



MOTORS - AC INDUCTION, SINGLE & POLYPHASE



16. Motor Accessories

Blower Cooling Fan (Option F & FC)

- Connection Diagram Shown on page 10
- Option FC is 1-phase, 115V
- Option F has capability of 1 phase by connecting a supplied capacitor

Option F – 3ph & 1ph 220-575V 50/60Hz

Motor Frame	60Hz Ratings			50Hz Ratings		
	Voltage [V]	Current [A]	Power [W]	Voltage [V]	Current [A]	Power [W]
Single phase connection - Δ (Delta)						
63	230 – 277	0.11	38	230 – 277	0.10	27
71	230 – 277	0.12	41	230 – 277	0.10	28
80	230 – 277	0.13	44	230 – 277	0.11	29
90	230 – 277	0.25	88	230 – 277	0.26	72
100	230 – 277	0.28	88	230 – 277	0.26	70
112	230 – 277	0.31	107	230 – 277	0.26	73
132	230 – 277	0.27	89	230 – 277	0.29	82
160 - 225	230 – 277	0.41	140	230 – 277	0.45	128
Three phase low-voltage connection - (Delta)						
63	220 – 332	0.08	23	220 – 290	0.10	27
71	220 – 332	0.08	24	220 – 290	0.10	30
80	220 – 332	0.08	25	220 – 290	0.01	29
90	220 – 332	0.21	64	220 – 290	0.28	86
100	220 – 332	0.21	66	220 – 290	0.27	86
112	220 – 332	0.23	70	220 – 290	0.27	85
132	220 – 332	0.25	74	220 – 290	0.32	96
160 - 225	220 – 322	0.49	165	220 – 290	0.52	155
Three phase high-voltage connection - (Y)						
63	380 – 575	0.04	23	380 – 500	0.05	29
71	380 – 575	0.04	25	380 – 500	0.05	30
80	380 – 575	0.04	26	380 – 500	0.05	29
90	380 – 575	0.12	62	380 – 500	0.16	82
100	380 – 575	0.12	66	380 – 500	0.16	83
112	380 – 575	0.13	70	380 – 500	0.16	82
132	380 – 575	0.14	75	380 – 500	0.18	96
160 - 225	380 – 575	0.28	165	380 – 500	0.29	155

Option FC – 115V 50/60Hz 1ph

Motor Frame	60Hz Ratings			50Hz Ratings		
	Voltage [V]	Current [A]	Power [W]	Voltage [V]	Current [A]	Power [W]
Single Phase Connection - Δ (Delta)						
63	100 – 135	0.23	42	100 – 135	0.30	42
71	100 – 135	0.23	47	100 – 135	0.30	44
80	100 – 135	0.27	57	100 – 135	0.30	43
90	100 – 135	0.46	102	100 – 135	0.57	78
100	100 – 135	0.53	105	100 – 135	0.54	78
112	100 – 135	0.60	115	100 – 135	0.55	80

Table 6 – Option F & FC



16. Motor Accessories Ctd.

Thermostats (Option TW and Option 2TW)

Standard connection	Series connected, one per phase
Contact	NC (Normally Closed)/ Auto Re-setting
Response Temperature (Option TW)	311 °F (155 °C) Shut-Off Device
Response Temperature (Option 2TW)	311 °F (155 °C) Shut-Off Device + 266°F (130 °C) Alarm Device
Nominal Current	1.6 Amp at 250 V
Resistance	< 50 mΩ
Switch Rebound	< 1ms
Insulation Rating	2000 VAC
Cycles	10,000 max
Lead Identification (inside terminal box)	P1 and P2 or TB1 and TB2 / 2TB1 and 2TB2

Motor thermostats or bi-metallic switches can be wired directly into the control circuit without a separate control module or tripping device. Thermostats operate on a relatively high control voltage so they are much less sensitive to voltage interference from the main power supply. Often one can run thermostat leads and motor power leads next to each other when using the appropriate shielded cable. The installer is responsible to wire the thermostats into the motor control circuit. The leads may be labeled in a variety of ways as indicated.

Thermistors (Option TF)

Standard Connection	Three devices, series connected, one per phase
Type	Positive temperature coefficient (PTC)
Transition Temperature	150°C±5 °C
Resistance	20... 500Ω (below transition) > 4 kΩ (above transition)
Reed Current	< 1mA
Max Voltage	30V
Lead Identification (inside terminal box)	P1 and P2 or TP1 and TP2

With a separate control module or tripping device (ex. Kirwan INT69) thermistors are used to sense motor overload/over temperature conditions by converting the critical operating temperature limit into large internal resistance change. Due to their small size, heat sink construction, and high change in resistance value, minor resistance variations caused by relatively long lead runs can be tolerated. This feature also allows for one controller to be used for several temperature sensing locations. Many variable frequency drives come with on-board thermistor inputs. NORD does not supply the thermistor control module.

	WARNING	
Thermostats and Thermistors will automatically reset.		

	WARNING	
All wiring must be completed by qualified personal and adhere to all local codes.		

Space Heaters (Option SH)

- Connection Diagram shown on Page 9
- Space Heaters are mounted directly on the motor winding
- The leads are brought into the terminal box and labeled H1 and H2
- They require a separate voltage supply and must not be energized when the motor is energized
- The heaters will keep the winding of the motor approximately 5°C above the surrounding ambient

Table 5. Space Heater Data

Frame Size	Wattage	Voltages	Heater Strips/MTR
63 & 71	18W	110V	1
		230V	
		460V	
80	25W	110V	1
		230V	
		460V	
90 – 112	50W	110V	2
		230V	
		460V	
132-180	100W	110V	2
		230V	
		460V	
200 & 225	120W	110V	2
		230V	
		460V	

Encoder (Option IG)

- Most standard encoders will be enclosed inside the fan cover
- Incremental, Quadrature, Differential, Marker Channel
- IP66 Protection
- IG1 = 1024PPR, IG2 = 2048PPR, IG4 = 4096PPR
- TTL/RS422, HTL/Push-Pull, Line Driver.
- 5V or 10-30V available.
- Absolute encoders also available.
- Separate encoder wiring instructions are provided by NORD.

17. Inspection

Inspect the motor after every 500 operating hours.

	WARNING	
	If it is necessary to clean the motor exterior, do not use shop air. Shop air can force contaminants into the motor and may cause parts damage or result in blowing debris causing injury.	

Table 8 - Inspection Guidelines

Inspect	Check	Action
Motor Exterior	Check the external surfaces for contamination. Accumulation of dirt and fibrous deposits must be removed.	Clean the motor external surfaces using clean, lint-free cloths. Clean deposits from between cooling fins using a vacuum cleaner and a stiff-bristled nylon brush.
	Check the external surfaces for oil film and greasy deposits.	Clean the oil film and greasy deposits from the motor surface using clean, lint-free cloths. If necessary, moisten the cloth with an approved non-flammable, residue-free solvent. Do not pour solvent on the motor.
	Check for evidence of damage or overheating.	If the motor has physical damage, replace the motor.
	Motor Mountings Make sure the mounting hardware is secure.	If the mounting hardware is not secure, check the motor/gearbox alignment, and tighten the mounting hardware.
Motor Electrical Connections	Check that all electrical connections are secure.	If the electrical connections are not secure, tighten them.
	Check the electrical connections for evidence of arcing.	Loose electrical connections can cause arcing, which is evident by discoloration and charring. If you find evidence of arcing, replace the damaged connections.
Insulation Resistance	Using an ohmmeter, check and record the resistance of motor winding insulation.	Compare the current resistance reading to previous readings. If the resistance drops significantly, perform an internal inspection for insulation damage or deterioration.
Motor Brake	On motors that have a brake, use a feeler gauge to check the air gap in between the brake pad and the rotor according to the appropriate user manual.	If the air gap exceeds the maximum allowed for that brake configuration provided in the manual, adjust the air gap or replace the brake pad according to user manual U35000.



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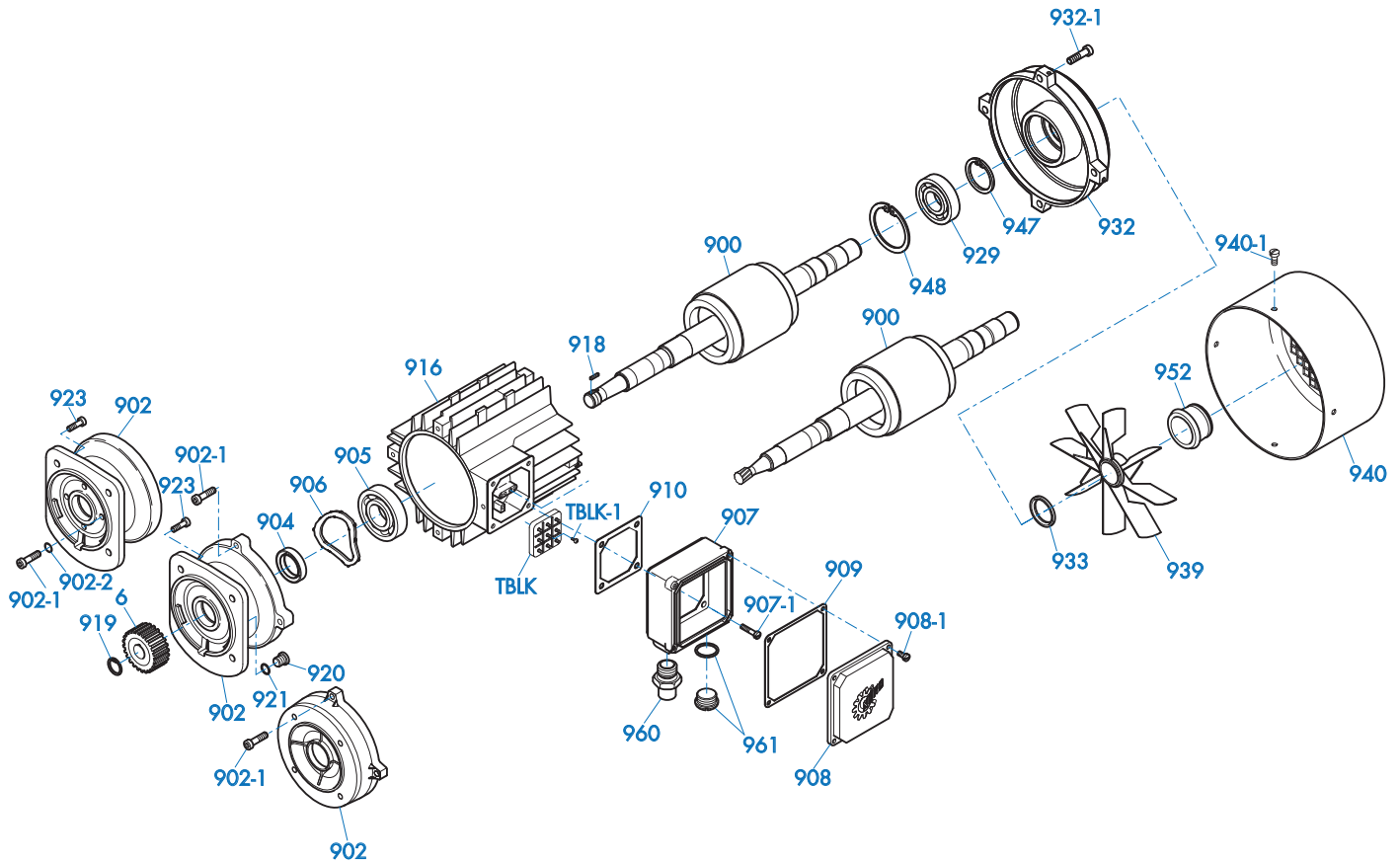


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18. Parts List

If you are ordering a part, provide the model and order number (table 1, page 2) of your motor. This will determine the specific part number you need.



Part Number	Part Description	Qty per Assembly
6	Input Pinion	1
900	Rotor Assembly	1
902	A-Endbell	1
902-1	Screw	4
902-2	Dubo Seal	4
904	Oil Seal	1
905	Bearing	1
906	Preload Spring	1
907	Terminal Box Frame	1
907-1	Screw	4
908	Terminal Box Cover	1
908-1	Screw	4
909	Gasket - Terminal Box Frame	1
910	Gasket - Terminal Box Cover	1
916	Stator	1
918	Key	1
919	Retaining Ring	1
920	Oil Plug	1

Part Number	Part Description	Qty per Assembly
921	Gasket	1
923	Screw	4
929	Bearing	1
932	B-Endbell	1
932-1	Screw	4
933	Oil Seal	1
939	Fan	1
940	Fan Cover	1
940-1	Screw	4
947	Retaining Ring	1
948	Retaining Ring	1
952	Fan Clip	1
960	NPT Thread Adapter	1
961	Plug (includes O-ring)	1
TBLK	Terminal Block	1
TBLK-1	Screw, Terminal Block Mounting	2
	Jumper Bar (not illustrated)	AR

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19. Repair

Reference the parts list drawing on page 14 for clarification.

- A. Disassemble the motor according to the general exploded view in PARTS INFORMATION. Disassemble only as far as necessary to replace the failed parts.
- B. Whenever the motor is disassembled, clean all dust and contamination from the motor interior using a vacuum cleaner and a soft-bristled nylon brush.
- C. The following parts must be replaced if they are removed:
- Oil seal (904), Oil seal (933)
 - Gasket (909), Gasket (910), Gasket (921)
 - Gasket on plug (961)
 - Self-locking screws (907-1, 908-1, 923, 932-1, 940-1)
 - Dubo Seals (902-2)
- D. If the following parts are removed, inspect them, and replace them if they are deformed or damaged:
- Retaining ring (919), Retaining ring (947), Retaining ring (948)
 - Fan clip (952)

20. Removing and Replacing Integral Motors

Reference the parts list on Page 14 for clarification.

- A. Disconnect the power to the electric motor. Make certain the motor is properly grounded, de-energized and secured with a lock-out/tag-out device.
- B. Drain the oil from the mating gearbox, or rotate the motor/gearbox assembly so that the motor is up, to prevent oil from spilling from the gearbox when the motor is removed.
- C. Support the motor and prepare it for removal. Steady the motor and support it. For larger motors, use of mechanical lifting or support devices to may be appropriate.
- D. Remove the fastening screws that hold the motor to the reducer input.



IMPORTANT NOTE



Most integral motor installations have mounting bolts accessible from the motor exterior. If the bolts are not clearly visible, unbolt the input flange from the gearbox. Remove the bolts securing the motor to the reducer input flange, and discard the old DUBO sealing rings that were under the screw heads.

- E. Maintain motor shaft alignment and move the motor directly away from its mounting surface until the motor shaft and mating input gear clear both the internal gear mesh and reducer input.

- F. Remove and discard the old flange gasket.
- G. Clean the gasket faces on the motor and gearbox, making sure no cleaning debris enters the gearbox.
- H. Check the replacement motor to make sure the motor flange, motor shaft, and motor pinion are identical to the motor that was removed.
- I. Place a new gasket between the gearbox and new motor.
- J. Position the motor on the gearbox, making sure the input pinion meshes with the input gear. Rotate the motor as necessary to align the bolt holes and seat the motor flange. Make sure the gasket remains properly aligned and seated.
- K. Apply a medium strength thread locking compound to the bolt threads. Install the bolts and tighten them to the appropriate torque.



IMPORTANT NOTE



If the motor/gearbox installation uses an input flange, first mount the input flange to the motor using the four mounting bolts and NEW DUBO sealing rings under the head of each fastening screw. Make sure the fastening screws are clean and apply new thread sealant if necessary.

- L. Check the gearbox oil level in accordance with the appropriate User Manual/s. If necessary fill or add oil to the gearbox.



HARMFUL SITUATION



Do not mix different types of oil!

- M. Re-establish the electrical connection to the motor.
- N. Observe the subsequent start-up closely to make certain the equipment is operating properly and there are no seal or gasket leaks.



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21. Removing and Replacing NEMA C-Face or IEC Flange-Mounted Motors

For further clarification of these instructions, reference the parts list on Page 14 of this manual.

- A. Disconnect the power to the electric motor. Make certain the motor is properly grounded, de-energized and secured with a lock-out/tag-out device.
- B. Support the motor and prepare it for removal. Steady the motor and support it. For larger motors, use of mechanical lifting or support devices to may be appropriate.
- C. Remove the fastening screws that hold the motor to the C-face or IEC mounting flange.
- D. Maintain motor shaft alignment, and move the motor directly away from its mounting surface until the motor shaft and mating coupling clear the mounting flange surface of the driven equipment.
- E. Measure and record the proper placement of the motor shaft coupling prior to removing it from the old motor.
- F. Make sure the new motor shaft, key and key slot are free of all nicks, burrs, and lubrication or grease.
- G. Install the new shaft key on the new motor. If the shaft key is not captured or if an open-ended key slot is utilized it is good practice to secure the key into the key slot with a medium strength thread locking agent or alternatively one may stake the key in place.
- H. Re-install the coupling on the new motor shaft, making sure the placement of the coupling is in the same location as it was on the old motor (See Step E).
- I. Clean all old gasket material, sealants, contamination, and corrosion from the flange surface on the driven equipment.
- J. If the motor is utilized in a wet or wash down environment apply a sealing gasket or gasket eliminating compound to the mating flange surface, as would seem most appropriate for the application.
- K. Support the new motor and mount it flush against the mating flange surface of the driven equipment.
- L. Apply a medium strength thread locking agent to the bolt threads.
- M. Install the bolts and tighten them to the appropriate torque.
- N. Re-establish the electrical connection to the motor.
- O. Observe the subsequent start-up closely to make certain the equipment is operating properly.

22. Testing



IMPORTANT NOTE



NORD electric motors do not require periodic testing. However, if a motor is removed from its installation, NORD recommends that the motor be checked according to the following static and dynamic testing procedures before it is reinstalled. Finding a condition that will require future repair before the motor is reinstalled decreases the overall maintenance time.

This section provides general test information and functional checks for the types of motors covered by this manual. Read and understand the tests and checks before performing them on your motor.

Record and date all measurements taken.

If the motor fails any of the test procedures provided below, use the troubleshooting guide to determine the motor problem.

Static Testing

- A. The motor can only be static tested if it is disconnected from the component it drives and securely mounted on a fixture or mounting plate. These tests are usually conducted when a motor has been removed for any reason other than failure
- B. Turn the motor shaft slowly by hand. Feel and listen for evidence of a failed bearing, which is indicated by a rough feel as the shaft rotates, and by noise.
- C. Check for smooth rotation, with no evidence of binding or catching. If the shaft does not rotate smoothly, or binds or catches, the bearings are worn or failing, lack lubrication, or are contaminated.
- D. Check the motor shaft for side play by applying pressure at right angles to the shaft in several places around the circumference. If the shaft moves perceptibly, the front bearing may be worn.

Dynamic Testing

- A. Find the motor voltage and rated load current values as listed on the motor nameplate.
- B. Using a volt-ohmmeter, verify that the motor power supply is in the correct range.
- C. Run the motor with no load. As the motor is operating, listen for unusual motor noise and check for excessive vibration. Vibration and motor noise are indications of bearing contamination, lack of lubrication, damage, or failure.
- D. Use an ammeter to measure the no-load current. Record the no-load current for comparison with previous readings, and for reference during future testing.
- E. If the motor passes the no-load test, operate the motor at rated load and check and record the current.
- F. Check the motor operating temperature at rated load. If the motor operates at a higher than normal temperature, the motor may be damaged, overloaded or failing.



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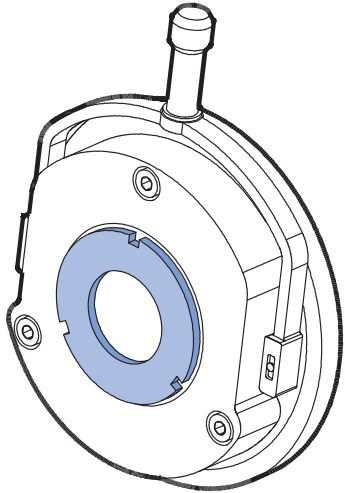
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23. Troubleshooting

Fault	Likely Cause	Corrective Action
Motor fails to start.	- Motor is mis-wired - Brake is may not be releasing. - Fan guard damaged and contacting fan. - Motor protection device has tripped or does not switch 1-Ph Capacitor or start switch has failed.	- Verify and correct motor wiring. - Troubleshoot brake per User Manual U35000. - Replace damaged fan guard. - Check motor protection device for correct setting and correct error. - Discharge capacitor and use a volt-ohm meter to check the capacitor for an open circuit - replace if needed. Inspect switch and connections. Replace if contacts look burned or pitted.
Fuses blow or motor protection faults immediately.	- Short circuit in line. - Lines connected incorrectly. - Fuse or circuit breaker tripped. - Motor is overloaded or equipment jammed. - Stator is shorted or went to ground.	- Rectify short circuit. - Check circuit diagram and make corrections. - Replace fuse or circuit breaker. - Make sure load is free. Verify motor amp draw compared to nameplate rating. - A damaged or blown stator will show a burn mark. Stator must be repaired or replaced.
Motor hums and has high current consumption	- Brake may not be releasing. - Rotor may be rubbing stator. - Defective or incorrect stator winding.	- Troubleshoot brake per User Manual U35000. - Send motor to a repair specialist.
Severe speed loss under load or excessive acceleration time.	- Overload. - Excessive voltage drop. - Damaged or failing motor bearings. - Damaged or worn gear unit. 1-Ph Capacitor or start switch has failed.	- Check load conditions and make certain system is unobstructed. Reduce load or consider a larger motor. - Verify service voltage is within specification. Check if nearby equipment is affecting incoming power. Make sure connection harness and wiring is adequate. - Replace motor bearings. - Replace or repair damaged gear unit. - See instructions under "Motor fails to start".
Motor runs the incorrect direction.	Incorrect wiring.	Rewire motor according to system schematic and/or switch two incoming motor phases.
Motor heats up excessively or thermal overload protection trips	- Overload. - Ambient temperature is too high. - Inadequate cooling. - Operation is outside the allowed duty cycle. - Motor protection device may be defective. - Excessive supply voltage. - System short or damaged stator.	- Make sure load is free. Verify motor amp draw compared to nameplate rating. Reduce load or consider a larger motor. - Do not operate above the rated conditions. - Correct cooling air supply. Open and clear cooling air passages. Retrofit with forced ventilator fan if needed. - Adjust operating duty cycle or contact a specialist to select a suitable motor or drive. - Replace motor protection device. - Adapt motor supply voltage. - Check for loose, cut or damaged wires. Check stator winding for defects or burn damage.
Excessive Noise or Vibration	- Motor bearings contaminated or damaged. - Excessive motor shaft end play. - Misaligned or imbalanced load.	- Test motor by itself. If bearings are bad noise may be heard or roughness detected. Replace bearings. Add lubrication if bearings have grease fittings. - Check shaft endplay with motor and system power disconnected. If shaft movement is excessive replace motor shaft bearings. - Check all mating shaft connections for proper alignment and correct all imbalanced load conditions.
1 Ph Start Capacitor Failures	- Motor is not coming up to speed quickly enough. - Motor is being cycled frequently - Start switch is defective or damaged.	- Verify motor size to load conditions. Motor should come up to speed in no more than 2-3 seconds. - Verify duty cycle and consult specialist for recommendations. - Replace start switch.
1 Ph Run Capacitor Failures	- Possible power surge to motor caused by transient voltage or lightening. - Excessive ambient temperature.	- Install proper surge protection. - Verify ambient conditions do not exceed nameplate value.



General Instructions

This manual describes general operating and maintenance guidelines for a majority of brake products shipped by NORD Gear. This instruction manual is not intended to include a comprehensive listing of all details or procedures required for installation, operation and maintenance.

Brakes covered in this manual are manufactured by PRECIMA. Please feel free to contact NORD with any questions about the supplied brake components.

Safety Notice

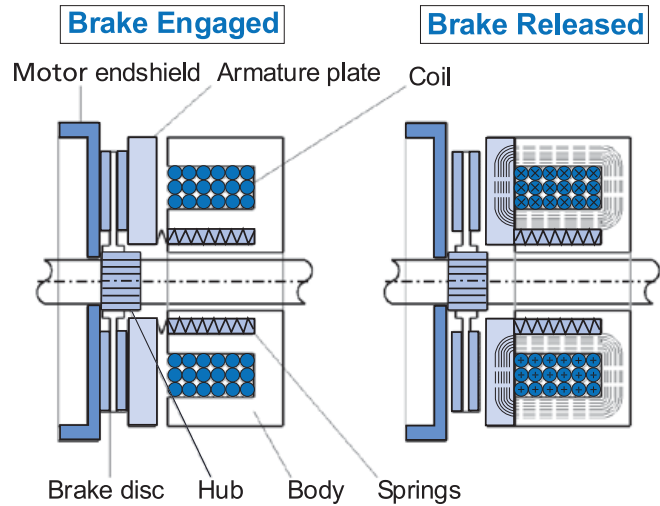
Only qualified personnel should attempt installation, operation and maintenance of NORD brakes. Read this manual in its entirety before operating, commissioning, servicing, or assembling the motor brake. If you have a question about a procedure or are uncertain about any detail, seek clarification and **DO NOT PROCEED!**

⚠	WARNING	⚠
• This equipment contains high electrical voltage. Remove and lockout all power from the electric motor and brake before any work is completed on the brake. • The user is responsible for conforming to all national and local electrical and safety codes. Wiring practices, proper grounding, disconnects, and over current protection, are of particular importance. • Make certain the load is supported when servicing the brake. Removing power from the brake or removing the brake from the motor will release the load, which may cause severe injury or death. • Failure to follow proper procedures and precautions may result in severe bodily injury or death.		

Brake Operation

The standard NORD motor brake is "spring-set". When power is removed and the brake is de-energized (power-off), the brake springs exert a force against the armature plate in turn preventing the brake rotor (or brake disc) from rotating. When the brake coil is energized (power-on), a magnetic field builds and pulls the armature plate across the air gap to the brake casing, which releases the brake rotor and allows the motor shaft to rotate.

Figure 1: Basic Brake Operation



NORD brakes are DC voltage brakes and in most instances are supplied with a motor mounted brake rectifier for easy connections to AC power. AC power is taken directly from the power line or from the terminal block of the motor and converted to DC by the supplied rectifier.

i	IMPORTANT NOTE	i
If the motor is connected to a frequency inverter, soft start, or is a two-speed motor, the AC power must be supplied to the brake rectifier separately from the motor power.		

Advantages

- Each NORD motor frame size has a number of brake sizes available, with different torque capacities.
- Brake torque adjustments are possible by changing the brake spring combinations. In addition, brake sizes from 5-40 Nm (3.7-30 lb-ft) are typically supplied with an additional spanner-nut adjustment on the back of the brake.
- NORD brakes provide a high degree of safety because when power is removed the brake will automatically set to hold the load.
- The brake rotor or brake disc is environmentally safe and asbestos-free.
- The connection between the rectifier and the brake coil is completed at the factory and the brake air-gap is factory-set but can be adjusted in the event of wear.

General Selection Considerations

As indicated in the NORD catalog, each NORD motor can be supplied with a number of brake torque sizes.

NORD relies on the equipment builder to specify appropriate brake sizing for their application, while giving consideration to the following:

- For most applications, we advise sizing the brake to 1.5 - 2 times the motor rated torque.
- For vertical applications, it may be advisable to size the brake size up to 3 times the motor rated torque.
- For some applications, it may be necessary to specify a reduced brake torque setting to prevent excessive peak load conditions developed at the reducer output.
- On travel drive applications, excessive brake torque may lead to wheel skid; in addition on crane applications excess hoist-cable swing can result.



CAUTIONS



- **Brake torque** - The brake torque is measured with a mean friction radius of the brake pad surface with a circumferential speed of 1m/sec (197 fpm).
- **Brake torque tolerance** - For different applications and operating conditions, brake torque can vary from +40/-20% compared to the rated brake torque.
- **Hoisting (lifting/lowering) applications** - must have the brake wired for fast response (DC-switching)
- **Initial operation & wear-in period** - In new condition, the brake will have a reduced torque of up to 30%. In order to achieve full rated brake torque, a short run-in period is required. The run in time will vary depending on system loads.
- **The brake rotor or brake pad** - must be protected against foreign matter, oil and grease. Contaminants of this type can greatly influence wear and reduce breaking torque.

Brake Torque Adjustment

Brake torque adjustments are possible by changing the brake spring combinations or by removing springs (Table 1).

In addition, brake sizes from 5-40 Nm (3.7-30 lb-ft) are typically supplied with a threaded adjustment nut or spanner nut to allow for additional fine torque adjustments of the brake. The braking torque can be adjusted by unscrewing the spanner nut a number of turns or "clicks" with a spanner wrench (Table 2).

Table 1a: Brake Torque Reduction - Spring Removal

"Brake Size"	7 Springs		5 Springs		3 Springs	
	[Nm]	[lb-ft]	[Nm]	[lb-ft]	[Nm]	[lb-ft]
BRE 5	5	3.7	3.5	2.6	2	1.5
BRE10	10	7.4	7	5.2	4	3.0
BRE20	20	14.8	14	10.3	8	5.9
BRE40	40	29.5	28	20.7	17	12.5
BRE60	60	44.3	43	31.7	26	19.2
BRE100	100	73.8	70	51.6	42	31.0
BRE150	150	111	107	78.9	65	47.9

On brake sizes 5-150 Nm (3.7-111 lb-ft) full brake torque is achieved with all (7) springs. The brake springs are placed in such a manner where there are (3) inner and (4) outer springs. When adjusting the brake torque, start by removing the outer springs at opposite corners to prevent uneven brake wear.

Table 1b: Brake Torque Reduction - Spring Removal

"Brake Size"	8 Springs		6 Springs		4 Springs	
	[Nm]	[lb-ft]	[Nm]	[lb-ft]	[Nm]	[lb-ft]
BRE250	250	184	187	138	125	92
BRE400	400	295	300	221	200	148
BRE800	800	590	600	443	400	295
BRE1200	1200	885	900	664	600	443

On brake sizes 250-1200 Nm (184-885 lb-ft) full brake torque is achieved with all (8) springs. The brake springs are placed in such a manner where there are (4) inner and (4) outer springs. When adjusting the brake torque, start by removing the outer springs at opposite corners to prevent uneven brake wear.

Table 2: Spanner Nut Adjustment

"Brake Size"	Torque Reduction*		Max. Turns	Minimum Torque*	
	[Nm]	[lb-ft]		[Nm]	[lb-ft]
BRE 5	0.2	0.15	6	0.8	0.59
BRE10	0.2	0.15	12	1.6	1.18
BRE20	0.3	0.22	12	4.4	3.25
BRE40	1	0.74	9	8.0	5.90

* With the minimum number of springs and maximum number of turns to the spanner nut.

* Per each turn of the spanner nut

Brake sizes from 5-40 Nm (3.7-30 lb-ft) are typically supplied with a threaded adjustment nut or spanner nut. Additional fine torque adjustment can be made by unscrewing the spanner nut a number of turns or "clicks" with a spanner wrench.

Brake Control Rectifiers

NORD brake control rectifiers convert AC voltage to DC voltage. Rectifiers are used because most applications require AC voltage to power the motor, but DC power is required to power the brake and DC power is not typically available. NORD brake motors typically include the rectifier located inside the terminal box.

Rectifier Advantages

- Individual power source for each brake.
- Compact size, mounted inside the terminal box.
- Multiple types, voltage options and release/engagement modes available.
- Mountable in a separate control cabinet.
- Integral protection against voltage spikes.

Model	Type	Part No.	Color	Input Voltage $V_{AC} \pm 10\%$	Rated Current A_{DC}	
					(40°C)	(75°C)
GVE20L	Full-wave	19141000	Black	110-275	1.5	1.0
GVE20V	Full-wave	19141030	Black	110-275	1.5	1.0
GHE40L	Half-wave	19141010	Yellow	200-480	2.0	1.0
GHE40V	Half-wave	19141040	Yellow	200-480	2.0	1.0
GHE50L	Half-wave	19141020	Gray	200-575	2.0	1.0
GHE50V	Half-wave	19141050	Gray	200-575	2.0	1.0
GUE40V	Dual-wave	19140300	Black	230-460	0.7	0.5
PMG500	Push-Hybrid	19140200	Black	200-500	4.0	2.8

Rectifier electronics are sealed for moisture-protection; electronics on models ending with the suffix "V" are resin-encapsulated to provide added protection if water should get into the motor terminal box.

Rectifier Types

Full-wave rectifier [GVE]:

A rectifier in which both the positive and negative half-cycles of the AC input signal are rectified to produce a uni-directional DC current supply to the load or the brake. The output voltage is 90% of the input voltage ($V_{DC} = 0.90 \times V_{AC}$).

Half-wave rectifier [GHE]:

A rectifier in which only alternate half-cycles of the AC input signal are rectified to produce a uni-directional DC current supply to the load or the brake. The output voltage is 45% of the input voltage ($V_{DC} = 0.45 \times V_{AC}$).

Dual Wave Rectifier [GUE]

A rectifier that can be wired as either a full-wave rectifier or a half-wave rectifier depending upon how it is connected to the AC input signal.



IMPORTANT NOTE



If the motor is connected to a frequency inverter, soft start, or is a two-speed motor, then separate AC power must be supplied to the brake rectifier.

Rectifier Types [Ctd.]

PMG 500 Push-Hybrid rectifier [PMG]:

A fast-acting or push-hybrid brake rectifier provides an initial "push" in the form of a timed full-wave brake-release function, which is then followed by a continuous half-wave brake-holding function. There are two ways to apply these rectifiers as follows:

- "Overexcitation" of the brake coil provides faster brake release or improved cycling capacity. The DC voltage of the brake coil is determined based upon using a half-wave rectifier. The output voltage is 45% of the input voltage ($V_{DC} = 0.45 \times V_{AC}$).
- "Reducer-Power Holding" of the brake coil maintains the brake in a released state by using only 25% of the power needed for the initial brake release. This results in very fast brake stopping. The DC voltage of the brake coil is determined based upon using a full-wave rectifier. The output voltage is 90% of the input voltage. ($V_{DC} = 0.90 \times V_{AC}$).

NORD offers additional fast-acting rectifiers besides the PMG 500. For additional details please reference User Manual U35100 – Fast Acting Brake Rectifiers.



IMPORTANT NOTE



In order to prevent rapid wear, the PMG 500 rectifier is required when utilizing the larger 800 Nm (590 lb-ft) and 1200 Nm (885 lb-ft) twin-rotor brakes. The PMG 500 rectifier is wired to "overexcite" the brake during its initial release.

Brake Switching Options

The rectifiers discussed in this manual can be wired to allow brake switching at either the AC power source (input) or the DC power source (output).

- AC switching allows the brake rectifier to be powered directly from the motor's terminal block with no additional wiring. However, this provides a slower brake stopping time due to the additional time needed to de-energize or collapse the motor's magnetic field.
- DC switching directly interrupts the current flow in the DC circuit of the brake rectifier. This method of brake switching guarantees faster brake stopping or brake engagement times.



WARNING



When the moving system undergoes a change in height (such as in a lift or incline conveyor application) or if the system tends to speed up or overhaul during normal operation, then DC-switching of the brake is required in order to prevent excessive load movement, drift or falling loads during stopping.

Figure 2.1: GVE/GHE Dimensions

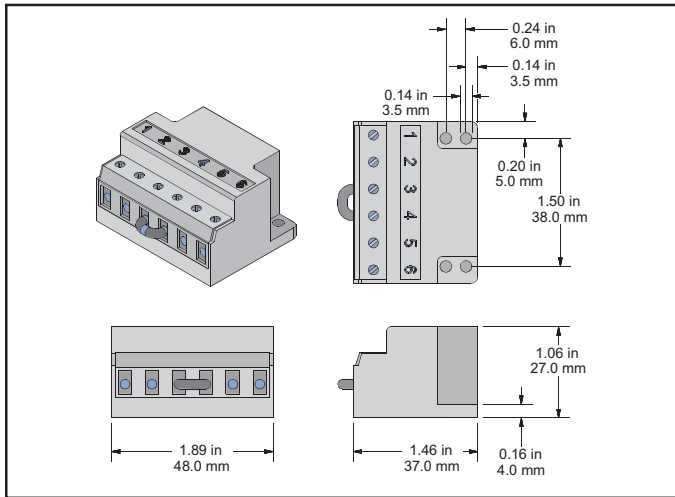


Figure 3.1: GUE Dimensions

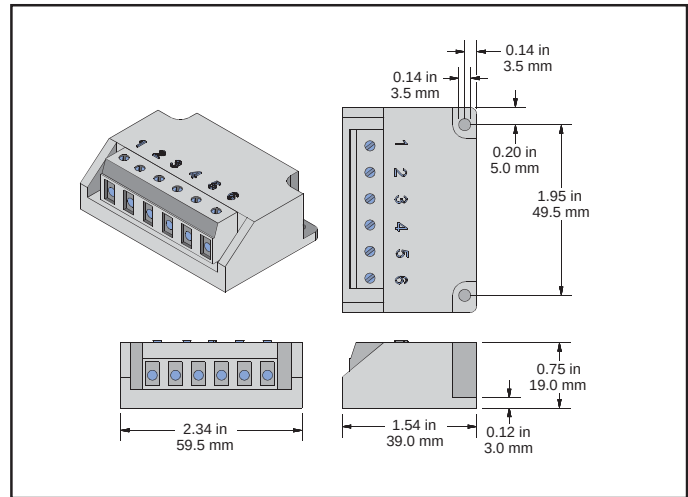


Figure 2.2: GVE/GHE Braking Methods

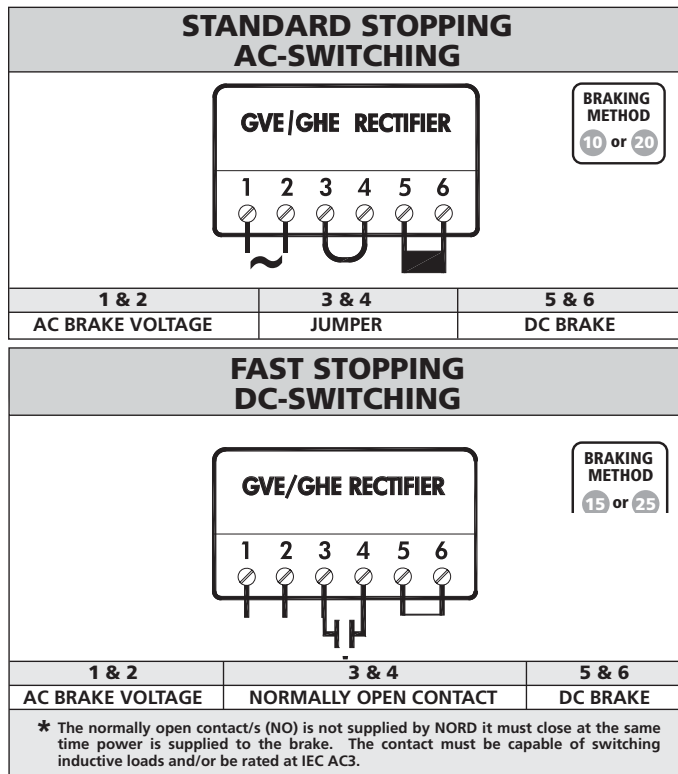
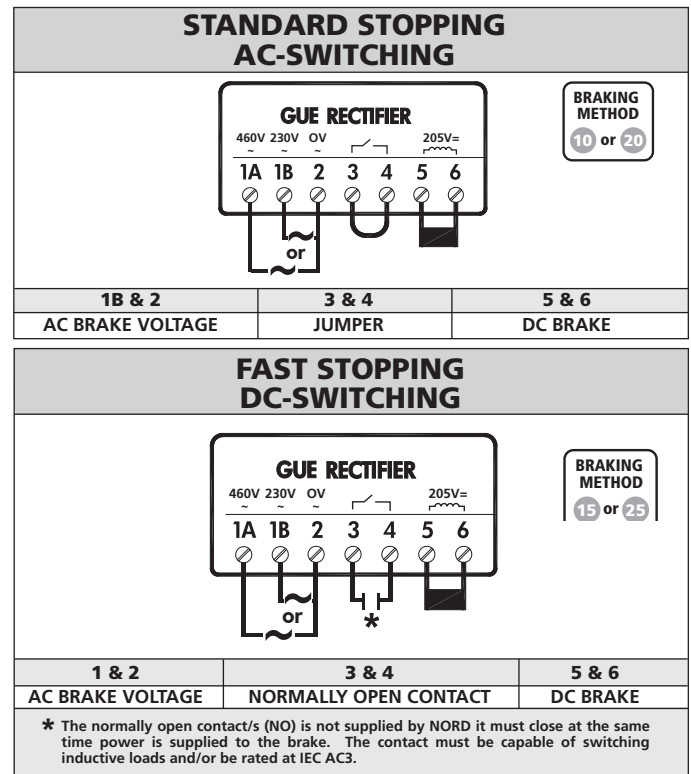


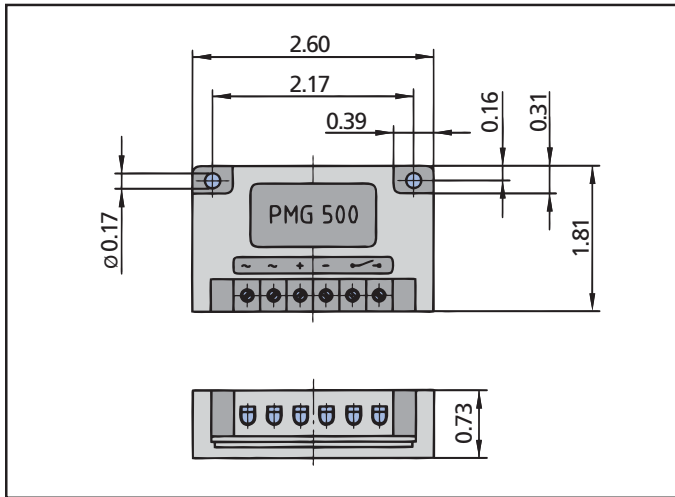
Figure 3.2: GVE/GHE Braking Methods



Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
10	Standard	Standard (AC-Switching)	Motor terminals
15	Standard	Fast (DC-switching)	Motor terminals
20	Standard	Standard (AC-Switching)	Separate power
25	Standard	Fast (DC-switching)	Separate power

Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
10	Standard	Standard (AC-Switching)	Motor terminals
15	Standard	Fast (DC-switching)	Motor terminals
20	Standard	Standard (AC-Switching)	Separate power
25	Standard	Fast (DC-switching)	Separate power

Figure 4.1: PMG 500 Dimensions



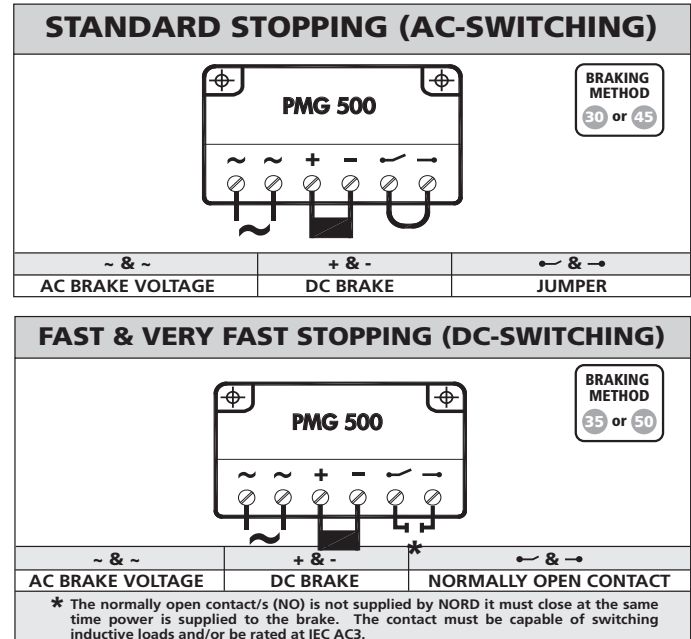
PMG 500 Push-Hybrid Rectifier

The PMG 500 rectifier provides an initial “push” the form of a timed full-wave brake-release function, which is then followed by a continuous half-wave brake-holding function.

- In order to prevent rapid wear, the PMG 500 rectifier is required when utilizing the larger 800 Nm (590 lb-ft) - and 1200 Nm (885 lb-ft) twin-rotor brakes.
- The PMG 500 rectifier is wired to “overexcite” the brake during its initial release. The DC voltage of the brake coil is determined based upon using a half-wave rectifier.

In some applications the PMG rectifier may be used for “Reduced Power Holding” or very fast brake engagement (See user manual U35100 for details).

Figure 4.2: PMG 500 Braking Methods



Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
30	Fast (Overexcitation)	Standard (AC Switching)	Motor terminals
35	Fast (Overexcitation)	Fast (DC Switching)	Motor terminals
45	Fast (Overexcitation)	Standard (AC Switching)	Separate power
50	Fast (Overexcitation)	Fast (DC Switching)	Separate power



IMPORTANT NOTE



If the motor is connected to an AC drive, soft start, or is a two-speed motor, the AC power must be supplied to the brake rectifier separately from the motor power.



MOTOR BRAKES INSTALLATION & MAINTENANCE



DRIVESYSTEMS

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U35000 - 6 of 18

BRAKE SIZE: BRE 5**BRAKE TORQUE: 5 Nm (3.7 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19010212	-	-	-	-	22	24	0.92	26.0
19010912	230	0.09	115	0.19	22	105	0.21	500
19011902	400	0.05	200	0.11	22	180	0.12	1475
19011912	460	0.05	230	0.10	22	205	0.11	1900
19012212	500	0.04	250	0.08	21	225	0.09	2450
19012512	575	0.04	-	-	22	250	0.09	2850

BRAKE SIZE: BRE 10**BRAKE TORQUE: 10 Nm (7.4 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19020222	-	-	-	-	28	24	1.17	20.6
19020922	230	0.14	115	0.28	33	105	0.32	332
19021902	400	0.07	200	0.15	29	180	0.16	1100
19021922	460	0.06	230	0.11	26	205	0.13	1620
19022222	500	0.06	250	0.12	30	225	0.13	1700
19022522	575	0.05	-	-	27	250	0.11	2323

BRAKE SIZE: BRE20**BRAKE TORQUE: 20 Nm (15 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19030222	-	-	-	-	34	24	1.42	16.9
19030922	230	0.18	115	0.35	41	105	0.39	270
19031922	400	0.09	200	0.17	34	180	0.19	950
19031932	460	0.07	230	0.13	30	205	0.15	1391
19032222	500	0.07	250	0.15	36	225	0.16	1391
19032522	575	0.06	-	-	35	250	0.14	1780

BRAKE SIZE: BRE40**BRAKE TORQUE: 40 Nm (30 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19040232	-	-	-	-	41	24	1.69	14.2
19040932	230	0.21	115	0.42	49	105	0.46	226
19041902	400	0.11	200	0.22	45	180	0.25	723
19041922	460	0.11	230	0.22	50	205	0.24	840
19042232	500	0.09	250	0.18	44	225	0.20	1150
19042532	575	0.08	-	-	44	250	0.18	1425

BRAKE SIZE: BRE 60**BRAKE TORQUE: 60 Nm (44 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19050252	-	-	-	-	52	24	2.18	11.0
19050952	230	0.27	115	0.54	63	105	0.60	174
19051902	400	0.13	200	0.27	54	180	0.30	602
19051952	460	0.12	230	0.25	57	205	0.28	740
19052252	500	0.10	250	0.20	50	225	0.22	1004
19052552	575	0.09	-	-	48	250	0.19	1300

BRAKE SIZE: BRE 100**BRAKE TORQUE: 100 Nm (74 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19060252	-	-	-	-	80	24	3.33	7.2
19060952	230	0.39	115	0.79	92	105	0.88	120
19061902	400	0.21	200	0.42	83	180	0.46	390
19061952	460	0.20	230	0.40	91	205	0.44	464
19062252	500	0.16	250	0.32	79	225	0.35	643
19062552	575	0.14	-	-	79	250	0.31	795

BRAKE SIZE: BRE 150**BRAKE TORQUE: 150 Nm (110 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19070252	-	-	-	-	77	24	3.20	7.5
19070952	230	0.39	115	0.79	92	105	0.88	120
19071902	400	0.18	200	0.36	73	180	0.40	445
19071952	460	0.15	230	0.31	70	205	0.34	600
19072252	500	0.15	250	0.30	76	225	0.34	670
19072552	575	0.14	-	-	76	250	0.30	825

BRAKE SIZE: BRE 250**BRAKE TORQUE: 250 Nm (185 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19080252	-	-	-	-	99	24	4.14	5.8
19080952	230	0.51	115	1.03	120	105	1.14	92
19081902	400	0.27	200	0.54	108	180	0.60	300
19081952	460	0.24	230	0.49	111	205	0.54	380
19082252	500	0.20	250	0.40	100	225	0.44	507
19081962	575	0.17	-	-	95	250	0.38	655

BRAKE SIZE: BRE 400**BRAKE TORQUE: 400 Nm (295 lb-ft) max.**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19092252	-	-	-	-	144	24	6.00	4.0
19092952	230	0.62	115	1.24	145	105	1.38	76
19093902	400	0.35	200	0.70	141	180	0.78	230
19093952	460	0.31	230	0.62	140	205	0.68	300
19093962	500	0.29	250	0.57	143	225	0.63	355
19093972	575	0.26	-	-	142	250	0.57	440

BRAKE SIZE: BRE 800**BRAKE TORQUE: 800 Nm (590 lb-ft) max. ❶**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19094252	-	-	-	-	144	24	6.00	4.0
19094952	230	0.62	-	-	145	105	1.38	76
19095902	400	0.27	-	-	108	180	0.60	300
19095902	460	0.31	-	-	140	205	0.68	300
19095962	500	0.29	-	-	143	225	0.63	355

BRAKE SIZE: BRE 1200**BRAKE TORQUE: 1200 Nm (885 lb-ft) max. ❷**

NORD Brake P/N	Half-Wave		Full-Wave		P _c	V _c	I _c	R _c
	[V _{AC}]	[A _{AC}]	[V _{AC}]	[A _{AC}]	[W]	[V _{DC}]	[A _{DC}]	[Ω]
19099802	230	0.62	-	-	145	105	1.38	76
19099902	400	0.27	-	-	108	180	0.60	300
19099902	460	0.31	-	-	140	205	0.68	300

Half-Wave [V_{AC}] = AC supply voltage with half-wave rectifierHalf-Wave [A_{AC}] = AC supply current to half-wave rectifierFull-Wave [V_{AC}] = DC supply voltage with full-wave rectifierFull-Wave [A_{AC}] = AC supply current to full-wave rectifier

❶ When used as a stopping brake, evaluation of brake work is essential.

❷ Designed as a holding brake or emergency stop brake only.

**IMPORTANT NOTE**

The PMG500 rectifier is required when utilizing the larger 800 Nm (590 lb-ft) - and 1200 Nm (885 lb-ft) twin-rotor brakes. In order to prevent rapid wear, NORD recommends using the PMG500 rectifier to "overexcite" the brake during its release. The brake coil should be sized utilizing the PMG rectifier like a half-wave rectifier.

P_c [W] = Power to brake coilV_c [V_{DC}] = DC brake coil voltage (range -30% to +10%)I_c [A_{DC}] = DC current top brake coilR_c [V] = Brake coil resistance (±5%)

Brake coil data based upon ambient conditions of 20°C (68°F).

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General Maintenance

Brake Air Gap

In order to obtain optimal brake performance and maximum brake life, it is necessary to periodically check and reset the brake air gap. As the brake rotor wears and decreases in thickness, the air gap will increase. If the air gap is too large, the brake coil may not have enough magnetic force to pull the metal armature disc across the gap and the brake will drag.



IMPORTANT NOTE

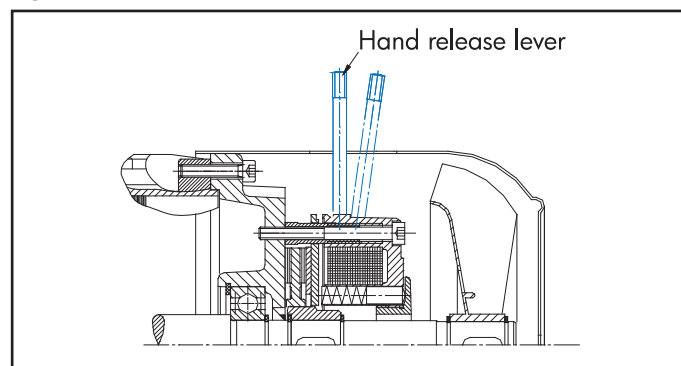


When a complete brake motor is supplied by NORD, the air gap is already set at the factory. If the brake is ordered as a part, the air gap must be set in the field. All brake air gap adjustments must be made with the brake assembled onto the motor and power off (brake engaged).

Hand Release Lever (HL)

It is common to supply the NORD brake with a hand release lever assembly. The hand release lever allows the brake to be manually released without requiring that the brake be energized with voltage. The lever has a spring return that allows the brake to be hand released and returned automatically to its set position. The handle of the hand release lever can be unscrewed for easy removal.

Figure 5



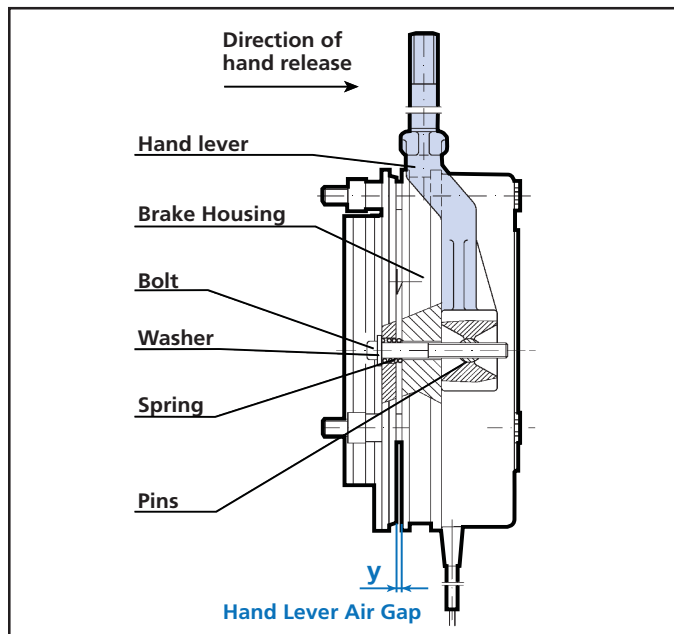
IMPORTANT NOTE



When a brake motor with hand-lever is supplied by NORD, both the hand lever air gap and brake air gap are set at the factory. When ordered as parts, proper hand-lever and air gap adjustments must be made in the field. Hand-lever adjustments must always be made prior to assembling the brake to the motor. All brake air gap adjustments must be made with the brake assembled to the motor and the power off (brake engaged).

Brake Hand-Lever Installation and Adjustment

Figure 6



1. Place the hand-lever over the brake housing (as shown) and align the pins.
2. Screw the bolts with washer and spring into the pins.
3. Using a feeler gage, adjust the hand-lever air gap per Table 5.

Table 5: Hand-Lever Air Gap Setting

Brake Size	Dimension "y" ❶		Brake Size	Dimension "y" ❶	
	[mm]	[in]		[mm]	[in]
BRE 5	1	0.040	BRE 100	1.2	0.047
BRE 10	1	0.040	BRE 150	1.2	0.047
BRE 20	1	0.040	BRE 250	1.5	0.059
BRE 40	1	0.040	BRE 400	1.5	0.059
BRE 60	1	0.040	BRE 800	1.5	0.059
			BRE 1200	1.5	0.059

❶ Tolerance: + 0.008 in [+ 0.2 mm]



IMPORTANT NOTE



When setting the hand-lever gap or dimension "y" the magnetic brake coil housing and the anchor plate must be kept uniform all around.



WARNING



- To assure proper assembly and proper functioning of the brake, the hand-lever must be assembled to the brake, and the hand-lever air gap must be adjusted, before the brake is assembled to the motor.
- Once adjusted properly, the hand-lever air gap setting should not be altered, even when readjusting the air gap setting.

Setting the Brake Air Gap

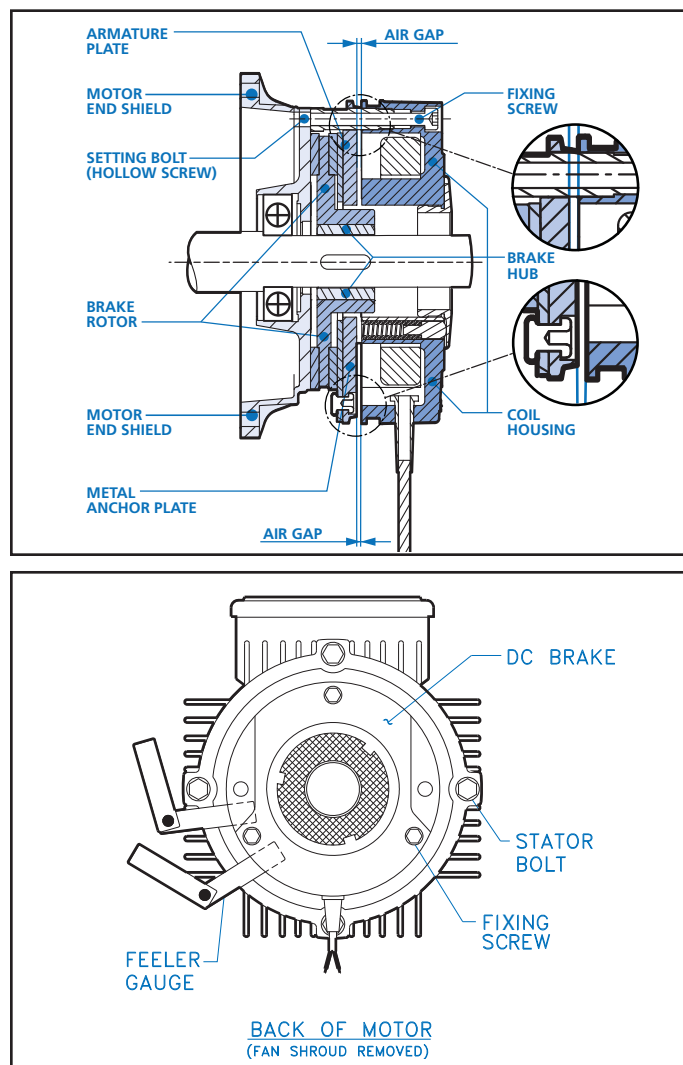
NORD spring-loaded brakes are virtually maintenance free. However, the air-gap of the brake rotor or brake disc must be periodically checked and adjusted. If necessary, the worn brake rotor must be replaced. Table 6 serves as guide to check and set the brake air gap as needed.

IMPORTANT NOTE

When a complete brake motor is supplied by NORD, the air gap is already set at the factory. If the brake is ordered as a part, the air gap must be set in the field. All brake air gap adjustments must be made with the brake assembled to the motor and the power off (brake engaged).

The brake air gap is checked by placing a feeler gage between metal anchor plate and the brake coil housing as shown in Figure 6. This procedure is identical even for the larger BRE800 and BRE1200 twin rotor brakes.

Figure 7 – Setting the Brake Air Gap



Procedure

1. Loosen the fixing screws that attach the brake to the motor's end-shield by approximately half a turn.
2. If required, the brake assembly may be loosened slightly from the motor's end shield by turning the threaded setting bolts (hollow screws) that surround the fixing screws, counter clockwise, into the brake coil housing.
3. Depending upon whether or not the air gap needs to be decreased or increased, turn the fixing screws accordingly until the desired nominal air gap (Table 6) is reached, as measured using the appropriate feeler gauge.
 - Turning the fixing screws clockwise allows the brake coil housing to be moved towards the anchor plate and reduces the air gap.
 - Turning the fixing screws counter-clockwise allows the brake coil housing to be moved away from the anchor plate and increases the air gap.
4. If the setting bolts (hollow screws) were adjusted as suggested in Step 2, re-secure the brake coil housing firmly against the motor's end shield by turning the setting bolts (hollow screws) clockwise, out of the brake coil housing.
5. Tighten the fixing screws to the appropriate torque.
6. Re-check and measure the air gap in multiple locations to check for appropriate spacing. Repeat the steps as needed until the desired air gap spacing is uniform and consistent all the way around the brake.

Table 6: Brake Air Gap Settings

Brake Size	Fixing Screw Tightening Torque		Nominal Air Gap Setting ①		Maximum Air Gap ②	
	[lb-ft]	[Nm]	[in]	[mm]	[in]	[mm]
BRE 5	2.2	3	0.008	0.2	0.024	0.6
BRE10	4.4	6	0.008	0.2	0.028	0.7
BRE20	7.4	10	0.012	0.3	0.031	0.8
BRE40	7.4	10	0.012	0.3	0.035	0.9
BRE60	18	25	0.012	0.3	0.039	1.0
BRE100 ③	18	25	0.016	0.4	0.043	1.1
BRE150 ③	18	25	0.016	0.4	0.043	1.1
BRE250	37	50	0.020	0.5	0.047	1.2
BRE400	37	50	0.020	0.5	0.047	1.2
BRE800	37	50	0.028	0.7	0.047	1.2
BRE1200	37	50	0.028	0.7	0.047	1.2

① Tolerance: + 0.004 in [+ 0.1 mm]

② Brake air gap must be re-adjusted before the stated value.

③ When using the stainless steel friction plate (RG) increase the nominal air gap to 0.6 mm (0.024 in.).

Brake Rotor (Brake Disc) Wear Assessment

Periodically the brake rotor or brake disc must also be checked for wear. If the brake rotors wear approaches the minimum allowed thickness, then the part should be replaced. Use Table 7 to determine whether or not the brake rotor requires replacement.

Table 7: Brake Rotor Thickness

Brake Size	Nominal Brake Rotor Thickness ❶		Minimum Brake Rotor Thickness ❷	
	[in]	[mm]	[in]	[mm]
BRE 5	0.295	7.5	0.177	4.5
BRE10	0.335	8.5	0.217	5.5
BRE20	0.406	10.3	0.295	7.5
BRE40	0.492	12.5	0.374	9.5
BRE60	0.571	14.5	0.453	11.5
BRE100	0.630	16	0.492	12.5
BRE150	0.709	18	0.571	14.5
BRE250	0.787	20	0.650	16.5
BRE400	0.787	20	0.650	16.5
BRE800	0.787	20	0.650	16.5
BRE1200	0.866	22	0.689	17.5

❶ As new condition.

❷ Worn condition - brake rotor replacement is required!

Brake Pad Replacement (reference to parts list on page 8)

When the brake pad is worn the pad should be replaced to maintain proper brake operation and ensure safety.

Required Tools

- Phillips head screw drivers (fan shroud removal)
- External snap ring pliers (fan and brake hub removal).
- Large flat head screw driver or small pry bar (fan removal)
- Metric T-handle wrenches and open-end wrenches.

Procedure

1. Remove the fixing screws (946) securing the fan cover (940) to the motor end-shield (932). If the brake has a hand release (937), the lever arm should be removed by unscrewing it.
2. Remove the fan cover (940) and note the position of the hand release slot if applicable.
3. Remove the snap ring holding the cooling fan (939) and carefully remove the cooling fan (939), key and second snap ring (997).
4. If the brake is equipped with a dust boot (992), remove it.
5. Remove the socket head cap screws holding the brake coil (936) to the motor end-shield (932).
6. Remove the brake coil (936), noting the hand release (937) and power cable locations.
7. Slide the brake rotor (993) off the brake hub (938) which is secured to the motor shaft.
8. Clean the brake, install the new brake rotor pad and reassemble the brake in reverse order of the steps outlined.

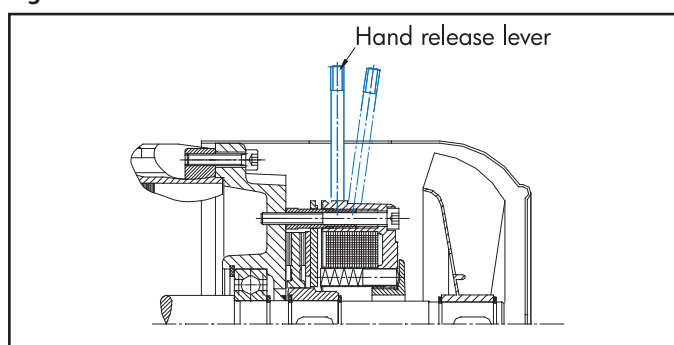
Optional Brake Accessories

NORD can supply a variety of brake options and accessories, of which some of the most common are noted below.

Hand Release Lever (HL)

The hand release lever allows the brake to be manually released without requiring that the brake be energized with voltage. The lever has a spring return that allows the brake to be hand released and returned automatically to its set position. The handle of the hand release lever can be unscrewed for easy removal.

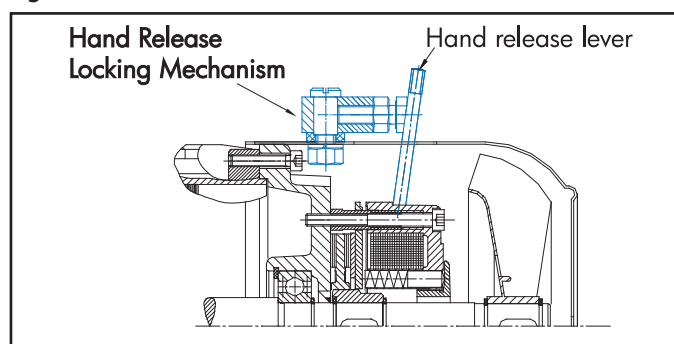
Figure 8



Locking Hand Release Lever (FHL)

This option allows the brake to be manually released and locked off without requiring voltage to the brake. The lock mechanism prevents the spring from returning the brake to a closed state without manual action by the user. The hand release lever can be unscrewed for easy removal.

Figure 9



Corrosion Protected Brake (RG)

The brake is fitted with a stainless steel brake plate to provide additional corrosion protection in severe and wet environments.

Dust & Corrosion Protected Brake (SR)

A rubber-sealing boot is installed on the brake to provide additional protection in dusty environments. This feature includes the stainless steel brake plate (RG).

IP66 Brake (IP66)

NORD can also provide an IP66 brake option designed for a bigger degree of protection against severe environments.



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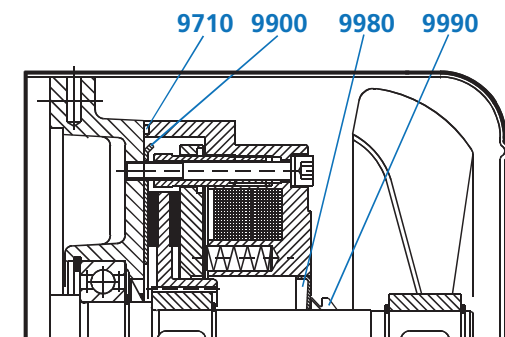
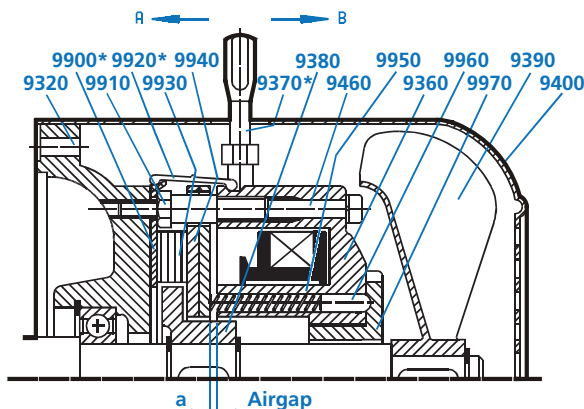
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Parts List - Precima Brakes



Normal Design, Enclosure IP55 with following options:

RG – Stainless Steel Disc (Item 9900)
 SR – Dust Boot-includes Option RG (Item 9920)
 HL – Hand Release (Item 9370)

Optional Brake with optional IP66 enclosure

9320 Non-drive end shield
 9360 Brake coil
 9370 Manual brake lever – optional
 9380 Brake hub
 9390 Fan
 9400 Fan cover
 9460 Fixing screw

9710 O-ring - optional
 9900 Friction plate - optional
 9910 Setting bolt
 9920 Dust protection ring
 9930 Brake rotor
 9940 Armature plate
 9950 Spring

9960 Pressure plate adjustment**
 9970 Adjustable ring **
 9980 Bushing/seal - optional
 9990 V-ring - optional

**** Only for brakes that are 5 Nm to 40 Nm**

Table 8: Spare Parts

Brake Size	NORD Motor Frame	Brake Rotor [Item 9930]	Brake Hub [Item 9380]	Brake Hub Bore / (Style)	Hand Release (HL) [Item 9370]	Stainless Disc (RG) [Item 9900]	Dust Boot (SR) [Item 9920]
BRE5	63/71/80	19120042	19100112	15 mm (hex)	19150042	19130042	19110042
BRE10	63/71	19120082	19100212	15 mm (hex)	19150082	19130082	19110082
BRE10	80/90	19120082	19100222	20 mm (hex)	19150082	19130082	19110082
BRE20	80/90/112	19120162	19100322	20 mm (hex)	19150162	19130162	19110162
BRE20	100	19120162	19100332	25 mm (hex)	19150162	19130162	19110162
BRE40	90/100	19120322	19100452	25 mm (spline)	19150322	19130322	19110402
BRE40	112	19120402	19100442	30 mm (hex)	19150322	19130322	19110402
BRE60	100	19120602	19100532	25 mm (spline)	19150602	19130602	19110602
BRE60	112	19120602	19100542	30 mm (spline)	19150602	19130602	19110602
BRE60	132	19120602	19100552	35 mm (spline)	19150602	19130602	19110602
BRE100	132/160	19120802	19100652	35 mm (spline)	19150802	19130802	19110802
BRE150	132	19121502	19100752	35 mm (spline)	19151502	19131502	19111502
BRE150	160/180	19121502	19100772	45 mm (spline)	19151502	19131502	19111502
BRE250	160/180	19122402	19100872	45 mm (spline)	19152402	19132500	19112502
BRE250	200	19122402	19100882	50 mm (spline)	19152402	19132500	19112502
BRE400	200/225	19124002	19100912	60 mm (spline)	19154003	10114020	19114002



IMPORTANT NOTES



- For brake coil part numbers, listed by brake size and coil voltage, please see page 4.
- The large BRE 800 and BRE 1200 twin rotor brakes are supplied to NORD pre-assembled and complete. For parts list details and spare parts information please contact NORD.

Brake Times & Electrical Selection

Brake timing performance is critical in selecting the optimal brake system. NORD brakes can provide exceptional performance in terms of the release (start) times and engagement (stop) times. Use the following guidelines in order to select the correct brake control components and connections.

- 1) Determine if the brake needs to be wired directly from the motor terminal block or powered by a separate power source.
 - If you are using a frequency inverter, soft-start or a two speed motor you will need to supply the rectifier from a separate power source.
 - If the motor is powered direct across-the-line the rectifier power can be supplied from the motor's terminal block.
- 2) What type of performance do I need?
 - Is the standard brake performance OK?
 - Is a higher performance required for fast brake release or very fast brake stopping?
- 3) Determine the brake supply voltage and check the rectifier compatibility using the table on page 10?

Selection Suggestions

When Fast Stopping is Recommended

Any applications that require quick stops and positive action at stand-still

Recommended Applications

- conveyors and inclined conveyors
- hoists and lifts
- bulk material handling equipment (bucket elevators, idler conveyor's).



CAUTION



- **Hoisting (lifting/lowering) applications** - must have the brake wired for fast response.

When Fast-Release is Recommended (Overexcitation)

Fast Release is recommended in any application that is very high-cycling with frequent starts and stops. These applications require the brake to release very-quickly in order to avoid excessive heat build-up in the AC motor and brake coil.

Recommended Applications

- Index conveyors
- Diverters
- Storage and retrieval crane systems

Power Source	Brake Release (start)	Brake engagement (stop)	Braking Method *	Rectifier
Motor Terminal Block	Standard	Standard (AC switching)	10	GVE/GHE/GUE
	Standard	Fast (DC switching)	15	GVE/GHE/GUE
	① Fast (Overexcitation)	Standard (AC switching)	30	PMG 500
	① Fast (Overexcitation)	Fast (DC switching)	35	PMG 500
Separate Power Source	Standard	Standard (AC switching)	20	GVE/GHE/GUE
	Standard	Fast (DC switching)	25	GVE/GHE/GUE
	① Fast (Overexcitation)	Standard (AC switching)	45	PMG 500
	① Fast (Overexcitation)	Fast (DC switching)	50	PMG 500

* Braking methods referenced in connection diagrams on pages 11-15.

① Please see important note below:



IMPORTANT NOTE



The PMG500 rectifier is required when utilizing the larger 800 Nm (590 lb-ft) - and 1200 Nm (885 lb-ft) twin-rotor brakes. In order to prevent rapid wear, NORD recommends using the PMG500 rectifier to "overexcite" the brake during its release. The brake coil should be sized utilizing the PMG rectifier like a half-wave rectifier.



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The table below determines the rectifier and DC brake voltage required, based on the AC supply voltage & braking method.

Rectifier Supply Voltage (VAC)	Brake Coil Voltage (VDC)	Braking Method	Rectifier Type	Rectifier P/N	BRE 5	BRE 10	BRE 20	BRE 40	BRE 60	BRE 100	BRE 150	BRE 250	BRE 400	BRE 800	BRE 1200
115 (105-120)	105	20	GVE20L	19141000	X	X	X	X	X	X	X				
	105	25	GVE20L	19141000	X	X	X	X	X	X	X				
208 (200-208)	180	10	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	180	15	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	180	20	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	25	GHE40L	19141010	X	X	X	X	X	X	X				
	105	25	GHE50L	19141020	X	X	X	X	X	X	X				
	180	25	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	30	PMG500	19140200										X	X
	105	35	PMG500	19140200										X	X
	105	45	PMG500	19140200										X	X
	105	50	PMG500	19140200										X	X
230 (220-240)	180	55	PMG500	19140200										X	X
	105	10	GHE40L	19141010	X	X	X	X	X	X	X				
	205	10	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	15	GHE40L	19141010	X	X	X	X	X	X	X				
	205	15	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	20	GHE40L	19141010	X	X	X	X	X	X	X				
	205	20	GUE40V	19140300	X	X	X	X	X	X	X				
	205	20	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	25	GHE40L	19141010	X	X	X	X	X	X	X				
	205	25	GUE40V	19140300	X	X	X	X	X	X	X				
	205	25	GVE20L	19141000	X	X	X	X	X	X	X	X	X		
	105	30	PMG500	19140200										X	X
	105	35	PMG500	19140200										X	X
	105	45	PMG500	19140200										X	X
	105	50	PMG500	19140200										X	X
332	180	30	PMG500	19140200										X	X
	180	35	PMG500	19140200										X	X
400 (380-415)	180	10	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	180	15	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	180	20	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	180	25	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	180	30	PMG500	19140200										X	X
	180	35	PMG500	19140200										X	X
	180	45	PMG500	19140200										X	X
	180	50	PMG500	19140200										X	X
460 (440-480)	205	10	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	205	15	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	205	20	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	205	20	GUE40V	19140300	X	X	X	X	X	X	X				
	205	25	GHE40L	19141010	X	X	X	X	X	X	X	X	X		
	205	25	GUE40V	19140300	X	X	X	X	X	X	X				
	205	30	PMG500	19140200										X	X
	205	35	PMG500	19140200										X	X
	205	45	PMG500	19140200										X	X
	205	50	PMG500	19140200										X	X
575 (550-600)	250	10	GHE50L	19141020	X	X	X	X	X	X	X	X	X		
	250	15	GHE50L	19141020	X	X	X	X	X	X	X	X	X		
	250	20	GHE50L	19141020	X	X	X	X	X	X	X	X	X		
	250	25	GHE50L	19141020	X	X	X	X	X	X	X	X	X		



Specify Rectifier Model Type

And DC Brake Voltage

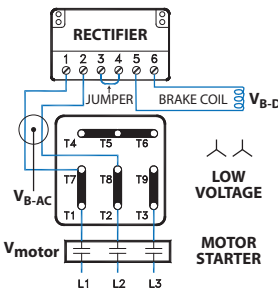
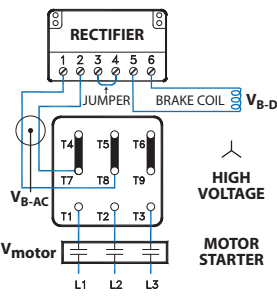
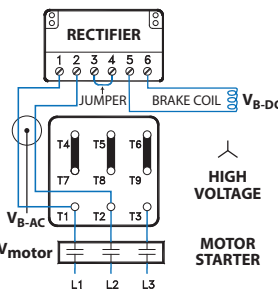
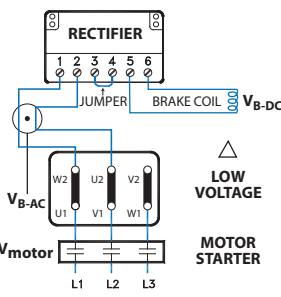
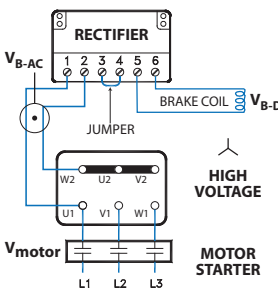
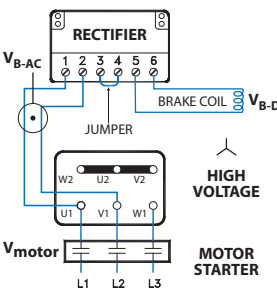
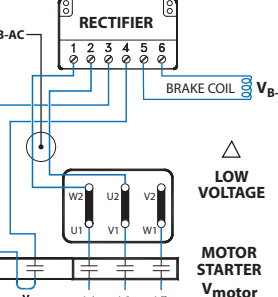
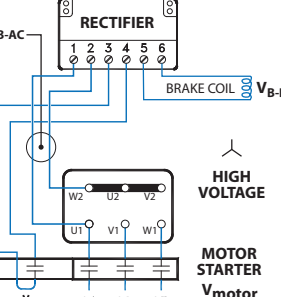
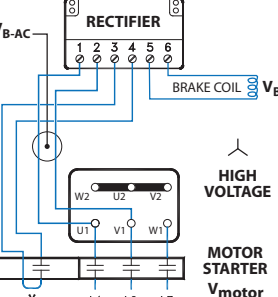
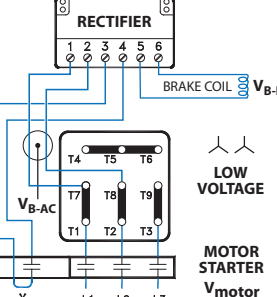
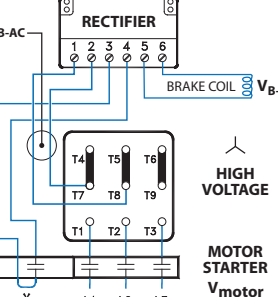
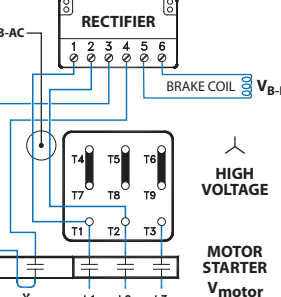
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Typical Connection Diagrams

BR101A POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208-230V/460V</td><td>GVE20</td><td>208 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>230V/460V</td><td>GVE20</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>230V/460V</td><td>GHE40</td><td>230 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	208-230V/460V	GVE20	208 VAC	230 VAC	205 VDC	230V/460V	GVE20	230 VAC	230 VAC	205 VDC	230V/460V	GHE40	230 VAC	230 VAC	105 VDC	BR101B POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230V/460V</td><td>GVE20</td><td>460 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230V/460V	GVE20	460 VAC	230 VAC	205 VDC	GP101C POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230V/460V</td><td>GHE40</td><td>460 VAC</td><td>460 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230V/460V	GHE40	460 VAC	460 VAC	205 VDC	BR601A POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208Δ/360V</td><td>GVE20</td><td>208 VAC</td><td>208 VAC</td><td>180 VDC</td></tr><tr><td>230Δ/400V</td><td>GVE20</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>400Δ/690V</td><td>GHE40</td><td>400 VAC</td><td>400 VAC</td><td>180 VDC</td></tr><tr><td>460Δ/7</td><td>GHE40</td><td>460 VAC</td><td>460 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	208Δ/360V	GVE20	208 VAC	208 VAC	180 VDC	230Δ/400V	GVE20	230 VAC	230 VAC	205 VDC	400Δ/690V	GHE40	400 VAC	400 VAC	180 VDC	460Δ/7	GHE40	460 VAC	460 VAC	205 VDC
MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}																																																																
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BR601B POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230Δ/400V</td><td>GVE20</td><td>400 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230Δ/400V	GVE20	400 VAC	230 VAC	205 VDC	BR601C POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 10 NORMAL STOPPING (AC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>332Δ/575V</td><td>GHE50</td><td>575 VAC</td><td>575 VAC</td><td>250 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	332Δ/575V	GHE50	575 VAC	575 VAC	250 VDC	BR603A POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208Δ/360V</td><td>GVE20</td><td>208 VAC</td><td>208 VAC</td><td>180 VDC</td></tr><tr><td>230Δ/400V</td><td>GVE20</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>400Δ/690V</td><td>GHE40</td><td>400 VAC</td><td>400 VAC</td><td>180 VDC</td></tr><tr><td>460Δ/7</td><td>GHE40</td><td>460 VAC</td><td>460 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	208Δ/360V	GVE20	208 VAC	208 VAC	180 VDC	230Δ/400V	GVE20	230 VAC	230 VAC	205 VDC	400Δ/690V	GHE40	400 VAC	400 VAC	180 VDC	460Δ/7	GHE40	460 VAC	460 VAC	205 VDC	BR603B POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230Δ/400V</td><td>GVE20</td><td>400 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230Δ/400V	GVE20	400 VAC	230 VAC	105 VDC										
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BR603C POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>332Δ/575V</td><td>GHE50</td><td>575 VAC</td><td>575 VAC</td><td>250 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	332Δ/575V	GHE50	575 VAC	575 VAC	250 VDC	BR103A POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208-230V/460V</td><td>GVE20</td><td>208 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>230V/460V</td><td>GVE20</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr><tr><td>230V/460V</td><td>GHE40</td><td>230 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	208-230V/460V	GVE20	208 VAC	230 VAC	205 VDC	230V/460V	GVE20	230 VAC	230 VAC	205 VDC	230V/460V	GHE40	230 VAC	230 VAC	105 VDC	BR103B POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230V/460V</td><td>GVE20</td><td>460 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230V/460V	GVE20	460 VAC	230 VAC	205 VDC	BR103C POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE 15 FAST STOPPING (DC-SWITCHING)  <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230V/460V</td><td>GHE40</td><td>460 VAC</td><td>460 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V _{motor}	V _{B-AC}	V _{B-DC}	230V/460V	GHE40	460 VAC	460 VAC	205 VDC															
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* The normally open contact/s (NO) is not supplied by NORD. It must close at the same time power is supplied to the brake. The contact must be capable of switching inductive loads and/or be rated IEC AC3.

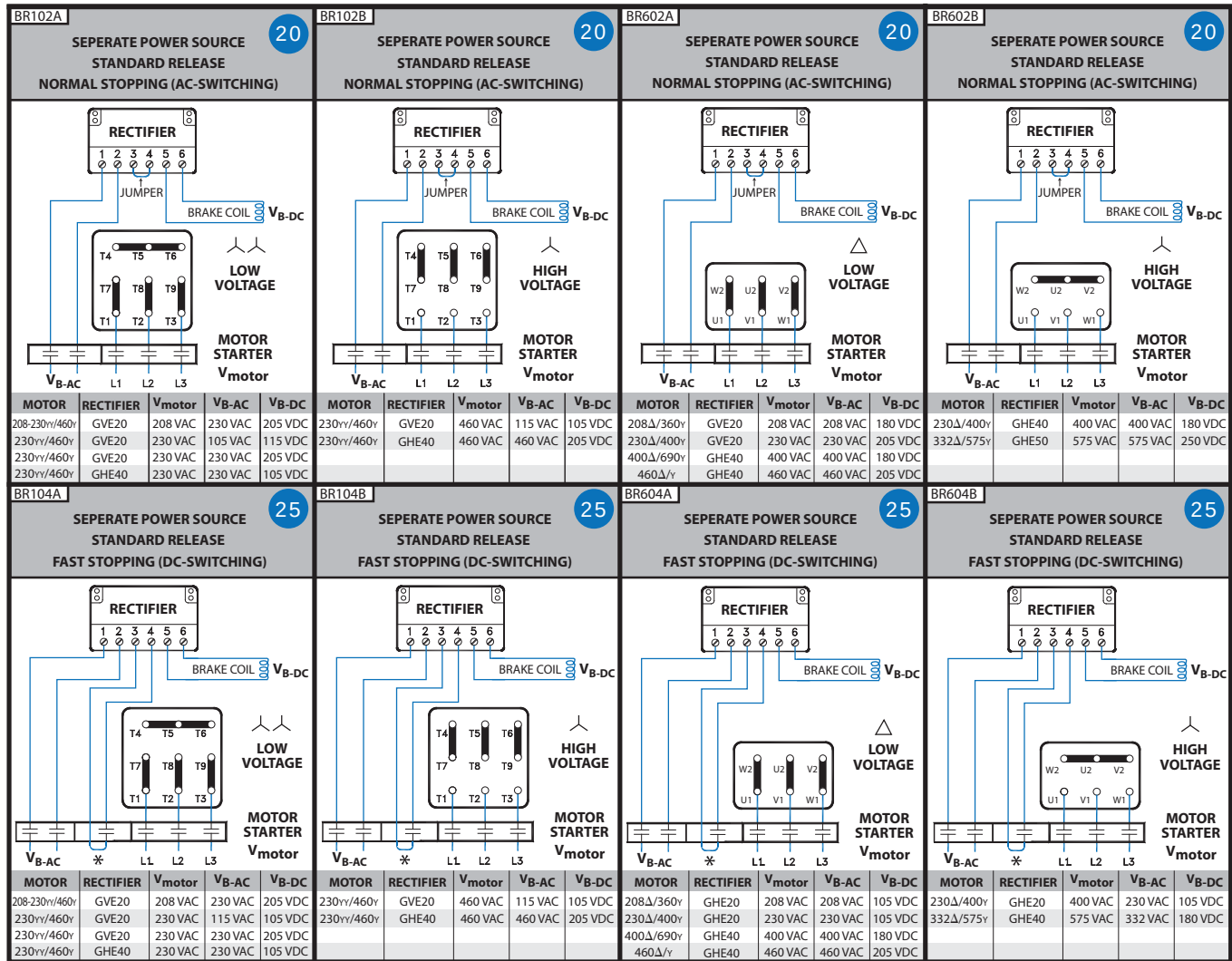
 = Braking Method

MOTOR BRAKES INSTALLATION & MAINTENANCE



RETAIN FOR FUTURE USE
Typical Connection Diagrams

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* The normally open contact/s (NO) is not supplied by NORD. It must close at the same time power is supplied to the brake. The contact must be capable of switching inductive loads and/or be rated IEC AC3.

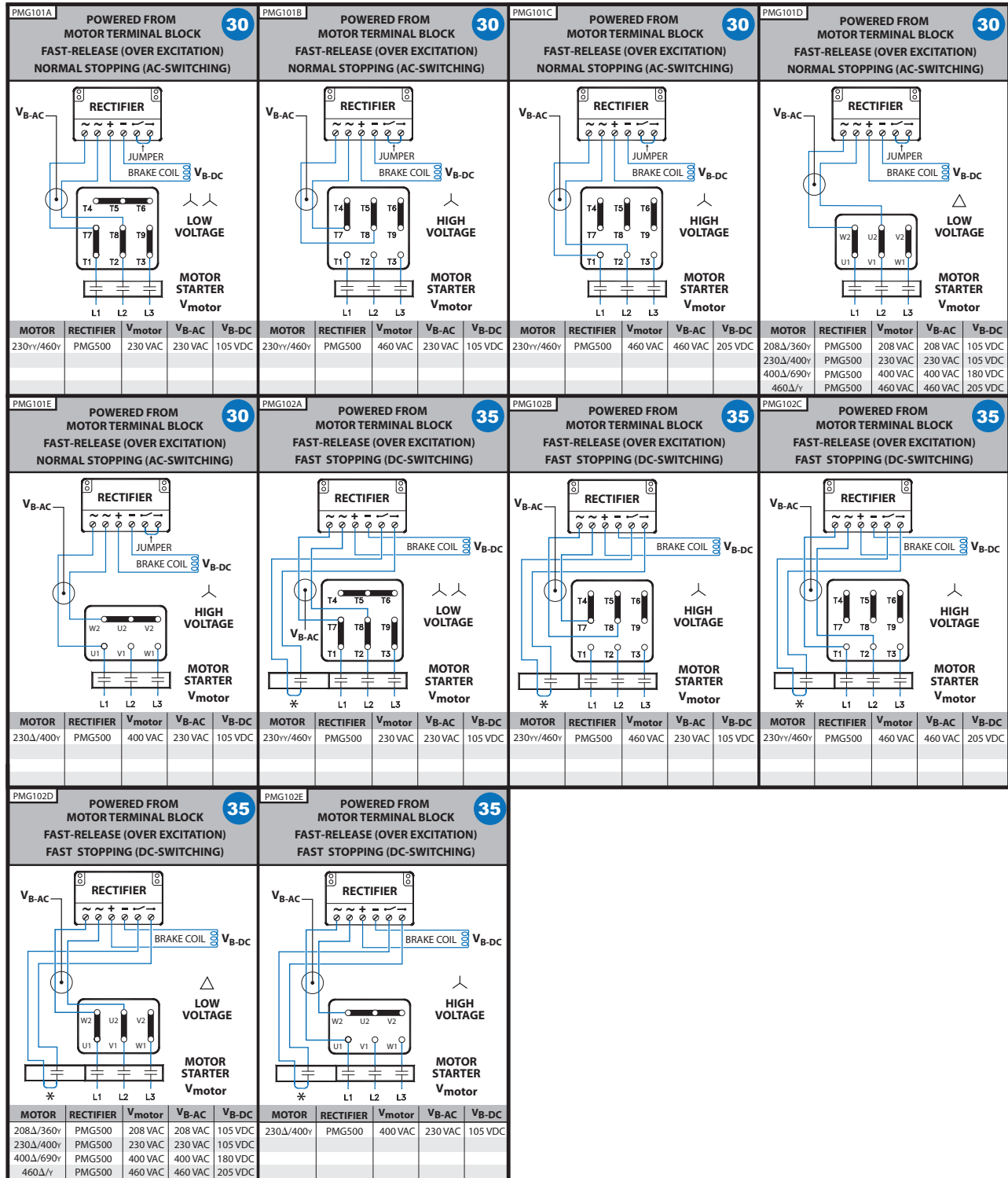
= Braking Method

MOTOR BRAKES INSTALLATION & MAINTENANCE

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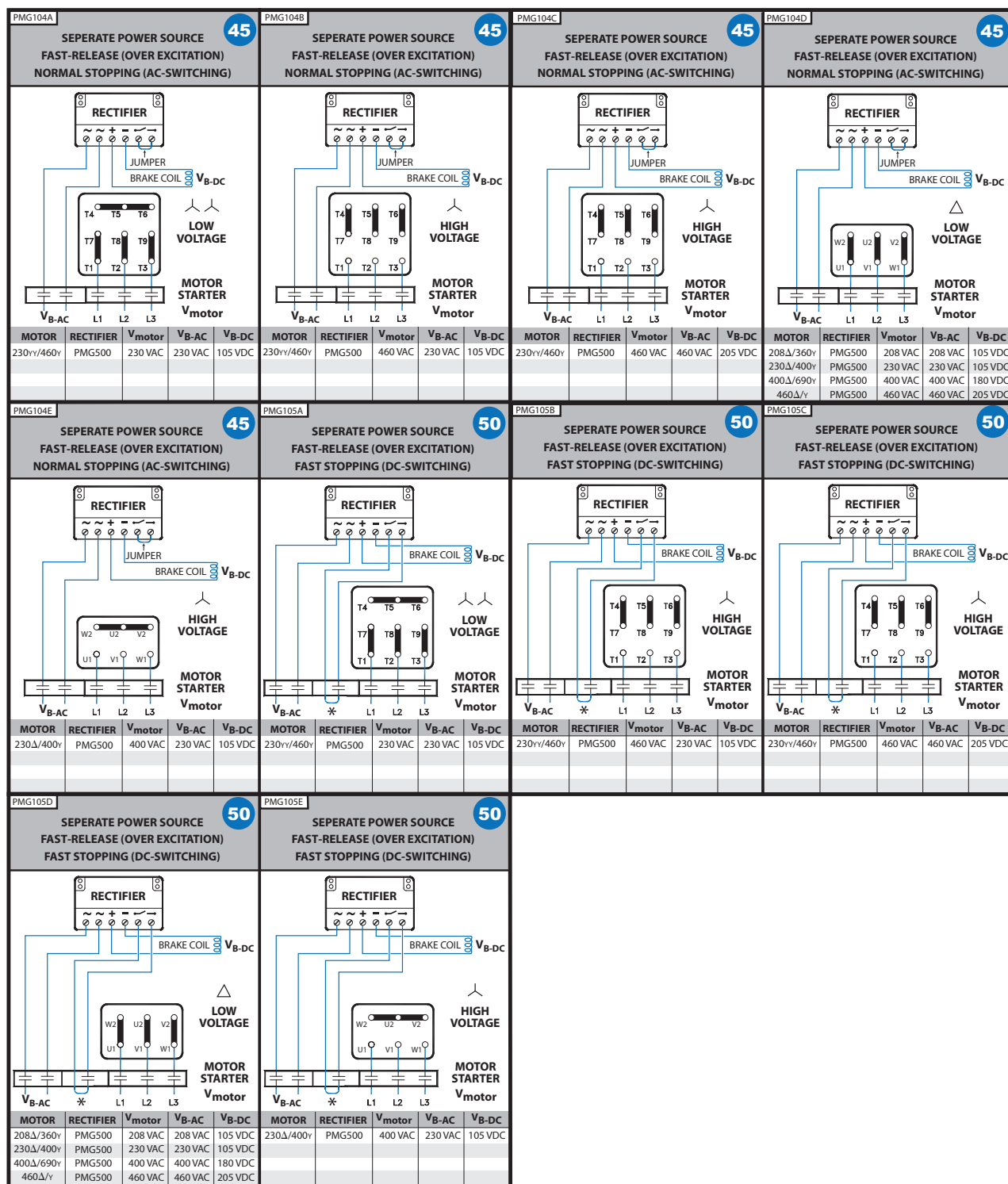
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Typical Connection Diagrams



* The normally open contact/s (NO) is not supplied by NORD. It must close at the same time power is supplied to the brake. The contact must be capable of switching inductive loads and/or be rated IEC AC3.

 = Braking Method



* The normally open contact/s (NO) is not supplied by NORD. It must close at the same time power is supplied to the brake. The contact must be capable of switching inductive loads and/or be rated IEC AC3.

 = Braking Method

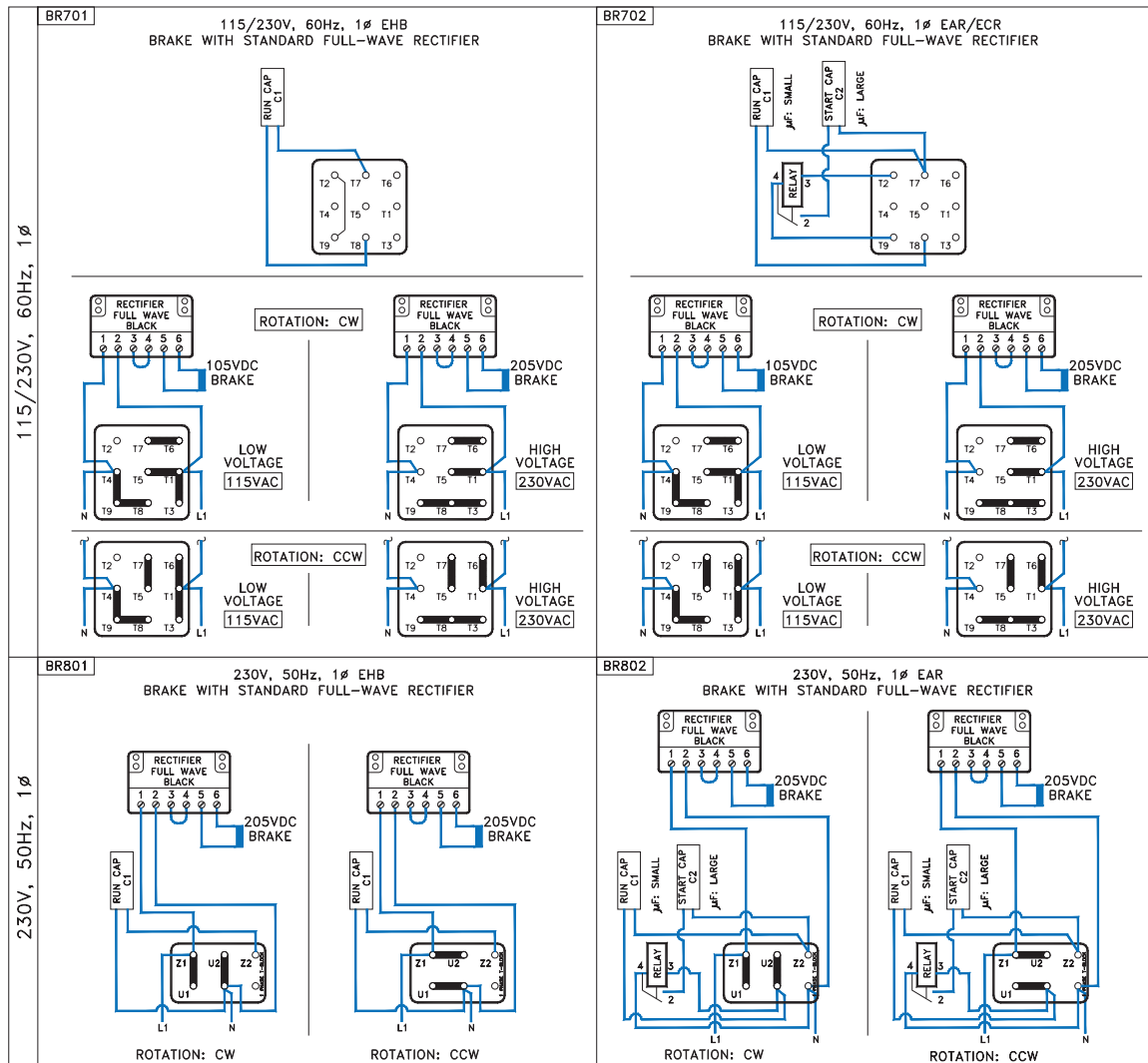
MOTOR BRAKES INSTALLATION & MAINTENANCE



RETAIN FOR FUTURE USE

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Typical Connection Diagrams - Single Phase Motors



MOTOR BRAKES INSTALLATION & MAINTENANCE

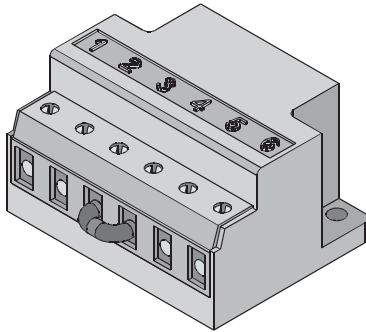
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Troubleshooting Information

Troubleshooting	Cause	Remedy
Brake doesn't release	Air gap too large	Check air gap and adjust
	Brake not receiving electrical power	Check electrical connection
	Failed rectifier	Replace rectifier
	Brake is getting too warm	Use fast response (FR) rectifier
	Voltage to brake coil too small	Check connection voltage of brake coil
	Rectifier supply voltage from inverter	Rectifier voltage must be from separate source. (Inverter output voltage varies)
Brake release is delayed	Air gap too large	Check air gap and adjust
	Voltage to brake coil too small	Check connection voltage of brake coil
Brake does not engage	Voltage to coil too large	Check connection voltages of brake windings
	Hand release is adjusted incorrectly	Adjust to correct air gap
	Anchor plate mechanically blocked	Remove mechanical blockage
Brake engagement is delayed	Voltage to coil too large	Check connection voltage of brake windings
	Brake is switched to AC side	Use DC switching



General Instructions

This manual provides general operating instructions for the "Fast Acting Brake Rectifiers type "GPE, GPU, and PMG" that are commonly offered by NORD in addition to the standard brake control rectifiers. Please feel free to contact NORD with any questions concerning the supplied brake rectifiers and brake components.

Safety Notice

Only qualified personnel should attempt installation, operation and maintenance of NORD brakes and brake rectifiers. If you have a question about a procedure or are uncertain about any detail, seek clarification and DO NOT PROCEED.

⚠	WARNING	⚠
• This equipment contains high electrical voltage. Remove and lockout all power from the electric motor and brake before any work is completed on the brake. • The user is responsible for conforming to all national and local electrical and safety codes. Wiring practices, proper grounding, disconnects, and over current protection, are of particular importance. • Make certain the load is supported when servicing the brake. Removing power from the brake or removing the brake from the motor will release the load, which may cause severe injury or death. • Failure to follow proper procedures and precautions may result in severe bodily injury or death.		

Brake Control Rectifiers

NORD brake control rectifiers convert AC voltage to DC voltage. Rectifiers are used because most applications require AC voltage to power the motor, but DC power is required to power the brake and DC power is not typically available. NORD brakemotors typically include the rectifier located inside the terminal box.

Rectifier Advantages

- Individual power source for each brake.
- Compact size, mounted inside the terminal box.
- Multiple types, voltage options and release/engagement modes available.
- Mountable in a separate control cabinet.
- Integral protection against voltage spikes.

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Standard Rectifier Types

Full-Wave Rectifier

A rectifier in which both the positive and negative half-cycles of the AC input signal are rectified to produce a uni-directional DC current supply to the load or the brake. The output voltage is 90% of the input voltage ($V_{DC} = 0.90 \times V_{AC}$).

Half-Wave Rectifier

A rectifier in which only alternate half-cycles of the AC input signal are rectified to produce a uni-directional DC current supply to the load or the brake. The output voltage is 45% of the input voltage ($V_{DC} = 0.45 \times V_{AC}$).

Dual-Wave Rectifier

A rectifier that can be wired as either a full-wave rectifier or a half-wave rectifier depending upon how it is connected to the AC input signal.

i	IMPORTANT NOTE	i
This manual provides general operating instructions for NORD brakes with Fast-Acting brake Rectifiers. For additional brake and brake rectifier information please reference User Manual U35000.		

Fast-Acting or Push-Hybrid Rectifiers [GPE, GPU & PMG]

A push-hybrid rectifier or fast-acting brake rectifier provides an initial "push" in the form of a timed full-wave brake-release function, which is then followed by a continuous half-wave brake-holding function. There are two ways to apply these rectifiers as follows:

- "Overexcitation" of the brake coil provides faster brake release or improved cycling capacity. The DC voltage of the brake coil is determined based upon using a half-wave rectifier. The output voltage is 45% of the input voltage ($V_{DC} = 0.45 \times V_{AC}$).
- "Reducer-Power Holding" of the brake coil maintains the brake in a released state by using only 25% of the power needed for the initial brake release. This results in very fast brake stopping. The DC voltage of the brake coil is determined based upon using a full-wave rectifier. The output voltage is 90% of the input voltage. ($V_{DC} = 0.90 \times V_{AC}$).

i	IMPORTANT NOTE	i
In order to prevent rapid wear, the PMG 500 rectifier is required when utilizing the larger 800 Nm (590 lb-ft) and 1200 Nm (885 lb-ft) twin-rotor brakes. The PMG500 rectifier is wired to "overexcite" the brake during its initial release.		

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FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



DRIVESYSTEMS

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Push-Hybrid Rectifiers External DC Switching (GPE)

Like the standard NORD brake control rectifiers, NORD's fast acting brake control rectifiers convert AC voltage to DC voltage. The "Fast Acting Brake Rectifiers" are utilized to improve brake performance and are often recommended in order to provide shorter brake release times or to provide faster stopping times.

The fast acting rectifiers are a two-stage "push" design, when power is first applied these rectifiers operate like a full-wave rectifier and then after a relatively short period of time they act like a half-wave rectifier. The GPE type rectifiers start out in full-wave mode when power is first applied and then after approximately 250 ms they switch to half-wave mode.

GPE rectifiers were designed for external control of the brake's DC-switching. GPE rectifiers are primarily used in across-the-line applications where the brake power is supplied by the motor terminals but they may also be used in situations where the brake power is supplied separately to the brake rectifier.

There are two ways to apply the fast acting rectifiers:

- The first method, known as "Overexcitation," provides fast brake release. The brake coil is selected like a half-wave system (45% of the AC supply voltage).
- The second method, known as "Reduced Power Holding," provides very fast brake stopping. The brake coil is selected like a full-wave system (90% of the AC supply voltage).

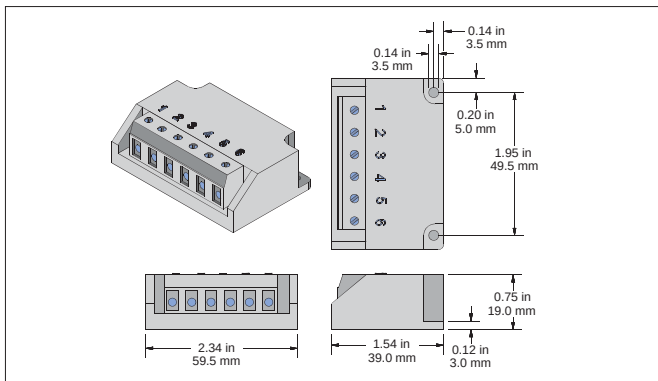


IMPORTANT NOTE



If the motor is connected to a frequency inverter, soft start, or is a two-speed motor, then separate AC power must be supplied to the brake rectifier.

GPE Rectifier Dimensions



Ratings & Part Numbers

Model Type	GPE20L	GPE40L
Part Number	19140230	19140240
Protection (electronics)	Coated	Coated
Color	Black	
Input Voltage (V _{AC})	200V-275V	380V-480V
Output Voltage (V _{DC})	(V _{DC} = 0.45 x V _{AC}) - As Half-Wave (V _{DC} = 0.90 x V _{AC}) - As Full-Wave	
Rated Current @ 40°C	0.7 A	0.7A
Rated Current @ 75°C	0.5 A	0.5A
Temperature Range	-20°C to 75°C	
DC-Switching via	External Contact or IR Relay	

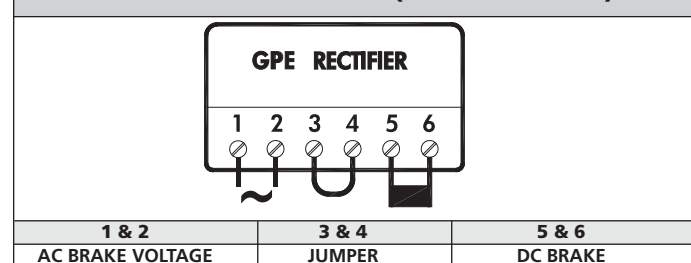
Braking Method

Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
40	Standard	Very Fast (Reduced Power Holding)	Motor terminals
30	Fast (Overexcitation)	Standard (AC Switching)	Motor terminals
35	Fast (Overexcitation)	Fast (DC Switching)	Motor terminals

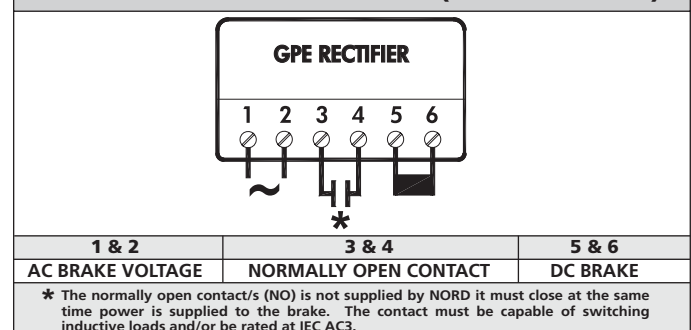
Basic Connection (AC & DC Switching)

The GPE brake system can be connected for standard stopping (AC-Switching), fast stopping (DC-Switching) and very fast stopping (Reduced power holding & DC-Switching). Fast brake release can also be achieved by selecting a different brake coil combination.

STANDARD STOPPING (AC-SWITCHING)



FAST & VERY FAST STOPPING (DC-SWITCHING)





FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



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Push-Hybrid Rectifiers Integrated DC Switching (GPU)

Like the standard NORD brake control rectifiers, NORD's fast acting brake control rectifiers convert AC voltage to DC voltage. The "Fast Acting Brake Rectifiers" are utilized to improve brake performance and are often recommended in order to provide shorter brake release times or to provide faster stopping times.

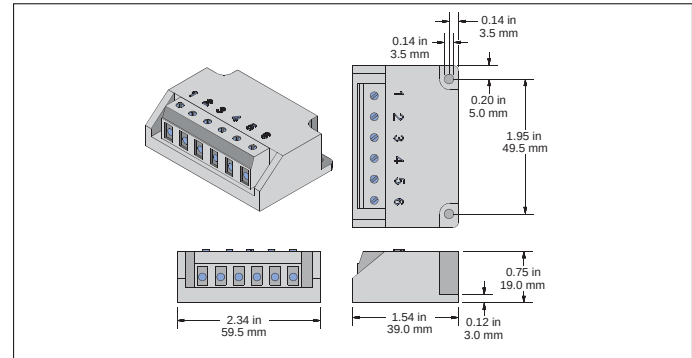
The fast acting rectifiers are a two-stage "push" design. When power is first applied these rectifiers operate like a full-wave rectifier and then after a relatively short period of time they act like a half-wave rectifier. The GPU rectifiers start out in full-wave mode when power is first applied and then after approximately 250 ms they switch to half-wave mode.

GPU rectifiers were designed for integrated control of the brake's DC-switching and are voltage sensing. GPU rectifiers are primarily used in applications where there is a frequency inverter, soft start, or two-speed motor. Separate AC power must be supplied to the brake rectifier.

There are two ways to apply the fast acting rectifiers:

- The first method, known as "Overexcitation," provides fast brake release. The brake coil is selected like a half-wave system (45% of the AC supply voltage).
- The second method, known as "Reduced Power Holding," provides very fast brake stopping. The brake coil is selected like a full-wave system (90% of the AC supply voltage).

GPU Rectifier Dimensions



Ratings & Part Numbers

Model Type	GPU20L	GPU40L
Part Number	19140090	19140170
Protection (electronics)	Coated	Coated
Color	Black	
Input Voltage (V _{AC})	200V-275V	380V-480V
Output Voltage (V _{DC})	(V _{DC} = 0.45 x V _{AC}) - As Half-Wave (V _{DC} = 0.90 x V _{AC}) - As Full-Wave	
Rated Current @ 40°C	0.7A	0.7A
Rated Current @ 75°C	0.5A	0.5A
Temperature Range	-20°C to 75°C	
DC-Switching via	Internal Activation	

Basic Connection (AC & DC Switching)

The GPU brake system can be connected for standard stopping (AC-Switching), fast stopping (DC-Switching) and very fast stopping (Reduced power holding & DC-Switching). Fast brake release can also be achieved by selecting a different brake coil combination.

IMPORTANT NOTE

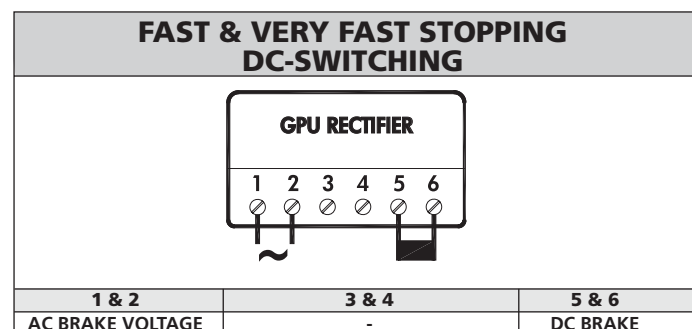
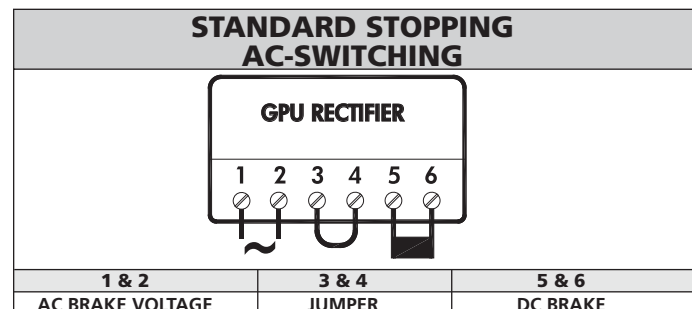
The GPU rectifier may also be utilized for across-the-line applications; however it must always be powered separate from the motor and have its own pair of contactors or starters. It is inadvisable to use the motor terminal block to supply the GPU rectifier's AC power due to the motor's slow energy dissipation when switched off.

IMPORTANT NOTE

If the motor is connected to a frequency inverter, soft start, or is a two-speed motor, then separate AC power must be supplied to the brake rectifier.

Braking Method

Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
55	Standard	Very Fast (Reduced Power Holding)	Separate power
45	Fast (Overexcitation)	Standard (AC Switching)	Separate power
50	Fast (Overexcitation)	Fast (DC Switching)	Separate power





FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



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Push-Hybrid Rectifiers External DC Switching (PMG)

Like the standard NORD brake control rectifiers, NORD's fast acting brake control rectifiers convert AC voltage to DC voltage. The "Fast Acting Brake Rectifiers" are utilized to improve brake performance and are often recommended in order to provide shorter brake release times or to provide faster stopping times.

The fast acting rectifiers are a two-stage "push" design. When power is first applied these rectifiers operate like a full-wave rectifier and then after a relatively short period of time they act like a half-wave rectifier. The PMG type rectifiers start out in full-wave mode when power is first applied and then after approximately 250 ms they switch to half-wave mode.

PMG rectifiers were designed for external control of the brake's DC-switching. PMG rectifiers are primarily used in across-the-line applications where the brake power is supplied by the motor terminals, but they may also be used in situations where the brake power is supplied separately from the brake rectifier.

There are two ways to apply the fast acting rectifiers:

- The first method, known as "Overexcitation," provides fast brake release. The brake coil is selected like a half-wave system (45% of the AC supply voltage).
- The second method, known as "Reduced Power Holding," provides very fast brake stopping. The brake coil is selected like a full-wave system (90% of the AC supply voltage).

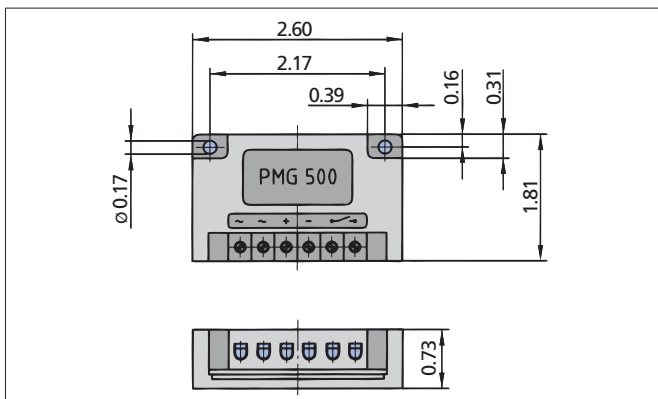


IMPORTANT NOTE



If the motor is connected to a frequency inverter, soft start, or is a two-speed motor, then separate AC power must be supplied to the brake rectifier.

PMG Rectifier Dimensions



Ratings & Part Numbers

Model Type	PMG 500
Part Number	19140200
Protection (electronics)	Coated
Color	Black
Input Voltage (V _{AC})	200-500V _{AC} +/- 10%
Output Voltage (V _{DC})	(V _{DC} =0.45 x V _{AC}) - As Half-Wave (V _{DC} =0.90 x V _{AC}) - As Full-Wave
Rated Current @ 40°C	4.0 A
Rated Current @ 75°C	2.8 A
Temperature Range	-15°C to 80°C
DC-Switching via	External Contact

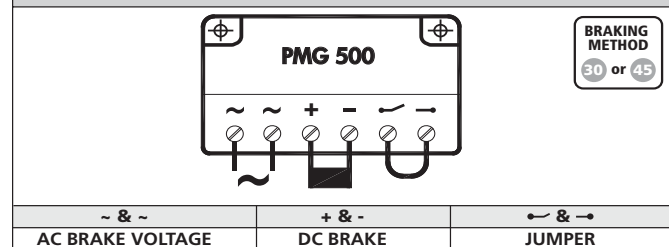
Braking Method

Braking Method	Break Release (Start)	Brake Engage (Stop)	Power Source
40	Standard	Very Fast (Reduced Power Holding)	Motor terminals
30	Fast (Overexcitation)	Standard (AC Switching)	Motor terminals
35	Fast (Overexcitation)	Fast (DC Switching)	Motor terminals
55	Standard	Very Fast (Reduced Power Holding)	Separate power
45	Fast (Overexcitation)	Standard (AC Switching)	Separate power
50	Fast (Overexcitation)	Fast (DC Switching)	Separate power

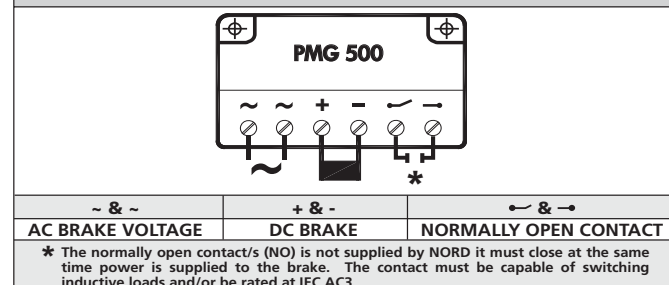
Basic Connection (AC & DC Switching)

The PMG brake system can be connected for standard stopping (AC-Switching), fast stopping (DC-Switching) and very fast stopping (Reduced power holding & DC-Switching). Fast brake release can also be achieved by selecting a different brake coil combination.

STANDARD STOPPING (AC-SWITCHING)



FAST & VERY FAST STOPPING (DC-SWITCHING)



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FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



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Brake Times & Electrical Selection

Brake timing performance is critical in selecting the optimal brake system. NORD brakes can provide exceptional performance in terms of the release (start) times and engagement (stop) times. Use the following guidelines in order to select the correct brake control components and connections.

- 1) Determine if the brake needs to be wired directly from the motor terminal block or powered by a separate source.
 - If you are using a frequency inverter, soft-start or a two speed motor you will need to supply the rectifier from a separate power source.
 - If the motor is powered direct across-the-line the rectifier power can be supplied from the motor's terminal block.
- 2) What type of performance do I need?
 - Is the standard brake performance OK?
 - Is a higher performance required for fast brake release or very fast brake stopping?
- 3) Determine the brake supply voltage and check the rectifier compatability using the table on the page 6.

Selection Suggestions

When Fast or Very Fast Stopping is Recommended

Any applications that require quick stops and positive action at stand-still

Recommended Applications

- conveyors and inclined conveyors
- hoists and lifts
- bulk material handling equipment (bucket elevators, idler conveyor's).



WARNING



Hoisting (lifting/lowering) applications - must have the brake wired for fast response (DC-switching)

When Fast-Release is Recommended (Overexcitation)

Any application that is very high-cycling with frequent starts and stops. These applications require the brake to release very-quickly in order to avoid excessive heat build-up in the AC motor and brake coil.

Recommended Applications

- Index conveyors
- Diverters

Power Source	Brake Release (start)	Brake engagement (stop)	Braking Method *	Rectifier
Motor Terminal Block	Standard	Very Fast (Reduced power holding)	40	GPE or PMG 500
	Fast (Overexcitation)	Standard (AC switching)	30	GPE or PMG 500
	Fast (Overexcitation)	Fast (DC switching)	35	GPE or PMG 500
Seperate Power Source	Standard	Very Fast (Reduced power holding)	55	GPU or PMG 500
	Fast (Overexcitation)	Standard (AC switching)	45	GPU or PMG 500
	Fast (Overexcitation)	Fast (DC switching)	50	GPU or PMG 500

* Braking methods referenced in connection diagrams on pages 7-11.



FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



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Rectifier Supply Voltage (VAC)	Brake Coil Voltage (VDC)	Braking Method	Rectifier Type	Rectifier P/N	BRE 5	BRE 10	BRE 20	BRE 40	BRE 60	BRE 100	BRE 150	BRE 250	BRE 400	BRE 800	BRE 1200
208 (200-208)	105	30	GPE20L	19140230	X	X	X	X							
	105	30	PMG500	19140200					X	X	X	X	X	X	X
	105	35	GPE20L	19140230	X	X	X	X							
	105	35	PMG500	19140200					X	X	X	X	X	X	X
	180	40	GPE20L	19140230	X	X	X	X	X	X	X				
	180	40	PMG500	19140200								X	X	X	X
	105	45	GPU20L	19140090	X	X	X	X							
	105	45	PMG500	19140200					X	X	X	X	X	X	X
	105	50	GPU20L	19140090	X	X	X	X							
	105	50	PMG500	19140200					X	X	X	X	X	X	X
	180	55	GPU20L	19140090	X	X	X	X	X	X	X				
230 (220-240)	105	30	GPE20L	19140230	X	X	X	X							
	105	30	PMG500	19140200					X	X	X	X	X	X	X
	105	35	GPE20L	19140230	X	X	X	X	X	X	X				
	105	35	PMG500	19140200								X	X	X	X
	205	40	GPE20L	19140230	X	X	X	X	X	X	X				
	205	40	PMG500	19140200								X	X	X	X
	105	45	GPU20L	19140090	X	X	X	X							
	105	45	PMG500	19140200					X	X	X	X	X	X	X
	105	50	GPU20L	19140090	X	X	X	X							
	105	50	PMG500	19140200					X	X	X	X	X	X	X
	205	55	GPU20L	19140090	X	X	X	X	X	X	X				
	205	55	PMG500	19140200								X	X	X	X
332	180	30	GPE40L	19140240	X	X	X	X	X	X	X				
	180	30	PMG500	19140200								X	X	X	X
	180	35	GPE40L	19140240	X	X	X	X	X	X	X				
	180	35	PMG500	19140200								X	X	X	X
	180	45	GPU40L	19140170	X	X	X	X	X	X	X				
	180	50	GPU40L	19140170	X	X	X	X	X	X	X				
400 (380-415)	180	30	GPE40L	19140240	X	X	X	X	X	X	X				
	180	30	PMG500	19140200								X	X	X	X
	180	35	GPE40L	19140240	X	X	X	X	X	X	X				
	180	35	PMG500	19140200								X	X	X	X
	180	45	GPU20L	19140090	X	X	X	X	X	X	X				
	180	45	PMG500	19140200								X	X	X	X
	180	50	GPU20L	19140090	X	X	X	X	X	X	X				
460 (440-480)	205	30	GPE40L	19140240	X	X	X	X	X	X	X				
	205	30	PMG500	19140200								X	X	X	X
	205	35	GPE40L	19140240	X	X	X	X	X	X	X				
	205	35	PMG500	19140200								X	X	X	X
	205	45	GPU40L	19140170	X	X	X	X	X	X	X				
	205	45	PMG500	19140200								X	X	X	X
	205	50	GPU40L	19140170	X	X	X	X	X	X	X				
	205	50	PMG500	19140200								X	X	X	X



FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



DRIVESYSTEMS

RETAIN FOR FUTURE USE

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GP101A POWERED FROM MOTOR TERMINAL BLOCK FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) RECTIFIER 123456 123456 789 101112 JUMPER 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 1051 1052 1053 1054 1055 1056 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 1083 1084 1085 1086 1087 1088 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 1099 1100 1101 1102 1103 1104 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 1115 1116 1117 1118 1119 1120 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 1131 1132 1133 1134 1135 1136 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 1147 1148 1149 1150 1151 1152 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 1163 1164 1165 1166 1167 1168 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 1179 1180 1181 1182 1183 1184 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198 1199 1200 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 1211 1212 1213 1214 1215 1216 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 1227 1228 1229 1230 1231 1232 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 1243 1244 1245 1246 1247 1248 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263 1264 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 1275 1276 1277 1278 1279 1280 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291 1292 1293 1294 1295 1296 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 1307 1308 1309 1310 1311 1312 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 1323 1324 1325 1326 1327 1328 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 1343 1344 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357 1358 1359 1360 1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 1403 1404 1405 1406 1407 1408 1409 1410 1411 1412 1413 1414 1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 1425 1426 1427 1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439 1440 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 1451 1452 1453 1454 1455 1456 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 1467 1468 1469 1470 1471 1472 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 1483 1484 1485 1486 1487 1488 1489 1490 1491 1492 1493 1494</

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FAST ACTING BRAKE RECTIFIERS (GPE, GPU & PMG)



DRIVESYSTEMS

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GP103C POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 40	GP103D POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 40	GP104A SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) 45	GP104B SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) 45																																																												
LOW VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208Δ/360v</td><td>GPE20L</td><td>208 VAC</td><td>208 VAC</td><td>180 VDC</td></tr><tr><td>230Δ/400v</td><td>GPE20L</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	208Δ/360v	GPE20L	208 VAC	208 VAC	180 VDC	230Δ/400v	GPE20L	230 VAC	230 VAC	205 VDC	HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230Δ/400v</td><td>GPE20L</td><td>400 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230Δ/400v	GPE20L	400 VAC	230 VAC	205 VDC	LOW VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230v/460v</td><td>GPU20L</td><td>230 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230v/460v	GPU20L	230 VAC	230 VAC	105 VDC	HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230v/460v</td><td>GPU20L</td><td>460 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230v/460v	GPU20L	460 VAC	230 VAC	105 VDC															
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GP104C SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) 45	GP104D SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) 45	GP104E SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) NORMAL STOPPING (AC-SWITCHING) 45	GP105A SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 50																																																												
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DRIVESYSTEMS

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GP106A SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55	GP106B SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55	GP106C SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55	GP106D SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55																																								
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PMG102D POWERED FROM MOTOR TERMINAL BLOCK FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 35 LOW VOLTAGE HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>208Δ/360v</td><td>PMG500</td><td>208 VAC</td><td>208 VAC</td><td>105 VDC</td></tr><tr><td>230Δ/400v</td><td>PMG500</td><td>230 VAC</td><td>230 VAC</td><td>105 VDC</td></tr><tr><td>400Δ/690v</td><td>PMG500</td><td>400 VAC</td><td>400 VAC</td><td>180 VDC</td></tr><tr><td>460Δ/7</td><td>PMG500</td><td>460 VAC</td><td>460 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	208Δ/360v	PMG500	208 VAC	208 VAC	105 VDC	230Δ/400v	PMG500	230 VAC	230 VAC	105 VDC	400Δ/690v	PMG500	400 VAC	400 VAC	180 VDC	460Δ/7	PMG500	460 VAC	460 VAC	205 VDC	PMG102E POWERED FROM MOTOR TERMINAL BLOCK FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 35 LOW VOLTAGE HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230Δ/400v</td><td>PMG500</td><td>400 VAC</td><td>230 VAC</td><td>105 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230Δ/400v	PMG500	400 VAC	230 VAC	105 VDC	PMG103A POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 40 LOW VOLTAGE HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230v/460v</td><td>PMG500</td><td>230 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230v/460v	PMG500	230 VAC	230 VAC	205 VDC	PMG103B POWERED FROM MOTOR TERMINAL BLOCK STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 40 LOW VOLTAGE HIGH VOLTAGE MOTOR STARTER V_{motor} <table><tr><th>MOTOR</th><th>RECTIFIER</th><th>V_{motor}</th><th>V_{B-AC}</th><th>V_{B-DC}</th></tr><tr><td>230v/460v</td><td>PMG500</td><td>460 VAC</td><td>230 VAC</td><td>205 VDC</td></tr></table>	MOTOR	RECTIFIER	V_{motor}	V_{B-AC}	V_{B-DC}	230v/460v	PMG500	460 VAC	230 VAC	205 VDC
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PMG105B SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 50 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Vr/460Vr PMG500 460 VAC 230 VAC 105 VDC	PMG105C SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 50 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Vr/460Vr PMG500 460 VAC 460 VAC 205 VDC	PMG105D SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 50 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 208Δ/360Vr PMG500 208 VAC 208 VAC 105 VDC 230Δ/400Vr PMG500 230 VAC 230 VAC 105 VDC 400Δ/690Vr PMG500 400 VAC 400 VAC 180 VDC 460Δ/γ PMG500 460 VAC 460 VAC 205 VDC	PMG105E SEPERATE POWER SOURCE FAST-RELEASE (OVER EXCITATION) FAST STOPPING (DC-SWITCHING) 50 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Δ/400Vr PMG500 400 VAC 230 VAC 105 VDC
PMG106A SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Vr/460Vr PMG500 230 VAC 230 VAC 205 VDC	PMG106B SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Vr/460Vr PMG500 460 VAC 230 VAC 205 VDC	PMG106C SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 208Δ/360Vr PMG500 208 VAC 208 VAC 180 VDC 230Δ/400Vr PMG500 230 VAC 230 VAC 205 VDC	PMG106D SEPERATE POWER SOURCE STANDARD RELEASE VERY FAST STOPPING (DC-SWITCHING + REDUCED POWER HOLDING) 55 MOTOR RECTIFIER V_{motor} V_{B-AC} V_{B-DC} 230Δ/400Vr PMG500 400 VAC 230 VAC 205 VDC

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CURRENT SENSING BRAKE RELAY (IR) INSTALLATION & MAINTENANCE



DRIVESYSTEMS

RETAIN FOR FUTURE USE

U35200 - 1 of 3

Motor Current Sensing Brake Relay (IR)

The current sensing relay, normally called the IR option, is used to achieve improved brake engagement or stopping time without the use of external control equipment or additional wiring. The relay is mounted directly onto the motor terminal box. The relay switch leads are connected to terminals 3 and 4 of the rectifier. When the power to the motor is shut off, the IR relay opens the brake circuit on the DC side; this allows the brake to demagnetize quickly.



WARNING



- Motor must be powered across-the-line (not inverter powered or controlled with a soft-start)
- The brake power must be provided from the motor's terminal block (not separately powered)
- Motor must be a single-speed (not possible with two-speed motors)

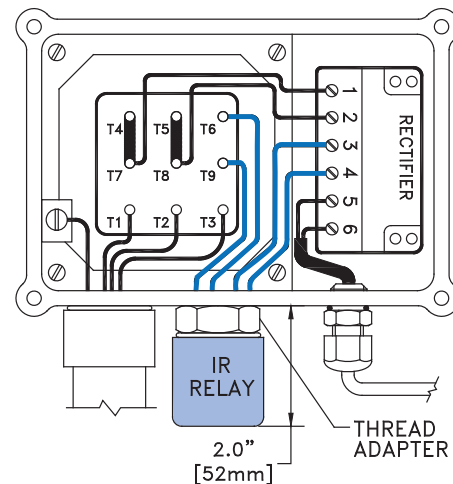
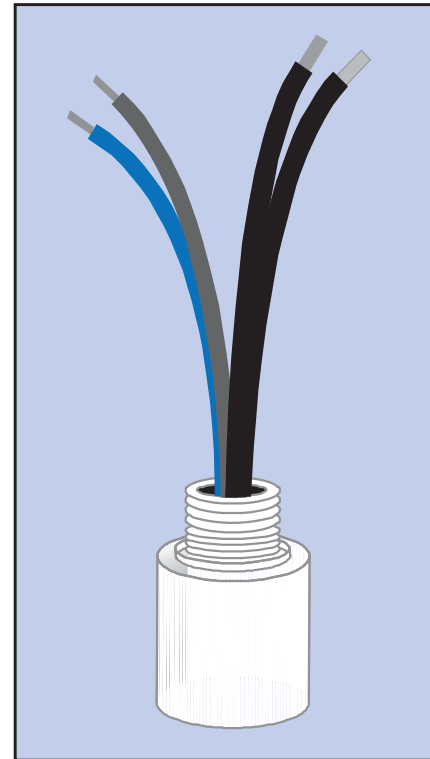
Ratings

Part Number	18556010	18556020
Motor Frame Sizes	63S – 180M*	180L – 225M
Maximum Cycles per hour	500	500
Switching Voltage	42-550V _{DC}	42-550V _{DC}
AC input current – black/white wires	25 A _{AC} - 75A _{AC} – 0.2 s	50 A _{AC} - 75A _{AC} – 0.2s
DC brake current – red and blue wires	1.0 A _{DC}	1.0 A _{DC}
Holding Current	0.7 A _{AC}	0.7 A _{AC}
Additional brake setting delay	18 ms	18 ms
Ambient temperature	- 25 to 90 °C - 40 to 167 °F	- 25 to 90 °C - 40 to 167 °F
Enclosure with o-ring mounted to a terminal box	IP65	IP65

* For the 180MX/4, 230/460V motor use part number 18556020

Connection Notes

Rectifier			IR Relay Wires To Rectifiers	
Type	Part Number	Design	Red	Blue
GVE20L	19141000	Full-Wave	3	4
GHE40L	19141010	Half-Wave	4	3
GHE50L	19141020	Half Wave	4	3
GPE20L	19140230	Push-Hybrid	4	3
GPE40L	19140240	Push-Hybrid	4	3



Conduit Box Thread Adapter

Thread	Motor Frame	Part number
M20	63-71	18542006*
M25	80-90	18522253
M32	100-132	18522320
M40	160-180	18522400 + 18522253

* Spacer

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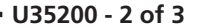
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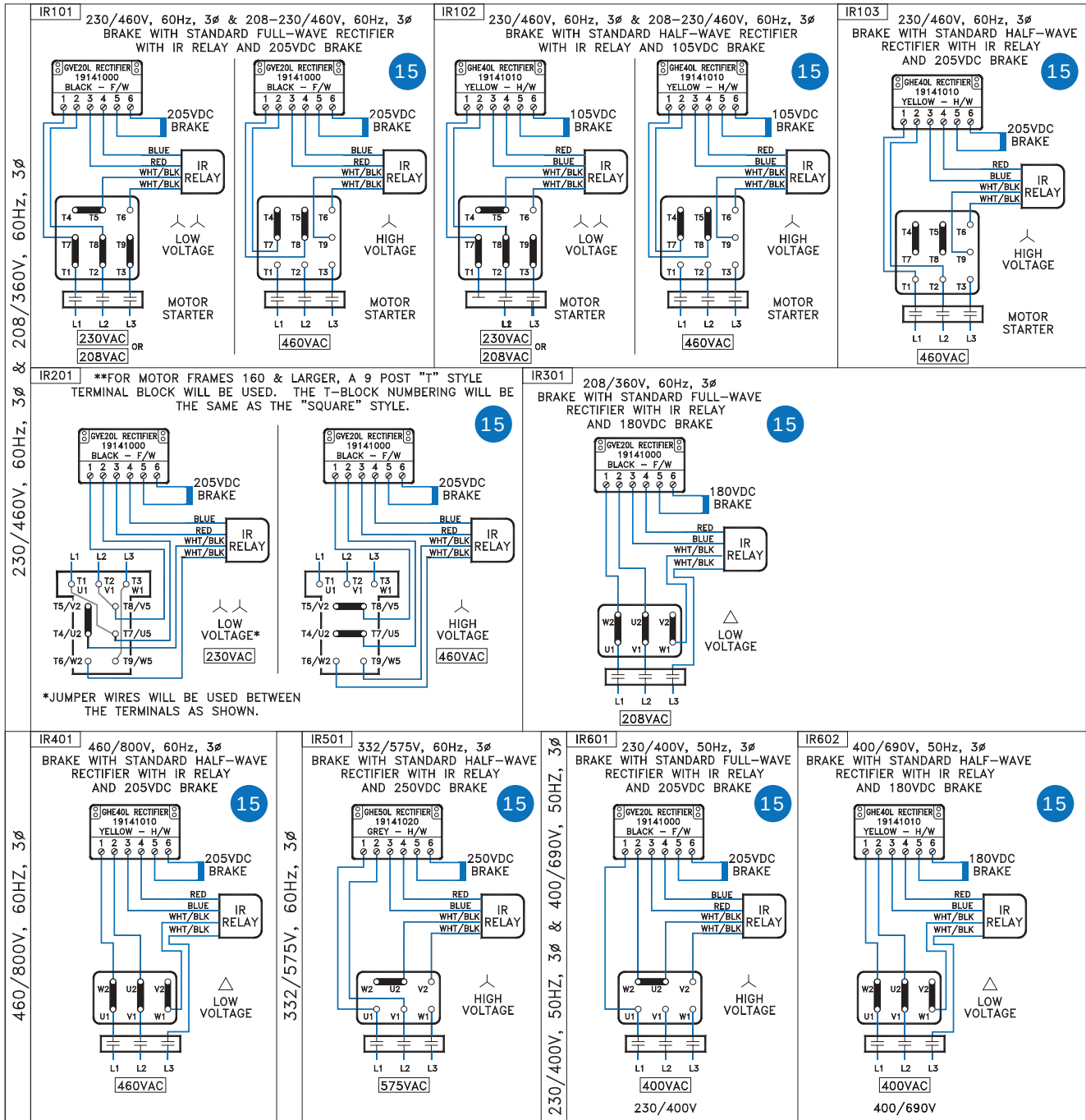


CURRENT SENSING BRAKE RELAY (IR) INSTALLATION & MAINTENANCE



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Connection Diagrams





DRIVESYSTEMS

CURRENT SENSING BRAKE RELAY (IR) INSTALLATION & MAINTENANCE



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Connection Diagrams GPE Rectifier with IR Relay used for External DC-Switching

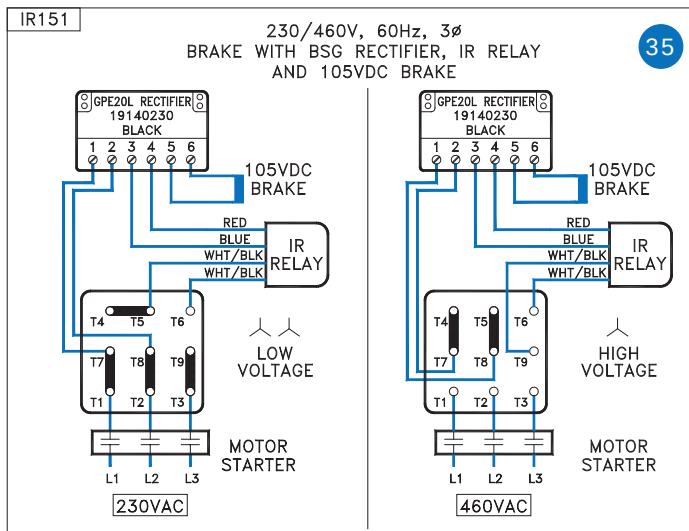
Method Operation

Start - Fast release (Overexcitation)

Stop - Fast stop (DC-Switching)

GPE type - External DC-Switching

Terminal 3 & 4 - Contact or IR-relay



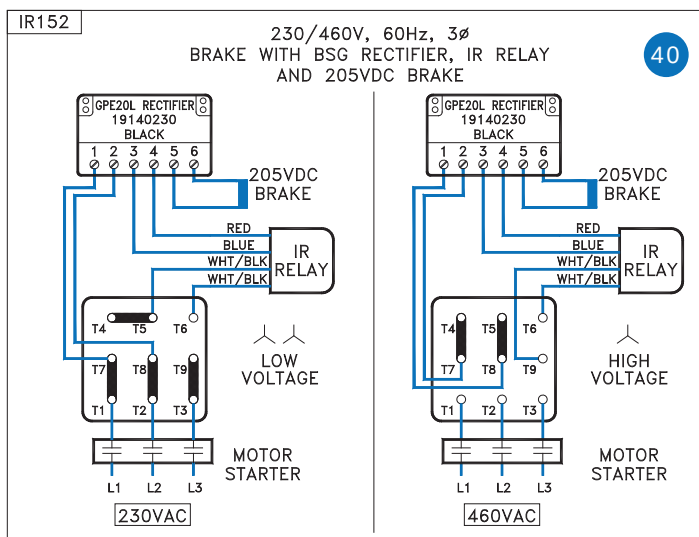
Method Operation

Start - Standard Release

Stop - Very Fast stop (Reduced power Hold)

GPE type - External DC-Switching

Terminal 3 & 4 - Contact or IR-relay



Additional Reference - U _____ GP Brake Rectifier Installation and Maintenance

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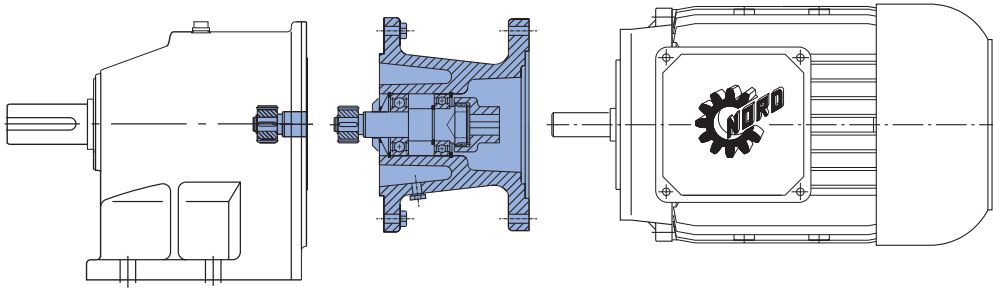
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WARNING



LOCK OUT POWER before any maintenance is performed. Make absolutely sure that no voltage is applied while work is being done on the gearbox or input.

NEMA/ IEC Motor Adapters

Motor adapters allow for easy installation and removal of industry standard motors. Motor adapters consist of a coupling and an adapter housing that connects the motor to the gear reducer.

NORD Gear supplies a coupling that is to be mounted on the motor shaft. It is important that the coupling is properly positioned.

- For NEMA Input Adapters, follow the Motor Installation Instructions on pages 3-4.
- For IEC Input Adapters, the supplied coupling will mount directly against the motor shaft shoulder. No locating measurements need to be taken.



NOTE



Some of the larger IEC inputs will have a coupling spacer included to help locate the coupling. Slide the spacer against the motor shaft shoulder, slide the coupling against the spacer and tighten set screw(s).



NOTE



For the larger motor adapters (IEC160 / N250TC and larger), an Automatic Lubricator is supplied. This will need to be activated at the time of startup. For operation and activation instructions, refer to user manual U45200.

NEMA/IEC Motor Weight Limits

When mounting a motor to a NORD NEMA C-face motor adapter it is important to consider the motor's weight. Following is a table that includes the maximum motor weight the NEMA adapter can support. If the motor exceeds the listed weight it must be externally supported. When a C-face mounted motor is externally supported care must be taken to ensure that the support system does not impose additional pre-loads on the NEMA motor adapter.

NEMA Motor Weight Limit

Motor FRAME	56C	143TC	145TC	182TC	184TC	210TC
Max Weight [lb]	66	88	110	130	175	220
Motor FRAME	250TC	280TC	324TC	326TC	365TC	
Max Weight [lb]	440	550	770	1100	1540	

IEC Motor Weight Limit

Motor FRAME	63	71	80	90	100	112
Max Weight [lb]	55	66	88	110	130	175
Motor FRAME	132	160	180	200	225	250
Max Weight [lb]	220	440	550	770	1100	1540

Couplings

Couplings are made with tough abrasion resistant materials, which resist most chemicals and petroleum products. They are electrically isolated (prevent metal to metal contact) and require no lubrication or maintenance. Depending upon the size of the C-face input, NORD provides either a gear or a jaw type coupling.

NORD supplies three different types of couplings depending on the size of input: "J" style, "M" style and "Jaw" style coupling. Following are instructions on how to properly mount each type of coupling onto the motor.



NEMA/IEC INPUT ADAPTERS & THEIR COUPLINGS



DRIVESYSTEMS

RETAIN FOR FUTURE USE

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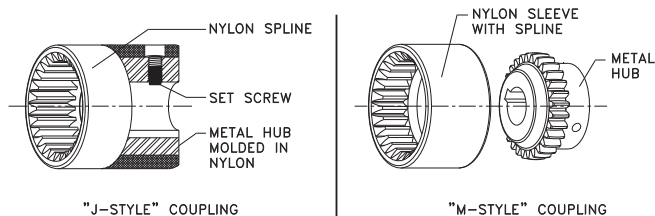
Couplings for the NEMA and IEC Adapters

Depending on the size of the input adapter to the gearbox, NORD Gear supplies two styles of couplings - BoWex® (gear tooth) and Rotex® (jaw) couplings.

BoWex® Couplings

NORD C-face adapter input shafts have a machined spline on the end. NORD incorporates two styles of BoWex® couplings, the "J" and "M" styles. The "J" style is a one-piece coupling with a metal hub and nylon spline. The "M" style is a two-piece coupling – the metal hub and a nylon sleeve. Nylon and steel components allow them to operate in high ambient temperatures without lubrication or maintenance.

- Nylon sleeves resist dirt, moisture, most chemicals and petroleum products
- No lubrication required
- Operating Conditions: -22°F - 212°F (-30°C - 100°C)
- Higher temperature coupling sleeve available up to 250°F (120°C)
- Special bore available



BoWex® Couplings Mechanical Ratings "J" Style

Coupling Type	Available Bore Sizes	Cont. / Peak Torque	Input
J14	11 mm, 14 mm 5/8 in	10/20 Nm 89/117 lb-in	IEC 63, 71 NEMA 56C
J24	19 mm, 24 mm 5/8 in, 7/8 in	20/40 Nm 117/354 lb-in	IEC 80, 90 NEMA 56C, 140TC
J28	28 mm 1-1/8 in	45-90 Nm 399/797 lb-in	IEC 100-112 NEMA 180TC

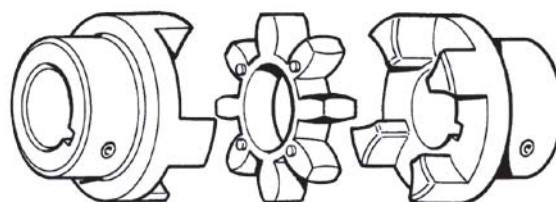
BoWex® Couplings Mechanical Ratings "M" Style

Coupling Type	Available Bore Sizes	Cont. / Peak Torque	Input
M14, M24, M28	Same as "J" Style	Same as "J" Style	Same as "J" Style
M38	38 mm 1-1/8 in, 1-3/8 in	80/160 Nm 708/1,416 lb-in	IEC 132 NEMA 180TC, 210TC
M42	42 mm 1-5/8 in	100/200 Nm 885/1,770 lb-in	IEC 160 NEMA 250TC
M48	48 mm 1-7/8 in	140/280 Nm 1,240/2,478 lb-in	IEC 180 NEMA 280TC

Rotex® Couplings

The cast iron jaw type couplings have an integral urethane "spider" that provides smooth transmission of the motor torque. A set screw on the coupling prohibits axial movement along the motor shaft.

- Excellent shock and vibration dampening
- Excellent resistance to oils and most chemicals
- No metal-to-metal contact
- Operating Conditions: -22°F - 195°F (-30°C - 90°C)
- Higher temperature material (Hytrel) spider available up to 230°F (110°C)
- Low temperature materials available upon request
- Special bores available



Rotex® Couplings Mechanical Ratings

Coupling Type	Available Bore Sizes	Cont. / Peak Torque	Input	Spider
R19	14 mm 19 mm	17/34 Nm 150/300 lb-in	SEK/SEP 100	Urethane 98 Shore A Hardness Color: Red
R24	19 mm 24 mm	60/120 Nm 530/1,060 lb-in	SEK/SEP 100 SEK/SEP 130	
R28	32 mm 38 mm	95/190 Nm 840/1,680 lb-in	SEK/SEP 65 SEK/SEP 215	Urethane 92 Shore A Hardness Color: Yellow
R38	1.89" (48 mm) Max Bore	190/382 Nm 1,680/3,380 lb-in	-	
R42	2.44" (62 mm) Max Bore	310/620 Nm 2,740/5,480 lb-in	-	
R48	42, 48 mm 1-5/8, 1 7/8 in	310/620 Nm 2,740/5,480 lb-in	IEC 160, 180 NEMA 250T NEMA 280T SEK/SEP 300 SEK/SEP 215	
R65	60 mm 2-1/8, 2-3/8 in	625/1,250 Nm 5,530/11,060 lb-in	IEC 225 NEMA 320T NEMA 360T	
R90	65, 75, 80 mm 2-1/8, 2-3/8 in	2,400/4,800 Nm 24,240/42,480 lb-in	IEC 250, 280 IEC 315 NEMA 360TC NEMA 400TS NEMA 440TS	

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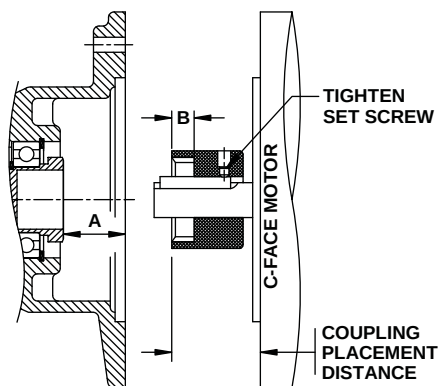


NEMA/IEC INPUT ADAPTERS & THEIR COUPLINGS



"J" Style Coupling NEMA C-face Motor Installation

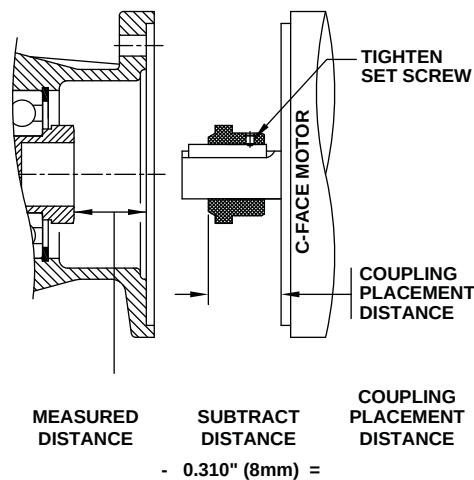
1. Measure the distance from the face of the input adapter to the face of the splined shaft and record that measurement as "A" in the equation below.
2. Measure depth of coupling engagement zone and record the measurement as "B" in the equation below.
3. Add "A" + "B" and subtract 0.08" (~2mm) from the distance. This needs to be done so that the coupling will not be preloaded after installation!
4. Use that measurement to locate the coupling from the face of the motor onto the shaft.
5. Once in place, tighten the set screw to lock the coupling in place. It is recommended that the key is staked or bonded (Loctite) in place to prohibit the key from vibrating out.
6. Mount the motor onto the input adapter with customer supplied bolts. Make sure that the coupling from the adapter and the motor engage securely. Use lock washers or Loctite to prohibit bolts from becoming loose from vibration.



MEASURED DISTANCES		SUBTRACT DISTANCE		COUPLING PLACEMENT DISTANCE
A + B		- 0.080" (2mm)	=	
_____	+	_____		_____

"M" Style Coupling NEMA C-face Motor Installation

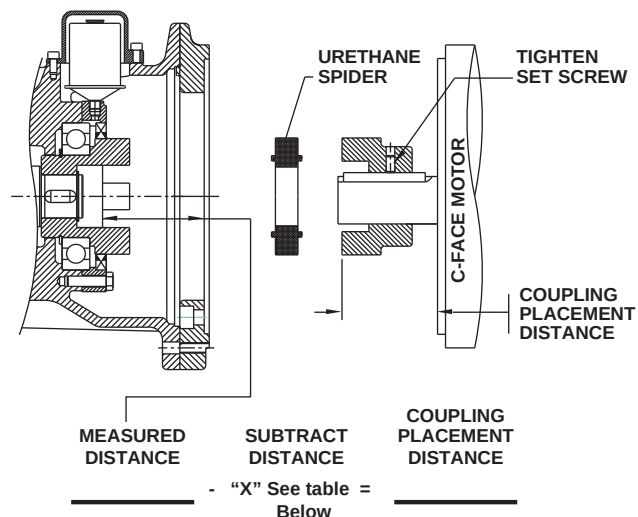
1. Measure the distance from the face of the input adapter to the face of the splined shaft & record that measurement.
2. Subtract 0.31" (~8mm) from the distance. This needs to be done so that the coupling will not be preloaded after installation!
3. Use that measurement to locate the coupling from the face of the motor onto the shaft.
4. Once in place, tighten the set screw to lock the coupling in place. It is recommended that the key is staked or bonded (Loctite) in place to prohibit the key from vibrating out.
5. Mount the motor onto the input adapter with customer supplied bolts. Make sure that the coupling from the adapter and the motor engage securely. Use lock washers or Loctite to prohibit bolts from becoming loose from vibration.



MEASURED DISTANCE		SUBTRACT DISTANCE		COUPLING PLACEMENT DISTANCE
_____	-	0.310" (8mm)	=	_____

"Jaw" Style Coupling NEMA C-face Installation

1. Measure the distance from the face of the input adapter to the face of the coupling as shown and record that measurement.
2. Subtract the "X" dimension from the measured distance. This needs to be done so that the coupling will not be preloaded after installation!
3. Use that measurement to locate the coupling from the face of the motor onto the shaft.
4. The metal portion of the coupling should be heated up prior to assembly, generally 250°F to 300°F (120°C to 150°C).




WARNING


DO NOT HEAT THE URETHANE SPIDER.

5. Once in place, tighten the setscrew to lock coupling in place. Let the coupling cool down before placing the spider into the jaws. It is recommended that the key is staked or bonded (Loctite) in place to prohibit the key from vibrating out.
6. Mount the motor onto the input adapter with customer supplied bolts. Make sure that the coupling from the adapter and the motor engage securely. Use lock washers or Loctite to prohibit bolts from becoming loose from vibration.

Coupling Size	"X" (Subtract this value from measured distance)
R14	0.06" (1.5 mm)
R19 & R24	0.08" (2.0 mm)
R28	0.10" (2.5 mm)
R38 & 42	0.12" (3.0 mm)
R48	0.14" (3.5 mm)
R65	0.18" (4.5 mm)
R90	0.22" (5.5 mm)



DRIVESYSTEMS

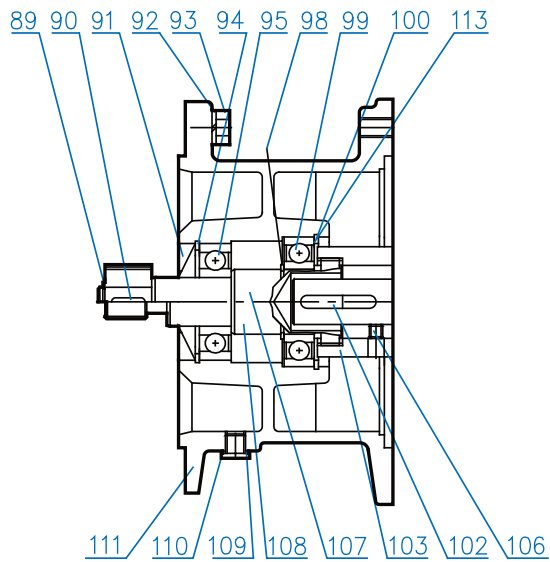
NEMA/IEC INPUT ADAPTERS & THEIR COUPLINGS



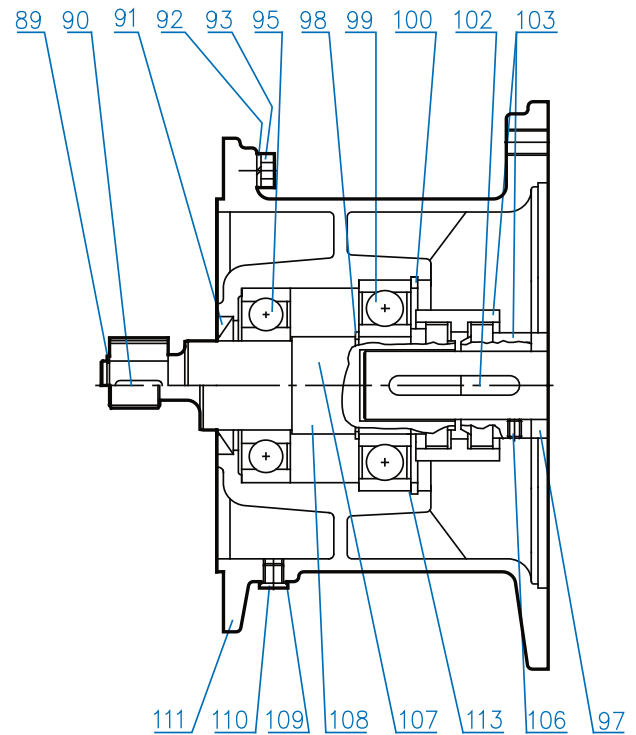
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NEMA/IEC Parts List for UNICASE Gearboxes

NEMA 56C - 180TC



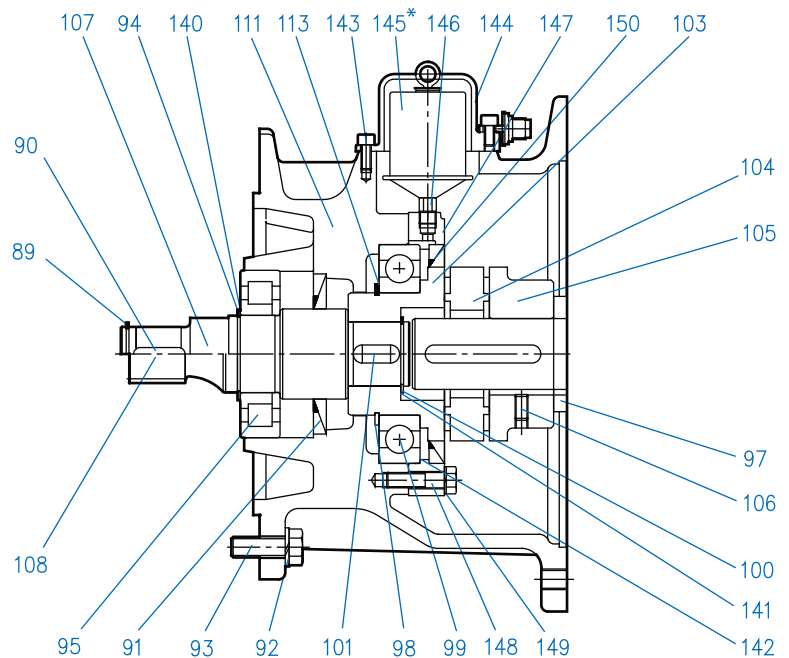
NEMA 180TC - 280TC



- 89 Circlip
- 90 Key
- 91 Shaft Seal
- 92 Washer
- 93 Hexagon Screw
- 94 Circlip
- 95 Clutch Shaft Bearing
- 97 Space
- 98 Circlip
- 99 Clutch Shaft Bearing
- 100 Circlip
- 101 Key
- 102 Key
- 103 Coupling
- 104 Coupling
- 105 Coupling
- 106 Set Screw
- 107 Clutch Shaft
- 108 Clutch Pinion Shaft
- 109 Seal
- 110 Oil-Plug
- 111 NEMA / IEC Adapter
- 112 Oil Flinger
- 113 Shim
- 140 Shim
- 141 Shim
- 142 Shim
- 143 Socket Head Screw
- 144 Cover
- 145 Automatic Lubricator*
- 146 Adapter
- 147 Bearing Cover
- 148 Hexagon Screw
- 149 Washer
- 150 Shaft Seal

* Please see U45250 for automatic lubricator Instructions.

NEMA 250TC - 400TC IEC 160 - IEC 315



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NEMA/IEC INPUT ADAPTERS & THEIR COUPLINGS



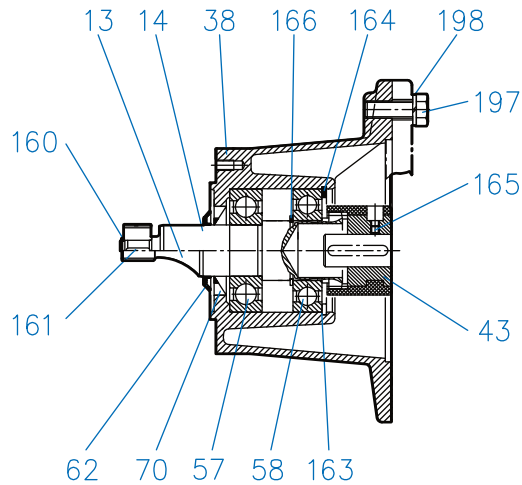
DRIVESYSTEMS

RETAIN FOR FUTURE USE

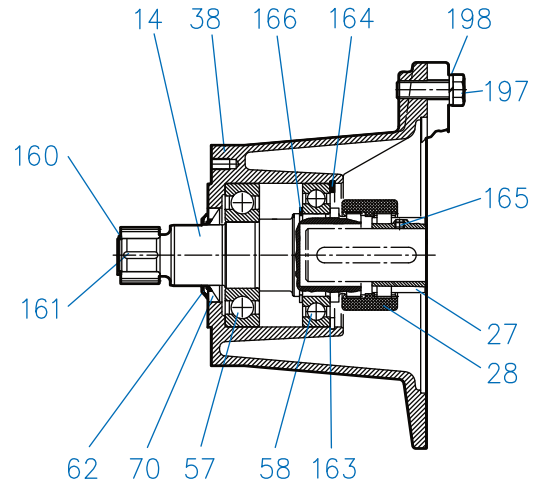
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NEMA/IEC Parts List for Nordbloc Gearboxes

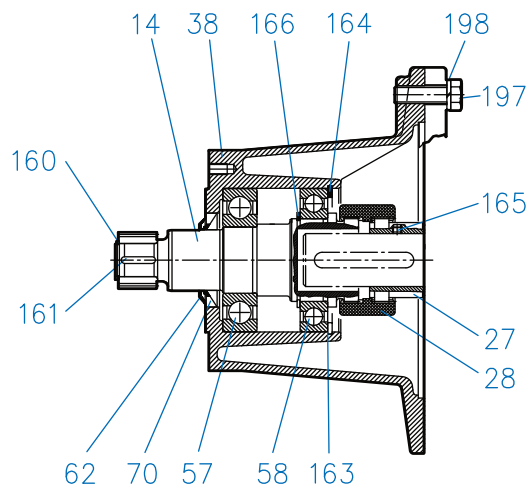
NEMA 56C - 180TC IEC 63 - IEC 112



NEMA 210TC - 280TC IEC 132-IEC 180



IEC 200



13	Clutch Pinion Shaft
14	Clutch Shaft
26	Coupling
27	Coupling
28	Coupling
38	IEC Adapter
43	Coupling
57	Clutch Shaft Bearing
58	Clutch Shaft Bearing
62	Oil Flinger
70	Shaft Seal
101	Key
160	Snap Ring
161	Key
163	Shim
164	Snap Ring
165	Set Screw
166	Snap Ring
197	Bolt
198	Spring Washer

Automatic Lubricator

Some NORD gear units with NEMA 250TC or IEC 160 and larger input adapters, have a PERMA® Classic automatic lubricator supplied to help dispense grease to the outboard bearing.

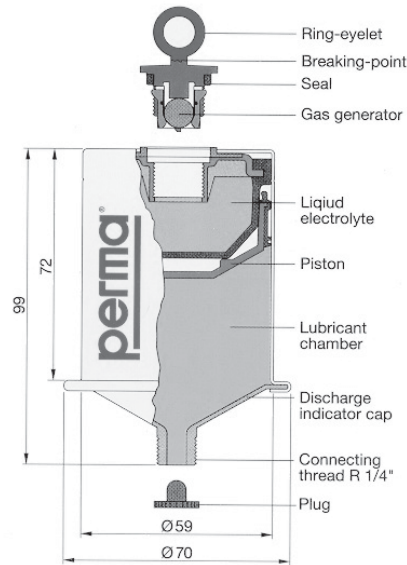
Helical Inline	SK62, SK72, SK73, SK82, SK83, SK92, SK93, SK102 and SK103
Parallel-Shaft Clincher™	SK6282, SK7282, SK7382 SK8282, SK8382, SK9282, SK9382, SK10282, SK10382, SK11282, SK11382, and SK12382
90.1 Series Helical-Bevel	SK9072.1, SK9082.1, SK9086.1, SK9092.1, and SK9096.1

Principle of Operation

The activation screw is secured into the top of the lubrication canister and tightened until the ring-eyellet reaches its breaking point. A zinc-molybdenum gas generator drops into a citric acid liquid electrolyte, that is contained within an elastic bladder. The gas generator starts an electrochemical reaction which gradually pressurizes the bladder by releasing hydrogen gas in very small amounts. The gas creates enough pressure (up to 4 bar or 58 psi) to expand the bladder and push the piston and the lubricant forward.

Lubricant is continuously injected into the lubrication point until the bearing cavity is full. Any back pressure from the bearing will cause the system to neutralize. The bladder inside the canister will continue to slowly build pressure so that once the equipment resumes normal operation, the lubricator will also resume its normal function. After 12 months of operation the PERMA® canister must be replaced.

The lubricator contains approximately 120 cm³ or 120 ml (4.8 oz) of grease. For reference, a single stroke of a typical grease gun delivers approximately 1.0-1.2 cm³ (0.03-0.04 oz) of grease. This means the canister contains approximately 100 strokes of grease. At the end of the lubrication period, the discharge indicator cap or piston becomes clearly visible through the clear nylon discharge indicator cap which is located at the bottom of the PERMA® canister; this helps indicate that the lubricant has been fully discharged.



HARMFUL SITUATION



- To prevent premature bearing failure, the lubrication dispenser must be activated prior to commissioning the gear reducer.
- The lubricator must only be used once and should never be opened or taken apart or permanent damage will result.
- Never unscrew the PERMA® canister from the lubrication point after activation or during the discharge period. This would cause a permanent pressure loss in the lubricator and would justify replacing the lubricator.



WARNING



- Avoid swallowing the gas generator, the liquid electrolyte, and the lubricant.
- Avoid contact of, the liquid electrolyte, and the lubricant with the eyes, skin or clothing.
- Observe all applicable MSDS sheets.
- Follow applicable local laws and regulations concerning waste disposal.

PERMA® Classic – Options Supplied by NORD

NORD Part Number	28301000	28301010
Lubrication Option	Synthetic (standard)	Food Grade (optional)
PERMA® Classic Temperature Range ♦	0 to 40 °C (32 to 104 °F)	0 to 40 °C (32 to 104 °F)
Lubrication Volume	120 cm ³ or 120 ml (4.8 oz)	120 cm ³ or 120 ml (4.8 oz)
Grease Lubrication Mfg. / Type	Klüber / Petamo GHY 133	Lubriplate / FGL1
Lubrication Temperature Range ♦	-30 to 120 °C (-22 to 248 °F)	-18 to 120 °C (0 to 248 °F)

♦ The temperature range values shown do not apply to other components and/or lubricants within the gear reducer.

The lubricator contents will dispense for a 12 month period when the average temperature is 20 °C (68 °F).

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Temperature Influences Discharge Rate

Discharge rate is based upon an ambient temperature of 20 °C (68 °F). The gray activating screw supplied by PERMA indicates that the lubricator contents will dispense for a 12 month period when the average temperature is 20 °C (68 °F).

- Lower ambient temperatures will lead to slower dispensing rates and higher ambient temperatures will lead to faster dispensing rates.
- Dispensing rates depend primarily on average ambient conditions and not extreme highs and lows.
- Discharge can also be influenced by type of lubricant, vibration, and the connecting parts and values shown are approximate, based upon supplier testing completed.

Average Ambient Temperature	Discharge Period Months ♦
0 °C (32 °F)	>18
10 °C (50 °F)	18
20 °C (68 °F)	12
30 °C (86 °F)	6
40 °C (104 °F)	3

♦ Values are approximate.

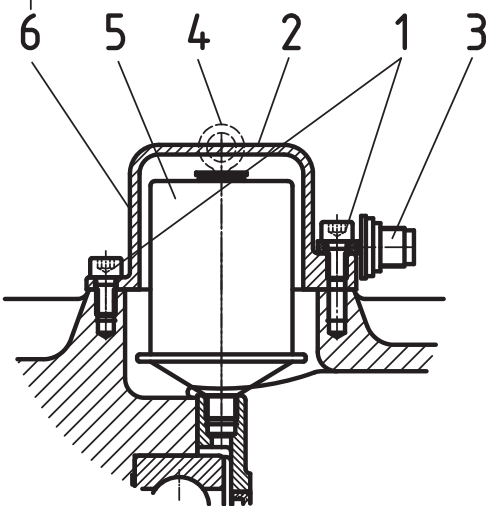
Attention!

Screw in the activation screw until the lug breaks off before commissioning the gear unit.

Dispensing time: 12 Months

Activation Date

Month	Year
1 2 3 4 5 6 7 8 9 10 11 12	11 12 13 14 15



Initial Assembly Instructions

When first receiving the gear unit with motor adapter, the automatic lubricator is installed as shown in the figure below.

1. Loosen and remove the M8 x 16 socket head cap screws (1) and the protective cartridge case cover (2).
2. Insert the gray colored activation screw (3) into the lubrication dispenser (5) and tighten securely by hand.
3. Put a suitable tool through the ring-eyelet (4) and use it to turn the activator screw until the eyelet breaks off. The lubricator is now activated.
4. Refit the protective cartridge case cover (2) and tighten the M18 x 16 socket head screws.
5. Mark the activation date indicating on the reddish-orange adhesive label (6) by indicating the month and year.
6. Take note of the activation date and replace the canister again in twelve months.

Replacement Assembly Instructions

1. Loosen and remove the M8 x 16 socket head cap screws (1) and the protective cartridge case cover (2).
2. Remove the expired or old PERMA® canister from the bearing housing.
3. Remove the protective shipping plug from the thread-end of the New PERMA® canister.
4. Screw the canister into the reducer bearing housing by hand until it is snug and secure. Do not over tighten or the plastic threads on the canister can become damaged!
5. Put a suitable tool through the ring-eyelet (4) and use it to turn the activator screw until the eyelet breaks off. The lubricator is now activated.
6. Refit the protective cartridge case cover (2), tighten the M18 x 16 socket head screws (1)
7. Take note of the activation date and replace the canister again in twelve months.



NEMA OR IEC INPUT ADAPTER WITH GREASE FITTING



DRIVESYSTEMS

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Application

NORD gear units listed in the table below that are supplied with a NEMA 250TC or IEC 160 and larger input adapter, may be supplied with an external grease fitting. The grease fitting allows the user to service the outboard bearing of the reducer's input assembly

Helical Inline	SK62, SK72, SK73, SK82, SK83, SK92, SK93, SK102 and SK103
Parallel-Shaft CLINCHER™	SK6282, SK7282, SK7382, SK8282, SK8382, SK9282, SK9382, SK10282, SK10382, SK11282, SK11382 & SK12382
90.1 Series Helical-Bevel	SK9072.1, SK9082.1, SK9086.1, SK9092.1 & SK9096.1

The grease fitting is an option which must be specified upon ordering, otherwise NORD will normally supply a PERMA Automatic Lubricator (See User Manual U45250).

Factory Supplied Grease

The bearing grease applied at the factory is as follows:

Brand	Mobil Polyrex EP 2
Thickener	Polyurea
NLGI Grade	2
Temperature Range	40°C to 120°C (-40°F to 250°F)



IMPORTANT NOTE



It is the user's responsibility to ensure that if replacement grease is used, that it is fully compatible with the factory supplied grease.

Service Instructions



WARNING



- While working on the gear drive system, make sure the power from the prime mover is isolated or secured on "lock-out" to prevent accidental start-up and to safeguard against injury!
- Surfaces of motors and gear units may become hot during operation or shortly after start-up. In some instances additional protection against accidental contact may be necessary. Use caution to avoid burns or serious injury!

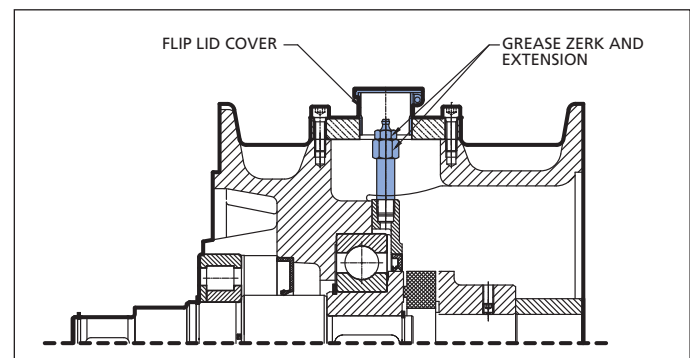
1. It is best to re-grease the bearing within a short period after the gear unit was operational because the old grease will be more viscous and will flow easier.
2. Ensure that the grease gun contains the right lubricant for the bearing to be re-greased.
3. Open the protective flip cover and clean the areas around the grease fitting to ensure that contaminants are not introduced into the bearing cavity.
4. Using a grease gun, apply 0.75 ounces (20-25 grams) of compatible bearing grease every 1,000 service hours.



IMPORTANT NOTE

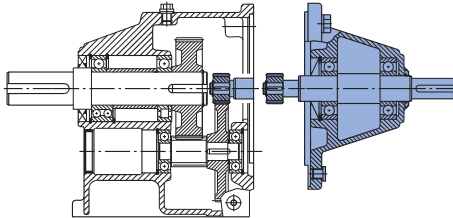


Re-greasing should be carried out while the bearing is still warm from operation and/or while rotating (if it is safe).



1. Solid Input Shaft (W)

The shaft will be inch or metric, depending on how the unit was ordered. Measure and verify the shaft before mounting anything on the shaft. Below are the tolerances used for the solid shafts.



2. Solid shaft diameter tolerance

Reducer input shaft extensions have a diameter tolerance as specified in Table 1.

Table 1: Solid Shaft Diameter Tolerance

Above ø (in)	To & Including ø (in)	Tolerance (in)	
0.375	1.750	+0.0000 / -0.0005	
1.750	2.750	+0.0000 / -0.0010	

Above ø (mm)	To & Including ø (mm)	Tolerance (mm)	ISO 286-2 Fit Class
10	18	+0.012 / +0.001	k6
18	30	+0.015 / +0.002	k6
30	50	+0.018 / +0.002	k6
50	70	+0.030 / +0.011	m6

3. Fitting drive elements onto the reducer solid shaft

Solid input shaft extensions are provided with a drill and tap feature as indicated in Table 2. When installing drive elements such as coupling hubs, pulleys, sprockets, or gears, NORD recommends using the threaded hole in the end of the shaft, along with a suitable assembly device fitted into the threaded hole.

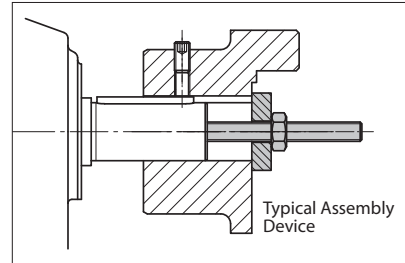


Table 2: Solid Input Shaft End - Threaded Holes

Above ø (in)	To & Including ø (in)	Tap size & Depth (in)
0.375	0.500	10-24 x 0.43 in
0.500	0.875	1/4-20 x 0.59 in
0.875	0.938	5/16-18 x 0.71 in
0.938	1.100	3/8-16 x 0.87 in
1.100	1.300	1/2-13 x 1.10 in
1.300	1.875	5/8-11 x 1.42 in
1.875	2.750	3/4-10 x 1.73 in

Above ø (mm)	To & Including ø (mm)	Tap Size & Depth (mm)
10	13	M4 x 10 mm
13	16	M5 x 12.5 mm
16	21	M6 x 16 mm
21	24	M8 x 19 mm
24	30	M10 x 22 mm
30	38	M12 x 28 mm
38	50	M16 x 36 mm
50	70	M20 x 42 mm



HARMFUL SITUATION



DO NOT DRIVE or **HAMMER** the coupling hub, pulley, sprocket, or gear into place. An endwise blow to the reducer shaft can generate damaging axial forces and cause damage to the reducer housing, bearings or internal components.



WARNING



To avoid serious injury the user must provide suitable safety guards for all rotating shafts and shaft components such as couplings, chain drives, belt drives, etc. All guarding must adhere to local regulations and safety standards.

4. Installing interference-fit hubs to the reducer shaft

Prior to installing any interference-fit hubs to the reducer shaft, consult with the manufacturer to determine proper assembly and fit. Interference-fits usually require heating the coupling, sprocket or gear hub, per the manufacturer's recommendations. Coupling hub installation typically follows ANSI/AGMA 9002-A86. Always make sure the reducer shaft seals are protected from the heat source. Apply uniform heat to the drive element hub to prevent distortion. NORD does not recommend heating the drive element hub beyond 212°F to 275°F (100°C to 135° C).

⚠	WARNING	⚠
When using heat to mount a drive element hub, do not use open flame in a combustible atmosphere or near flammable materials. Use suitable protection to avoid burns or serious injury.		

STOP	HARMFUL SITUATION	STOP
When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close to the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tighten the belts or chains.		

5. Coupling installation

The performance and life of any coupling depends upon how well it is installed. Coupling hubs are typically mounted flush with the shaft ends, unless specifically ordered for overhung mounting. Shaft couplings should be installed according to the coupling manufacturer's recommendations for gap, angular and parallel alignment. To help obtain critical shaft alignment coupling hubs may be installed to the machine shafts prior to final shimming or tightening of the foundation bolts. Proper coupling alignment allows for thermal and mechanical shaft movement during operation and ensures that only torque (no radial load) is transmitted between the mating shafts.

Coupling gap and angular alignment

The shaft gap must be sufficient to accommodate any anticipated thermal or mechanical axial movement. When setting the coupling gap, insert a spacer or shim stock equal to the required spacing or gap between the coupling hub faces. Measure the clearance using feeler gauges at 90-degree intervals, to verify the angular alignment.

Parallel (or offset) alignment

Mount a dial indicator to one coupling hub, and rotate this hub, sweeping the outside diameter of the other hub. The parallel or offset misalignment is equal to one-half of the total indicator reading. Another method is to rest a straight edge squarely on the outside diameter of the hubs at 90° intervals and measure any gaps with feeler gauges. The maximum gap measurement is the parallel or offset misalignment.

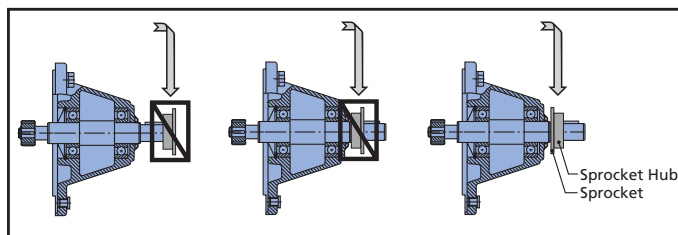
Check alignment

After both angular and parallel alignments are within specified limits, tighten all foundation bolts securely and re-check critical alignment. If any of the specified limits for alignment are exceeded, realign the coupling.

6. Installing sheaves (pulleys), sprockets and gears

To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, gears, etc.) so that the applied load center is as close to the gear housing as possible, as shown in **Figure 2**.

Figure 2: Pulley or Sprocket Mounting



Align the driver sheave or sprocket with the driven sheave or sprocket by placing a straight-edge length-wise across the face of the sheaves or sprockets. Alignment of bushed sheaves and sprockets should be checked only after bushings have been tightened. Check horizontal shaft alignment by placing one leg of a square or a level vertically against the face of the sheave or sprocket.

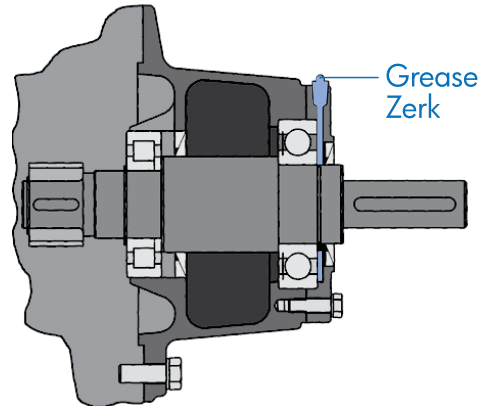
Always check component alignment and tension any belts or chains per the manufacturer's recommendation. The ideal belt or chain tension allows proper wrap of the driver and driven wheels, while maintaining the lowest possible tension of the belts or chain, so that no slipping occurs under load conditions. Check belt or chain tension frequently over the first 24 to 48 hours of operation.

STOP	HARMFUL SITUATION	STOP
When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close to the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tension the belts or chains.		

7. Service Guidelines for W-Shaft Input with Grease Fitting

On some solid shaft input (Type W) gear units, the outer roller bearing needs to be re-greased at regular service intervals. This is necessary for double-stage gearboxes sizes SK62 or SK6282 and larger, and triple-stage gearboxes from size SK73, SK7382 or SK9072.1 and larger.

To lubricate the bearing of the input shaft, approximately 0.75 to 1.0 ounces (20-25 grams) grease should be added by the grease fitting approximately after every 2,500 hours of service or at least every 6 months. The W-shaft input is factory assembled with the proper amount and type of grease. The type of grease supplied depends upon the type of oil specified at time of order.



Reducer Oil Type	Grease Type/Thickener	NLGI Grade	Ambient Temperature Range	Manufacturer Brand/Type
Mineral	Standard (Li-Complex)	NLGI 2	-30 to 60°C (-22 to 140°F)	Mobil Grease XHP222
Synthetic	High Temp (Polyurea)	NLGI 2	-40 to 80°C (-40 to 176°F)	Mobil / Polyrex EP 2
Food-Grade	Food-Grade (Polyurea)	NLGI 2	-30 to 40°C (-22 to 104°F)	Mobil SHC Polyrex 222



HARMFUL SITUATION



Grease compatibility depends upon the type of thickener or soap complex used, the base oil type suspended within the thickener, and the type of additives used. The user should check with the lubrication supplier before making substitutions in brand and type in order to assure compatibility and to avoid causing damage to the extended bearing.

W-Type Input Parts List for UNICASE Gearboxes

SK 02 - SK 52
SK 03 - SK 63

SK 0182NB - SK 6382

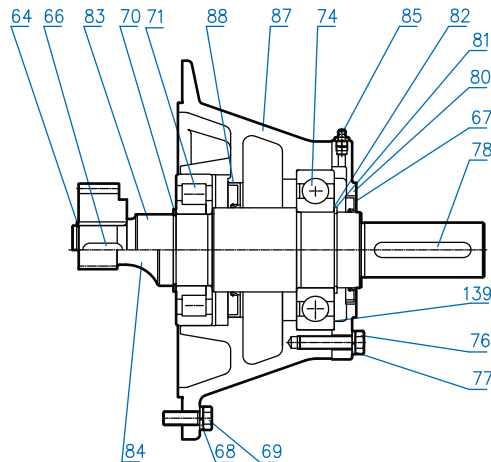
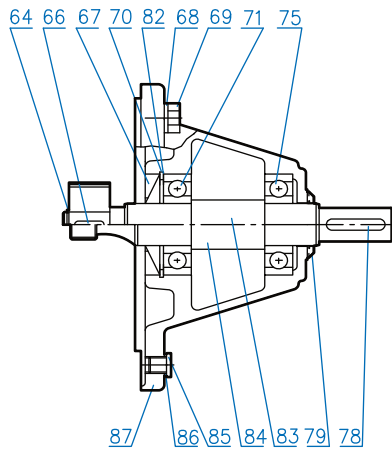
SK 02040 - SK 42125
SK 13050 - SK 43125

SK 9012.1 - SK 9052.1
SK 9013.1 - SK 9053.1

SK 62 - SK 72
SK 73 - SK 93

SK 6282 - SK 7282
SK 7382 - SK 9382

SK 9072.1



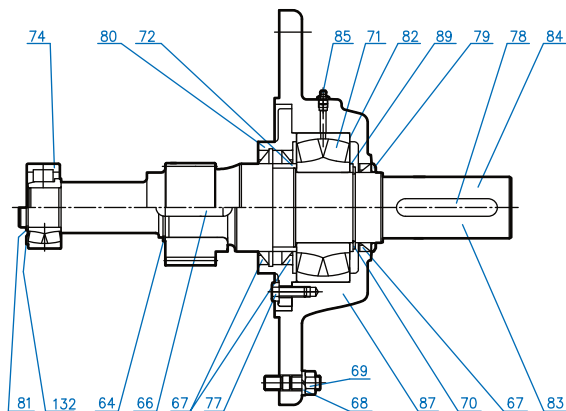
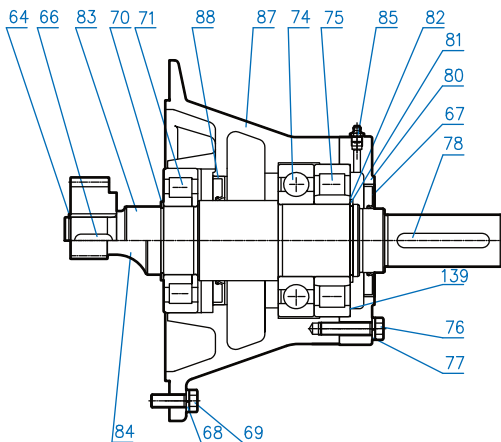
- | | |
|-----|--------------------------|
| 64 | Circlip |
| 66 | Key |
| 67 | Shaft Seal |
| 68 | Washer |
| 69 | Hexagon Screw |
| 70 | Circlip |
| 71 | Input Shaft Bearing |
| 74 | Ball Bearing |
| 75 | Input Shaft Bearing |
| 76 | Washer |
| 77 | Hexagon Screw |
| 78 | Key |
| 79 | Oil Flinger |
| 80 | Bearing Cover |
| 81 | Circlip |
| 82 | Shim |
| 83 | Input Shaft, Plain |
| 84 | Input Shaft, Gearcut |
| 85 | Drain Plug |
| 86 | Seal |
| 87 | Input Bearing Housing |
| 88 | Shaft Seal (Oil Flinger) |
| 139 | Shim |

SK 82 - SK 102
SK 103

SK 8282 - SK 9282

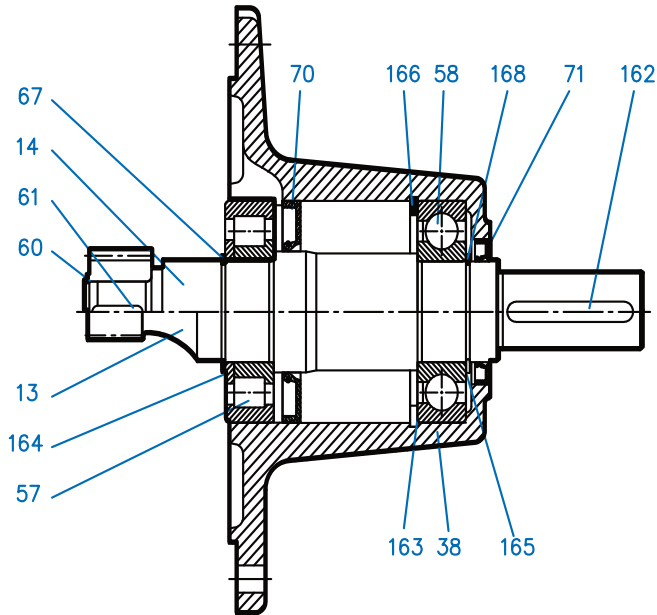
SK 9082.1 - SK 9092.1

SK 10282 - SK 12382



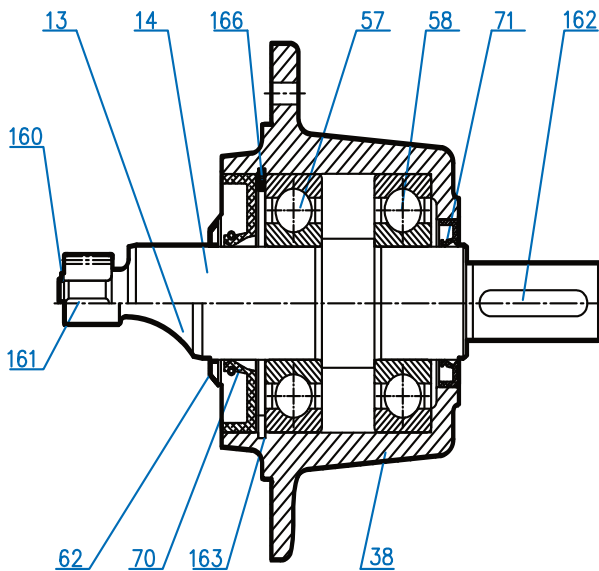
W-Type Inputs for Parts List for Nordbloc / 92 Bevel Gearboxes

SK172 - SK673
SK92072 - SK92372



13	Pinion Shaft
14	InputShaft
38	IEC Adapter
57	Bearing
58	Bearing
62	Oil Flinger
70	Shaft Seal
71	Shaft Seal
160	Snap Ring
161	Key
162	Key
163	Shim
164	Snap Ring
165	Set Screw
166	Snap Ring
167	Snap Ring
168	Snap Ring

SK772 - SK973
SK92672 - SK92772

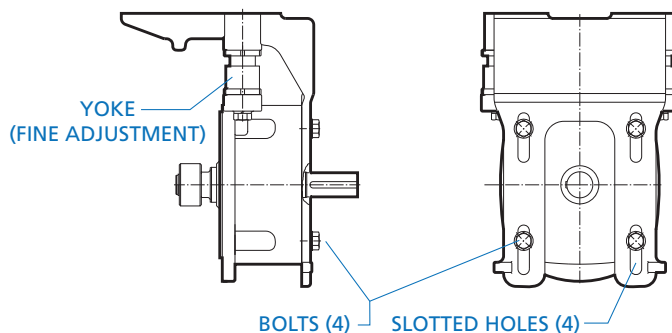


Motor Mount Platform (MK)

For proper installation of the belt drive, consult the manufacturer. NORD MK motor mounts are adjustable in two ways. Slotted holes are provided at the input cylinder for the initial height adjustment. There are two fine adjustments at the yoke to increase/decrease tension. Two spanner head wrenches will be needed to tighten/loosen the fine adjustments. The four bolts holding the motor platform to the input cylinder must be loosened in order to use the fine adjustments.

The motor mounting platform has tapped holes to accept the foot pattern of the standard footed NEMA or IEC motor. All MK mounting input shaft diameters are metric.

Align the sheaves or sprockets square and parallel by placing a straight edge across their faces. Alignment of bushed sheaves and sprockets should be checked after bushings have been tightened. Check horizontal shaft alignment by placing a level vertically against the face of the sheave or sprocket. Adjust belt or chain tension per the manufacturer's specified procedure. After a period of operation, recheck alignment and adjust as required.



WARNING



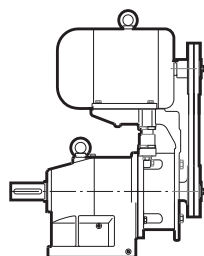
NORD Gear does not furnish the safety guards for the belt drive. It is the responsibility of the customer to install a safety guard to conform to OSHA standards.



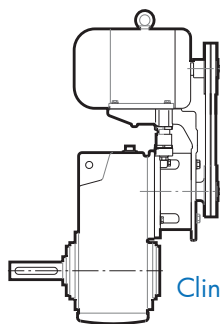
HARMFUL SITUATION



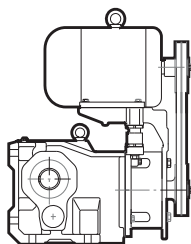
When using external chain or belt drives, make sure the reducer is sized so that the shaft and bearings have adequate capacity. To avoid unnecessary bearing loads and additional shaft deflection, mount all power take-off devices (sprockets, pulleys, etc.) so that the applied load center is as close to the gear housing as possible and check component alignment and tension of any belts or chains per the manufacturer's recommendation. Do not over tighten the belts or chains.



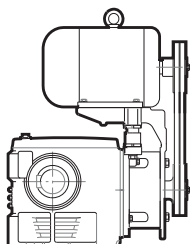
In-Line Unit



Clincher™ Unit

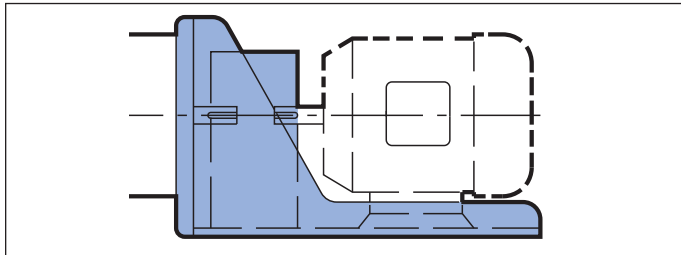


Bevel Unit



Worm Unit

Sugar Scoop



Each scoop bracket includes the coupling for the motor and the coupling guard.

- NORD's standard supplied coupling is the jaw-type coupling with elastomeric spider element.
- The reducer-side (driven) coupling hub is mounted by NORD.
- The motor-side (driver) coupling hub must be mounted by the party responsible for supplying or mounting the motor.
- The supplied coupling guard must be mounted after coupling installation.

Coupling Mounting Instructions

1. Make sure that the motor shaft is clean and free of burrs or defects.
2. Check the motor shaft, coupling hub bores, key and key seat dimensions to make sure they are the proper dimensions.
3. Mount the coupling onto the motor by placing the coupling so that the inside face is flush with the end of the motor shaft and tightening the set screws to hold it in place (Figure 1).

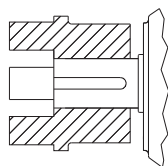


Figure 1. Place coupling flush with end of motor shaft and tighten setscrew.



IMPORTANT NOTE



Heating the coupling hub slightly, up to 176°F (80°C) will help facilitate installation onto the motor shaft.



WARNING



Wear appropriate safety gloves to handle the heated coupling hubs to avoid serious burns or injury.



HARMFUL SITUATION



DO NOT DRIVE or HAMMER coupling hubs into place. An end-wise blow to the reducer or motor shaft can generate damaging axial forces and cause damage to the reducer or motor housing, bearings, or internal components.

4. Let the coupling cool down before mounting the spider into the jaws. The spider should not be under axial compression when installed.
5. Place the motor onto the scoop and engage the couplings together. The scoop has slotted holes to help accommodate axial alignment. Secure the motor to the scoop bracket but do not completely tighten the fasteners.



IMPORTANT NOTE



Before tightening the motor to the scoop bracket, the alignment of the coupling must be checked. Shimming of the motor feet may be needed to properly align the couplings. Careful coupling alignment extends the life of not only the coupling but all the components of the drive train.

6. Check the parallel alignment by placing a straight edge or level across the two coupling hubs, and measure the maximum offset at various points around the circumference of the coupling, without rotating the coupling. The maximum parallel alignment should not exceed 0.015 inches (4 mm).
7. Check the angular alignment of the coupling without rotating the hubs. The maximum angular displacement should not exceed 1.0°.
8. After both angular and parallel alignment is within specified limits, tighten all motor mounting hardware to the appropriate torque specification.
9. Re-check the critical alignment and repeat steps 6 and 7 if needed.
10. Mount the coupling guard to the scoop.



WARNING



It is the customer responsibility to properly guard the rotating shaft and coupling connection and make sure the system meets all local safety regulations.



IMPORTANT NOTE



After a period of operation, it is suggested that the system be checked to make sure coupling alignment is being maintained.

Items included in the touch-up kit

- I. No Rinse Alodine® Touch-N-Prep pen.
- II. Color matched sealer pen



WARNING



- Always wear Personal Protective Equipment (PPE), including gloves and safety glasses with side shields.
- When opening individual pens, pull safety caps straight out from pen. Do not twist or torque the cap to avoid damaging the applicator assembly.
- Do not use fingers to prime the applicator tip. Priming takes 15-30 seconds.
- Make sure the surface is clean and dry.



IMPORTANT NOTE



- I. Metal temperature must be above 50° F
- II. Do not excessively use abrasive pad while removing surface oxidation. Oxidation only needs to be removed from areas with exposed aluminum.
- III. Use enough product to wet surface but avoid pooling.
- IV. Do not rinse or wipe Alodine coating before the product is allowed to dry.
- V. Allow to air dry or use a blow dryer. Do not use a heat gun. Maximum drying temperature is 140°F.
- VI. Dry color will appear opaque.

Part I: Allodine® 871 Touch-N-Prep® Pen Instructions

Touch-N-Prep® pens are designed for easy and safe repair of clean, bare, or previously painted aluminum surfaces. It is a non-rinse, dry-in-place application that can be applied using the following steps:

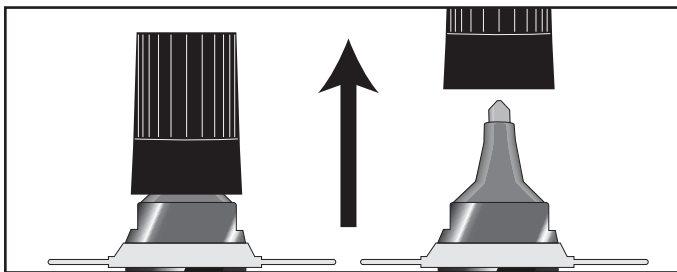
1. Surface Preparation



Before applying the coating, the treated surface must be cleaned using the following process:

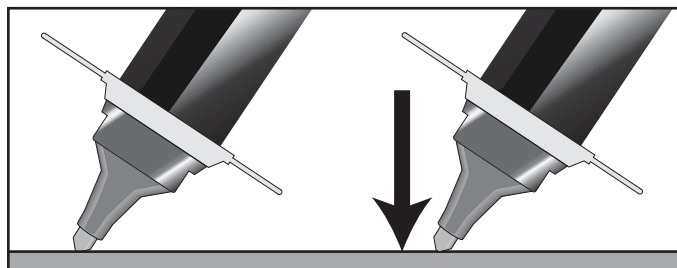
- If the scratch is more than 24 hours old use a moistened abrasive pad to remove oxides from the surface of the metal.
- Wipe substrate with a damp lint-free cloth to ensure complete removal of soils and dislodged oxides generated from the previous step.
- Allow Surface to dry before Touch-N-Prep® application.

2. Prime Applicator Tip

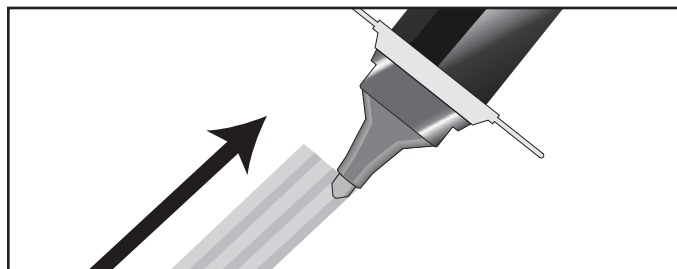


To activate, hold the Touch-N-Prep® pen upright and pop off the cap. Do not twist or turn to remove the cap, since this may result in the pen leaking. Hold the pen tip down onto a clean surface to begin the flow of solution to the tip.

3. Application

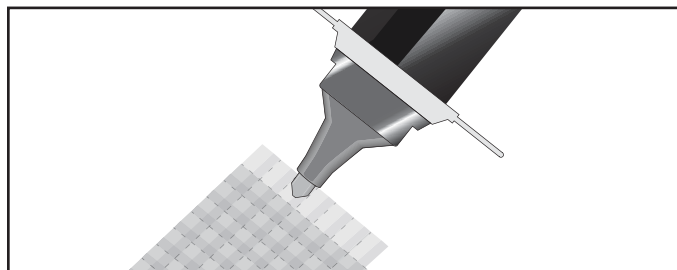


Press the pen tip down on the surface until solution fills the pen tip. Apply the Alodine® 871™ solution to the metal surface with firm, smooth, even strokes, covering all of the edges. Overlap each stroke and allow to dry.

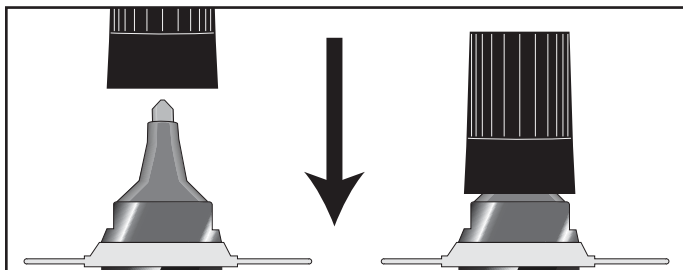


Frequent short jabs to re wet the application rip are preferred to maintain constant coating weights and avoid over-wetting the felt tip.

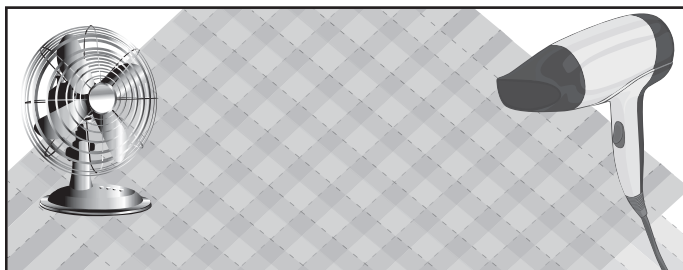
4. Re-Application



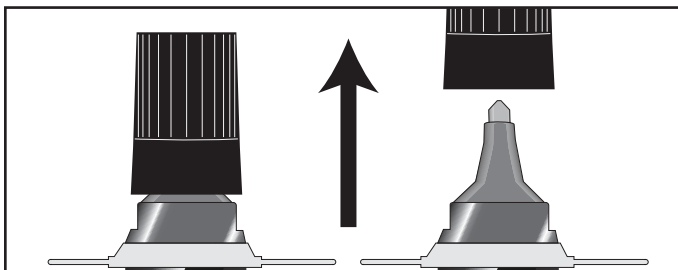
Within 5 minutes of the first coat, apply a second coat at a 90° angle to the first coat with the same smooth, firm stroke.

**5. Prepare the Pen for Storage**

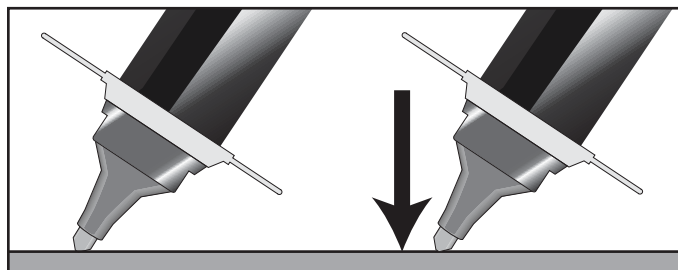
Always immediately replace the cap when not in use to avoid evaporation and contamination.

6. Drying

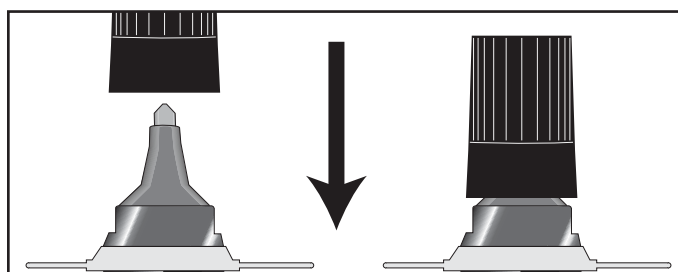
Allow the Alodine Touch-N-Prep® coating to air dry thoroughly.

Part II: Sealer Application**1. Prime Applicator Tip**

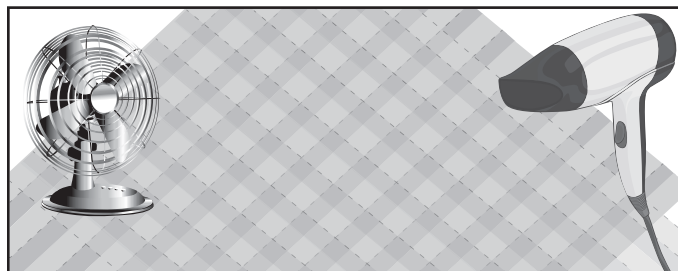
To activate, hold the pen upright and pop off the cap. Do not twist or turn to remove the cap, since this may result in the pen leaking. Hold the pen tip down onto a clean surface to begin the flow of solution to the tip.

2. Application

Press the pen tip down on the surface until solution fills the pen tip. Apply the sealer pen solution to the metal surface with firm, smooth, even strokes, covering all of the edges. Overlap each stroke and allow to dry.

3. Prepare the Pen for Storage

Always immediately replace the cap when not in use to avoid evaporation and contamination.

4. Drying

Allow the sealer pen coating to air dry thoroughly.



NORD GEAR CORPORATION



DRIVESYSTEMS

CONDITIONS OF SALE

WWW.NORD.COM

1. CONTRACT

Any contract between Nord Gear Corporation, hereinafter designated as Seller, and the Buyer is subject to the terms and conditions of sale hereinafter set forth. Any deviation from such terms and conditions must be specifically set forth in writing and consented to by Seller. Accordingly, the Buyer and Seller acknowledge and agree that the terms and conditions set forth below and on the face hereof shall govern Buyer's purchase of the goods described on the face hereof and shall take precedence over and represents the final agreement between Buyer and Seller, notwithstanding any inconsistent, contradictory or other prior or further conditions contained in any oral or written request or purchase order issued by Buyer or any other document furnished by Buyer in connection with its purchase of the Goods, regardless of whether such document or documents are exchanged simultaneously with this Invoice or prior or subsequent thereto. Any additional or different terms or conditions which may appear in any communication, oral or written, from Seller, its officers, employees, agents or representatives, are hereby expressly rejected and shall not be effective or binding upon the Seller, unless specifically hereafter agreed to in writing by Seller and no such additional or different terms or conditions in any document submitted to Seller by Buyer shall become part of the contract between Buyer and Seller, unless such written acceptance by Seller specifically recognizes and assents to their inclusion. Any objection by Buyer to the terms and conditions hereof shall be ineffective unless Seller is advised in writing thereof within two (2) days of the date of this Invoice.

2. CONFIRMATION

An order shall be deemed accepted only when duly confirmed by Seller, at Nord Gear Corporation's home office in Waukegan, Wisconsin, and upon such confirmation the order shall become a contract binding upon the parties hereto, their successors and assigns.

3. PRICES

Prices shown are list prices and may be subject to applicable discounts. Unless otherwise agreed upon in writing, prices are FOB factory Waukegan, Wisconsin. Prices and discounts are subject to change without notice until order is accepted. Seller's prices do not include cost of any inspection permits required.

4. LIMITED WARRANTY

Seller hereby warrants that the goods sold hereunder shall be free from material defects in material and workmanship, if properly installed and used under normal operating conditions, for a period of twelve (12) months from the date of installation or eighteen (18) months from date of shipment, whichever comes first (the "Warranty Period"). With respect to gears and housings only, the Warranty Period is extended to thirty-six (36) months from the date of invoice or twenty-four (24) months from the date of installation, whichever comes first. The limited warranty shall not apply to any components or parts which are subject to normal operational wear and tear, including, but not limited to, belts and traction discs. Should any goods fail to comply with the foregoing limited warranty, Buyer shall provide written notice to Seller of the claimed defect and all relevant details within thirty (30) days of Buyer's discovery of the claimed defect. Buyer shall return the allegedly defective goods to Seller at its facilities in Waukegan, Wisconsin or to such other location within the USA as may be designated by Seller in its sole discretion, with all shipping and transportation charges prepaid by Buyer. Seller shall then examine the returned goods to determine if the claimed defect is covered by the limited warranty. If the claimed defect is covered by the limited warranty, Buyer's sole and exclusive remedy shall be to have Seller repair or replace, at Seller's option, the defective goods or components in accordance with the terms of this limited warranty. Seller shall have a commercially reasonable time to make such repairs or replacements and may use new or reconditioned components. Any repair or replacement shall not extend the Warranty Period unless otherwise agreed by Seller. Buyer shall pay all shipping costs and any costs of removal and re-installation of goods or components.

The foregoing limited warranty shall not apply with respect to any goods or components (i) which are not installed, used, operated, serviced or maintained in accordance with manufacturer's instructions or which are otherwise not properly installed, used, operated, serviced or maintained, or (ii) which are misused, neglected, damaged, altered, repaired, reconfigured or incorrectly wired. Seller makes no representations as to the specifications, capacity or performance of the goods sold hereunder, except as may be specifically set forth in the invoice's written specifications, and any such representations are expressly conditioned upon the accuracy and completeness of the data and information furnished by the buyer and upon the goods being properly installed, used, serviced and maintained by Buyer. Any description or model of the goods is for identification or illustrative purposes only and shall not be deemed to create any warranty, express or implied.

THE FOREGOING LIMITED WARRANTY SHALL EXTEND SOLELY TO BUYER AND NOT TO ANY OTHER PARTY. THE FOREGOING LIMITED WARRANTY IS IN LIEU OF ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED. SELLER HEREBY EXCLUDES AND DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IF BUYER SHALL FAIL TO PAY WHEN DUE ANY PORTION OF THE PURCHASE PRICE OR ANY OTHER PAYMENT REQUIRED FROM BUYER TO SELLER UNDER THIS CONTRACT, ALL WARRANTIES AND REMEDIES SET FORTH HEREIN SHALL BE DEEMED NULL AND VOID, AB INITIO. THE PARTIES ACKNOWLEDGE AND AGREE THAT THE EXCLUSIVE REMEDY UNDER THE FOREGOING LIMITED WARRANTY SHALL NOT HAVE FAILED OF ITS ESSENTIAL PURPOSE (AS THAT TERM IS USED IN THE UNIFORM COMMERCIAL CODE) PROVIDED THAT SELLER REMAINS WILLING TO REPAIR OR REPLACE DEFECTIVE GOODS WITHIN A COMMERCIALLY REASONABLE TIME. BUYER SPECIFICALLY ACKNOWLEDGES AND AGREES THAT THE PRICE CHARGED BY SELLER FOR THE GOODS IS BASED UPON THE LIMITATIONS OF SELLER'S WARRANTY OBLIGATIONS AND OTHER LIABILITIES AS SET FORTH HEREIN.

LIMITATION OF LIABILITY. NOTWITHSTANDING ANY OTHER PROVISION HEREOF, IN NO EVENT SHALL SELLER BE LIABLE TO BUYER OR TO ANY OTHER PARTY FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, LOST PROFITS, OR FOR ANY LOSSES, CLAIMS OR DAMAGES RELATING TO OR ARISING FROM THE USE OR OPERATION OF THE GOODS, AND IN NO EVENT SHALL ANY CLAIM OR RECOVERY OF ANY KIND EXCEED THE PURCHASE PRICE OF THE GOODS IDENTIFIED IN THE RELATED INVOICE.

5. SHORTAGE AND NONCONFORMITY

Any claim of shortage or that the goods do not conform with the specifications of the order or model must be made in writing within ten (10) days after delivery of the goods (as to which such claim is made) to Buyer or its nominees, but in no event shall the claim be later than within the time limit provided by the carrier or insurance company, otherwise such claim shall be deemed waived. Buyer may not return any goods claimed to be in non-conformity without Seller's prior written authorization. Goods returned without permission will not be accepted, including for credit, and will be returned to Buyer, F.O.B. Seller's plant. Any claim based on the receipt of damaged Goods must be filed with the carrier which delivered the goods. The samples, measurements, dimensions and weights contained in the Seller's catalogs, sales manuals, photographs and drawings constitute only an approximate guide. The Seller reserves the right to make any change which the Seller, in its absolute discretion, considers necessary. While the goods will be delivered principally according to specifications or standards or quantities agreed upon, insignificant deviations or insignificant changes in construction are permissible. The same applies to partial deliveries. In the event that Buyer has a verified claim of shortage or nonconformity of the goods to the specifications of the order or the model, and if such claim has been submitted within the required time limit as set forth above, the Seller shall, at its own expense, make up for the shortage of the goods, or replace or repair the goods, as the case may be, but in no event shall Seller be or become liable to Buyer or to any other person or persons for any loss in damage, direct or indirect, arising out of or caused by such incidents or for the loss of profits, business or good will. The liability of the Seller to Buyer, if any hereunder, for breach of warranty, contract, negligence or otherwise, shall in no event exceed the amount of the purchase price of the goods sold with respect to which any damages are claimed. Shipping dates are estimates unless parties expressly agree on time of the essence.

6. FORCE MAJEURE

The obligation of the Seller shall be modified or excused, as the case may be, for reasons of Acts of God, war, governmental law regulations, strikes or lock-outs, fire, breakdown of machinery, whether in its own business enterprise, or if for any other cause beyond Seller's control, the goods cannot be delivered or their delivery becomes delayed in whole or in part. In the above instances time for delivery shall be extended for the period of the delay caused, with the proviso, however, that either party may cancel in writing the undelivered portion of the order or contract if the delay exceeds six (6) months from the delivery date originally confirmed by Seller. In no event shall Seller become liable in the aforesaid instances to Buyer or any third party for consequential damages or business loss.

7. SHIPMENT AS UNIT

Each shipment by Seller shall be treated as a separate and distinct unit with respect, but only with respect to forwarding, terms of payment, and the making of claims by the Buyer: provided, however, that if the Buyer defaults in the payment of any obligation to Seller or any installments thereof, under any agreement between Buyer and Seller, or if Buyer refuses to accept any goods when tendered for delivery, the Seller may, on fifteen (15) days written notice to the Buyer, without prejudice to Seller's other lawful remedies, either defer further performance until the defaulted payments are made in full, or make future deliveries for cash in advance only, or treat the entire contract or contracts with Buyer as breached by the Buyer and pursue its remedies for breach.

8. BUYER'S REFUSAL OF DELIVERY

If Buyer refuses to accept delivery of any goods tendered for delivery, then Seller, without prejudice to Seller's other lawful remedies, may either store or cause such goods to be stored in a warehouse, for buyer's account and at Buyer's cost, risk and expense, or sell such goods (without notice) to any purchaser at public or private sale, and hold the Buyer liable for any difference between (a) the contract price of the goods, and (b) the price at which goods are resold less the costs and expense of such resale including brokerage commissions, or restocking charges.

9. GOODS IN TRANSIT

If prior to delivery or while the goods are in transit, Buyer or Seller becomes bankrupt or insolvent, or any petition in bankruptcy or for the reorganization or for a state court receivership is filed against Buyer or Seller, as the case may be, then the other party hereto may forthwith terminate this contract by giving written notice of such termination. Such termination shall not affect any claim for damages available to the Buyer, provided that if Buyer is then indebted to Seller, the amount of any such damage claim shall be abated to the extent that the indebtedness of Buyer to Seller, as actually paid in money, is abated by any order of judgement entered or any plan adopted in any bankruptcy, reorganization, receivership, or similar proceeding. Such termination shall not prejudice the Seller's rights to any amounts then due under the contract. If Buyer becomes bankrupt or insolvent or any petition in bankruptcy or for reorganization or if a state court receivership is filed against Buyer, then, at its option Seller may take possession of any goods theretofore sold to Buyer, in connection with which the full purchase price has not been paid, analogous to the terms and provisions set forth in Paragraphs 11 and 12 hereinafter.

10. DELIVERY

(a) Any indicated dates of delivery are approximate only, but NORD Gear will attempt to meet them whenever possible. (b) NORD Gear will not be liable for any penalty clauses contained in any specifications or order submitted unless agreed to in writing by an authorized officer of NORD Gear Corporation. (c) Unless otherwise agreed, delivery of the goods to any carrier shall constitute delivery to the Buyer, and thereafter the risk of loss or damage to the goods shall be upon the Buyer. (d) If the Buyer does not give delivery instructions to the Seller at least (10) days prior to the delivery date ex factory confirmed by the Seller, the Seller may deliver the goods to a carrier of its own choosing, at Buyer's cost and risk, or, at Seller's option, may store the goods on the pier or any warehouse, at Buyer's cost and risk. Any purchase price in such event becomes due and payable within ten (10) days of such storage.

11. PAYMENT OF PURCHASE PRICE

Time of payment is of the essence under the contract. Unless otherwise provided, terms of payment are 30 days net from the date of invoice with a 1% discount if paid within 10 days of date of invoice. Upon default in any of the terms of the contract, or failure to comply with any of the conditions thereof, or upon seizure of the property under execution or other legal process, or if the Buyer becomes bankrupt or insolvent, or any petition for reorganization or for a state court receivership is filed against Buyer, or if the Buyer makes any assignment for the benefit of its creditors or otherwise sells, encumbers or disposes of the goods, or if for any other reason the Seller should deem itself insecure, the full amount of the purchase price then remaining unpaid shall at once become due and payable at the option of the Seller.

12. BUYER'S DEFAULT

Upon the Buyer's default, the Seller may dispose of the merchandise in any manner that it deems fit and, if it desires to resell same, may do so at private or public sale, with or without notice, and with or without the property being at the place of sale, subject, however, to applicable laws. The Seller or its assigns shall have the right to bid at such sale and may become the purchaser of the property. The proceeds of the sale shall first be applied to the expenses incurred in retaking, repairing, storing and selling the goods, reasonable attorney's fees included, and then shall be applied to the payment of the balance due under the contract. Any surplus amount shall be paid to the Buyer. If a deficiency results after the resale, the Buyer agrees to pay such forthwith, together with reasonable attorney's fees, for the recovery of the goods incurred by the Seller. If upon the Buyer's default, the Seller elects not to resell any goods which it may repossess, then the cost of repossession, including reasonable attorney's fees, shall forthwith be due and payable from Buyer to Seller. Buyer agrees to pay all reasonable costs and reasonable attorney's fees incurred by Seller in enforcing Seller's rights against Buyer, including Seller's right to payment of the purchase price of the goods and Buyer's payment of all other amounts owing to Seller required under this Invoice and Conditions of Sale.

13. SECURITY INTEREST AND TITLE

In states and localities which are governed by the Uniform Commercial Code, this contract shall serve as security agreement, reserving in Seller a security interest until full payment of purchase price. The provisions of the Uniform Commercial Code regarding security interest shall have preference and apply if inconsistent with other terms of the conditions of sale. In states and localities where the Uniform Commercial Code does not apply, title to the goods shall remain in the Seller or its assigns until full payment of the purchase price. Buyer agrees to execute forthwith any and all documents in such a way and form as Seller may need for filing or recording the security interest under the Uniform Commercial Code with the proper registers or offices, or for filing or recording the conditional sales contract.

14. SALES AND USE TAX

Buyer agrees to bear and pay any sales or use tax in connection with the purchase herein, and to hold the Seller harmless from payment. At the option the Seller, Buyer shall give evidence of payment or of exemption certificate.

15. INSURANCE

The Buyer shall keep the goods insured against damage by fire, water or other casualty as required by Seller, with a company acceptable to Seller, with loss payable to Seller for the total purchase price until the Seller is fully paid. Seller, if it so elects, may place said insurance at Buyer's expense; Seller may cancel such insurance at any time and without notice and may receive the return premium, if any.

16. MODIFICATION BY SELLER

Any contract may be assigned or transferred by the Seller, or the time for the making of any payment due by Buyer may be extended by Seller without derogation of any of the rights of the Seller or its assigns. Waiver by any party of any default shall not be deemed a waiver of any subsequent default.

17. RETURNED GOODS

No goods will be accepted for return unless authorized in writing by Seller. In all cases, transportation and restocking charges will be borne by Buyer.

18. PACKING

The Buyer will be charged for export packaging or other special packing desired. Cost for cartage to ship or transfer express will be added to the invoice. No credit will be allowed if no packing is required.

19. CHANGES/CANCELLATION

NORD Gear will not accept changes in specifications to a confirmed order unless such changes are requested in writing and confirmed back in writing. In addition, the purchaser must to agree to any additional charges that may arise from the change. Placing orders on hold or cancellation of orders require Seller's written approval, and are subject to cancellation and/or restocking charges.

20. BUYER'S RESPONSIBILITY AS TO MAINTENANCE

Buyer shall use and shall require its employees and agents to use all safety devices and guards and shall maintain the same in proper working order. Buyer shall use and require its employees and agents to use safe operation procedures in operating the equipment and shall further obey and have its employees and agents obey safety instructions given by Seller. If Buyer fails to meet the obligations herein, Buyer agrees to defend, indemnify and save Seller harmless from any liability or obligation with regard to any personal injuries or property damages directly or indirectly connected with the operation of the equipment. Buyer further agrees to notify Seller promptly and in any event not later than ten (10) days after notice or knowledge of any accident or malfunction involving Seller's equipment which has caused personal injury or property damages and to cooperate fully with Seller in investigating and determining the causes of such accident and malfunction. In the event that Buyer fails to give such notice to Seller or to cooperate with Seller, Buyer shall be obligated to defend, indemnify and save Seller harmless from any such claims arising from such accident.

21. MISCELLANEOUS PROVISIONS

(a) If for any reason a provision of a contract is legally invalid, then in such event the rest of the contract shall remain in full force and effect, except that the parties shall try to replace such invalid provision closest to their original mutual intentions. (b) This Invoice and these Conditions of Sale constitute the entire agreement between the parties regarding the subject matter hereof and supercedes all prior agreements, understandings and statements, whether oral or written, regarding such subject matter. No modification to, change in or departure from, the provisions of this Invoice and Conditions of Sale shall be valid or binding on Seller, unless approved in writing by Seller. No course of dealing or usage of trade shall be applicable unless expressly incorporated into this Invoice and Conditions of Sale. Any amendments to any contract or contracts between the parties shall be valid only upon the written consent of both parties.

22. NON ASSIGNMENT BY BUYER

Contract or contracts may not be assigned by the Buyer without prior written consent of the Seller.

23. APPLICABLE LAW AND VENUE

All contracts and their interpretation are governed by the applicable, substantive laws of the State of Wisconsin. Any litigation brought by the Buyer regarding this Invoice or goods purchased hereunder may only be brought in the Circuit Court for Dane County, Wisconsin.

NORD Gear Corporation

Toll Free in the United States: 888.314.6673

09.29.14

Nord Gear Company Terms 09/14

www.nord.com/d8c1



DRIVESYSTEMS

NORD GEAR LIMITED

TERMS & CONDITIONS OF SALE



WWW.NORD.COM

1. CONTRACT

Any contract between Nord Gear Limited, hereinafter designated as "Seller", and the party or parties accepting these terms and conditions of sale and any agent, officer, servant, employee or subcontractor of such party or parties, hereinafter designated as "Buyer", is subject to the terms and conditions of sale hereinafter set forth. Any deviation from such terms and conditions must be specifically set forth in writing and consented to by Seller.

2. CONFIRMATION

An order shall be deemed accepted only when duly confirmed by Seller, at Nord Gear Limited's home office in Brampton, Ontario, and upon such confirmation the orders shall become a contract binding upon the parties hereto, their successors and assigns.

3. PRICES

Prices shown are list prices and may be subject to applicable discounts. Unless otherwise agreed upon in writing, prices are FOB factory Brampton, Ontario. Prices and discounts are subject to change without notice until the order is accepted. Seller's prices do not include cost of any inspection permits required.

4. LIMITED WARRANTY

Seller warrants the goods sold hereunder to be free from defects in material and workmanship under normal use and service not arising from misuse, negligence, or accident, including but not limited to the use, installation, and transportation of the goods by Buyer, its agents, servants, employees, or by carriers. This warranty shall pertain to any part or parts of any goods to which Buyer or its assigns has within one year from date of delivery given written notice of claimed defects to Seller. Buyer shall be required to furnish Seller with details of such defects and this warranty shall be effective as to such goods which Seller's examination shall disclose to its satisfaction to have been defective and which at Seller's option shall promptly thereafter be returned to Seller or its nominees. EXCEPT FOR THE EXPRESS WARRANTIES SET FORTH ABOVE, SELLER HAS MADE NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, AS TO THE GOODS SOLD HEREUNDER, INCLUDING, BUT NOT LIMITED TO THEIR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. ANY DESCRIPTION OR MODEL OF THE GOODS IS FOR IDENTIFICATION OR ILLUSTRATIVE PURPOSES ONLY AND SHALL NOT BE DEEMED TO CREATE AN EXPRESS WARRANTY. The Buyer's exclusive remedy for claims arising from defective or nonconforming goods shall be limited to the repair or replacement thereof at the Seller's sole option. THE SELLER SHALL NOT BE RESPONSIBLE OR LIABLE FOR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE SALE, DELIVERY, USE, PERFORMANCE, OR SERVICE OF THE GOODS SOLD UNDER THIS AGREEMENT. SELLER SHALL NOT BE LIABLE FOR ANY LOST PROFITS OR FOR ANY CLAIM OR DEMAND AGAINST SELLER BY ANY PARTY. IN NO EVENT WILL SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, EVEN IF SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. SELLER'S AGGREGATE LIABILITY FOR DAMAGES UNDER THIS AGREEMENT, WHETHER ARISING FROM OR BASED UPON BREACH OF WARRANTY, BREACH OF CONTRACT, TORT OR OTHER CAUSE OF ACTION, SHALL IN NO CASE EXCEED THE PURCHASE PRICE THAT BUYER PAYS FOR THE PARTICULAR GOODS INVOLVED. Seller shall in no event be liable to any person or firm (including any assignee or Buyer) except Buyer and its successors. Unless specifically authorized by Seller in writing, Seller shall not become responsible for any repair work done by Buyer or any other party on any goods sold. Any costs of the return of such goods to Seller shall be borne by Buyer. Goods sold but not manufactured by Seller are being warranted as to defects in material and workmanship consistent with the limited warranty policy of the original manufacturer of the goods and if there is not such a limited warranty policy, the warranty shall be limited to the provisions of Article 4 herein. Standards for the operating characteristics of the gearboxes and the gear motors are in conformity with Seller's tests. THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE SELLER DOES NOT ASSUME, NOR DOES IT AUTHORIZE ANY PERSON TO ASSUME, ON ITS BEHALF, ANY OTHER OBLIGATION OR LIABILITY.

5. SHORTAGE AND NONCONFORMITY

Any claim of shortage or that the goods do not conform with the specifications of the order or model must be made in writing within ten (10) days after delivery of the goods (as to which such claim is made) to Buyer or its nominees, but in no event shall the claim be later than within the time limit provided by the carrier or insurance company, otherwise such claim shall be deemed waived. The samples, measurements, dimensions and weights contained in Seller's catalogs, sales manuals, photographs and drawings constitute only an approximate guide. Seller reserves the right to make any changes which Seller, in its absolute discretion, considers necessary. While the goods will be delivered principally according to specifications of standards or quantities agreed upon, insignificant deviations or insignificant changes in construction are permissible. The same applies to partial deliveries. In the event that Buyer has a verified claim of shortage or nonconformity of the goods to the specifications of the order or the model, and if such claim has been submitted within the required time limit as set forth above, Seller shall, at its own expense, make up for the shortage of the goods, or replace or repair the goods, as the cause may be, but in no event shall Seller be or become liable to Buyer or to any other person or persons for any loss in damage, direct or indirect, arising out of or caused by such incidents or for the loss of profits, business of good will. Shipping dates are estimates unless parties expressly agree on time of the essence.

6. FORCE MAJEURE

The obligation of Seller shall be modified or excused, as the case may be, for reasons of Acts of God, war, governmental law regulations, strikes or lock-outs, fire, breakdown of machinery, whether in its own business enterprise, or if for any other cause beyond Seller's control, the goods cannot be delivered or their delivery becomes delayed in whole or in part. In the above instances time for delivery shall be extended for the period of the delay caused, with the proviso, however, that either party may cancel in writing the undelivered portion of the order of contract if the delay exceeds six (6) months from the delivery date originally confirmed by Seller. In no event shall Seller become liable in the aforesaid instances to Buyer or any third party for consequential damages or business loss.

7. SHIPMENT AS UNIT

Each shipment by Seller shall be treated as a separate and distinct unit with respect, but only with respect to forwarding, terms of payment, and the making of claims by Buyer; provided, however, that if Buyer defaults in the payment of any obligation to Seller or any installments thereof, under any agreement between Buyer and Seller, or if Buyer refuses to accept any goods when tendered for delivery, Seller may, on fifteen (15) days written notice to Buyer, without prejudice to Seller's other lawful remedies, either defer further performance until the defaulted payments are made in full, or make future deliveries for cash in advance only, or to treat the entire contract or contracts with Buyer as breached by Buyer and pursue its remedies for breach.

8. BUYER'S REFUSAL OF DELIVERY

If Buyer refuses to accept delivery of any goods tendered for delivery, then Seller, without prejudice to Seller's other lawful remedies, may either store or cause such goods to be stored in a warehouse, for Buyer's account and at Buyer's cost, risk and expense, or sell such goods (without notice) to any purchaser at public or private sale, and hold Buyer liable for any difference between (A) the contract price of the goods, and (B) the price at which goods are resold less the costs and expense of such resale including brokerage commissions, or restocking charges.

9. GOODS IN TRANSIT

If prior to delivery or while the goods are in transit, Buyer or Seller becomes bankrupt or insolvent, or any petition in bankruptcy or for the reorganization or for appointment of a receiver is filed against Buyer or Seller, as the case may be, then the other party hereto may forthwith terminate this contract by giving written notice of such termination. Such termination shall not affect any claim for damages available to Buyer, to Seller, as actually paid in money, is abated by any order of judgment entered or any plan adopted in any bankruptcy, reorganization, receivership, or similar proceeding. Such termination shall not prejudice Seller's rights to any amounts then due under the contract. If Buyer becomes bankrupt or insolvent or any petition in bankruptcy or for reorganization or if a state court receivership is filed against Buyer, then, at its option, Seller may take possession of any goods theretofore sold to Buyer, in connection with which the full purchase price has not been paid, analogous to the terms and provisions set forth in Paragraphs 11 and 12 hereinafter.

10. DELIVERY

(A) Unless otherwise agreed, delivery of the goods to any carrier shall constitute delivery to Buyer, and thereafter the risk of loss or damage to the goods shall be upon Buyer. (B) If Buyer does not give delivery instructions to Seller at least ten (10) days prior to the delivery date ex factory confirmed by Seller, Seller may deliver the goods to a carrier of its own choosing, at Buyer's cost and risk, or, at Seller's option may store the goods on the pier or on any warehouse at Buyer's cost and risk. Any purchase price in such event becomes due and payable within ten (10) days of such storage.

11. PAYMENT OF PURCHASE PRICE

Time of payment is of the essence under the contract. Upon default in any of the terms of the contract, or failure to comply with any of the conditions thereof, or upon seizure of the property under execution or other legal process, or if Buyer becomes bankrupt or insolvent, or any petitions for reorganization or for appointment of a receiver is filed against Buyer, or if Buyer makes any assignment for the benefit of its creditors or otherwise sells, encumbers or disposes of the goods, or if for any other reason Seller should deem itself insecure, the full amount of the purchase price then remaining unpaid shall at once become due and payable at the option of Seller. Interest on the delinquent payment from the due date thereof until paid shall be at a rate of two (2%) percent per month.

12. BUYER'S DEFAULT

Upon Buyer's default, Seller may dispose of the merchandise in any manner that it deems fit and, if it desires to resell same, may do so at private or public sale, with or without notice, and with or without the property being at the place of sale, subject, however, to applicable laws. Seller or its assigns shall have the right to bid at such sale and may become the purchaser of the property. The proceeds of the sale shall first be applied to the expenses incurred in retaking, repairing, storing and selling the goods; reasonable solicitor's fees included, and then shall be applied to the payment of the balance due under the contract. Any surplus amount shall be paid to Buyer. If a deficiency results after the sale, Buyer agrees to pay such forthwith, together with reasonable solicitor's fees, for the recovery of the goods incurred by Seller. If upon Buyer's default, Seller elects not to resell any goods which it may repossess, then the cost of repossession, including reasonable solicitor's fees, shall forthwith be due and payable from Buyer to Seller.

13. SECURITY INTEREST AND TITLE

In provinces which are governed by a Personal Property Security Act, this contract shall serve as a security agreement, reserving in Seller a security interest until full payment of the purchase price. The provisions of the Personal Property Security Act regarding security interest shall have preference and apply if inconsistent with other terms of the conditions of sale herein. In provinces where a Personal Property Security Act does not apply, title to the goods shall remain in the Seller or its assigns until full payment of the purchase price. Buyer agrees to execute forthwith any and all documents in such a way and form as Seller may need for filing or recording the security interest under a Personal Property Security Act with the proper registers or offices, or for filing or recording the Conditional Sales Contract herein.

14. SALES AND USE TAX

Seller's prices do not include sales, use, excise or other taxes payable to any governmental authority in respect of the sale of Seller's goods. Buyer shall pay, in addition to Seller's price, the amount of any such taxes or shall reimburse Seller for the amount thereof that Seller may be required to pay. At the option of Seller, Buyer shall give evidence of payment or of exemption certificate.

15. INSURANCE

Buyer shall keep the goods insured against damage by fire, water or other casualty as required by Seller, with a company acceptable to Seller, with loss payable to Seller for the total purchase price until Seller is fully paid. Seller, if it so elects, may place said insurance at Buyer's expense; Seller may cancel such insurance at any time and without notice and may receive the return premium, if any.

16. MODIFICATION BY SELLER

Any contract may be assigned or transferred by Seller, or the time for the making of any payment due by Buyer may be extended by Seller without derogation of any of the rights of Seller or its assigns. Waiver by any party of any default shall not be deemed a waiver of any subsequent default.

17. RETURNED GOODS

No goods will be accepted for return unless authorized in writing by Seller. In all cases, transportation and restocking charges will be borne by Buyer.

18. PACKING

Seller does not charge for standard packaging for domestic shipment. Buyer will be charged, however, for export packaging or other special packing desired. Cost for cartage to ship or transfer express will be added to the invoice. No credit will be allowed if no packing is required.

19. EXPORT ORDER

Export orders are to be accompanied by a confirmed irrevocable Letter of Credit in Seller's favor, in Canadian currency, with an accredited Canadian bank, subject to Seller's draft, with shipping documents attached.

20. CANCELLATION

Placing orders on hold or cancellation of orders require Seller's written approval, and are subject to cancellation and/or restocking charges.

21. BUYER'S RESPONSIBILITY AS TO MAINTENANCE

Buyer shall use and shall require its employees and agents to use all safety devices and guards and shall maintain the same in proper working order. Buyer shall use and require its employees and agents to use safe operating procedures in operating the equipment and shall further obey and have its employees and agents obey safety instructions given by Seller. If Buyer fails to meet the obligations herein, Buyer agrees to indemnify and save Seller harmless from any liability or obligation with regard to any personal injuries or property damages directly or indirectly connected with the operation of the equipment. Buyer further agrees to notify Seller promptly and in any event not later than ten (10) days after notice or knowledge of any accident or malfunction involving Seller's equipment which has caused personal injury or property damages and to cooperate fully with Seller in investigating and determining the causes of such accident and malfunction. In the event that Buyer fails to give such notice to Seller or to cooperate with Seller, Buyer shall be obligated to indemnify and save Seller harmless from any such claims arising from such accident.

22. MISCELLANEOUS PROVISIONS

(A) If for any reason a provision of a contract is legally invalid, then in such event the rest of the contract shall remain in full force and effect, except that the parties shall try to replace such invalid provision with a provision closest to their original mutual intentions. (B) Any amendments to any contract or contracts require the consent in writing by both parties. Headings in this document are for ease of reference only.

23. NON ASSIGNMENT BY BUYER

Contract or contracts may not be assigned by Buyer without prior written consent of Seller.

24. APPLICABLE LAW

This agreement shall be governed by the laws of the Province of Ontario and the applicable laws of Canada. Buyer and Seller agree that any judicial proceeding with respect to this agreement must be brought and maintained in the City of Toronto, in the Province of Ontario.

25.

This instrument sets forth the entire understanding and agreement of the parties hereto in respect of the subject matter hereof, and all prior undertaking between the parties hereto, together with all representations and obligations of such parties in respect of such subject matter, shall be superseded by and merged into this instrument.

26.

The provisions of this agreement shall bind and ensure to the benefit of the parties hereto and their respective heirs, executors, administrators, successors and (subject to any restrictions or assignment herein above set forth) assigns, as the case may be.

27.

The parties acknowledge that they have requested this document and all notices or other documents relating thereto be drafted in the English language.

Les parties reconnaissent qu'ils ont requis que ce contrat et tous les avis ou autres documents qui s'y rapportent soient rédigés en langue anglaise.

Terms and Conditions in French available upon request.

NORD Gear Limited

Toll Free in Canada: 800.668.4378

09.29.14

NORD Gear Corporation
Toll Free in the United States: 888.314.6673

www.nord.com/d006

Product Overview

We can match our NORDAC AC vector drives with our Inverter/Vector Duty Motors and UNICASE™ Speed Reducers to provide a total AC Motor Drive solution from one trusted source.

UNICASE™ SPEED REDUCERS



HELICAL IN-LINE

- Foot or Flange Mount
- Torque up to 205,000 lb-in
- Gear ratios – 1.82:1 to over 300,000:1



NORDBLOC® HELICAL IN-LINE

- Foot or Flange Mount
- Torque up to 26,550 lb-in
- Gear ratios – 1.88:1 to over 370:1



PARALLEL HELICAL CLINCHER™

- Shaft, Flange or Foot Mount
- Torque up to 797,000 lb-in
- Gear ratios – 4.26:1 to over 300,000:1



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- Foot, Flange or Shaft Mount
- Torque up to 5,840 lb-in
- Gear ratios – 4.1:1 to 72:1



RIGHT ANGLE HELICAL-BEVEL

- Foot, Flange or Shaft Mount
- Torque up to 283,000 lb-in
- Gear ratios – 8.04:1 to over 300,000:1



RIGHT ANGLE HELICAL-WORM

- Foot, Flange or Shaft Mount
- Torque up to 27,585 lb-in
- Gear ratios – 4.40:1 to over 300,000:1



MINICASE™ RIGHT ANGLE WORM

- Foot, Flange or Shaft Mount
- Torque up to 3,540 lb-in
- Gear ratios – 5:1 to 500:1



FLEXBLOC™ WORM

- Modular bolt-on options
- Torque up to 4,683 lb-in
- Gear ratios – 5:1 to 3,000:1

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- Motor or remote mounted
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- 380-460V, 3-phase, to 5hp
- 200-240V, 3-phase, to 3hp



SK500/520/530E

- Compact, high performance
- 380-480V, 3-phase, to 10hp
- 200-240V, 3-phase, to 5hp
- 200-240V, 1-phase, to 3hp
- 110-120V, 1-phase, to 1.5hp



SK700E

- Flexible high performance
- 380-460V, 3-phase, to 200hp



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Installation, Operation and Maintenance Instructions

for AC Induction Motors
56- 6800 Frames (NEMA)
63 – 280 Frames (IEC)



A REGAL-BELOIT COMPANY

MARATHON ELECTRIC

Contact Motor Customer Service at:

Phone: (715) 675-3311

www.marathonelectric.com

INSTALLER: PLEASE LEAVE THIS MANUAL FOR THE OWNER'S USE
OWNER: READ AND SAVE THESE INSTRUCTIONS

SAFETY INSTRUCTIONS

 This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

WARNING

Before installing, using, or servicing this product, carefully read and fully understand the instructions including all warnings, cautions, & safety notice statements. To reduce risk of personal injury, death and/or property damage, follow all instructions for proper motor installation, operation and maintenance.

These instructions are not intended as a complete listing of all details for installation, operation, and maintenance. If you have any questions concerning any of the procedures, STOP, and call the appropriate Regal-Beloit motor company.

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motor is suitable for use on Pulse Width Modulated (PWM) type VFD power. In addition, the nameplate must be marked with the inverter rating; for example, "2:1 CT", "2 to 1 Constant Torque", etc.

1.0 INSTALLER/OWNER/OPERATOR RESPONSIBILITY:

1.1 ELECTRICAL SAFETY

⚠ WARNING: ELECTRICAL SHOCK HAZARD

Electrical connections shall be made by a qualified electrical personnel in accordance with all applicable codes, ordinances and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage. Only qualified personnel who are familiar with the applicable National Code (USA = NEC) and local codes should install or repair electrical motors and their accessories.

⚠ WARNING: ELECTRICAL LIVE CIRCUIT HAZARD

Do not touch electrically live parts. Disconnect, lockout and tag input power supply before installing or servicing motor (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

⚠ WARNING: ELECTRICAL GROUNDING HAZARD

Failure to properly ground motors, per the National Electrical Code (NEC) Article 430 and local codes may cause serious injury or death to personnel. For general information on grounding refer to NEC Article 250. (Also see "Ground Connections section 3.4.4").

⚠ WARNING: AUTOMATIC RESET PROTECTOR HAZARD

Do not use automatic reset protectors if automatically restarting the motor will place personnel or equipment at risk. Failure to follow this instruction could result in serious personal injury, death and/or property damage

⚠ WARNING: MANUAL RESET PROTECTOR HAZARD

If a tripped manual reset thermal protector is exposed to a temperature less than -7°C (20°F) it may reset and restart the motor automatically. If an application requires a motor with a manual reset thermal protector that will be operated at temperatures less than -7°C (20°F) contact the manufacturer to review the application / motor requirements. Failure to follow this instruction could result in serious personal injury, death and/or property damage

1.2 MECHANICAL SAFETY

⚠ WARNING: LOOSE PARTS HAZARD

Before starting the motor, remove all unused shaft keys and loose rotating parts to prevent them from flying off. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING: ROTATING PARTS HAZARD

Keep extremities, hair, jewelry and clothing away from moving parts. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

1.3 ENVIRONMENTAL SAFETY

⚠ WARNING: HAZARDOUS LOCATIONS

- (1) The NEC and the local authority having jurisdiction must be consulted concerning the installation and suitability of motors for use in Hazardous Locations. The local authority having jurisdiction must make the final determination of what type of motor is required. The application and operation is beyond the control of the motor manufacturer.
- (2) Division 1 Hazardous Locations motors can only be modified or reworked by the manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage.
- (3) Do not use a Hazardous Locations motor with a Variable Frequency Drive (VFD) unless the motor nameplate specifically states that the

2.0 RECEIVING AND INSPECTION

2.1 INITIAL INSPECTIONS

2.1.1 CHECK PACKING LIST AND INSPECT the packaging to make certain no damage has occurred in shipment. If there is visible damage to the packaging, unpack and inspect the motor immediately. Claims for any damage done in shipment must be made by the purchaser against the transportation company.

2.1.2 TURN MOTOR SHAFT by hand to be certain that it rotates freely. Note: Shaft seals and bearing seals may add drag.

2.1.3 CHECK NAMEPLATE for conformance with purchase order requirements and compliance with power supply and control equipment requirements.

2.2 HANDLING:

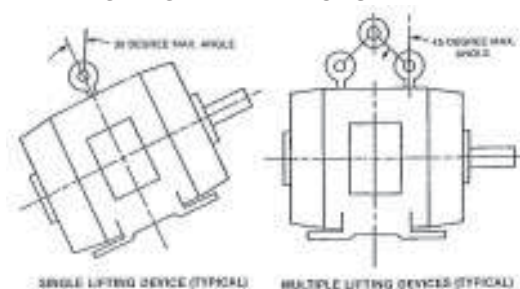
⚠ WARNING: FALLING OBJECT HAZARD

Eyebolts or lifting lugs, where provided, are intended for lifting only the motor and accessories mounted by the motor manufacturer (unless specifically stated otherwise on the motor). Utilizing the motor lifting provision to lift other components such as pumps and gear boxes could result in serious personal injury, death and/or property damage.

⚠ WARNING: FALLING OBJECT HAZARD

Before using the lifting provision, check the eyebolts and/or other lifting means to assure they are not bent or damaged and are completely threaded, seated & secured to the motor. Equipment to lift motor must have adequate lifting capacity. While lifting the motor DO NOT stand under or in the vicinity of the motor. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

2.2.1 LIFTING ANGLE LIMITATIONS



2.3 STORAGE: Motors, not put into service immediately, must be stored indoors in a clean, dry location. Avoid locations with large temperature swings that will result in condensation. Motors must be covered to eliminate airborne dust and dirt. If the storage location exhibits high vibration, place isolation pads under motor to minimize damage to motor bearings.

2.3.1 BEARING LUBRICATION: Bearings are grease packed at the factory; relubrication upon receipt of motor or while in storage is not necessary. If stored more than one year, add grease per lubrication instructions (Table 4-4) before start-up.

2.3.2 SHAFT ROTATION: It is recommended that the motor shaft be rotated 5 to 10 rotations every three months to distribute the grease in the bearings. This will reduce the chance for corrosion to form on the bearing rolling elements and raceways. Note: Shaft seals and bearing seals may add drag.

2.3.3 DAMP OR HUMID STORAGE LOCATIONS: Treat unpainted flanges, shafts, and fittings with a rust inhibitor. Apply appropriate power to the motor's space heaters (if so equipped)

3.0 INSTALLATION AND OPERATION

⚠ WARNING: Only qualified personnel who are familiar with the appropriate national code, local codes and sound practices should install or repair electrical motors and their accessories. Installation should conform to the appropriate national code as well as local codes and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

⚠ WARNING: ELECTRICAL LIVE CIRCUIT HAZARD

Do not touch electrically live parts. Disconnect, Lockout and Tag input power supply before installing or servicing motor (includes accessory devices). Use a voltmeter to verify that power is off before contacting conductors.

3.1 LOCATION

3.1.1 SELECTING A LOCATION: Consideration should be given to environment and ventilation. Motors should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. A motor with the proper enclosure for the expected operating condition should be selected. Provide accessible clearance for cleaning, repair, service, and inspections (See section 3.1.3 for construction clearances). The location should be considered for possible future motor removal / handling. The free flow of air around the motor should not be obstructed.

3.1.2 AMBIENT TEMPERATURE LIMITS: The ambient temperatures of the air inlet to the motor should not exceed 40°C (104°F) or be less than -30°C (-22°F) unless the motor nameplate specifically states an ambient temperature outside of these limits. The ambient inside an enclosure built around the motor shall not exceed the nameplate ambient. For ambient temperatures outside of these limits consult the motor manufacturer.

⚠ CAUTION: INSULATION DEGRADATION WARNING

Insulation at high temperatures ages at an accelerated rate. Each 10°C increase in temperature reduces the insulation life by one half.

⚠ WARNING: HAZARDOUS LOCATIONS AMBIENT LIMIT: Division 1 Hazardous Locations motors shall **NOT** be operated below -25°C (-13°F) ambient. (Low temperatures reduce the component mechanical properties.)

3.1.3 CONSTRUCTION SELECTION per LOCATION:

3.1.3.1 DRIPPROOF (OPEN) MOTORS are intended for use indoors where the atmosphere is relatively clean, dry, and non-corrosive. Recommended a minimum clearance of ½ the shaft height between vent openings and the nearest obstruction.

3.1.3.2 TOTALLY ENCLOSED MOTORS are suitable for indoor or outdoor standard service applications.

TEAO or AOM (Totally Enclosed Air Over) motors must be mounted in the air stream. When the motor nameplate states a minimum airflow the motor must be mounted in an air stream meeting this minimum value.

TEFC (Totally Enclosed Fan Cooled) motors must meet a minimum distance of ½ the shaft height between the fan guard grill openings and the nearest obstruction.

3.1.3.3 HAZARDOUS LOCATIONS MOTORS: Hazardous Locations motors are intended for installations in accordance with NEC Article 500. For all installations involving Hazardous Locations motors, consult the applicable national codes, local codes, and the authority having jurisdiction.

Division 1 Installations – includes Class I & II: Use only motors that are UL Listed and CSA Certified or UL Listed and UL Certified for Canada. These motors bear a separate nameplate that includes the UL Listing Mark and CSA Certification Mark or includes the UL Listing Mark and the UL Mark for Canada. This plate also bears the phrase: "Electric motor for Hazardous Locations" and is marked with the Class, Group and Operating Temperature Code.

Division 2 Installations – Class I only: Use only motors that are CSA Certified and bear the CSA Certification Mark. These motors include a phrase on the main motor nameplate that indicates the motor is CSA Certified for Class I, Division 2 / Zone 2 locations.

Division 2 Installation – Class II only: Use only Class II motors as described above under "Division 1 Installations".

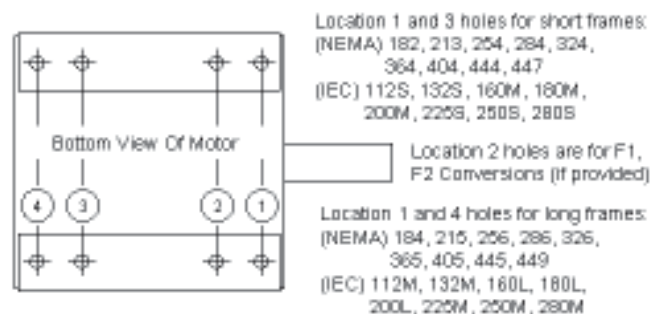
⚠ WARNING: EXPLOSION HAZARD

A motor should never be placed in an area with a hazardous process or where flammable gases or combustible materials may be present unless it is specifically designed and nameplated for this type of service. Hazardous Locations motors are intended for installations in accordance with NEC Article 500. For all installations involving Hazardous Locations motors, consult the NEC, local codes, and the authority having jurisdiction. Failure to follow these instructions could result in serious personal injury, death and/or property damage. (For other limitations see section 1.3)

3.2 MOUNTING MOTOR:

3.2.1 RIGID BASE (FOOTED): The motor must be securely installed to a rigid foundation or a mounting surface to minimize vibration and maintain alignment between the motor shaft and the load's shaft. The mounting surfaces of the four mounting pads must be flat within 0.01 inches for 210 frame & smaller; 0.015 inches for 250 frame & larger. [IEC 0.25 mm for 130 frame & smaller, 0.38 mm for 160 frame & larger]. This may be accomplished by shims under the motor feet. For special isolation mounting, contact manufacturer for assistance

3.2.2 RIGID BASE HOLE SELECTION -6 OR 8 HOLES



3.2.3 VERTICAL MOUNTING:

CAUTION: ENCLOSURE PROTECTION CAUTION: Most Drip-proof rigid base (footed) motors do **NOT** meet "Drip-proof" requirements when mounted vertically. If the motor is located in unprotected environments, the addition of a drip cover may be available. Drip covers not available for cast iron rigid base motors.

⚠ WARNING: FALLING OBJECT HAZARD

The lifting provision on standard horizontal footed motors is not designed for lifting the motor in a vertical shaft up or shaft down position. (see 2.2.1 lifting angles). Lifting method / provisions for

mounting a rigid base (footed) motor vertically is the responsibility of the installer.

VERTICAL SHAFT DOWN: Most standard horizontal motors thru 449 Fr. (excluding brake motors) can be mounted in a vertical shaft down orientation. For vertical brake motors see section 3.3.6.2.

VERTICAL SHAFT UP:

 **WARNING: HAZARDOUS LOCATIONS VERTICAL MOUNT:** Hazardous locations motors must **NOT** be mounted vertically shaft up without approval by the motor manufacturer. Without proper retaining provisions the rotor may move axially and contact components, creating a spark hazard.

Belted or Radial Load when mounted vertically: The following frame sizes / constructions with applied (axial) down loads within the limit stated are acceptable when mounted vertical shaft up.

Table 3-1 Belted or Radial Load Applications (All speeds)

Frame Size	Enclosure	Construction	Shaft Up OK	Max Applied Down Load ³
56	TEFC & ODP	Steel	Yes	25 lbs
140	TEFC	Steel & Cast Iron	Yes	25 lbs
	ODP	Steel	Yes	25 lbs
180	TEFC	All	Yes	35 lbs
	ODP	Steel	Yes	35 lbs
210	TEFC	All	Yes	40 lbs
	ODP	Steel	Yes	40 lbs
250	TEFC	All	Yes	40 lbs
	ODP	Steel	Yes	40 lbs
		Cast Iron	No ²	N/A
280-320	320 TTFC models	Cast Iron	Eng ¹	N/A
	All Other TEFC	Cast Iron & Aluminum	Yes	30 lbs
	ODP	Cast Iron	No ²	N/A
	TEFC & ODP	Steel	Build Up Only ⁴	N/A
360 & Up	TEFC	Cast Iron	Build Up Only ⁴	N/A
	ODP	Cast Iron	No ²	N/A
	TEFC & ODP	Steel	Build Up Only ⁴	N/A

Notes:

- ¹ For TEFC model numbers beginning with 324TTFC or 326TTFC consult the motor manufacturer to determine if a build up motor is required.
- ² The max applied down load is any applied load external to the motor, including such things as sheave weight, fan loads, axial belt force, pump load, etc. If the application is direct drive with no applied radial load, consult the motor manufacturer.
- ³ "Build-up only", refers to motors that are specifically ordered and built for shaft up applications. It does not imply that all build-up motors are suitable for shaft up applications.

3.3 APPLICATION ASSEMBLY TO MOTOR:

CAUTION: EQUIPMENT DAMAGE:

Do not connect or couple motor to load until correct rotational direction is established.

3.3.1 GENERAL: PROPER ALIGNMENT of the motor and driven equipment minimizes vibration levels, maximizes bearing life, and extends the overall life of the machinery. Consult the drive or equipment manufacturer for more information.

CAUTION: BEARING FAILURE

During assembly do NOT force components onto the shaft. Striking or hammering the component may result in bearing damage.

3.3.2 DIRECT COUPLING: Use flexible couplings if possible.

For applications that apply radial, axial or moment loading on the motor shaft see section 3.3.3.

CAUTION: BEARING FAILURE

Unless approved by the motor manufacturer do **NOT** direct couple a vertical shaft up or roller bearing motor. Direct coupling a vertical shaft up motor or a motor with a roller bearing may result in bearing damage.

3.3.3 DIRECT CONNECTED: Radial loading for direct connected equipment (gears, fans etc.) must be approved by the motor manufacturer unless within the maximum overhung load limits (Table 3-2). Combined loading (axial, radial and/or moments) must be approved by motor manufacturer. For belted loads see section 3.3.4.

Table 3-2 Maximum Radial Load (lbf) @ Middle of the Shaft Extension Length

Frame Number	Motor Rated RPM			
	3600	1800	1200	900
143T	106	166	193	210
145T	109	170	199	218
182T	187	230	261	287
184T	193	237	273	301
213T	319	317	470	510
215T	327	320	480	533
254T	500	631	729	793
256T	510	631	736	820
284T	-	866	990	1100
286T	-	871	1005	1107
324T	-	950	1100	1215
326T	-	950	1113	1230
364T	-	1078	1365	1515
365T	-	1078	1380	1540
404T	-	1388	1590	1762
405T	-	1400	1610	1780
444T	-	1580	1795	2005
445T	-	1520	1795	1985
447T	-	1455	1765	1985
449T	-	1640	1885	2130

Values based on 26,280 hrs B-10 Life

For "End of Shaft" Load multiply value by 0.88

To convert from lbf to N multiply value by 4.4482.

3.3.4 BELTED:

The goal of any belted system is to efficiently transmit the required torque while minimizing the loads on the bearings and shafts of the motor and driven equipment. This can be accomplished by following four basic guidelines:

1. Use the largest practical sheave diameter.
2. Use the fewest number of belts possible.
3. Keep sheaves as close as possible to support bearings.
4. Tension the belts to the lowest tension that will still transmit the required torque without slipping. It is normal for V-belts to squeal initially when line starting a motor

3.3.4.1 Sheave Diameter Guidelines:

In general, smaller sheaves produce greater shaft stress and shaft deflection due to increased belt tension. See Table 3-3 for recommended minimum sheave diameters. Using larger sheaves increases the contact with belts which reduces the number of belts required. It also increases the belt speed, resulting in higher system efficiencies. When selecting sheaves, do not exceed the manufacturer's recommended maximum belt speed, typically 6,500 feet per minute for cast iron sheaves. Determine belt speed by the following formula:

Figure 1



$$\text{BELT SPEED (Ft/min)} = \frac{\text{Shaft RPM} \times 3.14 \times \text{Sheave Dia (inches)}}{12}$$

3.3.4.2 Number of Belts

In general, use the fewest number of belts that will transmit the required torque without slipping. See Table 3-3 for recommended maximum number of belts. Each belt adds to the tension in the system, which increases load on the shafts and bearings. Belts are most efficient when operated at or near their rated horsepower. If the sheaves have more grooves than the number of belts required, use the grooves closest to the motor.

3.3.4.3 Sheave Location

Install sheaves as close to the housing as possible to increase the bearing life of the motor and driven equipment

3.3.4.4 Belt Tension

⚠ CAUTION: Equipment Failure Caution

Belt tensioning by feel is **NOT** acceptable. Tensioning by "feel" can be very misleading, and can damage motor and equipment. It is normal for V-belts to squeal initially when line starting a motor.

In general, belt tensions should be kept as loose as possible while still transmitting the required torque without slipping. Belt tensions must be measured with a belt tension gage. These inexpensive gages may be obtained through belt manufacturers, or distributors.

Proper belt tension is determined by measuring the force required to deflect the center of the belt a given distance. The proper deflection (in inches) is determined by dividing the belt span in inches by 64. Calculate the proper deflection and then see Table 3-3 for the required "Deflected Force" to achieve that deflection.

After tensioning the belt, rotate the sheaves for several rotations or operate the system for a few minutes to seat belts into the grooves, then re-tension the belts. New belts will stretch during use, and should be retensioned after the first eight hours of use.

Figure 2

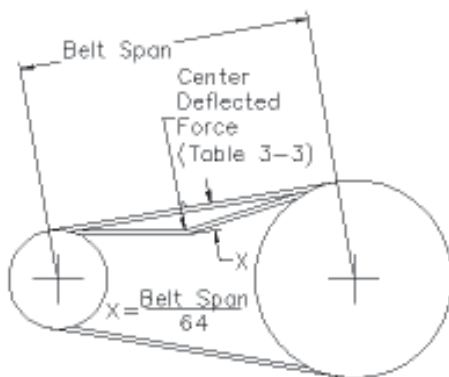
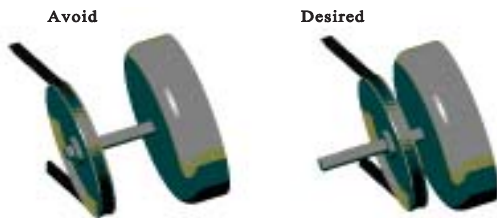


Table 3-3 Recommended Minimum Sheave Diameters, Belt Type, Number of Belts and Deflected Force

Motor Hp	1200 rpm				1800 rpm				3600 rpm			
	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)	Min Sheave Dia (in)	Belt Type	Max # of Belts	Avg. Deflected Force (lbs)
0.75	2.2	3VX	1	2.4	2.2	3VX	1	2.2	2.2	3VX	1	1.6
1	2.4	3VX	1	4.0	2.2	3VX	1	3.1	2.2	3VX	1	1.6
1.5	2.4	3VX	2	3.1	2.4	3VX	2	2.1	2.2	3VX	1	2.5
2	2.4	3VX	3	2.8	2.4	3VX	2	2.9	2.4	3VX	1	2.7
3	3.0	3VX	2	3.3	2.4	3VX	3	2.9	2.4	3VX	2	2.3
5	3.0	3VX	3	4.0	3.0	3VX	3	3.7	2.4	3VX	3	2.5
7.5	3.8	3VX	4	4.7	3.0	3VX	4	4.1	3.0	3VX	2	4.2
10	4.4	3VX	4	5.4	3.8	3VX	4	4.3	3.0	3VX	3	3.8
15	4.4	3VX	5	5.4	4.4	3VX	4	5.4	3.8	3VX	3	4.4
20	5.2	3VX	6	6.0	4.4	3VX	6	4.8	4.4	3VX	3	5.0
25	6.0	3VX	7	5.6	4.4	3VX	7	5.2	4.4	3VX	4	4.7
30	6.8	3VX	7	5.9	5.2	3VX	7	5.3	Contact Motor Manufacturer when Belting 3600 rpm Motors Greater than 25 HP			
40	6.8	5VX	4	11.6	6.0	3VX	7	6.0				
50	8.2	5VX	4	14.6	6.8	3VX	8	5.9				
60	8.2	5VX	5	14.1	7.4	5VX	4	13.3				
75	10.0	5VX	5	14.5	8.6	5VX	4	14.3				
100	10.0	5VX	6	16.0	8.6	5VX	6	13				
125	12.0	5V	7	14.1	10.5	5V	6	13.1				
150	13.2	5V	7	15.4	10.5	5V	7	13.4				
200	15.0	5V	8	16.0	13.2	5V	8	13.1				
250	15.0	8V	6	27.6	14.0	5V	9	13.8				
300	16.0	8V	7	27.1	14.0	5V/8V	11 / 7	23.4				
350	16.5	8V	7	30.3	14.5	5V/8V	12 / 7	26.0				
400	17.5	8V	8	29.1	15.0	5V/8V	13 / 8	25.7				
450	18	8V	8	31.6	16.0	5V/8V	14 / 9	25.2				
500	18.5	8V	9	30.7	16.5	5V/8V	15 / 9	26.9				
600					17.5	8V	11	26.3				
700					19.0	8V	12	27.3				
800					20.0	8V	13	28.2				

Notes:

1. Horsepower is the nameplate motor horsepower, and RPM is the motor (driver) speed.
2. Minimum sheave diameters are from NEMA standards where applicable.
3. **For variable speed applications or values outside these recommendations, consult motor manufacturer.**
4. Selections are based on a 1.4 service factor, 5 to 1 speed ratio and various Power Transmission Manufacturers' catalogs.
5. These selections are for Narrow V-belt sections only. Consult manufacturer for details on conventional V-belt sections (A, B, C, D and E), or other belt types.
6. "Average Deflected Force is per section 3.3.4.4 of this document and is the force required to deflect the center of a belt 1/64 of the belt span distance. Tolerance on this force is ± 1 lbf for forces ≤ 10 lbs, and ± 2 lbs for forces > 10 lbs as measured utilizing a belt tension gage.
7. When more than one belt is required the belts must be a matched set (matched for length).
8. If possible, the lower side of the belt should be the driving side to increase the length of wrap on the sheave).
9. For belted loads do not exceed 125% of 60 Hz operating RPM.

3.3.5 VFD (Variable Frequency Drives) OPERATION:



WARNING: VFD Motors with Reset Thermal Protectors
UL Recognition, UL Listing, or CSA certification does not apply to motors that are equipped with a manual or automatic reset thermal protector when the motor is operated on VFD power.



WARNING: Power Factor Correction Capacitors:
Power factor correction capacitors should never be installed between the drive and the motor.



CAUTION: VFD / Motor Setup:
It is the responsibility of the startup personnel during set up of the VFD / motor system to properly tune the drive to the motor for the specific application per the VFD user manual. The correct voltage boost and volts per hertz settings are application dependent and unique to each motor design. Failure to connect over temperature devices (when provided) will void the warranty.

3.3.5.1 Overspeed Capability:

Belted loads: Do not exceed 125% of 60 Hz operating RPM.

Table 3-4 Maximum Safe Continuous Speed (RPM) For Coupled and Direct Connected Loads

NEMA / [IEC] Frame Size	2-Pole	4, 6, or 8 Pole
56-180 [80-110]	7200 *	5400 *
210-250 [130-160]	5400 *	4200*
280 [180]	5400 *	3600
320 [200]	4500 *	3600
360 [225]	4500 *	2700
400-440 [250-280]	3600	2700
>440 [>280]	3600	1800

* = Fan cooled motors (Totally Enclosed & Hazardous Locations Motors) are limited to a maximum safe continuous speed of 4000 RPM **For higher speeds or shortened duty cycle contact motor manufacturer**

3.3.5.2 Cable Lengths: For optimum insulation life, limit VFD to motor cable lengths of general purpose motors

to Table 3-5 values. Definite purpose VFD motors may accommodate longer cable lengths. For additional information contact motor manufacturer.

Table 3-5 Max Cable Lengths General Purpose Motors

These values are based on 3 kHz carrier frequency. Add suitable VFD output-side filters when exceeding the listed values.

Frame Size	230V	460 V	575 V
NEMA 56-320	600 ft.	125 ft.	40 ft.
NEMA 360-5011	1000 ft.	225 ft.	60 ft.
IEC 80-200	180 m.	40 m.	12 m.
IEC 225-280.	300 m.	70 m.	18 m.

3.3.5.3 VFD Grounding: Equipment grounding conductors may be run in the same conduit as the AC motor power leads. This wire must be used as the equipment ground for the motor and not as the fourth current carrying wire of a "WYE" motor circuit. The grounded metal conduit carrying the output power conductors can provide EMI shielding, but the conduit does not provide an adequate ground for the motor; a separate grounding conductor must be used. Grounding the motor neutral (WYE) of a VFD powered motor may result in a VFD ground fault trip. Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. Refer to Grounding section 3.4.4

3.3.5.4 VFD – Single Phase:

CAUTION: SINGLE PHASE MOTOR FAILURE:

Single Phase motors are **NOT** suitable for use on VFD power. Connecting a Single Phase Motor to a VFD voids the warranty.

3.3.5.5 Stray Voltage on Accessory Leads:

VFD's will couple stray (common-mode) voltage to motor-mounted RTDs, thermistors, thermostats and space heaters. The leads of these elements must be properly insulated and control input circuits must be designed to withstand this common-mode voltage.

3.3.6 ACCESSORIES / PROVISIONS:

3.3.6.1 General: Carefully read and understand the accessory manufacturer's instructions, supplied with motor. Contact the manufacturer for additional information.

3.3.6.2 Brake Motors:

CAUTION: Vertical Motor Premature Brake Failure

Motors with brakes that are designed for vertical applications are equipped with springs to support the brake pressure plate. Mounting a horizontal brake motor vertically shaft up or down may require a pressure plate spring modification. Failure to modify the brake for the vertical application may result in premature brake failure. If in question, consult brake literature or brake manufacturer.

Brake Solenoid Wiring: Do NOT connect the brake solenoid to the output of a VFD. The brake solenoids must be wired to 50/60 Hz line power

3.3.6.3 Space Heaters:

Motors provided with space heaters have two leads that are brought into the conduit box or into an auxiliary box. These leads are marked "H1", "H2" ("H3", "H4" if a second space heater is supplied). See the space heater nameplate on motor for heater rating.

WARNING: DIVISION 2 EXPLOSION HAZARD

The space heater temperature rating when used in Class I, Division 2 motors shall **NOT** exceed 80% of the auto ignition temperature of the hazardous gas or vapor. See the space heater nameplate on motor for heater Temperature Code and heater rating. Failure to follow this instruction could result in serious personal injury, death and/or property damage

3.3.6.4 Thermal Protection:

General Information: When thermal protection is provided, one of the following will be stamped on the nameplate:

1. **"THERMALLY PROTECTED"** This motor has built in thermal protection. Thermal protectors open the motor circuit electrically when the motor overheats or is overloaded. The protector cannot be reset until the motor cools. If the protector is automatic, it will reset itself. If the protector is manual, disconnect motor from power supply. After protector cools (five minutes or more) press the reset button and reapply power to the motor. In some cases a motor is marked "Auto" and the connection diagram on the motor will identify T'Stat leads – see "2" below. (See warnings on Manual and Automatic reset protectors - section 1.1)

2. **"WITH OVERHEAT PROTECTIVE DEVICE"**: This motor is provided with an overheat protective device that does not directly open the motor circuit. Motors nameplated with this phrase have either thermostats, thermistors or RTD's. The leads to these devices are routed into the motor conduit box or into an auxiliary box. The lead markings are defined on the nameplate (normally "P1", "P2"). The circuit controlled by the overheat protection device must be limited to a maximum of 600 volts and 360 volt-amperes. See connection decal provided inside the terminal box cover. Failure to connect these over temperature devices (when provided) will void the warranty.

WARNING: EXPLOSION HAZARD

For Hazardous Locations motors provided with thermostats UL and the NEC require connection of thermostat leads into the control portion of a manual reset start circuit. Failure to follow this instruction could result in serious personal injury, death and/or property damage

Resistance Temperature Detectors (RTD): When winding and/or bearing RTDs are provided the RTD lead markings are defined on the nameplate. (Normally "R1", "R2", "R3" etc.)

3.3.6.5 RTD Alarm & Trip Settings:

Tables 3-6 & 3-7 are suggested initial RTD alarm and trip settings. For motors found to operate significantly below these values the settings may be reduced accordingly.

**Table 3-6 Winding RTD – Temperature Limit (°C)
40 °C Max Ambient**

Motor Load	Class B Temp Rise ≤ 80°C		Class F Temp Rise ≤ 105°C	
	Alarm	Trip	Alarm	Trip
Up to 1.0 SF	130	140	155	165
>1.0 to 1.15 SF	140	150	160	165

**Table 3-7 Bearing RTD – Temperature Limit (°C)
40 °C Max Ambient**

Ambient	Alarm	Trip
Up to 40°C	95	100
> 40°C	110	115
Bearings that are Heat Stabilized to 150 °C	130	135

3.3.7 GUARDS:

WARNING: ROTATING PARTS HAZARD

When devices are assembled to the motor shaft, be sure to install protective devices such as belt guards, chain guards, and shaft covers. These devices must protect against accidental contact with extremities, hair, and clothing. Consider the application and provide guarding to protect personnel. Remove all unused shaft keys and loose rotating parts to prevent them from flying off and causing bodily injury. Failure to follow this warning could result in serious personal injury, death and/or property damage.

3.4 ELECTRICAL CONNECTIONS:

WARNING: ELECTRICAL HAZARDS

Before proceeding read Section 1-1 on Electrical Safety. Failure to follow the instructions in Section 1-1 could result in serious personal injury, death and/or property damage

3.4.1 POWER SUPPLY / BRANCH CIRCUIT

WARNING: POWER SUPPLY INCOMPATIBILITY HAZARD

Check power supply to make certain that voltage, frequency and current carrying capacity are in accordance with the motor nameplate. Failure to match motor nameplate values could result in serious personal injury, death and/or property damage

WARNING: BRANCH CIRCUIT SUPPLY HAZARD

Motor and control wiring, fusing, overload protection, disconnects, accessories and grounding must always conform to the applicable electrical codes as well as local codes and sound practices.

3.4.1.1 Branch Circuit Supply to a motor should include a disconnect switch, short circuit current fuse or breaker protection, motor starter (controller) and correctly sized thermal elements or overload relay protection.

3.4.1.2 Fuses, Breakers, Overload Relays

Short Circuit Current Fuses or Breakers are for the protection of the branch circuit. Starter or motor controller overload relays are for the protection of the motor. Each of these should be properly sized and installed per the applicable electrical codes as well as local codes and practices.

WARNING: PROTECTIVE DEVICE DISABLED HAZARD

DO NOT bypass or disable protective devices. Protection removal could result in serious personal injury, death and/or property damage

3.4.1.3 AC Power Supply Limits

Motors are designed to operate within the following limits at the motor terminals:

- 1- AC power is within +/- 10 % of rated voltage with rated frequency applied. (Verify with nameplate ratings) **OR**
- 2- AC power is within +/- 5% of rated frequency with rated voltage **OR**
- 3- A combined variation in voltage and frequency of +/- 10% (sum of absolute values) of rated values, provided the frequency variation does not exceed +/-5% of rated frequency.
- 4- For 3 phase motors the line to line full load voltage must be balanced within 1%.
- 5- If the motor is rated 208-230V, the voltage deviations must be calculated from 230V.

CAUTION: Reduced Motor Performance

Operation outside of these limits will degrade motor performance and increase operating temperature.

3.4.2 TERMINAL BOX:

3.4.2.1 Conduit Opening: For ease of connections, motors are typically provided with large terminal boxes. Most motors have conduit access in 90 degree increments, the terminal box conduit opening is typically provided via knockouts, holes with covers, or the terminal box is rotate-able. Fabricated conduit boxes may have a removable plate for the installer to provide correctly sized hole(s).

3.4.2.2 Hazardous Locations Motors:

WARNING: EXPLOSION HAZARDS

(1) Terminal Boxes mounted to motor with a pipe nipple: If a pipe nipple mounted terminal box is removed or rotated it must be reassembled with a minimum of five full threads of engagement.

(2) Component Removal: Do not set a terminal box component on its machined surfaces. Prior to component reassembly wipe clean all machined surfaces.

(3) Machined Surface Gap (Hazardous Locations Terminal Boxes): The gap between mating surfaces with the machined terminal box MUST BE LESS THAN 0.002 inches. This gap must be checked with a feeler gage along the entire perimeter. If there is visible damage to the mating surfaces, or if the gap between these surfaces exceeds 0.002 inches, DO NOT complete the installation and contact the motor manufacturer. Failure to follow these instructions could result in serious personal injury, death and/or property damage

3.4.3 LEAD CONNECTIONS

Electrical connections to be made per nameplate connection diagram or separate connection plate. In making connections follow the applicable electrical code as well as local codes and practices.

WARNING: ELECTRICAL CONNECTION HAZARD

Failure to correctly connect the motor leads and grounding conductor can result in injury or death. Motor lead connections can short and cause damage or injury if not well secured and insulated.

3.4.3.1 Wire Size (Single Phase) Requirements

The minimum wire size for Single Phase, 115 & 230 Volt Circuits must meet table 3-8 for a given distance between motor and either Fuse or Meter Box.

**Table 3-8 Minimum Wire Gage Size Single Phase
115 & 230 Volt Circuits**

Distance (Feet) - Motor to Fuse or Meter Box								
Motor	100 Ft.		200 Ft.		300 Ft.		500 Ft.	
HP	115	230	115	230	115	230	115	230
1/4	14	14	10	12	8	10	6	8
1/3	12	14	10	12	6	10	4	8
1/2	10	12	8	10	6	8	4	6
3/4	10	12	6	10	4	8	2	6
1	8	10	6	8	4	6		4
1 1/2	4	10	0	8		6		4
2		8		6		4		2
3		8		6		4		2
5		6		4		2		0

3.4.3.2 Extension Cords (Single Phase Motors):

Where an extension cord(s) is utilized to provide power to the motor the extension cord(s) must be...(1) the proper gauge size per table 3-8, (2) in good working condition (3) properly grounded.

3.4.4 GROUND CONNECTION(S):

WARNING: ELECTRICAL GROUNDING HAZARD

For general information on grounding (USA) refer to NEC Article 250. Improper grounding of an inverter fed motor may result in frame voltages in excess of 500 Volts. In making the ground connection, the installer must make certain that a good electrical connection is obtained between motor and grounding lead. Failure to properly ground motors, per the applicable national code (such as NEC Article 430) and local codes may cause serious injury or death to personnel.

Primary "Internal" Ground: A grounding conductor must be connected to the grounding terminal provided in the terminal housing. This grounding terminal is either a ground screw, ground lug, or a tapped hole to be used with a separately provided ground screw. The internal grounding feature is accessible inside the terminal housing and must be used as the primary grounding connection.

Secondary "External" Ground: Some motors are provided with a supplemental grounding terminal located on the external surface of the motor frame or feet. This external terminal is for supplemental bonding connections where local codes permit or require such connection

3.4.5 START UP:

WARNING: ELECTRICAL SHOCK HAZARD:

Be certain that all connections are secure and the conduit box cover is fastened in place before electrical power is connected. Failure to follow these instructions could result in serious personal injury, death, and/or property damage.

**WARNING: LOOSE & ROTATING PARTS HAZARD**

Before proceeding read Section 1-2 on Mechanical Safety. Failure to follow the instructions in Section 1-2 could result in serious personal injury, death and/or property damage

**WARNING: EXCESSIVE SURFACE TEMPERATURE HAZARD**

Motors with the temperature code stated on the nameplate are designed to operate within this limit. Improper application or operation can cause the maximum surface temperature to be exceeded. A motor operated in a Hazardous Location that exceeds this surface temperature limit increases the potential of igniting hazardous materials. *Therefore, motor selection, installation, operation, and maintenance must be carefully considered to ensure against the following conditions:* (1) Motor load exceeds service factor value, (2) Ambient temperature above nameplate value, (3) Voltages outside of limits (3.4.1.3), (4) Loss of proper ventilation, (5) VFD operation exceeding motor nameplate rating, (6) Altitude above 3300 feet / 1000 meters, (7) Severe duty cycles, (8) Repeated starts, (9) Motor stall, (10) Motor reversing, and (10) Single phase operation. Failure to follow these instructions could result in serious personal injury, death and/or property damage.

**CAUTION: HOT SURFACE**

Normal motor surface temperatures may exceed 90 ° C (194° F). Touching the motor frame may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch.

3.4.5.1 Start Up - No Load Procedure

- 1. Check Instructions:** Before startup carefully read and fully understand these instructions including all warnings, cautions, and safety notice statements.
- 2. Motor out of storage after more than three months:** Check winding insulation integrity with a Megger. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before energizing the motor.
- 3. Check Installation: Mechanical** - Check tightness of all bolts and nuts. Manually rotate the motor shaft to ensure motor shaft rotates freely. Note: Shaft & bearing seals will add drag.
Electrical - Inspect all electrical connections for proper terminations, clearance, mechanical tightness and electrical continuity. Be sure to verify connections are made per the nameplate connection diagram or separate connection plate. Replace all panels and covers that were removed during installation before energizing the motor.
- 4. Energize Motor: Check Rotation**
If practical check motor rotation before coupling to the load. Unlock the electrical system. Momentarily provide power to motor to verify direction of rotation. If opposite rotation is required, lock out power before reconnecting motor. If motor has a rotational arrow only operate the motor in the rotation identified. Reapply power to ensure proper operation.
- 5. Record No Load Amps, Watts & Voltage:**
Recommend - To establish a baseline value check and record the no load amps, watts, and voltage.

3.4.5.2 Start Up – Load Connected Procedure

- 1. Check Instructions:** Before startup carefully read and fully understand these instructions including all warnings, cautions, & safety notice statements.
- 2. Coupling Installation:** Check that the connected equipment is properly aligned and not binding. Check that all guards and protective devices are properly installed.
- 3. Energize Motor:** When all personnel are clear of the machine, apply power and verify that the load is not transmitting excessive vibration back to the motor through the shaft or the foundation. Verify that motor amps are within nameplate rating. For repeated starts see 3.4.5.3. The equipment can now be fully loaded and operated within specified limits as stated on the nameplate.

3.4.5.3 Jogging and/or Repeated Starts

Do not start more than twice in succession under full load. Repeated starts and/or jogs of induction motors can cause overheating and immediate failure. Contact the motor manufacturer if it is necessary to repeatedly start or jog the motor.

4.0 MAINTENANCE:**WARNING: Hazardous Locations Motor Repair HAZARD:**

Division 1 Hazardous Locations motors can only be modified or repaired by the manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage.

**WARNING: ELECTRICAL SHOCK HAZARD**

Electrical connections are to be made by qualified electrical personnel in accordance with all applicable codes, ordinances and sound practices. Failure to follow these instructions could result in serious personal injury, death and/or property damage. Only qualified personnel who are familiar with the applicable national codes, local codes and sound practices should install or repair electric motors and their accessories.

**WARNING: ELECTRICAL LIVE CIRCUIT HAZARD**

Do not touch electrically live parts. Disconnect, lockout and tag input power supply before installing or servicing motor (includes accessory devices).

4.1 GENERAL INSPECTION

Inspect the motor approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation and fin openings clear. The following steps should be performed at each inspection:

4.1.1 VENTILATION: Check that the ventilation openings and/or exterior of the motor is free of dirt, oil, grease, water, etc, which can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.

4.1.2 INSULATION: Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. If winding resistance to ground is less than 1.5 Meg-ohms consult the local authorized service shop before re-energizing the motor.

4.1.3 ELECTRICAL CONNECTIONS: Check all electrical connectors to be sure that they are tight.

4.2 LUBRICATION & BEARINGS:

The lubricating ability of grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Longer bearing life can be obtained if the listed recommendations are followed:

NOTE: If lubrication instructions are provided on the motor nameplate, the nameplate instructions will supersede these instructions. Motors marked "Permanently Lubricated" do not require additional service.

**CAUTION: BEARING / MOTOR DAMAGE WARNING**

Lubricant should be added at a steady moderate pressure. If added under heavy pressure bearing shield(s) may collapse. Over greasing bearings greatly increases bearing friction and can cause premature bearing and/or motor failure.

4.2.1 GREASE TYPE (unless nameplate states otherwise):
Nameplate Ambient Temperature between -30°C (-22°F) to 65°C (150°F) inclusive: Recommended grease for standard service conditions is Mobil Polyrex® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube, Chevron SRI & Mobil SHC 100.

Nameplate Ambient Temperature below -30°C (-22°F): Special low temperature grease is recommended, such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.

Nameplate Ambient Temperature above 65°C (150°F): Dow Corning DC44 or equivalent, a special high temperature grease is required. Note that Dow Corning DC44 grease does not mix with other grease types.

For RTD settings see Table 3-7.

4.2.2 BEARING OPERATING TEMPERATURE:

CAUTION: HOT SURFACE

The external surface temperature of the end shield (bracket) bearing hub may reach 100° C (212° F) during normal operation. Touching this surface may cause discomfort or injury. Surface temperatures should only be measured with suitable instruments and not estimated by hand touch.

4.2.3 LUBRICATION INTERVALS: (For motors with regreasing provisions)

Eq. 4.2 Lubrication Interval = [(Table 4-1) hrs] x [Interval Multiplier (Table 4-2)] x [Construction Multiplier (Table 4-3)]

Table 4-1 Lubrication Intervals (Hours) These values are based on average use.

NEMA / [IEC] Frame Size	Operating Speed – RPM (See Table 3.4 for Maximum Operating Speed)					
	<7200	<5400	<4500	<3600	<1800	<1200
56-180 [80-110]	2500 Hrs.	4000 Hrs	5000 Hrs	6000 Hrs.	17000 Hrs.	20000 Hrs.
210-250 [130-160]		2500 Hrs	4000 Hrs	5000 Hrs.	12000 Hrs.	16000 Hrs.
280 [180]		2000 Hrs	3000 Hrs	4000 Hrs.	10000 Hrs.	14000 Hrs.
320 [200]			2000 Hrs	3000 Hrs.	9000 Hrs.	12000 Hrs.
360 [225]			1500 Hrs	2000 Hrs.	8000 Hrs.	10000 Hrs.
400-440 [250 – 280]				1500 Hrs.	4000 Hrs.	7000 Hrs.
>440 [>280]				1000 Hrs.	3000 Hrs.	5000 Hrs.

Seasonal Service: If motor remains idle for more than six months, Lubricate at the beginning of the season, then follow lubrication interval.

Do not exceed maximum safe operating speed Table 3-4 without manufacturer's approval

Table 4-2 Service Conditions

Use highest level Multiplier: Maximum Ambient Temperature and Contamination are independent factors

Severity of Service	Maximum Ambient Temperature	Atmospheric Contamination	Multiplier
Standard	Less than 40° C (104° F)	Clean, Slight Corrosion, indoors, less than 16 hrs per day	1.0
Severe	Above 40° C (104° F) to 50° C	Moderate dirt or Corrosion or outdoors or more than 16 hrs per day	0.5
Extreme	Greater than 50° C or Class H Insulation	Severe dirt or Abrasive dust or Corrosion	0.2

Table 4-3 Construction Multiplier

Construction	Multiplier
Angular Contact or Roller Bearing	0.5
Vertical Motor	0.5
All others	1.0

Table 4-4 Relubrication Amounts

Frame Size		Volume		
NEMA	IEC	Cu. In.	Fluid oz	ml
48-56	80	0.25	0.14	4.0
143-145	90	0.25	0.14	4.0
182-184	110	0.50	0.28	8.0
213-215	130	0.75	0.42	12.5
254-256	160	1.00	0.55	16.0
284-286	180	1.50	0.83	25.0
324-326	200	2.00	1.11	33.0
364-365	225	3.00	1.66	50.0
404-405	250	3.80	2.11	62.0
444-449	280	4.10	2.27	67.0
>449	>280	4.50	2.50	74.0

For regreasing while operating multiply volume by 125%.

4.2.4 LUBRICATION PROCEDURE: (For Motors with Regreasing Provisions)

CAUTION: BEARING DAMAGE WARNING

Added grease must be compatible with the original equipment's grease. If a grease other than those stated in 4.2.1 is to be utilized contact the motor manufacturer. Nameplate information supersedes section 4.2.1 (GREASE TYPE). New grease must be free of dirt. Failure to follow these instructions and procedure below may result in bearing and/or motor damage.

For an extremely dirty environment, contact the motor manufacturer for additional information.

LUBRICATION PROCEDURE:

1. Clean the grease inlet plug or zerk fittings prior to regreasing.
2. (If present) Remove grease drain plug and clear outlet hole blockage.

CAUTION: GREASE DRAIN PLUGGED:

Old grease may completely block the drain opening and must be mechanically removed prior to regreasing. Forcing a blocked drain open by increased greasing pressure may collapse bearing shields and / or force excess grease through the bearings and into the motor.

3. Add grease per Table 4-4
4. Re-install grease inlet and drain plugs (if removed).



WARNING: EXPLOSION HAZARD

Do NOT energize a Hazardous Locations motor without all grease fittings properly installed.

4.2.5 EXAMPLE: LUBRICATION

Assume - NEMA 286T (IEC 180), 1750 RPM Vertical motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 4-1 list 10,000 hours for standard conditions.
2. Table 4-2 classifies severity of service as "Severe" with a multiplier of 0.5.
3. Table 4-3 lists a multiplier value of 0.5 for "Vertical"
4. (Eq. 4.2) Interval = 10,000 hrs x 0.5 x 0.5 = 2500 hrs

Table 4-4 shows that 1.5 in³ of grease is to be added.

Relubricate every 2,500 hrs of service with 1.5 in³ of recommended grease.

4.3 TROUBLE-SHOOTING



WARNING: READ INSTRUCTIONS:

Before trouble-shooting a motor, carefully read and fully understand the warnings, cautions, & safety notice statements in this manual.



WARNING: Hazardous Locations Motor Repair:

Motors nameplated for use in Division 1 Hazardous Locations can only be disassembled, modified or repaired by the plant of manufacturer or a facility that is Listed under UL's category "Motors and Generators, Rebuilt for use in Hazardous Locations". Failure to follow these instructions could result in serious personal injury, death and/or property damage

CAUTION: DISASSEMBLY APPROVAL REQUIRED:

Motor disassembly must be performed by a party approved by the motor manufacturer. To disassemble the motor without approval voids the warranty.

4.3.1 GENERAL TROUBLE-SHOOTING WARNINGS

1. **DISCONNECT POWER TO THE MOTOR BEFORE PERFORMING SERVICE OR MAINTENANCE.**
2. **Discharge all capacitors before servicing motor.**
3. **Always keep hands and clothing away from moving parts.**
4. **Be sure required safety guards are in place before starting equipment.**
5. **If the problem persists contact the manufacturer.**

4.3.2 Motor Trouble-shooting Cause / Corrective Action - Table 4-5

Issue:		Likely Cause:	Corrective Action:
Motor fails to start upon initial installation:			
	A.)	Supply voltage is too low or is severely unbalanced (one phase is low or missing).	(1) Check power supply fuses (2) Match motor lead wiring to nameplate connection diagram and supply voltage (3) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (4) Obtain correct motor to match actual supply voltage.
	B.)	Motor leads are miswired at conduit box.	
	C.)	Driven load exceeds motor capacity	(1) Verify that motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely. Note: Roller bearings make noise when motor is uncoupled and shaft is rotated (3) Verify that motor starts when disconnected from load (4) Remove excessive / binding load if present.
	D.)	Load is jammed.	
	E.)	Fan guard is bent and making contact with fan	Replace fan guard & fan (if blades are damaged)
	F.)	VFD with power factor capacitors installed	Remove power factor correction capacitors if equipped
	G.)	VFD with motor neutral lead grounded	Ensure that motor neutral lead is ungrounded
	H.)	VFD programmed incorrectly	(1) Repeat checks listed above (2) Verify that VFD current limit and starting boost are set correctly (5) Double-check motor and feedback parameter settings and VFD permissives (6) Repeat autotune (for vector drives) procedure (7) Consult VFD supplier.
Motor has been running, then slow down, stalls, or fails to restart:			
	A.)	Supply voltage has drooped or has become severely unbalanced	(1) Replace fuse or reset circuit breaker. Allow motor to cool down before resetting manual protector on motor. Warnings - See section 1.1 for automatic and manual reset protector warnings (2) Verify that rated and balanced supply voltage has been restored before restarting motor. Measure voltage during restart. Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3).
	B.)	Motor is overloaded	(1) Verify that motor & load turn freely. Repair binding components as needed (2) Reduce driven load to match motor capacity or increase motor size to match load requirements.
	C.)	Motor bearings are seized	
	D.)	Load is jammed.	
	E.)	VFD will not restart motor after tripping	(1) Check fault codes on VFD and follow VFD troubleshooting procedures (2) Verify that VFD input voltage is balanced and within limits (3) Remove excessive mechanical load if present.
	F.)	Capacitor failure on single phase motor (if equipped)	Warning: Potential Shock Hazard: Contact service shop to check capacitor.
Motor takes too long to accelerate:			
	A.)	Motor leads are not connected correctly	Match motor lead wiring to nameplate diagram.
	B.)	Supply voltage has drooped or become severely unbalanced.	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3). Correct as needed (2) Obtain correct motor to match actual supply voltage.
	C.)	Load exceeds motor capability	Determine correct motor size and contact motor representative to obtain replacement motor.
	D.)	Faulty start capacitor (Single Phase)	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
	E.)	Mechanical Failure	(1) Check to make sure motor & load turn freely (2) Disconnect motor from load & ensure motor turns freely
Motor rotates in the wrong direction:			
	A.)	Incorrect wiring connection at motor	[Single Phase] Reconnect motor according to wiring schematic provided. Note: Some motors are non-reversible [Three Phase] Interchange any two power supply (phase) leads.
Motor overheats or overload protector repeatedly trips			
	A.)	Driven Load is excessive	(1) If motor current exceeds nameplate value, ensure that driven load has not increased. Correct as needed. (2) If new motor is a replacement, verify that the rating is the same as the old motor. If previous motor was a special design, a general purpose motor may not have the correct performance.
	B.)	Ambient temperature too high	Most motors are designed to operate in an ambient up to 40 °C. (See section 4.2.2 Hot Surface Caution)
	C.)	Motor cooling fins and/or vent openings blocked	Remove foreign materials – clear vent openings, fan guard air inlets and frame fins (TEFC motors)
	D.)	Insufficient Air Flow	TEAO (Totally Enclosed Air Over) motors: Measure airflow next to motor surface and obtain minimum requirements from motor manufacturer.

E.)	Motor is started too frequently	See section 3.4.5.3
F.)	Supply voltage too low, too high, or unbalanced	(1) Ensure that steady state supply voltage at motor terminals is within limits (see section 3.4.1.3) Correct as needed (2) Reconnect motor per input voltage (3) Obtain correct motor to match power supply.

Motor Vibrates

A.)	Motor misaligned to load.	Realign load
B.)	Load out of balance (Direct drive application)	(1) Ensure that load is dynamically balanced: (2) Remove motor from load and inspect motor by itself. Verify that motor shaft is not bent. Rule of thumb is 0.002" runout for shafts extension lengths up to 3.00". Add 0.0005" per every additional inch of shaft length beyond 3.00".
C.)	Uneven tension on multiple belts	Mixing new with used belts. Replace multiple belt applications with a complete set of matched belts.
D.)	Driven load operating at resonant point / natural frequency.	(1) De-energize motor and record vibration as load coasts from 100% speed to 0 RPM. If vibration drops immediately, vibration source is electrical. If levels do not drop immediately, source is mechanical (2) Redesign system to operate below the resonant point (3) On VFD-driven loads, program skip frequencies to bypass resonant points (4) Increase carrier frequency to obtain <3% THD current (5) On variable torque loads reduce volts/hertz below base speed.
E.)	VFD torque pulsations	(1) Adjust VFD to obtain <3% THD current @ rated motor current (2) Adjust VFD stability for smooth operation. Vector drives may be unstable at light load.
F.)	Motor miswired at terminal box	Match motor lead wiring to nameplate connection diagram.
G.)	Uneven, weak or loose mounting support.	Shim, strengthen or tighten where required.
H.)	Motor bearings defective	Test motor by itself. If bearings are bad, you will hear noise or feel roughness. Roller bearings are normally noisy when operated without load. If sleeve bearing, add oil per nameplate instructions. For motors with regreasing provisions, add grease per relubricating instructions (see section 4.2.3). If noise persists contact warranty service.
I.)	Motor out of balance	Disconnect from load. Set motor on rubber pads on solid floor. Secure a ½ height key in shaft keyway and energize from balanced power supply @ rated voltage. Record vibration levels and compare with appropriate standards. If excessive vibration persists contact motor manufacturer.

Bearings repeatedly fail.

A.)	Load to motor may be excessive or unbalanced	(1) If belt drive check system per section 3.3.4. (2) Other than belting, check loading on motor shaft. An unbalanced load will also cause the bearings to fail. (3) Check runouts of mating components, such as a C-face and pump flange.
B.)	Bearings contaminated.	Motor enclosure not suitable for environment. Replace with correct enclosure construction
C.)	Incorrect grease or bearings for ambient extremes.	See section 4.2.1
D.)	VFD bearing damage	Ground brush, common mode filter, or insulated bearings must be added. Contact motor manufacturer.

Motor, at start up, makes a loud rubbing, grinding, or squealing noise.

A.)	Contact between rotating and stationary components	Belt squeal during across the line starting is normal: (1) Verify that supply voltage is within limits (see section 3.4.1.3). (2) Ensure that motor lead wiring matches nameplate connection diagram: (3) Isolate motor from load. (4) To locate point of contact turn motor shaft by hand. (5) If point of contact is not located contact motor service shop.
------------	--	--

Start capacitors repeatedly fail.

A.)	The motor acceleration time is too long	Motor may be too small for load. Record acceleration time. Start capacitors may fail if acceleration time exceeds 3 seconds.
B.)	Motor is being started too frequently	Excessive starting will damage motor capacitors. Contact motor manufacturer if motor is started more than 20 times/hour or if acceleration time exceeds 3 seconds.
C.)	Motor voltage low	Verify that voltage at the motor terminals is within limits (see section 3.4.1.3).
D.)	Defective start switch inside motor	Motor internal switch failure overheats start capacitor. Contact service shop or motor manufacturer.

Run capacitor fails.

A.)	High ambient temperature	Verify that the ambient does not exceed motor's nameplate value
------------	--------------------------	---

	B.)	Input voltage exceeds limit	Verify that voltage to the motor terminals is within limits (see section 3.4.1.3).
	C.)	Power surge to motor (caused by lightning strike or other high transient voltage).	If a common problem, install surge protector.

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VEOLIA PROJECT: 5000 218 009

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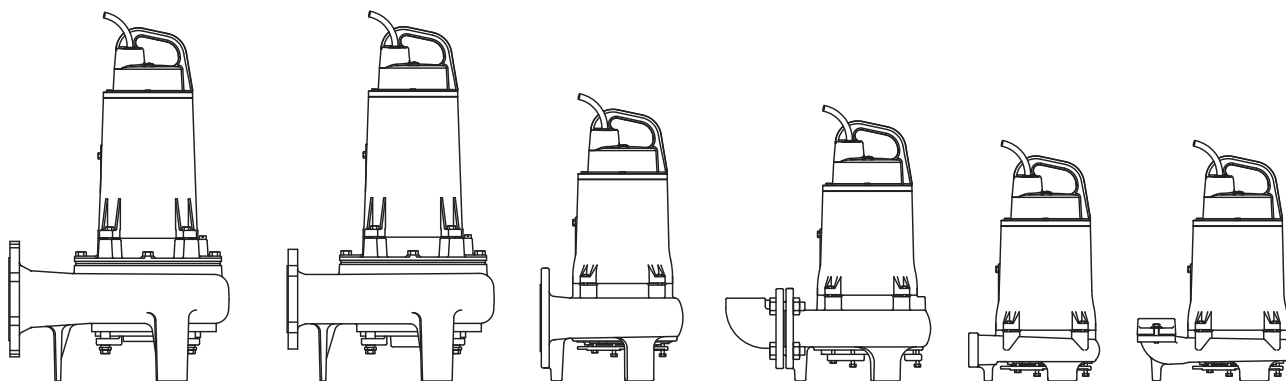
MODEL EJ 15D-2, SUBMERSIBLE PUMP

WATER TECHNOLOGIES

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SCAVENGER™ E SERIES MS

**EF SERIES EFFLUENT PUMPS
EJ SERIES SEWAGE EJECTOR PUMPS**



(EN) Installation Operation & Maintenance Manual

www.sulzer.com

Safety Instructions

**WARNING!**

Risk of serious injury or death from electric shock

- Insure that the pump motor is properly grounded prior to starting the pump.
- On pumps equipped with a plug, insure that the ground prong is intact in both the pump plug and any extension cords used to power the pump. Insure that the pump is plugged into a properly grounded receptacle.
- On pumps not equipped with a plug, insure that the green "ground" conductor in the pump power cable is properly grounded at the power supply or control panel per National Electrical Code requirements.
- Do not touch or hold the pump while it is connected to the electrical supply.
- Disconnect the pump from the electrical supply prior to performing any service work.
- Do not allow personnel to enter the water while the pump is running or is connected to the electrical supply. Disconnect the pump from the electrical supply prior to entering the water.
- Do not use the E Series Scavenger pumps in swimming pool applications or in any other application where people or animals may be in the water with the pump.
- In the event that the pump power cable is damaged, disconnect pump from power supply and have the cable replaced by a qualified ABS Service Center or repair shop. Do not operate the pump with a damaged power supply cable.

**CAUTION!**

Risk of injury during pump handling

- Prior to lifting the pump, insure that the pump lifting device (chain, wire rope, etc) is of suitable strength to lift the pump safely, and is in good condition.
- If the pump is to be lifted by a hoist, insure that the working load rating of the hoist exceeds the weight of the pump, and that the hoist is in good working condition.
- Never lift the pump by the power cable!
- Never work on a pump which is suspended in the air. Set the pump on the ground prior to performing any service or adjustments.
- Never apply power to a pump which is suspended in the air. The start reaction of the motor will cause the pump to spin violently and may cause injury.
- Scavenger pumps are made of cast iron and are heavy. Insure that pumps are handled in a manner that will prevent injury due to back strain, pinched fingers, foot injuries, etc.
- Disconnect pump from power supply prior to performing any service work or adjustments.

**WARNING!**

Risk of serious injury from spinning impeller

- Disconnect pump from power supply prior to performing any service work or adjustments.
- Do not put hands or feet inside pump discharge or suction for any reason.
- Do not check for pump rotation by putting hand or any object into pump discharge or suction.

**CAUTION!**

Risk of injury or loss from improper application or installation

- Insure that the Scavenger pump selected is the proper model for the intended application, and that the pump and electrical supply are fully compatible.
- Insure that the Scavenger pump has been properly installed and connected to the power supply prior to starting the pump.
- Do not use the Scavenger pump in applications where people or live animals will be in the water with the pump.
- Do not use the Scavenger pump in highly corrosive environments.
- Consult ABS for assistance with application or installation questions, or with any questions not addressed by this operation & maintenance manual.

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1.0 INTRODUCTION

1.1 INTRODUCTION

This manual was prepared to assist you in the correct installation, operation, and maintenance of your ABS pump. Please read it completely before installing the pump. Make certain that you are familiar with the contents, and that the chapters on installation and operation are fully understood before running the pump.

ABS pumps are designed for minimal maintenance. However, regular checks will ensure longer life and greater operating reliability.

- 1.2 The SCAVENGER™ series submersible pumps are designed to be used for pumping clean or contaminated water, residential or industrial sewage, or septic tank effluent. All liquids to be pumped must be compatible with the materials of construction of the pump. The pump consists of a fully submersible motor, close coupled to a non-clog type pump end.

- 1.3 **Warranty:** No repair work should be carried out during the warranty period without prior factory approval. To do so may render the warranty void.

Serial No.: In all correspondence and reports, make certain that the pump model and serial number is given.

2.0 DESIGN OF THE PUMP

- 2.1 ABS SCAVENGER™ submersible pumps are designed for continuous underwater operation in installations handling liquids containing suspended solids.

The motor and pump form a close coupled, watertight unit capable of operating while submerged to a depth of 65 feet. The squirrel cage induction motor is insulated against heat and moisture in accordance with Class "B" (130° C) regulations on models through 2 horsepower and class "F" (155° C) regulations on models from 3 to 10 horsepower.

The motor chamber is filled with non-toxic dielectric oil. This oil aids in motor heat transfer and lubricates the bearings. It also helps protect the motor from damage in the event of water entry.

The impeller is designed for efficient flow characteristics and clog-free operation.

Three-phase pumps are supplied with the free cable ends.

2.2 Table of Materials

Materials of Construction	
Housing & Volute	Cast Iron
Impeller and Wear Plate	Cast Iron
External Hardware	304 Stainless Steel
Motor Shaft	420 Stainless Steel
Mechanical Seals	Carbon/Ceramic (optional Silicon Carbide)
Bearings	Ball Bearings
Motor Windings	Copper (class B or F depending on model)
Start Switch (1 phase)	Solid State Electronic Switch
Power Cable	Thermoplastic Elastomer (20 ft. standard)
O-rings	Buna-N
Oil	Non-Toxic

3.0 UNPACKING, INSPECTION, AND STORAGE

- 3.1 ABS pumps are shipped from the factory ready for installation and use. They should be held in storage if the pump station is not complete.

Carefully open the shipping container and remove the pump. Check packing material for spare parts before discarding. Thoroughly inspect the pump for shipping damage. Pay special attention to the power cable, and discharge port threads (if applicable). Report any damage to the shipping carrier. In the event of damage, retain all packing material; it may be required to support a damage claim.

THE ENDS OF THE CABLE MUST BE PROTECTED AGAINST MOISTURE. DO NOT ALLOW THE CABLE ENDS TO COME IN CONTACT WITH WATER OR TO LAY ON THE GROUND OR FLOOR.

3.2 LONG TERM STORAGE

- 3.2.1 If it is necessary to store a pump for a long period of time, it should be stored indoors in a clean, dry temperature-stable environment. The pump should be left in its shipping container or otherwise protected from dirt and water. *The ends of the cable must be protected against moisture.*
- 3.2.2 Do not allow the pump to freeze. Water trapped during quality testing may expand and cause damage. If the pump must be stored in subfreezing environment, consult the factory for specific recommendations and precautions.
- 3.2.3 During storage, the impeller should be rotated a few turns once a month. Rotating the impeller will lubricate the seals and prevent seizing.

SCAVENGER™ E SERIES MS

- 3.2.4 Prior to installation, or if the pump has been unused for one month or longer, the impeller should be rotated by hand to ensure the seals are free-spinning.
- 3.2.5 Installed pumps which are idle for long periods of time should be started and run for a few seconds once a month to lubricate the seals.
- 3.2.6 Installed pumps which have been idle for longer than one month should be lifted from the wet well before being started. The impeller should be rotated by hand to ensure the seals are free-spinning. The pump should then be reinstalled and started.

4.0 INSTALLATION**4.1 FREE STANDING INSTALLATION**

The SCAVENGER™ pump may be installed using its integrated feet on any hard bottomed tank capable of supporting the weight of the pump. When installed in this manner, the pump stands vertically on its feet, and the discharge of the pump is hard piped from the pump flange to the exit of the wet well. The piping should include all the features shown in figure 4.1 including a coupling device which will allow the piping to be separated in the event the pump must be removed.

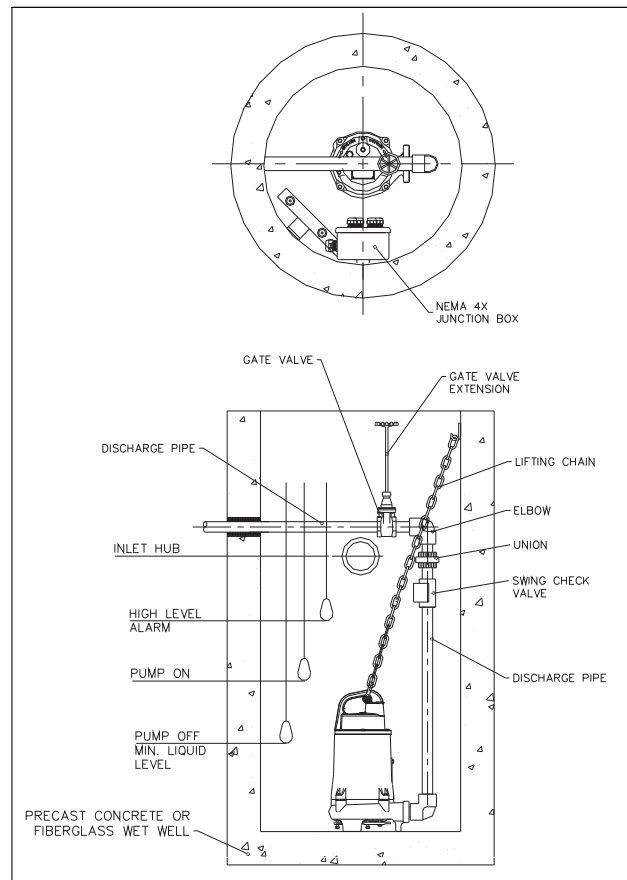
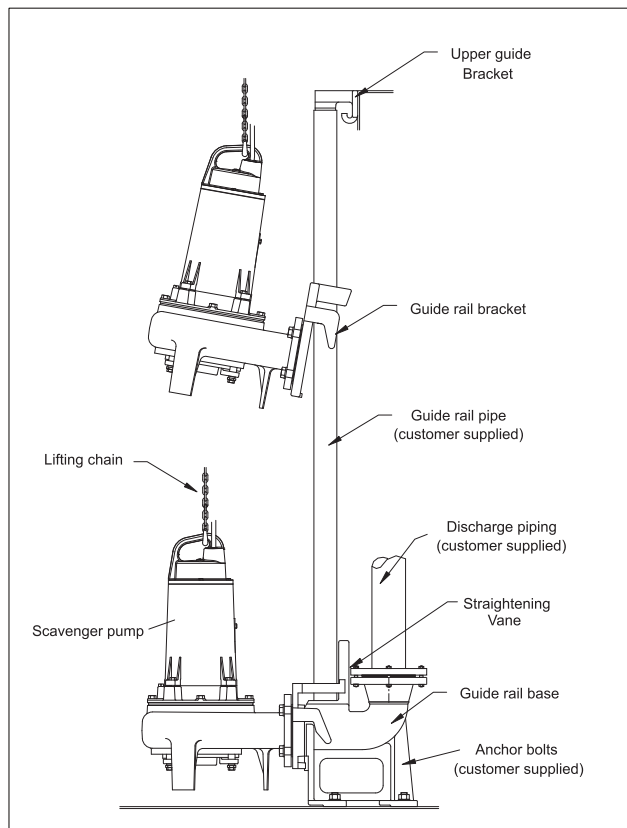
The pump should not be installed on a soft bottomed tank (dirt, sand, crushed stone, etc.) If installation on a soft bottomed tank is required, consult factory for a “mud plate” accessory, which must be installed on the pump to prevent it from sinking into the soft bottom.

The pump is designed to be installed with the motor oriented vertically. Consult factory for approval prior to attempting any horizontal mounting of a Scavenger pump.

4.2 GUIDE RAIL SYSTEM INSTALLATION

A guide rail system is a quick disconnect system which allows the pump to be removed from the wet well without disturbing the discharge piping. The guide rail base is anchored to the floor of the wet well and the discharge piping is attached to it.

A coupling bracket is attached to the discharge flange of the pump and allows the pump to slide up and down a guide rail pipe when being removed and installed. When the pump with coupling bracket attached, is lowered onto the guide rail base, the pump discharge seals against the base automatically using a profile gasket or o-ring (see figure 4.2)

**Figure 4-1****Figure 4-2**

4.2.1 Guide Rail Base Anchoring Methods

The preferred method of anchoring the guide rail base to the wet well floor is to use stainless steel stud anchors which are cast into the floor during wet well construction. These can be cast into a concrete floor when the floor is poured, or can be fiberglassed into the floor when using a fiberglass basin. In either case, stud spacing and alignment is critical, and must be carefully controlled so that the guide rail base installation goes smoothly. An alternate anchoring method for concrete wet wells is stud or bolt type anchors which are drilled into the concrete floor after the concrete is cured. These anchors are not as strong as the cast in type, but are suitable as long as they are properly selected and installed.

4.2.2 Guide Rail System Assembly & Installation

To assemble the Automatic Coupling System and to install the Guide Rail Assembly, follow these instructions. (See Figure 4.2)

1. Mount the straightening vane (5) to the guide rail base (6) with screws and spring washer.

Note: Some guide rail bases have an integrated straightening vane. *In this case, mounting of a bolt on straightening vane is not required.*

2. Install the guide rail base in the bottom of the wet well by means of cast-in anchor bolts (7). Check that the base is level, and insure that the base is positioned such that the guide rail pipe can be installed vertically between the base and upper guide rail bracket. Add grout beneath base to level. Re-check base after grout dries. Finally, secure in place with hex nuts and washers.
3. Position the upper guide bracket to the access cover or to the wall of the opening to determine length of guide rail. The guide rail, which is customer supplied, will be standard galvanized or stainless steel pipe. Pipe size depends on the particular guide rail base being installed. After positioning, cut pipe to the required length.
4. Install the guide rail pipe over the tapered plug of the guide rail base. Pipe should fit snugly over the plug.
5. Insert the upper guide bracket tapered plug into the upper end of the guide rail and locate so the guide rail is plumb. Secure upper guide bracket to the access cover or opening wall and Re-check for plumbness. Check that the guide rail base (6), the guide rail (2), and the upper guide bracket

(1) are on the same center line with the discharge connection and vertically aligned. This is necessary to assure that the pump will seal itself correctly. Press upper guide bracket (1) into the guide rail pipe (2) so that no play remains and finally secure the upper guide rail bracket by tightening the screws.

6. The molded profile gasket is placed in the pump bracket so that the thicker or rounded face points towards the guide rail base and the thinner or flat face points toward the pump flange.

Note: On some profile gaskets, both faces are the same shape and thickness. *In this case, the gasket can be installed either way.*

The pump bracket is fastened to the discharge of the pump with stainless steel fasteners. The bolts should be equally tightened in a cross-wise manner to prevent leakage of the seal.

7. The station discharge piping is attached to the threaded or flanged discharge connection of the guide rail base.

Piping should be provided with its own support mechanism so that the guide rail base is not required to support the full weight of the piping system.

4.3 FLOAT SWITCHES

Pumps are controlled by float switches mounted within the pump station wet well. Float switch cables are normally held in place with the float bracket mounted to the access cover frame or pit wall. See Figure 4-3 and 4-4. The floats must be secured so that they will not tangle with each other, catch on pipes, ladders or brackets.

High level Alarm-6 inches above the PUMP ON float.

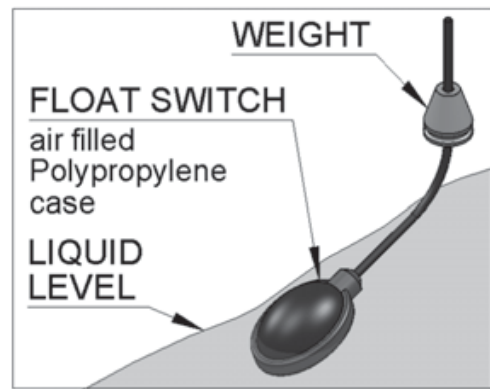


Figure 4-3

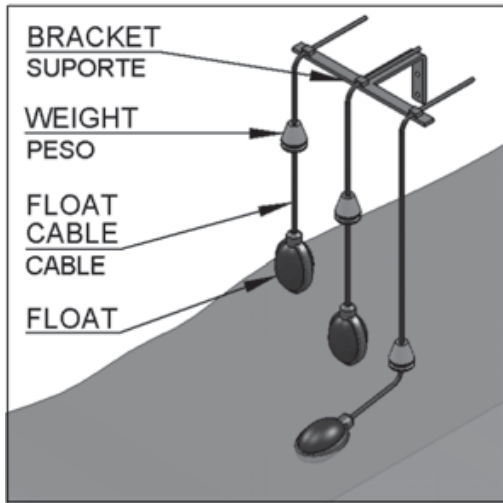


Figure 4-4

4.3.1 FLOAT SEQUENCE

1. As the liquid level in the wet well rises, the "PUMP OFF" float tilts, closing the switch. As the liquid level continues to rise, the "PUMP ON" float tilts. This switch closes, starting the pump.
2. The pump runs until the liquid level falls below the "PUMP OFF" float, emptying the wet well.
3. Duplex pump stations have an additional float for the second or lag pump. If the first pump fails to start or cannot keep up with the inflow and the wet well level continues to rise, the lag float is activated, bringing on the second pump. Both pumps then remain on until the wet well level drops below the off float level.
4. In the event of a malfunctioning float switch, control relay, or pump, the liquid level rises and tilts the "HIGH LEVEL ALARM" float activating the alarm.

4.3.2 FLOAT SWITCH INSTALLATION

The float switch levels will determine the storage volume of the pump station wet well. The storage volume is the main factor affecting the number of pump starts per hour.

Normally, all details of the pump station will be specified by engineering drawings. The drawings will specify the levels for PUMP ON and PUMP OFF floats and the HIGH-LEVEL ALARM float. If the float positions are not specified, the following guidelines for float switch levels will provide proper storage capacity and number of operating cycles for a standard pump station.

SIMPLEX PUMP STATION

Pump OFF-Minimum level at top of motor housing. Pump ON should be 1ft. minimum above pump OFF level. Keep a minimum of 1 ft. below bottom of influent pipe. High level alarm, 6" above lag float.

DUPLEX PUMP STATION

Pump OFF-Minimum level at top of motor housing. Lead pump ON float, minimum 1 ft. above OFF float (greater float spacing leads to fewer starts per hour, and is preferred). Lag float, 6" minimum above lead floats. High level alarm, 6" above lag floats.

If a specific installation cannot adhere to these guide lines, an engineer, the ABS representative, or the factory should be consulted for recommendations.

4.4 PUMP CONNECTIONS

The motor voltage and amp rating of the pump is shown on the nameplate of the pump.

Note: Some pumps are dual voltage or tri-voltage. The voltage for which the motor is connected is shown on a tag attached to the pump handle and on the carton label.

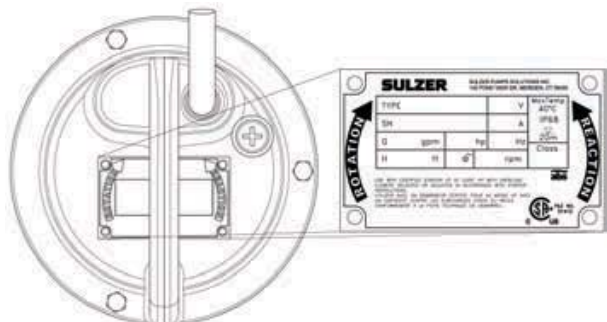
Check that the connected voltage is the same as the supply voltage. The connection of the pump cable leads should be carried out by a licensed electrician in accordance with the identification on the individual leads and the corresponding connections on the control panel. Refer to the Pump Wiring Diagram, Section 8.3.

After installing pump, insure that the power cable is properly secured; led straight up and away from the pump, so that it cannot get caught in the pump, and so that it is not bent and stressed at the point it enters the motor.

5.0 START UP

5.1 IMPELLER ROTATION

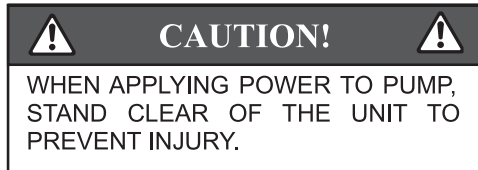
1. After the electrical connections are completed, and fully tested, the motor rotation must be checked. Incorrect rotation will result in low flow and can damage the motor.



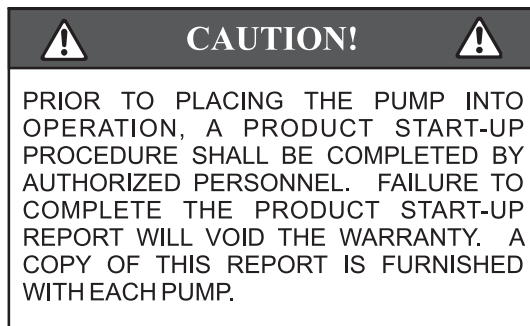
2. **Rotation.** Check to be sure the impeller is spinning in the proper direction before final installation of the pump. This is especially important with three phase pumps. Proper rotation is clock-wise when viewed from the

SCAVENGER™ E SERIES MS

top of the pump. Often the easiest method for determining rotation is the "Start Reaction" method. To check rotation this way, place the pump standing upright on the floor. Momentarily energize the power and watch the direction the pump body twists. This twist or "Start Reaction" will be in a direction opposite to the impeller rotation. The start reaction should twist the pump in a counter-clockwise direction when viewed from the top of the pump.



3. If the direction of rotation of a three phase pump is incorrect, disconnect power AHEAD of the control panel. Exchange any two of the motor input power leads at the power supply. This will reverse the rotation. Re-check pump for proper rotation after exchanging leads. If there are multiple pumps in the wet well, check rotation on each pump individually. Consult the factory immediately if a single phase pump runs backwards.
4. Run the pump under normal load, and check the motor amp draw with a clamp-on ammeter. Amp draw should be within the limits stated on the pump nameplate.



5.2 CURRENT UNBALANCE (three phase only)

After ensuring that the pump is rotating in the correct direction, and the current draw is within specifications, the Amount of current unbalance between phases must be calculated. Run the pump under water, simulating normal operating load conditions. Perform the measurements and calculations of the current unbalance equation. Enter the results of the current unbalance calculation on the Product Start-up Report.

CURRENT UNBALANCE EQUATION

$$\% \text{ OF CURRENT UNBALANCE} =$$

$$\frac{\text{MAX. CURRENT DIFFERENCE FROM AVERAGE CURRENT (X100)}}{\text{AVERAGE CURRENT}}$$

EXAMPLE:

1. MEASURE THE CURRENT (IN AMPS) OF EACH PHASE AT THE CONTROL PANEL TERMINAL STRIP.

$$\begin{aligned} T1 &= 10.0 \text{ AMPS} \\ T2 &= 10.5 \text{ AMPS} \\ T3 &= 10.5 \text{ AMPS} \end{aligned}$$

2. AVERAGE CURRENT

$$\frac{10.0 + 10.5 + 10.5}{3} = 10.33 \text{ AMPS}$$

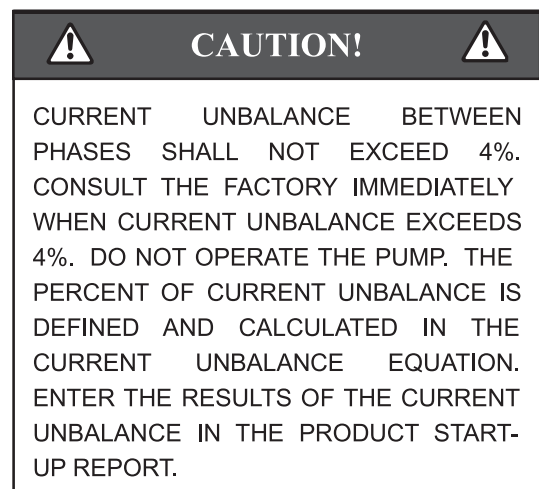
3. MAXIMUM CURRENT DIFFERENCE FROM AVERAGE

$$10.33 - 10.00 = .33 \text{ AMPS}$$

4. ACTUAL CURRENT UNBALANCE

$$\frac{.33}{10.33}(100) = 3.2\%$$

The current unbalance for this installation is 3.2% which is within specifications.



6.0 OPERATION & MAINTENANCE

6.1 OPERATION

After the electrical and mechanical installations have been performed, and the Product Start-Up Report completed, the pump is ready for operation. No operational procedures are required except to apply rated power to the pump. There are no specific shutdown procedures beyond disconnecting the power supply.

6.2 PREVENTATIVE MAINTENANCE

ABS pumps are designed with a minimum number of preventative maintenance checks. These checks are few but will add satisfactory service to the life of the pump. Maintenance checks should be performed at the intervals stated. Severe operating environments will require more frequent checks.

⚠	CAUTION!	⚠
UNDER NO CIRCUMSTANCES SHOULD TOOLS BE APPLIED TO THE PUMP AND MOTOR WITHOUT THE POWER TO THE CONTROL BOX BEING DISCONNECTED AND LOCKED OFF.		

6.2.1 Cable Inspection

The cable should be inspected for evidence of chafing, cuts or abrasion whenever the pumps is removed from the wet well. The area where the cable enters the terminal chamber should be examined carefully. If damage is found, the cable should be replaced.

6.2.2 Washdown

The accumulation of grease and sludge on the pump and float switches should be washed down at three month intervals to insure proper operation. This can be accomplished by using a high pressure hose. After cleaning the switches should be inspected and checked for proper operation.

6.2.3 Bottom Plate Clearance Adjustment

The SCAVENGER™ E Series pumps utilize the patented ABS Contrablock impeller system with an adjustable wear plate. This system provides superior solids handling ability and allows for easy impeller clearance adjustment for maximum pumping efficiency.

Clearance Adjustment

The wear plate on the bottom of the pump has been factory set during pump manufacture.

However, jostling during shipping can upset this adjustment. Prior to placing the pump in service, it is recommended that this adjustment be checked. This is especially true if the pump is found to be noisy during initial startup. A small amount of noise during initial operation is normal, but excessive noise or binding of the impeller indicates that adjustment is necessary.

To adjust the wear plate, lay the pump on it's side. Note that there are two sets of screws holding the wear plate; one set pulling the wear plate toward the impeller, and one set pushing it away. On some models, the hold down screws are threaded through a hole in the center of the push away screws. Adjusting the screws one quarter turn at a time, move the wear plate away from or toward the impeller to set the proper impeller clearance. The clearance is set properly when the impeller can be rotated freely, but the gap between the bottom of the impeller and wear plate is at a minimum. A small amount of contact between the impeller and wear plate is considered acceptable. Use care to insure that the wear plate is adjusted evenly against the impeller.

6.3 LUBRIATION

Internal pump components are lubricated during manufacture and do not require additional lubrication.

7.0 MAINTENANCE

7.1 MAJOR REPAIRS

Major repair tasks such as bearing, stator or motor shaft replacement should be performed only by ABS factory personnel or a technician trained by the ABS service department.

7.2 CABLE REPLACEMENT

The power cable is epoxy potted into the pump lid at the factory to guarantee a perfect seal. It is recommended that the ABS Service Dept. be contacted in the event a replacement cable assembly is required.

7.3 PARTS

For cross sectional drawings and part lists, please visit our website. You may also call or fax ABS to request this information. Be sure to include your pump model number in your request.

NOTE

If water is found in the motor chamber, the pump must be fully disassembled and major overhaul is required. This should only be performed by an ABS certified technician.

8.0 INTERNAL MOTOR CONNECTION

8.1 WIRE SIZE

All models must be wired to conform to the National Electric Code. Insure that the wire feeding the pump and control is of adequate size and rating for the full load amps of the motor.

8.2 WIRING

Check metal nameplate on unit to verify proper model, voltage and phase for which the unit is to be used; be sure they agree.

8.3 MOTOR VOLTAGE CHANGE

The operating voltage of 208-230/460 three phase models can be changed between 208-230 and 460 by reconnecting wires under the pump lid. Reconnection should be carried out by a qualified mechanic familiar with the wiring of electric motors. When removing the lid and changing the connections, insure that no dirt, debris, or wire slivers are allowed to drop into the motor.

8.3.1 Small Frame Scavengers (1-2 HP)

1. Winding connections are made using crimp connectors to join wires.
2. Note the position of the lid, then remove the lid and separate the quick connectors connecting the lid wires to the motor. Set the lid aside.
3. Using the appropriate wiring diagram on the next page, verify the present voltage connection by determining which wires are paired up with crimp connectors.
4. Cut the wires loose from the crimp connectors, being careful not to lose the wire markers.
5. Strip an appropriate amount of insulation back from each wire, and pair up the proper wires using new crimp connectors.
6. Verify that the proper wires are paired.
7. Clean the mating surface of the motor housing and lid. Clean and inspect the lid o-ring and set it in the groove on the motor housing.
8. Reconnect the wires from the lid to the motor and reinstall the lid being careful not to pinch any wires.

8.3.2 Large Frame Scavengers (3-10 HP)

The voltage change procedure is the same as for the small frame scavengers except no cutting

of wires is necessary. Wire connections are made by pairing appropriate wires on the terminal board. In the 208-230 volt configuration, jumpers are required between certain terminal posts. Jumpers are available from ABS, or 12 gauge solid copper wire can be used.

8.3.3 Single Phase Scavengers

The single phase EF05W-1H can be connected internally for either 115V or 230V.

All other single phase pumps can be connected for only 230V.

To reconnect the EF05W-1H pump for a different voltage, follow the same basic instructions as for the small frame three phase pumps, while using the appropriate single phase diagram shown on the next page. Be certain to make all the proper connections to the capacitor, start switch, and thermal overload shown in the diagram.

If changing a 115V pump to 230V, the plug on the end of the cord must be removed.

If changing from 230V to 115V, a plug may need to be added. After reconnecting pump, verify proper pump rotation prior to installation. If pump turns in the incorrect direction, exchange wires 5 & 8 to reverse rotation.

9.0 MONITORING SYSTEM

9.1 Application

The supervisory system is optional and can be applied to the pumps EJ10W until EJ 100D.

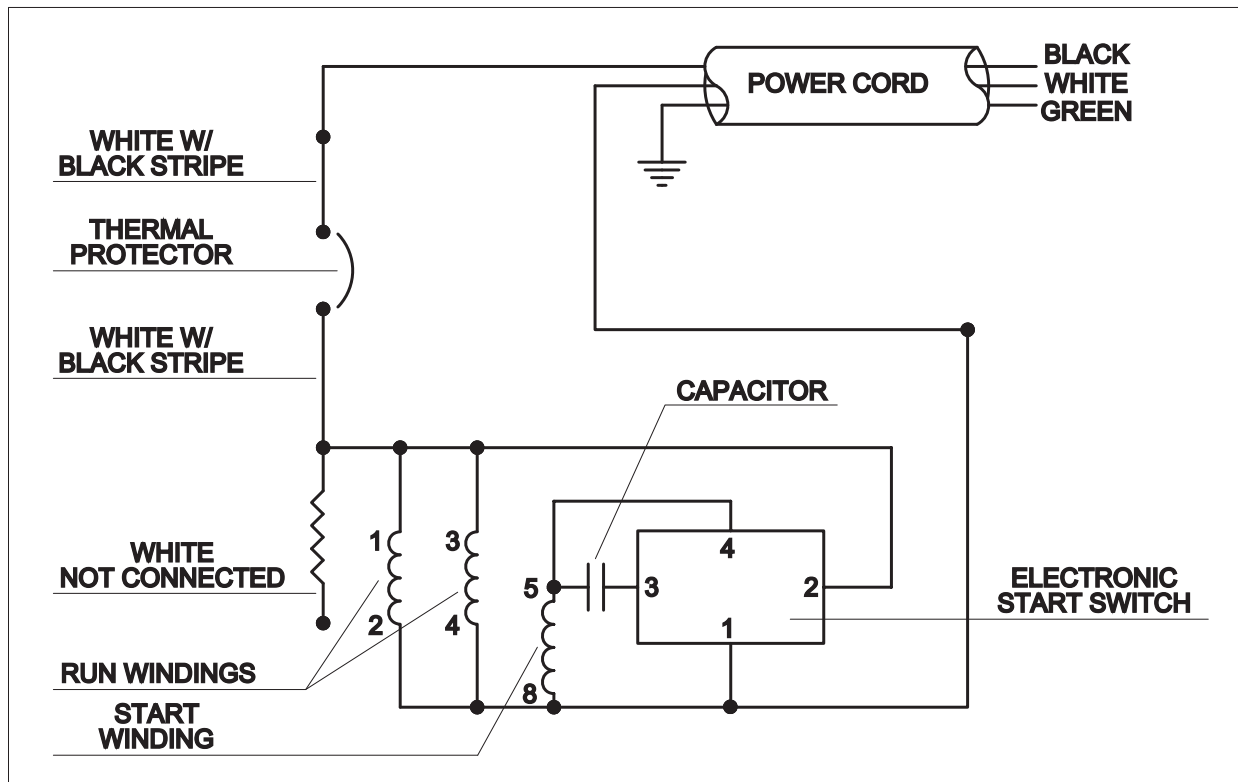
9.2 PROTECTION

A di-electrode, installed in the oil chamber, gives an early warning when moisture entered through the lower sealing.

Thermal protectors enclosed to the motor windings protect the motor against overheating.

The EJ 10W up to EJ 20W pumps, have an internal thermal protector. For these pumps, only a di-electrode is installed in the oil chamber and has to be wired to the control panel.

Wiring Diagrams



115V Single Phase Wiring Diagram.
Applies to 1/2 horsepower single phase models only.