bmc messsysteme gmbh

MA-UNI

Universal Measuring Amplifier
Patent No. 196 52 293

User Manual

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bavarian measurement company munich

Contents

1 Overview

1.1 Introduction

1.1.1 General

The **MA-UNI** (Measurement Amplifier Universal) is an electrically isolating universal measuring module, which complies with the 5B industrial standard and is suitable for almost all common measuring quantities and measuring transducers.

Figure 1

With the **MA-UNI**, voltages, current and resistance can be measured directly. Inductive and resistive measuring bridges as well as active or passive sensors can also be connected. Even tacho generators for speed measurement are possible.

The **MA-UNI** can be used for almost any measurements, in which a measured physical quantity must be conditioned to provide a scaled analog voltage signal. Almost all common measuring sensors are connectable to the module. The module can also be adapted for other measuring ranges and measuring tasks using only a few components.

The configuration of the operating modes and the filter cut-off frequencies is set by DIP switches at the front. Offset and gain are calibrated with trimmer potentiometers. One DIP switch will increase the offset adjustment range.

The module contains the following function groups:

- input preamplifier
- signal conditioning
- signal buffering
- output part with filter and switches
- generator
- power pack

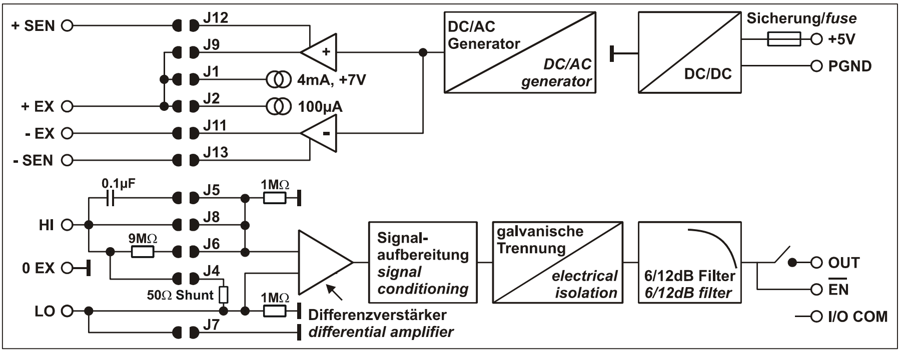

Figure 2

It is not allowed to use the measuring amplifier MA-UNI for protective measurement. Comply with the VDE regulations!

1.1.2 Fields of Application

The fields of application for the **MA-UNI** are very varied. The basic electrical quantities voltage, current and resistance can be measured directly. All "mechanical quantities" can be derived from these.

The following quantities are processed by the **MA-UNI**:

- voltage and current (DC + AC)
- resistance measurement with constant current
- carrier frequency procedure for inductive sensors
- DC generator for resistance measuring bridges

The following quantities can be measured with a suitable sensor:

- temperature, humidity
- length, angle
- pressure, force, strain gauge (DC)
- flow rate, sound
- brightness
- acceleration, velocity

The **MA-UNI** provides valuable assistance in pure signal conditioning as a

- filter
- preamplifier
- power module for active sensors

1.1.3 Parameters

- electrically isolated 5B compatible module
- differential input
- 1000V DC/DC converter and optocoupler insulation voltage
- 240V AC input protection, short-circuit proof outputs
- 6-wire technique with backplanes by BMC Messsysteme GmbH possible (for strain gauge measurements)
- up to 10 measuring ranges
- 3 selectable filter cut-off frequencies, 2 selectable offset ranges
- measuring class accuracy 0.1%

1.2 BMC Messsysteme GmbH

BMC Messsysteme GmbH stands for innovative measuring technology made in Germany. We provide all components required for the measuring chain, from sensor to software.

Our hardware and software components are perfectly tuned with each other to produce an extremely user-friendly integrated system. We put great emphasis on observing current industrial standards, which facilitate the interaction of many components.

Products by BMC Messsysteme are applied in industrial large-scale enterprises, in research and development and in private applications. We produce in compliance with ISO-9000-standards because standards and reliability are of paramount importance to us - for your profit and success.

Please visit us on the web (http://www.bmcm.de/us) for detailed information and latest news.

1.3 Copyrights

The Universal Measuring Amplifier MA-UNI is protected by patent (Patent No. 196 52 293).

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2 Basics

2.1 Technical Description

2.1.1 Selection of Operating Modes

The operating modes for the measurement of voltage, current or resistance are selected with two DIP switches and solder jumpers.

With three DIP switches the measuring ranges can be set in up to eight stages.

Three filter cut-off frequencies are selectable with two other DIP switches. One DIP switch will increase the offset adjustment range.

Offset and gain can be calibrated with trimmer potentiometers.

2.1.2 Description of the Operating Modes

2.1.2.1 Voltage Measurement Mode

The input resistance of the **MA-UNI** module is 1MΩ or 2MΩ in differential mode. To prevent interference the measuring cables should always be screened. Optimum results are obtained with a balanced connection.

The module is calibrated ex works in the range of ±1V.

2.1.2.2 Current Measurement Mode

The input resistance of 5Ω is the same in all measuring ranges. Because of the SMD technique used the accuracy of the shunt is just 0.5%. For accurate measurements the measuring amplifier must be calibrated. To prevent an accidentally wrong switch setting from damaging the module, the current measuring mode is not selected by means of a switch. The current shunt must be separately put into operation using the solder jumper **J4** on the bottom of the **MA-UNI**.

With 4-20mA interfaces the offset can be adjusted at 4mA using the extended offset (±100% ⇔ DIP6 ON). Gain calibration must also be carried out.

Excessively high input voltages and currents in the current measurement mode may damage the module. Take great care when making current measurements!

2.1.2.3 Resistance Measurement Mode

Measurement is made in all ranges with a 100µA impressed DC current. The input resistance of the measuring amplifier is 1MΩ and during the resistance measurement it is in parallel with the resistance to be measured. The resistance measurement is a 2-, 3- or 4-wire measurement.

The resistance measurement is possible only with backplanes which have the 0V pin (0EX) available. Alternatively it is also possible to close jumper J7.

2.1.2.4 Temperature Measurement

A temperature measurement can be made with PT100, thermocouple or semiconductor sensors (see "Temperature with Thermocouple" on page 37).

The 0°C point can be simulated with iced water and calibrated with the offset potentiometer or with external resistors. When changing the measuring range the offset must be reset. The temperature range can be accurately adjusted with software calibration, linearization, extended measuring range and gain calibration.

2.1.2.5 Carrier Frequency Measurement Mode

In the carrier frequency measurement mode, a 5kHz sine voltage is provided for the sensor as EX supply. The modulated sensor signal is converted by a demodulator into a DC voltage proportional to the sensor signal.

Half bridge mode by connecting the LO input to 0V is possible for inductive sensors. However, this causes a phase shift in long cables and a half bridge addition to the sensor may provide better results in such cases.

In carrier frequency mode, the maximum transmission bandwidth is approximately 200Hz, filtered with a 3-pole filter (18dB/oct.). In the case of large output signals, the carrier frequency with low amplitude is superimposed on the output signal. Therefore ensure that the output filter is set as low as possible (e.g. 10Hz). Use screened cables. Long cables result in gain, offset and phase errors, which may have to be compensated. In the case of very long cables (>25m) use large cable cross-sectional areas (>0,25mm^2).

2.1.2.6 Operation with Resistive Sensors

The module provides a supply voltage of ±2.5V DC. Measuring bridges or sensors >100Ω can be connected. Low-ohmic bridges produce less interference as a matter of course, but need more power. This results in higher module current consumption. Half bridge and quarter bridge operation is possible (see "Strain Gauge Measurement with DC" on page 35). Alternatively a 4mA power source for sensor supply is provided (e.g. for sensors by Kistler).

Note, in the case of screened cables, that long cables produce gain and/or offset errors, which may have to be compensated. In the case of very long cables (>25m) use large cable cross-sectional areas (>0.25mm²) or change over to the 6-wire technique.

When using long cables with strain gauge sensor the EX generator may start to swing because of cable capacities. To put things right connect a 10µF condenser in parallel (mind polarity!) to the ±EX supply of the sensor.

In the case of cable junctions ensure that the same materials are used to prevent thermoelectric voltages from causing errors.

2.1.2.7 Operation with AC-DC Rectification

The signal can be rectified in the *voltage* and *current* operating modes. Half-wave rectification with smoothing is used for this as with simple multimeters. The rectified value corresponds to 1.414 times the alternating voltage RMS value in the case of a sine-wave voltage. Asymmetric and non sine-wave AC voltages may falsify the rectified value. The smoothing allows only a measuring frequency up to approximately 10Hz.

2.2 Function Groups

2.2.1 Input Preamplifier

The input preamplifier operates in differential mode and therefore effectively suppresses hum interferences. At the HI and LO inputs the input resistance is 1MΩ, or 2MΩ in differential mode, which is relatively high. Therefore low-ohmic terminations should be provided in order to prevent interference.

Screening of the cable is always appropriate, since only by this means asymmetric interference is reliably eliminated. The 0EX connection can be used for this purpose. Earthing is not necessary. Should earthing of the screen be necessary for system reasons, the 0EX connection should not be used.

- **Always connect earthing or screening only to one end of the cable to prevent hum pick-up. Do not use screening as signal ground!**
- **Ensure that no voltage is applied in the current and resistance range, otherwise the module may be damaged!**

Direct decoupling prevents ground leakages and hum pick-up between the various measured variables and the measuring system, such as they are difficult to prevent in the case of larger test setups.

A measurement can be made at different potentials. Direct decoupling guarantees 1000V DC at the maximum. High potential differences (>60V) are not allowed by **VDE regulations**!

The input protection circuitry allows a short overload of the module up to approximately 240V AC.

2.2.2 Signal Conditioning

After the preamplifier the signal is conditioned according to the application by appropriate selection of operating mode.

2.2.2.1 Zero Adjustment (OFFSET)

Fine calibration in all measuring ranges is possible with the offset potentiometer. The fine calibration is preset ex works. However, slight deviations may occur in the various operating modes.

If you use self-applied measuring bridges you can switch to a larger calibration range (± 100%). However, this causes increased temperature drift of the module.

2.2.2.2 Gain Adjustment (GAIN)

Fine calibration is possible in all measuring ranges using the GAIN potentiometer. The fine calibration is preset ex works. However, slight deviations may occur in the various operating modes. Greater deviations, e.g. in the case of uncalibrated sensors, must be scaled with software and/or by an external measuring range extension circuit.

2.2.3 Signal Buffering

Signal buffering is provided by an optical buffer amplifier. This allows a high transmission bandwidth with low supply currents. The otherwise customary clocked buffer amplifiers have slightly better temperature drift characteristics, but produce high interference noise and are sensitive to EMC fields. The insulation voltages amount to several 1000V, but are prohibited from being utilized in such small modules by VDE regulations.

2.2.4 Output Range

The measuring amplifier supplies an electrically isolated output voltage of ±5V DC proportional to the input signal. The short-circuit proof output can drive loads greater than 1kΩ. Since the voltage drop at the output switch causes measurement errors, the load should be >10kΩ. If the module is overdriven, the output voltage rises to approximately ± 6.5V.

A semiconductor switch is integrated in the output circuitry. If this function is not needed, the enable circuit EN (PIN 22) must be connected to the output chassis IO COM (PIN 19). When actuating EN with a TTL signal with respect to supply chassis, a high resistance connection (e.g. 10kΩ) must be provided to the output chassis. The EN input can also be driven with an optocoupler or open collector.

2.2.4.1 Output Filter

The inherent noise of the module is low as a result of the analog signal insulation. For this reason a filter of only 12dB/oct. (at 10kHz) has been inserted.

Always use the cut-off frequency appropriate for your signal to ensure effective suppression of interference!

The following figure shows the filter function.

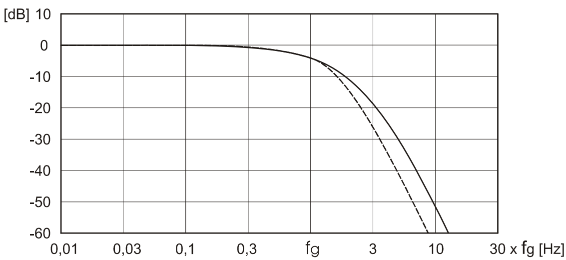

Figure 3

2.2.4.2 Generator for Sensor Supply

Inductive or resistive sensors in a full or half bridge circuit can be connected to the integral AC or DC generator. The AC generator supplies a sine-wave 5kHz signal, the DC generator supplies a ±2.5V DC voltage.

With half or quarter bridge mode the LO input must be connected to 0V. This simulates a half bridge extension. With quarter bridge operation external extension to a half bridge must be provided.

The SEN connections are provided for realization of a 6-wire technique and are used to compensate for long cables. This option can only be used with backplanes containing no thermocouple compensation (if necessary, unsolder the SEN pins).

For measuring resistances a 100µA DC power source is provided. For current operated sensors 4mA DC power source is available.

2.2.5 Power Supply

The power supply consist of two electrically isolated DC/DC converters. It produces supply voltages for the input and output circuitry. The DC/DC converter ensure 1000V insulation voltage. There is an SMD fuse in 5V supply line, which is accessible from the bottom of the module.

The supply voltage is 5V DC and must be stabilized. Voltages higher than 5.5V may damage the module!

2.2.6 Miscellaneous

The pin assignment of the modules corresponds to the 5B modules by Analog Devices® and BURR BROWN®. **In addition a 0V PIN (0EX) is used**, which is necessary especially for resistance measurements, screening purposes and multi-wire techniques. If the module is used in module backplanes by Analog Devices® or BURR BROWN® this pin must be removed or an appropriate hole must be provided in the backplane. If necessary also unsolder the SEN pins (see 2.2.4.2 Generator for Sensor Supply on page 17).

2.2.6.1 Calibrating Sensors

First bring the sensor to the mechanical zero position and adjust the module to zero at the output. Then apply a known load to the sensor, e.g. 10% of the rated load, and adjust the module output with the GAIN potentiometer to the relevant output voltage (e.g. 10% = 0.5V). When strain gauge sensors are used GAIN calibration with the potentiometer is often no longer possible, so that scaling must then be carried out with software and/or by an external measuring range extension circuit.

2.2.6.2 External Prefilter

The module is designed for a maximum transmission bandwidth of 10kHz. This means that with some applications a high noise level and mains hum are amplified along with the measurement signal. This can lead to measurement errors. If necessary a prefilter should be considered in this case. A simple passive filter will often provide good results in such cases (see 4.2.12 External Prefilters and Preamplifiers on page 38).

3 Installation and Configuration

3.1 Module Connection

The module is operated with a 5V DC power source. An appropriate module board is needed for this. In equipment by BMC Messsysteme GmbH (e.g. AP2, AP8, AAB-II, AAR) the module needs only to be inserted and screwed in position. The sensor or signal is connected to the appropriate screw terminals or 5-pole equipment connectors.

- **First ensure that the module settings are correct. Only one wrongly set DIP switch or jumper can set the module to a completely different operating mode and produce a wrong output signal.**
- **When inserting the module, turn of the device.**
- **Remove the sensor and check the measuring amplifier and the measuring circuits with external reference sources.**
- **Check the power supply of the measuring module.**
- **Check the correct reference ground of input and output signals.**
- **Check for hum pick-up: Electrical connection between in- and output?**
- **Is there any interference on the measurement signal (if necessary, check with oscilloscope)?**

3.2 Control Elements

The **MA-UNI** has different types of control elements. On top of the module there are eight configuration switches and three calibration potentiometers. The switches select operating mode, gain, offset range and cut-off frequency. The potentiometers select offset and gain. Coarse offset calibration is only possible after activating DIP switch 6.

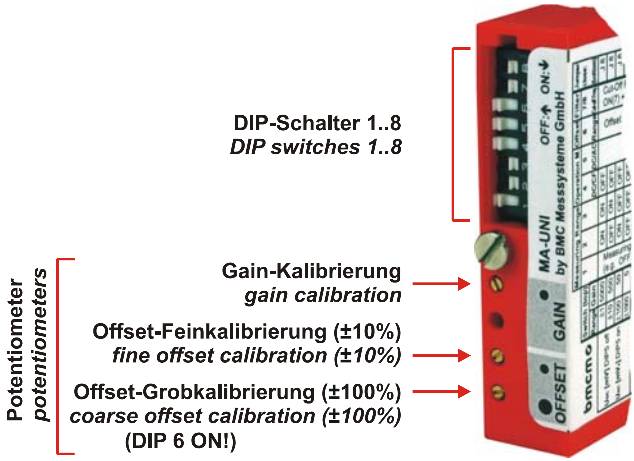

Figure 4

DIP switch	Function
1	half measuring range / double gain
2, 3	choose measuring range and gain
4	change to carrier frequency mode
5	switch between DC and AC
6	turn on coarse offset calibration (±100%)
7, 8	select filter cut-off frequency

The solder jumpers for configuration are placed on the bottom of the module.

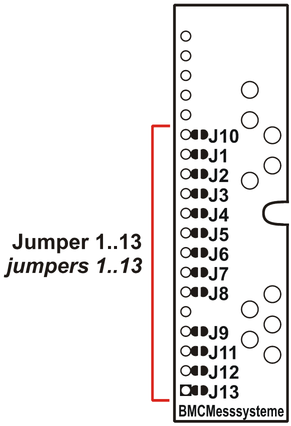

Figure 5

Jumper	Function
J1	4mA power source to +EX (**max. +7V**)
J2	100µA power source to +EX
J4	5Ω current shunt
J5	AC decoupling
J6	±10V measuring range (non-differential)
J7	LO to 0EX (input ground)
J8	HI direct input
J9	+2.5V EX
J11	-2.5V EX
J12	+SEN
J13	-SEN
J3, J10	(without function)

To prevent the modules from being damaged, close only jumpers required for the relevant application (see table, p. 24 and chapter 4.2). This applies especially to the power supply (close either J1 or J2 or J9!).

3.3 Pin Assignment

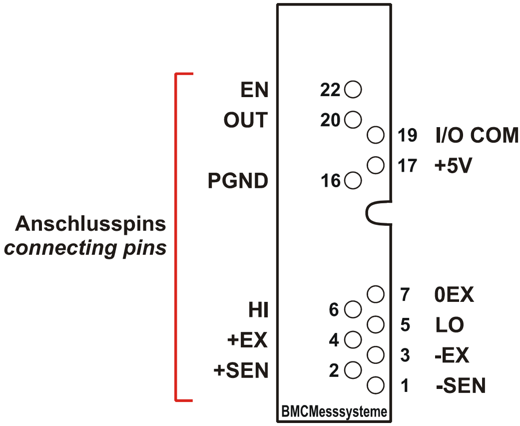

Figure 6

Pin	Assignment	Function
22	EN	Enable-Eingang
20	OUT	Ausgangssignal
19	I/O COM	Ausgangsmasse
17	+5V	+ Versorgung
16	PGND	Versorgungsmasse
7	0EX	0V-Potential des Eingangsverstärkers
6	HI	positiver Messverstärkereingang
5	LO	negativer Messverstärkereingang
4	+EX	positive Speisespannung
3	-EX	negative Speisespannung
2	+SEN	positiver SENSE-Eingang
1	-SEN	negativer SENSE-Eingang

The pin assignment conforms to the modules from the manufacturers BURR BROWN® and Analog Devices®. In addition, however, a connection pin (PIN 7; 0EX) has been defined to allow additional applications.

If using backplanes from the manufacturers BURR BROWN® or Analog Devices® with integrated cold-junction compensation, the sensor terminals -SEN and +SEN of the measuring amplifier have to be deactivated (open **J12**, **J13,** see 2.2.4.2 Generator for Sensor Supply on page 17) or the cold-junction compensation on the backplanes must be disabled.

3.4 Configuration Switches (on module)

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	Switch (top)		Measuring Range			Operation M.		Offset	Filter	Jumper
			1	2	3	4	5	6	7/8	close:
	Range	Gain				DC/CF	DC/AC	Range	Cut-off Freq.	(bottom)
U_{DC} [mV] U_{AC} [mV$_s$]	±1	5000	Measuring Range: OFF = 100%; ON = 50% (e.g. OFF: MR=1V; ON: MR=0,5V)	ON	ON	OFF	OFF = DC; ON = AC	Offset: OFF = ±10%; ON = ±100%	Cut-Off Frequency: ON(7) + OFF(8) = 100Hz; OFF(7) + ON(8) = 10Hz; ON(7) + ON(8) = 10kHz	J 8
	±10	500		OFF	ON	OFF				J 8
	±100	50		ON	OFF	OFF				J 8
	±1000	5		OFF	OFF	OFF				J 8
U non-differential	±10V	0,5		OFF	OFF	OFF				J 6, J 7
I_{DC} [mA] I_{AC} [mA$_s$]	±0,2	5000		ON	ON	OFF				J 4, J 8
	±2	500		OFF	ON	OFF				J 4, J 8
	±20	50		ON	OFF	OFF				J 4, J 8
	±200	5		OFF	OFF	OFF				J 4, J 8
R [Ω] EX = 100µA	10	5000		ON	ON	OFF	OFF			J 2, J 8
	100	500		OFF	ON	OFF	OFF			J 2, J 8
	1000	50		ON	OFF	OFF	OFF			J 2, J 8
	10k	5		OFF	OFF	OFF	OFF			J 2, J 8
strain gauge [mV/V] EX = ±2,5V	±0,2	5000		ON	ON	OFF	OFF			J 8,9,11
	±2	500		OFF	ON	OFF	OFF			J 8,9,11
	±20	50		ON	OFF	OFF	OFF			J 8,9,11
	±200	5		OFF	OFF	OFF	OFF			J 8,9,11
carrier freq. [mV/V] EX = 2V$_{eff}$ (5kHz)	±100	25		ON	OFF	ON	OFF			J 8,9,11
	±1000	2,5		OFF	OFF	ON	OFF			J 8,9,11

Patent No.196 52 293. Adjusted at ±1V$_{DC}$.
Not used jumpers must stay open. Test ok.
Close J12+13 only for 6-wire applications.
Output voltage: ±5V(R and AC: 0…5V)

Low Voltage only!

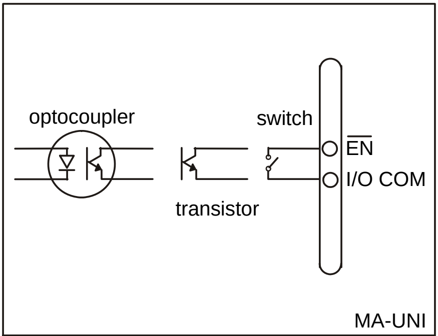
The table above shows which of the eight DIP switches must be in the position *ON* or *OFF* to determine the measuring range, the operating mode, the range for offset adjustment and the cut-off frequency and which jumpers must be set for the possible operating modes - voltage and current (AC or DC), resistance (R), strain gauge and carrier frequency.

Not used jumpers must stay open!

3.5 Output Switch

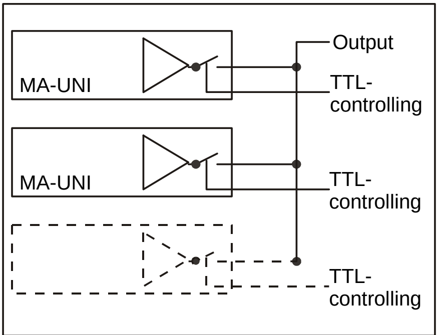
At the output the module is provided with a semiconductor switch, which is controlled by the EN pin of the measuring amplifier.

Der Enable Eingang (EN) des Moduls ist LOW ACTIVE.



Steuerung mit Optokoppler/Transistor/Schalter
Controlling with optocoupler/transistor/switch

The output switch has a reference to I/O COM. If the control signal is referred to PGND, a high-ohmic connection (e.g. 10kΩ) must be made between I/O COM and PGND (This influences the galvanic isolation between PGND and I/O COM!). The module is switched with a TTL or CMOS level. The EN input can be activated directly by means of a switch, transistor or optocoupler. If not used, EN must be put to I/O COM.



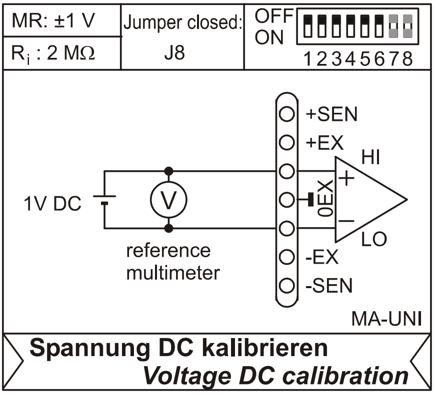
Multiplexer-Einsatz
Controlling as multiplexer

Using the EN input as multiplexer substitute

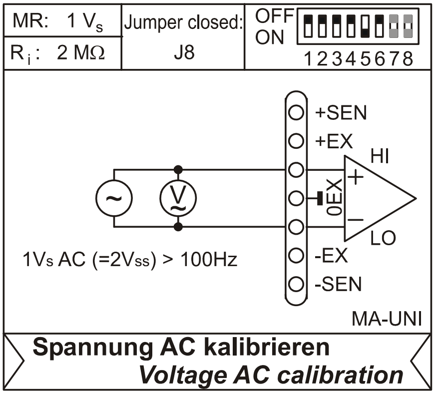
3.6 Calibration

The measuring ranges have an accuracy of ±0.1%. The accuracy of the various operating modes can be added to this in the worst case. To obtain accurate measurements, therefore, the respectively used measuring mode and range must be calibrated with reference units.

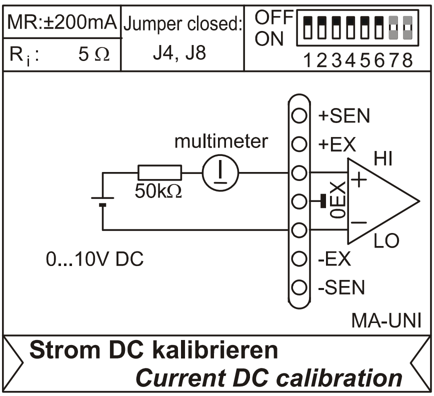
When calibrating, always adjust the offset first, then calibrate the range extremities (+5V or -5V) with gain.



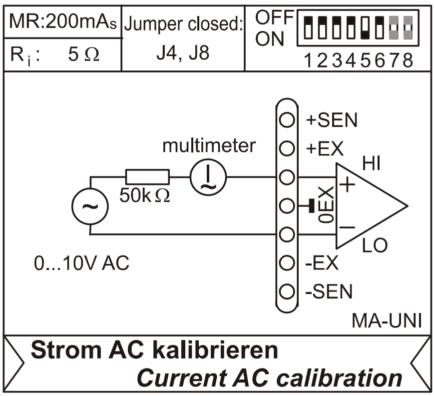
Spannung DC kalibrieren
Voltage DC calibration



Spannung AC kalibrieren
Voltage AC calibration



Strom DC kalibrieren
Current DC calibration



Strom AC kalibrieren
Current AC calibration

3.7 Software Parameter Setting

In many applications the output signal of the measuring amplifier is connected to analog/digital converter cards. These cards transform the analog output voltage of the measuring amplifier to digital values. The measuring system connected can convert these digital values, so that the corresponding physical quantities directly are displayed and recorded. Shown below is the parameter setting using the measuring software for data acquisition and processing **NextView®4**.

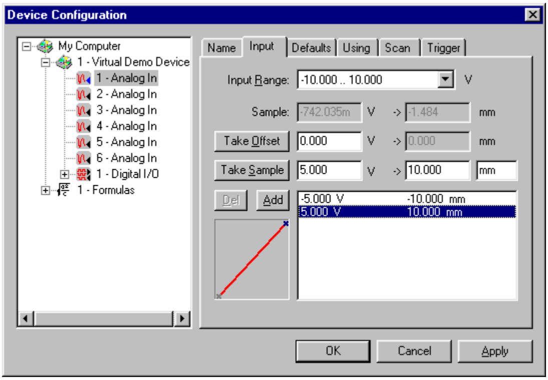


Figure 7

Conversion of voltage to the corresponding physical quantity is carried out in a very user-friendly dialog box.

4 Applications

4.1 Some Advice

The following examples illustrate the most common applications to facilitate first use of the **MA-UNI**. Yet not every detail will be examined. Many of the examples can also be combined with each other.

The measuring ranges are always only representative for an application. The filters must be set as appropriate for the application.

The module output is proportional to the input voltage (e.g. MR: ±1V ≈ ±5V at the output).

The fine adjustment of the measuring range is made by offset and gain adjustment.

In the case of long cables, it is essential to use will screened cables with large cross-sectional area.

- **Ensure that no external extensions cause the module limits to be exceeded.**
- **Comply with EN/VDE regulations!**
- **Connect the cable screen only at one end.**
- **For some applications better connect the screen to earth and not to the internal ground (0EX).**

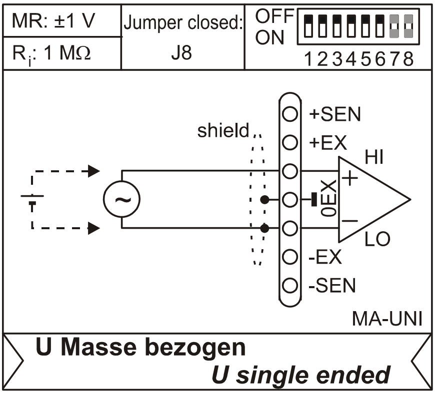
The following abbreviations are used in the examples:

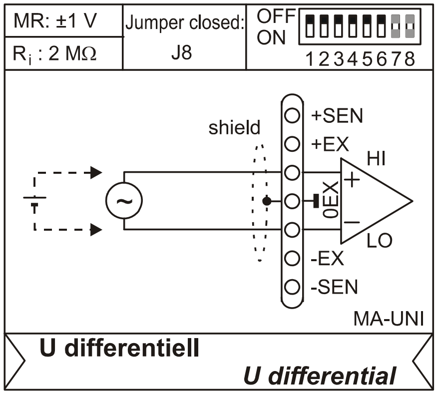
Kürzel	Beschreibung
MR	measuring range
HI	positive measuring amplifier input
LO	negative measuring amplifier input
+SEN	positive SENSE input
-SEN	negative SENSE input
+EX	positive supply voltage
-EX	negative supply voltage
0EX	0V potential of the input preamplifier
TC	temperature coefficient in ppm
R_i	input resistance
DMS	strain gauge resistance
CF	carrier frequency measuring method
GAIN	gain
OFFSET	offset
DC	DC voltage or current
AC	AC voltage or current
PT100	temperature precision resistor with 100Ω

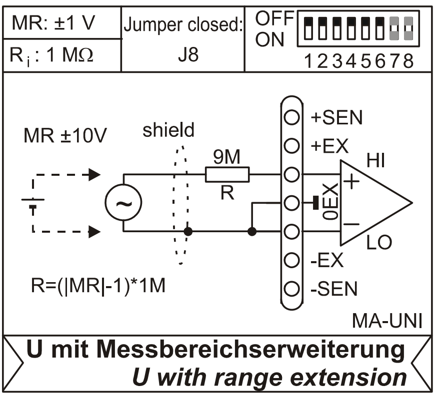
4.2 Examples

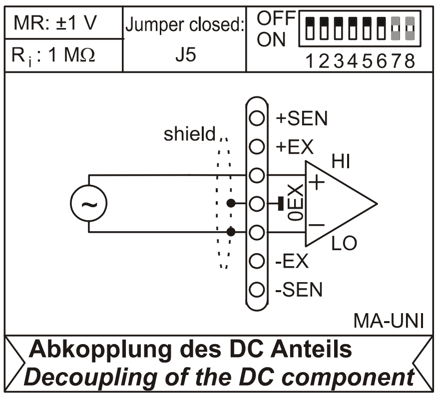
4.2.1 Voltage Measurement DC

The output voltage is proportional to the input voltage.





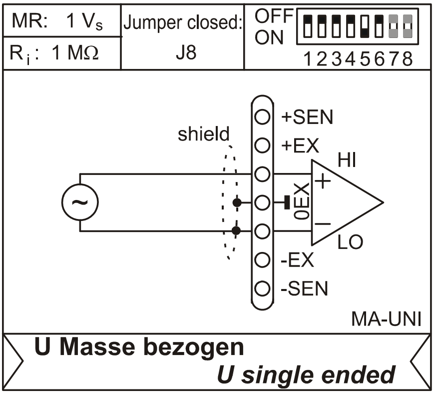


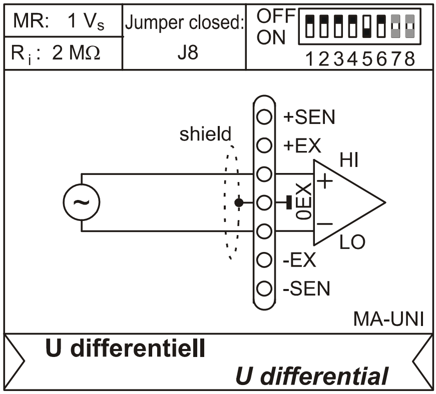


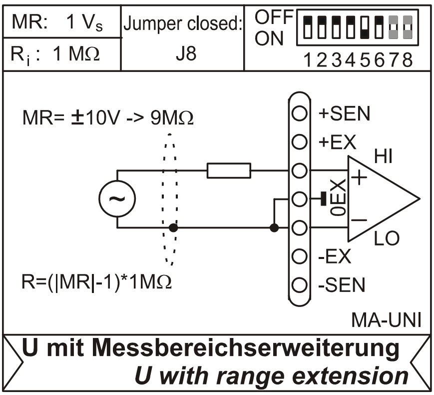
4.2.2 Voltage Measurement AC

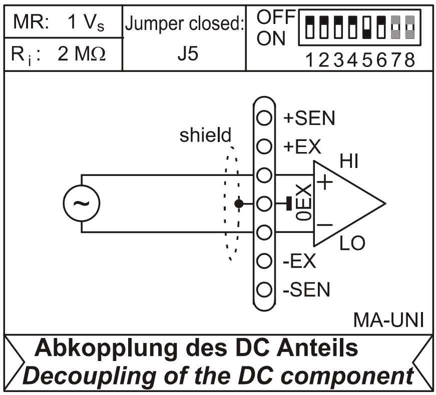
Active half-wave rectification is used for the rectifier function. Smoothing produces a maximum frequency transmission of approximately 10Hz. In the case of a sine-wave input voltage applies:

$$U_{out} = U_{ss} / 2 * GAIN \quad \text{and} \quad U_{eff} = \frac{U_{out}}{\sqrt{2}}$$







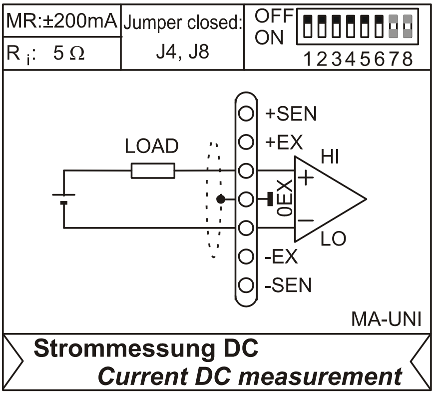


4.2.3 Current Measurement

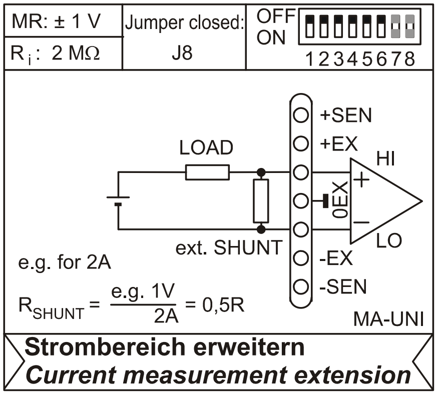
A 5Ω shunt is placed in the signal path for current measurement. The shunt is activated with **J4** on the bottom of the module. In the case of current measurement with rectification the rectified peak value of the AC current is shown.

The following applies for U_{out}: 0 .. $200mA_s \cong 0$ .. 5V

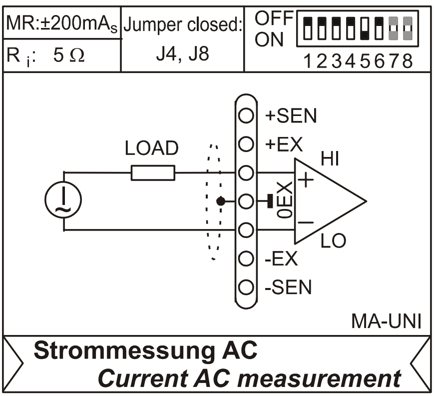
Do not connect power sources; danger of overloading the shunt!



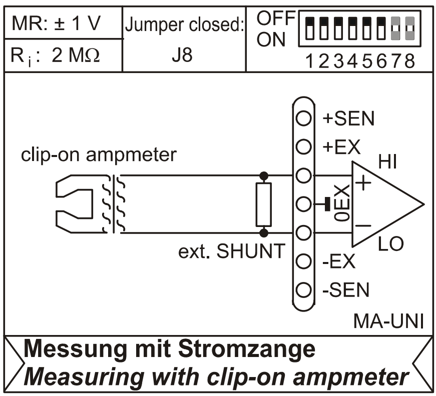
Strommessung DC
Current DC measurement



Strombereich erweitern
Current measurement extension



Strommessung AC
Current AC measurement



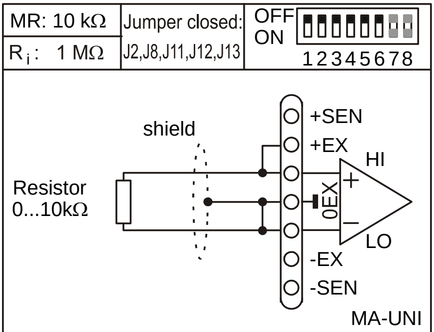
Messung mit Stromzange
Measuring with clip-on ampmeter

4.2.4 Resistance Measurement

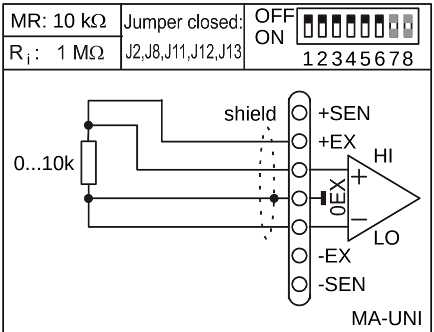
The resistance measurement is done using an impressed +100µA current. The output voltage is positive and proportional to the resistance. In 4-wire measurement the line losses are compensated. PT100 precision resistors are not linear and must be linearized.

The error measurement (because of R_i = 1MΩ) behaves as follows and for R? applies:

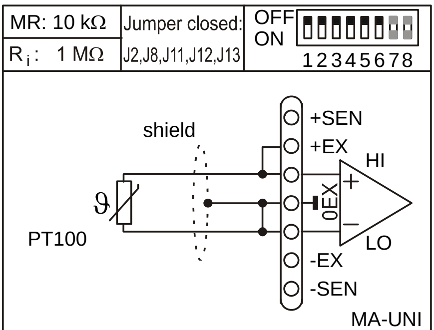
$$\frac{1}{R_{measured}} = \frac{1}{R?} + \frac{1}{1M\Omega} \qquad R? = \frac{R_{measured} * 1M\Omega}{1M\Omega - R_{measured}}$$



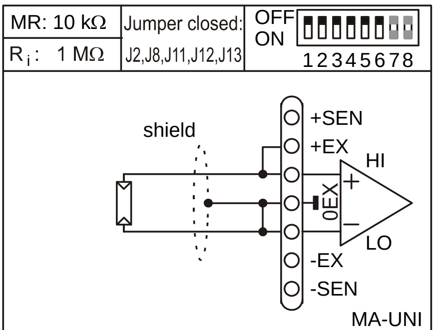
2 - Leitermessung
2 wire measurement



4 - Leitermessung
4 wire measurement



Temperaturmessung mit PT100
Temp. measurement with PT100

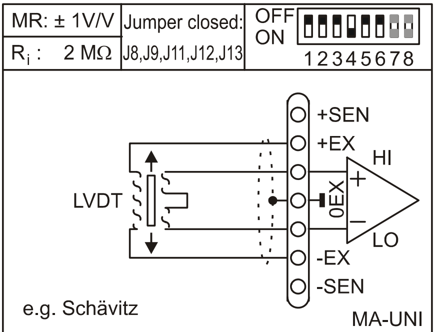


Helligkeit mit Photo R
Light measurement

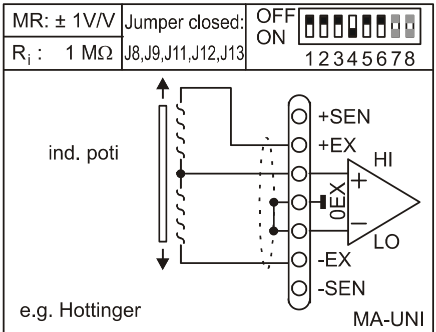
4.2.5 Distance Measurement with Carrier Frequency

Carrier frequency measurement is required when using differential suppressors and LVDTs. A 5kHz sine voltage with $2V_{eff}$ is present at the module EX pins. Phase adjustment has been omitted on purpose being too difficult to handle. That is why in the case of long cables phase errors must be expected. Using the carrier frequency mode f_g is 200Hz at the maximum. In the case of long cables a full bridge circuit at the sensor should be used.

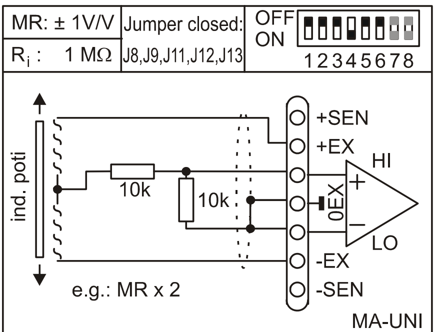
J12, J13 must only be closed in the case of 6-wire applications. For some applications better connect the screen to earth and not to the internal ground (0EX).



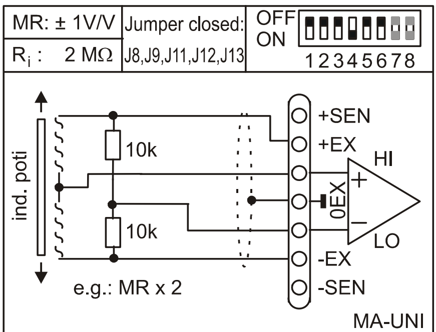
Trägerfrequenzmessung mit LVDT
Carrier freq. measurement w. LVDT



Trägerfrequenzmessung mit Linearpoti
Carrier frequency measurement w. poti



Messbereichserweiterung
Measurement extension



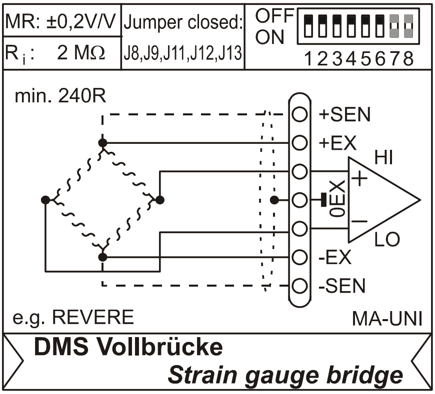
TF Messung m. langen Leitungen
Carrier freq. measurement w. long leads

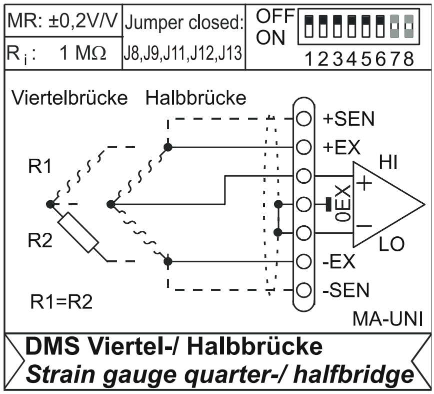
4.2.6 Strain Gauge Measurement with DC

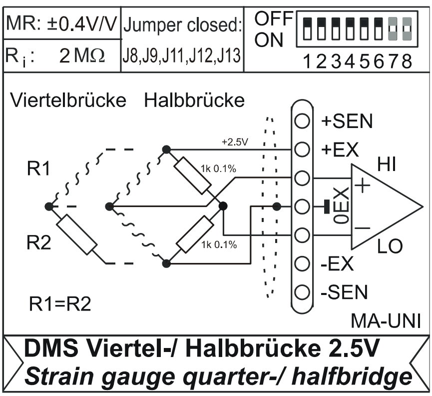
Strain gauges are resistors, which are operated in bridge circuits. The EX voltage is ±2.5V DC. The input amplifier uses the differential mode of operation. If necessary the sensor lines compensate for line losses.

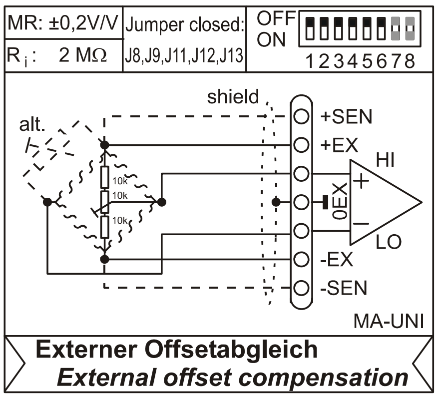
In the case of bridge extensions precise supplementary resistors must be used (0.1%; TC15). When using 100Ω bridges only +2.5V can be used, so that also the measuring range is divided in half.

J12, J13 must only be closed in the case of 6-wire applications. For some applications better connect the screen to earth and not to the internal ground (0EX). To avoid swings when using long cables in 6-wire technique connect a 100nF condenser in parallel to the ±EX supply of the sensor.



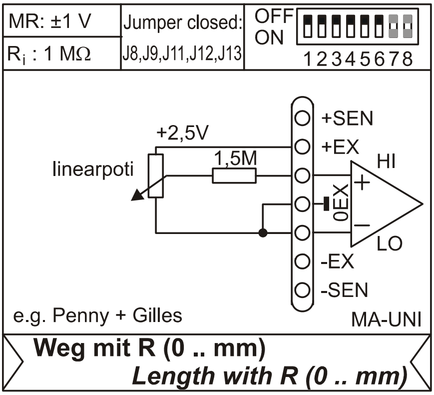


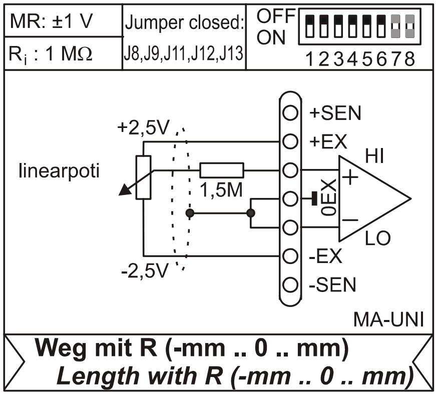




4.2.7 Length, Angle with Potentiometer

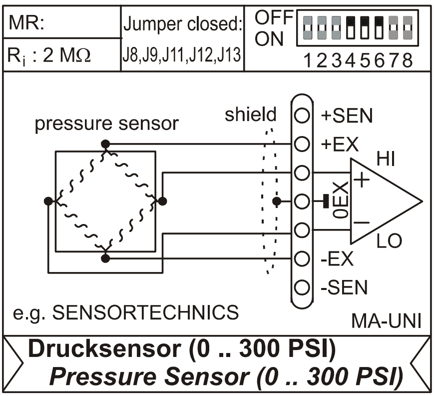
The length of a path or angles can be determined using precise linear potentiometers. The 1.5MΩ resistor provides an extended measuring range.

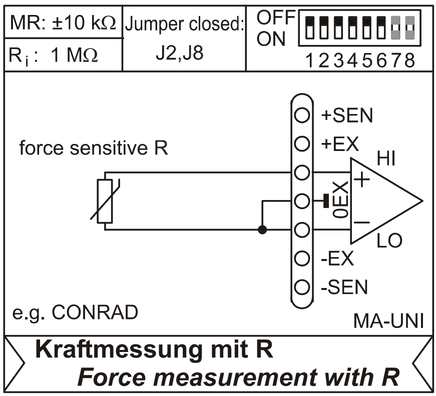




4.2.8 Pressure, Force

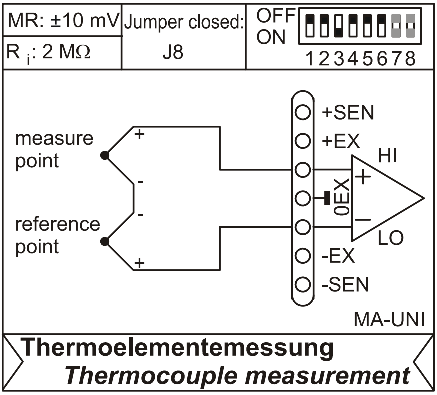
A half bridge serves as a pressure transducer. For the force measurement a pressure sensitive resistor is applied.





4.2.9 Temperature with Thermocouple

With thermocouples high temperatures can be measured. For compensation of cold junctions a second thermocouple is needed.



With 0°C provided as reference the temperature is indicated directly. Correction must be made with OFFSET at ambient temperature.

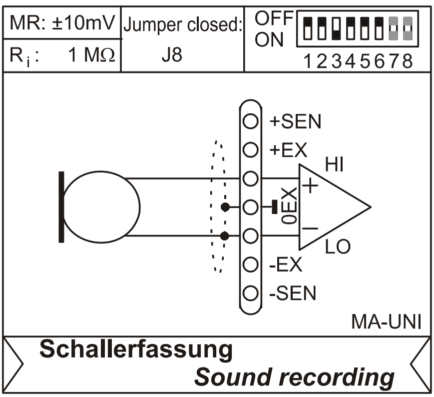
Type K elements: 40.6µV/K

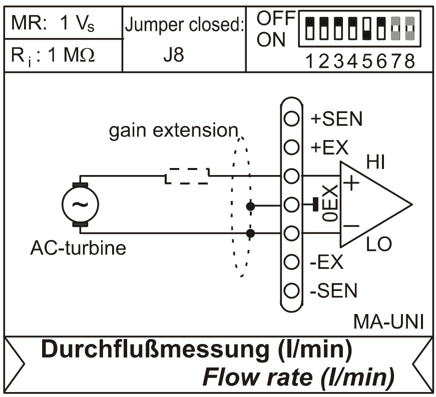
Type J elements: 51.7µV/K

4.2.10 Sound, Flow Rate

For sound recording a normal dynamic microphone can be used. A flow rate measurement is made by using an AC turbine.

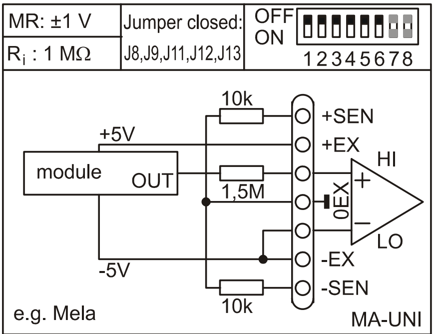
The rectified signal corresponds to the sound level or the flow rate.



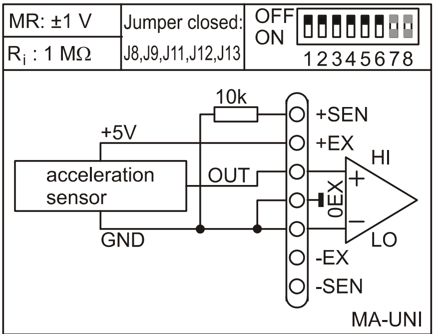


4.2.11 Humidity, Acceleration

Active sensors are used. The 1.5MΩ resistor serves for the adaptation of the measuring range if necessary. The sensors are supplied via the EX pins.



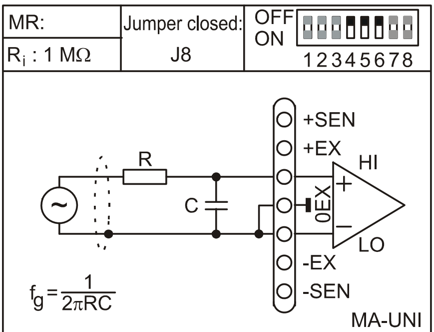
Relative Luftfeuchte
Relative Humidity



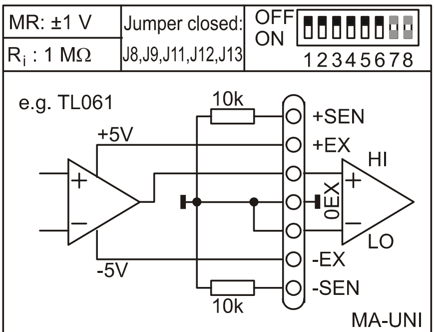
Beschleunigung
Acceleration

4.2.12 External Prefilters and Preamplifiers

The low-pass filter is suitable for filtering out high-frequency interference with 6dB/Okt. The resistor R forms a voltage divider with R_i = 1MΩ.



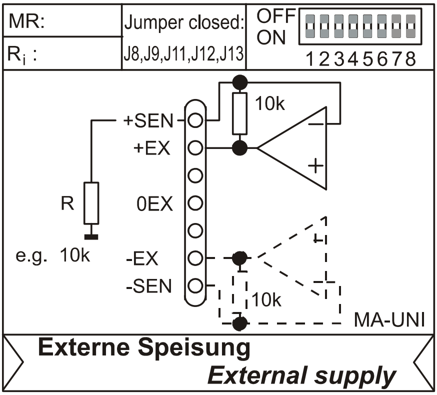
Passiver Tiefpassfilter
Passive low-pass filter



Vorverstärker (±5V; ±5mA)
Preamplification (±5V; ±5mA)

4.2.13 MA-UNI as ±5V DC Supply Module

When using EX connections for the supply of external sensors the EX voltage can be set with the SEN terminals.



The output voltage at the EX terminals is calculated as follows:

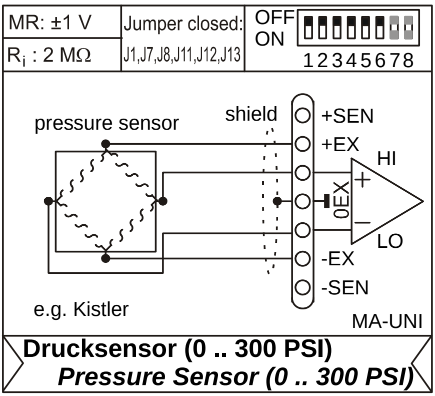
$$U_{ex} = 2.5V * (1 + \frac{10k}{R})$$

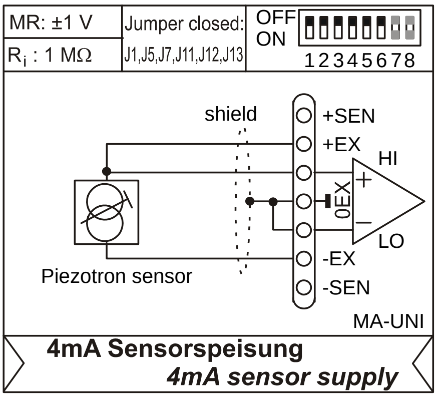
The maximum EX voltage for currents of up to 5mA is ±5V. With an EX voltage of <4V currents of up to ±25mA can be tapped off.

4.2.14 MA-UNI as 4mA DC Supply Module

For current operated sensors a 4mA DC power source is provided. The power source has a maximum amplitude of approximately 5V. Therefore, sensors with more than 2.5kΩ can not be used.

Piezotron® sensors (Kistler) usually are operated at AC decoupled amplifiers. The following example is realized in 3-wire technique.





5 Technical Data

- **Measuring Ranges**

Measuring range:	MR1	MR2	MR3	MR4
Amplification:	5000	500	50	5
bandwidth [kHz]:	1	5	10	10
Voltage DC [mV]:	±1	±10	±100	±1000*
Voltage AC [mV_S]:	±1	±10	±100	±1000
Current DC [mA]:	±0,2	±2	±20	±200
Current AC [mA_S]:	±0,2	±2	±20	±200
U_{Drop} current range DC[mV]:	±1	±10	±100	±1000
U_{Drop} current range AC[mV]:	1	10	100	1000
Resistance [Ω]:	10	100	1k	10k
Sensitivity SG (±2.5 V DC) [mV/V]:	0,2	2	20	200
Sensitivity CF at $2V_{eff}$ AC [mV/V]:	--	--	100	1000

At the output referred to: -5V..+5V (i.e. 0V..+5V to resistance test and rectification)
*** Open jumper J8 and close J6 and J7 to extend the ±1V measuring range to ±10V.**
Setting DIP switch 1 to ON reduces the respective measuring range to 50% (e.g. 1V → 0.5V).

- **Generator**

Generator voltage (strain gauge):	±2.5V DC
Generator voltage (LVDT):	$2V_{eff}$ at 5kHz AC
Generator current (+int. resistance):	100µA or 4mA, max. swing 5V, max. 50Ω
Connectable sensors:	strain gauge 100-1000Ω; ind. 8-20mH

- **Accuracy** (typ. at 20°C after 5 minutes and +5V supply)

Measuring range calibration (gain):	±10%
Zero fine adjustment (offset):	±10%
Zero coarse adjustment (offset):	±100% (temperature drift app. 200ppm)
Generator current:	±0.25%, max.: 1%; TC = 25ppm/°C; for 4mA: ±5%
Generator voltage:	±0.25% DC, max.: ±1%; ±2% AC
Residual ripple CF:	max. 0.2%
Filter accuracy of f_g:	max. ±15%
Relative range accuracy:	0.1%, if MR/2 typ. 1%, if MR = ±10V typ. 2%
Current measuring accuracy DC:	typ. ±0.2%
Current-/voltage measurement AC:	typ. ±5%
Amplifier accuracy:	typ. 0.01%; max. 0.1%
Non-linearity:	typ. 0.01%; max. 0.1%
Temperature drift offset + gain:	typ. 100ppm/°C; max. 200ppm/°C
Resistance measuring accuracy:	typ. 0.1%; max. 1%

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

- **Input range**

Input resistance:	single-ended 1MΩ, differential 2MΩ, switched off 100kΩ
Input resistance (for current):	5Ω shunt
Voltage drop (for current):	max. 1V
Input AC decoupling (J5):	0.1µF and 1MΩ for f_g >10Hz
Input suppressor circuit:	max. 240V AC for 1sec. (not in I measurement or R test)

- **Output range**

Output voltage:	±5V DC
CMOS output switch:	with TTL level or open collector switchable (low active)
Output switching time:	10µs at 200pF
Switch resistance:	typ. 50Ω; max. 100Ω (short-circuit proof)
Output load:	>1kΩ, >10kΩ for 0.1% accuracy
Output filter:	2-pole (12dB/oct.) for 10kHz; 1-pole (6dB/oct.) for 10Hz, 100Hz
Demodulator filter CF range:	3-pole (18dB/oct.) for 200Hz
Output hum / -ripple:	typ. 10mV_{ss} / max. 80mV_{ss} at MR ±1mV, f_g = 10kHz

- **Current supply**

Voltage supply:	+5V DC (±5%), protected by a Multifuse
Current without / with sensors:	app. 70mA / max. 250mA
Supply sensitivity at the output:	typ. ±5mV/V

- **General**

Max. permissible potentials:	60V (acc. to VDE)
CE standards:	EN61000-6-1, EN61000-6-3, EN61010-1; for decl. of conformity (PDF) visit www.bmcm.de
ElektroG // ear registration:	RoHS and WEEE compliant // WEEE Reg.-No. DE75472248
Protection type:	IP30
Housing:	plastic case 52 * 70 * 15mm
Temperature ranges:	operating temp. –25°C..+50°C, storage temp. –25°C..+70°C
Relative humidity:	0 – 90% (not condensing)
Patent no.:	196 52 293
Revision no.:	8.0
Delivery:	product, dokumentation
Accessories (available):	module carrier boards, boxes, racks: AP series, AMS series
Warranty:	2 years from date of purchase at bmcm, claims for damages resulting from improper use 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 bmcm at your own expense.

6 Index