RX72M Group

EtherCAT CiA402 Sample Program Firmware Information Technology

Summary

This application note describes a sample program which supports the CiA402 drive profile that is particularly for use in motor control through EtherCAT® communications. EtherCAT® is an Ethernet communications protocol for industrial applications.

This application note includes the sample code for the CiA402 drive profile which uses the EtherCAT FIT module.

Target Device

- RX72M Group

If you intend to use the program in a product, you need to evaluate it thoroughly in terms of suitability for the given environment.

When applying the program covered in this application note to another microcontroller, modify the program to suit the specifications of the target microcontroller and extensively evaluate the program after modification.

Table of Contents

1. Overview

1.1 About This Application Note

This application note describes the procedure through to the evaluation of the sample program for the CiA402 drive profile and the FIT modules such as that for EtherCAT and the board support package (BSP) in combination.

The sample program covered in this application note runs on the Renesas Starter Kit+ for RX72M (hereafter "the RSK board") and the RX72M evaluation board from Tessera Technology (hereafter "the communications board" or “COM board”), RX72M CPU Card with RDC-IC（hereafter “CPU card"）.

1.2 Operating Environment

Table 1-1 Testing Environment

Supported MCU	RX72M Group
Evaluation board	Renesas Starter Kit+ for RX72M (product type name: RTK5572MNxCxxxxxBJ)
	RX72M evaluation board TS-RX72M-COM from Tessera Technology
	RX72M CPU Card with RDC-IC
Integrated development environment (IDE)	e^2 studio 2024-01 from Renesas Electronics
Cross tool	C/C++ Compiler Package for RX Family V3.06.00 from Renesas Electronics
	GCC for Renesas RX 8.3.0.202305
Emulator	E2 Lite

1.3 FIT Module Configuration

The sample program covered in this application note is configured with the use of the following FIT modules.

Table 1-2 FIT Module Configuration

Type	Module Name	FIT Module Name	Rev.
Board Support Package	Board support package (BSP)	r_bsp	7.42
Device Driver	Compare-match timer (CMT)	r_cmt_rx	5.60
Device Driver	Serial communications interface (SCI)	r_sci_rx	4.90
Middleware	Byte queue buffer (BYTEQ)	r_byteq	2.10
Device Driver	EtherCAT	r_ecat_rx	1.31

1.4 The Projects

The projects covered in this application note are listed below.

The following sections describe the project for the RX72M communications board as an example. If you will be using the project for RSK board or CPU card, read the statements referring to the communications board as the RSK board or CPU card as required.

Table 1-3 List of Projects

MCU	Evaluation Board Name	Project Name
RX72M	RSK board	ecat_cia402_demo_rskrx72m
	Communications board	ecat_cia402_demo_comrx72m
	CPU card	ecat_cia402_demo_cpurx72m

2. Obtaining a Development Environment

2.1 How to Obtain e² studio

Access the following URL and download the e² studio.

https://www.renesas.com/en-sg/products/software-tools/tools/ide/e2studio.html

This application note assumes that you will be using 2024-01 or a later version of the e² studio. If you are using a version earlier than 2024-01, some functions of the e² studio may not be available.

When downloading the e² studio, obtain the latest version on the website.

2.2 How to Obtain the Compiler Package

Access the following URL and download the RX family C/C++ Compiler Package.

https://www.renesas.com/en-sg/products/software-tools/tools/compiler-assembler/compiler-package-for-rx-family.html

3. Building a Project

3.1 Importing the EtherCAT Slave Stack Code to the Sample Program

This project does not include the EtherCAT Slave Stack Code.

* The EtherCAT Slave Stack Code (SSC) tool is required to generate the EtherCAT Slave Stack Code.

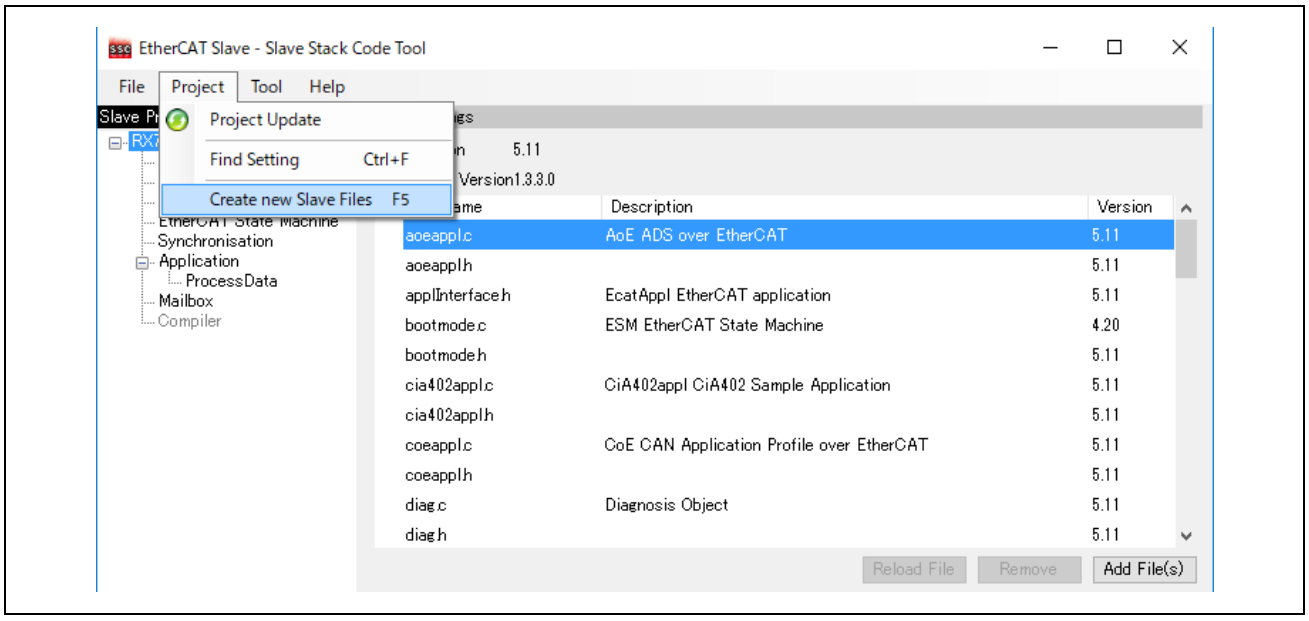
* The SSC tool can be obtained from EtherCAT Technology Group (ETG).

The sample program is provided in the zip format, "ecat_cia402_demo_comrx72m.zip". Unzip it in the desired folder in advance.

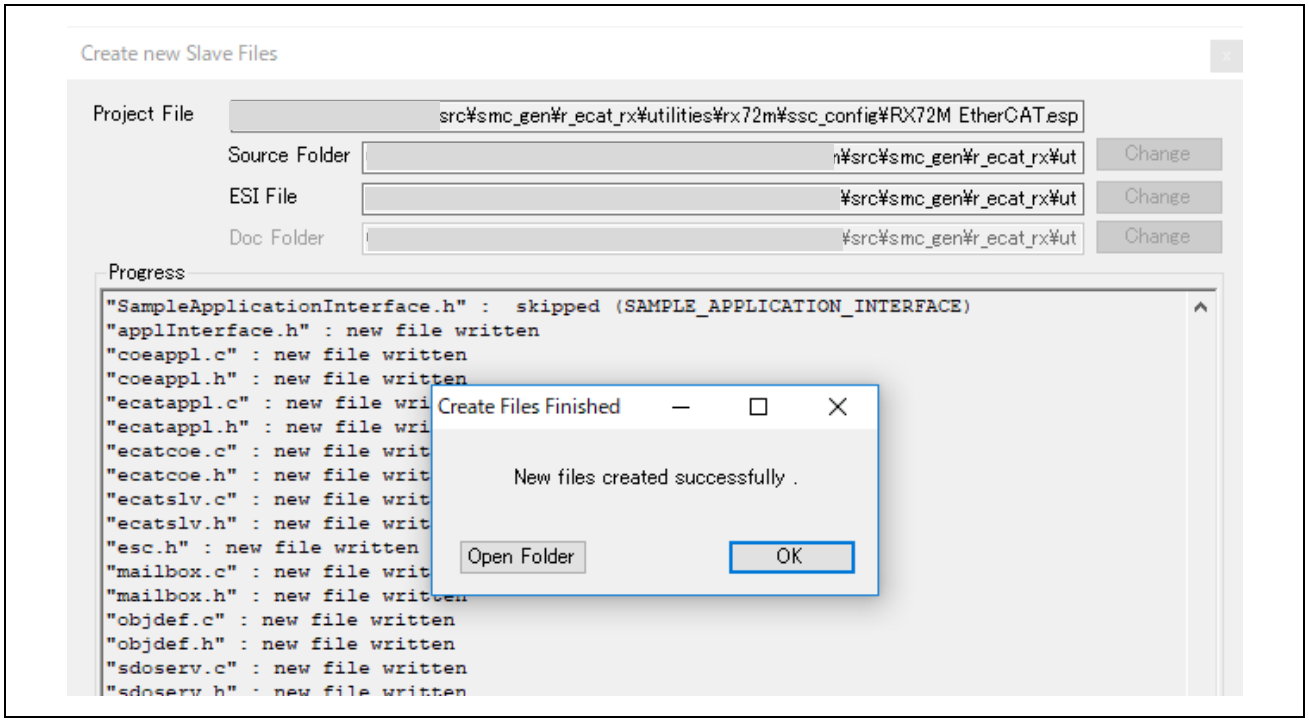
(1) Double-click on the SSC project file of the sample program to start the SSC tool.

ecat_cia402_demo_comrx72m\utilities\ssc_config\ RX72M EtherCAT CiA402.esp

(2) Click on [Project] → [Create new Slave Files]. In the [Current new Slave Files] dialog box, click on [Start].



(3) The source code is generated. If this is successful, the message "New files created successfully" will appear, so click on [OK].



(4) If the patch command is not installed on your PC, you will need to install ver. 2.5.9 or a later version of GNU patch.

If it is already installed, skip this step.

Download the patch command (currently ver. 2.5.9) from the following Web page and store "patch.exe" in a folder on a path that makes the file executable from the command prompt.

http://gnuwin32.sourceforge.net/packages/patch.htm

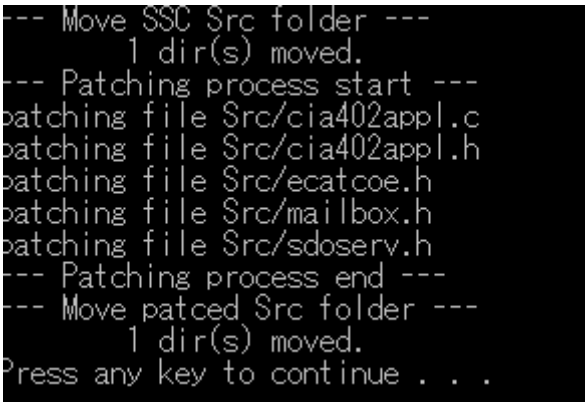
(5) Right-click on the apply_patch.bat file and select [Run as an administrator] → [Yes].

The patch file contains modifications to make the SSC source file suitable for the RX family.

ecat_cia402_demo_comrx72m\utilities\batch_files\apply_patch.bat

After execution of the patch, the modified source file is stored in the following folder.

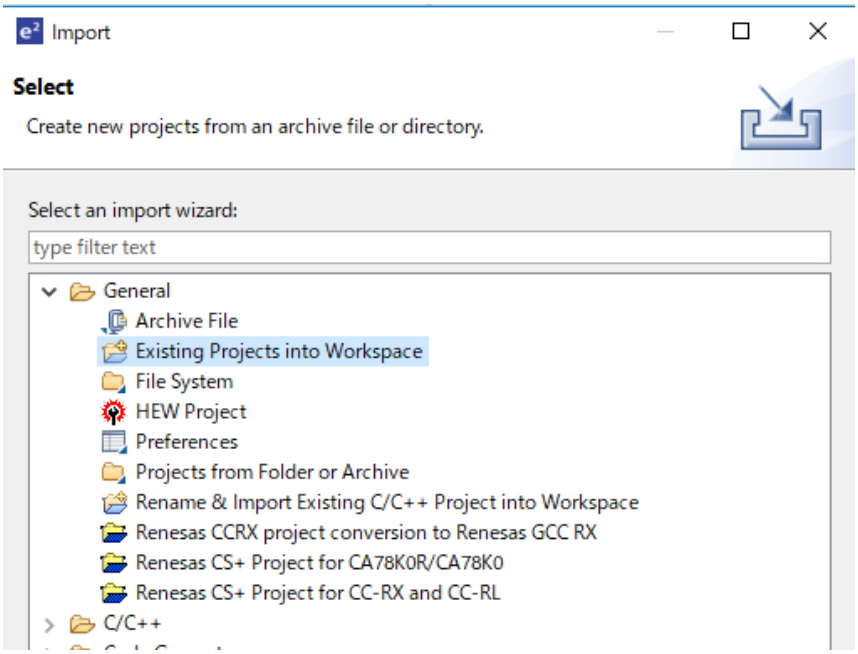
ecat_cia402_demo_comrx72m\project\src\application\ecat\beckhoff\Src



3.2 Importing a Project

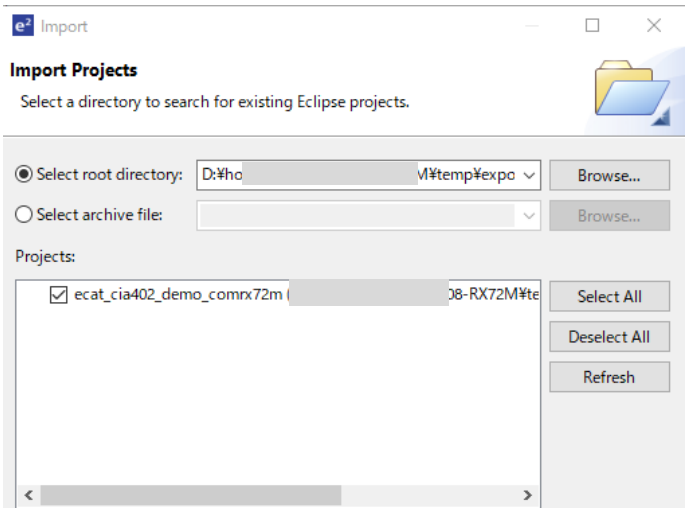
(1) Click on [File] → [Import].

(2) In the [Select] dialog box, select [General] → [Existing Projects into Workspace] and click on [Next].



(3) In the [Import Projects] dialog box, select the [Select root directory] checkbox and click on [Browse].

(4) Select "ecat_cia402_demo_comrx72m" as a sample project file for the communications board and click on [Open].



(5) Check "ecat_cia402_demo_comrx72m" under the [Projects] label and click on [Next]. The project will be imported into the workspace.

3.3 Changed Information

In this project, the file configuration of the EtherCAT FIT module and the settings in the configuration files for a few other FIT modules have been changed to configure them for use with the sample program. The details are described below.

Refer to the changed information when building a new project. When using the imported project, proceed to section 4, Checking the Operation.

3.3.1 Changing the Configurations

Change the configuration files for the other FIT modules where this is required to configure them for use with the sample program.

For the items and settings in the configuration files, refer to the manuals, etc. in the doc folder for each FIT module.

The table below lists the changes in configurations.

Table 3-1 List of Changes in Configurations

Item to be Changed	FIT Module Name	Configuration	Setting
Increase in heap size	r_bsp	Heap size	0x8000
Use user charget()	r_bsp	Enable user stdio charget function	Use user charget() function
Use user charput()	r_bsp	Enable user stdio charput function	Use user charput() function
Enabling SCI CH6	r_sci_rx	Include software suport for channel 6	Include
Enabling the transmission completed interrupt	r_sci_rx	Transmit end interrupt	Enable

The configuration of the EtherCAT FIT module is different for each evaluation board.

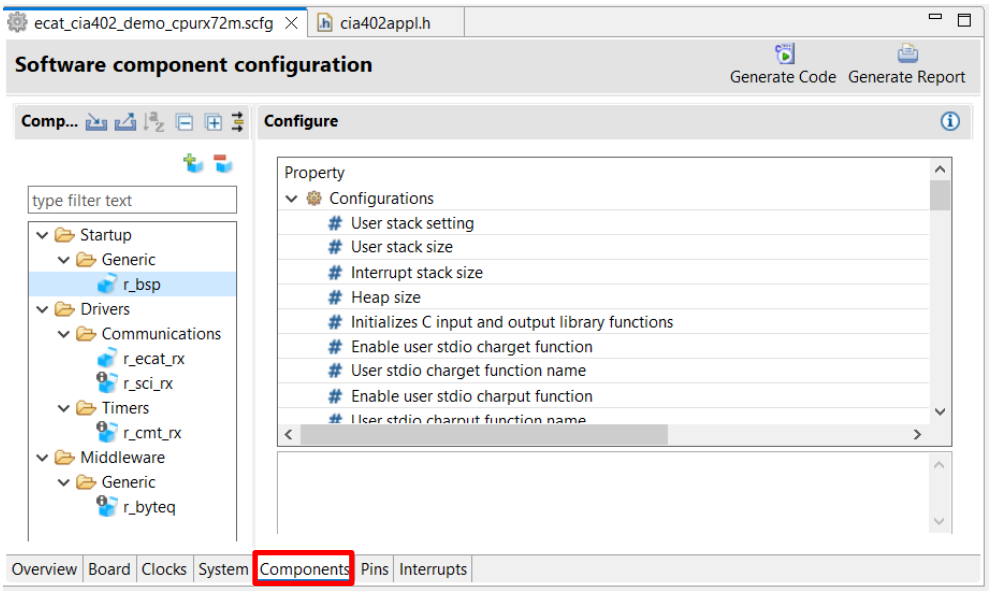
Table 3-2 EtherCAT FIT Module Settings (for COM board and CPU card)

Item to be Changed	FIT Module Name	Configuration	Setting
Setting the PHY Reset Wait Time	r_ecat_rx	The waitng time for reset completion of PHY-LSI (us)	500
Setting the PHY LSI to be used	r_ecat_rx	Use supported PHY-LSI	The KSZ8081MNX is used.

Table 3-3 EtherCAT FIT Module Settings (for RSK board)

Item to be Changed	FIT Module Name	Configuration	Setting
Setting the PHY Reset Wait Time	r_ecat_rx	The waitng time for reset completion of PHY-LSI (us)	1000
Setting the PHY LSI to be used	r_ecat_rx	Use supported PHY-LSI	The KSZ8041NL is used.

For each FIT configuration, you can open "ecat_cia402_demo_comrx72m.scfg" on e2 studio and check and change the FIT module configuration in the [Components] tab.

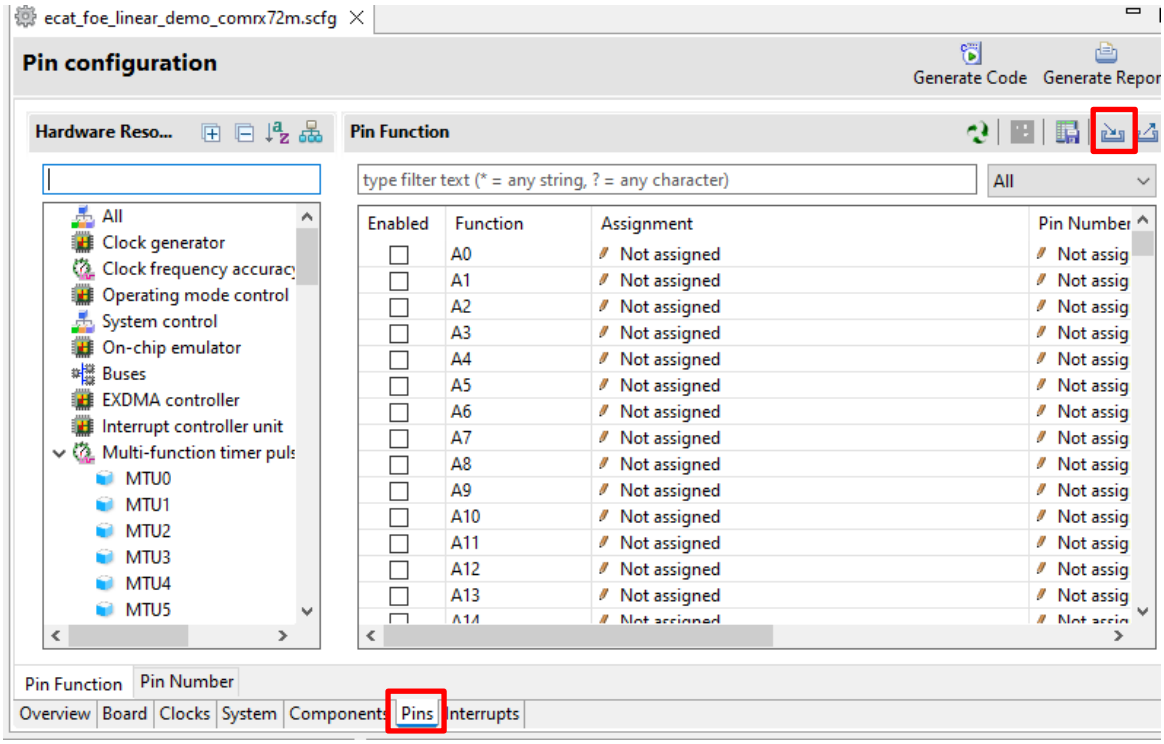


3.3.2 Pin settings

You can import the terminal settings to run the sample program.

On the [Pins] tab of Smart Configurator, click the [Import Terminal Function Arrangement] button and select "ecat_demo_comrx72m_board.xml".

The xml file is included in the sample program.



For the terminals used in the FIT module, the following items must be enabled in [Resources] on the [Component] tab of the Smart Configurator.

Component	Resources to enable	Pins to enable
r_ecat_rx	ESC ESC_MII0 ESC_MII1	All pins
r_sci_rx	SCI6	RXD6/SMISO6/SSCL6 pin TXD6/SMOSI6/SSDA6 pin

4. Checking the Operation

4.1 Preparation for Debugging

This section describes how to set up the evaluation board to run this sample program.

Table 4-1 Evaluation Board Settings

Setting Item	MCU	Evaluation board name	Setting contents
LAN Cable	RX72M	COM board	Connected to the "ECAT IN" side
		CPU card	Connected to the "CN8" side
		RSK board	Connected to the "ECAT IN" side
Debugger	RX72M	COM board	Connecting the E2 Lite to the JTAG Connector
		CPU card	Connect the USB cable to the USB connector
		RSK board	Connecting the E2 Lite to the JTAG Connector

(1) Connect the LAN cable as described in Table 4-1.

(2) Connect the E2 Emulator Lite to the JTAG connector on the evaluation board with the user interface cable as described in Table 4-1.

(3) Connect the E2 Emulator Lite to a USB port of the PC you are using. The "ACT" LED on the E2 Emulator Lite starts to blink.

(4) The "Found new hardware" wizard appears. Follow the procedure described below to install the driver. Installation on a PC running Windows™ 7, 8, or 8.1 requires logging in with a user name that has administrator rights.

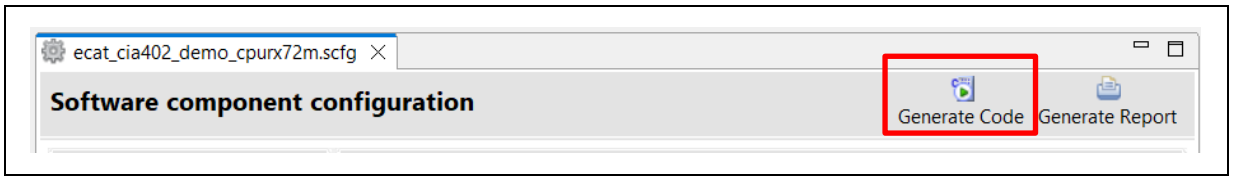
Windows™ 7/8/8.1: A notice appears on the Windows taskbar when the installation is finished.

Windows™ 10: A button for device configuration appears on the Windows taskbar and installation is automatic.

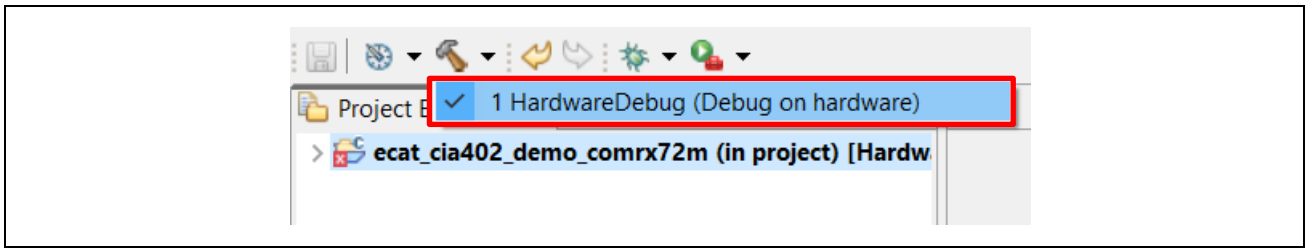
(5) Supply power to the evaluation board.

4.2 Building and Debugging the Project

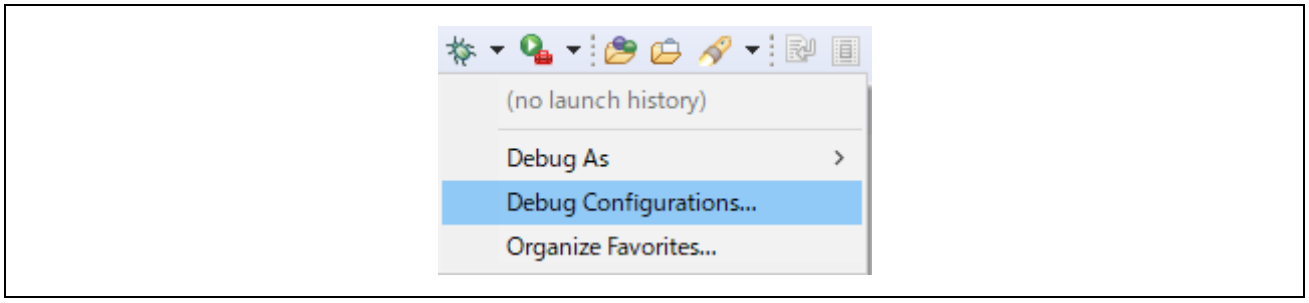
(1) Open the smart configuration file "ecat_cia402_demo_comrx72m.scfg" and press [Generate Code] to execute code generation.



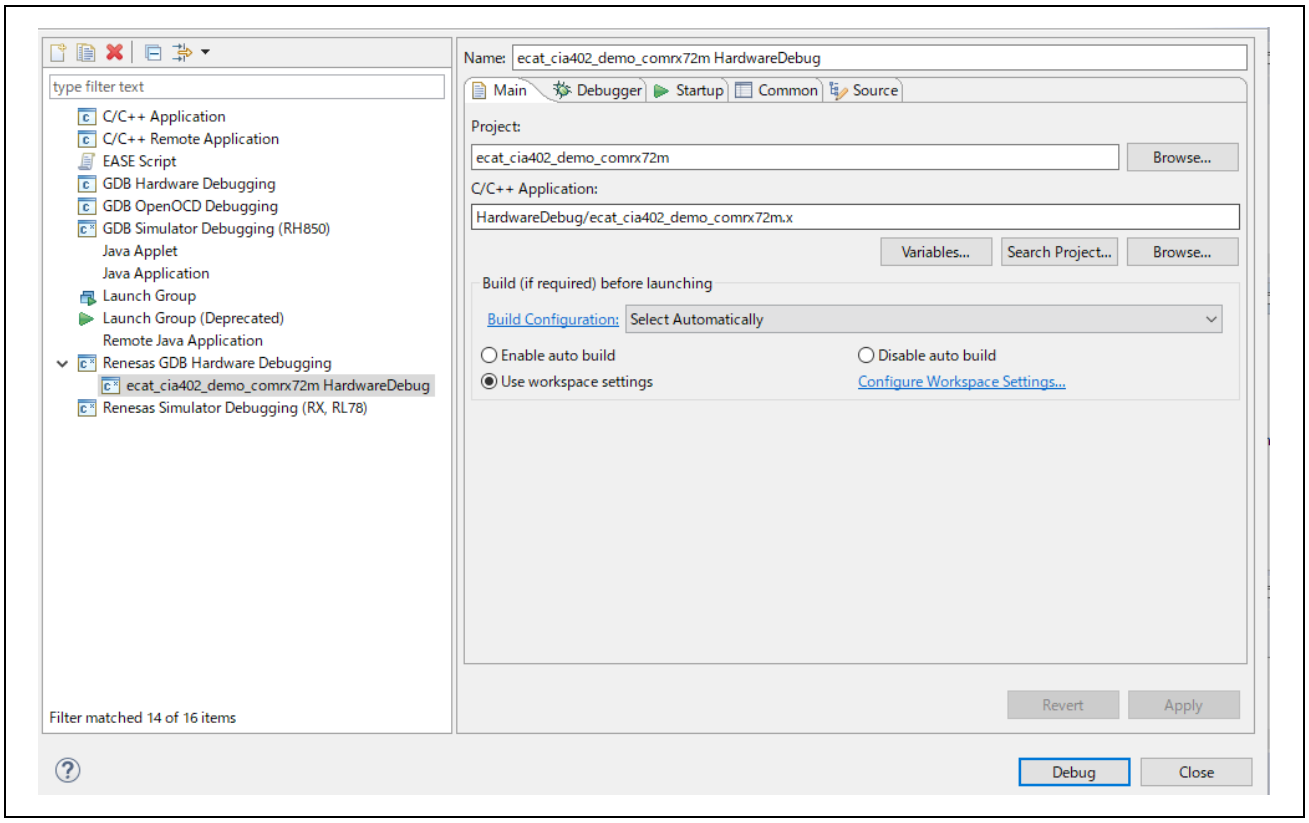
(2) Left-click on the "ecat_cia402_demo_comrx72m" project in the Project Explorer view. Click on the arrow next to the build button (hammer icon) and select [Hardware Debug] from the drop-down menu.



(3) e^2 studio will build the project. After building is completed, click on the arrow next to the [Debug] button (bug icon). You can start debugging by selecting [Debug Configurations].



(4) Click on "ecat_cia402_demo_comrx72m Hardware Debug" and download the program to the target device. Press the [Debug] button to start debugging.



(5) If a firewall warning is displayed for 'e2-server-gdb.exe', check the checkbox for [Private networks, such as my home or work network] and click on [Allow access].

(6) The User Account Control (UAC) dialog box may appear. Enter the administrator's password and click on [Yes].

(7) If the Confirm Perspective Switch dialog box appears prompting you to switch the perspective, check the checkbox for [Remember my decision] and click on [Yes].

(8) The green "ACT" LED on the E2 Lite debugger will be continuously lit.

(9) After downloading the program, click on the [Resume] button to run the code to the first line of the main function main (). If you click on the [Resume] button again, the target will run the remaining program.

5. Connection with TwinCAT

This section describes the procedure for operating the sample program using TwinCAT3.

5.1 Preparing the ESI File

Before starting up TwinCAT, copy the ESI file included in the sample program to the specified location for TwinCAT (\TwinCAT\3.x\Config\IO\EtherCAT).

ecat_cia402_demo_comrx72m\src\smc_gen\r_ecat_rx\utilities\rx72m\esi\RX72M EtherCAT CiA402.xml

5.2 Starting up TwinCAT

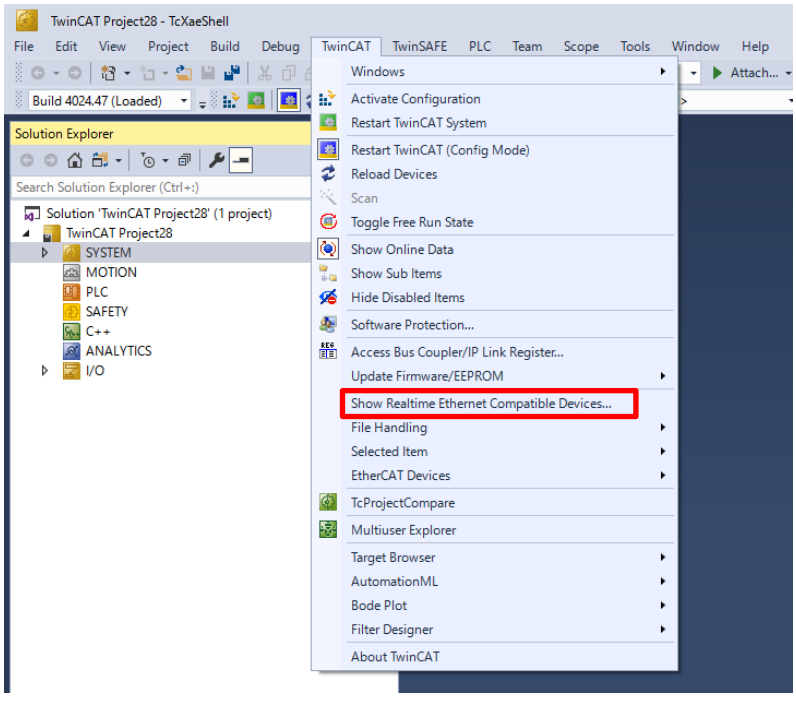
(1) From the start menu, select [Beckhoff] → [TwinCAT3] → [TwinCAT XAE (VS20xx)].

(2) After starting the program, select [File] → [New] → [Project] to create a new project of the TwinCAT XAE Project type.

5.3 Add Ether driver

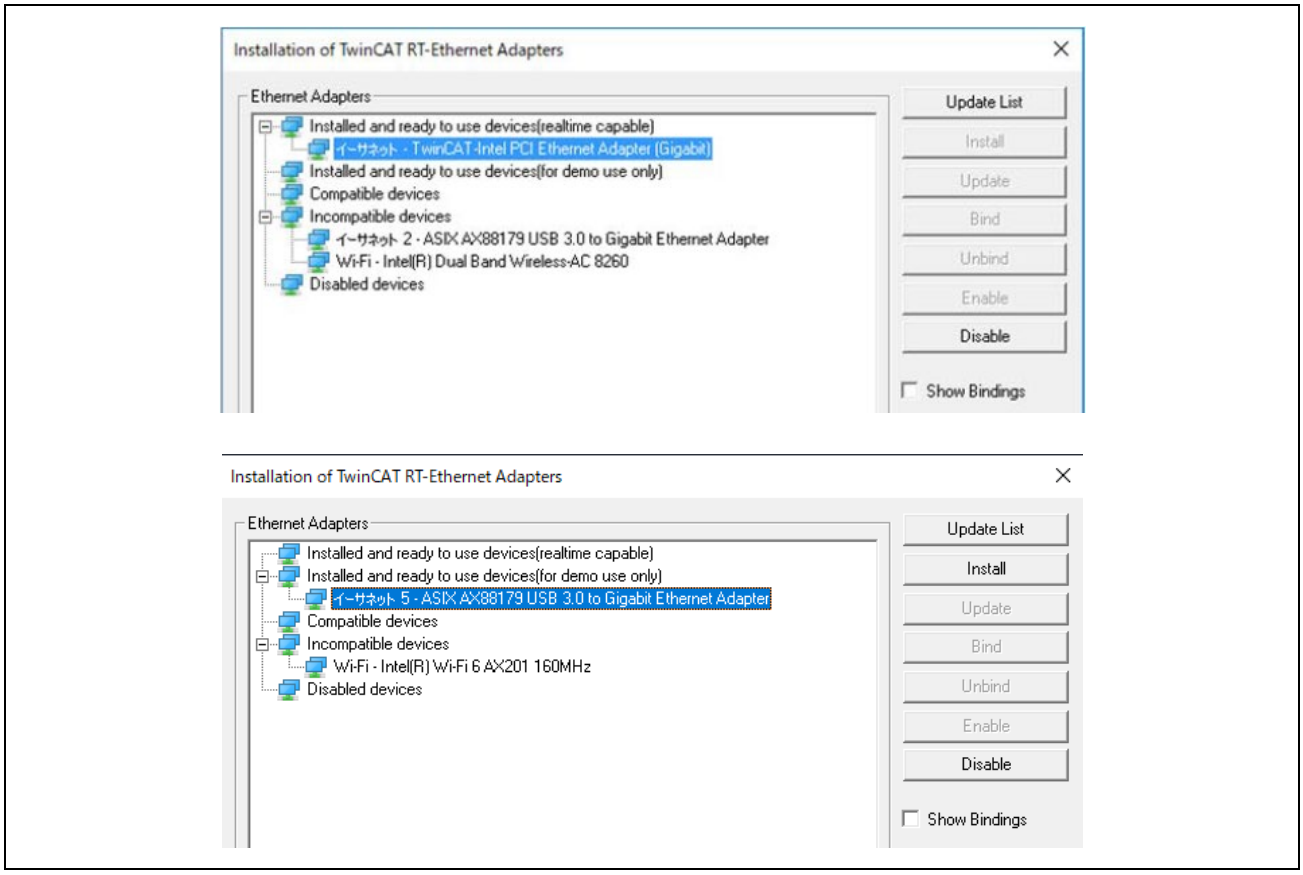
*If you have already processed this section, you do not need to process this section.

From the top menu bar, select [TwinCAT] → Select the [Show Realtime Ethernet Compatible Devices…]



After selecting the Ethernet adapter connected to the PC, press [Install] to install it.

Make sure that you add the installed driver to Installed and ready to use devices (realtime capable) or Installed and ready to use devices (for demo use only).



5.4 Scanning the Network

(1) In the System Manager tree, right-click on [I/O] → [Devices] and select [Scan].

(2) In the [HINT: Not all types of devices can be found automatically] dialog box, click on [OK].

(3) In the [new I/O devices found] dialog box, select the checkbox for the Ethernet adapter to be scanned and click on [OK].

(4) In the [Scan for Boxes] dialog box, click on [Yes].

(5) The "EtherCAT drive(s) added. Append linked axis to NC-Configuration" dialog box will be displayed. Click on [Yes].

(6) The "Active Free Run" dialog box will be displayed. Click on [Yes].

Scanning was successful if a box has been added, e.g. "Device 1" → "Box 1" under "I/O" → "Devices", in the System Manager tree.

5.5 Writing to the SII-Manufactured EEPROM

* The EEPROM on the communications board is blank at the time of shipment, so you will need to write to the board's EEPROM.

* The procedure described in this section is not required if the EEPROM has already been programmed.

If the EEPROM is blank, Box 1 is displayed in a form like "Box1 (PFFFFFFFF RFFFFFFFF)" in the System Manager tree.

(1) If you double-click on [Box 1] in the System Manager tree, a panel will be displayed on the right side of the screen.

(2) Select the [EtherCAT] tab and click on the [Advanced Settings] button.

(3) In the hierarchy of the tree on the left side of the [Advanced Settings] dialog box, select [ESC Access] → [EEPROM] → [Hex Editor].

(4) In the [Hex Editor] dialog box, select "Download from list".

(5) In the [Write EEPROM] dialog box, select [Renesas Electronics Corp.] → [Renesas RX72M Group] → [RX72M EtherCAT CiA402] and click on [OK]. Data are written to the EEPROM.

(6) After programming, restart the communications board (by resupplying power or applying a reset) to make sure that the written data are reflected in the operation of the microcontroller.

5.6 Rescanning the Device

(1) Delete [device x] under [devices] in [I/O].

(2) In the System Manager tree again, right-click [I/O] → [Devices] and select [Scan].

(3) In the [HINT: Not all types of devices can be found automatically] dialog, click [OK].

(4) In the [new I/O devices found] dialog, select the check boxes for the Ethernet adapters you want to scan, and click [OK].

(5) In the [Scan for Boxes] dialog, click [Yes].

(6) In the [Active Free Run] dialog box, click on [Yes].

This will be OK if "Box 1" in the System Manager tree has turned to "Box 1 (RX72M EtherCAT CiA402)".

5.7 Checking the Operation Mode

(1) If you double-click on [Box 1] in the System Manager tree, a panel will be displayed on the right side of the screen.

(2) Select the [Online] tab and check that "Current Status" has turned to "OP".

(3) In the System Manager tree, expand + on the left side of "Box 1".

5.7.1 CiA402 State Transition

To check the operation in csp and csv modes, the state must be changed to "Operation Enabled" in both modes.

Change the state by setting a value in the "Control Word" object and check the state by confirming the value of the "Status Word" object.

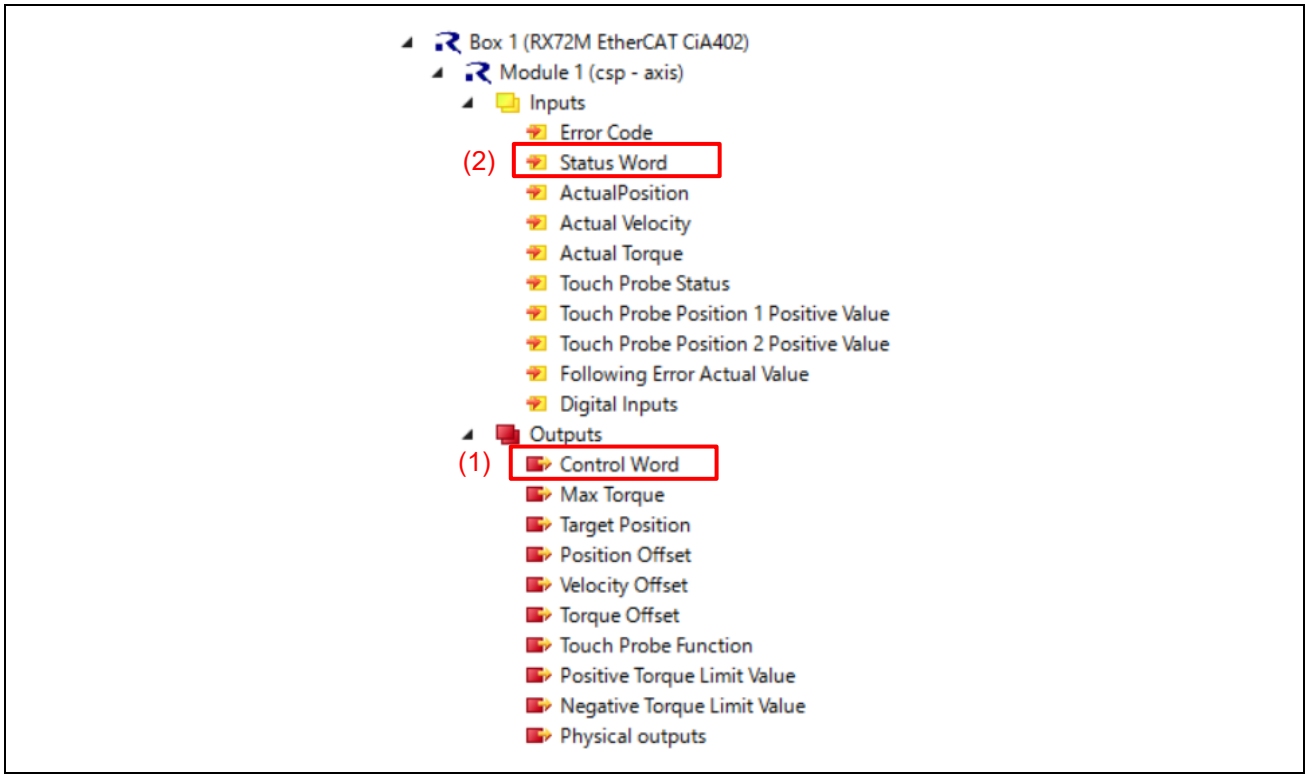
(1) Select "Outputs" → "Control Word" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

Click on [Write] and set values from [7] to [15] in that order.

(2) Select "Inputs" → "Status Word" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

If the value is [4663], the state is "Operation Enabled". Proceed to the next step.

If the value is [4616], the state is "Fault" for some reason. Set "Control Word" to [128] once and return to step (1).



5.7.2 csp Mode

Check that "Module 1" is displayed as "Module 1 (csp-axis)".

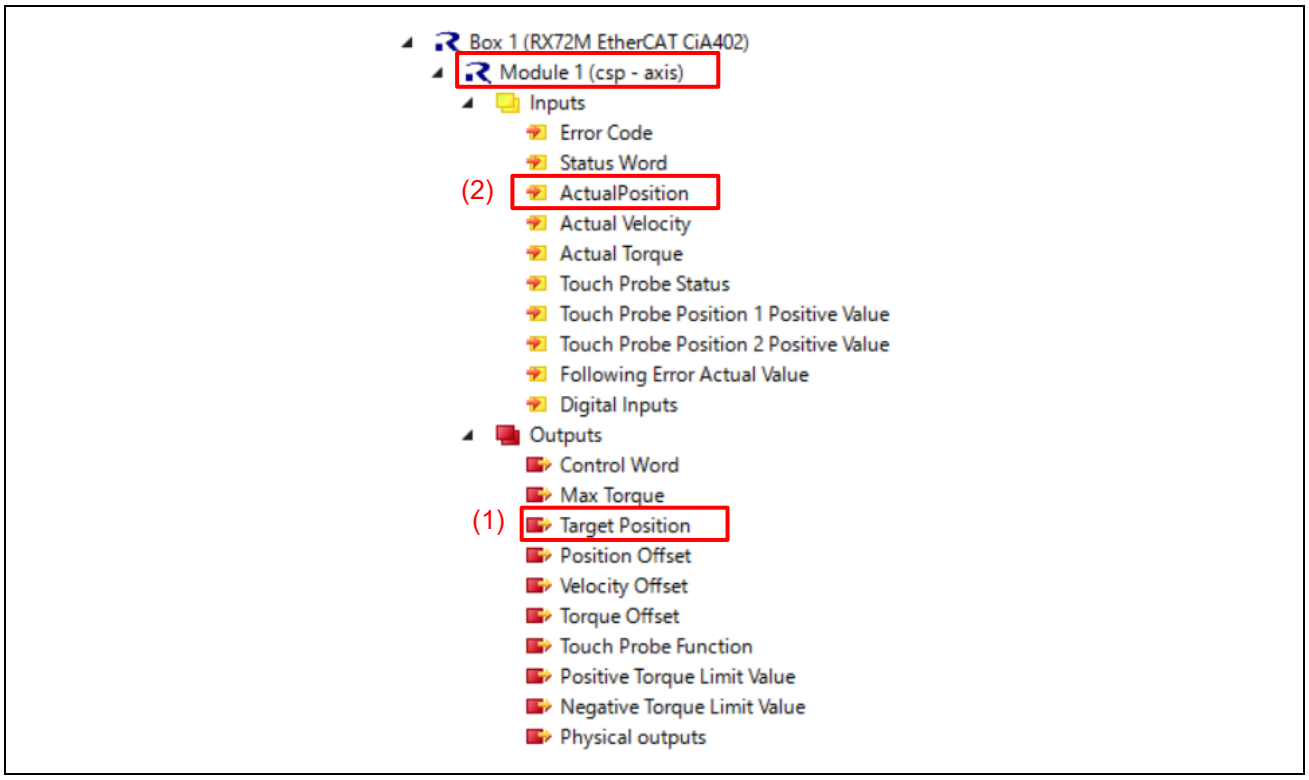
(1) Select "Outputs" → "Target Position" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

Click on [Write] and set a desired value.

Here, set [100000] as an example.

(2) Select "Inputs" → "Actual Position" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

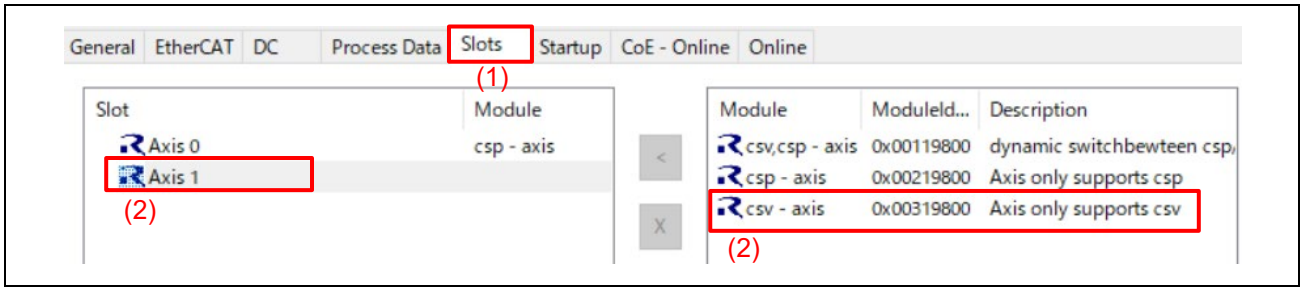
Check that the value set in "Target Position" allows incrementation up to [100000].



5.7.3 csv Mode

(1) In the System Manager tree, select "Box 1 (RX72M EtherCAT CiA402)" and then select the [Slots] tab on the right-side panel.

(2) If you select "Axis 1" under "Slot" in the left frame of the tabbed page, modules which can be added will be displayed in the right frame of the page, so add "csv-axis".



(3) Check that "Module 2 (csv-axis)" has been added in the System Manager tree.

(4) Follow the procedure described in section 5.6.1 to change the state to "Operation Enabled".

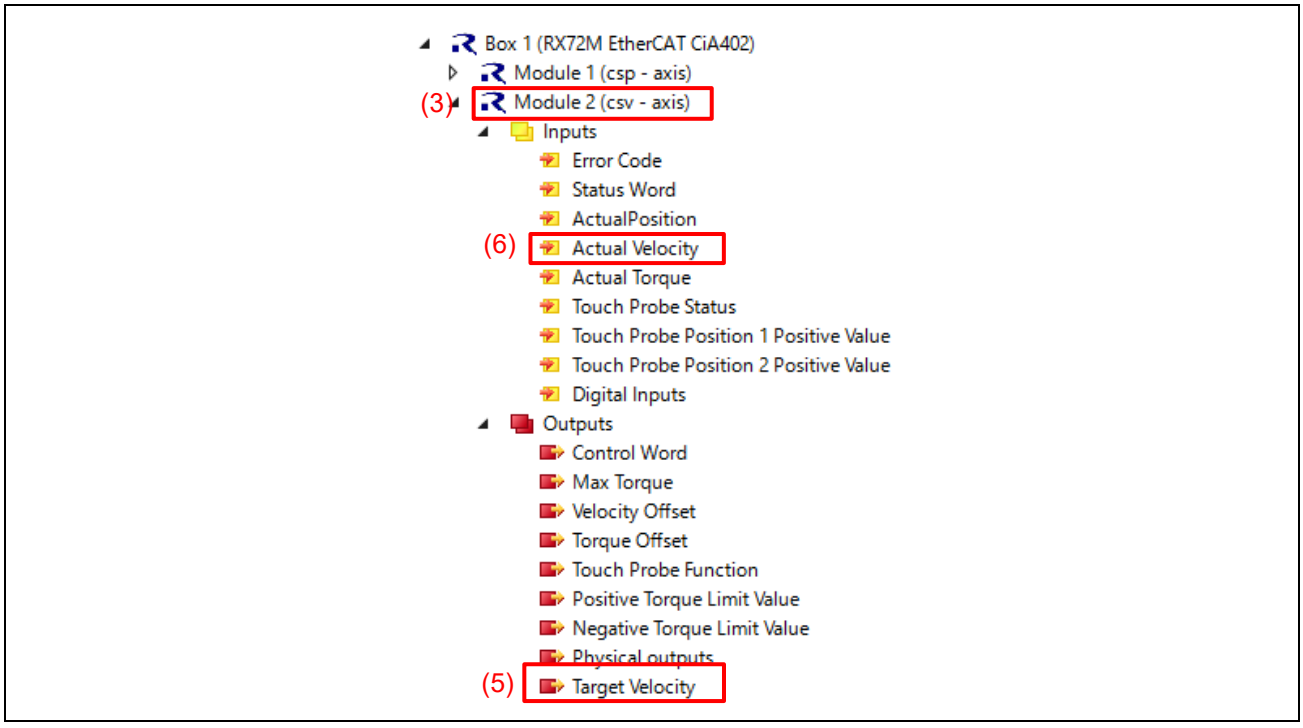
(5) Select "Outputs" → "Target Velocity" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

Click on [Write] and set a desired value.

Here, set [100000] as an example.

(6) Select "Inputs" → "Actual Velocity" in the System Manager tree and then select the [Online] tab on the right-side panel. A value will then be displayed.

Check that the value set in "Target Velocity" allows incrementation up to [100000].



6. CiA402 Drive Profile

The CiA402 drive profile is a device profile for driving motors and motion control and mainly defines functional operations for servo drives, sine-wave inverters and stepping motor controllers. In this profile, the multiple operation modes and corresponding parameters are defined as an object dictionary. Also, Finite State Automaton (FSA) to define the internal and external behavior in every state is included. When changing the state, the result after transition is reflected in the status word object that shows the current state by specifying the state through the control word object. The control word and various command values (such as speed) are assigned to RxPDO, and the status word and various real values (such as position) are assigned to TxPDO. Please see the contents of the CiA402 standard for more details.

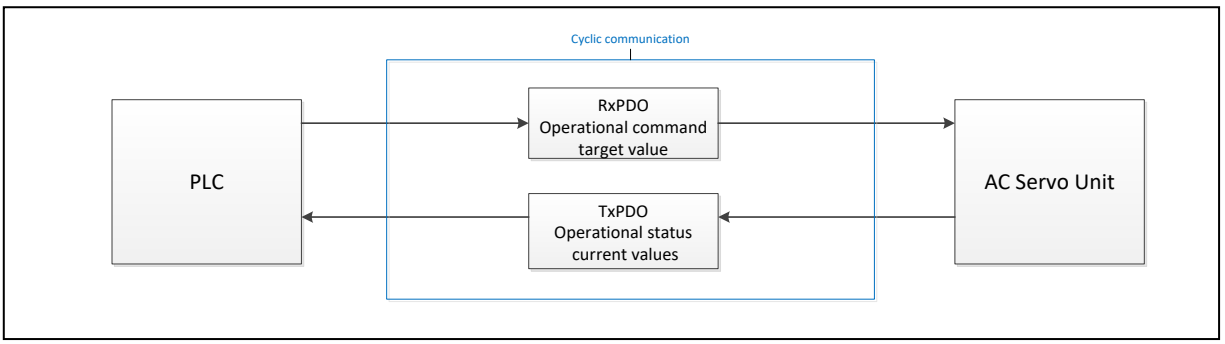


Figure 6-1 CiA402 Communication Flow

6.1 Operation Modes

In the application note, the following modes are supported from among the operation modes defined in the CiA402 standard.

Table 6-1 List of Supported Operation Modes

Operation Mode	Support
Profile position mode	No
Velocity mode (frequency converter)	No
Profile velocity mode	No
Profile torque mode	No
Homing mode	No
Interpolated position mode	No
Cyclic synchronous position mode	Yes
Cyclic synchronous velocity mode	Yes
Cyclic synchronous torque mode	No
Cyclic synchronous torque mode with commutation angle	No
Manufacturer specific mode	No

6.2 State Transition

In this application note, the following is supported as FSA defined in the CiA402 standard.

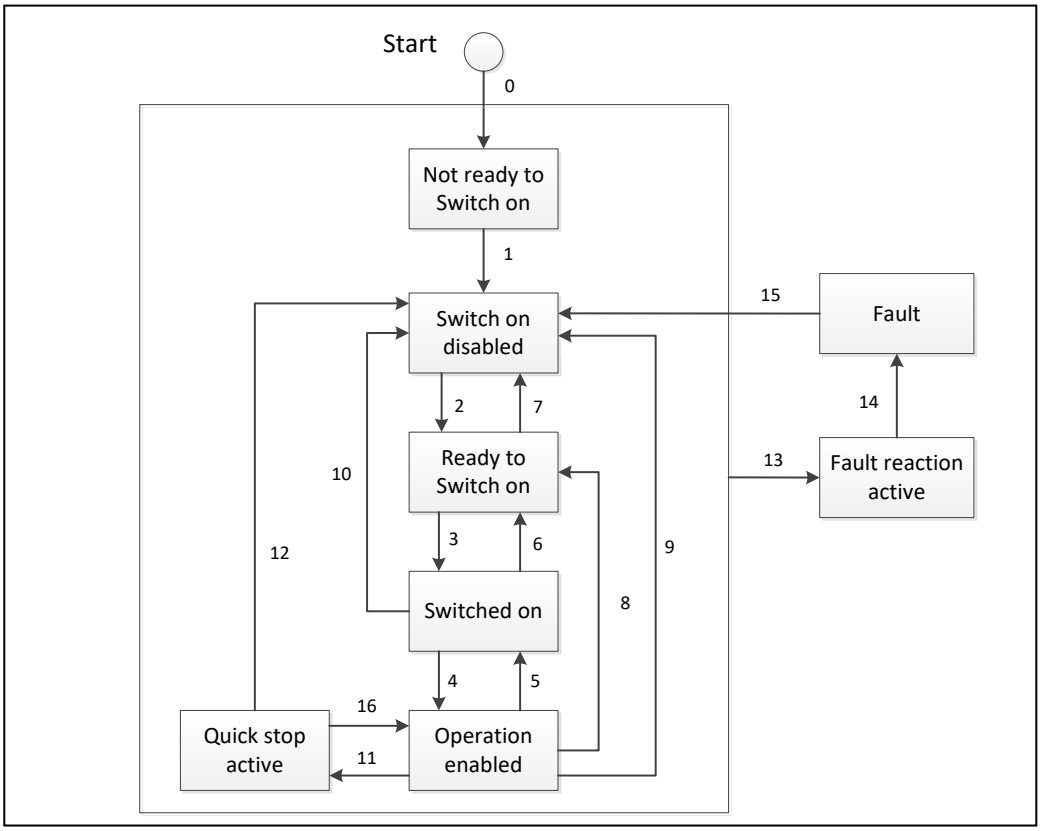


Figure 6-2 CiA402 State Transition Diagram

6.3 Object Dictionary

The following is the list of the object dictionaries supported in this application note.

Table 6-2 List of Supported Object Dictionaries

OperationMode	OBJECT Name	INDEX	Category	Access	DataType	PDO Mapping
Cyclic synchronous position mode + Cyclic synchronous velocity mode	**Position actual value**	**0x6064**	Mandatory	ro	INT32	Yes
	Following error window	**0x6065**	Optional	rw	UINT32	No
	Following error timeout	**0x6066**	Optional	rw	UINT16	No
	Velocity actual value	**0x606C**	Conditional	ro	INT32	Yes
	Max torque	**0x6072**	Optional	rw	UINT16	Yes
	Torque actual value	**0x6077**	Conditional	ro	INT16	Yes
	Target position	**0x607A**	Optional	rw	INT32	Yes
	Position range limit	**0x607B**	Optional	c,rw	INT32	No
	Software position limit	**0x607D**	Optional	c,rw	INT32	No
	Position offset	**0x60B0**	Optional	rw	INT32	Yes
	Velocity offset	**0x60B1**	Optional	rw	INT32	Yes
	Torque offset	**0x60B2**	Optional	rw	INT16	Yes
	Following error actual value	**0x60F4**	Optional	ro	INT32	Yes
	Target velocity	**0x60FF**	Conditional	rw	INT32	Yes

FunctionGroup	OBJECT Name	INDEX	Category	Access	DataType	PDO Mapping
Torque Limiting	Positive torque limit value	0x60E0	Conditional	rw	UINT16	Yes
	Negative torque limit value	0x60E1	Conditional	rw	UINT16	Yes
Homing	Home Offset	0x607C	Optional	rw	INT32	No
	Homing speeds	0x6099	Conditional	c,rw	UINT32	No
Touch Probe	Touch probe function	0x60B8	Optional	rw	UINT16	Yes
	Touch probe status	0x60B9	Optional	ro	UINT16	Yes
	Touch probe pos 1 positive value	0x60BA	Optional	ro	INT32	Yes
	Touch probe pos 1 negative value	0x60BB	Optional	ro	INT32	Yes
	Touch Probe Source	0x60D0	Conditional	c,rw	INIT16	No
Gear ratio	Gear ratio	0x6091	Optional	c,rw	UINT32	No
Other object	**OBJECT Name**	**INDEX**	**Category**	**Access**	**DataType**	**PDO Mapping**
Controlling the power drive system	Error code	0x603F	Optional	ro	UINT16	Yes
	Controlword	0x6040	Mandatory	rw	UINT16	Yes
	Statusword	0x6041	Mandatory	ro	UINT16	Yes
	Quick stop option code	0x605A	Optional	rw	INT16	No
	Shutdown option code	0x605B	Optional	rw	INT16	No
	Disable operation option code	0x605C	Optional	rw	INT16	No
	Halt option code	0x605D	Optional	rw	INT16	No
	Fault reaction option code	0x605E	Optional	rw	INT16	No
	Modes of operation	0x6060	Optional	rw	INT8	Yes
	Modes of operation disp	0x6061	Optional	ro	INT8	Yes
	Quick Stop Declaration	0x6085	Optional	rw	UINT32	Yes
	Interpolation Time Period	0x60C2	Conditional	c,rw	UINT8, INT8	No
	Supported drive modes	0x6502	Mandatory	ro	INT32	No
General object	Motor type	0x6402	Optional	rw	INT16	No
Position control function	Position demand value	0x6062	Optional	ro	INT32	No
	Position actual internal value	0x6063	Optional	ro	INT32	No
	Position window	0x6067	Optional	rw	UINT32	No
Optional application FE	Digital inputs	0x60FD	Optional	ro	UINT32	Yes
	Digital outputs	0x60FE	Optional	c,rw	UINT32	No,Yes

6.4 Implementing the Motor Control Program

According to the CiA402 standard from the list of CiA402 protocol stack I/F functions in Table 6-3, implement the motor control application. Each function links the number of each state transition of CiA402 FSA shown in Figure 6-2 and the corresponding function is called in case of state transition. In each function, describe the processing that calls the motor control program or the relevant processing of the main CPU.

Table 6-3 List of CiA402 Protocol Stack I/F Functions

CiA402_StateTransition1	
	Description This function is used when state transition 1 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition2	
	Description This function is used when state transition 2 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition3	
	Description This function is used when state transition 3 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition4	
	Description This function is used when state transition 4 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition5	
	Description This function is used when state transition 5 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.

CiA402_StateTransition6

Description

This function is used when state transition 6 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition7

Description

This function is used when state transition 7 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition8

Description

This function is used when state transition 8 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition9

Description

This function is used when state transition 9 has occurred.
Describe the operation in the case of the state transition.

Usage

#include "cia402appl.h"

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition10

Description

This function is used when state transition 10 has occurred.
Describe the operation in the case of the state transition.

Usage

#include "cia402appl.h"

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition11

Description

This function is used when state transition 11 has occurred.
Describe the operation in the case of the state transition.

Usage

#include "cia402appl.h"

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition12

Description

This function is used when state transition 12 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_LocalError

Description

This function is used when state transition 13 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

UINT16 ErrorCode

Return Value

None

Remark

If the error corresponding to state transition 13 occurs,
call this function after processing required and saving data at error location.

CiA402_StateTransition14

Description

This function is used when state transition 14 has occurred.
Describe the operation in the case of the state transition.

Usage

```
#include "cia402appl.h"
```

Parameters

TCiA402Axis *pCiA402Axis

Return Value

0	Normal end
1	Error

Remark

In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard.
If 1 is set to return value, state transition does not occur.

CiA402_StateTransition15	
	Description This function is used when state transition 15 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
CiA402_StateTransition16	
	Description This function is used when state transition 16 has occurred. Describe the operation in the case of the state transition.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark In the case of error occurrence during processing, exit the function by setting the appropriate values for each object in accordance with the CiA402 standard. If 1 is set to return value, state transition does not occur.
APPL_MOTOR_MotionControl_Main	
	Description Implement the motion control code when the state of CiA402 FSA is "Operation enabled". Describe the process for each mode of operation.
	Usage #include "cia402appl.h"
	Parameters TCiA402Axis *pCiA402Axis
	Return Value 0 Normal end 1 Error
	Remark At the initial state, this function is described in "main.c" and calls "CiA402_DummyMotionControl" function for reference.

Documents for Reference

User's Manual: Hardware

RX72M Group User's Manual: Hardware (Document No. R01UH0804)
Renesas Starter Kit+ for RX72M User's Manual (Document No. R20UT4383)
RX72M Group Communications Board Hardware Manual (Document No. R01AN4661)
RX72M CPU Card with RDC-IC User's Manual (Document No. R12UZ0098)
Download the latest version from Renesas Electronics website.

Startup Manual

RX72M Group RSK Board EtherCAT Startup Manual (Document No. R01AN4689)
RX72M Group Communications Board EtherCAT Startup Manual (Document No. R01AN4672)

Download the latest version from Renesas Electronics website.

Application Note

RX Family EtherCAT Module Firmware Integration Technology (Document No. R01AN4881)

Technical Updates/Technical News

Download the latest version from Renesas Electronics website.

User's Manual: Development Environment

RX Family C/C++ Compiler, Assembler, Optimizing Linkage Editor Compiler Package (R20UT0570)

Download the latest version from Renesas Electronics website.

CiA402 Standards:

IEC 61800-7-201 Edition 1.0
Adjustable speed electrical power drive systems Part 7-201: Generic interface and use of profiles for power drive systems Profile type 1 specification

IEC 61800-7-301 Edition 1.0
Adjustable speed electrical power drive systems Part 7-301: Generic interface and use of profiles for power drive systems Mapping of profile type 1 to network technologies

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug. 31, 2020	—	First edition issued
1.10	Feb. 15, 2024	Program	Support the EtherCAT FIT Module v1.31
			Add utilities and project folders to separate SSC-related files from project-related files.
			Support the e^2 studio 64bit version.
			Support the SSC 5.13
			Add CPU card projects
			Support EtherCAT Conformance Test Tool v2.5.0
		3	Update “Table 1-1 Testing Environment” and “Table 1-2 FIT Module Configuration”
		3	Add CPU card projects in “Table 1-3 List of Projects”
		4	Update the version of e^2 studio
		4, 6, 11	Change folder name due to the change in the folder structure.
		8	Delete “3.3.1 Changung the File Configuration of the EtherCAT FIT Module”
		8	Change the description to set the configuration settings in the Components tab.
		9	Add “3.3.2 Pin settings”
		10	Add the configuration of CPU card in “Table 4 1 Evaluation Board Settings”
		11	Update the picture due to the update of e^2 studio
		13	Add “5.3 Add Ether driver”
		15	Modify how to rescan the device
		20-21	Add Object 0x6066, 0x607B, 0x6085, 0x60BB, 0x60C2, 0x60D0 to Object Dictionary

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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.).
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   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.
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(Rev.4.0-1 November 2017)

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