

13.2 AT350 / AT450

13.2.1 General information

The AT350 and AT450 are temperature modules for PT100 temperature sensors.

13.2.2 Order Data

Model Number	Short Description	Image
3AT350.6	2005 Analog Input Module, 4 inputs, PT100 (3-line connection), -50 to +450 degrees C. Order TB170 terminal block separately.	
3AT450.6	2005 Analog Input Module, 4 inputs, PT100 (4-line connection), -50 to +450 degrees C. Order TB170 terminal block separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 275: AT350 / AT450 order data

13.2.3 Technical Data

Product ID	AT350	AT450
C-UL-US Listed	Yes	Yes
B&R ID Code	\$93	\$92
Number of Inputs	4 inputs for resistance measurement	
Electrical Isolation Input - PLC Input - Input	Yes No	
Sensor Type Connection Standard	PT100 3 line connection IEC/EN 60751	PT100 4 line connection IEC/EN 60751
Measurement Range	-50 to +450° C	
Resolution	Internal 13500 steps	
Measuring Procedure	Integrated Converter	
Measuring Time per Channel	20 or 16.67 ms	

Table 276: AT350 / AT450 technical data

Product ID	AT350	AT450
Conversion Time for all Channels	100 ms and 85 ms (depending on the measurement time per channel)	
Input Filter	Bessel low pass 1st order / cut-off frequency: 8 Hz	
Measurement Precision Basic Accuracy at 20° C Precision (0 to 60° C)	±0.1% ±0.2%	±0.1% ±0.15%
Linearization	Automatic in the module	
Measurement Current	2.5 mA (±0.2%)	
Power Consumption 5 V 24 V Total	Max. 1 W Max. 3 W Max. 4 W	
Mechanical Characteristics		
Dimensions	B&R 2005 single-width	

Table 276: AT350 / AT450 technical data (cont.)

13.2.4 Status LEDs

Image	LED	Description
	RUN	The analog/digital converter is running.
	60Hz	This LED indicates, which measurement time is switched on. If this LED is lit, the measurement time is set to 16.67 ms, which filters out a 60 Hz mains power hum. Otherwise a measurement time of 20 ms is selected (filtering of 50 Hz power hum).

Table 277: AT350 / AT450 status LEDs

13.2.5 Pin Assignments

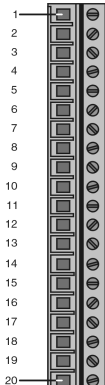
AT350	Connection	Assignment
 TB170	1	+ Sensor 1
	2	+ Sense 1
	3	- Sense/Sensor 1
	4	Shield
	5	+ Sensor 2
	6	+ Sense 2
	7	- Sense/Sensor 2
	8	Shield
	9	Shield
	10	Shield
	11	Shield
	12	Shield
	13	+ Sensor 3
	14	+ Sense 3
	15	- Sense/Sensor 3
	16	Shield
	17	+ Sensor 4
	18	+ Sense 4
	19	- Sense/Sensor 4
	20	Shield

Table 278: AT350 pin assignment

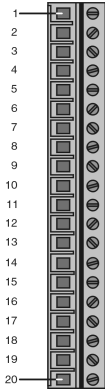
AT450	Connection	Assignment
 TB170	1	+ Sensor 1
	2	+ Sense 1
	3	- Sense 1
	4	- Sensor 1
	5	+ Sensor 2
	6	+ Sense 2
	7	- Sense 2
	8	- Sensor 2
	9	Shield
	10	Shield
	11	Shield
	12	Shield
	13	+ Sensor 3
	14	+ Sense 3
	15	- Sense 3
	16	- Sensor 3
	17	+ Sensor 4
	18	+ Sense 4
	19	- Sense 4
	20	- Sensor 4

Table 279: AT450 pin assignment

Signal Cable Connection

Shielded cables must be used for temperature sensor connection lines. The shield is grounded using the terminal block's shield connection.

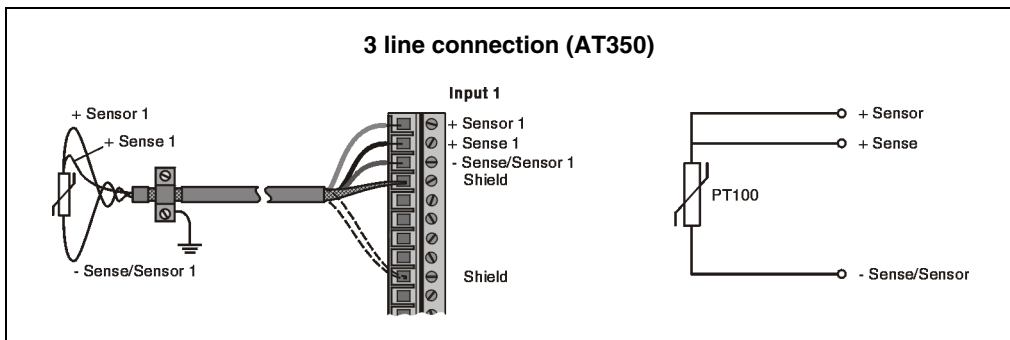


Figure 161: AT350 signal cable connection

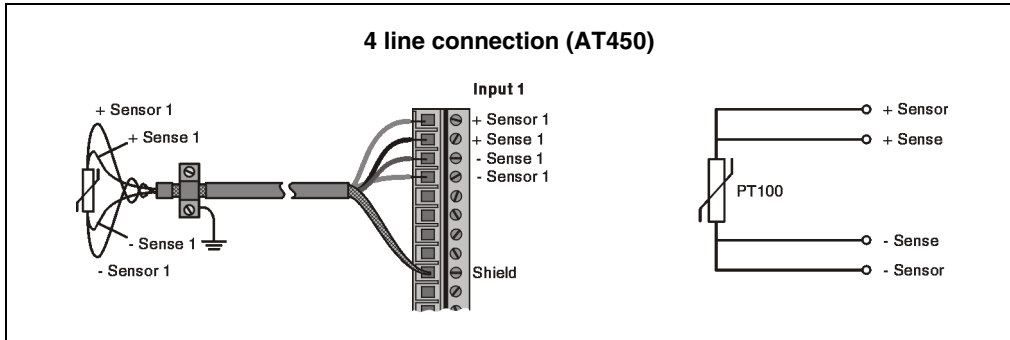


Figure 162: AT450 signal cable connection

All shielded connections are of the equal value and each connected via RC elements with ground ($\perp$, i.e. a spring contact and a mounting rail).

R: 22 k Ω , C: 10 nF / 60 V

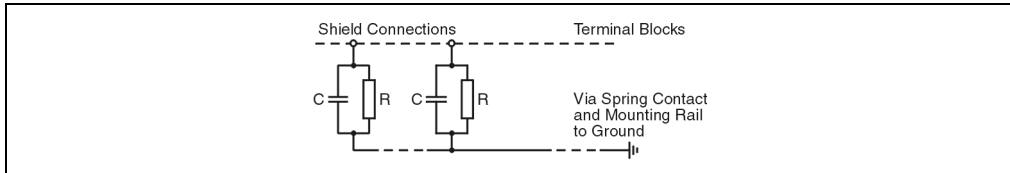


Figure 163: AT350 / AT450 shielded connection



With a 3-line connection (AT350), only sensors may be used for which the connection lines have the same electrical specifications i.e. same length, cross section, material and therefore very close to the same ohmic resistance.

The maximum total resistance between the + and - sensor connections may not exceed 600 Ω , otherwise the overload of internal current will lead to measurement errors.

Sensor or sensor lines are not allowed to be grounded or connected with any other sensor lines.

13.2.6 Input Circuit Diagram

AT350

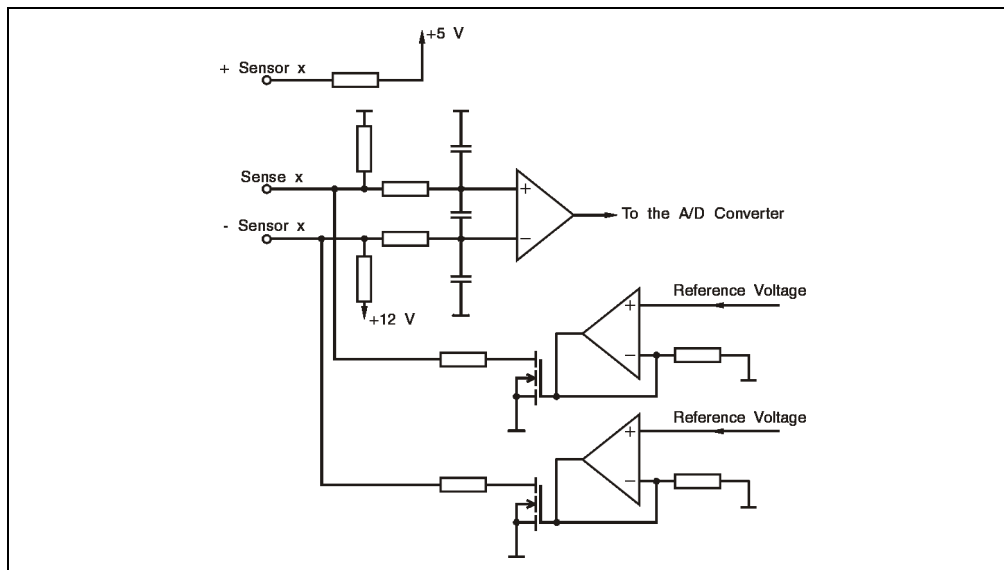


Figure 164: AT350 input circuit diagram

AT450

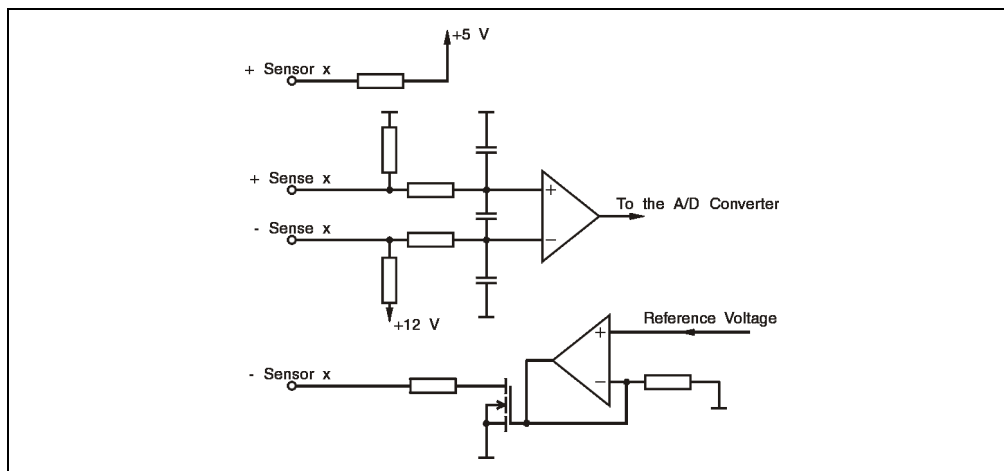


Figure 165: AT450 input circuit diagram

13.2.7 Relationship between Temperature and Converter Value

Data Format 1/10° C

Temperature	Converter Value	
	Hexadecimal	Decimal
< -65.8° C	8000	-32768
-65.8° C	FD6E	-658
:	:	:
-50.0° C	FE0C	-500
:	:	:
-0.1° C	FFFF	-1
0.0° C	0000	0
0.1° C	0001	1
:	:	:
50.0° C	01F4	500
:	:	:
+450.0° C	1194	4500
:	:	:
+474.1° C	1285	4741
> +474.1° C	7FFF	32767

Table 280: AT350 / AT450 data format 1/10° C

	Values within the range of -50 to +450° C corresponding to the precision given in the technical data.
	Over-range or under-range measurements of the -50 to +450° C range of measurements will be still interpreted as temperature values if they are between -65.8 to +474.1° C. However, the precision indicated in the technical data cannot be guaranteed for these values.
	Values outside the range of -65.8 to +474.1° C give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

Data Format 1/100° C

Temperature	Converter Value	
	Hexadecimal	Decimal
< -64.65° C	8000	-32768
-64.65° C	E6BF	-6465
:	:	:
-50.00° C	EC78	-5000
:	:	:
-0.01° C	FFFF	-1
0.00° C	0000	0
0.01° C	0001	1
:	:	:
50.00° C	1388	5000
:	:	:
+250.00° C	61A8	25000
:	:	:
+265.07° C	678B	26507
> +265.07° C	7FFF	32767

Table 281: AT350 / AT450 data format 1/100° C

With this data format the measurement range is also (-50° C to +450° C) but because of the data format, the output range is limited and the values between +265.08 to +450° C can no longer be displayed. They receive the value 32767 (7FFF).

	Values within the range of -50 to +250° C corresponding to the precision given in the technical data.
	Over-range or under-range measurements of the -50 to +250° C range of measurements will be still interpreted as temperature values if they are between -64.65 to +265.07° C. However, the precision indicated in the technical data cannot be guaranteed for these values.
	Values outside the range of -64.65 to +265.07° C give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

Data format 1/10 °F (Fahrenheit)

Temperature	Converter Value	
	Hexadecimal	Decimal
< -64.06° C	8000	-32768
-64.06° C	FCBF	-833
:	:	:
-45.56° C	FE0C	-500
:	:	:
-17.83° C	FFFF	-1
-17.78° C	0000	0
-17.72° C	0001	1
:	:	:
10.00° C	01F4	500
:	:	:
+454.44° C	2134	8500
:	:	:
+473.78° C	2290	8848
> +473.78° C	7FFF	32767

Table 282: AT350 / AT450 data format 1/10 °F (Fahrenheit)

	Values within the range of -50 to +850 °F corresponding to the precision given in the technical data.
	Over-range or under-range measurements of the -50 to +850 °F range of measurements will be still interpreted as temperature values if they are between -83.3 to +884.8 °F. However, the precision indicated in the technical data cannot be guaranteed for these values.
	Values outside the range of -83.3 to +884.8 °F give a conversion value of -32768 (8000) for under-range measurements and +32767 (7FFF) for over-range measurements.

13.2.8 Open Line Detection

The converter values -32768 (8000) and +32767 (7FFF) are not only sent to the PLC from the module as under-range and over-range measurements, but are also given if inputs are open or contacts broken.

AT350

Error	Converter Value	
	Hexadecimal	Decimal
Open Input (sensor is not connected)	8000	-32768
Broken Sensor Line	8000	-32768
Broken Sense Line	7FFF	32767

Table 283: AT350 open line detection

AT450

Error	Converter Value	
	Hexadecimal	Decimal
Open Input (sensor is not connected)	8000	-32768
Broken Sensor Line	8000	-32768
Broken Sense Line	8000	-32768

Table 284: AT450 open line detection

13.2.9 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan.
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 4
Mode Register The following settings can be changed by writing to this register: - Measurement Time 20 or 16.67 ms - Scan Order for the channels - Selection of the data format	tc_global	USINT	1	Status Out	0

Table 285: AT350 / AT450 variable declaration

13.2.10 Mode Register

The user can make different settings using the mode register. When writing to this register, please make sure that only the relevant bits are changed.

Mode Register	Bit	Description
	7	0
	6	0
	5	0
	3 - 4	Choosing the desired data format (choice of three formats)
	1 - 2	Scan order of the individual channels (choice of three options)
0 0 0 0 0 0 0 0	0	Measurement time 16.67 ms
7		0

Measurement Time

By setting the measurement time, a mains power hum of 50 or 60 Hz is suppressed. A choice of two measurement times are available:

Mode Register Bit 0	Measurement Time	Remark
0	20 ms	Standard setting after a hardware reset and switching on for 50 Hz
1	16.67 ms	Setting for 60 Hz

Table 286: AT350 / AT450 measurement time

Scan Order

It is possible to change the scan order, i.e. channels are not scanned and converted in succession. Individual channels can be scanned more often in order to register fast thermal changes more rapidly (e.g. heating cartridges).

Status Register		Scan Order	Remark
Bit 2	Bit 1		
0	0	0	Standard settings after hardware reset or when switched on
0	1	1	
1	0	2	
1	1	3	not used (corresponds to the scan order 0)

Table 287: AT350 / AT450 scan order definition

The scan order is graphically shown in the following diagram (values in parentheses apply to a set measurement time of 16.67 ms):

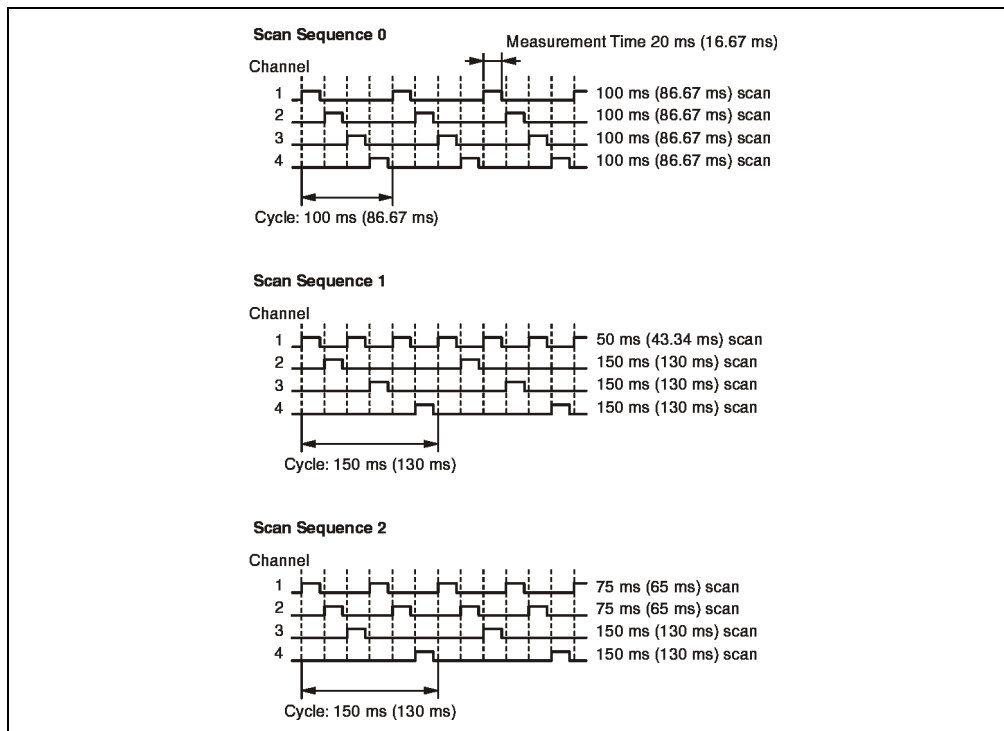


Figure 166: AT350 / AT450 scan order

Data Format

In addition to the $1/10^{\circ}\text{C}$ data format, two further formats are available, which can be selected using bits 3 and 4 of the status register. The relationship between temperature and data format is clarified in Section 13.2.7 "Relationship between Temperature and Converter Value", on page 444.

The selected data format is always valid for all four inputs.

Status Register		Data Format	Remark
Bit 4	Bit 3		
0	0	$1/10^{\circ}\text{C}$	Standard settings after hardware reset or when switched on
0	1	$1/100^{\circ}\text{C}$	
1	0	$1/-12.22^{\circ}\text{C}$	
1	1	---	Not used (reserved for service)

Table 288: AT350 / AT450 data format definition