

# e<sup>2</sup> studio IDE

R20AN0309EJ0100

Rev.1.00

## Usage of Trace Debug Features

Mar 15, 2014

### Introduction

Trace debug feature is used to record a history of the program execution. By using collected trace data and trace program execution until problem occurs, the Trace debug feature can be an effective tool for discovering root cause.

This application note explains on how to configure the trace conditions and use the trace function with E1 Emulator.

e<sup>2</sup> studio V.2.2.0.13

C/C++ Compiler for Renesas RX Family: V2.01.00

### Target Device

RX Family

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## 1. Overview

Trace is a function that acquires bus information per cycle and stores this information in trace memory during user program execution. User uses trace function to track the flow of program execution or to search for and examine the points where possible problems may occur.

This application note explains on how to configure the trace conditions and use the trace function with E1 Emulator in section 4. The E1 emulator supports internal trace function and on-chip trace buffers of 256 branches or cycles. Internal trace function refers to the acquiring of bus trace data on branches (source and destination address) using execution-address and data-access events. It uses the trace buffer of the MCU and the acquired trace data is displayed in the [Trace] window as bus information, disassembled code or source code. The [Trace] window is shown in Figure 1 and the view toolbar is shown in Table 1 on the next page.




The trace view as shown in Figure 1 shows the content of the trace memory. When the program stops execution due to an exception break, a forcible halt or breakpoint, the content stored in trace memory at that moment is being displayed as the trace result. The items shown in the [Trace] window varies with the MCU used.

Cycle	Label	Address	Source A...	Destinati...	Data	Size	R/W	BUS Mas...	Type	BCN	Branch T...	Channel	TimeSta...
-5	flashed.c	69	while (...					CPU	BRANCH				0
-4		FFFE8061	FFFE8061					CPU	DESTINA...				0
	r_cg_main.c	108	timer_...										
-3		FFFE8977	FFFE8977					CPU	BRANCH				0
	r_cg_main.c	108	timer_...										
-2	_stimer_adc	FFFE8990		FFFE8990				CPU	DESTINA...				0
	r_cg_main.c	155	R_S12...										
-1	_stimer_adc	FFFE8990	FFFE8990					CPU	BRANCH				0
	r_cg_main.c	155	R_S12...										
0	_R_S12ADb_Start	FFFE8C6A		FFFE8C6A				CPU	DESTINA...				0

Figure 1 Trace view

The trace window has four display modes:
















- Bus display (default)
- Disassemble display
- Source display
- Mixed display (mixed display of bus, disassemble and source display)

Trace data can be displayed in a mixed mode of bus, disassemble and/or source display modes by toggling the Bus, Disassembly, Source buttons    on the view toolbar as show in Figure 2.

The notation of each column in the trace window as shown in Figure 1 is given in the Help Contents (*In e<sup>2</sup> studio, go Help -> e2 studio Trace -> Viewing Trace Information*) of e<sup>2</sup> studio. This information applies to Bus display, Disassemble display and source display mode.

The following table shows the operation of each icon found in the toolbar menu of Trace view.

**Table 1 Operation of each icon found in the toolbar menu of Trace view**

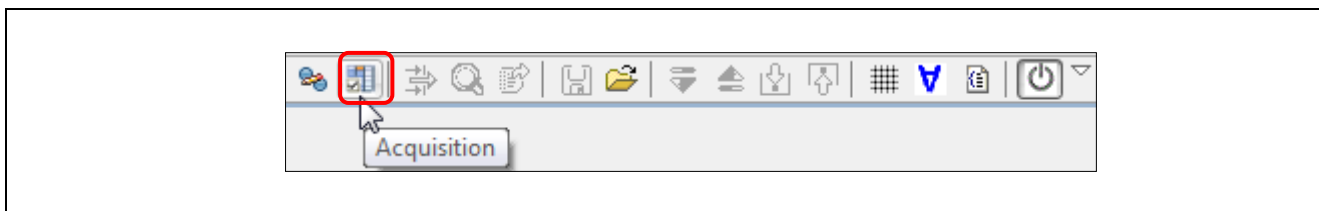
No	Icon	Description	Operation
1		Edit Trace Event Points	To add Trace Start, Trace Stop or Trace Record eventpoints
2		Acquisition	To set trace conditions
3		Filter	To specify selected trace results to view
4		Find	To search for specific trace results under a specified condition
5		Go To Source	Jump to source after setting source display mode and selecting a source line in the trace window
6		Save	Save the trace results to a file
7		Load	Load the saved trace results
8		Step Forward (*1)	Move focus to the next trace record and highlight the corresponding source line
9		Step Backward (*1)	Move focus to the previous trace record and highlight the corresponding source line
10		Run Forward (*1)	Search forward for the branch address record and highlight corresponding source line
11		Run Backward (*1)	Search backward for the branch address record and highlight corresponding source line
12		Bus	Set bus display mode
13		Disassembly	Set disassembly display mode
14		Source	Set source display mode
15		Turn Trace On/Off	Turn trace on or off

Note (\*1): Only available in source mode

## 2. About Trace Conditions

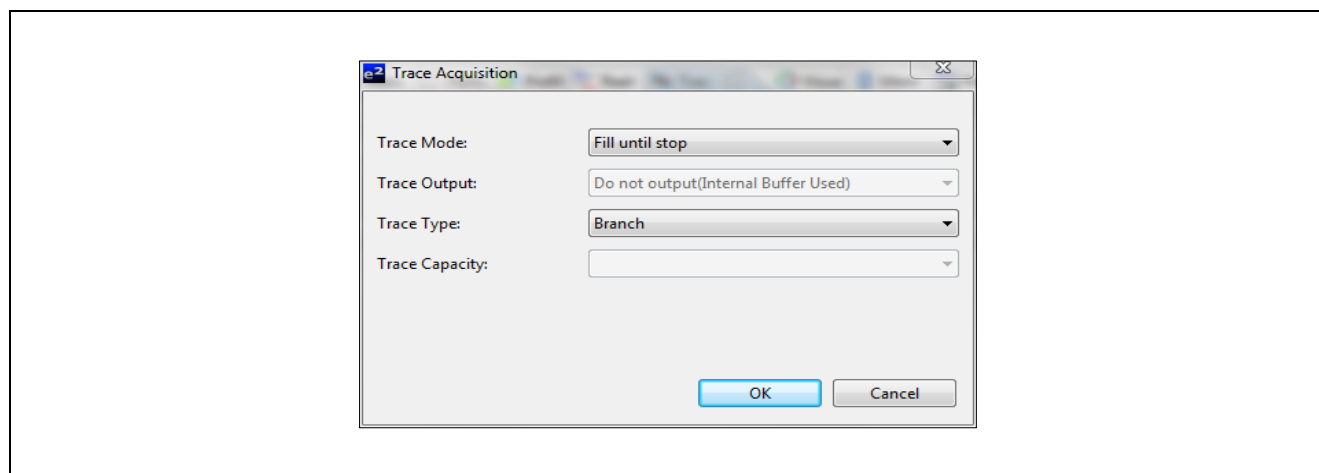
Prior to using the trace function, user must set the Trace conditions available in the [Trace Acquisition] dialog. When user does not set any trace condition, the default behavior of the emulator is set to acquire information of all bus cycles unconditionally. The oldest trace data will be overwritten with new trace data after the buffer is full due to the limited size of the buffer.

Double click "Acquisition" icon available in the toolbar of the Trace window as shown in Figure 2.



**Figure 2 "Acquisition" icon in the Trace toolbar**

This will launch the [Trace Acquisition] dialog as shown in Figure 3.



**Figure 3 Trace Acquisition Setting**

The following are four types of trace condition which can be set in the [Trace Acquisition] dialog.

1. Trace Mode (See table 2)
2. Trace Output (See table 3)
3. Trace Type (See table 4)
4. Trace Capacity (See table 5)

**Table 2 Trace Mode**

No	Trace Mode	Description
1	Fill until stop	Trace acquisition starts when the user program starts running. When the user program stops or an event selected to stop tracing occurs, the acquisition of trace data stops.
2	Fill until full	The acquisition of trace data stops when the trace buffer becomes full.

**Table 3 Trace Output**

No	Trace Output	Description
1	CPU execution	CPU execution is given priority. Some trace data may be lost.
2	Trace output	Tracing is given priority. CPU execution stops for the output of trace data, so this will affect the real-time operation.
3	Do not output	The trace buffer in the MCU will be used (i.e. no trace data are output)

Note: “Trace Output” is available when using external trace feature supported emulators. RX Simulator also supports “Trace Output” feature.

**Table 4 Trace Type**

RX100 Series MCUs		
No	Trace Type	Description
1	Branch	Traces source and destination address information on branch processes that occurred during program execution.
2	Data	Traces data information on events that occurred during program execution.
RX600 Series MCUs		
1	Branch	Traces source and destination address information on branch processes that occurred during program execution.
2	Branch + Data	Branch and data-access information is acquired.
3	Data	Traces data information on events that occurred during program execution.
RX200 Series MCUs		
1	Branch	Traces source and destination address information on branch processes that occurred during program execution.
2	Data	Traces data information on events that occurred during program execution.
3	Branch(Src)	Traces only the source address information on branch processes that occurred during program execution.
4	Branch(Src) + Time	Traces source address information and timestamp on branch processes that occurred during program execution.
5	Data + Time	Traces data information and timestamp on events that occurred during program execution.

**Table 5 Trace Capacity**

No	Trace Capacity	Description
1	1, 2, 4, 8, 16, or 32 Mbytes	Select the capacity of the trace buffer as 1, 2, 4, 8, 16, or 32 Mbytes.

Note: “Trace Capacity” will only be available when “Trace Output” has been selected.

### 3. About Trace Eventpoints

User may wish to use a combination of eventpoints to track certain CPU execution or data access event during debugging. This will ensure possible bugs are identified at the debugging state. Information on the trace eventpoints will be covered in this section.

Double click "Edit Trace Event Points" icon available in the toolbar of the Trace window as shown on Figure 4.

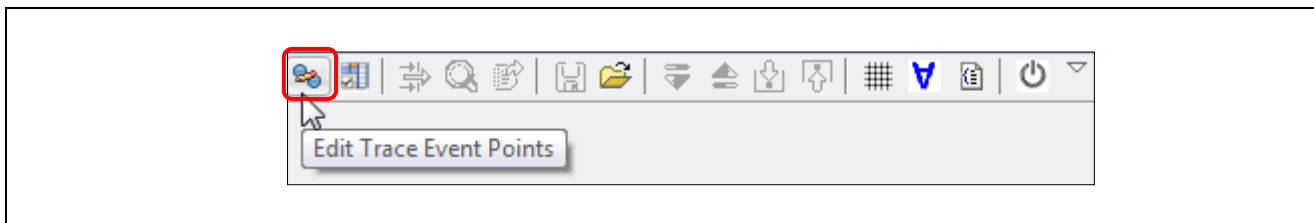


Figure 4 "Edit Trace Event Points" icon in the Trace toolbar

This will launch the [Trace Eventpoints] dialog as shown in Figure 5.

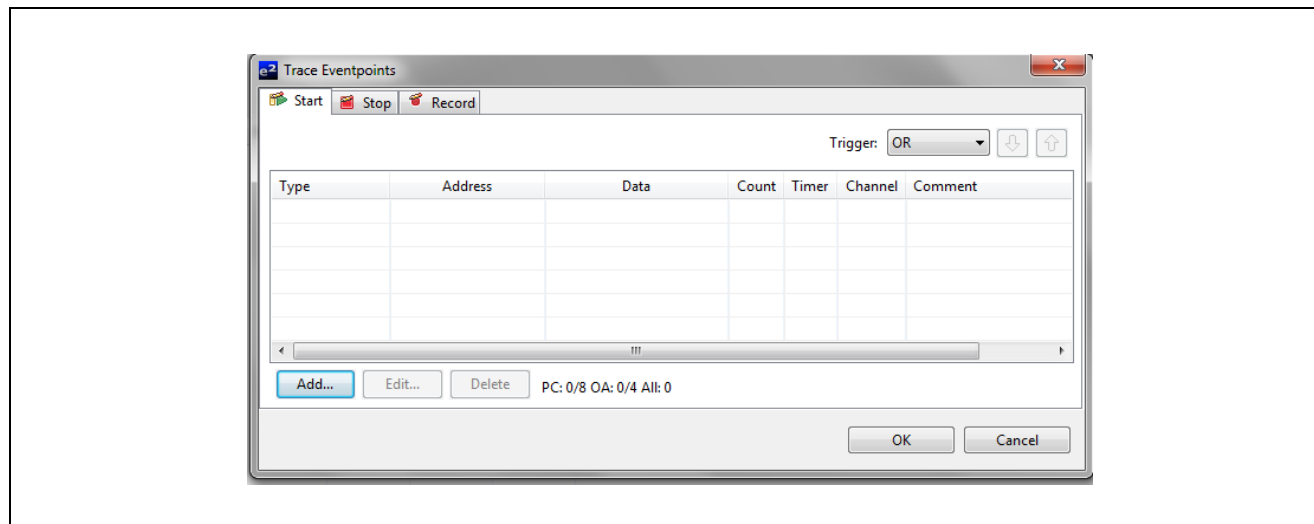



Figure 5 Trace Eventpoints Setting

User can also set the Trace Evenpoints through the [Eventpoints] view as shown in Figure 6. Click [Windows] → [Show View] → [Eventpoints] or icon  to open the [Eventpoints] view.

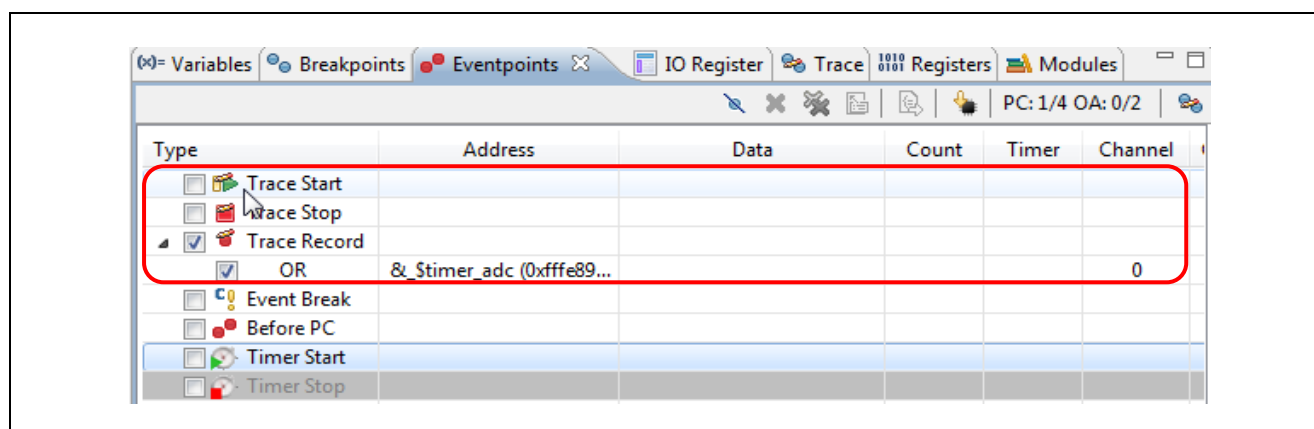


Figure 6 Trace Eventpoints in Eventpoint view

The following table shows the three types of trace eventpoints.

**Table 6 Trace Eventpoints**

No	Item	Description	
1	Trace Start Point (SP)	The trigger to start trace acquisition can be specified by a combination of events. If no trace acquisition start conditions are set, trace acquisition starts at the same time the program starts.	
		OR	The trace acquisition start condition is met when any of the set events occurs.
		AND (cumulative)	The trace acquisition start condition is met when all of the set events occur irrespective of the time base.
		Sequential	The trace acquisition start condition is met when the set events occur in a specified order.
2	Trace Stop Point (EP)	The trigger to stop trace acquisition can be specified by an event ("OR" only). If no trace acquisition stop conditions are set, trace acquisition stops at the same time the program stops.	
3	Trace Record	The trigger to extract trace information can be specified by an event ("OR" only).	

#### 4. Setting Trace Eventpoints

The example given below shows the setup of trace start and stop eventpoints to track a read/write cycle of data value '10' to a variable '&gFlashCount' with the trace conditions using Renesas starter kit RX62T target board with E1 Emulator.

1. Double click "Edit Trace Event Points" icon available in the toolbar of the Trace window as shown in Figure 7.

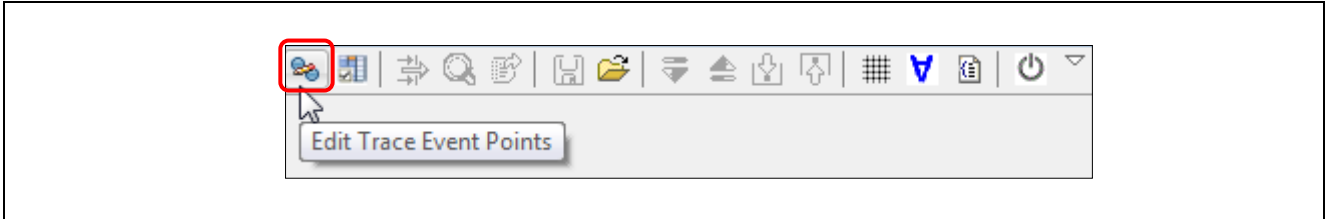


Figure 7 "Edit Trace Event Points" icon in the Trace toolbar

2. Set the [Trace Start] condition as shown in Figure 8.
  - a. At [Start] tab, click [Add...] button to set trace start at FlashLED routine.
  - b. At 'AddEventpoint' dialog box, Select 'Execution address' for [Eventpoint Type] to start trace at the execution of the address. Enter address '&FlashLED' for [Address Condition] and click 'OK'.

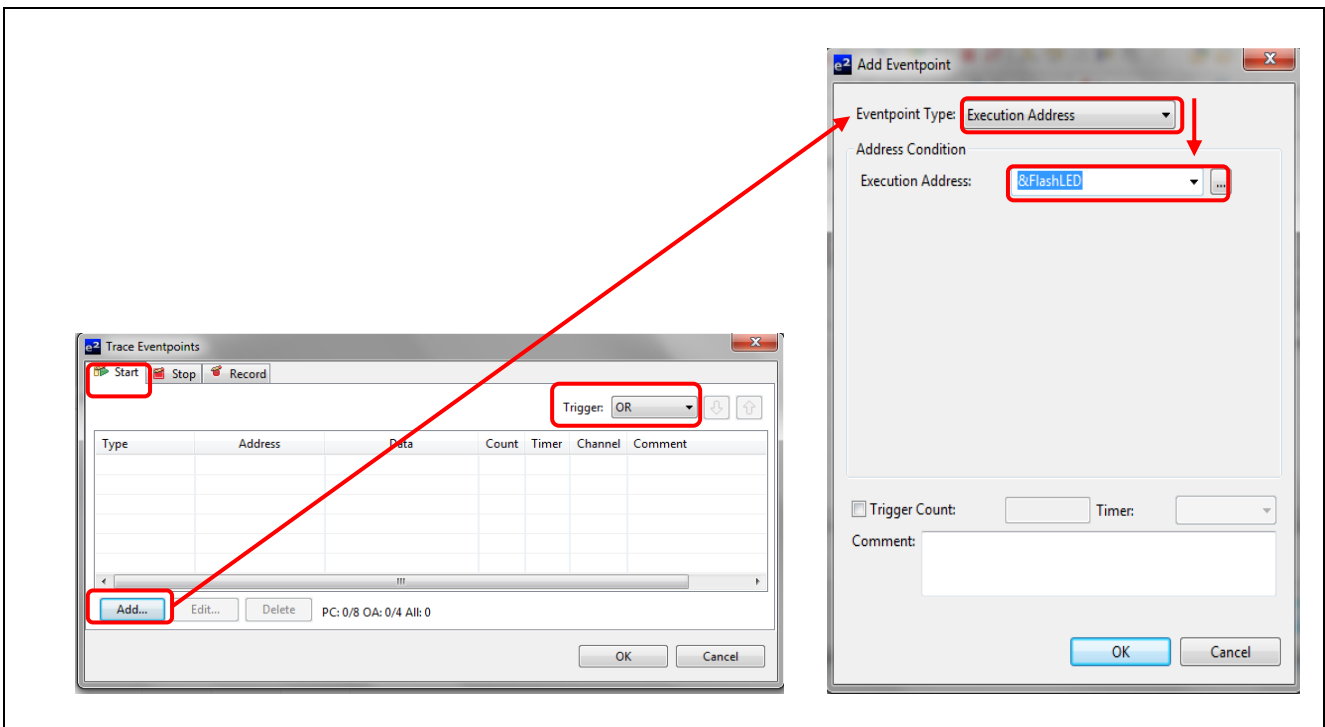


Figure 8 Configure [Trace Start] condition

3. Set the [Trace Stop] condition as shown in Figure 9 and 10.
  - a. At [Stop] tab, click [Add...] button to set trace stop for variable gFlashCount. See Figure 9.
  - b. At 'Add Eventpoint' dialog box, Select 'Data Access' for [Eventpoint Type] and enter address '&gFlashCount' for [Address Condition] at Address Setting tab. Set trigger count '4'. Click 'OK'.
  - c. At 'Edit Eventpoint' dialog box under Data Access Setting tab, select 'Read/Write' for [Read/Write], select 'Not Specified' for [Size] and check the [Compare Settings] box. Enter a data value '10'(0xa) for [Compare]. This is to stop trace at the execution of the address of variable gFlashCount when its value becomes '10'(0xa). Enter '0x0' for [Mask Value], select 'Equals' for [Comparison] and click 'OK'.



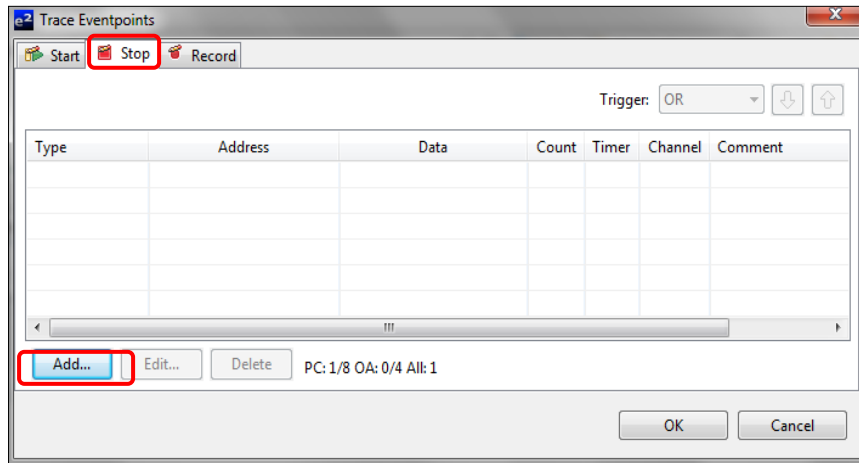


Figure 9 Configure [Trace Stop] condition

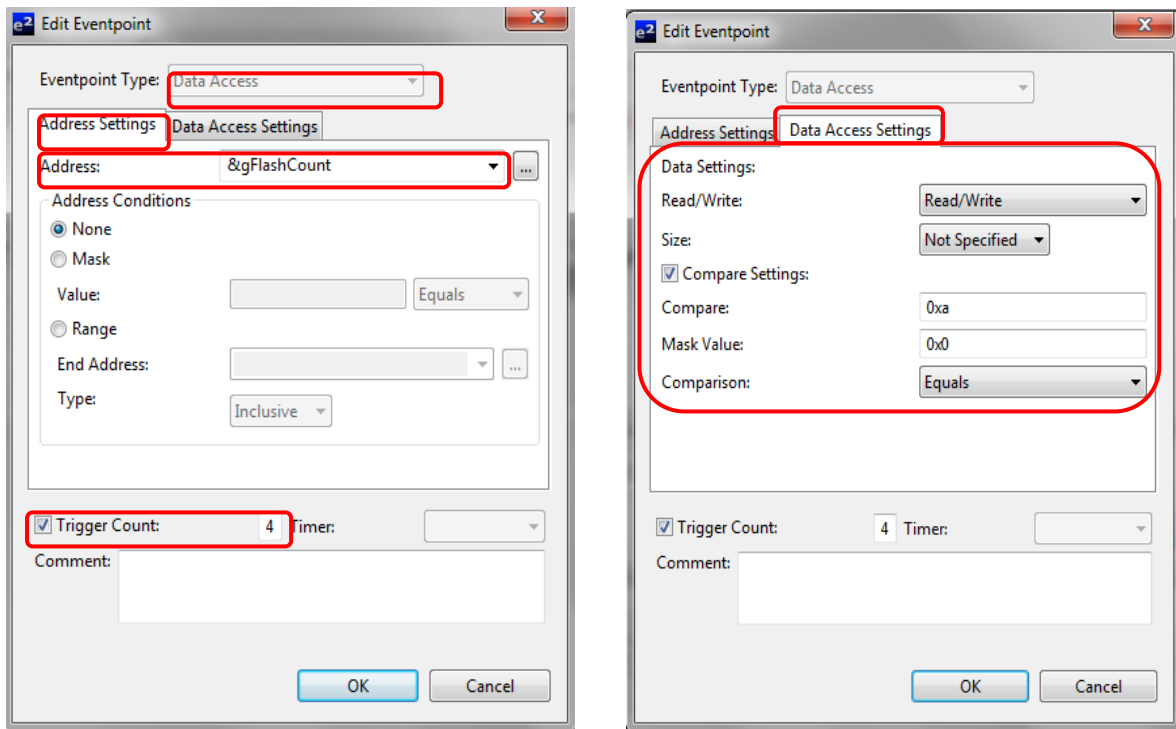


Figure 10 Configure [Trace Stop] condition for Data Access

4. Double click "Turn Trace On/Off" icon available in the toolbar of the Trace window to turn on Trace.

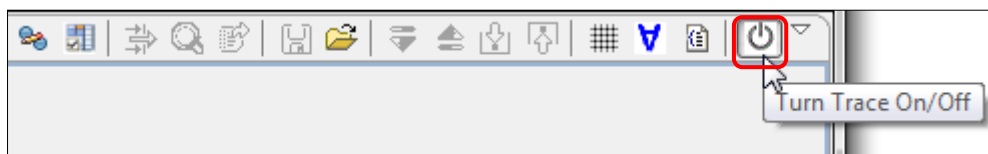


Figure 11 "Turn Trace On/Off" icon in the Trace toolbar

5. Double click "Acquisition" icon available in the toolbar of the Trace window to set trace acquisition setting

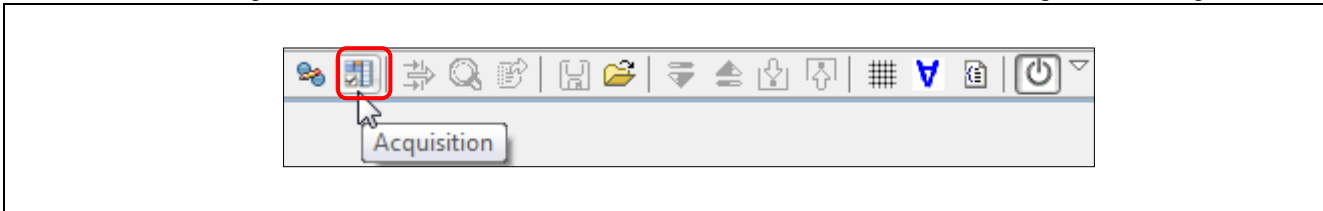


Figure 12 "Acquisition" icon in the Trace toolbar

6. The Trace Acquisition dialog box will appear. Select 'Fill until stop' for [Trace Mode] and 'Branch + Data' for [Trace Type].

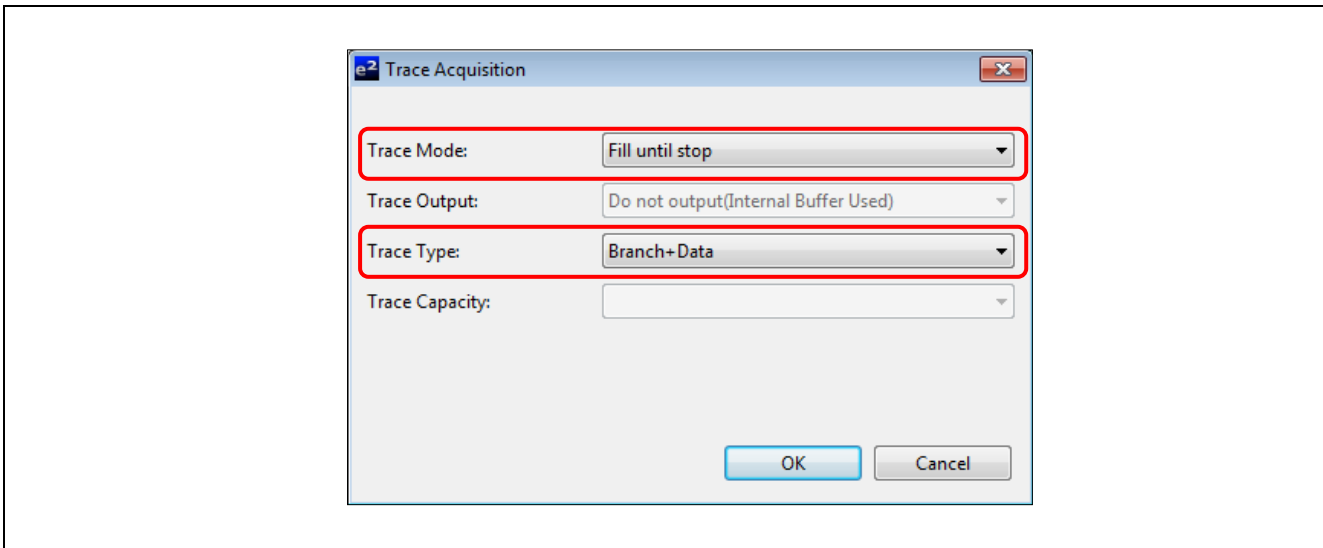



Figure 13 Trace Acquisition setting

- 7. Bus display mode is the default display mode. Click source display button  to enable the source display also.
- 8. Click [Resume] button to run the program.
- 9. Click [Suspend] button when LED blink turns to slow.
- 10. The trace results are shown in Figure 14, It can be seen that from the trace results starts execution from the FlashLED routine and acquisition fill until stops only when the value of gFlashcount is 0xa which matches the compare value set to 0xa.

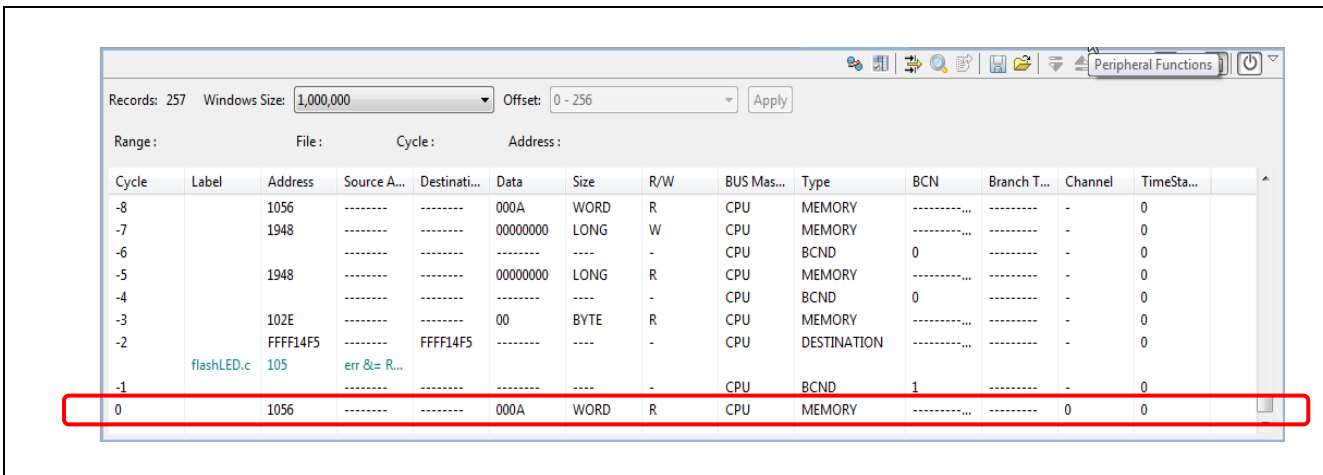

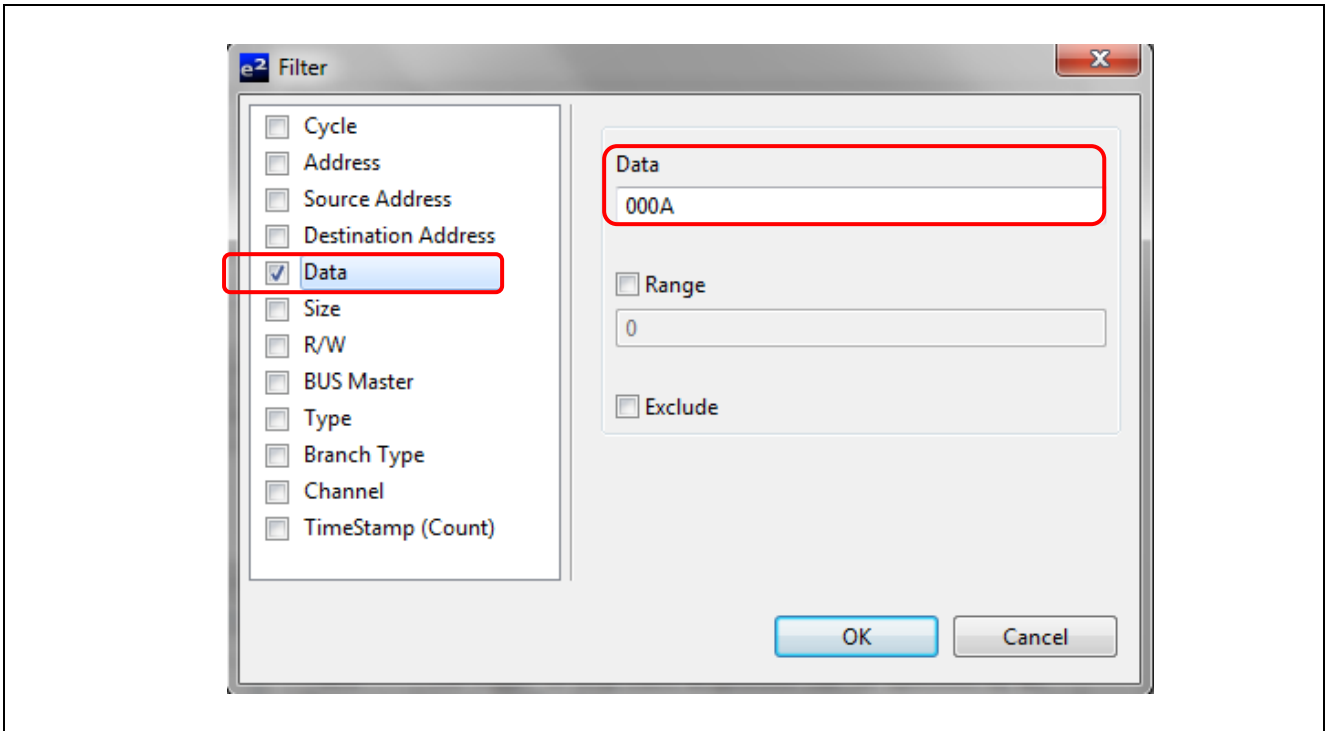


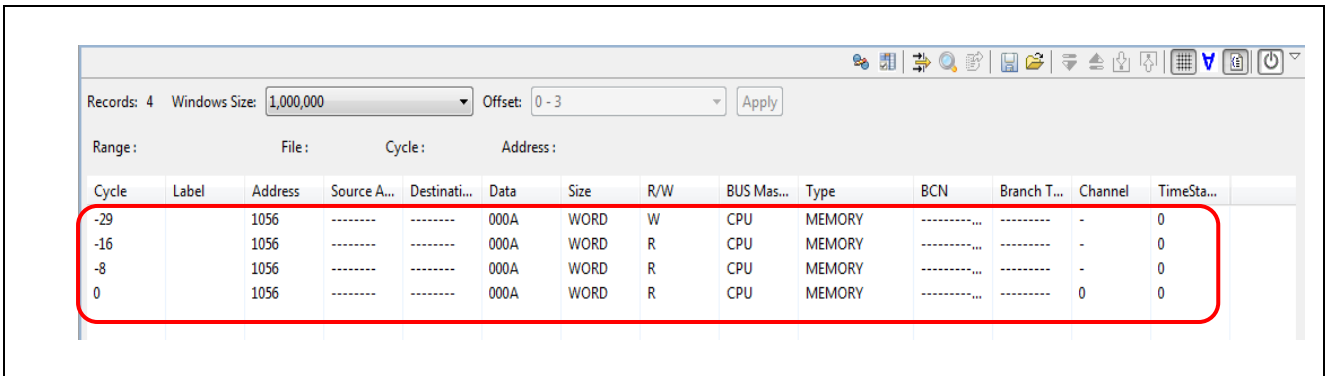
Figure 14 Acquired Trace results after specified events with trace conditions are met

- Click Filter button  and the Filter dialog appears. Check the box for data and enter '000A' in the empty field as shown in Figure 15.




**Figure 15 Set filter condition**

- It can be seen from Figure 16 that trigger count set to '4' is working as expected.



**Figure 16 Trigger count set to '4' fulfilled**

- Click save button  to save the trace results. Save the file in .txt format in the desired location.

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## Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar 15. 2014	-	First Edition Issued

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### 1. Handling of Unused Pins

Handle unused pins in accordance 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.

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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.

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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.

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