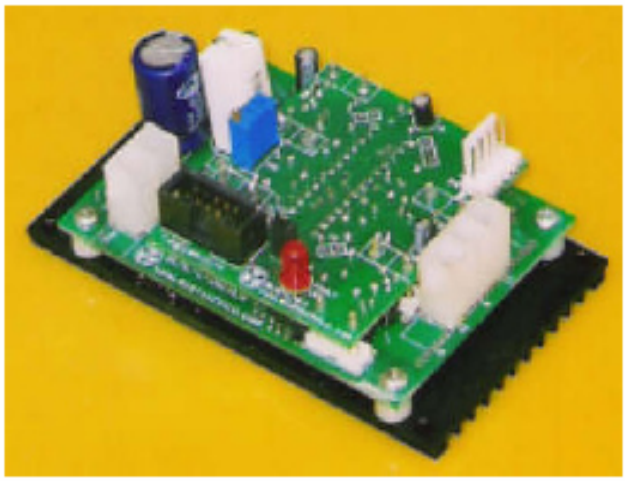
BLMC-L-S-I Low Voltage Brushless DC Motor Controller

Product Datasheet

BLMC-L-S-I is a low voltage, three phase, six step, full wave and hall sensor Brushless DC Motor controller. Its maximum output current is 15A. This controller has two sub-types, BLMC-L-S-I18/59. BLMC-L-S-I18 is suitable for 10 to 18VDC power supply. And BLMC-L-S-I59 is suitable for 18 to 59VDC power supply.

- Three Phase MOSFET H-Bridge (22kHz PWM)
- Electrical Hall Sensor Phasing 120°/240°
- Reference Voltage for Hall Sensors--Vhall
- Forward/Reverse Direction--F/R
- Run Enable/Disable--En
- Dynamic Braking--Brk
- Open Loop Stepless Speed Control--Adj
- System Malfunction Fault Output--Flt
- PWM Cycle-By-Cycle Current Limit
- Internal Undervoltage Lockout
- Internal Thermal Shutdown



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

- **This product should be installed and serviced by a qualified technician, electrician, or electrical maintenance person familiar with its operation and the hazards involved.**
- **Insulated adjustment tools must be used when working under power. Do not touch the PCB board and junctions when working under power.**
- **All output and input terminals are NOT isolated from the incoming supply.**

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Absolute Maximum Ratings

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

Parameter	Symbol	Value	Unit
Power Supply Peak Voltage	Vcc (BLMC-L-SL-I18) Vcc (BLMC-L-SL-I59)	18 59	VDC
Peak Current	Icc, IA, IB, Ic	20 (Less than 10s)	A
Continuous Current	Icc, IA, IB, Ic	15	A
Hall Sensor Reference Output Current	Ihall	30	mA
Digital Inputs Voltage	Ha, Hb, Hc, F/R, En, Brk	-0.3 to 6	V
Speed Control Input Voltage	Adj	-0.3 to 6	V
Fault Output Voltage	Flt	-0.3 to 6	V
Fault Output Sink Current	IFlt	10 (Sink)	mA
Max Controllable Motor Speed	One Magnetic Pole-pair Rotor	60,000	rpm
Surface Temperature of the Radiator	ST	85	℃
Operating Ambient Temperature Range	Ta	-20 to +85	℃

Thermal Characteristic

(Vcc=24VDC, Icc=5A, Ta=20℃, Motor Speed=5,000rpm, Good Free-convection Cooling)

Parameter	Symbol	Min	Typ	Max	Unit
Radiator Surface Temperature	ST	-	60	-	℃

Electrical Characteristics

(Vcc=24VDC, Ta=20℃, unless otherwise noted)

Parameter	Symbol	Min	Typ	Max	Unit
Vcc--DC Power Supply					
BLMC-L-S-I18	Vcc	10	12	18	VDC
BLMC-L-S-I59	Vcc	18	24, 36, 48	59	VDC
Quiescent Current	IQ	-	50	60	mA
Vhall--Reference Voltage for Hall Sensors					
Output Volt	Vhall	5.2	5.6	5.9	VDC
Output Current	Ihall	-	-	30	mA
Ha, Hb, Hc--Hall Digital Inputs					
High Threshold Volt	VIH	3.0	2.2	-	V
Low Threshold Volt	VIL	-	1.7	0.8	V
High State Current	IIH	-150	-	-20	uA
Low State Current	IIL	-600	-	-150	uA

F/R, En--Digital Inputs

High Threshold Volt	V_{IH}	3.0	2.2	-	V
Low Threshold Volt	V_{IL}	-	1.7	0.8	V
High State Current	I_{IH}	-75	-	-10	uA
Low State Current	I_{IL}	-300	-	-10	uA

Brk--Dynamic Braking Digital Input

High Threshold Volt	V_{IH}	-	2.0	-	V
Low Threshold Volt	V_{IL}	-	0.6	-	V
High State Current	I_{IH}	-0.8	-0.36	-	mA
Low State Current	I_{IL}	-0.9	-0.6	-	mA

Adj--Open Loop Stepless Speed Control Analog Input (Motor No Load Speed)

Full Speed Volt	V_{Up}	-	4.1	4.5	V
Zero Speed Volt	V_{Dn}	1.2	1.5	-	V

Flt--System Malfunction Digital Output

High State Volt	V_{OH}	2.6	3.9	-	V
Low State Volt	V_{OL}	-	0.25	0.5	V
Source Current	I_{OH}	-1	0	-	mA
Sink Current	I_{OL}	-	-	10	mA

Undervoltage Lockout

BLMC-L-S-I18	UV	-	9	-	VDC
BLMC-L-S-I59	UV	-	15	-	VDC

Thermal Shutdown

Thermal Shutdown	TS	-	170	-	℃

Junction Table

Junction	Pin	Type	Function
J1	A	Driver Output	A Phase Winding Driver
	B	Driver Output	B Phase Winding Driver
	C	Driver Output	C Phase Winding Driver
J2	Vcc	Power Supply	DC Power Supply, Positive Line
	GND	-	Power Supply GND, Negative Line
J3	GND	-	Hall Sensors GND
	Ha	Digital Input	A Hall Sensor, TTL Compatible
	Hb	Digital Input	B Hall Sensor, TTL Compatible
	Hc	Digital Input	C Hall Sensor, TTL Compatible
	Vhall	Reference Output	Reference Voltage for Hall Sensors
J4	F/R	Digital Input	Forward/Reverse Direction, TTL Compatible
	En	Digital Input	Run Enable, Logic High Active, TTL Compatible
	Brk	Digital Input	Dynamic Braking, Logic Low Active, TTL Compatible
	Up	Voltage Divider	Potentiometer Up Pin
	GND	-	Signals GND
	Adj	Analog Input	Open Loop Stepless Speed Control
	Flt	Digital Output	Output Low State When System Malfunction, TTL Compatible
	Dn	Voltage Divider	Potentiometer Down Pin
	FV	(NC)	NC
	FG	(NC)	NC

Main Functions Description

Vcc--DC Power Supply:

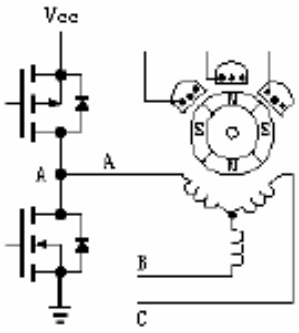
A stabilized power supply or battery is recommended. Please see the "Absolute Maximum Ratings" for proper operation.

This controller has two sub-types, BLMC-L-S-I18/59. BLMC-L-S-I18 is suitable for 10 to 18VDC power supply. And BLMC-L-S-I59 is suitable for 18 to 59VDC power supply. Because of the difference of the "Absolute Maximum Ratings", they cannot be substituted for each other.

A, B, C--MOSFET H-Bridge:

The driver circuit is shown in right figure. This controller could drive either Y or delta winding motor. Please see the "Commutation Truth Table" for details.

The use of 22kHz pulse width modulation at the three bottom MOSFETs provides an energy efficient method of controlling the motor speed by varying the average voltage applied to each stator winding during the commutation sequence.



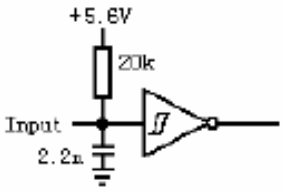
Vhall--Reference Voltage for Hall Sensors:

This reference power could output only 30mA for hall sensors. It is forbidden to supply any other loads.

Ha, Hb, Hc--Hall Digital Inputs:

Hall signals are all TTL compatible. The input circuit is shown in right figure. Please see the "Commutation Truth Table" for details.

The electrical hall sensor phasing must be 120°. And Ha, Hb, Hc signals must be connected correctly according to A, B, C windings. Otherwise the controller and motor may be damaged.

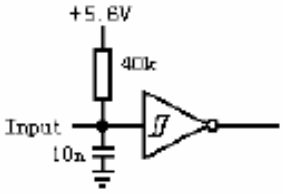


F/R, En--Digital Inputs:

These two signals are all TTL compatible. The input circuit is shown in right figure. Please see the "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.

A logic high or float at En pin causes the motor to run, while a low causes it to coast.

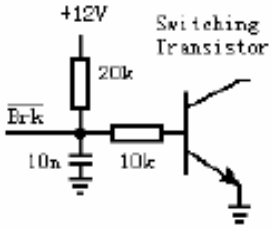


Brk--Dynamic Braking Digital Input:

This signal is TTL compatible. A logic high or float at Brk pin allows the motor to run, while a logic low causes it to brake--high damp rapid deceleration. The input circuit is shown in right figure.

This pin can be controlled by PWM signal. The frequency of PWM must be less than 30kHz.

Please fix the motor and the load carefully before this function is activated. Otherwise the load maybe broken by the brake force and people maybe injured.



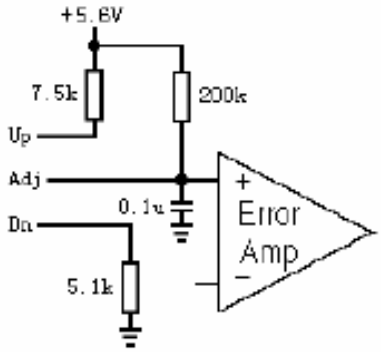
Adj--Open Loop Stepless Speed Control Analog Input:

The input circuit is shown in right figure. There are three methods to control the speed of the motor:

First, connect the top side and bottom side of a 10k ohm potentiometer to the Up pin and Dn pin of the junction 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.

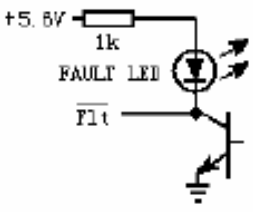
Third, connect a filtered PWM signal to Adj pin. The internal filter capacitance of this controller is 0.1uF. An external series-connection filter resistance is necessary and 10k ohm is recommended. The frequency of PWM should be greater than 5kHz.



When the average input voltage of Adj is lower than 1.5V, the motor stops. When the average input voltage of Adj is higher than 4.1V, the motor runs at maximum speed if no load.

Flt--System Malfunction Digital Output:

The output circuit of Flt pin is shown in right figure. A logic high means the motor works normally. A logic low means there are something wrong and causes the fault led on. Please see the "Commutation Truth Table" for details.



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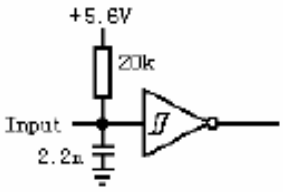

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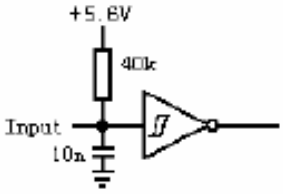
A logic high or float at En pin causes the motor to run, while a low causes it to coast.



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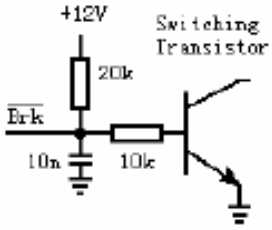
Please fix the motor and the load carefully before this function is activated. Otherwise the load maybe broken by the brake force and people maybe injured.



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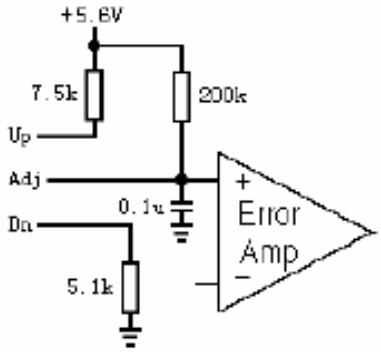

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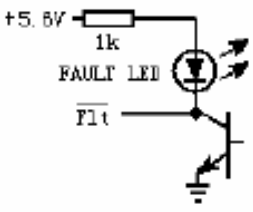


PWM Cycle-By-Cycle Current Limit:

There is a PWM Cycle-By-Cycle current limit circuit in this controller. The value of the limit is adjustable. Adjusting the VR1 potentiometer, clockwise decreases the value of the limit, counter-clockwise increases the value of the limit. For most loads, the current limit should be about 1.5 to 2 times as much as rated load current. But it must be less than 15A. When current limit, the Fault Led is on.

If the current limit works for long time, the controller may be damaged by hotness.

Undervoltage Lockout:

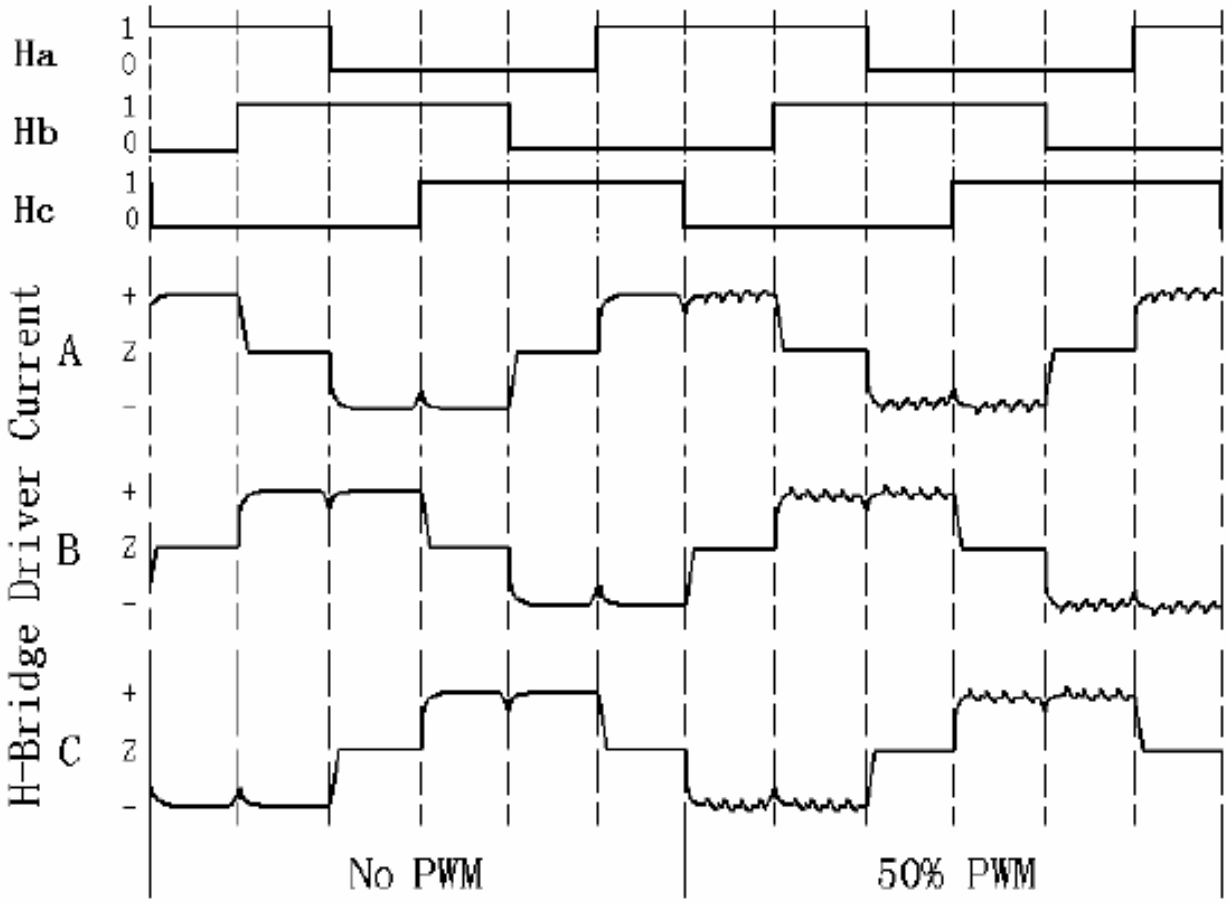
An undervoltage lockout has been incorporated to prevent damage to the IC and the MOSFETs. When Vcc of BLMC-L-S-I18/59 falls below 9 and 15VDC separately, the IC acts as though the Run Enable Pin was grounded, all the functions are disabled and the Fault Led is on.

Thermal Shutdown:

Internal thermal shutdown circuitry is provided to protect the IC from hotness. When activated, typically at 170℃, the IC acts as though the Run Enable Pin was grounded, all the functions are disabled and the Fault Led is on.

Commutation Truth Table

Hall Inputs			Control Inputs			Internal Protections	MOSFET H-Bridge Driver			Fault
Ha	Hb	Hc	F/R	En	Brk	CL or UV or TS	A	B	C	Flt
1	1	1	X	X	1	X	Z	Z	Z	0
0	0	0	X	X	1	X	Z	Z	Z	0
1	1	1	X	X	0	X	0	0	0	0
0	0	0	X	X	0	X	0	0	0	0
Six Valid Combinations (Figure Below)			X	1	1	Anyone Active	Z	Z	Z	0
			X	0	1	X	Z	Z	Z	0
			X	0	0	X	0	0	0	0
			X	1	0	X	0	0	0	1
			1/0	1	1	All Inactive	Normal Commutation (Figure Below)			1



Normal Commutation Waveforms, F/R=1

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

Controller Dimension and Connection Diagram (Unit: mm)

The controller dimension is 100 (L) X 60 (W) X 47 (H). This dimension is not including additional radiator. The additional radiator can be custom-made according to the motor power, heating and cooling of the application.

If the surface temperature of the radiator is higher than 85℃, cooling fan must be installed. Otherwise the controller may be damaged by hotness.

Line length is 0.5m, if customer does not specially order. The approximate weight of the controller is 160g, including 0.5m lines and intrinsic radiator.

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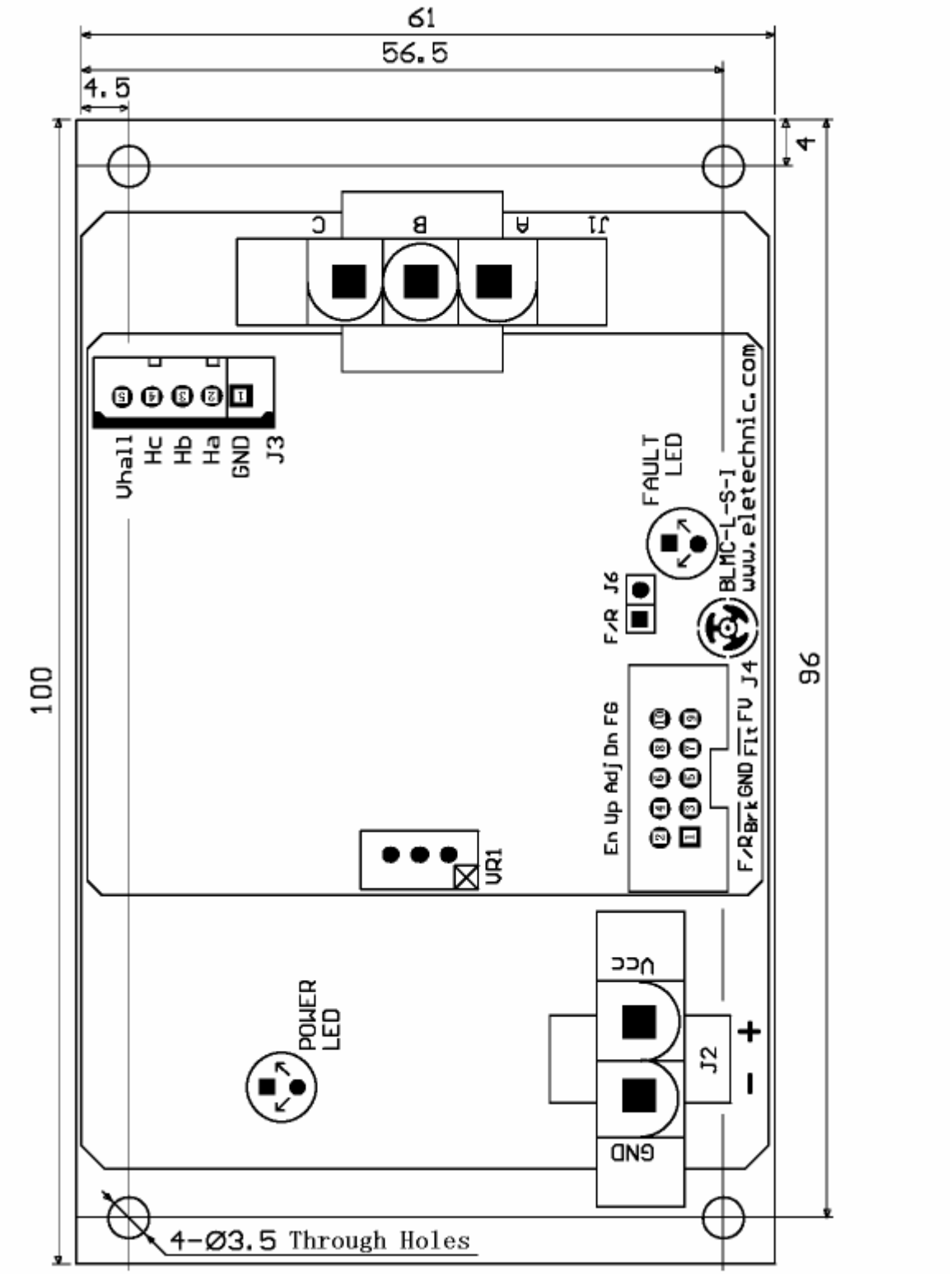
61
56.5
4.5
4
100
96
J1
C
B
A
Uhall
Hc
Hb
Ha
GND
J3
FAULT
LED
F/R J6
BLMC-L-S-I
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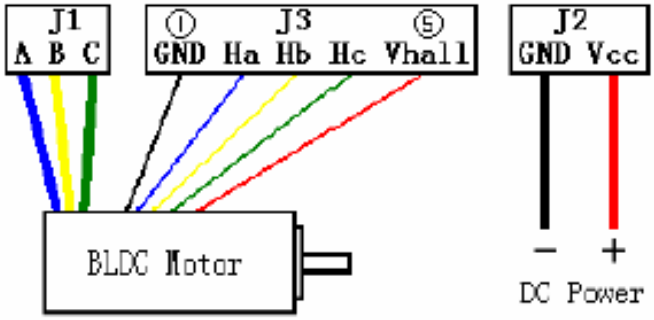
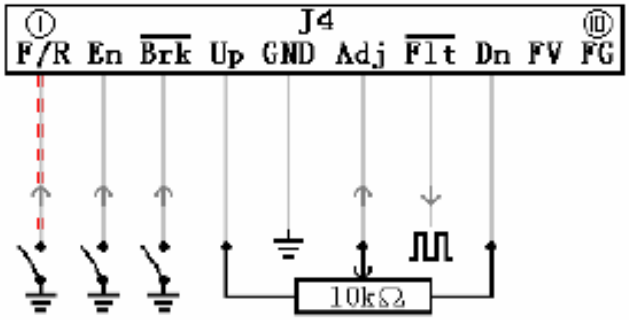
En Up Adj Dn FG
F/R Brk GND Flt FV J4
VR1
POWER
LED
Vcc
GND
J2
+
-
4-Ø3.5 Through Holes

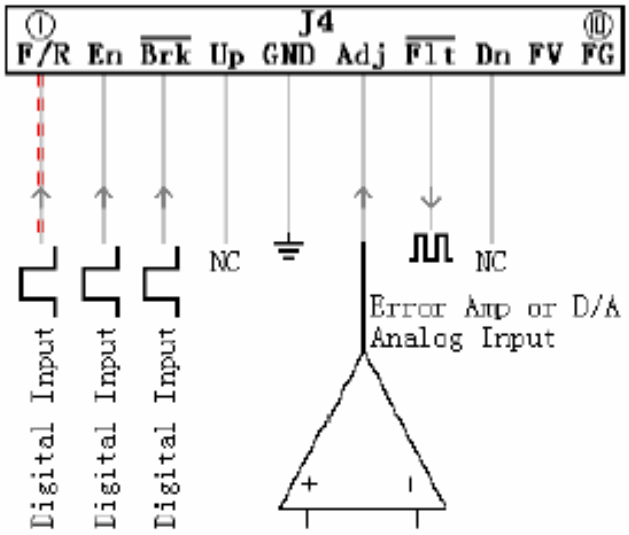
Application Circuit Examples



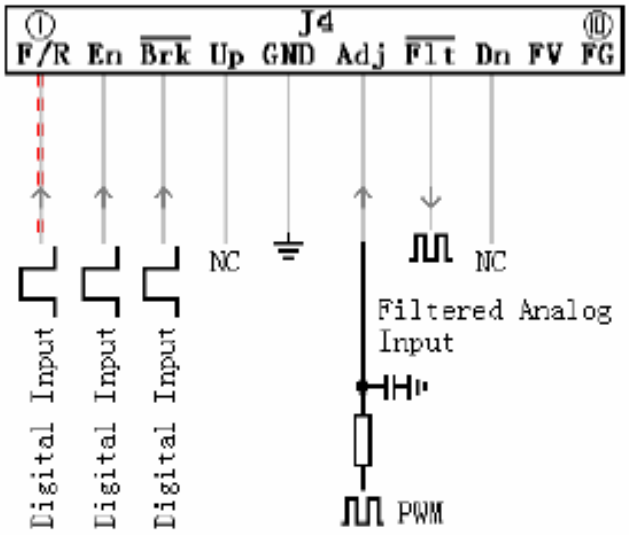
The Connection of BLDC Motor and Power



The Connection of On-off Control
and Potentiometer Speed Control



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



The Connection of Digital Control
and PWM Speed Control