

Appendix 3

IC Characterization for Ceramic Resonators

Introduction

Due to the number of variations in clock circuits found in today's microcontrollers, it is impossible to make a standard resonator that works with every one of the ICs. While much of the time an off the shelf resonator will work with a given IC's clock circuit (by "work" we mean stable oscillation and minimal frequency shift from the intended oscillation frequency), there are many cases where the resonator will:

- not start to oscillate
- stop oscillating at high or low temperature
- have sporadic or overtone oscillation
- resulting oscillation frequency not be in expected tolerance.

Most of the problems above are due to incompatibility between the resonator, hook-up circuit, and the IC's clock circuit. This is not an indication that the resonator is defective in some way. Such incompatibilities become more of a concern in high reliability applications like airbag controllers, ABS controllers, Aircraft controls, and Medical applications.

These incompatibilities result from the fact that resonator manufacturers must pick a standard test circuit to be used in production to confirm initial oscillation frequency of the ceramic resonator. For Murata, we use the RCA CD4069UBE as the CMOS resonator test circuit, and the Toshiba TC74HCU04 or TC40H004P as the HCMOS resonator test circuit (called out by the "x40" suffix in the resonator part number). For the big picture, there are inherent differences between CMOS and HCMOS IC technology that require us to offer these three sorting options. But, within each technology (CMOS vs. HCMOS) there can be many variations in IC design and die shrink level, that cause the resonator incompatibility / oscillation difficulties.

What can we do

To overcome these incompatibilities, Murata has chosen to take the route of IC characterization. Murata has a dedicated application engineering section, whose sole function is to perform IC characterizations between customer ICs and Murata ceramic resonators. By performing the IC characterization, we are able to solve most of the resonator incompatibility issues that arise. Many solutions are just minor changes to the hook-up circuit (like changing load capacitor values), or solutions can be as major as designing a custom resonator part. Either way, the recommendation will assure you of 100% operation for your IC (assuming no changes to the IC we characterize for you) and that all resonators will be shipped to the recommended resonator specification.

Murata has been performing IC characterizations for many years and has a great deal of experience in doing the evaluations. Many IC makers looking to put resonator recommendations in their IC's databooks, come to Murata for recommendations on resonators for their ICs via the IC characterization process.

Important Points of the Characterization Service

- The service is provided free of charge.
- The IC / resonator characterization is done with worst case resonator (per Murata specification).
- The customer gets the complete recommended hook up circuit between the IC and the resonator. The customer does not need to worry about how to hook up the resonator with the IC, since we have provided it.
- The customer is advised which specific Murata resonator they should use.
- The characterization is performed with the IC over either the standard temperature range (-20C to +80C) or the automotive temperature range (-40C to +125C). The customer is also advised about effects of variations in input supply voltage. This is very important for automotive applications.
- The characterization can take into account frequency correlation issues resulting from differences between customer ICs and Murata's standard sorting circuit.
- The customer gets a form report from Murata supporting the resonator / hook-up circuit recommendation.
- Typical lead time for the characterization is 6 to 8 weeks. Due to the time involved in doing the characterization, it is important that this process occur early in the design stage.

- The IC characterization is available to both direct and distribution customers.

Murata has made available via the Internet a listing of IC / resonator characterizations done in the past. This can be found at "<http://www.murata.com/develop/index.htm>".

Please be careful with recommendations from this web site. Many IC makers change IC's (like redesigns or change the process linewidth) that have a great impact on the characterization results. Most IC makers do not easily indicate via there part number if such changes have occurred. This could result in a characterization from the web not being accurate for currently available ICs even if they have the same part number. We recommend that all new resonator designs should have the IC characterization done to insure good operation.

This appendix contains a form to be filled out by the customer, sales rep, or distributor rep. This appendix also contains instructions that explain what additional information is needed for the IC characterization. Please use this included form on all new IC characterization requests to Murata, since it greatly lessens the time needed to process such requests. It also insures that all the important information needed will be supplied the first time around, preventing repeated requests to the customer for additional information.

What is needed from the customer for IC characterization

For IC characterizations, please provide the following:

- 2 to 5 bulk IC samples or the actual production PC board with ICs Mounted on it (the PC board is preferred so that parasitic effects on the board can be taken into account)*
- A top View Pin-Out Diagram for the package of the IC samples.
- The supply voltage **and tolerance** that the IC will operate under in design.
- The Murata resonator part number they want characterized with the IC samples
- The temperature range that the resonator must operate over in the design.

Notes:

1. If you are using a PIC micro-controller from Microchip, please provide information on which oscillator mode (XT or HS) you are using. If you can preprogram the oscillator mode on the IC samples, it will help speed up the evaluation process. If you can not preprogram the IC, it will take an additional 1 to 2 weeks to complete the evaluation.

2. If providing IC samples on PC boards, please attach wires for the power supply & ground and mark the wires.

Complete the form attached, arrange the above needed items, and mail or pass the completed form and IC samples (and any other needed items) to a local Murata Sales Representative. If you are not sure who your local Murata sales representative is, please consult the Murata Web page at www.Murata.com. This web page will have a link to a rep locator page, that will find the Murata rep for your area. The Murata rep will send the package on to the appropriate Murata Product Manager.

Within 4 to 5 weeks, Murata will provide the Initial Recommendation Report. This report will confirm the basic Murata resonator part number that insures stable oscillation and start-up over given circuit conditions. The only item not covered by this Initial Recommendation is frequency correlation (see Note below on Frequency correlation) between the standard Murata sorting IC and the IC under characterization. Within 4 to 5 weeks after providing the Initial Recommendation Report, Murata will provide the final Formal Recommendation Report. This report will cover correlation frequency.

Note: Correlation Frequency. It is very common to see a repeatable frequency shift between resonators sorted with Murata's standard sorting circuit and the actual IC used in design. This is mainly due to the various clock oscillator designs and construction methods used in the IC industry.

The following example demonstrates correlation frequency shift: a resonator sorted by Murata's standard production sorting circuit produces a resonator exactly at 4.000MHz. When this resonator is used with a different IC (not the Murata production sorting circuit) it oscillates at 3.98MHz. This is a 0.5% shift down. This difference between Murata's standard sorting circuit and the application IC's clock circuit is the correlation frequency shift. This correlation shift is not covered under the initial oscillation frequency specification for the resonator. This correlation frequency shift occurs with all resonators, regardless of resonator maker.

** If frequency tolerance is crucial to your design, Murata is able to compensate for such a correlation shift by custom production frequency sorting or by making a custom resonator. Please note on the Evaluation Form if the initial oscillation frequency is critical to your application.

IC Evaluation Information Sheet

Resonator

(Please Print All Information)

Application Information

Application: <i>(required)</i>	
Estimated Annual Usage: <i>(required)</i>	
Production Start Date: <i>(required)</i>	
Production Location: <i>(required)</i>	

IC and Test Information

IC Maker: <i>(required)</i>	
IC Part Number: <i>(required)</i>	
Resonator Part Number: <i>(required)</i>	
Supply Voltage: (example: 5V \pm 0.5%): <i>(required, must state tolerance for voltage)</i>	
Temperature Range: <i>(required)</i>	
Number of IC samples or modules enclosed:	
Current Customer Circuit Conditions: <i>(If available)</i>	Feedback resistor (Rf) = Load capacitors (CL1 / CL2) =
Can the circuit conditions be changed:	YES NO (please circle one)

Customer Contact Information

Customer Name: <i>(required)</i>	
Customer Contact Person: <i>(required)</i>	
Customer Contact Phone Number: <i>(required)</i>	
Customer Contact e-mail Address: <i>(If available)</i>	
Sales Rep. Name and Office:	

**Additional Comments or Requests (attach additional page if needed):

IC Characterization for Ceramic Discriminators

Introduction

Like resonators, discriminators are subject to the differences between ICs. However, these differences can affect discriminators more severely than resonators. Small differences in the characteristics of an IC can cause a large frequency shift in the discriminator that could cause a signal to be distorted or cut out completely. For this reason, Murata discriminators are IC specific, meaning that we have one discriminator for each IC.

What We Can Do

To resolve these incompatibilities, Murata performs IC characterizations to determine the discriminator characteristics required by each IC and the customer's application. Murata has a dedicated application engineering section whose sole function is to perform IC characterizations between customer ICs and Murata discriminators. Once the required characteristics are determined, a custom discriminator is produced and a part number is assigned that indicates the associated IC.

Important Points of the Characterization Service

- The service is provided free of charge
- The IC / discriminator characterization is done with the worst case discriminator (per Murata specification)
- The customer is provided with all external component values (L_S and R_P)
- The customer is advised of the discriminator part number
- The characterization is performed over the standard temperature range (-20C to +80C)
- Typical lead time for the characterization is 6 to 8 weeks. For this reason, it is important to begin the characterization early in the design stage.
- The IC characterization is available to both direct and distribution customers.

Murata has made available via the Internet a listing of IC / discriminator characterizations done in the past. This can be found at "<http://www.murata.com/develop/index.htm>". This list is also available in Appendix 5, but it is only current at the time of publication.

This appendix contains a form to be filled out by the customer, sales rep, or distributor rep. This appendix also contains instructions that explain what additional information is needed for the IC characterization. Please use this included form on all new IC characterization requests to Murata, since it greatly lessens the time needed to process such requests. It also insures that all the important information needed will be supplied the first time around, preventing repeated requests to the customer for additional information.

What is needed from the customer

The service is much the same as the resonator characterization, but we require some additional information:

- 2 to 5 bulk IC samples or the actual production PC board with ICs Mounted on it (the PC board is preferred so that parasitic effects on the board can be taken into account)*
- A top View Pin-Out Diagram for the package of the IC samples.
- The supply voltage **and tolerance** that the IC will operate under in design.
- The Murata resonator part number they want characterized with the IC samples
- The temperature range that the resonator must operate over in the design.
- The 3dB bandwidth desired
- The 3dB recovered audio voltage desired
- The signal input level
- The frequency deviation

- The modulation frequency

Note:

If providing IC samples on PC boards, please attach wires for the power supply & ground and mark the wires.

Complete the form attached, arrange the above needed items, and mail or pass the completed form and IC samples (and any other needed items) to a local Murata Sales Representative. If you are not sure who your local Murata sales representative is, please consult the Murata Web page at www.Murata.com. This web page will have a link to a rep locator page, that will find the Murata rep for your area. The Murata rep will send the package on to the appropriate Murata Product Manager.

The report will contain graphs of recovered audio voltage and total harmonic distortion for several values of R_P , L_S , C , V_{CC} , and signal input level. It will also contain the recommended values for the performance that comes closest to the desired performance indicated on the Characterization Form.

IC Evaluation Information Sheet

Discriminator

(Please Print All Information)

Customer Information

Customer Name: <i>(required)</i>	
Application: <i>(required)</i>	
Estimated Annual Usage: <i>(required)</i>	
Production Start Date: <i>(required)</i>	

IC Information

IC Maker: <i>(required)</i>	
IC Part Number: <i>(required)</i>	
Discriminator Part Number: <i>(required)</i>	
Target 3dB Bandwidth: <i>(example: ± 100kHz)</i> <i>(required)</i>	
Target 3dB Recovered Audio Voltage: <i>(example: 100mV) (required)</i>	
Signal Input Level: <i>(example: 100dBu)</i> <i>(required)</i>	
Frequency Deviation: <i>(example: +75kHz)</i> <i>(required)</i>	
Modulation Frequency: <i>(example: 1kHz)</i> <i>(required)</i>	
Supply Voltage: <i>(example: 5V ± 0.5%):</i> <i>(required, must state tolerance for voltage)</i>	

Customer Contact Information

Company Name: <i>(required)</i>	
Contact Name: <i>(required)</i>	
Contact Phone Number: <i>(required)</i>	
Sales Rep. Name and Office:	

Number of IC samples enclosed: _____

****Additional Comments or Requests (attach additional page if needed):**