

RL78/G23-128p Fast Prototyping Board

16

User's Manual

16-Bit Single-Chip Microcontrollers
RL78 Family

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General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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This Fast Prototyping Board is only intended for use in a laboratory environment under ambient temperature and humidity conditions. A safe separation distance should be used between this and any sensitive equipment. Its use outside the laboratory, classroom, study area, or similar such area invalidates conformity with the protection requirements of the Electromagnetic Compatibility Directive and could lead to prosecution.

The product generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment causes harmful interference to radio or television reception, which can be determined by turning the equipment off or on, you are encouraged to try to correct the interference by one or more of the following measures:

- Ensure attached cables do not lie across the equipment.
- Reorient the receiving antenna.
- Increase the distance between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Power down the equipment when not in use.
- Consult the dealer or an experienced radio/TV technician for help.

Note: It is recommended that wherever possible shielded interface cables are used.

The product is potentially susceptible to certain EMC phenomena. To mitigate against them it is recommended that the following measures be undertaken:

- The user is advised that mobile phones should not be used within 10 m of the product when in use.
- The user is advised to take ESD precautions when handling the equipment.

The Evaluation Kit does not represent an ideal reference design for an end product and does not fulfil the regulatory standards for an end product.

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How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the basic specifications and correct usage of this product.

The target users are those who will be using it in evaluating MCUs and debugging programs.

The target readers of this manual require basic knowledge regarding the facilities of MCUs and debuggers.

Particular attention should be paid to the precautionary notes when using the manual. These notes occur within the body of the text, at the end of each section, and in the Usage Notes section.

The revision history summarizes the locations of revisions and additions. It does not list all revisions. Refer to the text of the manual for details.

The following documents apply to the RL78/G23-128p Fast Prototyping Board. Be sure to refer to the latest versions of these documents.

Document Type	Description	Document Title	Document No.
User's manual	Hardware specifications	RL78/G23-128p Fast Prototyping Board User's Manual	R20UT4870EJ (this manual)
Circuit schematics	Circuit schematics	RL78/G23-128p Fast Prototyping Board Circuit Schematics	R20UT4993EJ
Parts list	Parts list	RL78/G23-128p Fast Prototyping Board BOM LIST	R12TU0139EJ
User's manual for the hardware*	Hardware specifications (pin assignments, memory maps, peripheral function specifications, electrical characteristics, timing charts) and descriptions of operation	RL78/G23 User's Manual: Hardware	R01UH0896EJ
Application note	Usage of the RL78 debugging functions using the serial port	RL78 Debugging Functions Using the Serial Port	R20AN0632EJ

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
Arduino™ MEGA	Connectors compatible with the Arduino™ MEGA board are mounted on the fast prototyping board.
CPU	Central Processing Unit
DIP	Dual In-line Package
DNF	Do Not Fit
Grove	A connector that is compatible with Grove modules can be mounted on the fast prototyping board.
IDE	Integrated Development Environment
IRQ	Interrupt Request
HOCO	High-Speed On-Chip Oscillator
LOCO	Low-Speed On-Chip Oscillator
LED	Light Emitting Diode
MCU	Micro-controller Unit
n/a (NA)	Not applicable
n/c (NC)	Not connected
PC	Personal Computer
RAM	Random Access Memory
RFP	Renesas Flash Programmer
ROM	Read Only Memory
SPI	Serial Peripheral Interface
TPU	Timer Pulse Unit
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
WDT	Watchdog timer

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1. Overview

This user's manual describes the RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ) (hereinafter referred to as "this product").

1.1 Purpose

This product is an evaluation tool for a Renesas MCU. This user's manual describes the hardware specifications, ways of setting switches, and the basic setup procedure.

1.2 Features

This product can handle the following tasks.

- Programming of the Renesas MCU
- Debugging of user code
- User circuits for switches and LEDs
- Capacitive touch buttons (two buttons connectable)
- Pmod™ connector*
- Arduino™ connector*
- Grove connector*

Note: We do not guarantee connection to all types of these connectors. For details on the connector specifications, refer to the descriptions in this document.

1.3 Preparation

- Watch the video on "Getting Started with Fast Prototyping Board for RL78 Family".
<https://www.renesas.com/video/getting-started-fast-prototyping-board-rl78-family>
- Install the integrated development environment (IDE) and required software on the host PC.
<https://www.renesas.com/development-tools>
- Prepare a micro-USB cable for data transfer.
- Refer to the following Web page and prepare the E2 emulator if required.
<https://www.renesas.com/e2>
- Refer to the following Web page and prepare the E2 emulator Lite if required.
<https://www.renesas.com/e2lite>

1.3.1 Installing the e² studio IDE

For details on the procedure for installation, watch the video on “e² studio Quick Start Guide Video for RL78 Family - Installation”.

<https://www.renesas.com/software-tool/rl78-software-tool-course>

1. Download the installer for the latest version of the e² studio from the following Web page.
<https://www.renesas.com/software-tool/e-studio>
2. Unzip the downloaded zip file and run the installer file.
3. Select “RL78” for [Device Families].
4. Confirm that the latest version of Renesas CCRL has been selected as the compiler.
5. Select the [I accept the terms of the Software Agreements] checkbox and then click on the [Install] button.
6. When the software produces an installer window in the middle of installation, proceed with installation according to the instructions from the wizard.
7. After installation has finished, click on the [OK] button.

1.3.2 Installing the CS+ IDE

1. Download the installer for the latest version of CS+ for CC from the following Web page.
<https://www.renesas.com/software-tool/cs>
2. Unzip the downloaded zip file and run the installer file.
3. Click on [Begin CS+ Startup].
4. Confirm that [Tools for RL78 family] has been selected.
5. After installation has finished, click on the [OK] button.

1.4 Board Specification Table

Table 1-1 shows the board specifications.

Table 1-1 Board Specification Table

Item	Specification
Evaluation MCU (RL78/G23 with 128 pins)	Part No.: R7F100GSN2DFB
	Package: 128-pin LFQFP
	On-chip memory: 768-KB ROM, 48-KB RAM, 8-KB data flash memory
Board size	53.34 mm x 99.06 mm
Power-supply voltage	VDD: 1.6 V to 5.5 V (EVDD is the same voltage as VDD.)
Power-supply circuit*2	USB connector: VBUS (5 V) or 3.3 V (default)
	External power supply: 1.6 V to 5.5 V
	E2 emulator or E2 emulator Lite
Current drawn	Max. 200 mA
Main clock*1	OSC1: Crystal oscillator (surface-mount technology (SMT)) for the main system clock
	OSC2: Crystal oscillator or ceramic resonator (lead type) for the main system clock
Sub-clock	OSC3: Crystal oscillator (SMT) for the sub-clock
Push switches	Reset switch x 1
	User switch x 1
LEDs	Power indicator: green x 1
	User: green x 2
Capacitive touch button	2
USB connector	Connector: Micro USB Type-B
Arduino™ connectors	Connectors: 8 pins x 5, 10 pins x 1 The interfaces are compatible with the Arduino™ MEGA board. (Digital pins D22 to D53 on Arduino™ Mega are not supported.)
Pmod™ connectors	Connectors: Angle type, 12 pins x 2
MCU headers*1	Headers: 28 pins x 1, 14 pins x 2, 12 pins x 1
USB-to-serial converter	Used as the interface with the RL78 COM port debug tool. FT232RQ from FTDI x 1
USB-to-serial converter reset header*1	Header: 2 pins x 1 (open-circuit by default)
Current measurement headers*1	Headers: 2 pins x 2
Power-supply selection header*2	Header: 3 pins x 1
Emulator connector*1	14-pin connector for connecting an E2 emulator or E2 emulator Lite
Grove connector	Interface for Grove modules I2C: 4; UART: 1

Notes: 1. This part is not mounted.

2. The intended source of power for the evaluation MCU on the board as shipped is VBUS (5 V). Setting a jumper is required if power is to be supplied from other sources. For details, refer to Chapter 5, User Circuits.

1.5 Block Diagram

Figure 1-1 shows the block diagram of this product.

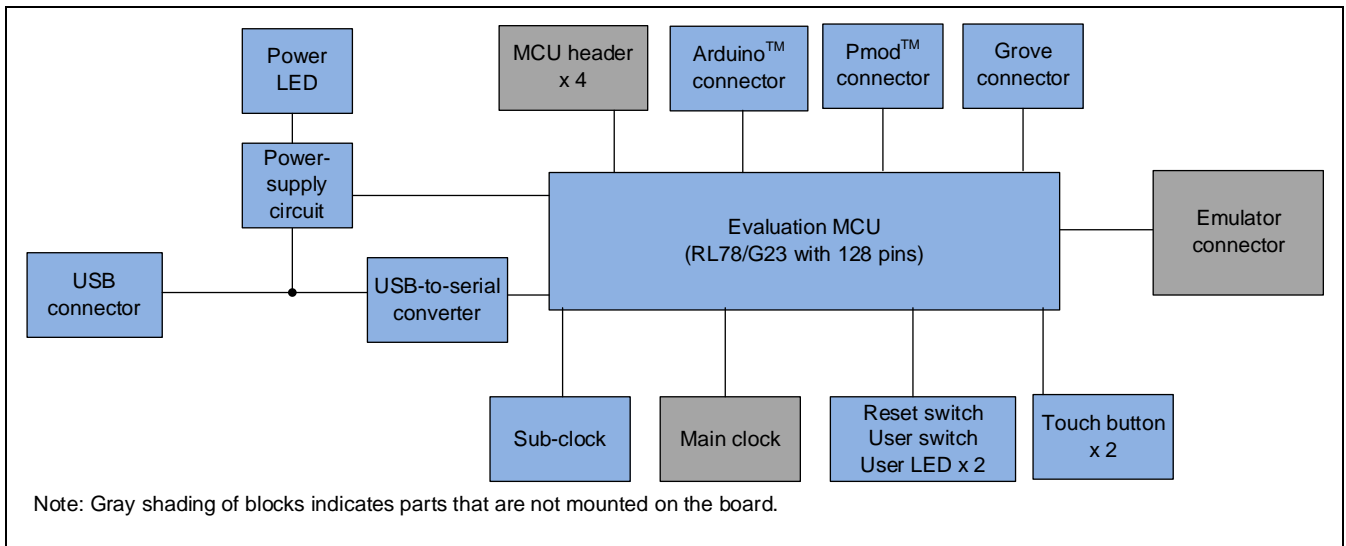


Figure 1-1 Block Diagram

2. Board Layout

Figure 2-1 shows the external appearance of the top side of this product.

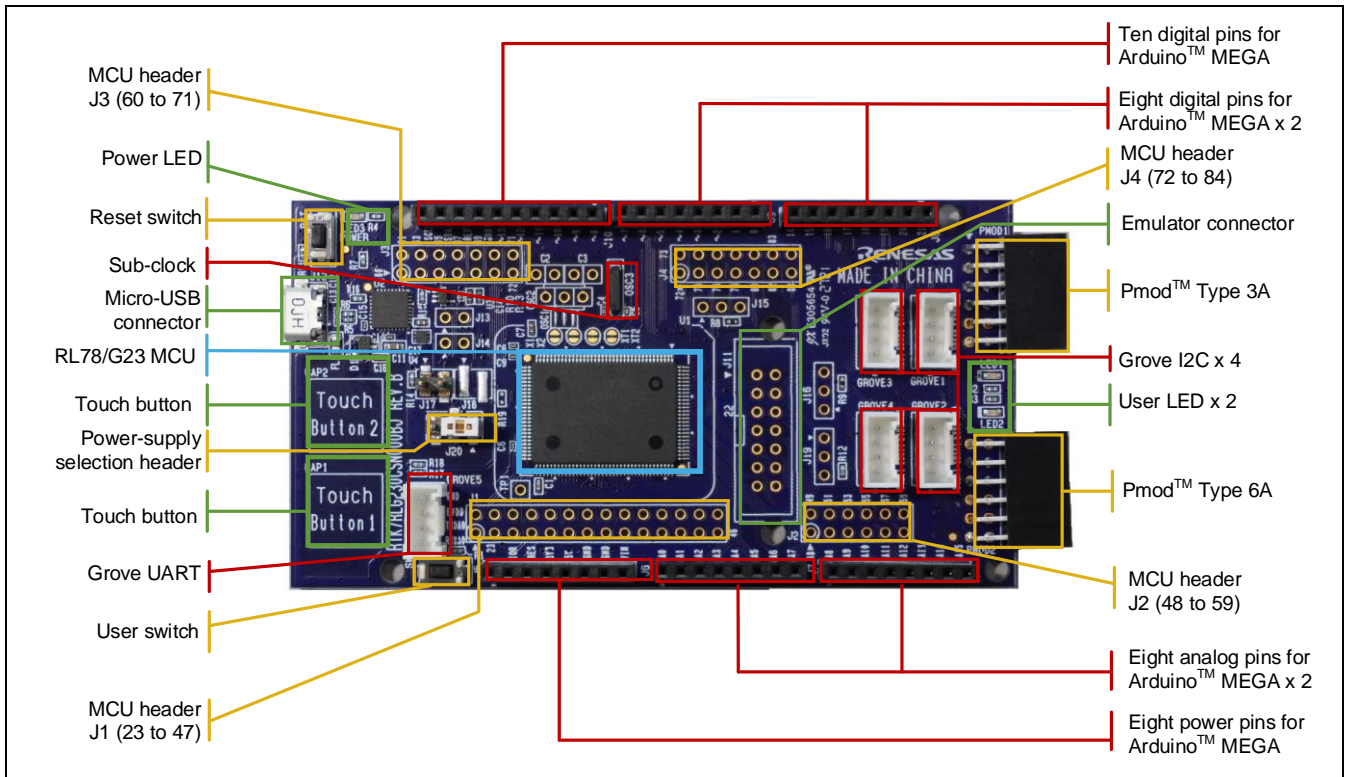


Figure 2-1 Board Layout (Top Side)

3. Parts Layout

Figure 3-1 shows the parts layout of this product.

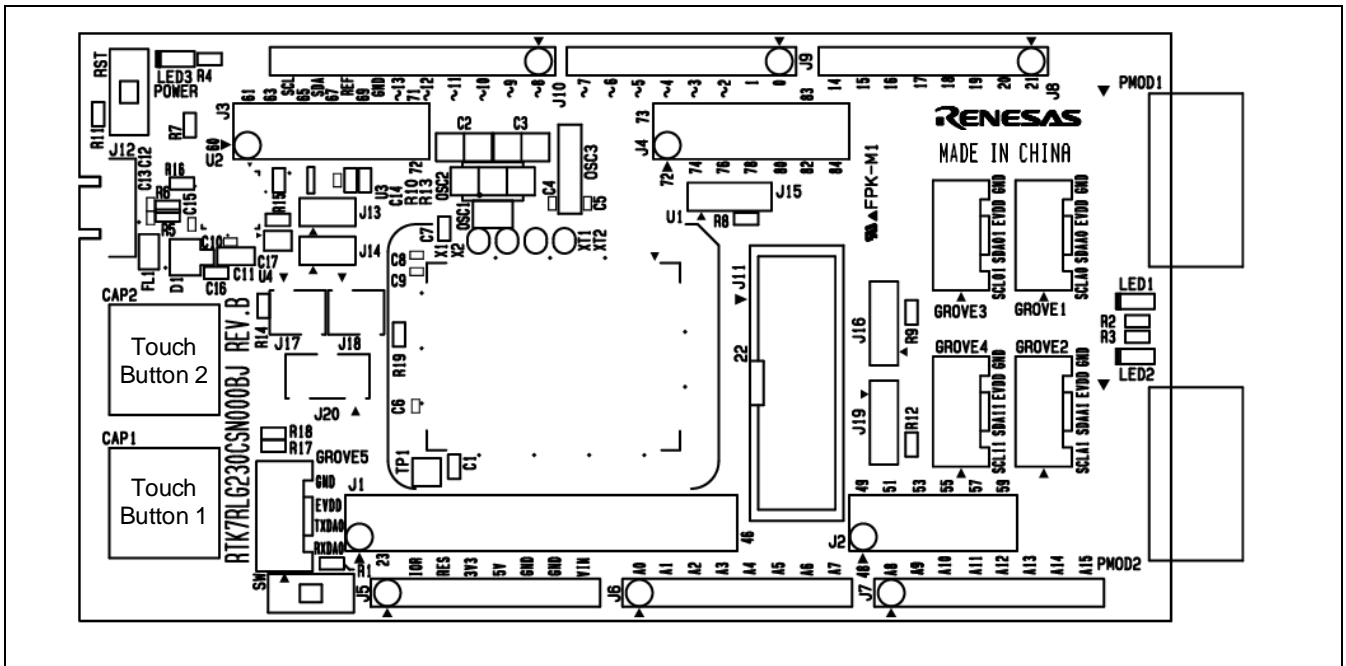


Figure 3-1 Parts Layout

Figure 3-2 shows the external dimensions of this product.

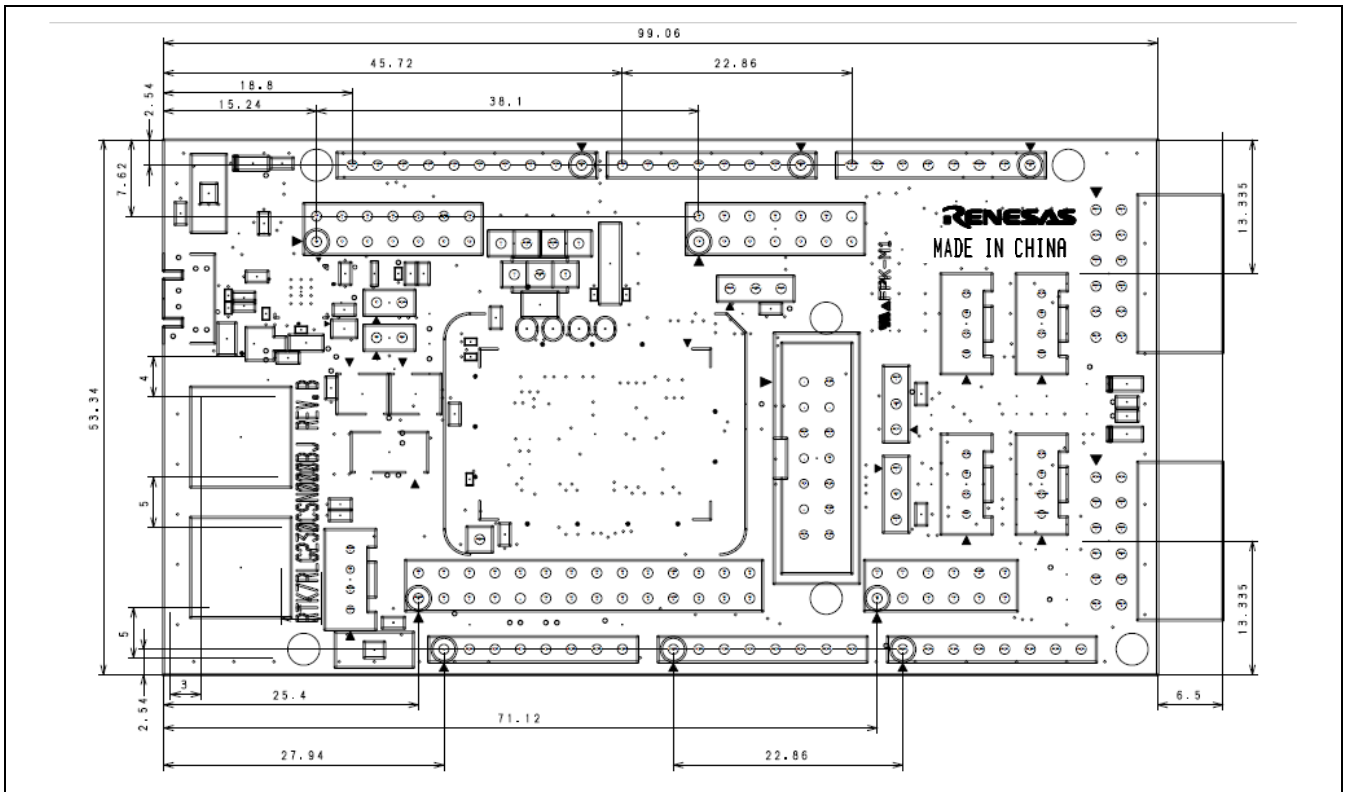


Figure 3-2 External Dimensions

4. Operating Environment

Figure 4-1 shows the operating environment of this product. Install the IDE on the host PC.

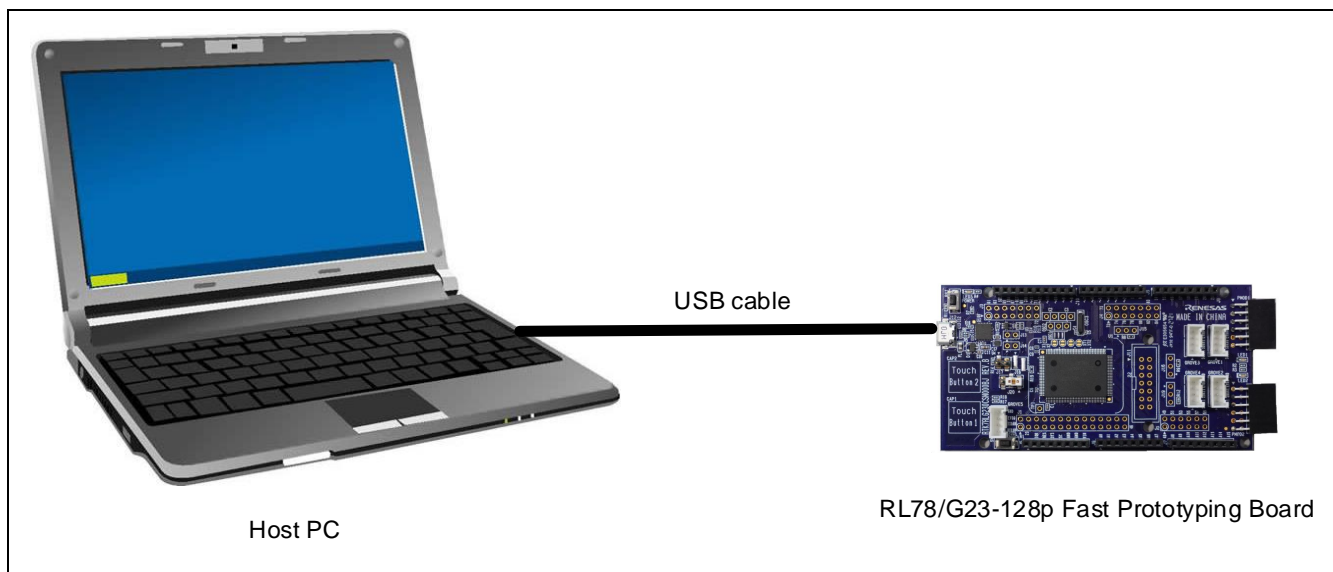


Figure 4-1 Operating Environment

5. User Circuits

5.1 Evaluation MCU

The specifications for the power supply, system clock, and reset of the evaluation MCU (RL78/G23 with 128 pins) at the time of shipment are as follows.

- Power supply: 5 V (VBUS) supplied from the USB (including the analog power supply)
- System clock: Operation with an on-chip oscillator
- Reset: Directed by the reset switch or IDE

5.2 USB Connector

The connector shape is micro-USB Type-B. It serves as a power-supply input and an interface for communications with the RL78 COM port debug tool (through USB-to-serial conversion). Connect the USB connector to the host PC by a USB cable. If the power supply on the host side is on, the power is supplied to this product at the same time as connection of the cable.

Note: The package does not include a USB cable. Do not connect a USB cable while the emulator is supplying power.

5.3 Power LED

While the power LED is illuminated, VDD power is being supplied. The LED is green.

Note: The LED may not be illuminated when the power supply voltage is 2.2 V or lower.

5.4 User LEDs

The optional user LEDs can be used for any purpose. LED1 and LED2 are mounted on the board and are respectively connected to the following ports. The LEDs are green.

- LED1: Pin 67, connected to port P50
- LED2: Pin 68, connected to port P51

Note: The LED may not be illuminated when the power supply voltage is 2.2 V or lower.

5.5 Capacitive Touch Buttons

The capacitive touch buttons can be used for any purpose. Two electrodes (touch button 1 and touch button 2) are mounted on the board and are respectively connected to the following ports.

- Touch button 1: Pin 55, connected to ports P05 and TS10
- Touch button 2: Pin 54, connected to ports P06 and TS11

P30 (pin 66) is connected for the TSCAP pin function by default.

Note: The condition for operating voltage of CTSU2L is $VDD = 1.8\text{ V}$ to 5.5 V . Use capacitive touch buttons that produce voltages within the range $VDD = 1.8\text{ V}$ to 5.5 V .

5.6 Arduino™ Connectors

The specification of the Arduino™ connectors is on the assumption that Arduino™ shields are to be connectable. However, we do not guarantee connection to all types of Arduino™ shield. Confirm the specifications of this product against any Arduino™ shield you intend to use.

Figure 5-1, Table 5-1, and Table 5-2 show the pin assignments of the Arduino™ connectors.

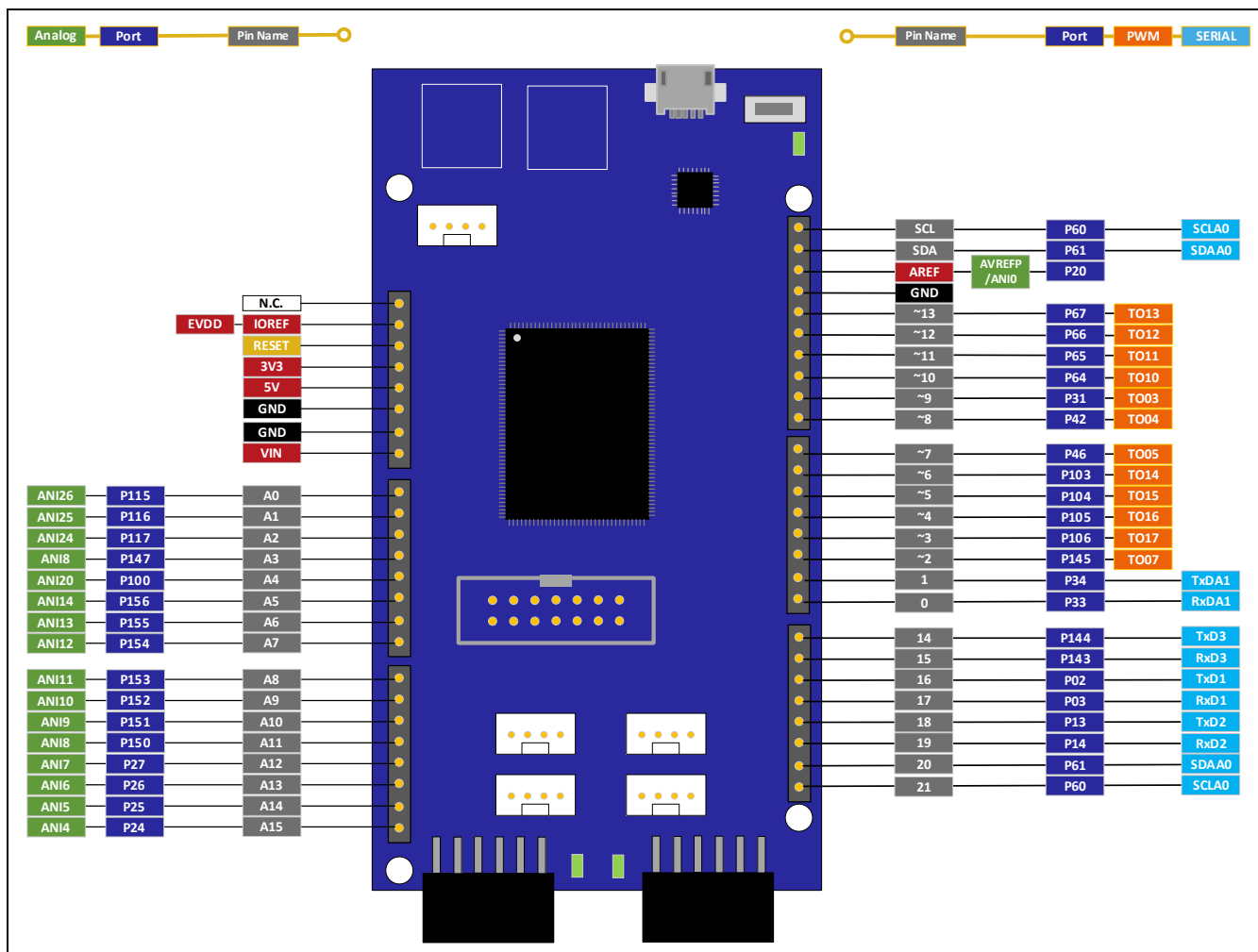


Figure 5-1 Pin Assignments of the Arduino™ Connectors

Table 5-1 Pin Assignments of the Arduino™ Connectors (1/2)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*	RL78/G23 (128 Pins)					
		Pin	Power Supply	Port	Analog	PWM	Serial
J5-1	N.C.	-	-	-	-	-	-
J5-2	IOREF	36	EVDD	-	-	-	-
J5-3	RESET	26	-	-	-	-	-
J5-4	3V3	-	-	-	-	-	-
J5-5	5V	-	-	-	-	-	-
J5-6	GND	33	VSS	-	-	-	-
J5-7	GND	33	VSS	-	-	-	-
J5-8	VIN	-	-	-	-	-	-
J6-1	A0	94	-	P115	ANI26	-	-
J6-2	A1	95	-	P116	ANI25	-	-
J6-3	A2	96	-	P117	ANI24	-	-
J6-4	A3	101	-	P147	ANI18	-	-
J6-5	A4	102	-	P100	ANI20	-	-
J6-6	A5	103	-	P156	ANI14	-	-
J6-7	A6	104	-	P155	ANI13	-	-
J6-8	A7	105	-	P154	ANI12	-	-
J7-1	A8	106	-	P153	ANI11	-	-
J7-2	A9	107	-	P152	ANI10	-	-
J7-3	A10	108	-	P151	ANI9	-	-
J7-4	A11	109	-	P150	ANI8	-	-
J7-5	A12	110	-	P27	ANI7	-	-
J7-6	A13	111	-	P26	ANI6	-	-
J7-7	A14	112	-	P25	ANI5	-	-
J7-8	A15	113	-	P24	ANI4	-	-

Note: The names of the signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>

Table 5-2 Pin Assignments of the Arduino™ Connectors (2/2)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*1	RL78/G23 (128 Pins)					
		Pin	Power Supply	Port	Analog	PWM	Serial
J8-1	21	37	-	P60	-	-	SCLA0
J8-2	20	38	-	P61	-	-	SDAA0
J8-3	19	78	-	P14	-	-	RxD2
J8-4	18	79	-	P13	-	-	TxD2
J8-5	17	122	-	P03	-	-	RxD1
J8-6	16	123	-	P02	-	-	TxD1
J8-7	15	128	-	P143	-	-	RxD3
J8-8	14	127	-	P144	-	-	TxD3
J9-1	0	9	-	P33	-	-	RxDA1
J9-2	1	8	-	P34	-	-	TxDA1
J9-3	~2	126	-	P145	-	TO07	-
J9-4	~3	11	-	P106	-	TO17	-
J9-5	~4	12	-	P105	-	TO16	-
J9-6	~5	13	-	P104	-	TO15	-
J9-7	~6	14	-	P103	-	TO14	-
J9-8	~7	16	-	P46	-	TO05	-
J10-1	~8	20	-	P42	-	TO04	-
J10-2	~9	41	-	P31	-	TO03	-
J10-3	~10	42	-	P64	-	TO10	-
J10-4	~11	43	-	P65	-	TO11	-
J10-5	~12	44	-	P66	-	TO12	-
J10-6	~13	45	-	P67	-	TO13	-
J10-7	GND	34	VSS	GND	-	-	-
J10-8	ADREF	117	-	P20*2	AVREFP /ANI0	-	-
J10-9	SDA	38	-	P61	-	-	-
J10-10	SCL	37	-	P60	-	-	-

- Notes: 1. The names of the signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>
2. P20 is connected to VDD by default. When P20 is disconnected from VDD, remove the given pattern for cutting (AVREFP).

5.7 Pmod™ Connectors

The specification of the Pmod™ connectors is on the assumption that Pmod™ modules are to be connectable.

Pmod1 is assumed to be connected to Pmod™ Interface Type 2A or 3A and [Wi-Fi Pmod Expansion Board](#) (RTK00WFMX0B00000BE).

Pmod2 is assumed to be connected to the Pmod™ Interface Type 6A module*.

Note: For details on the Pmod module from Renesas, refer to the Web site at: <https://www.renesas.com/quickconnect>.

However, we do not guarantee connection to all types of Pmod™ module. Confirm the specifications of this product against any Pmod™ module you intend to use.

Figure 5-2, Table 5-3, and Table 5-4 show the pin assignments of the Pmod™ connectors.

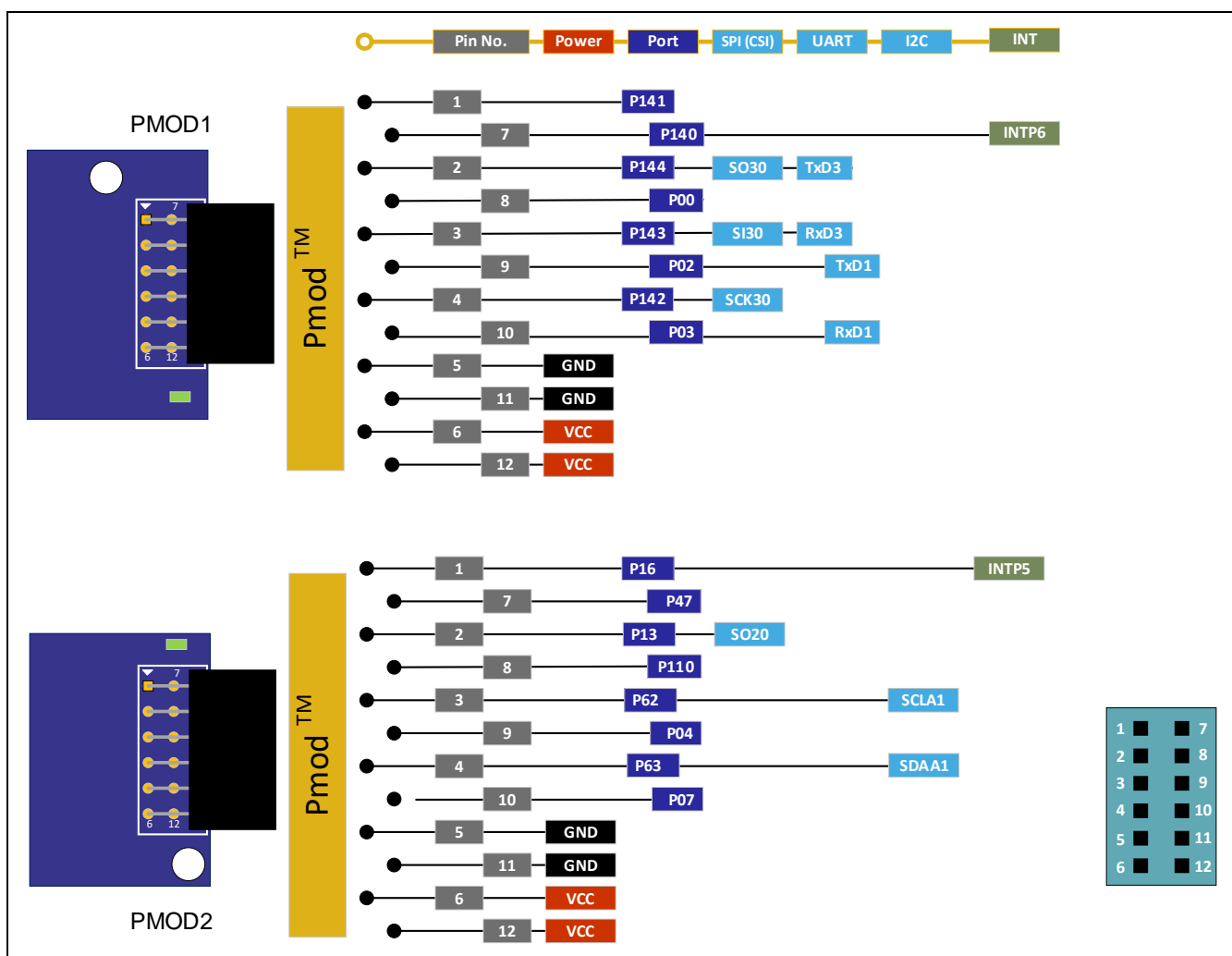


Figure 5-2 Pin Assignments of the Pmod™ Connectors

Table 5-3 Pin Assignments of Pmod™ (Pmod1)

Pin No. of Pmod™	Name of Pmod™ Signal 2A/3A	RL78/G23 (128 Pins)					
		Pin	Power Supply	Port	SPI (CSI)	UART	I2C
1	CS/CTS	2	-	P141	-	-	-
2	MOSI / TXD	127	-	P144	SO30	TxD3	-
3	MISO / RXD	128	-	P143	SI30	RxD3	(P60/SCLA0)*
4	SCK/RTS	1	-	P142	SCK30	-	(P61/SDAA0)*
5	GND	-	VSS	-	-	-	-
6	VCC	-	EVDD	-	-	-	-
7	INT/GPIO	3	-	P140/INTP6	-	-	-
8	RESET/G PIO	125	-	P00	-	-	-
9	CS2/GPIO	123	-	P02	-	TxD1	-
10	CS3/GPIO	122	-	P03	-	RxD1	-
11	GND	-	VSS	-	-	-	-
12	VCC	-	EVDD	-	-	-	-

Note: These signals can be used as Type 6A (I2C) by removing the patterns for cutting to disconnect P142 and P143 and short-circuiting the pads P60 and P61.

Table 5-4 Pin Assignments of Pmod™ (Pmod2)

Pin No. of Pmod™	Name of Pmod™ Signal 6A	RL78/G23 (128 Pins)					
		Pin	Power Supply	Port	SPI (CSI)	UART	I2C
1	INT	76	-	P16/INTP5	-	-	-
2	RESET	79	-	P13	SO20	TxD2	-
3	SCL	39	-	P62	(P14/SI20)*	(P14/RxD2)*	SCLA1
4	SDA	40	-	P63	(P15/SCK20)*	-	SDAA1
5	GND	-	VSS	-	-	-	-
6	VCC	-	EVDD	-	-	-	-
7	IO1	15	-	P47	-	-	-
8	IO2	98	-	P110	-	-	-
9	IO3	121	-	P04	-	-	-
10	IO4	120	-	P07	-	-	-
11	GND	-	EVSS	-	-	-	-
12	VCC	-	VDD	-	-	-	-

Note: These signals can be used as Type 2A or 3A (CSI or UART) by removing the patterns for cutting to disconnect P62 and P63 and short-circuiting the pads P14 and P15.

5.8 MCU Headers

The MCU headers are provided as through holes; J1 includes the headers for a total of 28 pins, J2 includes the headers for a total of 12 pins, and J3 and J4 include the headers for a total of 14 pins. The pin headers have a pitch of 2.54 mm and the evaluation MCU is connected to the through holes for the headers.

Note that a multiplexed pin function of Arduino™ signal 22 is for use as pin 5 of the emulator connector (J11). Table 5-5 to Table 5-8 show the pin assignments of the MCU headers.

Table 5-5 Pin Assignments of the MCU Headers (J11 and J1)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*1	RL78/G23 (128 Pins)			
		Pin	Power Supply	Port and Peripheral Modules	Others
J11-5	22	22	-	P40	TOOL0
J1-1	-	56	EVSS1	-	-
J1-2	-	57	EVDD1	-	-
J1-3	23	58	-	P80/(SCK10)/(SCL10)	-
J1-4	24	55	-	P05/TS10*2	Touch button 1
J1-5	25	59	-	P81/(SI10)/(RxD1)/(SDA10)	-
J1-6	26	60	-	P82/(SO10)/(TxD1)	-
J1-7	27	63	-	P85/(INTP7)/CLKA0	-
J1-8	28	64	-	P86/(INTP8)	-
J1-9	-	-	-	-	-
J1-10	29	65	-	P87/(INTP9)	-
J1-11	30	66	-	P30/INTP3/TSCAP/RTC1HZ/EI30/VCOUT0*3	TSCAP
J1-12	31	67	-	P50/CCD03/TS00/EI50/EO50	LED1
J1-13	32	68	-	P51/CCD02/EI51/EO51	LED2
J1-14	33	69	-	P52/SO31	-
J1-15	34	70	-	P53/SI31/SDA31	-
J1-16	35	71	-	P54/SCK31/SCL31	-
J1-17	36	72	-	P55/(PCLBUZ1)/(SCK00)	-
J1-18	37	73	-	P56/(INTP1)	-
J1-19	38	74	-	P57/(INTP3)	-
J1-20	39	75	-	P17/CCD01/TI02/TO02/EO17/(SO00)/(TxD0)	-
J1-21	40	80	-	P12/SO00/TxD0/TOOLTxD/EI12/EO12/(INTP5)/(TI05)/(TO05)	TOOLTxD
J1-22	41	81	-	P11/SI00/RxD0/TOOLRxD/SDA00/EI11/EO11/(TI06)/(TO06)	TOOLRxD
J1-23	42	82	-	P10/SCK00/SCL00/EI10/EO10/(TI07)/(TO07)	-
J1-24	43	83	-	P90	-
J1-25	44	84	-	P91	-
J1-26	45	85	-	P92	-
J1-27	46	86	-	P93	-
J1-28	47	87	-	P94	-

- Notes: 1. The names of the Arduino™ signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>
2. P05 is connected to touch button 1 (CAP1) by default. When P05 is to be used as a port pin, short-circuit the pad [P05].
3. P30 is connected to TSCAP (C1) by default. When P30 is to be used as a port pin, short-circuit the pad [P30]. Note that P30 cannot be used for application affected by the 0.01-uF capacitor.

Table 5-6 Pin Assignments of the MCU Headers (J2)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*1	RL78/G23 (128 Pins)			
		Pin	Power Supply	Port and Peripheral Modules	Others
J2-1	48	90	-	P97/SO11	-
J2-2	49	91	-	P112	-
J2-3	50	92	-	P113	-
J2-4	51	93	-	P114	
J2-5	52	97	-	P101	-
J2-6	53	99	-	P111/(INTP11)	-
J2-7	54	100	-	P146/(INTP4)	-
J2-8	55	114	-	P23/ANI3/ANO1/IVREF0/EI23/TS21	-
J2-9	56	115	-	P22/ANI2/ANO0/EI22/TS20	-
J2-10	57	116	-	P21/ANI1/AVREFM/EI21*2	GND
J2-11	58	118	-	P130	-
J2-12	59	119	-	P102/TI06/TO06	-

- Notes: 1. The names of the Arduino™ signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>
2. P21 is connected to GND by default. When P21 is to be disconnected from GND, remove the given pattern for cutting (AVREFM).

Table 5-7 Pin Assignments of the MCU Headers (J3)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*1	RL78/G23 (128 Pins)			
		Pin	Power Supply	Port and Peripheral Modules	Others
J3-1	60	54	-	P06/TS11*2	Touch button 2
J3-2	61	29	-	P137/INTP0/EI137	SW1
J3-3	62	53	-	P70/KR0/TS02/RIN0/SCK21/SCL21	-
J3-4	63	52	-	P71/KR1/TS03/SI21/SDA21	
J3-5	64	51	-	P72/KR2/TS04/SO21	-
J3-6	65	50	-	P73/KR3/TS05	-
J3-7	66	49	-	P74/KR4/TS06/INTP8	-
J3-8	67	48	-	P75/KR5/TS07/INTP9	-
J3-9	68	47	-	P76/KR6/TS08/INTP10/(RxD2)	-
J3-10	69	46	-	P77/KR7/TS09/INTP11/(TxD2)	-
J3-11	-	35	VDD	-	-
J3-12	-	33	VSS	-	-
J3-13	70	31	-	P121/X1/EI121/VBAT	
J3-14	71	30	-	P122/X2/EXCLK/EI122	

- Notes: 1. The names of the Arduino™ signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>
2. P06 is connected to touch button 2 (CAP2) by default. When P06 is to be used as a port pin, short-circuit the pad [P06].

Table 5-8 Pin Assignments of the MCU Headers (J4)

Part No. in the Circuit Schematics	Name of Arduino™ Signal*1	RL78/G23 (128 Pins)			
		Pin	Power Supply	Port and Peripheral Modules	Others
J4-1	72	28	-	P123/XT1*2	Sub-clock
J4-2	73	27	-	P124/XT2/EXCLKS*3	Sub-clock
J4-3	74	25	-	P125	-
J4-4	75	24	-	P126	
J4-5	76	23	-	P127	-
J4-6	77	21	-	P41	-
J4-7	78	17	-	P45/SO01	-
J4-8	79	10	-	P32/CLKA1	-
J4-9	80	7	-	P35/ANI23	-
J4-10	81	6	-	P36/ANI22	-
J4-11	82	5	-	P37/ANI21	-
J4-12	83	4	-	P120/ANI19/IVCMP1/EI120	-
J4-13	84	124	-	P01/TS27/EI01/EO01/TO00	-
J4-14	-	-	-	-	-

- Notes: 1. The names of the Arduino™ signals correspond to the pin numbers for the Arduino™ IDE. For more information about Arduino IDE please refer to the following URL: <https://github.com/renesas/Arduino/wiki/>
2. P123 is connected to the XT1 sub-clock by default. When P123 is to be used as a port pin, remove the pattern for cutting [XT1] and short-circuit the pad [P123].
3. P124 is connected to the XT2 sub-clock by default. When P124 is to be used as a port pin, remove the pattern for cutting [XT2] and short-circuit the pad [P124].

5.9 Grove Connector

The specification of the grove connector is on the assumption that Grove modules are to be connectable; GROVE1 to GROVE4 are for connection through I2C and GROVE5 is for connection through a UART. If a connector is mounted, however, connection to all Grove modules (through I2C or UART) is not guaranteed. Use this connector after having confirmed the specifications of this product and Grove modules (through I2C or UART) you intend to use.

Figure 5-3 and Table 5-9 to Table 5-13 show the pin assignments of the Grove connector.

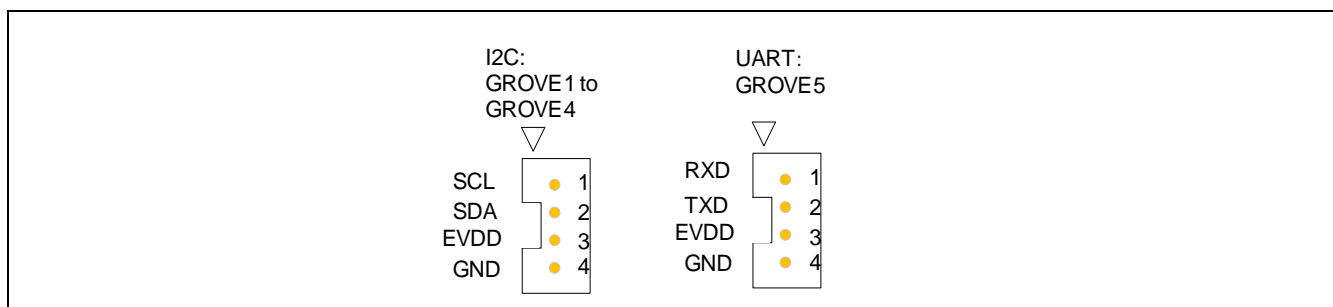


Figure 5-3 Pin Assignments of the Grove Connector

Table 5-9 Pin Assignments of the GROVE1 Connector

Part No. in the Circuit Schematics	RL78/G23 (128 Pins)			
	Pin	Power Supply	Port	I2C
GROVE1-1	37	-	P60	SCLA0
GROVE1-2	38	-	P61	SDAA0
GROVE1-3	-	EVDD	-	-
GROVE1-4	-	GND	-	-

Table 5-10 Pin Assignments of the GROVE2 Connector

Part No. in the Circuit Schematics	RL78/G23 (128 Pins)			
	Pin	Power Supply	Port	I2C
GROVE2-1	77	-	P15	SCL20
GROVE2-2	78	-	P14	SDA20
GROVE2-3	-	EVDD	-	-
GROVE2-4	-	GND	-	-

Table 5-11 Pin Assignments of the GROVE3 Connector

Part No. in the Circuit Schematics	RL78/G23 (128 Pins)			
	Pin	Power Supply	Port	I2C
GROVE3-1	19	-	P43	SCL01
GROVE3-2	18	-	P44	SDA01
GROVE3-3	-	EVDD	-	-
GROVE3-4	-	GND	-	-

Table 5-12 Pin Assignments of the GROVE4 Connector

Part No. in the Circuit Schematics	RL78/G23 (128 Pins)			
	Pin	Power Supply	Port	I2C
GROVE4-1	88	-	P95	SCL11
GROVE4-2	89	-	P96	SDA11
GROVE4-3	-	EVDD	-	-
GROVE4-4	-	GND	-	-

Table 5-13 Pin Assignments of the GROVE5 Connector

Part No. in the Circuit Schematics	RL78/G23 (128 Pins)			
	Pin	Power Supply	Port	I2C
GROVE5-1	62	-	P84	RXDA0
GROVE5-2	61	-	P83	TXDA0
GROVE5-3	-	EVDD	-	-
GROVE5-4	-	GND	-	-

5.10 Clock

Clock circuits are provided to handle the clock sources for the evaluation MCU. For details on the specifications of the evaluation MCU clocks, refer to the RL78/G23 User's Manual: Hardware. For details on the clock circuit of this product, refer to the circuit schematics of the RL78/G23-128p Fast Prototyping Board. Table 5-14 shows the details of the clocks on the RL78/G23-128p Fast Prototyping Board.

Table 5-14 Details of Clocks

Clock	Function and Usage	State as Shipped	Frequency	Package for the Oscillator
OSC1	Crystal oscillator for the main system clock (e.g. CSTNE20M0V5 from Murata Manufacturing Co., Ltd.)	Not mounted	n/a	SMT
OSC2	Crystal oscillator or ceramic resonator for the main system clock	Not mounted	n/a	Lead type
OSC3	Crystal oscillator for the sub-clock	Mounted	32.768 kHz	SMT

5.11 Reset Switch

Pressing the reset switch (RST) applies a hardware reset to the evaluation MCU.

5.12 User Switch

An optional user switch (SW) is mounted. It is connected to pin 29 of the evaluation MCU, which operates as pin function P137. The INTP0 interrupt is multiplexed on the same pin.

5.15 Power-Supply Selection Header

The operating power (VDD) of the evaluation MCU can be changed to supply from the emulator or external power, and to 5 V or 3.3 V with the use of a header (J20). Only change the jumper setting of J20 while power is not being supplied.

- 1-2 of J20 being short-circuit selects a 5-V power supply. This is the default setting as shipped (Figure 5-5).
- 2-3 of J20 being short-circuit selects a 3.3-V power supply (Figure 5-6).
- J20 being open-circuit selects supply from the emulator or external power. (Figure 5-7).

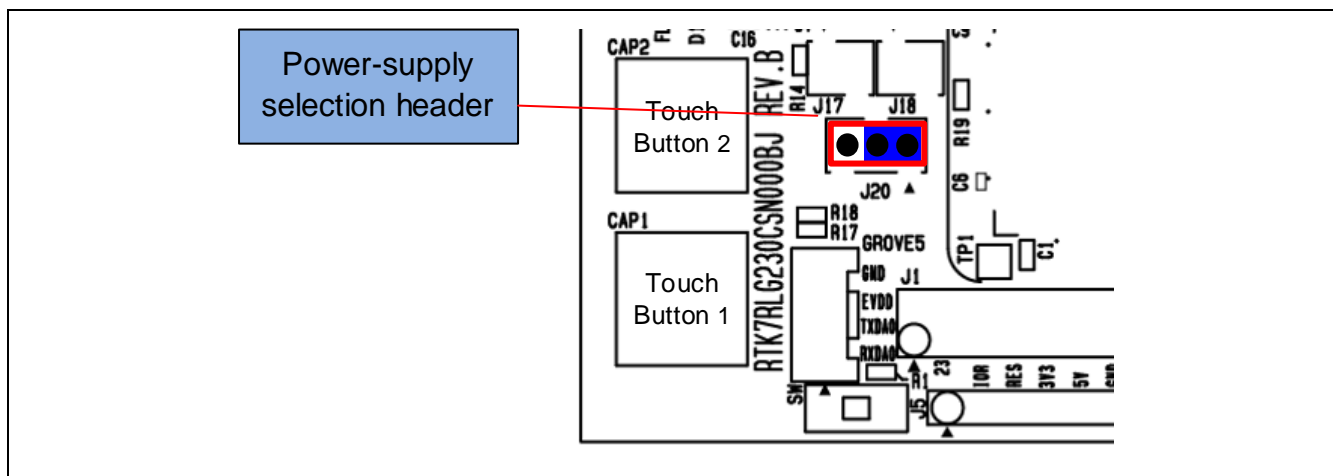


Figure 5-5 Setting of the Header to Select a 5-V Power Supply (Top Side)

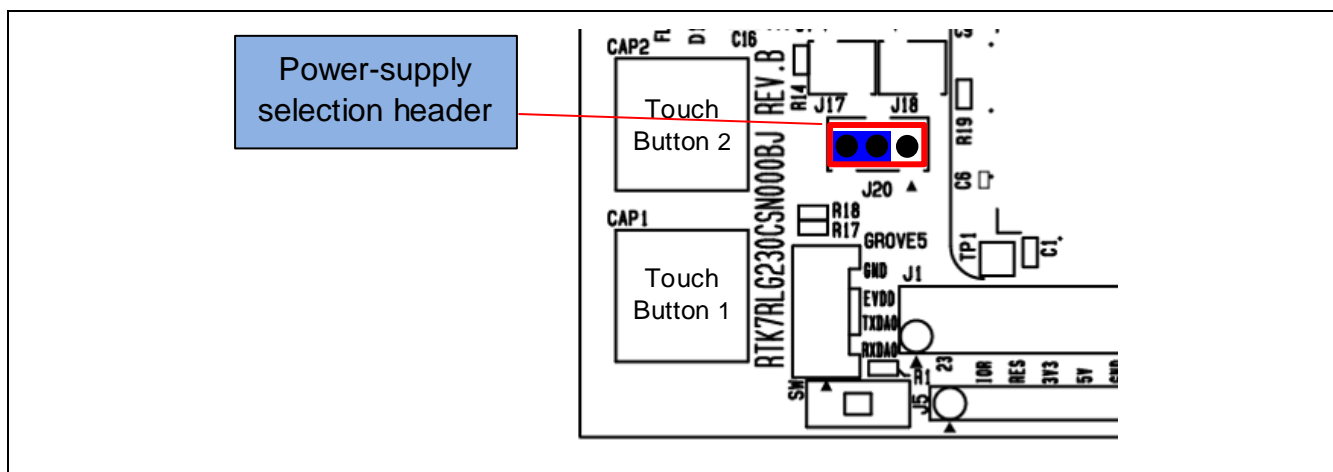


Figure 5-6 Setting of the Header to Select a 3.3-V Power Supply (Top Side)

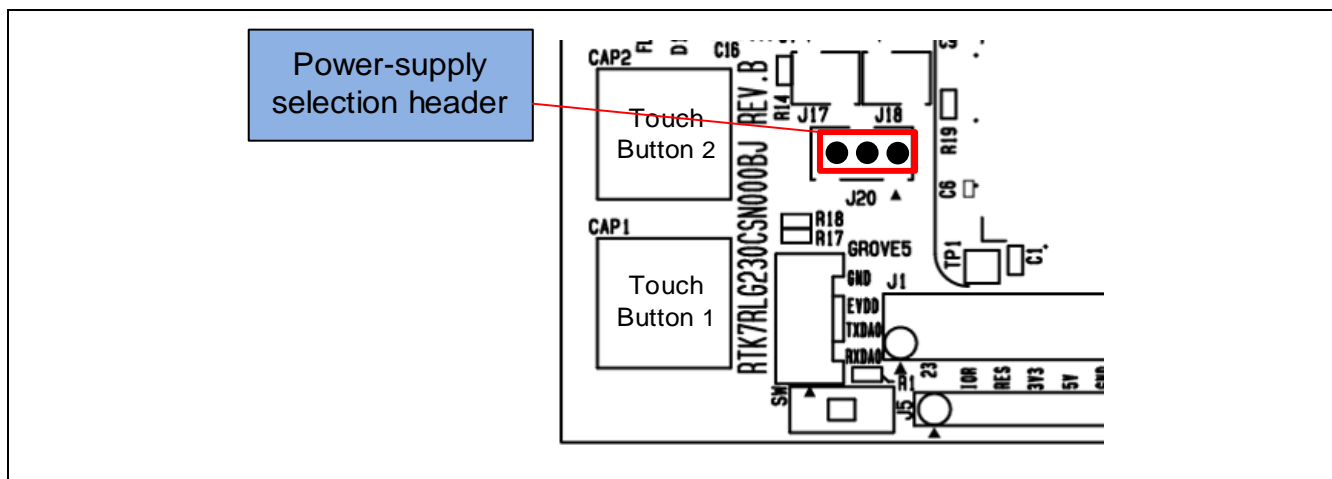


Figure 5-7 Setting of the Header to Select Supply from the Emulator or External Power (Top Side)

5.16 External Power Supply

When the evaluation MCU is to have a desired power-supply voltage, or when more current is required, use an external power supply. The usable voltages depend on the evaluation MCU.

Destinations for the connection of an external power supply:

- EVDD1: pin J1-2 on the MCU header; or VDD: pin J3-11 on the MCU header
- EVSS1: pin J1-1 on the MCU header; or VSS: pin J3-12 on the MCU header

Figure 5-8 shows the positions of the external power supply.

When an external power supply is used, confirm that the I/O voltages for Arduino™ shields, Pmod modules, or Grove modules are correct.

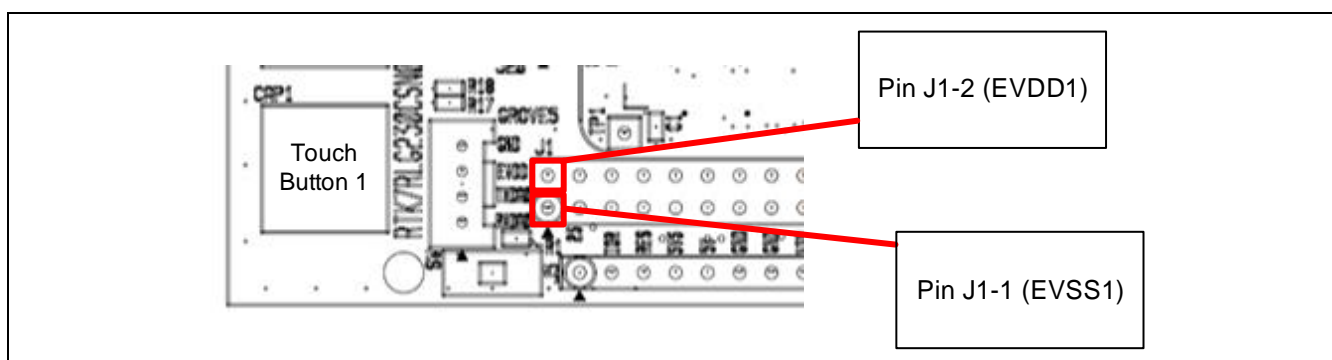


Figure 5-8 Positions of the Destinations for Connection of an External Power Supply (Top Side)

5.17 Current Measurement Header

This header (J13) is used to measure the current drawn by the evaluation MCU (J13 header components are not mounted). Connecting an ammeter to this product enables measurement of the current being drawn by the evaluation MCU. Take care to remove the given pattern for cutting (VDD) if this header is to be used. Figure 5-9 shows the positions of the current measurement header and pattern for cutting.

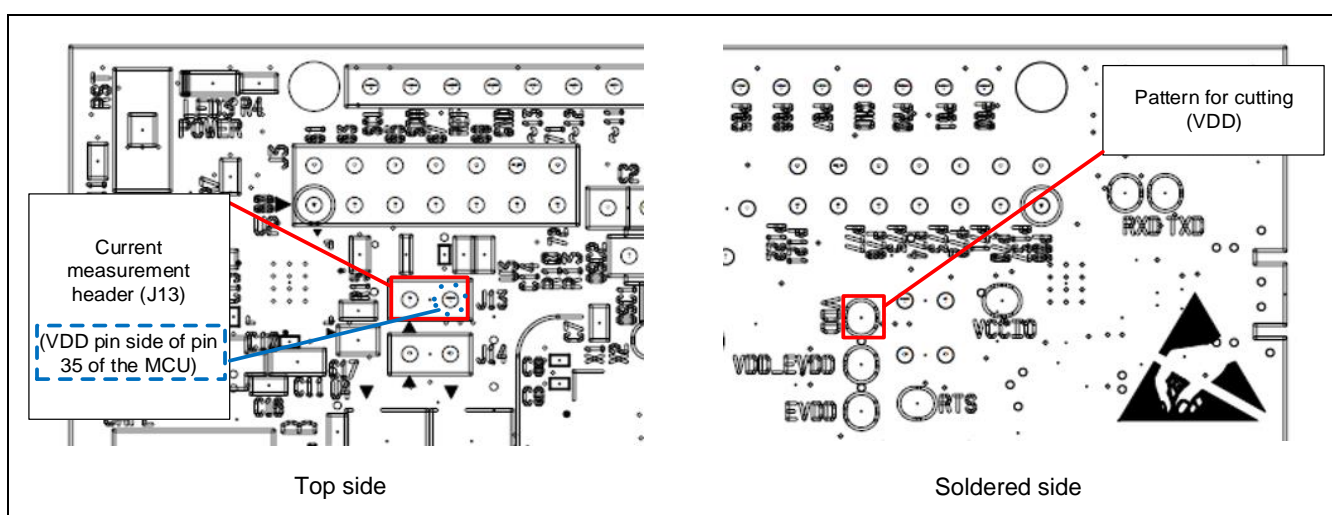


Figure 5-9 Positions of the Current Measurement Header (J13) and Pattern for Cutting (VDD)

Insert an ammeter between the sockets of the current measurement header (J13) to measure the current. Remove the pattern for cutting (VCCIO) (Figure 5-12) and turn down the LED to reduce the current drawn with an MCU other than the evaluation MCU.

When the current is to be measured with EVDD turned off and the MCU in a low-power state, remove the pattern for cutting (VDD_EVDD) (Figure 5-11) to separate VDD from EVDD.

Figure 5-10 is a block diagram of the power-supply lines related to the measurement of current drawn. For a block diagram of the power-supply circuit as a whole, refer to Figure 6-1.

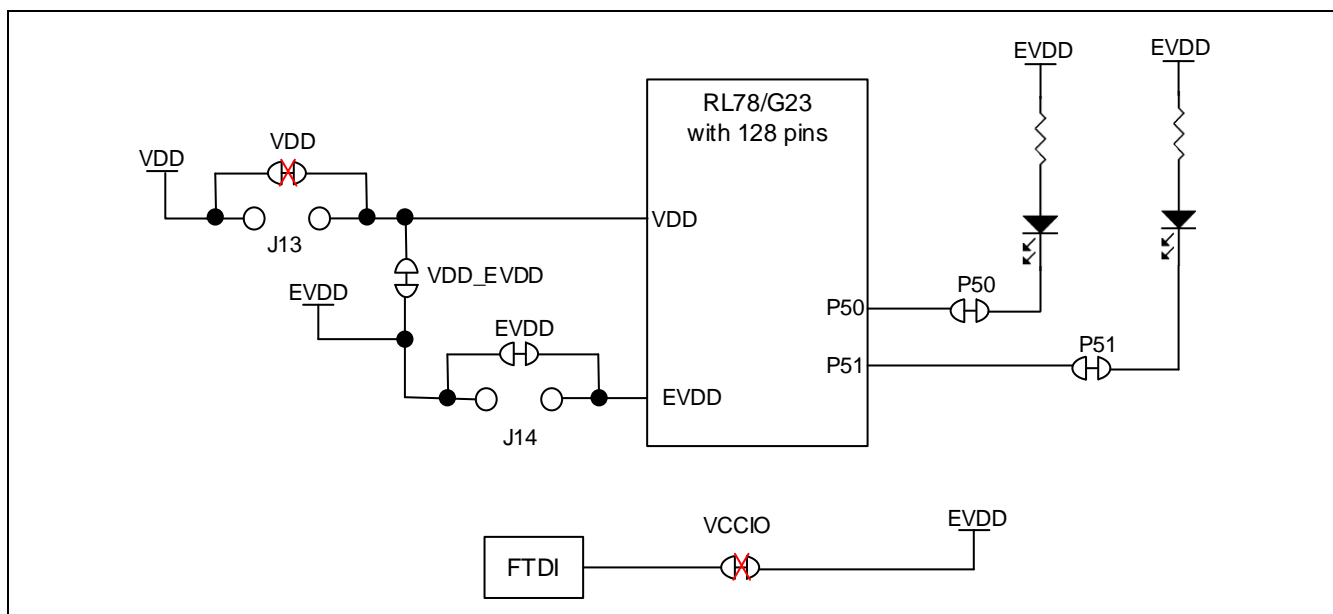


Figure 5-10 Block Diagram of the Headers Related to Current Measurement

5.18 Separate Pattern for VDD and EVDD

When VDD and EVDD are to be used with different potentials, remove the given pattern for cutting (VDD_EVDD). Figure 5-11 shows the position of the pattern for cutting.

Destination for the connection of an external power supply of EVDD to the source with a different potential:

- EVDD1 side: pin J1-2 on the MCU header

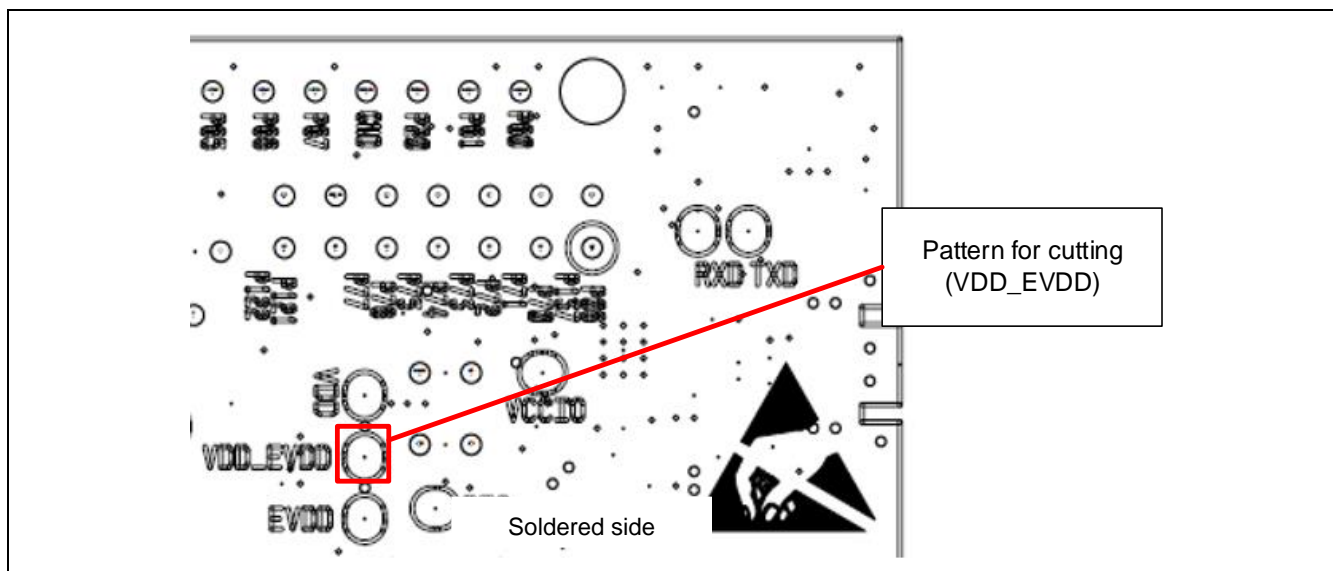


Figure 5-11 Position of the Pattern for Cutting (VDD_EVDD)

5.19 Pattern for Cutting the I/O Power Supply for the USB-to-Serial Converter

If you intend to use this board without connecting a USB connector, remove the given pattern for cutting (VCCIO). Figure 5-12 shows the position of the pattern for cutting.

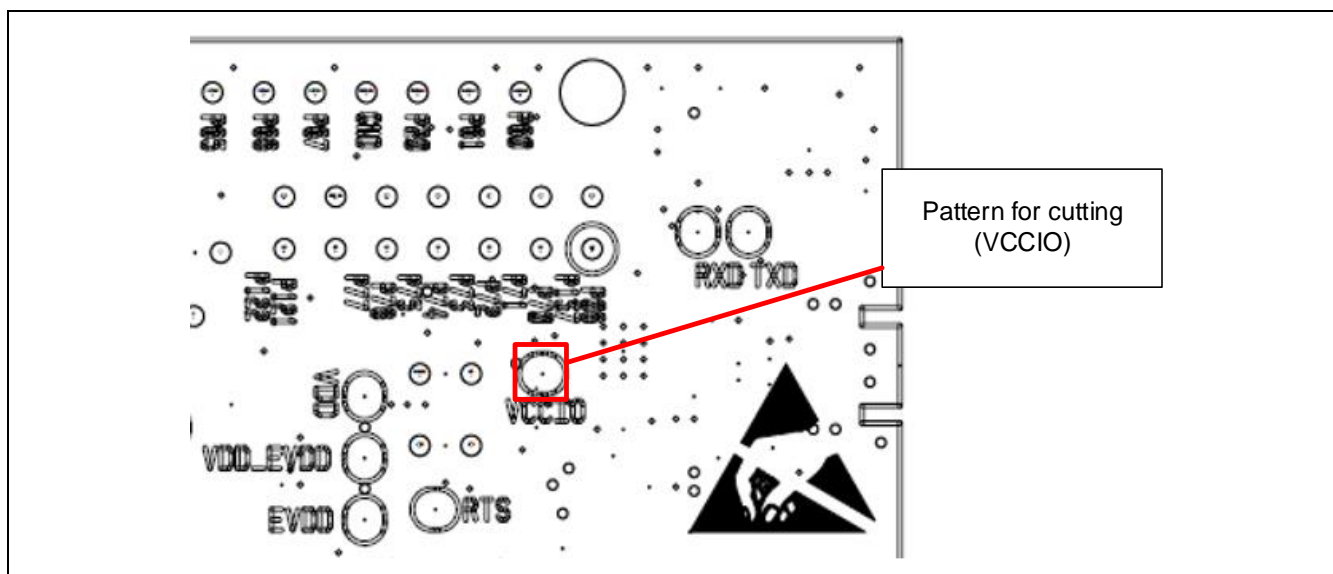


Figure 5-12 Position of the Pattern for Cutting (VCCIO)

5.20 Emulator Connector

This 14-pin connector (J11) is used to connect this product to an on-chip debugging E2 emulator or E2 emulator Lite, from Renesas Electronics, incorporating programming facilities (the connector is not mounted). The emulator is used for programming or debugging the evaluation MCU.

To connect the emulator, change the circuit as follows.

- J11: 14-pin connector must be mounted.
- J15, J16, and J19: pins 2-3 are short-circuit
- Pattern for cutting [TOOL0_USB]: removed
- Pattern for cutting [RESET]: removed
- Pattern for cutting [T_RESET]: removed

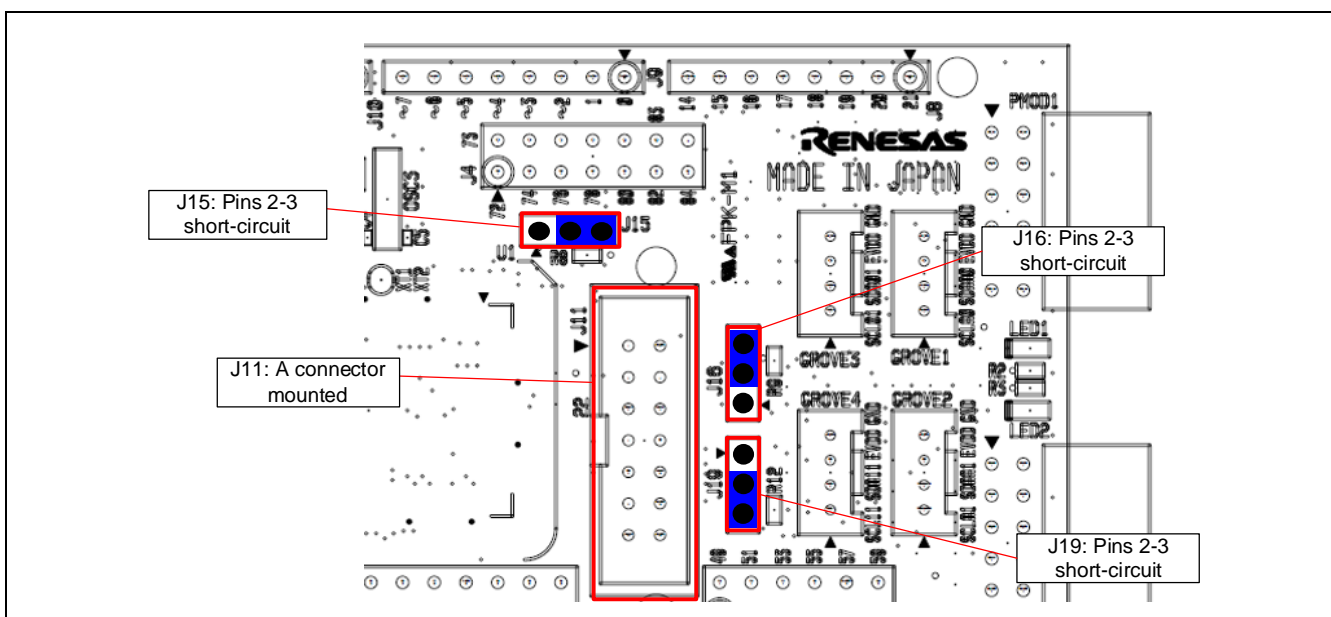


Figure 5-13 Settings for Use with the Emulator Connector (Top Side)

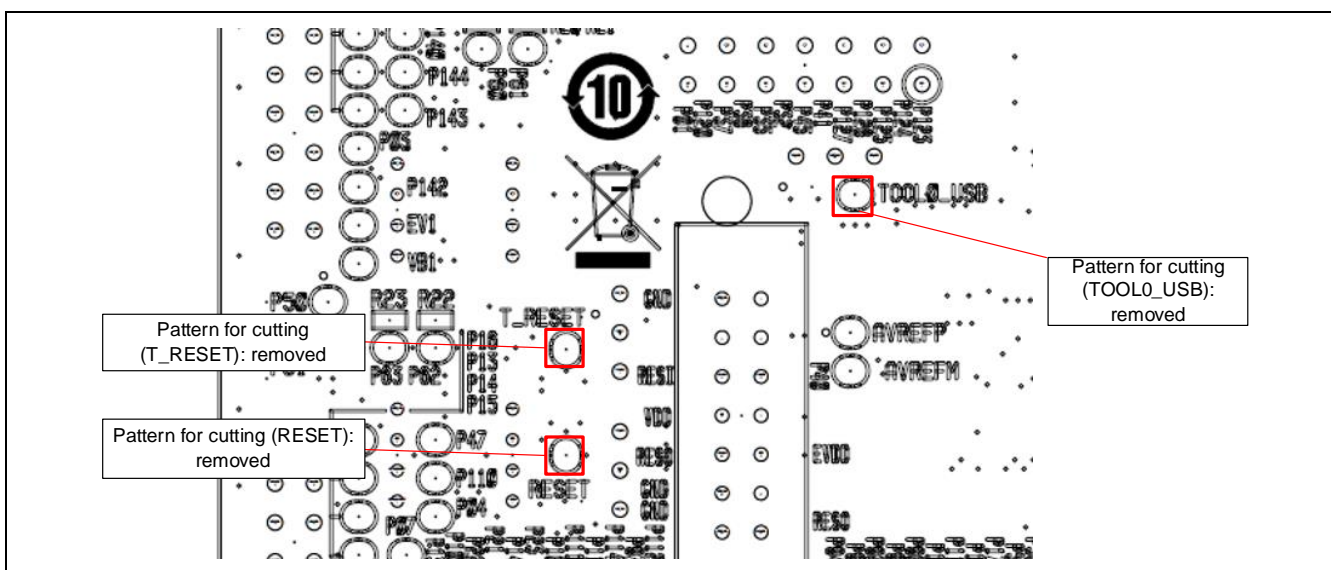


Figure 5-14 Settings for Use with the Emulator Connector (Soldered Side)

For the usage of the emulator, refer to the E1/E20/E2 Emulator, E2 emulator Lite Additional Document for User's Manual (Notes on Connection of RL78) (R20UT1994).

After the changes to the circuit have been made to connect the emulator as described in the previous page, if you want to restore the settings to those for COM port debugging with the use of the USB-to-serial converter, make the following change of setting as follows.

- J15, J16, and J19: pins 1-2 are short-circuit

For the patterns for cutting that were removed on the previous page, solder need not to be applied.

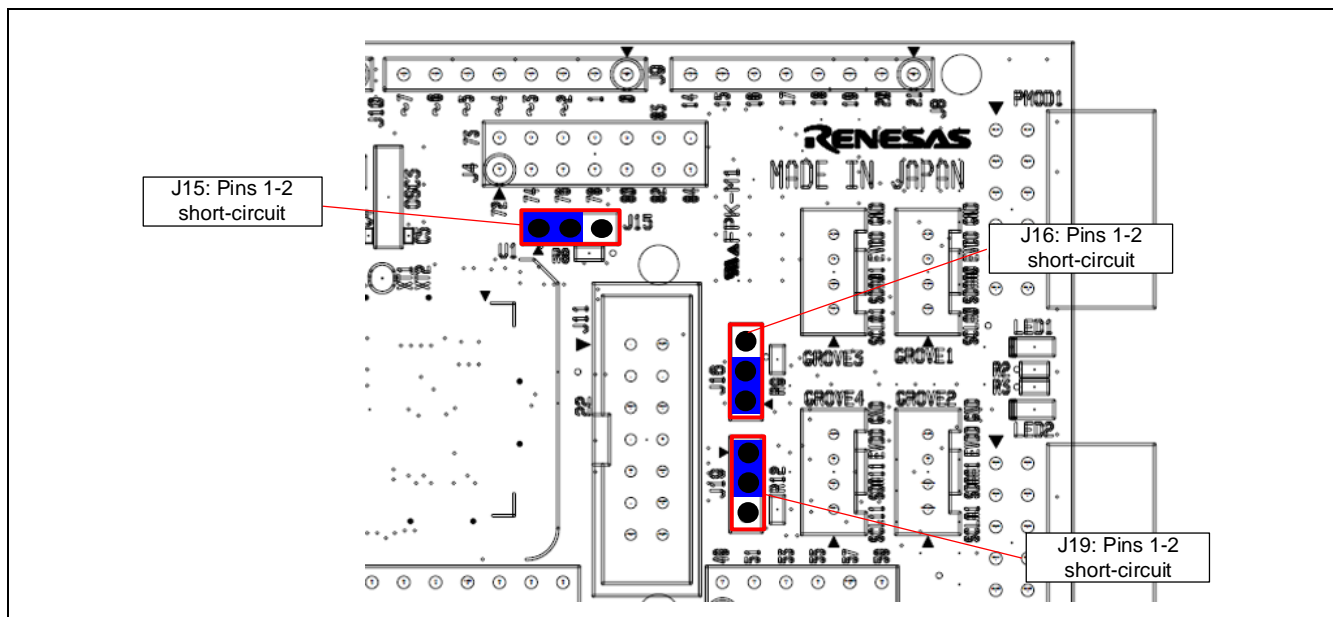


Figure 5-15 Settings for Use with COM Port Debugging (Top Side)

6. Handling Precautions

6.1 Power to be Supplied

When power is supplied to this product from an emulator or through the USB, note that the total current of VDD, EVDD, 5 V, and 3.3 V should not exceed the maximum current of 200 mA.

6.2 Remodeling the Board

Any modification of the board (including removing the patterns for cutting) shall be conducted at the user's own responsibility.

The following shows the settings of jumpers as shipped.

- J17: open-circuit
- J20: pins 1-2 are short-circuit

6.3 Power Supplies and Usage Conditions

Different power supplies can be selected. Table 6-1 shows the relationship between power-supply sources and usage conditions.

Figure 6-1 shows the block diagram of the power-supply circuit.

Table 6-1 Power-Supply Sources and Usage Conditions

Power-Supply Source	Usage Condition				
	Power supplied to the evaluation MCU	Use of Arduino™ shields*1	Use of Pmod or Grove modules*1	Use of an emulator and IDE	Jumper setting*2
USB*4 (default)	5 V or 3.3 V	Possible	Possible	Possible*3	Not required <ul style="list-style-type: none"> • J20: 1-2 short-circuit: 5 V (default) Required <ul style="list-style-type: none"> • J20: 2-3 short-circuit: 3.3 V
External power supply	1.6 V to 5.5 V	Possible	Possible	Possible*3	Not required <ul style="list-style-type: none"> • J20: open-circuit
Emulator	E2 Lite: 3.3 V E2: 1.8 V to 5.0 V	Not possible	Possible	Possible	Not required <ul style="list-style-type: none"> • J20: open-circuit

- Notes:
1. Connecting the RL78/G23-128p Fast Prototyping Board to an Arduino™ shield, a Pmod module, or a Grove module shall be conducted at the user's own responsibility and should only proceed after confirming the specifications of the power supply and interfaces. When an Arduino™ shield requires the supply of 5-V or 3.3-V power, connect the host PC to this board via the USB cable.
 2. Requirements for modifications after shipment are stated in this column.
 3. Use the IDE in a state where power is being supplied from a source other than the emulator.
 4. If power to be supplied to this product other than via the USB, remove the pattern for cutting (VCCIO).

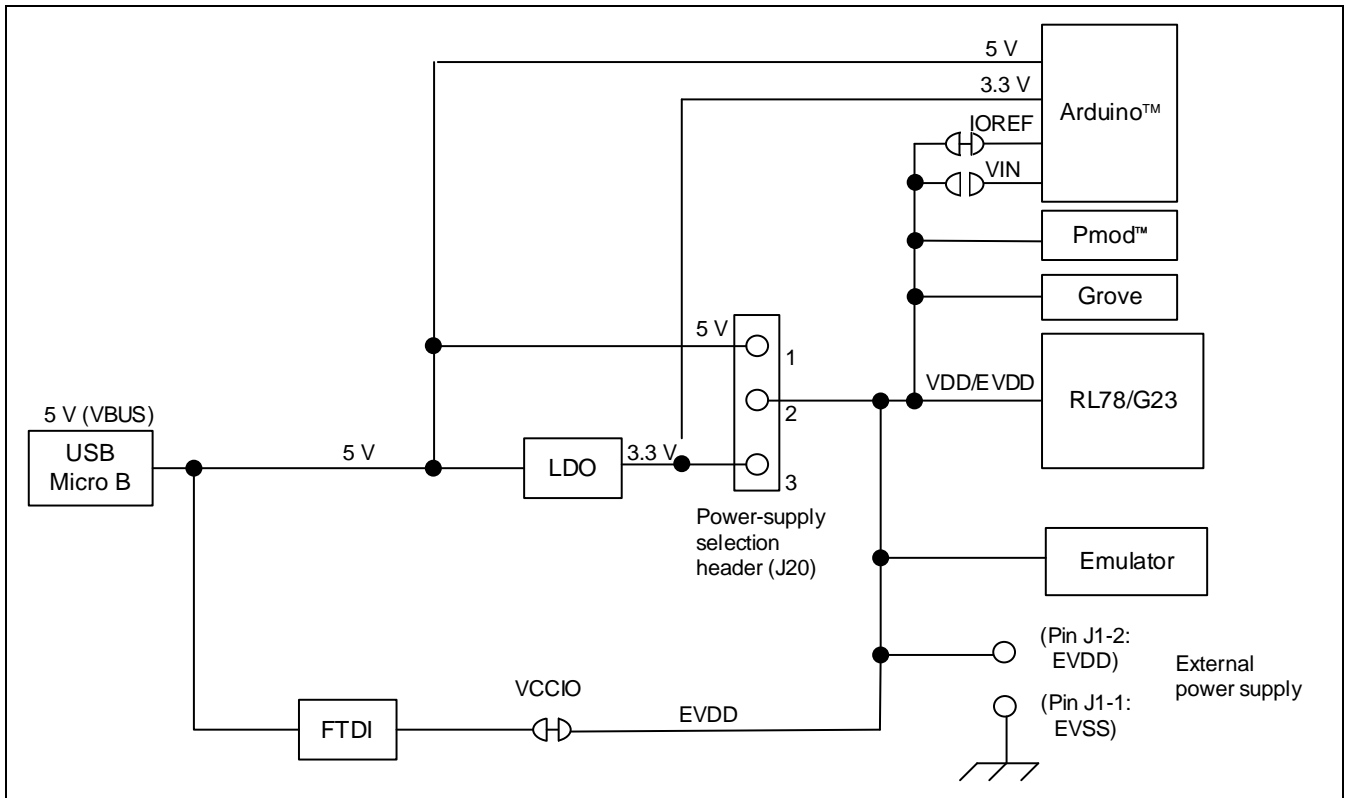


Figure 6-1 Block Diagram of the Power-Supply Circuit

6.4 Note on Using QE for Capacitive Touch

When you are using QE for Capacitive Touch (QE) with this product, change the circuits in the following cases (1) and (2).

For the methods for developing touch applications with the use of QE, refer to the application note “RL78 Family Using QE and SIS to Develop Capacitive Touch Applications” (R01AN5512).

(1) Usage with the serial connection function of QE

When the serial connection function of QE is to be used (serial communications via QE between the host PC and the USB connector on the board of this product), modify the board as follows.

- Pattern for cutting [RESET]: removed
- J19: pins 2-3 are short-circuit

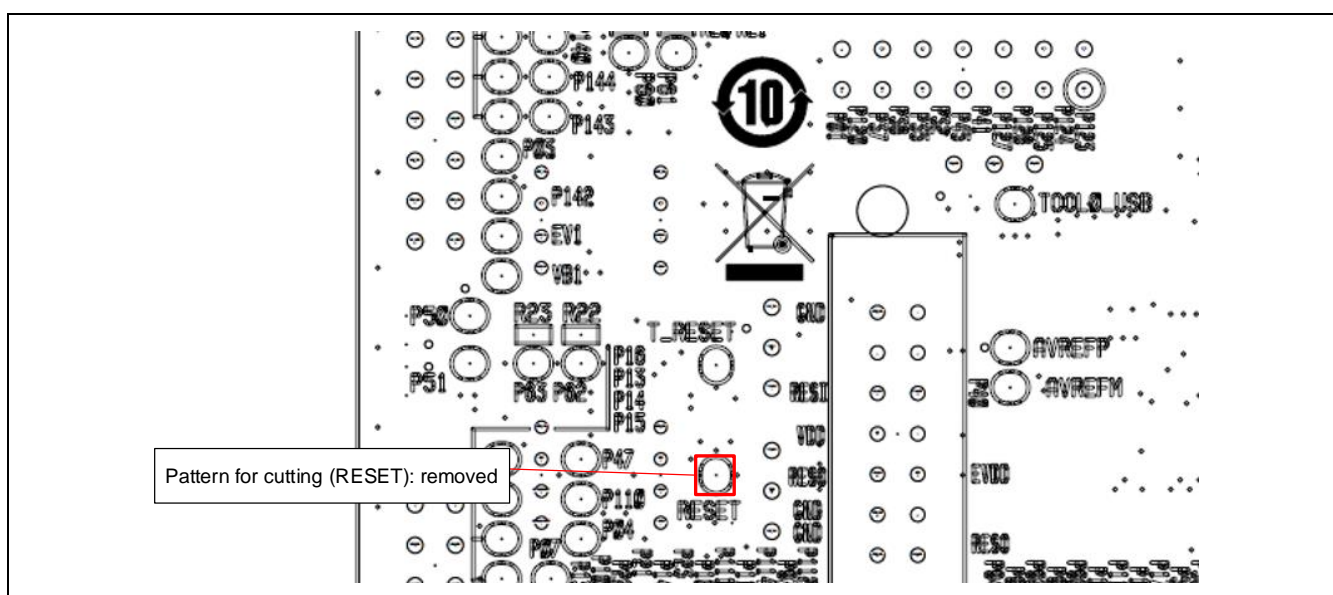


Figure 6-2 Settings for Use with the Serial Connection Function of QE (Soldered Side)

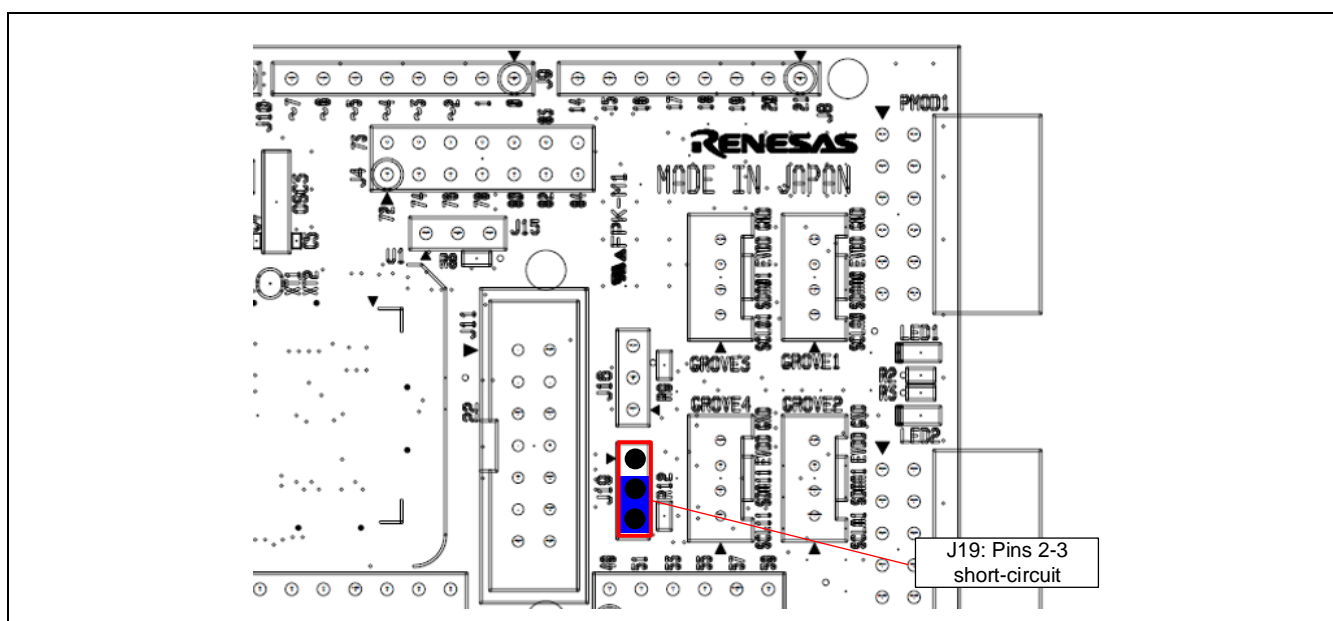


Figure 6-3 Settings for Use with the Serial Connection Function of QE (Top Side)

Note: When the circuit is configured for the case “(1) Usage with the serial connection function of QE” above, the following forms of usage are not available with QE.

- Debugging or programming through COM port debugging
- Reset by the reset switch
- Tuning the capacitive touch sensor via COM port debugging with the use of QE

(2) Not using the serial connection function of QE

As shown in Figure 5-15, Settings for Use with COM Port Debugging (Top Side), use QE with the circuit retaining its default connections.

After the changes to the circuit have been made as described under “(1) Usage with the serial connection function of QE”, if you want to restore the settings to those for COM port debugging (the usage described under note in the previous page), make the following change of setting as follows.

- J19: pins 1-2 are short-circuit

For the patterns for cutting that were removed, solder need not to be applied.

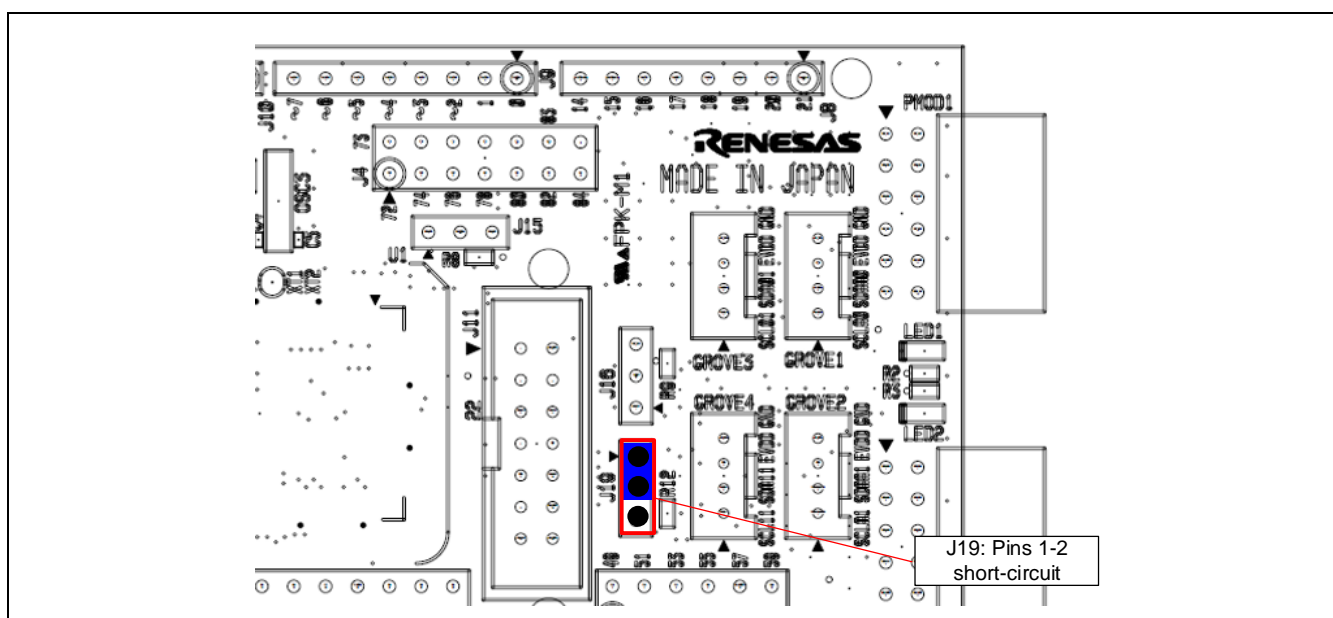


Figure 6-4 Settings for Use with COM Port Debugging (Top Side)

7. Developing Code

Use the e² studio or CS+, both of which support the evaluation MCU (RL78/G23 with 128 pins).

7.1 Using the e² studio

Figure 7-1 shows the settings of the e² studio when it is to be connected to the RL78/G23-128p Fast Prototyping Board.

- [Debug hardware]: Select [COM port (RL78)].
- [Target Device]: Select [R7F100GSN].
- [Connection with Target Board]:
 - [COM Port]: Select the COM port number for assignment to the RL78/G23-128p FPB from the pull-down list.
 - [Reset control pin]: Select [DTR].

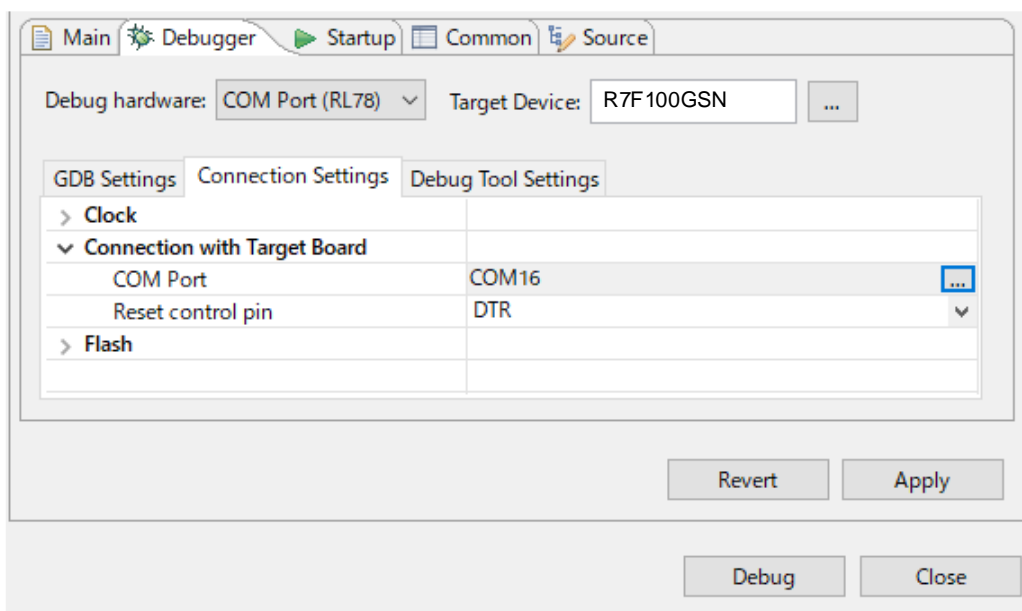


Figure 7-1 Settings of the e² studio

7.2 Using CS+

Figure 7-2 and Figure 7-3 show the settings of CS+ when it is to be connected to the RL78/G23-128p Fast Prototyping Board.

- [Using Debug Tool]:
Select [RL78 COM Port] from [Using Debug Tool] in the [Debug] menu.

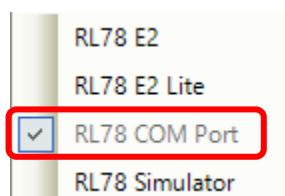


Figure 7-2 Panel for Selecting the Debug Tool

- [Connection with Target Board]:
[Communication port]: Select the COM port number for assignment to the RL78/G23-128p FPB from the pull-down list.
[Reset control pin]: Select [DTR].

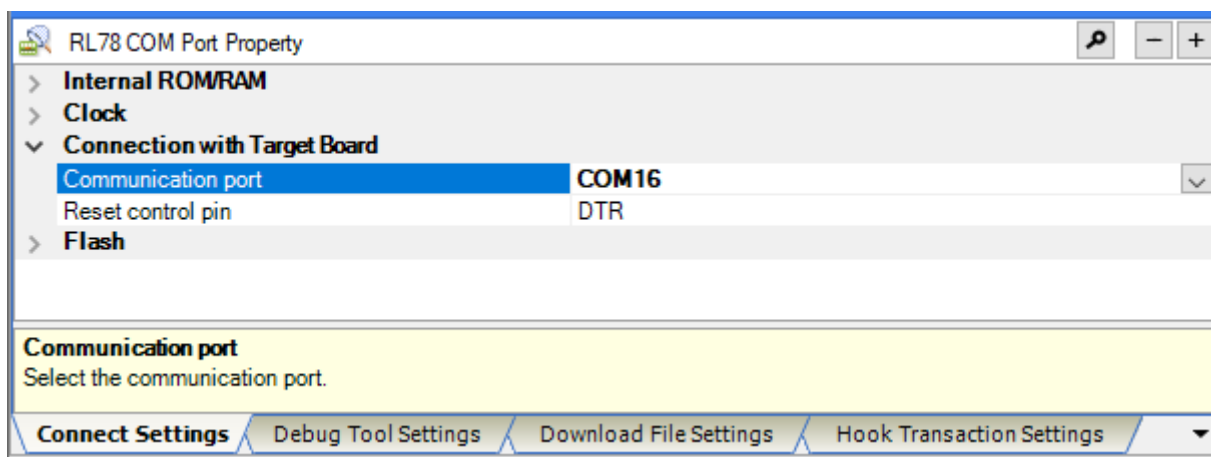


Figure 7-3 [Connect Settings] Tabbed Page of CS+

For details and points for caution, refer to the following application note for the RL78 COM port debug tool.

- RL78 Debugging Functions Using the Serial Port (R20AN0632)

8. Certifications

The RL78/G23-128p Fast Prototyping Board meets the following certifications/standards. See page 4 of this user's manual for the disclaimer and precautions.

8.1 EMC/EMI Standards

- CE Class A (EMC)



This product is herewith confirmed to comply with the requirements set out in the Council Directives on the Approximation of the laws of the Member States relating to Electromagnetic Compatibility Directive 2014/30/EU.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct this interference.

1. UKCA Class A (EMC)



This product is in conformity with the following relevant UK Statutory Instrument(s) (and its amendments): 2016 No. 1091 Electromagnetic Compatibility Regulations 2016.

Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures to correct this interference.

- Taiwan: Chinese National Standard 13438, C6357 compliance, Class A limits
- Australia/New Zealand AS/NZS CISPR 32:2015, Class A

8.2 Material Selection, Waste, Recycling and Disposal Standards

- EU RoHS
- China SJ/T 113642014, 10-year environmental protection use period.
- WEEE Directive (2012/19/EU) & The Waste Electrical and Electronic Equipment Regulations 2013
The WEEE (Waste Electrical and Electronic Equipment) regulations put responsibilities on producers for the collection and recycling or disposal of electrical and electronic waste. Return of WEEE under these regulations is applicable in the UK and European Union.



This equipment (including all accessories) is not intended for household use. After use the equipment cannot be disposed of as household waste, and the WEEE must be treated, recycled and disposed of in an environmentally sound manner.

Renesas Electronics Europe GmbH can take back end of life equipment. Register for this service at; <https://www.renesas.com/eu/en/support/regional-customer-support/weee>

8.3 Safety Standards

- UL 94V-0

9.Design and Manufacturing Information

The design and manufacturing information for the RL78/G23-128p Fast Prototyping Board is available on https://www.renesas.com/rl78g23-128p_fpb.

Table 2. RL78/G23-128p Fast Prototyping Board design and manufacturing

File Type	Content	Title
File (PDF)	Schematics	RL78/G23-128p Fast Prototyping Board Schematics
File (PDF)	BoM	RL78/G23-128p Fast Prototyping Board BoM List
File (Zip)	PCB Design Files	RL78/G23-128p Fast Prototyping Board Desing and Gerber Files

10. Website and Support

Visit the following URLs to learn about the kit and the RL78 family of microcontrollers, download tools and documentation, and get support.

RL78/G23-128p Fast Prototyping Board Resources	https://www.renesas.com/rl78g23-128p_fpb
RL78 Product Information	renesas.com/rl78
RL78 Product Support Forum	https://community.renesas.com/mcu-mpu/rl78/
RL78 Videos	https://www.renesas.com/us/en/products/microcontrollers-microprocessors/rl78-low-power-8-16-bit-mcus#videos_training
Renesas Support	renesas.com/support

Revision History	RL78/G23-128p Fast Prototyping Board User's Manual
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Rev.	Date	Description	
		Page	Summary
1.00	Sep.16.21	—	First Edition issued
1.10	Nov.5.24	10	Table 5-1 modified Par No. in the Circuit Schematic False: J6-8 True:J6-6, False: J6-9 True:J6-8
		11	Table 5-2 modified Par No. in the Circuit Schematic False: J4 True:J10
		17-18	Table 5-7 modified Name of Arduino Signal False:62-86 True:60-84
		-	Add Disclaimer, Precautions, Proprietary Notic. Add "8.Cetifications", "9.Design and Manufacturing Information", "10.Website and Support".

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