# RENESAS

## R-IN32M4 Series

### R-IN32M4-CL3 Replacement Guide

## OVERVIEW

This document describes the differences between industry ethernet communication LSI R-IN32M4-CL2 (CL2) and R-IN32M4-CL3 (CL3), and the precautions when replacing. This document is for users who have developed CC-Link IE Filed Network intelligent device stations or remote device stations using CL2.

The following shows the combinations of the development patterns in replacing CL2 with CL3 and the references.

## Operation confirmation device

R-IN32M4-CL3

Contents

## 1.  Overview

This document describes the differences between industry ethernet communication LSI R-IN32M4-CL2 (CL2) and R-IN32M4-CL3 (CL3), and the precautions when replacing. This document is for users who have developed CC-Link IE Filed Network intelligent device stations or remote device stations using CL2.

The following shows the combinations of the development patterns in replacing CL2 with CL3 and the references.

Table 1.1    Development patterns

| Development | Former LSI | Former development devices | New LSI | New development devices | Note |
|---|---|---|---|---|---|
| 1 | CL2 | CC-Link IE Field Intelligent device station/ Remote device station | CL3 | CC-Link IE Field Intelligent device station/ Remote device station | Refer to 2.1 |
| 2 | CL2 | CC-Link IE Field Intelligent device station/ Remote device station | CL3 | CC-Link IE TSN Remote station | Refer to 2.2 |

## 2.   Replacement steps

The following is an overview of the replacement procedure.

## 2.1   Replacement of CL2 (CC-Link IE Field) with CL3 (CC-Link IE Field)

### 2.1.1   CL2 application circuit change (H/W related)

The differences in communication LSI and changes in cl2 application circuits are described in this article, "3 H/W-Related Differences."

### 2.1.2   Modify theCL2 sample program (S/W related)

The CL2 sample code (CC-Link IE Field) Cc-Link IE Field communicates the same process, so all user program parts can be diverted.

However, the driver part must be replaced because theh/w-dependent processing is different. Merge user changes, such as OS-related resource settings(kernel_cfg.c).

The differences and diversions of CL2 sample code are described in this article, "Differences between Appendix A CL2(CC-Link IE Field) and CL3 (CC-Link IE Field)."



Fig 2.1   Sample program modify and Replacement Image (CC-Link IE Field  →  CC-Link IE Field)

## 2.2   Replacement from CL2 (CC-Link IE Field) to CL3 (CC-Link IE TSN)

### 2.2.1   CL2 application circuit change (H/W related)

The differences in communication LSI and changes in cl2 application circuits are described in this article, "3 H/W-Related Differences."

### 2.2.2   Modify the CL2 sample program (S/W related)

The CL2 sample code(CC-Link IE Field)describes the communication process of the CC-Link IE Field. Cannot be diverted to CC-Link IE TSN. Both the user program and driver departments need to be replaced.

However, some of the user program parts (user-created processing) can be diverted.

The differences and diversions of CL2 sample code are described in this article, "Differences between Appendix B CL2 (CC-Link IE Field) and CL3 (CC-Link IE TSN)."
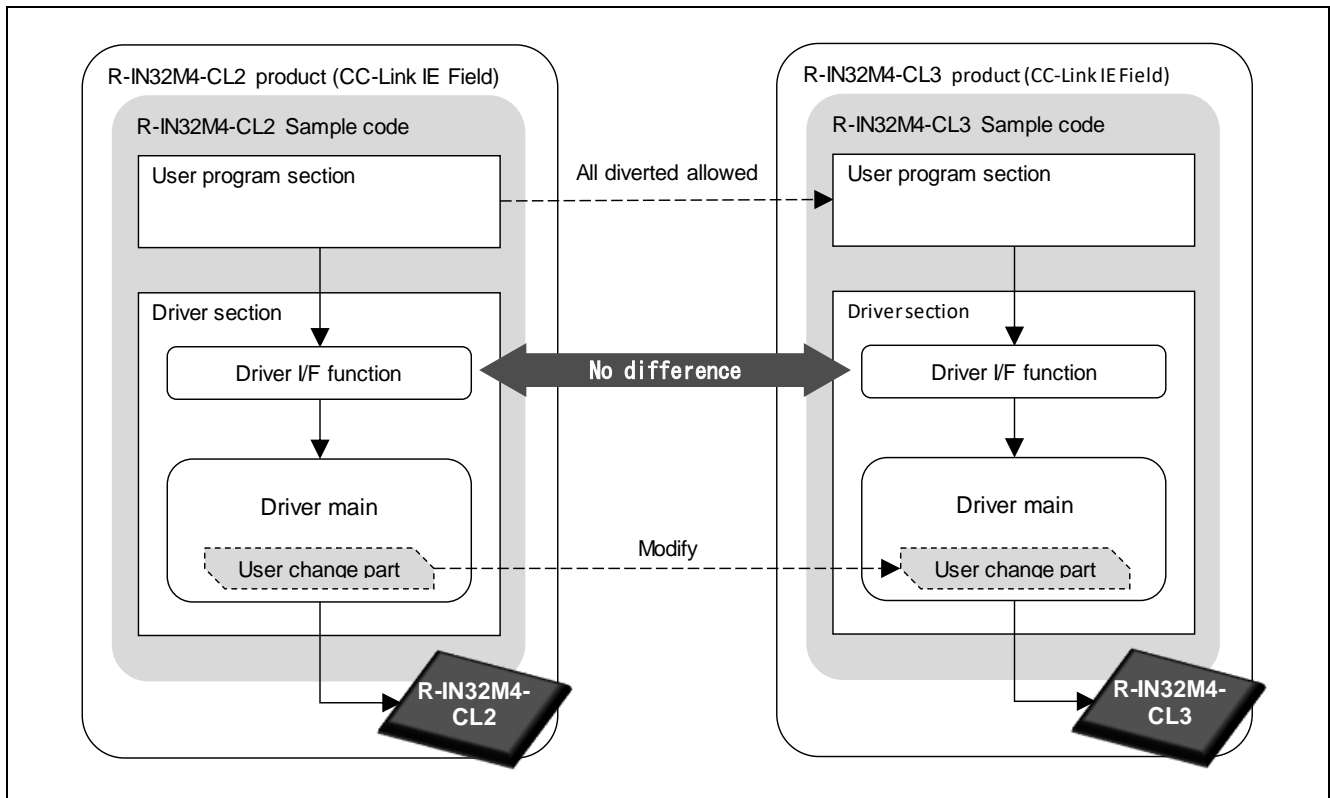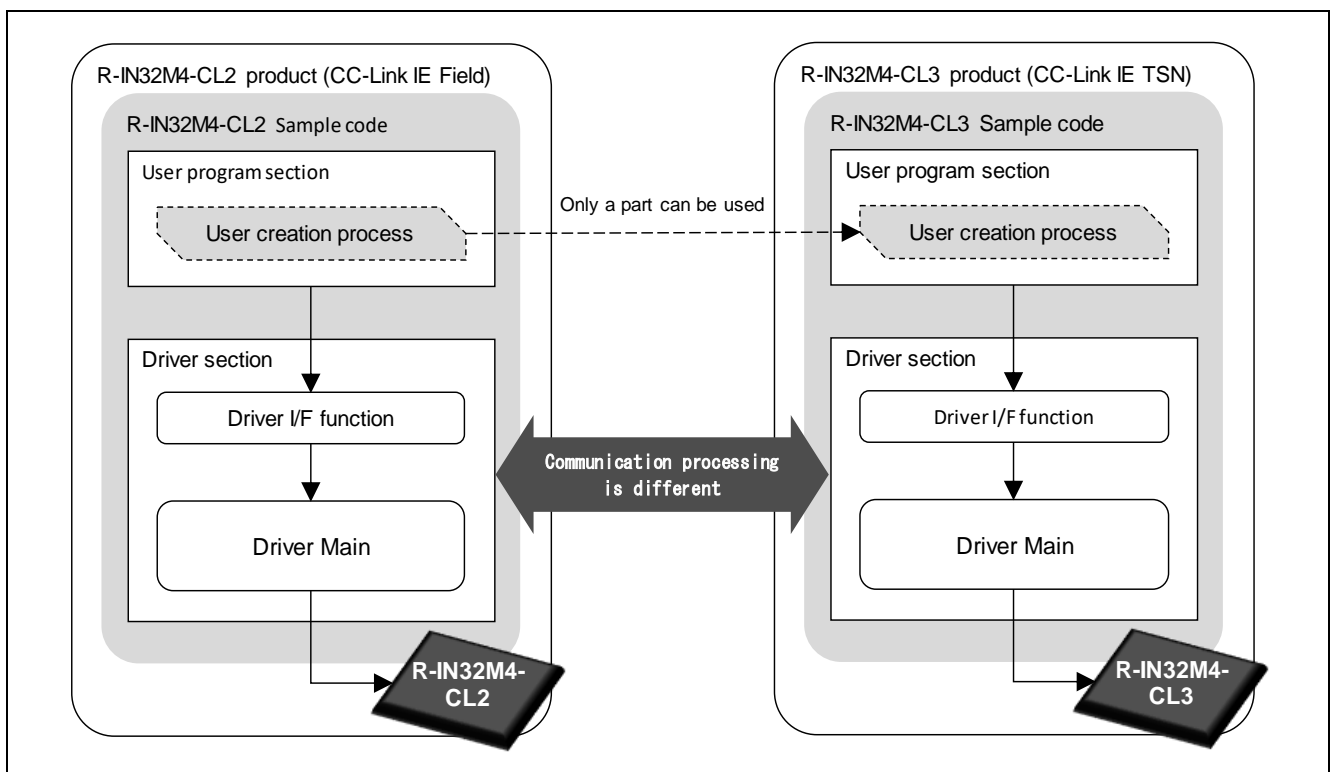


Fig 2.2    Sample program modify and Replacement Image (CC-Link IE Field  →  CC-Link IE TSN)

## 3.　H/W related differences

CL3 has pin compatibility with CL2, but there are the following differences. In order to replace CL3 on the CL2 board, it is necessary to modify part of the CL2 board. Differences and contents are shown below.

Table 3.1　Differences in specifications when replacing CL2 with CL3

| No. | Item | CL2 | CL3 | CL2 board modification necessity | Reference |
|---|---|---|---|---|---|
| 1 | Power supply voltage | 1.0V±0.05V | 1.15V±0.06V | Necessity | 3.1.1 |
| 2 | Crystal oscillator input-output (OSCTH=0) | XT1 pin：input<br>XT2 pin：output | XT1 pin：output<br>XT2 pin：input | Necessity | 3.1.2 |
| 3 | 2.5V internal regulator | No | Yes | Unnecessity | 3.1.3 |
| 4 | A/D converter | Yes | No | Unnecessity (*) | 3.1.4 |
| 5 | Buffer driving ability | 3mA/6mA/9mA | 12mA/8mA/10mA | Unnecessity | 3.1.5 |
| 6 | I/O buffer Pull-up/pull-down resistor value | Pull-Up　：50kΩ<br>Pull-down：50kΩ | Pull-up　：130kΩ<br>Pull-down：160kΩ | Unnecessity | 3.1.6 |
| 7 | Input buffer type | Normal | Schmitt | Unnecessity | 3.1.7 |
| 8 | 2.097152MHz clock | External supply | External supply or Internal generation | Unnecessity | 3.1.8 |
| 9 | Pin differences | ― | ― | Unnecessity | 3.1.9 |
| 10 | Register differences | ― | ― | Unnecessity | 3.1.10 |

*：When the AIN[7:0] pins of CL2 are connected to GND or open, no change is required.

## 3.1  Differences and precautions for replacement

These sections describe hardware-related differences and precautions for replacement.

### 3.1.1  Power supply voltage

Core voltage in CL3 changes from 1.0V+/-0.05V to 1.15V+/-0.06V. Generate 1.15V+/-0.06V by changing constant of power generation circuit.

### 3.1.2  Crystal oscillator input-output (OSCTH=0)

When crystal oscillator is used in CL3, input and output of XT1 and XT2 are reversed. Change the resistor position as shown below. Since oscillator circuit characteristics change, the external constant including the existence and the insertion position of the resistor must be revalidated.
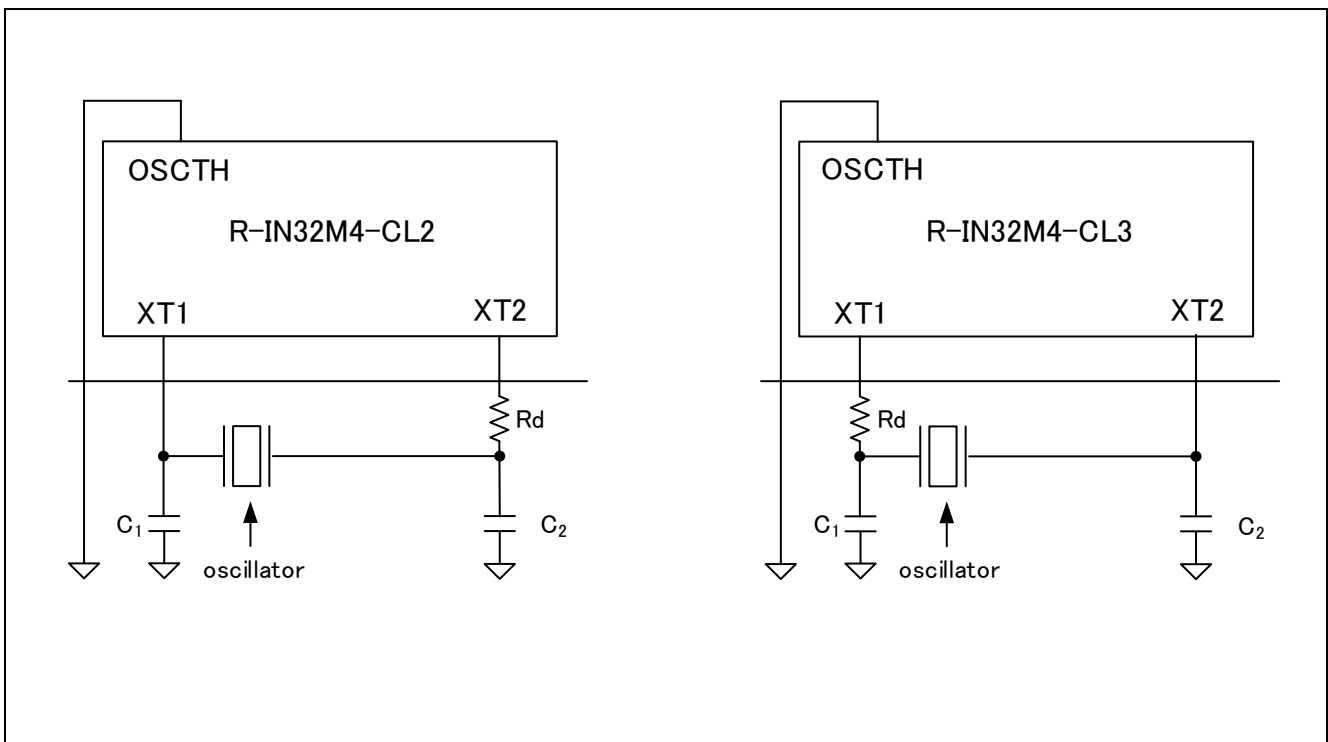


Fig 3.1   CL2, CL3 resistor position

### 3.1.3  2.5V internal regulator

CL3 has the internal regulator, but when CL3 is replaced on the CL2 board, the external 2.5V supply is used as it is. Thus, there is no need to modify the CL2 board.

### 3.1.4  A/D converter

Although CL2 has A/D converter, CL3 doesn't have it. Connect the AIN[7:0] pins of CL2 to GND or leave them open.

### 3.1.5 Buffer driving ability

In CL3, the pin driving ability has been changed as follows.

Table 3.1.5   Buffer driving ability

| Target pins | CL2 | CL3 |
|---|---|---|
| PHY0_LED0、PHY1_LED0 | 3mA | 12mA |
| CSZ0、RDZ、WRSTBZ、WRZ0、WRZ1、RSTOUTZ、<br>A2-A20、D0-D15、<br>P00-P07、P10-P17、P20-P27、P30-P37、P40-P47、P50-P52、P57、P60-P67、P70-P77、<br>RP00-RP07、RP10-RP17、RP20-RP27、RP30-RP37、<br>EXTP0-EXTP9、<br>TRACECLK、TRACEDATA0-TRACEDATA3、TMS、TDO | 6mA | 8mA |
| BUSCLK | 9mA | 10mA |

### 3.1.6 I/O buffer Pull-up/pull-down resistor value

In CL3, the I/O buffer pull-up/pull-down resistor value has been changed as follow.

Table 3.1.6   I/O buffer pull-up/pull-down resistor value

| Pull-up/Pull-down | CL2 | CL3 |
|---|---|---|
| Pull-up resistor | 50kΩ | 130kΩ |
| Pull-down resistor | 50kΩ | 160kΩ |

### 3.1.7 Buffer type

In CL3, the input buffer type has been changed as follows.

Table 3.1.7   Input buffer type

| Target pins | CL2 | CL3 |
|---|---|---|
| P20-P23、P25-P27、P30-P33、P44、P53-P56、P60-P67、<br>RP00-RP04、RP20-RP27 | Normal input | Schmitt input |

### 3.1.8 2.097152MHz clock

CL3 can select 2.097152MHz clock with the CLK2MSEL pin, but when CL3 is replaced on the CL2 board, the external 2.097152MHz clock is selected as it is. Thus, there is no need to modify the CL2 board.

RENESAS

### 3.1.9 Pin differences

In CL3, the following pins have been changed as follows. there is no need to modify the CL2 board. (No.1 needs to be confirmed)

Table 3.1.9 Pin differences

| No | CL2 | CL3 | Pin position | Remarks |
|---|---|---|---|---|
| 1 | AIN[7:0] | GND/OPEN | J22, J21, K22, K21, L22, L21, L20, L19 | Refer to 3.1.4<br>When the AIN[7:0] are connected to GND or leave them open, there is no need to modify board. |
| 2 | AVREFP | VDD33 | K20 | — |
| 3 | AVREFM | GND | J20 | — |
| 4 | AVDD | VDD33 | K19 | — |
| 5 | AGND | GND | J19 | — |
| 7 | TEST1<br>: Renesas test pin (GND connection) | GND | U6 | — |
| 8 | TEST2<br>: Renesas test pin (OPEN) | GND/OPEN | L10 | — |
| 9 | TMC1<br>: Renesas test pin(GND connection) | CLK2MSEL<br>: 2MHz clock selection<br>  0 : CCI_CLK2_097M<br>  1 : internal generated clock | R19 | Refer to 3.1.8 |
| 10 | TMC2<br>: Renesas test pin(GND connection) | TEST7<br>: Renesas test pin (GND connection) | P19 | — |
| 11 | GND | REG_EN | E6 | — |
| 12 | GND | AGND | E5, E4 | — |
| 13 | GND | AVDDREG_33 | G6 | — |
| 14 | GND | VDDREG_33 | G5 | — |
| 15 | GND | REG_OUT | F4 | — |
| 16 | GND | REG_FB | H4 | — |
| 17 | VDD33_GPHY | VDD33 | J9, J8, K9, L9, M9, N9, P9, P8 | — |
| 18 | VDD10 | VDD11 | H17, H16, H15, H14, H13, J17, J13, J7, J6, K17, K13, L17, L13, M17, M13, N17, N13, P18, P17, P13, P7, P6, R17, R16, R15, R14, R13 | — |
| 19 | VDD1A | VDD11A | K3, L3 | — |

### 3.1.10 Register differences

In CL3, the following registers of CC-Link, A/D converter and Motor control (TAPA/PIC) are removed from CL2. In addition, the following registers cannot be used. Do not write access these addresses and use the default values.

Table 3.1.10   Register Differences

| Register Name | Symbol | Address |
|---|---|---|
| PHY reset switching register | PHYRSTCH | BASE + 1224H |
| CC-Link IE Field Clock Gate Register | CIECLKGTD | BASE + 0938H |
| SRAM Bridge Select Register | SRAMBRSEL | BASE + 0804H |
| TOUTD output stop control register | STOP_TOUTD | BASE + 1260H |
| TOUTD output select register | TOUTD_SEL | BASE + 1264H |
| Error detection signal select register 0 | ERRDETSEL0 | BASE + 1268H |
| Error detection signal select register 1 | ERRDETSEL1 | BASE + 126CH |

Appendix

## S/W Related Differences

## A     Difference between CL2 (CC-Link IE Field) and CL3 (CC-Link IE Field)

In replacing CL2(CC-Link IEField) to CL3(CC-Link IEField), Shows the differences between S/W-related (sample code) and diversion.

### A-1     Differences in user program part

There is no difference in the user program part. All user program parts of the CL2 sample code can be diverted to CL3.

### A-2     Driver part differences

The driver part is different from the driver interface function and the driver callback function, but there is a difference in the driver body.

The change file of the driver part, the contents of the change, and the reason are shown below.

Table A.1    Definition of change reason number

| Number | Definition |
|---|---|
| 1 | It is a change of S/W definition and control with h/w change to CL3 such as ports and registers. |
| 2 | It is a change by the difference of the development environment. |
| 3 | Other (review and refactoring) changes. |

Table A.2    Change file

| No. | Folder under (root) ¥ Device ¥ Renesas ¥ RIN32M4 | | | File name | What's changed | Change Reason |
|---|---|---|---|---|---|---|
| 1 | Include | | | RIN32M4_CL3.h [1] (Before change RIN32M4.h) | Interrupt, change register definition | 1, 3 |
| 2 | Source¥Project¥TS-R-IN32M4-CL3 (TS-R-IN32M4-CL2 before change) | | | board_init.c | Port initialization, change control | 1 |
| 3 | | | | board_init.h | | |
| - | | cie_intelligent_device also cie_remote_device | | - | - | - |
| 4 | | | IAR | main_jp.ewp | Changing target devices Setting change due to IAR EWARM version up | 1, 2 |
| 5 | | | root | kernel_cfg.c | Stack resizing of main task | 3 |
| 6 | | | | main.c | Adding and changing CC-Link IE-related register control | 1 |
| 7 | | | root¥Japanese¥driver¥src also root¥English¥driver¥src | R_IN32D_reg.c | | |
| 8 | | | | R_IN32D_led.c | Add or change LED-related register control | 1 |
| 9 | | | | R_IN32M4_0.h | | |
| 10 | | | | R_IN32M4_1.h | | |

*1)   The contents that were defined in RIN32M4.h in CL2 are renamed in RIN32M4_CL3.h, with the file
      name changed in CL3. However, by including RIN32M4_CL3.h in RIN32M4.h, there is no change in the
      header file name to be included in the C file.

## B    Difference between CL2 (CC-Link IE Field) and CL3 (CC-Link IE TSN)

In replacing CL2(CC-Link IEField) to CL3(CC-Link IE TSN), Shows the differences between S/W-related
(sample code) and diversion.

### B-1    Differences in user program part

Indicates the difference and compatibility of the user program part. In addition, it shows the precautions at
the time of the diversion.

Table B.1    Definition of compatibility symbol

| Compati bility | Definition |
|---|---|
| ○ | The processing in the function is the same as before. (Variable prefixes and subroutine prefixes in functions are different from conventional ones.) It can be diverted as it is. |
| △ | The processing in the function is different from the past (The function function and purpose are the same, but the processing in the function is different.) Review the contents of the function described in Chapter 5 of "Creating a User Program" in "R-IN32M4-CL3 User's Manual CC-Link IE TSN" to determine whether it can be diverted and consider alternative processing if necessary. |
| ×1 | It's a newly created function that's not new. Review the contents of the appropriate function described in Chapter 5 of "Creating a User Program" in "R-IN32M4-CL3 User's Manual CC-Link IE TSN" and implement the new processing as needed. |
| ×2 | This is a function that was previously removed. Cc-Link IE TSN is a feature you don't need. |

Table B.2    Initial related

| No. | Project (Processing described in CL2) | CL2 function name | CL3 function name | Compa tibility |
|---|---|---|---|---|
| 1 | Main processing *1 | iUserMainRoutine | Main processing per task | ×1 |
| 2 | Initialization process *2 | iUserInitialization | iUserInitialization | △ |
| 3 | Communication start processing | iUserStart | iUserStart | ○ |

*1)   Distribute "User application main process" in iUserMainRoutine to main process in each task.
*2)   Use user processing (processing to obtain the H / W switch value on the CL2 application circuit) for
      CL3 IP address setting.

RENESAS

Table B.3   Cyclic transmission processing related

| No. | Project (Processing described in CL2) | CL2 function name | CL3 function name | Compa tibility |
|-----|---------------------------------------|-------------------|-------------------|----------------|
| 1 | Cyclic transmission stop processing | UserStopCyclic | No corresponding function | ×2 |
| 2 | MyStatus from master bureau and cyclic reception Processing※1 | UserReceiveCyclic | UserReceiveCyclic | △ |
| 3 | MyStatus send process | UserSendMyStatus | UserSendNodeStatus | ○ |
| 4 | Cyclic send process | UserSendCyclic | UserSendCyclic | △ |
| 5 | Communication state update process | UserUpdateStatus | UserUpdateStatus | ○ |
| 6 | Cyclic Transmission Status Update Processing | UserGetCyclicStatus | UserGetCyclicStatus | ○ |
| 7 | Token frame reception process addressed to your station | iUserMyStaRcvTkn | No corresponding function | ×2 |

※1   When porting Hold / Clear processing, note that the processing for determining whether there is an error in the master station is different.

Table B.4   State Management Related

| No. | Project (Processing described in CL2) | CL2 function name | CL3 function name | Compa tibility |
|-----|---------------------------------------|-------------------|-------------------|----------------|
| 1 | Self-station error handling | UserForceStop | UserForceStop | △ |
| 2 | Event Handling | iUserExecuteMain | iUserExecuteMain | △ |
| 3 | LED update processing | UserUpdateLed | UserUpdateLed | ○ |
| 4 | MIB information retrieval process | UserGetMIB | UserGetMIB | ○ |

Table B.5   Transient transmission (1)

| No. | Project (Processing described in CL2) | CL2 function name | CL3 function name | Compa tibility |
|-----|---------------------------------------|-------------------|-------------------|----------------|
| Send and receive main related | | | | |
| 1 | Transient1、Transient2、TransientAck Receive processing | UserReceiveTransient | UserSlmpReceive | ×1 |
| 2 | Transient1、Transient2、TransientAck Receive processing | UserSendTransient | UserSendSlmp | ×1 |
| Transient1-SLMP-related | | | | |
| 3 | SLMP Memory Read Request Frame Receive Response Processing | erUserHandleReceivedMem ReadRequest | erUserSlmpReceiveMemory ReadRequest | △ |
| 4 | SLMP Memory Write Request Frame Receive Response Processing | erUserHandleReceivedMem WriteRequest | erUserSlmpReceiveMemory WriteRequest | △ |
| 5 | SLMP Memory Read Request Frame Creation Process | erUserSetSlmpMemRead_ Request | iUserSlmpMakeMemoryRead Request | △ |

| 6 | SLMP Memory Read Response Frame Receive Processing | erUserHandleReceivedMemReadResponse | UserSlmpReceiveMemoryReadResponse | 〇 |
|---|---|---|---|---|

Table B.6    Transient transmission (2)

| No. | Project (Processing described in CL2) | CL2 function name | CL3 function name | Compatibility |
|---|---|---|---|---|
| | | Transient1 (CC-Link IE Field specific) related | | |
| 1 | Transient1 Received Data Processing | UserHandleReceivedTransient1 | No corresponding function | ×2 |
| 2 | Transient1 Received Data Assembly Start Processing | UserStartMakingReceivedTransient1 | Ditto | ×2 |
| 3 | Transient1 Received Data Assembly | blUserMakeReceivedTransient1 | Ditto | ×2 |
| | | Transient2 Related | | |
| 4 | Transient2 Received Data Processing | UserHandleReceivedTransient2 | No corresponding function | ×2 |
| 5 | Transient2 Receive Data Check Processing | erUserCheckReceivedTransient2 | Ditto | ×2 |
| 6 | Transient2 Memory Write Request Receive Processing | erUserHandleReceivedTransient2_RequestSetMemory | Ditto | ×2 |
| 7 | Transient2 Response Frame Creation Process | ulUserSetTransient2_Response | Ditto | ×2 |
| 8 | Transient2 Request Frame Creation Process | UserSetTransient2_Request | Ditto | ×2 |
| 9 | Transient2 Memory Read Request Frame Creation Process | ulUserSetTransient2_RequestGetMemory | Ditto | ×2 |
| 10 | Transient2 Memory Read Response Receive Processing | erUserHandleReceivedTransient2_ResponseGetMemory | Ditto | ×2 |
| | | TransientAck Related | | |
| 11 | TransientAck Received Data Processing | UserHandleReceivedTransientAck | No corresponding function | ×2 |
| 12 | TransientAck frame creation process | blUserSetTransientAck | Ditto | ×2 |

Note)    The frames used for transient transmission differ inthe CC-Link IE field network and the CC-Link IE TSN.    Therefore, the above frame-related processing (exceptSLMP) described in theCL2 sample code isnot in theCL3 sample code.
The CC-Link IE field network uses Transient1(Field-specific commands), Transient1(SLMP), Transient2, and TransientAck. The CC-Link IE TSN uses SLMP.

B-2    Driver part differences

The driver part differs from the driver interface function, the driver callback function, and the driver body.

The driver part of the CL2 sample code cannot be diverted to CL3. Use the CL3 driver described for CL3 to develop CC-Link IE TSN-enabled product.

**Revision History**

| Rev. | Date | Description | |
| --- | --- | --- | --- |
| | | Page | Summary |
| 1.00 | Nov 18, 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.

---

- Arm® and Cortex® are registered trademarks of Arm Limited (or its subsidiaries) in the EU and/or elsewhere. All rights reserved.
- Ethernet is a registered trademark of Fuji Xerox Co., Ltd.
- IEEE is a registered trademark of the Institute of Electrical and Electronics Engineers Inc
- TRON is an acronym for "The Real-time Operation system Nucleus.
- ITRON is an acronym for "Industrial TRON.
- $\mu$ ITRON is an acronym for "Micro Industrial TRON.
- TRON, ITRON, and $\mu$ ITRON do not refer to any specific product or products.
- Additionally all product names and service names in this document are a trademark or a registered trademark which belongs to the respective owners. a trademark or a registered trademark which belongs to the respective owners.

## 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/.