

EC-1 Series

Communication Board EtherCAT[®] Manual

Summary

This application note describes how to use the EtherCAT communication using the communication evaluation unit of the LSI EC-1 series for industrial Ethernet communication.

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1. Overview

A sample software program (referred to as sample software hereinafter) showing usage examples of each function is provided in the EC-1 series to promote software development.

This application note describes the EtherCAT[®] sample software configuration and the method of communication with the TwinCAT[®] master.

For other peripheral drivers, see "EC-1 Series Application Note Peripheral Driver Manual (R01AN3581EJxxxx)".

1.1 **Configuration**

The figure below shows a layer configuration of the sample software.



Figure 1-1 Layer Configuration of the Sample Software



1.2 **Development Environment**

The following describes software development tools.

1.2.1 Tool Chain

The table below shows the tool chain of this sample software.

Tool Chain	IDE	Compiler	Debugger	ICE
IAR	Embedded Workbench for ARM V7.70.1 or later (Use the latest version.) (IAR Systems)			I-jet JTAGjet-Trace-CM (IAR Systems)
GCC	e2 studio V5.4.0 (Renesas Electronics)	KPIT GNUARM-NONE-EABI Toolchain v16.01 (KPIT Technologies)		J-Link (SEGGER)

1.2.2 EtherCAT Slave Stack Code Tool

The EtherCAT sample software uses the EtherCAT Slave Stack Code generated by the EtherCAT Slave Stack Code Tool. To obtain the EtherCAT Slave Stack Code Tool, join the EtherCAT Technology Group and acquire a vendor ID.

Contact the EtherCAT Technology Group about the EtherCAT Slave Stack Code Tool. <u>https://www.ethercat.org/</u>

1.2.3 **TwinCAT**

In this application note, TwinCAT (software system of Beckhoff Automation GmbH) is used for programming in EEPROM and for EtherCAT sample software operation check.

TwinCAT is available from the Beckhoff Automation GmbH homepage.

http://www.beckhoff.com/



1.3 Memory Allocation



Figure 1-2 Memory Map



1.4 **Example of Program Allocation**

The figure below shows an example of program allocation when the serial flash ROM is booted.



Figure 1-3 Example of Program Allocation

For details, see Section 3.4, Operating Mode in the EC-1 User's Manual (Hardware).



2. File Configuration

This section describes the directory configuration and the file configuration of the sample software used in EtherCAT.

For files used in systems other than EtherCAT, see "EC-1 Series Application Note Peripheral Driver Manual (R01AN3581EJxxxx)".

2.1 Directory Configuration

Table 2-1 Directory Configuration of the Sample Software

Directory	Description
./	Sample software storage directory
./Include	Include file storage directory
./Library	Library storage directory
./Source	Source storage directory

2.2 ./Include: Include File

The table below shows the configuration of the include file used in the EtherCAT sample.

Table 2-2 File Configuration of the Include File Directory
--

Directory	File	Description
eth/	r_ether.h	Prototype declaration of ETHER driver

2.3 ./Library: Library

This directory contains no file.

2.4 ./Source: Source

The table below shows the configuration of the source directory.

Table 2-3 Configuration of the Source Directory

Directory	Description
Driver	Driver
Project	Sample application
Templates	Startup file, etc.

2.4.1 ./Source/Driver: Driver

The table below shows the source file configuration of the driver used in the EtherCAT sample. Table 2-4 File Configuration of the Driver-Related Directory

Directory	File	Description
ether/	r_ether.c	ETHER driver



2.4.2 ./Source/Project/EtherCAT_ComB: EtherCAT Sample Application

The table below shows the sample application configuration used in the EtherCAT sample. The EtherCAT sample needs the Slave Stack Code.

Directory	File	Description
EtherCAT_ComB/	board_communication.c	Board setting file
	EC-1 ComB.esp	SSC project file
		[Stored when SSC is created]
	EC-1 ComB.xml	EtherCAT Slave Information (ESI) file
		[Created after SSC is executed]
	main.c	Main processing
	renesashw.c	Hardware processing
	renesashw.h	Prototype declaration of hardware processing
GCC/	EC-1_e2sws_serial_boot.bat	e2Studio project startup batch file
	serial_boot_sample.zip	e2Studio project archive file
IAR/	EC-1_Comb_ecat.ewd	IAR project-related file
	EC-1_Comb_ecat.ewp	IAR project-related file
	EC-1_Comb_ecat.eww	IAR EWARM project file
SSC_config/	Renesas_EC-	SSC Tool configuration file
	1_ComB_config.xml	
Src/	applInterface.h	Prototype declaration of application interface
[Created after SSC is	coeappl.c	CoE application
executed]	coeappl.h	Prototype declaration of CoE application
	ecat_def.h	Prototype declaration related to EtherCAT
	ecatappl.c	Application
	ecatappl.h	Prototype declaration of application
	ecatcoe.c	CoE mailbox processing
	ecatcoe.h	Prototype declaration of CoE mailbox
	ecatslv.c	EtherCAT State Machine processing
	ecatslv.h	Prototype declaration of EtherCAT State Machine
	esc.h	Prototype declaration of EtherCAT Slave Controller (ESC)
	mailbox.c	Mailbox processing
	mailbox.h	Prototype declaration of Mailbox
	main.c	Main processing
	objdef.c	Processing related to Object Dictionary
	objdef.h	Prototype declaration of processing related to Object Dictionary
	renesashw.c	Hardware processing
	renesashw.h	Prototype declaration of hardware processing
	sampleappl.c	Sample application
	sampleappl.h	Prototype declaration of sample application
	sdoserv.c	SDO service processing
	sdoserv.h	Prototype declaration of SDO service processing

Table 2-5 File Configuration of the Sample Application Directory <R>

EC-1 Series

2.4.3

Directory	File	Description
EtherCAT_ComB_CiA402/	apply_patch.bat	Patch-applied bat file
	board_communication.c	Board setting file
	EC-1 CiA402.esp	SSC project file
		[Stored when SSC is created]
	main.c	Main processing
	renesashw.c	Hardware processing
	renesashw.h	Prototype declaration of hardware processing
	SSC_CiA402_yyyymmdd.patch	Patch file for CiA402
		(yyyymmdd: Patch file creation date)
ESI_File/	Renesas_EC-1_ComB_CiA402.xml	EtherCAT Slave Information (ESI) file
GCC/	EC-1_e2sws_serial_boot.bat	e2Studio project startup batch file
	serial_boot_sample.zip	e2Studio project archive file
IAR/	EC-1_Comb_ecat_CiA402.ewd	File related to IAR project
	EC-1_Comb_ecat_CiA402.ewp	File related to IAR project
	EC-1_Comb_ecat_CiA402.eww	IAR EWARM project file
SSC_config/	Renesas_EC-1_ComB_CiA402	SSC Tool configuration file
	_config.xml	
Src/	applInterface.h	Prototype declaration of application interface
[Created after SSC is	cia402appl.c	Sample application
executed]	cia402appl.h	Prototype declaration of sample application
	coeappl.c	CoE application
	coeappl.h	Prototype declaration of CoE application
	ecat_def.h	Prototype declaration related to EtherCAT
	ecatappl.c	Application
	ecatappl.h	Prototype declaration of application
	ecatcoe.c	CoE mailbox processing
	ecatcoe.h	Prototype declaration of CoE mailbox
	ecatslv.c	EtherCAT State Machine processing
	ecatslv.h	Prototype declaration of EtherCAT State Machine
	esc.h	Prototype declaration of EtherCAT Slave Controller (ESC)
	mailbox.c	Mailbox processing
	mailbox.h	Prototype declaration of Mailbox
	main.c	Main processing
	objdef.c	Processing related to Object Dictionary
	objdef.h	Prototype declaration of processing related to Object
		Dictionary
	renesashw.c	Hardware processing
	renesashw.h	Prototype declaration of hardware processing
	sdoserv.c	SDO service processing
	sdoserv.h	Prototype declaration of SDO service processing

./Source/Project/EtherCAT_ComB_CiA402: EtherCAT CiA402 Sample Application

The EtherCAT CiA402 sample application needs the Slave Stack Code.



2.4.4 ./Source/Templates: Startup File, etc.

The table below shows the source file configuration such as startup file.

Directory	File	Description
Templates/	exit.c	Exiting sequence
	r_atcm_init.c	ATCM access wait setting API
	r_cpg.c	CPG setting API
	r_ecm.c	ECM setting API
	r_icu_init.c	EC-1 device setting initialization
	r_mpc.c	MPC setting API
	r_reset.c	EC-1 reset API and low-power API
Templates/IAR/	loader_init.asm	EC-1 interrupt service routine
	vector.asm	Vector table setting
Templates/IAR/serial_boot	bus_init_serial_boot.c	Bus setting initialization
	EC-1_init_serial_boot.icf	Mapping file
	EC1_init_boot.mac	Initialization macro file
	loader_init_sflash.c	EC-1 peripheral setting initialization
	loader_param_serial_boot.c	Parameter setting for SPI boot mode
Templates/IAR/ram_debug	EC-1_init_ram_debug.icf	Mapping file
	EC1_init_ram_debug.mac	Initialization macro file
	loader_init_ram.c	EC-1 peripheral setting initialization
Templates/GCC	loader_init.asm	EC-1 interrupt service routine
	vector.asm	Vector table setting
Templates/GCC/ram_debug	loader_init_ram.c	EC-1 peripheral setting initialization
Templates/GCC/serial_boot	bus_init_serial_boot.c	Bus setting initialization
	loader_init_sflash.c	EC-1 peripheral setting initialization
	loader_param_serial_boot.c	Parameter setting for SPI boot mode



3. TwinCAT Master Communication

This section describes the method of communication between the TwinCAT3 master and the slave EtherCAT communication board.

3.1 Creating SSC Sample Software

The EtherCAT Slave Stack Code (SSC) is required to use the EtherCAT sample software. Perform the following procedure to create SCC sample software using the SSC Tool.

1. Start the SSC Tool from the Windows Start menu.



2. Select File > New.

<u>F</u> ile	_	nB - Slave Sta ect <u>T</u> ool	<u>H</u> elp	e 1001	
	<u>N</u> ew	Ctrl+N		Slave Settings	
2	<u>O</u> pen	Ctrl+O	1	SSC Version	5.11
	Save	Ctrl+S		Config File Ver	rsion1.3.3.0
	-			File name	
	Save <u>A</u>	s	nine 	aceapplic	
	E <u>x</u> it		L	aoeapplh	
_	Mailbo:	icessivala K	_	applInterfa	ceh
	Compil			bootmode.	



- 3. Click the [Import] button and select the SSC Tool configuration file for the EC-1 communication board.
 - EtherCAT sample application

./Project/EtherCAT_ComB/SSC_config/Renesas_EC-1_ComB_SSCconfig.xml

EtherCAT CiA402 sample application

./Project/EtherCAT_ComB_CiA402/SSC_config/Renesas_EC-1_ComB_CiA402_config.xml

Default	
O Custom EL9800 2Axis CiA402 Sample	\sim
Default SlaveStackCode configuration.	
All settings are available.	

4. After the configuration file is read, the window changes as follows:

ilave Stack Code Tool New Project	×
O Default	
Custom Renesas EC-1 Communication Board <renesas corp="" electronics=""></renesas>	\sim
Vendor: Renesas Electronics Corp. (0x766). Version: 0.0.0.1 NOTE: This configuration is not provided by Beckhoff Automation and files or file fragments may be added which are NOT covered by the license from Beckhoff Automation GmbH.	^
Shall be set if the Slave code executes on an Renesas communication board for the EC-1 ComB.	¥
Import OK	

Once the configuration file is read, it is registered in Custom and is selectable from the drop-down list.



- 5. Click the [OK] button, the following window opens.
 - EtherCAT sample application ./Project/EtherCAT_ComB/renesashw.c
 - EtherCAT CiA402 sample application
 - ./Project/EtherCAT_ComB_CiA402/renesashw.c

File Project Tool Help				
Slave Project Navigation	Slave Settings			
⊡- EtherCAT Slave SlaveInformation Generic	SSC Version 5.11 Config File Version1.3.3.0			
- Hardware - EtherCAT State Machine - Synchronisation - Application - ProcessData - Mailbox - Compiler	File name	Description	Version	^
	aceapplic	AoE ADS over EtherCAT	5.11	
	aoeapplh		5.11	
	applInterface h	EcatAppI EtherCAT application	5.11	
	bootmodec	ESM EtherCAT State Machine	4.20	
	bootmode h		5.11	
	cia402app1.c	5.11		
	cia402app1h		5.11	
	coeapplc	CoE CAN Application Profile over EtherCAT	5.11	
	coeapplh		5.11	
	diagic	Diagnosis Object	5.11	
	diagh		5.11	~
		Reload File Rem	ove Add File	(s)
	Conflicts			
	👥 Info 🔥 Warning	😢 Error		

6. Select Project > Create new Slave Files.

sse EtherCA	T Slave* - Slave Stack Cod	e Tool	
File Pro	ject Tool Help		
Slave Pr 🧭	Project Update		igs
⊡ Ethe	Find Setting Ctrl	+F	m 5.11
	Create new Slave Files	F5	Version1.3.3.0
- THOM	Create new Slave Files	FJ	ame
	hronisation	aoeapp	olo
📥 Apoli	cation		



7. Click the [Start] button to start creating the EtherCAT Slave Stack Code.

Project File	OB¥EC-1_sam	nplesoft¥EC-1_samplesoft¥Source¥Project¥EtherCAT_SSC_ComB¥EC-1 ComBesp	
	Source Folder	3¥EC-1_samplesoft¥EC-1_samplesoft¥Source¥Project¥EtherCAT_SSC_ComB¥Src	Change
	ESI File	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
	Doc Folder	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
Progress			

- 8. When a message "New files created successfully" appears, the creation processing is completed and a Src file is created.
 - EtherCAT sample application

./Project/EtherCAT_ComB/Src

EtherCAT CiA402 sample application

./Project/EtherCAT_ComB_CiA402/Src

· ·	UB#EC-T_san	plesoft¥EC-1_samplesoft¥Source¥Project¥EtherCAT_SSC_ComB¥EC-1 ComBesp	
	Source Folder	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
	ESI File	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
	Doc Folder	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
Progress			
"main.c" "applInte "ecatappl "ecatappl" "ecatslv. "ecatslv. "senesast "renesast "combappl" "combappl" "combappl" "combappl" "anin.c" Generate	: start eval : was not ev erface.h" : n L.c" : new fil h" : new fil h" : new fil : new file wr w.c" : new f w.h" : new f L.c" : new fi	aluate ew file write le writ e writ e writ Open Folder OK itten ile written le written le written le written le written ew titen ew titen ed	



9. Execute the "bat" file to apply patch (only for the EtherCAT CiA402 sample application).

For the sample application including the "bat" file, execute the "bat" file to apply patch.

If Patch Command has not been installed

Download the file from the link below and set it up or store the patch.exe file in the directory that has a path.

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

Applying patch

Right-click the "apply_patch.bat" file and select "Run as an administrator" > "Yes".

The patch file is executed and corrections of the sample application are applied to the SSC source file.

EtherCAT sample application

(Not required)

EtherCAT CiA402 sample application

./Project/EtherCAT_ComB_CiA402/apply_patch.bat (batch file)

./Project/EtherCAT_ComB_CiA402/SSC_CiA402_yyyymmdd.patch (patch file)

(yyyymmdd: Patch file creation date)

Patching process start		~
patching file Src/cia402appl.c		
patching file Src/cia402appl.h		
patching file Src/ecat_def.h		
patching file Src/ecatcoe.h		
patching file Src/mailbox.h		
patching file Src/sdoserv.h		
Patching process end		
続行するには何かキーを押してください		



3.2 Downloading the Sample Software Program

Perform the following procedure to download the created EtherCAT sample software to the communication board.

3.2.1 Startup sample project and build for EWARM

- 1. Connect the JTAG connector on the ICE to the CN2 connector on the communication board.
- 2. Start EWARM.

Double-click the EWARM project file of the sample software to start EWARM.

EtherCAT sample application

./Source/Project/EtherCAT_ComB/IAR/EC-1_Comb_ecat.eww

EtherCAT CiA402 sample application

./Source/Project/EtherCAT_ComB_CiA402/IAR/EC-1_Comb_ecat_CiA402.eww

EC-1_Comb_ecat.ewd	
EC-1_Comb_ecat.ewp	
K EC-1_Comb_ecat.eww	

3. Perform build.

EC-1_Comb_ec					
Eile Edit View Workspace RamDebug Files	Add <u>F</u> i Add <u>G</u> i Import Add <u>P</u> i Edi <u>t</u> Co Remoy	iles roup t File List roject Conne onfiguration	ction	window	Пеір
	<u>O</u> ption	ıs			Alt+F7
	Version	n Control S <u>y</u> s	tem		>
	<u>M</u> ake				F7
	<u>C</u> ompi	ile			Ctrl+F7
	Re <u>b</u> uil	d All			
	C <u>l</u> ean				



4. Download the sample software and perform debug.

🌪 📣 🌬 📑 👯 📚 🕭	1	>
	Do	wnload and Debug

5. Run the program.

Werkspace Image: Second Se	Section and MR Embedde	
Image: Imag		
Image: Solution of the second se	File Edit View Project Debu	g Disassembly I-jet/JTAGjet Tools Window Help
ETM SWO Go Workspace × RamDebug 62 Files 62 Go 63 Go 64 Files 65 Go 64 Go 64 Go 64 Go 64 Go 65 Go 66 Go 68 Go 10ader_init1: Go 71 Stack_init: 72 Go 73 Cps #17 FIQ mode		
Workspace × RamDebug 62 Files 62 Go 63 Go 64 ; Function Name : loader_init1 Go 7 Coscription : Initialize sysytem i Go ; Arguments : none 66 Go ; Return Value : none 68 Go 10 ader_init1: 70 Tomplates 69 loader_init1: Tom 71 stack_init: Tom 73 Cps #17 ; FIQ mode	๖▾╡▮╘┺┲┺	
Workspace × loader_init.asm RamDebug 62 Files 63 □ EC-1_Com ✓ □ IEC-1_Com ✓ □ IEC-1_ECCC ✓ □ IEC-1_ECCCC ✓ □ IEC-1_ECCCCC ✓ □ IEC-1_ECCCCCCCCCCCCCCC ✓ □ IEC-1_ECCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	ETM SWO	60
RamDebug 62 Files 63 Files 63 Files 64 Files 65 Files 66 Files 68 Files 69 Ioader_init1: 70 Files 73 Cps #17 FIQ mode	Workspace ×	
Files Files <td< td=""><td></td><td></td></td<>		
	☐ EC-1_Com ✓ ☐ drivers ☐ ample ☐ Templates	<pre>64 ; Function Name : loader_init1 65 ; Description : Initialize sysytem } 66 ; Arguments : none 67 ; Return Value : none 68 ;************************************</pre>
		78 ldr sp, =SFE(ABT_STACK) 79 cps #27 ; Undef mode



3.2.2 Startup sample project and build for e2sudio

- 1. Connect the JTAG connector on the ICE to the CN2 connector on the communication board.
- 2. Start e2 studio.

Double-click the Batch file of the sample software to start e2 studio.

- EtherCAT sample application
 - ./Source/Project/EtherCAT_ComB/GCC/EC-1_e2sws_serial_boot.bat
- EtherCAT CiA402 sample application

./Source/Project/EtherCAT_ComB_CiA402/GCC/EC-1_e2sws_serial_boot.bat



3. Import of Project (only first time)

By selecting [File] > [Import...], open the Import dialog. >

Select [General] > [Existing Projects into Workspace], and click "Next".

Select	projects from an archive file or directory.
Create new	projects nom an archive nie or directory.
<u>S</u> elect an i	mport source:
type filter	text
	eneral Archive File Convert CCRX to GNURX Project DS-5 KPIT GNUARM-BZ/NONE Project Existing Projects into Workspace File System HEW Project HEW Project Import KPIT GNUARM Project to GCC ARM Embedded Preferences Rename & Import Existing C/C++ Project into Workspace Renesas CA78K0R Project Renesas Common Project File



Open the Workspace from select the archive file > Browse > Select" serial_boot_sample.zip" > end

e ² Import	_	
Import Projects Select a directory to sear	ch for existing Eclipse projects.	
○ Select roo <u>t</u> directory:	~	B <u>r</u> owse
Select <u>a</u> rchive file:	D:¥Renesas_EC-1_samplesoft¥EC-1_sampleso \lor	B <u>r</u> owse
<u>P</u> rojects:		
✓ serial_boot_samp	Select All	
		Deselect All
		R <u>e</u> fresh

4. Go to build

By selecting [Project] \rightarrow [Build All], to run the Build





$\boldsymbol{5}$. Download

Click the "serial_boot_sample " in Project Explorer, > Click [Debug] after [Hardware Debug] is displayed.

(Next time only "Debug" click)



6. Execute the program

Click the "Restart" button, > Click the "Resume"

	rigate Search Project Renesas Views Run Window Help I 🛞 🕶 🔦 🐨 🔝 🔤 🕰 New Connection 🔽 💉 🕅 I 🗞 💌 📲 I 🗞 🔲	▶ 11 🔳 💦 🍕 Resume (F8)
🎄 Debug 🛛		(x)= Variables 🔀
∨ 🥐 sam ∨ 🖗 1	hread #11 (single core) (Suspended : Signal : SIGTRAP:Trace/breakpoint trap) stack_init() at loader_init.asm:61 0x802000 enesas/e2_studio/DebugComp/arm-none-eabi-gdb (7.8.2)	Name
S loader_init.a	sm 🔀	



3.3 Connecting TwinCAT

The following describes how to connect TwinCAT3 to the communication board using the EtherCAT.

1. Store the ESI file.

Store the EtherCAT Slave Information (ESI) file of the EtherCAT sample software for the communication board in the TwinCAT folder.

ESI file

• EtherCAT sample application (Created after SSC is executed)

./Source/Project/EtherCAT_ComB/EC-1 ComB.xml <R>

EtherCAT CiA402 sample application

./Source/Project/EtherCAT_ComB_CiA402/ESI_File/ Renesas_EC-1_ComB_CiA402.xml

Storage destination:

C:¥TwinCAT¥3.1¥Config¥lo¥EtherCAT

2. Make network adapter settings.

Display properties of the network adapter used as Windows network connection > TwinCAT. Enable only TwinCAT RT-Ethernet Filter Driver and TwinCAT Ethernet Protocol.

Local Area Connection Properties Networking Sharing Connect using:
TwinCAT-Intel PCI Ethernet Adapter (Gigabit)
<u>C</u> onfigure This connection uses the following items:
□ Client for Microsoft Networks □ □
Allows your computer to access resources on a Microsoft network.
OK Cancel

If TwinCAT RT-Ethernet Filter Driver is not indicated or the driver is not installed, install the driver according to Appendix A.



3. Start the TwinCAT.

Click "TwinCAT XAE (VS 20xx)" from task.

	0		
		<u>Ü</u> ber TwinCAT	
	60	TwinCAT XAE (VS 2010)	
	M	TwinCAT XAE (VS 2013)	
		Tools	۲
	æ	Echtzeit	
		Rou <u>t</u> er	
·s & _		<u>S</u> ystem	•
ia 🗕 🔺 📘		a 🗳 📲 🏅 2017/04/24	

Both VS 2010 and VS 2013 are executable. Only the installed Visual Studio versions are displayed.

4. Start the new TwinCAT project.

Select FILE > New > Project and then click the [OK] button to display the TwinCAT project.

TwinCAT Project1 - Microsoft Visual Studio				Quick Launch	(Ctrl+Q)	- • ×
EILE EDIT VIEW PROJECT BUILD DEBI	JG TWINCAT TWINSAFE PLC	TOOLS WINDOW HELP				
0-0 18-1-4 🖬 🖉 🗶 8 a 🔊			4) 🗸 🏓	- Q.		
🔛 🔟 🖉 🖉 🞯 🍋 < Local>						
Solution Explorer V A ×						
000 10- 67 P -						
Search Solution Explorer (Ctrl+:)						
Solution 'TwinCAT Project1' (1 project)						
TwinCAT Project1						
SYSTEM MOTION						
III PLC						
SAFETY						
C++ ▶ ☑ I/O						
	Error List					- 4 ×
	🔻 👻 😳 0 Errors 🛛 🔬 0 Warnings	0 Messages Clear			Search Error List	ρ-
	Description		File	▲ Line	Column Projec	t.
	Error List Output					



5. Execute scan.

Right-click I/O > Devices and execute scan.

TwinCAT Project1 - 1	licrosoft Visual Studio		
FILE EDIT VIEW I		TWINCAT TWINSAFE PL	
· · □ · · · · · · · · · · · · · · · · ·	🛯 🗳 🖌 司 台 🛛 🤊 - 🤆	🔹 🕨 Attach… 👻	
- 1 🔛 🖬 🗖 🕫 🖄 🌀	🔌 🐂 🛛 <local></local>	• ₌	
Solution Explorer	▼ ₽ ×		
○ ○ 습 io - i	-		
Search Solution Explorer	Ctrl+:) 🔑 -		
Solution TwinCAT Pr System Motion Motion Motion Motion SAFETY Motion SAFETY Motion Support			
Mappings	🗂 Add New Item	Ins	
	1 Add Existing Item	Shift+Alt+A	
	Event FAD Config File		
	🔆 Scan		
	🗇 Paste	Ctrl+V	
	Paste with Links		
•			

6. Select an adapter to be used.

When a slave compatible with the EtherCAT is connected, its checkbox (next to "Device") is selected. Click the [OK] button to execute Scan for Box.

● Device 1 (EtherCAT Automation Protocol) [Network Connect Adapter (Juniper Netwi Device 2 (EtherCAT Automation Protocol) ローカル エリア接続 (Realtek PCIe GBE Fami ✓ Device 4 (EtherCAT) ローカル エリア接続 3 (ASIX AX88178 USB2.0 to Gigab] Select All Unselect All	3	new I/O devices found	
		🔲 Device 2 (EtherCAT Automation Protocol) [ローカル エリア接続 (Realtek PCIe GBE Fami	Cancel Select All

[Check]

If no checkbox is selected automatically or [EtherCAT] is not displayed, the following causes are considered.

- An Ether cable is not connected to the communication board.
 - \rightarrow Connect an Ether cable between the communication board and a PC with TwinCAT installed.
- TwinCAT setting is not made in the network adapter settings.
 - \rightarrow Change the PC's network environment according to step 2 in this section.
- The EtherCAT driver is not installed.
 - \rightarrow Install the EtherCAT driver according to Appendix A.



7. When the scan has been successfully completed, the connected box (communication board) is displayed.



[Check 1]

If "Box 1 (PFFFFFFF RFFFFFFF)" appears, the Slave Information Interface (SII) may not have been programmed in the EEPROM on the communication board. In this case, program the EEPROM according to Appendix B.

[Check 2]

If the following warning appears, store the ESI file according to step 1 in this section and retry steps from step 3.

Use available online description instead (YES) or try to load app	ropriate descriptions from the web



8. Communication state

When EtherCAT communication has been established, "OP (Operational)" is shown in State.





4. Operating the Sample Application

4.1 EtherCAT Sample

This section describes the method of TxPDO/RxPDO communication between the TwinCAT master and the communication board.

The following sample application is provided in the sample software for the EtherCAT communication board.

TxPDO: Sends the 4-byte InputCounter value from the communication board to the TwinCAT master. RxPDO: Sends the 4-byte OutputCounter value from the TwinCAT master to the communication board.

- OutputCounter = 0: The 4-byte increment value is sent as InputCounter.
- OutputCounter \geq 1: A value of (OutputCounter + 1) is sent as InputCounter.
- 1. Read the InputCounter vale and write the OutputCounter value. When InputCounter(TxPDO) transitions to Safe-OP, it starts incrementing.

When it transitions to OP, OutputCounter(RxPDO) is enabled.

InputCounter reads the increment value.

Right-click OutputCounter and select "Online Write".





2. Write the OutputCounter value.

Enter the 4-byte RxPDO value to be sent from the TwinCAT master to the communication board, and then click the [OK] button.

		· · · · · · · · · · · · · · · · · · ·	
Set Val	lue Dia	log	
	_	_	
		Locut	
Dec:		12345	OK
		0.0000000	
Hex		0x00003039	Cancel
Float:		1.729903e-041	
Float		1.7233038-041	
Book			Hex Edit
BOOI.			Hex Luit
Binary		39 30 00 00	4
Dinaly	6	33 30 00 00	
Bit Siz	70'	◎1 ◎8 ◎16 ◎32	0 64 0 2
DROID		0100010032	004 01
	_		
		-	

3. Read the InputCounter value.

A value of (4-byte RxPDO input value + 1) is received from the slave as InputCounter of TxPDO.

Name	Online	Туре	Size	>Add	In/	Use	Linked to
🕫 InputCounter	12346	UDINT	4.0	26.0	Input	0	
🕫 WcState	0	BIT	0.1	1522.0	Input	0	
🕫 InputToggle	1	BIT	0.1	1524.0	Input	0	
🕫 State	8	UINT	2.0	1548.0	Input	0	
🔁 AdsAddr	192.168.225.22	AMSADDR	8.0	1550.0	Input	0	
📌 AoeNetId	0.0.0.0.0	AMSNETID	6.0	1558.0	Input	0	
OutputCounter	12345	UDINT	4.0	26.0	Out	0	



4.2 EtherCAT CiA402 Sample Application

This section describes the method of Cyclic Synchronous Position (CSP) mode communication between the TwinCAT master and the communication board.

The following sample application is provided in the CiA402 sample software for the EtherCAT communication board.

- Calls the DummyMotor() function at a 1 ms timer interrupt.
- Compares "Target position" (target position) with "Position actual value" (current position) by the DymmyMotor() function, and increments or decrements the current position until it matches the target position.

1. Writing to the Controlword object

Control CiA402 state transitions by Controlword(Outputs).

Entering " 000Fh (15)" makes a transition to the "Operation enabled" state.

EC-1 CiA402 - Microsoft Visual Studio	
File Edit View Project Build Debug TwinC The State of the State of th	
Solution Explorer	# × EC-1 CIA402 × Mariable Flags Online Value: 0 (0x0000) New Value: Force Comment: object 0x60400 Error List - # × Error List - # ×
	Set Value Dialog Dec: 15 Hex: Dx000F Bool: 0 1 Hex Edit Binary: 0F 00 2 Bit Size: 1 8 0 32 64 ?



2. Checking the Statusword object

Check the status by Statusword (Inputs).

When "xxxx xxxx x01x 0111b" is returned, it means the normal status.



3. Writing to the Target position object Enter any target position.

<u>File Edit View Project Build Debu</u>	-		
i 🔐 🚨 😂 📉 🎯 😚 🐂 < Loc		,	대 내 -
Solution Explorer	D2) axis) e ord actual value estion	-1 CIA402 × Variable Flags Online Value: 0 New Value: ForceRelease Write Comment: object 0x607A:0	E
A Module 2-(cop WcState WcState WR Ready	🚽 Erro	or List Error List 📱 Output	× # ×
VCState	🚽 Erro	Error List 📕 Output	
WcState	, Erro	Error List 📕 Output	
WcState	Set Value D	Error List 🖬 Output	
WcState	Set Value D	Error List Output	
WcState	Set Value D Dec: Hex:	Error List S Output	
WcState	Set Value D Dec: Hex: Float:	Error List Output	



4. Checking the Position actual value object

Check that the current position is incremented and stops at the target position.





5. Appendix A Installing the EtherCAT Driver

The TwinCAT driver must be installed to use the TwinCAT.

Perform the following installation procedure.

1. Start the TwinCAT.

Click "TwinCAT XAE (VS 20xx)" from task.



Both VS 2010 and VS 2013 are executable. Only the installed Visual Studio versions are displayed.

2. New Project

Open "New Project" and start the TwinCAT.

3. Display the Ethernet adapter.

Select TwinCAT > Show real Time Ethernet Compatible Devices.





4. Install the TwinCAT driver.

Select the network adapter to be an installation destination, and then click the [Install] button.

Installation of TwinCAT RT-Ethernet Adapters	Update List
Pinstalled and ready to use devices(realtime capable) Pinstalled and ready to use devices(for demo use only)	Install
- Ormatible devices	Update
ー・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・	Bind
□	Unbind
	Enable
	Disable
	🗖 Show Bindings

When the installed network adapter is displayed in "Installed and ready to use devices" at the end of installation, the installation has been successfully completed.

Installation of TwinCAT RT-Ethernet Adapters	×	
Ethernet Adapters	Update List	
Letelled and ready to use devices(reading capable) □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □	Install	
二一型 ローカル エリア接続 3 - ASIX AX88178 USB2.0 to Gigabit Ethernet Adapter 一愛 Compatible devices	Update	
ip	Bind	
ー 🔮 ローカル エリア接続 - Realtek PCIe GBE Family Controller - 👽 ワイヤレス ネットワーク接続 - Intel(R) Dual Band Wireless-AC 7265	Unbind	
Disabled devices	Enable	
	Disable	
	Show Bindings	



6. Appendix B EEPROM Program

The Slave Information Interface (SII) must have been programmed in the EEPROM. The EEPROM is blank in the initial state of the board. Perform the following procedure to program the SII.

1. Start Advanced Setting.

Double-click the box of the slave in which the SII is programmed, and then select the EtherCAT tab. Click "Advanced Setting".

Image: WinCAT Project1 - Microsoft Visual Studio FILE EDIT VIEW PROJECT BUILD DEBUG B C B C C C B C C C D C D C D C D C D C D C D C D C D C D C D C D C D C D C D C D C	- 🤆 - 🕨 Attach Release - TwinCAT RT (x64) - 📕
Solution Explorer	TwincAT Project1 * × General EtherCAT Type: -1/-1 Auto be Adde: 0 EtherCAT Adde: 0 EtherCAT Adde: 0 Beneral EtherCAT adde: Previous Port Master

2. Hex Editor

Select ESC Access > E2PROM > Hex Editor.

Click the [Download from List] button.

Advanced Settings General Behavior Himeout Settings Identification FMMU / SM Init Commands ESC Access ESPROM Configured Stati ESPROM Configured Stati Financed Link D Smart View Hex Editor FPGA Memory	Hex Editor 0000 FF		
× >	Operation File Upload Write to File	, Download from List OK キャンセル	



3. Select the ESI file.

Select the ESI file stored in step 1 in section 3.3, and then click the [OK] button.

Write EEPROM		×
Available EEPROM Descriptions:	Show Hidden Devices	OK Cancel

4. Download

When hexadecimal information is displayed as shown below, the programming has been completed.

After the EEPROM has been reprogrammed, turn off and on the board.

Upload Write to File	General Hex Editor Default Behavior Timeout Settings 000 80 0E 42 EE 10 27 00 00 00 00 00 00 00 00 00 00 00 00 00	*
----------------------	---	---



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Revision History

Rev.	Date	Page	Summary
1.00	Sep 04, 2018		First edition issued.
1.10	Sep 04, 2018	8	Update file configuration at Table 2 5 File Configuration of the Sample Application Directory.
		21	Update file path at 3.3 Connecting TwinCAT.

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1. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.
- 2. Processing at Power-on

The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not
 access these addresses; the correct operation of LSI is not guaranteed if they are accessed.
- 4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.
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