

Understanding Motor Nameplate Information – NEMA vs. IEC Standards

An Online Continuing Education Course for Engineers

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Understanding Motor Nameplate Information

NEMA vs. IEC Standards

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The motor standards can be grouped into two major categories: NEMA and IEC (and its derivatives). In North America, the National Electric Manufacturers Association (NEMA) sets motor standards, including what should go on the nameplate (NEMA Standard MG 1-10.40). In most of the rest of the world, the International Electrotechnical Commission (IEC) sets the standards or at least many countries base their standards very closely on the IEC standards (for example, Germany's VDE 0530 standard and Great Britain's BS 2613 Standard are close to IEC with minor exceptions).

The National Electrical Manufacturer's Association (NEMA) specifies that every motor nameplate must show these specific items:

- 1) Manufacturer's type
- 2) Rated volts and full load amps
- 3) Rated frequency & number of phases
- 4) Rated full load speed
- 5) Rated temperature rise or the insulation system class
- 6) Time rating
- 7) Rated horsepower
- 8) Locked rotor indicating code letter
- 9) Service Factor
- 10) Efficiency
- 11) Frame Size
- 12) Design Code

Additional information may also normally appear on the nameplates. This course shall examine closely the required nameplate items starting with the NEMA standards followed by comparing where IEC information differs from NEMA.

PART-1

MOTOR NAMEPLATE INFORMATION

Industry Standards

Many of today's motor standards have been established through organizations such as the National Electrical Manufacturers' Association (NEMA), which is primarily associated with motors used in North America. The standards developed represent general industry practices and are supported by the motor manufacturers. These standards can be found in NEMA Standard Publication No# MG-1.

IEEE is another agency that has established electrical standards and recommended practices for the motor industry.

International standards exist as well, with organizations such as the International Electrotechnical Commission (IEC), the Canadian Standards Association (CSA), the Japanese Standards (JEC), the British Standards (BS) and at least one organization for each country that exists.

Underwriters' Laboratories (UL) is an independent testing organization that sets standards for motors and other electrical equipment. The National Fire Protection Association, which sponsors the National Electrical Code (NEC), is used by insurance inspectors and many government bodies regulating building codes. Note that neither NEMA or IEC are a testing agencies, they are organizations that establish industry standards.

NAMEPLATE DATA

A critical part of making motors interchangeable is ensuring that nameplate information is common among manufacturers. The common language of the motor nameplate enables installation and maintenance personnel to quickly understand and recognize exactly what type of motor they're dealing with during a new installation or replacement procedure. As a basic requirement of the National Electrical Code (NEC), the motor nameplate must show the following information:

- Rated voltage or voltages
- Rated full-load amps for each voltage level
- Frequency
- Phase
- Rated full-load speed
- Insulation class and rated ambient temperature
- Rated horsepower
- Time rating
- Locked-rotor code letter
- Manufacturer's name and address

Additional information will normally appear on most nameplates as well. This information might include the motor service factor, enclosure type, the frame size, connection diagrams and unique

or special features. The best way to approach a basic understanding of what standardization means and to cover some of the material fundamental to standard induction motors is to examine in detail the nameplate information contained on a typical motor.

In order to fully understand the details presented on motor nameplates we'll examine each of these items more closely and explain its importance.

#1:

MANUFACTURER'S TYPE

NEMA requires a manufacturer's type, but there is no industry standard for what this is. It is sometimes used to define 1 or 3-phase; single or multi-speed; construction, etc. The "type" definition varies from manufacturer to manufacturer.

Below are some of the "types" of motors that may be encountered:

1. **1-Phase, Shaded Pole:** Lowest starting torque, low cost, low efficiency, no capacitors. No start switch. Used on small direct-drive fans and small gear motors.
2. **1-Phase, PSC (Permanent Split Capacitor):** Similar to shaded pole applications except much higher efficiency, lower current and higher horsepower capability. Has run capacitor in circuit at all times.
3. **1-Phase, Split Phase:** Moderate to low starting torque, no capacitor and has starting switch. Used on easy start, belt-drive fans and blowers light start pump applications and gear motors.
4. **1-Phase, Capacitor-Start:** Designed in both moderate and high starting torque types with both having moderate starting current and high breakdown torque. Uses include conveyors and air compressors.
5. **3-Phase:** Generally 3-phase induction motors have a high starting torque, high power factor, high efficiency, and low current. Does not use a switch, capacitor or relay for starting. Suitable for use on larger commercial and industrial applications.
6. **AC/DC (Universal or Series wound):** Operates on AC (60 or 50 Hz) power. High speed. Speed drops rapidly as load increases. Used for drills, saws, etc., where high output and small size are desired and speed characteristic and limited life (primarily of brushes) is acceptable.
7. **Shunt Wound and Permanent Magnet DC:** High starting and breakdown torque. Provide smooth operation at low speeds. Used on constant or diminishing torque applications with Type K rectified DC power.

Motors can also be classified by their purpose:

- a. **General Purpose Motors** are designed for mechanical loads and hard to start loads, including conveyors, belt-driven equipment, machine tools, reciprocating pumps and compressors, etc. Their bearings can handle heavier radial and axial loads, and their physical construction is more heavy-duty than some other motors
- b. **Special Purpose Motors** are specifically designed for certain applications. For example, HVAC motors are primarily designed for fans, centrifugal pumps, small tools, office equipment, and other light to medium duty applications. Other types of definite duty

motors include wash down, hazardous location, farm duty, pump duty, universal AC/DC, vacuum, etc.

Some manufactures simply add the model, date, & serial number here to aid in identification. You will also sometime notice other logos of additional agencies shown on the nameplate, including the UL recognition label, the 'CE' mark for the European Community and the Canadian Standards Association logo.

#2: RATED VOLTS

The rated voltage is the voltage at which the motor is designed to operate and yield optimal performance. Nameplate-defined parameters for the motor such as power factor, efficiency, torque, and current are at rated voltage and frequency. Application at other than nameplate voltage will likely produce different performance.

Since line voltage is apt to vary over a period of time due to power system load conditions, the motor must be designed to cope with some voltage variations. Standard induction motors are designed to tolerate voltage variations plus or minus 10%. Thus, a motor with a nameplate voltage rating of 230 could be expected to give satisfactory but not necessarily ideal performance when supplied with power ranging from a low value of 207 to a high extreme of 253 volts.

Manufacturers often put a wide variety of voltages on the nameplate. For example, a motor wound for 230 and 460 V (230/460 V) but operable on 208 V. In this case the nameplate would read 208-230/460 and will have degraded performance at 208 V.

#3: FULL LOAD AMPS (FLA)

When the full-load torque and horsepower is reached, the corresponding amperage is known as the full-load amperage (FLA). This value is determined by laboratory tests; the value is usually rounded up slightly and recorded as the nameplate value. Rounding up allows for manufacturing variations that can occur and some normal voltage variations that might increase the full-load amps of the motor. The nameplate FLA is used to select the correct wire size, motor starter, and overload protection devices necessary to serve and protect the motor.

Rated full load current is often abbreviated as 'FLA' on the nameplate. Unbalanced phases, under-voltage conditions, or both, cause current to deviate from nameplate amps.

#4: RATED FREQUENCY

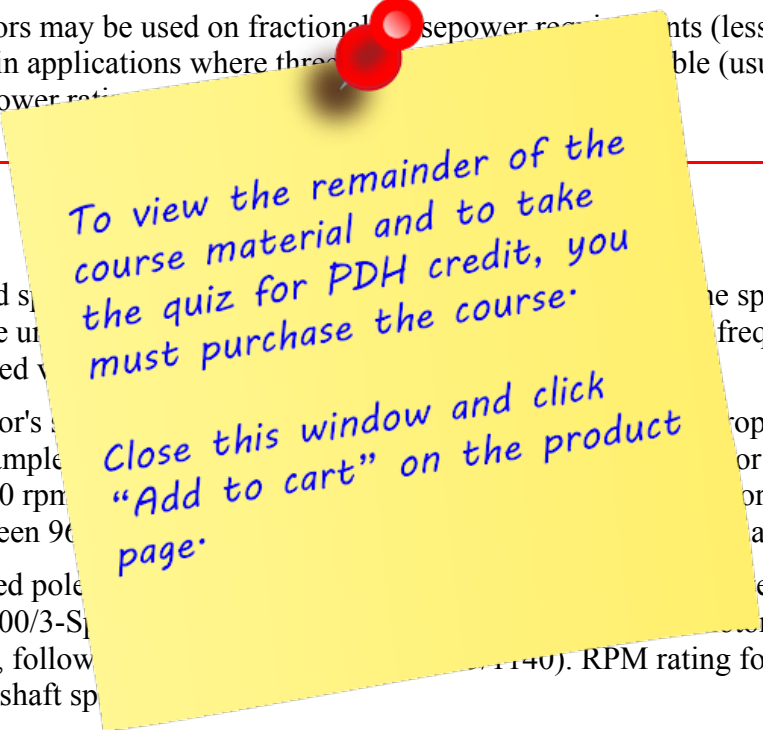
This indicates the frequency for which the motor is designed in hertz (cycles per second). 60 Hertz power is utilized throughout the United States and Canada, as well as a few other countries. Motors are designed to tolerate a frequency variance of plus or minus 5%, and a motor should be able to handle both voltage and frequency variations at the same time.

The motors designed to operate varying speeds using variable frequency drive (VFD); the frequency range is normally given.

#5: NUMBER OF PHASES

In most industrial and commercial installations, the power systems, and consequently the induction motors, will either be single phase or three phase. The cost effectiveness and efficiency of the three phase induction motor makes it the natural choice for all requirements where three phase power is available.

Single phase motors may be used on fractional horsepower requirements (less than one horsepower) and in applications where three phase power is not available (usually through a maximum horsepower rating).



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The rated full load speed of a motor will operate under constant at the rated speed. The speed at which the motor is held constant at the rated speed.

An induction motor's speed drops off as load increases. For example, a motor with a full load speed of 1750 rpm might have a full load speed of 1700 rpm or actual speed, will normally be between 90% and 95% of the rated speed as slip.

Multi-speed shaded pole motors are rated by total number of speeds (i.e., 3000/3-Speed). The first speed shown first, followed by the other speeds. RPM rating for a gear motor represents output shaft speed.

Note: "High" efficiency motors have usually higher speed ratings than comparable sized standard efficiency motors. This higher operating speed can actually increase power consumption in centrifugal loads (e.g., pumps and fans). For centrifugal loads, power varies as the cube of speed. Thus, a 1% increase in speed will result in a 3% increase in power ($1.01^3 = 1.03$).

#7: SYNCHRONOUS SPEED

Synchronous speed is the theoretical speed of a motor based on the rotating magnetic field. This is determined by the following:

$$S = (120 \times F) / P$$

Where

- S = speed in RPM