

THE MYSTERY OF MOTOR FRAME SIZE

INTRODUCTION

Industrial electric motors have been available for nearly a century. In that time there have been a great many changes. One of the most obvious has been the ability to pack more horsepower in a smaller physical size. Another important achievement has been the standardization of motors by the National Electric Manufacturers Association (NEMA).

A key part of motor interchangeability has been the standardization of frame sizes. This means that the same horsepower, speed, and enclosure will normally have the same frame size from different motor manufacturers. Thus, a motor from one manufacturer can be replaced with a similar motor from another company provided they are both in standard frame sizes.

THREE GENERATIONS

The standardization effort over the last forty years has resulted in one original grouping of frame sizes called "original". In 1952, new frame assignments were made. These were called "U frames". The current "T frames" were introduced in 1964. "T" frames are the current standard and most likely will continue to be for some time in the future.

Even though "T" frames were adopted in 1964, there are still a great many "U" frame motors in service that will have to be replaced in the future. Similarly there are also many of the original frame size motors (pre-1952) that will reach the end of their useful life and will have to be replaced. For this reason, it is desirable to have reference material available on frame sizes and some knowledge of changes that took place as a part of the so-called rerate programs.

FRAME SIZE REFERENCE TABLES

Tables 1 and 2 show the standard frame size assignments for the three different eras of motors. As you will note, these tables are broken down for open drip proof (table 1) and totally enclosed (table 2). Also, you will find that for each horsepower rating and speed, there are three different frame sizes. The first is the original frame size, the middle one is the "U frame" size, and the third one is the "T frame". These are handy reference tables since they give general information for all three vintages of three phase motors in integral horsepower frame sizes.

One important item to remember is that the base mounting hole spacing ("E" and "F" dimensions) and shaft height ("D" dimension) for all frames having the same three digits regardless of vintage, will be the same.

RERATING AND TEMPERATURES

The ability to rerate motor frames to get more horsepower in a frame has been brought about mainly by improvements made in insulating materials. As a result of this improved insulation, motors can be run much hotter. This allows more horsepower in a compact frame. For example, the original NEMA frame sizes ran at very low temperatures. The "U" frame motors were designed for use with Class A insulation, which has a rating of 105° C. The motor designs were such that the capability would be used at the hottest spot within the motor. "T" frame motor designs are based on utilizing Class B insulation with a temperature rating of 130° C. This increase in temperature capability made it possible to pack more horsepower into the same size frame. To accommodate the larger mechanical horsepower capability, shaft and bearing sizes had to be increased. Thus, you will find that the original 254 frame (5 HP at 1800 RPM) has a 1-1/8" shaft. The 254U frame (7-1/2 HP at 1800 RPM) has a 1-3/8" shaft, and the current 254T frame (15 HP at 1800 RPM) has a 1-5/8" shaft. Bearing diameters were also increased to accommodate the larger shaft sizes and heavier loads associated with the higher horsepowers.

FRAME SIZE BASIS

On page 14 you will find a Baldor frame size chart that is a great reference on "T" frame, "U" frame and original frame motors. Most of the dimensions are standard dimensions that are common to all motor manufacturers. One exception to this is the "C" dimension (overall motor length) which will change from one manufacturer to another.

FRACTIONAL HORSEPOWER MOTORS

The term “fractional horsepower” is used to cover those frame sizes having two digit designations as opposed to the three digit designations that are found in Tables 1 and 2. The frame sizes that are normally associated with industrial fractional horsepower motors are 42, 48, and 56. In this case, each frame size designates a particular shaft height, shaft diameter, and face or base mounting hole pattern. In these motors, specific frame assignments have not been made by horsepower and speed, so it is possible that a particular horsepower and speed combination might be found in three different frame sizes. In this case, for replacement it is essential that the frame size be known as well as the horsepower, speed and enclosure. The derivation of the two digit frame number is based on the shaft height in sixteenths of an inch. You can figure that a 48 frame motor will have a shaft height of 48 divided by 16 or 3 inches. Similarly, a 56 frame motor would have a shaft height of 3-1/2 inches. The largest of the current fractional horsepower frame sizes is a 56 frame which is available in horsepowers greater than those normally associated with fractionals. For example, 56 frame motors are built in horsepowers up to 3 HP and in some cases, 5 HP. For this reason, calling motors with 2 digit frame sizes “fractionals” is somewhat misleading.

INTEGRAL HORSEPOWER MOTORS

The term Integral Horsepower Motors generally refers to those motors having three digit frame sizes such as 143T or larger. When dealing with these frame sizes one “rule of thumb” is handy. It is that the centerline shaft height (“D” dimension) above the bottom of the base is the first two digits of the frame size divided by four. For example, a 254T frame would have a shaft height of $25 \div 4 = 6.25$ inches. Although the last digit does not directly relate to an “inch” dimension, larger numbers do indicate that the rear bolt holes are moved further away from the shaft end bolt holes (the “F” dimension becomes larger).

VARIATIONS

In addition to the standard numbering system for frames, there are some variations that will appear. These are itemized below along with an explanation of what the various letters represent.

- C — Designates a “C” face (flange) mounted motor. This is the most popular type of face mounted motor and has a specific bolt pattern on the shaft end to allow mounting. The critical items on “C” face motors are the “bolt circle” (AJ dimension), register (also called rabbet) diameter (AK dimension) and the shaft size (U dimension). C flange motors always have threaded mounting holes in the face of the motor.
- D — The “D” flange has a special type of mounting flange installed on the shaft end. In the case of the “D” flange, the flange diameter is larger than the body of the motor and it has clearance holes suitable for mounting bolts to pass through from the back of the motor into threaded holes in the mating part. “D” flange motors are not as popular as “C” flange motors.
- H — Used on some 56 frame motors, “H” indicates that the base is suitable for mounting in either 56, 143T, or 145T mounting dimensions.
- J — This designation is used with 56 frame motors and indicates that the motor is made for “jet pump” service with a threaded stainless steel shaft and standard 56C face.
- JM — The letters “JM” designate a special pump shaft originally designed for a “mechanical seal”. This motor also has a C face.
- JP — Similar to the JM style of motor having a special shaft, the JP motor was originally designed for a “packing” type of seal. The motor also has a C face.
- S — The use of the letter “S” in a motor frame designates that the motor has a “short shaft”. Short shaft motors have shaft dimensions that are smaller than the shafts associated with the normal frame size. Short shaft motors are designed to be directly coupled to a load through a flexible coupling. They are not supposed to be used on applications where belts are used to drive the load.
- T — A “T” at the end of the frame size indicates that the motor is of the 1964 and later “T” frame vintage.
- U — A “U” at the end of the frame size indicates that the motor falls into the “U” frame size assignment (1952 to 1964) era.
- Y — When a “Y” appears as a part of the frame size it means that the motor has a special mounting configuration. It is impossible to tell exactly what the special configuration is but it does denote that there is a special non-standard mounting.
- Z — Indicates the existence of a special shaft which could be longer, larger, or have special features such as threads, holes, etc. “Z” indicates only that the shaft is special in some undefined way.

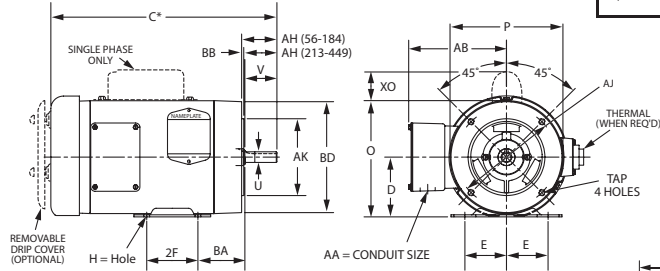
TABLE 1 – OPEN DRIP-PROOF												
THREE PHASE FRAME SIZES – GENERAL PURPOSE												
RPM NEMA Program HP	3600			1800			1200			900		
	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate
1	—	—	—	203	182	143T	204	184	145T	225	213	182T
1.5	203	182	143T	204	184	145T	224	184	182T	254	213	184T
2	204	184	145T	224	184	145T	225	213	184T	254	215	213T
3	224	184	145T	225	213	182T	254	215	213T	284	254U	215T
5	225	213	182T	254	215	184T	284	254U	215T	324	256U	254T
7.5	254	215	184T	284	254U	213T	324	256U	254T	326	284U	256T
10	284	254U	213T	324	256U	215T	326	284U	256T	364	286U	284T
15	324	256U	215T	326	284U	254T	364	324U	284T	365	326U	286T
20	326	284U	254T	364	286U	256T	365	326U	286T	404	364U	324T
25	364S	286U	256T	364	324U	284T	404	364U	324T	405	365U	326T
30	364S	324US	284TS	365	326U	286T	405	365U	326T	444	404U	364T
40	365S	326US	286TS	404	364U	324T	444	404U	364T	445	405U	365T
50	404S	364US	324TS	405S	365US	326T	445	405U	365T	504	444U	404T
60	405S	365US	326TS	444S	404US	364T	504	444U	404T	505	445U	405T
75	444S	404US	364TS	445S	405US	365T	505	445U	405T	—	—	444T
100	445S	405US	365TS	504S	444US	404T	—	—	444T	—	—	445T
125	504S	444US	404TS	505S	445US	405T	—	—	445T	—	—	—
150	505S	445US	405TS	—	—	444T	—	—	—	—	—	—
200	—	—	444TS	—	—	445T	—	—	—	—	—	—
250	—	—	445TS	—	—	—	—	—	—	—	—	—

TABLE 2 – TOTALLY ENCLOSED FAN COOLED												
THREE PHASE FRAME SIZES – GENERAL PURPOSE												
RPM NEMA Program HP	3600			1800			1200			900		
	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate	Orig.	1952 Rerate	1964 Rerate
1	—	—	—	203	182	143T	204	184	145T	225	213	182T
1.5	203	182	143T	204	184	145T	224	184	182T	254	213	184T
2	204	184	145T	224	184	145T	225	213	184T	254	215	213T
3	224	184	182T	225	213	182T	254	215	213T	284	254U	215T
5	225	213	184T	254	215	184T	284	254U	215T	324	256U	254T
7.5	254	215	213T	284	254U	213T	324	256U	254T	326	284U	256T
10	284	254U	215T	324	256U	215T	326	284U	256T	364	286U	284T
15	324	256U	254T	326	284U	254T	364	324U	284T	365	326U	286T
20	326	286U	256T	364	286U	256T	365	326U	286T	404	364U	324T
25	365S	324U	284TS	365	324U	284T	404	364U	324T	405	365U	326T
30	404S	326US	286TS	404	326U	286T	405	365U	326T	444	404U	364T
40	405S	364US	324TS	405	364U	324T	444	404U	364T	445	405U	365T
50	444S	365US	326TS	444S	365US	326T	445	405U	365T	504	444U	404T
60	445S	405US	364TS	445S	405US	364T	504	444U	404T	505	445U	405T
75	504S	444US	365TS	504S	444US	365T	505	445U	405T	—	—	444T
100	505S	445US	405TS	505S	445US	405T	—	—	444T	—	—	445T
125	—	—	444TS	—	—	444T	—	—	445T	—	—	—
150	—	—	445TS	—	—	445T	—	—	—	—	—	—

BALDOR

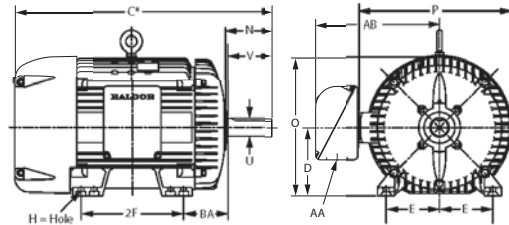
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**Leader in Energy Efficient
Industrial Electric Motors and Drives**



	NEMA Shaft			Keyseat Dimensions		
	(U)	(R)	(S)	(U)	(R)	(S)
	3/8	21/64	FLAT	1-7/8	1-19/32	1/2
	1/2	29/64	FLAT	2-1/8	1-27/32	1/2
	5/8	33/64	3/16	2-3/8	2-1/64	5/8
	7/8	49/64	3/16	2-1/2	2-3/16	5/8
	1-1/8	63/64	1/4	2-7/8	2-29/64	3/4
	1-3/8	1-13/64	5/16	3-3/8	2-7/8	7/8
	1-5/8	1-13/32	3/8	3-7/8	3-5/16	1

Drawings represent standard TEFC general purpose motors
*Dimensions are for reference only.



*Contact your local Baldor office for "C" Dimensions.

Dimensions - N, O, P, AB and XO are specific to Baldor.

NEMA QUICK REFERENCE CHART

NEMA FRAME	D	E	2F	H	N	O	P	U	V	AA	AB	AH	AJ	AK	BA	BB	BD	XO	TAP
42	2-5/8	1-3/4	1-11/16	9/32 SLOT	1-1/2	5	4-11/16	3/8	1-1/8	3/8	4-1/32	1-5/16	3-3/4	3	2-1/16	1/8	4-5/8	1-9/16	1/4-20
48	3	2-1/8	2-3/4	11/32 SLOT	1-7/8	5-7/8	5-11/16	1/2	1-1/2	1/2	4-3/8	1-11/16	3-3/4	3	2-1/2	1/8	5-5/8	2-1/4	1/4-20
56 56H	3-1/2	2-7/16	3/5	11/32 SLOT	2-7/16	6-7/8	6-5/8	5/8	1-7/8	1/2	5	2-1/16	5-7/8	4-1/2	2-3/4	1/8	6-1/2	2-1/4	3/8-16
143T 145T	3-1/2	2-3/4	4/5	11/32	2-1/2	6-7/8	6-5/8	7/8	2-1/4	3/4	5-1/4	2-1/8	5-7/8	4-1/2	2-1/4	1/8	6-1/2	2-1/4	3/8-16
182 184 182T 184T	4-1/2	3-3/4	4-1/2	13/32	2-11/16	8-11/16	7-7/8	7/8	2-1/4	3/4	5-7/8	2-1/8	5-7/8	4-1/2	2-3/4	1/8	6-1/2	2-3/8	3/8-16
213 215 213T 215T	5-1/4	4-1/4	5-1/2	13/32	3-1/2	10-1/4	9-9/16	1-1/8	3	3/4	7-3/8	2-3/4	5-7/8	4-1/2	2-3/4	1/8	6-1/2	2-3/8	1/2-13
254U 256U 254T 256T	6-1/4	5	8-1/4	17/32	4-1/16	12-7/8	12-15/16	1-3/8	3-3/4	1	9-5/8	3-1/2	5-7/8	7-1/4	8-1/2	4-1/4	1/4	10	1/2-13
284U 286U 284T 286T 284TS 286TS	7	5-1/2	9-1/2	17/32	5-1/8	14-5/8	14-5/8	1-5/8	4-7/8	1-1/2	13-1/8	4-7/8	5-7/8	10-1/2	4-3/4	1/4	11-1/4	-	1/2-13
324U 326U 324T 326T 324TS 326TS	8	6-1/4	10-1/2	21/32	5-1/2	16-1/2	16-1/2	1-7/8	5-5/8	2	14-1/8	5-1/4	5-7/8	11	12-1/2	5-1/4	1/4	13-3/8	5/8-11
364U 365U 364T 365T 364TS 365TS	9	7	11-1/4	21/32	6-3/4	18-1/2	18-1/4	2-1/8	6-3/8	2-1/2	15-1/16	6-1/8	5-7/8	11	12-1/2	5-7/8	1/4	13-3/8	5/8-11
404U 405U 404T 405T 404TS 405TS	10	8	12-1/4	13/16	7-3/16	20-5/16	20-1/8	2-3/8	7-1/8	3	18	6-7/8	5-7/8	11	12-1/2	6-5/8	1/4	13-7/8	5/8-11
444U 445U 444T 445T 444TS 445TS 447TS 449TS	11	9	14-1/2	13/16	8-5/8	22-7/8	22-3/8	2-7/8	8-5/8	3	19-9/16	8-5/8	6-1/8	14	16	7-1/2	1/4	16-3/4	5/8-11

Both Baldor and Reliance products are shown in this catalog. There are slight differences in dimensions between the two product designs, primarily in the O and P dimensions. The above chart reflects Baldor dimensions. For more exact dimensional data, please check the specific drawing for the specific catalog number.

5000 FRAME	D	E	2F	H	O	P	U	V	AA	AB	BA
5008S	12-1/2	10	22	15/16	26-27/32	32.24	4.13	6.84	4-NPT	32.74	8-1/2
5008L	12-1/2	10	22	15/16	26-27/32	32.24	4.13	10.84	4-NPT	32.74	8-1/2
5010S	12-1/2	10	28	15/16	26-27/32	32.24	4.13	6.84	4-NPT	32.74	8-1/2
5010L	12-1/2	10	28	15/16	26-27/32	32.24	4.13	10.84	4-NPT	32.74	8-1/2
5012S	12-1/2	10	36	15/16	26-27/32	32.24	4.13	6.84	4-NPT	32.74	8-1/2
5012L	12-1/2	10	36	15/16	26-27/32	32.24	4.13	10.84	4-NPT	32.74	8-1/2

NEMA C-Face	BA Dimensions
143-5TC	2-3/4
182-4TC	3-1/2
213-5TC	4-1/4
254-6TC	4-3/4

BALDOR ELECTRIC COMPANY
P.O. BOX 2400
FORT SMITH, ARKANSAS
72902-2400 U.S.A.

Frame	D	E	2F	H	O	V	BA	
66	4-1/8	2-15/16	2-1/2	2-1/4	3/4	2-1/4	3-1/8	
203	5	4	2-3/4	3-1/4	2-7/16	3/4	2	3-1/8
224	5-1/2	4-1/2	3-3/8	3-1/4	1	3	3-1/8	
225	5-1/2	4-1/2	3-3/4	3-1/4	1	3	3-1/8	
254	6-1/4	5	4-1/8	3-7/16	1-1/8	3-3/8	4-1/4	
284	7	5-1/2	4-3/4	4-1/4	1-1/4	3-3/4	4-3/4	
324	8	6-1/4	5-1/4	5-3/8	1-5/8	4-7/8	5-1/4	
326	8	6-1/4	5-1/4	5-3/8	1-5/8	4-7/8	5-1/4	
364	9	7	5-5/8	5-5/8	1-7/8	5-3/8	5-7/8	
365	9	7	6-1/8	6-1/8	2-1/8	6-1/8	6-5/8	
404	10	8	6-1/8	6-3/8	2-1/8	6-1/8	6-5/8	
444	11	9	7-1/4	7-1/8	2-3/8	6-7/8	7-1/2	
445	11	9	8-1/4	8-1/4	2-3/8	6-7/8	7-1/2	
504	12-1/2	10	8	8	2-7/8	8-3/8	8-1/2	
505	12-1/2	10	9	8-5/8	2-7/8	8-3/8	8-1/2	