

## AN6070

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**Associated Project:** No

**Associated Part Family:** CY7C64713/14

CY7C68013A/14A/15A/16A

CY7C68023/24

CY7C68053

CY7C68300C/301C/320C/321C

CY7C65620/30

**Software Version:** N/A

**Associated Application Notes:** None

### Abstract

This application note is intended to delineate the requirements of the associate crystal and the use of a resonator in designing with the Cypress USB parts.

### Introduction

Most of the parts covered by this application note are high-speed USB device interface integrated circuits, the one exception is the CY7C64713/14 parts. The basic requirement in this series of part is that the crystal requirements are driven by the USB specification requirement for bit rate stability. The primary control of this is the clock input.

### Input Clock Requirement

The requirement for high-speed USB data rate is that the bit rate accuracy must be at most  $\pm 500$  ppm. Most of the Cypress data sheets state that the crystal input be  $\pm 100$  ppm.

If you summarize the common requirements of the crystal for these chips, the following requirements are listed:

- 24 MHz
- Parallel Resonant
- Fundamental Mode
- 500  $\mu$ W Drive Level
- 12-pF (5% tolerance) Load Capacitor

One other requirement is:

- Crystal Tolerance of  $\pm 100$  ppm or  $\pm 500$  ppm

This one requirement really stems from the USB requirement, which is driven by several components, the first of which is the USB bit rate accuracy. Other items that contribute to this and must be considered are the ppm accuracy of the crystal, the effects of crystal aging on the accuracy of the crystal, the tolerance of the load capacitors used, and the effects of the chip itself on this accuracy.

When designing with an oscillator as the input to the crystal input, the crystal output pin is always left open. The frequency tolerance on this input must be sufficiently low to stay within the USB specification on the bit rate tolerance of  $\pm 500$  ppm.

Likewise, when designing with resonators or crystals the overall design must keep the frequency bit rate within the USB specification of  $\pm 500$  ppm.

The crystal requirements have been selected to cover the variations from both the crystal and the capacitors. When using the resonators, both parts have been included within a single part and, therefore, the wider band of tolerance can be used.

## Resonators

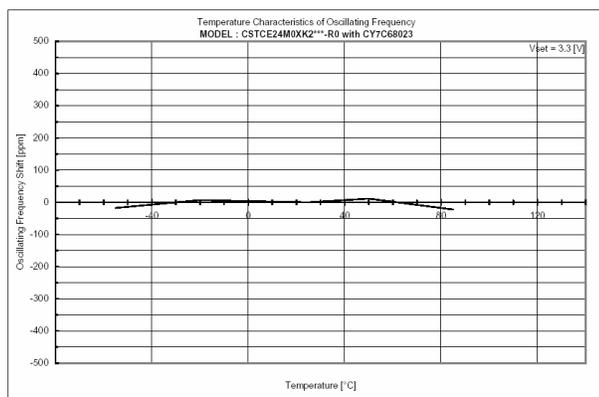
Many of the resonators currently on the market do not have a tight enough tolerance to operate within the requirements of the high-speed bit rate. One resonator that does meet the USB-IF requirement is the Murata CSTCE24M. This part has an initial tolerance of  $-250$  ppm to  $+200$  ppm.

The CSTCE24M series contains internal load capacitors and is trimmed to ensure the proper operating frequencies. Therefore, Murata will match this part to your circuit design.

Cypress has tested the Murata CSTCE24M0XK2\*\*\*-R0 and can recommend its use for the part listed. The part number for the resonator carries three digits labeled “\*\*\*”. These numbers are to be assigned to match the impedance characteristics of the PCB. If a layout is standardized and characterized, the same option number can be used on all boards.

## Operational Characteristics

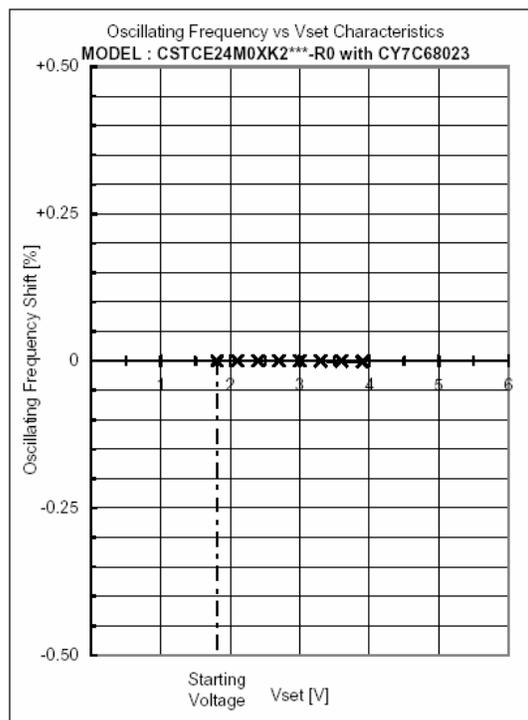
Test results from this family of USB parts were found to operate well within the USB limits. Across the operating temperature of the USB parts, the resonator’s variation is well within the requirements of the USB specification and is listed in the figure below.



Jitter measurements taken from the standard high-speed signal quality measurements showed that this part contributes to the jitter measurements in the same order as

that of the crystals that Cypress has used in the past and, therefore, come well within the limits of operation as a source for the clocks on these parts.

The variations in the oscillating frequency versus voltage were also within limits and are displayed in the figure below.



The Murata resonator’s size is listed as  $3.2 \times 1.3 \times 1$  mm.

## Conclusions

The resonator is a small package, which also reduces the external part count. The resonator has internal load capacitors and therefore saves the additional space of the load capacitors that crystals require as external components. The Murata resonator (part number CSTCE24M0XK2\*\*\*-R0) can be used with the Cypress USB family of parts listed above and meets the requirements that Cypress has for these parts to function properly.

## Document History

**Document Title: Using a Resonator for USB - AN6070**

**Document Number: 001-66117**

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	3116858	CSAI	12/21/2010	Obtain spec. # for note to be added to spec. system. This note had no technical updates.

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