BLDC SPEED CONTROL INSTRUCTION MANUAL

Low voltage Brushless DC control

groschopp.com

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Warranty

Groschopp, Inc. (GI) warrants its products to be free from defects in material and workmanship. The exclusive remedy for this warranty is GI factory replacement of any part or parts of such product which shall within 12 months after delivery to the purchaser be returned to GI factory with all transportation charges prepaid and which GI determines to its satisfaction to be defective. This warranty shall not extend to defects in assembly by other than GI or to any article which has been repaired or altered by other than GI or to any article which GI determines has been subjected to improper use. GI assumes no responsibility for the design characteristics of any unit or its operation in any circuit or assembly. This warranty is in lieu of all other warranties, express or implied; all other liabilities or obligations on the part of GI, including consequential damages, are hereby expressly excluded.

NOTE: Carefully check the control for shipping damage. Report any damage to the carrier immediately. Do not attempt to operate the drive if visible damage is evident to either the circuit or to the electronic components.

All information contained in this manual is intended to be correct, however information and data in this manual are subject to change without notice. GI makes no warranty of any kind with regard to this information or data. Further, GI is not responsible for any omissions or errors or consequential damage caused by the user of the product. GI reserves the right to make manufacturing changes which may not be included in this manual.

Warning

Improper installation or operation of this control may cause injury to personnel or control failure. The control must be installed in accordance with local, state, and national safety codes. Make certain that the power supply is disconnected before attempting to service or remove any components!!! If the power disconnect point is out of sight, lock it in disconnected position and tag to prevent unexpected application of power. Only a qualified electrician or service personnel should perform any electrical troubleshooting or maintenance. At no time should circuit continuity be checked by shorting terminals with a screwdriver or other metal device.

Introduction

Groschopp's DB1110D Series is a family of general purpose brushless motor controls. These controls commutate power into standard 3 phase sensored brushless (BLDC) motors.

The DB1110D Series uses DC power sources of 11 to 15VDC or 18 to 54VDC, including batteries of 12, 24, 36, and 48 volts. The DB1110D Series will supply up to 7.5 amperes of continuous current to the motor without an additional heat sink. It is available in either a chassis or enclosed, NEMA 4X versions, and can drive Groschopp's brushless motor products.

A 14 position terminal strip connects the control to the DC power source, the motor, the speedpot, and the forward/reverse control switch. A pluggable terminal strip is also available. There is a ¼" spade pin that can be used for inhibiting the control. There is a 1/8" spade pin that can be used to brake the control. The control's PC board carries the minimum speed, maximum speed and current limit trimpots for the DB1110D, a gain trimpot, as well as Accel and Decel trimpots for the DB1110D.

Standard Features

- *POWER MOSFET TRANSISTORS*
- *QUIET 17KHz "PULSE WIDTH MODULATED" SWITCHED FREQUENCY*
- *FORWARD/REVERSE DIRECTIONAL CONTROL*
- *5KΩ SPEED POTENTIOMETER W/ DIAL, LEADS & KNOB FOR REMOTE MOUNTING*
- *ANODIZED CHASSIS*
- *INHIBIT INPUT PIN FOR START/STOP OPERATION*
- *BRAKE INPUT PIN FOR QUICK STOP OPERATION*
- *INTERNAL +6.2 VOLT DC SUPPLY FOR MOTOR HALL EFFECT SENSORS*

Unpacking

Unpack the control and check for shipping damage. Locate the Groschopp brushless motor and Groschopp's Brushless DC motor connection diagram (AS-190). In addition, the 5KΩ speedpot supplied with the chassis control, a DC power source, hook-up wires, and appropriate tools for installation are needed. If the motor does not have a timing diagram, an ammeter of at least a rating of 200% of the full load motor current and a small hand-held DC volt-ohmmeter are required.

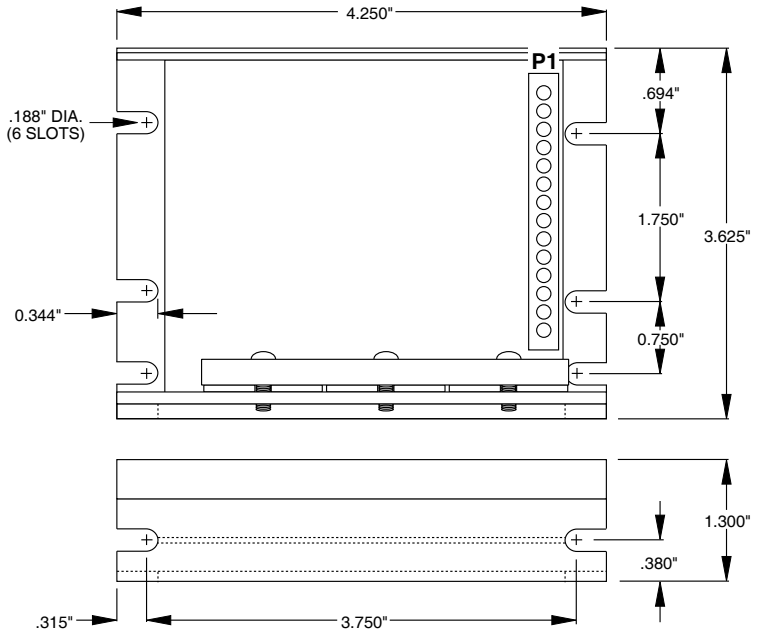
Mounting Instructions and Dimensions

1. Six 3/16" wide slots are provided for control mounting (see dimension diagram below).
2. Control chassis can be used as a template.
3. Use standard hardware to mount.

Caution:
Do not mount where ambient temperature is outside range of -10° C (15° F) to 40° C (104° F).

Brushless Motor Control Hook-up & Fusing

Brushless DC motors have eight (8) wires: three (3) phase lines to the motor, three (3) Hall sensor lines, and sensor power and common. Groschopp's BLDC motors are designed with 120-degree sensor spacing, but the DB1110D controls can accomodate 60- or 120-degree spacing.



STANDARD DB111OD SERIES

Power is connected to terminals P1-4 and P1-5 through an appropriate switch and fuse. Groschopp recommends the use of a Littlefuse 314 Series or Bussman ABC Series type fuse rated at 150% of the full load motor current. The power should be off until the hook-up procedure is complete and the motor is ready to run.

Hook-up Diagram

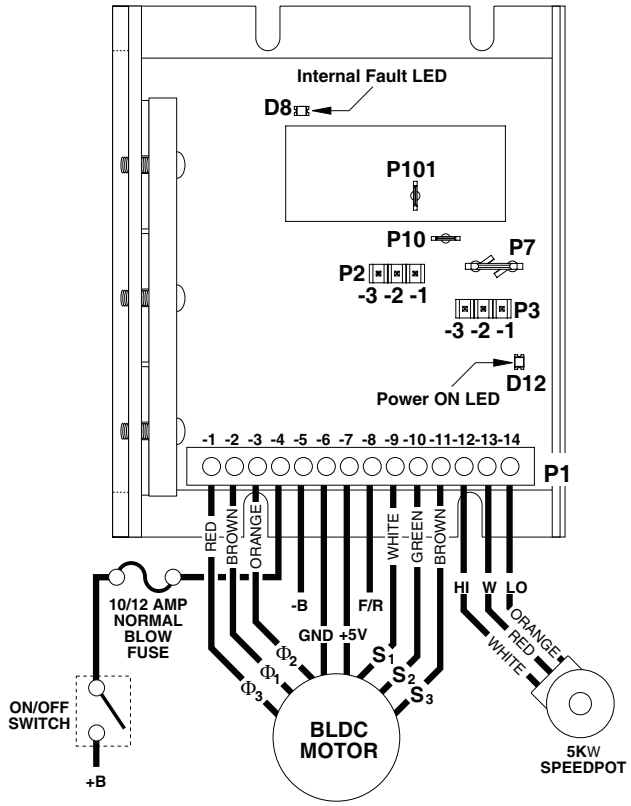


Figure 1

Hook-up Procedure for Groschopp BLDC Motors

Locate Groschopp drawing AS-190 ("Motor Connection Diagram - Brushless DC Motor"). The diagrams in AS-190 show the sequencing of the Hall sensor outputs as related to the motor phases.

Return to the correct wiring diagram and connect the sensors to terminals S3, S2 and S1 of P1.

After the sensors are connected, attach the sensor power line to terminal 6.25V of P1. The sensor common line is connected to terminal COM of P1. Now attach the three motor armature wires and test for proper hook-up.

Now apply power to the control. Slowly increase the speed by adjusting the Speed Pot clockwise. Watch for erratic rotation or excessive source current. If either occurs, immediately turn the Speed Pot counterclockwise to reduce speed, and turn off the power. The correct combination will allow smooth rotation of the motor and the lowest current draw from the DC source. Refer back to Figure 1 and make sure the motor and drive are connected correctly.

Features

Sensor Spacing & Input Voltage Selection

Normally the DB1110D Series control is shipped ready for 120 degree sensor spacing (P2-2 and P2-3 connected). The drive can be configured to work with a motor with 60-degree spacing by connecting P2-2 to P2-1 with a jumper.

The input voltage is also jumper selectable and is shipped with the standard setting of 24/48VDC input (P3-2 and P3-3 connected). If 12 volt input is desired, move the supplied jumper to connect P3-2 to P3-1. See figure 1 of the Hook-Up Diagram section for location of the selectable input voltage connector and attached jumper connector.

Speed Command Selection and Hook-up

The DB1110D series controls can be operated with a 5K potentiometer (supplied with control) or a 0 to 5VDC power source. The 5K ohm speedpot is connected to terminals P1-12, P1-13, and P1-14. Connect the speedpot “LO” lead (orange wire) to terminal P1-14, the speedpot “WIPER” lead (red wire) to P1-13, and the speedpot “HI” lead (white wire) to P1-12. A 0 to 5V DC signal can also be used to regulate the speed. This is accomplished by connecting the DC source signal lead to terminal P1-13 (WIPER) and the common lead to terminal P1-14 (LO).

Note: A 5K ohm resistor must be connected from the Pot Hi terminal (P1-12) to the Pot Lo terminal (P1-14) for proper operation of the Min trimpot.

Inhibiting the Control

The DB1110D series control has a ¼” spade pin (P7) on the control that can be used to inhibit the control. Tying this pin to the control common terminal (P1-6) will stop the control and override any other speed command. Using inhibit to start and stop the control will over ride the Accel and Decel settings. For a start and stop function with Accel and Decel, it is recommended the pot wiper or signal wire, via a switch, be connected to the control wiper input terminal (P1-13) and opened for stop and closed for start.

Braking the Control

The DB1110D series control has a 1/8" spade pin (P10) on the control that can be used to brake the control. Tying this pin to the control common terminal (P1-6) will quickly stop the control and override any other speed command. Using brake to start and stop the control will override the Accel and Decel settings. For a start and stop function with Accel and Decel, it is recommended the pot wiper or signal wire, via a switch, be connected to the control wiper input terminal (P1-13) and opened for stop and closed for start.

Motor Direction Selection and Reversing

Terminal P1-8 on the DB1110D is the forward/reverse control. Allowing terminal P1-8 to remain unconnected will let the motor turn in a particular direction. Connecting terminal P1-8 to P1-6 will reverse the rotation direction. Either a jumper wire, switch, relay, or an open collector NPN transistor can be used to make this connection. **MAKE SURE WHEN THE MOTOR DIRECTION IS REVERSED THAT THE MOTOR IS STOPPED. THE CONTROL ISN'T DESIGNED FOR PLUG REVERSING.** Sometimes it may be necessary to reverse the motor without using terminal P1-8. This is done by stopping the motor and exchanging terminals P1-1 with P1-2 and terminals P1-10 with P1-11. This will work with either a 60 or 120 degree motor.

Power ON LED

The internal 12V supply has a green LED attached to it for an indication that the internal power supply is operating and power is applied to the control.

Internal Fault LED

The internal fault LED (Red) indicates that there is a fault condition present with the control. One or several of the following fault conditions can be present: invalid sensor input code, 60°/120° phasing jumper in wrong direction, over current condition (i.e. Current Limit set too low), undervoltage lockout (i.e. +12V supply is less than 10.0V) or thermal shutdown (i.e. U2 is too hot). Typical fault conditions are: invalid sensor attachment, 60°/120° phasing jumper is in the wrong position, or Current Limit is set too low.

Adjustments

Current Limit

Groschopp has factory set the Current Limit to 125% of 7.5 Amps DC. This setting should not need to be increased. If the current limit needs to be set to a lower value, do so by adjusting the Current Limit trimpot (CL) CCW until the desired setting is achieved.

Setting Current Limit

Current Limit should normally be set to approximately 125% of the FLA rating of the motor that is running. To set current limit for the specific motor or application, follow these steps while monitoring motor current:

1) Preset Current Limit trimpot (CL) fully CW.
2) Run motor at full or normal running speed.
3) Load motor to 125% of its FLA rating or the desired maximum load.
4) Measure the DC input current with an analog DC current meter placed in series with the Positive DC input lead.
5) Decrease the Current Limit trimpot setting until the motor current begins to drop, and then slowly increase the setting until just reaching the desired maximum current as obtained in step 3.

Note: Do not use the Current Limit trimpot as a torque control or to reduce the speed of a motor.

Caution: Remember, keep the average current at 7.5 Amps or under, and make sure the motor is rotating. A stalled motor, after about 30 seconds, may overheat and cause extensive damage to the control and/or motor.

Minimum Speed

Turn the speedpot to zero (fully CCW). Next turn the minimum trimpot (MIN) clockwise until the motor begins to rotate. Slowly rotate the trimpot CCW until the motor stops. The control will now run with a zero deadband. If a nonzero minimum speed is desired, rotate the trimpot CW to the desired setting.

Maximum Speed

Turn the speedpot fully clockwise. Adjust the maximum trimpot (MAX) counterclockwise to the desired maximum output.

Closed Loop Gain

1. Adjust the Maximum speed trimpot (MAX) to 50% CW rotation.
2. Set Closed Loop Gain trimpot to the fully CW position.
3. Advance speedpot to the fully CW position. The motor should now be rotating at its maximum speed*.
4. Slowly rotate the Closed Loop Gain trimpot CCW until the motor speed decreases slightly**, then rotate the trimpot back CW just enough to return the motor to full speed.
5. Refer to the above Minimum Speed (MIN) and Current Limit (CUR LIM) trimpot adjustments.

* If the motor doesn't reach its maximum speed with the speedpot and the gain pot fully CW, rotate the MAX trimpot CW until it does. Proceed with step 4.

** If rotating the Closed Loop Gain trimpot fully CCW and the motor speed doesn't decrease, rotate the MAX trimpot CCW just enough to make the speed decrease slightly. Then rotate the Closed Loop Gain trimpot CW just enough to return the motor to full speed.

Accel and Decel

Accel - The Accel trimpot is adjustable from 0-10 second of maximum output speed setting. The setting of the accel time is approximately proportional to the rotation of the Accel trimpot. As an example, a 50% setting of the Accel trimpot will result in approximately a 5 second linear accel ramp from zero to maximum speed. To test a setting, turn the speedpot to zero (fully CCW). Next turn the Accel trimpot CW to the estimated accel setting. Quickly rotate the speedpot full CW and time the motor accel ramp from zero to maximum speed. If necessary, adjust the Accel trimpot setting as needed and test again.

Decel - The Decel trimpot is adjustable from 0-10 second of maximum output speed setting. The setting of the decel time is approximately proportional to the rotation of the Decel trimpot. As an example, a 50% setting of the Decel trimpot will result in approximately a 5 second linear decel ramp from maximum to zero speed. To test a setting, turn the speedpot to maximum (fully CW). Next turn the Decel trimpot CW to the estimated decel setting. Quickly rotate the speedpot full CCW and time the motor decel ramp from maximum to zero speed. If necessary, adjust the Decel trimpot setting as needed and test again.

Note: Minumum, Maximum and Gain trimpot settings must already be completed to properly set and test Accel and Decel. Refer to the Open Loop and Closed Loop Trimpot sections above for Minimum Speed (MIN), Maximum speed (MAX), Current Limit (CUR LIM) and Gain trimpot adjustments.

Heatsink & Cooling

Groschopp motors and drives are rated for continuous operation in ambient temperatures of 40°C (104°F) or below. The control, as shipped from the factory, will normally handle up to 7.5 Amps continuous current. If the ambient temperature increases above 40° C (104° F), contact Groschopp to determine alternate solutions. Typical heat sink temperatures for the drive are 75°C (167°F) or below.

Specifications

INPUT VOLTAGE (JUMPER SELECTABLE) ..... 11 to 15VDC OR 18 to 54VDC
OUTPUT VOLTAGE ..... 0 to INPUT VOLTAGE
MOTOR HALL SPACING - ELECTRICAL (JUMPER SELECTABLE) ..... 60° OR 120°
LOAD CURRENT (CONTINUOUS) ..... 7.5 AMPS
SPEED RANGE ..... 50 : 1
MINIMUM SPEED TRIMPOT ..... ADJUSTABLE 0-30% OF MAX.
MAXIMUM SPEED TRIMPOT ..... ADJUSTABLE 60 to 100% OF INPUT VOLTAGE
CURRENT LIMIT TRIMPOT ..... ADJUSTABLE
INPUT / OUTPUT CONNECTIONS ..... 14 POSITION TERMINAL BLOCK
INPUT / OUTPUT CONNECTIONS USING -P OPTION..... 14 POSITION PLUGGABLE
SPEED COMMAND SIGNAL ..... 5K Ohm SPEED POTENTIOMETER or 0 to +5V DC SIGNAL
OPERATING TEMPERATURE ..... 0° C to 40° C (32° F to 104° F)
CLOSED LOOP SPEED REGULATION ..... ± 1/2% OF BASE SPEED
ACCELERATION / DECELERATION..... ADJUSTABLE 0 – 10 SECONDS
INTERNAL VOLTAGE SUPPLY (FOR MOTOR HALL SPACINGS) ..... +6.2 VDC