

**HOTTINGER BALDWIN MESSTECHNIK**  
**HBM Mess- und Systemtechnik GmbH**



**Electrical  
measurement  
of mechanical  
quantities**

## ***Operating manual***

**Force transducer  
with strain gauge  
measuring system**

**C9B**

B 20.C9B.20 e



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## Safety instructions

### Use in accordance with the regulations

Force transducers in the C9B range are designed for measuring static and dynamic compressive forces. Use for any additional purpose shall be deemed to be **not** in accordance with the regulations.

In the interests of safety, the transducer should only be operated as described in the Mounting Instructions. It is also essential to observe the appropriate legal and safety regulations for the application concerned during use. The same applies to the use of accessories.

The transducer is not a safety element within the meaning of its use as intended. Proper and safe operation of this transducer requires proper transportation, correct storage, assembly and mounting and careful operation and maintenance.

### General dangers due to non-observance of the safety instructions

The C9B force transducer corresponds to the state of the art and is fail-safe. The transducers can give rise to residual dangers if they are inappropriately installed and operated by untrained personnel.

Everyone involved with the installation, commissioning, maintenance or repair of a force transducer must have read and understood the Mounting Instructions and in particular the technical safety instructions.

### Residual dangers

The scope of supply and performance of the transducer covers only a small area of force measurement technique. In addition, equipment planners, installers and operators should plan, implement and respond to the safety engineering considerations of force measurement technique in such a way as to minimise residual dangers. Prevailing regulations must be complied with at all times. There must be reference to the residual dangers connected with force measurement technique.

In these mounting instructions residual dangers are pointed out using the following symbols:



Symbol: **DANGER**

Meaning: **Highest level of danger**

Warns of a **directly** dangerous situation in which failure to comply with safety requirements **will** lead to death or serious physical injury.



Symbol: **WARNING**

Meaning: **Possibly dangerous situation**

Warns of a **potentially** dangerous situation in which failure to comply with safety requirements **can** lead to death or serious physical injury.



Symbol: **ATTENTION**

Meaning: **Possibly dangerous situation**

Warns of a **potentially** dangerous situation in which failure to comply with safety requirements **could** lead to damage to property, slight or moderate physical injury.



Symbol: **NOTE**

Refers to the fact that important information is being given about the product or its use.

Symbol: **CE**

Meaning: **CE mark**

The CE mark signals a guarantee by the manufacturer that his product meets the requirements of the relevant EC directives (see Declaration of conformity at the end of this document).

## **Prohibition of own conversions and modifications**

The transducer must not be modified from the design or safety engineering point of view except with our express agreement. Any modification shall exclude all liability on our part for any damage resulting therefrom.

## **Qualified personnel**

This instrument is only to be installed by qualified personnel strictly in accordance with the technical data and with the safety rules and regulations which follow. It is also essential to observe the appropriate legal and safety regulations for the application concerned. The same applies to the use of accessories.

Qualified personnel means persons entrusted with the installation, fitting, commissioning and operation of the product who possess the appropriate qualifications for their function.

## **Conditions on site**

Protect the transducer from damp and weather influences such as rain, snow, etc.

## **Maintenance**

The C9B force transducer is maintenance free.

## **Accident prevention**

Although the specified nominal force in the destructive range is several times the full scale value, the relevant accident prevention regulations from the trade associations must be taken into consideration.

## 1 Scope of delivery

Force transducer C9B; mounting instruction

## 2 Field of application and notes on use

The transducers are intended for measuring static and dynamic compressive forces. Their very small dimensions make them ideal for use where little space is available (for example for measuring penetration forces in manufacturing processes).

The force transducers are designed for harsh environmental conditions and stringent service in requirements. They are maintenance-free and can even be installed in places where access is difficult. Their electrical measuring signals can be transmitted to remote measuring stations and control rooms and displayed or recorded there and used for control and regulating duties.

The transducers, as precision measuring instruments, require careful handling during transport and installation. Loading impacts (for example "free fall" application of the load) even during measurement operations can lead to unexpected overloads with permanent damage.

Special care must therefore be given to the base of the housing, which is relatively thin.

The limits for permissible mechanical, thermal and electrical stressing are given in the technical data. It is essential that these be respected.

## **3 Structure and mode of operation**

### **3.1 Measuring element**

The force is transferred to the diaphragm measuring element in the C9B by a crowned load button. This type of measuring element has the advantage in that it also acts as a housing, protecting the applied strain gauges. The transducer is hermetically sealed by a cover welded on the bottom.

### **3.2 Measuring procedure, output signal**

The measuring spring and strain gauges are elastically deformed by a load acting in the direction of measurement. The strain gauges modify their resistance proportionally 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.

A measuring amplifier, suitable for strain gaugs measurements, is needed to process the measurement signal.

## 4 Conditions at the site of installation

### 4.1 Ambient temperature

To achieve optimum measuring results, the nominal temperature range from  $-10^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  must be maintained. Ideally, the temperatures should be constant or subject to slow variations. The temperature effects indicated are applicable – in compliance with VDI/VDE Recommendation 2637 – when the temperatures do not change faster than 5 K/h.

Temperature gradients in the transducer by cooling or heating on one side (radiant heat) cause problems. A screen to protect against radiant heat and thermal insulation on all sides produce marked improvements. Naturally, these should not cause any force shunt.



#### NOTE:

The transducer output signal can be affected by the warmth of the hand. If measurements are made at room temperature (about  $20^{\circ}\text{C}$ ), then you should wait about 15 min. after handling the transducer before taking measurements.

### 4.2 Humidity

Ambient humidity and a tropical climate do not affect the function of the transducer, according to the classification of the protection indicated, corresponding to protection class IP 67 to EN 60 529.

IP 67 means protected against the ingress of dust. It is also protected against water, if the transducer is immersed in water under specified conditions with regard to pressure and time (0.5 h in 1 m depth of water).

The housings of the transducers are manufactured entirely in stainless steel. They can be used in harsh environments. The sheath of the connection cable consists of polyurethane (PU).

### 4.3 Deposits

Dust, dirt and other foreign bodies should not be allowed to accumulate to the point where they convey part of the measuring force to the housing, thus falsifying the measured value (force shunt).

## 5 Mechanical installation

### 5.1 Important precautions during installation

- Handle the transducers carefully.
- The force application surfaces on the transducer and on the mounting accessories must be absolutely clean and seat properly.
- Each transducer should be shunted by a stranded copper cable (approx. 50mm<sup>2</sup>) during or immediately after installation. For this purpose, HBM supplies very flexible earthing cable EEK

### 5.2 General guidelines for installation

Force must act on the force transducer precisely in the direction of measurement as far as possible. Off-centre loading and side loading or lateral forces are interference variables, and therefore causes for measuring errors, and they can damage the transducer by exceeding the permissible limits. Side loads and lateral forces also include the relevant components of any measurement quantities which may be introduced at an oblique angle.

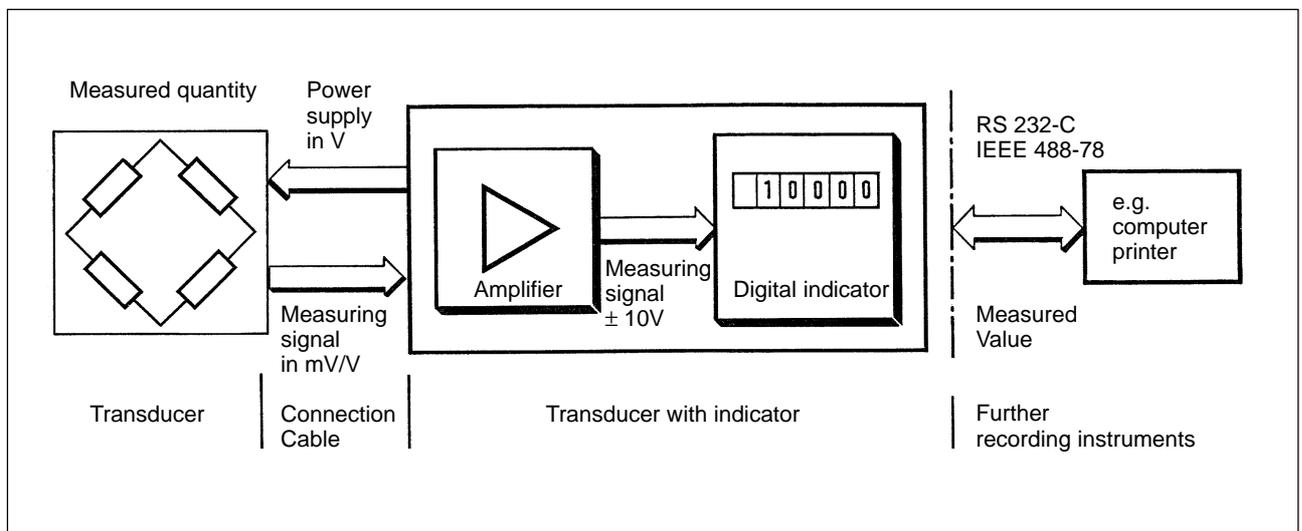
## 6 Measurement equipment

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<sup>\*)</sup> can be used .



**Fig. 6.1:** Basic diagram of measuring system

<sup>\*)</sup> The common-mode rejection ratio of the measuring amplifier that is used should be  $\geq 80\text{dB}$ .

## 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 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 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 minimum distance of 50cm is maintained to the other cables.
- 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.
- Further information can be taken from our reprint "Electromagnetic Compatibility EMC"

### 7.2 Allocation of the cable cores

The 1.5 m long connection lead of the transducer has colour-coded free core ends. The cable screen (YE) should be connected to the transducer ground. 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. If a negative output voltage is required at the measuring amplifier during compressive loading, cores white and red of the transducer should be changed over at the amplifier input.

Allocation of connections for HBM amplifiers:

Funktion	Core colour
Measuring signal (+)	White
Bridge excitation voltage (-)	Black
Bridge excitation voltage (+)	Blue
Measuring signal (-)	Red
Cable screen	Yellow

### 7.3 Connection technique

The transducers are fitted with a four-core connection cable and calibrated as standard using the four-wire circuit

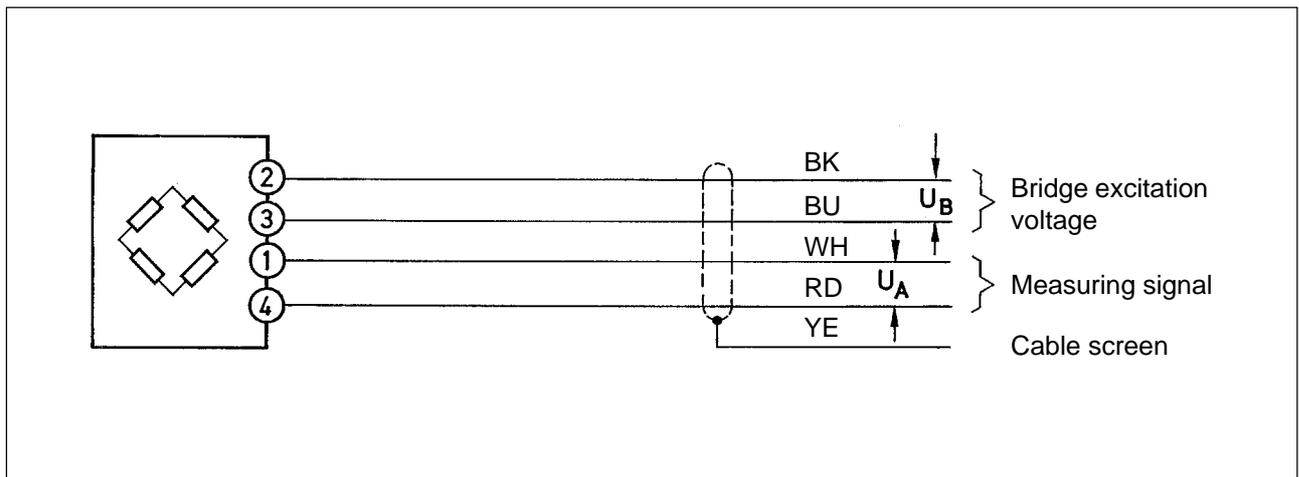


Fig. 7.1: Transducer with four-core cable



#### ATTENTION:

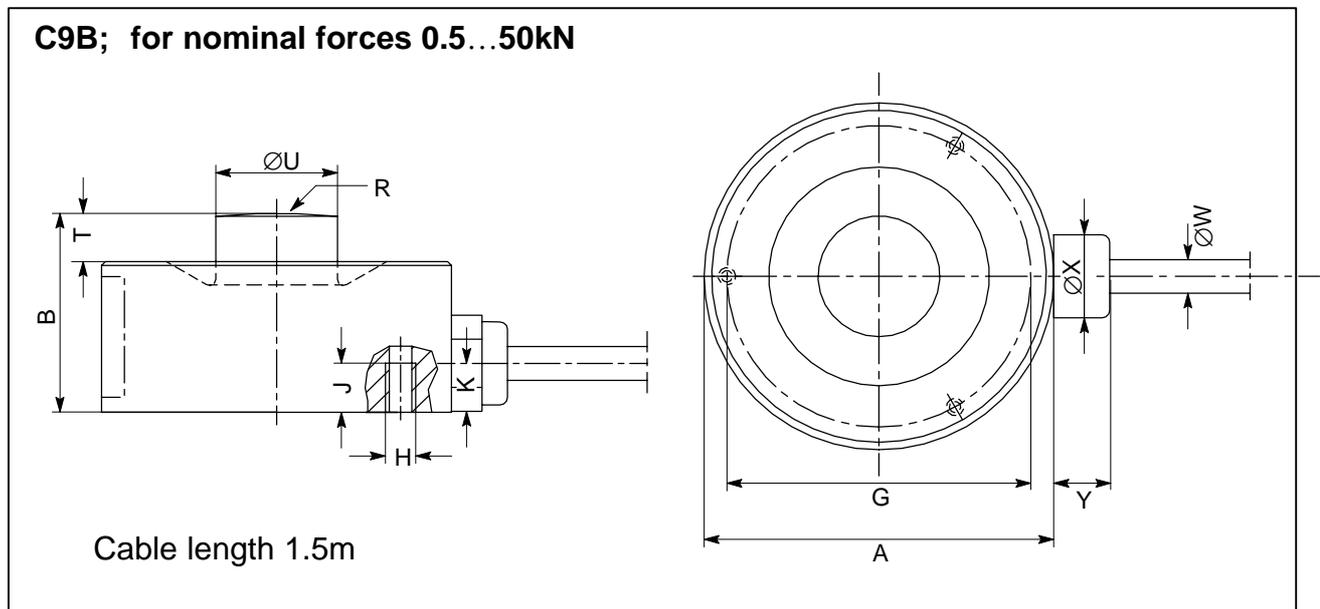
There are balancing resistors under a coloured heat-shrink sleeve at the end of the cable that must **not** be removed (re-use when shortening the cable).

## 7.4 Cable extensions

Extension cables must be of the screened low-capacitance type (HBM cables fulfil this requirement). For cable extensions, care must be taken to ensure a satisfactory connection with the lowest transfer resistance and good insulation. The plug connectors from HBM fulfil these requirements.

If special humidity protection is required, e.g. the KVM Cable Joining Sleeves (soldered and potted joints) or the VKK cable connection box (screwed connections in cast housing) can be used.

## 8 Dimensions (in mm)



Nominal force C9B	A <sub>-0.1</sub>	B	G <sub>±0.1</sub>	H	J	R	T	U <sub>-0.1</sub>	W	X	Y
0.5...20 kN	26	13	22.75	3xM2	3.5	40	1	8	9	approx. 10.5	approx. 5.5
50 kN	46	28	40	4xM4	6	80	8	16	9	approx. 10.5	approx. 5.5

## 9 Technical data

Type			C9B						
Nominal force		kN	0.5	1	2	5	10	20	50
Accuracy class			0.5						1
Nominal sensitivity	$C_{nom}$	mV/V	1						
Relative sensitivity deviation	$d_c$	%	$\leq 1$						
Effect of temperature per 10K on sensitivity in the nominal temperature range in the service temperature range	$TK_C$	%	$\leq \pm 0.5$						
		%	$\leq \pm 0.8$						
Effect of temperature per 10K on zero signal in the nominal temperature range in the service temperature range	$TK_0$	%	$\leq \pm 0.5$						$\leq \pm 1$
		%	$\leq \pm 0.8$						$\leq \pm 1$
Linearity			$\leq \pm 0.5$						
Hysteresis related to measuring range limit	U	%	$\leq \pm 0.5$						
Span in fixed mounting orientation			$\leq \pm 0.5$						
Creep at nominal load and reference temperature over 30 min	$d_{crF+E}$	%	$\leq \pm 0.2$						
Input resistance (BK-BU) at reference temperature	$R_e$	$\Omega$	$>345$						
Output resistance (RD-WH) at reference temperature	$R_a$	$\Omega$	300–400						
Insulation resistance	$R_{Is}$	G $\Omega$	$> 1$						
Service range of supply voltage	$B_{U,G}$	V	0.5...12						
Reference supply voltage	$U_{ref}$	V	5						
Reference temperature	$t_{ref}$	$^{\circ}C [^{\circ}F]$	+ 23 [+73.4]						
Nominal temperature range	$B_{t,nom}$	$^{\circ}C [^{\circ}F]$	-10...+70 [+14...+158]						
Service temperature range	$B_{t,G}$	$^{\circ}C [^{\circ}F]$	-30...+85 [-22...+185]						
Storage temperature range	$B_{t,S}$	$^{\circ}C [^{\circ}F]$	-30...+85 [-58...+185]						
Protection class to EN 60 529			IP 67						
Nominal measurement displacement $\pm 15\%$	$S_{nom}$	mm	0.04		0.06	0.09	0.11	0.13	
Natural frequency $\pm 15\%$			3.5	5	7	13	15.1	20	12
Service load	$(F_G)$	%	120						
Breaking load	$(F_B)$	%	$>400$						
Relative static side-load limit	$(F_Q)$	%	40						
Permissible vibration amplitude to DIN 50 100	$F_{rb}$	%	70						40
Weight, approx.			65						260
Safety data for explosion protected transducers in the class of intrinsically safe [(Ex) ib] with retention of the maximum safety values ( $U_{max}=23V$ ; $I_{max}=196mA$ ; $P_{max}=1,13W$ ; other values on request).									

# 10 Copy of Declaration of Conformity



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## Konformitätserklärung

## Declaration of Conformity

## Déclaration de Conformité

Document: 065/05.1996

Wir,

We,

Nous,

**Hottinger Baldwin Messtechnik GmbH, Darmstadt**

erklären in alleiniger Verantwortung, daß das Produkt

declare under our sole responsibility that the product

déclarons sous notre seule responsabilité que le produit

### **Kraftaufnehmer der Typenreihe U9B ( C9B und Sondertypen)**

auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder normativen Dokument(en) übereinstimmt (siehe Seite 2) gemäß den Bestimmungen der Richtlinie(n)

to which this declaration relates is in conformity with the following standard(s) or other normative document(s) (see page 2) following the provisions of Directive(s)

auquel se réfère cette déclaration est conforme à la (aux) norme(s) ou autre(s) document(s) normatif(s) (voir page 2) conformément aux dispositions de(s) Directive(s)

89/336/EWG - Richtlinie des Rates vom 3. Mai 1989 zur Angleichung der Rechtsvorschriften der Mitgliedsstaaten über die elektromagnetische Verträglichkeit, geändert durch 91/263/EWG, 92/31/EWG und 93/68/EWG

Die Absicherung aller produkt-spezifischen Qualitätsmerkmale erfolgt auf Basis eines von der DQS (Deutsche Gesellschaft zur Zertifizierung von Qualitätsmanagementsystemen) seit 1986 zertifizierten Qualitätsmanagementsystems nach DIN ISO 9001 (Reg.Nr. DQS-10001).  
Die Überprüfung der sicherheits-relevanten Merkmale (Elektromagnetische Verträglichkeit, Sicherheit elektrischer Betriebsmittel) führt ein von der DATech erstmals 1991 akkreditiertes Prüflaboratorium (Reg.Nr. DAT-P-006 und DAT-P-012) unabhängig im Hause HBM durch.

All product-related features are secured by a quality system in accordance with DIN ISO 9001, certified by DQS (Deutsche Gesellschaft zur Zertifizierung von Qualitätsmanagementsystemen) since 1986 (Reg. No. DQS-10001). The safety-relevant features (electromagnetic compatibility, safety of electrical apparatus) are verified at HBM by an independent testing laboratory which has been accredited by DATech in 1991 for the first time (Reg. Nos. DAT-P-006 and DAT-P-012).

Chez HBM, la détermination de tous les critères de qualité relatifs à un produit spécifique est faite sur la base d'un protocole DQS (Deutsche Gesellschaft zur Zertifizierung von Qualitätsmanagementsystemen) certifiant, depuis 1986, notre système d'assurance qualité selon DIN ISO 9001 (Reg.Nr. DQS-10001).  
De même, tous les critères de protection électrique et de compatibilité électromagnétique sont certifiés par un laboratoire d'essais indépendant et accrédité depuis 1991 (Reg.Nr. DAT-P-006 et DAT-P-012).

Darmstadt, 10.05.96

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Diese Erklärung bescheinigt die Übereinstimmung mit den genannten Richtlinien, beinhaltet jedoch keine Zusicherung von Eigenschaften.  
Die Sicherheitshinweise der mitgelieferten Produktdokumentation sind zu beachten.

This declaration certifies conformity with the Directives listed above, but is no asseveration of characteristics.  
Safety directions of the delivered product documentation have to be followed.

Cette déclaration atteste la conformité avec les directives citées mais n'assure pas un certain caractère.  
S.v.p. observez les indications de sécurité de la documentation du produit ajoutée.

Folgende Normen werden zum Nachweis der Übereinstimmung mit den Vorschriften der Richtlinie(n) eingehalten:

The following standards are fulfilled as proof of conformity with the provisions of the Directive(s):

Pour la démonstration de la conformité aux disposition de(s) Directive(s) le produit satisfait les normes:

**prEN 50082-2 : 1992****Elektromagnetische Verträglichkeit (EMV); Fachgrundnorm Störfestigkeit; Teil 2: Industriebereich; Deutsche Fassung****EN 50082-2 : 1995****Elektromagnetische Verträglichkeit (EMV); Fachgrundnorm Störfestigkeit; Teil 2: Industriebereich; Deutsche Fassung**







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