RL78/G13, 78K0/Kx2

Migration Guide from 78K0 to RL78: Serial interface UART6 to Serial Array Unit

Introduction

This application note describes how to migrate the Serial interface UART6 of the 78K0/Kx2 to the serial array unit (SAU) of the RL78/G13.

Target Device

RL78/G13, 78K0/Kx2

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Functions of Serial interface UART6 and Serial array unit

Table 1.1 shows the functions of the Serial interface UART6, and Table 1.2 shows the functions of the serial array unit (SAU).

Table 1.1 Functions of Serial interface UART6

Function	Explanation
Asynchronous serial interface (UART) mode	This is a start-stop synchronization function using two lines: serial data transmission (TxD6) and serial data reception (RxD6) lines.
LIN communication	LIN stands for Local Interconnect Network and is a low-speed (1 to 20 kbps) serial communication protocol designed to reduce the cost of an automobile network.

Table 1.2 Functions of Serial Array Unit

Function	Explanation
3-wire serial I/O	This is a clocked communication function that uses three lines: serial clock (SCK) and serial data (SI and SO) lines.
UART	This is a start-stop synchronization function using two lines: serial data transmission (TXD) and serial data reception (RXD) lines.
Simplified I^2C (only master function with a single master)	This is a clocked communication function to communicate with two or more devices by using two lines: serial clock (SCL) and serial data (SDA).
LIN Communication (Note)	LIN stands for Local Interconnect Network and is a low-speed (1 to 20 kbps) serial communication protocol designed to reduce the cost of an automobile network.

Note. The LIN-bus is accepted in UART2 (channels 0 and 1 of unit 1)

The serial interface UART6 incorporated in the 78K0/Kx2 has one channel of input and output pins for data transfer. Figure 1.1 shows a block diagram of the serial interface UART6.

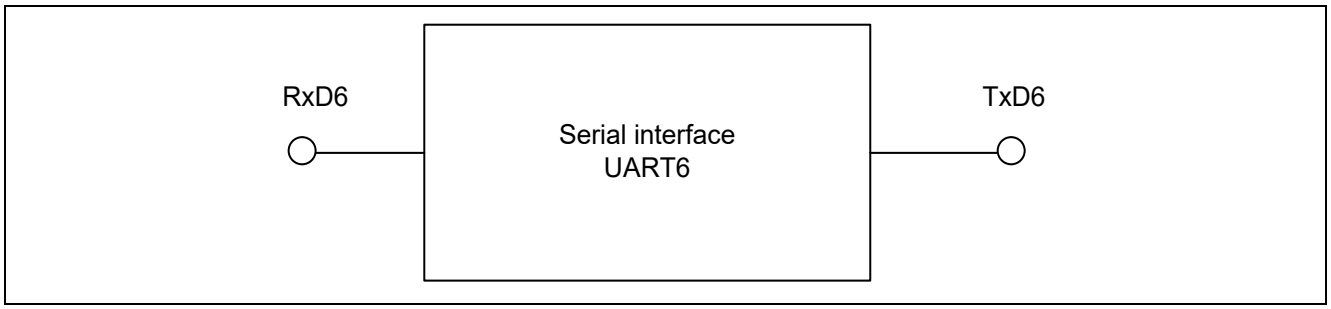

Figure 1.1 Block Diagram of Serial interface UART6

A single serial array unit (SAU) in the RL78/G13 has up to four serial channels. Each channel can achieve 3-wire serial (CSI), UART, and simplified I2C communication. UART communication is implemented by two serial channels of SAU.

Figure 1.2 shows a block diagram of the UART in the serial array unit (SAU) of the RL78/G13.

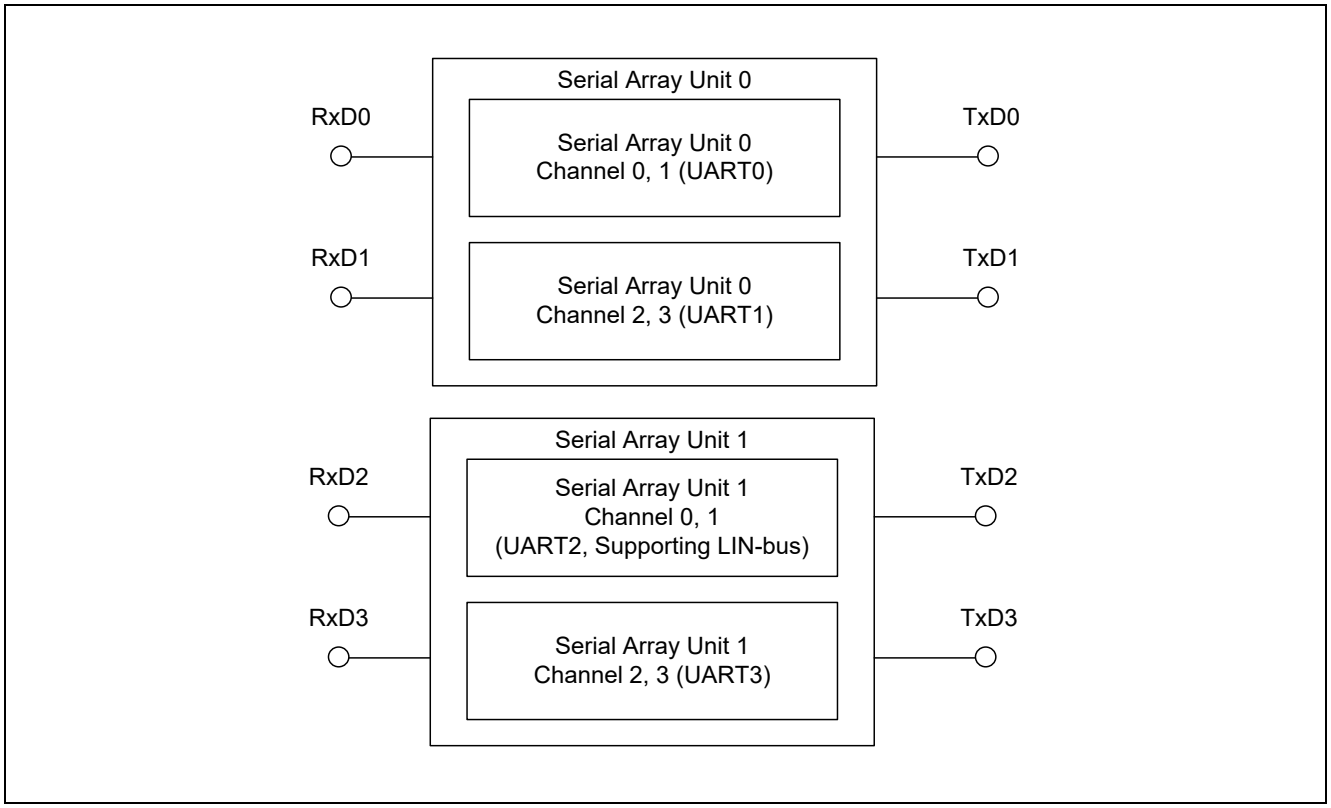

Figure 1.2 Block Diagram of Serial Array Unit (SAU) UART

Table 1.3 shows the SAU functions corresponding to the Serial interface UART6.

Table 1.3 Correspondence between Functions

78K0/Kx2 Serial interface UART6	RL78/G13 Serial Array Unit (SAU)
-	3-wire serial I/O
Asynchronous serial interface (UART) mode	UART
-	Simplified I^2C
LIN Communication (Uses external interrupt and 16-bit timer/event counter 00)	LIN Communication (Uses external interrupt and Channel 7 of timer array unit)

The asynchronous serial interface (UART) mode of the Serial interface UART6 correspond to the UART of the SAU.

The LIN Communication mode of the Serial interface UART6 correspond to the LIN Communication of the SAU.

2. Difference between Serial interface UART6 and Serial Array Unit

Table 2.1 and Table 2.2 shows the differences between the UART.

Table 2.1 Differences between UART (1/2)

Item	78K0/Kx2 UART6	RL78/G13 Serial Array Unit (SAU) UARTq
Transfer data length	7 bits, 8 bits	7 bits, 8 bits, 9 bits (Note)
Transfer data length	625kbps	5.3Mbps
First bit specification	- LSB first - MSB first	- LSB first - MSB first
Selection of parity bit	- Does not output the parity bit - Outputs 0 parity - Outputs even parity - Outputs odd parity	- Does not output the parity bit - Outputs 0 parity - Outputs even parity - Outputs odd parity
Selection of stop bit	Transmission 1 bit, 2 bits Reception 1 bit	Transmission 1 bit, 2 bits Reception 1 bit
Transfer data reverse function	Yes (Transmit data only) - Non-inverted output, non-inverting reception (default) - Inverted output, non-inverting reception	Yes - Non-reverse output, Non-reverse input (default) - Reverse output, Reverse input
Continuous transmission function	Yes Use TXBF6 bit	Yes Use buffer empty interrupt (In Continuous Transmission Mode)
Noise elimination	Data are sampled with the base clock (f_{XCLK0}), and when two sampled values match, the value is determined as the received data.	Data are sampled with the operating clock (f_{MCK}) of the target channel, and when two sampled values match, the value is determined as the received data. Note that the SNFENq0 bit in the NFEN0 register should be set to 1.
Disables operation	ASIM6 register POWER6 = 0	STm register STmn = 1
Enables operation	ASIM6 register POWER6 = 1	SSm register SSmn = 1
Selection of operation mode	- Transmission - Reception - Transmission/reception (Full-duplex operation)	- Transmission - Reception - Transmission/reception (Full-duplex operation)
Transmit buffer register	TXB6 register	Lower 8/9 bits of SDRmn register (Note)
Receive buffer register	RXB6 register	Lower 8/9 bits of SDRmn register (Note)

Note. Only the following UARTs can be specified for the 9-bit data length.

- 20 to 64-pin products: UART0
- 80 to 128-pin products: UART0, UART2

Remarks1. m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), q: UART number (q = 0 to 3)

Remarks2. The functions incorporated and port functions to use are different depending on the product. For details, refer to the appropriate user's manuals (hardware).

Table 2.2 Differences between UART (2/2)

Item	78K0/Kx2 UART6	RL78/G13 Serial Array Unit (SAU) UARTq
Data transmission is started	Write transmit data to TXB6 register. Set transmit data to TXB6 at least one base clock (f_{XCLK6}) after setting TXE6 = 1.	Write transmit data to SDRmn register.
Data reception is started	When the start bit has been detected. Set POWER6 to 1 and then set RXE6 to 1 while a high level is input to the RxD6 pin.	When the start bit has been detected.
Interrupt	Transmission - Transmission completion interrupt request (INTST6) Reception - Transfer end interrupt (INTSR6) - Communication error occurrence (INTSRE6)	Transmission - Transfer end or buffer empty interrupt (INTSTq) Reception - Transfer end interrupt (INTSRq) - Communication error occurrence (INTSREq)
Interrupt occur timing	Transmission - After the last stop bit is transmitted. For example, when the stop bit length is set to two bits, an interrupt occurs when the second stop bit is transmitted. Reception - When the stop bit is received (including the case where a parity error or framing error occurs). - When an overrun error occurs.	Single-transmission mode - After the last stop bit is transmitted. Continuous transmission mode - When the transmit data is transferred from the SDRmn register to the shift register. Reception - When the stop bit is received (including the case where a parity error or framing error occurs). - When an overrun error occurs.
Reception errors	- Parity error - Framing error - Overrun error	- Parity error - Framing error - Overrun error
Clearing the error flag	Read ASIS6 register and then read RXB6 register.	Write 1 to the FECTmn, PECTmn, and OVCTmn bits in the SIRmn register.
Serial data input pin	RxD6 pin	RxDq pin
Serial data output pin	TxD6 pin	TxDq pin

Remarks1. m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), q: UART number (q = 0 to 3)

Remarks2. The functions incorporated and port functions to use are different depending on the product. For details, refer to the appropriate user's manuals (hardware).

3. Register Compatibilities

Table 3.1 to Table 3.3 compares the registers for the 78K0/Kx2 Serial interface UART6 and the registers for the RL78/G13 Serial Array Unit used as UART.

Table 3.1 Comparison between Registers (1/3)

Item	78K0/Kx2	RL78/G13
Clock supply to serial array unit	None	PER0 register SAUmEN bit
Disables operation	ASIM6 register POWER6 bit	STm register STmn bit
Enables operation	ASIM6 register POWER6 bit	SSm register SSmn bit
Indication of operation enable/stop status	None	SEm register SEmn bit
Mode control Selection	ASIM6 register TXE6 bit, RXE6 bit	SCRmn register TXEmn bit (Note1), RXEmn bit (Note1)
Setting of parity bit	ASIM6 register PS61 bit, PS60 bit	SCRmn register PTCmn1 bit, PTCmn0 bit
First-bit specification	ASICL6 register DIR6 bit	SCRmn register DIRmn bit
Specifies character length of transmit/receive data	ASIM6 register CL6 bit	SCRmn register DLSmn1 bit (Note2), DLSmn0 bit
Specifies number of stop bits of transmit data	ASIM6 register SL6 bit	SCRmn register SLCmn1 bit (Note3), SLCmn0 bit
Selects inversion of the level of the transmit data	ASICL6 register TXDLV6 bit	SOLm register SOLmn bit (Note3)
Controls inversion of level of receive data	None	SMRmn register SISmn0 bit (Note4)
Enables/disables occurrence of reception completion interrupt in case of error	ASIM6 register ISRM6 bit	SCRmn register EOCmn bit
Status flag indicating parity error	ASIS6 register PE6 bit	SSRmn register PEFmn bit (Note4)
Status flag indicating framing error	ASIS6 register FE6 bit	SSRmn register FEFmn bit (Note5)
Status flag indicating overrun error	ASIS6 register OVE6 bit	SSRmn register OVFmn bit (Note5)

Note1. UART Transmission: TXEmn = 1, RXEmn = 0 (mn = 00, 02, 10, 12)

UART Reception: TXEmn = 0, RXEmn = 1 (mn = 01, 03, 11, 13)

Note2. UART0 (SCR00 and SCR01 registers) and UART2 (SCR10 and SCR11 registers) for 80 to 128-pins products only. Others are fixed to 1.

Note3. mn = 00, 02, 10, 12 (Even channel is UART transmission function)

Note4. mn = 01, 03, 11, 13 (Odd channel is UART reception function)

Note5. In the UART mode, this flag is valid only during reception.

Remarks1. m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), q: UART number (q = 0 to 3)

Remarks2. The functions incorporated and port functions to use are different depending on the product. For details, refer to the appropriate user's manuals (hardware).

Table 3.2 Comparison between Registers (2/3)

Item	78K0/Kx2	RL78/G13
Transmit buffer register	TXB6 register	Lower 8/9 bits (Note3) of SDRmn register (Note1)
Receive buffer register	RXB6 register	Lower 8/9 bits (Note3) of SDRmn register (Note2)
Buffer register status indication flag	ASIF6 register TXBF6 bit	SSRmn register BFFmn bit(Note1)
Communication status indication flag	ASIF6 register TXSF6 bit	SSRmn register TSFmn bit
Base clock selection	CKSR6 register TPS63 - TPS60 bit	SPSm register PRSmk3 - PRSmk0 bit SMRmn register CKSmn bit, CCSmn bit
Output clock selection of 8-bit counter	BRGC6 register	None
Transfer clock setting by dividing the operation clock	None	Upper 7 bits of SDRmn register
Switching input of timer	ISC register ISC1 bit	ISC register ISC1 bit
Switching external interrupt input	ISC register ISC0 bit	ISC register ISC0 bit
SBF reception status flag	ASICL6 register SBRF6 bit	None
SBF reception trigger	ASICL6 register SBRT6 bit	None
SBF transmission trigger	ASICL6 register SBTT6 bit	None
SBF transmission output width control	ASICL6 register SBL62 - SBL60 bit	None

Note1. mn = 00, 02, 10, 12 (Even channel is UART transmission function)

Note2. mn = 01, 03, 11, 13 (Odd channel is UART reception function)

Note3. Only the following UARTs can be specified for the 9-bit data length.

- 20 to 64-pin products: UART0
- 80 to 128-pin products: UART0, UART2

Remarks1. m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), q: UART number (q = 0 to 3)

Remarks2. The functions incorporated and port functions to use are different depending on the product. For details, refer to the appropriate user's manuals (hardware).

Table 3.3 Comparison between Registers (3/3)

Item	78K0/Kx2	RL78/G13
Selection of start trigger source	None	SMRmn register STSmn bit
Setting of operation mode	None	SMRmn register Set MDmn2 bit to 0, MDmn1 bit to 1
Selection of interrupt source of channel n	None	SMRmn register MDmn0 bit
Selection of data and clock phase in CSI mode	None	SCRmn register Set DAPmn bit to 0, CKPmn bit to 0
Clear trigger of framing error	None	SIRmn register FECTmn bit
Clear trigger of parity error flag	None	SIRmn register PECTmn bit
Clear trigger of overrun error flag	None	SIRmn register OVCTmn bit
Serial output enable/stop	None	SOEm register SOEmn bit
Serial clock output	None	SOm register CKOmn bit
Serial data output	None	SOm register SOmn bit
Selection of whether to enable or disable the generation of communication error interrupts in the SNOOZE mode	None	SSCm register SSECm bit
Setting of the SNOOZE mode	None	SSCm register SWCm bit
Use of noise filter	None	NFEN0 register Set SNFENq0 to 1

Remarks1. m: Unit number (m = 0, 1), n: Channel number (n = 0 to 3), q: UART number (q = 0 to 3)

Remarks2. The functions incorporated and port functions to use are different depending on the product. For details, refer to the appropriate user's manuals (hardware).

4. Sample Code for Serial Array Unit

The sample code for Serial Array Unit is explained in the following application notes.

- RL78/G13 Serial Array Unit (UART Communication) CC-RL (R01AN2517)
- RL78/G13 DMA Controller (UART Sequential Reception) CC-RL (R01AN2835)
- RL78/G13 Self-Programming (Received Data via UART) CC-RL (R01AN2761)
- RL78/G13 Low-power Consumption Operation (UART in SNOOZE Mode) CC-RL (R01AN2713)

5. Documents for Reference

User's Manual:

- RL78/G13 User's Manual: Hardware (R01UH0146)
- 78K0/Kx2 User's Manual: Hardware (R01UH0008)

  The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News:

The latest information can be downloaded from the Renesas Electronics website.

Revision History

Rev.	Data	Description	
		Page	Summary
1.00	Jul.24, 2019	-	First edition issued

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.

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 claims 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, drawings, charts, programs, algorithms, and 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 reverse engineer 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, copying or reverse engineering.
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; 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.

   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or 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 damage (space system; 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 any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
6. When using 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 dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of 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. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a 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. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating 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. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using 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 comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
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.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.