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Quickly Solve Problems from Your Customers!

Using Trace Data of Program Execution History

# Introducing E2 Emulator Software Trace Function

## Outline

This document gives you an overview of the advanced on-chip debugging emulator (E2 Emulator) based on a concept of “improvement of development efficiency,” and introduces our “Software Trace” function for RH850 family. This software tracing feature enables you to view the execution history of the programs on the MCUs, including the ones that do not include internal trace memory, and helps you to quickly solve various issues from your customers.

## 1. Overview of E2 Emulator

The E2 emulator is an advanced on-chip debugging emulator and flash programmer designed on the concept of "improvement of development efficiency". The download speed is up to x2 faster than the E1 emulator. The “Software Trace” function in combination with the CAN Communication Time Measurement Solution and other useful features, can reduce the time needed for development.

For details on the E2 emulator, refer to the URL below.
https://www.renesas.com/e2

## 2. Software Trace Function

The software trace function enables users to view the execution history of the programs such as the values of the program counter (PC) and the register values together with the debug instructions of MCUs for RH850 family.

Using this feature, unlike the conventional method of “tracing data with the settings of events and conditions,” users can generate the execution history data such as the PC values and register values simply by inserting the debug instructions to the location where you like to check in the program.

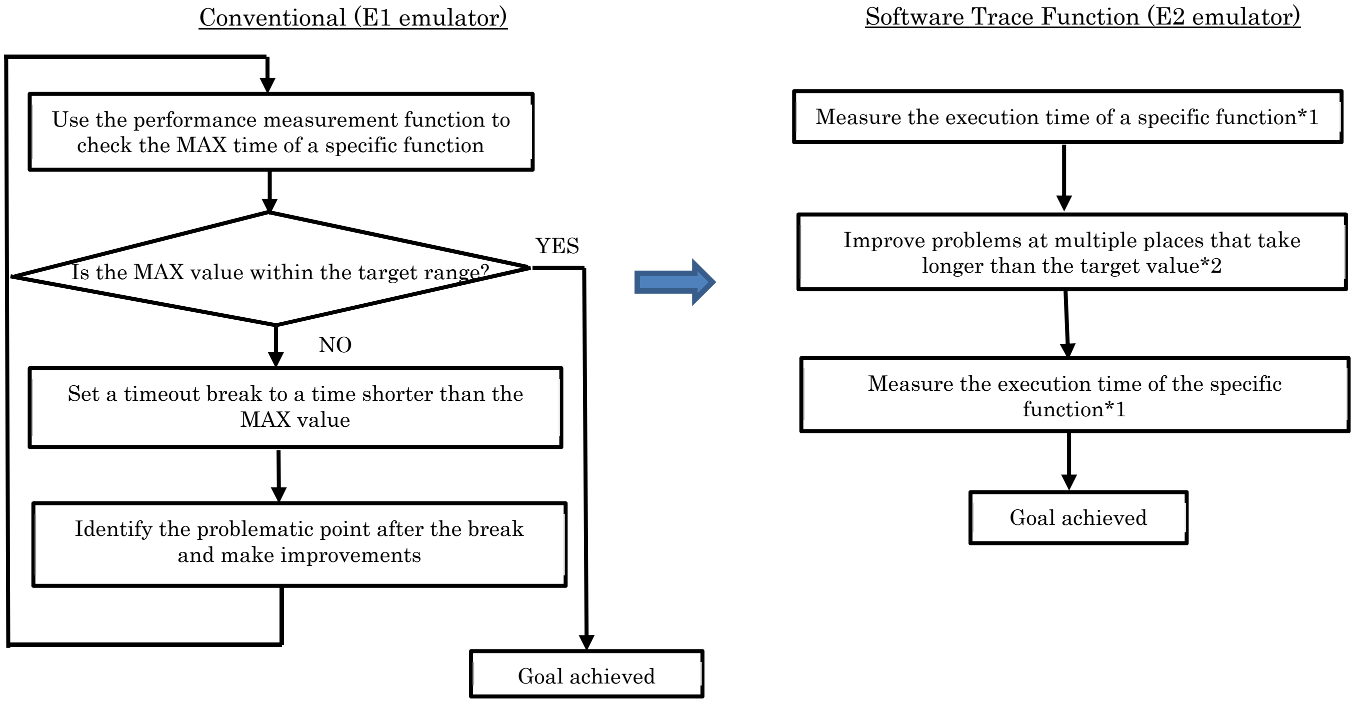
You can also leave the debug instruction inserted in the programs at shipment as when the emulator is disconnected, the debug instructions embedded in the program will not be output to external pins as software trace data. This allows the users to collect the trace data easily in case there is a trouble with the shipped products.

This feature is available in all RH850 family MCUs, including the ones do not have internal trace memory when debugging.

## 3. Application Example - You can Identify Multiple Attributes to Poor Performance Instantly and Reduce Time Needed to Make Improvement -

As you can measure the execution time of any functions, you can easily view the execution time distribution of the functions. This makes it easy to identify the bottleneck of the execution time and significantly reduces the loop processes needed for performance improvement as shown in the following chart.

The following chart shows the debugging methods used for performance improvement; a conventional method using E1 emulator and another method using E2 emulator software trace function.


Conventional (E1 emulator)
Use the performance measurement function to check the MAX time of a specific function
Is the MAX value within the target range?
YES
NO
Set a timeout break to a time shorter than the MAX value
Identify the problematic point after the break and make improvements
Goal achieved
Software Trace Function (E2 emulator)
Measure the execution time of a specific function*1
Improve problems at multiple places that take longer than the target value*2
Measure the execution time of the specific function*1
Goal achieved

*1: Time measurement method

In the debugging method using the software trace function, you need to insert the debug instruction "DBCP(Note)" at the beginning and the end of the function to measure the time of the specified function. The time of a specified function can be measured from the values of the time stamps which indicate the time elapsed from the beginning to the end.

*2: How to identify the problem

Insert the debug instructions "DBCP(Note)" at the beginning of each interrupt. This allows you to easily identify which interrupt has occurred, therefore enables you to detect the cause of poorly performing functions.

Note: for details on the debug instructions, see Table 1 RH850 family Debug Instructions in Section 5.

## 4. Other Application Examples

- Checking for a memory leak

  You can check whether there is a memory leak by inserting the debug instruction “DBPUSH(Note)” in the program such as the cycle timer function to view the stack pointer values.

- Checking for a variation in a constant period operation

  Insert the debug instructions “DBCP(Note)” or “DBTAG(Note)” at the beginning and the end in the program operating at a constant cycle and check the time stamp values indicating the time elapse to look for a variation in the constant period operation. This enables you to quickly detect a problem.

Note: for details on the debug instructions, see Table 1 RH850 family Debug Instructions in Section 5.

## 5. Debug Instructions and Software Trace Function of MCUs for RH850 Family

The MCUs for RH family stores the software trace data by the debug instruction as shown in Table 1 to the internal trace memory. The software trace memory that is “output from the LPD pin(Note)” is stored in the memory within the E2 emulator. You can display the stored data of the execution history on CS+ or e$^2$ studio IDE.

Note: Only when connected to the E2 emulator.

Table 1 RH850 Family Debug Instructions

| Debug instruction | Software trace data*1 |
|---|---|
| DBCP | - PC value |
| DBPUSH | - PC value<br>- Register number and register value from general register rh to rt |
| DBTAG | - PC value<br>- 10-bit immediate (imm 10) value |

* 1: When data is stored in the memory of the E2 emulator, a time stamp value indicating the elapsed time is added.

For the number of frames of trace data that can be acquired with the E2 emulator, see Table 2.

Table 2 Number of frames of acquirable trace data with E2 emulator

| Software trace function of the RH850 family | Maximum number of frames of acquirable trace data | Notes |
|---|---|---|
| External | 500,000 | - The number of frames depends on the number of acquired registers. |
| Internal | 4,000 | - Only MCUs of the RH850 family that have internal trace memory can acquire data.<br>- The number of frames depends on the number of acquired registers and the MCU. |

## 6. How to Purchase the Product

For product ordering, contact your local Renesas Electronics marketing office or distributor with the following information.

For product pricing, make inquiries in the same manner.

| Product Name | E2 emulator |
|---|---|
| Orderable Part Name | RTE0T00020KCE00000R |

## Revision History

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 1.00 | Sep. 01, 2018 | - | First edition issued |
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