Freescale Semiconductor, Inc.

MOTOROLA
intelligence everywhere™

digital dna✳™

By: Jim Feddeler
Motorola 8/16 Bit Division

Introduction

This bulletin addresses the usage of OSC2 or XTAL as a clock output (as the clock input to other devices) in applications using the Motorola M68HC05, M68HC08, M68HC11, and M68HC12/HCS12 Families of microcontrollers. This bulletin applies to all microcontrollers in these families, regardless of fabrication facility, memory type (ROM, OTP, EPROM, EEPROM, or FLASH), peripheral set, or package, unless specifically documented otherwise in the microcontroller's specification or datasheet. It is Motorola's position that the usage of the OSC2 output (on the M68HC05 and M68HC08 Families) or the XTAL output (on the M68HC11 and M68HC12/HCS12 Families) for any purpose other than as a completion of the quartz resonator, ceramic resonator, or RC oscillator circuit (as appropriate per microcontroller) is not recommended and may lead to application failure.

Description of Intended Functionality of OSC2/XTAL

The OSC2/XTAL output on these microcontroller families is the output of a transconductance amplifier, which is necessary to provide the gain and phase requirements of an oscillation circuit. The external oscillation circuit consists of either a resonator (quartz or ceramic) with necessary components or RC oscillator components configured as documented in the microcontroller specification. The OSC1 (on M68HC05 and M68HC08 Families) or EXTAL (on M68HC11 and M68HC12/HCS12 Families) pin completes the circuit by connecting to the input of the transconductance amplifier.

Because the OSC2/XTAL pin is designed to provide necessary transconductance to the oscillator circuit, its drive characteristics are not compatible with typical port pins. Particularly, to ensure that the drive strength of the amplifier does not exceed the maximum drive power of the crystal or the maximum gain allowed for oscillation to start, the drive characteristics are weaker and not compatible with the V_{IL}/V_{IH} requirements of the input pins of

most other products. In many cases, the OSC2/XTAL output will not swing full-rail and may have a significant offset from either V_{SS} or V_{DD}. These characteristics are acceptable to the internal oscillator circuit. In fact, a less than full-rail sinusoid output on OSC2/XTAL is desirable because drive power and noise emissions are reduced.

Possible Failure Mode if OSC2/XTAL Are Used Incorrectly

Because the OSC2/XTAL output may not swing full-rail, any application using OSC2/XTAL as an input to another product may observe failure of that product due to violation of that product's V_{IH}/V_{IL} specification. Unless specifically mentioned otherwise in the microcontroller's documentation, there are no written or implied specifications on the output swing of OSC2/XTAL, so this does not represent a violation of the intended performance of the microcontroller.

Because the drive strength of the OSC2/XTAL pin is weaker and the offset is determined differently than on standard port pins, the levels observed will be more sensitive to voltage, temperature, capacitive or resistive loading, and routine variability in silicon processing. Because of this, the empirically observed levels on OSC2/XTAL of the microcontroller in application should not be used as a guarantee of robust or future operation. It is possible that a product which typically demonstrates full-rail output swing may demonstrate less-than-full-rail or offset output swing as a result of minor variations in the application, environment, or processing. This could lead to application failure in the field even after significant empirical evidence of functionality has been established.

Suggested Corrective Actions if OSC2/XTAL are Used Incorrectly

Applications using OSC2/XTAL as an input to another product in the application may exhibit sensitivity to slight variances in process, environment, or application. These applications should consider implementing one of the following courses of action to reduce susceptibility to failure:

- Use a separate clock source for the other product.
- Use an external clock generator (canned oscillator) to drive both the microcontroller and the other product.
- Use one of the microcontroller's functional outputs as a clock input for the other product. This may result in a different clock speed for the other product, depending on the specifications of the functional output. Refer to the microcontroller's documentation.

Conclusion

Applications using OSC2/XTAL for any purpose other than as a completion of a quartz or ceramic resonator or RC oscillator circuit may be sensitive to normal variations in process, temperature, voltage, loading, or other parasitics. This sensitivity may exist on any product in the M68HC05, M68HC08, M68HC11, or M68HC12/HCS12 product families, regardless of silicon processing location, memory type, or peripheral set. This sensitivity does not create a functionality issue provided the OSC2/XTAL output is being used in its intended manner. If OSC2/XTAL outputs are used incorrectly, corrective action may be necessary to avoid application failures.

HOW TO REACH US:

USA/EUROPE/LOCATIONS NOT LISTED:

Motorola Literature Distribution;
P.O. Box 5405, Denver, Colorado 80217
1-303-675-2140 or 1-800-441-2447

JAPAN:

Motorola Japan Ltd.; SPS, Technical Information Center,
3-20-1, Minami-Azabu Minato-ku, Tokyo 106-8573 Japan
81-3-3440-3569

ASIA/PACIFIC:

Motorola Semiconductors H.K. Ltd.;
Silicon Harbour Centre, 2 Dai King Street,
Tai Po Industrial Estate, Tai Po, N.T., Hong Kong
852-26668334

TECHNICAL INFORMATION CENTER:

1-800-521-6274

HOME PAGE:

http://www.motorola.com/semiconductors

Information in this document is provided solely to enable system and software implementers to use Motorola products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part.

MOTOROLA

Motorola and the Stylized M Logo are registered in the U.S. Patent and Trademark Office. digital dna is a trademark of Motorola, Inc. All other product or service names are the property of their respective owners. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

© Motorola, Inc. 2002