

# Load Cell for Manually Operated Presses

## Model 8451

<b>1. Introduction .....</b>	<b>2</b>
<b>2. Preparing for use.....</b>	<b>2</b>
2.1 Unpacking.....	2
2.2 Using the instrument for the first time.....	2
2.3 Grounding and potential connection.....	2
2.4 Storage .....	3
<b>3. Principle of operation .....</b>	<b>3</b>
3.1 Spring element .....	3
3.2 Mechanical design.....	4
3.3 Function of the strain gauge .....	5
3.4 Strain gauge wiring.....	5
3.5 Deflection full scale.....	6
3.6 External forces.....	7
3.7 Overload protection .....	7
<b>4. Installation .....</b>	<b>7</b>
4.1 Surrounding mechanical parts and fastening .....	7
4.1.1 Adaptation.....	7
4.1.2 Mounting.....	8
4.2 Electrical system, evaluation instrumentation.....	8
<b>5. Measuring chain adjustment.....</b>	<b>9</b>
5.1 Using the data of the test and calibration report.....	10
5.2 Using calibration offset (shunt calibration).....	10
5.3 Using a physical magnitude.....	10
5.4 Using a strain gauge simulator .....	11
5.5 Using a precision voltage source.....	11
<b>6. Note .....</b>	<b>12</b>

# 1. Introduction

The load cells in the model 8451 series are primarily designed for the measurement of force in production equipment, using Newtons (N) as the unit of measurement.

The local gravitational acceleration ( $g \approx 9.81 \text{ m/s}^2$ ) must be taken into account when determining masses.

## 2. Preparing for use

### 2.1 Unpacking

- Inspect the sensor carefully for damage.

If you suspect that the unit has been damaged during shipping, notify the delivery company within 72 hours. Keep all packaging materials for inspection by the representative of the manufacturer or delivery company.

- Only transport the model 8451 sensors in their original packaging or in packaging of equivalent quality.

### 2.2 Using the instrument for the first time

- Only connect the sensor to instrumentation amplifiers that are fitted with a safety transformer according to EN 61558.

#### **Note:**

Transmitters connected to the outputs or other devices that are galvanically connected to the sensor's signal lines must also be fitted with safety transformers according to EN 61558.

### 2.3 Grounding and potential connection

All connecting wires (including the cable screening braid) are electrically insulated from the sensor body.

The insulation resistance between the connecting wires and the sensor body is measured.

The test certificate states that the minimum resistance is greater than  $10 \text{ M}\Omega$  (test voltage 45 V).

## **2.4 Storage**

- The sensor must be stored under the following conditions only:
  - dry
  - no condensation
  - temperature between 0 °C and 60 °C

### **Note:**

Provided the storage conditions have been observed, no special steps need to be taken after storage and prior to commissioning.

## **3. Principle of operation**

The sensor operates with the aid of a spring element. The force to be measured deforms the spring element elastically.

This deformation is transformed into an electrical signal by strain gauges. They, together with the spring element, constitute the measuring element of the sensor.

### **3.1 Spring element**

The spring element is the most important mechanical part of a load cell. Its purpose is to take the force being measured and convert it into a linear extension. It relies on the elastic properties of the material in order to determine the force indirectly.

The materials of which load cells are made must satisfy other conditions in addition to their elastic properties. As a result, only a small number of carefully selected materials come into question for high-quality load cells.

burster is going one step further than this, using mainly materials from the aeronautical industry that satisfy additional quality requirements in the place of DIN materials.

## 3.2 Mechanical design

### Measurement ranges smaller than 0...2 kN

In the sensors with measurement ranges smaller than 0...2 kN a horizontally mounted elastic membrane is used as the spring element.

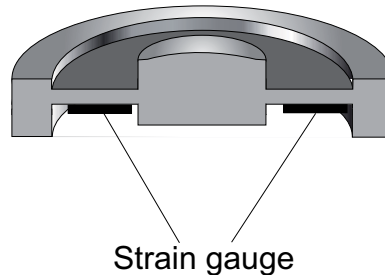


Figure 1: principle of a horizontally mounted membrane

This elastic membrane is deflected by the applied force, resulting in a reduction in the sensor's overall height. This deformation cannot be seen by the naked eye. It is measured by strain gauges. In these sensors the strain gauges are mounted on the underside of the spring element. This ensures that they are subject to the same deformation as the spring element.

### Measurement ranges greater than 0...2 kN

The spring element in the sensors with measurement range greater than 0...2 kN is implemented as a hollow compression body.

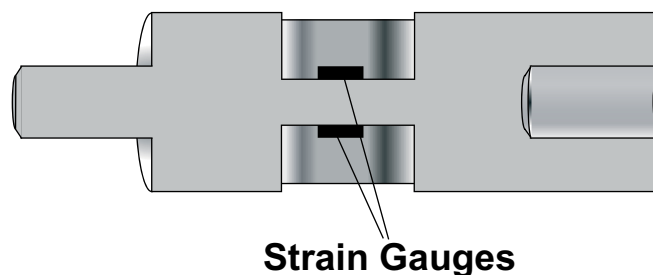


Figure 2: principle of the 8451 compression body

A key feature of this sensor is its relatively compact design for its rated force. The combination of compact size and high spring constant ensures a high resonant frequency, allowing this sensor to make rapid measurements.

### 3.3 Function of the strain gauge

The electrical resistance of a wire rises with increasing length and falling cross-section. When a wire is pulled, it becomes thinner and longer – both of these effects result in an increase in its electrical resistance.

This is the principle on which the function of strain gauges is based. In practice, however, strain gauges do not consist of a single wire, but of a metal foil laminated onto a carrier material. The metal foil is etched to create a meandering structure (see Figure 3:).

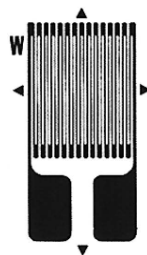


Figure 3: Foil strain gauge

Special techniques are used to mount strain gauges manufactured in this way onto the surface of the spring element.

### 3.4 Strain gauge wiring

In order to reduce undesirable influences on the measurement, the strain gauges in the 8451 sensors are connected as a Wheatstone bridge. Figure 4: illustrates this wiring in a simplified form.

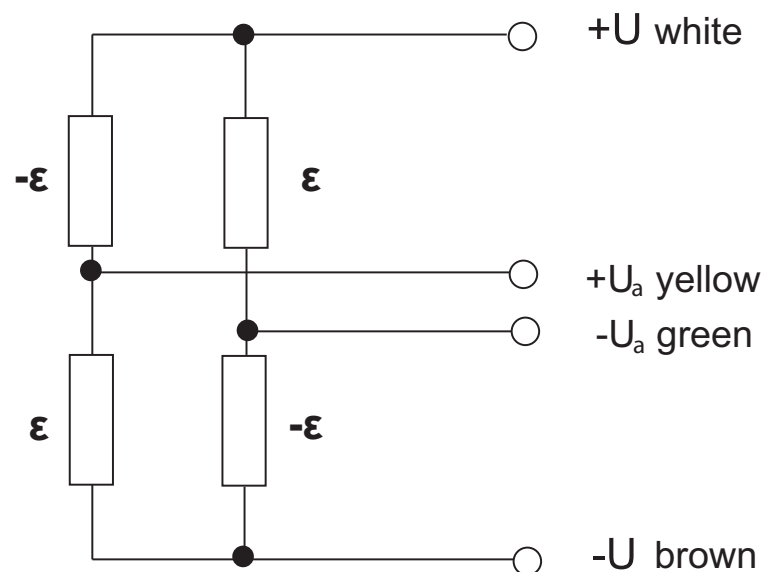


Figure 4: Strain gauge full-bridge

In addition to the four strain gauges shown here, compensation resistors to reduce the effect of temperature and balancing resistors to balance the bridge circuit are also incorporated.

Depending on the sensor model, further resistors for the purpose of standardizing the rated characteristic are integrated into the cable or the connector.

The output voltage of the sensor at maximum load,  $U_a$ , is calculated as follows:

$$U_a = c \times U_b$$

- $U_b$ : excitation voltage
- $c$ : characteristic value (sensitivity) of the sensor.

The sensitivity parameter "c" can be found in the test report. It is in the range between approx. 0.35 and approx. 1.5 mV/V.

If excitation voltages ( $U_b$ ) in the range of approx. 5 mV DC are used, 0...100 % loading of the sensor yields output voltages ( $U_a$ ) between 0 and 6 mV.

## **3.5 Deflection full scale**

### **Measurement ranges of 0...2 kN or smaller**

For sensors with diaphragm, the load lowers the middle of the measuring element. This deformation, known as the deflection full scale, is so small that it cannot be seen with the naked eye. For sensors of the measurement range 0...2 kN or smaller it can range from 30 up to 50  $\mu\text{m}$  at max. load, dependent on the sensor's measurement range. The deflection is directly proportional to the load.

### **Measurement ranges greater than 0...2 kN**

For sensors with a compression body, the load compresses the measuring element, changing the overall height of the sensor. This deformation, known as the rated measurement travel, is so small that it cannot be seen with the naked eye. It can range from 10 and up to 20  $\mu\text{m}$  at max. load and is directly proportional to the load.

## 3.6 External forces



### **CAUTION!**

**Sensor will be damaged!**

**Avoid vibrations, even if the loads caused by these vibrations are less than the rated maximum. Design your measuring system in such a way as to prevent these external forces.**

#### **Note:**

External forces, acting on the sensor, adulterate the result materially.

External forces here refer to any force that acts outside the sensor's axis of symmetry - transverse forces, bending moments and twisting moments in particular.

## 3.7 Overload protection

Sensors with measuring ranges up to and including 0 ... 2 kN have overload protection up to five times their rated load. Those sensors with higher measuring ranges ( $\geq 0 \dots 5$  kN), however, only have overload protection up to 1.5 times their rated load. The data sheet contains the precise values.

## 4. Installation

### 4.1 Surrounding mechanical parts and fastening

#### 4.1.1 Adaptation

Sensors of type 8451 have a peg on their top face with a 10 e7 or 20 e7 fit (measuring ranges  $\geq 0 \dots 50$  kN). You can use this peg to fit the sensor in one of the standard commercial presses, either a manually operated lever press or a pneumatically driven press.

The sensor underside contains a hole of fit 10 H7 or 20 H7. This is used to hold the tool (centers and fixes it in place).

The sensor peg has two flat faces, allowing for two different orientations when fitting the sensor. This means that you can fit the sensor on presses designed for left-handed or right-handed operators without the sensor cable getting in the way. Unlike other sensors, the 8451 sensor can be fitted without any extra mechanical parts for guiding forces onto the sensor axis.

### **4.1.2 Mounting**

It is important to ensure when fitting the 8451 sensor that the force will be applied axially to the sensor. This is essential to measurement accuracy and sensor operating life.

- Insert the peg of the sensor into the press tool holder at far as it will go.

The circular contact surfaces of the sensor must fit tight against the tool holder. Only then is the force path guaranteed to be homogeneous.

- Orientate the sensor so that it faces the correct way for right-handed or left-handed operation.

The sensor has two flat faces on opposite sides of the peg for this purpose.

- Now use the clamping screw to fix the sensor in the press tool holder.
- Let the sensor cable run loosely with enough play and arranged in the shape of a gooseneck.

The cable must not be under tension or bending strain.

- Now insert the tool into the hole in the underside of the sensor.

The tool must fit tight against the circular contact surface of the sensor. Otherwise it is not possible to measure any forces. This means that the maximum length of the tool punch must not exceed the hole length, i.e. must not exceed the sensor peg length, which is designed to be the same length as the hole.

- Fix the tool in the sensor using the clamping screw.

Once you have fixed the tool in place, the 8451 is fully fitted.



## 4.2 Electrical system, evaluation instrumentation



### **CAUTION!**

If the cable sheath is damaged, fluids can penetrate and damage the sensor.

For this reason:

Take suitable precautions to relieve the bending stress exerted by the connecting cable on the cable bushing at the sensor housing. In particular, pulsating or alternating loads acting on this bushing will damage it and hence the cable will come loose.

Make sure that you lay the cables with sufficiently large bend radii.

Avoid vibration on the cables.

Protect the cables from strain.

Protect the sensor from vapors and liquids.

The output signal of the 8451 normally lies between 0 and 6 mV. Hence for a measurement accuracy of 1 % you will need a resolution of approx. 20  $\mu$ V or better. Hence the sensor, cables and measurement electronics, will pick up interference.

### **The following points apply to the sensor's electrical connection:**

- Locate the sensor, the cable and the measuring instrument outside the fields of high-energy equipment.  
This includes transformers, motors, contactors, frequency converters and so forth. Otherwise the electromagnetic fields from such equipment will act with their full effect on the measuring chain, causing incorrect measurements.
- Lay the measuring lines separately from high-power cables.  
If the measuring lines are laid parallel to such cables, interference will be coupled in inductively and capacitatively.

In some cases it will be helpful to place an extra shield as additional protection over the measuring cable, or to lay it in a metal tube or pipe.

## 5. Measuring chain adjustment

The sensors of the model 8451 are calibrated ex works. Because of this, every sensor has an individual test and calibration report.

However, you basically have to align every following electronic to the particular sensor. After this adjustment you have done a basic adjustment of the measuring chain.

### 5.1 Using the data of the test and calibration report

Depending on the type of the following electronic, you are able to insert the data of test and calibration report directly or you have to use strain gauge simulator or a shunt resistor. With the help of this strain gauge simulator or a shunt resistor you are able to pretend the electric values to the electronic.

### 5.2 Using calibration offset (shunt calibration)

#### Function

During shunt adjustment, a precision resistor (the calibration shunt) is connected between the negative pin of the signal input and the negative pin of the reference supply voltage. The imbalance thus created in the bridge circuit corresponds to a specific change in length, i.e. to a particular load applied to the load cell. An offset, defined in this way, appears at the same time in the output signal, and can be used to adjust the entire measurement chain. The magnitude of the change in the output signal, and the value of the associated calibration shunt, can be found in the sensor's test certificate.

### 5.3 Using a physical magnitude

#### Function

The sensor is subjected to a known physical magnitude. In this way, the calibration is carried out over the entire measuring chain, consisting of the sensor and display device or amplifier.

## **Adjustment**

- Remove any load from the sensor.
- Adjust the zero.
- Load the sensor with a known reference weight.
- Adjust the reference scale value.

If desired, we can prepare factory calibration or recalibration certificates for the sensor or for the entire measuring chain.

These measurements are carried out at the factory on measurement installations.

## **5.4 Using a strain gauge simulator**

### **Function**

A strain gauge simulator is a bridge simulation circuit, built from precision resistors, which can be put into various output states. The strain gauge simulator (e.g. the burster strain gauge simulator model 9405) is connected to the instrumentation amplifier instead of the sensor.

## **5.5 Using a precision voltage source**

### **Note:**

The supply voltage of full-bridge strain gauge sensors affects the result of the measurement. It is possible that the actual supply voltage will vary slightly from the rated supply voltage. If you want to verify the proper function of the instrumentation amplifier using a voltage source, you must measure the sensor supply voltage with a precision digital voltmeter, and then calculate the calibration voltage.

### **Function**

The sensor is simulated by a precision voltage source (e.g. the burster DIGISTANT<sup>®</sup> model 4411 or 4423), which you connect to the instrumentation amplifier.

## **6. Note**

### Exclusion of warranty liability for operating manuals

All information in the present documentation was prepared and compiled with great care and reproduced subject to effective control measures. No warranty is provided for freedom from errors. We reserve the right to make technical changes. The present information as well as the corresponding technical data can change without notice. Reproduction of any part of this documentation or its processing or revision using electronic systems is prohibited without the manufacturer's prior written approval.

Components, devices and measured value sensors made by burster praezisionsmesstechnik (hereinafter referred to as "product") are the results of targeted development and meticulous research. As of the date of delivery, burster provides a warranty for the proper condition and functioning of these products covering material and production defects for the period specified in the warranty document accompanying the product. However, burster excludes guarantee or warranty obligations as well as any liability beyond that for consequential damages caused by improper use of the product, in particular the implied warranty of success in the market as well as the suitability of the product for a particular purpose. Furthermore, burster assumes no liability for direct, indirect or incidental damages as well as consequential or other damages arising from the provision and use of the present documentation.

834-008451EN-5170-071518