HOTTINGER BALDWIN MESSTECHNIK HBM

Electrical measurement of mechanical quantities

Operating manual

Load cells and force transducers with strain gauge measuring systems

Z 7 . . .

Contents **Page**

Important Note:

The load cells and force transducers in the Z 7 . . . range can be used as machine components (e.g. with container weighing).

Please note in these cases that, in order to provide a high sensitivity, the transducer is not designed with a safety factor (1 ..20) which is normally applied in machine design.

In particular please take account of the following details given in Chapter 8:

- max. loading limits
- max. longitudinal forces
- max. transverse forces

The technical data on the transducer is valid only within the permissible loading limits specified in Chapter 8 (Technical Data).

Where a fracture may involve damage to property and injuries to persons, appropriate safety measures (e.g. support against collapse, overload protection) must be taken by the user. Observe the relevant accident prevention regulations. In this respect see Chapter 5, "Mechanical Installation".

The electronic system processing the measurement signal should be designed such that no consequential damage occurs as the result of failure of the measurement signal.

1. Introduction

The only difference between load cells and force transducers is the nature of their measurement quantity, according to the intended application in each case:

- Load cells measure loads in the units of weight g, kg or t.
- Force transducers measure forces in the units of force mN, N, kN or MN.

The series discussed in this operating manual are quoted by HBM in the catalogue as load cells, as they are used in particularly large numbers in weighing. They are also obtainable on request as force transducers. The Operating Manual covers all versions.

The local gravitational acceleration in Darmstadt, $g = 9.81029\ m/s^2$, is the basis for calibration of the HBM load cells. The following relationships are applicable for the conversion from kilograms to Newtons and vice versa:

$1\ N \triangleq 0.102\ kg$
$1\ kg \triangleq 9.81\ N$

2. Area of use and application hints

The transducers of the Z 7 . . . series utilize the shear beam principle. They are mounted at one end like a cantilever beam. The load is applied at the other end.

The type series are distinguished by accuracy class, sensitivity tolerance and ratings which are available (see technical data).

Z 7 . . . transducers have only one loading direction. However, owing to their design the loading may be compressive or tensile.

In accordance with the intended application the transducers are calibrated either as load cells in units of mass or as force transducers in units of force. The type of calibration of the present transducer is indicated on the name plate.

Test reports from the Physikalisch-Technische Bundesanstalt (PTB) (German Federal Legal Metrology Authority) are available for load cells of series Z 7 . . ., stating that they are suitable for use in weighing machines for applications for which there is a statutory calibration requirement.

HBM load cells Z 7 . . . measure very exact static loads as well as dynamic loads in the loading direction.

HBM load cells and force transducers are completely maintenance-free and may even be mounted at places with difficult access. Their electrical measurement signals may be transmitted to distant control panels or control stands, and can be indicated, recorded or may be used for control purposes.

As they are precision measuring instruments load cells and force transducers require careful handling. This is of greatest importance especially during transport and mounting.

Where areas are subject to explosion hazards the load cells and force transducers in the ranges Z 7 A and Z 7-2 are available for use in inherently safe circuits [(Ex) i]. HBM can also supply series devices for explosion protection (range VG . . .).
Peak loads e.g. free fall loading may lead to unexpected overloading or even permanent damage. If such peak loads cannot be excluded for sure they must be avoided by suitable means.

The limit of the permitted mechanical, thermal and electrical stresses are given in the technical data and should be strictly adhered to. Please take this into consideration when planning the measurement setup, when mounting the transducer as well as during the operation.

3. Design and function

3.1 Measuring element

The schematic design of the Z 7 . . . transducers is given in Fig. 3.1.

The shear beam transducer is equipped with a shear web between the mounting point and the load introduction hole which is a section with a reduction in cross section shaped like an I beam. Close to the neutral phase the strain gauges are arranged under 45° to the horizontal axis of the transducer, to measure the shear strains. Strains due to bending or torsion moments are negligible because of the small distance of the gauges to the neutral phase and because of their alignment.

3.2 Protection for the transducer circuit

The circuitry is contained in two opposite holes which provide the reduction in cross section. These holes are sealed by a multilayer protective coating which provides mechanical protection of the strain gauges and, amongst others, ensures that no cavities are formed which might give access to air after extended periods of time. Furthermore, the coating protects the strain gauges against humidity (protection level IP 67 to DIN 40050 of 4.2 page 6). The connecting cable from silicone rubber is brought out at the transducer outlet with the aid of a protective rubber sleeve and traction relief clamp.

3.3 Measurement action, output signal

The force acting in the direction of measurement flexibly deforms the measuring element and hence the strain gauges. The strain gauges vary their ohmic resistance in proportion to their change in length. The Wheatstone bridge is thus detuned. When a bridge excitation voltage is applied, the circuit supplies an output signal proportional to the change in resistance and hence also proportional to the force applied.

An electronic follow-up unit (e.g. amplifier) which is part of a complete measuring system is required for further processing of the measuring signal (see Chapter 4).

3.4 Error influences and their compensation

The measurement springs are designed and the strain gauges are precisely applied and connected that error loads like torsion, bending and side loads have only a relatively slight influence on the output signal of the transducer. Therefore, such error loads do not impair the measurement accuracy, as long as these are only slight. On principle, error loads shall be avoided.

The influence of the ambient temperature on the zero signal and the sensitivity is compensated by special compensation resistors.

Variations on the ambient pressure do not influence the measurement result.

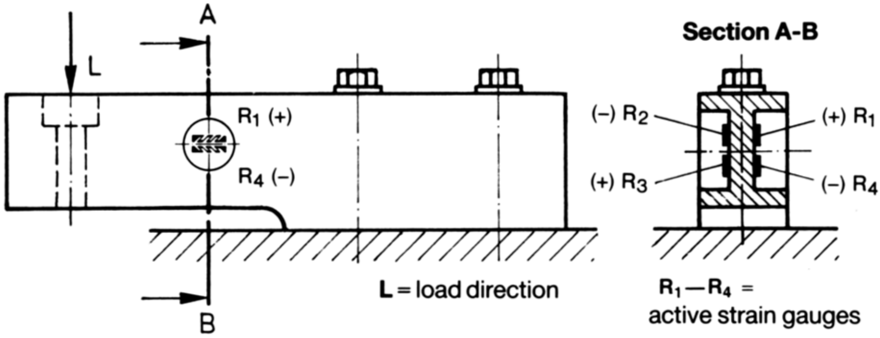


Fig. 3.1: Schematic drawing

4. Conditions on site

4.1 Ambient temperature

The nominal temperature range shall be observed in order to obtain optimum measurement results. It is the best to maintain constant temperatures, if not possible then at least slowly changing temperatures. The quoted temperatures are valid (in accordance to VDE/VDI guideline 2637) for temperature changes of less than 5 K/h. Temperature gradients inside the transducer body e.g. from sunshine, are most disturbing. A shield against heat radiation and heat insulation at all sides will improve the situation considerably. However, one should avoid to form force bypasses.

4.2 Protection against Humidity and Corrosion!

The surface of Z 7 . . . transducers is Nickel-plated (thickness approx. 20 µm); a multi-layer compound protects the strain gauge application area. These provisions are sufficient under normal ambient conditions (protection class IP 67 to DIN 40050).

Should the transducers, however, be exposed to severe ambient conditions – under water for a longer period of time, direct atmospheric influences, contact with basic or acid media, high humidity of the air – additional protection has to provided by the user.

The load cell can be coated additionally (underbody protection coating, etc.) or protected by a housing. Force shunts must, however, be avoided.

4.3 Ambient pressure

Only atmospheric pressure variations are permissible.

5. Mounting

5.1 Important precautions during mounting

- Handle transducer with care.
- The support shall be stable enough to receive the loads envisaged.
- The seating plane must be horizontal and even throughout. It shall be clean and the transducer mounting plane also.
- Do not overload the weighing cell, not even short term e.g. by unevenly distributed loads.
- Especially in the case of more than three transducers (statically indeterminate support) align all load introduction points to same height. The output signals of all transducers should be about equal if a central load is applied.
- Each transducer should be shunted by a stranded copper cable (approx. 50 mm^2) during or immediately after installation. For this purpose, HBM supplies very flexible earthing cable EEK in lengths of 0.4 m, 0.6 m and 0.8 m. The cable is secured above and below the transducer (for example with screws M10). This prevents any welding currents flowing through the transducer and welding together the force introduction point.

5.2 General mounting instructions

Loads on the load cell (or forces on the force transducer) shall act directly in the load direction. Torsion moments, off centre loads and side loads or side forces will cause measurement errors and may lead to permanent damage of the transducer. Side loads may also be caused by the appropriate components of slanted loads.

Influences normal to the measurements direction, caused by wind, acceleration, friction on conveyor belts shall be taken by suitable supports. These may be stayrods or guiding rolls, which stabilise the construction and at the same time fix the container sideways or limit the movement in that direction (see Fig. 5.2c). These supports shall not receive components of the load or force in the direction of measuring i.e. shall not form load bypasses.

Thermal expansion or other displacements between support structure and load element may cause cosiderable side loads, especially in the case of several support points and if both ends of the transducer are firmly clamped. Some of the many possibilities to introduce the load by flexible members are shown in section 5.4.

5.3 Mounting

Important: The transducers in the series Z7 . . . 20 t **must** be mounted using plain washers.

The transducer shall be mounted firmly by means of bolts through the mounting holes. Use screws strength class 10.9 (Tightening torque see Fig. 5.1).

The loads and forces have to be introduced exactly in the centre of the load introduction bore and vertical to the seating plane (Fig. 5.1). The load direction shown in Fig. 5.1 has to be followed.

When load is applied in opposite direction the mounting screws may break.

When excentric load is applied, the following errors may occur:

When displacing the point of application of force on the longitudinal axis, the change of sensitivity may be ≦ ± 0.02 %. The change of sensitivity is systematic:

Sensitivity rices	(+) when displaced to the outside
Sensitivity reduces	(–) when displaced to the inside

The combined error may change by ≦ ± 0.001 %/mm when the point of application of force is displaced on the longitudinal axis.

The force introduction point should not be displaced by more than 25 mm in the longitudinal direction of the transducer.

If the transducer is finally aligned and clamped its position should be marked and fixed by stops at the end and one side (see Fig. 5.1).

5.4 Load introduction

HBM supplies load buttons for the transducers type Z 7 . . . compression loads, spherical load washers for tension loads, and pendle bearings ZPL as well as elastomer rubber bearings ZEL (see cap. 9.2). These can absorb to a certain degree unwanted side load components.

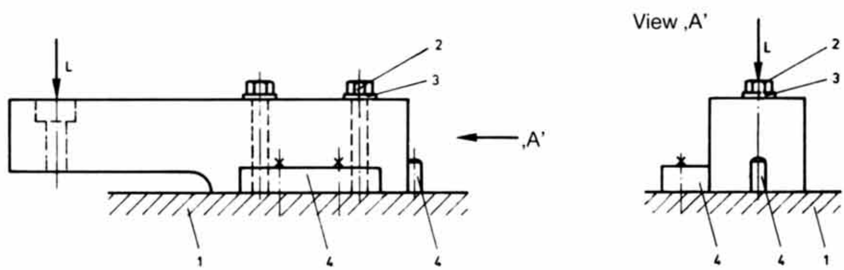
Fig. 5.2 shows an example of various possible load introductions.

Pendle bearings ZPL introduce the load through a pendle and compression piece to the weighing cell, which will be vertical in the rest position. Side load components which occur by horizontal shifts of the loads will produce reaction forces that try to restore the system to its initial position. The design of the pendle bearing parts will make the restoring forces so small that the unwanted force components are so small that errors from side loads are negligible.

The self-restoring action of the pendle bearings makes horizontal stayrods unnecessary thus avoiding force shunts. It will only be necessary to arrange side and height stops to limit the displacement (see fig. 5.2a).

The well defined load introduction enables very accurate measurements in container weighing as well as in railway and platform scales made with Z 7 A transducers.

If the scale is designed with elastomer rubber bearings ZEL a certain freedom for the loaded construction against side shifts is permitted. It will also take side changes, shocks, and vibration. Due to the elastic design elastomer rubber bearings can take side shear forces and will restore the loaded construction to its initial position.



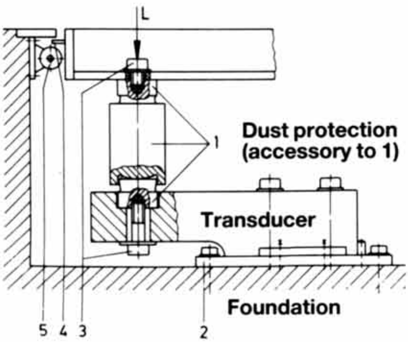
Tightening torque of fixing screws (item 2); oil-lubricated screws

Nominal load (t)	**Screw 10.9**	**Tightening torque** (Nm)
0.5 . . . 2	2 × M 12	110
5	2 × M 20	540
10	2 × M 24	850
20	6 × M 20	540

1 = seating plane; **2** = mounting screws; **3** = washers; **4** = stops to fix transducer position; **L** = load direction.

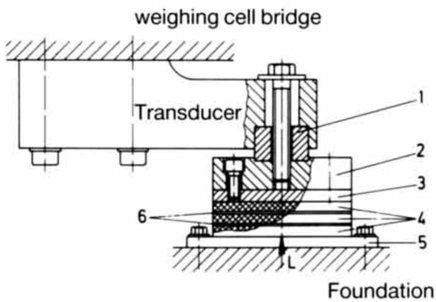
Fig. 5.1: Mounting of transducers Z 7 . . .

a) Pendle bearing ZPL



a)
1 = pendle bearing; **2** = base plate; **3** = fixing screw for pressure piece; **4** = height stop; **5** = adjustable stop; **L** = load direction

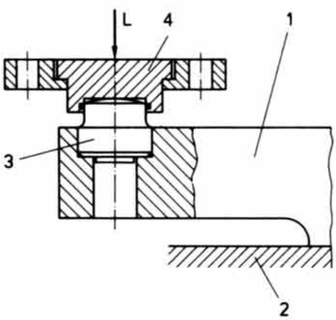
b) Elastomer rubber bearing ZEL



b)
1 = intermediate ring; **2** = pressure distribution plate; **3** = cover plate; **4** = elastomer rubber layers; **5** = mounting plate; **6** = steel shims; **L** = load direction

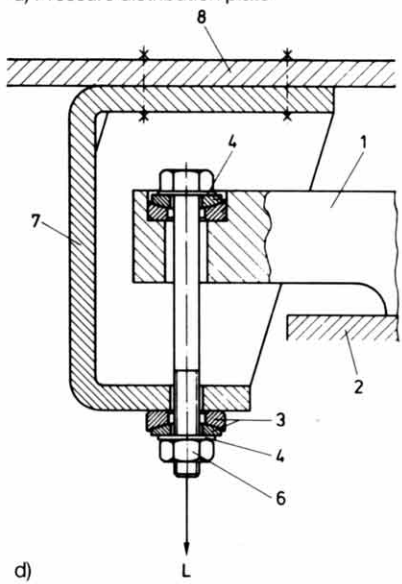
The items 3-6 form the elastomer rubber bearing ZEL.

c) Fixed bearing



c)
1 = transducer; **2** = seating plane; **3** = load button insert ZL; **4** = pendle bearing, upper part EPO 3; **L** = load direction

d) Pressure distribution plate



d)
1 = transducer; **2** = seating plane; **3** = spherical washer, ZK; **4** = washers; **5** = tension rods; **6** = locknut; **7** = loading member; **8** = container; **L** = load direction

Fig. 5.2: Examples for compression and tension loading

In general no restraining elements will be required. In weighing equipments with four supports the spring characteristics will assure uniform load distribution.

As the influences from errors due to higher restorig forces will be greater than compared with a smiliar construction using the ZPL pendle bearing, the elastomer rubber bearings ZEL are most suitable mounting in rough ambient conditions, in conjunction with Z7-2 transducers.

5.5 Precautions

An overload stop shall be provided whereever possible. Because of the very small displacement (see technical data) at the free end of the transducer overload stops must be precisely adjustable and easy to secure. The overload stop shall engage at 140 % of rated load and shall not hinder measurements up to 120 % of rated load. A useful means are for instance prestressed springs – prestressed to about 130 % of the rated load – mounted in the flow of load.

Crash protection elements must be added in all cases where persons may be injured when a breakage form overloading may happen.

6. Measurement equipment

A complete measuring system is required in order to be able to take measurements using the transducer. This system consists of:

- transducer
- amplifier
- wiring cable
- recording device (optional)

An amplifier is required to provide the transducer with the bridge excitation voltage and to amplify the measurement signal. Both carrier frequency and DC amplifiers can be used.

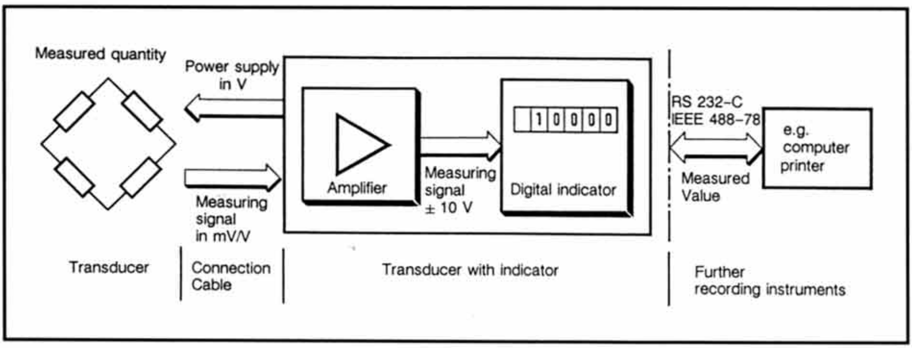


Fig. 6.1: Basic diagram of a measuring system

7. Electrical connection

7.1 Notes on wiring

Electrical and magnetic fields often cause the introduction of disturbing voltages into the measuring circuit. These disturbances are chiefly caused by heavy current conductors installed parallel to the measuring lines, but they can also be produced by contactors or electric motors in the vicinity. Also interference voltages can be occur along the electrical path, in particular through earthing the measuring system at a number of points, causing differences in potential.

Please note following hints:

- Use only screened, low capacitance measuring cable (cable from HBM fulfills these requirements).
- Do not lay the measuring cable parallel to power and control lines. If this is not possible (e.g. in cable ducts), the measuring cable can be protected, e.g. by steel conduit and a miniumum distance of 50 cm is maintained to the other cables. Power cables and control lines should be of the twisted type (15 twists per meter).
- The stray fields of transformers, motors and contactors must be avoided.
- Do not wire the transducer, amplifier and display device to multiple earths. All equipment in the measuring system should be connected to the same earth conductor.
- **Connect the screens of the cables to the operating voltage zero on the amplifier – not to the earth of the housing.**

7.2 Allocation of the cable cores

The connection lead of the transducer has colour-coded free core ends. You can connect transducers with soldering or terminal type connections directly. For transducers with connection sockets, you must first solder a plug onto the cable. The allocation of connections for HBM amplifiers is given in the following table:

The cable screen (yel) should not be connected to the transducer ground, but must be connected to the operating voltage zero (contact 12, E) on the measuring amplifier.

		Electronic unit with	
Core colour	Function	Terminal or soldered connection	7-terminal connection plug
2 Grey (GY)	Sensing conductor	16	G
2 Black (BK)	Bridge excitation voltage	21	B
3 Blue (BU)	Bridge excitation voltage	20	C
3' Green (GN)	Sensing conductor	17	F
1 White (WH)	Measuring signal	22	A
4 Red (RD)	Measuring signal	19	D
5 Yellow (YE)	Cable screen	12	E

If the transducer is connected according to the information given in the table, the output voltage from the amplifier is positive for a compression load on the transducer.

7.3 Methods of connection

The transducers are equipped with a six-core connection cable. This is a prerequisite for operating the measuring system in the six-wire mode, which alone can ensure the greatest accuracy of measurement.

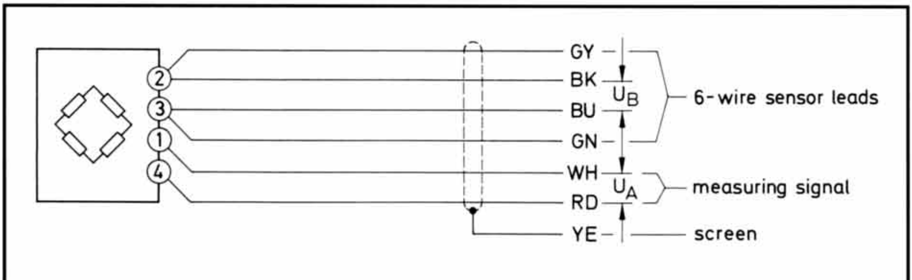


Fig. 7.1: Transducer with six-core cable

Six-wire technique

The extra cores (green and grey) in addition to the traditional four-wire connection pick up the actual value of the bridge excitation voltage at the transducer and feed it back to a suitable electronic measuring unit. The electronic unit now regulates the excitation voltage so that the value adjusted is available at the transducer free from losses. Any changes in resistance of the cable caused by the effects of temperature are thus constantly eliminated, even during measurement. A cable extension is possible without any problems.

Four-wire technique

The transducers are calibrated at the factory so that when the bridge excitation voltage is applied and the nominal load is present, the nominal output signal (nominal sensitivity) is available at the end of the cable. The cable is thus included in the calibration. If the length of the cable changes, this leads to changes in sensitivity. The effects of temperature on the cable are not compensated.

For many requirements in metrology, the four-wire technique is entirely sufficient today. Not all measuring amplifiers are yet suitable for the six-wire technique.

Identification of the transducers:

Transducer calibrated in the six-wire technique:	Yellow cable sleeve The letter "K" is stamped into the type plate
Transducer calibrated in the four-wire technique:	Black cable sleeve Grey-black and blue-green cable cores are soldered together

Connect the transducer using the technique for which it was calibrated at the factory.

Connecting a four-wire transducer by the six-wire technique and vice versa leads to changes in sensitivity and the effect of temperature on sensitivity.

7.4 Transducer connected in the four-wire technique

The sensor conductors for six-wire operation are soldered together with the conductors for the bridge excitation voltage. Do not separate the blue-green and black-grey conductors which have been soldered together. Also, do not shorten the cable.

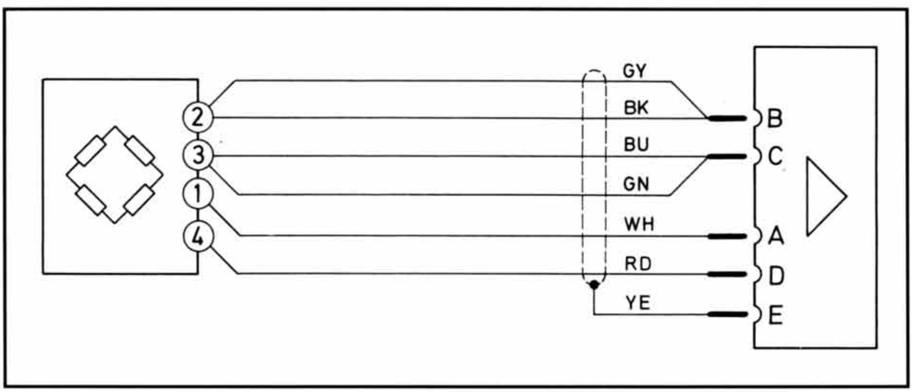


Fig. 7.2: Transducer using the four-wire technique, amplifier using the four-wire technique

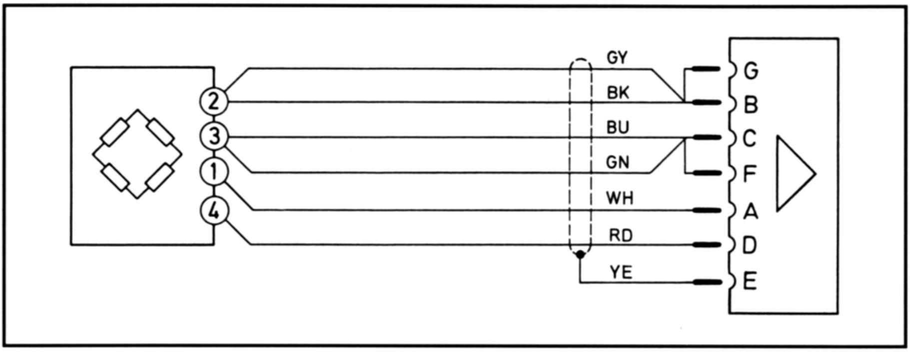


Fig. 7.3: Transducer using four-wire technique, amplifier using six-wire technique

7.5 Connection in the six-core technique

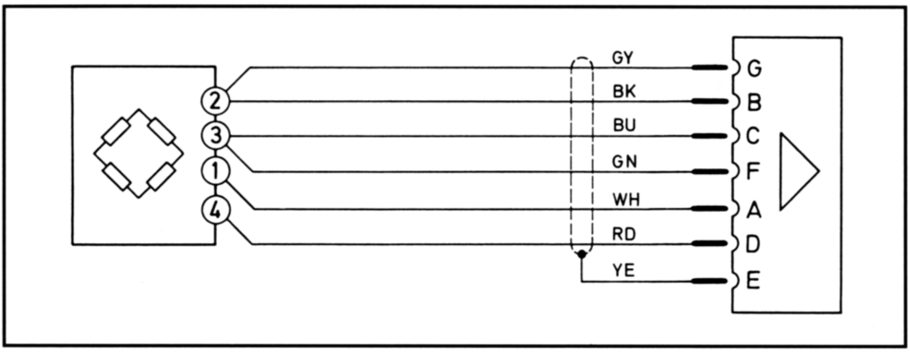


Fig. 7.4: Transducer using six-wire technique, amplifier using six-wire technique

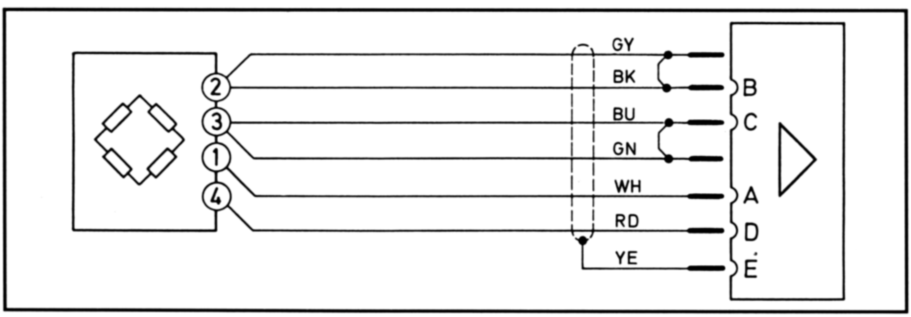


Fig. 7.5: Transducer using six-wire technique, amplifier using four-wire technique

When connecting to the amplifier using the four-wire technique, join together the blue and green cores, and the black and grey cores.

The following deviations from the sensitivity and temperature coefficient of the sensitivity occur:

Weighing cell/Force transducer	Z7...
Sensitivity	−0.066 %
TKc	−0.00257 %/10 K

7.6 Cable extension

Extension cables must be screened and of the low capacitance type. We recommend the use of HBM cables which fulfil these requirements. For cable extensions, care must be taken to ensure a satisfactory connection with the lowest possible transfer resistance and good insulation. The plug connectors from HBM fulfil these requirements. If special humidity protection required, the KVM cable connection sleeves, for example, (connections soldered and potted) or the VKK cable connection box (screwed connections in a cast housing) can be used. If the transducer has already been equipped with a long cable at the factory, this is included in the calibration.

When placing the order you can also state whether, when compensating for the effects of temperature on sensitivity, the same temperatures should be assumed for the transducer, the entire cable or only part of it.

With long cables the effects of the temperature dependence of the resistance should be compensated. The six-wire circuit should therefore be used and this is possible with a number of HBM amplifiers.

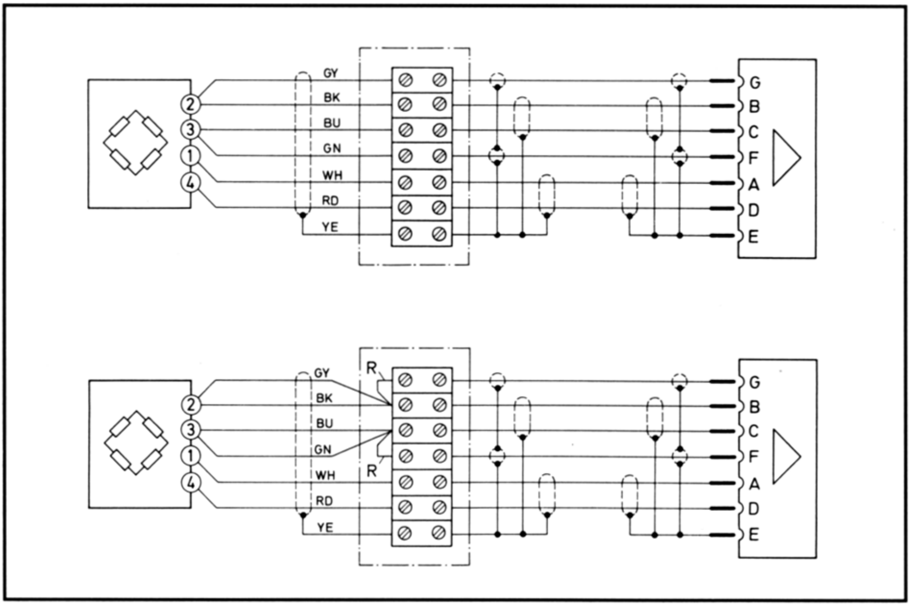


Fig. 7.6: Connection in Six-core (Four-core) technique with extension

The complete measurement system should be recalibrated if a four-core cable is extended and connected to a measuring amplifier. The effects of temperature on the extension cable are not compensated.

Attention: The effects of temperature are balanced out only for the extension cable, not for the standard cable. The standard cable should be loosely wound round the transducer so that it is subject as far as possible to the same temperature.

7.7 Parallel connection of more than one strain gauge transducers

If more than one transducers with the same nominal load are connected in parallel, they can, if the load is evenly distributed, bear a total load corresponding to the sum of the individual nominal loads. The parallel connection of strain gauge transducers then gives the output signal 2 mV/V for loading with the total load.
An overload of individual load cells cannot be detected from the output signal. Therefore appropriate safety precautions should be taken (mechanical overload stops).

The transducers are connected in parallel electrically by joining together the core ends of the transducer connection cables having the same colour (figure 7.7).

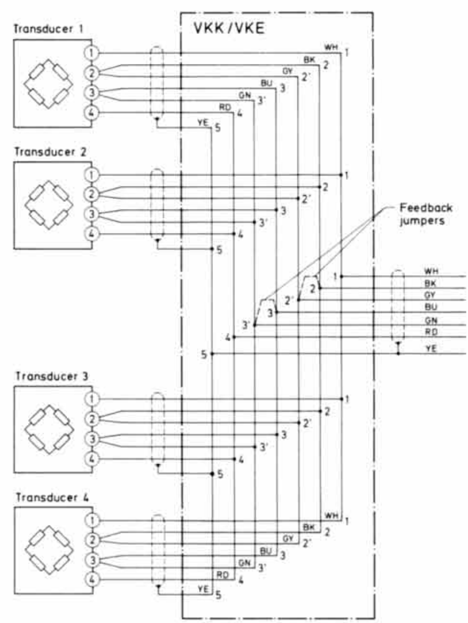


Fig. 7.7: Load cells wired in parallel

The VKK terminal boxes from the HBM range are suitable for this connection.
The cables between the transducers and terminal boxes must be equal in length.

If you would like comprehensive information on the parallel connection of strain gauge transducers, we recommend the HBM special publication "Parallel connection of strain gauge transducers", which you can obtain from your HBM representative.

8. Electrical balancing of the measuring system

The amplifier is adjusted in accordance with the operating manual of the amplifier used, after connection of the transducer. Proceed as follows:

- Bridge excitation voltage — for strain gauge transducers we recommend $U_B = 5$ V
- Measuring bridge — strain gauge full bridge
- Carry out zero-point balancing
- Calibration

8.1 Zero balancing

By zero balancing, you ensure that when the transducer is not loaded the amplifier output signal is ZERO.
In this way any signal that is present on the unloaded transducer (e.g. through the weight of the installation fittings) is electrically balanced.

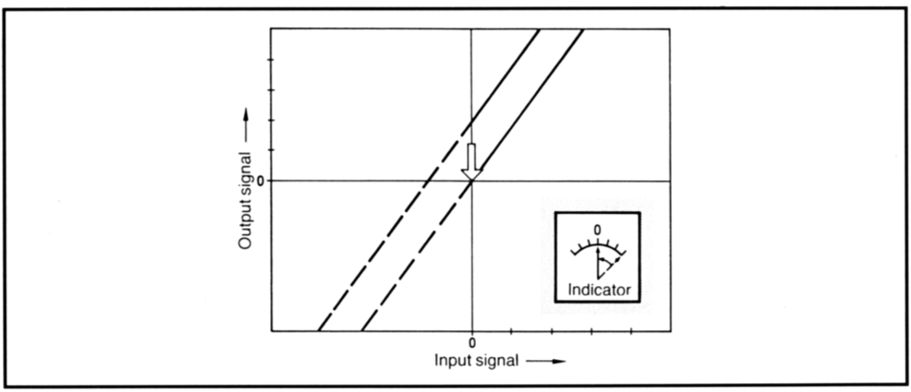


Fig. 8.1: Effect of adjusting the zero point

The zero balancing of the bridge is carried out with no load on the transducer. With carrier frequency amplifiers, zero balancing according to magnitude (R balance) and phase (C balance) is carried out. Please see the operating manual of the amplifier concerned for further information.

8.2 Calibration

By calibration, we mean the clear indication of the mechanical quantity to be measured from the electrical output signal of the electronic measuring unit.

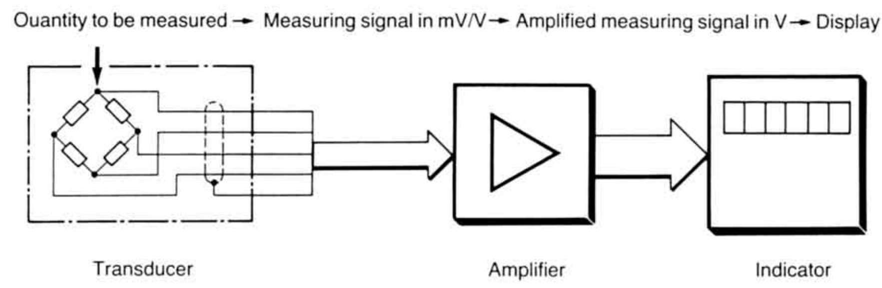


Fig. 8.2: Signal flow diagram of a measuring system

The transducers are supplied with calibrated sensitivity, that is, the type plate indicates accurately what output signal arises at nominal load (maximum value of the measuring range). The standard cable (or on request an extension) is included in this value.

8.2.1 Amplifiers with permanently set measurement range

For amplifiers with a calibrated measuring range, the ratio of output signal to input signal is permanently preset. The mechanical quantity sought can be determined by calculation using this equation:

$$\frac{\text{Cal. measuring range (mV/V)}}{\text{Nominal sensitivity (mV/V)}} \cdot \frac{\text{indicated Digits}}{\text{full load indication (Digits)}} \cdot \text{Nom. load} = \text{mechanical quantity}$$

<u>Example:</u>

Transducer: nominal load 500 kg
nominal sensitivity 2.00 mV/V

Amplifier: measurement range 2 mV/V
With digital display including adjustable matching*

The nominal output signal of the transducer is 10 V, that is, an input signal of 2 mV/V is amplified to 10 V.

If the indicator at the amplifier displays 6800 Digits, for example, the mechanical quantity is calculated as follows:

$$\frac{2 \text{ mV/V}}{2.00 \text{ mV/V}} \cdot \frac{6800 \text{ Digits}}{10000 \text{ Digits}} \cdot 500 \text{ kg} = 340 \text{ kg}$$

* see cap. 8.2.3

8.2.2 Amplifier with adjustable measuring range

With amplifiers with adjustable measuring range the ratio of the output to the input voltage can be separately set. To do this, the following is required:

1. application of a defined signal to the amplifier input.
2. adjustment of the amplifier output voltage with its measuring range adjustment ("MEASURING range fine") to the desired value (changing the gain).

The ratio of the voltages at the amplifier can be represented by a characteristic. Figure 8.3 shows as an example two characteristics when the gain is adjusted differently.

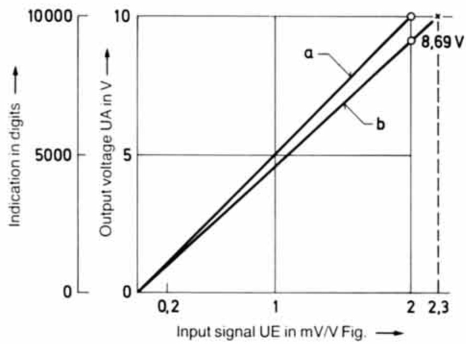


Fig. 8.3: Amplifier characteristics with different gain

Depending on the measurement task, the accuracy requirements and the justifiable expenditure, you can produce a defined input signal by:

- ○ direct mechanical loading
- ○ a calibration signal within the amplifier
- ○ a calibration unit

○ Calibration with the calibration signal inside the amplifier

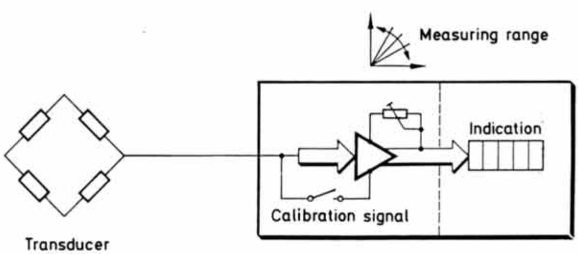


Fig. 8.4: Calibration with the calibration signal inside the amplifier

Many HBM amplifiers have an internal calibration signal which is applied to the input of the amplifier in place of the measuring signal. You can set the required output signal with the amplifier's measurement range adjustment.

Advantage: Easy to apply and free from problems.

Disadvantage: The calibration does not include the entire measuring system. The components from the amplifier input to the transducer are not taken into consideration. In particular, when the measuring cables are long and there is a four-wire circuit, inaccuracies can be expected here.

Example: Calibration with the calibration signal inside the amplifier. Direct reading indication with the correct decimal position (for digital indicators only)

○ Transducer: nominal load 500 kg nominal sensitivity 2.0 mV/V

○ Amplifier: With digital display including adjustable matching* Internal calibration signal: 1 mV/V

You would like the indicator to show the value 5000 when the transducer is fully loaded.

> Connect the Transducer

> Set the "MEASURING range coarse" multiple-step switch to 2 mV/V

> Adjust the "indicator matching" selector switch to 5000

> Calculate the setting of the display for a 1 mV/V calibration signal
Indication = Calibration signal/Nominal sensitivity × desired indication
1 mV/V / 2.0 mV/V × 5000 digits = 2500

> Call up the calibration signal, hold the button pressed and
Adjust the indication of 2500 with the **"MEASURING range fine"** adjustment

When loaded at the nominal load of 500 kg, the indicator now shows 5000, the value with the correct figures. If you can also select the position of the decimal point at the indicator, a display with the correct decimal position can also be obtained (250 for the calibration signal; 500 for nominal load).

○ Calibration with a calibration unit

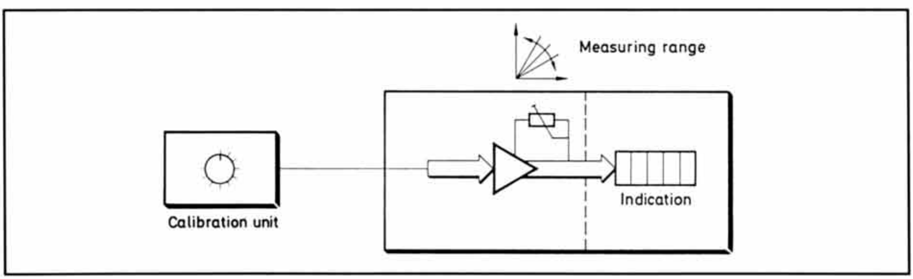


Fig. 8.5: Calibration with a calibration unit

* see cap. 8.2.3

A calibration unit is connected into the measuring system in place of the transducer. You can set different calibration signals in steps on the calibration unit, e.g. K3607. These signals are then present on the amplifier input.

Advantage: The complete measuring system is calibrated, because the cable is included in the calibration process.

Disadvantage: Calibration unit must have the same bridge resistance as the transducer

Example: Calibration with the calibration unit

The display should show a correctly formatted figure when the transducer is loaded with the nominal load.

- Transducer: nominal load 500 kg
  nominal sensitivity 2.0 mV/V
- Amplifier: With digital display including adjustable matching*
- Calibration unit: K 3607

> Adjust the **"MEASURING range coarse"** multiple step switch to 2 mV/V

> Adjust the "Indicator matching" selector switch to 5000

> Adjust the calibration value at the calibration unit to 2.0 mV/V

> Adjust the output signal to 5000 Digits with "MEASURING range fine"

> Connect the transducer into the measuring system in place of the calibration unit

When loaded at the nominal load of 500 kg, the indicator now shows 5000, the value with the correct figures. If you can also select the position of the decimal point at the indicator, a display with the correct decimal position can also be obtained (250 for the calibration signal; 500 for nominal load).

- Calibration with direct mechanical load

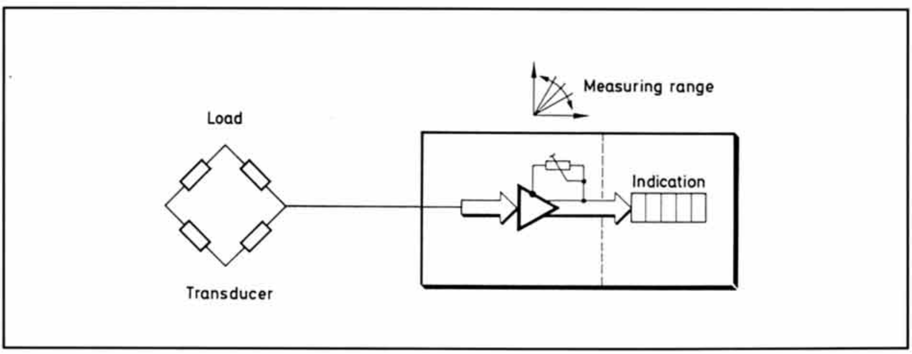


Fig. 8.6: Calibration with direct mechanical loading

* see cap. 8.2.3

The amplifier is loaded with a defined mechanical load (e.g. with calibrated weights). You can then set the required measurement display with the measurement range adjustment on the amplifier.

Advantage: Most accurate method, because calibration is made using the accuracy of the calibrated weights; cable effects are taken into account.

Disadvantage: Often associated with disproportionately high expenditure.

Example: Calibration by direct mechanical loading of the transducer

○ Transducer: nominal load 100 kg
nominal sensitivity 2.0 mV/V

○ Amplifier: With digital display including adjustable matching*

> Set the “MEASURING range coarse” multiple-step switch to 2 mV/V

> Adjust the “Indicator matching” selector switch to 10000

> Apply a known load to the transducer, ideally the nominal load.

> Set the display to the value of the applied load with MEASUREMENT range fine.

The display shows the correct significant figures. If you can also select the position of the decimal point at the indicator, a display with the correct decimal position can also be obtained.

8.2.3 Calibration with amplifiers without display matching

Please note the following when using an amplifier without a selector switch for display matching:

This item is no longer valid:

> Adjust the “Indicator matching” selector switch to . . .

Without a selector switch you must set the required display with both step switches, MEASUREMENT RANGE course and MEASUREMENT RANGE fine.

The sensitify is increased by reducing the measurement range is however restricted). Please take into account the range tolerances of your amplifier (see the technical description of the relevant amplifier plug-in module).

* see cap. 8.2.3

9. Technical Data

Series Accuracy class		Z7A 0.03	Z7-2 0.1	Z7H2 0.03	Z7H3 0.02
Nominal load	kg t	500 1; 2; 5; 10; 20		2; 5; 10	
Sensitivity (output at nominal load)	mV/V	2			
Sensitivity tolerance Calibration tolerance of the output signal at nominal load and g = 9.81029 m/s²)	%	< ± 0.1			
Temperature coefficient of sensitivity per 10 K in the nominal temperature range in the service temperature range	% %	< ± 0.015 < ± 0.03	< ± 0.1 < ± 0.1	< ± 0.01 < ± 0.02	< ± 0.008 < ± 0.02
Temperature coefficient of the zero signal per 10 K in the nominal temperature range in the service temperature range	% %	< ± 0.03 < ± 0.05	< ± 0.05 < ± 0.05	< ± 0.013 < ± 0.025	< ± 0.013 < ± 0.025
Combined error	%	< ± 0.03	< ± 0.05	< ± 0.02	< ± 0.017
Variability (repeatability)	%	< ± 0.01	< ± 0.03	< ± 0.01	< ± 0.01
Creep at nominal load and reference temperature over 30 min over 4 h	% %	< ± 0.03	< ± 0.06	< ± 0.025 < ± 0.05	< ± 0.017 < ± 0.05
Relative minimum application range referred to nominal load	%	15			20
Protection class (DIN 40050)		IP 67			
Input resistance at reference temperature	Ω	350 ± 2			
Output resistance at reference temperature	Ω	350 ± 1.5			
Insulation resistance	GΩ	> 5			
Nominal range of supply voltage	V	0.5 ... 12			
Maximum supply voltage	V	18			
Reference temperature	°C	+ 23			
Nominal temperature range	°C	− 10 ... + 70		− 10 ... + 40	
Service temperature range	°C	− 30 ... + 85			
Storage temperature range	°C	− 50 ... + 85			

Mechanical Data

Nominal load F_N	Service load	Limit load	Breaking load	Permissible dynamic loading	Relative static limit transverse load F_Q*) with respect to nominal load	Max. permissible longitud. load F_L**) (referred to the nominal load)	Nominal measuring displacement ± 15 %	Weight
500 kg	650 kg	750 kg	> 1.5 t	350 kg	100 %	100 %	0.25 mm	2.3 kg
1 t	1.3 t	1.5 t	> 3 t	0.7 t	50 %	100 %	0.30 mm	2.3 kg
2 t	2.6 t	3 t	> 6 t	1.4 t	25 % (100 %)	100 %	0.35 mm	2.3 kg
5 t	6.5 t	7.5 t	> 15 t	3.5 t	15 % (100 %)	100 %	0.45 mm	5 kg
10 t	13 t	15 t	> 30 t	7 t	18 % (100 %)	100 %	0.70 mm	8 kg
20 t	26 t	30 t	> 60 t	14 t	7.5 % (100 %)	100 %	1.0 mm	24 kg

*) At nominal load the values of the transverse load F_Q are limited by the amount of friction present between the mounting surface and the transducer foot. Therefore the values given are valid only when the fixing screws have been tightened to the appropriate torque (compose with page 8, Fig. 5.1 Mounting of transducers Z 7 A, Z 7-2).

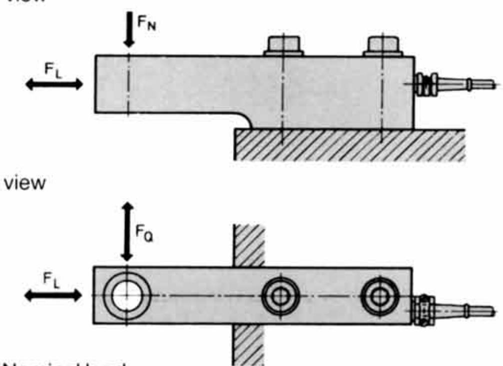
The values in brackets refer to the situation where all effective movements of the transducer foot have been prevented. However, with this method large error effects are to be excepted.

**) Refer to the situation where all effective movements of the transducer foot have been prevented.

Fig. 9.1: Direction of load

Side view

Plan view

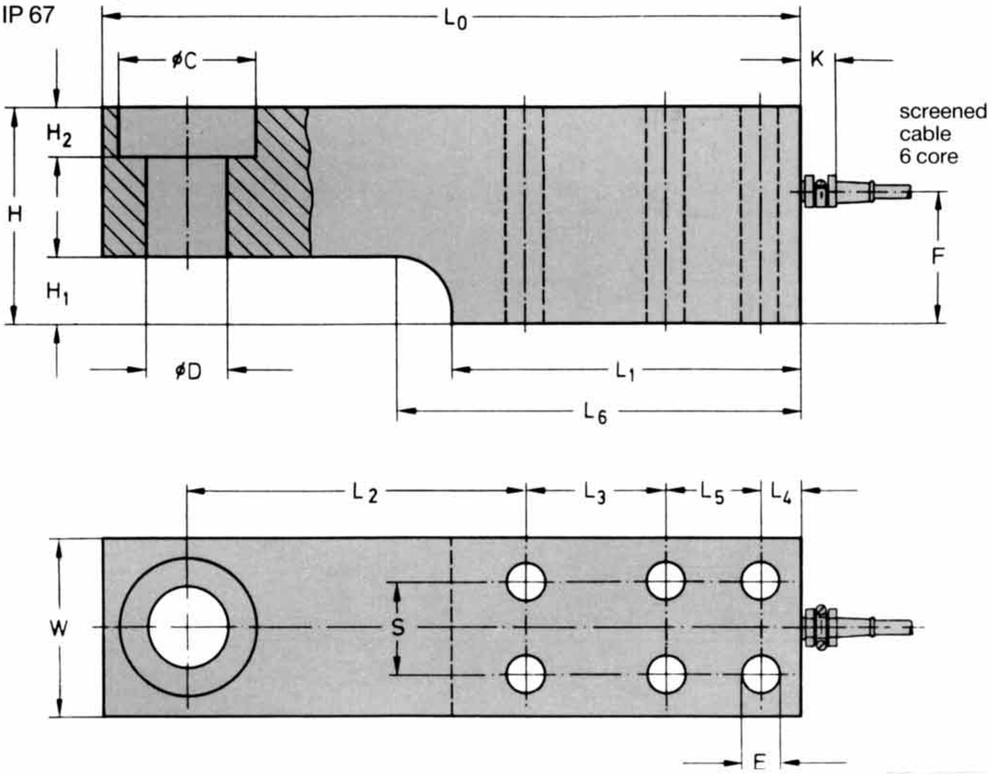


F_N = Nominal load,
F_L = Longitudinal load, F_Q = Transverse load limit

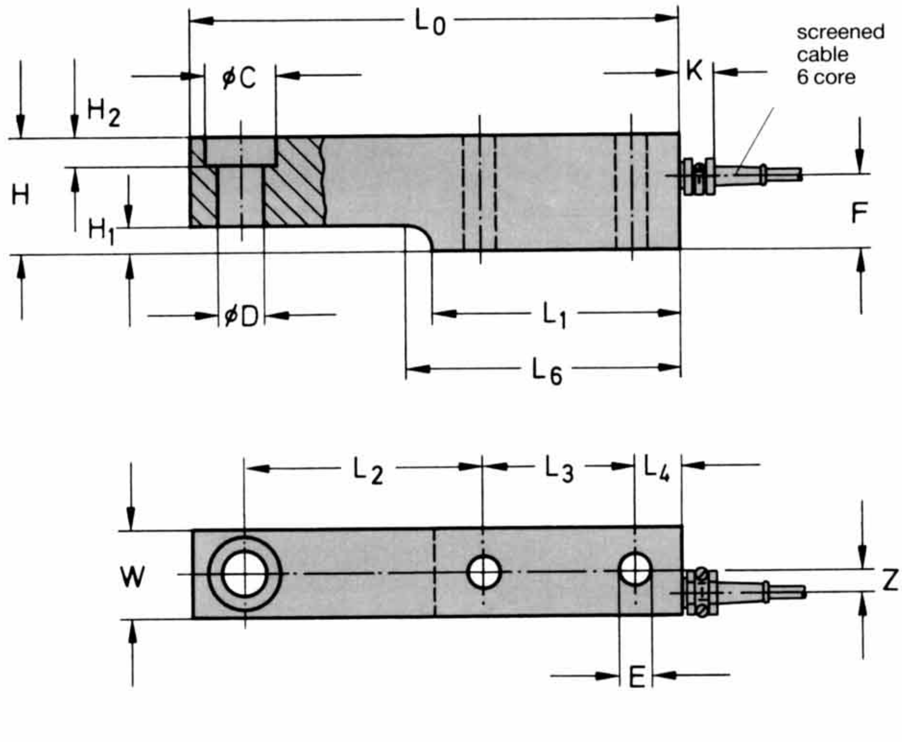
10. Dimensions (Dimensions with medium tolerances to DIN 7168)

10.1 Transducers

Z 7 ...
for nominal loads 20 t
(for nominal forces 200 kN)
Protection class IP 67
Surfaces nickel-plated

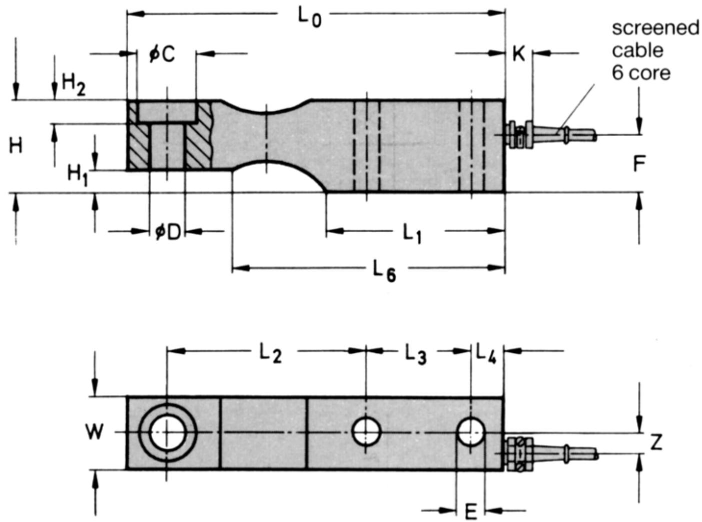


Z 7 ...
for nominal loads 2 t . . . 10 t
(for nominal forces 20 kN . . . 100 kN)
Protection class IP 67;
Surface nickel-plated



Z 7 . . .
for nominal loads 0.5 t and 1 t
(for nominal forces 5 kN and 10 kN)

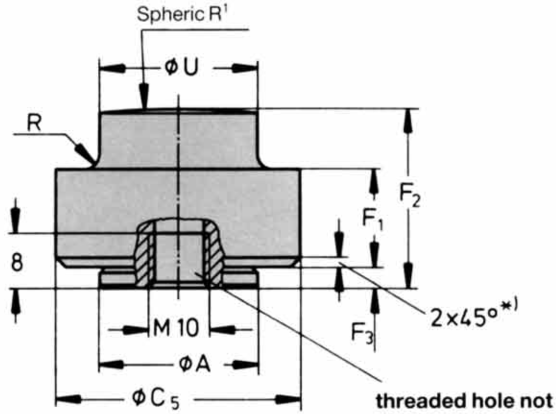
Protection class IP 67;
Surface nickel plated



Nominal load [t]	Dimensions in mm																
	∅$C^{+0.2}$	∅D	∅E	F	H	H_1	H_2	K_{max}	L_0	L_1	L_2	L_3	L_4	L_5	L_6	S	W	Z
0.5...1	30.2	17.5	13.4	29	47.6	11.1	11.9	13	203.2	101	98.3	63.5	19.1	–	150	–	36.5	10.6
2	30.2	17.5	13.4	29	47.6	11.1	11.9	13	203.2	101	98.3	63.5	19.1	–	124	–	36.5	10.6
5	41.3	25.5	22.5	46	70	22.2	15.9	13	235	118	123.7	66.5	20.6	–	138	–	47.6	16
10	51	32	27	51	82.6	19.1	20.7	13	279.4	140	139.7	82.6	25.4	–	162	–	60.3	21
20	73.3	44.5	22.5	77	117.5	36.5	31	16	374.7	187	180.8	76.2	22.2	50.8	223	50.8	95.3	–

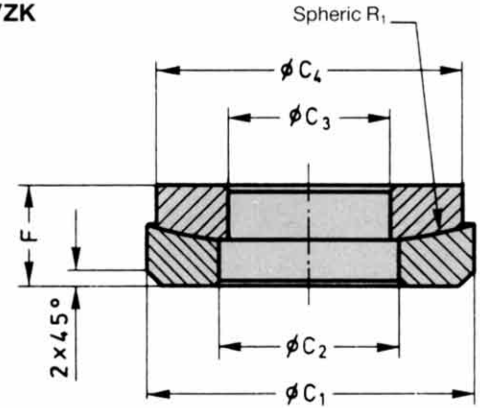
10.2 Mounting Accessories

Load button insert
Z7/...t/ZL



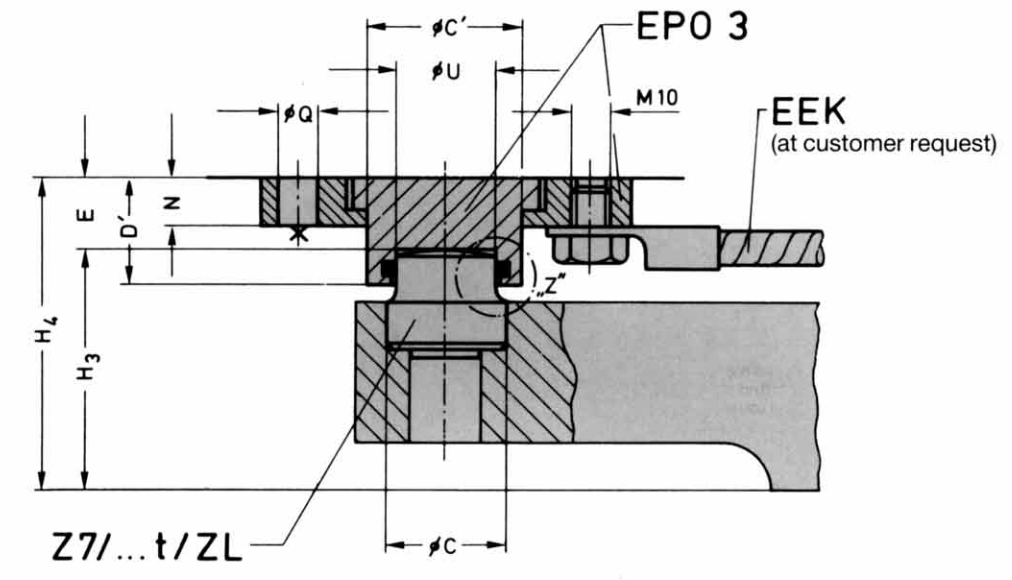
*) 50 t: 3 × 45°

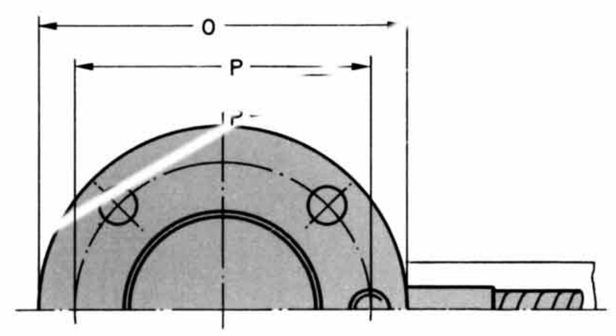
Spherical washer
Z7/...t/ZK



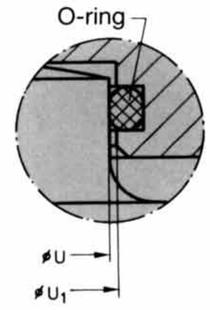
Nominal load [t]	Load button insert	Dimensions in mm								Spheric. washer	Dimensions in mm					
		∅C_5	∅A_{d9}	F_1	F_2	F_3	∅U	R_1	R		∅$C_{1\ -0.1}$	∅C_2	∅C_3	∅C_4	F	R_2
0.5...2	Z7/ 2t/ZL	29	17.5	12	27.5	4.5	$25^{-0.05}_{-0.1}$	60	3	Z7/ 2t/ZK	30	15	13	28	10	38
5	Z7/ 5t/ZL	40	25.5	16	31.5	4.5	$25^{-0.05}_{-0.1}$	60	3	Z7/ 5t/ZK	41.1	23	21	39	12	57
10	Z7/10t/ZL	50	32	21	39.5	5.5	$32^{-0.05}_{-0.1}$	160	3	Z7/10t/ZK	50.8	28	25	47	15	70
20	Z7/20t/ZL	72	44.5	31	49.5	5.5	$32^{-0.05}_{-0.1}$	160	3	Z7/20t/ZK	73	40	37	70	24	76

Pendle Bearing, Upper Part
EPO 3



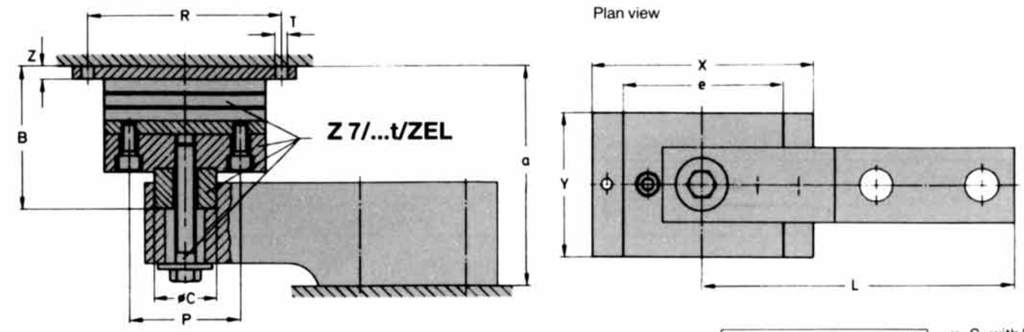


detail "Z"



Nominal load [t]	Pendle bearing, upper part	Dimensions in mm $ØC_{-0.1}$	$ØC'_{-0.1}$	D'	E	H_3	H_4	N	ØO	ØP	ØQ	ØU	$U_{1_{-0.2}}$
0.5…2	EPO 3/ 5t	29	37.9	21	16	58.7	74.7	12	89	70	9	$25^{-0.05}_{-0.01}$	25.7
5	EPO 3/ 5t	40	37.9	21	16	81.1	97.1	12	89	70	9	$25^{-0.05}_{-0.01}$	25.7
10	EPO 3/20t	50	47.9	28	20	95.9	115.9	14	114	90	13	$32^{-0.05}_{-0.01}$	33
20	EPO 3/20t	72	47.9	28	20	130.5	150.5	14	114	90	13	$32^{-0.05}_{-0.01}$	33

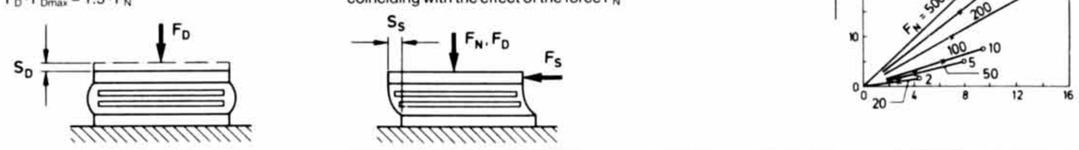
Elastomer rubber bearing



Max. displacement of the elastomer rubber bearing

Vertical deformation S_D (mm) in relation to the force $F_D \cdot F_{Dmax} = 1.5 \cdot F_N$

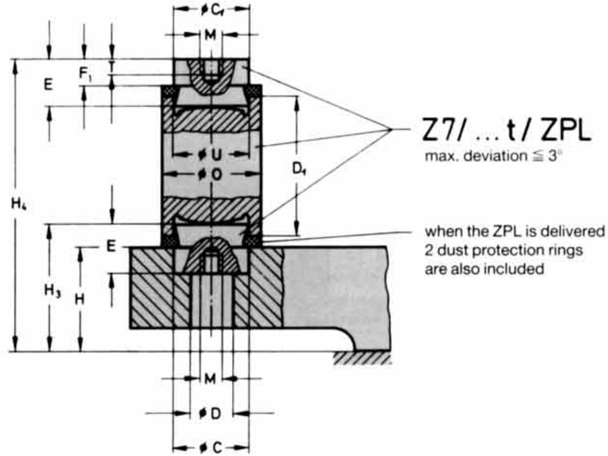
Horizontal shear deformation S_S (mm) in relation to the shear force F_S coinciding with the effect of the force F_N



x S_S with $F_S = 0.05 \cdot F_N$ ≙ 5 % rel. stat. long term loading of the load cell.
o S_S max. = max. allowed shear deformation.

Nominal load [t]	Elastomer rubber bearing	(mm) B	$ØC^{-0.1}_{-1}$	L	P	R	T	X	Y	Z	a	e	S_D
0.5…2	Z7/ 2t/ZEL	76,3	30	180,9	70	100	9	120	60	10	$112^{+1.5}_{-1.7}$	80	0,9
5	Z7/ 5t/ZEL	93	41,1	210,8	70	125	11	150	100	10	$147^{+1.2}_{-2.0}$	100	0.75
10	Z7/10t/ZEL	114,1	50,9	247,7	90	175	13	200	100	12	$176^{+1.8}_{-2.0}$	130	0.73
20	Z7/20t/ZEL	130.5	73.1	330	90	230	13	260	150	12	$217^{+1.9}_{-2.1}$	200	0.77

Pendle bearing ZPL



Nominal load [t]	Pendle bearing ZPL	Dimensions in mm											
		$\varnothing C^{+0.2}$	$\varnothing C_1^{-0.1}$	$\varnothing D$	D_1	E	F_1	H_3	H_4	M	$\varnothing O$	T	$\varnothing U_{h9}^{D10}$
0.5...2	Z7/ 2t/ZPL	30.2	30	17.5	60	22	14	58.5	130 ± 0.5	M 10	42	8	30
5	Z7/ 5t/ZPL	41.3	41.1	25.5	73	26	16	80	169 ± 0.5	M 10	48	8	30
10	Z7/10t/ZPL	51	50.8	32	82	32	21	94	196 ± 0.5	M 12	58	10	40
20	Z7/20t/ZPL	73.3	73.1	44.5	102	43	31	129.5	262.5 ± 0.5	M 16	58	14	40

HBM

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