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Determining Resonance Frequency

When exposed to an AC electric field, a piezoelectric ceramic element changes dimensions cyclically, at the cycling frequency of the field.

As the frequency of cycling is increased from zero, the ceramic element's oscillation approach a frequency at which impedance is minimum. At this minimum impedance frequency (f_m) or resonance frequency (f_r) the ceramic element will vibrate most readily, and will most efficiently convert the electrical energy input into mechanical energy.

As the cycling frequency is further increased, impedance increases to a maximum -- the maximum impedance frequency (f_n) or antiresonance frequency (f_a). For some applications (ultrasonic motors, other high power applications) it can be advantageous to operate a piezoelectric ceramic element at its antiresonance frequency, rather than at its resonance frequency.

The composition of the ceramic material and the shape and volume of the element determine the resonance frequency. Generally, a thicker element has a lower resonance frequency than a thinner element of the same composition and shape. Values for minimum impedance / resonance frequency and maximum impedance / antiresonance frequency can be determined by using the system illustrated here. The procedure follows:

- Set the switch to A.
- Place the ceramic element into position.
- Adjust the frequency generator to give a maximum voltage value on the voltmeter. This value is the resonance frequency.
- Set the switch to B.
- Adjust R4 to give a voltage value on the voltmeter equal to the value in step 3. This value is the impedance resonance (Zr).
- Set the switch to A.
- Adjust the frequency generator to give a minimum voltage value on the voltmeter. This value is the antiresonance frequency.

System for Determining Resonance Frequency and Antiresonance Frequency of a Piezoelectric Ceramic Element