ATO

DB Series

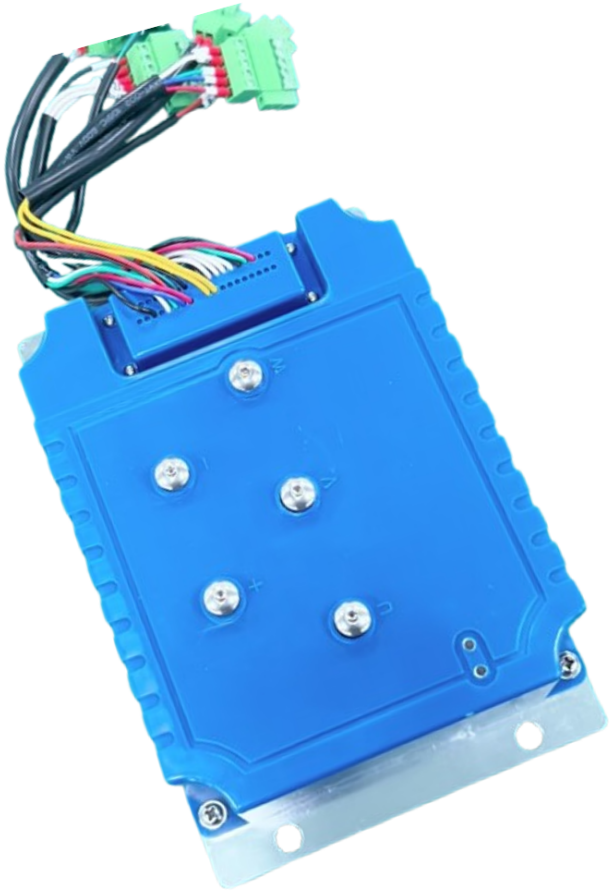
BLDC Motor Driver with Hall Sensor

User Manual

This user manual applies to the following models:

DBLDX-50A485S

DBLDX-100A485S



Catalogs

Preamble

Brief description

Thank you for purchasing DB series of DC brushless drivers.

DB series DC brushless driver is a low-voltage DC brushless platform driver, which is a general-purpose low-voltage DC brushless driver with high protection and wide voltage input range, a safety and high performance driver.

The power range 0.75kW~10.0kW of this series products, supports CANBUS communication, which can form a network system with multiple brushless drivers. This series of products with the latest easy-to-use functions driver, Hall sensors integrated low-voltage DC brushless motors, which makes the brushless motor control simple and easy to use.

Low-voltage DC brushless drivers are equipped with IP65 protection and superior heat dissipation performance, which drive low-voltage DC brushless motors with IP65 protection. The driver supports DC wide voltage input with built-in mechanic brake output function, makes the low-voltage brushless drive safer. These all secure the equipment to produce a safety production.

This series of brushless drivers are suitable for the automation equipment in logistics, new energy, AGV and other industries, realizing fast and accurate speed and torque control with high power, high performance, and safer and more universal solutions.

This manual describes the functions and parameters of the product, including an overview of the functions, basic functions, adjustments and parameter descriptions.

Version Change Log

Revision date	Release Version	Changes
2024-06	A00	First release of the manual

Warranty Statements

Under normal use, the product malfunction or damage, provide warranty service within the warranty period (please refer to the order form for details of the product warranty period). Beyond the warranty period, repair costs will be charged.

During the warranty period, repair costs will be charged for damage to the product caused by the following conditions

Damage to the product caused by not operating the product as specified in the manual.

Fire, flood, abnormal voltage, resulting in damage to the product.

Product damage caused by using the product for abnormal functions.

Damage to the product caused by exceeding the scope of use specified for the product.

Force majeure (natural disasters, earthquakes, lightning strikes) factors caused by secondary damage to the product.

The relevant service costs are calculated according to the manufacturer's uniform standards, and if there is a contract, the contract will be handled on a priority basis. Please refer to the Product Warranty Card for detailed warranty description.

Safety Caution

Security Statement

※ This chapter explains the safety precautions that you need to pay attention to in order to use this product properly. Before using this product, read the instruction manual and correctly understand the information regarding the safety precautions. Failure to observe the matters agreed upon in the safety precautions may result in death or serious injury, or damage to the equipment.

※ The DANGERS, WARNINGS, and CAUTIONS in this manual do not represent the full range of safety precautions to be observed, but are intended to be in addition to the full range of safety precautions.

※ This product should be used in an environment that complies with the design specifications, otherwise it may cause malfunctions. Abnormal functioning or damage to parts, etc. caused by failure to comply with the relevant regulations are not covered by the product quality warranty.

※ We will not be held legally responsible for any personal safety accidents, property damage, etc. caused by failure to comply with the contents of this book or illegal operation of the product.

Definition of Security Levels

Indicates death or serious bodily injury if not followed.

Indicates that if not followed, death or serious bodily injury may result.

Indicates that minor bodily injury or equipment damage may result if not followed.

Safety Precautions

※ The illustrations of the product in this manual are sometimes intended to show the detailed parts of the product, and the product is in the state of removing the outer cover or safety cover. When using the product, be sure to attach the outer cover or cover as specified and follow the instructions for use.

※ The product illustrations in this manual are examples only and may differ slightly from the product you ordered, so please refer to the actual product you ordered.

※ Operators must take mechanical protective measures to protect their personal safety, please wear and wear the necessary protective equipment, such as wearing anti-smash shoes, safety clothing, safety goggles, protective gloves and cuffs.

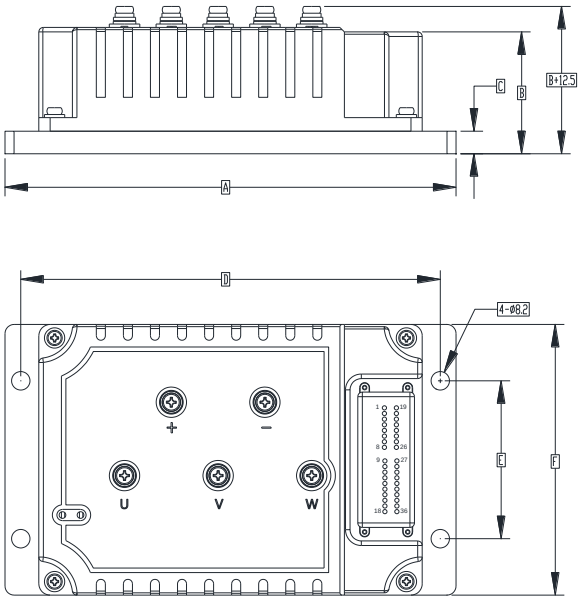
Clarification

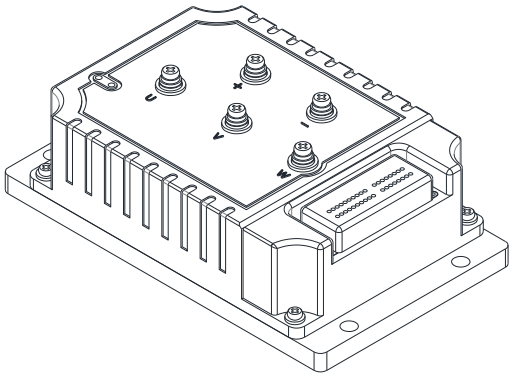
The driver can overload 150% of the rated current, the overload alarm time is related to the amount of overload, the higher value of current makes the faster to alarm.

The rated operating currents are all values corresponding to 48V input bus voltage. If the input voltage exceeds 60V, the current is calculated by the output power. If the power of 50A is 2500W, the current can only go up to about 34A when working under 72V bus voltage.

2 Mechanical Installation

2.1 Size





Model	A	B	C	D	E	F
DBLDX-50A485S	200	56	10	186	70	120
DBLDX-100A485S	200	58	12	186	82	132

Fixing Screws: 4*M8, recommended locking torque: 0.55N.m.

2.2 Preparation of Mounting Options

Fuse

In order to comply with the safety standards for CE certification, be sure to connect a fuse on the input side to prevent accidents caused by short circuits in the internal circuit.

EMC Filters

The filter should be mounted close to the input terminals of the driver, and the connecting cable between them should be less than 30 cm. The ground terminal of the filter and the ground terminal of the driver should be connected together, and make sure that the filter and the driver are mounted on the same conductive mounting plane, which is connected to the main ground of the cabinet.

2.3 Cable Preparation

For the driver to connect properly, the power supply cable, phase power cable, sensor cable, control cable and communication cable need to be used together at the same time.

If you are making your own cable or have a specific cable length requirement, please contact technical support.

2.4 Security Tips

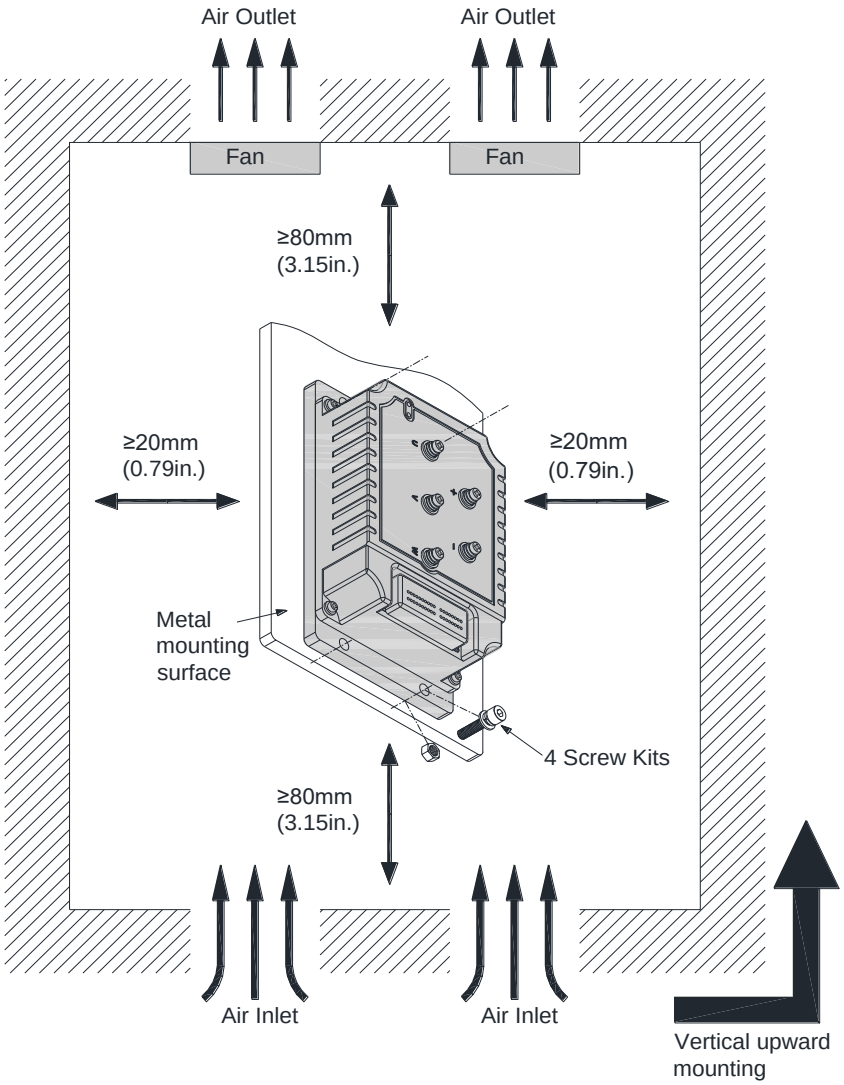
Item	Description
Installation	Please install the product vertically upwards to facilitate heat dissipation upwards. If there are many products in the cabinet, install them side by side. If the product is to be mounted up or down, install a heat-insulating deflector. Make sure the mounting direction is perpendicular to the wall. Use natural convection or a fan to cool the drive. Securely fasten the driver to the mounting surface through 2 ~ 4 (number of mounting holes varies depending on capacity) mounting holes. When installing, face the front of the driver (the actual mounting surface for the operator) toward the operator and keep it perpendicular to the wall. If a mounting bracket is required, be sure to use a flame-retardant material for the mounting bracket.
Cooling	To ensure cooling by fan and natural convection, leave enough space for heat dissipation around the driver and take into account the heat dissipation of other devices in the cabinet. Install a cooling fan on the upper part of the driver, and keep the temperature inside the cabinet uniform so that the ambient temperature of the driver is not locally too high.
Ground	Be sure to ground the ground terminal, otherwise there may be a risk of electric shock or interference resulting in malfunction.
Layout	When wiring the driver, route the cables downward to avoid flowing into the driver along the cables if there is liquid attached to the cables in the field. Power, motor phase cable should not be tied together with the signal and communication cable, to layout them separately.

2.5 Pre-installation Inspection

SN	Checking Items	Appr.
1	The product received is the same model as the product ordered.	□
2	The product shell is free of deformation and cracks.	□
3	There are no loose or stripped screws on the product.	□
4	Signal terminals are free of cracks, foreign objects, and skew.	□

2.6 Installation of Driver

Retaining the mounting distance, the driver heatsink contact surface is metal, and the thermal performance is required.



2.7 Installation Inspection

SN	Checking Items	Appr.
1	Terminal screws are locked and marked to the specified torque.	□
2	The driver and external braking resistor are not placed on combustible objects.	□
3	There are no foreign objects such as wire tips or metal shavings inside or outside the driver that could cause short circuits in the signal and power cables.	□
4	The motor mounting, shaft and mechanical connections must be reliable.	□
5	The motor and connected machinery must be in operable condition.	□
6	The main electrical wiring is securely installed.	□

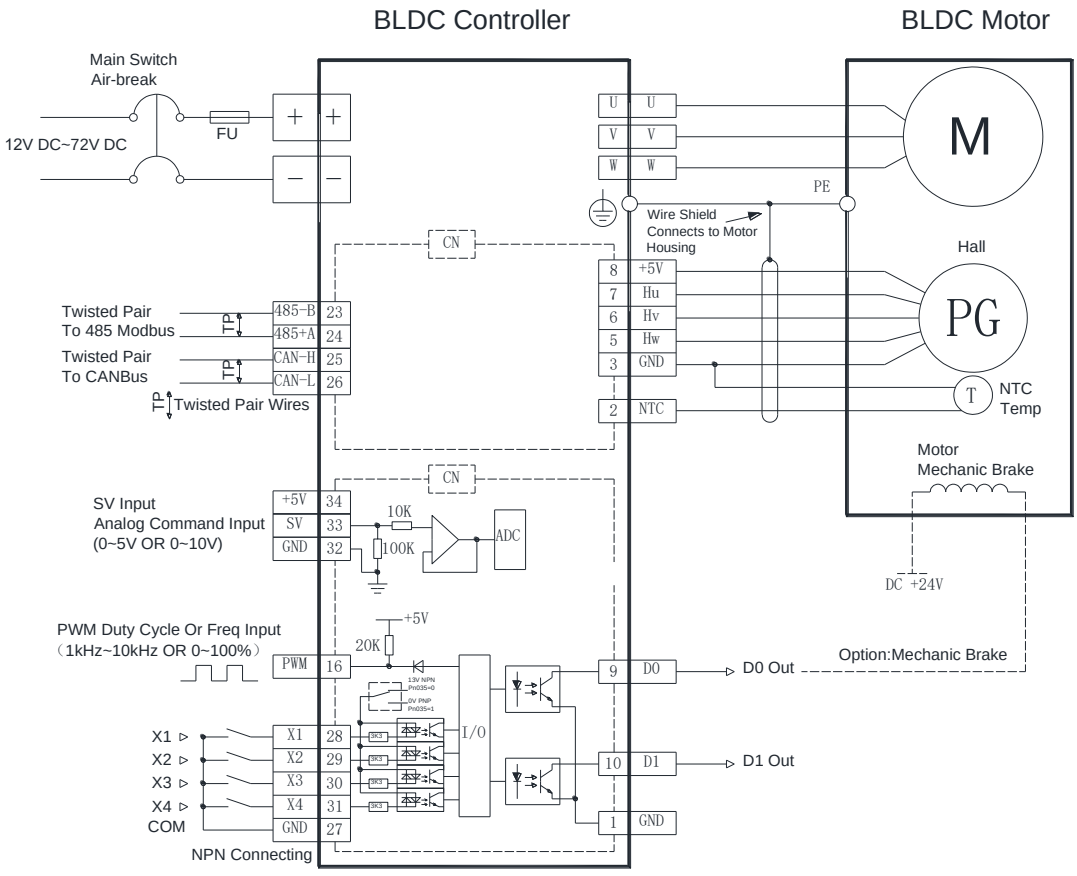
3 Electrical Installation

3.1 Installation Tips

Observe the following precautions when wiring the power supply and main circuit:

- If the main circuit terminals are connectors, remove the connectors from the driver before wiring.
- One of the connector's cord sockets is capable of inserting only one cord.
- When inserting wires, do not short-circuit the burrs of the core wire to neighboring wires.
- Insulate the power terminal connections, otherwise electric shock may result.
- Safety devices such as circuit breakers are provided to prevent fires that may result from short- circuiting of external wiring.
- It is strictly prohibited to place the cable under heavy objects or drag it vigorously, as this may result in damage to the cable and electric shock.
- Use a power filter to minimize the effects of electromagnetic interference, which can cause interference with electronic equipment near the drive.

3.2 Electrical Diagram



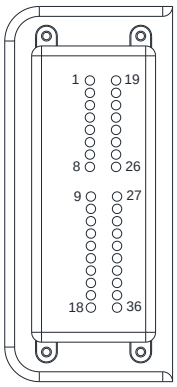
Clarification

Where the power supply +, - is prohibited from being reversed to prevent damage to the driver.

When making cable connections, the U, V, and W phase order must not be connected incorrectly, otherwise there is a risk of wrong running.

The PE wire from the motor is connected to the driver mounting bolts and connected to the equipment earth ground.

3.3 Cable Pin Definition



Pin No.	Name	Color	Description
Power & Phase	+	Follow motor	DC 12V~72V input
	-	Follow motor	
	U	Follow motor	Motor phase line outputs
	V	Follow motor	
	W	Follow motor	
1	GND		Digital GND
2	NTC	-	NTC Sensors
3	GND	Follow motor	Analog GND
5	HW	Follow motor	Hall Sensor Input
6	HV	Follow motor	
7	HU	Follow motor	
8	5V	Follow motor	5V Output
9	D0	-	Open-drain NPN output Voltage: 30V, Current: 500mA
10	D1	-	
16	PWM	-	Frequency range: 1~10kHz (50% duty cycle) Duty cycle range: 0~100% (100Hz~1000Hz) Signal voltage: DC 5~24V
23	485+A	-	485 communication port
24	485-B	-	
25	CAN-H	-	CAN communication port
26	CAN-L	-	
27	GND	Black	digital GND
28	X1_IN	-	Support NPN, PNP NPN: 0V is low, 5~24V is high, current 20mA PNP: output is 13V high, low to GND
29	X2_IN	-	
30	X3_IN	-	
31	X4_IN	-	
32	GND	Black	GND
33	SV	-	DC 0~5V range DC 0~10V ange Deadband voltage adjustment range 0.2~1.0V Input internal resistance: 100kOhm
34	+5V	Red	5V Output

2.2 Check After Wiring

SN	Checking Items	Appr.
1	The power input terminals (V+, V-) must be properly connected.	□
2	The driver output terminals (U, V, W) and motor phase cables (U, V,W) are in phase and properly connected.	□
3	The power input terminals (V+, V-) and phase output terminals (U, V, W) of the driver are not shorted.	□
4	All cables are stressed within specified limits.	□
5	The driver and motor must be reliably grounded.	□
6	Wiring terminals are insulated.	□

4 Function Summary

The following is a list of the functions of the DC brushless driver. For details of each function, please refer to the specific descriptions in each chapter.

Function	Contents
Speed control mode	The brushless driver operates in speed control mode.
Torque control mode	The brushless driver operates in torque control mode.
IO+SV input control	The brushless driver works through IO switching and SV analog input commands.
IO + Duty Cycle Input Control	The brushless driver works through IO switching and PWM duty cycle input commands.
IO + frequency input control	The brushless driver operates via IO switching and PWM frequency input commands.
IO+485 communication input control	The brushless driver works through IO switching and 485 communication data input commands.
Segment speed input control	The brushless driver works through segment speed input commands.
ModBus communication control	The brushless driver works by inputting commands via ModBus communication.
CANBus communication control	The brushless driver works by inputting commands via CANBus communication.
Synchronous rectification [1]	The brushless driver can respond to application scenarios that require more rigidity by turning on this control.
Temperature Sensor Input	A specified temperature sensor can be accessed to monitor the motor temperature.
Input signal selection	Input functions such as motor start enable can be defined to the corresponding pins.
Output signal forced output	Realize forced output with brushless driver status signal, which can be used to detect the wiring of the output signal.
status display	The main circuit power indicator and fault indicator show the current status of the brushless driver.
External I/O Display	Displays the ON/OFF status of external I/O signals.
Alarm history	The last 10 alarms can be recorded and the alarm history can also be cleared.
Alarm code output	Outputs a 2-digit length alarm code when an alarm occurs.
black box function	The data before and after the occurrence of a fault alarm are captured and saved in the brushless driver, and these data are read with the background software for further analysis and research use.
Built-in holding brake function	Built-in holding brake as standard, real-time monitoring of the status of the holding brake.
JOG mode	Run brushless motors directly through the brushless driver APP without inputting a physical signal for trial operation.
Driver Debugging Platform	Using a personal computer, you can perform operations such as parameter setting, trial operation, and status display.

Clarification

[1]: Synchronous rectification can be enabled only for power requirements less than 1kW.

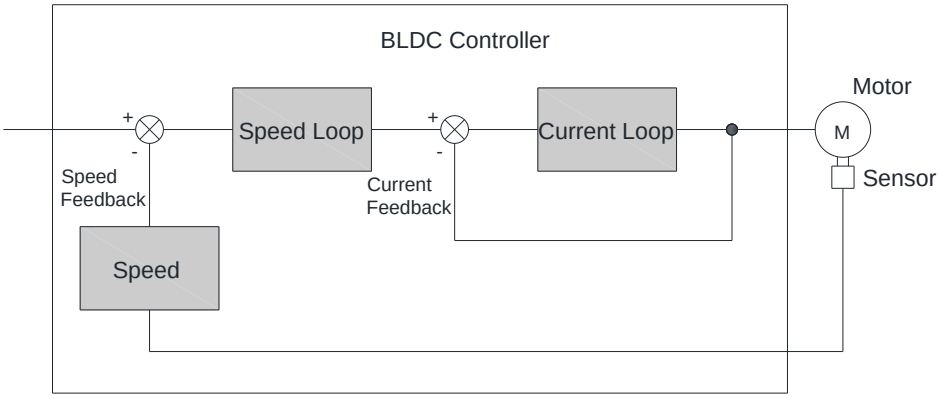
5 Technical Specification

The following is a list of technical specifications for brushless DC drives.

Item	Specification
Rated Input Voltage Range	DC +24~+72V(Controller input voltage = motor rated voltage ± 10%) DC +12V (Customized)
Rated Current	DBLDX-30A485S: 30A DBLDX-50A485S: 50A DBLDX-100A485S:100A
Operating Temperature Range	-40~+80℃
IO input	Supports NPN, PNP NPN: 0V is low, 5~24V is high, current 20mA PNP: 13V high output, low to ground
IO output	Open Drain NPN Output Voltage: not exceed 30V, Current: 500mA
SV Input Characteristics	DC 0~5V range or DC 0~10V range Deadband voltage adjustment range 0.2~1.0V Input internal resistance: 100k
PWM Input Characteristics	Frequency range: 1~10kHz (50% duty cycle) Duty cycle range: 0~100%(100Hz~1000Hz) Signal voltage: DC 5~24V
Carrier Frequency	10~20kHz
485 Communication Parameters	ID: 1~255 Baud rate: 9600 / 19200 / 38400 / 57600 / 115200 bps
CAN Communication Parameters	ID: 0~255 Baud rate: 125 / 250 / 500 kbps
Load	150% of rated current Overload duration: 30~1s (at 150% rated)
External Temperature Sensor	Customizable ntc= mf52-103f-3435-55l
Control Method	Torque Loop (Open Loop) Speed Loop (Close Loop)
Acceleration And Deceleration Times	0.5~16s motor without load
Overheating Protection	Inside the driver: +85°C
Protection Class	IP65(DB series only)
Debugging Software	Universal Brushless Motor Control APP
Certification	

6 Control Mode

- The brushless system consists of three main components: the driver, the motor and the sensor.



The driver is the control core of the DC brushless control system. By processing the input signal and feedback signal, the brushless driver can provide accurate speed and torque control of the brushless motor, i.e., speed and torque control mode. Among them, speed control is the most important and commonly used control mode of the system.

Each control mode is described below:

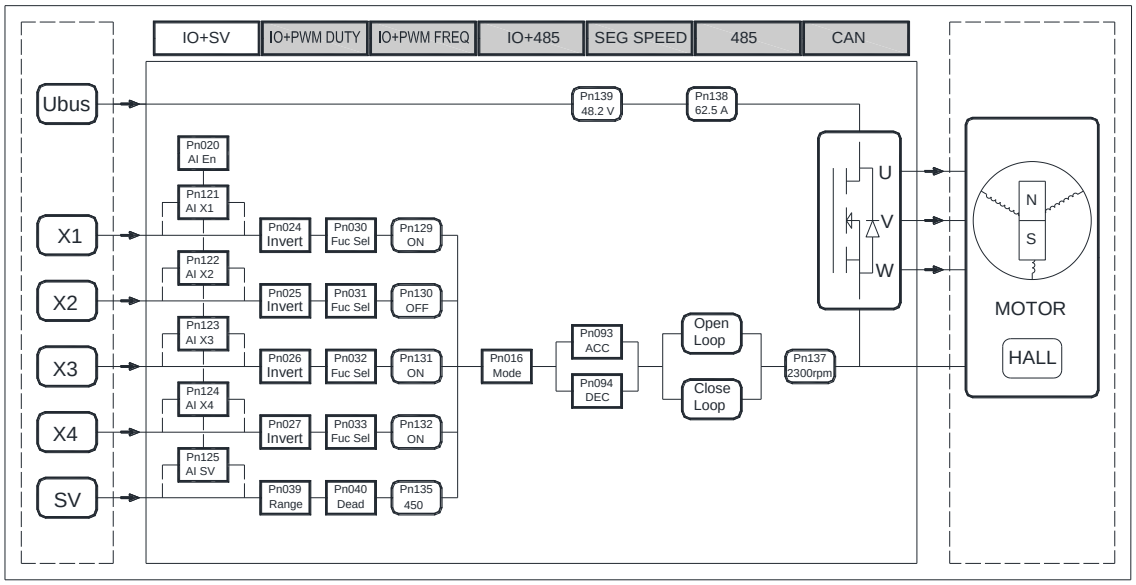
- Speed control refers to controlling the speed of a motor through a speed command. By communicating a given speed command, the driver is able to achieve fast and accurate control of the motor speed. Therefore, the speed control mode is mainly used in applications where the speed is controlled or where the output of the host computer is used as the speed command input to the driver, such as belt transfer equipment.
- The current and torque of a brushless motor are linearly related, so the control of the current realizes the control of the torque. Torque control means to control the output torque of the motor by torque command. The torque command can be given through communication. The torque control mode is mainly used in installations that do not require an accurate speed, such as applications with wind or liquid loads.
- By changing Pn016: =1 for torque control mode, =2 for speed control mode.

6.1 IO+SV Control

Control by IO switching and SV analog inputs as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**1**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**1**	-	Ctrl Channel	Reboot	IO switching as a control source
30	001Eh	0	4	**0**	-	X1 Function	Immediate	X1 as start/stop control
31	001Fh	0	4	**1**	-	X2 Function	Immediate	X2 as brake control
32	0020h	0	4	**2**	-	X3 Function	Immediate	X3 as direction control
33	0021h	0	4	**3**	-	X4 Function	Immediate	X4 as fault clearing control
39	0027h	0	1	**0**	-	SV Range	Immediate	0~5V as data command
40	0028h	100	1000	**500**	mV	SV Start Voltage	Immediate	Deadband voltage = 0.5V

The control block diagram is shown below:



In this control mode, the switching inputs of X1~X4 are used as motor start/stop, brake and direction change control.

The analog voltage of the SV is used as the speed RPM input, and this voltage range can be selected via Pn039.

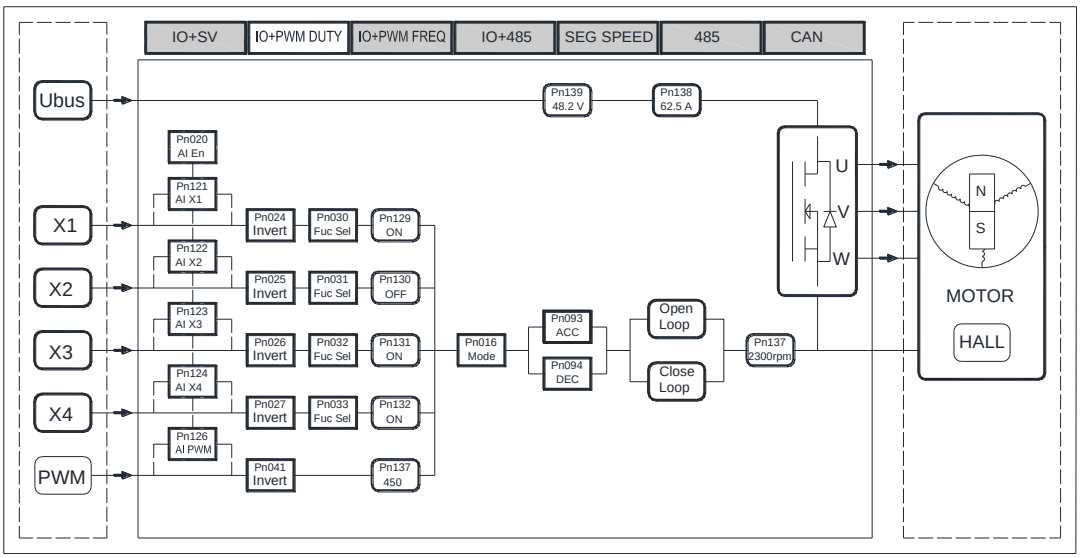
In the debugging stage, by setting the Pn020 virtual enable, virtual data can be used to replace the actual physical signals, thus realizing the debugging of the control system for JOG mode without connecting any control cables.

6.2 IO+PWM Dutycycle Control

Control by IO switching and PWM dutycycle inputs as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**4**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**1**	-	Ctrl Channel	Reboot	IO switching as a control source
30	001Eh	0	4	**0**	-	X1 Function	Immediate	X1 as start/stop control
31	001Fh	0	4	**1**	-	X2 Function	Immediate	X2 as brake control
32	0020h	0	4	**2**	-	X3 Function	Immediate	X3 as direction control
33	0021h	0	4	**3**	-	X4 Function	Immediate	X4 as fault clearing control

The control block diagram is shown below:



In this control mode, the switching inputs of X1~X4 are used as motor start/stop, brake and direction change control.

The PWM input duty cycle is used as speed input, and the frequency range of PWM is 100~1000 Hz. It is recommended to use a low frequency signal so that the duty cycle data will be more accurate.

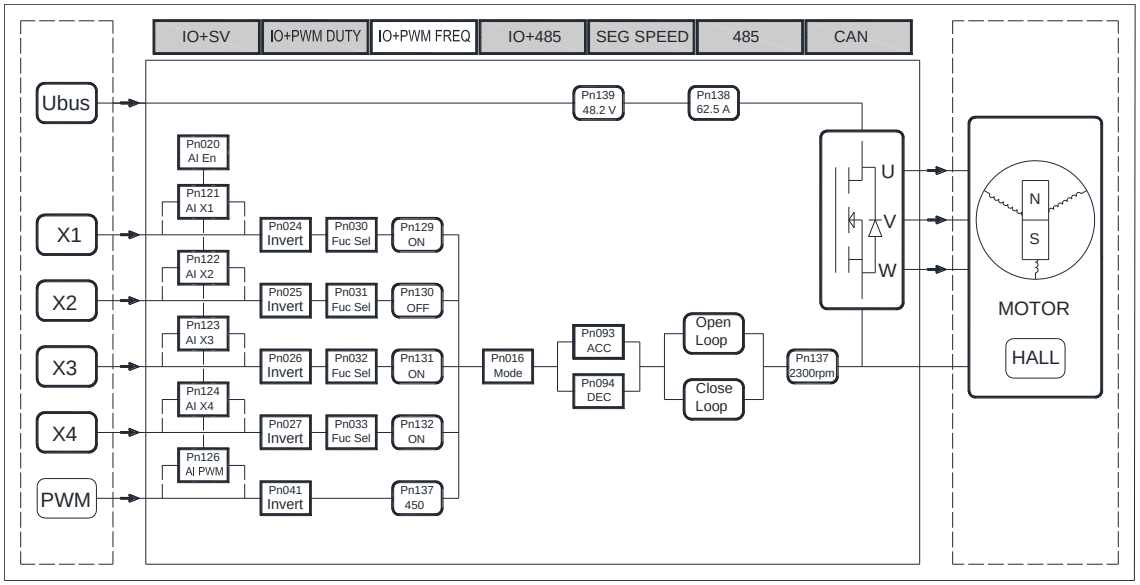
In the debugging stage, by setting the Pn020 virtual enable, virtual data can be used to replace the actual physical signals, thus realizing the debugging of the control system for JOG mode without connecting any control cables.

6.3 IO+PWM Frequency Modulation Control

Control by IO switching and PWM frequency inputs as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**5**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**1**	-	Ctrl Channel	Reboot	IO switching as a control source
30	001Eh	0	4	**0**	-	X1 Function	Immediate	X1 as start/stop control
31	001Fh	0	4	**1**	-	X2 Function	Immediate	X2 as brake control
32	0020h	0	4	**2**	-	X3 Function	Immediate	X3 as direction control
33	0021h	0	4	**3**	-	X4 Function	Immediate	X4 as fault clearing control

The control block diagram is shown below:



In this control mode, the switching inputs of X1~X4 are used as motor start/stop, brake and direction change control.

The PWM frequency input is used as the speed input, and the PWM speed regulation frequency range is 1kHz to 10kHz (the signal duty cycle is set to 50%).

In the debugging stage, by setting the Pn020 virtual enable, virtual data can be used to replace the actual physical signals, thus realizing the debugging of the control system for JOG mode without connecting any control cables.

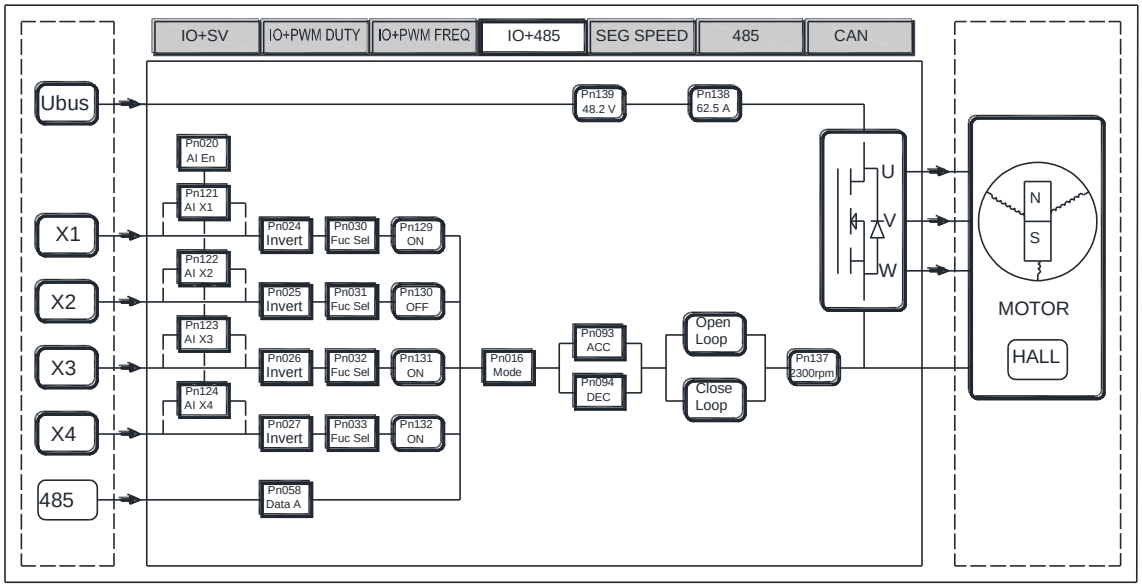
6.4 IO+485 Modbus Control

Control by IO switching and 485 modbus inputs as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**2**	-	Data Channel	Reboot	SV input as a data source

15	000Fh	1	4	**1**	-	Ctrl Channel	Reboot	IO switching as a control source
30	001Eh	0	4	**0**	-	X1 Function	Immediate	X1 as start/stop control
31	001Fh	0	4	**1**	-	X2 Function	Immediate	X2 as brake control
32	0020h	0	4	**2**	-	X3 Function	Immediate	X3 as direction control
33	0021h	0	4	**3**	-	X4 Function	Immediate	X4 as fault clearing control
58	003Ah	0	0xFFFF	**0**	rpm	Data A	Immediate	485 Data A

The control block diagram is shown below:



In this control mode, the switching inputs of X1~X4 are used as motor start/stop, brake and direction change control.

The speed data is set via 485. This control method is suitable for application scenarios where the speed is constant and the motor operation is controlled only by switching.

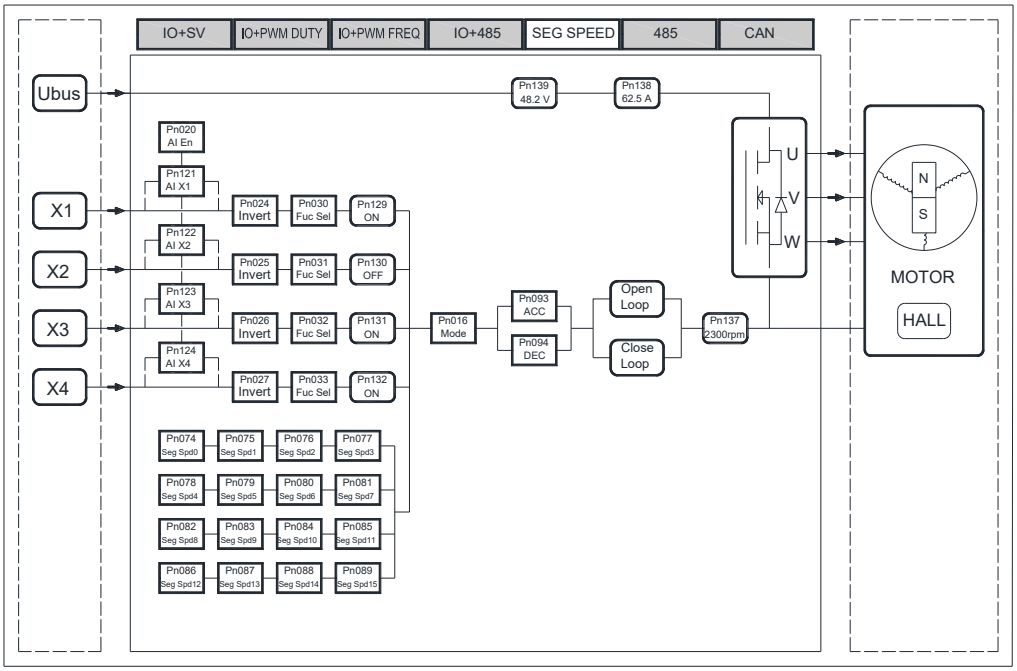
In the debugging stage, by setting the Pn020 virtual enable, virtual data can be used to replace the actual physical signals, thus realizing the debugging of the control system for JOG mode without connecting any control cables.

6.5 Segment Speed Control

Control by segment speed input as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**6**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**4**	-	Ctrl Channel	Reboot	IO switching as a control source
30	001Eh	0	4	**4**	-	X1 Function	Immediate	X1 as start/stop control
31	001Fh	0	4	**4**	-	X2 Function	Immediate	X2 as brake control
32	0020h	0	4	**4**	-	X3 Function	Immediate	X3 as direction control
33	0021h	0	4	**4**	-	X4 Function	Immediate	X4 as fault clearing control

The control block diagram is shown below:



In this control mode, the switching inputs of X1~X4 are used as the control inputs for segment speeds, and the 16 states of the 4 inputs correspond to the 16 speeds in the parameters Pn074~Pn089 respectively.

It is also possible to select only 1 input, 2 inputs, or 3 inputs of the X1~X4 inputs as segment speed inputs, then the corresponding 2, 4, or 8 speeds are controlled.

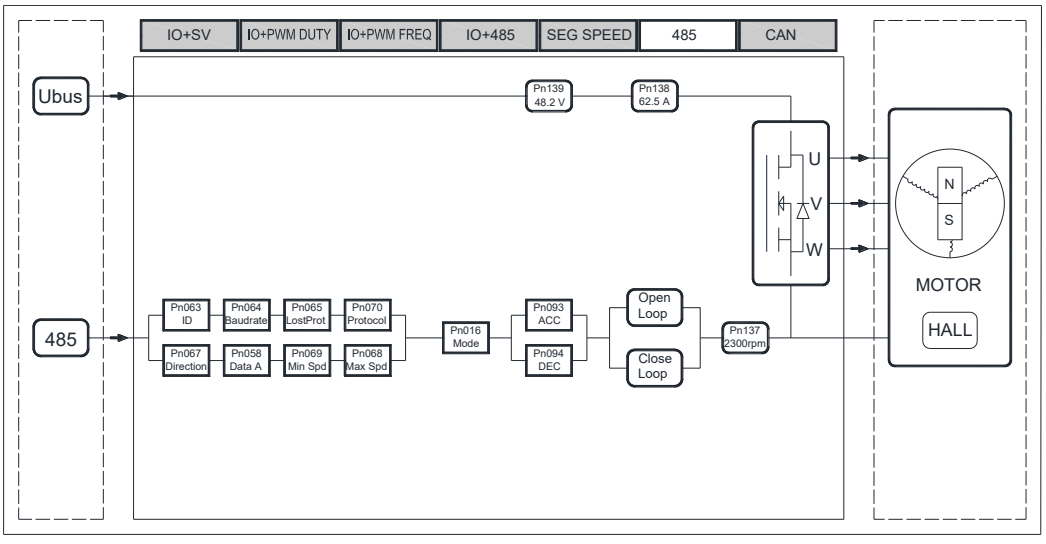
In the debugging stage, by setting the Pn020 virtual enable, virtual data can be used to replace the actual physical signals, thus realizing the debugging of the control system for JOG mode without connecting any control cables.

6.6 485 Modbus Control

Control by 485 modbus inputs as commands, the parameters are set as follows:

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**2**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**2**	-	Ctrl Channel	Reboot	IO switching as a control source
58	003Ah	0	0xFFFF	**0**	rpm	Data A	Immediate	485 Data A

The control block diagram is shown below:



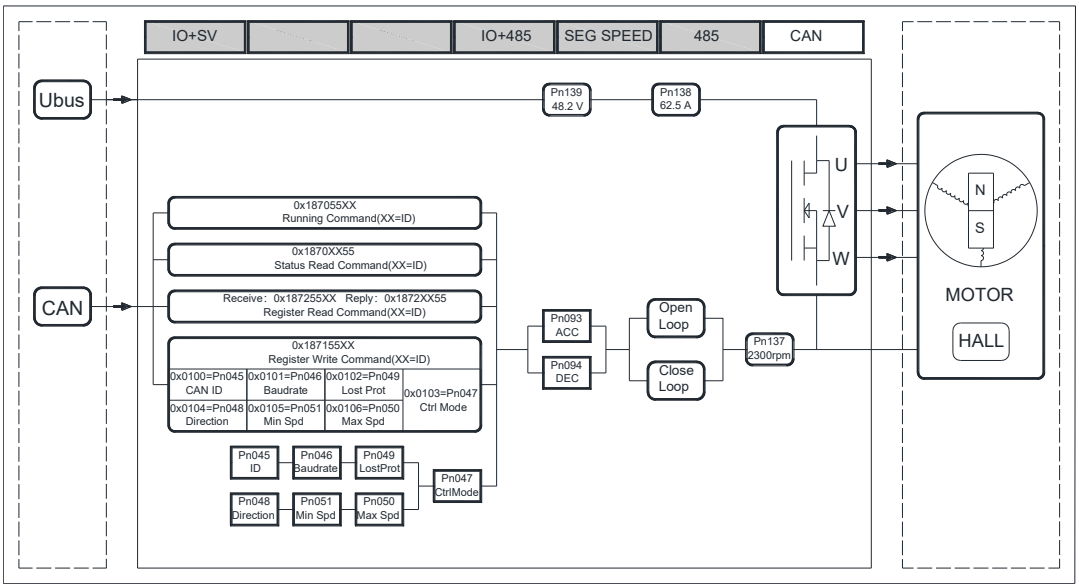
In this control mode, the control of the system can be realized only through the 485 communication port, and the communication protocol is standard ModBus.

6.7 CAN Control

Control by CANBUS inputs as commands, the parameters are set as follows：

Pn	HEX	Min	Max	Default	Unit	Name	Attr.	Description
14	000Eh	1	6	**3**	-	Data Channel	Reboot	SV input as a data source
15	000Fh	1	4	**3**	-	Ctrl Channel	Reboot	IO switching as a control source
45	002Dh	0	255	0	-	CAN ID	Reboot	
46	002Eh	0	2	2	-	Baud rate	Reboot	0=125k，1=250k，2=500k
49	0031h	0	0xFFFF	1000	mS	Heart Beat Protection	Immediate	0=Disable，NOT 0=Heart beat interval
50	0032h	0	0xFFFF	3000	rpm	Max Speed	Immediate	Exceeding this value is considered to be this value
51	0033h	0	0xFFFF	200	rpm	Min Speed	Immediate	A value below this is considered to be this value

The control block diagram is shown below:



In this control mode, the control of the system can be realized only through the CAN communication port, and the communication protocol is customized CAN protocol.

7 Special Application

7.1 Synchronous qectification

The synchronous rectification function can be turned on by setting parameter.

The synchronous rectification function is generally used in application scenarios that require a faster response to speed regulation.

Turning on the synchronous rectifier will limit the maximum output current rating of the system to 20A.

After starting the synchronous rectifier, be aware of the problem of BEMF(Back Electromotive Force). If the system is battery powered and the battery can be recharged during output ports, the electricity generated by the motor will be absorbed by the power supply battery.

If the system is powered by a switching power supply and the system will become a reverse engine power generation due to motor inertia or passive rotation, it is recommended that a braking resistor control unit be added to the power supply side to prevent high voltage shocks to the entire system from excessive supply voltage.

7.2 Phase n rder Adjustment

The power line output sequence can be changed by setting the value of Pn019.

This function can be used to find the correct order by adjusting on the parameters when the order of the matched brushless motor power line UVW is not known.

Each half HEX bit of the parameter represents a phase, with 1, 2, and 3 representing U, V, and W, respectively.

For example, 0x0132, indicates that the current output order of the drive is: U, W, V. If the parameter is not set accurately, the driver will default to the order in which the output is UVW.

7.3 Motor s emperature

The sensor for motor temperature detection can be selected by setting the value of Pn101.

The driver is equipped with a temperature sensor input interface, if the system needs to monitor the motor temperature, you can access the sensor models in the list and set the parameters to the corresponding values.

The sensor models that can be accessed are listed. You can contact the driver manufacturer to upgrade the firmware to match different sensor models, only NTC 100k type temperature sensors are supported.

7.4 Virtual(AI) hput

The virtual input can be enabled by setting the value of Pn120, for JOG running mode.

When this function is enabled, all physical quantity inputs can be replaced by 485 communication application data. This makes it easy for the user to run the system without connecting any wiring harnesses or switches to make the system working.

The virtual physical quantity inputs include: X1~X4 switch inputs, SV analog voltage inputs, PWM data inputs.

7.5 Current bontrol

The driver contains several key current parameters, from minimum to maximum:

① Pn003 Current Rating: defined as the current on the bus input at which the system can keep operating within this current.

② Overload current: automatically formed. Equal to 1~1.5 times the rated current of Pn003, i.e., in this current interval, the driver will perform overload timing, the higher the overload current, the faster the timing. Greater than 1~1.5 times rated current corresponds to 30~1 seconds overload allowed working time.

③ Pn013 Rated Current Limit: The upper limit of current on the bus that the control will limit the system from operating above.

④ Pn012 Rated overcurrent alarm value: the current alarm value on the bus, when the current on the bus reaches this value, the control will alarm and stop working.

⑤ Pn010 Peak current alarm value: defined as the instantaneous current alarm value on the phase line.

⑥ Hardware overcurrent alarm value: defined as the maximum tolerance value allowed by the hardware, hardware design value, and it cannot be set.

In general, the Pn003 rated current is set according to the rated power of the matched motor. Regarding the overload current, this overload protection can be turned off with Pn021, depending on the application scenario. When turned off, Pn013 automatically equals the value of Pn003. This application is suitable for long time high torque output scenarios.

7.6 Mechanic arake n utput

Both outputs D0 and D1 of the driver can be set as holding brake outputs with Pn036 and Pn037. When this function is set, the output can be connected to the mechanical holding brake of the motor for control.

The rotational speed associated with the holding brake output can be set via Pn099.

This function can be used in application scenarios where the motor needs to be held in the system to realize mechanical holding after motor stopped or power off.

8 Fault Process

When the driver detects a fault, the fault RED light will flash, and the number of flashes corresponds to the corresponding fault.

The fault type can also be determined by reading the Pn140 parameter.

The fault can be cleared by setting one of the X1~X4 inputs to the fault clear function. The current fault can also be cleared by setting Pn103, and the driver will restart when the fault is cleared by the command.

The driver has a black box function that records data to be saved to memory for analysis while detecting faults.

SN	Fault	Possible Reason
1	Stall	1, Power phase wire or hall sensor wiring error or omission, resulting in a normal start motor running under the command, the motor does not turn to produce this fault. Check the wiring to ensure that the correct wiring. 2, The motor load is too large, resulting in the motor not running, that will produce this fault, and try to reduce the load. 3, The motor 3-phase has a bad phase, resulting in the motor not running properly, that will result in this fault.
2	Overcurrent(H)	1. When the motor is not in running, this fault occurs, that means the hardware is failure and the repair is needed. 2, In the start of the motor running resulting this fault you can reduce the starting acceleration. Reduce the starting current can avoid this fault. 3, In the normal operation of the motor in the process of generating this fault, then the possible causes are the motor load suddenly become large, or phase line has a short-circuit condition.
3	Overcurrent(S)	1, In the start of the motor operation found in this fault, you can reduce the starting ACC. Reducing the starting current can avoid this fault. 2, In the normal operation of the motor in the process of generating this fault, then the possible causes are that the motor load suddenly become large, or phase line has a short-circuit condition.
4	Overcurrent Bus	Same as Overcurrent(S) fault.
5	Hall Error	1, When power on without running the motor producing this fault, check the wiring. 2、This fault occurs occasionally during operation, then the possible cause is hall signal interference. If hall lines are too long, it may produce this fault, or hall lines are not shielded and the power line tie with them together, the interference may cause this fault. 3, Once the motor is running producing this fault, it may be caused by the motor of the hall sensor position not accurate.
6	Under Voltage	1、When power on the motor without running causing this fault, the supply voltage may be too low. 2、When this fault occurs during operation, it may be the output current of the power supply equipment insufficient, that results in the voltage reduced to the alarm value. After the voltage is restored, the fault will disappear. checking the fault history.
7	Over Voltage	1, When power on without running the motor, produce this fault. The supply voltage may be too high. 2, during the operation resulting this fault, it may be due to that the motor becomes a generator generated by BEMF(Back Electromotive Force) resulting in the supply voltage rises. This situation generally occurs in the switching power supply system.
8	Over Speed	1. Under open-loop operation, this fault is generated. It may be caused by the motor running with a small load and the speed exceeding the set value at full speed. 2. Closed loop operation, this fault occurs. It may be because the power line sequence is connected wrongly, and the speed is out of control during operation.
9	Sample Base Error	When power on producing this fault, it is hardware failure, return for service.

10	Over Load	The driver has been running over its rated power for a long time, that will cause this fault.
11	Under Temperature	Driver detects low temperature
12	Over Temperature	The driver detects high temperatures and the system needs a better cooling environment.
13	PWM Input Signal Error	The PWM input signal frequency exceeds 1kHz to 10kHz range.
14	EERPROM Error	Data storage errors can be resolved by trying to upgrade the firmware.

9 RS485 Communication

9.1 RS485 Protocol

（1） Protocol format: Modbus RTU protocol

The MODBUS bus of this system adopts and supports the communication mode of RTU mode. For the use of MODBUS communication protocol, please refer to the MODBUS official website http://www.modbus.org for the most authoritative information.

（2） Baud rate: 9600/19200/38400/57600/115200 (default 38400)

Data bits: 8 bits

Parity bit: None

Stop bit: 1 bit

Checksum method: ModBus CRC16

9.2 Protocol Command Structure

Name	ID	WR	Address	Data	CRC16
byte(s)	1	1	2	2	2
Description	Device ID	0x03: Read 0x06: Write	HEX Address **PnXXX**	Data	Modbus CRC16
Sample	0x01	0x06	0x00 0x25	0x00 0x01	0x59 0xC1
	Set the parameter Pn37 (address is 0x0025) value 0x0001 **(Pn037=1)**				

10 CAN

The default communication rate is: 500Kbps The bus communication ID address is: 32-bit . The CAN bus communication cable is a shielded twisted pair and utilizes the CAN 2.0 standard protocol.

For multi-node inline use, the final node requires an additional 120 ohm terminating resistor. The node ID can be set according to the actual operation, 0x00 is the permanent ID.

10.1 Running Command

Driver receives run command data: (ECU, BCM, and other master control units →→ Driver)

Name	Interval	ID	Bytes	Bits	Description
Running	100mS	0x187055?? ??=CAN ID	Byte1		Target Data High Byte【Note1】
			Byte2		Target Data Low Byte【Note1】
			Byte3		Reserved
			Byte4		Reserved
			Byte5		Heart Beat High Byte【Note2】
			Byte6		Heart Beat Low Byte【Note2】
			Byte7		Byte1-6 Checksum High Byte【Note3】
			Byte8		Byte1-6 Checksum Low Byte【Note3】

[Note 1]

This motor target data Bit0-13, is the motor target speed data. Data Bit14-15 = bin00 for motor stop.

Data Bit14-15=bin01 for motor forward rotation. Data Bit14-15=bin10, for motor backward rotation. Data Bit14-15=bin11, for motor braking.

In the speed closed loop mode, Bit0-13 represents the target speed, if the absolute value of the set speed is less than the minimum speed of motor operation (default is 200rpm), the motor will not run. If the absolute value of the set speed is more than the maximum speed of motor operation (default is 4000rpm), the motor will run at the maximum speed of 4000rpm.

In the torq open loop mode, Bit0-13 represents the target regulation, valid range is 0-200, if the set regulation is greater than 200, it will operate according to the maximum regulation.

[Note 2]

Heartbeat number to prevent the host side of the ECU, BCM, etc. from dying and sending repetitive data without autonomous, if the heartbeat number of the command frame sent by the host side is unchanged from the previous command frame, this command is regarded as an invalid command frame.

[Note 3]

To prevent data transmission errors, Byte7 and Byte8 are the summation check digits for [Data1- Data6] data.

10.2 Status Data

Status data sent by the driver: (Driver →→ ECU, BCM, and other master control units):

Name	Interval	ID	Bytes	Bits	Description
Status	100ms	0x1870??55 ??=CAN ID	Byte1		Bus Voltage【Note4】
			Byte2		Bus Current【Note5】
			Byte3		Driver Temperature【Note6】
			Byte4		Motor Speed High Byte【Note7】
			Byte5		Motor Speed Low Byte【Note7】
			Byte6	Bit0	Bus Over Voltage【Note8】
				Bit1	Bus Under Voltage【Note8】
				Bit2	Controller Over Temp【Note8】
				Bit3	Controller Low Temp【Note8】
				Bit4	Over Current【Note 8】
				Bit5	Over Load【Note 8】
				Bit6	Hall Error【Note 8】
				Bit7	Stall【Note 8】
			Byte7		Byte1-6 Checksum High Byte【Note9】
			Byte8		Byte1-6 Checksum Low Byte【Note9】

[Note 4] Driver bus voltage: Unit V, 1:1 data.

[Note 5] Driver working current: Unit A, 1:1 data.

[Note 6] Driver temperature: 1:1 data in °C with an offset of -40, e.g. a value of 30 means -10 °C.

[Note 7] Actual motor speed: 1:1 data in rpm.

[Note 8: Fault status: 1 means the corresponding fault exists, 0 means the corresponding fault does not exist.

[Note 9] To prevent data transmission errors, Byte7 and Byte8 are checksum check digits for [Data1-Data6] data.

10.3 Register

CAN special function register settings (ECU, BCM, and other master control units→→Driver):

Name	Interval	ID	Bytes	Bits	Description
			Byte1		Address High Byte
			Byte2		Address Low Byte

SFR Setting		0x187155?? ??=CAN ID			
			Byte3		Data High Byte
			Byte4		Data Low Byte
			Byte5		Reserved
			Byte6		Reserved
			Byte7		Byte1-6 Checksum High Byte
			Byte8		Byte1-6 Checksum Low Byte

SFR explain:

Name	Add	Default Value
CAN ID	0x0100	0x0000
Baud rate	0x0101	0x0001
Heart Beat Interval	0x0102	0x0000
Work Mode	0x0103	0x0000
Direction	0x0104	0x0101
Max Speed Limit	0x0105	0x0FA0
Min Speed Limit	0x0106	0x00C8
Factory Setting	0x0F00	-

Device Node ID, default value: 0x0000

The range of setting value is 0~255, otherwise it is invalid.

0x00 is the permanent ID and the other set IDs are feature IDs. the ID code of the communication frame must match either the feature ID code or the permanent ID code.

Communication baud rate, default value: 0x0002 [500Kbps]

0x0000 corresponds to 125Kbps

0x0001 corresponds to 250Kbps

0x0002 corresponds to 500Kbps

Other values are invalid.

Communication heart beat Interval, default value: 0x0000 [unit ms]

A communication abnormality means that the master control unit does not transmit a run command or that the heartbeat number of the run command does not change. When using CAN to control motor operation, the driver automatically stops the motor when the communication abnormality time exceeds the value set in this data to protect the system from stopping due to CAN communication abnormality. Note: When this register is 0, the communication abnormality protection function is turned off.

Work mode, Register address 0x0103, register default value 0x0000

High byte for operating mode:

0x00 for speed open loop mode;

0x01 is the speed closed loop mode. .

Other values are invalid.

The low byte is the control channel:

0x03 is CAN control path

0x00 is physical signal control path (SV for RPM, CW/CCW for direction).

Other error values may introduce control disturbances.

Running Direction and Feedback Direction, Register address 0x0104, register default value 0x0101

The high byte is the setting value for the motor running direction polarity.

≠0 is positive polarity,

=0 is negative polarity.

The low byte is the setting value for motor feedback direction polarity. ≠0 is positive polarity, =0 is negative polarity.

When the motor running direction is found to be reversed, or the feedback motor direction is reversed, polarity reversal switching can be done by the corresponding byte of this register.

Maximum speed limit value, default value: 0x0FA0 [unit RPM]

Minimum speed limit value, default value: 0x00C8 [in RPM].

Restore Factory Settings.

Write operation to this register restores the factory setting regardless of the value set.

10.4 Special Register Read

Read SFR： (ECU, BCM, and other master control units →→ Driver)

Name	Interval	ID	Bytes	Bits	Description
SFR Read		0x187255?? ??=CAN ID	Byte1		Address High Byte
			Byte2		Address Low Byte
			Byte3		Data High Byte
			Byte4		Data Low Byte
			Byte5		Reserved
			Byte6		Reserved
			Byte7		Byte1-6 Checksum High Byte
			Byte8		Byte1-6 Checksum Low Byte

Read reply: (Driver →→ECU, BCM control center)

Name	Interval	ID	Bytes	Bits	Description
			Byte1		Address High Byte
			Byte2		Address Low Byte
			Byte3		Data High Byte

SFR Reply		0x1872??55 ??=CAN ID			
			Byte4		Data Low Byte
			Byte5		Reserved
			Byte6		Reserved
			Byte7		Byte1-6 Checksum High Byte
			Byte8		Byte1-6 Checksum Low Byte

SFR definition:

Name	Add	Description
Bus Voltage	0x0200	【Note4】
Bus Current	0x0201	【Note 5】
Driver Temp	0x0202	【Note 6】
Speed	0x0203	【Note 7】
Status	0x0204	0x0000=STOP，0x0001=CW，0x0002=CCW， 0x0003=BRAKE
Error Code	0x0205	【Note 8】
Position	0x0206	Electronic Signal Turns Count Value = Motor round * Motor Pole Pairs. The register value range -32768~32767, if the number of electronic revolutions has reached the register counting limit, it will not continue to accumulate. This register can be assigned with the 0x187155? instruction to assign a value to this register.

11 Parameter Pn List

Pn	HEX	Range		Default	Unit	Name	Attr.	Description
1	0001h	1	20	4	PP	Polar Pair	Reset	Motor parameter
2	0002h	300	10000	3000	rpm	Max Speed	Immediate	Motor parameter
3	0003h	5	40	40	A	Rated Current	Reset	Motor parameter
8	0008h	12	90	20	V	Under Voltage Alarm Value	Reset	System alarm after bus voltage is lower than this value for more than 300mS
9	0009h	12	90	90	V	Over Voltage Alarm Value	Reset	System alarm when bus voltage is higher than this value
10	000Ah	10	180	180	A	Peak Current Alarm Value	Immediate	System working peak current alarm value
12	000Ch	10	150	150	A	Bus Current Alarm Value	Immediate	System working bus current alarm value
13	000Dh	10	70	60	A	Bus Current Limit Value	Immediate	System working bus current limit value
14	000Eh	1	6	/	-	Data Channel	Reset	1=SV, 2=MODBUS, 3=CAN, 4=PWM dutycycle, 5=PWM frequency, 6=Segment speed
15	000Fh	1	4	/	-	Control Channel	Reset	1=IO switch, 2=MODBUS, 3=CAN, 4=Segment Speed
16	0010h	1	2	/	-	Control Mode	Reset	1=Torq(open loop), 2=Speed(close loop)
21	0015h	0	1	0	-	Disable Overload Alarm	Immediate	0=Not disable, 1=Disable(Bus current limit value will be Pn003 value)
24	0018h	0	1	0	-	X1 Inverse	Immediate	0=Not inverse, 1=X1 input signal inversed
25	0019h	0	1	0	-	X2 Inverse	Immediate	0=Not inverse, 1=X2 input signal inversed
26	001Ah	0	1	0	-	X3 Inverse	Immediate	0=Not inverse, 1=X3 input signal inversed
27	001Bh	0	1	0	-	X4 Inverse	Immediate	0=Not inverse, 1=X4 input signal inversed
28	001Ch	0	1	0	-	D0 Inverse	Immediate	0=Not inverse, 1=D0 output signal inversed
29	001Dh	0	1	0	-	D1 Inverse	Immediate	0=Not inverse, 1=D1 output signal inversed
30	001Eh	0	4	0	-	X1 Function Sel	Reset	0=EN(Start/Stop), 1=BRAKE, 2=F/R(Direction), 3=Error Clear, 4=Segment speed input
31	001Fh	0	4	1	-	X2 Function Sel	Reset	0=EN(Start/Stop), 1=BRAKE, 2=F/R(Direction), 3=Error Clear, 4=Segment speed input
32	0020h	0	4	2	-	X3 Function Sel	Reset	0=EN(Start/Stop), 1=BRAKE, 2=F/R(Direction), 3=Error Clear, 4=Segment speed input
33	0021h	0	4	3	-	X4 Function Sel	Reset	0=EN(Start/Stop), 1=BRAKE, 2=F/R(Direction), 3=Error Clear, 4=Segment speed input
35	0023h	0	1	0	-	NPN PNP Sel	Reset	X1~X4 input：0=NPN，1=PNP
36	0024h	0	4	0	-	D0 Function Sel	Immediate	0=Error Output, 1=FG speed signal, 2=Torq reached signal, 3=Mechanic brake, 4=Speed reached signal
37	0025h	0	4	1	-	D1 Function Sel	Immediate	0=Error Output, 1=FG speed signal, 2=Torq reached signal, 3=Mechanic brake, 4=Speed reached signal
39	0027h	0	1	0	-	SV Range	Immediate	0=0~5V，1=0~10V
40	0028h	100	1000	500	mV	SV Start Voltage	Immediate	SV dead area voltage
41	0029h	0	1	0	-	PWM Signal Inverse	Immediate	0=Not inverse, 1=Inversed
45	002Dh	0	255	0	-	CAN ID	Reset	CAN nod ID
46	002Eh	0	2	2	-	CAN Baudrate	Reset	0=125k，1=250k，2=500k
47	002Fh	0	0xFFFF	0x0103	-	CAN Control Mode	Reset	High Byte: 0x00=Torq(open loop), 0x01=Speed(close loop), others=null Low Byte: 0x03=CAN input command, 0x00=IO input command, others=null
48	0030h	0	0xFFFF	0x0000	-	CAN Direction	Immediate	High Byte: 0x01=Positive direction, 0x00=Negative direction, others=null Low Byte: 0x01=Positive feedback, 0x00=Negative feedback, others=null
49	0031h	0	0xFFFF	1000	mS	CAN Heartbeat Enable	Immediate	0=Disable, Others=Heartbeat protection interval
50	0032h	0	10000	3000	rpm	CAN Max Speed	Immediate	Command value which exceed this value is considered to be this value

51	0033h	0	10000	200	rpm	CAN Min Speed	Immediate	Command value which exceed this value is considered to be this value
58	003Ah	0	0xFFFF	0	rpm	Data A	Immediate	485 command data A
63	003Fh	0	255	2	-	485 ID	Reset	485 nod ID
64	0040h	0	4	2	-	485 Baudrate	Immediate	0=9600, 1=19200, 2=38400, 3=57600, 4=115200
65	0041h	0	0xFFFF	0	mS	485 Heartbeat Protection Enable	Immediate	0=Disable, Others=Heartbeat protection interval
67	0043h	0	0xFFFF	0x0101	-	485 Direction	Immediate	High Byte: 0x01=Positive direction, 0x00=Negative direction, others=null Low Byte: 0x01=Positive feedback, 0x00=Negative feedback, others=null
68	0044h	-10000	10000	3500	rpm	485 Max Speed	Immediate	Command value which exceed this value is considered to be this value
69	0045h	-10000	10000	200	rpm	485 Min Speed	Immediate	Command value which exceed this value is considered to be this value
74	004Ah	-10000	10000	0	rpm	Segment Speed 0	Immediate	Segment speed 0
75	004Bh	-10000	10000	200	rpm	Segment Speed 1	Immediate	Segment speed 1
76	004Ch	-10000	10000	400	rpm	Segment Speed 2	Immediate	Segment speed 2
77	004Dh	-10000	10000	800	rpm	Segment Speed 3	Immediate	Segment speed 3
78	004Eh	-10000	10000	1600	rpm	Segment Speed 4	Immediate	Segment speed 4
79	004Fh	-10000	10000	2000	rpm	Segment Speed 5	Immediate	Segment speed 5
80	0050h	-10000	10000	2400	rpm	Segment Speed 6	Immediate	Segment speed 6
81	0051h	-10000	10000	3000	rpm	Segment Speed 7	Immediate	Segment speed 7
82	0052h	-10000	10000	-200	rpm	Segment Speed 8	Immediate	Segment speed 8
83	0053h	-10000	10000	-400	rpm	Segment Speed 9	Immediate	Segment speed 9
84	0054h	-10000	10000	-800	rpm	Segment Speed 10	Immediate	Segment speed 10
85	0055h	-10000	10000	-1600	rpm	Segment Speed 11	Immediate	Segment speed 11
86	0056h	-10000	10000	-2000	rpm	Segment Speed 12	Immediate	Segment speed 12
87	0057h	-10000	10000	-2400	rpm	Segment Speed 13	Immediate	Segment speed 13
88	0058h	-10000	10000	-3000	rpm	Segment Speed 14	Immediate	Segment speed 14
89	0059h	-10000	10000	0	rpm	Segment Speed 15	Immediate	Segment speed 15
93	005Dh	0	65536	1000	mS	ACC	Immediate	0=No ramp, Others: mS/1000rpm(speed close loop)
94	005Eh	0	65536	1000	mS	DEC	Immediate	0=No ramp, Others: mS/1000rpm(speed close loop)
95	005Fh	0	65535	0	mS	Over Speed Alarm Period	Immediate	0=Disable over speed alarm, Others=Alarm after motor keeps this period in higher than Pn96 speed
96	0060h	1000	6500	3500	rpm	Over Speed Alarm Value	Immediate	Over speed value
97	0061h	1	500	20	A	Torq Reached	Immediate	System marks after working torq reached this value
98	0062h	300	10000	1000	rpm	Speed Reached	Immediate	System marks after working speed reached this value
99	0063h	0	1000	100	rpm	Mechanic Brake Speed	Immediate	Mechanic brake ON/OFF speed thresholds
101	0065h	0	1	/	-	Motor NTC Sel	Immediate	0=No sensor, 1=104F-RT NTC 100K
103	0067h	0	1	0	-	Error Clear Cmd	Immediate	Clear current error code, reset system
120	0078h	0	1	0	-	AI Input Enable	Immediate	0=Disable, 1=Enable. AI data will instead of IO/SV/PWM input signal
121	0079h	0	1	0	-	X1 AI	Immediate	X1 virtual input
122	007Ah	0	1	0	-	X2 AI	Immediate	X2 virtual input
123	007Bh	0	1	0	-	X3 AI	Immediate	X3 virtual input

124	007Ch	0	1	0	-	X4 AI	Immediate	X4 virtual input
125	007Dh	0	1000	0	‰	ADC AI	Immediate	ADC virtual input data
126	007Eh	0	1000	0	‰	PWM AI	Immediate	PWM virtual input data
127	007Fh	0	1	/	-	D0 AI	RO	D0 virtual output
128	0080h	0	1	/	-	D1 AI	RO	D1 virtual output
129	0081h	0	1	/	-	X1 Status	RO	X1 signal input status
130	0082h	0	1	/	-	X2 Status	RO	X2 signal input status
131	0083h	0	1	/	-	X3 Status	RO	X3 signal input status
132	0084h	0	1	/	-	X4 Status	RO	X4 signal input status
133	0085h	0	1	/	-	D0 Status	RO	D0 output status
134	0086h	0	1	/	-	D1 Status	RO	D1 output status
135	0087h	0	1000	/	%	ADC Data	RO	ADC input data
136	0088h	0	1000	/	%	PWM Data	RO	PWM input data
137	0089h	0	0xFFFF	/	rpm	Working Speed	RO	Working Speed
138	008Ah	0	300	/	A	Working Current	RO	Working Current
139	008Bh	0	1000	/	0.1V	Working Bus Voltage	RO	Working Bus Voltage
140	008Ch	0	0xFFFF	/	-	Error Code	RO	Code value=0x0001<<(n-1) ERR_STALL, // n=1 ERR_BKIN, // 2 ERR_OVER_CUR_PEAK, // 3 ERR_OVER_CUR_AVG, // 4 ERR_HALL, // 5 ERR_UNDER_UBUS, // 6 ERR_OVER_UBUS, // 7 ERR_OVER_SPEED, // 8 ERR_IBUS_OFFSET, // 9 ERR_OVER_LOAD, // 10 ERR_UNDER_TEMPER_PCBA, // 11 ERR_OVER_TEMPER_PCBA, // 12 ERR_PWM_SIGNAL, //13 ERR_EERPOM, // 14
141	008Dh	0	0xFFFF	/	-	Position High Byte	RO	Together with Pn142 becomes a s32 type data
142	008Eh	0	0xFFFF	/	-	Position Low Byte	RO	Together with Pn141 becomes a s32 type data
143	008Fh	0	0xFFFF	/	-	Firmware Version	RO	0x2425=Year 2024, Week 25
144	0090h	0	0xFFFF	/	-	Driver Temperature	RO	Temperature value=(Data-40)℃, If this value is 30, then temperature is - 10℃
145	0091h	0	0xFFFF	/	-	Motor Temperature	RO	0xFFFF=No NTC(Pn101=0), Others:Temperatue =(Data-40)℃