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

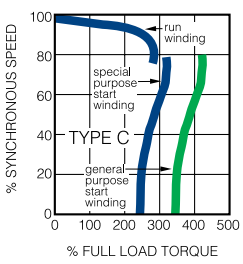
NAMEPLATE DATA

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



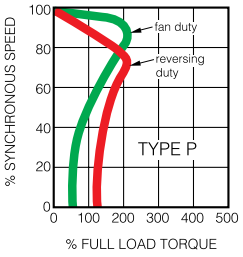
Capacitor Start/Induction Run

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.

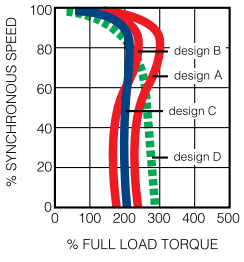
Capacitor Start/Capacitor Run

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.

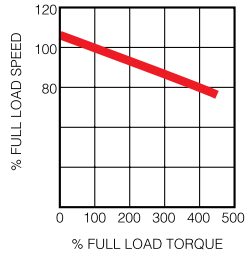


Three Phase or Polyphase

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" catalog 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.

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 117, 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	Catalog Number	Rated HP 1.05 FF
1/4	1750	90	**098002**	0.40
	1750	180	**098003**	0.50
1/3	1750	90	**098004**	0.50
	1750	90	**108424**	0.56
	1750	180	**098005**	0.50
1/2	2500	90	**098006**	0.75
	2500	180	**098007**	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
1 1/2	2500	180	**108265**	2.00
	1750	180	**108092**	1.75
	1750	180	**108262**	1.75
	1750	180	**108232**	1.75
	1750	180	**128000**	--
2	2500	180	**108266**	3.00
	1750	180	**128001**	--
	1750	180	**128010**	--
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 the Find-A-Product section on *www.leeson.com*.

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

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, F or H insulation systems unless otherwise noted. File Number E55555, Guide Number OBJY2.
3. Single phase motors with a model number prefix of "A" or "M" (automatic or manual protectors) have U.L. recognized protector winding combinations and component recognition. File Number E57955, Guide Number XEWR2.
4. Three phase motors with a model number prefix of "A" or "M" (automatic or manual protectors) 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, Guide Number PTDR.

   Explosion-Proof motors 182T and larger: File Number E12044, Guide Number PTDR.

   Explosion-Proof motors DC motors 48 frame: File Number E75276, Guide Number PTDR..
6. Permanent Magnet DC motors except PZ and P300 gearmotors are recognized components under File Number E57948, Guide Number PRGY2.
7. PZ and P300 Permanent Magnet DC gearmotors: File number E49849 or E49747, Guide Number PRGY2.
8. Speedmaster SCR Drives, Component Recognition, File E132235, Guide Number NMMS2, except catalog numbers 174902 and 174903.
9. Speedmaster SCR Drives, catalog numbers 174902 and 174903. File Number E154901, Guide Number NMFT2.
10. Speedmaster AC Adjustable Speed Drives, File Number E161242. Canadian UL covered by File Number E161242 also, Guide Number NMMS.
11. FHP Adjustable Speed Drives, file number E132235. Canadian UL covered by file number E132235, Guide Number NMMS7.

CANADIAN STANDARDS ASSOCIATION

1. Motor construction for all single and three phase NEMA 42 through S254T frame, IEC/metric 63 through 90L frame, and all sub-fractional horsepower motors: Report Number LR33543, Guide Number 260-0-0..
2. Motor construction for all steel or cast iron three phase NEMA 182T through 447T frame and IEC/metric 100L through 250M frame motors: Report Number LR62104.
3. Thermally protected single phase motors through 7½ HP, Report Number LR33543.
4. All Farm Duty motors 1/3 HP through 7½ HP, Report Number LR33543
5. Explosion proof single and three phase for 56, 143T and 145T frames: File Number LR47667.

   Explosion-Proof motors 182T and larger: File Number LR21839 and LR47504.

   Explosion-Proof DC motors 48 frame: File Number LR701080.
6. Permanent Magnet DC motors are listed under File Number LR33543.
7. Multi-Speed Motors, steel or cast iron, 182T through 447T frames are listed under file number LR33543.
8. Speedmaster SCR Drives, catalog numbers 174902 and 174903. File Number LR75790.
9. Speedmaster SCR Drives, except 174902 and 174903, file number LR41380.

U.S. DEPARTMENT OF ENERGY (DOE)

Compliance Certification (CC) number: CC005A

MOTOR EFFICIENCY VERIFICATION

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. The Grafton testing facility is qualified for CSA energy efficiency performance testing of polyphase induction motors. The Grafton Testing Facility is NVLAB recognized for energy efficiency testing of electric motors to EPACT requirements of the Department of Energy.

ISO QUALITY CERTIFICATION

Grafton, Wisconsin administrative and design engineering facility, ISO 9001:2000, Certificate Number A2239

Black River Falls, Wisconsin; Neillsville, Wisconsin; and West Plains, Missouri manufacturing facilities have been recommended for certification, ISO 9001:2000, Certificate Number A2239

Hanover, Ontario design engineering and manufacturing facility, ISO9001:2000 Certificate Number BSI #FM62785

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. The WBMQ Series of gear reducers are BISSC certified to Standard No. 29 for Electric Motors and Accessory Equipment, authorization number 941.

SAUDI ARABIAN STANDARDS ORGANIZATION

SCCP Ref. No.: R-100157

ROHS

A European directive. Restriction of Use of Certain Hazardous Substances (RoHS), 2002/95/EC. Applies to AC And DC 140 frame and below motors that are shipped into the EU (European Union) on or after July 1, 2006.

The CE Mark

CE is an acronym for the French phrase *"Conformite Europeene"* and is similar to the UL or CSA marks of North America. However, unlike UL or CSA which require independent laboratory testing, the CE mark can be applied by the motor manufacturer through "self certifying" that its products are designed to the appropriate standards. The European Union has issued 24 directives related to the **CE** mark. Three Directives apply to electric motors.

Low Voltage Directive (2006/95/EC) This directive applies to electrical equipment operating in the voltage range of 50-1000 volts AC or 75-1500 volts DC. Virtually all LEESON motors (except low voltage DC) are included in this directive.

Based on our testing to the applicable electrical and mechanical standards EN60034 and IEC 34, LEESON certifies conformity to this directive. All three phase 50 Hz stock motors comply with the nameplate designations, lead markings and connection diagrams required. A "Declaration of Conformity" accompanies these motors and a CE label is applied.

Machinery Directive (89/3392/EEC) This directive applies to machinery that may contain certain motors. This is an issue with equipment manufacturers and requires the use of a motor meeting the Low Voltage Directive and requires a "Declaration of Incorporation" document which means that only the motor complies with the requirements of the Low Voltage Directive. A CE label is applied to the motor but it remains the responsibility of the equipment manufacturer to obtain certification for the finished product.

Electromagnetic Compatibility (EMC) Directive (2004/108/EC) This directive addresses the final product and is again a concern for the equipment manufacturer. Since this Directive addresses electromagnetic interference (EMI) concerns, it does not affect three phase AC motors because they do not produce EMI. DC motors, however, do produce EMI. How much of the "noise" is emitted outside the machine depends on a host of factors. LEESON's Engineering Department can assist OEM's in applying DC motors in machinery destined for Europe and requiring certification to the EMC Directive.

CE CONFORMITE EUROPEENE