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# BLDC SPEED CONTROL INSTRUCTION MANUAL

Low voltage Brushless DC control

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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 DB1120D Series is a family of general purpose brushless motor controls. These controls commutate power into standard 3-phase brushless (BLDC) motors.

The series uses DC power sources from 10 to 54 volts. A DB1120D Series control will supply up to 20 amps of continuous current to the motor. They come in both chassis mount and enclosed NEMA 4X versions, and can drive Groschopp's brushless motor products.

The DB1120D Series is composed of two PC boards—an upper and a lower, connected by two small ribbon cables. A 10-position terminal strip on the upper board connects the control to the motor sensors, the speedpot, and the forward/reverse control switch (optional). The control's upper board also carries the trimpots for minimum speed, maximum speed, and current limit, as well as a means for selecting the sensor spacing. The DC power source and the three motor stator wires attach to a 5-position connector on the lower board.

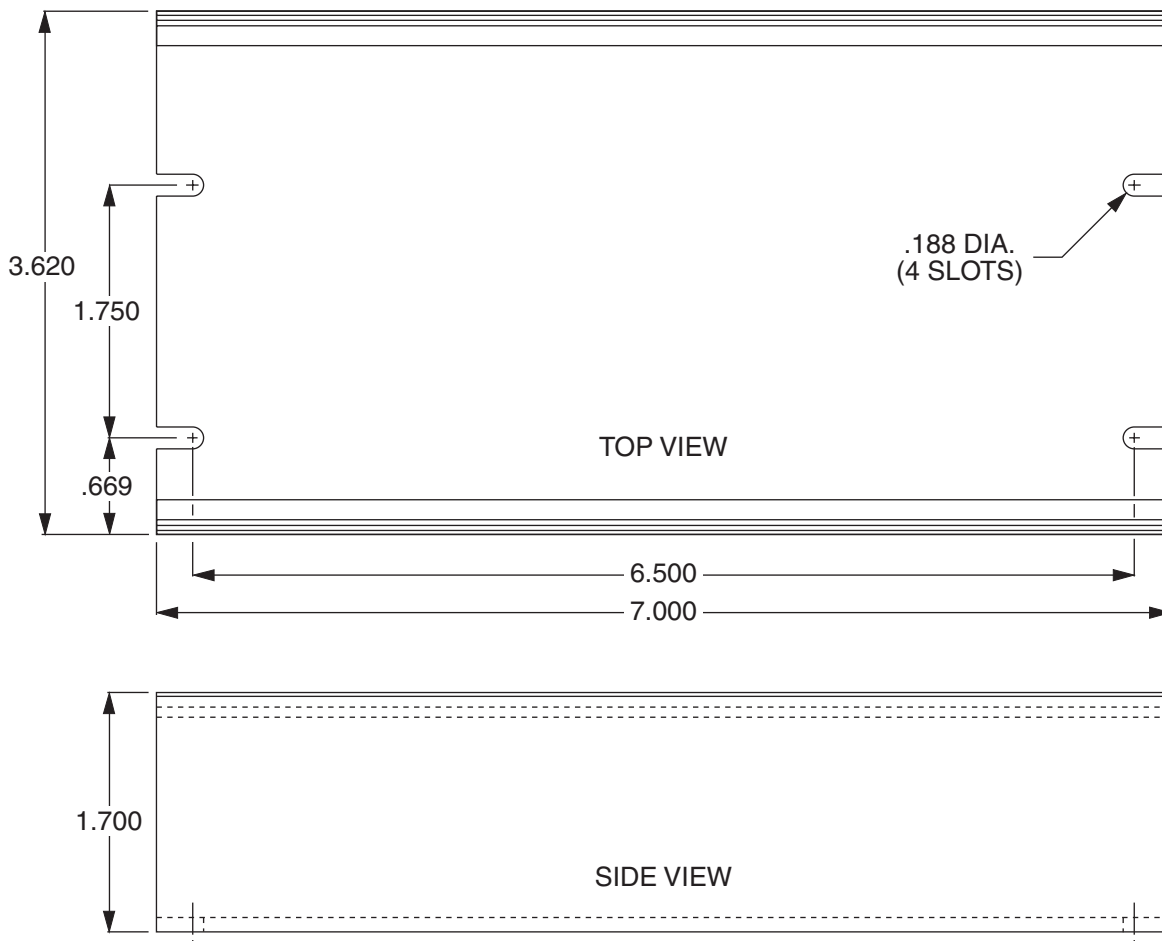
## UNPACKING

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, you will need the 5K Ohm speedpot supplied with the control, a DC power source, hook-up wires, and appropriate tools for installation.

## STANDARD FEATURES

- **ALL SOLID-STATE DESIGN**
- **QUIET 15KHz PWM SWITCHING FREQUENCY**
- **MOSFET POWER DEVICES**
- **FORWARD / REVERSE DIRECTION CONTROL**
- **5K Ohm SPEED POTENTIOMETER WITH LEADS, KNOB AND DIAL INCLUDED**
- **INTERNAL 6.25 VOLT DC SUPPLY FOR MOTOR HALL EFFECT SENSORS**
- **ANODIZED CHASSIS MOUNT HEATSINK**

# HEATSINK MOUNTING DIMENSIONS



## HOOK-UP OVERVIEW

Brushless DC motors have eight (8) wires: three (3) armature wires, three (3) motor sensor wires, and two (2) wires for sensor power and sensor common.

Power is connected to terminals P1-1 and P1-5 on the lower board. The power should be off until the hook-up procedure is complete.

### 12/24-48 Volt Operation

There is a jumper on the **lower board** to accommodate two ranges of dc source voltage. This jumper is shown near the bottom of Figure 1 (page 4). If you have a 12 volt DC source, the jumper must be placed in the left-most (dashed) position, as illustrated in Figure 1. With DC sources from 24 to 48 volts, the jumper must be placed in the right-most (solid) position, which is also illustrated in Figure 1.

### 60°/120° Sensor Spacing

There is a jumper on the **upper board** to switch between 60° and 120° Hall sensor spacings. This jumper is shown in the upper left portion of Figure 1 (page 4). Place this jumper in the left-most (dashed) position for 60° operation, or in the right-most (solid) position for 120° operation. Groschopp standard motors are designed for 120° spacing and DB1120D drives are set to 120° spacing by default.

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# DB1120D SERIES HOOK-UP DIAGRAM

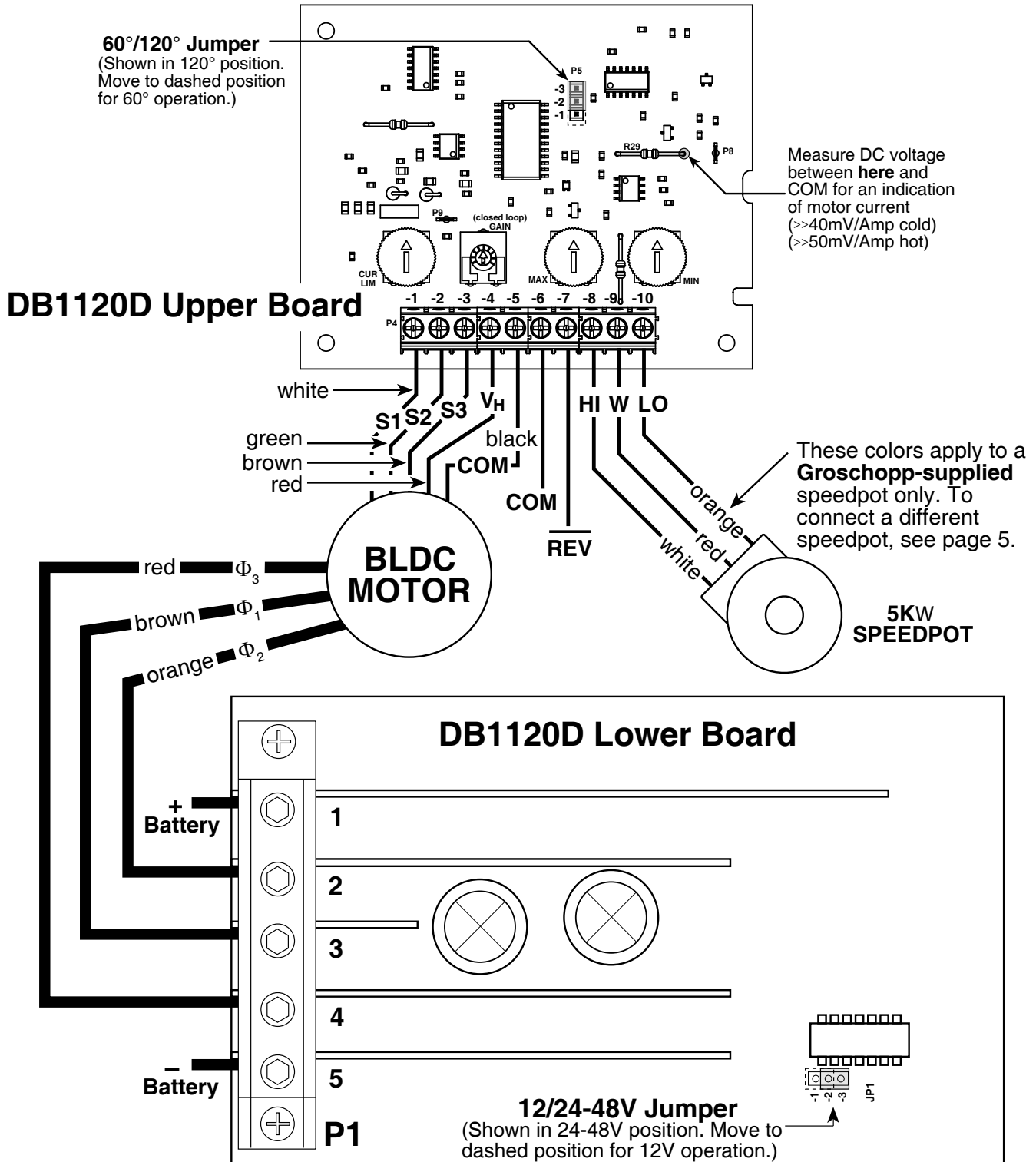


Figure 1

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## **Speedpot and Signal Input**

The 5Kohm speedpot is connected to terminals P4-8, P4-9, and P4-10. If you don't have the furnished speedpot with orange, red, and white wires attached to it, any 5Kohm pot may be used. Simply rotate the shaft of the speedpot fully CCW (counterclockwise), and measure the resistance between the wiper and each terminal. The terminal that measures about 5Kohm is referred to as pot "HI", and the terminal that measures about 0 ohm is referred to as pot "LO". Connect pot "HI" to terminal P4-8, pot "LO" to terminal P4-10, and the wiper to P4-9.

NOTE: IT IS IMPORTANT THAT WHEN POWER IS FIRST APPLIED TO THE SYSTEM, THE SPEEDPOT IS SET TO FULL CCW.

## **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 three motor phases.

Return to the section "60°/120° Sensor Spacing" (page 3) and make sure the control is set to 120° spacing. Return to Figure 1 and connect the sensors to terminals P4-1 through P4-3.

After the sensors are connected, attach the sensor power line (notated by  $V_H$  in Figure 1) to terminal P4-4. The sensor common line (notated by COM in Figure 1) is connected to terminal P4-5. Now attach the three motor armature wires and test for proper hook-up.

Now apply power to the control. Slowly turn the speedpot CW. Watch for erratic rotation or current over 2 amps. If any of these conditions occur, immediately return the speedpot fully CCW, and turn off the power. Refer back to Figure 1 and make sure the motor and drive are correctly connected.

Rotation will be smooth and the DC current will be less than 2 amps. You have now found the correct hook-up for your motor.

## **ADJUSTING CURRENT LIMIT**

Groschopp has factory-set the Current Limit to 20 amps. You should not have to change this setting. You can set the current limit to a lower value by turning the Current Limit trimpot CCW.

### **Determining Motor Current**

There are several ways to determine motor current. Two convenient methods are listed below.

- 1) Refer to figure 1 on page 4. Measure the DC voltage (with reference towards COM) at the point indicated on the upper board, then divide by 40mV to obtain the motor current in amperes.

**Example:** If you measure 0.35V, the motor current is  $0.35/0.040=8.75$  amperes.

This method will always work, regardless of motor speed, speedpot position, current limit, etc.

The next method will work only within strict constraints, but within those constraints, it may be more easily done than method 1.

- 2) Monitor current by placing an ammeter in series with the DC source.

**NOTE: The current measured with the ammeter in series with the DC source will be equal to the motor current only when the speedpot is at or near the fully clockwise (CW) position, the max. speed trimpot is fully clockwise (CW), and the control is not in current limit.**

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**Otherwise, the DC source current will be less than actual motor current.** Don't let the current exceed 20 amperes. Limit the average current with prudent use of torque and speed settings, **not** with the Current Limit trimpot.

**CAUTION: KEEP THE AVERAGE CURRENT UNDER 20 AMPS, AND MAKE SURE THE MOTOR IS ROTATING. A STALLED MOTOR WILL QUICKLY OVERHEAT.**

## ADJUSTING MINIMUM SPEED

Turn the speedpot to zero (fully CCW). Next turn the minimum speed trimpot CW 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 non-zero minimum speed is desired, rotate the minimum speed trimpot CW to the desired setting.

## ADJUSTING MAXIMUM SPEED

Turn the speedpot fully CW and adjust the Maximum adjust trimpot to the desired maximum output.

## 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 20 amps continuous current. If the ambient temperature increases above 40°C (104°F), contact Groschopp to discuss alternate solutions. Typical heatsink temperatures for the drive are 75°C (167°F) or below.

## ADJUSTING CLOSED LOOP GAIN

The standard DB1120D series control is a closed loop device. These controls use additional circuits to transform the sensor signals into tachometer information and accurately control the speed of the motor. A trimpot labeled **Closed Loop Gain** (Shown in Figure 1 on page 4) is used to adjust the closed loop feedback to allow the drive to be used for a wide variety of motors.

### **To adjust the control to your motor:**

- 1) Set the Maximum Speed (MAX.) trimpot to the position shown in Figure 1 on page 4.
- 2) Set the Minimum Speed (MIN.) and Closed Loop Gain trimpots to their fully counterclockwise (CCW) positions.
- 3) Advance your speedpot to the fully clockwise (CW) position. Your motor should now be spinning at its maximum speed.\*
- 4) Slowly rotate the Closed Loop Gain trimpot clockwise until the motor speed decreases slightly\*\*, then rotate the trimpot back counterclockwise just enough to return the motor to full speed.

\* If your motor doesn't reach its maximum speed with the speedpot fully clockwise, rotate the MAX. trimpot clockwise until it does. Proceed with step 4.

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\*\* If you rotate the Closed Loop Gain trimpot fully clockwise and the motor speed doesn't decrease, rotate the MAX. trimpot counterclockwise just enough to make the speed decrease slightly. Then rotate the Closed Loop Gain trimpot counterclockwise just enough to return the motor to full speed.

## **REVERSING**

Terminal P4-7 on the DB1120D Series is the forward/reverse control. You can reverse motor direction by connecting P4-7 to P4-6. Use a jumper wire, switch, relay, or an open collector NPN transistor. **WHEN YOU REVERSE DIRECTIONS, MAKE SURE THE MOTOR IS STOPPED. THE CONTROL ISN'T DESIGNED FOR PLUG REVERSING.**

Sometimes it may be necessary to reverse motor direction without using terminal P4-7. This is done by stopping the motor and exchanging terminals P1-3 with P1-2 on the lower board, and terminals P4-1 with P4-3 on the upper board.

## **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 position, undervoltage lockout (i.e. +12V supply is less than 10.0V) or thermal shutdown (i.e. U4 is too hot). Typical fault conditions are: invalid sensor attachment or 60°/120° phasing jumper is in the wrong position.



# SPECIFICATIONS

|                                       |   |
|---------------------------------------|---|
| INPUT VOLTAGE .....                   | (jumper selectable) 10-13.5 VDC or 18-54 VDC  |
| LOAD CURRENT (CONTINUOUS) .....       | 20 AMPS   |
| OVERLOAD CURRENT .....                | 200% FOR 30 SECONDS   |
| SPEED RANGE .....                     | CLOSED LOOP = 50 : 1  |
| MINIMUM SPEED TRIMPOT .....           | ADJUSTABLE 0-30% OF MAX.  |
| MAXIMUM SPEED TRIMPOT .....           | 60 TO 100% OF INPUT VOLTAGE   |
| CURRENT LIMIT .....                   | ADJUSTABLE 0-200%   |
| MOTOR HALL SPACING (ELECTRICAL) ..... | (jumper selectable) 60° or 120°   |
| INPUT / OUTPUT CONNECTION .....       | 10-POSITION TERMINAL BLOCK (upper board)<br>5-POSITION TERMINAL BLOCK (lower board) |
| SPEED CONTROL .....                   | 5K Ohm SPEED POTENTIOMETER or<br>0 TO +6.25V SIGNAL (GROUNDED OR UNGROUNDED SIGNAL) |
| OPERATING TEMPERATURE .....           | 0°C - 40°C (32°F - 104°F)   |
| CLOSED LOOP SPEED REGULATION .....    | ± 1/2% OF BASE SPEED  |
| TOTAL CONTROL HEIGHT .....            | 2.00 INCHES   |
| TOTAL CONTROL LENGTH .....            | 7.00 INCHES   |
| TOTAL CONTROL WIDTH .....             | 3.62 INCHES   |
| TOTAL CONTROL WEIGHT .....            | 16 OUNCES   |

