Renesas Synergy™ Platform

S7G2 MCU Oscillation Stop Detection using CAC

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Introduction

This application note explains how to use the Clock Frequency Accuracy Measurement Circuit (CAC) to detect stopped oscillation.

Target Device

Renesas Synergy™ S7G2 MCU Group

Contents

1. Overview

There are two ways to detect an oscillation stop:

1. Use the oscillation stop detection circuit (See the Oscillation Stop Detection function in the *SSP User's Manual*)
2. Use the CAC frequency counter circuit and detect the clock oscillation stop through its error interrupt (CAC_FERRI)

This application note explains the second method. The CAC has a frequency error interrupt that can be used for oscillation stop detection.

In the CAC function, the target clock is the Main Oscillator, and the reference clock is MOCO or HOCO (see figure below).

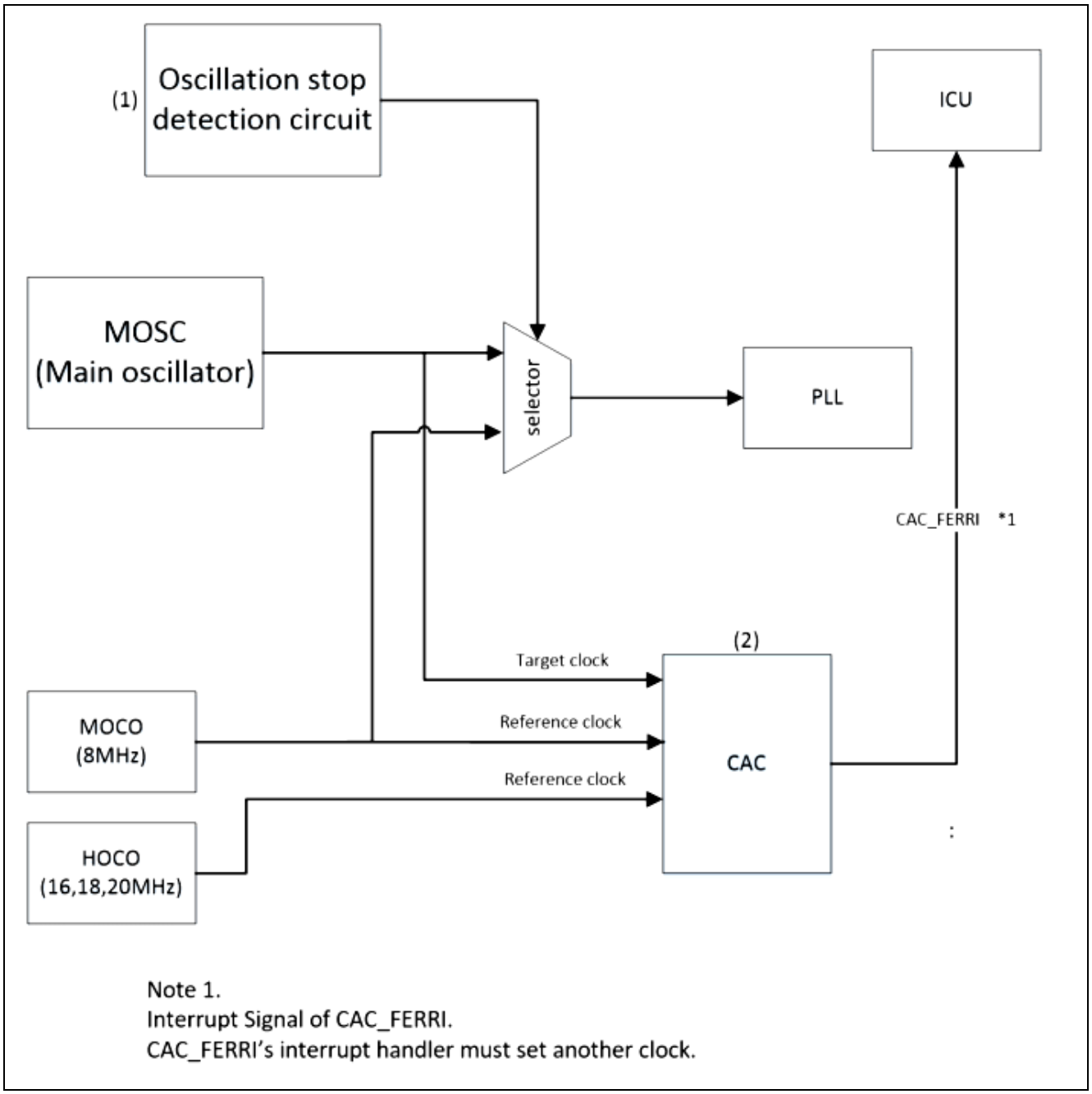

Figure 1 Oscillation stop detection by CAC

2. Oscillation Stop Detection by CAC Frequency Error Interrupt (CAC_FERRI)

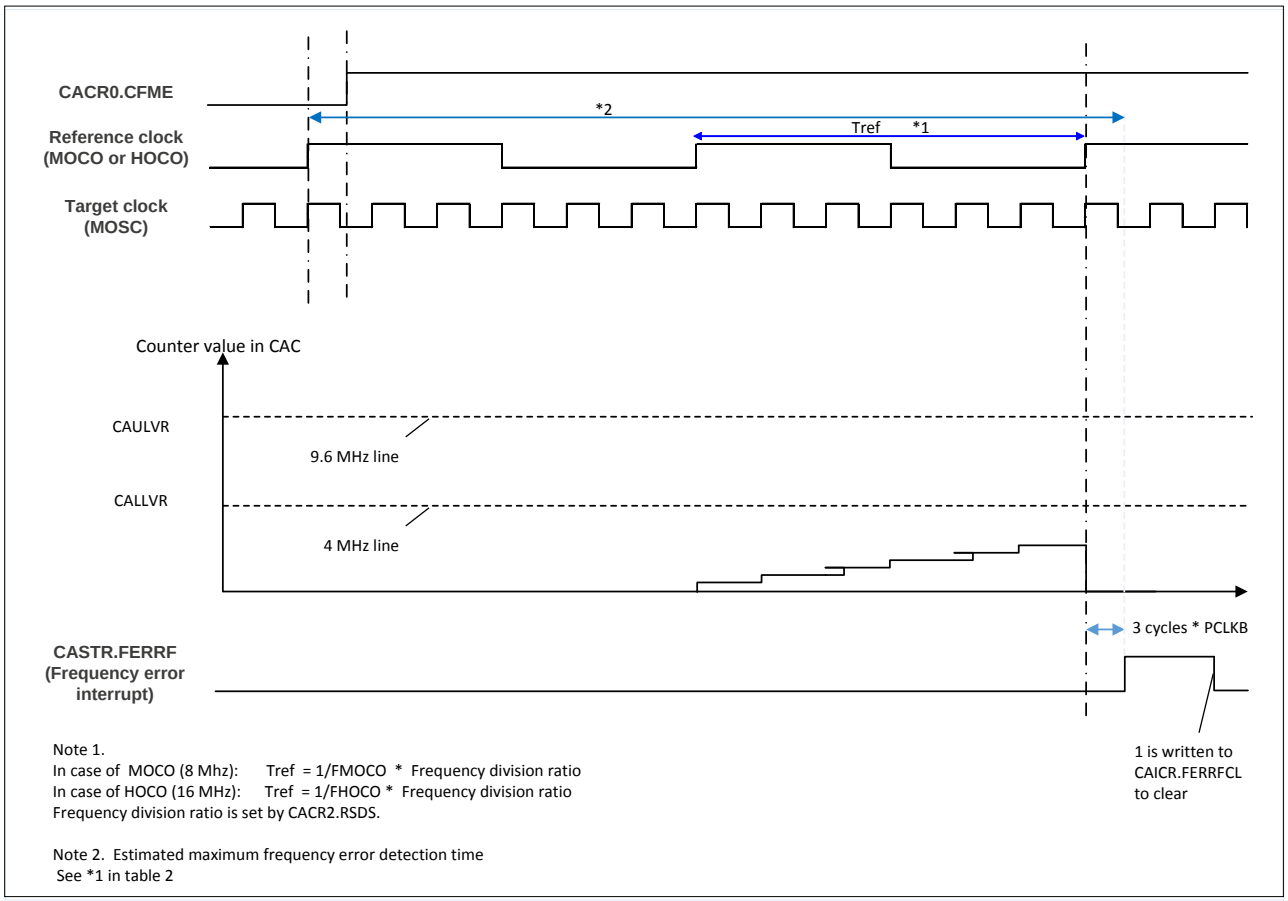

Figure 2 CAC frequency error interrupt for oscillation detection stop

The CAC counts Main Oscillator clock pulses to check the frequency. If the MOSC's frequency is irregular, it triggers the frequency error interrupt. The interrupt can be used for oscillation stop detection.

3. CAC Operation for Frequency Error Interrupt (CAC_FERRI)

3.1 CAC Register Initial Setting

Table 1 is an example of the CAC's register initial settings. Section 3.2 shows the settings and data flow for CAC operation.

Table 1 Example of initial settings for CAC register (MOSC = 8 MHz, MOCO = 8 MHz or HOCO = 16 MHz)

Register name	Bit setting	Notes
CACR0	CFME = 1	Clock frequency measurement enable
CACR1	FMCS = 011b	Measurement target clock = MOSC
CACR2	RPS = 1	1 = Internal clock
	RSCS = 011b or 010b	Measurement reference clock 011b = MOCO clock 010b = HOCO clock
	RSDS = 10b	Measurement reference clock frequency division ratio select 10b = 1/1024 clock*1
CAICR	FERRIE = 1	Frequency error interrupt request enable
CAULVR	In case of MOCO (8 MHz) CAULVR = 1228d = 4cch	CAULVR is set as 9.6 MHz

Register name	Bit setting	Notes
	In case of HOCO (16 MHz) CAULVR = 614d = 266h	
CALLVR	In case of MOCO (8 MHz) CALLVR = 512d = 200h In case of HOCO (16 MHz) CALLVR = 256d = 100h	CALLVR is set as 4 MHz

Note: See Table 2 for details.

3.2 CAC Operation Flow

Figures 3 and 4, below show an example of the flow for the frequency error interrupt used for oscillation stop detection by CAC.

- Target clock is MOSC (8 MHz)
- The reference clock is MOCO (8 MHz) or HOCO (16 MHz) which is divided
- Use the Frequency error interrupt when MOSC is less than 4 MHz

In the Figure 3 and Figure 4, (3) – (7) are the initial settings for the CAC. After that, if the frequency error occurs at (8), flow passes to the interrupt handler of CAC_FERRI which sets another system clock by software.

Figure 3 shows the case of reference clock MOCO (8 MHz).

Figure 4 shows the case of reference clock HOCO (16 MHz).

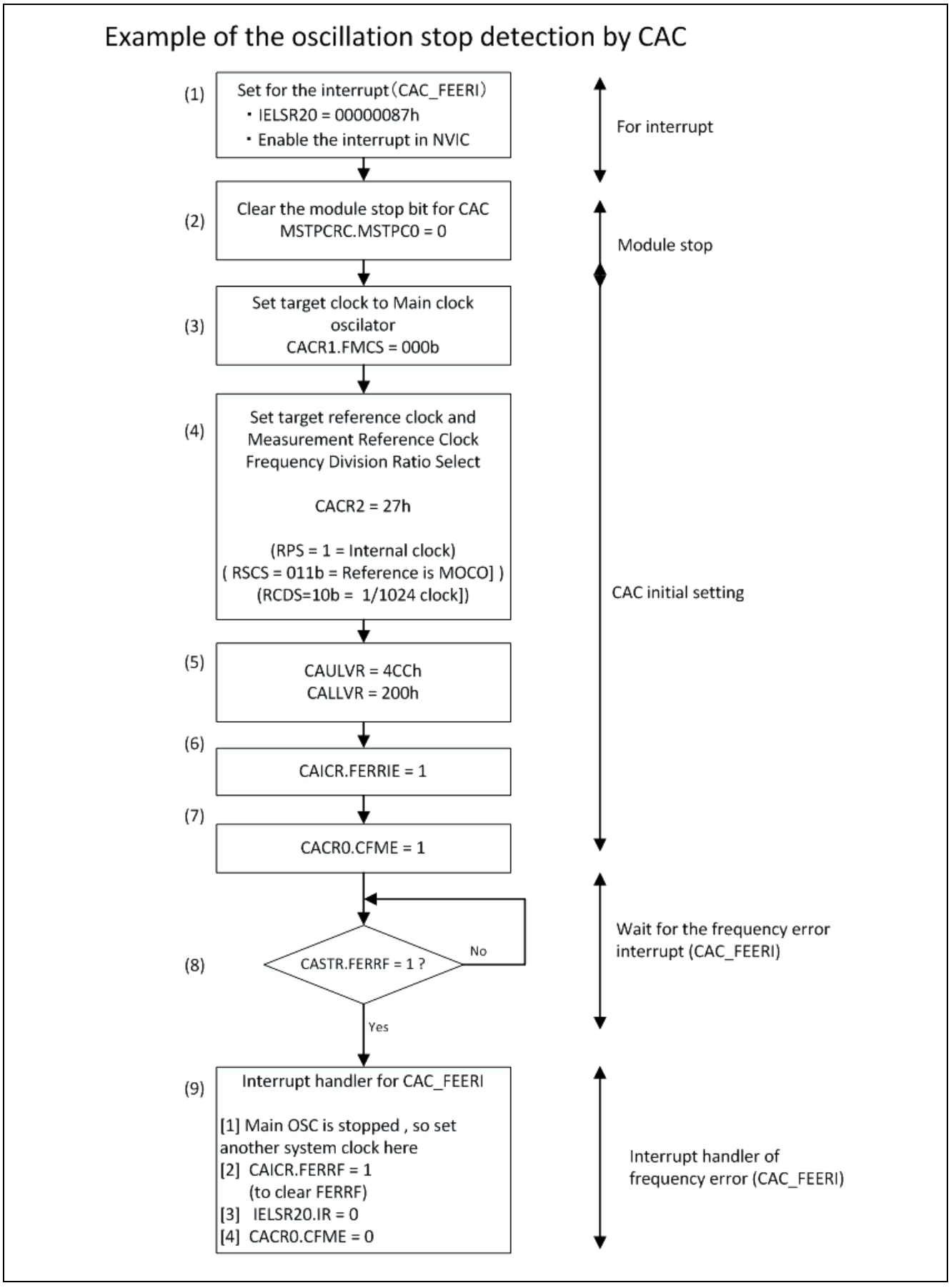

Figure 3 CAC frequency error interrupt for oscillation stop detection (Reference Clock is 8 MHz MOCO)

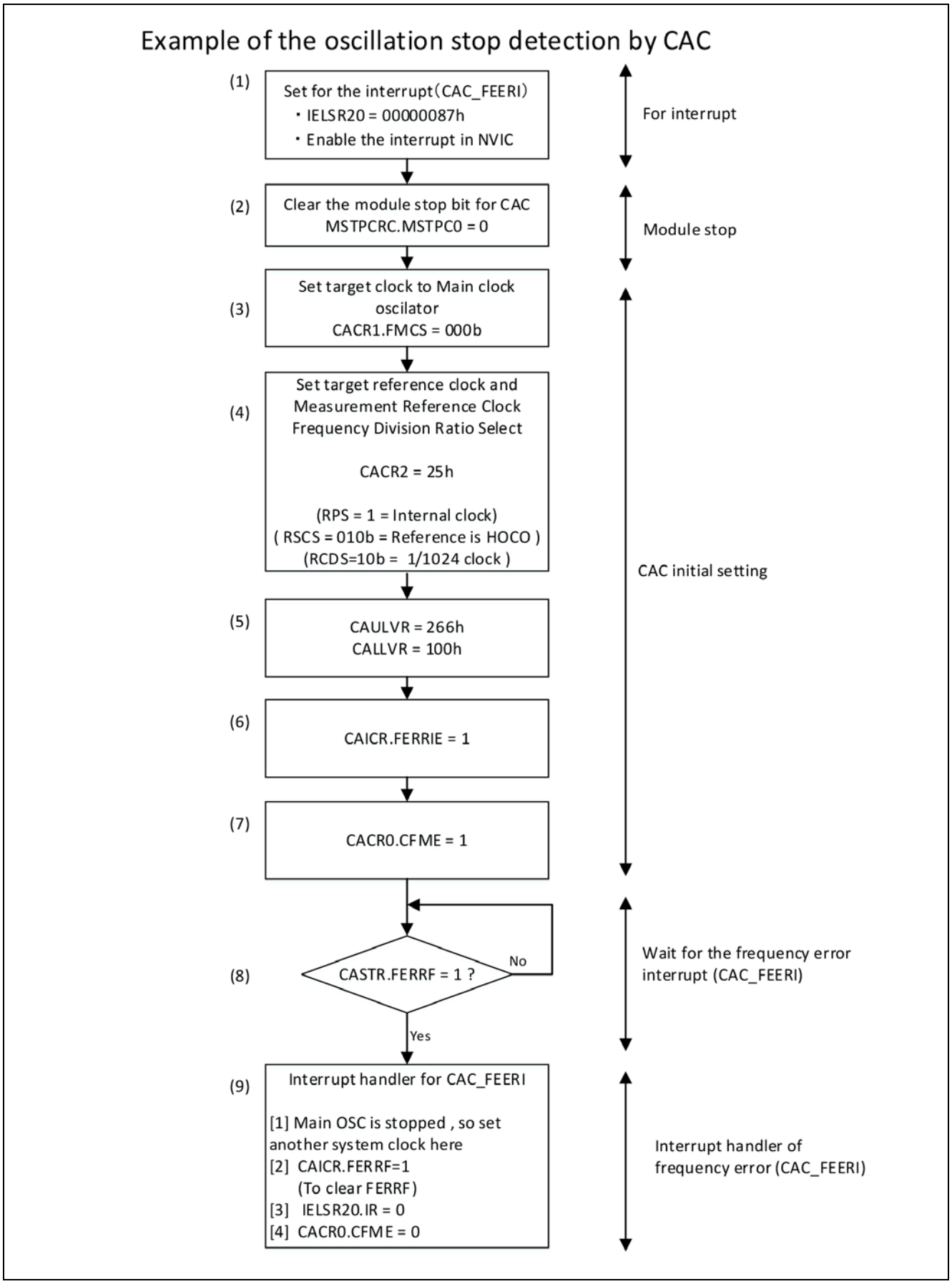

Figure 4 CAC Frequency Error Interrupt for Oscillation Stop Detection (Reference Clock is 16 MHz HOCO)

4. Usage Notes

4.1 Estimated maximum frequency error detection time

Table 2 shows the estimated maximum frequency error detection time.

Table 2 CAC frequency error detection time

- Measurement clock: Main Oscillator Clock (MOSC) (8 MHz)
- Criteria for oscillation stopping: Main Oscillator Clock ≦ 4 MHz

Case	Reference clock (RSCS[2:0])	Division ratio (RCDS[1:0])	Estimated maximum frequency error detection time (µs)*1
1	MOCO (8 MHz)	x 32	20.9
2	MOCO (8 MHz)	x 128	47.6
3	MOCO (8 MHz)	x 1024	296.5
4	MOCO (8 MHz)	x 8192	2287.5
5	HOCO (16 MHz)	x 32	16.2
6	HOCO (16 MHz)	x 128	28.5
7	HOCO (16 MHz)	x 1024	144.0
8	HOCO (16 MHz)	x 8192	1067.7

Note: See *2 in Figure 2.

The calculation formula is:

$$\frac{1}{(F \times freq\_accuracy)} \times Division\_ratio \times 2 + PCLKB \times 3$$

F (clock frequency): MOCO (8 MHz), HOCO (16 MHz)
freq_accuracy (frequency accuracy): MOCO (0.9), HOCO (0.97)
*PCLKB * 3* = (1/8 MHz * 32) *3 = (125 ns * 32) *3 = 12 µs

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Jun 21, 2016	-	Initial version
1.01	Nov 18, 2016	-	Minor format changes
1.02	Jun 22, 2017	-	Minor format changes
1.04	Jul 6, 2017	-	Minor interrupt name changes
1.05	Jul 25, 2017	-	Initial release

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