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April 1st, 2010
Renesas Electronics Corporation

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E8a Emulator

Outline of the Start/Stop Feature and an Example of Its Application for Time Measurement

Summary

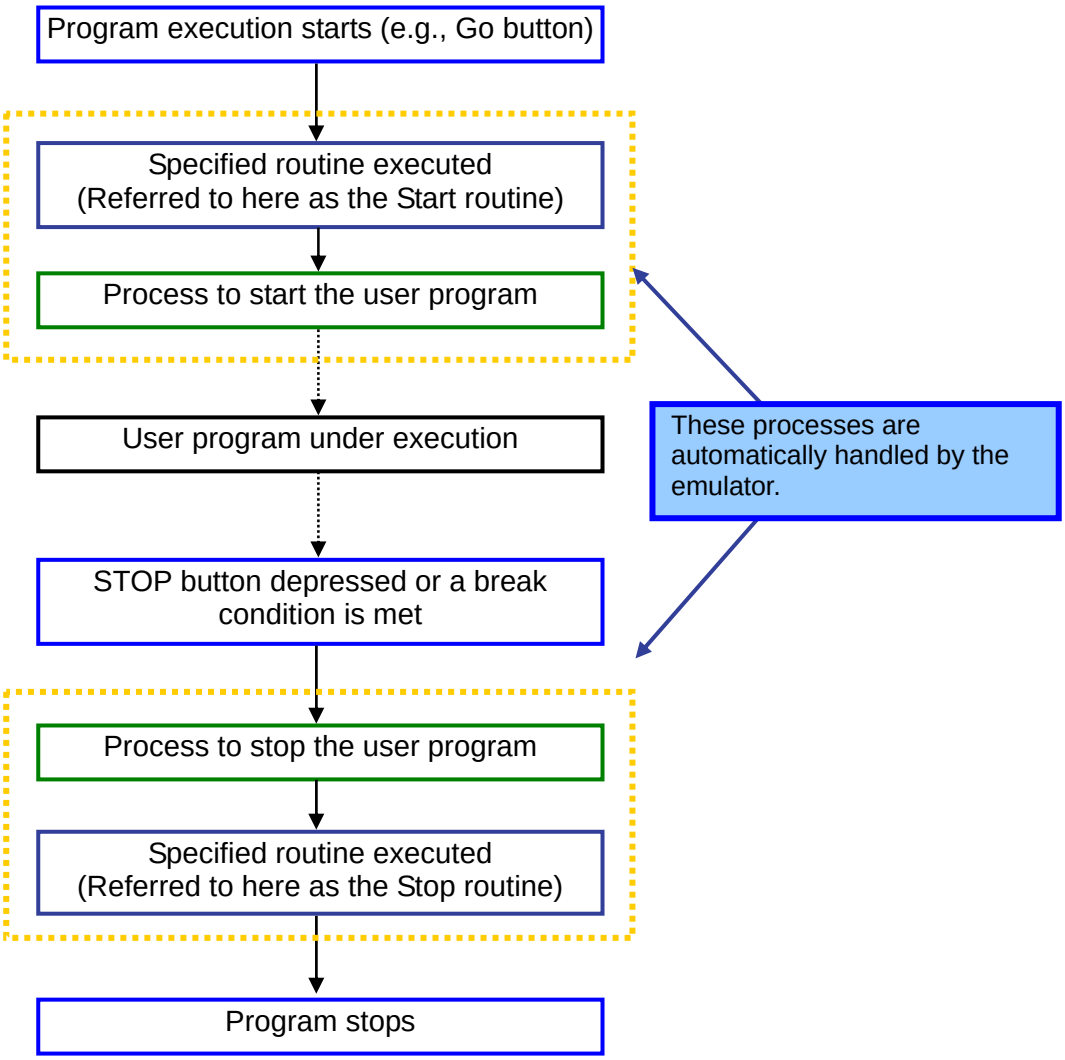
The E8a emulator has a facility to execute a user program's specified routine immediately before the user program starts running and immediately after it has stopped. This facility is called the Start/Stop feature.
In a motor control or similar other application, if the user program is halted abruptly during a debug, the motor will be made to stop suddenly. This will cause a problem to occur. Therefore, use of the Start/Stop feature permits a process to stop motor or timer control or a process to restart it to be executed immediately after the user program has stopped or immediately after it has started. That way, it is possible to debug the program safely.
This document explains the outline of the Start/Stop feature and describes how to use the Start/Stop feature to measure the execution time of a user program as an example of its application.
The explanation in this document assumes that Renesas Starter Kit for R8C/2D and the tutorial program attached to it are used. However, if the timer processing part of the program is altered, the explanation here can also be applied to other Renesas microcomputers.

NOTE: In this document, we use E8a Emulator Software V.1.01 Release 00.
Be aware that in E8a Emulator Software V.1.01 Release 00, the Start/Stop feature cannot be used for the H8/Tiny, H8/SLP series, 740 family, and the R8C/10, 11, 12 and 13.

Table of Contents

1. Outline of the Start/Stop Feature

Using the Start/Stop feature, it is possible to execute a user program's specified routine immediately before the user program starts running and immediately after it has stopped, as shown below.
The routine to be executed immediately before the user program starts running and immediately after it has stopped can be set separately. These routines are executed with the timing shown by a flow diagram below.



Actually, there exist some firmware processing before the user program actually starts running after execution of the Start routine is complete, and before the Stop routine is executed after the program has stopped in the above flow diagram.
Although it varies with the microcomputer or the software version used, there is needed a finite time of about 50 to 100 cycles before the user program actually starts running after execution of the Start routine is complete and a finite time of about 100 to 150 cycles before the Stop routine is executed after the program has stopped.

In a motor control program, etc., specifying a process to stop the motor as the Stop routine and a process to restart the motor as the Start routine, it is possible to safely stop and restart the motor even when the user program has stopped during a debug.

2. Precautions to Take When Writing Start/Stop Routines

Although the Start/Stop routines can be written in C language and assembler, it is necessary that each routine should end with an RTS instruction.

Furthermore, since the Start/Stop feature is closely associated with control of the emulator debugger, unless the precautions described below are observed, the emulator will become uncontrollable.
(Here, the Start and the Stop routines are collectively referred to as the “specified” routine.)

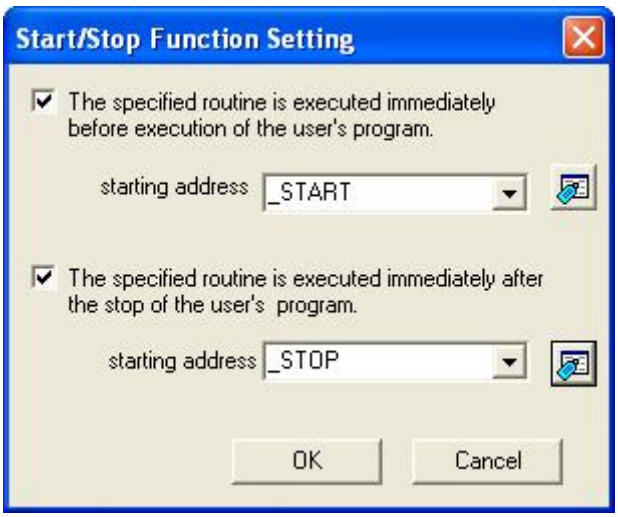
- Do not alter the SFRs used by the firmware of the E8a emulator.
  For details about the SFRs used by the firmware of the E8a emulator, see the separate E8a emulator user’s manual provided for each MCU type.
- When using the watchdog timer, be sure to refresh the watchdog timer in the specified routine, not just in the user program alone.
- Do not set breakpoints in the specified routine.
- To use a stack within the specified routine, always be sure to use the user stack (USP). The interrupt stack (ISP) cannot be used.
- The register values at the time when execution of the specified routine starts are indeterminate. Although it is possible to alter the register values within the specified routine, the registers and flags listed below are subject to limitations.

Register/flag name	Limitations
ISP register	When the specified routine terminates, restore this register to the value it had when execution of the specified routine started.
U flag	When the specified routine terminates, always set the value of this flag to 0.
B flag	Do not set the value of this flag to 1 within the specified routine.
I flag	Interrupts are disabled while the specified routine is executed. Do not set the value of this flag to 1 within the specified routine.

3. Method for Specifying the Start/Stop Routines

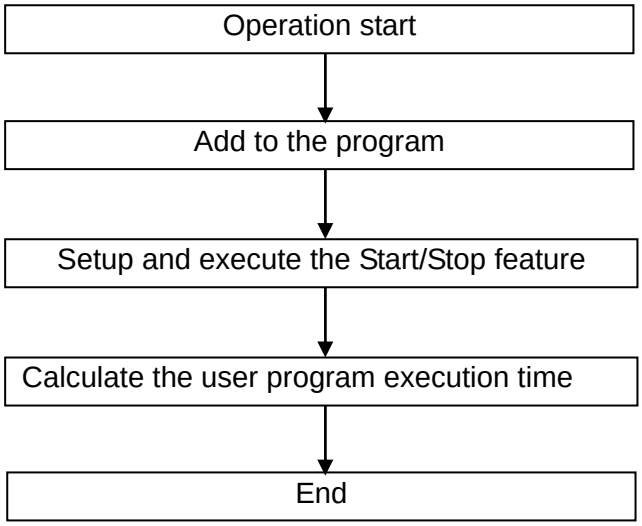
Use the Start/Stop feature setup dialog box to specify the Start/Stop routines. To open the Start/Stop feature setup dialog box, choose Emulator and then Set Up Start/Stop Feature from the Basic Settings menu of High-performance Embedded Workshop.

The Start/Stop feature setup dialog box permits you to specify a routine to be executed immediately before the program starts running and a routine to be executed immediately after the program has stopped, respectively.



4. Example Application: Using the Start/Stop Feature to Measure a Program's Execution Time

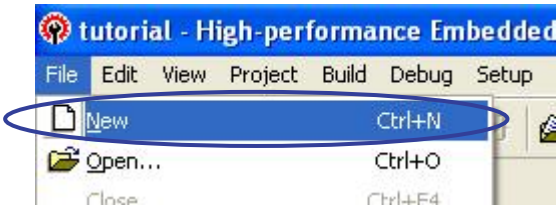
The E8a emulator measures a program's execution time using the timer of a PC, so that the accuracy of its measurement is in the order of several 10 ms. Furthermore, since the measurement result includes the time spent for communication between the microcomputer and PC, an error occurs. Therefore, using the internal timer of the R8C/2D, it is possible to measure a short time that is impossible to measure on the PC side or measure a program execution time with higher accuracy.
In this document, we use the timer RC of the R8C/2D to measure the execution time of a user program as an example application of the Start/Stop feature, following the procedure shown below.



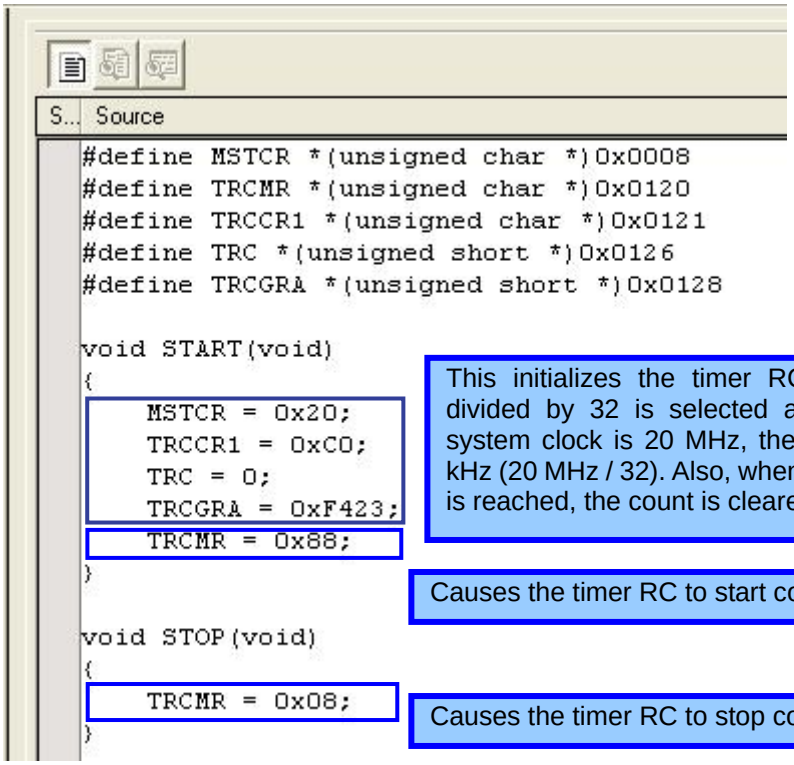
4.1 Adding to the Program

To the tutorial program included with Renesas Starter Kit for R8C/2D, add the timer start and stop processes to be set in the Start/Stop feature.
If you already have a workspace, these processes may be added to it.

(1) Choose New from the File menu.

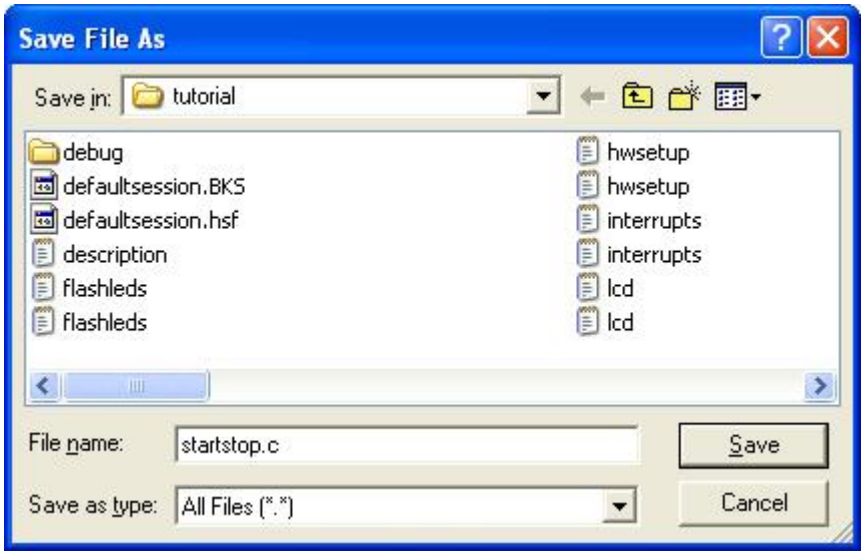


(2) Create a program as shown below.
Create the Start routine as a START function and the Stop routine as a STOP function. In the START function, perform processes to initialize the timer and start counting. In the STOP function, perform a process to stop the timer.
When the program has stopped, check the count result of the timer. Multiplying it by the timer's count source, it is possible to find the execution time of the program.
Described here is an example using the timer RC of the R8C/2D. These contents of processing may be corrected to suit the timer usage condition in your program or the microcomputer you use to make them applicable for your system. For timer settings, see the hardware manual of your microcomputer.



(3) Add the program you've created to a project.
Right-click to open a context menu, from which choose Add Files to Project and then a project name "tutorial."

The Save As dialog box will be displayed.
In this document, we save the file under the name "startstop.c."



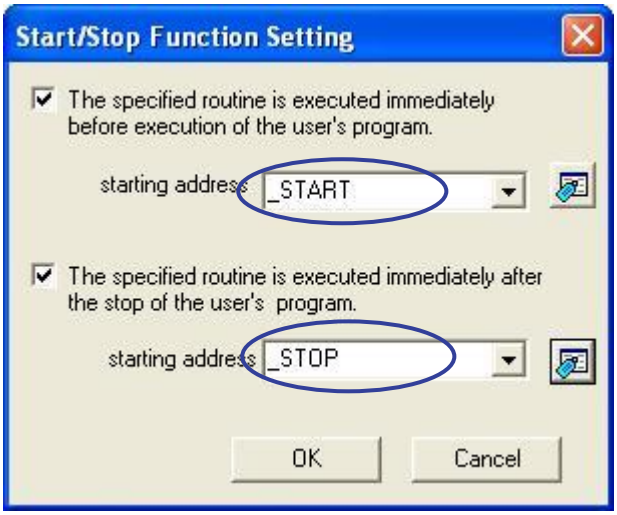
We've now finished adding the timer start and stop processes to be set in the Start/Stop feature.
Build the source file and check to see that there are no errors.
Then download the program and reset the CPU.

4.2 Setting Up and Executing the Start/Stop Feature

Set the timer start and stop processes you've created in the Start/Stop feature.

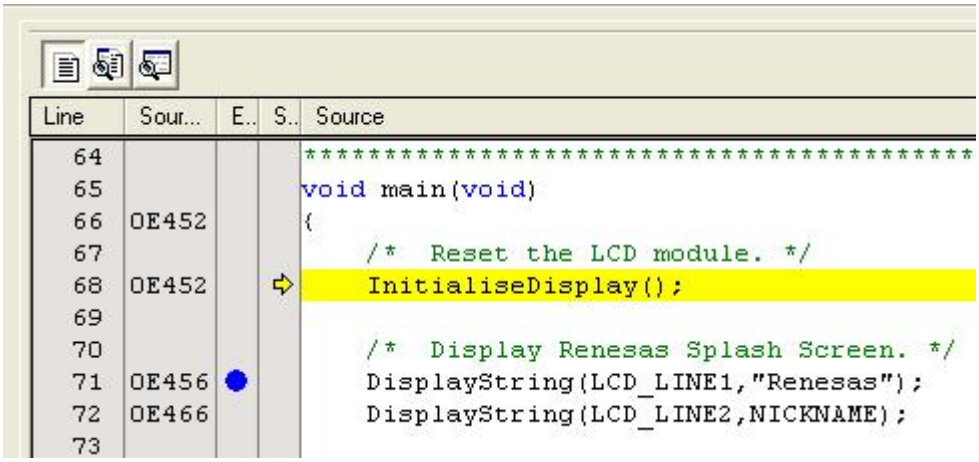
(1) Open Emulator from the Basic Settings menu and select Set Up Start/Stop Feature.

(2) The Start/Stop Feature Setup dialog box will be displayed.
In this dialog box, set those routines to be executed immediately before the user program starts running and immediately after it has stopped that you've created in the preceding section, as shown below. Here, since it is necessary that functions be specified with assembler symbols, the specified function names are prefixed by an underscore "_."

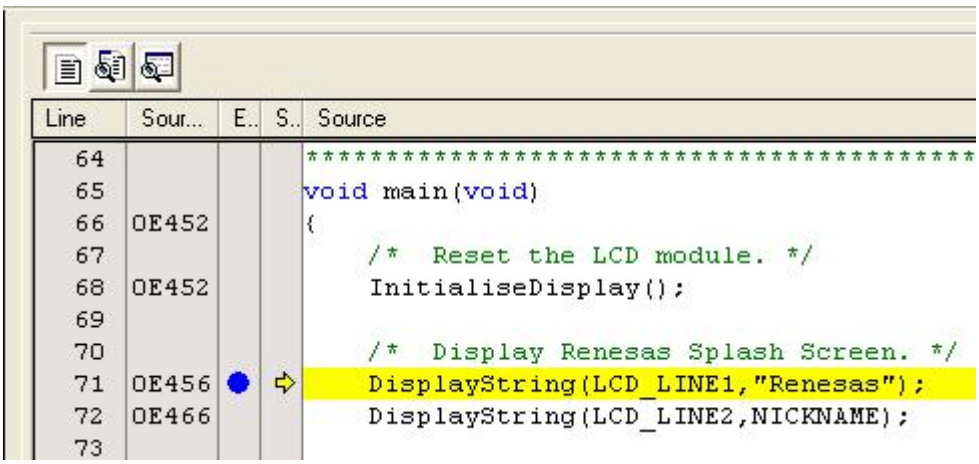


We've now finished setting up the Start/Stop feature.

(3) Set a breakpoint in the 68th line of the source file “main.c” and then run the program.
The program will break at the address where the breakpoint is set.
Clear the breakpoint in the 68th line and set a new breakpoint in the 71st line.
Measure the user program execution time from the 68th line to the 71st line.
* When using a timer to measure a program execution time, be aware that if the timer’s count source is changed in the middle, the execution time cannot be measured correctly.
Although the R8C/2D operates with the low-speed on-chip oscillator immediately after reset, its clock source normally is switched to the main clock (XIN) before the main function is reached. Therefore, the program in this example is once run up until the beginning of the main function.



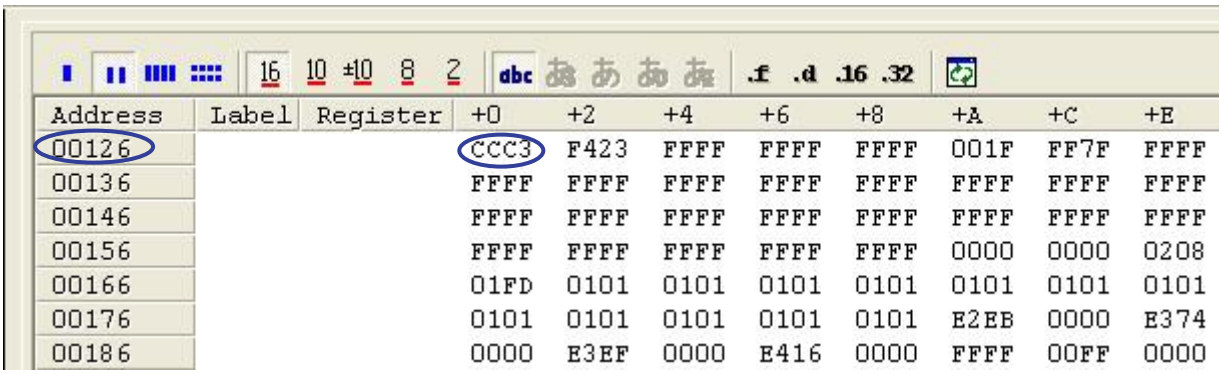
(4) Run the program.
The program will break at the address where a breakpoint is set.
This permits you to measure the program execution time from the beginning of the main function (address 0E452) to where the DisplayString function is called (address 0E456)



4.3 Calculating the User Program Execution Time

Calculate the user program execution time from the timer's count value.

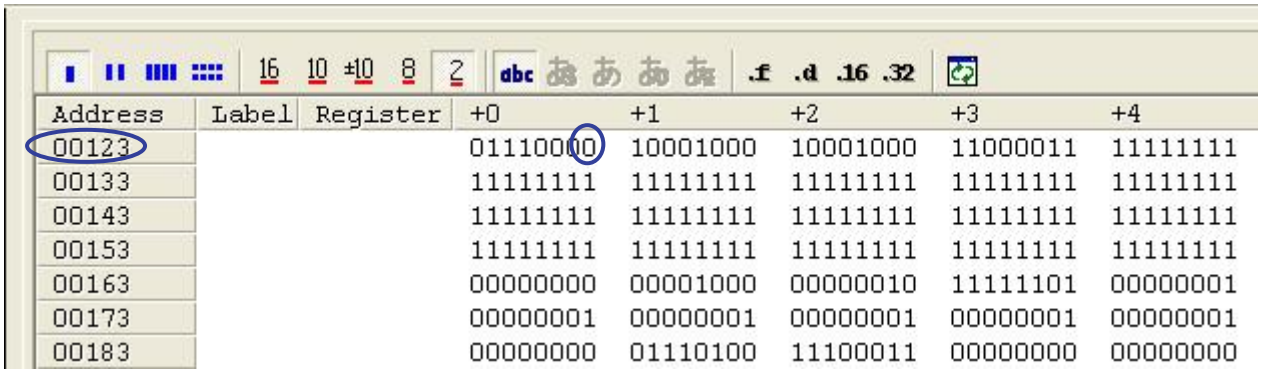
(1) Open the address H'00126 in the memory window and display it in 2-byte length.
Shown at the address H'00126 is the count register of the timer RC.



Address	Label	Register	+0	+2	+4	+6	+8	+A	+C	+E
00126			CCC3	F423	FFFF	FFFF	FFFF	001F	FF7F	FFFF
00136			FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF
00146			FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF	FFFF
00156			FFFF	FFFF	FFFF	FFFF	FFFF	0000	0000	0208
00166			01FD	0101	0101	0101	0101	0101	0101	0101
00176			0101	0101	0101	0101	0101	E2EB	0000	E374
00186			0000	E3EF	0000	E416	0000	FFFF	00FF	0000

The count value as can be seen is H'CCC3 (= 52419).

(2) Next, open the address H'00123 in the memory window and display it in 1-byte long, binary representation.
Shown at the address H'00123 is the status register of the timer RC.



Address	Label	Register	+0	+1	+2	+3	+4
00123			01110000	10001000	10001000	11000011	11111111
00133			11111111	11111111	11111111	11111111	11111111
00143			11111111	11111111	11111111	11111111	11111111
00153			11111111	11111111	11111111	11111111	11111111
00163			00000000	00001000	00000010	11111101	00000001
00173			00000001	00000001	00000001	00000001	00000001
00183			00000000	01110100	11100011	00000000	00000000

Bit 0 of the timer RC status register is a compare match flag A.
In this document, the timer RC is set up in such a way that when a count of H'F423 is reached, the count register value is cleared, at which time bit 0 of the timer RC status register is set to 1. Therefore, if this bit is set to 1, it means that the count value has overflowed.

In this example, since bit 0 of the timer RC status register is 0, we see that the count register value has not once been cleared. Therefore, a count of 52,419, or the timer RC status register value, directly indicates the user program execution time.
In the example presented in this document, since the selected count source is 625 kHz, 1 count is equal to 1.6 µs (1/625 kHz = 1.6 µs). Therefore, the user program execution time is 1.6 µs * 52,419 = (83,870.4 µs) = 83.8704 ms.
That way, the Start/Stop feature permits you to measure a short execution time that is impossible to measure on the E8a emulator (PC side). Note, however, that this measurement result includes the execution time of the firmware as described in Section 1, "Outline of the Start/Stop Feature."

NOTE: In this document, the system clock divided by 32 is selected as the count source for the timer RC. If the system clock is changed in the middle before the user program stops after it started running, the amount of time equal to 1 count of the timer becomes inconsistent and the execution time cannot be measured.

5. FAQ

Question: Is it only when the user program starts running and when it has stopped that the specified routine can be executed?

Answer: The specified routine is also executed when one of the following operations are preformed.
- The user program is single-stepped.
- Memory is referenced or altered while the user program is running.
- An event break is set while the user program is running.

Question: A flash memory rewrite occurs while the user program is running. What is the reason that such a rewrite occurs?

Answer: If any contents set in the Start/Stop Feature Setup dialog box are changed, a rewrite to the flash memory block where the firmware is located occurs while the user program is running.

Question: Is there any precaution to take when using the Start/Stop feature?

Answer: The precautions to take are summarized in Section 2 of this document, “Precautions to Take When Writing Start/Stop Routines,” so see that section for details.

6. Related Documents

The E8a emulator and HEW offer a variety of convenient features and facilities other than the one presented here. For detailed specification, technical information, limitations, and other useful information on each product, see the related documents listed below.

E8a emulator related documents
- E8a Emulator User's Manual
- E8a Emulator User's Manual, Supplementary Volume
  Precautions to take when connecting the emulator to the R8C/2A, R8C/2B, R8C/2C, or R8C/2D

High-performance Embedded Workshop related documents
- High-performance Embedded Workshop User's Manual
- High-performance Embedded Workshop Release Notes

CPU related documents
- R8C/2C and R8C/2D Group Hardware Manual
- R8C/Tiny Series Software Manual
- Renesas Starter Kit for R8C/2D Quick Start Guide
- Renesas Starter Kit for R8C/2D Tutorial Manual
- Renesas Starter Kit for R8C/2D User's Manual

M16C series C compiler package related documents
- M3T-NC30WA V.5.43 C Compiler User's Manual
  (C compiler package for the R8C/Tiny, M16C/60, M16C/30, M16C/20, M16C/10, and M16C/Tiny series)

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Revision Record

Rev.	Issue date	Contents of revision	
		Page	Points
1.00	2009.02.13	—	First edition issued

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