A. Decimal and Metric Equivalents

Fraction	(Inch)	Decimal (Inch)	mm	Fraction	(Inch)	Decimal (Inch)	mm
	1/64	0.01562	0.397		33/64	0.51562	13.097
1/32		0.03125	0.794	17/32		0.53125	13.494
	3/64	0.04688	1.191		35/64	0.54688	13.891
1/16		0.06250	1.588	9/16		0.56250	14.288
	5/64	0.07812	1.984		37/64	0.57812	14.684
3/32		0.09375	2.381	19/32		0.59375	15.081
	7/64	0.10938	2.778		39/64	0.60938	15.478
1/8		0.12500	3.175	5/8		0.62500	15.875
	9/64	0.14062	3.572		41/64	0.64062	16.272
5/32		0.15625	3.969	21/32		0.65625	16.669
	11/64	0.17188	4.366		43/64	0.67188	17.066
3/16		0.18750	4.763	11/16		0.68750	17.463
	13/64	0.20312	5.159		45/64	0.70312	17.859
7/32		0.21875	5.556	23/32		0.71875	18.256
	15/64	0.23438	5.953		47/64	0.73438	18.653
1/4		0.25000	6.350	3/4		0.75000	19.050
	17/64	0.26562	6.747		49/64	0.76562	19.447
9/32		0.28125	7.144	25/32		0.78125	19.844
	19/64	0.29688	7.541		51/64	0.79688	20.241
5/16		0.31250	7.938	13/16		0.81250	20.638
	21/64	0.32812	8.334		53/64	0.82812	21.034
11/32		0.34375	8.731	27/32		0.84375	21.431
	23/64	0.35938	9.128		55/64	0.85938	21.828
3/8		0.37500	9.525	7/8		0.87500	22.225
	25/64	0.39062	9.922		57/64	0.89062	22.622
13/32		0.40625	10.319	29/329		0.90625	23.019
	27/64	0.42188	10.716		59/64	0.92188	23.416
7/16		0.43750	11.113	15/16		0.93750	23.813
	29/64	0.45312	11.509		61/64	0.95312	24.209
15/32		0.46875	11.906	31/32		0.96875	24.606
	31/64	0.48438	12.303		63/64	0.98438	25.003
1/2		0.50000	12.303	1/1		1.00000	25.400

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B. Design Letter

The design letter that is assigned to a polyphase motor is defined by NEMA®† in Section MG1-16-1. The letter is a function of torques and locked amps exhibited by the motor. NEMA®† does not define values for every rating. If a rating is not contained within the NEMA®† "envelopes" shown below, it cannot have a design letter on the nameplate. Voltage is not a factor, only HP and speed. Note that multispeed have no design letter.

60 Hz							
HP	SYNCHRONOUS SPEED, RPM						
	3600	1800	1200	900	720	600	514
1/2	-	-	-				
3/4	-	-					
1	-						
1-1/2							
2							
3				DEFINED			
5							
7-1/2				RATINGS			
10-125, INCLUSIVE							
150							-
200						-	-
250					-	-	-
300-350				-	-	-	-
400-500, INCLUSIVE			-	-	-	-	-

50 Hz				
HP	SYNCHRONOUS SPEED, RPM			
	3600	1500	1000	750
1/2	-	-	-	
3/4	-	-		
1	-			
1-1/2				
2				
3			DEFINED	
5				
7-1/2			RATINGS	
10-125, INCLUSIVE				
150				
200				

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C. Formulas

kW = HP x .746	
Torque in lb-ft	$\frac{\text{HP x 5250}}{\text{RPM}}$
Motor synchronous speed in RPM	$\frac{\text{120 x Hz}}{\text{number of poles}}$
Three-phase full-load amp	$\frac{\text{HP x .746}}{\text{1.73 x kV x efficiency x power factor}}$
Rated motor kVA	$\frac{\text{HP (.746)}}{\text{efficiency x power factor}}$
kW loss	$\frac{\text{HP (.746) (1.0 efficiency)}}{\text{efficiency}}$
Wk^2 referred to motor shaft speed	$\left[\text{driven machine } Wk^2 \frac{(\text{driven machine rpm})^2}{\text{motor RPM}}\right]$ + gear Wk^2 at motor speed
Accelerating time	$\frac{.462\ (Wk^2 \text{ of motor and load})\ RPM^2}{\text{motor rated kW x 106 x per unit effective accelerating torque}}$
kVA in-rush	percent in-rush x rated kVA
Approximate voltage drop (%)	$\frac{\text{motor kVA in-rush}}{\text{transformer kVA}}$ x transformer impedance (normally 5% to 7%)
Stored kinetic energy in kW-sec	2.31 x (total Wk^2) x RPM^2 x 10^7
Inertia constant (H) in seconds	$\frac{\text{stored kinetic energy in kW-seconds}}{\text{HP (.746)}}$
Conversion factors:	CV = (metric HP) = 735.5 watts = 75 kg-m/sec Wk^2 (lb-ft) = 5.93 x GD^2 ($kg\text{-}m^2$)
Ventilating-air requirements:	100-125 cfm of 400C air at 1/2-in. water pressure for each kW of loss
Degrees C	(Degrees F-32) x $\frac{5}{9}$
Degrees F	$\left[(\text{Degrees C}) \times \frac{9}{5}\right]$ + 32

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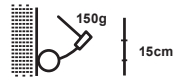
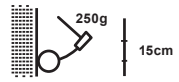
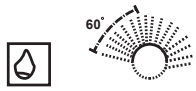
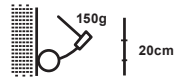
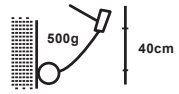
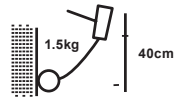
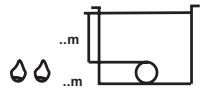
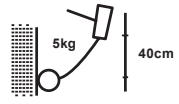
D. Index of Protection

Protection Against Solid Objects			Protection Against Liquids			Mechanical Protection		
No.	**Tests**	**Definition**	**No.**	**Tests**	**Definition**	**No.**	**Tests**	**Definition**
0		**No protection**	**0**		**No protection**	**0**		**No protection**
1	Ø50mm 	Protected against solid objects over 50mm (e.g. accidental hand contact)	**1**		Protected against vertically dripping water (condensation)	**1**		Impact energy: 0.225J
2	Ø12mm 	Protected against solid objects over 12mm (e.g. finger)	**2**		Protected against water dripping up to 15° from the vertical	**2**		Impact energy: 0.375J
3	Ø2.5mm 	Protected against solid objects over 2.5mm (e.g. tools, wire)	**3**		Protected against rain falling at up to 600 from the vertical	**3**		Impact energy: 0.500J
4	Ø1mm 	Protected against solid objects over 1mm (e.g. thin wire)	**4**		Protected against water splashes from all directions	**4**		
5 		Protected against dust (no deposits of harmful material)[1]	**5** 		Protected against jets of water from all directions[2]	**5**		Impact energy: 2J
6 		Totally protected against dust. Does not involve rotating machines	**6** 		Protected against jets of water comparable to heavy seas	**6**		
			7 		Protected against the effects of immersion to depths of between 0.15 and 1m	**7** 		Impact energy: 6J[3]
			8 		Protected against the effects of prolonged immersion at depth	**8**		
						9 		Impact energy: 20J

Atmospheric Protection Index. Weatherproof construction reduces the penetration of rain, snow and airborne particles to a value compatible with the correction running of the machine. Indicated when the letter W is inserted between IP and index numbers.

1. Motor protected against dust and accidental contact.
   Test result: No dust enters in harmful quantities; no risk of direct contact with rotating parts.
2. Motor protected against jets of water from all directions from hoses at 3 m distance with a flow rate of 12.5 l/min at 0.3 bar.
   Test result: No damage from water projected onto the machine while in operation.
3. Motor resistant to impacts of 6 joules (impact of a 1.5 kg hammer from a height of 0.4 meters).
   Test result: Damage caused by impacts does not affect the running of motor.

The conditions and severity of the tests must be subject to a specific agreement between the manufacturer and the end user.

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E. Long-term Storage for Motors with Grease and Oil-lubricated Bearings

NOTE: DO NOT WRAP OR COVER MOTOR WITH PLASTIC!

1. When to put a motor in storage

If a motor is not put into immediate service (one month or less), or if it is taken out of service for a prolonged period, special storage precautions should be taken to prevent environmental damage. The following schedule is recommended as a guide to determine storage needs.

- Out of service in storage less than one month -- no special precautions except that space heaters, if supplied, must be energized any time the motor is not running.
- Out of service or in storage for more than one month but less than six months -- store per items 2A, B, C, D, E, F2 and G, items 3A, B and C, and item 4.
- Out of service or in storage for six months or more -- all recommendations.

2. Storage Preparation

- Where possible, motors should be stored indoors in a clean, dry area.
- When indoor storage is not possible, the motors must be covered with a tarpaulin. This cover should extend to the ground; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors.
- Whether indoors or out, the area of storage should be free from ambient vibration. Excessive vibration can cause bearing damage. A unit which must be stored in areas with high ambient vibration, such as from heavy construction equipment or other sources, must have the shaft locked to prevent any movement.
- Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must be taken to prevent insects, such as mud dauber wasps, from gaining access to the interior of the motor.
- Inspect the rust preventative coating on all external machined surfaces, including shaft extensions. If necessary, recoat the surfaces with a rust preventative material, such as Rusto Veto No. 342 (manufactured by E.F. Houghton Co.) or an equivalent. The condition of the coating should be checked periodically and surfaces recoated as needed.
- Bearings:

1) Grease-lubricated cavities must be completely filled with lubricant during storage. Remove the drain plug and fill cavity with grease until grease begins to purge from the drain opening. Refer to the section on “LUBRICATION” in the U.S. MOTORS® Installation/Maintenance Instruction and/or review motor’s lubrication nameplate for correct lubricant.

CAUTION

Do not attempt to grease bearings with drain closed or when unit is in operation.

2) Oil-lubricated motors are shipped without oil and must be filled to the maximum capacity as indicated on the oil chamber sight gauge window immediately upon receipt. Fill reservoir to maximum level with a properly selected oil containing rust and corrosion inhibitors such as TEXACO®† Regal Marine #77, MOBIL™ Vaprotec Light, or an equivalent.

NOTE: Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage, then refill when at new location.

- To prevent moisture accumulation, some form of heating must be utilized to prevent condensation. This heating should maintain the winding temperature at a minimum of 500C above ambient. If space heaters are supplied, they should be energized. If none are available, single phase or “trickle” heating may be utilized by energizing one phase of the motor’s winding with a low voltage. Request the required voltage and transformer capacity from Nidec Motor Corporation. A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing
warm air into the motor.

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E. Long-term Storage for Motors with Grease and Oil-lubricated Bearings *(continued)*

3. Periodic Maintenance

- Oil should be inspected monthly for evidence of moisture or oxidation. The oil must be replaced whenever contamination is noted or every twelve months, whichever occurs first.
- Grease lubricated bearings must be inspected once a month for moisture and oxidation by purging a small quantity of grease through the drain. If any contamination is present, the grease must be completely removed and replaced.
- All motors must have the shaft rotated once a month to insure the maintenance of a coating lubricant film on the bearing races and journals.
- Insulation History:
  The only accurate way to evaluate the condition of the winding insulation is to maintain a history of the insulation readings. Over a period of months or years these readings will tend to indicate a trend. If a downward trend develops, or if the resistance drops too low, thoroughly clean and dry the windings, retreating if necessary, by an authorized electrical apparatus service shop.

The recommended insulation resistance tests are as follows:

Two tests are used to evaluate the condition of the winding insulation. The first of these is the one minute insulation resistance test (IR1) and the second is the polarization index test (PI), which can also be referred to as a dielectric absorption test. The results of either of these tests can be skewed by factors such as the winding temperature and its relation to the dew point temperature at the time the test was conducted. The PI test is less sensitive to these factors than the IR test, but its results can still be affected significantly. Due to these factors, the most reliable method for evaluating the condition of the winding insulation is to maintain a record of periodic measurements, accumulated over months or years of service, for one or both of these tests. It is important that these tests be conducted under similar conditions of winding temperature, dew point temperature, voltage magnitude and duration, and relative humidity. If a downward trend develops in the historical data for either test, or if the readings from both tests drop below a minimum acceptable value, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and re-treat if necessary.

1. The recommended procedure for the IR1 test is as follows:

(1) Disconnect all external accessories or equipment that have leads connected to the winding and connect them to a common ground. Connect all other accessories that are in contact with the winding to a common ground.

WARNING

Failure to have accessories grounded during this test can lead to the accumulation of a hazardous charge on the accessories.

(2) Using a megohmmeter, apply DC voltage at the level noted below for 1 minute and take a reading of the insulation resistance between the motor leads and ground.

Rated Motor Voltage	Recommended DC Test Voltage
UP to 1000 (inclusive)	500 VDC
1001 to 2500 (inclusive)	500 to 1000 VDC
2501 to 5000 (inclusive)	500 to 2500 VDC
5001 and up	500 to 5000 VDC

WARNING

Follow appropriate safety procedures during and after high voltage testing. Refer to the instruction manual for the test equipment. Make sure the winding insulation is discharged before beginning the test. The winding insulation will retain a potentially dangerous charge after the DC voltage source is removed, so use proper procedures to discharge the winding insulation at the end of the test. Refer to IEEE-43™ Standard for additional safety information.

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E. Long-term Storage for Motors with Grease and Oil-lubricated Bearings *(continued)*

(3) The reading should be corrected to a 40°C base temperature by utilizing the formula:

$$R_{40C} = K_T R_T$$

Where:

R_{40C} = insulation resistance (in megohms) corrected to 40°C

K_T = insulation resistance temperature coefficient at temperature T°C

R_T = measured insulation resistance (in megohms) at temperature T°C

The value of K_T can be approximated by using the formula:

$$K_T = (0.5)^{(40-T)/10}$$

Where:

T = the winding temperature in °C that the insulation resistance was measured at

The recommended procedure for the PI test is as follows:

(1) Perform steps 1 and 2 from the IR1 test procedure. Heed the safety warnings given in the IR1 test procedure.

(2) With DC voltage still being applied by the megohmmeter, taken an additional reading of insulation resistance between the motor leads and ground 10 minutes after the DC voltage was initially applied. To minimize measurement errors, the variation in winding temperature between the 1 minute and 10 minute readings should be kept to a minimum.

(3) Obtain the polarization index by taking the ratio of the 10 minute resistance reading to the 1 minute resistance reading.

If historical data from previous IR1 and / or PI tests is available, then a comparison of the present test result to previous tests can be used to evaluate the condition of the insulation. To minimize error, all readings that are compared should be taken at test voltages, winding temperatures, dew point temperatures, and relative humidities that are similar as possible. If a downward trend in the readings develops over time, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then, repeat the test and re-check results before returning the motor service. If historical data from previous IR1 or PI tests is not available, then compare readings from the present test to the recommended minimum values listed below. If the readings from both tests fall below the minimum, have an authorized electrical apparatus service shop thoroughly clean and dry the winding and, if necessary, retreat the winding. Then, repeat the tests and re-check results before returning the motor to service.

The recommended minimum value for the 1 minute insulation resistance reading corrected to 40°C is:

Rated Motor Voltage	Minimum Insulation Resistance
Up to 999 (inclusive)	5 Megohms
1000 and up	100 Megohms

The recommended minimum value for the polarization index is 2.0. if the 1 minute insulation resistance reading corrected to 40°C is above 5000 megohms, however, the polarization index may not be meaningful. In such cases, the polarization index may be disregarded as a measure of insulation condition.

Refer any question to the Nidec Motor Corporation Product Service Department.

For more information, refer to the IEEE-43™ Standard.

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E. Long-term Storage for Motors with Grease and Oil-lubricated Bearings *(continued)*

4. Start-up Preparations After Storage

- Motor should be thoroughly inspected and cleaned to restore to an “As Shipped” condition.
- Motors which have been subjected to vibration must be disassembled and each bearing inspected for damage.
- Oil and/or grease must be completely changed using lubricants and methods recommended on the motor’s lubrication plate, or in the section titled “LUBRICATION” in the Installation/Maintenance manual.
- The winding must be tested to obtain insulation resistance and dielectric absorption ratio as described in section III, item 3.
- If storage has exceeded one year, the Nidec Motor Corporation Quality Assurance Department must be contacted prior to equipment startup.

F. Temperature Classification of Insulation Systems

Insulation System		Temperature Classification	
(1) Class A	Class 105	105°C	221°F
(2) Class E*	Class 120	120°C	248°F
Class B	Class 130	130°C	266°F
Class F	Class 155	155°C	311°F
Class H	Class 180	180°C	356°F
(1) Class N	Class 200	200°C	392°F
(1) Class R	Class 200	220°C	428°F
(1) Class S	Class 240	240°C	464°F
(1) Class C	Class over -- 240	Over 240°C	Over 464°F

** Used in European equipment*
(1) Not an available motor insulation system.

The temperature classification indicates the maximum (hot-spot) temperature at which the insulation system can be operated for normal expected service life.

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