User's Manual

E2 Emulator, E2 Emulator Lite

Additional Document for User's Manual

(Notes on Connection of RA Devices)

Supported Devices:

RA Family

Renesas Electronics
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Table of Contents

Terminology

Some specific words used in this user's manual are defined below.

Host machine

This means a personal computer used to control the emulator.

User system

This means a user's application system in which the MCU to be debugged is used.

User program

This means the program to be debugged.

Programming Software

In this document, this indicates the Renesas Flash Programmer that can be used with the E2 or E2 Lite.

Emulator

In this document, this refers to the E2 or E2 Lite.

DLM

Device lifecycle management

1. Overview

1.1 Overview of E2 Emulator and E2 Emulator Lite

In this document, we describe ‘E2 Emulator’ as ‘E2’ and ‘E2 Emulator Lite’ as ‘E2 Lite’.

The E2 and E2 Lite are on-chip debugging emulators for Renesas' mainstream MCUs.

The E2 Lite is highly affordable development tools providing basic debugging functions. The E2 handles high-speed downloading at up to twice the rate of the E2 Lite. In addition, the E2 can supply power that is adjustable from 1.8 V to 5.0 V at 0.1-V intervals. As a development tool, the E2 allows more advanced debugging than the E2 Lite. The E2 and E2 Lite can also serve as a Flash Programmer.

1.2 Configuration of E2/E2 Lite Manuals

The E2/E2 Lite manual consists of the following.

- E2 Emulator User’s Manual
- E2 Emulator Lite User’s Manual
- E2 Emulator, E2 Emulator Lite Additional Document for User’s Manual

Be sure to read each user’s manual before using the E2 or E2 Lite.

(1) E2 emulator user’s manual

The E2 emulator user’s manual has the following contents:

— Components of the E2
— E2 hardware specification
— Connection to the E2 and the host machine and user system

(2) E2 Emulator Lite user’s manual

The E2 Emulator Lite user’s manual has the following contents:

— Components of the E2 Lite
— E2 Lite hardware specification
— Connection to the E2 Lite and the host machine and user system

(3) E2 Emulator, E2 Emulator Lite Additional Documents for User's Manual (Notes on Connection of RA Devices) (this document)

The E2 Emulator, E2 Emulator Lite Additional Documents for User's Manual (Notes on Connection of RA Devices) describes information necessary for hardware design such as connection examples and interface circuits.

(4) Renesas Flash Programmer Flash memory programming software User’s Manual

The Renesas Flash Programmer Flash memory programming software User’s Manual describes the specifications of the software and the method of operation for the Renesas Flash Programmer.

- For the debugging configuration of the E2 or E2 Lite emulator debugger, refer to the help system for the e^2 studio.

1.3 Preparation

Obtain an integrated development environment (IDE) and other required software from links at the following URL and install them on the host machine.

https://www.renesas.com/development-tools

When you are using the e^2 studio for Linux, refer to the guide “e2studio_setup.md”, which is separately provided in “E2 emulator, E2 emulator Lite Linux driver” on each emulator website. Note that this is a markdown-format English file.

1.4 Supported Devices

Table 1.1 Supported Device List

Supported Device	E2			E2 Lite		
	SWD I/F	JTAG I/F	SCI I/F	SWD I/F	JTAG I/F	SCI I/F
RA2 series	DBG	—	PRG	DBG	—	PRG
RA4 series	DBG	DBG	PRG	DBG	—	PRG
RA6 series	DBG	DBG	PRG	DBG	—	PRG

* DBG: Can be used for debugging, PRG: Can be used for flash programming and transition of the DLM state

2. Designing the User System

2.1 Connecting the Emulator with the User System

To connect 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.

2.2 Installing the Connector on the User System

Table 2.1 and Table 2.2 list the recommended connectors and user system interface cables for the emulator, respectively.

Table 2.1 Recommended Connectors

Connector	Type Number	Manufacturer	Specifications
20-pin (1.27-mm pin pitch) connector	FTSH-110-01-L-DV-K	Samtec	20-pin surface-mount technology (SMT) straight type
10-pin (1.27-mm pin pitch) connector	FTSH-105-01-L-DV-K	Samtec	10-pin SMT straight type
10-pin (1.27-mm pin pitch) connector	FTSH-105-01-L-DV* (without a marking for matching the position of the connector; keying shroud)	Samtec	10-pin SMT straight type

Note: When using a connector without a guide marking (keying-shroud type), take care with regard to the direction for insertion of the cable.

Table 2.2 User System Interface Cables

Cable Type	Type Number	E2	E2 Lite
20-pin to 20-pin cable* (for the 20-pin (1.27-mm pin pitch) connector)	RTE0T00020KCAC0000J	Comes with the product	Separately sold
20-pin to 10-pin cable (for the 20-pin (1.27-mm pin pitch) connector)	RTE0T00020KCAC1000J	Separately sold	Separately sold

Note: The 20-pin to 20-pin cable can be connected to the guideless 10-pin (1.27-mm pin pitch) connector; when doing so, however, check the pin assignments and take care with regard to the direction for insertion of the cable.

Only connect the emulator after confirming that there are no mismatches of alignment on the user system port connector. Incorrect connection will result in the host machine, the emulator, and the user system emitting smoke or catching fire.

2.2.1 Connecting the User System Interface Cable to the 20-Pin Connector

Figure 2.1 shows how to connect the user system interface cable to the 20-pin connector.

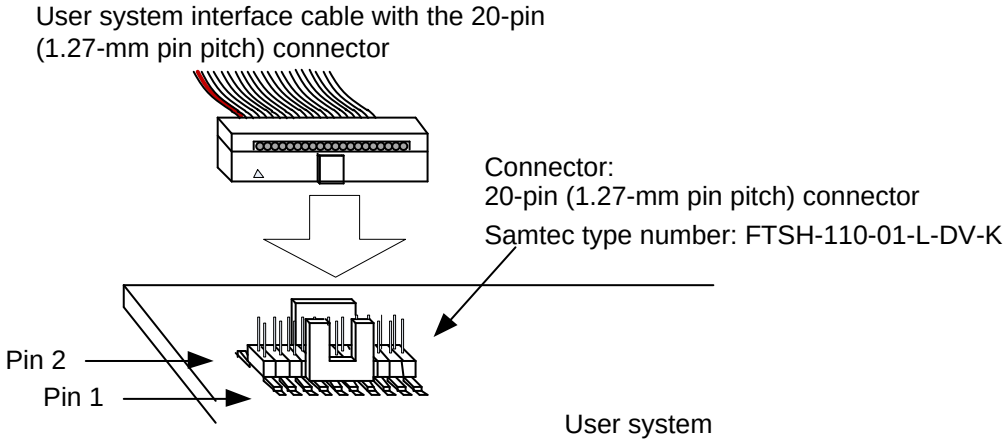


Figure 2.1 Connecting the User System Interface Cable to the 20-Pin Connector

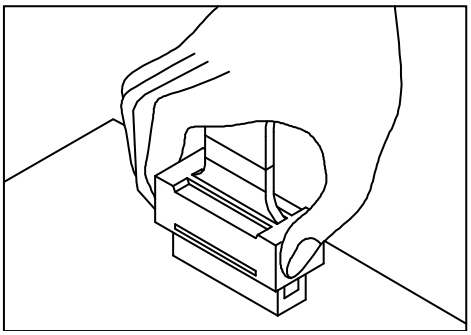
CAUTION

Notes on connector insertion and removal:

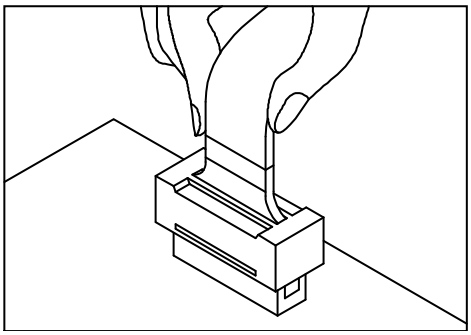
When connecting or disconnecting the user-system interface cable and the emulator or user system, grasp the connector cover at the end of the cable. Pulling the cable itself will damage the wiring.

Also, be aware that the user-system interface cable has the direction in which it must be inserted. If the cable is connected in the wrong direction, it may be damaged.

Correct example



Incorrect example



2.3 Pin Assignments of the Connector on the User System

2.3.1 20-Pin and 10-Pin Connector Specifications

Figure 2.2 shows the specifications of the 20-pin and 10-pin (1.27-mm pitch) connectors.

Table 2.3 and Table 2.4 show the pin assignments for the SWD and JTAG interface connections, respectively.

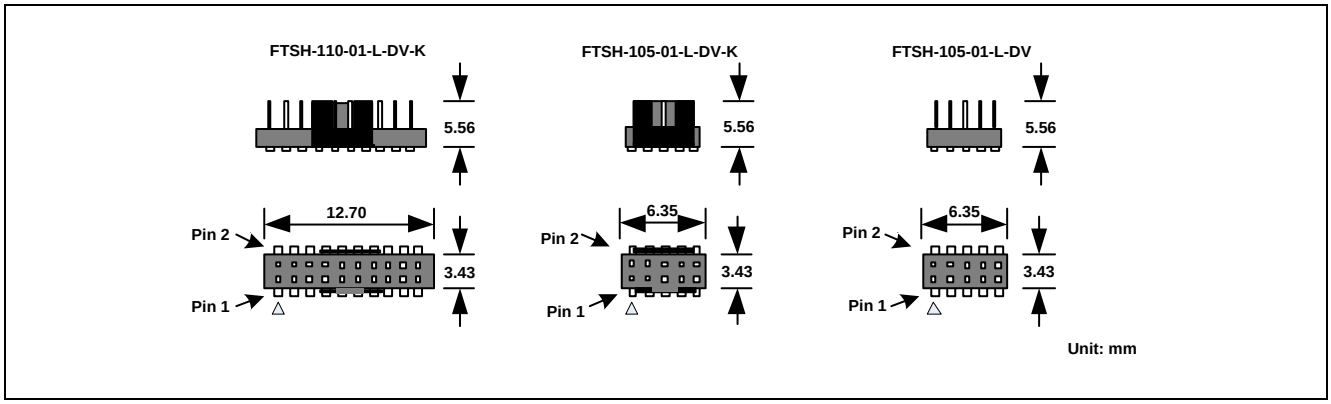


Figure 2.2 20-Pin and 10-Pin Connector Specifications

Table 2.3 Pin Assignments for SWD Interface Connection

Pin No.	Signal	Direction*1	Note
1	VCC	–	Power supply
2	SWDIO	I/O	For debugging communications
3	GND	–	
4	SWCLK	Input	Clock for debugging communications
	MD		For setting the operating mode
5	GND	–	
6	TxD9	Output	For programming flash memory and transition of the DLM state
7	NC	–	
8	RxD9	Input	For programming flash memory and transition of the DLM state
9	UCON	–	Connect this signal to ground on the user system. It is used to confirm the connection between the emulator and user system.
10	RES#	I/O	User system reset
11*2	NC	–	
12*2	NC	–	
13*2	NC	–	
14*2	NC	–	
15*2	GND	–	
16*2	NC	–	
17*2	GND	–	
18*2	NC	–	
19*2	GND	–	
20*2	NC	–	

Notes: 1. Input to or output from the user system.
"Input" refers to input from the emulator to the user system and "output" refers to output from the user system to the emulator.
2. If a 10-pin connector is mounted on the user system, pins 11 to 20 are not used.

Table 2.4 Pin Assignments for JTAG Interface Connection

Pin No.	Signal	Direction*1	Note
1	VCC	–	Power supply
2	TMS	Input	For debugging communications
3	GND	–	
4	TCK	Input	Clock for debugging communications
	MD		For setting the operating mode
5	GND	–	
6	TDO/TxD9	Output	For debugging communications, programming flash memory, and transition of the DLM state
7	NC	–	
8	TDI/RxD9	Input	For debugging communications, programming flash memory, and transition of the DLM state
9	UCON	–	Connect this signal to ground on the user system. It is used to confirm the connection between the emulator and user system.
10	RES	I/O	User system reset
11*2	NC	–	
12*2	NC	–	
13*2	NC	–	
14*2	NC	–	
15*2	GND	–	
16*2	NC	–	
17*2	GND	–	
18*2	NC	–	
19*2	GND	–	
20*2	NC	–	

Notes: 1. Input to or output from the user system.
"Input" refers to input from the emulator to the user system and "output" refers to output from the user system to the emulator.
2. If a 10-pin connector is mounted on the user system, pins 11 to 20 are not used.

2.4 Recommended Circuit between the Connector and the MCU

This section shows recommended circuits for connection between the connector and the MCU. For details on the handling of signals, refer to section 2.5, Notes on Connection.

2.4.1 SWD Interface Connection

Figure 2.3 shows a recommended circuit for connection through the SWD interfaces.

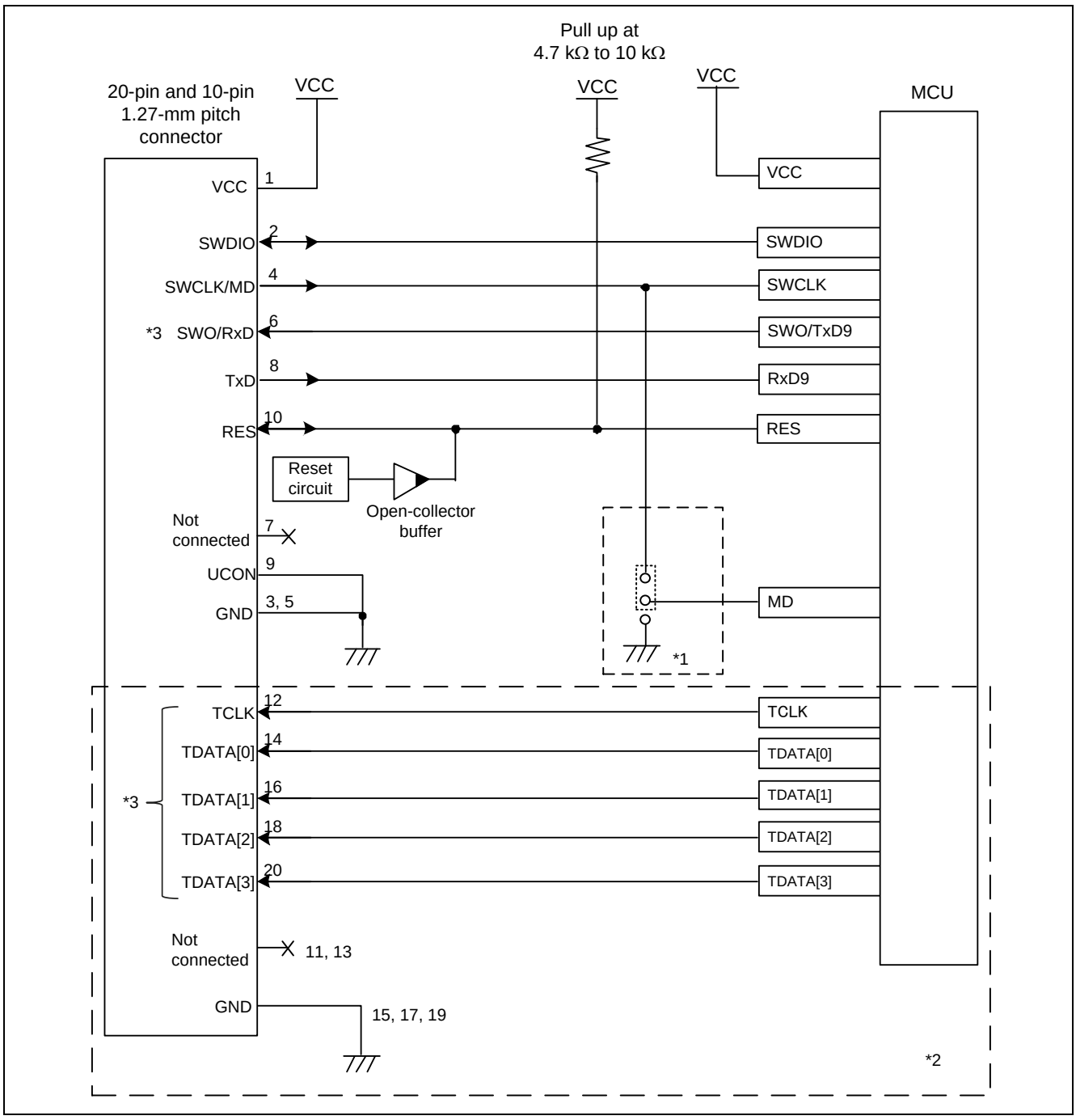


Figure 2.3 Example of Connection through the SWD Interfaces

Notes:
1. It depends on the device. Refer to the "Flash memory" chapter- "Precautions" section- "Emulator connection" section of the "User's Manual Hardware Edition" of each MCU of the RA family. And if it is recommended to connect the MD pins of MCU to SWCLK/MD pins of emulator, connect them. When the MD pin is not connected to the emulator's SWCLK/MD pin, a special circuit for the pin must be configured on the user system. For details on handling of the MD pin, refer to section2.5,Notes on Connection.
2. If a 10-pin connector is mounted on the user system, pins 11 to 20 are not used.
3. E2 Lite emulator does not support outputting trace data in Emulator Debugger.
   On the other hand, E2 emulator only handles outputting trace data from SWO pin.

2.4.2 JTAG Interface Connection

Figure 2.4 shows a recommended circuit for connection through the JTAG interfaces. The E2 Lite does not support JTAG interface connection.

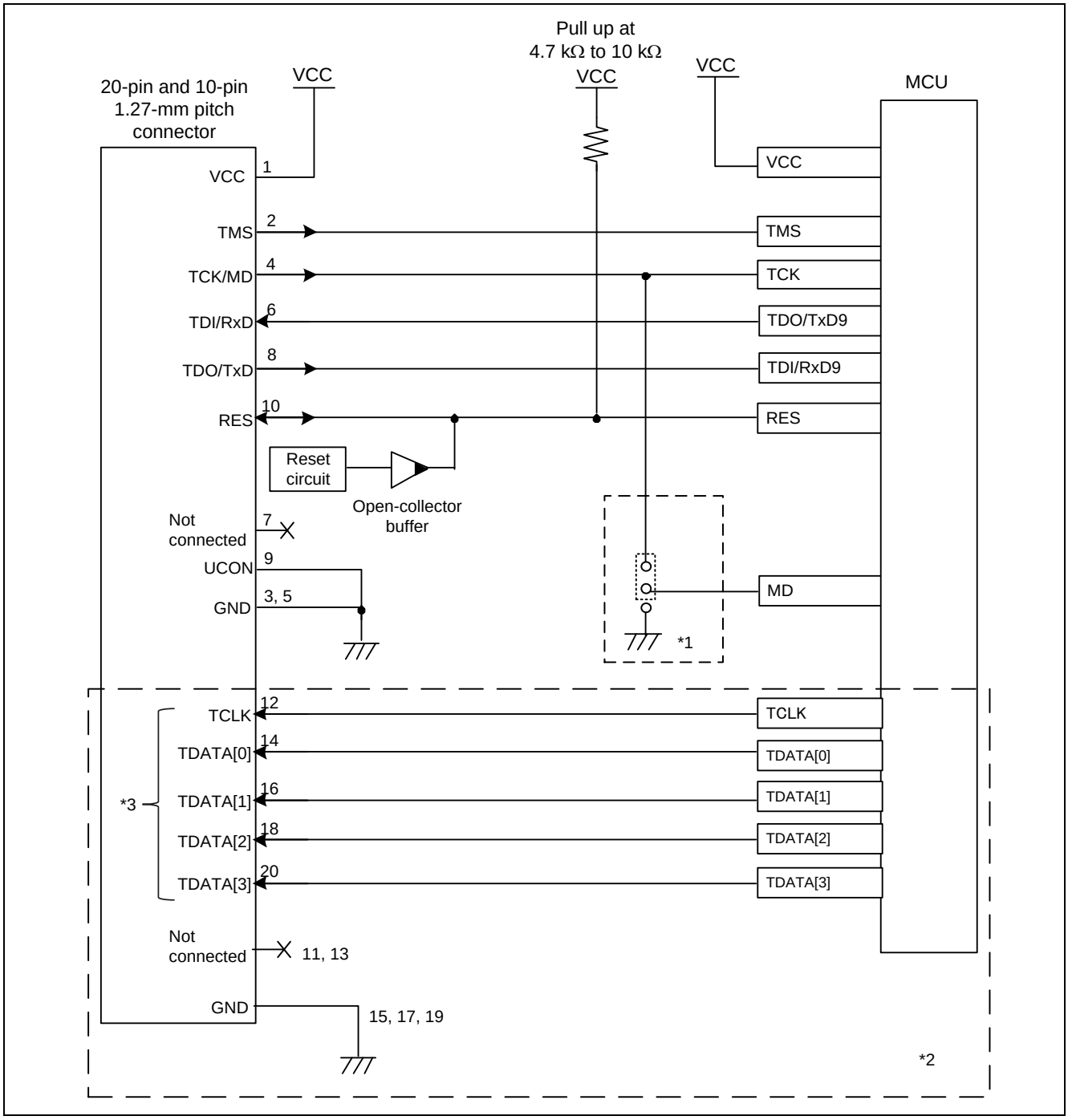


Figure 2.4 Example of Connection through the JTAG Interfaces

Notes:
1. It depends on the device. Refer to the "Flash memory" chapter- "Precautions" section- "Emulator connection" section of the "User's Manual Hardware Edition" of each MCU of the RA family. And if it is recommended to connect the MD pins of MCU to TCK/MD pins of emulator, connect them. When the MD pin is not connected to the emulator's TCK/MD pin, a special circuit for the pin must be configured on the user system. For details on handling of the MD pin, refer to section2.5,Notes on Connection.
2. If a 10-pin connector is mounted on the user system, pins 11 to 20 are not used.
3. The E2 emulator does not support a trace output facility.

2.4.3 SCI Interface Connection

Figure 2.5 shows a recommended circuit for connection through Renesas Flash Programmer. This circuit is only used in the case when writing a program into flash memory without any debugging operations.

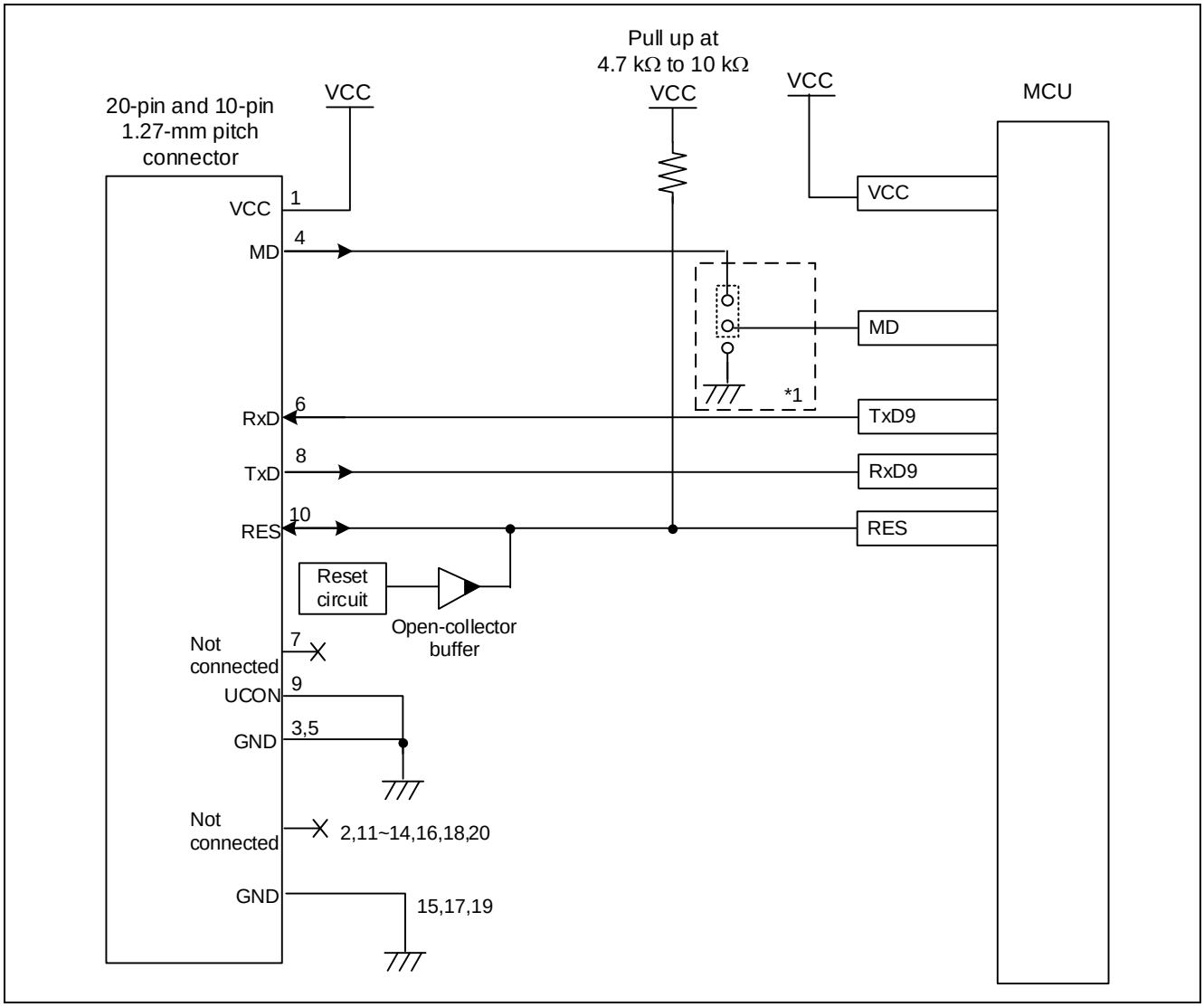


Figure 2.5 Example of Connection through SCI Interfaces

Notes: 1. It depends on the device. Refer to the "Flash memory" chapter- "Precautions" section- "Emulator connection" section of the "User's Manual Hardware Edition" of each MCU of the RA family. And if it is recommended to connect the MD pins of MCU to MD pins of emulator, connect them. When the MD pin is not connected to the emulator's MD pin, a special circuit for the pin must be configured on the user system. For details on handling of the MD pin, refer to section2.5,Notes on Connection.

2.5 Notes on Connection

Wiring patterns between the connector and the MCU must be as short as possible (within 50 mm is recommended). Do not connect the signal lines between the connector and MCU to other signal lines on the board.

For the handling of pins while the emulator is not in use, refer to the hardware manual for the MCU.

2.5.1 RES Pin

The emulator uses the RES pin.

If the user system includes a user logic reset circuit, the output signal from the reset circuit must be connected to the RES pin of the connector via an open-collector buffer as shown below. If there is no reset circuit, the RES pin from the connector must be directly connected to the RES pin of the MCU.

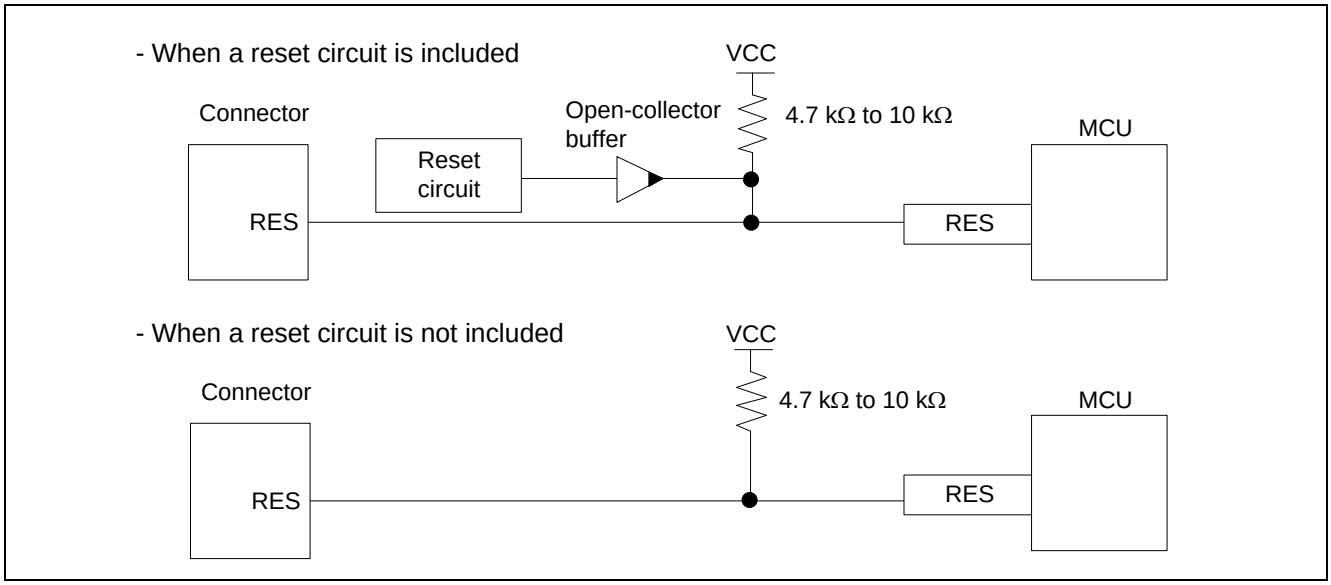


Figure 2.6 Connection of the RES Pin

Do not install capacitors, series resistors, or filters on signal lines; if this is attempted, correct communication may not be established.

2.5.2 MD Pin

Refer to the "Flash memory" chapter- "Precautions" section- "Emulator connection" section of the "User's Manual Hardware Edition" of each MCU of the RA family. And if it is recommended to connect the MD pins of MCU to SWCLK/TCK/MD pins of emulator, the emulator uses the MD pin. The circuit for the MD pin of the MCU includes a pull-up resistor.

When the MD pin is to be used in SCI or USB boot mode without use of the emulator, the MD pin must be handled so that it is switched to the low level.

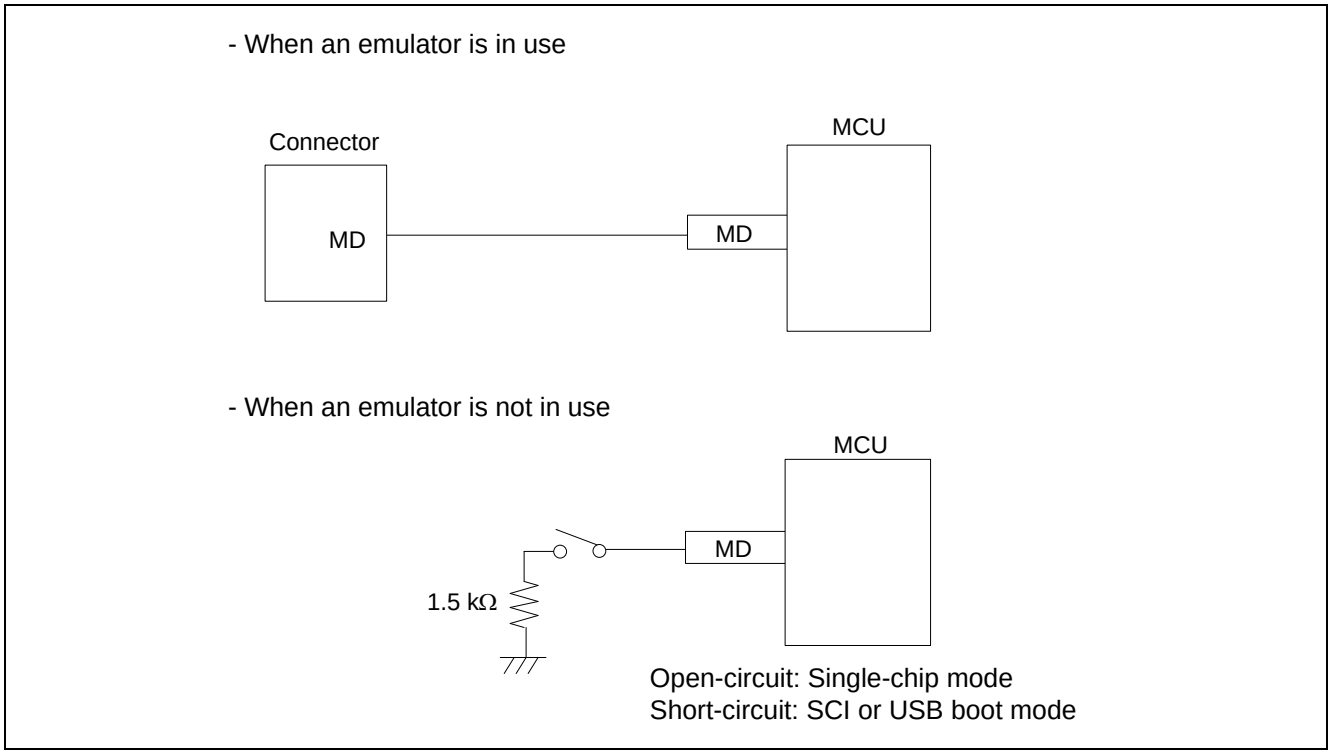


Figure 2.7 Connection of the MD Pin

2.5.3 GND

The pins of the connector marked "GND" must be at the same ground level as the VSS pin of the MCU.

2.5.4 VCC

Connect the VCC of the connector to the VCC (power supply) of the user system.

Use the emulator within the power supply voltage of 1.8 V to 5.5 V and within the operating voltage range of the MCU.

When power is supplied to the user system from other than the emulator, the E2/E2 Lite consumes the power supply for the last output and first input buffers of the emulator.

- E2: 3.3 V: approximately 20 mA, 5.0 V: approximately 40 mA
- E2 Lite: 3.3 V: approximately 20 mA, 5.0 V: approximately 40 mA

The E2/E2 Lite can supply power to a simple evaluation system.

- E2: Can supply power of 1.8 V to 5.0 V, up to 200 mA.
- E2 Lite: Can supply power of 3.3 V, up to 200 mA.

When using the power supply function of the E2 or E2 Lite, check the voltage that is actually being supplied to the user system since this depends on the environment.

Power supply from the E2/E2 Lite depends on the quality of the USB power supply of the host machine, and as such, precision is not guaranteed. When writing a program that requires reliability, do not use the power supply function of the E2/E2 Lite. Use a stable, separate power supply for the user system. As the software when writing a program in a mass-production process, use the Renesas Flash Programmer.

For details on the programming software, refer to the following:

Renesas Flash Programmer: https://www.renesas.com/RFP

When the MCU is changed to low power mode, the internal debugging circuit continues to run. This leads to the MCU drawing more electric current than is listed in the DC characteristics of the target MCU.

WARNING

Warning for Turning the Power On/Off:

When supplying power, ensure that there are no shorts between Vcc and GND. Only connect the E2/E2 Lite after confirming that there are no mismatches of alignment on the user system port connector. Incorrect connection will result in the host machine, the E2/E2 Lite, and the user system emitting smoke or catching fire.

2.5.5 RxD9 and TxD9 Pins (Flash Programming via an SCI)

When flash memory is programmed via an SCI, the RxD9 and TxD9 pins must be connected to the emulator. For MCUs in which the RxD9 and TxD9 pins can be allocated to multiple pins, check the hardware manual of the MCU to confirm which of the pins is used in boot mode.

2.6 Internal Circuits of the Emulator

2.6.1 Internal Circuits of the E2

Figure 2.8 and Figure 2.8 respectively show the internal circuits of product revisions C and D of the E2.

The alphabet at the end of the serial No. written on the E2 main unit indicates the product revision.

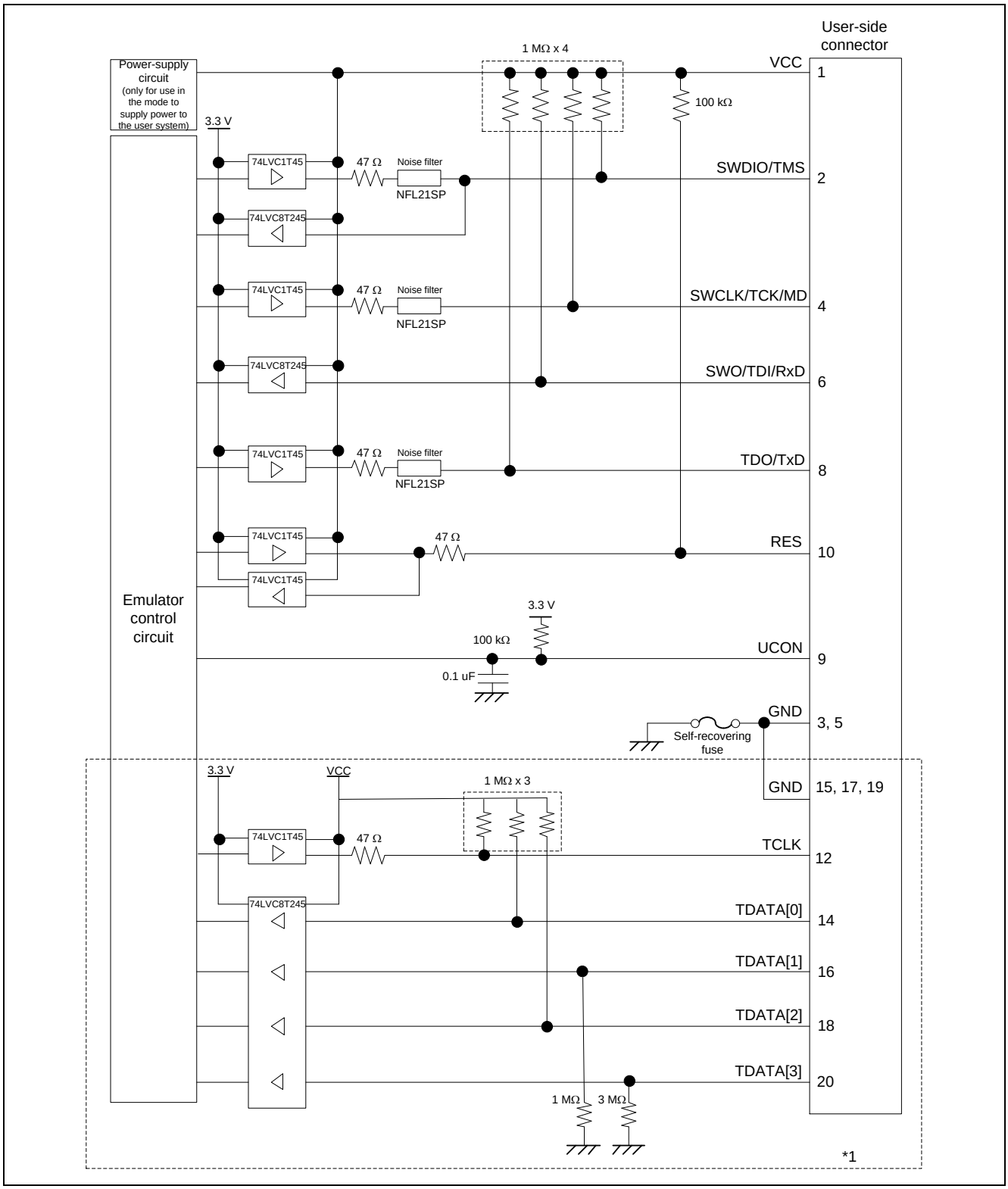


Figure 2.8 Internal Circuits of the E2 (Rev. C)

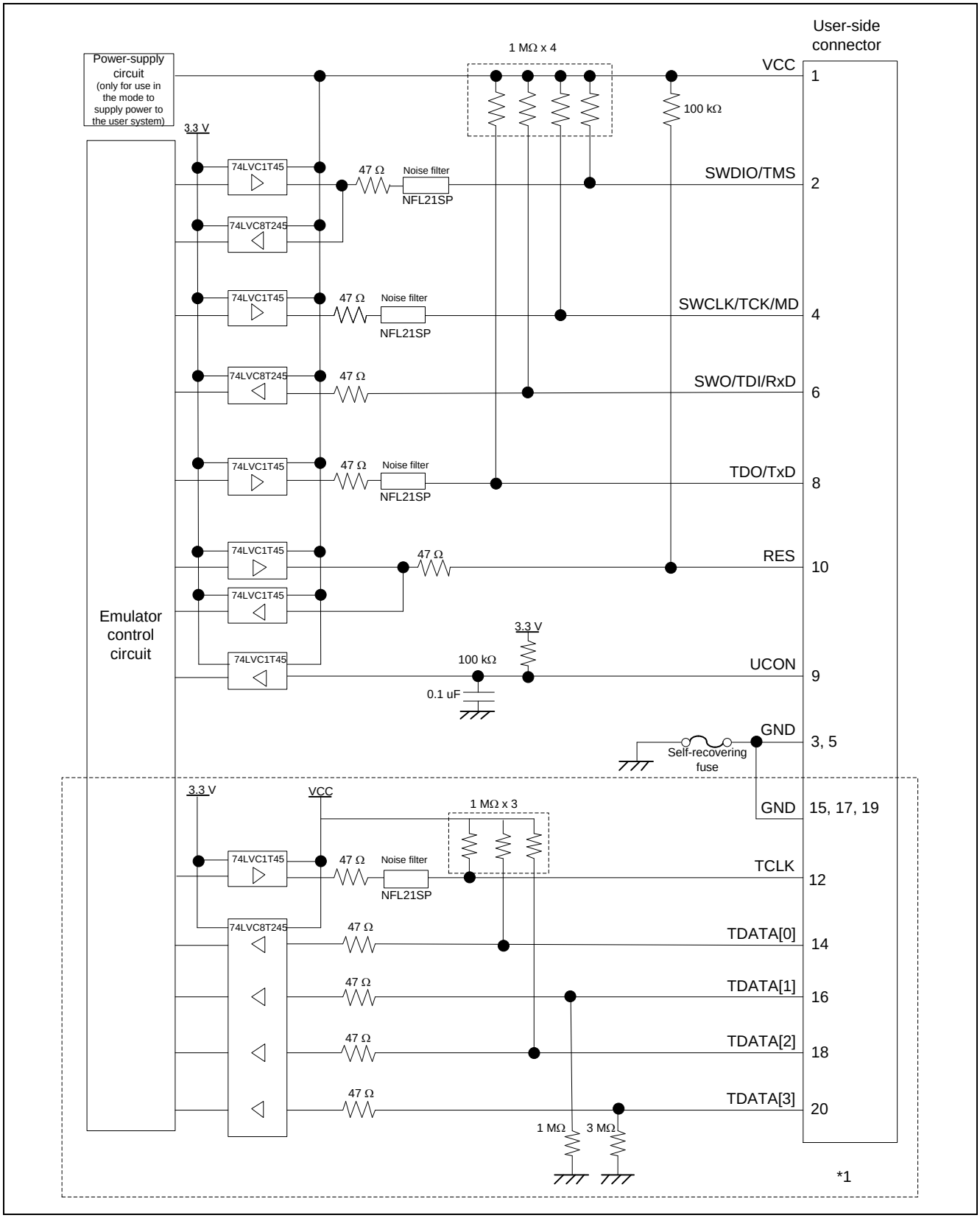


Figure 2.9 Internal Circuits of the E2 (Rev. D)

Note 1: If a 10-pin connector is mounted on the user system, pins 11 to 20 are not used.

2.6.2 Internal Circuits of the E2 Lite

Figure 2.10 shows the internal circuits of the E2 Lite.

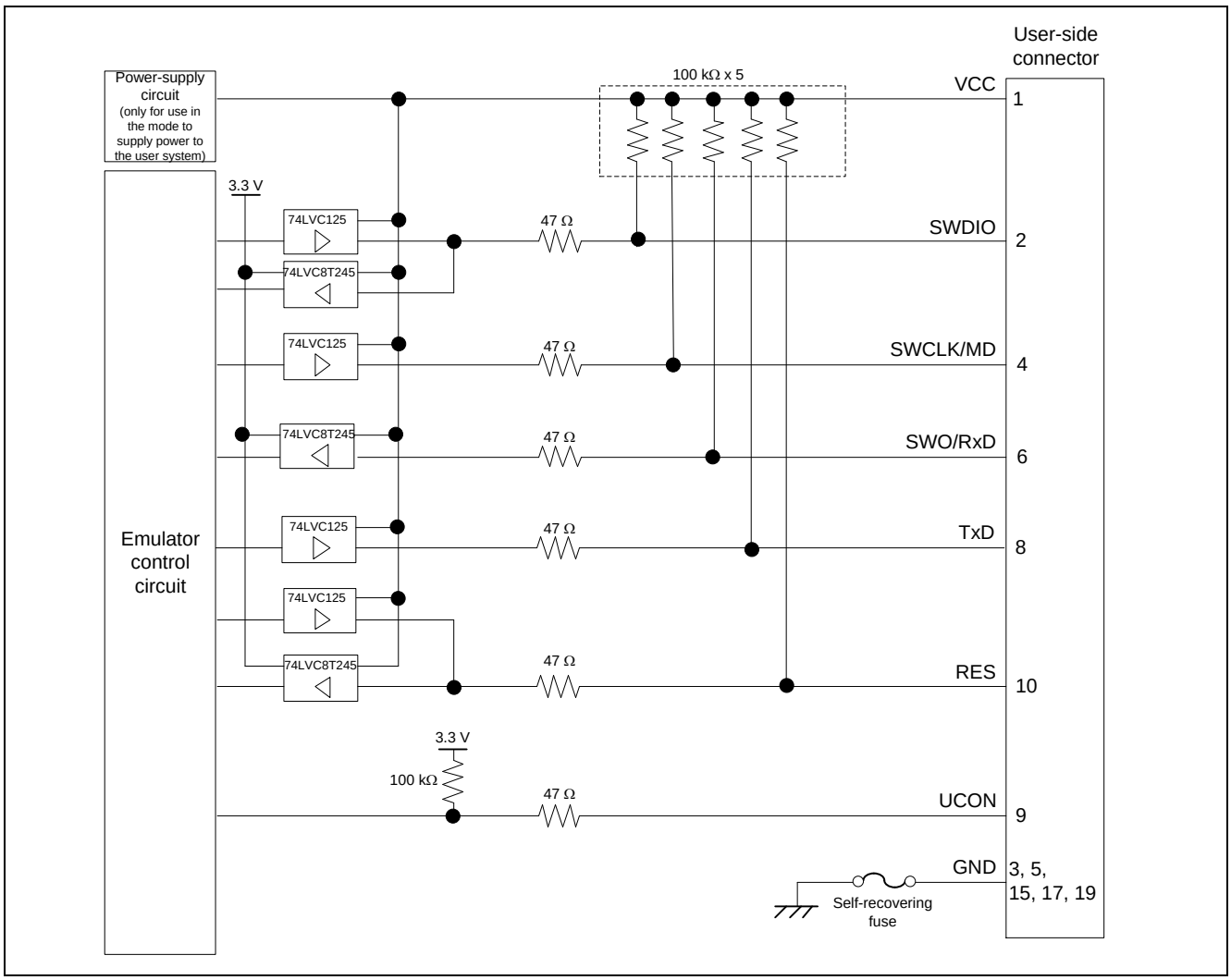


Figure 2.10 Internal Circuits of the E2 Lite

3. Notes on Usage

3.1 Turning the Power On/Off

Turn the power of the emulator and the user system following the procedure below.

3.1.1 When a Separate Power Supply is Used for the User System

<When using the emulator>

(1) Check that the power is off.
(2) Connect the user system.
Connect the emulator and the user system with a user-system interface cable.
(3) Connect the host machine and turn on the emulator.
Connect the emulator and the host machine with a USB interface cable. The E2/E2 Lite is turned on by connecting the USB interface cable.
(4) Launch the emulator debugger or programming software.
Launch the emulator debugger or programming software.
(5) Turn on the user system.
Turn on the user system.
(6) Connect the emulator debugger or programming software to the emulator.
Connections may vary depending on software.

<When finished using the emulator>

(1) Disconnect the emulator from the emulator debugger or programming software.
Disconnections may vary depending on software.
(2) Turn off the user system.
Turn off the user system.
(3) Close the emulator debugger or programming software.
Close the emulator debugger or programming software.
(4) Turn off the emulator and disconnect the emulator.
Disconnect the USB interface cable from the emulator. The E2/E2 Lite is turned off by disconnecting from the USB interface cable.
(5) Disconnect the user system.
Disconnect the user-system interface cable from the user system.

CAUTION

Notes on the User System Power Supply:

While the power of the user system is on, do not turn off the host machine or unplug the USB interface cable.
The user system may be damaged due to leakages current.

3.1.2 When Power is Supplied to the User System from the Emulator

<When using the emulator>

(1) Connect the user system.
Connect the emulator and the user system with a user-system interface cable.
(2) Connect the host machine and turn on the emulator.
Connect the emulator and the host machine with a USB interface cable, then turn on the emulator.
(3) Launch the emulator debugger.
Launch the emulator debugger and select the setting of power supply to the user system.
Under [Power] on the [Connection Settings] tabbed page, select [Yes] for [Power Target From The Emulator (MAX 200mA)]. Refer to section 3.3, Notes on Using the Emulator Debugger, for how to open the [Debug Configurations] window.

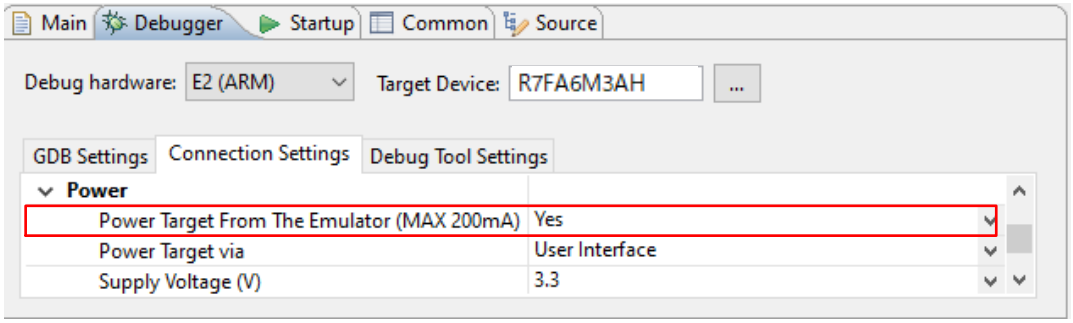


Figure 3.1 Setting for Supplying Power

(4) Connect the emulator debugger or programming software to the emulator.
Connections may vary depending on software.

<When finished using the emulator>

(1) Disconnect the emulator from the emulator debugger or programming software.
Disconnections may vary depending on software.
(2) Close the emulator debugger or programming software.
Close the emulator debugger or programming software.
(3) Turn off the emulator and disconnect the emulator.
Disconnect the USB interface cable from the emulator, then turn off the emulator.
(4) Disconnect the user system.
Disconnect the user-system interface cable from the user system.

3.2 Power Supply Function of the E2/E2 Lite

The E2/E2 Lite can supply power to a simple evaluation system.

- E2: Can supply power of 1.8 V to 5.0 V, up to 200 mA.
- E2 Lite: Can supply power of 3.3 V, up to 200 mA.

When using the power supply function of the E2 or E2 Lite, check the voltage that is actually being supplied to the user system since this depends on the environment.

3.3 Notes on Using the Emulator Debugger

This section describes how to set the [Debug Configurations] window of the e² studio. To open the [Debug Configurations] window, click on [Run] → [Debug Configurations…] or the downward-pointing arrow next to the icon→ [Debug Configurations…].

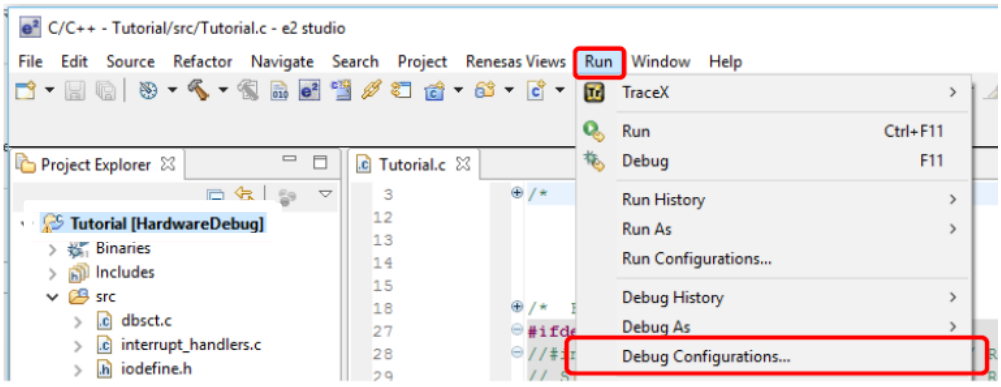


Figure 3.2 Opening the [Debug Configurations] Window

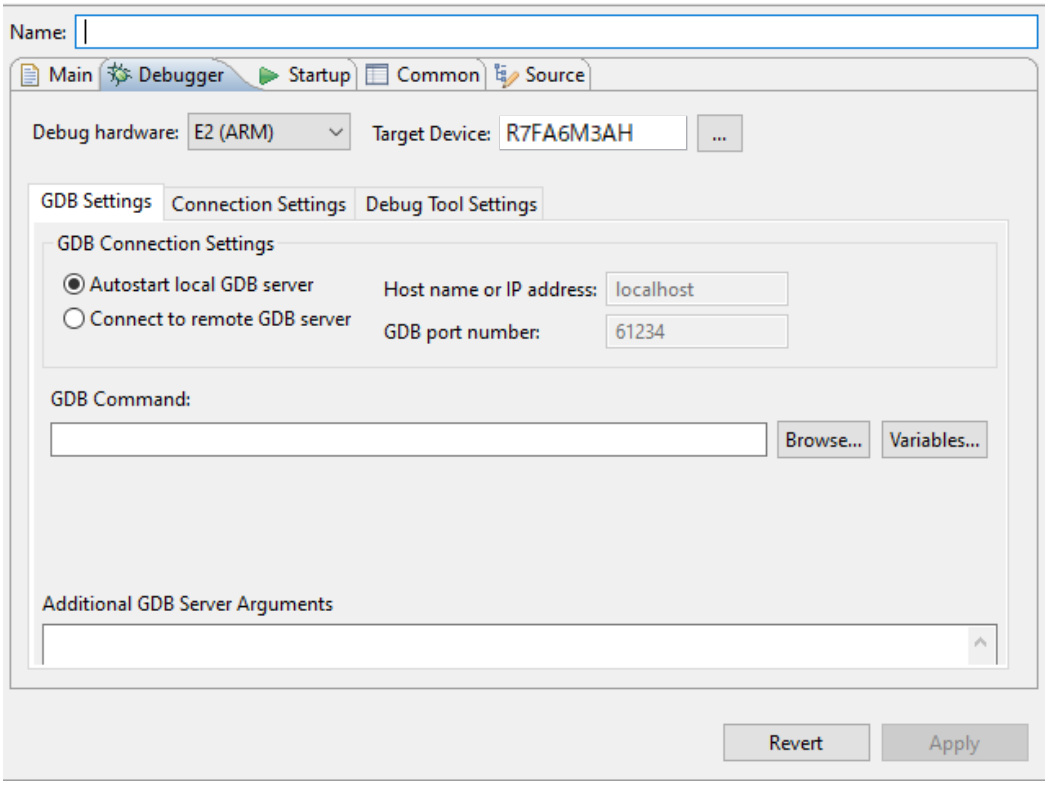


Figure 3.3 [Debug Configurations] Window

3.3.1 Notes on Connecting the Emulator Debugger

(1) Reset state

Under [Connection] on the [Connection Settings] tabbed page, be sure to select [Yes] for [Hold reset during connect].

When [Yes] is selected, during connection to the emulator debugger, the emulator maintains the low-level output on the RES# pin of the MCU and places the MCU in the OCD mode. However, to start the operation of the built-in debugging circuits of the MCU, the emulator releases the reset for about 50 msec while it is connected, and the user program automatically runs during that period.

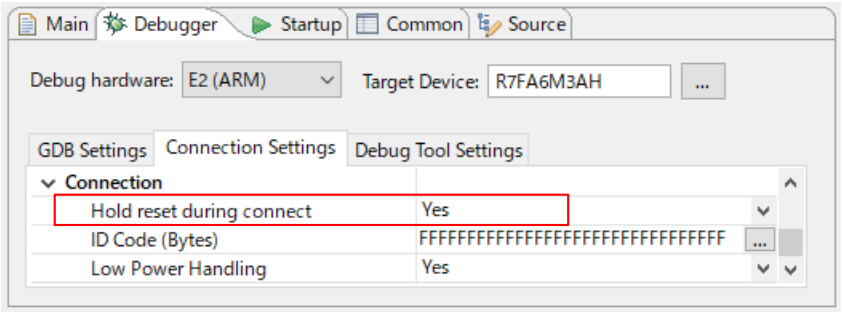


Figure 3.4 Setting of [Hold reset during connect]

(2) Startup mode

When the emulator debugger is connected, handle the pins on the user system so that the startup mode of the MCU is single-chip mode.

In single-chip mode, the MD pin is at the high level. Correct connection of the emulator debugger is not possible in SCI/USB boot mode.

(3) Debugging after rewriting ID code

If the ID code (OSIS register) has been rewritten, enter the new ID code.

Here, the ID code to be entered means the value to be entered in [ID Code (Bytes)] under [Connection] on the [Connection Settings] tabbed page.

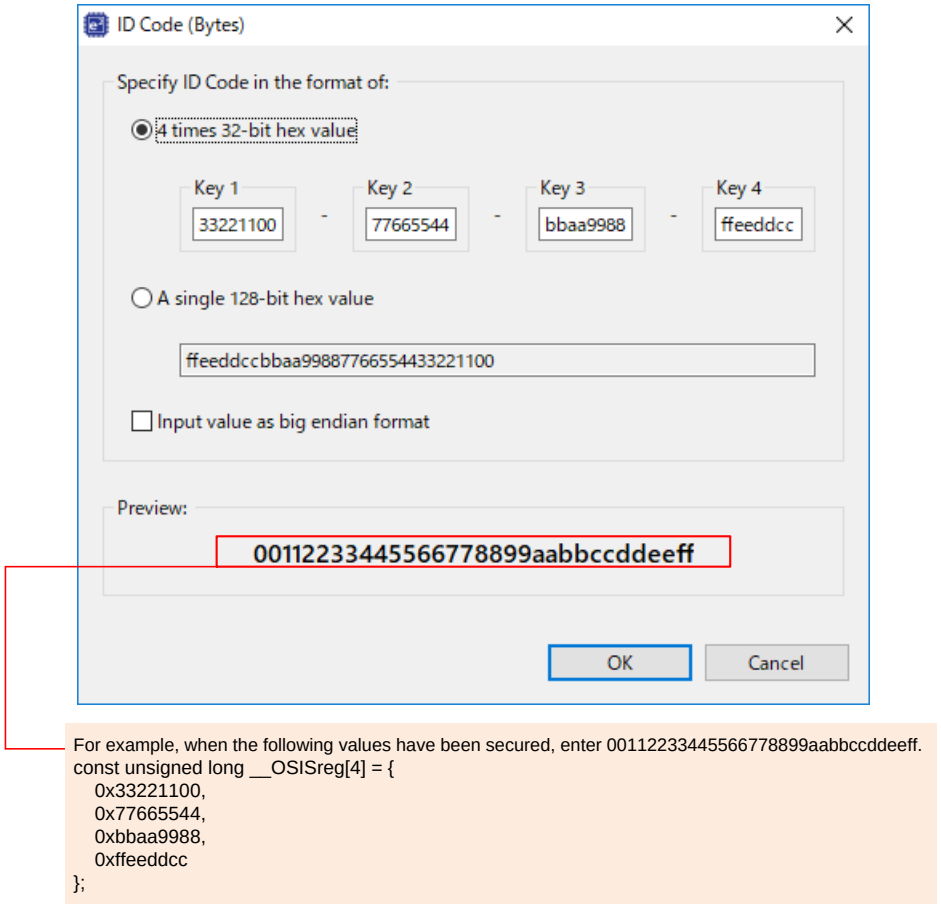


Figure 3.5 Setting of [ID Code (Bytes)]

Devices incorporating DLM facilities, such as those of the RA6M4 group, do not have ID code authentication.

(4) Entering the ALeRASE command for ID code

If an ALeRASE command (FFFFFFFFFFFFFFFFFF45534152654C41) is entered in [ID Code (Bytes)] under [Connection] on the [Connection Settings] tabbed page, the code flash memory and option-setting memory will be erased when the emulator debugger is connected.

For details on entering the ALeRASE command, refer to E2/E2 Lite (RA) Connection Settings in the help system for the e^2 studio.

For the conditions under which the ALeRASE command is usable, refer to the hardware manual for the MCU you are using. If the ALeRASE command is entered then the emulator debugger is connected while the command is not usable on the MCU, an error message “Failed to erase all flash memory by the ID for erasing all flash memory.” is displayed and the connection process is suspended.

Since devices such as those of the RA6M4 group have DLM facilities and so do not have ID code authentication, the ALeRASE command cannot be used.

(5) Connection speed

The speed for the connection of the emulator to the target board is specified within the following upper-limit values.

— JTAG (E2 only): 25000 kHz
— SWD (with an E2): 25000 kHz
— SWD (with an E2 Lite): 6000 kHz

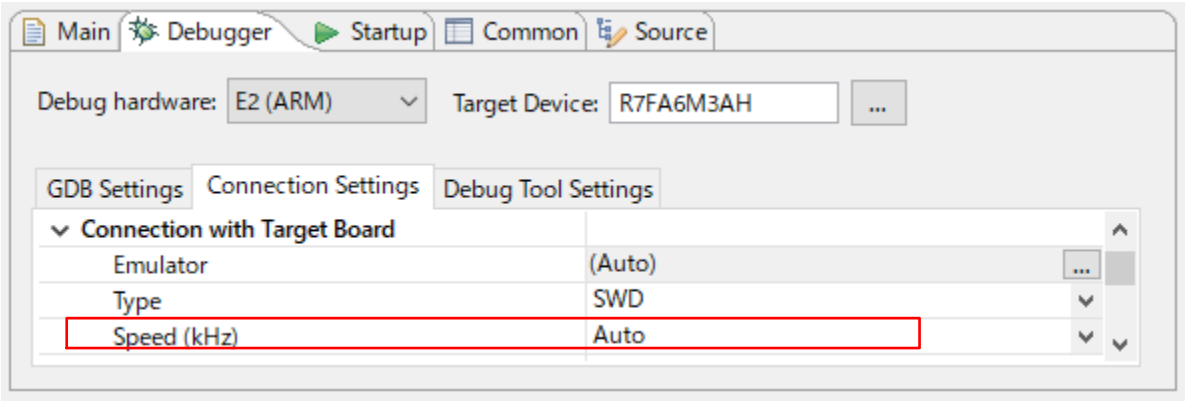


Figure 3.6 Setting the Connection Speed

Incidentally, the maximum speed for connection will be set Automatically when selecting “Auto”.

3.3.2 Notes on a Debugging Operation that Involves Reprogramming of Flash Memory

A “debugging operation that involves reprogramming of flash memory” refers to the following operations of the emulator debugger.

- Downloading data to flash memory
- Using software break functions in flash memory
  (a) Setting and canceling breakpoints
  (b) Executing or step-executing programs from a breakpoint
  (c) Using the “Run to Line” function from the state where a break was set

(1) Program for reprogramming flash memory

Since the emulator debugger enables a debugging operation that involves reprogramming of flash memory, the emulator writes the program for reprogramming flash memory to the on-chip SRAM and executes the program to reprogram the flash memory. After the flash memory has been reprogrammed, the emulator debugger restores the on-chip SRAM to its initial state.

(2) Destination for allocation of the program for reprogramming flash memory

By default, the program for reprogramming the flash memory is allocated to the 5-Kbyte space from the address where the SRAM0 area starts (or the address where the SRAMHS area starts for devices that do not include an SRAM0 area). If the default allocation destination is not available due to the security settings or DMAC/DTC transfer*, enter the start address of an available space in the on-chip RAM in units of 1000h bytes against [Work RAM Start Address] under [Flash] on the [Debug Tool Settings] tabbed page for the emulator debugger.

Note: The DMAC or DTC will continue to operate even during a break. Take care that a transfer source or destination for the DMAC or DTC is not within the address range of the working RAM where the program is to be allocated.

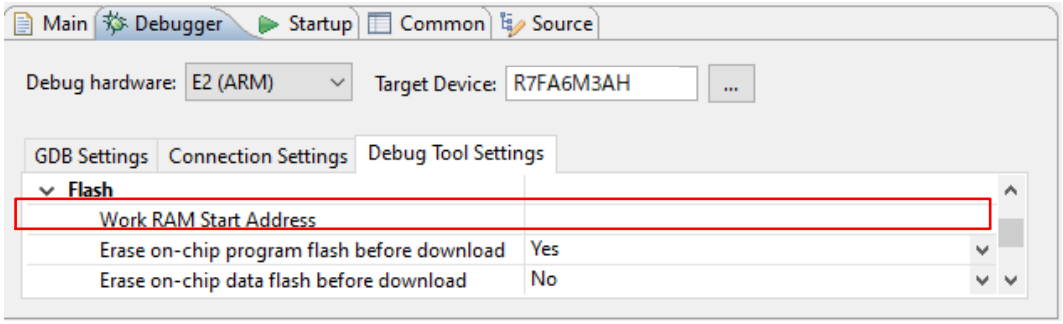


Figure 3.7 Setting of [Work RAM Start Address]

Do not deploy the program for reprogramming flash memory when the device incorporates the TrustZone® facility (for example, those of the RA6M4 group) and the emulator debugger is connected to the device with debugging-access level DBG1.

(3) Interrupts and resets during execution of the program for reprogramming flash memory

Interrupts other than non-maskable interrupts are to be masked while the program for reprogramming flash memory is being executed. Also, so that the program for reprogramming flash memory is correctly executed, all interrupt source flags which have been set before executing the program are cleared.

If a non-maskable interrupt occurs, the emulator continues running the program for reprogramming flash memory. If a reset occurs while the program for reprogramming flash memory is being executed, the emulator shows an error message and stops processing. Since doing so may damage the contents of flash memory, do not apply a reset while the program is running.

(4) Conditions for downloading data to flash memory being available

When the MCU satisfies all the following conditions, the downloading of data to flash memory can proceed.

(a) The code flash memory of the MCU is in read mode.

(b) The frequency of the system clock (ICLK) of the MCU is 1 MHz or higher.*

Note: For [Clock] in the [Connection Settings] tabbed page of the emulator debugger, when [Yes] is selected for [Permit Clock Source change on writing on-chip Flash Memory], condition (b) can be excluded.

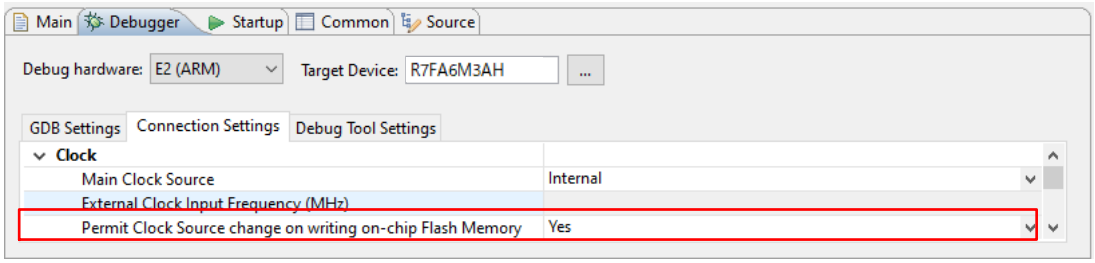


Figure 3.8 Setting of [Permit Clock Source change on writing on-chip Flash Memory]

If data are downloaded to flash memory while any condition is not satisfied, the emulator shows an error message and stops processing. In such a case, restart downloading of data to flash memory after the CPU has been reset or reconnect the emulator debugger after reviewing its settings.

(5) Downloading data to a secure area

When downloading data to a secure area which has been specified for the security MPU, for [Flash] in the [Debug Tool Settings] tabbed page of the emulator debugger, select [Yes] for [Erase on-chip program flash before download].

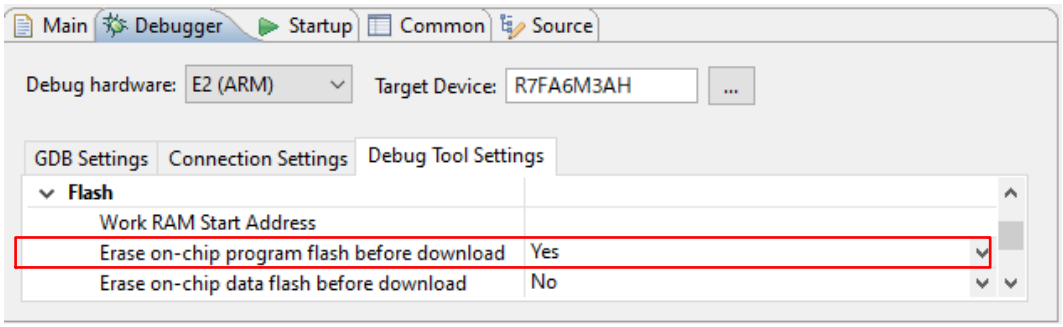


Figure 3.9 Setting of [Erase on-chip program flash before download]

(6) Access window function

When the access window function of the MCU is to be used, only reprogram the flash memory in the area specified for access.

(7) Conditions for using software breaks in flash memory

When the MCU satisfies all the following conditions, the software break function for flash memory is enabled.

(a) The code flash memory of the MCU is in read mode.

(b) The frequency of the system clock (ICLK) of the MCU is 1 MHz or higher.*

(c) For [Break] in the [Debug Tool Settings] tabbed page, [Yes] is selected for [Use Flash Breakpoints].

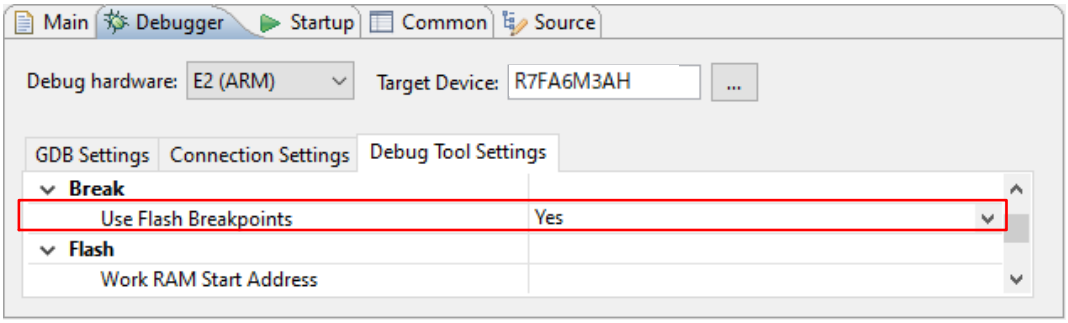


Figure 3.10 Setting of [Use Flash Breakpoints]

Note: For [Clock] in the [Connection Settings] tabbed page of the emulator debugger, when [Yes] is selected for [Permit Clock Source change on writing on-chip Flash Memory], condition (b) can be excluded.

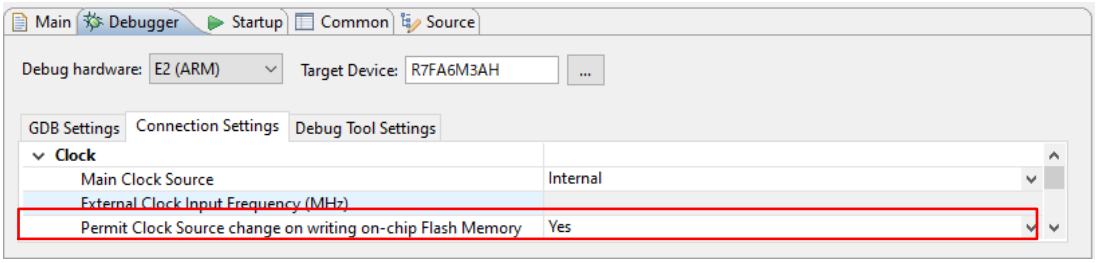


Figure 3.11 Setting of [Permit Clock Source change on writing on-chip Flash Memory]

If the software break function is used with any condition not satisfied, the emulator shows an error message. In such a case, use the hardware break or confirm that conditions (a) to (c) above are satisfied.

(8) Flash memory I/O register

After a debugging operation that involves reprogramming of flash memory, the value of the flash memory I/O register is rewritten by the emulator debugger.

3.3.3 Note on Using Software Breaks in the On-Chip SRAM

(1) Overwriting of software breakpoints by user programs

If a software breakpoint is overwritten by a user program, the program will not stop even if it runs through the address. In such a case, set the software breakpoint after the target on-chip SRAM has been rewritten by the program.

3.3.4 Notes on Using Software Breaks (Common to the On-Chip SRAM and Flash Memory)

(1) Setting software breakpoints in a secure area

Do not set software breakpoints in a secure area which has been specified by the security MPU. If this is attempted, an instruction code may be restored as incorrect data on release of the break.

(2) Reading an address where a software breakpoint has been set

Do not read an address where a user program has set a software breakpoint. Doing so may cause the program to operate in a different way from in the normal state.

(3) Viewing memory in the [Memory] view

During execution of the user program, if a range of memory in which a software breakpoint has been set is displayed in the [Memory] view of the emulator debugger, the value (BKPT instruction code) that is shown is different from that in the actual program data.

(4) Removal of software breakpoints when the emulator debugger is to be disconnected

When the emulator debugger is to be disconnected, remove all software breakpoints that have been set. At this time, reset the CPU since the emulator debugger is certain to reprogram the flash memory.

3.3.5 Note on Peripheral I/O Registers Occupied by the Debugger

(1) Peripheral I/O registers occupied by the debugger

The emulator debugger occupies the following peripheral I/O registers during debugging. Do not change the values of these registers, since continued debugging might not be possible after having done so.

- Debug stop control register (DBGSTOPCR)
- Micro trace buffer (MTB) (SFR area)
- System control OCD control register (SYOCDCR)

3.3.6 Note on Using the MTB Trace Function

When the MTB trace function is in use, the trace recording area is the size of recorded tracing that has been selected for the emulator debugger from the address where the on-chip SRAM starts. When the on-chip SRAM is in use by a user program, do not use the trace recording area. For details on the address where the on-chip SRAM starts, refer to the hardware manual for the given MCU.

If the size of the trace recording area for the emulator debugger is changed, the linker script must also be changed.

3.3.7 Notes on Using the ETB Trace Function

The following describes points for caution regarding the ETB trace function of MCUs which have a Cortex-M33 core.

(1) When a branch instruction is step-executed, the results of tracing are not correct.
After step-execution of the instruction, the address that is displayed is not that of the branch destination but that of the branch source.

(2) The operation of data comparison events as trace events is not normal.
Even if a data comparison event is set as a trace event, the data are not compared but the event condition is satisfied at the time of access to the location alone.

(3) If a reset is applied during the execution of a program, trace information will not be acquired.

(4) If any of the following exceptions occur, the results of tracing may not be correct.
- HardFault
- MemManage
- BusFault
- Debug Monitor
- PendSV
- SysTick

3.3.8 Notes on SWO Trace

E2 emulator has roles for acquiring and displaying trace data which is output serially via SWO pin. (Referred to below as SWO Trace.) Notes on SWO Trace are provided below.

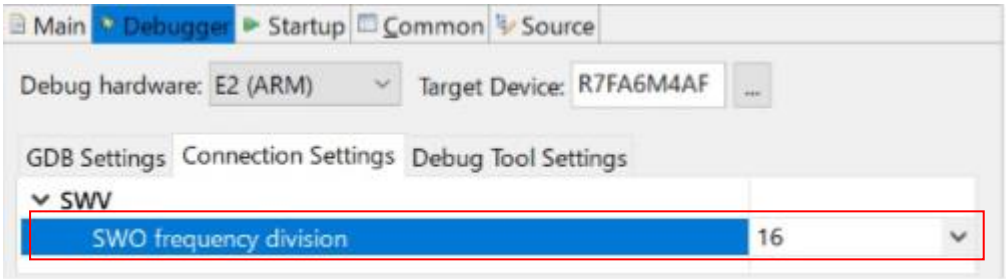
(1) SWO pin interface clocking
- E2 emulator handles up to 15MHz for the interface clock of SWO pin to output SWO trace data.
- SWO Interface clock is set via “SWO frequency division” on Emulator Debugger※1 for clock source frequency in the microcomputer’s system.
- Trace information will not be displayed correctly when SWO interface clock is greater than 15MHz as the emulator cannot receive trace data properly. Therefore, SWO interface clock needs to be set less than 15MHz on Emulator Debugger※1.

(e.g., Target device: RA6M4, ICLK: 100MHz, and 2 frequency divisions for ICLK (SCKDIVCR.ICK : 001b))

Because clock source frequency will be 200MHz with parameters above, a value greater than “16” (lower than 12.5MHz) needs to be selected in “SWO frequency division” on Emulator Debugger※1.

※1: "SWO frequency division" on Emulator Debugger

[Debugger] tab > [Connection Settings] tab > [SWV] > [SWO frequency division]



(2) Buffer overflow in the microcomputer

Trace buffer overflow can occur in the microcomputer as output trace data from microcomputer to emulator cannot be sent as requested due to some factors such as a program itself, debugging functions running simultaneously or output settings of the microcomputer.

Therefore, trace data cannot be displayed on Emulator Debugger when the overflow occurs.

For more detail on the conditions when buffer overflow occurs in the microcomputer, refer to “Architecture Reference Manual” for a target CPU.

(3) Buffer overflow in the emulator

When using SWO Trace, receive buffer on the emulator can overflow because reading buffered trace data from the emulator to Emulator Debugger cannot keep up with outputting trace data from the microcomputer to the emulator.

— In case buffer overflow occurs, Emulator Debugger displays warning references and keep acquiring and displaying trace data. However, trace data will not be shown while buffer overflow is occurring

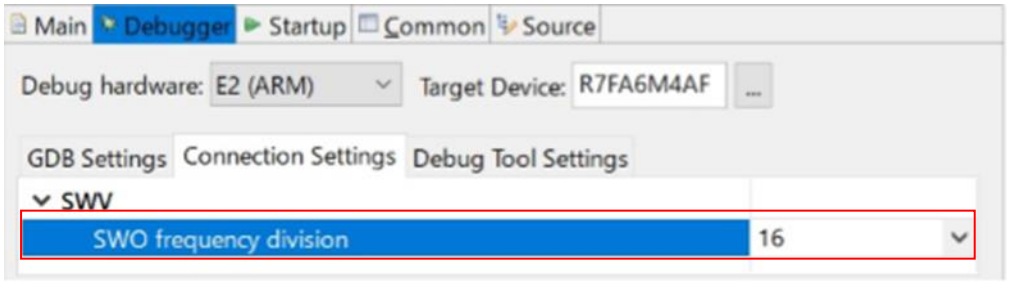
— Buffer overflow can be caused by various factors such as host PC performance, operating frequency of microcomputer, the number of output trace data or debugging functions running at same time.

— To resolve buffer overflow, the following measures to reduce trace data transmitted to emulator.

- Change the value greater in “SWO frequency division” on Emulator Debugger※1.
- When “PC Sampling” is “Enable”, set greater value in “Resolution” ※2.
- When “Timestamp” is “Enable”, set greater value in “Prescaler” ※2.
- Disable SWO Trace (e.g., “PC Sampling” and “Timestamp”) running at same time ※2.
- When outputting trace data with user program, change the program and adjust output interval greater.

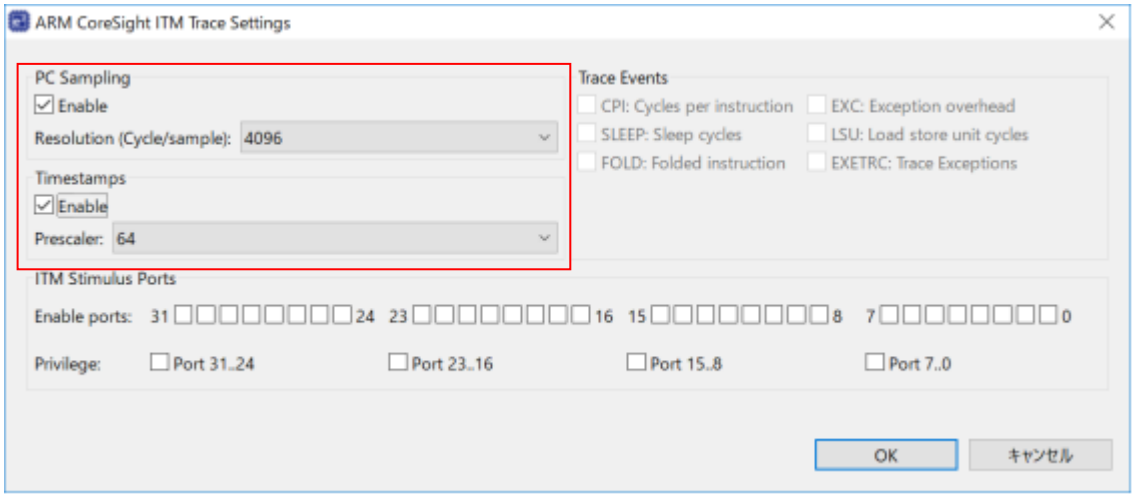
※1: "SWO frequency division" on Emulator Debugger

[Debugger] tab > [Connection Settings] tab > [SWV] > [SWO frequency division]



※2: [CoreSight ITM Settings]

Open [Live Trace Console] view > Click [CoreSight ITM Settings] button



3.3.9 Notes on Low-Power Modes

(1) Debugging in SSTBY or SNOOZE mode

In SSTBY or SNOOZE mode, the emulator debugger does not have access to the system bus of the MCU. While the user program is being executed or during mode transitions of the MCU, setting and viewing of the memory or peripheral I/O registers and setting and changing breakpoints are not possible.

(2) Forcibly stopping a program in SSTBY or SNOOZE mode

When a program is forcibly stopped in SSTBY or SNOOZE mode, proceed with one of the following operations. Each operation leads to release from SSTBY or SNOOZE mode.

— Using [Reset] of the emulator debugger makes the MCU stop the user program and go to the position indicated by the reset vector.

— Using [Suspend] of the emulator debugger stops the MCU at the next instruction after the WFE instruction which led to the mode transition. When [Suspend] is to be used, for [Connection] on the [Connection Settings] tabbed page of the emulator debugger, select [Yes] for [Low Power Handling].

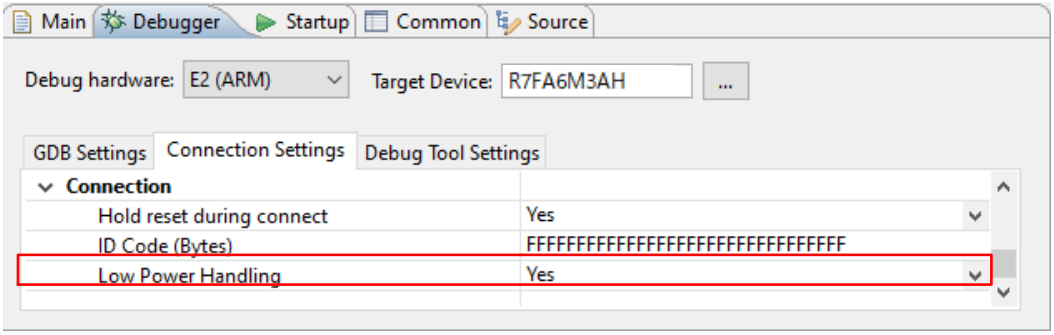


Figure 3.12 Setting of [Low Power Handling]

Even if [Yes] is selected for [Low Power Handling], forcibly stopping the program in SSTBY or SNOOZE mode on a device that incorporates the TrustZone® facility (for example, an RA6M4 device) is not possible.

(3) Debugging in DSTBY mode

Debugging a program that has entered DSTBY is not supported.

3.3.10 Current Drawn during Debugging

Since the debugging circuits within the MCU are always active during connection of the emulator debugger, the MCU draws more current than in the actual user system. Take care on this point when attempting to measure the current drawn in the user system.

3.3.11 Note on the Memory Protection Units (MPUs)

(1) Access to protected areas

Table 3.1 shows the operation of the emulator debugger in response to attempted access to areas protected by each of the MPUs.

Table 3.1 Access to MPU-Protected Areas

Protected Area	Operation of the Emulator Debugger
Arm® MPU	Accessible
Bus master MPU	The protected area is not accessible.
Slave MPU	Accessible
Security MPU	On-chip SRAM/peripheral I/O registers • Reading: A dummy value (0x00) is read. • Writing: Writing is ignored. Flash memory • Reading: A dummy value (0x00) is read. • Writing: Writing is possible if data are downloaded and written.

3.3.12 Notes on the TrustZone® Facility

(1) When the DLM state of the device is NSECSD, the emulator debugger is connected to the device with debugging-access level DBG1.

(2) When the emulator debugger is connected to the device with debugging-access level DBG1, a program must have already been written such that execution by the device correctly enters the non-secure area after release from a CPU reset (after the emulator debugger is connected, the execution will stop at the first instruction where execution by the device enters the non-secure area.)

(3) While the emulator debugger is connected with debugging-access level DBG1, breakpoints cannot be set in a secure area.

(4) Access to secured areas

Table 3.2 shows the operation of the emulator debugger in response to attempted access to areas secured by the TrustZone® facility during connection with debugging-access level DBG1.

Table 3.2 Access to Secured Areas

Secured Area	Operation of the Emulator Debugger
Peripheral I/O registers	Reading: A dummy value (0x00) is read.* Writing: Writing is ignored.
On-chip SRAM	Reading and writing: A security error is indicated.

Note: For the values read from peripheral I/O registers, refer to the specifications of each register.

(5) Software break functions used in debugging-access level DBG2. (Flash Memory)

When debugging programs deployed not only in Secure area but also in Non-Secure area simultaneously, do not execute debugging operations related to the following software break functions.

— Setting and cancelling software breakpoint on NSC and Non-Secure area.

— Setting and cancelling software breakpoint in the situation when a program breaks in Non-Secure area.

— Moving to Non-Secure area by stepping through after a program stops at software breakpoint in Secure area.

When executing the operations above, due to Trust Zone functions, program faults or reprogramming flash memory can fail in further debugging operations, and debugging cannot be continued.

If it is necessary to set breakpoint in the cases above, use hardware breakpoint instead.

3.3.13 Note on the Code Flash Dual Mode Facility

When the code flash dual mode (including the bank-swapping facility) and code flash block-swapping facility are to be used, select [No] for [Erase on-chip program flash before download] for [Flash] on the [Debug Tool Settings] tabbed page of the emulator debugger. For [System], select [Yes] for [Debug the program re-writing the on-chip data flash].

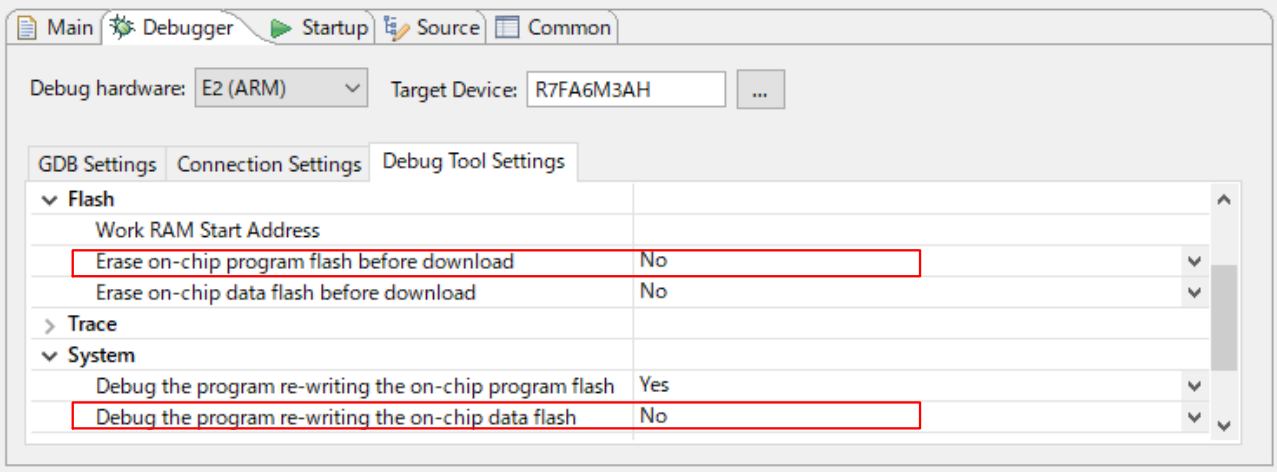


Figure 3.13 Setting of Items under [Flash] and [System]

3.3.14 Notes on S cache and C cache functions

When using S cache and C cache functions, use hardware breakpoints instead of software breakpoints if all the following conditions are met.

- CPU is Non-Secure state.
- Control registers (CCACTL, CCAFCT, SCACTL and SCAFCT) for S cache and C cache functions are Secure state.

Or when downloading with all the conditions above, invalidate cache contents after download because there can be differences between written contents and cache memory.

3.4 MCUs that are Used in Debugging

After debugging with the emulator, if the MCU is disconnected from the emulator and run on its own, correct operation cannot be guaranteed. To operate the MCU on its own, use the programming software to re-program the MCU.

MCUs that are connected to the emulator and used in debugging are placed under stress by repeated programming of flash memory during emulation. Do not use MCUs that were used in debugging in mass-production for end users.

3.5 Final Evaluation of the User Program

Before entering the mass-production phase, be sure to perform a final evaluation of the program which has been written to the flash ROM by the programming software, without the emulator connected.

Revision History	E2 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RA Devices)

Rev.	Date	Description	
		Page	Summary
1.00	Mar.16.20	—	—
2.00	Oct.01.20	—	With the addition of support for TrustZone® and DLM, relevant information was included. Section 3.3.7, Notes on Using the ETB Trace Function, was added.
3.00	Aug.16.21	—	Added new sections 2.4.3. SCI Interface Connection, 3.3.8. Notes on SWO Trace, 3.3.14. Notes on S cache and C cache functions. Added a new item 3.3.12. (5) Software break functions used in debugging-access level DBG2. Updated an item 3.3.1. (5) Connection speed.
3.10	Jun.16.22	13 to 15	Change “Note1”.

E2 Emulator, E2 Emulator Lite
Additional Document for User's Manual
(Notes on Connection of RA Devices)

Publication Date: Rev.3.10 Jun.16.22

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E2 Emulator, E2 Emulator Lite
Additional Document for User's Manual
(Notes on Connection of RA Devices)

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