

Informative Application Guidelines, with respect to *Motors & Drives* to keep you better INFORMED.

APPLICATION GUIDELINE #03

('NEMA' Definition & Purpose)

.....Brought to you by your Motor & Drive Specialists

NEMA (National Electrical Manufacturers Association)

The National Electrical Manufacturers Association (NEMA) is a nonprofit U.S. organization consisting of members from the manufacturing sector. One of the stated purposes of NEMA is "to promote the standardization of electrical apparatus and supplies". The NEMA working document for Low Voltage Motors is Standard No. MG1, for "Motors and Generators". NEMA standards "are intended to assist users in the proper selection and application of motors". The Electrical and Electronic Manufacturers Association of Canada (EEMAC) uses MG1 with some modifications.

Please see attached list of the more useful Part numbers of the NEMA MG1 standard.

It is in Part 4 and 11, where standard labeling and dimensions are controlled. In North America, the "T" frame is the modern NEMA motor frame designation (replacing the older "U" frame standard). Motors in frame sizes up to 449T are completely interchangeable, with specific frame assignments for each horsepower/rpm combination, while mounting dimensions on frames larger than 449T are NOT necessarily interchangeable. Not all motor dimensions are designated by NEMA, and the end user must take care to ensure that critical dimensions have been considered. However, NEMA does define certain critical dimensions for T-frame motors, including foot mounting dimensions, and shaft height, etc.. NEMA defines 'Small' machines as those rated at <1 hp. For small machines in two digit frame sizes, the frame number is the "D" dimension in inches, multiplied by 16. (The "D" dimension is the distance from the centerline of the shaft to the bottom of the feet.) For 'Medium' machines (1 - 500hp), the first two digits of the frame number are equal to the "D" dimension in 1/4 inches, and the third digit (and fourth digit when required) establishes the distance between the centerlines of the mounting holes of the feet or base (side view). This provides for a high degree of interchangeability between offerings of various manufacturers (hence the tendency to view the LVM as a commodity), and minimizes motor spare requirements.

One thing that most often frustrates customers is the fact that the bolt hole locations and sizes for T-boxes are NOT standard from one manufacturer to another. That is because the T-box dimensions are NOT controlled by NEMA.

At the end of the T-Frame designation, an "S" suffix denotes a motor with a short shaft, and ball type drive end bearing, suitable for direct coupling. A "Z" suffix denotes a shaft extension modification (usually a longer shaft, with a roller bearing on the drive end, suitable for belt coupled applications). A "C" suffix denotes a C-face flange. 'No suffix' indicates a motor with ball bearings and a standard shaft, suitable for direct coupling, and which may also be suitable for belt coupled applications. The manufacturer should be consulted prior to using a standard shaft motor on a belt coupled application. Motor frames may be of cast iron, or rolled steel or rolled aluminum. Cast iron is generally considered to be the most suitable frame material for industrial use, due to its high resistance to corrosion, extreme rigidity, etc..

TOSHIBA

With the growth in VFD applications, *Part 30 and Part 31 of NEMA* have been referred to more often than ever and is often used as a reference in specifications.

Part 30 in NEMA is titled “Application Considerations for constant speed motors used on a sinusoidal bus with harmonic content and general purpose motors used with variable voltage or variable frequency controls or both”. It provides industry guidelines and recommendations regarding all kinds of things but what’s most relevant is:

1. Derates for harmonic content
2. C.T. speed ranges (low speed issues including torque derates)
3. Constant HP ranges (overspeed issues including torque derates and max speed limits)
4. Voltage Stress Limits

Part 31 in NEMA is titled “Definite Purpose Inverter Fed Polyphase Motors”, which has similar guidelines as found in Part 30 but covers more topics and is more detailed:

1. Nameplate Service Factor derate to 1.0
2. Temperature rise limits
3. Longer discussion on Voltage spike limits ($V_{peak}=3.1 \times 575v=1,783\text{volts}$, rise time $\geq 0.1\mu s$)
4. Shaft voltages and bearing insulation issues
5. Neutral Shift issues
6. Nameplate marking requirements

The table on the next page is a quick reference that highlights the key topics and sections of NEMA. NEMA will be referred to often in upcoming guidelines. For further information about NEMA please feel free to contact us or your own copy can be ordered from www.nema.org/stds/mg1.cfm

TOSHIBA

NEMA (MG-1)

PART 1 -----“REFERENCED STANDARDS AND DEFINITIONS”

- 1.17.1.2 Definition ‘Design B Polyphase Motors’
- 1.66 Classification of Insulation Systems, ‘Class F’ (A,B,F,H)
“insulation must have suitable thermal endurance”

PART 4 -----“DIMENSIONS, TOLERANCES AND MOUNTING”

- 4.01 Drawing labeling for controlled dimensions D, 2F, E
- 4.04.1 Knockout and Clearance Hole Diameter For Machine Terminal Boxes

PART 7 ----- “MECHANICAL VIBRATION-MEASUREMENT”

- 7.08.1 Standard Machine, Unfiltered Vibration Limits

PART 10 -----“RATINGS”

- 10.37.2 Code letters for Locked Rotor KVA, $6x=G$

PART 11 -----“DIMENSIONS AC & DC MACHINES”

- 11.01.2 Frame Numbering for Medium Machines (1-500Hp)
- 11.31 Dimensions for AC foot mounted Machines with Single Straight Shaft Extension

PART 12 -----“TESTS AND PERFORMANCE”

- 12.35 Maximum Locked Rotor Currents over Hp range
- 12.38 Locked Rotor Torque, Design A, B, Design C etc.
- 12.39 Break Down Torque
- 12.40 Pull Up Torque
- 12.43 Allowable Temperature Rise for Medium Motors
- 12.44 Variations from rated voltage and rated frequency
- 12.45 Voltage unbalance $\leq 1\%$
- 12.46 Variations from rated speed $\leq 20\%$ of (Synch. Speed–Rated Speed)
- 12.47 Nameplate Amperes, $\leq 10\%$ of nameplate value
- 12.48 Occasional Excess Current, withstand $(1.5x)$ current for ≥ 2 min.
- 12.49 Stall Time, withstand LRC >12 sec.
- 12.50 Overspeed, withstand 25% overspeed ≤ 2 min.
- 12.54 Number of Starts, withstand 2Cold/1Hot start with wk2 \leq table12-5
- 12.55 Routine Tests
- 12.56 Thermal Protection
- 12.57 Efficiency

PART 14 -----“APPLICATION DATA”

- 14.30 Effects of Voltage and Frequency variation upon performance
- 14.31 Operation of AC motors from Variable Frequency –or- Variable Voltage –or- Both
- 14.32 Effects of Voltages over 600 volts on performance of LVM
- 14.35 Effects of Unbalanced Voltages on performance
- 14.41 Application of V-Belt Sheave Dimensions to AC motors having anti-friction bearings
- 14.46 Effects of Load on motor Efficiency

PART 30 -----“APPLICATION CONSIDERATIONS FOR GENERAL PURPOSE MOTORS WITH VARIABLE VOLTAGE OR VARIABLE FREQUENCY CONTROLS OR BOTH”

PART 31 ----- “DEFINITE-PURPOSE INVERTER-FED MOTORS”

- 30.30 Rating (Basis of Rating based on identification of four points)
- 30.30.7 Service Factor (shall be SF=1.0)
- 31.40 Performance
 - 31.41.1 Temperature Rise, (shall not exceed normal levels 105°C for Class F)
 - 31.41.2 Torque (Breakaway Torque 140%min. requiring not more than max 150% current)
 - 31.40.4.2 Voltage Spikes (be able to withstand operating under the following limits ($V_{peak} \leq 1800v$, Rise time $\geq 0.1\mu s$))
 - 31.40.4.3 Shaft Voltages & Bearing Insulation (Potential problems cannot be consistently determined)
- 31.5 Nameplate Marking

Reliability in motion