User's Manual

E1 Emulator

Additional Document for User's Manual (Notes on Connection for RL78)

Supported Devices:
RL78 Family
RL78/G13
RL78/G14
RL78/I1A

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Contents

1. Outline

1.1 Features

E1 Emulator is an on-chip debug emulator with flash programming function, which is used for debugging and programming a program to be embedded in on-chip flash memory microcontrollers. This product can debug with the target microcontroller connected to the user system, and can write programs to the on-chip flash memory of microcontrollers.

1.2 Configuration of Manuals

Documentation for the E1/E20 emulator manual is in two parts: the E1/E20 Emulator User's Manual and the E1/E20 Emulator Supplementary Document for the User's Manual (this manual). Different versions of the latter correspond to different sets of MCU. Be sure to read both of the manuals before using the E1/E20 emulator (hereinafter referred to as "the emulator").

(1) The E1/E20 emulator user's manual has the following contents:

- Components of the emulators
- Emulator hardware specification
- Connection to the emulator and the host computer and user system

(2) The E1/E20 Emulator Supplementary Document for the User's Manual has the following contents:

- For use in hardware design, an example of connection and the interface circuit required to connect the emulator.
- Notes on using the emulator
- Software specifications and so on for using each microcomputers

2. Designing the User System

To connect the E1 emulator (hereinafter referred to as the emulator), a connector for the user system interface cable must be mounted on the user system. When designing the user system, read this section of this manual and the hardware manual for the MCUs.

2.1 Connecting the Emulator with the User System

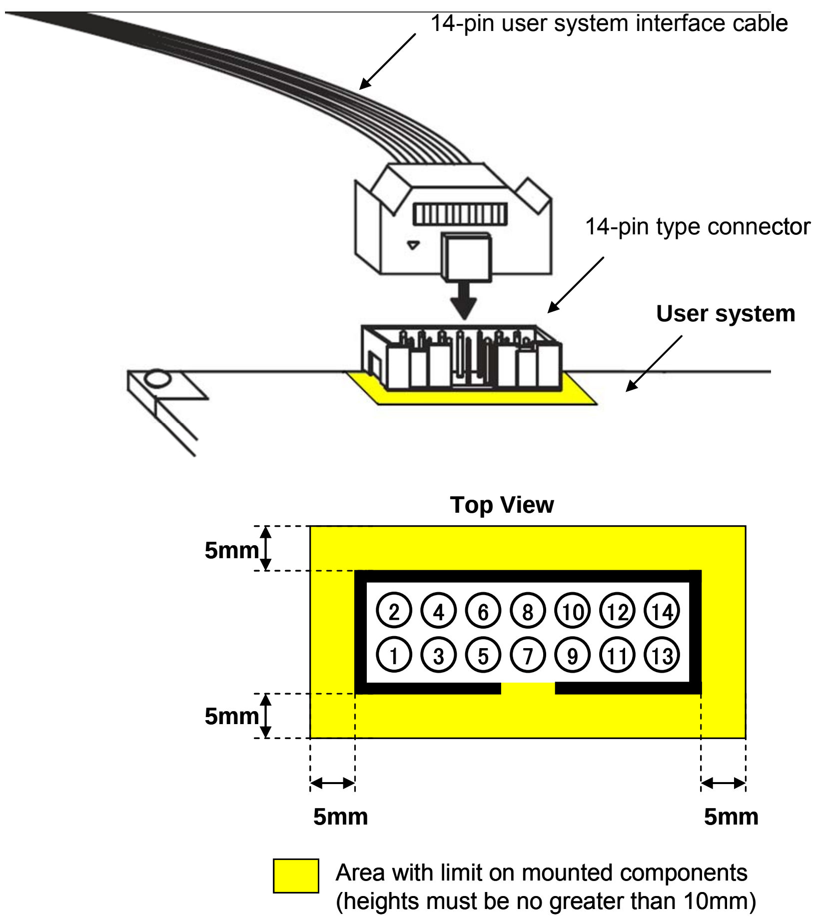
Table 2-1 shows the connector type numbers of the E1 emulators

Table 2-1 Connector Type Numbers

	Type Number	Manufacturer	Specifications
14-pin Connector	7614-6002	Sumitomo 3M Limited	14-pin straight type (Japan)
	2514-6002	3M Limited	14-pin straight type (other countries)

Figures 2.1 show examples of the connection between a user system interface cable of the 14-pin type. Do not mount other components with a height exceeding 10 mm within 5 mm of the connector on the user system.

Figure 2-1 Connecting the User System Interface Cable to the 14-pin Connector of the E1 Emulator



2.2 Pin Assignments of the Connector on the User System

Table 2-2 shows the pin assignments of the 14-pin connectors.

Table 2-2 Pin assignments of the connector (14-pin)

Pin No.	Signal	Input/Output[note]
1	R.F.U	-
2	GND	-
3	R.F.U	-
4	R.F.U	-
5	TOOL0	Input/Output
6	$\overline{\text{TRESET}}$	Input
7	R.F.U	-
8	VDD	-
9	EMVDD	-
10	$\overline{\text{RESET}}$	Output
11	R.F.U	-
12	GND	-
13	$\overline{\text{RESET}}$	Output
14	GND	-

Note: Input to or output from the emulator

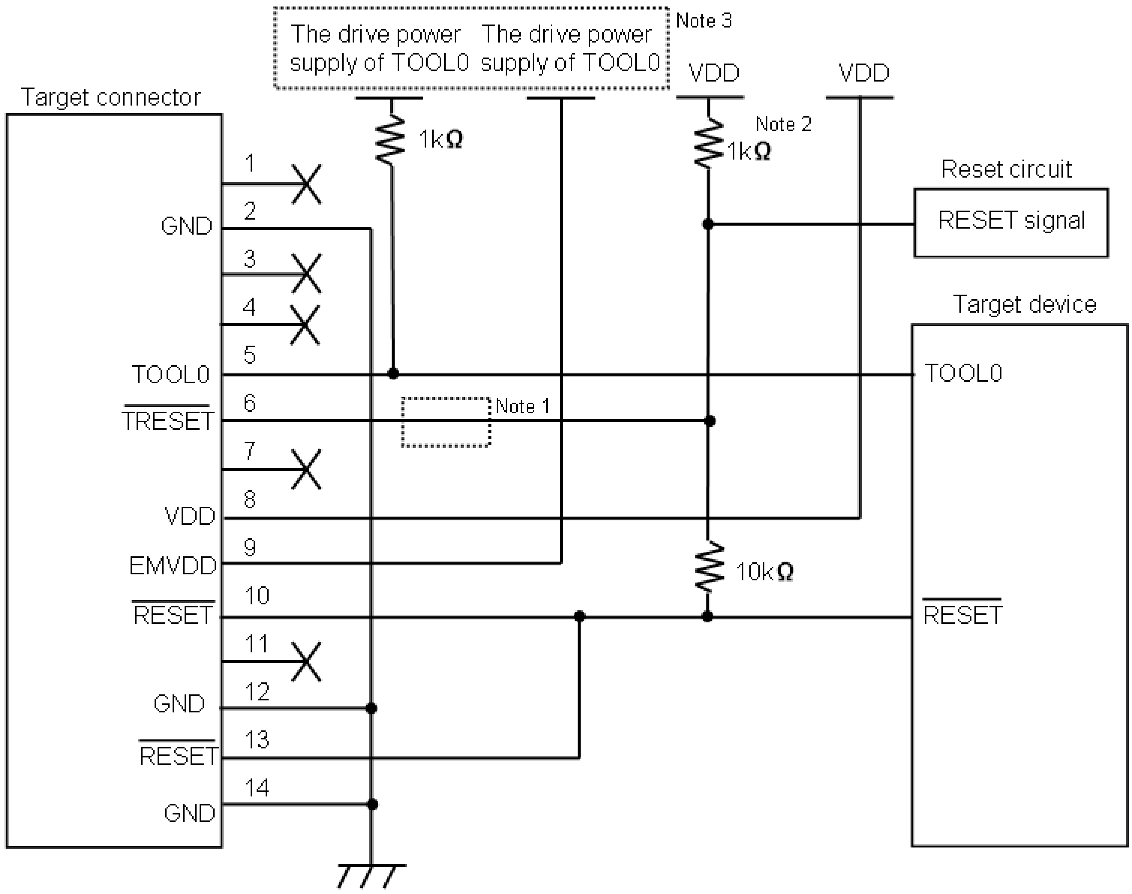
2.3 Recommend Circuit between the Connector and the MCU

2. 3. 1 Recommend Circuit Connection

Refer to Figure 2-2 and design an appropriate circuit.

Be sure to take into consideration the specifications of the target device as well as measures to prevent noise when designing your circuit.

Figure 2-2 Recommended Circuit Connection



Note 1. The circuit enclosed by a dashed line is not required when only flash programming is performed.

2. Pull-up resistor is not required if the reset circuit on the user system contains no buffers and the reset signal is only generated via resistors or capacitors.

3. The drive power supply of TOOL0 is different depending on devices.

Defer to user's manual of device.

2.3.2 Regarding Connection of RESET

This section describes the connection of the reset pin, for which special attention must be paid, in the circuit connection example shown in the previous section.

During on-chip debugging, a reset signal from the user system is input to the emulator, masked, and then output to the target device. Therefore, the reset signal connection varies depending on whether the emulator is connected.

For flash programming, the circuit must be designed so that the reset signals of the user system and the emulator do not conflict.

Select one of the following methods and connect the reset signal in the circuit. The details of each method are described on the following pages.

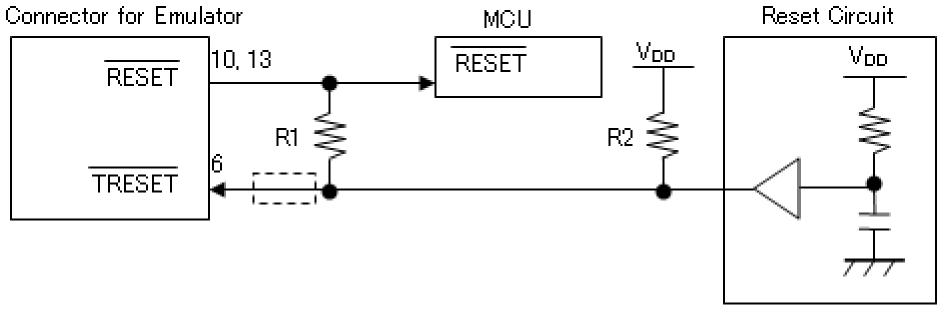
(1) Automatically switching the reset signal via series resistor (recommended; described in recommended circuit connection in the previous section)
(2) Manually switching the reset signal with jumper
(3) Resetting the target device by power-on reset (POR) only

(1) **Automatically switching the reset signal via series resistor**

Figure 2-3 illustrates the reset pin connection described in **2.3.1 Recommend Circuit Connection**.

This connection is designed assuming that the reset circuit on the user system contains an N-ch open-drain buffer (output resistance: 100Ω or less). The VDD or GND level may be unstable when the logic of $\overline{\text{TRESET}}$ / $\overline{\text{RESET}}$ of the emulator is inverted, so observe the conditions described below in **Remark**.

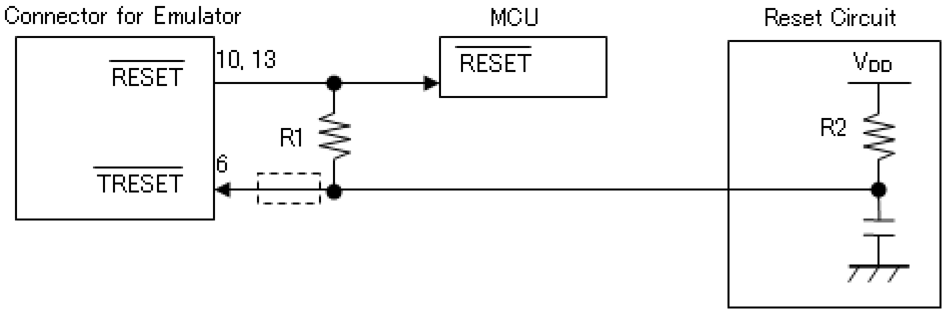
Figure 2-3 Circuit Connection with Reset Circuit That Contains Buffer



Remark Make the resistance of R1 at least ten times that of R2, R1 being 10 kΩ or more.
Pull-up resistor R2 is not required if the buffer of the reset circuit consists of CMOS output.
The circuit enclosed by a dashed line is not required when only flash programming is performed.

Figure 2-4 illustrates the circuit connection for the case where the reset circuit on the user system contains no buffers and the reset signal is only generated via resistors or capacitors. Design the circuit, observing the conditions described below in **Remark**.

Figure 2-4 Circuit Connection with Reset Circuit That Contains No Buffers

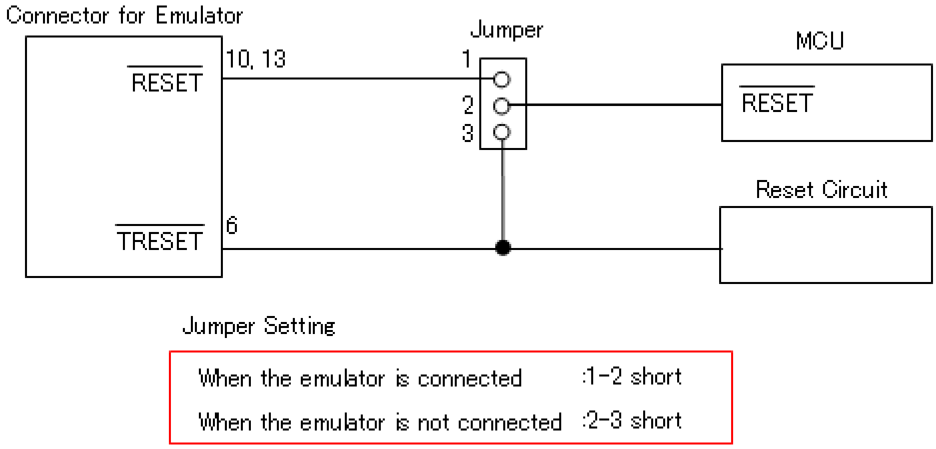


Remark Make the resistance of R1 at least ten times that of R2, R1 being 10 kΩ or more.
The circuit enclosed by a dashed line is not required when only flash programming is performed.

(2) **Manually switching the reset signal with jumper**

Figure 2-5 illustrates the circuit connection for the case where the reset signal is switched using the jumper, with or without the emulator connected. This connection is simple, but the jumper must be set manually.

Figure 2-5 Circuit in connection for Switching Reset Signal with Jumper

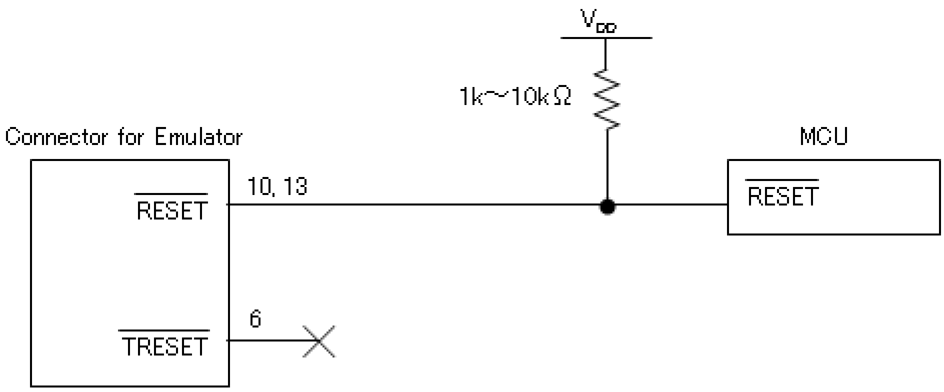


(3) **Resetting the target device by power-on reset (POR) only**

Figure 2-6 illustrates the circuit connection for the case where the target device is only reset via POR without using the reset pin. $\overline{\text{RESET}}$ is valid only when the debugger is running or during flash programming.

Do not turn off a power supply of the user system during a break.

Figure 2-6 Circuit Connection for the Case Where Target Device Is Only Reset via POR



3. Setting of Security ID and Securing of debugging resources

The user must prepare the following to perform communication between E1 emulator and the target device and implement each debug function. Refer to the descriptions on the following sections and set these items in the user program or using the build tool property. When C-SPY manufactured by IAR Systems is used, read also the following material.
- IAR C-SPY Hardware Debugger Systems User Guide issued by IAR Systems

3.1 Setting of Security ID

This setting is required to prevent the memory from being read by an unauthorized person. Embed a security ID at addresses 0xC4 to 0xCD in the internal flash memory. The debugger starts only when the security ID that is set during debugger startup and the security ID set at addresses 0xC4 to 0xCD match. If the ID codes do not match, the debugger manipulates the target device in accordance with the value set to the on-chip debug option byte area (refer to **Table 3-2**).
If the user has forgotten the security ID to enable debugging, erase the flash memory and set the security ID again.

Caution Do not set all F ("FFFFFFFFFFFFFFFFFFFF") as security ID.

[How to set security ID]
A setting method of the security ID is following. When both (a) and (b) methods are done at a time, method (b) has a priority.
(a) Embed the security ID at addresses 0xC4 to 0xCD in the user program.
(b) Setting of the security ID by build tool common options. (In case of CubeSuite+)

(a) Embed a security ID at addresses 0xC4 to 0xCD in the user program.
For example If the security ID is embedded as follows, the security ID set by the debugger is ″0123456789ABCDEF1234″ (not case-sensitive).

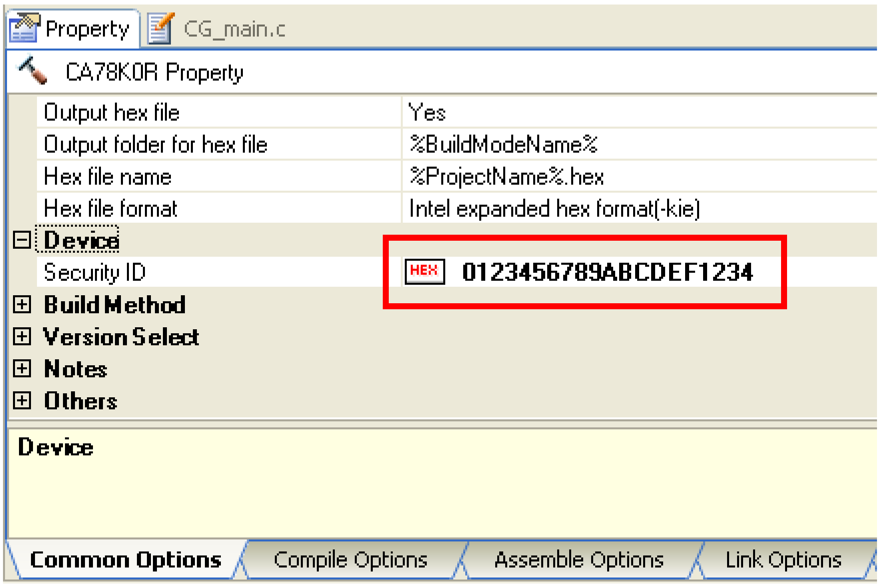
Table 3-1 Security ID

Address	Value
0xC4	0x01
0xC5	0x23
0xC6	0x45
0xC7	0x67
0xC8	0x89
0xC9	0xAB
0xCA	0xCD
0xCB	0xEF
0xCC	0x12
0xCD	0x34

(b) Setting of the security ID by build tool common options. (In case of CubeSuite+)

Set in “device” in the common options tab as figure 3-1.

Figure 3-1 Examples for Setting of the security ID by build tool common option



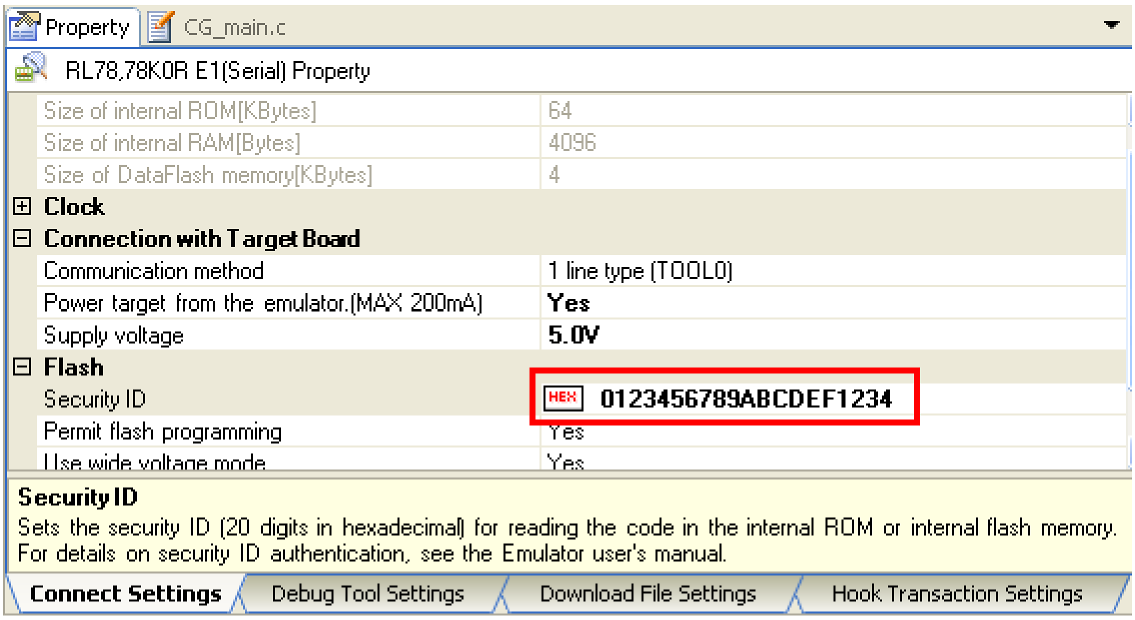
[How to authenticate the security ID at debugger startup]

When connecting a debugger to the device set the security ID, it is necessary to specify the security ID by connection settings in debug tool property. (Default security ID is set in build tool property.)

Set in “Flash” in the connect settings tab as figure 3-2.

Caution **When security ID on device is erased, set all 0 ("00000000000000000000") as security ID for authentication.**

Figure 3-2 Examples for Setting of the security ID at debugger startup



3.2 Setting of On-chip debug option byte

This is the area for the security setting to prevent the flash memory from being read by an unauthorized person. The debugger manipulates the target device in accordance with the set value, as shown below.

Table 3-2 On-Chip Debug Option Byte Setting and Operation

Set Value	Description	Remark
0x04	Debugging is disabled	This setting is available only for flash programming and self programming.
0x85	The on-chip flash memory is not erased no matter how many times the security ID code authentication fails.	-
0x84	All on-chip flash memory areas are erased if the security ID code authentication fails.	-
Other than above	Setting prohibited	-

[How to secure areas]

A setting method of On-chip debug option byte is following. When setting each other, priority is (b).

(a) Embed the On-chip debug option byte at addresses 0xC3 in the user program.

(b) Set the On-chip debug option byte by build tool link options. (In case of CubeSuite+)

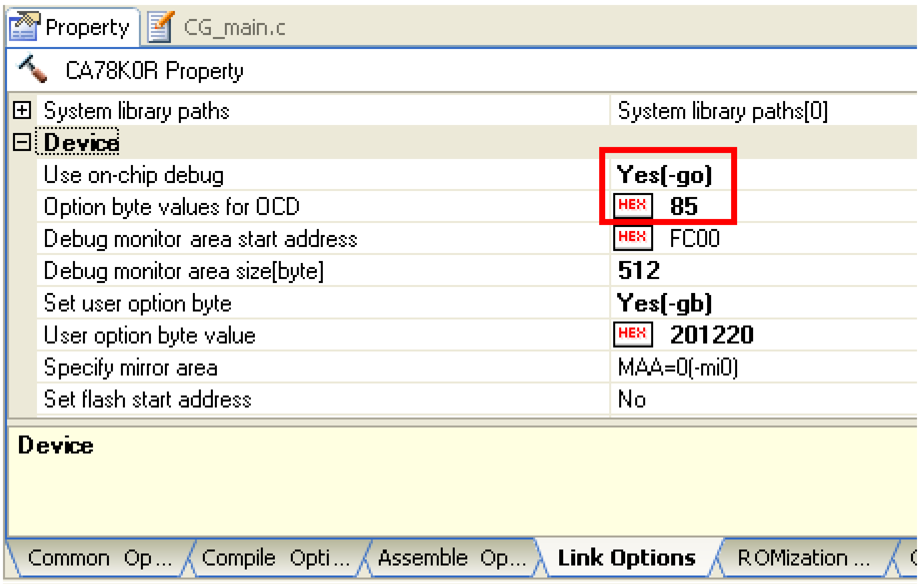
(a) Embed the On-chip debug option byte at addresses 0xC3 in the user program

Embed the On-chip debug option byte at addresses 0xC3 in the user program

(b) Set the On-chip debug option byte by build tool link options. (In case of CubeSuite+)

Set in “device” in the link options tab as figure 3-3.

Figure 3-3 Examples for Setting the On-chip debug option byte

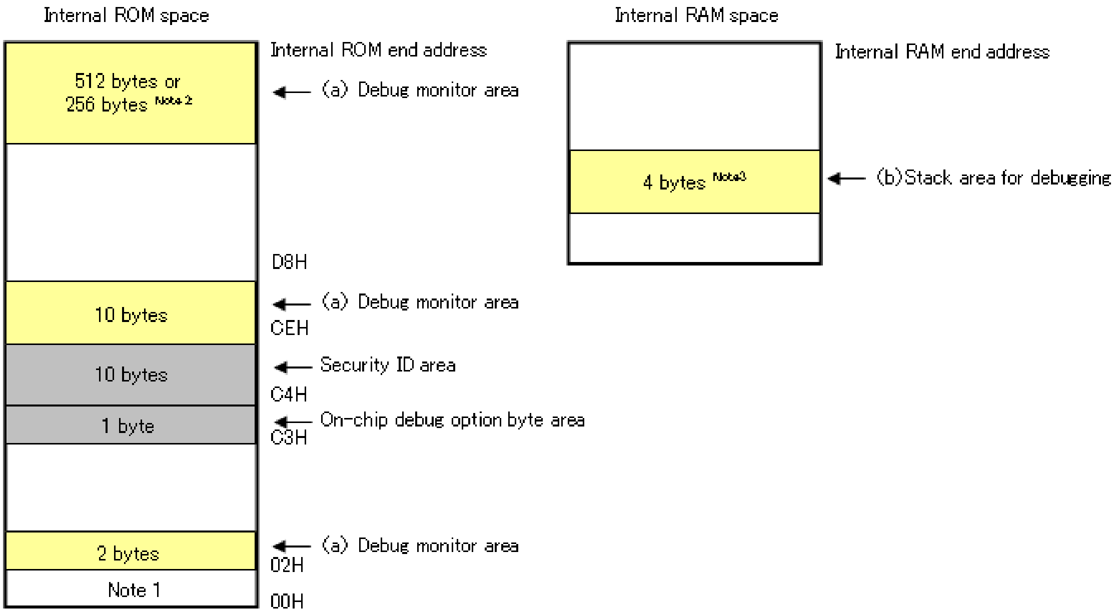


3.3 Securing of area for debugging

The yellow portions in Figure 3-4 are the areas reserved for placing the debug monitor program, so user programs or data cannot be allocated in these spaces. These spaces must be secured so as not to be used by the user program. Moreover, this area must not be rewritten by the user program.

Secure the resources for debugging with the contents explained by (a) and (b).

Figure 3-4 Memory Spaces Where Debug Monitor Programs Are Allocated



Note 1. In debugging, reset vector is rewritten to address allocated to a monitor program.

2. When the pseudo RRM function and DMM function is not used , it will be 256 bytes.

3. When the self programming is executed, it will be 12 bytes.

(a) Securing of debug monitor area

This is the area to which the debug monitor program is to be allocated. The monitor program performs initialization processing for debug communication interface and RUN or break processing for the CPU.

This user programs or data must not be placed in an area of 22 bytes near the on-chip debug option byte, and an area of 512 bytes [Note] before the internal ROM end address. In addition, reset vector is rewritten to address allocated to a monitor program.

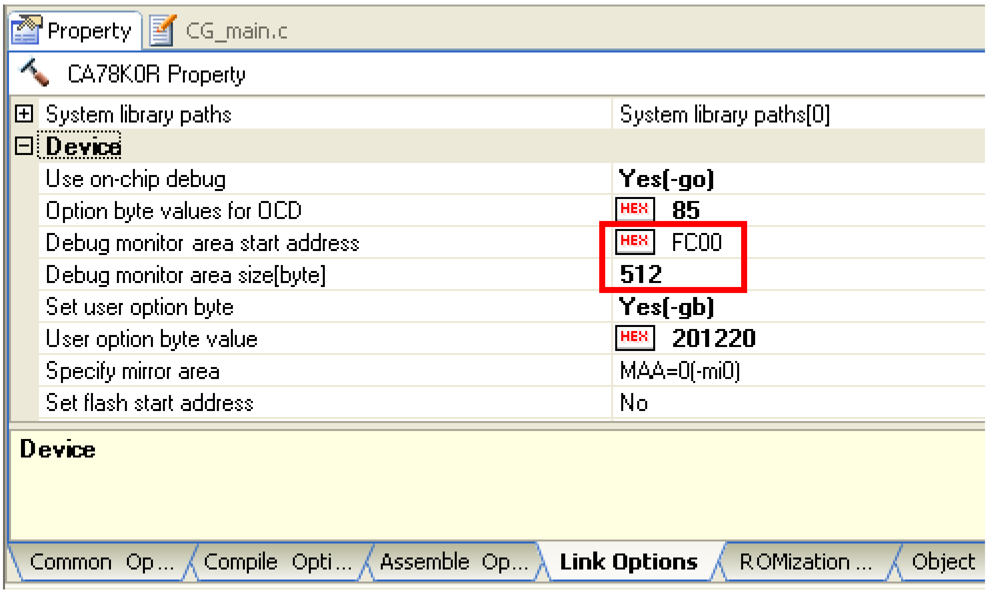
Note It is an area of 256 bytes when the pseudo RRM function and DMM function is not used during debugging. If the internal ROM end address is 0x3FFFF, a monitor program of 256 bytes is allocated to the area from 0x3FDAA to 0x3FFFF.

[How to secure areas]

It is not necessarily required to secure this area if the user program does not use this area.

However To avoid problems that may occur during the debugger startup, it is recommended to secure this area in advance, using the compiler. Figure 3-5 shows example for securing the area, using the CubeSuite+. Set in “device” in link options tab as figure 3-5.

Figure 3-5 Example for securing the debug monitor area



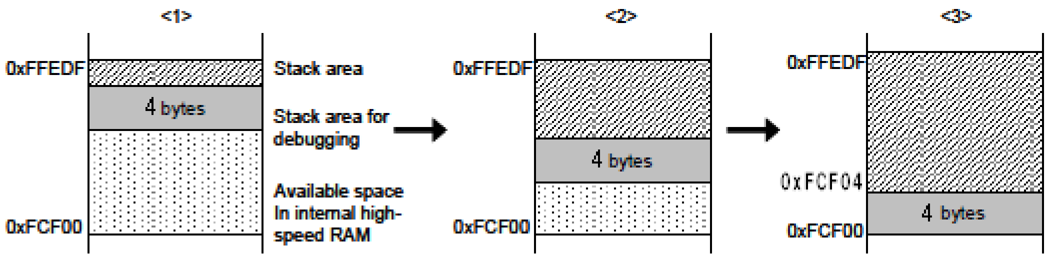
(b) Securing of stack area for debugging

This area requires 4 bytes as the stack area for debugging [Note]. Since this area is allocated immediately before the stack area, the address of this area varies depending on the stack increase and decrease. That is, 4 extra bytes are consumed for the stack area used.

Figure 3-6 illustrates the case where the stack area is increased when the internal high-speed RAM starts from 0xFCF00.

Note When the self programming is executed, it will be 12 bytes.

Figure 3-6 Variation of Address of Stack Area for Debugging



[How to secure areas]

Set the stack pointer by estimating the stack area consumed by the user program + 4 bytes. Make sure that the stack pointer does not extend beyond the internal high-speed RAM start address.

Remark Refer to the self programming manual for how to secure the stack area for self programming.

4. Specifications

Specifications are below table.

Large Item	Middle Item	Small Item	Specification
Hardware Common	Target host machine		Computer equipped with a USB port OS is due to the software tool.
	User system interface		14-pin connector
	Host machine interface		USB2.0 (Full speed/ High speed)
	Connection to the user system		Connection by the provided user-system interface cable
	Power supply function		3.3V or 5.0V, set in software tool, can be supplied to the user system from VDD pin of the emulator (with current up to 200 mA)
	Power supply for the emulator		No need (the host computer supplies power through the USB)
Related debugging	Break	Software break	2000 points
		Hardware break	1points (commonly used by execution and access)
		Forced break	Available
	Event	Number of events	1points (commonly used by execution and access)
		Available function	Only hardware break
	Trace		Unavailable
	Performance measurement	Measurement item	From run to break
		Performance	Resolution 100us, Max. measurement time 100 hour
	Real time RAM monitor		Available (CPU is used when monitoring)
	Direct memory modification		Available (CPU is used when executing)
	Hot plug-in		Unavailable
	Security		10-byte ID code authentication
Related programming	Clock supply		Clock mounted on the user system can be used
	Security flag setting		Available
	Standalone operation		Unavailable (must be connected to host machine)

5. Notes on Usage

Make sure to notes on usage in this section.

5.1 Lists

Table 5-1 Lists of notes on usage

No	Item
1	Handling of device that was used for debugging
2	Flash self programming
3	Operation after reset
4	Operation when debugger starts
5	Operation at voltage with which flash memory cannot be written
6	On-chip debug option byte setting (address C3H)
7	Pseudo real-time RAM monitor function

5.2 Details

No.1 Handling of device that was used for debugging

Do not mount a device that was used for debugging on a mass-produced product, because the flash memory was rewritten during debugging and the number of rewrites of the flash memory cannot be guaranteed.

Moreover, do not embed the debug monitor program into mass-produced products.

No.2 Flash self programming

If a space where the debug monitor program is allocated is rewritten by flash self programming, the debugger can no longer operate normally. This caution also applies to boot swapping for such an area.

No.3 Operation after reset

After an external pin reset or internal reset, the monitor program performs debug initialization processing. Consequently, the time from reset occurrence until user program execution differs from that in the actual device operation. If “No” is selected in the Permit Flash Programming of the debug tool property, the time until the user program is executed compared with the time when “Yes” is selected is delayed several 100 ms.

No.4 Operation when debugger starts

When the debugger is started, if there are no the debug monitor program in device for debugging, the internal flash memory is erased.

No.5 Operation at voltage with which flash memory cannot be written

If any of the following debugger operations <1> to <7>, which involve flash memory rewriting, is performed while flash memory cannot be rewritten, the debugger automatically changes the register setting so as to enable flash memory rewriting, and restores the register setting after the operation is completed. If any of the following operations <1> to <7> is performed while flash memory rewriting has been disabled or operation is performed at a voltage with which flash memory cannot be rewritten, however, the debugger outputs an error and the operation is ignored.

<1> Writing to internal flash memory
<2> Setting or canceling of software breakpoint
<3> Starting execution at the set software breakpoint position
<4> Step execution at the set software breakpoint position
<5> Step-over execution, Return Out execution
<6> Come Here
<7> If permit is selected in the Flash Programming area in the Configuration dialog box, the following operations cannot be performed.
    a) Setting, changing, or canceling of hardware breaks
    b) Masking/unmasking of internal reset
    c) Switching of peripheral breaks

No.6 On-chip debug option byte setting (address C3H)

The on-chip debug option byte setting is rewritten arbitrarily by the debugger.

No.7 Pseudo real-time RAM monitor function

Note the following points when using the pseudo real-time RAM monitor function.

<1> Standby mode (HALT or STOP) may be cancelled during monitoring.
<2> The pseudo real-time RAM monitor function does not operate while the CPU operating clock is stopped.
<3> The pseudo real-time RAM monitor function does not operate while the self programming execution.

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