Nu-Step DA
Series Stepper Drivers
User's Manual

Stepper Driver Based on EtherCAT Field Bus

Manual Rev.:	1.0
Revision Date:	June 7, 2023
Part Number:	50M-40802-1000

LEADING EDGE COMPUTING

Preface

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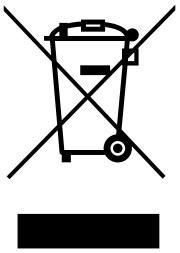

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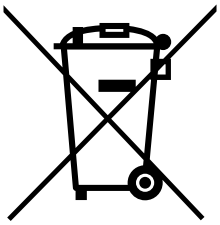

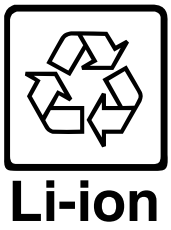

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Revision History

Revision	Description	Date	By
1.0	Initial release	2023-06-07	RA

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1. Introduction

The ADLINK Nu-Step DA Series is a stepper driver based on the EtherCAT bus featuring a 32-bit ARM processor and advanced variable current and frequency conversion technology. The driver generates less heat and motor vibration for more stable operation. It not only supports the standard EtherCAT specification, but also supports table comparison triggers for automated optical inspection (AOI) and linear comparison triggers for line scanning. According to the standard EtherCAT specification, various EtherCAT masters can be supported. Compared with the traditional communication protocols, EtherCAT offers improved reliability, reduces the influence of noise on instructions and greatly extends the communication distance with improved frame error detection and processing.

The Nu-Step DA Series stepper drivers exchange data with a master through an EtherCAT field bus that includes motion control commands, feedback, and parameters. With the built-in comparison trigger function, the system meets a variety of process control requirements, including area scanning, line scanning and EMG functions commonly used in AOI. Through the use of an EtherCAT field bus the complexity and difficulty of cable installation between the host controller and the slave can be greatly reduced, saving on cabling and equipment development costs.

In order to meet the diversified process requirements of automation equipment, the Nu-Step DA Series supports the standard EtherCAT field bus control mode up to 250μs cycles. Operation modes include CSP, PP, PV and HM, with programmable positive and negative limits, home and digital input and digital output, which can make more effective use of digital input and output channels on the driver to achieve more accuracy, safety and faster process procedures.

The Nu-Step DA Series also supports both software slave ID configuration and hardware slave ID configuration with a DIP switch, so that different equipment can be leverage which greatly reduces the development and design costs caused by the integration and use of different drivers. A built-in digital filtering function can also effectively inhibit noise, avoid system process operational errors to improve reliability.

The Nu-Step DA Series has a built-in single-axis comparison trigger function with a frequency up to 1KHz, which supports real-time comparison trigger functionality that cannot be provided by an EtherCAT field bus alone. This function is ideal for frame grabbing and signal measurement process requirements by various detection devices in the Nu-Step DA Series of stepper drivers.

Whether in the EMS, LED or PCB industries, the Nu-Step DA Series stepper drivers can provide high reliability and compatibility solutions for processes after upgrading to an EtherCAT field bus.

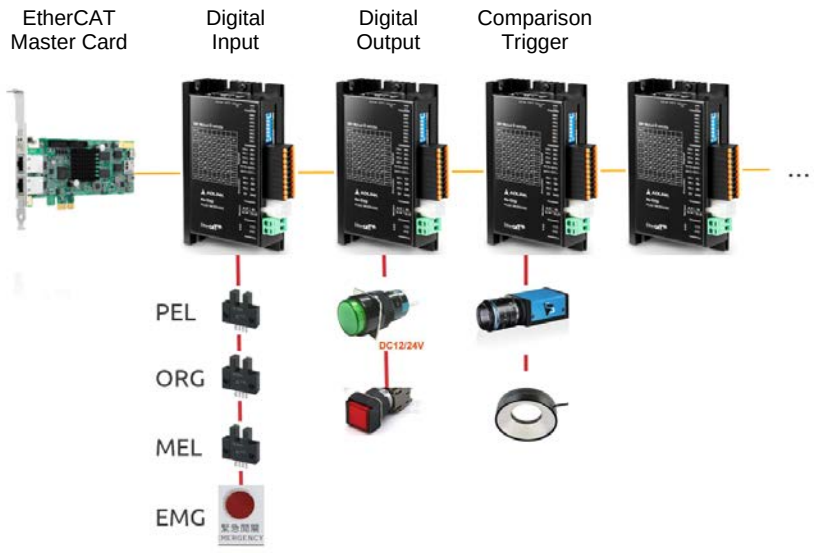


Figure 1: Application architecture of Nu-Step DA Series

Based on the specific implementation requirements, all digital inputs can be configured for motion control functions, or simply digital input. All digital outputs can be configured for standard digital output or comparison trigger output channels.

1.1. Definitions and Abbreviation

CAN	Controller Area Network
CiA	CAN in Automation
COB	Communication Object (CAN message). A unit of transportation in a CAN network. Data must be sent across a network inside a COB.
COB-ID	COB-Identifier. Identifies a COB uniquely in a network. The identifier determines the priority of that COB in the MAC sublayer.
PDO	Process Data Object. Object for data exchange between several devices.
SDO	Service Data Object. Peer-to-peer communication with access to the object dictionary of a device.
pp	Profile Position Mode
pv	Profile Velocity Mode
vl	Velocity Mode
hm	Homing Mode
ip	Interpolated Position Mode
pt	Profile Torque Mode
all	Mandatory for all modes
ce	Common entries in the object dictionary
dc	Device Control
pc	Position Control Function
CSP	Cyclic Synchronous Position
CSV	Cyclic Synchronous Velocity
CST	Cyclic Synchronous Torque
OD	Object Dictionary

1.2. Specifications

1.2.1. Open-Loop Stepper Driver Specifications

Model	DA2D530EO	DA2D542EO	DA2D580EO
Output Current	0.2-3.0A	1.0-4.2A	2.4-8.0A
Input Voltage	15-50V DC		
Weight	0.2 kg		
Size	116 x 69.2 x 26.5 mm		
Interface Type	Single-ended		
Control Protocol	EtherCAT		
Operation Mode	CSP / PP/ PV/ HM		
Encoder Support	No		
Comparison Trigger	Yes		
EtherCAT Bus Cycle	250μs / 500μs / 1ms / 2ms / 4ms		
Digital Input Channel	4		
Digital Output Channel	2		
Software Slave ID	Yes		

1.2.2. Closed-Loop Stepper Driver Specifications

Model	DA2D530EC	DA2D542EC	DA2D580EC
Output Current	0.2-3.0A	1.0-4.2A	2.4-8.0A
Input Voltage	15-50V DC		
Weight	0.2 kg		
Size	116 x 69.2 x 26.5 mm		
Interface Type	Single-ended		
Control Protocol	EtherCAT		
Operation Mode	CSP / PP/ PV/ HM		
Encoder Support	Yes		
Comparison Trigger	Yes		
EtherCAT Bus Cycle	250μs / 500μs / 1ms / 2ms / 4ms		
Digital Input Channel	4		
Digital Output Channel	2		
Software Slave ID	Yes		

1.2.3. IO Interface

Input Signal	Home, positive limit, negative limit, emergency stop, active level (normal open/normal closed)
Output Signal	Alarm, in-position, comparison trigger, master control, active configuration (normal open/normal closed)
Alarm Function	Overcurrent, overvoltage, out-of-tolerance and OP damage

1.2.4. Environmental Specifications

Cooling Mode	Natural Cooling or Forced Air Cooling	
Environment	Location	Cannot be placed next to other heating equipment, dust, oil mist, corrosive gas; high humidity and strong vibration places are avoided, and combustible gas and conductive dust are prohibited.
	Temperature	-10°C to +50°C
	Humidity	40% to 90%RH
	Vibration	Maximum 5.9 m/s^2
Storage Temperature		-20°C to +60°C
Altitude		Below 1000 meters
Weight		0.2 kg

1.3. EtherCAT Field Bus Support and Tool Program

1.3.1. EtherCAT Topology

EtherCAT supports almost all connection topologies, including linear, tree, star and daisy chain, making it possible to have a pure bus topology or linear topology with hundreds of nodes without any limitations that cascaded switches or hubs usually have.

Connecting a mainline to a spur or vertical line in a system is beneficial because the ports required to create a spur are directly integrated into multiple I/O modules. No additional switches or activated base components are required.

Flexible and diverse cable types are supported. In 100BASE-TX mode, an economical industrial Ethernet cable can be used between two nodes with a distance of no more than 100m. Optical fiber (e.g. 100BASEFX) can also be used when the node distance exceeds 100m.

Up to 65,535 devices can be connected to EtherCAT, extending the network almost indefinitely while allowing Ethernet to change freely between physical layers.

1.3.2. Motion Creator Pro 2

Motion Creator Pro 2 is a user interface developed specifically for ADLINK motion control products in commonly used Windows environments. With Motion Creator Pro 2, you can easily set the parameters of the stepper actuator corresponding to the EtherCAT field bus. The ADLINK EtherCAT upper controller PCIe-833x can be used to carry out basic continuous testing and action operations to reduce the development time of application programs. Motion Creator Pro 2 cannot only effectively shorten the development time, but also verify the whole mechanical and electrical design simultaneously through all single-axis and interpolation motion operation pages.

1.4. Model Nomenclature

For Nu-Step DA Series model designation, refer to the following information. For example, model DA2D530EC can be interpreted as:

1	2	3	4	5	6	7
DA	2	D	5	30	E	C

No.	Description	Example
1	Series	DA: DA series
2	Phase number	2: 2 phase, 3: 3 phase
3	Type of power supply	D: DC, A: AC
4	Maximum operating voltage of driver	=Vmax / 10 (5 means maximum operation voltage is 50 volts)
5	Maximum peak value of driver	=Amax x 10 (30 means peak current is 3 Amps)
6	Upper control mode	SS: STD, E: ECAT
7	Motor control mode	O: Open-loop, C: Closed-loop

2. Getting Started

This chapter describes how to install Nu-Step hardware and its I/O wiring.

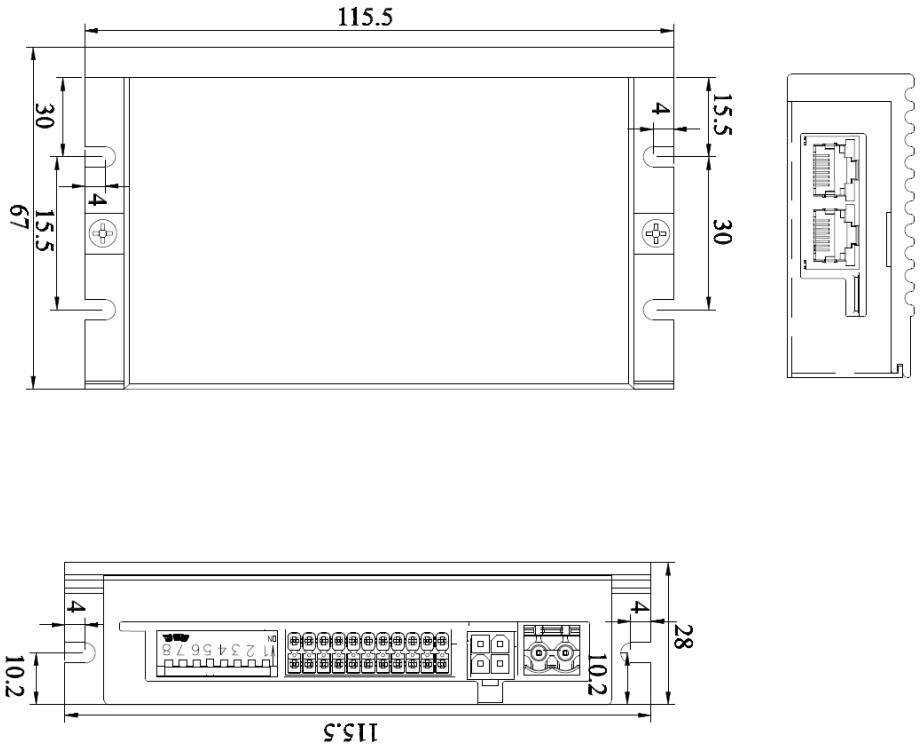
2.1. Package Contents

The following items are included in the product packaging:

- 1x Nu-Step DA Series driver body
- Relevant interface terminals are installed on the body
- 1x Product warranty card

If any items are found missing or damaged, consult your dealer immediately. Keep the products together with the items in the package for easy replacement or maintenance.

2.2. Mechanical Dimensions



All dimensions shown in millimeters.

Figure 2: Nu-Step Series Mechanical Dimensions

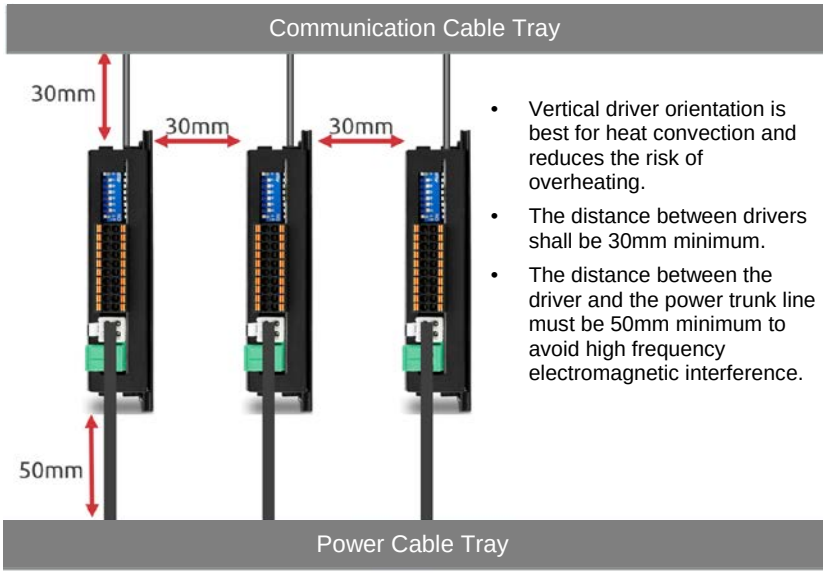
2.3. Hardware Installation

2.3.1. Hardware Configuration

The Nu-Step DA Series of stepper drivers conform to the standard EtherCAT field bus and CIA-402 protocol specifications. The upper controller can run different control modes for stepper motor behavior control and digital IO control.

2.3.2. Installation Procedures

1. Read this manual carefully and set the digital input and output ports and power supply to the correct modes.
2. The installation of multi-actuators must be kept above 30 mm to avoid the problems of poor heat dissipation and excessive EMI interference. Installation must follow the direction of the heat dissipation fins for better heat dissipation.
3. During installation, make sure that the locking screws are fixed correctly to avoid damage or short circuits.
4. For EtherCAT buses, use industrial communication wires with isolation protection, such as STP and FTP isolation network or isolation layer function wires, and correctly use shielded RJ45 connectors to reduce communication interference and improve operational efficiency.
5. Set the motion control related limit switch in the driver parameters and set the general digital signal wiring and levels.
6. Make sure the power input cord is as far away as possible from the EtherCAT field bus communication line, and the servo or stepper driver connections.
7. Turn on the power supply of the system, including the power supply of the upper controller and the power supply of the stepper driver.
8. If an ADLINK EtherCAT upper controller (card) is used, use Motion Creator Pro 2 to verify the I/O signals and the operation of the stepper driver and motor.



Make sure to ground the shielded end of the power terminal to reduce the risk of electric shock and ensure the proper operation of the product.

Caution

Before using the driver for the first time, disconnect the system load. Do not connect the motor driver to any mechanical equipment until the control system and driver are installed. Connect the system only after adjusting and confirming that the parameters of the corresponding mechanisms of the drivers are set normally. Otherwise, serious damage may be caused.

2.3.3. Protection Functions

Short Circuit Protection

In case of a phase-to-phase short circuit or internal overcurrent of the driver, the red light of the driver flashes once every 3 seconds. When this happens, the fault must be removed, and the system powered-on and reset.

Overvoltage Protection

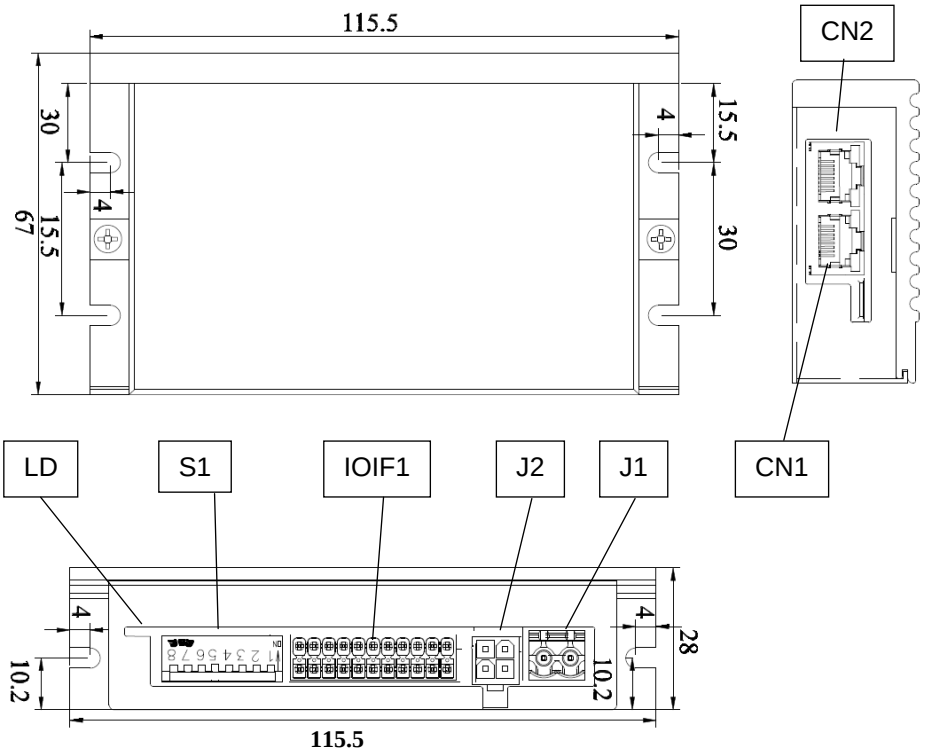
When the input voltage is higher than 55V, the red light of the driver flashes twice every 3 seconds. When this happens, the fault must be removed, and the system powered-on and reset.

Motor Open Circuit Protection

When the motor is open or has no connection, the red light of the driver flashes 4 times every 3 seconds. When this happens, the fault must be removed, and the system powered-on and reset.

2.4. Connector, Switch and LED Locations

This section describes the Nu-Step DA Series connectors and their pinouts, and the LEDs and switches that are used on the module.



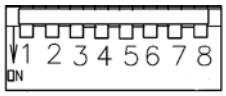
All dimensions shown are in millimeters.

Figure 3: Nu-Step Series Connector, Switch and LED Locations

Item	Description
S1	EtherCAT slave hardware ID of the dial switch. Set the ID range from 1-127 or set to 0 for software ID use.
J1	Power input port. Refer to the specifications of each model for specific input power specifications.
J2	Motor control current output port.
IOIF1	Digital input and output port, including motor encoder input port and 5V DC output power supply.
LD	LED status indicator.
CN1	EtherCAT input port using standard RJ45 terminals.
CN2	EtherCAT output port using standard RJ45 terminals.

2.4.1. Dial Switch, S1

Pin Orientation



Pin Assignment

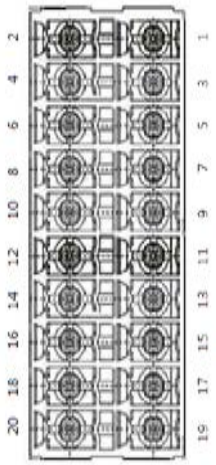
ID	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
0 (default)	Off	Off	Off	Off	Off	Off	Off	Reserved
1	On	Off	Off	Off	Off	Off	Off	Reserved
2	Off	On	Off	Off	Off	Off	Off	Reserved
3	On	On	Off	Off	Off	Off	Off	Reserved
4	Off	Off	On	Off	Off	Off	Off	Reserved
5	On	Off	On	Off	Off	Off	Off	Reserved
……	……	……	……	……	……	……	……	Reserved
127	On	On	On	On	On	On	On	Reserved

Table 1: Dial Switch S1 Pin Definition

The default exit value is ID=0. At this time, the EtherCAT slave ID of the driver is software ID, and the valid range of hardware ID is 1-127

2.4.2. IO Connector, IOIF1

Pin Orientation



Pin Assignment

Foot Position Number	Definition	Functional Description
1	DI0-	Digital input signal 0 negative terminal, differential mode, compatible level 5-24V DC
2	DI0+	Digital input signal 0 positive terminal, differential mode, compatible level 5-24V DC
3	DI1-	Digital input signal 1 negative terminal, differential mode, compatible level 5-24V DC
4	DI1+	Digital input signal 1 positive terminal, differential mode, compatible level 5-24V DC
5	DI2-	Digital input signal 2 negative terminal, differential mode, compatible level 5-24V DC
6	DI2+	Digital input signal 2 positive terminal, differential mode, compatible level 5-24V DC
7	DI3-	Digital input signal 3 negative terminal, differential mode, compatible level 5-24V DC
8	DI3+	Digital input signal 3 positive terminal, differential mode, compatible level 5-24V DC
9	DO0-	Digital output signal 0 negative terminal, maximum pull-up voltage 24V DC, pull-up resistor 2K Ω, maximum output current 100mA
10	DO0+	Digital output signal 0 positive terminal, maximum pull-up voltage 24V DC, pull-up resistor 2K Ω, maximum output current 100mA
11	DO1-	Digital output signal 1 negative terminal, maximum pull-up voltage 24V DC, pull-up resistor 2K Ω, maximum output current 100mA
12	DO1+	Digital output signal 1 positive terminal, maximum pull-up voltage 24V DC, pull-up resistor 2K Ω, maximum output current 100mA
13	EZ-	Encoder Z signal single-ended input interface negative terminal (open-loop stepper is not connected).
14	EZ+	Encoder Z signal single-ended input interface positive terminal (open-loop stepper is not connected).
15	EB-	Encoder B signal single-ended input interface negative terminal (open-loop stepper is not connected).
16	EB+	Encoder B signal single-ended input interface positive terminal (open-loop stepper is not connected).
17	EA-	Encoder A signal single-ended input interface negative terminal (open-loop stepper is not connected).
18	EA+	Encoder A signal single-ended input interface positive terminal (open-loop stepper is not connected).
19	GND	The encoder of the motor is provided with a negative electrode of DC reference terminal
20	+5V	The encoder of the motor is provided with DC voltage of 5V and a current of 100mA.

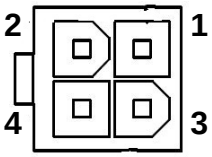
Table 2: IO Connector, IOIF1 Pin Definition

Notes:

- Shielded cable is recommended for digital input and output wire, with wire diameter >0.12 mm^2, AWG 24-26.
- Multi-core twisted pair shielded cable is recommended for encoder wire, with wire diameter >0.08 mm^2, AWG 24-28.
- Single-core wire is recommended for +5V DC power supply, with wire diameter >0.12 mm^2, AWG 22-26.
- Twisted pair shielded cable is recommended for non-power supply wire, and the cable length is as short as possible (recommended not to exceed 3 meters).
- The wire routing shall be as far away from the power wire routing as possible to prevent interference from entering the wire, which will lead to the misoperation of digital input and output.
- Install surge absorption components for inductive components (such as coils, etc.) in relevant lines; DC coil in reverse parallel freewheeling diode, AC coil in parallel resistance-capacitance absorption loop.

2.4.3. Motor Drive Output Connector, J2

Pin Orientation



Pin Assignment

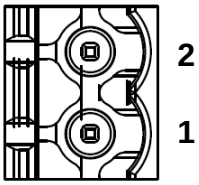
Pin No.	Signal	Functional Description	
1	A+	A+ phase winding interface of two-phase stepper motor, empty connection of three-phase stepper motor	Two-phase/three-phase motor drive power output
2	A-/U	A- phase winding interface of two-phase stepper motor or U-phase winding interface of three-phase stepper motor	
3	B+/V	B+ phase winding interface of two-phase stepper motor or V winding interface of three-phase stepper motor	
4	B-/W	B- phase winding interface of two-phase stepper motor or W-phase winding interface of three-phase stepper motor	

Table 3: Motor Drive Output Connector, J2 Pin Definition

Multi-core power wire is recommended, with wire diameter >0.3 mm^2, (AWG 15 - 22).

2.4.4. Driver Power Input Connector, J1

Pin Orientation



Pin Assignment

Pin No.	Signal	Functional Description	
1	+DC in	Positive electrode of DC power supply. Power supply voltage range: DC 15-50V DC, according to different power requirements of each machine type. Refer to 1.2.1 and 1.2.2 (24V DC or 36V DC recommended).	Module power input
2	DC GND	DC power supply ground	

Table 4: Driver Power Input Connector, J1 Pin Definition

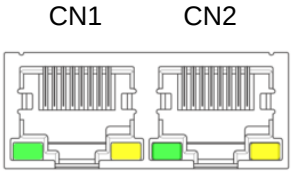
Single-core power wire is recommended, with wire diameter >0.3 mm^2, (AWG 15-22).

It is recommended that the power supply be powered by a noise filter to provide anti-interference.

Notes:

- Pay attention to the positive and negative poles of the power supply when wiring.
- When a non-regulated power supply is used, the current output capacity of the power supply shall be greater than 60% of the set current of the driver.
- When a regulated switching power supply is used, the output current of the power supply shall be greater than or equal to the working current of the driver.
- When the driver is connected in series to a power supply system, ensure that the power supply is large enough to support all the drivers.

2.4.5. EtherCAT Connector, CN 1/CN2



Pin Assignment

Pin No.	Signal	Functional Description	
1	TX+	EtherCAT data transmission positive terminal	EtherCAT IN/OUT
2	TX-	EtherCAT data transmission negative terminal	
3	RX+	EtherCAT data receiving positive terminal	
4	NC	Not connected	
5	NC	Not connected	
6	RX-	EtherCAT data receiving negative terminal	
7	NC	Not connected	
8	NC	Not connected	

Table 5: EtherCAT Connector, CN 1/CN2 Pin Definition

It is recommended to use CAT5e standard wire with isolation and shielded joints at both ends, and it is recommended to use a machine pressing process for RJ45 joints.

EtherCAT bandwidth: 100MHz, maximum distance between stations: 100m

2.4.6. Module Status LEDs

The blue LED is the power indicator, which is always on when the driver is turned on. When the driver loses power, the LED turns off.

The red LED is the fault indicator. When a fault occurs, the number of flashes occuring within 3 seconds represents the different fault condition, as shown in the following table.

Serial No.	Number of Flashes	Red LED Flash Waveform	Fault Description
1	1		Overcurrent fault
2	2		Overvoltage fault
3	7		Out-of-tolerance fault
4	9		Operational amplifier fault

When a fault is cleared, the red LED turns off.

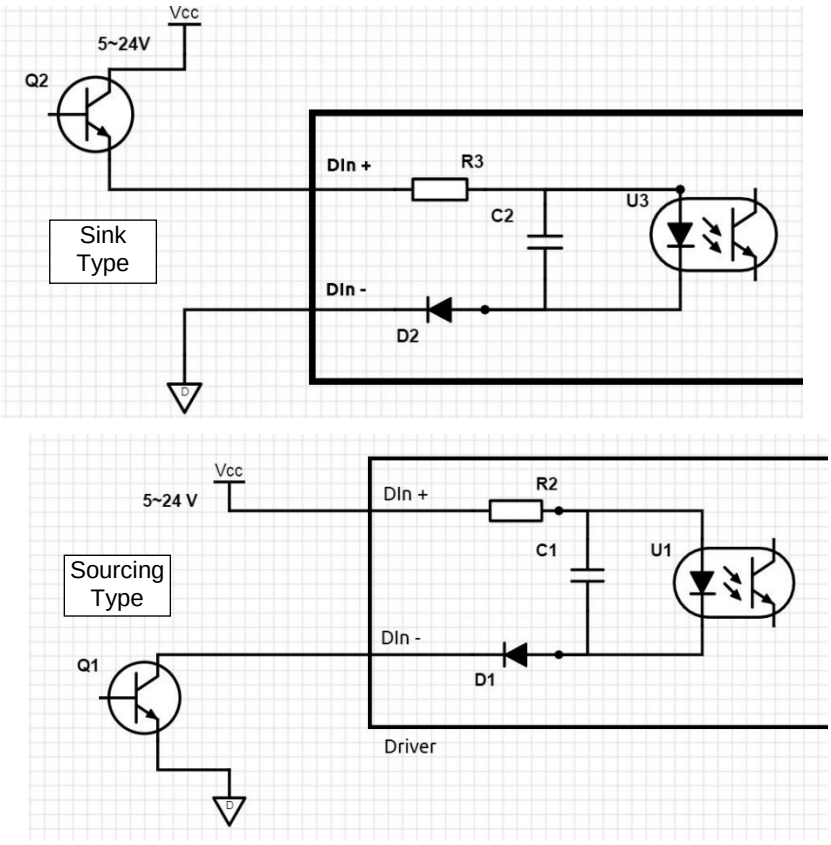
3. Signal Connection

The Nu-Step DA Series of stepper drivers offer 4-point digital inputs and 2-point digital outputs for use with standard EtherCAT upper motion controllers such as the PCIE-833x, Talos, TWINCAT and CODESYS. It also provides programmable function selection, so that users can set the stepper driver more easily.

The following sections give detailed descriptions for making signal connections and considerations for connecting to the EtherCAT bus.

3.1. Emergency Stop/Limit Switch/Home Switch Signal

3.1.1. Interface Circuit



3.1.2. Interface Circuit Specification

Digital Input Specification (Optical Isolation)	
Type	**Single-ended**
Voltage	5-24V DC
Current	6-16mA/Ch
Channels	4
Fastest COS frequency	1KHz

3.1.3. Input Function Setting Mode

Use OD 0x2152 to select functions.

OD Address		Function	Default Value	Function Options	Input Range
0x2152	1	DI0 function settings	0	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	2	DI1 function settings	1	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	3	DI2 function settings	2	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	4	DI3 function settings	3	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	5	Reserved	0	Reserve	x
0x2154	0	Digital input polarity setting	0	bit0: DI0 polarity setting bit1: DI1 polarity setting bit2: DI2 polarity setting bit3: DI3 polarity setting 0: Non Inverse 1: Inverse	1-15

Set the DI point to be active (active polarity). This value adopts a binary algorithm. If DI0 and DI2 need to reverse polarity, set this value to 5.

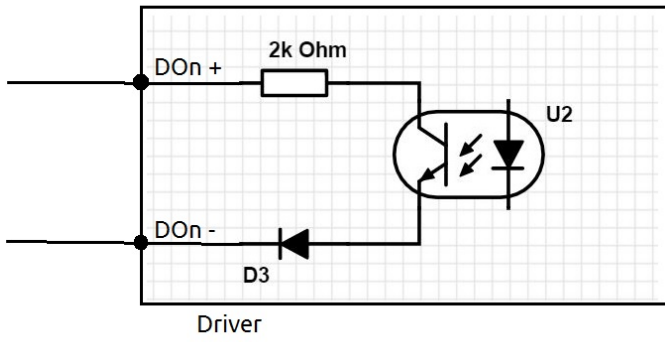
3.1.4. Input Status Corresponds to OD Address

Function	Abbreviation	OD address
0: Negative limit	MEL	0x60FD.0
1: Positive limit	PEL	0x60FD.1
2: Zero	ORG	0x60FD.2
3: Emergency stop	STO	0x6041.5

- Post-EMG behavior is defined in 0x605A according to CIA402.

3.2. Universal Digital Output/Alarm/In-Position Signal

3.2.1. Interface Circuit



3.2.2. Interface Circuit Specification

Digital Output Specification	
Type	**Single-ended**
Voltage	5-24V DC
Current	< 100mA/Chs, pull-up resistance 2k ohm
Channels	2
Fastest COS frequency	1KHz

3.2.3. Output Function Setting Mode

Use OD 0x2005 to select functions.

OD Address		Function	Default Value	Function Options	Input Range
0x2005	1	DO0 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4
	2	DO1 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4
0x2008	0	DO polarity setting	0	When 0x2005 is set to 1,2,4 bit0: DO0 polarity setting bit1: DO1 polarity setting 0: Normal Open 1: Normal Close	0-32767

Set the DO point to be active (active polarity). This value adopts a binary algorithm. If DO0 and DO1 need to reverse polarity, set this value to 3.

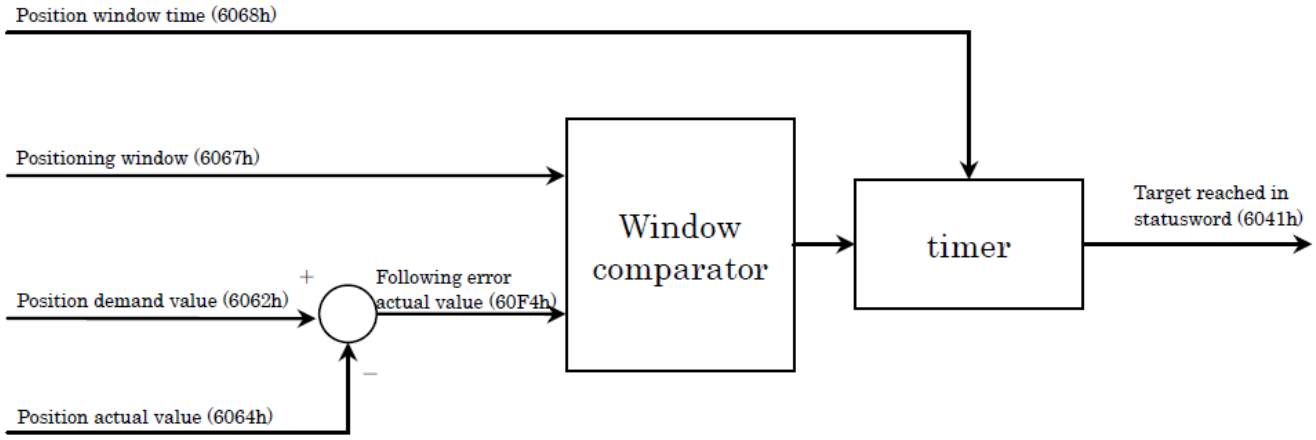
3.2.4. Output Status Corresponds to OD Address

As a general master control digital output.

IOIF1 Foot Position	Function	Functional Description
9/10	DO0	Digital output # 0, 0x60FE.1
11/12	DO1	Digital output # 1, 0x60FE.2

In-position

OD Address	Function	Functional Description
0x6041.10	In-position	True when 0x60F4=0



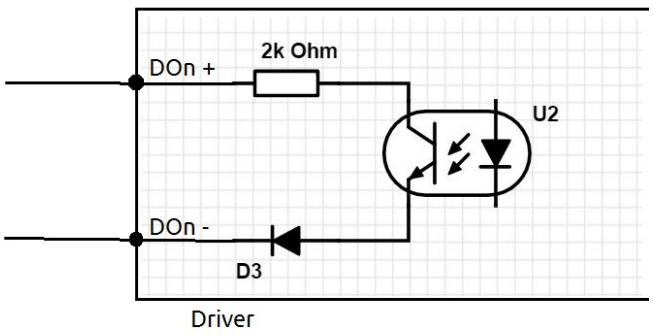
Alarm

OD Address	Function	Description
0x603F	Error code	When an error occurs in motion control, the error code is displayed.

3.3. Comparison Trigger Signals

The Nu-Step DA Series of stepper drivers supports the comparison trigger functions often used in electronic assembly manufacturing industry. They can be used for in-line scanning or triggering image taking used in AOI equipment.

3.3.1. Interface Circuit



3.3.2. Interface Circuit Specification

Digital Output Specification	
Type	**Single-ended**
Voltage	5-24V DC
Current	> 100mA/ Chs, Pull-up resistance 2k ohm
Channels	2
Fastest comparison trigger output frequency	1KHz

3.3.3. Output Function Setting Mode

Use OD 0x2005 to select functions.

OD address		Function	Default value	Function options	Input range
0x2005	1	DO0 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4
	2	DO1 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4

3.3.4. Linear Comparison Trigger Output Corresponds to OD Address

As a general master control digital output.

OD address		Function	Default Value	Function Options	Input Range
0x2164	1	Comparison trigger start	0	0: disable 1: LCMP enable 2: TCMP enable	0,1,2
	2	Default polarity	0	When DO is set to CMP, the polarity when not triggered is: 0: Normal Open 1: Normal Close	0,1
	3	Comparison trigger source	0	0: Command 1: Encoder	0,1
	4	Comparison trigger width	10	count x 50μs	1~2^32-1
	5	Total number of comparison trigger points	1	Total trigger points of LCMP & TCMP	U32
0x2165	1	Comparison trigger direction	1	0: Negative 1: Positive	0,1
	2	Start position of linear comparison trigger	10000	The first trigger point	-2^31~2^31-1
	3	Linear comparison trigger interval	10000	LCMP trigger interval	0~2^32-1

3.3.5. Point Table Comparison Trigger Output Corresponds to OD Address

OD Address		Function	Default Value	Function Options	Input Range
0x2164	1	Comparison trigger start	0	0: disable 1: LCMP enable 2: TCMP enable	0,1,2
	2	Default polarity	0	When DO is set to CMP, the polarity when not triggered 0: Normal Open 1: Normal Close	0,1
	3	Comparison trigger source	0	0: Command 1: Encoder	0,1
	4	Comparison trigger width	10	count x 50μs	1~2^32-1
	5	Total number of comparison trigger points	1	Total trigger points of LCMP & TCMP	U32
0x2165	1	Comparison trigger direction	1	0: Negative 1: Positive	0,1
0x2166	1-16	Point table comparison trigger positions 1-16	1000	# 1 - 16 TCMP comparison trigger point	-2^31~2^31-1

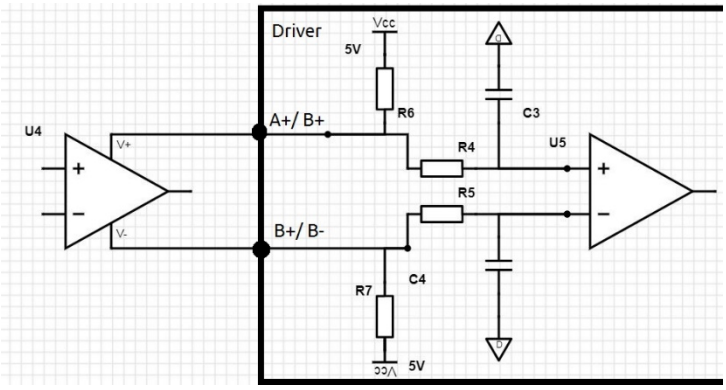
3.4. Encoder Input Signal

The Nu-Step DA Series of stepper drivers include open-loop and closed-loop products. When using closed-loop products, users need to input encoders into the drivers. Because of encoder feedback, the common out-of-step problem of traditional stepper motors can be avoided. See the following table for the corresponding pins of feedback signal input of Nu-Step DA Series of encoders.

3.4.1. Interface Circuit Specification

Encoder input specification	
Type	**Difference**
Voltage	5V DC
Current	+- 5mA
Channels	1 (one port each for + and -)
Maximum acceptance frequency	1MHz @ 4xAB

3.4.2. Interface Circuit Diagram



The encoder power supply is supplied to 5V from inside the driver. If the polarity of the encoder power line is reverse connected, the stepper motor or driver will be damaged.

The signals generated by the stepper motor or external encoder are 5V differential or single-ended signals, which are processed by the internal differential chip of the driver and then sent to the master control. The maximum voltage of the interface is only 5V, and if exceeded, the stepper driver will be damaged.

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4. Motion Control

This chapter describes the EtherCAT motion control function supported by the slave station of Nu-Step DA Series of stepper drivers, as well as the OD used and precautions.

In the EtherCAT specification, OD partitions are described as in the following table.

Indexes	Section Name	Description
0x1000-0x1FFF	Communication Objects	This section is defined in CIA301.
0x2000-0x2FFF	Manufacture Specific Area 1	In this section, 0x200 is allocated for each axis following CIA402.
0x3000-0x3FFF	Input Area	In this section, 0x400 is allocated for each module following ETG.5001. These ODs are used to store TxPDO.
0x4000-0x4FFF	Output Area	In this section, 0x400 is allocated for each module following ETG.5001. These ODs are used to store RxPDO.
0x5000-0x5FFF	Manufacture Specific Area 2	In this section, 0x400 is allocated for each module following ETG.5001. These ODs are used to store manufacturer-specific parameters.
0x6000-0x9FFF	CIA402 Area	In this section, 0x800 is allocated for each axis following CIA402.
0xA000-0xEFFF	Reserved	
0xF000-0xFFFF	Device Area	This section follows ETG. 5001. These ODs are used to store MDP device parameters.

4.1. OD Summary Table

This section describes the OD list and the corresponding EtherCAT mode parameters required for the Nu-Step DA Series of stepper drivers. In addition, the basic settings of the drivers before motion control and the basic mode of operation are explained.

4.1.1. OD Summary Table

4.1.1.1. Communication Data

Index	Sub-Index	Data	
		Description	Data Type
0x1000	0	Device Type	UDINT
0x1001	0	Error Register	USINT
0x1008	0	Device Name	STRING(7)
0x1009	0	Hardware Version	STRING(5)
0x100A	0	Software Version	STRING(5)
0x100B	0	Manufactory Version	
	1	Firmware Version	UNSIGNED32
	2	SDK version	VISIBLE_STRING
	3	Hardware Version	UNSIGNED32
	4	Software Version	UNSIGNED32
	5	ADLINK Serial Number [31:0]	UNSIGNED32
	6	ADLINK Serial Number [39:32]	UNSIGNED32
	7	Driver Version	VISIBLE STRING
	8	Library Version	VISIBLE STRING

Index	Sub-Index	Data	
		Description	Data Type
0x1010	0	Store Parameters	UNSIGNED32
	1	Save All parameters	UNSIGNED32
	2	Save Communication Parameters	UNSIGNED32
	3	Save Application Parameters	UNSIGNED32
	4	Save Manufacturer Parameters	UNSIGNED32
0x1011	0	Restore Parameters	UNSIGNED32
	1	Restore All Default Parameters	UNSIGNED32
	2	Restore Communication Default Parameters	UNSIGNED32
	3	Restore Application Default Parameters	UNSIGNED32
	4	Restore Manufacturer Default Parameters	UNSIGNED32
0x1018	0	Identity Object	Identity (23h)
	1	Vendor ID	UNSIGNED32
	2	Product Code	UNSIGNED32
	3	Revision Number	UNSIGNED32
	4	Serial Number	UNSIGNED32
0x1600	0-8	RXPDO 1 Mapping Parameter	PDO Mapping (21h)
0x1601	0-8	RXPDO 2 Mapping Parameter	PDO Mapping (21h)
0x1602	0-8	RXPDO 3 Mapping Parameter	PDO Mapping (21h)
0x1603	0-8	RXPDO 4 Mapping Parameter	PDO Mapping (21h)
0x1A00	0-8	TXPDO 1 Mapping Parameter	PDO Mapping (21h)
0x1A01	0-8	TXPDO 2 Mapping Parameter	PDO Mapping (21h)
0x1C00	0	SM Communication Type	
	1	Comm. Type, Sync Manager 0	
	2	Comm. Type, Sync Manager 1	
	3	Comm. Type, Sync Manager 2	
	4	Comm. Type, Sync Manager 3	
0x1C12	0	SM2(Outputs) PDO Assignment	
	1	Sync Manager 2, PDO Mapping 0	
	2	Sync Manager 2, PDO Mapping 1	
	3	Sync Manager 2, PDO Mapping 2	
	4	Sync Manager 2, PDO Mapping 3	
0x1C13	0	SM3(Inputs) PDO Assignment	
	1	Sync Manager 3, PDO Mapping 0	
	2	Sync Manager 3, PDO Mapping 1	

Index	Sub-Index	Data	
		Description	Data Type
0x1C32	0	SM2(Outputs) SyncManager Parameter	
	1	Synchronization Type	
	2	Cycle Time	
	3	Shift Time	
	4	Sync Types Supported	
	5	Minimum Cycle Time	
	6	Calc and Copy Time	
	7	Minimum Delay	
	8	Get Cycle Time	
	9	Minimum Hardware Delay	
	10	Sync Cycle Time	
0x1C33	0	SM3(Inputs) SyncManager Parameter	
	1	Synchronization Type	
	2	Cycle Time	
	3	Shift Time	
	4	Sync Types Supported	
	5	Minimum Cycle Time	
	6	Calc and Copy Time	
	7	Minimum Delay	
	8	Get Cycle Time	
	9	Minimum Hardware Delay	
	10	Sync0 Cycle Time	

4.1.1.2. Driver Setting Parameters

Index	Sub-Index	Data	
		Description	Data Type
0x2000	0	Peak Current	UINT
0x2001	0	Motor Resolution	UINT
0x2002	0	Standby Time	UINT
0x2003	0	Standby Current Percentage	UINT
0x2005	0	Outputs Function	
	1	DO0 Function	UINT
	2	DO1 Function	UINT
0x2008	0	DOs Polarity	UINT
0x2010	0	Filter Time	
	1	FIR Filter Time	UINT
	2	IIR Filter Time	UINT
0x2013	0	AutoTune Enable	UINT
0x2015	0	Current Loop Kp	UINT
0x2016	0	Current Loop Ki	UINT
0x2035	0	position loop Kp	UINT

Index	Sub-Index	Data	
		Description	Data Type
0x2036	0	position loop Ki	UINT
0x2037	0	position loop Kd	UINT
0x2038	0	position loop Kvff	UINT
0x2049	0	Motor rigidity	UINT
0x2051	0	Polarity	UINT
0x2071	0	Encoder Direction	UINT
0x2150	0	Slave Alias	UINT
0x2151	0	Slave Alias Source	UINT
0x2152	0	Inputs Function	
	1	DI0 Function	UINT
	2	DI1 Function	UINT
	3	DI2 Function	UINT
	4	DI3 Function	UINT
	5	Reserve	
0x2153	0	Inputs Digital Filter	
	1	DI0 Filter Timer	UINT
	2	DI1 Filter Timer	UINT
	3	DI2 Filter Timer	UINT
	4	DI3 Filter Timer	UINT
	5	Reserve	
0x2154	0	DIs Polarity	UINT
0x2164	0	CMP	
	1	trigger Enable	UDINT
	2	default Status	UDINT
	3	Source	UDINT
	4	Trigger high width	UDINT
	5	Total trigger count	UDINT
0x2165	0	CMP_1	
	1	Trigger Direction	UDINT
	2	Start position	DINT
	3	Interval	DINT

Index	Sub-Index	Data	
		Description	Data Type
0x2166	0	CMP_POS	DINT
	1	POS1	DINT
	2	POS2	DINT
	3	POS3	DINT
	4	POS4	DINT
	5	POS5	DINT
	6	POS6	DINT
	7	POS7	DINT
	8	POS8	DINT
	9	POS9	DINT
	10	POS10	DINT
	11	POS11	DINT
	12	POS12	DINT
	13	POS13	DINT
	14	POS14	DINT
	15	POS15	DINT
	16	POS16	DINT

To restore driver parameters to factory settings, 0x1011.4 = 0x64616f6c must be written, and then read back. When the read back value is 1, the action is completed; however, it will not be enabled until the power is turned off and the system restarted.

For the storage mode of drive parameters, 0x1010.04 = 0x65766173 must be written, and then read back. When the read back value is 1, the action is completed; however, it will not be enabled until the power is turned off and the system restarted.

Note: After the factory setting is restored, the 0x2000 current peak value will be restored to the lowest driving capacity value to avoid burning the motor. Reset the correct current peak value to avoid motor non-rotation.

4.1.1.3. CiA 402 Related Parameters

Index	Sub-Index	Data	
		Description	Data Type
0x603F	0	Last Error Code	UINT
0x6040	0	Control Word	UINT
0x6041	0	Status Word	UINT
0x605A	0	Quick Stop Option Code	INT
0x6060	0	Modes of Operation	USINT
0x6061	0	Modes of Operation Display	USINT
0x6062	0	Commanded Position	DINT
0x6064	0	Actual Position	DINT
0x606B	0	Commanded Velocity	DINT
0x606C	0	Actual Velocity	DINT
0x6077	0	Torque Actual Value	
0x607A	0	Profile Target Position	DINT
0x607C	0	Homing Offset	DINT

Index	Sub-Index	Data	
		Description	Data Type
0x6081	0	Profile Target Velocity	UDINT
0x6082	0	End Velocity	UDINT
0x6083	0	Profile Target Acceleration	UDINT
0x6084	0	Profile Target Deceleration	UDINT
0x6085	0	Quick Stop Deceleration	UDINT
0x6098	0	Homing Method	SINT
0x6099	0	Homing Velocity	
	1	Homing velocity(fast)	
	2	Homing velocity(slow)	
0x609A	0	Homing Acceleration	UDINT
0x60B0	0	Position Offset	DINT
0x60B8	0	Touch Probe Function	UINT
0x60B9	0	Touch Probe Status	UINT
0x60BA	0	Touch Probe 1 Positive Value	DINT
0x60BB	0	Touch Probe 1 Negative Value	DINT
0x60C2	0	Interpolation Time Period	
	1	Interpolation Time value	
	2	Interpolation Time units	
0x60D5	0	Touch Probe 1 Positive Counter	UINT
0x60D6	0	Touch Probe 1 Negative Counter	UINT
0x60FD	0	Digital Inputs	UDINT
0x60FE	0	Digital Outputs	
	1	Output_0	
	2	Output_1	
0x60FF	0	Target Velocity	DINT
0x6502	0	Supported Drive Modes	UDINT

4.1.2. Driver Parameter Setting Table and Definition

OD Address		Function	Default Value	Function Options	Input Range
0x2000	0	Maximum instantaneous output current	1000	Maximum instantaneous output current (mA)	0-10000
0x2001	0	Single turn resolution	10000	Single turn resolution (pulse/rev)	1-51200
0x2002	0	Delay time of braking after setting	300	Delay time of braking after setting (ms)	50-10000
0x2003	0	Current value of braking after setting	50	Current value of braking after setting (%)	0-100

OD Address		Function	Default Value	Function Options	Input Range
0x2005	0	DO function settings	2	NA	x
	1	DO0 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4
	2	DO1 function settings	4	1: Alarm 2: In-position 3: CMP 4: Master control	1-4
0x2008	0	DO polarity setting	0	When 0x2005 is set to 1,2,4: bit0: DO0 polarity setting bit1: DO1 polarity setting 0: default high, active low 1: default low, active high	0-32767
0x2010	0	Filtering time	1	NA	x
	1	FIR filtering time	4000	Motor pre-filter time range	50-25600μs
	2	X	X	not supported	x
0x2013	0	Automatic adjustment takes effect	1	Automatically setting current loop PI when power on: 0: No automatic adjustment 1: Automatic adjustment after enabling	0,1
0x2015	0	Current loop proportional gain value	1000	When 0x2013=1, the parameter is read only	R
0x2016	0	Current loop integral gain value	200	When 0x2013=1, the parameter is read only	R
0x2035	0	Position loop proportional gain value	85	Closed-loop KP gain value	0-200
0x2036	0	Position loop integral gain value	0	Closed-loop KI gain value	0-200
0x2037	0	Position loop differential gain value	6000	Closed-loop KD gain value	0-6000
0x2038	0	Position loop velocity feedforward gain value	85	Closed-loop Kvff gain value	0-1000
0x2049	0	Rigid adjustment	0	Closed-loop PID automatic adjustment, 0: weaker 1: stronger	0,1
0x2051	0	Steering adjustment	0	0: forward 1: reverse	0,1
0x2071	0	Encoder direction	1	Motion direction fed back by encoder; Closed-loop efficiency 0: no reverse 1: reverse	0, 1
0x2150	0	Software slave station number	1	Software Slave ID	1-65535
0x2151	0	Station number basis	0	Specify slave ID source: 0: hardware 1: software	0,1

OD Address		Function	Default Value	Function Options	Input Range
0x2152	0	DI function settings	5	NA	x
	1	DI0 function settings	0	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	2	DI1 function settings	1	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	3	DI2 function settings	2	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	4	DI3 function settings	3	0: negative limit 1: positive limit 2: zero 3: emergency stop	0-3
	5	Reserved	0	Reserved	x
0x2153	0	DI digital filtering time	5	NA	x
	1	DI0 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	2	DI1 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	3	DI2 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	4	DI3 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	5	Reserved	100	Reserved	x
0x2154	0	DI polarity setting	0	bit0: DI0 polarity setting bit1: DI1 polarity setting bit2: DI2 polarity setting bit3: DI3 polarity setting 0: Non Inverse 1: Inverse	1-15
0x2164	0	Comparison trigger	5	NA	X
	1	Comparison trigger start	0	0: disabled 1: LCMP enabled 2: TCMP enabled	0,1,2
	2	Default polarity	0	When DO is set to CMP, the polarity when not triggered: 0: Normal Open 1: Normal Close	0,1
	3	Comparison trigger source	0	0: Command 1: Encoder	0,1
	4	Comparison trigger start width	10	count x 50μs	1~2^32-1
	5	Total number of comparison trigger points	1	Total trigger points of LCMP & TCMP	U32
0x2165	0	Comparison trigger_1	3	NA	x
	1	Comparison trigger direction	1	0: Negative 1: Positive	0,1
	2	Start position of linear comparison trigger	10000	Trigger the first point	-2^31~2^31-1
	3	Linear comparison trigger interval	10000	LCMP trigger interval	0~2^32-1

OD Address		Function	Default Value	Function Options	Input Range
0x2166	0	Point table comparison trigger position	16	NA	x
	1	Point table comparison trigger position 1	1000	#1 TCMP comparison trigger point	-2^31-2^31-1
	2	Point table comparison trigger position 2	2000	#2 TCMP comparison trigger point	-2^31-2^31-1
	3	Point table comparison trigger position 3	3000	#3 TCMP comparison trigger point	-2^31-2^31-1
	4	Point table comparison trigger position 4	4000	#4 TCMP comparison trigger point	-2^31-2^31-1
	5	Point table comparison trigger position 5	5000	#5 TCMP comparison trigger point	-2^31-2^31-1
	6	Point table comparison trigger position 6	6000	#6 TCMP comparison trigger point	-2^31-2^31-1
	7	Point table comparison trigger position 7	7000	#7 TCMP comparison trigger point	-2^31-2^31-1
	8	Point table comparison trigger position 8	8000	#8 TCMP comparison trigger point	-2^31-2^31-1
	9	Point table comparison trigger position 9	9000	#9 TCMP comparison trigger point	-2^31-2^31-1
	10	Point table comparison trigger position 10	10000	#10 TCMP comparison trigger point	-2^31-2^31-1
	11	Point table comparison trigger position 11	11000	#11 TCMP comparison trigger point	-2^31-2^31-1
	12	Point table comparison trigger position 12	12000	#12 TCMP comparison trigger point	-2^31-2^31-1
	13	Point table comparison trigger position 13	13000	#13 TCMP comparison trigger point	-2^31-2^31-1
	14	Point table comparison trigger position 14	14000	#14 TCMP comparison trigger point	-2^31-2^31-1
	15	Point table comparison trigger position 15	15000	#15 TCMP comparison trigger point	-2^31-2^31-1
	16	Point table comparison trigger position 16	16000	#16 TCMP comparison trigger point	-2^31-2^31-1

4.1.2.1. Braking Function

Braking can reduce the problem of steep motion in place. Setting the current power of a motor under load conditions can reduce overheating.

OD Address		Function	Default Value	Function Options	Input Range
0x2002	0	Delay time of braking after setting	300	Delay time of braking after setting (ms)	50-10000
0x2003	0	Current value of braking after setting	50	Current value of braking after setting (%)	0-100

- 0x2002: Set the delay time for the driver to start the braking automatically after the motor setting is completed.
- 0x2003: Set the current value to use when locking the motor.

4.1.2.2. Adjustment Function

This function is effective for closed-loop motors.

OD Address		Function	Default Value	Function Options	Input Range
0x2013	0	Automatic adjustment takes effect	1	Automatically setting current loop PI when power on: 0: No automatic adjustment 1: Automatic adjustment after enabling	0,1
0x2015	0	Current loop proportional gain value	1000	When 0x2013=1, the parameter is read only.	R
0x2016	0	Current loop integral gain value	200	When 0x2013=1, the parameter is read only.	R
0x2035	0	Position loop proportional gain value	85	Closed-loop KP gain value	0-200
0x2036	0	Position loop integral gain value	0	Closed-loop KI gain value	0-200
0x2037	0	Position loop differential gain value	6000	Closed-loop KD gain value	0-6000
0x2038	0	Position loop velocity feedforward gain value	85	Closed-loop Kvff gain value	0-1000
0x2049	0	Rigid adjustment	1	Closed-loop PID automatic adjustment 0: weaker 1: stronger	0,1
0x2071	0	Encoder direction	1	Motion direction fed back by encoder; Closed-loop efficiency 0: no reverse 1: reverse	0, 1

- When 0x2013 is set to 0, the closed-loop gain of 0x2035-0x2038 can be adjusted.
- When 0x2013 is set to 1, the self-adjustment function is started and the adjusted PI gain values are 0x2015 and 0x2016, which can be used for automatic adjustment.
- 0x2049 is a simple rigid adjustment.

4.1.2.3. Using Software ID

OD Address		Function	Default Value	Function Options	Input Range
0x2150	0	Software slave station number	1	Software Slave ID	1-65535
0x2151	0	Station number basis	0	Specify slave ID source 0: hardware, 1: software	0,1

- When 0x2151 is set to 0, the slave ID is the set value of SW1.
- When 0x2151 is set to 1, the slave ID is set to 0x2150.

4.1.2.4. Digital Input Uses Digital Filtering Function

OD Address		Function	Default Value	Function Options	Input Range
0x2153	0	DI digital filtering time	5	NA	x
	1	DI0 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	2	DI1 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	3	DI2 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	4	DI3 digital filtering time	100	1 - 32768, 1=50μs, digital filtering	1-32767
	5	Reserved	100	Reserved	x

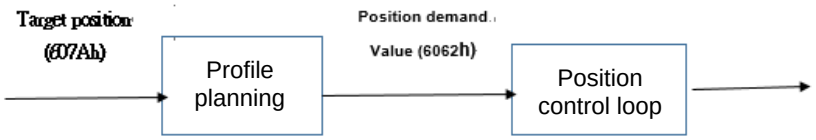
0x2053 is a digital filtering function and the filtering time of each digital input point is 0x2153.1 - 0x2153.4 * 50μs. When it is set to 1, high signals with a long time <50μs will be filtered out. For example, if it takes 1ms for a high signal to be recognized, set the value to 20.

4.2. Operation Mode

EtherCAT offers several motion control modes. This section describes only the modes supported in the Nu-Step DA Series: PP, PV, CSP and HM.

4.2.1. Profile Position Mode (PP mode)

When running PP mode, the PTP motion is executed by the profile planning function of the driver, and the target position, profile speed and profile acceleration and deceleration are required to be input until the stroke is completed.



4.2.1.1. Operational Steps

1. Set the operation mode to profile position mode and the object (Mode of operations: 6060h) to 0x01.
2. Set the object (Target position: 607Ah) to the target position value and plan the execution path.
3. Set the object (Profile velocity: 6081h) to the profile velocity value setting.
4. Set the object (Profile acceleration: 6083h) and (Profile deceleration: 6084h) to the acceleration/deceleration value settings (millisecond from 0 rpm to 3000 rpm).
5. Change the object (Controlword: 6040h) value from 0x06 to 0x0F, so that the control system is in the Servo On state, and then the motor starts to operate.
6. Set the positive and negative errors allowed by the object (Position window: 6067h) to announce the arrival of the target position and confirm whether the target position is reached or not. In addition, the object (Position window time: 6068h) can be determined as Target Reached after judging how long it has stayed within the error range (ms).
7. Object (following error window: 6065h) position command error tolerance value. Object (following error window time: 6068h), after determining how long it has stayed within the error range (ms), can be confirmed whether it is positioned in a relative position.

Serial Number	Object Dictionary	Description	Set Value	Unit
1	6060H	Operation mode	1	None
2	6040H	Control word	Set as needed	None
3	607AH	Target location	Set as needed	Unit
4	6081H	Protocol speed in location mode	Set as needed	Unit/S
5	6082H	Take-off speed and stop speed in position mode	Set as needed	Unit/S
6	6083H	Protocol acceleration	Set as needed	Unit/(S*S)
7	6084H	Protocol deceleration	Set as needed	Unit/(S*S)
8	6085H	Emergency stop deceleration. Use depends on the value of 605A.	Set as needed	Unit/(S*S)
9	605AH	Whether emergency stop deceleration is adopted (5: adopted; Other values: not adopted)	Set as needed	None

4.2.2. Profile Velocity Mode (PV mode)

Set the target speed and plan the stroke acceleration and deceleration to reach the final speed stroke.

4.2.2.1. Operational Steps

1. Set the object of mode of operations (6060h) to the profile velocity mode value = 0x03.
2. Change the driver to Serve On state and the object (Controlword: 6040h) setting value from 0x06 to 0x0F.
3. The object (Profile acceleration: 6083h) and (Profile deceleration: 6084h), plan the path acceleration and deceleration. (Millisecond from 0 rpm to 3000 rpm.)
4. Set the object of target velocity (Target velocity: 60FFh). According to the value, the motor runs to the target speed.

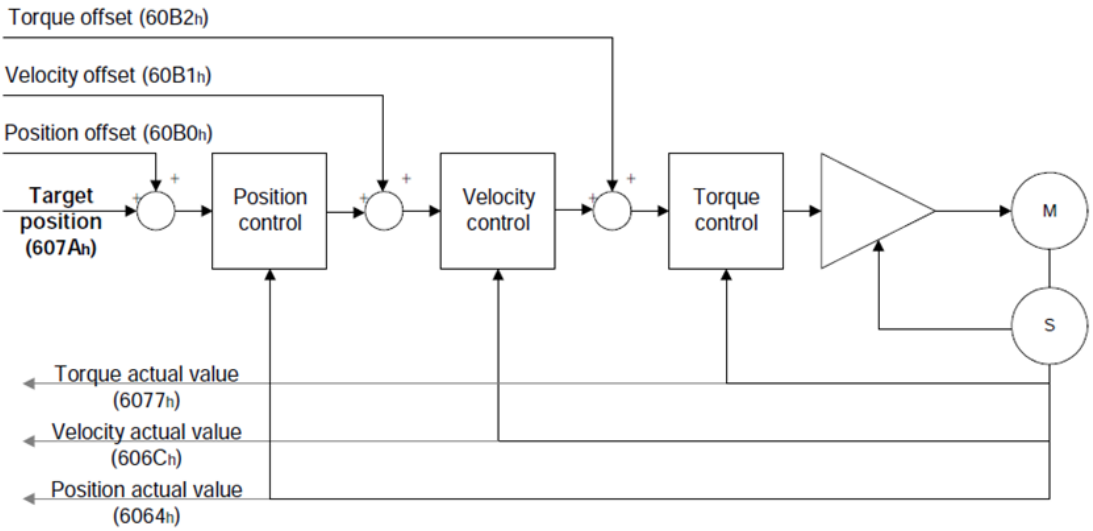
Serial Number	Object Dictionary	Description	Set Value	Unit
1	6060H	Operation mode	3	None
2	6040H	Control word	Set as needed	None
3	60FFH	Protocol speed in speed mode	Set as needed	Unit/S
4	6083+00H	Protocol acceleration	Set as needed	Unit/(S*S)
5	6084+00H	Protocol deceleration	Set as needed	Unit/(S*S)

4.2.3. Cyclic Synchronous Position Mode (CSP mode)

In this mode, the upper controller needs to have the profile planning function, and only needs to input the target position. Then the position command can be transmitted to the driver in a cyclic synchronous way.

4.2.3.1. Operational Steps

1. Set the object of mode of operations (6060h) to cyclic synchronous position mode value (0x08) and write the object (Target position: 607Ah) to the target location.
2. Change the object (Controlword: 6040h) value from 0x06 to 0x0F, so that the control system is in the Servo On state, and then the motor starts to operate.



Serial Number	Object Dictionary	Description	Set Value	Unit
1	6060H	Operation mode	8	None
2	6040H	Control word	Set as needed	None
3	607AH	Target location	Set as needed	Unit

4.3. Homing Mode

This section introduces the method for the driver to search for the original position (also known as a reference point or zero point). Several modes can be achieved by using a limit switch at the end of the trip or a home switch (zero switch) at the middle of the stroke. Most modes also use the index pulse (zero) of the incremental encoder. Since the Nu-Step DA Series of stepper drivers do not support EZ signals, they only support zero return mode, with the exception of 33 and 34.

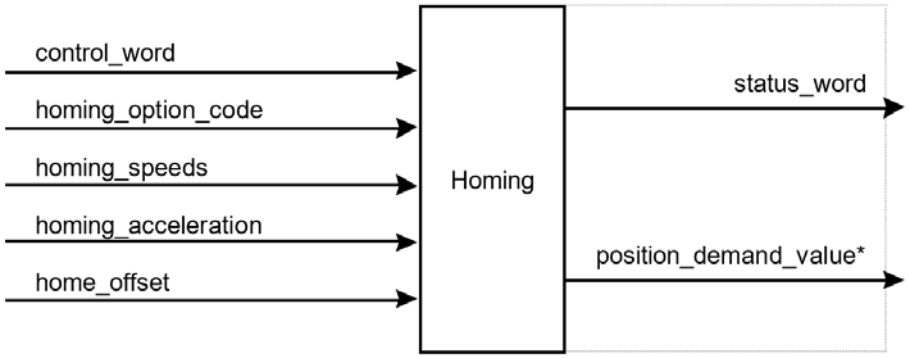


Figure 4: Homing Function

OD definition of zero return mode.

Index	Object	Name	Type	Attr.	M/O
$607C_h$	VAR	*Home offset*	INTEGER32	rw	O
6098_h	VAR	*Homing method*	INTEGER8	rw	M
6099_h	ARRAY	*Homing speeds*	UNSIGNED32	rw	M
$609A_h$	VAR	*Homing acceleration*	UNSIGNED32	rw	O

OD definition related to non-zero return mode.

Index	Object	Name	Type	Attr.	M/O
6040_h	VAR	*Controlword*	UNSIGNED16	dc	6040_h
6041_h	VAR	*Statusword*	UNSIGNED16	dc	6041_h

Functional Description

The following settings will also be established:

- Zero return signal (positive limit switch, negative limit switch, home switch)
- Driving direction and appropriate direction
- Position of the index pulse

The difference between the home position and the zero position is the home offset. For how to use this offset, refer to the definition of the home offset in 4.3.2.1.

The figures in the following sections show various zero returns. The circled number represents the code used to select the zero return position. The direction of motion is also indicated. You can use negative zero return mode definitions and other zero return modes.

Four types of zero return signals are available: negative and positive limit switches, home switch, and index pulse from the encoder.

In the zero return sequence diagrams shown below, the encoder count increases as the axis position moves to the right; in other words, the left side is the minimum position and the right side is the maximum position.

In order to run the position control driver, it is usually necessary to have an exact understanding of the absolute position. Because drivers usually do not have an absolute encoder for cost reasons, a zero return operation must be performed. Each mode clearly describes the exact sequence of zero return operations. In some cases, the device can choose from multiple modes using the zero return mode.

4.3.1. Zero Return Mode

This section describes the details of how each zero return mode works.

4.3.1.1. Mode 1: zero return on negative limit switch and index pulse

If the negative limit switch is not activated, the initial direction of motion will be left when using this mode. The starting position is at the first index pulse to the right of the position where the negative limit switch becomes invalid.

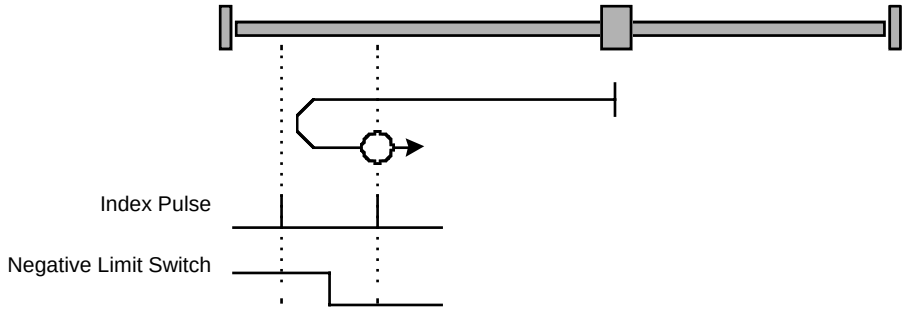


Figure 5: Zero return on negative limit switch and index pulse

4.3.1.2. Mode 2: Zero return on positive limit switch and index pulse

With this mode, if the positive limit switch is not activated, the initial direction of movement is to the right. The home position is at the first index pulse to the left of the position where the positive limit switch becomes invalid.

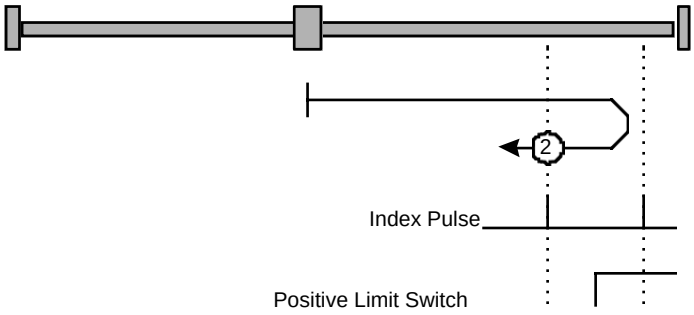


Figure 6: Zero return on positive limit switch and index pulse

4.3.1.3. Modes 3 and 4: zero return on positive home switch and index pulse

With modes 3 or 4, the initial direction of motion depends on the state of the home switch. The home position is at the index pulse to the left or right of the point where the home switch changes state. If the initial position is positioned so that the direction of motion must be reversed during the return to zero, the point at which the reversal occurs will be anywhere after the home switch state has changed.

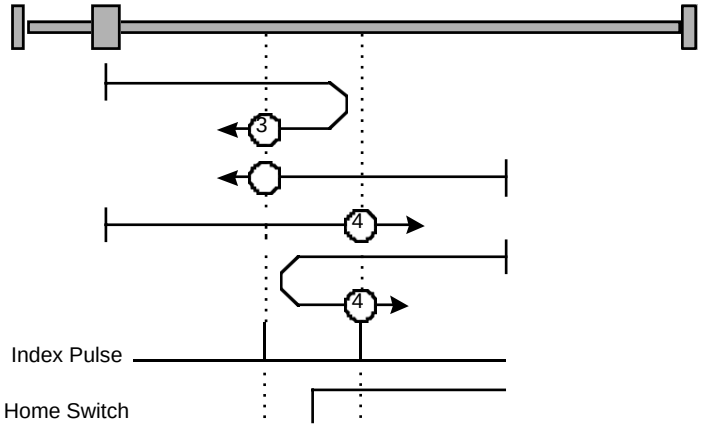


Figure 7: Zero return on positive home switch and index pulse

4.3.1.4. Modes 5 and 6: zero return on negative home switch and index pulse

With modes 5 or 6, the initial direction of motion depends on the state of the home switch. The home position is at the index pulse to the left or right of the point where the home switch changes state. If the initial position is positioned so that the direction of motion must be reversed during the return to zero, the point at which the reversal occurs will be anywhere after the home switch state has changed.

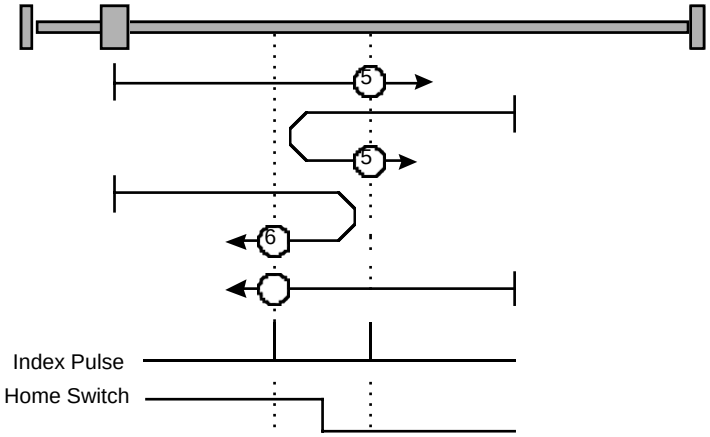


Figure 8: Zero return on negative home switch and index pulse

4.3.1.5. Modes 7 to 14: zero return on home switch and index pulse

These modes use a home switch, which only works on the part of the stroke and, in effect, has an "instantaneous" effect when the position of the axle sweeps across the switch.

Using modes 7 to 10, the initial direction of motion is right. Using modes 11 to 14, the initial direction of motion is left, unless the home switch is active at the beginning of the motion. In this case, the initial direction of motion depends on the edge to be sought. The original position is at the index pulse on either side of the rising or falling edge of the original switch, as shown in the following two figures. If the initial direction of motion is away from the home switch, the driver must reverse when it encounters the associated limit switch.

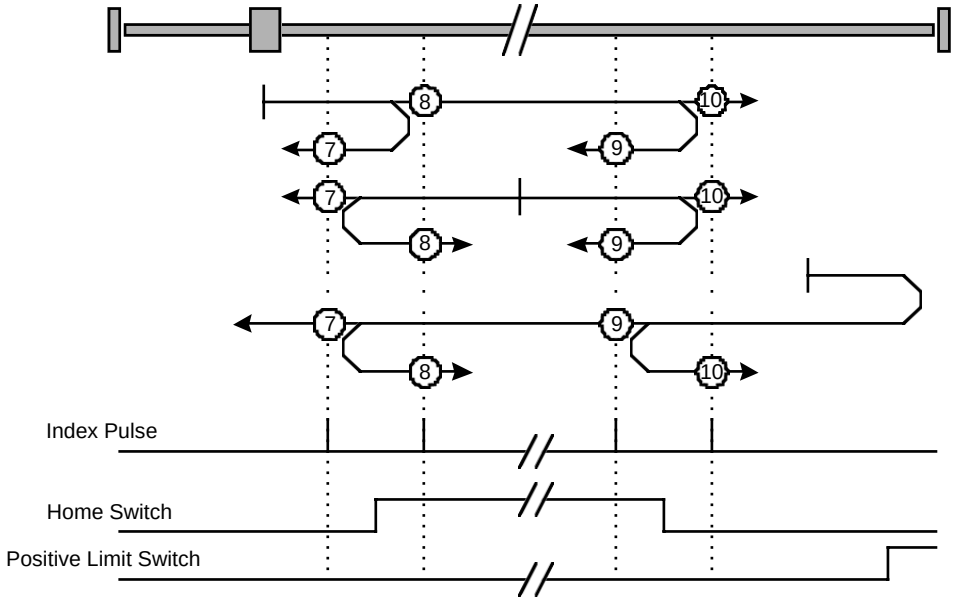


Figure 9: Homing on the home switch and index pulse - positive initial move

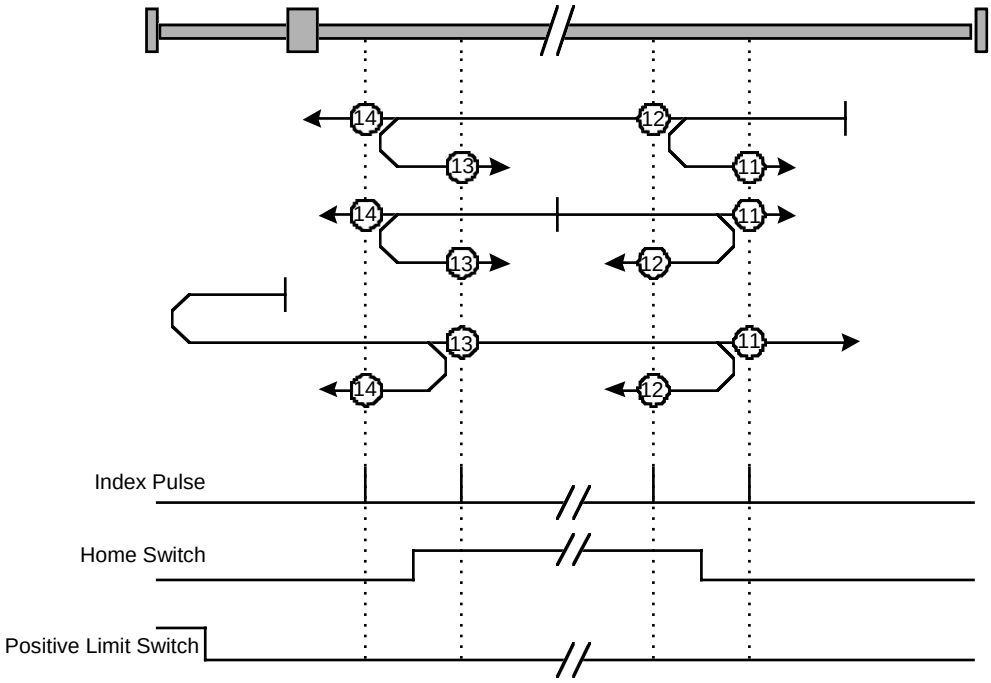


Figure 10: Homing on the home switch and index pulse - negative initial move

4.3.1.6. Modes 15 and 16: Reserved

These modes are reserved for future zero return mode extensions.

4.3.1.7. Modes 17 to 30: zero return without index pulse

These modes are similar to modes 1 to 14 except that the original position does not depend on the index pulse, but only on the associated original or limit switch transition. For example, modes 19 and 20 are similar to modes 3 and 4 shown in the following figure.

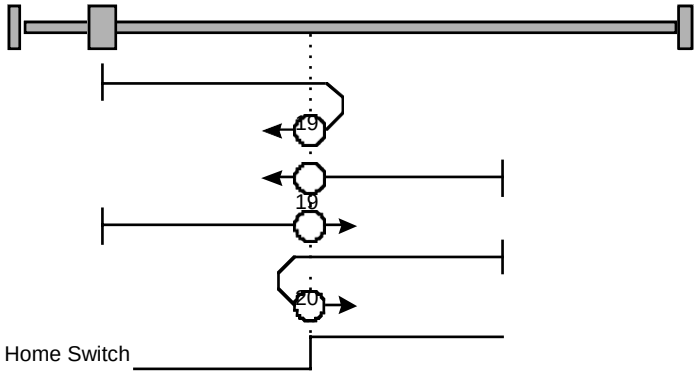


Figure 11: Homing on the positive home switch

4.3.1.8. Modes 31 and 32: Reserved

These modes are reserved for future zero return mode extensions.

4.3.1.9. Modes 33 to 34: zero return on index pulse

Using modes 33 or 34, the direction back to home is negative or positive, respectively. The original position is on the index pulse found in the selected direction.

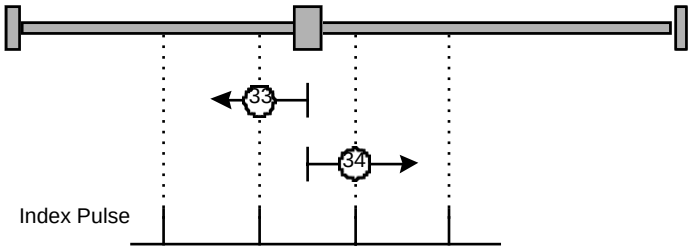


Figure 12: Homing on the index pulse

4.3.1.10. Mode 35: zero return to current position

In mode 35, the current position is set to the original position.

4.3.2. Zero Return Object Definition

4.3.2.1. Home Offset

This object shall indicate the configuration difference between the zero position of the application and the home position of the machine (found during zero return). In the process of zero return, find the home position of the machine, and after zero return, offset the zero point from home by adding the home offset to the home position. All subsequent absolute movements shall be relative to the new zero position. If this object is not implemented, the home offset shall be considered zero. The value of this object shall be given in user-defined location units. Negative values indicate an opposite direction.

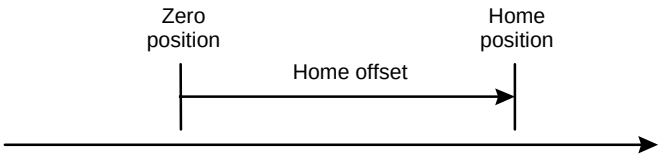
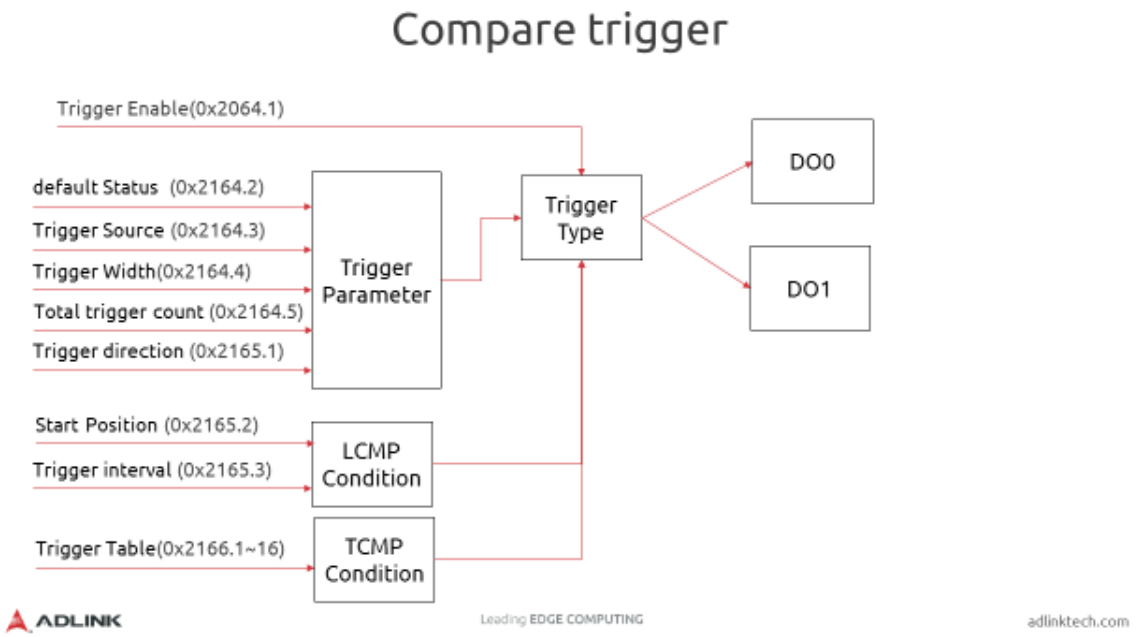


Figure 13: Home offset definition

4.4. Comparison Trigger Mode

The Nu-Step DA Series of stepper drivers supports the standard EtherCAT protocol and adds the comparison trigger function commonly used in equipment, so customers can easily apply this function to AOI detection triggered by camera image acquisition or module data acquisition. The OD used in the comparison trigger does not support PDO input, and the trigger frequency is up to 1KHz.

4.4.1. Comparison Trigger Function Module



- Only LCMP or TCMP can be used at the same time.
- It can output comparison trigger positions DO0 and DO1 at the same time.

4.4.2. How to Use Linear Comparison Trigger LCMP

1. Input appropriate parameters 0x2164.2-0x2164.5 and 0x2165.1 for comparison trigger.
2. Input parameters 0x2165.2 and 0x2165.3 required for the corresponding comparison trigger.
3. Input 0x2164.1=1 after confirming the above two points of data to complete the input.
4. Confirm that the digital output point function for 0x2005 is set to 3 (CMP).
5. The axis motion can be triggered according to the set conditions.
6. After the trigger is finished, 0x2164.1 will be automatically set to 0 (Disabled). If the comparison trigger is needed for the following motion, you can set steps 3-5.

4.4.3. How to Use Point Table Comparison Trigger TCMP

1. Input appropriate parameters 0x2164.2-0x2164.5 and 0x2165.1 for comparison trigger.
2. Input the order of points required for the corresponding comparison trigger requirement to mark 0x2166.1-0x2166.16, with a maximum of 16 points.
3. Input 0x2164.1=2 after confirming the above two points of data to complete the input.
4. Confirm that the digital output point function for 0x2005 is set to 3 (CMP).
5. The axis motion can be triggered according to the set conditions.
6. After the trigger is finished, 0x2164.1 will be automatically set to 0 (Disabled). If the comparison trigger is needed for the following motion, you can set steps 3-5.

4.5. Error code

The error code is defined in OD 0x603F. The related fault and LED lamp number are displayed as follows.

OD address: 0x603F

Error codes:

Overcurrent: 0x50e0 (with the indicator flashing once)

Overvoltage: 0x2811 (with the indicator flashing twice)

Out of tolerance: 0x2810 (with the indicator flashing seven times)

Operational amplifier fault: 0x50a0 (with the indicator flashing nine times)

Safety Instructions

Read and follow all instructions marked on the product and in the documentation before you operate your system. Retain all safety and operating instructions for future use.

- Please read these safety instructions carefully.
- Please keep this User‘s Manual for later reference.
- Read the specifications section of this manual for detailed information on the operating environment of this equipment.
- When installing/mounting or uninstalling/removing equipment, turn off the power and unplug any power cords/cables.
- To avoid electrical shock and/or damage to equipment:
  - Keep equipment away from water or liquid sources.
  - Keep equipment away from high heat or high humidity.
  - Keep equipment properly ventilated (do not block or cover ventilation openings).
  - Make sure to use recommended voltage and power source settings.
  - Always install and operate equipment near an easily accessible electrical socket-outlet.
  - Secure the power cord (do not place any object on/over the power cord).
  - Only install/attach and operate equipment on stable surfaces and/or recommended mountings.
  - If the equipment will not be used for long periods of time, turn off and unplug the equipment from its power source.
- Never attempt to fix the equipment. Equipment should only be serviced by qualified personnel.

Getting Service

Ask an Expert: https://www.adlinktech.com/en/Askanexpert

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