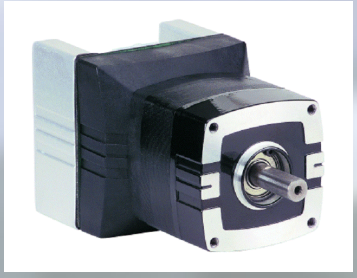
Instructions for Installation and Operation

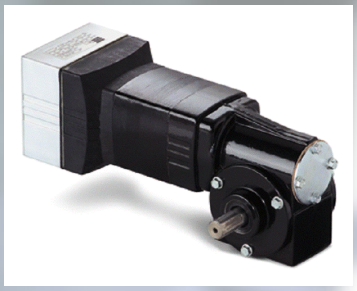
# INTEGRAmotor™

## Brushless DC Motors and Gearmotors with Built-In PWM Speed Control



### Direct Drive Motors

- 22B2BEBL/SR
- 22B4BEBL/SR



### Right-Angle Gearmotors

- 22B4BEBL/SR-3N

### Parallel Shaft Gearmotors

- 22B2BEBL/SR-D3
- 22B2BEBL/SR-D4
- 22B3BEBL/SR-Z2
- 22B3BEBL/SR-Z3
- 22B2BEBL/SR-Z4

# QUICK REFERENCE

**IMPORTANT**

Read this manual completely and carefully. Pay special attention to all warnings, cautions, and safety rules. Failure to follow the instructions could produce safety hazards which could injure personnel or damage the control, motor, or other equipment. If you have any doubts about how to connect the control or motor, refer to the detailed sections of this manual.

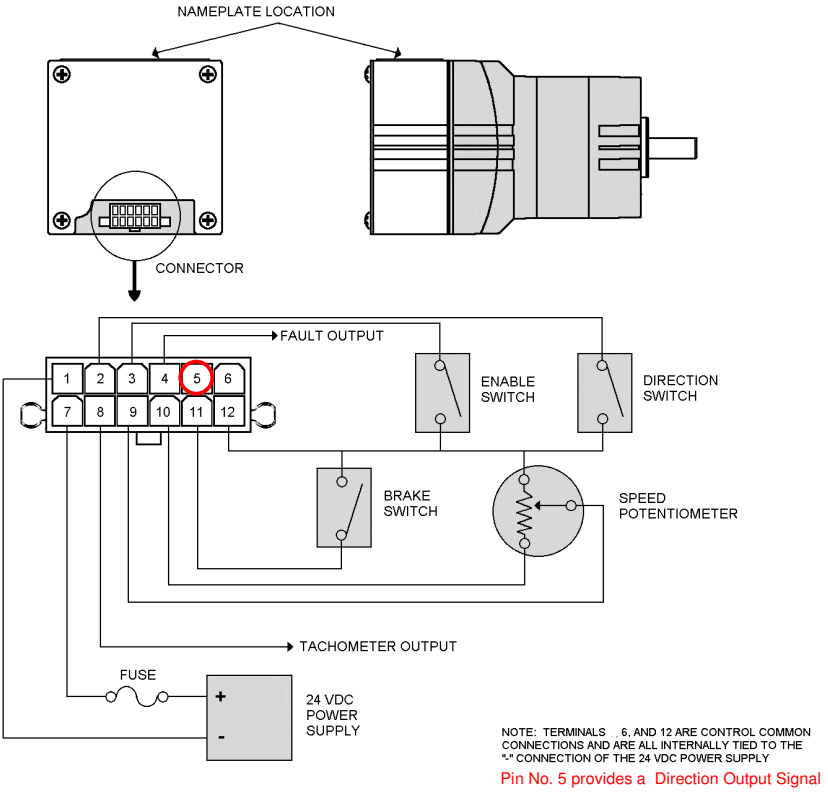



**Figure 1 - Basic Connection Diagram**

# CONTENTS

This manual contains the basic information needed to install and operate a Bodine INTEGRAmotor™ brushless DC motor & control system. This manual does not profess to cover all details or variations in equipment, nor to provide for every possible contingency associated with installation, operation, or maintenance. No warranty of fitness for purpose is expressed or implied. Should further information be desired or should particular problems arise which are not covered sufficiently for the user's purpose, the matter should be referred to the Bodine Electric Company.

# PRODUCT SPECIFICATIONS

Ambient Rating: +25°C (+77°F)
Environmental Protection: IP-00

## SPECIFICATIONS OF DIRECT DRIVE MODELS

| | | | MOTOR OUTPUT | | | CONTROL INPUT | |
|---|---|---|---|---|---|---|---|
| Model Number | Frame Type | Weight (lbs) | Speed (rpm) | Torque (oz-in) | HP | Volts (VDC) | Cont. Amps |
| **3802** | 22B2BEBL/SR | 2.5 | 200 to 2500 | 25 | 1/16 | 24 | 4.0 |
| **3804** | 22B4BEBL/SR | 3.5 | 200 to 2500 | 50 | 1/8 | 24 | 6.0 |

## SPECIFICATIONS OF PARALLEL SHAFT MODELS

| | | | GEARMOTOR OUTPUT | | | | CONTROL INPUT | |
|---|---|---|---|---|---|---|---|---|
| Model No. | Frame Type | Weight (lbs) | Speed (rpm) | Torque (lb-in) | Gear Ratio | HP | Volts (VDC) | Cont. Amps |
| **N3826** | 22B2BEBL/SR-D3 | 3.8 | 33 to 417 | 5.8 | 6:1 | 1/16 | 24 | 4.0 |
| **3827** | 22B2BEBL/SR-D3 | 3.8 | 17 to 208 | 12 | 12:1 | 1/16 | 24 | 4.0 |
| **N3828** | 22B2BEBL/SR-D3 | 3.8 | 11 to 139 | 17 | 18:1 | 1/16 | 24 | 4.0 |
| **3829** | 22B2BEBL/SR-D3 | 3.8 | 7 to 83 | 29 | 30:1 | 1/16 | 24 | 4.0 |
| **N3834** | 22B2BEBL/SR-D3 | 3.8 | 3 to 42 | 40 | 60:1 | 1/16 | 24 | 4.0 |
| **N3835** | 22B2BEBL/SR-D4 | 3.8 | 2 to 28 | 40 | 90:1 | 1/16 | 24 | 4.0 |
| **3836** | 22B2BEBL/SR-D4 | 3.8 | 1 to 14 | 40 | 180:1 | 1/16 | 24 | 4.0 |
| **N3837** | 22B2BEBL/SR-D5 | 3.8 | 0.7 to 8 | 40 | 300:1 | 1/16 | 24 | 4.0 |
| **3857** | 22B3BEBL/SR-Z2 | 5.3 | 33 to 417 | 10 | 6:1 | 1/11 | 24 | 5.0 |
| **N3858** | 22B3BEBL/SR-Z2 | 5.3 | 17 to 208 | 20 | 12:1 | 1/11 | 24 | 5.0 |
| **N3859** | 22B3BEBL/SR-Z2 | 5.3 | 11 to 139 | 31 | 18:1 | 1/11 | 24 | 5.0 |
| **3860** | 22B3BEBL/SR-Z3 | 5.3 | 7 to 83 | 52 | 30:1 | 1/11 | 24 | 5.0 |
| **N3861** | 22B3BEBL/SR-Z3 | 5.3 | 3 to 42 | 95 | 60:1 | 1/11 | 24 | 5.0 |
| **N3862** | 22B2BEBL/SR-Z4 | 4.8 | 2 to 28 | 97 | 90:1 | 1/16 | 24 | 4.0 |
| **3863** | 22B2BEBL/SR-Z4 | 4.8 | 1 to 14 | 100 | 180:1 | 1/16 | 24 | 4.0 |
| **N3864** | 22B2BEBL/SR-Z4 | 4.8 | 0.7 to 8 | 120 | 300:1 | 1/16 | 24 | 4.0 |

## SPECIFICATIONS OF RIGHT ANGLE MODELS

| | | | GEARMOTOR OUTPUT | | | | CONTROL INPUT | |
|---|---|---|---|---|---|---|---|---|
| Model No. | Frame Type | Weight (lbs) | Speed (rpm) | Torque (lb-in) | Gear Ratio | HP | Volts (VDC) | Cont. Amps |
| **N3865** | 22B4BEBL/SR-3N | 5.4 | 3 to 42 | 37 | 60:1 | 1/8 | 24 | 6.0 |
| **3866** | 22B4BEBL/SR-3N | 5.4 | 5 to 62 | 37 | 40:1 | 1/8 | 24 | 6.0 |
| **N3867** | 22B4BEBL/SR-3N | 5.4 | 10 to 125 | 35 | 20:1 | 1/8 | 24 | 6.0 |
| **3868** | 22B4BEBL/SR-3N | 5.4 | 20 to 250 | 22 | 10:1 | 1/8 | 24 | 6.0 |
| **N3869** | 22B4BEBL/SR-3N | 5.4 | 40 to 500 | 11 | 5:1 | 1/8 | 24 | 6.0 |

# IMPORTANT SAFETY PRECAUTIONS

"The use of electric motors and generators, like that of all other utilization of concentrated power, is potentially hazardous. The degree of hazard can be greatly reduced by proper design, selection, installation, and use, but hazards cannot be completely eliminated. The reduction of hazard is the joint responsibility of the user, the manufacturer of the driven or driving equipment, and the manufacturer of the motor or generator."*

Please read through this operations manual in detail and observe those paragraphs with the safety alert symbol.

| | |
|---|---|
| **WARNING** | WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. |
| **CAUTION** | CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. |
| **CAUTION** | CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage. |

**WARNING**

- Do not touch printed circuit board (PCB) right after turning off power.
- Do not attempt to wire circuitry while power is on.
- Do not attempt to examine components and signals on the PCB while the INTEGRAMOTOR™ is operating.
- Do not attempt to disassemble or modify internal components or wiring of the INTEGRAMOTOR™.

* Standards Publication No. ANSI/NEMA MG-2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators." (Ref.: www.nema.org).

# INSTALLATION

This product should only be installed by a qualified person familiar with its operation and associated hazards. The National Electrical Code (NEC), local electrical and safety codes, and when applicable, the Occupational Safety and Health Act (OSHA) should be observed to reduce hazards to personnel and property.

## Step 1. Examine before installation

**CAUTION**

- The PCB of the INTEGRAmotor™ is vulnerable to static electrical charges. For this reason, the INTEGRAMOTOR™ is packaged in an anti-static bag. Remove the INTEGRAmotor™ from the bag only in an area protected from electrostatic discharges (ESD).

Check the items you received against the model numbers specified on your purchase order. The serial number is printed on an adhesive label on the top side of the control housing. The first four digits in the serial number correspond to the model number. Carefully examine the product for shipping damage. Parts errors should be reported to Bodine. Shipping damage claims should be made to the freight carrier.

**CAUTION**

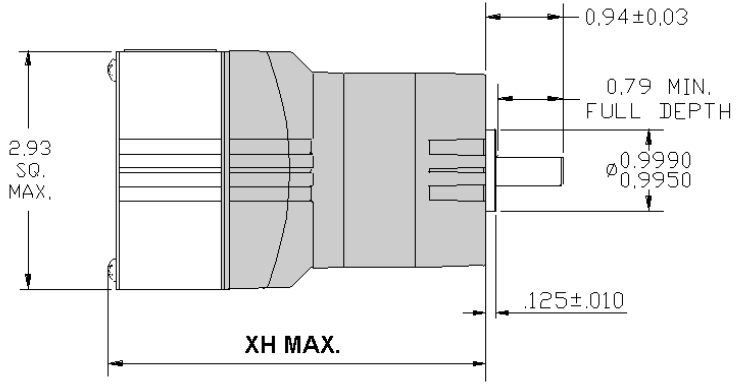
Do not connect the INTEGRAmotor™ to the power supply if there is any sign of shipping damage.

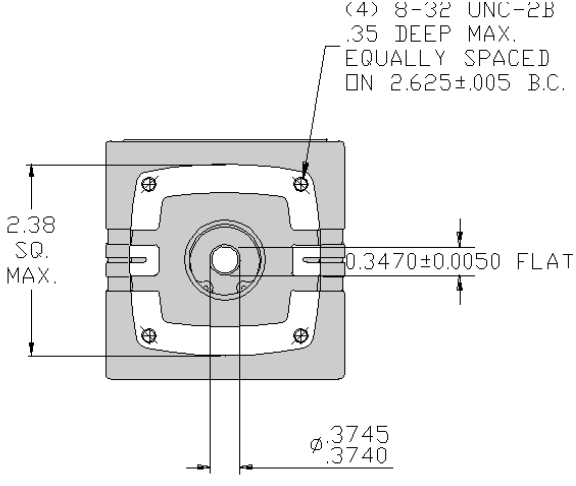
## Step 2. Mount the INTEGRAMOTOR™

Install the INTEGRAMOTOR™ onto a firm base by inserting screws into the four threaded holes in the mounting surface. See the following dimension drawings for location of mounting holes.

- INTEGRAmotors™ without gearing can be mounted in any position. Our standard gearmotors are designed for universal horizontal mounting orientation. Consult the factory for suggestions if the gearmotors are mounted vertically.
- Surrounding air temperature can be from $0^{O}$ C to $+25^{O}$ C (rated ambient temp.).
- Prevent liquid from dripping onto the INTEGRAmotor™.
- Avoid environments that are humid or that have corrosive gas.
- Avoid locations near radioactive matter, flammable material, or by equipment that emits electromagnetic interference (EMI).
- Avoid mounting the INTEGRAmotor™ to a surface that experiences excessive vibration.

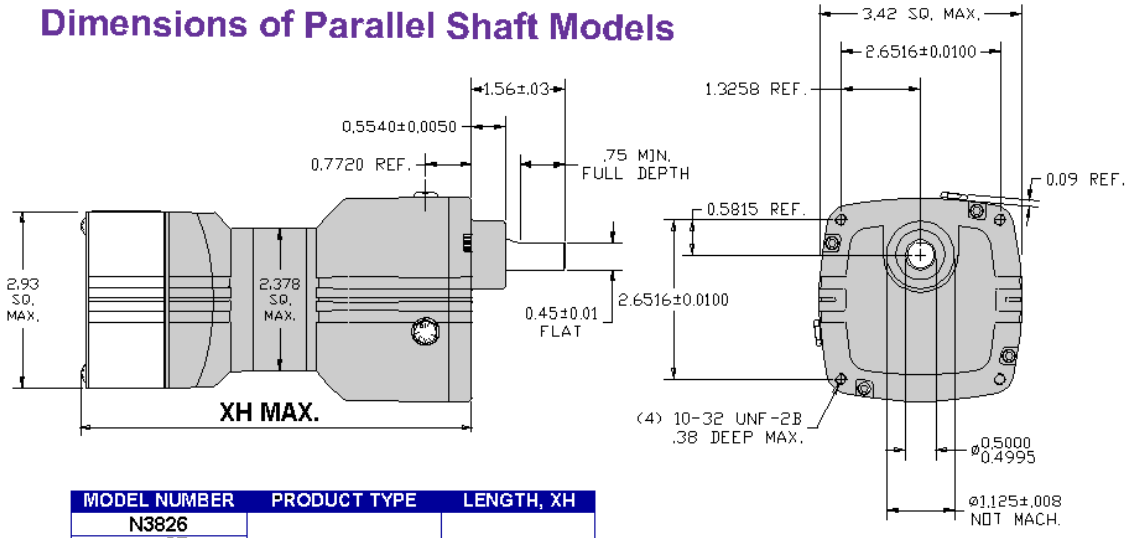
## Dimensions of Direct Drive Models



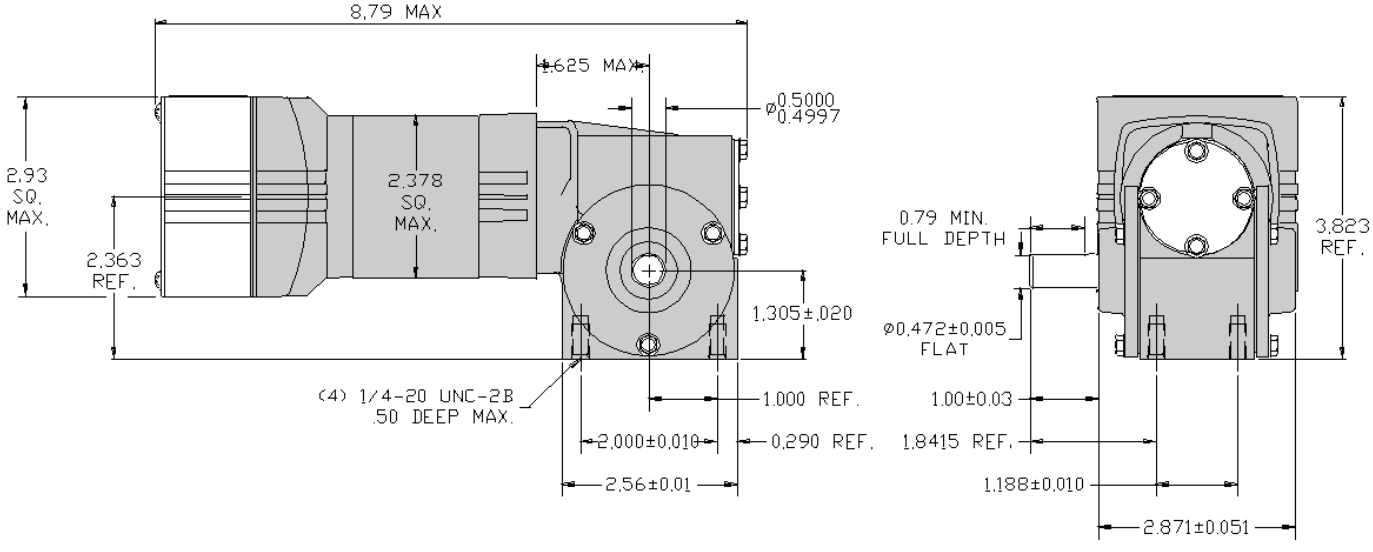

| MODEL NUMBER | PRODUCT TYPE | LENGTH, XH |
|---|---|---|
| 3802 | 22B2BEBL/SR | 4.727 |
| 3804 | 22B4BEBL/SR | 5.687 |

# Dimensions of Parallel Shaft Models




| MODEL NUMBER | PRODUCT TYPE | LENGTH, XH |
|---|---|---|
| N3826 | 22B2BEBL/SR-D3 | 6.639 |
| 3827 | | |
| N3828 | | |
| 3829 | | |
| N3834 | | |
| N3835 | 22B2BEBL/SR-D4 | 6.639 |
| 3836 | | |
| 3857 | 22B3BEBL/SR-Z2 | 7.443 |
| N3858 | | |
| N3859 | | |
| 3860 | 22B3BEBL/SR-Z3 | 8.343 |
| N3861 | | |
| N3862 | 22B2BEBL/SR-Z4 | 7.863 |
| 3863 | | |

# Dimensions of Right Angle Models



## Step 3 – Electrical Connections

## Step 3a – Make a Cable

The INTEGRAmotor™ has a single plug-in header for all electrical connections. Fig. 3 shows the location of this header. The mating connector is supplied in the packaging of the INTEGRAmotor™, but the user must attach wires to that connector. It is recommended that the wires used to connect the INTEGRAmotor™ to the 24V power supply be less than 12 feet long. Although this restriction doesn't apply to the wires for the logic connections, it is recommended that shielded cable be used if the logic wires are longer than 5 feet. It is also recommended that the power wires be separate from the shielded cable used for logic connections. If it is desired for the power wires to be shielded, then a separate shielded cable should be used for the power and logic connections.

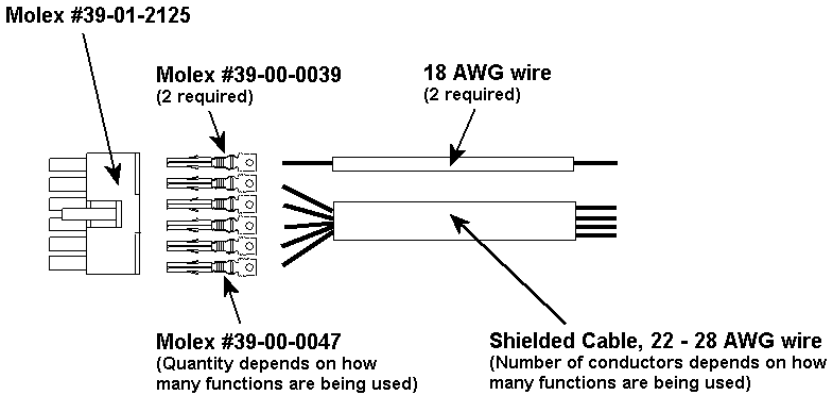



**Figure 2 - Construction of Mating Cable**

## Step 3b – Connect Remote Control Devices to Cable

**CAUTION**

- The printed circuit board (PCB) of the INTEGRAMOTOR™ is vulnerable to electrostatic discharges (ESD). Do not contact the PCB unless precautions are followed to prevent ESD.

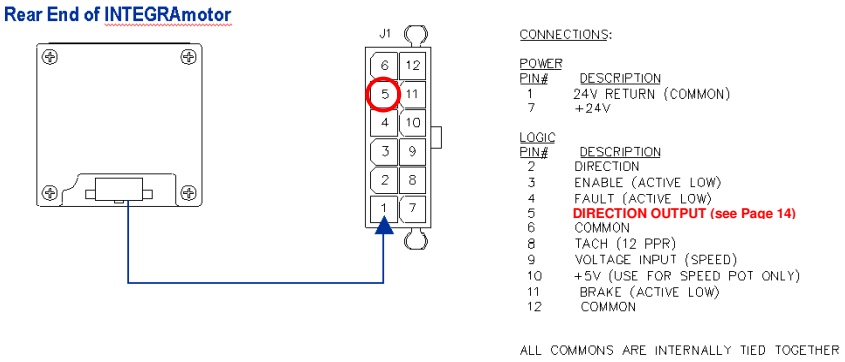



**Figure 3 - Functions of Connector Terminals**

The INTEGRAmotor™ can be connected for manual operation with switches and a speed potentiometer, as shown in Fig. 1, or it can be connected for remote operation from a programmable logic controller (PLC) or other control device.

**DIRECTION INPUT (Terminal 2)** - This input is normally high, pulled up to the internal 5V reference. If left high, rotation of the motor shaft will be counter-clockwise (CCW) looking at the motor shaft (clockwise for parallel shaft gearmotors having an odd number of gearing stages). To reverse motor rotation, pull the input low. It can be pulled low by either connecting it to a switch to one of the common terminals (Terminals 6 and 12), as shown in Fig. 1, or by connecting it to an open collector output from a PLC or other control device. Note that it is not recommended to change direction while the INTEGRAMOTOR™ is running. It should be brought to a stop first, and then reversed. A schematic diagram is shown in Fig. 4.

**ENABLE INPUT (Terminal 3)** – This input is normally high, pulled up to the internal 5V reference, and must be pulled low to allow operation of the INTEGRAMOTOR™. It can be pulled low by either connecting it to a switch to one of the common terminals (Terminals 6 and 12), as shown in Fig. 1, or by connecting it to an open collector output from a PLC or other control device. A schematic diagram for this input is shown in Fig. 4.

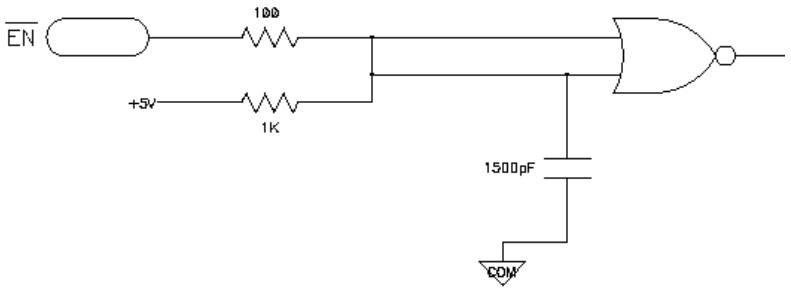



**Figure 4 - Schematic diagram for Enable, Direction, and Brake Inputs**

**FAULT OUTPUT (Terminal 4)** – The fault output is an open drain output connected directly to the main controller chip. It can be connected to a maximum of 12 VDC with a 10.0k ohm, 1/8 Watt resistor. The fault output will switch low to indicate at least one of the following conditions: (1) the controller is disabled because the enable input is high, (2) a shutdown has occurred because there is less than 20 VDC applied to the power input of the INTEGRAMOTOR™ (undervoltage lockout), (3) a shutdown has occurred because of an invalid combination of commutation sensor signals, or (4) a shutdown has occurred because of an overcurrent from the controller chip (not the motor windings).

**TACHOMETER OUTPUT (Terminal 8)** – This output is normally high, pulled up to the internal 5V reference. It can be connected to an external device to monitor the speed of the INTEGRAMOTOR™. The output is a negative pulse that goes from high to low, as seen in Fig. 5. Note that this is not the same as the square wave output of a typical encoder. The active portion of the signal, that part at common, has a fixed width of 0.8 msec, while the high portion of the signal will change width based on the speed of the INTEGRAMOTOR™. Twelve pulses are produced for each revolution of the motor shaft (not the same as the driveshaft on a geared INTEGRAMOTOR™). To calculate the resolution of the tach output with respect to the driveshaft of a geared INTEGRAMOTOR™, multiply the gear ratio by 12. No external pull-up resistor is necessary if the remote control device operates with 5V supply. The tach output will work with supply voltages up to 24 VDC with a user-supplied 10k pull-up resistor, per Figure 6.

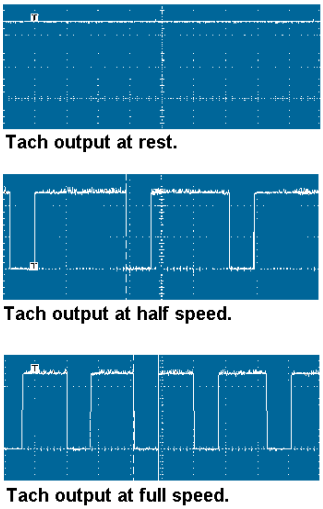



**Figure 5 - Waveform of Tach Output**

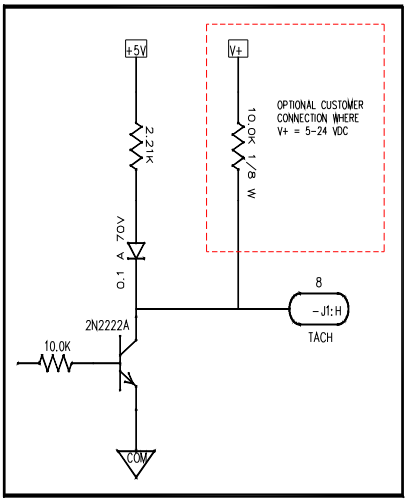



**Figure 6 – Schematic diagram of Tach Output**

**SPEED SIGNAL INPUT (Terminal 9)** – Connect a remote analog voltage signal to terminal 9. The drive will accept a 0 – 5 VDC signal. This signal does not have to be isolated since the 24 VDC power supply already isolates the INTEGRAMOTOR™ from the AC line. Alternatively, a speed potentiometer can be connected to the drive as shown in Fig. 1 with the wiper connected to terminal 9 and the two end terminals of the speed pot connected to terminals 10 and 12. Since the speed pot acts as a voltage divider, the exact value is not critical, but a 10k ohm potentiometer is recommended. A schematic diagram for the speed signal input is shown in Fig. 7. A typical response curve, showing the relationship between the rotor speed of the INTEGRAMOTOR™ to the voltage of the speed signal, is shown in Fig. 11.

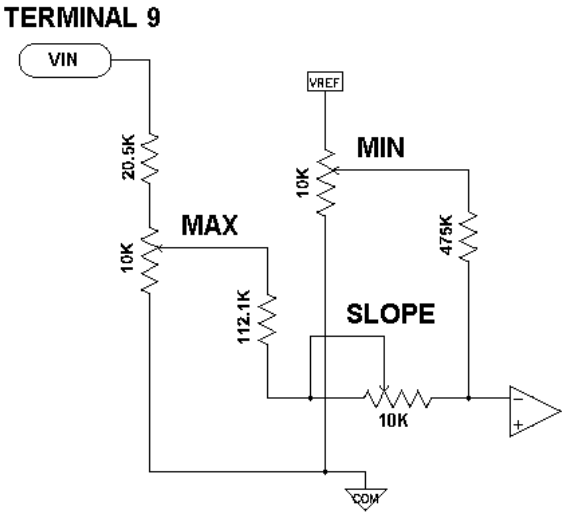



**Figure 7 - Schematic diagram for speed signal input**

**BRAKE INPUT (Terminal 11)** - This input is normally high, pulled up to the internal 5V reference. To dynamically brake the INTEGRAMOTOR™ to a stop, pull the input low. It can be pulled low by either connecting it to a switch to one of the common terminals (Terminals 6 and 12), as shown in Fig. 1, or by connecting it to an open collector output from a PLC or other control device. Note that this function is not the same as a holding brake. It brings the INTEGRAMOTOR™ to a quick stop, but will not hold it in place. The stopping time is a function of many variables and must be determined independently for each application. Some of the variables include the size of the INTEGRAMOTOR™, the gear ratio, the load inertia, and friction. Typical stopping performance is shown graphically in Fig. 8, with time divisions of 10 msec. A schematic diagram for the brake input is shown in Fig. 4.

**DIRECTION OUTPUT (Terminal 5, page 11)** – The direction output will be at +5V while the motor is turning CCW (looking at the motor shaft), and 0V when the motor is turning CW. This output will change state after the motor has been running in the new direction for at least 1/2 revolution. For gearmotors, the direction output will change after the motor has run 1/(2*n) revolutions where n is the gear ratio. If the number of gear stages is odd, the direction output will be inverted as compared to motors with an even number of stages or no gearing. For compatibility with the new versions Bodine recommends existing users update their designs to leave pin 5 unterminated or connected to a logic input.

## Step 3c – Ground the INTEGRAMOTOR™

There is no ground wire or ground terminal on the INTEGRAmotor™. It must be grounded through the mounting points or a user-supplied ground wire must be connected to the frame.

## Step 3d – Connect Fuse

The INTEGRAMOTOR™ must be protected by a user-supplied fuse. In a system with multiple INTEGRAMOTORs™, each one must be protected separately. Make sure the fuse is connected in series with the +24 volt lead of the power supply. See Fig. 1. The rating of the fuse is dependent on the amount of input current drawn by the control when the motor is operated at full load. Determine the fuse rating by multiplying the nameplate current rating of the INTEGRAMOTOR™ by 1.25 and round the number up to the closest commercially available fuse rating. Note that maximum current is drawn by the INTEGRAMOTOR™ in a condition where the INTEGRAMOTOR™ is set for full speed and is overloaded, but not enough to cause a stall. Because of the nature of the PWM type drive, the current is actually lower when the INTEGRAMOTOR™ is stalled.

## Step 3e – Connect DC Power Supply to Cable

**CAUTION**

- Use a power supply that is regulated to a voltage between 20 VDC and 28 VDC, and that has a current rating that matches the INTEGRAMOTOR™ rating.

## Step 3f – Plug Cable into INTEGRAmotor™

# OPERATION

## Step 4 – Check System Before Starting

**WARNING**

- Recheck all connections.
- Do not remove the cover over the electronics when the power is ON to avoid personnel injury caused by electrical shock.
- Do not attempt to install or remove the electrical connector when the power supply is turned on. Do not attempt to wire circuitry while power is on.

**CAUTION**

- Check that motor is securely mounted.
- Test INTEGRAMOTOR™ unloaded first.
- Check all rotating members. Be sure keys, pulleys, etc. are securely fastened and safety guards are in place.
- Check for proper mounting and alignment of products, and verify safe loading on shafts and gears.

## Step 5 – Operate the INTEGRAMOTOR™

Assuming the INTEGRAMOTOR™ has been connected as in Fig. 1, use the following procedure to start the motor, adjust the speed, stop the motor, and reverse direction.

**1) START AND ADJUST SPEED**

a) Set the ENABLE switch high, the SPEED POT to zero, and the BRAKE input high.
b) Turn the 24 VDC power supply ON.
c) Switch the ENABLE input low.
d) Turn the SPEED POT to start rotation and to increase motor speed.

**2) COAST TO STOP AND RESTART**

a) Switch the ENABLE input high to cut power to the INTEGRAMOTOR™ and bring it to a slow stop.
b) Turn SPEED POT to zero.
c) Switch ENABLE input low.
d) Turn SPEED POT to start rotation and increase speed.

**3) BRAKE TO STOP AND RESTART**

a) Switch the BRAKE input low to dynamically brake the INTEGRAMOTOR™ to a quick stop. Typical stopping time is shown in Fig. 8.
b) Turn SPEED POT to zero.
c) Switch BRAKE input high.
d) Turn SPEED POT to start rotation and increase speed.

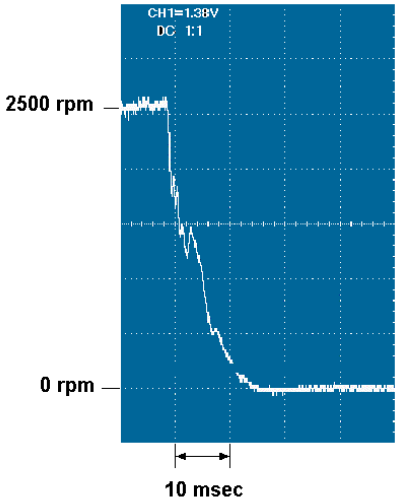



**Figure 8 - Typical Braking Time**

**4) STOP, CHANGE DIRECTION, AND RESTART**

a) Stop the INTEGRAMOTOR™ using either the ENABLE input or the BRAKE input, as described above.
b) Turn the SPEED POT to zero.
c) Switch the DIRECTION input to change the INTEGRAMOTOR™'s direction of shaft rotation. Note the DIRECTION input should not be changed while the INTEGRAMOTOR™ is running.
d) Restart the INTEGRAMOTOR™ as described above.

**5) STOP AND RESTART WITHOUT ZEROING SPEED SIGNAL**

a) Stop the INTEGRAMOTOR™ using either the ENABLE input or the BRAKE input, as described above.
b) Leaving the SPEED POT set at some speed higher than zero, restart the INTEGRAMOTOR™.

Note that there is some overshoot of the set speed during the acceleration, as shown in Fig. 9. This is because the control in the INTEGRAmotor™ does not have a ramping circuit. If overshoot is not acceptable in the application, then zero the speed signal before restarting, as described above or refer to Figure 14 on page 22.

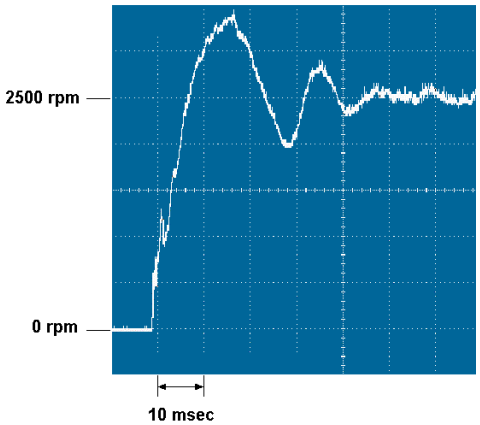



**Figure 9 - Starting With Nonzero Speed Signal**

## 6) INTERNAL ADJUSTMENTS

**CAUTION**

- The printed circuit board (PCB) of the INTEGRAMOTOR™ is vulnerable to electrostatic discharges (ESD). Do not contact the PCB unless precautions are followed to prevent ESD.

Most applications should not require the user to remove the metal plate that covers the control PCB. However, certain situations (see "TROUBLESHOOTING" section) may require adjustment of the trim potentiometers on the PCB. The trim pots affect the response of the INTEGRAMOTOR™ to the speed signal at Terminal 9. They are factory calibrated so that the INTEGRAMOTOR™ will not run when the speed signal is 0V (with a little dead band to account for component tolerances) and so it will run at 2500 rpm (before any gear reduction) when the speed signal is 5V. See Fig. 10 for location of the trim pots and Fig. 11 for the response curve.

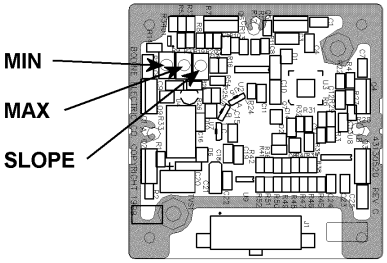



**Figure 10 - Location of Trim Pots**

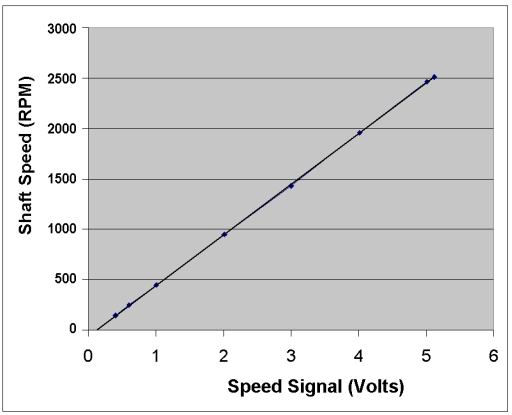



**Figure 11 - Response Curve, Speed/Volts**

**7) IF PROBLEMS OCCUR**

If the INTEGRAMOTOR™ does not start promptly and run smoothly, refer to the "TROUBLESHOOTING" section. Make sure the INTEGRAMOTOR™ isn't just overloaded. Fig. 12 shows the stall point for each size INTEGRAMOTOR™ (without gearing).

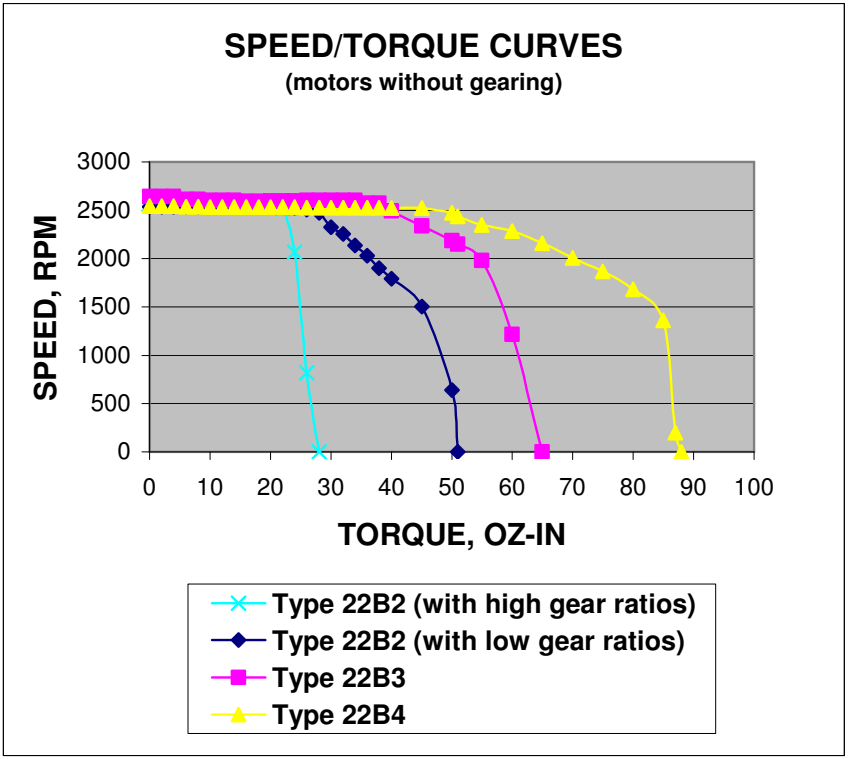



**Figure 12 – Speed/Torque Curves showing effect of current limit**

# TROUBLESHOOTING

**WARNING**

- Do not remove the cover over the electronics when the power is ON to avoid personnel injury caused by electrical shock.
- Do not attempt to install or remove the electrical connector when the power supply is turned on. Do not attempt to wire circuitry while power is on.

If you encounter a problem, read all instructions and double-check the wiring. Even if the INTEGRAMOTOR™ itself is definitely defective, it may be that another defective component in the system caused it to fail, in which case replacing the INTEGRAMOTOR™ alone and not tending to the root cause of the failure may result in another damaged product. Figure 13 may assist in troubleshooting foreseeable problems which may occur during installation and operation.

If problems persist, contact your source of purchase or a Bodine Authorized Service Center and describe the problem in detail. Do not disassemble the product unless authorized by Bodine Electric Company. Performing unauthorized repairs will void the Warranty.

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**GENERAL EVALUATION** – Knowing the circumstances under which the problem occurred can help to identify the root cause of the problem. The following are two questions you should ask yourself before tearing everything apart:

***Has the system ever operated properly?*** If the system was just installed and hasn't worked right from the beginning, then it is very likely that something wasn't done correctly in the installation. Focus on incorrect wiring or incorrect programming of remote devices. On the other hand, if the system has been working for an extended period of time and just recently stopped working, then this would indicate that the system was initially installed properly but has somehow changed. Focus instead on failed components or deteriorated wiring.

***Is the problem continuous or intermittent?*** If the problem always occurs and never goes away, then it would indicate something inherently wrong in the connections or a defective component. On the other hand, if the system operates properly most of the time and only occasionally does something wrong, then this might indicate loose connections or electrical noise interference.

**ISOLATE THE PROBLEM** – If there are no obvious indications that the INTEGRAmotor™ has failed (i.e. burn marks or smoke), then don't assume that it is the defective component.

***Disconnect external devices*** – Disconnect all external devices to make sure they are not causing the problem. Leave only the power supply connected, to terminals 1 and 7, but make sure first that power is actually getting to the INTEGRAMOTOR™. Hard wire the ENABLE by connecting a short loop of wire between terminals 3 and 12. Hard wire the INTEGRAMOTOR™ for full speed operation by connecting a short loop of wire between terminals 9 and 10. Connect nothing else to the INTEGRAMOTOR™. Now turn on the power and observe if the INTEGRAMOTOR™ runs at full speed. If it does, then proceed to the next step. If it doesn't, then the INTEGRAMOTOR™ probably needs service.

***Reconnect external devices one at a time*** - Assuming the system worked okay with just the INTEGRAMOTOR™ and power connected, reconnect and test each external device separately to identify which one is causing the problem. Remember that the problem may not be the device itself, but the wiring connecting it to the INTEGRAMOTOR™.

**FIGURE 13** - General problem evaluation method

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| Does not operate | Incorrect power supply wiring | • Check that power source is switched on.<br>• Check connections. Look for shorts and repair as required. |
| | Incorrectly sized power supply | • Replace power supply with unit having sufficient voltage and current capacity to provide 24V under full load |
| | Blown fuse | • Replace fuse. |
| | ENABLE input is high | • Correct any loose or open connection to ENABLE input<br>• Switch ENABLE input low if it is high. |
| | No speed signal | • Check if speed potentiometer, if used, is working properly.<br>• Check wiring for speed potentiometer or remote analog input signal<br>• Check that remote device, if used, is giving a signal to the INTEGRAMOTOR™. |
| | BRAKE input is low | • Correct any loose or bare wires that might be shorting BRAKE input to ground.<br>• Switch BRAKE input high if it is low. |
| | INTEGRAMOTOR™ is overloaded | • Reduce load<br>• Replace INTEGRAMOTOR™ with stronger model |
| | INTEGRAMOTOR™ is damaged | • Contact Bodine or an Authorized Service Center for assistance. |
| Operates, but in wrong direction | Direction input set wrong | • Switch DIRECTION input. |

**FIGURE 13** - General problem evaluation method (continued)

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| Operates, but speed can't be adjusted | Defective speed potentiometer | ● Replace speed potentiometer |
| | Incorrect wiring of speed potentiometer or remote speed signal | ● Check and correct connections |
| Operates, but won't come up to speed | INTEGRAMOTOR™ is overloaded | ● Reduce load<br>● Replace INTEGRAMOTOR™ with stronger model |
| | MAX trim pot set too low | ● Adjust MAX trim pot |
| | Incorrectly sized power supply | ● Replace power supply with unit having sufficient voltage and current capacity to provide 24V under full load |
| Operates, but with abnormal speed variations | Speed setting too low | ● Increase speed<br>● Replace INTEGRAMOTOR™ with model having higher gear ratio |
| Operates, but won't stop with zero speed signal | Defective speed potentiometer | ● Replace speed potentiometer |
| | Incorrect wiring of speed potentiometer or remote speed signal | ● Check and correct connections |
| | MIN trim pot set too high | ● Adjust MIN trim pot |
| Operates, but surges when started | Starting with speed signal set higher than zero | ● Set speed pot or remote signal to zero before starting<br>● Add external circuitry to provide a ramping function (consult Bodine) |
| Operates, but won't maintain speed under load | Incorrectly sized power supply | ● Replace power supply with unit having sufficient voltage and current capacity to provide 24V under full load |
| | INTEGRAMOTOR™ is overloaded | ● Reduce load<br>● Replace INTEGRAMOTOR™ with stronger model |

**FIGURE 14** – External “ramping circuit” for smooth 22B/SR acceleration (Refer to 5b on page 16)