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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



Drives & Automation

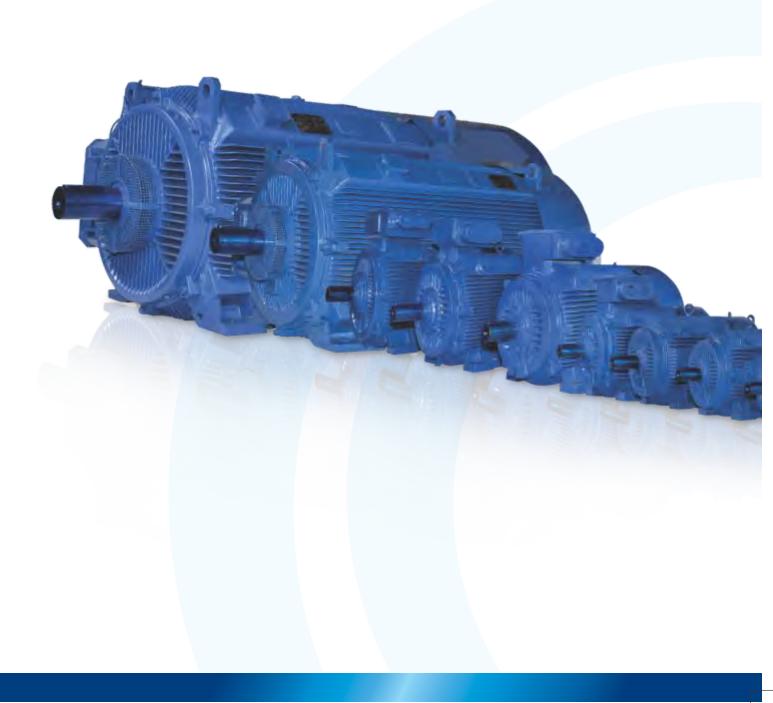


MV Motors 160kW to 1000kW, up to 6.6kV



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.





INDUSTRIAL MOTORS

	General Technical Information - Effects of converter (VFD) supply voltage on motor performance	1
:	1. Standard Motors	12
	a. Performance Tables	
	b. General Arrangement Drawings	
:	2. IE2 Series Motors	21
	a. Energy Efficient Motors - General Information	
	b. Performance Tables	
	c. General Arrangement Drawings	
:	3. High Efficiency 8 Pole Motors	33
	a. Performance Table	
	b. General Arrangement Drawing	
	4. IE3 Series Motors	39
	a. Energy Efficient Motors - General Information	
	b. Performance Tables	
	c. General Arrangement Drawings	
!	5. High Efficiency Large Motor with DCCA	48
	a. Performance Table	
	b. General Arrangement Drawing	
AN	NEXURE	54

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 Large LT Motors(DCCA)	112 to 180 355 to 450	1.50 to 22 280 to 1250	4 2, 4, 6, 8	A COLORADO
Standard Flame Proof Motors	80 to 315	0.37 to 200	2, 4, 6, 8	SEM.
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	Comments.
				0
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	
	71 +- 255	0.27 + . 400	4.6.0	
Crane & Hoist Duty Motors	71 to 355	0.37 to 400	4, 6, 8	
				I
Brake Motors	71 to 132	0.25 to 9.3	2, 4, 6, 8	400
Slip ring Motors	100 to 160	1.10 to 10	4,6	
Toytilo Motors Dire France	100 to 160	1.1 to 15	1	
Textile Motors - Ring Frame	100 (0 160	1.1 (0 15	4	
				The star
Cane Unloader Motors	160 to 225	11 to 30	6	-
Marine Duty Motors	63 to 450			
	A			
Roller Table Motors	As per requirement			C. C
Railway Auxilliary Motors	As per			- CA
	requirement			- all
Medium Voltage Motors	355 to 450	160 to 1000	2,4,6,8	
				A CONTRACT OF A

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Product Range

Туре	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

	ors with nt 40° C	For motors with Ambient 50° C		
Amb. Temp. (°C) 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	

Variation in Ambient & Altitude for all Motors

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		ethod of Starting	No. Lead	
Up to & including 1.5 kW		DOL	3 (Internal Star connection), fo MA series moto 6 (for 2H series motors)	
Above 1.5 kW	DOL o	r 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.

- GD² 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	Enclosure	Terminals	Box Location
Size	Materials	Standard	Option
			Available
63-80	Aluminum	TOP	
	Aluminum	TOP	
90S-132M	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	ТОР	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.

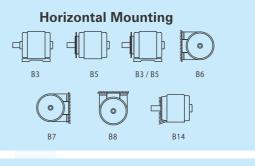
Type of Construction

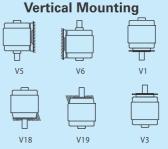
Standard motors are designed for foot mounting (B3). Motors up to frame 355 are also suitable for B6, B7, B8, V5 and V6 mounting.

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.

Frame	Sizo		g Nos. C3 rance	Terminal Box	Terr	minal	No. & size of	Max cond. Cross Sec. area		
Fidilie	5120	DE	NDE	Type/ Location	No. Size		No. Size		Cable entries	mm2
63		6201 2Z	6201 2Z							
71		6202 2Z	6202 2Z	gk030/ TOP	3					
80		6004 2Z	6004 2Z	-			1 2 / 4 //			
90S, 9	90L	6205 2Z	6205 2Z	gk130/TOP		M4	1×3/4"	4		
100	L	6206 2Z	62052Z		3*					
112	M	6206 2Z	6205 2Z	gk230/TOP						
132S, 1	.32M	6208 2Z	6208 2Z	gk330/TOP			2 × 1"	10		
160M,	160L	6309 2Z	6209 2Z	gk330/RHS	6	M5		16		
180M, 180	L(IE2 4 P)	6310 2Z	6309 2Z	gk430/RHS	6	M6	2 × 1-1/2"	50		
180M, 180L (S 4P, 6P, 8P & I		6310 2Z	6210 2Z	gk430/RHS	6	M6	2 × 1-1/2"	50		
200	L	6312 2Z	6212 2Z	TB225/RHS	6	MO				
225S, 2	25M	6313	6213	10225/КП5	6	M8		70		
250	M	6315	6215				2 × 2"			
280 S/M	2P	6316	6316	TB280/ TOP	6	M10	2.02	150		
	4,6 & 8P	6317	6316							
3155,		6319	6319	TB315/ TOP	6	M12	2x2"	185		
315							2x2 ½ "	240		
355		6322	6322	TB 355/ TOP	6	M16	2 X 3"	300		
	2P 4P	6319	6319	-						
355L/K	6P	6322	6322	TB400/RHS						
	8P	0022	0322							
	2P									
40014/1	4P	6224	6322	TB400/ TOP	6	M20	2x3"	400		
400M/L	6P	6324	6322	TB400/ TOP			273	100		
	8P									
	4P	1								
450M/L	6P	6326	6326	TB400/ TOP						
	8P									

Bearing and Terminal Box Details

*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	Relub	orication
Dearing	FUIE	Quantity (gm)	Interval (Hrs)
	2		3200
6313	4	120	9000
0515	6	120	15000
	8 2		21000
			2800
6315	4	150	8200
0515	6	150	10000
	8		18000
6316	2	180	2000
	4		7500
6317	6	180	13000
	8		17500
	2		2000
6319	4	220	5000
0519	6	220	7500
	8		10000
	2		1000
6322	4, 6	40	3000
	8		6000
	2	40	1000
6324	4, 6		2500
	8		5000
6226	4, 6	40	2000
6326	8	40	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 DIME	NSIONS	MOTOR
		LENGTH	WIDTH	HEIGHT	GROSS WEIGHT IN Kg
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
2255	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 μ s. 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.

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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.

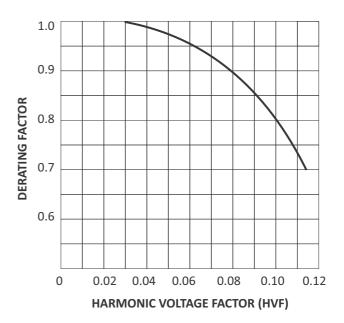
Temperature Rise of the Motor

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°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° 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.

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

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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.



Motor Parameters	BBL Standard	Customer
Base voltage and	Base Voltage: 415V	Specification Customer to specify
kW rating at 50Hz	kW Rating: As per Customer requirement	
Four point rating as per IS 15881	As per customer requirement	Customer to specify
Duty Details (Torque at different speeds and time d uration)	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	Forced cooling arrangement for speeds 30% or below	Customer to specify
Torque	For other speeds, refer to works	customer to specify
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 /	F to F at 100% load (VFD supply)	
Temperature rise	F to B at 85% load (VFD supply)	Customer to agree
(F to F / F to B)	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 enco der 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

Checklist For Motors To Be Run On VFD Supply

CE TECHNICAL INFORMATION ATION

6 μsec or more	Customer to agree
6 μsec or more	Customer to agree
Installation requirements	
Special high frequency earthing (at customer's end)	Customer to provide
Shielded cables recommended	Customer to provide
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
Mandatory for high switching frequency (5kHz or more) and higher cable lengths (>5m)	Customer to agree
Not to be used	Customer to note
	6 μsec or more Installation requirements Special high frequency earthing (at customer's end) Shielded cables recommended 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 Mandatory for high switching frequency (5kHz or more) and higher cable lengths (>5m)



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

:415V+/-10%

Voltage

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 63 to 355L Performance table for 2 Pole motors

Duty : S1(Continuous) Ambient : 50° C

Ins. Class : F

Current, mem FL M-1 T/1 T/1 Current, mem T oppide (mem T oppide mem T oppide mem <tht oppide<br="">mem <tht oppide<br="">mem</tht></tht>	Rated Output Frame Type ref. B3 Rated	Type ref. B3	Rated		Rated		Operating chai	Ambient : 50 C Duty : 51(Continuous) 3000 rpm (2-Pole) aracteristics at rated out Power Factor	Ambient: 50. C Duty: 51(Continuous) 3000 rpm (2-Pole) rating characteristics at rated output Power Factor		% Efficiency		With DO Starting Current	With DOL starting arting Starting rrent Torque	Pullout Torque to Rated	Temp. Rise : 8 Protection : IP Rotor : 0 GD ²	:: B3 B3
1270 057 006 076 056 052 580 570 37 27 30 00009 2730 051 013 080 075 056 710 50 23 23 00019 2730 051 013 080 075 056 710 50 23 23 00019 2800 151 013 080 075 056 710 50 23 23 00019 2800 151 036 082 075 056 730 750 57 23 00019 2800 151 036 083 075 850 830 760 57 23 30 00018 2800 151 133 088 083 076 850 830 65 23 30 00018 2800 151 133 088 088 076 830 65 23 30 0				speed RPM	Amps.	- w-by	FL	3/4L	1/2L	FL	3/4L	1/2L	to Kated Current Ratio	to rated torque ratio	Torque Ratio	Kgmz	constr. kg
2720 0.05 0.09 0.82 0.73 0.65 0.65 0.74 0.65 0.74 0.65 0.005 0.005 2806 1.11 0.13 0.79 0.72 0.66 710 760 50 27 30 0.0019 2806 1.13 0.13 0.79 0.72 0.66 770 760 770 570 27 30 0.0019 2807 1.16 0.73 0.85 0.74 0.65 780 650 27 30 0.0019 2807 1.14 0.85 0.74 0.65 780 65 2.7 30 0.0019 2800 1.15 0.13 0.86 0.74 857 850	0.25 63 MA063213		13	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
2790 091 013 0.80 0.72 0.60 710 6.00 2.3 2.8 0.0013 2800 1.31 0.13 0.73 0.73 0.73 0.73 0.73 0.73 0.73 0.70 0.70 7.00 5.0 2.5 2.8 0.0031 2800 1.55 0.53 0.82 0.73 0.63 790 770 5.0 5.7 2.8 0.0031 2800 1.51 1.24 0.85 0.80 0.74 85.0 88.0 74.0 5.7 2.8 0.0031 2900 1.11 1.13 0.83 0.74 85.0 88.0 86.0 5.7 2.3 3.0 0.0138 2901 1.15 1.13 0.83 0.76 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0 88.0	0.35 63 MA063233		233	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
2806 1.31 0.19 0.79 0.77 0.56 7.40 7.10 5.0 2.7 3.00 0.0037 2830 1.65 0.38 0.82 0.73 0.63 730 750 5.0 5.9 2.7 3.0 0.0037 2840 1.65 0.38 0.82 0.75 0.63 790 750 5.9 2.7 3.0 0.0037 2840 7.12 1.34 0.85 0.80 0.76 850 83.0 76.0 5.5 2.7 3.0 0.0039 2920 101 1133 0.88 0.76 85.0 83.0 6.5 2.3 3.0 0.0139 2920 115 3.17 0.89 0.86 83.0 85.0 85.0 85.0 85.0 85.0 85.0 85.0 85.0 3.0 0.0139 0.0149 0.0149 0.0149 0.0149 0.0149 0.0149 0.0149 0.0149 0.0149 0.0149 0.014	71		213	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	9
3830 1165 0.26 0.82 0.74 0.62 770 760 750 550 257 230 0.0071 2840 3.01 0.55 0.55 0.55 0.55 2.73 300 0.0071 2830 4.35 0.76 0.85 0.76 80.6 78.0 740 5.5 2.7 30 0.0071 2830 1.11 1.83 0.85 0.76 85.0 78.0 76.0 5.5 2.3 30 0.0031 2900 1.11 1.83 0.88 0.76 85.0 87.0 86.0 87.0 5.5 2.3 30 0.0036 2900 1.12 1.83 0.89 87.0 86.0 87.0 65 2.3 30 0.0760 2920 51.5 0.99 0.88 0.88 86.0 87.0 65 2.2 2.5 0.076 2920 51.6 51.0 0.99 88.0 87.0	0.75 71 MA071233		233	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
2840 2.55 0.38 0.82 0.75 0.53 79.0 79.0 76.0 5.5 2.7 3.0 0.0051 2825 3.01 0.75 0.83 0.83 0.76 83.0 76.0 5.5 2.7 3.0 0.0039 2800 7.12 1.24 0.85 0.83 0.76 85.0 83.0 65 2.3 3.0 0.0039 2900 13.16 1.24 0.85 0.87 85.0 85.0 65 2.4 2.9 0.0980 2920 19.5 3.10 0.89 0.87 0.76 88.0 86.0 5.8 2.4 2.9 0.0980 2920 19.5 3.10 0.89 0.87 0.87 89.0 88.0 5.8 2.4 2.9 0.014 2920 19.5 3.10 0.89 0.87 89.0 88.0 5.8 2.0 3.0 0.014 2920 19.1 8.1 0.89	1.0 80 MA080213		0213	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
2885 3.01 0.52 0.86 0.33 0.76 8.05 78.0 78.0 55 27 3.0 0.0011 2830 7.15 1.14 0.85 0.85 0.85 0.86 0.76 8.0 76.0 6.5 2.8 3.0 0.0188 2800 1.11 1.83 0.85 0.85 0.77 8.57 8.50 8.00 6.5 2.3 3.0 0.0038 2920 1.55 3.50 0.89 0.77 8.57 8.50 8.00 6.5 2.3 3.0 0.0038 2920 15.5 0.89 0.87 0.35 8.00 850 5.5 2.3 3.0 0.0138 2920 316 7.11 0.89 0.87 0.86 8.0 8.0 5.5 2.3 3.0 0.0138 2920 316 7.11 0.99 0.88 0.86 8.0 8.0 5.5 2.2 3.0 0.0149	1.5 80 MA080233		0233	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
2830 436 0.76 0.85 0.82 0.74 82.5 80.0 76.0 6.0 30 3.0 0.0033 2900 7.12 1.24 0.85 0.80 0.70 85.0 83.0 78.0 6.5 2.3 3.0 0.0030 2920 11.5 1.34 0.83 0.84 0.76 87.0 86.0 82.0 6.5 2.3 3.0 0.0050 2920 155 3.10 0.89 0.87 0.83 89.0 86.0 87.0 65 2.3 3.0 0.0760 2920 155 500 0.99 0.87 0.83 89.0 86.0 5.8 2.4 2.9 0.0960 2920 116 6.17 0.99 0.87 0.89 9.5 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9.0 9	2.0 90S MA09S233		S233	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
2900 712 1124 0.85 0.80 0.70 85.0 83.0 78.0 6.5 2.8 3.0 0.01630 2200 10.1 1.83 0.88 0.85 0.77 85.7 85.0 80.0 65 2.3 3.0 0.01630 2200 16.5 3.10 0.89 0.87 0.76 88.0 86.0 83.0 65.5 2.4 2.9 0.0960 2201 16.5 3.10 0.89 0.87 0.87 89.0 88.0 86.0 58.0 65.7 2.4 2.9 0.014 2920 251.6 0.91 0.88 0.86 88.0 86.0 58.0 65.7 2.4 2.9 0.014 2920 51.2 9.91 0.88 0.86 65.7 2.4 2.9 0.051 2920 51.2 9.91 0.88 0.86 58.0 65.7 2.4 2.9 0.014 2930 51.2 9.9	3.0 90L MA09L253		L253	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
2920 10.1 183 0.88 0.87 85.7 85.0 85.0 65.7 2.3 30.0 00560 2920 13.6 2.5.0 0.88 0.84 0.76 87.0 86.0 6.5 2.3 30.0 0.0760 2920 19.5 3.16 0.89 0.87 0.87 89.0 86.0 5.7 2.3 30 0.134 2920 19.3 3.67 0.89 0.87 0.83 89.0 86.0 5.8 2.0 30 0.134 2920 31.6 0.39 0.88 0.86 90.5 5.0 30 0.134 2920 31.6 0.89 0.88 0.86 90.5 5.0 30 0.134 2920 51.7 0.99 0.88 0.86 90.5 5.0 30 0.134 2950 51.7 0.89 0.87 90.7 92.5 2.5 2.5 0.5 2.5 2960	5.0 100L MA10L213		JL213	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
2920 13.6 2.50 0.88 0.84 0.76 87.0 85.0 6.5 2.3 3.0 0.0760 2920 16.5 3.10 0.89 0.87 0.87 88.0 88.0 88.0 87.0 5.8 0.07 3.0 0.071 1 2920 16.5 3.10 0.89 0.87 0.80 88.0 88.0 5.8 2.0 3.0 0.071 1 2920 31.6 6.17 0.90 0.88 0.89 9.80 88.0 5.8 2.0 3.0 0.114 2920 31.6 6.17 0.90 0.88 0.89 9.80 88.0 5.8 2.0 3.0 0.114 2930 31.6 6.17 0.90 0.88 0.89 9.80 9.80 88.0 5.80 5.0 5.0 5.0 0.30 0.114 2930 91.1 0.81 0.80 0.80 9.90 89.0 5.0 5.1	7.5 132S MA13S2B3		\$S2B3	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
2200 165 3.10 0.89 0.85 0.76 88.0 86.0 5.8 2.4 2.9 0.0380 2200 11.3 3.67 0.89 0.87 0.83 89.0 86.0 5.8 2.0 3.0 0.134 2200 31.6 6.17 0.99 0.88 0.87 0.80 88.0 5.5 2.0 3.0 0.134 2290 31.6 6.17 0.99 0.88 0.85 99.5 99.0 88.0 5.5 2.0 3.0 0.134 2290 51.1 991 0.88 0.85 93.3 93.5 91.0 6.5 2.5 1.5 0.5 2950 89.1 81.1 0.90 0.87 0.84 93.3 92.5 91.0 6.5 2.5 1.5 1.6 2950 89.1 81.1 0.90 0.86 0.84 93.3 92.5 91.0 6.5 2.5 1.5 1.6 <	10.0 132S MA13S2E3		S2E3	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
2920 19.3 3.67 0.89 0.87 0.83 89.0 88.0 6.6 5.8 3.0 0.134 2920 26.2 5.00 0.89 0.88 0.88 0.87 0.03 0.03 0.134 2920 31.6 6.17 0.90 0.88 0.88 0.88 0.87 0.03 0.013 0.013 2920 31.6 6.17 0.90 0.88 0.86 9.95 9.95 5.7 2.0 3.0 0.114 2950 51.2 9.91 0.88 0.87 0.92 93.0 93.0 91.0 6.6 2.7 2.5 0.61 2960 74.4 14.8 0.90 0.87 93.7 93.0 91.0 6.0 2.7 2.6 0.73 0.7 2960 74.4 14.8 0.90 0.84 93.7 91.0 6.0 2.7 2.6 0.61 2970 142 293 91.0 6.0	12.5 132M MA13M2N3		M2N3	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
2920 26.2 5.00 0.88 0.88 0.82 89.5 89.0 87.0 6.0 2.0 3.0 0.171 2920 31.6 6.17 0.90 0.88 0.86 90.5 90.0 88.0 6.5 2.0 30 0.255 2950 51.2 9.91 0.88 0.86 90.5 92.5 88.0 6.5 2.5 2.5 0.30 0.30 2950 51.2 9.91 0.88 93.5 93.0 91.0 6.0 2.5 2.5 0.61 1.3 2950 744 14.8 0.90 0.87 93.3 93.2 91.0 6.0 2.5 2.5 0.61 1.4 2970 114 0.92 0.91 0.86 93.3 93.2 91.0 6.0 2.5 2.5 0.61 1.4 2970 114 0.92 0.84 93.7 92.5 91.0 6.0 2.5 2.5 5.0	15 160M MA16		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
2920 31.6 6.17 0.90 0.88 0.80 90.5 90.0 88.0 6.5 2.0 3.0 0.225 2930 37.6 7.31 0.89 0.87 0.80 91.5 90.5 88.0 6.5 2.7 0.30 0.325 2950 51.2 9.91 0.88 0.87 0.87 0.79 93.0 91.0 6.5 2.5 2.5 0.61 2960 89.1 18.1 0.90 0.87 0.83 93.3 92.8 91.0 6.6 2.5 2.5 0.61 2970 146 2.95 0.91 0.86 93.7 92.6 91.0 6.0 1.8 2.7 3.01 2970 146 2.95 0.91 0.86 93.7 93.0 91.0 6.0 2.7 2.63 2.0 2970 146 2.95 0.91 0.86 93.7 91.0 6.0 2.1 2.63 2.0 <	20 160M MA16		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
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 2950 51.2 9.91 0.88 0.85 0.79 93.0 92.6 65.5 2.55 2.55 0.55 0.57 0.52 2945 62.9 12.2 0.88 0.85 0.79 93.0 92.5 91.0 6.5 2.55 1.04 1.04 2960 74.4 14.8 0.90 0.87 0.83 93.5 93.0 91.0 6.0 2.1 2.55 1.04 2970 146 2.95 0.91 0.86 0.78 94.0 94.0 91.5 6.0 1.8 2.7 2.63 2982 215 43.1 0.90 0.86 0.78 94.0 91.0 6.0 2.5 5.0 6.2 2982 215 43.1 0.90 0.86 0.78 94.0 91.5 7.0 2.5	160L	_	MA16L273	2920	31.6	6.17	06.0	0.88	0.86	90.5	90.06	88.0	6.5	2.0	3.0	0.225	123
2950 51.2 9.91 0.88 0.85 0.79 92.6 92.6 92.5 91.0 6.5 2.5 2.5 0.52 0.52 2945 62.9 112.2 0.88 0.85 0.79 93.0 93.5 91.0 6.5 2.5 2.5 0.61 1 2946 74.4 14.8 0.90 0.87 0.83 93.5 93.0 91.0 6.0 2.5 2.5 0.61 2970 1122 24.6 0.91 0.89 0.84 93.7 92.5 91.0 6.0 1.8 2.7 2.63 2970 1146 52.9 0.90 0.84 93.7 92.5 91.0 6.0 1.8 2.7 2.63 2982 180 35.9 0.89 0.84 0.76 94.0 91.5 7.0 2.7 2.63 5.0 2982 215 43.1 0.90 0.86 0.78 94.0 91.5 7.0	180M	_	3M213	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
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 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 1 2950 89.1 18.1 0.90 0.87 0.84 93.7 92.5 90.0 6.0 2.1 2.65 2.11 2970 122 24.6 0.91 0.89 0.84 93.7 92.5 90.0 6.0 1.8 2.7 2.63 2.11 2970 146 29.5 0.91 0.84 93.7 93.6 91.0 6.0 1.8 2.7 2.63 3.1 2982 215 43.1 0.90 0.86 0.76 94.7 93.5 7.0 2.7 2.1 2.63 7.0 2982 216 43.1 0.90 0.84 94.7 93.5 7.0	40 200L MA2		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
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 2960 89.1 18.1 0.92 0.91 0.86 93.3 92.8 91.5 6.0 2.1 2.63 2.11 2970 122 24.6 0.91 0.89 0.84 93.7 92.5 90.0 6.0 1.8 2.7 2.63 2.11 2.63 2.11 2.63 2.11 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.11 2.7 2.63 2.01 2.7 2.63 2.0 2.0 2.12	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
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 2970 122 24.6 0.91 0.89 0.84 93.7 92.5 90.0 6.0 1.8 2.7 2.63 2.13 2970 146 29.5 0.91 0.89 0.84 94.0 93.0 91.0 6.0 1.8 2.7 2.63 7.0 2982 180 35.9 0.90 0.86 0.78 94.7 94.0 91.5 7.0 2.0 2.7 2.0 7.0 2982 215 43.1 0.90 0.86 0.76 94.7 94.7 94.7 7.0 2.0 2.7 5.0 7.0 2982 214 49.0 0.89 0.84 0.76 94.7 94.7 7.0 2.0 2.6 5.0 2982 250 52.3 0.50 0.76 94.7 94.7 7.0	225M	_	MA22M233	2960	74.4	14.8	0.00	0.87	0.83	93.5	93.0	91.0	6.0	2.5	2.5	1.04	348
2970 122 24.6 0.91 0.89 0.84 93.7 92.5 90.0 6.0 1.8 2.7 2.63 2970 146 29.5 0.91 0.89 0.84 94.0 93.0 91.0 6.0 1.8 2.7 2.03 2970 146 29.5 0.91 0.89 0.84 94.0 93.0 91.0 6.0 1.8 2.7 3.01 2982 180 35.9 0.90 0.86 0.78 94.7 94.0 91.5 7.0 2.0 2.5 5.0 2982 215 43.1 0.90 0.86 0.78 94.7 94.0 92.0 7.0 2.0 2.5 5.0 2982 247 49.0 0.89 0.84 0.76 94.7 94.7 7.0 2.0 2.5 6.2 6.2 2982 250 52.3 0.50 0.76 94.7 94.7 7.0 2.0 2.5 6.2 </td <td>75 250M MA2</td> <td>_</td> <td>MA25M213</td> <td>2960</td> <td>89.1</td> <td>18.1</td> <td>0.92</td> <td>0.91</td> <td>0.86</td> <td>93.3</td> <td>92.8</td> <td>91.5</td> <td>6.0</td> <td>2.1</td> <td>2.6</td> <td>2.11</td> <td>523</td>	75 250M MA2	_	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
2970 146 29.5 0.91 0.89 0.84 94.0 93.0 91.0 6.0 1.8 2.7 3.01 3.01 2982 180 35.9 0.90 0.86 0.78 94.5 94.0 91.5 7.0 2.0 2.5 5.0 5.0 2982 216 40.8 0.89 0.86 0.78 94.7 94.7 91.5 7.0 2.2 2.6 5.0 5.0 2982 215 43.1 0.90 0.86 0.78 97.0 94.0 92.0 7.0 2.2 2.6 5.0 5.0 2982 247 49.0 0.89 0.84 0.76 95.1 94.7 92.7 7.0 2.0 2.5 6.2 2982 220 52.3 0.90 0.86 0.77 95.2 94.7 92.7 7.0 2.0 2.5 6.2 2982 2299 58.8 0.88 0.88 0.77 95.2 94.7 92.7 7.0 2.0 2.5 6.2 2982 2299 58.8 0.88 0.87 0.77 95.2 94.7 92.7 7.0 2.0 2.5 6.2 2982 244 81.6 0.88 0.88 0.88 0.88 0.77 95.2 7.0 2.0 2.5 6.2 2982 240 81.6 92.7 7.0 2.0 2.6 2.7 7.0 2982 404 81.6	_	_	28S213	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
2982 180 35.9 0.90 0.86 0.78 94.5 94.0 91.5 7.0 2.0 2.5 5.0 5.0 2982 206 40.8 0.89 0.85 0.76 94.7 93.5 91.5 7.0 2.2 2.6 5.0 7.0 2982 215 43.1 0.90 0.86 0.78 95.0 94.0 92.0 7.0 2.2 2.6 5.0 7.0 2982 247 49.0 0.89 0.84 0.76 95.1 94.7 7.0 7.0 2.5 6.2 6.2 2982 250 52.3 0.90 0.85 0.77 95.2 94.7 7.0 2.0 2.5 6.2 <t< td=""><td>280M</td><td></td><td>8M233</td><td>2970</td><td>146</td><td>29.5</td><td>0.91</td><td>0.89</td><td>0.84</td><td>94.0</td><td>93.0</td><td>91.0</td><td>6.0</td><td>1.8</td><td>2.7</td><td>3.01</td><td>669</td></t<>	280M		8M233	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
2982 206 40.8 0.89 0.85 0.76 94.7 93.5 91.5 7.0 2.2 2.6 5.0 5.0 2982 215 43.1 0.90 0.86 0.78 95.0 94.0 92.0 7.0 2.2 2.5 5.0 5.0 2982 247 49.0 0.89 0.84 0.76 95.1 94.2 92.0 7.0 2.0 2.5 5.0 2982 260 52.3 0.90 0.85 0.77 95.2 94.7 7.0 2.0 2.5 6.2 7.7 2982 299 58.8 0.88 0.87 0.75 95.3 94.7 7.0 2.0 2.5 6.2 7.7 2985 324 65.3 0.88 0.88 0.87 0.85 95.3 94.7 7.0 2.0 2.5 6.2 7.7 2985 324 65.3 95.3 95.7 7.0 7.0 2.6	150 315S MA3		1S233	2982	180	35.9	06.0	0.86	0.78	94.5	94.0	91.5	7.0	2.0	2.5	5.0	898
2982 215 43.1 0.90 0.86 0.78 95.0 94.0 92.0 7.0 2.0 2.5 5.0 5.0 2982 247 49.0 0.89 0.84 0.76 95.1 94.2 92.2 7.0 2.0 2.5 6.2 6.2 2982 260 52.3 0.90 0.85 0.77 95.2 94.6 92.7 7.0 2.0 2.5 6.2 6.2 2982 299 58.8 0.88 0.82 0.75 95.3 94.7 92.7 7.0 2.0 2.5 6.2 7.7 2985 324 65.3 0.90 0.87 0.85 95.3 94.7 92.7 7.0 2.0 2.5 6.2 7.7 2985 324 65.3 0.90 0.87 0.85 95.3 95.7 7.0 7.0 2.6 2.4 12.0 7.7 2985 404 81.6 0.95.7 95.7 <td>_</td> <td>_</td> <td>1M2A3</td> <td>2982</td> <td>206</td> <td>40.8</td> <td>0.89</td> <td>0.85</td> <td>0.76</td> <td>94.7</td> <td>93.5</td> <td>91.5</td> <td>7.0</td> <td>2.2</td> <td>2.6</td> <td>5.0</td> <td>940</td>	_	_	1M2A3	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
2982 247 49.0 0.89 0.84 0.76 95.1 94.2 92.2 7.0 2.0 2.5 6.2 6.2 2982 260 52.3 0.90 0.85 0.77 95.2 94.6 92.7 7.0 2.0 2.5 6.2 6.2 2982 290 58.8 0.88 0.82 0.77 95.2 94.6 92.7 7.0 2.0 2.5 6.2 6.2 2982 294 65.3 0.90 0.87 0.82 95.7 95.0 93.0 7.0 2.0 2.5 7.7 2985 324 65.3 0.90 0.87 95.7 95.0 93.0 7.0 1.6 2.4 12.0 2985 404 81.6 0.90 0.88 0.84 95.7 95.7 93.7 7.0 1.6 2.4 12.0 2085 508 10.28 0.84 95.3 95.7 93.7 7.0 1.6 </td <td></td> <td></td> <td>1M233</td> <td>2982</td> <td>215</td> <td>43.1</td> <td>06.0</td> <td>0.86</td> <td>0.78</td> <td>95.0</td> <td>94.0</td> <td>92.0</td> <td>7.0</td> <td>2.0</td> <td>2.5</td> <td>5.0</td> <td>940</td>			1M233	2982	215	43.1	06.0	0.86	0.78	95.0	94.0	92.0	7.0	2.0	2.5	5.0	940
2982 260 52.3 0.90 0.85 0.77 95.2 94.6 92.7 7.0 2.0 2.5 6.2 6.2 2982 299 58.8 0.88 0.82 0.75 95.3 94.7 92.7 7.0 2.0 2.5 6.2 7.7 2982 324 65.3 0.90 0.87 0.82 95.5 95.0 93.0 7.0 2.0 2.5 7.7 2985 3404 81.6 0.90 0.87 0.82 95.7 95.0 93.0 7.0 1.6 2.4 12.0 2058 404 81.6 0.90 0.88 0.84 95.7 95.7 93.7 7.0 1.6 2.4 12.0 12.0 2058 508 102.8 0.88 0.84 95.3 93.7 7.0 1.6 2.4 12.0 12.0 2058 508 102.8 0.84 95.3 93.3 7.0 1.6 2.	200 315L MA3		1L2A3	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
2982 299 58.8 0.88 0.82 0.75 95.3 94.7 92.7 7.0 2.0 2.5 7.7 7.0 2985 324 65.3 0.90 0.87 0.82 95.5 95.0 93.0 7.0 1.6 2.4 12.0 2985 340 81.6 0.90 0.88 0.84 95.7 95.2 93.0 7.0 1.6 2.4 12.0 2985 404 81.6 0.90 0.88 0.84 95.7 95.2 93.7 7.0 1.6 2.4 12.0 2085 508 102.8 0.88 0.84 95.3 93.7 7.0 1.6 2.4 12.0 2085 508 102.8 0.98 0.84 95.3 93.8 7.0 1.6 2.4 12.0	215 315L MA3		31L253	2982	260	52.3	06.0	0.85	0.77	95.2	94.6	92.7	7.0	2.0	2.5	6.2	1100
324 65.3 0.90 0.87 0.82 95.5 95.0 93.0 7.0 1.6 2.4 12.0 404 81.6 0.90 0.88 0.84 95.7 95.2 93.7 7.0 1.6 2.4 12.0 508 102.8 0.90 0.88 0.84 95.3 93.3 7.0 1.6 2.4 12.0	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
2985 404 81.6 0.90 0.88 0.84 95.7 95.2 93.7 7.0 1.6 2.4 12.0 2985 508 102.8 0.90 0.88 0.84 95.3 93.7 7.0 1.6 2.4 12.0 2985 508 102.8 0.90 0.88 0.84 95.3 93.8 7.0 1.6 2.4 14.7	355L	_	35L2A3	2985	324	65.3	06.0	0.87	0.82	95.5	95.0	93.0	7.0	1.6	2.4	12.0	1680
2985 508 102.8 0.90 0.88 0.84 95.8 95.3 93.8 7.0 1.6 2.4 14.7	355L		35L213	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
	425 355L MA3	_	5L233	2985	508	102.8	06.0	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

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VD STANDARD TEFC SCR MOTORS OTORS

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)

Ins. Class : F Temp. Rise : B Protection : IP5

Combined	Combined Variation : +/-10%	+/-10%						1500 rpm (4-Pole)	(4-Pole)						P	Protection : IP55	55
							Operating ch	Operating characteristics at rated output	s at rated our	tput			With DOL starting	starting	Pullout		Net
Rated	Rated Output	Frame size	Type ref. B3 construction	Rated Speed	Rated Current	Rated Torque	4	Power Factor			% Efficiency		Starting Current to Rated	Starting Torque to rated	Torque to Rated	Rotor GD ²	Weight B3
kW	ΗЬ	EC		RPM	Amps.	kg-m	FL	3/4L	1/2L	FL	3/4L	1/2L	Current Ratio	torque ratio	Ratio	Kgmz	kg
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	ъ
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	9
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	MA095433	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	106	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	MA1354B3	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	90.06	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	90.06	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	90.06	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	MA285413	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

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

14

:415V+/-10%

Voltage

Frequency : 50Hz+/-5%

Performance table for 6 Pole motors

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

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

Combined	Combined Variation : +/-10%	/-10%						1000 rpm (6-Pole)	pm (6-Pole)						Pro	Protection : IP55	5
							Operating ch	naracteristics	Operating characteristics at rated output	out			With DC	With DOL starting	Pullout		Net
Rated	Rated Output	Frame size IEC	Type ref. B3 construction	Rated Speed	Rated Current	Rated Torque	<u>ц</u>	Power Factor		~	% Efficiency		Starting Current to Rated	Starting Torque to rated	Torque Torque	Rotor GD² kgm2	Weight B3 constr.
kW	ЧН			М Ч Х Ч Х	Amps.	kg-m	FL	3/4L	1/2L	FL	3/4L	1/2L	Current Ratio	torque ratio	Ratio		kg
0.25	0.35	71	MA071633	875	0.80	0.28	0.70	09.0	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	30L	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	MA1356B3	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	MA285613	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
06	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	066	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	066	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	066	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	066	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	066	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	066	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	066	434	246.0	0.84	0.80	0.70	95.5	95	93.5	6.0	2.0	2.5	35.5	1780
Notes:																	

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.

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STANDARD TEFC SCR MOTORS OTORS

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

Performance table for 8 Pole motors

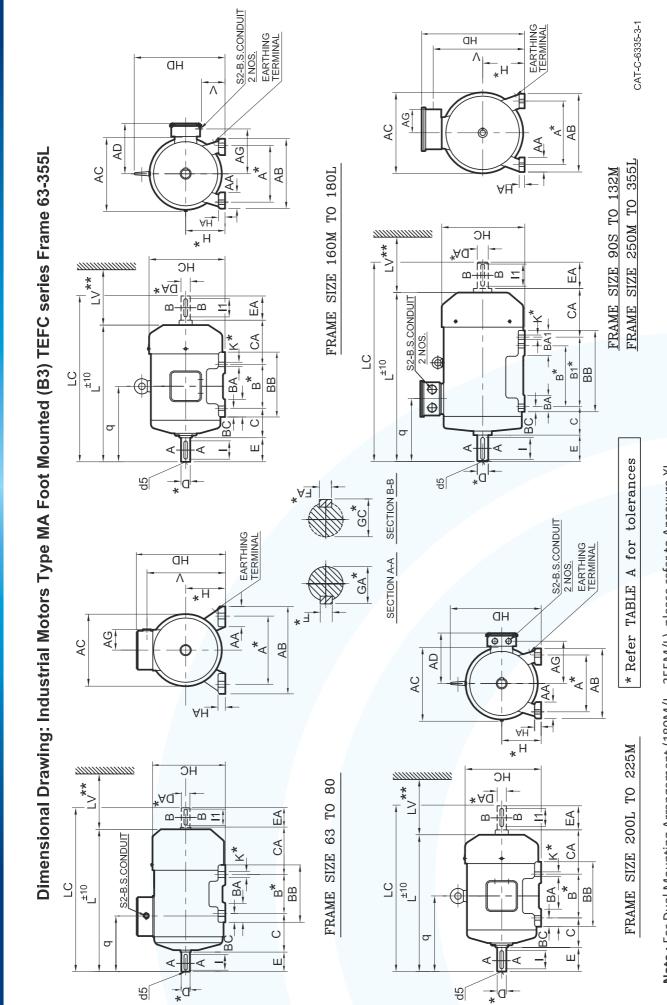
TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 90S to 355L

55	Net	Weight B3	constr. kg	11	14	18	21	25	57	88	101	119	177	182	282	329	369	472	615	665	912	912	1010	1170	1340	1340	1670	1670	1780	1780
lns. Class :F Temp. Rise :B Protection :IP55		Rotor GD ²	kgm2	0.01100	0.01400	0.0230	0.0270	0.0510	0.0990	0.217	0.299	0.400	0.620	0.720	1.32	1.950	2.410	3.720	5.83	6.86	10.7	12.4	15.5	18.0	21.5	21.5	28.7	28.7	35.5	35.5
Ins Pr	Pullout	Torque to Rated	Torque Ratio	2.1	2.4	1.8	2.3	2.2	2.3	2.0	2.2	2.2	2.2	2.2	2.3	2.2	2.2	2.2	2.2	2.2	2.4	2.4	2.4	2.4	2.4	2.4	2.2	2.2	2.2	2.2
	starting	Starting Torque	to rated torque	1.8	2.0	1.6	1.9	1.7	1.8	1.8	1.9	2.1	2.1	2.1	2.5	2.1	2.1	2.5	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	1.8	1.8	1.8	1.8
	With DOL starting	Starting Current	to Rated Current	2.7	2.9	3.0	3.3	3.8	3.5	4.4	4.8	5.5	4.5	4.5	5.5	5.3	5.3	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
			1/2L	48.0	58.0	64.0	71.0	75.0	75.0	78.0	82.0	82.0	85.0	86.0	87.0	87.0	87.0	89.0	90.06	91.0	90.5	92.0	92.5	92.5	92.5	92.8	92.5	92.5	92.3	92.5
		% Efficiency	3/4L	55.0	62.0	70.0	73.0	77.0	78.0	82.0	84.5	84.0	86.5	87.5	88.5	88.0	89.0	90.5	92.0	92.0	92.5	93.0	93.5	93.7	93.7	94.0	94.0	94.5	94.3	94.5
			FL	62.0	67.0	70.0	74.0	77.0	78.0	82.0	84.5	86.0	86.5	87.5	88.5	89.0	0.06	91.0	92.0	92.0	93.0	93.5	94.0	94.2	94.3	94.5	94.6	95.0	95.0	95.0
tinuous) e)	rated output	L	1/2L	0.41	0.43	0.50	0.48	0.50	0.64	0.65	0.65	0.65	0.64	0.64	0.71	69.0	69.0	0.68	0.65	0.65	0.62	0.62	0.62	0.62	0.64	0.64	09.0	09.0	0.60	0.60
Ambient : 50° C Duty : S1(Continuous) 750 rpm (8-Pole)	Operating characteristics at rated output	Power Factor	3/4L	0.52	0.55	0.63	0.62	0.62	0.74	0.74	0.74	0.74	0.74	0.74	0.79	0.77	0.77	0.78	0.75	0.75	0.73	0.73	0.73	0.73	0.73	0.73	0.70	0.70	0.70	0.70
Ат Du 750	rating chara		FL	0.63	0.63	0.73	0.71	0.70	0.78	0.78	0.78	0.78	0.79	0.79	0.82	0.79	0.79	0.82	0.79	0.79	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
	Ope	Rated	kg-m	0.51	0.78	1.07	1.55	2.07	3.04	5.01	7.49	10.29	12.7	14.9	20.3	24.9	29.6	40.0	49.4	60.0	72.4	98.7	118.5	144.8	164.5	173.7	197.4	210.6	236.9	263.2
		Rated	Amps.	1.32	1.81	2.04	2.91	3.87	5.03	8.05	11.6	15.6	18.9	22.1	28.8	36.6	43.0	55.9	70.8	86.1	105	143	171	208	236	249	283	300	338	375
		Rated	RPM	700	690	685	690	705	705	720	715	710	715	720	720	725	725	730	730	730	740	740	740	740	740	740	740	740	740	740
		Type ref. B3 construction		MA09S813	MA09L853	MA10L813	MA10L833	MA11M813	MA13S8B3	MA16M813	MA16M833	MA16L873	MA18M813	MA18L833	MA20L833	MA22S813	MA22M833	MA25M813	MA28S823	MA28M853	MA31S813	MA31M833	MA31M853	MA31L873	MA31L8A3	MA31L893	MA35L8A3	MA35L813	MA35L8B3	MA35L833
)% % 10%		Frame size	IEC	90S	106	100L	100L	112M	132S	160M	160M	160L	180M	180L	200L	225S	225M	250M	280S	280M	315S	315M	315M	315L	315L	315L	355L	355L	355L	355L
: 415V+/-10% : 50Hz+/-5% ariation : +/-10 [°]		Indinc	НР	0.50	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10.0	12.5	15	20	25	30	40	50	60	75	100	120	150	170	180	200	215	240	270
Voltage : 415V+/-10% Frequency : 50Hz+/-5% Combined Variation : +/-10%		Kated Output	kW	0.37	0.55	0.75	1.1	1.5	2.2	3.7	5.5	7.5	9.3	11	15	18.5	22	30	37	45	55	75	06	110	125	132	150	160	180	200

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.



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

STANDARD TEFC SCR MOTORS OTORS OTORS

STANDARD TEFC SCR MOTORS OTORS OTORS

_	d5	M4	M5	M6		ΔIX	M10	M10	0	7 1 1			N116			017		M20	2		120			0210		0710		0010	0710		M20	124
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	>	149	166	185		199	225	249		667			00			ç							570		638			272			R REO	
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	CA	75	83	94	10	0	125	141	189 172	232	172	203	183	203	183	217	218	262	239	231	276	231	262	007	171		010	240	151	1 7 1	158	00+
	ГС	241	278	324	374	399	448	471	568 552	659	590	741	721	785	765	799	838	920	897	976	956	1001	1065	1000	1160	1100	1293	1353	1458	1518	1622	1682
	L	206	234	267	302	327	366 ,		475 4	556	497	605	585	649	629	679	717 8	\vdash	772	827	837	852 1	111		1010		1137	1167	1302			1491
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 ()	- -	40 6	45 7	50 8		20 00	63 10	70 11		200				1 091 901			121 180	133 20	<u>í</u>		149 225		1000	100 72	190 280	2 2		0 0	012		251 35E	<u>54 0</u>
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Ш 	*@	80	90	100	100	125	140	140	140	1	1/8	010	2	254	† 2	241	279	305	2	286	311			343	368 4	2	406 AE7	1	508	2	630	
L	*∢	100	112	125		041	160	190 140					, , , , , , , , , , , , , , , , , , ,			020		318	, , ,		356	-		400	457	2		002			۵10 ۵10	010
	Pole	2 & 4	2,4 & 6	2,4 & 6	2,4,6 & 8	-	2,4,6 & 8 160 140	4,6 & 8	2 4,6 & 8	2	4,6	2	4,6 & 8	2	4,6 & 8	2,4,6 & 8	2,4,6 & 8		4,6 & 8	4,6 & 8		4,6 & 8		4,6 & 8	2	4,6 & 8	2	4,6 & 8	2	4,6 & 8		8
	IEC Fr. size	63	71	80	S06	90L	100L	112M	132S -	NOC F		160M		1601		180M	180L	1000	1001	225S	DOEM!			INING7	- MISORC		215C/M		2461	<u>כ כ</u> ר ר	3551	000L

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

□ 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 IS: 2048 IS: 2540 GA,GC,F,FA d5(centering) S: 1231 +0.360+0.430

CAT-C-6335-3-2

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

Key / key way fit : h9 / N9 (1) Without Eye bolt

Specification

24,28Ø

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Tolerance 11,14,19,2 38,42,480 55,60,65.7

Dimension D,DA

Specification

Tolerance

Dimension

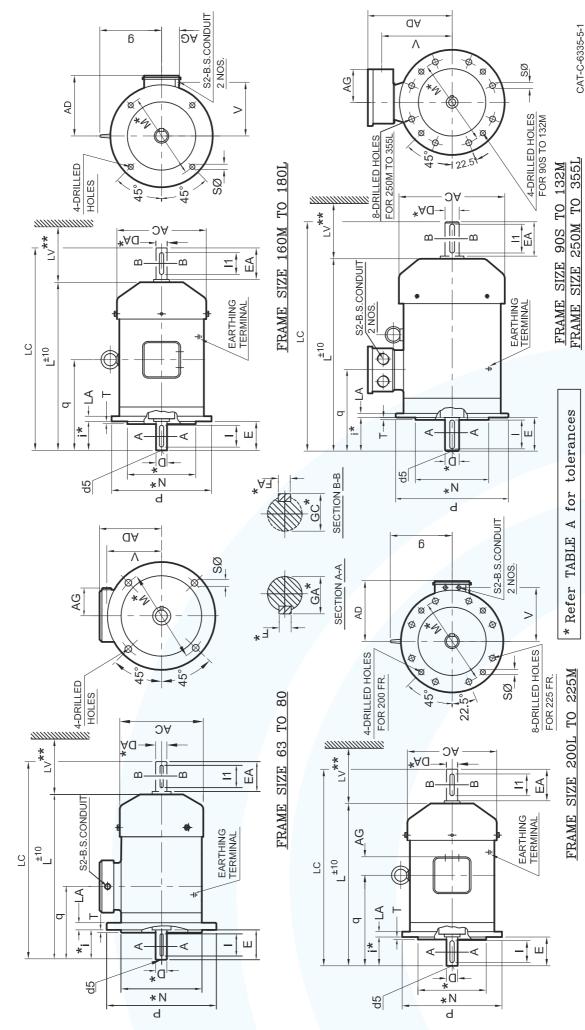
A,B т \mathbf{x}

TABLE A

S: 1231

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

STANDARD TEFC SCR MOTORS OTORS



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

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STANDARD TEFC SCR MOTORS OTORS OTORS

																																	12 0 00	Note. For bo/bo intrung motor in mane oo α / i refer to Sales office				
	Г	d5	M4	M5	MG	M8		M10	M10	M12				M16			M16		M20		M20		UCIV	IMIZU	M20	0.4		M20			M20	M24				haft		
55L		- 5	18	25	35	45	:	55	55	20				105			100		100	130	100	130	130	130	130	130	130	160	130	160	130	160	~~	nıını		o D.E.sl		л С
series Frame 63-3551	FT	GA* GC*	12.5	16	21.5	27	i	31	31	41				45		_	51.5		59	64		64			-	79.5	69	85	69	85	79.5	100	201	Note: For bo/bo mo refer to Sales office		□ 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
me	- SHAFT	н Н Н Н Н Н	4	5	9	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	,	∞	∞	10	2			12		+	4		16	18	16	18	18	18		20	18	22	18	22		25		to Sale		sion ide		intaine
E F		ЕA	23	30	40	50	3	60	60	80	;			110			110		110	140	110	140	140	140	140	140	140	170	140	170	140	170	0+014	refer	5	dimen		be ma
eries		* * D,DA	11	14	19	24		28	28	38				42			48		55	60	55	60	60	65	65	75	65	08 0	65	80	75	95			vards	h shaft	S 2253	notor to
FCs	ГX	S2 B.S.C	3/4"	3/4"	3/4"	3/4"	;				-			-			1 1/2"		2		2"		"0	J	"	1	2"		"0/1 0	2112	ۍ ۲	,			□ 8 Nos. Fixing Holes from 225S/M frame onwards	ded witl	Also suitable for V1 & V3 mounting as per IS 2253	ng ot m
Ш	AL BC	AG	40	40	40	52	-	56	56	63	3			63		_	97		172		172		576		243	2		278-			403	2			/M fra	provio	nting a	t cooll
(B5)	FTERMINAL BOX	b	109	127	112		_	152	157	196	215		323		345	352			396	432.5	415	445	357	700	360		386			416		464		6	1 225S	can be	3 moul	fficien
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unc	Γ	б *				e	+	'	1	'				206			232		262		284											_	bolt	av fit	g Hole	t exter	e for V	Istance
eM		**	30	30	30	35		40	45	202	3		_	- 60			2		80		8		100		115			130			145		ut Eve	kev w	Fixing	e shaf	suitable	num d
ang		LC	260	305	324	374	399	448	471	568 552	659 500		704	785	765	2004	838	920	897	976	956	1001	1065	CO01	1160	-	1293	1353	1458	1518	1622	1682	(1) Without Eve bolt	O Kev / kev wav fit : h9 / N9	8 Nos	Doub	Also s	* Minir
IA FI	RAL	_	225	261	267	302	327	366	388	475 459	556	104	505	000	629	679	717	795	772	827	837	852	011	1	1010	2	1137	116/	1302	1332	1461	1491	E					*
pe N	-GENERAL	AC	124	140	157	174		195	220	- Uac	2024			316 -			354 -		394		450		180	400	544	;		600			900	3		Specification	C - 1231		IS : 2048	2540
s Ty		AD	116	124	134	140		157	170	206	2004			226			265		319		344		115	2	445	2		515	2		584	5	ļ	Spec	<u>.</u>		+	S
otor		ΓA	6	<i></i> б	10	10		11	÷	10	1			13			13		15		16		10	<u>•</u>	6	2		22	1		75	3	ļ	e	4,28Ø	5,80,950		
Ĕ	Ц	T	3	3.5	3.5	3.5		4	4	r	F			5			Ð		2		5		ч	2	LC.)		ű	>		ű	>	Γ	Tolerance	<u>јб</u> 11,14,19,24,28Ø ve за из иво	m6 55,60,65,7		
Istri	Г	S	10	10	12	12	!	15	15	15	2			19			19		19		19		10	<u>מ</u>	19	2		74	1		PC				јб 11, ке 38	m6 55,		
ndu	0	*	23	30	40	50		60	60	вn	8			110			110		110	140	110	140	1 10	-40	140	2	140	170	140	170	140	170		Dimension		j	GA,GC,F,FA	ntering)
alls:	- FIXING	*⊻	115	130	165	165		215	215	265	200			300			300		350		400		200	nnc	200			600	2		740	- 1	LEA	<u>D</u>			GA,G	d5(ce
Deta		*z	95	110	130	130		180	180	030	200			250			250		300		350		A E O	400	450	2		550			680		TABI	_				
ona		Ч	140	160	200	200		250	250	002	200			350			350		400		450		EE0	nee	550)		660			ROOR	200		Specification		IS : 2223		
Dimensional Details: Industrial Motors Type MA Flange Mounted (B5) TEFC		Pole	2&4	2,4 & 6	2,4 & 6	2,4,6 & 8	,4,6 & 8	2,4,6 & 8	4,6 & 8	2 4,6 & 8	2 18.6	4 Q0	7	4,6 & 8	ح 4.6 & 8	246&8	24628	2 2 2	4,6 & 8	4,6 & 8	2	4,6 & 8	2	4,6 & 8	2	4,6 & 8	2	4,6 & 8	2	4,6 & 8	2	4,6 & 8			0 450 2 450		265 <u>-</u>	0 85 85
D		IEC Fr. size	63	71	80	~		100L 2	112M	132S	132M		160M		160L	180M	1		200	225S 4	205M	_	DEON!		280S/M		315S/M	+	3151	_	3551			To	j6 UPTO 450 is6 OVER 450	+ +		±1 UPTO 85 +1.5 OVFR 85
																																		Dimension	z	M	ž	

Dimensional Details: Industrial Motors Type MA Flange Mounted (B5) TEEC series Frame 63-3551

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

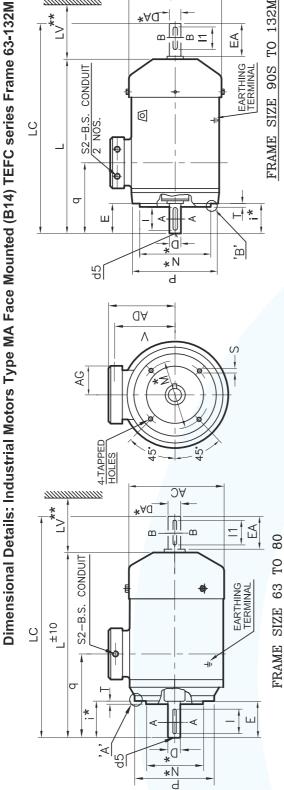
±0.5 OVER 265 UPTO 85 OVER 85

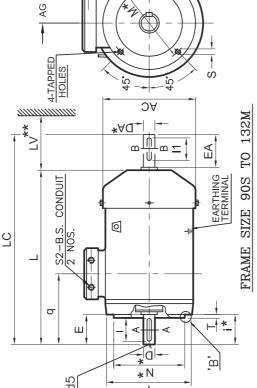
±1.5

CAT-C-6335-5-2

All Dimensions are in mm unless otherwise specified.

STANDARD TEFC SCR MOTORS OTORS OTORS





S2-CONDUIT

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	OF CIRCLE 'B'
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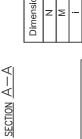
40 M6X13

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2,4 & 6

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	O 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
	Specification	10.1004	1021.0	IS : 2048	IS : 2540	
	Tolerance	j6 11,14,19,24,28Ø	k6 38Ø			
		<u>9</u>	k6			
TABLE A —	Dimension		ל ב בי	GA,GC,F,FA	d5(centering)	
11	Specification	C - 2223	•			
	Tolerance	9 <u>(</u>	±0.3	±1		
L	Dimension	z	Σ			

*Refer for t

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

CAT-C-6313-4-1

****** Minimum distance for efficient cooling of motor to be maintained by user All Dimensions are in mm unless otherwise specified.

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 energyefficiency 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

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%

more accurately.

- 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°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

Туре	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.

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.

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

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)	1.36-1.0	062=0.298	3.636-2.	894=0.742
Saving in energy (kWH) @8000 Hrs running per year	2	384	5	936
Average Energy Cost (Rs.)		-	7	
Annual Saving (Rs.)	16	5688	41	1552
Payback period for additional purchase cost for IE2	3.35	month	5.11	month
Saving (Rs.) in 20 years	33	3760	83	1040

Efficiency comparison and energy saving of standard motor and IE2 motor

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



(IE2)

E LEZ SERIES TEFC SCR MOTORS OTORS OTORS



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	2 Pole			4	4 Pole			9	6 Pole	
Rating kW	Standard eff2 Motor (ŋ%)	BBL IE2 Motor (ŋ%)	Normalized IE2 ŋ with 0.5% Stray Ioad Iosses	Saving in kWh/Year @8000 Hrs running	Standard eff2 Motor (ŋ%)	BBL IE2 Motor(ŋ%)	Normalized IE2 ŋ with 0.5% Stray load losses	Saving in kWh/Year @8000 Hrs running	Standard eff2 Motor (ŋ%)	BBL IE2 Motor(1] %)	Normalized IE2 ŋ with 0.5% Stray Ioad Iosses	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	0.06	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				

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HIGH EFFICIENCY IE2 SERIES MOTORS - TYPE 2H

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

Applicable standard for testing & efficiency determination: IS 15999

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

Duty : S1 (Continuous) Ambient : 50° C

Temp. Rise : B Ins. Class : F

Image: functional problem in the problem i	Three Three <th< th=""><th>Voltage Frequency Combined V</th><th>Voltage : 415V+/-10% Frequency : 50Hz+/-5% Combined Variation : +/-10%</th><th>.0% 5% -10%</th><th></th><th></th><th></th><th></th><th></th><th>Ambient : 50° C Duty : S1 (Cont 3000 rpm (2-Po</th><th>Ambient:50°C Duty :S1 (Continuous) 3000 rpm (2-Pole)</th><th>(sn</th><th></th><th></th><th></th><th></th><th>Ins. Ten Pro</th><th>lns. Class :F Temp. Rise :B Protection :IP55</th><th>E</th></th<>	Voltage Frequency Combined V	Voltage : 415V+/-10% Frequency : 50Hz+/-5% Combined Variation : +/-10%	.0% 5% -10%						Ambient : 50° C Duty : S1 (Cont 3000 rpm (2-Po	Ambient:50°C Duty :S1 (Continuous) 3000 rpm (2-Pole)	(sn					Ins. Ten Pro	lns. Class :F Temp. Rise :B Protection :IP55	E
Indext, free,	Sefficiency Starting current to reque current Starting current roque current Starting current roque roque stio Starting current roque roque stio Pullout roque roque roque roque roque roque roque roque Roto corrent roque roq				Lino H			Op	erating Chai	acteristics a:	t Rated outp	ut		$\left[\right]$	With DC	JL Starting	:		
Her Each Mared Current Mared Current Mared Current Mared Current Mared Current Mared	1 FL 3/4L 0.6 Rated Current to Rated Ratio to Rate	Ratec	l Output	size	l ype Ref.	Rated	Rated	Rated Torque	Ŀ	ower Facto	-L	0			Starting Current	Starting Torque	Pullout Torque	Rotor	Net Weight
010 11 2001134 2001 013 01011 0101 0101 <th< td=""><td>60 72.2 72.0 66.0 5.0 2.6 3.0 0.0019 58 74.8 74.0 70.0 5.0 2.7 3.0 0.0013 63 74.4 76.5 73.5 5.0 2.7 3.0 0.0013 63 79.6 73.5 6.0 2.7 3.3 0.0013 64 81.3 81.3 81.3 81.3 81.3 0.013 0.0013 65 85.5 85.0 85.0 85.0 6.5 3.3 0.013 0.013 75 85.5 85.0 6.5 2.6 3.3 0.023 0.013 75 85.5 85.0 6.5 2.6 3.0 0.0380 0.013 76 88.6 85.0 6.5 2.6 3.0 0.0380 0.013 76 88.1 87.0 85.0 6.5 2.6 3.0 0.0360 88 88.6 85.0 6.5 2.0</td><td>3</td><td>유</td><td>IEC</td><td>B3 Construction</td><td>Speed RPM</td><td>Current Amps.</td><td>Kg.m</td><td>FL</td><td>3/4L</td><td>1/2L</td><td>FL</td><td>3/4L</td><td>1/2L</td><td>to Rated Current Ratio</td><td>to Rated Torque Ratio</td><td>to Kated Torque Ratio</td><td>kgm²</td><td>вз Constn. Kg</td></th<>	60 72.2 72.0 66.0 5.0 2.6 3.0 0.0019 58 74.8 74.0 70.0 5.0 2.7 3.0 0.0013 63 74.4 76.5 73.5 5.0 2.7 3.0 0.0013 63 79.6 73.5 6.0 2.7 3.3 0.0013 64 81.3 81.3 81.3 81.3 81.3 0.013 0.0013 65 85.5 85.0 85.0 85.0 6.5 3.3 0.013 0.013 75 85.5 85.0 6.5 2.6 3.3 0.023 0.013 75 85.5 85.0 6.5 2.6 3.0 0.0380 0.013 76 88.6 85.0 6.5 2.6 3.0 0.0380 0.013 76 88.1 87.0 85.0 6.5 2.6 3.0 0.0360 88 88.6 85.0 6.5 2.0	3	유	IEC	B3 Construction	Speed RPM	Current Amps.	Kg.m	FL	3/4L	1/2L	FL	3/4L	1/2L	to Rated Current Ratio	to Rated Torque Ratio	to Kated Torque Ratio	kgm²	вз Constn. Kg
075 71 2HM02133 2805 1.29 0.29 0.29 0.24 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.26 0.003 1 1 0 2400233 280 1.40 0.26 0.82 0.76 0.66 756 755 66 27 35 0.003 1 2.0 0.00 2400 0.31 0.24 0.82 0.76 0.86 81.3 <td< td=""><td>58 74.8 74.0 70.0 5.0 5.0 5.0 5.0 0.0013 62 77.4 76.5 73.5 5.0 2.5 2.8 0.0037 63 79.6 75.5 6.0 2.7 3.3 0.0031 68 81.3 81.3 81.3 6.5 3.3 3.5 0.0013 68 83.2 88.0 87.0 6.5 3.3 3.3 0.0013 75 85.1 85.1 6.5 3.3 3.3 0.0013 88 88.0 88.0 87.0 6.5 2.6 3.0 0.013 87 88.1 87.0 6.5 2.0 2.3 0.171 88 88.6 85.0 6.5 2.0 3.0 0.023 88 88.6 85.0 6.5 2.0 2.5 0.171 88 88.6 85.0 6.5 2.0 2.5 0.171 88 90.3<td>37</td><td>0.50</td><td>71</td><td>2H0712A3</td><td>2800</td><td>0.96</td><td>0.13</td><td>0.74</td><td>0.68</td><td>0.60</td><td>72.2</td><td>72.2</td><td>66.0</td><td>5.0</td><td>2.6</td><td>3.0</td><td>0.0019</td><td>7</td></td></td<>	58 74.8 74.0 70.0 5.0 5.0 5.0 5.0 0.0013 62 77.4 76.5 73.5 5.0 2.5 2.8 0.0037 63 79.6 75.5 6.0 2.7 3.3 0.0031 68 81.3 81.3 81.3 6.5 3.3 3.5 0.0013 68 83.2 88.0 87.0 6.5 3.3 3.3 0.0013 75 85.1 85.1 6.5 3.3 3.3 0.0013 88 88.0 88.0 87.0 6.5 2.6 3.0 0.013 87 88.1 87.0 6.5 2.0 2.3 0.171 88 88.6 85.0 6.5 2.0 3.0 0.023 88 88.6 85.0 6.5 2.0 2.5 0.171 88 88.6 85.0 6.5 2.0 2.5 0.171 88 90.3 <td>37</td> <td>0.50</td> <td>71</td> <td>2H0712A3</td> <td>2800</td> <td>0.96</td> <td>0.13</td> <td>0.74</td> <td>0.68</td> <td>0.60</td> <td>72.2</td> <td>72.2</td> <td>66.0</td> <td>5.0</td> <td>2.6</td> <td>3.0</td> <td>0.0019</td> <td>7</td>	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
10 80 24000233 230 164 0.52 0.74 0.65 755 65 735 65 735 600 73 730 00051 10 90 2400233 230 0.31 0.32 0.32 0.32 0.35 0.31 2.3 3.0 0.0051 10 101 2400 313 0.31 0.32 0.32 0.32 0.33 0.031 3.5 0.0031 10 1135 1143503 235 0.31 0.32 0.32 0.32 0.32 0.33 0.31 0.	62 77.4 76.5 73.5 5.0 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 6.00 2.5 0.0031 1 7.6 83.2 83.2 83.1 6.5 3.3 3.5 0.0133 1 7.7 85.5 84.0 6.5 3.3 3.5 0.0133 1 8.8 88.1 88.1 6.5 2.5 3.3 0.0133 1 8.8 88.1 88.0 6.5 2.2 2.5 0.0303 1 1 8.8 88.0 6.5 2.2 2.5 0.5 0.013 1 1 1 1 1 1 1 1 1 1 1 1 1	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
15 80 21400233 2330 0.23 0.23 0.23 0.23 0.23 0.23 0.23 0.23 0.2013 30 905 2400273 2840 4.49 0.73 0.82 0.73 81.3	63 79.6 79.6 75.5 6.0 2.7 3.0 0.0051 68 81.3 81.3 78.0 6.5 3.3 3.5 0.0013 68 83.2 81.3 81.3 78.0 6.5 3.3 3.5 0.0133 7.6 85.5 84.0 6.5 3.3 3.5 0.0130 7.8 85.5 84.0 6.5 3.0 3.5 0.0130 87 85.5 84.0 6.5 3.0 0.23 0.030 88 88.1 88.5 6.5 2.0 3.0 0.170 88 88.6 6.5 2.0 2.0 0.013 1.13 88 88.6 6.5 2.0 2.0 0.013 1.13 88 90.0 88.0 6.5 2.0 0.013 1.13 88 90.0 88.0 7.0 2.7 0.01 1.13 89 90.0 88.0 7.0	75	1.0	80	2H080213	2830	1.64	0.26		0.74	0.62	77.4	76.5	73.5	5.0	2.5	2.8	0.0037	10
10 000 1000333 2800 6440 0.25 0.26 633 633 60031 633 00031 10 1010 214004.23 2800 6.44 0.75 0.82 0.75 853 851 65 330 333 00021 175 1132 2930 6.44 1.35 0.890 6.84 0.35 0.80 653 530 531 0.013 1.0020 1.00	68 81.3 81.3 78.0 6.5 3.3 5.0001 6.001 75 85.5 83.2 81.7 6.5 3.3 3.5 0.0013 7 75 85.5 85.5 84.0 6.5 3.3 3.5 0.0133 7 83 87.0 85.0 85.0 6.5 2.6 3.0 0.0212 7 83 87.0 85.0 85.0 6.5 2.6 3.0 0.0380 7 84 87.1 87.0 6.5 2.0 3.0 0.0360 7 85 88.8 85.0 6.5 2.0 2.0 3.0 0.011 86 90.3 90.0 85.0 6.5 2.0 2.0 0.013 7 86 90.3 90.3 88.0 6.5 2.0 2.0 0.013 7 87 90.3 6.5 2.0 2.0 2.0 2.0 0.013 <	.1	1.5	80	2H080233	2830	2.34	0.38		0.75	0.63	79.6	79.6	75.5	6.0	2.7	3.0	0.0051	11
310 901 2H104.73 2840 449 0.75 0.23 0.73 83.2 81.7 61.0 53.0 0.33 0.013 750 1302 2H10.233 2890 6.44 1.25 0.83 0.83 6.5 2.5 3.3 0.0030 750 1325 2H13.2303 2935 1.32 0.93 0.83 6.5 5.5 5.5 3.0 0.0080 10.0 1325 2H16X33 2935 15.4 3.09 0.83 0.83 6.5 2.5 0.013 0.0080 10.0 1404 249 0.90 0.87 0.87 88.6 6.5 2.6 3.0 0.0080 10.0 1600 H16M33 293 15.4 3.09 0.89 0.86 0.87 9.01 8.90 6.5 2.0 2.5 0.103 1.013 200 1600 2100 299 0.89 0.86 0.25 9.2 0.2 2.5	68 83.2 81.7 6.5 3.3 3.5 0.0113 75 85.5 85.5 84.0 6.5 3.0 3.3 0.0212 83 87.0 85.0 85.0 6.5 3.0 3.3 0.0212 83 87.0 86.0 82.0 6.5 2.6 3.0 0.0380 84 88.1 87.0 6.5 5.5 5.2 3.0 0.0380 85 88.6 85.0 6.5 2.5 3.0 0.0380 88.1 88.4 85.0 6.5 2.0 3.0 0.0380 88.1 88.0 6.5 2.0 2.0 0.013 0.013 88.0 90.0 88.0 6.5 2.0 3.0 0.013 0.013 88.0 90.0 88.0 6.5 2.0 2.0 0.021 0.013 88.0 90.0 88.0 7.0 2.7 0.13 0.13 89.1	5	2.0	90S	2H09S243	2840	3.13	0.51		0.78	0.68	81.3	81.3	78.0	6.5	3.3	3.5	0.0091	17
5 10 2110	75 85.5 84.0 6.5 3.0 0.0212 0.0212 83 87.0 86.0 82.0 6.5 2.6 3.0 0.0380 84 87.1 87.5 85.0 6.5 2.6 3.0 0.0380 82 88.1 87.5 85.0 6.5 2.0 3.0 0.0380 84 88.4 85.0 6.5 5.0 2.0 2.0 0.0380 85 88.8 85.0 65.0 5.0 2.0 2.0 0.0360 86 90.9 90.7 88.0 5.0 2.0 2.0 0.017 86 90.9 90.7 88.0 5.0 2.0 2.0 0.014 86 91.3 91.0 7.0 2.0 2.0 0.014 1.13 86 92.0 92.0 91.0 7.0 2.0 2.0 0.014 86 92.0 92.0 92.0 91.0 2.0 <t< td=""><td>.2</td><td>3.0</td><td>106</td><td>2H09L273</td><td>2840</td><td>4.49</td><td>0.75</td><td>0.82</td><td>0.78</td><td>0.68</td><td>83.2</td><td>83.2</td><td>81.7</td><td>6.5</td><td>3.3</td><td></td><td>0.0113</td><td>20</td></t<>	.2	3.0	106	2H09L273	2840	4.49	0.75	0.82	0.78	0.68	83.2	83.2	81.7	6.5	3.3		0.0113	20
1 1 1 2 1	83 87.0 86.0 82.0 6.5 2.6 3.0 0.0820 82 88.1 87.0 6.5 2.6 3.0 0.0980 1 82 88.1 87.0 6.5 2.0 3.0 0.0980 1 82 88.6 85.0 6.5 2.0 2.0 0.0170 1 86 89.4 87.0 6.5 2.0 3.0 0.0171 1 87 90.0 88.0 6.5 2.0 3.0 0.0141 1 86 90.0 88.0 6.5 2.0 2.0 0.0261 1 87 90.0 88.8 7.0 2.0 2.0 0.014 1 86 90.0 88.8 7.0 2.0 2.0 0.014 1 1 86 92.0 91.0 88.8 7.0 2.0 2.0 0.014 1 86 92.0 92.0 91.0 7.0 <td>.7</td> <td>5.0</td> <td>100L</td> <td>2H10L233</td> <td>2890</td> <td>6.84</td> <td>1.25</td> <td></td> <td>0.83</td> <td>0.75</td> <td>85.5</td> <td>85.5</td> <td>84.0</td> <td>6.5</td> <td>3.0</td> <td>3.3</td> <td>0.0212</td> <td>26</td>	.7	5.0	100L	2H10L233	2890	6.84	1.25		0.83	0.75	85.5	85.5	84.0	6.5	3.0	3.3	0.0212	26
100 1325 2H13X13 2935 13.2 24.9 0.90 0.87 0.81 87.1 87.5 85.0 55.0 55.0 53.0 50.0 53.0 50.0 53.0 50.0 53.0 50.0 53.0 50.0 53.0 <	82 88.1 87.5 85.0 6.5 2.6 3.0 0.0980 77 88.8 88.6 85.0 6.5 2.0 2.0 0.171 7.6 89.4 89.4 87.0 6.5 2.0 2.0 0.0360 7.6 89.4 89.4 87.0 6.5 2.0 2.0 0.017 86 90.3 90.0 88.0 6.5 2.0 2.0 0.036 86 90.3 90.0 88.0 7.0 2.4 2.7 0.24 87 92.0 92.0 92.0 92.0 7.0 2.4 2.7 0.34 86 92.0 92.0 92.0 7.0 2.2 2.1 0.34 86 93.2 92.0 7.0 2.0 2.30 0.13 86 93.2 92.1 92.0 7.0 2.2 2.1 1.3 86 93.2 93.2 92.2 92.3 2.3 <td>.5</td> <td>7.5</td> <td>132S</td> <td>2H13S2G3</td> <td>2935</td> <td>9.77</td> <td>1.83</td> <td>0.90</td> <td>0.88</td> <td>0.83</td> <td>87.0</td> <td>86.0</td> <td>82.0</td> <td>6.5</td> <td>2.6</td> <td>3.0</td> <td>0.0820</td> <td>55</td>	.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
115 160m 2116 mode 116 mode 216	82 88.6 85.0 6.5 2.0 0.1500 0 76 89.4 89.4 87.0 6.5 2.3 3.0 0.171 89.4 89.4 87.0 6.5 2.3 3.0 0.171 82 90.3 90.0 88.0 6.5 2.0 2.5 0.203 86 90.3 90.0 88.8 7.0 2.4 2.7 0.34 87 91.3 91.0 88.8 7.0 2.4 2.7 0.34 80 92.0 90.0 7.0 2.4 2.7 0.34 80 92.0 91.0 7.0 2.4 2.7 0.34 80 92.0 91.0 7.0 2.5 0.34 0.34 80 93.2 91.0 7.0 2.7 0.34 0.34 80 94.1 91.0 7.0 2.5 5.0 0.54 80 94.1 91.0 7.0	.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
1 1	.76 89.4 87.0 6.5 2.3 3.0 0.171 .82 90.3 90.0 88.0 6.5 2.0 2.5 0.203 8 .86 90.3 90.0 88.0 6.5 2.0 2.5 0.268 8 .86 91.3 91.0 88.8 7.0 2.7 0.34 8 .87 91.3 91.0 88.8 7.0 2.6 2.7 0.34 8 .80 92.0 92.0 90.0 7.0 2.5 0.64 1.3 .80 92.0 92.0 92.0 0.0 7.0 2.5 0.64 1.3 .80 92.3 92.0 0.50 7.0 2.5 0.50 1.3 .80 93.4 93.0 90.0 6.5 2.0 2.5 0.64 .80 94.1 93.3 90.2 6.5 2.6 5.0 5.0 .80 94.1 91.5	.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
20.0 160M 2146M/263 2930 26.0 4.99 0.88 0.88 0.90 88.0 6.5 2.0 2.5 0.208 75.0 160U 2141M/233 2333 31.5 61.5 0.90 0.88 90.9 90.7 89.0 6.5 2.0 0.50 0.50 75.0 2010 2141M/33 2555 64.0 12.2 0.89 0.86 90.9 90.7 89.0 6.5 2.0 0.50 0.60 70.0 2010 2140M/33 2555 64.0 12.2 0.89 0.86 90.2 90.7 90.0 7.0 2.5 0.5 1.13 60.0 255M 2400 12.2 0.81 0.84 0.76 92.7 91.0 7.0 2.5 2.5 1.13 1.13 100 255M 2400 12.2 0.81 0.84 0.76 92.7 91.0 7.0 2.5 2.5 2.5 2.5 2.5	82 90.3 90.0 88.0 6.5 2.0 2.5 0.203 80.0 86 90.9 90.7 89.0 6.5 2.0 2.5 0.268 0.346 87 91.0 88.8 7.0 2.5 0.547 0.346 88 91.0 88.8 7.0 2.5 0.54 0.34 80 92.0 92.0 90.0 7.0 2.5 0.54 0.54 7.6 92.5 91.0 7.0 2.5 0.54 0.54 0.54 7.8 92.9 92.0 92.0 5.0 2.55 0.54 1.3 8.6 94.1 91.0 7.0 2.2 2.5 5.0 1.3 8.6 94.1 91.5 7.0 2.2 2.5 5.0 1.3 8.6 94.1 91.5 7.0 2.2 2.5 5.0 1.3 8.6 94.5 91.5 7.0 2.2 2.5 <td>[]</td> <td>15.0</td> <td>160M</td> <td>2H16M253</td> <td>2935</td> <td>19.2</td> <td>3.65</td> <td>0.89</td> <td>0.84</td> <td>0.76</td> <td>89.4</td> <td>89.4</td> <td>87.0</td> <td>6.5</td> <td>2.3</td> <td>3.0</td> <td>0.171</td> <td>112</td>	[]	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
5.0 160. 2H16L33 233. 51.5 0.5	.86 90.9 90.7 89.0 6.5 2.0 2.5 0.268 0.268 .82 91.3 91.0 88.8 7.0 2.4 2.7 0.34 0 .80 92.0 92.0 90.0 7.0 2.4 2.7 0.34 0 .70 92.5 91.0 7.0 2.4 2.5 0.13 0 .71 92.5 92.0 90.0 7.0 2.5 1.13 0 <td>5</td> <td>20.0</td> <td>160M</td> <td>2H16M263</td> <td>2930</td> <td>26.0</td> <td>4.99</td> <td>0.89</td> <td>0.88</td> <td>0.82</td> <td>90.3</td> <td>90.0</td> <td>88.0</td> <td>6.5</td> <td>2.0</td> <td>2.5</td> <td>0.203</td> <td>120</td>	5	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
30.0 180M 2H18M233 2937 7.30 0.89 0.87 0.82 91.3 91.0 88.8 7.0 2.4 2.7 0.34 40.0 200L 2H01233 2955 51.0 989 0.89 0.86 9.87 9.20 92.0 26.0 7.0 2.55 2.50 7.05 60.0 250M 2H201233 2955 64.0 12.2 0.88 0.87 92.0 92.0 7.0 2.55 2.50 11.3 60.0 250M 2H22M323 2950 14.6 0.91 0.89 0.87 92.0 92.0 65 2.50 2.51 2.50 1.13 60.0 250M 2H38X33 2970 14.6 0.91 0.89 0.86 93.2 92.0 65 2.50 2.50 2.50 5.00 700 2150 2H38X33 2970 146 29.1 0.89 93.2 94.1 94.2 2.50 2.50 2.50<	82 91.3 91.0 88.8 7.0 2.4 2.7 0.34 80 92.0 92.0 92.0 90.0 7.0 2.6 3.0 0.61 7.0 7.6 92.5 92.5 91.0 7.0 2.6 3.0 0.61 7.0 7.6 92.5 92.7 91.0 7.0 2.5 2.5 0.54 7.0 7.8 92.9 92.7 91.0 7.0 2.5 2.5 0.50 7.1 8.6 93.2 92.1 90.0 7.0 2.2 2.5 1.13 7.0 8.6 94.1 93.2 91.5 7.0 2.2 2.5 5.0 7.0 8.0 94.5 91.5 7.0 2.2 2.5 5.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0 7.0	3.5	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
400 2001 2H20L33 2955 64.0 12.2 0.89 0.86 0.80 92.0 92.0 70.0 7.0 2.6 3.0 0.61 60.0 2030 2120233 2955 64.0 12.2 0.87 0.84 0.76 92.5 91.0 7.0 2.25 2.5 0.64 60.0 205M 2H2N233 2965 90.2 14.8 0.89 0.89 92.5 92.7 91.0 7.0 2.5 2.5 0.64 10.0 2850M 2H2N333 2965 90.2 14.8 0.91 0.89 0.86 93.3 93.6 90.0 7.0 2.5 2.5 2.6 0.64 10.0 280M 146 29.5 0.91 0.89 0.86 94.1 94.1 91.5 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 2.6 <td>80 92.0 92.0 90.0 7.0 2.6 3.0 0.61 1 7.6 92.5 92.5 91.0 7.0 2.2 0.64 0.64 0 7.8 92.5 92.7 91.0 7.0 2.2 2.5 1.13 0 8.6 93.2 92.7 90.0 7.0 2.2 2.5 1.13 0 8.6 93.2 92.0 91.0 7.0 2.2 2.5 1.13 0<td>22</td><td>30.0</td><td>180M</td><td>2H18M233</td><td>2935</td><td>37.7</td><td>7.30</td><td>0.89</td><td>0.87</td><td>0.82</td><td>91.3</td><td>91.0</td><td>88.8</td><td>7.0</td><td>2.4</td><td>2.7</td><td>0.34</td><td>177</td></td>	80 92.0 92.0 90.0 7.0 2.6 3.0 0.61 1 7.6 92.5 92.5 91.0 7.0 2.2 0.64 0.64 0 7.8 92.5 92.7 91.0 7.0 2.2 2.5 1.13 0 8.6 93.2 92.7 90.0 7.0 2.2 2.5 1.13 0 8.6 93.2 92.0 91.0 7.0 2.2 2.5 1.13 0 <td>22</td> <td>30.0</td> <td>180M</td> <td>2H18M233</td> <td>2935</td> <td>37.7</td> <td>7.30</td> <td>0.89</td> <td>0.87</td> <td>0.82</td> <td>91.3</td> <td>91.0</td> <td>88.8</td> <td>7.0</td> <td>2.4</td> <td>2.7</td> <td>0.34</td> <td>177</td>	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
60.0 200.1 2H20L73 2950 64.0 12.2 0.84 0.76 92.5 91.0 7.0 2.2 2.5 0.64 75.0 255M 2H2XM23 2955 76.6 14.8 0.88 0.85 0.78 92.9 92.7 91.0 7.0 2.5 2.5 1.13 75.0 255M 2H2XM23 2955 90.2 18.1 0.91 0.88 0.78 0.78 2.5	.76 92.5 91.0 7.0 2.2 0.64 0.64 .78 92.9 92.7 91.0 7.0 2.5 1.13 1.13 .78 92.9 92.7 91.0 7.0 2.5 2.5 1.13 1.13 .86 93.2 93.6 92.0 6.5 2.0 2.8 3.01 1.3 .86 94.1 93.6 92.0 6.5 2.0 2.8 3.01 1.3 .86 94.1 93.6 90.9 6.5 2.0 2.8 3.01 1.3 .80 94.1 91.3 7.0 2.2 2.5 5.0 1.4 .80 94.5 93.5 91.3 7.0 2.2 5.0 5.0 1.4 .80 94.7 93.7 7.0 2.2 2.5 5.0 1.4 .81 94.7 93.7 7.0 2.4 2.5 5.0 1.4 .80 94.7	0	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
60.0 225M 2H2M233 2965 76.6 14.8 0.88 0.88 0.78 92.9 92.7 91.0 7.0 2.5 1.13 2.60 75.0 250M 2H2M233 2955 90.2 18.1 0.91 0.89 0.86 93.2 92.7 90.0 7.0 2.3 2.60 1.13 2.60 100 2805 2H3K33 2970 122 24.6 0.91 0.89 0.86 93.1 93.6 92.0 2.60 2.8 3.01 1100 2805 2H3K33 2970 146 29.5 0.91 0.89 0.86 94.1 93.9 90.9 6.5 2.0 2.8 3.01 1101 2150 2131 2970 143 0.90 0.86 0.86 94.1 94.9 91.9 7.0 2.6 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 </td <td>78 92.9 92.7 91.0 7.0 2.5 1.13 1.13 86 93.2 92.7 90.0 7.0 2.3 2.7 2.60 1 86 93.2 93.6 92.0 6.5 2.3 2.7 2.60 1 86 94.1 93.9 90.9 6.5 2.0 2.8 3.42 1 80 94.1 93.9 90.9 6.5 2.0 2.8 3.42 1 1 80 94.1 91.3 7.0 2.2 2.5 5.0 1 1 80 94.5 93.5 91.3 7.0 2.2 5.0 5.0 1 80 94.7 93.7 91.3 7.0 2.6 5.0 1 <</td> <td>37</td> <td>50.0</td> <td>200L</td> <td>2H20L273</td> <td>2955</td> <td>64.0</td> <td>12.2</td> <td>0.87</td> <td>0.84</td> <td>0.76</td> <td>92.5</td> <td>92.5</td> <td>91.0</td> <td>7.0</td> <td>2.2</td> <td>2.5</td> <td>0.64</td> <td>275</td>	78 92.9 92.7 91.0 7.0 2.5 1.13 1.13 86 93.2 92.7 90.0 7.0 2.3 2.7 2.60 1 86 93.2 93.6 92.0 6.5 2.3 2.7 2.60 1 86 94.1 93.9 90.9 6.5 2.0 2.8 3.42 1 80 94.1 93.9 90.9 6.5 2.0 2.8 3.42 1 1 80 94.1 91.3 7.0 2.2 2.5 5.0 1 1 80 94.5 93.5 91.3 7.0 2.2 5.0 5.0 1 80 94.7 93.7 91.3 7.0 2.6 5.0 1 <	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
75.0 250M 2H25M233 2905 90.1 0.01 90.2 91.7 90.0 7.0 2.3 2.7 2.00 100 2805 2H28X233 2970 122 24.6 0.91 0.89 0.86 93.6 93.6 93.6 92.0 6.5 2.00 2.8 3.142 100 2805 2H28X233 2970 146 29.5 0.91 08.4 94.1 91.5 2.0 2.0 2.8 3.142 110 2150 2141X23 2920 180 0.81 0.89 0.86 0.80 94.1 91.5 7.0 2.2 2.5 5.0 110 315M 2H31M23 2922 216 0.91 0.89 0.80 94.1 91.5 7.0 2.5 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0	86 93.2 92.7 90.0 7.0 2.3 2.7 2.60 86 93.8 93.6 92.0 6.5 2.0 2.8 3.01 86 94.1 93.9 90.9 6.5 2.0 2.8 3.01 86 94.1 93.9 90.9 6.5 2.0 2.8 3.01 80 94.5 93.5 91.5 7.0 2.2 2.5 5.0 80 94.5 93.5 91.5 7.0 2.2 2.5 5.0 5.0 80 94.5 93.5 91.5 7.0 2.2 2.5 5.0 5.0 80 94.6 93.6 7.0 2.2 2.5 5.0 5.0 80 94.7 93.7 7.0 2.2 2.5 5.0 5.0 80 94.7 93.7 7.0 2.2 2.5 5.0 5.0 80 94.7 93.7 7.0 2.4 </td <td>15</td> <td>60.0</td> <td>225M</td> <td>2H22M253</td> <td>2965</td> <td>76.6</td> <td>14.8</td> <td></td> <td>0.85</td> <td>0.78</td> <td>92.9</td> <td>92.7</td> <td>91.0</td> <td>7.0</td> <td>2.5</td> <td>2.5</td> <td>1.13</td> <td>353</td>	15	60.0	225M	2H22M253	2965	76.6	14.8		0.85	0.78	92.9	92.7	91.0	7.0	2.5	2.5	1.13	353
10028052H28533297011224,60.910.890.8693.693.665.62.02.83.013.011102120280M2H28M23297014629.50.910.890.9494.191.50.9065.72.002.83.423.42110110315M2H31X33298218035.90.900.860.800.840.800.94.10.91.510.72.062.07 <td>86 93.8 93.6 92.0 6.5 2.0 2.8 3.01 3.01 86 94.1 93.9 90.9 6.5 2.0 2.8 3.42 3.42 80 94.1 91.5 7.0 2.8 2.9 5.0 7.0 80 94.3 94.1 91.5 7.0 2.2 2.5 5.0 70 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.4 2.5 5.0 7.0 80 94.7<td>5</td><td>75.0</td><td>250M</td><td>2H25M233</td><td>2965</td><td>90.2</td><td>18.1</td><td></td><td>0.89</td><td>0.86</td><td>93.2</td><td>92.7</td><td>90.0</td><td>7.0</td><td>2.3</td><td>2.7</td><td>2.60</td><td>550</td></td>	86 93.8 93.6 92.0 6.5 2.0 2.8 3.01 3.01 86 94.1 93.9 90.9 6.5 2.0 2.8 3.42 3.42 80 94.1 91.5 7.0 2.8 2.9 5.0 7.0 80 94.3 94.1 91.5 7.0 2.2 2.5 5.0 70 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.5 93.5 91.3 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.2 2.5 5.0 7.0 80 94.7 93.7 7.0 2.4 2.5 5.0 7.0 80 94.7 <td>5</td> <td>75.0</td> <td>250M</td> <td>2H25M233</td> <td>2965</td> <td>90.2</td> <td>18.1</td> <td></td> <td>0.89</td> <td>0.86</td> <td>93.2</td> <td>92.7</td> <td>90.0</td> <td>7.0</td> <td>2.3</td> <td>2.7</td> <td>2.60</td> <td>550</td>	5	75.0	250M	2H25M233	2965	90.2	18.1		0.89	0.86	93.2	92.7	90.0	7.0	2.3	2.7	2.60	550
120 280M 2H28M253 2970 146 29.5 0.01 0.88 04.1 93.9 09.0 6.5 2.0 2.8 3.42 150 155 2H315233 2922 180 35.9 0.90 0.86 0.80 94.3 94.1 91.5 7.0 2.2 2.5 5.0 170 315M 2H31M23 2982 207 40.8 0.89 0.86 0.80 94.5 91.5 7.0 2.2 2.5 5.0 7.0 180 315M 2H31M23 2982 216 49.0 0.86 0.80 94.5 91.5 7.0 2.2 2.5 5.0 7.0 201 315L 2H31L23 2982 201 0.89 0.86 0.80 94.5 91.5 7.0 2.0 2.5 5.0 7.0 7.0 2.5 5.0 7.0 2.5 5.0 7.0 2.5 5.0 7.0 2.5 5.0 7.0	86 94.1 93.9 90.9 6.5 2.0 2.8 3.42 3.42 80 94.3 94.1 91.5 7.0 2.2 5.0 5.0 70 94.5 93.5 91.5 7.0 2.2 2.5 5.0 70 94.5 93.5 91.3 7.0 2.2 2.5 5.0 80 94.6 93.6 91.3 7.0 2.2 2.5 5.0 80 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 75 94.7 93.7 7.0 2.0 2.5 6.2 7.0 80 94.7 93.7 7.0 2.0 2.5 6.2 7.0 81 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.0 82 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.0 84 95.0 94.1 <td>'5</td> <td>100</td> <td>280S</td> <td>2H28S233</td> <td>2970</td> <td>122</td> <td>24.6</td> <td>0.91</td> <td>0.89</td> <td>0.86</td> <td>93.8</td> <td>93.6</td> <td>92.0</td> <td>6.5</td> <td>2.0</td> <td>2.8</td> <td>3.01</td> <td>699</td>	'5	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	699
150 3155 2H315233 2982 180 35.9 0.90 0.86 0.80 0.81 0.15 7.0 2.2 2.5 5.0 5.0 170 315M 2H31523 2922 207 40.8 0.89 0.86 0.80 0.81 94.5 91.5 7.0 2.2 2.5 5.0 7.0 180 315M 2H31M23 2922 216 43.1 0.90 0.86 0.80 94.6 91.5 7.0 2.2 2.5 5.0 7.0 200 315L 2H31L23 2922 216 43.1 0.90 0.86 0.80 94.6 94.7 91.7 7.0 2.0 2.5 5.0 7.0 201 2151 2131123 2982 261 0.90 0.86 0.80 94.8 94.1 91.7 91.2 7.0 2.5 6.2 6.2 6.2 6.2 6.2 6.2 6.2 6.2 6.2 6.2	80 94.3 94.1 91.5 7.0 2.2 2.5 5.0 5.0 78 94.5 93.5 91.5 7.0 2.2 2.6 5.0 7.0 80 94.5 93.5 91.5 7.0 2.2 2.6 5.0 7.0 80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 7.0 78 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 80 94.7 93.0 7.0 2.0 2.5 6.2 7.0 81 94.1 93.0 7.0 2.0 2.5 6.2 7.0 75 94.9 93.0 7.0 2.4 2.5 6.2 7.0 80 94.5 93.0 7.0 2.0 2.5 7.0 7.0 81 94.0 94.1 93.0 7.0 2.4 12.0 7.0 84 95.0	06	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
170 315M 2H31M2A3 2982 207 40.8 0.89 0.85 0.78 94.5 94.5 94.5 94.5 94.5 7.0 2.2 2.6 5.0 180 315M 2H31M233 2982 216 43.1 0.90 0.86 0.80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 200 315L 2H31L23 2982 261 0.90 0.86 0.80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 5.0 210 215L 2H31L23 2982 261 0.90 0.86 0.80 94.8 94.1 93.0 7.0 2.0 2.5 6.2 6.2 6.2 6.2 7.0 2.4 2.5 6.2 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7.7 7	.78 94.5 93.5 91.5 7.0 2.2 2.6 5.0 5.0 .80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 5.0 .80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 5.0 .78 94.7 93.7 92.2 7.0 2.0 2.5 6.2 5.0 .80 94.7 93.0 7.0 2.0 2.5 6.2 6.2 .81 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.7 .82 94.9 94.1 93.0 7.0 2.4 12.0 7.7 .82 95.0 94.5 92.8 7.0 1.6 2.4 12.0 .84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	10	150	315S	2H31S233	2982	180	35.9		0.86	0.80	94.3	94.1	91.5	7.0	2.2	2.5	5.0	898
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 5.0 200 315L 2H31L23 2982 248 94.0 0.89 0.84 0.78 94.7 93.7 92.2 7.0 2.5 6.2 6.2 215 215L 2H31L23 2982 261 0.89 0.86 0.80 94.9 93.7 92.2 7.0 2.0 2.5 6.2 6.2 215 215L 2982 261 0.29 0.88 0.88 0.82 0.75 94.9 93.0 7.0 2.0 2.5 6.2 7.7 210 215L3 2982 300 58.8 0.88 0.82 0.75 94.9 93.0 7.0 2.0 2.5 6.2 7.7 8.2 210 255L 258 355 255L 258 0.50 94.5 <t< td=""><td>80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 5.0 7.8 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 80 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 80 94.8 94.1 93.0 7.0 2.0 2.5 6.2 7.0 80 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.7 81 95.0 94.1 93.0 7.0 2.0 2.4 12.0 12.0 84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 12.0 84 95.0 94.5 93.0 7.0 1.6 2.4 14.7</td><td>25</td><td>170</td><td>315M</td><td>2H31M2A3</td><td>2982</td><td>207</td><td>40.8</td><td></td><td>0.85</td><td>0.78</td><td>94.5</td><td>93.5</td><td>91.5</td><td>7.0</td><td>2.2</td><td>2.6</td><td>5.0</td><td>940</td></t<>	80 94.6 93.6 91.3 7.0 2.0 2.5 5.0 5.0 7.8 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 80 94.7 93.7 92.2 7.0 2.0 2.5 6.2 7.0 80 94.8 94.1 93.0 7.0 2.0 2.5 6.2 7.0 80 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.7 81 95.0 94.1 93.0 7.0 2.0 2.4 12.0 12.0 84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 12.0 84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	25	170	315M	2H31M2A3	2982	207	40.8		0.85	0.78	94.5	93.5	91.5	7.0	2.2	2.6	5.0	940
200 3151 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 6.2 215 3151 2H31L23 2985 261 52.2 0.90 0.86 0.80 94.8 94.1 93.0 7.0 2.4 2.5 6.2 216 2131 2982 300 58.8 0.90 0.86 0.87 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.7 270 3551 2H35L23 2985 355 65.3 0.90 0.87 0.82 95.0 94.1 93.0 7.0 2.6 2.5 6.2 7.7 270 3551 2H35L23 2985 325 65.3 0.90 0.88 0.84 95.0 94.2 92.0 7.0 1.6 7.0 7.4 7.0 7.4 7.0 7.4 7.0 7.4 7.0 7.0	.78 94.7 93.7 92.2 7.0 2.0 2.5 6.2 6.2 .80 94.8 94.1 93.0 7.0 2.4 2.5 6.2 6.2 .75 94.9 94.1 93.0 7.0 2.4 2.5 6.2 6.2 .75 94.9 94.1 93.0 7.0 2.4 2.5 7.7 .82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 .84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 .84 95.0 94.5 93.0 7.0 1.6 2.4 12.0	32	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
215 3151 2H31L23 2985 261 52.2 0.90 0.86 0.80 94.8 94.1 93.0 7.0 2.4 2.5 6.2 6.2 240 3151 2H31L23 2982 300 58.8 0.88 0.82 0.75 94.9 94.1 93.0 7.0 2.4 2.5 6.2 7.7 270 3551 2H35L33 2985 325 65.3 0.90 0.87 0.82 95.0 94.2 7.0 7.0 2.6 7.7 7.7 355 3551 2H35L33 2985 40.7 81.6 0.98 0.88 0.84 95.0 94.2 7.0 1.6 7.4 7.7 7.7 355 2H35L213 2985 40.7 81.6 0.88 0.88 0.84 95.0 94.2 7.0 1.6 7.4 7.2 7.4 7.0 355 2H35L213 2985 513 0.91 95.0 94.5 <td>80 94.8 94.1 93.0 7.0 2.4 2.5 6.2 6.2 75 94.9 94.1 93.0 7.0 2.0 2.5 6.2 7.7 82 94.9 94.1 93.0 7.0 2.0 2.5 7.7 7.7 82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 1 84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 1 84 95.0 94.5 93.0 7.0 1.6 2.4 12.0 1</td> <td>50</td> <td>200</td> <td>315L</td> <td>2H31L2A3</td> <td>2982</td> <td>248</td> <td>49.0</td> <td></td> <td>0.84</td> <td>0.78</td> <td>94.7</td> <td>93.7</td> <td>92.2</td> <td>7.0</td> <td>2.0</td> <td>2.5</td> <td>6.2</td> <td>1100</td>	80 94.8 94.1 93.0 7.0 2.4 2.5 6.2 6.2 75 94.9 94.1 93.0 7.0 2.0 2.5 6.2 7.7 82 94.9 94.1 93.0 7.0 2.0 2.5 7.7 7.7 82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 1 84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 1 84 95.0 94.5 93.0 7.0 1.6 2.4 12.0 1	50	200	315L	2H31L2A3	2982	248	49.0		0.84	0.78	94.7	93.7	92.2	7.0	2.0	2.5	6.2	1100
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 7.7 270 355L 2H35L2A3 2985 325 65.3 0.90 0.87 0.82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 335 355L 2H35L213 2985 407 81.6 0.90 0.88 0.84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 335 355L 2H35L213 2985 513 103 0.88 0.84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 425 355L 2H35L233 2985 513 103 0.84 0.84 95.0 94.5 93.0 7.0 1.6 2.4 12.0	.75 94.9 94.1 93.0 7.0 2.0 2.5 7.7 8.7 .82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 12.0 .84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 13.0 .84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 14.7 .84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	60	215	315L	2H31L253	2985	261	52.2		0.86	0.80	94.8	94.1	93.0	7.0	2.4	2.5	6.2	1100
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 12.0 335 355L 2H35L213 2985 407 81.6 0.90 0.88 0.84 95.0 94.5 92.2 7.0 1.6 2.4 12.0 4 335 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 4 25 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	.82 95.0 94.2 92.2 7.0 1.6 2.4 12.0 .84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 .84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 .84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	80	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
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 12.0 425 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	.84 95.0 94.5 92.8 7.0 1.6 2.4 12.0 .84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	00	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
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	.84 95.0 94.5 93.0 7.0 1.6 2.4 14.7	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
	• Efficiency clase 'IF2' will be numched on the namenlates as ner IS • 17615-2011 for ratings from 0 37kw to 375kw	315	425	355L	2H35L233	2985	513	103		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

HIGH EFFICIENCY IE2 SERIES MOTORS - TYPE 2H

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Applicable standard for testing & efficiency determination: IS 15999

5 (E2)		3	L ² Constn. Kg	33 7	72 11	82 12	.5 15	9 19	8 26	6 36	64	3 74	7 105	_	0 128	0 188	1 200	3 275	362	5 377	500	3 670	5 735	7 862	7 965	7 965	0 1145	0 1145	5 1225		3 1680	7 1855	9 2025
lns. Class : F Temp. Rise : B Protection : IP55		Rotor		0.0033	0.0072	0.0082	0.015	0.019	0.028	0.066	0.126	0.163	0.177	0.229	0.300	0.540	0.61	0.93	1.60	1.85	3.06	5.53	6.36	9.97	11.7	11.7	14.0	14.0	15.6	17.8	23.3	32.7	37.9
lns. (Tem Prot		Pullout Torque	to Kated Torque Ratio	2.5	3.0	3.0	2.8	3.0	3.0	3.0	2.8	2.8	2.8	2.8	2.7	2.9	3.0	2.6	2.6	2.6	2.6	2.8	2.8	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.5	2.5	2.5
	With DOL Starting	Starting Torque	to Rated Torque Ratio	2.3	2.8	2.8	2.4	2.7	2.6	2.7	2.2	2.2	2.5	2.5	2.5	2.7	2.8	2.6	2.6	2.6	2.5	2.6	2.3	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.2	2.2	2.2
	With D0	Starting Current	to Rated Current Ratio	3.4	5.0	5.0	6.0	5.5	6.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7.0	7.0	7.0	7.0	6.7	6.5	6.5	6.5	6.5	6.5	6.5	6.5	7.0	6.5	6.5	6.5
		Ś	1/2L	65.0	68.0	74.0	77.5	80.0	82.0	84.0	86.0	87.0	87.0	88.0	89.5	89.5	89.8	90.0	90.5	91.0	91.0	93.0	93.2	92.3	92.7	93.0	92.8	93.1	93.2	93.3	93.5	93.5	93.5
		% Efficiency	3/4L	70.1	75.1	79.6	81.4	82.8	84.3	86.3	87.7	88.7	89.4	89.8	90.7	91.2	91.6	92.0	92.5	92.8	93.0	94.0	94.2	94.3	94.3	94.5	94.4	94.6	94.7	94.8	94.9	94.8	94.9
(snoi	d output		FL	70.1	75.1	79.6	81.4	82.8	84.3	86.3	87.7	88.7	89.4	89.8	90.7	91.2	91.6	92.3	92.7	93.1	93.5	94.0	94.2	94.5	94.6	94.7	94.7	94.9	95.0	95.1	95.1	95.1	95.1
Ambient:50° C Duty:51 (Continuous) 1500 rpm (4-Pole)	erating Characteristics at Rated output	tor	1/2L	0.50	0.50	0.53	0.57	0.57	0.60	0.62	0.74	0.74	0.68	0.70	0.72	0.76	0.70	0.72	0.77	0.77	0.76	0.74	0.74	0.76	0.74	0.76	0.72	0.78	0.76	0.76	0.75	0.75	0.75
Ambier Duty 1500 rp	g Characteri	Power Factor	3/4L	0.62	0.64	0.66	0.70	0.70	0.74	0.76	0.82	0.82	0.76	0.80	0.82	0.82	0.78	0.82	0.85	0.85	0.84	0.82	0.82	0.83	0.81	0.83	0.80	0.84	0.83	0.83	0.85	0.85	0.85
	Operatin		F	0.71	0.74	0.75	0.77	0.78	0.81	0.80	0.85	0.85	0.82	0.84	0.85	0.85	0.84	0.86	0.87	0.87	0.86	0.85	0.85	0.86	0.85	0.86	0.84	0.87	0.86	0.86	0.88	0.88	0.88
		Rated Torque	Kg.m	0.26	0.38	0.52	0.75	1.02	1.49	2.49	3.69	5.04	6.20	7.31	9.97	12.3	14.6	19.9	24.5	29.8	36.2	49.2	59.0	72.1	81.9	86.5	98.2	105	118	131	164	206	232
		Rated	Current Amps.	1.03	1.38	1.75	2.44	3.23	4.48	7.46	10.3	13.8	17.6	20.3	27.1	33.2	39.8	52.6	63.8	77.3	95.2	131	156	188	216	225	262	270	307	340	416	524	590
		Rated		1380	1420	1410	1430	1435	1435	1450	1450	1450	1460	1465	1465	1465	1470	1470	1470	1470	1480	1485	1485	1485	1486	1487	1488	1487	1487	1489	1488	1488	1488
	T	ı ype Ref.	B3 Construction	2H071433	2H080433	2H080453	2H09S423	2H09L473	2H10L473	2H11M473	2H13S4K3	2H13M4T3	2H16M4C3	2H16M4K3	2H16L4T3	2H18M473	2H18L483	2H20L453	2H22S433	2H22M453	2H25M433	2H28S423	2H28M453	2H31S413	2H31M4A3	2H31M433	2H31L4A3	2H31L453	2H31L463	2H31L473	2H35L413	2H35L433	2H35L453
.0% 5% -10%		size	IEC	71	80	80	90S	106	100L	112M	132S	132M	160M	160M	160L	180M	180L	200L	225S	225M	250M	280S	280M	315S	315M	315M	315L	315L	315L	315L	355L	355L	355L
Voltage : 415V+/-10% Frequency : 50Hz+/-5% Combined Variation : +/-10%		Rated Output	문	0.50	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10	12.5	15.0	20.0	25.0	30	40	50	60	75	100	120	150	170	180	200	215	240	270	335	422	475
Voltage Frequency Combined V		Ratec	kW	0.37	0.55	0.75	1.1	1.5	2.2	3.7	5.5	7.5	9.3	11	15	18.5	22	30	37	45	55	75	06	110	125	132	150	160	180	200	250	315	*355

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

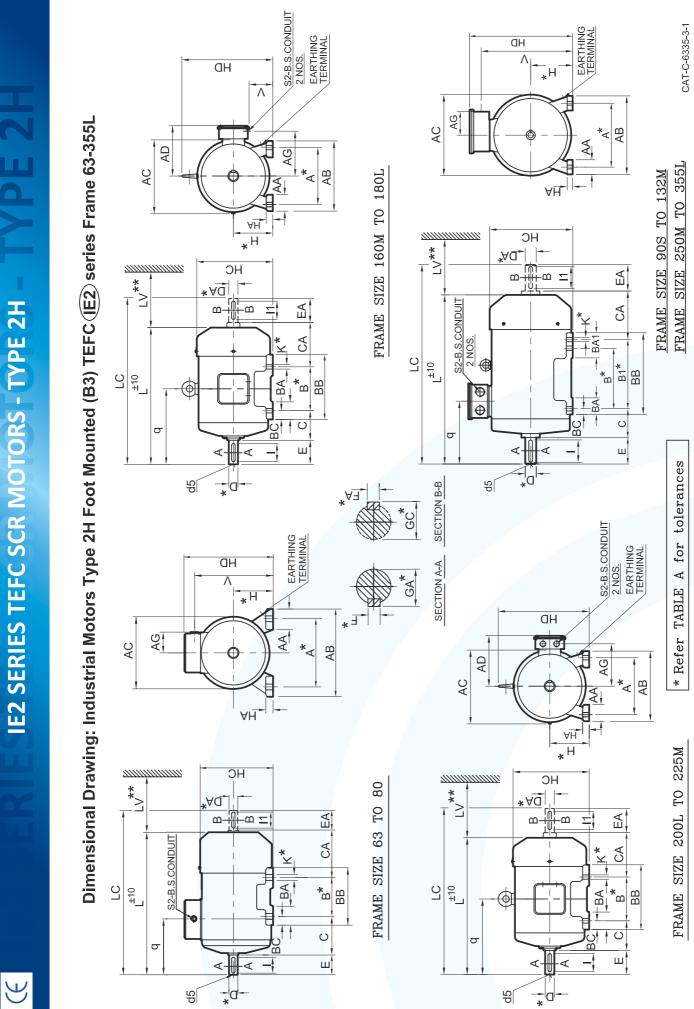
TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 355L

Applicable standard for testing & efficiency determination: IS 15999 Voltage : 415V+/-10% 50H 7+ /- 50X

(ES)		Net Weight	B3 Constn. Kg	10	11	14	17	22	33	52	75	103	113	123	200	254	270	358	528	573	620	830	912	1010	1175	1175	1231	1231	1670	1670	1780	
: F : B : IP55		Rotor CD ²	kgm²	0.0060	0.0084	0.0122	0.0160	0.0250	0.065	0.130	0.193	0.276	0.34	0.40	0.82	1.20	1.37	2.41	3.72	5.11	6.16	10.7	12.4	15.5	18.0	18.0	21.5	21.5	28.7	28.7	35.5	
Ins. Class : F Temp. Rise : B Protection : IP55		Pullout Torque	to Rated Torque Ratio	2.3	2.5	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.3	2.3	2.3	2.2	2.3	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
	With DOL Starting	Starting Torque	to Rated Torque Ratio	2.1	2.2	2.0	2.0	2.0	2.1	2.0	2.0	2.0	2.1	2.0	2.6	2.6	2.6	2.5	2.5	2.5	2.4	2.4	2.2	2.3	2.3	2.3	2.0	2.0	2.0	2.0	2.0	
	With DO	Starting Current	to Rated Current Ratio	3.0	4.0	4.0	4.0	4.5	5.0	5.5	6.0	5.5	5.5	6.0	5.5	5.5	6.0	7.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	
		~	1/2L	67.0	68.5	72.3	74.0	75.0	79.8	82.0	82.0	85.2	86.7	87.0	87.2	88.3	88.8	88.7	91.0	91.2	91.0	92.5	92.9	93.3	93.0	93.8	92.8	93.0	93.3	93.5	93.4	
		% Efficiency	3/4L	69.0	72.9	75.9	78.1	79.6	81.8	83.5	84.5	87.2	88.0	88.7	89.7	90.4	90.9	91.2	92.2	92.7	93.1	93.7	94.0	94.3	94.2	94.6	94.3	94.5	94.6	94.7	94.7	
(snor	tput		F	69.0	72.9	75.9	78.1	79.8	81.8	84.3	86.0	87.2	88.0	88.7	89.7	90.4	90.9	91.7	92.2	92.7	93.1	93.7	94.0	94.3	94.4	94.6	94.7	94.8	94.9	95.0	95.0	
Ambient:50° C Duty :51 (Continuous) 1000 rpm (6-Pole)	at Rated out	or	1/2L	0.48	0.48	0.50	0.50	0.52	0.58	0.60	0.60	0.64	0.64	0.66	0.62	0.69	0.69	0.76	0.82	0.72	0.76	0.75	0.74	0.74	0.72	0.74	0.70	0.71	0.65	0.70	0.70	375kw.
Ambier Duty 1000 r	ting Characteristics at Rated output	Power Factor	3/4L	0.60	0.62	0.61	0.61	0.60	0.65	0.70	0.70	0.74	0.74	0.77	0.75	0.77	0.77	0.84	0.85	0.80	0.83	0.82	0.80	0.81	0.80	0.81	0.79	0.81	0.77	0.80	0.80	n 0.37kw to
	Operating Ch		FL	0.70	0.71	0.72	0.72	0.72	0.75	0.74	0.74	0.80	0.80	0.80	0.80	0.82	0.82	0.86	0.88	0.84	0.86	0.84	0.84	0.84	0.83	0.84	0.82	0.84	0.82	0.84	0.84	r ratings froi
	0	Rated Torque	Kg.m	0.40	0.59	0.79	1.15	1.56	2.28	3.75	5.58	7.61	9.44	11.1	15.1	18.5	22.0	30.0	36.8	44.5	54.4	73.9	88.6	108	123	130	148	157	177	197	246	615-2011 fo
		Rated	Current Amps.	1.07	1.48	1.91	2.72	3.63	4.99	8.25	12.0	15.0	18.4	21.6	29.1	34.7	41.1	52.9	63.4	80.4	95.6	133	159	193	222	231	269	280	322	349	436	as per IS : 12
		Rated		910	915	925	930	935	940	960	960	960	960	965	965	975	975	975	980	984	984	988	989	989	066	066	066	066	066	066	066	nameplates
	F	rype Ref.	B3 Construction	2H080613	2H080633	2H09S633	2H09L653	2H10L633	2H11M653	2H13S6G3	2H13M6T3	2H16M633	2H16L663	2H16L673	2H18L633	2H20L633	2H20L653	2H22M643	2H25M633	2H28S613	2H28M633	2H31S613	2H31M633	2H31M653	2H31L6A3	2H31L673	2H31L6B3	2H31L693	2H35L6A3	2H35L613	2H35L633	Note : Efficiency class 'IE2' will be punched on the nameplates as per IS : 12615-2011 for ratings from 0.37kw to 375kw.
.0% 5% -10%		size	IEC	80	80	90S	30L	100L	112M	132S	132M	160M	160L	160L	180L	200L	200L	225M	250M	280S	280M	315S	315M	315M	315L	315L	315L	315L	355L	355L	355L	E2' will be pu
Voltage : 415V+/-10% Frequency : 50H2+/-5% Combined Variation : +/-10%		Rated Output	ЧН	0.55	0.75	1.0	1.5	2.0	3.0	5.0	7.5	10	12.5	15	20	25	30	40	50	60	75	100	120	150	170	180	200	215	240	270	335	ency class 'If
Voltage Frequency Combined V		Ratec	kW	0.37	0.55	0.75	1.1	1.5	2.2	3.7	5.5	7.5	9.3	11	15	18.5	22	30	37	45	55	75	90	110	125	132	150	160	180	200	250	Note : Effici

Note : Enliciently class liez with be puricitied on the nameprates as per 15.112.404.1 All performance values are subject to tolerance as per 15/1EC 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.



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

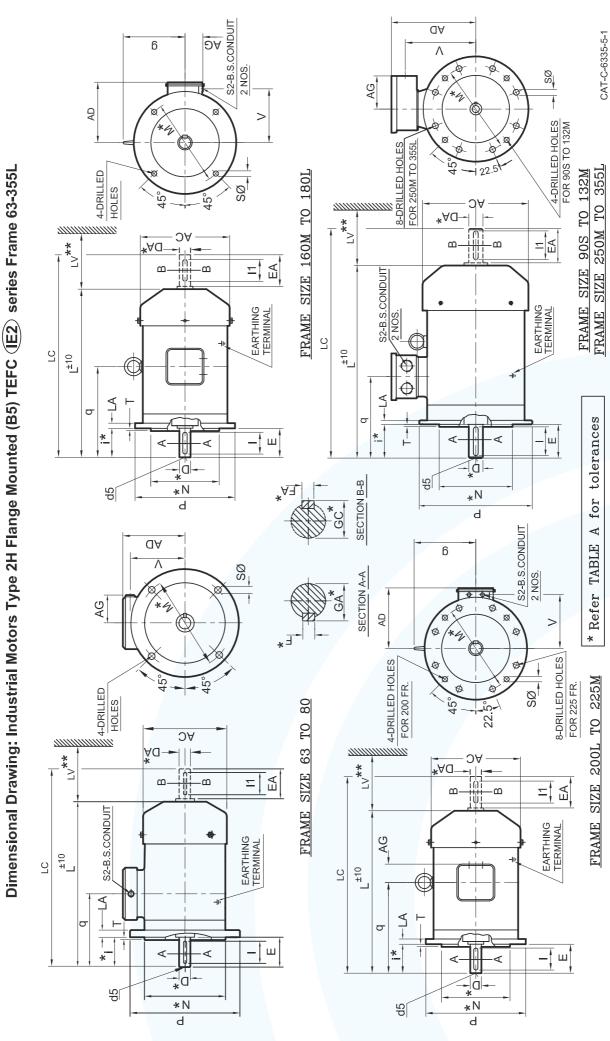
PE 2H IE2 SERIES TEFC SCR MOTORS - TYPE 2H -

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Ц	CA			1	152	152	146	172	228		232	- 233		233	220	-	262		281													
ш Ц	LC		I		408	433	469	502	617		659	1 1		815	802 841	5	920	Ι	1026]		ave			
IABLE	L			1	336	361	387	419	518		556	635	1	679	698 737	5	795		877					1				ks	will h	6		
	Pole				2 & 4	2 & 4	2 & 4	4	2 & 4		4	2 & 4		2 & 4 (4 <	╈	4		4					1		1		Special Remarks	15kW/2P & 11kW/4P in 160M will have	dimensions "L","LC" & "CA" as Indicated in table "B"		
ſ																	-					0			•			pecial	V/4P	LC" &		
Г	d5	M4	M5	M6	-	N N N N N	M10	1 1		Z N			5 M16) M16	+	0 M20			0_M20		0 M20		M20		130 M20		Š	11kV	dimensions "L", "LC"		
		5 18	25	5 35		45	55	55	1	2			105		5 100		100	130							130 160				'2P &	sions		
SHAF I-	GA*	12.5	16	21.5		2/	3	31		4			45		51.5		59	64	54 64	+	\rightarrow	69 79.5			69		DO L		5kW/	limen	Inica	
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Ł	S2 B.S.C.	3/4"	3/4"	3/4"		3/4"	÷	÷	Ę	-		:	-		1 1/2"		2"	°.		2	1	2"	2"		2 1/2"	3"				tolerances		
L A	AG		40	40	(L	79	56	56		6			-186		216		249	1	C17	243		243		278		403				olera		
	σ	104	102	112	139				196	01F	2	323		345	352	5	396	432.5 432.5	4 13			360	386		386 416	1 1	404					
	>	149	166	185		199	225	249	000	222			80		83					578	3	638		728		850				for		
П	۲۷**	30	30	30		35	40	45		20			60		70		80		06		3	115		130	2	145				LE A		
	AC	124	140	157	į	1/4	192	220	000	700			316		354	T	394	C L	450	480	2	544		600		685				TABLE		
	CA	75	83	94		118	125		172	170	7/	203 183		183	217		262		231		268	271	340	P	454	458						
	C	241	278	324	-	1	448		552	200		741		. 291	799 828	+	920 897	1001		+ +	1065	1160		-	1518 1518		_			*Refer		N / 04
			234 2	267 3		+		+	459 5	407 E		605 7 585 7	+	629 7	679 7 717 8	╋	772 8	852 1			914 1			-	1302 1 1332 1	+						Without Eye bolt
	AD	2			C C		-		4		1		2.70		265 6		319 /		344 8 8		<u>ი</u>	- 10	÷	- → 	₽ ₽		-	Specification	S: 1231	S: 2048	S : 2540	Without Eye bolt
ž		 6	5	4			- 2									╀				665	2	2		0	,	- I б	-	Speci	<u>0</u>	S	<u>s</u>	Withc
	Р Н	5 179	195	9 214		230	3 257			0000			366		7 412	+	7 462		RNG 1	-	\rightarrow	2 725		0 830		3 939	-		0	95Ø	Η	<u> </u>
5 	HC	125	141	159	-	177	198		260	_			318		357	\downarrow	2 397		450	495	\rightarrow	552		600		693		0	11,14,19,24,280 38,42,480	75.80.		E shaf
	C HA	13 7	13 7	15 9		18 12	21 12	21 12		2			23 20		3 26	+	28 32		Z8 34	49 42	-	40 42	46	45	46	73 45	-	Tolerance	14,19, 42,480	<u> 30.65.</u>		to DE
	BA1 BC	-	-	-		<u> </u>			c	ч 					- 23		5	0	√ 	4	-	149 4	155 4		4			101	11, . 38, ²	55.(ntica
	BA B	30 -	30	35 -	L	31.5	36 -	36	50		t 1		- 02		- 02	+	85 -	L	L CO	15		110 1	1 20 1		120	170			9 9 9		Ц	on ide
	AA	28	31	31		34 5		1 1		40			28		. 29	╞	85	<u> </u>	C C C	425 100 115		100	120			770 110 170		lsion	~	=,FA	sring)	nensic 3 225
	BB	100	135 110	150 124	125		174 43.5	174	180		0 V	250		294	281 310	3	355	336	361	425		540 490 100 110	540 120		593 120	770		Dimension	D,DA	A,GC,I	d5(centering)	aft din
Ч	AB	126	135			168	190	220	C L	007			310		344		398	007	400	506		540		625		710		Щ		Ó	df	th shi
ſ	*⊻ *⊥	3 7	1 7	0 10		90 10	0 12			71 70			0 15		180 15	+	00 19	10	<u>.</u>	0 24		80 24		315 28		355 28		cation		IS : 1231		ed wi
5	т О	40 63	45 71	50 80	-	26	63 100			201 22			108 160		121 18	+	133 200	140 206	77 04	168 250		419 190 280		216 31)	254 35	$\left \right $	Specification		S S		V.6 m
PNIXI	* <u>-</u>	4	4	1	\vdash	 		~					-		-	+	-	- -		7	•	119	457			<u> </u>	$\left \right $	\vdash	80	3	ğ	1 be p V5 &
	*@	80	06	100	100	125	140	140	140	110	0	210	120	704	241	2	305	286	311	340	2	368 4	406 4		508	630		JCe	PTO 2	0VER 28 7,10Ø	12,15Ø 19.24.28Ø	7 R8
Ц	*∢	100	112	125 100		140	160 140	190					254		279	Ţ	318		0000	406		457 (508		610	<u> </u>	Tolerance	<u>±0./5</u> UPTO 280			tensic R6 R
	Pole	2&4	2,4 & 6	2,4 & 6	6 & 8 8		6 & 8 8		6&8	u	5	2 & 4 6 & 8		in No No	2,6 & 8 6 & 9		5 & 8 6 & 8	4 (0		00	2 4,6 & 8	2	4,6 & 8	2 46&8	5 5	4,0 & 0		-0.5	+0.36	+0.430	Double shaft extension can be provided with shaft dimension identical to DE shaft. Also suitable for REV R2V6. Als avunting as nor IS 2253.
	IEC Fr. size	63	71 2	80	90S	90L	100L	112M	132S	130M		160M	1601	OUL	180M 2	2	200L	225S	225M	250M	+	280S/M	315S/M	_	315L	355L	-	Dimension	A.B		¥	Double Also suit

Dimensional Details: Industrial Motors Type 2H Foot Mounted (B3) TEFC (F2) series Frame 63-355L

Ы **IE2 SERIES TEFC SCR MOTORS - TYPE 2H**



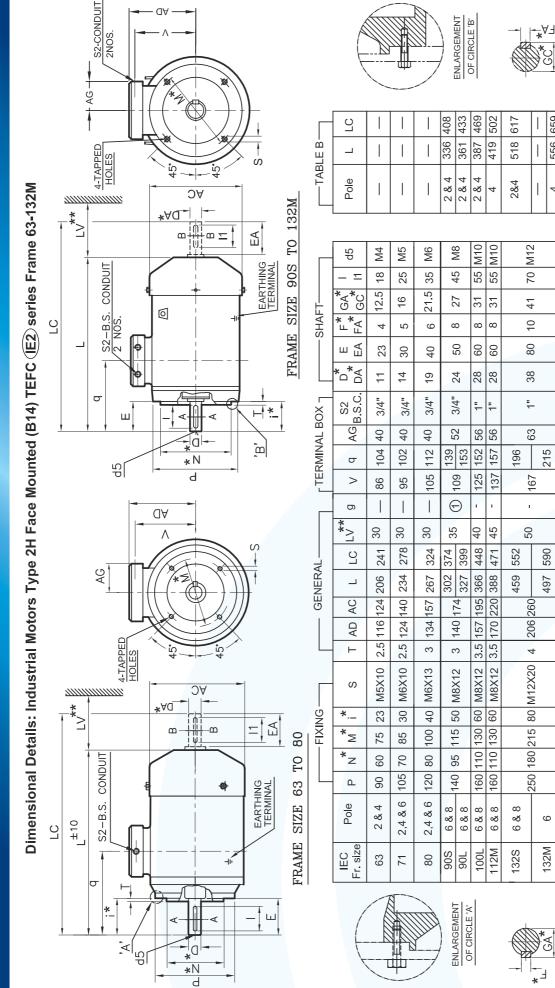
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YPE 2 IE2 SERIES TEFC SCR MOTORS - TYPE 2H

2				- FIXING	0 0		, L ;	22		-GENERAL	ERAL		GENERAL	Г		MINAL	LTERMINAL BOX				SHAFT		Γ	L	TABLE		Б
IEC Fr. size	Pole		*z		*_	S		P	AD	AC	L	LC	**>	- D	>	۹ ۲	AG B.S	U U	D,DA E/	1	FA* GA	GA* GC*	d5		Pole		L C
63	2 & 4	140	95	115	23	5	m	6	116	124	225	260	30	T	86 1	109 4	40 3/4"	\vdash	11 2	23 4		5 18	M4			.	
71	2,4 & 6	160	110	130	30	10	3.5	6	124	140	261	305	30	1	95 1	127 4	40 3/		14 3	30 5	16	3 25	M5			· 	
80	2,4 & 6	200	130	165	40	12	3.5	10	134	157	267	324	30		105 1	112 4	40 3/4"		19 4	40 6	21.5	.5 35	M6				
806	6 & 8	200	130	165	50	12	3.5	10	140	174	302	374	35	Ð	109	<u> </u>	52 3/	3/4"	24	50 8	27	7 45	M8				408
90L	0 8 0 0 8 0				_	1	-	-	1 57	105	321	399	40			_		ŧ		+	+	+		_	Z & 4 3(433
100	0 8 0	ncz.		GLZ	+	<u></u> !	4	=	/01	193	300	448	- 1 0					+	_	_	_	_		N		+	00
112M	6 & 8 8	250	180	215	8	15	4	=	170	220	388	471	45	•	137	157 5	26	-	28	800	ñ	1 55	M10		4	419 5	502
132S	6&8	006	030	265	Q	4	~	ç	206	760	459	552	C L	1	167	196		رد. +	00 	80 10	41	70	M10	0	& 4 5′	518 6	617
132M	9		007	07	8	2	4	2	2002	2007	497	590	00			215								'	4 55	 556 6	
1 ROM	2 & 4										605	741				323									\vdash	\vdash	
	6 & 8 8	350	250	300	110	19	ß	13	226	316	585	721	60	206	186		63 1"	" 42		110 12	2 45	105	5 M16	2	& 4 63	635 7	171
160L	6 & 8)))							629	765				345								' ~	2 & 4 6	- <u>-</u> 679 8	815
180M	2.6 & 8				1	-	'	2	100	i c	679	799	1	-		352	7	1/0"		+	-	-	+			-	802
180L	6&8	350	750	300	110	19	ς	13	C02	354	717	838	0	232	912	371	a/		40	110 14	- 10 -				4 73	-	841
	2	400	300	350	1	, 0	Ľ	и 7	310	304	795	920	0	262	070	396 1	170 2"		ББ 4,	110 16	202	100					
ZUUL	6 & 8 8		2	8	2	_	2 V	2	0 0	100	772	897	8	_											4	795 9	920
225S	4				140						852	1001			4	432.5				0 18					' 		
225M	2	450	350	400	110	19	2	16	344	450	837	956	06	284	273 4	415 1	172	2"	-	\rightarrow	+	+	M20			+	
1017	6 & 8 8				140						852	1001			4	445	_	0		140 18	_		_		4 877		1026
250M	2	550	450	500	140	19	ŝ	00	415	489	993	1134	100		328 3	352 2	243 2"		-	-	+	+	M20			<u>'</u>	
	4,6 & 8		2		2	_	, 	2	2		914	1065	2					+	+	\rightarrow	+	-	+	' .		'	1
280S/M	2 4,6 & 8	- 550	450	500	140	19	5	18	445	544	1010	1160	115		358 3	360 2	243 2"		65 1 ² 75 1 ²	140 18 140 20	8 69 0 79.5) 130 5 130) M20	- 0	 		
315S/M	2				140						1137	1293				386	°.			$ \rightarrow $						'	
	4,6 & 8	660	550	600	170	74	د د	22	515	600	1167	1353	120		413 4		278			170 22	_	_				· -	1
315L	2 4,6 & 8)))			140 170		>		2		1302 1332	1458 1518	001			386 [–] 416	2	1/2" 6	65 1 ⁴ 80 1 ¹	140 18 170 22	85 69	9 130 160		, 	 		1
355L	7	800	680	740	<u> </u>	24	9	25	584	690	1461	1622	145	Ī	495		403 3	3" 7	\vdash	+		+					
	4,6 & 8				1170	,					1491	1082	2			404		-	95 1	1/0 22	100	0 160	0 M24	+	_	-	
					<u>I ABLE A</u>	A H			Г														Special	Special Remarks			_
Dimension	ř,		Specification	ation		Dimension	nsion	Ĭ	Tolerance		Specif	Specification		4. Dofers	1 T C V T						15	15kW/2P 8	11kW/	& 11kW/4P in 160M will have	M will I	Jave	
z	I 40 of ish OVF	07/FR 450				D DA	- -	јо 11,14,19,2 ке за из иво	јо 11,14,19,24,280 ке за из иво	,280	- 1231 - 1231	231	N N N N N N N N N N N N N N N N N N N	ler	IAD		A TOL		LOIELAIICES	CGS	dir	nension	s "L" & "	dimensions "L" & "LC" as Indicated in	ndicated	L I	
A	+	UPTO 265	IS : 2223	223		<u>,</u>	_	m6 55,60,65,75,80,95Ø	50,65,75	,80,956			м Ф	 Without Eye bolt 	Eye b	olt					tat	le "B"					
		OVER 265				GA,GC,F,FA	, F, FA				IS: 2048	048	₩ * *	inimur	n dista	ance f	or effic	cient co	oling c	of moto	r to b€	** Minimum distance for efficient cooling of motor to be maintained by user	ned by I	user			
	±1.5 OVE	OVER 85				do(cen	rering/				S S	540	Note: For	For B	3/B5	mount	ing me	B3/B5 mounting motor in frame	frame (63 & 71	1 refer to		Sales office				
Double	□ Double shaft extension can be provided with	sion cai	n be pro	ovided	with	shaft	shaft dimension		identical to D.E.shaft	to D.E	shaft	П Key	Key / key way fit : h9 / N9	/ay fit	1 / 64 :	6N				AILE	imensi	ons are	n mm r	All Dimensions are in mm unless otherwise specified.	wise spe	scified.	
□ Also su	□ Also suitable for V1 & V3 mounting as per IS 2253	1 & V3	mountir	d as pr	er IS	2253		-	ī			N 8	□ 8 Nos. Fixing Holes from 225S/M frame onwards	Ig Hold	es froi	m 225	S/M fr	ame or	wards						CAT-	CAT-A-6335-5-2	5-5-2

Dimensional Details: Industrial Motors Type 2H Flange Mounted (B5) TEFC (E2) series Frame 63-355L

4 **IE2 SERIES TEFC SCR MOTORS - TYPE 2H**



Note: For non-standard motors, these dimensions may change. Please contact sales office for details. *Refer TABLE A for tolerances

****** 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

IS: 2048 IS: 2540

GA,GC,F,FA d5(centering)

D Key / key way fit : h9 / N9

All Dimensions are in mm unless otherwise specified.

CAT-C-6313-4-1

SECTION B-B

① Without Eye bolt □ Also suitable for V19 & V18 mounting as per IS 2253

Specification

Tolerance

Dimension

Specification

Tolerance

Dimension

z \geq

TABLE A

215

590

497

IS: 1231

j6 11,14,19,24,28Ø k6 38Ø

D,DA

IS: 2223

±0.3 <u>0</u>

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132M

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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 :415V+/-10% Voltage

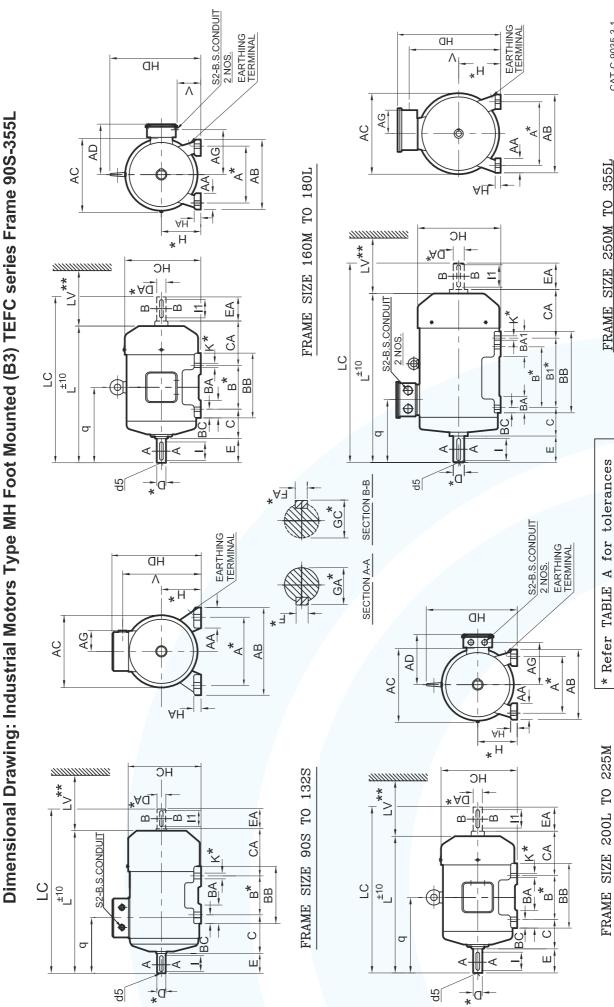
Ins. Class : F

Frequency Combined V	Frequency : 50Hz+/-5% Combined Variation : +/-10%	5% -10%						Duty 750 rp n	Duty : S1(Continuous) 750 rpm (8-Pole)	(snc					Temp. Rise :B Protection :IP55	B IP55	
								Operatir	Operating Characteristics at Rated output	istics at Rate	d output		5	With DOL Starting	ing		
Rated	Rated Output							Power Factor	Factor		% Efficiency	iency	Starting	Starting	Pullout		
		Frame size	Type ref	Rated Speed	Rated Current	Rated Torque							Current to Rated	Torque to Rated	Torque to Rated	Rotor GD ²	Net Weight
kW	ΗР			RPM	Amps	Kg.m	F	3/4L	1/2L	FL	3/4L	1/2L	Current Ratio	Torque Ratio	Torque Ratio	kgm²	Kg
0.37	0.50	90S	MH095813	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	069	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	0660.0	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
06	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 :																	

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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.





CAT-C-9035-3-1

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HIGH EFFICIENCY 8 - POLE MOTORS - TYPE MH

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	- <u>-</u>	45 N	55 N	55 N	70		2		2 00	100	130 N	130	130 N	160	160	160 M24
	GA* GC		31	31	41		- 0	L	- <u>c i c</u>	59	64	69	79.5 1	85 1	85 1	100 1
SHAFT	9 0 * *Ч	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	00	00	10		<u>v</u>	-	ດ 1	16	18	18	20 7	22	22	25 1
	ЕA	50	60	60	80				2	110	140	140	140	170	170	170
	D,DA	24	28	28	38	C 7		C T		55 1	60 1	65 1	75 1	80	80	95 1
_									7							
LTERMINAL BOX	B.S.C.	3/4"		<u>-</u>	-	÷			-	2"	5"	5"	2"	5	2 1/2"	3"
INAL	AG	3 52	2 56	7 56	6 63	· · · ·	20		2 V V	6 249	5 273	2 243	0 243		0 1/0	464 403
ERM	d	139 153	5 152	9 157	196	323	345	352	371	- 396	- 445	8 352	360	416	416	
F	>	199	225	249	299	ĉ	000	0	3			578	638		07/	850
Γ	۲۸**	35	40	45	50		60	C P	2	80	06	100	115		130	145
	AC	174	192	220	260	210	010	25.1	†	394	450	489	544	000	000	685
	CA	118	125	141	172	183	183	217	218	239	231	268	271	340	454	458
	LC	374 399	448	471	561	721	765	799	838	897	976	1065	1160	1353	1518	1682
		302 327	366	388	459	585	629	679	717	772	827	914	1010	1167	1332	1491
	AD	1		•			- 077	100	C07	319	344					
GENERAL	ан	230	257	282	338	366	200	10		462	509	665	725		0.00	939
GEN	Р	177 2	198	222	262	2 α			100	397	450	495	552		000	693
	HAH	12 1	12	12	17 2			00		32	34 4	42	42 5		2 2 1	45 6
		18	21	21	23		C V	6	_	28	28	49	40	46	46	73
	BA1 BC												149	155		
	BA	31.5	36	36	50		2			85	85	115	110	120	120	710 770 110 170
	AA	34	43.5	47	64		°.	1	$ \rightarrow $	85	85	100	540 490 100	120	3 120	110
	BB	3 125 150	174	0 174	5 180		1 234	281	319	355	3 361	5 425	0 490	540	593	2220
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FIXING	U *_	- 56	- 63	- 70	- 89		2	- ,	2		- 149	16	9 19			- 25
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	*) 100 125	0 140	0 140	6 140		+ Z24	241	279	8 305	6 311	6 349	7 36	406	508	610 630
L	*<	- 140	160	190	216	30	- 204 	070		318	356	406	457			61
	Pole	∞∞	œ	∞	œ	ω	œ	∞	∞	œ	ω	œ	œ	∞	œ	œ
	IEC Fr. size	30L	100L	112M	132S	160M	160L	180M	180L	200L	225M	250M	280S/M	315S/M	315L	355L

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

	Specification		IS: 1231		IS : 2048	IS: 2540		
	Tolerance	6 24.28Ø	k6 38,42,48Ø	m6 55.60.65.75.80.95Ø				
TABLE A	Dimension		D,DA		GA,GC,F,FA	d5(centering)		-
TAE	Specification				IS:1231			-
	Tolerance	±0.75	UPTO 280	OVER 280	10Ø	12,15Ø	19,24,28Ø	-
	Tole	9	-0.5	-	+0.360	+0.430	+0.520	
	Dimension	A.B	:	E		¥		

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

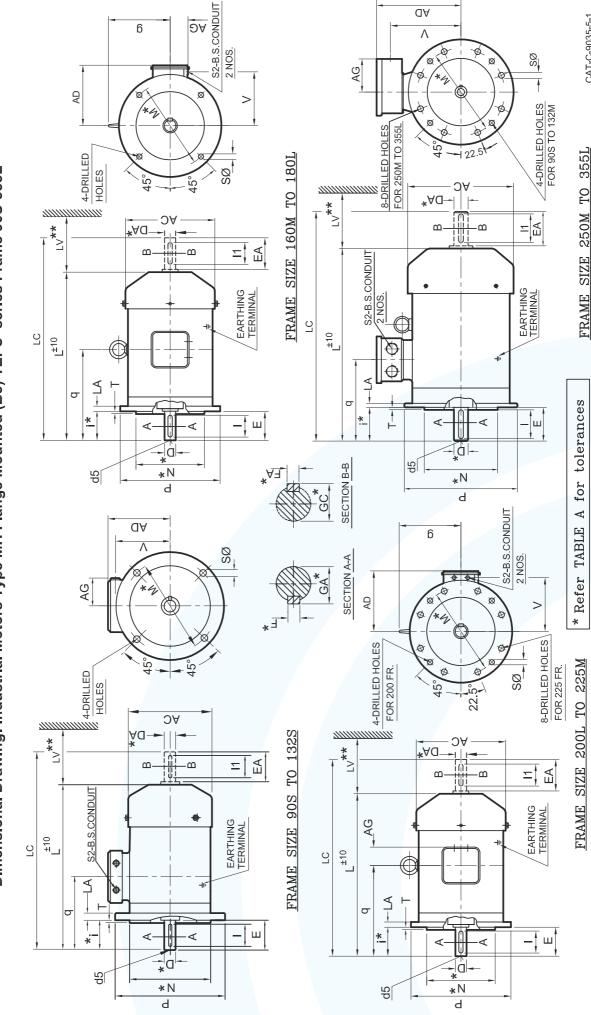
*Refer TABLE A for tolerances

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-9035-3-2

HIGH EFFICIENCY 8 - POLE MOTORS - TYPE MH



CAT-C-9035-5-1

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

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YPE HIGH EFFICIENCY 8 - POLE MOTORS - TYPE MH

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Г	d5	MB	NIO	M10	M10	M12	M16		M16		M20	M20	M20	M20			M24
	- =	15	5	55	55	70	105		100	2	100	130	130	130	160	160	160
SHAFT —	ся ССА ССА	70	17	31	31	41	45	2	ה ה	2	59	64	69	79.5	85	85	100
- SH	* * u u	٥	0	8	∞	10	12	ļ	7	<u>t</u>	16	18	18	20	22	22	25
	БA	U U	DC DC	60	60	80	110) -	110	2	110	140	140	140	170	170	170
	* * D,DA	10	44	28	28	38	42	l	48	2	55	60	65	75	80	80	95
К	S2 B.S.C.	3/4"	5	1"	1"	-	÷		1 1/2"		۵ <u>"</u>	2"	2"	2"	2"	2 1/2"	3"
AL BO	- BA	53	40	56	56	63	63	8	10		172	172	243	243	020		403
LTERMINAL BOX	d	139	153	152	157	196	323	345	352	371	396	445	352	360	416	416	464
ΞĽ	>	100	2	125	137	167	186	3	218-	2	249	273	328	358	0 1 1	1 2 2	495
` r	0	6	-	1	ı	ı	206	2	232	101	262	284					
-	**	25		40	45	50	e0	3	70	2	80	06	100	115	0	130	145
	L L	374	399	448	471	561	721	765	799	838	897	976	1065	1160	1353	1518	1682
GENERAL	L	302	327	366	388	459	585	629	679	717	772	827	914	1010	1167	1332	1491
-GENI	AC	174	-	195	220	260	316		351	t	394	450	489	544	600	000	690
;	AD	140		157	170	206	276	0	265	204	319	344	415	445	14	00	584
	ΓA	10	2	11	11	12	4	2	10	2	15	16	18	18	сс С	77	25
	-	א א	<u>,</u>	4	4	4	Ľ	,	Ľ	2	2	5	5	2	c	٥	9
Γ	S	10	4	15	15	15	10	2	10	2	19	19	19	19	Č	24	24
	*	20	3	60	60	80	110	2	110	2	110	140	140	140	170	170	170
FIXING	*≥	165	3	215	215	265		000	300		350	400	500	500	000	000	740
	*z	130	202	180	180	230	260	002	250	2004	300	350	450	450	C L	nec	680
		000	2004	250	250	300	2 E O	000	350		400	450	550	550	000	000	800
	Pole	œ	8	8	8	ω	œ	œ	∞	ω	œ	00	œ	8	ω	ø	8
	IEC Fr. size	S06	90L	100L	112M	132S	160M	160L	180M	180L	200L	225M	250M	280S/M	315S/M	315L	355L

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

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-9035-5-2

Double shaft extension can be provided with shaft dimension identical to D.E.shaft
 Key / key way fit : h9 / N9

 Also suitable for V1 & V3 mounting as per IS 2253

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

*Refer TABLE A for tolerances

Specification

Tolerance j6 24,28Ø k6 38,42,48Ø

Dimension D,DA

Specification

Tolerance

Dimension

Z Σ

IS: 2223

j6 UPTO 450 js6 OVER 450 ±0.3 UPTO 265 ±0.5 OVER 265

±1.5 OVER 85

TABLE A

IS: 1231

m6 55,60,65,75,80,95Ø

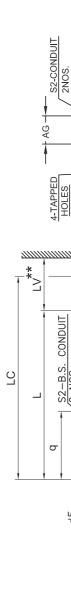
(1) Without Eye bolt

IS : 2048 IS : 2540

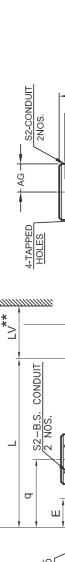
GA,GC,F,FA d5(centering)

HIGH EFFICIENCY 8 - POLE MOTORS - TYPE MH

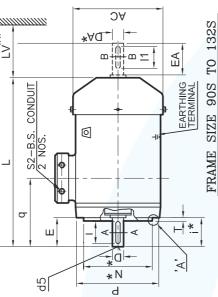


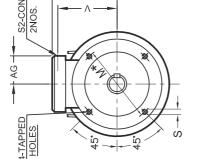


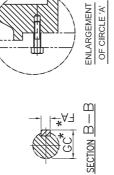
Dimensional Details: Industrial Motors Type MH Face Mounted (B14) TEFC series Frame 90S-132S











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	d5	010		M10	M10	70 M12
		15	1 1	55	55	
	°4* CA	2C 0	7	31	31	80 10 41
-SHAFT	н НА КР	٥	o	∞	ω	10
	ЕA	C	nc	60	60	80
	*_*Y	۴c	۲4	28	28	38
TERMINAL BOX	V 9 AG 82 D* E F* 6A	"1/0	40			÷
AL B	AG	52	70	56	56	63
MIN/	σ	139	153		157	167 196 63
- TER	>			125 152	137 157	167
		•		ı	1	1
	T AD AC L LC LV ^{**} 9	35		40	45	50
	L C	374	399	448	471	
GENERAL		302	3 140 1/4 327 399	3.5 157 195 366 448	3.5 170 220 388 471	4 206 260 459 561
GEN	AC	1	4	95	220	260 4
	AD		1 0	157	170	206
	F	C	o	3.5	3.5	4
	ى v	110 05 115 50 MOV12		160 110 130 60 M8X12	160 110 130 60 M8X12	250 180 215 80 M12X20
FIXING -	*	C L	20	60	60	80
FIXI	*≥	115		130	130	215
	*≥ *∠	0F	2	110	110	180
L	<u>с</u>	140		160	160	250
	Pole	8	8	ω	8	œ
	IEC Fr. size	S06	30L	100L	112M	132S

	Specification	10.1101	1021.0	IS : 2048	IS : 2540
	Tolerance	j6 24,28Ø	k6 38Ø		
TABLE A	Dimension			GA,GC,F,FA	d5(centering)
TA	Tolerance Specification	IC - 7772	C777 - C		
	Tolerance	<u>j</u>	±0.3	н Т	
L	Dimension	z	Σ		

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

*Refer TABLE A for tolerances

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

All Dimensions are in mm unless otherwise specified.

CAT-C-9013-4-1



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)	3	7	
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 m	onths	
Total Saving Over Motor's 20 year Life(Rs.)	1224 (Approxi 11.75 time: purchas	mately s of motor	

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

		Standa	ard design	Optional
		Deep groo	ve 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
200	2	6316 C3	6316 C3	NU316
280	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
132225	Locating bearing	Non-locating bearing
250355	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	Тор	6	M4	4	3/4"
90	Тор	6	M4	4	3/4"
100	Тор	6	M4	10	1"
112	Тор	6	M4	10	1"
132	Тор	6	M5	16	1"
160	Тор	6	M5	16	1"
180	Тор	6	M6	35	1"
200	Тор	6	M8	50	1-1/4"
225	Тор	6	M8	50	1-1/4"
250	Тор	6	M10	150	2"
280	Тор	6	M10	150	2"
315	Тор	6	M12	240	2-1/2"
355	Тор	6	M16	300	3"

🕞 📵 Bharat		3 Phase Iction Motor	IE3 O
No. LIBU2574	1822 6. 000	Misc.	UL VI. W
W/HP states	Eff. IE3 and %	Pr Date	W2 U2 V2
Volts 415 = 105	Rpm.	Amps en_	H Y B
版 50 = 55.	T.Rise 'C	3" oc dmA	UI .VI .WY
8 55	Duty 51	Intôl. F	wz luz luz
La 13 C3 🚽	D 213 C3	410 kg	RII
Grease: Laur	1/K	M/Y /1_	
Regreasing Hrs -	inco , an g/brg	IEC 60034-1	CEO
Works: No.2, MIE	C, Airoli, Navi Mu	mbai 400708	un -

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E3

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

		motor weight)		kg	17	18	25	27	37	79	82	120	127	144	161	192	306	315	475	550	675	760	940	1100	1390	1390	1680	1680	1680	1870	1870
lns. Class : F Temp. Rise : B Protection : 1P55		Rotor GD ²			kgm²	0.009	0.011	0.013	0.016	0.021	0.134	0.150	0.190	0.220	0.300	0.374	0.500	0.910	1.13	2.11	2.60	3.08	3.69	5.00	6.20	7.70	7.70	12.0	12.0	12.0	14.7	14.7
Ins. Class Temp. Rise Protection	<u>س</u>	Pullout Torque	to Rated	Torque	Ratio	3.5	3.5	3.3	3.3	3.3	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.8	2.8	2.7	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.4	2.5	2.4	2.5	2.4
	With DOL Starting	Starting Torque	to Rated	Torque	Ratio	3.0	3.0	3.0	3.0	3.0	2.3	2.3	2.5	2.5	2.5	2.5	2.6	2.2	2.2	2.1	2.4	2.0	2.0	2.4	2.4	2.4	2.4	1.8	2.0	1.8	2.0	1.8
	Wit	Starting Current	to Rated	Current	Ratio	6.0	6.0	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.6	6.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.5	7.0	6.5
				1/2L		78.0	80.0	83.2	85.9	87.3	87.8	88.7	88.7	89.2	0.06	90.8	91.0	91.5	92.0	93.0	93.0	92.7	93.0	93.2	93.4	93.5	93.6	93.7	93.8	93.8	93.8	93.8
ls)	output	% Efficiency		3/4L		80.7	82.7	84.2	85.9	87.8	89.2	90.1	90.7	91.2	91.9	92.4	92.7	93.3	93.7	94.0	94.3	94.7	95.0	95.2	95.4	95.5	95.6	95.7	95.8	95.8	95.8	95.8
: 50 °C : S1 (Continuous) Pole)	Operating Characteristics at Rated output			FL		80.7	82.7	84.2	85.9	87.8	89.2	90.1	90.7	91.2	91.9	92.4	92.7	93.3	93.7	94.0	94.3	94.7	95.0	95.2	95.4	95.5	95.6	95.7	95.8	95.8	95.8	95.8
Ambient: : 50 ° Duty : S1 ((3000 rpm (2-Pole)	Ig Characteri			1/2L		0.68	0.68	0.70	0.75	0.70	0.75	0.75	0.76	0.76	0.77	0.79	0.78	0.79	0.79	0.82	0.80	0.86	0.86	SA	0.80	0.80	0.80	0.86	0.84	0.84	0.86	0.86
Ar Du 30	Operatir	Power Factor		3/4L		0.80	0.80	0.81	0.83	0.82	0.84	0.84	0.83	0.83	0.84	0.86	0.84	0.85	0.85	0.88	0.86	0.89	0.89	0.86	0.86	0.86	0.86	0.89	0.89	0.89	06.0	06.0
		P		FL		0.84	0.84	0.86	0.87	0.87	0.87	0.87	0.86	0.86	0.87	0.88	0.88	0.87	0.87	0.90	0.89	0.91	0.91	0.88	0.88	0.88	0.88	0.92	0.92	0.92	0.92	0.92
0		Rated Torque		Kg.m		0.26	0.38	0.51	0.74	1.25	1.81	2.47	3.08	3.64	4.96	6.12	7.24	9.84	12.1	14.8	18.0	24.6	29.5	35.9	43.1	48.9	52.2	58.7	65.2	73.4	81.5	91.3
ition: IS 1599!		Rated Current		Amps.		1.54	2.20	2.88	4.10	6.74	9.86	13.3	16.6	19.5	26.1	31.7	37.5	51.4	63.1	74.0	91.2	121	145	183	219	248	265	284	316	355	395	442
cy determina		Rated Speed	-	RPM		2840	2840	2885	2885	2890	2960	2960	2945	2945	2945	2945	2960	2970	2970	2970	2970	2970	2970	2985	2985	2985	2985	2987	2988	2987	2988	2987
ing & efficier %		Frame size		IEC		80	80	90S	106	100L	132S	132S	160M	160M	160M	160L	180M	200L	200L	225M	250M	280S	280M	315S	315M	315L	315L	355L	355L	355L	355L	355L
ndard for test : 415V+/-10% : 50Hz+/-5% iation : +/-109		Rated Output		НР		1	1.5	2	3	5	7.5	10	12.5	15	20	25	30	40	50	60	75	100	120	150	180	200	215	240	270	335	335	375
Applicable standard for testing & efficiency determination: IS 15999 Voltage : 415V+/-10% Frequency : 50Hz+/-5% Combined Variation : +/-10%		Rated		kW		0.75	1.1	1.5	2.2	3.7	5.5	7.5	9.3	11	15	18.5	22	30	37	45	55	75	06	110	132	150	160	180	200	225	250	280

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

E3 PREMIUM EFFICIENCY IE3 SERIES MOTORS - TYPE 3H S - TYP



Applicable standard for testing & efficiency determination: IS 15999

Ambient: : 50 °C

Tempolity 15(4): 4(4) Tempolity 15(4)	Voltage	: 415V+/-10%	%(Duty		: S1(Continuous)	5)				Ins. Class :	ц.	
Indext, frame Frame Anno. Anno. Anno. Anno. Anno. i frame frame <td< td=""><td>Frequency Combined V</td><td>: 50Hz+/-55 /ariation : +/-1</td><td>% 10%</td><td></td><td></td><td></td><td></td><td>15</td><td>00 rpm (4-Po</td><td>le)</td><td></td><td></td><td></td><td></td><td>Temp. Rise Protection</td><td>: B : IP55</td><td></td></td<>	Frequency Combined V	: 50Hz+/-55 /ariation : +/-1	% 10%					15	00 rpm (4-Po	le)					Temp. Rise Protection	: B : IP55	
i i dec add	Rated	Output	Frame					Operatin	g Characteris	ttics at Rated o	output		Wit	h DOL Startin _§	bD		
HP FC MPM			size	Rated Speed	Rated Current	Rated Torque	Ē	ower Factor			% Efficiency		Starting Current	Starting Torque	Pullout Torque	Rotor GD ²	motor weight
1 600 140 102 0.7 0.7 0.7 0.7 0.7 0.7 0.7 1 10 140 140 140 140 0.7	kW	đH	IEC	RPM	Amps.	Kg.m	FL	3/4L	1/2L	Ŀ	3/4L	1/2L	to Kated Current Ratio	to Kated Torque Ratio	to Kated Torque Ratio	kam ²	ß
1 0% 14% 0% 14% 0% 14% 0% 14% 0% 14% 0% 14% 0% 14% 0% <	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 0.0 143 0.38 10.3 0.83 0.83 0.83 0.83 0.83 0.03 0.03 7 10.0 1430 4.53 149 0.73 0.73 0.73 0.73 0.03 7 10.0 1430 4.53 149 0.73 0.73 0.74 0.60 86.7 86.7 86.7 56.6 3.0 3.0 0.03 7 1335 1470 133 6.16 0.83 0.73 0.66 9.0 86.7 86.7 86.7 86.7 56.7 26.6 3.0 0.34 1 133 140 133 6.16 0.83 0.73 0.74 9.0	1.1	1.5	30S	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
3 1001 4400 453 104 733 104 643 <td>1.5</td> <td>2</td> <td>30L</td> <td>1425</td> <td>2.98</td> <td>1.03</td> <td>0.82</td> <td>0.78</td> <td>0.68</td> <td>85.3</td> <td>85.3</td> <td>85.3</td> <td>5.5</td> <td>2.8</td> <td>3.3</td> <td>0.023</td> <td>28</td>	1.5	2	30L	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
1 1	2.2	£	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
15 132 1470 164 364 082 028 896 890 65 26 33 0141 11 113 1470 133 6497 083 078 904 904 65 275 33 0133 11 11 1147 014 1147 0143 0144 0144 0144	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
10 12.0 13.0 43.0 0.33 0.73 0	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
11 160 170 173 6.16 0.82 0.77 0.86 9.10 9.00 6.5 2.7 3.2 0.340 1 1 100 1470 204 7.29 082 0.71 0.86 9.14 90.8 65 2.7 3.2 0.375 2 1 100 1470 2.73 0.87 0.87 0.70 9.26 9.21 0.75 2.7 3.2 0.375 0.375 3 180 1470 3.19 193 0.87 0.87 0.74 9.26 9.26 0.5 2.7 3.0 0.375 4 0.01 1470 3.19 0.87 0.84 0.77 9.26 9.26 0.26 3.0 0.375<	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
1 1	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
20 1601 1470 27.3 9.9.4 0.8.3 0.7.3 0.7.3 0.8.4 0.7.3 0.5.20 <th< td=""><td>11</td><td>15</td><td>160M</td><td>1470</td><td>20.4</td><td>7.29</td><td>0.82</td><td>0.77</td><td>0.68</td><td>91.4</td><td>91.4</td><td>90.8</td><td>6.5</td><td>2.7</td><td>3.2</td><td>0.375</td><td>135</td></th<>	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
250180M147031.912.30.870.840.760.7692.692.692.65.53.00.753.00.750310180L147037.814.60.870.840.770.840.7593.093.093.555.5.53.00.8601.3840200L147551.319.80.870.840.7793.693.993.994.556.52.53.00.8601.3850255M142266.024.30.830.800.7494.294.594.595.65.02.63.02.53.00.8601.3866250M148286.129.60.830.800.7494.294.594.594.66.02.02.62.63.01.38100250M148286.129.60.830.800.7495.295.995.62.6	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
30 1801 1770 37.8 14.6 0.87 0.84 0.76 93.0 93.0 65.5 5.5 3.0 0860 138 40 2001 1475 51.3 19.8 0.87 0.84 0.77 93.6 93.5 61.5 5.6 3.0 138 138 60 2050 1482 60.0 243 0.83 0.80 0.74 93.5 93.5 6.7 2.6 3.0 2.6 3.0 138 60 225M 1482 60.1 29.5 0.80 0.74 94.2 94.2 93.6 6.0 2.0 2.3 3.0 5.3 7 250M 1480 96.3 0.80 0.74 95.2 95.6 95.6 5.3 3.0 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3 5.3	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
40 2001 1475 51.3 19.8 0.87 0.84 0.77 93.6 93.6 6.5 2.6 3.0 1.38 1.38 7 70 2255 1482 660 24.3 0.83 0.83 0.84 0.74 93.9 93.4 6.0 2.0 2.6 2.30 2.33 2.30 2.33 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30 2.30	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
502255148266024.30.830.800.740.930.390.346.02.02.62.302.3060225M148280.129.60.830.830.800.7494.294.293.66.02.02.62.832.8377250M148096.356.20.830.800.7494.294.695.62.02.02.62.832.631002805148512894.20.840.700.7495.095.095.72.02.02.02.02.02.01102805148515390.20.860.820.820.7495.095.095.06.02.02.02.02.02.01102807148513972.00.860.820.7495.495.495.96.02.02.02.02.02.02.0110215018018072.00.860.7495.495.495.96.02.0	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
6 (0)225M148280.129.60.830.800.7494.294.294.294.60.560.202.02.62.837 7250M148096.336.20.840.890.7294.694.694.694.76.02.002.073.061002805148512894.20.860.820.840.820.7495.095.094.56.52.53.05.361012806148515359.00.860.820.820.7495.495.495.96.52.53.06.36102280M14891290.800.850.820.7495.495.495.96.62.53.014.71111121130.840.850.820.720.7495.494.16.82.53.014.71121131141130.840.850.820.7295.695.694.56.62.73.014.71131141141180.840.820.820.7295.695.694.56.62.73.014.01141141141180.840.820.820.7295.995.695.695.73.014.01141141141141180.840.800.7295.995.095.06.72.73.014.6 </td <td>37</td> <td>50</td> <td>225S</td> <td>1482</td> <td>66.0</td> <td>24.3</td> <td>0.83</td> <td>0.80</td> <td>0.74</td> <td>93.9</td> <td>93.9</td> <td>93.4</td> <td>6.0</td> <td>2.0</td> <td>2.6</td> <td>2.30</td> <td>400</td>	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
75 250M 1480 96.3 6.0.4 0.80 0.72 94.6 94.6 93.8 6.0 2.0 2.6 3.06 100 2805 1485 128 99.2 0.82 0.74 95.0 95.0 95.6 6.5 2.5 3.0 5.35 110 280M 1485 153 0.80 0.85 0.82 0.74 95.0 95.0 6.5 2.5 3.0 5.35 5.30 110 280M 1485 153 0.90 0.85 0.82 0.74 95.0 95.0 6.5 2.5 3.00 5.35 5.30 5.35 110 110 270 0.85 0.82 0.74 95.4 95.6 95.4 95.6 95.7 95.7 95.0 95.7 95.0 95.0 95.6 95.0 95.6 95.0 95.0 95.0 95.0 95.0 95.0 95.0 95.0 95.0 95.0 95.0 95.0	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
11002805143512849.20.860.820.820.7495.095.094.50.52.53.05.53<	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
1 120 280M 1485 153 59.0 0.86 0.82 0.74 95.2 95.0 6.5 3.0 6.36 6.36 1 150 3155 1488 189 72.0 0.85 0.82 0.74 95.4 95.9 6.5 3.0 6.36 11.7 11.7 1 150 315M 1488 189 72.0 0.85 0.82 0.74 95.4 95.4 6.8 2.5 3.0 11.7 11.7 1 215 315L 1490 277 105 0.84 0.80 0.72 95.4 95.4 6.6 2.7 3.0 17.6	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
1150315514881897200.850.820.820.7495.495.493.96.82.53.011.711180315M148822686.40.850.820.7205.695.694.16.82.53.014.014.0221514902771050.840.800.7295.995.694.66.62.73.017.815.62240315L14913111180.840.800.7295.995.994.66.62.73.017.815.62270315L14913451310.840.800.7295.095.095.095.095.017.817.817.817.82270315L14913451310.840.800.7295.095.095.06.62.73.017.817.83300355L14903751470.870.830.7296.095.06.01.72.42.317.817.83355L14923750.870.830.7296.095.095.06.61.72.42.317.817.817.817.817.817.817.817.817.817.817.817.817.817.817.817.817.817.817.817.917.917.917.9<	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
180 315M 1488 226 86.4 0.85 0.82 0.74 95.6 94.1 6.8 2.5 3.0 14.0 215 315L 1490 277 105 0.84 0.80 0.72 95.8 94.5 6.6 2.5 3.0 17.6 17.6 240 215L 1491 311 118 0.84 0.80 0.72 95.9 95.6 94.6 6.6 2.7 3.0 17.8 17.8 270 315L 1491 345 131 0.84 0.80 0.72 95.9 95.0 95.0 6.6 2.7 3.0 17.8 17.8 300 355L 1490 375 147 0.84 0.83 0.72 96.0 95.0 6.6 1.7 3.0 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8 17.8	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
215 315L 1490 277 105 0.84 0.80 0.72 95.8 94.5 6.6 2.5 3.0 15.6 17.8 240 315L 1491 311 118 0.84 0.80 0.72 95.9 94.6 6.6 2.7 3.0 17.8 17.8 270 315L 1491 345 131 0.84 0.80 0.72 95.0 95.0 6.6 2.7 3.0 17.8 17.8 300 355L 1491 345 131 0.84 0.80 0.72 96.0 95.0 6.6 1.7 3.0 17.8	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
240 315L 1491 311 118 0.84 0.80 0.72 95.9 94.6 6.6 2.7 3.0 17.8 17.8 270 315L 1491 345 131 0.84 0.80 0.72 96.0 95.0 6.6 2.7 3.0 17.8 17.8 300 355L 1490 375 147 0.87 0.83 0.72 96.0 95.0 6.0 1.7 2.4 2.3 17.8 300 355L 1490 375 147 0.87 0.83 0.72 96.0 95.0 6.0 1.7 2.4 2.3.3 17.8 335 355L 1492 163 0.87 0.83 0.72 96.0 95.0 6.5 1.8 2.4 2.3 3.7 422 355L 1492 525 206 0.60 95.0 6.5 1.8 2.4 2.3 3.7 422 355L 1492	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
270 315L 1491 345 131 0.84 0.80 0.72 96.0 96.0 95.0 6.6 2.7 3.0 17.8 300 355L 1490 375 147 0.87 0.83 0.72 96.0 96.0 95.0 6.0 1.7 2.4 23.3 335 355L 1492 163 0.87 0.83 0.72 96.0 96.0 95.0 6.0 1.7 2.4 23.3 335 355L 1492 163 0.87 0.83 0.72 96.0 95.0 6.5 1.8 2.4 23.7 420 355L 1492 525 206 0.87 96.0 95.0 65.0 1.8 2.4 32.7	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
300 355L 1490 375 147 0.87 0.83 0.72 96.0 96.0 95.0 6.0 1.7 2.4 2.33 335 355L 1492 416 163 0.87 0.83 0.72 96.0 95.0 6.5 1.8 2.4 23.3 422 355L 1492 525 206 0.83 0.72 96.0 95.0 6.5 1.8 2.4 32.7	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
335 355L 1492 416 163 0.87 0.83 0.72 96.0 95.0 6.5 1.8 2.4 32.7 422 355L 1492 525 206 0.87 0.83 0.72 96.0 95.0 6.5 1.8 2.4 32.7	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
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	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

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(E3)

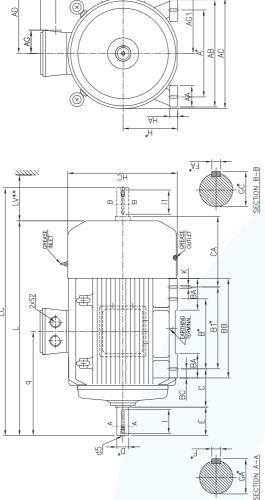
TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 90 to 355L

weight 1670 motor 138 145 210 295 302 410 528 573 620 830 1010 1175 1670 1780 1995 125 912 8 25 27 36 50 72 83 0.029 0.276 0.450 0.560 0.646 0.017 0.025 0.074 0.202 2.10 6.16 15.5 18.0 35.5 Rotor kgm² 1.20 1.81 5.1128.7 43.3 3.51 3.72 12.4 28.7 GD² 10.7 Protection : IP55 Temp. Rise: B Ins. Class : F to Rated Torque Torque Pullout Ratio 3.0 3.0 3.0 3.0 3.0 2.5 3.2 3.0 2.5 2.5 2.5 2.5 2.3 2.3 3.0 3.0 3.2 3.5 3.2 3.2 3.2 2.5 2.5 2.5 With DOL Starting Torque Starting Torque to Rated Ratio 1.8 2.5 2.6 2.6 3.0 2.6 2.3 2.3 1.8 2.5 2.5 2.5 2.8 2.6 2.5 2.5 2.5 2.5 2.0 2.0 2.0 2.0 2.1 2.1 to Rated Current Starting Current Ratio 4.0 4.0 4.5 6.0 5.0 5.5 6.5 6.5 6.5 6.0 6.0 6.0 6.0 6.0 6.0 5.0 5.5 5.5 5.5 6.5 6.0 6.0 6.0 6.0 88.0 91.5 92.8 92.9 93.6 78.9 81.0 82.5 81.0 89.1 89.8 91.2 92.2 92.5 93.2 93.9 94.2 94.4 94.0 94.1 86.5 90.3 93.0 94.1 1/2L % Efficiency 81.0 82.5 95.8 78.9 84.3 86.5 88.0 89.1 89.8 90.3 91.7 92.2 92.9 93.3 93.7 94.6 94.9 95.1 95.4 95.6 95.7 95.8 91.2 94.1 3/4L Operating Characteristics at Rated output : S1(Continuous) 78.9 81.0 82.5 84.3 86.5 88.0 89.1 89.8 91.2 92.2 92.9 93.3 93.7 94.6 94.9 95.195.6 95.8 95.8 90.3 91.7 94.1 95.4 95.7 Ц : 50 °C 1000 rpm (6-Pole) 0.54 0.58 0.64 0.68 0.68 0.68 0.75 0.76 0.72 0.78 0.72 0.66 0.70 0.70 0.52 0.62 0.79 0.72 0.52 0.72 0.77 0.72 0.72 0.71 1/2L Ambient: Duty Power Factor 0.76 0.62 0.62 0.70 0.75 0.74 0.76 0.76 0.78 0.83 0.85 0.84 0.86 0.80 0.82 0.82 0.82 0.80 0.78 0.80 0.80 0.84 0.81 3/4L 0.72 0.72 0.78 0.80 0.80 0.88 0.89 0.85 0.87 0.85 0.84 0.82 0.84 0.84 0.72 0.75 0.80 0.80 0.83 0.87 0.88 0.85 0.85 0.84 Ц Torque Rated 44.5 73.6 1.567.53 15.0 21.9 Kg.m 2.23 5.55 9.29 11.0 18.4 54.4 1.133.73 29.7 36.7 88.4 108 130 0.77 157 177 197 246 Applicable standard for testing & efficiency determination: IS 15999 Current Rated 14.6 78.6 Amps. 1.842.62 3.51 7.44 18.0 21.2 27.6 32.3 37.7 62.0 93.5 130 229 319 346 4.84 11.151.1 155 189 277 432 Speed Rated RPM 970 945 945 935 960 965 965 975 975 977 977 984 992 992 992 992 990 977 984 982 984 066 991 991 Frame 100L 112M 132M 160M 160L 180L 200L 200L 225M 250M 280M 315M 315M 315L 132S 315S 280S 160L 355L 355L 355L 355L size 90S **J0**6 EC Combined Variation : +/-10% : 415V+/-10% : 50Hz+/-5% 12.5 120 150 180 215 240 270 100 1.5 7.5 335 10 15 20 25 30 40 50 60 75 ЧЬ -2 m ഹ Rated Output Frequency 0.75 18.5 110 132 200 Voltage 160 180 1.5 5.5 7.5 1.12.2 3.7 9.3 22 30 45 90 250 k⊻ 1115 37 55 75

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







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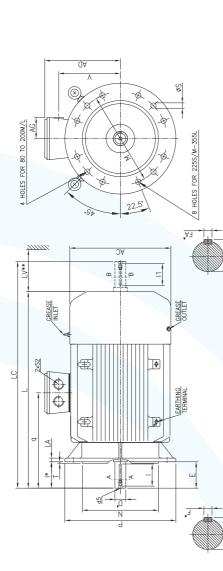
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	d5	M6	M8	M10	M10	M12	M16	M16	M20	M20	M20	M20	M20	M20	M24
	- 1	35	45	55	55	70	105	100	100	100 130	130 130	130 130	130 160	130 160	130 160
VET	GA* GC*	21.5	27	31	31	41	45	51.5	59	59 64	64 69	69 79.5	69 85	69 85	79.5 100
SHAFT	F* FA*	9	∞	∞	00	10	12	14	16	16 18	18 18	18 20	18 22	18 22	20 25
	ЕA	40	50	60	60	80	110	110	110	110 140	140 140	140 140	140 170	140 170	140 170
	D* DA*	19	24	28	28	38	42	48	55	55 60	60 65	65 75	65 80	65 80	75 95
	S2 BSC	3/4"	3/4"	1"	1"	1"	1"	1 1/2"	"2"	2"	2"	"2	2"	2 1/2"	3"
×	AG1	Ι	I	138	151	173	203	234	268	286	328	358	413	413	495
TERMINAL BOX	V1	Ι	I	66	80	69	97	83		I	I		Ι	I	I
ERMIN	AG	40	52	56	56	63	63	97	155	155	243	243	278	278	403
	σ	118	138	152	157	204	345	371	396	445	352	360	386 416	386 416	434 464
	>	191	209	225	249	305	363	414	468	511	578	638	728	728	850
	AC	174	195	195	220	294	348	394	438	472	489	544	604	604	695
	LV**	30	35	40	45	50	60	70	80	06	100	115	130	130	145
	CA	100	129	146 125	172	191	208	225	262	292	337 268	271	240	454	458
	LC	335	410	469 448	502	618	790	845	920	972 1032	1134 1065	1160	1293 1353	1458 1518	1622 1682
	_	292	355	387 366	419	533	673	728	803	855 885	983 914	1010	1137 1167	1302 1332	1461 1491
	AD	Ι	I	179	191	208	238	290	336	354	415	445	515	515	584
ΥΓ	ЯΗ	220	240	257	282	340	398	470	536	579	665	725	830	830	939
GENERAL	HC	168	188	198	222	279	334	377	419	461	495	552	615	615	693
	НA	12	12	12	12	17	20	26	32	34	42	42	45	45	45
	BC	12	12.5	21	21	20	20	20	25	25	49	40	46	46	73
	BA1	I	61	I	Ι	91	105	108	120	85	I	149	155	Ι	I
	BA	36	38	36	36	53	70	70	85	85	115	110	120	120	170
	AA	32	34	43.5	47	50	58	65	85	85	100	100	120	120	110
	BB	124	150	174	174	218	294	319	355	361	425	490	540	593	770
1	AB	150	168	190	220	256	310	344	398	437	506	540	625	625	710
	*≻	10	10	12	12	12	15	15	19	19	24	24	28	28	28
3	*	80	06	100	112	132	160	180	200	225	250	280	315	315	355
FIXING	U	50	56	63	70	89	108	121	133	149	168	190	216	216	254
FIX	B1*	I	125	Ι	Ι	178	254	279	305	311	Ι	419	457	Ι	
	в*	100	100	140	140	140	210	241	267	286	349	368	406	508	630
	A*	125	140	160	190	216	254	279	318	356	406	457	508	508	610
	Pole	2,4&6	2,4&6	2&4 6	4&6	2,4&6	2,4&6	2,4&6	2,4&6	2 4&6	2 4&6	2 4&6	2 4&6	2 4&6	2 4&6
	IEC Fr. Size	80	J/S06	100L	112M	132S/M	160M/L	180M/L	200M/L	225S/M	250M	280S/M	315S/M	315L	355L

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





GC SECTION B-B

SECTION A-A

C (IE3) series Frame 80-355L
nted (B5) TEFC
3H Flange Moui
rial Motors Type 3
Drawing: Industr
Dimensional I

	d5	M6	M8	M10	M10	M12	M16	M16	M20	M20	M20	M20	M20	M20	M24
	- =	35	45	55	55	70	105	100	100	100 130	130 130	130 130	130 160	130 160	130 160
Ŀ	gA*	21.5	27	31	31	41	45	51.5	59	59 64	64 69	69 79.5	69 85	69 85	79.5 100
SHAFT	FA *	9	∞	8	8	10	12	14	16	16 18	18 18	18 20	18 22	18 22	20 25
	БA	40	50	60	60	80	110	110	110	110 140	140 140	140 140	140 170	140 170	140 170
	DA*	19	24	28	28	38	42	48	55	55 60	60 65	65 75	65 80	65 80	75 95
	S2 BSC	3/4"	3/4"	1"	1=	1"	1"	$1 \ 1/2"$	2"	2"	2"	2"	2"	2 1/2"	3"
AI, BOX	AG	40	52	56	56	63	63	97	155	155	243	243	278	278	403
TERMINAL BOX	٩	118	138	152	157	204	345	371	396	445	352	360	386 416	386 416	434 464
	>	111	119	125	137	173	203	234	268	286	328	358	413	413	495
	AC	174	195	195	220	294	348	394	438	472	489	544	604	604	695
	۲۸**	30	35	40	45	50	60	70	80	06	100	115	130	130	145
	LC	335	410	469 448	502	618	790	845	920	972 1032	1134 1065	1160	1293 1353	1458 1518	1622 1682
GENERAL	-	292	355	387 366	419	533	673	728	803	885	983 914	1010	1137 1167	1302 1332	1461 1491
	AD	140	150	157	170	208	238	290	336	354	415	445	515	515	584
	LA	10	10	11	11	12	13	13	15	16	18	18	22	22	25
	μ	3.5	3.5	4	4	4	5	5	5	5	5	5	6	6	6
	s	12	12	15	15	15	19	19	19	19	19	19	24	24	24
	*	40	50	60	60	80	110	110	110	110 140	140	140	140 170	140 170	140 170
FIXING	*	165	165	215	215	265	300	300	350	400	500	500	600	600	740
	*z	130	130	180	180	230	250	250	300	350	450	450	550	550	680
	٩	200	200	250	250	300	350	350	400	450	550	550	660	660	800
	Pole	2,4&6	2,4&6	2&4 6	4&6	2,4&6	2,4&6	2,4&6	2,4&6	2 4&6	2 4&6	2 4&6	2 4&6	2 4&6	2 4&6
	IEC Fr. Size	80	90S/L	100L	112M	132S/M	160M/L	180M/L	200M/L	225S/M	250M	280S/M	315S/M	315L	355L

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







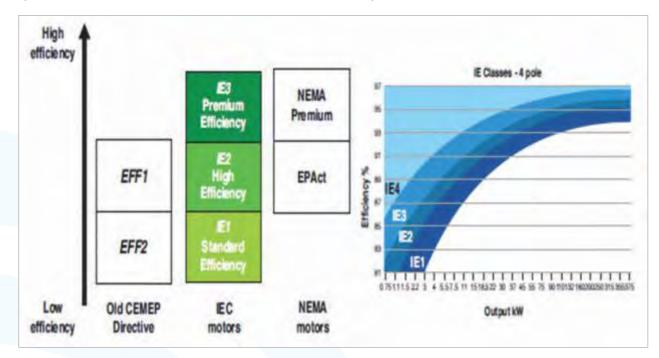
Common Queries

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

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.

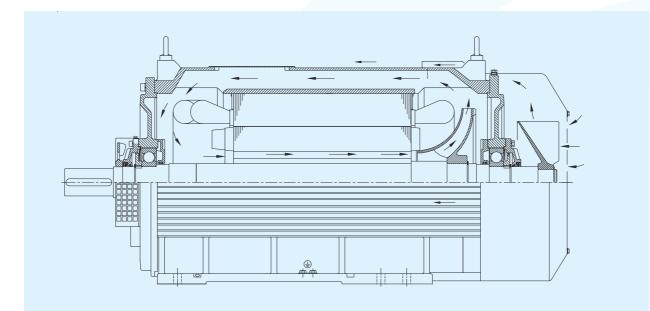
Technology

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

	Ins. Class : F	Temp. Rise:B Protection :IP55		Nat	Weight	Constn.	Бу	2040	2160	2280	2380	2880	3260			Net Workt			kg	2160	2270	2380	2810	3000	4100	4300	4500	5650
	Ins. C	Temp Prote		Rotor	GD ² kam ²	- 		23.30	26.00	28.60	31.30	51.30	57.30			Rotor	GDz	kgm²		30.60	33.70	36.80	63.00	70.50	108.0	120.0	132.0	160.0
				Pullout	Torque to Rated	Torque	0,000	2.5	2.5	2.5	2.5	2.5	2.5			Pullout	Torque	to Rated	Torque Dotio	2.5	2.5	2.4	2.5	2.5	2.5	2.5	2.5	2.5
_				- Starting	Starting Torque	to Rated Torque	Ratio	1.7	1.7	1.7	1.7	1.7	1.7		- Starting	Starting	Torque	to Rated	Torque	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
/K to 450				With DOL	Starting Current	to Rated Current	Ratio	6.5	6.5	6.5	6.5	7.0	7.0		With DOL	Starting	Current	to Rated	Current	6.5	6.5	6.5	6.8	6.8	6.8	6.8	6.8	6.8
duction Motors - DCCA Series - Frame size 355L/K to 450L					cy	1/2L		94.0	94.4	94.6	94.8	92.4	92.6			CV.			1/2L	94.8	95.0	95.1	95.0	95.1	95.0	95.2	95.4	95.6
- Frame s					% Efficiency	3/4L		94.8	95.4	95.6	95.8	94.4	94.6			% Efficiency			3/4L	95.8	96.0	96.1	95.8	95.9	95.8	96.0	96.2	96.4
A Series	(sno			d output		FL		95.1	95.6	95.8	96.0	95.2	95.4	_	d output				Γ	96.0	96.2	96.3	96.4	96.5	96.2	96.4	96.6	96.8
rs - DCC/	t: 40°C : S1(Continuous)	3000 rpm (2-Pole)		Operating Characteristics at Kated output	ctor	1/2L		0.82	0.82	0.84	0.84	0.80	0.80	1500 rpm (4-Pole)	Operating Characteristics at Rated output	tor			1/2L	0 73	0.73	0.74	0.78	0.78	0.76	0.76	0.76	0.76
on Moto	Ambient: 40°C Dutv : S1(Co	3000 гр		Characteris	Power Factor	3/4L		0.87	0.87	0.88	0.88	0.88	0.88	 1500 rl	Characteris	Power Factor			3/4L	0.82	0.82	0.83	0.85	0.85	0.84	0.84	0.84	0.84
e Inducti			:	Operating		FL		0.89	0.89	0.90	0.90	0.90	06.0		Operating				Η	0.86	0.86	0.87	0.88	0.88	0.88	0.88	0.88	0.88
TEFC 3 Phase Squirrel Cage In					Rated	Torque kg.m		116	131	147	163	183	206				Rated	Torque	кg.ш	262	295	327	366	411	463	522	587	652
nase Squ						Amps.		584	654	726	805	910	1023					Current Amps.	-	674	757	830	918	1032	702	789	886	982
EFC 3 PI						RPM		2982	2982	2982	2982	2985	2985					BPM		1488	1488	1488	1492	1492	1493	1493	1493	1493
н	(up to 630kW) (710kW & above)				Type Ref.	B3 Construction		2H35K2M3	MH35K2P3	MH35K2T3	MH35K2W3	MH40L293	MH40L2A3			Tvne	Ref.	. B3	Construction	MH35K4P3	MH35K4T3	MH35K4W3	MH40L493	MH40L4A3	MH45M413	MH45M433	MH45M453	MH45L473
	: 415V± 10% (up to 630kW) : 690V± 10% (710kW & abo	c± 5% : ± 10%			Frame	IEC		355L/K	355L/K	355L/K	355L/K	400L	400L			L	rrame siza	IEC 250		3551 /K	355L/K	355L/K	400L	400L	450M	450M	450M	450L
	: 415V : 690V	Frequency : 50Hz± 5% Combined Variation : ± 10%			Rated Output	ЧН		475	536	603	670	750	845			Rated Output			ЧН	536	603	670	750	845	952	1072	1206	1340
	Voltage	Frequency Combined			Ratec	kW		355	400	450	500	560	* 630			Rateo			kW	400	450	500	560	630	710	800	006	1000

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"

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Performance Table for 2-Pole & 4-Pole Motors

HIGH EFFICIENCY LARGE MOTORS WITH DCCA VITH DC



Performance Table for 6-Pole Motors

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

Duty : S1(Continuous) Ambient : 40°C

(710kW & above) (up to 630kW)

: 415V± 10% : 690V± 10% : 50Hz±-5%

Voltage

Combined Variation : ± 10%

Frequency

1000 rpm (6-Pole)

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

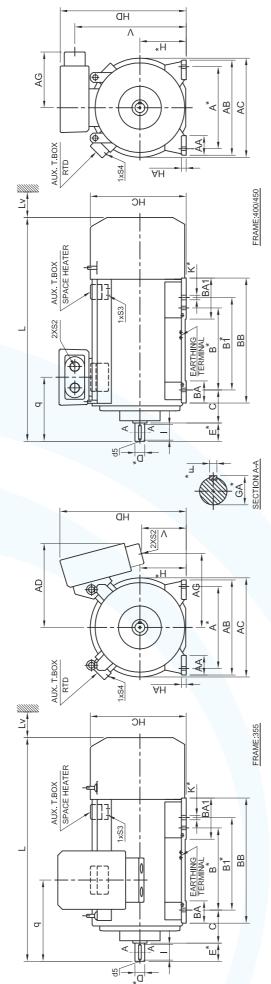
4 - 14	Weight	B3 Constn. kg	1980	2280	2410	2810	3000	4100	4300	4400	5600
	Rotor	GD² kgm²	56.90	66.00	69.70	77.00	86.00	160.0	180.0	200.0	236.0
T	Torque	to Kated Torque Ratio	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
With DOL Starting	Starting Torque	to Rated Torque Ratio	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
With DOI	Starting Current	to Rated Current Ratio	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	cy	1/2L	94.2	94.2	95.4	95.0	95.2	95.6	95.8	96.1	96.2
	% Efficiency	3/4L	95.0	95.0	96.0	96.0	96.2	96.2	96.4	96.6	96.7
utput		FL	95.0	95.0	96.0	96.2	96.4	96.5	96.6	96.7	96.8
at Rated or	tor	1/2L	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Operating Characteristics at Rated output	Power Factor	3/4L	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
rating Char		Ę	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Ope	Rated	Torque kg.m	309	349	393	441	490	549	618	696	785
		Amps.	549	619	069	775	859	961	1080	731	823
	10000	RPM	992	992	992	993	993	993	993	993	993
Tvne	Ref.	B3 Construction	2H35K6M3	2H35K6P3	MH35K6T3	MH40L693	MH40L6A3	MH45M613	MH45M633	MH45M653	MH45L673
Frame	size	EC	355L/K	355L/K	355L/K	400L	400L	450M	450M	450M	450L
	Rated Output	ЧH	422	475	536	603	670	750	845	952	1072
	Rated	кW	315	355	400	450	500	560	630	710	800

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.

Y

Y



E2 Series, Frame Size- 355/400/450
(B3), TEFC IE2 S
ot Mounted (B3
Type-2H, Fo
Industrial Motors
Dimensional Details:

				FIXI	FIXING														
IEC Fr.	nolo	* V	*	, * 10	L	*□	*/1	q	00	~~	٧d	1 1 1	V II	J		2	-	J.v	
Size	LOIE	z	6	TQ	ر	-	2	AD	QQ	¥	Ρd	THO	Ч	2	2	Ą	-	AL	2
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
				TEDAIN	TEDMINIAL BOV					CUAET	1								

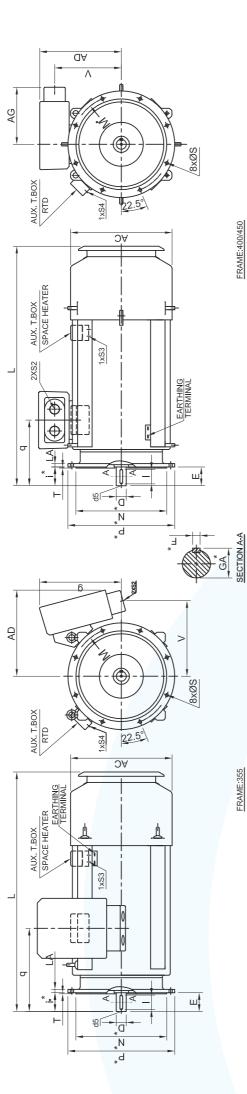
				TERMIN	TERMINAL BOX					SHAFT	AFT		
IEC Fr. Size	Pole	>	b	AG	S2 B.S.C.	S2 B.S.C. S3 B.S.C. S4 B.S.C.	S4 B.S.C.	*D	ш	F*	*A9	_	d5
355L/K	2	345	625	595	3"	3/4"		75	140	20	79.5	130	M20
355L/K	4/6/8	345	655	595	3"	3/4"	1"	56	170	25	100	160	M24
400M/L	2	952	560	590	3"	3/4"	1"	80	170	22	85	160	M20
400M/L	4/6/8	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
					TAB	TABLE A							
Dimension	nsion	A	В	т	Х	D	GA	ц	d5 (Centering)	itering)]		
Tolerance	ance	±0.75	±0.75	-1	-	тб		64			±50		
: ;			100101				0.000	0.00	0 4 1 0 0 1				

	_	±50	•	
	d5 (Centering)		IS:2540	
	ц	64	IS:2048	
	GA	-	IS:2048	
rable a	D	шб	IS:1231	
TAB	Х		IS:1231	
	н	-1	IS:1231	
	В	±0.75	IS:1231	
	A	±0.75	IS:1231	
	Dimension	Tolerance	Specification	

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







	S4 B.S.C.	1"	1"	1"	1"	1"
X	S3 B.S.C.	3/4"	3/4"	3/4"	3/4"	3/4"
TERMINAL BOX	S2 B.S.C.	3"	3"	3"	3"	3"
Ħ	ЭЮ			290	290	065
	b	625	655	560	600	600
	^	570	570	552	552	636
	60	630	630	,		
	٦	1835	1865	1935	1975	2125
GENERAL	AC	765	765	852	852	972
	AD	685	685			
	ΓV	25	25	25	25	30
	Т	9	9	9	9	9
	S	24	24	24	24	28
	*!	140	170	170	210	210
FIXING	*W	740	740	740	740	1080
	*N	680	680	680	680	1000
	Ч	800	800	800	800	1150
	Pole	2	4/6/8	2	4/6/8	4/6/8
	IEC Fr. Size	355L/K	355L/K	400M/L	400M/L	450M

3/4"

-

4/6/8

450L

				HS	SHAFT		
IEC Fr. Size	Pole	*0	ш	*	GA*	-	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

	d5 (Centering)		IS:2540	
	F	h9	IS:2048	
	GA		IS:2048	
TABLE A	D	m6	IS:1231	
		±1.5		
	Μ	±0.5	IS:2233	
	N	js6	IS:2233	
	Dimension	Tolerance	Specification	

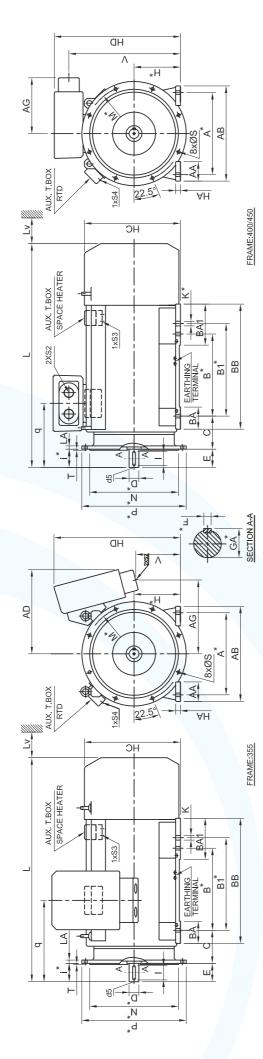
±50

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

HIGH EFFICIENCY LARGE MOTORS WITH DCCA

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





	d5	M20	M24	M20	M24	M24	M24
	-	130	160	160	180	180	180
VFT	GA*	79.5	100	85	116	127	127
SHAFT	F*	20	25	22	28	32	32
	ш	140	170	170	210	210	210
	P*	75	95	80	110	120	120
	S	24	24	24	24	28	28
	*	140	170	170	210	210	210
	*W	740	740	740	740	1080	1080
	*2	680	680	680	680	1000	1000
	d	800	800	800	800	1150	1150
FIXING	*Х	28	28	35	35	42	42
	*Н	355	355	400	400	450	450
	С	254	254	280	280	250	250
	в1*	710	710	800	800		
	B*	630	630	710	710	1000	1250
	*A	610	610	686	686	800	800
	Pole	2	4/6/8	2	4/6/8	4/6/8	4/6/8
	IEC Fr. Size	355L/K	355L/K	400M/L	400M/L	450M	450L

S2 B.S.C. S3 B.S.C. 54 B.S.C.	" 3/4" 1"	3/4" 1"	3/4" 1"	1"	1"	1"		
S2 B.S.C. S3 B.S.C.		3/4"	4"					
S2 B.S.C.	-		3/	3/4"	3/4"	3/4"		
	3"	3"	3"	3"	3"	3"		
AG	595	595	590	590	590	590		
ъ	625	655	560	600	600	605		
>	345	345	952	952	1086	1086		
2	200	130	250	200	200	200		
AC	765	765	852	852	972	972		
-	1735	1765	1835	1875	2025	2347		
AD	685	685						
£	985	985	1076	1076	1210	1210		
НС	736	736	824	824	935	935		
НА	36	36	35	35	42	42		
BA1	315	315	260	260	-	390		
BA	170	170	170	170	260	260		TABLE A
AA	150	150	140	140	180	180		
88	960	960	940	940	1180	1430		
AB	730	730	820	820	940	940		
P	25	25	25	25	30	30		
F	9	9	9	9	9	9		
Pole	2	4/6/8	2	4/6/8	4/6/8	4/6/8		
Size	355L/K	355L/K	400M/L	400M/L	450M	450L		
	Pole T LA AB BB AA BA BA BA1 HA HC HD AD L AC Lv V q AG	Pole T LA AB BB AA BA BA1 HA HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595	Pole T LA AB BB AA BA BA1 HA HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595 4/6/8 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595 4/6/8 6 25 730 960 150 170 315 36 765 130 345 655 595	Pole T LA AB BB AA BA BA1 HA HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595 4/6/8 6 25 730 960 170 315 36 736 985 685 1735 765 130 345 655 595 4/6/8 6 25 730 960 170 315 36 765 130 345 655 595 2 6 25 824 1076 - 1835 852 250 955 595 2 6 140 170 260 35 852 550 595	Pole T LA AB BB AA BA BA1 HA HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595 4/6/8 6 25 730 960 170 315 36 736 985 685 1735 765 130 345 655 595 2 6 25 730 960 170 315 36 785 685 1765 765 130 345 655 595 2 6 25 824 1076 - 1835 852 550 595 595 4/6/8 6 25 824 1076 - 1875 852 500 952 560 590 5	Pole T LA AB BB AA BA BA1 HG HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 625 595 4/6/8 6 25 730 960 170 315 36 736 985 685 1765 765 130 345 655 595 2 6 25 730 960 170 315 36 785 685 1765 765 130 345 655 595 2 6 25 820 940 170 260 35 882 1855 852 250 952 560 590 4/6/8 6 20 940 170 260 35 852 200 952 560	Pole T LA AB BB AA BA BA1 HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 655 595 4/6/8 6 25 730 960 170 315 36 736 985 685 1765 765 130 345 655 595 4/6/8 6 25 820 940 170 260 35 824 1076 - 1875 852 560 590 4/6/8 6 30 940 180 170 260 35 1875 852 200 952 600 590 4/6/8 6 30 940 170 260 353 1875 852 200 912 600 59	Pole T LA AB BB AA BA BA1 HA HC HD AD L AC Lv V q AG 2 6 25 730 960 150 170 315 36 736 985 685 1735 765 200 345 655 595 4/6/8 6 25 730 960 170 315 36 736 985 685 1755 765 130 345 655 595 4/6/8 6 25 820 940 170 260 35 824 1076 - 1875 852 500 345 655 595 4/6/8 6 30 940 140 170 260 35 824 1076 - 1875 852 500 590 590 4/6/8 6 30 940 180 170 206 350 </td

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M ±0.5 IS:223

> js6 IS:223

> > IS:1231

H -1 IS:1231

> ±0.75 IS:1231

> ±0.75 IS:1231

Dimension Tolerance Specification

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d5 (Centering) -IS:2540

ВA

ANNEXURE - I -

Methods of Cooling

Designation system concerning methods of cooling refers to standard IEC 60034-6. **Explanation of the product code**

					national Cooling	5		
1st C	Character	2nd	Character	3rd	d Character		4th Character	5th Character
	•		•		•		★	★
Circ	cuit Arrange	ment	Primary Co	olant	Method of Movement Primary Cool	of	Secondary Coolant	Method of Movement of Secondary Cooling
	For Tota	Ily Enclosed	Three-Phase I	Inductio	n Motors in BBI	_, follo	owing are the applic	able codes
Exa	mple	Frame surface cooled	Coolant is Usually omi nomencla	tted in	Self Circulati	on	Coolant is air. Usually omitted in nomenclature	Different methods of movement of secondary coolant
Totally	11 Enclosed Cooled	4	-		1		-	1 – Self Circulation
Totally	16 Enclosed Cooled	4	-		1		-	6 – Machine mounted independent component
Totally	10 Enclosed e Cooled	4	-		1		-	0 – Free
IC 01	P		(type) Self-v	G) /entilat			n cooling (DP) notor by a fan mou	nted on the shaft.
IC 06			(type) Separ Coolir	GI) <u>rate ve</u> n ng air is	s blown throug	h the	Il fitted fan unit (F e motor by a sepa ipped with an air fil	rately excited fan
IC 17			(type (<u>Single</u> Coolir with a	G) <mark>e pipe v</mark> ng air is a sepa		the er pr	ovided external	e pipe connection blower fan and
IC 410	Enclosure IP 44 - IP 55 (type GZ) <u>Totally-enclosed non ventilated (TENV)</u> Cooling without using a fan, only by nature ventilation and radiat on the totally enclosed motor surface.							tion and radiation
IC 411			(type) Totall Coolir	GZE) I <mark>y-encl</mark> e ng air is	44 - IP 55 osed fan-cool blown over th he shaft.			or surface by a fan
IC 416			(type)	GZO) nal sur ng air is	44 - IP 55 face cooling (s blown over the solution over the sol	he to		tor surface by an
IC 37			(type (<u>Doub</u> Coolir means	GZ) Ie pipe ng air is s of a	separate cust	the i omer	motor through a pi	ipe connecting by al blower fan and

ANNEXURE - II –

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° 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
5	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.
(\bigcirc)	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).
S	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.	
	2	Protected against dripping water when enclosure is tilled 15°	 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 	
	3	Protected against spraying water up to 60°	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.	
	4	Water splashed from any direction shall have no harmful effect.	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.	
- Ching			 b) In case of this test on a machine not running, the machine shall be operated under no-load conditions at rated voltage 	
	5	Water hosed against the enclosure shall have no harmful effect(water jets)	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).	
	6	Water from powerful jets of heavy seas shall have no harmful effects	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.	

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, $\cos\Phi$, 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) <i>PN</i> < 1 kW <i>PN</i> 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.

AN ANNEXURE - IV - V

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

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.

ANNEXURE - V -

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.

ANANNEXURE - V -

• 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.

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.

ANNEXURE - V

- 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.

AN ANNEXURE - V

- 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

ANANNEXURE - V -

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

AN ANNEXURE - VI -

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.

AN ANNEXURE - VII-

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

5: Troubles related to bearings

6: Troubles related to noise and vibrations

8: Troubles related to motor operation with VFDs

7: Troubles related to input power circuit

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
- Section 1 : Motor burnt out.
- TroubleProbable causePossible remedyMotor 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 cooling ribs, end windings filled with dust or lint (dust may be cement, saw dust, rock dust, grain dust, coal dust e	fine body. Dismantle entire motor. Clean fan and fan cowl. Clean all windings. Clean
	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.

AN ANNEXURE - VII

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.		

AN ANNEXURE - VII-

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
	If slip ring motor, improper operation of	terminals or reduce load. Correct secondary controlgear.
	secondary control gear resistance.	, ,
	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)	Use higher voltage tap on transformer terminals.
	Inadequate motor starting torque when using a reduced voltage starting system (star-delta, part winding or auto	a) Reduce the starting load or use a larger motor.
	transformer starting)	 b) Use a starting system which develops higher starting torque (VFD or slip ring motor or fluid coupling)

AN ANNEXURE - VII

	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

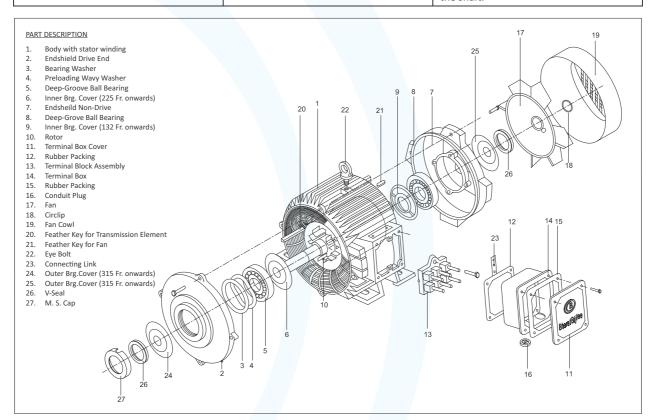
Trouble	Probable cause	Possible remedy
Wrong rotation	Wrong sequence of phases	Reverse two phase connections at switchboard or at motor.
Unbalanced line currents drawn by the motor	Unbalanced terminal voltage at motor terminals	Check loads and connections
	Single phase operations	Check for open contacts
	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.

AN ANNEXURE - VII

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.



AN ANNEXURE - VII

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	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.
caused by an improper mounting.		
	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.

AN ANNEXURE - VII-

	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.

AN ANNEXURE - VIII

MOTOR SERVICE RECORD

Serial No				_ kW_					т	уре			
Speed Volts	;		_ Ampe	res			Phase		F	requency	у		
nsulation Class			_ Tempe	rature l	Rise			°C I	Frame Siz	e			
Connection Diagram-Rot	tor					_ State	or						
Owner Order No			Item	No					Date Pur	chased $_{-}$			
MACHINE TY	PE			WEA	THER PI	ROTEC	TED			L	UBRIC	ATION	N
- Horizontal - Vertical - Totally-Enclosed - Explosion-Proof			Bearing - Ball - Roller -Sleeve		D				-	Shaft ngth	Extens		
Date Installed		Lo	ocation					Applicat	tion	D	ist. kep	ot for c	ooling
Date Repaired or Replaced	Re	epairs or	Parts Re	placed				Fault	:		aired oy		Total Cost
Name of Part	No. Per		acturer's	Date	Qty. Repl.	Cost	Date	Qty. Repl.	Cost	Date		ty. epl.	Cost
	Machine		lo.		nepi.			Nepi.				.р . .	
Rotor											_		
Stator Coils													
Bearing, DE													
NDE													
Cooling fan													
											-		
Others							TION						
Date													
Bearings		-											
Lubrication													+
Excess Heat		1											+
Excess Noise													
Speed													_
Voltage in 3 ph			1										+
Voltage Variation													-
Voltage Unbalance			1										
Current in 3 ph													-
Current Variation			1										1
Current Unbalance		1	1										1
Insulation Resistance	e	1					1						+
Clean & clear air passages													
Alignment													
Vibration													
Body Temp.													
Abnormal noise													

AN ANNEXURE - IX - X

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

IS 12075 : 2008

SI.No	Shaft Height mm	56 < H ≤132	(132	132 <	132 < H ≤225	225 < H ≤400	\$400	H > 400	0
	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	> 1500and up to3000
		rms va	alue of vibration	velocity in m	m/s for the shar	rms value of vibration velocity in mm/s for the shaft height H in mm			
:=	N(Normal)	1.8	18	1.8	2.8	2.8	4.5	2.8	4.5
≔	R(Reduced)	0.71	0.71	0.71	1.12	1.8	2.8		
i<	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 <	56 < H ≤132	2				132 <	132 < H ≤225	ß			7	25 < 1	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 500 600 750 1000 1500 3000	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000	500	600	750	1000	1500	3000
						>	bratic	n lim	nit in n	naxim	Vibration limit in maximum displacement amplitude, in μm	placen	lent	ampli	tude,	in µm								
N(Normal) 96 80 64	96	80	64	48	32	16	16 96	80	80 64	48	32	25	150	125	100	25 150 125 100 75	50	42	150	125	42 150 125 100 75		50 40	40
R(Reduced)	36	30	30 24	18	12	9	36	30 24	24	18	12	10	96	80	64	48	32	26				1		
S(Special)	24	20	24 20 16	12	∞	4	24	20	16	12	∞	9	50	50 60 40	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.

ANNEXURE - X

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: True Power 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 threephase integrating watthour meter for measuring the true power and an integrating sine meter for measuring the wattless component in which case the ratio:

> Wattless kVA Hours 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

ANANNEXURE - X

Existing		Proposed Pov	ver Factor	·	
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 0.69	0.329 0.209	0.459 0.429	0.595 0.565	0.750 0.720	1.079 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 0.74	0.186 0.159	0.316 0.289	0.452 0.425	0.607 0.580	0.936 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 0.78	0.079 0.053	0.209 0.183	0.345 0.319	0.500 0.474	0.829 0.803
0.79	0.026	0.156	0.292	0.447	0.776
0.80		0 120	0.266	0.421	0.750
0.80 0.81	-	0.130 0.104	0.266 0.240	0.421 0.395	0.750 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 0.99					0.203 0.143
0.33	_	-		_	0.143

Table 10: Factors for obtaining Reactive Capacity from Load

ANNEXURE - X

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

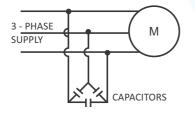
Best results are obtained by connecting the capacitor as close as possible to the motor or other apparatus which requires power factor correction. In practice, however, this is not always possible. In cases where one capacitor has to correct the power factor of several motors, the capacitor should be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

Correction

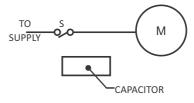
Group correction is often advisable, especially when the total average load represents only a part of the installed motor rating and is fairly constant. If, however, the existing power factor is as low as, says, 0.60 or less, and the load not constant, skilled attendence for the switching operation may 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.

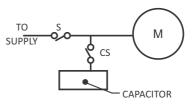
Details of connections are illustrated in Fig. 1



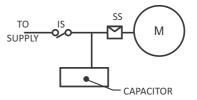
1 A Shows connections of capacitors to three phase motor. The capacitors are delta-connected, which is standard practice on three-phase supply



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



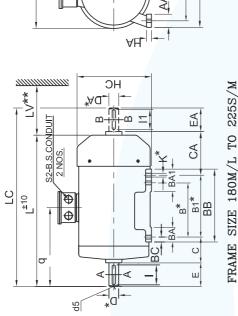
1 D No separate capacitor switch is shown. Where isolator 'IS' and 'SS' are in existence, the capacitor is connected to a point between these switches

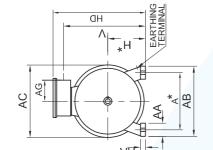
FIG. 1 Individual Connections

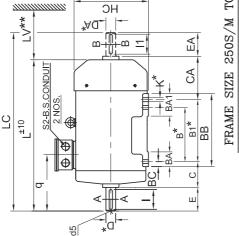
Where a capacitor is connected across the terminals of an induction motor, care should be taken that the current taken by the capacitor does not exceed the motor magnetizing current as otherwise dangerous over-voltages may be setup when the motor is switched off due to the self excillation effect, values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

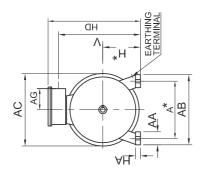
A N ANNEXURE - XI - X

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









FRAME SIZE 250S/M TO 355M/L

	d5	M16			M20 M20 M20				M20 M20						M24		
	_ <u>_</u>	100 N	100		100 N	130 N	130 _N	130	130	130	130	160	130	160	130		
	GA* GC*	1.5 1	1	_	59 1	64 1	64 1	69 1	69 1	79.5 1	69 1	85 1	69 1	85 1	79.5 1	100 160	
SHAFT	ЕА <mark>*</mark> 6	14 51.5	4		16	18	18	18	18	20 7	18 (22 8	18	22	20 7	25 1	
ĺ	EA	110		011	110	140	140	140	140	140 2	140	170 2	140	170	140	170	
	D,DA	48	7 2		55 1	60 1	60 1		65 1	75 1	65 1	80 1	65 1	80	75 1	95 1	
Ŷ	S2 B.S.C D	1 1/2"	5		ē					4	2"		1,0"	1			
BO)	AG B.	97 1	1 22		15									N			
TERMINAL BOX	q A	371 9	11 200		115 15		Ċ	352 243 360 243		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	00 278			434 10	34 40		
rern	>						02	578 352 638 360			728 386 416 416 416						
F	*	396		9 449	100											nco q	
	LV**	20		80	00		001	115		130				145			
	AC	354	-	334		276 231 450		489		5 5 5 7					<u> </u>	C00	
	CA	218	262	239	276			200	271		010	040		40 1	458		
	ГC	838	920	897	956	1001	1005	0001	14.60		1293	1353	1458	1518	1622	1682	
	L	717	795	772	837	852	1	ע ד 4	1010		1137	1167	1302	1332	1461	1491	
GENERAL	머	445	1	212	Ee0		665		706	C 7 1			830		000	309	
Ш О П	ЧC	357	202	_		450		430	552		600			603	C80		
	HA	26	6	32		5	42		42				45		45	2	
	BA1 BC	23		20	110 20	07	10		10	40		5 5				13	
	BA1	108 23		123	7	-	127	ñ	280 24 540 490 100 110 149 40		155		i ,	120 171		1 / N Z4U	
	BA	70	ł	cα	0	6	Ч Т	2	7	2	120		0				
	AA	65		ŝ	05	8	001	2	007	3	120	04		021 280		0	
	BB	319		300	264	100	506 425 100		490		540 120			283		n / /	
L	AB	344		19 330	120 201	000	506		10	040		100	C70				
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	*±	180		zuu	22E 10	077	2007	002	0ac	2004		1.0	212 20			200	
0	0	~	0	0	6							Ċ	0				
FIXING	* B1*	279	01 100	202	7	-		04 <i>0</i>	110	2	467			200		000	
Ī	*ഫ	241	100	201	200	007	7	311 343 100	168	2	106	2 2 2	467				
L	*∢	279 241 279 12	730 010	2010	366 206 244 440			400	157 368 110 100	, D						0 0	
	Pole	2,4,6,8	2	4,6,8	2	4,6,8	2	4,6,8	2	4,6,8	2	4,6,8	2	4,6,8	2	4,6,8	
	IEC Fr. size	180M/L			006C/M				11/0000		215C/N		0.4 E N A /I		DEENAU		

	*Refer TABLF A for tolerances			NITE ANTIC CONTRACTOR OF AND A CONTRACTOR OF A		Fabricated body. Refer Sales office for offer				
	Specification		C 1231	1071.0		IS : 2048		S : 2540		
	Tolerance	k6 480			m6 55,60,65,75,80,95Ø					
- TABLE A	Dimension					GA,GC,F,FA	15/00toine/	(four lease of the		
TAE	Specification				IS: 1231					
	Tolerance	±0.75	-0 5 11PTO 280	0.07	-1 OVER 280	+0.430 15Ø		10.11.00	+0.320 19,24,200	
	Dimension	A,B			E		7	2		

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

Key / key way fit : h9 / N9 □ 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.

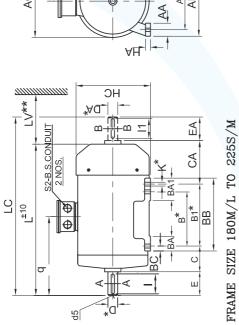
All Dimensions are in mm unless otherwise specified.

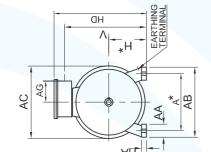
CAT-A-6335-3-2

78

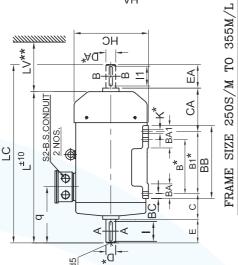
A N ANNEXURE - XII-

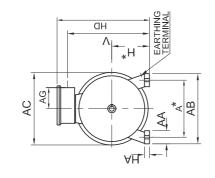






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Щ	ГС		841	Ι	920		1026	1			1	1		I	1			
TABLE			737		795		877	I				1						
Ĺ	Pole		2,4		4		4					1			1	1		
												I				I		
	d5		M16	000		M20	M20			UCIV						-		
	- <u>-</u>		100	7		100	130	130	130	130	130	130	160	130	160	130	160	
FT-	GC*		51.5	C L	28	59	64	64	69	69	79.5	69	85	69	85	79.5	100	
-SHAFT	г* FA*		14	ų 1	10	16	18	18	18	18	20	18	22	18	22	140 20	170 25	
	ЕA		110			110	140	140	140	140 18	140	140	170	140	170	140	170	
	* D,DÅ		48	5	00	55	60	60	65	65	75	65	80	65	80	75	95	
Ко	S2 B.S.C.		1 1/2"	ŗ	۷	ē	v	ā	N		1	"0	1	"C/1 C	7	5	°	
AL B	AG	ļ	97	1		12	2		243	010	4		020			0	400	
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і Б	>	000	396		449	001	100) 1 1	8/G	620	000		002				2002	
	۲√**		20	:	80	00	06		100	L	<u>c</u>		001	130			145	
	AC	, L	354	.00	394	150	004	0	489	5 1 1	1 1 1		000	000		L	680	
	CA		218	262	239	276	231	337	268		- 17		34U	151	1 2 1		400	
	LC		838	920	897	956	1001	1134	1065	1400	0011	1293	1353	1458	1518	1622	1682	
	L		717	795	772	837	852	983	914	1010		1137	1167	1302	1332	1461	1491	
GENERAL	дH	!	445	071	2 2	E CO		L	C00	705			000			000	333	
- GEI	НС	-	357	207	33 /	150	200	LCV	495	500	700		600	000		000	090	
	ΗA		26	_	32		5		44	ç			μ			15	5 C	-
	BA1 BC		108 23	Ċ	287	00	07	-	4 V		5 5	9		ý	40	1	240 73	
	BA1		108	007	123	7	07 011		2	1 10		7	001		2			
	ΒA		20	L C	ςχ	0	00	7		457 368 419 190 280 24 540 400 100 110	2	007		007	033 170 170	i ,	0/1 011 0/1 01/ 22 23 28 29 10 0/1 0/1 0/1 0/1	
	AA		65	_	ςχ	05	3	007	3	007		1 20	071 071 070	00			110	
	BB	0,0	319		398 355	261		105	4 2 2		100	4			283	1	/ / 0	A
	AB		344	000	390	901	500	003	000		040		100	C70		1	0L7	TABI F A
	*⊻	1	279 241 279 121 180 15	1		366 206 211 110 226 10	<u></u>	ā	349 108 200 44	ō	7		ĉ	07 010 017		8	ΩZ	₹
	*エ		180		ZUU	205	C 7 7		NG7	0 a c	2024		, 1	0 0			355	
9 N	U		121	, c ,	cc	1 10		0	168	100	2			2		ľ	254	
FIXING	B1		279	100	cnc	14	-		349	110	2	157	401	508			0.3U	
	*а		241	207	201	200	007			892	3	304	00+	157	ž		noc	
	*∢		519	0	010	2 E C	2		406 311	157	È		00				DI C	
	Pole		8,9	2	6,8	2	6,8	2	ω	2	4,6,8	2	4,6,8		4,6,8		4,6,8	
						VVV.				V V V		V N V		_	<u> </u>			
	IEC Fr. size		180M/L	000		DJECINA	2222					0110		21500/	200		/MICCC	

	Specification		IC - 1231		1,95Ø	IS: 2048	0110	- 052:21		
Γ	Tolerance	46 480A	201	m6 55,60,65,75,80,95Ø						
TABLE A		re re	2	•	9m					
	Dimension			בב		GA,GC,F,FA	GA,GC,F,FA d5(centering)			
	Specification					IS : 1231				
	olerance	±0.75	11PTO 280	201	OVER 280	15Ø			13,24,200	
	Tole	0 H	-0 Z	2	-1	+0.430		00101	070.04	
	Dimension	A,B		-	E		2	<		

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

*Refer TABLE A for tolerances

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.

Key / key way fit : h9 / N9

All Dimensions are in mm unless otherwise specified.

CAT-A-6335-3-2

79

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