RX63N Group, RX631 Group

How to Detect Abnormal Frequencies in the Main Clock

R01AN1069EJ0100
Rev. 1.00
Apr. 05, 2013

Abstract

This document describes how to use the frequency measurement circuit (MCK) and multi-function timer pulse unit 2 (MTU) to detect abnormal frequencies in the main clock.

Products

RX63N Group, 176-Pin and 177-Pin Packages, ROM Capacities: 768 Kbytes to 2 Mbytes

RX63N Group, 144-Pin and 145-Pin Packages, ROM Capacities: 768 Kbytes to 2 Mbytes

RX63N Group, 100-Pin Package, ROM Capacities: 768 Kbytes to 2 Mbytes

RX631 Group, 176-Pin and 177-Pin Packages, ROM Capacities: 256 Kbytes to 2 Mbytes

RX631 Group, 144-Pin and 145-Pin Packages, ROM Capacities: 256 Kbytes to 2 Mbytes

RX631 Group, 100-Pin Package, ROM Capacities: 256 Kbytes to 2 Mbytes

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Specifications

This document describes how to detect abnormal frequencies in the main clock using the MCK and MTU. When using the MCK, a clock source independent of the system clock can be selected as the reference clock.

The oscillation frequency of the main clock which is the count source of the PLL circuit is measured using the sub-clock. If the result of the measurement falls within the permissible range of the frequency error, the oscillation frequency is determined to be normal; if the results of the measurement fall outside the permissible range of the frequency error, the oscillation frequency is determined to be abnormal.

This measurement is only performed once, and the result is stored in the global variable.

In this application note, the cycle of the frequency measured is approximately 15.6 ms (sub-clock divided by 512). The permissible range of the frequency error is ±10% of the standard value.

Table 1.1 lists the Peripheral Functions and Their Applications, Figure 1.1 shows the Block Diagram, and Figure 1.2 shows the Operation Overview.

Table 1.1 Peripheral Functions and Their Applications

Peripheral Function	Application
MCK	Selects the reference clock for the frequency measurement
MTU2a channel 0 (MTU0)	Generates the cycle of the frequency measurement
MTU2a channel 1 (MTU1)	Obtains the result of the frequency measured

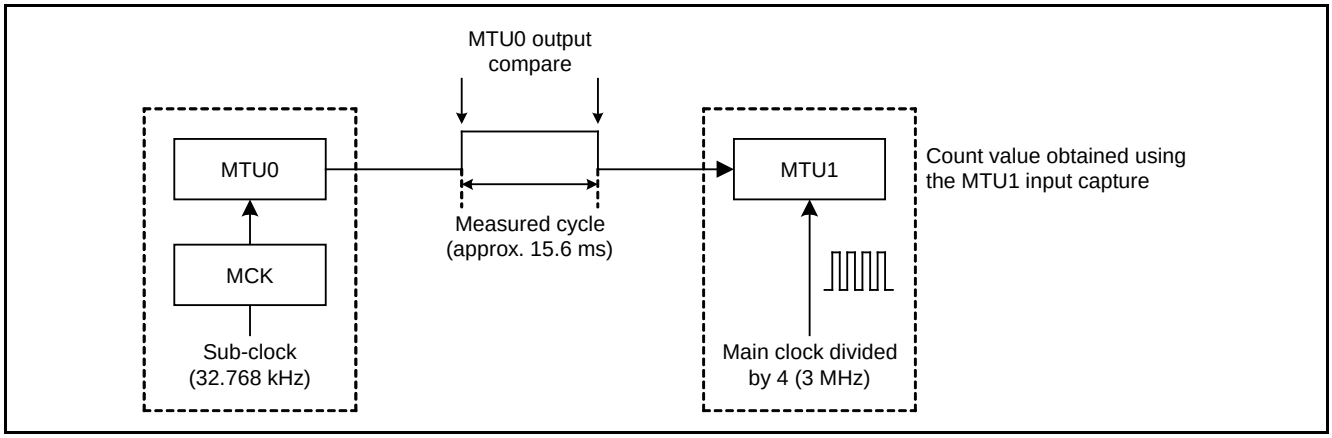

Figure 1.1 Block Diagram

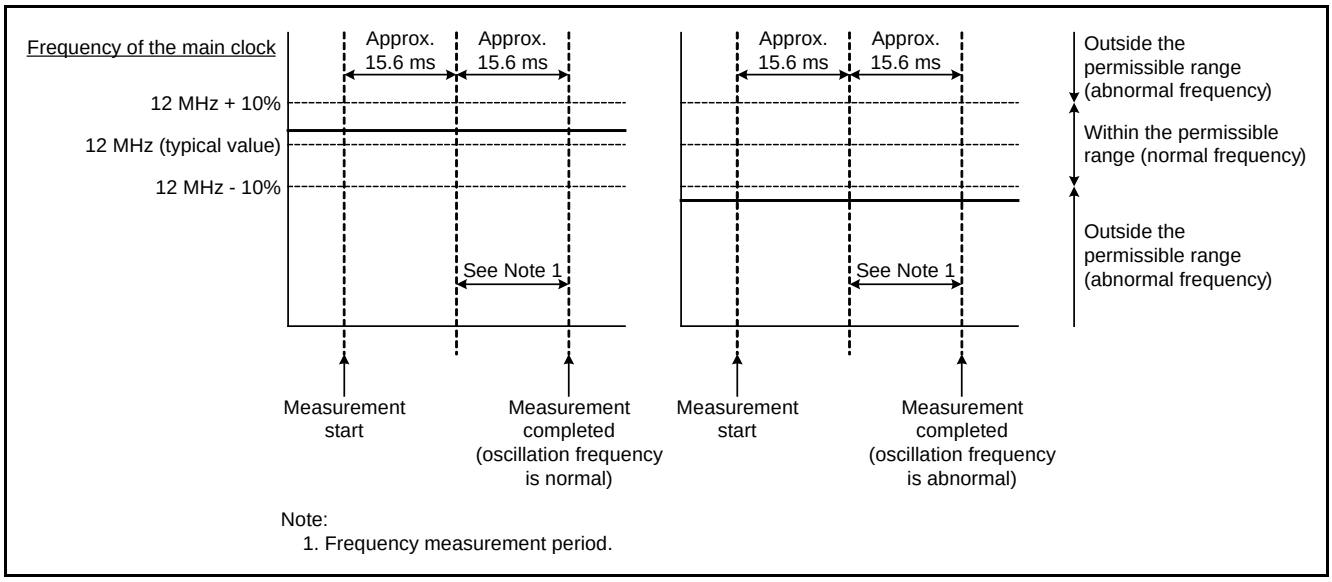

Figure 1.2 Operation Overview

2. Operation Confirmation Conditions

The sample code accompanying this application note has been run and confirmed under the conditions below.

Table 2.1 Operation Confirmation Conditions

Item	Contents
MCU used	R5F563NBDDFC (RX63N Group)
Operating frequencies	• Main clock: 12 MHz • Sub-clock: 32.768 kHz • PLL: 192 MHz (main clock divided by 1 and multiplied by 16) • System clock (ICLK): 96 MHz (PLL divided by 2) • Peripheral module clock B (PCLKB): 48 MHz (PLL divided by 4)
Operating voltage	3.3 V
Integrated development environment	Renesas Electronics Corporation High-performance Embedded Workshop Version 4.09.01
C compiler	Renesas Electronics Corporation C/C++ Compiler Package for RX Family V.1.02 Release 01
	Compile options -cpu=rx600 –output=obj="$(CONFIGDIR)¥$(FILELEAF).obj" -debug -nologo The default setting is used in the integrated development environment.
iodefine.h version	Version 1.50
Endian	Little endian
Operating mode	Single-chip mode
Sample code version	Supervisor mode
Board used	Version 1.00
Device used	Renesas Starter Kit for RX63N (product part number: R0K50563NC010BR)

3. Reference Application Note

For additional information associated with this document, refer to the following application note(s).

- RX63N Group, RX631 Group Initial Setting Rev. 1.00 (R01AN1245EJ0100_RX63N)

The initial setting functions used in the reference application note are used in the sample code attached to this document. The revision number of the reference application note is current at the time this document was created. When a more recent version of the reference application note is available, use the more recent version. The latest version can be downloaded from the Renesas Electronics website.

4. Software

Setting the frequency measurement start flag to 1 starts the frequency measurement. Determine the results of the measurement (MTU1.TGRA register value) in the MTU1 input capture A interrupt handling, set the frequency error detection flag, and set the frequency measurement complete flag to 1.

The criteria for determining the measurement result and the formula for calculating the measurement value are shown below.

Criteria for determining the measurement result

The frequency is normal when 42,187 ≤ measurement result ≤ 51,562 (42,187 is the standard value minus 10%, and 51,562 is the standard value plus 10%). The frequency is abnormal in all other cases.

Formula for calculating the measurement value

Standard value = Frequency measurement cycle ÷ MTU1 counter clock cycle

= (Reference clock cycle × frequency division ratio by MTU0) ÷ MTU1 counter clock cycle

= ((1 ÷ 32.768 kHz) × 512) ÷ (1/3 MHz)

= 46,875

Standard value minus 10% = Standard value × 0.9 = 42,187

Standard value plus 10% = Standard value × 1.1 = 51,562

Settings for the peripheral functions are listed below.

MCK

Reference clock: Sub-clock

MTU0

Counter clock: Rising edge of the MTCLKD pin input (sub-clock)

Operating mode: Normal mode

Timer general register (TGRA): Used as an output compare register. Set this register to "512 – 1" (frequency division ratio of the reference clock minus 1).

MTIOC0A pin: Output disabled

Counter clear: The TCNT counter is cleared by TGRA compare match.

Interrupts: Not used

MTU1

Counter clock: Rising edge of PCLKB divided by 16

Operating mode: Normal mode

Timer general register (TGRA): Used as an input capture register.

MTIOC1A pin: Input capture at generation of MTU0.TGRA compare match.

Counter clear: The TCNT counter is cleared by TGRA input capture.

Interrupts: TGR input request A (TGIA1) is used.

4.1 Operation Overview

(1) Initial setting
After the initial setting, set the frequency measurement start flag to 1.

(2) Start frequency measurement
Set the frequency measurement start flag to 0 and the frequency measurement complete flag to 0 to start count operations of MTU0 and MTU1.

(3) First MTU1 input capture A interrupt
An MTU1 input capture A interrupt occurs by a compare match with MTU0. Since the first MTU1.TGRA register value is invalid data, the data cannot be used and the interrupt handling is ended.

(4) Second MTU1 input capture A interrupt
Read the MTU1.TGRA register value (measurement result) and stop the MTU0 and MTU1 count operations. Determine the measurement result and set the frequency error detection flag. Set the frequency measurement complete flag to 1 to end the interrupt handling.

Figure 4.1 shows the Timing Diagram.

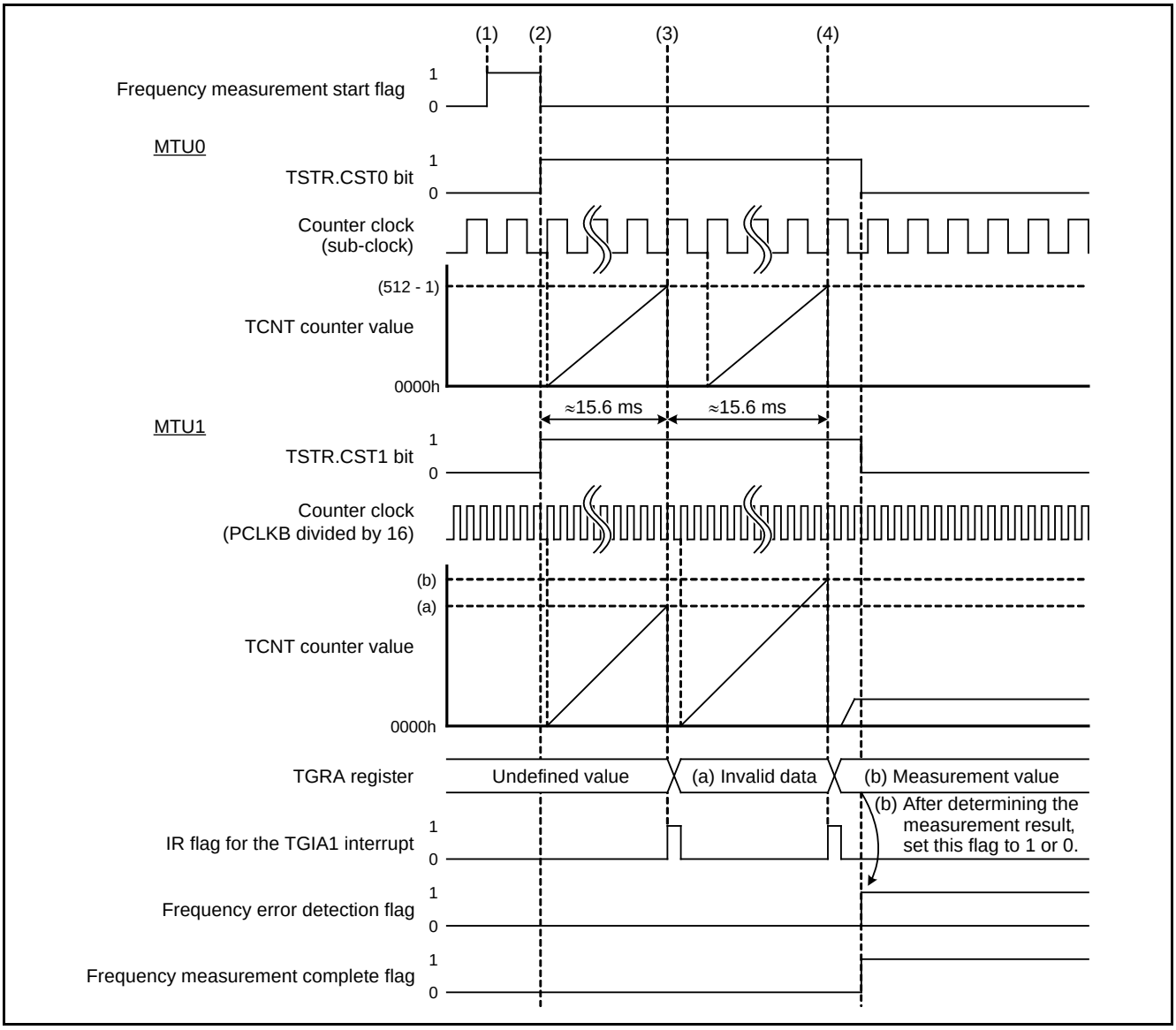

Figure 4.1 Timing Diagram

4.2 File Composition

Table 4.1 lists the Files Used in the Sample Code. Files generated by the integrated development environment are not included in this table.

Table 4.1 Files Used in the Sample Code

File Name	Outline
main.c	Main processing
r_init_stop_module.c	Stop processing for active peripheral functions after a reset
r_init_stop_module.h	Header file for r_init_stop_module.c
r_init_non_existent_port.c	Nonexistent port initialization
r_init_non_existent_port.h	Header file for r_init_non_existent_port.c
r_init_clock.c	Clock initialization
r_init_clock.h	Header file for r_init_clock.c

4.3 Option-Setting Memory

Table 4.2 lists the Option-Setting Memory Configured in the Sample Code. When necessary, set a value suited to the user system.

Table 4.2 Option-Setting Memory Configured in the Sample Code

Symbol	Address	Setting Value	Contents
OFS0	FFFF FF8Fh to FFFF FF8Ch	FFFF FFFFh	WDT and IWDT are stopped after a reset.
OFS1	FFFF FF8Bh to FFFF FF88h	FFFF FFFFh	After a reset, the voltage-monitoring 0 reset and HOCO oscillation are disabled
MDES	FFFF FF83h to FFFF FF80h	FFFF FFFFh	Little endian

4.4 Constants

Table 4.3 lists the Constants Used in the Sample Code.

Table 4.3 Constants Used in the Sample Code

Constant Name	Setting Value	Contents
MCK_DIV	512	Frequency division ratio for the reference clock
FREQ_MIN	42,187	Minimum value of the measurement result in the permissible range
FREQ_MAX	51,562	Maximum value of the measurement result in the permissible range

4.5 Variables

Table 4.4 lists the Global Variables.

Table 4.4 Global Variables

Type	Variable Name	Contents	Function Used
unsigned char	mck_start_flag	Frequency measurement start flag 0: Measurement start not requested 1: Measurement start requested	main
unsigned char	mck_end_flag	Frequency measurement complete flag 0: Premeasurement or midmeasurement 1: Measurement completed	mck_start Excep_MTU1_TGIA1
unsigned char	freq_err_flag	Frequency error detection flag 0: Normal frequency 1: Abnormal frequency	Excep_MTU1_TGIA1
unsigned char	mtu1_tgia1_cnt	MTU1 input capture A interrupt counter	mck_start Excep_MTU1_TGIA1

4.6 Functions

Table 4.5 lists the Functions.

Table 4.5 Functions

Function Name	Outline
main	Main processing
R_INIT_StopModule	Stop processing for active peripheral functions after a reset
R_INIT_NonExistentPort	Nonexistent port initialization
R_INIT_Clock	Clock initialization
peripheral_init	Initialize peripheral functions
mck_start	Start frequency measurement
Excep_MTU1_TGIA1	MTU1 input capture A interrupt handling

4.7 Function Specifications

The following tables list the sample code function specifications.

main	
Outline	Main processing
Header	None
Declaration	void main(void)
Description	After the initial setting, set the frequency measurement start flag to 1 and call the start frequency measurement function.
Arguments	None
Return value	None

R_INIT_StopModule	
Outline	Stop processing for active peripheral functions after a reset
Header	r_init_stop_module.h
Declaration	void R_INIT_StopModule(void)
Description	Configure the setting to enter the module-stop state.
Arguments	None
Return value	None
Remarks	Transition to the module-stop state is not performed in the sample code. For details on this function, refer to the application note listed in chapter 3 of this document.

R_INIT_NonExistentPort	
Outline	Nonexistent port initialization
Header	r_init_non_existent_port.h
Declaration	void R_INIT_NonExistentPort(void)
Description	Initialize port direction registers for ports that do not exist in products with less than 176 pins.
Arguments	None
Return value	None
Remarks	The number of pins in the sample code is set for the 176-pin package (PIN_SIZE=176). After this function is called, when writing in byte units to the PDR registers which have nonexistent ports, set the corresponding bits for nonexistent ports as follows: set the I/O select bits in the PDR registers to 1 and set the output data store bits in the PODR registers to 0. For details on this function, refer to the application note listed in chapter 3 of this document.

R_INIT_Clock	
Outline	Clock initialization
Header	r_init_clock.h
Declaration	void R_INIT_Clock(void)
Description	Initialize the clock.
Arguments	None
Return value	None
Remarks	The sample code selects processing which uses PLL as the system clock, and uses the sub-clock. For details on this function, refer to the application note listed in chapter 3 of this document.

peripheral_init	
Outline	Initialize peripheral functions
Header	None
Declaration	void peripheral_init(void)
Description	Perform the initial setting for the peripheral functions.
Arguments	None
Return value	None

mck_start	
Outline	Start frequency measurement
Header	None
Declaration	void mck_start(void)
Description	Start measuring the frequency.
Arguments	None
Return value	None

Excep_MTU1_TGIA1	
Outline	MTU1 input capture A interrupt handling
Header	None
Declaration	void Excep_MTU1_TGIA1(void)
Description	Determine the frequency measurement result and set the global variables.
Arguments	None
Return value	None

4.8 Flowcharts

4.8.1 Main Processing

Figure 4.2 shows the Main Processing.

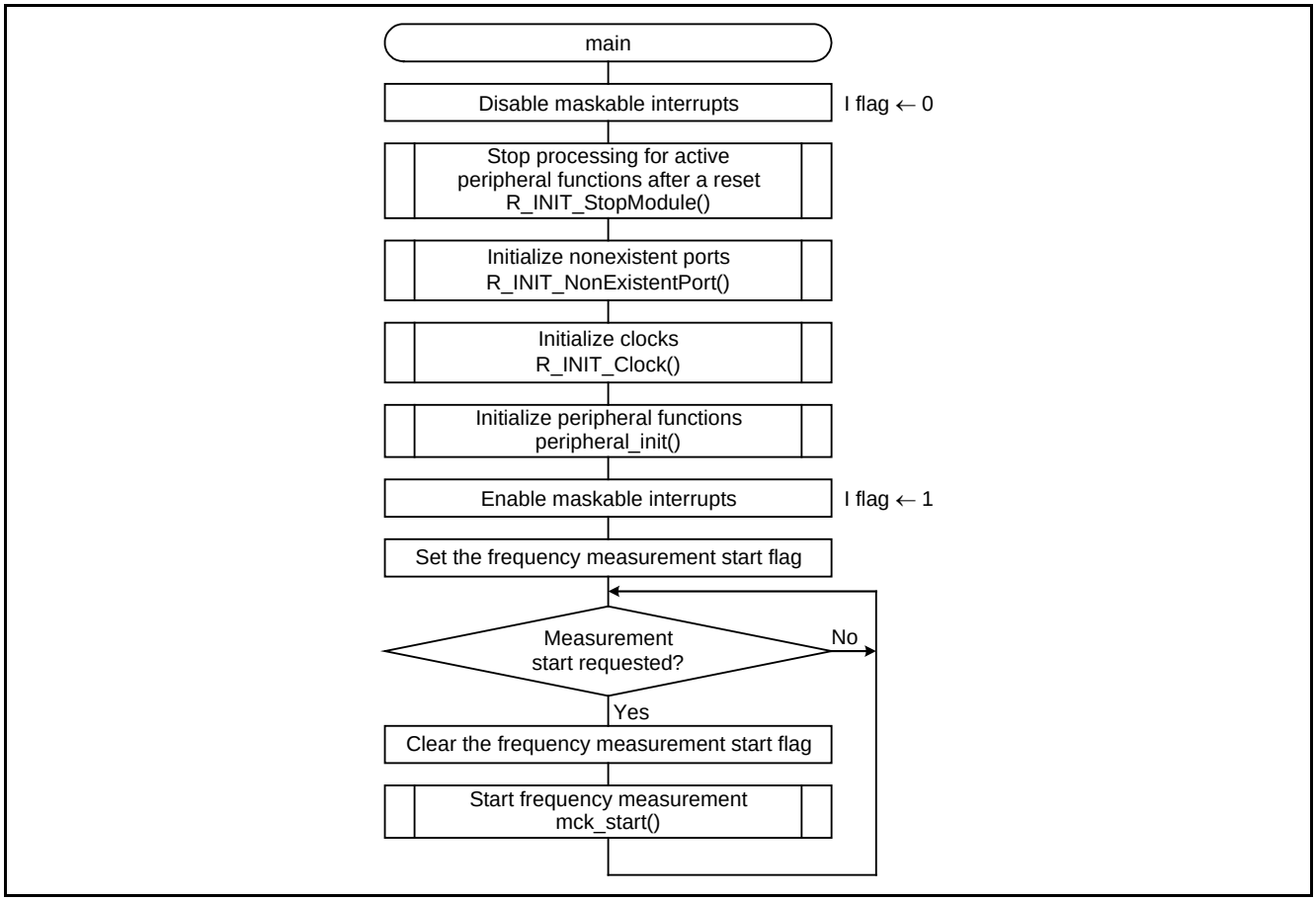

Figure 4.2 Main Processing

4.8.2 Initial Setting of Peripheral Functions

Figure 4.3 shows the Initial Setting of Peripheral Functions.

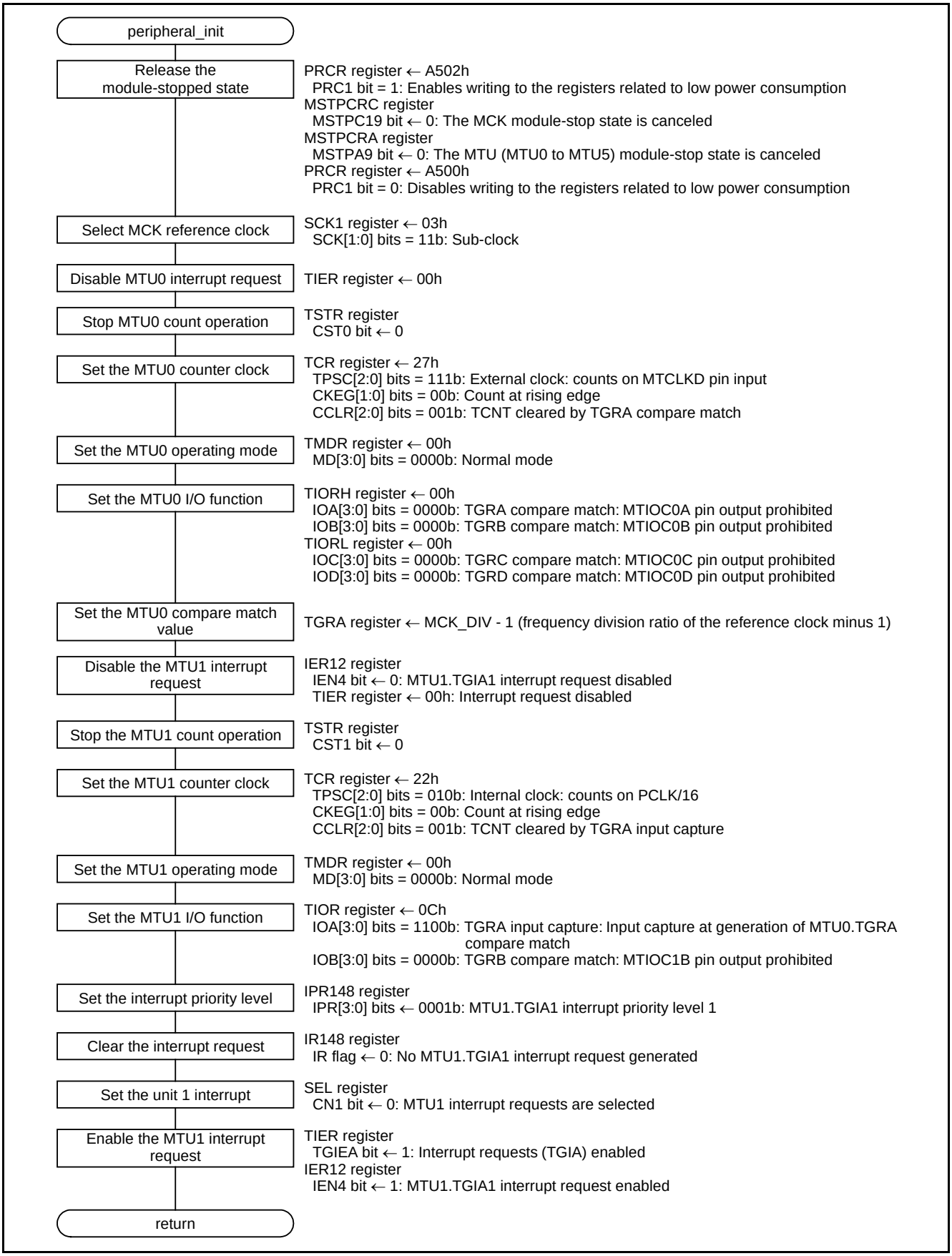

Figure 4.3 Initial Setting of Peripheral Functions

4.8.3 Start Frequency Measurement

Figure 4.4 shows the Start Frequency Measurement.

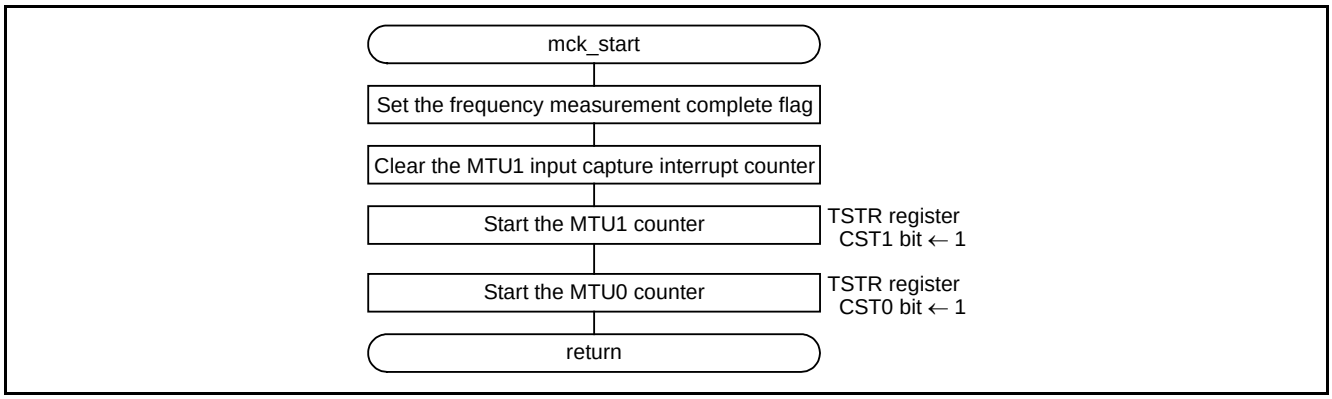

Figure 4.4 Start Frequency Measurement

4.8.4 MTU1 Input Capture A Interrupt Handling

Figure 4.5 shows the MTU1 Input Capture A Interrupt Handling.

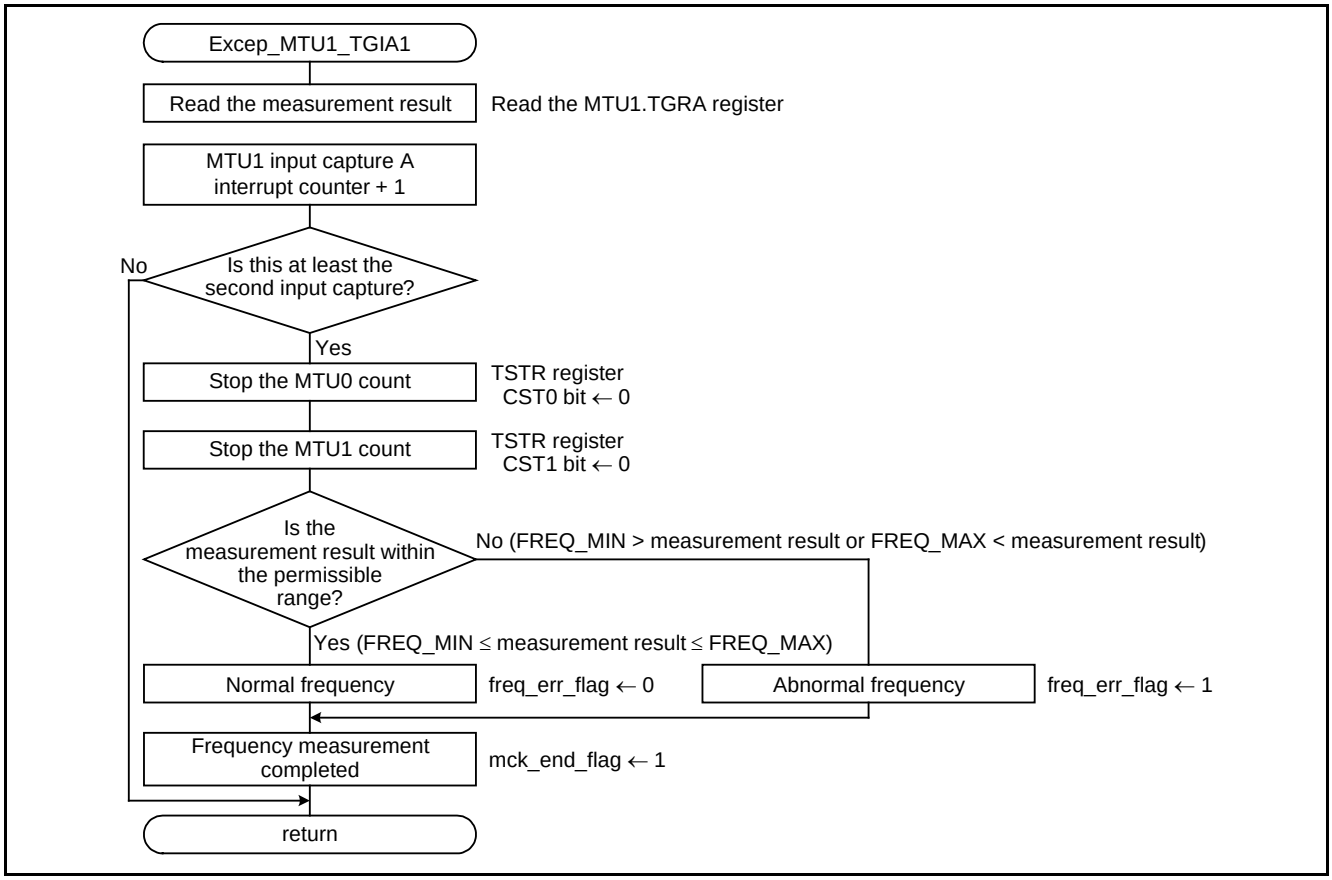

Figure 4.5 MTU1 Input Capture A Interrupt Handling

5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

6. Reference Documents

User's Manual: Hardware

RX63N Group, RX631 Group User's Manual: Hardware Rev.1.50 (R01UH0041EJ)
The latest version can be downloaded from the Renesas Electronics website.

Technical Update/Technical News

The latest information can be downloaded from the Renesas Electronics website.

User's Manual: Development Tools

RX Family C/C++ Compiler Package V.1.01 User's Manual Rev.1.00 (R20UT0570EJ)
The latest version can be downloaded from the Renesas Electronics website.

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REVISION HISTORY	RX63N Group, RX631 Group Application Note How to Detect Abnormal Frequencies in the Main Clock

Rev.	Date	Description	
		Page	Summary
1.00	Apr. 05, 2013	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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