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M16C/60 Series PC7501 Emulator

C0 Coverage Facility

Summary

The full-spec emulator PC7501 for the M16C/60 series incorporates the C0 coverage facility. This document explains how to use the C0 coverage facility while using the PC7501 emulator.

Explained in this document is for the case where the user system incorporating an M16C/60 series microcomputer and the PC7501 emulator are used in combination. The content of this document may be used in common for even a different target microcomputer providing it is one of the M16C/60 series microcomputers.

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1. Overview

The coverage facility refers to the one that measures the extent of a test covered. The coverage rate of a test program measured while it was run is used to determine the validity of the test program. The coverage facility comes in several types such as C0 coverage and C1 coverage. Incorporated in the PC7501 is the C0 coverage. Also known as instruction coverage, the C0 coverage allows measuring the coverage of whether instructions were executed. On the other hand, the C1 coverage, also referred to as branch coverage, allows measuring the coverage of whether a branch occurred on true or false side of a conditional branch instruction.

The PC7501 can not only display the result of a C0 coverage measurement in the C0 coverage window, but also permits you to verify instruction execution or non-execution in source line units using the editor window columns, as well as verify instruction execution or non-execution in address units in the memory window. The coverage measurement area can be any area comprised of 1 to 32 blocks (up to 8 Mbytes) beginning with the 256-kbyte boundary. There is another thing to be noted for the PC7501's C0 coverage facility that its measurement result includes prefetches.

2. Facilities Used

In this document, the method of C0 coverage measurement is explained using the sample program included in the CD-ROM supplied with the PC7501 emulator or a downloaded package from the Renesas website.

The tool versions used are listed below.

M16C R8C PC7501 Emulator Debugger V.1.03 Release 00 for the M16C series

3. Preparing the Software

3.1 Getting Started

Install the software included in the CD-ROM that is supplied with the PC7501 emulator.

The sample program (tutorial workspace) used in this document will be expanded in your PC.

The software included in the CD-ROM that is supplied with the PC7501 emulator may also be installed in a PC that has had the High-performance Embedded Workshop already installed. In this case, part of the dialogs displayed during the installation work will be omitted.

3.2 Installing the Software Supplied with the PC7501 Emulator

Execute M16cPc7501 Debugger.exe present in the CD-ROM supplied with the PC7501 emulator.

For details on how to install, see the PC7501 emulator setup guide published at the Renesas website. During installation work, follow the instructions displayed on the screen. The installation procedure is omitted here.

3.3 Auto Update Utility

If you've selected the auto update utility when installing the software, it is possible to confirm via the Internet whether the latest version of each tool is available.



4. Operational Description

This section describes the method for using the C0 coverage facility after starting the High-performance Embedded Workshop (HEW). The procedure is shown below.



Figure 4.1 Example Program Execution Procedure

4.1 Starting the High-performance Embedded Workshop

To begin with, first connect the PC7501 emulator that has the user system connected to it and the host computer with USB cable, and check to see that everything is ready to debug.

Next, start the High-performance Embedded Workshop.

From All Programs on the Start menu, choose Renesas \rightarrow High-performance Embedded Workshop \rightarrow High-performance Embedded Workshop, to start.





4.2 Opening a Workspace

(1) The Welcome! dialog box will be displayed in the High-performance Embedded Workshop.

🖗 High-performance Embedded Workshop	. ð 🗙
File Edit View Project Build Debug Setup Tools Test Window Help	
Welcome! Image: Create a new project workspace OK Cancel Image: Create a new project workspace: Image: Create a new project workspace	
× 01 01 01 01 01 02 02 02 02 02 02 02 02 02 02 02 02 02	
✓ The second	× ×
Ready INS	NUM

Select the "Browse Another Project Workspace" radio button in the Welcome! dialog box and click the OK button.

Welcome!		? 🛛
👔 🤉 Create a ne	w project workspace	
Den a rec	ent project workspace:	Administration
Browse to a	another project workspace	



(2) The Open a Workspace dialog box will be displayed.

Open Work	space		? 🔀
Look jn: 🔀) Tutorial	- 🗲 🔁 (* 💷 *
Tutorial			
File <u>n</u> ame:	Tutorial		Select
Files of tupe:	HE) ()) (orkepaper (* hum)		Cancel

If the installation of the CD-ROM of this product is complete, the workspace "Tutorial.hws" is stored as standard in the folder position shown below. Check folder positions in order while you locate. When the workspace "Tutorial.hws" is found, specify it and click the Select button.



[Note] Depending on the software version used, it will occur that the above directory cannot be specified. In such a case, select the directory given below.

<Directory in which the High-performance Embedded Workshop is installed>

\Tools\Renesas\DebugComp\Platform\E8\M16C\Tutorial

Examples of directory:

C:\hew3\Tools\Renesas\DebugComp\Platform\E8\M16C\Tutorial

C:\hew2\Tools\Renesas\DebugComp\Platform\E8\M16C\Tutorial

(3) If the workspace version is old, the dialog box shown below is displayed. To update it to a new version, click the OK button.

High-pe	erformance Embedded Workshop 🛛 🔀
<u>.</u>	The Workspace you are about to open was created with an earlier version of HEW. The data files for the workspace, projects and sessions will be updated. Once updated this workspace cannot be opened by an older version of HEW. Backup versions of your old files will be created in the workspace and project directories with the prefix 'old_version_xxx'. Do you wish to continue ?



(4) When the workspace is opened, you are ready to use the High-performance Embedded Workshop. Change sessions to connect the PC7501 emulator. To do it, change "DefaultSession" in the toolbar to "SessionM16C_R8C_PC7501_Emulator."

Before changing sessions here, be sure that the interface select switch on the back panel of the PC7501 emulator main body is set to the USB side, and then turn the power for the PC7501 emulator on.



If a dialog box is displayed prompting for your confirmation of whether to save the previous session, click the Yes button.





(5) The Init (M16C R8C PC7501 Emulator) dialog box will be displayed. Select the "USB" radio button on the MCU tab of the dialog box and click OK.

Init (M16C R8C PC7501 Emulator)	
MCU Debugging Information Emulator Script	
MCU: M16C62P.mcu	
CLPT CLAN CUSI	3
Serial No.: 5AS1567B Target	sk
Debug Option	Automatically selected
Debug the program using the CPU Rewrite Mode.	
OK Cancel He	lp

- If your emulator is connected via LPT or LAN instead of USB, visit the Renesas website and see the PC7501 user's manual.
- (6) The MCU Setting dialog box will be displayed. Select "Single-Chip Mode" for Processor Mode on the MCU tab of the dialog box and click OK.

MCU Setting	MCU Status
MCU: M16C/62P	
External Data Bus Width: 16-bit Memory Space Expansion: Normal Mode PM13 (b3 of 000005H) is '1'. PM10 (b0 of 000005H) is '1'.	RDY*: H CNVss: NC BYTE NC
Debug Option Disable Internal Flash ROM (for 10MHz or be	low operating



(7) A connection of the PC7501 emulator will be completed, by which the High-performance Embedded Workshop screen becomes ready to operate. When this connection is complete, a message "Connected" is displayed on the Debug tab of the output window.



4.3 Downloading the Target Program

First, download the target program.

(1) In the example here, we'll download the program "Tutorial.x30 - 00000000" appearing beneath Download Modules in Workspace. Double-click it to download.



When the program is successfully downloaded, its icon is marked by a down arrow.





4.4 Measuring the C0 Coverage

To view the results of coverage measurements, open the coverage window.

(1) From the View menu, choose Code and then Coverage.

🖗 Tutorial	High-performance Embedde	d W	Vorkshop - [ncrt0.a30]	
🧼 File Edit	View Project Build Debug Set	qu	Tools Test Window Help	
🛛 🗅 🖨 🖬	Differences		- th d	ñ
	Мар			
-	Command Line Ctrl+L			
E-G Tutor	🍇 TCL Toolkit Ctrl+Shift+K	8	<u> </u>	
Ē.	Workspace Alt+K	8	ine Sour A S Source	
	Dutput Alt+0		27 ; Inter	ru
	Status Bar Alt+A		29	
	💭 Disassembly Ctrl+D	8	30 31	
	CPU	۲	32 start: 33 ;	
	Symbol	Þ	34 ; after 35 ;	r
	Graphic	۲	• 36 F43C8 ↔	1
	🛃 Script		38 F43D0	n
	Code	¢		
	Break	٠	Stack Trace Ctrl+K	1
	Irace	Þ	43 .else	1
	<u>R</u> TOS	Þ	45 .endif	-
		L,		

(2) The coverage window will open. The window shows the function names of the target program under the heading "Function," as well as the start addresses under "Start," the end addresses under "End" and the C0 coverage measurement result under "Coverage." At this point in time, the values under "Coverage" are 0.00% because the program is not run yet.

In the explanation in this document, the Auto Display Update icon is "enabled" (the icon is depressed when enabled).

Function	Start	End	Coverage
change	OF41BE	OF4219	0.00 %
init	OF4014	OF4100	0.00 %
sort	OF4102	OF41BD	0.00 %
abort	OF4376	OF4376	0.00 %
nain	OF421A	OF4223	0.00 %
tutorial	OF4224	OF4375	0.00 %



• Description of the icons

멶

Source selection: Selects the source file for which the results of coverage measurements are displayed.

When you select the Source Select icon, the Select Source Files dialog box is displayed, allowing you to display only a selected source file in the coverage window.

Select Source File		
C Select all files	le name	
Tutorial.c		•
Select a source file:	rial.c	
	OK	Cancel



the icon is depressed when enabled

Automatic display update: Automatically updates the displayed coverage measurement result when the target program stops.

۲

Display update: Updates the displayed coverage measurement result.

ѷ

Initialization: Initializes the coverage measurement result.



(3) Double-click any function line displayed in the coverage window. The function you've selected will be displayed in the editor window.



(4) We'll now try stopping the program immediately before a call to the sort function to see how the C0 coverage will be measured.

Double-click in the Address Match Breakpoint column at line No. 40 of the source file "Tutorial.c."



Since we've set the program to break immediately before the source address "F4276" of the sort function is executed, the functions change and abort present ahead of it are not executed.



(5) Run the target program to measure the C0 coverage. Select the Run After Reset icon to run the program.



The program can also be run from the Debug menu.



(6) While a C0 coverage measurement is in progress, the "Coverage" values in the coverage window are shown as "- %."

Function	Start	End	Coverage
change	OF41BE	OF4219	- %
init	OF4014	OF4100	- 8
sort	OF4102	OF41BD	- 8
abort	OF4376	OF4376	- 8
main	OF421A	OF4223	- 8
tutorial	OF4224	OF4375	- %



(7) The program will stop at the breakpoint, showing the result of the C0 coverage measurement in the coverage window.

- 5 T.t.					0				
	oriai Assemblu source fili	-		Line	Sour	Α.,	S., 9	Source	
	liocennoly cocilico ni ≚li nort0.a30	10		36	F4259			i = -i;	
	C source file			37				}	
	≚] sort.c			38	F4262			a[i] = j;	
	≚] Tutorial.c			39				,	
😑 🔂 🗖	Download modules				F4276	•	⇔	sort(a);	
	🔓 Tutorial.x30 - 0	0000000		41	F427E			change (a);	
ė 🔄 🖸	Dependencies			• 42	- Concernation				
	(=)			43	F4286			p sam->s0=a[0];	
Drojecte	E Templates *	Navigation	Tort	1 10	10000000000000000000000000000000000000			그는 🛶 이 것이 이 것이 이 것이 있는 것이 이 것이 가지 않아요.	
Projects	Templates	Navigation	Test	44	F4298			p_sam->s1=a[1];	
Projects	Templates 🔌	Navigation	Test	44 45	F4298 F42AE			p_sam->s1=a[1]; p_sam->s2=a[2];	
Projects	Templates 🤇	Navigation	Test	44 45 46	F4298 F42AE F42C6			p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3];	
Projects	Templates 4	Navigation	Test .	44 45 46 47	F4298 F42AE F42C6 F42DE			sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4];	
Projects	Templates	Navigation		14 44 45 46 47 48	F4298 F42AE F42C6 F42DE F42F6			p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5];	
Projects	Start	End	Coverage	44 45 46 47 48 49	F4298 F42AE F42C6 F42DE F42F6 F430E			p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s6=a[6];	
Function	Start OF41BE	End OF4219	Coverage	44 45 46 47 48 49 50	F4298 F42AE F42C6 F42DE F42F6 F43OE F4326			<pre>p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s6=a[6]; p_sam->s7=a[7];</pre>	
Function change	Start OF41BE OF4014	End OF4219 OF4100	Coverage 0.00 %	▲ × 44 ▲ × 45 46 47 48 49 50 51	F4298 F42AE F42C6 F42DE F42F6 F430E F4326 F433E			<pre>p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s5=a[6]; p_sam->s7=a[7]; p_sam->s8=a[8];</pre>	
Projects	Start OF41BE OF4014 OF4012	End 0F4219 0F4100 0F41BD	Coverage 0.00 % 100.00 %	44 45 46 47 48 49 50 51 52	F4298 F42AE F42C6 F42DE F42F6 F430E F4326 F433E F4356			<pre>p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s6=a[6]; p_sam->s7=a[7]; p_sam->s8=a[8]; p_sam->s9=a[9];</pre>	
Function change init sort abort	Start OF41BE OF4014 OF4014 OF402 OF4376	End OF4219 OF4100 OF41BD OF4276	Coverage 0.00 % 100.00 % 1.06 %	44 45 46 47 48 49 50 51 52 53	F4298 F42AE F42C6 F42DE F42F6 F430E F4326 F433E F4356 F436E			<pre>p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s6=a[6]; p_sam->s7=a[7]; p_sam->s8=a[8]; p_sam->s9=a[9]; p_sam = NULL;</pre>	
Function change init sort abort woin	Start 0F41BE 0F41BE 0F4014 0F4102 0F4376 0F4314	End 0F4219 0F4100 0F418D 0F4376 0F4376	Coverage 0.00 % 100.00 % 1.06 % 0.00 %	144 45 46 47 48 49 50 51 52 53 54	F4298 F42AE F42C6 F42DE F42F6 F430E F4326 F433E F4356 F436E F436E F4374		}	<pre>p_sam->s1=a[1]; p_sam->s2=a[2]; p_sam->s3=a[3]; p_sam->s4=a[4]; p_sam->s5=a[5]; p_sam->s6=a[6]; p_sam->s6=a[6]; p_sam->s9=a[9]; p_sam = NULL;</pre>	

In this case, the function change to be called after the function sort and the function abort used for interrupts were not executed. Therefore, as you can see, their measured values are shown as "0.00%."

(8) The result of C0 coverage can also be verified in the editor window. Choose "Set Display Columns" from the Edit menu.





(9) The Entire Column State of Editor dialog box will be displayed. Select the "Coverage" and "Coverage-ASM" check boxes in the dialog box and click OK.



Coverage: Permits you to verify C0 coverage in C source units.

Coverage-ASM: Permits you to verify C0 coverage in assembly units.

(10) The "Coverage" column will be added in the editor window, allowing you to verify C0 coverage visually. The yellow part of this column represents executed instructions, and the gray part represents unexecuted instructions.



In mixed mode or disassembly mode too, it is possible to verify C0 coverage visually in the same way.



(11) What's more, it is possible to verify C0 coverage visually in address units using the memory window. Choose CPU and then Memory from the View menu.

🖗 File Edit	View Project Build D	ebug Setup Tools	Test Window	Help				
	Differences			→ M €				
1 m	мер Мар	T E	1 I I I I I I I I I I I I I I I I I I I					
	Command Line	Ctrl+L						
E 🔂 E	🍇 TCL Toolkit 🛛 🔇	itrl+Shift+K						
	Workspace	Alt+K		Line Sou				
L.e	Dutput	Alt+O		36 F42				
	🔲 Status Bar	Alt+A		38 F42				
	🔊 Disassembly	Ctrl+D		39 40 F42				
	<u>C</u> PU	RI F	legisters	Ctrl+R				
Project	≦ymbol	• 💷	<u>1</u> emory	Ctrl+M 42				
	<u>G</u> raphic	• I/0 I	0	Ctrl+I 42				
8 🌆 🌤	🔀 Script	F	itat <u>u</u> s	Ctrl+U 42				
Function	⊆ode	۹ 💭	42 RamMonitor 43					
change	Break	▶ 0.0	ເວົາ 🛛	50 F43				
change			IO &	51 143				
init		IU.L		52 F43				
init sort	<u>T</u> race	→ 1.0	16 8	52 F43 53 F43				

(12) The Display Start Address dialog box will be displayed. Set "H'F4270" for Display Start Address in this dialog box and click OK.

Display Address		? 🛛
Display Address:	F4270	- 🔊
Scroll Start Address:	000000	- 🔊
Scroll End Address:	OFFFF	• 🔊
ОК	Cancel	



(13) The memory window will open. Right-click in the window and from the ensuing menu, choose Coverage and then Enable.

1 11 100		16 10) ± <u>10</u> {	<u>S</u> et		.16 .3	2 2	2	
Address	+0	+1	+2	<u>E</u> ill		+A	+B	+C	+D
OF4270	04	с9	1B	<u>M</u> ove		FD	02	41	OF
OF4280	14	04	FD	⊆ompare		в5	FC	75	2 F
OF4290	C9	24	77	Test		FA	73	в5	FC
OF42AO	77	E5	75	Save Memory contents		75	2 F	1A	04
OF42BO	FA	73	в5			75	2 F	1C	04
OF42CO	77	E5	75	Search		в5	FC	77	44
OF42D0	77	E5	75	Search <u>N</u> ext		75	2 F	22	04
OF42E0	FA	73	в5			75	2 F	24	04
OF42FO	77	E5	75	<u>A</u> ddress		в5	FC	77	44
OF4300	77	E5	75	Scroll Area		75	2 F	2A	04
OF4310	FA	73	в5	Register	•	75	2 F	2C	04
OF4320	77	E5	75	Followed Stack Pointer		в5	FC	77	44
OF4330	77	E5	75	Set Start Lip Symbol		75	2 F	32	04
OF4340	FA	73	в5	Set Start Op Symbol		75	2 F	34	04
OF4350	77	E5	75	<u>R</u> efresh		в5	FC	77	44
OF4360	77	E5	75	Lock Refresh		75	2 F	ЗA	04
OF4370	FA	D9	ОВ			C6	41	7D	E2
				<u>D</u> ata Length	•				
				Radi <u>x</u>	•				
nert0 a30	104	Tuto	rial c	Code					
		1 410		Lavout					
				Caluma	2222				
				Co <u>v</u> erage	- (·	Enat	ole		
			L.	<u>S</u> ave					
				Load					

(14) The memory window will be color-coded. Shown in the blue part are the executed instructions, and those in the gray part are the unexecuted instructions.

I II III		<u>16</u> 10	±10	8	2 d	bc 🚲	あ	ão da	f.	.d	.16 .3	2	2			
Address	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+A	+B	+C	+D	+E	+F
OF4270	04	C9	1B	FE	FE	CB	75	C1	14	04	FD	02	41	OF	75	C1
OF4280	14	04	FD	BE	41	OF	73	в4	FA	73	в5	FC	75	2 F	14	04
OF4290	C9	24	77	E5	75	2 F	16	04	73	в4	FA	73	в5	FC	С9	44
OF42AO	77	E5	75	2 F	18	04	С9	24	77	E5	75	2 F	1A	04	73	в4
OF42B0	FA	73	в5	FC	77	44	08	00	77	E5	75	2F	1C	04	С9	24
OF42CO	77	E5	75	2 F	1E	04	73	в4	FA	73	в5	FC	77	44	0C	00
OF42DO	77	E5	75	2 F	20	04	с9	24	77	E5	75	2 F	22	04	73	в4
OF42E0	FA	73	в5	FC	77	44	10	00	77	E5	75	2 F	24	04	C9	24
OF42FO	77	E5	75	2 F	26	04	73	в4	FA	73	в5	FC	77	44	14	00
OF4300	77	E5	75	2 F	28	04	C9	24	77	E5	75	2 F	2A	04	73	в4
OF4310	FA	73	в5	FC	77	44	18	00	77	E5	75	2 F	2C	04	с9	24
OF4320	77	E5	75	2 F	2 E	04	73	в4	FA	73	в5	FC	77	44	1C	00
OF4330	77	E5	75	2 F	30	04	С9	24	77	E5	75	2F	32	04	73	в4
OF4340	FA	73	в5	FC	- 77	44	20	00	77	E5	75	2 F	34	04	С9	24
OF4350	77	E5	75	2 F	36	04	73	в4	FA	73	в5	FC	77	44	24	00
OF4360	77	E5	75	2 F	38	04	C9	24	77	E5	75	2F	3A	04	D9	OB
OF4370	FA	D9	ОB	FC	7D	F2	F3	в4	7D	E 2	C6	41	7D	E 2	6D	4E
OF4380	73	FO	10	04	73	F2	12	04	FD	AC	43	OF	7D	в4	77	40



(15) Try verifying the content of the internal RAM following the same procedure. Right-click in the memory window and from the ensuing menu, choose Start Address. The PC7501's coverage facility permits you to measure the coverage of data areas (whether addresses accessed), not just the coverage of instruction execution.

1 11 111	···· 16	<u>S</u> et	t.	÷
Address	+0	<u>F</u> ill	+8 -	+
OF4270	04	<u>M</u> ove	14 (ō
OF4280	14	<u>⊂</u> ompare	FA '	7
OF4290	C9	Test	73 1	в
OF42AO	77	Save Memory contents	77 1	E
OF42BO	FA	2	I 77 I	E
OF42CO	77	Search	FA '	7
OF42DO	77	Search Next	77 1	E
OF42EO	FA		77 1	E
OF42FO	77	<u>A</u> ddress	FA '	7
OF4300	77	Scroll Area	1 77 1	E
OF4310	FA	Register	▶ 77 I	E
OF4320	77	- Followed Stack Pointer	FA '	7
OF4330	77	Sat Start Lie Suppel	77 1	E
OF4340	FA	set start op symbol	1 77 1	E

(16) The Display Start Address dialog box will be displayed. Set "H'400" for Address in this dialog box and click OK.



(17) The window permits you to verify the variables in the internal RAM that were accessed and those that were not accessed.

Transfer Constants	in in								W				_			
1 11 100		<u>16</u> <u>10</u>	±10	<u>8</u>	2	dbc 🗟	あ	动动	.f	.d	.16 .3	2 2	2			
Address	+0	+1	+2	+3	+4	1 +5	+6	+7	+8	+9	+A	+B	+C	+D	+E	+F
000400	00	00	00	00	00	00 (00	00	00	00	00	00	00	00	00	00
000410	DF	D5	F6	OF	CE	5 41	00	00	7E	16	00	00	81	27	00	00
000420	6B	44	00	00	41	3 79	00	00	FB	15	00	00	E 2	59	00	00
000430	FB	1C	00	00	- 54	1 3F	00	00	F6	OF	00	00	00	00	00	00
000440	00	00	00	00	00	00 (00	00	00	00	00	00	00	00	00	00
000450	00	00	00	00	00	00 (00	00	00	00	00	00	00	00	00	00
000460	00	00	00	00	60	C OA	00	00	00	03	00	00	E3	55	73	AF
000470	81	48	08	01	68	3 D4	3A	56	CF	DA	F4	FB	7B	5A	FF	FE
000480	AB	47	27	2 D	00) DE	C5	81	F4	вО	D8	С1	7D	BD	EB	63
000490	9A	01	55	C1	BE	5 9E	8 E	8A	6E	27	DF	EB	7C	ЗF	ΕO	F5
0004A0	A1	66	FO	7A	83	24	26	28	4F	99	AC	8 F	DF	E8	F4	E5
0004B0	88	С3	8 E	08	A2	C2	1C	62	F7	ЗD	CD	FF	ЗF	5F	E7	AF
0004c0	83	6E	43	24	31	L 75	37	71	46	BF	FF	EE	8A	70	8 D	C7
0004D0	A8	60	OF	61	18	3 17	C5	48	42	2F	7D	57	1D	F4	7B	в6
0004E0	C9	1A	52	04	81	L 19	4D	15	54	AB	в6	4F	2F	D5	ЗD	FF
0004F0	4D	54	C1	00	00) D6	DA	23	BF	4F	DE	FD	C8	43	00	OF
000500	05	1E	F8	D6	88	3 16	в6	74	В1	в8	AA	A6	F3	ЗD	E5	FF
000510	11	CP	02	1 5	56	: 00	1.4	05	00	75	DD	45	74	PD	20	πA

These coverage facilities allow you not only to verify the validity of a test program, but also measure the usage rate, etc. of the RAM space in actual program operation.



5. Frequently Asked Questions

5.1 Why do the measurement result in source units and that in the coverage window differ?

Run the sample program once up until it ends and see the result of C0 coverage measurement. It will look like the one shown below.

Function	Start	End	Coverage
change	OF41BE	OF4219	100.00 %
init	OF4014	OF4100	100.00 %
sort	OF4102	OF41BD	100.00 %
abort	OF4376	OF4376	100.00 %
main	OF421A	OF4223	100.00 %
tutorial	OF4224	OF4375	98.22 %

Taking a look at the C0 coverage of the function tutorial in C source units, you'll find that the function appears to have been executed in whole.

Γ	•) Q				
L	.ine	Sour	C.,	Α.,	S.,	Source
	23					
	23 24 25 26 27 28 29 30 31 32 33 34 35	F4224 F4227 F4231 F4230 F4248 F4254				<pre>void tutorial(void) { long j; int i; struct Sample far *p_sam; p_sam= &st init(p_sam); for(i=0; i<10; i++)(j = rand(); if(i < 0)(</pre>
	35	F4254				if(j < 0){
	37	14239				; ; ;
	38	F4262				a[i] = j;
	39					}
	40	F4276				sort(a);
	41	F427E				change (a) ;
	42					Property AL CONCIDE
	43	F4286				p_sam->s0=a[0];
	44	F4298				p_sam->s1=a[1];
	45	F42AE				p_sam->s2=a[2];
	46	F42C6				p_sam->s3=a[3];
	47	F42DE				p_sam->s4=a[4];
	48	F42F6				p_sam->s5=a[5];
	49	F430E				p_sam->s6=a[6];
	50	F4326				p_sam->s7=a[7];
	51	F433E				p_sam->s8=a[8];
	52	F4356				p_sam->s9=a[9];
	53	F436E				p_sam = NULL;
	54	F4374				}
	55					and the state of t
	56	20				void abort (void)
	57	F4376				(
	58					
	59	F4376				}
	60					



However, if the C0 coverage of the function tutorial is verified in assembly units, you'll find that part of the function was unexecuted.

 ĐĄ								
Line	C., A.	. S.	. Disass	Obj code	Label	Mixed		
23								
24						void tutorial (void)		
25	-					(
	<u> </u>		F4224	7CF2OA	_tutorial	ENTER #OAH		
26						long j;		
27						int i;		
28						struct Sample far	*p_sam;	
29								
30	- P					p_sam= &st		
			F4227	75CBFA3C04		MOV.W:G #043CH,-6H[F	B]	
	- A.		F422C	75CBFC0000		MOV.W:G #0000H,-4H[F	B]	
31						init (p_sam);		
			F4231	754BFC		PUSH.W:G -4H[FB]		
			F4234	754BFA		PUSH.W:G -6H[FB]		
			F4237	FD14400F		JSR.A		
	- A.		F423B	7DB4		ADD.B:Q #4H,SP		
32								
33						for(i=0; i<10; i+	+) {	
			F423D	D90BFE		MOV.W:Q #OH,-2H[FB]		
			F4240	778BFE0A00		CMP.W:G #000AH,-2H[F	в]	
	<u> </u>		F4245	7DCA2F		JGE F4276H		
34						j = rand();		
			F4248	FD78430F		JSR.A rand F4378H		
			F424C	7CF3		EXIS.W RU		
			F424E	732888		MOV.W:G RZ,-SH[FB]		
25			14251	73UBF 6		MOV.W:G RU,-AH[FB]		
35			RADEA	SEDDOF				
			F4257	(LDDCF				
26	-		14237	OAUA		JEQ 14202H		
50			F4250	757880		NOT H.CPHIERI	Execute	ed up until here
			F425C	755886		NEG N - NH[FB]	in accor	mbly unite
)	F425E	775858		ADCE N _SHIFB]	III assei	noiy units
32			1-12.51	TITEDIO				
38						e[i] = i.		
00			F42.62	7384FE		MOV. N:G -2H[FB]. AD		
			F4265	F914		SHL W #2H MO		
			F4267	73BCF61404		MOV.W:G -AH[FB].0414	HLYOI	-
			F426C	73BCF81604		MOV.W:G -8H[FB].0416	HITOJ	
			F4271	C91BFE		ADD.W:Q #1H,-2H[FB]	1999 - 199	
			F4274	FECB		JMP.B F4240H		
39						}		

The reason why such a phenomenon occurs is because a prefetch is involved. Instructions are loaded into the cache beforehand no matter whether the next data is required. Once prefetched, when in assembly units, instructions are executed after the JEQ instruction up until the next instruction. When this is verified in C source units, instructions are assumed to have been executed up until "j = -j," so that it appears on the surface that all instructions were executed.

If you want to verify C0 coverage at the source level, we recommend verifying the result in mixed mode or disassembly mode.



6. Related Documents

The PC7501 emulator and the HEW have numerous other convenient facilities and features not discussed in this document. Detailed specifications, technical information, limitations and other useful information on each product are described in the related documents listed below. Please see these manuals along with this document.

[PC7501 emulator related documents]

- M16C R8C PC7501 Emulator Debugger User's Manual (for the M16C/60, M16C/30, M16C/Tiny and R8C/Tiny series)
- M16C R8C PC7501 Emulator Debugger Release Notes (for the M16C/60, M16C/30, M16C/Tiny and R8C/Tiny series)
- PC7501 Setup Guide (M16C Family Emulator)
- PC7501 User's Manual (M16C Family Emulator)

[High-performance Embedded Workshop related documents]

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

[CPU related documents]

- M16C/60 Series Hardware Manual
- M16C/60, M16C/20, M16C/Tiny Series Software Manual

[M16C/60 series C compiler related documents]

- M3T-NC30WA C Compiler Guidebook (C compiler package for the R8C/Tiny, M16C/60, M16C/30, M16C/20, M16C/10 and M16C/Tiny series)
- M3T-NC30WA Assembler User's Manual (C compiler package for the R8C/Tiny, M16C/60, M16C/30, M16C/20, M16C/10 and M16C/Tiny series)

To see more information on the PC7501 emulator, please visit the Renesas websites given below.

Japan site:	http://japan.renesas.com/pc7501
Global site:	http://www.renesas.com/pc7501



Home Page and Where to Contact for Support

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Revision Record

			Contents of revision							
Rev.	Issue date	Page	Points							
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