

# NIDEC MOTOR CORPORATION

8050 WEST FLORISSANT AVE.  
ST. LOUIS, MO 63136



DATE: 2/17/2015

P.O. NO.: CE46  
Order/Line NO.: 19061 MN 100

TO:

Model Number: CE46  
Catalog Number:  
Titan Horizontal TEFC Config.  
CONF,MOTOR,TITAN HORIZ TEFC

REVISIONS:  
(NONE)

**ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.  
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.**

## Features:

Horsepower ..... 00350.00~00000.00 ~ KW: 261.1  
Enclosure ..... TEFC  
Poles ..... 04~00 ~ RPM: 1800~0  
Frame Size ..... 449~T  
Phase/Frequency/Voltage.. 3~060~460 ~ Random Wound  
Service Factor ..... 1.15  
Insulation Class ..... Class "F" ~ VPI-2000  
Altitude In Feet (Max) .. 3300 Ft.(1000 M)  
Ambient In Degree C (Max) +40 C  
Assembly Position ..... "F-1" Assembly Position  
Efficiency Class ..... Premium Efficiency  
Application ..... Centrifugal Pump  
Customer Part Number ....  
Max Shaft Runout = 0.0015 TIR  
"AK" Dimension (Inches).. NA  
Temperature Rise (Sine Wave): "B" Rise @ 1.0 SF (Resist)  
NEMA Design ..... B  
Starting Method ..... Direct-On-Line Start  
Duty Cycle ..... Continuous Duty  
Efficiency Value ..... 95.4 % ~ Typical  
Load Inertia (lb-ft<sup>2</sup>): NEMA ~ NEMA Inertia: 1373.00 ~ 1.00  
Number Of Starts Per Hour: NEMA  
Motor Type Code ..... JCE  
Rotor Inertia (LB-FT<sup>2</sup>) ..... 127. LB-FT<sup>2</sup>  
Qty. of Bearings PE (Shaft) 1  
Qty. of Bearings SE (OPP) 1  
Bearing Number PE (Shaft) C2220  
Bearing Number SE (OPP) 100BC02J3

Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.

# NIDEC MOTOR CORPORATION

8050 WEST FLORISSANT AVE.  
ST. LOUIS, MO 63136



DATE: 2/17/2015

P.O. NO.: CE46  
Order/Line NO.: 19061 MN 100

TO:

Model Number: CE46  
Catalog Number:  
Titan Horizontal TEFC Config.  
CONF, MOTOR, TITAN HORIZ TEFC

REVISIONS:  
(NONE)

ALL DOCUMENTS HEREIN ARE CONSIDERED CERTIFIED BY NIDEC MOTOR CORPORATION.  
THANK YOU FOR YOUR ORDER AND THE OPPORTUNITY TO SERVE YOU.

## Accessories:

26,400 Hours L-10 Bearing Life  
Inpro Seal - Both Ends  
Belted Connection To Load  
Corro-Duty / IEEE-841  
Counter CW Rotation FODE  
Special Foot Flatness  
Ground Lug In Conduit Box  
Tapped Hole On Foot (Ground)  
Special Balance  
Belting Data:  
Motor Sheave Pitch Dia. (Dm).. UNKNOWN  
Motor Face-Sheave Center (L)..  
Face Width-Motor Sheave (Ws)..  
Driven Sheave Pitch Dia (D1).. UNKNOWN  
C/L To C/L Of Sheaves .....  
Number Of Belts ..... UNKNOWN  
Belt Size & Type ..... UNKNOWN  
Direction Of Belt Pull .....  
Belt Manufacturer .....  
Dimensions Are Given In ..... Inches  
Standard Leadtime: REFER TO OFFICE  
Est. Weight (lbs ea): 2400 ~ F.O.B.: St. Louis, MO

## USE THE DATA PROVIDED BELOW TO SELECT THE APPROPRIATE DIMENSION PRINT

Horsepower	350
Pole(s)	04
Voltage(s)	460
Frame Size	449T
Shaft U Diameter	3.375
Outlet Box AF	8.06
Outlet Box AA	3.50

Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.

EFFECTIVE:  
**11-MAY-12**

SUPERSEDES:  
**22-MAR-11**

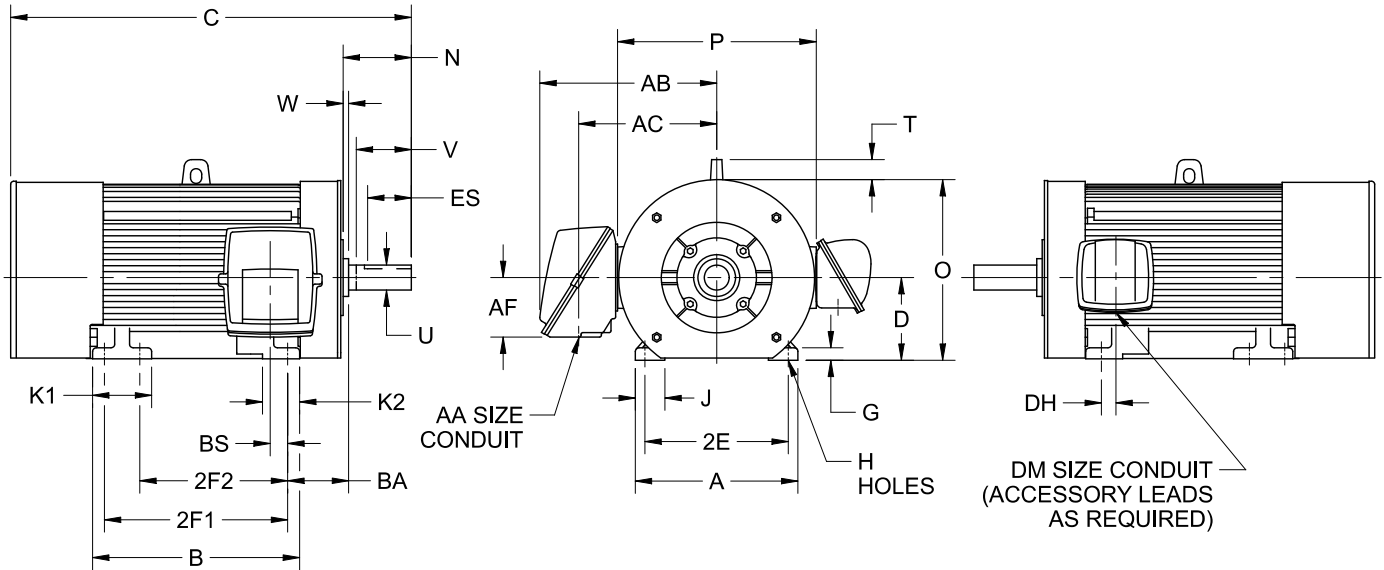
# HORIZONTAL MOTORS

## TOTALLY ENCLOSED FAN COOLED

FRAME: 449  
BASIC TYPE: J, JC

PRINT:  
**07-2044**

SHEET:  
**1 OF 1**



ALL DIMENSIONS ARE IN INCHES AND MILLIMETERS

UNITS	A	B	D	2E	2F1	2F2	G	H	J
IN	22.00	28.00	-.06	±.03	±.03	±.03	1.50	+.05	4.00
MM	559	711	279	457	635	508	38	21	102

UNITS	K1	K2	O	P <sup>2</sup>	T	W	BA	BS
IN	8.00	5.00	24.06	26.50	2.88	.13	7.50	2.50
MM	203	127	611	673	73	3	191	64

UNITS	VOLTS	AB	AC	AF	DH
IN	460	24.25	18.53	8.06	2.50
MM		616	471	205	64
IN	2300	24.25	18.53	8.06	2.50
MM		616	471	205	64
IN	4000	24.75	20.63	10.00	2.50
MM		629	524	254	64

UNITS	FRAME	C	N	U	V	ES	SQ
IN	449T	55.13	8.63	-.001	8.25	7.00	.875
MM		1400	219	85.73	210	178	22.23
IN	449TL	57.13	10.63	4.375	10.25	8.50	1.000
MM		1451	270	111.13	260	216	25.40
IN	449TM	51.38	4.88	2.875	4.50	3.63	.750
MM		1305	124	73.03	114	92	19.05
IN	449TS	51.38	4.88	2.375	4.50	3.13	.625
MM		1305	124	60.33	114	80	15.88

AA	DM
2 NPT	3/4 NPT
2 1/2 NPT	1 NPT
3 NPT	1 1/4 NPT
3 1/2 NPT	
4 NPT	

- DIMENSIONS MAY VARY BY .25" DUE TO CASTING AND/OR FABRICATION VARIATIONS.
- LARGEST MOTOR WIDTH.
- STANDARD ASSEMBLY POSITION F-1 IS SHOWN. F-2 IS PROVIDED WHEN SPECIFIED.  
CONDUIT OPENINGS MAY BE LOCATED IN STEPS OF 90 DEGREES REGARDLESS OF LOCATION. STANDARD AS SHOWN WITH CONDUIT OPENING DOWN.
- TOLERANCES SHOWN ARE IN INCHES ONLY.



# NAMEPLATE DATA

CATALOG NUMBER				NAMEPLATE PART #:		422704-006	
MODEL	CE46	FR	449T	TYPE	JCE	ENCL	TEFC
SHAFT END BRG		C2220 - QTY 1		OPP END BRG		100BC02J3 - QTY 1	
PH	3	MAX AMB	40 C	ID#			
INSUL CLASS	F	Asm. Pos	F1	DUTY	CONT		
HP	350	RPM	1785	HP		RPM	
VOLTS	460			VOLTS			
FL AMPS	381.0			FL AMPS			
SF AMPS	443.0			SF AMPS			
SF	1.15	DESIGN	B	CODE	G		
NEMA NOM EFFICIENCY	96.2	NOM PF	89.5	KiloWatt	261.100		
GUARANTEED EFFICIENCY	95.4	MAX KVAR	48.2	HZ	60		

**HAZARDOUS LOCATION DATA (IF APPLICABLE):**

DIVISION		CLASS I		GROUP I	
TEMP CODE		CLASS II		GROUP II	

**VFD DATA (IF APPLICABLE):**

VOLTS		
AMPS		
TORQUE 1		
VFD LOAD TYPE 1		
VFD HERTZ RANGE 1		
VFD SPEED RANGE 1		
TORQUE 2		
VFD LOAD TYPE 2		
VFD HERTZ RANGE 2		
VFD SPEED RANGE 2		
SERVICE FACTOR		
NO. POLES	4	
VECTOR MAX RPM		
Radians / Seconds	1	
FL SLIP		
MAGNETIZING AMPS	71.1	
Encoder PPR		
Encoder Volts		

**TEAO DATA (IF APPLICABLE):**

HP (AIR OVER)		HP (AIR OVER M/S)		RPM (AIR OVER)		RPM (AIR OVER M/S)	
FPM AIR VELOCITY		FPM AIR VELOCITY M/S		FPM AIR VELOCITY SEC			

**ADDITIONAL NAMEPLATE DATA:**

Decal / Plate	WD=499495	Customer PN	
Notes		Non Rev Ratchet	
Max Temp Rise	80C RISE/RES@1.00SF	OPP/Upper Oil Cap	GREASE
Thermal (WDG)		SHAFT/Lower Oil Cap	GREASE
Altitude			
Regulatory Notes		Regulatory Compliance	CC 030A
COS		Marine Duty	
Balance	0.06 IN/SEC	Arctic Duty	
3/4 Load Eff.	96.6	Inrush Limit	
Motor Weight (LBS)	2400	Direction of Rotation	
Sound Level		Special Note 1	
Vertical Thrust (LBS)		Special Note 2	
Thrust Percentage		Special Note 3	
Bearing Life		Special Note 4	
Starting Method		Special Note 5	
Number of Starts		Special Note 6	
200/208V 60Hz Max Amps		SH Max. Temp.	
190V 50 hz Max Amps		SH Voltage	
380V 50 Hz Max Amps		SH Watts	
NEMA Inertia		Load Inertia	
Sumpheater Voltage		Sumpheater Wattage	
Special Accessory Note 1		Special Accessory Note 16	MEETS INTENT IEEE841
Special Accessory Note 2		Special Accessory Note 17	
Special Accessory Note 3		Special Accessory Note 18	
Special Accessory Note 4		Special Accessory Note 19	
Special Accessory Note 5		Special Accessory Note 20	
Special Accessory Note 6		Special Accessory Note 21	
Special Accessory Note 7		Special Accessory Note 22	
Special Accessory Note 8		Special Accessory Note 23	
Special Accessory Note 9		Special Accessory Note 24	
Special Accessory Note 10		Special Accessory Note 25	
Special Accessory Note 11		Special Accessory Note 26	
Special Accessory Note 12		Special Accessory Note 27	
Special Accessory Note 13	SPECIAL WINDING	Special Accessory Note 28	
Special Accessory Note 14	CONTACT USEM PRIOR	Special Accessory Note 29	
Special Accessory Note 15	TO REMWINDING,CALL	Special Accessory Note 30	

**NIDEC MOTOR CORPORATION**  
ST. LOUIS, MO



TYPICAL NAMEPLATE DATA  
ACTUAL MOTOR NAMEPLATE LAYOUT MAY VARY  
SOME FIELDS MAY BE OMITTED

Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.

## MOTOR PERFORMANCE

MODEL NO.	CATALOG NO.	PHASE	TYPE	FRAME
CE46	NA	3	JCE	449T

ORDER NO.	19061	LINE NO.
-----------	-------	----------

MPI:	100888
HP:	350
POLES:	4
VOLTS:	460
HZ:	60
SERVICE FACTOR:	1.15
EFFICIENCY (%):	
S.F.	95.8
FULL	96.2
3/4	96.7
1/2	96.6
1/4	94.9
POWER FACTOR (%):	
S.F.	88.9
FULL	89.5
3/4	89.5
1/2	86.8
1/4	73.8
NO LOAD	5.2
LOCKED ROTOR	20.8
AMPS:	
S.F.	443
FULL	381
3/4	284
1/2	195
1/4	117
NO LOAD	71.1
LOCKED ROTOR	2384.5
NEMA CODE LETTER	F
NEMA DESIGN LETTER	B
FULL LOAD RPM	1785
NEMA NOMINAL EFFICIENCY (%)	96.2
GUARANTEED EFFICIENCY (%)	95.4
MAX KVAR	48.2
AMBIENT (°C)	40
ALTITUDE (FASL)	3300
SAFE STALL TIME-HOT (SEC)	25
SOUND PRESSURE (DBA @ 1M)	84
TORQUES:	
BREAKDOWN{% F.L.}	242
LOCKED ROTOR{% F.L.}	125
FULL LOAD{LB-FT}	1031

NEMA Nominal and Guaranteed Efficiencies are up to 3,300 feet above sea level and 25 ° C ambient

The Above Data Is Typical, Sinewave Power Unless Noted Otherwise

**NIDEC MOTOR CORPORATION**  
ST. LOUIS, MO

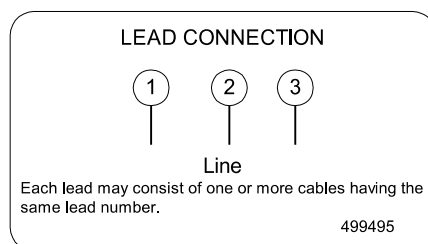
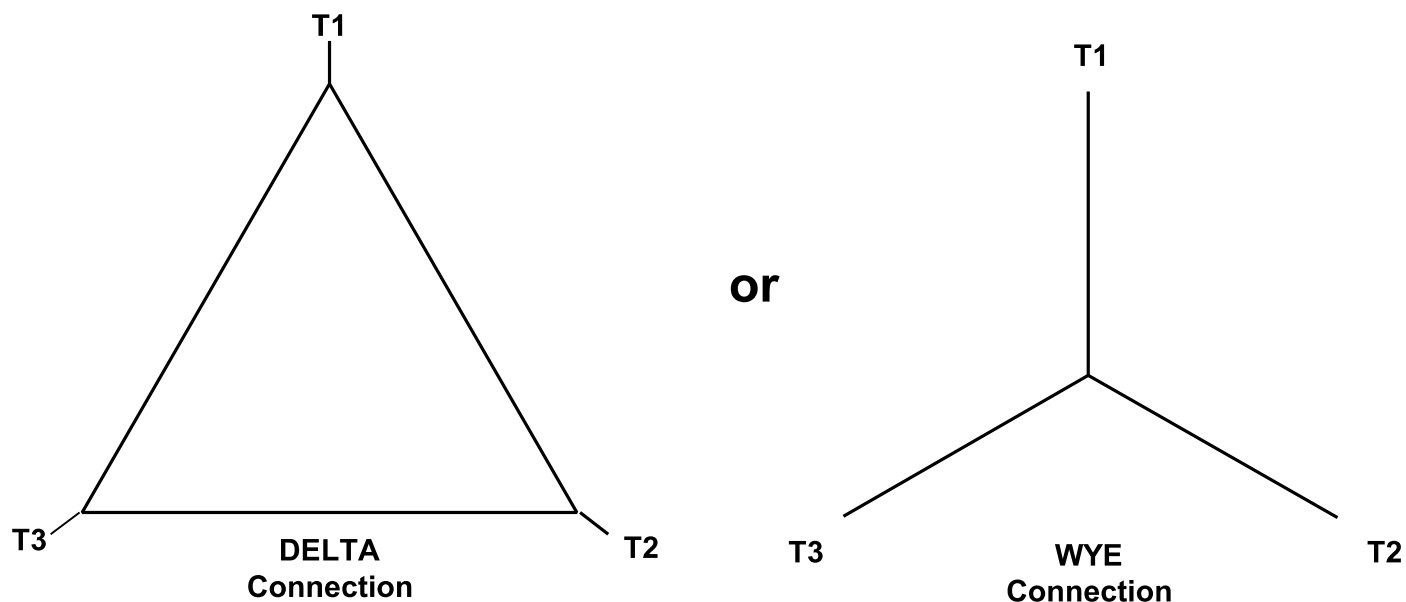


Nidec trademarks followed by the ® symbol are registered with the U.S. Patent and Trademark Office.



499495

## Motor Wiring Diagram

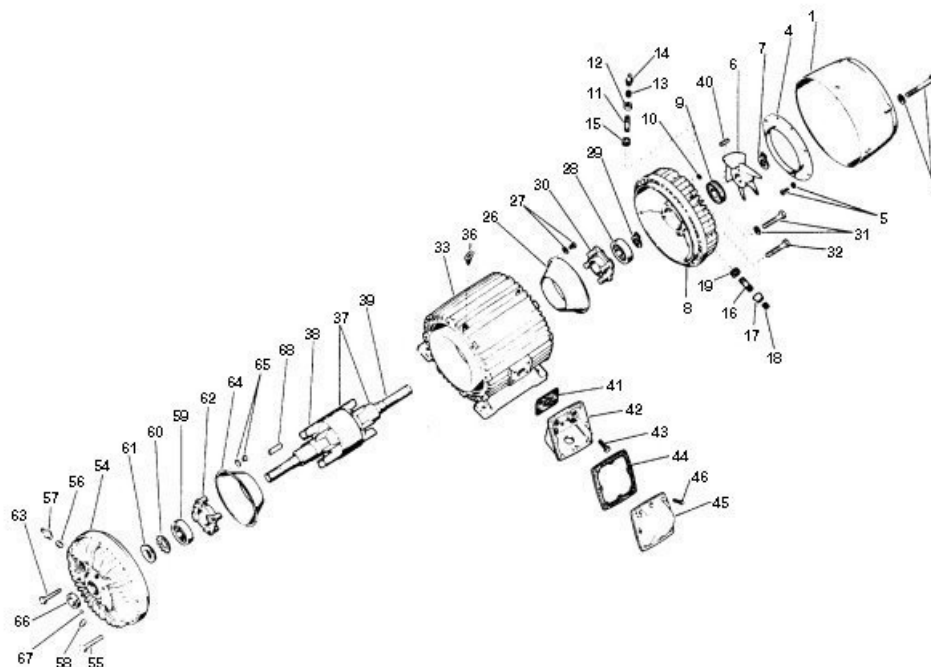


To reverse direction of rotation interchange connections L1 and L2.

Each lead may be comprised of one or more cables.  
Each cable will be marked with the appropriate lead number.

## RENEWAL PARTS

FRAMES 449, 5004 THRU 5811 - TOTALLY ENCLOSED AND EXPLOSION PROOF MOTORS  
 TYPES: E, EC, ECEI, EEI, J, JAD, JADF, JADI, JC, JCE, JCEF, JCEI, JCI, JDE, JDEI, JDI, JE, JEI, JF, JI, JNI, NC, NCE



ITEM NO.	QTY	NAME OF PART
1	1	Fan Cover Guard
2	4	Hex Head Cap Screw & Lockwasher (Fan Cover to Bracket)
3	1	Air Deflector (Fan Cover) (Used on 6 Poles) (Not Illustrated)
4	1	Fan Shroud Assembly (Fan Cover) (Used on 2 Pole)
5	8	Self Tapping Screw & Lockwasher (Air Deflector or Fan Shroud)

ITEM NO.	QTY	NAME OF PART
6	1	Propeller Fan (Used on 2 Pole) Sirocco Fan (Used on 4 Pole) Fan Assembly (Used on all others)
7	1	Retaining Snap Ring (Fan) (Used on 2 and 4 Pole)
8	1	Bracket (Short End)

### WARNING:

Any disassembly or repair work on explosionproof motors will void the Underwriters Laboratories, Inc. label unless done by the manufacturer, or a facility approved by the Underwriters Laboratories, Inc. Refer to your nearest sales office for assistance.

### BEARINGS:

Refer to motor nameplate for the bearing numbers.

### PRICES:

Parts stocking distributors: refer to renewal parts numerical index. All Others: refer to your nearest parts distributor.

reference: Renewal Parts Section 700, Pages 29 & 30



## RENEWAL PARTS

FRAMES 449, 5004 THRU 5811 - TOTALLY ENCLOSED AND EXPLOSION PROOF MOTORS  
 TYPES: E, EC, ECEI, EEI, J, JAD, JADF, JADI, JC, JCE, JCEF, JCEI, JCI, JDE, JDEI, JDI, JE, JEI, JF, JI, JNI, NC, NCE

ITEM NO.	QTY	NAME OF PART
9	1	Water Deflector (Short End) (Used on J) Water Deflector Assembly (Short End) (Used on E, Includes item 10)
10	2	Socket Set Screw (Water Deflector) (Used on E)
11	1	Pipe Nipple (Short End Fill)
12	1	Pipe Coupling (Short End Fill)
13	1	Pipe Plug (Short End Fill) (Used on 5004, 5004S, 5004SS, 5805ML, & 5805SS)
14	1	Grease Fitting (Short End Fill) (Used on 5008, 5008S & 5008SS)
15	1	Grommet (Short End Fill)
16	1	Pipe Nipple (Short End Drain)
17	1	Pipe Reducer Coupling (Short End Drain)
18	1	Countersunk hex Pipe Plug (Short End Drain)
19	1	Grommet (Sort End Drain)
20-25	-	Not Used
26	1	Air Deflector (Short End)
27	8	Hex Head Cap Screw & Lockwasher (Air Deflector) (Qty. 4 on 5004 & 5004S)
28	1	Ball Bearing (Short End) (Refer to section 775)
29	1	Retaining Snap Ring
30	1	Bearing Cap
31	4	Hex Head Cap Screw (Bearing Cap)
32	8	Hex Head Cap Screw (Bracket to Stator)
33	1	Wound Stator Assembly
34	1	Shroud (Not Illustrated)
35	8	Hex Head Cap Screw (Shroud) (Not Illustrated)
36	1	Eyebolt (Qty. 2 on 5004, 5004S, 5004SS)
37	1	Rotor Assembly (Includes items 38 & 39)

ITEM NO.	QTY	NAME OF PART
38	1	Rotor Core
39	1	Rotor Shaft
40	1	Woodruff Key (Fan) (Used on 2 Pole) Square Key (Used on 4, 6 & 8 Pole)
41	1	Gasket (Base) (Used on J)
42	1	Outlet Box Base
43	4	Hex Head Cap Screw (Base)
44	1	Gasket (Cover) (Used on J)
45	1	Outlet Box Cover
46	8	Hex Head Cap Screw (Cover) (Qty. 4 on J)
47-53	-	Not Used
54	1	Bracket (Pulley End)
55	8	Hex Head Cap Screw (Bracket to Stator)
56	1	Pipe Plug (Pulley End Fill) (Used on 5004, 5004S, 5004SS, 5805ML & 5805SS)
57	1	Grease Fitting (Pulley End Fill) (Used on 5008, 5008S & 5008SS)
58	1	Square Head Pipe Plug (Pulley End Drain)
59	1	Bearing (Pulley End) (Refer to section 775)
60	1	Lockwasher (Used on 5805ML) (Includes item 61)
61	1	Lock Nut (Used on 5805ML) (Includes item 60)
62	1	Bearing Cap (Pulley End)
63	4	Hex Head Cap Screw (Bearing Cap)
64	1	Air Deflector (Pulley End)
65	8	Hex Head Cap Screw & Lockwasher (Air Deflector) (Qty. 4 on 5004 & 5004S)
66	1	Water Deflector Assembly (Pulley End) (Includes item 67)
67	2	Socket Set Screw (Water Deflector)
68	1	Square Key

### WARNING:

Any disassembly or repair work on explosionproof motors will void the Underwriters Laboratories, Inc. label unless done by the manufacturer, or a facility approved by the Underwriters Laboratories, Inc. Refer to your nearest sales office for assistance.

### BEARINGS:

Refer to motor nameplate for the bearing numbers.

### PRICES:

Parts stocking distributors: refer to renewal parts numerical index. All Others: refer to your nearest parts distributor.

reference: Renewal Parts Section 700, Pages 29 & 30

# Suitability of Integral Horsepower (IHP)\* Motors on Variable Frequency Drives

## Variable Frequency Drives (VFD)

All Nidec Motor Corporation inverter duty motors have 40°C ambient, 1.0 SF on Inverter Power, 3300 ft. max altitude, 460 voltage or less line power, up to 10:1 speed range on Variable Torque and Class F Insulation.

Nidec Motor Corporation's INVERTER GRADE® insulated motors exceeded NEMA® MG-1 Part 30 & 31 before the standards were established.

We are a leader in the development of electric motors to withstand pulse width modulated (PWM) drives evolution from power transistors to higher switching frequency insulated gate bipolar transistors (IGBTs).

Today, as the need for medium duty motor inverter applications grows, Nidec Motor Corporation provides products to meet these demands.

Through continued research and development, Nidec Motor Corporation has included the insulation wire from its INVERTER GRADE® motors in all Premium Efficient motors, enhancing their potential inverter compatibility.

Inverter compatibility with motors is complex. As a result, many variables must be considered when determining the suitability of certain types of motors. These variables include:

- Torque requirements (Constant or Variable)
- Speed Range
- Line/System Voltage
- Cable Length between VFD & Motor
- Drive Switching (Carrier) Frequency Motor Construction
- VFD dv/dt
- High Temperatures High Humidity

Wider speed ranges, higher voltages, higher switching frequencies and increased cable lengths all add to the severity of the application and therefore the potential for premature motor failure. Nidec Motor Corporation has differentiated its products into families for your ease of selection for various inverter applications.

## Warranty Guidelines

The information within this section refers to the motor and drive application guidelines and limitations for warranty.

## Hazardous Location Motors

Use of a variable frequency drive with the motors in this catalog, intended for use in hazardous locations, is only approved for Division 1, Class I, Group D hazardous location motors with a T2B temperature code, with a limitation of 2:1 constant torque or 10:1 variable torque output. No other stock hazardous location motors are inherently suitable for operation with a variable frequency drive. If other requirements are needed, including non-listed Division 2, please contact your Nidec Motor Corporation territory manager to conduct an engineering inquiry.

## 575 Volt Motors

575 volt motors can be applied on inverters when output filters are used.

## Applying INVERTER GRADE® Insulated Motors on Variable Frequency Drives (2, 4, 6 pole)

The products within this catalog labeled "Inverter Duty" or "Vector Duty" are considered INVERTER GRADE® insulated motors. INVERTER GRADE® motors exceed the NEMA® MG-1 Part 31 standard.

Nidec Motor Corporation provides a three-year limited warranty on all NEMA® frame INVERTER GRADE® insulated motors and allows long cable runs between the motor and the VFD (limited to 400 feet typical without output filters). Cable distance can be further limited by hot and humid environments and VFD manufacturers cable limits. These motors may be appropriate for certain severe inverter application or when the factors relating to the end use application are undefined (such as spares).

Nidec Motor Corporation's U.S. Motors® brand is available in the following INVERTER GRADE® insulated motors:

- Inverter Duty NEMA® frame motors good for 10:1 Variable Torque & 5:1 Constant Torque, including Vertical Type RUSI
- Inverter Duty motors rated for 10:1 Constant Torque
- ACCU-Torq® and Vector Duty Motors with full torque to 0 Speed
- 841 Plus® NEMA® Frame Motors

## Applying motors that do not have INVERTER GRADE® insulation on Variable Frequency Drives (2, 4, 6 pole)

Meet NEMA® MG-1, Section IV, Part 31.4.4.2. They can be used with adjustable frequency drives under the following parameters: On NEMA® frame motors, 10:1 speed rating on variable torque loads & 4:1 speed range on constant torque loads. On TITAN® frame motors, 10:1 speed rating on variable torque loads. On TITAN® frame motors, inquiry required for suitability on constant torque loads. Cable distances are for reference only and can be further limited by hot and humid environments. Refer to specific VFD manufacturers cable limits.

Cable Distances			
Maximum Cable Distance VFD to Motor			
Switching Frequency	460 Volt	230 Volt	380 Volt
3 KHz	127 ft	400 ft	218 ft
6 KHz	90 ft	307 ft	154 ft
9 KHz	73 ft	251 ft	126 ft
12 KHz	64 ft	217 ft	109 ft
15 KHz	57 ft	194 ft	98 ft
20 KHz	49 ft	168 ft	85 ft

**Applying Standard & Energy Efficient Motors on Variable Frequency Drives is not recommended. VFD related failures on standard and energy efficient motors 444 frame and above will not be covered under warranty.**

\*This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL® & CSA® listings where indicated.

† All marks shown within this document are properties of their respective owners.



# Motor / Inverter Compatibility

---

## Thermal Overloads and Single Phase Motors

Motors with thermal overloads installed may not operate properly on a VFD. The current carrying thermal overload is designed for sine wave power. Operation on a VFD may cause nuisance tripping or potentially not protect the motor as would be expected on line power. Thermo-stats or thermistors installed in the motor and connected properly to the VFD may provide suitable thermal overload protection when operating on a VFD. (Consult Codes)

Single phase motors and other fractional horsepower ratings are not designed to be operated on a VFD. Within Nidec Motor Corporation standard products, all motors NEMA® 48 frame (5.5" diameter) and smaller are not suitable for VFD applications. Three phase 56 and 143/145 frame applications should be noted on the catalog price page; or if in doubt ask an Nidec Motor Corporation technical representative for recommendations on compatibility with a VFD.

## Slow Speed Motors

Motors with a base design of slower than six poles require special consideration regarding VFD sizing and minimizing harmonic distortion created at the motor terminals due to cable installation characteristics. Additional external PWM waveform filters and shielded motor cables designed for PWM power may be required to provide acceptable motor life. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%).

## 690V Applications

Motors that will be applied to 690VAC PWM VFDs require the use of an external filter to limit peak voltage spikes and the use of an INVERTER GRADE® motor. Where available, an alternative to using an output filter is to upgrade to a 2300V insulation system.

## Low Voltage TITAN® Motors

When using 449 frame and larger motors on PWM type VFDs consider the use of an external filter and shielded motor cables designed for PWM power to minimize harmonic distortion and peak voltages at the motor terminals. Harmonic distortion on the output waveform should be kept to a minimum level (less than 10%).

## Bearing Currents related to PWM waveform

Due to the uniqueness of this condition occurring in the field, protection of the motor bearings from shaft currents caused by common mode voltages is not a standard feature on sine wave or Inverter Duty motor products, unless explicitly noted. Some installations may be prone to a voltage discharge condition through the motor bearings called fluting.

Fluting damage is related to characteristics of the PWM waveform, VFD programming and characteristics and installation.

Bearing fluting as a result of VFD waveform characteristics may be prevented by the installation of a shaft grounding device such as a brush or ring and/or correction of the installation characteristics causing the shaft voltage condition. Insulated bearing(s) may be required. VFD filters may be needed if bearing fluting is to be avoided.

## Multiple Motors on a Single VFD

Special considerations are required when multiple motors are powered from a single VFD unit. Most VFD manufacturers can provide guidelines for proper motor thermal considerations and starting/stopping of motors. Cable runs from the VFD and each motor can create conditions that will cause extra stress on the motor winding. Filters may be required at the motor to provide maximum motor life.

## Grounding and Cable Installation Guidelines

Proper output winding and grounding practices can be instrumental in minimizing motor related failures caused by PWM waveform characteristics and installation factors. VFD manufacturers typically provide detailed guidelines on the proper grounding of the motor to the VFD and output cable routing. Cabling manufacturers provide recommended cable types for PWM installations and critical information concerning output wiring impedance and capacitance to ground.

## Vertical Motors on VFDs

Vertical motors operated on VFD power present unique conditions that may require consideration by the user or installation engineer:

- Non-reversing-ratchet operation can interfere at low speeds (up to 300 RPM) causing locked rotor and drive tripping.
- Unexpected / unacceptable system vibration and or noise levels caused by the torque pulsation characteristics of the PWM waveform, a system critical frequency falling inside the variable speed range of the process or the added harmonic content of the PWM waveform exciting a system component
- Application related problems related to the controlled acceleration/ deceleration and torque of the motor on VFD power and the building of system pressure/ load.
- The impact the reduction of pump speed has on the down thrust reflected to the pump motor and any minimum thrust requirements of the motor bearings
- Water hammer during shutdown damaging the non-reversing ratchet

## Humidity and Non-operational Conditions

The possible build-up of condensation inside the motor due to storage in an uncontrolled environment or non-operational periods in an installation, can lead to an increased rate of premature winding or bearing failures when combined with the stresses associated with PWM waveform characteristics. Moisture and condensation in and on the motor winding over time can provide tracking paths to ground, lower the Megohm resistance of the motor winding to ground, and lower the Corona Inception Voltage level of the winding.

Proper storage and maintenance guidelines are important to minimize the potential of premature failures. Space heaters or trickle voltage heating methods are the preferred methods for drying out a winding that has low megohm readings. Damage caused by these factors are not covered by the limited warranty provided unless appropriate heating methods are properly utilized during non-operational periods and prior to motor start-up.

**NEMA® Application Guide for AC Adjustable Speed Drive  
Systems:** <http://www.nema.org/stds/acadjustable.cfm#download>

\*This information applies only to Integral Horsepower (IHP) motors as defined on the Agency Approval page, under UL® & CSA® listings where indicated.

† All marks shown within this document are properties of their respective owners.

