CERAMIC RESONATORS

Why Ceramic Resonators? Ceramic resonators stand between quartz crystals and LC/RC oscillators in regard to accuracy. They offer low cost and high reliability timing devices with improved start-up time to quartz crystals.

Package styles: Abracon offers a wide variety of package styles for ceramic resonators. They come with two or three terminals leaded type or surface-mount type.

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 wafer by an applied electric field.

Oscillation mode: The ceramic resonator oscillates in thickness-shear vibration mode for Fundamental frequencies (typical less or equal than 8MHz) and thickness-longitudinal vibration mode for third-overtone mode (above 8MHz to 50MHz).

Frequency range: The available frequency range varies from 182kHz to 50MHz.

Frequency tolerance at 25°C: The maximum allowable frequency deviation from the nominal frequency at room temperature. Frequency tolerance is expressed in percent. Typical frequency tolerance is ± 0.5% max. Frequency tolerance can be controlled tighter on built-in capacitance type.

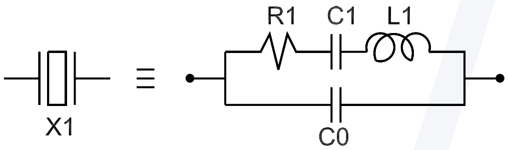
Frequency stability: The maximum allowable deviation compared to the measured frequency at 25°C over the temperature window, i.e. –20°C to +80°C or –40°C to +125°C. Standard frequency stability is ± 0.3%.

Resonant Impedance: The net impedance of the ceramic resonator at resonant frequency. Ceramic resonators have superior resonant impedance than quartz crystal, which offer much better start-up time.

Aging: The relative frequency change over 10 years period. The aging is ± 0.3% max. over 10 years.

Load capacitance CL: Since ceramic resonators have very large parallel resonance area and frequency is very sensitive to load capacitance, exact value of load capacitance must be specified. This process is usually been done through IC matching and characterization. Please contact Abracon for details.

Equivalent circuit: The equivalent circuit of the ceramic resonator is similar to the quartz crystal, but motional parameters are very different.
See figure 1 below:
For 4MHz: L1 = 385µH, C1 = 4.4pF, C0 = 36.3pF, R1 = 8Ω, Q = 1134, ∆F = 228kHz.



Manufacturing Process: Material Mixing – Calcination – Milling – Spray Dry Seving – Pressing – Sintering – Printing – Sintering – Poling – Slicing – Sputtering – Dicing – Wire forming – Soldering – Lead frame insert – Wax coating – Epoxy coating – Epoxy curing – Inspection – Packaging – Shipping.

Why do ceramic resonators have lower cost than quartz crystals?: Because ceramic resonators have high mass production rate, small size, no need for adjustment.

Properties of automotive and industrial grade ceramic resonators: Abracon offers a new line up of automotive and industrial grade ceramic resonators operating at –40°C to +125°C, in supplement to its current consumer grade products which are operating at –20°C to +80°C. The automotive grade, which offers excellent frequency tolerance, stability, provides a reliable start-up over the wide temperature. The parts can be ultrasonic (1 minute at 60°C, frequency 28kHz, output 20W/L) or rinse washed with water for a limited time and must be dried completely to guarantee performance.

IC characterization for ceramic resonators: Due to ceramic resonators' properties, IC matching must be studied and performed to satisfy oscillation conditions. The following possible causes may occur if IC matching was not performed:

- -In-circuit oscillation frequency off tolerance limit.
- -Not-start-up or start-up at an unwanted frequency.
- -Stop oscillating or oscillating off limits over temperature.
- -Oscillation at overtone mode.
- -Poor aging due to over power driving.

Also, there is possibility between frequency correlation between test jig and customer IC. The circuits below show an example between IC characterization of a TMP87P808M and correlation of in-house test jig using CD4069UBE.

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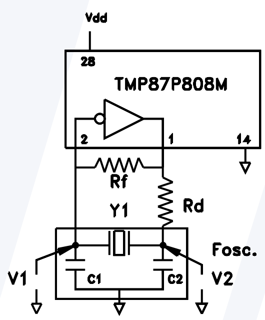
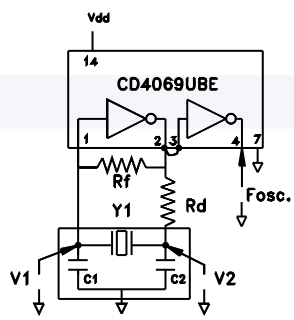
IC characterization steps:
Frequency correlation between customer's IC and standard IC tested.
Temperature characteristics of oscillating frequency.
Temperature characteristics of oscillating voltage.
Rise time vs. Vdd characteristics.
Oscillating frequency vs. Vdd characteristics.
Oscillating voltage vs. Vdd characteristics.
Oscillating frequency vs. C1 values (C2 constant)
Oscillating frequency vs. C2 values (C1 constant)
Oscillating voltage vs. C1 values (C2 constant)
Oscillating voltage vs. C2 values (C1 constant)
Oscillating frequency vs. CL value (C1 = C2)
Oscillating voltage vs. CL value (C1 = C2)
Rise time vs. CL characteristics (C1 = C2)
Starting voltage vs. CL characteristics (C1 = C2)





Polarization on ceramic resonators: Both quartz crystals and ceramic resonators do not have polarity since leads can be mounted interchangeably. However, since ceramic resonator has much wider trim sensitivity vs. load capacitors value ± 20%, we recommend mounting in the same way as we do the characterization.

IC characterization request: Abracon will offer our customer, in most cases, IC characterization at no cost. It is very important to have this process done in early stage of design and board evaluation. However, please allow us extra time to complete and submit the report. We need the following information to send along when submitting a request:

Application. Please be specific either automotive or consumer grade applications.
Package style (leaded or surface-mount).
Electrical parameters.
Estimate annual usage.
Pilot run and production date.
IC part number and manufacturer
Applied voltage and tolerance, e.g. 12Vdc ± 10%
Operating temperature.
2 to 5 bulk IC samples or the actual PCB with components mounted in oscillator section. The PCB is preferred so that parasitic effects on the board can be taken into account.
A top view pin assignment for the package of the IC samples.
Attached schematic shown values of components values such as Rd, Rf, C1, C2, etc.
Specify date needed.
Name and E-mail contact.

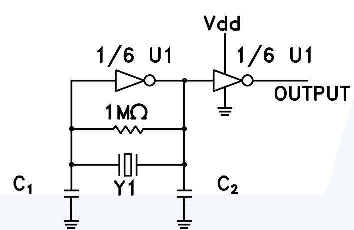
As soon as we received the complete information and materials as specified, we will submit the report and recommendations within 4 to 6 weeks.

LAYOUT HINTS:
When you design circuit on a PCB, please take the following considerations:

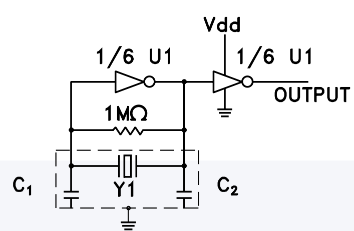
Please design the trace length as short as possible.
Try to avoid thin line on resonator traces (< 0.010"). Design as wide as possible.
If noise occurs, please insert EMI filter with serial mode between XOUT pin and resonator or between capacitor and GND.

TEST CIRCUITS:
We used standard CMOS and HCMOS ICs in our test set-up.
CMOS: CD4069UBP tested at 12VDC for F < 8MHz
HCMOS: TC74HCU04 tested at 5VDC.

We used standard 30pF ± 20% capacitors for C1 and C2, unless otherwise specified.



U1: CD4069UB
74HCU04 (>8MHz)
Y1: RESONATOR
C_1 C_2 : 30pF ± 20%



U1: CD4069UB
74HCU04
Y1: RESONATOR
C_1 C_2 : 30pF ± 20% (Built-in)

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