

ESI-100 USER Manual

EtherCAT Slave Digital I/O Module

Record of Revision

Version	Date	Page	Description	Remark
1.00	2021/03/16	All	Official Release	

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Declaration of Conformity

FCC

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

CE

The products described in this manual complies with all applicable European Union (CE) directives if it has a CE marking. For computer systems to remain CE compliant, only CE-compliant parts may be used. Maintaining CE compliance also requires proper cable and cabling techniques.

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1

GENERAL INTRODUCTION

1.1 Overview

Thank you for your selection of EtherCAT module ESI-100 digital input output interface.

EtherCAT become a reliable and low cost solution of real time control data communication standard. To utilize the EtherCAT as data communication highway of industrial control devices is more attractive than ever.

ESI-100 module is a multifunction digital I/O control module. We provide the dll's of Window's or Linux system, enabling you to code the flexible application as if it is an add-on card without the knowledge of EtherCAT protocol. But for the expert of EtherCAT, you can also use the basic EtherCAT command to your application.

Stable, high reliability and remote addressable module give you a new approach of application.

Any comment is welcome, please visit our website <http://www.vecow.com/>

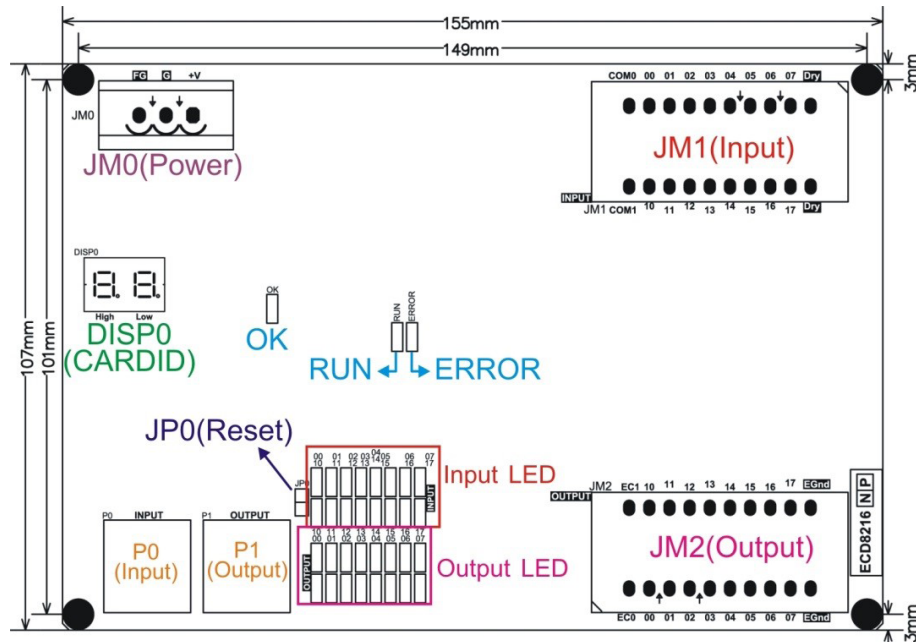
1.2 Features

- Compatible with all Vecow product series
- EtherCAT compliant slave module
- Bi-directional photo-coupler input with multiple input configuration
- Digital I/P as counter in put
- Photo-coupled NMOS output
- EtherCAT distributed clock (DC) function enabled
- No extra real time master stack software
- Easy to program as if traditional add-on card

1.3 Product Specification

Digital Input	
Photo Isolated Input	16
Logic High Level	3mA (max)
Logic Low level	6mA (min)
Counter Input	any digital input
Counter Speed	100Hz (max) square wave
Digital Output	
MOS Output Points	16 (NMOS)
MOS Capacity	1A @48V DC
Mechanical	
Dimension	160.0mm x 120.1mm x 61.2mm (6.30" x 4.73" x 2.42")
Weight	248g
Environment	
Power Requirement	24V DC (18-36V DC) 0.5A
Operation Temperature	0°C to +70°C
Storage Temperature	-20°C to +80°C
Operation Humidity	5 to 95% RH, non-condensing

1.4 Layout and Dimensions



JM0 : external power 18-36V DC connector

JM1 : Input connector

DISP0 : CardID or module address display

OK : system active LED, flashing per second

RUN : ESC (EtherCAT slave controller) status LED, while

LED off : ESC initialization

LED blinking (slow) : ESC in pre op state

LED single flash : ESC in safe op state

LED on : ESC in op state

LED flickering (fast) : ESC in bootstrap state

ERROR : ESC (EtherCAT slave controller) error LED, while

LED off : ESC no error

LED flickering (fast) : ESC error in bootstrap state

LED blinking (slow) : ESC error in pre op state

LED single flash : local application error

LED double flash : master is disconnected

LED on : local controller fail

P0 : EtherCAT RJ45 input socket

P1 : EtherCAT RJ45 output socket

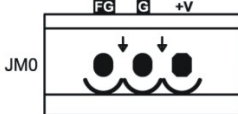
Input LED : Input status display

Output LED : Output status display

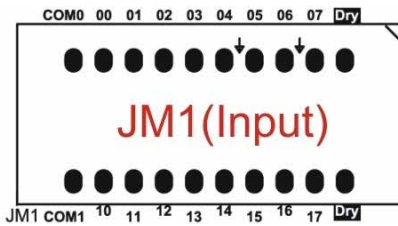
JM2 : Output connector

1.5 Pin Definition

1.5.1 JM0 Pin Definitions

	+V	External power supply +24V (18 ~ 36V DC)
	G	External power supply ground
	FG	Frame ground for the device

1.5.2 JM1 Pin Definitions (Input Connector)

			
COM0	Common reference of input port0	COM1	Common reference of input port1
IN00	input point 0 of port 0	IN10	input point 0 of port 1
IN01	input point 1 of port 0	IN11	input point 1 of port 1
IN02	input point 2 of port 0	IN12	input point 2 of port 1
IN03	input point 3 of port 0	IN13	input point 3 of port 1
IN04	input point 4 of port 0	IN14	input point 4 of port 1
IN05	input point 5 of port 0	IN15	input point 5 of port 1
IN06	input point 6 of port 0	IN16	input point 6 of port 1
IN07	input point 7 of port 0	IN17	input point 7 of port 1
Dry	ground of Dry contact input or 5V TTL input	Dry	ground of Dry contact input or 5V TTL input
for the input connection, please refer 6.1 Input diagram			

1.5.3 JM2 Pin Definitions (Output Connector)

EC1	Common reference of output port1 (connect to external power)	EC0	Common reference of output port0 (connect to external power)
OUT10	output point 0 of port 1	OUT00	output point 0 of port 0
OUT11	output point 1 of port 1	OUT01	output point 1 of port 0
OUT12	output point 2 of port 1	OUT02	output point 2 of port 0
OUT13	output point 3 of port 1	OUT03	output point 3 of port 0
OUT14	output point 4 of port 1	OUT04	output point 4 of port 0
OUT15	output point 5 of port 1	OUT05	output point 5 of port 0
OUT16	output point 6 of port 1	OUT06	output point 6 of port 0
OUT17	output point 7 of port 1	OUT07	output point 7 of port 0
EGnd	External power ground	EGnd	External power ground
for the output connection, please refer 6.2 Output diagram			

1.6 I/O Interface Diagram

1.6.1 Input Diagram

I/P WIRING **Input Interface**

For input : IN00 ~ IN07, IN10 ~ IN17
I/P specification :

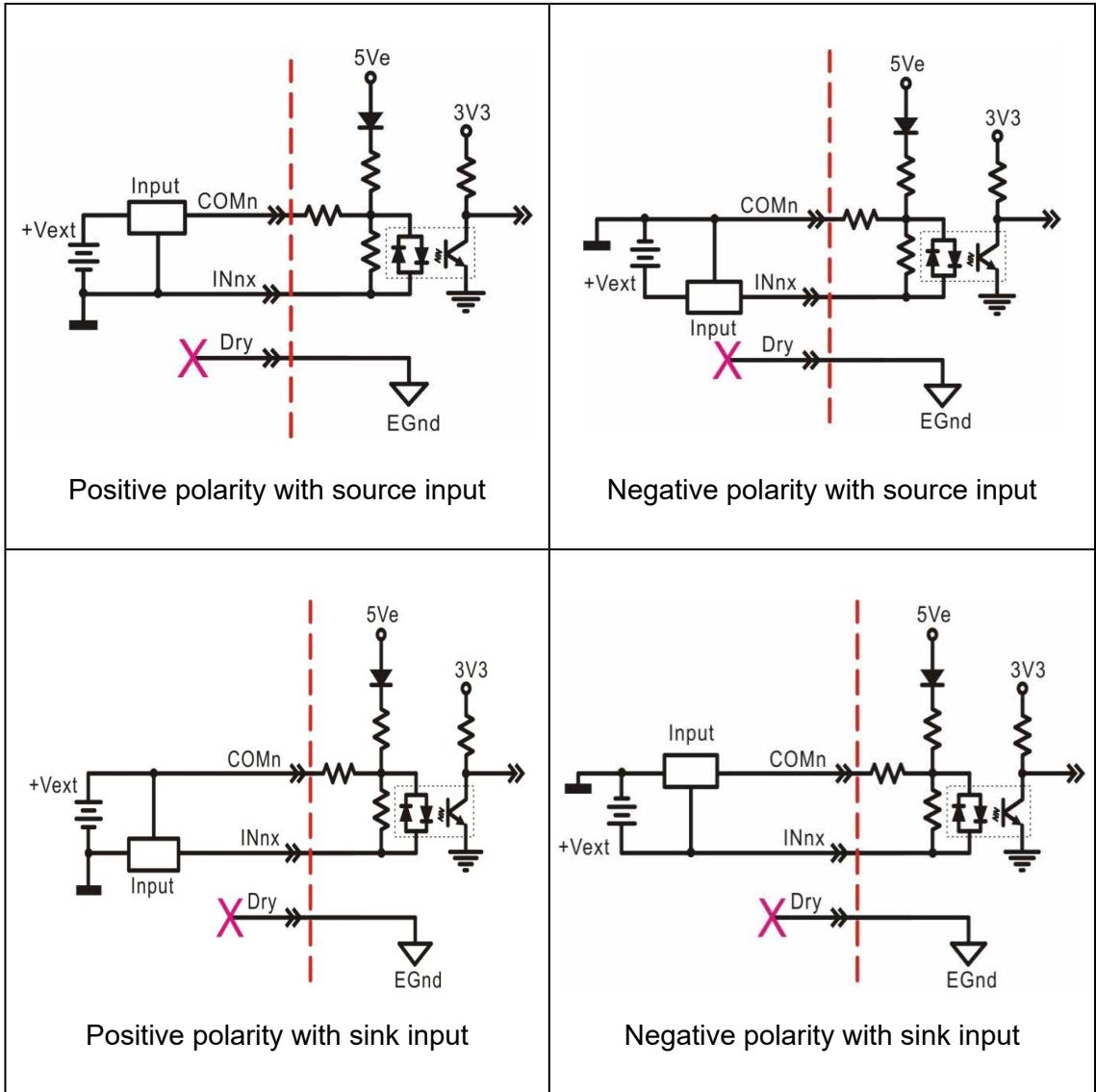
Ii (input current)	
IIH (max)	3mA
IIL (min)	6mA

** IIH, High-level input current
** IIL, Low-level input current

Suggestion of input connection

for dry contact input

for TTL input



1.6.2 Output Diagram

For NMOS output : OUT00 ~ OUT07,
OUT10 ~ OUT17

O/P specification :

VO (output voltage)	
VO (max)	48V DC
IO (output current)	
IO (cont)	sink 1A (rms)

For NMOS output : OUT00 ~ OUT07,
OUT10 ~ OUT17

O/P specification :

VO (output voltage)	
VO (max)	48V DC
IO (output current)	
IO (cont)	source 1A (rms)

Suggestion of output connection

NMOS output

PMOS output

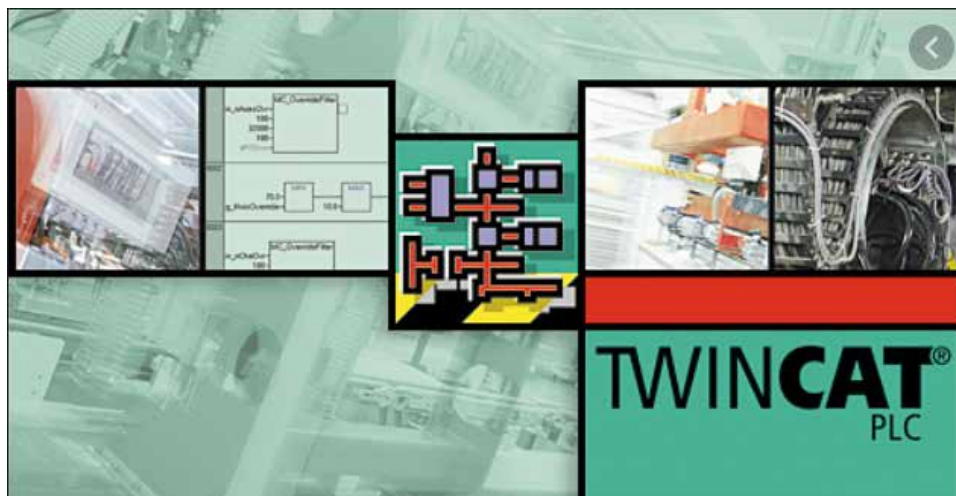
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SOFTWARE

2.1 EtherCAT Master Supported List

Master	Windows	Linux	ESI File (xml)
Beckhoff	O	x	O
Codesys	O	O	O
EtherCAT Master SDK	O	O	O

2.1.1 Beckhoff



The Windows Control and Automation Technology

The Beckhoff TwinCAT software system turns almost any compatible PC into a real-time controller with a multi-PLC system, NC axis control, programming environment and operating station. TwinCAT replaces conventional PLC and NC/CNC controllers as well as operating devices with :

- open, compatible PC hardware
- embedded IEC 61131-3 software PLC, software NC and software CNC in Windows NT/2000/XP/Vista, Windows 7, NT/XP Embedded, CE, Windows 10 LTSC
- programming and run-time systems optionally together on one PC or separated
- connection to all common fieldbuses
- PC interfaces support
- data communication with user interfaces and other programs by means of open Microsoft standards (OPC, OCX, DLL, etc.)

Windows 10 IoT Enterprise (LTSB)

For the industrial area Windows 10 IoT Enterprise (LTSB, Long Term Servicing Branch) is available with the following features :

- License activation is not necessary.
- Updates and patches are not installed automatically.
- The time when updates and patches are installed can be controlled.

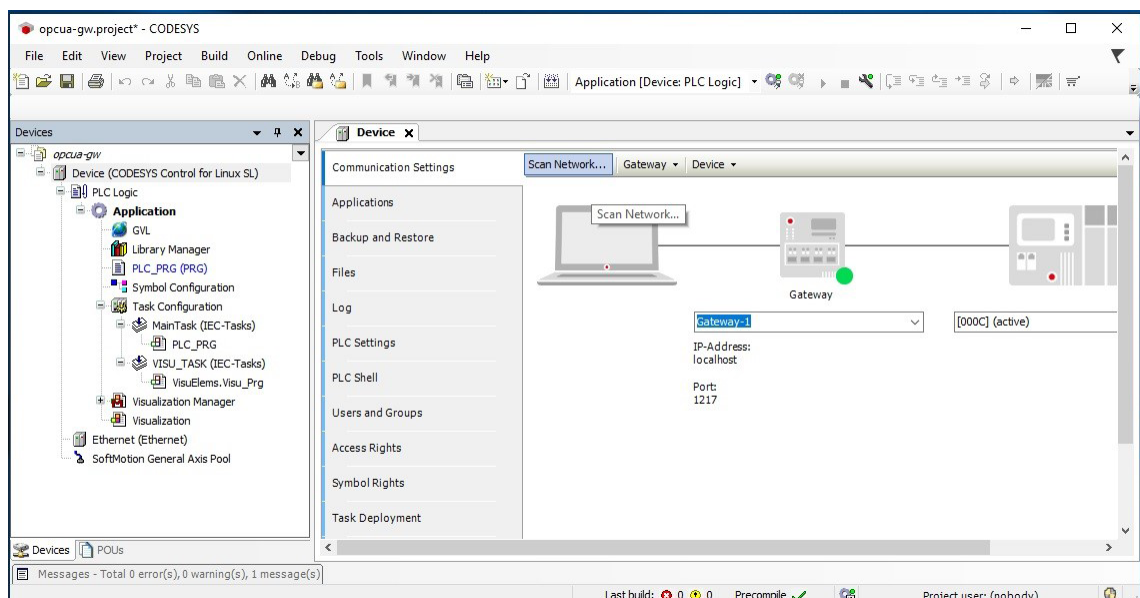
The LTSB version has no access to the Microsoft Store and the assistant "Cortana" is also not available.

System Requirements

Component	Description
Processor	1,75 GHz (or faster)
Main memory	1 GB for 32 bit or 2 GB for 64 bit
Free disc space	minimum 10 GB (32 bit) or 13,5 GB (64 bit) When updates are installed the values can become even bigger over time.

2.1.2 Codesys

CODESYS provides an IDE (integrated development environment) for Windows. Using the CODESYS IDE, control applications can be developed, tested, and compiled for the CODESYS Windows/Linux runtime. A typical IDE project environment is presented in the image below.



Linux Runtime :

CODESYS provides a Linux runtime that allows control applications to execute on Linux-based systems. ECS images can be built with the CODESYS Linux runtime by selecting the **CODESYS Software PLC** feature option during image setup. Please refer to VHub_EtherCAT_Codesys.pdf more information.



2.1.3 SDK

Windows SDK :

Header Files and Import Libraries for Different Development Environments		
Language	Header File	Import Library
Microsoft Visual C/C++	VCAT.h	VCAT.lib
Microsoft Visual C#	VCAT.cs	N/A

Vecow provided SDK package as below :

1. VCAT Configuration Tool : VCAT.exe
2. VCAT Master DLL : VCAT.dll

Linux SDK : Please contact with Vecow.

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MAILBOX (SDO) LIST

3.1 Register List

Direct address	R/W	Descriptions	Mnemonics	
2000H	R/W	card ID register	CARD_ID	0x2000
2001H	R/W	Auto increment addressing	AP_ADDRESS	
2002H	R/W	Addressing mode	ADDRESS_MODE	
2003H	R/W	I/O led level	LED_LEVEL	
2004H	RO	Firmware version	FIRMWARE_VERSION	
2010H	R/W	select inport debounce frequency	INPUT_DEBOUNCE	
2030H	R/W	WDT enable/disable	WDT_CONTROL	
2031H	R/W	WDT config	WDT_CONFIG	
2032H	R/W	WDT reload	WDT_RELOAD	
2040H	R/W	Inport counter enable/disable	IN_COUNTER_CONTROL	
2041H	R/W	In counter mask	IN_COUNTER_MASK	
2048H	R/W	In_00 counter ~ In_07 counter	IN_PORT0_COUNTER	
2049H	R/W	In_10 counter ~ In_17 counter	IN_PORT1_COUNTER	
6000H	R	input state 8bit. (byte array)	INPORT_U8	
6002H	R/W	Input polarity 8bit. (byte array)	IN_POLARITY_U8	
6020H	R	input state bit. (Boolean array)	INPORT_BIT	
6030H	R/W	Input polarity bit. (Boolean array)	IN_POLARITY_BIT	
6100H	R	input state 16 bit. (U16)	INPORT_U16	
6102H	R/W	Input polarity 16 bit. (U16)	IN_POLARITY_U16	
6200H	R/W	output state 8bit. (byte array)	OUTPURT_U8	
6202H	R/W	output polarity 8bit. (byte array)	OUT_POLARITY_U8	
6220H	R/W	output state bit. (Boolean array)	OUTPURT_BIT	
6240H	R/W	output polarity bit. (Boolean array)	OUT_POLARITY_BIT	
6300H	R/W	output state 16 bit. (U16)	OUTPURT_U16	
6302H	R/W	output polarity 16 bit. (U16)	OUT_POLARITY_U16	

3.2 Comment Register

CARD_ID User defined modules ID						
Index	Data type	AL-state	Access	SDO/PDO	range	Default
2000H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0x00 ~ 0xFF	0x00

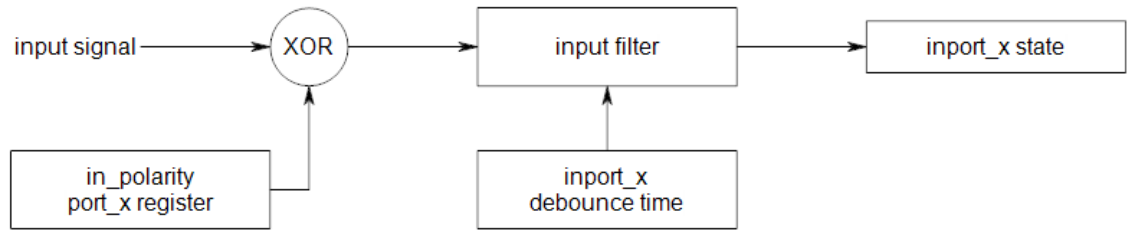
AP_ADDRESS Auto Increment Address						
Index	Data type	AL-state	Access	SDO/PDO	range	Default
2001H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0x00 ~ 0xFF	0x00

ADDRESS_MODE Select SEG7 show address 0x1 is CARD_ID, 0x2 is AP_address						
Index	Data type	AL-state	Access	SDO/PDO	range	Default
2002H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0x1 or 0x2	Show CARD_ID

LED_LEVEL Led light level, Light level = (LED_level + 1) * 2.5%						
Index	Data type	AL-state	Access	SDO/PDO	range	Default
2003H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0 ~ 39	30

FIRMWARE_VERSION When value = 0x0120, Firmware Version is V1.2						
Index	Data type	AL-state	Access	SDO/PDO	Range	Default
2004H	UINT16	Pre-Op Safe-Op Op	RO	SDO	0x0000 ~ 0xFFFF	Version

3.2.1 Input Function



INPUT_DEBOUNCE						
Choose input debounce time level by port. Debounce = 0 is no debounce (pass) Debounce = 1 is 50Hz Debounce = 2 is 100Hz Debounce = 3 is 200Hz Debounce = 4 is 1KHz						
Index	Data type		AL-state			
2010H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Debounce channel	RO	N/A	2	2
01h	UINT8	Inport0 debounce	R/W	SDO	0 ~ 4	2
02h	UINT8	Inport1 debounce				

Debounce Table

Debounce Mode HEX	Debounce	counter value based on 10KHz	Number of samples	sample frequency (10KHz)
0	0 (PASS)	0	0	PASS
1	50Hz	40	5	250Hz
2	100Hz	20	5	500Hz
3	200Hz	10	5	1KHz
4	1KHz	2	5	5KHz

INPORT_U8						
Read input state by U8 type.						
Index	Data type		AL-state			
6000H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In port	RO	N/A	2	2
01h	UINT8	Inport0 state	RO	SDO and PDO mapping	0x00 ~ 0xFF	0xFF
02h	UINT8	Inport1 state				

IN_POLARITY_U8 Input polarity by U8 type.						
Index	Data type		AL-state			
6002H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In polarity	RO	N/A	2	2
01h	UINT8	In0_polarity	R/W	SDO and PDO mapping	0x00 ~ 0xFF	0x00
02h	UINT8	In1_polarity				

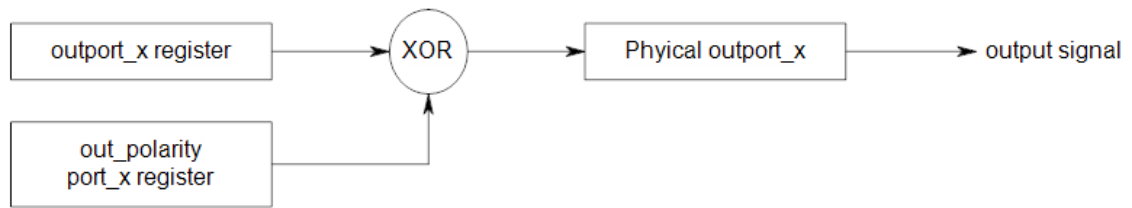
INPORT_BIT Input state by boolean type.						
Index	Data type		AL-state			
6020H	boolean Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In polarity	RO	N/A	16	16
01h	Boolean	In00_state	RO	SDO	True or False	True
02h	Boolean	In01_state				
03h	Boolean	In02_state				
04h	Boolean	In03_state				
05h	Boolean	In04_state				
06h	Boolean	In05_state				
07h	Boolean	In06_state				
08h	Boolean	In07_state				
09h	Boolean	In10_state	RO	SDO	True or False	True
0Ah	Boolean	In11_state				
0Bh	Boolean	In12_state				
0Ch	Boolean	In13_state				
0Dh	Boolean	In14_state				
0Eh	Boolean	In15_state				
0Fh	Boolean	In16_state				
10h	Boolean	In17_state				

IN_POLARITY_BIT Input polarity by boolean type.						
Index	Data type		AL-state			
6030H	boolean Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In polarity	RO	N/A	16	16
01h	Boolean	In00_polarity	R/W	SDO	True or False	True
02h	Boolean	In01_polarity				
03h	Boolean	In02_polarity				
04h	Boolean	In03_polarity				
05h	Boolean	In04_polarity				
06h	Boolean	In05_polarity				
07h	Boolean	In06_polarity				
08h	Boolean	In07_polarity				
09h	Boolean	In10_polarity	R/W	SDO	True or False	True
0Ah	Boolean	In11_polarity				
0Bh	Boolean	In12_polarity				
0Ch	Boolean	In13_polarity				
0Dh	Boolean	In14_polarity				
0Eh	Boolean	In15_polarity				
0Fh	Boolean	In16_polarity				
10h	Boolean	In17_polarity				

INPORT_U16 Read input state by U16 type.						
Index	Data type		AL-state			
6100H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In port	RO	N/A	1	1
01h	UINT16	Inport1_0 state	RO	SDO	0x0000 ~ 0xFFFF	0xFFFF

IN_POLARITY_U16 Input polarity by U16 type.						
Index	Data type		AL-state			
6102H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In polarity	RO	N/A	1	1
01h	UINT16	In1_0_polarity	R/W	SDO	0x0000 ~ 0xFFFF	0x0000

3.2.2 Output Function



OUTPUT_U8 output state by U8 type.						
Index	Data type		AL-state			
6200H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Out port	RO	N/A	2	2
01h	UINT8	Outport0 state	R/W	SDO and PDO mapping	0x00 ~ 0xFF	0x00
02h	UINT8	Outport1 state				

OUT_POLARITY_U8 Output polarity by U8 type.						
Index	Data type		AL-state			
6202H	UINT8 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Out port	RO	N/A	2	2
01h	UINT8	Outport0 polarity	R/W	SDO and PDO mapping	0x00 ~ 0xFF	0x00
02h	UINT8	Outport1 polarity				

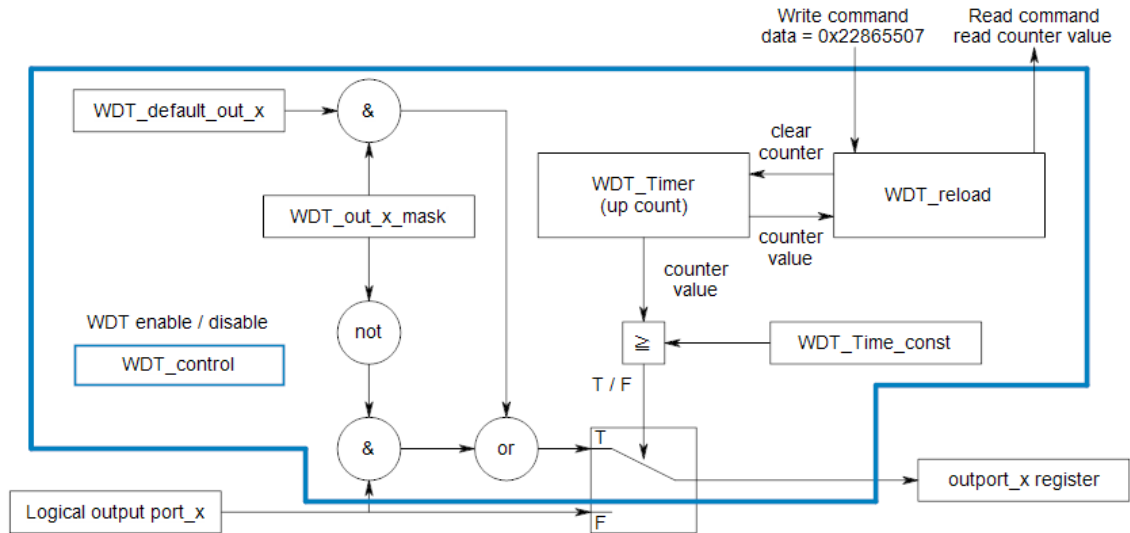
OUTPUT_BIT output state by Boolean type.						
Index	Data type		AL-state			
6220H	Boolean Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Out port	RO	N/A	16	16
01h	Boolean	Outport00 state	R/W	SDO	True or False	False
02h	Boolean	Outport01 state				
03h	Boolean	Outport02 state				
04h	Boolean	Outport03 state				
05h	Boolean	Outport04 state				
06h	Boolean	Outport05 state				
07h	Boolean	Outport06 state				
08h	Boolean	Outport07 state				
09h	Boolean	Outport70 state	R/W	SDO	True or False	False
0Ah	Boolean	Outport71 state				
0Bh	Boolean	Outport72 state				
0Ch	Boolean	Outport73 state				
0Dh	Boolean	Outport74 state				
0Eh	Boolean	Outport75 state				
0Fh	Boolean	Outport76 state				
10h	Boolean	Outport77 state				

OUT_POLARITY_BIT output polarity by Boolean type.						
Index	Data type		AL-state			
6240H	Boolean Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Out port	RO	N/A	16	16
01h	Boolean	Out00 polarity	R/W	SDO	True or False	False
02h	Boolean	Out01 polarity				
03h	Boolean	Out02 polarity				
04h	Boolean	Out03 polarity				
05h	Boolean	Out04 polarity				
06h	Boolean	Out05 polarity				
07h	Boolean	Out06 polarity				
08h	Boolean	Out07 polarity				
09h	Boolean	Out70 polarity	R/W	SDO	True or False	False
0Ah	Boolean	Out71 polarity				
0Bh	Boolean	Out72 polarity				
0Ch	Boolean	Out73 polarity				
0Dh	Boolean	Out74 polarity				
0Eh	Boolean	Out75 polarity				
0Fh	Boolean	Out76 polarity				
10h	Boolean	Out77 polarity				

OUTPURT_U16 output state by U16 type.						
Index	Data type		AL-state			
6300H	UINT16 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In port	RO	N/A	1	1
01h	UINT16	Outport1_0 state	R/W	SDO	0x0000 ~ 0xFFFF	0xFFFF

OUT_POLARITY_U16 Output polarity by U16 type.						
Index	Data type		AL-state			
6302H	UINT16 Array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of In polarity	RO	N/A	1	1
01h	UINT16	Out1_0_polarity	R/W	SDO	0x0000 ~ 0xFFFF	0x0000

3.2.3 WDT Function



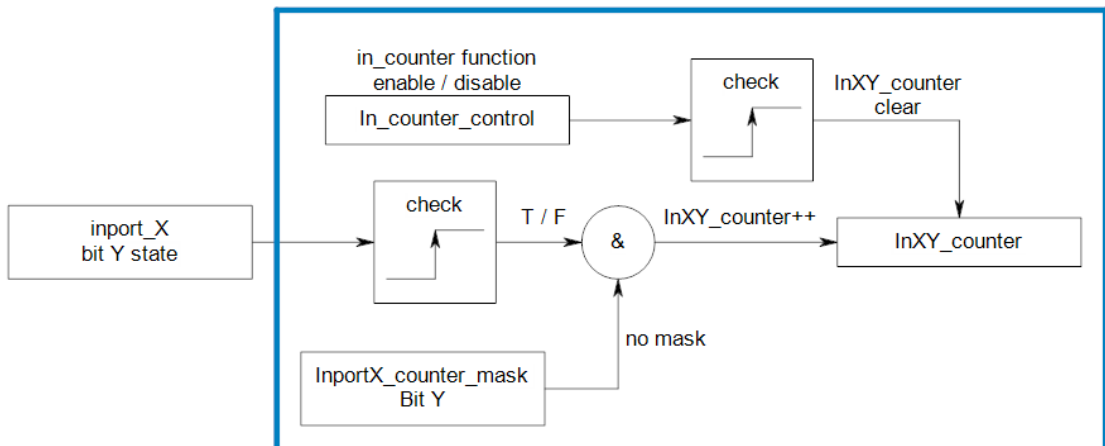
WDT_CONTROL						
WDT_control = 1, Enable WDT function						
WDT_control = 0, Disable WDT function						
Index	Data type	AL-state	Access	SDO/PDO	Range	Default
2030H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0x0 or 0x1	Disable

WDT_RELOAD						
write 0x22865507 to WDT_RELOAD and triggers wdt_clear_command for resetting wdt_counter*1.						
Read back WDT_counter from WDT_RELOAD.						
Index	Data type	AL-state	Access	SDO/PDO	Range	Default
2032H	UINT32	Pre-Op Safe-Op Op	R/W	SDO	0x00000000 ~ 0xFFFFFFFF	wdt_counter

*1 : Logical address polling also reset WDT.

WDT_CONFIG						
WDT time constant is 100uS time based.						
WDT_Time = constant * 100us, when constant is 1000, WDT_Time is 100mS						
While WDT triggers the preset data will override the output port_x.						
Index	Data type		AL-state			
2031H	WDT config structure		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Debounce channel	RO	N/A	5	5
01h	UINT32	WDT time constant	R/W	SDO	1 ~ 1000000	1000
02h	UINT8	WDT_default_out_0	R/W	SDO	0x00 ~ 0xFF	0x00
03h	UINT8	WDT_default_out_1				
0Ah	UINT8	WDT_out_0_mask	R/W	SDO	0x00 ~ 0xFF	0x00
0Bh	UINT8	WDT_out_1_mask				

3.2.4 In_counter Function



IN_COUNTER_CONTROL						
In_counter_control = 1, Enable in_counter function						
In_counter_control = 0, Disable in_counter function						
Index	Data type	AL-state	Access	SDO/PDO	Range	Default
2040H	UINT8	Pre-Op Safe-Op Op	R/W	SDO	0x0 or 0x1	Disable

IN_COUNTER_MASK						
inportx_counter_mask b0 for inx0_counter (x is port number)						
inportx_counter_mask b1 for inx1_counter (x is port number)						
....						
inportx_counter_mask b7 for inx7_counter (x is port number)						
Any bit =0, mask off (default)						
Any bit =1, no mask						
Index	Data type		AL-state			
2041H	UINT8 array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Debounce channel	RO	N/A	2	2
01h	UINT8	Inport0_counter_mask	R/W	SDO	0x00 ~ 0xFF	0x00
02h	UINT8	Inport1_counter_mask				

IN_PORT0_COUNTER						
Read back in_counter value, or write/clear in_counter value						
Index	Data type		AL-state			
2048H	UINT8 array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Debounce channel	RO	N/A	8	8
01h	UINT32	In00_counter	R/W	SDO	0x00000000 ~ 0xFFFFFFFF	0x0000_0000
02h	UINT32	In01_counter				
03h	UINT32	In02_counter				
04h	UINT32	In03_counter				
05h	UINT32	In04_counter				
06h	UINT32	In05_counter				
07h	UINT32	In06_counter				
08h	UINT32	In07_counter				

IN_PORT1_COUNTER						
Read back in_counter value, or write/clear in_counter value						
Index	Data type		AL-state			
2049H	UINT8 array		Pre-Op/Safe-Op/Op			
Sub Index	Data type	Description	Access	SDO/PDO	Range	Default
00h	UINT8	Number Of Debounce channel	RO	N/A	8	8
01h	UINT32	In10_counter	R/W	SDO	0x00000000 ~ 0xFFFFFFFF	0x0000_0000
02h	UINT32	In11_counter				
03h	UINT32	In12_counter				
04h	UINT32	In13_counter				
05h	UINT32	In14_counter				
06h	UINT32	In15_counter				
07h	UINT32	In16_counter				
08h	UINT32	In17_counter				



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