PiezoClamping®

Prestress and Charge Meter for Piezoceramics

For assembling converters and bolt-clamped transducers with optimal prestress.


PiezoClamping® is an innovation for direct measurement of prestress in piezoceramics. It is practical, accurate and immune to the variations undermining traditional control methods by torque and charge measurement.

How it works

Simply connect the PiezoClamping®, entry the ceramics' parameters and tighten the transducer bolt until reach the target prestress. The tightening can be applied slowly and with pauses without affecting the result.

Unlike the tightening torque, prestress does not depend on the dimensions and quantity of ceramics, bolt type, threads finishing and lubrication.

Features
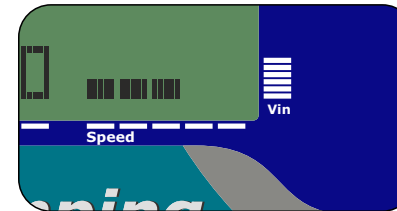
Speed control.
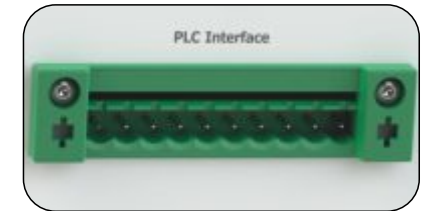
Automation interface.

Technical specifications

Prestress:	From 0.1 to 99.9 MPa
Electrical charge:	From 0.1 to 999.9 μC
Precision:	±1%
Number of piezoceramics:	From 1 to 8 units

PiezoClamping®:

- **Prevents damages and standardizes the prestress.**
- **Calibratable with traceability to SI units.**


WORLDWIDE 2 YEARS WARRANTY

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Prestress technology for ultrasonic transducers and converters

Prestress is the mean static stress in the piezos and is equal to the bolt traction force divided by the rings' cross-section area. Prestressing aims to maximize simultaneously the maximum power and effective contact area between the transducers' elements, besides avoiding displacements during operation.

The optimum prestress depends on the piezoelectric material compression strength and static pressure distribution on the rings, typical values are 45 MPa for the PZT-8 and 35 MPa for PZT-4. Unlike prestress, the torque is proportional to the piezos cross-section area and highly sensitive to the bolt dimensions and friction coefficients.

Prestress is critical and determinant for lifespan, maximum operating power and efficiency of transducers and converters. Prestress in excess changes the piezoelectric material properties and may cause crushing, while insufficient prestress allows lateral displacement of the ceramics in high power, leading to cracks, electric arcs and short-circuits.
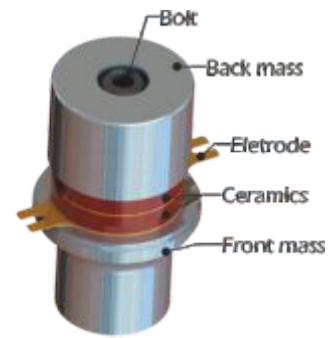
Ultrasonic welding converter: Typical example of Langevin-type power ultrassonic transducer

Prestress control and application

Prestress control has been limited to torque control or by electrical charge storage, without due concern for the prestress absolute value in pressure unit (MPa or ksi).

Prestress control based on torque is practical. However, it is indirect and inaccurate because the prestress and torque correlation depends on friction coefficients, which varies greatly with surface finishing, cleanness and lubrification. For example, if the bolt gets stuck because issues of issues on threads, the prestress will be much lower than expected, despite of the target torque was reached.

The control by the electric charge generated on the ceramics is a direct measurement, although it is also of low accuracy because the charge is consumed by the voltmeter, which makes the measurement dependent on the speed of prestress application. In addition, the measured value is an electric voltage proportional to the force on the rings, demanding calculations to determine the prestress.

PiezoClamping® employs a novel technology in which the prestress is measured during the tightening process accurately [1], steadily and free of the variations that undermine the accuracy of control methods by torque and charge measurement using a capacitor and a voltmeter.

Optimum prestress provides higher power and extends lifespan.

The excess of prestress changes the piezo material properties and may cause crushing.

The lack of prestress allows ceramics displacements, resulting in cracks, electric arc and short-circuit.

Optimum prestress application using PiezoClamping®

❶ Assemble the transducer parts and configure the PiezoClamping®:

Number of ceramics:

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Number of piezos
2
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Dimensions:

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Piezo diam. (mm)
OD 38.0 ID 15.0
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Charge constant:

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d33
245 pC/N
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❷ Tighten until reach the target prestress (full bargraph):

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Real-time prestress:

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16.0 MPa
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Notes: To assemble the transducer, ensure that interfaces, threads and all parts are clean, dry and non-lubricated (only the bolt head seat can be lubricated to reduce the torque required to achieve the target prestress). PiezoClamping® must be set for the target prestress, number and specific characteristics of the piezoceramics. To protect the bolt whether it gets stuck, use a click torque wrench with the torque set to 120% of the typical torque required to achieve the target prestress. To increase stability and reduce prestress relaxation over time and use, tighten and untighten the transducer a few times before the final tightening. PiezoClamping® can also measure the retained prestress by transducer simply loosening the bolt with the PiezoClamping® connected and properly configured.

[1] H. Alves. Instrument for measuring prestress in piezoceramics during bolt-clamped Langevin-type transducers preloading. Proceedings 49th Annual UIA Symposium, 2021.

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