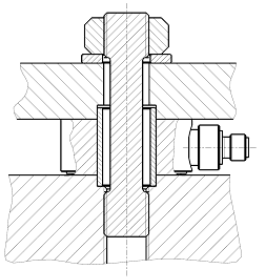
5 rules for installation and mounting of piezoelectric force transducers

Piezoelectric force transducers offer numerous advantages for applications in the industrial environment:

- Piezoelectric transducers are extraordinarily compact
- Piezoelectric measurement chains, when appropriately laid out, evidence extremely high overload capacity and negligible displacement
- This results in high rigidity and therefore excellent dynamic properties.

1. Is an initial stress required?



HBM has two different piezoelectric force transducer designs available:

The **CFW force washers** and the **CFT force transducers**.

The **CFT force transducers** are calibrated and are delivered with test certificates. As these **force transducers** are already pre-stressed internally, they are suitable for immediate application. Renewed calibration of the measurement chain is not necessary.

The **CFW force washers** are significantly flatter in design and are not pre-stressed. Pre-stressing is required when mounting.

These transducers must be calibrated when in a mounting condition.

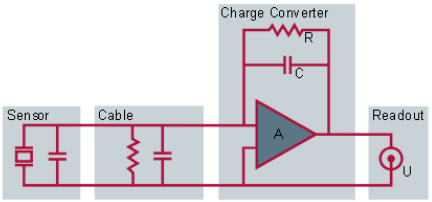
The **pre-stressing of the force washer** is necessary to ensure the linearity and structural durability of the transducer.

This **pre-stressing** means that another mechanical element is mounted parallel to the force transducer.

We recommend that the force washer is **pre-stressed to at least 10% of its nominal (rated) force**. The force washer itself can be used to determine the initial stress.

A part of the measuring force is now **shunted through the pre-stressing element**. Pre-stress and force shunt are determined by the installation situation. It is therefore necessary to calibrate the force washers after mounting is complete, i.e. to compare the output signal of the transducer with a known force. The **accuracy of the measurement results** depends here mainly on the accuracy of the calibration.

2. Increase the quality of your output signal



Block diagram of a charge amplifier

The **charge output** by a piezoelectric transducer is converted into a directly proportional voltage by means of a charge amplifier.

Piezoelectric sensors are ideally suited for **dynamic, i.e. non-zero point-related measurements**. The drift generated by piezoelectric measurement chains is so low that it does not affect accuracy even with high requirements.

The drift is an effect of the **charge amplifier**. The transducers themselves do not display drift if mounting and connection are implemented correctly. The **maximum drift** of a measurement chain is 0.1 pC/s or 25 mN/s if quartz is used as sensor material and 13 mN/s for the sensor material gallium phosphate.

In order to achieve a lower drift, please note the following two points:

1. Running-in behavior of the charge amplifier

The charge amplifier should run in at least a hour before measurements start.

2. Cleanliness of the connections

If the **insulation resistance** of the cable between transducer and charge amplifier is too low, the measurement chain will drift as charge will discharge via the too low insulation resistance. In order to keep the piezoelectric measurement chain drift low, all plugs and sockets must be kept clean at all times.

Please ensure that you **do not touch open contact surfaces** with the hand as this reduces the required insulation resistance.

We also recommend that **protective caps** (scope of delivery) should be left on the sockets of the sensors and charge amplifiers until the sensor or charge amplifier is connected. When the connections are disconnected, the protective caps should be screwed back on again.

Piezoelectric transducers must be connected with a charge amplifier with a high quality coaxial cable, HBM offers the cable 1-KAB143/3 for this purpose. Such a cable cannot be repaired, it must be **replaced if damaged**.

If the measurement chain is always operated with a connected cable and the sensors always stored with protective caps, then contaminated contact surfaces do not generally occur.

3. Clean contaminated sockets

If however, despite all care, sockets are contaminated, they can be cleaned as follows:

- First of all, unscrew the socket
- Dry wipe the white surfaces of the socket with a cleaning pad (e.g. HBM Order number 1-8402.0026)
- Spray the socket with pure isopropanol (e.g.: IPA200 from RS Components)
- Clean again with a new cleaning pad

The cable plugs cannot be cleaned, i.e. if the cable is contaminated , it must be replaced.

The cleaning agent RMS1, which is used for cleaning strain gauge installation points, is not suitable for cleaning piezoelectric sensors.

4. Optimize the environment for the force measurement

Influence of transducer temperature on the characteristic curve:

The **influence of temperature** on the sensitivity of the transducer is very low with 0.2% / 10K and is negligible for most applications.

Temperature changes lead to **thermal stresses**. In addition, the E modulus of the pre-stressing elements is temperature dependent.

It is important that the output signal only changes in the case of a temperature modification. In stationary states, a charge is not generated and there is no influence of the temperature changes on the measurement.

The temperature effects can be minimized if it is ensured that

- The transducer is stored for sufficient time at the application temperature
- The transducer is not touched shortly before measurement as hand heat can warm up the sensors unevenly
- A reset is implemented after every measurement cycle.

The **influence of drift and temperature changes** are extremely low, particularly with measurement times up into the minute range and larger forces, and therefore do not lead to relevant inaccuracies in measurement.

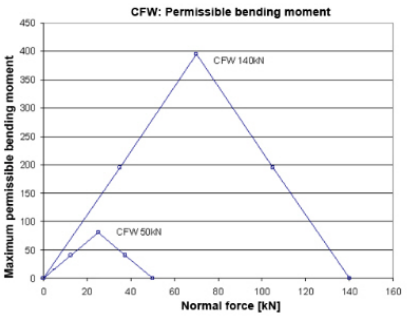
5. Note the load limits

In **piezoelectric force transducers**, the crystal lies in the direct force flow. The measuring elements (quartz or GaPO4) are designed for each transducer at the maximum occurring normal force.

Applied **bending moments** can lead to a overload of the transducer as the crystal is more strongly loaded on one side and, in contrast, the load is relieved on the other side.

The maximum mechanical stress is calculated from the addition of the stresses caused by the bending moment in the **crystal and the load stresses** of the axial forces to be measured. The maximum permitted surface pressure must not be exceeded under any circumstances.

As the **output signal** is not dependent on the nominal (rated) force of the sensor in piezoelectric transducers, it is possible to select transducers with a higher nominal force in order to avoid an overload in such cases. The following diagram shows the maximum permissible bending moment, dependent on the process force. The highest permissible bending moment can be accepted by the force washer with 50% load stress.



If the bending moment is generated by a force from the side, a lateral force is also produced reducing the maximum values.

The measurement error caused by the bending moment is low, as the higher material stresses on the one side of the crystal are compensated for by the lower stress on the other side.

If a piezoelectric force washer (1-CFW/50kN) is loaded with a bending moment of 100 Nm, this produces an output signal of -2.3N. Please note the maximum lateral force as per data sheet.