



ELECTRIC MOTOR CODES AND STANDARDS

INTRODUCTION

Electric motors are often required to meet various industry standards and national codes in addition to specific application requirements. The more common of these standards and codes are explained in this Engineering Letter. Also included are some general motor dimensions and weights for reference purposes.

In the early days of electric motors, motors were built to the specifications and standards of individual manufacturers. Each brand usually had its own unique nomenclature, dimensions, ratings, etc., thus interchangeability was seldom possible.

Currently, a number of independent groups and several special interest organizations provide uniform specifications to which motor manufacturers can comply on a selective or voluntary basis. Some of the more common of these are listed below.

MOTOR STANDARDS ORGANIZATIONS

AIM - Automotive Industrial Motors include specific brands manufactured on a selective basis to meet the specifications established by the automotive industry. Examples include GMC - 7EQ, Ford EM-1, and Chrysler NPEM-100.

ANSI - American National Standards Institute represents manufacturers, distributors, and consumers. A wide variety of subjects are covered, such as dimensions, material specifications, test methods, and performance. Standards frequently reference those adopted by NEMA and IEEE.

CSA - Canadian Standards Association provides material standardization services for Canada. It develops or adopts standards for safety, quality, and performance.

IEC - International Electrotechnical Commission defines metric equivalencies to some NEMA standards, such as enclosures, frame sizes, conduit box locations, and mounting arrangements.

IEEE - Institute of Electrical and Electronics Engineers covers such fundamentals as basic standards for temperature rise, classification of insulating materials, and the appropriate test codes and rating methods.

ISO - International Standards Organization establishes uniform terminology, units, and equivalencies in international metric terms.

NEC - National Electric Code is an ANSI standard sponsored by the National Fire Protection Association for the purpose of safeguarding persons and property from electrical hazards. The code covers wiring methods and materials, protection of branch circuits, motors and controls, grounding, hazardous locations, and recommendations. See Figure 1.

NEMA - National Electrical Manufacturers Association is a trade association organized and supported by manufacturers of electrical equipment and supplies. Voluntary standards define products, processes, and procedures with reference to nomenclature, construction, dimensions, tolerances, operating characteristics, performance, testing, and rating. The standards cover such matters as motor-frame sizes and designations, circuit connections, lead markings, torque classifications, and a basis for ratings. Some of the more important items standardized by NEMA are:

- Speeds - see Figure 3.
- Horsepower Ratings - see Figure 3.
- Frame Sizes and Dimensions - see Figure 4.
- Conduit Box Locations - see Figure 5.
- Standard Voltages and Frequencies*
- Service Factors*
- Enclosures*
- Starting Current
- Torques

* Note: refer to Engineering Letter 22 - Integral Motors for Centrifugal Fans.

UL - Underwriters Laboratories, Inc. is an independent testing organization specializing in testing products, systems, and materials with particular reference to life, fire, and casualty hazards. Standards have been developed for motors and controls in cooperation with the manufacturers. The variety of standards for motors compliance include:

1. Motors for use where explosive vapors, combustible dusts, or easily ignitable flyings exist...as adopted by NEC.
2. Motor-operated appliances.
3. Motor overload protection devices.

NEC EXPLOSION-PROOF MOTOR DESIGNATIONS

The National Electrical Code categorizes common hazardous atmospheres and locations. Classification of hazards might be defined by the plant safety engineer or by the insurance company. Since the type and degree of hazard varies widely according to the materials encountered and their probable presence in hazardous quantities, the following methods of identification are used:

Class - materials are “classed” as flammable vapors or gases (Class I); or as combustible dusts (Class II).

Group - materials are “grouped” according to their relative degree of hazard with Groups C and D applicable to vapors or gases, and Groups E through G applicable to combustible dusts.

Division - the containment aspects are defined by “divisions” according to the likely concentration of the hazard. Division 1 is applicable to routine or periodic exposure, while Division 2 refers to a hazard that is normally confined within a system or container and which would only escape in the event of some abnormal circumstance or equipment failure. NEC requires the use of explosion-proof motors for all Division 1 locations.

Class I Group C - Atmospheres containing ethyl vapors, ethylene, or cyclopropane.

Class I Group D - Atmospheres containing gasoline, hexane, naphtha, benzine, butane, alcohol, acetone, benzol, lacquer-solvent vapors, or natural gas.

Class II Group E - Atmospheres containing metal dust.

Class II Group F - Atmospheres containing carbon black, coal, or coke dust.

Class II Group G - Atmospheres containing flour, starch, or grain dust.

The specific motor Class and Group must be determined for the particular hazard involved. Motors designed and rated for one type of hazard or location are not necessarily suitable for use in another situation . . . consult the motor manufacturer for specific application information.

The explosion-proof motor ratings normally stocked by motor manufacturers or distributors are Class I, Group D and Class II, Groups F and G, Division 1. Other ratings, such as Class I, Group C or Class II, Group E, Division 1 are non-standard but are available on special order.

Figure 1

COMMON MOTOR WEIGHTS AND SHEAVE LIMITS

Frame	Motor Weights (lbs.) ¹		Sheave Limitations (Inches) ²		
	ODP	TE	Min.	Maximum Width	
	Min./Max.	Min./Max.	Pitch Dia.	Narrow	Conven.
143T	26/41	28/65	2.2	21/4	41/4
145T	33/55	35/70	2.4	21/4	41/4
182T	50/105	55/111	2.6	23/4	51/4
184T	60/120	70/125	3.0	23/4	51/4
213T	90/137	99/197	3.0	33/8	61/2
215T	100/160	121/224	3.8	33/8	61/2
254T	145/275	23 1/384	4.4	4	73/4
256T	160/3 10	265/415	4.6	4	73/4
284T	228/374	359/495	5.0	45/8	9
284TS	225/372	356/425	*	*	*
286T	275/409	390/499	5.4	45/8	9
286TS	250/380	380/475	*	*	*
324T	366/495	490/700	6.0	51/4	101/4
324TS	333/478	458/671	*	*	*
326T	415/600	526/766	6.8	51/4	101/4
326TS	406/565	490/73 8	*	*	*
364T	580/792	748/948	7.4	57/8	111/2
364TS	519/777	730/916	*	*	*
365T	620/835	804/1040	9.0	57/8	111/2
365TS	600/821	777/1004	*	*	*
404T	845/1110	1100/1220	9.0	71/4	141/4
404TS	750/1108	1000/1211	*	*	*
405T	816/1163	1049/1368	11.5	71/4	141/4
405TS	800/1150	907/1312	*	*	*
444T	1122/1528	1400/1820	11.0	81/2	163/4
444TS	1100/1515	1365/1799	*	*	*
445T	1250/1750	1500/2458	13.2	81/2	163/4
445TS	1200/1600	1481/2300	*	*	*

* Not recommended for belt drive

Figure 2

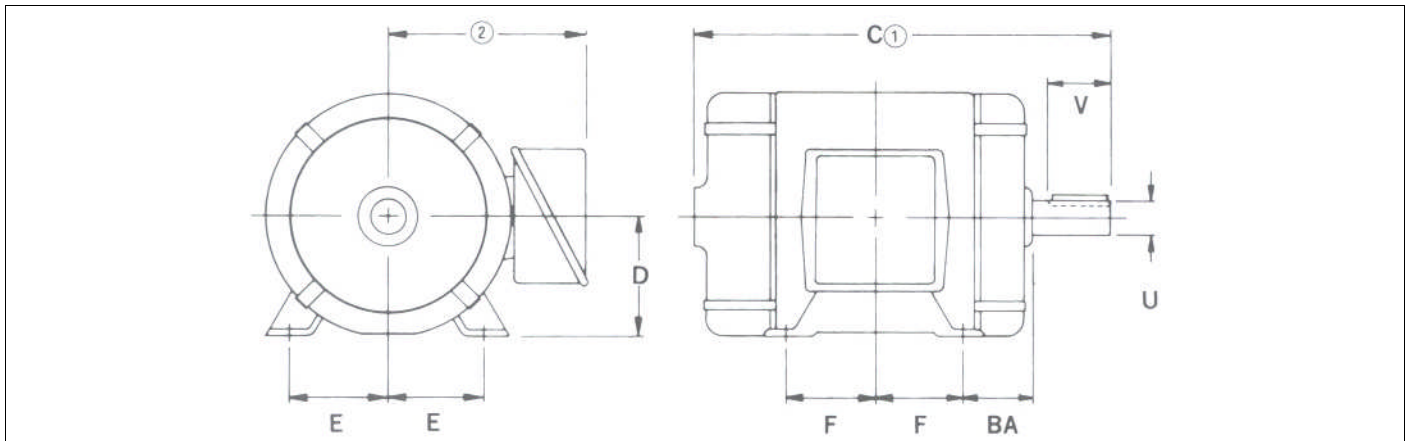
NEMA STANDARD FRAME SIZES

Rating (HP)	Synchronous Speed (RPM) ³					
	3600		1800		1200	
	ODP	TEFC	ODP	TEFC	ODP	TEFC
3/4	--	--	--	--	143T	143T
1	--	--	143T	143T	145T	145T
1 1/2	143T	143T	145T	145T	182T	182T
2	145T	145T	145T	145T	184T	184T
3	145T	182T	182T	182T	213T	213T
5	182T	184T	184T	184T	215T	215T
7 1/2	184T	213T	213T	213T	254T	254T
10	213T	215T	215T	215T	256T	256T
15	215T	254T	254T	254T	284T	284T
20	254T	256T	256T	256T	286T	286T
25	256T	284TS	284T	284T	324T	324T
30	284TS	286TS	286T	286T	326T	326T
40	286TS	324TS	324T	324T	364T	364T
50	324TS	326TS	326T	326T	365T	365T
60	326TS	364TS	364T	364T	404T	404T
70	364TS	365TS	365T	365T	405T	405T
100	365TS	405TS	404T	405T	444T	444T
125	404TS	444TS	405T	444T	445T	445T
150	405TS	445TS	444T	445T	445T	445T
200	444TS	447TS	445T	445T	445T	447T

Figure 3

- Motor weights are not standardized and vary with manufacturer, enclosure, frame, etc. The minimum and maximum weights shown are representative of the range available from several major manufacturers as of November, 1995. Where exact weights are required, consult the specific manufacturer.
- The sheave limitations shown represent the most restricted parameters from several major manufacturers. It may be possible to exceed these parameters for a given situation by consulting the specific manufacturer.
- Motor frame sizes may vary with special features or characteristics. Refer to Engineering Letter 22 - Integral Motors for Centrifugal Fans for nominal speeds.

NEMA STANDARD DIMENSIONS (Inches)



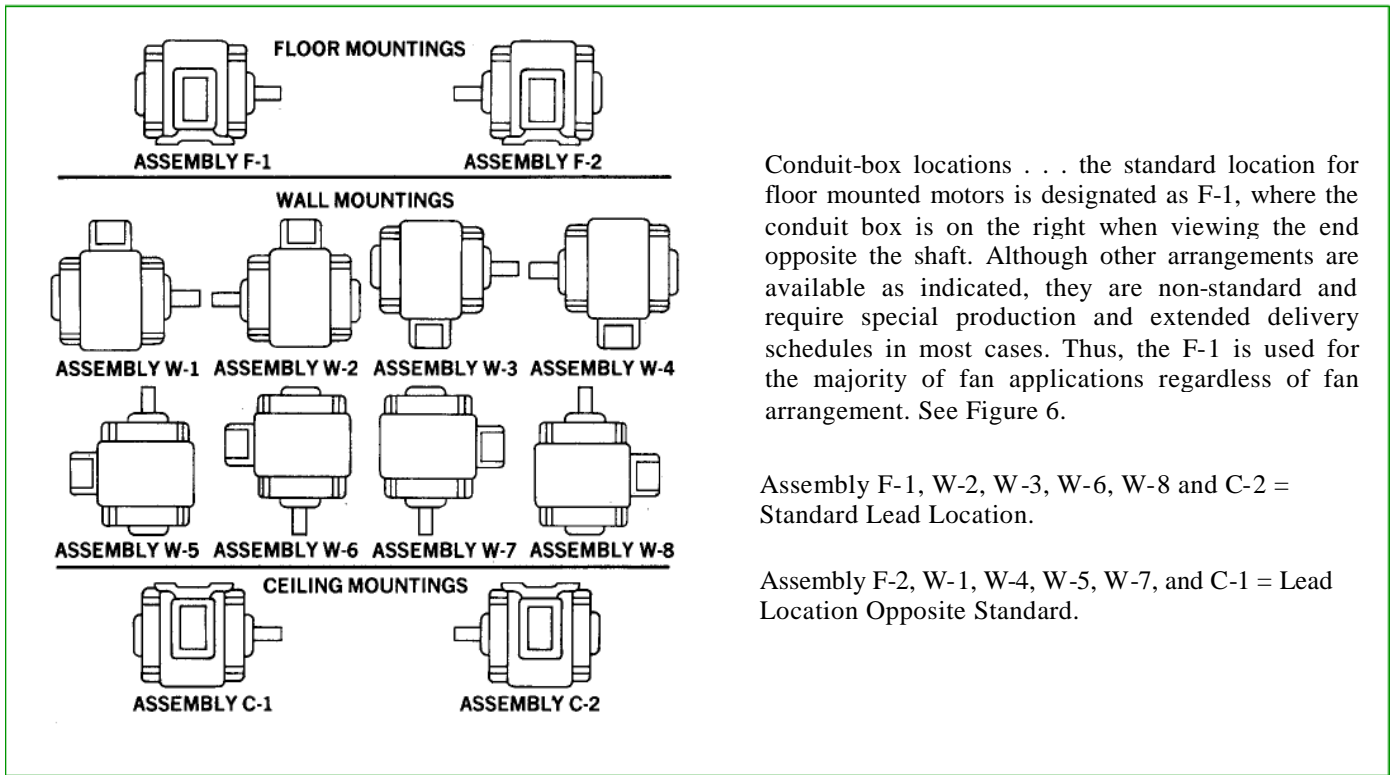
Frame	BA	D*	E	F	U□	V †	C-ODP ¹		C-TE ¹	
							Min.	Max.	Min.	Max.
143T	2.25	3.50	2.75	2.00	.875	2.00	10.99	12.82	10.45	13.35
145T	2.25	3.50	2.75	2.50	.875	2.00	11.12	12.99	11.45	14.35
182T	2.75	4.50	3.75	2.25	1.125	2.50	12.36	14.72	13.55	17.15
184T	2.75	4.50	3.75	2.75	1.125	2.50	13.56	16.50	13.55	17.15
213T	3.50	5.25	4.25	2.75	1.375	3.13	15.50	18.19	17.18	20.28
215T	3.50	5.25	4.25	3.50	1.375	3.13	16.31	18.19	17.18	20.28
254T	4.25	6.25	5.00	4.12	1.625	3.75	20.00	22.32	21.50	25.60
256T	4.25	6.25	5.00	5.00	1.625	3.75	21.69	23.19	23.20	25.60
284T	4.75	7.00	5.50	4.75	1.875	4.38	23.19	25.94	25.33	28.93
284TS	4.75	7.00	5.50	4.75	1.625	3.00	21.82	22.44	23.95	27.55
286T	4.75	7.00	5.50	5.50	1.875	4.38	23.81	25.06	26.83	28.93
286TS	4.75	7.00	5.50	5.50	1.625	3.00	22.44	23.69	25.45	27.55
324T	5.25	8.00	6.25	5.25	2.125	5.00	21.38	27.25	28.15	32.25
324TS	5.25	8.00	6.25	5.25	1.875	3.50	21.38	25.75	26.65	30.75
326T	5.25	8.00	6.25	6.00	2.125	5.00	26.69	28.50	29.65	32.25
326TS	5.25	8.00	6.25	6.00	1.875	3.50	25.19	27.00	28.15	30.75
364T	5.88	9.00	7.00	5.62	2.375	5.63	28.62	29.69	31.28	34.28
364TS	5.88	9.00	7.00	5.62	1.875	3.50	26.50	29.70	29.15	32.15
365T	5.88	9.00	7.00	6.12	2.375	5.63	26.57	29.69	31.28	34.28
365TS	5.88	9.00	7.00	6.12	1.875	3.50	27.50	29.81	29.15	32.15
404T	6.63	10.00	8.00	6.12	2.875	7.00	32.38	34.19	33.88	39.91
404TS	6.63	10.00	8.00	6.12	2.125	4.00	29.38	31.19	30.89	36.91
405T	6.63	10.00	8.00	6.87	2.875	7.00	33.88	34.19	36.85	41.95
405TS	6.63	10.00	8.00	6.87	2.125	4.00	30.88	31.19	33.85	38.95
444T	7.50	11.00	9.00	7.25	3.375	8.25	37.56	39.94	39.56	46.68
444TS	7.50	11.00	9.00	7.25	2.375	4.50	33.81	36.18	35.31	42.93
445T	7.50	11.00	9.00	8.25	3.375	8.25	38.62	39.94	39.56	48.68
445TS	7.50	11.00	9.00	8.25	2.375	4.50	35.87	36.18	35.31	44.93

*Tolerance: 8" or less, + .000, - .03 1, Over 8", +.000, - .062. □ Tolerance: 1 1/2" dia. or less +.0000, - .0005; Over 1 1/2" dia. + .000, - .001.
 † V is usable shaft length.

Figure 4

1. The overall motor length is uniformly designated as NEMA "C," but the dimension itself varies between manufacturers. The "C" dimensions shown are representative of the range available from several manufacturers as of November, 1995. Where exact dimensions are required, consult the specific motor manufacturer.
2. The distance from the center of the motor shaft to the outside edge of the conduit box is known as NEMA "AB." Since this dimension varies with manufacturer, enclosure, frame, etc., consult the specific motor manufacturer.

NEMA MOTOR ASSEMBLY DESIGNATIONS



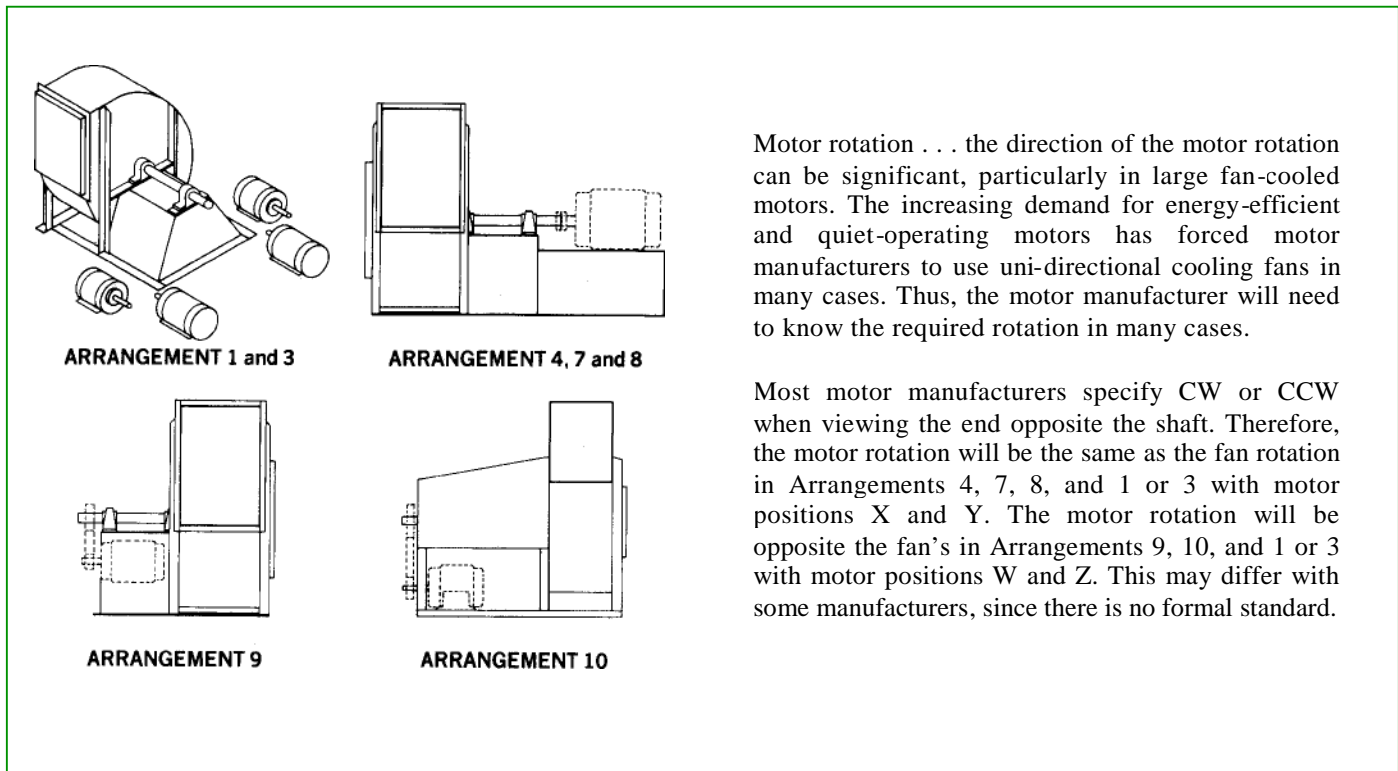
Conduit-box locations . . . the standard location for floor mounted motors is designated as F-1, where the conduit box is on the right when viewing the end opposite the shaft. Although other arrangements are available as indicated, they are non-standard and require special production and extended delivery schedules in most cases. Thus, the F-1 is used for the majority of fan applications regardless of fan arrangement. See Figure 6.

Assembly F-1, W-2, W-3, W-6, W-8 and C-2 = Standard Lead Location.

Assembly F-2, W-1, W-4, W-5, W-7, and C-1 = Lead Location Opposite Standard.

Figure 5

MOTOR ROTATION DESIGNATIONS



Motor rotation . . . the direction of the motor rotation can be significant, particularly in large fan-cooled motors. The increasing demand for energy-efficient and quiet-operating motors has forced motor manufacturers to use uni-directional cooling fans in many cases. Thus, the motor manufacturer will need to know the required rotation in many cases.

Most motor manufacturers specify CW or CCW when viewing the end opposite the shaft. Therefore, the motor rotation will be the same as the fan rotation in Arrangements 4, 7, 8, and 1 or 3 with motor positions X and Y. The motor rotation will be opposite the fan's in Arrangements 9, 10, and 1 or 3 with motor positions W and Z. This may differ with some manufacturers, since there is no formal standard.

Figure 6