1. Introduction
The load cells of the series Type 8415 are primarily designed for force measurements in the unit N in conjunction with manufacturing facilities. When determining masses it is important to take the local acceleration of free fall \( g \approx 9.81 \text{ m/s}^2 \) into consideration.

2. Preparation for operation

2.1 Unpacking
Carefully check the sensor for damage. Should transport damage be suspected, please notify the supplier within 72 hours. The packaging must be kept for inspection by the manufacturer's representative and/or the supplier. Transportation of the Type 8415 may only be performed in the original or equivalent packaging.

2.2 Start-up
The load cell is connected exclusively to measurement amplifiers equipped with a safety transformer as specified according to VDE 0551. Even the transmitter and devices connected downstream, which are electrically connected to the sensor's signal lines, must be equipped with a safety transformer according to VDE 0551.

2.3 Grounding and isolating
All lines are isolated from the housing, however the maximum permissible voltage is 30 V. The cable shielding is not connected on the sensor-side.

2.4 Storage
The sensor must be dry-stored at 0 ... 60 °C. Dampness is not permitted. Special measures need not to be taken for commissioning after storage.

3. Operating principle
A load cell consists of a spring element which is deformed by the applied force being measured and a device which measures this deformation.

3.1 Spring element
The spring element constitutes the most important mechanical component of the load cell. It is designed to absorb the load being measured and to transfer it to an area of homogenous extension. Here the elastic properties of the spring materials are used to indirectly determine the force. In addition to these elastic properties the materials used in load cells must also meet other conditions with the result that only a few selected materials come into question for high-quality sensors. burster goes one step further and primarily uses aviational materials instead of DIN-approved materials, as these have additional quality requirements.

In the Type 8415 the spring element is designed as a horizontally positioned membrane (Fig. 1). Here the force being applied bends the membrane which manifests itself in a reduction of element's height. This deformation is so slight that it is invisible. Characteristic here is the small body compared to the nominal force, which, in conjunction with the high spring rate, ensures high resonance frequencies and thus permits rapid measurements to be performed.

Elongation or strain measurement:
The elongation of the spring's surface is measured using strain gauges, see Fig. 2. The gauges are attached to the spring of the load cell making them subject to the same deformation as the spring. As such the elongation and therewith the force can be measured as a change in electric resistance. In Type 8415 the strain gauges are attached to the inner side of the spring element.
**4. Installation instructions**

**4.1 Mechanics**

**Force application**

The way force is applied is of primary importance to the quality of measurement. This must be carried out so that the force's line of application coincides exactly with the geometric axis of the load cell (centric load). It is also of great importance that no side forces and torques are applied to the load cell.

Side forces mainly arise due to excentric load, slanted or oblique force application and as a result of friction arising from rotating parts. Friction arises on the surfaces which are not hardened enough or whose quality is insufficient.

- The parts where force is being applied must be even (not convex), ground and as lapped as possible. The working material must be fully hardened (not just surface hardened) and demonstrate at least 60 HRC.
- There are no bore holes in the part where force is being applied, also no central bore hole is permitted for the lathes.

**Regarding the function of the strain gauges (foils):**

The resistance of a wire rises with increasing length and decreasing cross-section. If you pull on a wire, it becomes thinner and longer. As a result its electrical resistance increases. The function of strain gauges is based on this principle.

In practice strain gauges do not consist of a round wire, but a metal foil, which is laminated onto the carrier material. From this metal foil the meander-shaped resistance structure is etched out. Special techniques are used to attach this foil to the surface of the spring element.

**3.2 Connection**

To reduce the effect of undesired variables the four strain gauges in the load cell Type 8415 are connected into a bridge configuration (Wheatstone bridge), see Fig. 3.

The illustration shows the connection in simplified form. In addition to the strain gauges there are also compensation resistors built-in to reduce temperature effects. Furthermore, depending on the design of the sensor, additional resistors can be integrated for the output standardization of the sensor in the cable or plug.

The output voltage $U_{out}$ of the sensor is computed as follows: $U_{a} = c \cdot U_{b}$

Where $U_{a}$ is the operating voltage and $c$ is the nominal characteristic value of the sensor. The nominal characteristic value $c$ of the sensor can be taken from the calibration certificate and is fixed at $c = 1.2 \text{ mV/V}$. In conjunction with operating voltages $U_{b} = 2.5 \ldots 5 \text{ V}$ you typically obtain output voltages of $U_{out} = 3.0 \ldots 6.0 \text{ mV}$. 

![Fig. 1: Horizontally positioned membrane](image1)

![Fig. 2: Strain gauge foil](image2)

![Fig. 3: Strain gauge full-bridge](image3)
Mounting surface
The structure of the mounting surface is just as important for the quality of measurement attainable. For clarification: Depending on the measuring range the measurement path of the spring of force sensor 8415 lies in the range from approx. 30 µm up to 60 µm for full deflection. This also means that a modulation of 1% of the nominal force corresponds to a measuring path of 0.3 µm up to 0.6 µm.
It is very important that the sensor lies flush with its contact surface on the underlying object to avoid any undesired deformations of the housing. To rule out any distorting deformations of the underlying object, the object must be sufficiently stable and full hardened (not just surface hardened).
- The sensor must be mounted with its entire surface on a fully hardened (60 HRC), ground, as lapped as possible, non-laquered underlying object.
- Surface quality: N 3 (Rz 1), flatness: 2 µm
- There are no bore holes or machined pockets permissible in the surface of the underlying object.

Overload
Elastic membranes are relatively sensitive to overload. Damage to the sensor element resulting from overload is recognized by an increased output signal without load. The sensor should be inspected starting at approx. 5 % signal increase of the zero point.
- Due to the small deflection path it is virtually impossible to provide overload protection using a path stop directly on the sensor. In many cases the sensor can be placed on a spring with a guided underlying object. This increases the measuring path by the amount of the spring path and makes it easy to implement path limiting for slow loading processes.
- When loading is performed with hydraulic or pneumatic cylinders these can be equipped with pressure limiters.
- Do not apply abrupt loads. The high spring rate of the sensor leads to short "braking paths" of masses in motion, resulting in the generation of very high force levels.

Cables
Parameter defining components have been integrated into the cable or plug. For that reason the cable cannot be shortened arbitrarily without reinstalling these components. The cables need to be laid out so that as little vibration as possible arises.
The cable is equipped with a TPE sheath. Do not exceed bending radii > 10 mm. The cable sheath might also develop leakage if exposed to heavy vibration over time. If this occurs the sensor can be damaged from penetrating fluid coming from the capillary effect (e.g. deposits of oil mist). Special measures must be taken the presence of vapours or fluids. Furthermore the cable may not be exposed to any tensile loads.

4.2 Attachment
In general
THE LOAD CELL MAY NOT UNDER ANY CIRCUMSTANCES BE SUBJECT TO LATERTAL TENSION OR BE PRESSSED INTO BORE HOLES.

Screws
The load cell is operated in the compression direction, for that reason fastening screws play a subordinate role. They are merely used to attach the sensor.

Clamping
The sensor can be installed so that it is held in place using pre- or basic tension, produced, for example, by a spring. This method guarantees that there is a constantly equal loading point on the sensor thus minimizing the problems of non-reproducible measurement results.

4.3 Electrical features
The output signal of the Type 8415 typically amounts to 3.0 ... 6.0 mV under full load. If you wish to measure precisely to 1 % you must obtain a resolution greater than approx. 10 µV. To accomplish this it is necessary to prevent any corresponding disturbances which these low signals produce from affecting the sensor, the sensors lines and the measuring instrument.
For that reason if it is at all possible avoid placing the load cell and the measuring instrument in the vicinity of powerful switching stations or gears. (Examples: transformers, motors, contactors, frequency converters). The electromagnetic fields could unabatedly affect the measuring instrument and load cell and thus lead to falsified measurement results. The measuring leads may not be laid in parallel to power carrying lines because inductive as well as capacitive disturbances could get coupled into the measuring lines.

In some cases it has proven useful to pull an added screen over the measuring cable to give added protection or to lay the cable in a metal tube or pipe.

5. Calibration of the measuring system

An existing measuring configuration comprising load cell and measurement amplifier can be calibrated using various methods. Using methods 5.2 or 5.3 only the measurement amplifier is calibrated, that means only errors in the sensor are tracked. If the corresponding equipment as stated under 5.1 is not available the load cell or the measuring configuration can be calibrated in the factory.

5.1 With physical variables

Function
The load cell is fed with known physical variables.

Example: A scale or balancing device consisting of a load cell and an indicating instrument is relieved of load and the zero point adjusted. Then a known reference value is placed on the device and the final value is set. Works calibrating certification for the load cell or the entire measuring configuration can be performed on request - also for recalibrations - in the factory on weight measuring systems. For direct contact Mr. H. J. Legat +49-7224-64557 or Mr. H. Bok +49-7224-64545

5.2 With strain gauge simulator

Function
By the strain gauge simulator we mean a substitute bridge circuit comprising precision resistors, which is able to assume various output states. The strain gauge simulator is connected to the measurement amplifier instead of the sensor (e.g. with burster simulator Type 9405).

5.3 With precision voltage source

Function
The sensor is simulated using a precision voltage source (e.g. burster DIGISTANT® Type 4405, 4422), which is connected to the measuring amplifier.

Note: Please bear in mind that in strain gauge full-bridge sensors the feed voltage enters the measurement result. It is possible that the actual feed voltage slightly deviates from the nominal feed voltage. If you would like to verify the functionality of the measurement amplifier using voltage sources, you must measure the sensor excitation voltage with a precision digital voltmeter and then calculate the calibration voltage.

5.4 Shunt calibration

Function
During shunt calibration a precision resistor (calibration shunt) is connected between (-) signal input and (-) excitation. This tunes the bridge so that for a certain degree of elongation it corresponds to a certain load of the sensor. This defined bridge tuning brings about a defined step change of the output signal with which the entire measurement configuration is calibrated. The amplitude of the output signal’s step change and the value of the corresponding calibration shunt are specified in the calibration certificate of the sensor.

This method only tests the sensor’s electrical function, its properties in a measurement circuit have not yet been verified.

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