TRZ®

Ultrasonic Transducer and Horn Analyzer

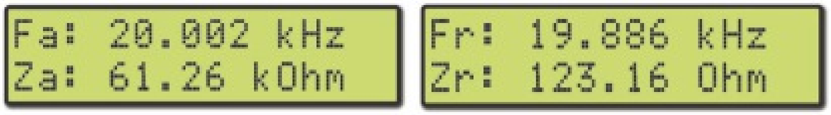
For testing and tuning power ultrasonic transducers, converters, boosters, horns and stacks.

WORLDWIDE 2 YEARS WARRANTY

TRZ® Analyzer is the key instrument for effective manufacturing, quality control and maintenance of power ultrasonic transducers, converters, boosters, horns and acoustic stacks.

How it works

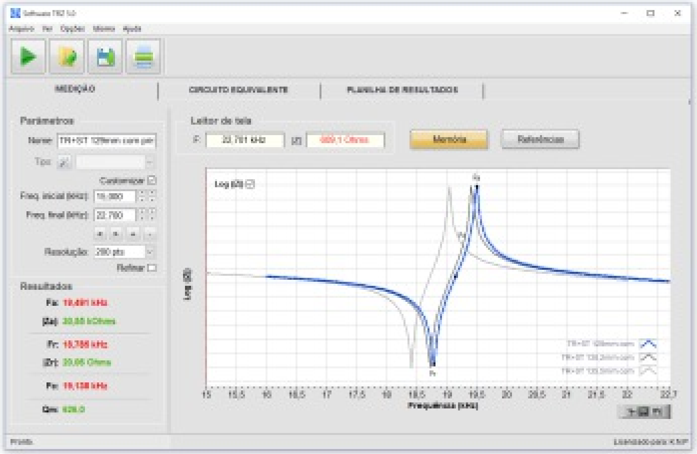
TRZ® determines the resonance and antiresonance frequencies and impedances of the device under test. See the last page for information on how to use these results.



Result of a 20 kHz welding converter test.

Software TRZ®

TRZ® Analyzer includes the TRZ® Software, which makes the tuning process easier, calculates the mechanical quality factor and determines the BVD equivalent circuit. The Software also applies acceptance criteria, generate test report, save and compare results.



Curves of a ultrasonic horn along the tuning process.

The TRZ® Analyzer provides:

- ***Maintenance and manufacturing cost reduction.***
- ***Traceability to the International System of Units.***

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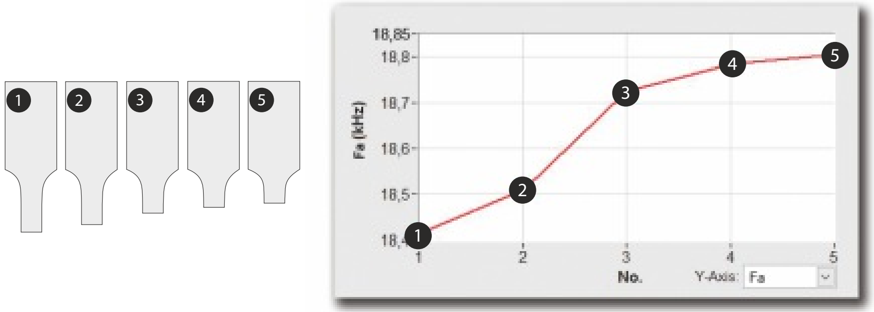
Follow the tuning process with graphics

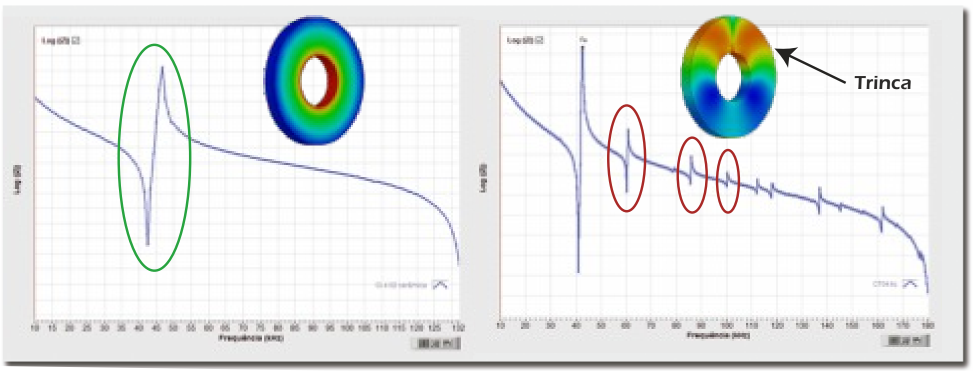


TRZ® Software allows the step-by-step monitoring of frequency and other parameters variation along the machining process, as well as a function of time and temperature.

Piezo ceramics testing for cracks detection

By using the "PiezoHolder" accessory, it is possible to test piezoelectric ceramics for internal cracks detection, perform the quality control of new ceramics and reuse recovered ones with reliability.

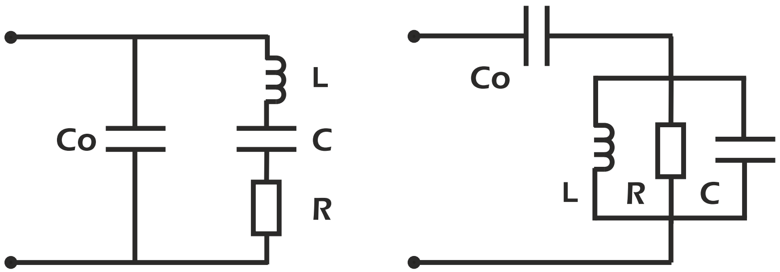
"PiezoHolder"



Measurements showing the pattern of a ceramic with no cracks (left graph) and of one with an internal crack (right graph). The presence of cracks is easily identifiable by additional resonances.

Calculate the equivalent circuit and the quality factor

The TRZ® Software is able to calculate the Butterworth-Van Dyke (BVD) series and parallel equivalent circuit of the device under test, and from this o fator de qualidade Q.



Series and parallel configurations of the Butterworth-Van Dyke equivalent circuit.

Technical specifications:

Frequency range:	1 - 200 kHz with 1 Hz resolution
Frequency uncertainty:	± 0.05 % @ 25 °C
Impedance range:	0.1 Ω – 999.9 kΩ
Impedance uncertainty:	± 3 % @ 20 kHz within the range 0.1 Ω - 10 kΩ
Memory:	01 (last measurement)
Dimensions and weight:	26 x 25 x 10 cm / 3.8 kg

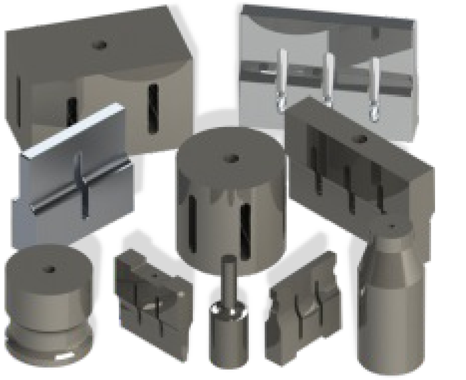
The TRZ® Analyzer calibration and functional test may be easily performed by using the "TRZ® Calibration Kit". This accessory is especially interesting for critical applications, eg. for the quality control of medical equipment. The "TRZ® Calibration Kit" consists of a 10 kΩ precision resistor and a standard 100 kHz resonator.

"TRZ® Calibration Kit"

Basic information for tuning and maintaining ultrasonic horns

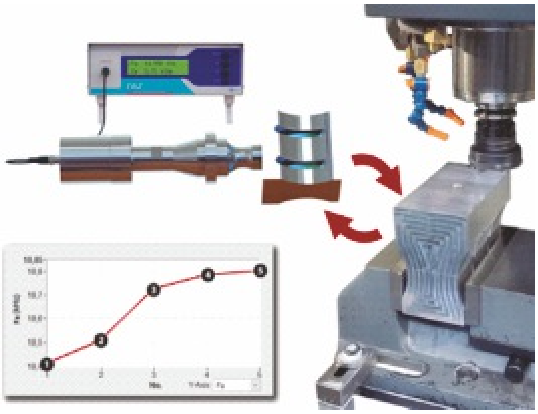
Tuning of ultrasonic horns, sonotrodes and similar parts is required to compensate for frequency deviations caused by wear, machining tolerances and variations in material properties. The typical tolerance for horn frequency is ± 0.25%, which is equivalent to ± 50 Hz at 20 kHz.

For welding machines, the horn frequency must be compatible with the booster and converter for the acoustic stack to vibrate efficiently and also to match with replacement parts. These requirements also apply to medical and dental equipment (scalpels, tweezers and scalers), polishing and grinding equipment.

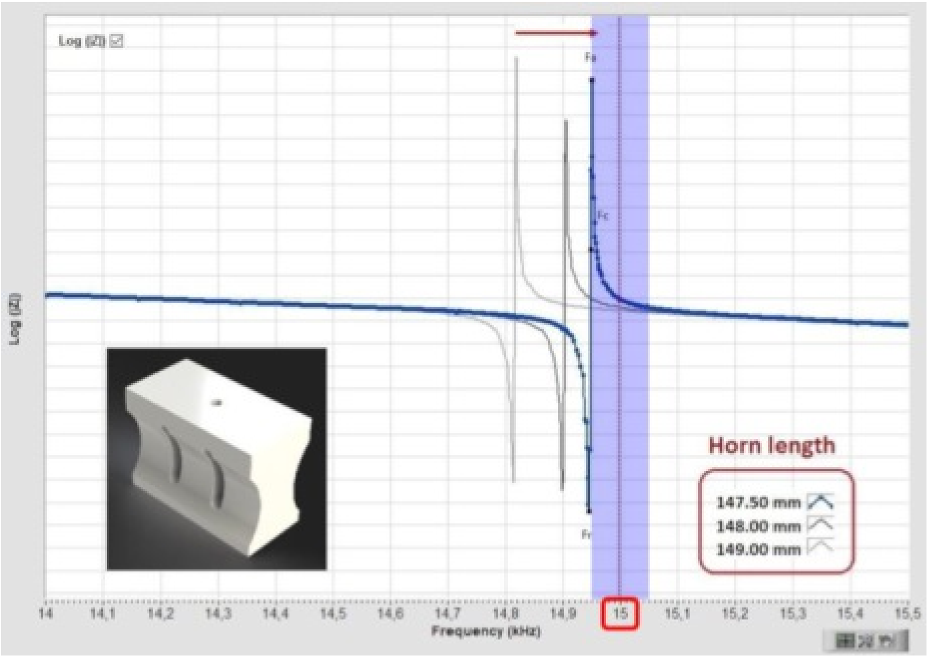


Tuning Process

The process consists of intercalating small dimensional changes with frequency measurements using the TRZ® Analyzer until the desired frequency is reached. In order to be measured, horns must be assembled in an ultrasonic stack and as in real use.



New ultrasonic horns and sonotrodes are manufactured longer and the standard tuning operation is to shorten the length to increase frequency. For horn maintenance, tuning is usually performed via changes in lateral dimensions to reduce frequency and correct the elevations caused by wear and shortening.

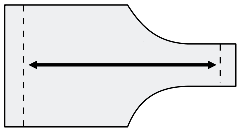


Note: It is not possible to repair a cracked horn. You can tune it, but the crack will keep the quality factor and performance low by dissipating power.

To change the frequency

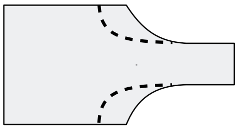
Tuning consists of adjusting the frequency through dimensional changes of the horn, which may raise or lower the frequency depending on where they are performed:

To increase the frequency, reduce the length.

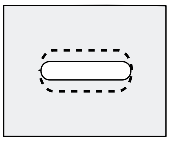


To reduce the frequency:

- Advance the curve position;



- Widen the slots.



The sensitivity and practicality of changes that raise the horn's frequency are much superior to those that reduce it frequency. Therefore, the horns are initially manufactured longer and with lower frequency for later tuning them with length reduction.

Ultrasonic horn types

The most common ultrasonic horn types are cylindrical, square and rectangular; they may also be solid or slotted. In general, horns can be solid when the diameter or edge is up to half its length. For large horns, slots are required to decouple lateral vibration modes. Additionally, notches may be required to improve the homogeneity of the vibration amplitude on the face. There are also insert and blade shaped horns for medical and dental applications.

Metal alloys for ultrasonic horns:

- 7075-T6 Aluminum
- 6Al-4V Titanium (grade 5)
- VND tool steel
- VC131 Tool steel
- 4043 stainless steel

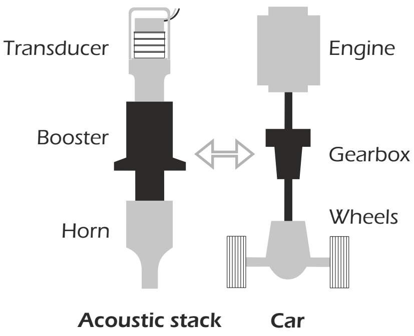
The vibration direction of the horn must be the same as the direction of lamination or extrusion of the material.

Guide to preventive maintenance of acoustic stacks

This guide enables the identification of defective elements in acoustic stacks and similar indicating preventive maintenance actions.

Acoustic stacks convert electrical energy into vibration, to understand their operation we can use the car analogy: the transducer or converter converts the energy (engine), the acoustic transformer adjusts the ratio between pressure and amplitude (gearbox) and the horn applies vibration to perform the work (wheels) [1].

In cars, the gears must be compatible for the power transmission to be efficient; in ultrasonic stacks, elements' frequencies must be aligned and the elements perfectly coupled. Additionally, in the elements of the acoustic stack, nodal lines must coincide with the mechanical fixing points.

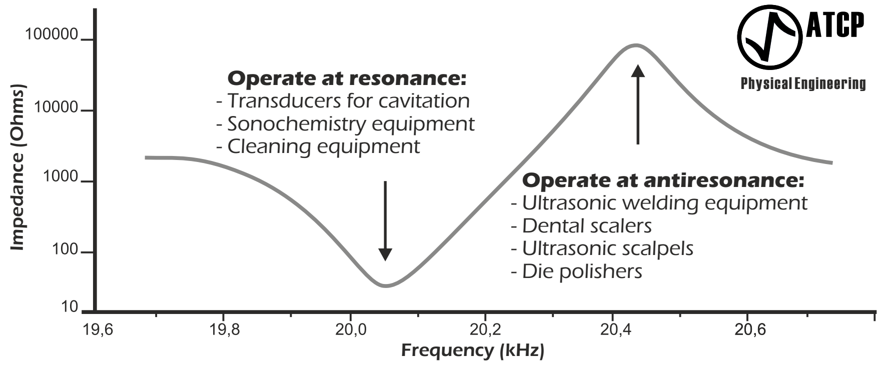


Operation modes

Transducers and acoustic stacks have two identifiable operating frequencies on the curve of impedance modulus versus frequency:

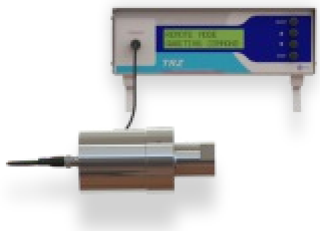
The maximum corresponds to the anti-resonant frequency (Fa or series frequency), where the maximum vibration amplitude occurs and operates most ultrasonic welding machines.

The minimum corresponds to the resonant frequency (Fr or parallel frequency), where the maximum vibration pressure occurs and the ultrasonic cleaning equipment operates.

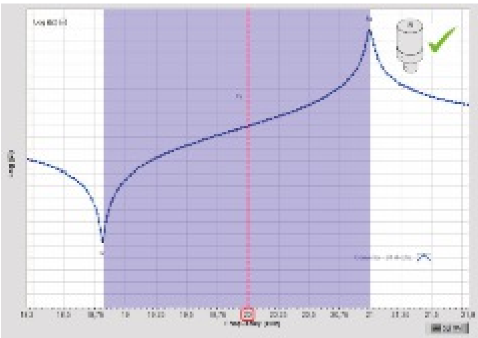


1 Converter testing

The first step to identify the defective element in the stack is to separate its elements and test the converter. Tests must be performed with the elements in the horizontal position.



The mechanical quality factor (Qm) of the converter must be equal to or greater than 250 for any frequency, power and manufacturer. The antiresonance impedance (Za) must be greater than 10 kΩ. The frequency range $[Fr\text{-}Fa]_C$ (purple shadow in the graph below) should contain the stack's nominal frequency (red dotted line).



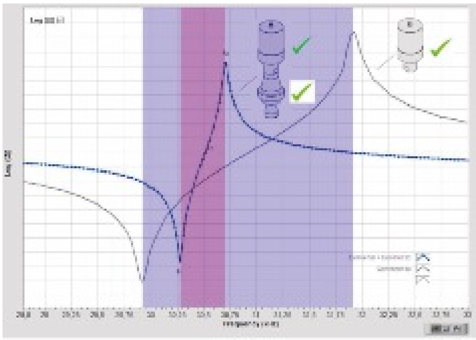
If the converter is approved, proceed to booster testing. If it fails, replace the converter or refurbish it. Before replacing it, it is important to test the new one, even if it is newly purchased.

To perform the refurbishing, employ identical piezoelectric ceramics and control precompression with PiezoClamping®.

2 Booster testing

Reassemble the booster in the converter using the manufacturer's recommended procedures and torque (it is not possible to test the booster and horn separately from the converter).

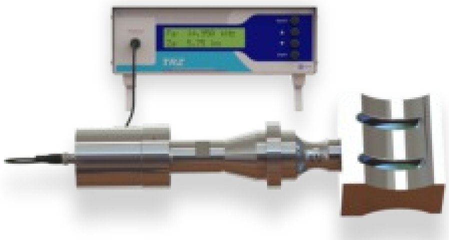
The mechanical quality factor (Qm) of the converter + booster must be equal to or greater than 700. The impedance at antiresonance must be equal to or greater than 5 kΩ. The $[Fr\text{-}Fa]_{C+B}$ frequency range (red shadow in the graph below), or at least the antiresonance frequency Fa, must be contained in the $[Fr\text{-}Fa]_C$ range (purple shadow).



If the booster is approved, proceed to horn testing. If it fails, replace the booster or refurbish it. Changing the O-rings is usually enough to restore the mechanical quality factor. Frequency deviations caused by cracks and nodal line displacement by asymmetrical wear are irreparable defects.

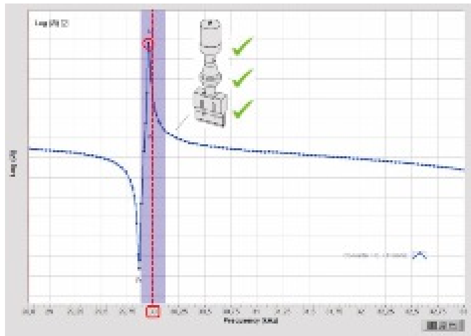
3 Horn and stack testing

Reassemble the horn on the booster + converter using the procedures and torque recommended by the manufacturer. The horn test is also the complete stack test.



The mechanical quality factor (Qm) of the complete set (C+B+H) must be equal to or greater than 1000. The impedance at antiresonance must be equal to or greater than 3 kΩ.

The operating frequency (red dotted line in the graph below) must be within the frequency range $[Fr\text{-}Fa]_{C+B+H}$ (purple shadow).



If the horn / complete stack is approved, the equipment problem may be in the generator. If it fails, replace the horn or refurbish it.

Refurbishing usually consists of retuning the element to compensate for the wear, which is possible to some extent. Cracks may also occur, which are irreparable defects.

[1] Ultrasonic assembly of thermoplastic moldings and semi-finished products - Recommendations on methods, construction and applications. ZVEI (German Electrical Manufactures Association).