

## Ceramic Resonator terms and application notes

### GENERAL DESCRIPTION

**Why ceramic resonators?** Ceramic resonators stand between quartz crystal oscillators and LC/RC oscillators in regard to accuracy. They are considerably smaller, require no adjustments, with improved start-up time and low in cost.

**Package:** Ceramic resonators come with standard, single-in-line package (LXZT and HXZT), or 3-leads with built-in capacitors (ACR).

**Properties:** The oscillation of ceramic resonators is dependent upon mechanical resonance associated with their piezoelectric crystal structure. These materials (usually barium titanate or lead-zirconium titanate) have large dipole movement which causes the distortion or growth of the crystal by an applied electric field.

**Frequency Range:** The available frequency range varies from 190 kHz to 50 MHz.

**Frequency Stability:** The maximum allowable frequency deviation compared to the measured frequency at 25°C over the temperature window, i.e., -20°C to +80°C. The typical stability is  $\pm 0.3\%$  ( $\pm 3000\text{ppm}$ ).

**Frequency Tolerance:** The allowable deviation from the nominal frequency at room temperature. Frequency tolerance is expressed in percentage, typical  $\pm 0.5\%$  or in parts per millions (ppm),  $\pm 5000\text{ppm}$ .

**Resonant Impedance:** The value of impedance the crystal exhibits in the operating resonant circuit.

**Aging:** The relative frequency change over a certain period of time. This rate of change of frequency is normally exponential in character. Typically, aging is  $\pm 0.5\%$  over 10 years.

**Frequency Stability:** The maximum allowable frequency deviation compared to the measured frequency at 25°C over the temperature window, i.e., -20°C to +80°C.

**Load Capacitance:** Load capacitance ( $C_L$ ) is the amount of capacitance that the oscillator exhibits when looking into the circuit through the two resonator terminals. Load capacitance is expressed in a pair of  $C_1$  and  $C_2$  with the default values given in table.

**Equivalent Circuit:** Its equivalent circuit is similar to the quartz crystal equivalent circuit, i.e., consists of a series  $L_1$ ,  $C_1$ ,  $R_1$  circuit shunting with a parallel  $C_0$  capacitance. A standard ZTAS-MG-4.00MHz has its typical parameters as follows: L - 330uH,  $C_1$  - 5pF,  $C_0$  - 40pF, and  $Q \sim 900$ .

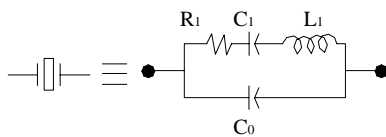


Figure 1

### TEST CIRCUITS FOR CERAMIC RESONATORS

**Ceramic resonators: with built-in capacitors:** It consists of a CMOS inverter with a feedback resistor  $R_f$  (figure 2). The feedback resistor allows oscillation

to start when power is initially applied. Its value is generally 1 MΩ. The values of  $C_1$  and  $C_2$  are given in the table or specified by customer.

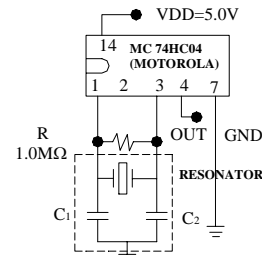


Fig. 2 Test circuit

### APPLICATIONS

Ceramic resonators are used mainly as a source of clock signals for many microprocessors, which tight frequency stability is not a primary concern. Ceramic resonators are low in cost and are built-in with capacitance for space savings. Ceramic resonators are mainly used in consumer electronics applications (TV, VCR, games, radios) and household appliances. Fig. 3 shows a typical curve of impedance vs. phase of a 4 MHz ceramic resonator.

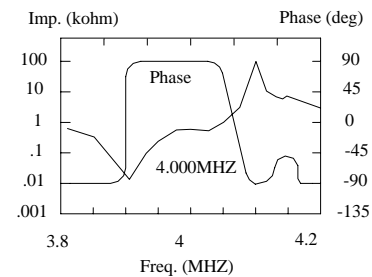


Fig. 3 Impedance vs. phase of a 4.000 MHz ceramic resonator.

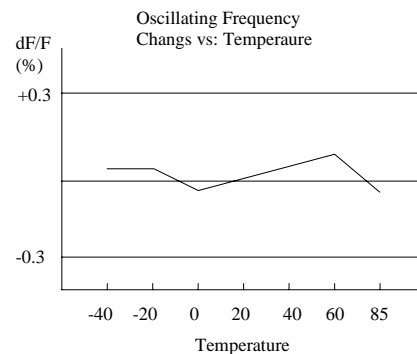


Fig. 4 Typical curve of frequency vs. temperature