CHIEFTEK PRECISION CO., LTD.

Will1-B Series Installation Guide

Ver. 2.3

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About this Guide

1.1. Safety Information

Please take the time to read this guide carefully to operate the Will1-B Driver correctly and safely. The information here helps you prevent serious accidents and ensures safety while operating.

Please read this section carefully before installation.

Make sure all parts are grounded properly and ensure the electrical resistance with ground is low. Only qualified personnel are to proceed with the installation. Professional knowledge of electronics, installation, testing, and motor operations are required for qualified persons.

There are sensitive and precision electrical parts inside the Will1-B Driver. If the installation fails, or the Driver is heavily impacted or dropped, the parts will be damaged. The Will1-B Driver should be kept away from highly-polluted environments or electrically conductive objects. Make sure that the installation personnel is free of static electricity and is not carrying objects that may conduct or generate static electricity. To prevent accidents, make sure that all parts are properly tightened and that both the limit switch and safety switch is functional. Keep the floor clean and the motor operation area clutter free.

1.1.1. Symbols

CAUTION
ISO 7000-0434 (2004-01)

Protective Ground Connection
IEC 60417-5019 (2006-08)

Warning: High Voltage
IEC 60417-5036 (2002-10)

Caution: Hot Surface
IEC 60417-5041 (2000-10)

1.1.2. Disclaimer

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1.2. Revision History

Version	Date	Description	Remarks
1.0	September 2017	Initial release	--
1.1	October 2017	First revision	Amended and revised Specifications data (3.4)
2.0	July 2018	Second revision	1. Changed electrical circuit designs (3.12) 2. Changed pin-definitions of General (3.9), Controller (3.10), and Feedback Ports (3.11) 3. Added feedback mechanism: Resolver 4. More detailed circuit diagram of Thermistor (2.11) 5. Added the section ‘‘Parts of the Drive’’ 6. Added a picture indicating location of nameplate (3.1) 7. Added pin-definitions of CANopen and EtherCAT ports (3.8)
2.1	June 2019	Third revision	1. Added data for 21A Driver 2. Changed model name from ‘‘TC’’ to ‘‘Will’’
2.2	February 2020	Fourth revision	English version
2.3	April 2026	Fifth revision	1. 21A Driver parameter correction 2. Troubleshooting added exception codes

1.3. Ordering Information

Will1-	B	9	P	/230-	H	R	E
							None: CANopen E: EtherCAT
						None: No resistor R: Brake resistor	
					None: No heatsink H: Passive heatsink F: Heatsink with fan		
				AC Supply: 230VAC			
			None: Normal P: Extended peak current [Note]				
		Continuous current (Amps): 3, 9, 21					
	None: A-type B: B-type						
Servo Driver							

Note: Current sensor with a wide input range is used at the cost of additional signal noise and reduced resolution. This setup is suitable for applications where the motor mostly operates in short, high current bursts. (H/R types for 3A/9A series only)

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1.5. How to use this guide

To install and operate the cpc Will1-B drive correctly, please reference this guide together with other cpc documents. This Installation Guide is your first step; please read the Safety Information in the first chapter carefully then the remaining chapters pertaining to Installation and Specifications as seen below:

- Chapter 3, Installation, provides step-by-step instructions for installing, connecting and powering up the Will1-B Driver.

- Chapter 4, Technical Specifications, lists all Driver ratings and specifications.

Upon completing the installation according to the instructions in this guide, the Will1-B driver should be successfully mounted and installed. Next, consult the cpc GUI Software User Guide to configure and fine-tune the system for optimal performance.

2. Features

2.1. Driver Description

The Will1-Bxx/230 series Servo Driver is optimized for operating with linear Permanent Magnet Synchronous Motors (PMSM). It can operate in standalone configuration using an internal virtual scripting engine, supports external analog or pulse commands, and compatible with industry standard fieldbus systems by conforming to CANopen DS402 specifications.

2.2. Current Loop

- Fully digital
- 12-bit current loop resolution
- 20 kHz working frequency
- Automatic and manual gain-tuning, to compensate for variations in the Servo Motor
- Frequency response and time response testing
- Automatic Phasing

2.3. Auto Phase

- Sensor-less
- Digital Hall Sensor — up to 20 kHz

2.4. Velocity Loop

- Fully digital
- 10 kHz working frequency
- Automatic and manual gain-tuning, to compensate for variations in the Servo Motor
- Frequency response and time response testing
- Gain switch by condition of digital input, demand, feedback, error and reach of target
- 3 sets of notch or low-pass filters

2.5. Position Loop

- Incremental Encoder — up to 20 Mega counts/s
- Position Count Range — $-2^{31} \sim 2^{31}$

2.6. Command

- A/B Incremental command — up to 4 MHz
- Pulse-direction command — up to 4 MHz
- Up-down command — up to 2 MHz
- Analog ±10V command to current, velocity or position

2.7. Gain Switch

- 3 sets of gain switch groups
- Switching per digital input, demand, feedback, error and reach of target
- Controllable switching time

2.8. Homing

- 31 types of standard CiA402 methods
- 5 methods for Home positioning with mechanical hard stop

2.9. Filters

- Current Filter
- Velocity Filter
- Auxiliary Command Filter

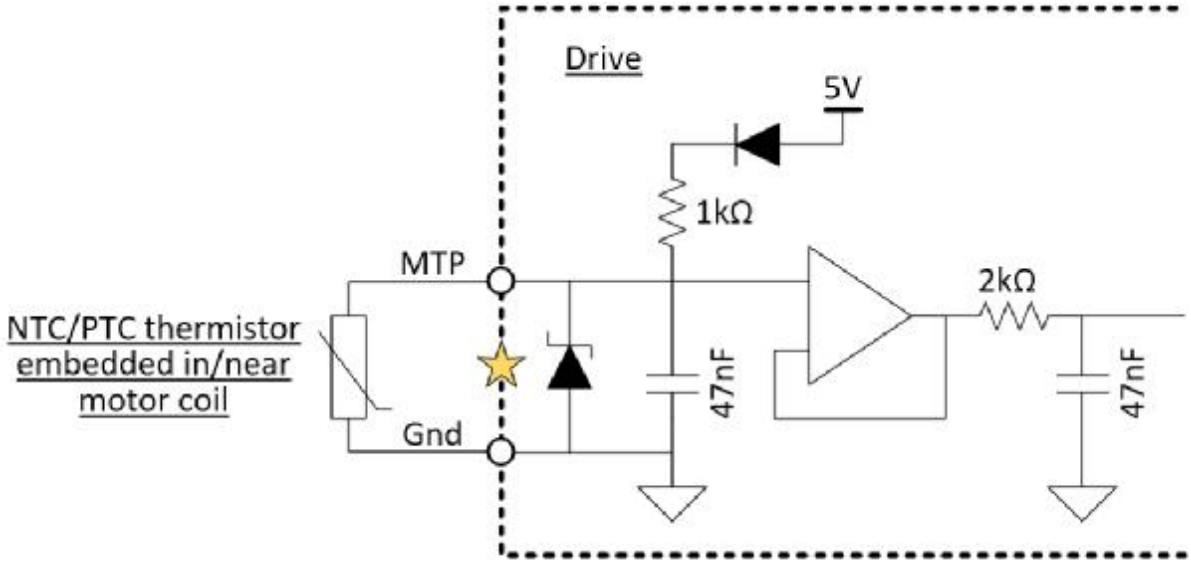
2.10. Scripts

- Point to point instructions up to 128 steps
- 16KB FLASH memory
- User friendly interface
- Modular instructions

2.11. Motor Temperature Detection

1. To more accurately detect the motor temperature*, the Will1-B series includes a 0~5V analog input to connect with the thermistor on the motor so as to know the voltage on the drive input. The UI will show users this monitored voltage. Due to variations of different thermistors, users will need to calculate the resistance (ohm) according to the voltage and then derive the corresponding temperature. Please see the circuit diagram and calculation formula below.
   (* The Will1 series only displays temperatures as either High or Low)

<Equivalent Circuit Diagram>



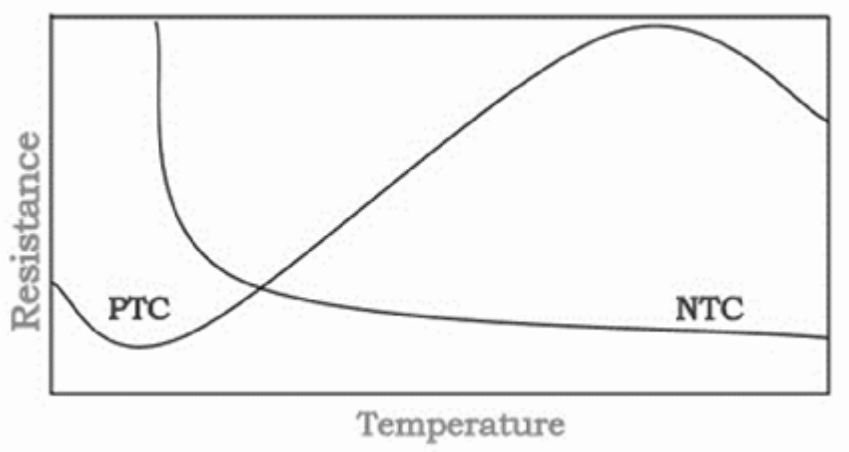
Acquisition formula for Resistance (ohm) of position☆:

(The voltage of position☆ is known and monitored by the UI)

$$V = \frac{5R}{R+1000} \quad , \quad R = \frac{1000V}{5 - V}$$

2. A preferred temperature curve can be chosen in the UI.

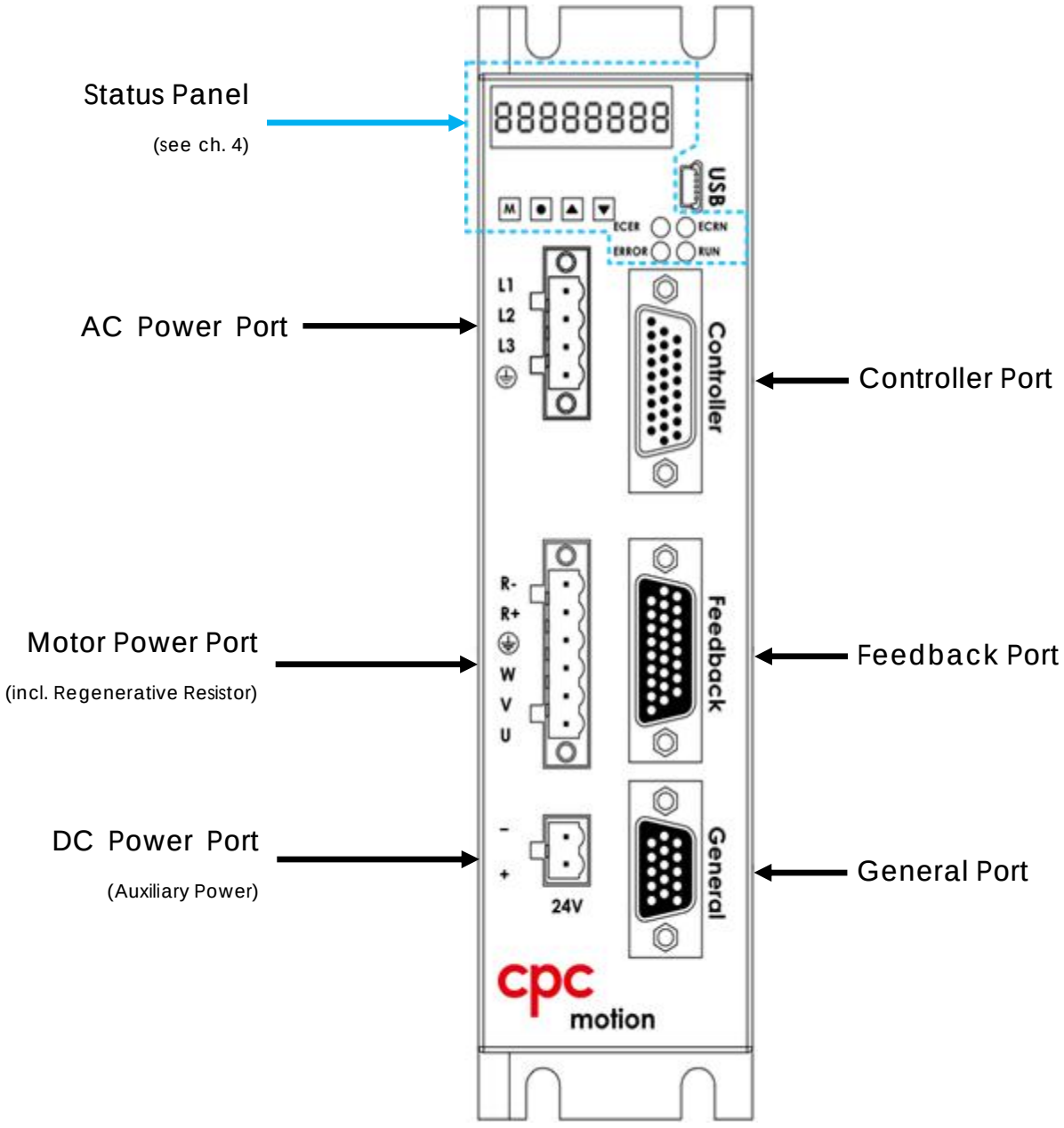
<Thermistor — Diagram of Temperature & Resistance>



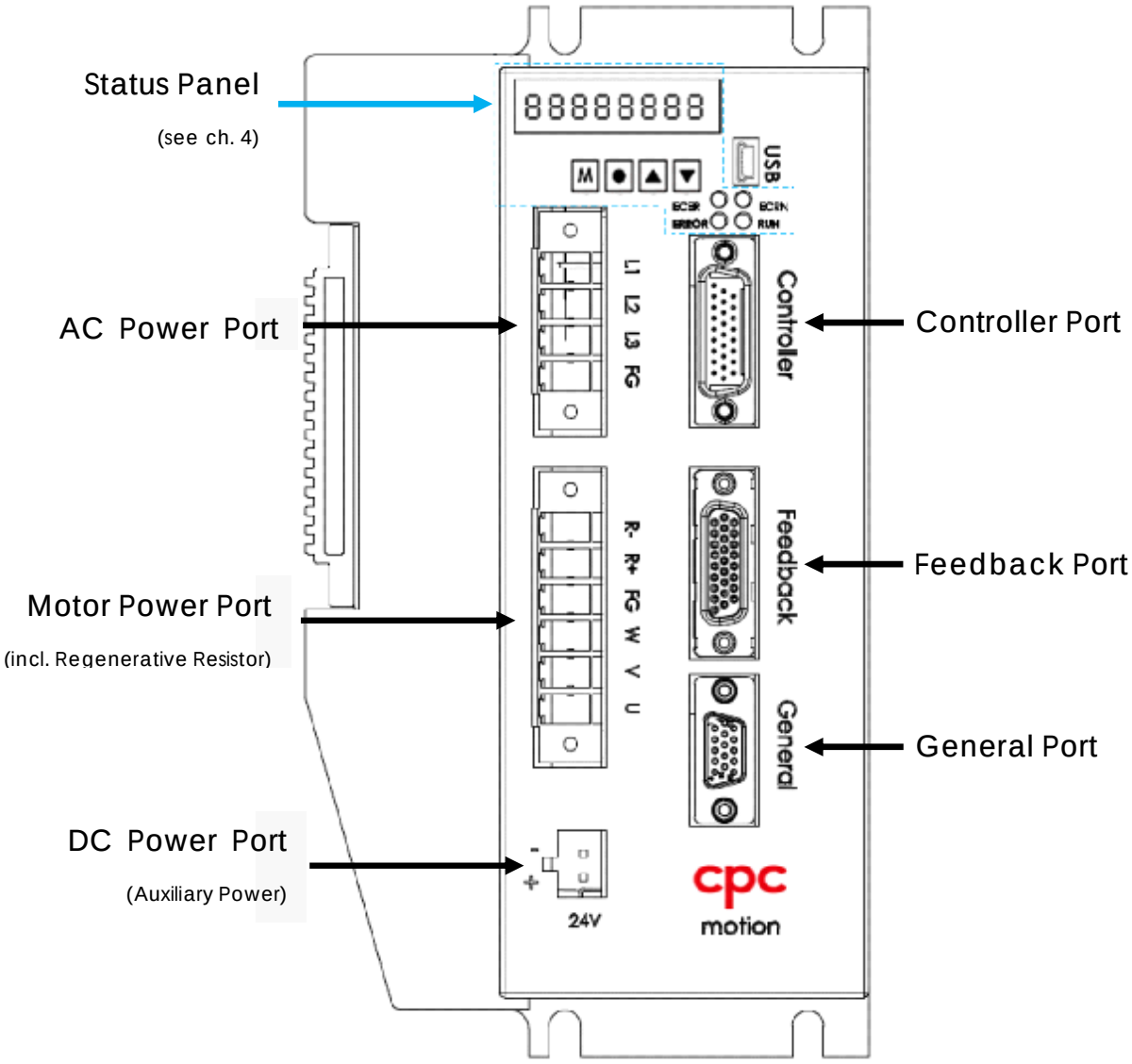
3. Installation

3.1. Parts of the Drive

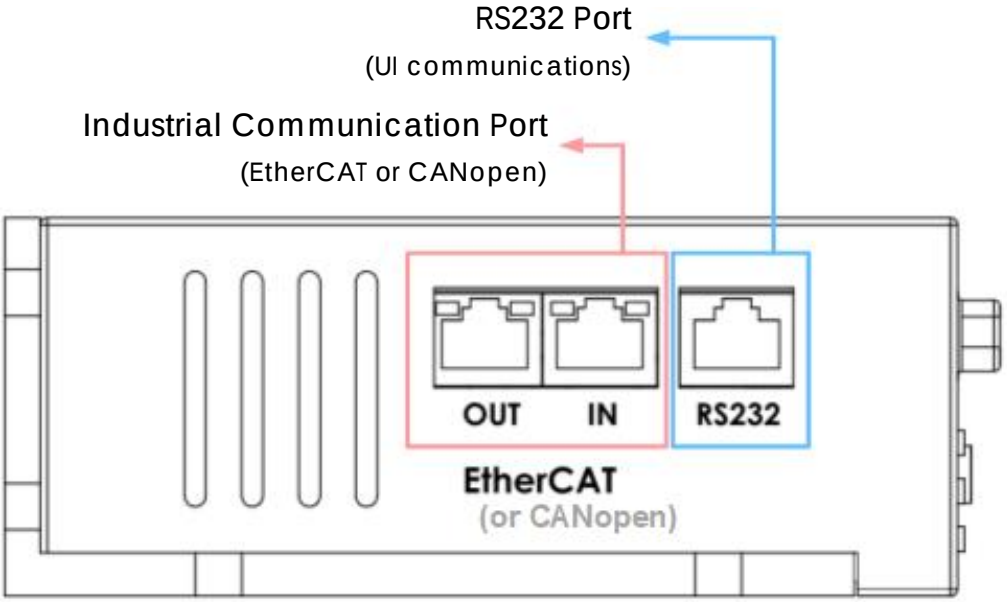
Front side (3A/9A)



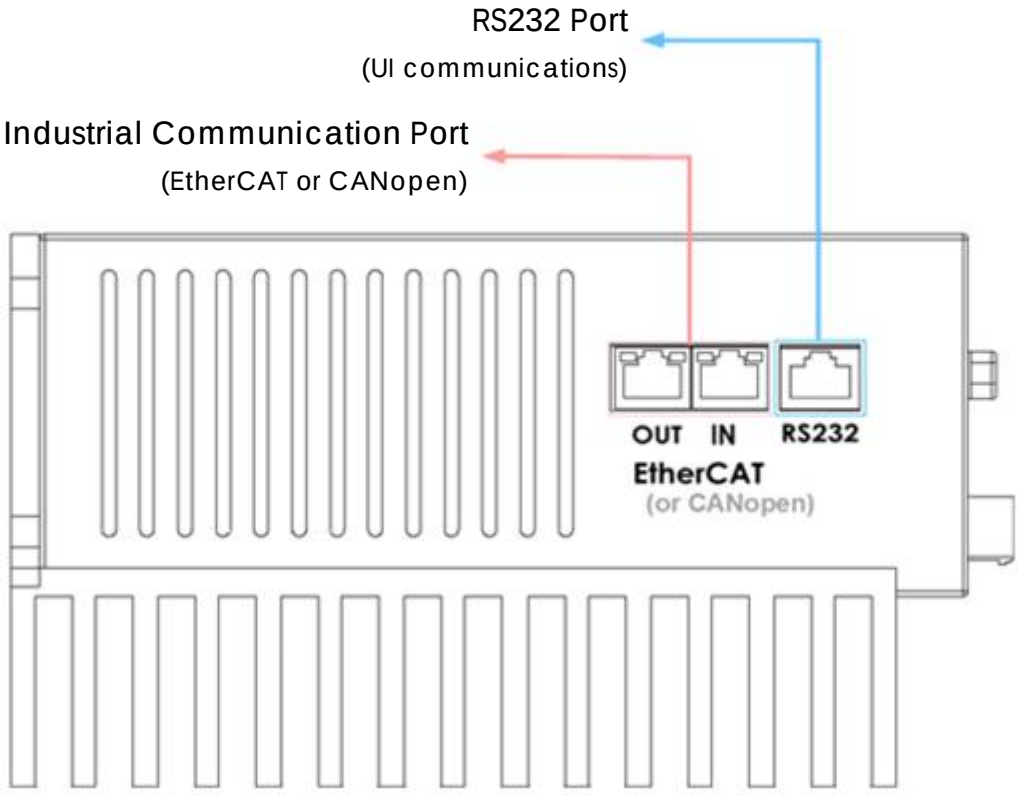
Front side (21A)



Lateral side (3A/9A)



Lateral side (21A)



The location of nameplate sticker is shown below. Confirm the product name under ‘‘Model Description’’ on sticker.

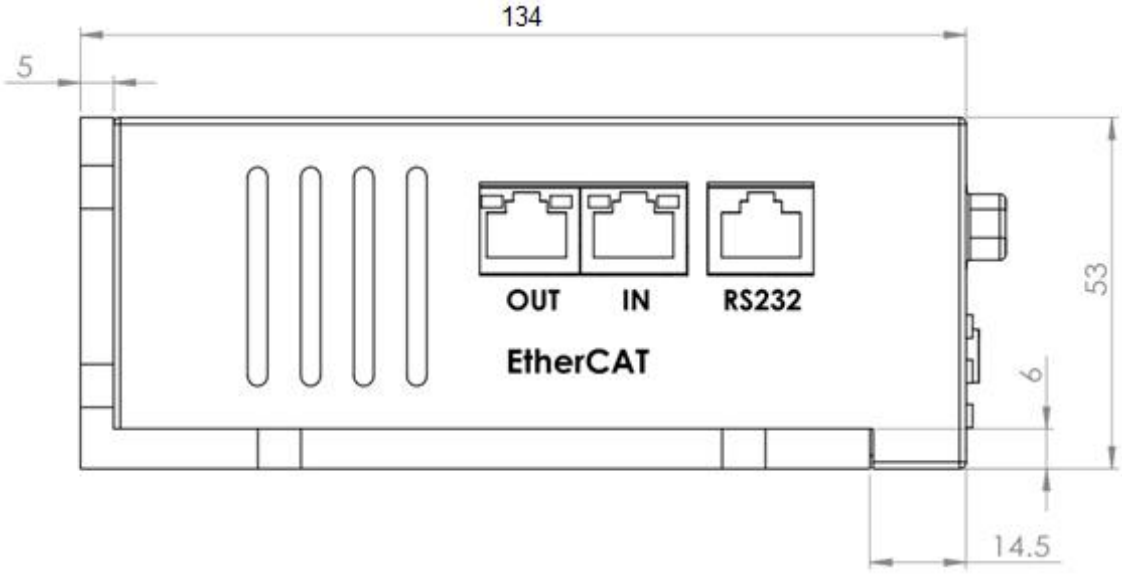
(3A/9A)

(21A)

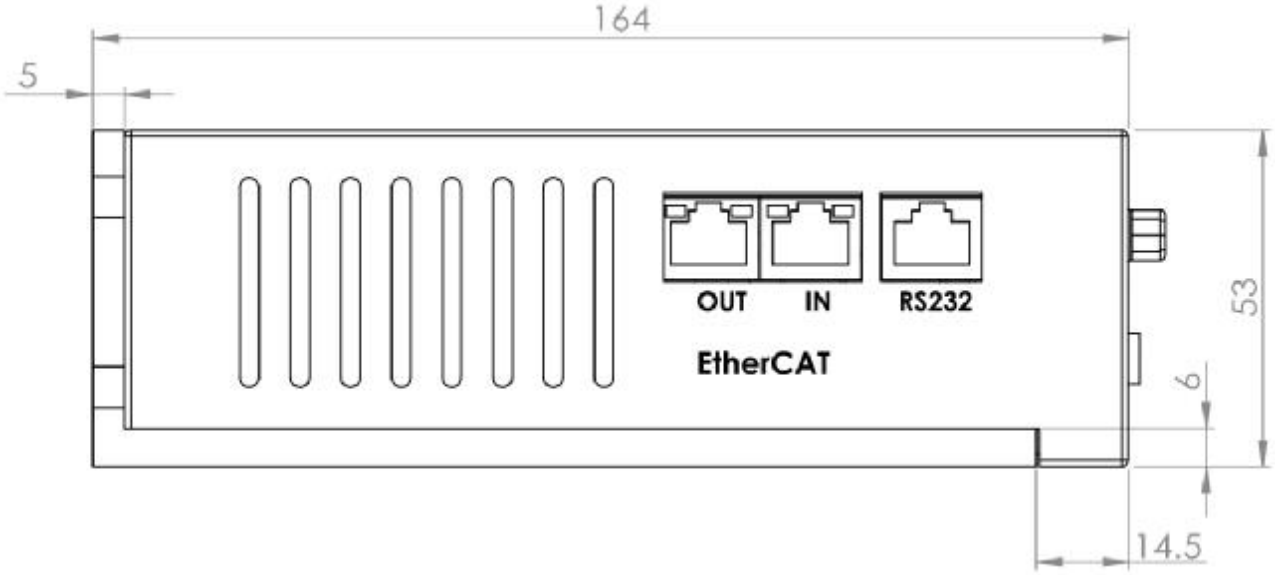
3.2. Dimensions

All units of measurement for dimensions in this manual are in millimeters (mm).

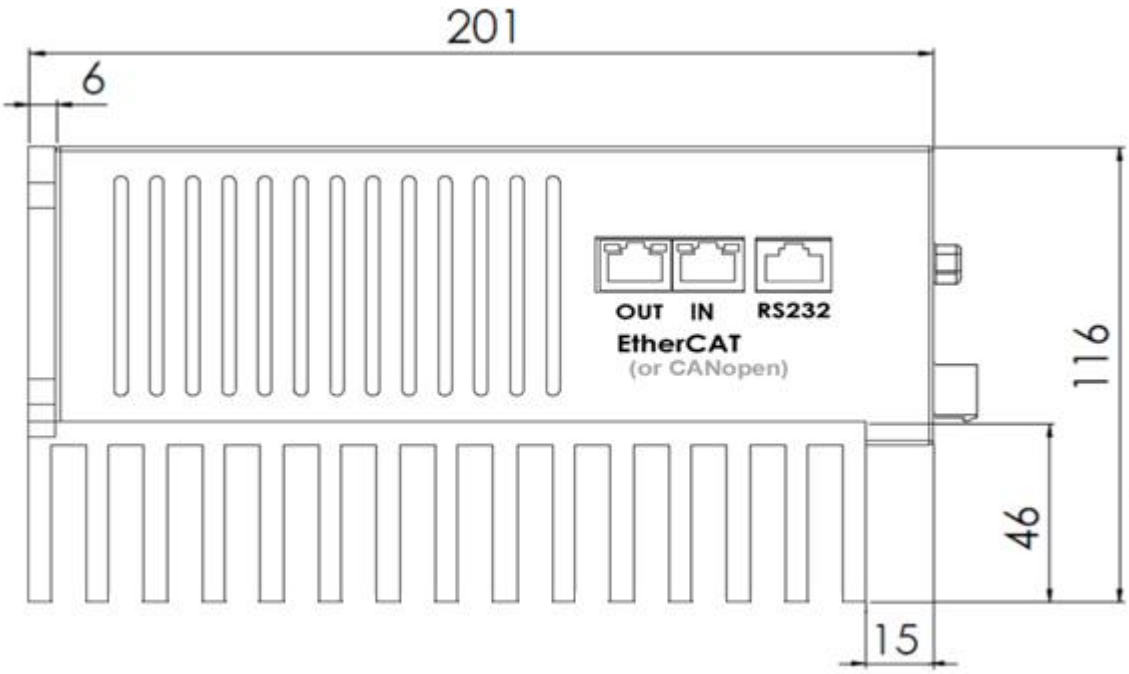
3.2.1. 3A-type Will1-B Driver



3.2.2. 9A-type Will1-B Driver

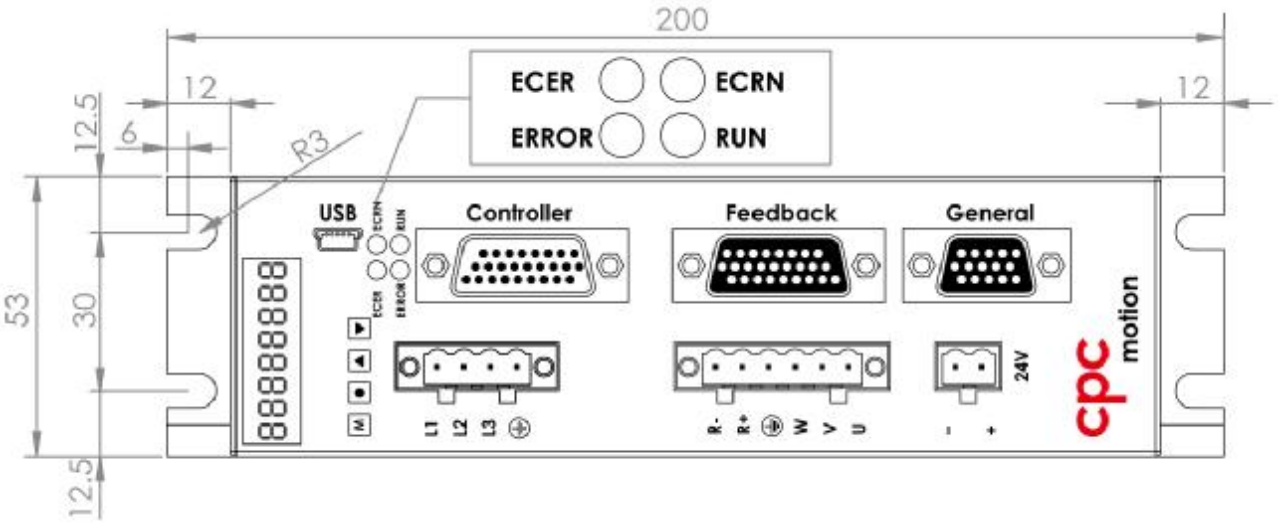


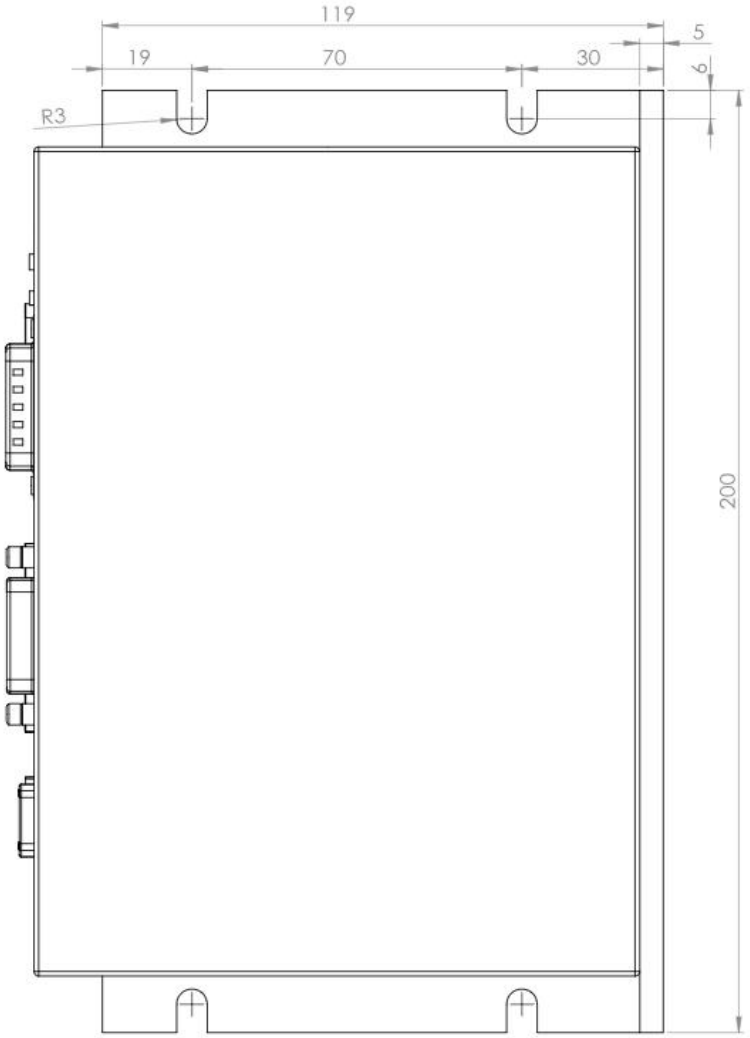
3.2.3. 21A-type Will1-B Driver



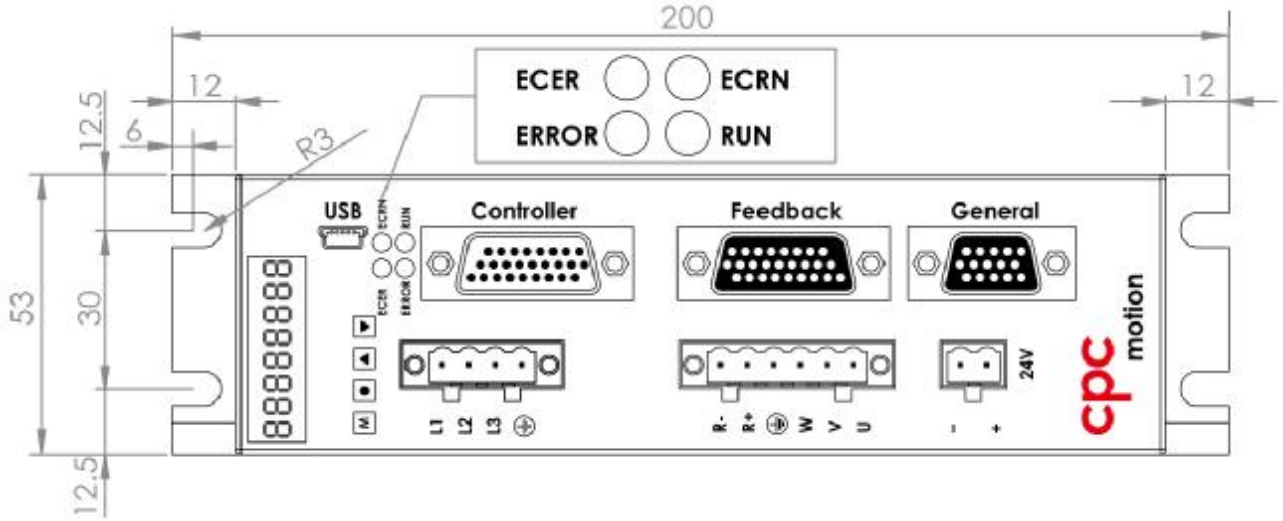
3.3. Mounting

3.3.1. 3A-type Will1-B Driver

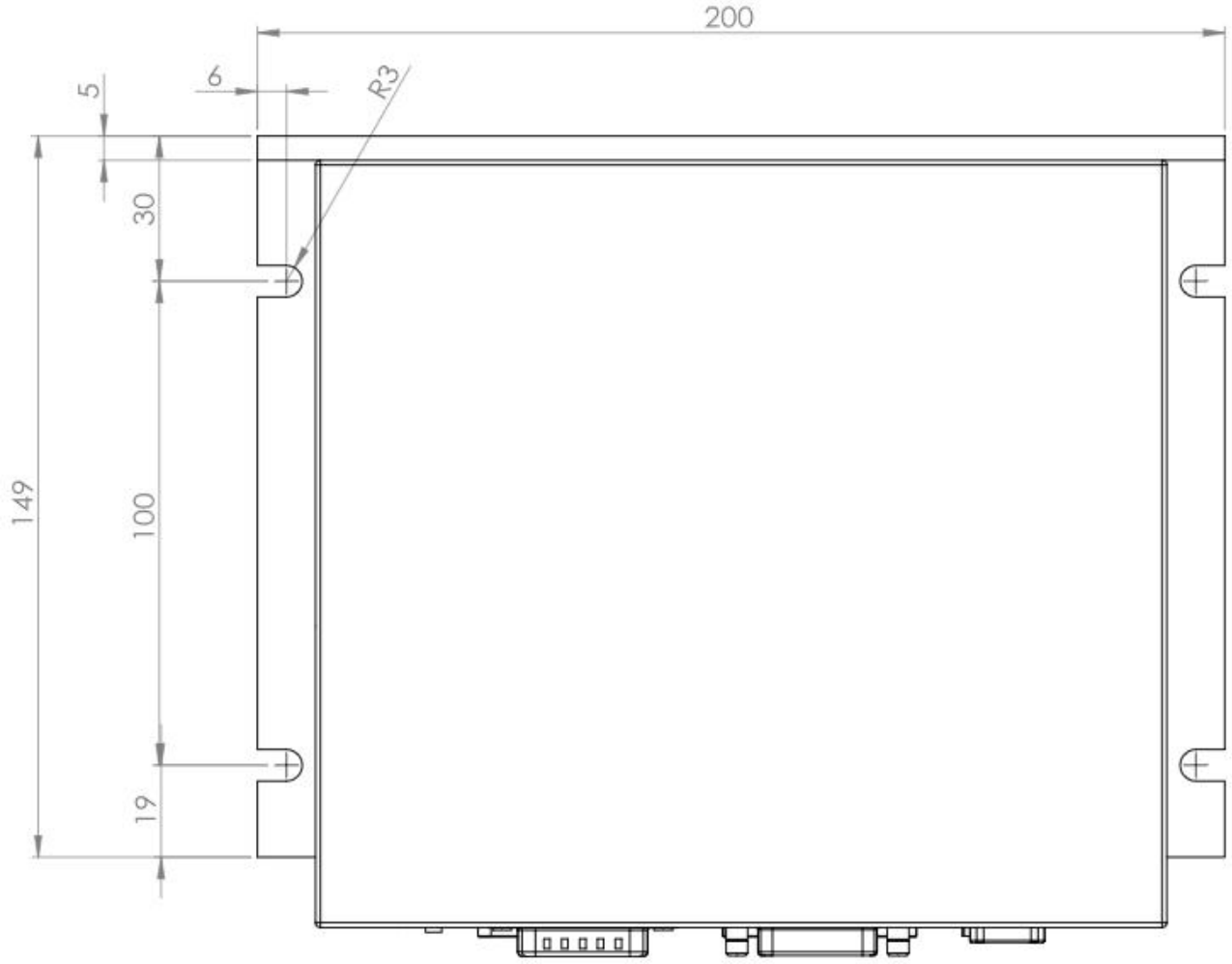




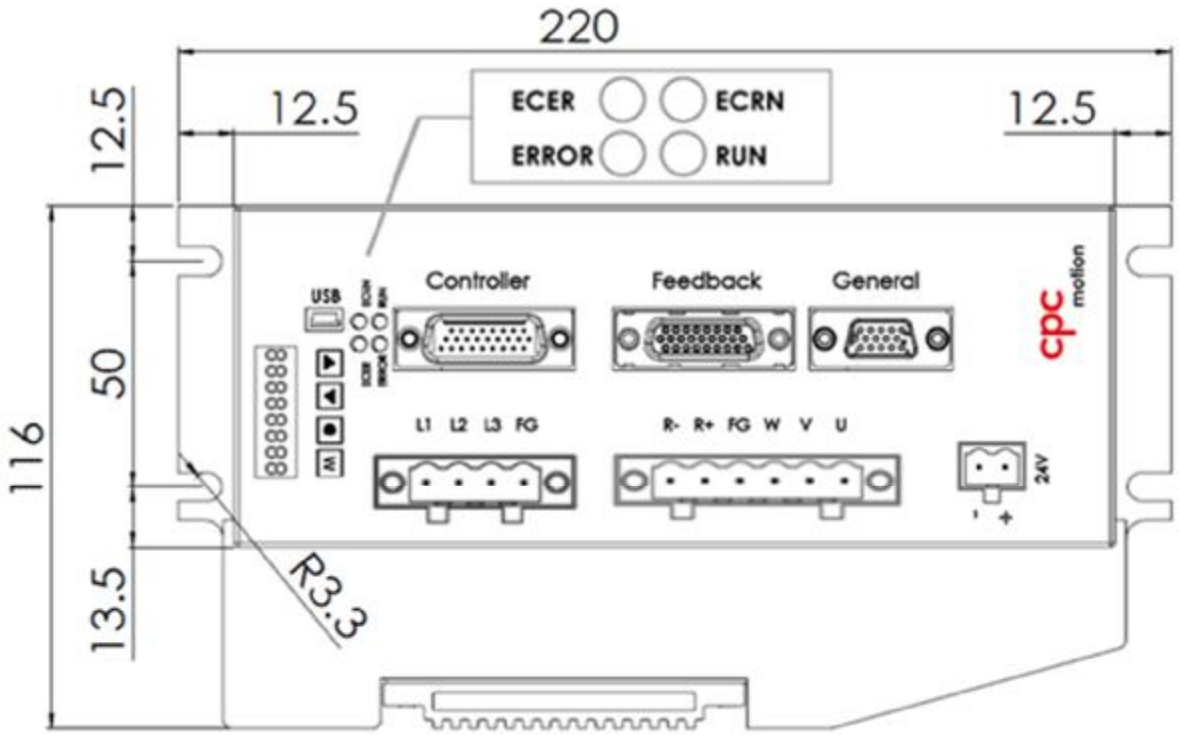
3.3.2. 9A-type Will1-B Driver

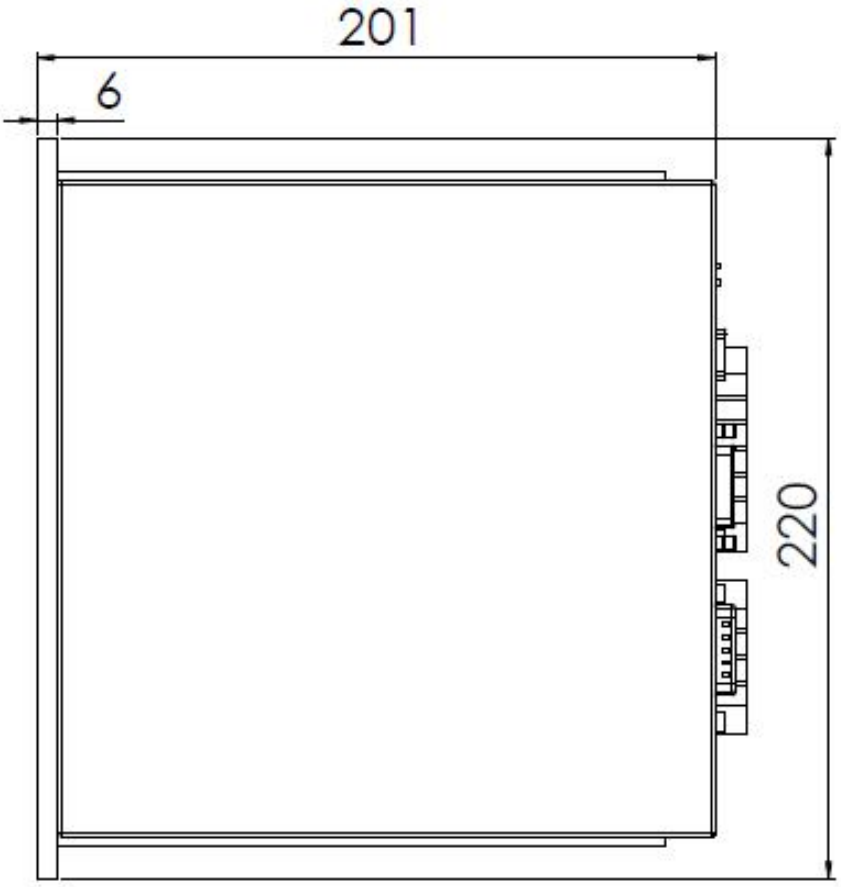


↑ The dimensions of this side are the same for both 3A-type and 9A-type Will1-B Drivers.



3.3.3. 21A-type Will1-B Driver





3.4. Mechanical and Electrical Specifications

Specifications			Will1-B Series			
Model			Will1-B3/230	Will1-B9/230	Will1-B9P/230	Will1-B21/230
Input Power	Voltage and Phase		100 to 230 VAC 1 ∅	100 to 230 VAC 1 ∅ or 3 ∅		
	DC Bus Peak Voltage (VDC)		390			
	Frequency (Hz)		50 to 60			
	Power Rating (W)		1125	3375		7875
Control Logic Power	Voltage Range (VDC)		24			
	Current (A)		>0.5			
Output Power	Continuous Current (A)		3 (2.12 RMS)	9 (6.36 RMS) *Note 2	9 (6.36 RMS) *Note 2	21 (14.85 RMS)
	Peak Current (A)		9 (6.36 RMS)	20 (14.14 RMS)	30 (21.22 RMS) *Note 1	60 (42.42 RMS)
	Peak Current Time (sec)		2.5			
	Peak Power Output (kW)		1.3	4.4	6.6	13.2
	5V Supply Current Output (A)		0.5			
Encoder Input	Digital	Signal Type	A/B Incremental (RS-422 signaling)			
		Work Frequency	20 Mega counts/sec max			
		Count Rage	$\pm 2^{31}$ counts max			

Specifications			Will1-B Series			
Model			Will1-B3/230	Will1-B9/230	Will1-B9P/230	Will1-B21/230
Encoder Input	Analog (sin/cos)	Amplitude	1 V_{P-P}			
		Operating Frequency	Max 100 kHz, 4096 count/period Interpolation			
	Absolute	Signal Type	BiSS-C, Tamagawa, EnDat 2.2, SSI			
Encoder Output	Signal Type		RS-422			
	Operating Frequency		Max: 20 Mega counts/sec			
Feedback Position Error Mapping			Yes			
Regenerative Resistor	Active Voltage (VDC)		Default: 360			
	Stop Voltage (VDC)		Default: 350			
	Resistance (Ohm)		60 (optional)			20
	Continuous Dissipation (Watt)		100 (optional)			250
	DC Bus Capacitance (uF)		540	1350	1350	2240
	Pulse Braking Energy (Joule)		5000 (optional)			12500
	Peak Switch Current (A)		10	20		
Control Loop	Position Control	Loop Frequency	5 kHz			
		Trajectory Generator	Trapezoidal with S-curve filter			
		Count Range	−2,147,483,648 to 2,147,483,647 counts/sec			

Specifications			Will1-B Series			
Model			Will1-B3/230	Will1-B9/230	Will1-B9P/230	Will1-B21/230
Control Loop	Velocity Control	Loop Frequency	10 kHz			
		Output Filter	x3 (Low-pass or Notch)			
		Count Range	−2,147,483,648 to 2,147,483,647 pulses/sec			
	Current Control	Loop Frequency	20 kHz			
		Modules	SVPWM			
Auxiliary Command Input	Position Mode	A/B Incremental	4 Mega counts/sec max			
		Pulse/Direction	4 Mega counts/sec max			
		CW/CCW	2 Mega counts/sec max			
		Analog Voltage	±10 V			
	Velocity Mode	Analog Voltage	±10 V			
	Current Mode	Analog Voltage	±10 V			
DS 402 Operating Modes			PP, PV, PT, HM, CST, CSV, CSP			
Serial Bus			RS232			
Pulse Command Frequency	RS422		10 MHz max			
	5V Single-end		1 MHz max			
	24V Single-end		50 kHz max			
Total Digital Inputs			x12 (5~24 V)			
Total Digital Outputs (Open-Collector)			x3 (24 V, 400 mA); x3 (24 V, 200 mA)			
High Speed Position Comparator Output			x1 (RS422)			

Specifications		Will1-B Series			
Model		Will1-B3/230	Will1-B9/230	Will1-B9P/230	Will1-B21/230
Analog Input	Input Type	x1 (±10V single-end)			
		x1 (±10V differential)			
	ADC Resolution	12-bit			
Autotuning		Torque/Velocity/Position loop gain, motor phasing setup, sin/cos encoder calibration			
Gain Switch Function		Yes			
Control Panel		x1 (8-digit LCD), x4 (push buttons)			
Software Protection		Dynamic brake, motor over-current, over/under-position, over-velocity, virtual/physical position limit switch, Hall Signal loss, external fault trigger, tracking error			
Hardware Protection		Drive over-temperature (analog), 5V output short circuit, motor over-temperature (analog)			
Dimensions (LxHxW) [mm]		200 x 134 x 53	200 x 164 x 53		220 x 201 x 116
Weight (Kg)		1.2	1.6 (without optional heatsink)		3.6

Specifications		Will1-B Series			
Model		Will1-B3/230	Will1-B9/230	Will1-B9P/230	Will1-B21/230
Application Conditions	Operating Temperature	0°C ~ 40°C			
	Storage Temperature	-20°C ~ 85°C			
	Ambient Humidity	0~95%			
	Altitude	0~2000 m			
	Vibration	1G			
	IP Protection Class	IP20			
Motor Selection	1. Linear AC Servo Motor or Rotary AC Servo Motor				
	2. Protective Class 1 with IEC60034-1compliance				
	3. Refer to the Output Power mentioned previously for your selection of Servo Driver				
Remarks	Note 1: Current sensor with a wide input range is used at the cost of additional signal noise and reduced resolution. This setup is suitable for applications where the motor mostly operates in short, high current bursts.				
	Note 2: Additional heatsink is required to ensure continuous operation at rated output.				

3.5. Recommended Wiring Selection

The recommended wire gauges are as follows:

Wiring for	Connection	Wire Diameter mm² (AWG)
AC Input	L1, L2, L3	0.5 to 5 mm^2, 20 to 10 AWG
DC Input (Auxiliary Power)	24V+, 24V-	0.12 to 0.2 mm^2, 26 to 24 AWG
Motor	U, V, W	0.5 to 5 mm^2, 20 to 10 AWG
Protective Ground	PE	
Regenerative Resistor	R+, R-	0.5 to 2 mm^2, 20 to 14 AWG

The metal casing or any grounded wiring may conduct electricity. To prevent direct or indirect contact while using RCD (Residual Current Device) or RCM (Residual Current Monitoring), only Type B (IEC 60755) RCD or RCM should be used at the power supply side.

u Recommended connection method:

(a) A fixed connection and:

- protective ground conductor with a cross-section of at least 10 mm^2 Cu or 16 mm^2 Al, or
- automatic disconnection of the power supply in case of discontinuity of the protective ground conductor; or
- provision an additional terminal for a second protective ground conductor of the same cross-sectional area as the original protective ground conductor,

OR

(b) Connection with an industrial connector in accordance with IEC 60309 and a minimum protective ground. Appropriate wire protection sleeves shall be used.

u Powertrain System Labeling

DANGER: Where an isolating device is not intended to interrupt load current, a warning shall state: DO NOT OPEN WHILE UNDER LOAD.

The following requirements apply to any emergency power cut-off system (power isolation device) which does not disconnect all sources of power.

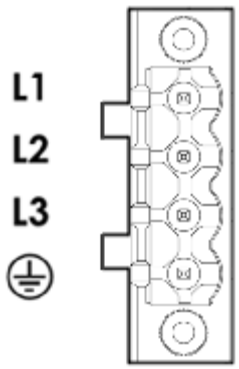
- If the power isolator/disconnector device is mounted in an equipment enclosure with the operating handle externally operable, a warning label shall be posted close to the operating handle stating that it does not disconnect all power to the Driver.
- Where a control circuit disconnector can be confused with power circuit disconnectors due to size or location, a warning label shall be posted close to the operating handle of the control circuit disconnector stating that it does not disconnect all power to the Driver.

3.6. Driver Power Wiring

Ports on Driver		3A-type Will1-B Driver	9A-type Will1-B Driver	21A-type Will1-B Driver
Power Port(s)	AC power	4-pin with 5.0mm pitch (DECA ME060-50004); matching male connector: DECA MC101-50004		4-pin with 7.62mm pitch (DINKLE EC762VM-04P); matching male connector: DINKLE ECH762RM-04P
	24V DC auxiliary power	2-pin with 5.0mm pitch (DECA ME030-50002); matching male connector: DECA MC100-50002		
Motor Power Port		6-pin with 5.0mm pitch (DECA ME060-50006); matching male connector: DECA MC101-50006		6-pin with 7.62mm pitch (DINKLE EC762VM-06P); matching male connector: DINKLE ECH762RM-06P

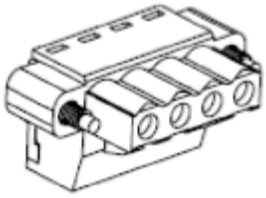
3.6.1. AC Power Wiring

- 3A-type & 9A-type Driver side female connector: DECA ME060-50004



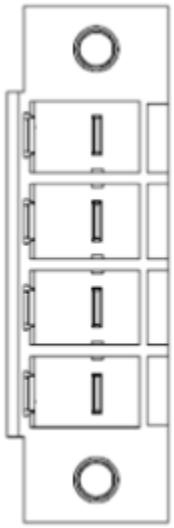
For the single-phase model such as Will1-B3/230, L3 is internally not connected. Connect Live and Ground to L and N respectively.

- 3A-type & 9A-type matching male connector: DECA MC101-50004

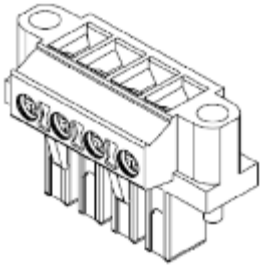


Vendor	Model number
DECA	MC101-50004

- 21A-type Driver side female connector: DINKLE ECH762RM-04P



- 21A-type matching male connector: DINKLE EC762VM-04P

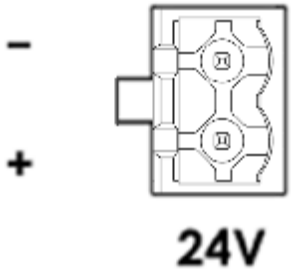


Vendor	Model number
DINKLE	DINKLE EC762VM-04P

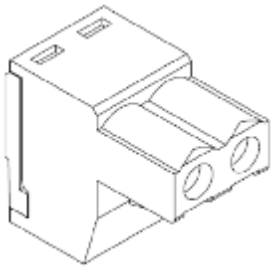
If screw flange is not needed at both sides of the connector, most 5.0 (7.62) mm pitch EU standard male connectors can also be used.

3.6.2. 24V DC Auxiliary Power Wiring

- Driver side female connector: DECA ME030-50002



- Matching male connector: DECA MC100-50002

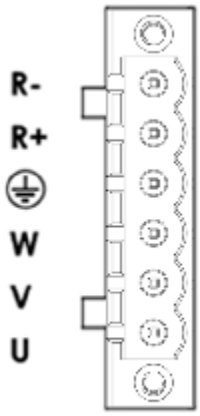


Vendor	Model number
DECA	MC100-50002

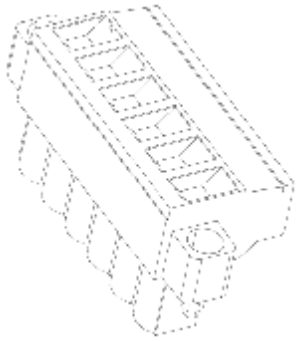
Most 5.0mm pitch EU standard male connectors can also be used.

3.7. Motor Power Wiring

- 3A-type & 9A-type Driver side female connector: DECA ME060-50006

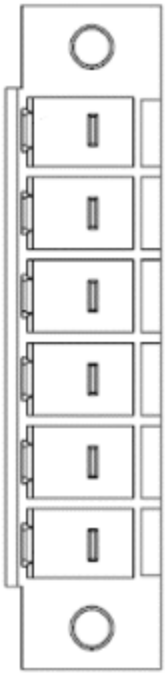


- 3A-type & 9A-type matching male connector:

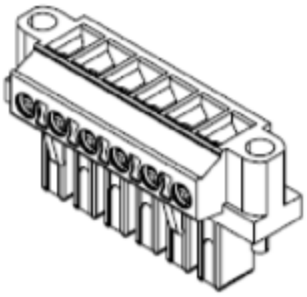


Vendor	Model number
DECA	MC101-50006

- 21A-type Driver side female connector: DINKLE ECH762RM-06P



- 21A-type matching male connector: DINKLE EC762VM-06P

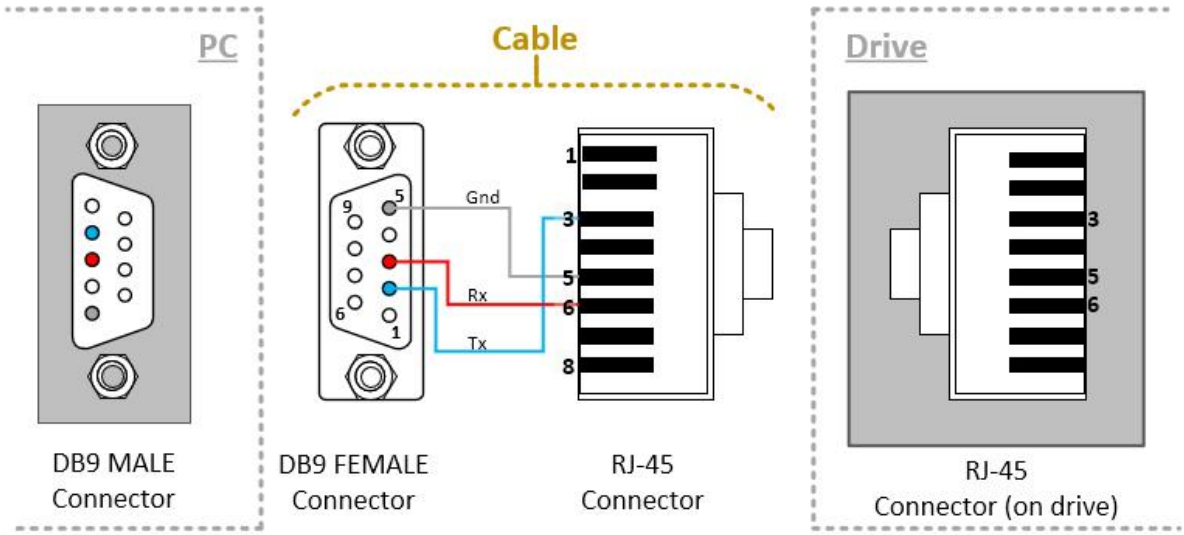


Vendor	Model number
DINKLE	DINKLE EC762VM-06P

If screw flange is not needed at both sides of the connector, most 5.0 (7.62) mm pitch EU standard male connectors can also be used.

3.8. Communication Port Wiring

3.8.1. RS232 Cable



DB9 female connector pin-definitions

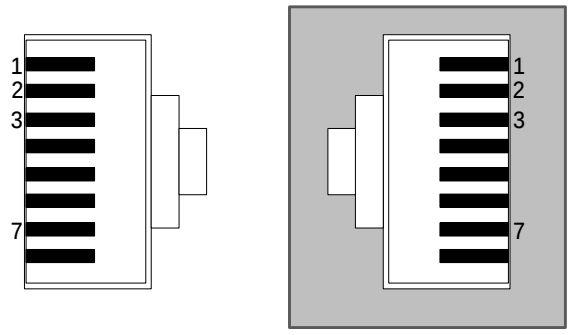
Pin#	Signal	Function
1	N/C	-
2	Tx	Transmit
3	Rx	Receive
4	N/C	-
5	GND	Ground
7, 8, 9	N/C	-

RJ-45 connector pin-definitions

Pin#	Signal	Function
1, 2	N/C	-
3	Tx	Transmit
4	N/C	-
5	GND	Ground
6	Rx	Receive
7, 8	N/C	-

3.8.2. CANopen Standard Communication Cable

RJ-45 connectors on both ends of cable.



RJ-45
(Cable)

RJ-45
(Port on driver)

CANopen IN	
1	CAN_H
2	CAN_L
3	CAN_GND
4	--
5	--
6	--
7	--
8	--

CANopen OUT	
1	CAN_H
2	CAN_L
3	CAN_GND
4	--
5	--
6	--
7	--
8	--

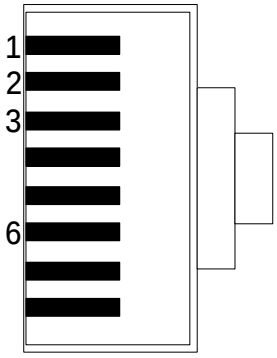
3.8.3. USB Cable

Mini USB

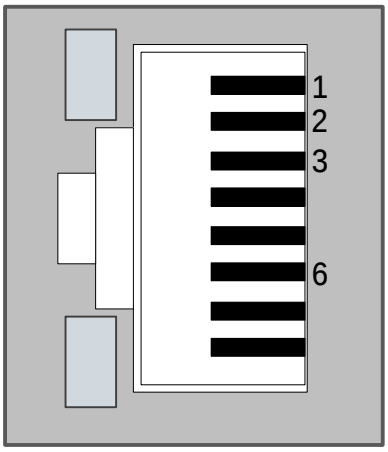
Mini USB Pin#	Signal	Function
1	VBUS	Power
2	D-	Data- Signal Line
3	D+	Data+ Signal Line
4	----	----
5	GND	Ground

3.8.4. EtherCAT In/Out (Optional)

RJ-45 connectors on both ends of cable.



RJ-45
(Cable)

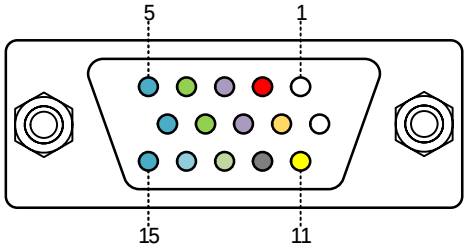


RJ-45
(Port on driver)

EtherCAT IN	
1	TX+
2	TX-
3	RX+
4	--
5	--
6	RX-
7	--
8	--

EtherCAT OUT	
1	TX+
2	TX-
3	RX+
4	--
5	--
6	RX-
7	--
8	--

3.9. General Port Wiring

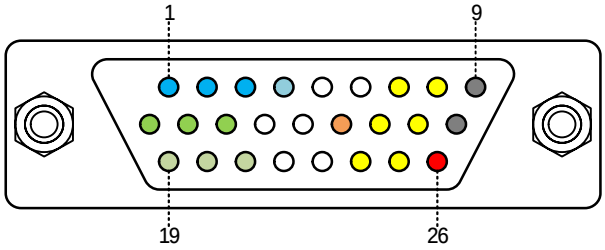


DB15 female connector on the Driver

Pin#	Signal	Function
1	AI-0-	Analog input 0 LOW Input
2	5V	5V supply output
3	TrigOut+	Position trigger HIGH output
4	DO-A1	General purpose digital output
5	DI-A0	General purpose digital input
6	AI-0+	Analog Input 0 HIGH Input
7	AGnd	Analog ground
8	TrigOut-	Position trigger LOW output
9	DO-A0	General purpose digital output
10	DI-A1	General purpose digital input
11	AI-1	±10V analog input 1
12	Gnd	Ground
13	DO-ACOM	Digital output common
14	DI-ACOM	Digital input common
15	DI-A2	General purpose digital input

3.10. Controller Port Wiring

The pin-definitions of the controller port may vary according to the mode in use. The different modes are: A/B mode, Step/Dir mode, and CW/CCW mode.



DB26 MALE connector of the Driver

Pin#	Signal	Function		
		A/B/Z Mode	Step/Dir Mode	CW/CCW Mode
1	DI-C0	General purpose digital input		
2	DI-C1	General purpose digital input		
3	DI-C2	General purpose digital input		
4	DI-CCOM	Digital input common		
5	RZ+	----		
6	RZ-	----		
7	OZ+	Buffered RZ/EZ signal HIGH output		
8	OZ-	Buffered RZ/EZ signal LOW output		
9	Gnd	Ground		
10	DO-C0+	General purpose digital output (collector)		
11	DO-C1+	General purpose digital output (collector)		

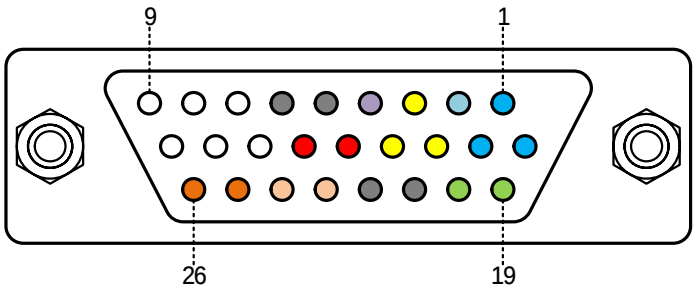
Pin#	Signal	Function		
		A/B/Z Mode	Step/Dir Mode	CW/CCW Mode
12	DO-C2+	General purpose digital output (collector)		
13	RA+	Reference A HIGH input	STEP+ STEP HIGH input	CCW+ CCW HIGH input
14	RA-	Reference A LOW input	STEP- STEP LOW input	CCW- CCW LOW input
15	RCOM24V	Reference input 24V Common		
16	OB+	Buffered RB/EB signal HIGH output		
17	OB-	Buffered RB/EB signal LOW output		
18	Gnd	Ground		
19	DO-C0-	General purpose digital output (emitter)		
20	DO-C1-	General purpose digital output (emitter)		
21	DO-C2-	General purpose digital output (emitter)		
22	RB+	Reference B HIGH input	DIR+ DIR HIGH input	CW+ CW HIGH input
23	RB-	Reference B LOW input	DIR- DIR LOW input	CW- CW LOW input
24	OA+	Buffered RA/EA signal HIGH output		
25	OA-	Buffered RA/EA signal LOW output		
26	5V	5V supply output		

3.11. Feedback Port Wiring

The feedback cable is used to transfer data from the Encoder to the Driver. The Will1-B series can accept the following types of feedback devices:

- A/B/Z-type Encoder
- Analog sin/cos Encoder
- Absolute Encoder (EnDat encoder, BiSS-C encoder, Tamagawa, and Nikon encoder)
- Resolver

Pin-definitions may vary when wiring with different types of feedback device; see subsequent chapters for further information.



DB26 FEMALE connector on the Driver

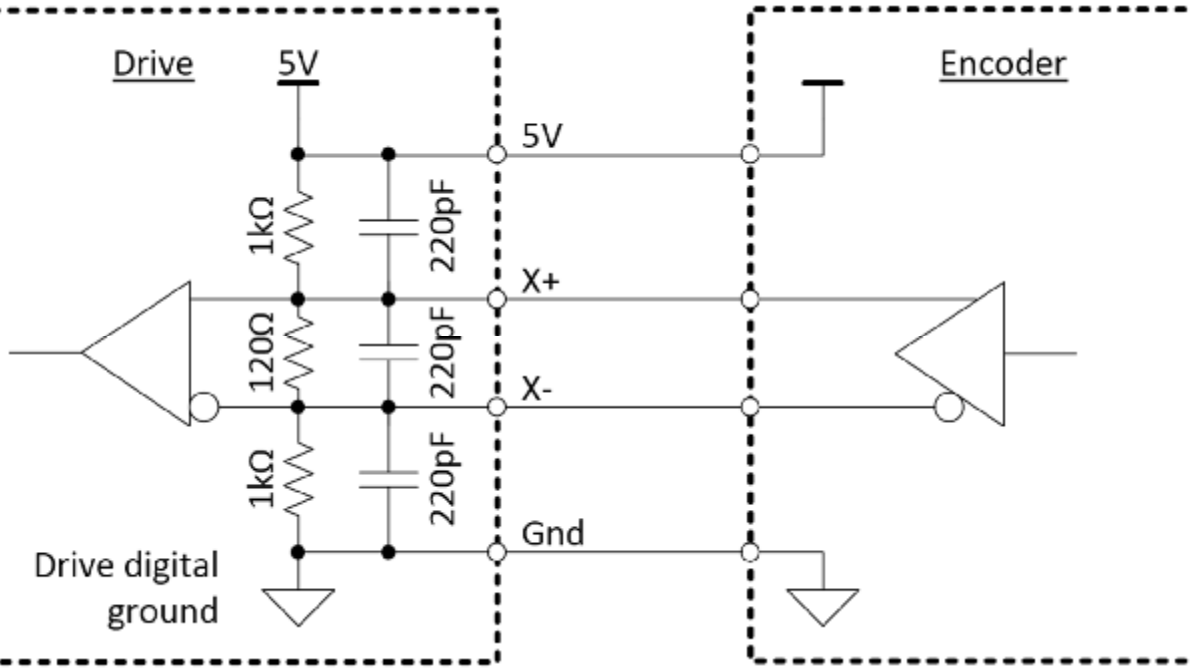
Pin#	Signal	Function				
		A/B/Z-type Encoder	Sin/Cos Encoder	EnDat or BiSS-C Encoder	Resolver	Tamagawa / Nikon Encoder
1	DI-B4	General purpose digital input				
2	DI-BCOM	Digital input common				
3	DI-B1	General purpose digital input (or Hall Sensor B) (non-isolated)				
4	MTP (Motor Temp. Protection)	5V Analog input				

<table>
<tr><th rowspan="2">Pin#</th><th rowspan="2">Signal</th><th colspan="5">Function</th></tr>
<tr><th>A/B/Z-type Encoder</th><th>Sin/Cos Encoder</th><th>EnDat or BiSS-C Encoder</th><th>Resolver</th><th>Tamagawa / Nikon Encoder</th></tr>
<tr><td>5, 6</td><td>Gnd</td><td colspan="5">Ground</td></tr>
<tr><td>7</td><td>EZ+</td><td>Encoder Z+</td><td>Encoder Z+</td><td rowspan="3">Not used</td><td>Not used</td><td rowspan="3">Not used</td></tr>
<tr><td>8</td><td>EB+</td><td>Encoder B+</td><td>SIN+</td><td>S2</td></tr>
<tr><td>9</td><td>EA+</td><td>Encoder A+</td><td>COS+</td><td>S1</td></tr>
<tr><td>10</td><td>DI-B5</td><td colspan="5">General purpose digital input</td></tr>
<tr><td>11</td><td>DI-B3</td><td colspan="5">General purpose digital input</td></tr>
<tr><td>12</td><td>DI-B2</td><td colspan="5">General purpose digital input (or Hall Sensor C) [non-isolated]</td></tr>
<tr><td>13</td><td>DI-B0</td><td colspan="5">General purpose digital input (or Hall Sensor A) [non-isolated]</td></tr>
<tr><td>14, 15</td><td>5V</td><td colspan="5">5V supply output</td></tr>
<tr><td>16</td><td>EZ-</td><td>Encoder Z-</td><td>Encoder Z-</td><td rowspan="3">Not used</td><td>Not used</td><td rowspan="3">Not used</td></tr>
<tr><td>17</td><td>EB-</td><td>Encoder B-</td><td>SIN-</td><td>S4</td></tr>
<tr><td>18</td><td>EA-</td><td>Encoder A-</td><td>COS-</td><td>S3</td></tr>
<tr><td>19</td><td>DO-B0+</td><td colspan="5">General purpose digital output (collector)</td></tr>
<tr><td>20</td><td>DO-B0-</td><td colspan="5">General purpose digital output (emitter)</td></tr>
<tr><td>21, 22</td><td>Gnd</td><td colspan="5">Ground</td></tr>
<tr><td>23</td><td>DAT+</td><td rowspan="4">Not used</td><td rowspan="4">Not used</td><td>Data+</td><td rowspan="2">Not used</td><td>SD+ (Serial Data HIGH)</td></tr>
<tr><td>24</td><td>DAT-</td><td>Data-</td><td>SD- (Serial Data LOW)</td></tr>
<tr><td>25</td><td>CLK-</td><td>Clock-</td><td>R2</td><td rowspan="2">Not used</td></tr>
<tr><td>26</td><td>CLK+</td><td>Clock+</td><td>R1</td></tr>
</table>

DI-B0~B2 can be used as Hall Signal sensor input when Hall Signal Source is set to "Feedback Port" in the UI.

3.12. I/O Pin Electrical Characteristics

3.12.1. Differential Input Equivalent Circuit of Feedback Port (A/B/Z Mode)



X: (X+, X-)
X = EZ, EB, EA

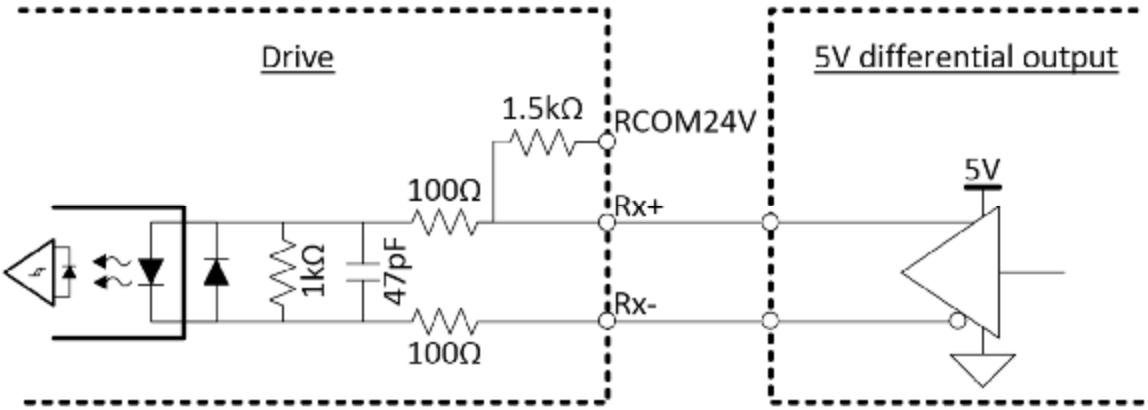
EA: (9, 18)
EB: (8, 17)
EZ: (7, 16)

3.12.2. Differential Input Equivalent Circuit of Controller Port (RA/RB/RZ)

There are 4 connection methods corresponding to different types of external signals.

When connecting with:

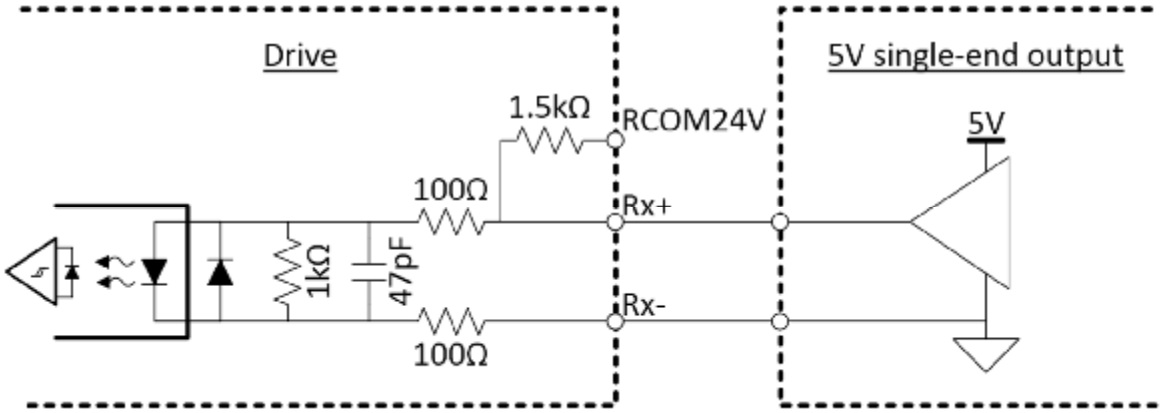
(1) External 5V differential signal



Rx: (Rx+, Rx-)
x = A, B, Z

RA: (13, 14)
RB: (22, 23)
RZ: (5, 6)

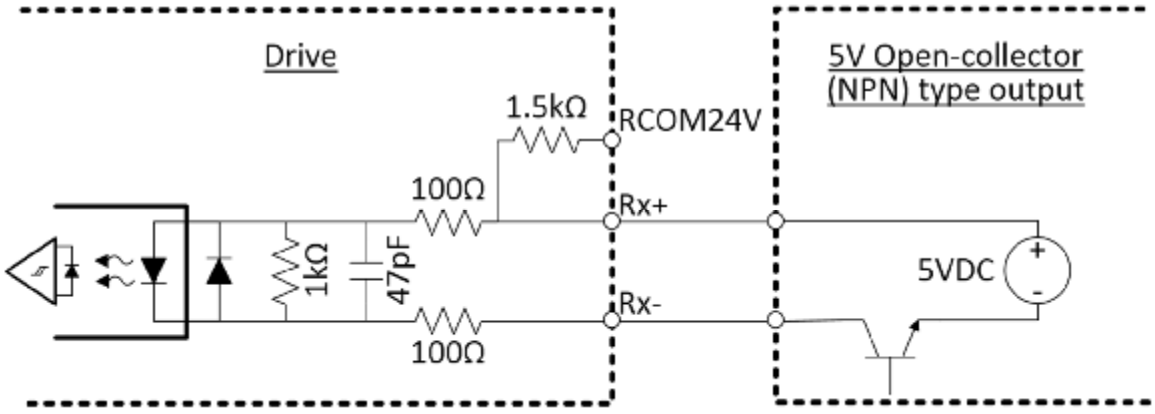
(2) External 5V single-end signal



Rx: (Rx+, Rx-)
x = A, B, Z

RA: (13, 14)
RB: (22, 23)
RZ: (5, 6)

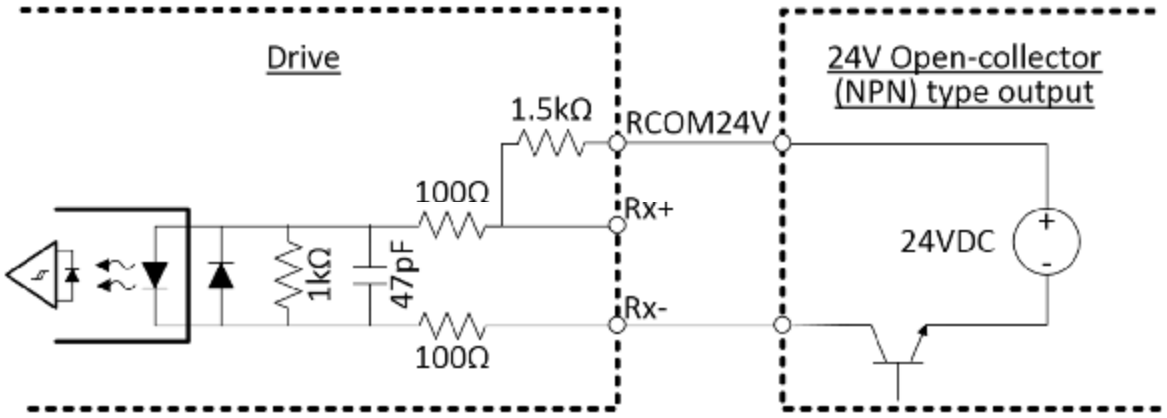
(3) External 5V open-collector (NPN) signal



Rx: (Rx+, Rx-)
x = A, B, Z

RA: (13, 14)
RB: (22, 23)
RZ: (5, 6)

(4) External 24V open-collector (NPN) signal



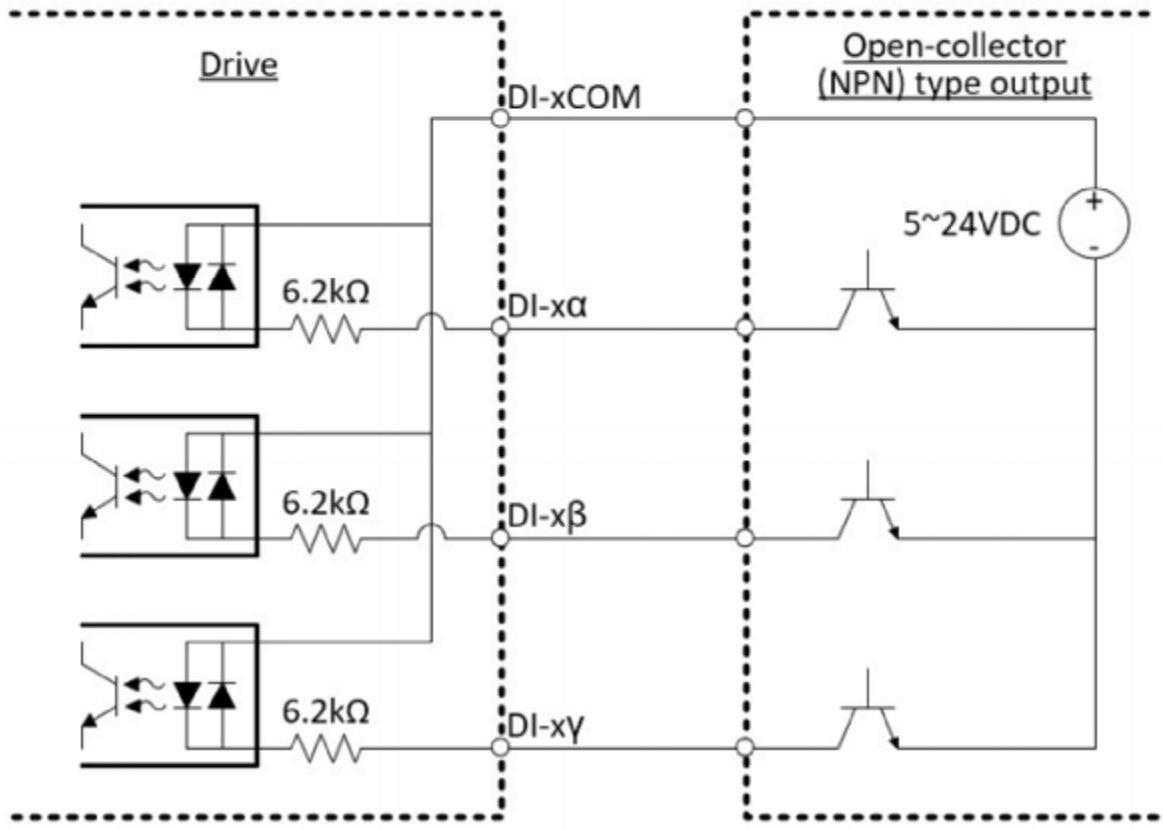
Rx: (Rx+, Rx-)
x = A, B, Z

RA: (13, 14)
RB: (22, 23)
RZ: (5, 6)

3.12.3. Digital Input up to 24V

All digital input pins of the Will1-B Driver series can accept digital commands up to 24V, whereas Will1 series can only accept up to 5V.

(1) Isolated Connection



↑ DI-xCOM, DI-x**α**/x**β**/x**γ**:

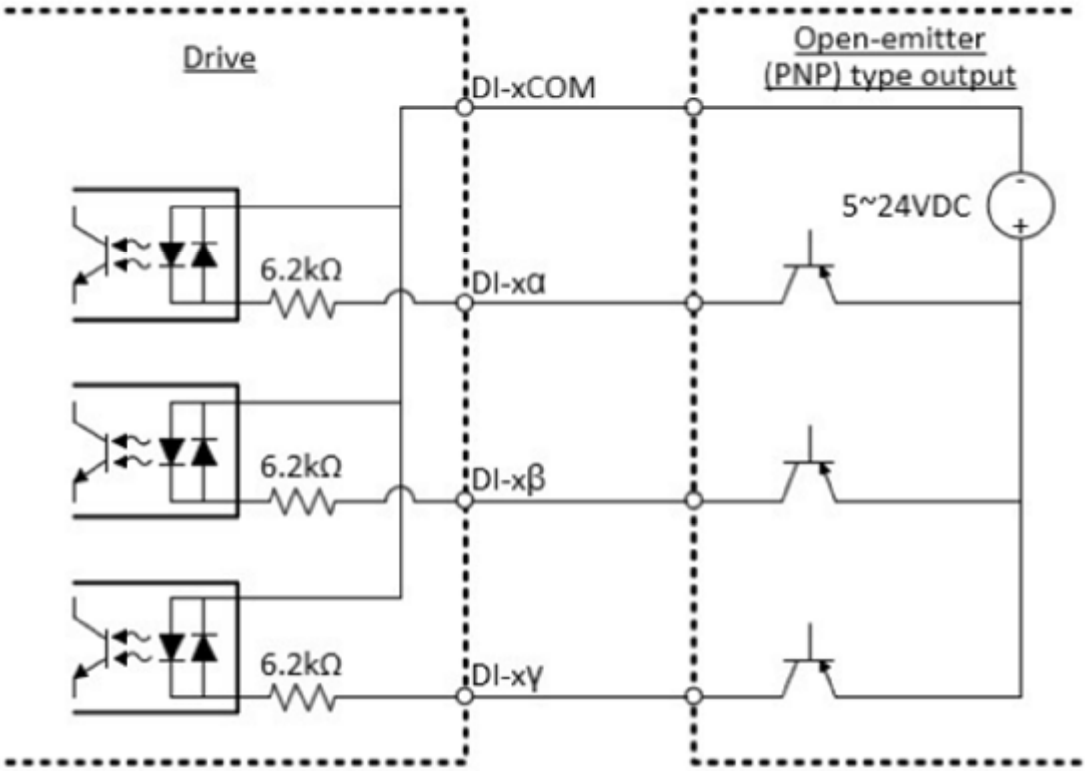
x = A, B, C

α / **β** / **γ**: serial numbers

General Port **è** x = A; α / β / γ = 0, 1, 2 (ex: ACOM, A0, A1, A2)

Feedback Port **è** x = B; α / β / γ = 3, 4, 5

Controller Port **è** x = C; α / β / γ = 0, 1, 2



↑DI-xCOM, DI-x**α**/x**β**/x**γ**:

x = A, B, C

α / **β** / **γ**: serial numbers

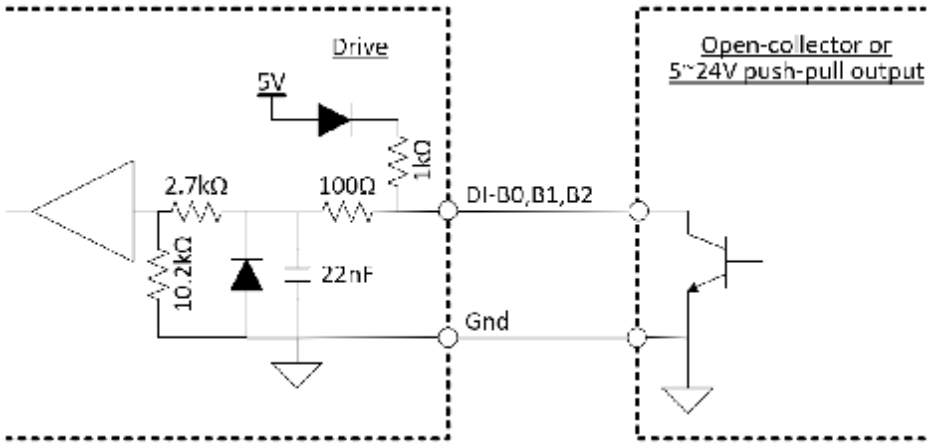
General Port **è** x = A; α / β / γ = 0, 1, 2 (ex: ACOM, A0, A1, A2)

Feedback Port **è** x = B; α / β / γ = 3, 4, 5

Controller Port **è** x = C; α / β / γ = 0, 1, 2

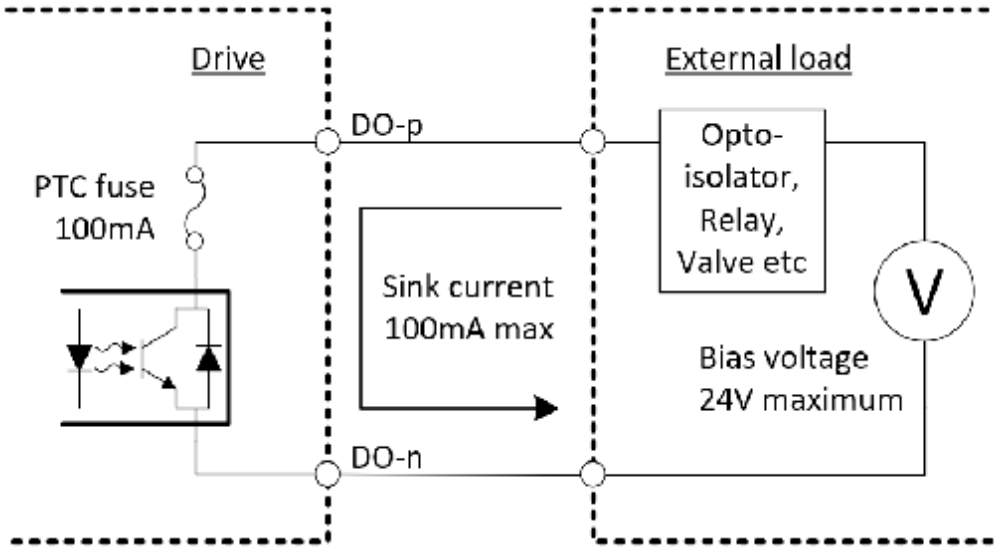
(2) Non-isolated Connection

Mainly for Hall Sensor use.



3.12.4. Digital Output (Open-Collector)

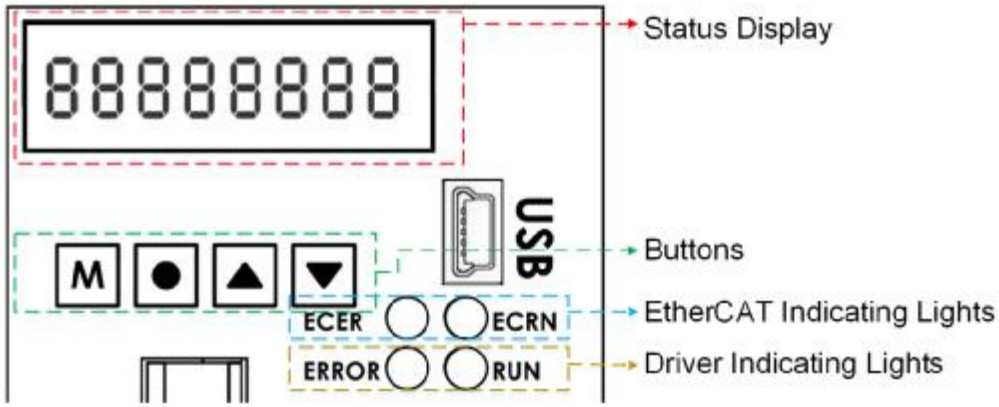
Maximum current allowed for DO: 100 mA.



↑Pin pairs:

DO-p	DO-n
DO-A0, A1	DO-ACOM
DO-B0+	DO-B0-
DO-C0+	DO-C0-
DO-C1+	DO-C1-
DO-C2+	DO-C2-

4. Status Panel



4.1. Indicating Lights

4.1.1. Driver Indicating Lights

When observing the Driver Indicating Lights, look for the green light first.

4.1.1.1. Flashing rate of Driver Indicating Lights

There are three possible states to the flashing of Driver Indicating Lights, these are: blink, flash or alternate blinking.

A. Blink:

The lights are on for 64 ms and off for 64 ms.

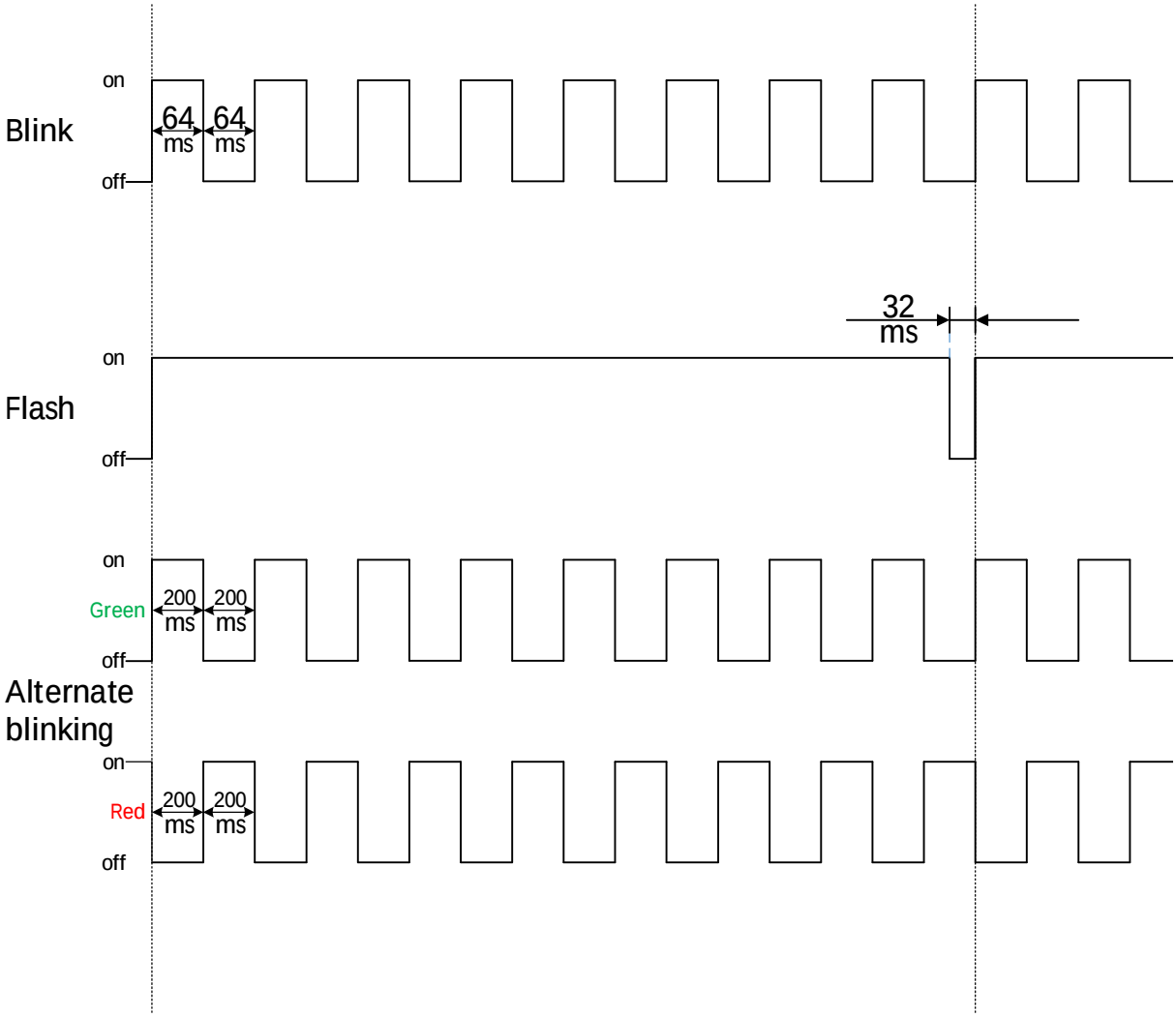
B. Flash:

The lights are on for 480 ms and off for 32 ms.

C. Alternate blinking:

The green and red lights takes turns flashing alternatively, on for 200 ms and off for 200 ms.

<Flashing Rate of Driver Indicating Lights>



4.1.1.2. Driver Indicating Lights Defined

Green (Run)	Red (Fault)	Description
Off	Off	Powered off
	Blink	Fault detected
	On	Fault cleared (need reset)
On	Off	Standby
	On	Motor is off, waiting for manual power on
Blinking	Off	Motor is on
	Flash	Executing phase-find or in powerup delay time*
Flashing	Off	Motor is off and dynamic brake is engaged
	Blink	Fault detected and dynamic brake is engaged
	Flash	Motor is off, waiting for manual power on, dynamic brake is engaged
	On	Fault cleared (need reset), and dynamic brake is engaged
Green/Red Alternate Blinking		■ Saving parameters to flash memory OR ■ Updating Driver firmware (Will1-B series only)

* Motor powerup delay time: 100 ms.

4.1.2. EtherCAT Indicating Lights (Optional)

We are compliant with regulations written in "Document: ETG.1300 S (R) V1.1.1" by EtherCAT Technology Group.

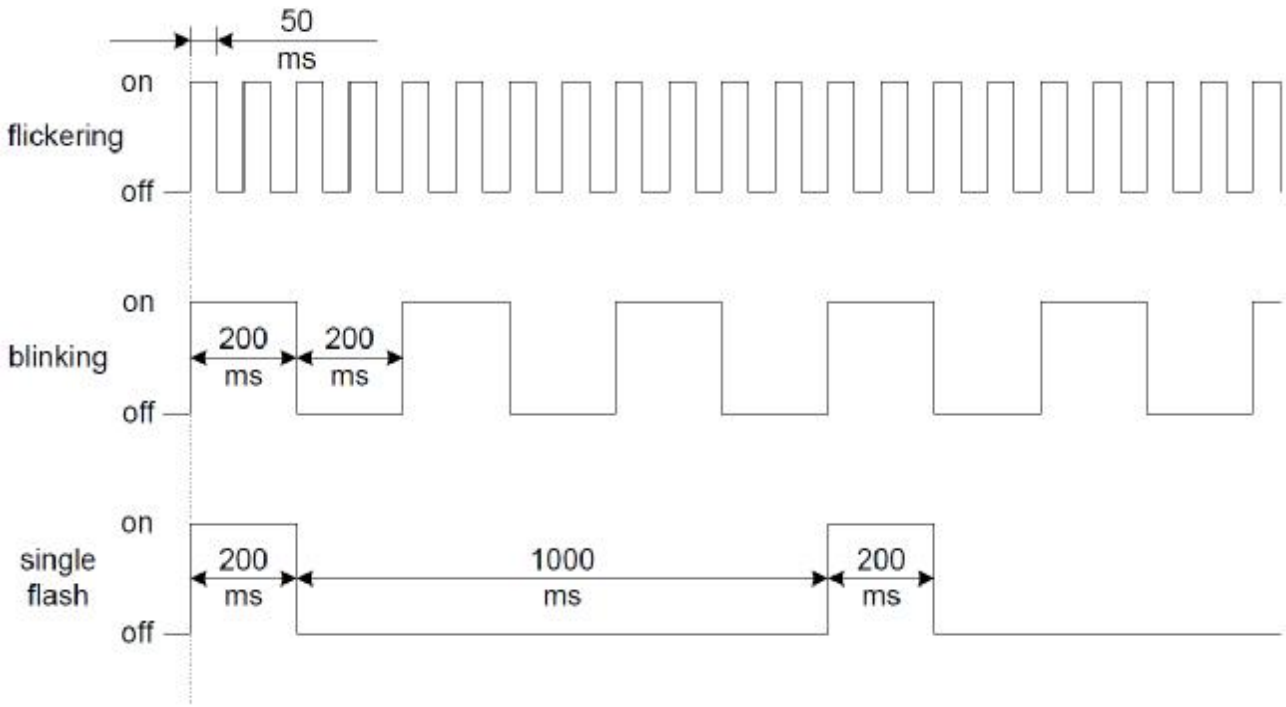
4.1.2.1. Flashing rate of EtherCAT Indicating Lights

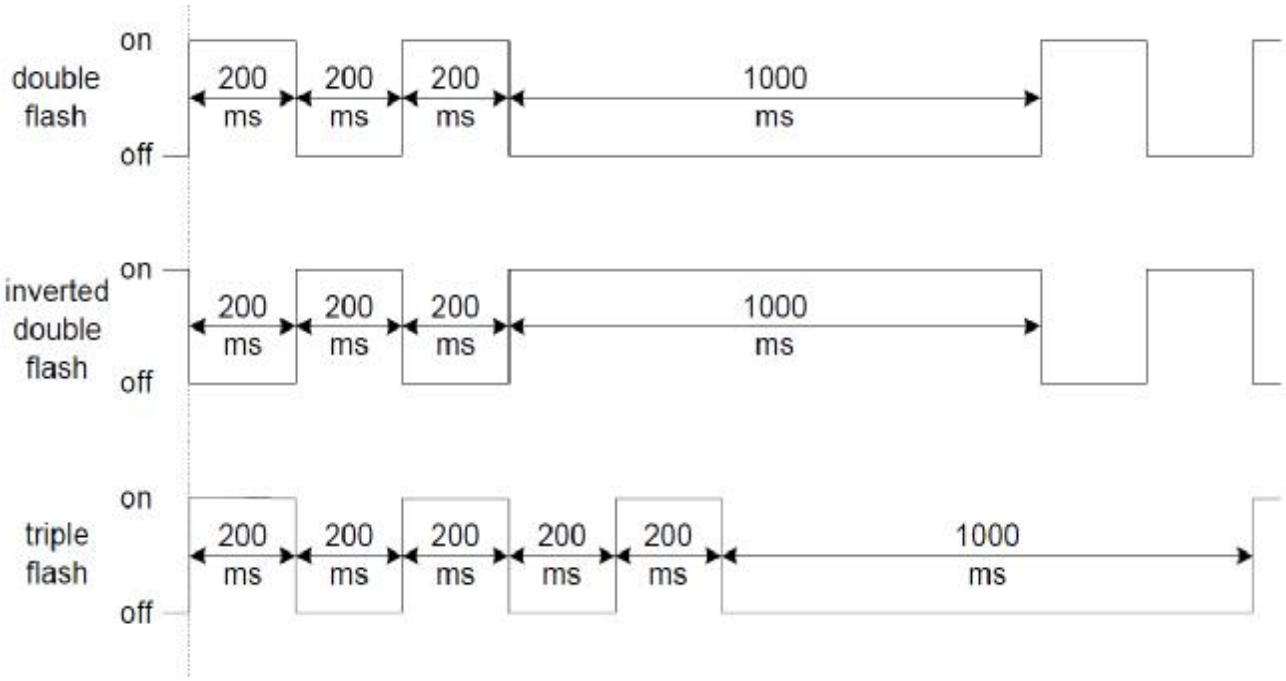
The indicating lights (or "indicator") states are defined in Table 1 and the flashing rates in Figure 1. The times listed are met with a tolerance of less than +/-20%.

<Table>

Indicator states Definition	Definition
On	The indicator shall be constantly on
Off	The indicator shall be constantly off
Flickering	The indicator shall turn on and off with a frequency of 10 Hz: on for 50 ms and off for 50 ms
Blinking	The indicator shall turn on and off with a frequency of 2.5 Hz: on for 200 ms followed by off for 200 ms
Single flash	The indicator shall show one short flash (200 ms) followed by a long off phase (1000 ms)
Double flash	The indicator shall show a sequence of two short flashes (200 ms), separated by an off phase (200 ms), and followed by a long off phase (1000 ms)
Inverted double flash	The indicator shall show a sequence of two short off flashes (200 ms), separated by an on phase (200 ms), and followed by a long on phase (1000 ms)
Triple flash	The indicator shall show a sequence of three short flashes (200 ms), separated by an off phase (200 ms), and followed by a long off phase (1000 ms)

<Figure 1: EtherCAT Indicator flashing rate>





4.1.2.2. RUN Indicator

The RUN indicator shows the status of the ESM.

1. LED: The color of the RUN indicator is green.
2. Labeling: The RUN indicator is labeled "ECRN".
3. States: The RUN indicator states are specified in Table 2.

<Table 2>

Indicator States	Slave State	Description
Off	INIT	The device is in Init state
Blinking	PRE-OP	The device is in Pre-Operational state
Single Flash	SAFE-OP	The device is in Safe-Operational state
On	OP	The device is in Operational state
Flickering	INIT or BOOTSTRAP	The device is booting and has not yet entered INIT state or the device is in BOOTSTRAP Mode (firmware download in progress)

4.1.2.3. Error Indicator

The Error Indicator shows errors resulting from local errors (i.e. input errors) such as timeouts and unsolicited state changes.

1. LED: The color of the Error Indicator is red.
2. Labeling: The Error Indicator is labeled ‘‘ECER’’.
3. States: The Error Indicator states are specified in Table 3.

<Table 3>

ERR State	Error Name	Description	Example
On	Application controller failure	A critical communication or application controller error has occurred	Application controller is not responding any more (PDI Watchdog Timeout detected by ESC)
Double Flash	Process Data Watchdog Timeout / EtherCAT Watchdog TIMEOUT	An application watchdog timeout has occurred	Sync Manager / Watchdog timeout
Single Flash	Local Error	Slave device application has changed the EtherCAT state autonomously, due to local error (see ETG. 1000 part 6 EtherCAT State Machine). Error Indicator bit is set to 1 in AL Status register	Device changes its EtherCAT stater from Op to SafeOpError due to a synchronization error
Blinking	Invalid Configuration	General Configuration Error	State change commanded by master is impossible due to register or object settings, or invalid hardware configuration (pin sharing violation detected by ESC)
Flickering	Booting Error	Booting Error was detected. INIT state reached, but Error Indicator bit is set to 1 in AL Status register	Checksum error in Application controller flash memory
Off	No error	The EtherCAT communication of the device is in working condition	-

4.2. Buttons and Status Display

D. Buttons

Item	Description
	Menu
	Enter
	Switch data source
	Switch data source

E. Status Display

Data Source	Description	Unit
	Script Step Number	-
	Current Auxiliary Command	0.1A
	Current Reference	0.1A
	Current Feedback	0.1A
	Velocity Auxiliary Command	cnt/s/1000
	Velocity Reference	cnt/s/1000
	Velocity Feedback	cnt/s/1000
	Position Auxiliary Command	cnt/1000
	Position Reference	cnt/1000
	Position Feedback (default)	cnt/1000

	Position Error	cnt
	cpc internal use only	
		

5. Maintenance

5.1. General

DANGER: To prevent electrical shock, disconnect the power cable before doing maintenance or repair work.

CAUTION: Excessive adjustments could lead to a hazardous state of the Servo Driver.

Do not open this device for any inspections or repairs. Contact cpc Customer Service for servicing requirements.

When the Will1-B Driver encounters errors such as over temperature, protection threshold exceeded, incorrect wiring, signal accessing errors, etc. the ‘‘Error Log’’ will record the date/time and error codes as they occur. If Will1-B Driver shuts down due to errors, users can trace the cause of the malfunction by checking the error logs.

When the Will1-B Driver detects multiple errors, it will only display the error code of the last found error. Prior errors can be checked through the UI.

5.2. Troubleshooting

Error Code	Error Message	Description	Action Required
2220	ContinuousOverCurrent_DeviceInternal	A short-circuit in Driver's internal power module is detected	Check for unstable current loop gain
2310	ContinuousOverCurrent_MotorSide	Motor current exceeds limit	Check for unstable current loop gain
3210	DCLinkOverVoltage	Internal DC capacitor exceeded limit (default: 375V)	1. Check external AC power source 2. Consider adding additional regenerative braking resistor
3220	DCLinkUnderVoltage	Internal DC capacitor under limit (default: 48V)	Check AC power source
3380	OutputVoltageExt5V	External 5V power supply does not start	Check DC power supply
3381	OutputVoltageExt7V	7V external power supply overload	Check the DC power supply and whether the external DC 5V supply is overloaded.
4310	ExcessTemperatureDrive	Driver's internal temperature exceeded safe limit	Improve environment cooling conditions
5520	ROM_EPROM	Factory calibration settings lost	Contact Customer Service
5530	EEPROM	Stored parameters lost	Reload Driver settings from file

Error Code	Error Message	Description	Action Required
7121	MotorBlocked	Motor stuck detected	Check motor stuck settings or if the block is stuck
7122	MotorErrorOrCommutationMalfunc	Failure during Phase Find	Check 1. Motor wiring 2. Execute ‘‘Phase Find’’ again
7305	IncrementalSensor1Fault	Encoder Feedback Signal error	Check Encoder wiring or improve system noise
7306	IncrementalSensor2Fault	External Auxiliary Command Signal error	Check Controller wiring or improve system noise
8481	OverVelocityAbsolute	Motor Velocity Feedback exceeded Velocity Protection Limit	Check motor operation or Over-Velocity Protection settings
8611	FollowingError	Motor Position error exceeded tolerance	Check 1. Motor operation 2. The settings for ‘‘Following Error Window/Timeout’’
8682	PositionLimitMinimum	Motor Position Feedback exceeded Position Protection Limit	Check motor operation or Over-Position Protection Setting
8683	PositionLimitMaximum	Motor Position Feedback under Position Protection Limit	Check motor operation or Under-Position Protection Setting
90F0	ExternalAlarmDigitalInput	External alarm triggered	Check controller operation

Error Code	Error Message	Description	Action Required
FF01	MainISROverload	CPU overload	Contact Customer Service
FF02	CurrentSensorU	Motor Current Sensor error	Restart Driver
FF03	CurrentSensorV	Motor Current Sensor error	Restart Driver
FF05	HallSensorCodeInvalid	Invalid Hall Sensor code detected	Check Hall Sensor configuration
FF07	MotorCtrlOpModeInvalid	Invalid Operation Mode code	Check Operation Mode and wiring
FF08	CommutationRequired	Attempting to activate Motor without performing Phase Find first	1. Check ‘‘Phase Find’’ settings 2. Execute ‘‘Phase Find’’ again

6. Model Variations

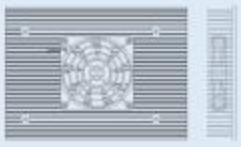
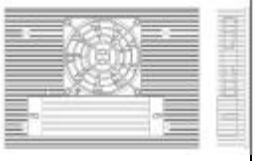
- Please refer to chapter 1.3 (Ordering Information) for model variations (P, H, F, R and E) and also chapter 6 on choosing the correct model needed. In addition, we offer optional accessories (chapter 7) such as EMI Board and Ferrite Choke. When placing orders, please specify your requirements.

Note: The variations of P, H, and F are for the 9A-type Will1-B Driver ONLY.

Will-	B	9	P	/230-	H	R	E
							None: CANopen E: EtherCAT
						None: Resistor R: Brake resistor	
					None: No heatsink H: Passive heatsink F: Heatsink with fan		
				AC supply: 230VAC			
			None: Normal P: Extended peak current (Note)				
		Continuous current (Amps): 3, 9, 21					
	None: A-type B: B-type						
Servo Driver							

- A Summary Table is also provided below for easier reference.

<Summary Table>

	Will-B3/230	Will1-B9/230			Will1-B21/230
Continuous current application	3A	3A	6A	9A	21A
Corresponding Heatsink Types	N/A	N/A	H type Factory-installed 	F type Factory-installed 	N/A
Regenerative Resistor	Optional Installed by users	Optional Installed by users		Factory-installed 	Standard N/A

6.1. P: Extended Peak Current (for 9A-type Will1-B Driver only)

The peak current feature is for 9A-type Will1-B Driver only and can be up to 30A.

Specifications			
Model No.		Will-B9/230	Will-B9P/230
Output Power	Continuous Current	9 (6.36 RMS)	9 (6.36 RMS)
	Peak Current	20 (14.14RMS)	30 (21.22RMS)
	Peak current	2.5	

6.2. Heatsink (for 9A-type Will1-B Driver only)

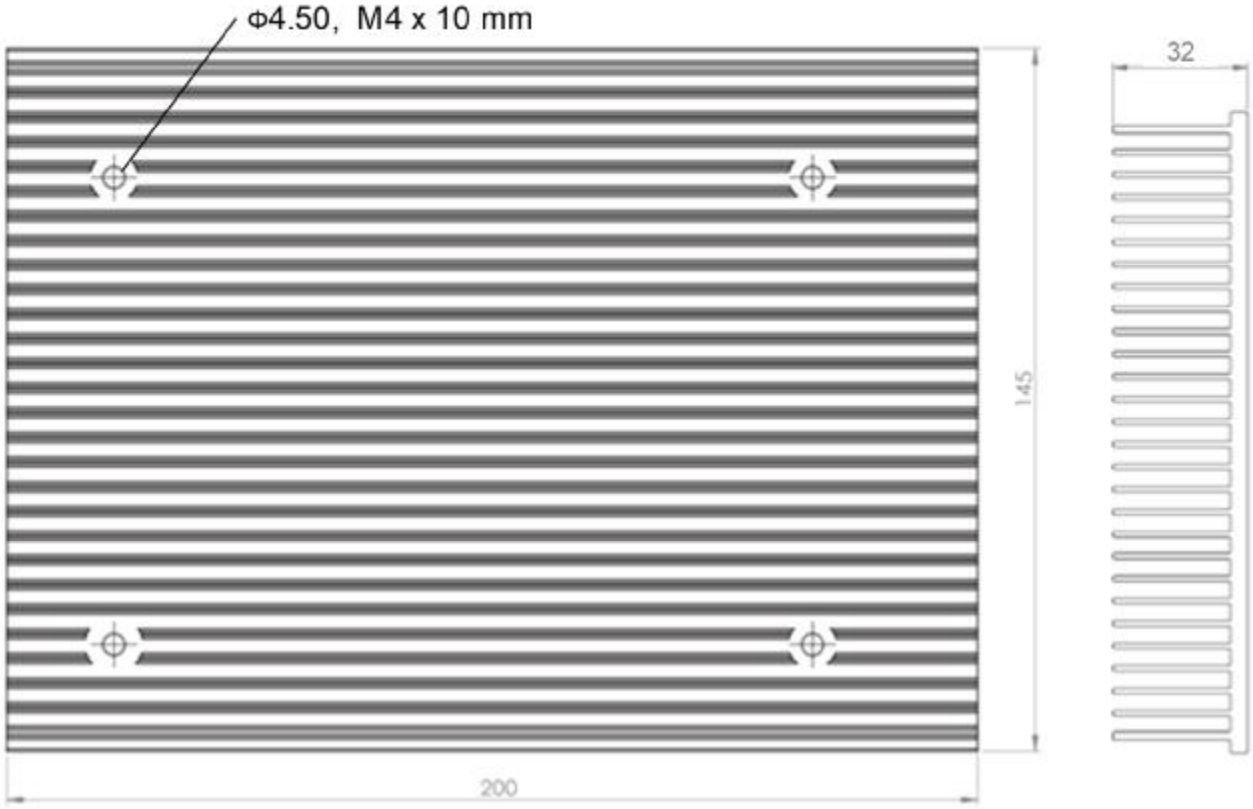
Note: Heatsink options are H and F types and are for the 9A type Driver only.

6.2.1. H: Passive heatsinks (for 9A-type Will1-B Driver only)

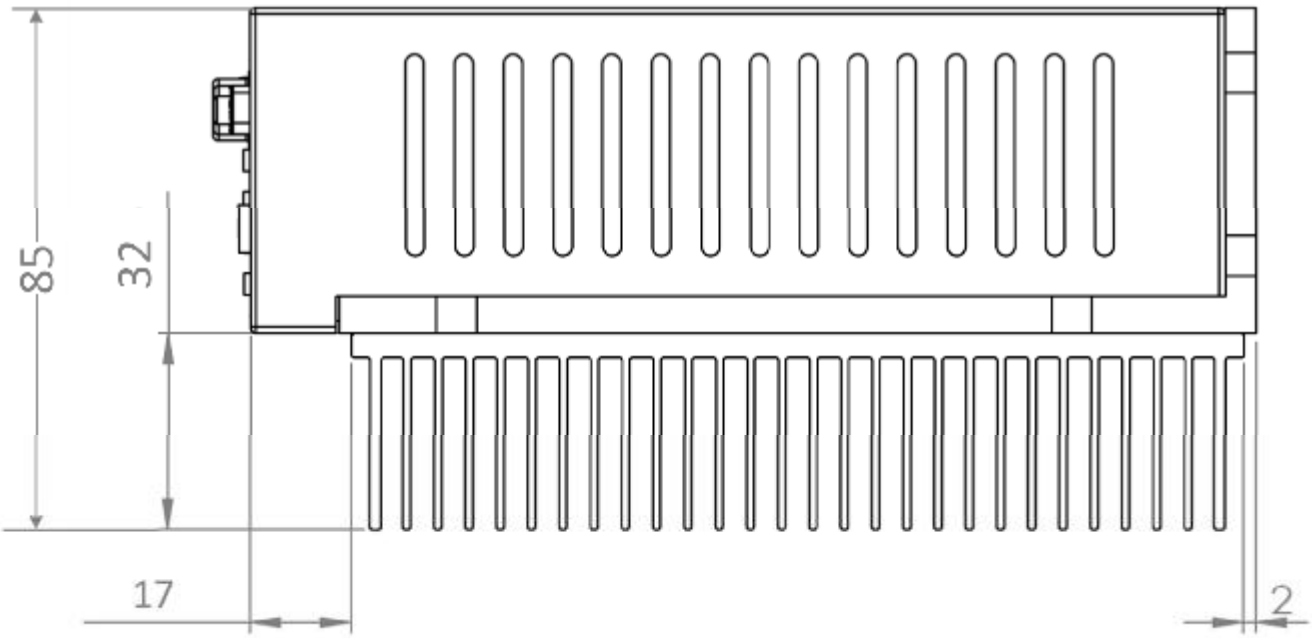
1. For 9A-type Will1-B Driver only.
2. If a continuous current of 6A is needed, equipping this type of passive heatsink is highly recommended.
3. The passive heatsink will be installed by cpc before shipment.

6.2.1.1. Dimensions of H-heatsink

(1) H-heatsink:



(2) H-heatsink installed on Driver

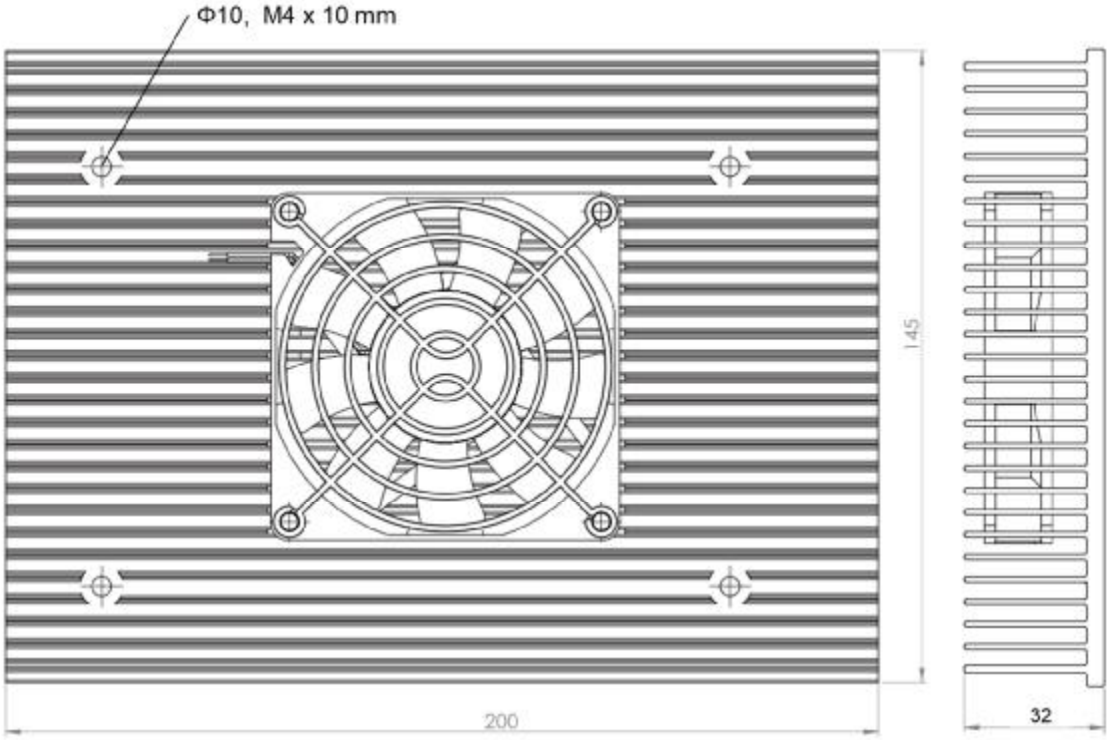


6.2.2. F: Heatsink with fan (for 9A-type Will1-B Driver)

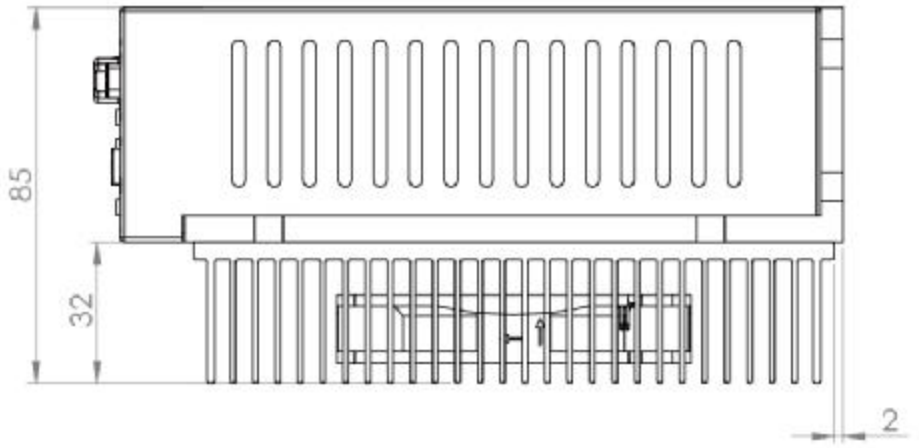
1. For 9A-type Will1-B Drivers only.
2. If a continuous current of 9A is needed, equipping this passive heatsink with fan is highly recommended.
3. Passive heatsink with fan will be installed by cpc before shipment.

6.2.2.1. Dimensions of F-heatsink

(1) F-heatsink:



(2) F-heatsink installed on Driver



6.3. R: Regenerative Resistor

Both the 3A-type and the 9A-type Will1-B Driver can be fitted with regenerative resistor.

A. Compatible with 3A-type Will1-B Driver
Users will need to install the regenerative resistor by themselves.

B. Compatible with 9A-type Will1-B Driver
1. Without heatsink
Users will need to install the regenerative resistor by themselves.

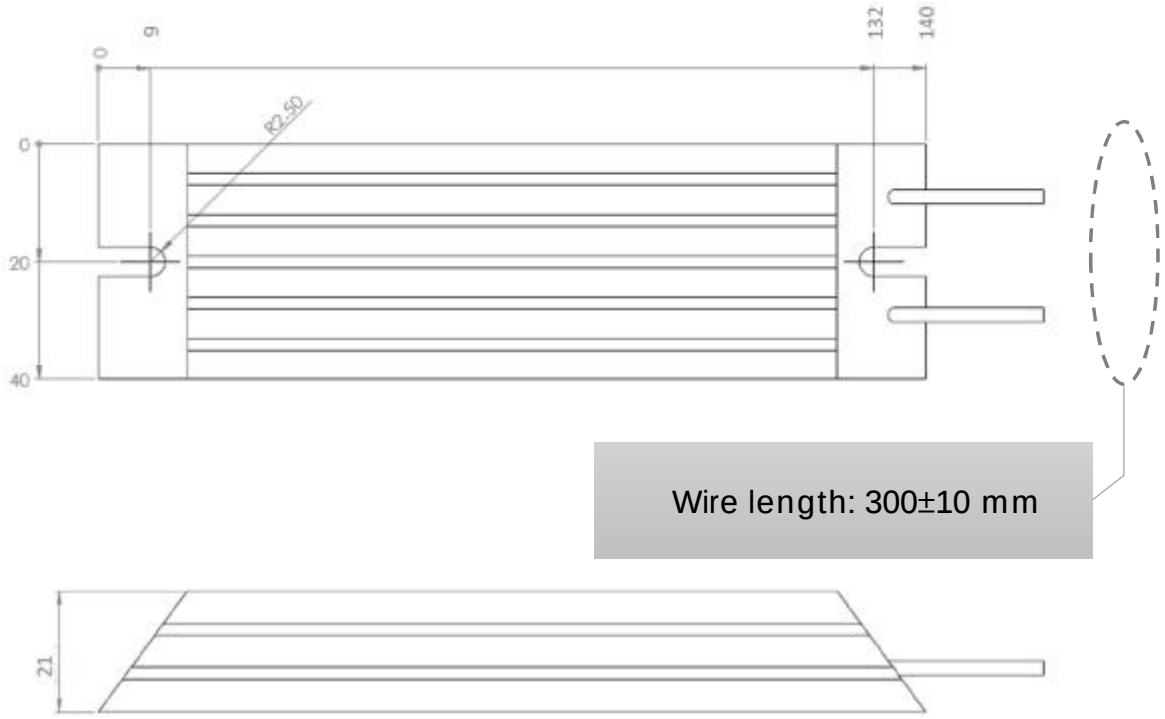
With heatsink
(a) H-heatsink (to facilitate continuous current of 6A)
Users will need to install the regenerative resistor by themselves.
(b)F-heatsink (to facilitate continuous current of 9A)
The regenerative resistor will be embedded in the heatsink for the 9A-type Will1-B Driver and will be installed by cpc before shipment. See Ch. 6.3.1 (2) for details.

Please refer to the Summary Table in chapter 6.

C. Compatible with 21A-type Will1-B Driver
Users will need to install the regenerative resistor by themselves.

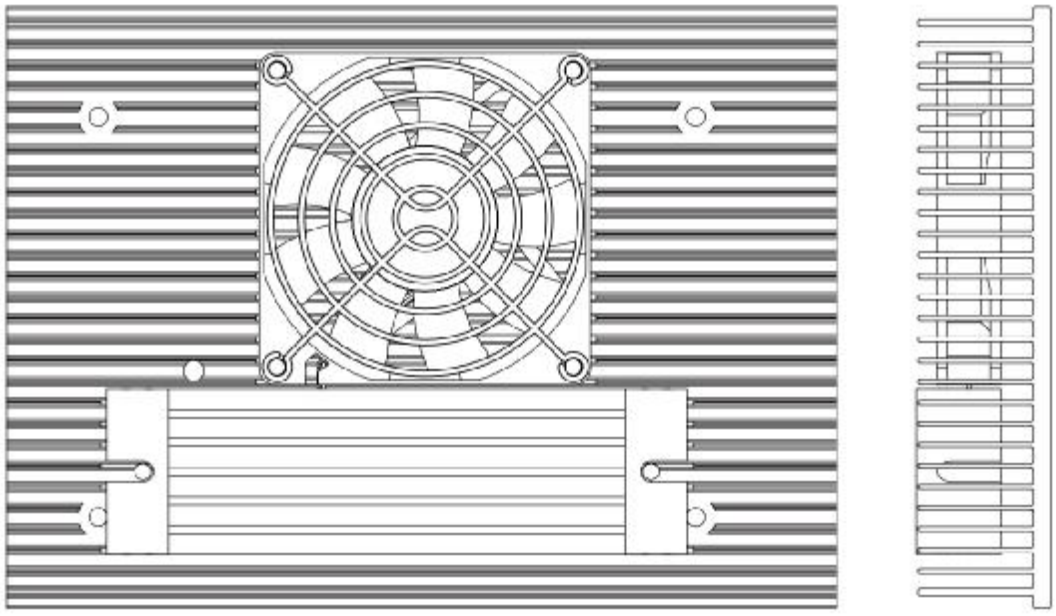
6.3.1. Dimensions of Regenerative Resistor

(1) Regenerative resistor

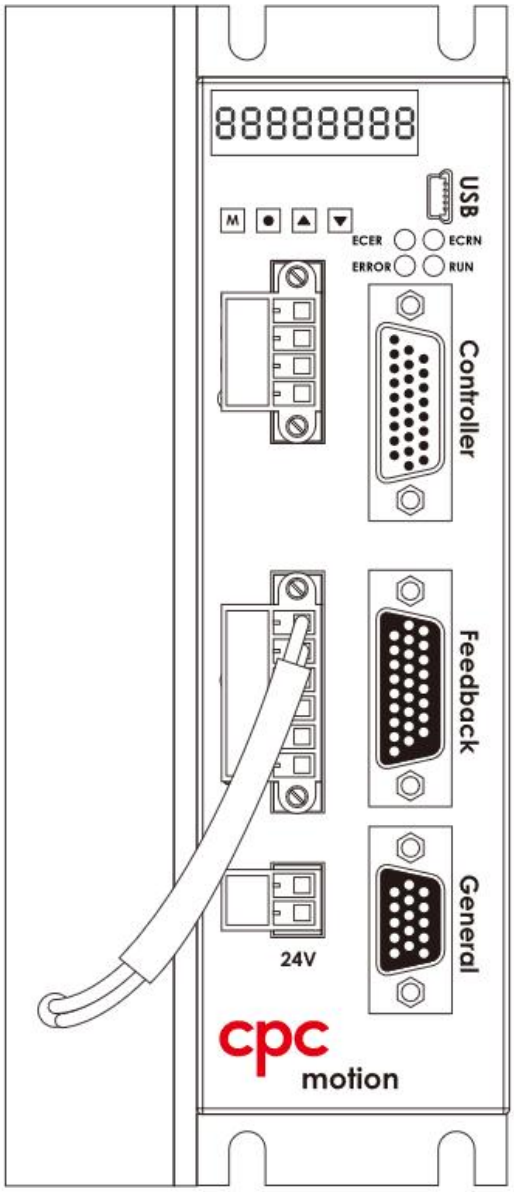


(2) Regenerative resistor embedded in the F-heatsink

Side view



Front view



6.4. E: EtherCAT

The customer can choose to equip the Will1-B Drivers with either CANopen, the standard option, or EtherCAT interfaces.

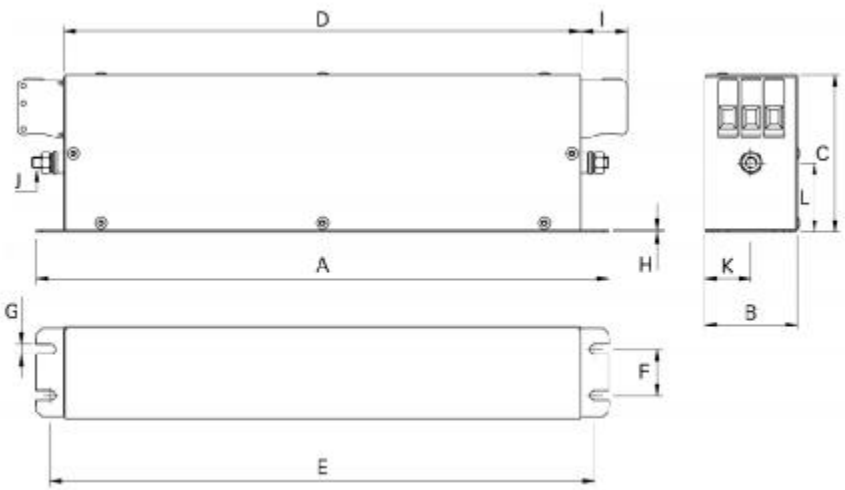
7. Optional Accessories

7.1. AC Power Filter

The AC power filter optional accessory is made by SCHAFFNER.
Matching model information are below:

(1) 3A & 9A-type Will1 Driver: Uses SCHAFFNER FN3258-7-45 (7 Amperes).
(2) 21A-type Will1 Driver: Uses SCHAFFNER FN3258-16-45 (16 Amperes).

7.1.1. Dimensions of AC Power Filter



Dimensions

	7 A	16 A
A	190	250
B	40	45
C	70	70
D	160	220
E	180	235
F	20	25
G	4.5	5.4
H	1	1
I	22	22
J	M5	M5
K	20	22.5
L2	29.5	29.5

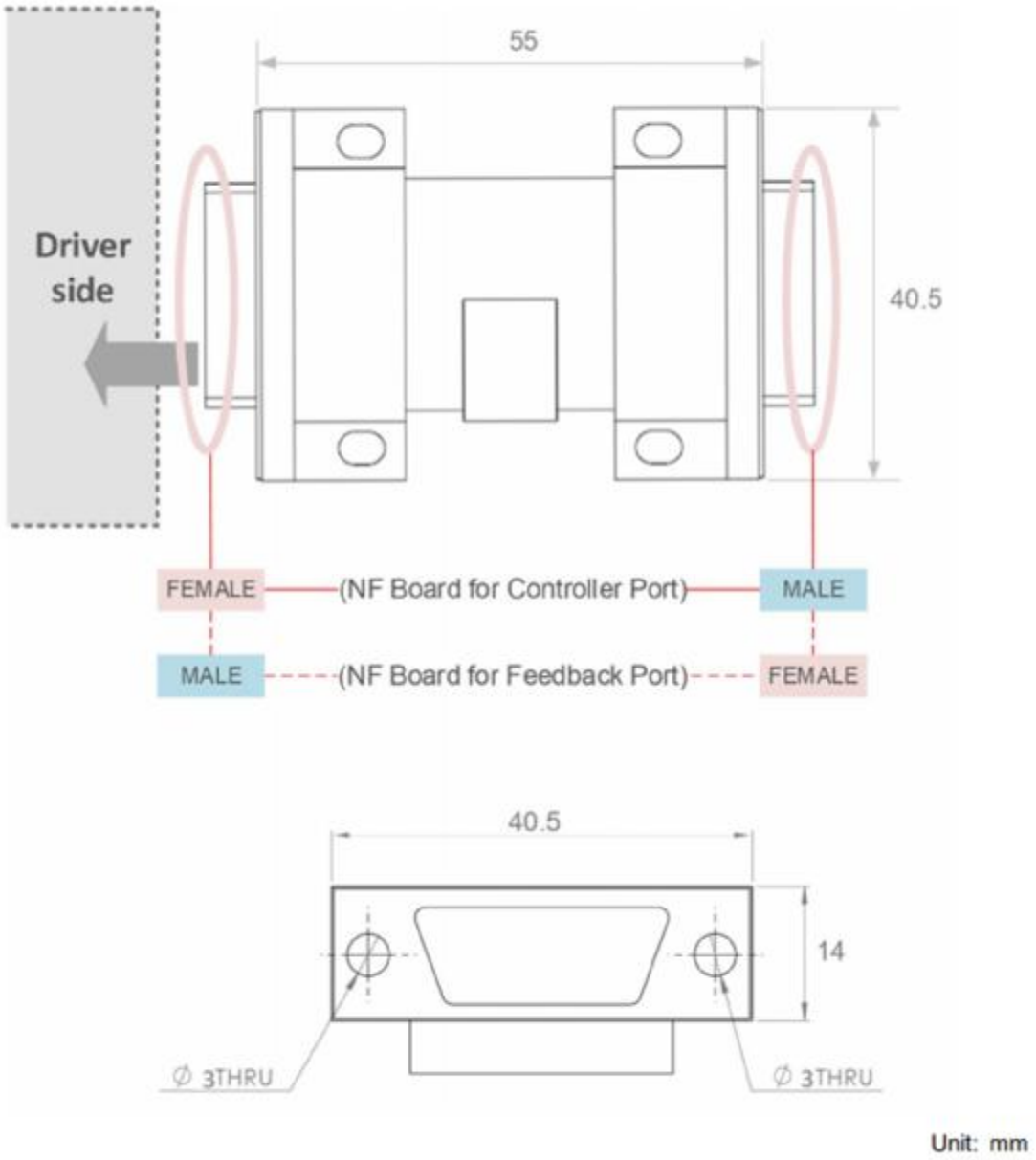
All dimensions in mm; 1 inch = 25.4 mm

For further product information please visit the SCHAFFNER official website.

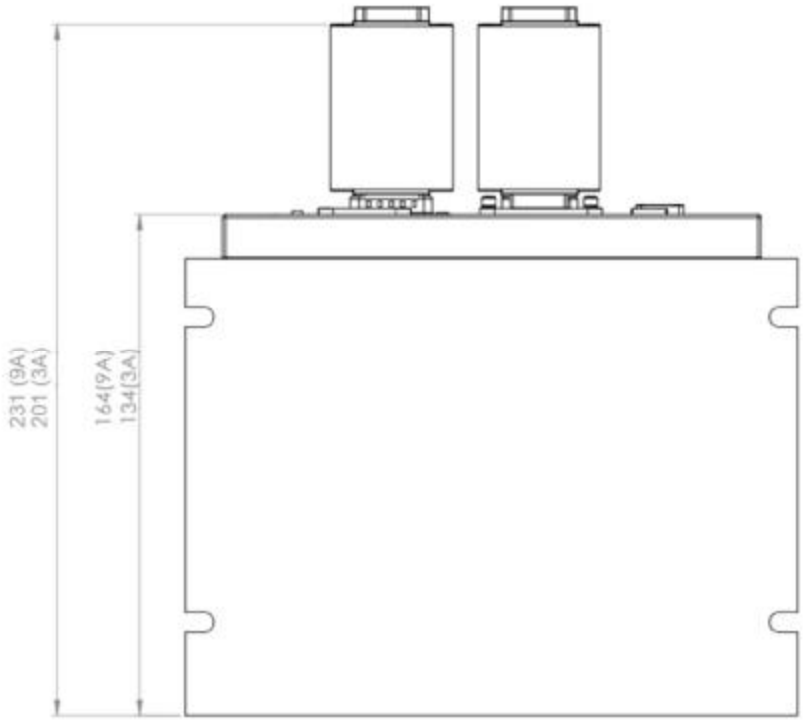
7.2. Noise Filter Board for Will1-B Driver Will1-B

The Noise Filter Board* (NF board) helps shield noise conducted from the signal cables. Please insert the NF board to the proper corresponding port.
(* Current version: 0.3)

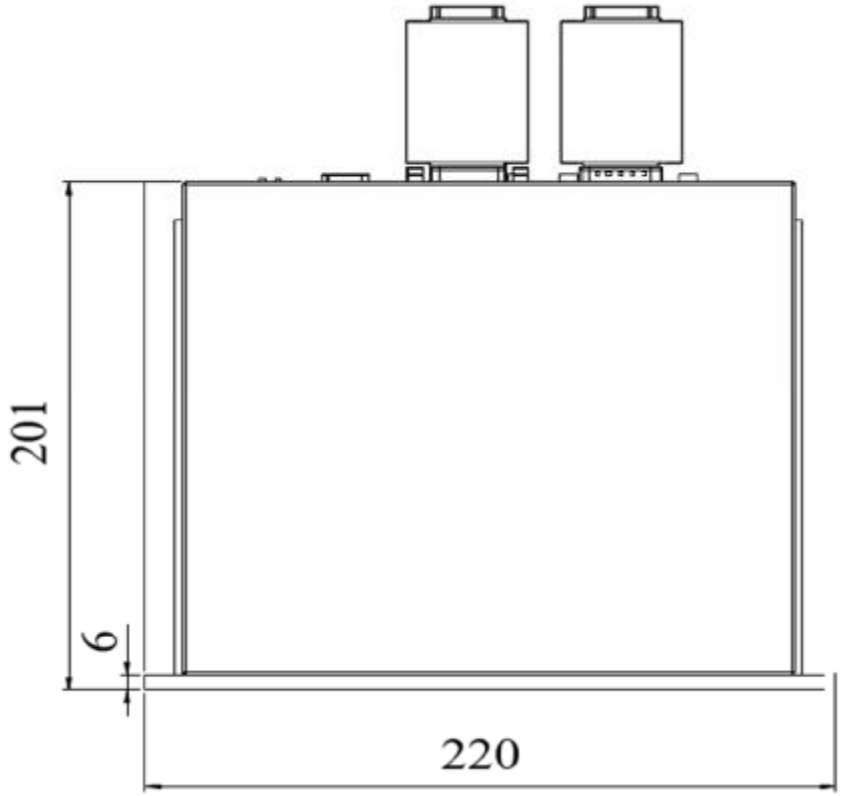
7.2.1. Dimensions of NF Board (stand-alone/assembled)



(3A/9A)

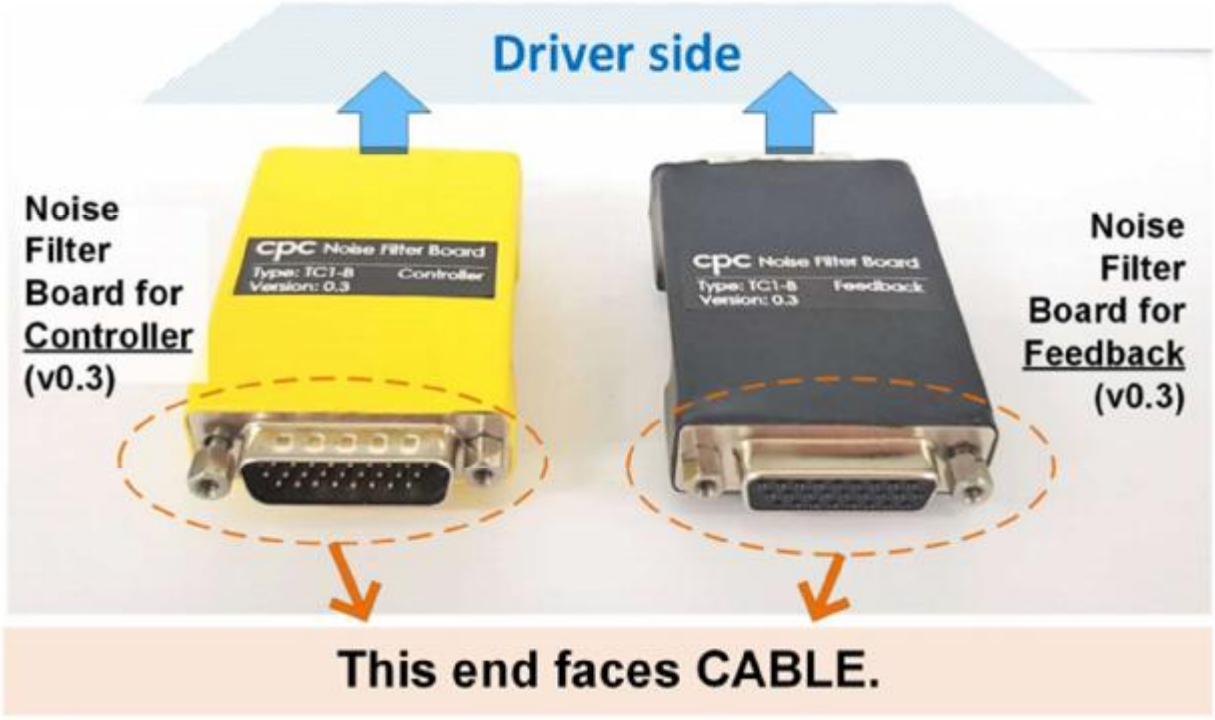


(21A)



7.2.2. Install Orientation and Steps

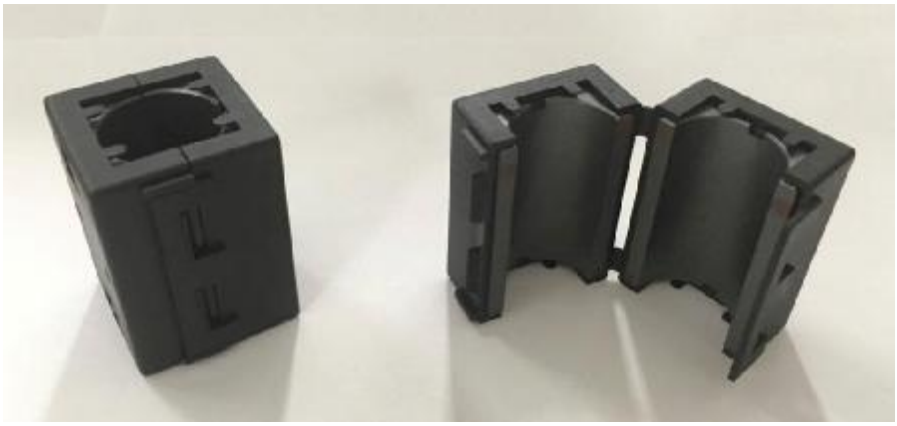
- During installation, the Boards must be oriented correctly.



- Installation Steps: (using Feedback as example)
  (1) Insert the NF Board for Feedback into the Feedback Port and tighten the screws.
  (2) Attach the signal cable.

7.3. Ferrite Choke

A Ferrite Choke helps shield external noises.



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