

Murata's IC Characterization Service

What is Murata's IC Characterization Service:

When a ceramic resonator is designed into a circuit, it is expected that the ceramic resonator will work every time, regardless of any part to part variation of production parts. To support this expectation and confirm oscillation performance, Murata offers a free service that verifies the operational combination of a specific ceramic resonator with a specific IC (microcontroller) and recommends external passive component values in the oscillation circuit (load capacitors, feedback resistors, and dumping resistor), as needed.

The output of this service is Murata's recommendation of a specific ceramic resonator part number that works completely with the customer's target IC, hook-up circuit, and PCB (if provided), and over the ceramic resonator's production variation and environmental temperature variation. It is also possible to frequency correlate a ceramic resonator to a customer's circuit, especially where tight tolerance ceramic resonators are used.

Two Phase Characterization Process:

- **OPERATIONAL CONFIRMATION** – Determine optimal circuit values to guarantee operation over the ceramic resonator's variation to specification, over the operating temperature range, and over the IC's drive voltage variation. This step prevents stop oscillation and irregular oscillation from occurring.
- **FREQUENCY CORRELATION** – Optional - Measure and compensate for any frequency difference between Murata's production frequency sorting circuit and a customer selected clock circuit and PCB. This step is important for any tight tolerance resonator (initial tolerance +/-0.3% or tighter).
Please see Frequency Correlation section for explanation.

Benefits:

- **FREE** - IC evaluation service is free.
- **SAVE TIME AND EFFORT** - Customer can save engineering time and effort in designing oscillation circuits.
- **GUARANTEED OSCILLATION** - Murata guarantees resonator oscillation with optimum resonator part number and circuit conditions assuming no changes made to IC and/or PCB.
- **ELIMINATE UNEXPECTED FREQUENCY SHIFTS** - Murata can measure and advise the percent of frequency correlation between customer circuit and Murata sorting circuit. If desired, the resonator frequency can be adjusted to compensate for any shift. We recommend this for any tight tolerance resonator.

What is needed for IC Characterization:

1. Completed "IC Evaluation Request Form". A copy of the form is included at the end of this section.
2. One to Two ICs samples or modules.
 - If submitting modules, please attach red wire to power and black wire to ground, so we may power the board correctly.
 - All submitted modules and ICs are returned after characterization.
 - If Microcontroller or DSP has multiple user selected internal clock circuits, please program the IC with the desired clock circuit. Please advise which clock circuit is used on IC Evaluation Request Form.
3. Top View Pin-out Diagram of the microcontroller or DSP that contains the clock circuit. If module, please include (in addition to IC pin-out diagram) schematic of the resonator hookup circuit to the IC.

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Process Flow of IC Characterization Service:

- 4 to 6 weeks after initial submission, Murata reports oscillation stability, recommended hook-up circuit, frequency correlation, and the final recommended part number.
- In addition to the above report, Murata will send a second report that presents some graphs of test data from the characterization process, as well as a rise time measurement. For frequency correlation, the percent of frequency shift between Murata's test circuit and the customer's IC or module is reported. Murata will advise a recommendable part number that is compensated for this frequency shift.

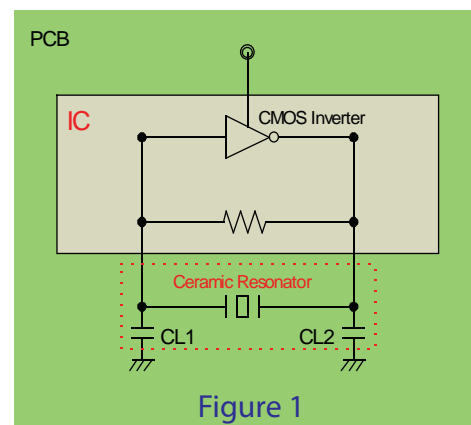
Frequency Correlation Explained

Simple Calculation of Oscillation Frequency

The oscillation circuit is made up of an inverter or amplifier (inside the microcontroller) and an external ceramic resonator with load capacitors, CL1 and CL2, (see Figure 1). The oscillation frequency is calculated using the resonant frequency (F_r), static capacitance (C_0), and motional capacitance (C_1) of the ceramic resonators and the influence of the load capacitor (CL). See the below equation:

$$F_{osc} = F_r \sqrt{1 + \frac{C_1}{C_0 + CL}} \quad CL = \frac{(CL1 \times CL2)}{(CL1 + CL2)}$$

For standard tolerance ceramic resonators (± 5000 ppm initial tolerance), the frequency shift of stray capacitances is not very important due to the large initial tolerance of the resonator.

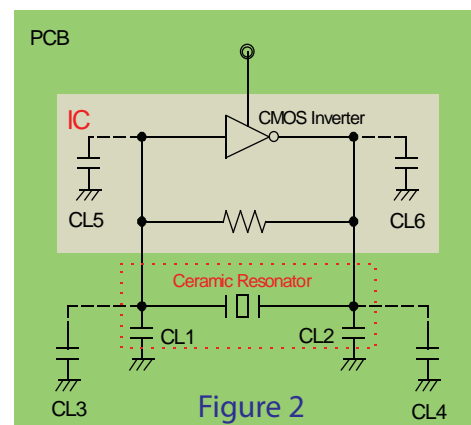


Expanded Calculation of Oscillation Frequency, including all capacitances.

For tighter frequency tolerance oscillation circuits (resonators with initial tolerance tighter than ± 5000 ppm), the influence of all capacitance must be accounted for (IC input capacitance AND PCB stray capacitance). These “normally ignored” capacitances can shift the oscillation frequency, causing a tight tolerance resonator to oscillate outside intended tolerance when combined with the IC and customer's PCB. The ceramic resonator would still operate within its specification, but the additional external capacitance from the IC's input and PCB stray capacitance would shift the actual oscillation frequency.

Taking into account stray PCB Capacitance (CL3 and CL4) and stray input capacitance of the IC (CL5 and CL6) shown in Figure 2, the new calculation for oscillation frequency is given by the below equation:

$$F_{osc}' = F_r \sqrt{1 + \frac{C_1}{C_0 + CL'}} \quad CL' = \frac{(CL1 + CL3 + CL5) \times (CL2 + CL4 + CL6)}{(CL1 + CL2 + CL3 + CL4 + CL5 + CL6)}$$



The Problem and the Solution

When a ceramic resonator is made, Murata uses a standard test circuit in production (per the part's specification) to confirm oscillation frequency. If the customer's final PCB and IC is different from this test circuit, then there could be a frequency correlation error between the two circuits. This is because almost all ICs have different input capacitances (that is due to internal design or IC package selection), and PCB capacitances can vary based on number of layers in the PCB and trace size. Even with the ceramic resonator working within specification, the different stray capacitance in the customer's IC/PCB combination could shift the oscillation frequency outside of the intended range. This correlation error can cause a resonator (in specification) to be shifted out of the expected tolerance on the customer's final PCB.

To solve this problem, Murata can measure the amount of frequency shift due to the difference between the customer's application circuit and Murata test circuit, and adjust the resonator frequency to compensate for this shift. This adjusted ceramic resonator will now always oscillate within the intended range in the customer's circuit. No additional cost is needed for this adjustment.