R12AN0124EJ0502
Rev.5.02
Aug.8, 2024

RZ/T2M Group, RZ/T2L Group, RZ/N2L Group

CN032 AC Servo Solution Startup Guide (for EtherCAT)

Introduction

This manual explains the procedure for performing motion control by EtherCAT® communication using Renesas Electronics CN032 AC Servo Solution Kit.

The sample program for RZ/T2M is dual core control, and by performing motion control with Cortex®-R52 and performing EtherCAT communication with Cortex®-R52, communication processing is possible without degrading the processing performance of motion control.
Data is exchanged between the two cores via the shared memory, and by access right management using the semaphore register, access conflict to the shared memory is prevented.

The sample program for RZ/T2L or RZ/N2L is single core control, and by performing motion control and EtherCAT communication with Cortex®-R52.

EtherCAT communication processing implements the CiA402 drive profile and it is possible to evaluate more practical control.

For details of each function, you can download documents separately from the Renesas Electronics website.

<<Caution when handling the solution board>>
Don't touch the board while power is supplied because CN032 AC servo solution board contains high voltage circuits.

Target Device

RZ/T2M Group

RZ/T2L Group

RZ/N2L Group

Related Document

- CN032 AC Servo Solution Controller Board Manual (for RZ/T2M, RZ/N2L)
- CN032 AC Servo Solution Controller Board Manual (for RZ/T2L)
- CN032 AC Servo Solution Inverter Board Manual
- CN032 AC Servo Solution Firmware Manual
- CN032 AC Servo Solution Startup Guide (for EtherCAT) (this manual)
- CN032 AC Servo Solution Startup Guide (for Motion Utility Control)

- RZ/T2M Group User's Manual: Hardware
- RZ/T2L Group User's Manual: Hardware
- RZ/N2L Group User's Manual: Hardware

Contents

How to Use This Manual

1. Purpose and Target Readers

This manual is designed to provide the user with an understanding of the set-up of the CN032 AC Servo Solution Kit. It is intended for users evaluating the RZ/T2M or RZ/N2L. A basic knowledge of electric circuits, logical circuits, and MCUs is necessary in order to use this manual. The manual comprises a step-by-step description of the installation and initial usage of an application software package that includes the CN032 AC Servo Solution Kit package.

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

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

2. List of Abbreviations and Acronyms

Abbreviation	Full Form
CPU	Central Processing Unit
PC	Personal Computer
UART	Universal Asynchronous Receiver / Transmitter
FSP	Flexible Support Package
FSA	Finite State Automaton
SSC	Slave Stack Code

1. Operating Environment

The sample program in this manual assumes the following environment.

Table 1-1 Operation Environment

Item		Contents		
		RZ/T2M edition	**RZ/T2L edition**	**RZ/N2L edition**
MPU	Series	RZ/T2M Dual Arm Cortex®-R52	RZ/T2L Single Arm Cortex®-R52	RZ/N2L Single Arm Cortex®-R52
	Package	R9A07G075M24: 225-pin FBGA	R9A07G074M08: 196- pin FBGA	R9A07G084M04: 225-pin FBGA
Operating frequency		800MHz	800MHz	400MHz
Operation mode		xSPI0 boot mode (x1 boot Serial flash)		
Operating voltage		3.3V/1.8V/1.1V		
Communication protocol		EtherCAT		
Integrated development environment Refer to Appendix 6.2 on how to install.		IAR Systems Embedded Workbench for ARM 9.32.2		
		Renesas Electronics e²studio 2023-07 Toolchain GNU ARM Embedded 9.3.1 (*1)		
		Renesas Electronics FSPSC 2023-07 (*2)		
Flexible Support Package (FSP)		RZT FSP v1.3.0		RZN FSP v1.3.0
Emulator		IAR Systems I-jet		
		SEGGER J-Link EDU Version 11.0		
SSC Tool		Provided by EtherCAT Technology Group (ETG) Slave Stack Code (SSC) Tool Version 5.12		
Software PLC		Beckhoff Automation TwinCAT® 3		

(*1) For instructions on how to install the toolchain, refer to Chapter 6.2.2 Toolchain Install.

(*2) FSP SC (Smart Configurator) is a code generation tool for IAR Embedded Workbench.

The installation of the integrated development environment, SSC Tool, software PLC has been completed.

The Table 1-2 Controller board and inverter board combination shows the combination of the controller board and inverter board. Operation is not guaranteed with any combination other than the following.

Table 1-2 Controller board and inverter board combination

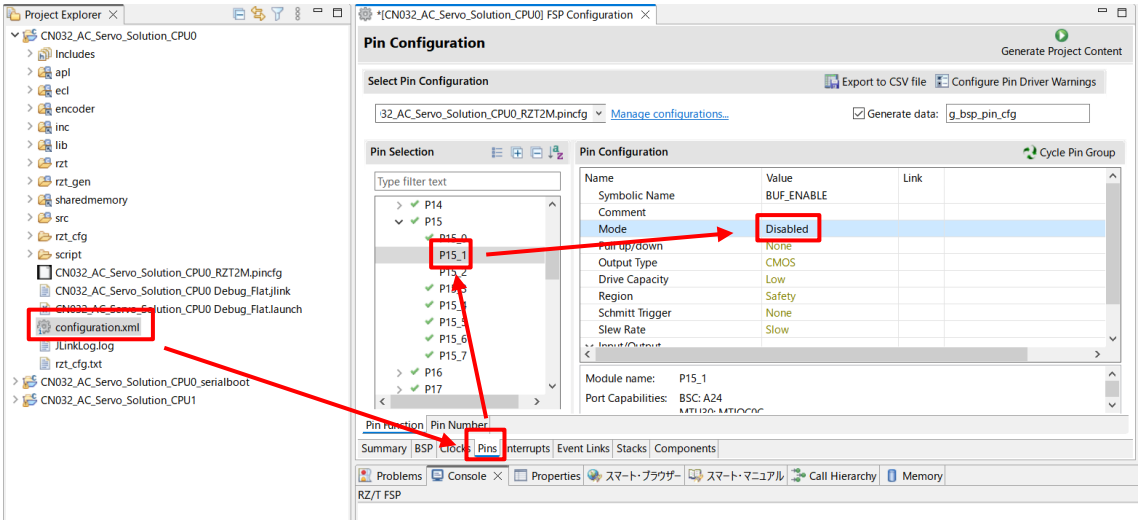
No.	Controller board	Inverter board		
		V1.1	V1.2	V2.1
1	RZ/T2M(v1.1), RZ/N2L(v1.1)	Available	Available	N/A
2	RZ/T2M(v2.1), RZ/N2L(v2.1)	N/A	N/A	Available
3	RZ/T2L(v1.0)	Available	Available	N/A
4	RZ/T2L(v2.0)	N/A	N/A	Available

The No.2 in Table 1-2 requires Software Package Ver.5.02(r12an0123xx0502-cn032-ac-servo-solution) or later, the No. 4 requires Software Package Ver.5.01(r12an0123xx0501-cn032-ac-servo-solution) or later.

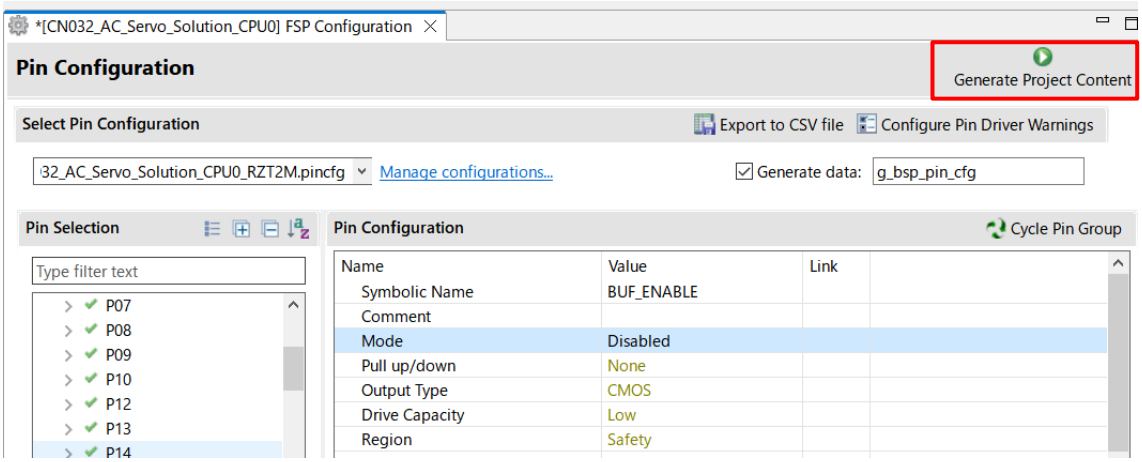
When operating No.1 in Table 1-2 on Software Package Ver.5.02(r12an0123xx0502-cn032-ac-servo-solution) or later, change the mode of P03_5 to “Disable” in Pin Configurations.

When operating No.3 in Table 1-2 on Software Package Ver.5.01(r12an0123xx0501-cn032-ac-servo-solution) or later, change the mode of P15_1 to “Disable” in Pin Configurations.

The procedure will be explained using the development environment e^{2}studio of No.3 as an example.



Then click “Generate Project Content” button.



2. Preparation of CN032 AC Servo Solution Kit

The first step of getting started with the CN032 AC Servo Solution Kit is connecting the power supply, the motor, the encoder and the communication cable. Follow the steps using the cables and the motor included with the kit.

2.1 Precaution before Operation

When using this kit, please kindly comply with the following 1 to 3:

1. Use stable power supply with current 1[A] limit setting to inverter board.
2. Do not use DC12-24[V] power supply jack to controller board.
   ※The power of controller is supplied from the inverter board.
3. Even after turning off, please do not touch the inverter board when high voltage LED(D27) is on which could be about 3 minutes or more.

If motor malfunctions or makes noise during use, please turn off the power to the inverter board immediately.

If this malfunction symptom continues, please contact our sales office or agency.

2.2 Connecting the Logic and Motor Power

The power can be inputted from 100V to 250V AC. From this chapter onwards, the procedure for operating the 220V AC servo motor control system with 220V AC power supply is described.

The power consumption when the controller is idle is around 0.288A but can go up to 0.312A depending on the connected encoders, sensors and other loads.

The motor that is delivered with the kit is prepared for 220V operation. Power is supplied via 12-pin connector P4 on the inverter board as shown in Figure 2-1. The 4-pin cable for P4 is included in the kit.

Note: It is recommended to use separate power supplies for logic and motor.

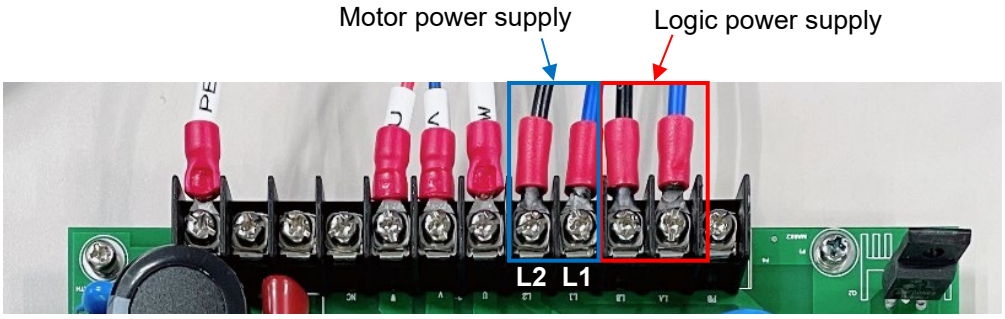


Figure 2-1 power connection via P4

2.3 Connecting the Motor Windings

The motor windings are connected using P4 on the inverter board. When connecting, you need to consider the signal names printed on the motor cable and the inverter board. Figure 2-2 shows the position of the connections for the motor windings.

Note: silk for U/W on the inverter board (v1.1 only) is wrong printed.

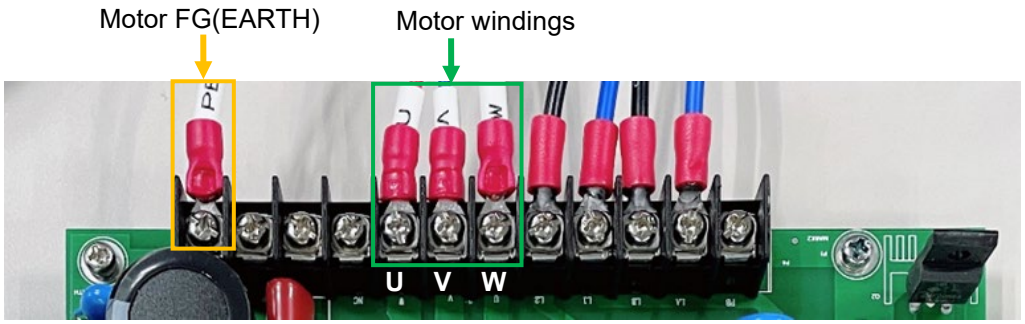


Figure 2-2 Connecting the motor windings to P4

2.4 Connecting the Encoder

The encoder is connected to J13 on the controller board via a DB 15 connector. A second encoder (not included in the kit) can be connected to J14 if desired. The position of J13 on the controller board is illustrated in Figure 2-3. The encoder of the motor that is supplied with the kit is prepared for immediate connection. AC Servo Solution Kit is supported Tamagawa encoder.

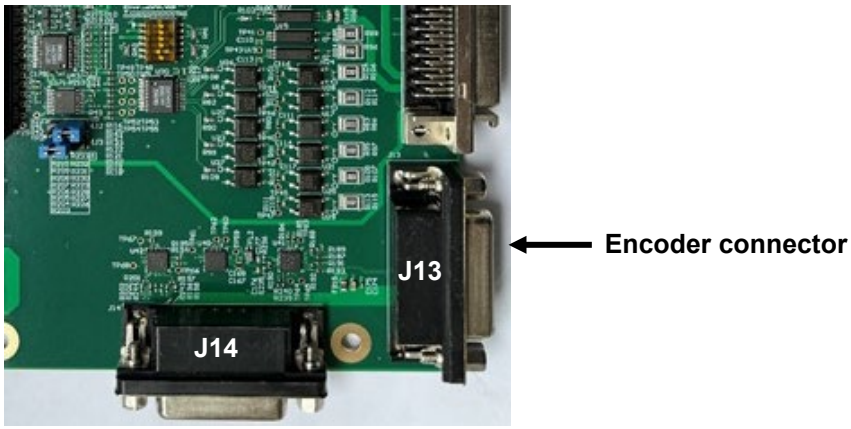
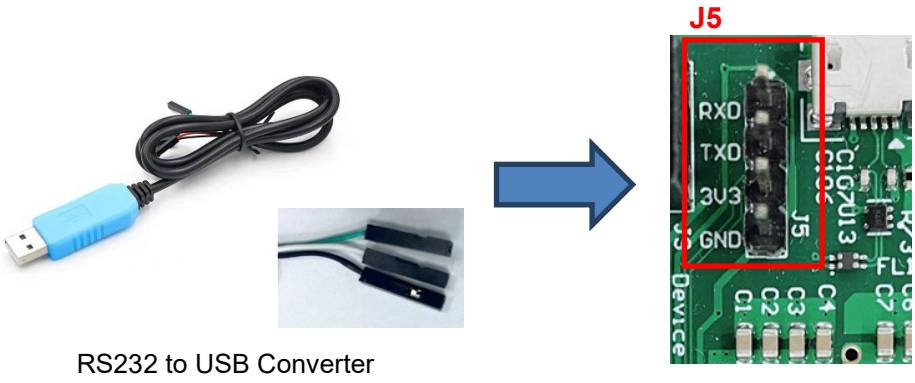


Figure 2-3 Connecting the encoder

2.5 Connecting the UART communication cable

2.5.1 RS232 to USB

Communication with the host PC is done via a serial interface available on J5 of the controller board. The RS232 to USB converter is used when connecting. A suitable serial cable is included in the kit. The connection is shown in Figure 2-4.



RS232 to USB Converter

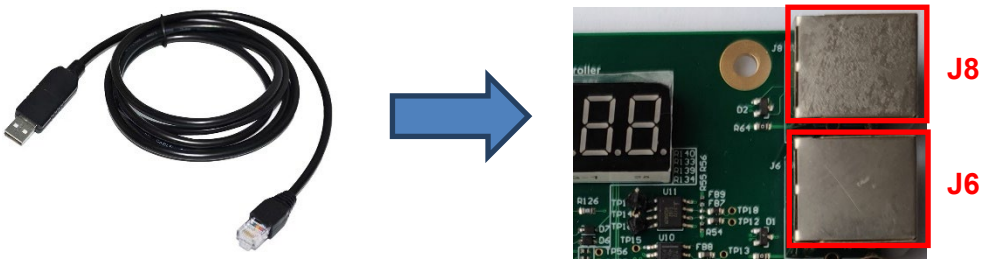
Figure 2-4 Serial connection to host PC

Table 2-1 Connection RS232 to USB Converter with controller board

RS232 to USB converter	J5	Note
TXD(Green)	RXD(J5-1)	
RXD(White)	TXD(J5-2)	
NC	3V3(J5-3)	Connection is not needed
GND(Black)	GND(J5-4)	

2.5.2 RS485 to USB

The RS485 to USB converter is connected the J6 or J8 of the controller board.
Table 2-5 is shown the connection with controller board.



RS485 to USB Converter

Figure 2-5 Serial connect to host PC

2.5.3 Selection for RS232 and RS485

RS232 or RS485 can be selected by SW2-1 according to Table 2-2.

Table 2-2 Communication selection

	RS232	RS485(default)
SW2-1	ON	OFF

SW2 on the board

2.6 Connecting the JTAG interface

This connection is required for development purposes or in case new firmware has to be loaded. The JTAG connector is using a MIPI10 connector (as specified by IAR). The pins are spaced 1.27mm apart and the connector is polarized.

The connection is shown in Figure 2-6.

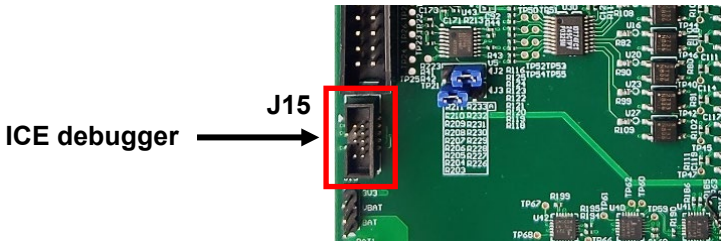


Figure 2-6 Hardware debugger connection

2.7 Connecting the Ethernet Interface

An Ethernet connection to the PC or a PLC can be prepared using one of the two RJ-45 connectors J11 or P12. For running the EtherCAT sample program you can use any of the two connectors.

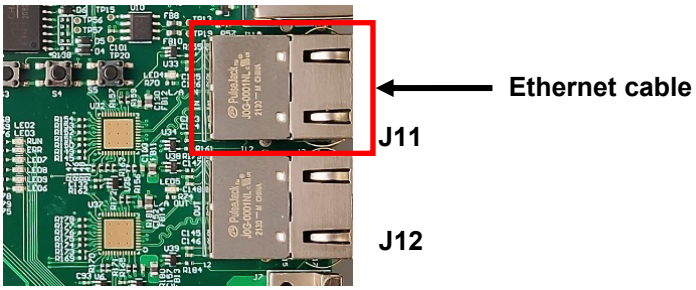


Figure 2-7 Ethernet connection

2.8 Overall connection configuration

After connecting chapter 2.1 to 2.6 above, the boards will look like the figure below.

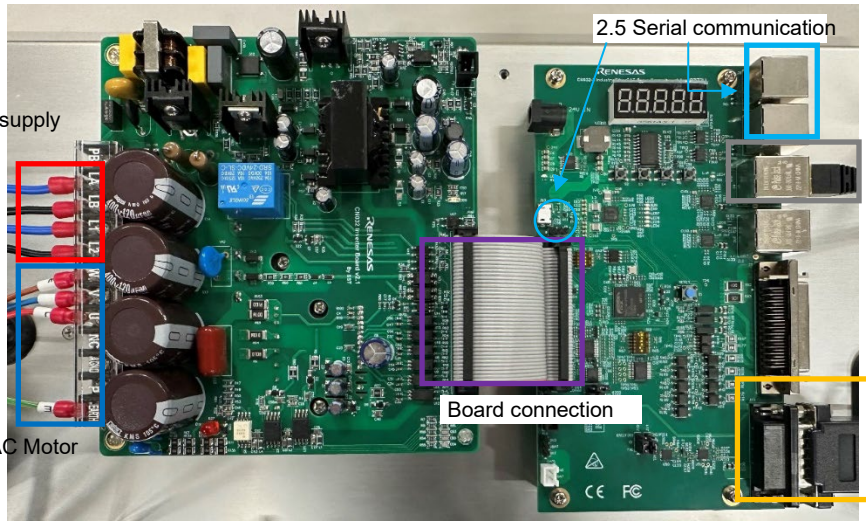
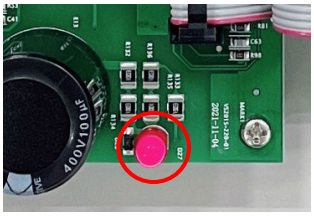


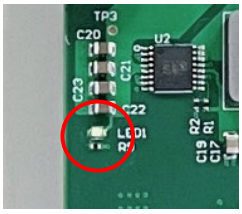
Figure 2-8 Overall connection configuration

2.9 Power supply to the board

① xSPI0 boot mode setting
Set SW1 of the controller board to the following.

② Power supply to the inverter board, and then the red lamp lights up.
Additionally, the controller board is supplied 5V DC power from inverter board and then LED1 lights up.


Power lamp of the inverter board



Power LED of the controller board

If LED7 does not light up, program for motor control is not written to the flash memory. So, the program need to be written to the flash memory according to the chapter 6.1 and 6.3.

3. Preparing EtherCAT Communication

This chapter describes a couple of steps required before actually running the EtherCAT sample project on the RZ/T2M, RZ/T2L or RZ/N2L.

3.1 TwinCAT®3 Installation

The TwinCAT®3 installation is straight forward and simple. You can download TwinCAT®3 from

http://www.beckhoff.com/english/download/tc3-downloads.htm?id=1905053019883865

Please keep in mind that screen shots and operation method may change without notice for newer versions of the software. Above URL will lead you to a screen as shown in Figure 3-1.

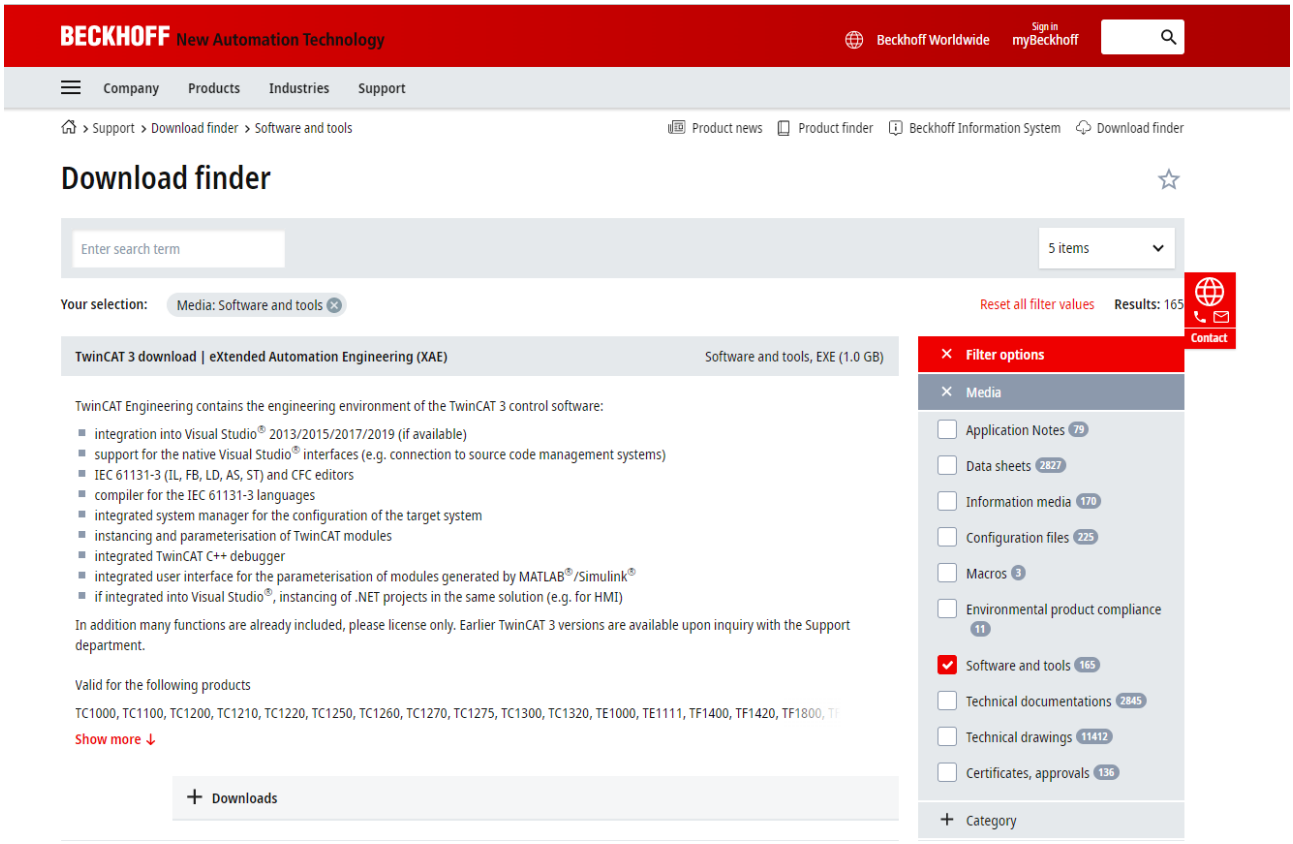


Figure 3-1 TwinCAT®3 Download Screen

Select the TE1xxx|Engineering software package for download. If you are no registered user, you can register and download as guest; the registration is free of charge. You will then get an e mail with a download link. After download, TwinCAT®3 can be installed on your PC. The installation procedure guides you through a number on steps that we will not detail here; simply follow the default installation.

- The installation procedure asks for a serial number. This field can be left empty.
- In the ‘Select Installation Level’ dialog select TwinCAT PLC – IEC 61131-3 PLC system
- In the ‘Select Installation Type’ dialog select 30 days demo version (the functions that are required to run our example last longer than 30 days)
- Install all features
- Target directory for the installation should be C:\TwinCAT

After installation one important point needs to be checked in order to control whether the installation has completed properly. It is the selection of the network adapter for TwinCAT®3. To check that, start TwinCAT®3 and in the start-up screen select “Show Realtime Ethernet Compatible Devices” from the “TwinCAT” menu (see Figure 3-2).

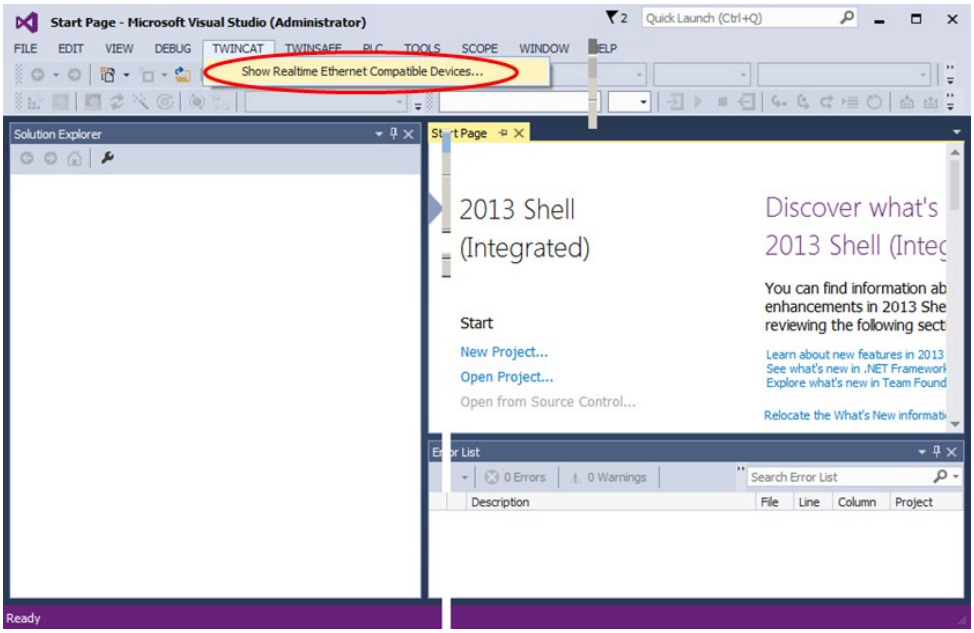


Figure 3-2 Checking available network adapters for TwinCAT®3

TwinCAT®3 will then show you a list of the network adapters in your PC, grouped into several categories. There should be at least one adapter listed under “Compatible devices” as shown in Figure 3-2. Select one of the compatible devices and click “Install”. The network adaptor is then moved to the “Installed and ready to use devices (realtime capable)” category.

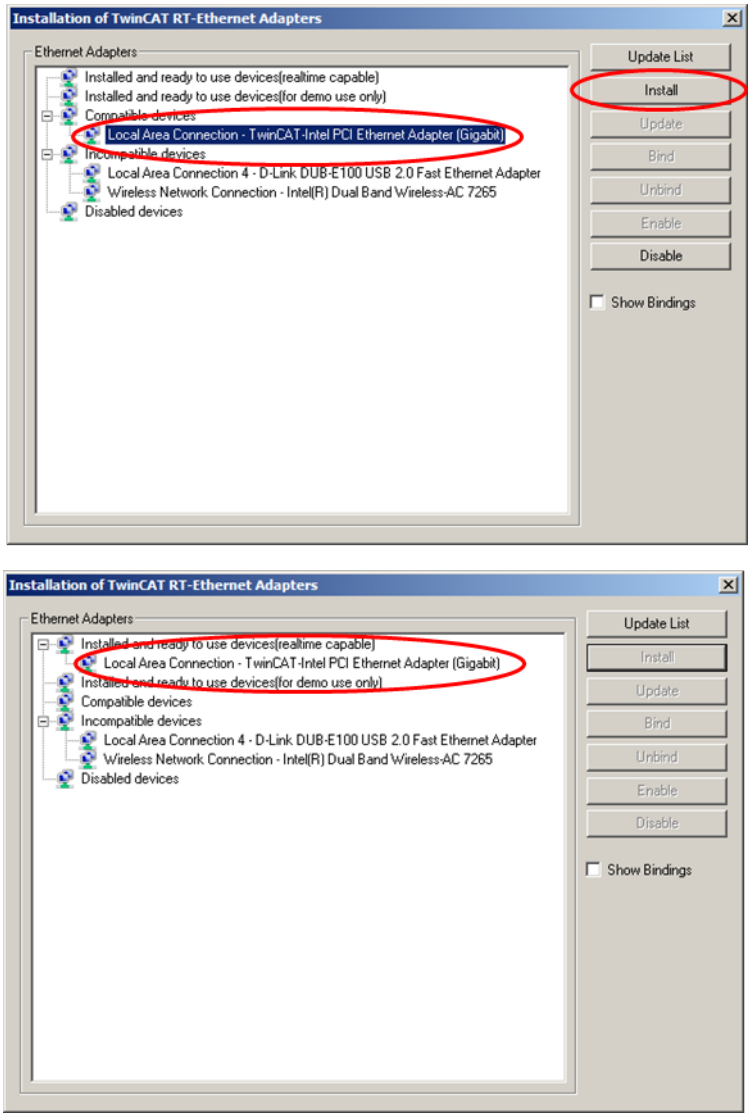


Figure 3-3 Selecting a compatible network adapter

Check the properties of the network adapter that you use for the EtherCAT connection. Open the Network and Sharing Center in MS Windows, right-click on the network adapter used for EtherCAT and select “Properties”. You will then see a list of supported protocols and/or services for this adapter similar to Figure 3-4.

Please uncheck all items that are not EtherCAT related as shown in the screenshot. Then retry to scan for devices.

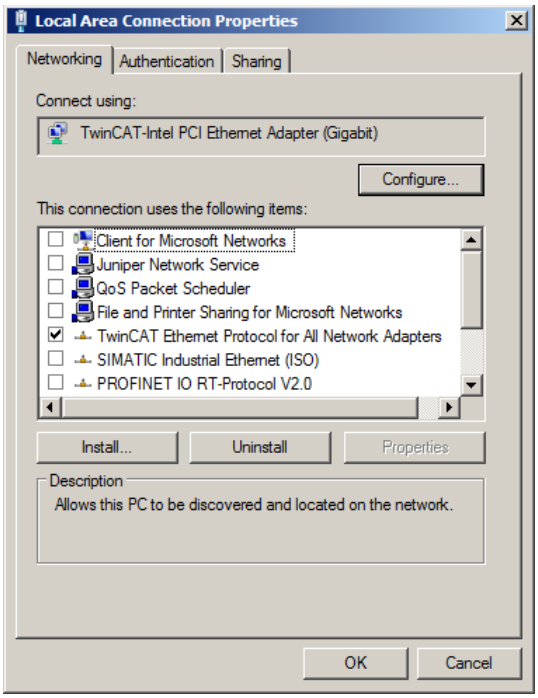


Figure 3-4 Setting the network adapter used for EtherCAT

3.2 Copying the ESI File

Obtain the ESI (EtherCAT Slave Information) file " Renesas_CN032_AC_Servo_Solution_CiA402.xml " file from the following location shown in Figure 3-5.

Case of the AC Servo Solution Kit (RZ/T2M)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Common\ethercat\src\r_ecat\utilities\esi”

Case of the AC Servo Solution Kit (RZ/T2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Common\ethercat\src\r_ecat\utilities\esi”

Case of the AC Servo Solution Kit (RZ/N2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Common\ethercat\src\r_ecat\utilities\esi”

Then, copy the obtained file to the following folder, in which TwinCAT®3 has been installed:

“\TwinCAT\3.x\Config\Io\EtherCAT”

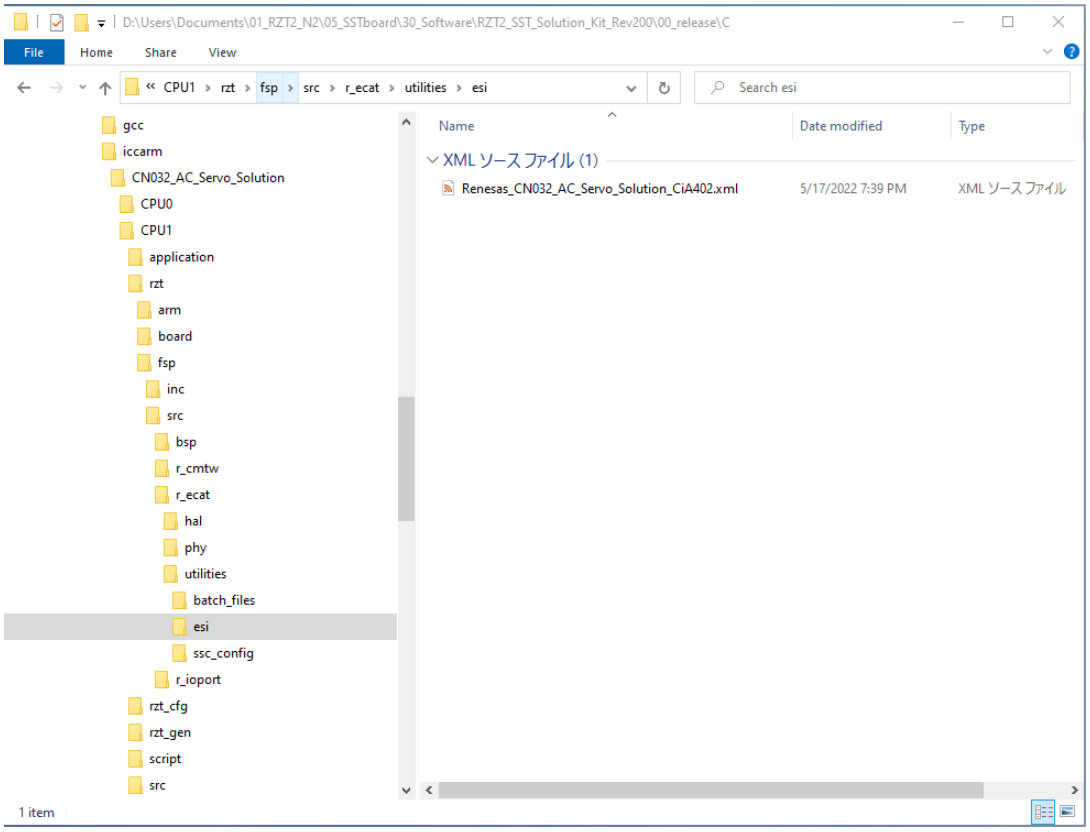


Figure 3-5 Copying the ESI file

4. Confirm Communication with TwinCAT®3

4.1 Starting TwinCAT®3

(1) Start the "TwinCAT XAE" program by one of the following methods.

1. From the task tray, select [TwinCAT Config Mode] > [TwinCAT XAE (VS2013)]
2. From the start menu, select [All Programs] > [Beckhoff] > [TwinCAT 3] > [TwinCAT XAE (VS2013)]

(2) After starting the program, select [New TwinCAT Project] as shown in Figure 4-1 and create a new project of type TwinCAT XAE Project. Note that the creation of the new project may take several 10 seconds and watch the progress bar in the lower right corner of the TwinCAT®3 window.

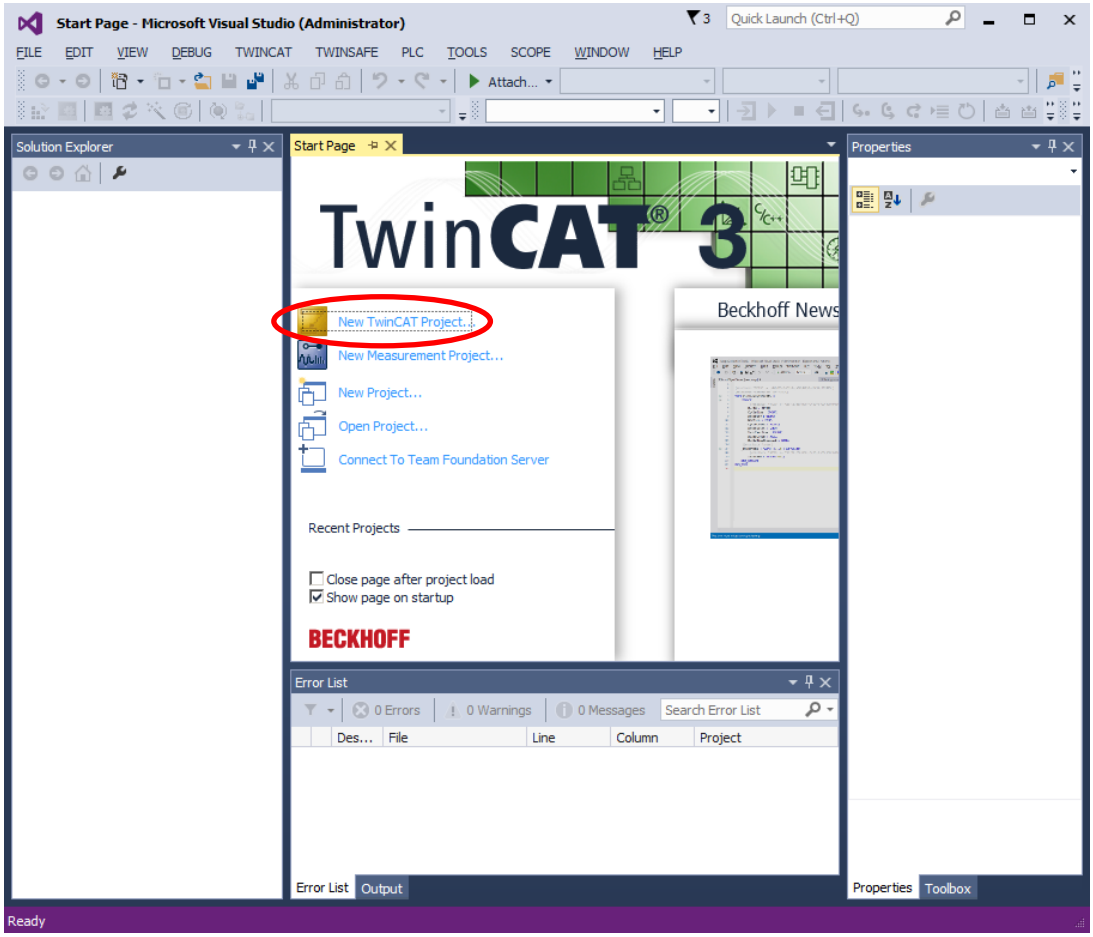


Figure 4-1 TwinCAT®3 start-up screen

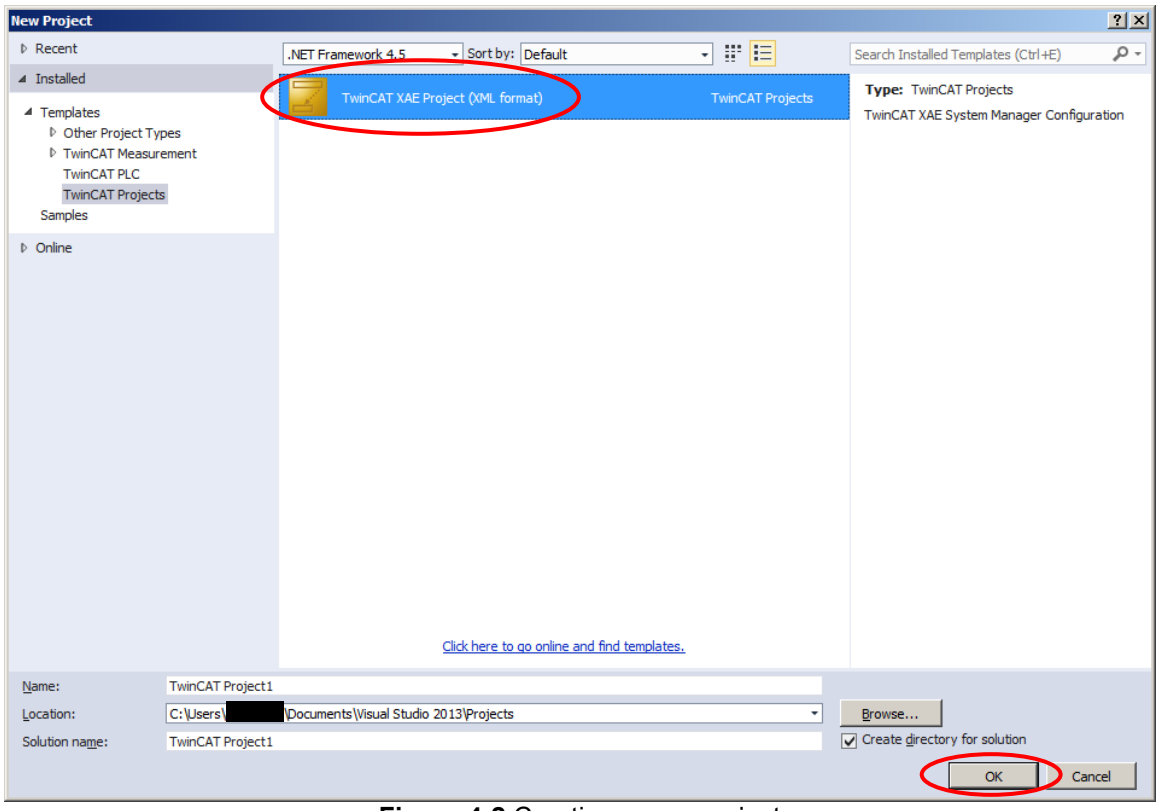


Figure 4-2 Creating a new project

When the project is created, open the “TWINCAT” menu, chose “EtherCAT Devices” and execute “Reload Device Descriptions”. This ensures, that the device description (aka .ESI file), that you have copied into the TwinCAT®3 installation file structure in chapter 3.2 can really be used in our project.

Make sure that the CN032 AC Servo Solution firmware project on the RZ/T2M, RZ/T2L or RZ/N2L is up and running before the next steps in TwinCAT®3. When the project is not up and running, see chapter 6 to execute the project.

(3) Right-click [Devices] and select [Scan] (Figure 4-3)

After you have clicked [Scan], you will be prompted that not all devices in the network can be found automatically. Click ok. TwinCAT®3 will then show you a list of available devices in the network. Select the [EtherCAT] device connected to the network controller that you use for the CN032 AC Servo Solution board (see Figure 4-4) and click ok

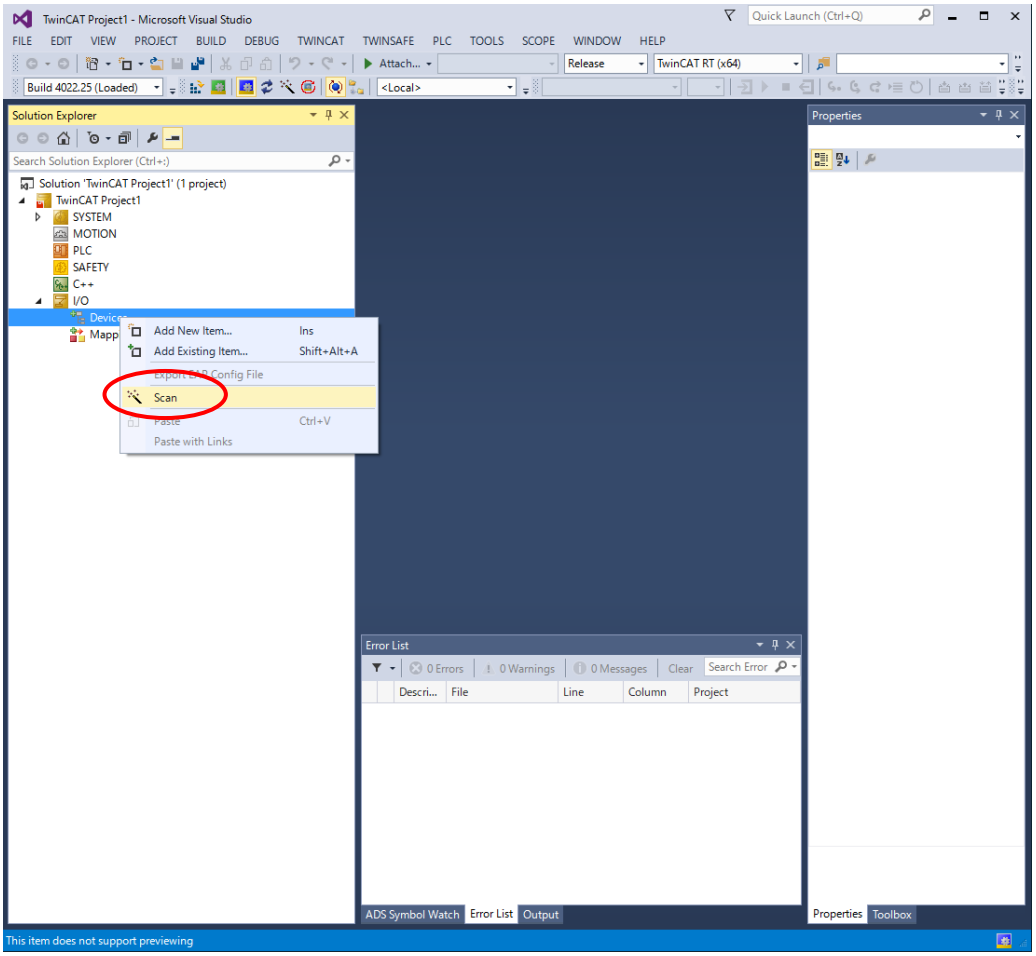


Figure 4-3 Scanning the network for new devices

(4) Select only [EtherCAT] and click [OK].

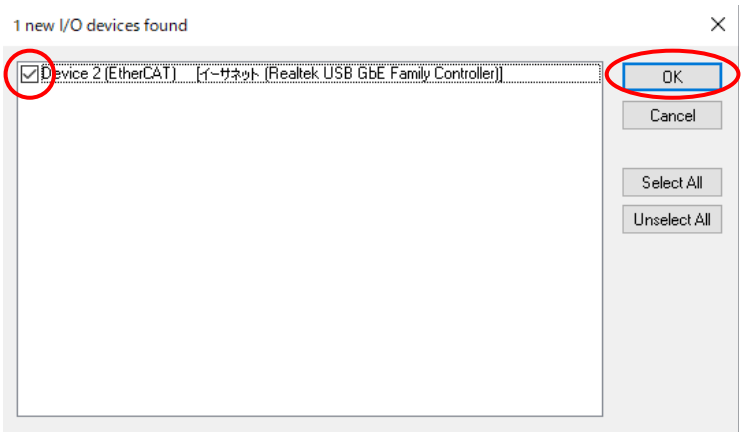
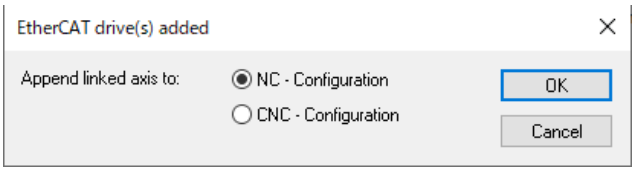


Figure 4-4 Selecting the proper EtherCAT device

Note). When scanning the device, the CiA402's ESI is used, so the axis configuration settings are displayed.
Select [NC-Configuration]



After clicking ok you will be prompted, whether you want to “scan for boxes” and to “activate Free Run”. In both cases click “yes”. When Free Run was activated, the RUN and ERR LEDs begin flashing and the L/A IN LED is flashing rapidly.

Note that if you repeat the “Scan” process in the same project in the same environment, you will be informed that no new devices were found. This is no bad thing as there has been no change in the network.

(5) The scan result is displayed as "Drive x (CN032 AC Servo Solution CiA402)".

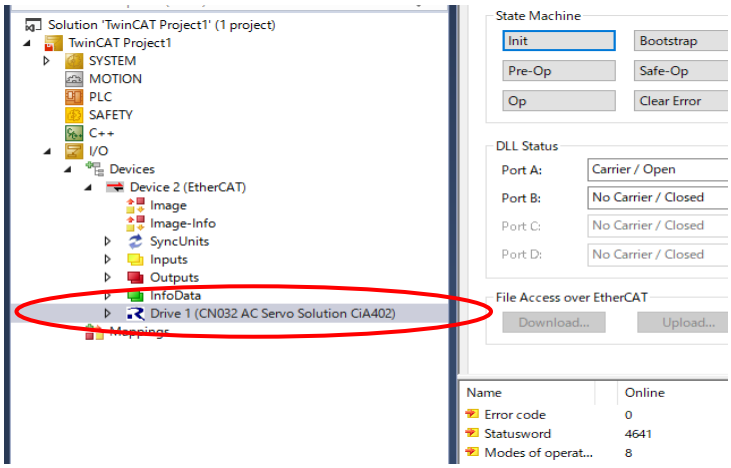


Figure 4-5 Result of scan for EtherCAT slave devices

When the scan result is displayed as "Box 1 (Pxxxxxxxx Rxxxxxxxx)” as like Figure 4-6. EEPROM data should be written according to chapter 6.5. After EEPROM write, Box 1 will be displayed as "Drive x (CN032 AC Servo Solution CiA402)". EEPROM rewrite is described in chapter 6.5.

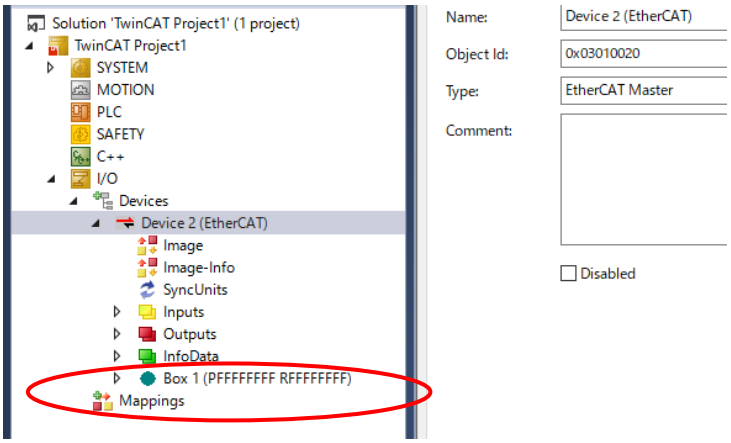


Figure 4-6 Result of scan for unknow devices

Your TwinCAT®3 project is now ready for operation.

4.2 Checking the Communication Status

To confirm that TwinCAT®3 and the software on the RZ/T2M are running properly, it is recommended to check the communication status in TwinCAT®3. For the check, double click the "Drive 2 (CN032 AC Servo Solution CiA402)" device (1), select the “Online” tab (2) and check, whether the current state is “OP” (3).

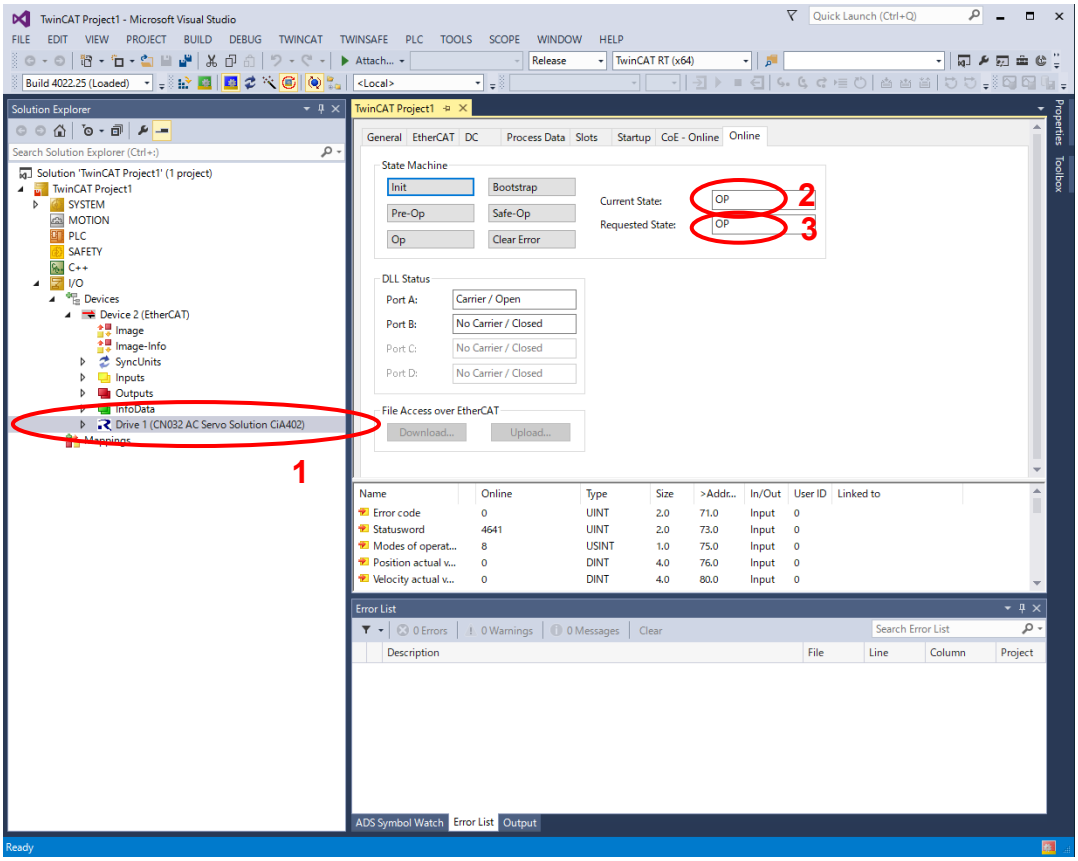


Figure 4-7 Checking the communication status

In case that the current state is not “OP” (i.e. “INIT”) please restart establishing the communication with the [Restart TwinCAT (Config Mode)] button shown in Figure 4-8. You will then be prompted for

- Restarting TwinCAT System in Config Mode
- Loading I/O Devices
- and Activating Free Run

In all three dialogues simply click “yes”. When communication is re-established, the device state in the “Online” tab must change to “OP” as shown in Figure 4-7.

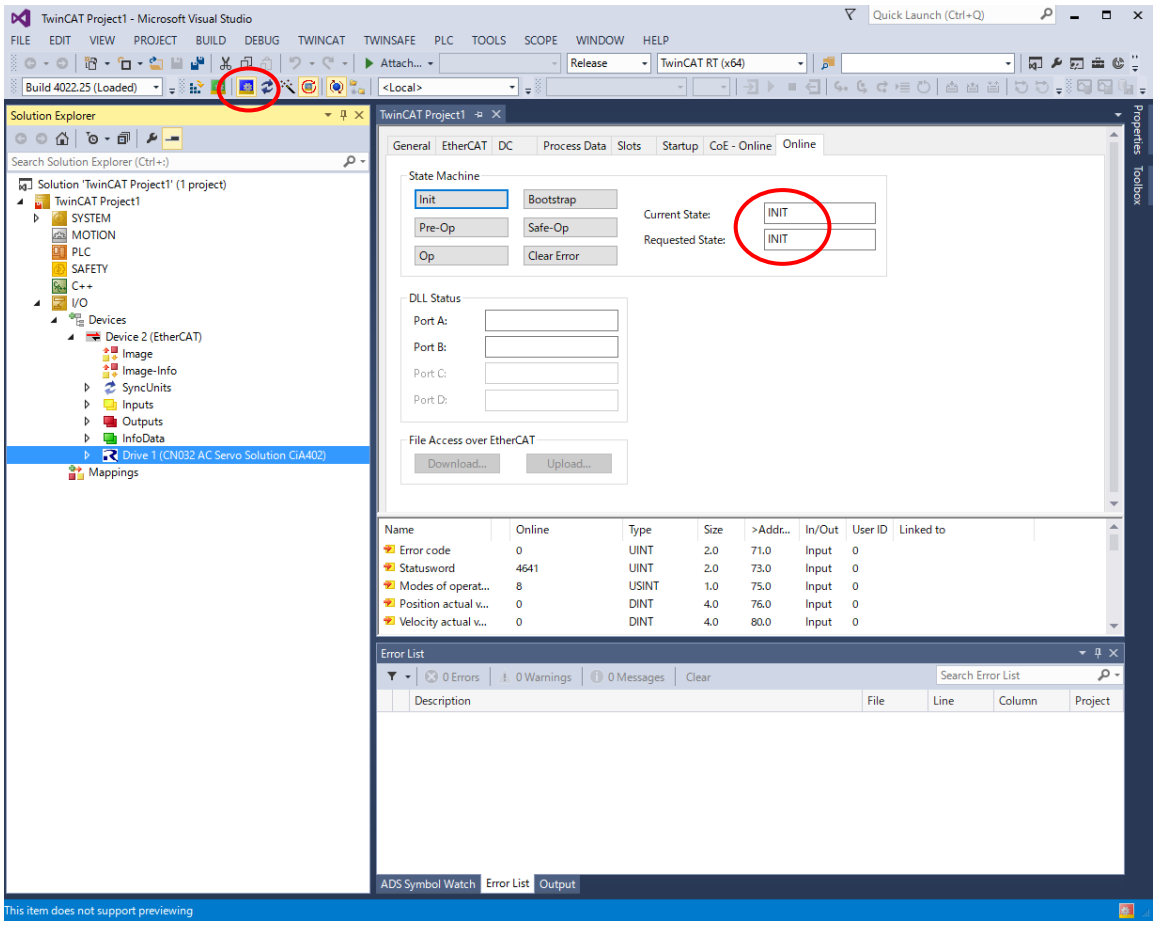


Figure 4-8 Restarting TwinCAT®3 system in config mode

4.3 CiA402 Drive Profile Operation

The operation mode of CiA402 drive profile supported by CN032 AC Servo Solution Kit is shown as 5.1 Operation Modes.

4.3.1 Operation mode setting

When change the operation mode, following the steps below.

(1) Select “Drive x (CN032 AC Servo Solution CiA402)”.

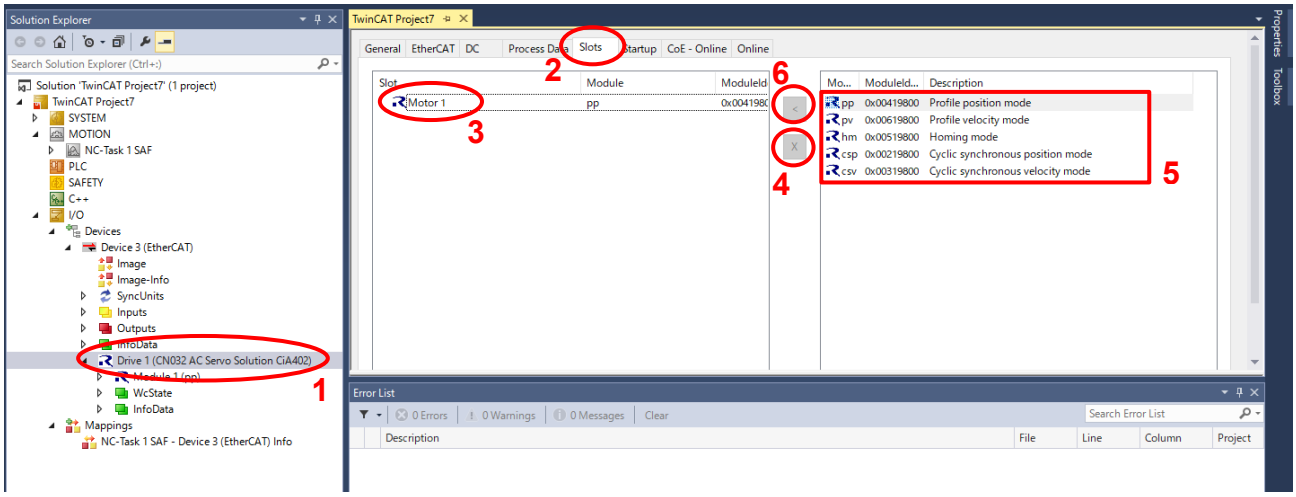
(2) Select “Slots” tab.

(3) Select “Motor 1”.

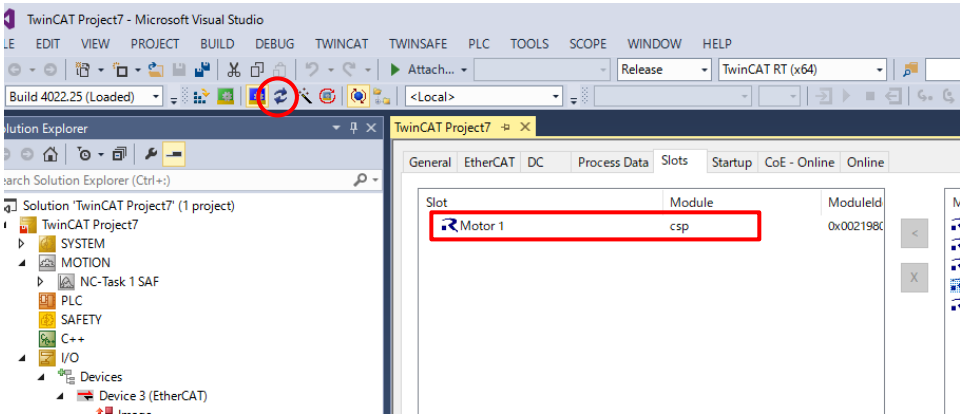
(4) Push “X” button to remove current module setting.

(5) Select any module from multiple modules supported CN032 AC Servo Solution.

(6) Push “<” button to apply selected module setting.



Check the module of Motor 1 was changed to module you selected and then push “ ” button to reload the device.



4.3.2 Profile Position Mode (pp)

Make sure Module 1 is applied to the operation of Profile position mode (1). Expand the “Drive x (CN032_AC_Servo_Solution_CiA402)” tree and expand “Module 1” as far as possible as shown in Figure 4-9. For the sake of comfort add the input values to an extra watch window by right-clicking at a value (2) and selecting “Add to watch” (3).

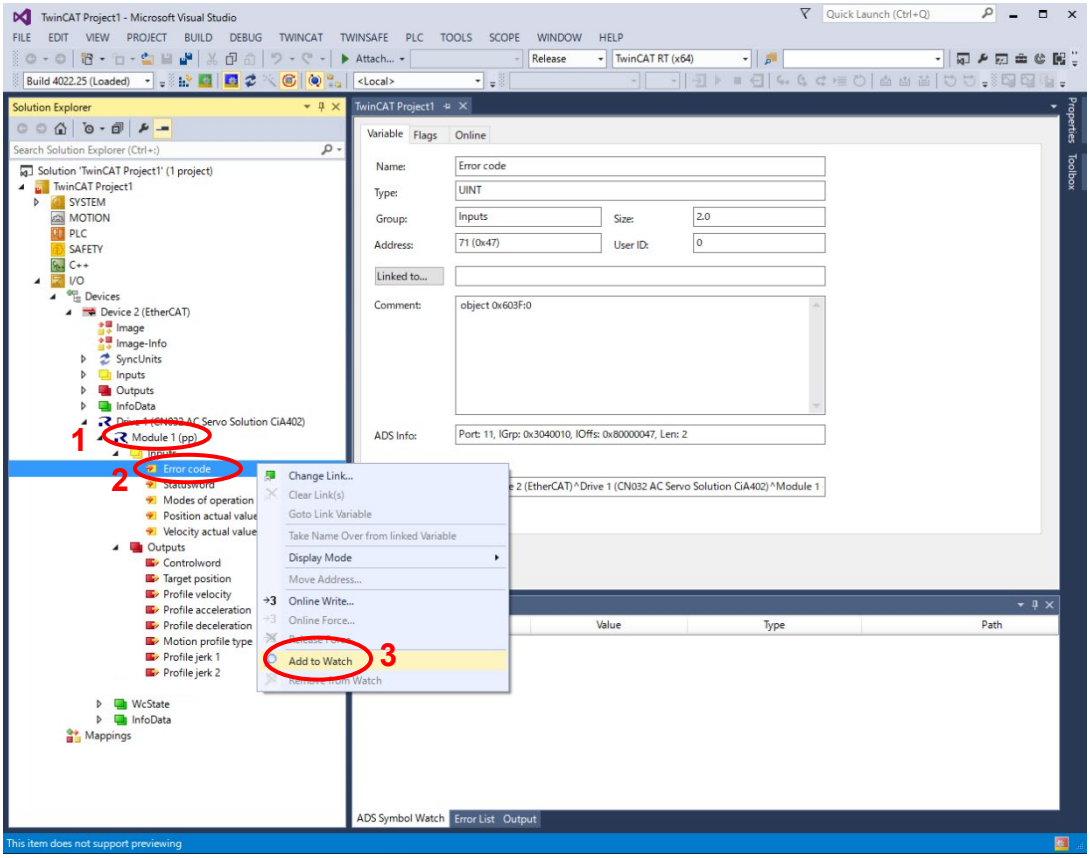


Figure 4-9 Adding values to a watch

If you repeat this exercise for all five input values for “Module 1”, you will get a permanently updated watch window as illustrated in Figure 4-10.

ADS Symbol Watch

Symbol	Value	Type	Path
Error code	0	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 1 (CN032 AC Servo Solution CiA402).I
Statusword	545	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 1 (CN032 AC Servo Solution CiA402).I
Modes of operation display	1	USINT	I/O.Devices.Device 2 (EtherCAT).Drive 1 (CN032 AC Servo Solution CiA402).I
Position actual value	0	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 1 (CN032 AC Servo Solution CiA402).I
Velocity actual value	0	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 1 (CN032 AC Servo Solution CiA402).I

Figure 4-10 Input value watch for “Module 1”

Note: “Input” and “output” are always seen from the perspective of the EtherCAT PLC respectively the TwinCAT®3 GUI. Therefore you send commands to the drive (i. e. the CN032 AC Servo Solution) using output variables, while the feedback from the drive is reflected by the input variables.

The values listed under “Output” in the tree structure in TwinCAT®3 can be altered online. By clicking on “Controlword” more detailed information about the variable can be shown in the TwinCAT®3 window (1). A value for “Controlword” can then be sent to the drive via EtherCAT by clicking on the “Online” tab (2) and on the “Write” button (3). This opens a dialog for entering “Controlword” in different formats. Please enter 128 in decimal format. Closing the dialog with “Ok” (4) sends the value via EtherCAT.

Controlword 128 (or 0x80) is a kind of reset command that sets the drive to an initial state. If the error code in the watch window has been different from 0 before sending 128 (as in Figure 4-11), it should be 0 afterwards. Statusword should show the value 545.

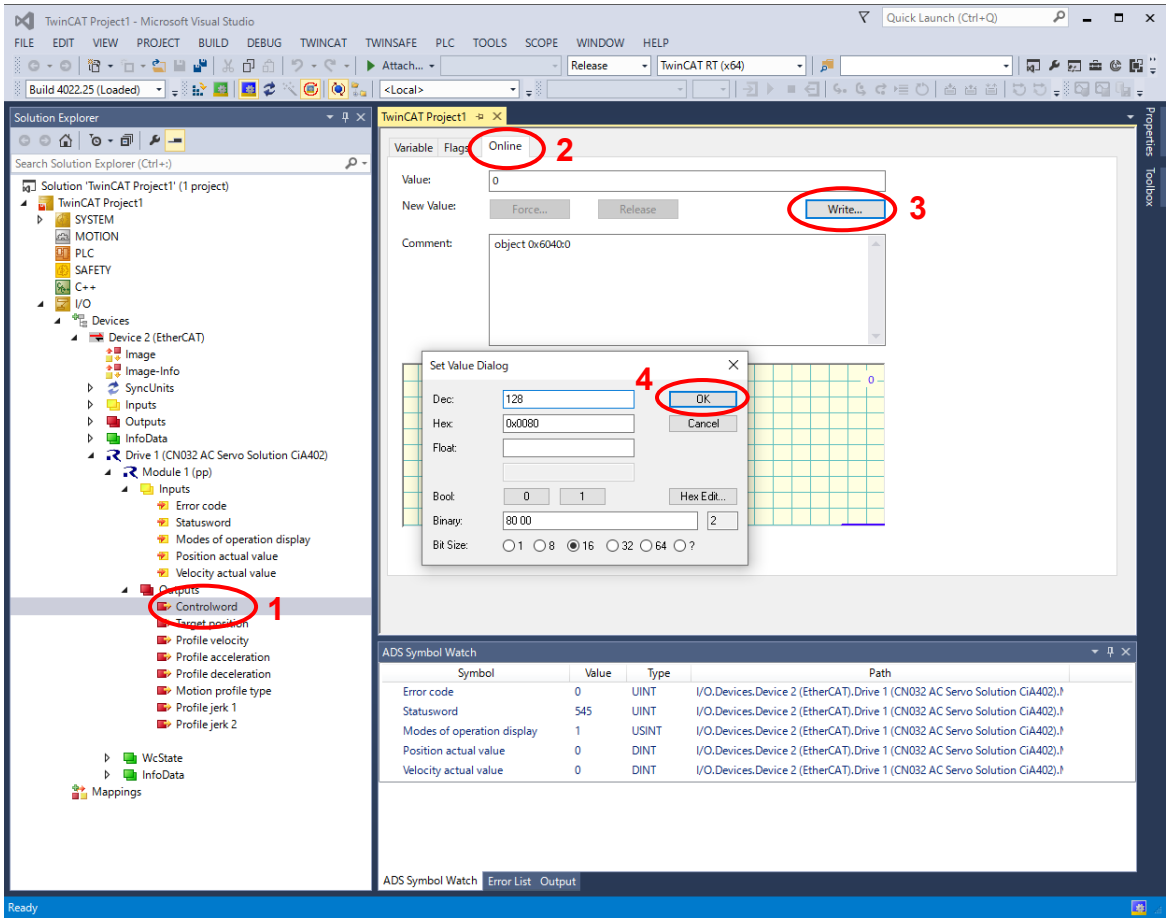


Figure 4-11 Sending a Controlword for resetting the drive

You can start drive operation by sending the Controlword 15 (or 0x0F).

Next, send values for “Target position”, “Profile velocity”, “Profile acceleration” and “Profile deceleration” with the same method. Good values for a first experiment are

- 800000 for target position
- 50 for profile velocity
- 100 for profile acceleration and deceleration
- 0 for motion profile type, profile jerk 1 and 2

Figure 4-12 Sending a Controlword for profile velocity illustrates this for “Profile velocity”; use the same method for the other values. Having sent theses values you can finally start motor spinning by sending the Controlword 31 (0x1F). The motor will now start spinning with the preset acceleration, velocity and deceleration until the target position is reached. In the watch window you can observe current speed and position. after motor spinning, Statusword is changed to 545 by sending the Controlword 6 (0x6). Figure 4-13 shows you three screen shots of the watch window before, during and after operation.

In case that the motor does not start spinning, you may try to send 128 again and/or to reset the CN032 AC Servo Solution board, which will automatically re-connect to TwinCAT®3.

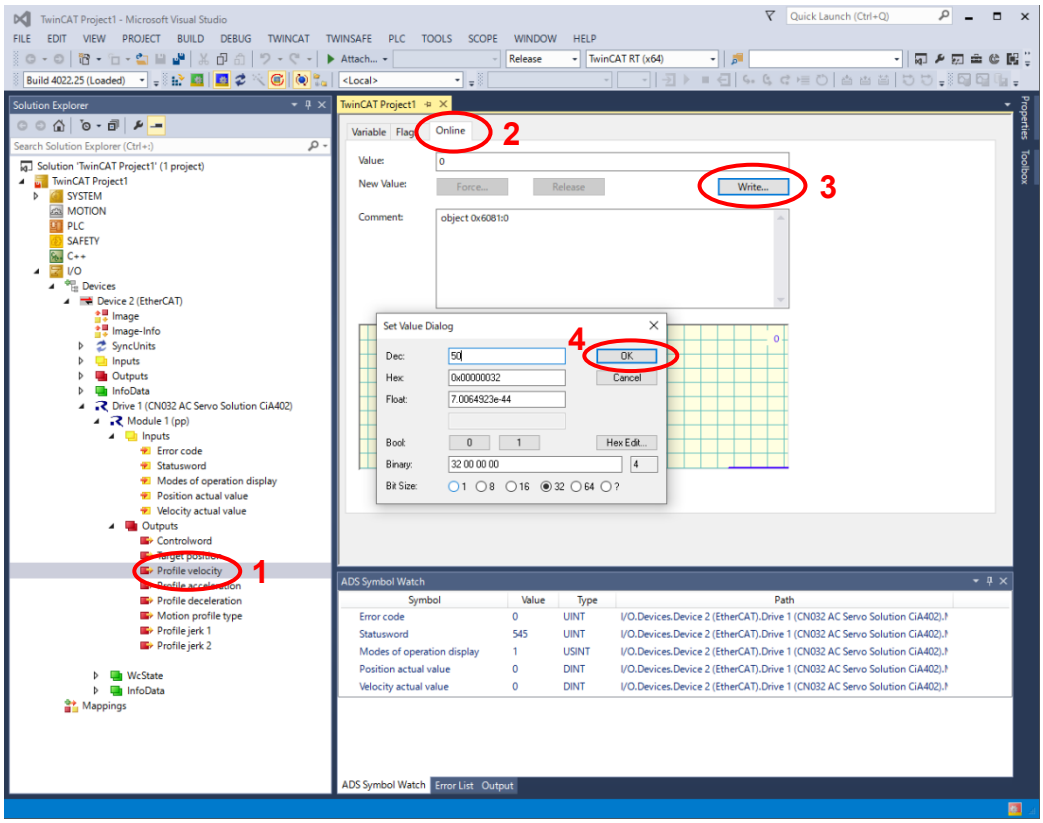


Figure 4-12 Sending a Controlword for profile velocity

1) before spinning

ADS Symbol Watch

Symbol	Value	Type	Path
Error code	0	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Statusword	545	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Modes of operation display	1	USINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Position actual value	0	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Velocity actual value	0	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)

2) while spinning

ADS Symbol Watch

Symbol	Value	Type	Path
Error code	0	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Statusword	4663	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Modes of operation display	1	USINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Position actual value	83935	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Velocity actual value	44	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)

3) after spinning

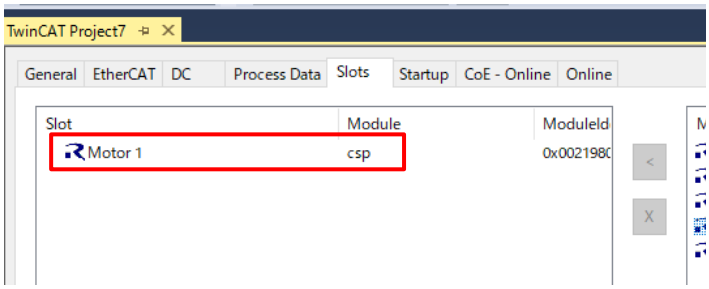
ADS Symbol Watch

Symbol	Value	Type	Path
Error code	0	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Statusword	1591	UINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Modes of operation display	1	USINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Position actual value	800000	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)
Velocity actual value	0	DINT	I/O.Devices.Device 2 (EtherCAT).Drive 2 (CN032_AC_Servo_Solution_CiA402)

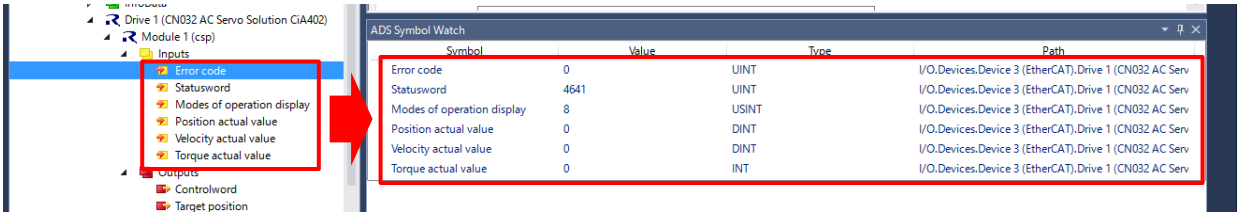
Figure 4-13 Watch value changes while motor spins

4.3.3 Cyclic Synchronous Position Mode (csp)

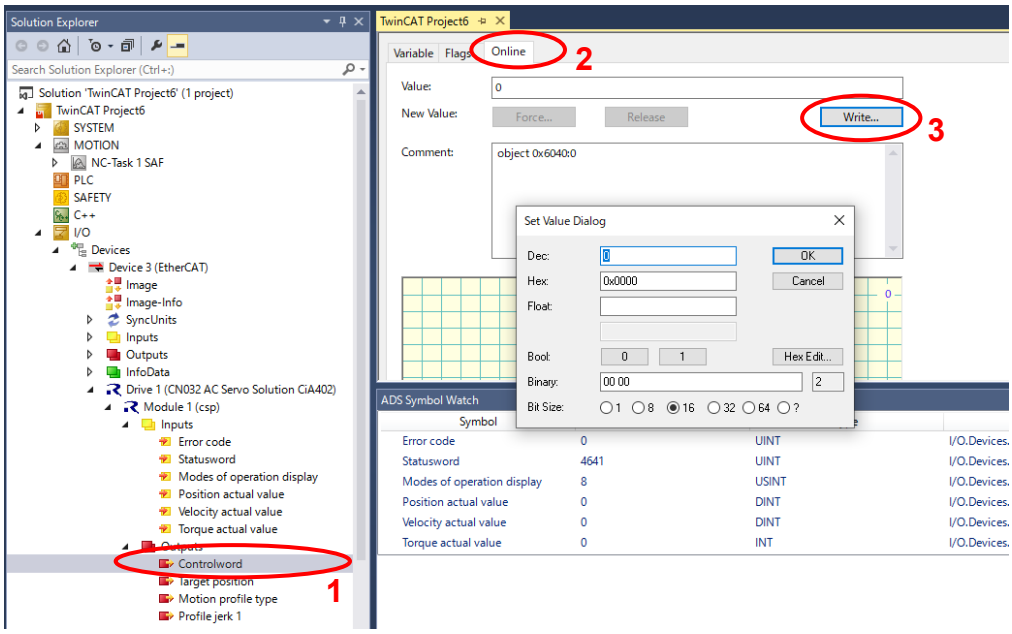
Confirm that the operation mode is “csp”. Otherwise, change the operation mode to “csp” by following 4.3.1 Operation mode setting.



Just like the steps described for pp mode, add the input values to an extra watch window for the sake of comfort.

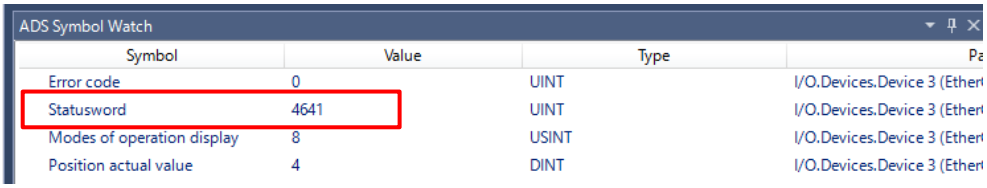


Follow steps (1) to (3) to open a dialog to send the value of Controlword.

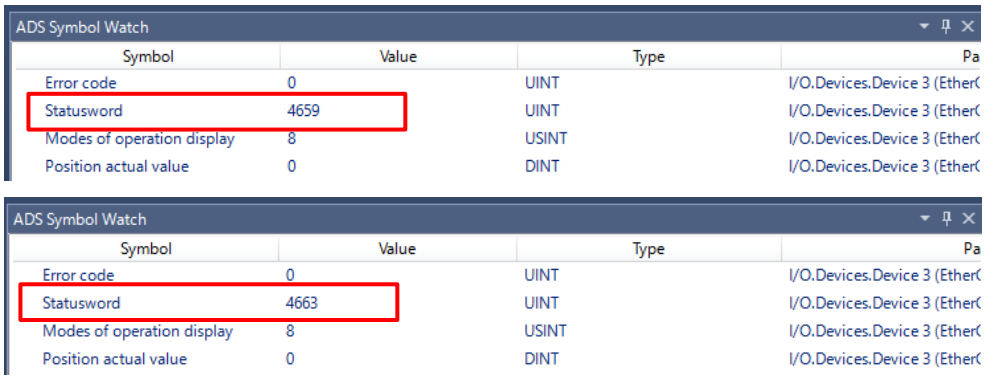


Follow steps A) to B) to send the Controlword value and make the motor controllable.

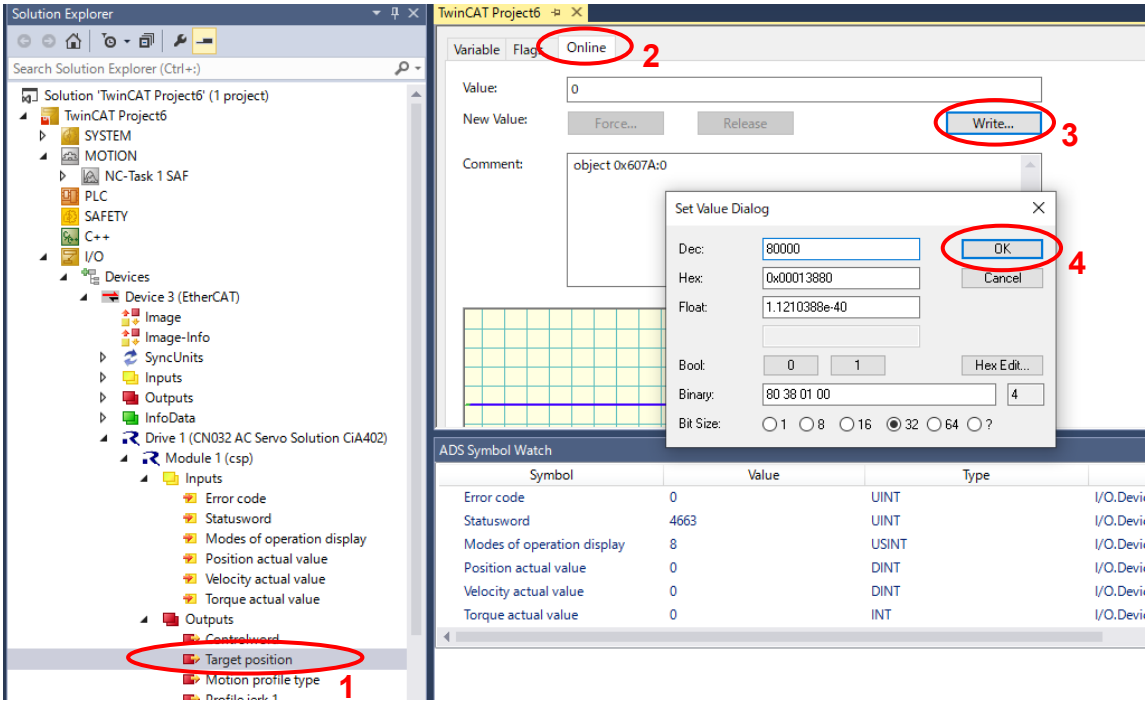
A) Confirm that Statusword is “4641”. Otherwise, set Controlword to 128 to reset Statusword.



B) Set Controlword to “15” and then Statusword will be “4659” (Power on) and then immediately change to ”4663” (Servo on).



Follow steps (1) to (3) to open a dialog to send the value of Target Position.
Enter the Target Position value and closing the dialog with “Ok” (4) sends the value via EtherCAT.

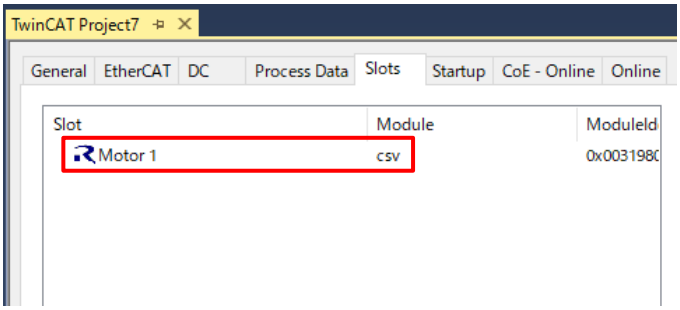


Then, the motor rotates until the Position actual value counts up to the Target Position value.

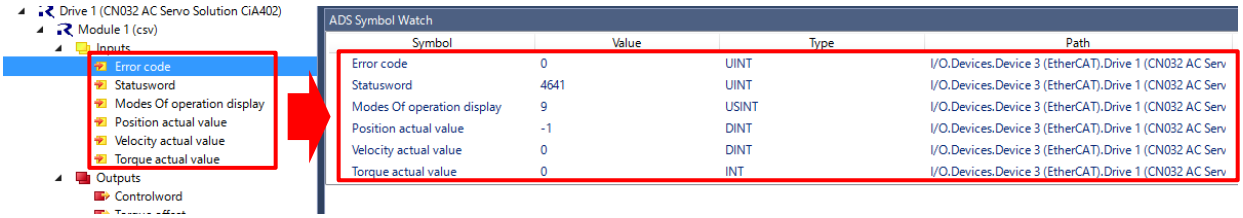
When stop the motor control, set Controlword to “6” and then Statusword will be “4641”.

4.3.4 Cyclic Synchronous Velocity Mode (csv)

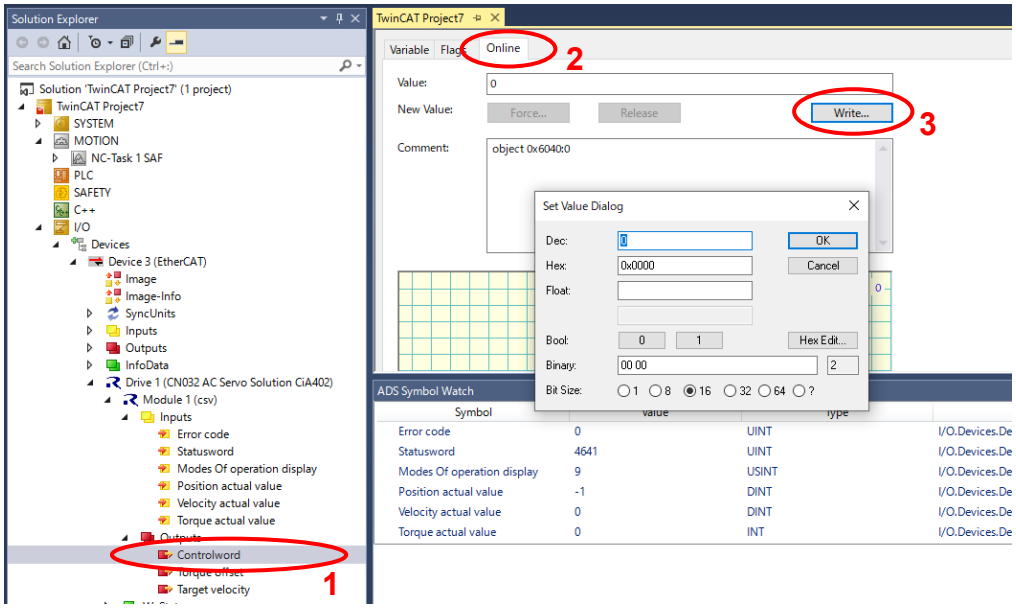
Confirm that the operation mode is “csp”. Otherwise, change the operation mode to “csp” by following 4.3.1 Operation mode setting.



Just like the steps described for pp mode, add the input values to an extra watch window for the sake of comfort.

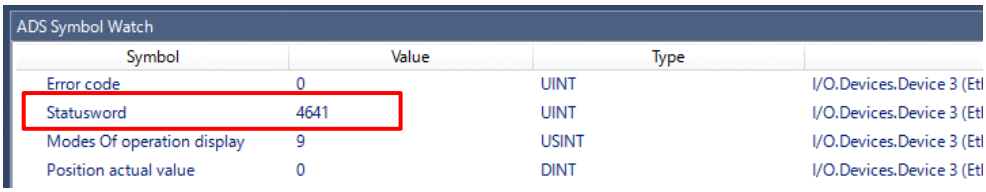


Follow steps (1) to (3) to open a dialog to send the value of Controlword.

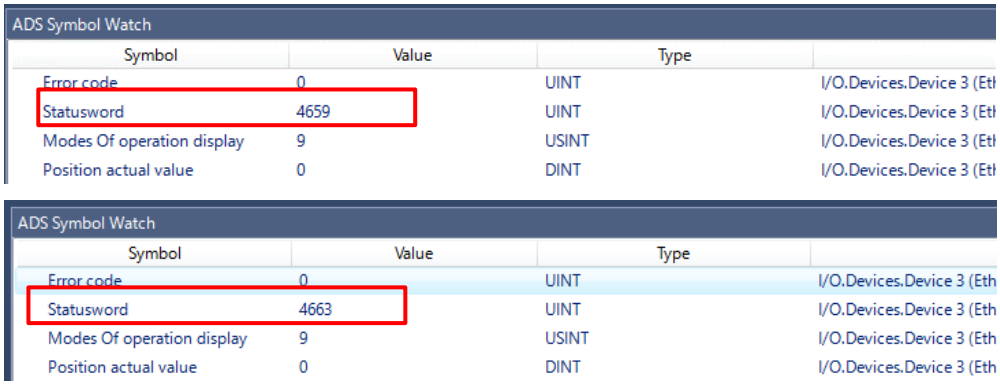


Follow steps A) to B) to send the Controlword value and make the motor controllable.

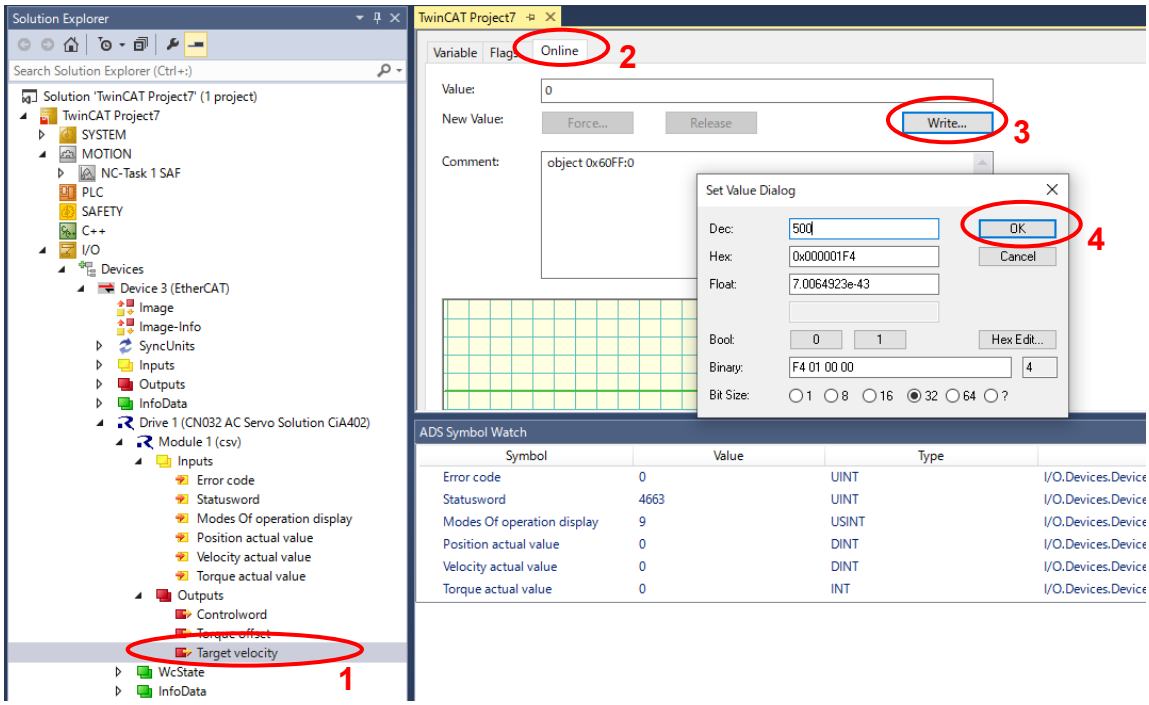
A) Confirm that Statusword is “4641”. Otherwise, set Controlword to 128 to reset Statusword.



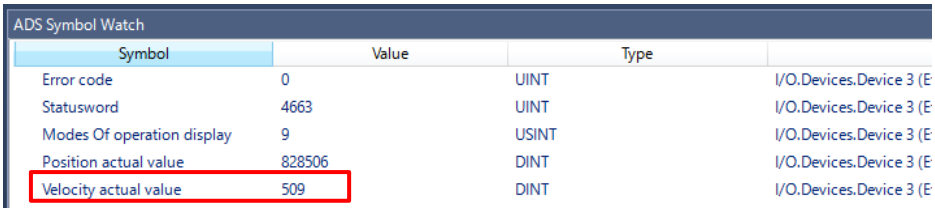
B) Set Controlword to “15” and then Statusword will be “4659” (Power on) and then immediately change to ”4663” (Servo on).



Follow steps (1) to (3) to open a dialog to send the value of Target Velocity.
Enter the Target Velocity value and closing the dialog with “Ok” (4) sends the value via EtherCAT.



Then, the motor rotates while controlling the Velocity actual value to the Target Velocity value.



When stop the motor control, set Controlword to “6” and then Statusword will be “4641”.

You can now modify the parameters as you like for further experiments. The full “command set” that is covered by the Controlword and the specific meaning of error codes or Statusword can be studied in the “CANopen Device Profile Drives and Motion Control” control document, that is available from the CAN in Automation organization at

https://www.can-cia.org/can-knowledge/canopen/cia402/

Please note that the document can only be downloaded by organization members. Copies of old versions are vagabonding on the www.

5. 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.

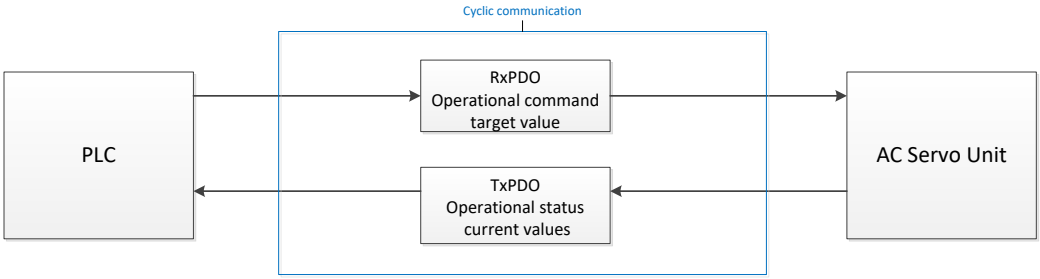


Figure 5-1 CiA402 Communication Flow

5.1 Operation Modes

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

Operation Mode	Support
Profile position mode	Yes
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

Table 5-1 List of Supported Operation Modes

5.2 State Transition

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

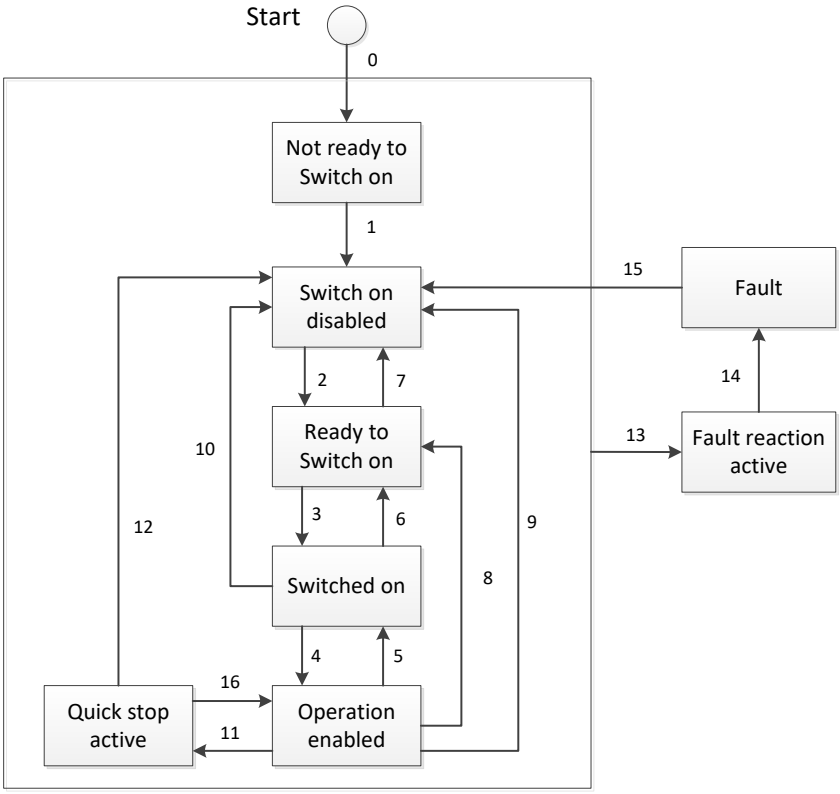


Figure 5-2 CiA402 State Transition Diagram

5.3 Object Dictionary

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

Operation Mode	OBJECT Name	INDEX	Category	Access	Data Type	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
	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
	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

Function Group	OBJECT Name	INDEX	Category	Access	Data Type	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 pos value	0x60BA	Optional	ro	INT32	Yes
	Touch probe pos 2 pos value	0x60BC	Optional	ro	INT32	Yes
Gear ratio	Gear ratio	0x6091	Optional	c,rw	UINT32	No
Other object	**OBJECT Name**	**INDEX**	**Category**	**Access**	**Data Type**	**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
	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

Table 5-2 List of Supported Object Dictionaries

5.4 Implementing the Motor Control Program

According to the CiA402 standard from the list of CiA402 protocol stack I/F functions in Table 5-3, implement the motor control application. Each function links the number of each state transition of CiA402 FSA shown in Figure 5-2 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.

CiA402_StateTransition1	
	Description This function is used when state transition 1 has occurred. Describe the operation in the case of the state transition. This function issues a POWEROFF command.
	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. This function is not used.
	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.
This function issues a POWERON command and energizes the motor.

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.
This function issues a SERVOON command and put the motor in torque on state.

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.
This function issues a SERVOOFF command and release the motor from torque on state.

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.
This function issues a POWEROFF command.

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.
This function is not used.

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.
This function issues a POWEROFF command.

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. This function issues a POWEROFF command.
	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. This function issues a POWEROFF command.
	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. This function issues a QUICKSTOP command.
	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.
This function issues a POWEROFF command.

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.
This function is called if an error was detected.

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.
This function issues a POWEROFF command.

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. This function is called when transitioning from Fault state to Switch on disabled state.
	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. This function issues a SERVOON command and put the motor in torque on state.
	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.

Table 5-3 List of CiA402 Protocol Stack I/F Functions

6. Appendix

6.1 Preparation in advance

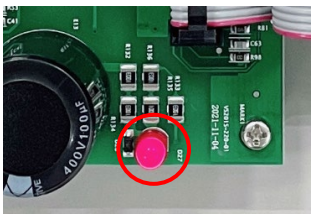
This chapter is shown preparation for writing a program to flash memory and debugging

6.1.1 Power Supply

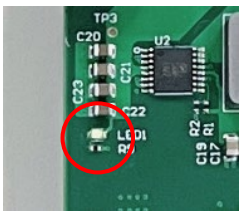
Configure the board connection according to the chapter 2.

③ xSPI0 boot mode setting
Set SW1 of the controller board to the following.

④ Power supply to the inverter board, and then the red lamp lights up.
Additionally, the controller board is supplied 5V DC power from inverter board and then LED1 lights up.



Power lamp of the inverter board

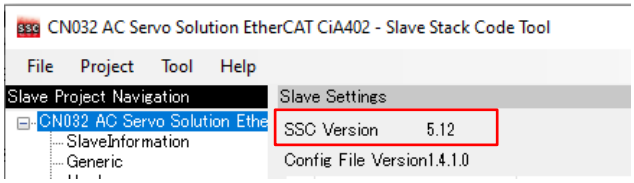


Power LED of the controller board

6.1.2 Generating the Slave Stack Code

To run the EtherCAT communication you must generate the EtherCAT slave code using a special code generation tool provided by Beckhoff. The slave code generation is performed based on the formal description of the slave properties in the ESI file that you have copied in the previous chapter.

Make sure the version of the installed SSC tool is V5.12.
Do not update even if receiving update notification when starting the tool.



(1) Start SSC Tool

Start SSC Tool by double-clicking the SSC project file " CN032 AC Servo Solution EtherCAT CiA402.esp " in the following location:

Case of the AC Servo Solution Kit (RZ/T2M)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Common\ethercat\src\r_ecat\utilities\ssc_config"

Case of the AC Servo Solution Kit (RZ/T2L)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Common\ethercat\src\r_ecat\utilities\ssc_config"

Case of the AC Servo Solution Kit (RZ/N2L)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Common\ethercat\src\r_ecat\utilities\ssc_config"

(2) Generate a slave stack code

In SSC Tool, select [Project] > [Create new Slave Files], and then click [Start] as shown in Figure 6-1. The slave stack code is then generated in the following location:

Case of the AC Servo Solution Kit (RZ/T2M)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Common\ethercat\src\r_ecat\utilities\ssc_config\Src"

Case of the AC Servo Solution Kit (RZ/T2L)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Common\ethercat\src\r_ecat\utilities\ssc_config\Src"

Case of the AC Servo Solution Kit (RZ/N2L)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Common\ethercat\src\r_ecat\utilities\ssc_config\Src"

Then, click [OK], and then [Close] to terminate the SSC Tool.

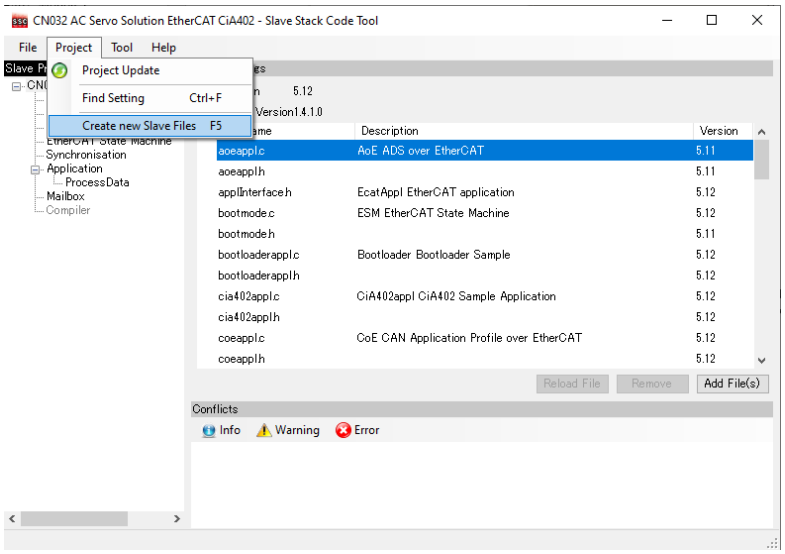


Figure 6-1 Creating the EtherCAT slave stack code

(3) Prepare a patch command

Last but not least it is required to install a patch file on your computer and to make it usable as an environment variable. Please download the GNU Patch program (version: 2.5.9 or later) from the following website:

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

Then, store the patch.exe file, that is part of the download somewhere, and add the (preferably short) storage path to an environmental variable: In the Windows Control Panel go to ‘System’ and then to ‘Advanced system settings’. In the ‘System Properties’ dialog select ‘Environment Variables’ as illustrated in Figure 6‑2.

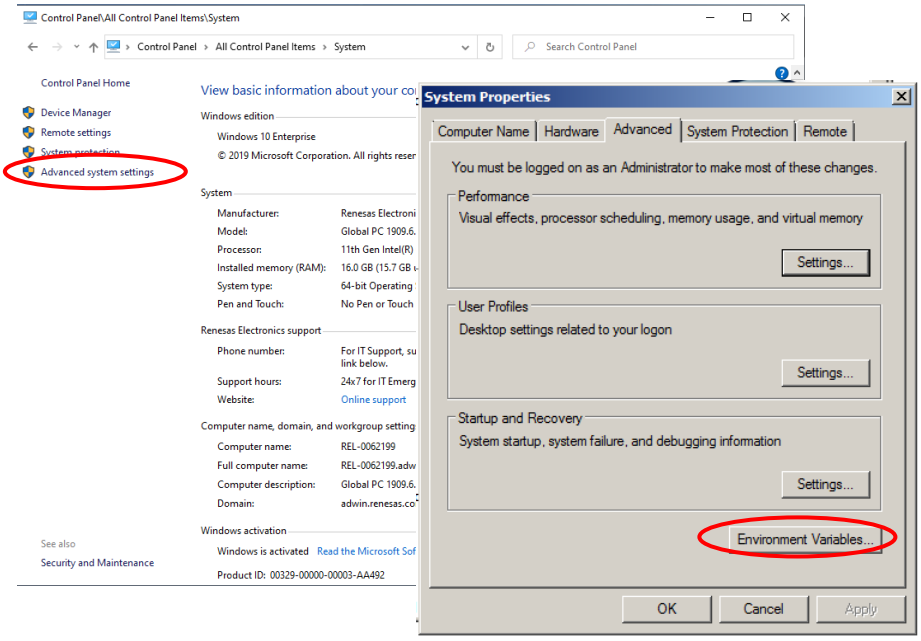


Figure 6-2 Adding a new environment variable

Select ‘Path’ in the list of system variables and then ‘Edit’. Add the path, where you have stored the patch file (in our case C:\Program Files (x86)\GnuWin32\bin), to the already existing search path. Click ‘Ok’ twice to accept the changes.

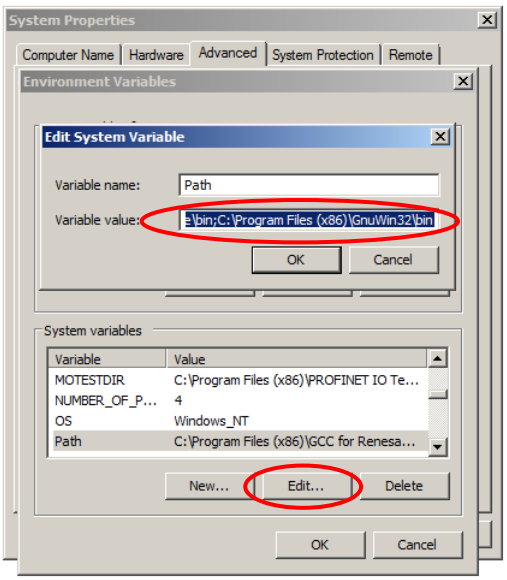


Figure 6-3 **Editing the system variable ‘Path’**

(4) Apply the patch

Next, the patch has to be executed once. Double-click the ‘apply_patch.bat’ file in

Case of the AC Servo Solution Kit (RZ/T2M)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Common\ethercat\src\r_ecat\utilities\batch_files”

Case of the AC Servo Solution Kit (RZ/T2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Common\ethercat\src\r_ecat\utilities\batch_files”

Case of the AC Servo Solution Kit (RZ/N2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Common\ethercat\src\r_ecat\utilities\batch_files”

The script in this file moves the directory that contains the slave stack code, and then applies the patch that makes the corrections for the sample program.

If a “Patching file …” message similar to Figure 6-4 does not appear, the patch is not applied. In this case, right-click “apply_patch.bat”, and then select “Run as administrator”.

If a message such as "Hunk #xx failed with xxx" is displayed, change the line breaks in slave stack code to LF(Line Feed).

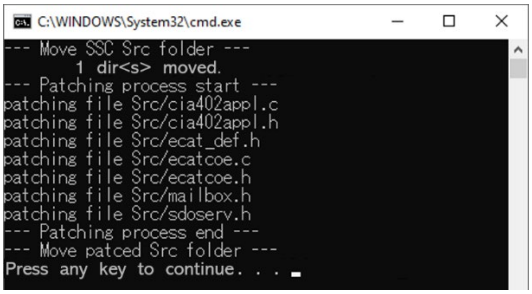


Figure 6-4 Patch file execution messages

Now the preparations for running the EtherCAT project are finally completed.

6.2 How to Install Development Environments

6.2.1 Development Environments Install

AC Servo Solution Kit (RZ/T2M, RZ/T2L)

Download e²studio or FSPSC for **RZT FSP v1.3.0** from the following web site.

Release v1.3.0 · renesas/rzt-fsp · GitHub

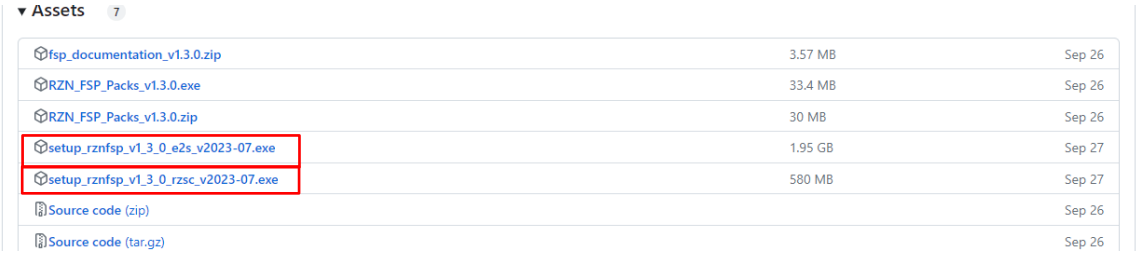
Download “setup_rztfsp_v1_3_0_e2s_v2023_07.exe” for FSP with e2studio installer.
If using IAR, download “setup_rztfsp_v1_3_0_rzsc_v2023_07.exe” for smart configurator installer.

AC Servo Solution Kit (RZ/N2L)

Download e2studio or FSPSC for **RZN FSP v1.3.0** from the following web site.

Release v1.3.0 · renesas/rzn-fsp · GitHub

Download “setup_rznfsp_v1_3_0_e2s_v2023_07.exe” for FSP with e2studio installer.
If using IAR, download “setup_rznfsp_v1_3_0_rzsc_v2023_07.exe” for smart configurator installer.



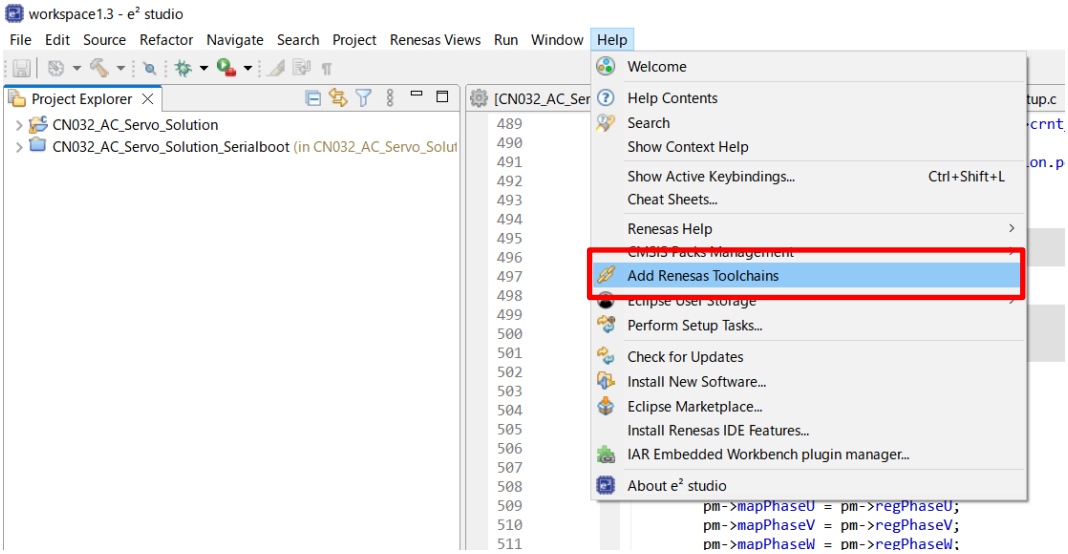
If using IAR, download IAR Embedded Workbench® for Arm Version 9.32.2 from IAR web site.

Products | IAR Systems

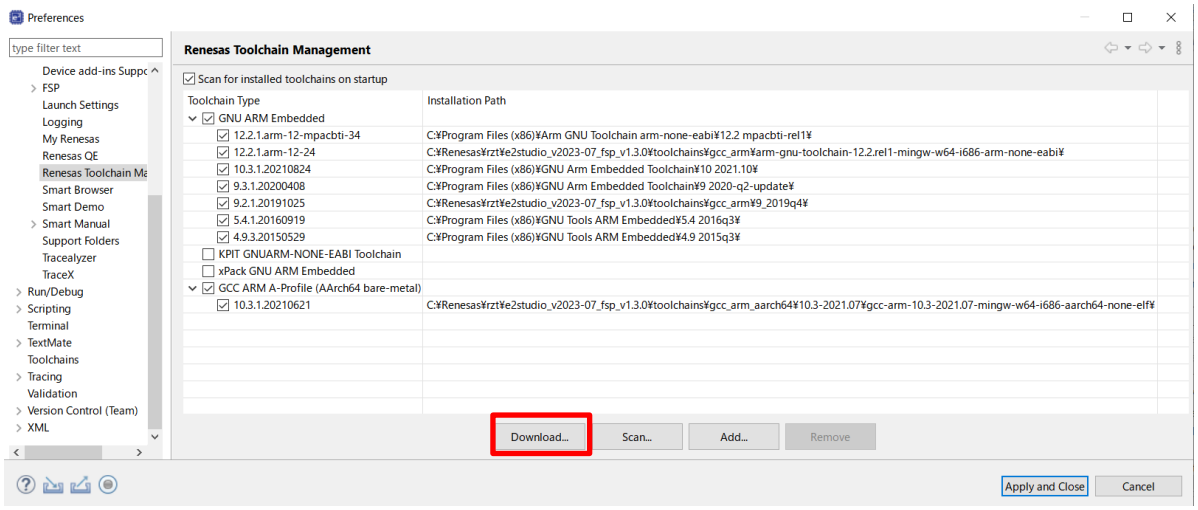
6.2.2 Toolchain Install

When using e² studio, install the toolchain “GNU ARM Embedded 9.3.1” by following the steps below.

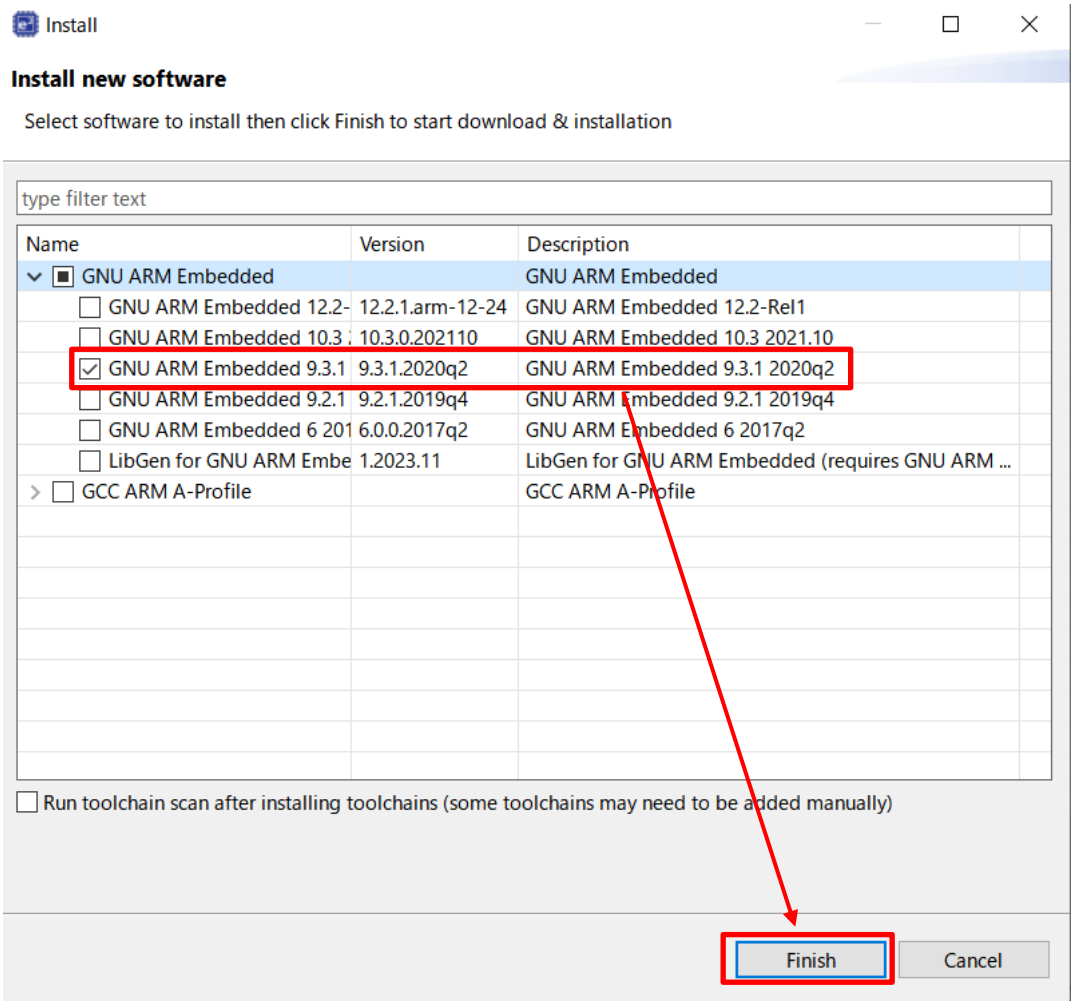
(1) Select the “Add Renesas Toolchains” item from the “Help” menu.



(2) Click “Download…” button.

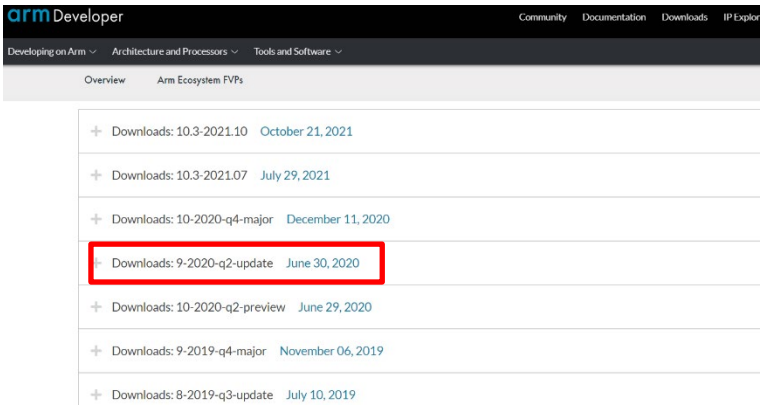


(3) Open “GNU ARM Embedded” tab, select “GNU ARM Embedded 9.3.1”, and click “Finish” button.

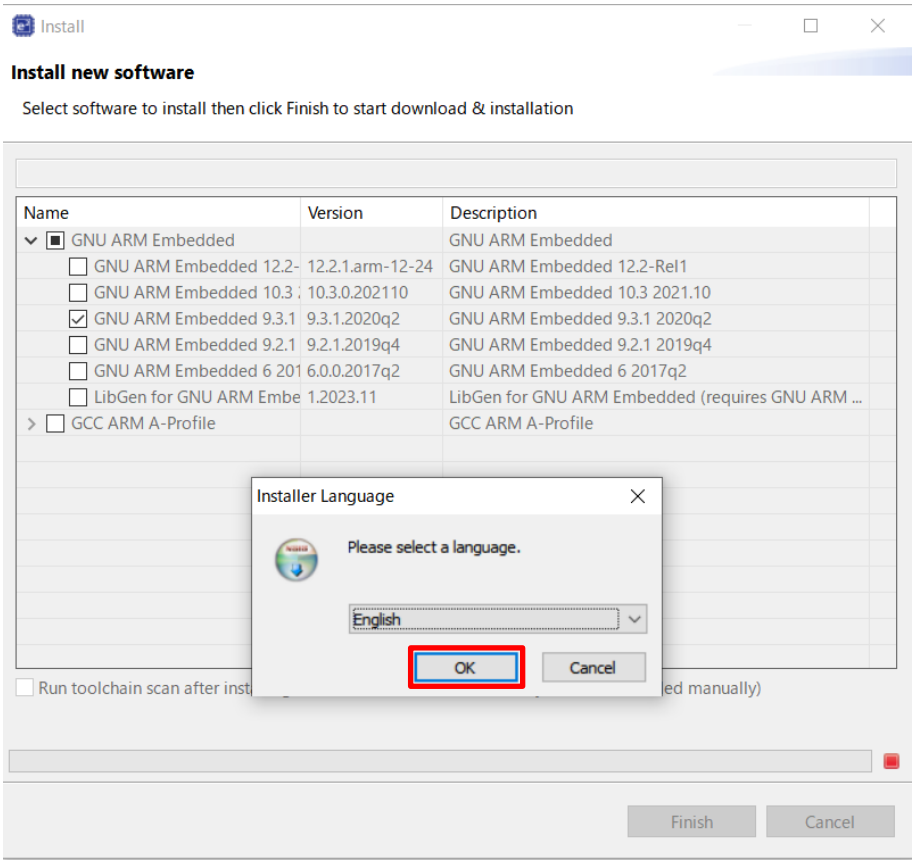


*If you cannot find “GNU ARM Embedded 9.3.1” in the above window, please download “9-2020-q2-update” from the following URL, then restart e^2 studio and try again.

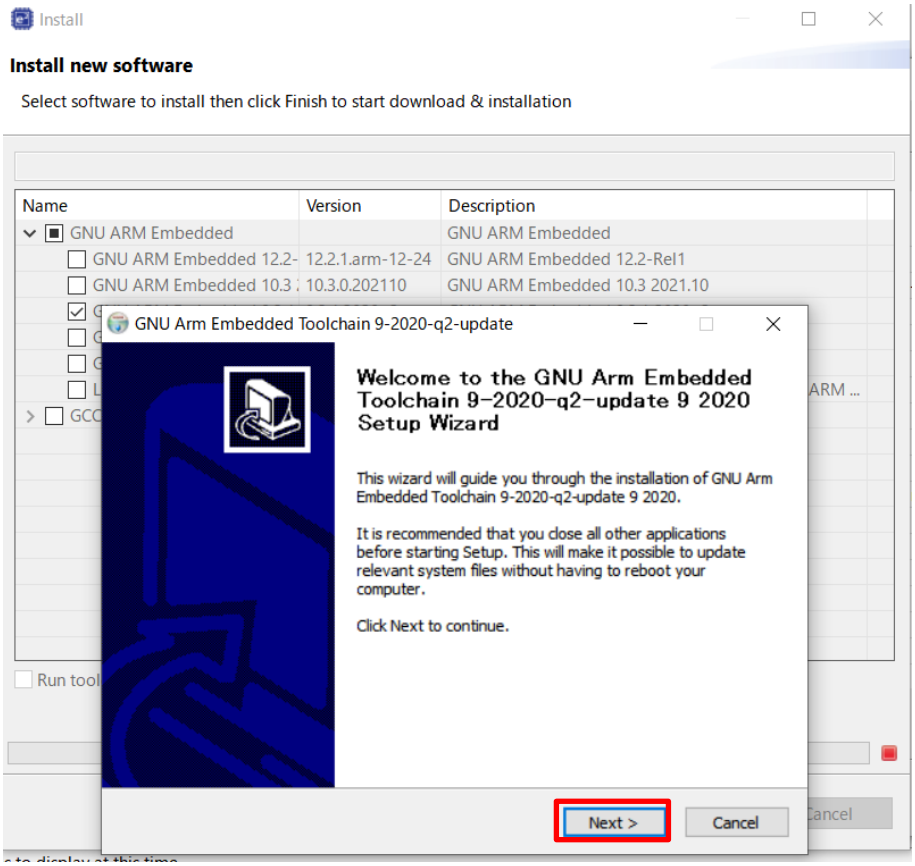
https://developer.arm.com/downloads/-/gnu-rm



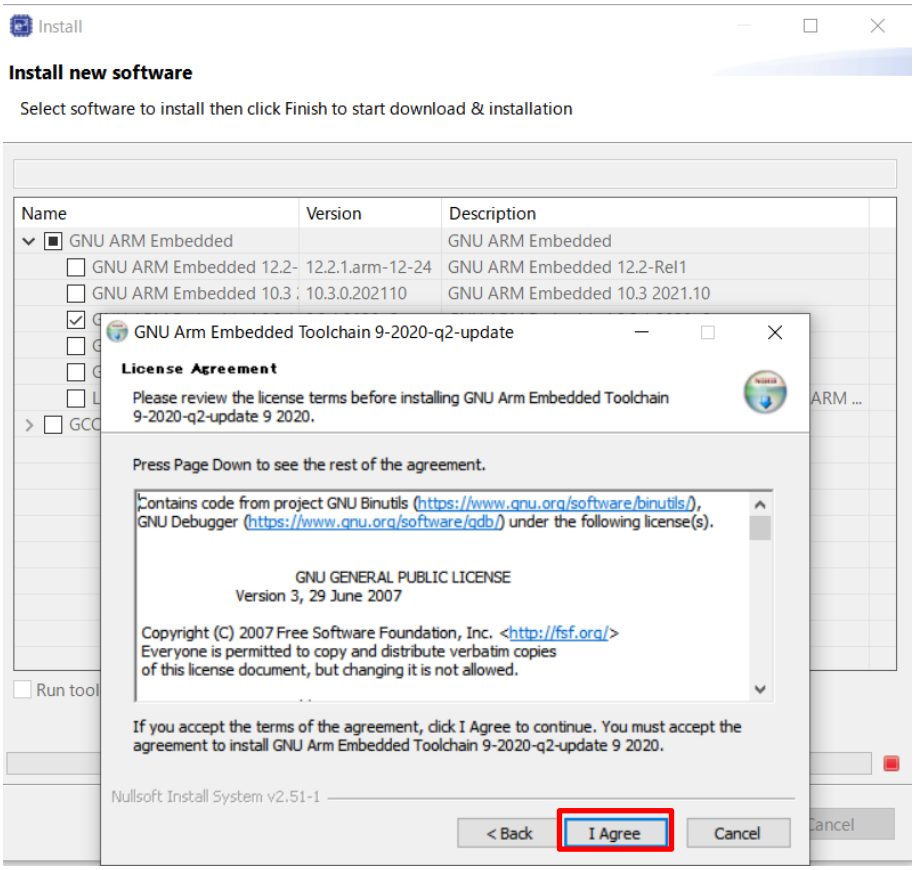
(4) Select language and click “OK” button.



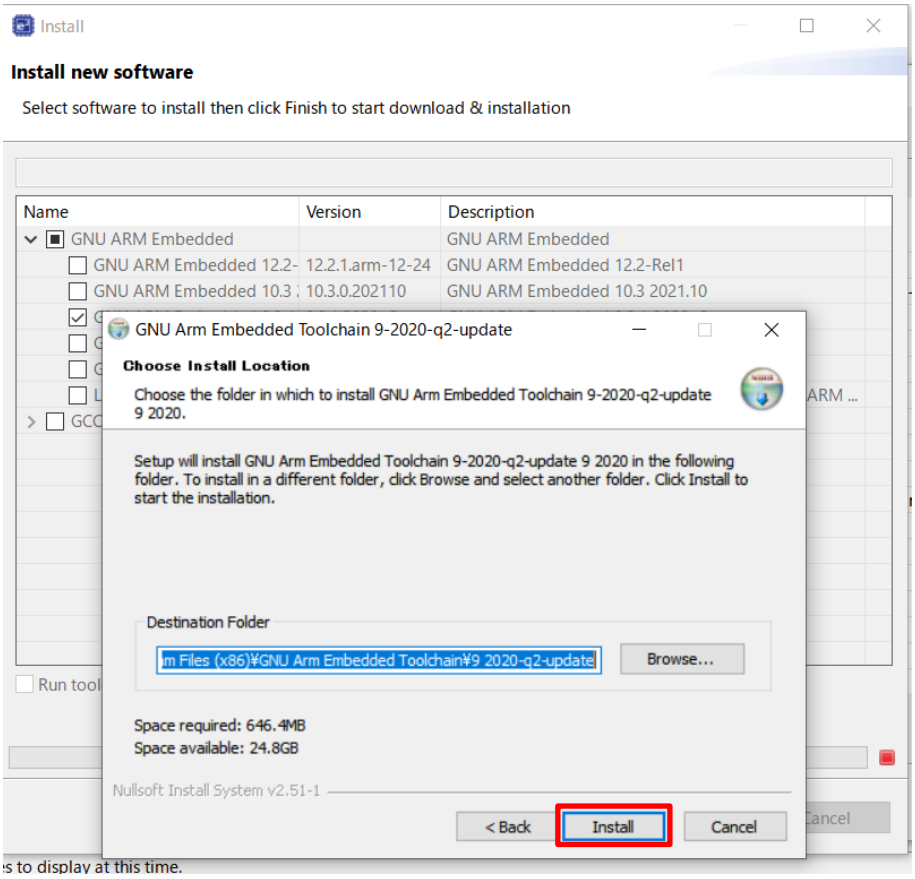
(5) Click “Next” button.



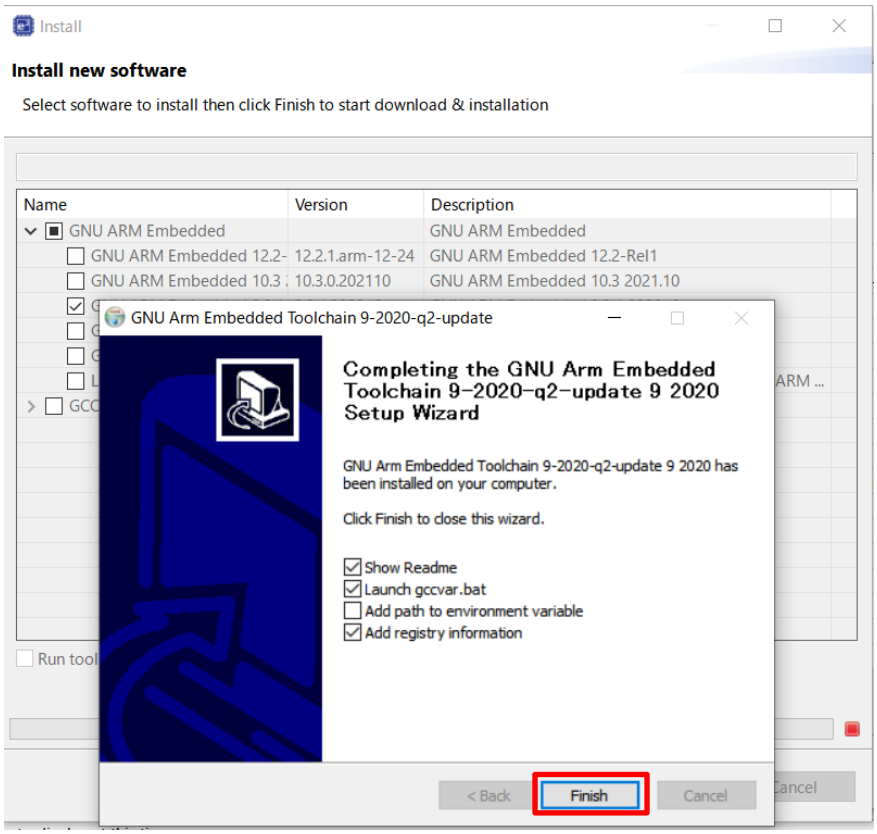
(6) After reading click “I Agree” button.



(7) Click “Install” button.



(8) Installation is complete. Click the “Finish” button.



6.3 Program Writing Procedure

This chapter is shown how to write a program to serial Flash ROM.

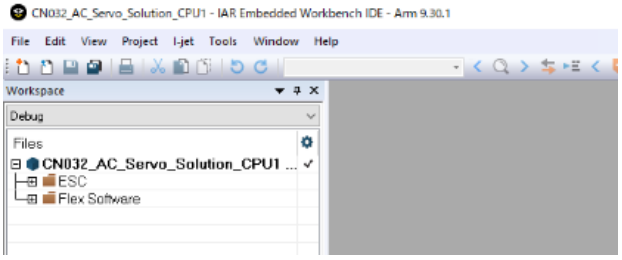
6.3.1 Program writing by IAR EWARM

(1) Build the project for CPU1

Case of the AC Servo Solution Kit (RZ/T2M)

① Open the sample project on IAR EWARM.

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Project\iccarm\CPU1\CN032_AC_Servo_Solution_CPU1.eww"



② Then, generated the binary file for CPU1 "CN032_AC_Servo_Solution_CPU1.bin" in the following folder

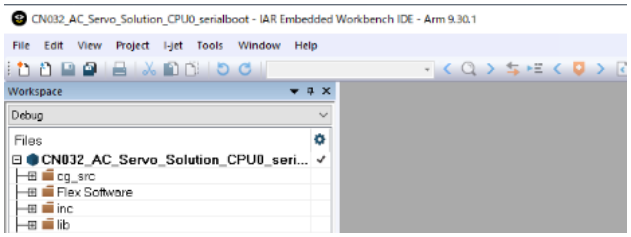
"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Project\iccarm\CPU0_serialboot\CPU1_boot_bin"

(2) Build the project for CPU0

① Open the following sample project on IAR EWARM.

Case of the AC Servo Solution Kit (RZ/T2M)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Project\iccarm\CPU0_serialboot\CN032_AC_Servo_Solution_CPU0_serialboot.eww"

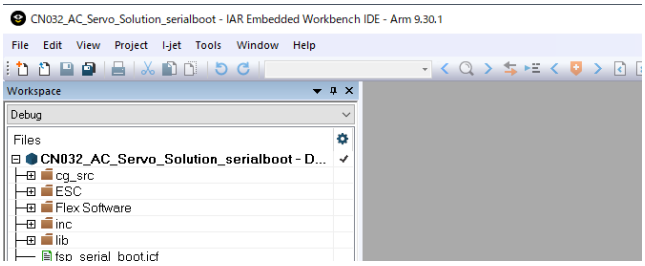


Case of the AC Servo Solution Kit (RZ/T2L)

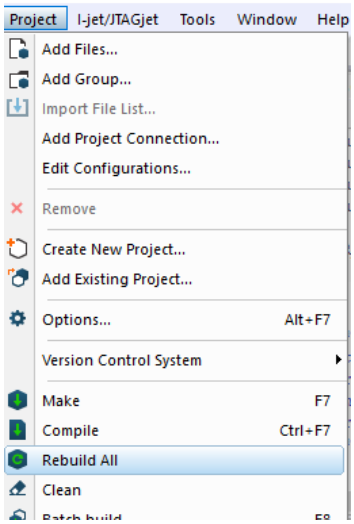
"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Project\iccarm\serial_boot\CN032_AC_Servo_Solution_serialboot.eww"

Case of the AC Servo Solution Kit (RZ/N2L)

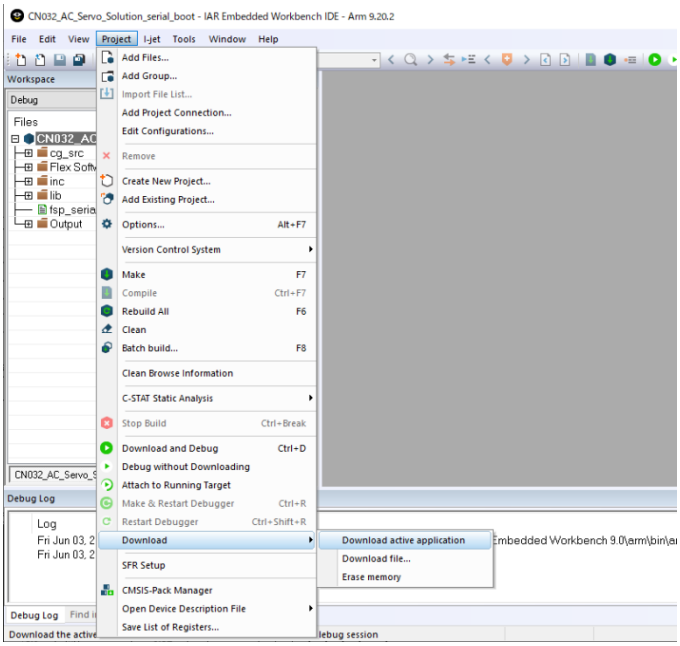
"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Project\iccarm\serial_boot\CN032_AC_Servo_Solution_serialboot.eww"



② Execute build. Select [Project] > [Rebuild All].



③ Select the [Project] > [Download] > [Download active application] to write the program to serial Flash ROM.



6.3.2 Program writing by Renesas e2studio

① Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace].
Check the “select root directory” and select the folder below.

Case of the AC Servo Solution Kit (RZ/T2M)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Project\gcc”

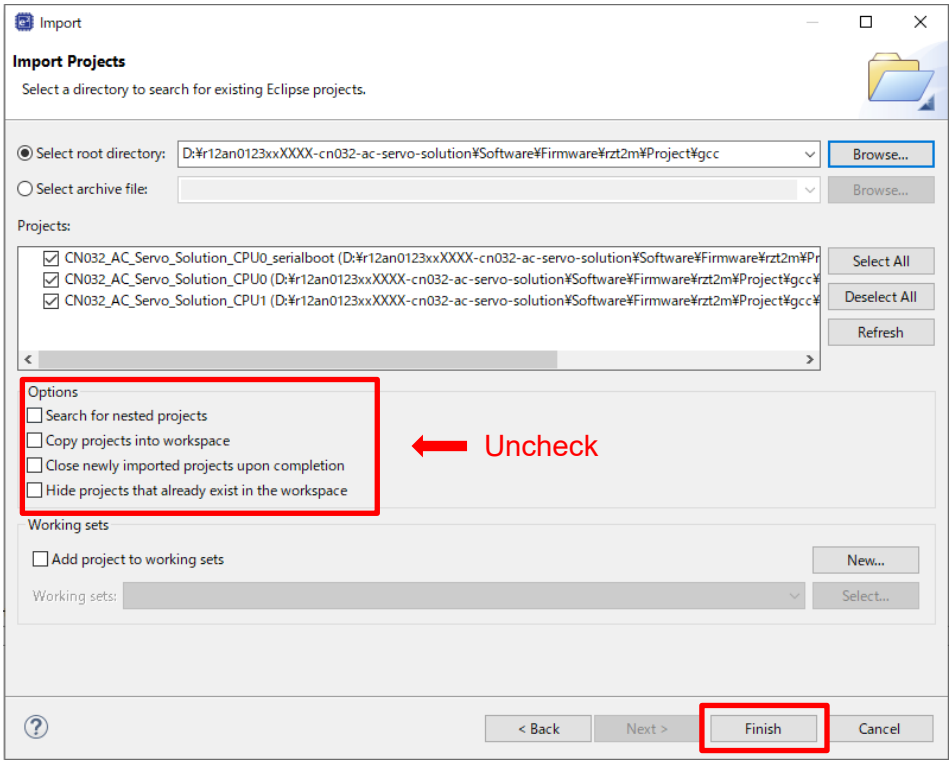
Case of the AC Servo Solution Kit (RZ/T2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Project\gcc”

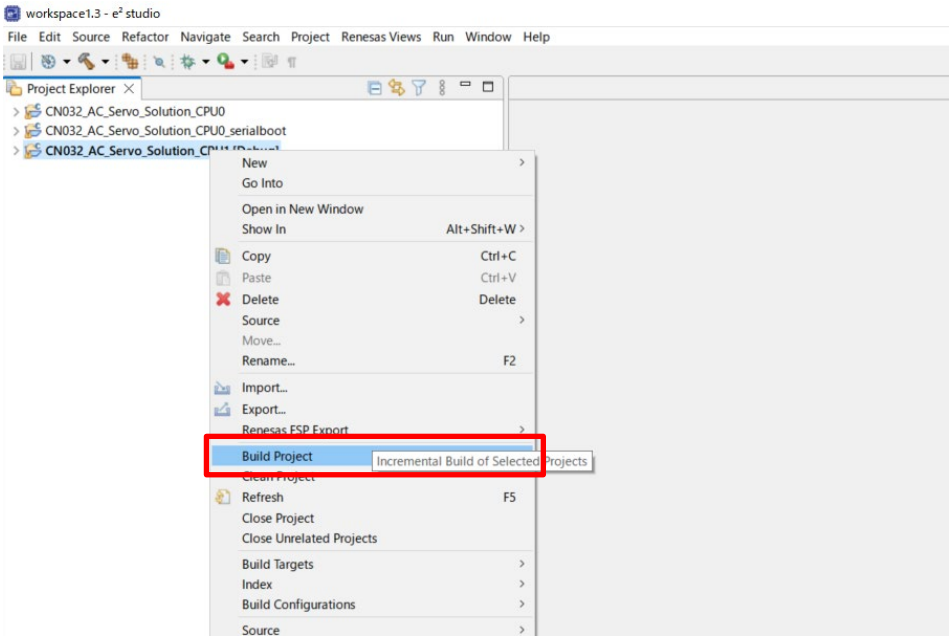
Case of the AC Servo Solution Kit (RZ/N2L)

“\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Project\gcc”

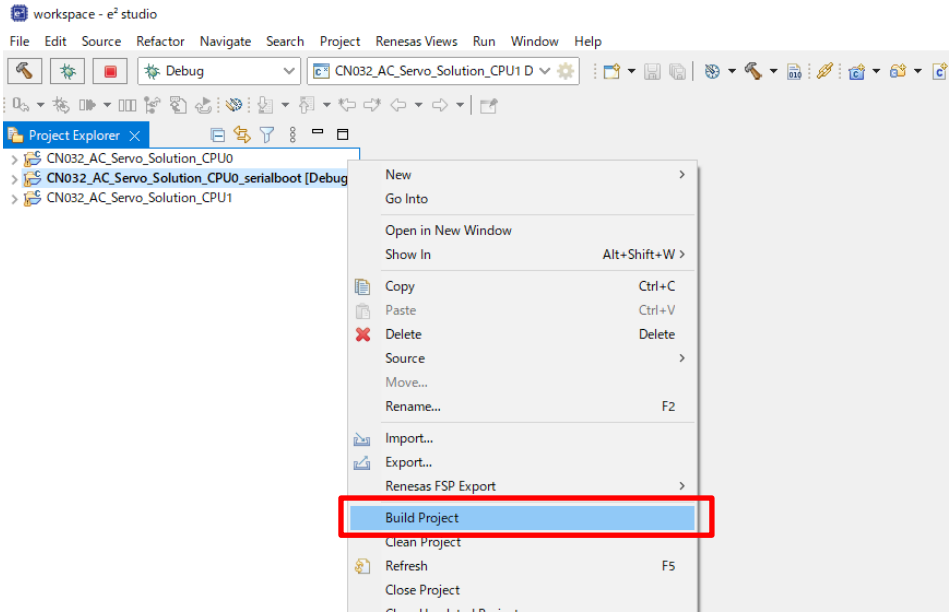
If “Copy projects into workspace" is checked, uncheck it and then selecting [Finish].



② Build the “CN032_AC_Servo_Solution_CPU1” project.

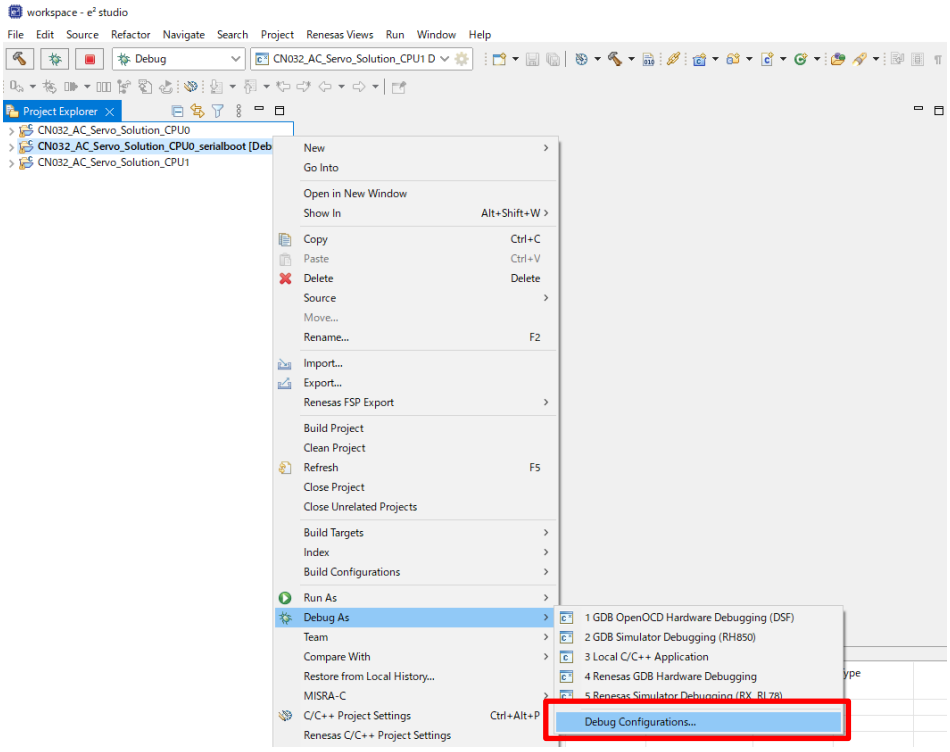


③ Build the “CN032_AC_Servo_Solution_CPU0_serialboot” project In [Project Explorer] view, right click the node of the project to be debugged and select [Build Project].

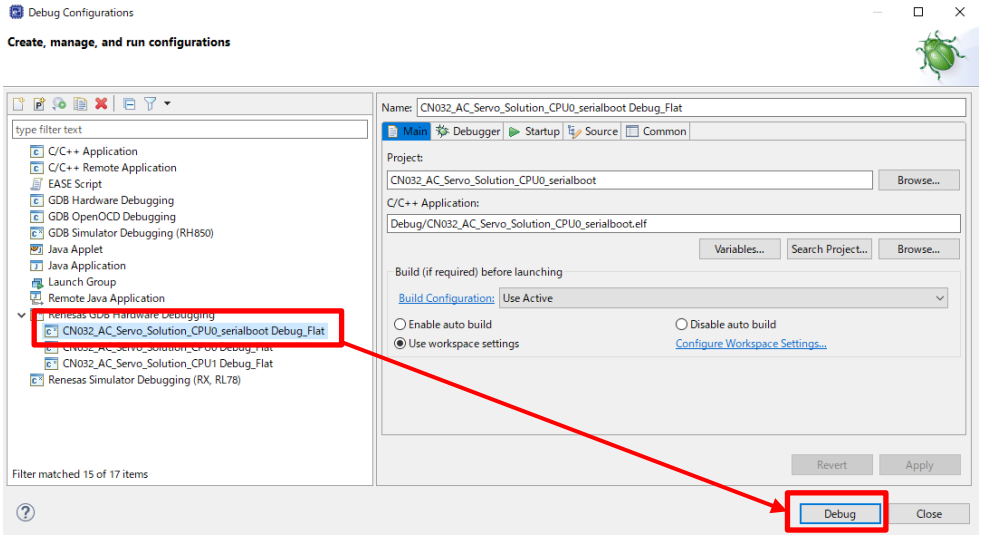


④ Press the “RESET” switch of the Controller board

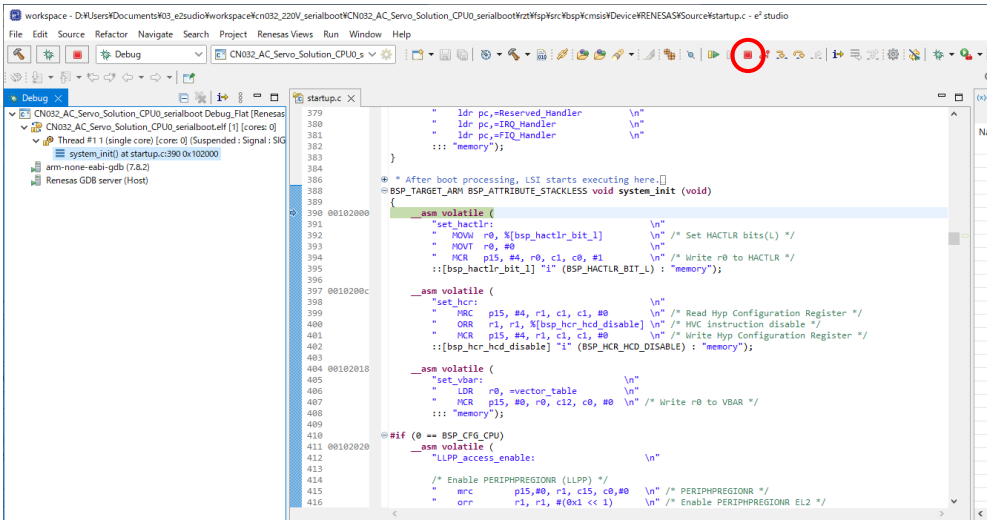
⑤ While the board and J-LINK are connected, start writing to the flash memory in the following order
In [Project Explorer] view, right click the node of the CPU0 project to be debugged and select [Debug As] → [Debug Configurations].



[Renesas DBG Hardware Debugging] → [CN032_AC_Servo_Solution_CPU0_serialboot Debug_Flat] item, then press [Debug].



⑥ Press the terminate button to stop the debugging window



Press the reset button of the Controller board, and then running the program written to the flash memory

6.4 Debugging the Sample Project

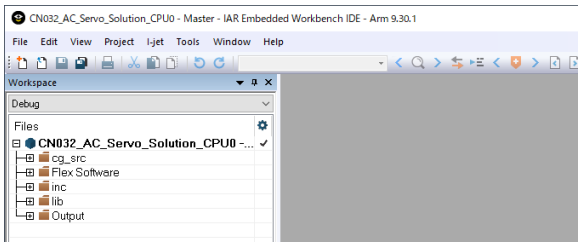
6.4.1 Debugging the Sample Project in IAR EWARM

In this chapter we will describe, how the sample project for motion control via EtherCAT communication is debugged using the IAR EWARM environment.

(1) Open the following sample project.

Case of the AC Servo Solution Kit (RZ/T2M)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2m\Project\iccarm\CPU0 \CN032_AC_Servo_Solution_CPU0.eww"

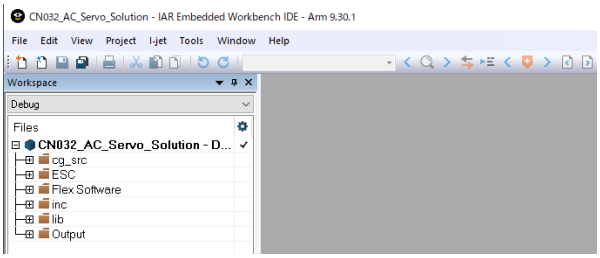


Case of the AC Servo Solution Kit (RZ/T2L)

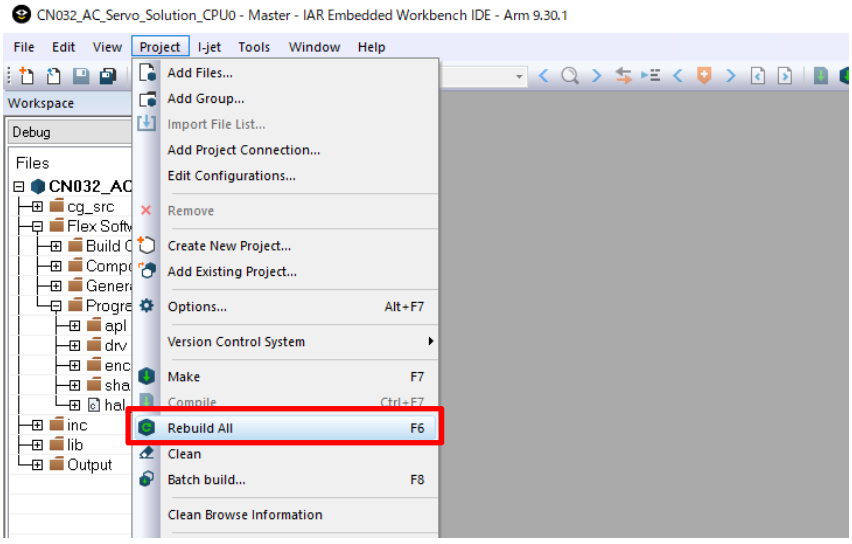
"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzt2l\Project \iccarm\ram_exe \CN032_AC_Servo_Solution.eww"

Case of the AC Servo Solution Kit (RZ/N2L)

"\r12an0123xxXXXX-cn032-ac-servo-solution\Software\Firmware\rzn2l\Project \iccarm\ram_exe \CN032_AC_Servo_Solution.eww"

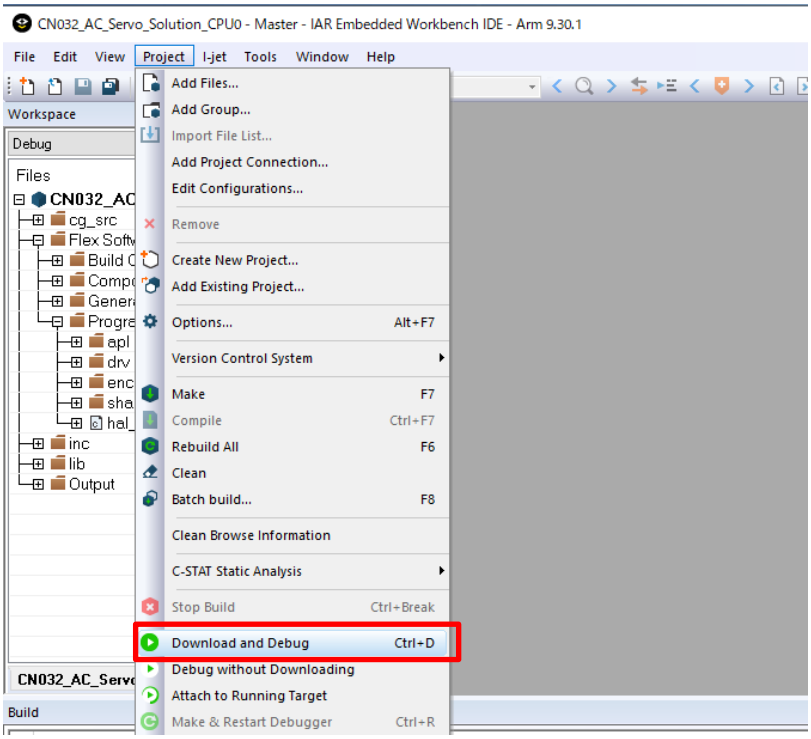


(2) Select the "Rebuild All" item from the "Project" menu to rebuild the project.



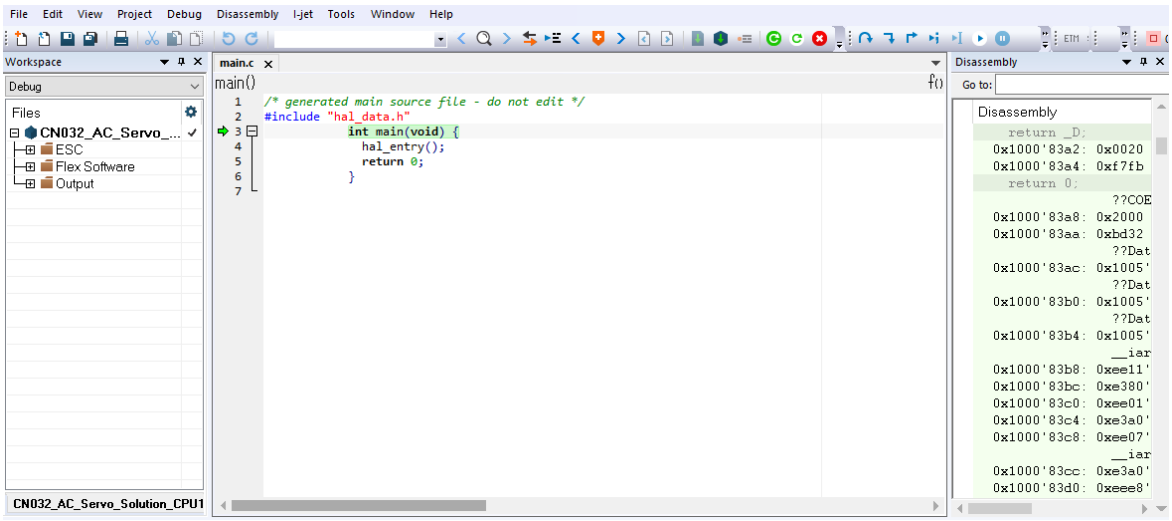
(3) Press the "RESET" switch of the Controller board.

(4) While the board and I-jet are connected, click on the “Download and debug” button in the “Project” toolbar.



Case of the AC Servo Solution Kit (RZ/T2M)

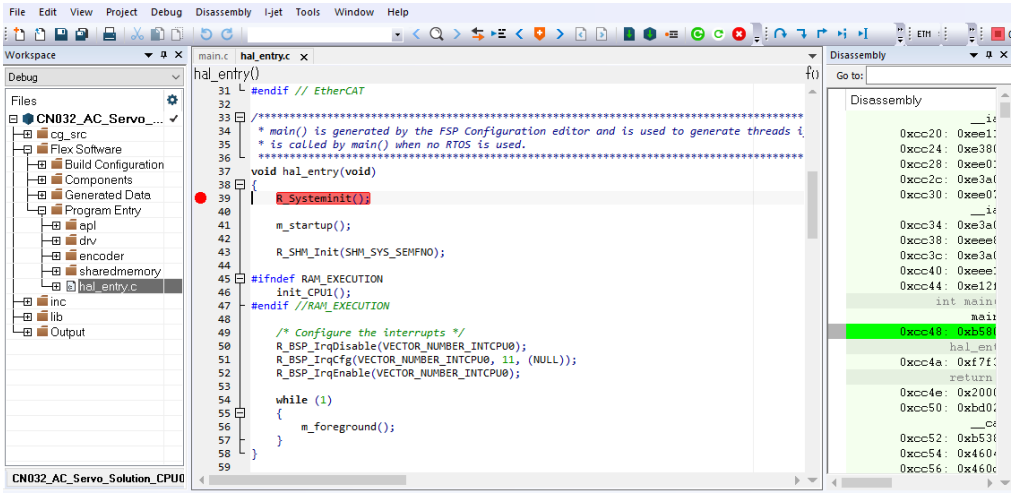
After that, the CPU1 project which name is CN032_AC_Servo_Solution_CPU1 will open and debug connection for CPU1 will also be started automatically. The program will break at the first code in “main” in both projects.



Case of the AC Servo Solution Kit (RZ/T2M)

Follow the step (5) to (7) when using the AC Servo Solution Kit (RZ/T2M).

(5) Set the break point at the first code of hal_entry(), and Press the “Go” button in the CPU0 project.



Initial settings of cores and registers in SSLB and the program will break at the first code of “hal_entry()”

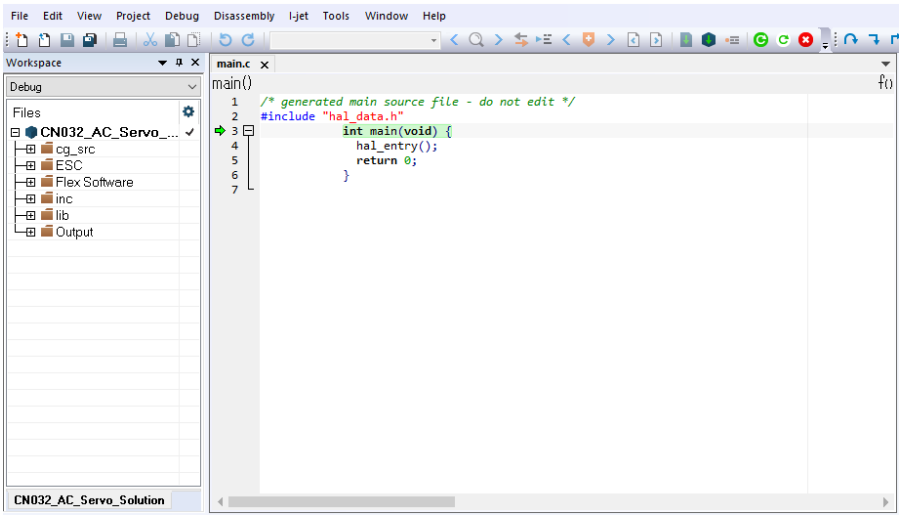
(6) Press the “Go” button in the CPU1 project. Initial settings of cores and registers in SSLB and the EtherCAT application program will be run.

(7) While the CPU1 is running, Press the “Go” button in the CPU0 project.

Case of the AC Servo Solution Kit (RZ/T2L, RZ/N2L)

Follow the step (5) when using the AC Servo Solution Kit (RZ/T2L, RZ/N2L).

(5) The program will break at the first code in “main”, and then the program is running by pressing the “Go” button.

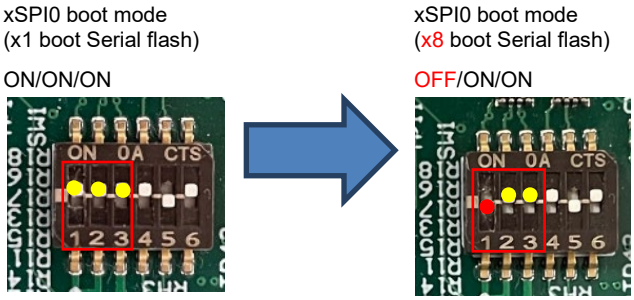


6.4.2 Debugging the Sample Project in Renesas e2studio

In this chapter we will describe, how the sample project for motion control via EtherCAT communication is debugged using the Renesas e2studio environment.

Before debugging the sample project in e2studio, make sure the dipswitch setting (SW1).

Set SW1 to other than xSPI0 boot mode (x1 boot Serial flash) and then, press the reset switch for board reset.
e.g.)



See the section 3.4 Mode Switch in CN032 AC Servo Solution Hardware Manual about the operating mode.

(1) Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace]. Check the “select root directory” and select the following folder.

Case of the AC Servo Solution Kit (RZ/T2M)

“r12an0123xxXXXX-cn032-ac-servo-solution\Software\firmware\rzt2m\Project\gcc”

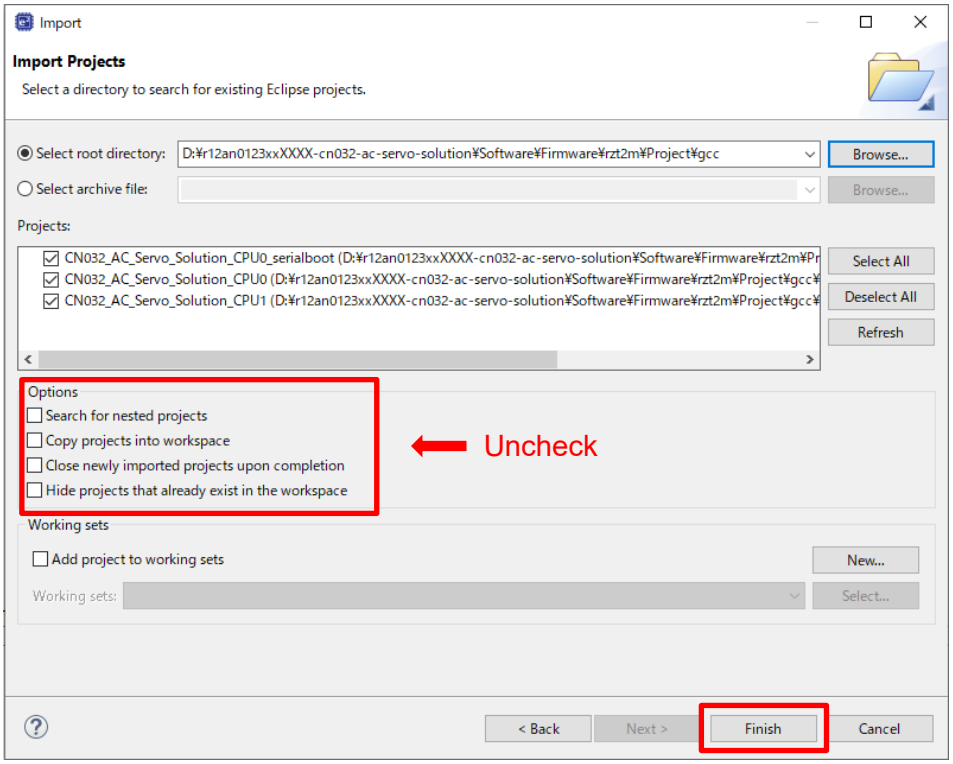
Case of the AC Servo Solution Kit (RZ/T2L)

“r12an0123xxXXXX-cn032-ac-servo-solution\Software\firmware\rzt2l\Project\gcc”

Case of the AC Servo Solution Kit (RZ/N2L)

“r12an0123xxXXXX-cn032-ac-servo-solution\Software\firmware\rzn2l\Project\gcc”

If “Copy projects into workspace" is checked, uncheck it and then selecting [Finish].



(2) Press the “RESET” switch of the CN032 AC Servo Solution board.

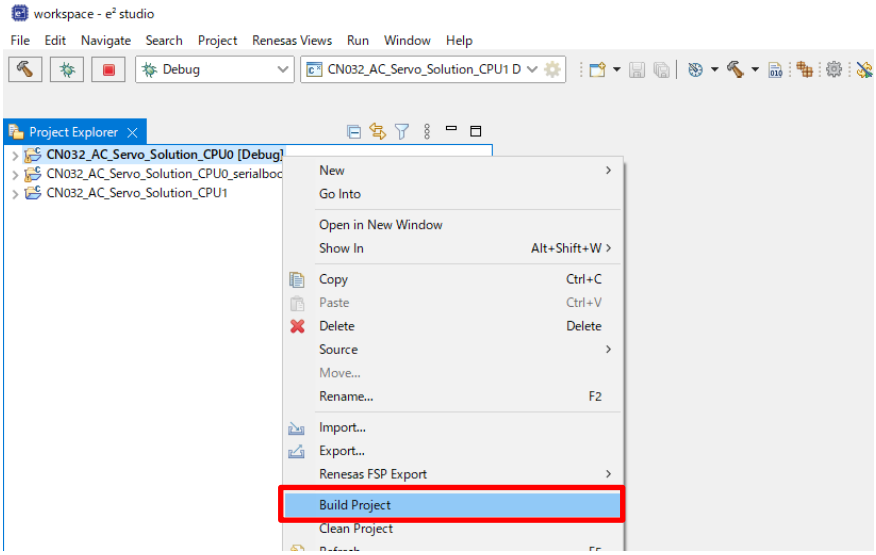
Case of the AC Servo Solution Kit (RZ/T2M)

Follow the step (3) to (4) when using the AC Servo Solution Kit (RZ/T2M).

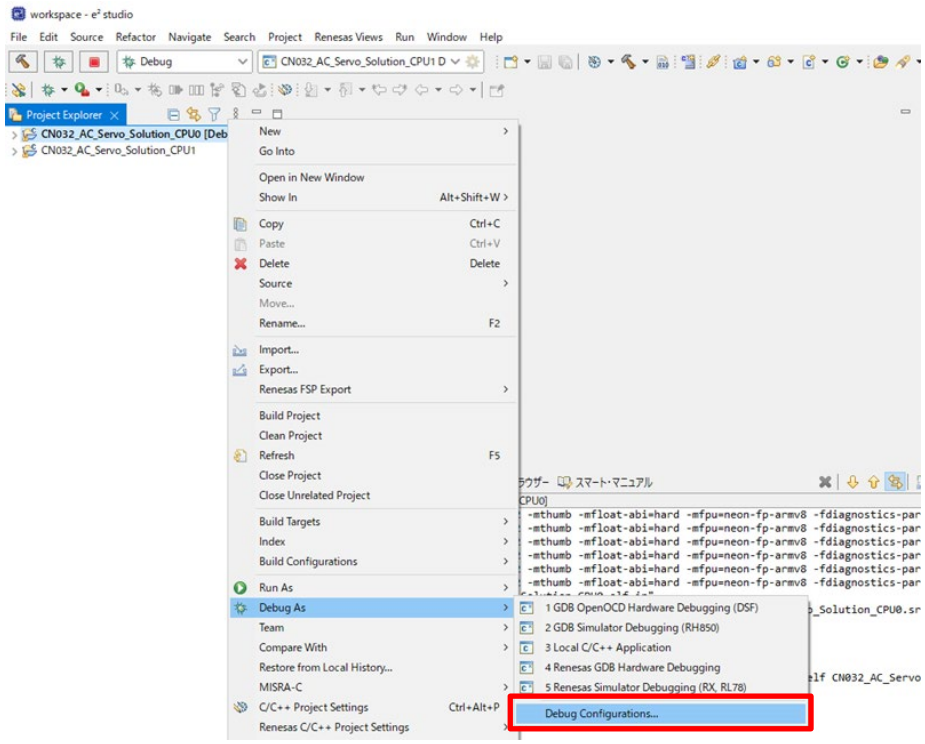
(3) While the board and J-LINK are connected, start debugging in the following order

<< CPU0 Project >>

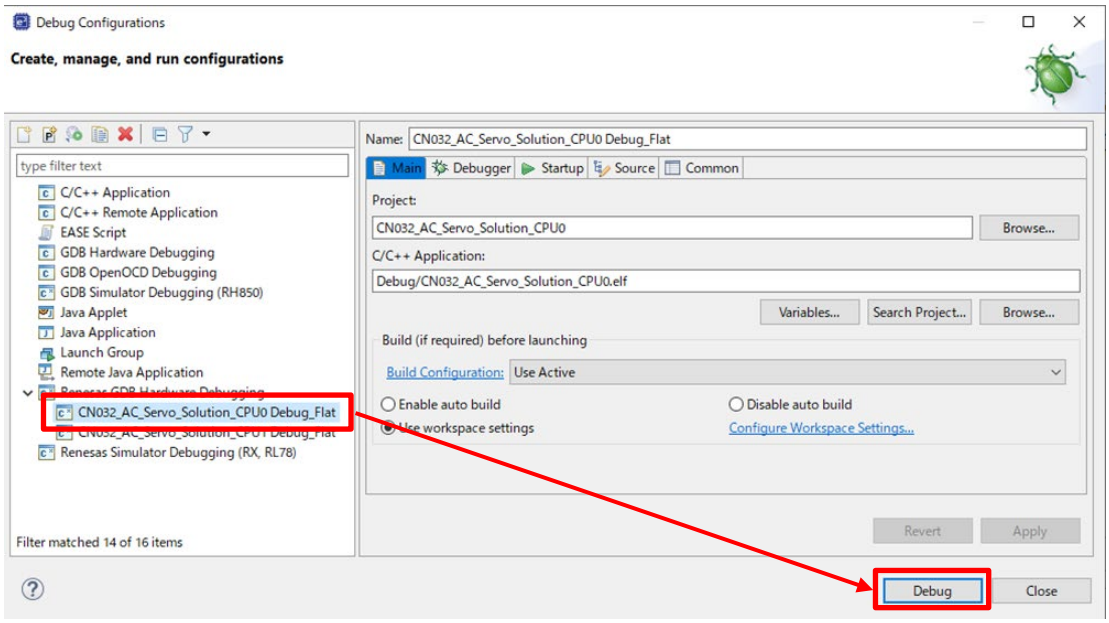
In [Project Explorer] view, right click the node of the “CN032_AC_Servo_Solution_CP0” project to be built and select [Debug As] → [Build Project].



In [Project Explorer] view, right click the node of the “CN032_AC_Servo_Solution_CP0” project to be debugged and select [Debug As] → [Debug Configurations].



[Renesas DBG Hardware Debugging] → [CN032_AC_Servo_Solution_CPU0 Debug_Flat] item, then press [Debug].



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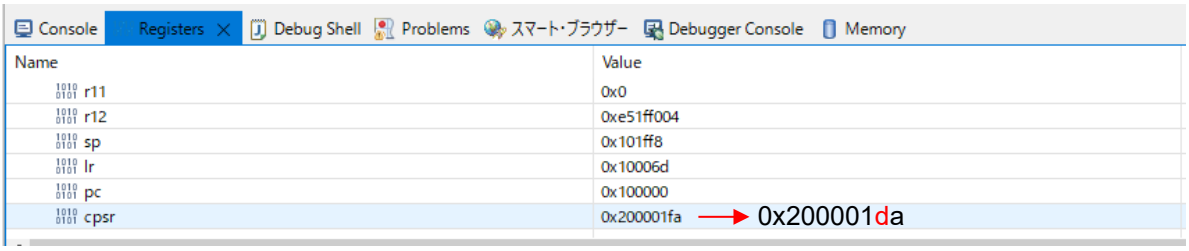
This step can be skipped in case of using software package **Rev4.00** later.

If a bit [5] value of CPSR register is “1b”, change it from "1b" to "0b" by using [Register] view.
For example, the register value of CPSR is changed from "0x20000fa" to "0x20000da" in the following.



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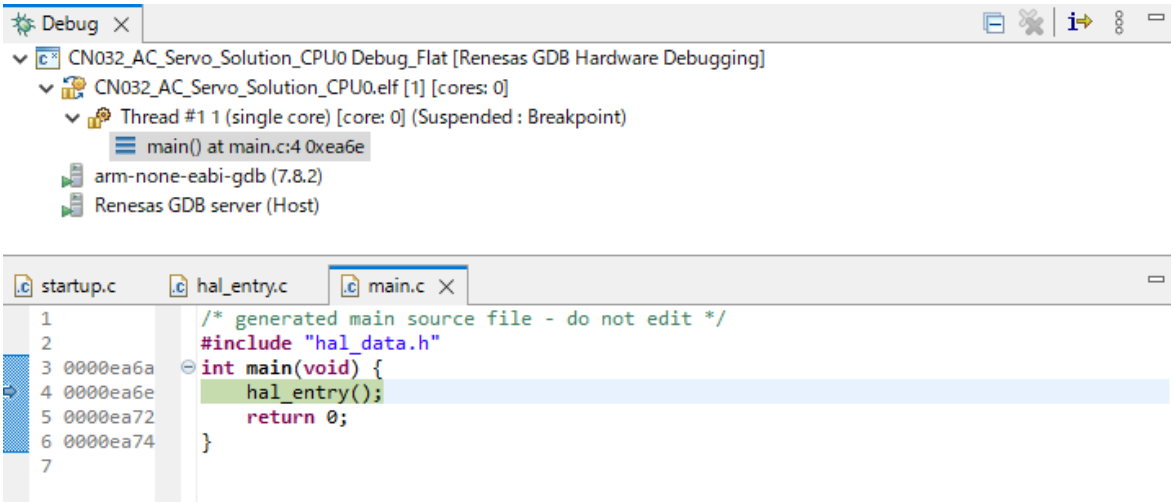
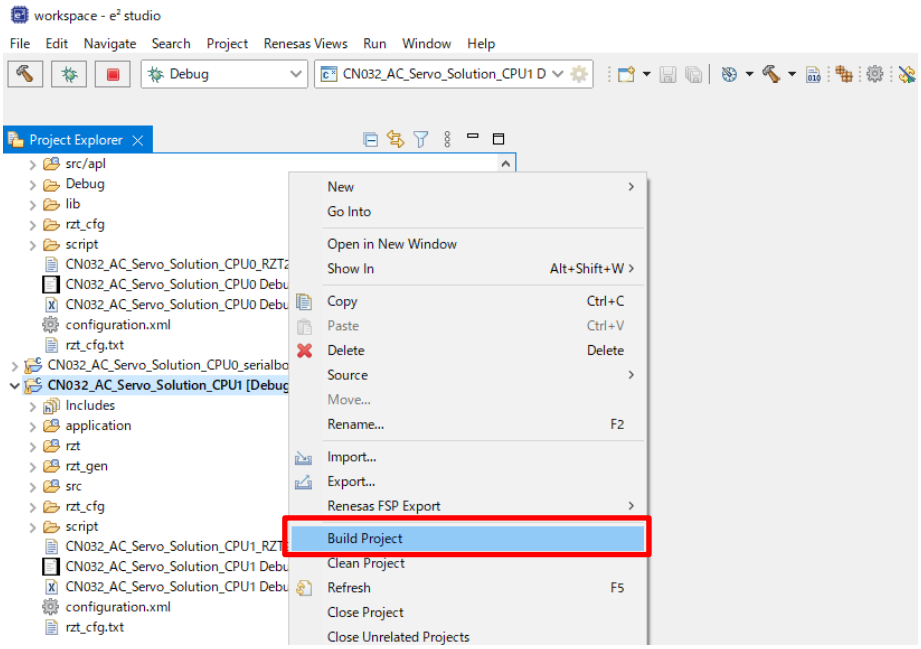
Press the "Resume" button.

When debugging CPU0 is started, the program is interrupted with "hal_entry ();" in main.c.

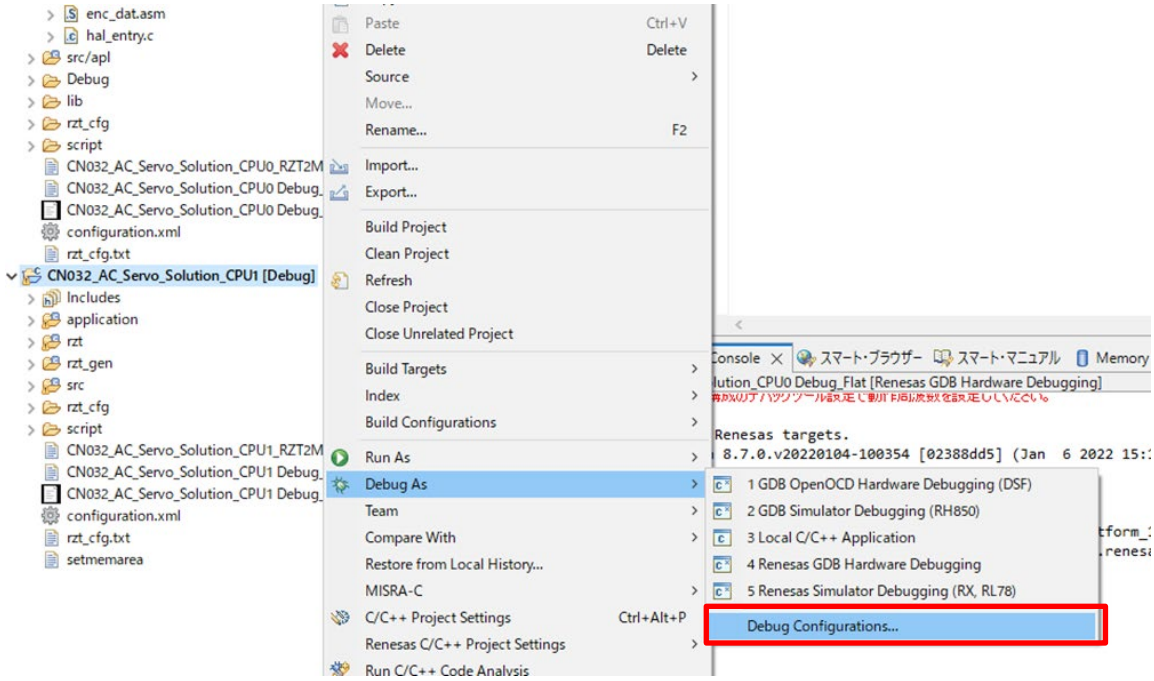


<< CPU1 Project >>

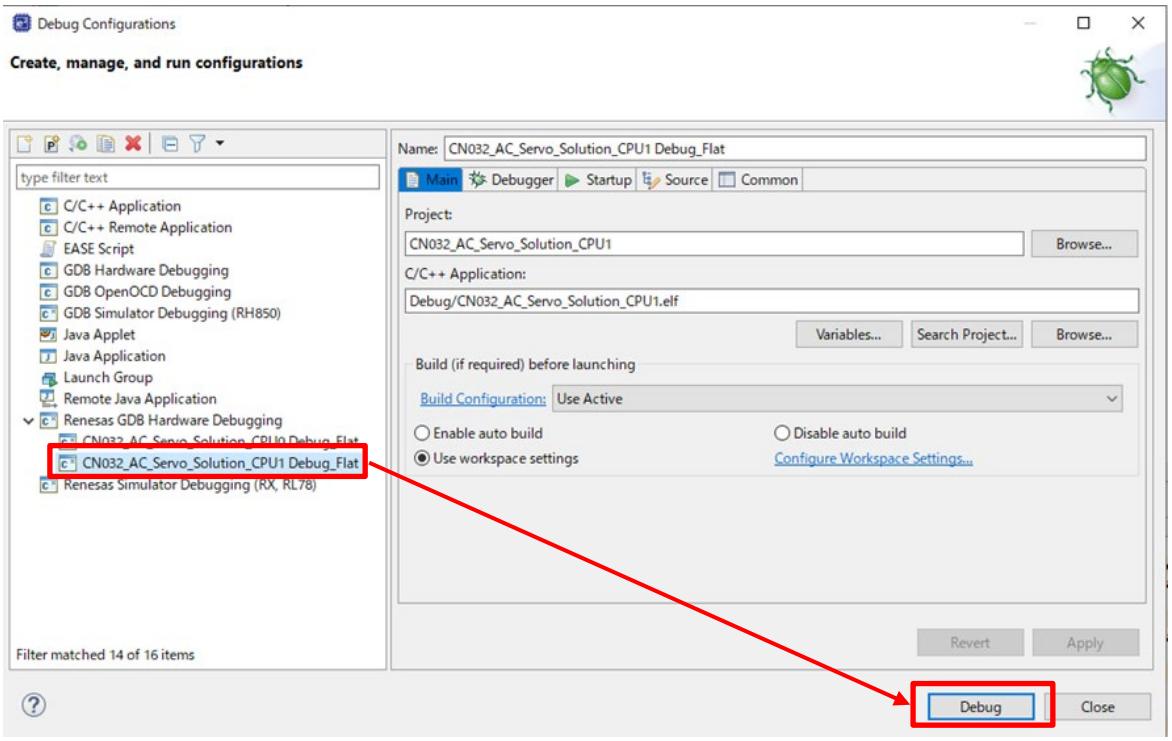
In [Project Explorer] view, right click the node of the “CN032_AC_Servo_Solution_CP1” project to be built and select [Debug As] → [Build Project].



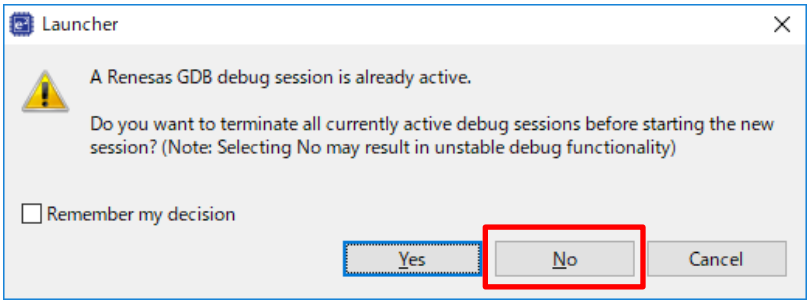
In [Project Explorer] view, right click the node of the “CN032_AC_Servo_Solution_CP1” project to be debugged and select [Debug As] → [Debug Configurations].



[Renesas DBG Hardware Debugging] → [CN032_AC_Servo_Solution_CPU1 Debug_Flat] item, then press [Debug].

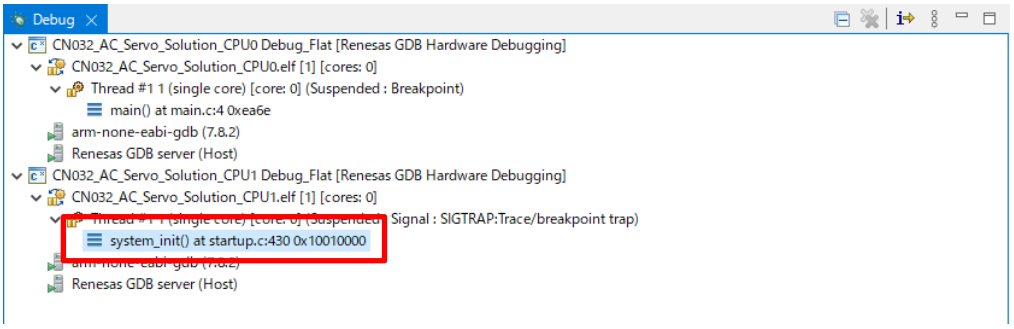


The message "The Renesas GDB debug session is already active" is displayed. Select "No".



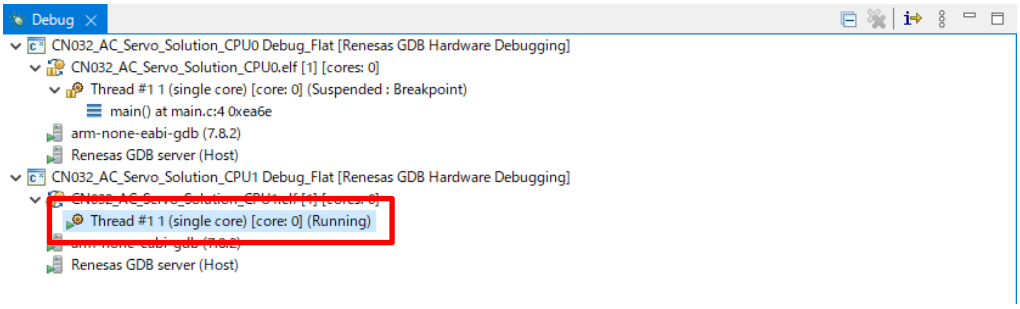
After that, the CPU1 project which name is CN032_AC_Servo_Solution_CPU1 will open and debug connection for CPU1 will also be started automatically.

Click "system_init() at startup.c:430 0x10010000" in CPU1 project Thread, then switches to the debug screen of CPU1. While CPU1 debugging screen, press the "Resume" button.

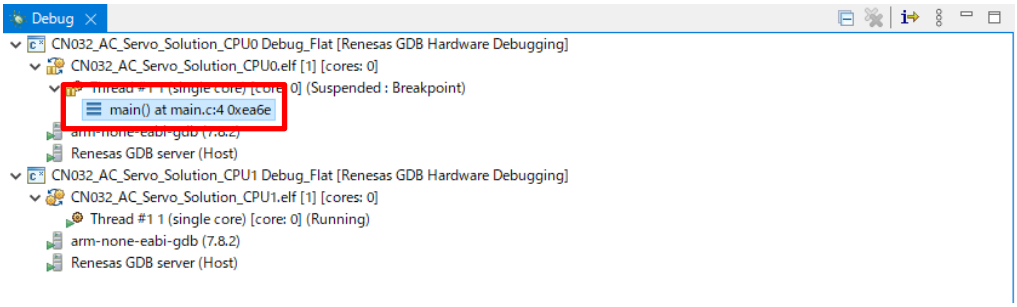


The program will break at “hal_entry();”in main.c .

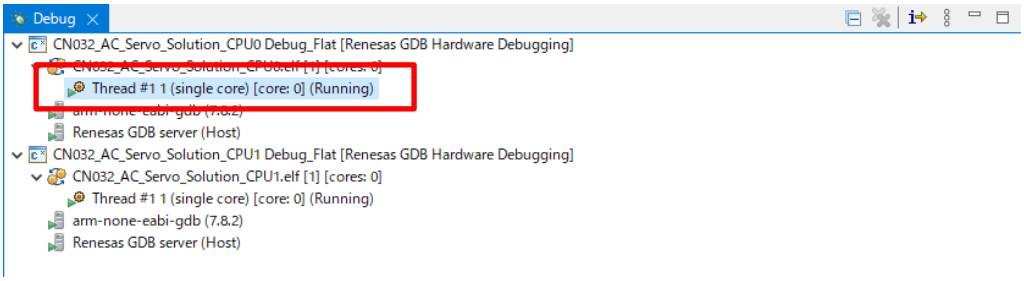
Press the “Resume” button again to execute the CPU1 application program.



(4) Restart debugging the CPU0 project. In [Debug] view, Click "main() at main.c:4 0xea6e" in CPU0 project Thread, then switches to the debug screen of CPU0. Press the “Resume” button to execute the CPU0 application program.



Execute the CPU0 application program.

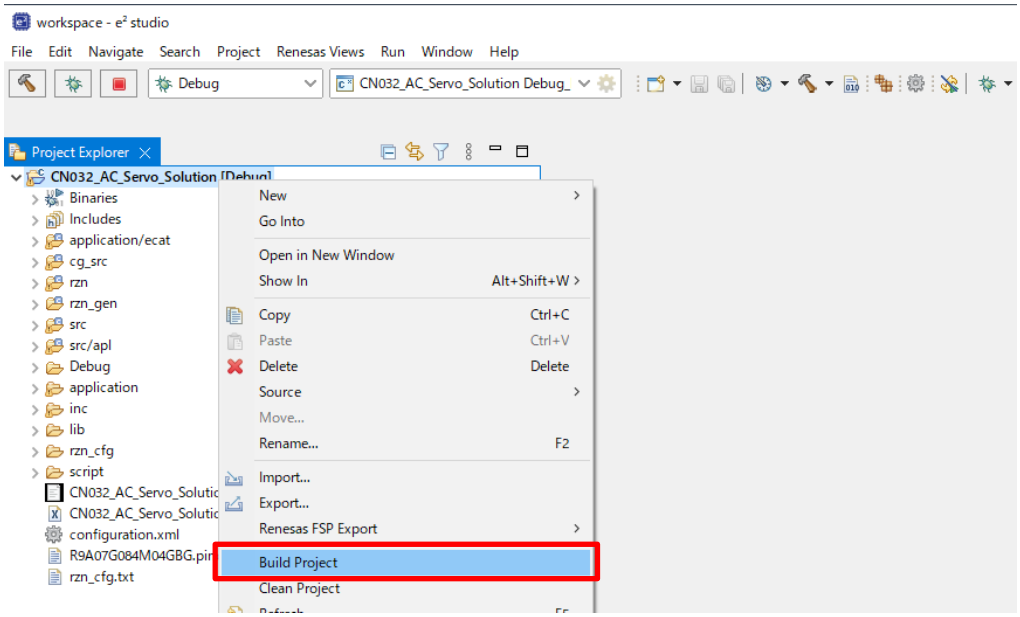


Case of the AC Servo Solution Kit (RZ/T2L, RZ/N2L)

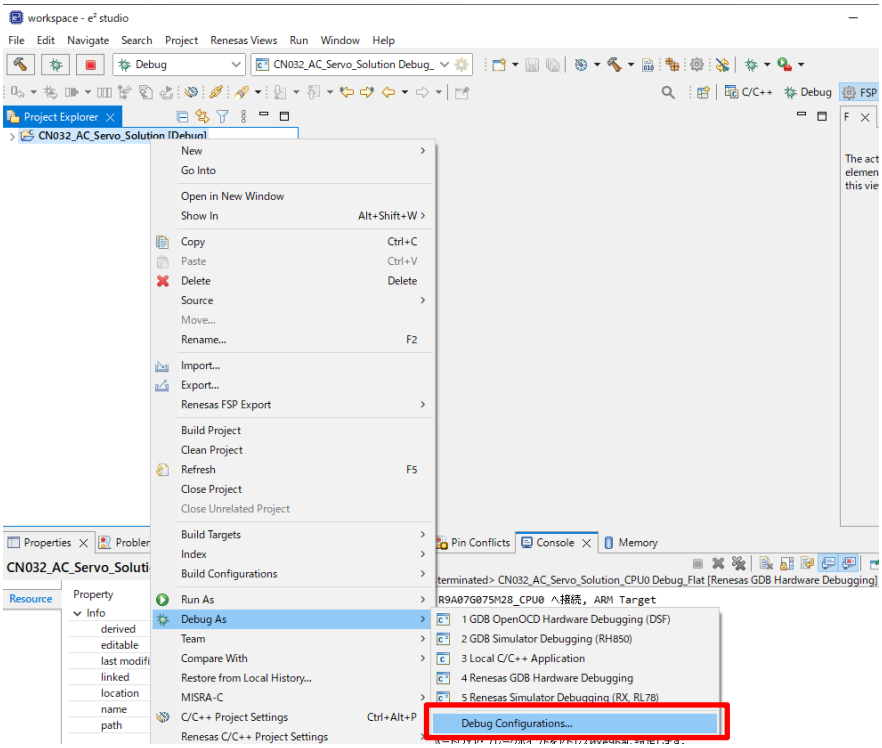
Follow the step (3) when using the Controller board with RZ/T2L, RZ/N2L.

(3) While the board and J-LINK are connected, start debugging in the following order

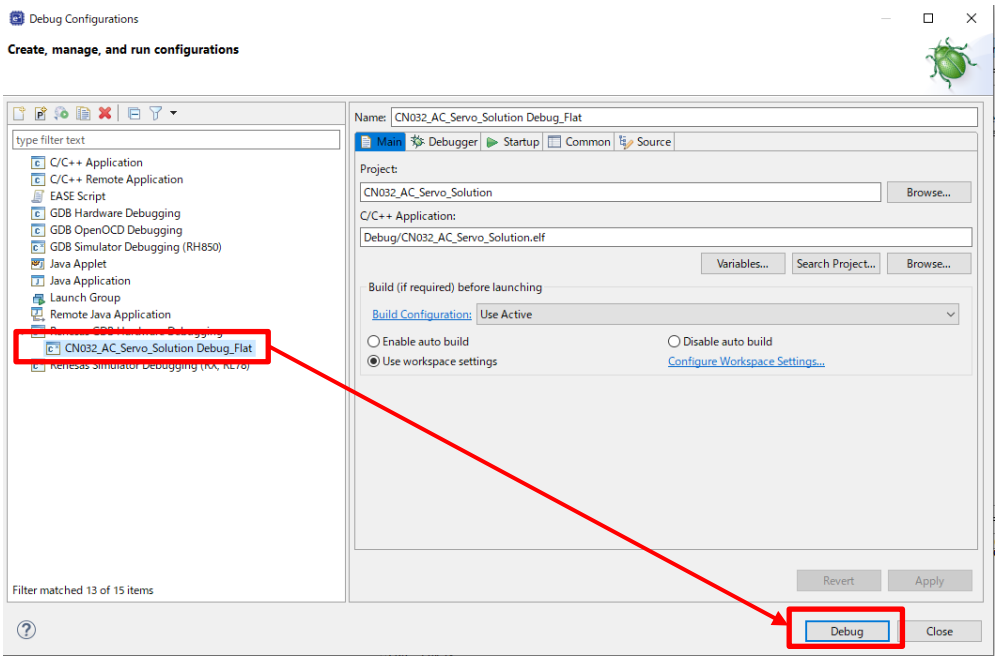
In [Project Explorer] view, right click the node of the RZ/T2L, RZ/N2L project to be built and select [Debug As] → [Build Project].



In [Project Explorer] view, right click the node of the RZ/T2L, RZ/N2L project to be debugged and select [Debug As] → [Debug Configurations].



[Renesas DBG Hardware Debugging] → [CN032_AC_Servo_Solution Debug_Flat] item, then press [Debug].



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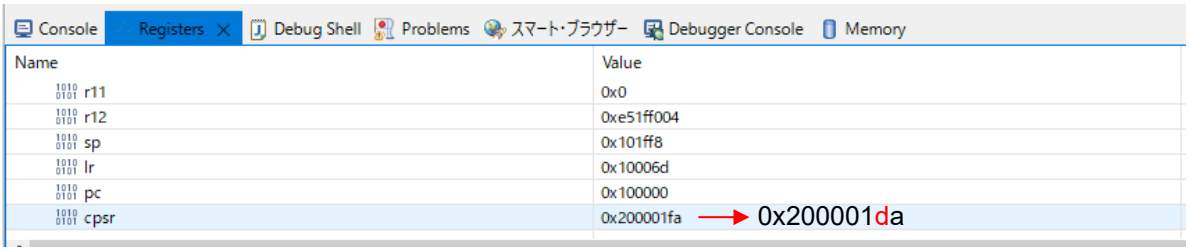
This step can be skipped in case of using software pachage **Rev4.00** later.

If a bit [5] value of CPSR register is “1b”, change it from "1b" to "0b" by using [Register] view.
For example, the register value of CPSR is changed from "0x20000fa" to "0x20000da" in the following.



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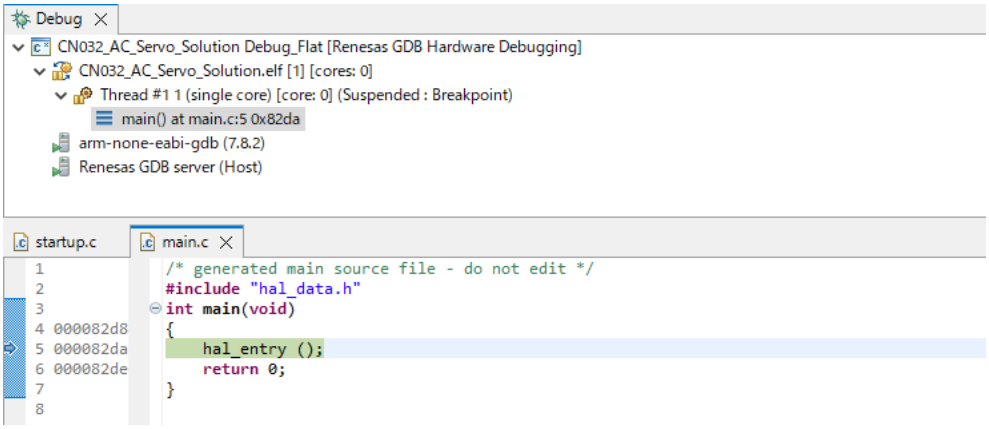
Press the "Resume" button.

When debugging RZ/T2L, RZ/N2L is started, the program is interrupted with “hal_entry ();” in main.c.



And then, press the “Resume” button again to execute the RZ/T2L, RZ/N2L application program.

6.5 EEPROM Data Update on CN032 AC Servo Solution

If the link between TwinCAT®3 and CN032 AC Servo Solution is established, you can update EEPROM data on the kit from TwinCAT®3. The EEPROM contains identification data like VendorID or Product ID.

The EEPROM is blank when purchasing the CN032 AC Servo Solution; in this case Box1 will be displayed as “PFFFFFFFF RFFFFFFFF” as shown in Figure 4-6. Depending on the history of your board you may as well find other data in the EEPROM; therefore we recommend to update the EEPROM in any case as described in the next steps.

To update the EEPROM, double-click on Box 1 (1), select the “EtherCAT” tab (2) and click the “Advanced settings” button (3) as illustrated in Figure 6-5.

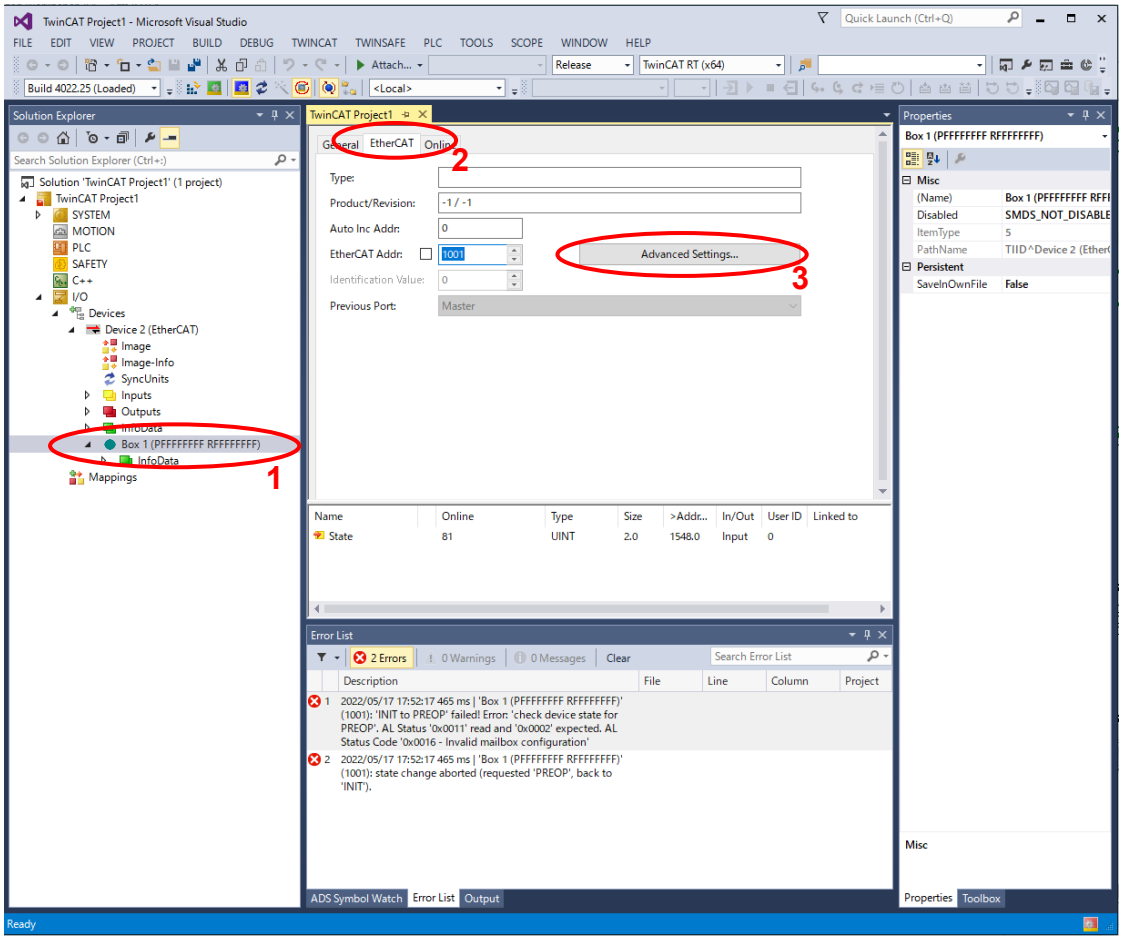


Figure 6-5 Updating the EEPROM

Then expand the list of advanced settings accordingly, so that you can select the “Hex Editor” (1). In the “Hex Editor” view click “Download from List” (2) (See Figure 6-6). This list contains numerous devices for which the required EEPROM content is ready to use.

At the bottom of the list you find as well some Renesas devices Select “CN032 AC Servo Solution CiA402” and click ok (see Figure 6-7).

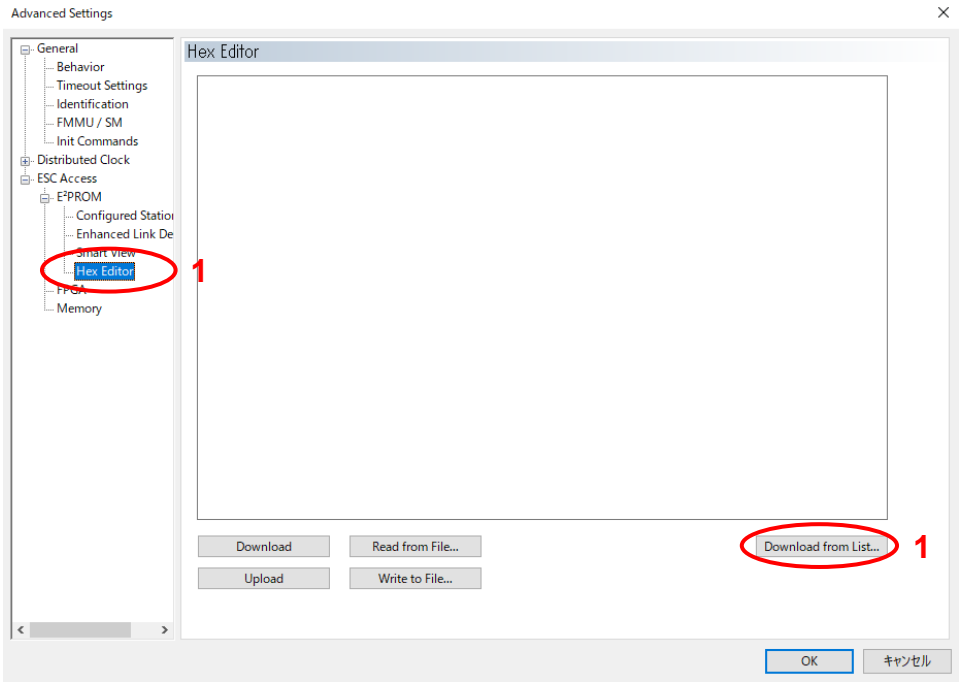


Figure 6-6 Selecting the hex editor for EEPROM file download

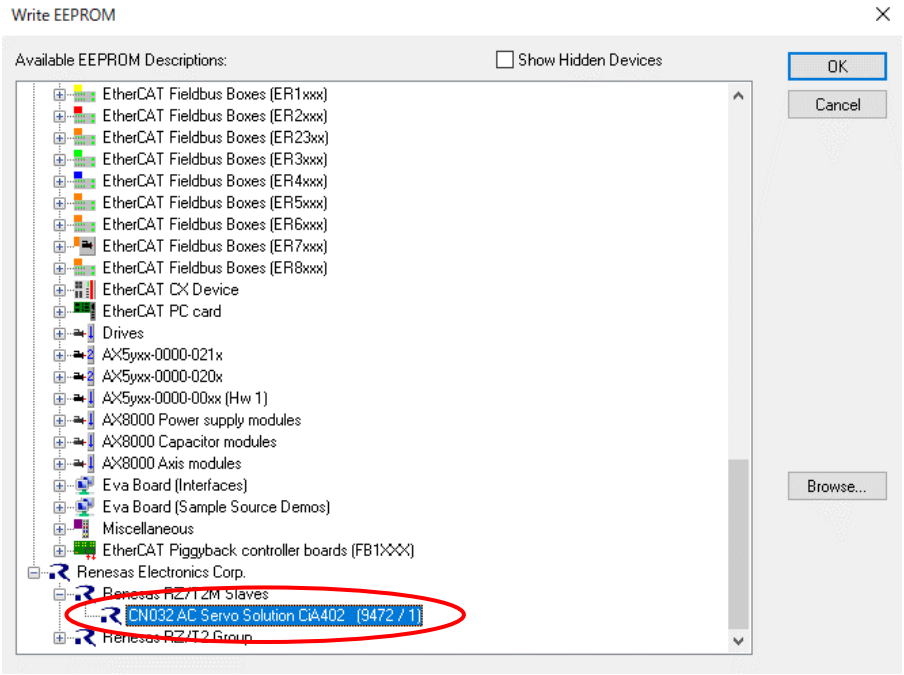


Figure 6-7 Selecting the proper EEPROM description file

The data is then downloaded to the EEPROM; at the end of the download process the data is automatically verified. With “Upload” (see Figure 6-6) you can check, whether the EEPROM programming was successful.

Now repeat the device scan shown in Figure 6-8. TwinCAT®3 will now scan once more for devices and it will find the CN032 AC Servo Solution board with the updated description data in EEPROM. The subsequent “Check Configuration” dialog shows you the list of found items. Copy the “CN032 AC Servo Solution CiA402” device with “Copy All” into the list of “Configured Items” (1). When the representation of the devices in the list changes to green, leave the dialog with “OK” (2).

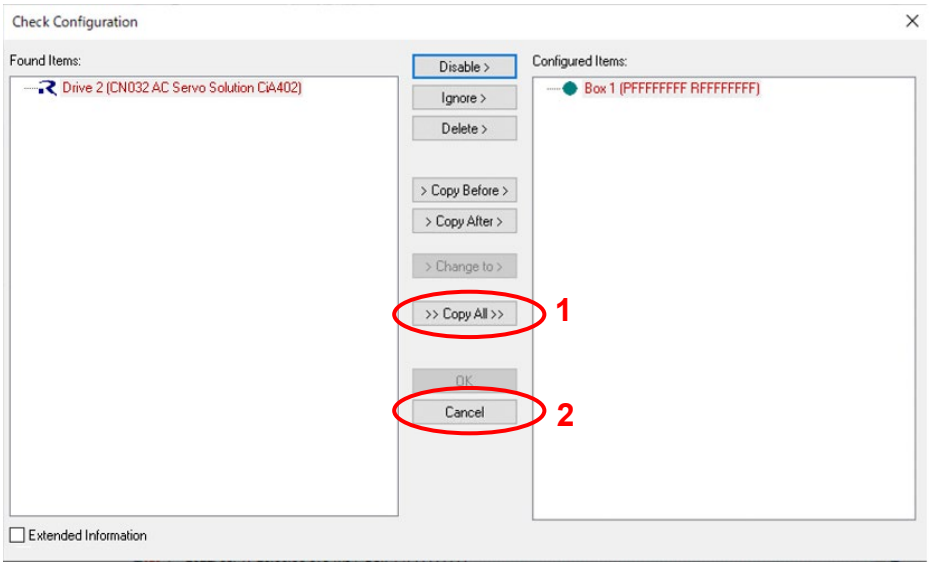


Figure 6-8 Copy the found device into the configuration

Website and Support

Renesas Electronics website

http://www.renesas.com/

Inquiries

http://www.renesas.com/inquiry

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.7, 2022		First Edition issued
2.00	Aug.9, 2022	1,3,4,13, 34,37,38, 43-53 40-42 23-32	Description for AC Servo Solution (RZ/N2L) added. Description for program writing by e2studio with RZ/T2M added. Description for CiA402 Drive Profile added.
3.00	Sep.30, 2022	1 4 20 24-28 29 13,40,42, 43,45,48, 51	Caution when handling the solution board added RZ/N2L FSP is updated to V1.00. 4.3.1 operation mode setting added. 4.3.3 Cyclic Synchronous Position Mode and 4.3.3 Cyclic Synchronous Velocity Mode added Type fixed. File path is changed for firmware Rev3.00.
4.00	Feb.28, 2023	1,4,14,41, 43,45,47, 50,52,53, 59,60 6,7 41 44 55,60	Description for AC Servo Solution (RZ/T2L) added. Description of RS485 communication added. Description of SSC tool version added. Description of development environment install added. Description of CPSR register control changed.
5.00	Dec.15, 2023	4 5 44	Operating Environment table is updated. Precaution is added. Development Environment install is updated.
5.01	Jun.18,2024	1 4 5 7 11 45 47 54 55 62 63 65	Related Document updated. Operating Environment table is updated. Controller board and inverter board combination added. Note: v1.1 only added. Figure 2.8 is updated to the latest AC Servo Solution kit. Description of Apply the patch fixed. 6.2.2 Toolchain Install chapter added. Description of import the sample project fixed. Build the “CN032_AC_Servo_Solution_CPU1” project added. Description of import the sample project fixed. The detailed name of the CPU0 project fixed. The detailed name of the CPU1 project fixed.
5.02	Aug.8,2024	1 5	Related Document updated. Controller board and inverter board combination is updated. Description of change the BUF_ENABLE pin fixed.

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

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