

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.

R01AN3853EJ0110 Rev.1.10 Sep 04, 2018 Table of Contents

1. Overview	.3
1.1 Configuration	. 3
1.2 Development Environment	. 4
1.2.1 Tool Chain	. 4
1.2.2 EtherCAT Slave Stack Code Tool	. 4
1.2.3 TwinCAT	. 4
1.3 Memory Allocation	. 5
1.4 Example of Program Allocation	. 6
2. File Configuration	.7
2.1 Directory Configuration	. 7
2.2 ./Include: Include File	. 7
2.3 ./Library: Library	. 7
2.4 /Source: Source	. 7
2.4.1 ./Source/Driver: Driver	. 7
2.4.2 ./Source/Project/EtherCAT_ComB: EtherCAT Sample Application	. 8
2.4.3 ./Source/Project/EtherCAT_ComB_CiA402: EtherCAT CiA402 Sample Application	. 9
2.4.4 ./Source/Templates: Startup File, etc	10
3. TwinCAT Master Communication	11
3.1 Creating SSC Sample Software	11
3.2 Downloading the Sample Software Program	16
3.2.1 Startup sample project and build for EWARM	16
3.2.2 Startup sample project and build for e2sudio	18
3.3 Connecting TwinCAT	21
4. Operating the Sample Application	26
4.1 EtherCAT Sample	26
4.2 EtherCAT CiA402 Sample Application	28
5. Appendix A Installing the EtherCAT Driver	31
6. Appendix B EEPROM Program	33
Homepage and Customer Support	35



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.

Table 1-1 Software Develo	pment Tools (Tool Chain)
---------------------------	--------------------------

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.

able 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>

The EtherCAT CiA402	sample application needs the SI	ave Stack Code.	
Table 2-6 File Configuration of the Sample Application Directory			
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	
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	

Prototype declaration of CoE mailbox

EtherCAT State Machine processing

Prototype declaration of Mailbox

Processing related to Object Dictionary

Mailbox processing

Main processing

Hardware processing

SDO service processing

Dictionary

Prototype declaration of EtherCAT State Machine

Prototype declaration of processing related to Object

Prototype declaration of hardware processing

Prototype declaration of SDO service processing

Prototype declaration of EtherCAT Slave Controller (ESC)

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

The table below shows the file configuration of the EtherCAT CiA402 sample application.

ecatcoe.h ecatslv.c

ecatslv.h

mailbox.c

mailbox.h

main.c

objdef.c objdef.h

renesashw.c

renesashw.h sdoserv.c

sdoserv.h

esc.h

2.4.3

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

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

Table 2-7 File Configuration of	of the Startup-Related Directory
---------------------------------	----------------------------------

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	<u>P</u> roje	ect <u>T</u> ool	ск Соа <u>H</u> elp		N-11 ¹	
	<u>N</u> ew	Ctrl+N		Slave S	pettings	
1	<u>O</u> pen	Ctrl+O	I	SSC V	ersion	5.11
	<u>S</u> ave Ctrl+S Save <u>A</u> s		nine	Config	File Versi	on1.3.3.0
				F	ile name	
				ao	eapple	
	E <u>x</u> it		I	ao	eapplh	
	Mailbox			ар	plInterface	h
	Compil	er		ьо	otmode.c	



- 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		
Oustom	EL9800 2Axis CiA402 Sample	\sim
Default Slav All settings	eStackCode configuration. are available.	

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

are stack code lost previ reget	^
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	·

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	CiA402appl CiA402 Sample Application	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	Version1.3.3.0	
- THOM	Create new Slave Files	ame	
Sync	hronisation	aoeapp	olo
📥 Apoli	cation		



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

in ojecti ne	OB¥EC-1_sam	plesoft¥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

Project File OB	B¥EC-1_sam	plesoft¥EC-1_samplesoft¥Source¥Project¥EtherCAT_SSC_ComB¥EC-1 ComBesp	
Sou	ource Folder	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
ESI	SI File	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
Doc	oc Folder	D:#work#Product#EC-1#soft#EC1_CB#EC-1_samplesoft#EC-1_samplesoft#Source	Change
Progress			
"combapplobje "main.c" : st "main.c" : st "applInterfac "ecatappl.c" "ecatappl.c" "ecatslv.h" : "esc.h" : new "renesashw.c" "combappl.c" "combappl.c" "combappl.c" "combapplobje "main.c" : ne Generate file Create Slave	<pre>jects.h":: start eval %as not ev ace.h":n ":new fil ":new fil aw file wr file wr file wr file wr ":new fil yects.h": new file w les finish a files fi</pre>	<pre>vas m Create Files Finished -</pre>	



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_det.h		
patching file Src/ecatcoe.h		
patching țile Src/mailbox.h		
patching file Src/sdoserv.h		
here Patching process end here		
続行するには何かキーを押してくたさい		



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.ewp		EC-1_Comb_ecat.ewd
💥 EC-1_Comb_ecat.eww		EC-1_Comb_ecat.ewp
	×	EC-1_Comb_ecat.eww

3. Perform build.

EC-1_Comb_ec	at - IAR En	nbedded Workb	Tools	E - ARM 7. Window	80.3 Help
	Eroject Ac Im Ac Ed Re Cri Ac	I - Jet/JTAGJet Id <u>F</u> iles Id <u>G</u> roup port File List Id <u>P</u> roject Conn i <u>t</u> Configuration mo <u>v</u> e eate <u>N</u> ew Projec Id <u>E</u> xisting Projec	<u>1</u> 001s ection Is	window	<u>н</u> егр
	Op	otions			Alt+F7
	Ve	rsion Control Sy	stem		>
	M	ake			F7
	<u>C</u> o	mpile			Ctrl+F7
	Re	<u>b</u> uild All			
	Cle	ean			



4. Download the sample software and perform debug.

🌪 🏟 🌬 ो 📴 🙀 🏂	♪	D
	[Download and Debug

5. Run the program.

EC 1 Comb and IAD Forb		
K EC- I_COMD_ecat - IAK Emb	edded	a workbench IDE - AKM 7.80.3
File Edit View Project	Debug	g Disassembly I-jet/JTAGjet Tools Window Help
🗅 🚔 🖬 🕼 👹 🐰	è 🖡	<u>i lo</u> cel 🗸 🖉 🙀 💆
๖▾▮▮๖ъፊё	; 2	😕 🗙
ETM SWO		60
Workspace	×	loader_init.asm
RamDebug	\sim	62
Files Comments ← Comments ← Co		<pre>63 ;************************************</pre>



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 Import KPIT GNUARM Project to GCC ARM Embedded Preferences Rename & Import Existing C/C++ Project into Workspace Renesas CA78K0R Project



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

e ² Import Import Projects Select a directory to search	ch for existing Eclipse projects.	
 Select root directory: Select archive file: <u>P</u>rojects: 	∨ D:¥Renesas_EC-1_samplesoft¥EC-1_sampleso ∨	B <u>r</u> owse B <u>r</u> owse
serial_boot_samp	le (serial_boot_sample)	Select All Deselect All Refresh

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"

the Dahuar 😒						Resume (F8)
A Debug 23		🍇 🔩 🔻 🇞 [)) III 😭 😵	🕹 🕅 i⇒	🏟 🔻	 (×)= Variables 🔀
✓ 🔐 samp ✓ 🖗 Th III IIII IIIII IIIII IIIIII IIIIII IIII	e_cr4.x [1] read #1 1 (single c stack_init() at loa iesas/e2_studio/D erver	ore) (Suspended : Sig der_init.asm:61 0x80; ebugComp/arm-non	gnal : SIGTRAP: 2000 e-eabi-gdb (7.4	Trace/breakpoir	nt trap)	 Name
S loader_init.as	m 23					
61 008020	00 cps	#17 /* FIQ :	mode */			



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¥Io¥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.

Networking Sharing
TwinCAT-Intel PCI Ethernet Adapter (Gigabit)
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.

	2	<u>Ü</u> ber TwinCAT
	1	TwinCAT XAE (VS 2010)
i k	٩	TwinCAT XAE (VS 2013)
		Tools +
-08	P	Echt <u>z</u> eit
		Rou <u>t</u> er •
8 _		System
💾	-	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.

M TwinCAT Broject1 Microsoft Viewal Studio			7	Ouick Launch (Ctrl)	- 9	Π×
FILE EDIT VIEW PROJECT BUILD DEE	UG TWINCAT TWINSAFE PLC	TOOLS WINDOW HELP		dana canar (co.		
0-0 8-5-9 B B X 8 8	0 - C - Attach	Release TwinCAT RT (x64)	- 3	- ସେଥ ସ	金命服用-	
		引き=引いをはたの 白山	400-	100 1 100		
Solution Evaluator v II - 1						
Search Solution Explorer (Ctrl+:)	•					
Solution 'TwinCAT Project1' (1 project)						
Image: Strater Project (1 project) Image:						
SYSTEM						
I PLC						
3 SAFETY						
6 C++						
V 🔤 1/0						
	Error List					- -
	🔻 🛛 🙁 0 Errors 🛛 🔬 0 Warnings	0 Messages Clear		Se	arch Error List	ρ-
	Description		File 🔺	Line 0	Column Project	
	Error List Output					
						120



5. Execute scan.

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

VinCAT Project1 - Microsoft Visual Studio	
FILE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINSAFE PLC	
🖇 © → © 🔀 → 💼 → 🖕 🔛 🚜 🕹 🗗 > < < → 🕨 Attach… →	
🕴 🔐 🔟 🅏 🔨 🎯 闷 🐂 🛛 <local> 🚽 🕫</local>	
Solution Explorer 🗾 👻 🗏	
Search Solution Explorer (Ctrl+:)	
 ✓ TwinCAT Project1 ▶ ✓ SYSTEM ✓ MOTION ☑ PLC ✓ SAFETY ✓ C++ ✓ I/O 	
Add New Item Ins	
Add Existing Item Shift+Alt+A	
Eventh FAD Config File	
No. Com	
Scall	
D 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.

3	new I/O devices found	
	Device 1 (EtherCAT Automation Protocol) [Network Connect Adapter (Juniper Network)] Device 2 (EtherCAT Automation Protocol) [ローカル エリア接続 (Realtek PCIe GBE Family)] Device 4 (EtherCAT) [ローカル エリア接続 3 (ASIX AX88178 USB2.0 to Gigab]	OK Cancel Select All Unselect 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 truito load appror	
	riate 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 Value D	Dialog	×
	Local	
Dec:	12345	UK
Hex:	0x00003039	Cancel
Float:	1.729903e-041	
Book	0 1	Hex Edit
Binary:	39 30 00 00	4
Bit Size:	○ 1 ○ 8 ○ 16	◎ 64 ◎ ?

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/	AT PLC Tools Scope Window Help
🖥 • 🕮 • 😂 😹 🥔 👗 🖦 🛍 🔊 • (* • 4	🔋 - 🖳 🕨 Release 🔹 TwinCAT RT (x86) 🔹 🧭 🦉
i 🔛 🖪 🖉 🋠 📉 🎯 🔐 🐾 🛛 <local></local>	
Solution Explorer 🗸 🗸	P × EC-1 CIA402 × →
 Trive 1 (EC-1 CiA402) Module 1 (csp - axis) Inputs Error code Statusword Position actual value Outputs Outputs Controlword rarget position Kodule 2 (csp - axis) WcState 	e Error List Force Release Write Error List Comment: object 0x6040:0 Comment: objec
	Set Value Dialog



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</u>	Debug TwinCAT PLC	Tools Scope Window Help	
	19-6- <u>1-</u> 1	🕨 Release 🔹 TwinCAT RT (x86) 🔹 🍅 🔹 🔹	1 X2 🛃 🏺
: 🗠 🚨 🛯 🗣 🏹 🔟 🚳 🏹 🛛	<local></local>	,: 	
Solution Explorer	CiA402) (csp - axis) or code itusword sition actual value ts trabuord get position	1 CiA402 × Ariable Flags Online Value: 0 New Value: Force Release Write Comment: object 0x607A:0	
Module 2 Module 2 WcState Tr Ready		or List Error List 📱 Output	× 4 •
► 🕻 Module 2 ► 🛄 WcState ≪ 👘 👘	Set Value D	br List Error List 🖬 Output	× # ×
► • ₹ Modure ► ■ WcState ★ Ready	Set Value D	bialog	× # •
P ↓ Modure P ↓ WcState Ready	Set Value D Dec: Hex:	bialog	× ∓ ×
▶ • ₹ Module -> ▶ • ■ WcState ★	Set Value D Dec: Hex: Float:	Dr List Error List Coutput Dialog DK DK Cancel 1.4012985e-040	× 4 •
P ↓ Modure -> P ↓ WcState Ready	Set Value D Dec: Hex: Float: Bool:	bialog OK 0x000186A0 OK 1.4012985e-040 0 1 Hex Edit	× 4 •
Ready	Set Value D Dec: Hex: Float: Bool: Binary:	Dr List Error List Output Dialog Dialog Dialog Dialog DK Cancel 1.4012985e-040 D Hex Edit A0 86 01 00 4	× 4 •



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
Installed and ready to use devices(realtime capable) Installed and ready to use devices(for demo use only)	Install
- ↓ Compatible devices	Update
ローカル エリア接続 3 - ASIX AX88178 USB2.0 to Gigabit Ethernet Adapter	Bind
D バレン オットワーク接続 - Intel(R) Dual Band Wireless AC 7265 Distriction	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
Installed and ready to use devices(realiting capable) □ □ □ □ Installed and ready to use devices(for demo use only)	Install
二 🔮 ローカル エリア接続 3 - ASIX AX88178 USB2.0 to Gigabit Ethernet Adapter	Update
	Bind
デローカルエリア接続 - Realtek PCIe GBE Family Controller	Unbind
Disabled devices	Enable
	Linduic
	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".

WinCAT Project1 - Microsoft Visual Studio FILE EDIT VIEW PROJECT BUILD DEBU ● ● 10 • 10 • 10 • 10 • 10 • 10 ● ● 10 • 10	G TWINCAT TWINSAFE PLC TOOLS WINDOW HELP ・ ♥ ▼ ▶ Attach… ▼ - Release ▼ TwinCAT RT (x64) ● 第 ・ ↓ ◎ - 日 ▶ = 日 ↓ ♥ □ △ 曲 歯 口 つ ↓
Solution Explorer - # × Search Solution Explorer (Ctrl+:) > Solution TwinCAT Project1 > Image: TwinCAT Project1 > Image: TwinCAT Project1 > Solution TwinCAT Project1 > Image: Transge: Tran	TwinCAT Project1 * × General EtherCAT Online Type: -1/-1 Auto hor Adds: 0 EtherCAT Addr: 0 EtherCAT Addr: 0 Previous Port: Master

2. Hex Editor

Select ESC Access > E2PROM > Hex Editor.

Click the [Download from List] button.

General General Behavior Timeout Settings Identification FMMU / SM Init Commands Distributed Clock EPROM GEPROM GEPROM GEPROM General Configured Statis General General	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	Image: Configure 2 EE (10 27 00 00 00 00 00 00 00 00 00 00 00 00 00	*
----------------------	---	---



Homepage and Customer Support

Renesas Electronics homepage: <u>http://japan.renesas.com/</u>

Contact:

http://japan.renesas.com/contact/

All trademarks and registered trademarks are the property of their respective owners.



Revision History

		Description	
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 .

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. 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.
- 5. Differences between Products

Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

 The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product. Arm and Cortex are registered trademarks of Arm Limited (or its subsidiaries) in the EU and/or elsewhere. All rights reserved.

Ethernet is a registered trademark of Fuji Xerox Co., Ltd.

IEEE is a registered trademark of the Institute of Electrical and Electronics Engineers Inc

- TRON is an acronym for "The Real-time Operation system Nucleus.

- ITRON is an acronym for "Industrial TRON.

- μITRON is an acronym for "Micro Industrial TRON.

- TRON, ITRON, and µITRON do not refer to any specific product or products.

EtherCAT® and TwinCAT® are registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

- Additionally all product names and service names in this document are a trademark or a registered trademark which belongs to the respective owners.

Notice

- 1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
- 2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples
- 3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others,
- 4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
- 5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system: undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet. user's manual or other Renesas Electronics document

- 6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges
- 7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
- 8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
- 9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions
- 10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document
- 11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
- 12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.
- (Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries
- (Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics

(Rev.4.0-1 November 2017)

RENESAS

Renesas Electronics Corporation

http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.

SALES OFFICES

1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A. Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited 9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3 Tel: +1-905-237-2004

Renesas Electronics Europe Limited Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH Arcadiastrasse 10, 40472 Düsseldorf, Germany Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd. Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd. Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited

Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.

13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd. 80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949 Tel: +65-6213-0200, Fax: +65-6213-0300 Renesas Electronics Malaysia Sdn.Bhd. Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia Tel: +60-3-7955-9390, Fax: +60-3-7955-9510 Renesas Electronics India Pvt. Ltd. No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India Tel: +91-80-67208700, Fax: +91-80-67208777 Renesas Electronics Korea Co., Ltd. 17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea Tel: +82-2-558-3737, Fax: +82-2-558-5338