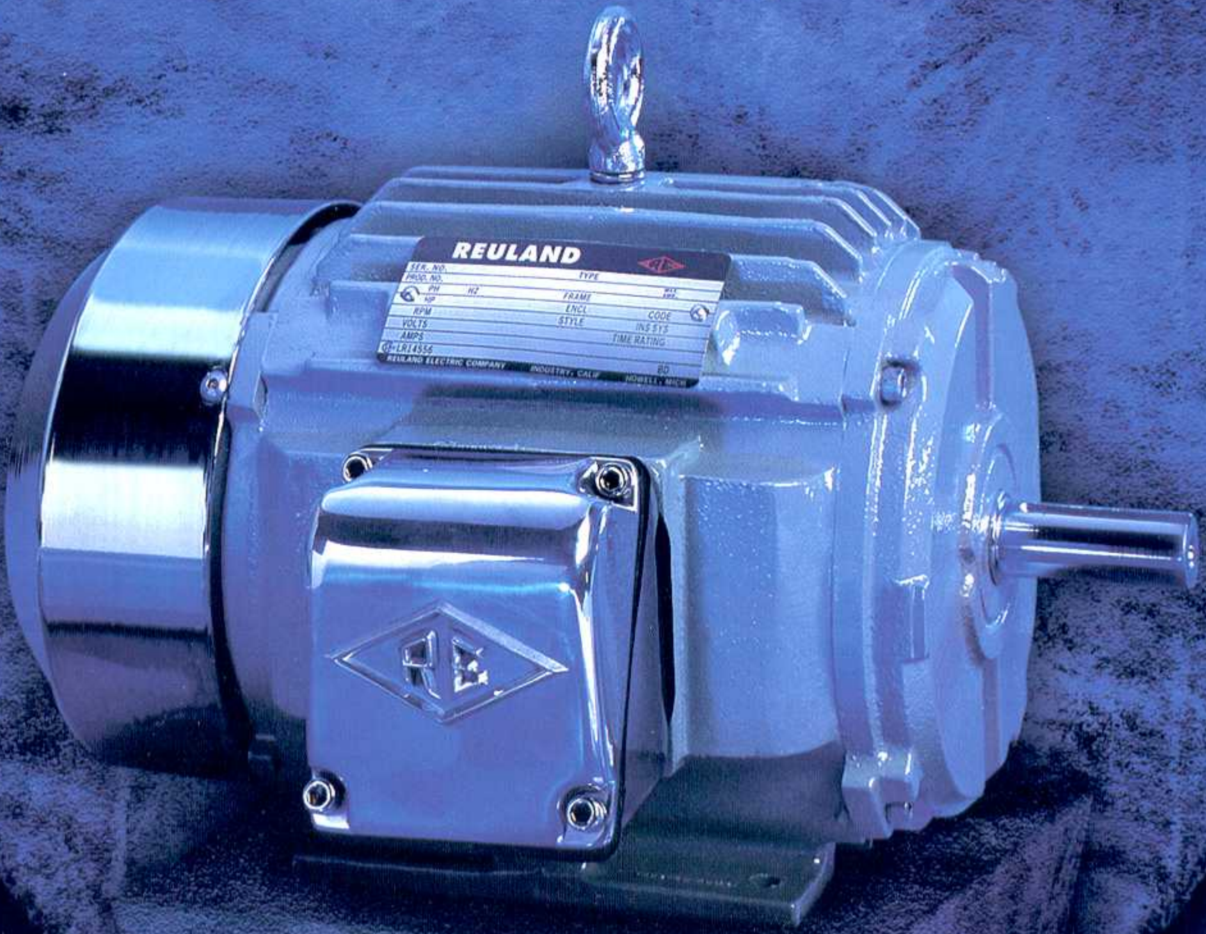
PERMANENT MAGNET SYNCRONOUS A.C. MOTORS



REULAND ELECTRIC

Manufacturer of Electric Motors and Related Products

REULAND PERMANENT MAGNET SYNCHRONOUS A.C. MOTORS:

Industry's Key To Precise Speed Control, Synchronization And Energy Efficiency

Demands for higher productivity, improved product quality and increased energy efficiency in today's industries make the need for motors that provide precise speed control, process synchronization and a high power factor more acute than ever before. Reuland Permanent Magnet Synchronous Motors offer a comprehensive answer to these needs in the form of state-of-the-art designs built from the ground up to suit a customer's exact electrical and mechanical requirements.

Optimum Performance And Dependability

Offering up to 20% greater efficiency than induction motors and up to 30% higher power factor than competing synchronous designs, Reuland Permanent Magnet Synchronous Motors boost productivity and help reduce plant energy costs. Because there is no need for D.C. braking, tachometers or regulators, system complexity is reduced and component costs are less. And for assured performance and increased reliability, High Coercive Force Magnets prevent motor demagnetizing under over-voltage conditions.

Liquid-Cooled, Air-Cooled And Partial Motor Configurations

Reuland Permanent Magnet Synchronous Motors are available in configurations to suit your specific performance and application requirements, including Liquid-Cooled, Air-Cooled and Partial Motor versions. Popular applications include synthetic fiber and glass production machinery, machine tool transfer lines, wire drawing, packaging and folding machinery, conveyor line drives and medical equipment.

Custom-Designed For Uncompromising Customers

Utilizing Maximum Energy Density Permanent Magnets that enable smaller, lighter designs with lower inertia, Reuland leverages its industry-leading cooling and lubrication technology to offer motors that meet or exceed each customer's specific performance and control requirements. And where standard dimensioning is a cost and installation advantage, Reuland offers Permanent Magnet Synchronous Motors in a wide range of NEMA, SAE, DIN and IEC frame styles (see Frame Table, page 6).

THE REULAND DIFFERENCE

Meeting the needs of today's industries and anticipating the engineering challenges of the future are Reuland's goals for every motor that leaves the factory. To achieve these goals, we work hand in hand with our customers through all phases of design, manufacture and implementation to ensure that our brilliant designs perform just as brilliantly on the job.

Product Quality Is Our Mirror

At Reuland, we believe that product quality most accurately reflects our pride, professionalism and commitment to our customers. As part of our "total ownership" approach to quality, we develop the design and produce the prototype. We even operate our own pattern shop. To provide optimum electrical characteristics, we hand-wind every stator. To assure ultimate reliability, we painstakingly insulate every critical winding. Additionally, our digitally-controlled machining process assures accurate alignment and absolute product consistency.

We then subject every product to an exhaustive process of testing, re-testing and testing again. Of course, the ultimate validation of Reuland quality can be found in the many thousands of Reuland motors that flawlessly serve a wide array of industries and applications throughout the world every day.

Our Only Standard Is Excellence

Because there are no "standard customers" at Reuland, we have no "standard solutions" to a customer's needs. Every application is treated as a unique challenge by our team of electrical and mechanical designers, manufacturing engineers, quality control technicians, customer support staff and account managers. At Reuland, we succeed only to the degree to which we help our customers succeed. That's The Reuland Difference.

PERMANENT MAGNET SYNCHRONOUS A.C. MOTORS

Mechanical Features

Enclosures	Fan-Cooled (Totally Enclosed); Auxiliary-Ventilated (Totally Enclosed); Non-Ventilated (Totally Enclosed); Liquid-Cooled, Precision.
Bearings	High-Precison to suit specific applications.
Bearing Lubrication	Pre-Lubricated Sealed or Shielded; Re-Greasable Open; Oil Jet; Mist-Lubricated with Reservoir, Regulator, Pressure Gauge and Manifold.
Materials	Stainless-Steel Liquid-Cooled Shells; Cast Aluminum; Cast Iron; Corrosion-Proof Features.
Balance and Runout	Precision and/or NEMA Standard.
Speeds	Up to 18,000 RPM.
Auxiliaries	All conventional motor options.
Insulation	Class H.
Brakes	Inherent (Self-Braking).
Shafts	Standard NEMA T and TS; Taper; Straight; Solid or Hollow; Splined; Standard or Stainless. Special designs available.
Mounting	Foot or Footless; Precision Bracket Mounting; Standard NEMA, C or D Flange; SAE; IEC; Metric DIN Flanges.
Gear Reduction	All types available.

Electrical Features

Voltage	Up to 600 volt.
Phase	1,2 & 3 phase.
Frequency	To nominal 1000 Hz.
Volts/Hertz Range	Per Customer Requirements.
Number of Poles	2, 4, 6 and 8.
Magnets	Maximum Energy Density Permanent Magnet.
Variable Frequency Control	Flux Vector and PWM Inverter.

Permanent Magnet Synchronous Motor Benefits

- Synchronization
- High Power Factor
- Lower Current Draw
- Less Heat
- Lower Cooling/Operating Costs
- Longer Service Life
- Smaller Frame Size
- Low Electrical Noise
- Excellent Performance At Low Frequencies
- Inherent Braking Capability (Self-Braking)

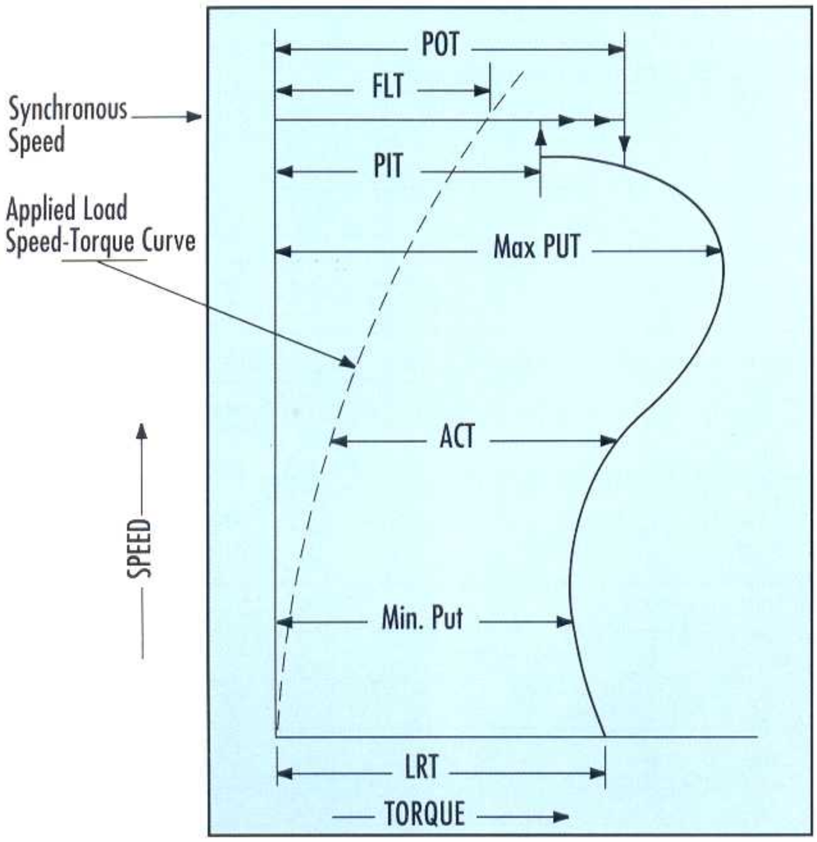
Reuland Design Advantages

- **Customer/Application-Optimized Custom Design.**
- **Hand-Wound Stator** for enhanced design flexibility, precision performance.
- **Maximum Energy Density Permanent Magnets** enable smaller, lighter motor designs with lower inertia than competing synchronous designs.
- **High Coercive Force Magnets** — Prevents motor from demagnetizing at over-voltage conditions for increased reliability, consistent performance.
- **Customizable Design Capability** includes special flanges (SAE, NEMA, DIN IEC) and shafts to suit specific customer requirments.
- **Available in NEMA frames 56 through 326.**
- **Available in 2-, 4-, 6- and 8-pole configurations.**
- **Speeds up to 18,000 RPM.**
- **Class H Insulation** for high integrity, durability.
- **150% Nominal Pull Out Torque** attainable for outstanding performance.

PERMANENT MAGNET SYNCHRONOUS A.C. MOTORS

Performance Characteristics

Permanent Magnet Synchronous Motor Speed Vs. Torque Curve



POT	Pull-Out Torque
FLT	Full-Load Torque
PIT	Pull-In Torque
PUT	Pull-Up Torque
ACT	Acceleration Torque
LRT	Locked Rotor Torque

Glossary Of Terms

Appreciating the performance characteristics of a Reuland Permanent Magnet Synchronous Motor is the first step in any successful application of this technology. The Speed vs. Torque diagram, together with the Glossary of Terms that follows, is intended to aid in your evaluation. For additional information, please contact Reuland directly.

Some performance characteristics defined in this section are similar to induction motors, some are similar to any synchronous motor, and some specifically apply to Reuland Permanent Magnet Synchronous Motors.

POT — Pull-Out Torque

Pull-out torque is the maximum load torque that can be applied to the motor and still maintain synchronous speed. If a load greater than POT is applied to a synchronous operating motor, the motor will pull out of synchronism and again operate as an induction motor until it reaches breakdown and goes to stall.

The speed-torque relationship described for PUT in the diagram again applies, except now the speed is decreasing with load application as shown by the curve.

Breakdown Torque

Breakdown torque is the maximum developed torque of the motor while operating at sub-synchronous speed. Therefore, on the speed-torque curve it is the point of maximum PUT.

This characteristic point is similar to that of an induction motor. The name comes from induction motor performance where, as an ever-increasing load is applied, the speed continues to drop until a point is reached where the motor cannot support more load and the speed drops suddenly to a low value or to a complete stall. This maximum load torque is therefore known as breakdown torque.

The point is named for a loading and decreasing speed condition, but the same point also exists as the maximum PUT value.

Glossary Of Terms (continued)

Units For Measuring Torque

The standard unit now used for measuring and expressing torque values is the pound-foot. A turning force of one pound applied at a point one foot from the center of rotation is one pound-foot of torque. Likewise, if a motor causes a scale to register one pound when connected to a one-foot torque arm it is said to be developing one pound-foot of torque. The standard abbreviation is ft. lb. Sometimes torque will be shown pound force-feet (or lb.-ft.) to indicate that torque is actually a force vector rather than mass.

Most often, specific torque points are usually expressed as a percentage of full-load torque (FLT). Thus, a motor may have a 135% LRT, 150% POT. Per-unit notation with FLT equal to 1.0 is sometimes used.

Adjustable Frequency Operation

The majority of synchronous motors now being applied are being used over a wide range of frequencies. Because there is little standardization of ratings or of frequency ranges, each motor must be designed specifically for an application.

In general, a motor can better synchronize larger inertias at higher frequencies than at lower frequencies. This assumes that, as the frequency is changed, the voltage also changes to maintain a constant voltage-to-frequency ratio. In the very low frequency range, the voltage must be raised above this ratio to maintain torque values.

FLT — Full-Load Torque

Load torque (LT) is not a motor quantity but is one that must be considered in any motor application. Load torque is the torque demanded by the load connected to the motor. Load torque at synchronous speed is called full-load torque (FLT).

PIT — Pull-In Torque

Pull in is the point in the acceleration curve where the motor pulls in and locks to synchronous speed.

Synchronizing

Synchronizing is the action of the motor rotor achieving the same rotational speed as that of the magnetic field set up by the stator winding. Running in synchronism occurs when the rotor continues to run at the same speed as the magnetic field.

When operating at synchronous speed, the "poles" lock-in with the rotating flux created by the stator. Upon starting, as the motor speed approaches synchronous speed, the rotor locks in with the rotating magnetic field.

PUT — Pull-Up Torque

The shaft output torque of the synchronous motor between zero speed and the point where the motor pulls into synchronism is the pull-up torque. The shape of the speed-torque curve in this range is similar to that of an induction motor. The PUT is not constant but varies with speed.

ACT — Accelerating Torque

The accelerating torque is that which is available at any speed to accelerate the load and motor rotor to higher speeds. The ACT available is the PUT (pull-up torque) minus the LT (load torque) at any one speed. The amount of ACT available and the inertia at the motor plus the reflected load inertia determines how long it will take the system to "come up to speed." When the LT becomes equal to the available PUT, at any speed, the motor will "hang up" at that sub-synchronous speed. The motor will continue to operate at this speed until electrical power is removed, the load is reduced, or the motor windings fail.

LRT — Starting Torque or Locked Rotor Torque

The starting or locked rotor torque is the output torque at zero speed with rated voltage at rated frequencies applied to the motor terminals. The Torque varies with the relative angle between the rotor and stator. The minimum value is taken to be the LRT. The load torque at zero speed must be less than the LRT or the motor will not rotate.

LRA — Locked Rotor Current

The current at start is known as locked rotor current. This is the sustained current value obtained with the rotor locked and rated voltage and frequency applied. The relative rotor position which produces maximum LRT results in maximum current. This is the value given as LRA.

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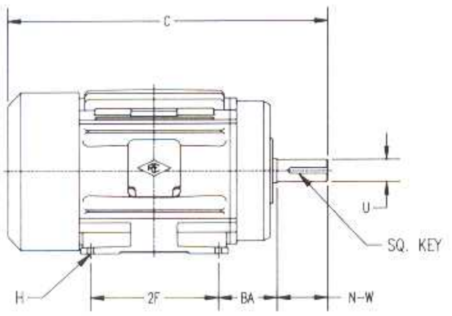
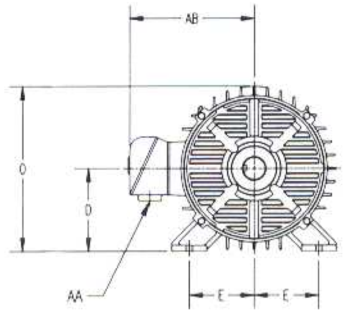
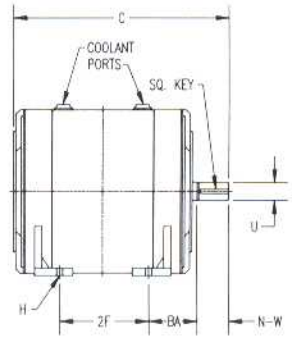
NEMA Frame Tables



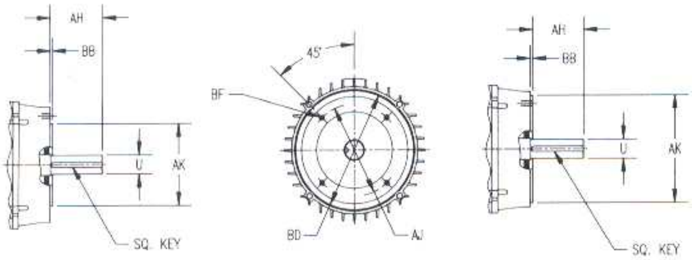


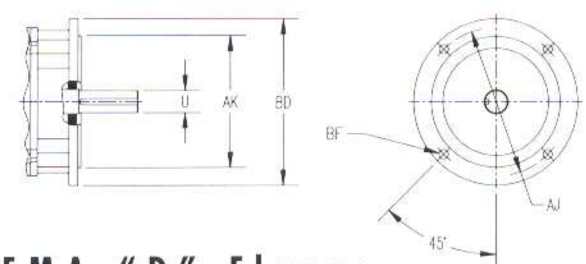


Standard NEMA

TENV (Totally Enclosed Non-Ventilated) TEFC (Totally Enclosed Fan Cooled) TEAV (Totally Enclosed Auxiliary Ventilated) TELC (Liquid Cooled, Precision)

	FRAME	C				D	E	2F	H	O	P	U	N-W	AB	BA	SQ. KEY	AA
		TELC	OPEN TENV	DPFC TEFC	DPAV TEAV												
NEMA (IN.)	56	11.25	11.25	13.63	16.88	3.50	2.44	3.00	.34 x .75	7.50	8.00	0.625	1.88	6.38	2.75	0.188	0.75
	56H	11.25	11.25	13.63	16.88	3.50	2.44	5.00	.34 x .75	7.50	8.00	0.625	1.88	6.38	2.75	0.188	0.75
	145T	11.63	11.63	14.00	17.50	3.50	2.75	5.00	0.34	7.50	8.00	0.875	2.25	6.38	2.25	0.188	0.75
	184T	13.63	13.63	16.63	19.88	4.50	3.75	5.50	0.41	9.25	9.50	1.125	2.75	7.18	2.75	0.25	0.75
	215T	17.63	17.44	20.50	24.25	5.25	4.25	7.00	0.41	11.00	11.50	1.375	3.38	9.00	3.50	0.312	1.00





NEMA "C" Flange

	FRAME	AH	AJ	AK	BB	BD	BF(4)
NEMA (IN.)	56C	2.06	5.875	4.50	0.16	6.50	3/8-16
	145TC	2.12	5.875	4.50	0.16	6.50	3/8-16
	184TC	2.62	7.25	8.50	0.25	9.00	1/2-13
	215TC	3.12	7.25	8.50	0.25	9.50	1/2-13

NEMA "D" Flange

	FRAME	AH	AJ	AK	BB	BD	BF(4)
NEMA (IN.)	56			NOT AVAILABLE			
	145TD	2.25	10.00	9.00	0.25	11.00	0.53
	184TD	2.75	10.00	9.00	0.25	11.00	0.53
	215TD	3.38	10.00	9.00	0.25	11.00	0.53

Typical Performance Data — 4 Pole Designs

HORSEPOWER @ 60 Hz	(1) FREQUENCY (HERTZ)	MOTOR SPEED (RPM)	(2) VOLTAGE (VOLTS)	(3) FULL LOAD EFFICENCY (%)	FULL LOAD POWER FACTOR (%)	(4) NO LOAD CURRENT (AMPS)	(4) FULL LOAD CURRENT (AMPS)	(5) LOCKED ROTOR CURRENT (AMPS)	(6) PULL-OUT TORQUE (% F.L.)	* FRAME SIZE
1/4	15-120	450-3600	58-460	80.00	90.00	0.16	0.32	2.00	150	143T
1/2	15-120	450-3600	58-460	82.00	90.00	0.30	0.63	4.00	150	143T
1	15-120	450-3600	58-460	82.00	90.00	0.60	1.27	8.30	150	143T
2	15-120	450-3600	58-460	85.00	90.00	1.20	2.45	16.00	150	145T
3	15-120	450-3600	58-460	85.00	90.00	1.70	3.67	24.00	150	182T
5	15-120	450-3600	58-460	85.00	90.00	3.00	6.12	40.00	150	184T
7.5	15-120	450-3600	58-460	88.00	88.00	4.00	9.10	60.00	150	184T
10	15-120	450-3600	58-460	87.00	88.88	4.50	12.10	80.00	150	215T

(1) Constant torque from 15 to 120 Hz
(2) Constant volts per Hz
(3) Value shown is at 60 Hz. Efficiency will be slightly higher at lower frequencies, and slightly lower at higher frequencies.
(4) At 60 Hz and 460 V
(5) At 60 Hz. Starting at lower frequencies will greatly reduce the starting amps.
(6) 150% pull-out torque is standard. Higher torques available when application requires.
*Optional larger frame and pole selection available, consult factory.

Data subject to change without notice.

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