Identifying rating information of motors without nameplates

Steps to determine characteristics needed for finding a replacement

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A motor is received from a customer with the request that it be replaced. However, it does not have a nameplate. The steps to determine the motor characteristics needed for identifying a replacement will be described here. These same steps can also be used in the case of repair of a motor without a nameplate, so that a new nameplate with key identification characteristics can be made and attached to the repaired motor. The focus of this article will be NEMA or IEC horizontal motors in standard frame sizes.

Determine frame dimensions

Upon receipt of the motor, the key dimensions needed to identify the frame size should be measured prior to disassembly. The required measurements are the front-to-back foothole centerline distance (NEMA 2F, IEC B), side-to-side foothole centerline distance (NEMA 2E, IEC A), mounting surface-to-shaft centerline distance (NEMA D, IEC H), and shaft diameter (NEMA U, IEC D).

An example of a NEMA frame identification would be a motor with 2F = 11.25", 2E = 14.00" (E = 7.00"), D = 9.00", and U = 2.375". The applicable NEMA frame can be identified from a table of frame dimensions such as can be found in the *EASA Electrical Engineering Pocket Handbook* (see **Table 1**). In this case the NEMA frame is 364T. An example of an IEC frame identification would be a motor with B = 140 mm, A = 160, H = 100 mm, and D = 28 mm (see **Tables 2 and 3**). As with the NEMA motor example, the applicable IEC frame can be identified from tables of frame dimensions and shaft dimensions such as can be found in the *EASA Electrical Engineering Pocket Handbook*. Note that the IEC frame motor shaft size is indirectly associated with the frame size and the power rating (see **Table 4**). In this case the IEC frame is 100L.

Check lead connections

It may be possible to estimate the voltage rating by checking the number of external winding leads. If the motor has 9 leads, it is probably dual voltage; 230/460 volts if it is a T frame; or 220/440 volts if it is a U frame. Motors with 3, 6, or 12 leads require additional information. Regardless of the number of leads, ask the end user to provide the actual supply voltage where the motor is installed. When a motor has more than 3 leads, always ask the starting method. Confusion between part-winding starting and wye-delta starting is a common source of error. If the motor is to be operated from a variable frequency drive (VFD), that will influence your new motor specification.

Inspect the lead connection for motors with more than 3 leads and use the customer provided voltage to determine the probable voltage rating. If the motor was received with all leads open, you will need to rely on the customer reported voltage rating when selecting the replacement motor. If the external leads are still interconnected, you may be able to confirm the probable voltage rating.

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Table 1: Example of NEMA frame dimensions.

NEMA FRAME DIMENSIONS
FOOT-MOUNTED AC MACHINES
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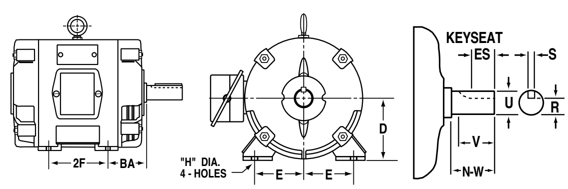

* Dimensions in inches

FRAME DESIGNATION	D	E	2F	BA	H**	U	N-W	V MIN	KEYSEAT		
									R	ES MIN	S
364	9.00	7.00	11.25	5.88	0.66	1.875	5.62	5.38	1.591	4.28	0.500
364S	9.00	7.00	11.25	5.88	0.66	1.625	3.25	3.00	1.416	1.91	0.375
364U	9.00	7.00	11.25	5.88	0.66	2.125	6.38	6.12	1.845	5.03	0.500
364US	9.00	7.00	11.25	5.88	0.66	1.875	3.75	3.50	1.591	2.03	0.500
364T	9.00	7.00	11.25	5.88	0.66	2.375	5.88	5.62	2.021	4.28	0.625
364TS	9.00	7.00	11.25	5.88	0.66	1.875	3.75	3.50	1.591	2.03	0.500
365	9.00	7.00	12.25	5.88	0.66	1.875	5.62	5.38	1.591	4.28	0.500
365S	9.00	7.00	12.25	5.88	0.66	1.625	3.25	3.00	1.416	1.91	0.375
365U	9.00	7.00	12.25	5.88	0.66	2.125	6.38	6.12	1.845	5.03	0.500
365US	9.00	7.00	12.25	5.88	0.66	1.875	3.75	3.50	1.591	2.03	0.500
365T	9.00	7.00	12.25	5.88	0.66	2.375	5.88	5.62	2.021	4.28	0.625
365TS	9.00	7.00	12.25	5.88	0.66	1.875	3.75	3.50	1.591	2.03	0.500
404	10.00	8.00	12.25	6.62	0.81	2.125	6.38	6.12	1.845	5.03	0.500
404S	10.00	8.00	12.25	6.62	0.81	1.875	3.75	3.50	1.591	2.03	0.500
404U	10.00	8.00	12.25	6.62	0.81	2.375	7.12	6.88	2.021	5.53	0.625
404US	10.00	8.00	12.25	6.62	0.81	2.125	4.25	4.00	1.845	2.78	0.500
404T	10.00	8.00	12.25	6.62	0.81	2.875	7.25	7.00	2.450	5.65	0.750
404TS	10.00	8.00	12.25	6.62	0.81	2.125	4.25	4.00	1.845	2.78	0.500
405	10.00	8.00	13.75	6.62	0.81	2.125	6.38	6.12	1.845	5.03	0.500
405S	10.00	8.00	13.75	6.62	0.81	1.875	3.75	3.50	1.591	2.03	0.500

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For example, if the motor has 12 leads and the customer indicated it was used at 460 volts, check the external lead connections. If, for example, the terminations are leads 1-12, 2-10 and 3-11 to supply lines and leads 4-7,5-8 and 6-9 were joined in pairs and electrically isolated, the connection is a high (versus low) voltage delta. The connection and the utilization voltage agree with each other; thus it is probable that the voltage rating is 460 volts.

Identify number of poles

The motor will need to be disassembled to determine the motor speed and to estimate the power rating. Count the number of groups of coils in the winding, number of slots, and determine the coil span. If the winding is concentric, determine the maximum and minimum span. If the winding has salient (alternating) poles, the number of groups divided by 3 will equal the number of poles. If the winding has consequent poles, i.e., all coils of the same polarity, divide the number of groups by 1.5 to determine the number of poles. The span can be used to confirm the number of poles and whether the winding is connected salient or consequent pole.

The number of poles can be approximated by dividing the number of slots by the lap winding coil span or the concentric winding average span. If the value that results is not an even whole (integer) number, round it down to the nearest even whole number. An example of using this check with a lap winding is a 36-slot stator that has coils spanning 7 teeth (1-8 pitch). Dividing 36 by 8 equals 4.5 which rounds down to 4, thus the winding is probably 4 poles. If the coils spanned 4 teeth (1-5 pitch), the value would be 36 divided by 4 equals 9; and since 9 is an odd number, round it down to 8, indicating a probable 8 pole winding.

Estimate power rating

At this point the frame size and poles have been identified, and by inspection it can be determined that the enclosure is either drip-proof or totally enclosed. With this information the estimated power rating can be determined for a NEMA frame motor by checking tables of horsepower, speed (poles) and frame size for the applicable enclosure. These tables can be found in the *EASA Electrical Engineering Pocket Handbook*. If the motor is an IEC frame, use **Table 4**.

If the frame dimensions apply to more than one power rating or if greater certainty of the power rating is desired, the stator core dimensions can be used for further evaluation. Measure the stator core length and bore (inside diameter) and

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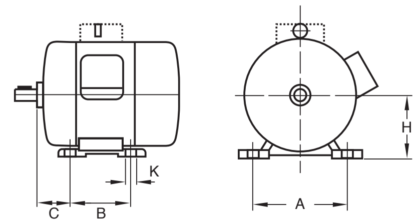
Table 2: Example of IEC frame dimensions.

IEC MOUNTING DIMENSIONS*
FOOT-MOUNTED AC AND DC MACHINES

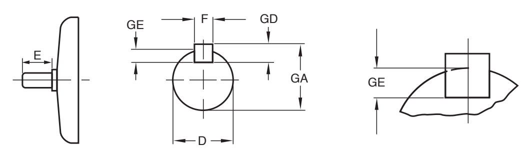


*Dimensions in millimeters

FRAME NUMBER	H	A	B	C	K	BOLT OR SCREW
56 M	56	90	71	36	5.8	M5
63 M	63	100	80	40	7	M6
71 M	71	112	90	45	7	M6
80 M	80	125	100	50	10	M8
90 S	90	140	100	56	10	M8
90 L	90	140	125	56	10	M8
100 S	100	160	112	63	12	M10
100 L	100	160	140	63	12	M10
112 S	112	190	114	70	12	M10
112 M	112	190	140	70	12	M10
132 S	132	216	140	89	12	M10
132 M	132	216	178	89	12	M10

Table 3: Example of IEC shaft dimensions.

IEC SHAFT EXTENSION, KEY AND KEYSEAT DIMENSIONS*
CONTINUOUS DUTY AC MOTORS



*Dimensions in millimeters

	D			KEY		KEYSEAT		
FRAME	2 POLE	4, 6, 8 POLE	E	F	GD	F	GE	GA
56M	9	9	20	3	3	3	1.8	10.2
63M	11	11	23	4	4	4	2.5	12.5
71M	14	14	30	5	5	5	3	16
80M	19	19	40	6	6	6	3.5	21.5
90S	24	24	50	8	7	8	4	27
90L	24	24	50	8	7	8	4	27
100L	28	28	60	8	7	8	4	31
112M	28	28	60	8	7	8	4	31
132S	38	38	80	10	8	10	5	41
132M	38	38	80	10	8	10	5	41
160M	42	42	110	12	8	12	5	45
160L	42	42	110	12	8	12	5	45
180M	48	48	110	14	9	14	5.5	51.5
180L	48	48	110	14	9	14	5.5	51.5
200L	55	55	110	16	10	16	6	59
225S	55	—	110	16	10	16	6	59
225M	55	—	110	16	10	16	6	59
225S	—	60	140	18	11	18	7	64
225M	—	60	140	18	11	18	7	64
250M	60	—	140	18	11	18	7	64
250M	—	65	140	18	11	18	7	69
280S	65	—	140	18	11	18	7	69
280M	65	—	140	18	11	18	7	69
280S	—	75	140	20	12	20	7.5	79.5
280M	—	75	140	20	12	20	7.5	79.5
315S	65	—	140	18	11	18	7	69
315M	65	—	140	18	11	18	7	69
315S	—	80	170	22	14	22	9	85
315M	—	80	170	22	14	22	9	85

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Table 4: IEC frame (TEFC motors) versus power rating (kW) and speed (poles)

Frame Size		Shaft extension diameter		Rated output kW	
	2 pole mm (in)	4, 6, 8 pole mm (in)	2 pole	4 pole	6 pole
56M	9 (0.354)	9 (0.354)	0.09, 0.12	0.06, 0.09	–
63M	11 (0.433)	11 (0.433)	0.18, 0.25	0.12, 0.18	–
71M	14 (0.551)	14 (0.551)	0.37, 0.55	0.25, 0.37	–
80M	19 (0.748)	19 (0.748)	0.75, 1.1	0.55, 0.75	0.37, 0.55
90S	24 (0.945)	24 (0.945)	1.5	1.1	0.75
90L	24 (0.945)	24 (0.945)	2.2	1.5	1.1
100L	28 (1.102)	28 (1.102)	3	2.2, 3	1.5
112M	28 (1.102)	28 (1.102)	4	4	2.2
132S	38 (1.496)	38 (1.496)	5.5, 7.5	5.5	3
132M	38 (1.496)	38 (1.496)	–	7.5	4, 5.5
160M	42 (1.654)	42 (1.654)	11, 15	11	7.5
160L	42 (1.654)	42 (1.654)	18.5	15	11
180M	48 (1.890)	48 (1.890)	22	18.5	–
180L	48 (1.890)	48 (1.890)	–	22	15
200L	55 (2.165)	55 (2.165)	30, 37	30	18.5, 22
225S	55 (2.165)	60 (2.362)	–	37	30
225M	55 (2.165)	60 (2.362)	45	45	30
250M	60 (2.362)	65 (2.559)	55	55	37
280S	65 (2.559)	75 (2.953)	75	75	45
280M	65 (2.559)	75 (2.953)	90	90	55
315S	65 (2.559)	80 (3.150)	110	110	75
315M	65 (2.559)	80 (3.150)	132	132	90

count the number of slots. With that information and the number of poles, the *EASA Motor Rewind Data* winding database can be searched for windings that match the four parameters.

Use a 2% tolerance for the length and bore for the initial search; increase the tolerance 1% at a time up to 5% if necessary to obtain search results. Statistically, if more than 50% of the results are of the same power rating, that is the most probable rating. The greater the number of equal power ratings versus the total results, the greater the probability of that result being the rating for the motor being evaluated.

For example, if 87 of 93 motor windings that came up in a search were rated 100 hp, there would be a very high certainty that the motor was 100 hp.

This process can be used with even greater certainty if the no nameplate motor winding data is known. In those cases the winding data can be compared to the *EASA Motor Rewind Data* database to locate an equal or close match. Also, if the air gap flux density (AGD) has been calculated for the no nameplate motor that is being evaluated, the AGD can be compared to the AGD values of stators that closely match (generally within 5%) the core length and bore and that have the same number of poles and slots.

For example, if the no nameplate motor has a calculated AGD of 55,000 lines per sq.in., and the nominal AGD of search result motors rated 60 hp is also close to 55,000 lines per sq.in., the probable rating is 60 hp.

If the above comparison results in more than one possible power rating, the nominal ampere rating of the *Rewind Data* windings for each power rating can be used to calculate the wire area per amp (CMA) of the no nameplate motor. The CMA value of the power rating that most closely matches the CMA of the no nameplate motor indicates its most probable rating.

NEMA design letter

While not absolute, visual inspection of the rotor can reveal evidence of the NEMA design letter. For example, a dual-cage rotor or rotor end rings that appear to be a brass or zinc alloy are indicators that the motor design is something other than a standard design motor.

The most reliable way to avoid supplying the incorrect motor design is to have the customer describe the application. Conveyor, crusher, punch-press and similar applications require special starting torque and slip characteristics. If a conventional NEMA design B motor is placed into service in one of these applications, it will fail prematurely. ■

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