北京亿利泰达科技有限公司
Beijing Eletechnic Ltd.

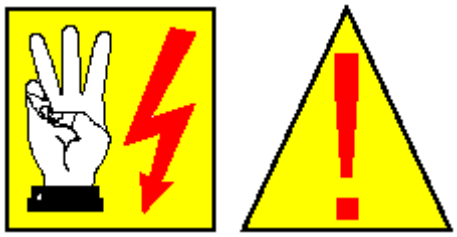
BLMD-8TC39-1P-SL23 High Voltage Sensorless

Brushless DC Motor Driver Product Datasheet

BLMD-8TC39-1P-SL23 is a high voltage, three phase, full wave and sensorless Brushless DC Motor Driver. This driver has two sub-types, AC type and DC type. AC type is suitable for 75-275VAC, 50/60Hz, one phase power supply. And DC type is suitable for 55-390VDC power supply. Rated output current of the three phases is 8ADC.

- Internal AC to DC Rectifier and Filter (Only for AC type)
- Three Phase IGBTs H-Bridge (20kHz PWM)
- Sensorless, Three Phase Lines, No Centertap
- Speed Frequency Generator--FG
- Forward/Reverse Direction--F/R
- Run Enable/Disable--En
- Open Loop Stepless Speed Control--ADJ
- Speed Setup--SS
- Dynamic Braking--BRK (Conditional)
- Over Temperature Lockout and Unlock--OT
- Motor Line Current Feedback--CFB
- Sink Temperature Feedback--TFB
- Current Limit
- Undervoltage Lockout

BLMD	-	8	T	C	39	-	1P	-	SL	23
Brushless Motor Driver		Rated Output: 8ADC		Temperature Lockout	Current Limit		Max Input: 390VDC		One Phase Protection	S: Sensor SL: Sensorless	Sub-series



Please read Safety Warning below carefully before installing and operating this driver!

- **This product should be installed and serviced by a qualified technician, electrician, or electrical maintenance person familiar with its operation and the hazards involved.**
- **Proper installation, which includes wiring, mounting in proper enclosure, fusing, cooling, and grounding can reduce the chance of electrical shocks, fires, or explosion in this product or products used with this product, such as motors, coils, junctions and/or other circuits connected to it.**
- **Be sure to eliminate body static electricity when operation.**
- **To connect or disconnect J3 or C1 or C2 when power on is FORBIDDEN. J3 phase missing is FORBIDDEN.**
- **Do not touch the PCB board, and/or other circuits connected to it, when power on. Eye protection must be worn and insulated tools must be used when working under power.**
- **All output and input terminals are NOT isolated from the incoming AC mains supply and may be at up to 400V with respect to earth, regardless of the input mains supply voltage applied. These terminals are live during connection. Do not attempt to access these terminals during this time.**

Absolute Maximum Ratings

(The Absolute Maximum Ratings are those values beyond which the safety of the driver cannot be guaranteed)

Parameter	Symbol	Value	Unit
Power Supply Voltage	V_{J1}	390 (275rms)	V
Peak Output Current	I_A, I_B, I_C	22 peak (Approximate)	ADC
Rated Output Current	I_A, I_B, I_C	8	ADC
Min Permissible Inductance of Motor	L_{Motor}	1 (Line to Line)	mH
Max Controllable Motor Speed	One Magnetic Pole-pair Rotor	40000	rpm
Digital Inputs Voltage	F/R, EN, SS, BRK, OT	-0.3 to 6.5	V
FG, OT Output Voltage	FG, OT	-0.3 to 6.5	V
FG Output Current	I_{FG}	5 (Sink and Source)	mA
OT Output Current	I_{OT}	5 (Sink Only)	mA
Speed Control Input Voltage	ADJ	-0.3 to 6.5	V
CFB, TFB Output Current	I_{CFB}, I_{TFB}	5 (Source and Sink)	mA
Operating Ambient Temperature Range	Ta	-20 to +85	C

Electrical Characteristics

(J1=220VAC/310VDC, Ta=20C, unless otherwise noted)

Parameter	Symbol	Min	Typical	Max	Unit
J1--Power Supply					
AC 50/60Hz, 1 Phase	VAC	75	110/220	275	VAC
DC	VDC	55	155/310	390	VDC
FG--Speed Frequency Generator Digital Output					
High State Volt	V_{OH}	-	5.2	-	V
Low State Volt	V_{OL}	-	0.8	-	V
Source Current	I_{OH}	-1	0	-	mA
Sink Current	I_{OL}	-	-	5	mA
F/R, EN, BRK--Digital Inputs					
High Threshold Volt	V_{IH}	-	3.5	-	V
Low Threshold Volt	VIL	-	1.2	0.8	V
High State Current	IIH	-75	-	-10	uA
Low State Current	IIL	-300	-	-10	uA
ADJ--Open Loop Stepless Speed Control Analog Input					
100% PWM	V_{UP}	-	4.2	4.5	V
0% PWM	V_{DN}	1.2	1.5	-	V
ADC Resolution	ΔV	-	1/64	-	-

SS—Speed Setup Three States Digital Input

High State Volt (H)	V_H	4	-	5	V
Middle State Volt (M)	V_M	2	-	3	V
Low State Volt (L)	V_L	0	-	1	V

OT--Over Temperature Lockout Digital Output/Unlock Digital Input

High State Volt	V_{OH}	-	-	6.2	V
Low State Volt	V_{OL}	-	0.8	-	V
Source Current	I_{OH}	-	-1	-	mA
Sink Current	I_{OL}	-	-	5	mA
Unlock Input Volt	V_{UnLock}	-	3	-	V

CFB--Motor Line Current Feedback Analog Output

Output Volt Range	V_{CFB}	0	-	6.2	V
Output Current	I_{CFB}	-	-	5	mA
Coefficient	K_{CFB}	0V=0ADC	2ADC/1V	6.2V=12.4ADC	ADC/V

TFB--Sink Temperature Feedback Analog Output

Output Volt Range	V_{TFB}	0	-	6.2	V
Output Current	I_{TFB}	-	-	5	mA

Temperature Range of Lockout/Auto Unlock

Lockout	Ts	80	85	90	C
Auto Unlock	Ts	70	75	80	C

Current Limit

Peak Current	I_A, I_B, I_C	-	22	-	ADC
Average Current	I_A, I_B, I_C	-	8 (Approx.)	-	ADC

Undervoltage Lockout

AC Supply	UV	-	30	-	VAC
DC Supply	UV	-	40	-	VDC

Junction Table

Junction	Pin	Type	Function
J1	L(+)	Power Supply	AC Live Line, DC Positive
	N(-)	Power Supply	AC Null line, DC Negative
	To Earth	-	Earth Line
J2	FG	Digital Output	Speed Frequency Generator, TTL Compatible
	F/R	Digital Input	Forward/Reverse Direction, TTL Compatible
	EN	Digital Input	Run Enable/Disenable, TTL Compatible
	UP	Voltage Divider	Potentiometer Up Pin

Continue	ADJ	Analog Input	Open Loop Stepless Speed Control
	DN	Voltage Divider	Potentiometer Down Pin
	SS	Three States Digital Input	Motor Speed Setup, Three States Digital Input
	BRK	Digital Input	Dynamic Braking, TTL Compatible
	GND	-	Signals GND
	OT	Digital I/O	Over Temperature Lockout and Unlock, TTL Compatible
	CFB	Analog Output	Motor Line Current Feedback
	TFB	Analog Output	Sink Temperature Feedback
J3	A	Driver Output	A Phase Winding Driver
	B	Driver Output	B Phase Winding Driver
	C	Driver Output	C Phase Winding Driver
C1	C1 +/-	Capacitor	Ramp up Capacitor 1
C2	C2 +/-	Capacitor	Ramp up Capacitor 2

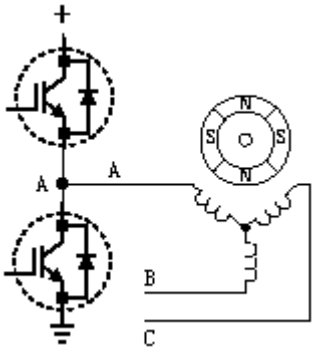
Main Functions Description

J1--Power Supply:

This driver has two sub-types, AC type and DC type. AC type is suitable for 75-275VAC, 50/60Hz, 1 Phase power supply. There is a build-in rectifier and filter AC to DC converter, its maximum load capability is about 11AAC. DC type is suitable for 55-390VDC power supply, its maximum load capability is about 8ADC. The FUSE is 15A.

Because of the different connections of GND Lines, these two sub-types cannot be substituted for each other. Otherwise the GND Lines will be broken.

J3--A, B, C Three Phase Winding Driver:



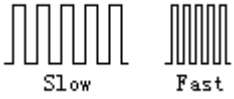
The driver output circuit is shown in right figure. Three Phase, Full wave, H-Bridge could drive either Y or Delta winding motor. Centertap is unwanted. Please see "Commutation Truth Table" for details.

The use of 20kHz pulse width modulation at the three bottom IGBTs provides an energy efficient method of controlling the motor speed by varying the average voltage applied to each stator winding during the commutation sequence.

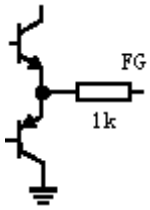
The running direction depends on the connection sequence of three phase lines. Exchanging any two lines of the three will cause the motor to run in the opposite direction. The running direction also depends on the state of F/R and the structure of BLDC motor.

To connect or disconnect J3 when power on is FORBIDDEN! J3 phase missing is FORBIDDEN!

FG--Speed Frequency Generator Digital Output:



TTL compatible. Open collector output. The internal circuit is shown in right figure.



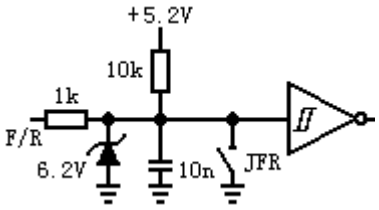
Its frequency is directly proportional to the motor speed. Pulse duty cycle is about 50%. The output waveforms are shown in left figure.

FG is low at start ramp up mode OR upon a detection of a fault. So it can be used as RAMP OR FAULT signal.

FG (Hz) = Speed (rpm) * N * 3 / 60. N means the number of magnetic pole-pairs (NOT POLES) of the rotor.

F/R--Forward/Reverse Direction Digital Input:

TTL compatible. The internal circuit is shown in right figure. Please see "Commutation Truth Table" for details.



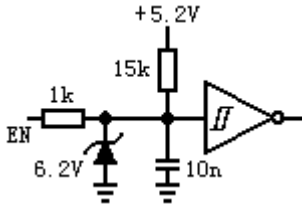
When F/R signal is high or float, the direction of motor rotation is forward. When F/R is low, it is reverse. The running direction also depends on the structure of BLDC motor.

JFR switch could change the direction on board. But when using J2-F/R pin as signal source, please set JFR OPEN. Otherwise the J2-F/R signal will be grounded for ever.

Reversing when running is FORBIDDEN! That means the motor must be disable (En=0) and speed down to quiescence first, then give F/R reverse signal, then enable (En=1) and speed up.

En--Run Enable/Disenable Digital Input:

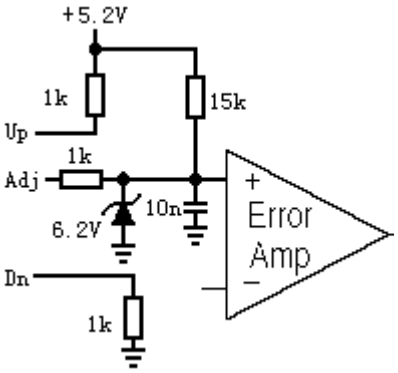
TTL compatible. The internal circuit is shown in right figure. Please see "Commutation Truth Table" for details.



A logic high or float at En pin causes the motor to run, while a low causes motor to coast and ABC three phases output Z state.

ADJ--Open Loop Stepless Speed Control Analog Input:

Analog signal. The internal circuit is shown in right figure. There are three ways to control speed: (Please see "Application Circuit Examples" for details)



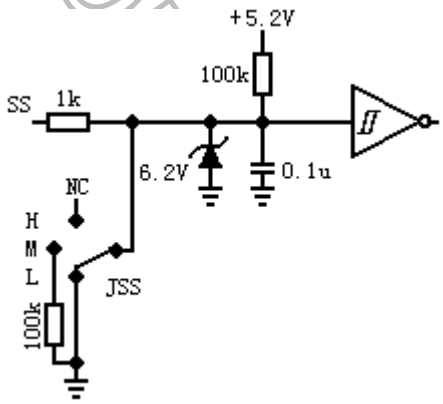
First, connect the top side and bottom side of a 10kOhm potentiometer to the UP pin and DN pin of J2 separately. And connect the middle pin of the potentiometer to ADJ pin.

Second, using an operational amplifier (or D/A). Connect the output of operational amplifier (or D/A) directly to ADJ pin.

Third, connect a filtered pulse width modulation signal directly to ADJ pin. The external filter RC>2ms and f>10kHz is recommended.

When the average input voltage of Adj is higher than 4V, the motor runs at maximum speed if no load. When the average input voltage of Adj is lower than 1V, the motor stops. Usually before the motor stops, the controller comes into ramp mode. Ramp mode varies depending on the characteristics of the motor and its load. Please see "Ramp Mode and Adjusting Components" for details.

SS-- Motor Speed Setup Three States Digital Input



Three States Digital Input. The internal circuit is shown in right figure.

Please see chapter "Electrical Characteristics--SS" for detail setting of SS.

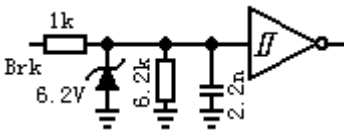
Please see chapter "Ramp Mode and Adjusting Components" for details function of SS.

J2-SS has the same function as JSS switch. When using J2-SS pin as signal source, DO NOT set JSS to L, otherwise the J2-SS signal will be grounded for ever.

BRK--Dynamic Braking Digital Input (Conditional):

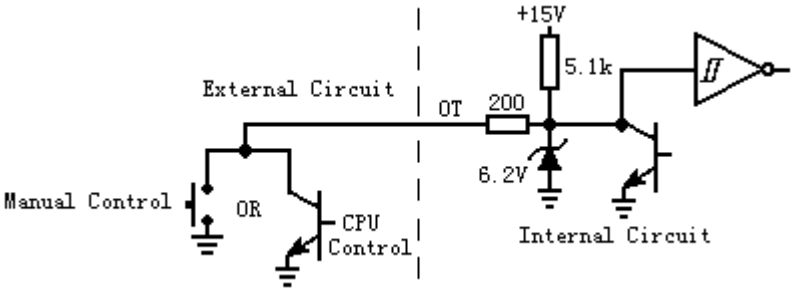
TTL compatible. When En=0 AND BRK=1, brake function is active. The internal circuit is shown in below figure.

Using this function need high qualify engineer and additional external circuits. Incorrect operation will cause over voltage, over current and other serious results. The default setting of this function is DISABLED. That means any operation on this pin is invalid. Please contact us for technical supports if you want this function, and ask for additional Appendix Datasheets.



OT--Over Temperature Lockout Digital Output and Unlock Digital Input:

TTL compatible. I/O bi-direction. Open collector output. The internal circuit is shown in below figure. Please see "Commutation Truth Table" for details.



There is an over temperature protection inside the driver. 85C sink temperature causes over temperature protection active and system auto lockout. OT becomes high, ABC three phases output Z state, all junction pins invalid, OTC Led on, motor stops.

When sink temperature drops below 75C, over temperature protection is inactive. But if system could unlock depends on Unlock Mode Setting.

There are two Unlock Modes: Auto Unlock Mode and Passive Unlock Mode.

If choose Auto Unlock Mode. When sink temperature drops below 75C. System auto unlock, OT becomes low, OTC Led off and motor re-start normally.

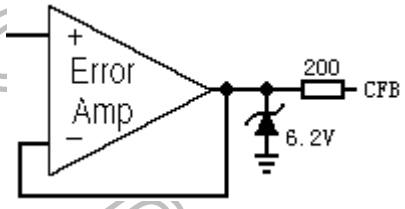
If choose Passive Unlock Mode. Even if sink temperature drops below 75C, system will keep locking until an external negative pulse input from OT pin. The external control circuit is shown in above figure. Open collector external circuit is recommended, push-pull circuit is FORBIDDEN!

The default setting of this drive is Passive Unlock Mode.

CFB--Motor Line Current Feedback Analog Output:

Analog signal. The internal circuit is shown in right figure.

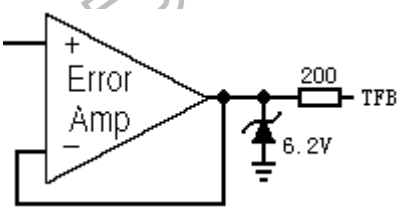
This signal feeds back the line current of BLDC motor, its unit is DC Ampere. It is linear. Coefficient is about 2ADC/1V.



TFB--Sink Temperature Feedback Analog Output:

Analog signal. The internal circuit is shown in right figure.

This signal feeds back the temperature of the sink. It is non-linear due to the NTC. Please check below table for details.



Approximate linear formula: Ts (C)=85-10*(4.2-V_{TFB}). This formula is precise enough in temperature range from 70 to 85C.

Sink Temperature	Ts	50	60	70	75	80	85	C
Output Volt	V_{TFB}	1.3	1.9	2.7	3.2	3.7	4.2	V

Current Limit:

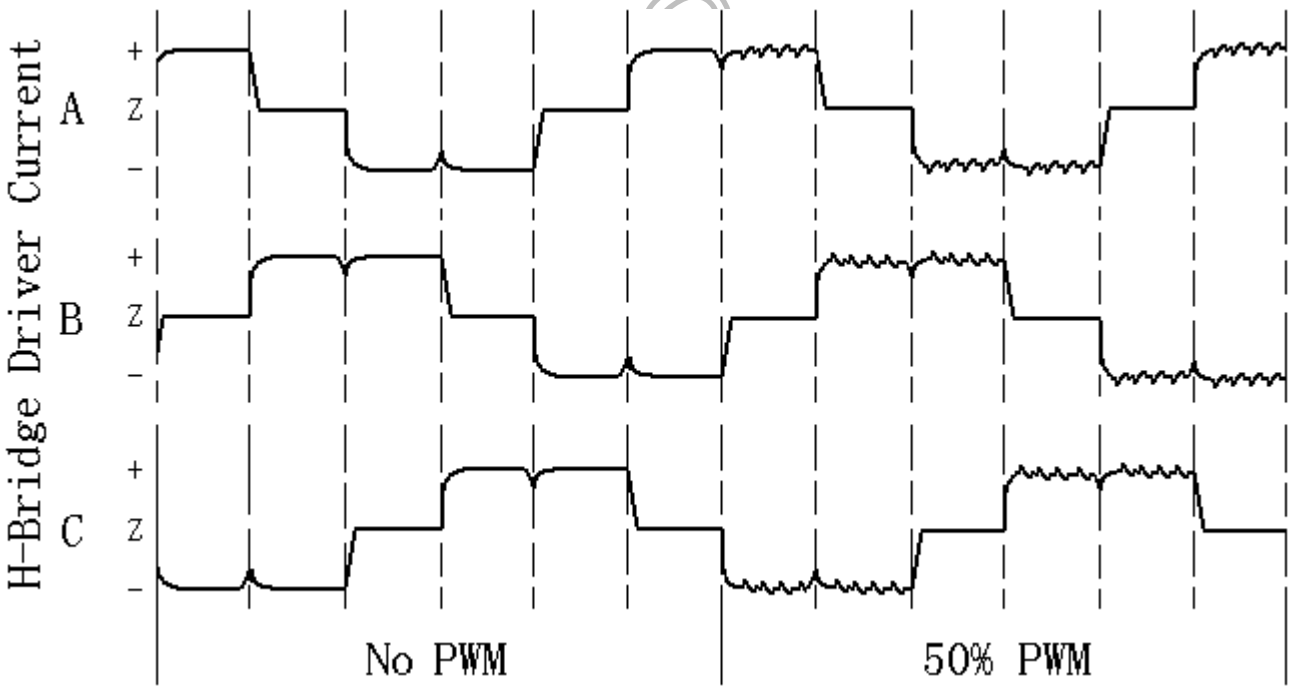
An internal current limit circuit is inside this driver in order to protect J3 H-Bridges. 22ADC peak current limitation value is set, and average current is about 8ADC. When over current is active, OTC Led is on. Please see "Commutation Truth Table" for details.

Undervoltage Lockout:

An undervoltage lockout has been incorporated to prevent damage to the IC and the IGBTs. When power supply AC<30V or DC<40V, driver turns off, and auto-restart when voltage goes up.

Commutation Truth Table (OT Mode is Auto Unlock Mode)

Control Inputs			Over	Over	H-Bridge Driver			Signal Outputs	
F/R	En	Brk	Temp	Crnt	A	B	C	OT	OTC LED
X	X	X	Act	X	Z	Z	Z	1	ON
X	X	X	X	Act	Z	Z	Z	0	ON
X	0	0	Inact	Inact	Z	Z	Z	0	OFF
X	0	1	Inact	Inact	0	0	0	0	OFF
1/0	1	X	Inact	Inact	Normal Commutation (Figure Below)			0	OFF



Normal Commutation Waveforms, F/R=1

Note: "1"=High, "0"=Low, "X"=Don't care, "Z"=High impedance, "+"= Positive current, "-"=Negative current

Ramp Mode and Adjusting Components

Ramp Mode:

When the motor is stationary, runs very slowly or forward/reverse through zero speed, there is no or not enough back-EMF and the rotor position is unknown. For this reason, the sensorless BLDC controller has to activate the rotor in forced commutation mode. This mode is called ramp mode. During ramp period, current will be higher and the rotor will oscillate or jump for a short while, usually less than 3 seconds. Long time ramp mode maybe cause the controller damaged by hotness.

Ramp mode varies depending on the characteristics of the motor and its load, and can be adjusted by matching the below components on the controller.

Adjusting Components:

There are three adjustable components: JSS (or J2-SS pin), C1 and C2.

JSS is a three band switch, designed to match the motor speed. L is suitable for low speed motor. If the rotor is one magnetic pole-pair, the speed range is about below 5000rpm. M is suitable for middle speed motor, approximately between 5000rpm and 15000rpm for one pole-pair rotor. H is suitable for high speed motor, above 15000rpm for one pole-pair rotor. Please see chapter "Main Functions Description--SS" for internal circuit.

C2 is a capacitor, designed to adjust the startup current of the motor. Smaller C2 will cause the startup current higher, vice versa. High power, high torque and/or high inertia motor need high startup current, vice versa. If the startup current is too low, the motor will have not enough torque to ramp. But the startup current should not exceed the current limit.

C1 is a capacitor, designed to adjust the time of ramp mode. Smaller C1 will cause the ramp time shorter, vice versa. High torque, high damp and/or high inertia motor need long ramp time, vice versa. Of course, short ramp time is always wanted. But, on the contrary, too short ramp time will extend ramp process because the motor has not enough time to ramp up.

Experientially, C2 is about 2 times as much as C1. C2 from 0.47uF to 1uF and C1 from 0.22uF to 0.47uF seem to be suitable for most no-load motors. To connect or disconnect C1 and C2 when power on is FORBIDDEN!

Usually, because the details of client's application are unknown, the default values of the above three components are set only for no load characteristics. Loaded values must be matched by client's technician carefully and experimentally.

If you do not know one or more of the above values, it is still possible to pick components for the controller, but some experimentation may be necessary to determine the optimal value. You can set about the experimentation from the default (no load) values. When loaded, C2 should be decreased and C1should be increased bit by bit. JSS should be maintained the default value or switch to the next lower speed range. Shorter ramp time (usually less than 3 seconds) and rational startup current is the end of the experimentation.

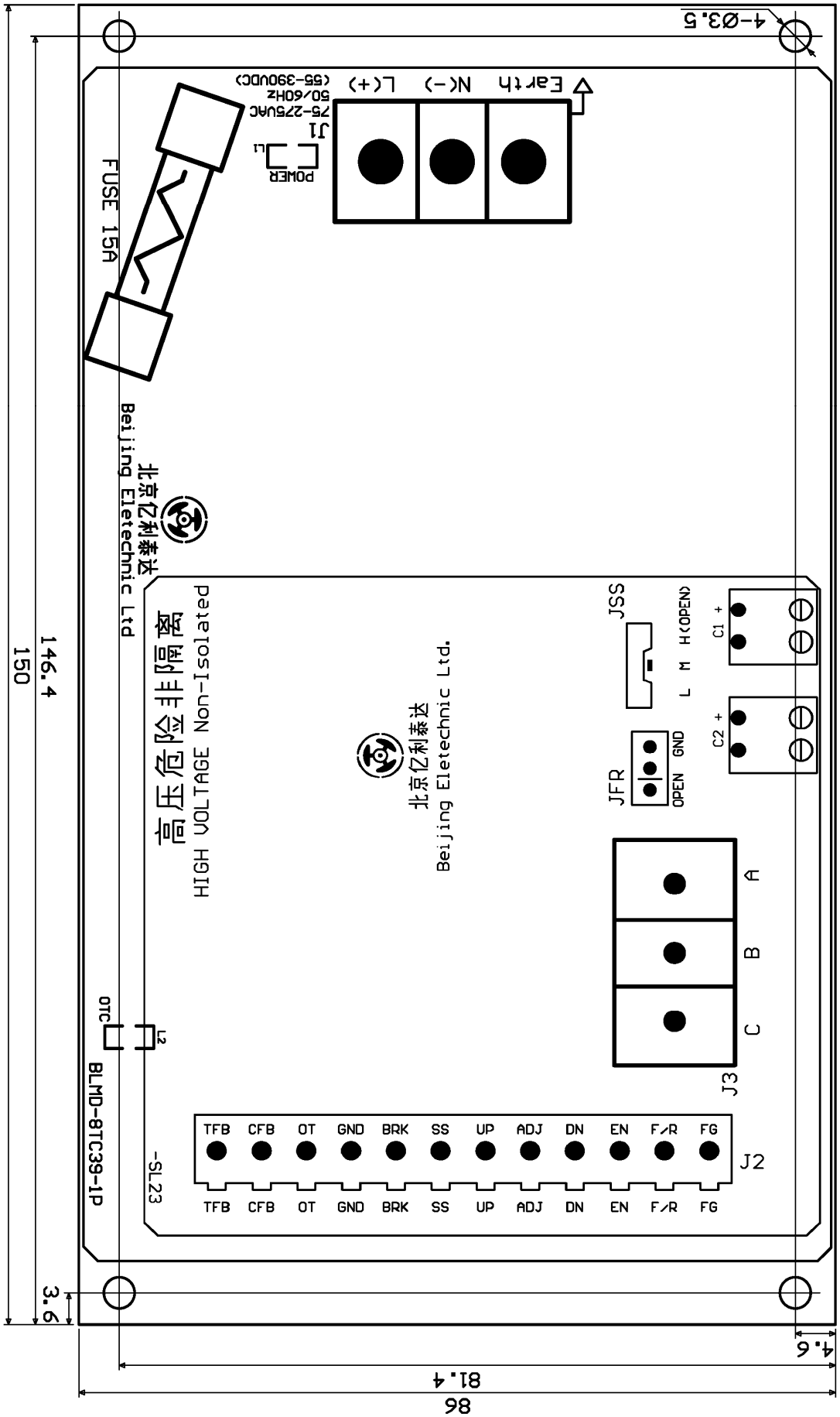
If the motor type or load is changed, the above three components must be re-adjusted.

Driver Dimension and Connection Diagram (Unit: mm)

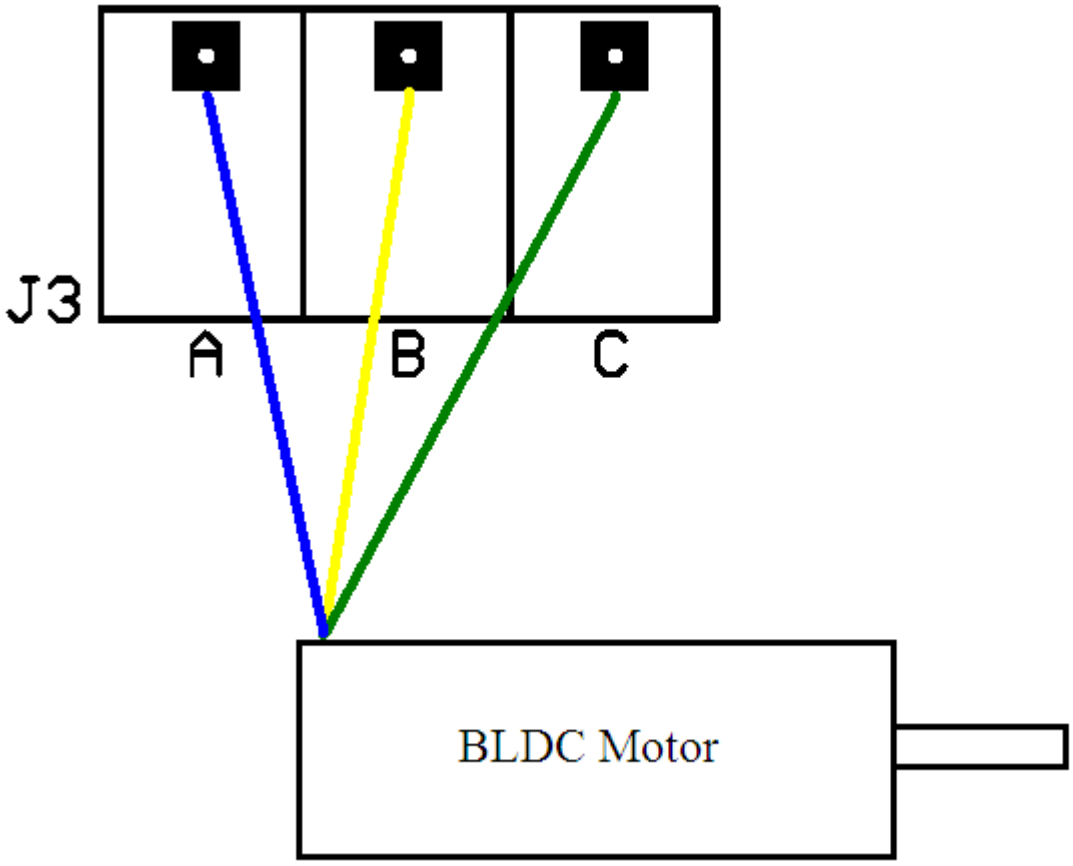
The driver dimension is 150 (L) X 86 (W) X 78 (H). The approximate weight of the driver is 520g (including intrinsic sink).

The size of the sink can be custom-ordered according to the motor power, heating and cooling of the application.

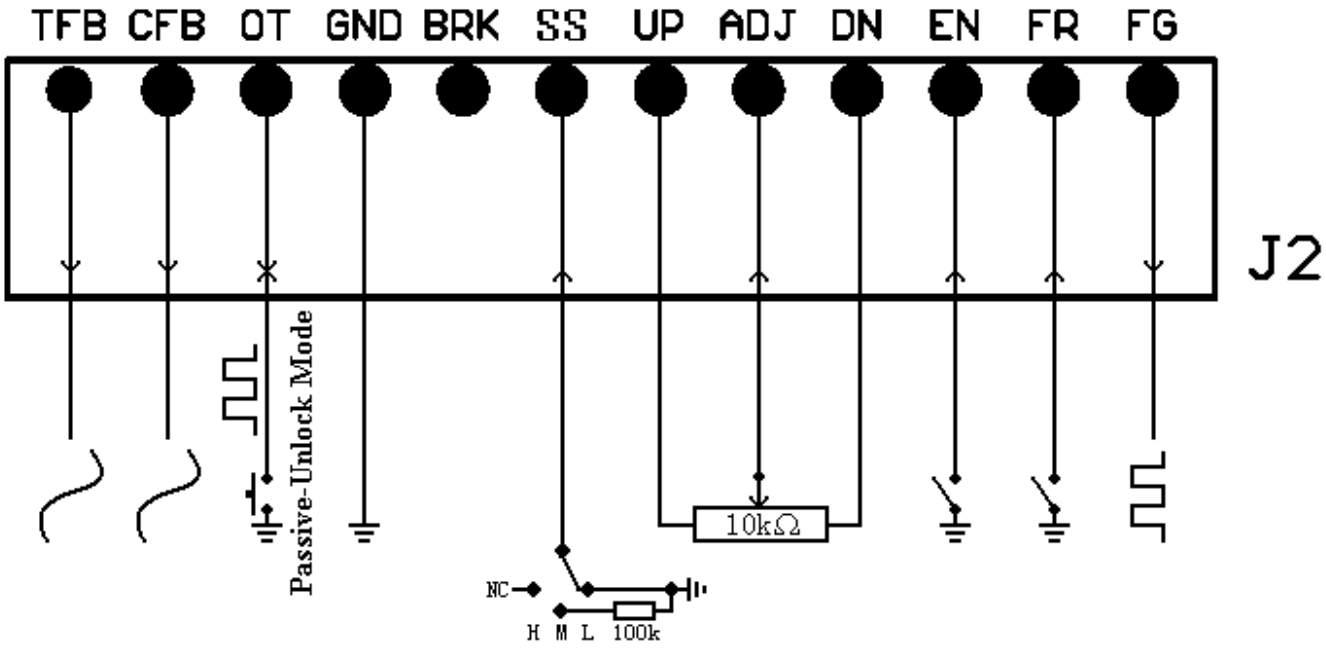
If the surface temperature of the sink is always higher than 85C, cooling fan must be installed. Otherwise the driver would be over temperature lockout.


4-Ø3.5
Earth
N(-)
L(+)
(55-390VDC)
75-275VAC
50/60Hz
J1
POWER
FUSE 15A
Beijing Eletechnic Ltd
北京亿利泰达
高压危险非隔离
HIGH VOLTAGE Non-Isolated
北京亿利泰达
Beijing Eletechnic Ltd.
JSS
L M H(OPEN)
C1 +
C2 +
JFR
OPEN GND
A
B
C
J3
TFB CFB OT GND BRK SS UP ADJ DN EN F/R FG
J2
OTC
J2
BLMD-8TC39-1P
-SL23
150
146.4
3.6
4.6
81.4
86

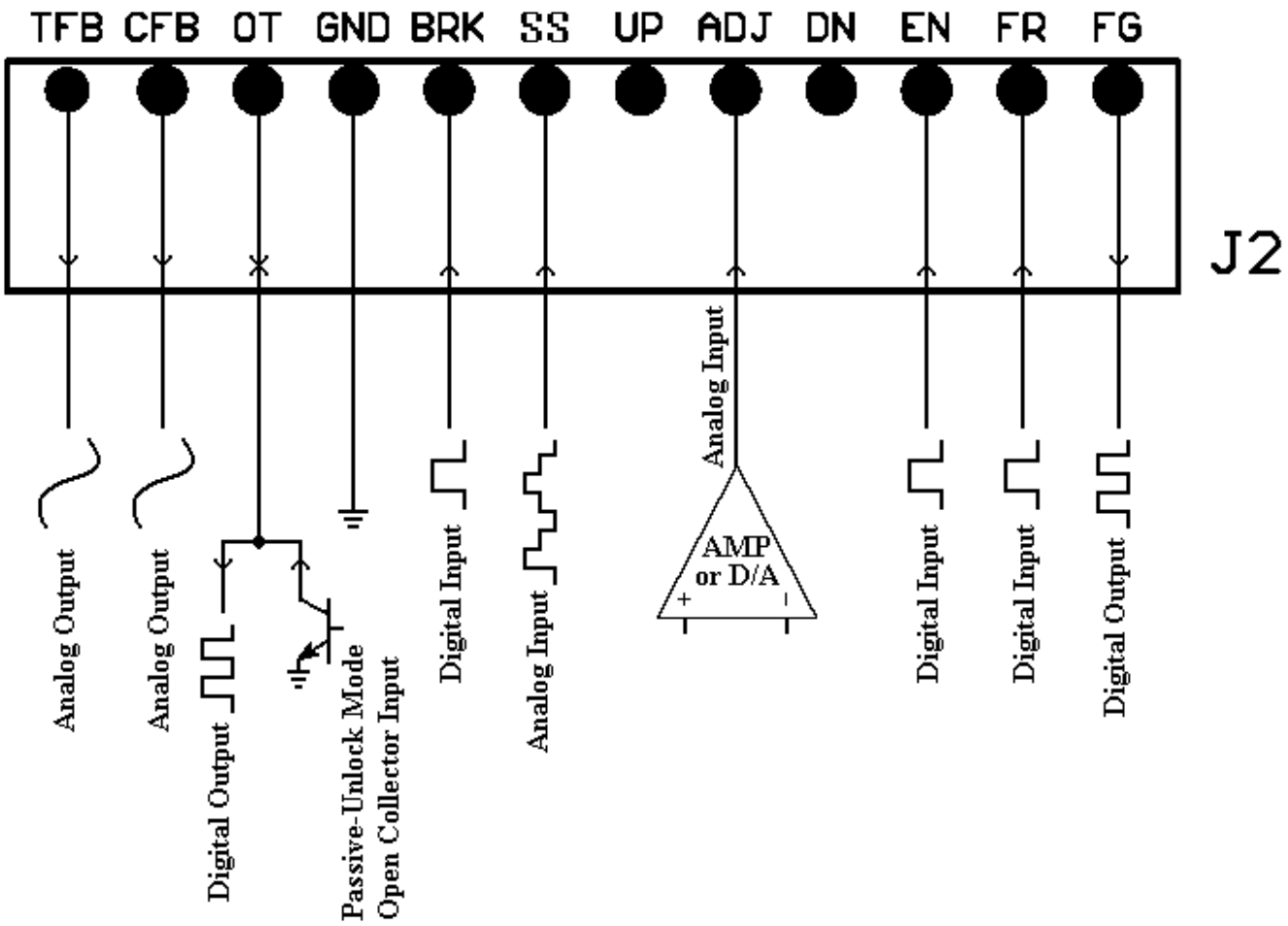
Application Circuit Examples



The Connection of BLDC Motor



The Connection of Mechanical Switches and Potentiometer Speed Control



The Connection of Digital Control and Operational Amplifier (or D/A) Speed Control

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