ELECTRIC MOTORS INC.

Brushless Ferrite Motors
Installation and Operation Manual

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WARNING!!! IF YOU DO NOT INSTALL AND SERVICE THIS EQUIPMENT CORRECTLY, YOU OR SOMEONE ELSE COULD BE INJURED.

APPLICATION CHECKLIST

1. UPON RECEIPT

Our Quality Control Department inspects the motors and packing before shipment. When you receive it, inspect your order. Look for any mechanical damage that may have occurred during shipment. Report any damage you find to the freight carrier FIRST. Then call **Ohio Electric Motors** for help in assessing the damage.

2. STORAGE

You should store a motor in its original packaging. Keep it in a clean, dry location, protected from extremes in temperature and humidity. Rotate the shaft of a stored motor monthly. The grease may settle in the bearings and harden over time.

3. HANDLING

Use care in handling the motor. Avoid dropping it. Prevent sudden impacts, especially on the shaft.

4. ENVIRONMENT

The motor ratings are for an altitude of less than 3300 feet (1000 meters). You must derate the motor for higher altitudes.

5. GENERAL MECHANICAL INSPECTION

Before you install the motor, verify that the motor shaft is free to turn and all mechanical parts are in their proper position. Turn the motor shaft by hand to check for damage to the rotor.

NOTE: If you have power leads shorted together in the junction box, the motor shaft will not turn.

6. MOUNTING

You can mount the motor in any shaft position as long as you keep radial and thrust loads within limits. Install foot-mounted motors on a rigid foundation. You must use shims if the motor mounting base is uneven. Do not cause unnecessary stress on feet, frame and bearings by using poor mounting practices.

After installation, make sure that all bolts that hold the motor in place are tight. See Mounting Bolt Torques on page 15.

7. ALIGNMENT

If the motor is directly coupled to the load, alignment is very important. The type of coupling device determines alignment tolerances. Poor alignment allows vibration, resulting in damage to the coupling, bearings, rotor, or accessory devices.

8. BELTED APPLICATIONS

It is important that you use the correct sheave size and type. You must select the proper belts. See the Maximum Shaft Radial Loading Table on page 15. When you size the sheaves wrong or tension the belts improperly, premature bearing or shaft failure may occur. Mount the sheave as close as you can to the motor housing. If you need help on sheave sizing, call **Ohio Electric Motors.**

WHEN REMOVING PULLEYS FROM THE MOTOR SHAFT, USE A PROPER PULLER. DO NOT PRY PULLEYS OFF BY LEVERAGE AGAINST THE FRAME. YOU MAY DAMAGE THE BEARINGS OR THE RETAINER PLATES BY PLACING STRESS ON THE MOTOR SHAFT RELATIVE TO THE FRAME.

(CONTINUED ON PAGE 5)

ALTITUDE DERATING CHART

ALTITUDE (X 1000) in feet above sea level
Motors are rated in accordance with NEMA Standard MG1-14.04
For altitudes below sea level, use standard ratings.
For altitudes above 24,000 feet, consult the factory.
At a specific altitude: Multiply the motor HP by the de-rating factor.

AMBIENT TEMPERATURE DERATING CHART

TEMPERATURE °C
Motors are rated in accordance with NEMA Standard MG1-12.43.
For ambient temperatures below 40 °C, use the 40°C rating.
For ambient temperatures below 0°C, consult the factory.
At a given ambient temperature: Multiply the motor HP by the de-rating factor.

Install the motor in a clean, dry, well-ventilated area away from heat sources. Air temperature should not exceed 40 °C (104° Fahrenheit). For higher ambient temperatures, you must derate the motor. See the “Ambient Temperature Derating Chart” to the left.

De-rating is cumulative.
First de-rate for altitude; then de-rate for temperature.

((CONTINUED FROM PAGE 2)

9. OPERATION

After you complete the mounting and alignment steps, you may make electrical connections. You must follow the connection diagrams exactly or the motor will not operate.

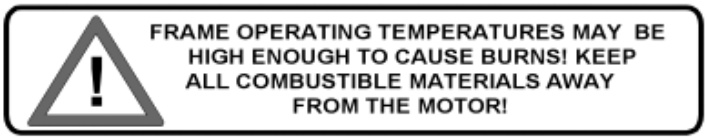
If turning the wrong way will damage the equipment, verify motor direction before connecting the load. Monitor motor current during the first operation of the motor. Compare it to the motor nameplate value.

Check the motor cooling right after the start up. Check it at fifteen minute intervals until the motor gets to normal temperature (about four hours at full load).

10. MAINTENANCE

Make the first inspection within a few hours after placing the motor in service, to catch problems caused by the installation. Check the motor at least once per month after start-up.

Preventive maintenance means checking the motor often. Make frequent checks for excess vibration, loose mounting bolts and belts, odd noises (a steady hum is normal), and high heat output.



SUMMARY OF WARRANTY

Brushless DC motors built by Ohio Electric Motors, Inc. are warranted against defects in materials and workmanship for a period of two years from the date of shipment from the factory. If a motor fails for any of these reasons during this period of time, we will repair the motor or, at our option, replace the motor. We reserve the right to determine who will make repairs, and where the repairs will be made. Claims for repairs under warranty must be submitted within 30 calendar days from the first indication of the defect. Unauthorized repairs are not covered by the warranty.

WARRANTY PROCEDURE

1. When a problem with the motor is confirmed, write down the serial number and model number, and job number of the motor. This information is listed on the nameplate.

2. Call your OEM distributor, or our Service Department at (828) 626 2901 or FAX the information to (828) 626-2155.

3 Our service personnel will attempt to resolve the problem over the phone. They may ask for information in the machine, environment, and operation.

4. If the problem cannot be resolved over the phone, we will determine the best course of action to resolve the problem. This may consist of sending parts, or returning the motor for repairs.

5. If parts are to be sent, a purchase order will be required. A **Returned Goods Authorization (RGA)** number will be issued for the parts. If the service is covered by warranty, credit for the parts will be issued upon inspection of the old parts at the factory.

6. Before the motor is returned to the factory for repair, an RGA number must be issued by the service department..

7. The **RGA** number must be displayed on the packaging of the motor and on all paperwork. The paperwork must include a description of the problem and return shipping instructions. Motors returned without an **RGA** will not be acknowledged, and we are not responsible for them.

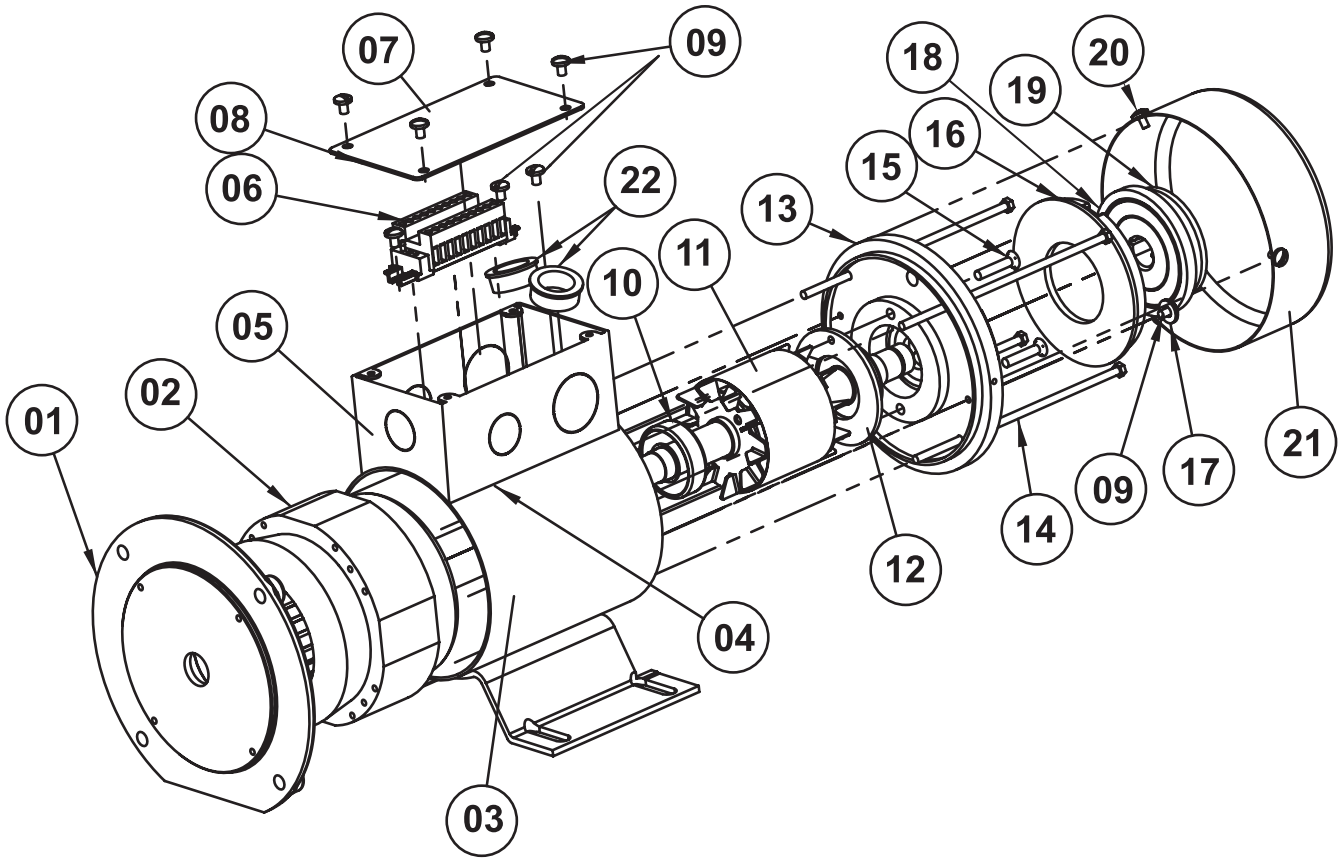
8. On repairs covered by warranty, there will be no charges for materials and labor at the factory. The repaired or replacement motor will be sent freight collect to the user.

9. Repairs and replacements will be made in a timely manner. If the user requires expedited service, there will be a charge for the expedited service.

The warranty does not cover failures due to misapplication, improper installation, accidental or intentional abuse, incorrect electrical connections, and damages due to transportation or handling. The warranty does not apply if any unauthorized alteration has been done to the motor.

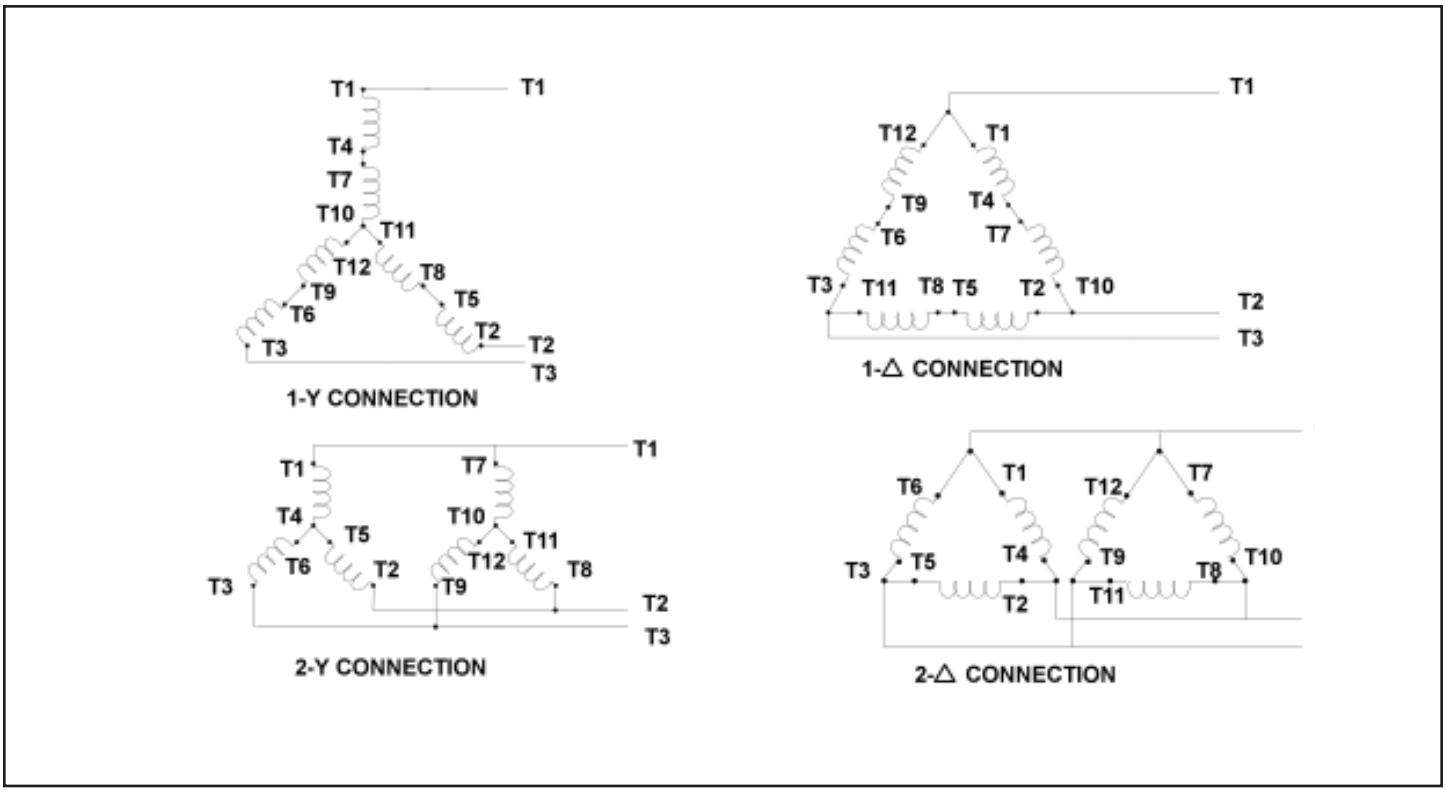
Ohio Electric Motors is not responsible for removal or re installation costs, shipping charges, nor consequential costs or losses. There is no other warranty, expressed or implied, including fitness for the purpose intended. The maximum liability of Ohio Electric Motors, Inc. shall be limited to the purchase price of the motor.

OHIO ELECTRIC BRUSHLESS MOTOR EXPLODED VIEW AND PARTS LIST.



PART NAME	QTY	PART NAME	QTY
01. Pulley End Cover	1.0	13. Sensor End Cover	1.0
02. Stator Core Assembly	1.0	14. Motor Thru Bolt	4.0
03. Complete Stator Assembly	1.0	15. Flat Head Machined Screw 10-32 UNC-2A	2.0
04. Terminal Box Gasket	1.0		
05. Terminal Box	1.0	16. Hall Effect Sensor	1.0
06. Complete Terminal Assembly	1.0	17. #10 Washer	1.0
07. Terminal Box Lid	1.0	18. XOLOX Magnet	1.0
08. Lid Gasket	1.0	19. XOLOX Hub	1.0
09. 8-32 Screw	9.0	20. Socket Head cap Screw 6-32-1/4	3.0
10. Bearings	2.0		
11. Complete Rotor Assembly	1.0	21. Drip Cover	1.0
12. Bearing Retainer	1.0	22. Snap Cap	2.0

POSSIBLE MOTOR CONNECTIONS



ELECTRICAL CONNECTIONS

All connections for the motor are in the main terminal box.

POWER LEADS

The motor ships from the factory already connected for the speed, voltage, and power listed on the nameplate. The correct connection of the motor is shown on the nameplate as "CONNECTION _ D _ Y". There will be a number “1” or “2” in front of one of these symbols.

Whatever the motor connections, you must connect the **T1** motor lead to the **T1** or **U** terminal on the motor control. You must connect the motor **T2** to the **T2** or **V** terminal on the motor control. You must connect the motor **T3** to the **T3** or **W** terminal on the motor control. The motor may draw up to 150% of this value for periods of up to one minute.

In addition to the wiring of T1, T2, and T3, you must install a ground wire, which may be one size smaller than the power leads. It must run from a ground bolt in the motor's junction box to a ground bolt on the motor control. This ground wire is in addition to required grounding of the motor to its frame.

Electrical connections to the motor must be tight and well insulated from each other and from the frame.

MOTOR PROTECTION

Ohio Electric Motors Brushless Series come in two types:

Resolver type motors are equipped with an integral resolver mounted in the rear of the motor (non-drive end), and with one switch in the windings.

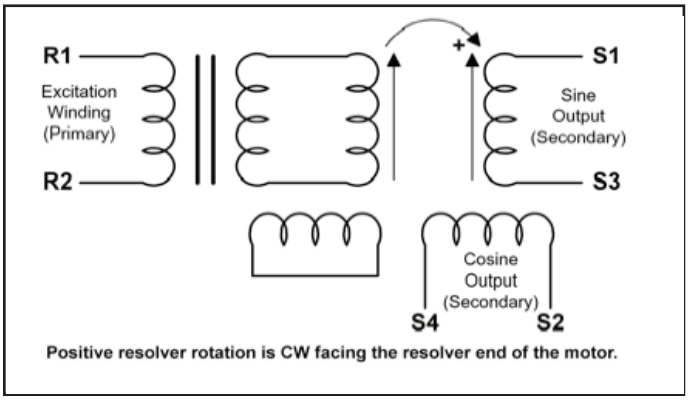
Encoder type motors are equipped with a hall-effect encoder mounted in the non-drive end of the motor and a bi-metallic thermal switch in the windings.

RESOLVER EQUIPPED MOTORS

The resolver supplied with Ohio Electric motors is a frameless, single speed, transmitter type, mounted on the back of the motor. The rotor element is mounted on the shaft.

See the"Thermistor Resistance Table" at the right for resolver specifications.

RESOLVER WIRING CONFIGURATION



The resolver puts out two sinusoidal waves which are in quadrature, i.e., 90° out of phase with each other. The leading wave is called the SIN output (S1 and S3) and the trailing wave is called the COS output (S2 and S4).

There is one electrical cycle of each signal for each revolution of the motor. The difference between the two waves reveals the position of the motor. By looking at the period of the waveforms, the drive can determine the speed of the motor. And by looking at which waveform is leading, the drive knows in which direction the motor is turning.

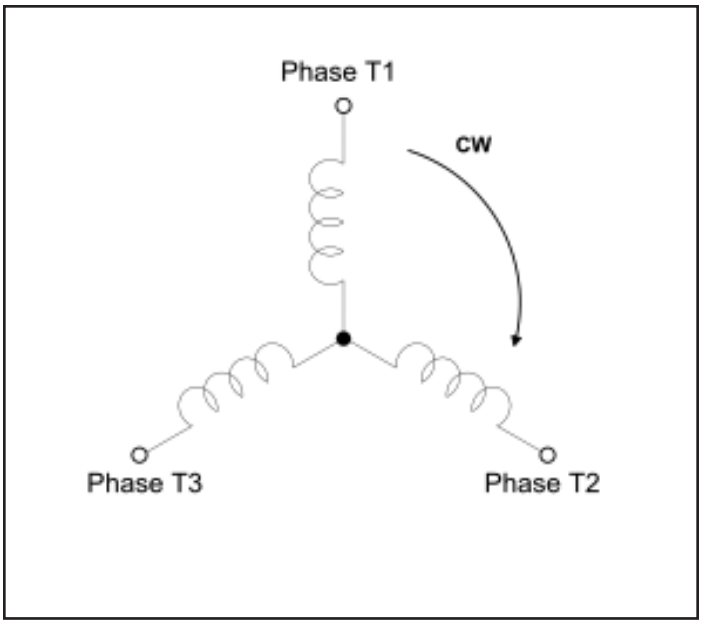
Thermistor Resistance Table

Nominal Resistance between P1 and P2 in ohms

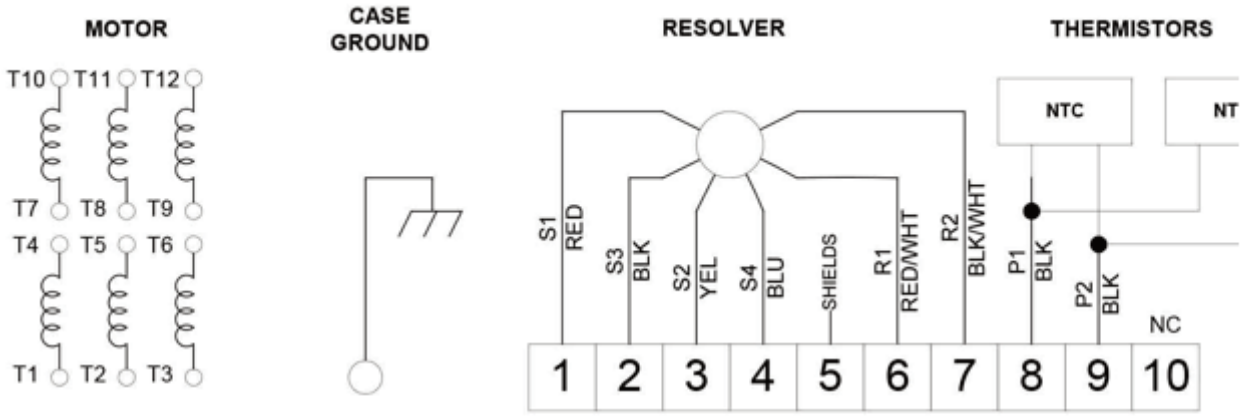
Resistance tolerance is +/- 5%

Winding Temp.	R_{P1-P2}	Winding Temp.	R_{P1-P2}
°C	ohms	°C	Ohms
-30	88500	90	459
-20	48535	100	340
-10	27665	110	255.5
0	16325	120	194.5
10	9950	130	150.5
20	6250	140	117.5
30	4028	150	92.5
40	2663	160	74
50	1801	170	59.5
60	1244	180	48.5
70	876	190	39.7
80	629	200	32.8

PHASING DIAGRAM OF MOTOR STATOR



RESOLVER MOTORS -- CONNECTIONS AND TERMINAL MARKINGS



MOTOR / RESOLVER LEADS

Motors are shipped with nameplate connections (i.e., 1-Y, 1-D, 2Y, or 2-D)
Check Motor nameplate for correct connections.
See page 7 for connection diagrams.
Consult drive manual for motor / drive interconnections.

OTHER ACCESSORIES

Check motor nameplate and accessories nameplates for conections and ratings.

CAUTION: Connect Cable shields to desinated points only..**DO NOT** connect shield to ground.

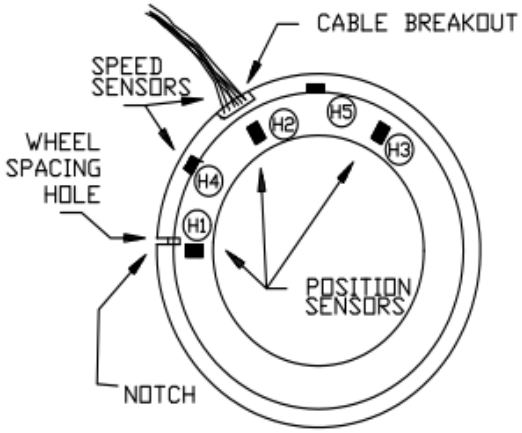
THERMISTORS AND THERMAL SWITCHES

The Overtemperature threshold for totally enclosed motors is 145°C (104.2 0hms).

Since the potential exists for a thermistor to open up, Motor Overtemperature Warnings should be set no higher than 80% of Fault Temperature on totally enclosed motors.

ENCODER EQUIPPED MOTORS

The encoder connections must be run in a shielded cable. There are seven connections to the encoder. When the motor thermal is run in the 24VDC or 48VDC control circuit, it may also be run in the cable. A cable such as BELDEN® part #9539 may be used.



A connection diagram is supplied with each motor control. The shield should be connected at the drive end at TB1 terminal 1. The shield on the motor end should be connected to the terminal strip in the motor at terminal 10. DO NOT GROUND THE SHIELD AT ANY POINT. If there are junction boxes between the motor and the control, install a terminal to continue the shield through the junction box.

ENCODER ALIGNMENT PROCEDURE

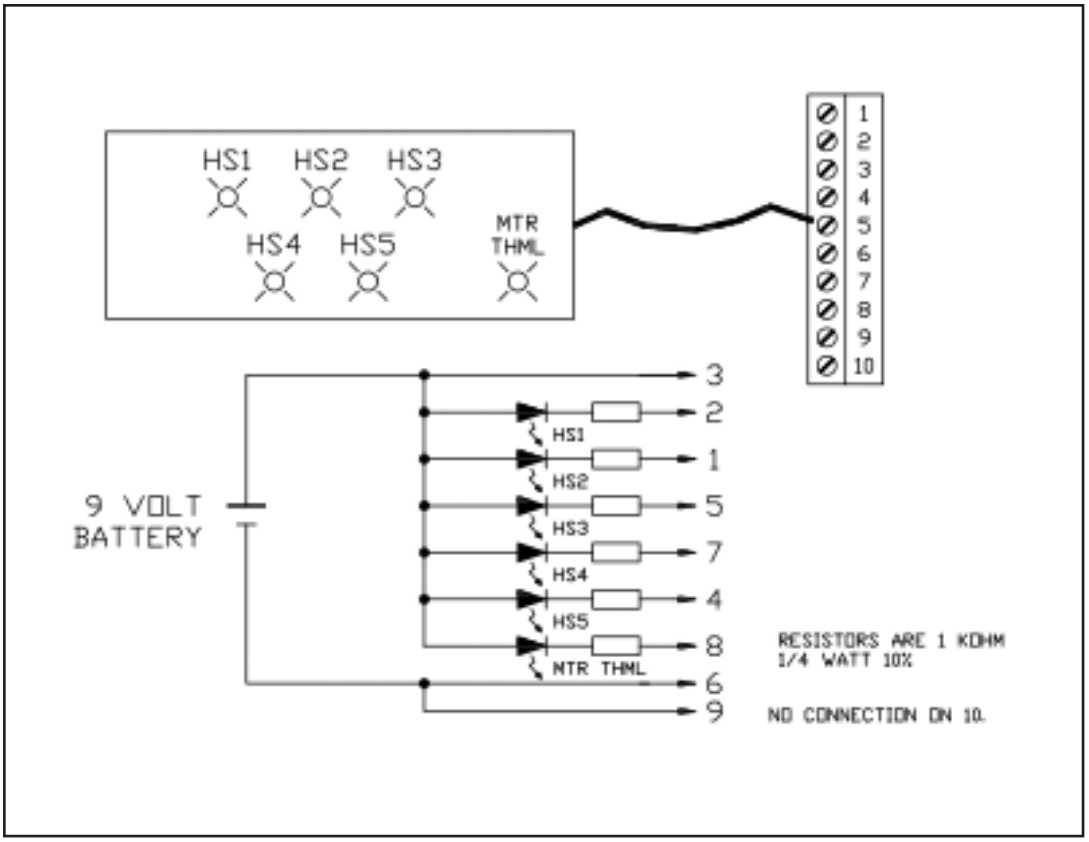
If a motor has been disassembled, the encoder must be lined up again so that it is properly aligned with the magnets on the rotor and the windings of the stator. Also, if the encoder has been replaced, adjustment of the assembly is necessary.

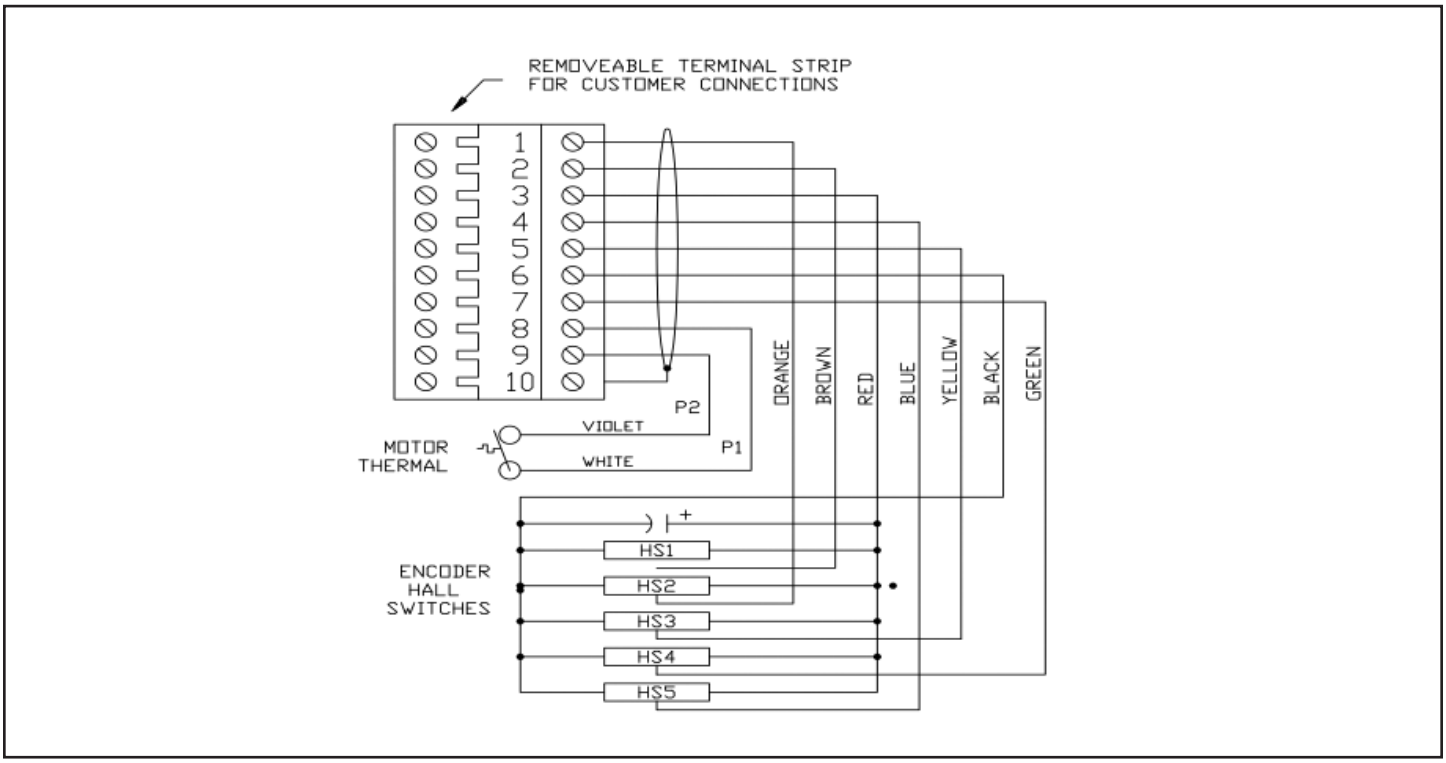
PROCEDURE

1. The encoder feedback assembly mounts in the back of the motor. The hole in the end bell on the junction box side locates the cable breakout point from the feedback assembly. An end bell mark shows the notch location.

2. After the feedback assembly is mounted, but before the magnetic wheel is mounted on the shaft of the rotor, it is necessary to align the rotor with the stator. The connections on the power leads must be made according to the nameplate. Start with the keyway of the motor shaft in the 12 o'clock position (up) with the motor standing on its feet.

3. The alignment of the rotor may be done on small motors by attaching any battery (such as a 9 volt cell) to the power leads. The positive terminal should be connected to the T1 lead of the motor, and the negative terminal of the battery should be connected to the T2 lead of the motor. The rotor will move to the nearest pole. Do not leave the battery connected or it will quickly be drained.





SETTING NEUTRAL

The preceding procedure is used at the factory to do the initial setting of the encoder alignment. Then factory alignment marks are placed on the end bell for the position of the notch on the feedback assembly, and on the motor shaft and encoder magnetic wheel to show the alignment of the encoder parts. The previous procedure can be bypassed if the factory marks are plainly evident and the motor has not been rewound.
Installing a new encoder on the motor or reinstalling the old one may be done by the factory marks as long as the motor is properly assembled. Then it is necessary to set the actual position of the feedback assembly to set the neutral of the encoder. This is the fine tuning of the encoder alignment.

PROCEDURE

Connect a true RMS AC voltmeter to motor leads T1 and T2. Do not use a peak-reading meter.
Run the motor with no load at rated RPM in the forward direction and note the AC voltage level on the meter.
3. Run the motor in the reverse direction at rated RPM and note the voltage on the meter.
Adjust the feedback assembly (by loosening the two mounting screws) a few degrees left or right to equalize the AC voltage in both directions within one percent.

MOTOR THERMAL SWITCH

-- There is a motor temperature thermal switch in the motor, inserted in the stator windings. The motor thermal switch leads are located in the main junction box. **THIS MOTOR THERMAL SWITCH MUST BE USED TO PROPERLY PROTECT THE MOTOR!** Failure to use this switch may result in the destruction of the motor. Brushless DC motor thermal switches work better than their brush-type DC motor counterparts because the heat in a Brushless DC motor is produced in the stator, where the switch is located.

The motor thermal switch is rated as follows:

MAX AMPS BREAK: 12 amps @ 120VAC
8 amps @ 240VAC
2 amps @ 24VDC
CONTINUOUS AMPS: 2 amps at all voltages above.

MOTOR ENCLOSURE

The enclosure type is determined by whether the motor is cooled by air moving through it, or by convection to the ambient air around it, or by air moving over it. CONSTANT TORQUE SPEED RANGE (CTSR) is a thermal consideration. The constant torque speed range is the range of speeds (based on base speed) over which the motor will run at full load without overheating or de-rating. De-rating the motor beyond its speed range does not mean it will not put out full torque. It means the motor cannot thermally support full torque output continuously.

TENV -- TOTALLY ENCLOSED, NON-VENTILATED

The totally enclosed non-ventilated motor is dust-tight with no openings to the ambient air. The motor is cooled by natural convection and radiation. The CTSR of the TENV motor is 100:1 or greater, but the horsepower range is limited to smaller sizes.

MOTOR SERVICE PROCEDURE

Any competent motor shop that can overhaul AC induction motors may service Brushless DC motors. There are differences that must be observed in the permanent magnet rotor, the feedback, and the bearings.

PERMANENT MAGNET ROTOR - Permanent magnets used in the Brushless DC motor are constructed of a highly stable material and will not demagnetize under normal conditions. The motors can be disassembled and reassembled without affecting the strength of the magnets.

HANDLE THE ROTOR WITH GREAT CARE SINCE THE MAGNETS ARE BRITTLE AND CAN BE DAMAGED IF DROPPED! DO NOT SET ON A STEEL SURFACE!

RESOLVER - The resolver consists of two parts: a rotor mounted on the shaft and the stator attached to the motor's end bell at the non-drive end. These components must line up properly if the motor is to operate correctly. See pages 8-9 for the encoder alignment procedure after re-assembling an encoder equipped motor.

BEARINGS -- Bearings are press-fit on the rotor shaft. The rear (non-drive end) bearing is fixed in place by a bearing retainer plate, and both bearings are slip fit into their housings. When replacing bearings, they must be positioned up against the bearing shoulder on the shaft.

DIS-ASSEMBLY OF THE MOTOR

Refer to exploded view drawing and parts list on page 6. This is a general drawing, and not all details are shown.

1. Before disassembling the motor, remove the rear cover (#21) from the bracket (#13) to expose the resolver/hall sensor.

2. Make sure that there are marks on the end bells (#1 and #14), stator (#3), sensor assy (#16), hub (#19), and motor shaft/rotor (#11) to locate parts when the motor is reassembled. Be sure those marks will not be obscured in the process.

3. Remove the hub (#19) from the shaft. It is secured by two set screws 90° apart on the hub.

4. Remove the two bearing retainer plate screws in the non-drive end. This releases rear bearing and allows removal of the shaft or end bell.

5. Carefully slide the pulley end cover (#1) off of the shaft. Don't allow the end bell to scrape the shaft as it is removed. Note carefully the location of parts that come loose as the end bell is removed, such as the wave washer (not shown) in the front housing. The rotor stays in the frame assembly.

6. The rotor (#11) may now be removed by sliding it slowly out. The banding will protect the magnets against damage while sliding out straight. Avoid jerky side to side movements. While the rotor is out of the motor, protect the banding and magnets from sharp blows and pointed objects.

DO NOT PULL ON THE WIRES OF THE CABLE OR ON THE ASSEMBLY. Pull the outside cable jacket only.

RE-ASSEMBLY OF THE MOTOR

1. Make sure the inside surface of the stator is smooth with no foreign material (such as metal shavings) in the area. Also check rotor assembly for foreign matter (like metals).

2. Carefully slide the rotor (#11) into the stator assembly (#25) slowly, **BEING VERY CAREFUL TO AVOID INJURY TO THE HANDS OR ARMS.** Make sure you insert the rotor from the drive end of the frame.

3. Once the rotor is inside the stator assembly, the Sensor End Cover (#13) may be installed. Make sure the marks made before disassembly line up properly. Use long screws to position the bearing retainer plate before pushing end bell in. Replace bearing retainer plate screws (#13).

4. Position the wave washer in position in the front housing. Replace Pulley End Cover (#1) according to the marks made before disassembly, being careful not to scratch the shaft.

5. Reinsert four bolts (#14) into holes in the end bells of the motor making sure the end bells are seated properly in the ends of the frame.

6. Install the Sensor (#16) according to the orientation marks and connect cable leads to the terminal assy (#6) according to the drawing on page 7.

7. Reinstall rotor (#11) on the shaft aligning the marks.

8. Turn the motor by hand to check for rubbing, scraping, and make sure the shaft turns freely. Check for lengthwise and sideways movement of the shaft.

9 . Torque down all bolts and screws, and proceed to motor resolver alignment or motor encoder alignment.

TROUBLESHOOTING

When a motor does not operate as expected, there may be a valid reason other than that the motor is bad. **Troubleshooting involves looking at the entire system of motor, control and environment.** Problems that occur when a motor is first put into service are most likely caused by misapplication, improper connection or lack of understanding. Problems that occur after a motor has been in service for some time period may be due to motor, control or environment.

These troubleshooting tips cover possible problems as well as problems which were seen in the past.

PROBLEM… SHAFT ROCKS BACK & FORTH.

1. Motor leads T1, T2, and T3 are not connected to the corresponding terminals on the motor control. T1 MUST be connected to T1, T2 MUST be connected to T2 and T3 MUST be connected to T3.

2. Encoder cable is connected to control improperly. Check the connections to the control per the card supplied with the control. The main connections involved are the connections involving HS1, HS2, and HS3.

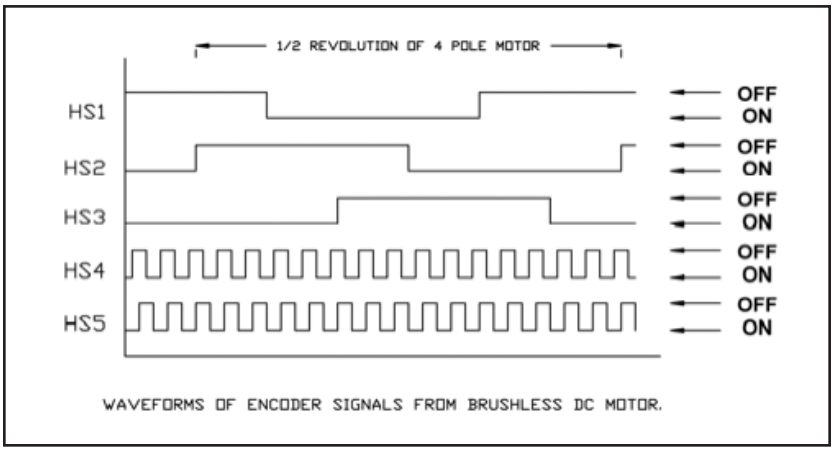
PROBLEM…ERRATIC SPEED

1. Motor is going at or above base speed while cold. Allow motor to warm up before adjusting maximum speed.

2. Feedback cable from motor to control is improperly shielded, run with power cables, or defective. Check the cable connections per the card supplied with the control.

3. Feedback signals are improper or missing. Check resolver signals against wave forms on page 8. Check encoder waveforms against drawing below. The drawing below is for a four pole motor. An eight pole motor will have the same waveforms, but the interval marked as being 1/2 revolution of the motor in the drawing below will be 1/4 revolution in an eight pole motor.

(CONTINUED ON PAGE 14)



WAVEFORMS OF ENCODER SIGNALS FROM BRUSHLESS DC MOTOR.

(CONTINUED FROM PAGE 13)

4. Bearings are worn. This will likely show up as increased current and an overheating motor, but severe bearing problems may affect speed control of the drive.

5. Severe load variations, such as a high inertia load changing speeds quickly may result in speed being erratic. Consult Ohio Electric Motors.

6. Drive is unstable. Adjust gain and/or stability

PROBLEM EXCESS END PLAY OF THE SHAFT.

Check for excessive thrust loading on the shaft.

1. Check the tightness of the bearing retainer plate by checking the bearing retainer plate screws on the non-drive end.

2. The bearings may be excessively worn.

3. The shaft bearing journals may be shot.

PROBLEM…EXCESS RADIAL SHAFT PLAY.

*Make sure radial loading on shaft is not excessive.

1. The shaft may be loose in the bearing I.D.

2. The bearings may be excessively worn.

3. The bearing housing may be worn.

PROBLEM…EXCESS VIBRATION.

1. The load may be out of balance. Check the load balance.

2. The motor mounting bolts may be loose. Check for tightness.

3. The rotor may be unbalanced. Run the motor unloaded.

4. There may be excessive radial play. See above.

5. The bearings may be worn. Listen for bearing noise.

6. Noise on drive speed reference.

PROBLEM…MOTOR RUNS HOT LOADED.

DO NOT JUDGE MOTOR TEMPERATURE BY TOUCH. USE A TEMPERATURE MEASURING DEVICE.

1. Check ambient temperature. It must be less than rated (40°C).

2. Check the load on the motor. Do not exceed rated current.

3. Check the duty cycle of the motor. It may not exceed 100% RMS.

4. The brake, if there is one, may not be releasing.

5. The bearings may be worn. Run motor unloaded.

6. The rotor may be rubbing the stator. Listen for noise.

PROBLEM MOTOR RUNS HOT UNLOADED

1. CHECK ALL ITEMS UNDER MOTOR RUNS HOT LOADED.

2. The motor control may be misadjusted. Check motor control

3. The encoder or resolver may be improperly set up. See Page 8.

4. The motor may be demagnetized. Check terminal voltages.

PROBLEM…MOTOR RUNS TOO FAST

1. Check the maximum speed setting on the motor control.

2. HS4 and HS5 on the encoder signals may be swapped.

3. Resolver or encoder misaligned.

4. Motor may be demagnetized. Check terminal voltages.

PROBLEM…LOW OUTPUT TORQUE

1. Improper alignment of feedback device

2. Open power connection.

3. Open or shorted stator windings.

4. Motor may be partially demagnetized.

ROUTINE MAINTENANCE

Observe the motor during operation, checking for excess vibration, unusual noises and excess heat.

1. VIBRATION

1. Check for signs of excess vibration. It may be the result of poor alignment, worn or loose couplings or sheaves, or damaged bearings. It may be a poorly designed base. Excess vibration causes damage to the bearings, shaft, mounting feet and accessories.

2. Noise on the speed reference input to high performance drives has been known to cause vibration in motors.

3. When checking balance on an unloaded motor, install a half key in the shaft keyway.

2. NOISE

1. Listen for noise in the area of the bearing housings. Rubbing noises may be a sign of internal damage.

2. A steady high pitched hum is normal in a BLDC motor, and there may be short interruptions of this hum under no load conditions. If you hear growling or an erratic hum above 20 RPM, check the drive.

3. TEMPERATURE

1. Totally Enclosed motors (TENV) may have surface readings as high as 100 °C. Before checking the temperature of a motor, check the load on the motor. Use a thermal probe for an objective reading.

DO NOT CHECK MOTOR TEMPERATURE WITH YOUR BARE HAND!!! HIGH TEMPERATURES MAY CAUSE BURNS!

4. FEEDBACK DEVICE

1. The feedback device is located inside the motor. It requires no maintenance unless you disassemble the motor.

2. The alignment of the motor feedback device is important. If it is removed, it must be re-installed correctly.

5. SECONDARY FEEDBACK DEVICE

Check externally mounted encoders (coupling and mounting bolts) periodically for tightness.

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6. BEARINGS AND RE-LUBRICATION

42 frame motors have permanently lubricated bearings. Replace damaged or worn bearings.

MOUNTING BOLT TORQUES

Motors must be mounted on a solid, rigid base or foundation. Poor base design can result in resonance in the motor/base system that can result in bearing, motor feet, frame to foot fasteners, or other, and motor damage.

All hold-down bolts must be of the correct grade for the type of mounting, and for the method of coupling the motor to the load. Some considerations are:

1. Direct coupled or belt drives

2. Motor feet orientation (horizontal, wall, or ceiling mounting).

Bolts must be evenly torqued to their recommended value. Recommended bolt torques for SAE grade foot bolts are given below in foot-pounds. (All components are dry, i.e., not lubricated):

Foot Frame Size	Bolt Hole Diam.	Steel Size & Third	Steel Grade 1	Grade 5	Socket Head
42	.34	5/16-18	10	15	25

The above values are suitable for most applications. Heavily loaded systems and systems that are dynamic may require careful study in choosing a suitable mounting system, grade of bolt to be used, and hence the required bolt torques.

RADIAL LOADING OF THE MOTOR

When a motor is driving a belt-driven load, care must be taken to prevent the side pulling forces to damage the bearings and/or the shaft of the motor.

MAXIMUM SHAFT RADIAL LOADING

Standard Ball Bearings and Standard Shaft Extension

Radial load Centered at tip of shaft.

Expected L10 life 1750 RPM average speed of 20,000 hours

Foot Frame Size	Bolt Hole Diam.	Steel Size & Third	Steel Grade 1	Grade 5	Socket Head
42	.34	5/16-18	10	15	25

If radial loads exceed the "MAX radial Load" or the sheave diameter is too small, roller bearings are required.

MOTOR NAMEPLATE DATA

FRAME- An alphanumeric designation of the size of a motor. These designations are standardized in the USA by the National Electrical Manufacturers Association **(NEMA)**.

MODEL-The **MODEL** number of the brushless series motors is a description of how the motor is put together. The model number describes the windings and connections as well as frame size, configuration, and options.

HP-The rated output horsepower of the motor is listed in the HP block. This value of horsepower is only valid at base speed, or above base speed, if the drive is equipped to operate in extended speed range.

RPM-The base speed of the motor, the speed at which rated horsepower is developed. From zero to this speed is the **CONSTANT TORQUE** speed range. If there are two numbers in this block with a slash between them, the first number is the base speed and the second number is the top speed. Between these two speeds is the CONSTANT HORSEPOWER range.

BUS VDC-For a Brushless DC motor, this is the voltage level of the DC supply from which the drive operates the motor. In most cases, this value is the nominal capacitor bank voltage level, which is about 1.4 times the RMS value of the AC input to the drive.

DUTY-This is a rating which may limit how the motor is used. If the designation CONT is in this block, the motor may be used for continuous duty up to its full ratings. A 30 MIN rating in the DUTY block indicates that the motor may be run to its full rating for 30 minutes, after which it must cool to ambient temperature.

S.F.- The **SERVICE FACTOR** is a multiplier to the HP, indicating how much power may be used under rated conditions.

INSUL. CL.- INSULATION CLASS "F" is rated for 105°C rise above an ambient temperature of 40°C.

AMB °C - The AMBIENT TEMPERATURE in which the motor operates should not exceed this number.

ENCL- This is the type of enclosure of the motor. In Europe, it is called the PROTECTION CLASS. There are two basic types: OPEN and CLOSED. See "MOTOR ENCLOSURES" on page 6 for a description of the standard NEMA motor enclosures

SERIAL NO. -Use when calling to ask questions or to order spare parts.