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Bharat Bijlee

LOW VOLTAGE MOTORS

0.12kW to 1250kW

BBL/CAT/004 NOVEMBER 2016

Industrial Motors

Over the last 70 years, we have become a reflection of the strength and purpose that today represent Indian Industry and its growing power internationally. Bharat Bijlee has evolved from a pioneer of electrical engineering in India to one of the most trusted names in the industry. Our portfolio of products and services includes Power Transformers, Projects, Motors, Drives & Automation and Magnet Technology Machines and caters to a spectrum of industries and the builders of the nation's infrastructure: Power, Refineries, Steel, Cement, Railways, Machinery, Construction and Textiles.

Our products must perform faultlessly and we must fulfill the most demanding delivery schedules. We value innovation and are proud of the customer - centric outlook that enables us to develop specialised solutions for a wide range of utility and industrial markets. Our plant near Mumbai & our extensive network of Sales and Service offices are integrated by enterprise - wise management and information systems. Technology and innovation coverage to offer our customers integrated solutions that meet their specific needs. We are growing; expanding both our manufacturing range and capacities, venturing into related diversifications and exploring new markets with new partners.

Transformers

Projects

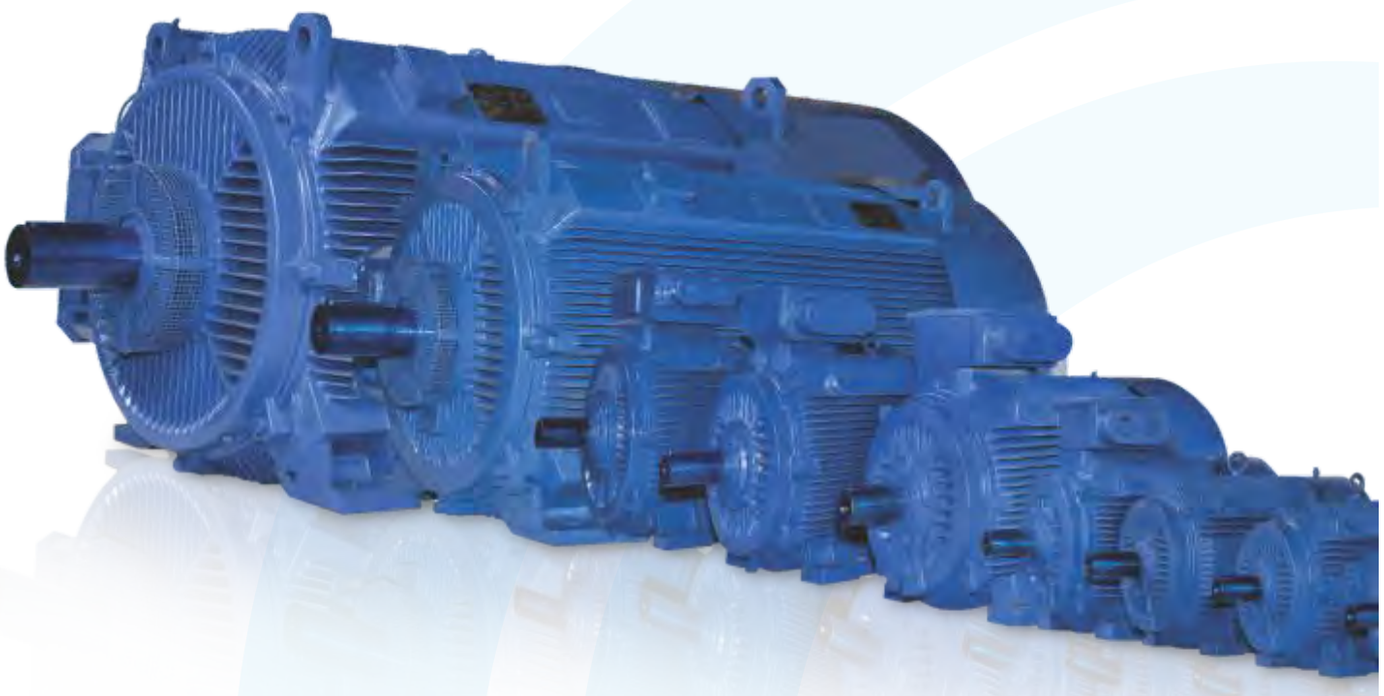
LT Motors
0.12kW to 1250 kW, up to 690V

MV Motors
160kW to 1000kW, up to 6.6kV

Drives & Automation

Magnet Technology Machines

Complete range of BBL mot
(0.12kW to 1250kW) suitable for a



otors from frame 56 to 450
r all applications across industries.

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INDUSTRIAL MOTORS

PRODUCT RANGE

Bharat Bijlee manufactures a complete range of three phase squirrel cage induction motors.

Motor Type	Frame	Power (kW)	Polarity	
Standard Motors	63 to 355	0.18 to 315	2, 4, 6, 8	
IE2 Motors	71 to 355	0.37 to 375	2,4,6	
IE3 Motors	80 to 355	0.75 to 315	2,4,6	
IE4 Motors	112 to 180	1.50 to 22	4	
Large LT Motors(DCCA)	355 to 450	280 to 1250	2, 4, 6, 8	
Standard Flame Proof Motors	80 to 315	0.37 to 200	2, 4, 6, 8	
IE2 Flame Proof Motors	80 to 315	0.37 to 200	2, 4, 6	
IE3 Flame Proof Motors	80 to 315	0.75 to 180	2, 4, 6	
Non - Sparking Motors	63 to 400	0.12 to 560	2, 4, 6, 8	
Increased Safety Motors	63 to 355	0.12 to 400	2, 4, 6, 8	
Crane & Hoist Duty Motors	71 to 355	0.37 to 400	4, 6, 8	
Brake Motors	71 to 132	0.25 to 9.3	2, 4, 6, 8	
Slip ring Motors	100 to 160	1.10 to 10	4,6	
Textile Motors - Ring Frame	100 to 160	1.1 to 15	4	
Cane Unloader Motors	160 to 225	11 to 30	6	
Marine Duty Motors	63 to 450	----	----	
Roller Table Motors	As per requirement	----	----	
Railway Auxilliary Motors	As per requirement	----	----	
Medium Voltage Motors	355 to 450	160 to 1000	2,4,6,8	

Product Range

Type	Series	Frame Size	kW Range	Poles
Standard TEFC SCR Motors	MA	63 to 355L	0.12 to 355	2P, 4P, 6P, 8P
High Efficiency IE2 Series Motors	2H	71 to 355L	0.37 to 355	2P, 4P, 6P
High Efficiency 8 Pole Motors	MH	90 to 355L	0.37 to 200	8P
Premium Efficiency IE3 Motors	3H	80 to 355	0.75 to 315	2P, 4P, 6P
Large Motors with DCCA	2H/ MH	355LK to 450L	250 to 1250	2P, 4P, 6P, 8P

Reference Standards

Motors comply with following Indian & International standards as applicable.

IS/IEC 60034-1	Three Phase Induction motor specifications ("Rotating Electrical Machines - Part 1: Rating & Performance").
IS : 900	Code of practice for installation & maintenance of induction motors
IS : 1231	Dimensions of foot mounted A.C induction motors
IS : 2223	Dimensions of flange mounted A.C induction motors
IS : 4029	Guide for testing three phase induction motors (For Standard TEFC SCR Motors)
IS : 4889	Methods of determination of efficiency of rotating electric machines (For Standard TEFC SCR Motors)
IS /IEC 60034-5	Degree of protection provided by the integral design of Rotating Electrical Machines (IP code classification)
IS : 6362 / IEC 60034-6	Designation of method of cooling for Rotating Electrical Machines / Method of cooling (IC code)
IS:12065/ IEC 60034-9	Permissible limits of noise level for Rotating Electric Machines
IS:12075 : 2008	Mechanical Vibration of Rotating Electrical Machines
IS:12615: 2011	Energy Efficient Induction Motors Three phase Squirrel Cage (For IE2 Series Motors)
IEC 60034-30	Rotating Electrical Machines - Efficiency classes of line operated AC motors (IE code)
IEC 60072-1	Dimension & Output rating of Rotating Electrical machines
IS:15999 (Part 2 / Sec 1)	Standard Methods for determining Losses and Efficiency from Tests (For IE Series Motors)

CE MARK

All motors have CE mark on the nameplate

ELECTRICAL FEATURES

Standard Operating Conditions

Supply Conditions (Voltage & Frequency)

Voltage : 415 V ± 10%
Frequency : 50Hz ± 5%
Combined variation : ± 10%
(Absolute sum with max frequency variation 5%)

For motors above 710kW the standard supply voltage is 690V ± 10%.
690V motors wire wound or strip wound can be offered on request.

Ambient

Motors are designed for ambient temperature as mentioned in the performance tables. Higher ambient temperature motors can be offered on request.

Altitude

Motors are designed for an altitude up to 1000m above mean sea level. Motors can be offered for higher altitudes on request.

Re-rating Factors

The re-rating applicable under different conditions of variations in supply voltage, frequency, ambient & altitude are obtained by multiplying following factors.

Variation in Supply Voltage & Frequency

Voltage Variation (%)	Frequency Variation (%)	Combined Voltage & Frequency Variation (%)	Permissible output as % of rated value
± 10	± 5	± 10	100
± 12.5	± 5	± 12.5	95
± 15	± 5	± 15	90

Variation in Ambient & Altitude for all Motors

For motors with Ambient 40° C		For motors with Ambient 50° C	
Amb. Temp. (°C)	Permissible output as % of rated value	Amb. Temp. (°C)	Permissible output as % of rated value
20	107	30	107
21-35	103	30-45	103
40	100	50	100
45	95	55	96
50	91	60	92

Altitude above sea level (m)	Permissible output as % of rated value
1000	100
1500	97
2000	94
2500	90
3000	86
3500	82
4000	77

Method of Starting

Bharat Bijlee motors are suitable for direct on line (DOL) or star/delta starting as shown below. All IE2 series motors and Large LT motors are suitable for inverter duty starting.

kW Rating	Method of Starting	No. of Leads
Up to & including 1.5 kW	DOL	3 (Internal Star connection), for MA series motors
		6 (for 2H series motors)
Above 1.5 kW	DOL or Star/Delta	6

Starting current measurement of BBL Motors

Induction motor starting current is generally 6 to 7 times the full load current of the motor. This is a characteristic feature of the motor and though undesirable, it is inevitable in the design of the motor. Measurement of this starting current at rated voltage becomes difficult since it demands higher capacity of the supply system as well as use of appropriate CTs in the circuit of meters. Generally a fraction of rated starting current is passed in the motor due to capacity constraints. This current is extrapolated to rated voltage. If this measurement is done at higher voltage then the estimated starting current is more accurate. At Bharat Bijlee, starting current measurement is done as per below table

kW Range	Measurement at % of voltage to rated voltage
0.12kW to 90kW	70%
90kW to 200kW	60%
200kW to 355kW	35%
355kW to 560kW	25%
560kW and above (with rated voltage 690V or higher)	25%

Duty, Starting Time & Number of Consecutive Starts

Motors are designed for continuous (S1) Duty. Other types of duty (S2 to S9) can be offered on request. For load $GD^2 \leq$ Motor GD^2, the motors can safely withstand 3 consecutive starts from cold condition & 2 consecutive starts from hot condition. In application where more severe starting conditions are encountered, a special enquiry should be made to our Sales Office. e.g.

- Drives with high inertia e.g flywheel drives, eccentric presses, large fans etc.
- Drives involving intermittent duty of motors with frequent starts e.g. rolling mills, centrifuges and conveyor motors etc.

The enquiry should be accompanied with following information.

- GD^2 and relevant speed of driven equipment
- Duty cycle/sequence of operation/no. starts/ hour
- Speed-Torque diagram of driven equipment
- Method of braking (Electrical or Mechanical)
- Method of starting
- Method of coupling

Insulation and Endurance

The motors are provided with Class F insulation scheme with temperature rise limited to Class B. These motors can be overloaded continuously by 10% (service factor = 1.1). The temperature rise will be still within limits of Class F.

All insulation materials used are adequately resistant to the action of microbes and fungi.

Standard Winding

The stators are wound with modified polyester enamel covered (IS 13730: Part 3, thermal class 155) copper wires and are flood impregnated.

Insulation Scheme for Inverter Duty Motors

- The stators are wound with polysteremide coated with polyamide-imide top coat, (dual coated) wires as per IS 13730: part 13, thermal class 200 copper wires
- Vacuum Pressure Impregnation (VPI) is provided to windings on request
- Depending on the voltage wave rise time (dv/dt) and the maximum peak to peak voltage at the motor terminals, suitable insulation schemes are provided on request
- On customer's demand, insulated bearings are offered from frame size 160 and onwards on the non driving end side of the motor

For frame size below 160, please contact our sales office.

Options (On request)

- Class 'H' insulation
- VPI for frames 63 to 280
- Winding with dual coated wires

Thermal Protection (for Winding & Bearing)

PTC thermisters / thermostats etc. can be embedded in stator winding on request. All Large Motors with DCCA are provided with 3 numbers of simplex PT 100 platinum RTD's for winding temperature detection. In case of frame sizes 250 & above, Resistance Temperature Detectors (RTD) & Bearing Temperature Detectors (BTD) can be supplied on request.

Earthing Terminals

Two earthing terminals are provided on the body and one earthing terminal is provided in the terminal box.

Anti-condensation Method

In order to avoid condensation of water inside the motors, they can be heated up by connecting a voltage 4 to 10% of rated voltage to the motor terminals. Adequate heating is obtained with current equal to 20-25% of rated motor current. Alternatively, any of the methods indicated in IS: 900 for heating stator winding can be adopted.

Motors can also be offered with built in space heaters in frame size 90 and above. Built in space

heaters are provided as a standard feature for all Large Motors with DCCA.

Frame Size	Enclosure Materials	Terminals Box Location	
		Standard	Option Available
63-80	Aluminum	TOP	---------
90S-132M	Aluminum	TOP	---------
	Cast Iron (on request)	RHS	TOP & LHS
160M-225M	Cast Iron	RHS	TOP & LHS
250M-355L	Cast Iron	TOP	RHS & LHS
355 L/K	Cast Iron	RHS	LHS/TOP
400L/450M/ 450L	Fabricated MS with CI E/s	TOP	RHS & LHS

MECHANICAL FEATURES

Enclosures: (Material and Terminal Box Location)

Motors are offered with following enclosure

All foot mounted motors are with integral feet construction. All motors up to 280 frame are with integral bearing covers, and motors in frame 315 & above are with separate bearing covers.

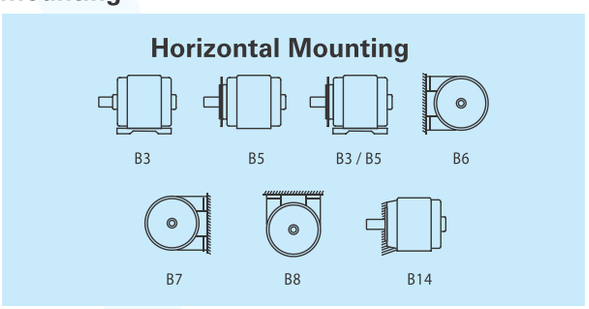
Type of Construction

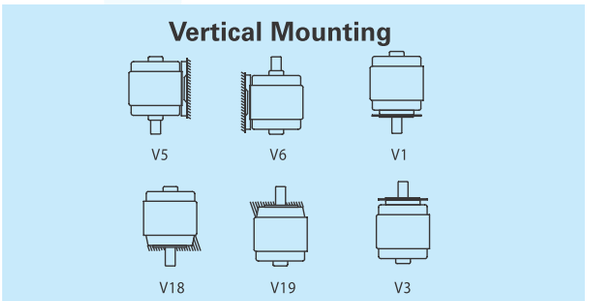
Standard motors are designed for foot mounting (B3). Motors up to frame 355 are also suitable for B6, B7, B8, V5 and V6 mounting.

Motors can be supplied in flange mounting (B5). Flange mounted motors up to frame 355 are also suitable for V1 and V3 mounting.

Large Motors with DCCA can be supplied in B3, V1 and B35 construction with dimensions as per IEC 60072-1 and IEC 60072-2.

Mounting





Cooling

All motors are Totally Enclosed Fan Cooled (TEFC-IC411 as per IS: 6362, IC4A1A1 as per IEC 60034-6). The cooling is effected by self driven, bi-directional centrifugal fan protected by fan cover. Following cooling types can be provided on request.

- Natural ventilation [TESC or TENV (IC410)]
- Forced cooling for frame sizes 132 and above. (IC 416) Minimum cooling distance, as indicated in the GA drawing has to be provided for effective cooling of the motor.

  For Large Motors with DCCA special bearing cooling fan is provided at driving end to reduce bearing temperature and increase bearing life. Minimum cooling distance, as indicated in the GA drawing has to be provided for effective cooling of the motor.

Note: For more details, refer to annexure I.

Bearing and Terminal Box Details

Frame Size		Bearing Nos. C3 clearance		Terminal Box Type/ Location	Terminal		No. & size of Cable entries	Max cond. Cross Sec. area mm2
		DE	NDE		No.	Size		
63		6201 2Z	6201 2Z	gk030/ TOP	3	M4	1×3/4”	4
71		6202 2Z	6202 2Z					
80		6004 2Z	6004 2Z					
90S, 90L		6205 2Z	6205 2Z	gk130/TOP	3*			
100L		6206 2Z	62052Z	gk230/TOP			2 × 1”	10
112M		6206 2Z	6205 2Z					
132S, 132M		6208 2Z	6208 2Z	gk330/TOP	6	M5		
160M, 160L		6309 2Z	6209 2Z	gk330/RHS				16
180M, 180L(IE2 4 P)		6310 2Z	6309 2Z	gk430/RHS	6	M6	2 × 1-1/2”	50
180M, 180L (Standard 2P, 4P, 6P, 8P & IE2 2P,6P)		6310 2Z	6210 2Z	gk430/RHS	6	M6	2 × 1-1/2”	50
200L		6312 2Z	6212 2Z	TB225/RHS	6	M8	2 × 2”	70
225S, 225M		6313	6213					
250M		6315	6215	TB280/ TOP	6	M10		
280 S/M	2P	6316	6316					150
	4,6 & 8P	6317	6316					
315S/M		6319	6319	TB315/ TOP	6	M12	2x2”	185
315L							2x2 ½ “	240
355 L		6322	6322	TB 355/ TOP	6	M16	2 X 3”	300
355L/K	2P	6319	6319	TB400/RHS	6	M20	2x3”	400
	4P	6322	6322					
	6P							
	8P							
400M/L	2P	6324	6322	TB400/ TOP				
	4P							
	6P							
	8P							
450M/L	4P	6326	6326	TB400/ TOP				
	6P							
	8P							

*3 Terminals up to and including 1.5kW & 6 terminals for higher kW outputs, except IE2 motors.
Note: L10 bearing life is 50,000 hours for directly coupled loads through flexible couplings only.

Roller Bearing and Insulated Bearing

Motors with insulated bearing on NDE side can be offered from frame size 132 & above on request. Motors can also be offered with cylindrical roller bearing (NU) on DE side for frame sizes 132 and above on request.

Bearing Lubrication

Sealed bearing (2Z) are filled with grease Unirex N3-ESSO.Others are filled with SKF LGMT3 of SKF make. Special high temperature grease can be provided on request.

On line Greasing

On line greasing arrangement is provided in frame sizes 225 and above. For frame sizes 180 and 200 it can be provided on request.

Bearing	Pole	Re-lubrication	
		Quantity (gm)	Interval (Hrs)
6313	2	120	3200
	4		9000
	6		15000
	8		21000
6315	2	150	2800
	4		8200
	6		10000
	8		18000
6316	2	180	2000
6317	4	180	7500
	6		13000
	8		17500
6319	2	220	2000
	4		5000
	6		7500
	8		10000
6322	2	40	1000
	4, 6		3000
	8		6000
6324	2	40	1000
	4, 6		2500
	8		5000
6326	4, 6	40	2000
	8		4000

Degree of Protection

All motors have IP55 degree of protection as per IS/IEC 60034-5. Higher degree of protection such as IP56, IP66 can be provided on request. All flange mounted motors are additionally provided with oil tight shaft protection on driving end side.

Note: For more details, refer to annexure II.

Rotor

Entire range of motors is fitted with dynamically balanced aluminum die cast squirrel cage rotors.

Shaft

All motors are provided with single shaft extension in accordance with IS: 1231. The shaft material is C40 (EN8) steel. However, special shaft extension and /or special shaft material e.g. EN24 or stainless steel, is provided on request.

Large Motors with DCCA are provided with single shaft extension in accordance with IS: 8223. Shafts material is EN8 for 355 & 400 frames, and EN19 for 450 frames. Shafts of these frames are ultrasonically tested.

Balancing & Vibration

The balancing grade is G2.5 as per ISO: 1940. Rotors are dynamically balanced with a half key in the shaft extension. All motors have vibration grade A as per IEC 60034 - 14. Other grades as per IEC 60034 - 14 or IS 12075 - 2008 can be offered on request.

Note: For more details, refer to annexure IX.

Direction of Rotation

All motors are suitable for bi - directional rotation.

Lifting Arrangement

All motors with frame size 100 and above are provided with lifting hooks. When two or more hooks are provided, all hooks to be used simultaneously for lifting the motor.

Noise Level

Motors are designed for noise level well below the limits specified in IS: 12065 and IEC 60034 - 9.

Note: For more details, refer to annexure IV.

Paint

All motors are painted with acrylic base paint shade RAL 5000. Motors used in corrosive atmosphere are painted with epoxy base paint, any other shade or material (e.g. polyurethane paint) can be offered on request.

Packing

Motors up to 132 frame are packed in thermocol /corrugated boxes. Wooden packing boxes or wooden pallets are provided for higher frame size. sea worthy / Export packing case for home market (without fumigation certificate) is also available on request.

Shipping Dimensions

FRAME	TYPE REF	PACKING BOX DIMENSIONS			MOTOR GROSS WEIGHT IN Kg
		LENGTH	WIDTH	HEIGHT	
63	MA063433G	260	180	240	5.5
71	MA071433G	300	200	260	8
80	2H080453G	320	240	290	13
90S	2H09S423G	390	280	320	16
90L	2H09L473G	390	280	320	20
100L	2H10L473G	455	320	370	28
112M	2H11M473G	555	470	380	38
132S (TOP TB)	2H13S2N3G	600	430	490	70
132S (Side TB)	2H13S2N3G	570	500	400	70
132M	2H13M4T3G	690	410	410	77
160M	2H16M4K3G	660	440	390	155
160L	2H16L4T3G	820	540	440	167
180M	2H18M473G	820	540	440	235
180L	2H18L483G	820	540	440	248
200L	2H20L453G	890	610	560	364
225S	2H22S433G	970	660	610	452
225M	2H22M453G	970	660	610	467
250M	2H25M233G	1050	610	790	646
280SM	2H28M453G	1100	660	820	885
315SM	2H31M653G	1300	720	940	1,179
315L	2H31L693G	1500	720	940	1,400
355L	2H35L453G	1680	840	1050	2,194
400M	MH40M453G	2110	1100	1400	2,915
400L	MH40L6A3G	2110	1100	1400	3,500
450L	MH45L893G	2290	1200	1430	6,350

EFFECT OF CONVERTER (VFD) SUPPLY VOLTAGE ON MOTOR PERFORMANCE

Motor Terminal Voltage Transients

Modem controls use power transistors that switch at very high rates. To achieve this, the devices have very fast turn on times that result in voltage pulses with high dv/dt. When such a drive is used with a squirrel cage induction motor, the pulses, in combination with the cable and motor impedence, generate high peak voltages at motor terminals. These peak voltages are repetitive. They occur continuously and can reduce motor insulation system life.

Due to space & surface charge creation within the insulation components, the electric stress is not only defined by the instantaneous voltage itself but also by the peak voltages that have been stressing the insulation previously. Generally, it has been shown by experience that, within certain limits valid for drive systems, the stressing parameter is the peak/ peak voltage.

In order to guarantee a normal service life, one must be sure that these peak voltages do not exceed the maximum repetitive voltage rating of the motor.

As per NEMA MG1 Part 31, definite purpose, inverter fed motors are designed to withstand maximum repetitive voltage peaks at motor terminals equal to 3.1 times the motor's rated RMS voltage with a rise time not less than 0.1 μs. For 415 volt motor, these peaks will be of the order of 415 × 3.1 = 1286.5 volts.

Fundamental Contributors to Peak Voltages Stressing Motor Insulation

It is difficult to determine if a particular drive & cable will cause peak voltage in excess of the motor's insulation capability. There are six fundamental issues that determine the amount of peak voltage that will exist at the motor's terminals: pulse rise time, cable length, minimum time between pulse, minimum pulse duration, transition type (single or double), & the use of multiple motors.

1. Pulse Rise Time

A certain amount of time is required for the voltage at the drive terminals for transition from low to high. This is called the rise time. A shorter rise time will cause the peak voltage at the motor's terminals to reach a higher value for a given cable length between the motor and the drive.

2. Cable Length

In general, longer cable will increase the value of the peak voltage at the motor's terminals. With modern IGBT drives, the peak voltage begins to occur with a cable length of a few meters and can reach 2 times the control DC bus voltage at a length less than 20 meters. In some cases, however, very long cables (in excess of 130 meters, for example) can result in a situation where the peak voltage does not decay quickly enough. In this case, the peak voltage can be more than 2 times the control DC bus voltage.

3. Minimum Time between Pulses and Minimum Pulse Duration

An adjustable frequency drive creates average voltage changes by varying the width of the pulses it produces and the time between them. The peak voltage is potentially at its worst when time between pulses is at the minimum for drive and the length of the pulse duration is at the minimum. The minimum time between pulses is most likely to occur at high output voltage and during transient conditions, such as acceleration & deceleration. Minimum pulse width is most likely to occur at low output voltages. If the time between pulses or the minimum pulse duration is less than three times the resonant period of the cable (0.2 to 2 μs for industrial cable), higher peak voltage will occur. The only way to be sure this condition does not exist in any particular drive is by measuring the pulses directly or by contacting the manufacturer of the drive.

4. Transition Type

Each of a drive's three output phases is capable of being switched. Generally, only one of the three phases is switched at any given instant. This situation is called a single transition. Some drives will switch two phases simultaneously. This is referred to, as a double transition. The result is a line-to-line polarity reversal with twice the voltage excursion as that of single transition. This causes higher peak voltage at the motor's terminals. Some drives perform double transitions only during transient conditions such as acceleration and deceleration. Double transitions are generally found in old drives and are not widely used today. The only way to be sure a drive does not perform double transitions is by measuring the pulses directly or by contacting the manufacturer of the drive.

5. Multiple Motors

If more than one motor is connected to a drive, there can be higher peak voltage due to reflections from each motor. The situation is made worse when there is a long length of cable between the drive and the common connection of motor. This length of lead acts to decouple the motor from the drive. As a result, reflection which would normally be absorbed by the drive's low impedence can be carried to another motor and add to the peak voltage at its terminals.

6. Switching Frequency

Many PWM drives provide for convenient user adjustment of the switching frequency. This frequency can be adjusted over a range as broad as 500 Hz to 20 kHz. The choice of switching frequency is significant because it defines the number of peak voltages that will be occurring at the motor in a certain amount of time. The higher the switching frequency, the greater the number of peak voltage and their magnitude that will be stressing the motor's insulation system.

(Reference: From NEMA - Application guide for AC adjustable Speed Drive Systems**)**

Proper care must be taken to limit the peak voltages to the limits of insulation scheme used in the motor.

This includes provision of suitable chokes / filters at converter output voltage.

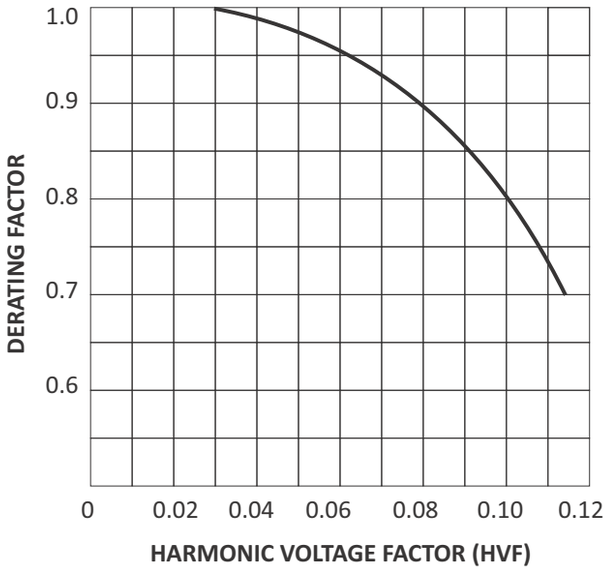
Temperature Rise of the Motor

Converter output voltage is not sinusoidal, but it contains higher order harmonics. These harmonics create additional losses in core, stator winding and rotor of the motor. This in turn, results in higher temperature rise of the motor, crossing the normal class B limits at rated load. The increase in temperature rise is of the order 15 to 20^{0}C

In order to keep the temperature rise of the motor within acceptable limits, torque de-rating of the motor is essential.

NEMA MG1 - Part 30 considers a de-rating factor (torque de-ration) to avoid excessive overheating of a general purpose motor fed by converter, compensating for the circulation of harmonic currents and the additional heat generated due to the PWM voltage harmonic content.

Following figure provides the de-ration factor based on the Harmonic Voltage Factor (HVF).



Another way of keeping the temperature rise within limit is to provide independent cooling system (separate ventilation) to the motor.

If one uses sine wave filter after converter, the additional temperature rise gets reduced to about 5^{0}C, but, usually, the user avoids to put the filter for cost considerations.

Temperature Rise of the Windings for Variable Torque Applications

When motor speed is reduced in variable torque application (generally parabolic torque speed curve characteristic), ventilation due to fan reduces. But motor losses also reduce drastically.
To limit the winding temperature rise to class B limits at rated output with converter supply, permissible rated output must be reduced to 85% of the motor nameplate output on sinusoidal supply.

Temperature Rise of the Windings for Constant Torque Applications

When motor speed is reduced in constant torque application, ventilation due to fan reduces. Motor losses remain practically constant in this application but ventilation reduces considerably. Hence, in addition to harmonics effect, the temperature rise is additionally increased due to reduced speed of the cooling fan. Providing independent cooling system (separate ventilation) to the motor in this case is very effective in keeping the temperature rise within acceptable limits.

Bearing Currents

Voltage is generated at shaft ends due to high switching frequency of converter and the excess length of cable between converter and motor. This results in currents flowing through bearings and results in bearing failure. One remedy is to use the insulated bearing on non drive end side.

Accoustic Noise

In case of motors fed by converter supply, the electromagnetically excited noise can be significantly higher owing to the harmonic contents of the converter supply voltage.

Higher switching frequencies tend to reduce the magnetically excited noise of the motor.

Motor Applications for VFD

- Constant Torque - Crane, Hoist, Reciprocating Compressor etc.
- Variable Torque - Centrifugal Pump, Fan, Blowers etc.
- Constant Power - Metal cutting, Lathes, Coiler / Decoiler Machines etc.
- Custom built to suit customer's specific requirements.

Motors for Constant Torque application suitable for speed range of 1:10, 1:5, 1:2 etc can be provided. Depending on the speed range, motors can be offered with forced cooling (IC 416) or in higher frame sizes. Please check with our Sales Office for motors to be operated beyond the speed given in TableI.

Table I

Frame	2 Pole	4 Pole	6 Pole
112	5200	3600	2400
132	4500	2700	2400
160	4500	2700	2400
180	4500	2700	2400
200	4500	2300	2400
225	3600	2300	1800
250	3600	2300	1800
280	3600	2300	1800
315	3600	2300	1800

These are maximum safe operating speeds of a direct coupled motor, as per IS 15880:2009.

Special Features of Bharat Bijlee Motors for Running on Converter Supply

Bharat Bijlee motors are provided with special impregnation system / Vacuum Pressure Impregnation, special slot insulation paper, special phase insulation paper and dual coated winding wire to take care of the stresses. This insulation scheme is as per the requirement of IEC 60034-18-41. For voltages higher than 500V, please refer to our sales office.

Shaft induced voltage occurs due to the use of VFD. This causes flow of currents through bearing which can lead to premature bearing failure. Insulated bearings can be provided in frames from 132 onwards on request. In closed loop system operations, speed feedback is obtained through encoder mounted on the shaft of the motor. We provide encoder mounting arrangements on non drive end side shaft of the motor on request. We require Encoder Mounting Details to check the suitability of mounting the same on our motor (Hollow Shaft Type Encoder recommended).

Conclusion:

As explained above, motors which are required to operate with VFD supply need special design considerations. Please refer such requirements to our sales office with load details and speed range.

We are giving herewith standard service conditions for BBL motors working on VFD supply. If the properties /characteristics of VFD are different than those specified here, please contact sales office for necessary selection at our end.

Checklist For Motors To Be Run On VFD Supply

Motor Parameters	BBL Standard	Customer Specification
Base voltage and kW rating at 50Hz	Base Voltage: 415V kW Rating: As per Customer requirement	Customer to specify
Four point rating as per IS 15881	As per customer requirement	Customer to specify
Duty Details (Torque at different speeds and time duration)	As per customer requirement	Customer to specify
Time duration for which motor is running at minimum speed	As per customer requirement	Customer to specify
Application: Constant Torque	Forced cooling arrangement for speeds 30% or below	Customer to specify
	For other speeds, refer to works	
Application: Variable Torque (Pump or Fan)	10% to 100% speed variation with temperature rise F to F For temperature rise to be limited to Class B, refer to Sales Office	Customer to specify
Base Speed (Polarity of motor)	As per customer requirement	Customer to specify
Speed Range (frequency variation)	10% to 100% with forced cooling arrangement for constant torque application	Customer to specify
Maximum safe operating speed	As per IS 15880 : 2009 (Table 1)	–
Operation above base speed	Constant Power	Customer to agree
Insulation class / Temperature rise (F to F / F to B)	F to F at 100% load (VFD supply)	Customer to agree
	F to B at 85% load (VFD supply)	
	F to B at 100% load (grid supply)	
Hazardous area zone 1 or zone 2	Combined testing at rated torque is a statutory requirement to determine temperature class	Customer to pay extra charges
Accessories		
Encoder	NDE side extension for encoder mounting on request	Customer to specify
Thermisters /RTD/ BTD	On request	Customer to specify
Bearing insulation	On request, recommended from 315 frame	Customer to agree
VFD parameters		
THD of the drive output voltage	Up to 3% THD, de ra-tion not required For 5% THD, de-ration factor is 0.95 For 10% THD de-ration factor is 0.80 For THD higher than 10%, contact sales office	Customer to specify
Voltage boost	Required for speed below 33% of rated speed (for constant torque application)	Customer to note
Carrier or switching frequency	Max 5.0kHz	Customer to specify
Rise time	0.1µsec or more	Customer to specify
Individual drive or multi motor drive	Individual drive	Customer to specify
Voltage at motor terminals from drive (if less than permissible variation of rated voltage, then de-ration factor to be considered while arriving at motor kW)	Rated voltage required at motor terminals	Customer to specify

Minimum time between pulses	6 µsec or more	Customer to agree
Minimum pulse duration	6 µsec or more	Customer to agree
Installation requirements		
Earthing	Special high frequency earthing (at customer's end)	Customer to provide
Type of power cable	Shielded cables recommended	Customer to provide
Cable length between drive and motor, along with peak voltage limit for motor insulation	Generally <13m For higher length, customer or his system integrator has to ensure by using sine filters / dv/dt filters / chokes/ lower switching frequencies such that: a) For VFD motors having rated voltage up to 500V, the peak to peak phase voltage is not exceeding 1.56 kV at motor terminals b) For VFD motors with rated voltage up to 690V, peak to peak phase voltage is not exceeding 2.15 kV at motor terminals. Above voltage values are as per IEC 60034-25 c) For standard motor the peak voltage at motor terminals should not exceed 800V	Customer to agree
dv/dt filters or sine wave filter	Mandatory for high switching frequency (5kHz or more) and higher cable lengths (>5m)	Customer to agree
Motor power factor correction capacitors	Not to be used	Customer to note

Note:
1) Efficiency class is not applicable for VFD driven motors. For further information refer to sales office.
2) For rated voltage above 500 volts, please refer enquiry to sales office.

Applicable standard for testing: IS 4029
Applicable standard for efficiency determination: IS 4889

Performance table for 2 Pole motors

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 63 to 355L

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50°C
Duty : S1(Continuous)
3000 rpm (2-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size IEC	Type ref. B3 construction	Operating characteristics at rated output									With DOL starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm2	Net Weight B3 constr. kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque kg-m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to rated torque ratio			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
0.18	0.25	63	MA063213	2720	0.57	0.06	0.76	0.66	0.52	58.0	57.0	52.0	3.2	2.7	3.0	0.00085	5
0.25	0.35	63	MA063233	2720	0.65	0.09	0.82	0.75	0.63	65.0	60.0	54.0	3.5	2.4	2.6	0.00099	5
0.37	0.50	71	MA071213	2790	0.91	0.13	0.80	0.72	0.60	71.0	68.0	62.0	4.0	2.3	2.8	0.0015	6
0.55	0.75	71	MA071233	2805	1.31	0.19	0.79	0.72	0.58	74.0	74.0	71.0	5.0	2.7	3.0	0.0019	7
0.75	1.0	80	MA080213	2830	1.65	0.26	0.82	0.74	0.62	77.0	76.0	72.0	5.0	2.5	2.8	0.0037	10
1.1	1.5	80	MA080233	2840	2.36	0.38	0.82	0.75	0.63	79.0	79.0	76.0	5.9	2.7	3.0	0.0051	11
1.5	2.0	90S	MA09S233	2825	3.01	0.52	0.86	0.83	0.76	80.6	78.0	74.0	5.5	2.7	3.0	0.0071	15
2.2	3.0	90L	MA09L253	2830	4.36	0.76	0.85	0.82	0.74	82.5	80.0	76.0	6.0	3.0	3.0	0.0093	18
3.7	5.0	100L	MA10L213	2900	7.12	1.24	0.85	0.80	0.70	85.0	83.0	78.0	6.5	2.8	3.0	0.0188	24
5.5	7.5	132S	MA13S2B3	2920	10.1	1.83	0.88	0.85	0.77	85.7	85.0	80.0	6.5	2.3	3.0	0.0630	52
7.5	10.0	132S	MA13S2E3	2920	13.6	2.50	0.88	0.84	0.76	87.0	86.0	82.0	6.5	2.3	3.0	0.0760	65
9.3	12.5	132M	MA13M2N3	2920	16.5	3.10	0.89	0.85	0.76	88.0	86.0	83.0	6.5	2.4	2.9	0.0980	67
11	15	160M	MA16M213	2920	19.3	3.67	0.89	0.87	0.83	89.0	88.0	86.0	5.8	2.0	3.0	0.134	95
15	20	160M	MA16M253	2920	26.2	5.00	0.89	0.88	0.82	89.5	89.0	87.0	6.0	2.0	3.0	0.171	112
18.5	25	160L	MA16L273	2920	31.6	6.17	0.90	0.88	0.86	90.5	90.0	88.0	6.5	2.0	3.0	0.225	123
22	30	180M	MA18M213	2930	37.6	7.31	0.89	0.87	0.80	91.5	90.5	88.0	6.5	2.2	2.7	0.30	168
30	40	200L	MA20L233	2950	51.2	9.91	0.88	0.85	0.79	92.6	92.0	89.5	6.5	2.5	2.5	0.52	253
37	50	200L	MA20L253	2945	62.9	12.2	0.88	0.85	0.79	93.0	92.5	91.0	6.5	2.5	2.5	0.61	264
45	60	225M	MA22M233	2960	74.4	14.8	0.90	0.87	0.83	93.5	93.0	91.0	6.0	2.5	2.5	1.04	348
55	75	250M	MA25M213	2960	89.1	18.1	0.92	0.91	0.86	93.3	92.8	91.5	6.0	2.1	2.6	2.11	523
75	100	280S	MA28S213	2970	122	24.6	0.91	0.89	0.84	93.7	92.5	90.0	6.0	1.8	2.7	2.63	626
90	120	280M	MA28M233	2970	146	29.5	0.91	0.89	0.84	94.0	93.0	91.0	6.0	1.8	2.7	3.01	669
110	150	315S	MA31S233	2982	180	35.9	0.90	0.86	0.78	94.5	94.0	91.5	7.0	2.0	2.5	5.0	898
125	170	315M	MA31M2A3	2982	206	40.8	0.89	0.85	0.76	94.7	93.5	91.5	7.0	2.2	2.6	5.0	940
132	180	315M	MA31M233	2982	215	43.1	0.90	0.86	0.78	95.0	94.0	92.0	7.0	2.0	2.5	5.0	940
150	200	315L	MA31L2A3	2982	247	49.0	0.89	0.84	0.76	95.1	94.2	92.2	7.0	2.0	2.5	6.2	1100
160	215	315L	MA31L253	2982	260	52.3	0.90	0.85	0.77	95.2	94.6	92.7	7.0	2.0	2.5	6.2	1100
180	240	315L	MA31L2B3	2982	299	58.8	0.88	0.82	0.75	95.3	94.7	92.7	7.0	2.0	2.5	7.7	1185
200	270	355L	MA35L2A3	2985	324	65.3	0.90	0.87	0.82	95.5	95.0	93.0	7.0	1.6	2.4	12.0	1680
*250	335	355L	MA35L213	2985	404	81.6	0.90	0.88	0.84	95.7	95.2	93.7	7.0	1.6	2.4	12.0	1680
*315	425	355L	MA35L233	2985	508	102.8	0.90	0.88	0.84	95.8	95.3	93.8	7.0	1.6	2.4	14.7	1870

Notes:

- All performance values are subject to tolerance as per IS/IEC 60034-1
- Ratings above 355kW up to 630kW are available in 355 & 400 frames with Dual Circuit Cooling Arrangement (DCCA).
- Efficiency measurement are without sales

*- These ratings are suitable for class F temperature rise

Applicable standard for testing: IS 4029
Applicable standard for efficiency determination: IS 4889

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Performance table for 4 Pole motors

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 63 to 355L

Ambient : 50° C
Duty : S1 (Continuous)
1500 rpm (4-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size IEC	Type ref. B3 construction	Operating characteristics at rated output									With DOL starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm2	Net Weight B3 constr. kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque kg-m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to rated torque ratio			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
0.12	0.16	63	MA063413	1330	0.41	0.09	0.75	0.65	0.50	54.0	48.0	40.0	2.4	1.9	2.3	0.00140	5
0.18	0.25	63	MA063433	1350	0.56	0.13	0.75	0.65	0.50	60.0	56.0	50.0	3.0	2.0	2.3	0.00160	5
0.25	0.35	71	MA071413	1370	0.68	0.18	0.76	0.63	0.51	67.0	64.0	58.0	3.0	2.0	2.5	0.0024	6
0.37	0.50	71	MA071433	1360	1.02	0.26	0.71	0.62	0.50	71.0	70.0	64.0	3.4	2.3	2.5	0.0033	7
0.55	0.75	80	MA080413	1405	1.28	0.38	0.81	0.70	0.56	74.0	71.0	67.0	4.0	2.4	2.6	0.0061	10
0.75	1.0	80	MA080433	1405	1.74	0.52	0.78	0.70	0.58	77.0	76.0	72.0	4.5	2.8	3.0	0.0072	11
1.1	1.5	90S	MA09S433	1410	2.45	0.76	0.80	0.73	0.61	78.0	77.0	72.0	4.2	2.3	2.7	0.0120	14
1.5	2.0	90L	MA09L453	1410	3.26	1.04	0.80	0.72	0.58	80.0	79.0	75.0	5.0	2.5	3.0	0.0160	17
2.2	3.0	100L	MA10L433	1420	4.55	1.51	0.82	0.69	0.53	82.0	80.0	76.0	5.5	2.5	3.0	0.0210	22
3.7	5.0	112M	MA11M433	1430	7.3	2.52	0.83	0.76	0.65	85.0	85.0	82.0	6.0	2.6	3.0	0.0530	32
5.5	7.5	132S	MA13S4B3	1450	10.3	3.69	0.86	0.81	0.70	86.5	86.0	84.0	6.0	2.4	3.0	0.1040	50
7.5	10.0	132M	MA13M4K3	1450	13.7	5.04	0.87	0.82	0.72	87.5	87.0	85.0	6.0	2.3	3.0	0.1260	74
9.3	12.5	160M	MA16M4A3	1450	17.4	6.25	0.84	0.80	0.72	88.5	88.0	87.0	6.0	2.0	2.5	0.141	93
11	15	160M	MA16M4C3	1450	20.5	7.39	0.84	0.81	0.76	89.0	89.0	86.0	6.0	2.1	2.5	0.177	105
15	20	160L	MA16L4K3	1450	27.5	10.1	0.84	0.83	0.79	90.2	90.5	90.0	6.0	2.1	2.5	0.235	113
18.5	25	180M	MA18M433	1460	33.2	12.3	0.85	0.82	0.72	91.2	91.2	90.0	6.0	2.4	2.5	0.460	160
22	30	180L	MA18L473	1460	39.2	14.7	0.85	0.82	0.72	91.8	91.5	90.0	6.0	2.4	2.5	0.540	188
30	40	200L	MA20L433	1465	51.6	19.9	0.88	0.84	0.77	92.0	92.0	90.0	6.0	2.6	2.6	0.860	270
37	50	225S	MA22S413	1470	63.6	24.5	0.87	0.83	0.75	93.0	93.0	91.0	6.0	2.5	2.5	1.32	328
45	60	225M	MA22M433	1470	76.3	29.8	0.88	0.84	0.75	93.2	93.2	91.0	6.0	2.5	2.5	1.60	362
55	75	250M	MA25M413	1478	93.8	36.2	0.87	0.84	0.77	93.8	93.5	92.0	6.0	2.4	2.5	2.78	500
75	100	280S	MA28S413	1485	129	49.2	0.86	0.83	0.75	94.2	94.0	93.0	6.0	2.1	2.8	5.00	653
90	120	280M	MA28M433	1485	154	59.0	0.86	0.83	0.75	94.7	94.5	93.5	6.0	2.1	2.8	6.00	713
110	150	315S	MA31S413	1485	188	72.1	0.86	0.83	0.76	94.7	94.5	93.2	6.5	2.5	3.0	9.97	862
125	170	315M	MA31M4A3	1486	216	81.9	0.85	0.81	0.74	94.8	94.5	93.3	6.5	2.5	3.0	11.7	965
132	180	315M	MA31M433	1487	225	86.5	0.86	0.83	0.76	95.0	94.8	93.8	6.5	2.5	3.0	11.7	965
150	200	315L	MA31L4A3	1488	261	98.2	0.84	0.80	0.72	95.2	95.0	93.9	6.5	2.5	3.0	14.0	1145
160	215	315L	MA31L453	1487	268	104.8	0.87	0.84	0.78	95.4	95.2	94.0	6.5	2.4	3.0	14.0	1145
180	240	315L	MA31L463	1487	305	117.9	0.86	0.83	0.76	95.5	95.3	94.0	6.5	2.5	3.0	15.6	1225
200	270	315L	MA31L473	1489	338	130.8	0.86	0.83	0.76	95.6	95.4	94.0	7.0	2.5	3.0	17.8	1290
250	335	355L	MA35L413	1488	413	163.6	0.88	0.85	0.75	95.8	95.5	94.0	6.5	2.2	2.5	23.3	1680
315	422	355L	MA35L433	1488	519	206.2	0.88	0.85	0.75	96.0	95.6	94.2	6.5	2.2	2.5	32.7	1855
*355	475	355L	MA35L453	1488	585	232.4	0.88	0.85	0.75	96.0	95.6	94.2	6.5	2.2	2.5	37.9	2025

Notes:

- All performance values are subject to tolerance as per IS/IEC 60034-1
- Ratings above 400 kW up to 1000kW are available in 355, 400 & 450 frames with Dual Circuit Cooling Arrangement (DCCA).
- Efficiency measurement are without sales

*- These ratings are suitable for class F temperature rise

Applicable standard for testing: IS 4029
Applicable standard for efficiency determination: IS 4889

Performance table for 6 Pole motors

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 71 to 355L

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50° C
Duty : S1 (Continuous)
1000 rpm (6-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size IEC	Type ref. B3 construction	Operating characteristics at rated output									With DOL starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm2	Net Weight B3 constr. kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque kg-m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to rated torque ratio			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
0.25	0.35	71	MA071633	875	0.80	0.28	0.70	0.60	0.48	62.0	62.0	55.0	2.6	2.0	2.3	0.00380	7
0.37	0.50	80	MA080613	910	1.08	0.40	0.70	0.60	0.48	68.0	66.0	61.0	3.0	2.1	2.3	0.00600	10
0.55	0.75	80	MA080633	915	1.56	0.59	0.71	0.62	0.48	69.0	70.0	64.0	4.0	2.2	2.5	0.0084	11
0.75	1.0	90S	MA09S633	925	1.99	0.79	0.72	0.61	0.50	73.0	70.0	69.0	3.4	2.0	2.5	0.0122	14
1.1	1.5	90L	MA09L653	930	2.80	1.15	0.72	0.61	0.50	76.0	74.0	72.0	4.0	2.1	2.6	0.0160	17
1.5	2.0	100L	MA10L633	935	3.72	1.56	0.72	0.64	0.52	78.0	75.0	72.0	4.0	2.0	2.5	0.0250	22
2.2	3.0	112M	MA11M633	935	4.97	2.29	0.77	0.68	0.55	80.0	80.0	74.0	5.0	2.0	2.5	0.0500	29
3.7	5.0	132S	MA13S6B3	950	8.05	3.79	0.77	0.72	0.60	83.0	83.0	82.0	5.0	2.2	2.8	0.118	50
5.5	7.5	132M	MA13M6N3	950	11.6	5.64	0.78	0.74	0.64	84.5	84.5	83.0	5.5	2.5	3.0	0.172	71
7.5	10.0	160M	MA16M633	960	14.8	7.61	0.80	0.74	0.64	88.0	88.0	86.0	5.4	2.0	2.5	0.276	103
9.3	12.5	160L	MA16L663	960	18.4	9.44	0.80	0.74	0.64	88.0	88.0	87.0	5.5	2.1	2.5	0.340	113
11	15	160L	MA16L673	965	21.6	11.1	0.80	0.77	0.70	88.5	88.0	87.0	6.0	2.0	2.5	0.400	123
15	20	180L	MA18L613	965	29.0	15.1	0.80	0.75	0.62	90.0	90.0	87.0	5.5	2.6	2.3	0.680	175
18.5	25	200L	MA20L613	975	34.0	18.5	0.83	0.78	0.70	91.1	91.0	88.0	5.8	2.6	2.3	1.00	241
22	30	200L	MA20L633	975	40.3	22.0	0.83	0.77	0.68	91.5	91.0	88.0	5.8	2.6	2.3	1.20	254
30	40	225M	MA22M623	975	52.1	30.0	0.87	0.84	0.76	92.0	91.0	88.0	6.0	2.3	2.2	2.10	336
37	50	250M	MA25M603	975	63.2	37.0	0.88	0.85	0.82	92.5	92.5	91.0	6.0	2.5	2.3	3.51	458
45	60	280S	MA28S613	984	80.1	44.5	0.84	0.80	0.72	93.0	92.5	92.0	6.0	2.5	2.4	5.11	573
55	75	280M	MA28M633	984	95.2	54.4	0.86	0.83	0.76	93.5	93.0	92.0	6.0	2.4	2.4	6.16	620
75	100	315S	MA31S613	988	132	73.9	0.84	0.82	0.75	94.0	94.0	92.2	6.0	2.4	2.5	10.7	830
90	120	315M	MA31M633	989	158	88.6	0.84	0.80	0.74	94.2	94.2	92.5	6.0	2.2	2.5	12.4	912
110	150	315M	MA31M653	989	193	108.3	0.84	0.81	0.74	94.5	94.5	92.5	6.0	2.3	2.5	15.5	1010
125	170	315L	MA31L6A3	990	221	123.0	0.83	0.80	0.72	94.7	94.6	92.6	6.0	2.3	2.5	18.0	1175
132	180	315L	MA31L673	990	230	129.9	0.84	0.81	0.74	95.0	94.9	93.0	6.0	2.3	2.5	18.0	1175
150	200	315L	MA31L6B3	990	268	147.6	0.82	0.79	0.70	95.0	94.3	92.8	6.0	2.0	2.5	21.5	1231
160	215	315L	MA31L693	990	279	157.4	0.84	0.81	0.71	95.0	94.5	93.0	6.0	2.0	2.5	21.5	1231
180	240	355L	MA35L6A3	990	321	177.1	0.82	0.77	0.65	95.1	94.6	93.0	6.0	2.0	2.5	28.7	1670
200	270	355L	MA35L613	990	348	196.8	0.84	0.80	0.70	95.2	95	93.3	6.0	2.0	2.5	28.7	1670
250	335	355L	MA35L633	990	434	246.0	0.84	0.80	0.70	95.5	95	93.5	6.0	2.0	2.5	35.5	1780

Notes:

- All performance values are subject to tolerance as per IS/IEC 60034-1
- Ratings above 315kW up to 800kW are available in 355, 400 & 450 frames with Dual Circuit Cooling Arrangement (DCCA).

Efficiency measurements are without seals.

Performance table for 8 Pole motors

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 90S to 355L

Applicable standard for testing: IS 4029
Applicable standard for efficiency determination: IS 4889

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50° C
Duty : S1(Continuous)

750 rpm (8-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

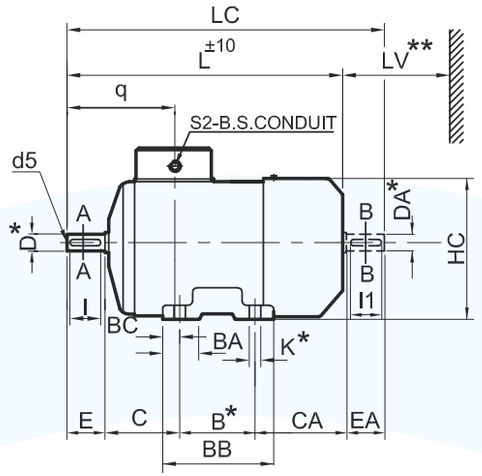
Rated Output		Frame size IEC	Type ref. B3 construction	Operating characteristics at rated output									With DOL starting		Pullout Torque to Rated Torque Ratio	Rotor GD^2 kgm2	Net Weight B3 constr. kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque kg-m	Power Factor			% Efficiency			Starting Current to Rated Current	Starting Torque to rated torque			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
0.37	0.50	90S	MA09S813	700	1.32	0.51	0.63	0.52	0.41	62.0	55.0	48.0	2.7	1.8	2.1	0.01100	11
0.55	0.75	90L	MA09L853	690	1.81	0.78	0.63	0.55	0.43	67.0	62.0	58.0	2.9	2.0	2.4	0.01400	14
0.75	1.0	100L	MA10L813	685	2.04	1.07	0.73	0.63	0.50	70.0	70.0	64.0	3.0	1.6	1.8	0.0230	18
1.1	1.5	100L	MA10L833	690	2.91	1.55	0.71	0.62	0.48	74.0	73.0	71.0	3.3	1.9	2.3	0.0270	21
1.5	2.0	112M	MA11M813	705	3.87	2.07	0.70	0.62	0.50	77.0	77.0	75.0	3.8	1.7	2.2	0.0510	25
2.2	3.0	132S	MA13S8B3	705	5.03	3.04	0.78	0.74	0.64	78.0	78.0	75.0	3.5	1.8	2.3	0.0990	57
3.7	5.0	160M	MA16M813	720	8.05	5.01	0.78	0.74	0.65	82.0	82.0	78.0	4.4	1.8	2.0	0.217	88
5.5	7.5	160M	MA16M833	715	11.6	7.49	0.78	0.74	0.65	84.5	84.5	82.0	4.8	1.9	2.2	0.299	101
7.5	10.0	160L	MA16L873	710	15.6	10.29	0.78	0.74	0.65	86.0	84.0	82.0	5.5	2.1	2.2	0.400	119
9.3	12.5	180M	MA18M813	715	18.9	12.7	0.79	0.74	0.64	86.5	86.5	85.0	4.5	2.1	2.2	0.620	177
11	15	180L	MA18L833	720	22.1	14.9	0.79	0.74	0.64	87.5	87.5	86.0	4.5	2.1	2.2	0.720	182
15	20	200L	MA20L833	720	28.8	20.3	0.82	0.79	0.71	88.5	88.5	87.0	5.5	2.5	2.3	1.32	282
18.5	25	225S	MA22S813	725	36.6	24.9	0.79	0.77	0.69	89.0	88.0	87.0	5.3	2.1	2.2	1.950	329
22	30	225M	MA22M833	725	43.0	29.6	0.79	0.77	0.69	90.0	89.0	87.0	5.3	2.1	2.2	2.410	369
30	40	250M	MA25M813	730	55.9	40.0	0.82	0.78	0.68	91.0	90.5	89.0	5.5	2.5	2.2	3.720	472
37	50	280S	MA28S823	730	70.8	49.4	0.79	0.75	0.65	92.0	92.0	90.0	5.5	2.2	2.2	5.83	615
45	60	280M	MA28M853	730	86.1	60.0	0.79	0.75	0.65	92.0	92.0	91.0	5.5	2.2	2.2	6.86	665
55	75	315S	MA31S813	740	105	72.4	0.78	0.73	0.62	93.0	92.5	90.5	5.5	2.1	2.4	10.7	912
75	100	315M	MA31M833	740	143	98.7	0.78	0.73	0.62	93.5	93.0	92.0	5.5	2.1	2.4	12.4	912
90	120	315M	MA31M853	740	171	118.5	0.78	0.73	0.62	94.0	93.5	92.5	5.5	2.1	2.4	15.5	1010
110	150	315L	MA31L873	740	208	144.8	0.78	0.73	0.62	94.2	93.7	92.5	5.5	2.1	2.4	18.0	1170
125	170	315L	MA31L8A3	740	236	164.5	0.78	0.73	0.64	94.3	93.7	92.5	5.5	2.1	2.4	21.5	1340
132	180	315L	MA31L893	740	249	173.7	0.78	0.73	0.64	94.5	94.0	92.8	5.5	2.1	2.4	21.5	1340
150	200	355L	MA35L8A3	740	283	197.4	0.78	0.70	0.60	94.6	94.0	92.5	5.5	1.8	2.2	28.7	1670
160	215	355L	MA35L813	740	300	210.6	0.78	0.70	0.60	95.0	94.5	92.5	5.5	1.8	2.2	28.7	1670
180	240	355L	MA35L8B3	740	338	236.9	0.78	0.70	0.60	95.0	94.3	92.3	5.5	1.8	2.2	35.5	1780
200	270	355L	MA35L833	740	375	263.2	0.78	0.70	0.60	95.0	94.5	92.5	5.5	1.8	2.2	35.5	1780

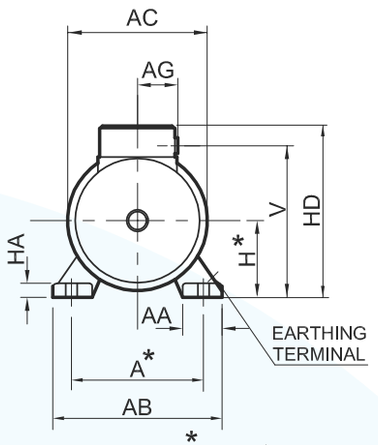
Notes:

- All performance values are subject to tolerance as per IS/IEC 60034-1
- Ratings above 250 kW up to 630kW are available in 355, 400 & 450 frames with Dual Circuit Cooling Arrangement (DCCA). For more details please contact sales office.

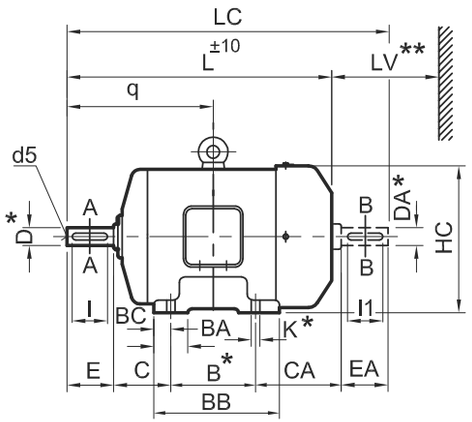
Efficiency measurements are without seals.

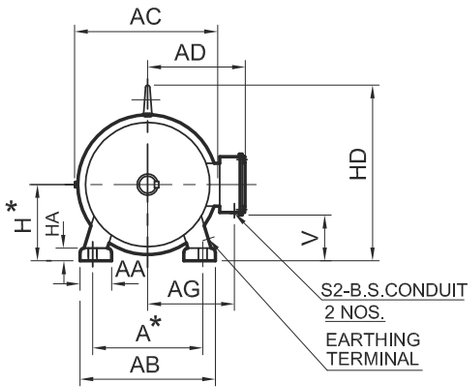
Dimensional Drawing: Industrial Motors Type MA Foot Mounted (B3) TEFC series Frame 63-355L



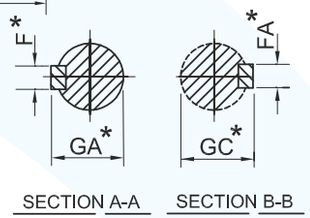


FRAME SIZE 63 TO 80

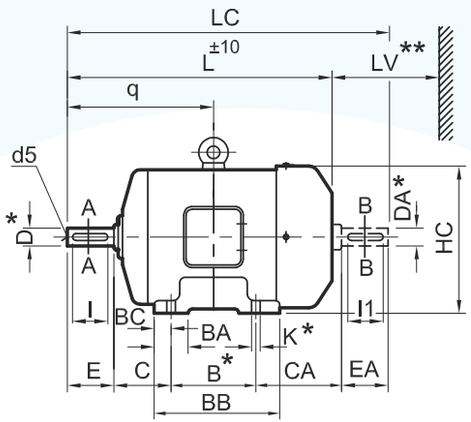


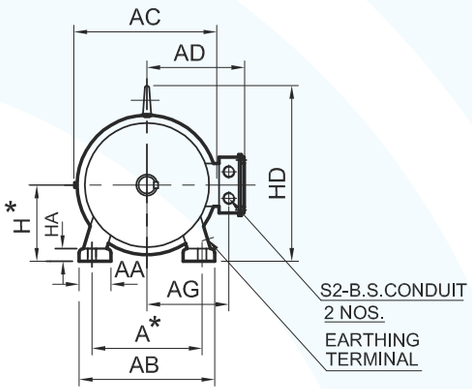


FRAME SIZE 160M TO 180L

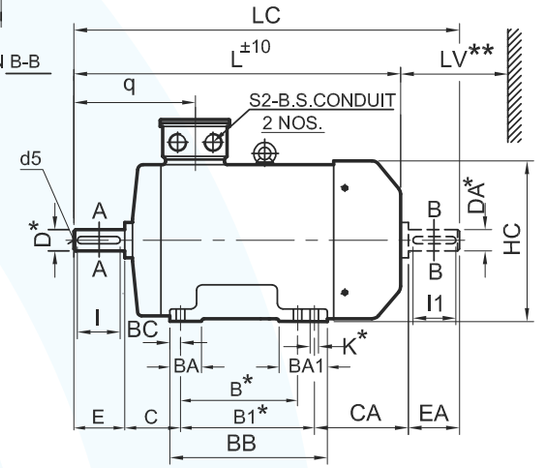


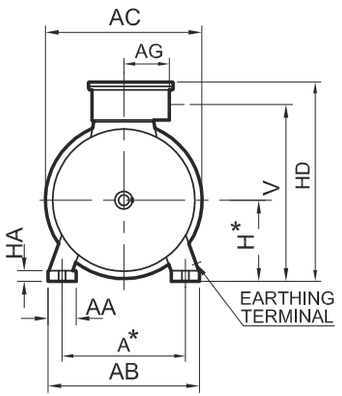
SECTION A-A SECTION B-B





FRAME SIZE 200L TO 225M





FRAME SIZE 90S TO 132M
FRAME SIZE 250M TO 355L

* Refer TABLE A for tolerances

CAT-C-6335-3-1

Note : For Dual Mounting Arrangement (180M/L - 355M/L), please refer to Annexure XI

Dimensional Details: Industrial Motors Type MA Foot Mounted (B3) TEFC series Frame 63-355L

		FIXING						GENERAL														TERMINAL BOX				SHAFT					
IEC Fr. size	Pole	A*	B*	B1*	C	H*	K*	AB	BB	AA	BA	BA1	BC	HA	HC	HD	AD	L	LC	CA	AC	LV**	V	q	AG	S2 B.S.C.	D,DA**	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	100	80	—	40	63	7	126	100	28	30	—	13	7	125	179	—	206	241	75	124	30	149	104	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	112	90	—	45	71	7	135	110	31	30	—	13	7	141	195	—	234	278	83	140	30	166	102	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	125	100	—	50	80	10	150	124	31	35	—	15	9	159	214	—	267	324	94	157	30	185	112	40	3/4"	19	40	6	21.5	35	M6
90S	2,4,6 & 8	140	100	—	56	90	10	168	125	34	31.5	—	18	12	177	230	-	302	374	118	174	35	199	139	52	3/4"	24	50	8	27	45	M8
90L	2,4,6 & 8		125						150									327	399					153								
100L	2,4,6 & 8	160	140	—	63	100	12	190	174	43.5	36	—	21	12	198	257	-	366	448	125	192	40	225	152	56	1"	28	60	8	31	55	M10
112M	4,6 & 8	190	140	—	70	112	12	220	174	47	36	—	21	12	222	282	-	388	471	141	220	45	249	157	56	1"	28	60	8	31	55	M10
132S	2	216	140	—	89	132	12	256	180	64	50	—	23	17	262	338	-	475	568	189	260	50	299	196	63	1"	38	80	10	41	70	M12
	4,6 & 8																	459	552	172											
132M	2		178						218		54							556	659	232				215							
	4,6																	497	590	172											
160M	2	254	210	—	108	160	15	310	250	58	70	—	23	20	318	366	226	605	741	203	316	60	98	323	186	1"	42	110	12	45	105	M16
	4,6 & 8																	585	721	183											
160L	2		254						294									649	785	203				345							
	4,6 & 8																	629	765	183											
180M	2,4,6 & 8	279	241	—	121	180	15	344	281	65	70	—	23	26	357	412	265	679	799	217	354	70	83	352	216	1 1/2"	48	110	14	51.5	100	M16
180L	2,4,6 & 8		279						319									717	838	218				371							
200L	2	318	305	—	133	200	19	398	355	85	85	—	28	32	397	462	319	795	920	262	394	80	—	396	249	2"	55	110	16	59	100	M20
	4,6 & 8																	772	897	239											
225S	4,6 & 8	356	286	—	149	225	19	436	336	85	85	—	28	34	450	509	344	827	976	231	450	90	—	432.5	273	2"	60	140	18	64	130	M20
225M	2		311						361									837	956	276				415			55	110	16	59	100	
	4,6 & 8																	852	1001	231				445			60	140	18	64	130	
250M	2	406	349	—	168	250	24	506	425	100	115	—	49	42	495	665	—	914	1065	268	489	100	578	352	243	2"	60	140	18	64	130	M20
	4,6 & 8																										65	140	18	69	130	
280S/M	2	457	368	419	190	280	24	540	490	100	110	149	40	42	552	725	—	1010	1160	271	544	115	638	360	243	2"	65	140	18	69	130	M20
	4,6 & 8																										75	140	20	79.5	130	
315S/M	2	508	406	457	216	315	28	625	540	120	120	155	46	45	615	830	—	1137	1293	240	600	130	728	386	278	2"	65	140	18	69	130	M20
	4,6 & 8																	1167	1353					416			80	170	22	85	160	
315L	2		508	—					593	120	120	—	46					1302	1458	454				386		2 1/2"	65	140	18	69	130	
	4,6 & 8																	1332	1518					416			80	170	22	85	160	
355L	2	610	630	—	254	355	28	710	770	110	170	—	73	45	693	939	—	1461	1622	458	685	145	850	434	403	3"	75	140	20	79.5	130	M20
	4,6 & 8																	1491	1682					464			95	170	25	100	160	M24

TABLE A

Dimension	Tolerance		Specification
A,B	±0.75		
H	-0.5	UPTO 280	IS : 1231
	-1	OVER 280	
K	+0.360	7,10Ø	
	+0.430	12,15Ø	
	+0.520	19,24,28Ø	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

① Without Eye bolt

□ Key / key way fit : h9 / N9

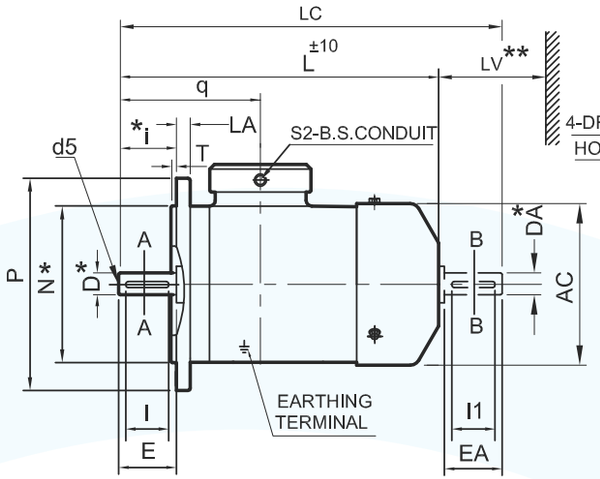
□ Double shaft extension can be provided with shaft dimension identical to DE shaft.

□ Also suitable for B6,B7,B8,V5 & V6 mounting as per IS 2253.

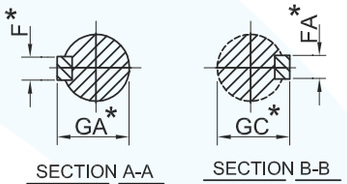
** Minimum distance for efficient cooling of motor to be maintained by user

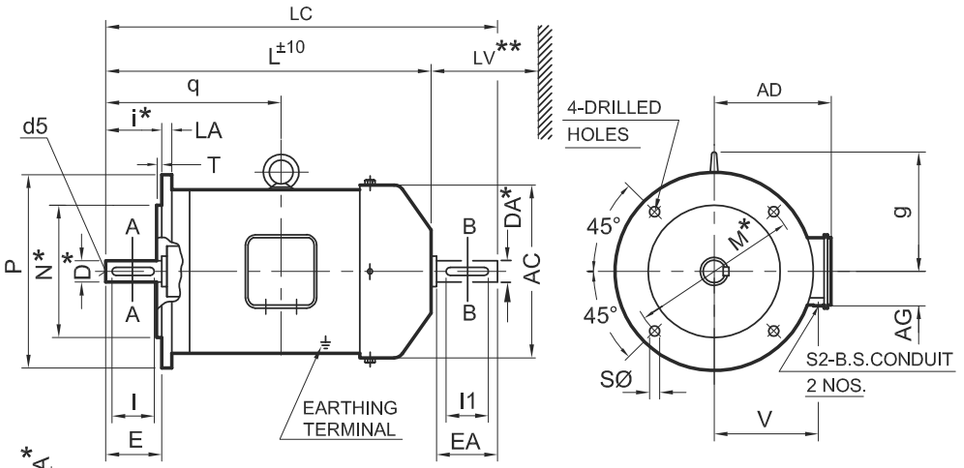
Note: For non-standard motors, these dimensions may change. Please contact sales office for details. All Dimensions are in mm unless otherwise specified.

Dimensional Drawing: Industrial Motors Type MA Flange Mounted (B5) TEFC series Frame 63-355L

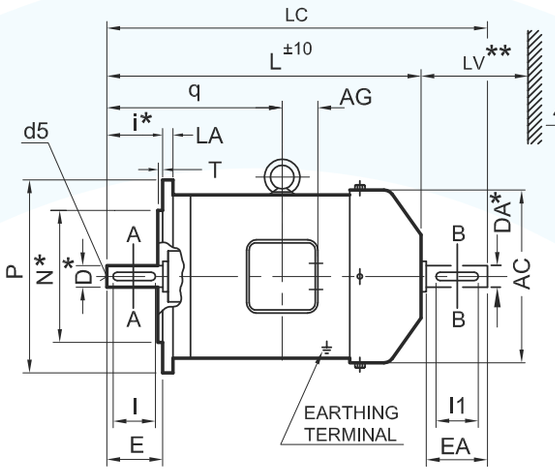


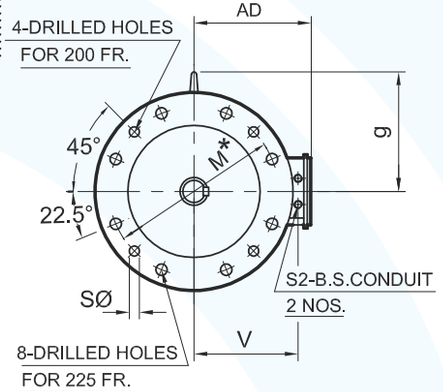
FRAME SIZE 63 TO 80



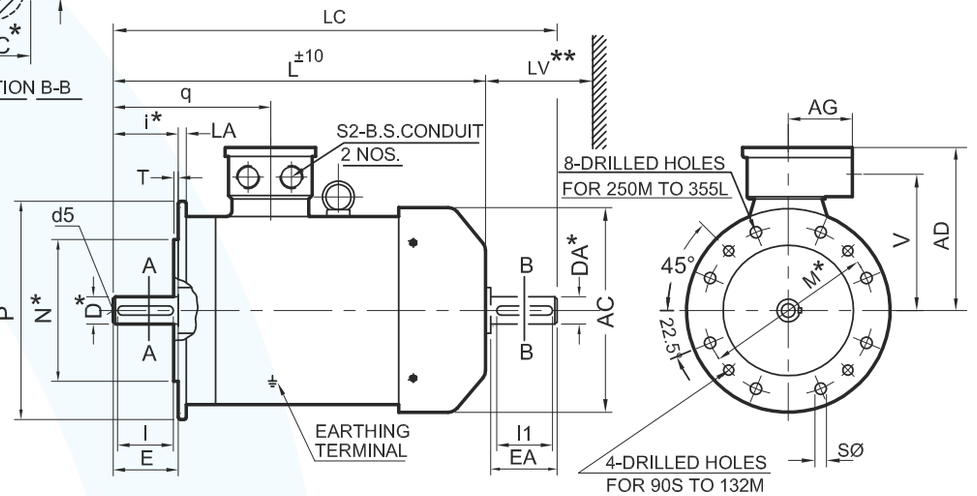


FRAME SIZE 160M TO 180L





FRAME SIZE 200L TO 225M



FRAME SIZE 90S TO 132M
FRAME SIZE 250M TO 355L

* Refer TABLE A for tolerances

CAT-C-6335-5-1

Dimensional Details: Industrial Motors Type MA Flange Mounted (B5) TEFC series Frame 63-355L

		FIXING					GENERAL								TERMINAL BOX				SHAFT					
IEC Fr. size	Pole	P	N*	M*	i*	S	T	LA	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D,DA**	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	140	95	115	23	10	3	9	116	124	225	260	30	—	86	109	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	160	110	130	30	10	3.5	9	124	140	261	305	30	—	95	127	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	200	130	165	40	12	3.5	10	134	157	267	324	30	—	105	112	40	3/4"	19	40	6	21.5	35	M6
90S	2,4,6 & 8	200	130	165	50	12	3.5	10	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	2,4,6 & 8										327	399				153								
100L	2,4,6 & 8	250	180	215	60	15	4	11	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	4,6 & 8	250	180	215	60	15	4	11	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	2	300	230	265	80	15	4	12	206	260	475	568	50	-	167	196	63	1"	38	80	10	41	70	M12
	4,6 & 8										459	552												
132M	2										556	659				215								
	4&6										497	590												
160M	2	350	250	300	110	19	5	13	226	316	605	741	60	206	186	323	63	1"	42	110	12	45	105	M16
	4,6 & 8										585	721												
160L	2										649	785				345								
	4,6 & 8										629	765												
180M	2,4,6 & 8	350	250	300	110	19	5	13	265	354	679	799	70	232	216	352	97	1 1/2"	48	110	14	51.5	100	M16
180L	2,4,6 & 8										717	838				371								
200L	2	400	300	350	110	19	5	15	319	394	795	920	80	262	249	396	172	2"	55	110	16	59	100	M20
	4,6 & 8										772	897												
225S	4,6 & 8	450	350	400	140	19	5	16	344	450	827	976	90	284	273	432.5	172	2"	60	140	18	64	130	M20
225M	2				110						837	956				415			55	110	16	59	100	
	4,6 & 8				140						852	1001				445			60	140	18	64	130	
250M	2	550	450	500	140	19	5	18	415	489	914	1065	100	—	328	352	243	2"	60	140	18	64	130	M20
	4,6 & 8																		65	140	18	69	130	
280S/M	2	550	450	500	140	19	5	18	445	544	1010	1160	115	—	358	360	243	2"	65	140	18	69	130	M20
	4,6 & 8																		75	140	20	79.5	130	
315S/M	2	660	550	600	140	24	6	22	515	600	1137	1293	130	—	413	386	278	2"	65	140	18	69	130	M20
	4,6 & 8				170						1167	1353				416			80	170	22	85	160	
315L	2				140						1302	1458				386		2 1/2"	65	140	18	69	130	
	4,6 & 8				170						1332	1518				416			80	170	22	85	160	
355L	2	800	680	740	140	24	6	25	584	690	1461	1622	145	—	495	434	403	3"	75	140	20	79.5	130	M20
	4,6 & 8				170						1491	1682				464			95	170	25	100	160	M24

TABLE A

Dimension	Tolerance		Specification
N	j6	UPTO 450	IS : 2223
	js6	OVER 450	
M	±0.3	UPTO 265	
	±0.5	OVER 265	
i	±1	UPTO 85	
	±1.5	OVER 85	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

① Without Eye bolt

- Key / key way fit : h9 / N9
- 8 Nos. Fixing Holes from 225S/M frame onwards
- Double shaft extension can be provided with shaft dimension identical to D.E.shaft
- Also suitable for V1 & V3 mounting as per IS 2253

** Minimum distance for efficient cooling of motor to be maintained by user

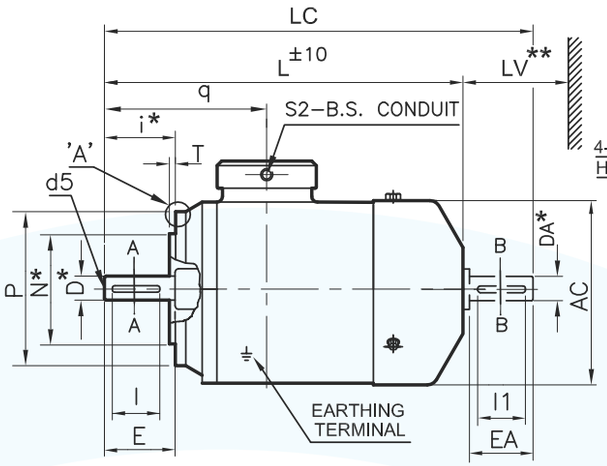
Note: For B3/B5 mounting motor in frame 63 & 71 refer to Sales office

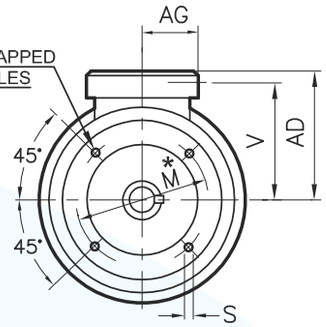
All Dimensions are in mm unless otherwise specified.

CAT-C-6335-5-2

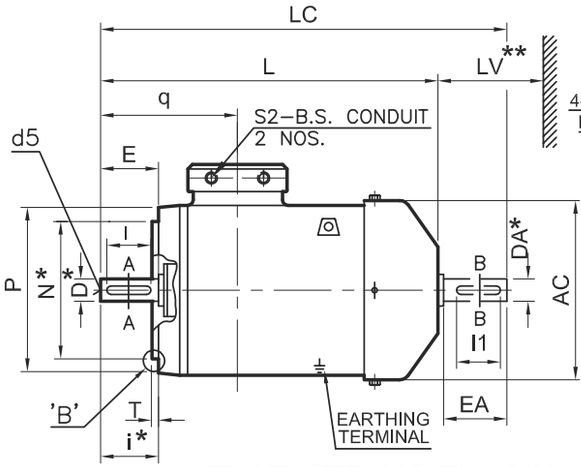
Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

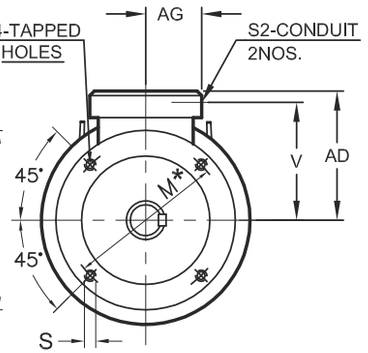
Dimensional Details: Industrial Motors Type MA Face Mounted (B14) TEFC series Frame 63-132M





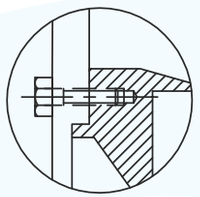
FRAME SIZE 63 TO 80



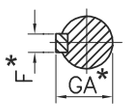


FRAME SIZE 90S TO 132M

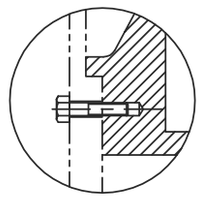
		FIXING					GENERAL							TERMINAL BOX			SHAFT						
IEC Fr. size	Pole	P	N*	M*	i*	S	T	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D* DA*	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	90	60	75	23	M5X10	2.5	116	124	206	241	30	—	86	104	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	105	70	85	30	M6X10	2.5	124	140	234	278	30	—	95	102	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	120	80	100	40	M6X13	3	134	157	267	324	30	—	105	112	40	3/4"	19	40	6	21.5	35	M6
90S	2,4,6 & 8	140	95	115	50	M8X12	3	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	2,4,6 & 8									327	399				153								
100L	2,4,6 & 8	160	110	130	60	M8X12	3.5	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	2,4,6 & 8	160	110	130	60	M8X12	3.5	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	2	250	180	215	80	M12X20	4	206	260	475	568	50	-	167	196	63	1"	38	80	10	41	70	M12
	4,6 & 8									459	552												
132M	2									556	659				215								
	4 & 6									497	590												



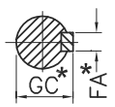
ENLARGEMENT OF CIRCLE 'A'



SECTION A–A



ENLARGEMENT OF CIRCLE 'B'



SECTION B–B

TABLE A

Dimension	Tolerance	Specification
N	j6	IS : 2223
M	±0.3	
i	±1	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

① Without Eye bolt
- Also suitable for V19 & V18 mounting as per IS 2253
- Key / key way fit : h9 / N9
- Double shaft extension can be provided with shaft dimension identical to D.E. shaft

** Minimum distance for efficient cooling of motor to be maintained by user

All Dimensions are in mm unless otherwise specified.

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Global warming is a reality and world over people are working towards reduction in carbon foot print. Electric motor applications, in Indian industry, consume about seventy percent of the generated electrical energy in India. Improving efficiency of the motor is therefore a major concern in energy-efficiency efforts. Electric motors with improved efficiency, in combination with frequency converters can save about 7% of the total worldwide electrical energy. Roughly one quarter to one third of these savings come from the improved efficiency of the motor. A need was felt amongst users, consultants and manufacturers in India to revise existing BIS standard IS 12615:2004 to harmonize with the international standards. This will lead us to be in line with international code of standards and practices. This will also result in having uniform test procedures to facilitate the end user to compare the performance and energy efficiency of motors manufactured by different manufacturers .

Motors from 0.37kW to 375kW make up the vast majority (approximately 90%) of installed motor population and are covered by the standard IS12615:2011. This fulfils the need of the manufacturers to design motor for a global market. This standard defines three efficiency classes and corresponding efficiency values for motors operating at 50Hz frequency.

Salient features of BIS standard IS 12615:2011 (second revision)

This standard is primarily based on IEC 60034-30:2008 issued by the International Electrotechnical Commission except that additional performance parameters other than efficiency values have also been included such as starting current, starting torque and full load speed.

The efficiency levels in IS 12615:2011 are based on test methods specified in IS 15999 (Part 2/sec 1): 2011 /IEC 60034-2-1:2007. The standard specifies methods used to determine losses and efficiency, with the objective to calculate efficiency values more accurately.

The standard specifies rated voltage as 415V, and rated frequency as 50Hz. Also the permissible variations in voltage and frequency are as below

- Voltage: ±10%
- Frequency: ±5%
- Combined variation: ±10%

The standard specifies output kW rating and frame relationship up to 160kW for 2P & 4P ratings and up to 132kW for 6P ratings. Above these ratings, the frame selection is left to the manufacturer.

New IE Efficiency Classes are as given below

Efficiency Class	Description	
IE1	Standard efficiency	Comparable to eff2
IE2	High efficiency	Comparable to eff1
IE3	Premium	Premium

The standard covers low voltage, AC three phase squirrel cage, single speed induction motors for

- Rated voltage $\leq$ 1000V
- Rated frequency 50Hz
- Rated output between 0.37kW to 375kW
- 2, 4 & 6 Pole motors
- Rated on the basis of continuous duty (S1) or intermittent periodic duty (S3) with 80% or higher cyclic duration factor
- Capable of operating direct on line
- Rated for ambient temperature of 40^{0}C & altitude not exceeding 1000m
- Degree of protection IP44 or superior
- Method of cooling IC 411
- Fixing dimensions as per IS 1231 & IS 2223
- Determination of total losses with stray load loss determination from residual losses

This standard does not cover

- 8P & higher polarity motors
- Pole changing motors (multispeed motors)
- Motors made exclusively for converter duty application
- Motors completely integrated into the machine. (for example, pumps, compressors that cannot be tested separately from the machine)
- Crane & hoist duty motors

Highlight

- Efficiency values of different manufacturers are comparable only if they are measured by the same method as per IS 15999 (Part 2/sec 1):2011 / IEC 60034-2-1:2007.
- IE Class efficiencies are subject to tolerance as per IS/IEC 60034-1.
- For conditions of limitations on grid supply (e.g. limiting starting current, high tolerances of voltage and/or frequency), it may not be possible to achieve the same IE efficiency class.
- Energy efficient cage-induction motors are typically built with more active material to achieve higher efficiency and hence the starting performance of these motors differ somewha

from motors with a lower efficiency. The locked rotor current increases approximately by 10 to 15 percent for increase in each level of efficiency for the same output power. For replacing existing motors, this should be checked by the user with manufacturer for proper sizing of the protective devices.

Old efficiency levels were eff2 and eff1 (as per CEMEP). For calculation of these efficiencies, fixed stray load losses (0.5% of motor input) were assumed and not measured. Hence efficiency values were with high uncertainty. Now IS : 12615:2011 refers to IS : 15999 (Part 2/sec 1):2011 / IEC 60034-2-1:2007 for calculation of efficiency. This calculation is based on the new methods of stray load loss measurement specified in the standard. The effect is in reduction of efficiency value than the earlier values.

Bharat Bijlee's IE2 Motors Product Range

Type	Frame Size	kW Range
IE2 High efficiency-2H	71 TO 355L	0.37 TO 355

Bharat Bijlee IE2 motors are readily suitable for inverter duty -

Features:

- All motors with dual coat winding wires
- Special Impregnation to suit inverter duty
- 6 terminals in the terminal box for all motors

Stray Load Loss Measurement and Efficiency Determination of IE2 Motor

The most significant difference in the efficiency determination method of standard motors (as per old IS 12615:2004) and IE2 motors (as per IS 12615-2011).

Effect of additional stray load losses for efficiency determination as per IS : 12615-2011.

The new standard follows IS : 15999 / IEC 60034-2-1 for arriving at the stray load losses. These losses can vary from 2.5% in small motors to 0.5% in higher ratings up to 10MW. (reference - graph. In figure 11 of standard IS : 15999).

The earlier standard IS : 12615-2004 used for eff1 motors assumed stray load losses as 0.5% of output. Hence the efficiency values tested by the earlier standard would be 0% to 2.0% higher than the new standard for the same motor.

Example is given below

Rating 4 Pole	eff1 specified in IS : 12615-2004 (%)	IE2 specified in IS : 12615-2011 (%)	Reduction in efficiency from eff1 due to additional stray load losses (%)
0.75kW	82.5	79.6	2.9
55kW	94.2	93.5	0.7

When comparing eff1/eff2 motor & IE2 motor, it is necessary to note the difference in testing methods. The standard has reduced the efficiency value to take care of this. At first glance, a customer would feel that an IE2 motor is inferior to an eff1 motor though both might be identical.

Hence for any comparison, it is necessary to use the same method of loss calculation.

The worked out example shown below gives the energy savings per year (for 8000 hours running) of a BBL IE2 motor (normalized for 0.5% stray load loss) over a BBL standard motor. Stray load losses are taken from figure 11 of IS : 15999.

Efficiency comparison and energy saving of standard motor and IE2 motor

Rating (kW)	11		55	
Efficienct Standared	Standard	IE2	Standard	IE2
Purchase Cost (Rs.)	25676	30340	132236	149944
Catalogue Efficiency %	89.0	89.8	93.8	93.5
Input Power (kW) for IE2 motor as per catalogue		11.0/0.898 =12.249		55.0/0.935 =58.824
Additional Stray load losses (kW) over Standard motor		(0.2424-0.0550) = 0.187		(0.959-0.275) =0.684
Normalized IE2 Efficiency % with 0.5% Stray losses assumed		11.0 / (12.249 -0.187) =91.2		55.0/ (58.824-0.684) =94.6
Motor losses(kW)	(11.0/0.89) - 11.0 =1.36	(11.0/0.912) - 11.0 =1.062	(55.0/0.938) -55.0 =3.636	(55.0/0.95) -55.0 =2.894
Saving (kW)	1.36-1.062=0.298		3.636-2.894=0.742	
Saving in energy (kWH) @8000 Hrs running per year	2384		5936	
Average Energy Cost (Rs.)	7			
Annual Saving (Rs.)	16688		41552	
Payback period for additional purchase cost for IE2	3.35 month		5.11 month	
Saving (Rs.) in 20 years	333760		831040	

For Standard motor, stray load loss is 0.5% of output
Stray load loss for 11kW motor is 0.055 kW
Stray load loss for 55kW motor is 0.275 kW

For IE2 motor, as per nomogram
(figure 11 of IS 15999)
Stray load loss for 11kW motor is 0.2424 kW
Stray load loss for 55kW motor is 0.959 kW

Table shown below gives the Energy Savings Per Year (for 8000 hours running) of a BBL IE2 Motor (normalized for 0.5% stray load loss) over a standard eff2 motor as per IS 12615-2004

	2 Pole				4 Pole				6 Pole			
Rating kW	Standard eff2 Motor (η%)	BBL IE2 Motor (η%)	Normalized IE2 η with 0.5% Stray load losses	Saving in kWh/Year @8000 Hrs running	Standard eff2 Motor (η%)	BBL IE2 Motor(η%)	Normalized IE2 η with 0.5% Stray load losses	Saving in kWh/Year @8000 Hrs running	Standard eff2 Motor (η%)	BBL IE2 Motor(η %)	Normalized IE2 η with 0.5% Stray load losses	Saving in kWh/Year @8000 Hrs running
0.37	66.0	72.2	73.78	472.8	66.0	70.1	71.64	353.1	65.0	69	70.52	356.4
0.55	70.0	74.8	76.42	528.4	70.0	75.1	76.73	551.3	68.0	72.9	74.49	563.8
0.75	73.0	77.4	79.07	631.0	73.0	79.6	81.31	839.9	71.0	75.9	77.54	713.2
1.1	76.2	79.6	81.29	723.4	76.2	81.4	83.12	961.8	74.0	78.1	79.77	859.6
1.5	78.5	81.3	82.96	822.5	78.5	82.8	84.49	1083.4	76.0	79.8	81.44	1054.6
2.2	81.0	83.2	84.82	979.2	81.0	84.3	85.94	1248.8	79.0	81.8	83.40	1175.6
3.7	84.0	85.5	87.06	1237.4	84.0	86.3	87.87	1551.2	82.5	84.3	85.84	1396.2
5.5	85.7	87.0	88.50	1624.3	85.7	87.7	89.21	2018.2	84.5	86	87.49	1777.9
7.5	87.0	88.1	89.55	1965.7	87.0	88.7	90.16	2416.9	86.0	87.2	88.64	2079.2
9.3	87.7	88.8	90.22	2367.8	87.7	89.3	90.72	2827.4	87.0	88	89.41	2304.0
11	88.4	89.4	90.79	2621.8	88.4	89.8	91.20	3051.6	87.5	88.7	90.08	2884.3
15	89.4	90.3	91.64	3278.6	89.4	90.6	91.94	3710.2	88.5	89.7	91.03	3771.8
18.5	90.0	90.9	92.20	3927.0	90.0	91.2	92.50	4452.6	89.5	90.4	91.70	3961.9
22	90.5	91.3	92.57	4349.4	90.5	91.6	92.87	4969.2	90.0	90.9	92.17	4597.1
30	91.4	92.0	93.21	5107.6	91.4	92.3	93.52	5940.5	91.0	91.7	92.91	5423.3
37	92.0	92.5	93.67	5750.0	92.0	92.7	93.88	6428.6	91.5	92.2	93.37	6484.8
45	92.5	92.9	94.04	6360.4	92.5	93.1	94.24	7178.9	92.0	92.7	93.84	7653.4
55	93.0	93.2	94.30	6509.7	93.0	93.5	94.60	7999.8	92.5	93.1	94.20	8568.3
75	93.6	93.8	94.84	8361.3	93.6	94	95.04	9701.0	93.0	93.7	94.74	11824.9
90	93.9	94.1	95.10	9681.9	93.9	94.2	95.20	10481.8	93.3	94.0	95.00	13811.3
110	94.0	94.3	95.26	12383.0	94.4	94.5	95.46	10362.0	93.5	94.3	95.26	17389.3
125	94.5	94.5	95.43	10360.3	94.7	94.6	95.53	9227.8	93.6	94.4	95.33	19430.6
132	94.5	94.6	95.52	11972.5	94.7	94.7	95.62	10774.2	93.8	94.6	95.52	20311.7
150	94.6	94.7	95.60	13231.2	94.8	94.7	95.60	10555.0				
160	94.8	94.8	95.68	12475.1	95.0	94.9	95.78	11035.5				

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 71 to 355L

Applicable standard for testing & efficiency determination: IS 15999

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50° C
Duty : S1 (Continuous)
3000 rpm (2-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

IE2

Rated Output		Frame size	Type Ref.	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD^2 kgm^2	Net Weight B3 Constn. Kg
				Rated Speed	Rated Current	Rated Torque	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP	IEC	B3 Construction	RPM	Amps.	Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L					
0.37	0.50	71	2H0712A3	2800	0.96	0.13	0.74	0.68	0.60	72.2	72.2	66.0	5.0	2.6	3.0	0.0019	7
0.55	0.75	71	2H071233	2805	1.29	0.19	0.79	0.72	0.58	74.8	74.0	70.0	5.0	2.7	3.0	0.0019	7
0.75	1.0	80	2H080213	2830	1.64	0.26	0.82	0.74	0.62	77.4	76.5	73.5	5.0	2.5	2.8	0.0037	10
1.1	1.5	80	2H080233	2830	2.34	0.38	0.82	0.75	0.63	79.6	79.6	75.5	6.0	2.7	3.0	0.0051	11
1.5	2.0	90S	2H09S243	2840	3.13	0.51	0.82	0.78	0.68	81.3	81.3	78.0	6.5	3.3	3.5	0.0091	17
2.2	3.0	90L	2H09L273	2840	4.49	0.75	0.82	0.78	0.68	83.2	83.2	81.7	6.5	3.3	3.5	0.0113	20
3.7	5.0	100L	2H10L233	2890	6.84	1.25	0.88	0.83	0.75	85.5	85.5	84.0	6.5	3.0	3.3	0.0212	26
5.5	7.5	132S	2H13S2G3	2935	9.77	1.83	0.90	0.88	0.83	87.0	86.0	82.0	6.5	2.6	3.0	0.0820	55
7.5	10.0	132S	2H13S2N3	2935	13.2	2.49	0.90	0.87	0.82	88.1	87.5	85.0	6.5	2.6	3.0	0.0980	67
9.3	12.5	160M	2H16M233	2935	16.4	3.09	0.89	0.86	0.82	88.8	88.6	85.0	6.5	2.0	2.5	0.1500	105
11	15.0	160M	2H16M253	2935	19.2	3.65	0.89	0.84	0.76	89.4	89.4	87.0	6.5	2.3	3.0	0.171	112
15	20.0	160M	2H16M263	2930	26.0	4.99	0.89	0.88	0.82	90.3	90.0	88.0	6.5	2.0	2.5	0.203	120
18.5	25.0	160L	2H16L293	2930	31.5	6.15	0.90	0.89	0.86	90.9	90.7	89.0	6.5	2.0	2.5	0.268	137
22	30.0	180M	2H18M233	2935	37.7	7.30	0.89	0.87	0.82	91.3	91.0	88.8	7.0	2.4	2.7	0.34	177
30	40.0	200L	2H20L2A3	2955	51.0	9.89	0.89	0.86	0.80	92.0	92.0	90.0	7.0	2.6	3.0	0.61	274
37	50.0	200L	2H20L273	2955	64.0	12.2	0.87	0.84	0.76	92.5	92.5	91.0	7.0	2.2	2.5	0.64	275
45	60.0	225M	2H22M253	2965	76.6	14.8	0.88	0.85	0.78	92.9	92.7	91.0	7.0	2.5	2.5	1.13	353
55	75.0	250M	2H25M233	2965	90.2	18.1	0.91	0.89	0.86	93.2	92.7	90.0	7.0	2.3	2.7	2.60	550
75	100	280S	2H28S233	2970	122	24.6	0.91	0.89	0.86	93.8	93.6	92.0	6.5	2.0	2.8	3.01	669
90	120	280M	2H28M253	2970	146	29.5	0.91	0.89	0.86	94.1	93.9	90.9	6.5	2.0	2.8	3.42	750
110	150	315S	2H31S233	2982	180	35.9	0.90	0.86	0.80	94.3	94.1	91.5	7.0	2.2	2.5	5.0	898
125	170	315M	2H31M2A3	2982	207	40.8	0.89	0.85	0.78	94.5	93.5	91.5	7.0	2.2	2.6	5.0	940
132	180	315M	2H31M233	2982	216	43.1	0.90	0.86	0.80	94.6	93.6	91.3	7.0	2.0	2.5	5.0	940
150	200	315L	2H31L2A3	2982	248	49.0	0.89	0.84	0.78	94.7	93.7	92.2	7.0	2.0	2.5	6.2	1100
160	215	315L	2H31L253	2985	261	52.2	0.90	0.86	0.80	94.8	94.1	93.0	7.0	2.4	2.5	6.2	1100
180	240	315L	2H31L2B3	2982	300	58.8	0.88	0.82	0.75	94.9	94.1	93.0	7.0	2.0	2.5	7.7	1390
200	270	355L	2H35L2A3	2985	325	65.3	0.90	0.87	0.82	95.0	94.2	92.2	7.0	1.6	2.4	12.0	1680
*250	335	355L	2H35L213	2985	407	81.6	0.90	0.88	0.84	95.0	94.5	92.8	7.0	1.6	2.4	12.0	1680
*315	425	355L	2H35L233	2985	513	103	0.90	0.88	0.84	95.0	94.5	93.0	7.0	1.6	2.4	14.7	1870

Note : Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings from 0.37kw to 375kw.
All performance values are subject to tolerance as per IS/IEC 60034-1
Efficiency measurements are without seals.

*- These ratings are suitable for class F temperature rise

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 71 to 355L

Applicable standard for testing & efficiency determination: IS 15999

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50° C
Duty : S1 (Continuous)
1500 rpm (4-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

IE2

Rated Output		Frame size	Type Ref.	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm²	Net Weight B3 Constn. Kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP	IEC	B3 Construction			Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L					
0.37	0.50	71	2H071433	1380	1.03	0.26	0.71	0.62	0.50	70.1	70.1	65.0	3.4	2.3	2.5	0.0033	7
0.55	0.75	80	2H080433	1420	1.38	0.38	0.74	0.64	0.50	75.1	75.1	68.0	5.0	2.8	3.0	0.0072	11
0.75	1.0	80	2H080453	1410	1.75	0.52	0.75	0.66	0.53	79.6	79.6	74.0	5.0	2.8	3.0	0.0082	12
1.1	1.5	90S	2H09S423	1430	2.44	0.75	0.77	0.70	0.57	81.4	81.4	77.5	6.0	2.4	2.8	0.015	15
1.5	2.0	90L	2H09L473	1435	3.23	1.02	0.78	0.70	0.57	82.8	82.8	80.0	5.5	2.7	3.0	0.019	19
2.2	3.0	100L	2H10L473	1435	4.48	1.49	0.81	0.74	0.60	84.3	84.3	82.0	6.0	2.6	3.0	0.028	26
3.7	5.0	112M	2H11M473	1450	7.46	2.49	0.80	0.76	0.62	86.3	86.3	84.0	6.5	2.7	3.0	0.066	36
5.5	7.5	132S	2H13S4K3	1450	10.3	3.69	0.85	0.82	0.74	87.7	87.7	86.0	6.5	2.2	2.8	0.126	64
7.5	10	132M	2H13M4T3	1450	13.8	5.04	0.85	0.82	0.74	88.7	88.7	87.0	6.5	2.2	2.8	0.163	74
9.3	12.5	160M	2H16M4C3	1460	17.6	6.20	0.82	0.76	0.68	89.4	89.4	87.0	6.5	2.5	2.8	0.177	105
11	15.0	160M	2H16M4K3	1465	20.3	7.31	0.84	0.80	0.70	89.8	89.8	88.0	6.5	2.5	2.8	0.229	115
15	20.0	160L	2H16L4T3	1465	27.1	9.97	0.85	0.82	0.72	90.7	90.7	89.5	6.5	2.5	2.7	0.300	128
18.5	25.0	180M	2H18M473	1465	33.2	12.3	0.85	0.82	0.76	91.2	91.2	89.5	6.5	2.7	2.9	0.540	188
22	30	180L	2H18L483	1470	39.8	14.6	0.84	0.78	0.70	91.6	91.6	89.8	6.5	2.8	3.0	0.61	200
30	40	200L	2H20L453	1470	52.6	19.9	0.86	0.82	0.72	92.3	92.0	90.0	7.0	2.6	2.6	0.93	275
37	50	225S	2H22S433	1470	63.8	24.5	0.87	0.85	0.77	92.7	92.5	90.5	7.0	2.6	2.6	1.60	362
45	60	225M	2H22M453	1470	77.3	29.8	0.87	0.85	0.77	93.1	92.8	91.0	7.0	2.6	2.6	1.85	377
55	75	250M	2H25M433	1480	95.2	36.2	0.86	0.84	0.76	93.5	93.0	91.0	7.0	2.5	2.6	3.06	500
75	100	280S	2H28S423	1485	131	49.2	0.85	0.82	0.74	94.0	94.0	93.0	6.7	2.6	2.8	5.53	670
90	120	280M	2H28M453	1485	156	59.0	0.85	0.82	0.74	94.2	94.2	93.2	6.5	2.3	2.8	6.36	735
110	150	315S	2H31S413	1485	188	72.1	0.86	0.83	0.76	94.5	94.3	92.3	6.5	2.5	3.0	9.97	862
125	170	315M	2H31M4A3	1486	216	81.9	0.85	0.81	0.74	94.6	94.3	92.7	6.5	2.5	3.0	11.7	965
132	180	315M	2H31M433	1487	225	86.5	0.86	0.83	0.76	94.7	94.5	93.0	6.5	2.5	3.0	11.7	965
150	200	315L	2H31L4A3	1488	262	98.2	0.84	0.80	0.72	94.7	94.4	92.8	6.5	2.5	3.0	14.0	1145
160	215	315L	2H31L453	1487	270	105	0.87	0.84	0.78	94.9	94.6	93.1	6.5	2.4	3.0	14.0	1145
180	240	315L	2H31L463	1487	307	118	0.86	0.83	0.76	95.0	94.7	93.2	6.5	2.5	3.0	15.6	1225
200	270	315L	2H31L473	1489	340	131	0.86	0.83	0.76	95.1	94.8	93.3	7.0	2.5	3.0	17.8	1290
250	335	355L	2H35L413	1488	416	164	0.88	0.85	0.75	95.1	94.9	93.5	6.5	2.2	2.5	23.3	1680
315	422	355L	2H35L433	1488	524	206	0.88	0.85	0.75	95.1	94.8	93.5	6.5	2.2	2.5	32.7	1855
*355	475	355L	2H35L453	1488	590	232	0.88	0.85	0.75	95.1	94.9	93.5	6.5	2.2	2.5	37.9	2025

Note : Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings from 0.37kw to 375kw.
All performance values are subject to tolerance as per IS/IEC 60034-1
Ratings above 400 kW up to 1000kW are available in 355, 400 & 450 frames with Dual Circuit Cooling Arrangement (DCCA).
Efficiency measurements are without seals.
*-These ratings are suitable for class F temperature rise

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 355L

Applicable standard for testing & efficiency determination: IS 15999

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient : 50° C
Duty : S1 (Continuous)
1000 rpm (6-Pole)

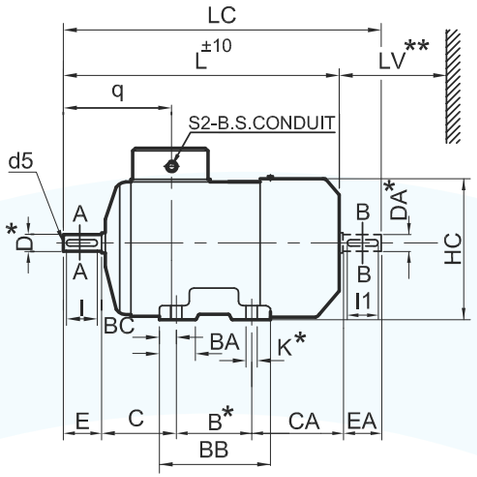
Ins. Class : F
Temp. Rise : B
Protection : IP55

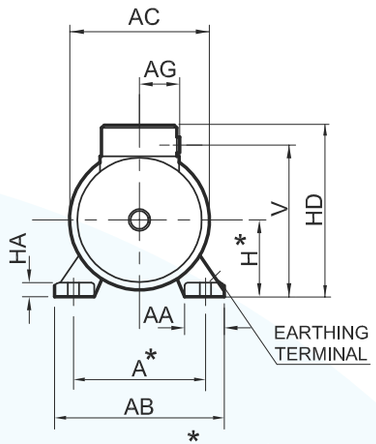
IE2

Rated Output		Frame size	Type Ref.	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm²	Net Weight B3 Constn. Kg
				Rated Speed RPM	Rated Current Amps.	Rated Torque	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP	IEC	B3 Construction			Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L					
0.37	0.55	80	2H080613	910	1.07	0.40	0.70	0.60	0.48	69.0	69.0	67.0	3.0	2.1	2.3	0.0060	10
0.55	0.75	80	2H080633	915	1.48	0.59	0.71	0.62	0.48	72.9	72.9	68.5	4.0	2.2	2.5	0.0084	11
0.75	1.0	90S	2H09S633	925	1.91	0.79	0.72	0.61	0.50	75.9	75.9	72.3	4.0	2.0	2.5	0.0122	14
1.1	1.5	90L	2H09L653	930	2.72	1.15	0.72	0.61	0.50	78.1	78.1	74.0	4.0	2.0	2.6	0.0160	17
1.5	2.0	100L	2H10L633	935	3.63	1.56	0.72	0.60	0.52	79.8	79.6	75.0	4.5	2.0	2.5	0.0250	22
2.2	3.0	112M	2H11M653	940	4.99	2.28	0.75	0.65	0.58	81.8	81.8	79.8	5.0	2.1	2.5	0.065	33
3.7	5.0	132S	2H13S6G3	960	8.25	3.75	0.74	0.70	0.60	84.3	83.5	82.0	5.5	2.0	2.5	0.130	52
5.5	7.5	132M	2H13M6T3	960	12.0	5.58	0.74	0.70	0.60	86.0	84.5	82.0	6.0	2.0	2.5	0.193	75
7.5	10	160M	2H16M633	960	15.0	7.61	0.80	0.74	0.64	87.2	87.2	85.2	5.5	2.0	2.5	0.276	103
9.3	12.5	160L	2H16L663	960	18.4	9.44	0.80	0.74	0.64	88.0	88.0	86.7	5.5	2.1	2.5	0.34	113
11	15	160L	2H16L673	965	21.6	11.1	0.80	0.77	0.66	88.7	88.7	87.0	6.0	2.0	2.5	0.40	123
15	20	180L	2H18L633	965	29.1	15.1	0.80	0.75	0.62	89.7	89.7	87.2	5.5	2.6	2.3	0.82	200
18.5	25	200L	2H20L633	975	34.7	18.5	0.82	0.77	0.69	90.4	90.4	88.3	5.5	2.6	2.3	1.20	254
22	30	200L	2H20L653	975	41.1	22.0	0.82	0.77	0.69	90.9	90.9	88.8	6.0	2.6	2.3	1.37	270
30	40	225M	2H22M643	975	52.9	30.0	0.86	0.84	0.76	91.7	91.2	88.7	7.0	2.5	2.2	2.41	358
37	50	250M	2H25M633	980	63.4	36.8	0.88	0.85	0.82	92.2	92.2	91.0	6.0	2.5	2.3	3.72	528
45	60	280S	2H28S613	984	80.4	44.5	0.84	0.80	0.72	92.7	92.7	91.2	6.0	2.5	2.4	5.11	573
55	75	280M	2H28M633	984	95.6	54.4	0.86	0.83	0.76	93.1	93.1	91.0	6.0	2.4	2.4	6.16	620
75	100	315S	2H31S613	988	133	73.9	0.84	0.82	0.75	93.7	93.7	92.5	6.0	2.4	2.5	10.7	830
90	120	315M	2H31M633	989	159	88.6	0.84	0.80	0.74	94.0	94.0	92.9	6.0	2.2	2.5	12.4	912
110	150	315M	2H31M653	989	193	108	0.84	0.81	0.74	94.3	94.3	93.3	6.0	2.3	2.5	15.5	1010
125	170	315L	2H31L6A3	990	222	123	0.83	0.80	0.72	94.4	94.2	93.0	6.0	2.3	2.5	18.0	1175
132	180	315L	2H31L673	990	231	130	0.84	0.81	0.74	94.6	94.6	93.8	6.0	2.3	2.5	18.0	1175
150	200	315L	2H31L6B3	990	269	148	0.82	0.79	0.70	94.7	94.3	92.8	6.0	2.0	2.5	21.5	1231
160	215	315L	2H31L693	990	280	157	0.84	0.81	0.71	94.8	94.5	93.0	6.0	2.0	2.5	21.5	1231
180	240	355L	2H35L6A3	990	322	177	0.82	0.77	0.65	94.9	94.6	93.3	6.0	2.0	2.5	28.7	1670
200	270	355L	2H35L613	990	349	197	0.84	0.80	0.70	95.0	94.7	93.5	6.0	2.0	2.5	28.7	1670
250	335	355L	2H35L633	990	436	246	0.84	0.80	0.70	95.0	94.7	93.4	6.0	2.0	2.5	35.5	1780

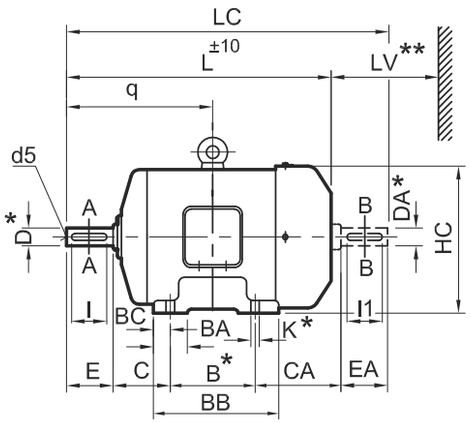
Note : Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings from 0.37kw to 375kw.
All performance values are subject to tolerance as per IS/IEC 60034-1
Ratings above 315kW up to 800kW are available in 355, 400 & 450 frames with Dual Circuit Cooling Arrangement (DCCA).
Efficiency measurements are without seals.

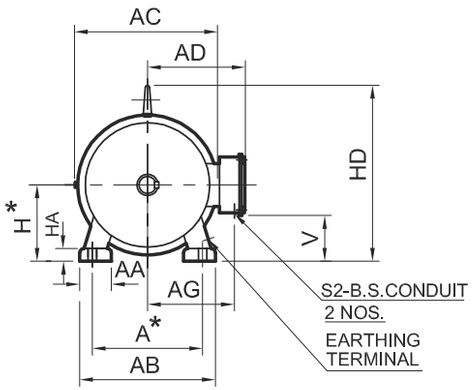
Dimensional Drawing: Industrial Motors Type 2H Foot Mounted (B3) TEFC IE2 series Frame 63-355L





FRAME SIZE 63 TO 80





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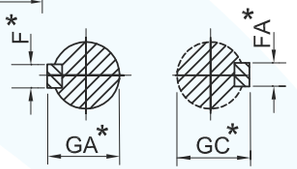
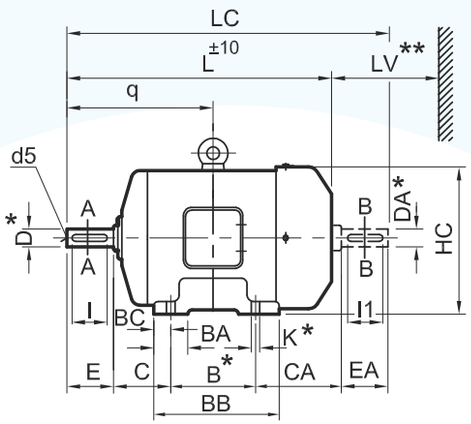
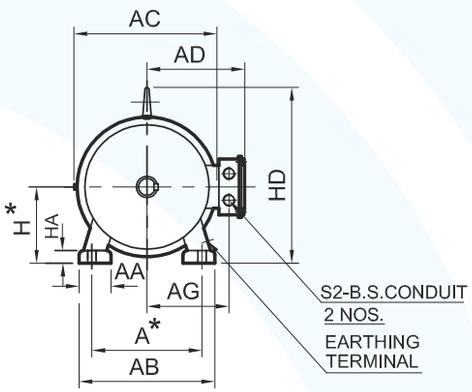
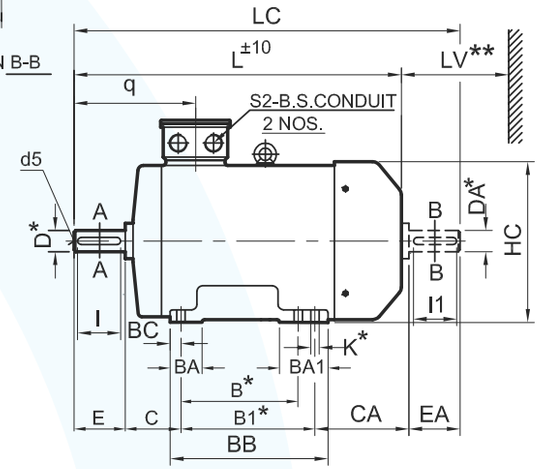


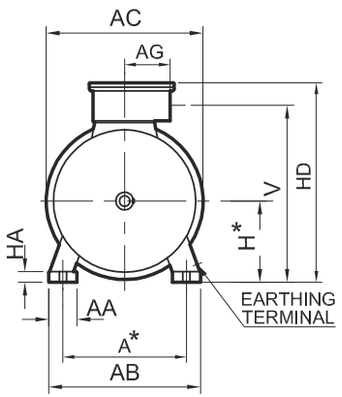
SECTION A-A SECTION B-B





FRAME SIZE 200L TO 225M





FRAME SIZE 90S TO 132M
FRAME SIZE 250M TO 355L

* Refer TABLE A for tolerances

CAT-C-6335-3-1

Note : For Dual Mounting Arrangement (180M/L - 355M/L), please refer to Annexure XII

Dimensional Details: Industrial Motors Type 2H Foot Mounted (B3) TEFC IE2 series Frame 63-355L

		FIXING			GENERAL												TERMINAL BOX			SHAFT							
IEC Fr. size	Pole	A*	B*	B1*	C	H*	K*	AB	BB	AA	BA	BA1	BC	HA	HC	HD	AD	L	LC	CA	AC	LV**	V	q	AG	S2 B.S.C.	D,DA*	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	100	80	—	40	63	7	126	100	28	30	—	13	7	125	179	—	206	241	75	124	30	149	104	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	112	90	—	45	71	7	135	110	31	30	—	13	7	141	195	—	234	278	83	140	30	166	102	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	125	100	—	50	80	10	150	124	31	35	—	15	9	159	214	—	267	324	94	157	30	185	112	40	3/4"	19	40	6	21.5	35	M6
90S	6 & 8	140	100	—	56	90	10	168	125	34	31.5	—	18	12	177	230	-	302	374	118	174	35	199	139	52	3/4"	24	50	8	27	45	M8
90L	6 & 8		125						150									327	399					153								
100L	6 & 8	160	140	—	63	100	12	190	174	43.5	36	—	21	12	198	257	-	366	448	125	192	40	225	152	56	1"	28	60	8	31	55	M10
112M	6 & 8	190	140	—	70	112	12	220	174	47	36	—	21	12	222	282	-	388	471	141	220	45	249	157	56	1"	28	60	8	31	55	M10
132S	6 & 8	216	140	—	89	132	12	256	180	64	50	—	23	17	262	338	-	459	552	172	260	50	299	196	63	1"	38	80	10	41	70	M12
132M	6		178						218		54							497	590	172				215								
160M	2 & 4	254	210	—	108	160	15	310	250	58	70	—	23	20	318	366	226	605	741	203	316	60	98	323	186	1"	42	110	12	45	105	M16
	6 & 8																	585	721	183												
160L	6 & 8		254						294									629	765	183				345								
180M	2,6 & 8	279	241	—	121	180	15	344	281	65	70	—	23	26	357	412	265	679	799	217	354	70	83	352	216	1 1/2"	48	110	14	51.5	100	M16
180L	6 & 8		279						319									717	838	218				371								
200L	2	318	305	—	133	200	19	398	355	85	85	—	28	32	397	462	319	795	920	262	394	80	—	396	249	2"	55	110	16	59	100	M20
	6 & 8																	772	897	239												
225S	4	356	286	—	149	225	19	436	336	85	85	—	28	34	450	509	344	852	1001	281	450	90	—	432.5	273	2"	60	140	18	64	130	M20
225M	2		311						361									837	956	276				415			55	110	16	59	100	
	6 & 8																	852	1001	231				445			60	140	18	64	130	
250M	2	406	349	—	168	250	24	506	425	100	115	—	49	42	495	665	—	993	1134	337	489	100	578	352	243	2"	60	140	18	64	130	M20
	4,6 & 8																	914	1065	268							65	140	18	69	130	
280S/M	2	457	368	419	190	280	24	540	490	100	110	149	40	42	552	725	—	1010	1160	271	544	115	638	360	243	2"	65	140	18	69	130	M20
	4,6 & 8																										75	140	20	79.5	130	
315S/M	2	508	406	457	216	315	28	625	540	120	120	155	46	45	600	830	—	1137	1293	340	600	130	728	386	278	2"	65	140	18	69	130	M20
	4,6 & 8																	1167	1353					416			80	170	22	85	160	
315L	2		508	—					593	120	120	—	46					1302	1458	454				386		2 1/2"	65	140	18	69	130	
	4,6 & 8																	1332	1518					416			80	170	22	85	160	
355L	2	610	630	—	254	355	28	710	770	110	170	—	73	45	693	939	—	1461	1622	458	685	145	850	434	403	3"	75	140	20	79.5	130	M20
	4,6 & 8																	1491	1682					464			95	170	25	100	160	M24

TABLE B

Pole	L	LC	CA
—	—	—	—
—	—	—	—
—	—	—	—
2 & 4	336	408	152
2 & 4	361	433	152
2 & 4	387	469	146
4	419	502	172
2 & 4	518	617	228
—	—	—	—
4	556	659	232
—	—	—	—
2 & 4	635	771	233
—	—	—	—
2 & 4	679	815	233
4	698	802	220
4	737	841	221
—	—	—	—
4	795	920	262
—	—	—	—
—	—	—	—
—	—	—	—
4	877	1026	281
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—

TABLE A

Dimension	Tolerance		Specification
A,B	±0.75		
H	-0.5	UPTO 280	IS : 1231
	-1	OVER 280	
K	+0.360	7,10Ø	
	+0.430	12,15Ø	
	+0.520	19,24,28Ø	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

Special Remarks

15kW/2P & 11kW/4P in 160M will have dimensions "L","LC" & "CA" as Indicated in table "B"

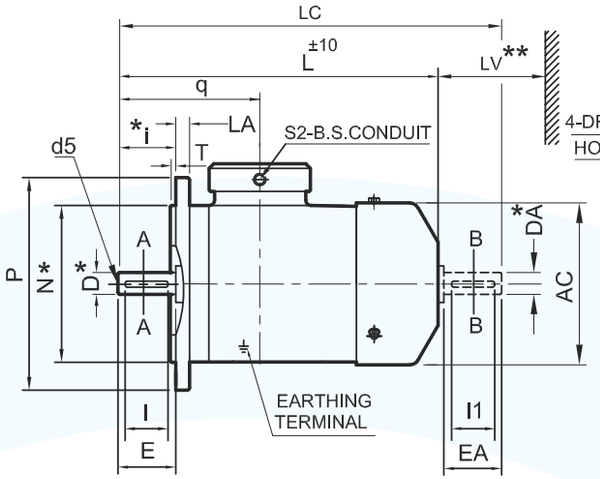
- Double shaft extension can be provided with shaft dimension identical to DE shaft.
- Also suitable for B6,B7,B8,V5 & V6 mounting as per IS 2253.
- ** Minimum distance for efficient cooling of motor to be maintained by user
- (1) Without Eye bolt
- Key / key way fit : h9 / N9

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

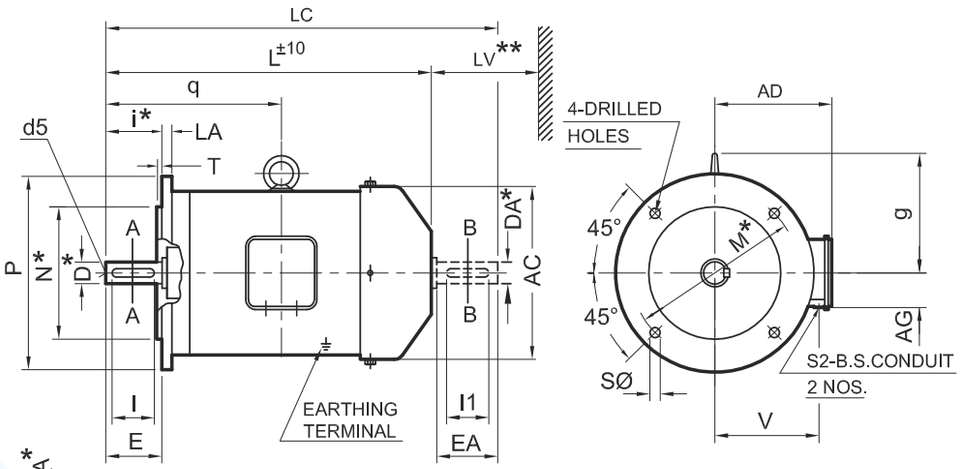
All Dimensions are in mm unless otherwise specified.

CAT-A-6335-3-2

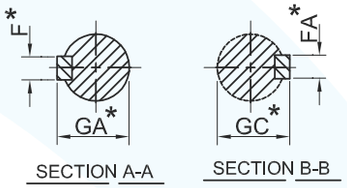
Dimensional Drawing: Industrial Motors Type 2H Flange Mounted (B5) TEFC IE2 series Frame 63-355L



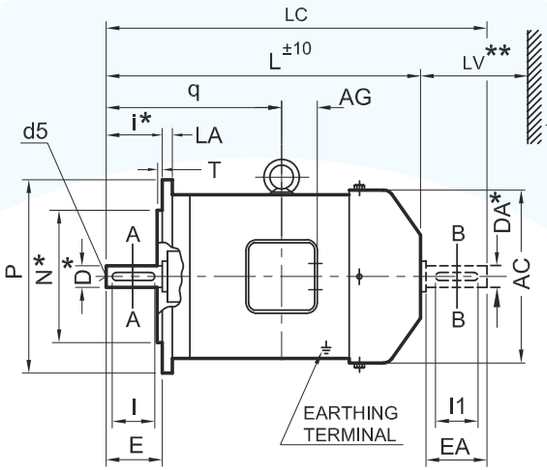
FRAME SIZE 63 TO 80

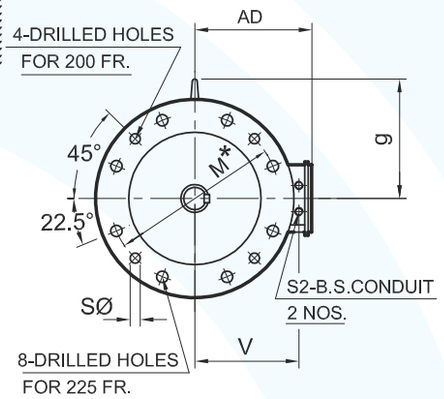


FRAME SIZE 160M TO 180L



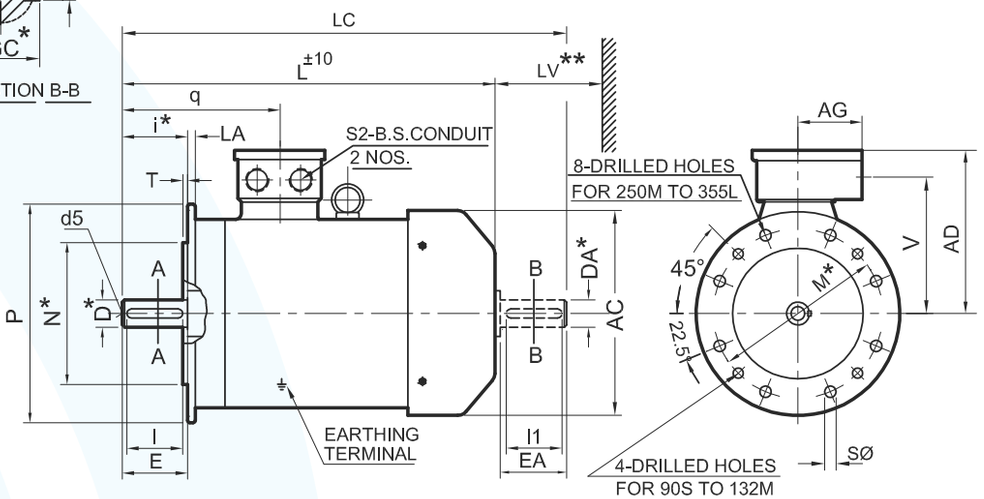
SECTION A-A SECTION B-B





FRAME SIZE 200L TO 225M

* Refer TABLE A for tolerances



FRAME SIZE 90S TO 132M
FRAME SIZE 250M TO 355L

CAT-C-6335-5-1

Dimensional Details: Industrial Motors Type 2H Flange Mounted (B5) TEFC IE2 series Frame 63-355L

		FIXING					GENERAL								TERMINAL BOX				SHAFT						
IEC Fr. size	Pole	P	N*	M*	i*	S	T	LA	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D,DA* *	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	140	95	115	23	10	3	9	116	124	225	260	30	—	86	109	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	160	110	130	30	10	3.5	9	124	140	261	305	30	—	95	127	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	200	130	165	40	12	3.5	10	134	157	267	324	30	—	105	112	40	3/4"	19	40	6	21.5	35	M6
90S	6 & 8	200	130	165	50	12	3.5	10	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	6 & 8										327	399				153								
100L	6 & 8	250	180	215	60	15	4	11	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	6 & 8	250	180	215	60	15	4	11	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	6 & 8	300	230	265	80	15	4	12	206	260	459	552	50	-	167	196	63	1"	38	80	10	41	70	M12
132M	6										497	590				215								
160M	2 & 4	350	250	300	110	19	5	13	226	316	605	741	60	206	186	323	63	1"	42	110	12	45	105	M16
	6 & 8										585	721												
160L	6 & 8										629	765				345								
180M	2,6 & 8	350	250	300	110	19	5	13	265	354	679	799	70	232	216	352	97	1 1/2"	48	110	14	51.5	100	M16
180L	6 & 8										717	838				371								
200L	2	400	300	350	110	19	5	15	319	394	795	920	80	262	249	396	172	2"	55	110	16	59	100	M20
	6 & 8										772	897												
225S	4	450	350	400	140	19	5	16	344	450	852	1001	90	284	273	432.5	172	2"	60	140	18	64	130	M20
225M	2				110						837	956				415			55	110	16	59	100	
	6 & 8				140						852	1001				445			60	140	18	64	130	
250M	2	550	450	500	140	19	5	18	415	489	993	1134	100	—	328	352	243	2"	60	140	18	64	130	M20
	4,6 & 8										914	1065							65	140	18	69	130	
280S/M	2	550	450	500	140	19	5	18	445	544	1010	1160	115	—	358	360	243	2"	65	140	18	69	130	M20
	4,6 & 8																		75	140	20	79.5	130	
315S/M	2	660	550	600	140	24	6	22	515	600	1137	1293	130	—	413	386	278	2"	65	140	18	69	130	M20
	4,6 & 8				170						1167	1353				416			80	170	22	85	160	
315L	2				140						1302	1458				386		2 1/2"	65	140	18	69	130	
	4,6 & 8				170						1332	1518				416			80	170	22	85	160	
355L	2	800	680	740	140	24	6	25	584	690	1461	1622	145	—	495	434	403	3"	75	140	20	79.5	130	M20
	4,6 & 8				170						1491	1682				464			95	170	25	100	160	M24

TABLE B

Pole	L	LC
—	—	—
—	—	—
—	—	—
2 & 4	336	408
2 & 4	361	433
2 & 4	387	469
4	419	502
2 & 4	518	617
—	—	—
4	556	659
—	—	—
2 & 4	635	771
—	—	—
2 & 4	679	815
4	698	802
4	737	841
—	—	—
4	795	920
—	—	—
—	—	—
4	877	1026
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—

TABLE A

Dimension	Tolerance		Specification
N	j6	UPTO 450	IS : 2223
	js6	OVER 450	
M	±0.3	UPTO 265	
	±0.5	OVER 265	
i	±1	UPTO 85	
	±1.5	OVER 85	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

① Without Eye bolt

** Minimum distance for efficient cooling of motor to be maintained by user

Note: For B3/B5 mounting motor in frame 63 & 71 refer to Sales office

Special Remarks

15kW/2P & 11kW/4P in 160M will have dimensions "L" & "LC" as Indicated in table "B"

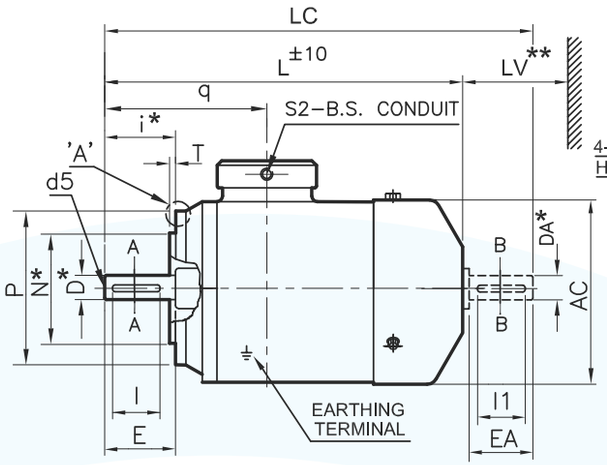
- Double shaft extension can be provided with shaft dimension identical to D.E.shaft
- Also suitable for V1 & V3 mounting as per IS 2253
- Key / key way fit : h9 / N9
- 8 Nos. Fixing Holes from 225S/M frame onwards

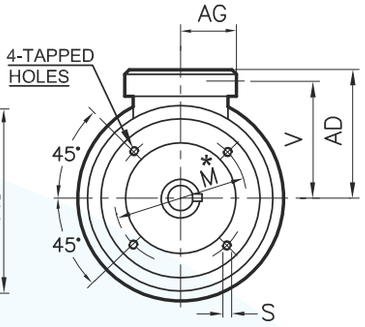
All Dimensions are in mm unless otherwise specified.

CAT-A-6335-5-2

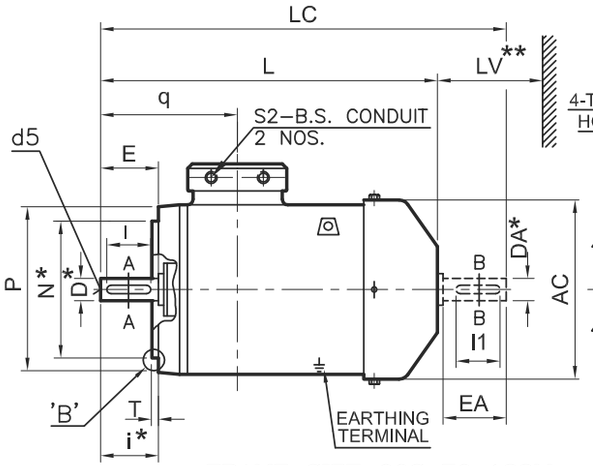
Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

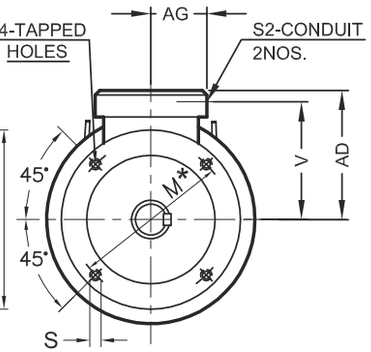
Dimensional Details: Industrial Motors Type 2H Face Mounted (B14) TEFC IE2 series Frame 63-132M





FRAME SIZE 63 TO 80

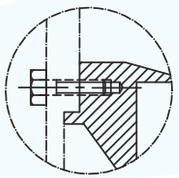




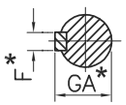
FRAME SIZE 90S TO 132M

		FIXING					GENERAL							TERMINAL BOX			SHAFT						
IEC Fr. size	Pole	P	N*	M*	i*	S	T	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D* DA*	E EA	F* FA*	GA* GC*	I I1	d5
63	2 & 4	90	60	75	23	M5X10	2.5	116	124	206	241	30	—	86	104	40	3/4"	11	23	4	12.5	18	M4
71	2,4 & 6	105	70	85	30	M6X10	2.5	124	140	234	278	30	—	95	102	40	3/4"	14	30	5	16	25	M5
80	2,4 & 6	120	80	100	40	M6X13	3	134	157	267	324	30	—	105	112	40	3/4"	19	40	6	21.5	35	M6
90S	6 & 8	140	95	115	50	M8X12	3	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	6 & 8									327	399				153								
100L	6 & 8	160	110	130	60	M8X12	3.5	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	6 & 8	160	110	130	60	M8X12	3.5	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	6 & 8	250	180	215	80	M12X20	4	206	260	459	552	50	-	167	196	63	1"	38	80	10	41	70	M12
132M	6									497	590				215								

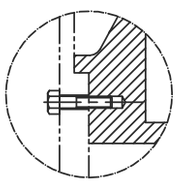
TABLE B		
Pole	L	LC
—	—	—
—	—	—
—	—	—
2 & 4	336	408
2 & 4	361	433
2 & 4	387	469
4	419	502
2&4	518	617
—	—	—
4	556	659



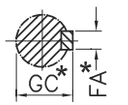
ENLARGEMENT OF CIRCLE 'A'



SECTION A–A



ENLARGEMENT OF CIRCLE 'B'



SECTION B–B

TABLE A

Dimension	Tolerance	Specification
N	j6	IS : 2223
M	±0.3	
i	±1	

Dimension	Tolerance		Specification
D,DA	j6	11,14,19,24,28Ø	IS : 1231
	k6	38Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

① Without Eye bolt
- Also suitable for V19 & V18 mounting as per IS 2253
- Key / key way fit : h9 / N9
- Double shaft extension can be provided with shaft dimension identical to D.E. shaft

** Minimum distance for efficient cooling of motor to be maintained by user

All Dimensions are in mm unless otherwise specified.

CAT-C-6313-4-1

*Refer TABLE A for tolerances

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Standard TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 90s to 355L

Applicable standard for testing: IS 4029
Applicable standard for efficiency determination: IS 4889

Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

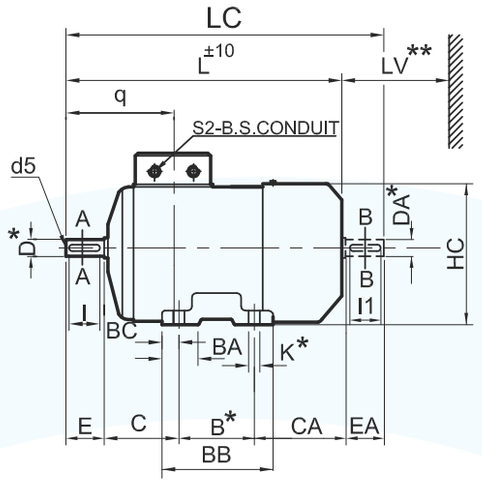
Ambient : 50° C
Duty : S1(Continuous)
750 rpm (8-Pole)

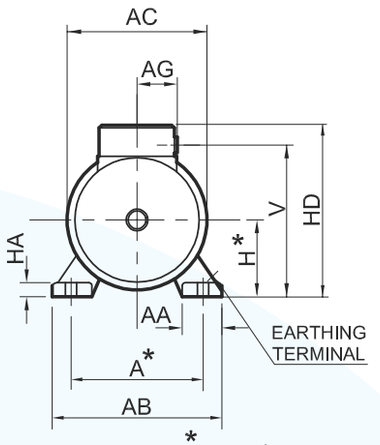
Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size	Type ref	Rated Speed RPM	Rated Current Amps	Rated Torque Kg.m	Operating Characteristics at Rated output						With DOL Starting			Rotor GD² kgm²	Net Weight Kg
								Power Factor			% Efficiency		Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio	Pullout Torque to Rated Torque Ratio		
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
0.37	0.50	90S	MH09S813	700	1.22	0.51	0.63	0.52	0.41	66.8	60.0	52.0	2.7	1.8	2.1	0.0110	11
0.55	0.75	90L	MH09L853	690	1.71	0.78	0.63	0.53	0.43	71.1	67.0	62.0	2.9	2.0	2.4	0.0140	14
0.75	1.0	100L	MH10L813	685	1.94	1.07	0.73	0.63	0.50	73.8	73.8	67.0	3.0	1.7	2.0	0.0230	18
1.1	1.5	100L	MH10L833	690	2.83	1.55	0.71	0.62	0.48	76.2	76.2	73.0	3.3	1.9	2.3	0.0270	21
1.5	2.0	112M	MH11M813	705	3.83	2.07	0.70	0.62	0.50	77.9	77.9	75.0	3.8	1.7	2.2	0.0510	25
2.2	3.0	132S	MH13S8B3	705	4.87	3.04	0.78	0.74	0.64	80.5	80.0	76.0	3.5	1.8	2.3	0.0990	57
3.7	5.0	160M	MH16M813	720	7.95	5.01	0.78	0.74	0.65	83.0	83.0	78.0	4.4	1.8	2.0	0.217	88
5.5	7.5	160M	MH16M833	720	11.5	7.44	0.78	0.74	0.65	85.1	85.1	82.0	4.8	1.9	2.2	0.299	101
7.5	10	160L	MH16L873	715	15.5	10.2	0.78	0.74	0.65	86.4	86.4	84.0	5.5	2.1	2.2	0.400	119
9.3	12.5	180M	MH18M813	720	18.8	12.6	0.79	0.74	0.64	87.3	87.3	85.0	5.0	2.1	2.2	0.620	177
11	15	180L	MH18L833	720	22.0	14.9	0.79	0.74	0.64	88.1	88.1	87.0	5.0	2.1	2.2	0.720	182
15	20	200L	MH20L833	720	28.6	20.3	0.82	0.79	0.71	89.0	89.0	88.0	6.0	2.5	2.3	1.32	282
18.5	25	225S	MH22S823	725	36.3	24.9	0.79	0.77	0.69	89.8	89.8	88.0	5.5	2.1	2.2	2.10	329
22	30	225M	MH22M833	725	43.0	29.6	0.79	0.77	0.69	90.2	90.2	88.0	5.5	2.1	2.2	2.41	369
30	40	250M	MH25M813	730	55.6	40.0	0.82	0.78	0.68	91.5	91.5	89.0	6.0	2.5	2.2	3.72	472
37	50	280S	MH28S823	730	70.8	49.4	0.79	0.75	0.65	92.0	92.0	90.0	5.5	2.2	2.2	5.83	615
45	60	280M	MH28M853	730	85.8	60.0	0.79	0.75	0.65	92.4	92.4	90.0	5.5	2.2	2.2	6.86	665
55	75	315S	MH31S813	740	105	72.4	0.78	0.73	0.64	93.0	92.5	90.5	5.5	2.1	2.4	10.7	912
75	100	315M	MH31M833	740	143	98.7	0.78	0.73	0.64	93.5	93.5	92.0	5.5	2.1	2.4	12.4	912
90	120	315M	MH31M853	740	171	118	0.78	0.73	0.65	94.0	94.0	93.0	5.5	2.1	2.4	15.5	1010
110	150	315L	MH31L873	740	208	145	0.78	0.73	0.64	94.3	94.0	93.0	5.5	2.1	2.4	18.0	1170
125	170	315L	MH31L8A3	740	236	165	0.78	0.73	0.64	94.6	94.4	93.6	5.5	2.1	2.4	21.5	1340
132	180	315L	MH31L893	740	248	174	0.78	0.73	0.64	94.8	94.7	94.0	5.5	2.1	2.4	21.5	1340
150	200	355L	MH35L8A3	740	282	197	0.78	0.70	0.60	95.0	95.0	93.0	5.5	1.8	2.2	28.7	1670
160	215	355L	MH35L813	740	300	211	0.78	0.70	0.60	95.0	95.0	93.0	5.5	1.8	2.2	28.7	1670
180	240	355L	MH35L8B3	740	337	237	0.78	0.70	0.60	95.2	95.2	93.2	5.5	1.8	2.2	35.5	1780
200	270	355L	MH35L833	740	374	263	0.78	0.70	0.60	95.3	95.3	93.3	5.5	1.8	2.2	35.5	1780

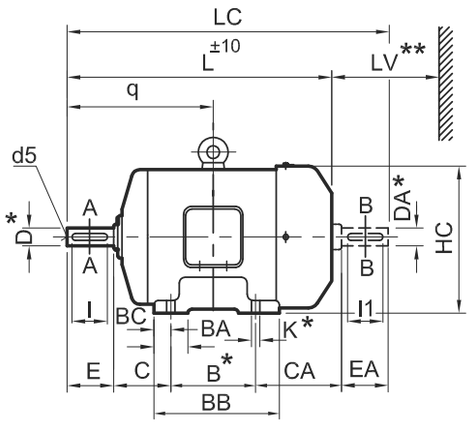
Note :
All performance values are subject to tolerance as per IS/IEC 60034-1
Efficiency measurements are without seals.
Ratings above 200kW/8P upto 630kW/8P are available in Frame 400 & 450. For details contact our sales office.

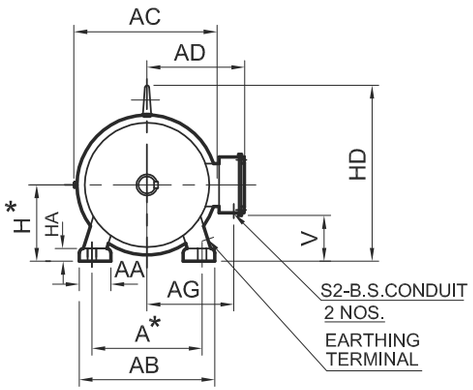
Dimensional Drawing: Industrial Motors Type MH Foot Mounted (B3) TEFC series Frame 90S-355L



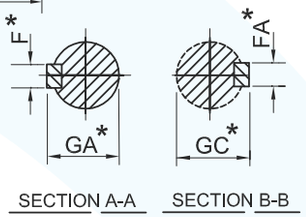


FRAME SIZE 90S TO 132S

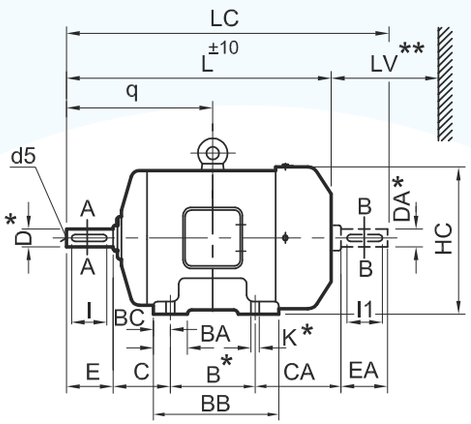


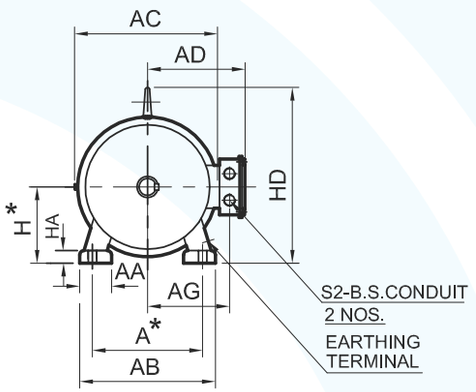


FRAME SIZE 160M TO 180L



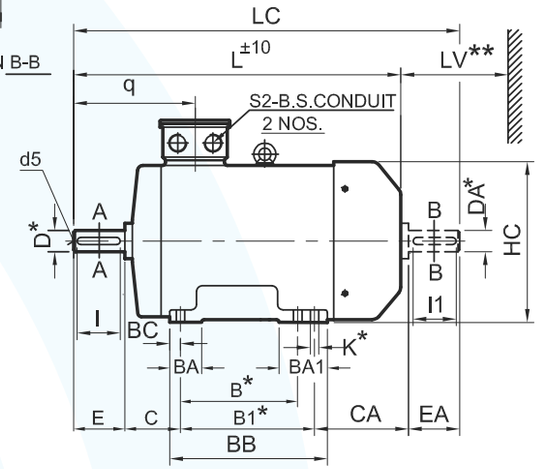
SECTION A-A SECTION B-B

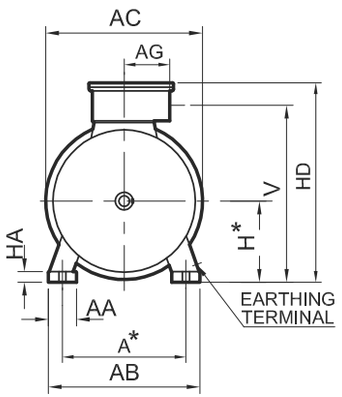




FRAME SIZE 200L TO 225M

* Refer TABLE A for tolerances





FRAME SIZE 250M TO 355L

CAT-C-9035-3-1

Dimensional Details: Industrial Motors Type MH Foot Mounted (B3) TEFC series Frame 90S-355L

		FIXING						GENERAL														TERMINAL BOX				SHAFT					
IEC Fr. size	Pole	A*	B*	B1*	C	H*	K*	AB	BB	AA	BA	BA1	BC	HA	HC	HD	AD	L	LC	CA	AC	LV**	V	q	AG	S2 B.S.C.	D,DA*	E EA	F* FA*	GA* GC*	I I1	d5
90S	8	140	100	—	56	90	10	168	125	34	31.5	—	18	12	177	230	-	302	374	118	174	35	199	139	52	3/4"	24	50	8	27	45	M8
90L	8		125						150									327	399					153								
100L	8	160	140	—	63	100	12	190	174	43.5	36	—	21	12	198	257	-	366	448	125	192	40	225	152	56	1"	28	60	8	31	55	M10
112M	8	190	140	—	70	112	12	220	174	47	36	—	21	12	222	282	-	388	471	141	220	45	249	157	56	1"	28	60	8	31	55	M10
132S	8	216	140	—	89	132	12	256	180	64	50	—	23	17	262	338	-	459	561	172	260	50	299	196	63	1"	38	80	10	41	70	M12
160M	8	254	254	—	108	160	15	310	294	58	70	—	23	20	318	366	226	585	721	183	316	60	98	323	186	1"	42	110	12	45	105	M16
160L	8																	629	765	183				345								
180M	8	279	241	—	121	180	15	344	281	65	70	—	23	26	357	412	265	679	799	217	354	70	83	352	216	1 1/2"	48	110	14	51.5	100	M16
180L	8		279						319									717	838	218				371								
200L	8	318	305	—	133	200	19	398	355	85	85	—	28	32	397	462	319	772	897	239	394	80	—	396	249	2"	55	110	16	59	100	M20
225M	8	356	311	—	149	225	19	436	361	85	85	—	28	34	450	509	344	827	976	231	450	90	—	445	273	2"	60	140	18	64	130	M20
250M	8	406	349	—	168	250	24	506	425	100	115	—	49	42	495	665	—	914	1065	268	489	100	578	352	243	2"	65	140	18	69	130	M20
280S/M	8	457	368	419	190	280	24	540	490	100	110	149	40	42	552	725	—	1010	1160	271	544	115	638	360	243	2"	75	140	20	79.5	130	M20
315S/M	8	508	406	457	216	315	28	625	540	120	120	155	46	45	600	830	—	1167	1353	340	600	130	728	416	278	2"	80	170	22	85	160	M20
315L	8		508	—					593	120	120	—	46					1332	1518	454				416		2 1/2"	80	170	22	85	160	
355L	8	610	630	—	254	355	28	710	770	110	170	—	73	45	693	939	—	1491	1682	458	685	145	850	464	403	3"	95	170	25	100	160	M24

TABLE A

Dimension	Tolerance		Specification
A,B	±0.75		
H	-0.5	UPTO 280	IS : 1231
	-1	OVER 280	
K	+0.360	10Ø	
	+0.430	12,15Ø	
	+0.520	19,24,28Ø	

Dimension	Tolerance		Specification
D,DA	j6	24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

- Double shaft extension can be provided with shaft dimension identical to DE shaft.
- Also suitable for B6,B7,B8,V5 & V6 mounting as per IS 2253.
- ** Minimum distance for efficient cooling of motor to be maintained by user
- ① Without Eye bolt
- Key / key way fit : h9 / N9

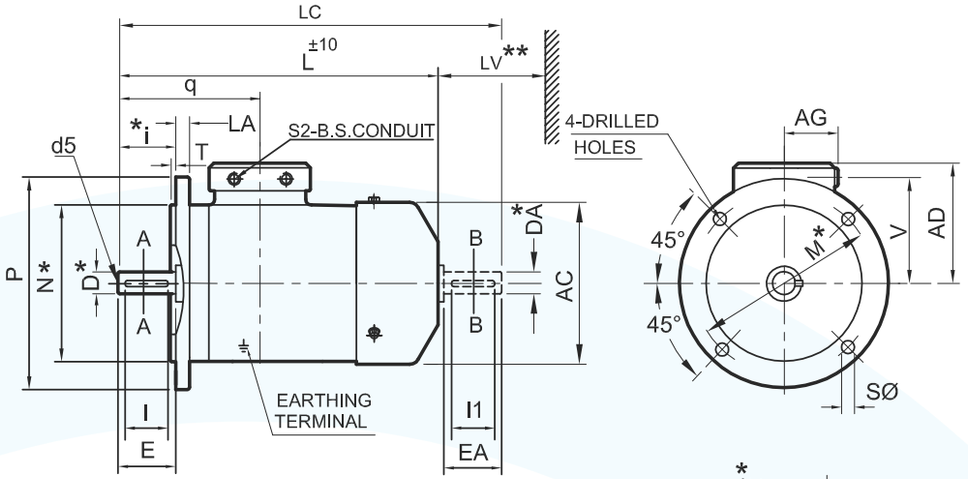
Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

*Refer TABLE A for tolerances

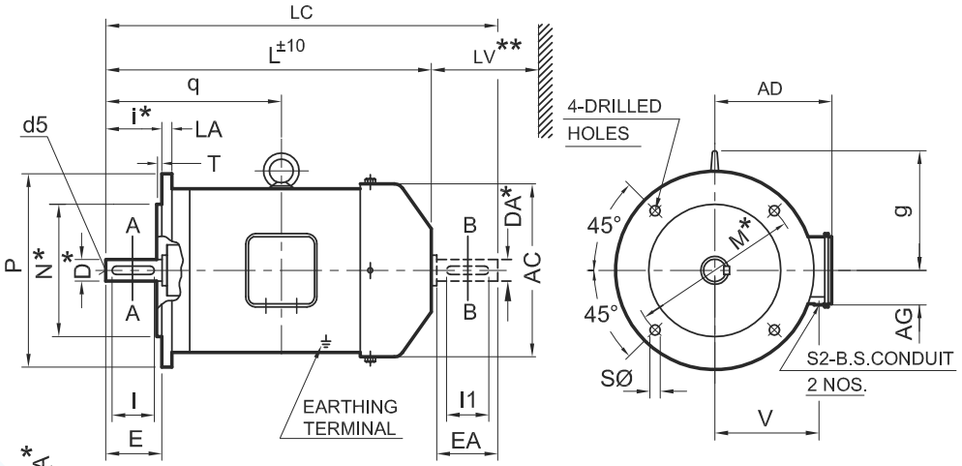
All Dimensions are in mm unless otherwise specified.

CAT-A-9035-3-2

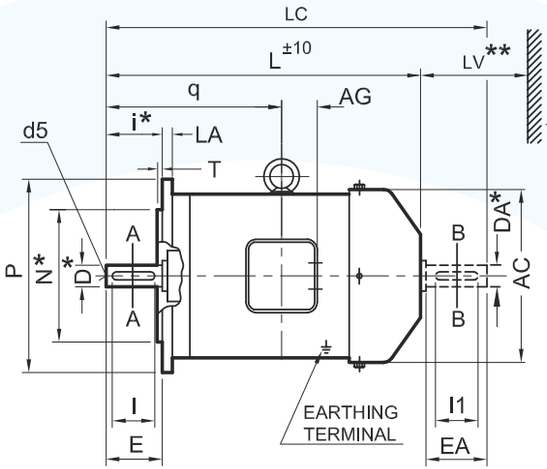
Dimensional Drawing: Industrial Motors Type MH Flange Mounted (B5) TEFC series Frame 90S-355L

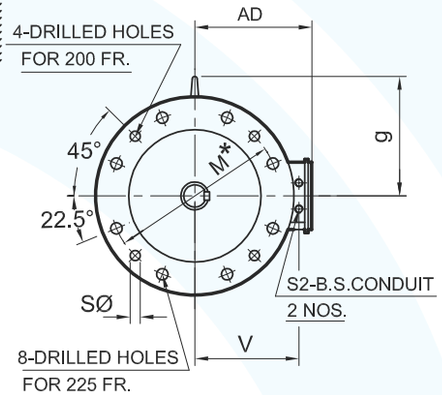


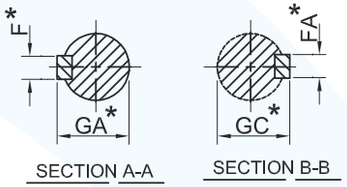
FRAME SIZE 90S TO 132S



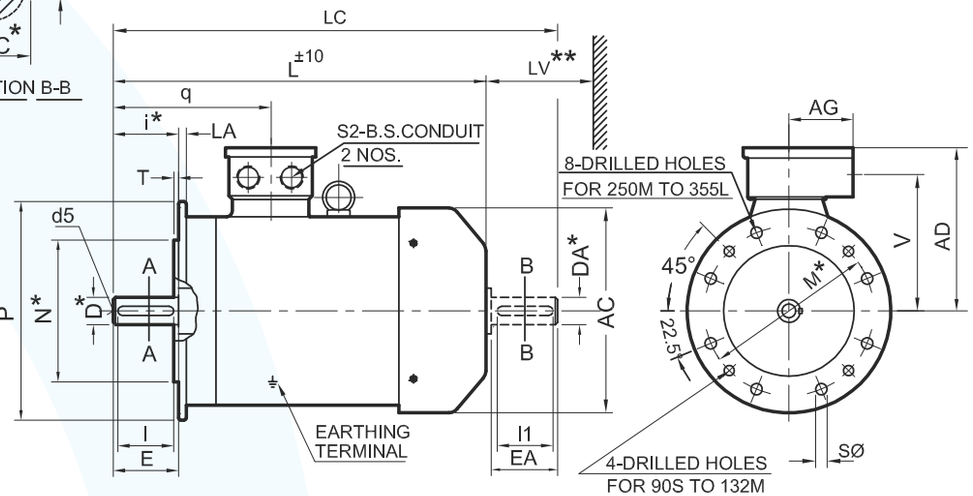
FRAME SIZE 160M TO 180L







FRAME SIZE 200L TO 225M



FRAME SIZE 250M TO 355L

* Refer TABLE A for tolerances

CAT-C-9035-5-1

Dimensional Details: Industrial Motors Type MH Flange Mounted (B5) TEFC series Frame 90S-355L

		FIXING					GENERAL								TERMINAL BOX				SHAFT					
IEC Fr. size	Pole	P	N*	M*	i*	S	T	LA	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D,DA* *	E EA	F* FA*	GA* GC*	l l1	d5
90S	8	200	130	165	50	12	3.5	10	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	8										327	399				153								
100L	8	250	180	215	60	15	4	11	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	8	250	180	215	60	15	4	11	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	8	300	230	265	80	15	4	12	206	260	459	561	50	-	167	196	63	1"	38	80	10	41	70	M12
160M	8	350	250	300	110	19	5	13	226	316	585	721	60	206	186	323	63	1"	42	110	12	45	105	M16
160L	8										629	765				345								
180M	8	350	250	300	110	19	5	13	265	354	679	799	70	232	216	352	97	1 1/2"	48	110	14	51.5	100	M16
180L	8										717	838				371								
200L	8	400	300	350	110	19	5	15	319	394	772	897	80	262	249	396	172	2"	55	110	16	59	100	M20
225M	8	450	350	400	140	19	5	16	344	450	827	976	90	284	273	445	172	2"	60	140	18	64	130	M20
250M	8	550	450	500	140	19	5	18	415	489	914	1065	100	—	328	352	243	2"	65	140	18	69	130	M20
280S/M	8	550	450	500	140	19	5	18	445	544	1010	1160	115	—	358	360	243	2"	75	140	20	79.5	130	M20
315S/M	8	660	550	600	170	24	6	22	515	600	1167	1353	130	—	413	416	278	2"	80	170	22	85	160	M20
315L	8				170						1332	1518				416		2 1/2"	80	170	22	85	160	
355L	8	800	680	740	170	24	6	25	584	690	1491	1682	145	—	495	464	403	3"	95	170	25	100	160	M24

TABLE A

Dimension	Tolerance		Specification
N	j6	UPTO 450	IS : 2223
	js6	OVER 450	
M	±0.3	UPTO 265	
	±0.5	OVER 265	
i	±1	UPTO 85	
	±1.5	OVER 85	

Dimension	Tolerance		Specification
D,DA	j6	24,28Ø	IS : 1231
	k6	38,42,48Ø	
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

① Without Eye bolt

** Minimum distance for efficient cooling of motor to be maintained by user

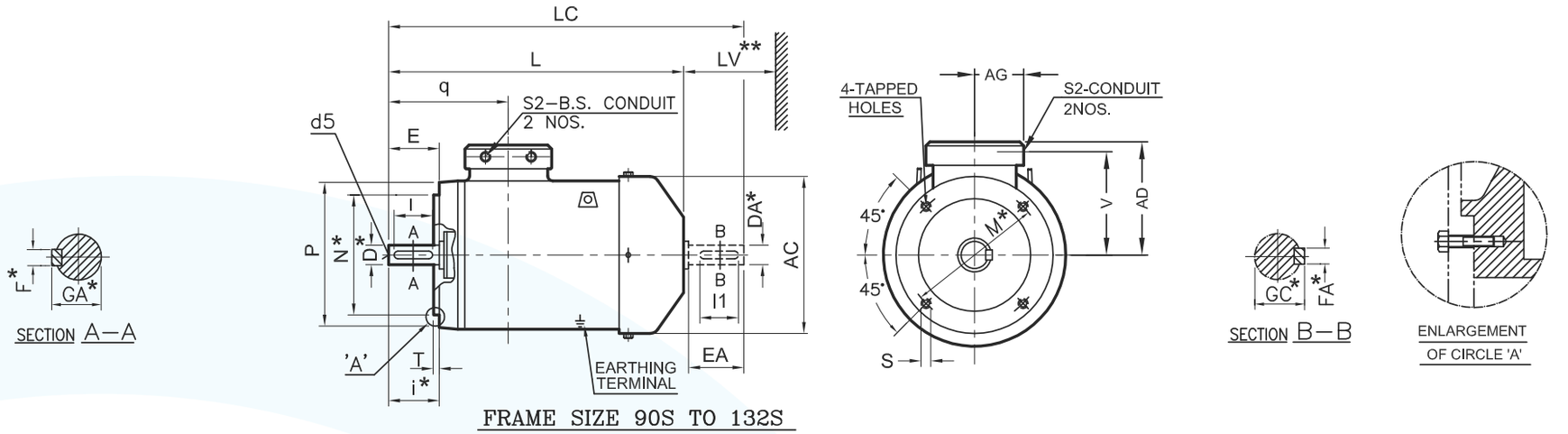
- Double shaft extension can be provided with shaft dimension identical to D.E.shaft
- Also suitable for V1 & V3 mounting as per IS 2253
- Key / key way fit : h9 / N9
- 8 Nos. Fixing Holes from 225S/M frame onwards

All Dimensions are in mm unless otherwise specified.

CAT-A-9035-5-2

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Dimensional Details: Industrial Motors Type MH Face Mounted (B14) TEFC series Frame 90S-132S



FRAME SIZE 90S TO 132S

	FIXING						GENERAL						TERMINAL BOX				SHAFT					
IEC Fr. size	Pole	P	N*	M*	i*	S	T	AD	AC	L	LC	LV**	g	V	q	AG	S2 B.S.C.	D* DA*	E EA	F* FA*	GA* GC*	I I1	d5
90S	8	140	95	115	50	M8X12	3	140	174	302	374	35	①	109	139	52	3/4"	24	50	8	27	45	M8
90L	8									327	399				153								
100L	8	160	110	130	60	M8X12	3.5	157	195	366	448	40	-	125	152	56	1"	28	60	8	31	55	M10
112M	8	160	110	130	60	M8X12	3.5	170	220	388	471	45	-	137	157	56	1"	28	60	8	31	55	M10
132S	8	250	180	215	80	M12X20	4	206	260	459	561	50	-	167	196	63	1"	38	80	10	41	70	M12

TABLE A

Dimension	Tolerance	Specification
N	j6	IS : 2223
M	±0.3	
i	±1	

Dimension	Tolerance		Specification
D,DA	j6	24,28Ø	IS : 1231
	k6	38Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

① Without Eye bolt
- Also suitable for V19 & V18 mounting as per IS 2253
- Key / key way fit : h9 / N9
- Double shaft extension can be provided with shaft dimension identical to D.E. shaft

** Minimum distance for efficient cooling of motor to be maintained by user

All Dimensions are in mm unless otherwise specified.

CAT-C-9013-4-1

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Need for premium efficiency motors

Ever increasing energy costs and increasing concerns about environment are the main focus areas across the globe.

Electric motors consume about 65-70% of electrical energy used in the industry. Therefore, improvement in motor efficiency will result in significant reduction in energy consumption.

Purchase cost and running cost of motor

Purchase cost of the motor is insignificant when compared to the running cost of the motor over a period of 20 years. This can be seen in the table below:

	IE3	IE1
Power Rating (kW)	37	
Purchase Cost of Motor (Rs.)	104200	77260
Motor Efficiency	93.90%	91.20%
Per Hour kW Consumption	39.40	40.57
Annual running Hours (24Hrs X 313 Days)	7500	7500
Power Consumption/Annum (kW)	295527	304276
Average energy cost(Rs./kWH)	7	7
Average energy cost /annum	2068690	2129934
Annual Saving(Rs.)	61244	
Payback period for added cost	5.3 months	
Total Saving Over Motor's 20 year Life(Rs.)	1224882 (Approximately 11.75 times of motor purchase cost)	

Reducing energy costs is one way organizations can cut their overheads to remain competitive. Significant savings can be made by installing energy efficient motors either new installations or equipment packages, replacing oversized and under-loaded motors, making major modifications to facilities or processes, or instead of repairing or rewinding a failed motor.

IE3 Efficiency class of motors from Bharat Bijlee:

Bharat Bijlee's new IE3 efficiency class of motors is an improvement over IE2 efficiency class of motors. An energy efficient solution to save energy, these motors is designed for loss reduction of 15-20 % over IE2 efficiency class of motors. Therefore the energy saving by using these motors is much higher when compared to IE1 class of efficiency motors running in the plant. Upgradation to IE3 motors is smooth and easy since the frame size is same and there is no change in mandatory mounting dimensions, shaft diameter and shaft extension length.

Advantages:

- High Efficiency
- Inverter Grade Winding
- Optimized ventilation system for cooler operation and reduced Noise
- Reduced Vibration Levels
- Highly reliable under most demanding conditions
- Reduced Life Cycle Cost

Standards compliance:

These motors comply with the latest efficiency standards and requirements of IS:12615-2011 and IEC 60034-30. Bharat Bijlee closely follows the developments in the global regulatory environments and develops the product complying with these requirements.

Efficiency values defined in IEC 60034-30

	2 POLE			4 POLE			6 POLE		
kW	IE1	IE2	IE3	IE1	IE2	IE3	IE1	IE2	IE3
0.75	72.1	77.4	80.7	72.1	79.6	82.5	70.0	75.9	78.9
1.1	75.0	79.6	82.7	75.0	81.4	84.1	72.9	78.1	81.0
1.5	77.2	81.3	84.2	77.2	82.8	85.3	75.2	79.8	82.5
2.2	79.7	83.2	85.9	79.7	84.3	86.7	77.7	81.8	84.3
3	81.5	84.6	87.1	81.5	85.5	87.7	79.7	83.3	85.6
4	83.1	85.8	88.1	83.1	86.6	88.6	81.4	84.6	86.8
5.5	84.7	87.0	89.2	84.7	87.7	89.6	83.1	86.0	88.0
7.5	86.0	88.1	90.1	86.0	88.7	90.4	84.7	87.2	89.1
11	87.6	89.4	91.2	87.6	89.8	91.4	86.4	88.7	90.3
15	88.7	90.3	91.9	88.7	90.6	92.1	87.7	89.7	91.2
18.5	89.3	90.9	92.4	89.3	91.2	92.6	88.6	90.4	91.7
22	89.9	91.3	92.7	89.9	91.6	93.0	89.2	90.9	92.2
30	90.7	92.0	93.3	90.7	92.3	93.6	90.2	91.7	92.9
37	91.2	92.5	93.7	91.2	92.7	93.9	90.8	92.2	93.3
45	91.7	92.9	94.0	91.7	93.1	94.2	91.4	92.7	93.7
55	92.1	93.2	94.3	92.1	93.5	94.6	91.9	93.1	94.1
75	92.7	93.8	94.7	92.7	94.0	95.0	92.6	93.7	94.6
90	93.0	94.1	95.0	93.0	94.2	95.2	92.9	94.0	94.9
110	93.3	94.3	95.2	93.3	94.5	95.4	93.3	94.3	95.1
132	93.5	94.6	95.4	93.5	94.7	95.6	93.5	94.6	95.4
160	93.8	94.8	95.6	93.8	94.9	95.8	93.8	94.8	95.6
200	94.0	95.0	95.8	94.0	95.1	96.0	94.0	95.0	95.8
250	94.0	95.0	95.8	94.0	95.1	96.0	94.0	95.0	95.8
315	94.0	95.0	95.8	94.0	95.1	96.0	94.0	95.0	95.8
355	94.0	95.0	95.8	94.0	95.1	96.0	94.0	95.0	95.8
375	94.0	95.0	95.8	94.0	95.1	96.0	94.0	95.0	95.8

Range and Standard features:

Range in kW	0.75kW to 315kW*
Polarity	2P, 4P & 6P
Frame size	80 to 355L
Insulation	Class F, temperature rise limited to class B
Supply condition	415V+/ -10%, 50Hz +/-5%
Ambient temperature	50 deg C
Protection	IP 55
Mounting	B3 & B5 (Dual mounting hole)
Re greasing facility	From 225 frame and onwards

* Contact sales office for rating above 315 kW.

Optional features available

- Frequency 60Hz
- Voltages from 220V to 690V
- Class H insulation
- Re-greasing facility from frame 180 and above
- Roller bearings at DE from frame 180 and above
- Insulated Bearings at NDE from frame 160 and above
- Forced cooling arrangement / Encoder Mounting from frame 250 and above
- RTD, Thermistor in the winding
- BTD on the bearings from frame 250 and above
- Space Heaters
- Larger Size Terminal Box
- Non Standard Shaft Extension

Bearing Details for IE3 Motors

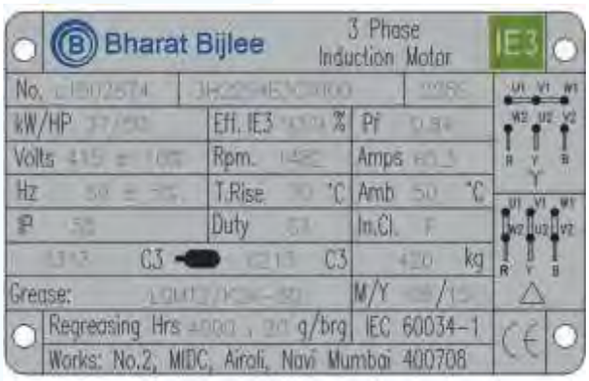
		Standard design		Optional
		Deep groove ball bearing		Roller bearings
Frame Size	Number of Poles	Drive end	Non-drive end	Drive end
80	2,4&6	6204 2ZC3	6204 2ZC3	-
90	2,4&6	6205 2ZC3	6205 2ZC3	-
100	2,4&6	6206 2ZC3	6205 2ZC3	-
112	2,4&6	6206 2ZC3	6205 2ZC3	-
132	2,4&6	6208 2ZC3	6208 2ZC3	-
160	2,4&6	6309 2ZC3	6209 2ZC3	-
180	2,4&6	6310 2ZC3	6210 2ZC3	NU310
200	2,4&6	6312 2ZC3	6212 2ZC3	NU312
225	2,4&6	6313 C3	6213 C3	NU313
250	2,4&6	6315 C3	6215 C3	NU315
280	2	6316 C3	6316 C3	NU316
	4&6	6317 C3	6316 C3	NU317
315	2,4&6	6319 C3	6319 C3	NU319
355	4&6	6322 C3	6322 C3	NU322

Standard design of Bearings

Frame Size	Bearing Drive end	Bearing Non-drive end
132...225	Locating bearing	Non-locating bearing
250...355	Non-locating bearing	Locating bearing

Terminal Box Details

Frame Size	Terminal box position	No of terminals	Terminal bolt size	Max. conductor cross section (mm^2)	Hole for cable entry (BSC)
80	Top	6	M4	4	3/4"
90	Top	6	M4	4	3/4"
100	Top	6	M4	10	1"
112	Top	6	M4	10	1"
132	Top	6	M5	16	1"
160	Top	6	M5	16	1"
180	Top	6	M6	35	1"
200	Top	6	M8	50	1-1/4"
225	Top	6	M8	50	1-1/4"
250	Top	6	M10	150	2"
280	Top	6	M10	150	2"
315	Top	6	M12	240	2-1/2"
355	Top	6	M16	300	3"



TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 355L

Applicable standard for testing & efficiency determination: IS 15999
Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient: : 50 °C
Duty : S1 (Continuous)

3000 rpm (2-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size	Rated Speed	Rated Current	Rated Torque	Operating Characteristics at Rated output						With DOL Starting			Rotor GD²	motor weight
						Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio	Pullout Torque to Rated Torque Ratio		
kW	HP	IEC	RPM	Amps.	Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L				kgm²	kg
0.75	1	80	2840	1.54	0.26	0.84	0.80	0.68	80.7	80.7	78.0	6.0	3.0	3.5	0.009	17
1.1	1.5	80	2840	2.20	0.38	0.84	0.80	0.68	82.7	82.7	80.0	6.0	3.0	3.5	0.011	18
1.5	2	90S	2885	2.88	0.51	0.86	0.81	0.70	84.2	84.2	83.2	6.5	3.0	3.3	0.013	25
2.2	3	90L	2885	4.10	0.74	0.87	0.83	0.75	85.9	85.9	85.9	6.5	3.0	3.3	0.016	27
3.7	5	100L	2890	6.74	1.25	0.87	0.82	0.70	87.8	87.8	87.3	6.5	3.0	3.3	0.021	37
5.5	7.5	132S	2960	9.86	1.81	0.87	0.84	0.75	89.2	89.2	87.8	6.5	2.3	3.0	0.134	79
7.5	10	132S	2960	13.3	2.47	0.87	0.84	0.75	90.1	90.1	88.7	6.5	2.3	3.0	0.150	82
9.3	12.5	160M	2945	16.6	3.08	0.86	0.83	0.76	90.7	90.7	88.7	6.5	2.5	3.0	0.190	120
11	15	160M	2945	19.5	3.64	0.86	0.83	0.76	91.2	91.2	89.2	6.5	2.5	3.0	0.220	127
15	20	160M	2945	26.1	4.96	0.87	0.84	0.77	91.9	91.9	90.0	6.5	2.5	3.0	0.300	144
18.5	25	160L	2945	31.7	6.12	0.88	0.86	0.79	92.4	92.4	90.8	6.5	2.5	3.0	0.374	161
22	30	180M	2960	37.5	7.24	0.88	0.84	0.78	92.7	92.7	91.0	6.5	2.6	3.0	0.500	192
30	40	200L	2970	51.4	9.84	0.87	0.85	0.79	93.3	93.3	91.5	6.5	2.2	2.8	0.910	306
37	50	200L	2970	63.1	12.1	0.87	0.85	0.79	93.7	93.7	92.0	6.5	2.2	2.8	1.13	315
45	60	225M	2970	74.0	14.8	0.90	0.88	0.82	94.0	94.0	93.0	6.6	2.1	2.7	2.11	475
55	75	250M	2970	91.2	18.0	0.89	0.86	0.80	94.3	94.3	93.0	6.5	2.4	2.8	2.60	550
75	100	280S	2970	121	24.6	0.91	0.89	0.86	94.7	94.7	92.7	7.0	2.0	2.7	3.08	675
90	120	280M	2970	145	29.5	0.91	0.89	0.86	95.0	95.0	93.0	7.0	2.0	2.7	3.69	760
110	150	315S	2985	183	35.9	0.88	0.86	SA	95.2	95.2	93.2	7.0	2.4	2.7	5.00	940
132	180	315M	2985	219	43.1	0.88	0.86	0.80	95.4	95.4	93.4	7.0	2.4	2.7	6.20	1100
150	200	315L	2985	248	48.9	0.88	0.86	0.80	95.5	95.5	93.5	7.0	2.4	2.7	7.70	1390
160	215	315L	2985	265	52.2	0.88	0.86	0.80	95.6	95.6	93.6	7.0	2.4	2.7	7.70	1390
180	240	355L	2987	284	58.7	0.92	0.89	0.86	95.7	95.7	93.7	7.0	1.8	2.4	12.0	1680
200	270	355L	2988	316	65.2	0.92	0.89	0.84	95.8	95.8	93.8	7.0	2.0	2.5	12.0	1680
225	335	355L	2987	355	73.4	0.92	0.89	0.84	95.8	95.8	93.8	6.5	1.8	2.4	12.0	1680
250	335	355L	2988	395	81.5	0.92	0.90	0.86	95.8	95.8	93.8	7.0	2.0	2.5	14.7	1870
280	375	355L	2987	442	91.3	0.92	0.90	0.86	95.8	95.8	93.8	6.5	1.8	2.4	14.7	1870

Note : Efficiency class 'IE3' will be punched on the nameplate as per IS:12615-2011
All perfromance values are subject to tolerance as per IS/IEC 60034-1

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 355L

Applicable standard for testing & efficiency determination: IS 15999
Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

Ambient: : 50 °C
Duty : S1(Continuous)
1500 rpm (4-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size	Rated Speed	Rated Current	Rated Torque	Operating Characteristics at Rated output						With DOL Starting			Rotor GD²	motor weight
						Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio	Pullout Torque to Rated Torque Ratio		
kW	HP	IEC	RPM	Amps.	Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L				kgm²	kg
0.75	1	80.00	1430	1.62	0.51	0.78	0.74	0.60	82.5	82.5	82.5	5.0	2.6	2.8	0.015	19
1.1	1.5	90S	1425	2.22	0.75	0.82	0.78	0.68	84.1	84.1	84.1	5.5	2.8	3.3	0.017	24
1.5	2	90L	1425	2.98	1.03	0.82	0.78	0.68	85.3	85.3	85.3	5.5	2.8	3.3	0.023	28
2.2	3	100L	1440	4.53	1.49	0.78	0.74	0.60	86.7	86.7	85.8	6.0	2.5	3.0	0.028	35
3.7	5	112M	1455	7.28	2.48	0.80	0.74	0.60	88.4	88.4	86.5	6.5	3.0	3.5	0.066	49
5.5	7.5	132S	1470	10.4	3.64	0.82	0.78	0.68	89.6	89.6	89.0	6.5	2.6	3.0	0.141	75
7.5	10	132M	1470	13.9	4.97	0.83	0.78	0.68	90.4	90.4	90.4	6.5	2.6	3.3	0.193	87
9.3	12.5	160M	1470	17.3	6.16	0.82	0.77	0.68	91.0	91.0	90.0	6.5	2.7	3.2	0.340	124
11	15	160M	1470	20.4	7.29	0.82	0.77	0.68	91.4	91.4	90.8	6.5	2.7	3.2	0.375	135
15	20	160L	1470	27.3	9.94	0.83	0.78	0.70	92.1	92.1	91.1	6.5	2.7	3.2	0.520	153
18.5	25.0	180M	1470	31.9	12.3	0.87	0.84	0.76	92.6	92.6	92.0	6.5	2.5	3.0	0.750	200
22	30	180L	1470	37.8	14.6	0.87	0.84	0.76	93.0	93.0	92.5	6.5	2.5	3.0	0.860	220
30	40	200L	1475	51.3	19.8	0.87	0.84	0.77	93.6	93.6	91.5	6.5	2.6	3.0	1.38	295
37	50	225S	1482	66.0	24.3	0.83	0.80	0.74	93.9	93.9	93.4	6.0	2.0	2.6	2.30	400
45	60	225M	1482	80.1	29.6	0.83	0.80	0.74	94.2	94.2	93.6	6.0	2.0	2.6	2.83	430
55	75	250M	1480	96.3	36.2	0.84	0.80	0.72	94.6	94.6	93.8	6.0	2.0	2.6	3.06	500
75	100	280S	1485	128	49.2	0.86	0.82	0.74	95.0	95.0	94.5	6.5	2.5	3.0	5.53	670
90	120	280M	1485	153	59.0	0.86	0.82	0.74	95.2	95.2	95.0	6.5	2.5	3.0	6.36	735
110	150	315S	1488	189	72.0	0.85	0.82	0.74	95.4	95.4	93.9	6.8	2.5	3.0	11.7	965
132	180	315M	1488	226	86.4	0.85	0.82	0.74	95.6	95.6	94.1	6.8	2.5	3.0	14.0	1115
160	215	315L	1490	277	105	0.84	0.80	0.72	95.8	95.8	94.5	6.6	2.5	3.0	15.6	1225
180	240	315L	1491	311	118	0.84	0.80	0.72	95.9	95.9	94.6	6.6	2.7	3.0	17.8	1290
200	270	315L	1491	345	131	0.84	0.80	0.72	96.0	96.0	95.0	6.6	2.7	3.0	17.8	1290
225	300	355L	1490	375	147	0.87	0.83	0.72	96.0	96.0	95.0	6.0	1.7	2.4	23.3	1680
250	335	355L	1492	416	163	0.87	0.83	0.72	96.0	96.0	95.0	6.5	1.8	2.4	32.7	1855
315	422	355L	1492	525	206	0.87	0.83	0.72	96.0	96.0	95.0	6.5	1.8	2.4	37.9	2025

Note : Efficiency class 'IE3' will be punched on the nameplate as per IS:12615-2011
All perfromance values are subject to tolerance as per IS/IEC 60034-1

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 90 to 355L

Applicable standard for testing & efficiency determination: IS 15999
Voltage : 415V+/-10%
Frequency : 50Hz+/-5%
Combined Variation : +/-10%

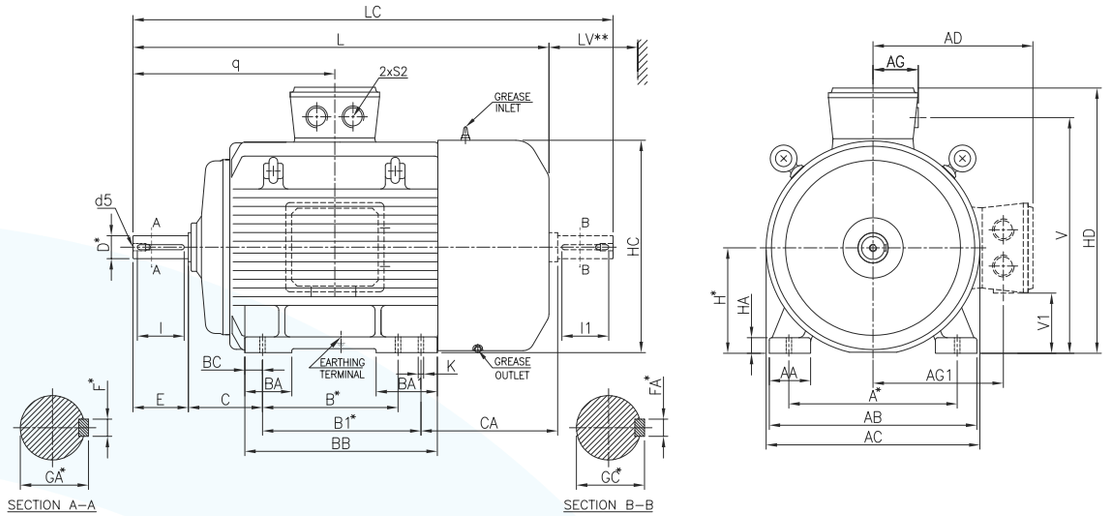
Ambient: : 50 °C
Duty : S1(Continuous)
1000 rpm (6-Pole)

Ins. Class : F
Temp. Rise : B
Protection : IP55

Rated Output		Frame size	Rated Speed	Rated Current	Rated Torque	Operating Characteristics at Rated output						With DOL Starting			Rotor GD²	motor weight
						Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio	Pullout Torque to Rated Torque Ratio		
kW	HP	IEC	RPM	Amps.	Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L				kgm²	kg
0.75	1	90S	945	1.84	0.77	0.72	0.62	0.52	78.9	78.9	78.9	4.0	2.1	2.5	0.017	25
1.1	1.5	90L	945	2.62	1.13	0.72	0.62	0.52	81.0	81.0	81.0	4.0	2.1	2.5	0.025	27
1.5	2	100L	935	3.51	1.56	0.72	0.62	0.54	82.5	82.5	82.5	4.5	2.3	2.5	0.029	36
2.2	3	112M	960	4.84	2.23	0.75	0.70	0.58	84.3	84.3	81.0	6.0	2.3	2.5	0.074	50
3.7	5	132S	965	7.44	3.73	0.80	0.75	0.64	86.5	86.5	86.5	5.0	1.8	2.3	0.202	72
5.5	7.5	132M	965	11.1	5.55	0.78	0.74	0.62	88.0	88.0	88.0	5.0	1.8	2.3	0.276	83
7.5	10	160M	970	14.6	7.53	0.80	0.76	0.68	89.1	89.1	89.1	5.5	2.5	3.0	0.450	125
9.3	12.5	160L	975	18.0	9.29	0.80	0.76	0.68	89.8	89.8	89.8	5.5	2.5	3.0	0.560	138
11	15	160L	975	21.2	11.0	0.80	0.76	0.68	90.3	90.3	90.3	5.5	2.5	3.0	0.646	145
15	20	180L	977	27.6	15.0	0.83	0.78	0.72	91.2	91.2	91.2	5.5	2.5	3.0	1.20	210
18.5	25	200L	977	32.3	18.4	0.87	0.83	0.75	91.7	91.7	91.5	6.5	2.6	3.2	1.81	295
22	30	200L	977	37.7	21.9	0.88	0.85	0.76	92.2	92.2	92.2	6.5	2.6	3.2	2.10	302
30	40	225M	984	51.1	29.7	0.88	0.84	0.77	92.9	92.9	92.5	6.5	3.0	3.5	3.51	410
37	50	250M	982	62.0	36.7	0.89	0.86	0.79	93.3	93.3	92.8	6.5	2.8	3.2	3.72	528
45	60	280S	984	78.6	44.5	0.85	0.80	0.72	93.7	93.7	92.9	6.0	2.6	3.2	5.11	573
55	75	280M	984	93.5	54.4	0.87	0.84	0.78	94.1	94.1	93.2	6.0	2.6	3.2	6.16	620
75	100	315S	992	130	73.6	0.85	0.82	0.72	94.6	94.6	93.6	6.0	2.5	3.0	10.7	830
90	120	315M	992	155	88.4	0.85	0.82	0.72	94.9	94.9	93.9	6.0	2.5	3.0	12.4	912
110	150	315M	992	189	108	0.85	0.82	0.72	95.1	95.1	94.2	6.0	2.5	3.0	15.5	1010
132	180	315L	992	229	130	0.84	0.80	0.72	95.4	95.4	94.4	6.0	2.5	3.0	18.0	1175
160	215	355L	990	277	157	0.84	0.81	0.71	95.6	95.6	93.0	6.0	2.0	2.5	28.7	1670
180	240	355L	990	319	177	0.82	0.78	0.66	95.7	95.7	94.0	6.0	2.0	2.5	28.7	1670
200	270	355L	991	346	197	0.84	0.80	0.70	95.8	95.8	94.1	6.0	2.0	2.5	35.5	1780
250	335	355L	991	432	246	0.84	0.80	0.70	95.8	95.8	94.1	6.0	2.0	2.5	43.3	1995

Note : Efficiency class 'IE3' will be punched on the nameplate as per IS:12615-2011
All perfromance values are subject to tolerance as per IS/IEC 60034-1

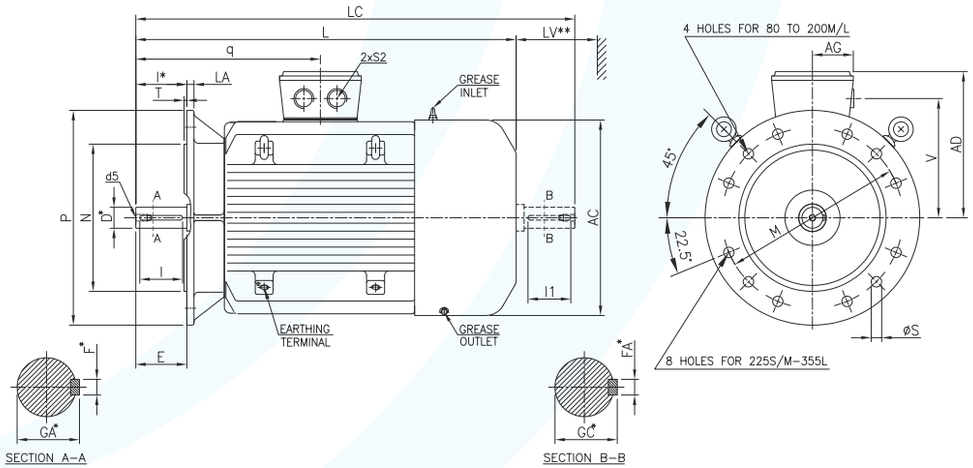
Dimensional Drawing: Industrial Motors Type 3H Foot Mounted (B3) TEFC (IE3) series Frame 80-355L



		FIXING						GENERAL														TERMINAL BOX						SHAFT					
IEC Fr. Size	Pole	A*	B*	B1*	C	H*	K*	AB	BB	AA	BA	BA1	BC	HA	HC	HD	AD	L	LC	CA	LV**	AC	V	q	AG	V1	AG1	S2 BSC	D* DA*	E EA	F* FA*	GA* GC*	I I1	d5
80	2,4&6	125	100	—	50	80	10	150	124	32	36	—	12	12	168	220	—	292	335	100	30	174	191	118	40	—	—	3/4"	19	40	6	21.5	35	M6
90S/L	2,4&6	140	100	125	56	90	10	168	150	34	38	61	12.5	12	188	240	—	355	410	129	35	195	209	138	52	—	—	3/4"	24	50	8	27	45	M8
100L	2&4 6	160	140	—	63	100	12	190	174	43.5	36	—	21	12	198	257	179	387 366	469 448	146 125	40	195	225	152	56	66	138	1"	28	60	8	31	55	M10
112M	4&6	190	140	—	70	112	12	220	174	47	36	—	21	12	222	282	191	419	502	172	45	220	249	157	56	80	151	1"	28	60	8	31	55	M10
132S/M	2,4&6	216	140	178	89	132	12	256	218	50	53	91	20	17	279	340	208	533	618	191	50	294	305	204	63	69	173	1"	38	80	10	41	70	M12
160M/L	2,4&6	254	210	254	108	160	15	310	294	58	70	105	20	20	334	398	238	673	790	208	60	348	363	345	63	97	203	1"	42	110	12	45	105	M16
180M/L	2,4&6	279	241	279	121	180	15	344	319	65	70	108	20	26	377	470	290	728	845	225	70	394	414	371	97	83	234	1 1/2"	48	110	14	51.5	100	M16
200M/L	2,4&6	318	267	305	133	200	19	398	355	85	85	120	25	32	419	536	336	803	920	262	80	438	468	396	155	—	268	2"	55	110	16	59	100	M20
225S/M	2 4&6	356	286	311	149	225	19	437	361	85	85	85	25	34	461	579	354	855 885	972 1032	292	90	472	511	445	155	—	286	2"	55 60	110 140	16 18	59 64	100 130	M20
250M	2 4&6	406	349	—	168	250	24	506	425	100	115	—	49	42	495	665	415	983 914	1134 1065	337 268	100	489	578	352	243	—	328	2"	60 65	140 140	18 18	64 69	130 130	M20
280S/M	2 4&6	457	368	419	190	280	24	540	490	100	110	149	40	42	552	725	445	1010	1160	271	115	544	638	360	243	—	358	2"	65 75	140 140	18 20	69 79.5	130 130	M20
315S/M	2 4&6	508	406	457	216	315	28	625	540	120	120	155	46	45	615	830	515	1137 1167	1293 1353	240	130	604	728	386 416	278	—	413	2"	65 80	140 170	18 22	69 85	130 160	M20
315L	2 4&6	508	508	—	216	315	28	625	593	120	120	—	46	45	615	830	515	1302 1332	1458 1518	454	130	604	728	386 416	278	—	413	2 1/2"	65 80	140 170	18 22	69 85	130 160	M20
355L	2 4&6	610	630	—	254	355	28	710	770	110	170	—	73	45	693	939	584	1461 1491	1622 1682	458	145	695	850	434 464	403	—	495	3"	75 95	140 170	20 25	79.5 100	130 160	M24

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Dimensional Drawing: Industrial Motors Type 3H Flange Mounted (B5) TEFC (IE3) series Frame 80-355L



		FIXING					GENERAL							TERMINAL BOX				SHAFT					
IEC Fr. Size	Pole	P	N*	M*	i*	S	T	LA	AD	L	LC	LV**	AC	V	q	AG	S2 BSC	D* DA*	E EA	F* FA*	GA* GC*	I I1	d5
80	2,4&6	200	130	165	40	12	3.5	10	140	292	335	30	174	111	118	40	3/4"	19	40	6	21.5	35	M6
90S/L	2,4&6	200	130	165	50	12	3.5	10	150	355	410	35	195	119	138	52	3/4"	24	50	8	27	45	M8
100L	2&4 6	250	180	215	60	15	4	11	157	387 366	469 448	40	195	125	152	56	1"	28	60	8	31	55	M10
112M	4&6	250	180	215	60	15	4	11	170	419	502	45	220	137	157	56	1"	28	60	8	31	55	M10
132S/M	2,4&6	300	230	265	80	15	4	12	208	533	618	50	294	173	204	63	1"	38	80	10	41	70	M12
160M/L	2,4&6	350	250	300	110	19	5	13	238	673	790	60	348	203	345	63	1"	42	110	12	45	105	M16
180M/L	2,4&6	350	250	300	110	19	5	13	290	728	845	70	394	234	371	97	1 1/2"	48	110	14	51.5	100	M16
200M/L	2,4&6	400	300	350	110	19	5	15	336	803	920	80	438	268	396	155	2"	55	110	16	59	100	M20
225S/M	2 4&6	450	350	400	110 140	19	5	16	354	885	972 1032	90	472	286	445	155	2"	55 60	110 140	16 18	59 64	100 130	M20
250M	2 4&6	550	450	500	140	19	5	18	415	983 914	1134 1065	100	489	328	352	243	2"	60 65	140 140	18 18	64 69	130 130	M20
280S/M	2 4&6	550	450	500	140	19	5	18	445	1010	1160	115	544	358	360	243	2"	65 75	140 140	18 20	69 79.5	130 130	M20
315S/M	2 4&6	660	550	600	140 170	24	6	22	515	1137 1167	1293 1353	130	604	413	386 416	278	2"	65 80	140 170	18 22	69 85	130 160	M20
315L	2 4&6	660	550	600	140 170	24	6	22	515	1302 1332	1458 1518	130	604	413	386 416	278	2 1/2"	65 80	140 170	18 22	69 85	130 160	M20
355L	2 4&6	800	680	740	140 170	24	6	25	584	1461 1491	1622 1682	145	695	495	434 464	403	3"	75 95	140 170	20 25	79.5 100	130 160	M24

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Testing Facility To Meet Global Standards

Bharat Bijlee has made a proactive initiative towards producing energy efficient motors with our technologically advanced in-house test facility for complete range of IE motors as per latest International Standards and in line with future revision.

Salient Features

- Direct Load Test up to 560 kW (380V to 6600V, 50/60 Hz)
- Mixed Frequency Testing Facility up to 1250 kW
- Test set up for efficiency determination as per IEC: 60034-2-1:2014 and IS:15999 (part 2/sec 1):2011
- Loading as per full load torque and stray load loss determination from residual loss method 2-1-1B (In line with IEC: 60034-2-1:2014)
- Five test stations for IE2/IE3/IE4 efficiency determination
- Efficiency calculation through special software in line with IEC: 60034-2-1:2014
- Combined testing of Motor + Drive for Safe and Hazardous Area Motors
- Data measurement up to 22kW through SCADA is established and higher ratings under upgradation

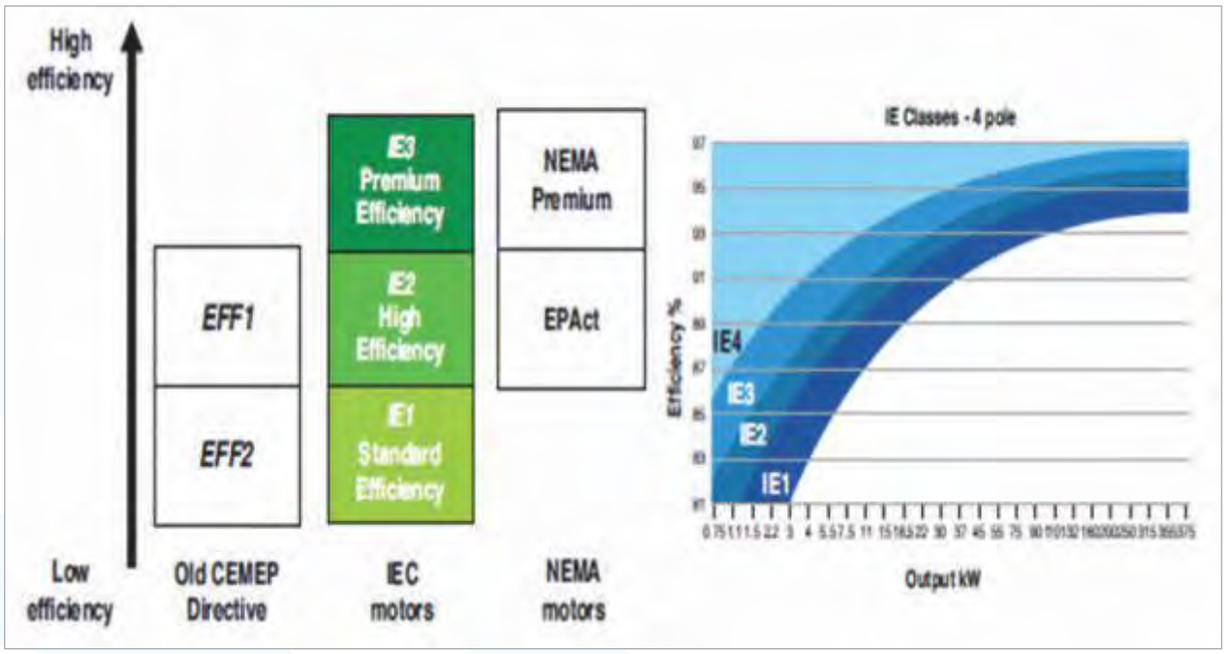
Common Queries

IE Class Efficiency

IE is International Efficiency Class - IE1, IE2, IE3 & IE4. IS 12615:2011 is referring to these classes and is identical to IEC 60034-30:2008. This IEC standard is accepted globally. IS 12615 refers to IS 15999 (Part 2/ Sec1):2011 / IEC 60034-2-1:2007 for calculation of efficiency. This calculation is based on the new methods of stray load loss measurement specified in the standard.

Comparision of New IE Efficiency Classes & Old Efficiency Classes

Old efficiency levels were eff2 and eff1 (as per CEMEP). For calculation of these efficiencies, fixed stray load losses (0.5% of motor output) were assumed. Now IS 12615: 2011 refers to IS 15999 (Part 2/ Sec1): 2011/ IEC 60034 - 2 -1: 2007 for calculation of efficiency. This calculation is based on the new methods of stray load loss measurement specified in the standard. The effect is in reduction of efficiency value than the earlier ones.



Can eff1 motors simply be relabeled as IE2 without retesting?

No - IE and eff ratings are not the same or equivalent. Motors that have been given an eff rating will have to be retested before being given an IE rating.

When Should I Consider Buying Energy Efficient Motor?

- For all new installations
- When purchasing equipment packages, such as compressors, HVAC systems and Pump
- When measure modifications are made to facilities or processes
- Instead of rewinding older, standard efficiency units
- To replace oversized and under loaded motors
- As part of a preventive maintenance or energy conservation programmes

Extending IE Class Performance to Motors used in Hazardous Area

Bharat Bijlee continues the practice of extending the advantage of higher efficiency series for hazardous area also.

- Ex - d Flameproof
- Ex - e Increased Safety
- Ex - n Non Sparking

HIGH EFFICIENCY LARGE MOTORS WITH DCCA

Large Motors with DCCA are manufactured using dual circuit cooling technology, offering high power and better reliability. The outputs which are normally available in HT range are now offered in low voltage range with this new technology.

These motors are suitable for use in various industrial sectors such as power generation, petrochemical, cement, steel, paper and pulp, waste water treatment, chemical industries, sugar etc.

The motors can serve various applications such as pump, compressor, conveyor, fan, blower, etc.

Technology

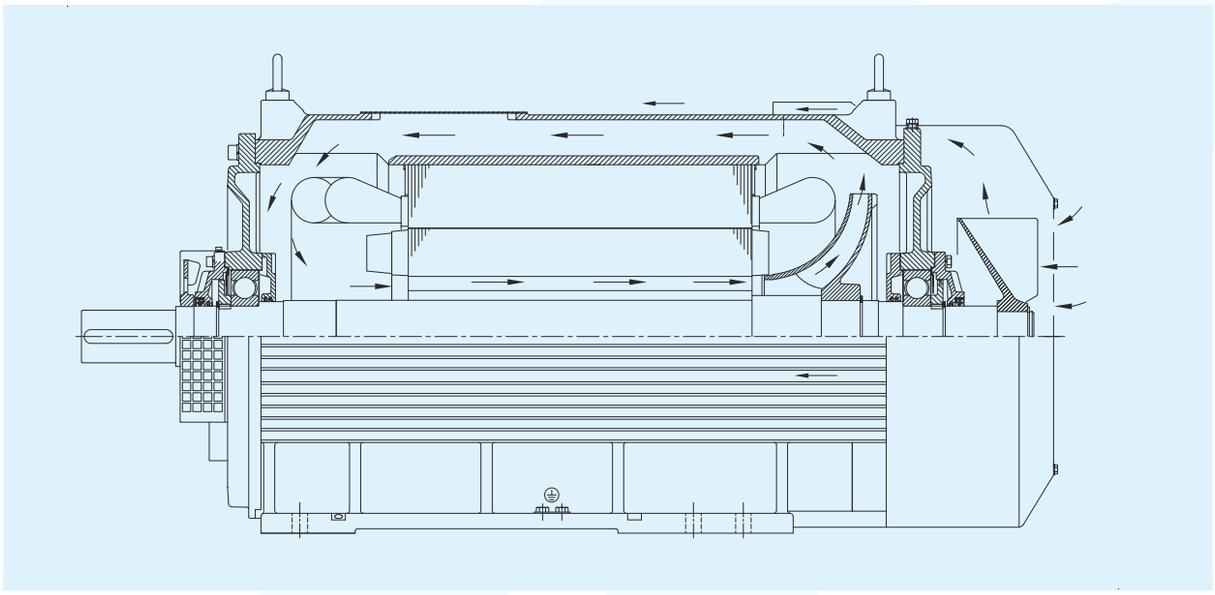
The Dual Circuit Cooling Arrangement (DCCA) is new efficient cooling system used by Bharat Bijlee for High Efficiency Large LT Motors. This technology consists of two independent cooling systems which improves the overall cooling of the motor.

The primary cooling circuit is the regular stator body fin cooling in which the shaft mounted external fan blows air over the stator body fins and cools the motor by forced convection and radiation.

The secondary internal cooling circuit consists of rotor with vent holes, an aluminum impeller and four ventilating ducts on the inside of the stator body. The air inside the motor is circulated by the impeller which passes through the ventilating ducts where it gets cooled on its way from non driving end to the driving end by the primary circuit. This cool air then passes over the DE overhangs and through the rotor vents to the non driving end and on its way absorbing heat from the overhangs and from the rotor. This heated air again passes through the impeller to the ventilating ducts and the cycle repeats.

The advantages of this technology are:

- Lower temperature rise of the winding
- Reduced temperature gradient between DE and NDE sides of the winding on account of uniform distribution of heat
- Enhanced insulation life
- Increased motor reliability
- Reduction in motor size and as a result, higher outputs can be drawn from the same motor.



Dual Circuit Cooling Arrangement

Performance Table for 2-Pole & 4-Pole Motors

TEFC 3 Phase Squirrel Cage Induction Motors - DCCA Series - Frame size 355L/K to 450L

Voltage : 415V± 10% (up to 630kW)
: 690V± 10% (710kW & above)
Frequency : 50Hz± 5%
Combined Variation : ± 10%

Ambient: 40°C
Duty : S1(Continuous)

Ins. Class : F
Temp. Rise : B
Protection : IP55

3000 rpm (2-Pole)

Rated Output		Frame size IEC	Type Ref. B3 Construction	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm²	Net Weight B3 Constn. kg
				Speed RPM	Current Amps.	Rated Torque kg.m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
355	475	355L/K	2H35K2M3	2982	584	116	0.89	0.87	0.82	95.1	94.8	94.0	6.5	1.7	2.5	23.30	2040
400	536	355L/K	MH35K2P3	2982	654	131	0.89	0.87	0.82	95.6	95.4	94.4	6.5	1.7	2.5	26.00	2160
450	603	355L/K	MH35K2T3	2982	726	147	0.90	0.88	0.84	95.8	95.6	94.6	6.5	1.7	2.5	28.60	2280
500	670	355L/K	MH35K2W3	2982	805	163	0.90	0.88	0.84	96.0	95.8	94.8	6.5	1.7	2.5	31.30	2380
560	750	400L	MH40L293	2985	910	183	0.90	0.88	0.80	95.2	94.4	92.4	7.0	1.7	2.5	51.30	2880
* 630	845	400L	MH40L2A3	2985	1023	206	0.90	0.88	0.80	95.4	94.6	92.6	7.0	1.7	2.5	57.30	3260

1500 rpm (4-Pole)

Rated Output		Frame size IEC	Type Ref. B3 Construction	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm²	Net Weight B3 Constn. kg
				Speed RPM	Current Amps.	Rated Torque kg.m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP						FL	3/4L	1/2L	FL	3/4L	1/2L					
400	536	355L/K	MH35K4P3	1488	674	262	0.86	0.82	0.73	96.0	95.8	94.8	6.5	2.0	2.5	30.60	2160
450	603	355L/K	MH35K4T3	1488	757	295	0.86	0.82	0.73	96.2	96.0	95.0	6.5	2.0	2.5	33.70	2270
500	670	355L/K	MH35K4W3	1488	830	327	0.87	0.83	0.74	96.3	96.1	95.1	6.5	2.0	2.4	36.80	2380
560	750	400L	MH40L493	1492	918	366	0.88	0.85	0.78	96.4	95.8	95.0	6.8	2.0	2.5	63.00	2810
630	845	400L	MH40L4A3	1492	1032	411	0.88	0.85	0.78	96.5	95.9	95.1	6.8	2.0	2.5	70.50	3000
710	952	450M	MH45M413	1493	702	463	0.88	0.84	0.76	96.2	95.8	95.0	6.8	2.0	2.5	108.0	4100
800	1072	450M	MH45M433	1493	789	522	0.88	0.84	0.76	96.4	96.0	95.2	6.8	2.0	2.5	120.0	4300
900	1206	450M	MH45M453	1493	886	587	0.88	0.84	0.76	96.6	96.2	95.4	6.8	2.0	2.5	132.0	4500
1000	1340	450L	MH45L473	1493	982	652	0.88	0.84	0.76	96.8	96.4	95.6	6.8	2.0	2.5	160.0	5650

Note : 1. Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings up to 375kw for 2,4 & 6 Pole ratings.
2. All performance values are subjected to tolerance as per IS: 325 IS/IEC 60034-1.
3. Higher ratings can be offered on request in 4, 6 and 8 polarity.
* Temperature rise limited to class "F"

Performance Table for 6-Pole Motors

TEFC 3 Phase Squirrel Cage Induction Motors - DCCA Series - Frame size 355L/K to 450L

Voltage : 415V± 10% (up to 630kW)
: 690V± 10% (710kW & above)
Frequency : 50Hz±-5%
Combined Variation : ± 10%

Ambient : 40°C
Duty : S1(Continuous)

Ins. Class : F
Temp. Rise : B
Protection : IP55

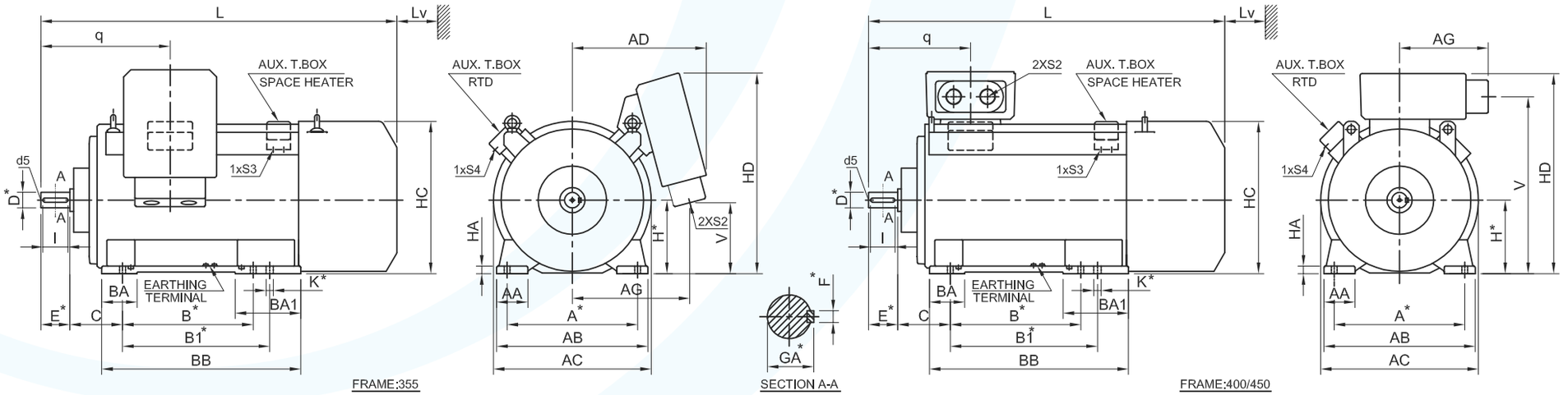
1000 rpm (6-Pole)

Rated Output		Frame size	Type Ref.	Operating Characteristics at Rated output									With DOL Starting		Pullout Torque to Rated Torque Ratio	Rotor GD² kgm²	Net Weight B3 Constn. kg
				Speed RPM	Current Amps.	Rated Torque kg.m	Power Factor			% Efficiency			Starting Current to Rated Current Ratio	Starting Torque to Rated Torque Ratio			
kW	HP	IEC	B3 Construction				FL	3/4L	1/2L	FL	3/4L	1/2L					
315	422	355L/K	2H35K6M3	992	549	309	0.84	0.80	0.70	95.0	95.0	94.2	6.5	1.9	2.5	56.90	1980
355	475	355L/K	2H35K6P3	992	619	349	0.84	0.80	0.70	95.0	95.0	94.2	6.5	1.9	2.5	66.00	2280
400	536	355L/K	MH35K6T3	992	690	393	0.84	0.80	0.70	96.0	96.0	95.4	6.5	1.9	2.5	69.70	2410
450	603	400L	MH40L693	993	775	441	0.84	0.80	0.70	96.2	96.0	95.0	6.5	1.9	2.5	77.00	2810
500	670	400L	MH40L6A3	993	859	490	0.84	0.80	0.70	96.4	96.2	95.2	6.5	1.9	2.5	86.00	3000
560	750	450M	MH45M613	993	961	549	0.84	0.80	0.70	96.5	96.2	95.6	6.5	1.9	2.5	160.0	4100
630	845	450M	MH45M633	993	1080	618	0.84	0.80	0.70	96.6	96.4	95.8	6.5	1.9	2.5	180.0	4300
710	952	450M	MH45M653	993	731	696	0.84	0.80	0.70	96.7	96.6	96.1	6.5	1.9	2.5	200.0	4400
800	1072	450L	MH45L673	993	823	785	0.84	0.80	0.70	96.8	96.7	96.2	6.5	1.9	2.5	236.0	5600

Note : 1. Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings up to 375kw for 2,4 & 6 Pole ratings.
2. All performance values are subjected to tolerance as per IS: 325 IS/IEC 60034-1.

For 8 Pole ratings please refer to sales office.

Dimensional Details: Industrial Motors Type-2H, Foot Mounted (B3), TEFC IE2 Series, Frame Size- 355/400/450



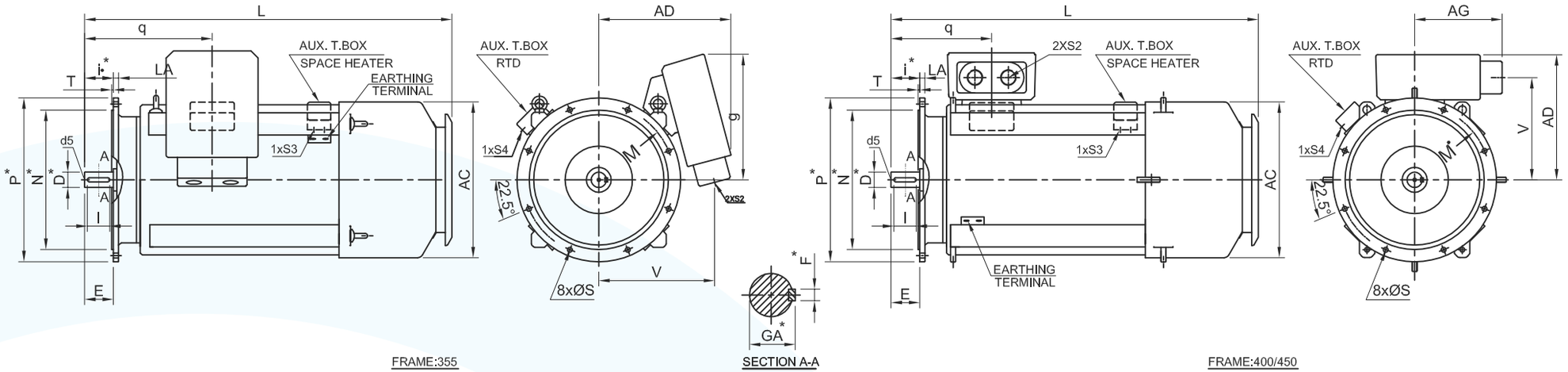
		FIXING																	
IEC Fr. Size	Pole	A*	B*	B1*	C	H*	K*	AB	BB	AA	BA	BA1	HA	HC	HD	AD	L	AC	Lv
355L/K	2	610	630	710	254	355	28	730	960	150	170	315	36	736	985	685	1735	765	200
355L/K	4/6/8	610	630	710	254	355	28	730	960	150	170	315	36	736	985	685	1765	765	130
400M/L	2	686	710	800	280	400	35	820	940	140	170	260	35	824	1076	-	1835	852	250
400M/L	4/6/8	686	710	800	280	400	35	820	940	140	170	260	35	824	1076	-	1875	852	200
450M	4/6/8	800	1000	-	250	450	42	940	1180	180	260	-	42	935	1210	-	2025	972	200
450L	4/6/8	800	1250	-	250	450	42	940	1430	180	260	390	42	935	1210	-	2347	972	200

		TERMINAL BOX						SHAFT					
IEC Fr. Size	Pole	V	q	AG	S2 B.S.C.	S3 B.S.C.	S4 B.S.C.	D*	E	F*	GA*	I	d5
355L/K	2	345	625	595	3''	3/4''	1''	75	140	20	79.5	130	M20
355L/K	4/6/8	345	655	595	3''	3/4''	1''	95	170	25	100	160	M24
400M/L	2	952	560	590	3''	3/4''	1''	80	170	22	85	160	M20
400M/L	4/6/8	952	600	590	3''	3/4''	1''	110	210	28	116	180	M24
450M	4/6/8	1086	600	590	3''	3/4''	1''	120	210	32	127	180	M24
450L	4/6/8	1086	605	590	3''	3/4''	1''	120	210	32	127	180	M24

TABLE A									
Dimension	A	B	H	K	D	GA	F	d5 (Centering)	L
Tolerance	±0.75	±0.75	-1	-	m6	-	h9	-	±50
Specification	IS:1231	IS:1231	IS:1231	IS:1231	IS:1231	IS:2048	IS:2048	IS:2540	-

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Dimensional Details: Industrial Motor Type- 2H, Flange Mounted (V1), TEFC IE2 Series, Frame Size- 355/400/450



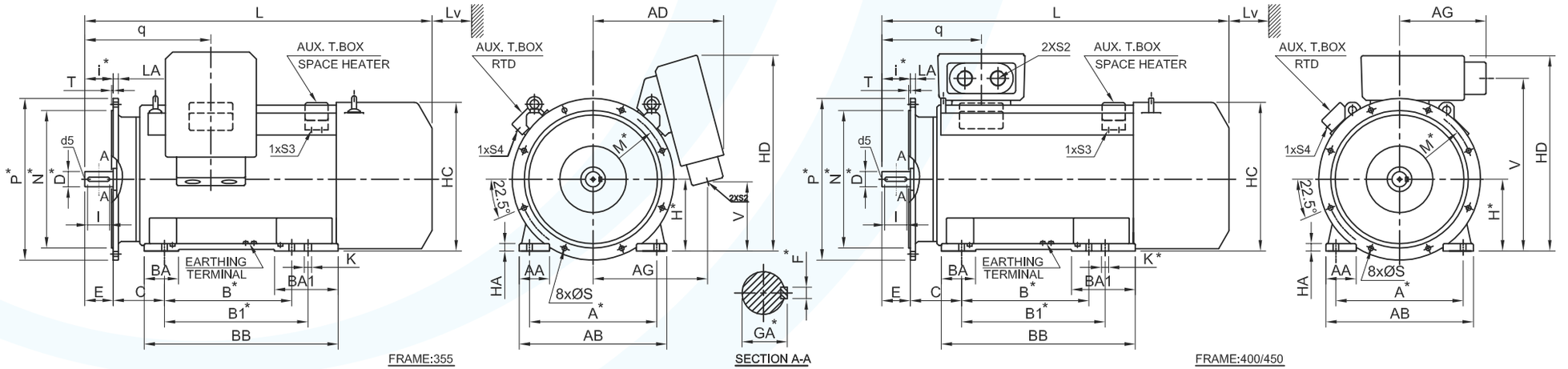
		FIXING					GENERAL							TERMINAL BOX				
IEC Fr. Size	Pole	P	N*	M*	i*	S	T	LA	AD	AC	L	g	V	q	AG	S2 B.S.C.	S3 B.S.C.	S4 B.S.C.
355L/K	2	800	680	740	140	24	6	25	685	765	1835	630	570	625	-	3"	3/4"	1"
355L/K	4/6/8	800	680	740	170	24	6	25	685	765	1865	630	570	655	-	3"	3/4"	1"
400M/L	2	800	680	740	170	24	6	25	-	852	1935	-	552	560	590	3"	3/4"	1"
400M/L	4/6/8	800	680	740	210	24	6	25	-	852	1975	-	552	600	590	3"	3/4"	1"
450M	4/6/8	1150	1000	1080	210	28	6	30	-	972	2125	-	636	600	590	3"	3/4"	1"
450L	4/6/8	1150	1000	1080	210	28	6	30	-	972	2447	-	636	605	590	3"	3/4"	1"

		SHAFT					
IEC Fr. Size	Pole	D*	E	F*	GA*	l	d5
355L/K	2	75	140	20	79.5	130	M20
355L/K	4/6/8	95	170	25	100	160	M24
400M/L	2	80	170	22	85	160	M20
400M/L	4/6/8	110	210	28	116	180	M24
450M	4/6/8	120	210	32	127	180	M24
450L	4/6/8	120	210	32	127	180	M24

TABLE A								
Dimension	N	M	i	D	GA	F	d5 (Centering)	L
Tolerance	js6	±0.5	±1.5	m6	-	h9	-	±50
Specification	IS:2223	IS:2223	-	IS:1231	IS:2048	IS:2048	IS:2540	-

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Dimensional Details: Industrial Motor Type- 2H, Foot and Flange Mounted (B35), TEFC IE2 Series, Frame Size- 355/400/450



		FIXING											SHAFT					
IEC Fr. Size	Pole	A*	B*	B1*	C	H*	K*	P	N*	M*	i*	S	D*	E	F*	GA*	l	d5
355L/K	2	610	630	710	254	355	28	800	680	740	140	24	75	140	20	79.5	130	M20
355L/K	4/6/8	610	630	710	254	355	28	800	680	740	170	24	95	170	25	100	160	M24
400M/L	2	686	710	800	280	400	35	800	680	740	170	24	80	170	22	85	160	M20
400M/L	4/6/8	686	710	800	280	400	35	800	680	740	210	24	110	210	28	116	180	M24
450M	4/6/8	800	1000	-	250	450	42	1150	1000	1080	210	28	120	210	32	127	180	M24
450L	4/6/8	800	1250	-	250	450	42	1150	1000	1080	210	28	120	210	32	127	180	M24

		GENERAL														TERMINAL BOX					
IEC Fr. Size	Pole	T	LA	AB	BB	AA	BA	BA1	HA	HC	HD	AD	L	AC	Lv	V	q	AG	S2 B.S.C.	S3 B.S.C.	S4 B.S.C.
355L/K	2	6	25	730	960	150	170	315	36	736	985	685	1735	765	200	345	625	595	3''	3/4''	1''
355L/K	4/6/8	6	25	730	960	150	170	315	36	736	985	685	1765	765	130	345	655	595	3''	3/4''	1''
400M/L	2	6	25	820	940	140	170	260	35	824	1076	-	1835	852	250	952	560	590	3''	3/4''	1''
400M/L	4/6/8	6	25	820	940	140	170	260	35	824	1076	-	1875	852	200	952	600	590	3''	3/4''	1''
450M	4/6/8	6	30	940	1180	180	260	-	42	935	1210	-	2025	972	200	1086	600	590	3''	3/4''	1''
450L	4/6/8	6	30	940	1430	180	260	390	42	935	1210	-	2347	972	200	1086	605	590	3''	3/4''	1''

TABLE A												
Dimension	A	B	H	K	N	M	i	D	GA	F	d5 (Centering)	L
Tolerance	±0.75	±0.75	-1	-	js6	±0.5	±1.5	m6	-	h9	-	±50
Specification	IS:1231	IS:1231	IS:1231	IS:1231	IS:2223	IS:2223	-	IS:1231	IS:2048	IS:2048	IS:2540	-

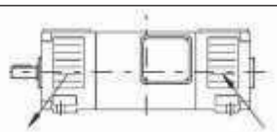
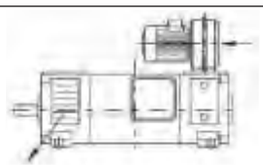
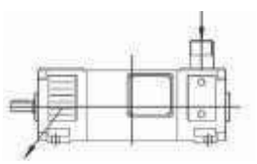
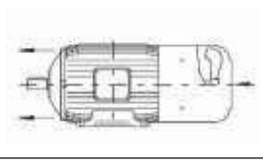
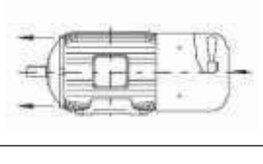
Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

Methods of Cooling

Designation system concerning methods of cooling refers to standard IEC 60034-6.

Explanation of the product code

IC – International Cooling					
1st Character	2nd Character	3rd Character	4th Character	5th Character	
↓	↓	↓	↓	↓	
Circuit Arrangement	Primary Coolant	Method of Movement of Primary Coolant	Secondary Coolant	Method of Movement of Secondary Cooling	
For Totally Enclosed Three-Phase Induction Motors in BBL, following are the applicable codes					
Example	Frame surface cooled	Coolant is air. Usually omitted in nomenclature	Self Circulation	Coolant is air. Usually omitted in nomenclature	Different methods of movement of secondary coolant
411 Totally Enclosed Fan Cooled	4	-	1	-	1 – Self Circulation
416 Totally Enclosed Forced Cooled	4	-	1	-	6 – Machine mounted independent component
410 Totally Enclosed Surface Cooled	4	-	1	-	0 – Free

IC 01		Enclosure IP 21 - IP 23 (type G...) **Self-ventilated with integral fan cooling (DP)** Cooling air is blown through the motor by a fan mounted on the shaft.
IC 06		Enclosure IP 21 - IP 23 (type G...I) **Separate ventilation with radial fitted fan unit (FV)** Cooling air is blown through the motor by a separately excited fan motor. The inlet side may be equipped with an air filter.
IC 17		Enclosure IP 21 - IP 23 (type G..) **Single pipe ventilated (FV)** Cooling air is blown across the motor through the pipe connection with a separate customer provided external blower fan and discharges on the other side to open space.
IC 410		Enclosure IP 44 - IP 55 (type G..Z) **Totally-enclosed non ventilated (TENV)** Cooling without using a fan, only by nature ventilation and radiation on the totally enclosed motor surface.
IC 411		Enclosure IP 44 - IP 55 (type G..ZE) **Totally-enclosed fan-cooled (TEFC)** Cooling air is blown over the totally enclosed motor surface by a fan mounted an the shaft.
IC 416		Enclosure IP 44 - IP 55 (type G..ZO) **External surface cooling (TEFV)** Cooling air is blown over the totally enclosed motor surface by an separately excited fan motor.
IC 37		Enclosure IP 44 - IP 55 (type G..Z) **Double pipe ventilated (TEPV)** Cooling air is blown across the motor through a pipe connecting by means of a separate customer provided external blower fan and discharges on the other side's pipe connecting.

Degree of Protection

Degree of protection for rotating machines are indicated according to IS/IEC 60034-5 using the characteristic letters 'IP' followed by two characteristic numerals for the degree of protection.

The first numeral indicates protection against contact and ingress of foreign bodies.

The second numeral indicates protection against ingress of water.

First characteristic numeral

IP2X Protected against solid objects greater than 12mm

IP5X Dust protected motors, Ingress of dust is not fully protected ,but dust can not enter in an amount sufficient to interface with satisfactory operations of the motor.

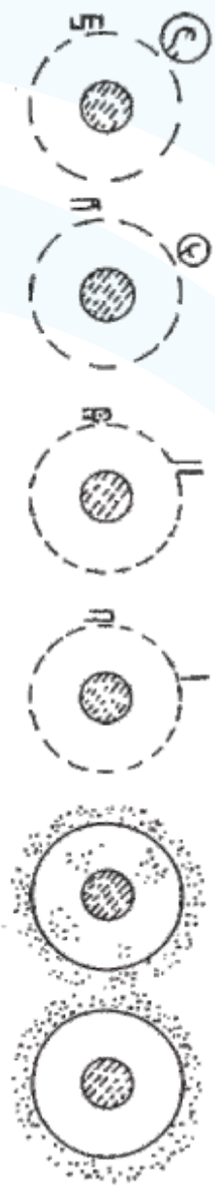
Second characteristic numeral

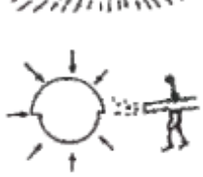
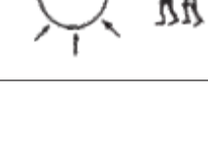
IPX3 Protected against spraying water, sprayed up to angle of 60^{o} from vertical shall have no harmful effect.

IPX5 Protected against water, jets by a nozzle from any direction shall have no harmful effect.

IPX6 Protected against heavy seas, powerful jets from all direction shall have no harmful effect.

Degree of protection Schematic

1st Numeric		Protection	Acceptance Conditions as per IEC 60034-5 : 2006
	0	No protection	No Test Required
	1	Protected against solid objects greater than 50mm (e.g. hand)	The protection is satisfactory if 50mm diameter sphere does not pass through any opening and adequate clearance is maintained to parts which are normally live in service or moving parts inside the machine.
	2	Protected against solid objects greater than 12.5mm (e.g. figure)	The protection is satisfactory if 12.5mm diameter sphere does not pass through any opening and adequate clearance is maintained to live or moving parts inside the machine.
	3	Protected against solid objects greater than 2.5mm (e.g. tools, wires)	The protection is satisfactory if wire or rod of 2.5mm diameter cannot enter enclosure.
	4	Protected against solid object greater than 1mm (e.g. wire or strips)	The protection is satisfactory if wire or rod of 1.0mm diameter cannot enter enclosure.
	5	Ingress of dust is not totally protected, but does not enter in sufficient quantities to harm equipment	TEST: The test is carried out in a closed test chamber. Talcum powder is used to check if the enclosure is protected against entry of fine particles inside the enclosure. Talcum powder is sucked inside the motor enclosure by appropriate means. ACCEPTANCE: The protection is satisfactory if, on inspection, talcum powder has not accumulated in a quantity or location such that, it could interfere with the satisfactory operation of the machine. No dust should deposit where it could lead to tracking along the creepage distances (e.g. terminal Plate).
	6	No ingress of dust	The teat is carried out as described above. The protection is satisfactory if, on inspection, there is no ingress of talcum powder.

2nd Numeric	Protection		Acceptance Conditions as per IEC 60034-5 : 2006
	0	No protection	No Test Required
	1	Dripping water shall have no harmful effect.	After the Test in accordance with Table 5 of IS/IEC 60034-5 : 2000 has been carried out, the machine shall be inspected for ingress of water and subject to the following verification & Tests. a) The amount of water which has entered the machine shall not be capable of interfering with its satisfactory operation. The windings and live parts (not designed to operate when wet) shall not be wet & no accumulation of water which could reach them shall occur inside the machine. This indicates that, water can get accumulated at bottom most portion of stator body, however quantity of water should be such that it does no winding / overhang. It is permissible for the blades of fans inside rotating machines to be wet and leakage along shaft is allowed if provision is made for drainage of this water. b) In case of this test on a machine not running, the machine shall be operated under no-load conditions at rated voltage for 15Min, and then high-voltage test is carried out, with test voltage being 50% of the test voltage for a new machine (But not less than 125% of the rated voltage). For a motor with rated voltage upto 415V, this voltage limit works out to 915V. The Test is deemed satisfactory if above checks show no failure.
	2	Protected against dripping water when enclosure is tilled 15°	
	3	Protected against spraying water up to 60°	
	4	Water splashed from any direction shall have no harmful effect.	
	5	Water hosed against the enclosure shall have no harmful effect(water jets)	
	6	Water from powerful jets of heavy seas shall have no harmful effects	

ANNEXURE - III

Tolerances (Reference IS/IEC 60034-1)

Unless stated otherwise, tolerances on declared values are applicable as given in the table below:

Schedule of tolerances on values of quantities

Quantity	Tolerance
Efficiency ŋ -Machines up to and including 150 kW (or kVA) -Machines above 150 kW (or kVA)	 -15 % of (1 - ŋ) -10 % of (1 - ŋ)
Power-factor, cosΦ, for induction machines	-1/6 (1 -cosΦ) Minimum absolute value 0.02 Maximum absolute value 0.07
Slip of induction motors (at full load and at working temperature) *PN* < 1 kW *PN* 1 kW	 ± 30 % of the slip ± 20 % of the slip
Locked rotor current of cage induction motors with any specified starting apparatus	+20 % of the current
Locked rotor torque of cage induction motors	+25 -15 % of the torque. (+25 % may be exceeded by agreement)
Breakdown torque of induction motors	-10% of the torque except that after allowing for this tolerance the torque shall be not less than 1.6 or 1.5 times the rated torque

Note: When tolerance is stated in only one direction, the value is not limited in the other direction.

Limiting Mean Sound Power Level Lw in dB(A) for Airborne Noise Emitted by Rotating Electrical Machines

IS: 12065

Protective Enclosure		IP22	IP44	IP22	IP44	IP22	IP44	IP22	IP44	IP22	IP44	IP22	IP44
Rating kW(or kVA)		Rated Speed (rpm)											
		960 and below		961 to 1320		1321 to 1900		1901 to 2360		2361 to 3150		3151 to 3750	
Above	Up to	Sound Power Level dB(A)											
-	1.1	-	76	-	79	-	80	-	83	-	84	-	88
1.1	2.2	-	79	-	80	-	83	-	87	-	89	-	91
2.2	5.5	-	82	-	84	-	87	-	92	-	93	-	95
5.5	11	82	85	85	88	88	91	91	96	94	97	97	100
11	22	86	89	89	93	92	96	94	98	97	101	100	103
22	37	89	91	92	95	94	97	96	100	99	103	102	105
37	55	90	92	94	97	97	99	99	103	101	105	104	107
55	110	94	96	97	101	100	104	102	105	104	107	106	109
110	220	98	100	100	104	103	106	105	108	107	110	108	112
220	630	100	102	104	106	106	109	107	111	108	112	110	114
630	1100	102	104	106	107	107	111	108	111	108	112	110	114
1100	2500	105	107	109	110	109	113	109	113	109	113	110	114
2500	6300	106	108	110	112	111	115	111	115	111	115	111	115
6300	16000	108	110	111	113	113	116	113	116	113	116	113	116

Note 1: IP22 corresponds generally to drip-proof, ventilated and similar enclosures.

IP44 corresponds generally to totally enclosed fan-cooled, closed air circuit air-cooled, and similar enclosures (See IS: 4691-1985*).

Note 2: No positive tolerance is allowed on the above sound power levels.

Storage and Handling of motors

Receipt and Handling of motors

Receipt of motors

- Inspect the condition of packaging immediately upon receipt for any damages during transportation. Unpack motor carefully and inspect for any hidden damage or missing parts (not visible before unpacking) before storage. A complete visual inspection of the motor must be performed after removing the package.

All damages must be immediately photographed, documented and reported to the transporter within 24 hours, and to the insurance company and to BBL local office, (through whom the motor is purchased), within 48 hours. This is required to maintain the time limits for filing claims. Failure to comply with this procedure will void the product warranty.

- While reporting damage, please mention motor serial number.
- In this case, installation must not be started, till the problem is solved.
- Check if the delivery of the order is complete. (Spare parts, documents etc.)
- Check the nameplate data corresponds with the application for which, the motor will be used. Make a special point of checking voltage and connection (delta or star)
- Rotate the shaft by hand to check free rotation.

Handling of motors

Steel cables and hoisting equipment must have capacity to bear the motor weight.

Failure to follow the following instructions, may result in the motor falling over, or slipping in the lifting tackle. The result can be death, serious damage, or material breakage.

- When lifting the motor, the correct hoisting points, the weight of the motor and the operating capacity of the hoisting crane must be matched. Motors packed in wooden crates must always be lifted by their own eyebolts/lifting lugs or by a proper forklift, and must not be lifted by its wooden crates.
- For lifting the motor, only the lifting eye-bolts provided with motor, are to be used. The eyebolts are designed for the motor weight only. Never use the eyebolts to lift the motor with additional loads, such as pumps, gear boxes, fans or any other driven equipment.
- Use all lifting eye-boltstogether, that are provided, for sharing the load. (If motor is provided with two eye-bolts, use both eye-bolts and not one). Ensure that the eyebolts are fully tightened upto their supporting surface, before lifting.
- The packing (wooden crate with motor) must not be dropped. It is to be carefully placed on the floor without impact to avoid the damage to the bearing. Jerks and jolts must be avoided.
- Do not use any other part of the motor for lifting including shaft.
- Do not use shaft projections for dragging the motor.
- Do not roll or drag the motor on the floor.
- Motors must not be kept in vertical position with external fan cowls as base.
- In vertical lifting, uncontrolled rotation of the motor must be prevented. Do not lift other equipments with motor lifting points only.
- During movement of the motor from one place to other place, the shaft must be locked with the locking device supplied with the motor (if any). The shaft locking device to be removed just before the installation of the motor.

Storage instructions for motors

- If the motor is not installed immediately after receipt, it must remain inside its packing and stored in a storeroom.
- For practical purposes, motor is considered to be in storage not only when it is in the storeroom but also when:
  - it has been delivered to the jobsite and is a waiting installation;
  - or, It has been installed but regular operation is delayed / pending completion of plant construction;
  - or, there are long, idle periods between operating cycles;
  - or, the plant or department is shutdown.

- The recommendations given here apply to conditions commonly found in indoor storage. Personnel responsible for care of the equipment should use good discretion in adapting these recommendations to the particular situation. Common sense and sound safety rules need to be followed.

Indoor storage

Wholly controlled atmosphere or partially controlled atmosphere

- Storage room must be clean, dust free and dry. The room must be properly covered and closed.
- Maintain temperature in the range 20 deg to 50 deg in the storage room
- Maintain uniform temperature throughout the room (Temperature variations causes condensation of moisture).
- Relative humidity to be 50% or less
- Ensure absence of harmful fumes and vapors, gases such as chlorine, sulfur dioxide and corrosive agents.
- Vibration free area to avoid bearing damage.
- Space heater must be energized if temperature falls below 10˚C or humidity is more than 50% to prevent harmful effects of moisture condensation.
- Ensure that no water dips on motor and no water accumulates under the motor.
- Ensure that all plugs originally provided are in place. (e.g. cable entry hole plugs, drain plugs and plug in fan cowl for greasing. If plugs are missing, all the openings to be covered with an adhesive plastic cloth.
- The enclosing structure should be designed to protect the motor from flying debris or other damage from high winds.
- Cover the motor completely in a strong, transparent plastic bag to exclude dirt, dust, moisture, and other foreign materials. Before sealing this bag, small bags of silica-gel desiccant should be put inside the bag, around the motor.
- Rodents, insects and other animals, like to house inside motors in search of warm surroundings or food. Some of them attack the insulating materials. Their access to the motor must be avoided.
- Do not remove the corrosion protection from the machined surfaces like shaft and flange. These protections must remain in place until the final assembly.
- Any damage to the painting or to the rust protections on the machined surfaces must be corrected.

Outdoor storage

- **Dry climate** (Conditions usually found) - Dust, sand, heat from the sun, and occasional rain or snow
- **Humid climate** (Conditions usually found) - Dust, rain and snow, organic (fungus) growth
- **Salty and industrial atmospheres** (Conditions usually found) - Moisture impregnated with salts or other acidic / alkaline chemicals, salty dust, sand, rain or snow, fungus growth, fumes, coal and chemical dust soot.

All precautions indicated in indoor storage to be taken. The storage location to be safe from flooding water and mud. Also, repair all damages to the packaging before storing the motor.

Place the motor on platform or foundations to protect it against ground humidity and from sinking into the soil. Free air circulation beneath the motor must be assured.

In addition, after the unit is covered as explained in those instructions, a shed should be erected to protect it from direct rain, snow, and excessive direct sun heat. At a bare minimum, a heavy water- proofed cover should be slipped over it. This cover must not be in direct contact with the motor surface. In order to ensure free air circulation between the motor and cover, use wooden block as spacers.

Extended storage

When the motor is stored for **long duration (two months to two years)**, before operation, it is subjected to different atmospheric conditions, such as ambient temperature variations, moisture, corrosive vapors etc. Empty spaces inside the motor are exposed to humidity and corrosive agents. The winding insulation resistance may drop below acceptable value. Grease in the bearings, loses its lubricating properties. It becomes highly risky, to start the motor after such extended storage.

ANNEXURE - V

All preventive measures described below including storage, maintenance, packaging, periodical inspections, must be followed and recorded. This is must for having product warranty. This is applicable, even when an operating motor is idle for two or more months.

Storage Location

In order to ensure the best storage conditions for the motor during long duration, the storage location must strictly meet the following conditions.

Indoor storage

All precautions as per clause 3.3.1 to be followed. In addition, following points to be observed.

- The environment must present an air - filtered ventilation system.
- Protection against dirt and dust accumulation.
- Fire detection system to be available.
- The location must have power supply to the space heaters.

In case the storage location does not meet any of these requirements, BBL recommends to have additional protections in the motor packaging during the storage period , as follows:

- Closed wooden crates or similar with proper electrical installation, providing power to the space heaters.
- If there is risk of infestation and fungus growth, the package must be protected on the site by spraying or painting it, with proper chemical agents.
- Package proportion must be carefully executed by experienced personnel.

Outdoor storage

Outdoor storage is not recommended. In the case outdoor storage is unavoidable, follow all the steps mentioned above at various places. Here, the motor is to be covered with water proof cover and also a shed to be constructed to protect the motor.

In case the motor is stored for long duration and/or idle period, it is must to inspect it regularly as per plan given in clause.

Space heaters

The space heaters provided with the motor must be kept on during storage to avoid moisture condensation within the motor, and to keep winding insulation resistance within acceptable limits. If motor is not having space heater, the motor has to be wrapped with an air-tight bag including sufficient amount of desiccant, keeping the enclosed volume dry.

Space heaters must be on when ambient temperature falls below 10 deg C or relative humidity is more than 50%.

Insulation resistance

During the storage period , motor winding insulation resistance must be measured and recorded every month, before the motor is installed. Any drop in the insulation resistance must be investigated immediately

Exposed machined surfaces

- All exposed machined surface (e.g. shaft end and flanges) are protected with a coat of rust inhibitor when despatched from works, which should not be taken off during normal storage periods.
- Periodic inspection of this coating is must during long duration storage. This protection film must be reapplied at least twice a year or when removed and/or damaged.
- Protective coatcan be easily taken off by using paraffin or other petroleum solvents.

Grease lubricated bearings

- The bearings are filled with grease at the factory, for proper lubrication.
- Special precautions need to be taken when the machine is idle for considerable period to avoid corrosion of the bearings and loss of grease.

- During the storage period, every week, the shaft lock must be removed and the shaft must be rotated (@30 rpm for minimum 15 sec.) and always finishing in a different position, in order to distribute grease inside the bearing (grease has tendency to settle at the bottom of the housing.) and to maintain good bearings conditions.
- After two months, the bearing covers should be removed and grease in the housing pressed with thumbs between the races of the bearing. If any deterioration of grease is apparent, the old grease should be removed and new grease pressed in the bearing housings.
- After 4 months of storage and before operating the motor, the old grease to be removed completely and the bearings must be filled with fresh grease again.
- If the motor remains stored for 18 months or more, the bearings must be disassembled, cleaned, inspected, and lubricated.
- Spare bearings (if in stock) to be given a coat of light oil or grease and packed in polythene bags for protection against moisture.

Terminal box

When the insulation resistance of the motor winding is measured, the main and auxiliary terminal boxes must also be inspected, considering the following points:

- The inside of terminal box must be dry, clean, and free of any dust accumulation.
- The contact elements cannot be corroded.
- The sealing must remain under appropriate conditions.
- The cable inlets must be correctly sealed.
- No insect, rodents inside the terminal box.
- If any of these items is not correct, the parts must be cleaned or replaced.

Complete motor:

When storage may last over one year, repaint all surfaces previously painted, before putting motor into service.

Inspections and records during storage

Stored motors must be periodically inspected and inspection records must be filled.

The following points must be inspected:

- Physical damage.
- Cleanliness.
- Signs of water condensation.
- Protective coating condition.
- Paint condition.
- Signs of vermin or insect activity.
- Satisfactory operation of space heaters.
- Record ambient temperature and air relative humidity around the motor, insulation resistance.
- The storage location must also be inspected to assert its compliance with the criteria described in the clause

Maintenance plan during storage:

During the storage period, motor maintenance must be performed and recorded in accordance with the plan described in the following table.

	Monthly	2 months	6 months	2 years	Before operating
Storage Location					
Inspect cleanliness conditions	X				X
Inspect humidity and temperature conditions	X				
Check for signs of insect infestation	X				
Measure vibration levels	X				
Packaging					
Inspect physical damages		X			
Inspect the relative humidity inside the motor		X			
Replace dehumidifier in the package (if any)1			X		
Space heater					
Check operation conditions	X				
Complete motor					
Perform external cleaning		X			X
Check paint conditions			X		
Check oxidation inhibitor on exposed machined parts			X		
Replace the oxidation inhibitor			X		
Windings					
Measure the insulation resistance	X				X
Measure the polarization index	X				X
Terminal box and grounding terminals					
Clean the boxes' inner parts		X			X
Inspect seals and sealing		X			X
Grease lubricated bearings					
Rotate the shaft	X				
Relubricate the bearing			X		X
Disassemble and clean the bearing				X	

Recommended Maintenance Schedule

1. DAILY MAINTENANCE

1.1 Examine visually earth connections. Check motor leads and cable connections are fully tight and not loose.
1.2 Check motor windings for overheating (the permissible maximum temperature is above that which can be comfortably felt by hand).
1.3 Examine control equipments.
1.4 Check body and bearing temperature
1.5 Check voltage and current in all three phases. Check voltage variation and unbalance.
1.6 Check vibrations at bearings.
1.7 Check if motor rotation is free and measure speed.
1.8 Check for any abnormal noise.

Note: In order to avoid opening up motors, a good indication is to observe the shell temperature under normal working conditions. Any increase not accounted for, for example by seasonal increase in ambient temperature, should be suspected.

2. WEEKLY MAINTENANCE

2.1 Check belt tension. In cases where this is excessive, it should immediately be reduced. Check motor pulley seat location. Pulley has to rest on shaft shoulder.
2.2 Check coupling condition.
2.3 Blow out windings of protected type motors situated in dusty locations. Check for any accumulation of dirt, sand or fine dust.
2.4 Examine starting equipment for burnt contacts where motor is started and stopped frequently.
2.5 For outdoor motors, check if canopy is at proper place.

3. MONTHLY MAINTENANCE

3.1 Overhaul Controllers.
3.2 Inspect and clean oil circuit breakers.
3.3 Wipe brush holders and check bedding of brushes of slip-ring motors.

4. HALF YEARLY MAINTENANCE

4.1 Clean windings of motors subjected to corrosive or other elements; also bake and varnish, if necessary.
4.2 In the case of slip-ring motors, check sliprings for grooving or unusual wear.
4.3 Check grease in ball and roller bearings and make it up where necessary taking care to avoid overfilling.

5. ANNUAL MAINTENANCE

5.1 Check all high speed bearings and renew, if necessary.
5.2 Blow out all motor winding thoroughly with clean dry air. Make sure that the pressure is not so high as to damage the insulation.
5.3 Clean and varnish dirty and oily windings.
5.4 Overhaul motors which have been subjected to severe operating conditions.
5.5 Renew switch and fuse contacts, if damaged. Check oil.
5.6 There can be cement dust / saw dust / rock dust / coal dust / grain dust on motor body. Blow out compressed air over motor body to clean this accumulated dust at the time of monthly maintenance. See to it that all ventilation paths are absolutely free.
5.7 Paint the motor if required.
5.8 Check insulation resistance to earth and between phases of motor winding, control gear and wiring.
5.9 Check resistance of earth connections.
5.10 Check air gaps.
5.11 Test the motor overload relays and breakers.

6. RECORDS

6.1 Maintain a register giving one or more pages for each motor and record therein all important inspection and maintenance works carried out from time to time. These records should show past performance, normal insulation resistance level, air gap measurements, nature of repairs and time between previous repairs and other important information which would be of help for good performance and maintenance. Sample format is attached.

Trouble Shooting

Properly installed and maintained motors, operated within the nameplate ratings and specifications, will run trouble free for many years. Problems and premature failures often indicate input power system troubles, poor or deteriorating mechanical installations, or malfunctions in the driven machinery. Therefore, motor troubleshooting involves the entire system, not just the motor.

SAFETY PROCEDURE

(A) WARNING

Dangerous voltages are present in the motor components which can cause serious injury, electrocution and equipment damage. To avoid serious injury and/or equipment damage - before any adjustments, servicing, wiring, parts replacement or any other act requiring physical contact with the electrical or mechanical working components of this equipment is performed, all equipment must be de-energized, disconnected and isolated to prevent accidental contact with live or rotating parts.

The success and safe operation of motors is dependent upon proper handling, installation, operation and maintenance, as well as upon proper design and manufacture. Failure to follow certain fundamental installation and maintenance requirements may lead to personal injury and the failure and loss of the motor as well as damage to other property.

(B) QUALIFIED PERSONNEL

Only qualified personnel should be involved in the inspection, maintenance and repair procedure and all plant safety procedures must be observed.

A qualified person is one who is familiar with the installation, construction and operation of the equipment, and the hazards involved. In addition, he has the following qualifications:

a. By reason of education level, training, experience, instruction, and knowledge of the relevant, product and safety standards, regulations, accident prevention rules and knowledge of working conditions, is authorized to perform the appropriate activities required, and therefore is able to recognize and prevent potentially dangerous situations.

b. Is trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

c. Is trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

d. Is trained in rendering first aid procedures and has knowledge of local rescue organizations.

Diagnosis of common motor troubles and their remedies

Properly installed and maintained motors, operated within the nameplate ratings and specifications, will run trouble free for many years. Problems and premature failures often indicate input power system troubles, poor or deteriorating mechanical installations, or malfunctions in the driven machinery. Therefore, motor troubleshooting involves the entire system, not just the motor.

!!Warning

Allow only qualified personnel to perform troubleshooting and maintenance of motors.
Be sure such technicians observe standard safety precautions.

Steps for effective troubleshooting

Determine answers for the following questions:

(1) What are the troubles and when did they first occur?

(2) If new, did the installation ever run properly? How long?

(3) If an established installation, is the trouble new or has it been occurring for years?

What changes, even if minor, occurred in the operation or maintenance of the equipment before the trouble started?

(4) Do you have accurate meter readings of current and voltage for all three phases of the input circuit? Such readings are needed to correctly determine the cause of most electrical troubles.

!!Warning!!
High voltage can kill

(1) Internal parts of the motor may be at line potential even when it is not rotating.

(2) When troubleshooting requires that measurements be taken with the input power on, the input power should be turned on only when necessary and extreme caution should be taken to avoid electric shock.

(3) Isolate your body from ground and do not touch electrically hot components. Wear dry insulating gloves.

(4) Disconnect all input power to the drive and motor before performing any maintenance.

!!Warning !!
Moving parts can injure

(1) Do not operate the motor at speeds above the motor maximum safe speeds.

(2) Operating the motor, above maximum safe speed may cause parts to be ejected resulting in body injury.

(3) All motor driven components must be designed by the machine builder to operate safely at the motor maximum safe speed, listed on the motor nameplate

Information in regard to some of the common motor faults, their causes and remedies is given in the following tables. It is recommended that a chart giving this information is kept readily available for assistance to the maintenance staff.

Type of Troubles

1 : Motor burnt out.
2: Troubles related to surrounding atmosphere
3: Troubles related to starting of the motor
4: Troubles related to running of the motor
5: Troubles related to bearings
6: Troubles related to noise and vibrations
7: Troubles related to input power circuit
8: Troubles related to motor operation with VFDs

Section 1 : Motor burnt out.

Trouble	Probable cause	Possible remedy
Motor burnt out. (Indicated by burning odour or smoke before the motor stopped, and / or bubbled or burnt paint)	Input power troubles, starting troubles, troubles while running, or excessive noise or vibrations, physical damage to the bearings, or bad bearings.	Install a new motor. Always determine the failure cause as indicated in following sections. Otherwise, the replacement motor, may also fail before it delivers a full life expectancy.

Section 2: Troubles related to surrounding atmosphere

Trouble	Probable cause	Possible remedy
Motor dirty	Ventilation blocked, dirt accumulated over cooling ribs, end windings filled with fine dust or lint (dust may be cement, saw dust, rock dust, grain dust, coal dust etc.)	Remove the accumulated dust on motor body. Dismantle entire motor. Clean fan and fan cowl. Clean all windings. Clean motor will run 10 to 30 deg.C cooler.
	Rotor winding clogged	Clean and grind slip rings. Clean and treat windings with good insulating varnish.
	Bearing and end shields	Clean and wash with cleaning solvent.
Motor wet	Subjected to dripping	Wipe motor and dry by circulating hot air over motor. Install canopy type cover over motor for protection.
	Submerged in flood water	Dismantle and clean the parts. Bake windings in oven at 90 deg.C for 24 hours or until insulation resistance is minimum 10 mega ohms.

Section 3: Troubles related to starting of the motor

Trouble	Probable cause	Possible remedy
Motor connected but does not start (No hum or heating) Note: Reset the overload relays, if tripped. Then try to restart the motor.	Faulty starting apparatus (Motor controller will not operate)	Check for proper functioning of the starting apparatus. Replace the defective controller.
	No supply voltage (Main supply switched off)	Check main switch. Check fuse and switch contacts and test lines for continuity. Check voltage in all three phases at the motor terminals. If there is no input voltage, locate and correct the problem in the input side.
Motor connected but does not start (Just hum and heats up) Note: Immediately switch off the power to prevent motor burning. The overload relays may trip.	a) One phase open due to blown fuse, faulty switch contact or broken lead.(Motor input side single phased i.e. No voltage in one or two phases, can be a temporary condition) b) Voltage too low than rated voltage of the motor	Check main switch. Check fuse and switch contacts and test lines for continuity. Check voltage in all three phases at the motor terminals. If single phase condition exists, correct the problem.
	Rotor control gear defective. Bad bedding of carbon brushes	a) Examine each step of the control gear for bad contacts or open circuit; and b) make sure, that brushes are making good contact with the slip rings. c) Check for continuity between rotor leads and starter.
	Starting torque required for load too high	a) For squirrel cage motor with autotransformer starting, change to a higher tap. b) For slip ring motor, lower the starting resistance
	Rotor defective	Look for broken bars and/or rings. New rotor may be required as repairs are usually temporary
	Poor stator coil connections. Interturn short in stator coil.	Remove endshields and locate the loose connections with test lamp. For interturn short, use surge tester.
	Mechanical locking in bearing or at air gap	Dismantle and repair. Clean air gap if choked.
	Wrong connections	Check with connection diagram supplied by manufacturer. See that connections are right.
	Motor may be overloaded. (Rotor and driven load is locked)	Disconnect the motor from driven load, to see if motor starts and achieves full speed in uncoupled condition. If so, then the trouble is with the load. Reduce starting load or install larger motor. If auto transformer is used, try higher tapping.

Motor does not come upto speed	Wrong selection / supply	Consult supplier for proper type
	Voltage too low at motor terminals because of line drop.	Check voltage at motor terminals. Use higher voltage tap on transformer terminals or reduce load.
	If slip ring motor, improper operation of secondary control gear resistance.	Correct secondary controlgear.
	Starting load too high	Check the load, motor is supposed to carry at start.
	Poor / no contact between brush and slip ring (brushes resting loose on slip rings)	Check that all brushes are riding on slip rings for all three phases. (Appropriate spring pressure required) Check secondary connections thoroughly and tighten the connections.
	Poor secondary connections	Check all secondary connections. Leave no leads poorly connected.
	Broken rotor bars	Look for cracks near the rings. Replace the rotor
		New rotor may be required as repairs are usually temporary.
	Open primary circuit	Locate fault with testing device and repair.
Motor stalls	Wrong application	Change type or size and consult manufacturer
	Overloaded motor	Reduce load.
	Incorrect control resistance of slip ring rotor	Check control sequence. Replace broken resistors. Repair open circuits.
	Low motor voltage	See that nameplate voltage is maintained/ available at motor terminals..
	Open circuit	Replace fuse, check overload relays, starter and push button.
	Mechanical locking in bearing or at air gap	Dismantle and repair. Clean air gap if choked.
	Poor contact at cable connections	Check supply cable connections at both sides.
Motor runs and then dies down	Power failure	Check for loose connections to line, to fuses and to controlgear.
	Overload	a) Examine if overload relay trips and see that they are set correctly to approximately 100% full load current. b) See that the dash-pots are filled with correct quantity and grade of oil.
Motor takes too long time to accelerate (10 or more seconds upto 180 frame, 12 or more second for 200 to 250 frame, 15 seconds or more for 280 and above frames)	Excessive starting load or high inertia loading	a) Reduce load / inertia or allow ample time for acceleration at low voltage. b) Install a larger motor. c) If motor is driving a heavy load, or is starting up a long line of shafting, start more slowly, allow time for acceleration.
	Applied voltage too low.(Excessive voltage drop-running more than 2-3 % below line voltage) Inadequate motor starting torque when using a reduced voltage starting system (star-delta, part winding or auto transformer starting)	Use higher voltage tap on transformer terminals. a) Reduce the starting load or use a larger motor. b) Use a starting system which develops higher starting torque (VFD or slip ring motor or fluid coupling)

	Poor rotor resistance circuit.	Check for high external rotor resistance.
	Defective squirrel cage rotor.	Replace with new rotor.
	Improper connections of motor leads to supply lines.	Correct connections.
Over current relay trips during starting	Motor overloaded	Reduce starting load or install larger motor
	Starter operated too quickly (Slip ring starter)	Start more slowly to allow current to fall as much as possible in each step.
	Time setting too low	Readjust time lag and fill with correct quantity of suitable oil, if it is oil filled type.
	Mains voltage lower than rated voltage of the motor (resulting high starting time)	Check mains voltage. Ensure that rated voltage of motor is same as main voltage.
	Overload relays undersized	Use the relay size suitable to motor nameplate current.

Section 4: Troubles related to running of the motor

Trouble	Probable cause	Possible remedy
Wrong rotation	Wrong sequence of phases	Reverse two phase connections at switchboard or at motor.
Unbalanced line currents drawn by the motor	Unbalanced terminal voltage at motor terminals	Check loads and connections
	Single phase operations	Check for open contacts
	Poor rotor contacts in external resistance of slip ring motor	Check control devices
	Brushes not in proper position in slip ring motor	See that brushes are properly seated and flexible shunts are in good condition.
Motor overheats while running under load.	Motor overloaded. This can be confirmed by measuring input current in all three phases.	Reduce load. See that current drawn by the motor does not exceed nameplate value of the current. Use larger rating motor
	Poor ventilation.Air intake area in fan cowl may be clogged with dirt, dust or cotton fluff.. Very less space for fan to suck the air.	Clean the clogged suction area meant for ventilation. Keep sufficient space for fan to suck the air. Verify that cooling air is flowing freely over the motor.
	Higher ambient temperature	Install motor designed for specific ambient conditions.
	Motor may have one phase open	Check to make sure that all three phases are well connected.
	Earthed coil	Locate the fault and repair.
	Unbalanced terminal voltage	Check for faulty leads, connections and transformer.
	Shorted stator coil	Repair and then check watt-meter reading.
	Voltage too high or too low	Check motor terminal voltage.
	Rotor rubs stator bore.	Replace worn out bearings.
	Switching too frequent. Too many intermittent overloads during the operating cycle.	Use specially designed motor to suit frequent starting. Reduce the number of starts, the number of intermittent overloads, the size of overload peaks, or install a larger motor.

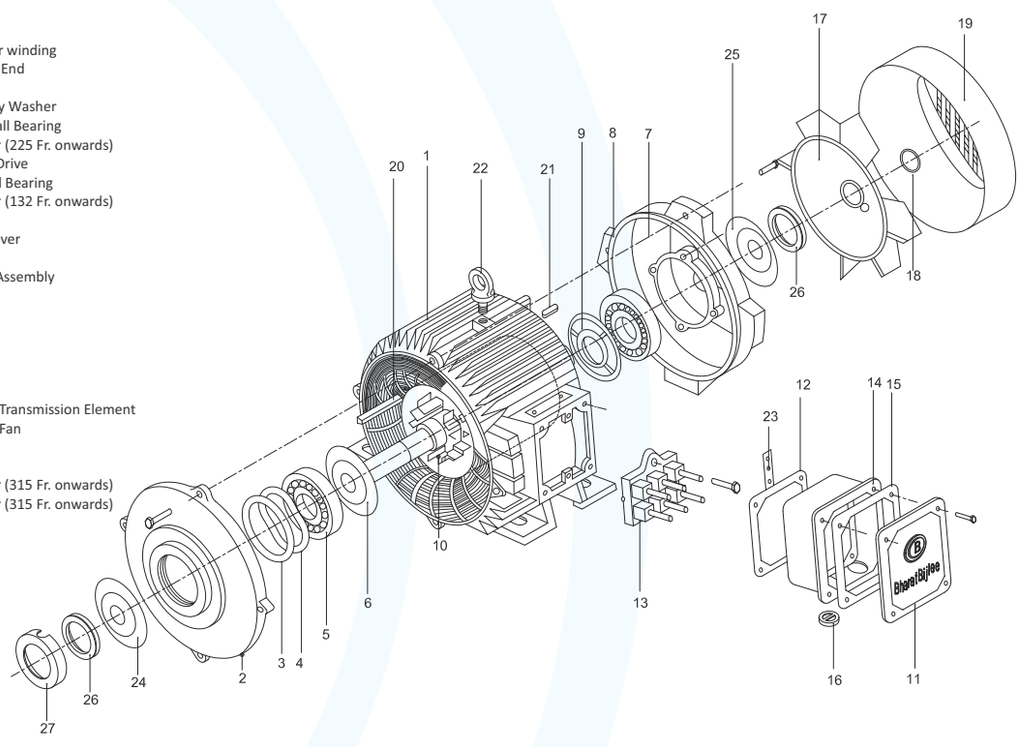
Motor sparking at slip rings	Motor may be overloaded	Reduce the load
	Brushes may not be of correct quality and may be sticking in the holders.	Use brushes of the grade recommended by the manufacturer.
	Brush pressure may be too light or too high.	Adjust the brush pressure correctly.
	Slip rings may be rough, dirty or oily.	Clean the slip rings and maintain them smooth, glossy and free from oil and dirt.
	Slip rings may be ridged or eccentric.	Turn and grind the slip rings in a lathe to a smooth finish.

Section 5: Troubles related to bearings

Trouble	Probable cause	Possible remedy
Hot bearings (general)	Bent or sprung shaft	Straighten or replace the shaft
	Excessive belt pull	Decrease belt tension
	Pulleys too far away from shaft shoulder	Move pulley closer to bearing
	Pulley diameter too small	Use larger pulley
	Misalignment	Correct by realignment of drive
Hot bearings (ball or roller)	Insufficient / no grease	Maintain proper quantity of grease in bearings
	Deterioration of grease or lubricant contaminated (dirt and foreign matters in the bearing grease)	Remove old grease, wash bearings thoroughly in petrol (to which a few drops of oil have been added) and replace with new grease.
	Excess grease	Reduce quantity of grease. (Bearings should not be more than half filled)
	Heat from hot motor or external source	Protect bearings by reducing motor temperature
	Overloaded bearings	Check alignment with driven equipment, excessive belt tension and / or end thrust. Reduce the load on the bearings.
	Broken ball or rough races	Replace bearings. Clean the housing thoroughly.
	Incorrect assembly	Ensure bearings assembled squarely on the shaft.

PART DESCRIPTION

1. Body with stator winding
2. Endshield Drive End
3. Bearing Washer
4. Preloading Wavy Washer
5. Deep-Groove Ball Bearing
6. Inner Brg. Cover (225 Fr. onwards)
7. Endsheild Non-Drive
8. Deep-Grove Ball Bearing
9. Inner Brg. Cover (132 Fr. onwards)
10. Rotor
11. Terminal Box Cover
12. Rubber Packing
13. Terminal Block Assembly
14. Terminal Box
15. Rubber Packing
16. Conduit Plug
17. Fan
18. Circlip
19. Fan Cowl
20. Feather Key for Transmission Element
21. Feather Key for Fan
22. Eye Bolt
23. Connecting Link
24. Outer Brg.Cover (315 Fr. onwards)
25. Outer Brg.Cover (315 Fr. onwards)
26. V-Seal
27. M. S. Cap



Section 6: Troubles related to noise and vibrations

Note: The troubles like vibration, mechanical noise and bearing noise are mostly caused by poor or deteriorating installation of the motor base, motor, driven load, sheaves or coupling. The motor and driven load must be mounted firmly and solidly with precise alignment or vibration will develop leading to mechanical failures. Foundations must be secure and stable. Shims must be as few in number as possible to insure that all motor feet are mounted in the same geometrical plane. Consider tapered shims, if necessary.

These are common failures. If motors and driven load are properly mounted, these failures can be virtually eliminated.

Trouble	Probable cause	Possible remedy
Motor vibrates during running and / or mechanical noise (It may originate in the driven load, coupling, or motor) Note: Loosening one motor foot at a time and listening may identify stresses caused by an improper mounting.	Motor shaft and driven equipment shaft misaligned, in close coupled application.	Check the alignment between the motor shaft and driven load. Realign the motor and driven equipment.
	Weak foundation	Strengthen the motor foundation.
	Poor or loosened motor or driven load mounting	Ensure that the foundations for the motor and the driven load are rigid. Mounting bolts are tight. Check any grouting for cracks.
	Unlevelled motor feet with foundation	Make proper leveling with the base. Ensure that the feet are properly shimmed and in the same plane.
	Unbalance in driven equipment	Disconnect the motor from the load and restart. If the noise and vibration are vanished, the problem is in the load. Balance the driven equipment
	Unbalance in coupling / pulleys	Remove the coupling / pulley. Secure a half key in the motor shaft keyway and restart the motor. If the vibration and noise is vanished, the trouble is in the coupling / pulley. Balance the motor coupling / pulleys
	Motor out of balance	If the problem persists after disconnecting coupling / pulley, recheck the motor mounting. If the mounting is OK, the problem may be bad bearings, or a bent shaft., or unbalanced rotor.
	Defective ball or roller bearings	Replace the bearings
	Bent shaft	Replace the motor. Always determine the root cause of the bent shaft to prevent recurrence of the problem.
	Rotor balancing weights shifted	Rebalance the rotor.
	Slip ring rotor rewound / coils replaced	Rebalance the rotor.
	Three phase motor running on two phases.	Check for open circuit.
	Motor out of balance	If the problem persists after disconnecting coupling / pulley, recheck the motor mounting. If the mounting is OK, the problem may be bad bearings, or a bent shaft., or unbalanced rotor.
	Defective ball or roller bearings	Replace the bearings
	Bent shaft	Replace the motor. Always determine the root cause of the bent shaft to prevent recurrence of the problem.
	Rotor balancing weights shifted	Rebalance the rotor.

	Slip ring rotor rewound / coils replaced	Rebalance the rotor.
	Three phase motor running on two phases.	Check for open circuit.
	Excessive end play	Dismantle motor and add thrust washers between bearing and endshield.
	Breaking of rotor bars / rings in case of built up copper rotor	Replace the bars / rings and rebalance the rotor.
Scrapping or mechanical noise	Fan rubbing air guide (SPDP motors) Fan rubbing endshields / fan cowls (TEFC motors)	Remove interference
	Normal motor noise amplified by resonant mounting. Motor loose on bedplate.	Tighten holding bolts. Cushion the mounting or dampen the source of the resonance
	Dirt in air gap	Irregular noise. Dismantle and clean the motor.
	Loose accessories on motor	Check and retighten such loose accessories parts.
Magnetic noise	Air gap not uniform	Check and correct bracket fits or bearing
	Loose bearings / worn bearings	Correct or replace bearings
	Rotor unbalance	Rebalance the rotor, dynamically. Shaft straightness to be checked and corrected, if required.
	System single phased. Motor may overheat and trip the overload relays.	Switch off the power and let motor come to rest, then again switch on. If the motor hums and heats, but does not start, single phasing exists.
A certain amount of magnetic noise is inherent in some low speed designs and should not be cause of alarm.		
Bearing noise	Poorly fit or damaged bearings	Listen to each bearing for the following sounds: 1) Smooth mid range hum-normal fit, bearing OK. 2) High whine-tight internal fit. Replace the bearing and check the fit. 3) Low rumble: Loose internal fit. Replace the bearing and check the fit 4) Rough clatter-Bearing destroyed. Replace the bearing. Always determine the root cause of the bearing failure or the trouble may reoccur. 5) Check bearing condition by SPM. Replace the bearings if damage confirmed.
	Dirty bearings	Wash out with turpe ntine, repack with grease and refit. If used for a long period beyond rated life, please replace bearings.

Note: For long bearing life, avoid the following.

Poor or loose mountings, misalignment, excessive vibrations and high belt tension.

Over greasing: More damage is done by excessive grease and contaminants introduced during greasing than by lack of greasing. Do not grease more than recommended by the motor manufacturer.

Water, dirt, or chemicals entering the motor. Consider totally enclosed motors when such contaminants exists.

Mixing of different types / makes of greases in the bearing.

Section 7: Troubles related to input power circuit

Note: These troubles as well as motor overloads are best identified by making following checks. Completing the entire process is also recommended even when the problem appears to be solved with an early step. It is to be noted that, the troubles can be intermittent and will not necessarily be identified during these checks. Knowing the history of recurring problems is crucial to arrive at final solution.

Step 1: Reset the overload relays, (if tripped) and start the motor.

Step 2: Measure the current in all three phases with the motor operating under load. If there is more than 5% deviation between phases, immediately switch off the power. See the remedies against "unbalance currents". If the currents are balanced, and overload relay is tripping, then the motor is probably overloaded. Go to step 3. To confirm an overload, note the current values with respect to the nameplate full load current value and proceed to step 4.

Step 3: Measure the voltage in all three phases with the motor off and with the motor running. Take the meter readings at the supply side and motor side of the controller and in the motor terminal box. If the voltage is 10% (or more) above or below the motor nameplate voltage with the motor both stopped and running, see the remedies against " high current in all three phases".

Step 4: Disconnect the motor from the load start the motor and measure the no load current in all three phases. If the no load current matches the value given by motor manufacturer, but the full load current is high, the motor is overloaded.

Trouble	Probable cause	Possible remedy
High current in all three phases	Line voltage 10% (or more) above or below the motor nameplate voltage.	Adjust the transformer tap to get correct nameplate voltage. Replace the motor with correct voltage rating.
	Motor overloaded (Voltage OK and load current high confirmed by normal no load current)	Reduce the load or install a larger motor.
Unbalance currents in the phases (5% or more deviation between phases from the average current)	Unbalanced line voltage, measured at the motor terminals, caused by the following: Unbalanced power supply (Unequal transformer tap settings) Unbalanced system loading High resistance connection Capacitor bank faulty Defective motor (Uneven air gap, wrong winding) Damaged supply cable. Poor connections at various stages.	Locate and correct the cause of unbalance (power line or motor).

Note: A small voltage unbalance will cause a large current unbalance. Depending upon the magnitude of the unbalance and size of the driven load, the current in one or two phases may exceed the rated motor current.

Section 8: Troubles related to motor operation with VFDs

Excessive electrical noise (humming and buzzing) and motor overheating. Occurs below half speed.	High voltage boost	Use correct volts/hertz ratio.
Excessive mechanical noise (sounds like stones in the air gap)	Unstable current loop	Check for loose encoder coupling.
Excessive mechanical noise (grinding and clanking)	Noise in operating frequency range	Programme the drive to skip the frequencies where noise occurs.
Motor overheats	If the motor has external fan, air is blowing in the wrong direction for cooling	Single phase blower motors-check for correct wiring of run capacitor. Three phase blower motors-interchange any two phase connections.
Motor will not start with drive in the across the line start mode	Volts/hertz curve does not match to the motor	Confirm volts/hertz as per nameplate.

MOTOR SERVICE RECORD

Serial No. _____ kW _____ Type _____

Speed _____ Volts _____ Amperes _____ Phase _____ Frequency _____

Insulation Class _____ Temperature Rise _____ °C Frame Size _____

Connection Diagram-Rotor _____ Stator _____

Owner Order No. _____ Item No. _____ Date Purchased _____

MACHINE TYPE	WEATHER PROTECTED	LUBRICATION
- Horizontal - Vertical - Totally-Enclosed - Explosion-Proof	**Bearings** - Ball - Roller -Sleeve Size : Drive End _____ Non Drive End _____	**Shaft Extension** Length _____

Date Installed	Location	Application	Dist. kept for cooling

Date Repaired or Replaced	Repairs or Parts Replaced	Fault	Repaired by	Total Cost

Name of Part	No. Per Machine	Manufacturer's No.	Date	Qty. Repl.	Cost	Date	Qty. Repl.	Cost	Date	Qty. Repl.	Cost
Rotor											
Stator Coils											
Bearing, DE											
NDE											
Cooling fan											
Others											

INSPECTION													
Date													
Bearings													
Lubrication													
Excess Heat													
Excess Noise													
Speed													
Voltage in 3 ph													
Voltage Variation													
Voltage Unbalance													
Current in 3 ph													
Current Variation													
Current Unbalance													
Insulation Resistance													
Clean & clear air passages													
Alignment													
Vibration													
Body Temp.													
Abnormal noise													

Table 8 Limits of Vibration Severity in Rotating Electrical Machines Measured in State of Free Suspension (Velocity Mode)

IS 12075 : 2008

Sl.No	Shaft Height mm	56 < H ≤132		132 < H ≤225		225 < H ≤400		H > 400	
i	Range of Speed, rpm	500 to 1500	> 1500 and up to 3000	500 to 1500	> 1500 and up to 3000	500 to 1500	> 1500 and up to 3000	500 to 1500	> 1500 and up to 3000
rms value of vibration velocity in mm/s for the shaft height H in mm									
ii	N(Normal)	1.8	18	1.8	2.8	2.8	4.5	2.8	4.5
iii	R(Reduced)	0.71	0.71	0.71	1.12	1.8	2.8	----	----
iv	S(Special)	0.45	0.45	0.45	0.71	1.12	1.8	----	----

Table 9 Derived Values of Limits of Vibration Severity in Rotating Electrical Machines Measured in State of Free Suspension (Displacement Mode)

Shaft Height	56 < H ≤132						132 < H ≤225						225 < H ≤400						H > 400					
Speed, rpm	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000
Vibration limit in maximum displacement amplitude, in µm																								
N(Normal)	96	80	64	48	32	16	96	80	64	48	32	25	150	125	100	75	50	42	150	125	100	75	50	40
R(Reduced)	36	30	24	18	12	6	36	30	24	18	12	10	96	80	64	48	32	26	---	---	---	---	---	---
S(Special)	24	20	16	12	8	4	24	20	16	12	8	6	50	60	40	30	20	17	---	---	---	---	---	---

Note: For the purpose of Table 9 f is assumed as frequency corresponding to rotor rpm. But for evaluation the dominant frequency should be determined by spectrum analysis and only that frequency should be used for calculation.

CORRECTION OF POWER FACTOR

EXPLANATION OF POWER FACTOR

The general supply of electricity in this country is being standardized to alternating current. With alternating current, the flow of electricity is not steady like gas or water through a pipe, but consists of a series of waves following each other in rapid succession.

The frequency of these waves is usually 50 c/s and therefore, it is referred to as a 50 cycles supply. The power of this supply depends upon two factors:

a) Voltage and
b) Amperes (or current).

Either of the two factors mentioned above might be represented individually by its own set of waves. If these waves coincide entirely, which means that they are in step with each other, the whole of the current in the circuits is doing useful work.

If however, the two sets of waves are out of step, only a part of the current flowing through the lines can be usefully employed. There is, therefore, a ratio between the true power doing useful work and the apparent power of the supply system. This ratio is called the power factor. In a circuit in which both voltage and current are in step, the power factor is 100 percent or unity. For certain technical reasons, such as the inductive effect of a motor or other apparatus, the current may lag behind the voltage. Then, as stated above, only a part of the current becomes available for doing useful work, and it is referred to as the lagging power factor. For example, if only 75 percent current does useful work the true power is 75 percent of the apparent power, and in this instance the-power factor is said to be 0.75. The remaining 25 percent of current in the circuit is termed watt loss or idle current. It does not do useful work, but tends to heat up the cables. This current, which is virtually wasted, has to be paid for. Many supply authorities, therefore, either penalize the consumer for a bad power factor, or give a rebate for a satisfactory power factor which allows a better employment of their distribution system.

CORRECTION OF POWER FACTOR

Most supply companies make no surcharge if the total power factor is not less than 0.95. The efficiency and power factor of motors at various loads may be obtained from the manufacturers.

The average power factor may be obtained from the meters employed by the supply company when a rate including surcharge for low power factor is in force.

The power factor is expressed by the ratio:

$$\frac{\text{True Power}}{\text{Apparent Power}}$$

True power is the reading given by a wattmeter. Apparent power is the product of volts and ampere (multiplied, in the case of a three-phase system, by $\sqrt{3}$ or 1.732). Most supply companies use a three-phase integrating watthour meter for measuring the true power and an integrating sine meter for measuring the wattless component in which case the ratio:

$$\frac{\text{Wattless kVA Hours}}{\text{kW Hours}}$$

is equal to the tangent of the angle of lag and the equivalent cosine may readily be found from mathematical tables. The cosine of the angle thus found is the power factor of the circuit.

Table 10 shows the factor by which the load in kW has to be multiplied to obtain the reactive capacity, as given below, kVA to improve the existing power factor to the proposed corrected one:

Reactive kVA = Load in kW x Factor

Table 10: Factors for obtaining Reactive Capacity from Load

Existing power factor	Proposed Power Factor				
	0.80	0.85	0.90	0.95	unity
0.40	1.537	1.668	1.805	1.959	2.288
0.41	1.474	1.605	1.742	1.896	2.225
0.42	1.413	1.544	1.681	1.836	2.164
0.43	1.356	1.487	1.624	1.778	2.107
0.44	1.290	1.421	1.558	1.712	2.041
0.45	1.230	1.360	1.501	1.659	1.988
0.46	1.179	1.309	1.446	1.600	1.929
0.47	1.130	1.260	1.397	1.532	1.881
0.48	1.076	1.206	1.343	1.497	1.826
0.49	1.030	1.160	1.297	1.453	1.782
0.50	0.982	1.112	1.248	1.403	1.732
0.51	0.936	1.066	1.202	1.357	1.686
0.52	0.894	1.024	1.160	1.315	1.644
0.53	0.850	0.980	1.116	1.271	1.600
0.54	0.809	0.939	1.075	1.230	1.559
0.55	0.769	0.899	1.035	1.190	1.519
0.56	0.730	0.860	0.996	1.151	1.480
0.57	0.692	0.822	0.958	1.113	1.442
0.58	0.655	0.785	0.921	1.076	1.405
0.59	0.618	0.748	0.884	1.039	1.368
0.60	0.584	0.714	0.849	1.005	1.334
0.61	0.549	0.679	0.815	0.970	1.299
0.62	0.515	0.645	0.781	0.936	1.265
0.63	0.483	0.613	0.749	0.904	1.233
0.64	0.450	0.580	0.716	0.871	1.200
0.65	0.419	0.549	0.685	0.840	1.169
0.66	0.388	0.518	0.654	0.809	1.138
0.67	0.358	0.488	0.624	0.779	1.108
0.68	0.329	0.459	0.595	0.750	1.079
0.69	0.209	0.429	0.565	0.720	1.049
0.70	0.270	0.400	0.536	0.691	1.020
0.71	0.242	0.372	0.508	0.663	0.992
0.72	0.213	0.343	0.479	0.634	0.963
0.73	0.186	0.316	0.452	0.607	0.936
0.74	0.159	0.289	0.425	0.580	0.909
0.75	0.132	0.262	0.398	0.553	0.882
0.76	0.105	0.235	0.371	0.526	0.855
0.77	0.079	0.209	0.345	0.500	0.829
0.78	0.053	0.183	0.319	0.474	0.803
0.79	0.026	0.156	0.292	0.447	0.776
0.80	-	0.130	0.266	0.421	0.750
0.81	-	0.104	0.240	0.395	0.724
0.82	-	0.078	0.214	0.369	0.698
0.83	-	0.052	0.188	0.343	0.672
0.84	-	0.026	0.162	0.317	0.645
0.85	-	-	0.136	0.291	0.620
0.86	-	-	0.109	0.264	0.593
0.87	-	-	0.083	0.238	0.567
0.88	-	-	0.054	0.209	0.538
0.89	-	-	0.028	0.183	0.512
0.90	-	-	-	0.155	0.484
0.91	-	-	-	0.124	0.453
0.92	-	-	-	0.097	0.426
0.93	-	-	-	0.066	0.395
0.94	-	-	-	0.034	0.363
0.95	-	-	-	-	0.329
0.96	-	-	-	-	0.292
0.97	-	-	-	-	0.250
0.98	-	-	-	-	0.203
0.99	-	-	-	-	0.143

POWER FACTOR CORRECTION DEVICES

Correction Devices

There are two practical methods of power factor correction as given below:

a) By means of shunt capacitors, and
b) By means of synchronous motors or Condensors.

The method synchronous motors or condensors are mainly applicable to large installations and is consequently beyond the scope of this code. Attention is, therefore, confined to the first method only.

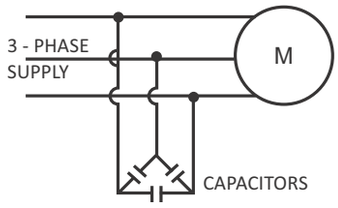
Location

Best results are obtained by connecting the capacitor as close as possible to the motor or other apparatus which requires power factor correction. In practice, however, this is not always possible. In cases where one capacitor has to correct the power factor of several motors, the capacitor should be connected across the LT side of the mains, and always on the load side of the supply meter.

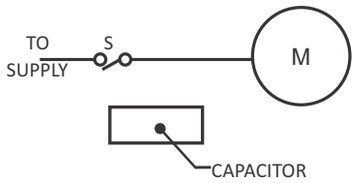
Correction

Group correction is often advisable, especially when the total average load represents only a part of the installed motor rating and is fairly constant. If, however, the existing power factor is as low as, says, 0.60 or less, and the load not constant, skilled attendence for the switching operation may be required. In such cases the human element may be eliminated by adopting individual correction which is also recommended where motors are being added to an existing installation.
However, each case has to be treated on its merits.

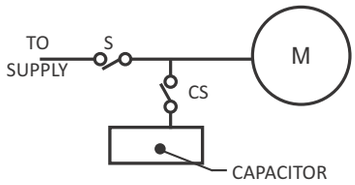
Details of connections are illustrated in Fig. 1



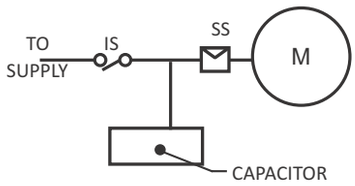
1 A Shows connections of capacitors to three phase motor. The capacitors are delta-connected, which is standard practice on three-phase supply



1 B The switch 'S' which controls the motor, simultaneously also switches the capacitor ON or OFF



1 C Aseparate switch 'CS' is provided for the capacitor. This refers to a case where the corrected power factor exceeds 0.95

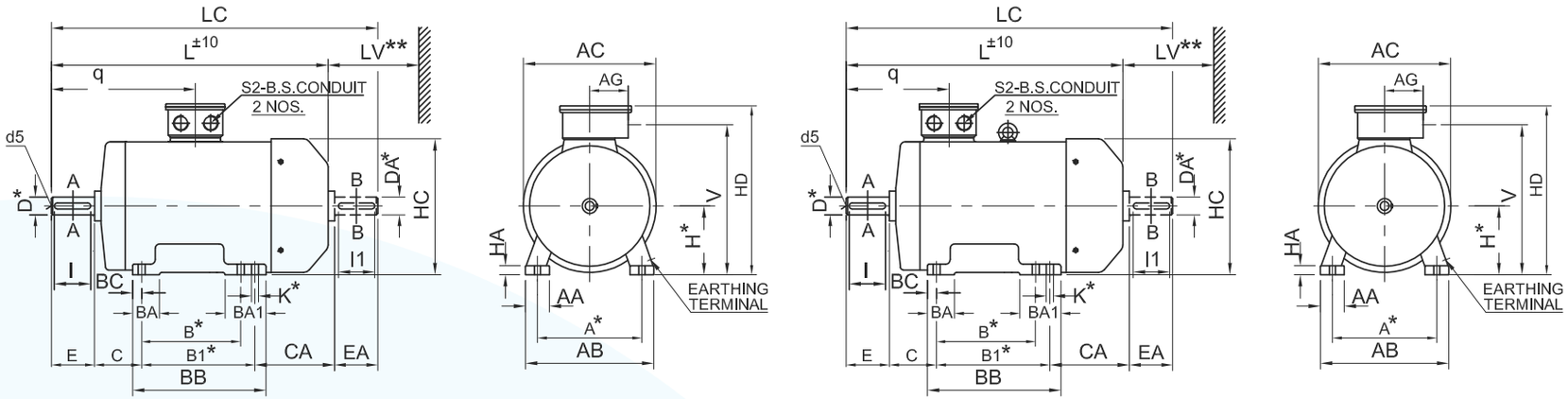


1 D No separate capacitor switch is shown. Where isolator 'IS' and 'SS' are in existence, the capacitor is connected to a point between these switches

FIG. 1 Individual Connections

Where a capacitor is connected across the terminals of an induction motor, care should be taken that the current taken by the capacitor does not exceed the motor magnetizing current as otherwise dangerous over-voltages may be setup when the motor is switched off due to the self excillation effect, values of magnitising current can be obtained from the manufacturer.

Dimensional Drawing: Industrial Motors Type MA Foot Mounted (B3) TEFC series Frame 180M/L- 355M/L (Dual Mounting)



FRAME SIZE 180M/L TO 225S/M

FRAME SIZE 250S/M TO 355M/L

IEC Fr. size	Pole	FIXING A*	FIXING B*	FIXING B1*	FIXING C	FIXING H*	FIXING K*	GENERAL AB	GENERAL BB	GENERAL AA	GENERAL BA	GENERAL BA1	GENERAL BC	GENERAL HA	GENERAL HC	GENERAL HD	TERMINAL BOX L	TERMINAL BOX LC	TERMINAL BOX CA	TERMINAL BOX AC	TERMINAL BOX LV**	TERMINAL BOX V	TERMINAL BOX q	TERMINAL BOX AG	TERMINAL BOX S2 B.S.C.	SHAFT D,DA*	SHAFT E	SHAFT EA	SHAFT F* FA*	SHAFT GA* GC*	SHAFT I	SHAFT I1	SHAFT d5
180M/L	2,4,6,8	279	241	279	121	180	15	344	319	65	70	108	23	26	357	445	717	838	218	354	70	396	371	97	1 1/2"	48	110	14	51.5	100		M16
200M/L	2	318	267	305	133	200	19	398	355	85	85	123	28	32	397	519	795	920	262	394	80	449	396	155	2"	55	110	16	59	100		M20
	4,6,8																772	897	239													
225S/M	2	356	286	311	149	225	19	436	361	85	85	110	28	34	450	569	837	956	276	450	90	498	445	155	2"	55	110	16	59	100		M20
	4,6,8																852	1001	231							60	140	18	64	130		M20
250S/M	2	406	311	349	168	250	24	506	425	100	115	137	49	42	495	665	914	1065	268	489	100	578	352	243	2"	60	140	18	64	130		M20
	4,6,8																									65	140	18	69	130		
280S/M	2	457	368	419	190	280	24	540	490	100	110	149	40	42	552	725	1010	1160	271	544	115	638	360	243	2"	65	140	18	69	130		M20
	4,6,8																									75	140	20	79.5	130		
315S/M	2	508	406	457	216	315	28	625	540	120	120	155	46	45	600	830	1137	1293	340	600	130	728	386	278	2"	65	140	18	69	130		M20
	4,6,8																1167	1353					416			80	170	22	85	160		
315M/L	2		457	508					593	120	120	171	46				1302	1458	454				386		2 1/2"	65	140	18	69	130		
	4,6,8																1332	1518					416			80	170	22	85	160		
355M/L	2	610	560	630	254	355	28	710	770	110	170	240	73	45	693	939	1461	1622	458	685	145	850	434	403	3"	75	140	20	79.5	130		M24
	4,6,8																1491	1682					464			95	170	25	100	160		

TABLE A

Dimension	Tolerance		Specification
A,B	±0.75		
H	-0.5	UPTO 280	IS : 1231
	-1	OVER 280	
K	+0.430	15Ø	
	+0.520	19,24,28Ø	

Dimension	Tolerance		Specification
D,DA	k6	48Ø	IS : 1231
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

Note: Motor in frame 315M/L & 355M/L will be offered with M.S. Fabricated body. Refer Sales office for offer

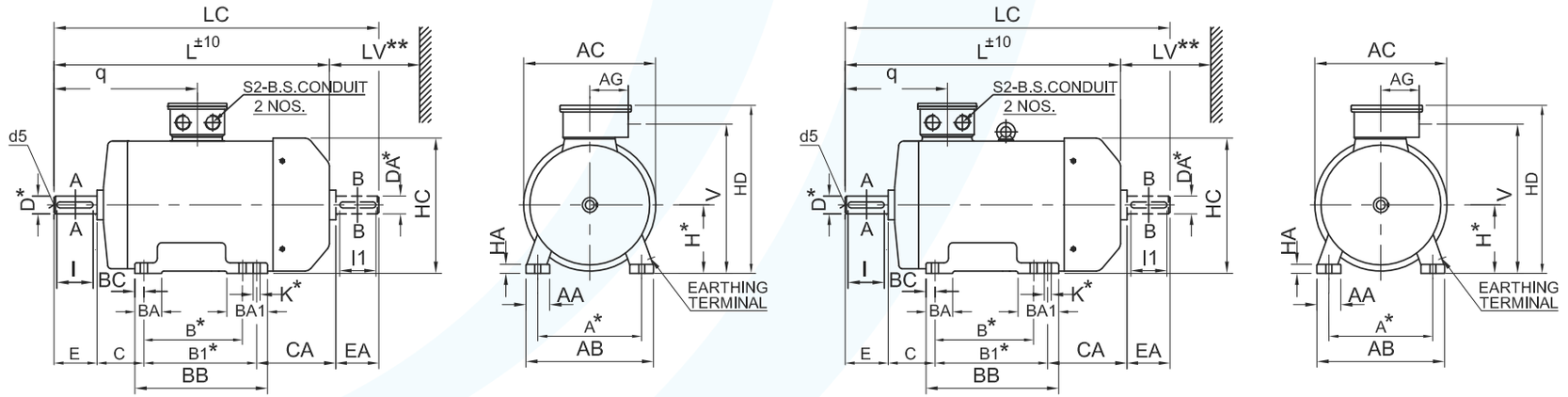
- Double shaft extension can be provided with shaft dimension identical to DE shaft.
- Also suitable for B6,B7,B8,V5 & V6 mounting as per IS 2253.
- Key / key way fit : h9 / N9

** Minimum distance for efficient cooling of motor to be maintained by user

Note: For non-standard motors, these dimensions may change. Please contact sales office for details.

All Dimensions are in mm unless otherwise specified.

Dimensional Drawing: Industrial Motors Type 2H Foot Mounted (B3) TEFC series Frame 180M/L- 355M/L (Dual Mounting)



FRAME SIZE 180M/L TO 225S/M

FRAME SIZE 250S/M TO 355M/L

IEC Fr. size	Pole	FIXING A*	B*	B1*	C	H*	K*	GENERAL AB	BB	AA	BA	BA1	BC	HA	HC	HD	L	LC	CA	AC	TERMINAL BOX LV**	V	q	AG	S2 B.S.C.	SHAFT D,DA**	E	F* FA*	GA* GC*	I I1	d5
180M/L	6,8	279	241	279	121	180	15	344	319	65	70	108	23	26	357	445	717	838	218	354	70	396	371	97	1 1/2"	48	110	14	51.5	100	M16
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	6,8																772	897	239												
225S/M	2	356	286	311	149	225	19	436	361	85	85	110	28	34	450	569	837	956	276	450	90	498	445	155	2"	55	110	16	59	100	M20
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	4,6,8																1332	1518					416			80	170	22	85	160	
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	4,6,8																1491	1682					464			95	170	25	100	160	

TABLE B

Pole	L	LC	CA
—	—	—	—
2,4	737	841	221
—	—	—	—
4	795	920	262
—	—	—	—
4	877	1026	281
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—

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D,DA	k6	48Ø	IS : 1231
	m6	55,60,65,75,80,95Ø	
GA,GC,F,FA			IS : 2048
d5(centering)			IS : 2540

*Refer TABLE A for tolerances

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- Key / key way fit : h9 / N9

** Minimum distance for efficient cooling of motor to be maintained by user

All Dimensions are in mm unless otherwise specified.

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BBL/CAT/001 SEPTEMBER 2016

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