Win-GRAF EtherCAT User Manual

English

Ver. 1.0.0, AUG. 2022

WARRANTY

All products manufactured by ICP DAS are warranted against defective materials for a period of one year from the date of delivery to the original purchaser.

WARNING

ICP DAS assumes no liability for damages consequent to the use of this product. ICP DAS reserves the right to change this manual at any time without notice. The information furnished by ICP DAS is believed to be accurate and reliable. However, no responsibility is assumed by ICP DAS for its use, nor for any infringements of patents or other rights of third parties resulting from its use.

COPYRIGHT

Copyright © 2022 by ICP DAS. All rights are reserved.

TRADEMARK

Names are used for identification only and may be registered trademarks of their respective companies.

CONTACT US

If you have any questions, please feel free to contact us via email at:

service@icpdas.com, service.icpdas@gmail.com





EMP-2848M

Table of Contents

	1
2. Software Installation	4
2.1. Workbench	4
3. EtherCAT Fieldbus	5
3.1. EtherCAT Variable Mapping	5
4. Quick Start	10
4.1. Control Slave Module Steps	10
4.2. Motion Control Steps	16
Revision History	23

Copyright © 2022 ICP DAS CO., Ltd. All Rights Reserved.

- 2 -

1. Introduction

EtherCAT (Ethernet Control Automation Technology) is a series of Ethernet-based industrial communication buses. It has established the mainstream in the industrial automation industry pursuing high precision, high efficiency, and low cost due to its high-speed communication performance and instant communication system.

Features:

- EtherCAT is industrial Ethernet The optimized EtherCAT data is included in the IEEE 802.3 Ethernet frame. The frame travels through the media at 100 Mbps in full-duplex mode.
- Flexible Topologies

With two EtherCAT ports on all devices, no additional switches are required to create a linear network. EtherCAT junction slaves can be used to build tree and star topologies.

Distributed Clocks

The EtherCAT node slave measures the time difference between incoming and returning frame - timestamp. With these timestamps the master can determine the propagation delay offset to the individual slave accurately. This mechanism ensures accurate synchronization between devices with less than 1 μ s jitter.

- Simple cabling 100Base-TX EtherCAT uses standard 100BASE-TX Ethernet communication very efficiently, over standard shielded Ethernet cables and connectors. No need for network switches.
- Easy use, easy connect When compared to a classic fieldbus system, EtherCAT is the obvious choice: node addresses can be set automatically, there's no need for network tuning, and onboard diagnostics with fault localization make pinpointing errors a snap. Despite these advanced features, EtherCAT is also easier to use than Industrial Ethernet: there are no switches to configure, and no complicated handling of MAC or IP addresses is required.
- Processing on the fly

The slave devices extract and/or insert data on the fly. This method assures the highest possible throughput.

- 3 -

This manual describes how to use the ENI file generated by the EMP-2848M website to configure Win-GRAF EtherCAT Fieldbus and how to map the local variables to these configuration variables to control the EtherCAT slave modules.

2. Software Installation 2.1. Workbench

The Win-GRAF workbench setup program "Win-GRAF_Workbench_xxxx_Setup" automatically installs the necessary EtherCAT plugin library

C:\Program Files (x86)\Win-GRAF Workbench\Win-GRAF Wb xx.xx\IOD\K5BusEcat.dll

Copyright © 2022 ICP DAS CO., Ltd. All Rights Reserved.

- 4 -

3. EtherCAT Fieldbus

This chapter describes how to create an interface for the PLC application to access EtehrCAT. The Win-GRF workbench provides a graphic plugin that allows the user to map local PLC variables to the EtherCAT Process Image shared memory.

The EtherCAT Process Image shared memory can be divided into read/write segments, which define the variables to be exchanged for the slave module PDO communication. When the local variables are mapped to the EtherCAT Process Image variables, Win-GRAF Runtime will update the EtherCAT Process Image variable data in each cycle task, and exchange the Process Image data in the next EtherCAT communication cycle.

3.1. EtherCAT Variable Mapping

The following steps describe how to configure the EtherCAT Fieldbus. [Steps]

- 1. Please follow the steps A~D of the Slave Free-Run/DC Setup and Control section in the website user manual to create the ENI file and execute EtherCAT Runtime.
- 2. Start the Win-GRAF workbench and create a new project.
- 3. Open the Fieldbus Configurations window by clicking on the 'Fieldbus Configuration' button in the toolbar 🐱 or double clicking the 'Fieldbus Configuration' node in the workspace.

<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	<u>I</u> nsert	<u>P</u> roject	<u>T</u> ools	<u>W</u> indow	Blocks	<u>H</u> elp		
	l' ev		χũĒ	XX	5 🤊	🤨 🛛 MainT	ask		##	恭
Wo	rkspace	e							M	
	🛃 Main	n task								
	📄 P	rograms	3							
	뷺 Fi	ieldbus	Confiqura	tions	_ <					

4. Click 'Insert Configuration' 🗟 button of the toolbar on the left of the 'IO Drivers' editor and select 'EtherCAT (ICPDAS)' from the 'Add Configuration' dialog.



- 5 -

5. Change the communication settings of Win-GRAF according to the hardware IP address.

Communication Settings	×
T5 protocol 127.0.0.1:1100 192.168.2.81:1100 192.168.2.87:1100	OK Cancel Browse Help
Timeout (seconds): 3	

6. Right-click on the 'EtherCAT (ICPDAS)' node and click on the 'Import ENI' option in the right-click menu.

C:\	Users\Bryan\Desktop\demo	\tasl	k_test\MainTask - IO Drivers *	_				
1	➡ EtherCAT (ICPDAS)	~	Properties					
몳	7		<u>r</u> iopenies					
	\backslash							
		çış	Disable Configuration					
		x	<u>C</u> lear					
5		ж	C <u>u</u> t					
₽		G	Сору					
٠		Ē	P <u>a</u> ste					
. ↑ . ↓		ш	Find					
٩		2	Eind Next					
		-	- Ind Next					
			<u>G</u> o to Variable Definition					
		1	I <u>n</u> sert Configuration					
		恭	In <u>s</u> ert Master/Port					
	Туре	•1	Ins <u>e</u> rt Slave/Data Block					
		ъ	Inse <u>r</u> t Variable					
			I <u>m</u> port Children					
			E <u>x</u> port Children					
			Edi <u>t</u> Configuration as Text					
		Ξ.	Cart Symbols					
		H +	Add /Demove Concreter often Item					
			Add/Remove Separator after Item					
			Dec <u>l</u> are Variable(s) in Database					
		#	Grid Ctrl+G					
			Generate Shared Memory					
н	↔ MainTask - IO D	Г						
Bu	ild							

7. Click the 'Download ENI' button from the Import ENI dialog to download the ENI file, wait for 100% progress and click the 'OK' button on the Download dialog to close the window, and then click the OK button on the Import ENI dialog to close the Import ENI dialog. The following describes the parameters and buttons of the Import ENI dialog.

Copyright © 2022 ICP DAS CO., Ltd. All Rights Reserved.

- 6 -

- Open the ENI file to create the configuration.

• Download the ENI file from the hardware to create the configuration.

Declare variables in database - Automatically create and map the global variables to the Process Image variables.

Import El	
	₽
Declar	e variables in database
	4
	OK
Load	
From:	192.168.2.81:1100/default_eni.xml
To:	C:\Users\Bryan\Desktop\demo\task_test\MainTask\default_eni.xml
100 %	

8. After downloading the ENI file from the hardware to create the configuration, the 'EtehrCAT Master' and 'Motion Control' (only when the motion control function is activated) nodes will be created automatically under the 'EtherCAT (ICPDAS)' node.

C:	\Users\Bryan\Desktop\demo\task_test\MainTask - IO Drivers *
眉	🔺 緈 EtherCAT (ICPDAS)
뮮	🖻 😅 EtherCAT Master
"∎	🖻 ڬ Motion Control
5	
<mark>≩</mark> 5	
₽	
÷	
. ↑ .	
٩	

9. Under the 'EtehrCAT Master' node there are master and slave Process Image variables that can be mapped.

- 7 -

The parameters of the variable nodes are described below: The following describes the parameters of the variable node. Symbol - Name of the local variable to be mapped. Tag - Variable name.

DataType - Variable data type.

- Index Variable index.
- Mode Variable data flow direction.
 - Input: Read master or slave variables to local variables.
 - Output: Write local variables to master or slave variables
- Bitoffs Variable offset on Process Image.
- BitSize Variable size.



10. As shown in the figure below, you can double-click the Symbol parameter to map the local variables or drag and drop the local variables to map.

222	
111	
Digital Outputs.Outp	
BITARR8	🛆 Variables: (all)
0	DO8 🚤
Output 1	
0	2
8	
	Variables: (all) Variables only Local variables only Hide FB instances
	Digital Octputs.Outp BITARR8 0 Output 0 8



Win-GRAF EtherCAT User Manual

11. If the motion control function is enabled, the axis nodes are automatically generated under the 'Motion Contorl->Axes' node and mapped to the automatically generated 'MC_AXIS_xxx' variables in the global variables. The data type of 'MC_AXIS_xxx' variable is 'AXIS_REF_xxx'. These axis reference variables are used for PLCopen function block.



					_	
Y	Name	Туре	Di	Pu	Attrib.	S
	Global variables					
	DO8	BOOL				
	MC_AXIS_000	lib:AXIS				
	MC_AXIS_001	lib:AXIS				
	💾 RETAIN variables					
	<					>
-	Variablas		_			
	Yanables					

4. Quick Start

This chapter explains how to map PLC program variables to EtherCAT Fieldbus and read/write these variables to control the slave modules.

4.1. Control Slave Module Steps

This section describes how to configure the EtherCAT Fieldbus and control the slave modules with the connected slave modules ECAT-2055 (DI/DO), ECAT-2011H (AI), ECAT-2028 (AO).

[Steps]

- 1. Please follow the steps A~D of the Slave Free-Run/DC Setup and Control section in the website user manual to create the ENI file and execute EtherCAT Runtime •
- 2. Open the Fieldbus Configurations window by clicking on the 'Fieldbus Configuration' button in the toolbar 📠 or double clicking the 'Fieldbus Configuration' node in the workspace.



- 3. Add 'EtherCAT (ICPDAS)' configuration.
 - (1) Click 'Insert Configuration' 🕫 button.
 - (2) Select 'EtherCAT (ICPDAS)'.



4. Change the communication settings of Win-GRAF according to the hardware IP address.

Communication Settings	×
T5 protocol 127.0.0.1:1100 192.168.2.81:1100 192.168.2.87:1100	OK Cancel Browse Help
Timeout (seconds): 3	

- 5. Automatically create a list of EtherCAT Process Image variables by importing ENI. (1) Right-click on the 'EtherCAT (ICPDAS)' node.
 - (2) Click on the 'Import ENI' option in the right click menu.

0:1	Users\Bry	an\Desktop\demo	Itasi	k_test(Main Task - 10 Drivers *	
E	🗢 Ethe	rCAT (ICPDAS)	ß	Properties	
कोठ °⊟				View Informations	
5		\backslash			
BBR			ç iş	Disable Configuration	
			~	Clear	
			$\hat{}$	Clear	
~			ж	C <u>u</u> t	
₽			6	Сору	
٠			Ē	P <u>a</u> ste	
• <u>↑</u> •			æ	Eind	
٩			R,	Find Next	
				<u>G</u> o to Variable Definition	
			E	Insert Configuration	
			쁆	In <u>s</u> ert Master/Port	
	Туре		旧	Insert Slave/Data Block	
			5	Inse <u>r</u> t Variable	
				I <u>m</u> port Children	
				E <u>x</u> port Children	
				Edi <u>t</u> Configuration as Text	
			₽ ↓	Sort Symbols	
				Add/Remove Separator after Item	
				Declare Variable(s) in Database	
			#	<u>G</u> rid	Ctrl+G
				Generate Shared Memory	
K	< > >	MainTask - 10 D		Import ENI	
Bu	ild				

- 11 -

- 6. Use the Import ENI dialog to download the ENI file.
 - (1) Click on the 'Download ENI' button.
 - (2) Wait for progress to 100%.
 - (3) Click the 'OK' button in the download dialog to close the window.
 - (4) Click the 'OK' button in the Import ENI dialog to close the window.

Import El		<
	↓	
Declar	e variables in database	
	OK	
Load		
From: To:	192.168.2.81:1100/default_eni.xml C:\Users\Bryan\Desktop\demo\task_test\MainTask\default_eni.xm	1
100 %	← 2 3 → ок]

- 7. Mapping local variables to control slave modules.
 - I. Slave DI/DO module read/write control. Connect the ECAT-2055 (DI/DO) pins DIx to DOx.
 - (1) Add variables do_8 (USINT), di_8 (USINT).
 - (2) Map the variables do_8, di_8 to the slave ECAT-2055 variables Digital Outputs.Output, Digital Inputs.Input.



- (3) In the Structured Text program, write the variable do_8 to the value 165.
- (4) Compile Win-GRAF program.
- (5) Download Win-GRAF program to hardware.
- (6) Run Win-GRAF program and perform online debugging.



(7) In online debug mode, check whether di_8 in the variable list is 165.

							_	
Y	Name	Value	Туре	Di	Pu	Attrib.	S	Init v
	🔺 🗋 ecat_die	o_demo						
	do_8	165	USINT					
	di_8	165	USINT					
1	🔓 Global v	ariables	X					
	RETAIN	variables	\backslash					
				7				
	<							>
4	• Variable	es						

 II. Slave AI/AO module read/write control, connects slave ECAT-2011H (AI), ECAT-2028 (AO) channel 0 pins.

(1) Add variable ai0_raw (INT).

(2) Map the variable ai0_raw to the slave ECAT-2011H variable AI0.Value.



(3) Add variable ao0_raw (INT).

(4) Map the variable ao0_raw to the slave ECAT-2028 variable AO0.Output.



(5) Add variable ai0_volt (LREAL), ao0_volt (LREAL).



(6) AO/AI use default range $\pm 10V$. In the Structured Text program, output AO 5V.

- (7) Compile Win-GRAF program.
- (8) Download Win-GRAF program to hardware.
- (9) Run Win-GRAF program and perform online debugging.

			789
dow	Blocks	<u>H</u> elp	
MainTa	ask		品 😘 😰 🏠 💼 🃷 🏄
C:\U	sers\Bry	an\Des	ktop\demo\ecat_demo\MainTask - ecat_aio_demo
A	1	ao()_volt := LREAL#5.0;
Ð	2		6
IF THEN	3	ao()_raw := ANY_TO_INT(ao0_volt * 3276.7);
-	4		
	5	a1(<pre>_volt := ANY_TO_LREAL(a10_raw) * (LREAL#10 / LREAL#32767);</pre>
-	6		

(10) In online debug mode, check whether ai0_volt in the variable list is 5V.

🝸 Name	Value		Туре	Di	Pu	Attrik
🔺 🗋 ecat_ai	o_demo					
ai0_raw	16368		INT			
ao0 raw	16383		INT			
ai0_volt	4.99527		LREAL			
ao0_volt	5		LREAL			
Global variables						
RETAIN variables						
			10			
<						>
✓ Variable	es					

4.2. Motion Control Steps

This section illustrates how to use the EtherCAT Fieldbus motion control function by connecting the CiA402 slave module.

[Steps]

- 1. Please follow the steps A~F in the Motion Control Setup and Control section of the web site user manual to create the ENI file and run EtherCAT Runtime.
- 2. Start the Win-GRAF workbench and create a new project.
- 3. Open the Fieldbus Configurations window by clicking on the 'Fieldbus Configuration' button in the toolbar 📠 or double clicking the 'Fieldbus Configuration' node in the workspace.

<u>F</u> ile	<u>E</u> dit	<u>V</u> iew	<u>I</u> nsert	<u>P</u> roject	<u>T</u> ools	<u>W</u> in	dow	Blocks	<u>H</u> elp	
	" By		ЖGе	X ₹	원 🤊	6	MainT	ask		
Work	space	9								ѫ
4 👵	Mair	ı task								
	📄 P	rograms	3							
	쁆 F	ieldbus	Confiqure	ations						

4. Click 'Insert Configuration' 🗟 button of the toolbar on the left of the 'IO Drivers' editor and select 'EtherCAT (ICPDAS)' from the 'Add Configuration' dialog.



5. Change the communication settings of Win-GRAF according to the hardware IP address.

- 16 -

Communication Settings	×
T5 protocol 127.0.0.1:1100 192.168.2.81:1100 192.168.2.87:1100	OK Cancel Browse Help
Timeout (seconds): 3	

6. Right-click on the 'EtherCAT (ICPDAS)' node and click on the 'Import ENI' option in the right-click menu.

C:\Users\Bryan\Desktop\demo\task_test\MainTask - IO Drivers *					
100	🜩 Ether	CAT (ICPDAS)			
뷺		7	¥	Properties	
°ا		$\langle \rangle$		View Informations	
<u>-</u>			ŝ	Disable Configuration	
			x	Clear	
ي ني			¥.	Cut	
E4			G	Copy	
-				Deste	
-			E	Paste	
1			e.	Eind	
٩			R,	Find Next	
				<u>G</u> o to Variable Definition	
			E	Insert Configuration	
			恭	Insert Master/Port	
	Туре		•1	Ins <u>e</u> rt Slave/Data Block	
			ъ	Inse <u>r</u> t Variable	
				Import Children	
				E <u>x</u> port Children	
				Edit Configuration as Text	
			₽	Sort Symbols	
				Add/Remove Separator after Item	
				Declare Variable(s) in Database	
			#	Grid	Ctrl+G
				Generate Shared Memory	
K	< > >	Main Lask - 10 D	ſ	Import ENI	
Bu	lld				

- 7. Click the 'Download ENI' button from the Import ENI dialog to download the ENI file, wait for 100% progress and click the 'OK' button on the Download dialog to close the window, and then click the OK button on the Import ENI dialog to close the Import ENI dialog. The following describes the parameters and buttons of the Import ENI dialog.
 - ...

- Open the ENI file to create the configuration.

Image: The second state of the second state

Declare variables in database - Automatically create and map the global variables to the

Copyright © 2022 ICP DAS CO., Ltd. All Rights Reserved.

- 17 -

Process Image variables.

I Declare variables in database	
Declare variables in database	
4	
	OK
Load	
From: 192.168.2.81:1100/default_eni.xml To: C:\Users\Bryan\Desktop\demo\task_test\MainTask\default	t_eni.xml

8. Verify that the 'Motion Contorl->Axes->Axis_xxx' variable is generated under the 'EtherCAT (ICPDAS)' node and mapped to the automatically generated 'MC_AXIS_xxx' variable in the global variable.



9. Enable Store complex variables in a separate segment.(1) Right-click on the project node in the workspace.(2) Click on the 'Settings' option in the right click menu.

Win-GRAF EtherCAT User Manual



(3) Click on the 'Options' item.

(4) Set the Store complex variables in a separate segment function to Yes.



- 10. Programming PLCopen Function Block motion control program.
 - (1) Add variable axis0_pwr_en (BOOL), axis0_pwr_status (BOOL), axis0_reset_exec (BOOL), axis0_mv_abs_exec (BOOL), axis0_mv_abs_pos (LREAL, 10), axis0_mv_abs_vel (LREAL, 5), axis0_mv_abs_acc (LREAL, 50), axis0_mv_abs_bm (MC_BUFFER_MODE_EMP2K), axis0_get_pos_en (BOOL, TRUE), axis0_act_pos (LREAL)

Y	Name	Туре	Dim.	Pu	A. S Init value	Us.		
١.,	▲ □ mc_demo					_		
	axis0_pwr_en	BOOL						
	axis0_pwr_staus	BOOL						
	axis0_reset_exec	BOOL						
	axis0_mv_abs_exec	BOOL						
	axis0_mv_abs_pos	LREAL			LREAL#10			
	axis0_mv_abs_vel	LREAL			LREAL#5			
	axis0_mv_abs_acc	LREAL			LREAL#50			
	axis0_mv_abs_bm	MC_BUFFER_MODE_EMP2K						
	axis0_get_pos_en	BOOL			TRUE			
	axis0_act_pos	LREAL						
Γ.	🖻 🖻 Global variables							
	RETAIN variables							
	<				Ŭ.	>		
•	Variables Properties	3						

(2) Add MC_POWER_EMP2K, MC_RESET_EMP2K, MC_MOVEABSOLUTE_EMP2K, MC_READACTUALPOSITION_EMP2K Function Block in the Function Block Diagram (FDB) Editor.



Copyright © 2022 ICP DAS CO., Ltd. All Rights Reserved.

- 20 -

(3) Connect each variable to the Function Block.



- (4) Compile Win-GRAF program.
- (5) Download Win-GRAF program to hardware.
- (6) Run Win-GRAF program and perform online debugging.



- 11. Absolute position movement control in online debugging mode.
 - (1) Set axis0_pwr_en = TRUE to power ON the single axis.



(2) If an error occurs in a single axis, set axis0_reset_exec = TRUE to clear the error.



(3) Set axis0_mv_abs_exec = TRUE to start absolute position movement.

3	Inst_MC_MOVE	ABSOLUTE_E	
	MC_MOVEABS	OLUTE_EMP2K	
MC AXIS 000	Axis	Done	þ
axis0_mv_abs_exec = TRUE	Execute	Busy	þ
axis0_mv_abs_pos = 10 —	Position	Active	þ
axis0_mv_abs_vel = 5 —	Velocity	CommandAb	þ
axis0_mv_abs_acc = 50 —	Acceleration	Error	þ
axis0_mv_abs_bm = mcAb	BufferMode	ErrorID	

(4) Verify that the final movement position of the single axis matches the input position.

4	Inst_MC_RE	ADACTUALPOSITION_EMP2K		
MC AXIS 000	Axis	Valid	I	
axis0_get_pos_en = TRUE	Enable	Busy	l	
		Error	l	
		ErrorID	l	
		Position	-	axis0_act_pos = 10

Revision History

Revision	Date	Description
1.0	2022/07	Initial issue