal cold junction sensors in the module. When you select the "Internal" cold junction type for a channel, the corresponding cold junction for this channel is automatically assigned to it.
External	You can connect a Pt 100 sensor to every plug as an external cold junction sensor. Two external cold junctions are therefore available. One of these two external cold junctions can be assigned to each of the four channels.
Process data	This parameterization offers the following option: Determine the temperature of the cold junction via an additional device. Transfer this temperature to the temperature module via the first process data output word. Use IB IL format with a resolution of 0.1°C.

Resolution	Code (bin)	Code (hex)
0.1 °C (or 1 µV for sensor type linear voltage ±100 mV) (default)	**00**	**0**
1°C (or 10 µV for sensor type linear voltage ±100 mV)	01	1
0.1 °F	10	2
1 °F	11	3

Sensor type	Code (bin)	Code (hex)
K	00000	0
J	00001	1
E	00010	2
R	00011	3
S	00100	4
T	00101	5
B	00110	6
N	00111	7
U	01000	8
L	01001	9
C	01010	A
W	01011	B
HK	01100	C
Reserved	01101	D
Reserved	01110	E
Cold junction (CJ)	01111	F
Linear voltage ±100 mV	10000	10
Channel inactive (default)	**11111**	**1F**
Reserved	Other	

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

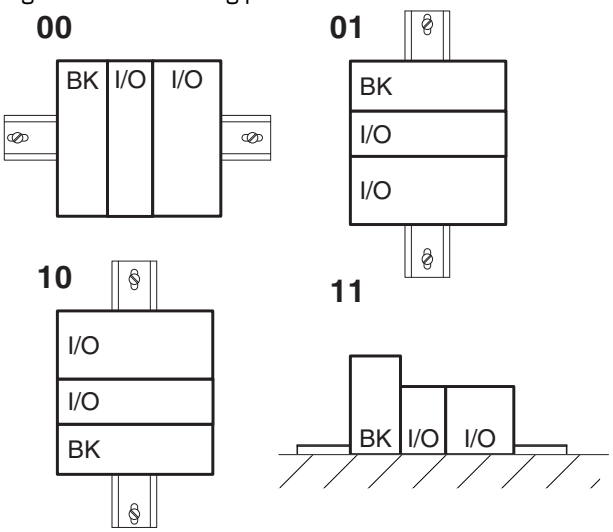
Data format, mounting position

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	Mount-ing posi-tion		0	0	Data format		0	0	0	0	0	0	0	0

Data format	Code (bin)	Code (hex)
IB IL (default)	**00**	**0**
S7-compatible	10	2
Reserved	Other	

Mounting position	Code (bin)	Code (hex)
Horizontal (preferred mounting position) (default)	**00**	**0**
Vertical, bus coupler above	01	1
Vertical, bus coupler below	10	2
Lying	11	3

Figure 15 Mounting position



BK Bus coupler
I/O I/O module

Set all unused bits to 0.

18.2 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})
Millivolts (mV)	36 (24_{hex})

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

18.3 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 = $7FFF\ 7FFF\ 7FFF\ 7FFF\ 7FFF_{hex}$

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 [5] of INT16	10	Read all elements
1	INT16	2	Minimum process data value channel 1
:	:	:	:
4	INT16	2	Minimum process data value channel 4
5	INT16	2	Minimum process data value voltage input

18.4 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 = $8000\ 8000\ 8000\ 8000\ 8000_{hex}$

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 [5] of INT16	10	Read all elements
1	INT16	2	Maximum process data value channel 1
:	:	:	:
4	INT16	2	Maximum process data value channel 4
5	INT16	2	Maximum process data value voltage input

18.5 Local adjust values ($008F_{hex}$)

This object supports a channel-specific path calibration function for maximum accuracy. This means, for example, that you can finely tune the tolerances by means of the TC connecting cables and the sensors.

The calibration data is stored retentively on the module.

The object contains the temperature offset of the cold junction with reference to each channel in IB IL format with a resolution of 0.1°C.

$008F_{hex}$: local adjust values (read, write)			
Subindex	**Data type**	**Length in bytes**	**Meaning**
0	Octet string	8	Local adjust values

Element	Data type	Length in bytes	Meaning	Contents	Default value
1	Var	2	Temperature offset channel 1	-20.0 °C ... +20.0 °C (-200_{dec} ... $+200_{dec}$)	0000_{hex}
:	:	:	:	:	:
4	Var	2	Temperature offset channel 4	-20.0 °C ... +20.0 °C (-200_{dec} ... $+200_{dec}$)	0000_{hex}

Example:

Channel 1 is measuring +2.0°C too high.

A negative offset of -2.0°C is required to correct this error.

In IB IL format, -2 °C corresponds to a value of $-20_{dec} = FFEC_{hex}$.

18.6 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**	**Contents**	
0	Var	1	Channel Scout	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.

19 Writing the analog values over the PDI channel

PDI = Parameters, Diagnostics and Information

To set the temperature of the external cold junction via the PDI channel rather than in the process data, you must change the exclusive right first.

To do this, proceed as follows:

- Write the ASCII string "Superuser" to the "Password" ($001D_{hex}$) object.
- Write the value 01_{hex} to the “Request exclusive write access” object (0027_{hex}).

You may now write to the "Output process data" (0026_{hex}) object.

20 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 bus coupler used at the following address:
www.phoenixcontact.com/products.