REJ10J0956-0300

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E8 Emulator

Additional Document for User's Manual
R0E000080KCE00EP15

Renesas Microcomputer Development Environment System
M16C Family / R8C/Tiny Series
Notes on Connecting the R8C/20, R8C/21, R8C/22 and R8C/23

User's Manual

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This user's manual is applicable to the E8 emulator software V.2.10 Release 00 or later.

Section 1 Inside the E8 Emulator User's Manual

The E8 manual consists of two documents: the E8 User's Manual and the E8 Additional Document for User's Manual (this document). Be sure to read BOTH documents before using the E8 emulator.

(1) E8 Emulator User's Manual
The E8 Emulator User's Manual describes the hardware specifications and how to use the emulator debugger.

- E8 emulator hardware specifications
- Connecting the E8 emulator to the host computer or user system
- Operating the E8 emulator debugger
- Tutorial: From starting up the E8 emulator debugger to debugging

(2) E8 Additional Document for User's Manual
The E8 Additional Document for User's Manual describes content dependent on the MCUs and precautionary notes.

- MCU resources used by the E8 emulator
- Example of the E8 emulator connection or interface circuit necessary for designing the hardware
- Notes on using the E8 emulator
- Setting the E8 emulator debugger during startup

Section 2 E8 Emulator Specifications

Table 2.1 shows the E8 emulator specifications for the R8C/20, R8C/21, R8C/22 and R8C/23 Groups.

Table 2.1 E8 Emulator Specifications for the R8C/20, R8C/21, R8C/22 and R8C/23 Groups

Target MCUs	M16C Family R8C/Tiny Series R8C/20, R8C/21, R8C/22 and R8C/23 Groups
Available operating modes	Single-chip mode
Break functions	- Address match break, 4 points, or Address match break, 2 points + Data condition break, 1 point - PC break points (maximum 255 points) - Forced break
Trace functions	Last 4 branch instructions
Flash memory programming function	Available
User interface	1-line clock asynchronous serial interface (communication via MODE pin) * UART1 function cannot be used in a user program
MCU resources to be used	- ROM size: 2 KB [*1] - RAM size: 256 bytes [*1] - Stack 8 bytes - Address match interrupt - UART 1 function
Emulator power supply	Unnecessary (USB bus powered, power supplied from the PC)
Interface with host machine	USB (USB 1.1, full speed) * Also connectable to host computers that support USB 2.0
Power supply function	Can supply 3.3 V or 5.0 V to the user system (maximum 300 mA)
Power voltages	2.7 - 5.5 V

Note:
1. Varies depending on the MCU. For details, see "Section 6 Notes on Using the E8 Emulator".

Table 2.2 shows the operating environment of the E8 emulator.

Table 2.2 Operating Environment

Temperatures	Active	: 10°C to 35°C
	Inactive	: –10°C to 50°C
Humidity	Active	: 35% RH to 80% RH, no condensation
	Inactive	: 35% RH to 80% RH, no condensation
Vibrations	Active	: maximum 2.45 m/s^2
	Inactive	: maximum 4.9 m/s^2
	Transportation	: maximum 14.7 m/s^2
Ambient gases	No corrosive gases	

Section 3 Connecting the E8 Emulator to the User System

Before connecting the E8 emulator to the user system, a connector must be installed in the user system so a user system interface cable can be connected. When designing the user system, refer to Figure 4.1 “E8 Connecting Connector Pin Assignments” and Figure 5.1 “Example of an E8 Connection”.
Before designing the user system, be sure to read the E8 Emulator User’s Manual and related device hardware manuals.

Table 3.1 shows the recommended connector for the E8 emulator.

Table 3.1 Recommended Connector

	Type Number	Manufacturer	Specification
14-pin connector	2514-6002	3M Limited	14-pin straight type

Connect E8 connecting connector pins 2, 4, 6, 10, 12 and 14 firmly to the GND on the user system board. These pins are used as an electric GND and monitor the connection of the user system connector. Note the pin assignments for the user system connector.

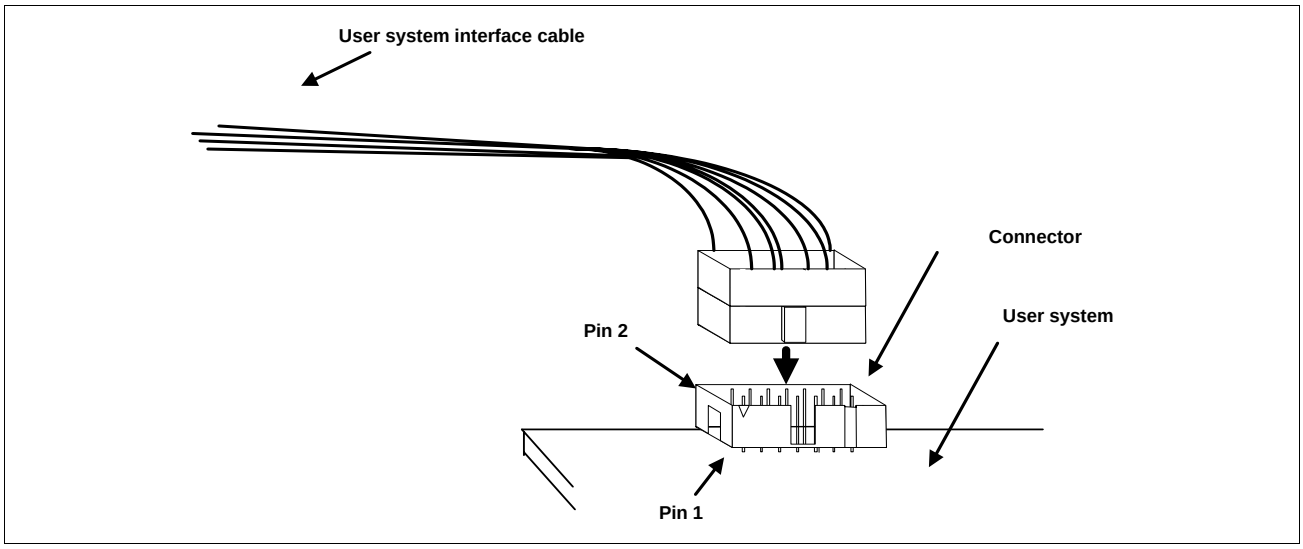
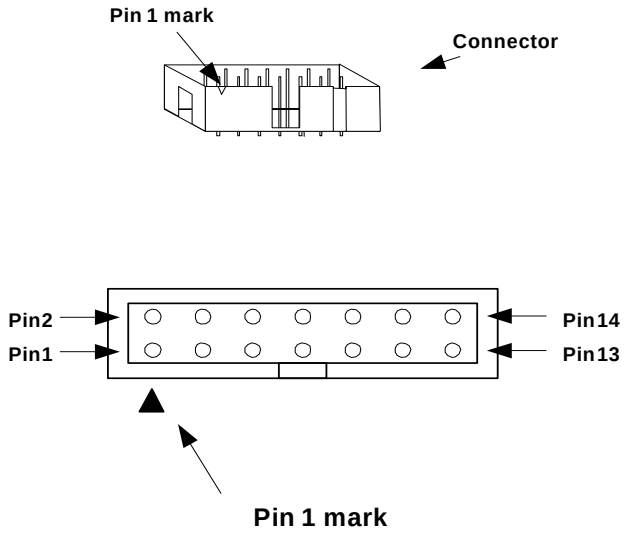


Figure 3.1 Connecting the User System Interface Cable with an E8 Connecting Connector

Notes:
1. Do not place any components within 3 mm area of the connector.
2. When using the E8 emulator as a programmer, connect it to the user system in the same way.

Section 4 E8 Connecting Connector Pin Assignments

Figure 4.1 shows the pin assignments for the E8 connecting connector.



Pin No.	R8C/20, 21, 22 and 23 MCU signals
1	N.C.
2	Vss
3	N.C.
4	Vss
5	N.C.
6	Vss
7	**MODE**
8	Vcc
9	N.C.
10	Vss
11	N.C.
12	Vss
13	**$\overline{\text{RESET}}$**
14	Vss

Figure 4.1 E8 Connecting Connector Pin Assignments

Note:
Pin 14 is used for checking the connection between the E8 and the user system, and Pin 4 is connected to the internal circuit. These pins are not directly connected to the Vss inside the E8. Make sure pins 2, 4, 6, 10, 12 and 14 are all connected to the Vss.

Section 5 Examples of E8 Connections

Figure 5.1 shows a connection example.

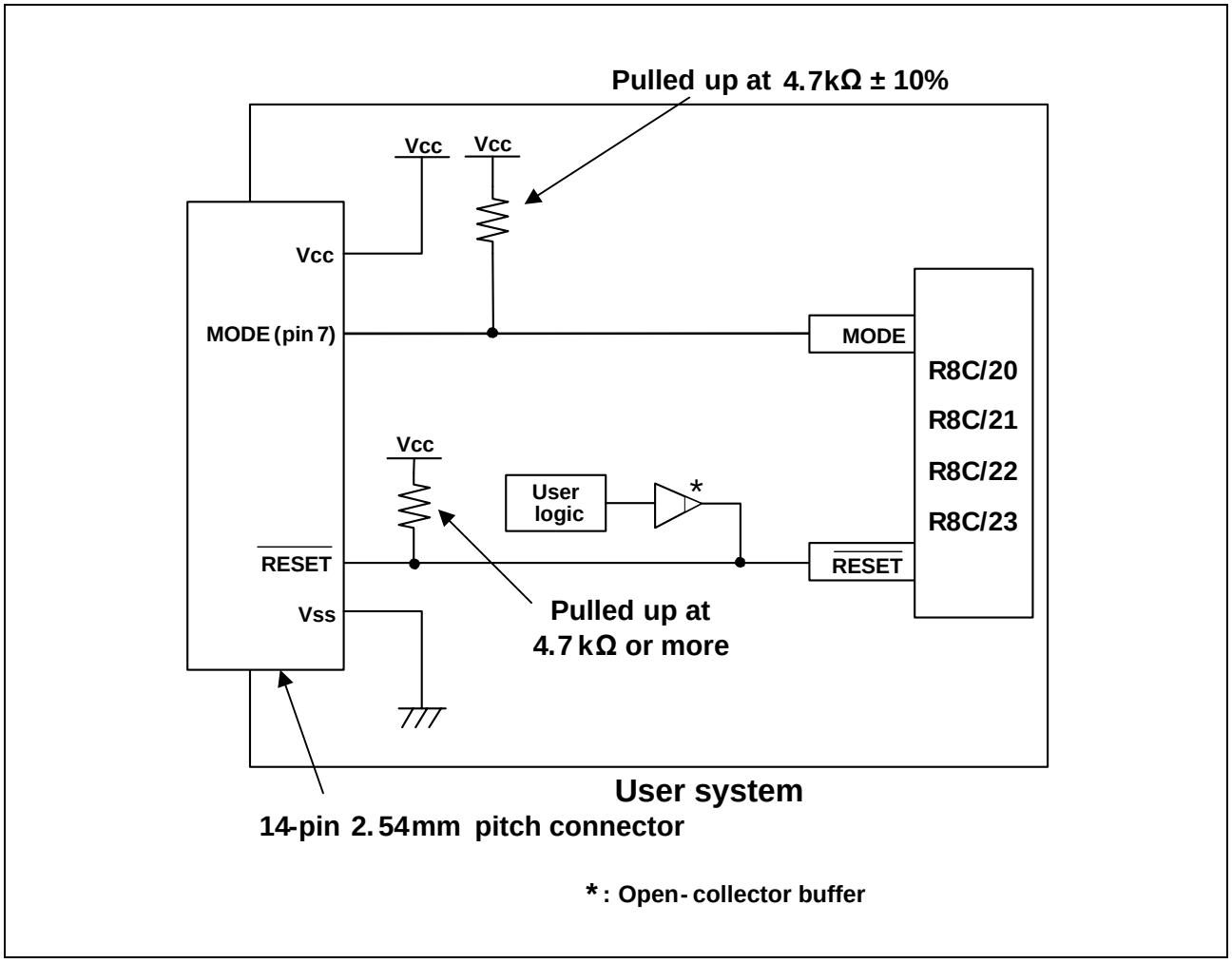


Figure 5.1 Example of an E8 Connection

When using the emulator as a programmer, the connection specification between the E8 and the MCUs is the same as shown in Figure 5.1.

Points to Remember

1. The E8 emulator uses the MODE pin for MCU control and forced break control. Pull up the E8 emulator and MCU pins and connect the E8 emulator.

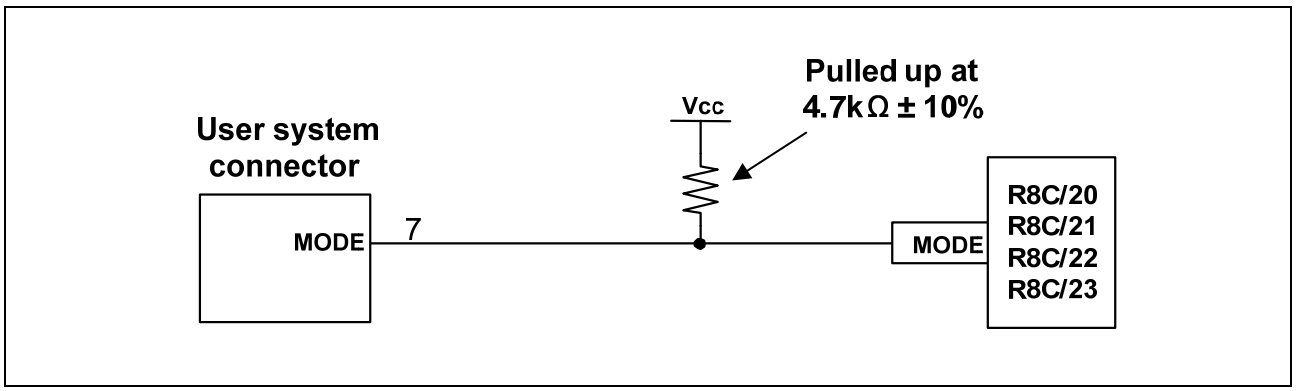


Figure 5.2 E8 Emulator and MODE Pin Connection

2. The $\overline{\text{RESET}}$ pin is used by the E8 emulator. Therefore, use an open-collector output buffer or a CR reset circuit as the reset circuit for the user system. The recommended pull-up value is 4.7 kΩ or more. The MCU can be reset by outputting "L" from the E8 emulator. However, if the reset IC output is "H", the user system reset circuit cannot be set to "L". As such, the E8 emulator will not operate normally.

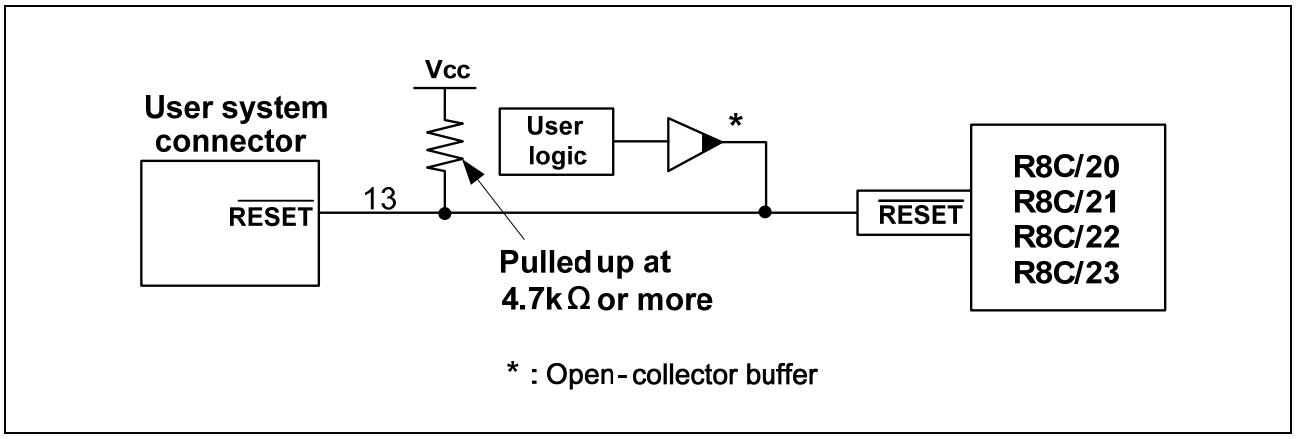
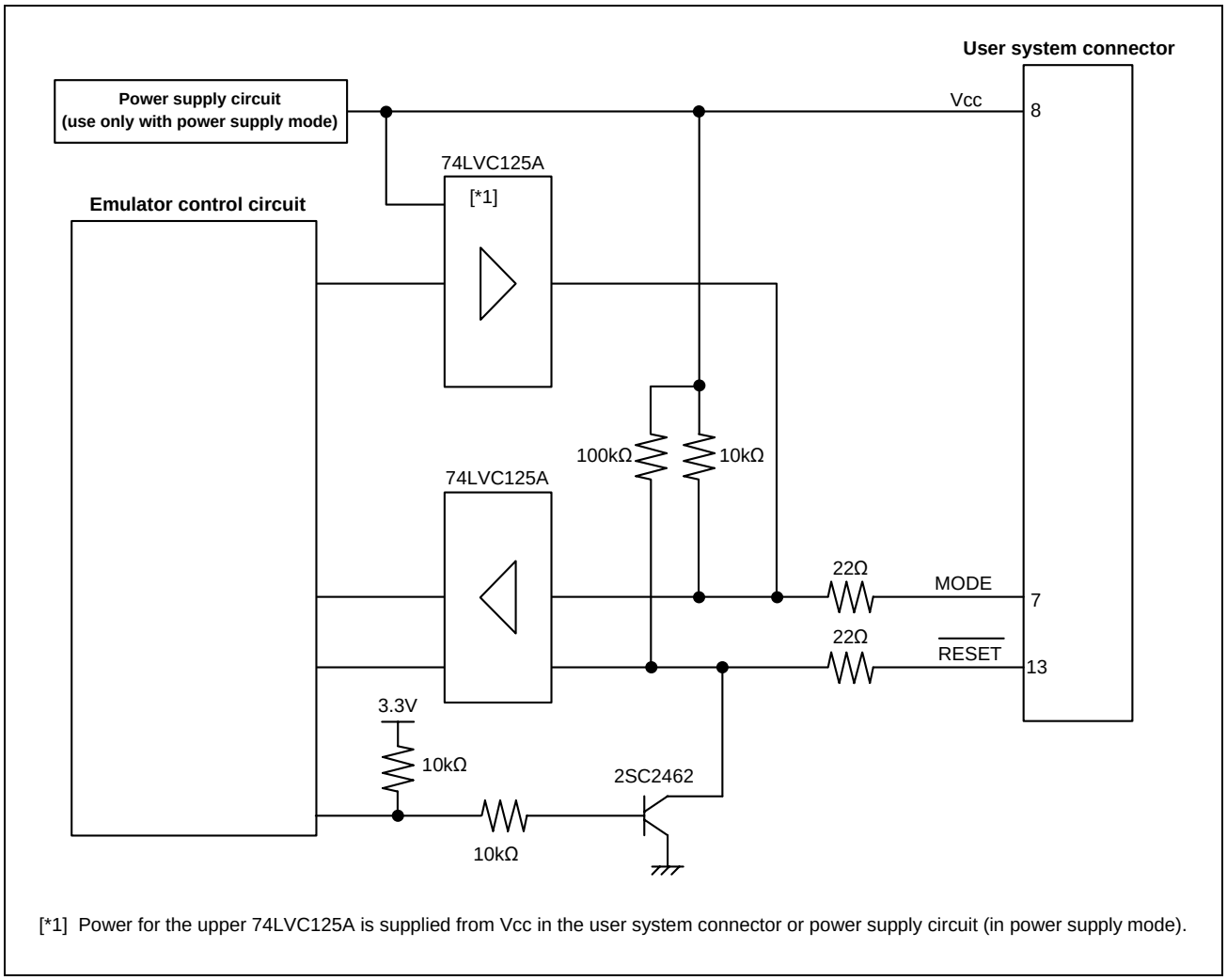


Figure 5.3 Example of a Reset Circuit

3. Connect Vss and Vcc to the Vss and Vcc of the MCU, respectively.
4. Do not connect anything to the N.C. pin.
5. The amount of voltage input to Vcc must be within the specified range of the MCU.
6. Pin 14 is used for checking the connection between the E8 and the user system, and Pin 4 is connected to the internal circuit. These pins are not directly connected to the Vss inside the E8. Make sure pins 2, 4, 6, 10, 12 and 14 are all connected to the Vss.

7. Figure 5.4 shows the interface circuit in the E8 emulator. Use this figure as a reference when determining the pull-up resistance value.



[*1] Power for the upper 74LVC125A is supplied from Vcc in the user system connector or power supply circuit (in power supply mode).

Figure 5.4 Interface Circuit Inside the E8 Emulator (For Reference)

Section 6 Notes on Using the E8 Emulator

1. Program area for the E8 emulator
   Table 6.1 lists the program areas allotted for the E8 emulator. Do not change this area allocation, otherwise the E8 emulator will not control the MCU. If settings were changed, disconnect the debugger and then reconnect it.

Table 6.1 Program Area for the E8 Emulator

Group	Part No.	ROM Size		Program Area for E8 Emulator		
		Programming Area	Data Area	Vector Area	RAM Area	ROM Area (Default Area)
R8C/20	R5F21206	32 KB	-	FFE4h - FFE7h, FFE8h - FFEBh, FFECh - FFEFh, FFF4h - FFF7h, FFF8h - FFFBh, FFFCh - FFFEh	-	-
	R5F21207	48 KB	-		-	-
	R5F21208	64 KB	-		F00h - FFFh	2 KB of the ROM area [*1] (User Flash Area 13800h - 13FFFh)
	R5F2120A	96 KB	-			-
	R5F2120C	128 KB	-			2 KB of the ROM area [*1] (User Flash Area 23800h - 23FFFh)
R8C/21	R5F21216	32 KB	2 KB		-	-
	R5F21217	48 KB	2 KB		-	-
	R5F21218	64 KB	2 KB		F00h - FFFh	2 KB of the ROM area [*1] (Data Flash Area 2400h - 2BFFh) or (User Flash Area 13800h - 13FFFh)
	R5F2121A	96 KB	2 KB			-
	R5F2121C	128 KB	2 KB			2 KB of the ROM area [*1] (Data Flash Area 2400h - 2BFFh) or (User Flash Area 23800h - 23FFFh)
R8C/22	R5F21226	32 KB	-		-	-
	R5F21227	48 KB	-		-	-
	R5F21228	64 KB	-		F00h - FFFh	2 KB of the ROM area [*1] (User Flash Area 13800h - 13FFFh)
	R5F2122A	96 KB	-			-
	R5F2122C	128 KB	-			2 KB of the ROM area [*1] (User Flash Area 23800h - 23FFFh)
R8C/23	R5F21236	32 KB	2 KB		-	-
	R5F21237	48 KB	2 KB		-	-
	R5F21238	64 KB	2 KB		F00h - FFFh	2 KB of the ROM area [*1] (Data Flash Area 2400h - 2BFFh) or (User Flash Area 13800h - 13FFFh)
	R5F2123A	96 KB	2 KB			-
	R5F2123C	128 KB	2 KB			2 KB of the ROM area [*1] (Data Flash Area 2400h - 2BFFh) or (User Flash Area 23800h - 23FFFh)

Note:
1. When starting the debugger, the [Emulator Setting] dialog box shown in Figure 6.1 is displayed. Specify the area which will not be used by the user system. If the [Enable advanced setting] check box is checked, the area used by the emulator can be specified with the address (Figure 6.2).

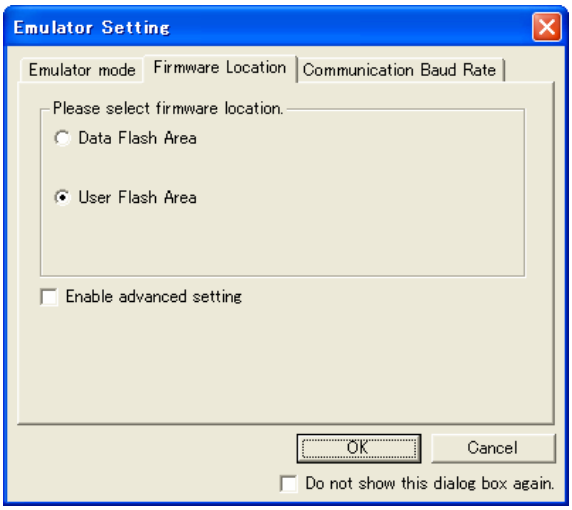


Figure 6.1 [Firmware Location] tab of [Emulator Setting] Dialog Box (1)

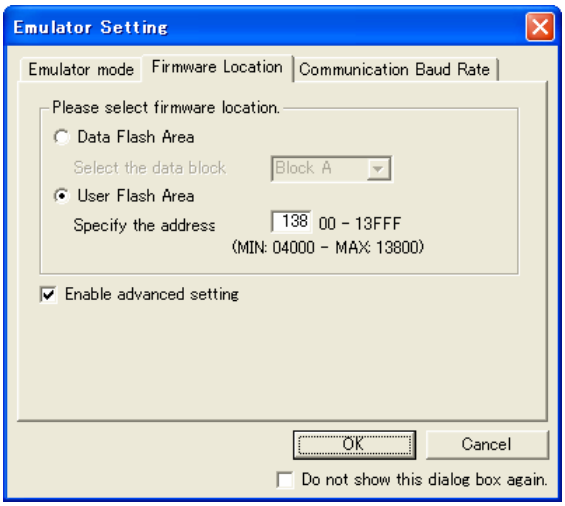


Figure 6.2 [Firmware Location] tab of [Emulator Setting] Dialog Box (2)

2. When the system is launched, the E8 emulator initializes the general registers and some of the flag registers as shown in Table 6.2.

Table 6.2 E8 Emulator Register Initial Values

Status	Register	Initial Value
E8 Emulator Activation	PC	Reset vector value in the vector address table
	R0 to R3 (bank 0, 1)	0000h
	A0, A1 (bank 0, 1)	0000h
	FB (bank 0, 1)	0000h
	INTB	0000h
	USP	0000h
	ISP	05FFh
	SB	0000h
	FLG	0000h

3. The E8 emulator communicates with the MCU by using the MODE and $\overline{\text{RESET}}$ pins.

4. The E8 emulator uses up to 8 bytes of the stack pointer during a user program break. Therefore, set aside 8 bytes for the stack area.

5. Peripheral function used by the E8 emulator program
UART1 is used by the E8 emulator. Do not use UART1 in the user program.

6. SFRs used by the E8 emulator program

The SFRs listed in Table 6.3 are used by the E8 emulator program as well as the user program. Do not change the value in the memory window, etc., by other than the user program. Note that although the SFRs can be changed during user program execution, the changed value cannot be read at the break.
The SFRs listed in Table 6.4 are used by the E8 emulator program, not the user program. Do not change the registers, otherwise the E8 cannot control the MCU. Note that UART1 transmit interrupt control register S1TIC and UART1 receive interrupt control register S1RIC always read out values used by the emulator.

The SFRs listed in Tables 6.3 and 6.4 are not initialized by selecting [Debug] -> [Reset CPU] or by using the RESET command. If register contents are referred to, a value that has been set in the E8 emulator program will be read out.

Table 6.3 SFRs Used by the E8 Emulator Program (1)

Address	Register	Symbol	Bit
000Ah	Protect register	PRCR	Bit 0 [*1]
0023h	High-speed on-chip oscillator control register 0	FRA0	Bit 0
0024h	High-speed on-chip oscillator control register 1	FRA1	All bits
01B3h	Flash memory control register 4	FMR4	Bit 7

Note:
1. As of Version 2.08 Release 00 of the E8 emulator software, the value for the protect register bit 1 can be changed by the user program as well as other programs.

Table 6.4 SFRs Used by the E8 Emulator Program (2)

Address	Register	Symbol	Bit	Notes on using the E8 emulator
0009h	Address match interrupt enable register	AIER	All bits	[*1]
0010h - 0012h	Address match interrupt register 0	RMAD0	All bits	[*1]
0014h - 0016h	Address match interrupt register 1	RMAD1	All bits	[*1]
00A8h	UART1 transmit/receive mode register	U1MR	All bits	[*1]
00A9h	UART1 bit rate register	U1BRG	All bits	[*1]
00AAh, 00ABh	UART1 transmit buffer register	U1TB	All bits	[*1]
00ACh	UART1 transmit/receive control register 0	U1C0	All bits	[*1]
00ADh	UART1 transmit/receive control register 1	U1C1	All bits	[*1]
00AEh, 00AFh	UART1 receive buffer register	U1RB	All bits	[*1]
00F8h	Port mode register	PMR	Bit 4	[*2]

Notes:
1. Do not change this register value.
2. Do not change the value of the bits listed in the column to the left. When operating this register, make changes using the bit operation instructions to avoid changing the bit values.

7. Interrupts used by the E8 emulator program

The BRK instruction interrupt, address match interrupt, single-step interrupt and address break interrupt are used by the E8 emulator program. Therefore, make sure the user program does not use any of these interrupts. The E8 emulator changes these interrupt vector values to the values to be used by the emulator. No problems occur if the interrupt vector values are written in the user program.

8. Debugging during a watchdog timer operation

When running the E8 emulator program, the program refreshes the watchdog timer. If memory access is executed through memory reference or modification, the watchdog timer will be refreshed by the E8 emulator program. Note that this timing will differ from the actual operational timing.

9. Flash memory ID code

This MCU function prevents the Flash memory from being read out by anyone other than the user. The ID code in Table 6.5 written to the flash memory of the MCU must match the ID code displayed in the Figure 6.3 [ID Code verification] dialog box at debugger startup, otherwise the debugger cannot be launched. Note that when the ID code is FFh, FFh, FFh, FFh, FFh, FFh, FFh, the ID code is regarded as undefined. In this case, the ID code is automatically authenticated and the [ID Code verification] dialog box is not displayed.

In 'Program Flash' mode, the contents of the user program are input into the ID code area. When debugging in other modes, FFh, FFh, FFh, FFh, FFh, FFh, FFh is written into the ID code area regardless of the contents of the downloaded user program.

Table 6.5 ID Code Storage Area of R8C/20, 21, 22 and 23

Address	Description
FFDFh	First byte of ID code
FFE3h	Second byte of ID code
FFEBh	Third byte of ID code
FFEFh	Fourth byte of ID code
FFF3h	Fifth byte of ID code
FFF7h	Sixth byte of ID code
FFFBh	Seventh byte of ID code

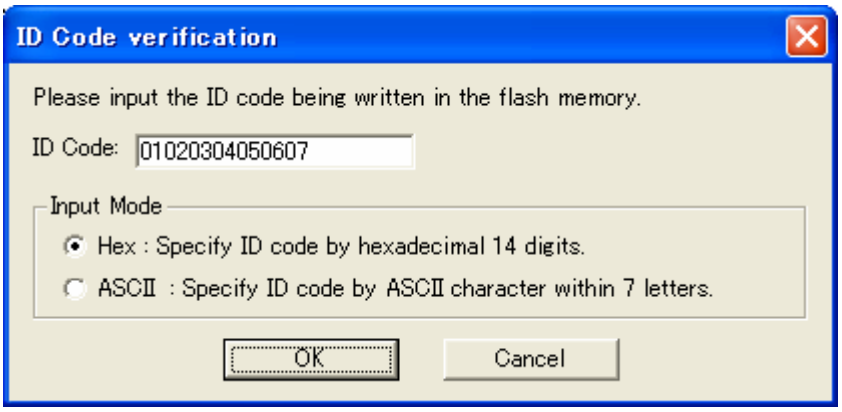


Figure 6.3 [ID Code verification] Dialog Box

Note on 'Program Flash' mode:

When the ID code is specified by the -ID option of the lmc30, download the MOT file or HEX file. When the X30 file is downloaded, the ID code is not valid. When downloading the X30 file, specify the ID code using an assembler directive command such as ".BYTE". The file to which the ID code specified by the assembler directive command ".ID" is output varies depending on the version of the assembler. For details, refer to the Assembler User's Manual.

10. Operation clock during a user program halt

    When the user program halts, the emulator changes the CPU clock to the internal high-speed on-chip oscillator (approx. 8MHz) to operate. However, the peripheral features operate with the clock specified by the user program.

11. Reset

    The reset vector is used by the E8 emulator program. If the MCU is reset while executing the user program, control is transferred to the E8 emulator program and the user program is forced to stop. Do not use the voltage monitor 1 reset, voltage monitor 2 reset, watchdog timer reset and software reset, otherwise the E8 emulator will not operate normally.

12. Memory access during emulation execution

    When referring to or modifying the memory contents, the user program is temporarily halted. For this reason, a real-time emulation cannot be performed. When a real-time emulation is necessary during a program execution, disable the automatic update in the watch window or fix the display in the memory window before running the program so that memory accesses do not occur during an execution.

13. When the E8 emulator does not supply power to the user system, it consumes the power voltage of the user system from several mA to more than 10 mA. This is because the user power supply drives one 74LVC125A to make the communication signal level match the user system power supply voltage.

14. When debugging, the Flash memory is frequently rewritten by the E8 emulator. Therefore, do not use an MCU that has been used for debugging in products. Also, as the E8 emulator program is written to the MCU while debugging, do not save the contents of the MCU Flash memory which were used for debugging nor use them as the ROM data for products.

15. Reserved area

    The addresses not specified in the Hardware Manual for R8C/20, R8C/21, R8C/22 and R8C/23 Groups are reserved area. Do not change the contents. Otherwise, the E8 emulator cannot control the MCU.

16. Debugging in stop mode or wait mode

    When debugging in stop mode or wait mode, do not operate windows until the program stops at the breakpoint by setting the breakpoint at the line of the program which will be executed after the stop mode or wait mode is cancelled. In addition, disable the automatic update in the watch window or fix the display in the memory window before running the program so memory accesses do not occur during an execution. When the program is forcibly stopped, or the memory is referred to or modified in stop or wait mode, the stop or wait mode will be cancelled.

17. Peripheral I/Os during a halt

    During a user program halt, interrupts are not accepted although peripheral I/Os continue to run. For example, a timer interrupt is not accepted although the timer continues to count when a user program is stopped by a break after the timer started.

18. Exceptional step execution

a) Software interrupt instruction

Step execution cannot be performed in the internal processing of instructions (undefined, overflow, BRK and INT) which generate a software interrupt continuously in the program.

Example: INT instruction

```
        NOP
        NOP
        INT#3
        NOP          ⤵ Passes through if the STEP execution is carried out.
        JMP MAIN
INT_3:
        NOP   ← Program should be stopped at this address.
        NOP
        NOP
        REIT
```

b) INT instruction

To debug the user program with the INT instruction, set a PC break for the internal processing of the INT instruction and execute the program with the GO command.

Example:

```
        NOP
        INT  #3
        NOP                    ↓ Execute using GO command.
        JMP  MAIN
INT_3:
NOP  Break  ←
NOP
REIT
```

19. "Go to cursor" function

The "Go to cursor" function is actualized using an address match break. Therefore, when you execute the "Go to cursor" command, all the address match breaks and hardware breaks you set become invalid, while all the PC breaks remain valid.

20. Note on PC break point

When downloading a user program after modifying it, the set address of PC break may not be corrected normally depending on the modification. Therefore, break points other than the set PC breaks may shift. After downloading a user program, check the setting of PC breaks in the event point window and reset it.

21. Note on setting the break condition of the hardware breaks

When selecting the normal address bus (selecting "Address" radio button in the [Break condition] dialog box) as a condition for the address bus, do not set the following addresses. Otherwise, an unauthorized break may occur.

- Address in the interrupt vector table
- Address set in the interrupt vector table (interrupt routine start address)
- Branch address of the branch instruction

Both fixed vector table and variable vector table are included with the interrupt vector table above.

22. Note on debugging in CPU rewrite mode

    CPU rewrite can be executed only for the data area. If it is executed for the program area, the E8 emulator cannot control the MCU. When rewriting the data area, do not halt the user program, while setting up the CPU rewrite mode and releasing it. If halted, the E8 emulator may not control the MCU. In addition, disable the automatic update in the watch window or fix the display in the memory window before running the program so memory accesses do not occur during an execution.

    To check the data after executing the CPU rewrite mode, halt the program after releasing the CPU rewrite mode and refer to the memory window, etc.

    If CPU rewrite can be executed for the data area, and erase/program process can be suspended, do not use software breaks.

23. Notes on rewriting Flash memory

    Do not reset the MCU when rewriting the Flash memory.

    The Flash memory is rewritten when the “Flash memory write end” is displayed in the output window of the High-performance Embedded Workshop. If the MCU is reset when rewriting the Flash memory, the user program or the E8 emulator program may be disrupted.

    Flash memory rewrite occurs:

    - When downloading the user program
    - After setting PC breaks in the Flash memory and executing the user program
    - After canceling PC breaks in the Flash memory and executing the user program
    - After rewriting the value of the Flash memory in the memory window and executing the user program

24. Notes on the E8 emulator power supply

    When writing a program with the E8 emulator for mass production processes, the program requires reliability, so do not use the E8 emulator power supply function. Supply power separately to the user system according to the allowable voltage for MCU writing. Voltage supplied from the E8 emulator depends on the quality of the USB power supply of the PC, and as such, precision is not guaranteed.

25. Notes on the emulator setup switch

    Use the emulator setup switch at the factory setting (upper side 1).

Section 7 Debugger Setting

1. [Emulator Setting] dialog box

The [Emulator Setting] dialog box is provided for setting items that need to be set when the debugger is launched. The contents set from this dialog box (excluding [Power Supply] group box items) also become valid the next time the debugger is launched. When launching the debugger for the first time after creating a new project work space, the [Emulator Setting] dialog box is displayed with the Wizard.

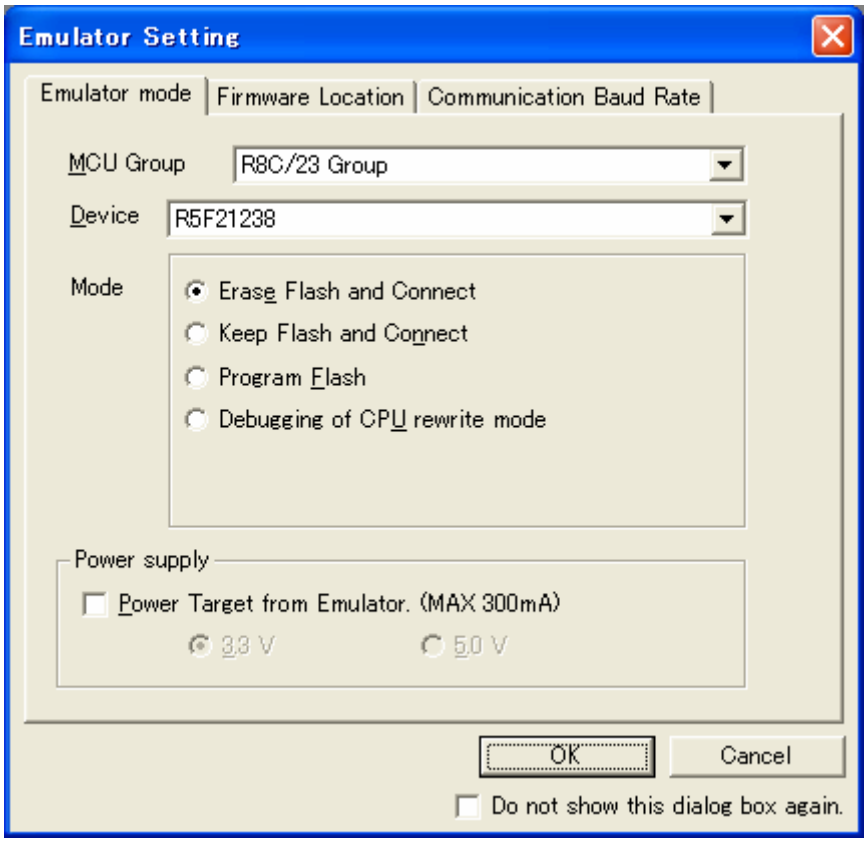


Figure 7.1 [Emulator Setting] Dialog Box

If you check “Do not show this dialog box again.” at the bottom of the [Emulator Setting] dialog box, the [Emulator Setting] dialog box will not be displayed the next time the debugger is launched. You can open the [Emulator Setting] dialog box using one of the following methods:

- After the debugger is launched, select Menu -> [Setup] -> [Emulator] -> [Emulator Setting...].
- Hold down the Ctrl key while launching the debugger.

When “Do not show this dialog box again.” is checked, the E8 does not supply power to the user system.

2. [Emulator mode] tab

Device selection, mode specification and power supply setting are made from the [Emulator mode] tab of the [Emulator Setting] dialog box.

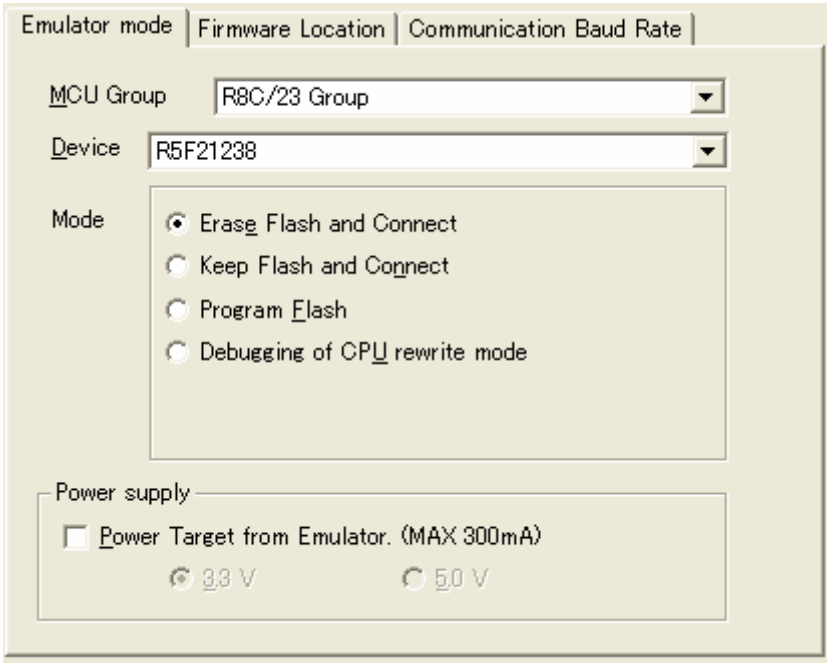


Figure 7.2 [Emulator mode] Tab

[MCU Group]

Select the name of the MCU group to be used from the [MCU Group] drop-down list.

[Device]

Select the type of MCU to be used from the [Device] drop-down list.

[Mode]

- Erase Flash and Connect
  When starting the debugger, the E8 emulator erases the Flash memory data for the MCUs and simultaneously writes the E8 emulator program.
- Keep Flash and Connect
  When launching the debugger, the E8 emulator retains the Flash memory data for the MCUs. Note that the area for the E8 emulator program and the vector area used by the E8 emulator will change.
- Program Flash
  The E8 emulator starts as a simple programmer. When downloaded, the E8 writes only the user program (E8 emulator program is not written). Therefore, the program cannot be debugged in this mode.
- Debugging of CPU rewrite mode
  Select this setting when debugging the program which rewrites the CPU. In this mode, the following debug operation which rewrites the Flash memory cannot be executed.

  - Setting the PC break points
  - Changing the memory contents in the Flash memory area

  In this mode, when starting the debugger, the E8 emulator erases the Flash memory data for the MCUs and simultaneously writes the E8 emulator program.

[Power supply]

When supplying power to the user system from the E8, click the [Power Target from Emulator. (MAX 300mA)] check box.

3. [Firmware Location] tab

For details, see “1. Program area for the E8 emulator” in “Section 6. Notes on Using the E8 Emulator”.

4. [Communication Baud Rate] tab

Select communication baud rate between the E8 and MCU in the [Communication Baud Rate] tab. 500000bps (default setting) should be selected during normal use.

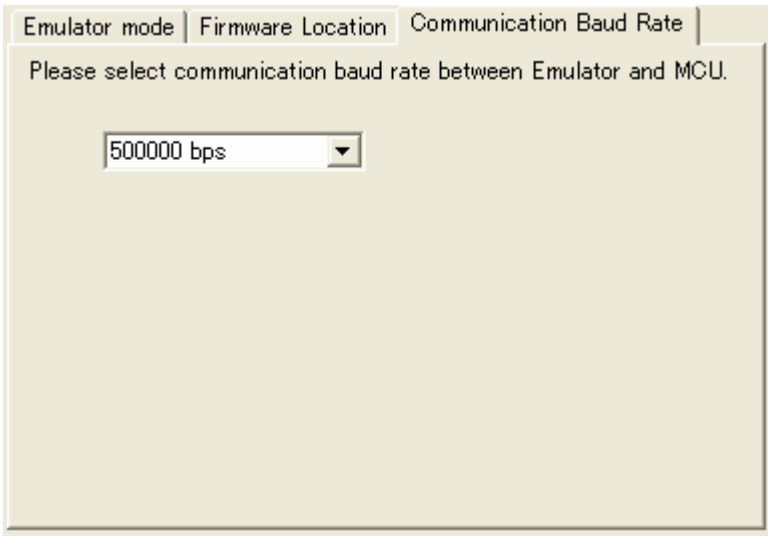


Figure 7.3 [Communication Baud Rate] Tab

Section 8 Applicable Tool Chain and Third-party Products

With the R8C/Tiny Series E8 emulator, you can debug a module created by the inhouse tool chain and third-party products listed in Table 8.1 below.

Table 8.1 Applicable Tool Chain and Third-party Products

Tool chain	M3T-NC30WA V.5.20 Release 1 or later NC8C V.5.30 Release 1 or later
Third-party products	TASKING M16C C/C++/EC++ Compiler V.2.3r1 or later IAR EWM16C V.2.12 or later

E8 Emulator
Additional Document for User's Manual
Notes on Connecting the R8C/20, R8C/21, R8C/22 and R8C/23

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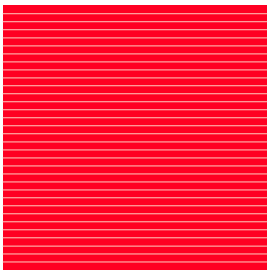
E8 Emulator
Additional Document for User's Manual



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