

FM3 Microcontroller Temperature Correction Method for High-Speed CR Oscillator

Associated Part Family:	Series Name	Product Number
	MB9B520M	MB9BF521K/522K/524K/521L/522L/524L/521M/522M/524M
	MB9B320M	MB9BF321K/322K/324K/321L/322L/324L/321M/322M/324M
	MB9B120M	MB9BF121K/122K/124K/121L/122L/124L/121M/122M/124M

High-speed CR oscillators mounted to FM3 products can adjust the offset of the frequency and reduce the frequency fluctuation due to the temperature by setting the trimming function.

Contents

1	Introduction.....	1	3.3	Example of Use Procedures for CR Trimming Area Stored Data in Flash Memory	3
2	Preface	1	3.4	High-speed CR Oscillation/Temperature Trimming Setting Register (MCR_TTRM)	4
3	Temperature Correction Method for High-speed CR Oscillator	2	3.5	Register Map	5
3.1	High-speed CR Oscillator Temperature Trimming Method	2	3.6	Usage Precautions	5
3.2	High-speed CR Trimming Function Setting Procedure Example.....	2	4	Document History.....	6
				Worldwide Sales and Design Support.....	7

1 Introduction

2 Preface

High-speed CR oscillators mounted to FM3 products can adjust the offset of the frequency and reduce the frequency fluctuation due to the temperature by setting the trimming function.

The high-speed CR trimming function is composed of the frequency trimming setting unit and the temperature trimming setting unit and has the functions below:

Frequency Trimming Setting Unit

The frequency offset of high-speed CR can be adjusted by writing the trimming value in the frequency trimming register (MCR_FTRM).

The setting value to the frequency trimming register can be calculated from the count value within a fixed period by using the input capture or the base timer.

Temperature Trimming Setting Unit

the temperature correction of high-speed CR can be executed by writing the trimming value in temperature trimming register (MCR_TTRM).

This application note explains the method of the temperature correction for the high-speed CR trimming.

For the frequency correction method, see "CHAPTER2-2 High-speed CR Trimming" in 'FM3 Family Peripheral Manual'.

3 Temperature Correction Method for High-speed CR Oscillator

3.1 High-speed CR Oscillator Temperature Trimming Method

The error of the high-speed CR clock due to the temperature variation can be corrected by writing trimming data value in the temperature trimming setting register (MCR_TTRM).

For the data to be written to the temperature trimming setting register (MCR_TTRM), use the value stored in "Temperature trimming data area" of the flash memory when shipped from the factory or use the value of the TTRMM bit of CR trimming data mirror register (CRTRMM).

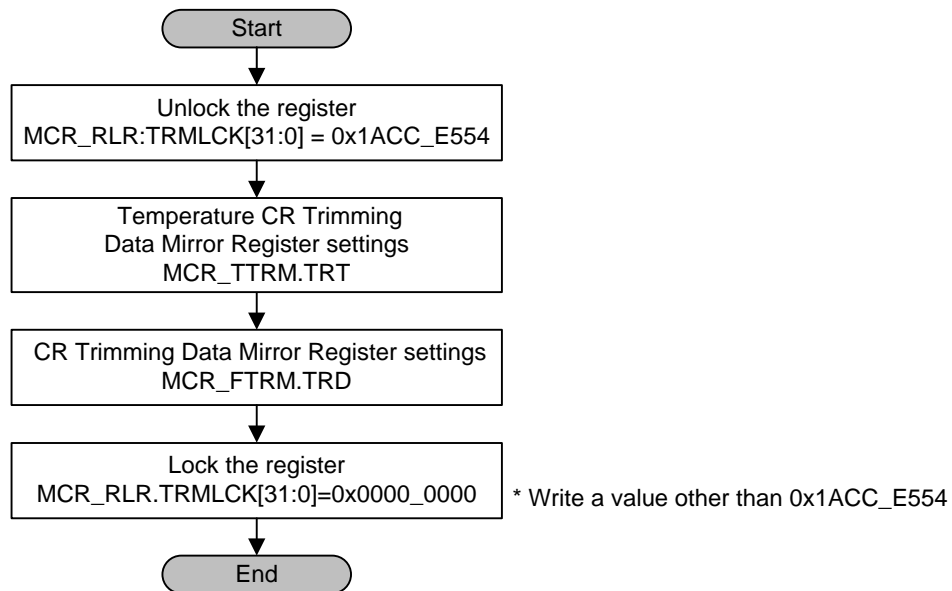
Regarding the address of "Temperature trimming data area", refer to the "MB9AB40N/A40N/340N/140N/150R/MB9B520M/320M/120M series flash programming manual".

3.2 High-speed CR Trimming Function Setting Procedure Example

The example of the setting procedure for the temperature correction is shown below.

1. Write "0x1ACCE554" in TRMLCK [31:0] bits of high-speed CR oscillation register write protect register (MCR_RLR), and release the lock of frequency trimming setting register (MCR_FTRM)/temperature trimming setting register (MCR_TTRM).
2. Set the trimming data to the TRT bit of temperature trimming setting register (MCR_TTRM).
3. Set the TRD bit of frequency trimming setting register (MCR_FTRM).
4. Write the value of "other than 0x1ACCE554" in TRMLCK[31:0] bits of high-speed CR oscillation register write protection register (MCR_RLR), and lock the frequency trimming setting register (MCR_FTRM)/temperature trimming setting register (MCR_TTRM).

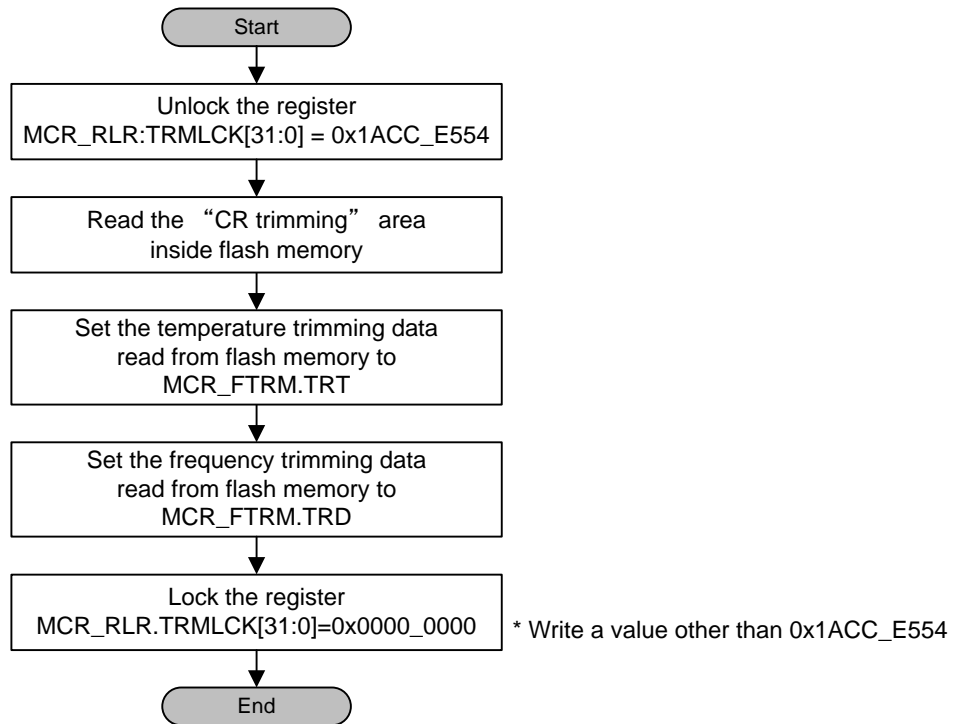
Figure 1. Frequency/Temperature Trimming Data Setting



3.3 Example of Use Procedures for CR Trimming Area Stored Data in Flash Memory

The procedure example of reading the trimming data stored in “CR trimming area” of the flash memory and setting them to the frequency trimming setting register and the temperature trimming setting register is shown in Figure 2 as follows.

Figure 2. Procedure Example of Using Temperature Trimming Data Area Stored Data



Note: For the address of "Temperature Trimming data area", see "MB9AB40N/A40N/340N/140N/150R/MB9B520M/320M/120M Series Flash Programming Manual".

3.4 High-speed CR Oscillation/Temperature Trimming Setting Register (MCR_TTRM)

The MCR_TTRM register sets the temperature trimming value.

This section explains the resistor configuration and functions.

Register Configuration

bit	31									16
Field	Reserved									
Attribute	-									
Initial value	-									
bit	15				5	4	3	2	1	0
Field	Reserved					TRT[4:0]				
Attribute	-					R/W				
Initial value	-					01111				

Register Functions

[bit31:5] Reserved: Reserved bits

“0” is always read.

Writing is ignored.

[bit4:0] Temperature Trimming Setting Bits

Bit4:0	Description
Writing	This bit corrects the frequency fluctuation due to the temperature. Write the value which is read from the temperature trimming bit stored area in the flash memory. For the value written to the temperature trimming setting bits, see "2.1 High-speed CR Oscillator Temperature Trimming Setting".
Reading	The set value is read. For the initial value, "0b01111" is read.

Note: - This register is not initialized by software reset.

Note: - To obtain the frequency trimming data, be sure to make the setting of this register in advance.

3.5 Register Map

For the register map of the high-speed CR trimming function, see Table 1.

Table 1. High-speed CR Trimming Function Register Map

0x4002_E000 + Address	Register			
	+3	+2	+1	+0
0x000	-	-	-	MCR_PSR[B,H,W] -----01
0x004	-	-	MCR_FTRM[B,H,W] -----10 00000000	
0x008	-	-	-	MCR_TTRM[B,H,W] ---01111
0x00C	MCR_RLR[W] 00000000 00000000 00000000 00000001			
0x010 - 0x0FC	-	-	-	-

3.6 Usage Precautions

Data stored in “CR Trimming” area

In “CR Trimming” area, the frequency/temperature trimming data defined at shipping from the factory. For addresses of “CR Trimming” area, see the following manual.

“ MB9AB40N/A40N/340N/140N/150R/MB9B520M/320M/120M Flash Programming Manual”

By erasing the data in the flash memory, the data in “CR Trimming” area are also erased. To use the data in “CR Trimming” area after erasing the data in the flash memory, save the data in “CR Trimming” area to a different area such as RAM area etc. before erasing the data.

Or, erase the sectors in areas other than “CR Trimming” area.

Oscillation Frequency Accuracy of High-speed CR Oscillator

Be sure to set either high-speed CR oscillation temperature trimming setting register (MCR_TTRM) or high-speed CR oscillation frequency trimming setting register (MCR_FTRM) for the product supporting the temperature correction function. Because the accuracy of high-speed CR oscillator described in the data sheet cannot be guaranteed when both registers are not set with the product supporting the temperature correction function.

4 Document History

Document Title: AN204425 - FM3 Microcontroller Temperature Correction Method for High-speed CR Oscillator

Document Number: 002-04425

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	—	YUIS	02/08/2013 to 01/31/2014	Initial Release Company name and layout design change
*A	5034368	YUIS	12/03/2015	Converted Spansion Application Note AN706-00064 to Cypress format
*B	5868612	YSAT	08/31/2017	Adapted new cypress logo

Worldwide Sales and Design Support

Cypress maintains a worldwide network of offices, solution centers, manufacturer's representatives, and distributors. To find the office closest to you, visit us at [Cypress Locations](#).

Products

ARM® Cortex® Microcontrollers	cypress.com/arm
Automotive	cypress.com/automotive
Clocks & Buffers	cypress.com/clocks
Interface	cypress.com/interface
Internet of Things	cypress.com/iot
Memory	cypress.com/memory
Microcontrollers	cypress.com/mcu
PSoC	cypress.com/psoc
Power Management ICs	cypress.com/pmic
Touch Sensing	cypress.com/touch
USB Controllers	cypress.com/usb
Wireless/RF	cypress.com/wireless

PSoC® Solutions

[PSoC 1](#) | [PSoC 3](#) | [PSoC 4](#) | [PSoC 5LP](#) | [PSoC 6](#)

Cypress Developer Community

[Community](#) | [Forums](#) | [Blogs](#) | [Video](#) | [Training](#)

Technical Support

cypress.com/go/support

All other trademarks or registered trademarks referenced herein are the property of their respective owners.



Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

© Cypress Semiconductor Corporation, 2013-2017. This document is the property of Cypress Semiconductor Corporation and its subsidiaries, including Spansion LLC ("Cypress"). This document, including any software or firmware included or referenced in this document ("Software"), is owned by Cypress under the intellectual property laws and treaties of the United States and other countries worldwide. Cypress reserves all rights under such laws and treaties and does not, except as specifically stated in this paragraph, grant any license under its patents, copyrights, trademarks, or other intellectual property rights. If the Software is not accompanied by a license agreement and you do not otherwise have a written agreement with Cypress governing the use of the Software, then Cypress hereby grants you a personal, non-exclusive, nontransferable license (without the right to sublicense) (1) under its copyright rights in the Software (a) for Software provided in source code form, to modify and reproduce the Software solely for use with Cypress hardware products, only internally within your organization, and (b) to distribute the Software in binary code form externally to end users (either directly or indirectly through resellers and distributors), solely for use on Cypress hardware product units, and (2) under those claims of Cypress's patents that are infringed by the Software (as provided by Cypress, unmodified) to make, use, distribute, and import the Software solely for use with Cypress hardware products. Any other use, reproduction, modification, translation, or compilation of the Software is prohibited.

TO THE EXTENT PERMITTED BY APPLICABLE LAW, CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT OR ANY SOFTWARE OR ACCOMPANYING HARDWARE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. To the extent permitted by applicable law, Cypress reserves the right to make changes to this document without further notice. Cypress does not assume any liability arising out of the application or use of any product or circuit described in this document. Any information provided in this document, including any sample design information or programming code, is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. Cypress products are not designed, intended, or authorized for use as critical components in systems designed or intended for the operation of weapons, weapons systems, nuclear installations, life-support devices or systems, other medical devices or systems (including resuscitation equipment and surgical implants), pollution control or hazardous substances management, or other uses where the failure of the device or system could cause personal injury, death, or property damage ("Unintended Uses"). A critical component is any component of a device or system whose failure to perform can be reasonably expected to cause the failure of the device or system, or to affect its safety or effectiveness. Cypress is not liable, in whole or in part, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from or related to all Unintended Uses of Cypress products. You shall indemnify and hold Cypress harmless from and against all claims, costs, damages, and other liabilities, including claims for personal injury or death, arising from or related to any Unintended Uses of Cypress products.

Cypress, the Cypress logo, Spansion, the Spansion logo, and combinations thereof, WICED, PSoC, CapSense, EZ-USB, F-RAM, and Traveo are trademarks or registered trademarks of Cypress in the United States and other countries. For a more complete list of Cypress trademarks, visit cypress.com. Other names and brands may be claimed as property of their respective owners.