MBI 46.31
In field housing

MBI 46.31
Eurocard PCB with
front panel

Operating Instructions

CF Measuring Amplifier

Series MBI 46.31

Contents

1 General

Read carefully before use!

Please read and always follow these operating instructions.

Retain for future reference!

Please retain these operating instructions in a safe location for future reference.

Treat the identification plate on the device with care!

If the device has to be repaired or replacement parts are needed, you must specify the model and the serial number. Both are indicated on the identification plate.

Warnings and safety instructions

Observe the warnings and safety instructions in these operating instructions to avoid physical injury and property damage.

1.1 Warranty and liability

Warranty and liability claims against MESSOTRON cannot be raised if

- damage occurs because the operating instructions are not followed or
- modifications have been made that are not documented in the operating instructions.

1.2 Technical support and contact details

Please contact us if you have any questions. You can reach us at the following contact address:

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Friedrich-Ebert-Str. 37
64342 Seeheim-Jugenheim, Germany

Phone: +49 (0) 6257 999 730

Email: info@messotron.de

For further information please visit our webpage: www.messotron.com.

2 Safety Instructions

2.1 Intended use

The carrier frequency measuring amplifier MBI 46.31 (“the device”) must only be used to operate inductive displacement sensors of the differential transformer type (LVDTs) and differential inductors / half-bridge sensors (LVITs) as well as the associated signal processing equipment. The device must only be used with passive displacement sensors (i.e. sensors without active embedded electronics). Any other use is considered improper use.

Observe the legal and safety regulations required for the respective application. This also applies to the use of accessories.

In order to ensure proper and safe operation, the device must only be operated according to the information provided in these operating instructions.

2.2 Conditions at the installation site

Check the required conditions at the installation site (e.g. temperature and weather conditions). The limits for the device are specified in chapter 11 “Technical Specifications”.

Have the device checked by MESSOTRON before putting it back into service if foreign objects or liquids got inside the device.

Do not use the device near other devices, machines or equipment that generate strong electric or magnetic fields.

2.3 General hazards if the safety instructions are not followed

The device is designed to the state of the art and is safe when used as intended. However, if the device is used and operated improperly (e.g. by insufficiently qualified personnel), residual hazards may arise.

2.4 Qualified personnel

The device must only be placed into service and operated by trained skilled persons who are aware of the hazards involved. The skilled persons must be familiar with the national occupational health and safety regulations, accident prevention regulations as well as approved technical practices and guidelines.

2.5 Check for transport damage

Before unpacking, check the packaging of the device for damage. If the packaging has been damaged during transport and there is reason to believe that the device may be damaged, it must not be placed into service. In this case, have the device checked by MESSOTRON before use.

3 Warning and Other Messages

3.1 Use of warning messages

The following hazard levels according to ANSI Z 535 are used for warning messages:

Warning sign, signal word	Explanation
DANGER	Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potential property damage: The product could be damaged or the environment could be harmed.

Warning messages affecting your personal safety are very clearly marked. Always observe these warnings to avoid physical injury and property damage.

A warning message (for either Danger, Warning or Caution) looks like this:

⚠	***WARNING***
Cause and potential consequences	
- How to avoid the hazard	

3.2 Other messages

NOTE	Notes contain important information for optimum use of the device.

	Not observing a note may result in incorrect measurements; however, this will usually not result in damage to the device.

4 Product Description

4.1 Glossary

Term	Definition
Carrier frequency measuring amplifier	Series MBI 46.31 CF measuring amplifiers are used in inductive measuring chains • to provide the inductive sensor with the required excitation voltage, • to amplify the sensor output signal and • to convert the output signal into a normalized analog current or voltage signal.
Types of displacement sensors	
Displacement sensor	In this these instructions the term “displacement sensor” often abbreviated to “sensor” is used. These devices are also known as “transducers” or “position sensors”. MESSOTRON differentiates the following three displacement sensor types:
Differential transformer (LVDT)	Differential transformers consist of a primary coil and two secondary coils placed around a movable magnetic core. The coils are coupled based on the transformer principle. The acronym LVDT stands for “Linear Variable Differential Transformer”.
Inductive half-bridge, differential inductor (LVIT)	Differential inductors represent a Wheatstone half-bridge with two measuring coils. The impedance of the two measuring coils is influenced in opposite directions by a movable magnetic core. They are also referred to as LVIT (Linear Variable Inductance Transducer).
Long-stroke sensors based on the eddy	Long-stroke sensors are inductive displacement sensors using a half-bridge circuit. Only one coil is used for measuring. The second coil is designed as a space-saving

Term	Definition
current principle	equivalent circuit. A movable measuring tube (made of a conductive material) changes the impedance of the measuring coil based on the eddy current principle.
Construction	
Symmetric sensor	The measuring coil halves of differential transformers and inductors are built in a symmetrically (mirrored) design. The electrical zero is at the center of the nominal stroke.
Asymmetric sensor	The space-saving equivalent circuit of the 2nd coil of the long-stroke sensors results in an asymmetric design enabling a more favorable displacement-to-length ratio. The electrical zero is at the start of the nominal stroke (when the measuring tube completely covers the measuring coil).
Immersion core (core with core rod)	The immersion core is a two-piece, rod-shaped part consisting of • a magnetic core and • a core rod, i.e. a purely mechanical extension made of a non-magnetic material.
Measuring tube	The measuring tube is made of aluminum. In asymmetric displacement sensors it is moved over the measuring coil drawing energy from the coil field proportional to the tube's position (eddy current effect).
Characteristic data	
Excitation voltage (U_{sp})	AC voltage (typically 1...5 Vpp), supplying the inductive sensor.
Carrier or bridge frequency	Excitation frequency (usually 5 or 10 kHz) to drive the inductive displacement sensor.

Measurement voltage	Output signal proportional to the displacement (AC voltage in the mV range) provided by the inductive displacement sensor.
Zero point	At the electrical zero, the output signal of the displacement sensor is zero. Refer to the data sheet of the displacement sensor for physical position of the zero point.
Rated output	The rated output of the sensor is defined as the ratio of the sensor output voltage (measurement voltage) to the sensor input voltage (excitation voltage) at the end of the nominal stroke. For calibrated displacement sensors the rated output is e.g. 80 mV/V, independent of the nominal stroke of the displacement sensor. In older displacement sensor data sheets, the term “nominal output” is used.
Sensitivity	The sensitivity is defined as the ratio of the measurement voltage to the excitation voltage per mm of displacement (e.g. 10 mV/V/mm). For standardization purposes information on sensitivity and rated output for MESSOTRON displacement sensors is determined and provided independent of phase (i.e. without consideration of a phase shift).
Phase (phase shift)	With inductive sensors and/or long connecting cables, there will be a noticeable phase shift between the excitation voltage and the measurement voltage. This phase shift lowers the (effective) sensitivity of the sensor in the measuring chain. All MESSOTRON series MBI 46.3x measuring amplifiers can compensate a phase shift.
Linearity error	The linearity error of measuring devices is the maximum deviation between the nominal characteristic (straight line) and the real characteristic of the measuring device. The error information is referenced to the total measuring range (FSO / Full Scale Output).

Signal output of the measuring amplifier	
(Nominal) output range	The (nominal) output range of the measuring amplifier indicates the range covered by the output signal, if the displacement sensor operates in the (nominal) measuring range.
Current output	Analog current output of the measuring amplifier: typically 4...20 mA for the nominal stroke
Voltage output	Analog voltage output of the measuring amplifier: a) typically ±10 V for symmetric displacement sensors b) typically 0...10 V for asymmetric displacement sensors

4.2 Function and design

The MBI 46.31 generates the AC voltage (excitation voltage U_{sp}) required for operating inductive displacement sensors. The frequency (carrier frequency) is typically 5 kHz (optionally 1...20 kHz).

The output signal proportional to the displacement (the measurement voltage) returned by the displacement sensor is preamplified by the measuring amplifier and evaluated ratiometrically, i.e. in relation to the excitation voltage. This way measurement errors are avoided that result from fluctuations of the excitation voltage, e.g. due to an impedance change of the displacement sensor.

In subsequent stages, the measurement signal is filtered and scaled to the desired output range for further processing.

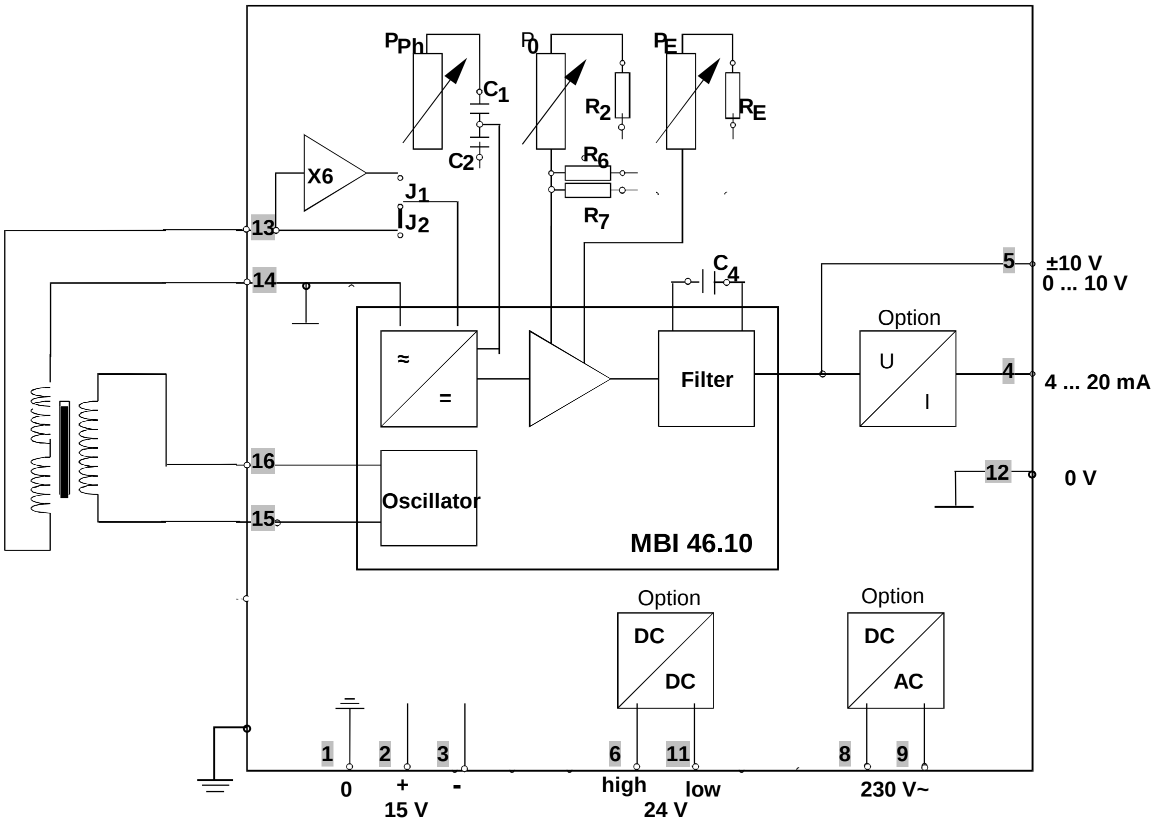


Figure 1 Block diagram with terminal assignment

P_E	Trimmer potentiometer for gain adjustment
P_0	Trimmer potentiometer for zero adjustment
P_{Ph}	Trimmer potentiometer for phase compensation
R_2	Resistor for setting the trim range for the zero point
R_6/R_7	Resistors for zero offset
R_E	Resistor for basic configuration of gain
C_1/C_2	Capacitors for phase compensation
C_4	Capacitor for adjustment of the cut-off frequency
J_1/J_2	Plug contact to switch on the preamplifier in case of low output signal of the displacement sensor; (position J_1: with 6x preamplification; position J_2: no preamplification)

4.3 Suitable displacement sensors

The MBI 46.31 CF measuring amplifier can be used with a variety of inductive sensors. For details on the requirements, refer to the technical specifications in chapter 11.

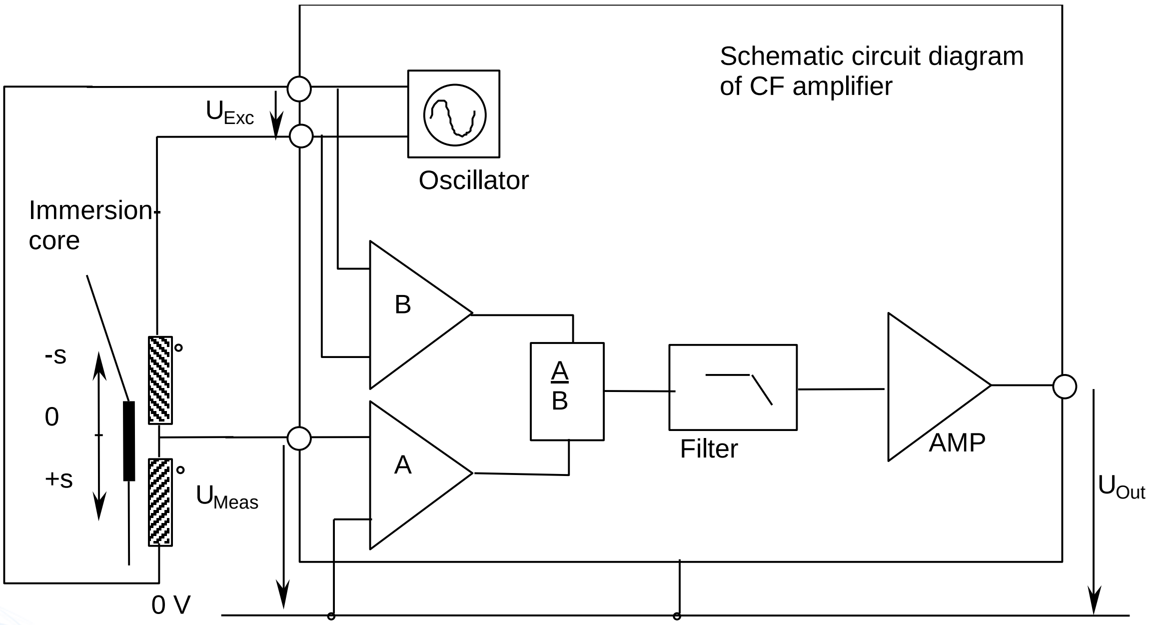
NOTE	In particular check the following: • Electrical design (type of displacement sensor), • Required carrier frequency, • Excitation voltage and • Rated output / sensitivity.

The following chapters describe the electrical design of the three displacement sensor types offered by MESSOTRON.

4.3.1 Linear Variable Inductance Transducers (LVITs)

Electrically displacement sensors based on the differential inductor principle, also called LVITs, represent a Wheatstone half-bridge consisting of two measuring coils. If the core moving inside the coils is in its mid-position (electrical zero), both measuring coils will show the same impedance. The bridge circuit is balanced. The measurement voltage is zero.

Figure 2 Measuring amplifier with differential inductor



If the core is moved out of its mid-position, the impedances of the two measuring coils change and the measurement voltage increases proportionally with the displacement within the measuring range.

4.3.2 Linear Variable Differential Transformers (LVDTs)

Differential transformers consist of a primary coil and two secondary coils placed around an immersion core. The coils are coupled based on the transformer principle.

AC voltage drives the primary coil inducing a voltage in the secondary coils. When the immersion core is at its mid-position, this voltage is zero due to the symmetrically wound secondary coils. If the immersion core is moved, the measurement voltage changes proportionally to the displacement of the core.

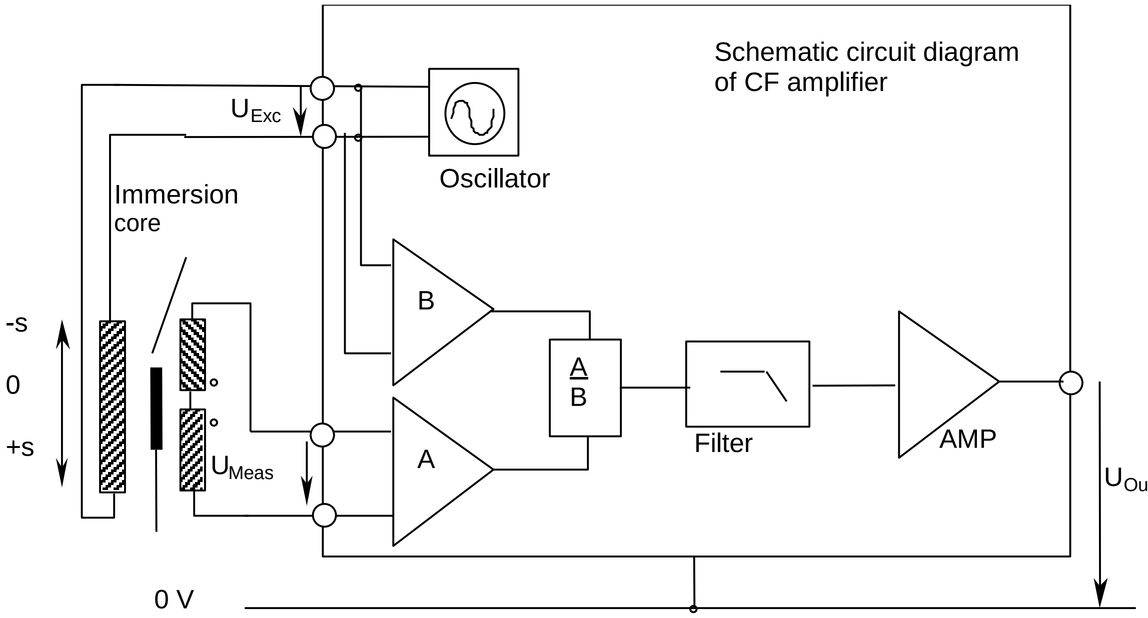
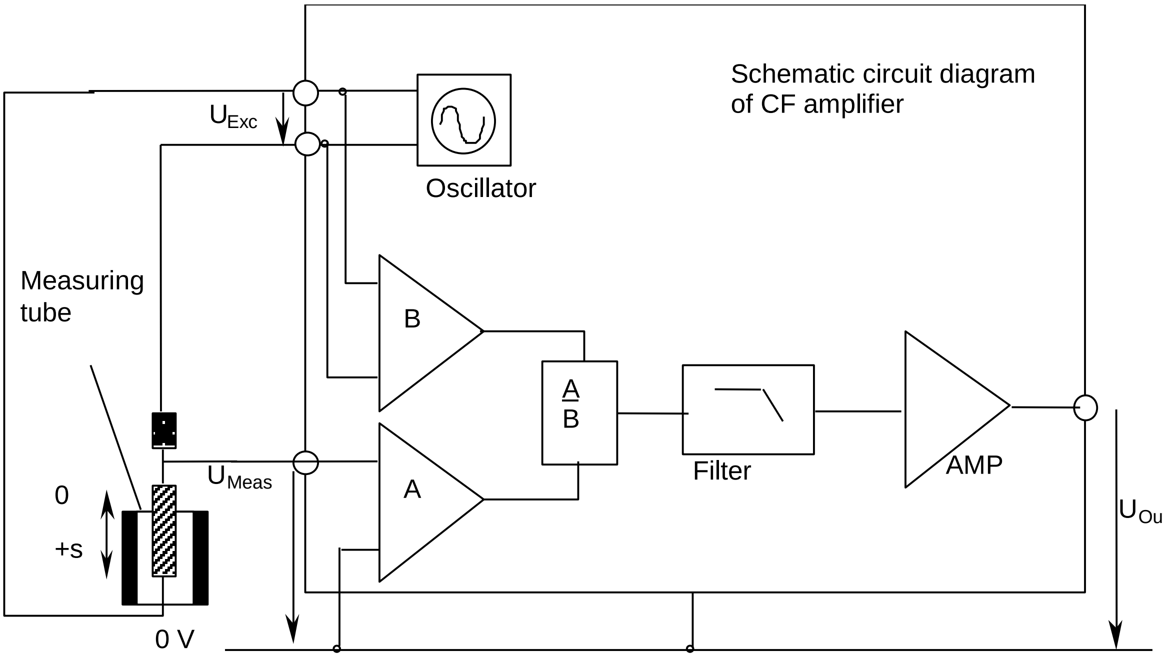


Figure 3 Measuring amplifier with differential transformer

4.3.3 Long-stroke sensor (eddy current principle)

Long-stroke sensors are displacement sensors using a half-bridge circuit. Only one coil is used as the measuring coil. The second coil is designed as a space-saving equivalent circuit. A movable measuring tube (made of a conductive material) changes the impedance of the measuring coil based on the eddy current principle. In contrast to symmetric displacement sensors, the electrical zero of long-stroke sensors is at the start of the nominal stroke (the measuring tube completely covering the measuring coil).

Figure 4 Measuring amplifier with long-stroke sensor



4.4 Overview of types and options

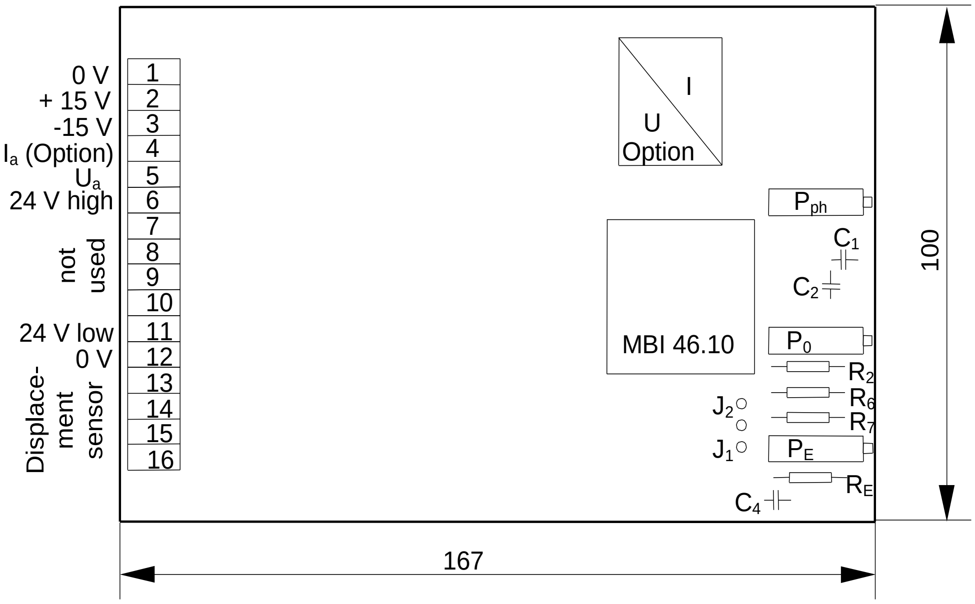
MBI 46.31. x	**y**	**/zzz**
Power supply	**Version and output signal**	**Options**
±15 VDC **1**	**1** Eurocard PCB without front panel, ±10 V output; connector	**/nn kHz** – alternative CF in the range 1...20 kHz
230 VAC **2**	**2** Eurocard PCB without front panel, 4 ... 20 mA output; connector	**/0-10 V** [1] output signal 0...10 V
+24 VDC **3**	**3** Eurocard PCB with front panel, ±10 V output; connector	**/0-20mA** output signal 0...20 mA
	4 Eurocard PCB with front panel, 4 ... 20 mA output; connector	
	5 Eurocard PCB without front panel, ±10 V output; terminal block	
	6 Eurocard PCB without front panel, 4 ... 20 mA output; terminal block	
	7 Field enclosure, ±10 V output	
	8 Field enclosure, 4 ... 20 mA output	

[1] Option for symmetric displacement sensors (instead of ±10 V)

Eurocard PCB with front panel	Field enclosure ±15 V and +24 V	Field enclosure 230 V

Figure 5 Available versions of measuring amplifier MBI 46.31

4.4.1 Eurocard PCB



Weight app. 0,1 kg

Figure 6 Enclosure dimensions and position of components for Eurocard PCBs

CF measuring amplifiers in the Eurocard PCB format are intended for mounting into subracks (3 U) or other suitable housings. When installing the measuring amplifiers, make sure there is sufficient distance between the amplifiers and electrically conductive parts. Depending on the version, the Eurocard PCBs are connected using a 32-pin type C connector to DIN 41612 or screw-type terminals. The potentiometers for adjustment of the measuring amplifier are located on the opposite side (front side).

4.4.2 Field enclosure

The aluminum enclosure can be mounted using 4x M6 screws. To mount the enclosure, the cover must be removed.

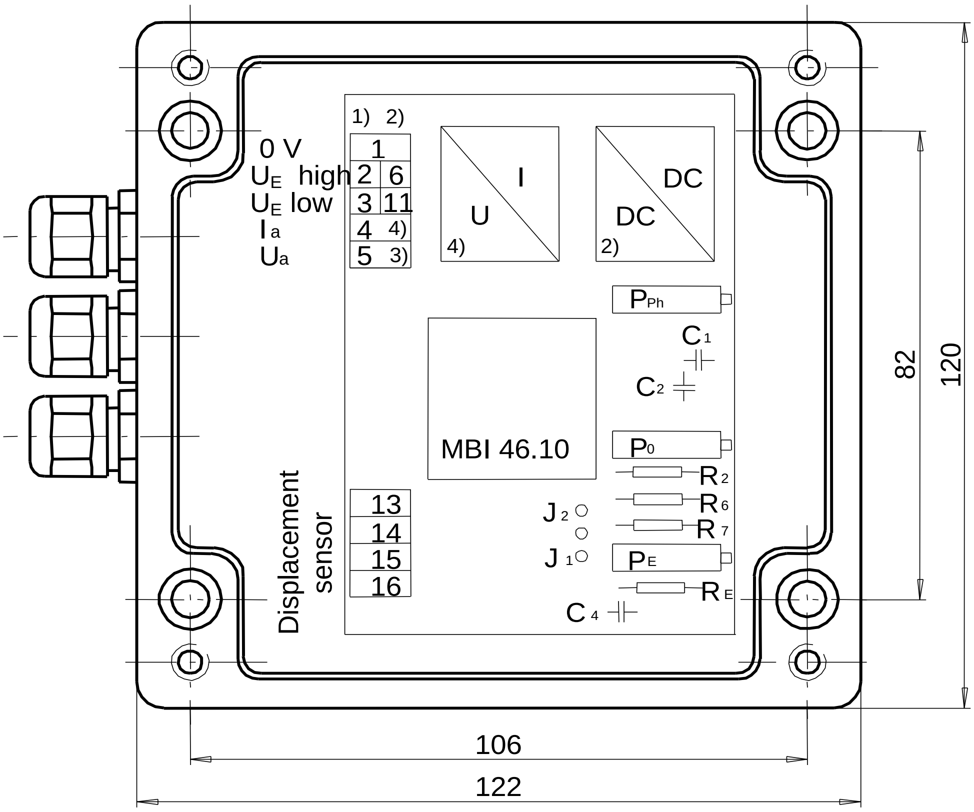
The measuring amplifiers in the aluminum enclosure are IP65 (DIN EN 60529) ingress-protection rated for protection against dust and water spray.

NOTICE

All unused cable passages must be closed using suitable sealing plugs for protection against moisture and dirt.

Connections for power supply, output signal and displacement sensors are routed to the outside using three M12 cable glands (maximum cable diameter 6.5 mm). The cables are connected to terminal blocks (for pin assignment, see chapter 5.1). The cable shield is not connected at the measuring amplifier. If required, connect the cable shield at the other cable end.

Field enclosure with ±15 VDC and +24 VDC supply

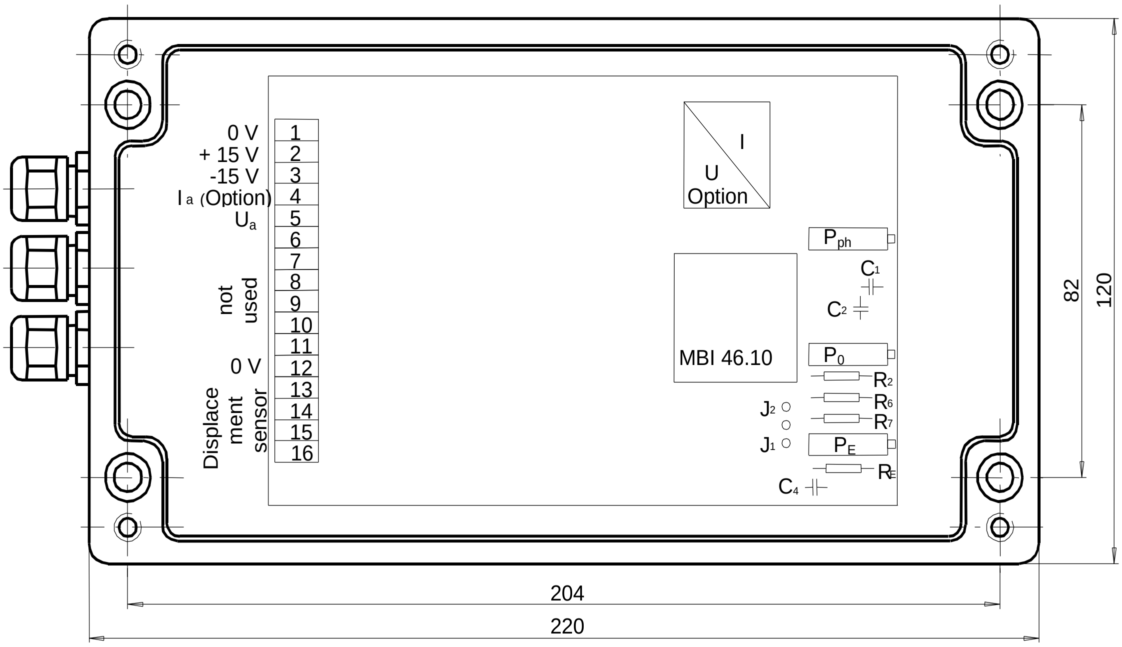


1) at ±15 V
2) at 24 V
3) Voltage output
4) Current output

Weight app. 1,4 kg

Figure 7 Enclosure dimensions and position of components for ±15 VDC and +24 VDC supply

Field enclosure with 230 VAC supply



Weight app. 2 kg

Figure 8 Enclosure dimensions and position of components for 230 VAC supply.

The power supply unit is located on a separate power supply board, mounted to the back of the main board.

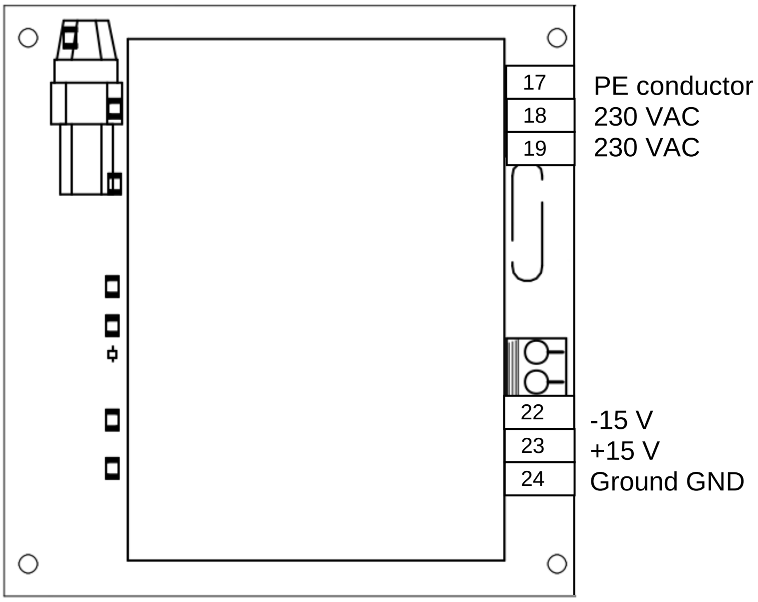


Figure 9 Power supply unit for 230 VAC supply

5 Placing into Service

NOTICE

Only qualified skilled persons are allowed to place the measuring amplifier into service.

NOTICE

Electrostatic discharge at electronic assemblies can damage the components before they are placed into service. Therefore, take all necessary measures to avoid electrostatic charging (ESD protective measures).

Provided the sensor cable is routed professionally, the distance between the displacement sensor and the measuring amplifier can be 100 m and more.

NOTE	Connect the inductive displacement sensor with the measuring amplifier using a screened, low-capacitance cable.
NOTE	Do not route the cable in parallel with power lines. In addition, maintain a sufficient distance to electric drives, transformers and frequency converters.

5.1 Pin assignment

NOTICE

Note that the pin assignment is different depending on the type of measuring amplifier.

The connections are not protected against reverse polarity.

If connections are reversed or if an incorrect external voltage is applied, the device can be destroyed.

The displacement sensors must be connected to the measuring amplifier according to the pin assignment specified in the table below. The supply voltage (V), the output signal (A) and the displacement sensor (W) are connected by cable for field enclosures and by connecting blocks or plug-in connections for Eurocard PCBs. Therefore, no soldering is required for installation.

⚠ ***WARNING***

Hazardous voltages inside the measuring amplifier with 230 V supply voltage (type 46.31.2x).

Touching live parts can result in death, serious injury or considerable property damage.

- Before opening the field enclosure, check all conductors. They must be de-energized.

Connector	**Terminal block**	**Wire color (field enclosure)**			**Assignment**
		W	**V**	**A**	
ac 2	16	WH			Excitation voltage +
ac 4	15	BU			Excitation voltage –
ac 6	14	RD			Amplifier input – (measuring signal –)
ac 8	13	BK			Amplifier input + (measuring signal +)
ac 10	12				0 V
ac 12	11		BK		Supply voltage 24 V, low
ac 14	10				not used
ac 16	9				not used
ac 18	8				not used
ac 20	7				not used
ac 22	6		RD		Supply voltage 24 V, high
ac 24	5			RD	Voltage output
ac 26	4			BU	Current output
ac 28	3		(BU)		Supply voltage –15 V
ac 30	2		(RD)		Supply voltage +15 V
ac 32	1		(BK)	BK	0 V

Figure 10 Pin assignment of measuring amplifier

If the displacement sensor is connected according to the table above, there is a positive (increasing) output signal, when the core moves out of the displacement sensor or the measuring tube moves downward from the sensor housing. If a negative (decreasing) signal is desired for this direction of movement, switch the connections ac 2 (terminal 16) and ac 4 (terminal 15).

Terminal	Assignment
17	PE conductor
18	230 VAC
19	230 VAC
22	-15 V
23	+15 V
24	Ground GND

Figure 11 Pin assignment of 230 V power supply

Amplifier		Linear Variable Differential Transformers all Dxx			Linear Variable Inductance Transducer all Wxx except WP			Long-stroke sensor e.g. WP	
Plug	Terminal	Wire strand	Cable	Plug	Wire strand	Cable	Plug	Cable	Plug
ac 2	16	WH (BN)	WH	2 (B)	BU	BU	3 (C)	BU	C
ac 4	15	BU	BU	3 (C)	RD	RD	2 (B)	RD	B
ac 6	14	RD	RD	1 (A)	-	-	-	-	-
ac 8	13	BK	BK	4 (D)	WH+YE	WH	1 (A)	WH	A

Figure 12 Connection of MESSOTRON displacement sensors

5.2 Setting options of the measuring amplifier

The measuring amplifier must be adapted to the (displacement) sensor used. The following parameters must be set:

- Position of the electrical zero point,
- Phase compensation (possibly caused by the sensor type and the connecting cable),
- Gain (compensation of sensor sensitivity).

At the factory, a **basic configuration** for all three parameters is set in the measuring amplifier. This is achieved by using a variable component assembly (resistors / capacitors) based on:

- a reference displacement sensor, if the sensor type is known,
- the sensor specification provided by the customer,

- the sensor that may have been ordered at MESSOTRON together with the amplifier or
- a typical adjustment, if the sensor is unknown.

The basic configuration can be changed, if required (see chapter 5.4 Basic configuration of measuring amplifier), for instance if a different sensor is used or if the output range of the measuring amplifier is changed ((such as from 0 V...10 V to ±10 V).

In any case, the measuring amplifier must be **adjusted** to the sensor used on site using the trimming potentiometer (see chapter 5.3 Adjustment using trimming potentiometer). The measuring amplifier will be fine-tuned at the MESSOTRON factory, if a sensor is ordered together with the measuring amplifier.

5.2.1 Position of the electrical zero point

The electric output signal of a real inductive displacement sensor is not always exactly zero at the mechanical zero point (Dimension A for MESSOTRON displacement sensors). Material and manufacturing tolerances may cause small deviations, which can be compensated using the zero-point potentiometer. Small tolerances in mechanical adjustments of the displacement sensor can be compensated in the same way.

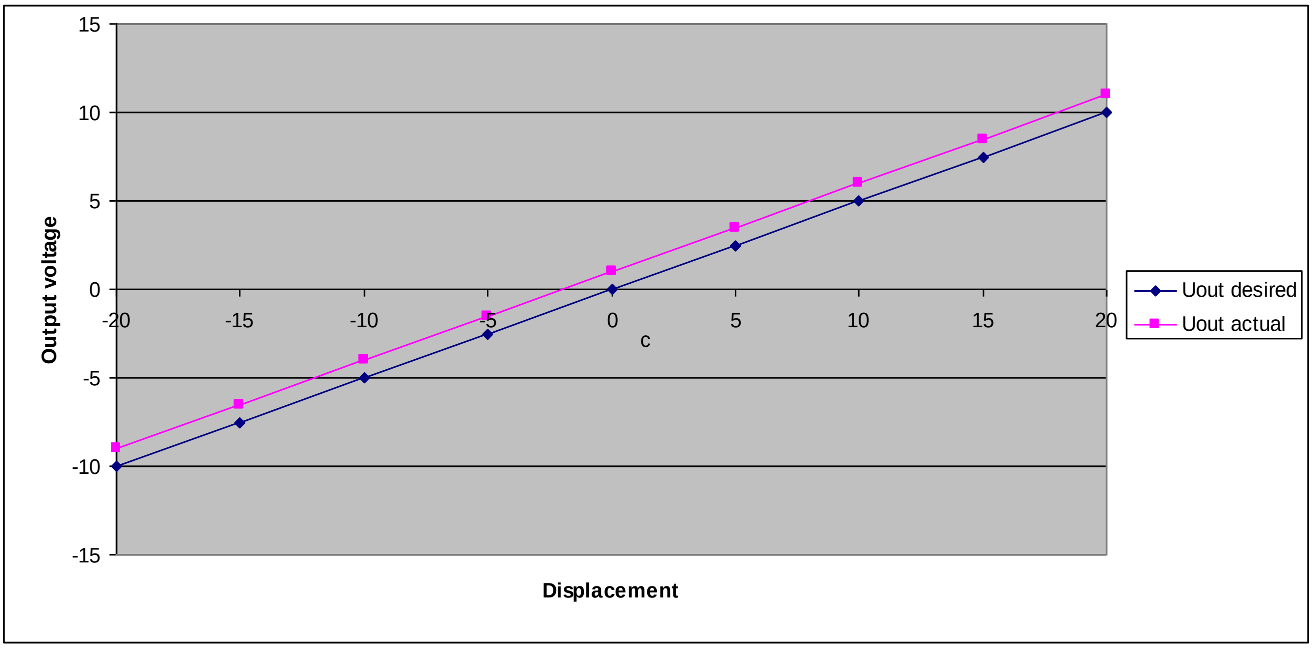


Figure 13 Correction of the zero point

If the zero-point potentiometer is twisted, this will result in a vertical shift of the characteristic curve for measured displacement to output signal.

If a more significant shift of the electrical zero point is required (e.g. to the start or to the end of the measuring range), the basic setting must be changed. This can only be accomplished by changing fixed resistors (refer to chapter 5.4.3).

5.2.2 Phase compensation

Due to the design principle, inductive displacement sensors can show a phase shift between the excitation voltage and the measurement voltage.

The measuring amplifier evaluates the ratio of excitation voltage and measuring voltage to suppress any measurement errors due to fluctuations of the excitation voltage. If the phase shift is not compensated, the sensitivity of the sensor may deviate.

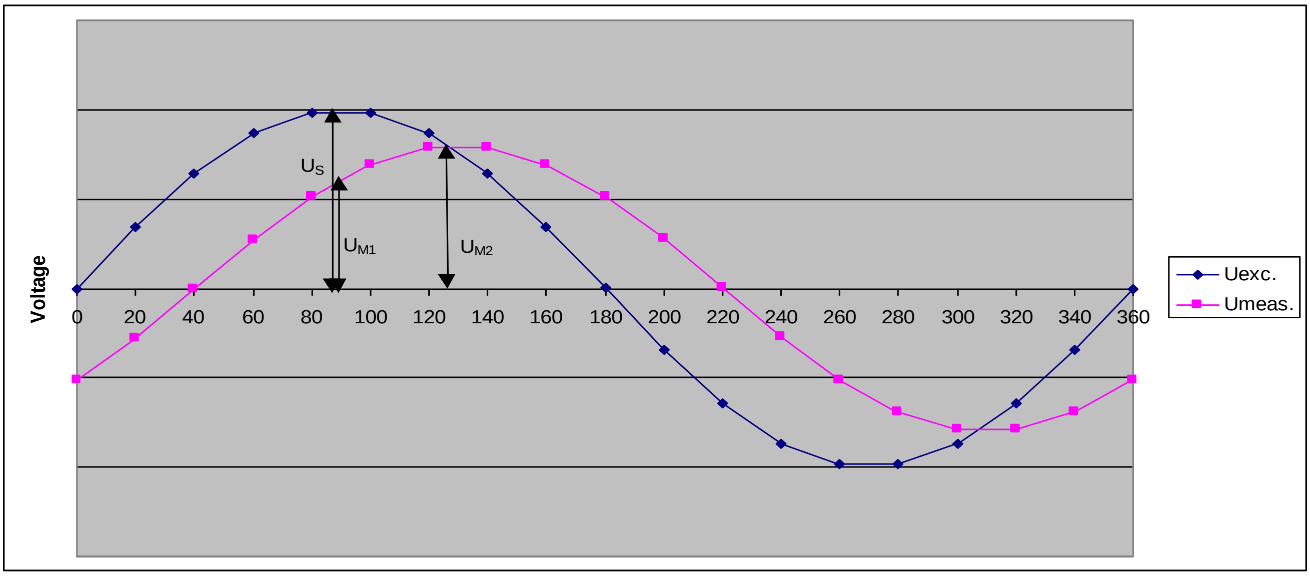


Figure 14 Phase shift

Figure 14 shows that there is a reduced voltage ratio of U_{M1}/U_S if there is no phase compensation. Phase compensation results in an optimized voltage ratio U_{M2}/U_S.

The phase compensation of the MBI 46.31 shifts the evaluation of the measurement voltage on the time axis in such a way that the phase position caused by the displacement sensor is compensated and the full sensitivity of the displacement sensor can be used.

5.2.3 Gain

To obtain the desired output signal, the gain of the measuring amplifier must be set depending on the rated output of the displacement sensor used. If the output signal does not reach the desired value, e.g. at the end of the nominal stroke, the gain must be increased.

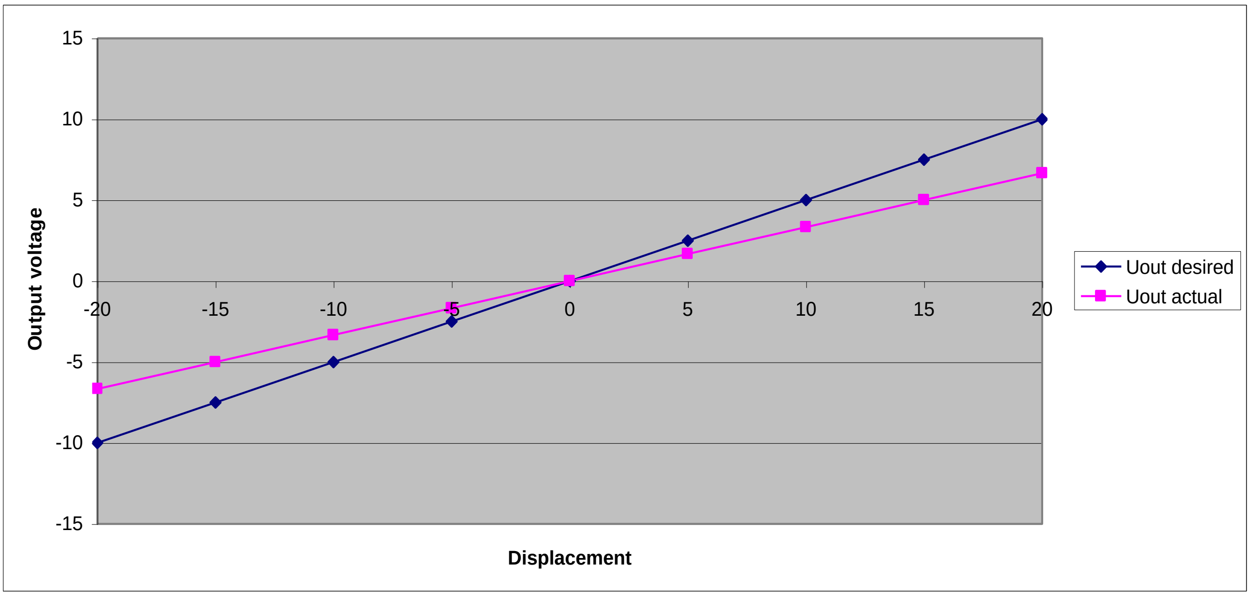


Figure 15 Gain correction

A larger gain causes an increase in the gradient of the displacement-to-output-signal characteristic curve (or a counter-clockwise rotation of the characteristic curve).

5.3 Adjustment using trimming potentiometer

NOTE	Make sure that the basic configuration of the measuring amplifier is suitable for the displacement sensor used. If this is not the case, change the basic configuration as described in chapter 5.4.

Using the trimming potentiometers, the measuring amplifier can be adjusted to the displacement sensor within certain limits. Likewise, small tolerances in adjustments of the displacement sensor can be compensated in the same way.

WARNING

Hazardous voltages inside the measuring amplifier with 230 V supply voltage (type 46.31.2x).

Touching live parts can result in death, serious injury or considerable property damage.

- Only qualified skilled persons are permitted to adjust the measuring amplifier.

NOTE The measuring amplifier will only show its nominal characteristics after a warm-up time of approximately 15 minutes.

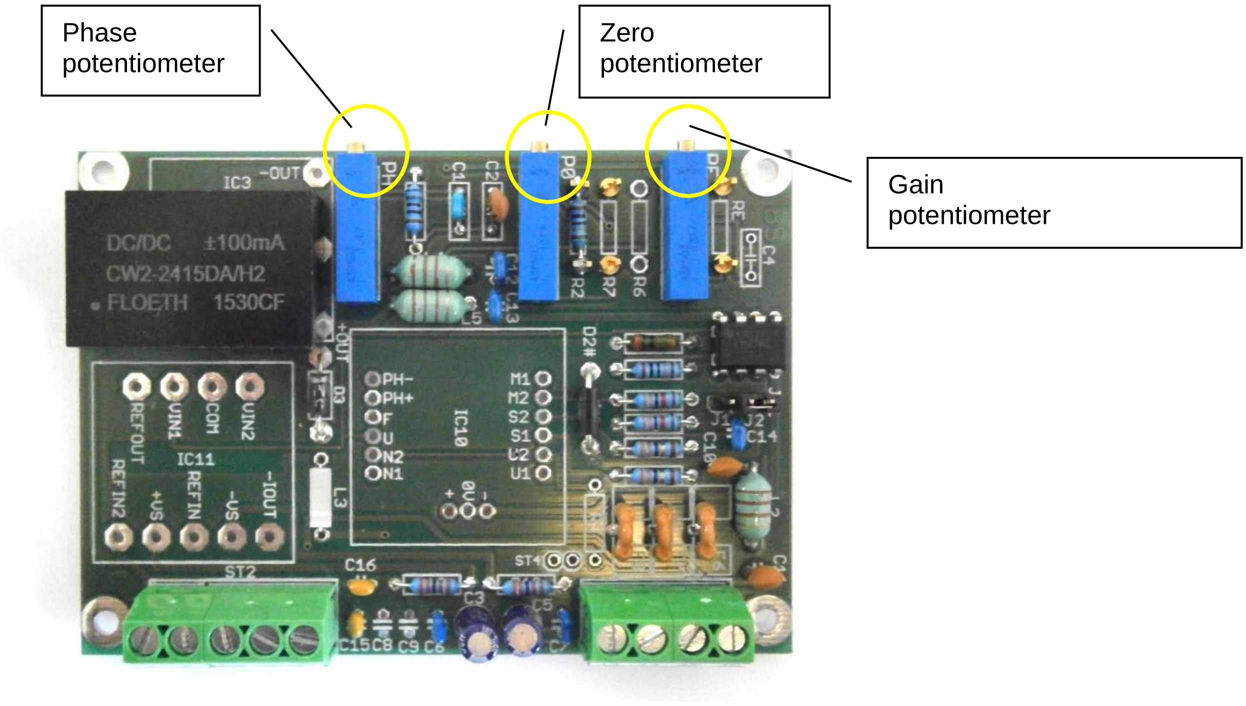


Figure 16 Location of trimming potentiometers

5.3.1 Adjustment for symmetric displacement sensors

With symmetric displacement sensors, the electrical zero is at the center of the nominal stroke. Typically, the voltage output of the measuring amplifier provides a symmetric output signal (-10 V...0 V...+10 V) for a symmetric displacement sensor. The current output provides a current of 12 mA (output ranges 4 mA...12 mA...20 mA) at the zero position.

NOTE	Other output ranges, e.g. 0...10 V, require a zero offset according to chapter 5.4.3.

- To **adjust the zero point**, remove the core from the sensor housing and set the output signal of the measuring amplifier to **0 V** or **12 mA** using the zero-point potentiometer P_0. Reinsert the core into the displacement sensor and secure the core to retain the output signal. Small corrections are permitted when using the zero-point potentiometer after the mechanical adjustment.

  If you cannot set the zero point as described above, then alternatively bring the core into the position where the displacement sensor provides the same value with the usual connection as well as with switched excitation wires (ac 2 / terminal 16 and ac 4 / terminal 15).

- To **adjust the phase**, move the core to a position just before the end of the (nominal) measuring range. Then set the maximum of the output signal using the phase potentiometer P_{Ph}. If the output signal is no longer close to the desired value, adjust the gain, if necessary.
- To **adjust the gain**, move the core to the end of the (nominal) measuring range and use the gain potentiometer P_E to set the voltage to the desired value (usually **10 V** or **20 mA**). Then check the setting at the start of the nominal measuring range and correct slightly, if required.

5.3.2 Setting instruction for asymmetric displacement sensor (e.g. type WP)

The electrical zero of asymmetric displacement sensors is typically at the start of the nominal stroke. Usually measuring amplifiers for asymmetric displacement sensors are set to provide an output signal of 0...10 V (or 4...20 mA) in the (nominal) measuring range of the displacement sensor.

- To **adjust the zero point**, move the measuring tube of the displacement sensor into the mechanical zero position (dimension “A”) according to the data sheet. Then set the output signal of the measuring amplifier to **0 V** or **4 mA** using the zero-point potentiometer P_0.
- To **adjust the phase**, move the measuring tube to a position just before the end of the (nominal) measuring range. Then set the maximum of the output signal using the phase potentiometer P_{Ph}. Adjust the gain, if necessary. Then check and correct the zero-point adjustment, if necessary.

- To **adjust the gain**, move the measuring tube to the end of the (nominal) measuring range and use the gain potentiometer P_E to set the output signal to the desired value (usually **10 V** or **20 mA**).

5.4 Basic configuration of measuring amplifier

If the adjustment range of a trimming potentiometer is not sufficient for the required adjustment, you must change the basic configuration. To change the basic configuration, solder in fixed resistors and/or capacitors.

⚠ ***WARNING***

Hazardous voltages inside the measuring amplifier with 230 V supply voltage (type 46.31.2x).

Touching live parts can result in death, serious injury or considerable property damage.

- Soldering work must only be done by qualified skilled persons and only in accordance with these instructions.
- Before opening the field enclosure, check all conductors. They must be de-energized.
- De-energize the device first, before doing any assembly and soldering work.

NOTE	If you cannot do the basic configuration on site, you can also have the conversion done at the factory. In this case, send the measuring amplifier freight prepaid along with your requirements (measurement range, desired output range) to MESSOTRON. If you are using a third-party sensor, we also need the displacement sensor or at least its specifications.

5.4.1 Location of fixed resistors and capacitors

The location of the components that may have to be replaced is shown in the following figure:

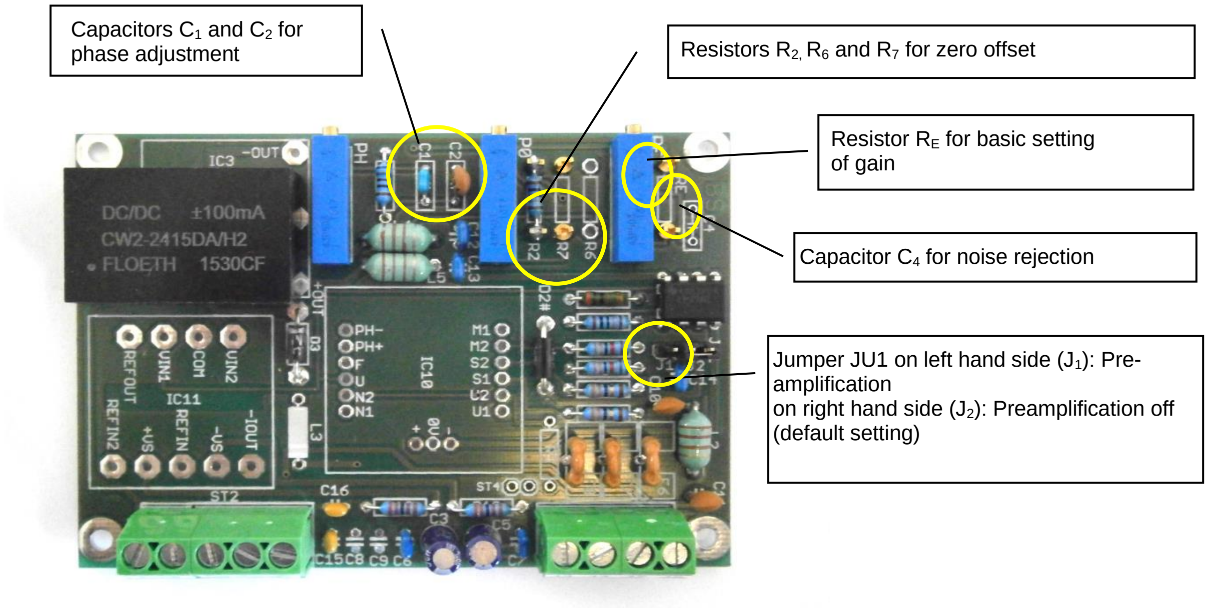
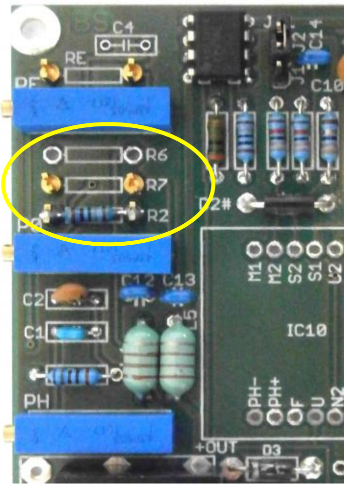


Figure 17 Location of setting components

NOTE	Only use resistors with a small temperature coefficient (TK25 or TK50).

5.4.2 Setting the phase compensation



The capacitors C_1 and C_2 are used together with the potentiometer P_{PH} to compensate a phase shift between the excitation voltage and the measurement voltage. Capacitor C_1 compensates a positive phase shift. Capacitor C_2 compensates a negative phase shift. The potentiometer is used for adjustment..

- Position the core or the measuring tube to approx. ¾ of the (positive) displacement.
- Instead of C_1 connect a capacitance decade box and determine the capacitance at which the output signal reaches its maximum.

- If the output signal decreases, then connect the decade box instead of C_2 and look for the maximum of the output signal there.
- For C_1 and/or C_2 solder in a capacitor which is approx. 10...20 % larger than the value you have determined.
- If both capacitors cause a reduction of the output signal, no phase capacitor is required.
- Then set the zero point and the gain.

5.4.3 Zero point / output range offset

If the adjustment range of the zero-point potentiometer P_0 is insufficient, it can be extended by reducing the resistor R_2.

NOTE	For reasons of stability, do not choose a smaller resistance value for R_2 than necessary.

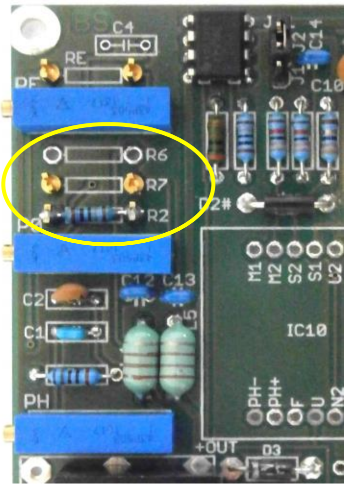


Figure 18

If only a positive (asymmetric) output voltage of e.g. . 0... 10 V is required when using a symmetric displacement sensor, a larger offset of the output range is required. The offset resistors R_6 (negative offset of output signal) and R_7 (positive offset of output signal) are provided for this purpose.

- Do a phase compensation before offsetting the output signals with the offset resistors.
- Then adjust the gain of the measuring amplifier. The stroke of the output signal in the measuring range must correspond to the desired output range. In this example -5...+5 V = 10 V. To do so, it will usually be necessary to replace the resistor R_E (see 5.4.4).
- With resistor R_7, you are now able to offset the output range in the positive direction from -5...+5 V to 0...10 V.
- Similarly, you can also move the output range in the negative direction if, for example, a symmetrical voltage output is required for an asymmetric displacement sensor (offset with R_6).
- You can also move the zero point to the end of the measuring range (output signal is positive). In this case, you must switch the excitation wires (ac 2 / terminal 16 and ac 4 / terminal 15) and install the offset resistor R_6.

NOTE	The required resistance values for the offset depend, among other things, on the adjusted amplification of the measuring amplifier. It is advisable that you use a resistance decade box to dimension the resistors. Connect it to the soldering terminals of the resistance to be determined

NOTICE

Determine the required resistance value R_6 or R_7 by reducing the decade value step by step – starting with 50 kΩ. When switching the decade box, make sure that the resistor is not short-circuited. Failure to do so can destroy the measuring amplifier.

- Then select a suitable fixed resistor R6 or R7 (±5 %) and solder it to the soldering terminals provided.

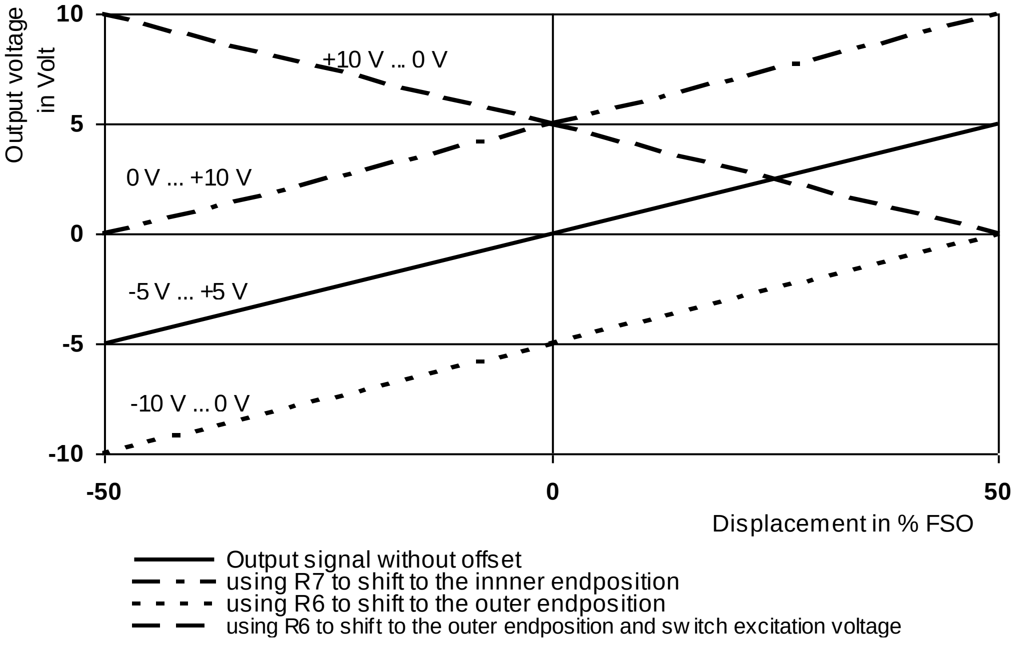


Figure 19 Different output ranges

5.4.4 Basic configuration of gain

The preamplifier, the fixed resistor R_E and the trimming potentiometer P_E determine the gain of the measuring amplifier. The fixed resistor and the trimming potentiometer (default 50 kΩ) are connected in series. The fixed resistor R_E determines the minimum and maximum gain, as well as the adjustment range of the trimming potentiometer (adjustment).

Displacement sensors with known rated output:

NOTE First check the position of jumper JU1. It provides a 6x pre-amplification of the measurement voltage.

- If the rated output (determined independently of the phase) of the sensor is 60 mV/V or more then the preamplifier can be switched off (jumper JU1 in plug position J_2).
- If the rated output is less than 60 mV/V, it is advisable to activate the preamplifier (jumper JU1 in plug position J_1. This minimizes the temperature-related error.

Normally the output range of the measuring amplifier is set to 4...20 mA (current output) or 0...+10 V or ±10 V (voltage output) for the nominal stroke of the displacement sensor used.

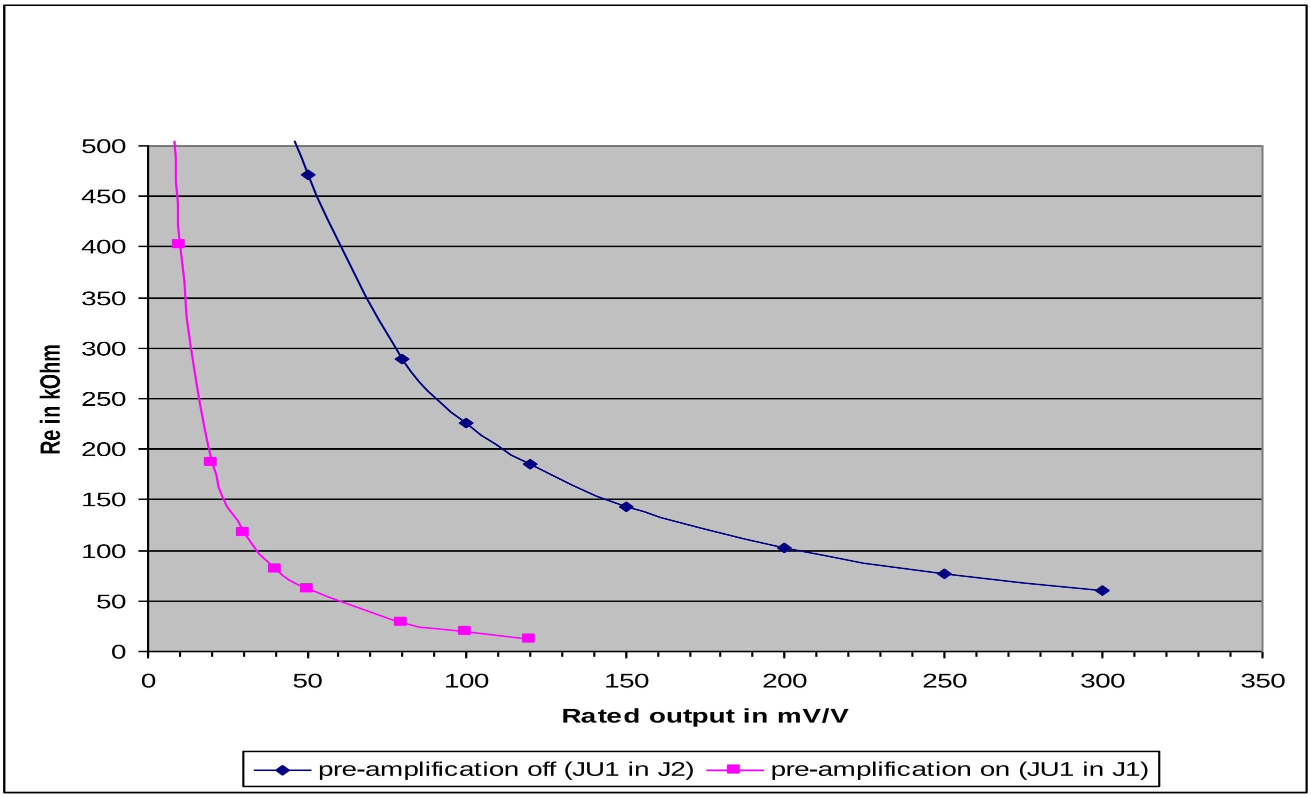


Figure 20 Finding R_E depending on the rated output of the sensor used (for the standard output range of the measuring amplifier)

- *After having switched the preamplifier on or off, a suitable fixed resistor R_E must be soldered in. Find the required value for R_E in Figure 20 and solder a corresponding fixed resistor to the soldering terminals for R_E.*

Displacement sensor with unknown rated output, changing the output range or reduced measuring range:

In these special cases, the fixed resistor R_E cannot be determined using Figure 20. It must be determined by experiment.

- First switch off the preamplifier (jumper JU1 in plug position J_2)
- Instead of R_E, connect a resistance decade box.
- Move the trimming potentiometer P_E to the mid-position.
- Set the displacement sensor to the end of the (used) measuring range. Use the resistance decade box to determine the value at which the measuring amplifier provides the desired output signal. If the value is larger than 300 kΩ switch on the preamplification and redetermine R_E in order to minimize the temperature-related error.
- For R_E, select a suitable fixed resistor (5 %) and solder it to the soldering terminals for R_E.

5.5 Optimizing the linearity characteristic of the measuring chain

The procedure for basic settings and adjustment described in the previous chapters applies to a measuring chain with an “ideal displacement sensor” without linearity deviation.

Some real displacement sensors show a distinctive “one-sided” linearity deviation. In these cases, the linearity behavior of the measuring chain can be further optimized taking into account the respective measuring task.

Figure 19 shows the typical linearity characteristic of a symmetric displacement sensor, as determined following the setting of the measuring amplifier as per the steps described above. The maximal linearity error in the measuring range considered is 0,5 %. It is zero in the middle and at the end of the measuring range.

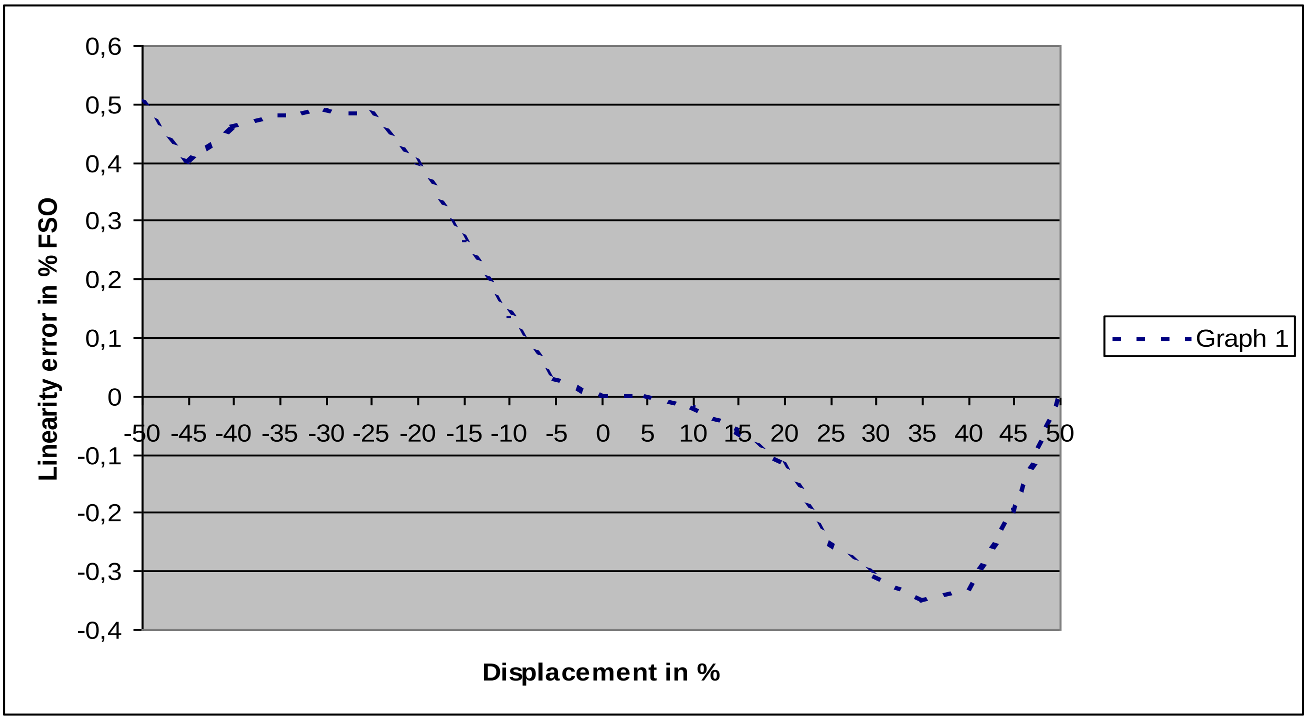


Figure 21 Typical error curve of a displacement sensor, zero-error setting at the zero point and at the end of the measuring range

5.5.1 Optimization with the smallest possible error in the zero point

If the measuring task mainly requires a minimum error at the zero point of the displacement sensor, then the maximum deviation needs to be reduced in the measuring range.

- To do so, reduce the gain in small steps. This causes a “rotation” of the linearity curve around the zero point. The zero-error setting at the end of the measuring range is given up.

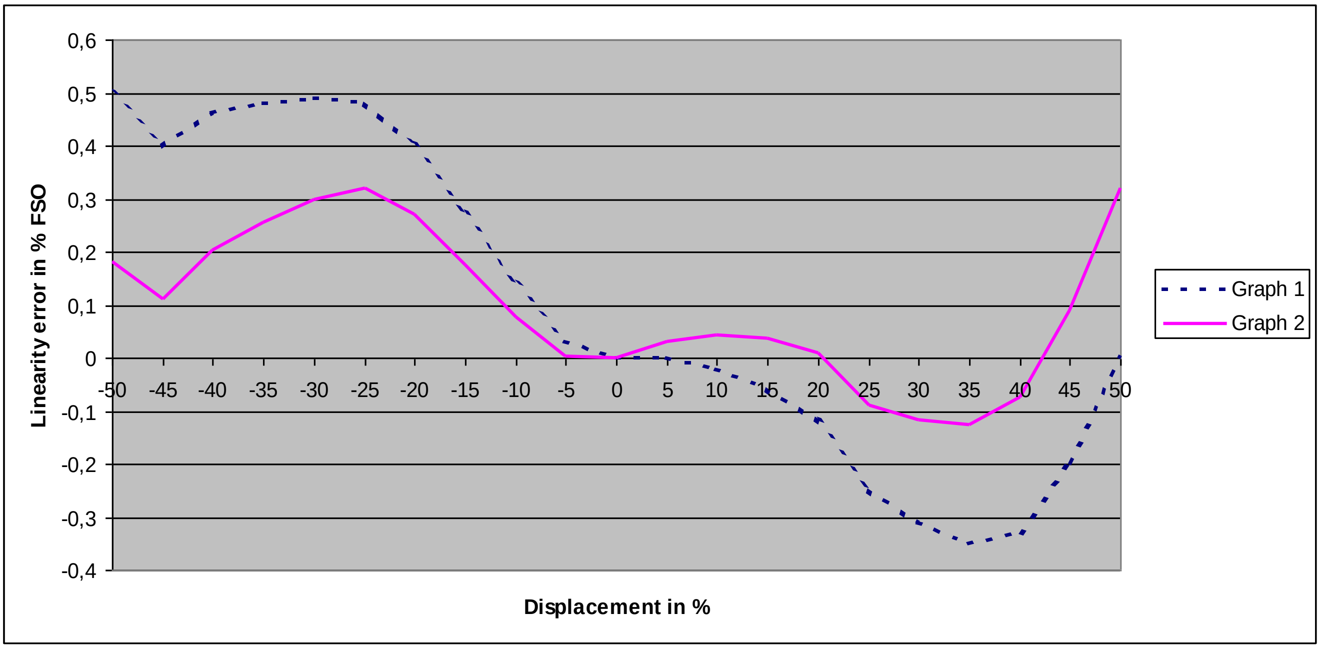


Figure 22 Ideal zero point, max. linearity error reduced to 0.32 %

5.5.2 Minimal error over the entire measuring range

Some measuring tasks do not require a certain measuring point to show a higher accuracy than others. In these cases, you can reduce the maximum linearity error in the entire measuring range further by giving up the zero-error setting in the zero point.

- Offset the linearity curve by slightly adjusting the zero-point potentiometer, until the maximum positive and negative deviation are of equal in magnitude.

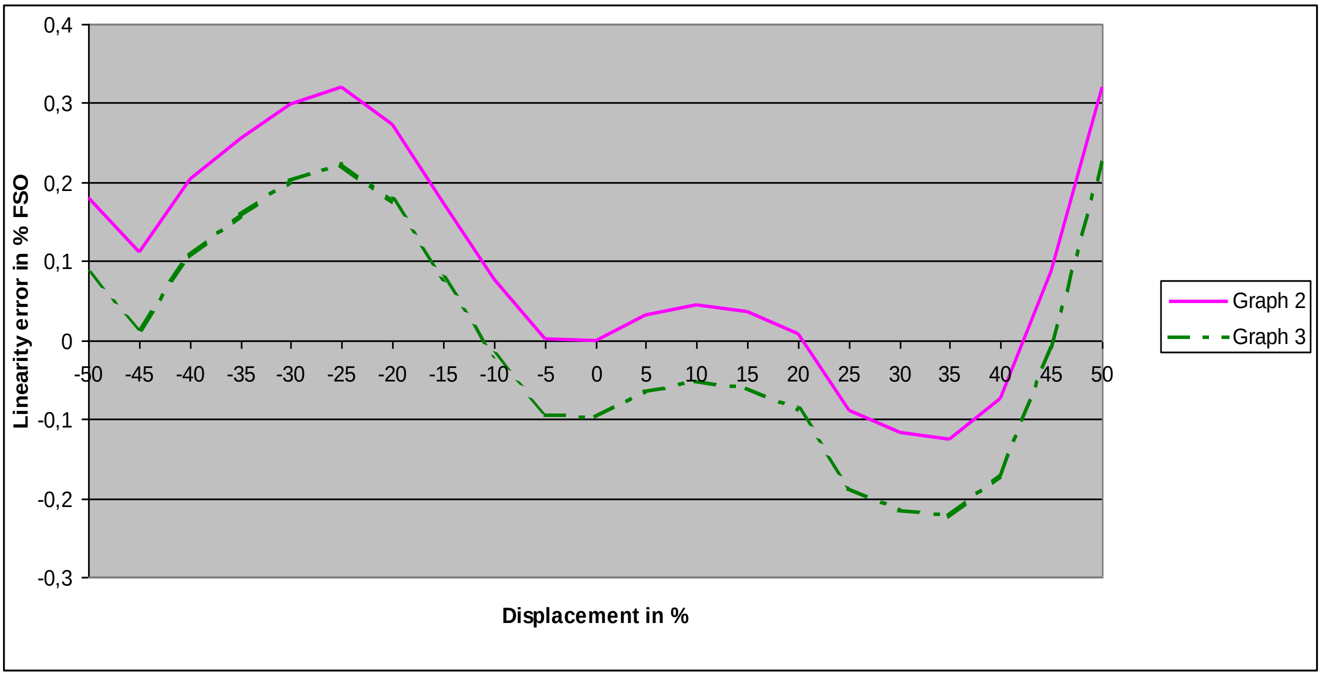


Figure 23 Smallest deviation over the entire measurement range

5.5.3 Other linearity optimizations

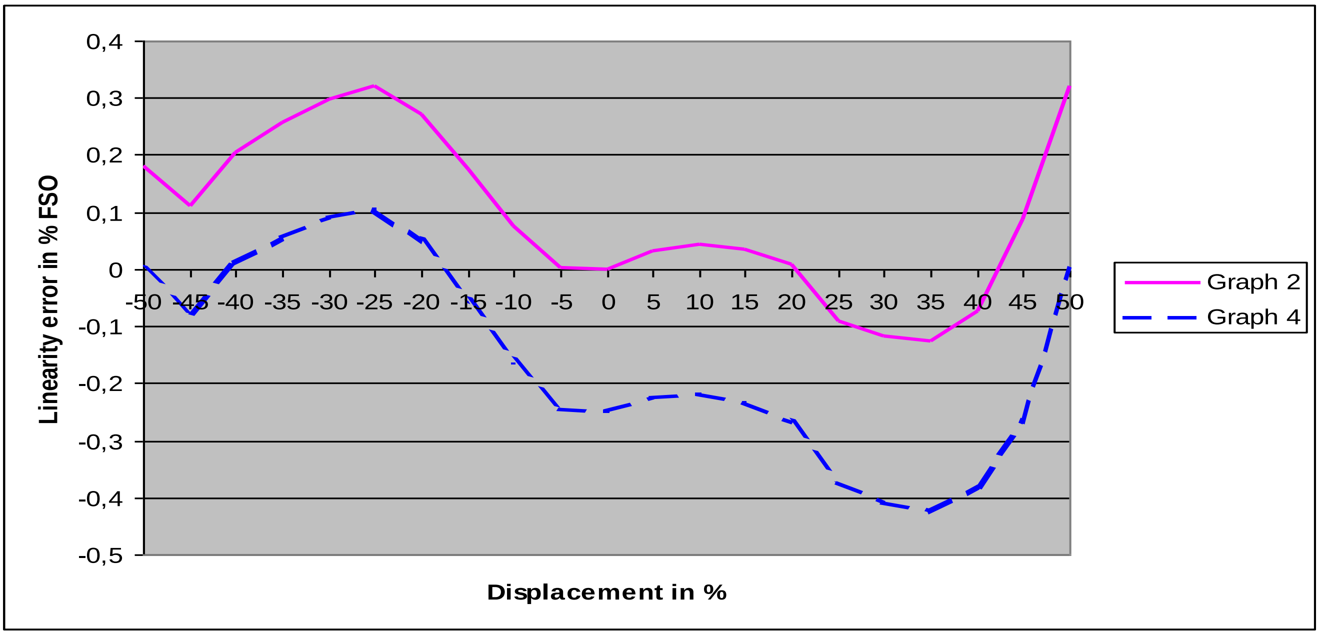


Figure 24 Zero-error setting at the beginning / end of the measuring range

You can further optimize the system depending on the measuring task by similar methods to those described in chapter 5.5.1 and 5.5.2. For instance, curve 4 shows the linearity characteristic of the measuring chain if the measuring amplifier is set to minimum deviation at the beginning and the end of the measuring range.

NOTE	To set the measuring amplifier according to these instructions, the linearity curve of the displacement sensor must be determined. As an option for all MESSOTRON displacement sensors, you can receive test reports with the linearity curve (according to 5.5.1 Optimization with the smallest possible error in the zero point).

5.6 Improving the noise rejection

The MBI 46.31 CF measuring amplifier series is suitable for use in highly dynamic applications. As delivered, the (3 dB) dynamic bandwidth is 1/10 of the carrier frequency. If only slow processes are to be measured, the dynamic bandwidth may be reduced for a better noise rejection performance.

- By fitting capacitor C4, you can additionally filter the output signal.
- First start with some 10 nF and then increase the capacitance incrementally.
- Make sure that the output signal is not distorted with the fast processes in your application. Otherwise you must select a capacitance value for C4 of the next smaller size.

NOTE	The actual capacitance value required for setting a specific dynamic bandwidth depends on the carrier frequency and the associated standard filtering of the measuring amplifier. Use a capacitance decade box (approx. 10...1000 nF) to determine the correct capacitors.

6 Operation

The MBI 46.31 measuring amplifier is designed for unattended continuous duty.

To take the measuring amplifier out of service, it must be disconnected from its voltage supply.

7 Repairs

NOTICE
Never try to repair a defective measuring amplifier. Repair attempts of any kind will immediately render warranty and liability claims invalid.

MESSOTRON electronics are designed for use in a rough industrial environment. They are designed for years of trouble-free operation.

In case of any malfunction or damage, please contact us by phone or email:

Phone: +49 (0) 6257 82331
Email: info@messotron.de

If required, send the product (freight prepaid) to:

MESSOTRON GmbH & Co KG
Friedrich-Ebert-Str. 37
64342 Seeheim-Jugenheim, Germany

Please enclose a delivery note and a detailed description of the error with all return shipments.

8 Maintenance

8.1 Preventative maintenance

The MBI 46.31 measuring amplifier does not contain any serviceable parts.

8.2 Cleaning

⚠ ***WARNING***

Hazardous voltages inside the measuring amplifier with 230 V supply voltage (type 46.31.2x).

Touching live parts can result in death, serious injury or considerable property damage.

- Before opening the field enclosure, check all conductors. They must be de-energized.

NOTICE

Electrostatic discharge at electronic assemblies can damage the components before they are put into service. Therefore, take all necessary measures to avoid electrostatic charging (ESD protective measures).

When cleaning, note the following:

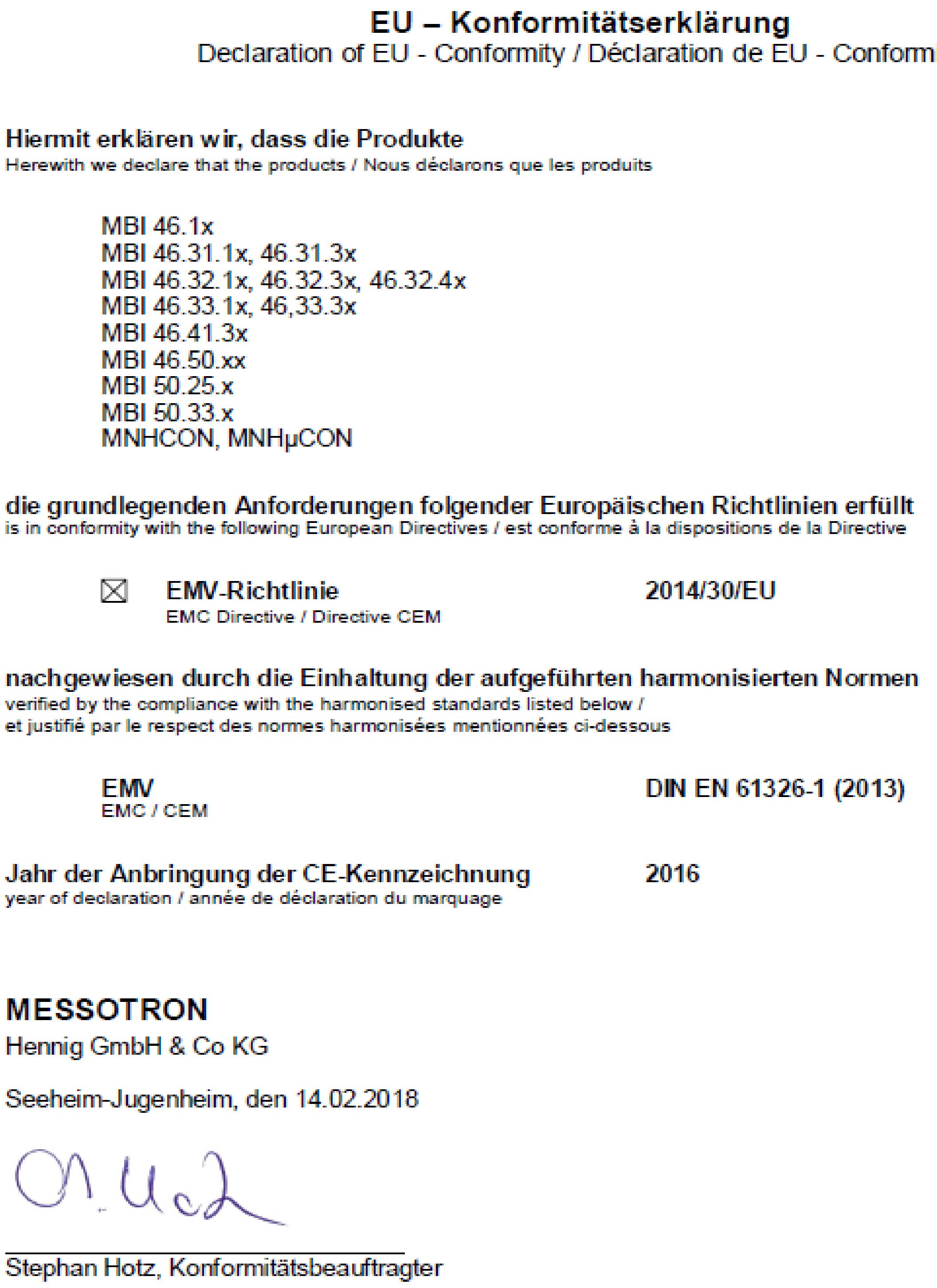
- To clean the enclosure and the front panel, only use a soft, slightly moist cloth.
- Remove dry dirt from PCBs carefully using a vacuum cleaner or a brush.
- If foreign liquids get inside the device, have it checked by MESSOTRON before putting it back into service.

9 Disposal

The device, any accessories and the packaging must be disposed of in accordance with the respective national regulations. Observe the national and local regulations regarding environmental protection and the reclamation of raw materials.

10 EU Declaration of Conformity

10.1 Electronics with a supply voltage < 50 V



EU – Konformitätserklärung
Declaration of EU - Conformity / Déclaration de EU - Conformité

Hiermit erklären wir, dass die Produkte
Herewith we declare that the products / Nous déclarons que les produits

MBI 46.1x
MBI 46.31.1x, 46.31.3x
MBI 46.32.1x, 46.32.3x, 46.32.4x
MBI 46.33.1x, 46,33.3x
MBI 46.41.3x
MBI 46.50.xx
MBI 50.25.x
MBI 50.33.x
MNHCON, MNHµCON

die grundlegenden Anforderungen folgender Europäischen Richtlinien erfüllt
is in conformity with the following European Directives / est conforme à la dispositions de la Directive

☒	**EMV-Richtlinie** EMC Directive / Directive CEM	**2014/30/EU**

nachgewiesen durch die Einhaltung der aufgeführten harmonisierten Normen
verified by the compliance with the harmonised standards listed below /
et justifié par le respect des normes harmonisées mentionnées ci-dessous

EMV EMC / CEM	**DIN EN 61326-1 (2013)**

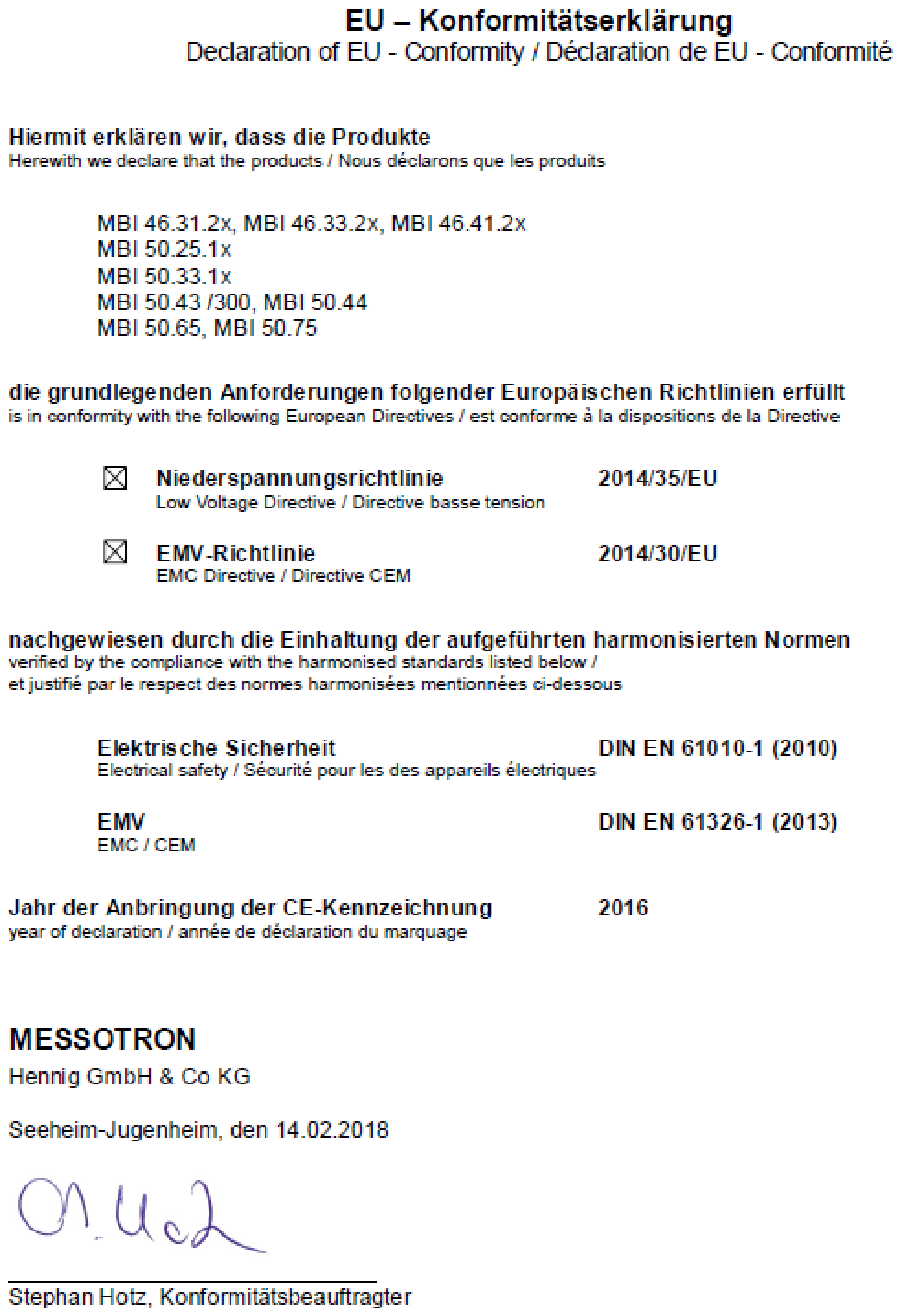
Jahr der Anbringung der CE-Kennzeichnung year of declaration / année de déclaration du marquage	**2016**

MESSOTRON
Hennig GmbH & Co KG

Seeheim-Jugenheim, den 14.02.2018

Stephan Hotz, Konformitätsbeauftragter

10.2 Electronics with a supply voltage > 50 V



EU – Konformitätserklärung

Declaration of EU - Conformity / Déclaration de EU - Conformité

Hiermit erklären wir, dass die Produkte
Herewith we declare that the products / Nous déclarons que les produits

MBI 46.31.2x, MBI 46.33.2x, MBI 46.41.2x
MBI 50.25.1x
MBI 50.33.1x
MBI 50.43 /300, MBI 50.44
MBI 50.65, MBI 50.75

die grundlegenden Anforderungen folgender Europäischen Richtlinien erfüllt
is in conformity with the following European Directives / est conforme à la dispositions de la Directive

☒ **Niederspannungsrichtlinie** **2014/35/EU**
Low Voltage Directive / Directive basse tension

☒ **EMV-Richtlinie** **2014/30/EU**
EMC Directive / Directive CEM

nachgewiesen durch die Einhaltung der aufgeführten harmonisierten Normen
verified by the compliance with the harmonised standards listed below /
et justifié par le respect des normes harmonisées mentionnées ci-dessous

Elektrische Sicherheit **DIN EN 61010-1 (2010)**
Electrical safety / Sécurité pour les des appareils électriques

EMV **DIN EN 61326-1 (2013)**
EMC / CEM

Jahr der Anbringung der CE-Kennzeichnung **2016**
year of declaration / année de déclaration du marquage

MESSOTRON
Hennig GmbH & Co KG

Seeheim-Jugenheim, den 14.02.2018

Stephan Hotz, Konformitätsbeauftragter

11 Technical Specifications

General information

Operating temperature	0...60 °C
Storage temperature	-25...85°C
Electromagnetic compatibility	DIN EN 61326-1
Electric safety	DIN EN 61010-1

Measuring amplifier

Linearity error	< 0,1 % FSO
Carrier frequency	5 kHz ±5 % (sine); optional 1...20 kHz
Excitation voltage (primary)	approx. 2 V_{rms} @ 5 kHz, sinusoidal max. 12 mA_{rms}
Input resistance (secondary)	approx, 200 kΩ
Output signal	4...20 mA, impedance < 500 Ω or. ±10 VDC, ballast resistor > 10 kΩ
Noise level and residual carrier voltage	< 5 mV_{rms}
Temperature coefficient of zero point	< 0,10 % / 10 K @ 100 mV/V < 0,15 % / 10 K @ 20 mV/V
Temperature coefficient of gain	< 0,05 % / 10 K @ 100 mV/V < 0,15 % / 10 K @ 20 mV/V
Dynamic bandwidth	500 Hz (± 3 dB) (max. 1/10 of carrier frequency)

Suitable sensors

- Inductive differential transformers (LVDTs)	with 4-wire technology
- Inductive haft bridges	Differential inductors (LVITs) and Long stroke sensors (eddy current design) i 3-wire technology
Rated output	20...600 mV/V
Input impedance	100...1000 Ω

Eurocard PCB

Supply voltage	MBI 46.31.1y: ±15 VDC stabilized MBI 46.31.3y: +20...+36 VDC
Power consumption	max. 2 W
Electrical connection Required mating plug	Connector to DIN 41612, 32-pin multi-point plug, type C 32-pin multi-point strip Special designs: 16-pin terminal block
Dimensional data Front panel	approx. W 100 x H 18 x D 167 mm approx. 35,3 x 128,4 mm (7 U, 3 U)
Weight	approx. 0.1 kg

Field enclosure (±15 V, 24 V)

Supply voltage	±15 VDC stabilized or +20...+36 VDC
Power consumption	max. 2 W
Electrical connection	Terminal block (internal), connecting cable for supply voltage, displacement sensor and output signal routed to the outside.
Dimensional data	approx. W 120 x H 91 x D 122 mm
Weight	approx. 1.4 kg
Protection rating	IP 65

Field enclosure (230 VAC)

Supply voltage	230 VAC (±10 %), 48...60 Hz
Power consumption	max. 4 W
Electrical connection	Terminal block (internal), connecting cable for supply voltage (with earthed safety plug), displacement sensor and output signal routed to the outside.
Dimensional data	approx. W 120 x H 91 x D 220 mm
Weight	approx. 2 kg
Protection rating	IP 65

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