22.6 AT6402

22.6.1 General information

The AT6402 module is equipped with six inputs for J, K, N and S thermocouple sensors. The module has an integrated terminal temperature compensation.

- 6 inputs for thermocouples
- For sensor types J, K, N, S
- Additional direct raw value measurement
- Integrated terminal temperature compensation
- Filter time can be configured

22.6.2 Order data

Model number	Short description	Figure
	Temperature module	
X20AT6402	X20 temperature input module, 6 thermocouple inputs, type J,K,N,S, resolution 0.1 K	
	Required accessories	
X20TB12	X20 terminal block, 12-pin, 24 V coded	
X20BM11	X20 bus module, 24 V coded, internal I/O supply is interconnected	

Table 541: AT6402 - Order data

22.6.3 Technical data

Product ID	AT6402
Short description	
I/O module	6 inputs for thermocouples
Thermocouple temperature inputs	
Input	Thermocouple
Digital converter resolution	16-bit
Filter time	Configurable between 1 ms and 66.7 ms
Conversion time 1 channel n channels	 80.4 ms at 50 Hz filter (n + 1) x 40.2 ms at 50 Hz filter
Output format	UINT
Basic accuracy Type J Type K Type N (Rev. ≥D0) Type S	 ±0.10% at 25°C [1)] ±0.11% at 25°C [1)] ±0.11% at 25°C [1)] ±0.17% at 25°C [1)]
Measurement area Sensor temperature FeCuNi: Type J NiCrNi: Type K NiCrSi: Type N (Rev. ≥D0) PtRhPt: Type S Terminal temperature Raw value	 -210°C to +1200°C -270°C to +1372°C -270°C to +1300°C -50°C to +1768°C -25°C to +85°C ±65.534 mV
Terminal temperature compensation	Internal
General information	
Status indicators	I/O function per channel, operating state, module status
Diagnostics Module run/error Inputs	 Yes, with status LED and software status Yes, with status LED and software status
Electrical isolation Channel - Bus Channel - Channel	 Yes No
Power consumption Bus I/O internal	 0.01 W 0.91 W
Certification	CE, C-UL-US, GOST-R
Operating conditions	
Operating temperature Horizontal installation Vertical installation	 0°C to +55°C 0°C to +50°C
Relative humidity	5 to 95%, non-condensing
Mounting orientation	Horizontal or vertical

Table 542: AT6402 - Technical data

Product ID	AT6402
Installation at altitudes above sea level 0 - 2000 m >2000 m	 No derating Reduction of ambient temperature by 0.5°C per 100 m
Protection type	IP20
Storage and transport conditions	
Temperature	-25°C to +70°C
Relative humidity	5 to 95%, non-condensing
Mechanical characteristics	
Spacing	12.5 $^{+0.2}$ mm
Comment	Order terminal block 1x X20TB12 separately Order bus module 1x X20BM11 separately

Table 542: AT6402 - Technical data (cont.)

1) Based on the measurement range, without consideration of the reference junction measurement error.

22.6.4 Additional technical data

Product ID	AT6402
Thermocouple temperature inputs	
Sensor standard	EN 60584
Resolution Sensor temperature Terminal temperature Raw value output with respect to gain	 1 LSB = 0.1°C 1 LSB = 0.1°C 1 LSB = 1 µV or 2 µV Gain setting - see the section 22.6.17 "Sensor type" on page 895
Standardization Type J Type K Type N (Rev. ≥D0) Type S Terminal temperature	 -210.0°C to +1200.0°C -270.0°C to +1372.0°C -270.0°C to +1300.0°C -50.0°C to +1768.0°C -25.0°C to +85.0°C
Monitoring Open inputs Wire break Below lower range limit Above upper range limit General error	 $7FFF $7FFF $8001 $7FFF $8000
Conversion method	Sigma Delta
Linearization method	Internal
Permitted input signal	Max. ±5 V
Input filter	Low pass 1st order / cut-off frequency 500 Hz
Maximum gain drift	0.01%/°C, based on the current measurement value

Table 543: AT6402 - Additional technical data

Product ID	AT6402
Maximum offset drift Type J Type K Type N (Rev. ≥D0) Type S	 0.0019%/°C 1) 0.0024%/°C 1) 0.0029%/°C 1) 0.0079%/°C 1)
Terminal temperature compensation precision with natural convection with artificial convection	 ±2°C after 10 min ±4°C after 10 min
Common-mode rejection DC 50 Hz	 >70 dB >70 dB
Synchronized zone	±15 V
Cross-talk between channels	>70 dB
Non-linearity	±0.001%, based on the entire measurement range
Isolation voltage betw. channel and bus	500 V_{eff}
General information	
B&R ID code	$1BA9

Table 543: AT6402 - Additional technical data (cont.)

1) Refers to the entire measurement range

22.6.5 Status LEDs

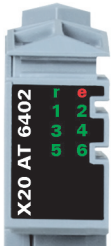
Figure	LED	Color	Status	Description
	r	Green	Off	Module supply not connected
			Single flash	Reset mode
			Blinking	Preoperational mode
			On	RUN mode
	e	Red	Off	Module supply not connected or everything is OK
			On	Error or reset state
			Single flash	Warning/error for an I/O channel. Overflow or underflow of the analog inputs.
	e + r	Steady red / single green flash		Invalid firmware
	1 - 6	Green	Off	The input is switched off
			Blinking	Overflow, underflow or broken connection
			On	The analog/digital converter is running, value is OK

Table 544: AT6402 - Status indicators

22.6.6 Pin assignments

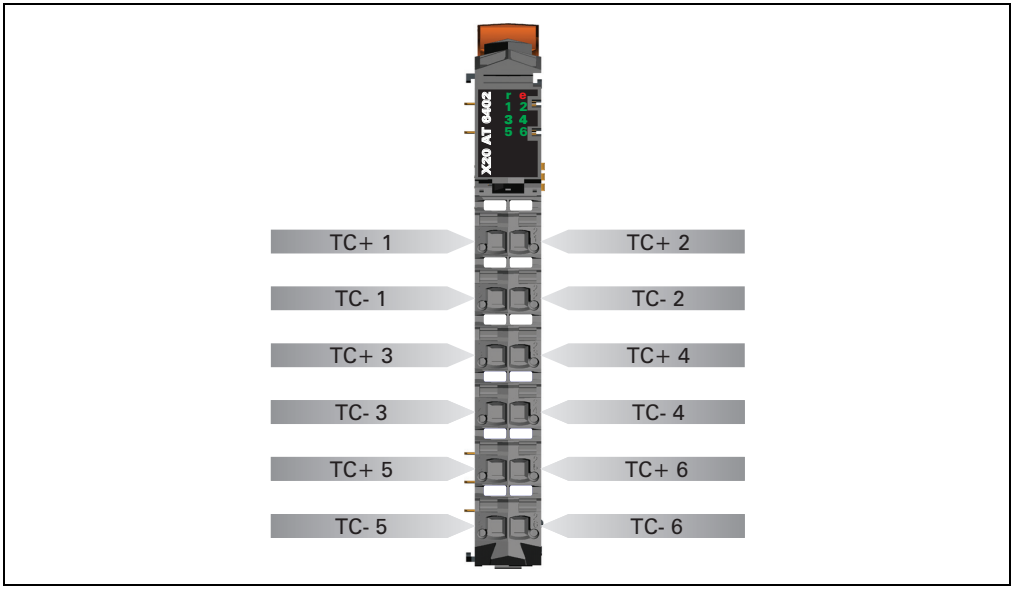


Figure 411: AT6402 - Pin assignments

22.6.7 Connection example

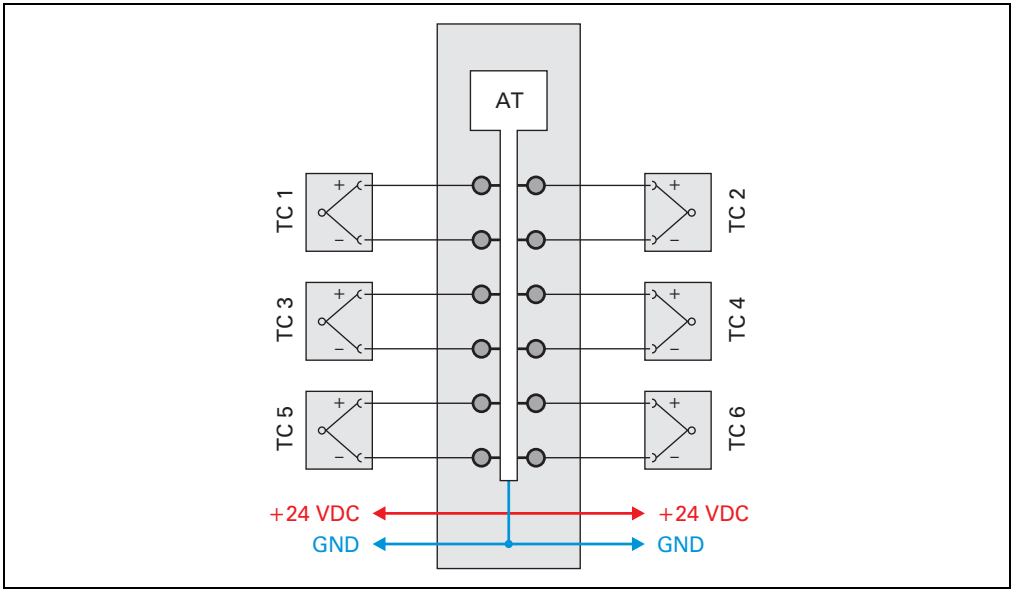


Figure 412: AT6402 - Connection example

22.6.8 Input circuit diagram

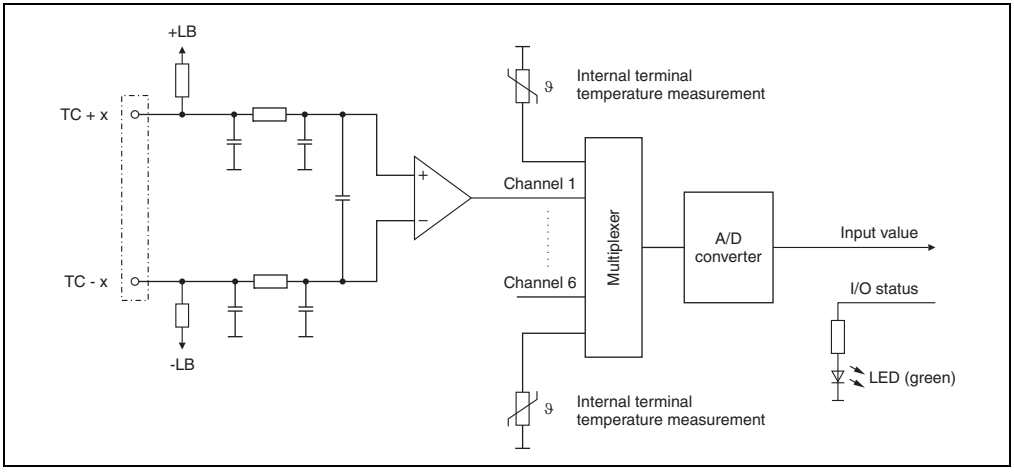


Figure 413: AT6402 - Input circuit diagram

22.6.9 Ceramic heating element with integrated thermo elements

We recommend connecting the minus input of the thermo element to the minus input of the supply feed module. This prevents potential measurement errors caused by ripple voltage effects in the measurement signal.

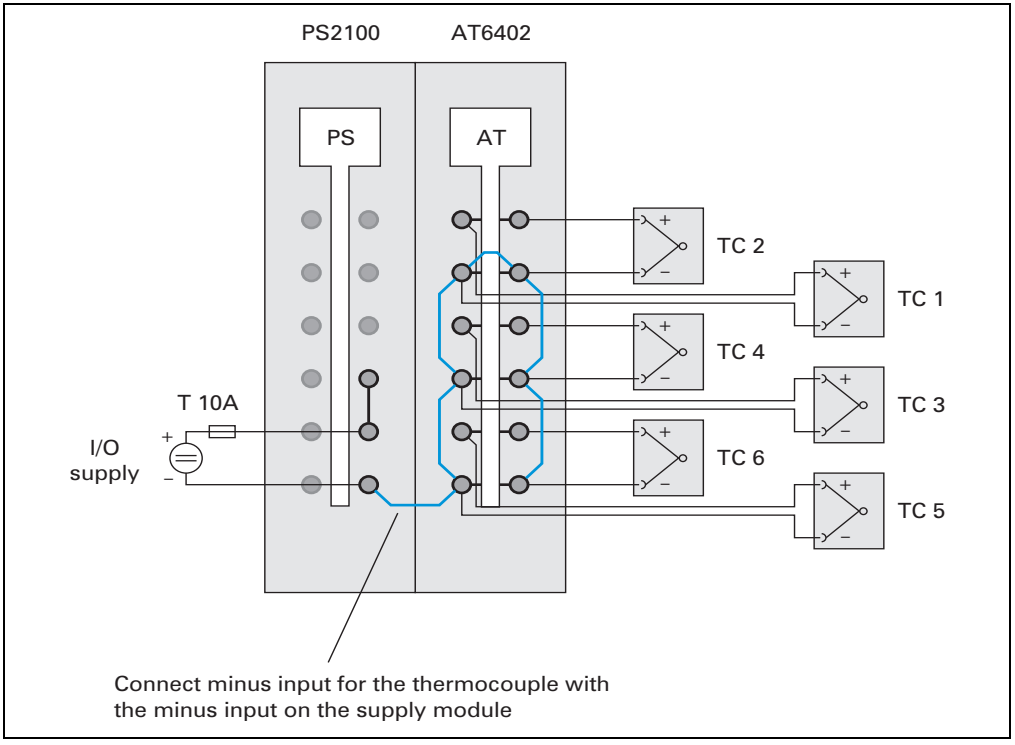


Figure 414: AT6402 - Connection of ceramic heating elements with integrated thermo elements

22.6.10 Analog inputs

The converted analog values are output by the module in the registers. The sensor type configured will affect the value ranges.

22.6.11 Raw value measurement

If a sensor type other than J, K, N or S is used, the terminal temperature must be measured on at least one input. Based on this value, the user must perform a terminal temperature compensation.

22.6.12 Timing setting

The timing setting for data acquisition is made using the converter hardware. All switched on inputs are converted during each conversion cycle. A terminal temperature measurement also takes place (not in function model 1).

If an input is not necessary, it can be switched off, thereby reducing the refresh time. Inputs can also be only temporarily switched off. The measurement of the terminal temperature is switched off in function model 1.

22.6.13 Conversion time

The conversion time depends on the number of channels and on the function model. For the formulas listed in the table, 'n' corresponds to the number of channels that are switched on.

Function model	Conversion time
Model 0 - n channels	$(n+1) \cdot (2 \cdot \text{FilterTime} + 200\mu s)$
Model 1 - n channels	$n \cdot (2 \cdot \text{FilterTime} + 200\mu s)$
Model 1 - 1 channel	Equal to the filter time

Examples

The inputs are filtered using a 50 Hz filter.

	Example 1		Example 2	
	Function model 0	Function model 1	Function model 0	Function model 1
Switched on inputs	1	1	1 - 6	1 - 6
Input conversion times	40.2 ms	20 ms	241.2 ms	241.2 ms
Conversion time for the terminal temperature	40.2 ms	-	40.2 ms	-
Total conversion time	80.4 ms	20 ms	281.4 ms	241.2 ms

22.6.14 Compensation temperature

The module's compensation temperatures can be read.

22.6.15 External reference junction

General information

Reference junction temperature values can be specified for each channel to correct measurements. This allows an external reference junction to be set up. It is important to ensure that operation with an external reference junction is only possible for the entire module.

An external reference junction is useful for the following applications:

- When there is a large distance between the controller and point of measurement
- To increase precision

Bridging large distances

When there is a large distance between the controller and the point of measurement, an external reference junction is recommended. The thermocouple voltage is fed via copper cable from the external reference junction to the terminal on the AT6402. The temperature measured at the external reference junction (e.g. using PT100 - AT4222) is stored in the I/O area of the AT6402 module. The AT6402 module calculates the thermocouple temperature internally from the measured voltage and the reference junction temperature value (per channel).

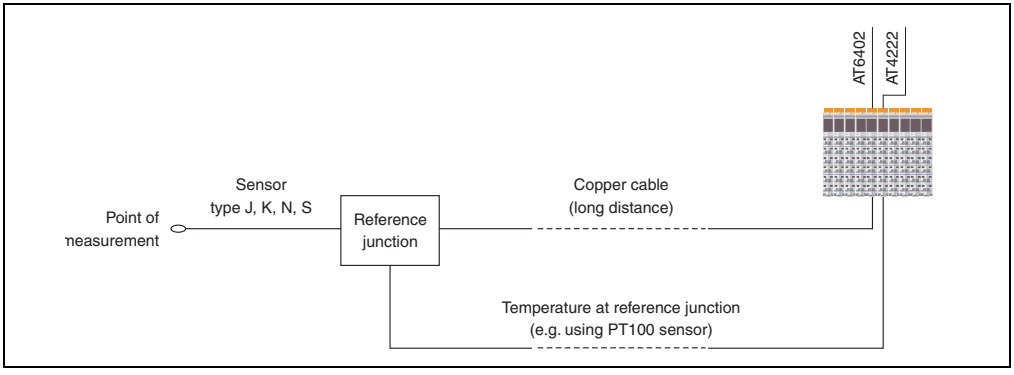


Figure 415: AT6402 - External reference junction for bridging large distances

Increased precision

To increase the precision, an external reference junction is recommended. The construction of the external reference junction is the same as described above. The installation of an external reference junction is especially helpful in the following cases.

- There is a module next to the AT6402 that requires more than 1 W
- There is no module next to the AT6402
- With strongly fluctuating ambient conditions (draft, temperature)

22.6.16 Input filter

The filter time for all analog inputs is defined using the input filter parameter.

Value	Filter	Filter time	Digital converter resolution
0	15 Hz	66.7 ms	16-bit
1	25 Hz	40 ms	16-bit
2	30 Hz	33.3 ms	16-bit
3	50 Hz	20 ms	16-bit
4	60 Hz	16.7 ms	16-bit
5	100 Hz	10 ms	16-bit
6	500 Hz	2 ms	16-bit
7	1000 Hz	1 ms	16-bit

22.6.17 Sensor type

The module is designed for various sensor types. The sensor type must be specified because of the different adjustment values.

Code	Input signal
0	Conversion switched off
1	Sensor type J
2	Sensor type K
3	Sensor type S
4	Sensor type N
5	Conversion switched off
6	Raw value without linearization and terminal temperature compensation Resolution 1 µV for a measurement range of ±32.767 mV
7	Raw value without linearization and terminal temperature compensation Resolution 2 µV for a measurement range of ±65.534 mV

22.6.18 Channel deactivation

The default setting for all channels is ON. To save time, individual channels can be switched off (see section 22.6.13 "Conversion time" on page 893).

Code	Description
0	Channel x: Switched off
1	Channel x: Switched on

22.6.19 Input status

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

Code	Channel x
0	No error
1	Below lower limit value
2	Above upper limit value
3	Wire break

22.6.20 "StatusInput01" register

Bit	Description
0 - 1	Channel 1: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break
2 - 3	Channel 2: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break
4 - 5	Channel 3: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break
6 - 7	Channel 4: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break

22.6.21 Register: "StatusInput02"

Bit	Description
0 - 1	Channel 5: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break
2 - 3	Channel 6: 00 ... No error 01 ... Below lower limit value 10 ... Above upper limit value 11 ... Wire break
4 - 7	0

In addition to the status info, the error type also sets the analog value as follows:

Error type	Digital value for error
Wire break	+32767 ($7FFF)
Above upper limit value	+32767 ($7FFF)
Below lower limit value	-32767 ($8001)
Invalid value	-32768 ($8000)

22.6.22 IOCyclicCounter

The cyclic counter increases after all input data have been updated.

22.6.23 B&R ID code

Code for module identification ($1BA9).

22.6.24 Minimum cycle time

The minimum cycle time is the minimum time needed for the bus cycle to be shut down without a communication error or malfunction occurring. It should be noted that very fast cycles reduce the idle time needed for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time	
In each operating mode and function model	150 µs

22.6.25 Minimum I/O update time

The minimum I/O update time refers to the minimum time it takes for the bus cycle to shut down, so that in each cycle an I/O update takes place.

For the formulas listed in the table, 'n' corresponds to the number of channels that are switched on.

Minimum I/O update time - Function model 0	
n inputs	$(n + 1) \cdot (FilterTime + 200\mu s)$

Minimum I/O update time - Function model 1	
1 input	Equal to the filter time
n inputs	$n \cdot (FilterTime + 200\mu s)$