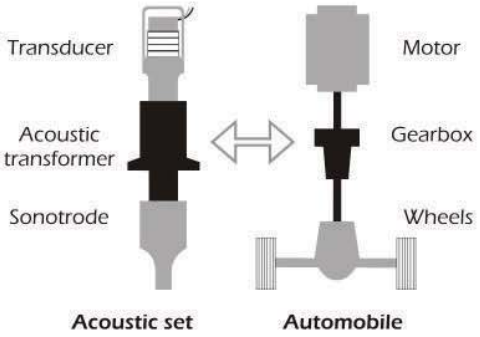
Principles of the power ultrasonic technology

Ultrasonic transducers, horns and acoustic sets are devices which convert electrical energy into vibration. To understand the operation principles, it can be done an analogy between an ultrasonic welding set and an automobile.

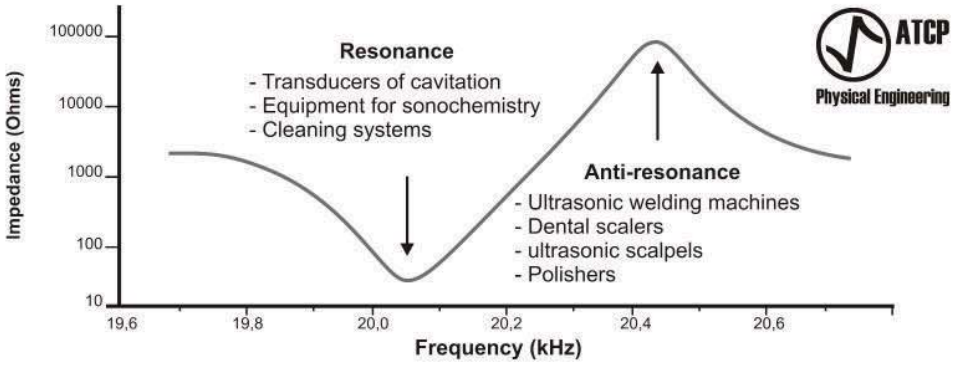
The transducer performs the energy conversion (as the motor), the transformer adjusts the ratio between force and velocity (as the gearbox), and finally, the sonotrode directs and applies this energy to do the work desired (as the wheels).

In the automobile all the mechanical system parts must be well designed and harmonic in order to improve the energy transmission efficiency as much as possible. The same occurs with ultrasonic systems, however in that case the key parameter to the efficiency is the frequency of the parts that should be matched as close as possible (for instance 20 kHz ± 50 Hz).



1 Operation

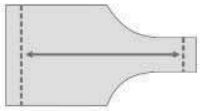
The transducer has two operating frequencies, which are easily identifiable in its electrical impedance curve. The impedance maximum corresponds to the anti-resonance frequency (maximum speed). Ultrasonic welding systems operate at anti-resonance frequency. The impedance minimum corresponds to the resonance frequency (maximum force). Ultrasonic cleaning systems operate at resonance frequency.



2 Sonotrode tuning

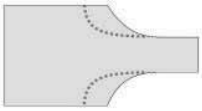
Sonotrodes must be tubed to work properly, to do not overheat and to have a long useful life. The frequency tolerance used to be around ± 0,25%, with reference to the nominal value, for instance, 20.000 ± 50 Hz.

To increase the sonotrode frequency:

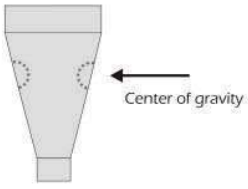


- Reduce the length.

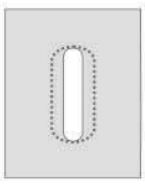
To decrease the sonotrode frequency:



- Move the stage back,,



- Grooves the center of gravity,



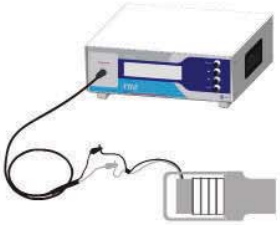
- Extend the slots.

The TRZ Horn Analyzer, together with the Software is used with the machining for tuning through adjustments of the dimensions.

3 Test of transducers

To work properly, the transducer frequency and impedance must be within tolerance ranges. For instance, for welding systems the frequency should be 2.5% higher than the nominal acoustic set frequency with a tolerance of ± 0.25%.

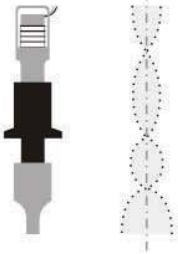
The determinant factors for the frequncy and impedance are the dimensional accuracy of the parts, the tightness applied, the ceramics quality and the tuning (in a similar way to the sonotrodes case).



4 Test of acoustic sets

The frequency and impedance of acoustic sets must be within acceptable ranges. In welding systems, the tolerance is ± 0,25% for the frequency, for example, 20kHz ± 50Hz.

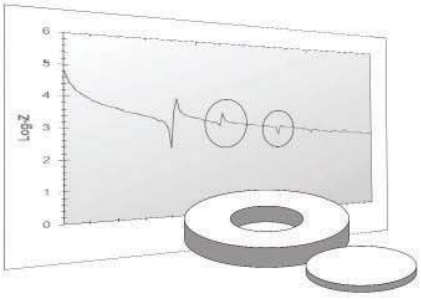
Performance depends on the frequency tuning and coherence between the parts. It may happen that a set has poor performance, even though operating at the right frequency, when combining tranducers and converters uncoupled (one with low frequency and another with high frequency). This type of problem is detected by measuring the impedance.



5 Test of piezo ceramics

The piezoelectric ceramics are the transducers core and a critical element. For power applications, it is usually applied the PZT-8 and PZT-4 types.

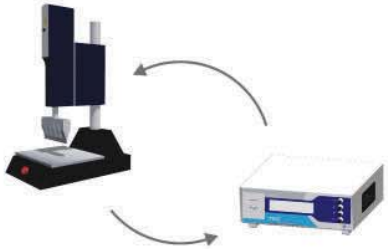
Before re-assemblages, it is essential to prove the ceramics for micro cracks. Using the TRZ Software the cracks are easily detected by the occurrence of anomalous peaks in the electrical impedance curve.



6 Predictive maintenance

Problems in ultrasonic systems cause trouble and damage that can be easily avoided with predictive maintenance.

In general, the deviations in the frequency indicate wear, and in the impedance, problems of coupling. These problems are solved by re-tightening and polishing of the interfaces.



Predictive maintenance with the TRZ Analyzer also includes the incoming inspection of new ultrasonic parts.

TRZ
Horn Analyzer

For ultrasonic transducers and sonotrodes testing

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Physical Engineering

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What it is?

The TRZ Horn Analyzer is an intrument for tune, testing, quality control and development of ultrasonic transducers and sonotrodes.

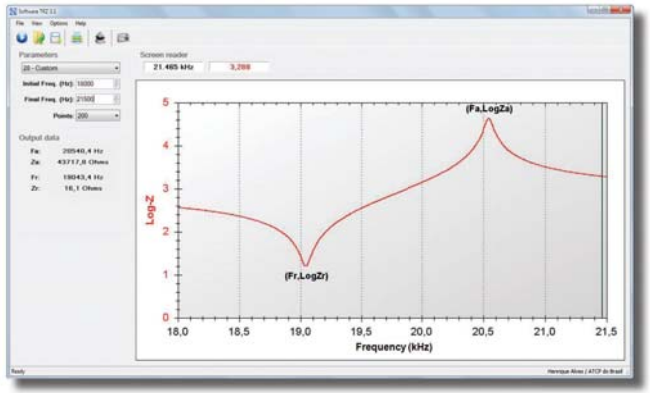
How does it works?

With a button touch, the TRZ determines the operation frequence and impedance of the item under test. Note: See the technical information about how to use these results on the other side of this leaflet.

Result of a welding transducer testing.

Software TRZ

The TRZ has software that allows to view the curve of the transducer, which is very useful for the tunning process and for quality control. This software allows to apply acceptance criteria, to generate reports and to save and retrieve results for comparative analysis.



Graph of a power ultrasonic transducer.

The TRZ:

- **Reduces maintenance costs**
- **Convenient**
- **Installation and training *in loco***