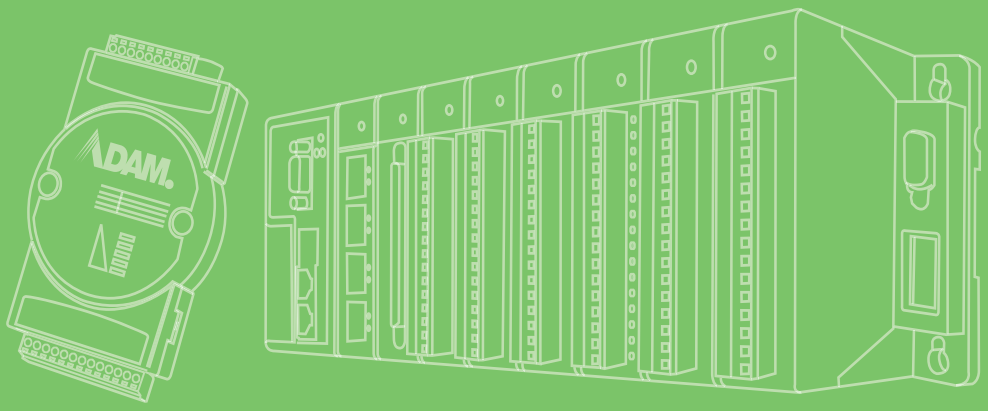

User Manual

AMAX-5000 Series

EtherCAT Slice I/O Modules

ADVANTECH

Enabling an Intelligent Planet

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Product Warranty (2 years)

Advantech warrants to you, the original purchaser, that each of its products will be free from defects in materials and workmanship for two years from the date of purchase.

This warranty does not apply to any products which have been repaired or altered by persons other than repair personnel authorized by Advantech, or which have been subject to misuse, abuse, accident or improper installation. Advantech assumes no liability under the terms of this warranty as a consequence of such events.

Because of Advantech's high quality-control standards and rigorous testing, most of our customers never need to use our repair service. If an Advantech product is defective, it will be repaired or replaced at no charge during the warranty period. For out-of-warranty repairs, you will be billed according to the cost of replacement materials, service time and freight. Please consult your dealer for more details.

If you think you have a defective product, follow these steps:

1. Collect all the information about the problem encountered. (For example, CPU speed, Advantech products used, other hardware and software used, etc.) Note anything abnormal and list any onscreen messages you get when the problem occurs.
2. Call your dealer and describe the problem. Please have your manual, product, and any helpful information readily available.
3. If your product is diagnosed as defective, obtain an RMA (return merchandize authorization) number from your dealer. This allows us to process your return more quickly.
4. Carefully pack the defective product, a fully-completed Repair and Replacement Order Card and a photocopy proof of purchase date (such as your sales receipt) in a shippable container. A product returned without proof of the purchase date is not eligible for warranty service.
5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

Part No.2003X50001 Edition 2

Printed in Taiwan October 2021

Declaration of Conformity

CE

This product has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

Test conditions for passing also include the equipment being operated within an industrial enclosure. In order to protect the product from damage caused by electrostatic discharge (ESD) and EMI leakage, we strongly recommend the use of CE-compliant industrial enclosure products.

FCC Class A

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 not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference. In this event, users are required to correct the interference at their own expense.

Technical Support and Assistance

1. Visit the Advantech website at www.advantech.com/support to obtain the latest product information.
2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
   - Product name and serial number
   - Description of your peripheral attachments
   - Description of your software (operating system, version, application software, etc.)
   - A complete description of the problem
   - The exact wording of any error messages

Safety Precaution - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

- To avoid electrical shock, always disconnect the power from your PC chassis before you work on it. Don't touch any components on the CPU card or other cards while the PC is on.
- Disconnect power before making any configuration changes. The sudden rush of power as you connect a jumper or install a card may damage sensitive electronic components.

Safety Instructions

1. Install the system only in area with restricted access.
2. Read these safety instructions carefully.
3. Retain this user manual for future reference.
4. Disconnect the equipment from all power outlets before cleaning. Use only a damp cloth for cleaning. Do not use liquid or spray detergents.
5. For pluggable equipment, the power outlet socket must be located near the equipment and easily accessible.
6. Protect the equipment from humidity.
7. Place the equipment on a reliable surface during installation. Dropping or letting the equipment fall may cause damage.
8. The openings on the enclosure are for air convection. Protect the equipment from overheating. Do not cover the openings.
9. Ensure that the voltage of the power source is correct before connecting the equipment to a power outlet.
10. Position the power cord away from high-traffic areas. Do not place anything over the power cord.
11. All cautions and warnings on the equipment should be noted.
12. If the equipment is not used for a long time, disconnect it from the power source to avoid damage from transient overvoltage.
13. Never pour any liquid into an opening. This may cause fire or electrical shock.
14. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
15. If any of the following occurs, have the equipment checked by service personnel:
    - The power cord or plug is damaged.
    - Liquid has penetrated the equipment.
    - The equipment has been exposed to moisture.
    - The equipment is malfunctioning, or does not operate according to the user manual.
    - The equipment has been dropped and damaged.
    - The equipment shows obvious signs of breakage.
16. Do not leave the equipment in an environment with a storage temperature of below -20 °C (-4 °F) or above 60 °C (140 °F) as this may damage the components. The equipment should be kept in a controlled environment.
17. CAUTION: Batteries are at risk of exploding if incorrectly replaced. Replace only with the same or equivalent type as recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions.
18. In accordance with IEC 704-1:1982 specifications, the sound pressure level at the operator's position does not exceed 70 dB (A).

DISCLAIMER: These instructions are provided according to IEC 704-1 standards. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

Contents

Chapter 1

Introduction

1.1 Introduction to AMAX-5000 Slice I/O Module

This manual will only introduce AMAX-5000 series slice I/O modules. To know more about the AMAX-5580 controller and AMAX-5400 series extension modules, please download AMAX-5580 user manual from our website.

Advantech provides different I/O modules for various applications. The following table outlines Advantech's supported I/O modules.

Table 1.1: AMAX-5000 series extension modules

Module	Name	Specifications
Infrastructure	AMAX-5001	Power input module - 24V_{DC} power input for Slice IOs* - Abnormal voltage detection - 4DI / wet contact * This should be the first module of the right side IO modules following to the AMAX-5580. It can also be added between AMAX-5000 modules to provide extra power.
	AMAX-5074	EtherCAT coupler - 24V_{DC} power input - 2xRJ45 (in*1, out*1) - Abnormal Voltage Detection *This module contains power input feature, so no need to add another AMAX-5001 to be the power input module
	AMAX-5079	EtherCAT Extension - Extend EtherCAT by RJ45 (out*1)
Analog I/O Module	AMAX-5015	4-ch RTD input module - 2 or 3 wire RTD sensor - Pt100, Pt1000, Balco500, Ni518 - 100Hz sample rate per channel
	AMAX-5017C	6-ch Current input module - Current Input - 16-bit resolution - 100Hz sample rate per channel - Support wire burn-out detection
	AMAX-5017V	6-ch Voltage input module - Voltage Input - 16-bit resolution - 100Hz sample rate per channel
	AMAX-5017H	4-ch High speed AI module - Current/ Voltage Input - 16-bit resolution - 10kHz sample rate per channel
	AMAX-5018	6-ch thermocouple input module - Support J/K/T/E/R/S/B type - 16-bit resolution - 100Hz sample rate per channel - Support wire burn-out detection
	AMAX-5024	4-ch analogue output module - Voltage and current - 16-bit resolution - Fail-safe value output

Digital I/O Module	AMAX-5051	8-ch Isolated digital input module - DI Voltage: 10~30V_{DC} - Filter : 3ms
	AMAX-5052	16-ch Isolated digital input module - DI Voltage: 10~30V_{DC} - Filter: 3ms
	AMAX-5056	8-ch Isolated digital output module - Sink Type - DO Voltage: 10~30V_{DC}
	AMAX-5056SO	8-ch Isolated digital output module - Source Type - DO Voltage: 10~30V_{DC}
	AMAX-5057	16-ch Isolated digital output module - Sink Type - DO Voltage: 10 ~30V_{DC}
	AMAX-5057SO	16-ch Isolated digital output module - Source Type - DO Voltage: 10~30V_{DC}
Counter/Encoder Module	AMAX-5080	2-ch Counter/encoder input module - Counter Range: 32-bit - Mode: Encoder mode, bi-direction mode
Digital I/O Module withTimestamp	AMAX-5051T	8-ch Digital input module (w/ 2-ch timestamp) - DI Voltage: 11~30V_{DC} - timestamp resolution: 1ns - Input delay: < 0.5us
	AMAX-5056T	2-ch Timestamp digital output module - DO voltage: 10~30V_{DC} - timestamp resolution: 1ns - Output delay: < 0.5us

1.2 Object for Internal Settings

1.2.1 Standard Object (0x1000 - 0x1FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
1000:00	Device type	Device type of the EtherCAT slave: The Lo-Word contains the CoE profile used (5001). The Hi-Word contains the module profile according to the modular device profile.	UDINT	RO	0x00001389 (5001 Dec)
1008:00	Device name	Device name of the EtherCAT slave	STRING(10)	RO	'AMAX-50XX'
1009:00	Hardware version	Hardware version of the EtherCAT slave	STRING(2)	RO	e.g. 'A1'
100A:00	Software version	Firmware version of the EtherCAT slave	STRING(5)	RO	e.g. 'V1.01'
Identity					
1018:01	Vendor ID	Vendor ID of the EtherCAT slave, 0x000013FE for Advantech Co., Ltd., assigned by ETG	UDINT	RO	0x000013FE
1018:02	Product code	Product code of the EtherCAT slave	UDINT	RO	0x00000000
1018:03	Revision	Revision number of the EtherCAT slave	UDINT	RO	0x00000000
1018:04	Serial number	Serial number of the EtherCAT slave (Reserved)	UDINT	RO	0x00000000
Error Settings					
10F1:01	Local Error Reaction	Local error reaction (Reserved)	UDINT	RW	0x01
10F1:02	Sync Error Counter Limit	Sync error counter limit	UINT	RW	0x04

Product Code (4 bytes):

The definition of product code (0xaaaabbbb) as below:

aaaa: Product series

0003: AMAX-5000

bbbb: Product ID

5001: AMAX-5001

5015: AMAX-5015 …

Revision (4bytes):

The definition of revision (0xaabbcdee) as below:

aa: Reserved

bb: Product sub ID

00: Standard
01: SO
02: C
03: V
04: H

c: Operation mode
0: SM Synchronous
1: DC Synchronous

d: Reserved

ee: Revision number of XML device description configuration file
01: V01
02: V02 …

The AMAX-5000 ESI v2.4 supports following modules:

Device Name	Product Code	Revision Number	Description
AMAX-5001	0x0003 5001	0x0000 0004	Power Input w/ 4-ch DI Module
AMAX-5015	0x0003 5015	0x0000 1002	4-ch RTD Input Module
AMAX-5017C	0x0003 5017	0x0002 1002	6-ch Current Input Module
AMAX-5017H	0x0003 5017	0x0004 0005	4-ch High Speed Analog Input Module
AMAX-5017V	0x0003 5017	0x0003 1002	6-ch Voltage Input Module
AMAX-5018	0x0003 5018	0x0000 1002	6-ch Thermocouple Input Module
AMAX-5024	0x0003 5024	0x0000 1002	4-ch Analog Output Module
AMAX-5051	0x0003 5051	0x0000 0002	8-ch Digital Input Module
AMAX-5051T	0x0003 5051	0x0000 1001	2-ch DI Timestamp, 6-ch DI w/o Timestamp Module
AMAX-5052	0x0003 5052	0x0000 0001	16-ch Digital Input Module
AMAX-5056	0x0003 5056	0x0000 0002	8-ch Sink Type Digital Output Module
AMAX-5056SO	0x0003 5056	0x0001 0002	8-ch Source Type Digital Output Module
AMAX-5056T	0x0003 5056	0x0000 1001	2-ch DO Timestamp Module
AMAX-5057	0x0003 5057	0x0000 0002	16-ch Sink Type Digital Output Module
AMAX-5057SO	0x0003 5057	0x0001 0002	16-ch Source Type Digital Output Module
AMAX-5074	0x0003 5074	0x0000 0004	EtherCAT Coupler w/ ID Switch Module
AMAX-5079	NA (Not an EtherCAT slave)		EtherCAT Extension Module
AMAX-5080	0x0003 5080	0x0000 0005	2-ch 24V HTL Encoder/Counter Module
AMAX-5081	0x0003 5081	0x0000 0001	1-ch TTL/RS-422 Encoder/Counter Module

Chapter 2

Hardware Installation

2.1 Install / Remove the Module

AMAX-5000 series is an easy-install design to help you maintain your modules easily.

2.1.1 Attach on the DIN-rail

Follow these steps to secure AMAX-5000 modules on the DIN-rail:

1. Unlock the latches at the bottom of AMAX-5000 module.
2. Plug in each module from the left to the right.
3. Make sure the modules are attached on the DIN-rail.
4. Lock down the latches.

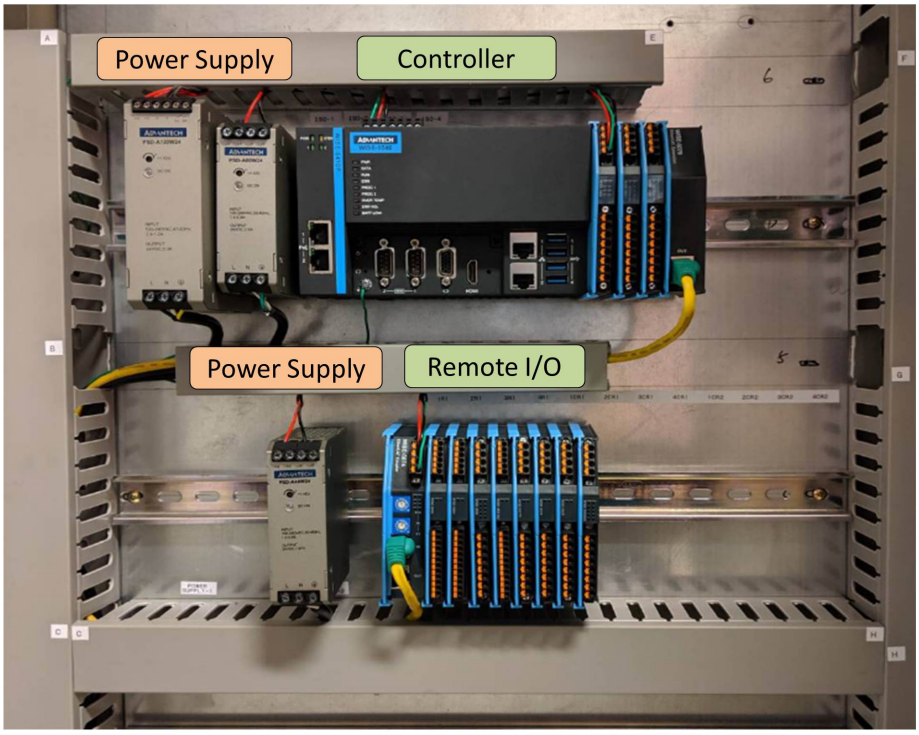


Figure 2.1 AMAX-5000 installed in control cabinet

2.1.2 Remove from the DIN-rail

You can easily detach the module by releasing the latch at the bottom of the module. Then you can pull out the module without any difficulty.

Figure 2.2 Unlock the latch to remove the module

Figure 2.3 AMAX-5000 module design

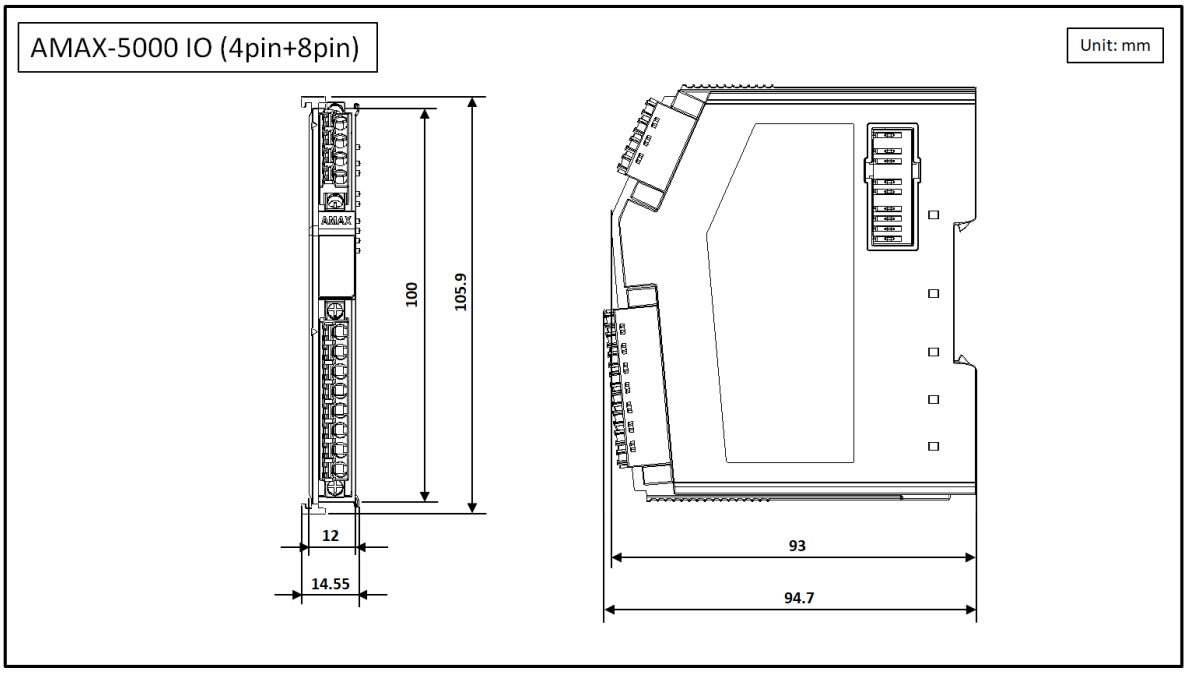
2.2 I/O Wiring

AMAX-5000 I/O modules leverage detachable clamp type terminal blocks. Comparing with traditional screw type terminal blocks, clamp type terminal blocks can save wiring time and provide better reliability for shock and vibration. Follow the procedures below for wiring your AMAX-5000 I/O module.

1. Use the screw driver to press the left notch on the terminal.
2. Insert the wire into the terminal.

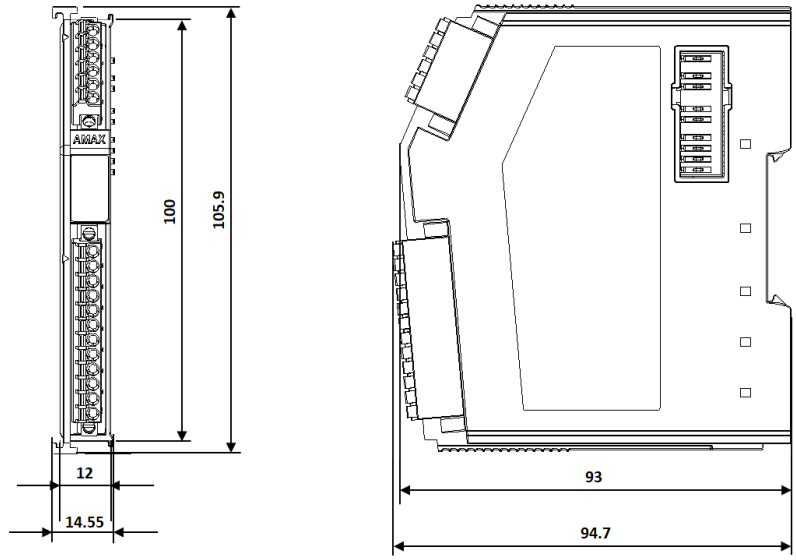
Note! *Please use # 14 AWG ~ 28 AWG wire for terminal block.*

2.3 Dimensions



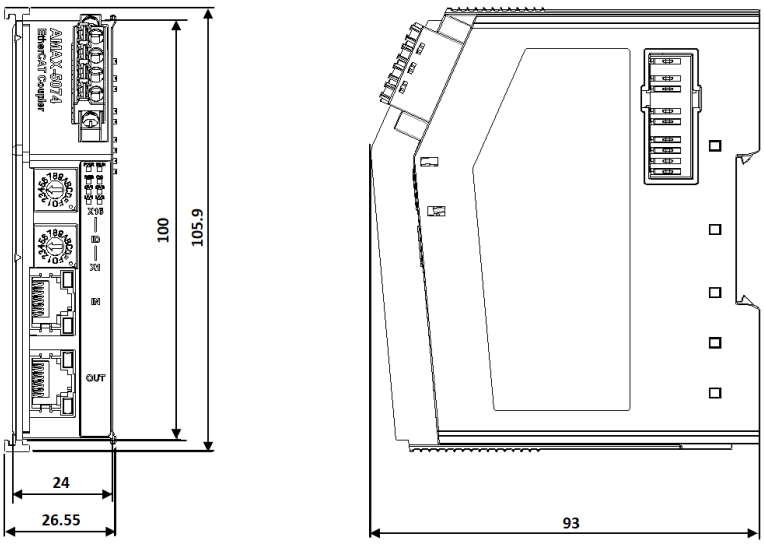
AMAX-5000 IO (6pin+12pin)

Unit: mm



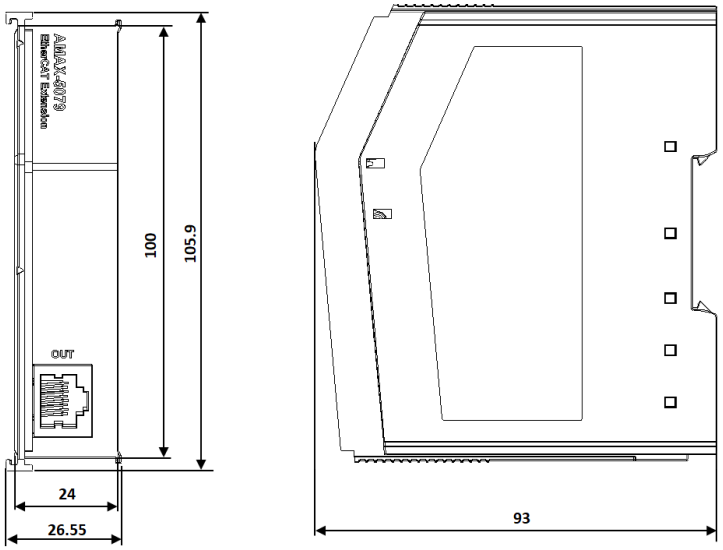
AMAX-5074

Unit: mm



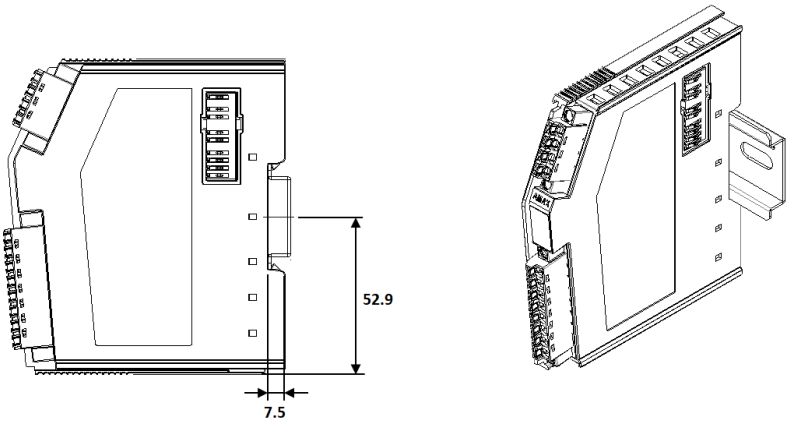
AMAX-5079

Unit: mm



AMAX-5000 DIN-Rail Kit

Unit: mm



Chapter 3

Infrastructure

3.1 AMAX-5001 Smart Power Input Module with 4-ch DI

AMAX-5001 is a smart power input module. It supports dual power - external 24V_{DC} power input, and a maximum 2A current to the EtherCAT bus to power the IO modules on the right side. AMAX-5001 has a smart diagnostic function to identify power errors on the external power supply and on the internal bus. Status on the process data is shown on the LED. AMAX-5001 is also equipped with 4-ch wet contact DI for users to connect to system events.

Figure 3.1 AMAX-5001 Module

3.1.1 AMAX-5001 Application

The AMAX-5580 controller does not provide power to the right side EtherCAT bus, due to power independent purpose, AMAX-5001 must be the first module on the right side to provide independent power to the EtherCAT bus. In configuration with large number of IO modules, it is possible to use another AMAX-5001 to provide the extra 2A power to the EtherCAT bus. It supplies power to the modules following on the right side, and isolates them from the power on the left side. Please refer to the following diagram for the details.

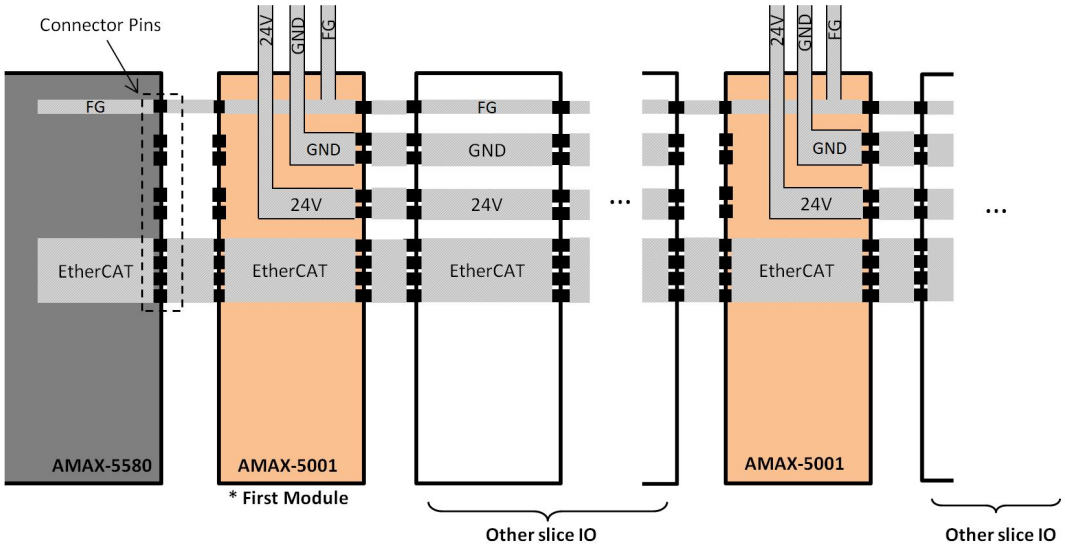


Figure 3.2 AMAX-5001 Application

3.1.2 AMAX-5001 Specification

3.1.2.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, Power Diagnosis LED
- **Weight:** Approx. 80g

3.1.2.2 Power Input

- **Rated Voltage:** $24V_{DC}$ (±20%)
- **Dual Power Input:** Supported
- **Max Current on Bus:** 2A
- **Diagnosis Function:**
  - Over/under voltage for input 1&2
  - Over current output on bus

3.1.2.3 Digital Input

- **Channels:** 4
- **Digital Input:**
  - Wet Contact:
    Rated voltage: $24V_{DC}$
    Logic level 1: 10~30 V_{DC} and -10~-30V_{DC}
    Logic level 0: -3~3V_{DC}
- **Input Delay:**
  - From logic 0 to 1: 4ms
  - From logic 1 to 0: 4ms
- **Digital Filter:** 3ms

3.1.2.4 Protection

Isolation Voltage: 2,000V_{DC}

3.1.2.5 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

3.1.3 LED Indicator

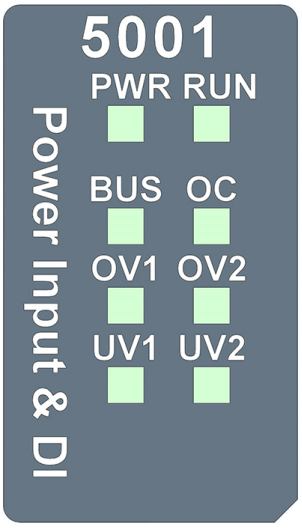


Figure 3.3 AMAX-5001 Module LED Indicator

Table 3.1: AMAX-5001 Module LED Indicator			
LED	**Color**	**Indication**	**Behavior**
PWR	Green	ON	Power on
Run	Green	ON	EtherCAT connection
BUS	Green	ON	BUS power on
OC	RED	ON	BUS over current
OV1	RED	ON	Vin1 over voltage (30V)
OV2	RED	ON	Vin2 over voltage (30V)
UV1	RED	ON	Vin1 under voltage (10.7V)
UV2	RED	ON	Vin2 under voltage (10.7V)

3.1.4 Pin Definition

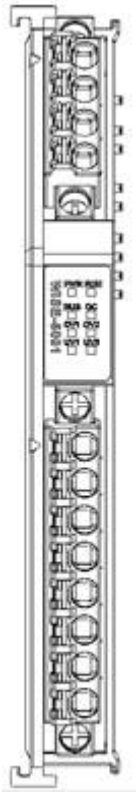


Figure 3.4 AMAX-5001 Module Front View

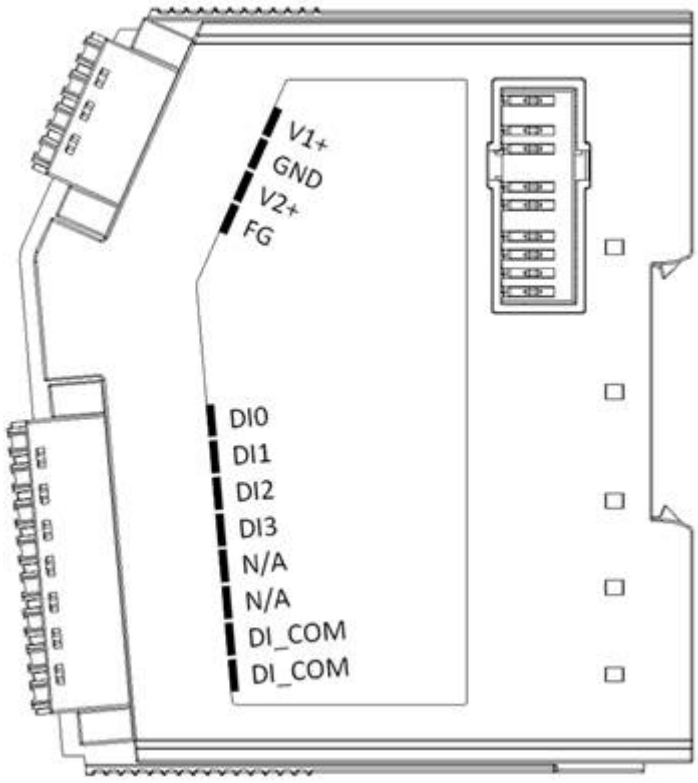


Figure 3.5 AMAX-5001 Module Side View

Table 3.2: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	V1+
2	GND
3	V2+
4	FG

Table 3.3: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DI0
2	DI1
3	DI2
4	DI3
5	N/A
6	N/A
7	DI_COM
8	DI_COM

3.1.5 Application Wiring

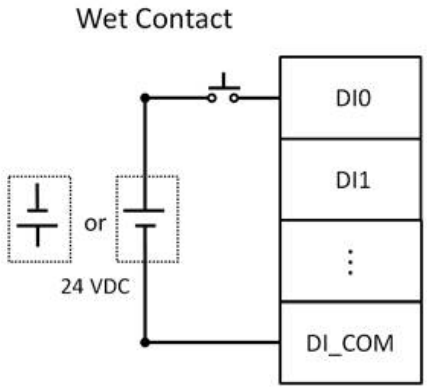


Figure 3.6 Wiring for AMAX-5001 Digital Input

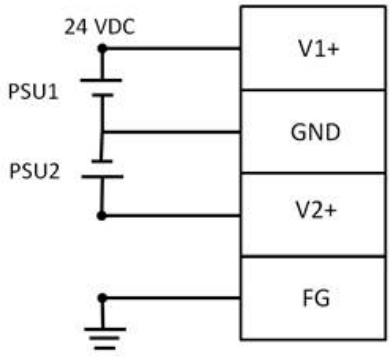


Figure 3.7 Wiring for AMAX-5001 Power Input

3.1.6 AMAX-5001 Object Dictionary

3.1.6.1 Input Data (0x6000 - 0x6FFF)

Table 3.4: Input Data (0x6000 - 0x6FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
6000:01	Over_Voltage_1	Voltage 1 > 28.8V (24V*1.2)	UINT	RO	0x00 (False)
6000:02	Under_Voltage_1	Voltage 1 < 19.2V (24V*0.8)	UINT	RO	0x00 (False)
6000:03	Over_Voltage_2	Voltage 2 > 28.8V (24V*1.2)	UINT	RO	0x00 (False)
6000:04	Under_Voltage_2	Voltage 2 < 19.2V (24V*0.8)	UINT	RO	0x00 (False)
6000:05	Over_Current	Bus current > 2A	UINT	RO	0x00 (False)
6000:06	DI0	Digital input channel 0	UINT	RO	0x00
6000:07	DI1	Digital input channel 1	UINT	RO	0x00
6000:08	DI2	Digital input channel 2	UINT	RO	0x00
6000:09	DI3	Digital input channel 3	UINT	RO	0x00
6000:11	Voltage_1	Input voltage 1	REAL	RO	0x0000 (0 Dec)
6000:12	Voltage_2	Input voltage 2	REAL	RO	0x0000 (0 Dec)
6000:13	Current	Input current	REAL	RO	0x0000 (0 Dec)

3.1.6.2 Configuration Data (0xF600 - 0xFFFF)

Table 3.5: Configuration Data (0xF600 - 0xFFFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)

3.1.6.3 PDO assignment (0x1C10 – 0x1C13)

Table 3.6: SM3, PDO assignment 0x1C13 (not changeable)

Index	Size (byte.bit)	Name	PDO content
0x1A00	32.0	Inputs process data mapping	6000:01 Over_Voltage_1; 6000:02 Under_Voltage_1; 6000:03 Over_Voltage_2; 6000:04 Under_Voltage_2; 6000:05 Over_Current; 6000:06 DI0; 6000:07 DI1; 6000:08 DI2; 6000:09 DI3; 6000:11 Voltage_1; 6000:12 Voltage_2; 6000:13 Current

3.2 AMAX-5074 EtherCAT Coupler with ID Switch

The AMAX-5074 is an EtherCAT coupler that connects remote EtherCAT slave IO modules to the EtherCAT through RJ-45 LAN port, it supports three main topologies: Ring, line, and star. It is also the power input module supporting 24 VDC dual input for maximum 2A current, providing power to the modules which are connected next to the AMAX-5074.

Figure 3.8 AMAX-5074 Module

3.2.1 AMAX-5074 Specification

3.2.1.1 General

- **Certification:** CE, FCC class A
- **Connector':** Pluggable 4P push-in terminal (#24~16 AWG) and 2x RJ45
- **Enclosure:** PC
- **Power Consumption:** 2.5W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, Power Diagnosis LED
- **Weight:** Approx. 97g

3.2.1.2 Power Input

- **Rated Voltage:** 24VDC (±20%)
- **Dual Power Input:** Supported
- **Max Current on Bus:** 2A
- **Diagnosis Function:**
  - Over/under voltage for input 1&2
  - Over current output on bus
- **Over Voltage LED Alarm:** Around 28.8V
- **Over Voltage Shutdown:** Around 36V
- **Under Voltage LED Alarm:** Around 19.2V
- **Under Voltage Shutdown:** Around 9V

3.2.1.3 EtherCAT Coupler

- **Function:** Coupling EtherCAT IO modules to 100BASETX EtherCAT network
- **Cable:** Ethernet/EtherCAT cable (min. Cat. 5), shielded
- **Distance between stations:** Max. 100 m (100BASETX)
- **Number of configurable IDs:** 256 (2 x 16-bit ID switch)
- **Bus Interface:** 2 x RJ45 (1 x Input, 1 x Output)

3.2.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

3.2.2 LED Indicator

Figure 3.9 AMAX-5074 Module LED Indicator

Table 3.7: AMAX-5074 Module LED Indicator			
LED	**Color**	**Indication**	**Behavior**
PW	Green	ON	Power on
Run	Green	ON	EtherCAT connection
BUS	Green	ON	BUS power on
OC	RED	ON	BUS over current 2A
OV1	RED	ON	Vin1 over voltage (28.8V)
OV2	RED	ON	Vin2 over voltage(28.8V)
UV1	RED	ON	Vin1 under voltage (19.2V)
UV2	RED	ON	Vin2 under voltage(19.2V)

3.2.3 ID Switch

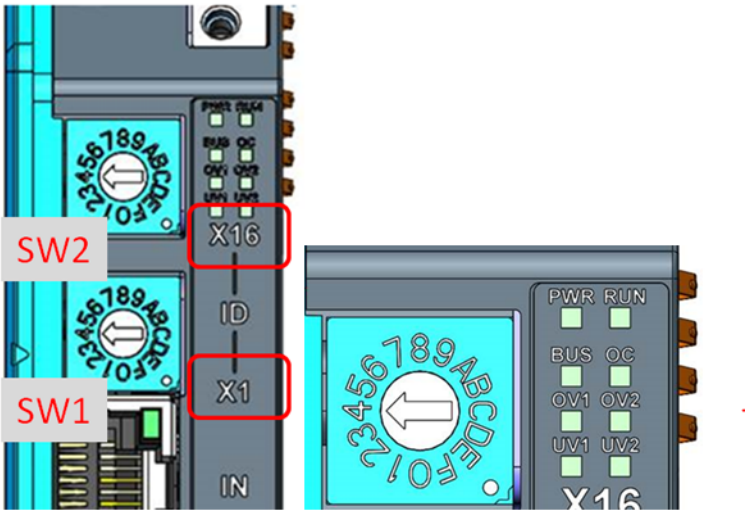


Figure 3.10 AMAX-5074 ID Switch

Table 3.8: AMAX-5074 ID Switch		
Switch Number	**Multiple**	**Range (HEX)**
SW1	X1	0~F
SW2	X16	0~F
Example	(SW2, SW1) = (4, C), then ID = 4 x16 + C x1 = 76	

Note! *Function Reserved, hot connection is currently not supported in CODE-SYS.*

3.2.4 Pin Definition

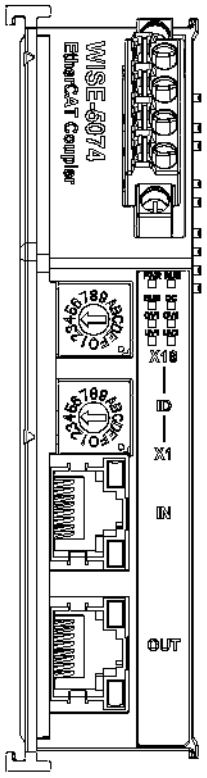


Figure 3.11 AMAX-5074 Module Front View

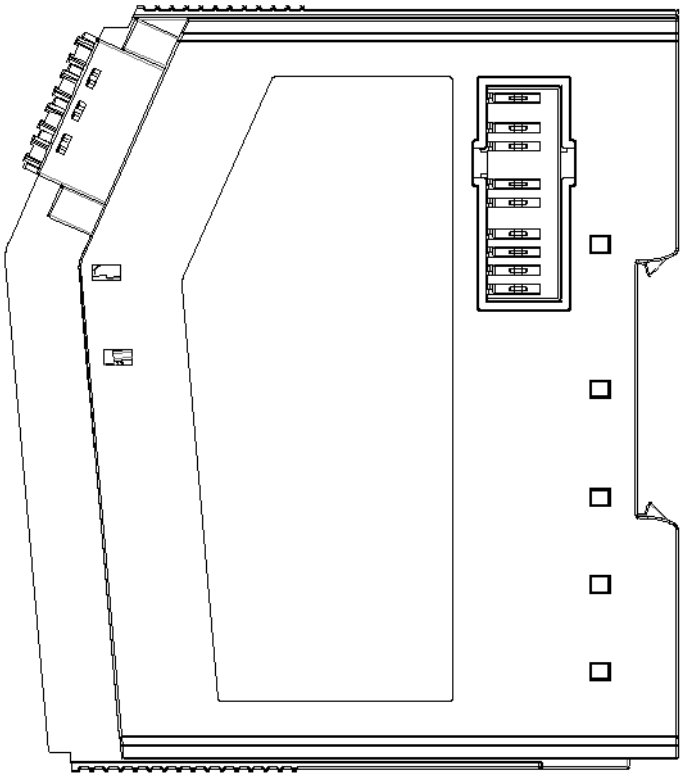


Figure 3.12 AMAX-5074 Module Side View

Table 3.9: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	V1+
2	GND
3	V2+
4	FG

Table 3.10: Lower 2 LAN Port	
LAN Number	**LAN Definition**
1	EtherCAT signal input
2	EtherCAT signal output

3.2.5 Application Wiring

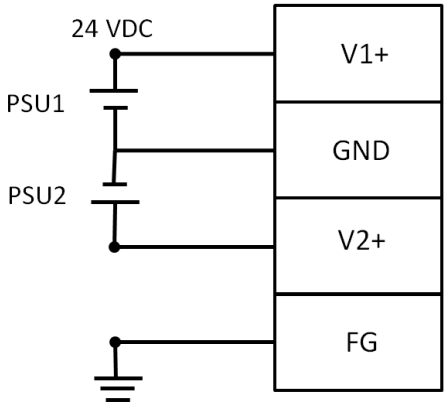


Figure 3.13 Wiring for AMAX-5074 Power Input

3.2.6 AMAX-5074 Object Dictionary

3.2.6.1 Input Data (0x6000 - 0x6FFF)

Table 3.11: Input Data (0x6000 - 0x6FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
6000:01	Over_Voltage_1	Voltage 1 > 28.8V (24V*1.2)	UINT	RO	0x00 (False)
6000:02	Under_Voltage_1	Voltage 1 < 19.2V (24V*0.8)	UINT	RO	0x00 (False)
6000:03	Over_Voltage_2	Voltage 2 > 28.8V (24V*1.2)	UINT	RO	0x00 (False)
6000:04	Under_Voltage_2	Voltage 2 < 19.2V (24V*0.8)	UINT	RO	0x00 (False)
6000:05	Over_Current	Bus current > 2A	UINT	RO	0x00
6000:06	Device_ID	ID Switch	UINT	RO	0x00
6000:11	Voltage_1	Input voltage 1	REAL	RO	0x0000 (0 Dec)
6000:12	Voltage_2	Input voltage 2	REAL	RO	0x0000 (0 Dec)
6000:13	Current	Input current	REAL	RO	0x0000 (0 Dec)

3.2.6.2 Configuration Data (0xF600 - 0xFFFF)

Table 3.12: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)

3.2.6.3 PDO assignment (0x1C10 – 0x1C13)

Table 3.13: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A00	24.0	Inputs process data mapping	6000:01 Over_Voltage_1; 6000:02 Under_Voltage_1; 6000:03 Over_Voltage_2; 6000:04 Under_Voltage_2; 6000:05 Over_Current; 6000:06 Device_ID; 6000:11 Voltage_1; 6000:12 Voltage_2; 6000:13 Current

3.3 AMAX-5079 EtherCAT Extension

The AMAX-5079 is an extension module converting EtherCAT bus to 100BASE-TX Ethernet through RJ-45 LAN port which can be connected to AMAX-5074 EtherCAT coupler or any EtherCAT devices to extend the EtherCAT network. AMAX-5079 should be installed at the end of the EtherCAT terminal and the maximum extension distance is 100m.

Figure 3.14 AMAX-5079 Module

3.3.1 AMAX-5079 Specification

3.3.1.1 General:

- **Certification:** CE, FCC class A
- **Connector':** 1 x RJ45
- **Enclosure:** PC
- **Power Consumption:** N/A
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **LED Indicator:** N/A
- **Weight:** Approx. 71g

3.3.1.2 EtherCAT Extension

- **Function:** Conversion of EtherCAT to 100BASE-TX Ethernet for extension of the EtherCAT network
- **Cable:** Ethernet/EtherCAT cable (min. Cat. 5), shielded
- **Distance between stations:** Max. 100 m (100BASETX)
- **Bus Interface:** 1 x RJ45
- **Power from bus:** N/A

3.3.1.3 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

3.3.2 Pin Definition

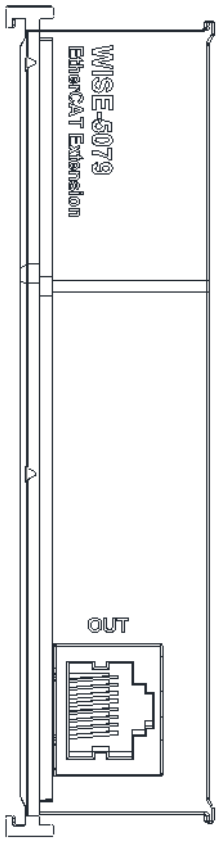


Figure 3.15 AMAX-5079 Module Front View

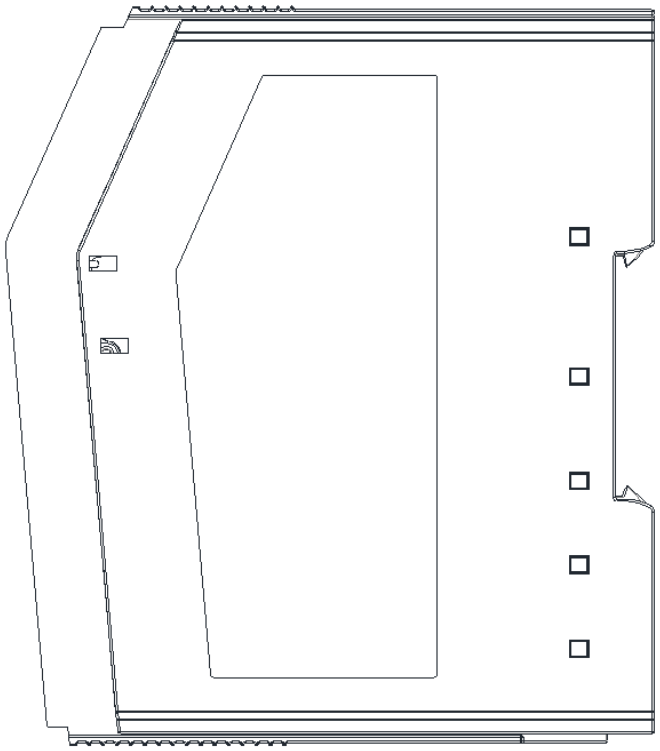


Figure 3.16 AMAX-5079 Module Side View

Table 3.14: LAN Port	
LAN Number	**LAN Definition**
1	EtherCAT signal output

Chapter 4

Analog Input/Output Modules

4.1 AMAX-5015 4-ch RTD Input Module

The AMAX-5015 is a 16-bit, 4-channel RTD input module that features programmable input ranges on all channels. This module is an extremely cost-effective solution for industrial measurement and monitoring applications. Its opto-isolated inputs provide 2,000 VDC of isolation between the analog input and the module, protecting the module and peripherals from damage due to high input line voltage.

Figure 4.1 AMAX-5015 Module

4.1.1 AMAX-5015 Specification

4.1.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24VDC
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN
- **Weight:** Approx. 80g

4.1.1.2 Analog Input

- **Channel:** 4
- **Input Connection:** 2 or 3 wire
- **Input Impedance:** >10MΩ
- **Temperature Range:**
  - **Pt 100 RTD:**
    Pt -50°C to 150°C
    Pt 0°C to 100°C
    Pt 0°C to 200°C
    Pt 0°C to 400°C
    Pt -200°C to 200°C IEC RTD 100 ohms
    (a = 0.00385)
    JIS RTD 100 ohms
    (a = 0.00392)
  - **Pt 1000 RTD:**
    Pt -40°C to 160°C
  - **Balco 500 RTD:**
    -30°C to 120°C
  - **Ni 518 RTD:**
    -80°C to 100°C
    0°C to 100°C
- **Resolution:** 16 bit with ±0.1% FSR accuracy @25°C
- **Sample Rate:** 100 sample/s (per channel)
- **Burn-out detection:** Yes

4.1.1.3 Protection

- **Isolation Voltage:** 2000V_{DC}

4.1.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

4.1.2 LED Indicator

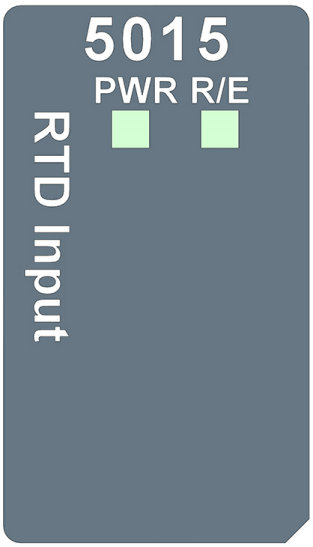


Figure 4.2 AMAX-5015 Module LED Indicator

Table 4.1: AMAX-5015 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.1.3 Pin Definition

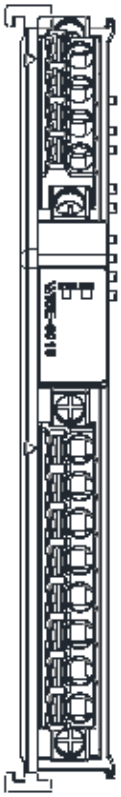


Figure 4.3 AMAX-5015 Module Front View

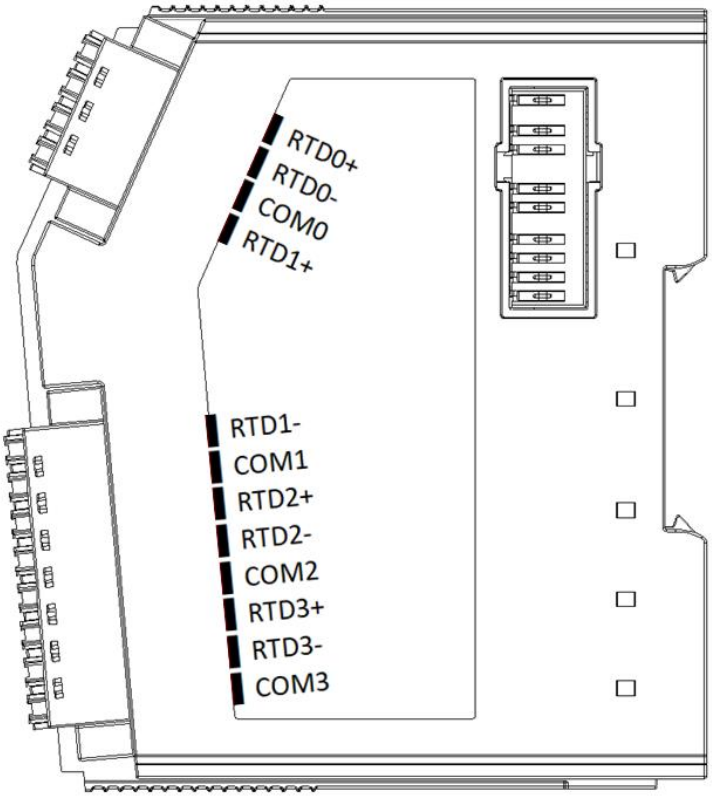


Figure 4.4 AMAX-5015 Module Side View

Table 4.2: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	RTD0+
2	RTD0-
3	COM0
4	RTD1+

Table 4.3: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	RTD1-
2	COM1
3	RTD2+
4	RTD2-
5	COM2
6	RTD3+
7	RTD3-
8	COM3

4.1.4 Application Wiring

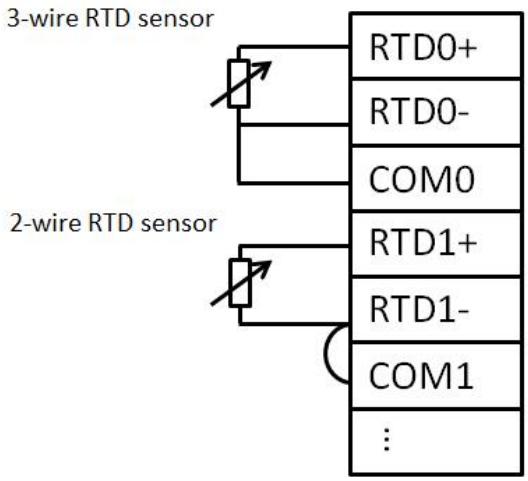


Figure 4.5 Wiring for AMAX-5015

4.1.5 AMAX-5015 Object Dictionary

4.1.5.1 Input Data (0x6000 - 0x6FFF)

Table 4.4: Input Data (0x6000 - 0x6FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
60n0:01	AIn_BurnOut	Burnout detection	BOOL	RO	0x00 (False)
60n0:02	AIn_OverRange	Over range detection	BOOL	RO	0x00 (False)
60n0:03	AIn_Under-Range	Under range detection	BOOL	RO	0x00 (False)
60n0:11	AIn_Raw	Analog input value (raw data)	UINT	RO	0x0000 (0 Dec)
60n0:13	AIn_Scale	Analog input value (scale data)	DINT	RO	0x0000 (0 Dec)

(n=0~3 for ch0~3)

AIn_Scale: This parameter shows the physical value of temperature, the value is multiplied by 10, and any digit under decimal point are rounded. E.g. (10.26°C -> 103)

Table 4.5: RTD Over/Under Range Limit		
Range Type	**Under_Temp**	**Over_Temp**
Pt-100 (-50~150 °C)	-70.85 °C	167.18 °C
Pt-100 (0~100 °C)	-25.48 °C	141.10 °C
Pt-100 (0~200 °C)	-25.48 °C	260.80 °C
Pt-100 (0~400 °C)	-12.76 °C	437.70 °C
Pt-100 (-200~200 °C)	-205.86 °C	224.97 °C
Pt-1000 (-40~160 °C)	-40.00 °C	160.00 °C
Balco (-30~120 °C)	-39.62 °C	141.65 °C
Ni (-80~100 °C)	-96.02 °C	128.59 °C
Ni (0~100 °C)	-8.61 °C	128.59 °C

4.1.5.2 Configuration Data (0x8000 - 0x8FFF)

Table 4.6: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
80n0:01	AIn_EnBurnOut	Enable burnout detection	BOOL	RW	0x01 (Enable)
80n0:11	AIn_Range	Input range type	UINT	RW	0x3A4 (Pt100 (385) -50~150 °C)
80n0:14	AIn_BurnOutValue	Burnout value	UINT	RW	1 (Up Scale)

(n=0~3 for ch0~3)

Table 4.7: Input RTD Type	
Item Name	**Value (UINT)**
Pt-100 (385) -50~150 °C	0x3A4
Pt-100 (385) 0~100 °C	0x3A5
Pt-100 (385) 0~200 °C	0x3A6
Pt-100 (385) 0~400 °C	0x3A7
Pt-100 (385) -200~200 °C	0x3A2
Pt-100 (392) -50~150 °C	0x3C4
Pt-100 (392) 0~100 °C	0x3C5
Pt-100 (392) 0~200 °C	0x3C6
Pt-100 (392) 0~400 °C	0x3C7
Pt-100 (392) -200~200 °C	0x3C2
Pt-1000 (385) -40~160 °C	0x3E2
Balco (500) -30~120 °C	0x300
Ni (518) -80~100 °C	0x320
Ni (518) 0~100 °C	0x321

Table 4.8: Burnout value	Table 4.9:
Item Name	**Value (UINT)**
Down Scale (output 0)	0
Up Scale (output 65535)	1

4.1.5.3 Configuration Data (0xF600 - 0xFFFF)

Table 4.10: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)
F600:11	AI_SamplingRate	Sampling rate (for all channels)	UINT	RW	0x01 (400Hz)

(Default sampling rate was 10Hz before revision number: 0x00001003)

Table 4.11: Sampling Rate	
Item Name	**Value (UINT)**
10Hz	0x00
400Hz	0x01

4.1.5.4 PDO assignment (0x1C10 – 0x1C13)

Table 4.12: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	10.0	Analog Input Channel n process data mapping	60n0:01 AIn_BurnOut; 60n0:02 AIn_OverRange; 60n0:03 AIn_UnderRange; 60n0:11 AIn_Raw; 60n0:13 AIn_Scale

(n=0~3 for ch0~3)

4.2 AMAX-5017C 6-ch Current Input Module

The AMAX-5017C is a 16-bit, 6-channel differential current input module that provides programmable input ranges on all channels, and different channels can be configured using different ranges. You can also use CODESYS to configure range type for each channel. This module is an extremely cost-effective solution for industrial measurement and monitoring applications. The module provides 2000V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules and control unit) won't be affected because it is already isolated.

Figure 4.6 AMAX-5017C Module

4.2.1 AMAX-5017C Specification

4.2.1.1 General

- **Certification:** CE, FCC class A
- **Protocol:** EtherCAT
- **Baud Rate:** 100M bps
- **Weight:** Approx. 80g

4.2.1.2 Analog Input

- **Channel:** 6 (Differential)
- **Input Impedance:** 120 Ω
- **Input Type:** mA
- **Voltage/Current Range:** ±20 mA, 0 ~ 20 mA, 4 ~ 20 mA
- **Span Drift:** 6 ppm/°C
- **Resolution:** 16 bit with ±0.2% FSR accuracy @25°C
- **Sampling Rate:** 100 sample/s (per channel)

4.2.1.3 Protection

- **Isolation Voltage:** 2000V_{DC}

4.2.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Operating Humidity:** 20 ~ 95% RH (non-condensing)
- **Storage Humidity:** 0 ~ 95% RH (non-condensing)

4.2.2 LED Indicator

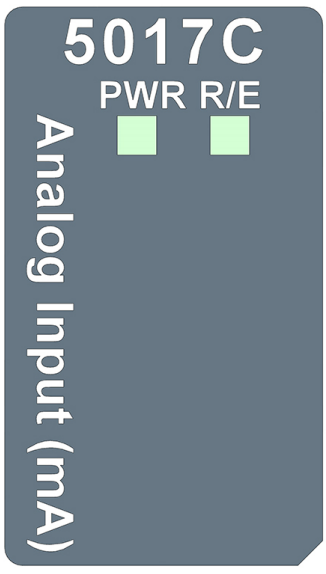


Figure 4.7 AMAX-5017C Module LED Indicator

Table 4.13: AMAX-5017C Module LED Indicator			
LED	**Color**	**Indication**	**Behavior**
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.2.3 Pin Definition

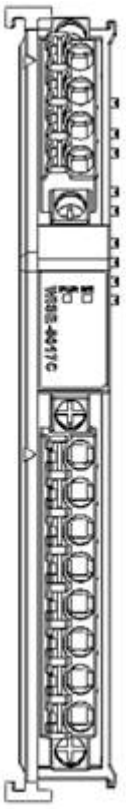


Figure 4.8 AMAX-5017C Module Front View

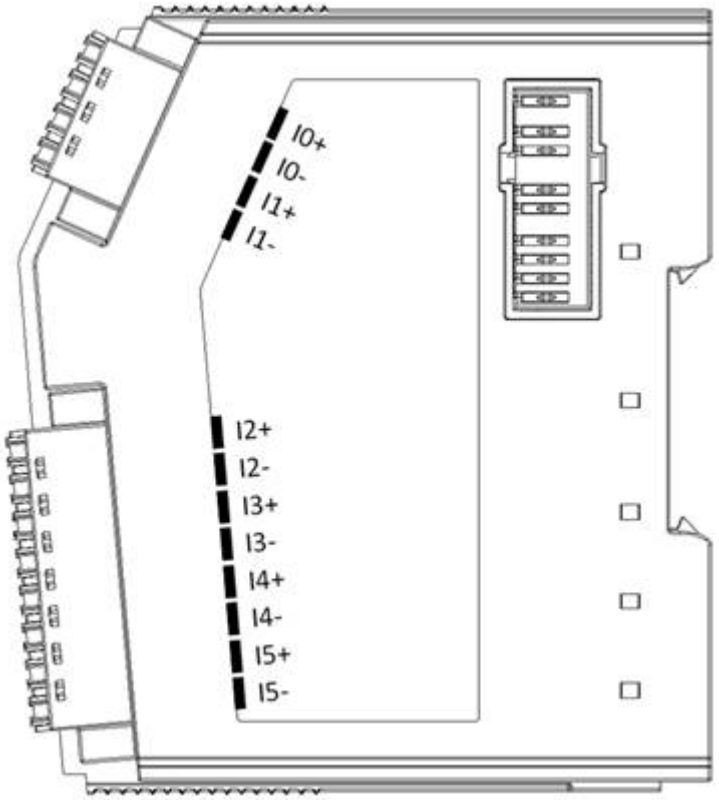


Figure 4.9 AMAX-5017C Module Side View

Table 4.14: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	I0+
2	I0-
3	I1+
4	I1-

Table 4.15: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	I2+
2	I2-
3	I3+
4	I3-
5	I4+
6	I4-
7	I5+
8	I5-

4.2.4 Application Wiring

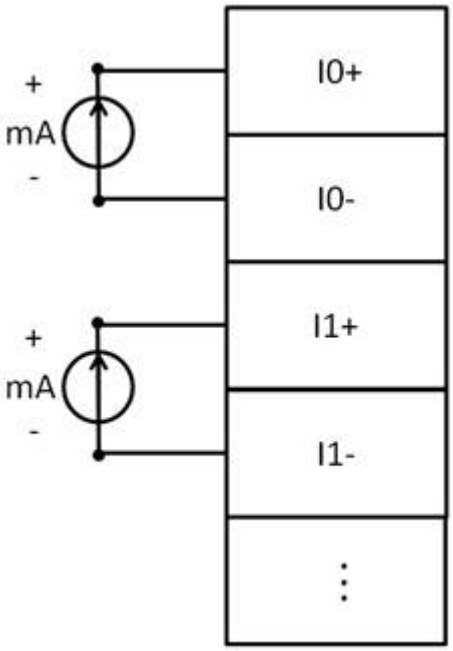


Figure 4.10 Wiring for AMAX-5017C

4.2.5 AMAX-5017C Object Dictionary

4.2.5.1 Input Data (0x6000 - 0x6FFF)

Table 4.16: Input Data (0x6000 - 0x6FFF)					
Index (hex)	Name	Meaning	Data type	Flags	Default value
60n0:01	AIn_BurnOut	Burnout detection	BOOL	RO	0x00 (False)
60n0:02	AIn_OverRange	Over range detection	BOOL	RO	0x00 (False)
60n0:03	AIn_Under-Range	Under range detection	BOOL	RO	0x00 (False)
60n0:11	AIn	Read current input value	UINT	RO	0x0000 (0 Dec)

(n=0~5 for ch0~5)

Converting current input value:

For the range 4~20 mA:

$$I_{in} = \left(\frac{Raw\ \ Data}{65536} \times 16mA\right) + 4mA$$

For the range ± 20 mA:

$$I_{in} = \left(\frac{Raw\ \ Data}{65536} \times 40mA\right) - 20mA$$

For the range 0~20 mA:

$$I_{in} = \frac{Raw\ \ Data}{65536} \times 20mA$$

4.2.5.2 Configuration Data (0x8000 - 0x8FFF)

Table 4.17: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
80n0:01	AIn_EnBurnOut	Enable burnout detection	BOOL	RW	0x01 (Enable)
80n0:11	AIn_Range	Input range type	UINT	RW	0x180 (4~20 mA)
80n0:14	AIn_BurnOutValue	Burnout value	UINT	RW	1 (Up Scale)

(n=0~5 for ch0~5)

Burnout/ Over Range/ Under Range Detection:

Burnout/ Over Range/ Under Range detections are only available for the range 4~20mA, the alarm status and output value show on the table below:

Table 4.18: Alarm Status for 4 ~ 20 mA Input Range		
Input Current	**Status**	**Output Value**
0 ~ 3 mA (or burnout)	Burnout	Up Scale: 65535; Down Scale (or burnout detection is disabled): 0
3 ~ 4 mA	Under Range	0
Above 20 mA	Over Range	65535

Table 4.19: Input Range Type	
Range Type	**Value (UINT)**
4~20 mA	0x180
± 20 mA (Full Scale Range)	0x181
0~20 mA	0x182

Table 4.20: Burnout value	
Item Name	**Value (UINT)**
Down Scale (output 0)	0
Up Scale (output 65535)	1

4.2.5.3 Configuration Data (0xF600 - 0xFFFF)

Table 4.21: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)
F600:11	AI_SamplingRate	Sampling rate (for all channels)	UINT	RW	0x01 (600Hz)

(Default sampling rate was 10Hz before revision number: 0x00021003)

Table 4.22: Sampling Rate	
Item Name	**Value (UINT)**
10Hz	0x00
600Hz	0x01

4.2.5.4 PDO assignment (0x1C10 – 0x1C13)

Table 4.23: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	4.0	Analog Input Channel n process data mapping	60n0:01 AIn_BurnOut; 60n0:02 AIn_OverRange; 60n0:03 AIn_UnderRange; 60n0:11 AIn

(n=0~5 for ch0~5)

4.3 AMAX-5017V 6-ch Voltage Input Module

The AMAX-5017V is a 16-bit, 6-channel differential voltage input module that provides programmable input ranges on all channels, and different channels can be configured using different ranges. You can also use CODESYS to configure range type for each channel. This module is an extremely cost-effective solution for industrial measurement and monitoring applications. The module provides 2000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules and control unit) won't be affected cause it is already isolated.

Figure 4.11 AMAX-5017V Module

4.3.1 AMAX-5017V Specification

4.3.1.1 General

- **Certification:** CE, FCC class A
- **Protocol:** EtherCAT
- **Baud Rate:** 100M bps
- **Weight:** Approx. 80g

4.3.1.2 Analog Input

- **Channel:** 6 (Differential)
- **Input Impedance:** >1MΩ
- **Input Type:** V, mV
- **Voltage Range:** 0~150 mV, ±150 mV, 0~500 mV, ±500 mV, 0~1 V, ±1 V, 0~5 V, ±5 V, 0~10 V, ±10 V
- **Span Drift:** 6 ppm/°C
- **Resolution:** 16-bit with ±0.1% FSR accuracy @25°C
- **Sampling Rate:** 100 sample/s (per channel)

4.3.1.3 Protection

- **Isolation Voltage:** 2000 V_{DC}

4.3.1.4 Environment

- **Operation Temperature:** -25~70°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Operating Humidity:** 20 ~ 95% RH (non-condensing)
- **Storage Humidity:** 0 ~ 95% RH (non-condensing)

4.3.2 LED Indicator

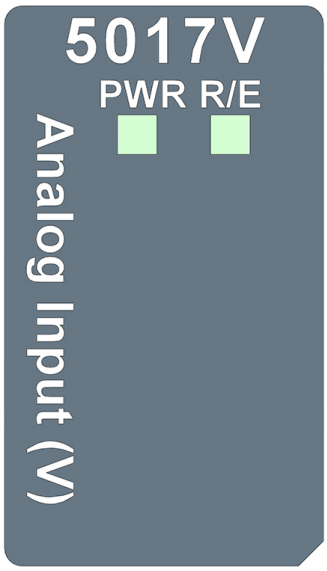


Figure 4.12 AMAX-5017V Module LED Indicator

Table 4.24: AMAX-5017V Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.3.3 Pin Definition

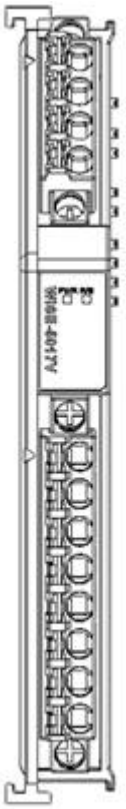


Figure 4.13 AMAX-5017V Module Front View

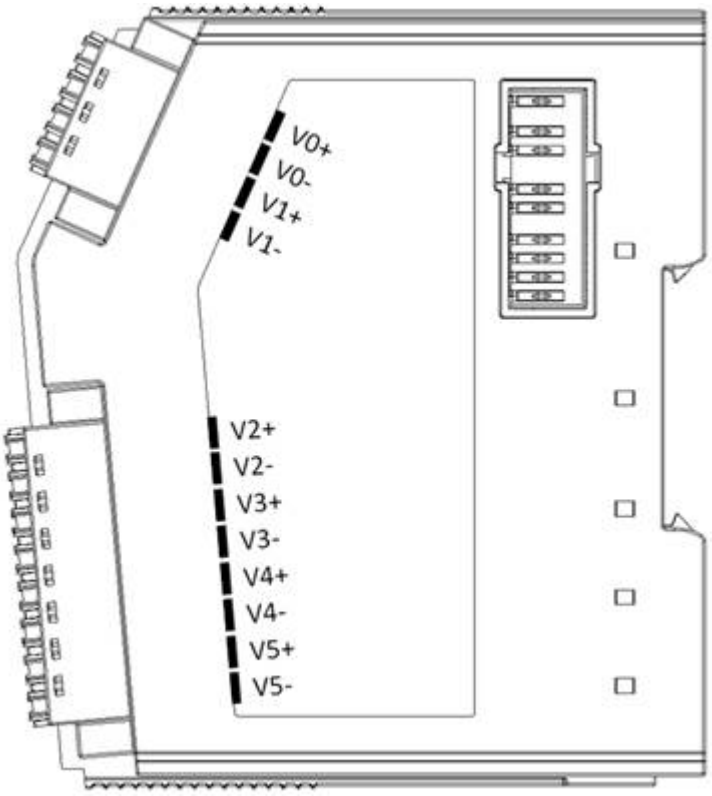


Figure 4.14 AMAX-5017V Module Side View

Table 4.25: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	V0+
2	V0-
3	V1+
4	V1-

Table 4.26: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	V2+
2	V2-
3	V3+
4	V3-
5	V4+
6	V4-
7	V5+
8	V5-

4.3.4 Application Wiring

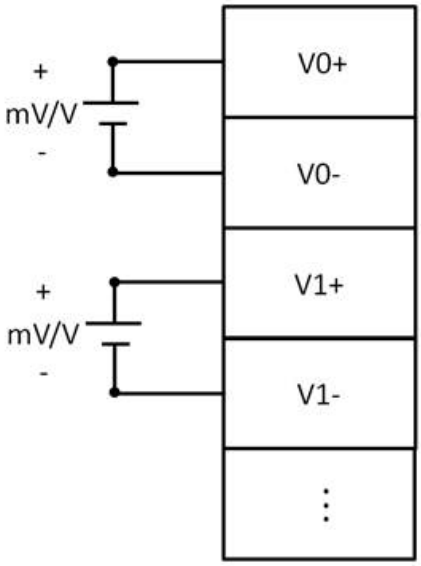


Figure 4.15 Wiring for AMAX-5017V

4.3.5 AMAX-5017V Object Dictionary

4.3.5.1 Input Data (0x6000 - 0x6FFF)

Table 4.27: Input Data (0x6000 - 0x6FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
60n0:11	AIn	Read voltage input value	UINT	RO	0x0000 (0 Dec)

(n=0~5 for ch0~5)

Converting voltage input value:

For the range ± 150 mV:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 300mV) - 150mV$$

For the range ± 500 mV:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 1000mV) - 500mV$$

For the range ± 1 V:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 2V) - 1V$$

For the range ± 5 V:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 10V) - 5V$$

For the range ± 10 V:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 20V) - 10V$$

For the range 0~150 mV:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 150mV$$

For the range 0~500 mV:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 500mV$$

For the range 0~1 V:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 1V$$

For the range 0~5 V:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 5V$$

For the range 0~10 V:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 10V$$

4.3.5.2 Configuration Data (0x8000 - 0x8FFF)

Table 4.28: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
80n0:11	AIn_Range	Input range type	UINT	RW	0x143 (±10 V)

(n=0~5 for ch0~5)

Table 4.29: Input Range Type	
Range Type	**Value (UINT)**
± 150 mV (Full Scale Range)	0x103
± 500 mV (Full Scale Range)	0x104
± 1 V (Full Scale Range)	0x140
± 5 V (Full Scale Range)	0x142
± 10 V (Full Scale Range)	0x143
0~150 mV	0x105
0~ 500 mV	0x106
0~1 V	0x145
0~5 V	0x147
0~10 V	0x148

4.3.5.3 Configuration Data (0xF600 - 0xFFFF)

Table 4.30: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)
F600:11	AI_SamplingRate	Sampling rate (for all channels)	UINT	RW	0x01 (600Hz)

(Default sampling rate was 10Hz before revision number: 0x00031003)

Table 4.31: Sampling Rate	
Item Name	**Value (UINT)**
10Hz	0x00
600Hz	0x01

4.3.5.4 PDO assignment (0x1C10 – 0x1C13)

Table 4.32: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	4.0	Analog Input Channel n process data mapping	60n0:11 AIn

(n=0~5 for ch0~5)

4.4 AMAX-5017H 4-ch High Speed Analog Input Module

The AMAX-5017H is a 16-bit, 4-channel differential analog input module with 10kHz sample rate. All channels can be configured to voltage or current input separately. This module is a cost-effective solution for industrial measurement and monitoring applications. The module provides 2000 VDC optical isolation between channels which can avoid high voltage or current damage the entire system.

Figure 4.16 AMAX-5017H Module

4.4.1 AMAX-5017H Specification

4.4.1.1 General

- **Certification:** CE, FCC class A
- **Protocol:** EtherCAT
- **Baud Rate:** 100M bps

4.4.2 Analog Output

- **Channel:** 4 (Differential)
- **Input Impedance:**
  - 800 kΩ, for voltage input
  - 500 Ω, for current input
- **Common Voltage Range:** ±275V
- **Input Type:** V, mV, mA
- **Voltage/Current Range:** ±10 V, 0~10V, 0~20mA
- **Accuracy:**
  - ±0.1% FSR for voltage input (25°C)
  - ±0.2% FSR for current input (25°C)
- **Span Drift:** ±30 ppm/°C
- **Zero Drift:** ±6 uV/°C
- **Resolution:** 16-bit
- **Sampling Rate:** 10k sample/s (per channel)

4.4.3 Protection

Isolation Voltage: 2000 V_{DC}

4.4.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Operating Humidity:** 20 ~ 95% RH (non-condensing)
- **Storage Humidity:** 0 ~ 95% RH (non-condensing)

4.4.5 LED Indicator

Figure 4.17 AMAX-5017H Module LED Indicator

Table 4.33: AMAX-5017H Module LED Indicator			
LED	**Color**	**Indication**	**Behavior**
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.4.6 Pin Definition

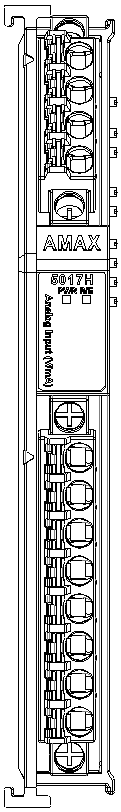


Figure 4.18 AMAX-5017H Module Front View

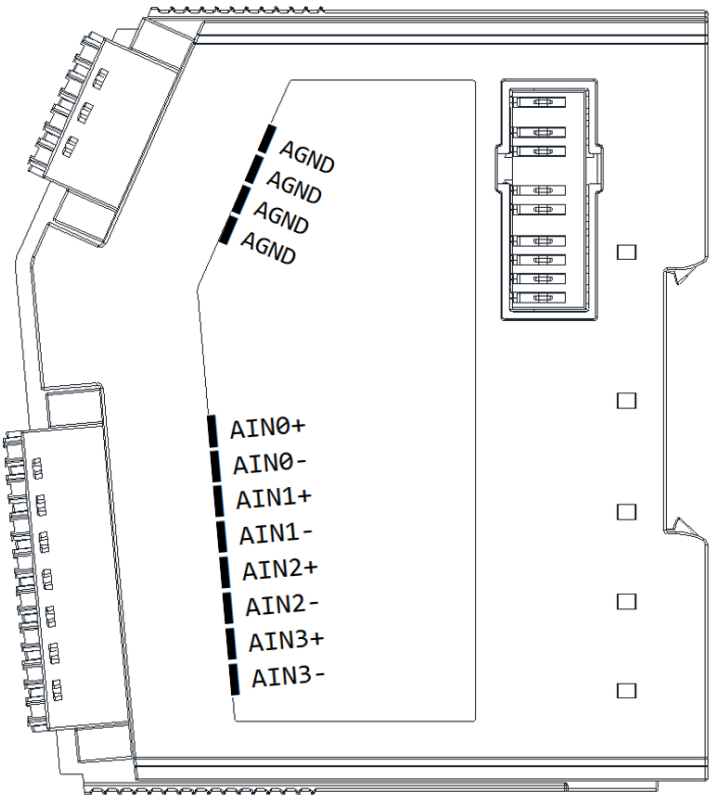


Figure 4.19 AMAX-5017H Module Side View

Table 4.34: Upper 4 Pin Connector

Pin Number	Pin Definition
1	AGND
2	AGND
3	AGND
4	AGND

Table 4.35: Lower 8 Pin Connector

Pin Number	Pin Definition
1	AIN0+
2	AIN0-
3	AIN1+
4	AIN1-
5	AIN2+
6	AIN2-
7	AIN3+
8	AIN3-

4.4.7 Application Wiring

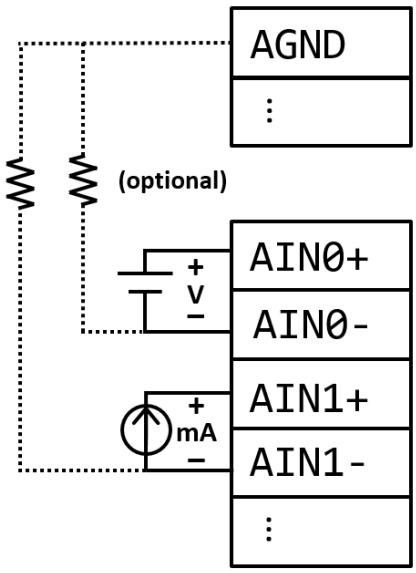


Figure 4.20 Wiring for AMAX-5017H

4.4.8 AMAX-5017H Object Dictionary

4.4.8.1 Input Data (0x6000 - 0x6FFF)

Table 4.36: Input Data (0x6000 - 0x6FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
60n0:11	AIn	Read analog input value	UINT	RO	0x0000 (0 Dec)

(n=0~3 for ch0~3)

4.4.8.2 Configuration Data (0x8000 - 0x8FFF)

Table 4.37: Configuration Data (0x8000 - 0x8FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
80n0:11	AIn_Range	Input range type	UINT	RW	0x143 (±10 V)

(n=0~3 for ch0~3)

Converting analog input value:

For the range ± 10 V:

$$V_{in} = (\frac{Raw\ \ Data}{65536} \times 20V) - 10V$$

For the range 0~10 V:

$$V_{in} = \frac{Raw\ \ Data}{65536} \times 10V$$

For the range 0~20 mA:

$$I_{in} = \frac{Raw\ \ Data}{65536} \times 20mA$$

Table 4.38: Input Range Type	
Range Type	**Value (UINT)**
± 10 V	0x143
0~10V	0x148
0~20mA	0x182

4.4.8.3 Configuration Data (0xF600 - 0xFFFF)

Table 4.39: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00 (Off)
F600:09	1st FPGA version	FPGA version	BIT8	RO	0x00

4.4.8.4 PDO assignment (0x1C10 – 0x1C13)

Table 4.40: SM2, PDO assignment 0x1C12 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	1.0	Dummy output	Dummy output 0

Dummy output:

The dummy output is designed for EtherCAT connectivity detection, if EtherCAT is disconnected, the error light turns on. **There is no actual output signal from the module.**

Table 4.41: SM3, PDO assignment 0x1C13 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	4.0	Analog Input Channel n process data mapping	60n0:11 AIn

(n=0~3 for ch0~3)

4.5 AMAX-5018 6-ch Thermocouple Module

The AMAX-5018 is a 16-bits 6-channel thermocouple module, which supports: J, K, T, E, R, S, B type thermocouple and multi-range voltage input (±50 mV, ±100 mV, ±500 mV, ±1 V, ±2.5 V), each channel supports open load detection. The module provides 2000 VDC optical isolation, if any surge voltage or current inputs the channel, the whole system (other modules or control unit) will not be damaged.

Figure 4.21 AMAX-5018 Module

4.5.1 AMAX-5018 Specification

4.5.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24VDC
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN
- **Weight:** Approx. 80g

4.5.1.2 Thermocouple Input

- **Channel:** 6 (Differential)
- **Input Impedance:** >2M Ω
- **Voltage Input:** ±50 mV, ±100 mV, ±500 mV, ±1 V, ±2.5 V
- **Sensor Type:**
  Type J (0 ~ 760°C)
  Type K (0 ~ 1370°C)
  Type T (-100 ~ 400°C)
  Type E (0 ~ 1000°C)
  Type R (500 ~ 1750°C)
  Type S (500 ~ 1750°C)
  Type B (500 ~ 1800°C)
- **Resolution:** 16 bit with ±0.1% FSR accuracy @25°C
- **Sample Rate:** 100 sample/s (per channel)
- **Burn-out detection:** Yes

4.5.1.3 Protection

- **Isolation Voltage:** 2000 V_{DC}

4.5.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Operating Humidity:** 20 ~ 95% RH (non-condensing)
- **Storage Humidity:** 0 ~ 95% RH (non-condensing)

4.5.2 LED Indicator

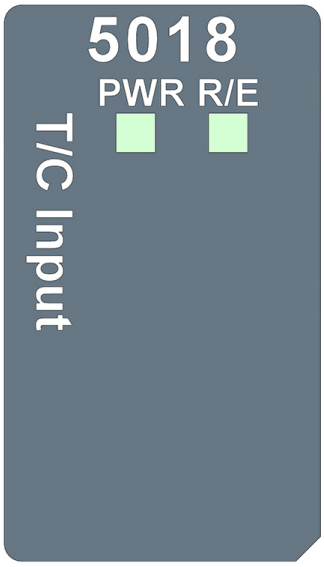


Figure 4.22 AMAX-5018 Module LED Indicator

Table 4.42: AMAX-5018 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.5.3 Pin Definition

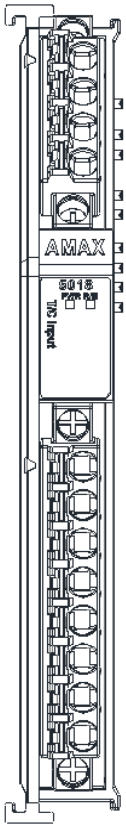


Figure 4.23 AMAX-5018 Module Front View

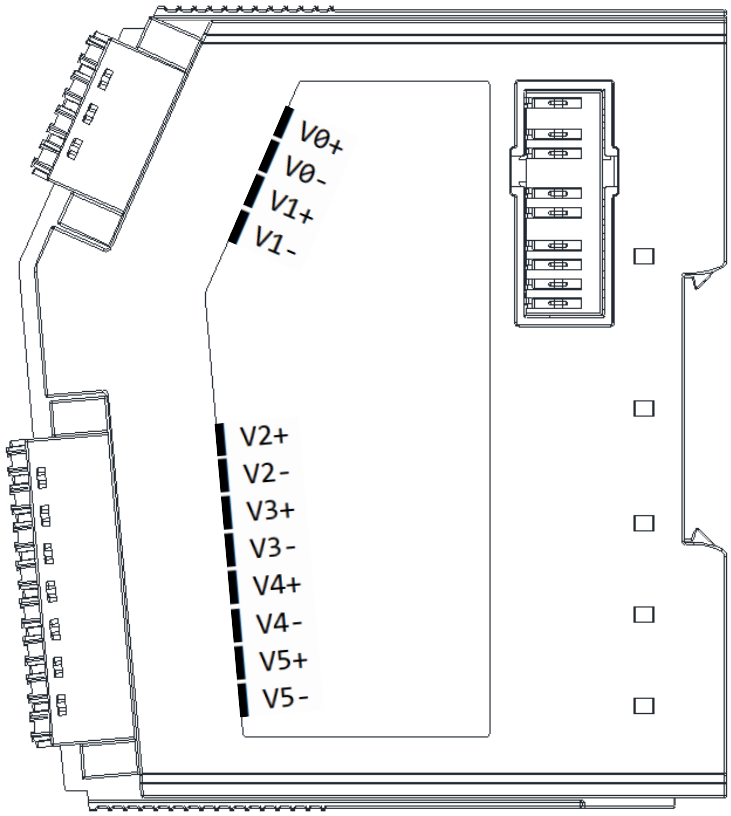


Figure 4.24 AMAX-5018 Module Side View

Table 4.43: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	V0+
2	V0-
3	V1+
4	V1-

Table 4.44: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	V2+
2	V2-
3	V3+
4	V3-
5	V4+
6	V4-
7	V5+
8	V5-

4.5.4 Application Wiring

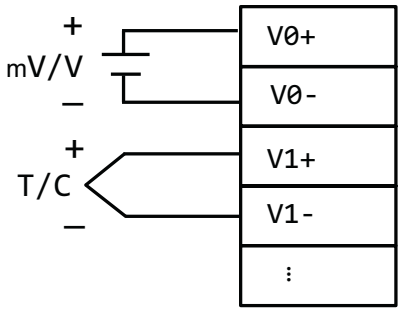


Figure 4.25 Wiring for AMAX-5018

4.5.5 AMAX-5018 Object Dictionary

4.5.5.1 Analog Input (0x6000 - 0x6FFF)

Table 4.45: Analog Input (0x6000 - 0x6FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
60n0:01	AIn_BurnOut	Burnout detection	BOOL	RO	0x00 (False)
60n0:02	AIn_OverRange	Over range detection	BOOL	RO	0x00 (False)
60n0:03	AIn_Under-Range	Under range detection	BOOL	RO	0x00 (False)
60n0:11	AIn_Raw	Analog input value (raw data)	UINT	RO	0x0000 (0 Dec)
60n0:13	AIn_Scale	Analog input value (scaled data)	DINT	RO	0x0000 (0 Dec)

(n=0~5 for ch0~5)

Burnout Detection

Burnout detection can be used when the AIn_EnBurnOut (0x80n0:01) is enabled, this function is only available for thermocouple input.

Over Range/ Under Range Detection

Over or under range detections are only available for thermocouple input, the alarm trigger value shows on the table below:

Table 4.46: Thermocouple Over/Under Range Limit		
Range Type	**Under_Temp**	**Over_Temp**
J (0~760°C)	-80°C	840°C
K (0~1370°C)	-100°C	1370°C
T (-100~400°C)	-140°C	400°C
E (0~1000°C)	-100°C	1000°C
R (500~1750°C)	320°C	1760°C
S (500~1750°C)	320°C	1760°C
B (500~1800°C)	320°C	1820°C

4.5.5.2 Analog Input (Scaled)

This parameter shows the physical value of temperature or voltage, the value is multiplied by a factor, and any digit under decimal point are rounded, for example:

If selecting voltage input range:

AIn_Scale = Round (Measured voltage x 10000). (E.g. 3.45678 mV -> 34568)

If selecting thermocouple input range:

AIn_Scale = Round (Measured temperature x 10). (10.26°C -> 103)

The actual display range for scaled data shows on the table below:

Table 4.47: Scaled Data Display Range		
Item Name	**Scaled Data**	**Physical Value**
+/-50 mV	-780000~780000	-78~78 mV
+/-100 mV	-1560000~1560000	-156~156 mV
+/-500 mV	-6250000~6250000	-625~625 mV
+/-1 V	-12500~12500	-1.25~1.25 V
+/-2.5 V	-25000~25000	-2.5~2.5 V
K 0~1370°C	0~1370	0~1370°C
J 0~760°C	0~7600	0~760°C
E 0~1000°C	0~10000	0~1000°C
T -100~400°C	-1000~4000	-100~400°C
R 500~1750°C	5000~17500	500~1750°C
S 500~1750°C	5000~17500	500~1750°C
B 500~1800°C	5000~18000	500~1800°C

4.5.5.3 Configuration Data (0x8000 - 0x8FFF)

Table 4.48: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
80n0:01	AIn_EnBurnOut	Enable burnout detection	BOOL	RW	0x00 (Disable)
80n0:11	AIn_Range	Input range type	UINT	RW	0x420 (K 0~1370 °C)
80n0:14	AIn_BurnOutValue	Burnout value	UINT	RW	1 (Up Scale)

(n=0~5 for ch0~5)

AIn_EnBurnOut

When burnout detection is enabled, the limitation of conversion time per channel will be 7.8ms. (21.4Hz for all channel)

Input Range Type

AMAX-5018 supporting voltage and thermocouple input range, like below:

Table 4.49: Input Range Type	
Item Name	**Value (UINT)**
+/-50 mV	0x101
+/-100 mV	0x102
+/-500 mV	0x104
+/-1 V	0x140
+/-2.5 V	0x141
K 0~1370°C	0x420
J 0~760°C	0x400
E 0~1000°C	0x460
T -100~400°C	0x440
R 500~1750°C	0x480
S 500~1750°C	0x4A0
B 500~1800°C	0x4C0

Table 4.50: Burnout value	
Item Name	**Value (UINT)**
Down Scale (output 0)	0
Up Scale (output 65535)	1

4.5.5.4 Configuration Data (0xF600 - 0xFFFF)

Table 4.51: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0
F600:03	UnderWindFlow	Set if module is under wind flow	BOOL	RW	0 (False)
F600:11	AI_Samplin-gRate	Sampling rate (for all channels)	UINT	RW	0x01 (600Hz)

(Default sampling rate was 10Hz before revision number: 0x00001003)

Table 4.52: Sampling Rate Table 4.53:	
Item Name	**Value (UINT)**
10Hz	0x00
600Hz	0x01

4.5.5.5 PDO assignment (0x1C10 – 0x1C13)

Table 4.54: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	10.0	Analog Input Channel n pro-cess data mapping	60n0:01 AIn_BurnOut; 60n0:02AIn_OverRange; 60n0:03AIn_UnderRange; 60n0:11AIn_Raw; 60n0:13AIn_Scale

(n=0~5 for ch0~5)

4.6 AMAX-5024 4-ch Analog Output Module

The AMAX-5024 is a 16-bit, 4-channel analog output module that provides programmable output ranges on every channel, and different channels can be configured using different ranges. The module provides 2000 VDC optical isolation, if any high voltage or current damage the channels, the whole system (other modules or control unit) will not be damaged.

Figure 4.26 AMAX-5024 Module

4.6.1 AMAX-5024 Specification

4.6.1.1 General

- **Certification:** CE, FCC class A
- **Protocol:** EtherCAT
- **Baud Rate:** 100M bps
- **Weight:** Approx. 80g

4.6.1.2 Analog Output

- **Channel:** 4
- **Output Range:** V, mA
- **Output Type:** 0~5 V,0 ~10 V, ±5V, ±10V, 4 ~ 20 mA, 0 ~ 20 mA
- **Drift:** ± 50 ppm/°C
- **Resolution:** 16-bit with ±0.01% of FSR accuracy @25°C
- **Current Load Resistor:** Max. 500 Ω
- **Voltage Load Resistor:** Min. 1K Ω
- **Slew Rate:** 1 V/μs for voltage output, 2.4 mA/μs for current output (configurable)

4.6.1.3 Protection

- **Isolation Voltage:** 2000 V_{DC}

4.6.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Operating Humidity:** 20 ~ 95% RH (non-condensing)
- **Storage Humidity:** 0 ~ 95% RH (non-condensing)

4.6.2 LED Indicator

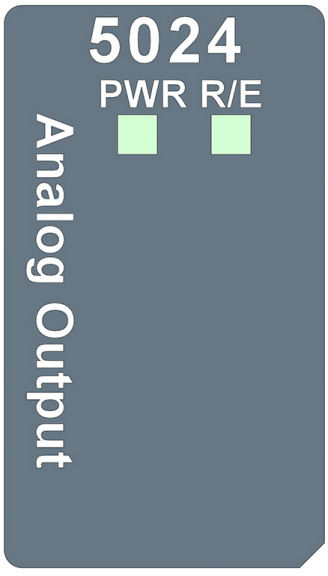


Figure 4.27 AMAX-5024 Module LED Indicator

Table 4.55: AMAX-5024 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	RED	ON/Blink	System Abnormal
		OFF	No Error

4.6.3 Pin Definition

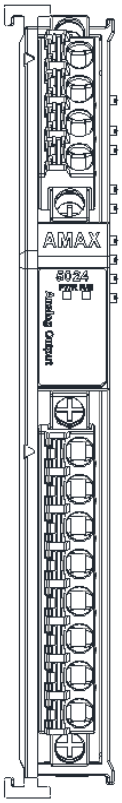


Figure 4.28 AMAX-5024 Module Front View

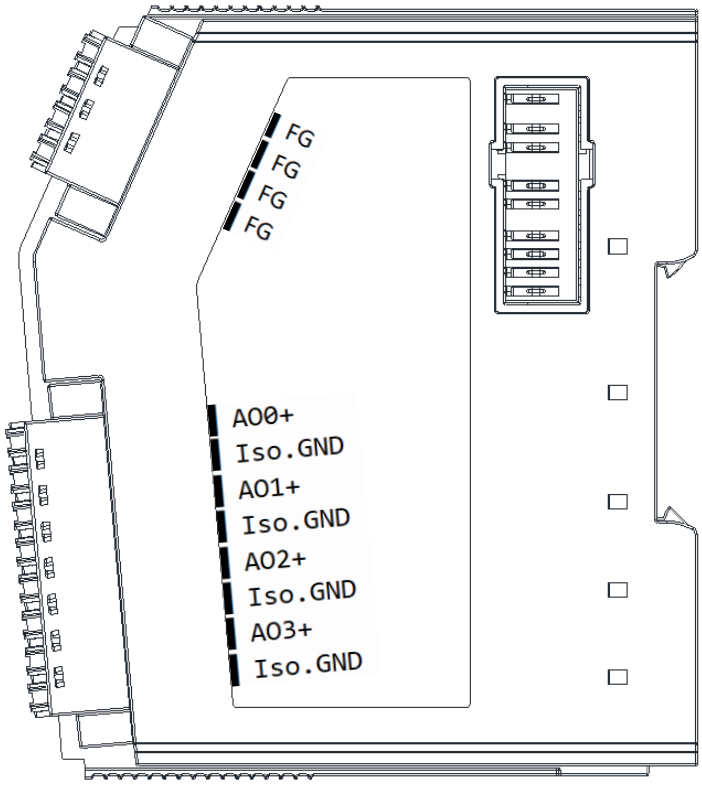


Figure 4.29 AMAX-5024 Module Side View

Table 4.56: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	FG
2	FG
3	FG
4	FG

Table 4.57: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	AO0+
2	Iso. GND
3	AO1+
4	Iso. GND
5	AO2+
6	Iso. GND
7	AO3+
8	Iso. GND

4.6.4 Application Wiring

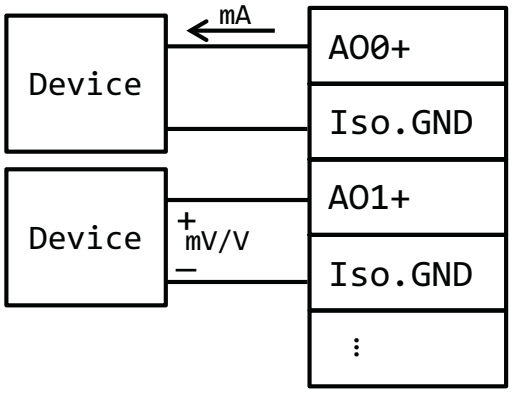


Figure 4.30 Wiring for AMAX-5024

4.6.5 AMAX-5024 Object Dictionary

4.6.5.1 Input Data (0x6000 - 0x6FFF)

Table 4.58: Input Data (0x6000 - 0x6FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
60n0:01	AOn_BurnOut	Detect whether the input circuit open	BOOL	RO	0x00 (0 Dec)
60n0:11	AOn	Read analog output value	UINT	RO	0x0000 (0 Dec)

(n=0~3 for ch0~3)

4.6.5.2 Output Data (0x7000 - 0x7FFF)

Table 4.59: Output Data (0x7000 - 0x7FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
70n0:11	AOn	Set analog output value	UINT	RW	0x0000 (0 Dec)

(n=0~3 for ch0~3)

Converting analog output value:

For the range 0~5 V:

$$V_{out} = \frac{Raw\ \ Data}{65536} \times 5V$$

For the range 0~10 V:

$$V_{out} = \frac{Raw\ \ Data}{65536} \times 10V$$

For the range ± 5 V:

$$V_{out} = (\frac{Raw\ \ Data}{65536} \times 10V) - 5V$$

For the range ± 10 V:

$$V_{out} = (\frac{Raw\ \ Data}{65536} \times 20V) - 10V$$

For the range 4 ~ 20 mA:

$$I_{out} = (\frac{Raw\ \ Data}{65536} \times 16mA) + 4mA$$

For the range 0~20 mA:

$$I_{out} = \frac{Raw\ \ Data}{65536} \times 20mA$$

4.6.5.3 Configuration Data (0x8000 - 0x8FFF)

Table 4.60: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
80n0:02	AOn_EnSle-wRate	Enable slew rate function	BOOL	RW	0x00 (Disable)
80n0:11	AOn_Range	Output range type	UINT	RW	0x180 (4~20 mA)
80n0:15	AOn_SlewRate	Slew rate setting	UINT	RW	0x01 (± 1 V(mA) /s)

(n=0~3 for Ch0~3)

(* Slew rate function can not be used under DC mode)

Table 4.61: Output Range Type	
Range Type	**Value (UINT)**
0~5 V	0x147
0~10 V	0x148
± 5 V	0x142
± 10 V	0x143
4~20 mA	0x180
0~20 mA	0x182

Table 4.62: Slew Rate Setting	
Slew Rate	**Value (UINT)**
+/-1 V(mA) /s	0x01
+/-2 V(mA) /s	0x02
+/-4 V(mA) /s	0x04
+/-8 V(mA) /s	0x08
+/-16 V(mA) /s	0x10
+/-32 V(mA) /s	0x20
+/-64 V(mA) /s	0x40

4.6.5.4 Configuration Data (0x6000 - 0xFFFF)

Table 4.63: Configuration Data of the Module (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0
F600:12	AO_SafetyValue	Set output safety value	UINT	RW	0 (zero)

AO_SafetyValue: This AO safety value will be triggered when the module is disconnected.

Table 4.64: Output Safety Value (for all channels)	
Safety Value	**Value (UINT)**
Zero	0x00
Last Value	0x01

4.6.5.5 PDO assignment (0x1C10 – 0x1C13)

Table 4.65: SM2, PDO assignment 0x1C12 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x160n	4.0	Analog Output Channel n process data mapping	70n0:11 AOn

(n=0~3 for ch0~3)

Table 4.66: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	4.0	Read Analog Output Channel n process data mapping	60n0:01 AOn_BurnOut; 60n0:11 AOn

(n=0~3 for ch0~3)

Chapter 5

Digital Module

5.1 AMAX-5051 8-ch Digital Input Module

The AMAX-5051 features 8 digital input (sink/source) channels. The digital input channels show LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.1 AMAX-5051 Module

5.1.1 AMAX-5051 Specification

5.1.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, DI status
- **Weight:** Approx. 80g

5.1.1.2 Digital Input:

- **Channels:** 8
- **Digital Input:**
  - Dry Contact:
    Logic level 1: close to Iso.GND
    Logic level 0: open
  - Wet Contact:
    Rated voltage: $24V_{DC}$
    Logic level 1: 10~30 V_{DC} and -10~-$30V_{DC}$
    Logic level 0: -3~$3V_{DC}$
- **Input Delay:**
  - From logic 0 to 1: 4ms
  - From logic 1 to 0: 4ms
- **Digital Filter:** 3ms
- **Typical Input Current:** Logic level 1: 1.3mA~4.3mA (10V~30V)

5.1.1.3 Protection

- **Isolation Voltage:** 2,000V_{DC}

5.1.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.1.2 LED Indicator

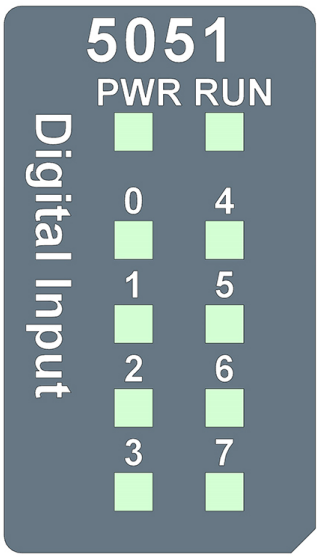


Figure 5.2 AMAX-5051 Module LED Indicator

Table 5.1: AMAX-5051 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission

DI0~7	Green	ON	Dry/Wet Logic "1"
		OFF	Dry/Wet Logic "0"

5.1.3 Pin Definition

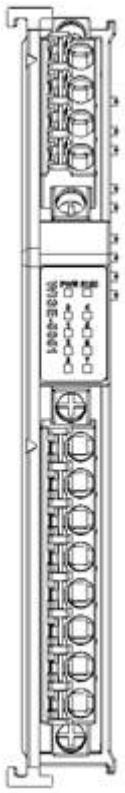


Figure 5.3 AMAX-5051 Module Front View

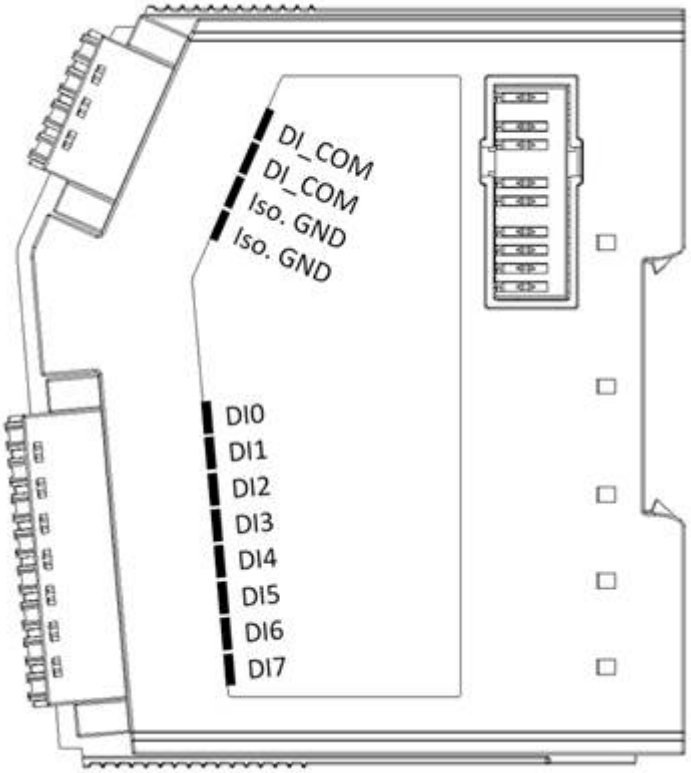


Figure 5.4 AMAX-5051 Module Side View

Table 5.2: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	DI_COM
2	DI_COM
3	Iso. GND
4	Iso. GND

Table 5.3: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DI0
2	DI1
3	DI2
4	DI3
5	DI4
6	DI5
7	DI6
8	DI7

5.1.4 Application Wiring

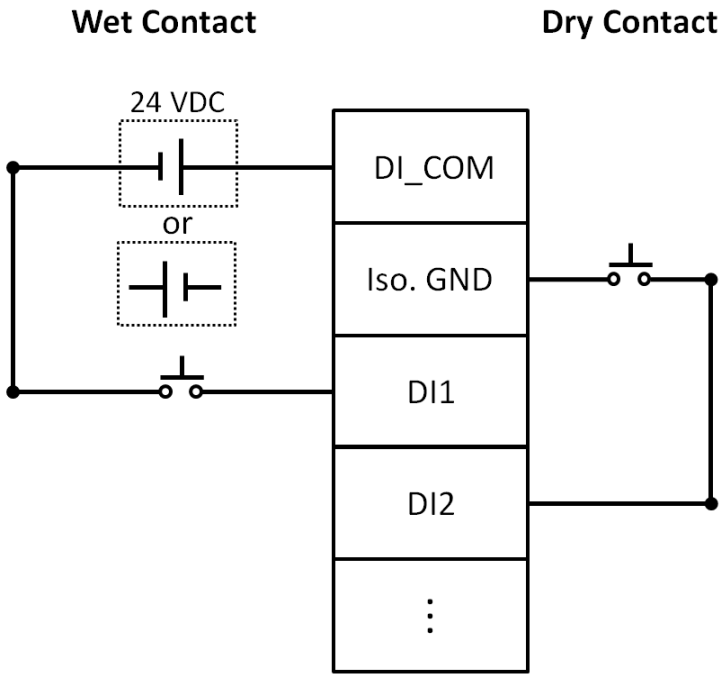


Figure 5.5 Wiring for AMAX-5051

5.1.5 AMAX-5051 Object Dictionary

5.1.5.1 Input Data (0x3001)

Table 5.4: Input Data (0x3001)

Index (hex)	Name	Meaning	Data type	Flags	Default value
3001:01	DI0	Digital Input Channel 0	BOOL	RO	0x00
3001:02	DI1	Digital Input Channel 1	BOOL	RO	0x00
3001:03	DI2	Digital Input Channel 2	BOOL	RO	0x00
3001:04	DI3	Digital Input Channel 3	BOOL	RO	0x00
3001:05	DI4	Digital Input Channel 4	BOOL	RO	0x00
3001:06	DI5	Digital Input Channel 5	BOOL	RO	0x00
3001:07	DI6	Digital Input Channel 6	BOOL	RO	0x00
3001:08	DI7	Digital Input Channel 7	BOOL	RO	0x00

5.1.5.2 PDO assignment (0x1C10 – 0x1C13)

Table 5.5: SM0, PDO assignment 0x1C10 (not changeable)

Index	Size (byte.bit)	Name	PDO content
0x1A00	1.0	Digital Input	3001:01 DI0; 3001:02 DI1; 3001:03 DI2; 3001:04 DI3; 3001:05 DI4; 3001:06 DI5; 3001:07 DI6; 3001:08 DI7

5.2 AMAX-5052 16-ch Digital Input Module

The AMAX-5052 features 16 digital input (sink/source) channels. The digital input channels offer LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.6 AMAX-5052 Module

5.2.1 AMAX-5052 Specification

5.2.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 6P+12P push-in terminal (#28~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN
- **Weight:** Approx. 80g

5.2.1.2 Digital Input

- **Channels:** 16
- **Digital Input:**
  - Dry Contact:
    Logic level 1: close to Iso.GND
    Logic level 0: open
  - Wet Contact:
    Rated voltage: $24V_{DC}$
    Logic level 1: 10~30 V_{DC} and -10~-$30V_{DC}$
    Logic level 0: -3~$3V_{DC}$
- **Input Delay:**
  - From logic 0 to 1: 4ms
  - From logic 1 to 0: 4ms
- **Digital Filter:** 3ms
- **Typical Input Current:** Logic level 1: 1.3mA~4.3mA (10V~30V)

5.2.1.3 Protection

- Isolation Voltage: $2,000V_{DC}$

5.2.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.2.2 LED Indicator

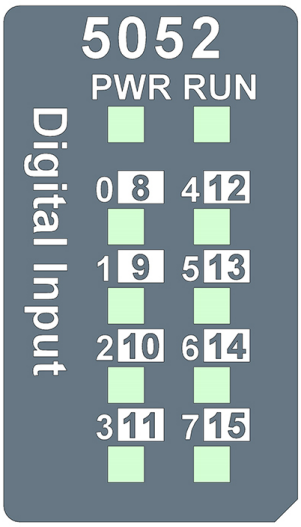


Figure 5.7 AMAX-5052 Module LED Indicator

Table 5.6: AMAX-5052Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
DI0~7	Green	ON	Dry/Wet Logic "1"
		OFF	Dry/Wet Logic "0"
DI8~15	Yellow	ON	Dry/Wet Logic "1"
		OFF	Dry/Wet Logic "0"

5.2.3 Pin Definition

Figure 5.8 AMAX-5052 Module Front View

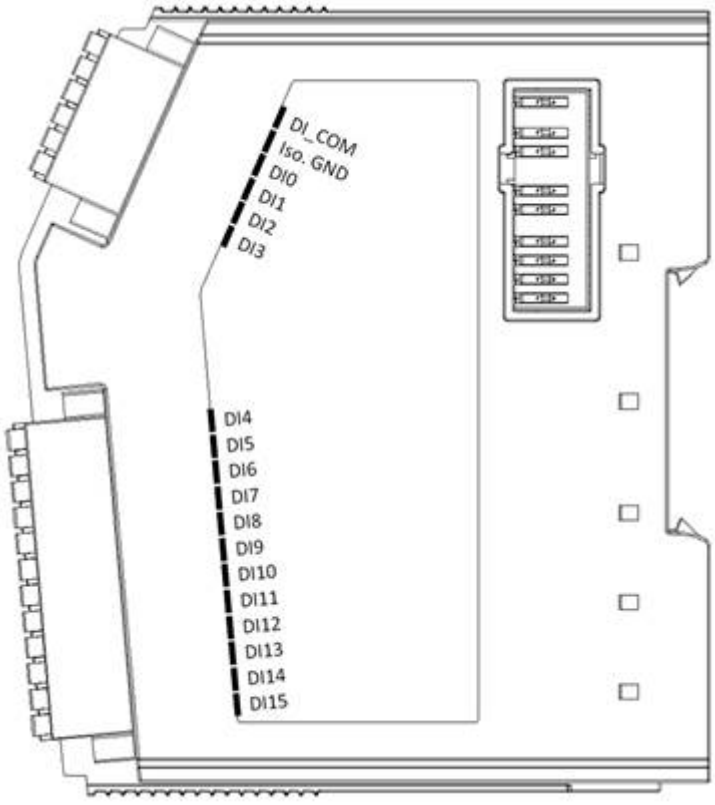


Figure 5.9 AMAX-5052 Module Side View

Table 5.7: Upper 6 Pin Connector	
Pin Number	**Pin Definition**
1	DI_COM
2	Iso. GND
3	DI0
4	DI1
5	DI2
6	DI3

Table 5.8: Lower 12 Pin Connector	
Pin Number	**Pin Definition**
1	DI4
2	DI5
3	DI6
4	DI7
5	DI8
6	DI9
7	DI10
8	DI11
9	DI12
10	DI13
11	DI14
12	DI15

5.2.4 Application Wiring

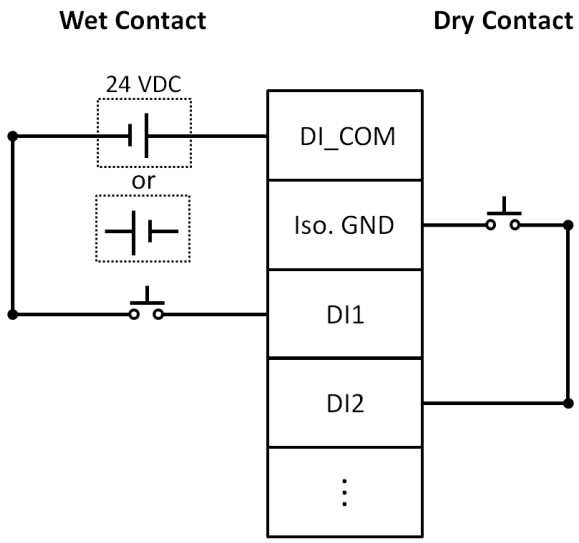


Figure 5.10 Wiring for AMAX-5052

5.2.5 AMAX-5052 Object Dictionary

5.2.5.1 Input Data (0x3001)

Table 5.9: Input Data (0x3001)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3001:01	DI0	Digital Input Channel 0	BOOL	RO	0x00
3001:02	DI1	Digital Input Channel 1	BOOL	RO	0x00
3001:03	DI2	Digital Input Channel 2	BOOL	RO	0x00
3001:04	DI3	Digital Input Channel 3	BOOL	RO	0x00
3001:05	DI4	Digital Input Channel 4	BOOL	RO	0x00
3001:06	DI5	Digital Input Channel 5	BOOL	RO	0x00
3001:07	DI6	Digital Input Channel 6	BOOL	RO	0x00
3001:08	DI7	Digital Input Channel 7	BOOL	RO	0x00
3002:01	DI8	Digital Input Channel 8	BOOL	RO	0x00
3002:02	DI9	Digital Input Channel 9	BOOL	RO	0x00
3002:03	DI10	Digital Input Channel 10	BOOL	RO	0x00
3002:04	DI11	Digital Input Channel 11	BOOL	RO	0x00
3002:05	DI12	Digital Input Channel 12	BOOL	RO	0x00
3002:06	DI13	Digital Input Channel 13	BOOL	RO	0x00
3002:07	DI14	Digital Input Channel 14	BOOL	RO	0x00
3002:08	DI15	Digital Input Channel 15	BOOL	RO	0x00

5.2.5.2 PDO assignment (0x1C10 - 0x1C13)

Table 5.10: SM0, PDO assignment 0x1C10 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A00	2.0	Digital Input	3001:01 DI0; 3001:02 DI1; 3001:03 DI2; 3001:04 DI3; 3001:05 DI4; 3001:06 DI5; 3001:07 DI6; 3001:08 DI7; 3002:01 DI8; 3002:02 DI9; 3002:03 DI10; 3002:04 DI11; 3002:05 DI12; 3002:06 DI13; 3002:07 DI14; 3002:08 DI15

5.3 AMAX-5056 8-ch Sink-type Digital Output Module

The AMAX-5056 module features 8 digital output (sink) channels. The digital output channels offer LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.11 AMAX-5056 Module

5.3.1 AMAX-5056 Specification

5.3.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, DO status
- **Weight:** Approx. 80g

5.3.1.2 Digital Output:

- **Channels:** 8 (Sink Type)
- **Voltage Rating:** 10~30V_{DC}
- **Rated Current Output:** 0.3A per channel at signal "1"
- **Leakage Current:** 25uA per channel at signal "0"
- **Output Delay:** From logic level 0 to 1: 10us
  From logic level 1 to 0: 100us

5.3.1.3 Protection

- **Isolation Voltage:** 2,000V_{DC}
- Internal Flyback diode for inductive load

5.3.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.3.2 LED Indicator

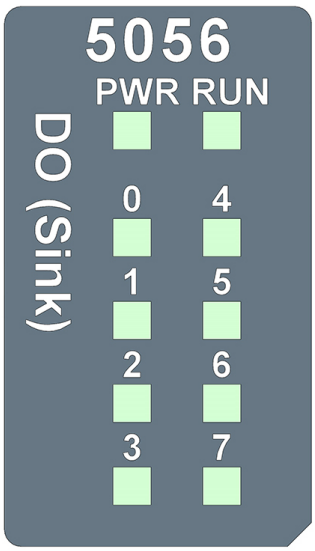


Figure 5.12 AMAX-5056 Module LED Indicator

Table 5.11: AMAX-5056 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
DO0~7	Green	ON	DO turn on
		OFF	DO turn off

5.3.3 Pin Definition

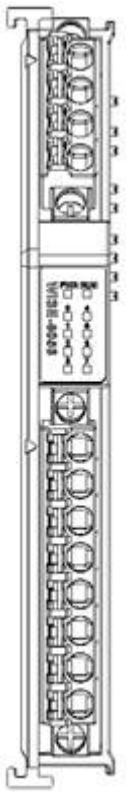


Figure 5.13 AMAX-5056 Module Front View

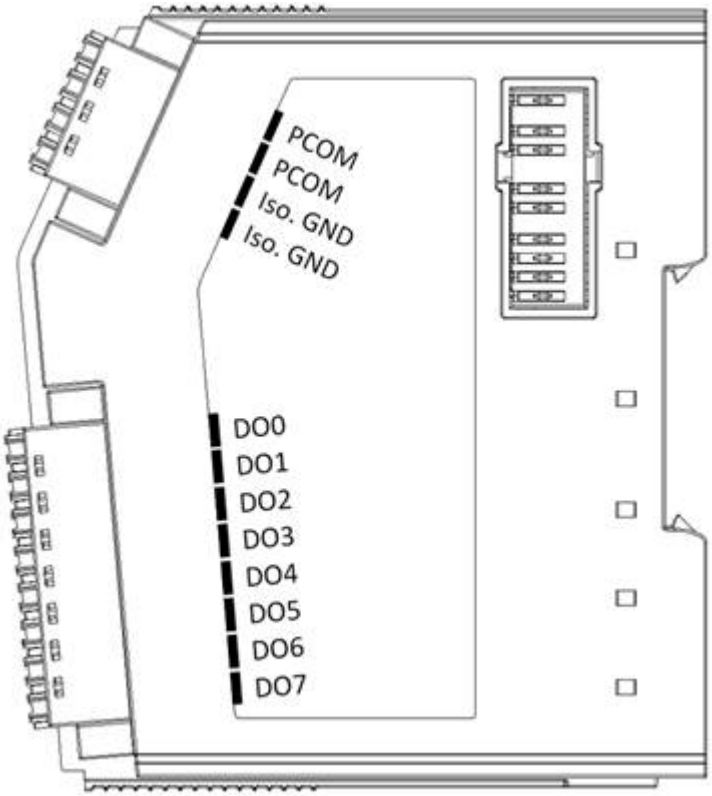


Figure 5.14 AMAX-5056 Module Side View

Table 5.12: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	PCOM
2	PCOM
3	Iso. GND
4	Iso. GND

Table 5.13: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DO0
2	DO1
3	DO2
4	DO3
5	DO4
6	DO5
7	DO6
8	DO7

5.3.4 Application Wiring

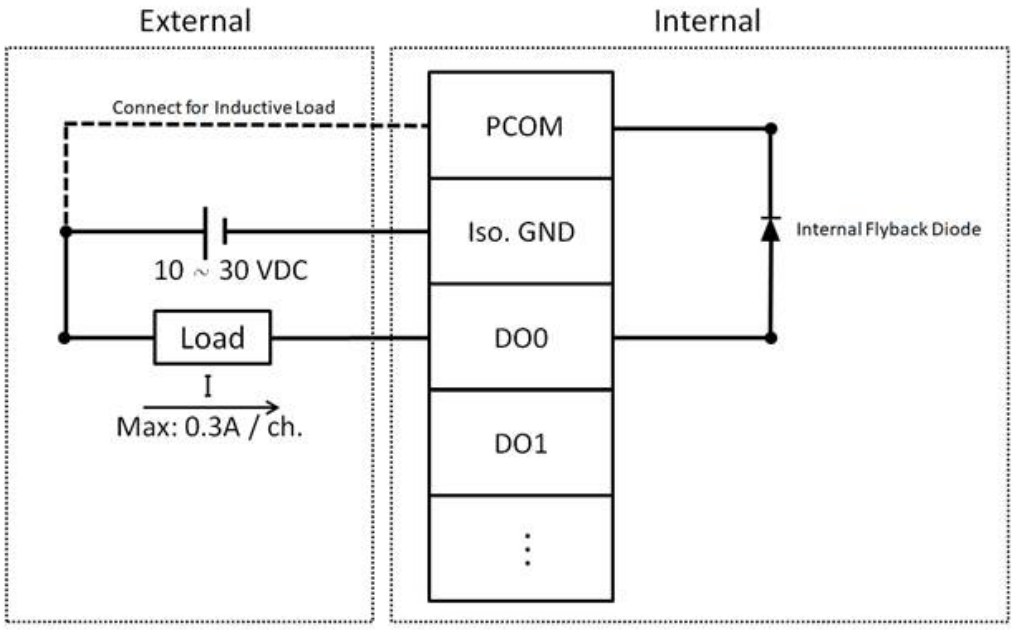


Figure 5.15 Wiring for AMAX-5056

5.3.5 AMAX-5056 Object Dictionary

5.3.5.1 Output Data (0x3101)

Table 5.14: Output Data (0x3101)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3101:01	DO0	Digital Output Channel 0	BOOL	RW	0x00
3101:02	DO1	Digital Output Channel 1	BOOL	RW	0x00
3101:03	DO2	Digital Output Channel 2	BOOL	RW	0x00
3101:04	DO3	Digital Output Channel 3	BOOL	RW	0x00
3101:05	DO4	Digital Output Channel 4	BOOL	RW	0x00
3101:06	DO5	Digital Output Channel 5	BOOL	RW	0x00
3101:07	DO6	Digital Output Channel 6	BOOL	RW	0x00
3101:08	DO7	Digital Output Channel 7	BOOL	RW	0x00

5.3.5.2 PDO assignment (0x1C10 - 0x1C13)

Table 5.15: SM0, PDO assignment 0x1C10 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	1.0	Digital Output	3101:01 DO0; 3101:02 DO1; 3101:03 DO2; 3101:04 DO3; 3101:05 DO4; 3101:06 DO5; 3101:07 DO6; 3101:08 DO7

5.4 AMAX-5056SO 8-ch Source-type Digital Output Module

The AMAX-5056SO module features 8 digital output (source) channels. The digital output channels offer and LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.16 AMAX-5056SO Module

5.4.1 AMAX-5056SO Specification

5.4.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, DO status
- **Weight:** Approx. 80g

5.4.1.2 Digital Output:

- **Channels:** 8 (Source Type)
- **Voltage Rating:** 10~30V_{DC}
- **Rated Current Output:** 0.5A per channel at signal "1"
- **Leakage Current:** 10uA per channel at signal "0"
- **Output Delay:** From logic level 0 to 1: 150us
  From logic level 1 to 0: 2ms

5.4.1.3 Protection

- **Isolation Voltage:** 2,000V_{DC}
- Internal Flyback diode for inductive load

5.4.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.4.2 LED Indicator

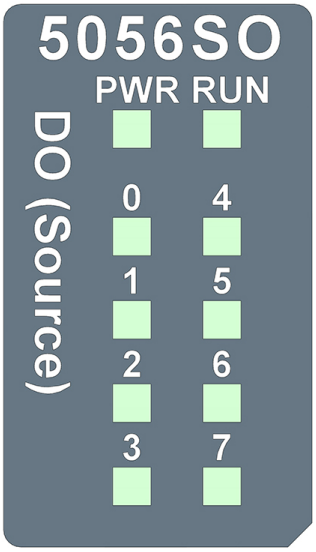


Figure 5.17 AMAX-5056SO Module LED Indicator

Table 5.16: AMAX-5056SO Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
DO0~7	Green	ON	DO turn on
		OFF	DO turn off

5.4.3 Pin Definition

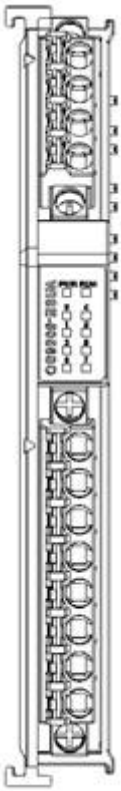


Figure 5.18 AMAX-5056SO Module Front View

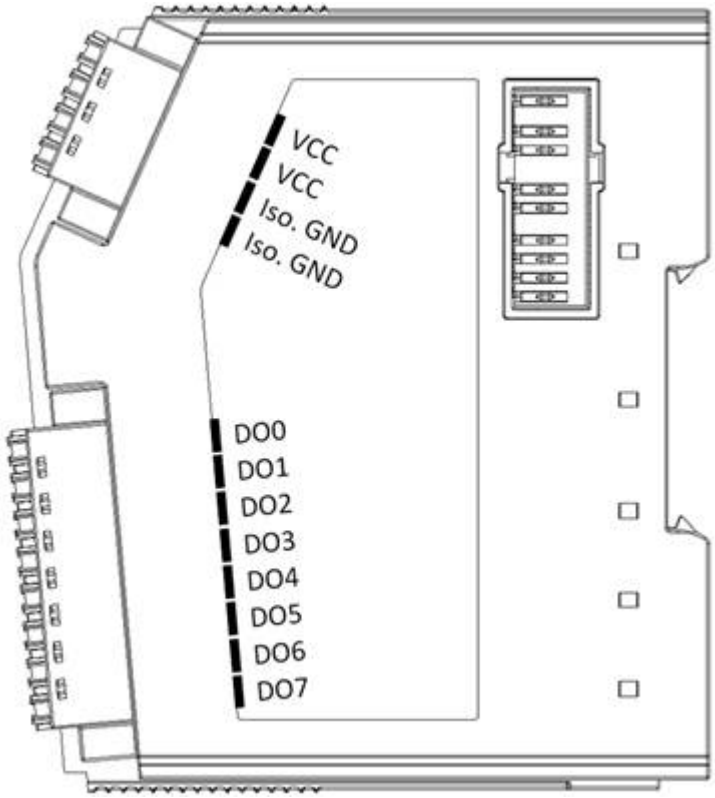


Figure 5.19 AMAX-5056SO Module Side View

Table 5.17: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	VCC
2	VCC
3	Iso. GND
4	Iso. GND

Table 5.18: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DO0
2	DO1
3	DO2
4	DO3
5	DO4
6	DO5
7	DO6
8	DO7

5.4.4 Application Wiring

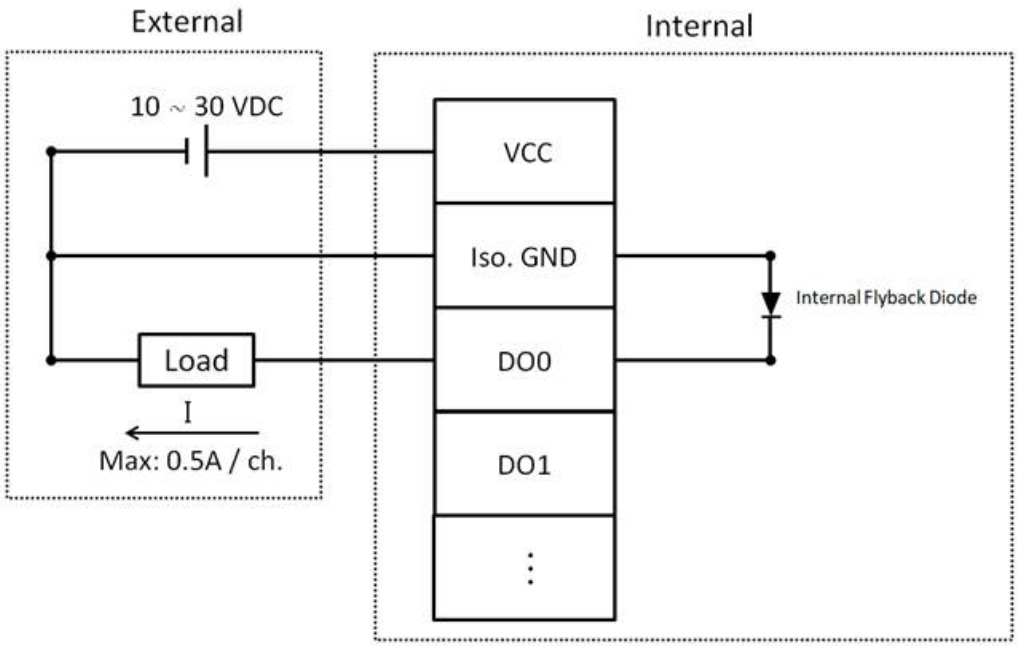


Figure 5.20 Wiring for AMAX-5056SO

5.4.5 AMAX-5056SO Object Dictionary

5.4.5.1 Output Data (0x3101)

Table 5.19: Output Data (0x3101)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3101:01	DO0	Digital Output Channel 0	BOOL	RW	0x00
3101:02	DO1	Digital Output Channel 1	BOOL	RW	0x00
3101:03	DO2	Digital Output Channel 2	BOOL	RW	0x00
3101:04	DO3	Digital Output Channel 3	BOOL	RW	0x00
3101:05	DO4	Digital Output Channel 4	BOOL	RW	0x00
3101:06	DO5	Digital Output Channel 5	BOOL	RW	0x00
3101:07	DO6	Digital Output Channel 6	BOOL	RW	0x00
3101:08	DO7	Digital Output Channel 7	BOOL	RW	0x00

5.4.5.2 PDO assignment (0x1C10 - 0x1C13)

Table 5.20: SM0, PDO assignment 0x1C10 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	1.0	Digital Output	3101:01 DO0; 3101:02 DO1; 3101:03 DO2; 3101:04 DO3; 3101:05 DO4; 3101:06 DO5; 3101:07 DO6; 3101:08 DO7

5.5 AMAX-5057 16-ch Sink-type Digital Output Module

The AMAX-5057 module features 16 digital output (sink) channels. The digital output channels offer LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.21 AMAX-5057 Module

5.5.1 AMAX-5056 Specification

5.5.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 6P+12P push-in terminal (#28~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2.5W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN
- **Weight:** Approx. 80g

5.5.1.2 Digital Output:

- **Channels:** 16 (Sink Type)
- **Voltage Rating:** 10~30V_{DC}
- **Rated Current Output:** 0.3A per channel at signal "1"
- **Leakage Current:** 25uA per channel at signal "0"
- **Output Delay:** From logic level 0 to 1: 10us
  From logic level 1 to 0: 100us

5.5.1.3 Protection

- **Isolation Voltage:** 2,000V_{DC}
- Internal Flyback diode for inductive load

5.5.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.5.2 LED Indicator

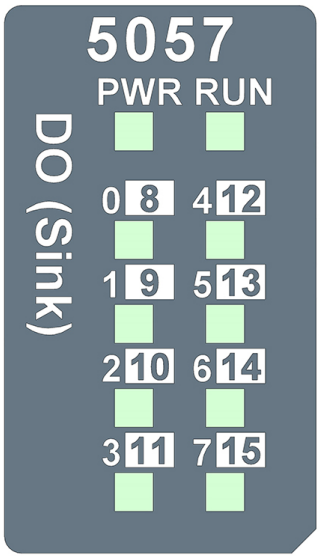


Figure 5.22 AMAX-5057 Module LED Indicator

Table 5.21: AMAX-5057 Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
DO0~7	Green	ON	DO turn on
		OFF	DO turn off
DO8~15	Yellow	ON	DO turn on
		OFF	DO turn off

5.5.3 Pin Definition

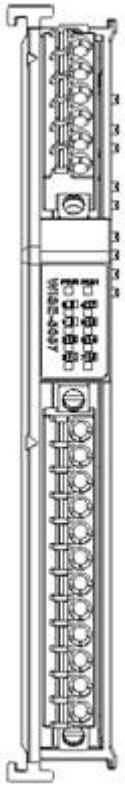


Figure 5.23 AMAX-5057 Module Front View

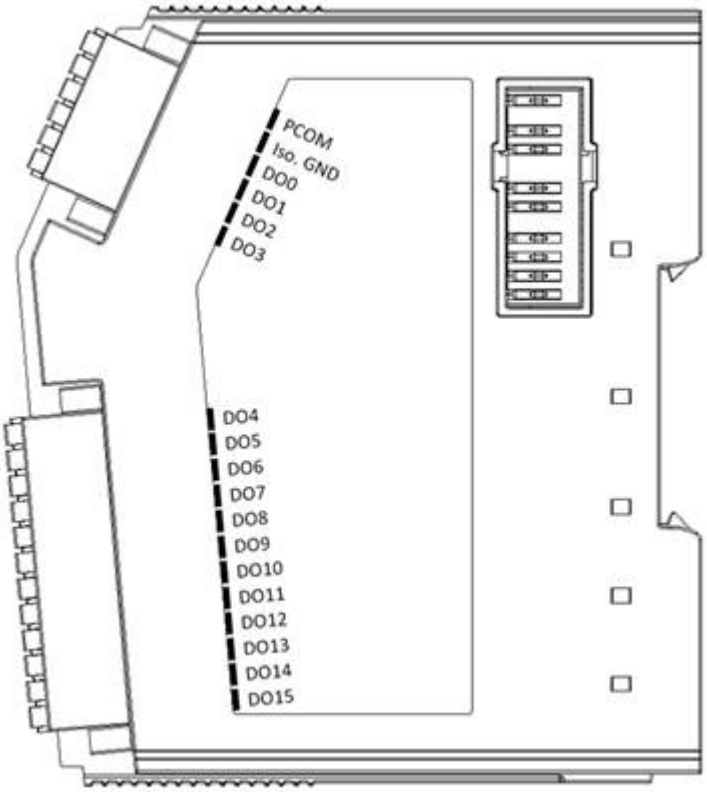


Figure 5.24 AMAX-5057 Module Side View

Table 5.22: Upper 6 Pin Connector	
Pin Number	**Pin Definition**
1	PCOM
2	Iso. GND
3	DO1
4	DO2
5	DO3
6	DO4

Table 5.23: Lower 12 Pin Connector	
Pin Number	**Pin Definition**
1	DO4
2	DO5
3	DO6
4	DO7
5	DO8
6	DO9
7	DO10
8	DO11
9	DO12
10	DO13
11	DO14
12	DO15

5.5.4 Application Wiring

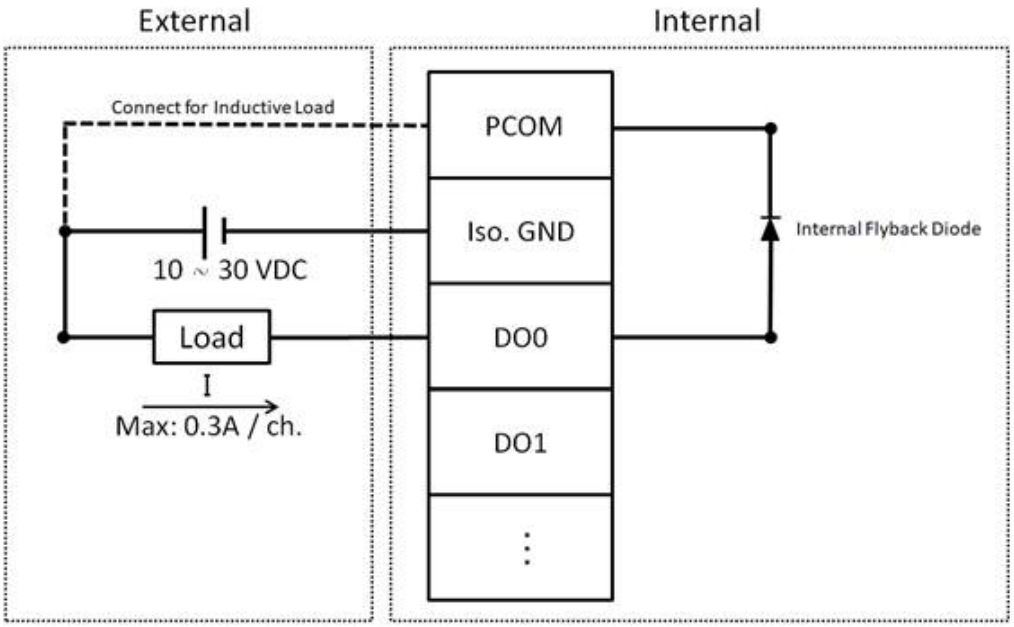


Figure 5.25 Wiring for AMAX-5057

5.5.5 AMAX-5057 Object Dictionary

5.5.5.1 Output Data (0x3101 – 0x3102)

Table 5.24: Output Data (0x3101 – 0x3102)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3101:01	DO0	Digital Output Channel 0	BOOL	RW	0x00
3101:02	DO1	Digital Output Channel 1	BOOL	RW	0x00
3101:03	DO2	Digital Output Channel 2	BOOL	RW	0x00
3101:04	DO3	Digital Output Channel 3	BOOL	RW	0x00
3101:05	DO4	Digital Output Channel 4	BOOL	RW	0x00
3101:06	DO5	Digital Output Channel 5	BOOL	RW	0x00
3101:07	DO6	Digital Output Channel 6	BOOL	RW	0x00
3101:08	DO7	Digital Output Channel 7	BOOL	RW	0x00
3102:01	DO8	Digital Output Channel 8	BOOL	RW	0x00
3102:02	DO9	Digital Output Channel 9	BOOL	RW	0x00
3102:03	DO10	Digital Output Channel 10	BOOL	RW	0x00
3102:04	DO11	Digital Output Channel 11	BOOL	RW	0x00
3102:05	DO12	Digital Output Channel 12	BOOL	RW	0x00
3102:06	DO13	Digital Output Channel 13	BOOL	RW	0x00
3102:07	DO14	Digital Output Channel 14	BOOL	RW	0x00
3102:08	DO15	Digital Output Channel 15	BOOL	RW	0x00

5.5.5.2 PDO assignment (0x1C10 - 0x1C13)

Table 5.25: SM0, PDO assignment 0x1C10 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	2.0	Digital Output	3101:01 DO0; 3101:02 DO1; 3101:03 DO2; 3101:04 DO3; 3101:05 DO4; 3101:06 DO5; 3101:07 DO6; 3101:08 DO7; 3102:01 DO8; 3102:02 DO9; 3102:03 DO10; 3102:04 DO11; 3102:05 DO12; 3102:06 DO13; 3102:07 DO14; 3102:08 DO15

(DO8-15 mapping to 0x1A01(SM1) before revision number: 0x00000002)

5.6 AMAX-5057SO 16-ch Source-type Digital Output Module

The AMAX-5057SO module features 16 digital output (source) channels. The digital output channels offer and LED to indicate digital status. The module provides 2,000 V_{DC} optical isolation between channels. If any high voltage or current damages the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 5.26 AMAX-5057SO Module

5.6.1 AMAX-5057SO Specification

5.6.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 6P+12P push-in terminal (#28~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2.5W @ 24V_{DC}
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN
- **Weight:** Approx. 80g

5.6.1.2 Digital Output

- **Channels:** 16 (Source Type)
- **Voltage Rating:** 10~30V_{DC}
- **Rated Current Output:** 0.5A per channel at signal "1"
- **Leakage Current:** 10uA per channel at signal "0"
- **Output Delay:** From logic level 0 to 1: 150us
  From logic level 1 to 0: 2ms

5.6.1.3 Protection

- **Isolation Voltage:** 2,000V_{DC}
- Internal Flyback diode for inductive load

5.6.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

5.6.2 LED Indicator

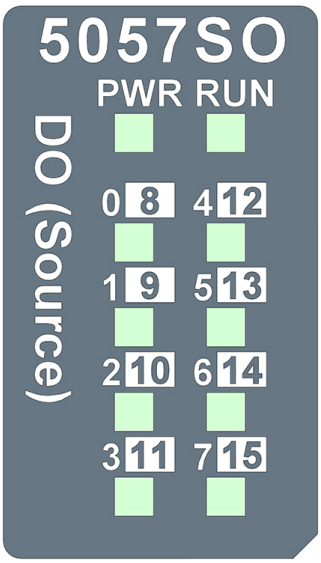


Figure 5.27 AMAX-5057SO Module LED Indicator

Table 5.26: AMAX-5057SO Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
DO0~7	Green	ON	DO turn on
		OFF	DO turn off
DO8~15	Yellow	ON	DO turn on
		OFF	DO turn off

5.6.3 Pin Definition and Wiring

Figure 5.28 AMAX-5057SO Module Front View

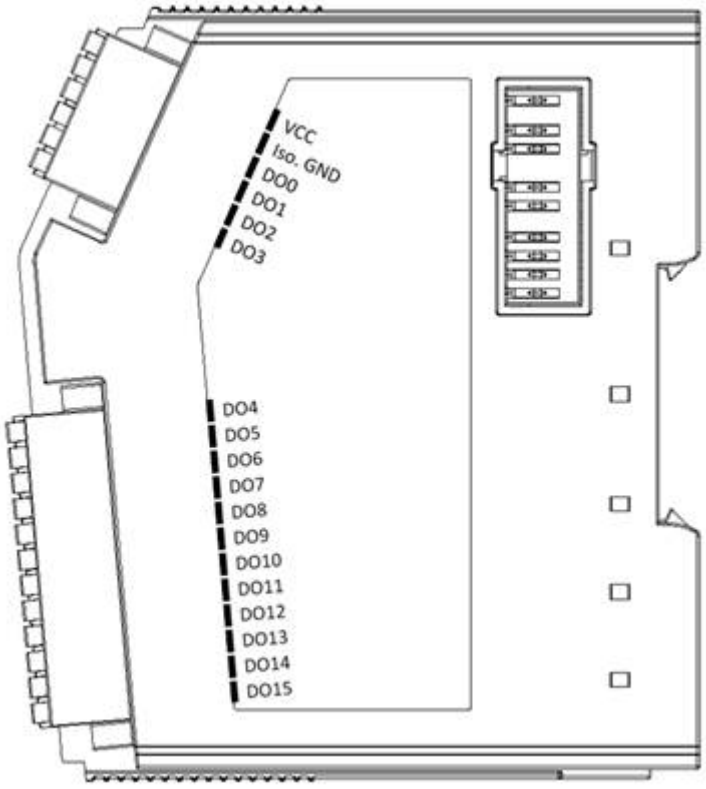


Figure 5.29 AMAX-5057SO Module Side View

Table 5.27: Upper 6 Pin Connector	
Pin Number	**Pin Definition**
1	VCC
2	Iso. GND
3	DO1
4	DO2
5	DO3
6	DO4

Table 5.28: Lower 12 Pin Connector	
Pin Number	**Pin Definition**
1	DO4
2	DO5
3	DO6
4	DO7
5	DO8
6	DO9
7	DO10
8	DO11
9	DO12
10	DO13
11	DO14
12	DO15

5.6.4 Application Wiring

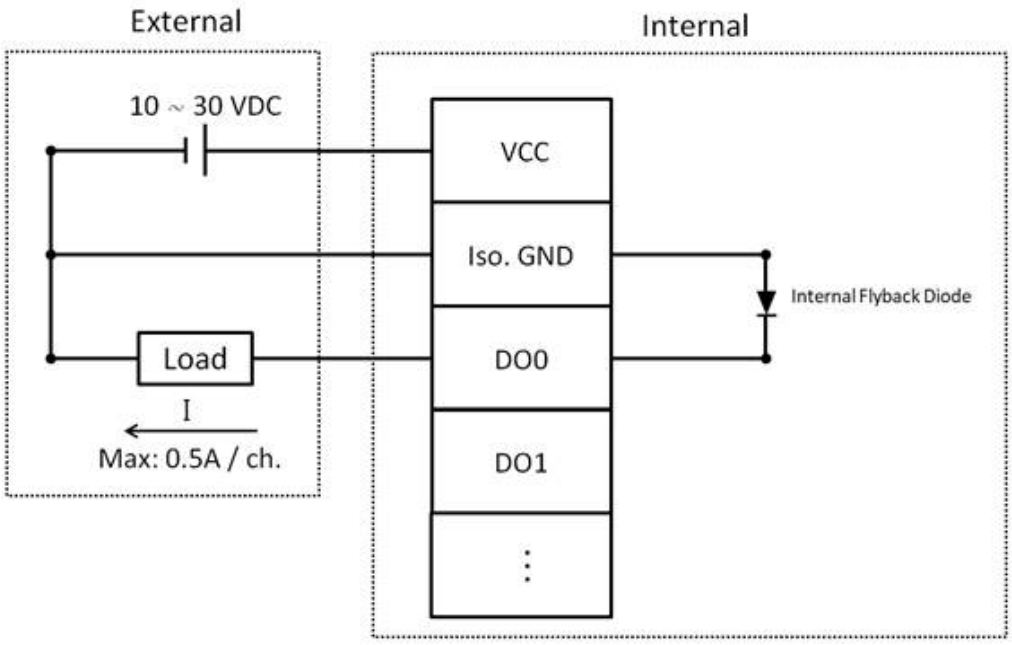


Figure 5.30 Wiring for AMAX-5057SO

5.6.5 AMAX-5057SO Object Dictionary

5.6.5.1 Output Data (0x3101 – 0x3102)

Table 5.29: Output Data (0x3101 – 0x3102)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3101:01	DO0	Digital Output Channel 0	BOOL	RW	0x00
3101:02	DO1	Digital Output Channel 1	BOOL	RW	0x00
3101:03	DO2	Digital Output Channel 2	BOOL	RW	0x00
3101:04	DO3	Digital Output Channel 3	BOOL	RW	0x00
3101:05	DO4	Digital Output Channel 4	BOOL	RW	0x00
3101:06	DO5	Digital Output Channel 5	BOOL	RW	0x00
3101:07	DO6	Digital Output Channel 6	BOOL	RW	0x00
3101:08	DO7	Digital Output Channel 7	BOOL	RW	0x00
3102:01	DO8	Digital Output Channel 8	BOOL	RW	0x00
3102:02	DO9	Digital Output Channel 9	BOOL	RW	0x00
3102:03	DO10	Digital Output Channel 10	BOOL	RW	0x00
3102:04	DO11	Digital Output Channel 11	BOOL	RW	0x00
3102:05	DO12	Digital Output Channel 12	BOOL	RW	0x00
3102:06	DO13	Digital Output Channel 13	BOOL	RW	0x00
3102:07	DO14	Digital Output Channel 14	BOOL	RW	0x00
3102:08	DO15	Digital Output Channel 15	BOOL	RW	0x00

5.6.5.2 PDO assignment (0x1C10 - 0x1C13)

Table 5.30: SM0, PDO assignment 0x1C10 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	2.0	Digital Output	3101:01 DO0; 3101:02 DO1; 3101:03 DO2; 3101:04 DO3; 3101:05 DO4; 3101:06 DO5; 3101:07 DO6; 3101:08 DO7; 3102:01 DO8; 3102:02 DO9; 3102:03 DO10; 3102:04 DO11; 3102:05 DO12; 3102:06 DO13; 3102:07 DO14; 3102:08 DO15

(DO8-15 mapping to 0x1A01(SM1) before revision number: 0x00000002)

Chapter 6

Counter/Encoder Module

6.1 AMAX-5080 2-ch Counter/ Encoder 32-bit

The AMAX-5080 is a 32-bit 2-ch counter/encoder module which supports Encoder Mode and Bi-direction Mode. It supports up to 1MHz input frequency. The module provides 2000 VDC optical isolation, if any high voltage or current damage the channels, the whole system (other modules or control unit) will not be damaged.

Figure 6.1 AMAX-5080 Module

6.1.1 AMAX-5080 Specification

6.1.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 6P+12P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **Distributed Clock:** Default not supported
- **LED Indicator:** PWR, RUN, A/B/Z/L status
- **Weight:** Approx. 80g

6.1.1.2 Counter Input

- **Channels:** 2
- **Counter Range:** 32 bit
- **Modes:** Counter (up/down, bi-direction, up, A/B/Z Phase, DI latch)
  Frequency:
- **Signal Input:**
  Logic 0: -3…+5 V (EN 61131-2, type 1/3)
  Logic 1: 11…30 V (EN 61131-2, type 3)
- **Input Frequency:** 1 MHz max.

6.1.1.3 Protection

Isolation Voltage: $2,000V_{DC}$

6.1.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

6.1.2 LED Indicator

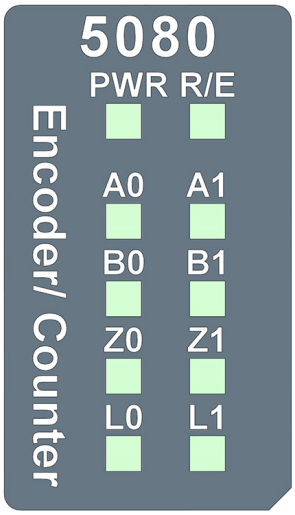


Figure 6.2 AMAX-5080 Module LED Indicator

Table 6.1: LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	Red	ON/Blink	System Abnormal
		OFF	No Error
A0	Green	ON	Signal Input
A1	Green	ON	Signal Input
B0	Green	ON	Signal Input
B1	Green	ON	Signal Input
Z0	Green	ON	Signal Input
Z1	Green	ON	Signal Input
L0	Green	ON	Signal Input
L1	Green	ON	Signal Input

6.1.3 Pin Definition

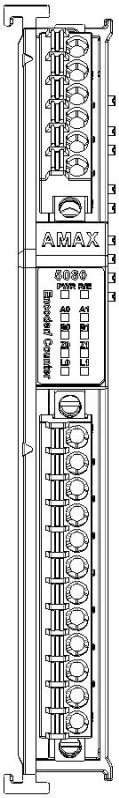


Figure 6.3 AMAX-5080 Module Front View

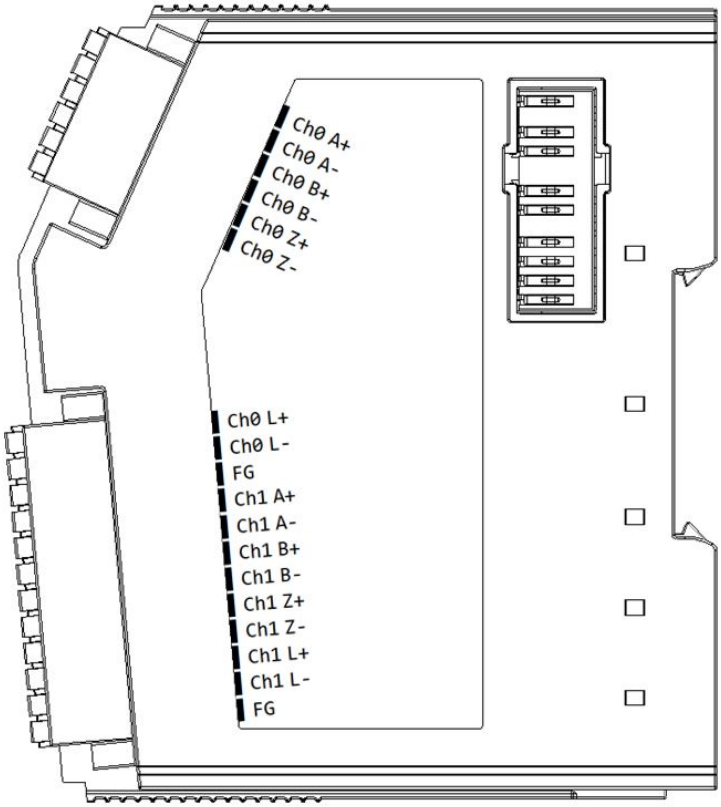


Figure 6.4 AMAX-5080 Module Side View

Table 6.2: Upper 6 Pin Connector	
Pin Number	**Pin Definition**
1	Ch0 A+
2	Ch0 A-
3	Ch0 B+
4	Ch0 B-
5	Ch0 Z+
6	Ch0 Z-

Table 6.3: Lower 12 Pin Connector	
Pin Number	**Pin Definition**
1	Ch0 L+
2	Ch0 L-
3	FG
4	Ch1 A+
5	Ch1 A-
6	Ch1 B+
7	Ch1 B-
8	Ch1 Z+
9	Ch1 Z-
10	Ch1 L+
11	Ch1 L-
12	FG

6.1.4 Application Wiring

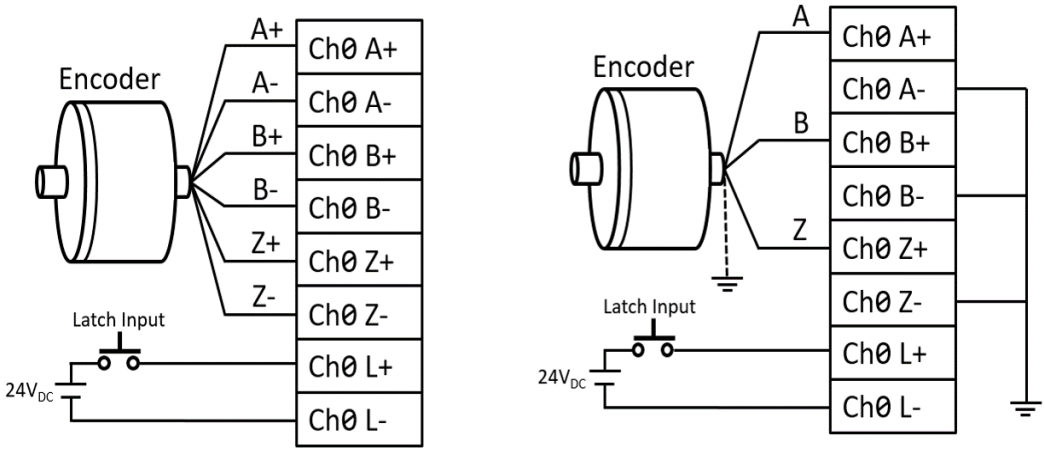


Figure 6.5 Wiring for AMAX-5080

6.1.5 Circuit Layout

6.1.5.1 Encoder Input

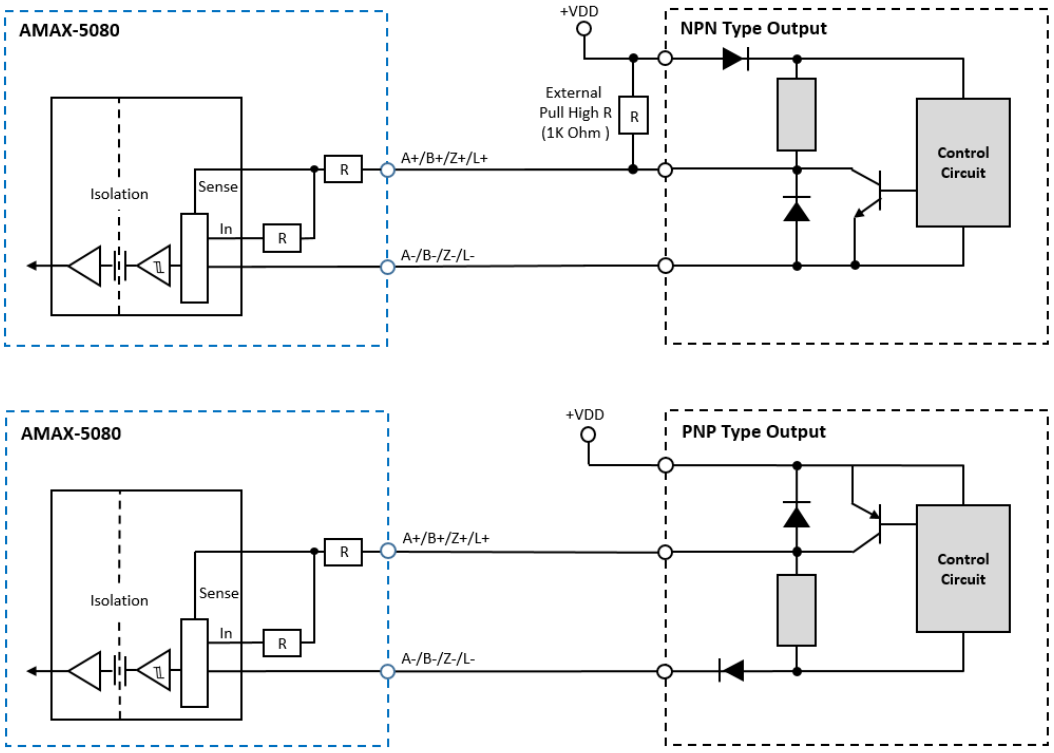


Figure 6.6 AMAX-5080 Encoder Input

6.1.6 AMAX-5080 Counter Mode

The AMAX-5080 supports two counter modes, the counter mode can be set by the Cn_Mode_Select (0x80n0:01) value “0” (Encoder Mode) or “1” (Bi-Direction Mode).

- Encoder Mode
- Bi-Direction Mode

Both modes support the following features:

- Overflow/underflow detection and reload counter
- Latch counter value
- Reset counter value
- Set counter value
- Counter frequency measurement
- Input Filter

6.1.6.1 Encoder Mode

The Behavior of A/B Phase 4X Quadrant Counter

The figure below shows Encoder Mode counter behavior. Ch0_A and Ch0_B are single-ended signals from the incremental encoder, if the “A” pulse is rising 90° ahead of the “B” pulse, the counter value increases; if the “B” pulse is rising ahead of the “A”, the counter value decreases.

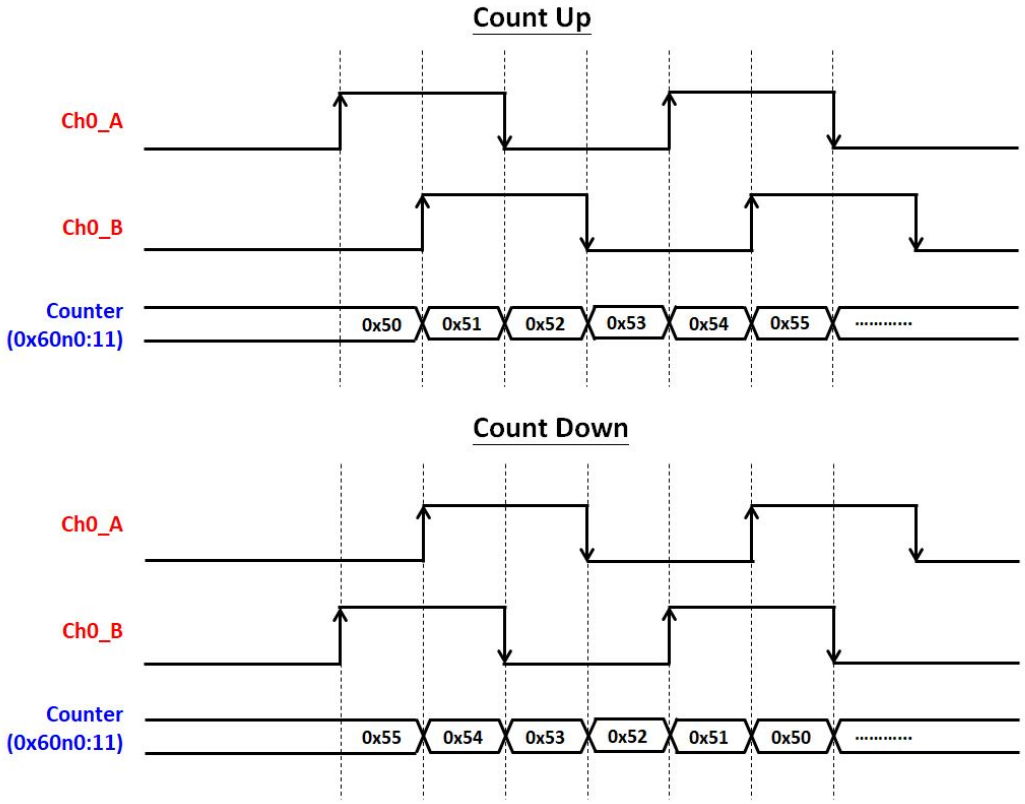


Figure 6.7 Encoder Mode – A/B Phase 4X

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

n=0~1 for Ch0~1

The counter value and A, B phase status can be read at below Index:

Table 6.4: Encoder Mode parameter index

Name	Index
CIn_Counter_Value	0x60n0:11
CIn_Status_of_Input_A	0x60n0:09
CIn_Status_of_Input_B	0x60n0:0A

6.1.6.2 Bi-Direction Mode

The Behavior of Pulse Direction Counter

The figure below shows Bi-Direction Mode counter behavior, Ch0_A is a single-ended pulse from encoder or any pulse generator. Ch0_B is a digital input which indicates the counter direction. When Ch0_B is high, the counter value counts up with the Ch0_A input pulse (Rising Edge-Triggered); when Ch0_B is low, the counter value counts down with the Ch0_A input pulse.

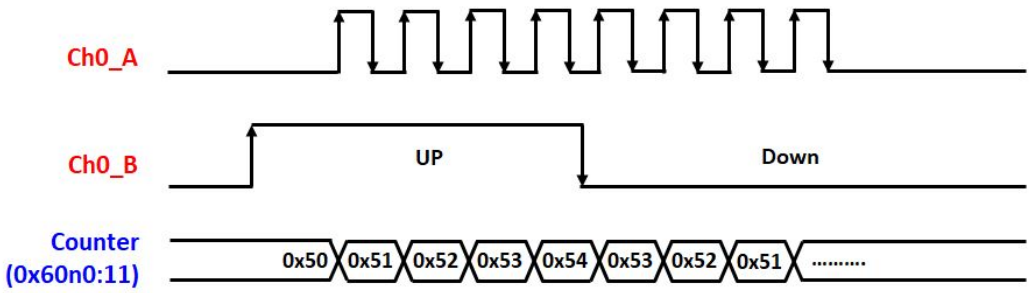


Figure 6.8 Bi-Direction Mode – Pulse Direction

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

n=0~1 for Ch0~1

The counter value and A, B signal input status can be read below:

Table 6.5: Bi-Direction Mode parameter index

Name	Index
CIn_Counter_Value	0x60n0:11
CIn_Status_of_Input_A	0x60n0:09
CIn_Status_of_Input_B	0x60n0:0A

6.1.7 Counter Features

These features are all applied for either Encoder Mode or Bi-Direction Mode. The PDO index is listed on 6.1.7 Object description and parameterization.

6.1.7.1 Overflow/Underflow Detection and Reload Counter

Overflow and Underflow

When counter value exceeds the counter boundaries, the CIn_Over_Flow (0x60n0:04) or CIn_Under_Flow (0x60n0:05) will be set to "1" correspondingly. The boundaries can be 0x00/0xFFFFFFFF or 0x00/Cn_Reload_Counter_Values (when the reload counter is set).

The figure below shows an example of overflow/underflow behavior under Bi-direction Mode, the same behavior also applies for Encoder Mode.

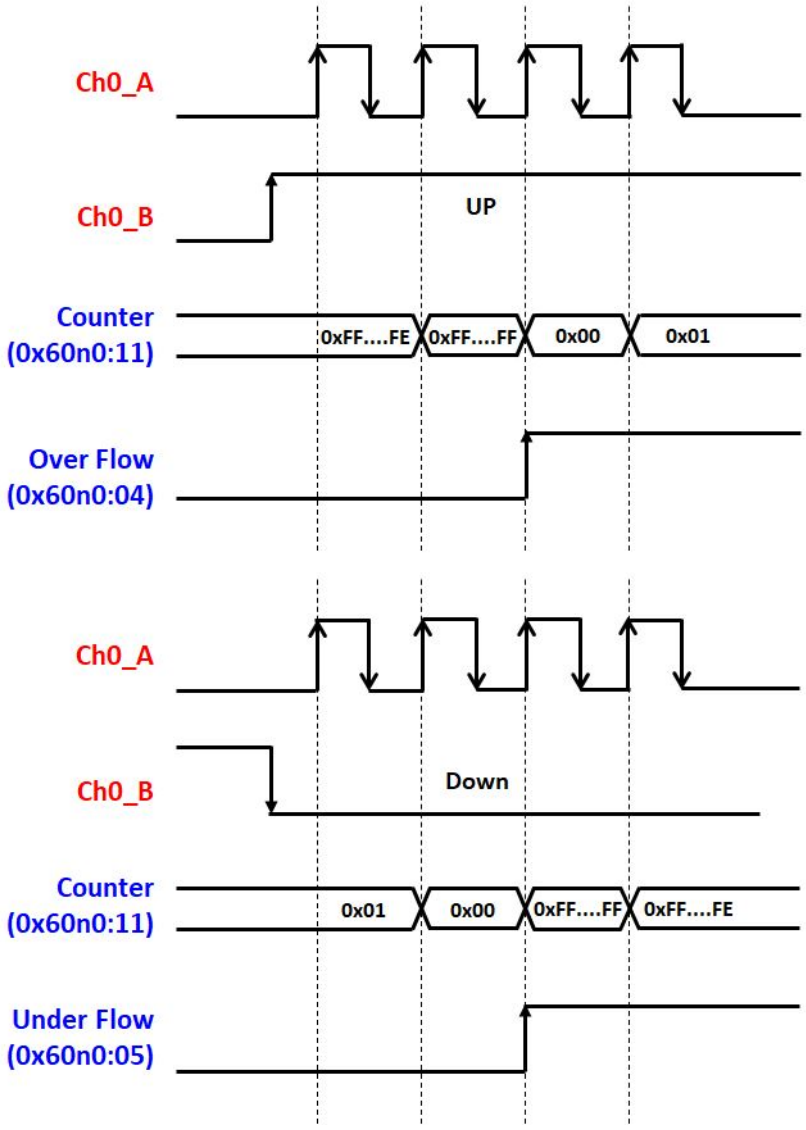


Figure 6.9 Counter Overflow and Underflow

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

n=0~1 for Ch0~1

Reset Underflow and Overflow flag

CIn_Over_Flow will be clear to “0” automatically once the counter value over 1/3 of the 0xFFFFFFFF or Cn_Reload_Counter_Values (when the reload counter is set) after overflow flag is triggered.

CIn_Under_Flow will be clear to “0” automatically once the counter value under 2/3 of the 0xFFFFFFFF or Cn_Reload_Counter_Values (when the reload counter is set) after underflow flag is triggered.

Reload Counter Value

Users can set the Cn_Reload_Counter_Values (0x80n0:07) to adjust the counter boundaries when Cn_Enable_Register_Reload (0x80n0:06) is enabled. The process of boundaries setting and the underflow/overflow status reset count can refer to below example.

Example: Set Reload Counter Value to 0x00003000

Step1: Set C0_Reload_Counter_Values to 0x00003000

Step2: Set C0_Enable_Register_Reload to Enable

Step3: Counter range will become 0 ~ 0x00003000

Table 6.6: Reload Counter Definitions

Reload Register	Reload Value	Counter Boundary	Overflow Status Reset	Underflow Status Reset
Enable	0x00003000	0 to 0x00003000	0x00001000	0x00002000
Disable (default)	NA	0 to 0xFFFFFFFF	0x55555555	0xAAAAAAAA

6.1.7.2 Latch Counter Value

The counter values can be latched by external signals. Both L or Z pin can be configured independently as an latch signal input pin, the latched counter value can be read at CI0_Latch_Values(0x6000:12). The active polarity (Rising or Falling Edge-triggered) of the latch input signal can also be configured. All related configurable parameters and the status of Z and L pin are listed below:

Table 6.7: Latch Counter Parameters

	Z pin	L pin
Enable Latch	COn_Enable_Latch_Z (0x70n0:02)	COn_Enable_Latch_External (0x70n0:03)
Enable Latch Valid	CIn_Latch_Z_Valid (0x60n0:02)	CIn_Latch_External_Valid (0x60n0:03)
Active Polarity	Cn_Z_Pulse_Active_Polarity (0x80n0:03)	Cn_External_Latch_Active_Polarity (0x80n0:05)
Status	CIn_Status_of_Input_Z (0x60n0:0C)	CIn_Status_of_Input_External_Latch (0x60n0:11)

* Active Polarity: 0: Rising Edge, 1: Falling Edge

n=0~1 for Ch0~1

The example below shows how to latch the counter value by an external signal at rising edge on Ch0 Z pin under Bi-Direction Mode:

Step 0: Set Rising Edge-Triggered at C0_Z_Pulse_Active_Polarity (0x8000:05)

Step 1: Enable CO0_Enable_Latch_Z (0x7000:02)

Step 2: Check CI0_Latch_Z_Valid (0x6000:02) frequently, if the bit is high, the counter value is successfully latched by an external signal.

Step 3: Read latch values at CI0_Latch_Values (0x6000:12)

Step 4: Before next latch signal coming, the CO0_Enable_Latch_Z (0x7000:02) should be toggled once to clear the CI0_Latch_Z_Valid (0x6000:02) status.

Step5: Once the CI0_Latch_Z_Valid (0x6000:02) bit is low, the module is ready for the next latching signal.

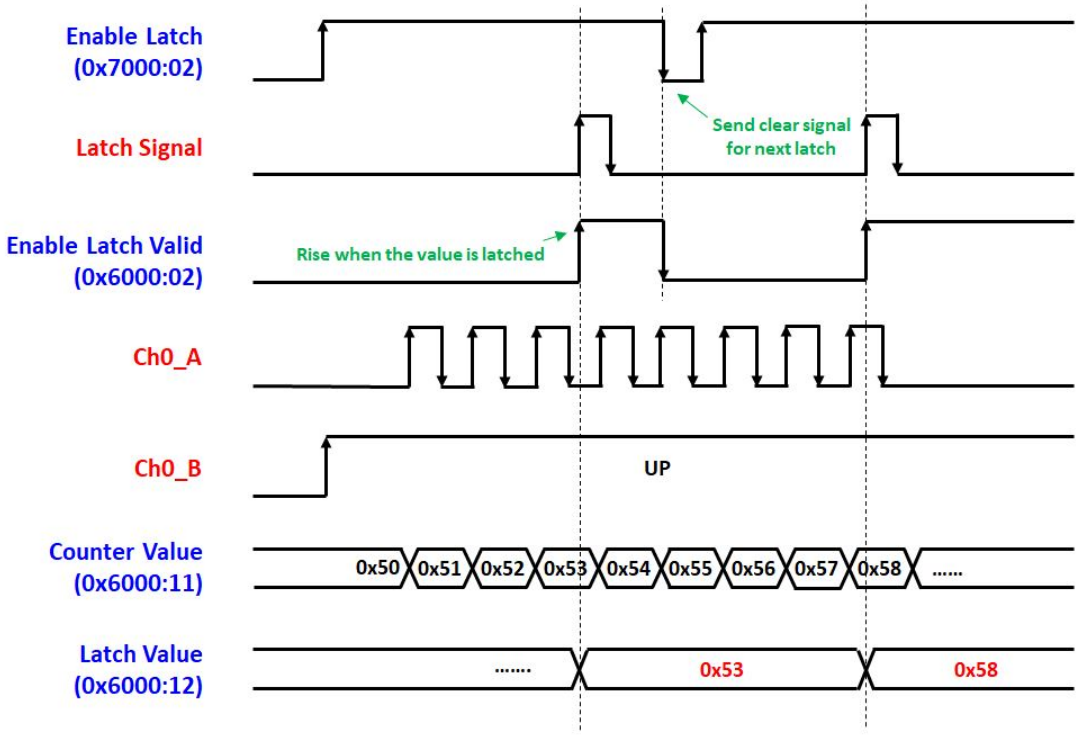


Figure 6.10 Latch Counter by Z pin

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

Note! *CI0_Latch_Values(0x6000:12) can be overwritten by both Z and L pin if those pins are configured correctly.*

6.1.7.3 Reset Counter Value

The counter values can also be reset by external signals.

Both L and Z pin can be configured independently as an reset signal input pin. Once the configured Reset pin is triggered, the CIn_Counter_Value (0x60n0:11) and the CIn_Latch_Values (0x60n0:12) will both reset to “0”.

If the Z or L pin is configured as a reset pin, the latch function of that pin will become invalid automatically.

The index of Enable Rest and the Status of Z and L pin are listed below:

Table 6.8: Reset Counter Parameters

	Z pin	L pin
Enable Reset	Cn_Enable_Z_Pulse_Reset (0x80n0:02)	Cn_Enable_External_Reset (0x80n0:04)
Enable Latch	COn_Enable_Latch_Z (0x70n0:02)	COn_Enable_Latch_External (0x70n0:03)
Status	CIn_Status_of_Input_Z (0x60n0:0C)	CIn_Status_of_Input_External_Latch (0x60n0:11)

* Enable Reset: 0: Disable, 1: Enable

n=0~1 for Ch0~1

The example below shows how to reset the counter value by an external signal on Ch0 Z pin in Bi-Direction Mode (Ch0 L pin as a Latch input):

Example: Reset Counter Value and Latch Counter Value

Step1: Set C0_Enable_Z_Pulse_Reset (0x8000:02) to “1”.

Step2: Set COn_Enable_Latch_Z (0x70n0:02) to "1"

Step3: An external reset signal (Rising edge-triggered) at Z pin will clear both CIn_Counter_Value (0x6000:11) and CIn_Latch_Values (0x600n0:12)

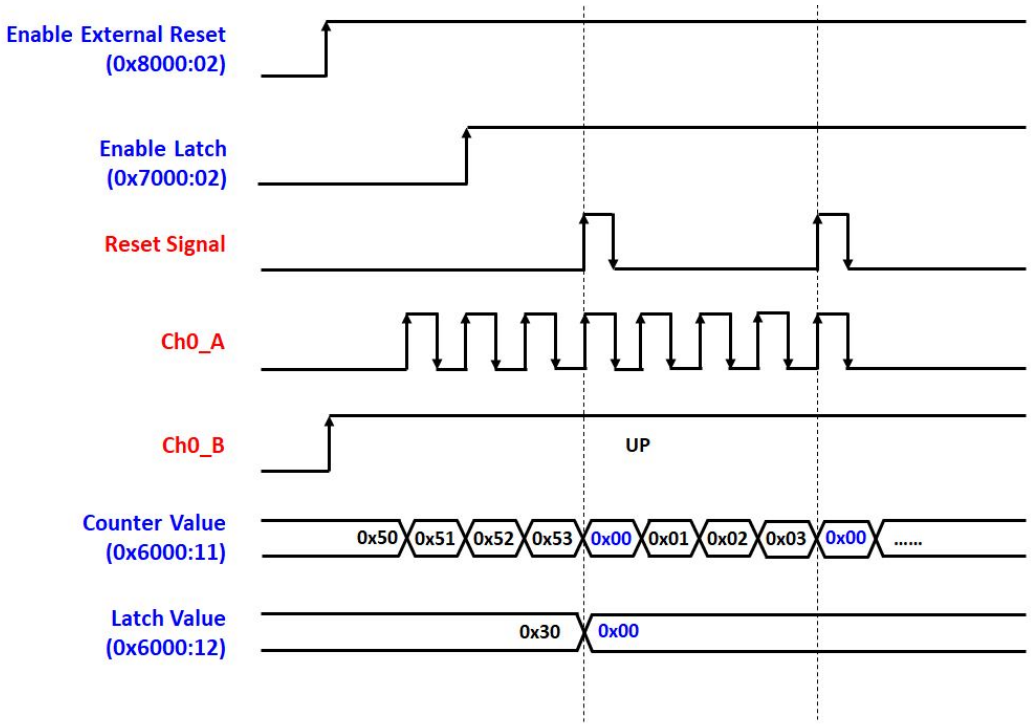


Figure 6.11 Reset Counter by Z pin

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

6.1.7.4 Set Counter Value

The counter value can be overwritten to a desired number by setting at address COn_Set_Counter_Value (0x70n0:11) and COn_Set_Counter (0x70n0:01) no matter if the counter is counting or not. This feature is usually used for restoring the last incremental encoder value after system reboot. Once the counter value is set, the CIn_Set_Counter_Done (0x60n0:01) will be changed to “1”.

Take Ch0 for example, the start counter value can be overwritten by following steps:

Step1: Set CO0_Set_Counter_Value (0x7000:11) to 0x00

Step2: Enable CO0_Set_Counter (0x7000:01)

Step3: When the CI0_Set_Counter_Done (0x6000:01) is true, the counter value is changed

Step4: CO0_Set_Counter (0x7000:01) should be set to “0” before the next change

Step5: CI0_Set_Counter_Done (0x6000:01) will set to False along with CO0_Set_Counter

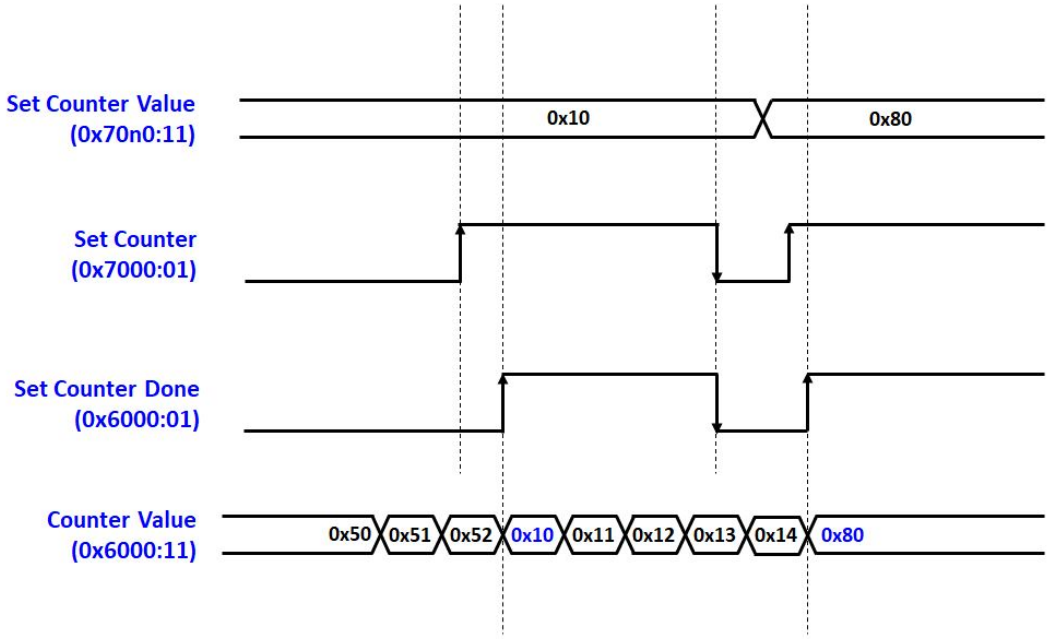


Figure 6.12 Set Counter Value

Note! *The counter value should not be set over Reload Counter Value.*

6.1.7.5 Counter Frequency Measurement

The increment (or decrement) frequency of counter value can be read by CIn_Frequency_Value (0x60n0:13), the value will be updated every second. This feature is often used to determine velocity.

6.1.7.6 Input Filter

AMAX-5080 supports input filter for A/B/Z/L input signal. The selectable filter for Cn_Input_Filter_Time (0x80n0:08) are listed as below:

Table 6.9: Input Filter Level

Filter Num.	Time	Frequency
0	Disable Filter	
1	0.3us	1.32MHz
2	0.6us	654KHz
3	1.2us	370KHz
4	2.4us	197KHz
5	3.6us	134KHz
6	4.8us	101KHz
7	7.2us	68KHz
8	9.6us	51KHz
9	14.4us	34KHz
10	19.2us	26.1KHz
11	28.8us	17.4KHz
12	38.4us	13.1KHz

6.1.8 AMAX-5080 Object Dictionary

6.1.8.1 Input Data (0x6000 - 0x6FFF)

Table 6.10: Input Data of the Module (0x6000 - 0x6FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default
60n0:01	CIn_Set_Counter_-Done	The counter was set.	BOOL	RO	0x00
60n0:02	CIn_Latch_Z_Valid	The counter is latched by Z input.	BOOL	RO	0x00
60n0:03	CIn_Latch_Exter-nal_Valid	The counter is latched by L input.	BOOL	RO	0x00
60n0:04	CIn_Over_Flow	Counter Over flow	BOOL	RO	0x00
60n0:05	CIn_Under_Flow	Counter under flow	BOOL	RO	0x00
60n0:09	CIn_Status_of_In-put_A	Status of input A	BOOL	RO	0x00
60n0:0A	CIn_Status_of_In-put_B	Status of input B	BOOL	RO	0x00
60n0:0B	CIn_Status_of_In-put_Z	Status of input Z	BOOL	RO	0x00
60n0:0C	CIn_Status_of_In-put_External_Latch	Status of input L	BOOL	RO	0x00
60n0:11	CIn_Counter_Value	Counter Value	UDINT	RO	0x00
60n0:12	CIn_Latch_Value	Latch Value	UDINT	RO	0x00
60n0:13	CIn_Frequen-cy_Value	Update Frequency every second	UDINT	RO	0x00

(n=0~1 for Ch0~1)

6.1.8.2 Output Data (0x7000 - 0x7FFF)

Table 6.11: Output Data (0x7000 - 0x7FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default**
70n0:01	COn_Set_Counter	Set Counter	BOOL	RW	0x00
70n0:02	COn_Enable_Latch_Z	Enable Z pin counter latching	BOOL	RW	0x00
70n0:03	COn_Enable_Latch_External	Enable L pin counter latching	BOOL	RW	0x00
70n0:11	COn_Set_Counter_Value	Set Counter Value	UDINT	RW	0x00

(n=0~1 for Ch0~1)

6.1.8.3 Configuration Data (0x8000 - 0x8FFF)

Table 6.12: Configuration Data (0x8000 - 0x8FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default**
80n0:01	Cn_Mode_Select	Select Encoder mode 0: Encoder mode 1: Bi-Direction Mode	UINT	RW	0x00
80n0:02	Cn_Enable_Z_Pulse_Reset	Enable Z pulse input to reset counter 0: Disable 1: Enable	UINT	RW	0x00
80n0:03	Cn_Z_Pulse_Active_Polarity	The active polarity of Z input 0: Rising Edge 1: Falling Edge	UINT	RW	0x00
80n0:04	Cn_Enable_External_Reset	Enable external input to reset counter 0: Disable 1: Enable	UINT	RW	0x00
80n0:05	Cn_External_Latch_Active_Polarity	The active polarity of Latch input 0: Rising Edge 1: Falling Edge	UINT	RW	0x00
80n0:06	Cn_Enable_Register_Reload	Enable the register change of reload counter 0: Disable 1: Enable	UINT	RW	0x00
80n0:07	Cn_Reload_Counter_Values	Reload counter value	UDINT	RW	0xFFFFFFFF
80n0:08	Cn_Input_Filter_Time	Input Filter Time	UINT	RW	0x00 (Disable)

(n=0~1 for Ch0~1)

Table 6.13: Input Filter Time	
Item Name	**Value (UINT)**
Disable	0x00
0.3us (1.32MHz)	0x01
0.6us (654KHz)	0x02
1.2us (370KHz)	0x03
2.4us (197KHz)	0x04
3.6us (134KHz)	0x05
4.8us (101KHz)	0x06
7.2us (68KHz)	0x07
9.6us (51KHz)	0x08
14.4us (34KHz)	0x09
19.2us (26.1KHz)	0x0A
28.8us (17.4KHz)	0x0B
38.4us (13.1KHz)	0x0C

6.1.8.4 Configuration Data (0xF600 - 0xFFFF)

Table 6.14: Configuration Data (0xF600 - 0xFFFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default**
F600:01	LocateModule	Turn on/off Locate LED	BOOL	RW	0x00(Off)
F600:09	Encoder_Firmware_Version	Encoder MCU Firmware Version	BIT8	RO	109
0xF600:0A	Alarm Status	**Alarm status:** 0x00: Normal 0x01: Encoder MCU is not ready, and encoder MCU FW version is 255 (Dec). 0x02: Encoder MCU is ready, but Firmware version is not between 100~254 (Dec.) 0x03: Encoder MCU is in boot mode, please upgrade firmware.	BIT8	RO	0x00

6.1.8.5 PDO assignment (0x1C10 - 0x1C13)

Table 6.15: SM2, PDO assignment 0x1C12 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x160n	6.0	ENC Output Channel n process data mapping	70n0:01COn_Set_Counter; 70n0:02COn_Enable_Latch_Z; 70n0:03COn_Enable_Latch_External; 70n0:11COn_Set_Counter_Value

(n=0~1 for ch0~1)

Table 6.16: SM3, PDO assignment 0x1C13 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A0n	14.0	ENC Input Channel n process data mapping	60n0:01CIn_Set_Counter_Done; 60n0:02CIn_Latch_Z_Valid; 60n0:03CIn_Latch_External_Valid; 60n0:04CIn_Over_Flow; 60n0:05CIn_Under_Flow; 60n0:09CIn_Status_of_Input_A; 60n0:0ACIn_Status_of_Input_B; 60n0:0BCIn_Status_of_Input_Z; 60n0:0CCIn_Status_of_Input_External_Latch; 60n0:11CIn_Counter_Value; 60n0:12CIn_Latch_Value; 60n0:13CIn_Frequency_Value

(n=0~1 for ch0~1)

6.2 AMAX-5081 1-ch TTL/RS-422 Encoder/Counter Module

The AMAX-5081 is a 32-bit 1-ch counter/encoder module for incremental encoders, which supports TTL or RS422 differential input with up to 10MHz input frequency. The module provides 2000 VDC optical isolation, if any high voltage or current damage the channels, the whole system (other modules or control unit) will not be damaged.

Figure 6.13 AMAX-5081 Module

6.2.1 AMAX-5081 Specification

6.2.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 3W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **LED Indicator:** PWR, R/E, A/B/Z, IN, OUT

6.2.1.2 Counter Input

- **Channels:** 1
- **Counter Range:** 32-bit
- **Modes:**
  Position Measure - Encoder x4
  Position Measure - Pulse/Dir.
  Position Measure - CW/CCW
  Position Measure - Pulse/Gate
  Pulse Train Output
- **Signal Input:**
  - Single-ended
    Logic 0: 0.8 V max.
    Logic 1: 2.8 V min. (12 V max.)
  - Differential
    Logic 0: -0.5 V max. (-12 V min.)
    Logic 1: 0.5 V min. (12 V max.)
- **Input Frequency:** 1 MHz max.

6.2.1.3 Latch Input

- Logic 0: 2V max.
- Logic 1: 5V min. (24V max.)

6.2.1.4 Comparison Output

- 5V TTL
- Logic 0: 0.8 V max.
- Logic 1: 2.0 V min. (5.25 V max.)

6.2.1.5 Protection

Isolation Voltage: $2,000V_{DC}$

6.2.1.6 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

6.2.2 LED Indicator

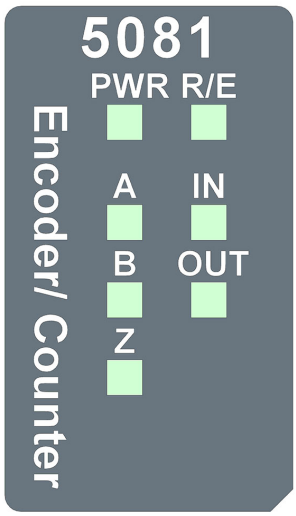


Figure 6.14 AMAX-5081 Module LED Indicator

Table 6.17: LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
	Yellow	ON	Locating Module
Run/Error	Green	ON	EtherCAT Connected
		Blink	EtherCAT Connecting
		OFF	EtherCAT Abnormal
	Red	ON/Blink	System Abnormal
		OFF	No Error
A	Green	ON	Encoder Signal Input
B	Green	ON	Encoder Signal Input
Z	Green	ON	Encoder Signal Input
IN	Green	ON	Latch Input
OUT	Green	ON	Compare Output/ Pulse Output

6.2.3 Pin Definition

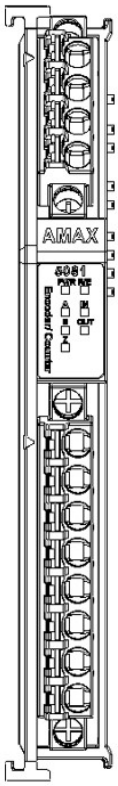


Figure 6.15 AMAX-5081 Module Front View

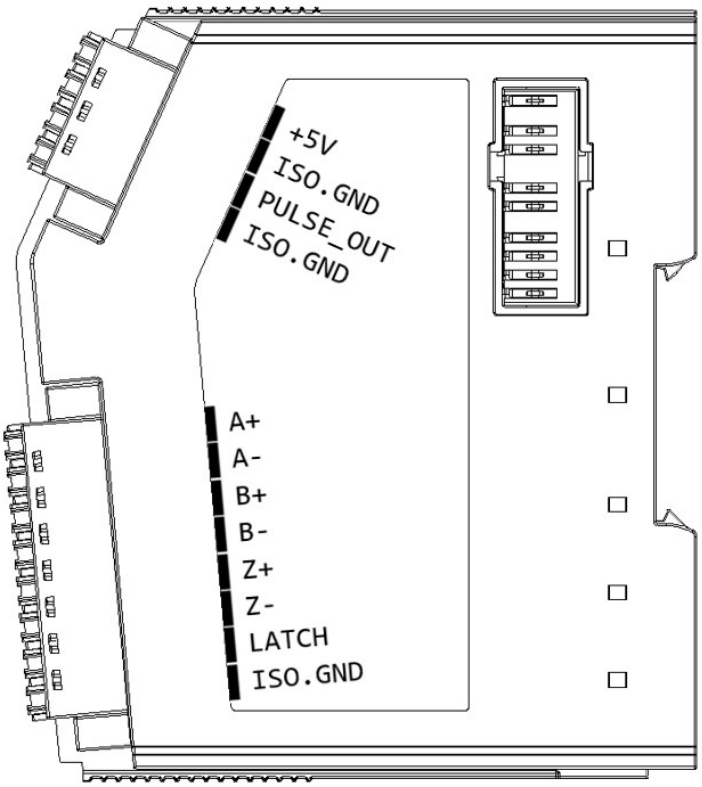


Figure 6.16 AMAX-5081 Module Side View

Table 6.18: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	+5V
2	ISO.GND
3	PULSE_OUT
4	ISO.GND

Table 6.19: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	A+
2	A-
3	B+
4	B-
5	Z+
6	Z-
7	LATCH
8	ISO.GND

6.2.4 Application Wiring

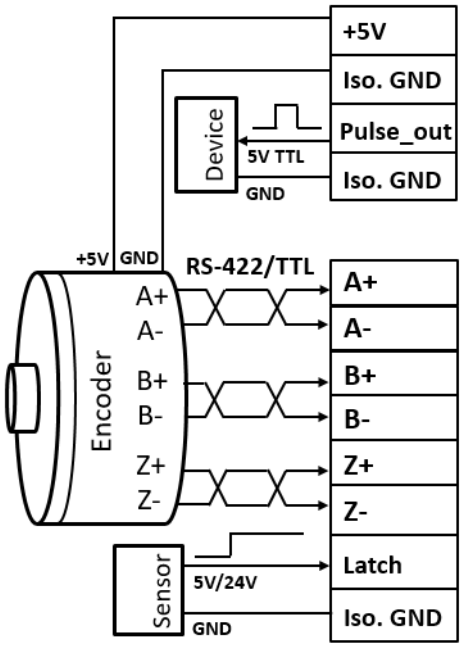


Figure 6.17 Wiring for AMAX-5081

6.2.5 Circuit Layout

6.2.5.1 Encoder Input

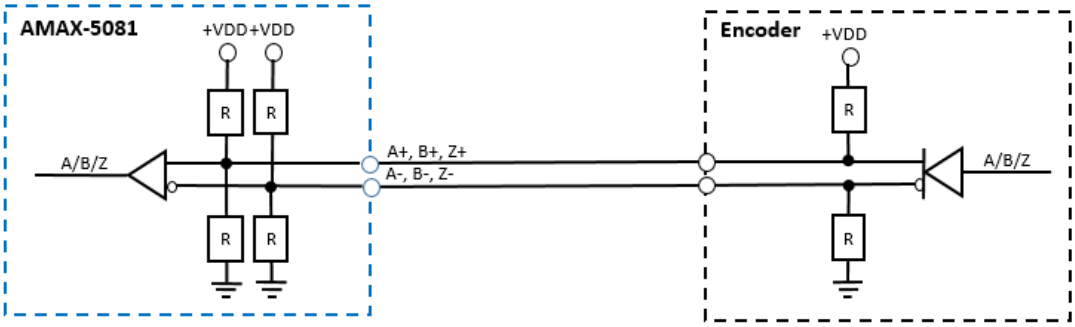


Figure 6.18 AMAX-5081 Encoder Differential Input

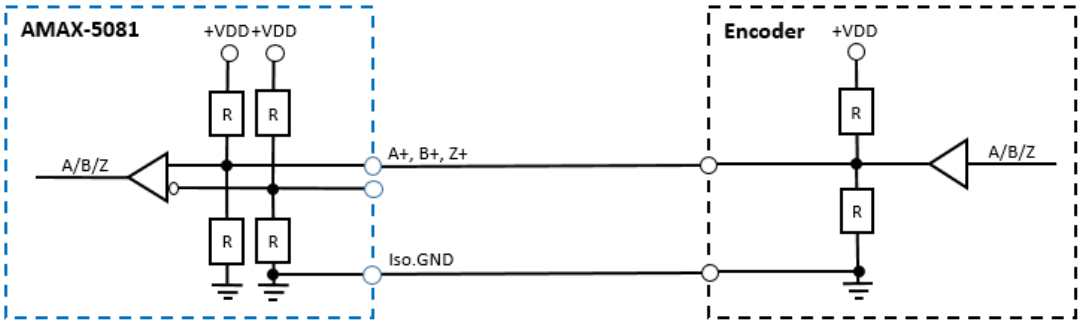


Figure 6.19 AMAX-5081 Encoder Single-Ended Input

6.2.5.2 Latch Input

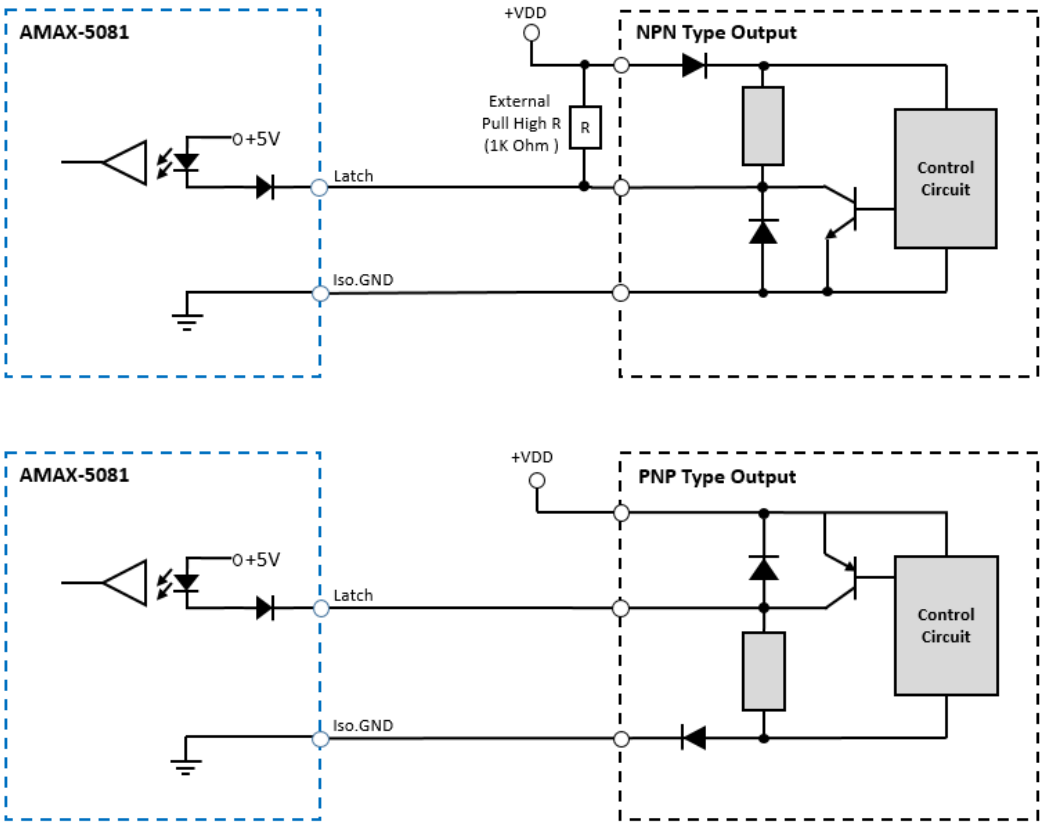


Figure 6.20 AMAX-5081 Latch Input

6.2.5.3 Comparison Output

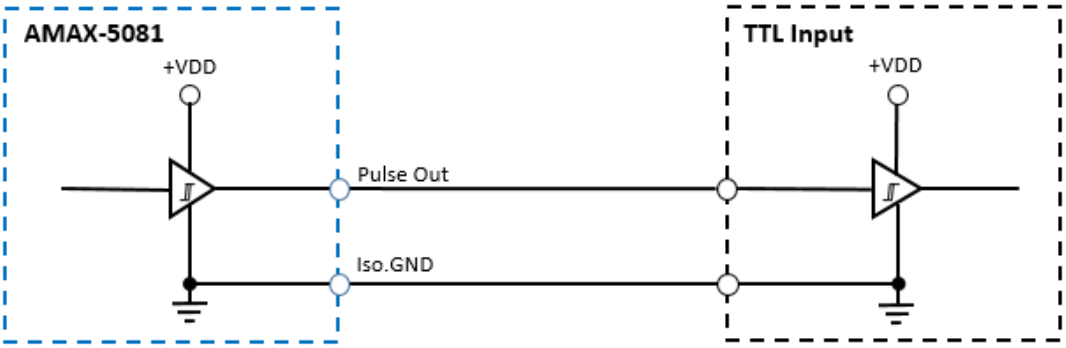


Figure 6.21 AMAX-5081 Comparison Output

6.2.6 AMAX-5081 Counter Mode

The AMAX-5081 supports four encoder/counter modes and one pulse output mode, it can be selected by Mode_Select (0x8000:01).

- 0: Position Measure - Encoder x4
- 1: Position Measure - Pulse/Dir.
- 2: Position Measure - CW/CCW
- 3: Position Measure - Pulse/Gate
- 4: Pulse Train Output

The following features are supported:

- Overflow/underflow detection
- Latch counter value
- Reset counter value
- Set counter value
- Input filter
- Position compare output
- Reversion of A/B phase Input
- Frequency measurement

The supported features for each mode are listed below:

Features	Encoder x4	Pulse/Dir.	CW/CCW	Pulse/Gate	Pulse Train Output
Overflow/underflow detection	O	O	O	O	X
Latch counter value	O	O	O	X	X
Reset counter value	O	O	O	X	X
Set counter value	O	O	O	O	X
Input filter	O	O	O	O	X
Position compare output	O	O	O	O	X
Reversion of A/B phase input	O	X	X	X	X
Frequency measurement	O	O	O	O	O

6.2.6.1 PDO Configuration

The PDO assignment should be defined on your EtherCAT master utility. The corresponding pair of the PDO content is required before using the AMAX-5081. (Please refer to PDO assignment (0x1C10 - 0x1C13)).

For example, if you're using the encoder + compare output feature, please select 0x1602 for SM2 and 0x1A02 for SM3. In this way, the related PDO will be added. Figures below show how PDO should be assigned on CODESYS when using the compare output.

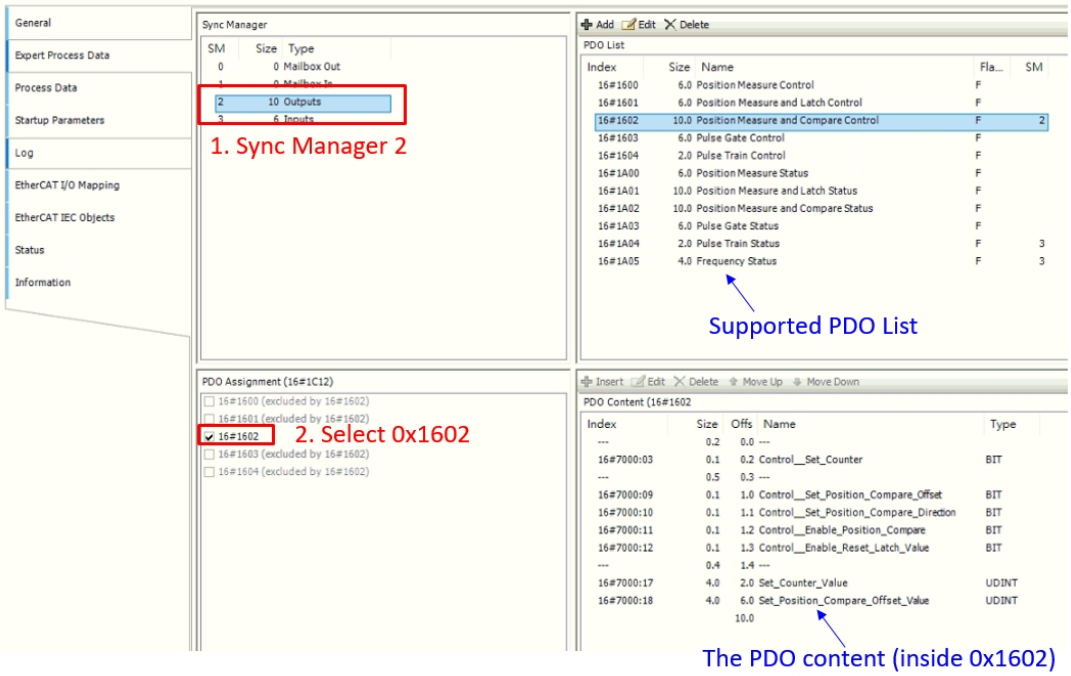


Figure 6.22 PDO assignment for SM2 - CODESYS interface

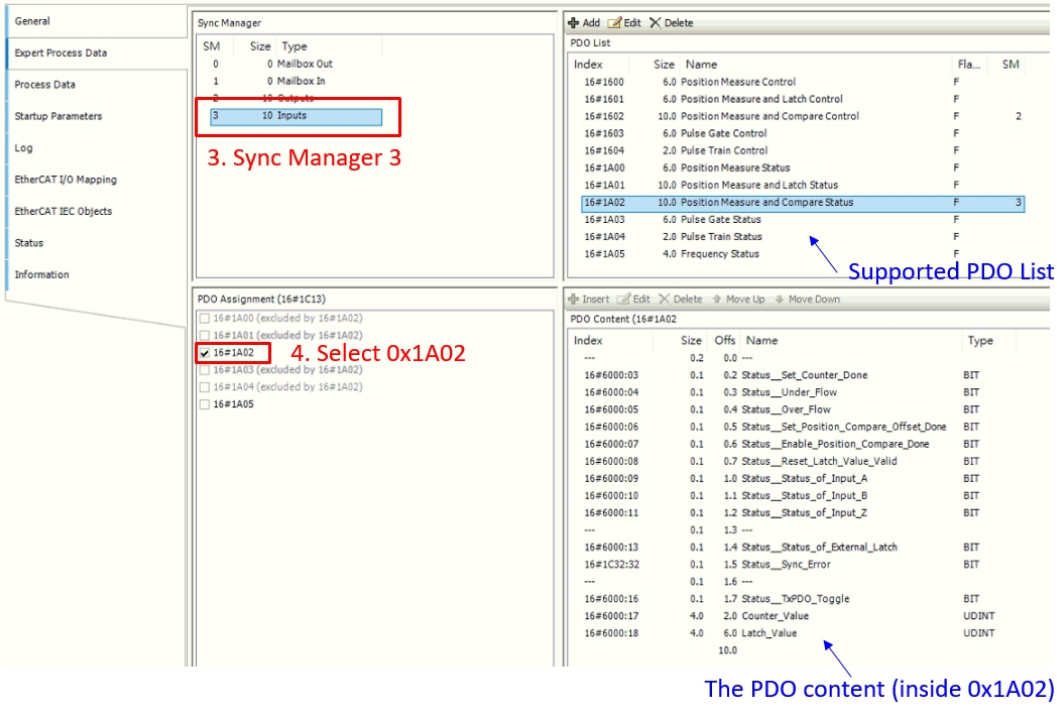


Figure 6.23 PDO assignment for SM3 – CODESYS interface

6.2.6.2 Position Measure - Encoder x4

The Behavior of A/B Phase 4X Quadrant Counter

Below figure shows the counter behavior of Encoder x4 mode. Ch_A and Ch_B are A/B phase encoder signal. If the "A" pulse is rising 90° ahead of the "B" pulse, the counter value is increasing; if the "B" pulse is rising 90° a head of the "A" pulse, the counter value is decreasing.

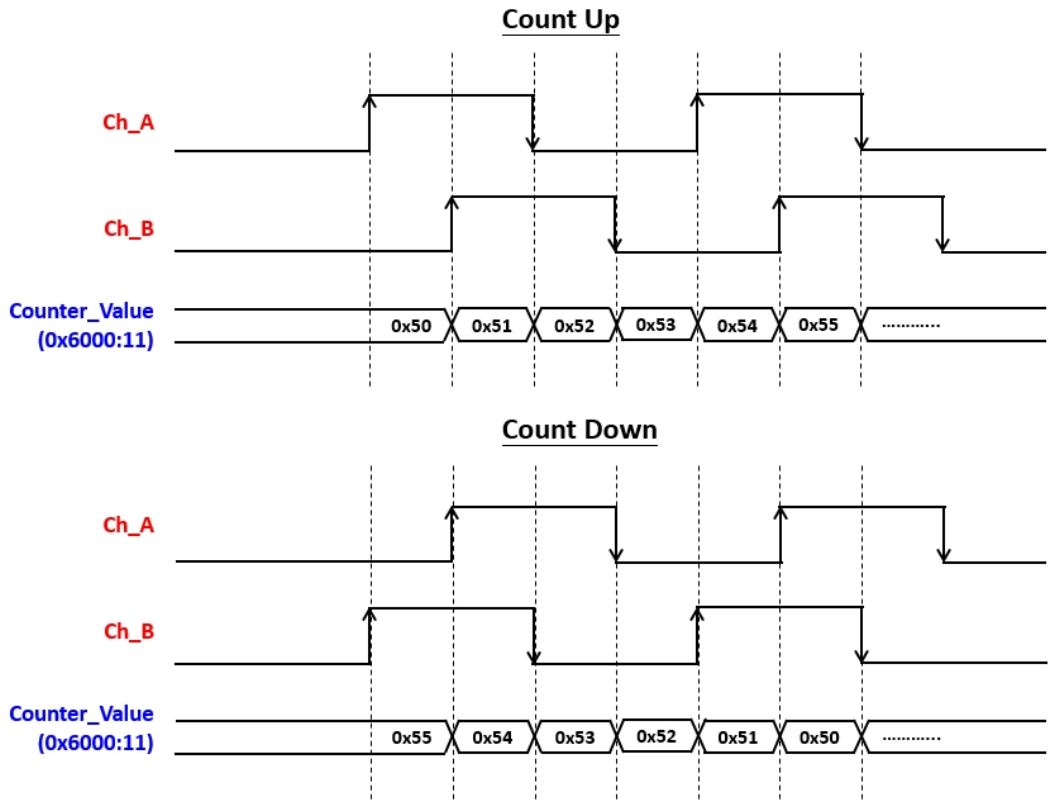


Figure 6.24 Encoder Mode – A/B Phase 4X)

Blue are the 0x6000, 0x7000, 0x8000 parameters.

Red are the external signals.

The counter direction can be reversed by setting the Reversion_Of_Rotation (0x8000:06), the following table is the list of all Encoder x4 mode related parameters.

Table 6.20: Encoder x4 Mode parameter index

Name	Index
Counter_Value	0x6000:11
Status_of_Input_A	0x6000:09
Status_of_Input_B	0x6000:0A
Reversion_Of_Rotation	0x8000:06

6.2.6.3 Position Measure - Pulse/Dir.

The Behavior of Pulse Direction Counter

Below figure shows the counter behavior of Pulse/Direction mode. Ch_A is a pulse from encoder or any pulse generator. Ch_B is a digital input which indicates the counter direction. When Ch_B is high, the counter value counts up with the Ch_A input pulse (Rising Edge-Triggered); when Ch_B is low, the counter value counts down with the Ch_A input pulse.

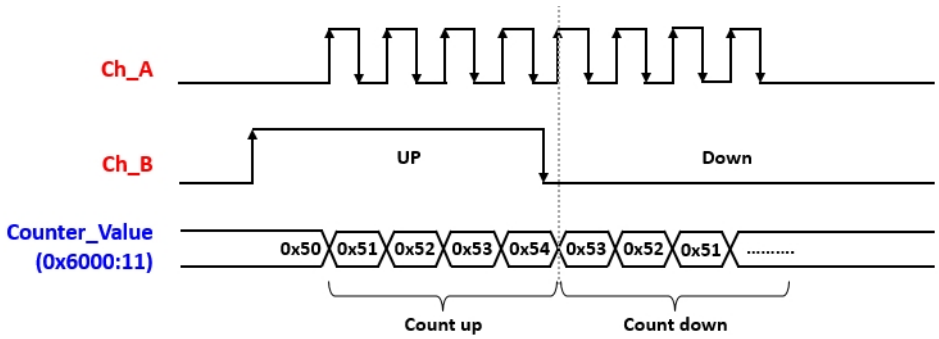


Figure 6.25 Encoder Mode – Pulse/Direction

Blue is the 0x6000, 0x7000, 0x8000 parameters.

Red are the external signals.

The counter value and A, B signal input status can be read at below index:

Table 6.21: Pulse/Direction Mode parameter index

Name	Index
Counter_Value	0x6000:11
Status_of_Input_A	0x6000:09
Status_of_Input_B	0x6000:0A

6.2.6.4 Position Measure - CW/CCW

The Behavior of CW/CCW Counter

Below figure shows the counter behavior of CW/CCW mode. Ch_A and Ch_B are the pulse from encoder or any pulse generator. The counter value counts up with the pulse Ch_A and counts down with the pulse Ch_B.

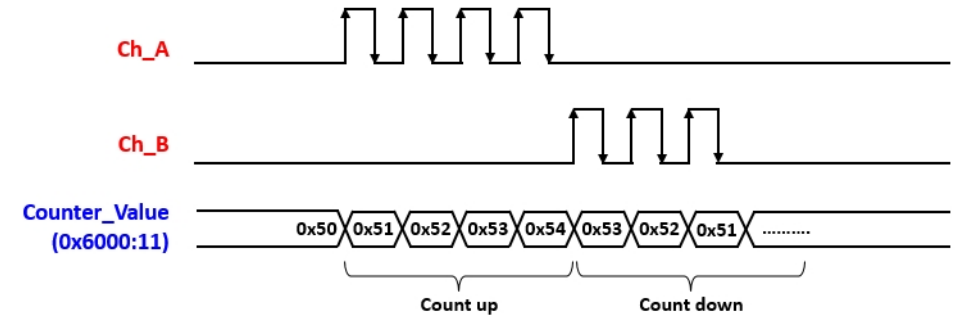


Figure 6.26 Encoder Mode – CW/CCW

Blue are the 0x6000, 0x7000, 0x8000 parameters.

Red are the external signals.

The counter value and A, B signal input status can be read at below Index:

Table 6.22: Pulse/Direction Mode parameter index

Name	Index
Counter_Value	0x6000:11
Status_of_Input_A	0x6000:09
Status_of_Input_B	0x6000:0A

6.2.6.5 Position Measure - Pulse/Gate

The Behavior of Pulse/Gate Counter

Below figure shows the counter behavior of Pulse/Gate mode. Ch_A is a Pulse from encoder or any pulse generator, the Counter_Value (0x6000:11) is increased along with Pulse signal. The Ch_B is an input digital level as the Gate of the counter value, if the Gate is active, the counter keeps the same value.

The activate polarity of Ch_B can be modified by the parameter Z_And_Gate_Active_Polarity (0x8000:03).

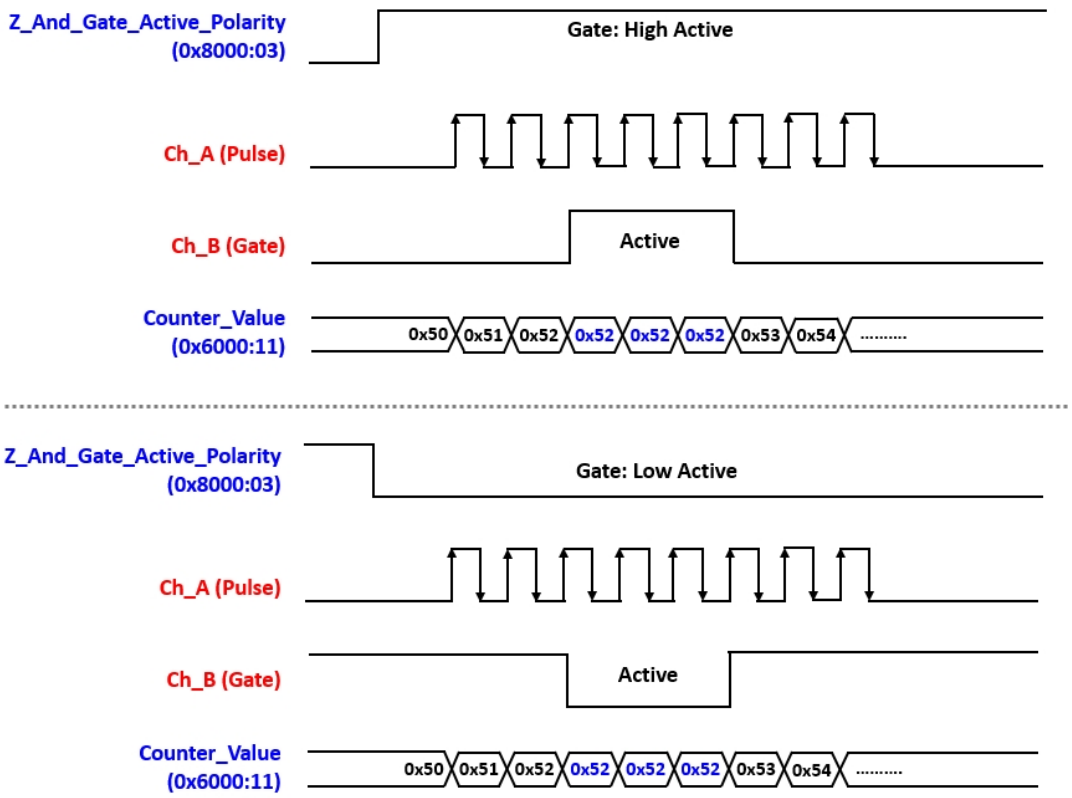


Figure 6.27 Encoder Mode – Pulse/Gate

Blue are the 0x6000, 0x7000, 0x8000 parameters.

Red are the external signals.

The counter value and A, B signal input status can be read at below Index:

Table 6.23: Pulse/Gate Mode parameter index

Name	Index
Counter_Value	0x6000:11
Status_of_Input_A	0x6000:09
Status_of_Input_B	0x6000:0A
Z_And_Gate_Active_Polarity	0x8000:03

6.2.6.6 Pulse Train Output

The Behavior of Pulse Train Output

The Pulse Train Output mode allows AMAX-5081 to generate a train of pulses with programmable frequency and duty cycle for a predetermined number of pulses.

The Pulse Width:

The positive and negative level duration of the pulse output can be adjusted by Pulse_Train_Pos_Width (0x8000:0B) and Pulse_Train_Neg_Width (0x8000:0C). In other words, a desired frequency and duty cycle can be adjusted by modifying these two factors.

One thing to notice is that if Pulse_Train_Pos_Width is set to m, Pulse_Train_Pos_Width is set to n, the duration of high/low level will be m * 50ns and n *50ns, and the number of m and n should between $1\sim2^{32}$.

For example, if Pulse_Train_Pos_Width set to 2000 and the Pulse_Train_Neg_Width set to 1000.

Each output pulse-width will be 100us high + 50us low.

Pulse Train Number:

The total number of pulse output can be set by Pulse_Train_Number (0x8000:0D), the number should between $0\sim2^{32}$ (0 is continues output).

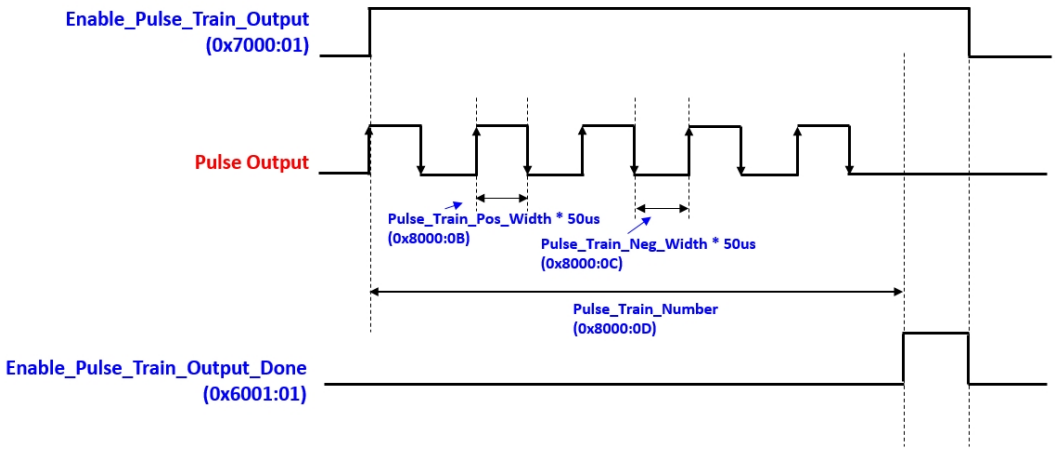


Figure 6.28 Pulse Train Output

Blue are the 0x6000, 0x7000, 0x8000 parameters.

Red is the output signal.

The related parameters are list below:

Table 6.24: Pulse Train Output parameter index

Name	Index
Enable_Pulse_Train_Output_Done	0x6001:01
Enable_Pulse_Train_Output	0x7001:01
Pulse_Train_Pos_Width	0x8000:0B
Pulse_Train_Neg_Width	0x8000:0C
Pulse_Train_Number	0x8000:0D

6.2.7 Counter Features

6.2.7.1 Overflow/Underflow Detection

Overflow and Underflow

When counter value exceeds the counter boundaries, the Under_Flow (0x6000:04) or Over_Flow (0x6000:05) will be set to "1" correspondingly.

The figure below shows an example of overflow/underflow behavior under Pulse/Dir. Mode, the same behavior also applies for other Encoder Modes.

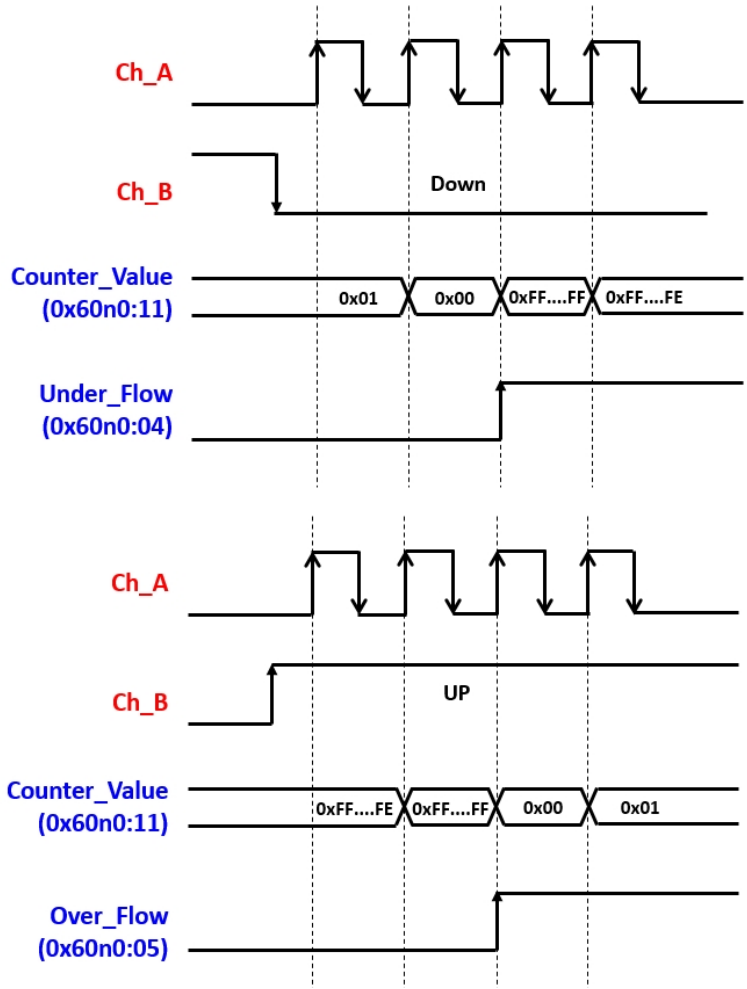


Figure 6.29 Counter Overflow and Underflow Detection

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

n=0~1 for Ch0~1

Reset Underflow and Overflow flags

Over_Flow will be clear to “0” automatically once the counter value over 1/3 of the 0xFFFFFFFF

Under_Flow will be clear to “0” automatically once the counter value under 2/3 of the 0xFFFFFFFF

6.2.7.2 Latch Counter Value

The counter values can be latch by an external signal at AMAX-5081 latch input pin. The latched counter value can be read at Latch_Value (0x6000:12). The active polarity (Rising or Falling Edge-triggered) of latch input signal can also be configured.

Below example shows how to latch the counter value by an external signal at rising edge under Pule/Direction Mode:

Step1: Enable rising edge-triggered at the address Enable_Latch_External_Rising (0x7000:02) (*Enable Enable_Latch_External_Falling (0x7000:04) for falling edge-triggered)

Step2: Check Latch_External_Valid (0x6000:02), if the bit is high, the counter value is successfully latched by an external signal.

Step3: Read latch values at Latch_Value (0x6000:12)

Step4: Before next latch signal comes, the Enable_Latch_External_Rising (0x7000:02) should be toggled once to clear the Latch_External_Valid (0x6000:02) status.

Step5: Once the Latch_External_Valid (0x6000:02) bit is low, the module is ready for the next latching signal.

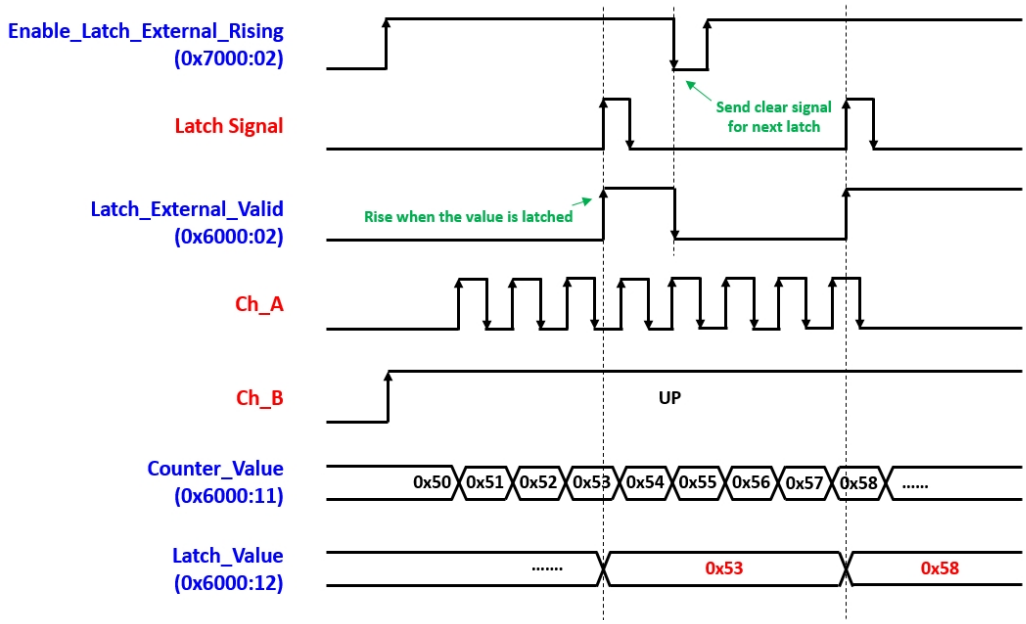


Figure 6.30 Latch Counter by Z pin

Blue are 0x6000, 0x7000, 0x8000 parameters.

Red are external signals.

All related configurable parameters for Latch Counter are listed below:

Name	Index
Enable_Latch_External_Rising	0x7000:02
Enable_Latch_External_Falling	0x7000:04
Counter_Value	0x6000:11
Latch_Value	0x6000:12

6.2.7.3 Reset Counter Value

The counter values can be reset with external signal by configuring the Z pin as the reset input. The reset signal can be triggered by encoder Z signal or any external sensor's signal.

To use the reset feature, please follow the steps below:

Configuration:

- Set Enable_Z_Pulse_Reset (0x8000:02) to 1 (Enable).
- Define Z_And_Gate_Active_Polarity (0x8000:03) as 0 (Rising Edge Active) or 1 (Falling Edge Active).

Enable Input:

Step1: Set Enable_Latch_Z (0x7000:01) to True.

Step2: Any reset signal from Z pin, the Counter_Value (0x6000:11) will be cleared.

Step3: Once counter value is cleared, Latch_Z_Valid (0x6000:01) will be raised to True.

Step4: Set Enable_Latch_Z (0x7000:01) to False to clear the flag for next input.

* When the reset is done, do the Step1 before next reset signal comes.

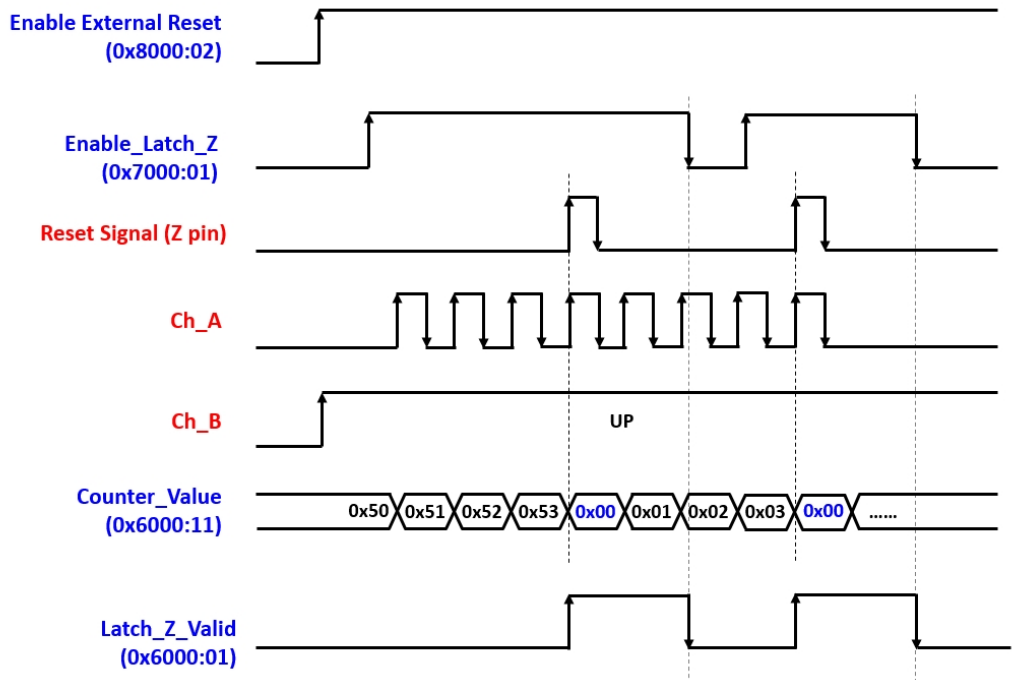


Figure 6.31 Reset Counter Value

6.2.7.4 Set Counter Value

The counter value can be overwritten to a desired number by setting at address Set_Counter_Value (0x7000:11) and Set_Counter (0x7000:03) no matter if the counter is counting or not. This feature is usually used for restoring the last incremental encoder value after system reboot. Once the counter value is set successfully, the Set_Counter_Done (0x6000:03) will be changed to “1”.

For example, the start counter value can be overwritten by following steps:

Step1: Set Set_Counter_Value (0x7000:11) to assign a counter value to be changed.

Step2: Enable Set_Counter (0x7000:03) to activate the change of counter value.

Step3: When the Set_Counter_Done (0x6000:03) is “1”, the counter value is changed

Step4: Set_Counter (0x7000:03) should be set to “0” before the next change

Step5: Set_Counter_Done (0x6000:03) will be restored to “0” along with Set_Counter.

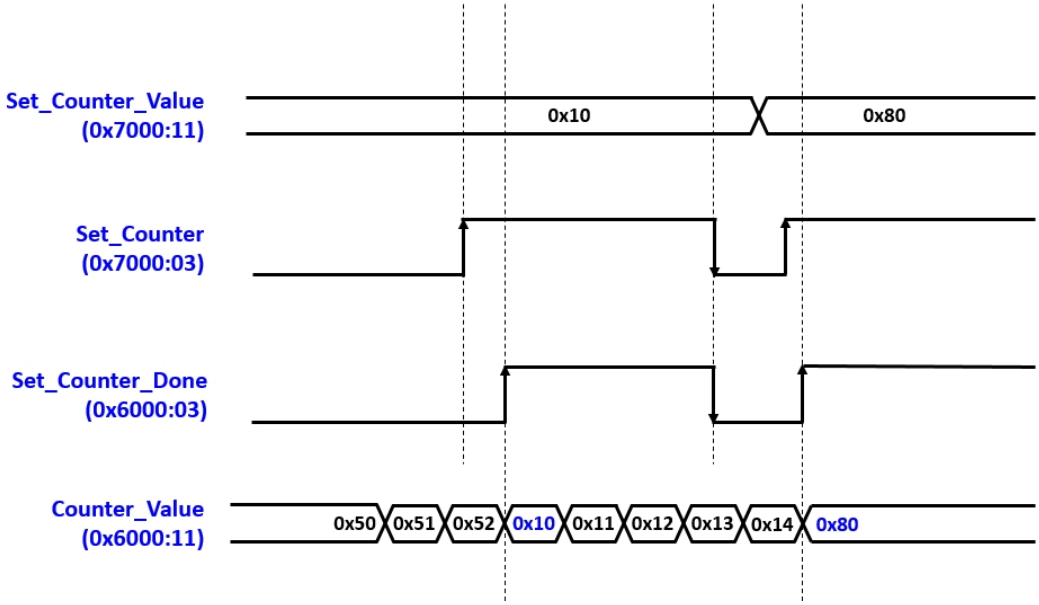


Figure 6.32 Set Counter Value

6.2.7.5 Input Filter

AMAX-5081 supports input filter for A/B/Z/Latch input signal. The selectable filter duration for Input_Filter_Time (0x8000:04) are listed as below:

Table 6.25: Input Filter Level

Filter Num.	Time
0	Disable Filter
1	1.28 us
2	10.24 us
3	163.84 us
4	1.31 ms

6.2.7.6 Position Compare Output – Hardware Trigger

The position compare output can let the module generate a pre-defined width of pulse, after a specific triggering signal, the signal can be triggered by hardware or software.

This section will show you how to configure and use hardware triggered position compare output.

Hardware Trigger Behavior

At the moment of AMAX-5081 detect an external signal entering the AMAX-5081 Latch pin, the module will generate a pre-defined width of pulse after a period of Off-set.

Hardware Trigger Configuration:

Configure Position Compare

Step0: Configure PDO, select Position Measure and Compare Control (0x1602) for SM2 and Position Measure and Compare Status (0x1A02) for SM3.

Step1 :Set Position_Compare_Source_Select (0x8000:07) to 0: HW

Step2: Set Position_Compare_Latch_Polarity (0x8000:08) to 0: Rising Edge Active; 1: Falling Edge Active.

Step3: Set Position_Compare_Output_Polarity (0x8000:09) to 0: Initial Low; 1: Initial High.

Set Output Pulse Width

Step4: Set Position_Compare_Output_Width (0x8000:0A) (Unit:10ns)

Note*: The actual output width is (Position_Compare_Output_Width + 2) * 10ns, and the minimum value for Position_Compare_Output_Width is “1”.

Set Position Compare Offset Value

Step5: Set Position_Compare_Direction (0x7000:0A) to 0: Forward counting; 1: Reverse counting

Step6: Set Set_Position_Compare_Offset_Value (0x7000:12) (0 ~ 232).

Step7: Set Position_Compare_Offset (0x7000:09) to “1” to write the offset into the buffer.

Step8: Read Set_Position_Compare_Offset_Done (0x6000:06), if the value is “1”, then the offset is written to the buffer successfully.

Step9: Set Position_Compare_Offset (0x7000:09) to “0” when buffer is written.

Step10: Read Set_Position_Compare_Offset_Done (0x6000:06) again, if the value is “0”, then the next offset value can be set to the buffer if needed.

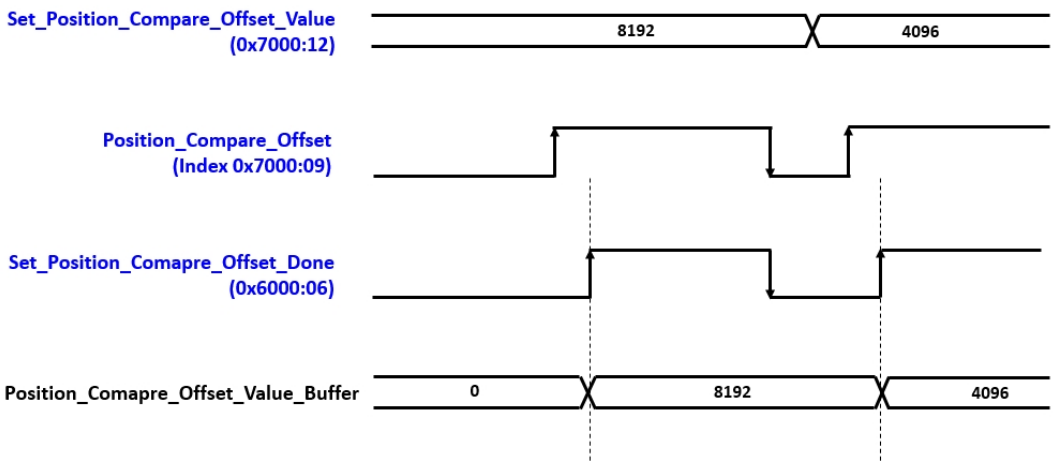


Figure 6.33 Set Position Compare Offset Value

Please refer to the following flow chart to set the position compare output configuration:

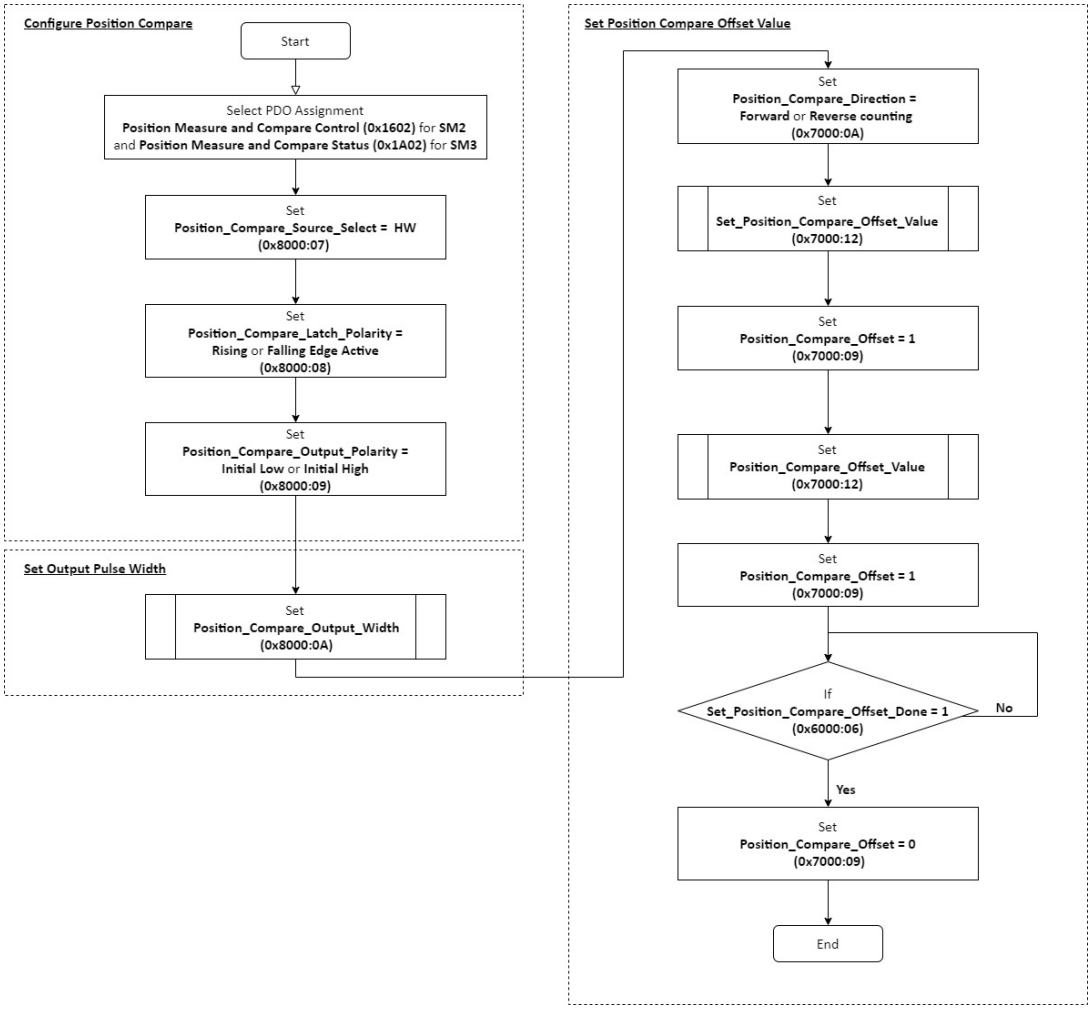


Figure 6.34 AMAX-5081 Hardware Position Compare Configuration – Flow Chart

Hardware Trigger Application:

Step1: Set Enable_Position_Compare (0x7000:0B) to “1”.

Step2: When a pulse input to the AMAX-5081 Latch pin, the current counter value will be updated to Latch_Value (0x6000:12).

Step3: Wait until the Counter_Value (0x6000:11) ≥ Latch_Value (0x6000:12) + Set_Position_Compare_Offset_Value (0x7000:12), the AMAX-5081 Pulse_Output pin will output a pre-defined width of pulse and the Enable_Position_Compare_ Done (0x6000:07) will be raise to “1”.

Step4: After the pulse output is done, set Enable_Position_Compare (0x7000:0B) to “0”

Step5: Check if Enable_Position_Compare_ Done (0x6000:07) is changed to “0” coordinately, and back to step1 for the next compare trigger signal.

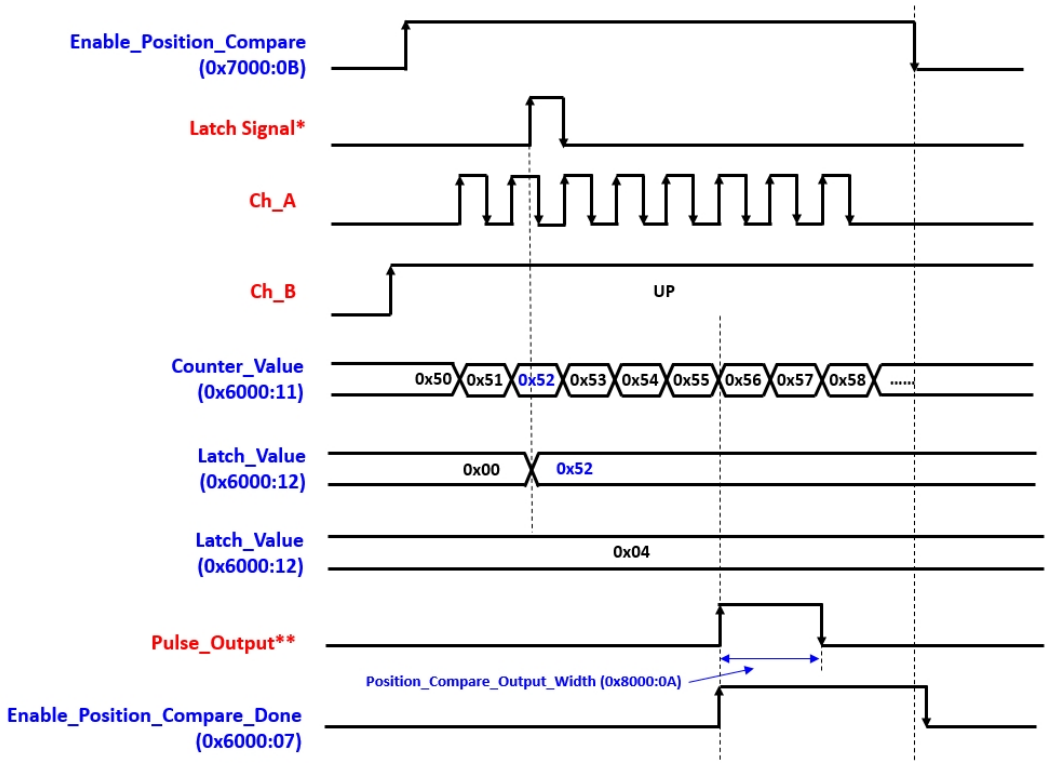


Figure 6.35 AMAX-5081 Hardware Position Compare Application – Timing Diagram

* Latch Signal can be rising edge or falling edge active (Position_Compare_Latch_Polarity (0x8000:08))

** Pulse_Output can be initial low or initial high (Position_Compare_Output_Polarity (0x8000:09))

Please refer to the following flow chart to use the position compare output:

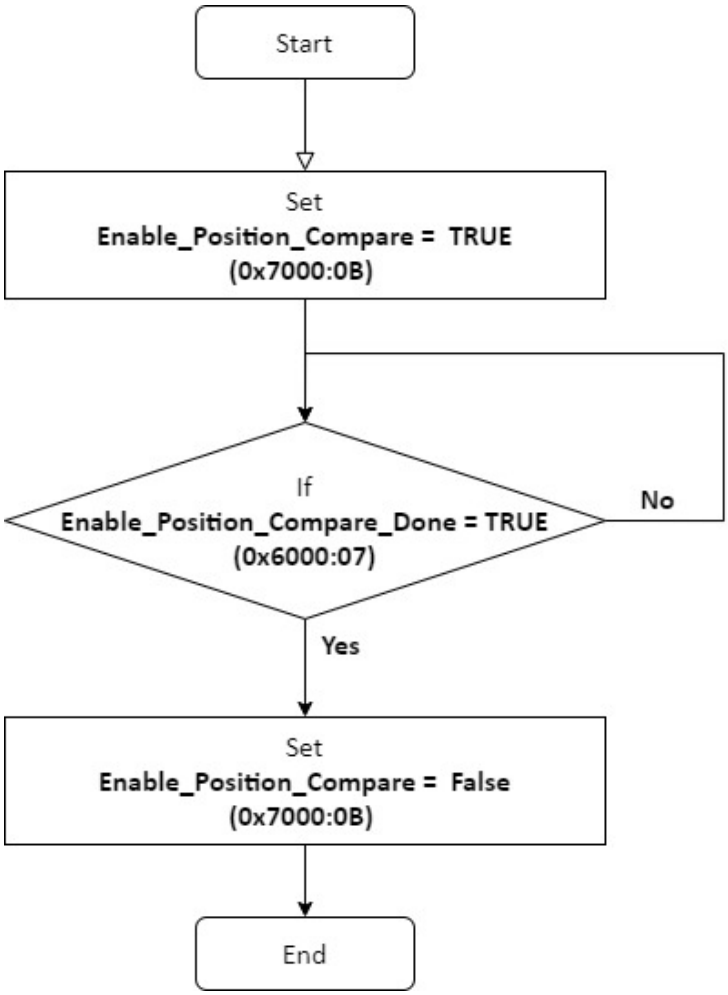


Figure 6.36 AMAX-5081 Hardware Position Compare Application – Flow Chart

6.2.7.7 Position Compare Output – Software Trigger

The position compare output can let the module generate a pre-defined width of pulse, after a specific triggering signal, the signal can be triggered by hardware or software.

This section will show you how to configure and use software triggered position compare output.

Software Trigger Behavior

At the moment of the EtherCAT master trigger the AMAX-5081 module by PDO, the module will generate a pre-defined width of pulse after a period of Offset.

Please follow the steps below to configure software triggered Position Compare Output function.

Software Trigger Configuration:

Configure Position Compare

Step0: Configure PDO, select Position Measure and Compare Control (0x1602) for SM2 and Position Measure and Compare Status (0x1A02) for SM3.

Step1: Set Position_Compare_Source_Select (0x8000:07) to 0: SW

Step2: Set Position_Compare_Output_Polarity (0x8000:09) to 0: Initial Low; 1: Initial High.

Set Output Pulse Width

Step3: Set Position_Compare_Output_Width (0x8000:0A) (Unit:10ns)

Note*: The actual output width is (Position_Compare_Output_Width + 2) * 10ns, and the minimum value for Position_Compare_Output_Width is “1”.

Set Position Compare Offset Value

Step4: Set Position_Compare_Direction (0x7000:0A) to 0: Forward counting; 1: Reverse counting

Step5: Set Set_Position_Compare_Offset_Value (0x7000:12) (0 ~ 232).

Step6: Set Position_Compare_Offset (0x7000:09) to “1” to write the offset into the buffer.

Step7: Read Set_Position_Compare_Offset_Done (0x6000:06), if the value is “1”, then the offset is written to the buffer successfully.

Step8: Set Position_Compare_Offset (0x7000:09) to “0” when buffer is written.

Step9: Read Set_Position_Compare_Offset_Done (0x6000:06) again, if the value is “0”, then the next offset value can be set to the buffer if needed.

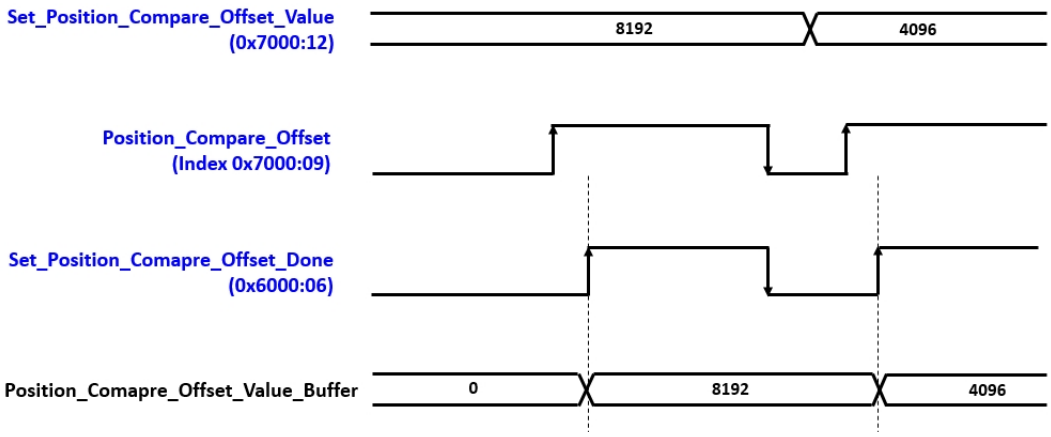


Figure 6.37 Set Position Compare Offset Value

Flow chart to set the position compare output configuration:

Figure 6.38 AMAX-5081 Software Position Compare Configuration – Flow Chart

Software Trigger Application:

Step1: Set Enable_Position_Compare (0x7000:0B) to “1”, then the current counter value will be updated to Latch_Value (0x6000:12).

Step2: Wait until the Counter_Value (0x6000:11) ≥ Latch_Value (0x6000:12) + Set_Position_Compare_Offset_Value (0x7000:12), the AMAX-5081 Pulse_Output pin will output a pre-defined width of pulse and the Enable_Position_Compare_ Done (0x6000:07) will be raise to “1”.

Step3: After the pulse output is done, set Enable_Position_Compare (0x7000:0B) to “0”

Step4: Check if Enable_Position_Compare_ Done (0x6000:07) is changed to “0” coordinately, and back to step1 for the next compare trigger signal.

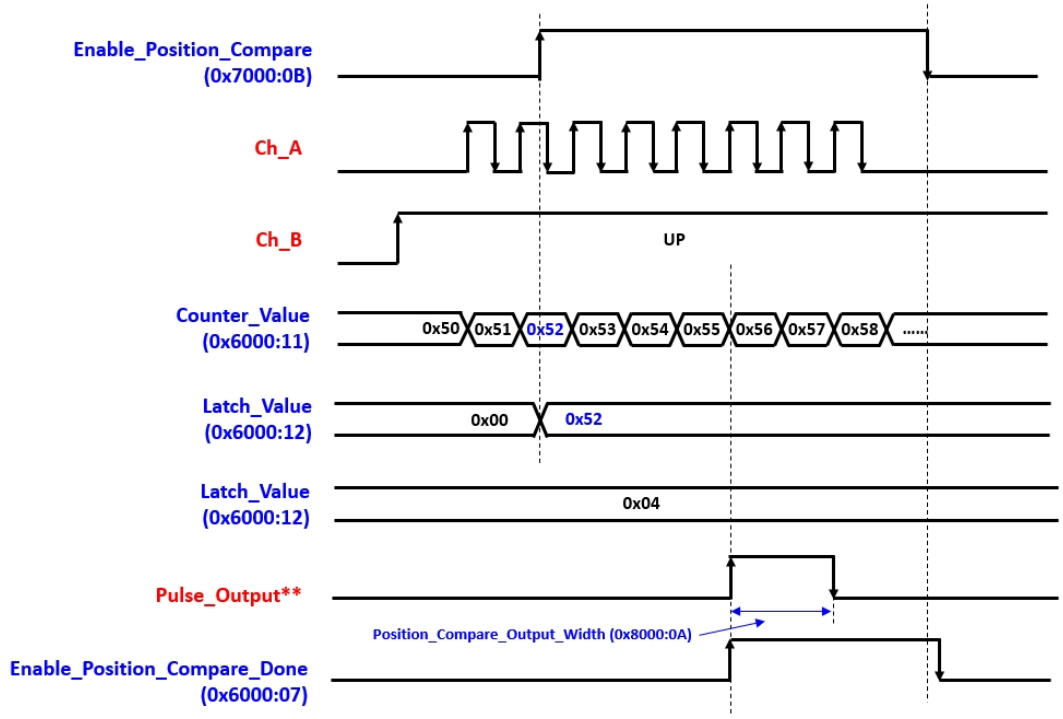


Figure 6.39 AMAX-5081 Software Position Compare Application – Timing Diagram Chart

* Latch Signal can be rising edge or falling edge active (Position_Compare_Latch_Polarity (0x8000:08))

** Pulse_Output can be initial low or initial high (Position_Compare_Output_Polarity (0x8000:09))

Please refer to the following flow chart to use the position compare output:

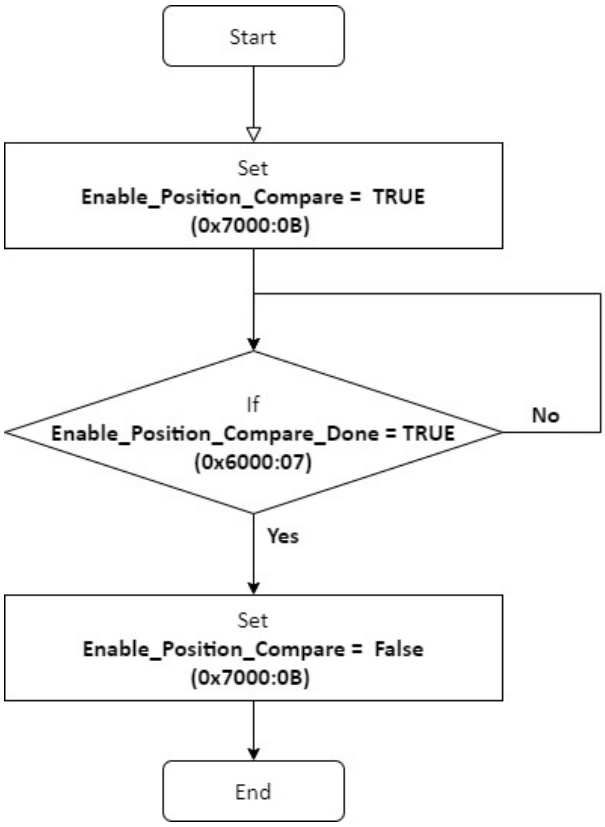


Figure 6.40 AMAX-5081 Software Position Compare Application

6.2.7.8 Reversion of A/B Phase Input

The A/B phase encoder counter direction can be reversed by Reversion_Of_Rotation (0x8000:06), this function only applies on Position Measure - Encoder x4 mode. (0: Disable, 1: Enable)

6.2.7.9 Frequency Measurement

Either Ch_A or Ch_B input pulse frequency can be measured by AMAX-5081, the measurement range is between 1Hz to 5MHz.

There are few settings should be done before using Frequency Measurement function:

1. Select 0x1A05 Frequency Status in SM3 PDO assignment.
2. Select input source ChA or ChB on Frequency_Measure_Input_Select (0x8000:05)

The input pulse frequency will be showed on Frequency_Value (0x6002:01), the value will be updated every second. This feature is often used to determine motor velocity.

6.2.8 AMAX-5081 Object Dictionary

6.2.8.1 Input Data (0x6000 - 0x6FFF)

Table 6.26: Input Data of the Module (0x6000 - 0x6FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
0x6000:01	Latch_Z_Valid	The counter is clear by Z input.	BOOL	RO	0x00
0x6000:02	Latch_External_Valid	The counter is latched by L input.	BOOL	RO	0x00
0x6000:03	Set_Counter_Done	The counter was set.	BOOL	RO	0x00
0x6000:04	Under_Flow	Counter under flow	BOOL	RO	0x00
0x6000:05	Over_Flow	Counter Over flow	BOOL	RO	0x00
0x6000:06	Set_Position_Compare_Offset_Done	Set Position Compare Offset Done	BOOL	RO	0x00
0x6000:07	Enable_Position_Compare_Done	Enable Position Compare Done	BOOL	RO	0x00
0x6000:08	Reset_Latch_Value_Valid	Reset Latch Counter Value	BOOL	RO	0x00
0x6000:09	Status_of_Input_A	Status of input A	BOOL	RO	0x00
0x6000:0A	Status_of_Input_B	Status of input B	BOOL	RO	0x00
0x6000:0B	Status_of_Input_Z	Status of input Z	BOOL	RO	0x00
0x6000:0D	Status_of_External_Latch	Status of input External	BOOL	RO	0x00
0x1C32:20	Sync_Error	The Sync Error bit is only required for DC mode. It indicates whether a synchronization error has occurred during the previous cycle.	BOOL	RO	0x00
0x6000:10	TxPDO_Toggle	The TxPDO toggle is toggled by the slave when the data of the associated TxPDO is updated.	BOOL	RO	0x00
0x6000:11	Counter_Value	Counter Value	UDINT	RO	0x00
0x6000:12	Latch_Value	Latch Value	UDINT	RO	0x00

6.2.8.2 Pulse Train Output Status (0x6001)

Table 6.27: Pulse Train Output Status (0x6001)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
0x6001:01	Enable_-Pulse_Train_Output_-Done	Pulse Train Output Last Pulse	BOOL	RO	0x00

6.2.8.3 ENC Frequency Input (0x6002)

Table 6.28: ENC Frequency Input (0x6002)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
0x6002:01	Frequency_Value	Update Frequency every second	UDINT	RO	0x00

6.2.8.4 Output Data (0x7000 - 0x7FFF)

Table 6.29: Output Data (0x7000 - 0x7FFF)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
0x7000:01	Enable_Latch_Z	Activate saving via input Z.	BOOL	RO	0x00
0x7000:02	Enable_Latch_External_Rising	Activate external latch with positive edge	BOOL	RO	0x00
0x7000:03	Set_Counter	Set Counter	BOOL	RO	0x00
0x7000:04	Enable_Latch_External_Falling	Activate external latch with positive edge	BOOL	RO	0x00
0x7000:09	Set_Position_-Compare_Offset	Set Position Compare Offset	BOOL	RO	0x00
0x7000:0A	Set_Position_-Compare_Direction	0: Used for forward counting 1:Used for reverse counting	BOOL	RO	0x00
0x7000:0B	Enable_Position_-Compare	Enable Position Compare	BOOL	RO	0x00
0x7000:0C	Enable_Reset_Latch_Value	Enable Reset Latch Counter	BOOL	RO	0x00
0x7000:11	Set_Counter_Value	Set Counter Value	UDINT	RO	0x00
0x7000:12	Set_Position_-Compare_Offset_Value	Set Counter Value	UDINT	RO	0x00

6.2.8.5 Pulse Train Output Status (0x7001)

Table 6.30: Pulse Train Output Status (0x7001)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
0x7001:01	Enable_-Pulse_Train_Output	Enable Pulse Train Output	BOOL	RO	0x00

6.2.8.6 Configuration Data (0x8000 - 0x8FFF)

Table 6.31: Configuration Data (0x8000 - 0x8FFF)

Index (hex)	Name	Meaning	Data type	Flags	Default
0x8000:01	Mode_Select	Select Encoder/Counter mode 0: Position Measure - Encoder x4 1: Position Measure - Pulse/Dir 2: Position Measure - CW/CCW 3: Pulse/Gate 4: Pulse Train Output	UINT	RW	0x00
0x8000:02	Enable_Z_-Pulse_Reset	A counter reset is triggered via the Z pulse input 0:Disable 1:Enable	UINT	RW	0x00
0x8000:03	Z_And_Gate_Active_Polarity	Z/Gate Pin Active Polarity 0:Rising Edge(High Active) 1:Falling Edge(Low Active)	UINT	RW	0x00
0x8000:04	Input_Filter_Time	Filter Timer Select 0: Disable 1: 1.28us 2: 10.24us 3: 163.84us 4: 1.31ms	UINT	RW	0x00
0x8000:05	Frequency_Measure_Input_Select	Position Measure Input Select 0:Ch A 1:Ch B	UINT	RW	0x00
0x8000:06	Reversion_Of_Rotation	Activates reversion of rotation 0: Disable 1: Enable	UINT	RW	0x00
0x8000:07	Position_Compare_Source_Select	Position Compare Source Select 0: HW 1: SW	UDINT	RW	0x00
0x8000:08	Position_Compare_Latch_Polarity	Position Compare Latch Pin active polarity 0:Rising Edge(High Active) 1:Falling Edge(Low Active)	UINT	RW	0x00
0x8000:09	Position_Compare_Output_Polarity	Compare Output Polarity 0:Initial Low 1:Initial High	UINT	RW	0x00
0x8000:0A	Position_Compare_Output_Width	Compare Output Positive Width	UINT	RW	0x0007A120
0x8000:0B	Pulse_Train_Pos_Width	Pulse Train Positive Width (50ns)	UDINT	RW	0x000186A0
0x8000:0C	Pulse_Train_Neg_Width	Pulse Train Negative Width (50ns)	UINT	RW	0x000186A0
0x8000:0D	Pulse_Train_Number	Pulse Train Number	UINT	RW	0x00000001

Pulse_Train_Pos_Width and Pulse_Train_Neg_Width:

The positive and negative level duration of the pulse output can be adjusted by these two factors. If Pulse_Train_Pos_Width (0x8000:0B) is n, the positive level duration will be n * 50 ns. The setting number should between 1~232.

For example, if Pulse_Train_Pos_Width set to 1,000,000, the Pulse_Train_Neg_Width set to 2,000,0000.

Each output pulse will be: 50ms high and 100ms low.

Pulse_Train_Number:

The total number of pulse output can be set by Pulse_Train_Number (0x8000:0D), the number should between 0~232 (0 is continues output).

6.2.8.7 Configuration Data (0xF600 - 0xFFFF)

Table 6.32: Configuration Data (0xF600 - 0xFFFF)

Index (hex)	Name	Meaning	Data type	Flags	Default value
0xF600:01	LocateModule	Control LED 0: Disable 1: Enable	BOOL	RW	0x00
0xF600:09	Encoder Firm-ware Version	Encoder FPGA Firm-ware Version	BIT8	RO	0x00
0xF600:0A	Alarm Status	AMAX-5081 Alarm status	BIT8	RO	0x00

F600:0A is System Alarm Status

0x00: Normal

0x01: Encoder FPGA is not Ready.(FPGA Firmware Version is 0x00 or 0xFF)

6.2.8.8 PDO assignment (0x1C10 - 0x1C13)

Table 6.33: SM2, PDO assignment 0x1C12 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1600	6.0	Position Measure Control	0x7000:03Set_Counter; 0x7000:11Set_Counter_Value
0x1601	6.0	Position Measure and Latch Control	0x7000:01Enable_Latch_Z; 0x7000:02Enable_Latch_External_Rising; 0x7000:03Set_Counter; 0x7000:04Enable_Latch_External_-Falling; 0x7000:0CEnable_Reset_Latch_Value; 0x7000:11Set_Counter_Value
0x1602	10.0	Position Measure and Compare Control	0x7000:03Set_Counter; 0x7000:09Set_Position_Compare_Offset; 0x7000:0ASet_Position_Compare_Direction; 0x7000:0BEnable_Position_Compare; 0x7000:0CEnable_Reset_Latch_Value; 0x7000:11Set_Counter_Value; 0x7000:12Set_Position_Compare_Offset_Value
0x1603	6.0	Pulse Gate Control	0x7000:03Set_Counter; 0x7000:11Set_Counter_Value
0x1604	2.0	Pulse Train Control	0x7001:01Enable_Pulse_Train_Output

*Note:

0x1600 ~ 0x1604 are mutually exclusive, the control mode should align with 0x1C13.

Table 6.34: SM3, PDO assignment 0x1C13 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A00	6.0	Position Measure Status	0x6000:03Set_Counter_Done 0x6000:04Under_Flow 0x6000:05Over_Flow 0x6000:09Status_of_Input_A 0x6000:0AStatus_of_Input_B 0x6000:0BStatus_of_Input_Z 0x6000:0DStatus_of_External_Latch 0x1C32:20Sync_Error 0x6000:10TxPDO_Toggle 0x6000:11Counter_Value

Table 6.34: SM3, PDO assignment 0x1C13 (selectable)			
0x1A01	10.0	Position Measure and Latch Status	0x6000:01Latch_Z_Valid; 0x6000:02Latch_External_Valid; 0x6000:03Set_Counter_Done; 0x6000:04Under_Flow; 0x6000:05Over_Flow; 0x6000:08Reset_Latch_Value_Valid; 0x6000:09Status_of_Input_A; 0x6000:0AStatus_of_Input_B; 0x6000:0BStatus_of_Input_Z; 0x6000:0DStatus_of_External_Latch; 0x1C32:20Sync_Error; 0x6000:10TxPDO_Toggle; 0x6000:11Counter_Value; 0x6000:12Latch_Value
0x1A02	10.0	Position Measure and Compare Status	0x6000:03Set_Counter_Done; 0x6000:04Under_Flow; 0x6000:05Over_Flow; 0x6000:06Set_Position_Compare_Offset_Done; 0x6000:07Enable_Position_Compare_Done; 0x6000:08Reset_Latch_Value_Valid; 0x6000:09Status_of_Input_A; 0x6000:0AStatus_of_Input_B; 0x6000:0BStatus_of_Input_Z; 0x6000:0DStatus_of_External_Latch; 0x1C32:20Sync_Error; 0x6000:10TxPDO_Toggle; 0x6000:11Counter_Value; 0x6000:12Latch_Value
0x1A03	6.0	Pulse Gate Status	0x6000:03Set_Counter_Done; 0x6000:04Under_Flow; 0x6000:05Over_Flow; 0x6000:09Status_of_Input_A; 0x6000:0AStatus_of_Input_B; 0x6000:0BStatus_of_Input_Z; 0x6000:0DStatus_of_External_Latch; 0x1C32:20Sync_Error; 0x6000:10TxPDO_Toggle; 0x6000:11Counter_Value
0x1A04	2.0	Pulse Train Status	0x6001:01Enable_Pulse_Train_Output_Done
0x1A05	4.0	Frequency Status	0x6002:01Frequency_Value

*Note:

0x1A00 ~ 0x1A04 are mutually exclusive, the control mode should align with 0x1C12.

Chapter 7

Digital I/O Module with Timestamp

7.1 The Benefit of Time-stamping Digital I/O

7.1.1 The EtherCAT data transfer in cycle base

For the standard EtherCAT digital IO module, the PDO data is transferred cyclically, and the digital signal state is detected or set at a specific time of the cycle, which means the response of the IO is restricted by the EtherCAT cycle time. There will be some limitations for both digital input and digital output in some application cases.

Take digital input as an example, if an external sensors response time is shorter than the EtherCAT cycle time, the input signal may not be detected. As shown below, if the EtherCAT cycle time is 1ms, and the sensor's input signal is 200µs for example, the sensors state change may be lost in this application (first pulse in the figure). Only the digital status at the moment of PDO data transfer can be detected (second pulse in the figure).

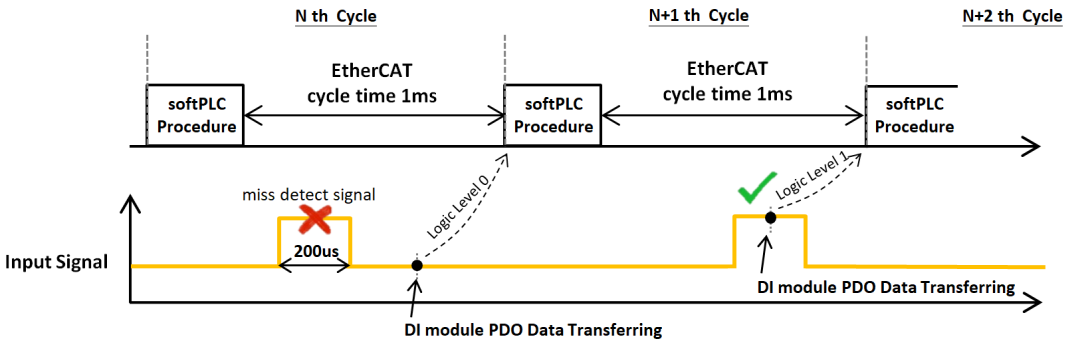


Figure 7.1 Standard Digital Input Module Signal Acquisition

Take digital output as another example, if two digital output modules are distributed to two different stations, when the master sets an output signal to both modules, the actual output will have little time difference between two modules as shown in the figure below. Even though the time difference is smaller than a cycle time, it can be critical especially on the application which needs synchronized signal output.

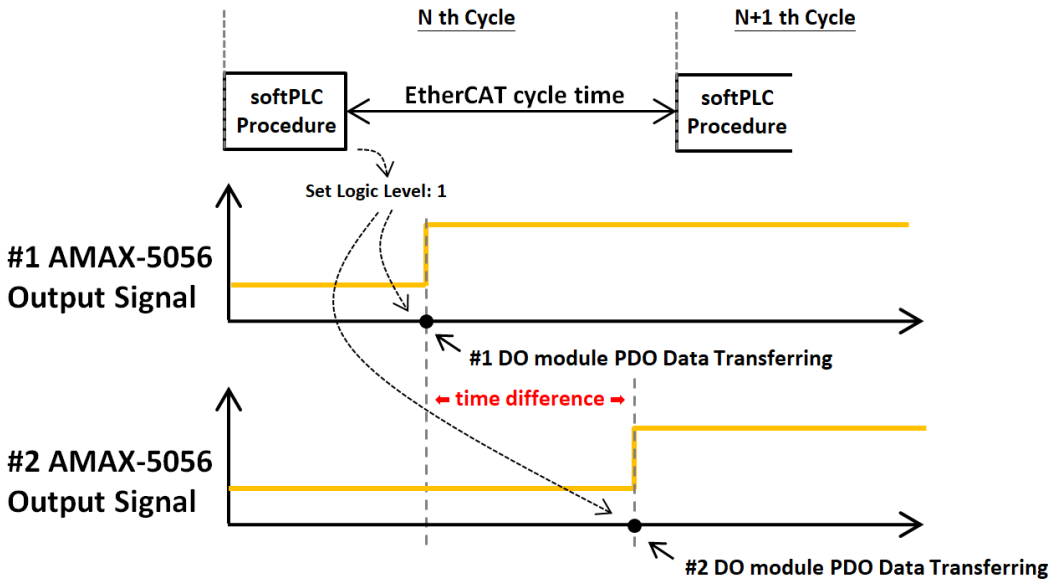


Figure 7.2 Standard Digital Output Module (SM mode)

Thus, shortening the EtherCAT cycle time is required for both scenarios. But most of the time, the limitation of the EtherCAT cycle time is restricted by the number of slave devices and the total data length of the PDOs and also, the minimum cycle times of the EtherCAT protocol which is about 100µs. Furthermore, shortening the EtherCAT cycle time will also increase the load of the master controller since the data acquisition frequency is increased; the system resource will be occupied by the data acquisition tasks. Therefore, a time-stamping function for digital IO modules has been designed for these advance applications.

7.1.2 The EtherCAT data transfer in time base

Benefiting from the EtherCAT distributed clock mechanism, all EtherCAT slave devices are able to synchronize to master controller's system time in a 64-bits time-stamp value with a resolution of 1ns. (The timestamp format is starting from 1.1.2000 00:00)

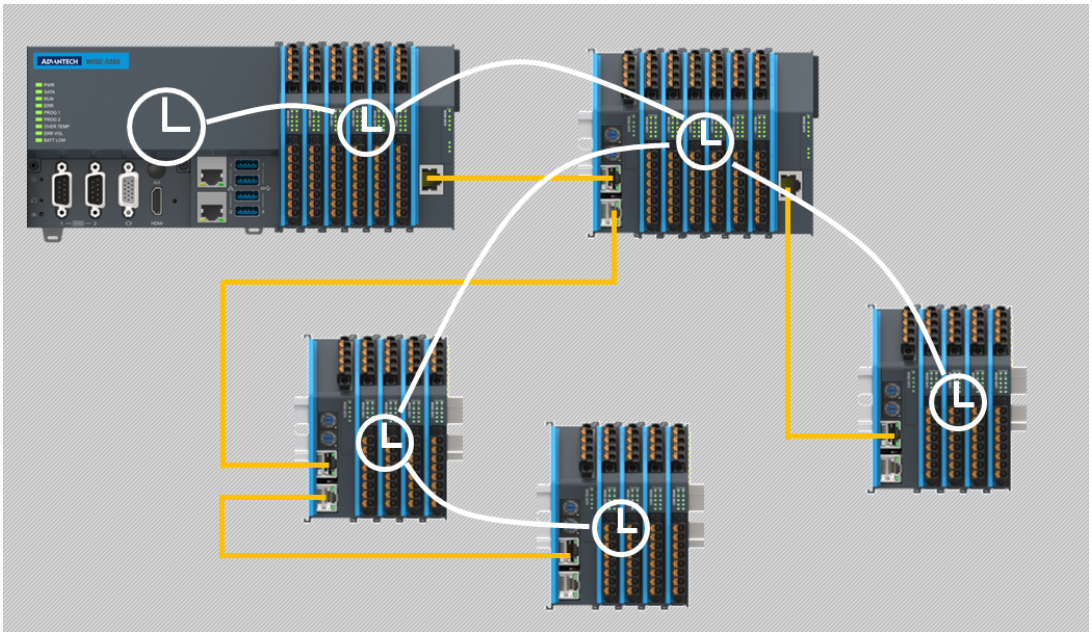


Figure 7.3 EtherCAT Distributed Clock

The time-stamped digital input/output signal transfers data via the EtherCAT bus, which makes the data exchange more precise and easier from the PLC cycle.

Digital Input with Timestamp

In order to latch the input signal, the digital input module contains a set of parameters to record the precise timestamp for each rising-edge (th) and falling-edge (tl).

One thing to be noticed, is that there is only one set of timestamp can be stored in the module, so the user should select the latching mode: Single Event or Continuous (default).

The Single Event mode only latches the first rising-edge and falling-edge timestamp and ignores any state change afterward. The Continuous mode will continuously update the latest timestamp of state change.

Each rising-edge (th) and falling-edge (tl) can be set to Single Event mode or Continuous mode independently.

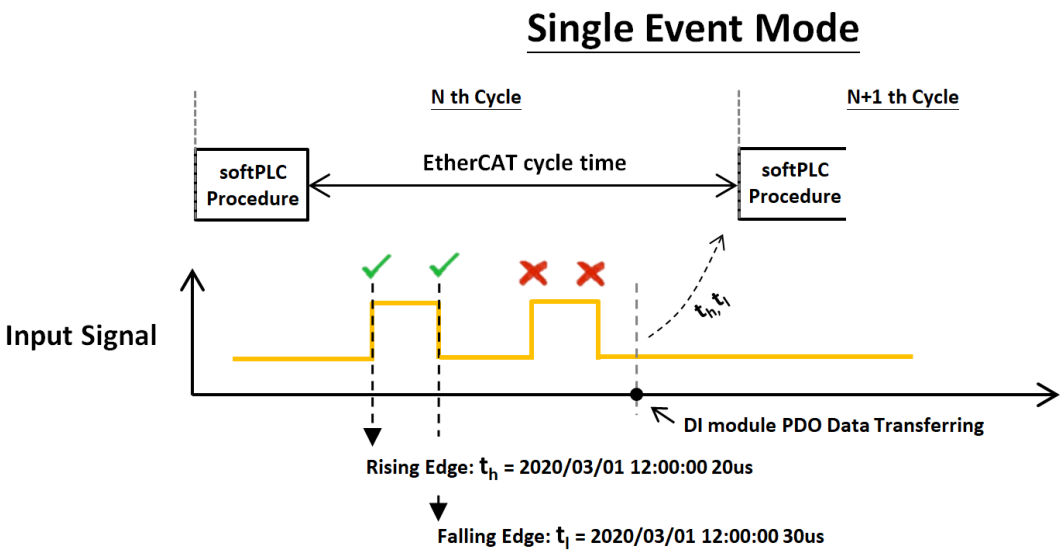


Figure 7.4 Digital Input with Timestamp - Single Event Mode

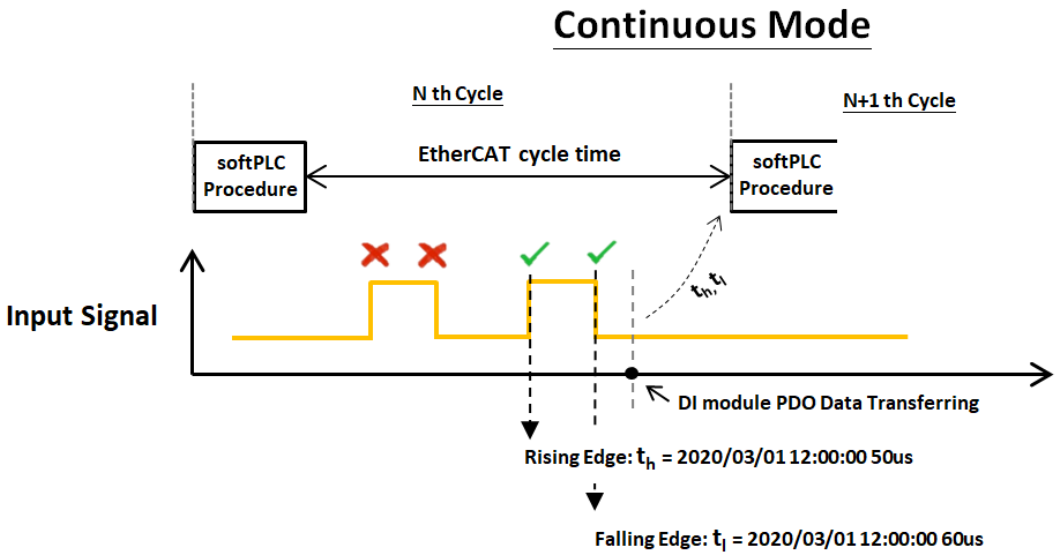


Figure 7.5 Digital Input with Timestamp - Continuous Mode

Digital Output with Timestamp

By setting Start Time and Activation to the time-stamping digital output module, the preset logic level will be activated at any specific time of the cycle as figure below. With this characteristic, the possibility of synchronizing multiple output signals can be realized.

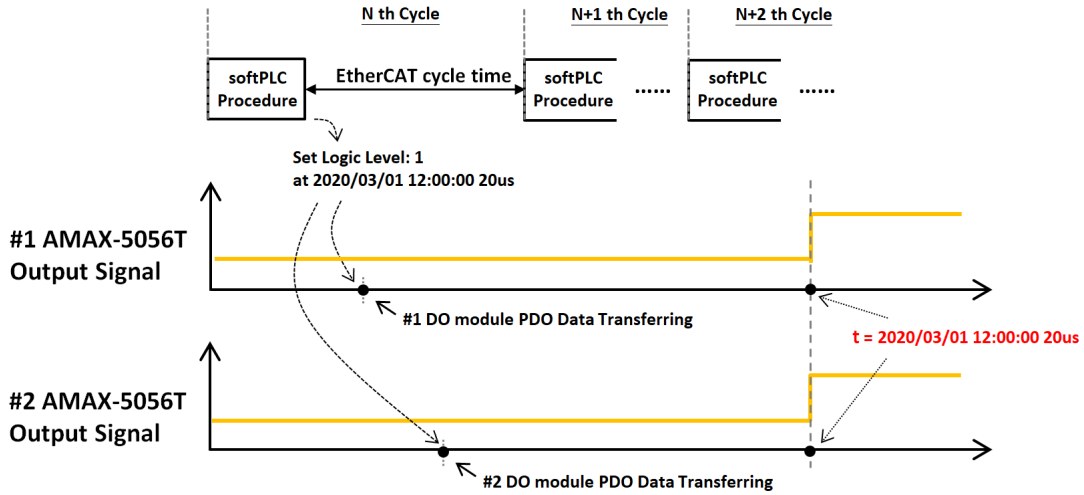


Figure 7.6 Digital Output with Timestamp

To sum up, these are the major benefits of using time-stamp technology on EtherCAT IO modules:

- Enabling the precise and deterministic IO responses.
- Releasing the data process from cycle base to time base, increasing the flexibility of cycle time of whole system.
- Reduces processor loading by reducing the data acquisition frequency.

7.2 AMAX-5051T 8-ch Digital Input Module (w/ 2-ch timestamp)

The AMAX-5051T is an 8-ch digital input module (including 2-ch timestamp DI). The timestamp enables a precise and deterministic DI latching at a resolution of 1ns. The digital input channels offer LED to indicate digital status. The module provides 2,000 VDC optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 7.7 AMAX-5051T Module

7.2.1 AMAX-5051T Specification

7.2.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **LED Indicator:** PWR, RUN, DI status
- **Weight:** Approx. 80g

7.2.1.2 Digital Input (w/ timestamp)

- **Channels:** 2 (DI0_TS~DI1_TS)
- **Digital Input:**
  - Wet Contact (only):
    Logic level 1: 11~30 V_{DC}
    Logic level 0: -3~5 V_{DC}
    (similar to EN 61131-2, type 3)
- **Input Delay:** < 0.5 us
- **DI Latch:** First Edge & Last Edge DI Latch
- **Resolution Timestamp:** 1ns
- **Typical Input Current:** Logic level 1: 1.4mA~4.3mA (11V~30V)

7.2.1.3 Digital Input (w/o timestamp):

- **Channels:** 6 (DI2~DI7)
- **Digital Input:**
  - Dry Contact:
    Logic level 1: close to Iso.GND
    Logic level 0: open
  - Wet Contact:
    Logic level 1: 11~30 V_{DC}
    Logic level 0: -3~5 V_{DC}
    (similar to EN 61131-2, type 3)
- **Input Delay:** < 10us
- **Typical Input Current:** Logic level 1: 1.4mA~4.3mA (11V~30V)

7.2.1.4 Protection

Isolation Voltage: 2,000V_{DC}

7.2.1.5 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

7.2.2 LED Indicator

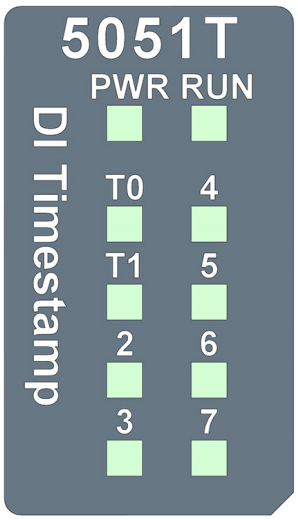


Figure 7.8 AMAX-5051T Module LED Indicator

Table 7.1: AMAX-5051T Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run/Error	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
T0~1 (timestamp)	Green	ON	Wet Logic “1”
		OFF	Wet Logic “0”
DI2~7	Green	ON	Dry/Wet Logic “1”
		OFF	Dry/Wet Logic “0”

7.2.3 Pin Definition

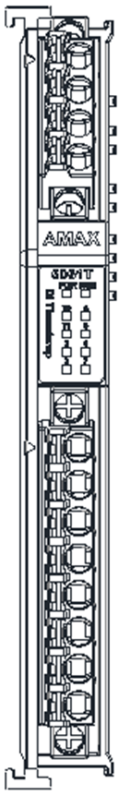


Figure 7.9 AMAX-5051T Module Front View

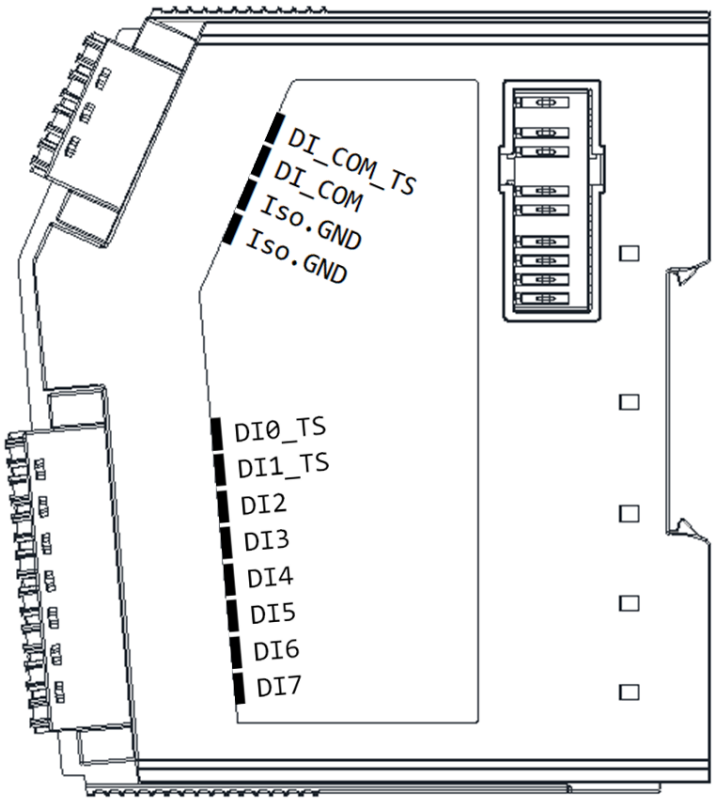


Figure 7.10 AMAX-5051T Module Side View

Table 7.2: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	DI_COM_TS
2	DI_COM
3	Iso.GND
4	Iso.GND

Table 7.3: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DI0_TS
2	DI1_TS
3	DI2
4	DI3
5	DI4
6	DI5
7	DI6
8	DI7

7.2.4 Application Wiring

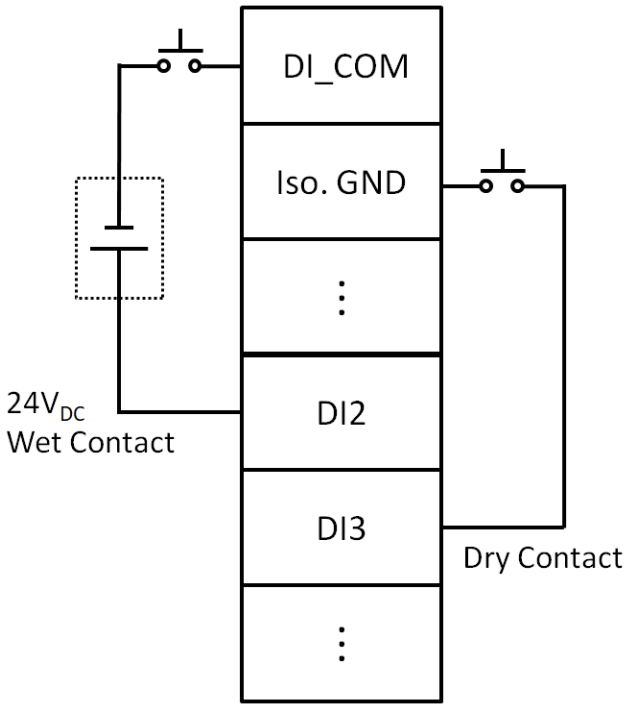


Figure 7.11 Wiring for AMAX-5051T standard DI

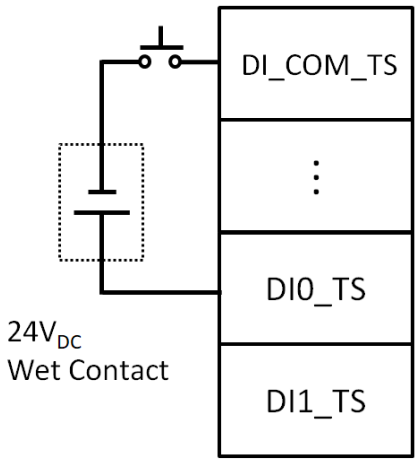


Figure 7.12 Wiring for AMAX-5051T timestamp DI

7.2.5 AMAX-5051T Object Dictionary

7.2.5.1 Input Data (0x1D09)

Table 7.4: Input Data (0x1D09)

Index (hex)	Name	Meaning	Data type	Flags	Default value
1D09:10	SysTime	32bit/64bit System Time	UDINT/ULINT	RO	0x00
1D09:AE	Status0	Timestamp DI0 Latch Status	USINT	RO	b#00000000
1D09:AF	Status1	Timestamp DI1 Latch Status	USINT	RO	b#00000000
1D09:B0	LatchPos0	The Time of First/Last Rising Signal Edge of DI0	ULINT	RO	0x00
1D09:B8	LatchNeg0	The Time of First/Last Falling Signal Edge of DI0	ULINT	RO	0x00
1D09:C0	LatchPos1	The Time of First/Last Rising Signal Edge of DI1	ULINT	RO	0x00
1D09:C8	LatchNeg1	The Time of First/Last Falling Signal Edge of DI1	ULINT	RO	0x00

Status0/Status1:

The status0 and status1 are the change record of timestamp DI0 and DI1 within a cycle, only SingleEventMode will change the status in following rules:

DI 0/1 logic level	0	0->1	1	1->0
Status 0/1	0x00000000	0x00000001	0x00000001	0x00000010

The statuses are displayed only in one EtherCAT cycle, the read of LatchPos and LatchNeg resets the status 0/1.

LatchPos0/1:

The LatchPos0/1 is the time of the first/last rising edge, depending on the setting of SingleEventMode or ContinuousMode.

LatchNeg0/1:

The LatchNeg0/1 is the time of the first/last falling edge, depending on the setting of SingleEventMode or ContinuousMode.

The time of LatchPos/LatchNeg are presented in the form of 64-bit timestamp.

7.2.5.2 Input Data (0x6000)

Table 7.5: Input Data (0x6000)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
6000:01	DI0	Digital Input Channel 0	BOOL	RO	0x00
6000:02	DI1	Digital Input Channel 1	BOOL	RO	0x00
6000:03	DI2	Digital Input Channel 2	BOOL	RO	0x00
6000:04	DI3	Digital Input Channel 3	BOOL	RO	0x00
6000:05	DI4	Digital Input Channel 4	BOOL	RO	0x00
6000:06	DI5	Digital Input Channel 5	BOOL	RO	0x00
6000:07	DI6	Digital Input Channel 6	BOOL	RO	0x00
6000:08	DI7	Digital Input Channel 7	BOOL	RO	0x00

7.2.5.3 PDO assignment (0x1C10 – 0x1C13)

Table 7.6: SM0, PDO assignment 0x1C10 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A14	4.0	SysTime	SysTime
0x1A15	8.0	SysTime	SysTime
0x1A0n	0.1	Channel n	DIn

(n=0~0 for ch0~7)

Note! *0x1A14 and 0x1A15 are mutually exclusive*

0x1A0n are not changeable

Table 7.7: SM1, PDO assignment 0x1C11 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A10	2.0	Latch	Status0; Status1
0x1A11	6.0	Latch	Status0; LatchPos0
0x1A12	18.0	Latch	Status0; LatchPos0; LatchNeg0
0x1A13	34.0	Latch	Status0; Status1; LatchPos0; LatchNeg0; LatchPos1; LatchNeg1
0x1A14	4.0	System	SysTime
0x1A15	8.0	System	SysTime

Note! *0x1A10 ~ 0x1A13 are mutually exclusive, it can only be selected either SM1 or SM2.*

0x1A14 ~ 0x1A15 are mutually exclusive, it can only be selected either SM1 or SM2.

Table 7.8: SM2, PDO assignment 0x1C12 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A10	2.0	Latch	Status0; Status1
0x1A11	6.0	Latch	Status0; LatchPos0
0x1A12	18.0	Latch	Status0; LatchPos0; LatchNeg0
0x1A13	34.0	Latch	Status0; Status1; LatchPos0; LatchNeg0; LatchPos1; LatchNeg1
0x1A14	4.0	System	SysTime
0x1A15	8.0	System	SysTime

Note! *0x1A10 ~ 0x1A13 are mutually exclusive, it can only be selected either SM1 or SM2.*

0x1A14 ~ 0x1A15 are mutually exclusive, it can only be selected either SM1 or SM2.

7.3 AMAX-5056T 2-ch Timestamp Digital Output Module

The AMAX-5056T is a 2-ch timestamp digital output module. The timestamp enables a precise DO sync. at a resolution of 1ns. The digital output channels offer LED to indicate digital status. The module provides 2,000 VDC optical isolation between channels. If any high voltage or current damage the channels, the whole system (other modules, and control unit) won't be affected because it is already isolated.

Figure 7.13 AMAX-5056T Module

7.3.1 AMAX-5056T Specification

7.3.1.1 General

- **Certification:** CE, FCC class A
- **Connector:** Pluggable 4P+8P push-in terminal (#24~16 AWG)
- **Enclosure:** PC
- **Power Consumption:** 2W @ $24V_{DC}$
- **Protocol:** EtherCAT
- **Transmission Rate:** 100Mbps
- **LED Indicator:** PWR, RUN, DO status
- **Weight:** Approx. 80g

7.3.1.2 Timestamp Digital Output

- **Channels:** 2
- **Digital Output:**
  - Rated Voltage:
    10~30 VDC
  - Rated Current Output:
    Logic level 1: 0.3A per channel
    Logic level 0: 25 μA per channel (leakage current)
- **Output Delay:** < 0.5 us
- **Resolution Timestamp:** 1ns

7.3.1.3 Protection

Isolation Voltage: 2,000V_{DC}

7.3.1.4 Environment

- **Operation Temperature:** -25~60°C (vertical mounted)
- **Storage Temperature:** -40~85°C
- **Relative Humidity:** 5~95% (non-condensing)

7.3.2 LED Indicator

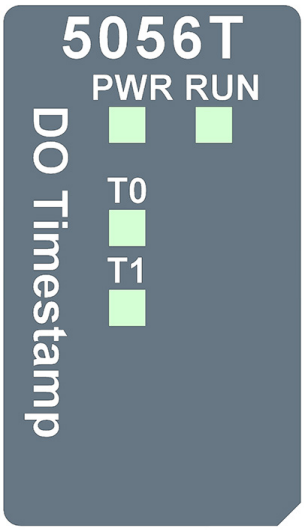


Figure 7.14 AMAX-5056T Module LED Indicator

Table 7.9: AMAX-5056T Module LED Indicator

LED	Color	Indication	Behavior
Power	Green	ON	Power on
Run/Error	Green	ON	EtherCAT connection
	Green	Blink	When TX/RX data in transmission
T0~1 (timestamp)	Green	ON	Wet Logic “1”
		OFF	Wet Logic “0”

7.3.3 Pin Definition

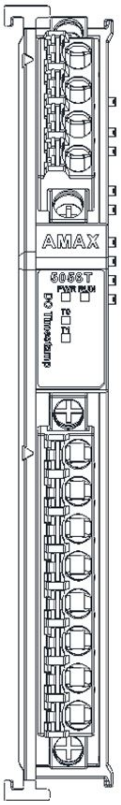


Figure 7.15 AMAX-5056T Module Front View

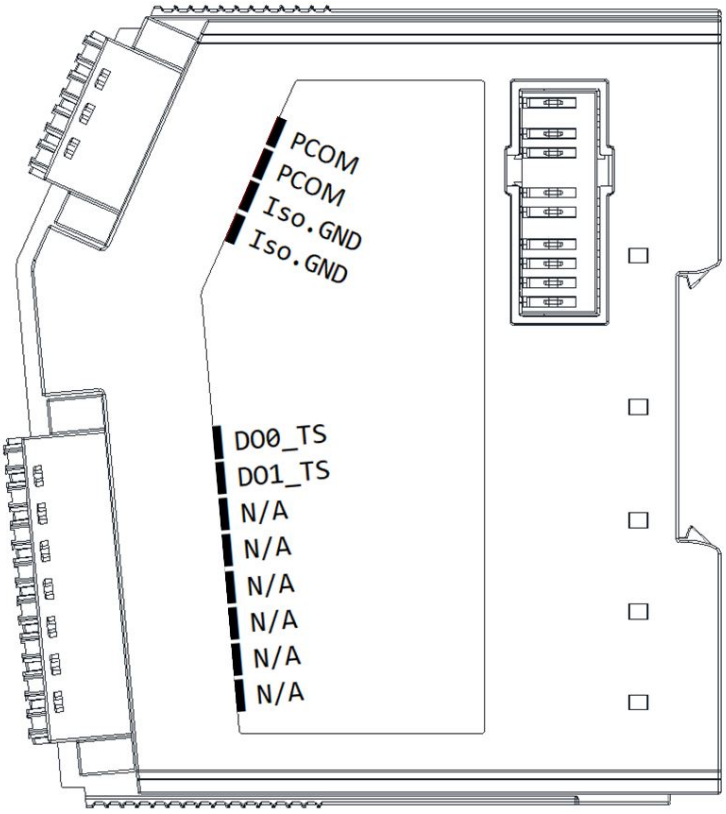


Figure 7.16 AMAX-5056T Module Side View

Table 7.10: Upper 4 Pin Connector	
Pin Number	**Pin Definition**
1	PCOM
2	PCOM
3	Iso.GND
4	Iso.GND

Table 7.11: Lower 8 Pin Connector	
Pin Number	**Pin Definition**
1	DO0_TS
2	DO1_TS
3	N/A
4	N/A
5	N/A
6	N/A
7	N/A
8	N/A

7.3.4 Application Wiring

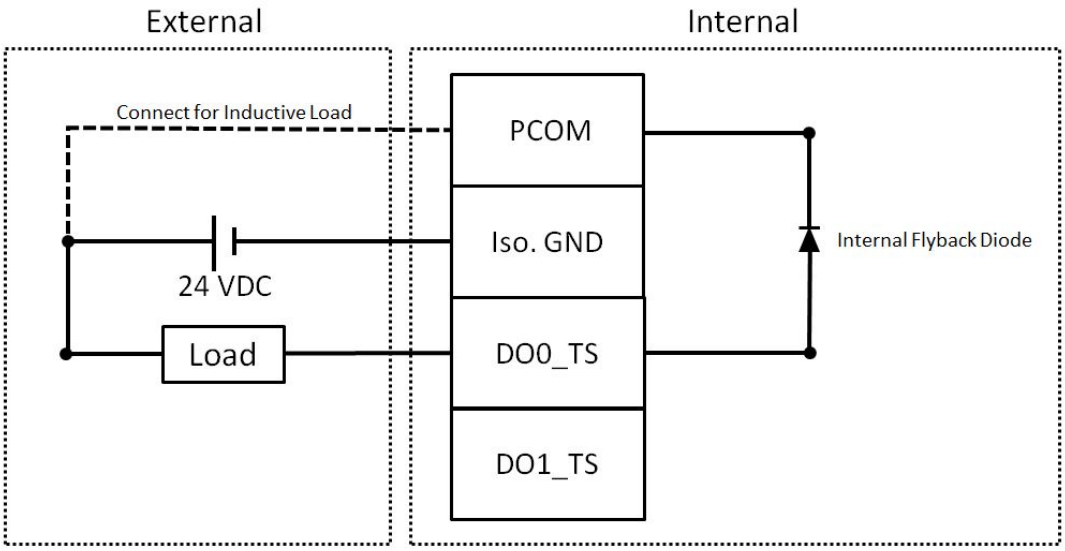


Figure 7.17 Wiring for AMAX-5056T timestamp DI

7.3.5 AMAX-5056T Object Dictionary

7.3.5.1 Input Data (0x1D09)

Table 7.12: Input Data (0x1D09)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
1D09:10	SysTime	32bit System Time	ULINT	RO	0x00

7.3.5.2 Output Data (0x1D09)

Table 7.13: Output Data (0x1D09)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
1D09:81	Active	Active	USINT	RW	0x00
1D09:90	StartTime	Output start time	ULINT	RW	0x00

7.3.5.3 Output Data (0x3000)

Table 7.14: Output Data (0x3000)					
Index (hex)	**Name**	**Meaning**	**Data type**	**Flags**	**Default value**
3001:01	DO0	Digital Output Channel 0	BOOL	RW	0x00
3001:02	DO1	Digital Output Channel 1	BOOL	RW	0x00

7.3.5.4 PDO assignment (0x1C10 – 0x1C13)

Table 7.15: SM0, PDO assignment 0x1C10 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1610	1.0	DC Sync Activate	Activate

Table 7.16: SM1, PDO assignment 0x1C11 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1611	10.0	DC Sync Start	StartTime

(n=0~1 for ch0~1)

Table 7.17: SM2, PDO assignment 0x1C12 (not changeable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x160n	0.1	Channel n	DOn

(n=0~1 for ch0~1)

Table 7.18: SM3, PDO assignment 0x1C13 (selectable)			
Index	**Size (byte.bit)**	**Name**	**PDO content**
0x1A00	8.0	SysTime	SysTime

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