

MAL-THR

Miniature Amplifiers for Thermocouple (type K)

Perfectly Conditioned. Temperature.

Temperature signals of a thermocouple sensor, type K can optimally be adjusted to the input of a PC data acquisition system with the miniature measuring amplifier MAL-THR.

Minimum Size. Great Performance. Small Price.

The miniature format of the MAL-THR is ideal to realize measurement applications even if the installation is in problematic locations. Despite the small size, the measuring amplifier features great functionality. All this at a reasonable price.

0..1250°C In. 0..5V Out.

The MAL-THR measures the voltage difference between the two conductors (NiCr-NiAl) of a thermocouple sensor resulting from input temperatures in the range of 0..1250°C. A 0..5V signal proportional to the input signal is provided at the output.

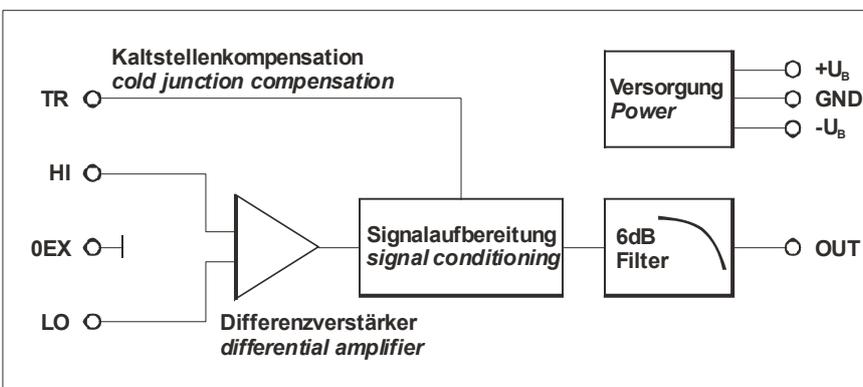


Compatibility.

The MAL series provides a great variety of measuring amplifiers, measuring converters, or filter modules. They can be used in any combination allowing for the solution of the most individual measuring tasks.

Get Connected.

With the backplanes of the BP series varying in size and design, signal connection is easy. The modules just have to be plugged on the relevant slot of the backplane.



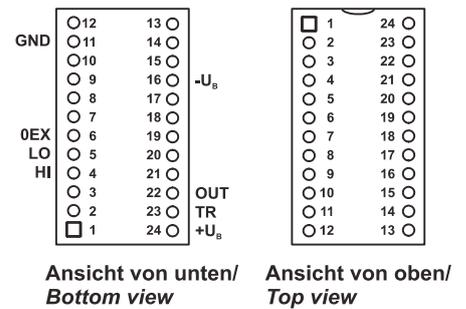
Functional diagram

1 Installation

The measuring amplifier is plugged onto a 24-pin socket. If the marking of the socket is on the left, pin 1 is bottom left.



Check for correct poling. Change modules only at no load!



2 Pin Assignment

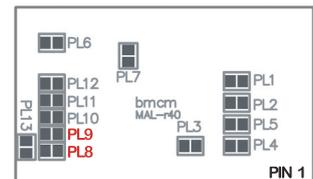
The pin assignment of the MAL-THR is illustrated in the figure above and in the following table.

Pin	Name	Function	Pin	Name	Function
1, 2	n. c.	-	13, 14, 15	n. c.	-
3	n. c.	-	16	-U _B	supply -7.5V..-15V
4	+IN	HI signal input	17, 18	n. c.	-
5	-IN	LO signal input	19, 20	n. c.	-
6	0EX	shield ground	21	n. c.	-
7, 8, 9, 10	n. c.	-	22	OUT	amplifier output 0..5V
11	GND	power supply ground	23	TR	temperature reference
12	n. c.	-	24	+U _B	supply +7.5V..+15V

3 Jumper Configuration

The cut-off frequency of the MAL-THR is set via the solder bridges PL8+9 on the bottom of the module (also see chapter 4 "Interfacing Examples").

Factory setting of the MAL-THR is 25Hz cut-off frequency (default setting marked in red).



All other jumpers are for internal use only and must not be changed!

Cut-off frequency f_g	PL8	PL9
25Hz	closed	open
3Hz	open	closed

4 Interfacing Examples

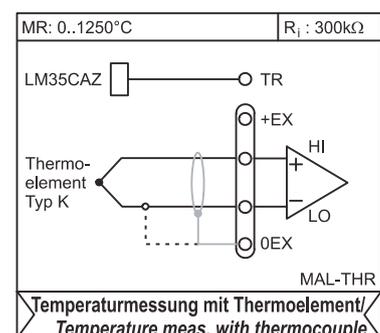
The module output is proportional to the input voltage in all operating modes and ranges. Apply cable shield at one end only. If earthing is required, connect the screen only at one end, otherwise there is a risk of hum pick-up.

4.1 Thermocouple Measurement with Cold-Junction Compensation

The MAL-THR amplifier serves for the acquisition of thermocouples type K and is not linearized (see chapter 5). The input amplifier is operated differentially, but has a connection to ground with 10kΩ!

The amplifier is prepared for cold-junction compensation and calibrated. For this a temperature reference sensor (LM35CAZ) must be connected (see chapter 6). Without the reference sensor, the module has an offset, which must be removed via software if necessary.

By opening PL8 and closing PL9, the cut-off frequency f_g can be reduced from 25Hz (default factory setting) to 3Hz (see chapter 3).



5 Approximation Formula for Linearizing the MAL-THR

As the MAL-THR amplifies thermocouple signals but does not linearize them, the following formula can be used providing good results in the range of app. $-20^{\circ}\text{C} \dots +480^{\circ}\text{C}$. See the FAQ area on the bmcm website (www.bmcm.de/us) for further information.

$$T(x) = \frac{a}{f^4}x^4 + \frac{b}{f^3}x^3 + \frac{c}{f^2}x^2 + \frac{d}{f}x + e$$

x = voltage in mV measured at the amplifier output

T = temperature in $^{\circ}\text{C}$

a = $-5.00055 \cdot 10^{-5}$

b = -0.000780486

c = 0.0230817

d = 24.4718

e = -0.0164727

f = $(4 \cdot 1000) / 41.276 = 96.9086$ (amplification factor MAL-THR)

6 Cold-Junction Compensation

The measured thermo voltage equals the temperature difference of the thermocouple and the junction of the connection plug. To generate an absolute temperature out of this, the temperature is measured at the junction. This temperature sensor is being connected to the TR-connection of the MAL-THR. The miniature measuring amplifier adjusts the measured values accordingly now.

A LM35CAZ semi-conductor sensor is recommended to be used for temperature reference (abs. accuracy $\pm 1^{\circ}\text{C}$). The assignment is illustrated in the figure on the right.



LM35CAZ



6.1 Cold-Junction Compensation with BP16

Available as accessory for the backplane BP16 from bmcm (see chapter 7) is the option ZU-TR. The LM35CAZ soldered to the D-Sub37 connector serves as a reference for cold-junction compensation.

If ZU-TR is attached to the 37-pin D-Sub IN female of the BP16, the temperature reference is provided at each slot. The measuring leads of the thermocouple only have to be soldered to the relating pins at the D-Sub37 male of the ZU-TR.



6.2 Cold-Junction Compensation with BP2 / BP2-BOX

The BP2 / BP2-BOX from bmcm (see chapter 7) already contains a cold-junction compensation at the terminal connector of the backplane.

7 Other MAL Amplifiers and Connection Technology (BP Series)

A great variety of miniature measuring amplifiers with or without galvanic isolation is available.

The backplanes of the BP series from bmcm different in size and design allow the comfortable connection to the data acquisition system and for the amplifier supply.

The MAL measuring converters can be plugged on the backplanes in any combination.



The following MAL modules and BP backplanes from bmc are available:

Product	Description
MAL-ISO1/5/10/50	Galvanically isolating miniature amplifier for voltage ($\pm 1V/\pm 5V/\pm 10V/\pm 50V$)
MAL-ISO20mA	Galvanically isolating miniature amplifier for current ($\pm 20mA$)
MAL-FU	Frequency-voltage converter in miniature format
MAL-I20mA	Miniature amplifier for current ($\pm 20mA$), 5V sensor supply
MAL-PT100	Miniature amplifier for temperature (PT100, 0..300°C)
MAL-R1K	Miniature amplifier for resistance (0..1k Ω)
MAL-SEIKA	Miniature amplifier for SEIKA sensors or semiconductor sensors with 2,5V mid-position
MAL-SG2/5	Miniature amplifier for strain gauge ($\pm 2mV/V$ or $\pm 5mV/V$)
MAL-THR	Miniature amplifier for temperature (thermocouple, type K, 0..1250°C)
MAL-UI/5/10	Miniature amplifier for voltage ($\pm 1V/\pm 5V/\pm 10V$), 5V sensor supply
BP16	16 slots, external device in aluminum housing, 5V sensor supply, connections: 2x Sub-D37
BP2	2 slots, for DIN rail mounting, 5V sensor supply, connections: screw terminals
BP2-BOX	2 slots, external device in IP65 box, 5V sensor supply, connections: screw terminals

8 Important Notes for Using the MAL-THR

- The MAL-THR is only suitable for extra-low voltages - please observe the relevant regulations!
- Only use an electrical isolated power supply unit (with CE).
- Turn off the power before mounting the module onto the carrier board.
- All accessible pins are electrostatic sensitive devices. Provide for a grounded conductive work place.
- MAL-THR must only be operated in closed housings (for reasons relating to EMC).
- Only use non-solvent detergents for cleaning. The product is designed to be maintenance-free.
- The module must not be used for safety-relevant tasks. With the use of the product, the customer becomes manufacturer by law and is therefore fully responsible for the proper installation and use of the product. In the case of improper use and/or unauthorized interference, our warranty ceases and any warranty claim is excluded.



Do not dispose of the product in the domestic waste or at any waste collection places. It has to be either duly disposed according to the WEEE directive or can be returned to bmc at your own expense.

9 Technical Data

(typical at 20°C, after 5min., +7.5V supply)

• Input Range

Measuring range (incoming temperature):	0..1250°C
Gain calibration at // Input resistance:	1000°C=4V // 300k Ω
Input suppressor circuit for 1sec:	max. 200V

• Output Range

Output voltage:	0..5V DC
Output load:	>1k Ω ; recommended for higher accuracy: >10k Ω
Amplifier accuracy // Temperature drift:	typ. 0.1% // 300ppm/°C
Output interference or output ripple:	typ. 5mV _{ss} at app. 100kHz (from DC/DC converter of the backplane)
Current supply sensitivity:	typ. $\pm 10mV/V$
Output filter // Filter cut-off frequency f_g :	1-pole (6dB/oct.) // 25Hz (ex works: PL8 closed, PL9 open) or 3Hz (PL8 open, PL9 closed)

The values for accuracy always relate to the respective measuring range. Errors might add at worst.

• General

Power supply // Current consumption:	$\pm 7.5V$ DC .. $\pm 15V$ DC // 1mA
CE standards:	EN61000-6-1, EN61000-6-3, EN61010-1; for decl. of conformity (PDF) visit www.bmc.de
ElektroG // ear registration:	RoHS and WEEE compliant // WEEE Reg.-No. DE75472248
Max. permissible potentials:	60V DC acc. to VDE, max. 1kV ESD on open lines
Dimensions // Protection type:	plastic housing 33mm x 20mm x 15mm // IP30
Temperature ranges:	operating temp.: -25°C..+50°C, storage temp.: -25°C..+70°C
Relative humidity:	0-90% (not condensing)
Delivery:	product, description
Available accessories:	module backplanes: BP16, BP2, BP2-BOX; temperature reference sensor ZU-TR (LM35CAZ)
Warranty:	2 years from date of purchase at bmc, claims for damages resulting from improper use excluded

Manufacturer: BMC Messsysteme GmbH. Subject to change due to technical improvements. Errors and printing errors excepted. Rev. 6.0 02/24/2016