INVERTER CAPABILITIES OF IRIS™ PROTECTED LEESON MOTORS

STEEL FRAME MOTORS	NEMA Frame	Variable Torque**	Constant Torque**	Constant HP**	Notes
Standard General Purpose					
TEFC	56-210 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
ODP	56-210 frame	6-60 Hz	20-60 Hz	to 90 Hz*	
WATTSAVER® Premium Efficiency					
TEFC	56-210 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
ODP	56-210 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
Special Purpose Motors					
WASHGUARD motors					
TENV	56-140 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
TEFC	56-210 frame	6-60 Hz	6-60 Hz	to 90 Hz*	

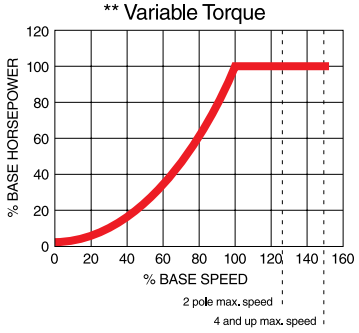
CAST IRON MOTORS	NEMA Frame	Variable Torque**	Constant Torque**	Constant HP**	Notes
Standard General Purpose					
TEFC	180-440 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
ODP	180-440 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
TEFC with blower kit	180-320 frame	5-60 Hz	5-60 Hz	to 90 Hz*	full torque at low speed with vector drive
WATTSAVER® Premium Efficiency					
TEFC	180-280 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
	320-440 frame	6-60 Hz	6-60 Hz	to 90 Hz*	CT: 6-90 Hz on some ratings
ODP	180-280 frame	6-60 Hz	6-60 Hz	to 90 Hz*	
	320-440 frame	6-60 Hz	6-60 Hz	to 90 Hz*	CT: 6-90 Hz on some ratings
TEFC with blower kit	180-320 frame	0-60 Hz	0-60 Hz	to 90 Hz*	full torque at zero speed with vector drive
SPEEDMASTER® Extreme-Duty Inverter Motors					
TENV	143TC-256TC	0-60 Hz	0-60 Hz	0-120 Hz	
TEBC	284T-449T	0-60 Hz	0-60 Hz	1-90 Hz	

* The maximum recommended frequency (speed) for 2 pole (3600 rpm) motors, without application analysis, is Hz=75, rather that 90 Hz. Contact factory for details.
** Operation for variable or constant torque is up to a base frequency of 60 Hz only. Operation above 60 Hz to the maximum frequency listed is constant horsepower (horsepower equal to motor rated horsepower).

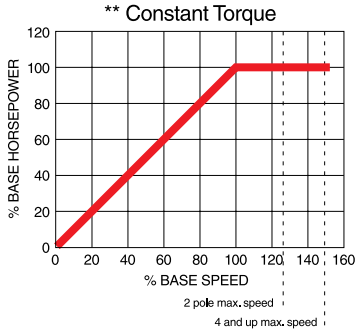
NOTES:

1. All motors are class F insulated, 40°C ambient, 3300 ft. and 1.0 service factor when used with an inverter.
2. Optimized voltage boost is required for continuous operation throughout the frequency range specified. (See operating curves.)
3. Motors with blower kits have continuous cooling and are capable of full rated torque at 0 speed with properly tuned vector drive.
4. Maximum recommended cable length for IGBT inverters is 250 ft. (longer cable lengths may require noise or voltage suppression).
5. All motors have LEESON's IRIS™ insulation system, which is designed to meet the NEMA requirements for peak voltages up to 1600 volts, and pulse rise time greater than or equal to 0.1 microseconds.
6. Operating curves are available for WATTSAVER® motors. Refer to curves for more details about frequency ranges.

** Variable Torque



** Constant Torque



MOTOR SELECTION

Electric motors are the workhorses of industry. Many applications exist where more than one motor can be used and/or the exact replacement is not available. LEESON makes every effort to maximize interchangeability, mechanically and electrically, where compromise does not interfere with reliability and safety standards. If you are not certain of a replacement condition, contact any LEESON Authorized Distributor or the LEESON District Sales Office.

SELECTION

Identifying a motor for replacement purposes or specifying a motor for new applications can be done easily if the following information is known:

1. Nameplate Data
2. Motor Type
3. Electrical and Performance Characteristics
4. Mechanical Construction

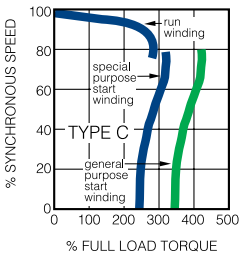
NAMEPLATE DATA

Nameplate data is the most important first step in determining motor replacement. Much of the information needed can generally be obtained from the nameplate of the motor to be replaced. Take time to record all the nameplate information because it can save time, avoid confusion and MISAPPLICATION.

MOTOR TYPE

Alternating current (AC) induction motors are divided into two electrical categories, based on power source—single phase and polyphase (three phase). Direct current (DC) motors are used in applications where precise speed control is required or when battery or generated direct current is the available power source.

TYPICAL SPEED TORQUE CURVES



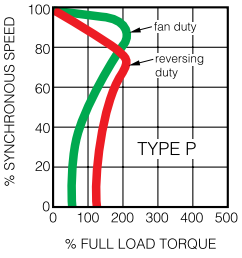
Capacitor Start/Induction Run

A single phase general purpose design, with an electrolytic capacitor in series with the start winding, offering maximum starting torque per ampere.

A centrifugal switch removes the auxiliary winding and capacitor when the motor approaches full load speed. The design is a heavy-duty unit which has approximately 300% (of full load) starting torque. Common applications include compressors, pumps, conveyors and other "hard-to-start" applications.

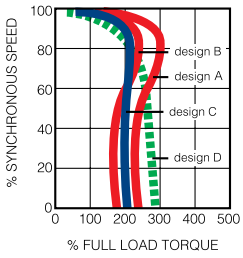
Capacitor Start/Capacitor Run

This design has two capacitors of different values. A centrifugal switch is used to remove the electrolytic capacitor when the motor approaches full load speed. A second run capacitor remains in series with the auxiliary winding during full load operation. This type of design has lower full-load amps as a result of the run capacitor and is consequently used on most higher horsepower single phase motors.



Permanent Split Capacitor (PSC)

This design has an auxiliary winding with a "run" capacitor, but unlike the capacitor start/induction run motor, the capacitor and auxiliary winding remain in the circuit under running conditions. (There is no centrifugal switch on this type motor.) A permanent split capacitor design has low starting torque and low starting current. They are generally used on direct-drive fans and blowers. They can also be designed for higher starting torque and intermittent applications, where rapid reversing is desired.

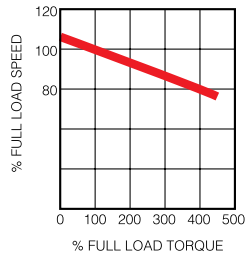


Three Phase or Polyphase

General purpose three phase motors have different electrical design classifications as defined by NEMA. NEMA Design A and B motors are of normal starting torque with normal starting current. NEMA Design C motors have higher starting torque with normal starting current. All three types have slip of less than 5%. ("Slip" being a term which expresses, as a percentage, the difference between synchronous motor speed and full load motor speed, for example, 1800 rpm synchronous versus a full load speed of 1740 rpm.

NEMA's Design B and C standards are minimum performance standards. In practice, some manufacturers (including LEESON) build small integral HP Design B motors with locked rotor and breakdown torque levels equalling NEMA Design C standards.

NEMA T frame motors 1 through 200 HP *covered* by EPACT (identified with a "G" catalogue prefix) are labeled Design B, exceed NEMA Design B performance levels, and have efficiencies equal to EPACT mandated levels. EPACT *exempt* three phase, base-mounted motors are labeled Design C and have performance characteristics meeting NEMA's Design C standards, with standard motor efficiencies. Motors 250 HP and larger are exempt from EPACT legislation.



Permanent Magnet DC

This design has linear speed/torque characteristics over the entire speed range. SCR rated motor features include high starting torque for heavy load applications and dynamic braking, variable speed and reversing capabilities. Designs are also available for use on generated low voltage DC power or remote applications requiring battery power.

ELECTRICAL AND PERFORMANCE CHARACTERISTICS

One of the best ways to guarantee economical performance and long motor life is to make sure your motors operate at nameplate voltage. Applying too high a voltage may reduce the motor's efficiency and increase operating temperatures. The net result is shorter motor life.

Under-voltage can also shorten motor life. Operating on too low a voltage reduces the motor's effective horsepower. The motor will attempt to drive the load it was intended to drive, become overloaded, draw more current than normal, and overheat. Again, the result will be premature failure.

ENCLOSURES AND ENVIRONMENT

DRIP-PROOF: Venting in end frame and/or main frame located to prevent drops of liquid from falling into motor within a 15° angle from vertical. Designed for use in areas that are reasonably dry, clean, and well ventilated (usually indoors). If installed outdoors, it is recommended that the motor be protected with a cover that does not restrict the flow of air to the motor.

TOTALLY ENCLOSED AIR OVER (TEAO): Dust-tight fan and blower duty motors designed for shaft mounted fans or belt driven fans. The motor must be mounted within the airflow of the fan.

TOTALLY ENCLOSED NON-VENTILATED (TENV): No vent openings, tightly enclosed to prevent the free exchange of air, but not airtight. Has no external cooling fan and relies on convection for cooling. Suitable for use where exposed to dirt or dampness, but not for hazardous (explosive) locations.

TOTALLY ENCLOSED FAN COOLED (TEFC): Same as the TENV except has external fan as an integral part of the motor, to provide cooling by blowing air around the outside frame of the motor.

TOTALLY ENCLOSED, HOSTILE AND SEVERE ENVIRONMENT MOTORS: Designed for use in extremely moist or chemical environments, but not for hazardous locations.

TOTALLY ENCLOSED BLOWER COOLED MOTORS (TEBC): Used to extend the safe speed range of inverter-fed motors. Similar to TEFC except a small, constant-speed fan provides uniform airflow regardless of the drive motor's operating speed.

EXPLOSION-PROOF MOTORS: These motors meet Underwriters Laboratories and Canadian Standards Association standards for use in hazardous (explosive) locations, as indicated by the UL label affixed to the motor. Locations are considered hazardous because the atmosphere does or may contain gas, vapor, or dust in explosive quantities.

IEC COOLING, INSULATION AND DUTY CYCLE INDEXES

IEC has additional designations indicating how a motor is cooled (two-digit IC codes). For most practical purposes, IC 01 relates to a NEMA open design, IC 40 to Totally Enclosed Non-Ventilated (TENV), IC 41 to Totally Enclosed Fan Cooled (TEFC), and IC 48 to Totally Enclosed Air Over (TEAO).

IEC winding insulation classes parallel those of NEMA and in all but very rare cases use the same letter designations.

Duty cycles are, however, different. Where NEMA commonly designates either continuous, intermittent, or special duty (typically expressed in minutes), IEC uses eight duty cycle designations.

S1—Continuous duty. The motor works at a constant load for enough time to reach temperature equilibrium.

S2—Short-time duty. The motor works at a constant load, but not long enough to reach temperature equilibrium, and the rest periods are long enough for the motor to reach ambient temperature.

S3—Intermittent periodic duty. Sequential, identical run and rest cycles with constant load. Temperature equilibrium is never reached. Starting current has little effect on temperature rise.

S4—Intermittent periodic duty with starting. Sequential, identical cycles of starting, running at constant load, electric braking, and rest. Temperature equilibrium is not reached, but starting current affects temperature rise.

S5—Intermittent periodic duty with electric braking. Sequential, identical cycles of starting, running at constant load, electric braking, and rest. Temperature equilibrium is not reached.

S6—Continuous operation with intermittent load. Sequential, identical cycles of running with constant load and running with no load. No rest periods.

S7—Continuous operation with electric braking. Sequential identical cycles of starting, running at constant load and electric braking. No rest periods.

S8—Continuous operation with periodic changes in load and speed. Sequential, identical duty cycles of start, run at constant load and and given speed, then run at other constant loads and speeds. No rest periods.

IEC DESIGN TYPES

The electrical performance characteristics of IEC Design N motors in general mirror those of NEMA Design B—the most common type of motor for industrial applications. By the same token, the characteristics of IEC Design H are nearly identical to those of NEMA Design C. There is no specific IEC equivalent to NEMA Design D.

U.L., CSA, ISO AND OTHER STANDARDS & APPROVALS

UNDERWRITERS LABORATORIES INC.

1. All motor models listed with prefix “C” have U.L. component recognition (without thermal overload). File Number E57948, Guide Number PRGY2.
2. All units have U.L. recognized Class B insulation system unless otherwise noted. File Number E55555, Guide Number OBJY2.
3. Single phase motors, open and totally enclosed with prefix “A” or “M” (automatic or manual protectors) through 3 HP, in frames 48 through 145T, have U.L. recognized protector winding combination and component recognition. File Number E57955, Guide Number XEWR2.
4. Three phase motors, open and totally enclosed, with prefix “A” or “M” (automatic or manual protectors) through 3 HP, in frames 48 through 145T, have U.L. recognized protector winding combinations plus have capability of providing U.L. recognized primary single phasing which is included in our U.L. file E57955, Guide Number XEWR2.
5. Explosion-Proof, single and three phase for 56, 143T and 145T frames: File Number E75276.

   Explosion-Proof motors 182T and larger: File Number E79167.
6. Permanent Magnet DC motors are recognized components under File Number E57948, Guide Number PRGY2.
7. Speedmaster SCR Drives, Component Recognition, File E35603, except catalogue numbers 174709, 174902 and 174903.
8. Speedmaster SCR Drives, catalogue numbers 174902 and 174903. File Number E78180.

CANADIAN STANDARDS ASSOCIATION

1. Motor construction for all single phase and three phase 48 through S215T frames and all AC sub-fractional horsepower motors: Report Number LR33543, Guide Number 260-0-0.
2. Motor construction for all cast iron three phase 182T through 447T frames: Report Number LR62104.
3. Thermally protected single phase motors through 7 1/2 HP, Report Number LR33543, Guide Number 260-0-0.
4. All Farm Duty motors 1/3 HP through 7 1/2 HP.
5. Explosion proof listing 56 and 143-145T frames, Class I Group D, Class II Group E,F & G, single phase through 1 HP, and three phase through 2 HP certified by C.S.A. File Number LR47667.
6. Permanent Magnet DC motors are listed under File Number LR33543.
7. Multi-speed motors are listed under File Number LR41757.
8. Speedmaster SCR Drives, catalogue numbers 174902 and 174903. File Number LR 85877.
9. Energy Efficiency Verification - Full load efficiency ratings of three phase, single speed, NEMA/EEMAC Design A or B squirrel cage induction motors, 1 through 200 HP, 230, 460 or 575 volts, 60 Hz, in totally enclosed and open, drip-proof enclosures for non-hazardous applications, CSA Report Number EEV 78720-1. Tested to CSA 390 (IEEE 112B) Standards.
10. Test facility qualified for energy efficiency performance testing of 3-base induction motors.

ISO QUALITY CERTIFICATION

Mississauga, Ontario administrative, sales and warehousing facility, ISO 9002 Certificate/File Number 003027.

Hanover, Ontario manufacturing facility, ISO 9002, Certificate/File Number 003028.

Grafton, Wisconsin administrative, design and manufacturing facility, ISO 9001, Certificate Number RvC #93-102. EN29001, BS5750: Part 1 and ANSI/ASQC Q91-19.

Black River Falls, Wisconsin manufacturing facility, ISO 9002, Certificate Number RvC #93-090.

BAKING INDUSTRY SANITATION STANDARDS COMMITTEE

WASHGUARD™ II, stainless steel washdown duty motors, NEMA frames 56, 143T, 145T, 182T and 184T are certified to Standard No. 29 for Electric Motors and Accessory Equipment, authorization number 769.

NEMA SERVICE FACTORS

HP	ENCLOSURE	RPM 3600	RPM 1800	RPM 1200
1/4-1/3	Open	1.35	1.35	1.35
1/2-3/4	Open	1.25	1.25	1.25
1 & Larger	Open	1.15	1.15	1.15
All	Totally Enclosed	1.00	1.00	1.00

Most LEESON Totally Enclosed Motors have 1.15 Service Factor. Refer to the Service Factor information on each page to identify specific totally enclosed motors with NEMA 1.00 Service Factor or LEESON 1.15 Service Factor. All drip-proof motors have NEMA Service Factors of 1.15 or higher. All three phase totally enclosed motors have NEMA Service Factors of 1.15 except when noted (♣).

SCR PM DC MOTORS ON PWM POWER SUPPLIES

Pulse width modulated DC controls have a voltage output similar to pure direct current which has a form factor of 1.00. SCR thyristor drives, such as the SPEEDMASTER® controls listed on page 83, have a form factor of 1.4.

LEESON stock SCR rated motors can also be used with PWM controls. In fact, the motor's HP rating can be increased because of less heating in the motor. In addition, the motor will operate quieter and the brush life will be extended.

Rated HP 1.40 FF	Rated RPM	Rated Volts	Catalogue Number	Rated HP 1.05 FF
1/4	1750	90	**098002**	0.40
	1750	90	**108010**	0.30
	1750	90	**108423**	0.30
	1750	180	**098003**	0.50
	1750	180	**108323**	0.37
1/3	1750	90	**098004**	0.50
	1750	90	**108011**	0.56
	1750	90	**108424**	0.56
	1750	180	**098005**	0.50
1/2	2500	90	**098006**	0.75
	2500	90	**108012**	0.63
	2500	180	**098007**	0.70
	2500	180	**108013**	0.70
	1750	90	**098000**	0.70
	1750	90	**108014**	0.75
	1750	90	**108226**	0.75
	1750	180	**098008**	0.56
	1750	180	**108015**	0.70
	1750	180	**108227**	0.70
3/4	2500	90	**098009**	1.00
	2500	90	**108016**	1.00
	2500	180	**098010**	1.00
	2500	180	**108017**	0.86
	1750	90	**098032**	1.00
	1750	90	**108018**	1.00
	1750	90	**108228**	1.25
	1750	180	**098069**	1.00
	1750	180	**108019**	1.00
	1750	180	**108229**	1.25
1	2500	90	**108020**	1.50
	2500	180	**108021**	1.50
	1750	90	**108022**	1.25
	1750	90	**108230**	1.25
	1750	180	**108023**	1.25
	1750	180	**108231**	1.25
1½	2500	180	**108265**	2.00
	1750	180	**108092**	1.75
	1750	180	**108262**	1.75
	1750	180	**108232**	1.75
	1750	180	**128000**	—
	1750	180	**108500**	—
2	2500	180	**108266**	3.00
	1750	180	**128001**	—
	1750	180	**108501**	—
3	2500	180	**128008**	—
	1750	180	**108502**	—

METRIC (IEC) DESIGNATIONS

The International Electrotechnical Commission (IEC) is a European-based organization that publishes and promotes worldwide mechanical and electrical standards for motors, among other things. In simple terms, it can be said that IEC is the international counterpart to the National Electrical Manufacturers Association (NEMA), which publishes the motor standards used in the United States.

IEC standards are expressed in metric units.

IEC ENCLOSURE PROTECTION INDEXES

Like NEMA, IEC has designations indicating the protection provided by a motor's enclosure. However, where NEMA designations are word descriptive, such as Open Drip-Proof or Totally Enclosed Fan Cooled. IEC uses a two-digit Index of Protection (IP) designation. The first digit indicates how well-protected the motor is against the entry of solid objects, the second digit refers to water entry.

By way of general comparison, an IP22 motor relates to Open Drip-Proof, IP54 to totally enclosed.

Protection Against Solid Objects		Protection Against Liquids	
Number	Definition	Number	Definition
0	No protection	0	No protection
1	Protected against solid objects of over 50 mm (e.g. accidental hand contact)	1	Protected against water vertically dripping (condensation)
2	Protected against solid objects of over 12 mm (e.g. finger)	2	Protected against water dripping up to 15° from the vertical
3	Protected against solid objects of over 2.5 mm (e.g. tools, wire)	3	Protected against rain falling at up to 60° from the vertical
4	Protected against solid objects of over 1 mm (e.g. thin wire)	4	Protected against water splashes from all directions
5	Protected against dust	5	Protected against jets of water from all directions
6	Totally protected against dust.	6	Protected against jets of water comparable to heavy seas
		7	Protected against the effects of immersion to depths of between 0.15 and 1m
		8	Protected against the effects of prolonged immersion at depth

IEC DESIGN TYPES

The electrical performance characteristics of IEC Design N motors in general mirror those of NEMA Design B—the most common type of motor for industrial applications. By the same token, the characteristics of IEC Design H are nearly identical to those of NEMA Design C. There is no specific IEC equivalent to NEMA Design D.

MOTOR EFFICIENCY TEST METHODS

Performance data of single phase motors is determined by using I.E.E.E. Std. 114 (Method B), three phase motors by I.E.E.E. Std. 112 (Method B). Motor efficiency is calculated using CSA C390. These testing methods meet the requirements of EPACT of 1992 and most utility companies.

For complete performance data on all LEESON motors, please review electronic Bulletin 1051 on *www.leeson.com*.