User's Manual

E1/E20/E2 Emulator, E2 Emulator Lite

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

Supported Devices:
RL78 Family
RL78/G10

All information contained in these materials, including products and product specifications, represents information on the product at the time of publication and is subject to change by Renesas Electronics Corporation without notice. Please review the latest information published by Renesas Electronics Corporation through various means, including the Renesas Electronics Corporation website (http://www.renesas.com).

Renesas Electronics
www.renesas.com

Rev.3.00 Jul 2017

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other disputes involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawing, chart, program, algorithm, application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics products.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
   Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (space and undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.
6. When using the Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat radiation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions or failure or accident arising out of the use of Renesas Electronics products beyond such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please ensure to implement safety measures to guard them against the possibility of bodily injury, injury or damage caused by fire, and social damage in the event of failure or malfunction of Renesas Electronics products, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures by your own responsibility as warranty for your products/system. Because the evaluation of microcomputer software alone is very difficult and not practical, please evaluate the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please investigate applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive carefully and sufficiently and use Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall not use Renesas Electronics products or technologies for (1) any purpose relating to the development, design, manufacture, use, stockpiling, etc., of weapons of mass destruction, such as nuclear weapons, chemical weapons, or biological weapons, or missiles (including unmanned aerial vehicles (UAVs)) for delivering such weapons, (2) any purpose relating to the development, design, manufacture, or use of conventional weapons, or (3) any other purpose of disturbing international peace and security, and you shall not sell, export, lease, transfer, or release Renesas Electronics products or technologies to any third party whether directly or indirectly with knowledge or reason to know that the third party or any other party will engage in the activities described above. When exporting, selling, transferring, etc., Renesas Electronics products or technologies, you shall comply with any applicable export control laws and regulations promulgated and administered by the governments of the countries asserting jurisdiction over the parties or transactions.
10. Please acknowledge and agree that you shall bear all the losses and damages which are incurred from the misuse or violation of the terms and conditions described in this document, including this notice, and hold Renesas Electronics harmless, if such misuse or violation results from your resale or making Renesas Electronics products available any third party.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

Contents

Page

1. Overview 6
1.1 Overview of E1/E20/E2 Emulator and E2 emulator Lite 6
1.2 Note on Using E20 6
1.3 Configuration of Manuals 7
1.4 Supported Devices 9
1.5 Overview of the Specifications of the External Trigger Input and Output 10
1.5.1 Assignments of the External Trigger Input and Output Pins 10
1.5.2 Specifications of the External Trigger Inputs and Outputs 11

2. Designing the User System 12
2.1 Connecting the E1/E20/E2/E2 Lite to the User System 12
2.2 Installing the Connector on the User System 12
2.2.1 Connecting the User System Interface Cable to the 14-Pin Connector 12
2.3 Pin Assignments of the Connector on the User System 16
2.3.1 14-Pin Connector Specifications 16
2.4 Recommended Circuits between the Connector and the MCU 18
2.4.1 Connection between the 14-Pin Connector and the RL78 Family MCUs 18
2.5 Notes on Connection 19
2.5.1 RESET# Pin 19
2.5.2 TOOL0 Pin 20
2.5.3 GND 21
2.5.4 VDD 21
2.6 Internal Circuits of the Emulator 23
2.6.1 Internal Circuits of the E1 (when the RL78 Family is Connected) 23
2.6.2 Internal Circuits of the E20 (when the RL78 Family is Connected) 24
2.6.3 Internal Circuits of the E2 (when the RL78 Family is Connected) 25
2.6.4 Internal Circuits of the E2 Lite (when the RL78 Family is Connected) 26
2.7 Notes on Designing the User System 27
2.7.1 Isolator for the E1 27
2.7.2 Low-Voltage OCD Board 27
2.7.3 Small Connector Conversion Adapter for the E1 28

3. Notes on Usage 30
3.1 Turning the Power On/Off 30
3.1.1 When a Separate Power Supply is Used for the User System 30
3.1.2 When Power is Supplied to the User System from the Emulator (E1/E2/E2 Lite Only) 32
3.2 Power Supply Function of the E1/E2/E2 Lite 33
3.3 MCU Resources to be Occupied 34
3.3.1 Securing an Area for the Debugging Monitor Program 34
3.3.2 Securing a Stack Area for Debugging 35
3.3.3 Setting an On-Chip Debugging Option Byte 35
3.3.4 Setting a Security ID 36
3.3.5 Area for Pseudo-RRM/Pseudo-DMM 36
3.4 Reset 37
3.4.1 Operation after a Reset 37
3.4.2 SP Value after a Reset 37
3.5 Flash Memory 37
3.5.1 Operation for Voltages Not Permitting Flash Memory Rewriting 37
3.5.2 Notes on Flash Memory Rewriting 37
3.6 RESET# Multiplexed Pin 37
3.7 MCUs that are Used in Debugging 38

3.7.1 Usage in Mass-Production 38
3.7.2 Standalone Operation 38
3.8 Final Evaluation of the User Program 38
3.9 Debug Functions 39
3.9.1 Step Execution 39
3.9.2 [Go to Here] 39
3.9.3 Debugging in Standby Mode 39
3.9.4 Pseudo-Real-Time RAM Monitor Function or Pseudo-Dynamic Memory Modification Function 39
3.9.5 Software Break Functions 40
3.9.6 Extended Functions of the E2 40

Revision History 41

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 Renesas Flash Programmer that can be used with the E1, E20, E2, or E2 Lite.

"#" at the end of a pin name (signal name)

"#" at the end of a pin name (signal name) indicates that the pin (signal) is active low (e.g., RESET#).

Extended function of the E2

This means an extended function which is available with the E2 emulator.

E2 expansion interface

This means the interface required for extended functions of the E2 emulator.

1. Overview

1.1 Overview of E1/E20/E2 Emulator and E2 emulator Lite

In this document, we describe ‘E2 Emulator’ as ‘E2’, ‘E1 Emulator’ as ‘E1’, ‘E20 Emulator’ as ‘E20’ and ‘E2 emulator Lite’ as ‘E2 Lite’.

The E1, E20, E2, and E2 Lite are on-chip debugging emulators for Renesas' mainstream MCUs.

The E1 and E2 Lite are highly affordable development tools providing basic debugging functions. The E20 is a development tool allowing sophisticated debugging through enhanced functions such as tracing and RAM monitoring as well as the basic debugging functions of the E1 and E2 Lite. The E2 is a development tool providing a solution for the tuning of current consumption and an external trigger function as extended functions beyond the basic debugging functions of the E1 and E2 Lite. The E1/E20/E2/E2 Lite can also serve as a Flash Programmer.

1.2 Note on Using E20

The large trace function and the real-time RAM monitoring function, which are the primary features of the E20, cannot be used with RL78 devices.

The available functions are equivalent to those of the E1/E2 Lite (only the internal trace function in the MCU and memory reference and modification during execution).

The power supply function from the E20 is not supported.

1.3 Configuration of Manuals

The E1, E20, E2, and E2 Lite manuals consist of the following.

- E1/E20 Emulator User's Manual
- E2 Emulator Lite User’s Manual
- E1/E20/E2 Emulator, E2 Emulator Lite Additional Document for User’s Manual

Be sure to read each user’s manual before using the E1, E20, E2, or E2 Lite.

(1) E2 Emulator User’s Manual

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

- Components of the E2
- Hardware specifications of the E2
- Connection to the E2 and the host machine and user system

(2) E1/E20 Emulator User’s Manual

The E1/E20 emulator user’s manual has the following contents:

- Components of the E1/E20
- Hardware specifications of the E1/E20
- Connection to the E1/E20 and the host machine and user system

(3) E2 Emulator Lite User’s Manual

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

- Components of the E2 Lite
- Hardware specifications of the E2 Lite
- Connection to the E2 Lite and the host machine and user system

(4) E1/E20/E2 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78)

The E1/E20/E2 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78) describes information necessary for hardware design such as connection examples, interface circuits, and notes on using the emulator.

(5) User’s manual and help for the emulator debugger

The user’s manual and help for the emulator debugger describe the functions of the E1/E20/E2/E2 Lite emulator debugger and the operating instructions.

Refer to the following.

- CS+ Integrated Development Environment User's Manual: RL78 Debug

- Help for e2 studio

When using C-SPY made by IAR Systems, also refer to "IAR C-SPY Hardware Debugger System User Guide issued by IAR Systems" published by IAR Systems.

(6) Application note for extended functions of the E2

The application note for extended functions of the E2 includes an explanation and descriptions of operation methods for an extended function of the E2 emulator. Refer to the Application Note for the Solution for the Tuning of Current Consumption.

1.4 Supported Devices

Table 1-1 Supported Device List

Item	Description
Target MCUs	RL78 Family (RL78-S1 Core) *1
	RL78/G1x: RL78/G10

Notes: 1. For details on the RL78-S1 core, refer to "RL78 Family User's Manual: Software".
2. When using other than the RL78/G10, refer to "E1/E20/E2 Emulator, E2 Emulator Lite Additional Document for User's Manual (Notes on Connection of RL78)".

Table 1-2 Debugging Function List

Item		Type of the RL78 Core	Description
		RL78-S1	
Memory reference or change during program execution			
Pseudo-real-time RAM monitor (RRM)		Supported	CPU is used when monitoring
Dynamic Memory Modification (DMM)		Supported	CPU is used when changing
Event		2 points (max)	Can be used for hardware break
Break	Software break	Not supported	
	Hardware break	Supported	Execution address
	Forced break	Supported	
Trace	Acquired information	Not supported	
	Start event	Not supported	
	End event	Not supported	
Performance measurement function	Measurement item	Supported	Between start and stop of user program execution
	Performance	Supported	Resolution: 100 µs Maximum measurement time: 119 hours 18 min
Hot plug-in		Not supported	
Coverage measurement function		Not supported	
Extended function of the E2*	Solution for the tuning of current consumption	Supported	Current consumption by the user system is measured when the power is supplied from the E2.
	External trigger input/output	Supported	External triggers can be input to or output from the E2 expansion interface.

Note: When the low-voltage OCD board is in use, the extended functions of the E2 are not available.

1.5 Overview of the Specifications of the External Trigger Input and Output

This section describes the specifications of the external trigger input and output, which is one of E2 extended functions of the E2.

1.5.1 Assignments of the External Trigger Input and Output Pins

The following figure and table show the assignments of the external trigger input and output pins for the E2 expansion interface.

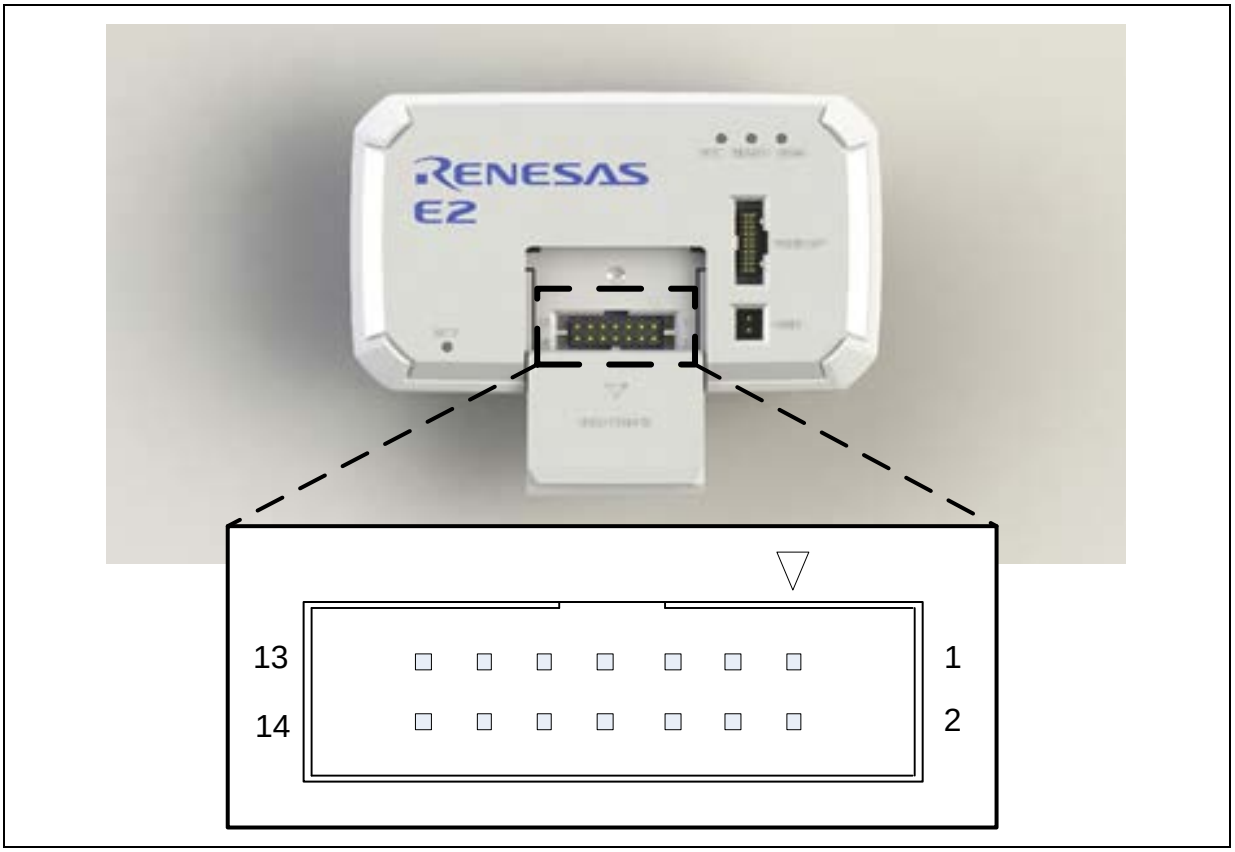


Figure 1-1 E2 Expansion Interface

Table 1-3 Assignments of the External Trigger Input and Output Pins for the E2 Expansion Interface

Pin No.	Input/Output	Description
1	—	Pin Nos. 1 to 8 are not used. These pins must be left open-circuit.
2	—	
3	—	
4	—	
5	—	
6	—	
7	—	
8	—	
9	Output	External trigger output (ch. 0)
10	Output	External trigger output (ch. 1)
11	Input	External trigger input (ch. 0)
12	Input	External trigger input (ch. 1)
13	—	GND
14	Output	A pin for output of the power-supply voltage for the E2 expansion interface (1.8 V to 5.0 V)

1.5.2 Specifications of the External Trigger Inputs and Outputs

Table 1-4 Specifications of the External Trigger Inputs and Outputs

Input signal channels	E2 expansion interface: 2 (ch. 0: pin 11, ch. 1: pin 12)
Output signal channels	E2 expansion interface: 2 (ch. 0: pin 9, ch. 1: pin 10)
Voltage of the E2 expansion interface	• When the function for supplying power to the user system is not in use: VDD voltage (any voltage from 1.8 V to 5.0 V) • When the power-supply function for the user system is in use: supply voltage (specified by the debugger)
Conditions for detecting an external trigger input	• Detecting edges (rising, falling, or both) • Detecting a level (low or high)
Operation during the input of an external trigger	• Break* • Recording the data from measuring the current consumption while the low or high level is being input
Condition for detecting an external trigger output	Detecting a break or a trigger condition for measuring the current consumption
Operation during the output of an external trigger	• When a break is detected, a low- or high-level pulse is output (the pulse width can be set to times in the range from 1 μsec to 65535 μsec). • When a trigger condition for measuring the current consumption is detected, a high-level pulse is output (the pulse width can be set to times in the range from 1 μsec to 65535 μsec). Otherwise, a high level is output while a condition is being satisfied.

Note: About 100 μs will be required from the detection of a condition for an external trigger input being satisfied until the user program is stopped.

2. Designing the User System

2.1 Connecting the E1/E20/E2/E2 Lite to the User System

To connect the E1/E20/E2/E2 Lite to the user system, 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 MCU in use.

2.2 Installing the Connector on the User System

Table 2-1 shows the recommended connectors for the E1/E20/E2/E2 Lite.

Table 2-1 Recommended Connectors

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

Note: Connection to the 38-pin connector of the E20 is not supported. To use the E20, use the 38-pin to 14-pin conversion adapter that comes with the E20 for connection to the 14-pin connector on the user system.

2.2.1 Connecting the User System Interface Cable to the 14-Pin Connector

The following figures show how to connect the user system interface cable to the 14-pin connector of each emulator.

E1/E2 Lite: Figure 2-1 (Connecting the User System Interface Cable to the 14-Pin Connector of the E1/E2 Lite Emulator)

E20: Figure 2-2 (Connecting the User System Interface Cable to the 14-Pin Connector of the E20 Emulator)

E2: Figure 2-3 (Connecting the User System Interface Cable to the 14-Pin Connector of the E2 Emulator)

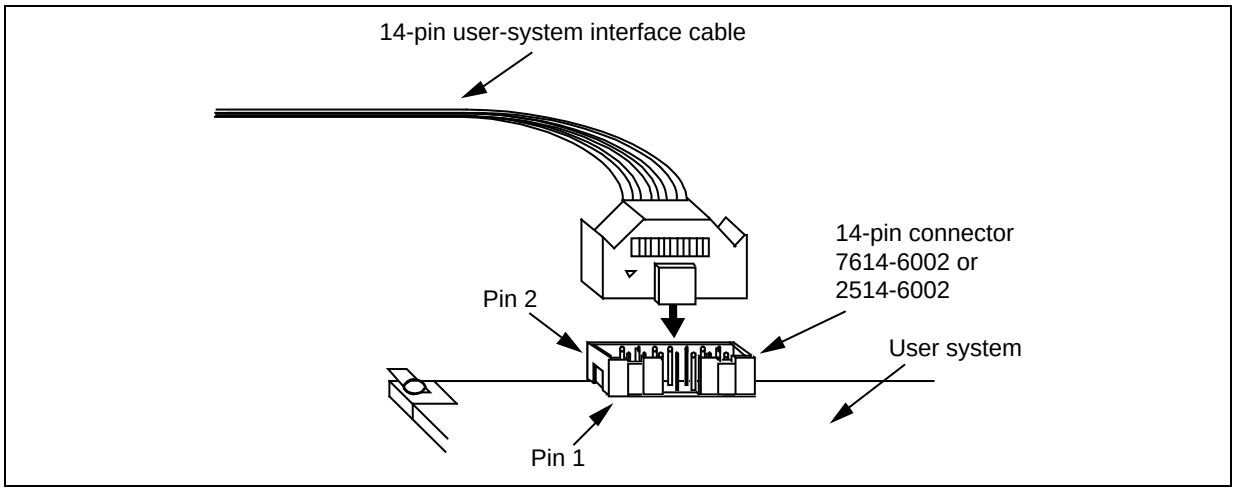


Figure 2-1 Connecting the User System Interface Cable to the 14-Pin Connector of the E1/E2 Lite Emulator

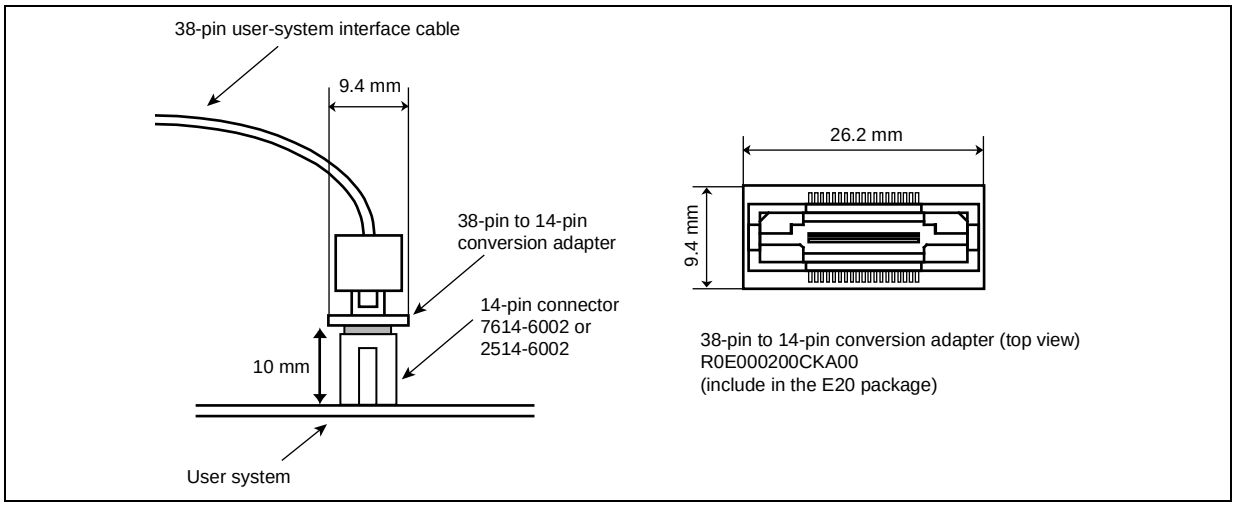


Figure 2-2 Connecting the User System Interface Cable to the 14-Pin Connector of the E20 Emulator

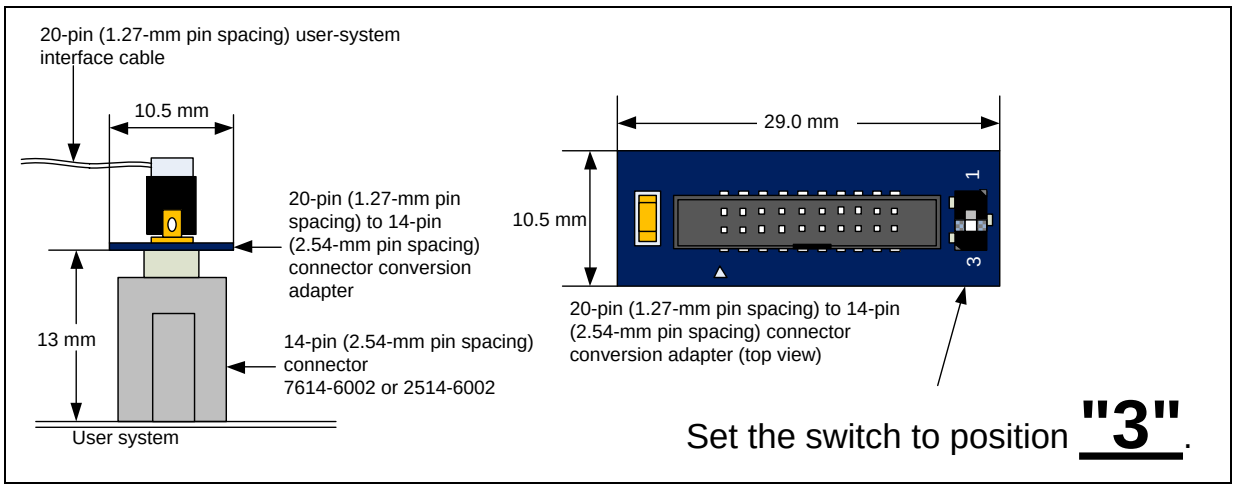


Figure 2-3 Connecting the User System Interface Cable to the 14-Pin Connector of the E2 Emulator

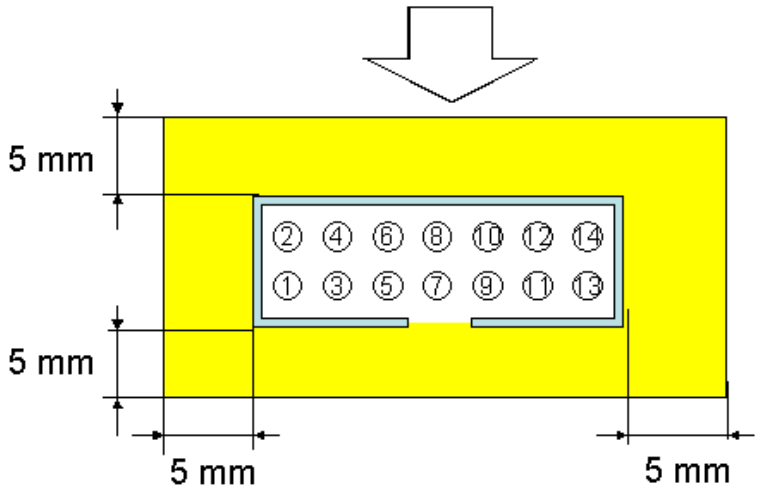
CAUTION

Limit to the height on connector periphery:

For a case where the R0E000200CKA00 is used for connecting the E20 to a 14-pin connector, do not mount other components with a height of 10 mm or more within 5 mm of the connector on the user system.

Type number: 7614-6002 (manufactured by 3M Japan Ltd.)
2514-6002 (manufactured by 3M Ltd.)

The emulator is connected from this direction.



Area with limit on mounted components
(heights must be no greater than 10 mm)

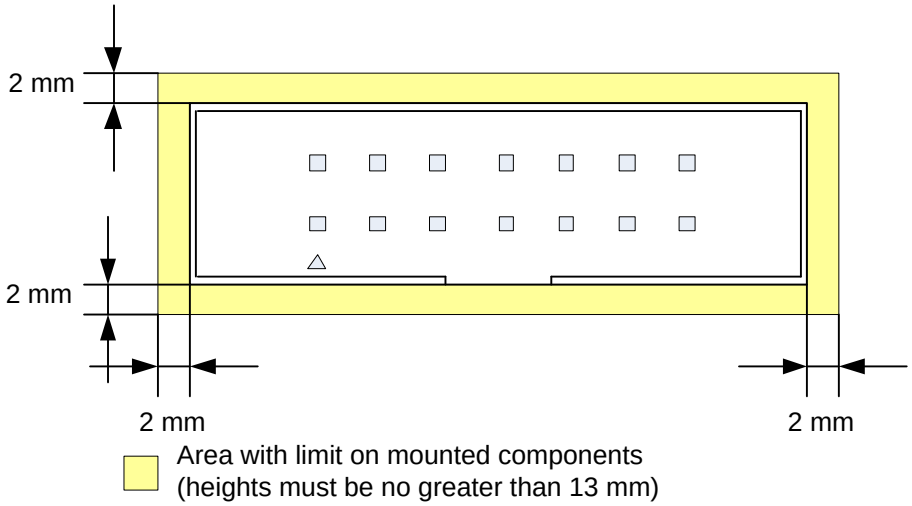
CAUTION

Limit to the height on connector periphery:

If the 20-pin (1.27-mm pin spacing) to 14-pin (2.54-mm pin spacing) connector conversion adapter is in use and the E2 is to be connected to the 14-pin connector, do not mount components with a height of 13 mm or more on the user system within a rectangle 2 mm from the edges of the connector.

Type number: 7614-6002 (manufactured by 3M Ltd.) (Japan)
: 2514-6002 (manufactured by 3M Ltd.) (other countries)

The emulator is connected from this direction.

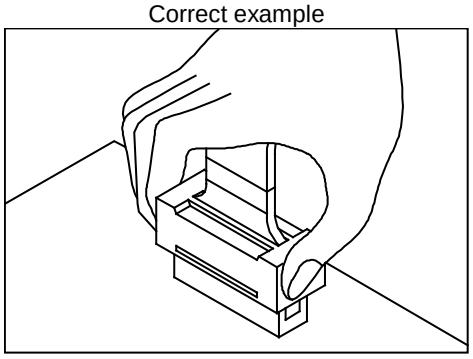


CAUTION

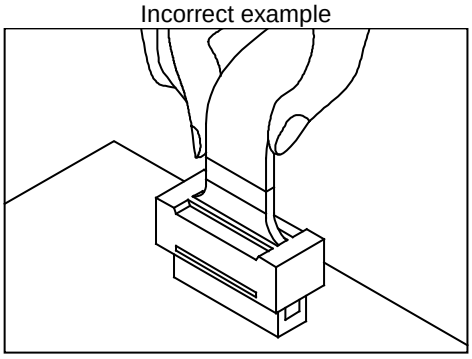
Notes on connector insertion and removal:

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 14-Pin Connector Specifications

Figure 2-4 shows the specifications of the 14-pin connector.

Table 2-2 on the following pages shows the pin assignments of the 14-pin connector.

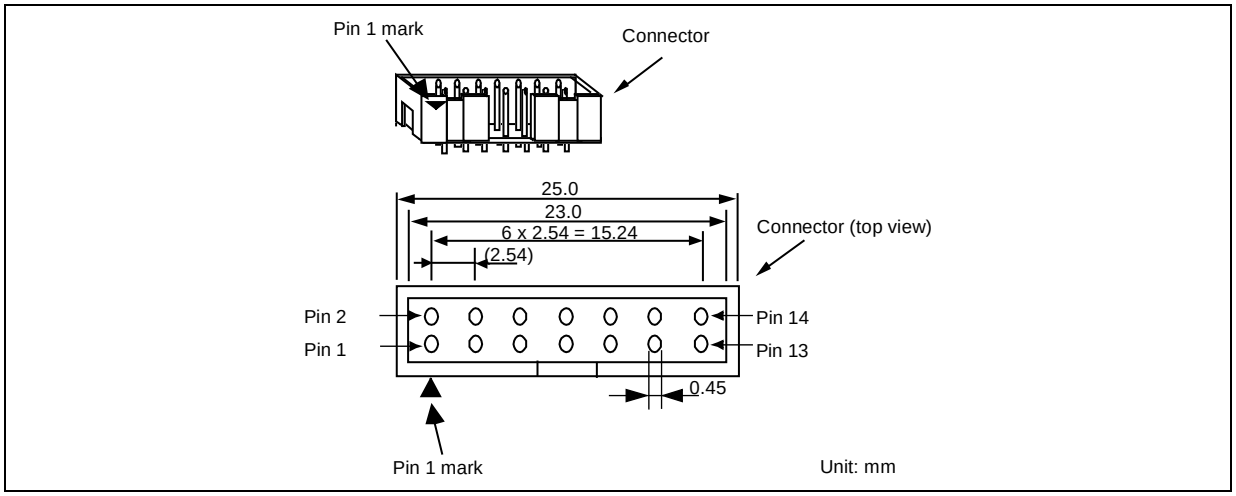


Figure 2-4 Emulator Connector Specifications (14 Pins)

Table 2-2 14-Pin Connector Pin Assignments

Pin No.	RL78/G10		Note
	Signal *1 *2	Direction *3	
1	R.F.U *6	—	
2	GND *4	—	
3	R.F.U *6	—	
4	RSTPU	Input	This pin is used to pull up the reset line.
5	TOOL0	I/O	This pin is used to transmit command/data to the target device.
6	RESET_IN	Output	This pin is used to input a reset signal from the user system.
7	R.F.U *6	—	
8	VDD	—	
9	EMVDD *7	—	
10	RESET_OUT *5	Input	This pin is used to output a reset signal to the target device.
11	R.F.U *6	—	
12	GND *4	—	
13	RESET_OUT *5	Input	This pin is used to output a reset signal to the target device.
14	GND *4	—	

*1 For details on the programming software, refer to the following.
https://www.renesas.com/RFP

*2 These are the names of the MCU pins at the time the E1/E20/E2/E2 Lite is connected (i.e. during debugging).

*3 Input to or output from the user system.

*4 Securely connect pins 2, 12, and 14 of the connector to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2/E2 Lite.

*5 Securely connect both pin 10 and pin 13.

*6 This pin is reserved. Perform the open processing.

*7 Connect VDD.

2.4 Recommended Circuits between the Connector and the MCU

This section shows recommended circuits for connection between the connector and the MCU when the E1/E20/E2/E2 Lite is in use. For processing of signals, refer to section 2.5, Notes on Connection.

2.4.1 Connection between the 14-Pin Connector and the RL78 Family MCUs

Figure 2-5 shows a recommended circuit for connection between the 14-pin connector and the RL78 family MCUs.

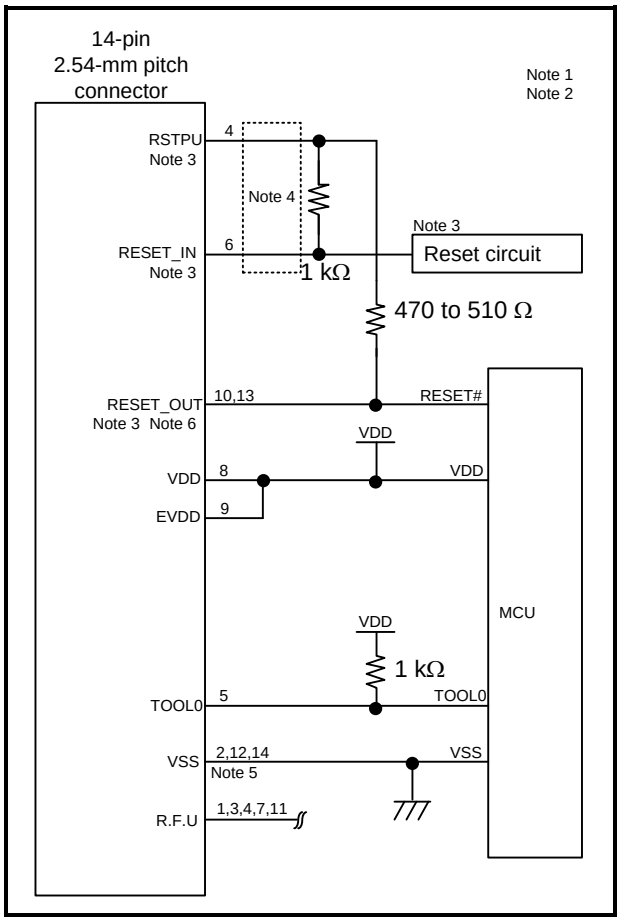


Figure 2-5 Example of Connection between the 14-Pin Connector and the RL78 Family MCUs

Notes:	1	The circuits and resistance values listed are recommended but not guaranteed. Determine the circuit design and resistance values by taking into account the specifications of the target device and noise. For flash programming for mass production, perform sufficient evaluation about whether the specifications of the target device are satisfied.
	2	For processing of pins not used by the E1/E20/E2/E2 Lite, refer to the hardware manual for the device.
	3	The recommended circuit for the RESET# pin differs depending on whether the multiplexed functions are used. For details on how to handle the RESET# pin, also refer to section 2.5, Notes on Connection.
	4	The RESET_IN pin is used only in debugging. It is not necessary in flash programming by the programming software.
	5	Securely connect pins 2, 12, and 14 of the connection to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2/E2 Lite.
	6	Securely connect both pin 10 and pin 13.

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 E1/E20/E2/E2 Lite is not in use, refer to the hardware manual for the MCU.

2.5.1 RESET# Pin

The RESET# pin is used by the E1/E20/E2/E2 Lite to monitor the pin state and issue a reset to the device.

Therefore, a reset signal on the user system is once input to the E1/E20/E2/E2 Lite where it is controlled by masking and then output to the target device. Connection examples of the RESET# pin section are shown in Table 2-3 and Figure 2-6 and Figure 2-7.

When flash programming by the programming software is to be performed, the RESET# pin should be designed so that the reset signal on the user system does not conflict with the reset signal from the E1/E20/E2/E2 Lite.

Table 2-3 Connection Examples According to the Reset Circuit on the User System

No.	Target Device	Case	Reference
1	RL78/G10	There is a reset circuit on the user system.	Figure 2-6
2		There is no reset circuit on the user system. (when using the P125/KR1 function which is multiplexed with RESET#)	Figure 2-7

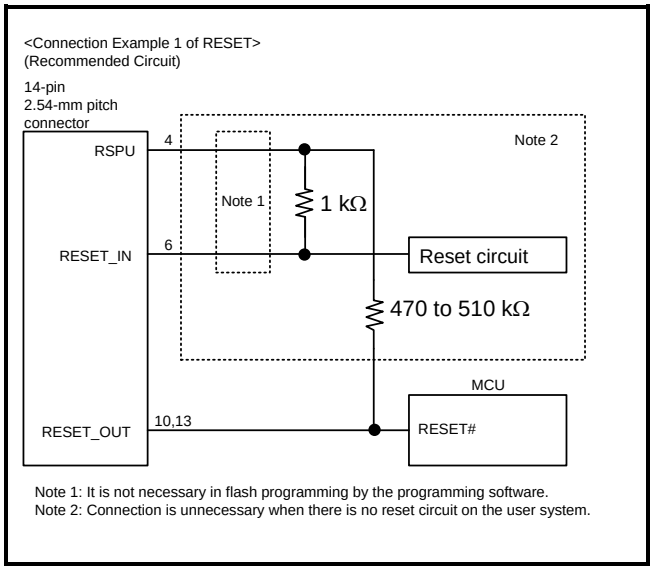


Figure 2-6 Connection Example 1 of RESET#

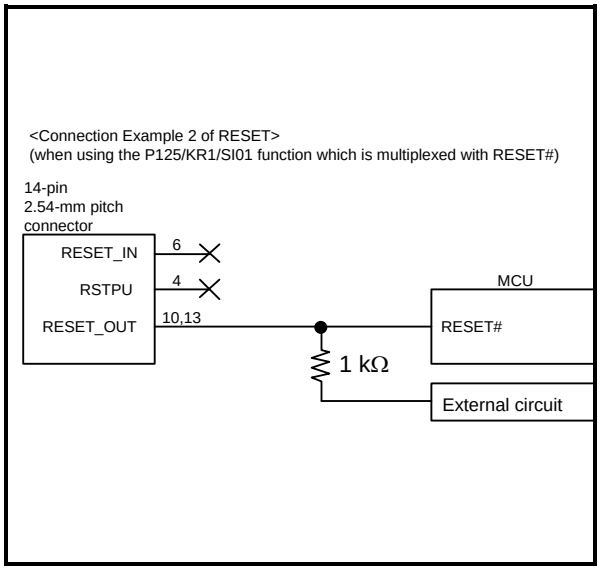


Figure 2-7 Connection Example 2 of RESET#

- Do not install capacitors, series resistors, or filters on signal lines; if attempted, correct communication may not be established.
- The circuits and resistance values listed are recommended but not guaranteed. Determine the circuit design and resistance values by taking into account the specifications of the target device and noise.
- Securely connect pins 2, 12, and 14 to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2/E2 Lite. Securely connect both pin 10 and pin 13.

2.5.2 TOOL0 Pin

The E1/E20/E2/E2 Lite uses the TOOL0 pin. Any functions that are multiplexed on this pin are not available.

Pull up the signals of the TOOL0 pin at 1 kΩ and do not arrange these signal lines in parallel with or across other high-speed signal lines.

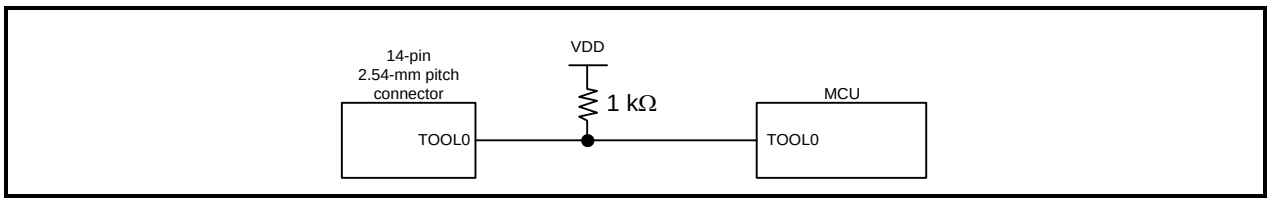


Figure 2-8 Connection Example of the TOOL0 Pin

Do not use adjacent resistors for pull-up of the TCK pin because they may affect or may be affected from other pins.
Do not install capacitors, series resistors, or filters on signal lines; if attempted, correct communication may not be established.

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 VDD

Connect the VDD of the connector to the VDD (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 E1/E20/E2/E2 Lite consumes the power supply for the last output and first input buffers of the emulator.

E1:	3.3 V: approximately 20 mA,	5.0 V: approximately 40 mA
E20:	3.3 V: approximately 40 mA,	5.0 V: approximately 100 mA
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 E1/E2/E2 Lite can supply power to a simple evaluation system.

E1: Can supply power of 3.3 V or 5.0 V, up to 200 mA.

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 E1/E2/E2 Lite, check the voltage supplied to the user system. Particularly when the 5.0-V supply option is selected, the voltage depends on the USB VBUS power-supply voltage.

E1: The voltage may drop by 0.5 V or more below 5.0 V.

E2: The voltage may drop by 0.3 V or more below 5.0 V.

The on-chip debugging circuit in the device operates during on-chip debugging. Therefore current consumption of the device increases. When correctly evaluating current consumption of the device, do not connect the E1/E20/E2/E2 Lite.

Power supply from the E1/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 E1/E2/E2 Lite. Use a stable, separate power supply for the user system. When writing a program for mass production processes, use the Renesas Flash Programmer.

For details on the programming software, refer to:

https://www.renesas.com/RFP

⚠ WARNING

Warning for Turning the Power On/Off:

When supplying power, ensure that there are no shorts between VDD and GND. Only connect the E1/E20/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 E1/E20/E2/E2 Lite, and the user system emitting smoke or catching fire.

2.6 Internal Circuits of the Emulator

2.6.1 Internal Circuits of the E1 (when the RL78 Family is Connected)

Figure 2-9 shows the internal circuits of the E1 with the RL78 family connected.

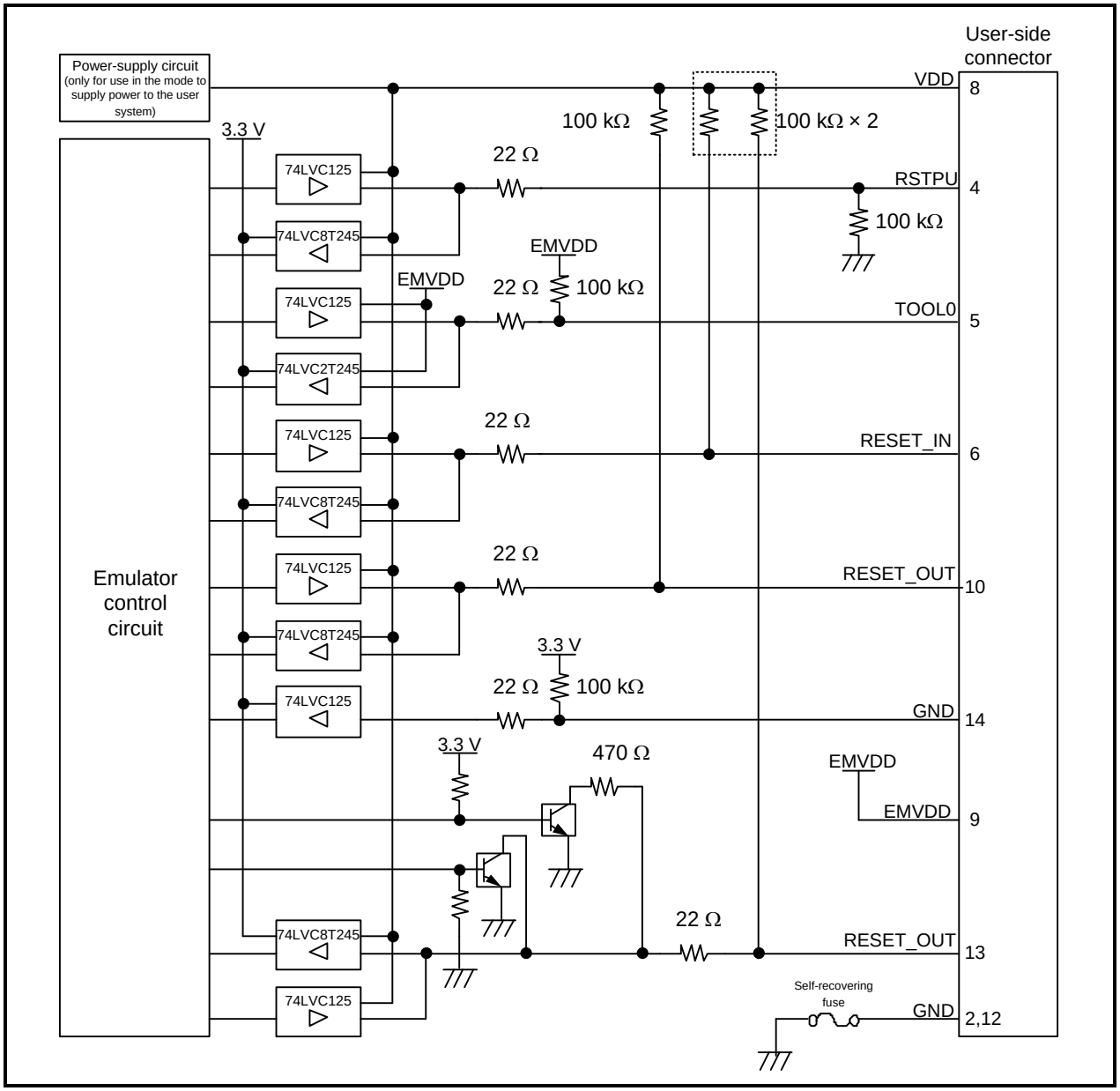


Figure 2-9 Internal Circuit of the E1 (when the RL78 Family is Connected)

2.6.2 Internal Circuits of the E20 (when the RL78 Family is Connected)

Figure 2-10 shows the internal circuits of the E20 with the RL78 family connected.

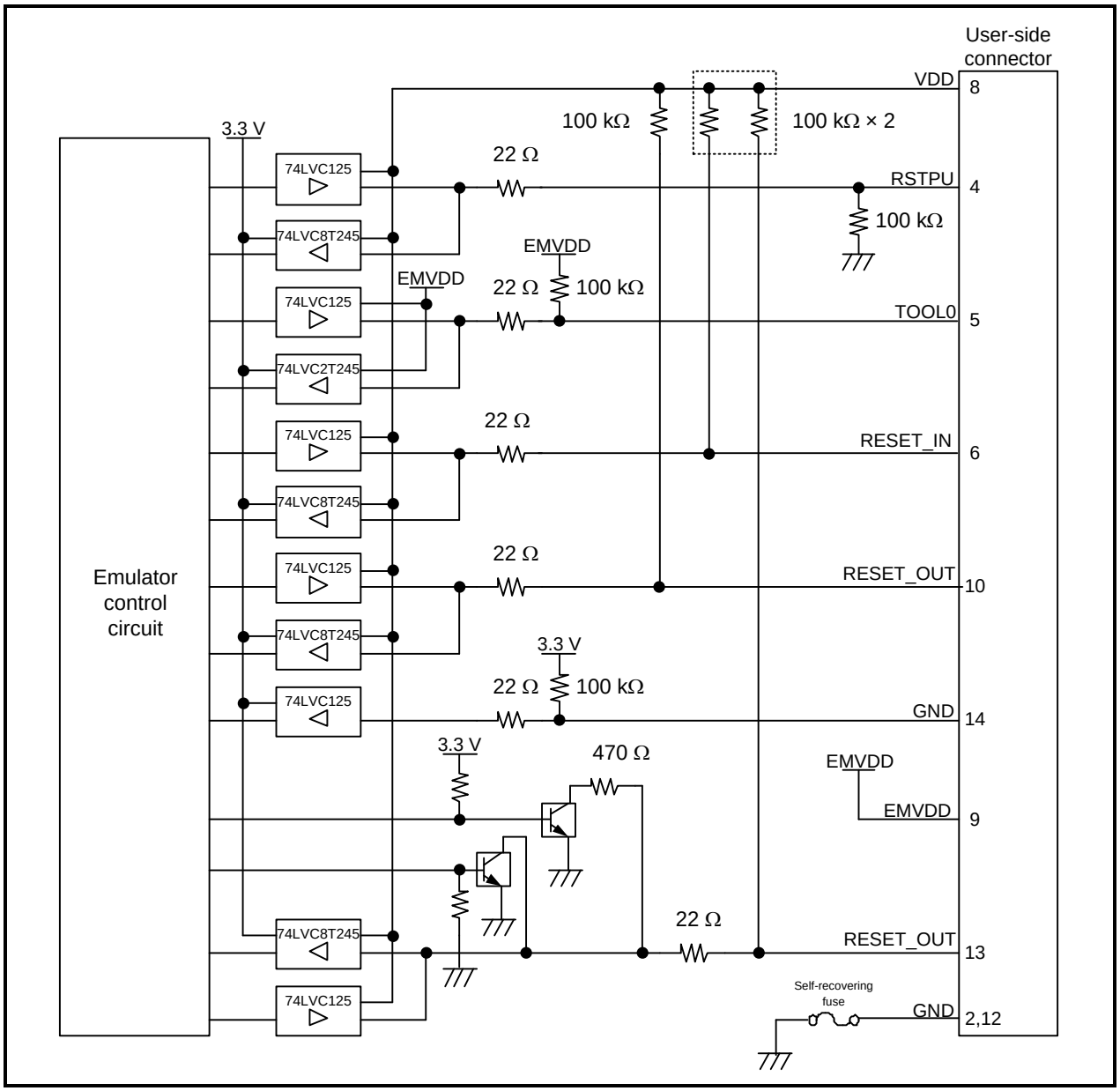


Figure 2-10 Internal Circuits of the E20 (RL78 Family)

2.6.3 Internal Circuits of the E2 (when the RL78 Family is Connected)

Figure 2-11 shows the internal circuits of the E2 with the RL78 family connected.

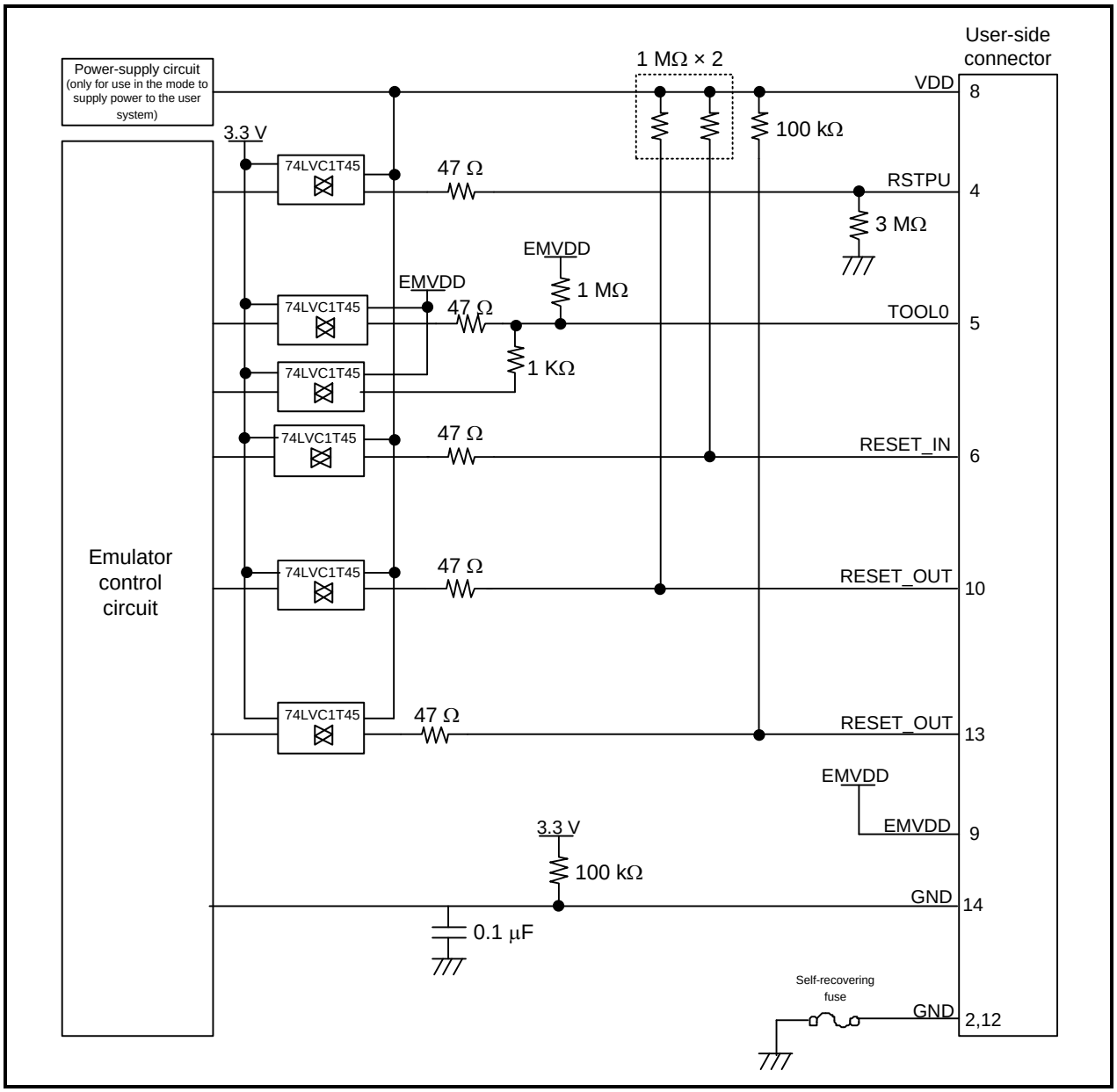


Figure 2-11 Internal Circuits of the E2 (RL78 Family)

Set the switch on the 20-pin (1.27-mm pin spacing) to 14-pin (2.54-mm pin spacing) connector conversion adapter to position “3”.

2.6.4 Internal Circuits of the E2 Lite (when the RL78 Family is Connected)

Figure 2-12 shows the internal circuits of the E2 Lite with the RL78 family connected.

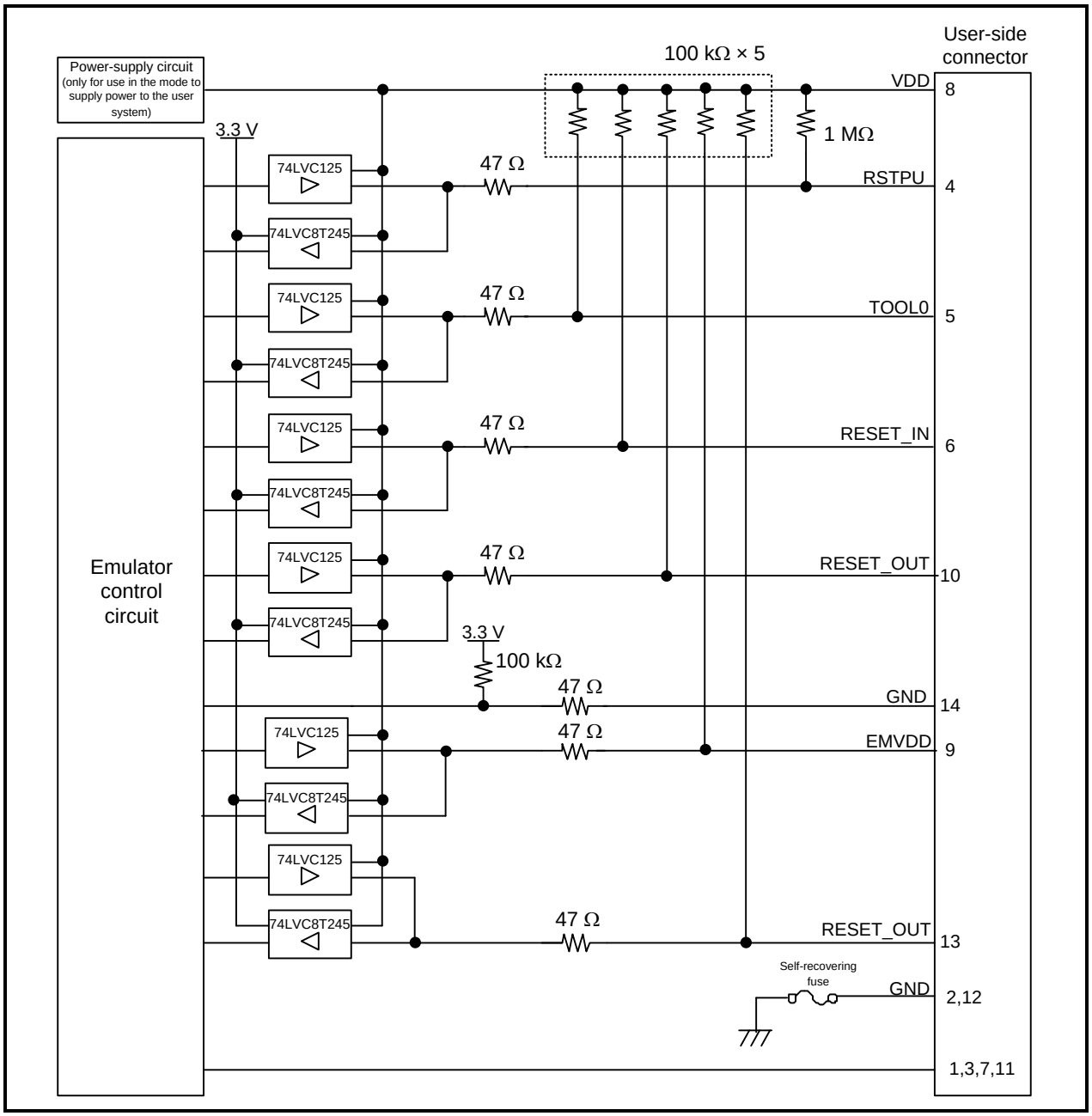


Figure 2-12 Internal Circuits of the E2 Lite (when the RL78 Family is Connected)

2.7 Notes on Designing the User System

2.7.1 Isolator for the E1

For a debugging environment where there is a difference in potential between the GND of the user system and that of the host PC, use the isolator for the E1 emulator (R0E000010ACB20) which is separately available from Renesas.

That is, use the isolator for the E1 (R0E000010ACB20) with the E2/E2 Lite in such situations.

2.7.2 Low-Voltage OCD Board

Since the RL78-S1 core device needs 4.5 V to 5.5 V as the voltage for rewriting flash memory, if the voltage is less than 4.5 V, the debugging functions that require flash memory to be rewritten (e.g., program download) cannot be operated. When debugging with a voltage less than 4.5 V, the low-voltage OCD board (R0E510Y47LVB00 or R0E510Y16LVB00) which is sold separately must be prepared. For details on the low-voltage OCD board, refer to the user's manual.

When the low-voltage OCD board is in use, none of the extended functions supported by the E2 emulator are available.

2.7.3 Small Connector Conversion Adapter for the E1

A small connector conversion adapter for the E1 (R0E000010CKZ11) is separately available from Renesas for user system boards which are too small to mount the 14-pin connector that is the standard connector for the E1 and E2 Lite. By using the adapter, you can reduce the area taken up by the connector mounted on your system.

However, when you use the small connector conversion adapter for the E1, be aware that the pin assignments of the connector differ from those of the standard interface connector for the E1 and E2 Lite. The pin assignments on the 14-pin connector when the small connector conversion adapter for the E1 is used are shown in Table 2-4.

The small connector conversion adapter for the E1 can also be used with the E2 Lite.

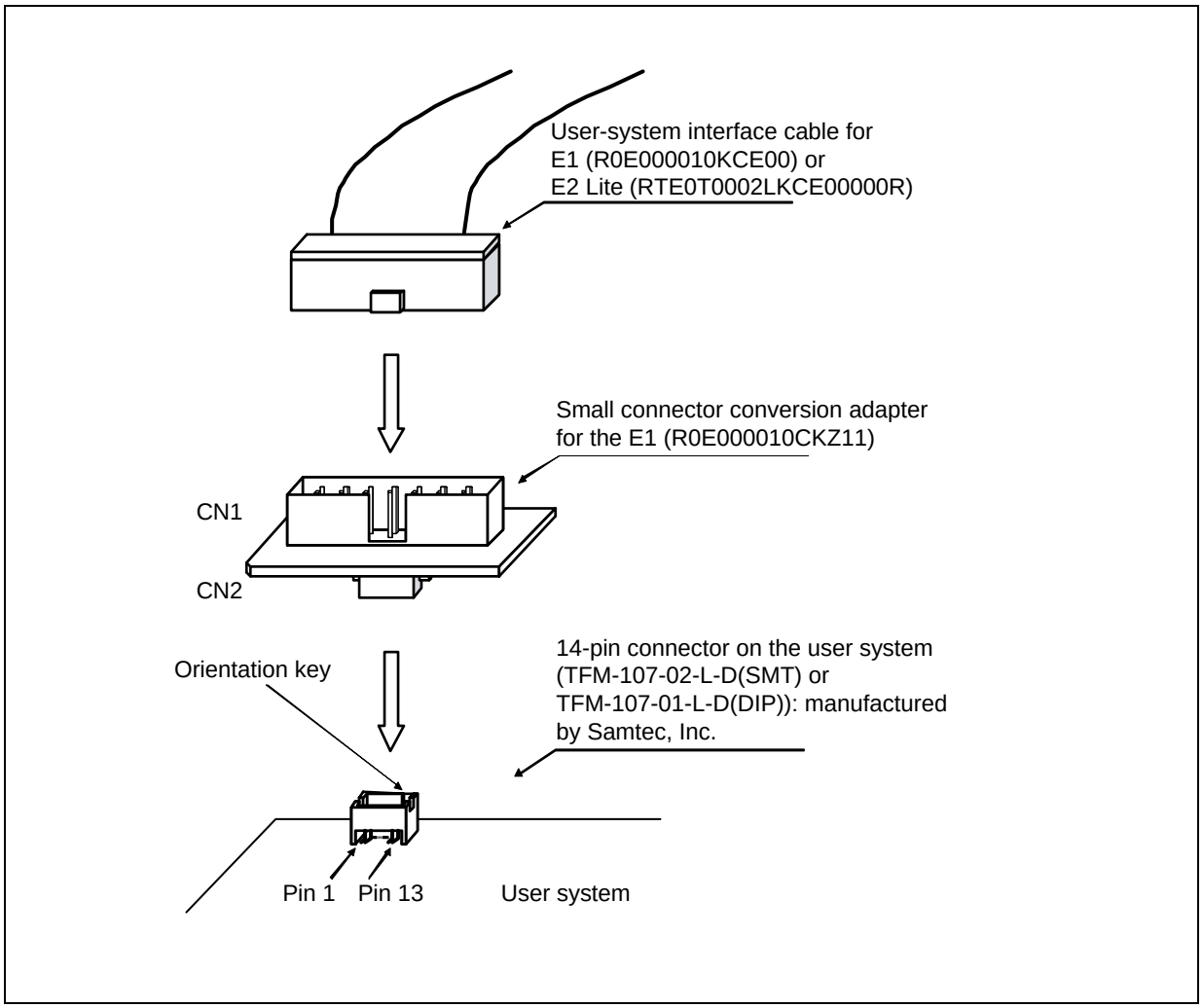


Figure 2-13 Usage of the Small Connector Conversion Adapter for the E1

Table 2-4 Connector Pin Assignments when the Small Connector Conversion Adapter for the E1 is Used

Pin No.	RL78/G10		Note
	Signal *1 *2	Direction *3	
1	GND *4	—	
2	R.F.U *6	—	
3	VDD	—	
4	R.F.U *6	—	
5	RESET_OUT *5	Input	This pin is used to output a reset signal to the target device.
6	GND *4	—	
7	RESET_OUT *5	Input	This pin is used to output a reset signal to the target device.
8	R.F.U *6	—	
9	R.F.U *6	—	
10	TOOL0	I/O	This pin is used to transmit command/data to the target device.
11	RSTPU	Input	This pin is used to pull up the reset line.
12	RESET_IN	Output	This pin is used to input a reset signal from the user system.
13	EMVDD *7	—	
14	GND *4	—	

*1 For details on the programming software, refer to the following.
https://www.renesas.com/RFP

*2 These are the names of the MCU pins at the time the E1/E20/E2 Lite is connected (i.e. during debugging).

*3 Input to or output from the user system.

*4 Securely connect pins 1, 6, and 14 of the connector to GND of the user system. These pins are used for electrical grounding as well as for monitoring of connection with the user system by the E1/E20/E2 Lite.

*5 Securely connect both pin 5 and pin 7.

*6 This pin is reserved. Perform the open processing.

*7 Connect VDD.

3. Notes on Usage

3.1 Turning the Power On/Off

Turn the power of the E1/E20/E2/E2 Lite 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.

Check that the user system is turned off. When using the E20, check its power switch is off.

(2) Connect the user system.

Connect the emulator and the user system with a user-system interface cable.

When the external trigger input/output function is to be used with the E2, connect the pins to be used.

(3) Connect the host machine and turn on the emulator.

Connect the emulator and the host machine with a USB interface cable. The E1/E2/E2 Lite is turned on by connecting the USB interface cable. When using the E20, turn on its power switch.

(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) Launch the emulator debugger or connect the programming software to the emulator.

Connections may vary depending on software.

<When finished using the emulator>

(1) Close the emulator debugger or disconnect the emulator from the 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 the programming software.

Close the emulator debugger or the programming software.

(4) Turn off the emulator and disconnect the emulator.

When using the E20, turn off its power switch. Disconnect the USB interface cable from the E1/E2/E2 Lite. The E1/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.

When the external trigger input/output function is to be used with the E2, disconnect the pins that were in use.

CAUTION

Notes on the User System Power Supply:

While the power of the user system is on, do not turn off the host machine, unplug the USB interface cable, or turn off the power switch of the E20.
The user system may be damaged due to leakages current.

3.1.2 When Power is Supplied to the User System from the Emulator (E1/E2/E2 Lite Only)

<When using the emulator>

(1) Connect the user system.

Connect the emulator and the user system with a user-system interface cable.

When the external trigger input/output function is to be used with the E2, connect the pins to be used.

(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 or programming software.

Launch the emulator debugger or programming software and select the setting of power supply to the user system.

(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 debugger or programming software from the emulator.

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.

When the external trigger input/output function is to be used with the E2, disconnect the pins that were in use.

3.2 Power Supply Function of the E1/E2/E2 Lite

When using the power supply function of the E1/E2/E2 Lite, check the voltage supplied to the user system. Particularly when the 5.0-V supply option is selected, the voltage depends on the USB VBUS power-supply voltage.

E1: The voltage may drop by 0.5 V or more below 5.0 V.

E2: The voltage may drop by 0.3 V or more below 5.0 V.

Note that the E2 Lite supports power supply of 3.3 V only.

For the E2, 1.8 V to 5.0 V can be specified as the supply voltage and 0 V can also be specified during execution of the user program. However, when an extended function is specified, do not set the voltage to 0 V during execution of the user program.

When the supply voltage is set to 0 V by the E2 during execution of the user program, continued debugging may not be possible if the voltage on the TOOL0 pin is unstable during the voltage drop. Also refer to the notes in section 2.5.2, TOOL0 Pin.

3.3 MCU Resources to be Occupied

Figure 3-1 shows the areas which are occupied by the E1/E20/E2/E2 Lite for debugging.

These areas (shaded sections) are used for debugging. These areas should not be changed to save the user program or data. If a change is made, control by the E1/E20/E2/E2 Lite is no longer possible.

However, when "No" is selected in the [Permit flash programming] property of the debugger, the internal ROM spaces shown in Figure 3-1 are not used (only the internal RAM spaces are used).

When selecting not to permit flash memory rewriting with the debugger's property, also refer to section 3.3.3, Setting an On-Chip Debugging Option Byte.

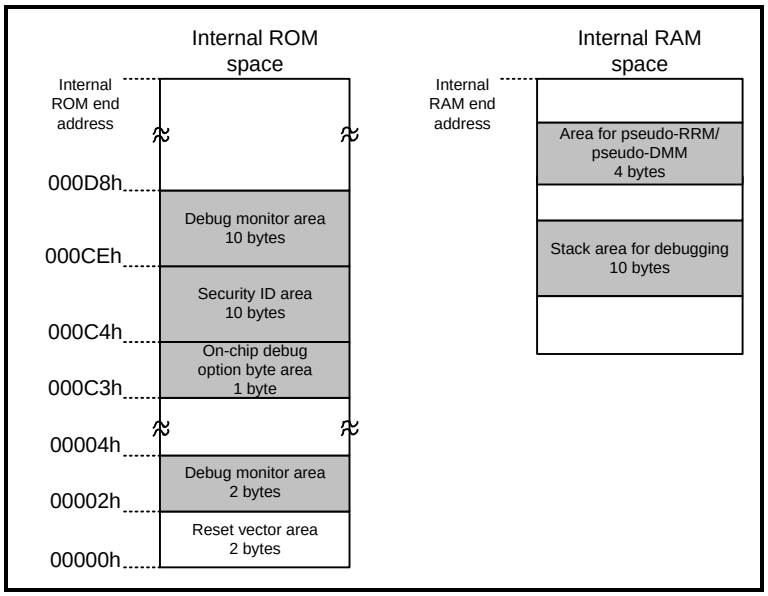


Figure 3-1 MCU Resources to be Occupied

*1	The reset vector area is used by the program for the E1/E20/E2/E2 Lite when performing debugging with the E1/E20/E2/E2 Lite. If the contents of the reset vector area are changed, control by the E1/E20/E2/E2 Lite is no longer possible.

3.3.1 Securing an Area for the Debugging Monitor Program

You may need to secure the area to which the debugging monitor program is to be allocated. The monitor program initializes the debugger communications interface and handles processing to make the CPU run or break execution.

The user program or data must not be placed within 23 bytes of the on-chip debugging option byte.

In addition, the reset vector must be changed if it points to an address to which the monitor program is allocated.

The working RAM for the pseudo-RRM/pseudo-DMM starts at addresses 0x02 and 0x03.

The internal ROM spaces, including the debug monitoring area, are erased when the debugger is closed.

[Securing the area]

Specifically securing the area for the monitor program is not necessarily required if the user program does not use the area.
However, to avoid problems that may occur while the debugger is starting up, we recommend securing this area in advance by using a build tool or some other means.

3.3.2 Securing a Stack Area for Debugging

The debugger requires 10 bytes as a stack area for debugging. Since this area is allocated immediately after the stack area, the address of this area varies depending on the stack increase and decrease. That is, 10 extra bytes are consumed for the stack area used.

Make sure the stack area for debugging does not exceed the range of the internal RAM space.

Figure 3-2 shows an example in which the stack area has increased with the start address of the internal RAM space being 0xFFE60.

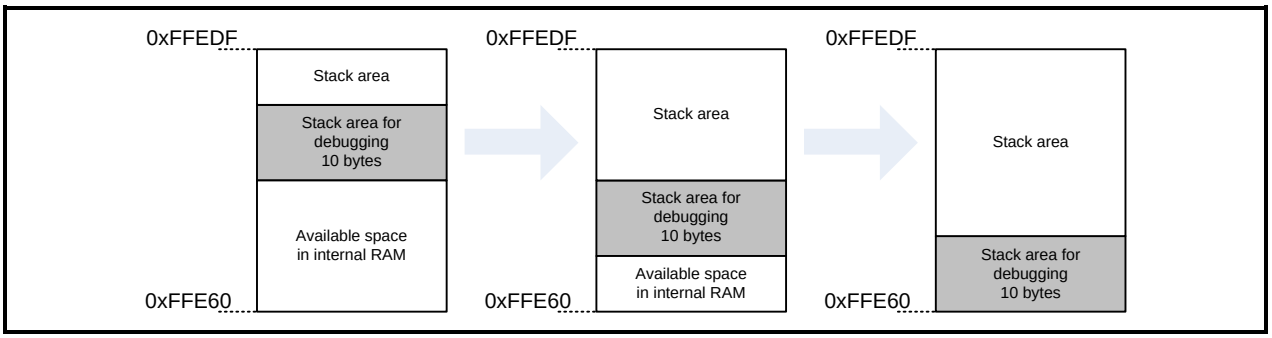


Figure 3-2 Variation of Address of Stack Area for Debugging

3.3.3 Setting an On-Chip Debugging Option Byte

This is the area for the security setting to prevent the flash memory from being read by an unauthorized person.

For settable values, refer to the user's manual for each MCU.

[Setting an on-chip debugging option byte]*1

Set the on-chip debugging option byte in either of the following ways.

(a) Embed the on-chip debugging option byte at address 0xC3 in the user program.

(b) Set the on-chip debugging option byte by the build tool.

For details on the setting method, refer to the user's manual for the build tool.

*1 If the value of the on-chip debugging option byte set in the device disables on-chip debugging (OCDENSET = 0), the debugger cannot be started when "No" is selected in the [Permit flash programming] property of the debugger. If a setting to enable flash programming is made, though the debugger can be started, the flash memory will be in an erased state when the debugger is started.

3.3.4 Setting a 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 the hardware manual for each MCU).

If the user has forgotten the security ID to enable debugging, erase the flash memory and set the security ID again.

Set the security ID in either of the following ways. When both methods (a) and (b) are carried out at the same time, method (b) has priority.

(a) Embed the 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).*1, *2

(b) Set the security ID by common options of the build tool.

For details on the setting method, refer to the user's manual for the build tool.

Table 3-1 Example of Security ID Setting

Address	Value
0x000C4	0x01
0x000C5	0x23
0x000C6	0x45
0x000C7	0x67
0x000C8	0x89
0x000C9	0xAB
0x000CA	0xCD
0x000CB	0xEF
0x000CC	0x12
0x000CD	0x34

Notes: 1 When connecting a debugger to a device for which the security ID has been set, the security ID needs to be entered in the debugger. For details on the authentication method, refer to the user's manual for the debugger in use.

2 The setting "0xFFFFFFFFFFFFFFFFFFFF", in which the value at all addresses is "0xFF", is prohibited.

3.3.5 Area for Pseudo-RRM/Pseudo-DMM

To use the pseudo-RRM/pseudo-DMM function in the RL78-S1 core device, a part (4 bytes) of the RAM area is used for the pseudo-RRM/pseudo-DMM function. Information, such as whether this area can be allocated by the build tool, can be confirmed in the user's manual for the build tool.

3.4 Reset

3.4.1 Operation after a 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 Permit flash programming in property of the debug tool, the time until the user program is executed compared with the time when “Yes” is selected is delayed (max. 100 ms).

3.4.2 SP Value after a Reset

While debugging with the E1/E20/E2/E2 Lite, the SP value after a reset becomes FED0h.

3.5 Flash Memory

3.5.1 Operation for Voltages Not Permitting Flash Memory Rewriting

When a voltage with which rewriting or erasure of flash memory cannot be performed has been selected or flash programming has been disabled with the debugger's property, the debugger operations that rewrite flash memory will cause an error in the debugger and the operations will be invalidated.

3.5.2 Notes on Flash Memory Rewriting

In the RL78-S1 core device, a pin reset is always necessary for rewriting of flash memory. For this reason, a pin reset always occurs at debugger operations (download, rewriting of flash memory from a memory window, etc.) that accompany rewriting of flash memory.

Since a part of the RAM area (0FFEC6h to 0FFECFh) is used by the E1/E20/E2/E2 Lite at rewriting of flash memory, the RAM data will be rewritten.

3.6 RESET# Multiplexed Pin

The RESET# pin has multiplexed pin functions. Therefore, if the following conditions are all satisfied, control by the E1/E20/E2/E2 Lite is no longer possible.

- The reset/port multiplexed pin is used as a port (PORTSELB = 0) due to the option byte setting (C1h).
- The option byte setting (C1h) has been rewritten during a break.
- "Yes" is selected in the [Mask INTERNAL RESET signal] property of the debugger.

3.7 MCUs that are Used in Debugging

3.7.1 Usage in Mass-Production

MCUs that are connected to the E1/E20/E2/E2 Lite 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.

Also, as the E1/E20/E2/E2 Lite 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.

3.7.2 Standalone Operation

After downloading a load module file to the device to for on-chip debugging, do not check the operation of this device without E1/E20/E2/E2 Lite.

A device after debugging contains the specific program for on-chip debugging, so it is different from actual operation.

3.8 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 Renesas Flash Programmer programming software or a flash programmer, without the emulator connected.

3.9 Debug Functions

3.9.1 Step Execution

(1) Cautions on using step-in (step execution)

The value of some SFRs (special function registers) might remain unchanged while stepping into code. If the values of the SFRs do not change while stepping into code, operate the microcontroller by continuously executing the instructions instead of executing them in steps.

Stepping into code: Instructions in the user-created program are executed one by one.

Continuous execution: The user-created program is executed from the current PC value.

3.9.2 [Go to Here]

If [Go to Here] is selected, event breakpoints that have been set so far will be temporarily invalidated.

3.9.3 Debugging in Standby Mode

The break is an interrupt function of the CPU. Standby mode is released by the break generated by using the following debugging functions.

<1> Forced break

<2> Step execution of the standby instruction (Stops the user program after execution instruction)

<3> Short break generated by the pseudo-RRM function (Break When Readout)

<4> Short break generated by the pseudo-DMM function (Break When Write)

<5> Short break generated by setting a breakpoint while executing the user program

3.9.4 Pseudo-Real-Time RAM Monitor Function or Pseudo-Dynamic Memory Modification Function

Note the following points when using the pseudo-real-time RAM monitor (RRM) function or the pseudo-Dynamic Memory Modification (DMM) function.

- Standby mode (HALT or STOP) may be cancelled during monitoring.
- The pseudo-RRM function or the pseudo-DMM function does not operate while the CPU operating clock is stopped.
- When the number of monitoring points is numerous, the response of the debugger becomes slow.
- Influence of the debugger response becomes small by using a watch panel instead of a memory panel.
- Four bytes of the RAM area are used when the pseudo-RRM and pseudo-DMM functions are used. The RAM area to be used when using the pseudo-RRM and pseudo-DMM functions should be set by the build tool.
(For details on setting the area, refer to the user's manual for the build tool.)
If no area is set, the four bytes at the beginning of the RAM area will be used.

3.9.5 Software Break Functions

The RL78-S1 core device does not have the software break function. The hardware break function can be used alternatively but a break will occur several instructions after the breakpoint because the hardware break function generates a break after execution of the instruction at the breakpoint. Note that if a branch occurs between the breakpoint and the point where program execution stops, the break appears to have not occurred at the breakpoint in some cases.

3.9.6 Extended Functions of the E2

3.9.6.1 Solution for the Tuning of Current Consumption

For notes on the solution for the tuning of current consumption, refer to the application note.

3.9.6.2 External Trigger Input and Output

- Use the value of the high-level voltage which can be input to the external trigger input in accordance with the value that has been set for the power-supply voltage of the E2 expansion interface.

- The value of the high-level voltage which is output on the external trigger outputs depends on the value that has been set for the power-supply voltage of the E2 expansion interface.

- When a break is detected and a low or high pulse is output with the external trigger output function, output of the pulse lags behind stopping of the program by a time between over a hundred microseconds and hundreds of milliseconds.
The time lag is up to 80 ms when the operating frequency is 1.25 MHz.

Revision History

Rev.	Date	Description	
		Page	Summary
3.00	Jul 1, 2017	All	Information on the E2 emulator was added.
		37	Notes on using the RESET# multiplexed pin were added to section 3.6.
		38	A note on standalone operation of the device was added to section 3.7.2.

E1/E20/E2 Emulator, E2 Emulator Lite

Additional Document for User's Manual

(Notes on Connection of RL78)

Publication Date: Jul 1, 2017 Rev.3.00

Published by: Renesas Electronics Corporation

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, P. R. China 200333
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL II Stage, Indiranagar, Bangalore, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
12F., 234 Teheran-ro, Gangnam-Gu, Seoul, 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

© 2017 Renesas Electronics Corporation. All rights reserved.

Colophon 4.1

E1/E20/E2 Emulator, E2 Emulator Lite
Additional Document for User's Manual
(Notes on Connection of RL78)

Renesas Electronics Corporation

R20UT2937EJ0300