D2 & D2T Applications for Tool Turret/Magazine

Version 1.3
October 2015

Contents

Revision History:

Version	Date	Applicability	Remarks
1.3	2015-10-30	D2-series drive	Frist release.

1. Framewrok

Automatic tool change (ATC) mechanism solution of D2-series drives can meet application requirements of different number of cutter and different gear ratio of reducer. Through process description language (PDL), which is a high degree of freedom of movement and diversity program, this solution can design special functionalities based on applications of tool turret or tool magazine.

1.1. Hardware platform

Hardware platform for automatic tool change mechanism is described as following table.

Table 1-1

Drive	D2	D2T	D2T with external I/O
Motor	Motor with 13-bit incremental encoder	Motor with 17-bit absolute encoder	Motor with 17-bit absolute encoder

1.2. Applicable limitation

Table 1-2

Drive	D2	D2T	D2T with external I/O
Number of cutter	21	21	31 (default)
Digital input	9	10	10 + 24
Digital output	**4 outputs:** (1) Servo Ready (2) Errors (3) Homed (4) In-Position	**5 outputs of following functions:** (1) Servo not Ready (2) Errors (3) Homed (4) Homing (5) Cutter offset warning (6) Cutter combination output (7) Absolute encoder battery error (8) Wrong absolute position	**5 outputs of following functions + 12 external digital outputs:** (1) Servo not Ready (2) Errors (3) Homed (4) Homing (5) Cutter offset warning (6) Cutter combination output (7) Absolute encoder battery error (8) Wrong absolute position
Jog Function	X	O	O
Homing mode	X	O (4 kinds of homing mode)	O (4 kinds of homing mode)

D2 Drive

9 DI and 4 DO
DI (Source & Sink)
DO (Source & Sink)

D2T Drive

10 DI and 5 DO
DI (Source & Sink)
DO (Source & Sink)

D2T Drive with external I/O

34 DI and 17 DO
DI (Source & Sink)
DO (Source & Sink)

Fig. 1-1

1.3. Servo control system

The servo control system of this ATC solution combines standard D2-series drives with exclusive PDL for ATC system to complete drive solutions of low cost and high functionality.

USB to Mini USB cable

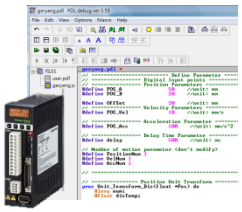


Fig. 1-2

2. Control Algorithm

2.1. D2 drive

2.1.1. Function

(1) Number of I/O: Total up to 9 inputs and 4 outputs.

(2) Model number: D2-☐☐23-S-☐0.

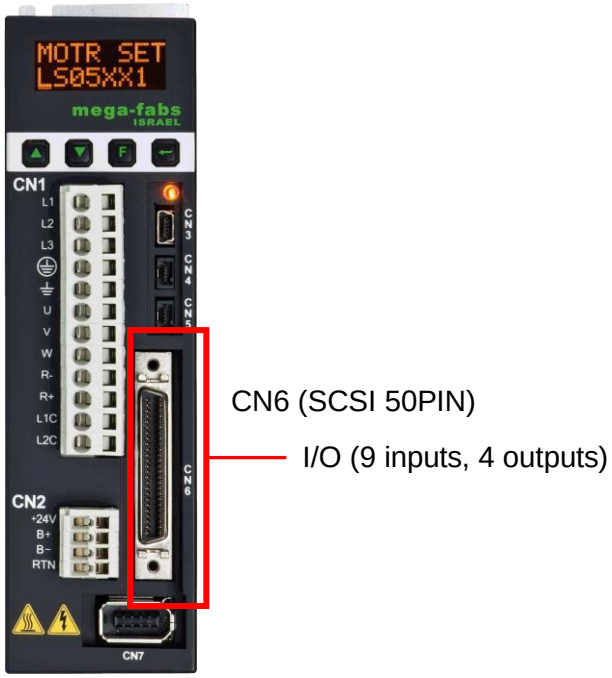


Fig. 2-1

Input: Power connection points of 9 inputs are the common point. Based on the signal of COM+/-, input signals could be wired by using source or sink method.

Output: Users can define the output signal as source or sink wiring.

Table 2-1 I/O functions of D2 drive

I/O	PIN	Function
Digital Input	I1	Start searching tool (Pos_Start)
	I2	Home sensor (Home_Sensor)
	I3	Enable (Axis enable)
	I4	Start homing (Start_Home)
	I5	Bit 4 of command input for indexing position code
	I6	Bit 3 of command input for indexing position code
	I7	Bit 2 of command input for indexing position code
	I8	Bit 1 of command input for indexing position code
	I9	Bit 0 of command input for indexing position code
Digital Output	O1	Servo Ready
	O2	Errors
	O3	In-Position
	O4	Homed

2.1.2. Digital input code

Table 2-2 Digital input code for D2 drive

I5	I6	I7	I8	I9	Definition
0	0	0	0	0	-
0	0	0	0	1	Indexing position 1
0	0	0	1	0	Indexing position 2
0	0	0	1	1	Indexing position 3
0	0	1	0	0	Indexing position 4
0	0	1	0	1	Indexing position 5
0	0	1	1	0	Indexing position 6
0	0	1	1	1	Indexing position 7
0	1	0	0	0	Indexing position 8
0	1	0	0	1	Indexing position 9
0	1	0	1	0	Indexing position 10
0	1	0	1	1	Indexing position 11
0	1	1	0	0	Indexing position 12
0	1	1	0	1	Indexing position 13
0	1	1	1	0	Indexing position 14
0	1	1	1	1	Indexing position 15
1	0	0	0	0	Indexing position 16
1	0	0	0	1	Indexing position 17
1	0	0	1	0	Indexing position 18
1	0	0	1	1	Indexing position 19
1	0	1	0	0	Indexing position 20
1	0	1	0	1	Indexing position 21

2.1.3. PDL parameter

Table 2-3 PDL parameters for D2 drive

Parameter	Range	Definition
Pos_Num	1 ~ 21	Total number of indexing position
Gear_Ratio	1 ~ 100	Gear ratio of reducer

2.1.4. Timing chart

(1) Homing:

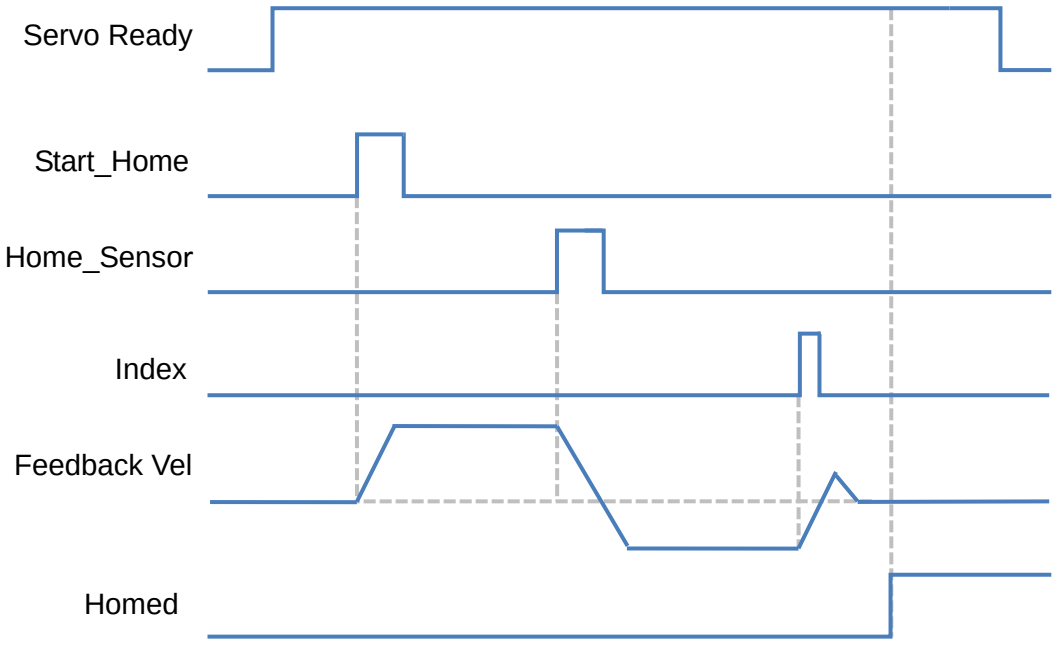


Fig. 2-2 Timing chart of homing for D2 drive

(2) Start searching tool

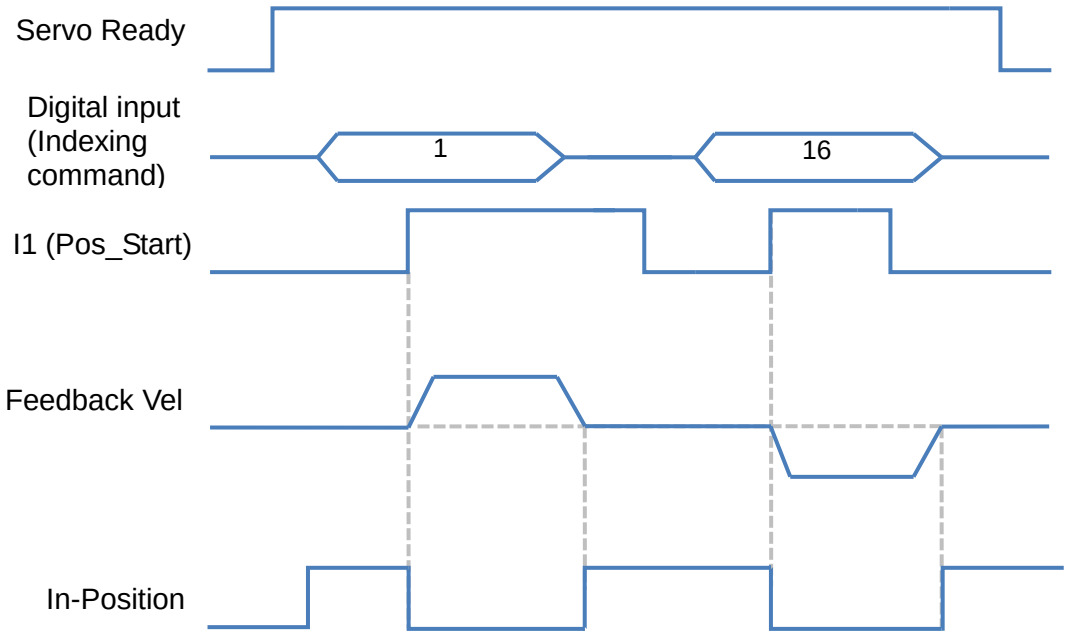


Fig. 2-3 Timing chart of start searching tool for D2 drive

2.2. D2T drive

2.2.1. Function

(1) Number of I/O: Total up to 10 inputs and 5 outputs.

(2) Model number: D2T-☐☐23-S-☐0.

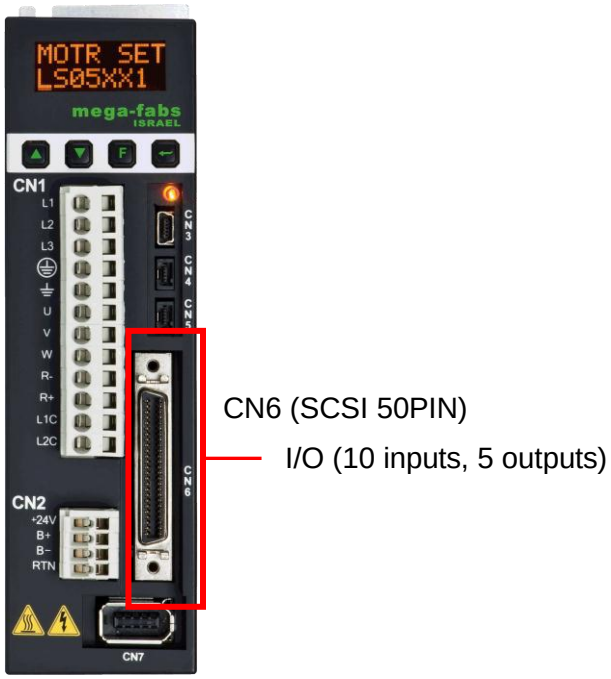


Fig. 2-4

Input: Power connection points of 10 inputs are the common point. Based on the signal of COM+/-, input signals could be wired by using source or sink method.

Output: Users can define the output signal as source or sink wiring.

Table 2-4 I/O functions of D2T drive

I/O	PIN	Function	
Digital Input	I1	Start searching tool (Pos_Start)	
	I2	Home sensor (Near_Home_Sensor / Setting_Home_Pos)	
	I3	Enable (Axis enable)	
	I4	Start homing (Start_Home)	
	I5	Bit 4 of command input for indexing position code	
	I6	Bit 3 of command input for indexing position code	
	I7	Bit 2 of command input for indexing position code	
	I8	Bit 1 of command input for indexing position code	
	I9	Bit 0 of command input for indexing position code	
	I10	Reset amplify (Reset)	
Digital Output	O1	Bit 0 of output code for indexing position	Other status outputs (see Table 2-6)
	O2	Bit 1 of output code for indexing position	
	O3	Bit 2 of output code for indexing position	
	O4	Bit 3 of output code for indexing position	
	O5	Bit 4 of output code for indexing position	

2.2.2. Digital input code

Table 2-5 Digital input code for D2T drive

I5	I6	I7	I8	I9	Definition
0	0	0	0	0	-
0	0	0	0	1	Indexing position 1
0	0	0	1	0	Indexing position 2
0	0	0	1	1	Indexing position 3
0	0	1	0	0	Indexing position 4
0	0	1	0	1	Indexing position 5
0	0	1	1	0	Indexing position 6
0	0	1	1	1	Indexing position 7
0	1	0	0	0	Indexing position 8
0	1	0	0	1	Indexing position 9
0	1	0	1	0	Indexing position 10
0	1	0	1	1	Indexing position 11
0	1	1	0	0	Indexing position 12
0	1	1	0	1	Indexing position 13
0	1	1	1	0	Indexing position 14
0	1	1	1	1	Indexing position 15
1	0	0	0	0	Indexing position 16
1	0	0	0	1	Indexing position 17
1	0	0	1	0	Indexing position 18
1	0	0	1	1	Indexing position 19
1	0	1	0	0	Indexing position 20
1	0	1	0	1	Indexing position 21
1	1	1	1	0	CCW reversal rotation
1	1	1	1	1	CW forward rotation

2.2.3. Digital output code

Table 2-6 Digital output code for D2T drive

O5	O4	O3	O2	O1	Definition
0	0	0	0	0	-
0	0	0	0	1	Indexing position 1
0	0	0	1	0	Indexing position 2
0	0	0	1	1	Indexing position 3
0	0	1	0	0	Indexing position 4
0	0	1	0	1	Indexing position 5
0	0	1	1	0	Indexing position 6
0	0	1	1	1	Indexing position 7
0	1	0	0	0	Indexing position 8
0	1	0	0	1	Indexing position 9
0	1	0	1	0	Indexing position 10
0	1	0	1	1	Indexing position 11
0	1	1	0	0	Indexing position 12
0	1	1	0	1	Indexing position 13
0	1	1	1	0	Indexing position 14
0	1	1	1	1	Indexing position 15
1	0	0	0	0	Indexing position 16
1	0	0	0	1	Indexing position 17
1	0	0	1	0	Indexing position 18
1	0	0	1	1	Indexing position 19
1	0	1	0	0	Indexing position 20
1	0	1	0	1	Indexing position 21
1	0	1	1	0	Reserved
1	0	1	1	1	Homing
1	1	0	0	0	Homed
1	1	0	0	1	Cutter offset warning
1	1	0	1	1	Servo not Ready
1	1	1	0	0	Absolute encoder battery error
1	1	1	0	1	Wrong absolute position
1	1	1	1	0	Serial Encoder Error
1	1	1	1	1	Errors

2.2.4. PDL Parameter

Table 2-7 PDL parameters for D2T drive

Parameter	Range	Definition	Unit
Pos_Num	1 ~ 21	Total number of indexing position	-
Gear_Ratio	1 ~ 100	Gear ratio of reducer	-
Homing_Mode	0	Searching external sensor mode	-
	1	Manual teaching home position mode	-
Search_Sensor_vel	1 ~ 3000	Speed for searching home sensor	rpm
Search_Index_vel	1 ~ 3000	Speed for searching index	rpm
Home_Offset_vel	1 ~ 3000	Speed for moving to home offset	rpm
Home_Offset	1 ~ 340787200	Home offset	count
Shift_Pos_Range	131072	Cutter ossfet	count
Motion_Mode	0	Indexing searching tool mode - To be with command input of indexing position code.	-
	1	Single-step searching tool mode - As the pin of start searching tool is rising-edge triggered the motor moves one indexing position. - The direction of searching tool is based on the value of Rotary_mode.	-
	2	Continuous single-step searching tool mode - As the pin of start searching tool is triggered and keeps the same level, this mode will be performed. - The direction of searching tool is based on the value of Rotary_mode. - Until the pin of start searching tool is OFF, motor will stop at the nearest tool slot.	-
Continuous_Step_delay	100 ~ 60000	Delay time for continuous single-step mode	ms
Rotary_Mode	0	Shortest-path searching tool	-
	1	Forward-rotation searching tool	-
	2	Reversal-rotation searching tool	-

2.2.5. Timing chart

(1) Homing:

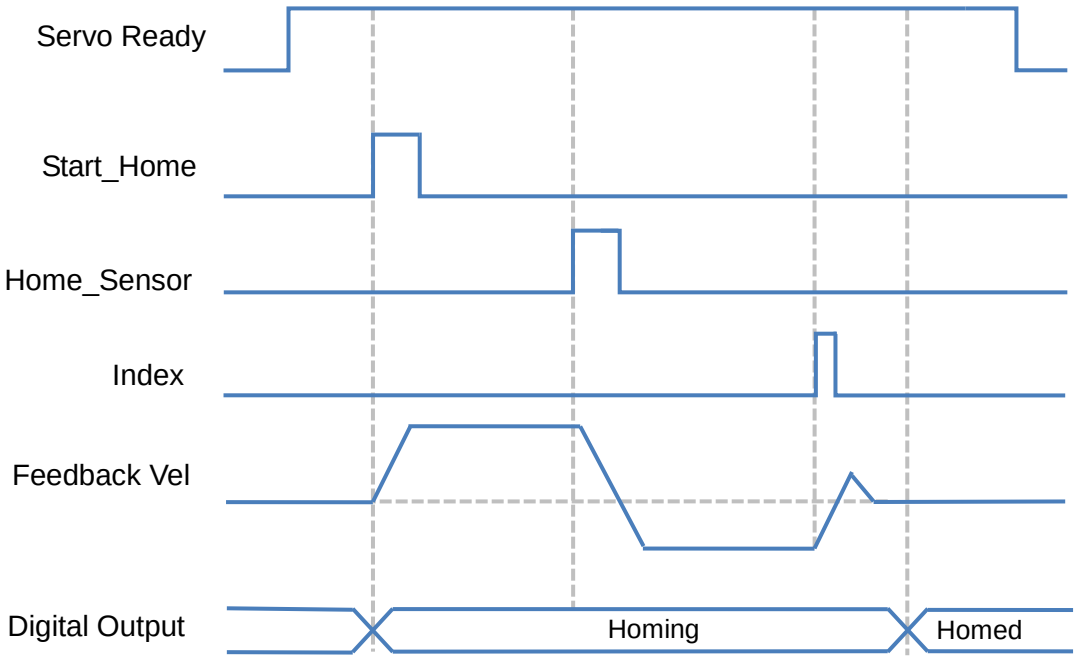


Fig. 2-5 Timing chart of homing for D2T drive

(2) Indexing searching tool mode (Motion_Mode = 0):

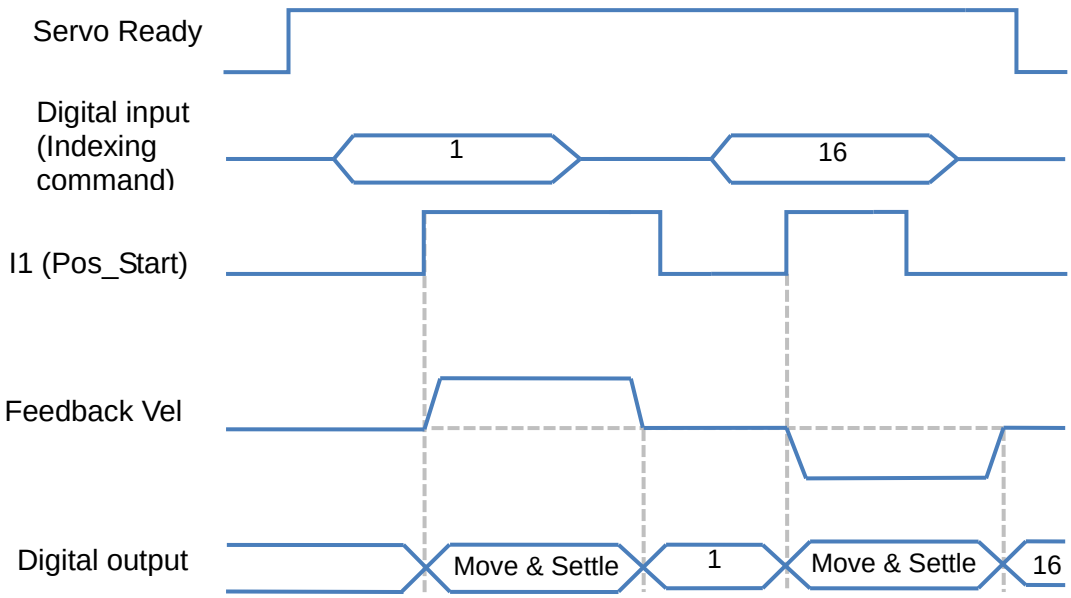


Fig. 2-6 Timing chart of indexing searching tool mode for D2T drive

(3) Single-step searching tool mode (Motion_Mode = 1):

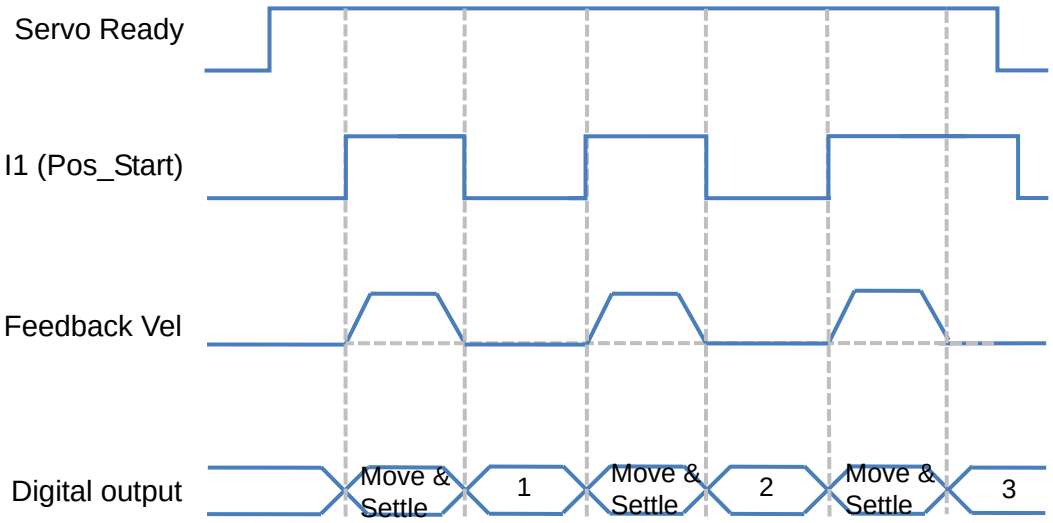


Fig. 2-7 Timing chart of single-step searching tool mode for D2T drive

(4) Continuous single-step searching tool mode (Motion_Mode = 2):

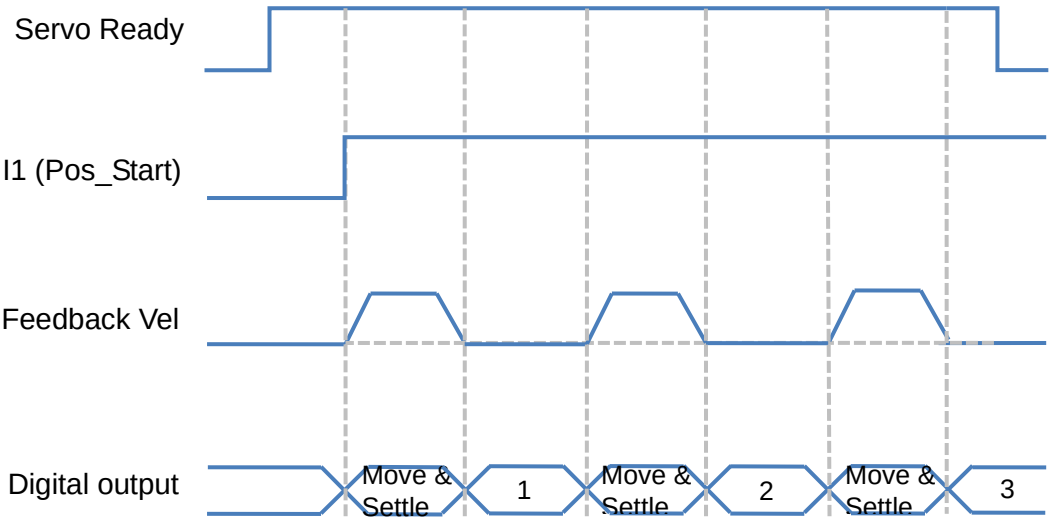


Fig. 2-8 Timing chart of continuous single-step searching tool mode for D2T drive

2.3. D2T drive with external I/O

2.3.1. Function

(1) Number of I/O for D2T drive: Total up to 10 inputs and 5 outputs.

(2) Number of I/O for external I/O module: Total up to 24 inputs and 12 outputs.

(3) Model number: D2T-☐☐23-K-☐0.

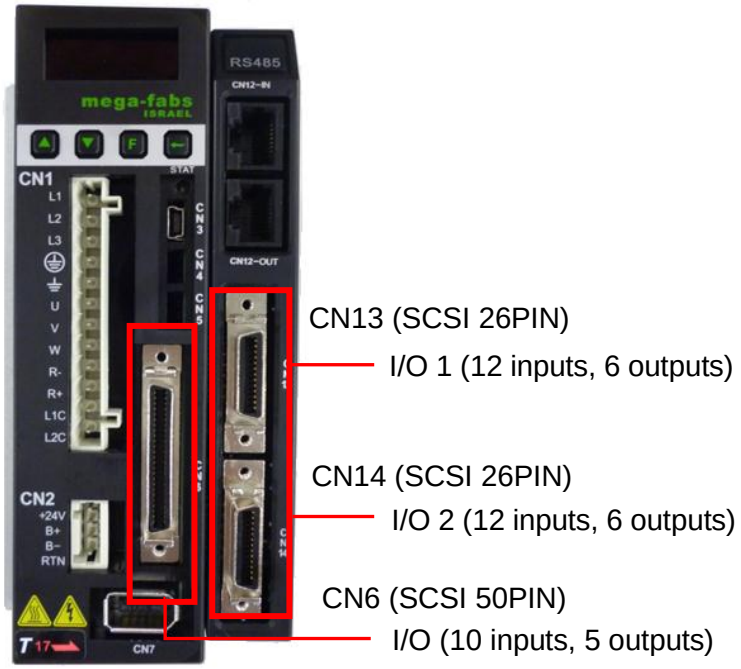


Fig. 2-9

Input: Power connection points of 10 inputs are the common point. Based on the signal of COM+/-, input signals could be wired by using source or sink method.

Output: Users can define the output signal as source or sink wiring.

Table 2-8 I/O functions of D2T drive with external I/O

<table>
<tr><th>I/O</th><th>PIN</th><th>Function</th></tr>
<tr><td rowspan="10">Digital Input</td><td>I1</td><td>Start searching tool (Pos_Start)</td></tr>
<tr><td>I2</td><td>Home sensor (Near_Home_Sensor / Setting_Home_Pos)</td></tr>
<tr><td>I3</td><td>Enable (Axis enable)</td></tr>
<tr><td>I4</td><td>Start homing (Start_Home)</td></tr>
<tr><td>I5</td><td>Bit 4 of command input for indexing position code</td></tr>
<tr><td>I6</td><td>Bit 3 of command input for indexing position code</td></tr>
<tr><td>I7</td><td>Bit 2 of command input for indexing position code</td></tr>
<tr><td>I8</td><td>Bit 1 of command input for indexing position code</td></tr>
<tr><td>I9</td><td>Bit 0 of command input for indexing position code</td></tr>
<tr><td>I10</td><td>Reset amplify (Reset)</td></tr>
<tr><td rowspan="15">External 1_
CN13 Input</td><td>Ex_I1</td><td rowspan="3">Homing, automatic single-step searching tool, manual single-step searching tool, shortest-path searching tool: Mode selection input pins (Ex_I1, Ex_I2).
<table><tr><th>Ex_I1</th><th>Ex_I2</th><th>Operational mode</th></tr><tr><td>Off</td><td>Off</td><td>Shortest-path searching tool</td></tr><tr><td>Off</td><td>On</td><td>Automatic single-step searching tool</td></tr><tr><td>On</td><td>Off</td><td>Manual single-step searching tool</td></tr><tr><td>On</td><td>On</td><td>Homing</td></tr></table>
When operational mode is at automatic/manual single-step searching tool, the rotation direction is defined by Ex_I3.
<table><tr><th>Ex_I3</th><th>Direction</th></tr><tr><td>On</td><td>Forward rotation</td></tr><tr><td>Off</td><td>Reversal rotation</td></tr></table></td></tr>
<tr><td>Ex_I2</td></tr>
<tr><td>Ex_I3</td></tr>
<tr><td>Ex_I4</td><td>Setting home position (Setting_Home_Pos)</td></tr>
<tr><td>Ex_I5</td><td>Manual homing: forward rotation.
- To be with I1 (Pos_Start) trigger.</td></tr>
<tr><td>Ex_I6</td><td>Manual homing: reversal rotation.
- To be with I1 (Pos_Start) trigger.</td></tr>
<tr><td>Ex_I7</td><td rowspan="6">User-defined input functions</td></tr>
<tr><td>Ex_I8</td></tr>
<tr><td>Ex_I9</td></tr>
<tr><td>Ex_I10</td></tr>
<tr><td>Ex_I11</td></tr>
<tr><td>Ex_I12</td></tr>
<tr><td rowspan="10">External 2_
CN14 Input</td><td>Ex_I13</td><td rowspan="10">User-defined input functions</td></tr>
<tr><td>Ex_I14</td></tr>
<tr><td>Ex_I15</td></tr>
<tr><td>Ex_I16</td></tr>
<tr><td>Ex_I17</td></tr>
<tr><td>Ex_I18</td></tr>
<tr><td>Ex_I19</td></tr>
<tr><td>Ex_I20</td></tr>
<tr><td>Ex_I21</td></tr>
<tr><td>Ex_I22</td></tr>
</table>

I/O	PIN	Function
	Ex_I23	
	Ex_I24	
Digital Output	O1	Bit 0 of output code for indexing position
	O2	Bit 1 of output code for indexing position
	O3	Bit 2 of output code for indexing position
	O4	Bit 3 of output code for indexing position
	O5	Bit 4 of output code for indexing position
External 1_ CN13 Output	Ex_O1	Cutter offset warning
	Ex_O2	Reserved
	Ex_O3	Servo not Ready
	Ex_O4	Wrong absolute position
	Ex_O5	Serial Encoder Error
	Ex_O6	Errors
External 2_ CN14 Output	Ex_O7	User-defined output functions
	Ex_O8	
	Ex_O9	
	Ex_O10	
	Ex_O11	
	Ex_O12	

2.3.2. Digital input code

Table 2-9 Digital input code for D2T drive with external I/O

I5	I6	I7	I8	I9	Definition
0	0	0	0	0	-
0	0	0	0	1	Indexing position 1
0	0	0	1	0	Indexing position 2
0	0	0	1	1	Indexing position 3
0	0	1	0	0	Indexing position 4
0	0	1	0	1	Indexing position 5
0	0	1	1	0	Indexing position 6
0	0	1	1	1	Indexing position 7
0	1	0	0	0	Indexing position 8
0	1	0	0	1	Indexing position 9
0	1	0	1	0	Indexing position 10
0	1	0	1	1	Indexing position 11
0	1	1	0	0	Indexing position 12
0	1	1	0	1	Indexing position 13
0	1	1	1	0	Indexing position 14
0	1	1	1	1	Indexing position 15
1	0	0	0	0	Indexing position 16
1	0	0	0	1	Indexing position 17
1	0	0	1	0	Indexing position 18
1	0	0	1	1	Indexing position 19
1	0	1	0	0	Indexing position 20

1	0	1	0	1	Indexing position 21
1	0	1	1	0	Indexing position 22
1	0	1	1	1	Indexing position 23
1	1	0	0	0	Indexing position 24
1	1	0	0	1	Indexing position 25
1	1	0	1	0	Indexing position 26
1	1	0	1	1	Indexing position 27
1	1	1	0	0	Indexing position 28
1	1	1	0	1	Indexing position 29
1	1	1	1	0	Indexing position 30
1	1	1	1	1	Indexing position 31

2.3.3. Digital output code

Table 2-10 Digital output code for D2T drive with external I/O

O5	O4	O3	O2	O1	Definition
0	0	0	0	0	-
0	0	0	0	1	Indexing position 1
0	0	0	1	0	Indexing position 2
0	0	0	1	1	Indexing position 3
0	0	1	0	0	Indexing position 4
0	0	1	0	1	Indexing position 5
0	0	1	1	0	Indexing position 6
0	0	1	1	1	Indexing position 7
0	1	0	0	0	Indexing position 8
0	1	0	0	1	Indexing position 9
0	1	0	1	0	Indexing position 10
0	1	0	1	1	Indexing position 11
0	1	1	0	0	Indexing position 12
0	1	1	0	1	Indexing position 13
0	1	1	1	0	Indexing position 14
0	1	1	1	1	Indexing position 15
1	0	0	0	0	Indexing position 16
1	0	0	0	1	Indexing position 17
1	0	0	1	0	Indexing position 18
1	0	0	1	1	Indexing position 19
1	0	1	0	0	Indexing position 20
1	0	1	0	1	Indexing position 21
1	0	1	1	0	Indexing position 22
1	0	1	1	1	Indexing position 23
1	1	0	0	0	Indexing position 24
1	1	0	0	1	Indexing position 25
1	1	0	1	0	Indexing position 26
1	1	0	1	1	Indexing position 27
1	1	1	0	0	Indexing position 28
1	1	1	0	1	Indexing position 29
1	1	1	1	0	Indexing position 30
1	1	1	1	1	Indexing position 31

2.3.4. PDL Parameter

Table2-2-11 D2T 擴充 I/O 機型 PDL Parameter

Parameter	Range	Definition	Unit
Pos_Num	1 ~ 21	Total number of indexing position	-
Gear_Ratio	1 ~ 100	Gear ratio of reducer	-
Search_Sensor_vel	1 ~ 3000	Speed for searching home sensor	*rpm*
Search_Index_vel	1 ~ 3000	Speed for searching index	*rpm*
Home_Offset_vel	1 ~ 3000	Speed for moving to home offset	*rpm*
Home_Offset	1 ~ 340787200	Home offset	*count*
Shift_Pos_Range	131072	Cutter offset	*count*
Continuous_Step_delay	100 ~ 60000	Delay time for continuous single-step mode	*ms*

2.3.5. Timing chart

(1) Homing:

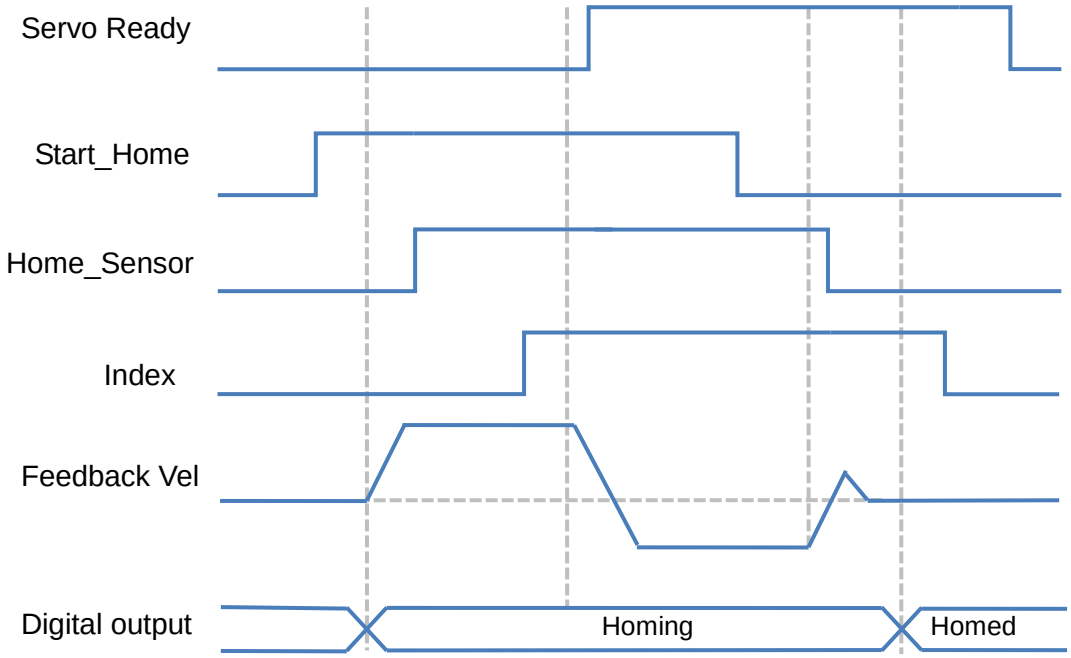


Fig. 2-10 Timing chart of homing for D2T drive with external I/O

(2) Indexing searching tool mode

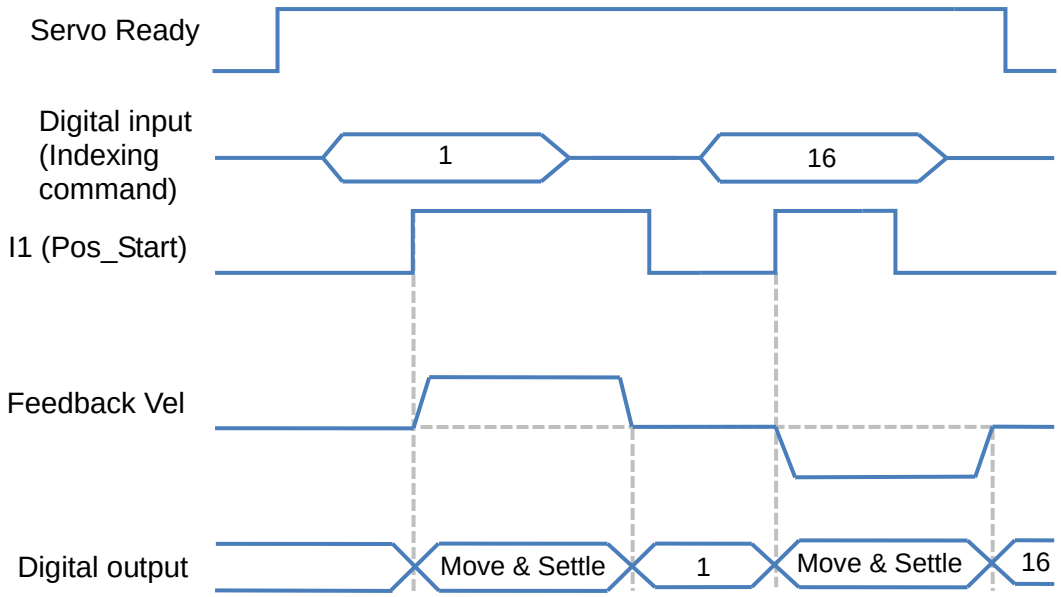


Fig. 2-11 Timing chart of indexing searching tool mode for D2T drive with external I/O

(3) Manual single-step searching tool

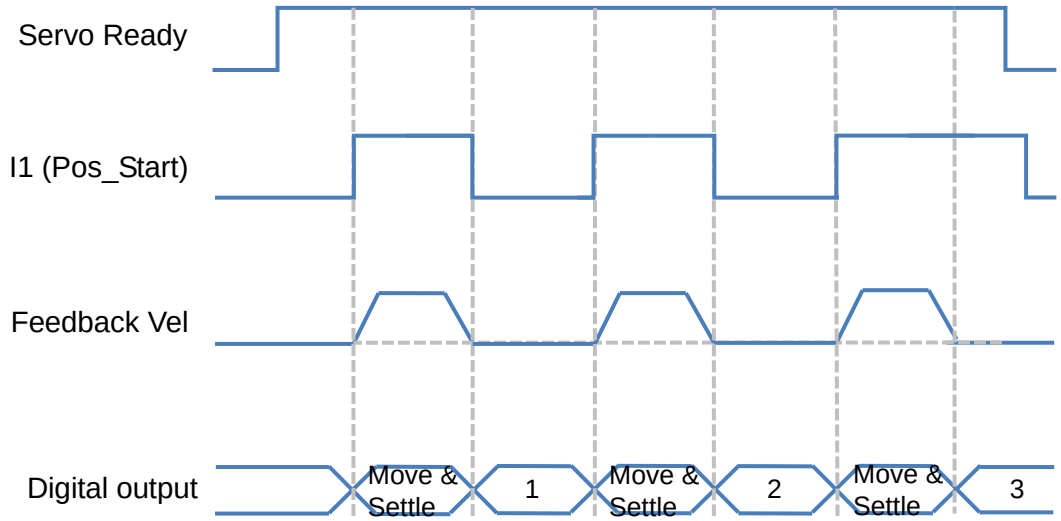


Fig. 2-12 Timing chart of manual single-step searching tool mode for D2T drive with external I/O

3. Wiring

3.1. System configuration and wiring

This chapter introduces the drive configuration and functions of each part. The following figure shows the details of drive configuration.

3.1.1. System wiring diagram

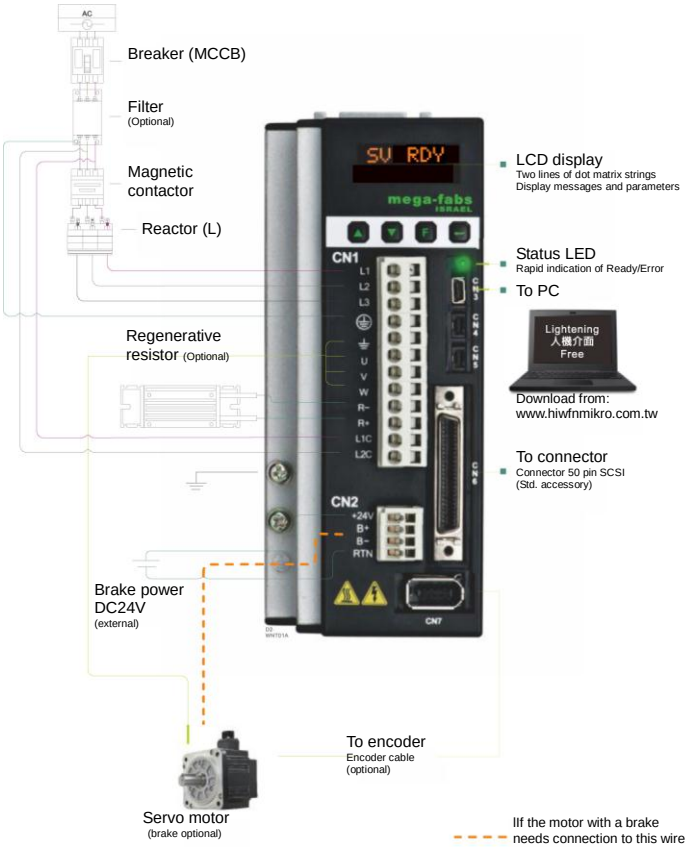


Fig. 3-1

Table 3-1

Item no.	Name	Description
1	AC main power cable (CN1)	L1, L2: Single-phase 200-240V AC, 50/60Hz L1, L2, L3: Three-phase 200-240V AC, 50/60Hz
2	Motor power cable (CN1)	Connection to motor, three-phase motor power (⏚, U, V, W)
3	Regenerative resistor (CN1)	Connection to motor regenerative resistor (optional/mounted according to actual application design) (REG-/REG+)
4	Control power cable (CN1)	For drive internal control and I/O power (L1C, L2C) L1C, L2C: Single-phase 200-240V AC, 50/60Hz
5	Brake (CN2)	Connection to brake (optional/mounted according to actual application design)
6	Mini USB communication (CN3)	Connection to PC (for setting parameters; to be removed after setting) Mini USB and the PC are used as links for monitoring, drive test runs, or writing parameters
7	Control signal (CN6)	Connection to the host controller
8	Feedback signal (CN7)	Connection to the motor encoder

3.1.2. CN1 power

The CN1 power wiring description includes single/three-phase power input, motor power output, regenerative resistor wiring, and single-phase control power input.

(1) Power wiring

Ensure that the drive has been grounded appropriately before connecting the drive to the main circuit.

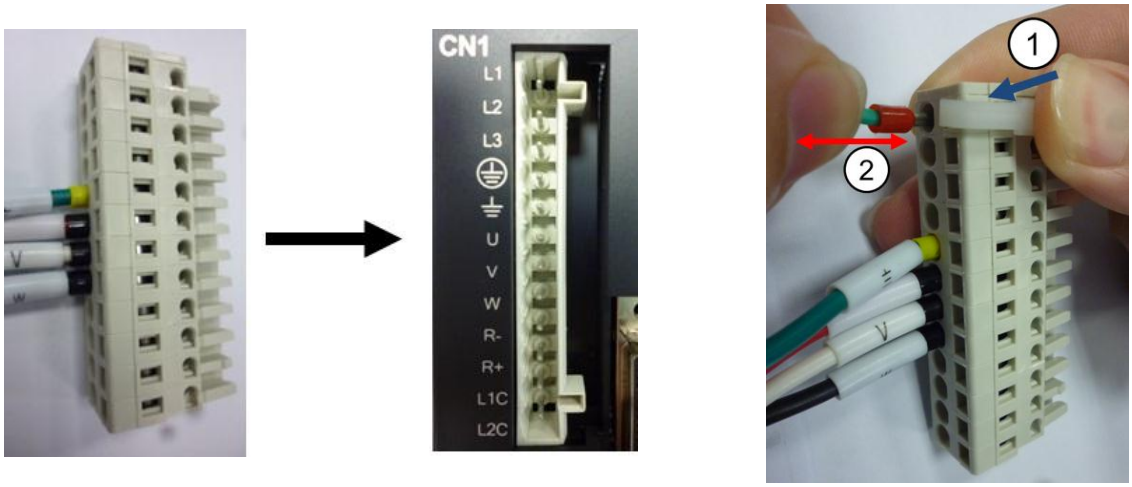


Fig. 3-2 CN1 connector and installation

Table 3-2

	Signal	Function
1	L1	AC main power, 220VAC (50/60Hz) single/three-phase
2	L2	AC main power, 220VAC (50/60Hz) single/three-phase
3	L3	AC main power, 220VAC (50/60Hz) three-phase
4	⏚	Ground input of AC main power
5	⏚	Ground input of motor
6	U	U phase input of motor
7	V	V phase input of motor
8	W	W phase input of motor
9	REG-	Negative input of regenerative resistor
10	REG+	Positive input of regenerative resistor
11	L1C	Control power, 220VAC (50/60Hz) single-phase
12	L2C	Control power, 220VAC (50/60Hz) single-phase

(2) Motor wiring
Well grounding is needed between the drive and the motor.

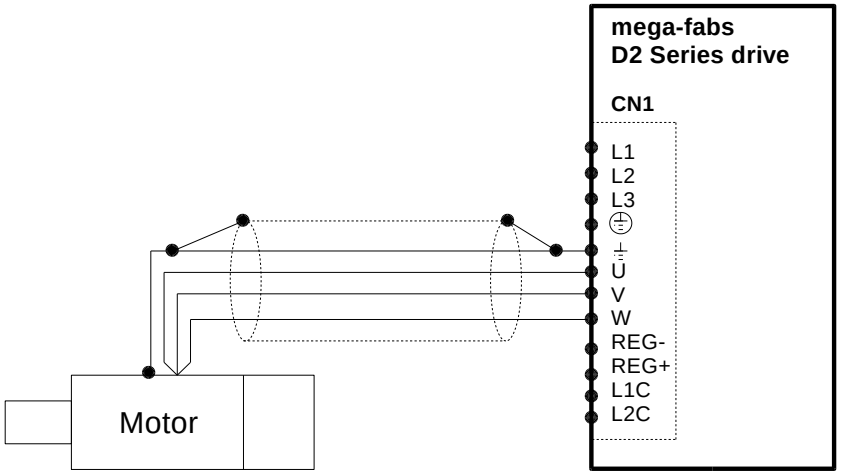


Fig. 3-3

(3) Regenerative resistor wiring
The regenerative resistor is mounted optionally according to the actual application design.

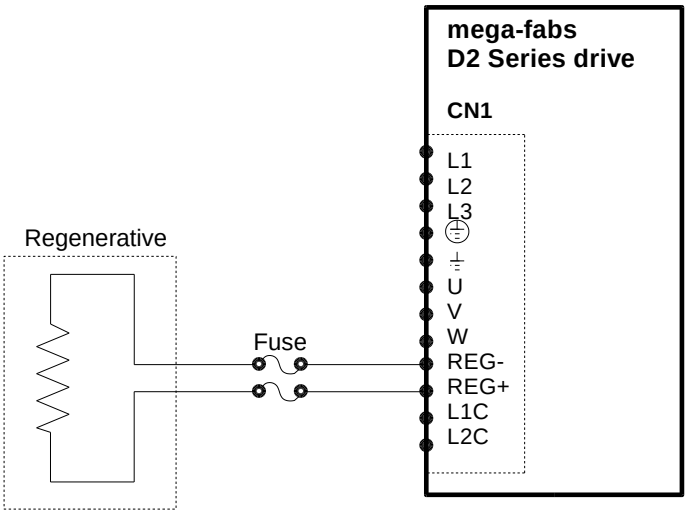


Fig. 3-4

Attention

- **Wiring and inspection must be conducted by professional technicians.**
- **Turn off the power before wiring or inspection to avoid electric shock and other dangers.**
- **High voltage may remain in the drive after the power is turned off. Wait for a while (up to five minutes) before touching the power terminal.**
- **Perform the wiring appropriately and reliably to ensure stable operation and avoid injury, damage or other accidents.**
- **Do not connect the motor U, V or W terminal to the power source.**
- **The motor power terminal must be securely connected to the power source to avoid fire.**
- **Ensure that the drive and motor are grounded appropriately.**
- **Wiring must be conducted after installation of the drive and motor to avoid electric shock.**
- **Do not damage, pull or squeeze the wire so as to avoid electric shock.**
- **The drive may interfere with the operation of nearby electronic equipment. A noise filter can be used to reduce such electromagnetic interference.**
- **Do not attempt to modify the drive.**
- **Do not put the main circuit cable, I/O signal cable, or encoder cable in the same duct or bind them together. A distance of more than 30 cm must be maintained between the cables.**
- **The following instructions must be observed for wiring the main circuit terminals:**
  - ※ Do not insert more than one wire in the same socket.
  - ※ Check there is no short circuit with any nearby wires after inserting the wire.
  - ※ Ensure the specified power voltage is used to avoid fire or damage.
- **If the drive is to be used under poor or significantly fluctuating power conditions, ensure power is supplied within the specified voltage fluctuation range so as to avoid damage.**
- **Install a breaker or other safety devices to prevent external short circuits from damaging the drive.**
- **Appropriate isolating and sheltering measures must be taken if the drive is used in the following places to avoid adverse operation.**
  - ※ Places exposed to static interference.
  - ※ Places exposed to strong electrical or magnetic fields.
  - ※ Places exposed to radiation.

3.1.3. CN2 brake

The brake can be wired with a relay. Refer to the wiring diagram for connection to the 24V DC brake. It is suggested that the brake power and other control power should not use the same power source.

(1) CN2 connector

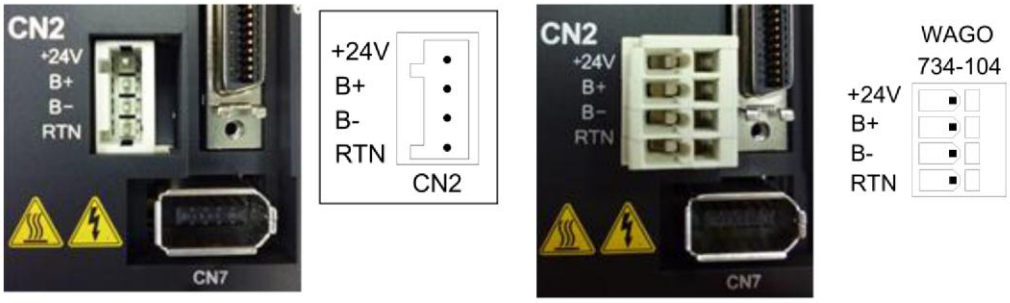


Fig. 3-5

(2) Brake wiring with a relay

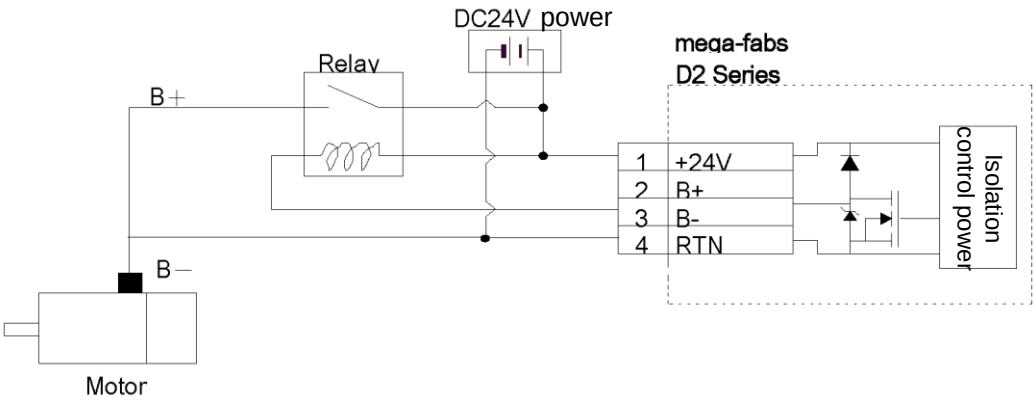


Fig. 3-6 Brake wiring with a relay

(3) Brake wiring without a relay

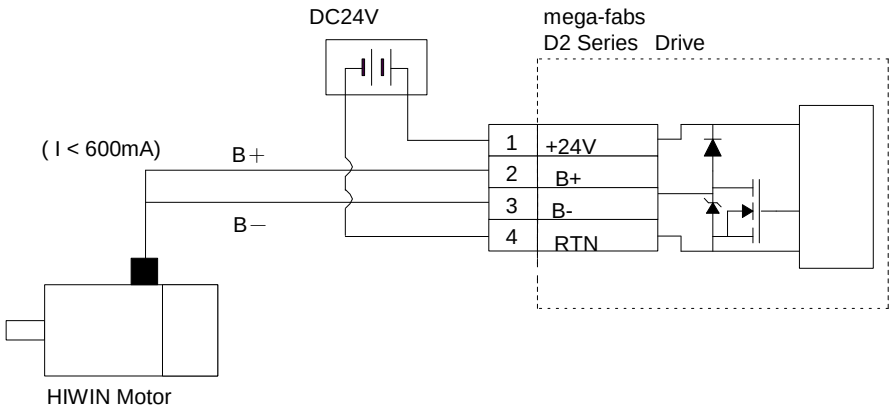


Fig. 3-7 Brake wiring without a relay

3.1.4. CN3 USB communication

Mini USB and a PC can be used as links for monitoring, performing drive test, or writing parameters. Please refer to Chapter 4.

Mini USB communication wiring diagram

Refer to HIWIN with a USB 2.0 Type A to mini-B 5-pin (1.8M) cable.

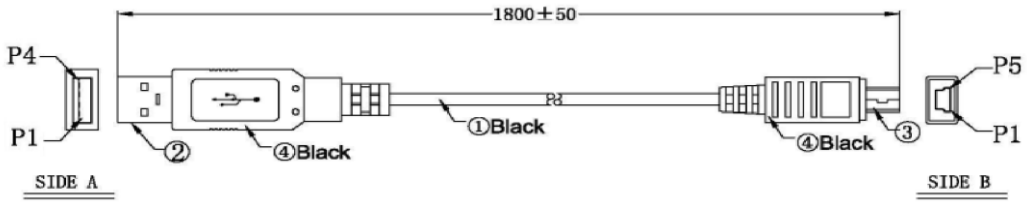
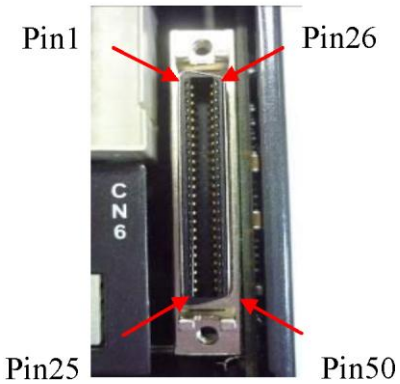
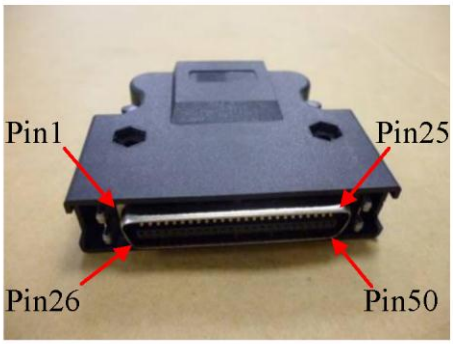


Fig. 3-8

3.1.5. CN6 control signal



SCSI 50PIN (Female)



SCSI 50PIN (Male)

Fig. 3-9

(1) CN6 pin definition:

Table 3-3

Pin	D2 Signal	D2T Signal	D2T with external I/O Signal	Function
1	CWL	CWL	CWL	Low-speed (500 Kpps) pulse command Channel 1: Pulse, CW, A phase
3	CWL+	CWL+	CWL+	
4	CWL-	CWL-	CWL-	
2	CCWL	CCWL	CCWL	Low-speed (500Kpps) pulse command Channel 2: Dir, CCW, B phase
5	CCWL+	CCWL+	CCWL+	
6	CCWL-	CCWL-	CCWL-	
13	SG	SG	SG	Digital signal ground reference
21	A	A	A	Output pulse of feedback (buffered encoder or emulated encoder)
22	/A	/A	/A	
48	B	B	B	
49	/B	/B	/B	
23	Z	Z	Z	
24	/Z	/Z	/Z	
25	SG	SG	SG	Digital signal ground reference
19	CZ	CZ	CZ	Z phase output (open collector)
44	CWH+	CWH+	CWH+	High-speed (4 Mpps) pulse command Channel 1: Pulse, CW, A phase
45	CWH-	CWH-	CWH-	
46	CCWH+	CCWH+	CCWH+	High-speed (4 Mpps) pulse command Channel 2: DIR, CCW, B phase
47	CCWH-	CCWH-	CCWH-	
7	COM	COM	COM	Common port for general purpose input signal; can be either Sink or Source
33	I1	I1	I1	General purpose input signal (programmable function)
30	I2	I2	I2	
29	I3	I3	I3	
27	I4	I4	I4	
28	I5	I5	I5	
26	I6	I6	I6	
32	I7	I7	I7	
31	I8	I8	I8	
9	I9	I9	I9	
8	N/A	I10	I10	
35	O1+	O1+	O1+	General purpose output signal (programmable function)
34	O1-	O1-	O1-	
37	O2+	O2+	O2+	
36	O2-	O2-	O2-	
39	O3+	O3+	O3+	
38	O3-	O3-	O3-	
11	O4+	O4+	O4+	
10	O4-	O4-	O4-	
40	N/A	O5+	O5+	
12	N/A	O5-	O5-	
50	FG	FG	FG	Frame ground reference

(2) System wiring diagram for pulse command

The host controller sends a pulse to the drive, which drives the motor to move a corresponding distance every time it receives a pulse. This pulse has a similar function to a position control command (P Command). The position mode receives host controller commands in three modes: Pulse/Dir, Pulse Up/Pulse Down (CW/CCW), and AqB.

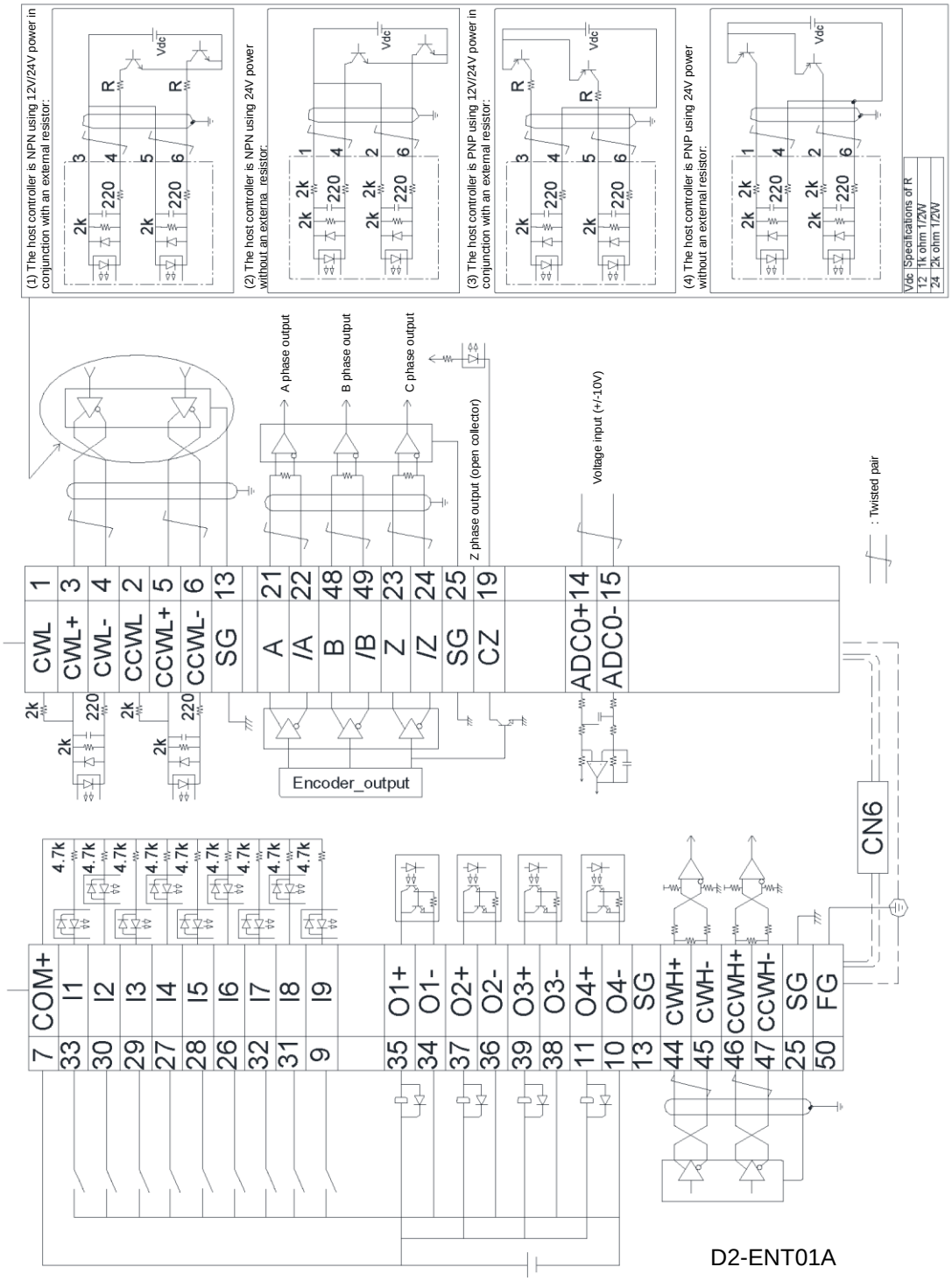


Fig. 3-10

3.1.6. CN13 & CN14 External I/O

CN13 and CN14 pin definition:

Table 3-4

CN13			CN14		
PIN	**Signal**	**Function**	**PIN**	**Signal**	**Function**
Output					
1	Ex_OUT1+	General purpose output signal	1	Ex_OUT7+	General purpose output signal
2	Ex_OUT1-		2	Ex_OUT7-	
3	Ex_OUT2+		3	Ex_OUT8+	
4	Ex_OUT2-		4	Ex_OUT8-	
5	Ex_OUT3+		5	Ex_OUT9+	
6	Ex_OUT3-		6	Ex_OUT9-	
7	Ex_OUT4+		7	Ex_OUT10+	
8	Ex_OUT4-		8	Ex_OUT10-	
9	Ex_OUT5+		9	Ex_OUT11+	
10	Ex_OUT5-		10	Ex_OUT11-	
11	Ex_OUT6+		11	Ex_OUT12+	
12	Ex_OUT6-		12	Ex_OUT12-	
Input					
13	COM1+/-	Common port for general purpose input signal	13	COM2+/-	Common port for general purpose input signal
14	Ex_I1	General purpose input signal	14	Ex_I13	General purpose input signal
15	Ex_I2		15	Ex_I14	
16	Ex_I3		16	Ex_I15	
17	Ex_I4		17	Ex_I16	
18	Ex_I5		18	Ex_I17	
19	Ex_I6		19	Ex_I18	
20	Ex_I7		20	Ex_I19	
21	Ex_I8		21	Ex_I20	
22	Ex_I9		22	Ex_I21	
23	Ex_I10		23	Ex_I22	
24	Ex_I11		24	Ex_I23	
25	Ex_I12		25	Ex_I24	

*** There is no connection between COM1+/- and COM2+/-.**

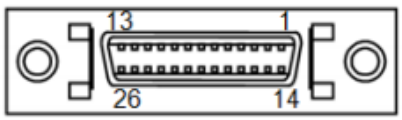
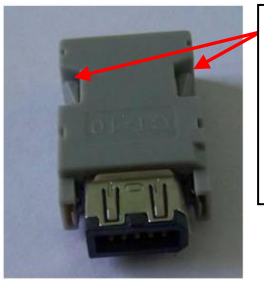


Fig. 3-11

3.1.7. CN7 encoder

Please press and pull the clamps on the both sides to remove CN7 connector.

SCR connector 10PIN (male)



Press and pull these clamps to remove CN7 connector

SCR connector 10PIN (female)

Fig. 3-12

Table 3-5

Pin	Signal	Function
1	+5V DC	Encoder power output (+5Vdc)
2	SG	Signal ground and +5Vdc ground
3	PS+	Serial encoder input
4	PS-	
5	A	Digital incremental encoder input
6	/A	
7	B	
8	/B	
9	Z	
10	/Z	

3.2. Standard main power wiring

Attention

- Wiring and inspection must be conducted by professional technicians.
- Turn off the power before wiring or inspection to avoid electric shock or other dangers.
- High voltage may remain in the drive after the power is turned off. Wait a while (up to five minutes) before touching the power terminal.
- Perform the wiring appropriately and reliably to ensure stable operation and to avoid injury, damage or other accidents.
- Do not attempt to modify the drive.

3.2.1. AC power wiring (single-phase)

It is recommended to use the FN2090-6-06 single-phase filter for 50W~400W AC motor, and the FN2090-10-06 single-phase filter for 750W~1KW AC motor

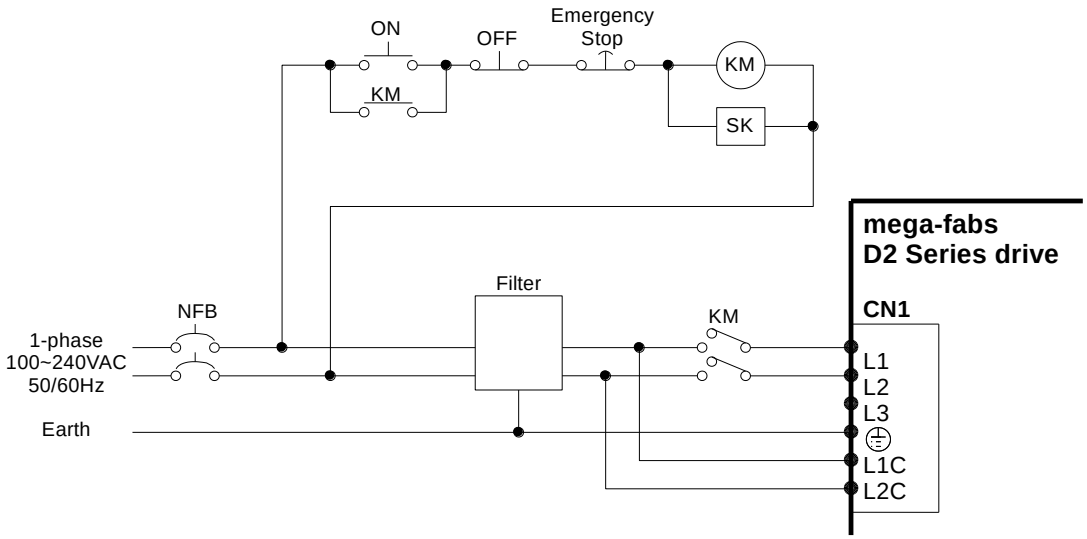


Fig. 3-13

Table 3-6

FN2090-6-06 filter	
Maximum continuous operating voltage	250V AC, 50/60Hz
Operating frequency	DC to 400Hz
Rated current	1 to 30 A@40℃
Surge pulse protection	2kV, IEC 61000-4-5

3.2.2. AC power wiring (three-phase)

It is recommended to use the FN3025HL-20-71 three-phase filter for D2-series drive.

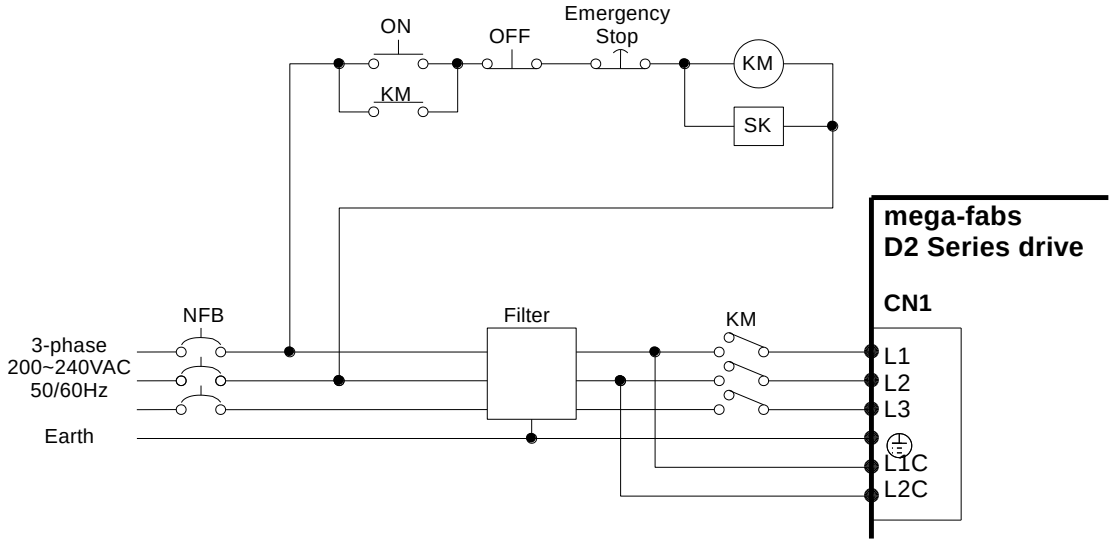


Fig. 3-14

Table 3-7

FN3025HL-20-71 filter	
Maximum continuous operating voltage	3 x 520/300V AC
Operating frequency	DC to 60Hz
Rated current	10 o 50A@50°C

3.3. I/O signal wiring

D2-model drive provides 9 general purpose inputs and 4 general purpose outputs on CN6 connector; while D2T-model drive provides 10 general purpose inputs and 5 general purpose outputs on CN6 connector. Users can define the function of each I/O point by using the software. In the following, the wiring examples D2-model drive are given. These examples can also be applied on D2T-model drive.

3.3.1. Digital input wiring

D2 general purpose input pins use an optical coupler input interface that is suitable for 12-24V DC voltage systems. D2 (D2T) has a total of 9 (10) general purpose inputs with a COM port suitable for Sink and Source connections. D2T drive with external I/O has 24 general inputs. COM ports of CN13 and CN14 are separated. They are suitable for Sink and Source connections.

I3 uses Axis Enable control by default and others are available for users to define HM functions based on their requirements.

(1) Input wiring

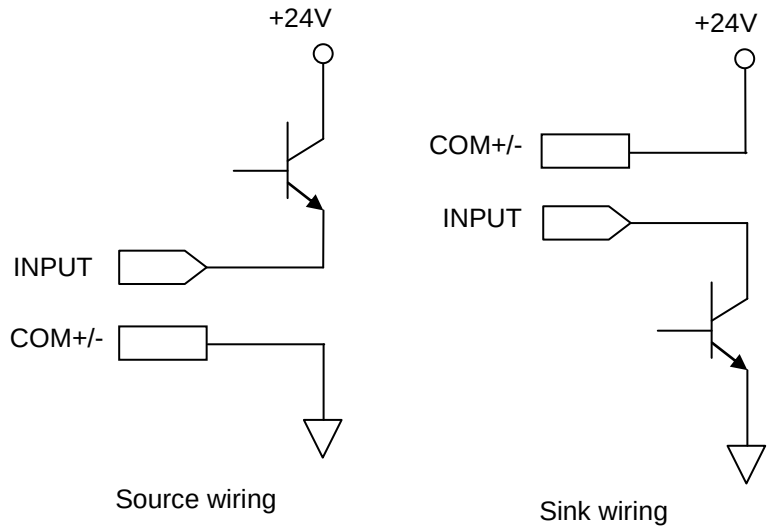


Fig. 3-15

(2) Sink input wiring

A. Input via a switch or relay:

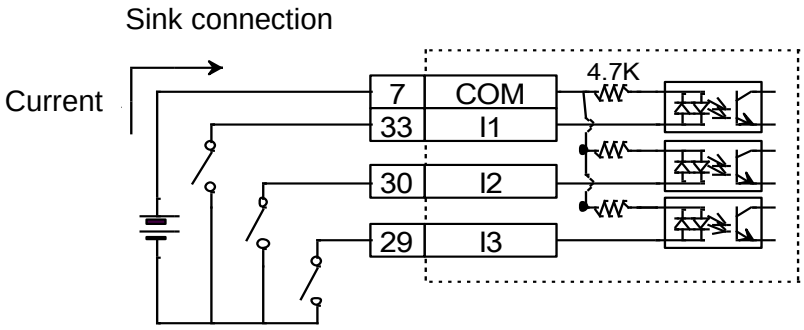


Fig. 3-16

B. Input via a transistor:

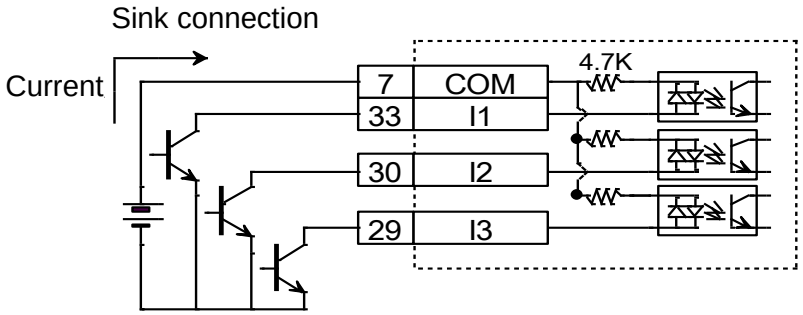


Fig. 3-17

(3) Source input wiring

A. Wiring for input via switches or relays:

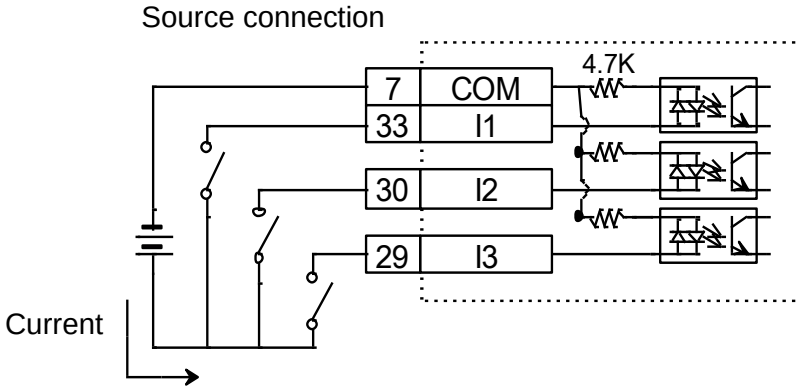


Fig. 3-18

B. Wiring for input via transistors:

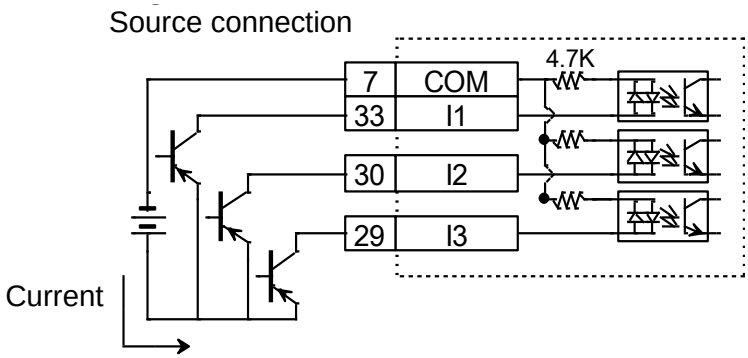


Fig. 3-19

3.3.2. Digital output wiring

D2 general purpose output pins use an optical coupler Darlington output interface that is suitable for a voltage system of less than 24V DC. D2 (D2T)-model drive has a total of 4 (5) general purpose outputs. Each output has an independent Darlington open collector circuit. The maximum allowable current is 100 mA. Users can define the function of each output by using the software.

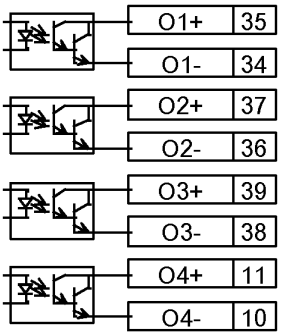


Fig. 3-20

(1) Output wiring

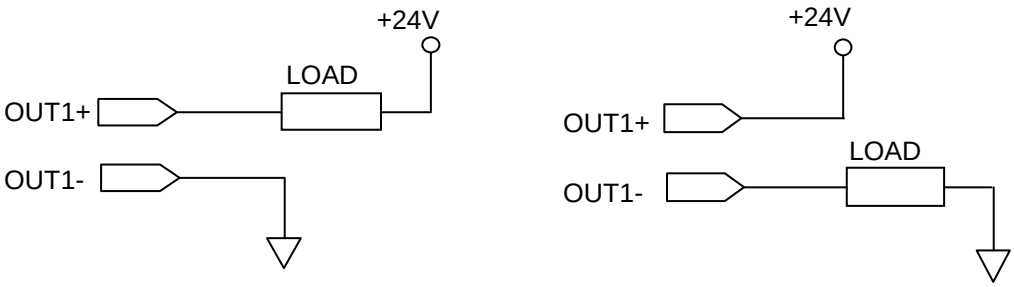


Fig. 3-21

(2) Output wiring via relays

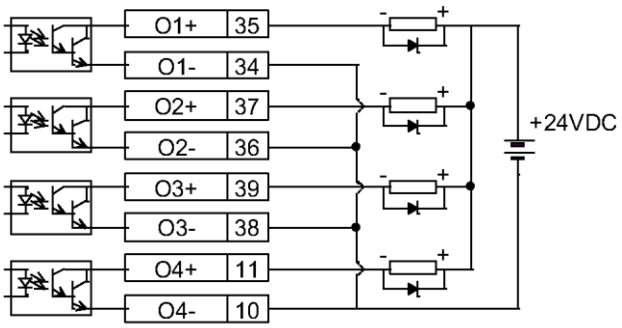


Fig. 3-22

(3) Output wiring via optical couplers

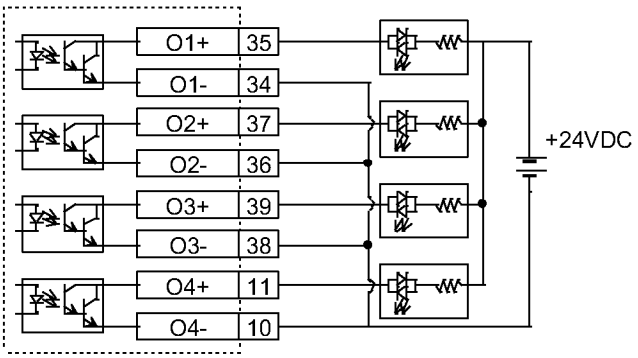


Fig. 3-23

4. Software Settings

4.1. Installation and communication

The human-machine interface (HMI) for D2-series drive is called Lightening. The communication between drive and PC is through USB connection. The Lightening graphical HMI on your PC can perform the functions including motor initialization, motor configurations, motion control, motor test runs and the corresponding parameter saving. This chapter describes how to install the product and connect it to your PC.

4.1.1. Setup file

The setup folder of the Lightening graphical HMI contains, among others, an auto execution file ‘setup.exe’ and a firmware folder ‘dce’ as shown in Fig. 4-1.

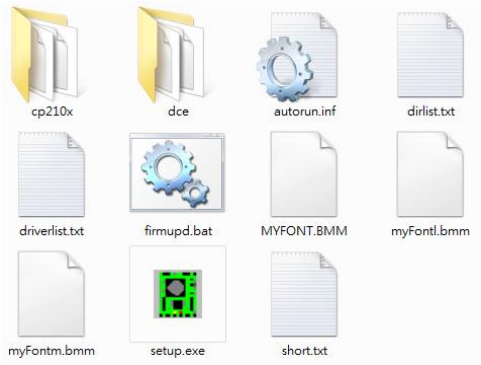


Fig. 4-1 Setup files

Please log in the HIWIN website to download the setup file. The path of this file is: “http://www.hiwinmikro.com.tw/hiwintree/Product_SubType.aspx?type=D2”. Execute ‘setup.exe’ directly after completing downloads. The installation screen is shown in Fig. 4-2. The preset destination for the installation is “C:\mega_fabs\” for Lightening 0.177 or below, and “C:\HIWIN\” for Lightening 0.178 or above. Do not try to change this path. Press ‘Start’ to perform the auto installation procedure. When the setup procedure is completed, a popup window appears to show successful installation of the software as shown in Fig. 4-3. If the USB drive installation screen (Fig. 4-4) appears during the setup procedure, click ‘Install’ and ‘OK’ to finish the setup procedure.

Fig. 4-2 Installation screen of the software

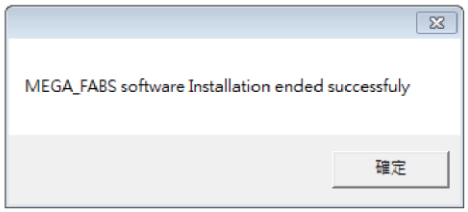


Fig. 4-3 Successful installation of the software

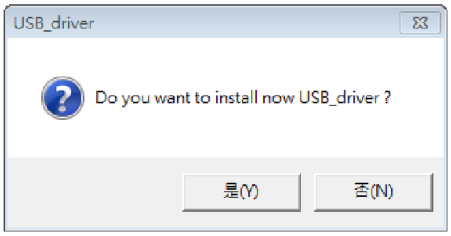


Fig. 4-4 Installation window for USB driver

The execution shortcut of the Lightening HMI program (Fig. 4-5) will appear on your PC desktop after installation. The path for this shortcut is:

“C:\mega_fabs\dce\toolswin\winkmi\lightening.exe” for Lightening 0.177 or below;

“C:\HIWIN\dce\toolswin\winkmi\lightening.exe” for Lightening 0.178 or above.

Fig. 4-5 Execution shortcut of the Lightening HMI program

4.1.2. Communication setup

The method to communicate with drive is using USB communication.

Using USB communication

Connect the drive via USB and turn on the power before opening Lightening. The drive will automatically connect to the Lightening HMI when it is opened. If not, click ‘Communication setup’ in the ‘Tools’ menu to change the communication setup.

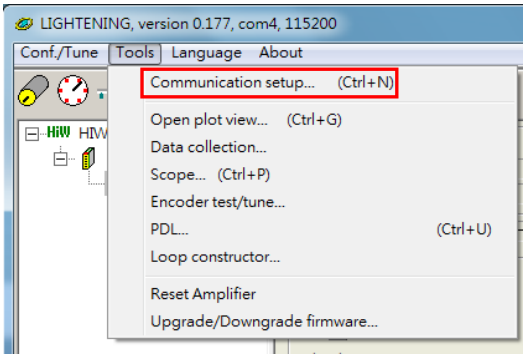


Fig. 4-6 Communication setup

The communication setup screen is shown below. D2 drive supports USB connections. “BPS” field shows the transmission rate and the default value is

115,200 bps (this should not be changed). The communication port is set in “Port” field. The field will display the existing port on your PC. Select the port that drive is actually connected to. Use default values in the remaining fields and the Lightening can be successfully communicated with drive.

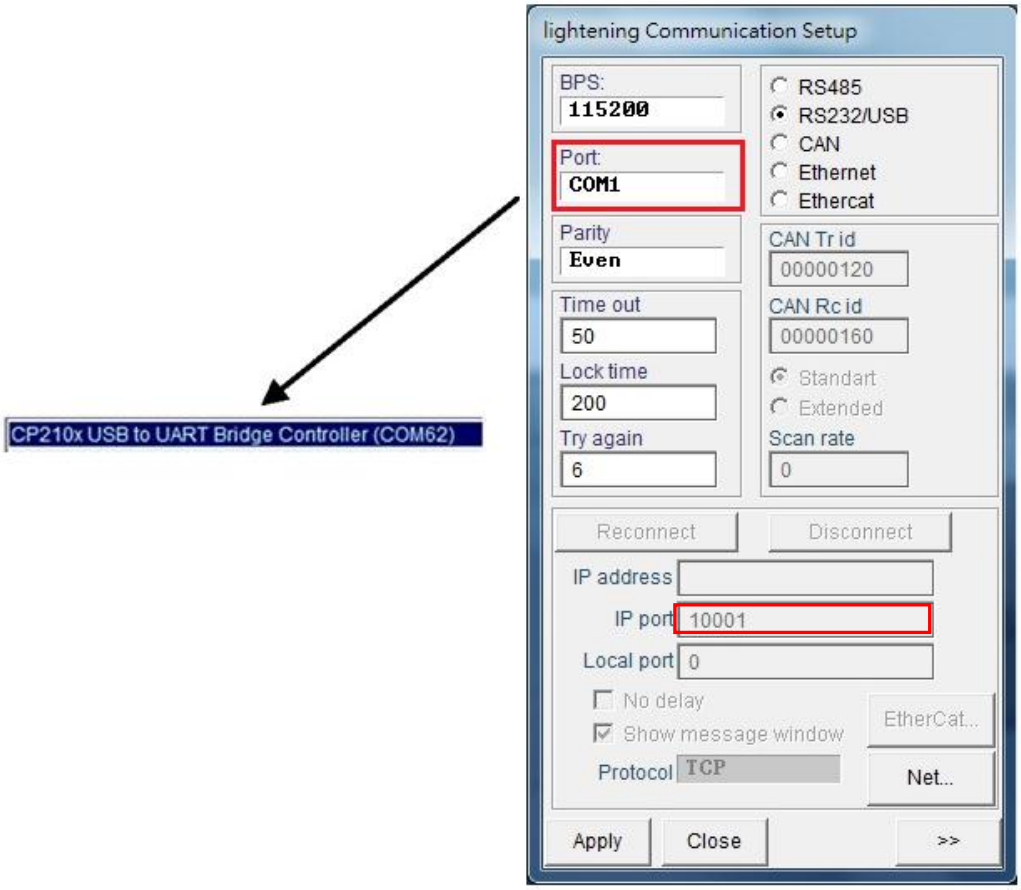


Fig. 4-7 Connection and transfer rate settings

4.1.3. HMI main window

The HMI main window after the communication is shown in Fig. 4-8. Clicking the right key of mouse at the axis name and choosing “Rename” can modify the axis name. Users can also modify the axis name directly by clicking at the axis name.

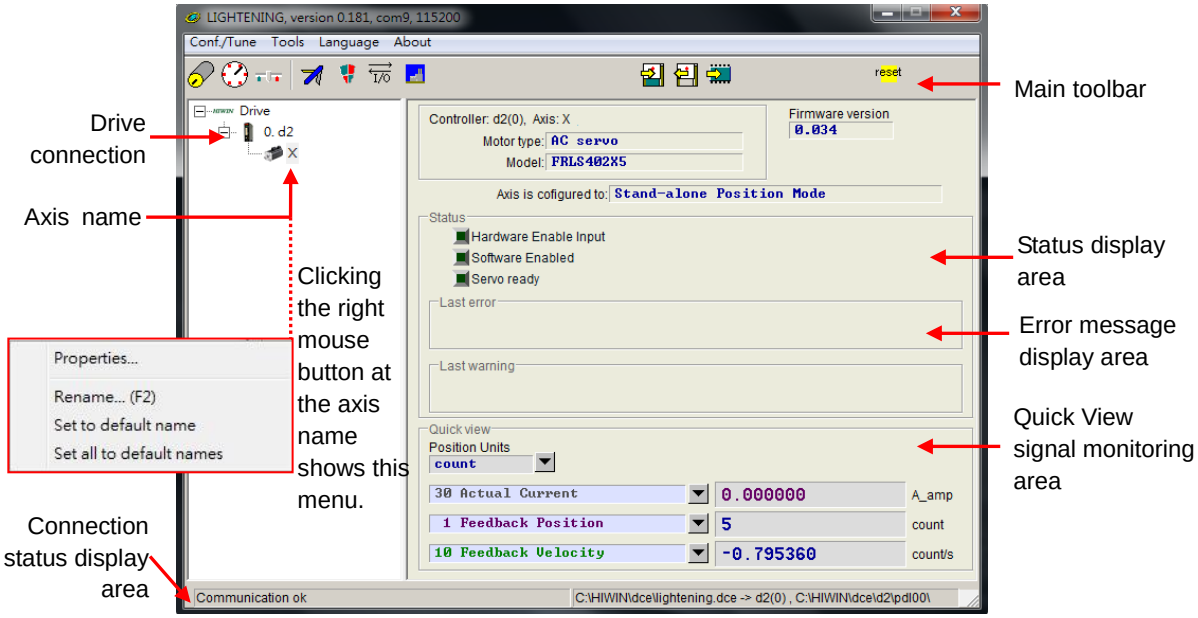


Fig. 4-8 Main HMI window

(1) Main toolbar

The function of each button in the main toolbar is described as below.

 : Save parameters in the RAM to file.

 : Load parameters in the file to RAM.

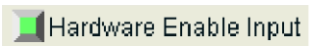
 : Save parameters in the RAM to FLASH.

 : Reset the drive.

(2) Status display

There are three indicators for displaying the statuses.

 : The green light is on when the drive is enabled and goes out when the drive is disabled.

 : The green light is on when the hardware is enabled. The drive cannot enable the motor if hardware is not enabled. Please refer to Appendix B for more information to enable hardware by using external input.

 : The green light is on when the software is enabled. Both hardware and software must be enabled for driving the motor. Click the 'Enable' button in the 'Performance Center' to enable the software, or click the 'Disable' button to disable the software. If there is no connection between your PC and the drive, the status of Software Enable is changed with the status of Hardware Enable. If you close Lightening when PC is connecting with drive, the Lightening HMI will query whether you want to enable or disable software after the window is closed.

(3) Drive property：

Clicking the right key of mouse at the axis name and choosing "Properties" can show the properties of this drive, as shown in Fig. 4-9.

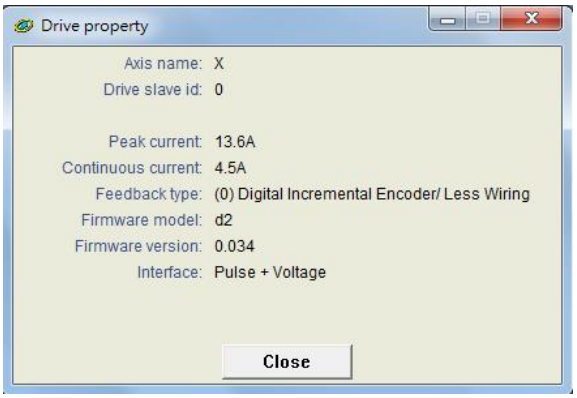


Fig. 4-9

Note: When using Lightening 0.144 (or older versions) for connection to a D2-model drive, or using Lightening 0.180 (or older versions) for connection to a D2T-model drive, an installation error message as shown in Fig. 4-10 appears after the connection. This is because these HMI versions do not contain the firmware version (e.g. v0.006) of D2-model or D2T-model drive. Thus, Lightening cannot identify these drives. Please click 'Do nothing' and download the latest version of Lightening from the HIWIN website.

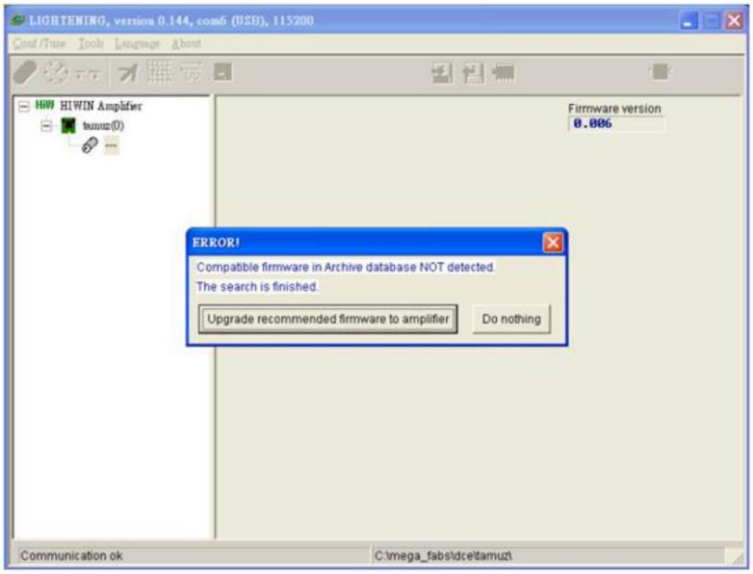


Fig. 4-10 Firmware version installation error message

4.2. Configuration center

When using a new drive or a new motor, please set up all required options according to your actual needs through 'Configuration Center'. Click in the main toolbar to enter the Configuration Center. The position of the button is shown in Fig. 4-11.

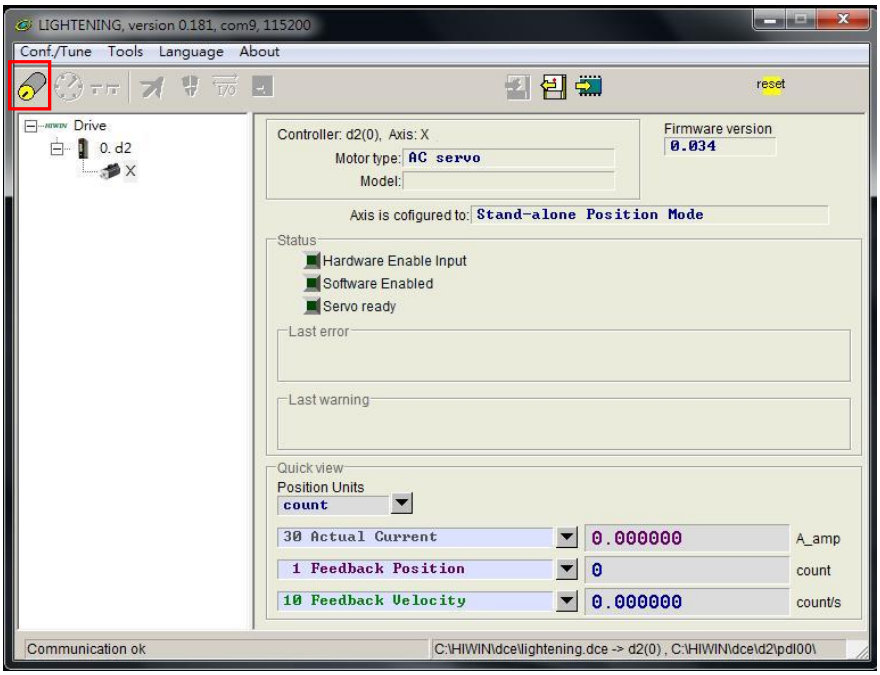


Fig. 4-11 Main functions screen

The following steps must be finished when using D2 drive to drive a motor:

(1) Motor type: Set the type and all related parameters of the motor.
(2) Encoder parameters: Set the type and the resolution of the encoder.
(3) Operation mode: Set the operation mode of the drive.

The setup procedure is described step-by-step in the following sections.

4.2.1. Motor configuration

D2 drive supports AC servo motors. The motor configuration page is at the first page of the Configuration Center. The options are listed below Motors. For the motor with serial encoder, users do not set motor parameters at this page, since the motor parameters are already stored in the encoder. Fig. 4-12 is the motor configuration page for Lightening 0.178 or above.

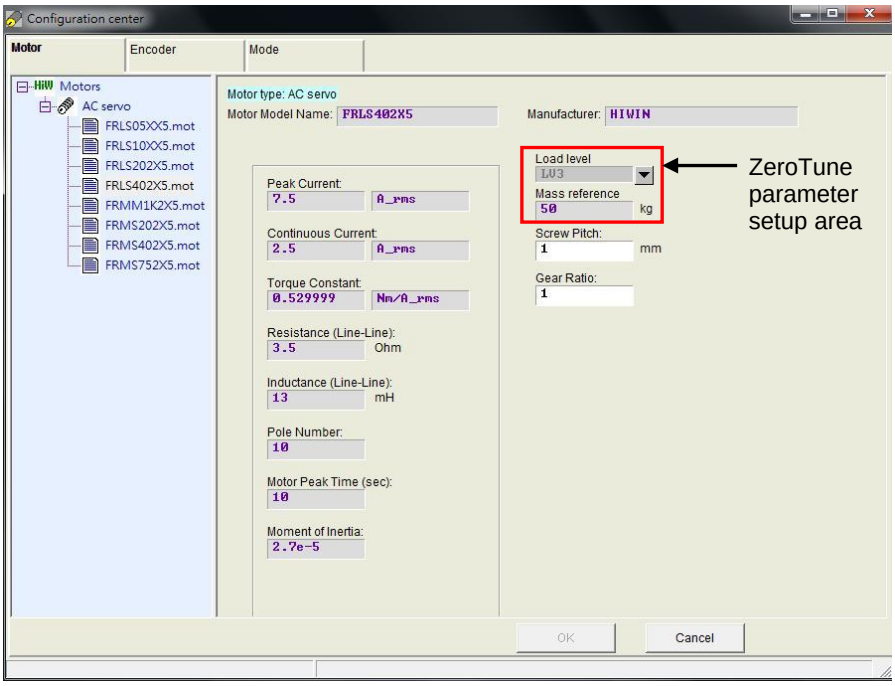


Fig. 4-12 Motor parameter settings for Lightening 0.178 or above

AC servo motor settings

(1) Motor parameters

Click on a HIWIN AC servo motor model. The parameters for the selected motor are displayed and can be set.

(2) Operation parameters

- Screw Moment of Inertia: the rotational inertia of the screw used. Unit: (Kg·m2).
- Load Mass: the mass to be loaded. Unit: Kg.
- Screw Pitch: the pitch of the ball screw (i.e. the linear movement amount of the screw in a revolution). Unit: mm
- Gear Ratio: the ratio of the gear teeth number at the load end to the gear teeth number at the drive end.

(3) ZeroTune parameters

- Servo loop gains can be easily set without complex procedures with this feature. By just selecting load level for a motor, stable velocity response can be achieved. Even beginners with no knowledge about servo control can easily drive a motor.

- Load level: the weight level of load. There are five levels, LV1~LV5. When this parameter shows “Tuned”, it means the gain is not set by ZeroTune, and is modified by Auto tune or manual tune.
- Mass reference: the maximum reference weight corresponding to the selected level. Unit: Kg. Table 4-1 shows the maximum reference weight at the different combination of motor power and load level.

Table 4-1 Mass reference of ZeroTune

Motor power	LV1	LV2	LV3	LV4	LV5
50W,100W	5kg	15kg	30kg	45kg	60kg
200W,400W	10kg	25kg	50kg	75kg	100kg
750W,1KW	20kg	50kg	80kg	110kg	140kg

Setting correct operation parameters for motor helps to calculate suitable values of driving parameters, and thus successfully drive the motor.

4.2.2. Encoder configuration

The drive normally receives a feedback signal from the position encoder to perform servo control. The 13-bit encoder setup page is shown in Fig. 4-13; while The 17-bit encoder setup page is shown in Fig. 4-14. Please select or input the correct type and parameters of the encoder on this page.

Note:

If a HIWIN series AC servo motor is adopted, users just need to select the correct motor model. The program will automatically create a link to the encoder parameters applicable to this motor after the motor model selection.

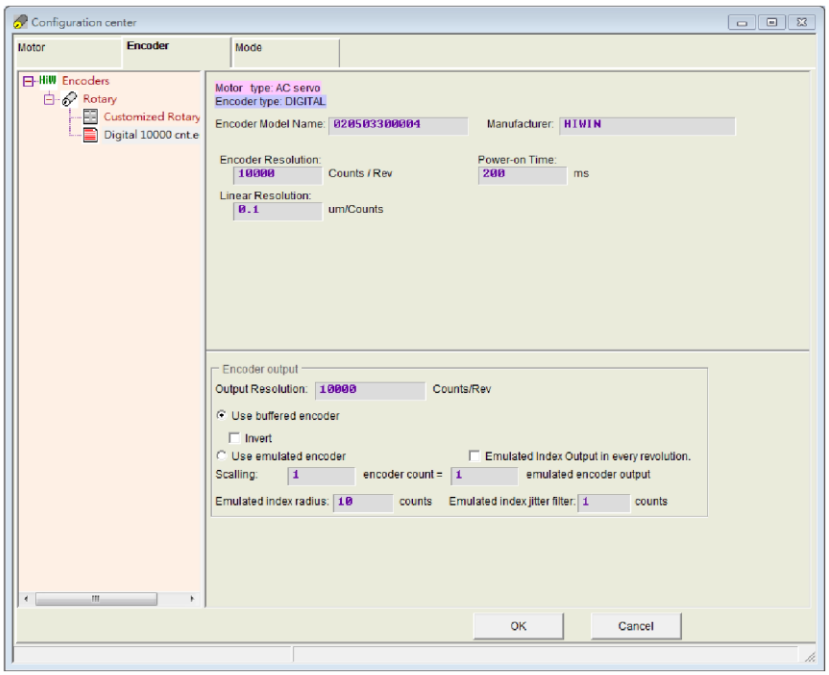


Fig. 4-13 13-bit encoder settings interface

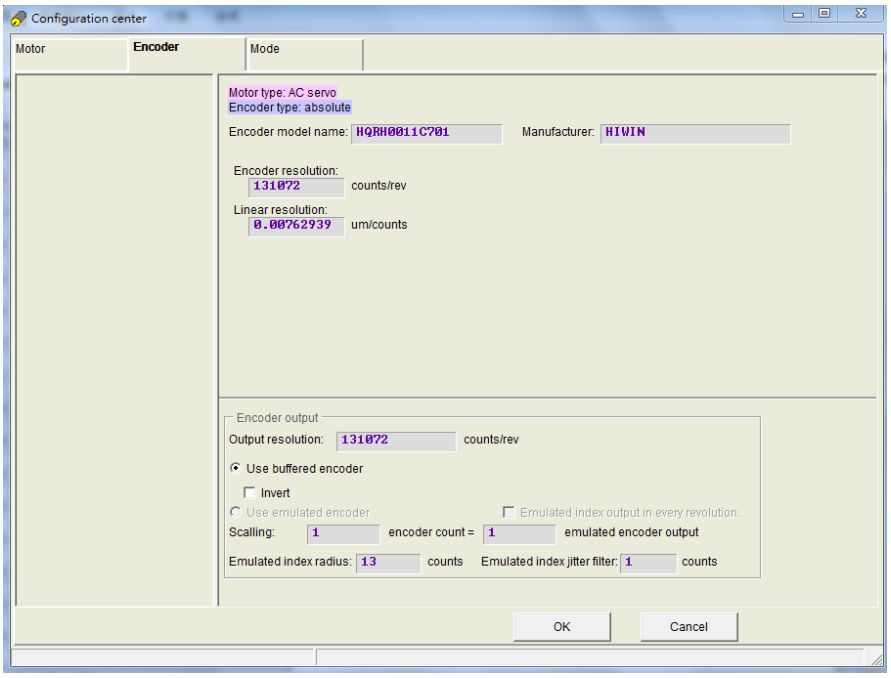


Fig. 4-14 17-bit encoder settings interface

There is a variety of resolution parameters commonly used with HIWIN motor on Encoder settings page. Besides, users can enter parameters for any third-party encoder in the customized settings field on the same page.

4.2.3. Operation mode configuration

The algorithm of tool turret and tool magazine uses PDL with I/O. Hence, the mode should be set to stand-alone mode.

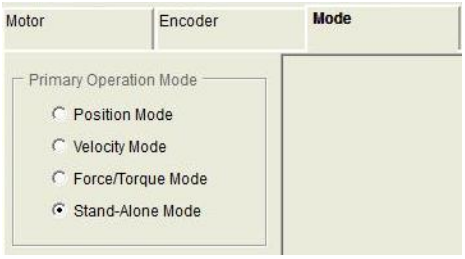


Fig. 4-15 Stand-Alone mode

4.2.4. Completing configuration procedure

After completing four parameter-setting steps above for the motor, encoder, hall sensor and operation mode, click ‘OK’ at the bottom of the screen. A window, as shown in Fig. 4-16, shows the parameters before and after the settings for comparison. After confirming the settings, click ‘Send to RAM’ to send the parameters to the drive. The screen returns to the Configuration Center if ‘Cancel’ is clicked.

Note:

When using a new drive without initialization, the ‘OK’ bottom at the end of configuration center is disabled and cannot be clicked. After motor parameters,

encoder parameters, and operation mode are set, the ‘OK’ bottom becomes enabling and has function.

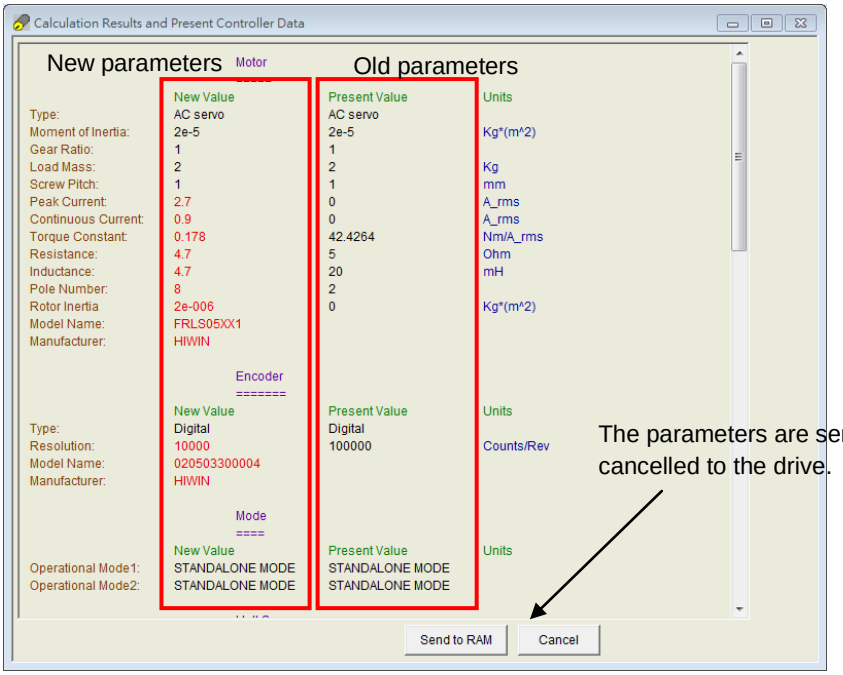


Fig. 4-16 Completion of the configuration procedure

To retain this set of parameters, click (‘Save to Flash’) in the main HMI window to save the parameters in the flash memory. Parameters saved in the flash memory will be retained even if the drive is turned off.

To save the parameters to a file on your PC, click (‘Save Parameters from Amplifier RAM to File’) to save the parameters to a file. The file extension is *.prm.

4.3. Auto phase center

4.3.1. Method overview

Click in the main toolbar of main HMI window to open the auto phase center. The drive provides the following two phase initialization methods.

(1) STABS

This mode is used in the phase initialization of 17-bit serial encoders. I

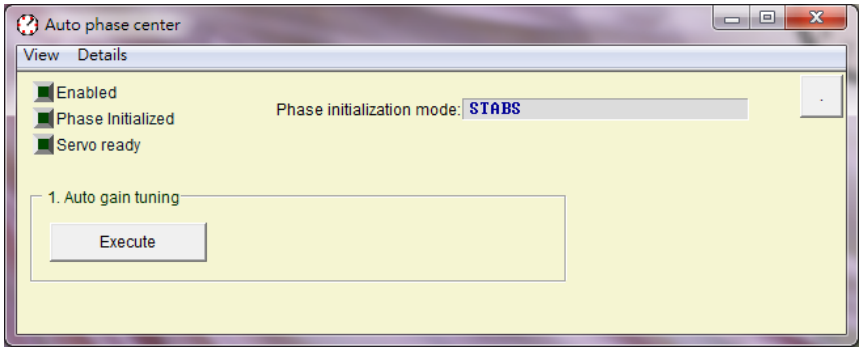


Fig. 4-17 For motors with HIWIN 17 encoder and so on.

(2) LSWIR

This method features a hall sensor built in with the wire-saving incremental encoder.

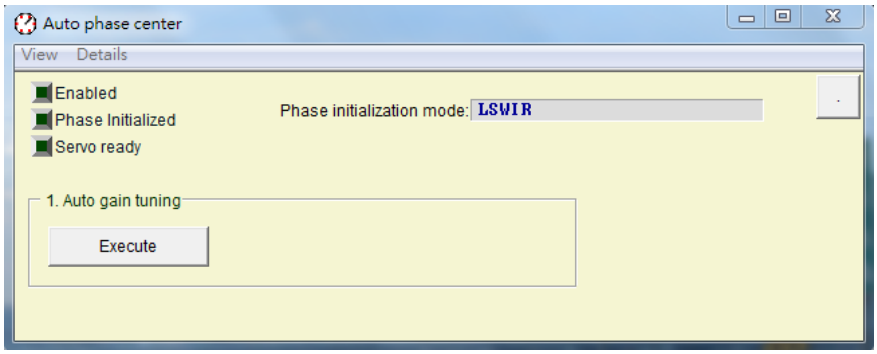


Fig. 4-18 For motors with wire-saving encoder

4.3.2. Pre-operation for phase initialization

※ Confirm the connection to the motor is correct.

※ Confirm the encoder signal is correct.

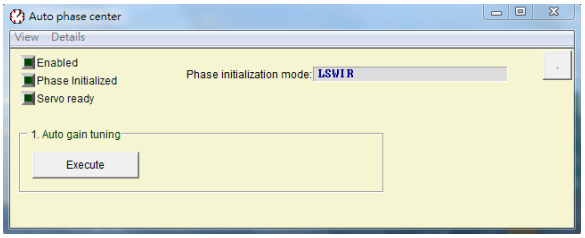
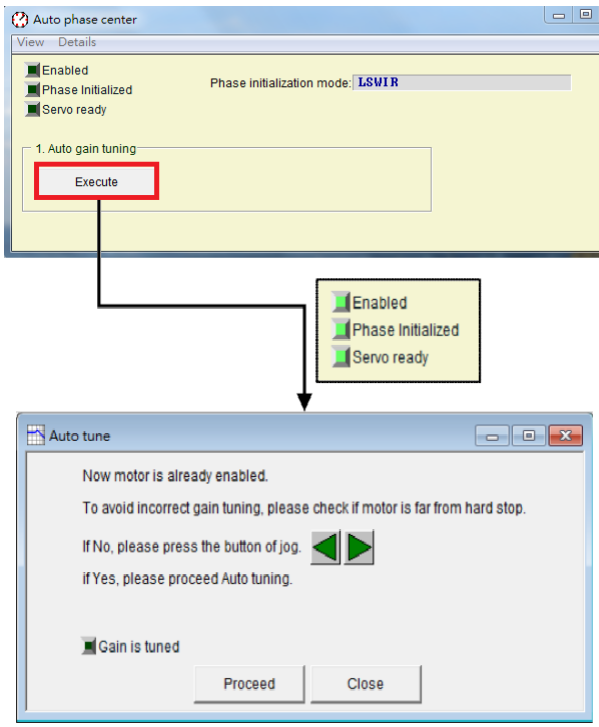
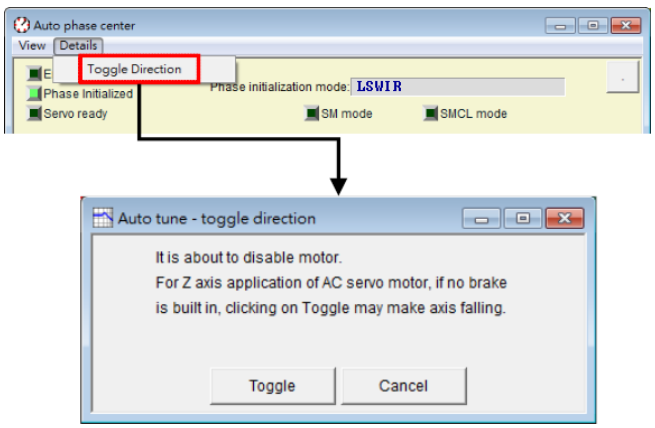
※ Confirm the drive can receive the hardware excitation signal (‘Hardware Enable’)

※ Confirm if the motor overheat signal is connected.

※ Confirm the AC main power has been turned on.

4.3.3. Procedure of phase initialization

In this section, the operational flow of the LSWIR method is given. As for the STABS method, it can use the same flow of the LSWIR.

Step	Graphical (HMI) description	Operation
1		**Phase initialization method:** If user selects that motor of model number ninth digit is 5. Lightening will automatically set LSWIR.
2		**Phase initialization and auto tune:** Click the 'Execute' button, as in the left figure, to start the phase initialization. The 'auto tune' window pops up when the initialization is complete. Use ◀ and ▶ to drive the motor and keep it operating continuously. Confirm that the motor has moved far from the stop. After the motor has moved, click the 'Proceed' button to start the auto tune. Click the 'Close' button to close the window after the tuning has been completed. Now the auto phase initialization is complete and test run functions can be performed. ※ Note: Hardware enable needs to be triggered for this step. ※ Note: Observe whether the Phase Initialized and Servo ready lights are green to check if the phase initialization was executed successfully and if the servo close-loop control is readv. ※ Note: The Gain is tuned status indicator flashes green during the auto gain process. The auto tuning is complete when it is continuously lit green or not continuously lit red. In this case, close the auto tune window and repeat Step 2.
3		If in the previous step, user finds that the positive moving direction is not according to expectation, it is possible to reverse the direction definition. Please use the "Toggle Direction" as shown in the left screen shots, and then carry out the previous step again.

4.4. PDL loading and firmware update

4.4.1. PDL loading

Step 1. Open PDL and click .

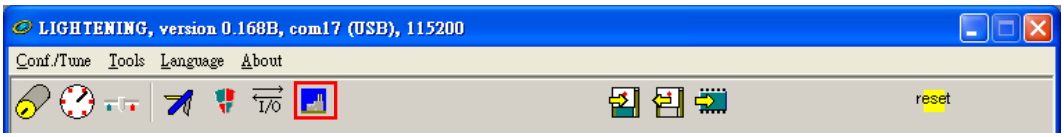


Fig. 4-19

Step 2. Click Edit bottom to open PDL edit page.

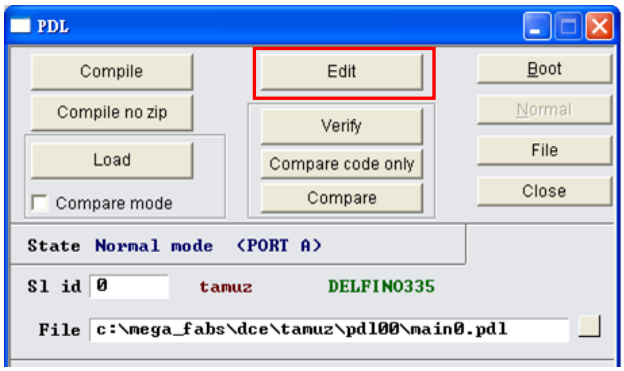


Fig. 4-20

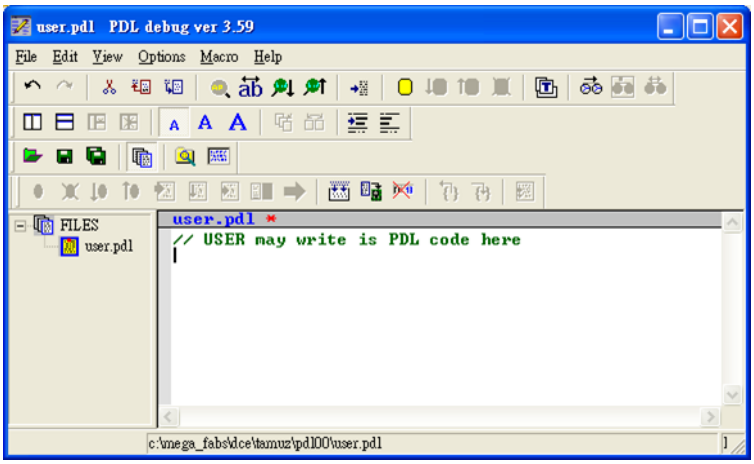


Fig. 4-21

Step 3. After loading PDL program or completing coding, click “Compile” icon ( ). When the compilation is finished, click “Send to slave” bottom and then click “Yes” bottom.

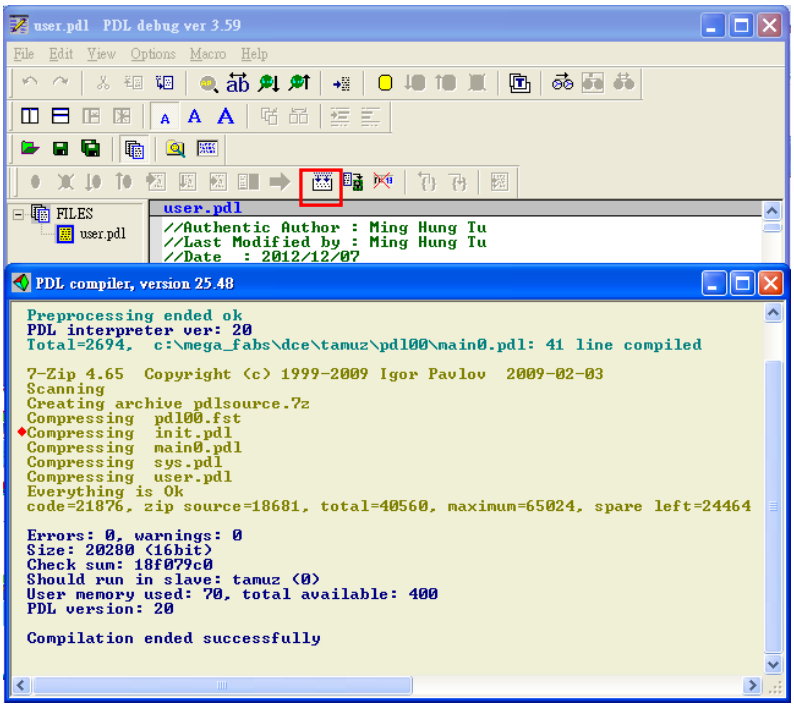


Fig. 4-22

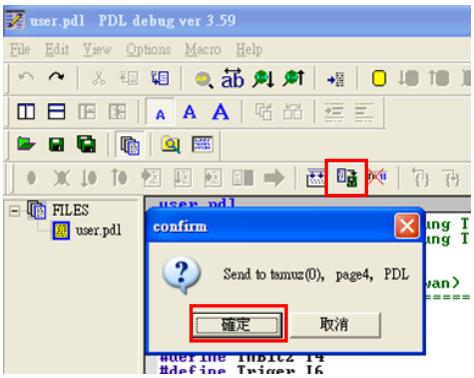


Fig. 4-23

Step 4. After PDL is sent to slave, the following window will close automatically, and the PDL loading is successful.

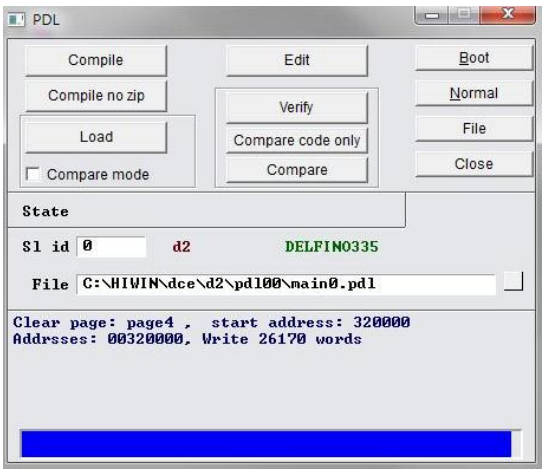


Fig. 4-24

4.4.2. Firmware update

To update the drive's firmware, click "Tools" on the HMI main window and select "Upgrade/Downgrade firmware..." as shown in Fig. 4-25. After clicking "Upgrade/ Downgrade firmware...", the window of "Upgrade/Down grade firmware" will appear, as shown in Fig. 4-26.

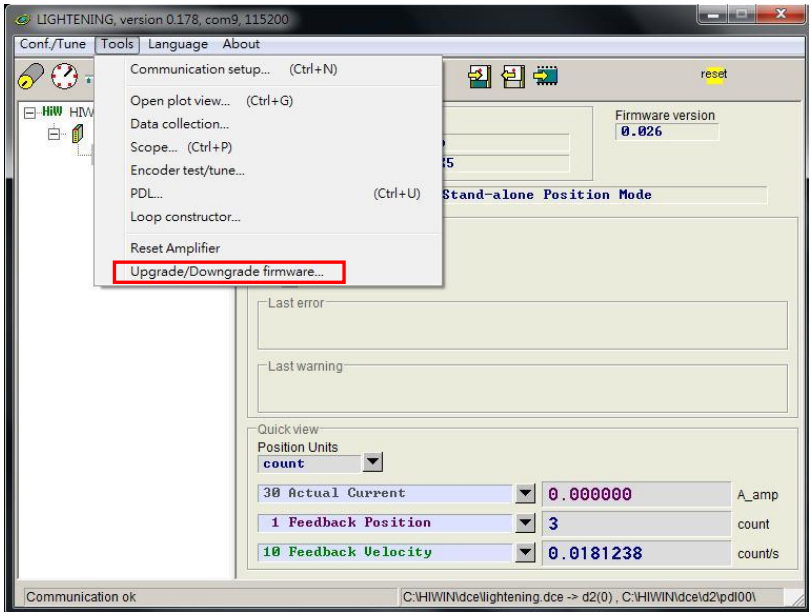


Fig. 4-25

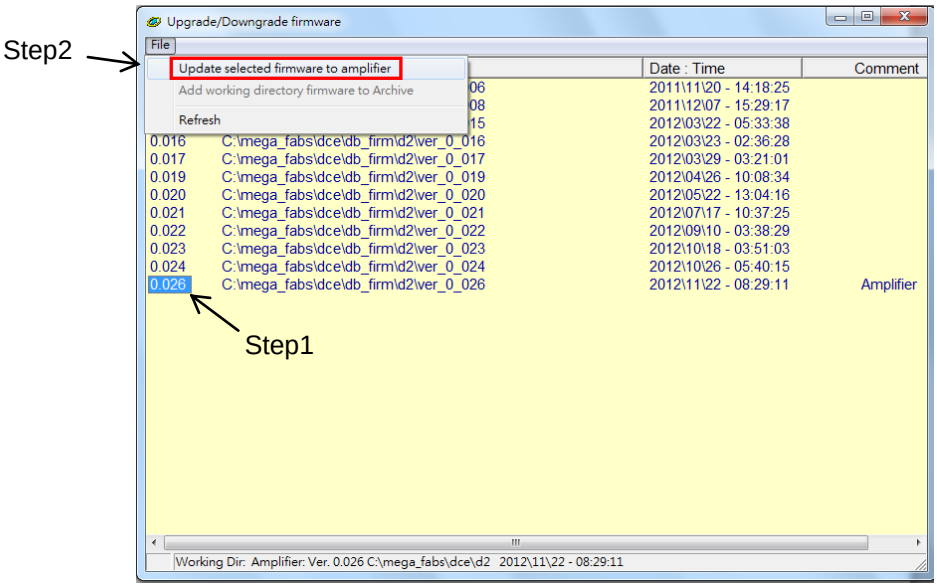


Fig. 4-26 Upgrade/Downgrade firmware

To update the firmware in the window of *Upgrade/Downgrade firmware*, please follow the steps below.

Step 1. Click the left key of mouse on the firmware version, which needs to be updated, and highlight it with white letters on the blue background.

Step 2. Click "File" at the left corner of window and select "Update selected firmware to amplifier" to open a dialog box, as shown in Fig. 4-27.

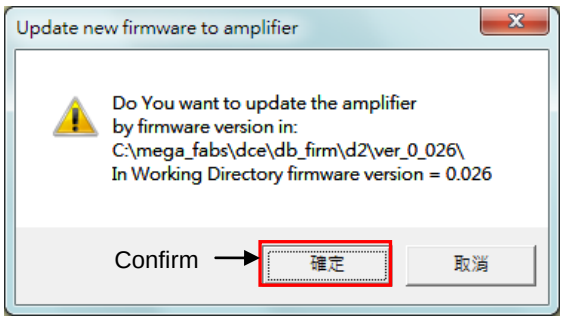


Fig. 4-27

Step 3. Click **Confirm** to open the window of "Auto load programs". The firmware will be loaded to drive automatically, as shown in Fig. 4-28.

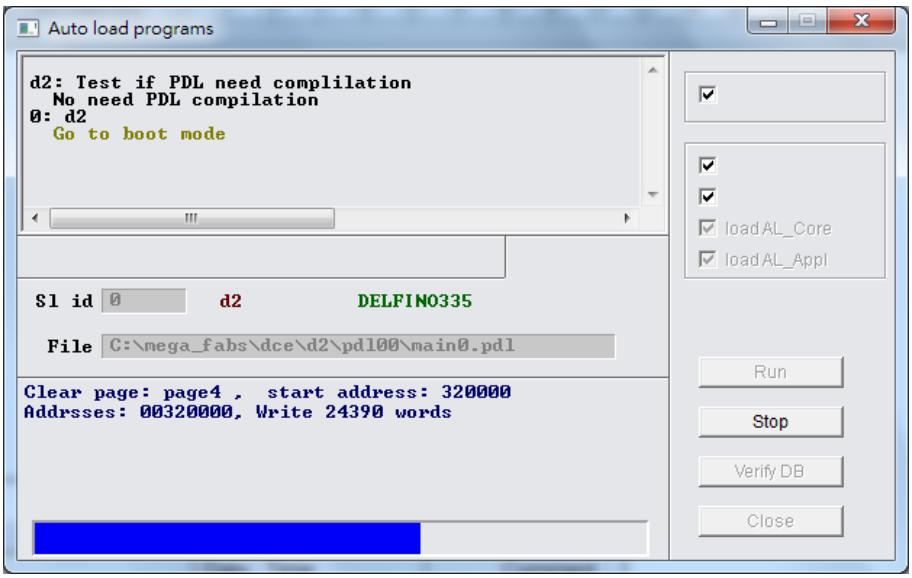


Fig. 4-28

Step 4. After the firmware is updated, the window of Fig. 4-29 appears. Click the **Conform** button.

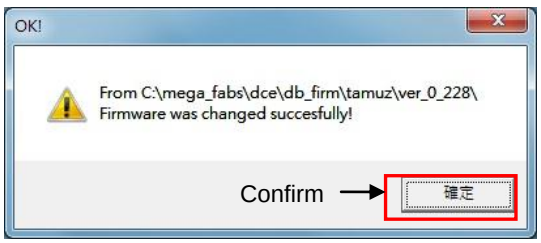


Fig. 4-29

Note: Suppose that the power-off occurs or the communication between PC and drive breaks during the firmware being loaded to drive. After the drive is power-on again or the communication is built again, Lightening will stay at the “Boot mode”, as shown in Fig. 4-30. Please contact the franchised dealer to assist excluded this problem.

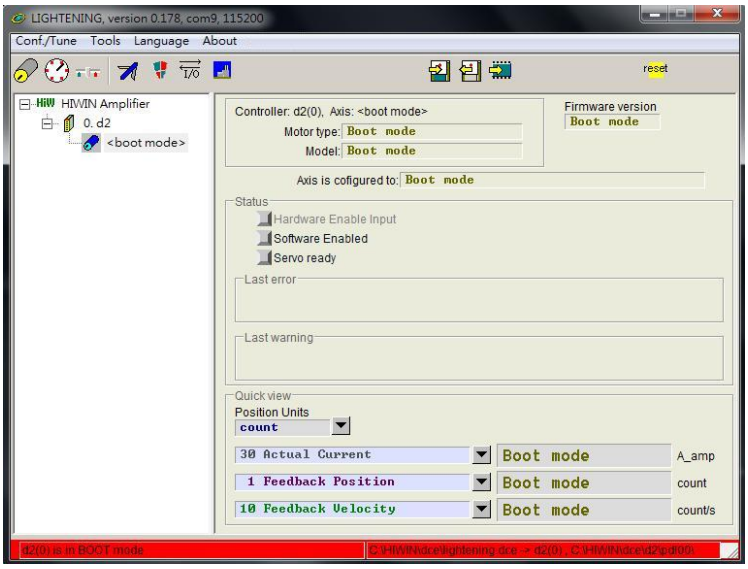
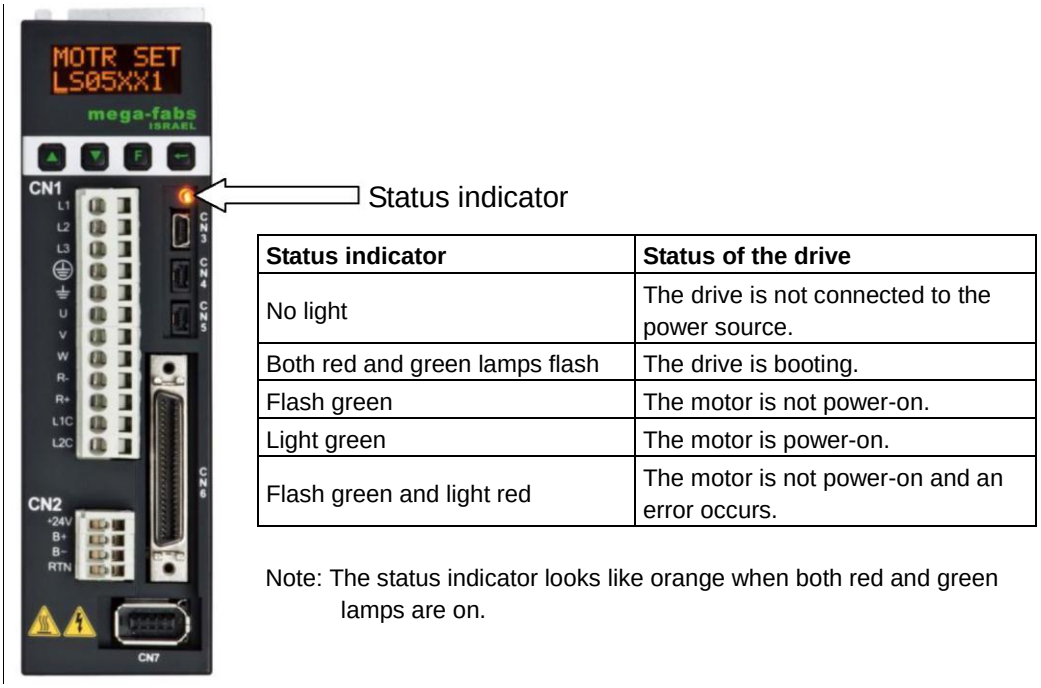


Fig. 4-30

5. Troubleshooting

5.1. Drive status indicators

The status indicator of drive is a LED lamp located at the front panel. It displays the current status of drive. The statuses are described in the table below:



Status indicator	Status of the drive
No light	The drive is not connected to the power source.
Both red and green lamps flash	The drive is booting.
Flash green	The motor is not power-on.
Light green	The motor is power-on.
Flash green and light red	The motor is not power-on and an error occurs.

Note: The status indicator looks like orange when both red and green lamps are on.

Fig. 5-1

5.2. Errors and warnings

5.2.1. Status display area on HMI

When an error is identified, D2 drive will start the protection mechanism and show the message of last error in the “Last error” area, as shown in Fig. 5-2. Users can use this message to adjust and confirm the error of drive. When any incident needs to be warned during the operation, the drive will show the warning message in the “Last warning” area.

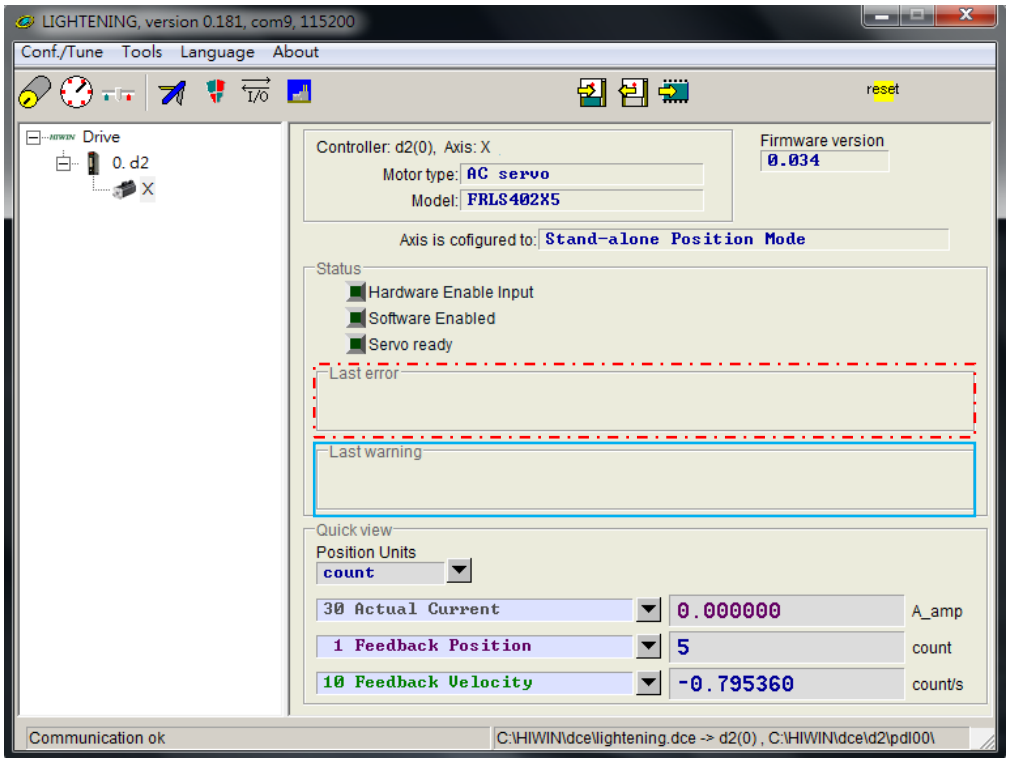


Fig. 5-2 Status display area

5.2.2. Errors and warnings log

When D2 drive detects the identified error or warning, it will store them in the *Errors and Warnings Log*, besides displaying in the error/warning display area on the HMI main screen, as shown in Fig. 5-2. The steps to open the window of *Errors and Warnings Log* are shown in Fig. 5-3.

.

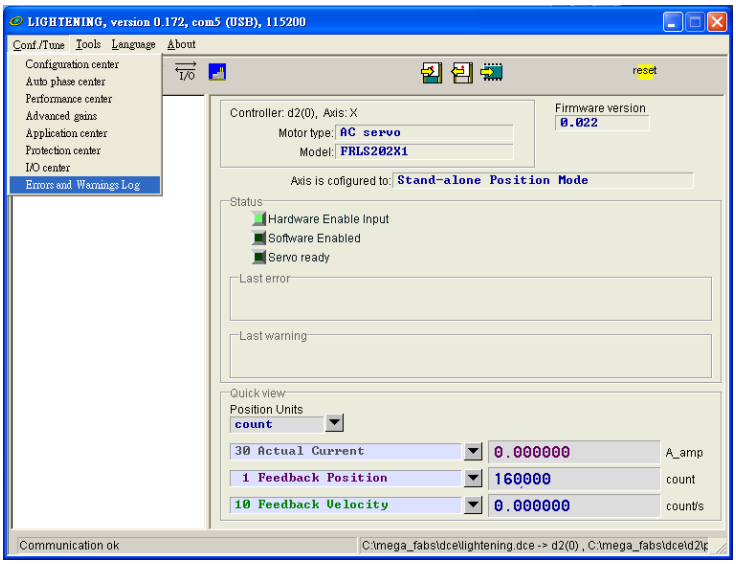


Fig. 5-3 Open the Errors and Warnings Log

Lightening provides this function to prevent that users might lose the displayed error or warning message reported by D2 drive. All error and warning messages occurring after the drive is power-on and the occurring number of them are recorded in the *Errors and Warnings Log*. The time log of the *Errors and Warnings Log* is shown in Fig. 5-4. All occurred errors and warnings are recorded in the "Type of error/warning" column based on the chronological order, and the time of each event is recorded in the "Time (seconds)" column.

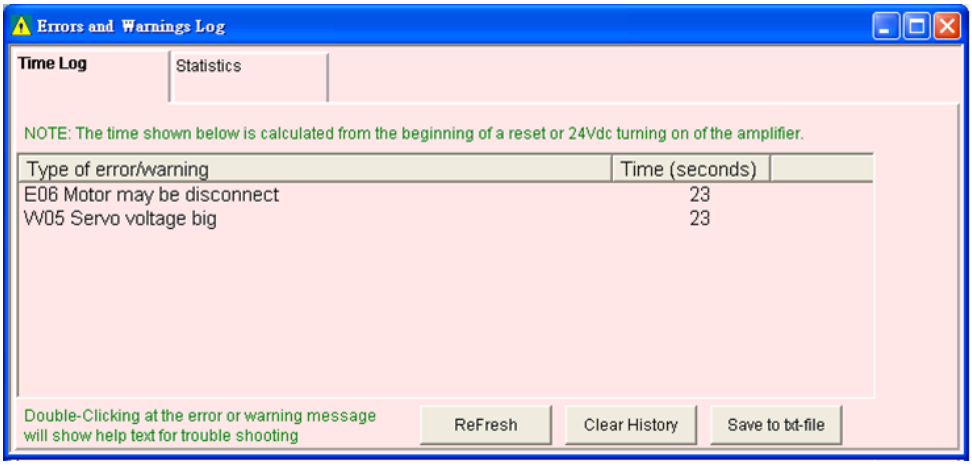


Fig. 5-4 Errors and Warnings Log

The statistics of the *Errors and Warnings Log* is shown in Fig. 5-5. The numbers of the occurred errors and warnings (*Frequency*) are also recorded in this log. With this information, users can understand the occurring frequency of each error and warning, and can take appropriate reactions.

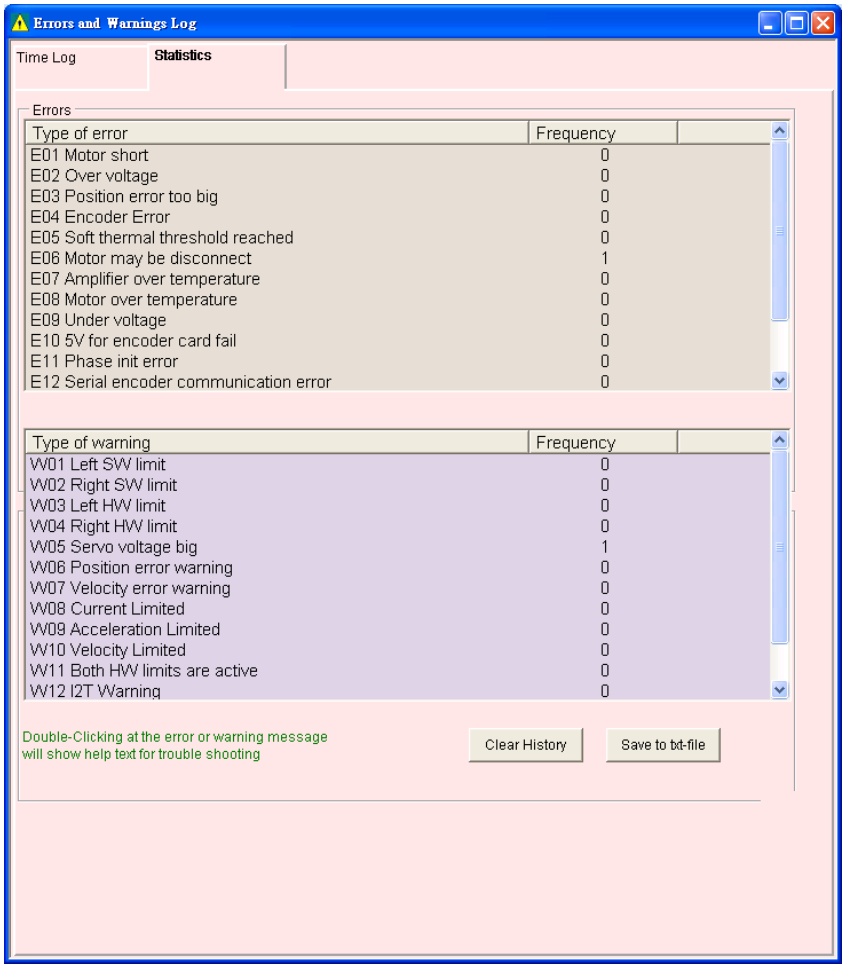


Fig. 5-5 Statistics of the Errors and Warnings Log

If users want to know the content of error or warning event, they can double click the event name of error or warning to get the “Help tips” dialog box, as shown in Fig. 5-6. In this example, click “E06 Motor may be disconnect” to open the dialog box of E06, which shows the possible cause and solution for this error.

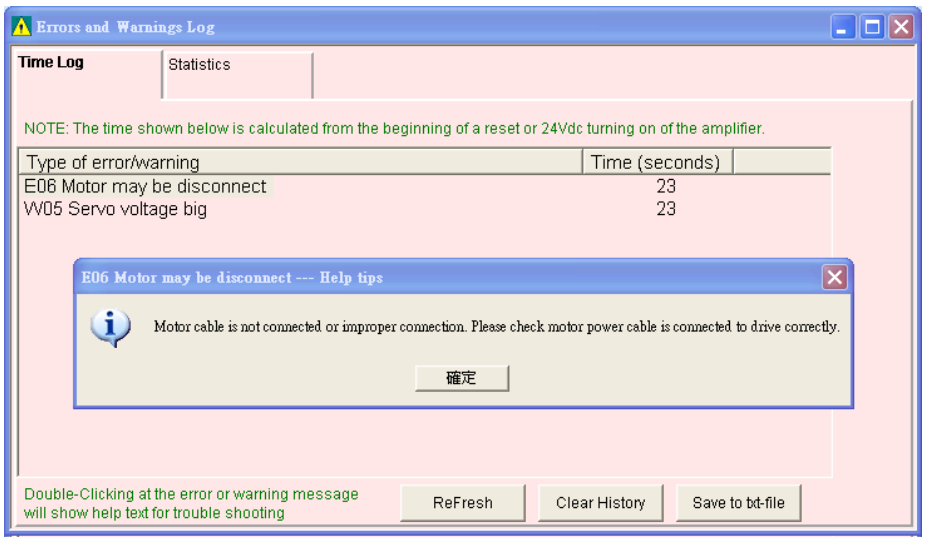


Fig. 5-6 Help tips window of the Errors and Warnings Log

5.3. Error codes and reactions

No.	Errors	LCD error codes	Reactions
1	Motor short (over current) detected	E01 SHORT	Motor power cable short is detected.
			(1) After the power-off, remove the UVW connector at the drive and check whether the short circuit happens between UVW and ground. The motor might be burned out if the short circuit occurs. (2) Measure the resistances between each line of motor's UVW to make sure that they are close to the specification. If the line resistance is much lower than the specifications, the motor might be burned out. (3) Separate the motor from the motor power cable and use a multimeter to check if the motor power cable is short.
2	Over voltage detected	E02 OVERV	DC bus voltage exceeds limit.
			When the motor sustains a heavy load and operates at a high speed, this error may occur if the counter electromotive force exceeds the voltage limit. A regenerative resistor can be used to solve this problem. The used regenerative resistor must conform to the load and motion specifications.
3	Position error too big	E03 PEBIG	Position error exceeds the set maximum position error window.
			(1) The gain is tuned inappropriately. (2) Confirm that Application center-> Protection-> maximum pos error is set appropriately. (3) The motion of motor is obstructed. (4) Check if the load is too heavy. (5) The guideway has not been maintained for a long time. (6) The cable trays are too tight. (7) W05 SVBIG happens continuously before E03 occurs. If the used power is 110 V, please change it to 220 V.
4	Encoder error	E04 ENCOD	Position feedback signal is incorrect or the encoder reports error via its corresponding connection pin.
			(1) Check that all connectors of the encoder are connected firmly. (2) Check that the encoder is wired correctly. (3) If a digital encoder is used, this error may occur due to the external interference. Check that the encoder has an anti-interference twisted wire and shield or is equipped with an iron core.

No.	Errors	LCD error codes	Reactions
5	Soft-thermal threshold reached	E05 SWHOT	Overcurrent protection. (The software detects over-temperature of the motor.)
			(1) Confirm that the continuous current and peak current of motor conforming to the motor's specifications during the motion. (2) The motion of motor is obstructed. (3) This error can be eliminated by resetting and re-enabling the drive, but it may recur if the output current exceeds the specified value due to the load and motion parameters. (4) Reduce the speed, acceleration or deceleration. (5) The motor model name or current parameter of motor is set incorrectly.
6	Motor maybe disconnected	E06 UVWCN	Motor power cable is not connected or improper connection.
			(1) Check that the connector of UVW power cable is connected firmly. (2) Check that the motor model name is set correctly.
7	Amplifier over temperature	E07 D.HOT	Drive exceeds maximum operating temperature.
			(1) Check that the position where the drive is installed is well ventilated. (2) Check that the ambient air temperature is not too high. (3) Wait for the down of the temperature inside the drive. (4) The load is too heavy or the operation cycle of drive is too high. A cooling fin can be mounted if needed.
8	Under voltage detected	E09 UND.V	The input voltage of AC main power is too low.
			Confirm that the L1 and L2 of drive are connected to a 100 or 220 Vac power source. Use a multimeter to make sure that there is a 100 or 220 Vac power input.
9	5V for encoder card fail	E10 V5ERR	False 5V dc power to encoder.
			(1) Remove the connectors of CN6, CN7, and motor power cable from D2 drive. Check whether E10V5ERR still occurs or not. If yes, please contact the manufacturer to repair and check. If no, please check if the short circuit happens and modify the wiring. (2) Do not hot-plug CN6 and CN7 connectors of D2 drive.
10	Phase initialization error	E11 PHINI	Motor phase initialization error. The 17-bit encoder cable is connected to the motor with 13-bit encoder.
			(1) Check that the UVW motor power cable is connected to the drive. (2) Check that the encoder cable is connected to the drive.

No.	Errors	LCD error codes	Reactions
11	Serial Encoder Communication Error	E12 SER.E	Serial encoder communication error. (1) Check that the encoder cable is connected to drive. (2) Check that the encoder cable conforms to the specification of motor.
12	Hall sensor error	E13 HAL.E	Hall signal of wire-saving encoder fails. Check that the encoder cable is connected to the drive correctly.
13	Current control error	E15 CURER	The control of current loop is incorrect. Please check whether motor model is set correctly, the gain of the current loop (Kp) is properly set, the CG is properly set, and the encoder wire is installed well.
14	Hybrid deviation too big	E17 HYBDV	Under dual loop control architecture, hybrid deviation exceeds the threshold. Please check whether linear encoder parameter is correct, the directions of the linear and the rotary encoder are matching, or the linear encoder has noise problems. Please check if the coupling and the gear are installed well, or the pitch tolerance and the backlash of the screw are small enough.
15	HFLT inconsistent error	E19 HFLT	The drive fault signals are inconsistent. Please check the grounding.

5.4. Warning codes and reactions

No.	Errors	LCD error codes	Reactions
1	Left SW limit	W01 SWLL	Motor reached left software limit position and is prohibited to move further toward left direction.
2	Right SW limit	W02 SWRL	Motor reached right software limit position and is prohibited to move further toward right direction.
3	Left HW limit	W03 HWLL	Left hardware limit switch is triggered and motor is prohibited to move further toward left direction (1) If the erroneous trigger occurs without any connection from hardware limit to drive. It is recommended to disable the hardware limit function. (2) If the hardware limit is not triggered, please check connection and whether activation logic is correct.
4	Right HW limit	W04 HWRL	Right hardware limit switch is triggered and motor is prohibited to move further toward right direction. (1) If the erroneous trigger occurs without any connection from hardware limit to drive. It is recommended to disable the hardware limit function. (2) If the hardware limit is not triggered, please check connection and whether activation logic is correct.
5	Servo voltage big	W05 SVBIG	The PWM output of drive exceeds the limit and the current output cannot be increased any more. The error code E03 PEBIG will happen if this warning occurs repeatedly under the position control. (1) Change the power source to 220 V if 110 V is used currently. (2) Decrease the speed, acceleration or deceleration.
6	Position error warning	W06 PE	Position error exceeds the set position error warning window. (1) Check if common gain is properly tuned. (2) Check if the warning window is not set too small. (3) When the motor is not implemented lubrication beyond the maintenance period, it may also cause this phenomenon.
7	Velocity error warning	W07 VE	Velocity error exceeds the set velocity error warning window. (1) Check if common gain is properly tuned. (2) Check if the warning window is not set too small. (3) When the motor is not implemented lubrication beyond the maintenance period, it may also cause this phenomenon.

No.	Errors	LCD error codes	Reactions
8	Current Limited	W08 CUR.L	The current has been saturated and reaches the peak current of motor. If this warning occurs repeatedly, E05 SWHOT may occur.
			(1) Decrease the speed, acceleration or deceleration. (2) Reduce the load.
9	Acceleration Limited	W09 ACC.L	The motor has reached the protection setting value of acceleration when it operates at the position or velocity mode.
			To increase the acceleration, set a higher protection value for acceleration or deceleration.
10	Velocity Limited	W10 VEL.L	The motor has reached the protection setting value of velocity when it operates at the velocity or torque mode.
			To increase the velocity, set a higher protection value for velocity.
11	Both HW limits active	W11 BOTH	Both left and right hardware limits have been triggered.
			(1) If the erroneous trigger occurs without any connection from hardware limit to drive. It is recommended to disable the hardware limit function. (2) If the hardware limit is not triggered, please check connection and whether activation logic is correct.
12	Homing fail	W13 HOM.E	Homing fails.
			(1) Check if left and right limit sensors, near home sensor, and index signal are installed correctly. (2) Check if values of time out and search end stop current are set well.
13	Pulse command and homing conflict	W14 HOM.C	Under position mode, the command conflict occurs when the drive is simultaneously receiving pulse command and homing.
			Please do not send pulse command and start the built-in homing feature at the same time.
14	Absolute encoder battery warning	W15 BAT.E	The absolute encoder battery voltage is too low. Please replace the battery.
15	Wrong absolute position	W16 ABS.W	The absolute position is wrong from the encoder. Please reset the home position.
			Please to check the statues of encoder battery.

6.Specifications & Accessories

6.1. Part numbers

Table 6-1 Part numbers

	Motor	Drive
50W	FRLS052□5XX△	D2-0123-S-A0
	FRLS052□4XX△	D2T-0123-S-A5
	FRLS052□4XX△	D2T-0123-K-A5
100W	FRLS102□5XX△	D2-0123-S-A0
	FRLS102□4XX△	D2T-0123-S-A5
	FRLS052□4XX△	D2T-0123-K-A5
200W	FRLS202□5XX△	D2-0423-S-B0
	FRLS202□4XX△	D2T-0423-S-B5
	FRLS052□4XX△	D2T-0423-K-B5
400W	FRLS402□5XX△	D2-0423-S-B0
	FRLS402□4XX△	D2T-0423-S-B5
	FRLS052□4XX△	D2T-0423-K-B5
750W	FRLS752□5XX△	D2-1023-S-C0
	FRLS752□4XX△	D2T-1023-S-C5
	FRLS052□4XX△	D2T-1023-K-C5
1KW	FRLS1K2□5XX△	D2-1023-S-C0
	FRLS1K2□4XX△	D2T-1023-S-C5
	FRLS052□4XX△	D2T-1023-K-C5

Note：

(1) The 9-bit of motor model name denotes encoder type, where 5 is for 13-bit incremental encoder and 4 is for 17-bit absolute encoder.

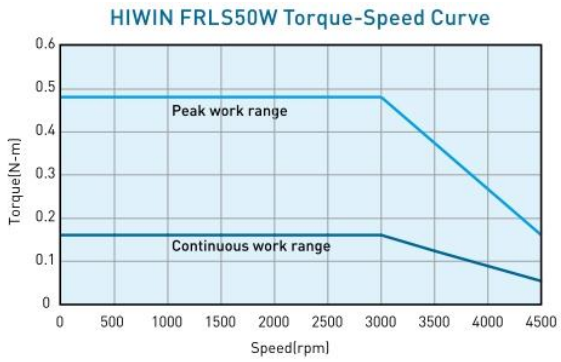
(2) In the motor model name, □ is for brake option, XX is for frame size, and △ is for shaft specification.

6.2. Motor specifications

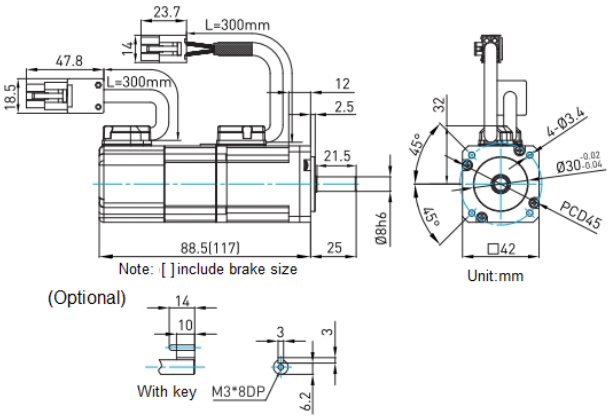
■ AC 50W (low inertia and small capacity)

Motor parameter	Symbol	Unit	FRLS052□□A4□
Drive input voltage	V	V	AC 220
Rated power	W	W	50
Rated torque	T_c	N.m	0.16
Rated current	I_c	A (rms)	0.9
Peak max. torque	T_p	N.m	0.48
Peak max. current	I_p	A (rms)	2.7
Rated speed	ω_c	rpm	3000
No load max. speed	ω_p	rpm	4500
Torque constant	K_t	N.m / A_{rms}	0.178
Back EMF constant	K_e	V_{rms} / k_{rpm}	10.74
Resistance (line to line)	R	Ω	4.7
Inductance (line to line)	L	mH	4.7
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	0.02 (0.022)
Weight (with brake)	M	kg	0.45 (0.58)
Motor insulation grade	Class A (UL)		
Motor protection	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Insulation resistance	10 MΩ, DC 500V		
Insulation strength	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	0.3
Brake exciting current	A_b	A	0.25
Brake voltage	V	V	DC 24 ± 10%
Brake pull-in time (max.)	t_o	ms	30
Brake release time (max.)	t_r	ms	20

■ Torque-Speed Curve



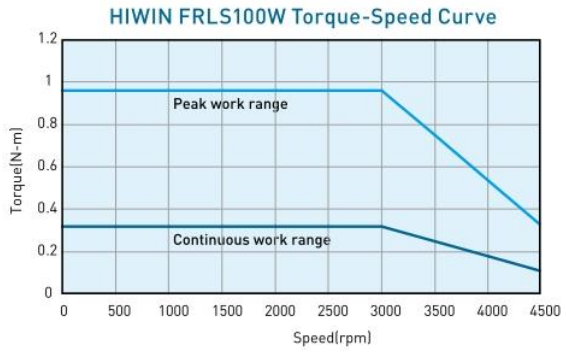
■ Dimensions



■ AC 100W (low inertia and small capacity)

Motor parameter	Symbol	Unit	FRLS102□□A4□
Drive input voltage	V	V	AC 220
Rated power	W	W	100
Rated torque	T_c	N.m	0.32
Rated current	I_c	A (rms)	0.9
Peak max. torque	T_p	N.m	0.96
Peak max. current	I_p	A (rms)	2.7
Rated speed	ω_c	rpm	3000
No load max. speed	ω_p	rpm	4500
Torque constant	K_t	N.m / A_{rms}	0.356
Back EMF constant	K_e	V_{rms} / k_{rpm}	21.98
Resistance (line to line)	R	Ω	8
Inductance (line to line)	L	mH	8.45
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	0.036 (0.038)
Weight (with brake)	M	kg	0.63 (0.76)
Motor insulation grade	Class A (UL)		
Motor protection	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Insulation resistance	10 MΩ, DC 500 V		
Insulation strength	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	0.3
Brake exciting current	A_b	A	0.25A
Brake voltage	V	V	DC24±10%
Brake pull-in time (max.)	t_o	ms	30
Brake release time (max.)	t_r	ms	20

■ Torque-Speed Curve



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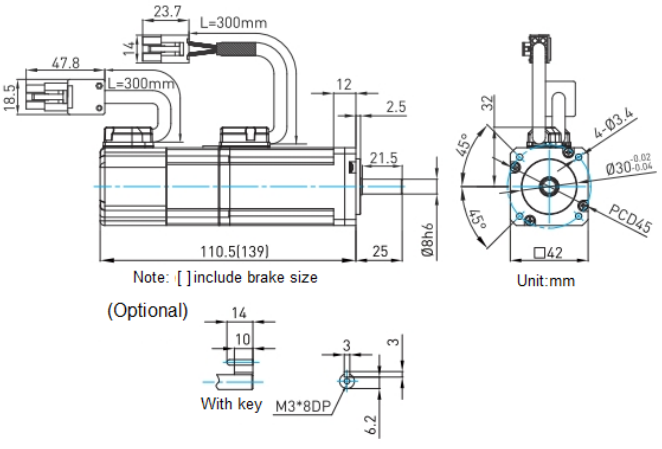
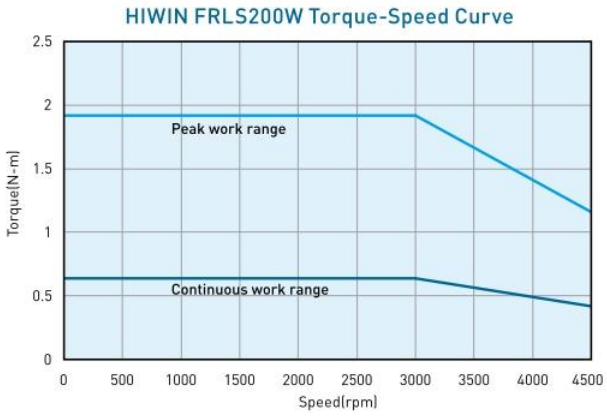


■ AC 200W (low inertia and small capacity)

Motor parameter	Symbol	Unit	FRLS202□□06□
Drive input voltage	V	V	AC 220
Rated power	W	W	200
Rated torque	T_c	N.m	0.64
Rated current	I_c	A (rms)	1.7
Peak max. torque	T_p	N.m	1.92
Peak max. current	I_p	A (rms)	5.1
Rated speed	ω_c	rpm	3000
No load max. speed	ω_p	rpm	4500
Torque constant	K_t	N.m / A_{rms}	0.38
Back EMF constant	K_e	V_{rms} / k_{rpm}	23
Resistance (line to line)	R	Ω	4.3
Inductance (line to line)	L	mH	13
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	0.17 (0.21)
Weight (with brake)	M	kg	0.95 (1.5)
Motor insulation grade	Class A (UL)		
Motor protection	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Insulation resistance	10 MΩ, DC 500V		
Insulation strength	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	1.3
Brake exciting current	A_b	A	0.32
Brake voltage	V	V	DC 24 ± 10%
Brake pull-in time (max.)	t_o	ms	30
Brake release time (max.)	t_r	ms	20

■ Torque-Speed Curve



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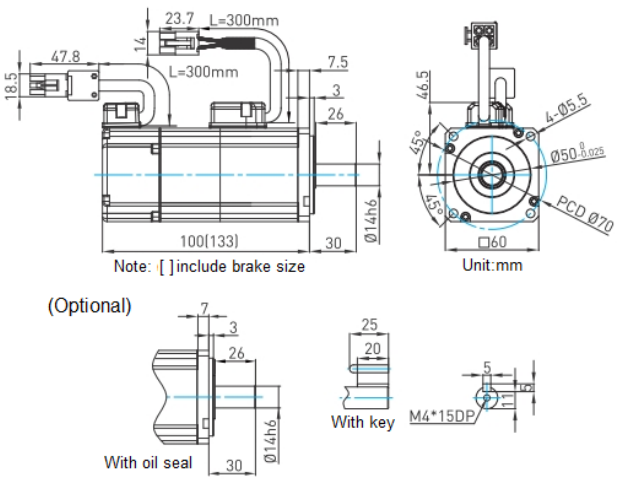
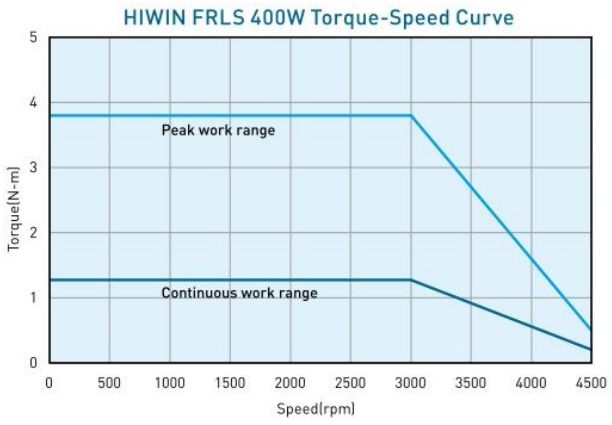


■ AC 400W (low inertia and small capacity)

Motor parameter	Symbol	Unit	FRLS402□□06□
Drive input voltage	V	V	AC 220
Rated power	W	W	400
Rated torque	T_c	N.m	1.27
Rated current	I_c	A (rms)	2.5
Peak max. torque	T_p	N.m	3.81
Peak max. current	I_p	A (rms)	7.5
Rated speed	ω_c	rpm	3000
No load max. speed	ω_p	rpm	4500
Torque constant	K_t	N.m / A_{rms}	0.51
Back EMF constant	K_e	V_{rms} / k_{rpm}	31.9
Resistance (line to line)	R	Ω	3.5
Inductance (line to line)	L	mH	13
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	0.27 (0.31)
Weight (with brake)	M	kg	1.31(1.86)
Motor insulation grade	Class A (UL)		
Motor protection	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Insulation resistance	10 MΩ, DC 500V		
Insulation strength	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	1.3
Brake exciting current	A_b	A	0.32
Brake voltage	V	V	DC 24 ± 10%
Brake pull-in time (max.)	t_o	ms	30
Brake release time (max.)	t_r	ms	20

■ Torque-Speed Curve



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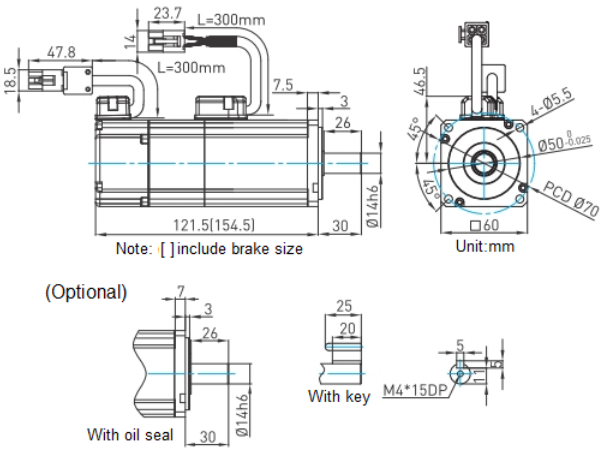
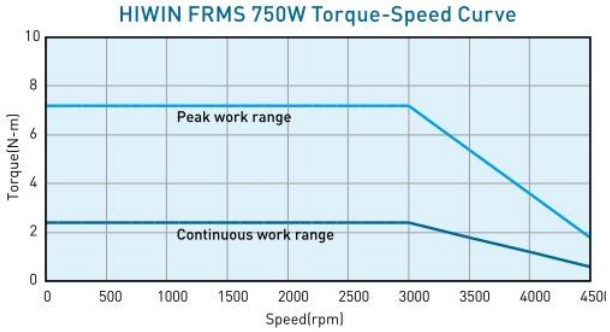


■ AC 750W (medium inertia and small capacity)

Motor parameter	Symbol	Unit	FRMS752□□08□
Drive input voltage	V	V	AC 220
Rated power	W	W	750
Rated torque	T_c	N.m	2.4
Rated current	I_c	A (rms)	5.1
Peak max. torque	T_p	N.m	7.2
Peak max. current	I_p	A (rms)	15.3
Rated speed	ω_c	rpm	3000
No load max. speed	ω_p	rpm	4500
Torque constant	K_t	N.m / A_{rms}	0.47
Back EMF constant	K_e	V_{rms} / k_{rpm}	28.4
Resistance (line to line)	R	Ω	0.813
Inductance (line to line)	L	mH	3.4
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	1.4 (1.46)
Weight (with brake)	M	kg	2.66 (3.32)
Motor insulation grade	Class A (UL)		
Motor protection	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Insulation resistance	10 MΩ, DC 500V		
Insulation strength	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	2.4
Brake exciting current	A_b	A	0.358
Brake voltage	V	V	DC 24 ± 10%
Brake pull-in time (max.)	t_o	ms	45
Brake release time (max.)	t_r	ms	10

■ Torque-Speed Curve



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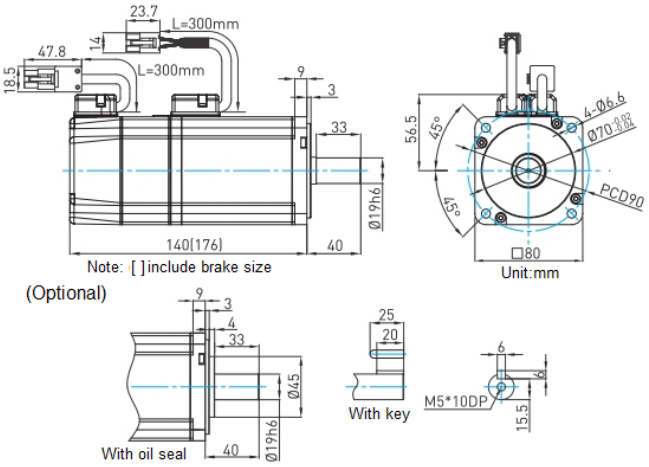
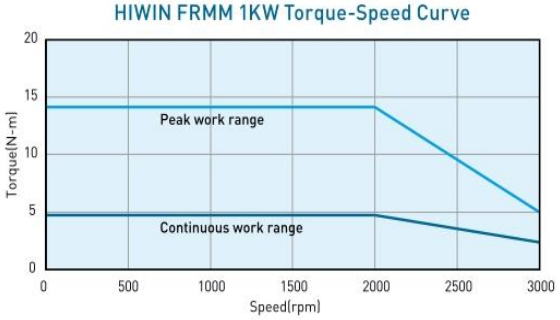


■ AC 1KW (medium inertia and medium capacity)

Motor parameter	Symbol	Unit	FRMM1K2□□13□
Drive input voltage	V	V	AC 220
Rated power	W	W	1000
Rated torque	T_c	N.m	4.77
Rated current	I_c	A (rms)	5.1
Peak max. torque	T_p	N.m	14.3
Peak max. current	I_p	A (rms)	15.3
Rated speed	ω_c	rpm	2000
No load max. speed	ω_p	rpm	3000
Torque constant	K_t	N.m / A_{rms}	0.94
Back EMF constant	K_e	V_{rms} / k_{rpm}	54.7
Resistance (line to line)	R	Ω	0.81
Inductance (line to line)	L	mH	8
Inertia of rotating parts (with brake)	J	kg-m^2($\times10^{-4}$)	7.6 (8.7)
Weight (with brake)	M	kg	5.4 (6.2)
Inertia of rotating parts (with brake)	Class A (UL)		
Weight (with brake)	Total enclosed, self-cooled, IP65 (Except for shaft and connector)		
Motor insulation grade	10 MΩ, DC 500V		
Motor protection	AC1500V, 60 sec		
Brake specifications			
Brake keep torque (min.)	T_b	N.m	10
Brake exciting current	A_b	A	0.56
Brake voltage	V	V	DC 24 ± 10%
Brake pull-in time (max.)	t_o	ms	80
Brake release time (max.)	t_r	ms	30

■ Torque-Speed Curve



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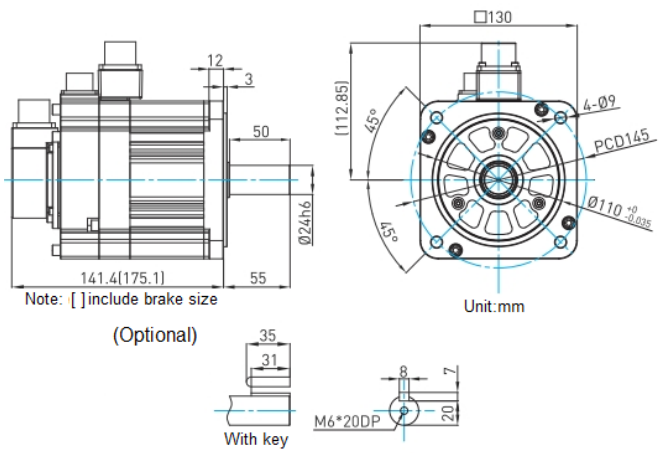


6.3. Drive dimensions

■ **A frame [D2(T)-01□□-S-A□]**

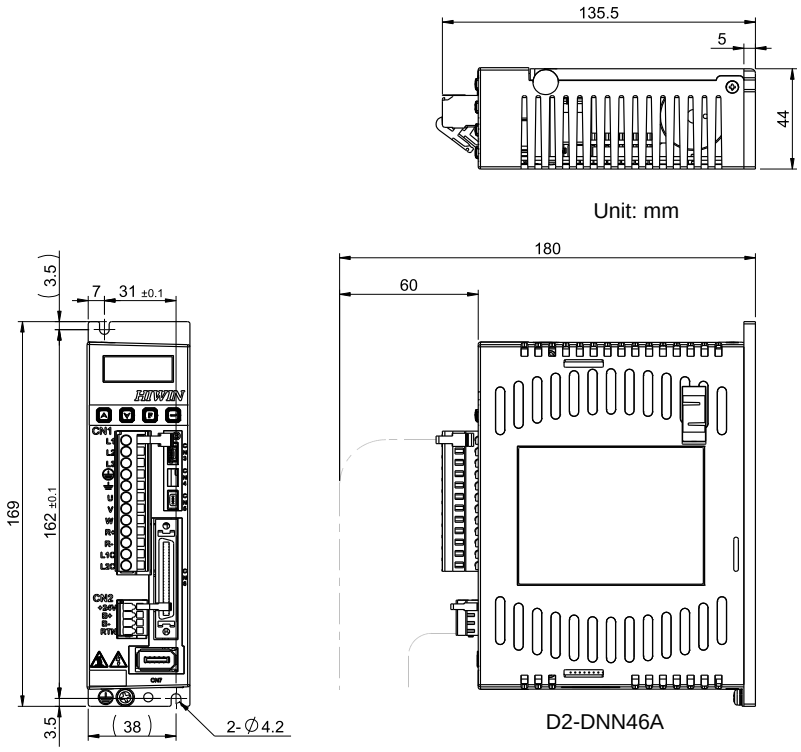


Fig. 6-1

■ **B frame [D2(T)-04□□-S-B□]**

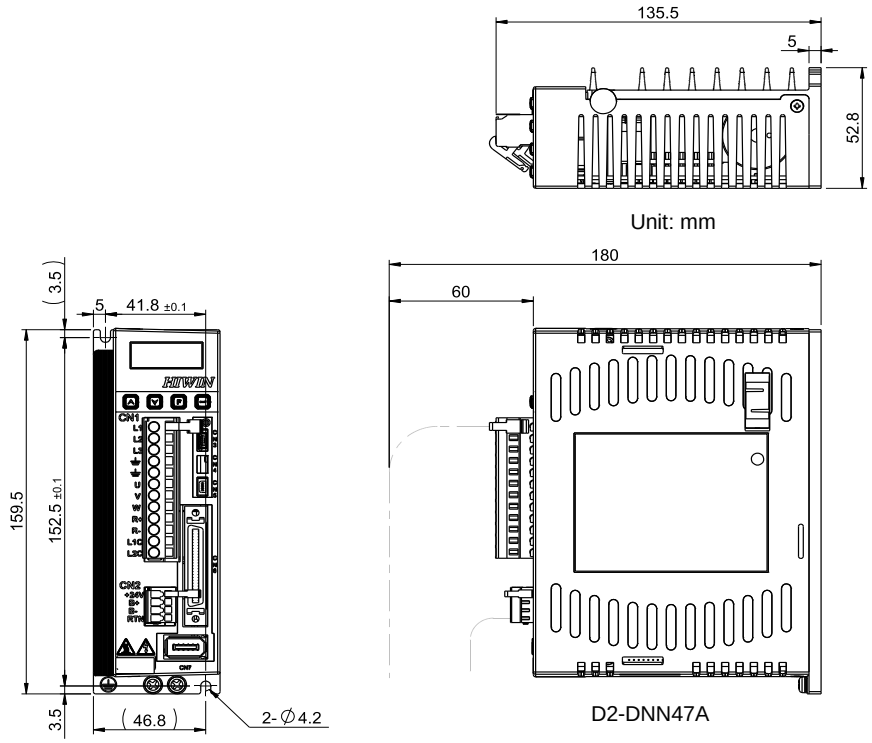


Fig. 6-2

■ C frame [D2(T)-10□□-S-C□]

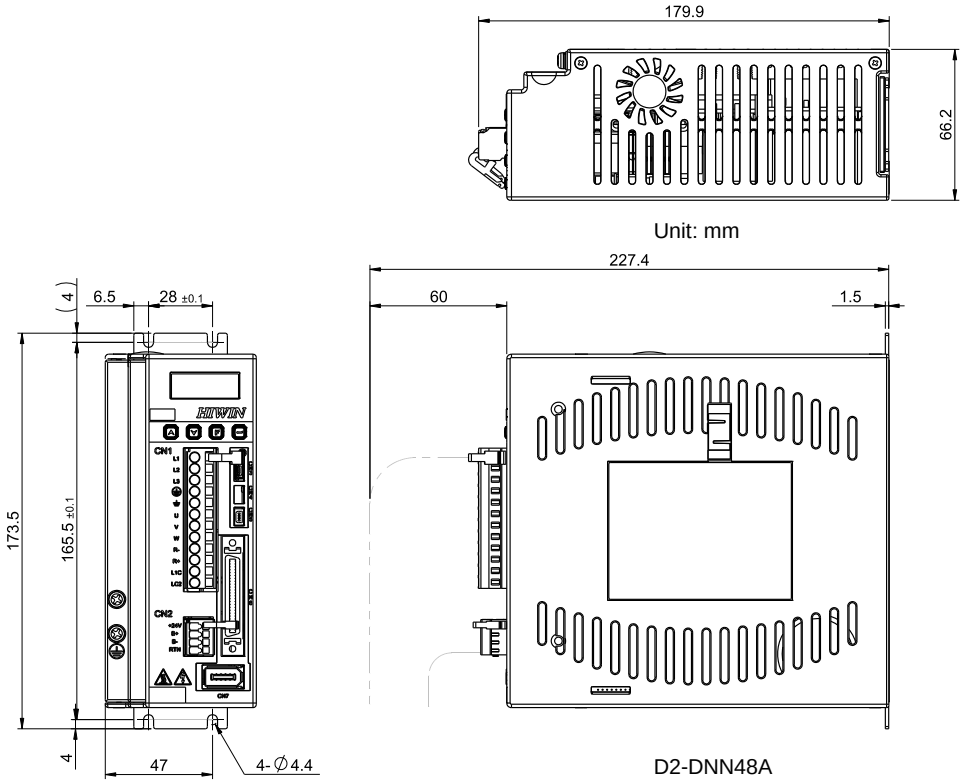


Fig. 6-3

■ A frame with external I/O [D2T-01□□-K-A□]

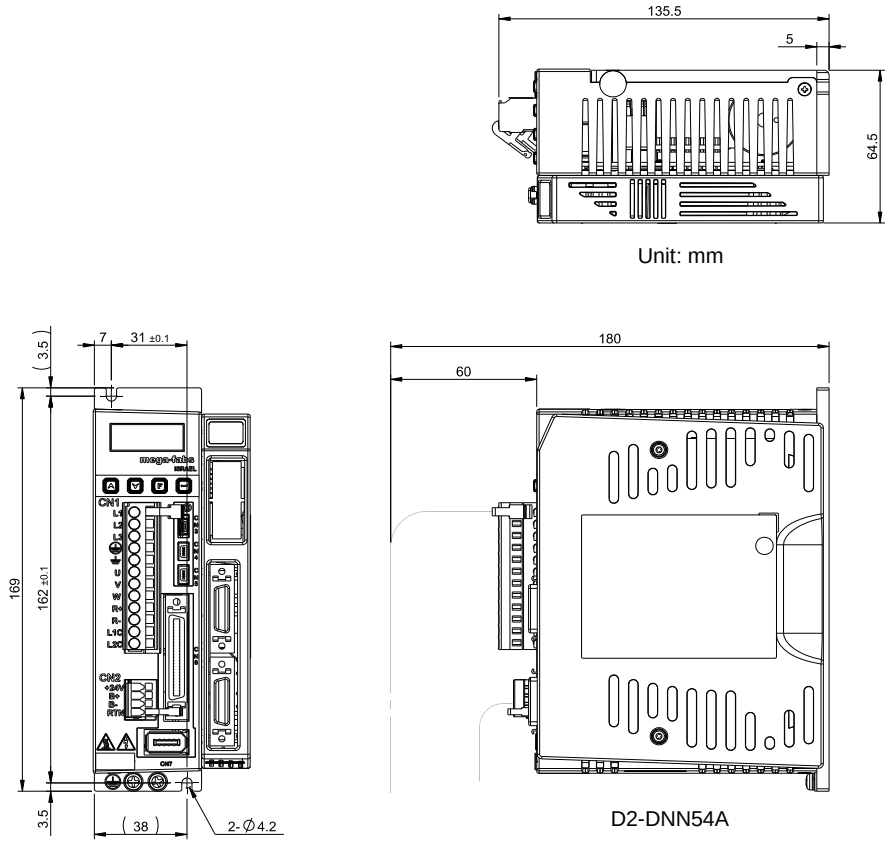
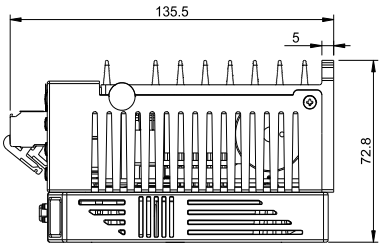
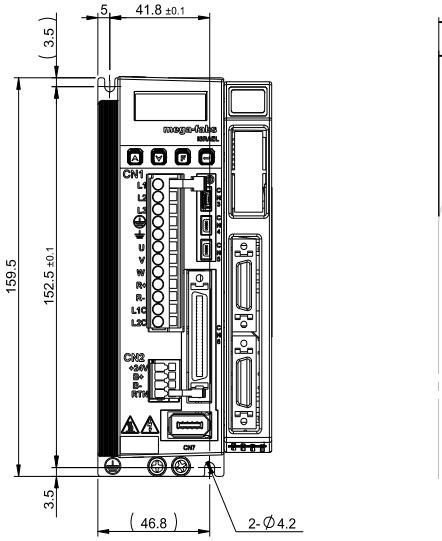


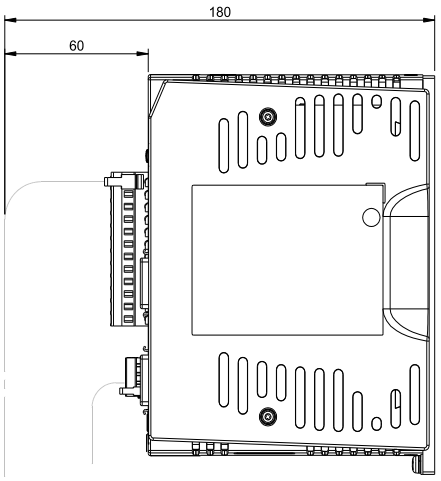
Fig. 6-4

■ B frame with external I/O [D2T-04□□-K-B□]



Unit: mm

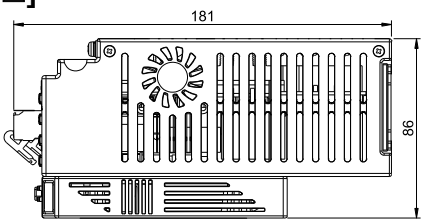




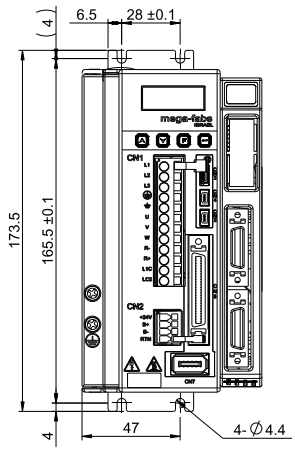
D2-DNN55A

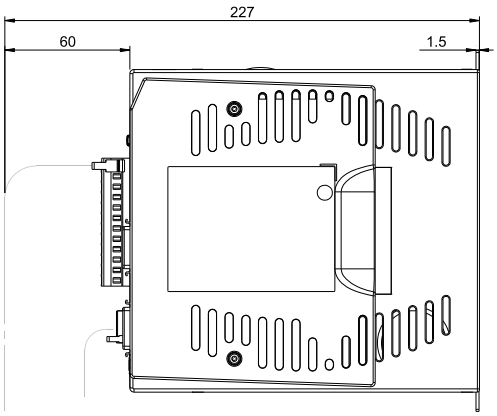
Fig. 6-5

■ C frame with external I/O [D2T-10□□-K-C□]



Unit: mm





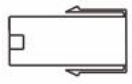
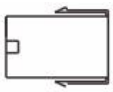
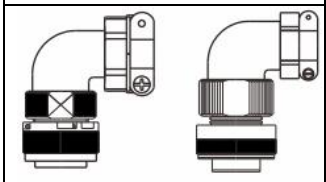
D2-DNN56A

Fig. 6-6

6.4. Cable and Connector

6.4.1. Motor cable

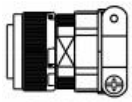
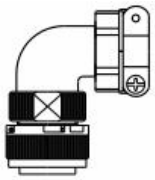
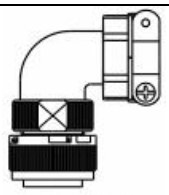
Table 6-2

Part name	Output power	Type	Length	Part No. Bendable type*
Motor cable	50W ~ 750W	 D2-DLN01A	3 m	HVPS04AA03MB
			5 m	HVPS04AA05MB
			7 m	HVPS04AA07MB
			10 m	HVPS04AA10MB
	1KW / 2KW	 D2-DLN02A	3 m	HVPM04BA03MB
			5 m	HVPM04BA05MB
			7 m	HVPM04BA07MB
			10 m	HVPM04BA10MB
		 D2-DLN03A	3 m	HVPM04CA03MB
			5 m	HVPM04CA05MB
			7 m	HVPM04CA07MB
			10 m	HVPM04CA10MB
Motor cable with brake	50W ~ 750W	 D2-DLN04A	3 m	HVPS06AA03MB
			5 m	HVPS06AA05MB
			7 m	HVPS06AA07MB
			10 m	HVPS06AA10MB
	1KW / 2KW	 D2-DLN05A	3 m	HVPM06BA03MB
			5 m	HVPM06BA05MB
			7 m	HVPM06BA07MB
			10 m	HVPM06BA10MB
		 D2-DLN06A	3 m	HVPM06CA03MB
			5 m	HVPM06CA05MB
			7 m	HVPM06CA07MB
			10 m	HVPM06CA10MB

*For the moving application, the bendable-type cable is suggested, e.g., robot.

6.4.2. Encoder cable

Table 6-3

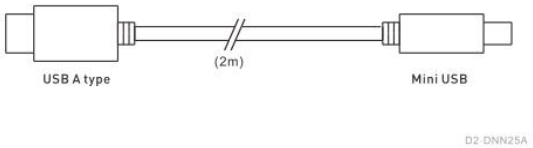
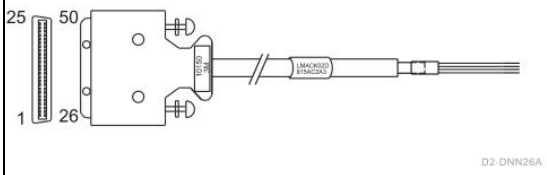
Part name	Output power	Type	Length	Part No. Bendable type*
13-bit encoder cable	50W ~ 750W	 D2-DLN07A	3 m	HVE13IAB03MB
			5 m	HVE13IAB05MB
			7 m	HVE13IAB07MB
			10 m	HVE13IAB10MB
	1KW / 2KW	 D2-DLN08A	3 m	HVE13IBB03MB
			5 m	HVE13IBB05MB
			7 m	HVE13IBB07MB
			10 m	HVE13IBB10MB
		 D2-DLN09A	3 m	HVE13ICB03MB
			5 m	HVE13ICB05MB
			7 m	HVE13ICB07MB
			10 m	HVE13ICB10MB
17-bit encoder cable	50W ~ 750W	 D2-DLN10A	3 m	HVE17IAB03MB
			5 m	HVE17IAB05MB
			7 m	HVE17IAB07MB
			10 m	HVE17IAB10MB
	1KW / 2KW	 D2-DLN11A	3 m	HVE17IBB03MB
			5 m	HVE17IBB05MB
			7 m	HVE17IBB07MB
			10 m	HVE17IBB10MB
		 D2-DLN12A	3 m	HVE17ICB03MB
			5 m	HVE17ICB05MB
			7 m	HVE17ICB07MB
			10 m	HVE17ICB10MB

*For the moving application, the bendable-type cable is suggested, e.g., robot.

6.5. Composition of peripheral equipment

6.5.1. Communication cable and control signal cable

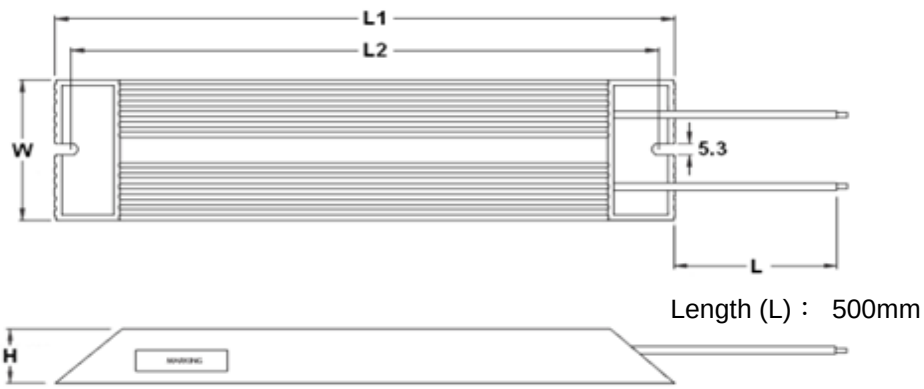
Table 6-4

Part name	Part No.	Connector	
USB communication cable	051700800366	CN3	
Control signal cable	LMACK02D	CN6	

6.5.2. Regenerative resistor

Table 6-5

Part name	Model	Description	L1 (mm)	L2 (mm)	W (mm)	H (mm)
Regenerative resistor	RG1	68 Ω Rated power: 100W Peak power: 500W (050100700001)	165±2	150±2	40±0.5	20±0.5
	RG2	120 Ω Rated power: 300W Peak power: 1500W (050100700009)	215±2	200±2	60±0.5	30±0.5



Length (L)： 500mm

Fig. 6-7

6.5.3. EMC accessory part

Table 6-6

Part name	Model	Description	Quantity
D2 EMC accessory pack for single-phase	D2-EMC1	Single-phase filter FN2090-6-06 (for 50W to 400W) - Rated current: 6 A - Leakage current: 0.67mA	1
		EMI core KCF-130-B	2
	D2-EMC3	Single-phase filter FN2090-10-06 (for 750W to 1KW) - Rated current: 10 A - Leakage current: 0.67mA	1
		EMI core KCF-130-B	2
D2 EMC accessory pack for three-phase	D2-EMC2	Three-phase filter FN3025HL-20-71 - Rated current: 20 A - Leakage current: 0.4mA	1
		EMI core KCF-130-B	2

D2/D2T Applications for Tool Turret/Magazine