40+ years of excellence
SINCE 1973

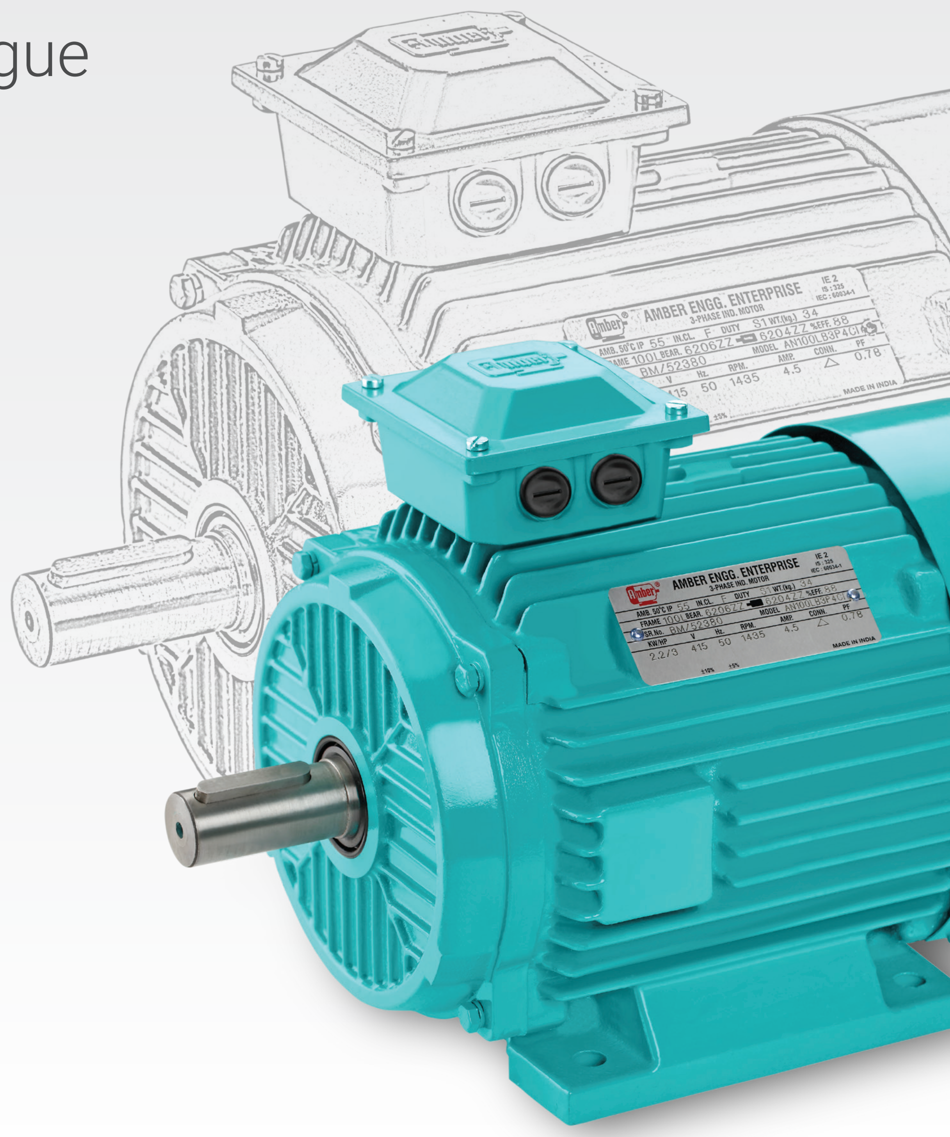
Amber®

Committed to Perform

IE2

Three Phase Induction Motors Technical Catalogue

AN Series



AMBER
ENGINEERING ENTERPRISE

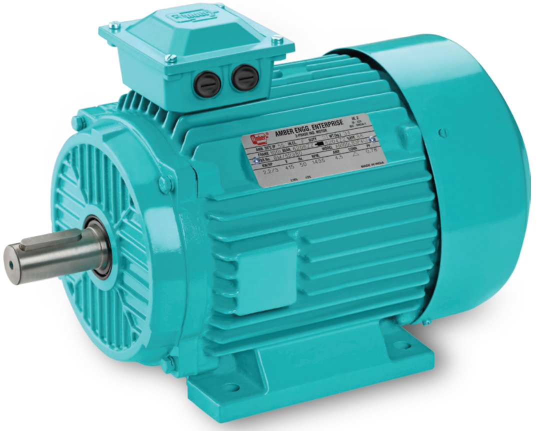
ambereng.com

AMBER
ENGINEERING ENTERPRISE

Amber Engineering Enterprise better known as Amber motors is engaged in manufacturing Single Phase and Three Phase A. C. Induction Motors, since 1973. Continuous search for excellence, adopting innovative ideas and strict adherence to quality and accuracy has and is still making Amber as a most trusted brand for Energy Efficient Electric motors. Helping its customers to use electric power effectively thereby increasing productivity with sustainability is strongly believed and applied at Amber.

As a leading Electric motor manufacturer Amber is a total solution provider for any type of A. C. Induction Motors benefiting wide range of customers. To remain aligned with the market latest technologies and newest features are always preferred to invest at Amber.

Amber is also renowned manufacturer of special electric motors and motor elements in models specially designed according to customized specifications. The high quality level, customized designs and years of experience ensure application-oriented drive solutions in accordance with individual customer requirements, which we can also manufacture in small series.



Having our own R&D department and state of the art technical equipment enable numerous design variants and guarantee the highest precision. We have become the leading supplier to original equipment manufacturer (OEM) for prominent machine factories the world over.

An essential strength of Amber is their outstanding manufacturing know-how and experience of over 35 Years in the same field. Whether development, design, mechanical calculation, electrical design or motor optimization for customer-specific applications – we excel in all stages of planning and manufacturing standard and special motors.

All essential electrical and mechanical motor components are manufactured at our premises. They are based on our own calculations and construction designs and meet the high quality standards our customers expect from our final products.

It is our target to create with our company permanent values, which is mainly and most importantly achieved together with the people working for us and with us. We are aware of the fact, that our economical targets can only be reached under consideration of environmental aspects, which are always handled in a gentle and responsible way.

Fair and open minded dealing with our partners, customers, suppliers and employees is a basic principle followed by us. Only based on long-term thinking and acting, products and relations can be developed. This makes us a reliable partner for our customers.

Extra ordinary innovative products with highest performance increase the competitiveness on both sides. This way of acting made us a successful medium-sized enterprise in the last years.

This simple and objective technical guide is created to help those who buy, sell and work with motors of Amber. It brings important information for the operation of various types of motors.

Enjoy your reading.

‘EFFICIENCY’ The need of hour

Definition ‘An Energy efficient motor is a motor that produces the same shaft output power, but uses less input power than a standard efficiency motor.’

In today’s world where requirement of electrical energy is considerably increasing due to automization, innovations, huge productions and many other factors, while on the other hand the resources for generating this energy are depleting slowly as a result of constant pressures on environment. It has become utmost necessity and duty of every manufacturer or industry to use energy efficient electrical products. The other fact is that the prices of electrical energy are escalating day by day which also promotes or forces each and every user to save daily power consumption costs by using energy efficient products.

The electric motors being the prime movers consume a significant amount of electricity since around 40% of global energy demand is estimated to be related to electric motor applications. As a result, any initiatives to increase energy efficiency, by using high efficiency electric motors and frequency inverters, are to be welcomed, as they can make a real contribution to reductions in global energy demand. The electric motor manufacturers are seeking methods for improving the motor efficiencies, which resulted in a new generation of electric motors that are known as ‘Energy Efficient Motors’.

Amber has well taken up this challenge and since its establishment (in 1973) has always and is manufacturing Energy Efficient motors. **All motors manufactured by Amber satisfy IE2 efficiency level in accordance with IEC 60034-30/IS:12615-2011.**

Amber energy efficient motors owe their higher performance to key design improvements and more accurate manufacturing tolerances. Long length cores and using of lower-electrical-loss steel, thinner stator laminations, and more copper in the windings help to reduce electrical losses in our motors. Improved bearings and a smaller, more aerodynamic cooling fan further increase efficiency. All Amber energy efficient motors generally have longer insulation and bearing lives, lower heat output, and less vibration. In addition, these motors are often more tolerant of overload conditions and normal phase imbalance. This results in low failure rates, which has prompted majority of manufacturers to use Amber Motors to save their energy consumption costs and maintenance costs.

The International Electrotechnical Commission IEC has developed and published an energy efficiency standard which replaces all previous standards. In parallel IEC developed and issued a new standard for determining motor efficiency as shown in Table 1 below. Previously according to the voluntary agreement between manufacturers there existed well known efficiency bands EFF1, EFF2 and EFF3. The new standard IEC 60034-30-2008/IS:12615-2011 defines and harmonizes worldwide efficiency classes IE1, IE2 and IE3 for low voltage three phase motors in the power range from 0.75 kW to 375 kW (2, 4 & 6 Poles).

IE1 - Standard Efficiency
IE2 - High Efficiency
IE3 - Premium Efficiency
IE4 - Super Premium Efficiency

Output KW	IE 1 – Standard Efficiency			IE 2 – High Efficiency			IE 3 – Premium Efficiency		
	Poles			Poles			Poles		
	2	4	6	2	4	6	2	4	6
0.75	72.1	72.1	70.0	77.4	79.6	75.9	80.7	82.5	78.9
1.1	75.0	75.0	72.9	79.6	81.4	78.1	82.7	84.1	81.0
1.5	77.2	77.2	75.2	81.3	82.8	79.8	84.2	85.3	82.5
2.2	79.7	79.7	77.7	83.2	84.3	81.8	85.9	86.7	84.3
3	81.5	81.5	79.7	84.6	85.5	83.3	87.1	87.7	85.6
4	83.1	83.1	81.4	85.8	86.6	84.6	88.1	88.6	86.8
5.5	84.7	84.7	83.1	87.0	87.7	86.0	89.2	89.6	88.0
7.5	86.0	86.0	84.7	88.1	88.7	87.2	90.1	90.4	89.1
11	87.6	87.6	86.4	89.4	89.8	88.7	91.2	91.4	90.3
15	88.7	88.7	87.7	90.3	90.6	89.7	91.9	92.1	91.2
18.5	89.3	89.3	88.6	90.9	91.2	90.4	92.4	92.6	91.7
22	89.9	89.9	89.2	91.3	91.6	90.9	92.7	93.0	92.2
30	90.7	90.7	90.2	92.0	92.3	91.7	93.3	93.6	92.9
37	91.2	91.2	90.8	92.5	92.7	92.2	93.7	93.9	93.3
45	91.7	91.7	91.4	92.9	93.1	92.7	94.0	94.2	93.7
55	92.1	92.1	91.9	93.2	93.5	93.1	94.3	94.6	94.1
75	92.7	92.7	92.6	93.8	94.0	93.7	94.7	95.0	94.6
90	93.0	93.0	92.9	94.1	94.2	94.0	95.0	95.2	94.9
110	93.3	93.3	93.3	94.3	94.5	94.3	95.2	95.4	95.1
132	93.5	93.5	93.5	94.6	94.7	94.6	95.4	95.6	95.4
160	93.8	93.8	93.8	94.8	94.9	94.8	95.6	95.8	95.6
200 up to 370	94.0	94.0	94.0	95.0	95.1	95.0	95.8	96.0	95.8

Table 1 - Efficiency Levels in accordance with IEC 60034-30-2008/IS:12615-2011

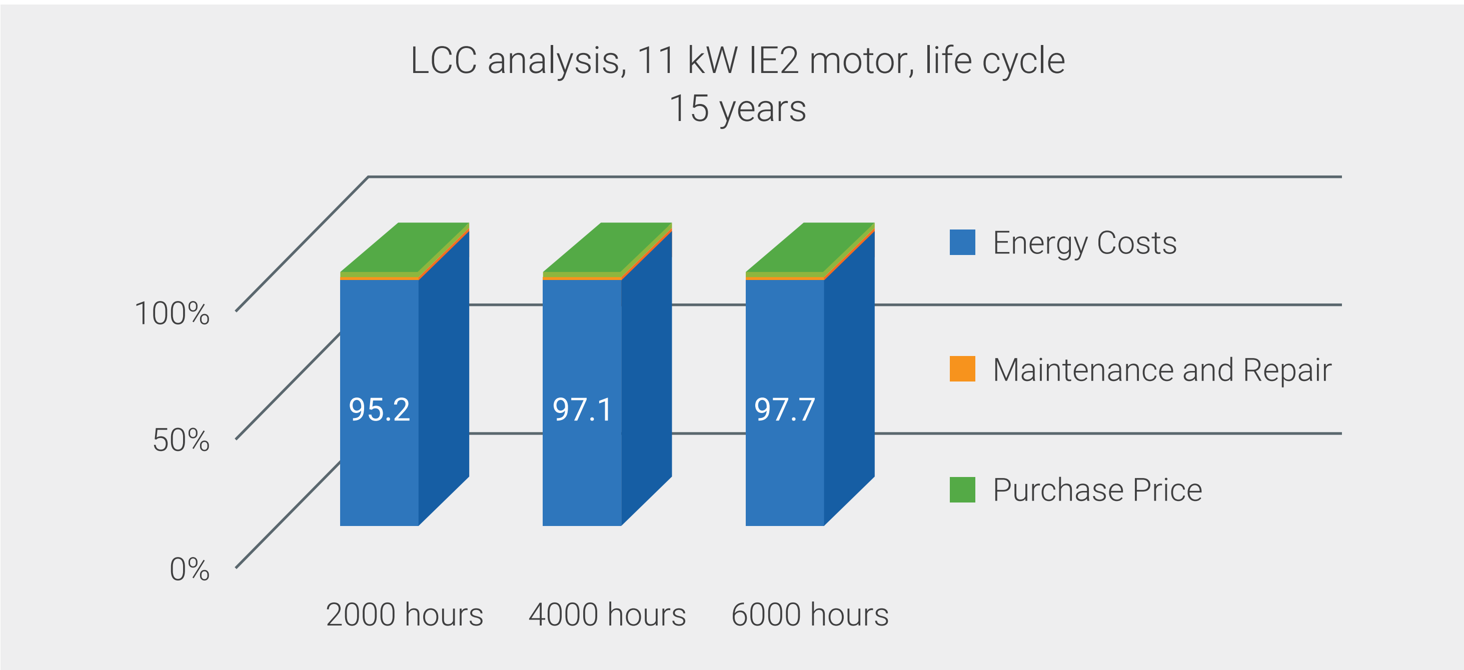
Payback calculation examples of 4 pole Amber motors with IE2 Efficiency level

Rating kW	Standard Eff2 Motor Efficiency	Amber IE2 Motor Efficiency	Standard Eff2 Motor Input kW	Amber IE2 Motor Input kW	Difference Input kW	Savings of kW/year @ 8000 hrs running
2.2	82.0	86.0	2.692	2.560	0.132	1056
11	88.4	90.0	12.443	12.222	0.221	1768

Motor Life Cycle Cost Analysis

2/3rd of all the electrical energy used in an industry is consumed by the machines in that industry driven by Electric Motors, which on the other hand has also a great impact on the environment.

As every electric motor on an average work for a large number hours and have proportionately long lifetimes, the greatest share of its environmental impact is in the use phase. So to reduce electric motors' environmental impacts and also its operational costs it is very important to reduce motors' energy consumption, by using energy efficient motors. The graph below will help to easily understand the result of a simple life cycle cost analysis (LCC) of a motor with 2, 4 and 6 thousand operating hours per year.



Hence above graph proves the fact that a higher initial purchase cost of a more efficient motor will, in fact, reward higher savings within short payback periods because purchase price of an electric motor is only 2% of their life cycle cost. More than 97% of the cost is the electricity used to operate the motor. The analysis presented shows that energy efficient motors are an opportunity for improving the efficiency of motor systems, leading to large cost-effective energy savings, improving of the industrial economic efficiency and reducing the environmental impacts.

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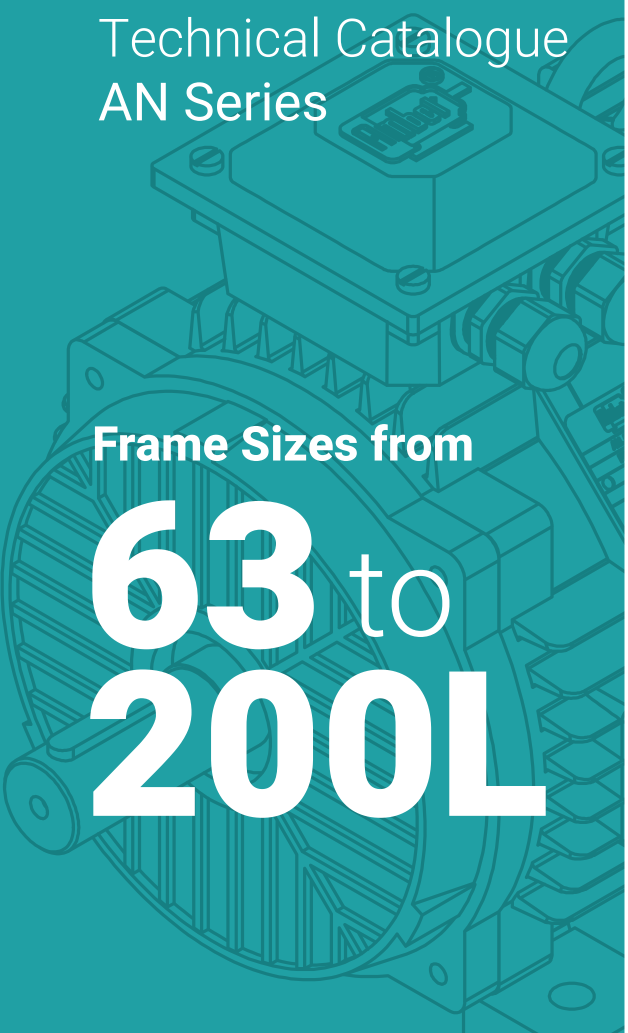


Frame Sizes from
63 to 200L

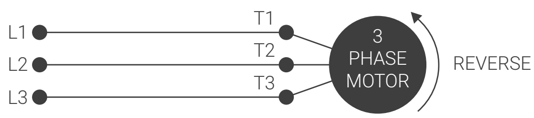
Electrical Features

Standard Operating Conditions

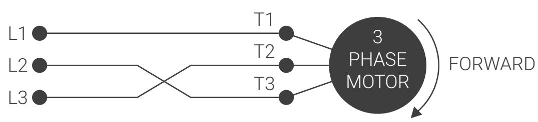
All standard motors manufactured at Amber are designed to operate at Voltage 415V (± 5%) and Frequency 50 Hz (± 5%). All standard dual voltage Amber motors, below 2.2 kW are designed to operate at 220V (± 5%) if Delta connected and at 415V (± 5%) if Star connected and frequency supply 50 Hz (± 5%) for both voltages. All standard motors equal or above 2.2 kW are star-delta connected suited to operate at 415V (± 5%) 50 Hz (± 5%) when powered through a star delta starter. As well as standard dual speed and three speed Amber motors are also designed to operate at 415V (± 5%) 50 Hz (± 5%).

However, motor with any type of voltage and frequency supply (other than above) can be manufactured on special request.

Direction of Rotation



Rotation before connections are changed



Rotation after connections are changed

All Amber standard motors, dual voltage and dual speed motors are capable of rotating in either direction (CW or CCW). The direction can be changed by interchanging leads of any two phases. Amber motors are also capable of frequent reverse - forward directions through phase interchanging switches through which the motor is powered or through Variable frequency drive.

Re-rating Factors

Variations in ambient temperature, altitude, supply voltage& frequency results in changes in the performance of the motor than that mentioned on its nameplate. Under such conditions the performance values of the motor are obtained by multiplying the following factors.

Altitude & Ambient Temperature

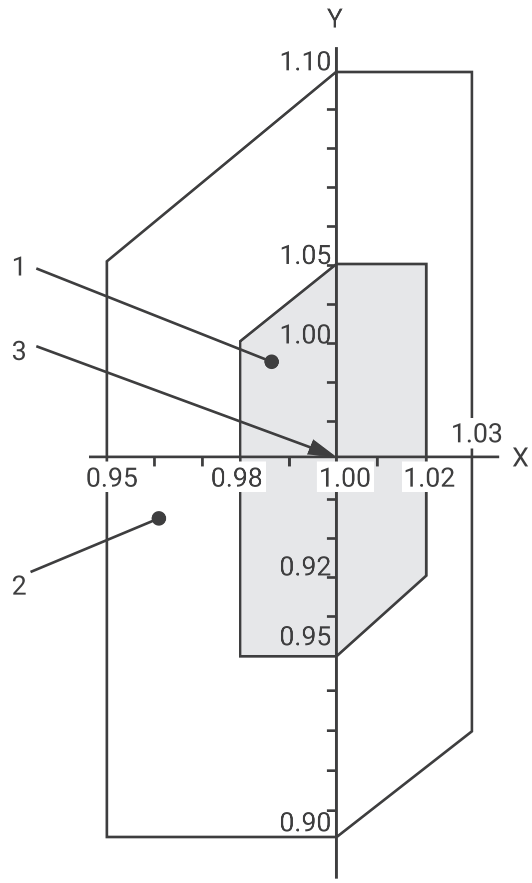
All standard Amber Motors perform equally as mentioned in the catalogue and name plate on the motor at or below 1000 meters of altitude and at 45 to 50°C ambient temperature. Same motor can surely operate at higher altitudes and higher or lower ambient temperatures but there performance values need to be re-rated as per the values mentioned in the table - 2.

Temp °C \ Altitude Mtrs	1000	1500	2000	2500	3000	3500	4000
20	1.1	1.08	1.05	1.02	1.01	1.00	0.98
25	1.08	1.05	1.02	1.01	1.00	0.98	0.93
30	1.05	1.02	1.01	1.00	0.98	0.94	0.87
35	1.02	1.01	1.00	0.98	0.94	0.86	0.83
40	1.01	1.00	0.98	0.94	0.88	0.84	0.80
45	1.00	0.98	0.94	0.89	0.83	0.81	0.77
50	1.00	0.94	0.88	0.82	0.80	0.78	0.75
55	0.94	0.88	0.83	0.80	0.77	0.75	0.73
60	0.88	0.82	0.79	0.76	0.74	0.73	0.69

Table 2 - Rerating values

Example : A class F insulation 15 HP Amber motor operating at an altitude of 2000mtrs above sea level and at ambient temperature of 50°C will perform at 88% (± 2%) of its output parameters mentioned on its nameplate.

Variation in frequency and supply table



1 zone A
2 zone B (outside zone A)
3 rating point

Figure - Voltage and frequency limits for motors

Table 3 - Variation in supply voltage & frequency

Voltage Variation %	Frequency Variation %	Combined Variation %	Permissible Output as % of rated value
±10	±5	±10	100
±12.5	±5	±12.5	95
±15	±5	±15	90

In IEC 60034-1 the combination of frequency and voltage variations are explained as Zone A and Zone B as shown in the figure (left) and table - 3.

The primary function of every motor as mentioned in IEC 60034-1 is to maintain and supply torque continuously at Zone A. Yet the motor may show some deviations as compared to its performance characteristics due to voltage and frequency variation as a result of which temperature rises may be higher than rated value.

The motor will also be capable to perform its primary function of supplying torque when variations in frequency and voltage supply are at Zone B but the deviations in its performance characteristics shall be greater than at Zone A and the temperature rise will also higher than operating at Zone A. So practically for better performance of motor it is advisable that motor does not operate at Zone B for a longer period.

Methods of Starting Motors

Direct On Line (DOL) is the easiest method of starting squirrel cage induction motors by direct connection to the main line. Usually, motors upto 1.5 KW are started with the DOL method. However all our motors are capable to start on DOL but if the motors above 1.5 KW are started on DOL the initial current impulse can lead to drop in the voltage of the system. Star connected motors having 3 leads can be started only by DOL method.

Star-Delta starting method is generally carried out with the help of star-delta starters for the motors of higher ratings (above 1.5 KW). The motor connected through star-delta starter must have 6 leads where in when the motor is started its terminals get connected in star initially thereby reducing the starting current. When the motor is accelerated to nearly 70% of full speed, the connections at the motor are changed to delta, for the normal running of the motor on load

Duty Cycles

As per IEC 60034-1 duty cycles for induction electric motors can be classified into ten basic duties ranging from S1 to S10 as described in the table - 4. Suitable motors can be offered to match the duty cycles of the driven machines

Duty	Type	Applications
S1	Continuous Duty	Compressors, Blowers, Fans, Pumps
S2	Short time duty	Operation of Gates of dams, siren, Capstan
S3	Intermittent periodic duty	Wire Drawing Machines, Valve Actuators
S4	Intermittent periodic duty with starting	Hoists, Cranes, Lifts
S5	Intermittent periodic duty with Electric Braking	Hoists, Cranes, Rolling Mills
S6	Continuous operation with periodic loading	Conveyors, Machine Tools
S7	Continuous operation with periodic loading & Electric Braking	Machine Tools
S8	Continuous duty with periodic speed variations	Special Applications where there are variations in speed and load while motor is operating
S9	Duty with non periodic load and speed variations	Special Applications where there are variations in speed and load while motor is operating
S10	Duty with discrete constant load and speed	Special Applications

Table 4 - Duty cycle in accordance with IEC 60034-1

Normally all our motors are of S1 Duty where in the motor can be operated continuously at a constant load till its thermal equilibrium is reached.

Insulation Class

The insulation system of an electric motor is determined by a given insulation class on the basis of its thermal resistance. This thermal resistance should be guaranteed by the entire set of electric insulating materials used in the motor insulating system.

Table - 5 shows maximum temperature rise at various ambient and the Hot spot temperature for the insulation system.

Insulation Class	Maximum Allowable Temp. Rise Limit (°C)	Temperature Margin (°C) or Hot spot	Max. Allowable Temperature rise at a given Ambient (°C)				
			40	45	50	55	60
A	105	5	60	55	50	45	40
E	120	5	75	70	65	60	55
B	130	10	80	75	70	65	60
F	155	10	105	100	95	90	75
H	180	15	125	120	115	110	105

Table 5 - Temperature rise limit

All the standard 'Amber' motors are manufactured with Class F insulation which means at the Ambient temperature of 45°C the temperature rise of the winding may be maximum 100°C with an additional temperature margin of 10°C. But the maximum permissible temperature rise of 'Amber' motors is limited to class B which allows 25°C reserve thermal capacity in the motor as a result helping to maintain integrity of the insulation and lengthening the life of the motor. All Insulation materials used are adequately resistant to action of microbes and fungi.

Options for insulation (on request)
1) Class H Insulation
2) Winding with dual coated wires

Overloading Capacity & Protection

As per IEC 60034-1, motors having rated output not exceeding 315 kW and rated voltages not exceeding 1 kV shall be capable of withstanding a current equal to 1.5 times the rated current for minimum 30 seconds and maximum 2 minutes maintaining rpm and torque simultaneously. For overload protection embedding of PTC Thermistors in the stator winding is feasible on request.

Winding

Winding Designs for all the motors at Amber are developed under latest software for electrical designs. This software critically helps to develop most accurate winding design providing the report of resulting parameters and obviously helps to reduce trial and error time for developing and applying new winding designs. Besides that any type of electrical customization is possible to develop motors for specific applications like motors with any type of given supply voltage & frequency, high or low output torque, specific winding temperature, specific efficiency or power factor,etc.

The stators of all the 'Amber' motors are wound with modified polyester enameled copper wire (IS 13730, Part 03, Thermal Class 155°C) and are impregnated by pouring oven baked varnish.

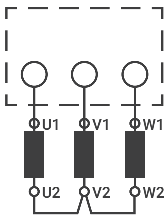
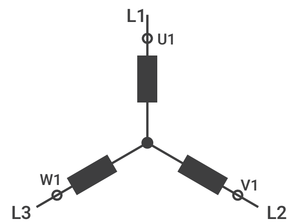
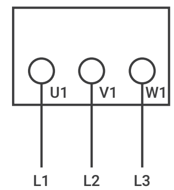
A sample wire from each and every copper wire reel is HV tested before making the coils for winding. During winding each phase is further separated by another layer of phase separator insulating film to guard the motor from the voltage spikes that usually arise when the motor is controlled by an inverter or variable frequency drive. After winding all the stators are 3 times HV tested at different stages before assembly according to the Dielectric inspection system which involves checking the leakage current at an applied voltage in conditions complying with standard IEC 60034-1.

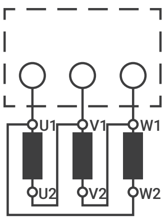
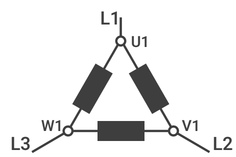
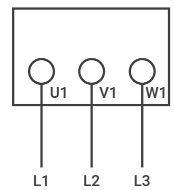
All standard dual speed Amber motors are divided into two types of windings:
a) Dahlander Winding
b) Independent or Separate Winding

Terminal Connection Diagrams

Single Speed Motors

<table>
<tr><th rowspan="2">Voltage and connections</th><th rowspan="2">Internal wiring diagrams</th><th rowspan="2">Winding outline diagrams</th><th colspan="2">External connection diagrams</th></tr>
<tr><th>D.O.L. starting</th><th>⅄/Δ starting</th></tr>
<tr><td colspan="5">Single Voltage motors (3 TERMINALS)</td></tr>
<tr><td>< 2.2 KW
- voltage: V
- Connection:
⅄ internal

Eg: 415 V/⅄</td>
<td></td>
<td></td>
<td></td>
<td>—</td></tr>
<tr><td>⩾ 2.2 KW
- voltage: V
- Connection:
Δ internal

Eg: 415 V/Δ</td>
<td></td>
<td></td>
<td></td>
<td>—</td></tr>
<tr><td colspan="5">Dual-Voltage motors with ⅄, Δ connections (6 TERMINALS)</td></tr>
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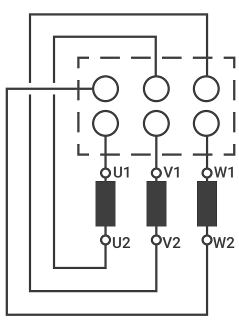
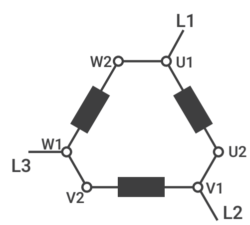
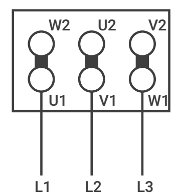
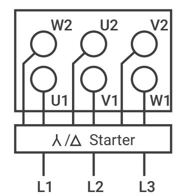
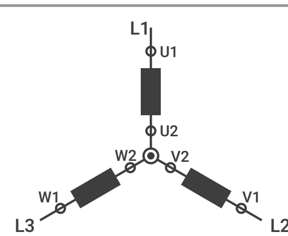
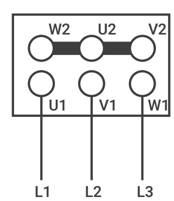
- Connection: Δ
(at lower voltage)

Eg: 230 V/Δ</td>
<td rowspan="2"></td>
<td></td>
<td></td>
<td></td></tr>
<tr><td>- voltage: V √3
- Connection: ⅄
(at higher voltage)

Eg: 415 V/⅄</td>
<td></td>
<td></td>
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Mechanical Features

Enclosures

Amber motors are manufactured in a robust and rugged cast iron and aluminium frames with integral feet and integral bearing covers (upto 200L Frame). The cooling fins are designed to maximize heat transfer and to minimize the accumulation of liquids and dust over the motor. The motor feet are completely solid for better mechanical strength, allowing easier alignment and installation. The stators are hydraulic press inserted in the body to minimize its loosening. All joints in terminal box are sealed with gaskets. Motors are supplied in TEFC (Totally Enclosed Fan Cooled) Enclosures. Cooling Tower motors are supplied in TE (Totally Enclosed) Enclosures. While motors on request can also be supplied in DP (Drip Proof) Enclosures.

Materials incorporated as per frame size in 'Amber' Motors

Frame	Housing (Body)		Side Cover (End shield)		Cooling Fan	Fan Cover	Terminal Box	
	Aluminium	Cast Iron	Aluminium	Cast Iron	Plastic	Sheet Metal	Aluminium	Nylon
63	✓		✓		✓	✓		✓
71	✓	✓	✓	✓	✓	✓		✓
80	✓	✓	✓	✓	✓	✓	✓	✓
90	✓	✓	✓	✓	✓	✓	✓	✓
100	✓	✓	✓	✓	✓	✓	✓	✓
112		✓		✓	✓	✓	✓	✓
132		✓		✓	✓	✓	✓	
160		✓		✓	✓	✓	✓	
180		✓		✓	✓	✓	✓	
200		✓		✓	✓	✓	✓	

Type of Construction

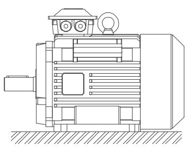
Asynchronous motors have standardized feet height (H) dimensions from base to shaft. This dimension defines the construction size of the motor. Dimension B measures the length (S, M, L) of the frame size.

Amber motors are manufactured in standardized construction sizes and standardized frame sizes according to IEC 60072-1 and EN 50347 standards as per mounting positions mention on page - 14.

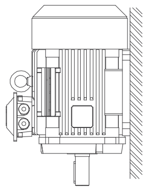
S - Short size frame length
M - Medium size frame length
L - Large size frame length

Motor Mounting Positions

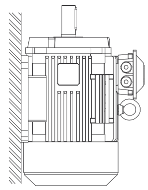
Foot mounting



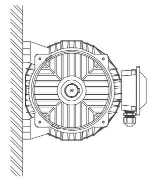
IM B3
IM 1001



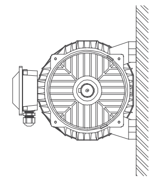
IM V5
IM 1001



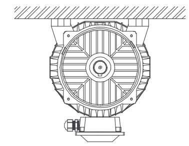
IM V6
IM 1031



IM B6
IM 1051

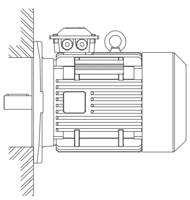


IM B7
IM 1061

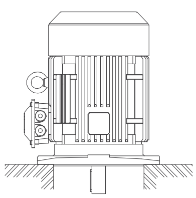


IM B8
IM 1071

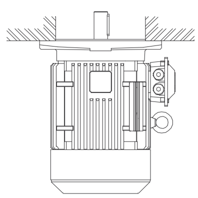
Flange mounting



IM B5
IM 3001

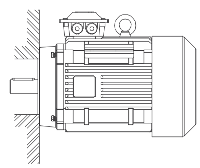


IM V1
IM 3011

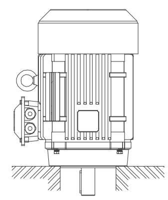


IM V3
IM 3031

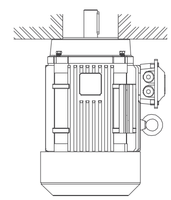
Face mounting



IM B14
IM 3601

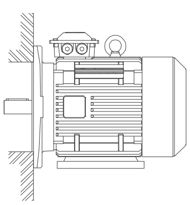


IM V18
IM 3611

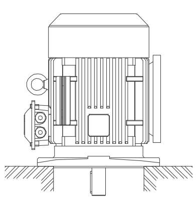


IM V19
IM 3631

Foot cum Flange mounting

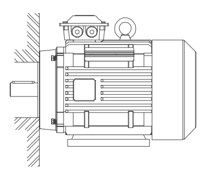


IM B35
IM 2001



IM V15
IM 2011

Foot cum Face mounting



IM B34
IM 2101

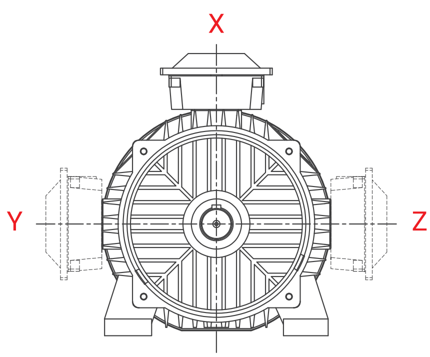
Terminal Box

The terminal box provided for AN Series standard motors is of die cast aluminum alloy. The degree protection provided is IP55. All joints in terminal box are sealed with gaskets.

For motors rated upto and including 1.5kW (2 HP) are provided with 3 terminals. For 2.2.kW (3HP) and above are provided with 6 terminals as a standard practice. The terminal markings U, V, W or U1, V1, W1, & U2, V2, W2 are provided on the motor lead sockets.

The terminal box is positioned towards the drive end of the motor. This arrangement allows improvement of the airflow over the cooling fins, thus reducing motor operating temperatures. Terminal box position on either the left or right hand side of the motor is possible in 90S to 132M frame sizes on request.

Positions of the Terminal Box in relation to the drive end (motor in IM 1001 Position)

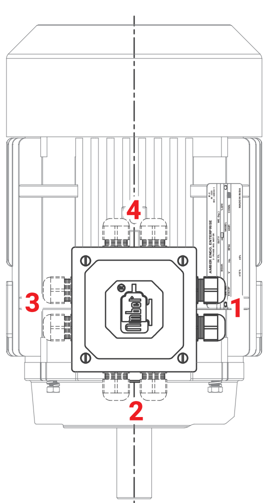


Terminal box position

Frame Size	X	Y	Z
63 to 80	Standard	Not available	Not available
90S to 132M	Standard	On request	On request
160M to 200L	Standard	Not available	Not available

- Standard
- On request
- Not available

Cable Gland Position



(Position 2 is possible in B3 and B14 Mountings but is practically not recommended as it is the drive end side)

Frame Size	Mounting	1	2	3	4
63 to 90L	B3	Standard	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box
100L to 200L	B3	Standard	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box	Possible by turning round the terminal box and removing lifting eyebolt.
63 to 90L	B5	Standard	Not possible	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box
100L to 200L	B5	Standard	Not possible	Possible by simply turning round the terminal box	Possible by turning round the terminal box and removing lifting eyebolt.
63 to 90L	B14	Standard	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box
100L to 132M	B14	Standard	Possible by simply turning round the terminal box	Possible by simply turning round the terminal box	Possible by turning round the terminal box and removing lifting eyebolt.

- Standard
- Possible by simply turning round the terminal box
- Possible by turning round the terminal box and removing lifting eyebolt.
- Not possible

Cooling

The aim of cooling is to transfer the heat from the motor to ambient. The objective is to keep the temperature of insulation materials under the limit values.

According to IEC 60034-6, all Amber motors are cooled using method IC 411, ie. "surface-cooled machine using the ambient air circulating round the machine". This is the most common used system in which cooling air is supplied by a plastic fan which is connected to the motor shaft at non drive end and operates inside a grilled sheet metal fan cover which acts as a safety guard; cooling is performed outside of the completely closed surface of the motor. The fan draws the air through the grille in the cover and blows it along the housing fins, giving an identical heat balance in either direction of rotation

Effect on cooling due to variation in frequency and supply

Whenever standard induction motors are being used with variable speed, powered by an inverter or voltage controller for a prolonged operation at low speed, cooling efficiency is greatly diminished which results to temperature rise of motor. It is therefore advisable to install a forced ventilation unit that will produce a constant flow of air independently of the motor speed.
In prolonged operation at high speed, the fan may make excessive noise and vibration. It is again advisable to install a forced ventilation unit.

Cooling Method	Description	IC Code	Availability
TEFC (Totally Enclosed Fan Cooled)	Cooling air is blown over the totally enclosed motor surface by fan mounted on the shaft	IC 411	Standard
TENV (Totally Enclosed Non Ventilated)	Cooling without using a fan, only by natural ventilation and radiation on the motor surface.	IC 410	On Request
TEFV (Totally Enclosed Forced Ventilated)	Cooling air is blown over the totally enclosed motor surface by an external fan motor	IC 416	On Request
DP (Dip Proof)	Cooling air is blown through the motor by a fan mounted on the shaft inside the motor enclosure	IC 01	On Request

Table 6 - Methods of cooling in accordance with IEC 60034-6

Bearings & Lubrication

Deep groove sealed (2Z) normal clearance ball bearings filled with mineral oil based, lithium soap thickened grease are used in all Amber motors. Rubber dust gaskets (V-ring) are placed in front and rear covers. Oil seal can be placed upon on request. As well as Tapper Roller Bearings, Angular contact bearings or self adjustable high accuracy bearings can also fitted in any Amber motor on special request or for suitable applications.

The nominal bearing life L10h (Basic rating life in hours) is 20000 or 40000 hours in conformance with maximum radial and axial loads. When direct coupled to the load (without axial or radial thrusts), the L10h bearing life is 50000 hours.

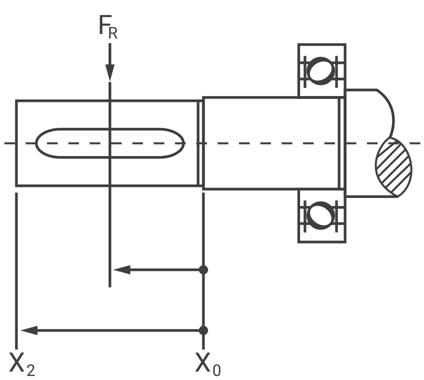
The lifetime of bearings depends on the type and size of the bearing, the radial and axial mechanical loads it is given, operating conditions (environment, temperature), rotational speed and grease life. Therefore, bearing lifetime is closely related to its correct use, maintenance and lubrication. Respecting the quantity of grease and lubrication intervals allows bearings to reach the lifetime given. Reduce in the bearing life may be observed when a motor is driven by a frequency drive at speeds above nominal. Speed itself is one of the factors taken into consideration when determining motor bearing life. For motors supplied with horizontal mounting but working vertically, lubrication intervals must be reduced by half.

Shafts

The shaft used in all standard Amber motors are made of C40(EN8) steel. On demand shafts with special steel material (i.e. EN24, EN57 or stainless steel grades) are also available to suit the requirement of the application.

Single shaft extension as per IS: 1231 is provided in all standard Amber motors. Extra shaft extension at the drive end or non drive end is also available in all standard Amber motors on specific requests.

Shafts of each and every Amber motor are cylindrically grinded with drive end size tolerance + 5 μm and the bearing fit sizes as per K5 tolerances.



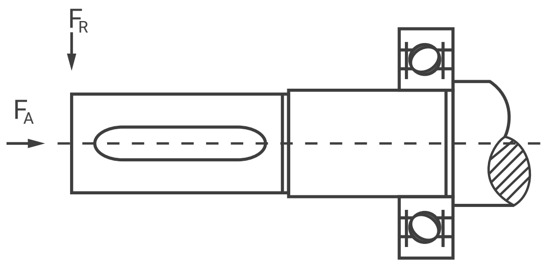
FR = Maximum Radial Load (belt load + weight of belt pulley

[N] = Newton

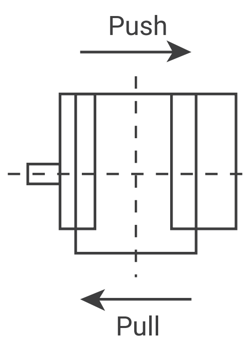
Frame Size	Poles	Permissible Radial Load FR [N]					
		Ball Bearings			Roller Bearings		
		X_0	X_1	X_2	X_0	X_1	X_2
63	2	390	360	340			
	4	390	360	340			
	6	440	410	480			
	8	490	450	420			
71	2	490	450	420			
	4	480	450	420			
	6	550	510	480			
	8	610	560	520			
80	2	640	590	540			
	4	640	580	540			
	6	730	660	610			
	8	800	730	670			
90	2	730	660	610			
	4	720	660	600			
	6	820	750	680			
	8	910	820	750			
100	2	1020	910	830			
	4	1010	910	820			
	6	1150	1030	940			
	8	1270	1140	1030			
112	2	1480	1350	1240			
	4	1470	1340	1230			
	6	1680	1530	1410			
	8	1850	1680	1550			
132	2	2160	1930	1750			
	4	2140	1910	1720			
	6	2450	2190	1970			
	8	2700	2410	2180			
160	2	2790	2470	2210	5720	5200	4680
	4	2770	2450	2190	5885	5350	4815
	6	3150	2790	2490	5995	5450	4905
	8	3480	3080	2750	6050	5500	4950
180	2	3600	3200	2850	6490	5900	5310
	4	3500	3350	2850	7040	6400	5760
	6	3900	3600	3300	7370	6700	6030
	8	4300	3950	3700	7480	6800	6120
200	2	4500	4300	4000	9680	8800	7920
	4	4550	4350	4100	10450	9500	8550
	6	5300	5500	5000	10780	9800	8820
	8	5500	5350	5050	10945	9950	8955

Table 7 - Permissible Radial Load

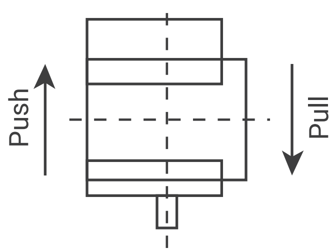
Permissible axial load on motor shaft with standard ball bearings



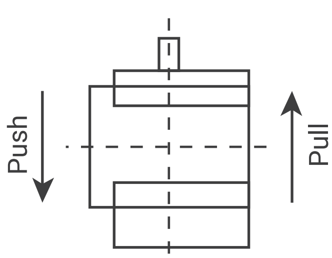
B3



V5



V6



Frame Size	Poles	Permissible Axial Load with F_R at X_2 - F_A[N]			
		Ball Bearings		Roller Bearings	
		B3 Push/Pull	V5/V6 Push/Pull	B3 Push/Pull	V5/V6 Push/Pull
63	2	120	110		
	4	120	110		
	6	140	130		
	8	160	150		
71	2	140	130		
	4	140	120		
	6	170	150		
	8	190	170		
80	2	190	170		
	4	190	160		
	6	220	190		
	8	250	220		
90	2	200	170		
	4	200	160		
	6	240	190		
	8	270	220		
100	2	280	230		
	4	280	220		
	6	330	260		
	8	370	300		
112	2	410	330		
	4	410	320		
	6	480	370		
	8	540	430		
132	2	590	430		
	4	590	380		
	6	690	470		
	8	780	560		
160	2	750	490	1000	700
	4	750	450	1200	840
	6	880	520	1300	910
	8	1000	640	1400	980
180	2	880	950	1000	700
	4	880	1150	1250	875
	6	1030	1350	1350	945
	8	1160	1550	1550	1085
200	2	1160	1100	1100	770
	4	1160	1200	1200	840
	6	1360	1400	1400	980
	8	1520	1600	1600	1120

Table 8 - Permissible Axial Load

Degree of Protection

Degrees of protection explain the ability of enclosure of an electrical equipment to protect itself from foreign elements like fingers, cable wires, dust, rain water, moisture drops, tools, mechanical striking forces, etc. which are described as ‘IP’ ratings (Standing for ‘Ingress Protection’) and which are specified by IEC 60034-5 and IEC 60529.

All AMBER motors as explained in table-9 are manufactured as per IP55 degree of protection. **Motors with higher degree of protection can be manufactured on specific requests.**

The **first digit** of the IP designation describes the degree of protection against access to hazardous parts.

The **second digit** designates the degree of protection against water.

The **third digit** describes the degree of protection against mechanical impact as per IEC 60529, and is often not specified.

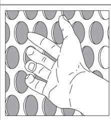
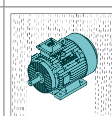
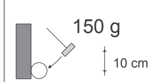
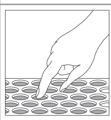
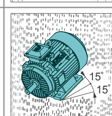
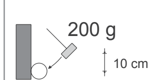
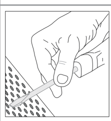
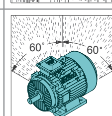
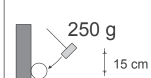
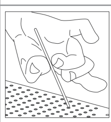
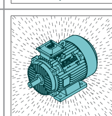
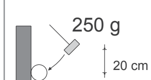
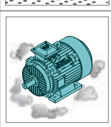
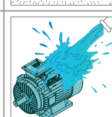
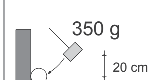
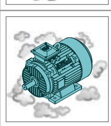
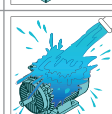
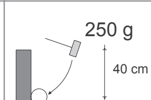
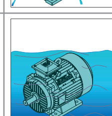
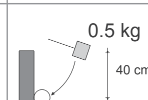
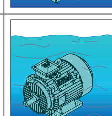
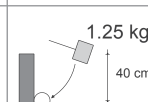
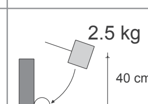
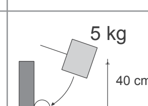
Protection against solid objects			Protection against water			Protection against mechanical impacts		
1st Digit	Description		2nd Digit	Description		3rd Digit	Description	
0		No. Protection	0		No. Protection	0		No. Protection
1		Protected against objects bigger than 50 mm	1		Protected against vertically falling water drops	1		Striking Force 0.15 Joule
2		Protected against objects bigger than 12mm	2		Protected against vertically falling water drops up to 15°	2		Striking Force 0.20 Joule
3		Protected against objects bigger than 2.5mm	3		Protected against vertically falling water drops up to 60°	3		Striking Force 0.37 Joule
4		Protected against objects bigger than 1mm	4		Protected against water splashing from any direction	4		Striking Force 0.50 Joule
5		Protected against dust	5		Protected against water jets from any direction	5		Striking Force 0.70 Joule
6		Dust tight protection	6		Protected against temporary immersion	6		Striking Force 1 Joule
			7		Protected against immersion between 0.15 & 1 m	7		Striking Force 2 Joule
			8		Protected against immersion at a fixed pressure and period	8		Striking Force 5 Joule
						9		Striking Force 10 Joule
						10		Striking Force 20 Joule

Table 9 - Degrees of Protection

Stator & Rotor

Best quality stacked decarburized laminations created by using Silicon Steel, also known as electrical steel, is steel with silicon added to it are used in all Amber motors. Adding silicon to steel increases its electrical resistance, improves the ability of magnetic fields to penetrate it, and reduces the steel's hysteresis or eddy current losses in the core thus justifying the additional cost by increased performance. The Annealed/ Decarburized Laminations with silicon steel in it can help to reduce corrosion; the primary purpose of adding silicon is to improve the steel's hysteresis loss.

Hysteresis is the lag between the times when a magnetic field is first generated or applied to the steel and when the field fully develops. The addition of silicon to steel makes the steel more efficient and faster in terms of building and maintaining magnetic fields. The rotors used in Amber motors are aluminium pressure die-casted with standard EC grade aluminium and skewed while die-casting to correct angles. These rotors are inserted on knurled motor shafts with hydraulic power press thus resulting to bare any type of starting jerks, instant reverse-forward direction jerks, inching jerks or high speed at any time.

Vibration

Balancing rotating equipment is critical producing an energy efficient product. Mass imbalances cause significant vibration due to the exertion of centripetal forces during rotation. Vibration generates heat and noise, which are forms of wasted energy; the energy is not being directed towards useful work and reduces product efficiency.

The rotors of all Amber motors are dynamically balanced on computerized machines at a mean speed in the keyway of the shaft extension with a half sized key (half-key balancing) according to standard IS12075/IEC 60034-14 and ISO 9921/ ISO 8821 norms. On specific request balancing with a full key or without a key can be availed. Ultimately the goal of rotor balancing is to reduce the unbalance to the point that machine life is not negatively impacted by the residual unbalance.

VIBRATION LIMITS ACCORDING TO IEC 60034-14

Allowable vibration levels are determined in IEC 60034- 14 standard and these values which are given in table - 10 are recommended as upper limit values for motor producers. Three separate vibration levels are determined according to this standard. Vibration levels of Amber motors are within normal limits and meet the standard provisions.

Vibration Grade	Shaft Height (mm)	56≤H≤132			132≤H≤280			H>280		
	Mounting	Displac. µm	Vol. mm/s	Acc m/s²	Displac. µm	Vol. mm/s	Acc m/s²	Displac. µm	Vol. mm/s	Acc m/s²
A	Free Suspension	25	1.6	2.5	35	2.2	3.5	45	2.8	4.4
	Rigid Mounting	21	1.3	2.0	29	1.8	2.8	37	2.3	3.6
B	Free Suspension	11	0.7	1.1	18	1.1	1.7	29	1.8	2.8
	Rigid Mounting				14	0.9	1.4	24	1.5	2.4

Grade 'A' applies to machines with no special vibration requirements.
Grade 'B' applies to machines with special vibration requirements. Rigid mounting is not considered acceptable for machines with shaft heights less than 132 mm.
The interface frequencies for displacement/velocity and velocity/acceleration are 10 Hz and 250 Hz respectively.

Table 10 - Vibration Limits

Inaccuracies due to construction (magnetic, mechanical and air-flow) lead to sinusoidal (or pseudo sinusoidal) vibrations over a wide range of frequencies. Other sources of vibration can also affect motor operation: such as poor mounting, incorrect drive coupling, end shield misalignment, etc. So vibration analysis should also be included in the periodic maintenance program in every factory because vibration in an electric motor and other rotating parts of a machine is a mechanical problem which starts small, unnoticed, and ends up causing a failure at the most inopportune time because no measures were in place to detect or prevent vibration.

Noise Level

In every Amber electric motor the total sound power emission is controlled considering a combination of three uncorrelated noise sources acting together. These sources are magnetic, cooling, and mechanical or rotational noise sources. (a) Air gap in every motor is inspected maintained as per standards to prevent magnetic noise resulting into temporal and spatial variations of magnetic force distribution. (b) Cooling fans are such designed to minimize the noise level and improve thermal efficiency. (c) To control rotational noise 1) Rotors and stators of all motors are burnished to smooth surface so that when rotor rotates in the cavity(core) there are no obstacles and discontinuities that create noise, and 2) the alignment of the shaft and mounting system & sizes of the bearings is strictly taken care of so that when shaft & bearing interact they do not create noise at any speed.

Noise limits according to IEC 60034-9
Surface sound pressure level LpA dB(A)

Frame Size	6 Poles		4 Poles		2 Poles	
	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz
63	42	45	45	48	51	56
71	44	47	46	49	52	56
80	45	48	47	51	55	58
90	46	49	48	52	56	60
100	49	53	50	54	59	64
112	54	59	56	59	63	67
132	57	61	40	64	66	69
160	63	66	64	68	70	74
180	63	66	64	68	71	75
200	64	67	64	68	73	76
225	64	67	65	69	74	78
250	66	69	68	71	76	80
280	67	71	68	71	77	80
315	73	77	74	78	79	82

Table 11 - Sound Pressure levels per frame size

SOUND POWER LEVEL$_{WA}$ (dB) AT UNLOADED OPERATION ACCORDING TO IEC 60034-9

MOTOR OUT PUT POWER P_H kW	8 Poles		6 Poles		4 Poles		2 Poles	
	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz
1.0<P_H≤2.2	70	71	70	71	70	71	78	85
2.2<P_H≤5.5	73	76	73	76	73	76	83	88
5.5<P_H≤11	77	80	77	80	78	81	88	91
11<P_H≤22	81	84	81	84	85	88	91	94
22<P_H≤37	84	87	84	87	88	91	93	100
37<P_H≤55	86	90	87	91	91	95	95	101
55<P_H≤110	89	93	91	95	95	98	97	104
110<P_H≤220	94	97	96	99	99	102	100	107
220<P_H≤440	96	98	98	101	102	105	103	109
440<P_H≤1000	97	99	99	102	105	108	105	110

Table 12 - Sound power level at unloaded operation

SOUND POWER LEVEL$_{WA}$ (dB) AT RATED POWER OPERATION ACCORDING TO IEC 60034-9

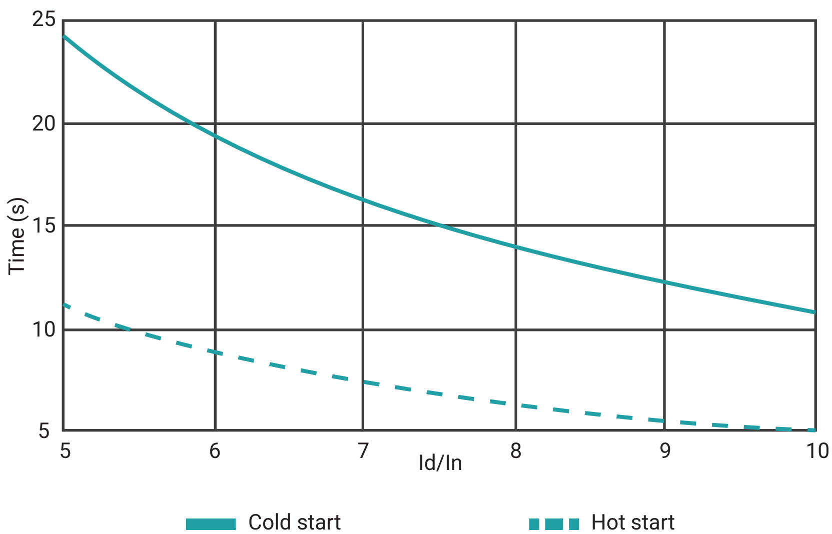
MOTOR OUT PUT POWER P_H kW	8 Poles		6 Poles		4 Poles		2 Poles	
	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz	50Hz	60Hz
1.0<P_H≤2.2	78	79	77	78	75	76	80	97
2.2<P_H≤5.5	81	84	80	83	78	81	85	90
5.5<P_H≤11	85	88	84	87	83	86	88	93
11<P_H≤22	88	91	87	90	89	92	90	96
22<P_H≤37	91	94	90	93	92	95	93	102
37<P_H≤55	92	96	92	96	94	98	95	103
55<P_H≤110	95	99	100	104	101	104	101	108
110<P_H≤220	99	102	100	104	102	105	102	109
220<P_H≤440	101	103	98	101	102	105	103	109
440<P_H≤1000	101	103	102	105	107	110	107	112

Table 13 - Sound power level at rated power operation

Starting Time and Starting Current

The Calculated starting times must remain within the limits of graph shown below which defines maximum starting times in relation to current surge.

Three successive cold starts and two consecutive hot starts are allowable with return to stop between each start. Permissible motor starting time as a function of the ratio I_D/I^N

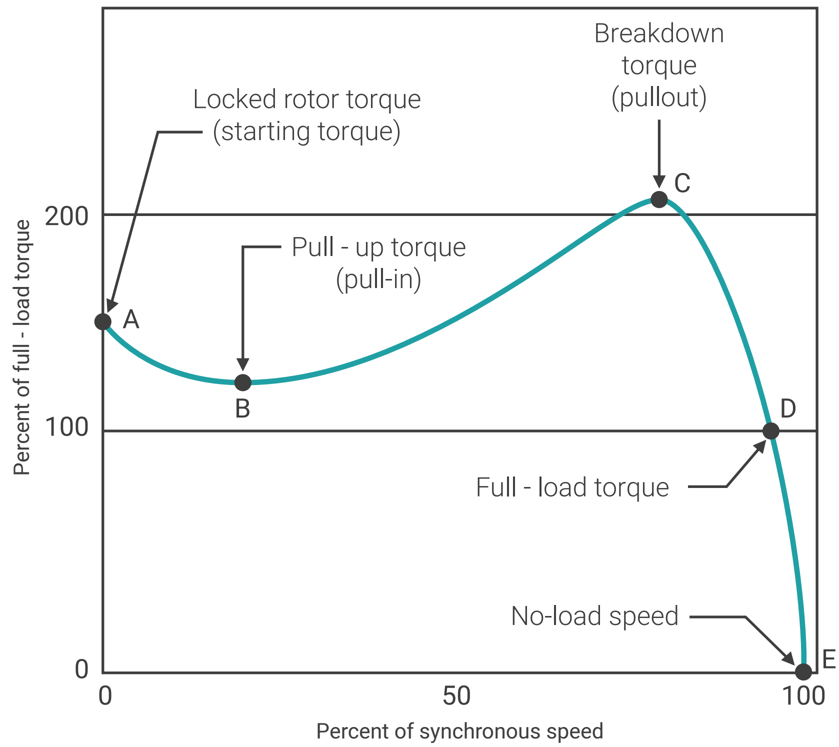


Torque

An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding.The torque produced by three phase induction motor depends upon the following three factors:

1) Magnitude of rotor current
2) Flux which interact with the rotor of three phase induction motor and is responsible for producing emf (Electromotive force), in the rotor part of induction motor &
3) Power factor of rotor of the three phase induction motor

Relationship of Speed and Torque



This is the typical torque speed curve for a standard AC induction motor

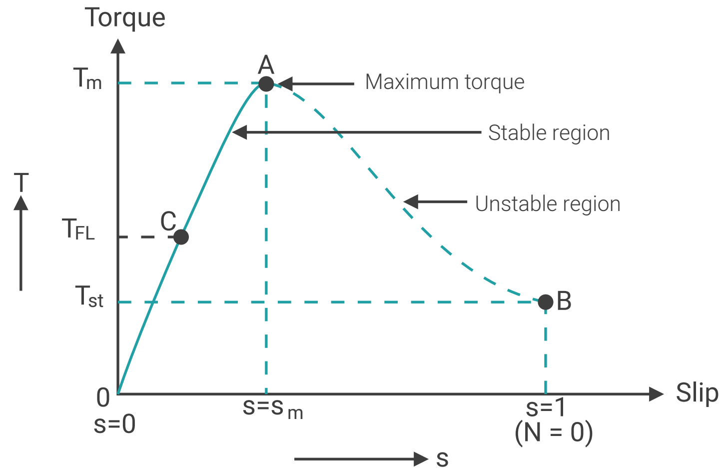
Type of Torque

Name	Also known as	Explanation
Locked rotor torque (TL)	Starting Torque, Breakaway Torque	This is the smallest measured torque value when the rotor of the motor is locked simultaneously applying electrical power.
Pull – up Torque (TU)	Minimum Torque, Pull in Torque	This is the minimum torque value that the motor's torque curve will dip to, between zero speed and the speed which corresponds to the breakdown torque, during the starting sequence.
Pull – out Torque (TB)	Breakdown Torque, Tip up Torque, Peak Torque	This is the maximum steady-state asynchronous torque which the motor develops without an abrupt drop in speed, when the motor is supplied at the rated voltage and frequency.
Full – Load Torque (TN)	Rated Load Torque, Running Torque	This is the stabilized torque when the motor is delivering the rated power output at the rated speed.

Table 14 - Types of Torque

Torque-Slip Characteristics In Three Phase Induction Motor

The actual speed of the motor shaft is somewhat less than synchronous speed. This difference between the synchronous and actual speeds is defined as slip. As the induction motor is located from no load to full load, its speed decreases hence slip increases. Due to the increased load, motor has to produce more torque to satisfy load demand. The behavior of motor can be easily judged by sketching a curve.



0A = Stable region
AB = Unstable region
Point A = Maximum torque
Point B = Starting torque
Point C = Full load torque

Each and every Amber motors are passed through rigorous torque tests like Starting torque test, Full load Torque and Pull out torque test as per IEC 60034-12

Variable Frequency Drive Application

Variable Frequency Drive (VFD) is a power conversion device. The VFD converts a basic fixed-frequency, fixed voltage sine-wave power (line power) to a variable frequency, variable-voltage output used to control speed of induction motors. VFDs are used in many applications in which the mechanical equipment powered by motors needs more or less speed than that generated by the motor at a given frequency supply. The VFDs provide extremely precise electrical motor control, so that motor speeds can be ramped up and down, and maintained, at speeds required; doing so utilizes only the energy required, rather than having a motor run at constant (fixed) speed and utilizing an excess of energy.

Considering Voltage Spikes

Motors connected to VFDs receive power that includes a changeable fundamental frequency, a carrier frequency, and very rapid voltage buildup. 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 an 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. As the stators of all standard Amber motors are wound with superior electrical insulation characteristics they are capable to bear maximum 3 times the rated voltage generated at motor terminals through DOL starting or via a variable speed drive. For extremely higher peak voltages at motor terminals (more than 3 or 4 times the rated voltage) a load reactor or dv/dt filter must be installed in the output of the VFD.

Noise

Operation of standard industrial AC induction motors on adjustable frequency power over a speed range often results in unacceptable sound power levels as well as an annoying tonal quality. The increase in sound level is typically in the range of 7 to 10 db. One source of acoustic noise is the air noise caused by running shaft driven fans above their design speed to achieve a wider speed range. A separately powered, unidirectional, constant speed cooling fan will provide a consistent level of air noise independent of motor speed and eliminates annoying sound level changes as the motor accelerates and decelerates.

Vibration

At lower speeds through VFD the vibration level in the Amber motors will of course be in accordance with IEC 60034-14 as rotors are dynamically balanced. At higher speed, if the direct coupled motor with VFD operate at maximum safe operating speeds as per IS 15880:2009, the vibration in the Amber motor will be lowest considering that all the other rotating parts connected with the motor are dynamically balanced. To avoid unexpected vibrations in motors run through VFD it is suggested that the foundation of the motors especially at high speeds be rigid and the alignment of all the rotating parts be highly accurate.

Temperature Rise

One of the more obvious sources of increased stress on an induction motor insulation system is higher operating temperature when run on variable frequency controllers. The higher operating temperatures are the result of increased motor losses due to harmonics and often reduced heat transfer as well. As a result motors will not achieve their nameplate rating when operated on a VFD at 50 or 60 Hz while remaining within temperature limits. Normally all the Amber motors are capable of withstanding temperature as per class B limit at rated load and at higher or lower speed through VFD. In order to keep the temperature rise of the motor within acceptable limits, torque de-rating of the motor is essential. Another way to keep temperature in control is to apply a forced ventilation or independent ventilation system to the motor.

Bearings

As a result of Bipolar Junction Transistors (BJT) or Isolated gate Bipolar Transistors (IGBT) in VFD systems which give a faster switching dv/dt with lower switching losses and excess length of cable between VFD and motor stray current is generated at the motor shaft ends. This stray current uses bearing as its path to ground, which result into bearing damage, bearing noise and further bearing failure. Normally motors up to frame size 132S/M generally do not require special features with respect to the bearings for variable speed drive application. There are three solutions that are commonly employed to solve this issue which are:

a) Mount Shaft Grounding Device to the non drive end of the motor shaft

b) Install Insulated Bearings in the motor

c) Attach Inductive Absorption Device to the motor

Torque

At lower frequencies than the rated frequency of the motor run through VFD the torque of the motor may not fluctuate more than the rated torque of the motor but at higher frequencies above 50 or 60 Hz the torque of the motor may constantly derail as the voltage through the VFD cannot be increased more than the rated output voltage of VFD. As frequency increases, the V/Hz ratio decreases and torque follows.

Conclusion

Thus, as per the above explanation a motor to be operated through VFD needs to be customized even though standard. It is advisable to mention the load, speed range and application details while ordering to purchase any standard Amber motor which is to be operated through VFD. Accordingly we can manufacture motor with special impregnation system, dual coated winding wire, insulated bearings, encoder mounting arrangement on the non drive end, etc.

IS & IEC Standards Followed

IS	Standards
325	Three phase induction motor specifications
1231	Dimensions of Three Phase Foot Mounted Induction Motors
2223	Dimensions of Three Phase Flange Mounted Induction Motors
2253	Designations for types of Constructions and Mounting Arrangements of Rotating Electric Machines
4029	Guide for testing three phase electric motors
4691	Degrees of protection provide by enclousers for rotating electrical machinery
6362	Designations for methods of cooling for Rotating Electrical Machines
12065	Permissible limits of noise levels for rotating electrical machines
12075	Permissible mechanical vibration limits of rotating electrical machines
12615	Energy Efficient three phase squirrel cage induction motors
15999 (Part 2/Sec1)	Rotating Electrical Machines Standard Methods for Determining Losses and Efficiency from Tests (Excluding Machines for Traction Vehicles)
4889	Method of determination of effeciency of rotating electrical machines.
8789	Values of performance characteristics of three phase induction motors.
12066	Specification for three phase induction motors for machine tools

IEC	Standards
60034-1	Rating and Performance
60034-2-1	Methods of determining losses and effeciency
60034-5	Classification of degrees of protection
60034-6	Methods of cooling
60034-8	Terminal Marking and Direction of Rotation
60034-9	Noise Limits
60034-14	Vibration Limits
60072-1	Dimensions and Output series of rotating electrical machines
60034-30	Specifications for Energy Efficient Induction Motors
60034-12	Starting Performance of single speed 3-phase Induction Motors

Permissible Electrical Tolerances

General allowable between the real performance values and the declared or guaranteed values as per IS 325/ IEC 60034-1

Power Factor (cosø)	-1/6 (1-cosøN), Minimum – 0.02, Maximum – 0.07
Efficiency (ŋ)	-15(1-ŋ)
Slip (n)	± 30% for P_N < 1 kW, ± 20% for P_N ≥ 1 kW
Locked Rotor Current (I_P/I_N)	+ 20% (I_P/I_N) No lower limit
Locked Rotor Torque (T_L/T_N)	Min (T_L/T_N) = -15%, Max (T_L/T_N) = +25%
Breakdown Torque (T_B/T_N)	-10% (T_B/T_N)
Moment of Inertia [$GD^2/4$ (kgm^2)]	± 10% [$GD^2/4$ (kgm^2)]

Customized Design Features

Electrical	Mechanical
• Non Standard Voltage and Frequency Variations • Dual Voltage and dual frequency motors • Premium Energy Efficient Motors (IE3) • Motors with High or Low Slip ratio • Motors with High or Low Torque ratio • A or H Class Insulated Motors • Motors with different service factors • Motors for frequent starts & stops/ reverse & forward • Inverter duty Motors • Motors to be run on Variable frequency drives at extra high speed • Textile duty motors • Motors with external cooling facility (≥ 90 Frame) • Motor with higher ambient temperatures • Intermittent duty motors	• Non-standard Mounting Dimensions • Motors with non-standard frame sizes • Extended shaft motors with non-standard dimensions • Shaft extended from the non drive end • Shaft with special material grade (Ex. : Stainless Steel) • Hollow or tapered or OD/ID Threaded motor shaft • Non-standard Cable Entries • Bearings other than deep groove ball bearings • Motors with CI or Aluminium Fans or Fan covers • Motors with Drip proof enclosures • Motors with ALuminium Extrusion or pressure die cast enclosures (upto 112M Frame) • Extra Low Vibration & Low Noise Level • Change in place or side of terminal box mounting • Special paint shade • Motor without terminal box, direct cable from the winding Motor body without fins/ plain round CI body • Cable glands of different materials (Brass, SS, Plastic) • Higher degree of protection • Bearing greasing nipple (132 Frame and above) • Detachable legs from the motor body

Testing

All Amber motors are strictly tested as per IS 325 (1996) and IEC 60034-1 (2004) with all the latest, periodically calibrated and highly accurate testing equipments. Following are the tests conducted at Amber.

Type Tests

Normally type test is performed on one of the motors in a series of similar motor or a batch of production of same motors. On special request of the customer all the motors in a batch can also be type tested. Type tests in Amber are carried out on a well equipped computerized auto testing system with voltage variac where motor is coupled with the respective dynamometer and following tests are performed:

1) Resistance Test
2) High Voltage Test
3) Insulation Resistance Test
4) No Load Test
5) Locked Rotor Test
6) Load Test at various loads (25%, 50%, 75%, 100%, 115%)

Parameters measured under load test are:

- Current
- RPM
- Watt Loss
- Slip
- Efficiency
- Power Factor
- Torque
- Pull out Torque

7) Temperature rise test
8) Reduced Voltage test
9) Temporary Overload test

Routine Tests

Routine tests are the tests carried out on each and every motor manufactured. Following are the routine tests which are performed for all ranges of Amber motors with the help of a manual test bench with digital read out meters and voltage variac.

1) Insulation Resistance Test
2) High Voltage Test
3) No load Test
4) Load test (at 100% load) where in current, RPM and temperature rise test are performed at rated voltage and frequency.
5) Momentary overload test

Optional Tests

These are the tests carried out on special request of customer or for special application of the motors. These tests include:

1) Vibration test
2) Sound level test
3) Degree of Protection Test
4) Over or under speed Test with the help of VFD.

Performance Datasheet

PERFORMANCE DATA SHEET OF 2 POLE (3000 RPM) INDUCTION MOTORS

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 63 to 200L

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

Ambient : 50°C
Duty : S1(Continuous)
Protection : IP55

Ins. Class : F
Temp. Rise : B

Frame Size	Output		Speed	Efficiency	PF	Current	Rated Torque (415V)	LRT to RT Ratio	BDT To RT Ratio	Locket Rotor Current Ratio	Moment of Inertia	Weight
	KW	HP	RPM	%	Cos ø	Amps	Nm	TL/TN	TB/TN	IP/IN	GD²/4 (kgm²)	kg
63	0.09	0.125	2710	57	0.58	0.30	0.40	2.30	2.5	4.50	0.0001	5
63	0.13	0.17	2710	56	0.60	0.40	0.60	2.30	2.5	4.70	0.0002	5.2
63	0.18	0.25	2730	60	0.77	0.48	0.70	2.20	2.4	4.80	0.0002	6.5
71	0.18	0.25	2750	61	0.76	0.76	0.80	2.40	2.8	4.80	0.0004	10.5
71	0.37	0.5	2760	70	0.75	1.15	1.40	2.50	3.0	4.60	0.0008	11
80	0.55	0.75	2790	72	0.77	1.32	1.90	2.60	3.0	5.00	0.0010	13
80	0.75	1	2810	78	0.82	1.68	2.80	3.00	3.3	5.00	0.0012	16
90S	1.1	1.5	2820	80	0.85	2.37	4.00	3.10	3.5	5.20	0.0015	21
90L	1.5	2	2860	82	0.87	3.10	5.20	2.80	3.5	5.50	0.0020	24
100L	2.2	3	2880	84	0.87	4.08	7.50	3.40	3.7	5.00	0.0028	35
100L	3	4	2880	85	0.86	5.80	9.80	3.20	3.4	5.80	0.0034	42
112M	3.7	5	2890	86	0.88	7.15	13.40	2.50	3.1	6.00	0.0062	45
112M	4	5.34	2880	86.5	0.90	7.30	13.50	2.40	3.2	6.00	0.0070	47
132S	5.5	7.5	2900	88	0.89	10.30	18.10	2.30	3.0	6.00	0.0120	66
132M	7.5	10	2920	89	0.88	14.10	24.90	2.40	3.2	6.80	0.0820	74
160M	9.3	12.5	2925	89.5	0.86	17.40	30.80	2.60	3.1	7.00	0.0910	82
160M	11	15	2925	90	0.87	20.80	36.20	2.50	2.9	7.00	0.1520	121
160L	15	20	2930	91	0.88	27.10	49.00	2.20	2.8	7.00	0.1780	138
160L	18.5	25	2930	91.5	0.88	32.80	61.00	2.40	3.0	6.80	0.1940	147
180L	22	30	2935	92	0.89	39.20	72.00	3.00	3.4	7.00	0.2120	180
200L	30	40	2940	92	0.89	52.30	97.50	2.70	3.1	6.50	0.2430	244

PERFORMANCE DATA SHEET OF 4 POLE (1500 RPM) INDUCTION MOTORS

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 63 to 200L

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

Ambient : 50°C
Duty : S1(Continuous)
Protection : IP55

Ins. Class : F
Temp. Rise : B

Frame Size	Output		Speed	Efficiency	PF	Current	Rated Torque (415V)	LRT to RT Ratio	BDT To RT Ratio	Locket Rotor Current Ratio	Moment of Inertia	Weight
	KW	HP	RPM	%	Cos ø	Amps	Nm	TL/TN	TB/TN	IP/IN	$GD^2/4$ (kgm^2)	kg
63	0.09	0.125	1370	55	0.63	0.35	0.80	2.0	2.2	4.00	0.0003	4.7
63	0.13	0.17	1370	58	0.68	0.45	0.90	2.2	2.3	4.10	0.0005	5
63	0.18	0.25	1370	60	0.72	0.56	1.40	2.2	2.4	4.30	0.0007	5.2
71	0.18	0.25	1375	62	0.71	0.69	1.50	2.3	2.5	4.20	0.0009	7
71	0.25	0.33	1370	64	0.73	0.78	1.80	2.4	2.6	4.30	0.0008	7.6
71	0.37	0.5	1375	66	0.70	1.08	2.80	2.5	2.7	4.40	0.0015	8.2
80	0.55	0.75	1390	70	0.72	1.54	4.00	2.5	2.9	4.80	0.0028	12
80	0.75	1	1390	80	0.74	1.83	5.16	2.8	3.2	4.80	0.0067	19
90S	1.1	1.5	1395	82	0.79	2.31	7.5	2.5	3.0	5.40	0.0074	23
90L	1.5	2	1400	83	0.79	3.45	10.3	2.9	3.3	5.50	0.0089	26
100L	2.2	3	1440	86	0.8	4.6	14.8	2.6	3.0	5.80	0.0115	38
100L	3	4	1430	86.5	0.81	5.71	20	3.0	3.4	6.40	0.0127	40
112M	3.7	5	1440	87	0.81	7.66	26	2.8	3.2	6.50	0.0190	48
132S	5.5	7.5	1460	88	0.8	10.84	36.5	3.1	3.4	7.10	0.0421	70
132M	7.5	10	1450	91	0.83	14.14	49.7	2.6	3.1	7.40	0.0732	82
160M	9.3	12.5	1450	89	0.83	17.8	60	2.4	2.9	7.20	0.1186	120
160M	11	15	1450	90	0.83	21.02	72.7	2.3	2.9	7.20	0.1423	138
160L	15	20	1465	91	0.83	28.90	96.4	2.5	3.1	7.40	0.1855	146
160L	18.5	25	1465	92	0.85	34.80	121.5	2.6	3.0	7.30	0.2146	178
180L	22	30	1470	92	0.84	41.00	144	2.6	3.1	7.30	0.2512	195
200L	30	40	1470	92.5	0.87	52.80	195	2.4	2.7	6.80	0.3733	242

PERFORMANCE DATA SHEET OF 6 POLE (1000 RPM) INDUCTION MOTORS

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 200L

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

Ambient : 50°C
Duty : S1(Continuous)
Protection : IP55

Ins. Class : F
Temp. Rise : B

Frame Size	Output		Speed	Efficiency	PF	Current	Rated Torque (415V)	LRT to RT Ratio	BDT To RT Ratio	Locked Rotor Current Ratio	Moment of Inertia	Weight
	KW	HP	RPM	%	Cos ø	Amps	Nm	TL/TN	TB/TN	IP/IN	$GD^2/4$ (kgm^2)	kg
80	0.18	0.25	900	60	0.64	0.9	2	1.9	2.0	3.00	0.0010	12
80	0.25	0.33	900	62	0.69	1.09	2.8	2.0	2.1	3.20	0.0009	13
80	0.37	0.5	920	65	0.71	1.15	4.1	2.0	2.3	3.30	0.0028	18
90S	0.55	0.75	925	75	0.73	1.4	5.8	2.1	2.3	3.30	0.0041	19
90L	0.75	1	930	79.5	0.73	1.9	7.6	2.3	2.7	4.00	0.0062	24
100L	1.1	1.5	920	78.5	0.73	2.7	11.5	2.4	2.6	4.20	0.0094	30
100L	1.5	2	930	80.3	0.76	3.4	15.3	2.2	2.5	4.50	0.0157	36
112M	2.2	3	940	82	0.76	4.9	22.4	2.0	2.5	5.00	0.0273	47
132S	3.7	5	950	85.7	0.78	8	39.5	1.9	2.4	5.60	0.0591	67
132M	5.5	7.5	960	86.1	0.77	12.2	54.8	2.4	2.8	6.30	0.0845	80
160M	7.5	10	960	88.5	0.78	15.7	74.2	2.3	2.7	6.40	0.1636	121
160L	11	15	970	89	0.79	22.8	110	2.4	2.8	6.20	0.2384	145
180L	15	20	970	90	0.85	27.8	149	2.4	2.9	6.30	0.4421	196
200L	18	25	970	90.5	0.85	35	183	2.3	2.8	6.30	0.5347	245
200L	22	30	970	91.2	0.83	42	218	2.3	2.8	6.40	0.6595	260

PERFORMANCE DATA SHEET OF 8 POLE (700 RPM) INDUCTION MOTORS

TEFC 3 Phase Squirrel Cage Induction Motors - Frame size 80 to 200L

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

Ambient : 50°C
Duty : S1(Continuous)
Protection : IP55

Ins. Class : F
Temp. Rise : B

Frame Size	Output		Speed	Efficiency	PF	Current	Rated Torque (415V)	LRT to RT Ratio	BDT To RT Ratio	Locked Rotor Current Ratio	Moment of Inertia	Weight
	KW	HP	RPM	%	Cos ø	Amps	Nm	TL/TN	TB/TN	IP/IN	$GD^2/4$ (kgm^2)	kg
80	0.18	0.25	670	48	0.6	0.9	2.7	2.3	2.9	3.00	0.0032	17
80	0.25	0.33	650	53	0.63	1.1	3.8	2.2	2.8	3.10	0.0048	18
90S	0.37	0.5	650	60	0.66	1.3	5.6	2.1	2.8	3.30	0.0064	22
90L	0.55	0.75	670	61	0.61	2.2	8.1	2.2	2.6	3.40	0.0081	26
100L	0.75	1	700	69	0.65	2.4	10.5	2.1	2.7	3.50	0.0129	32
100L	1.1	1.5	700	73	0.67	3.3	15	2.4	2.8	4.10	0.0193	37
112M	1.5	2	705	75	0.71	4.2	20.8	2.3	2.9	4.40	0.0265	49
132S	2.2	3	710	80	0.74	5.2	30	2.1	2.7	4.60	0.0737	67
132M	3.7	5	700	81	0.75	8.5	52.2	2.0	2.7	5.00	0.1680	84
160M	5.5	7.5	710	82	0.76	12.3	73.5	2.1	2.8	5.20	0.2310	130
160L	7.5	10	720	83	0.79	16.1	100	2.1	2.7	5.50	0.3136	146
180L	11	15	730	85	0.8	23.2	146	2.2	2.5	5.90	0.4820	185
200L	15	20	730	85	0.81	31.2	197	2.1	2.6	6.00	0.5744	245

Name Plate Description

Standard Single Speed Motor

AMBER ENGG. ENTERPRISE 3-PHASE IND. MOTOR						IE2 IS : 325 IEC : 60034-1
AMB. 50°C IP 55		IN.CL. F	DUTY S1	WT. (kg.) 138		
FRAME 160M	BEAR. 6210 ZZ			6210 ZZ	%EFF. 92	
SR. No.			MODEL AN160MB3P4			
KW/HP	V	Hz.	RPM	AMP.	CONN.	PF
11/15	415	50	1450	20.5	△	0.83
	±10%	±5%			MADE IN INDIA	

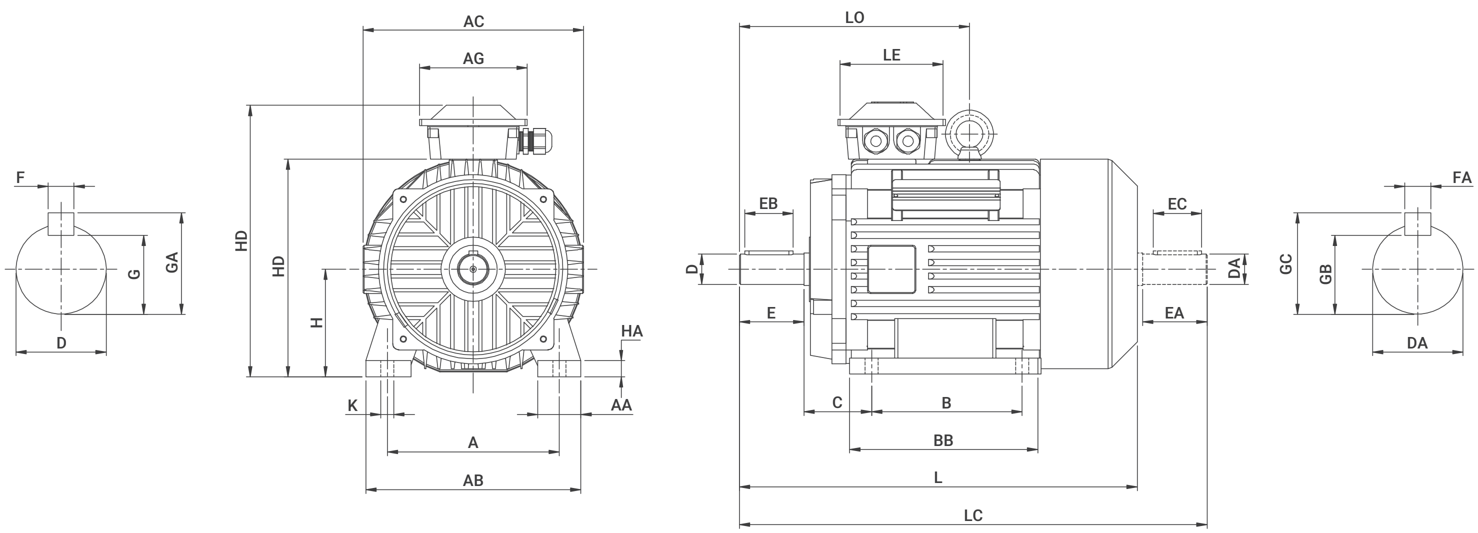
Standard Dual Voltage Motor

AMBER ENGG. ENTERPRISE 3-PHASE IND. MOTOR						IS : 325 IEC : 60034-1
AMB. 50°C IP 55		IN.CL. F	DUTY S1	WT. (kg.) 34		
FRAME 100L	BEAR. 6205 ZZ			6205 ZZ	%EFF. 87	
SR. No.			MODEL AN100LB3P4DV			
KW/HP	V	Hz.	RPM	AMP.	CONN.	PF
2.2/3	220 380	60	1730	9.5 6.2	△ ⅄	0.78 0.82
	±10%	±5%			MADE IN INDIA	

Standard Dual Speed motor

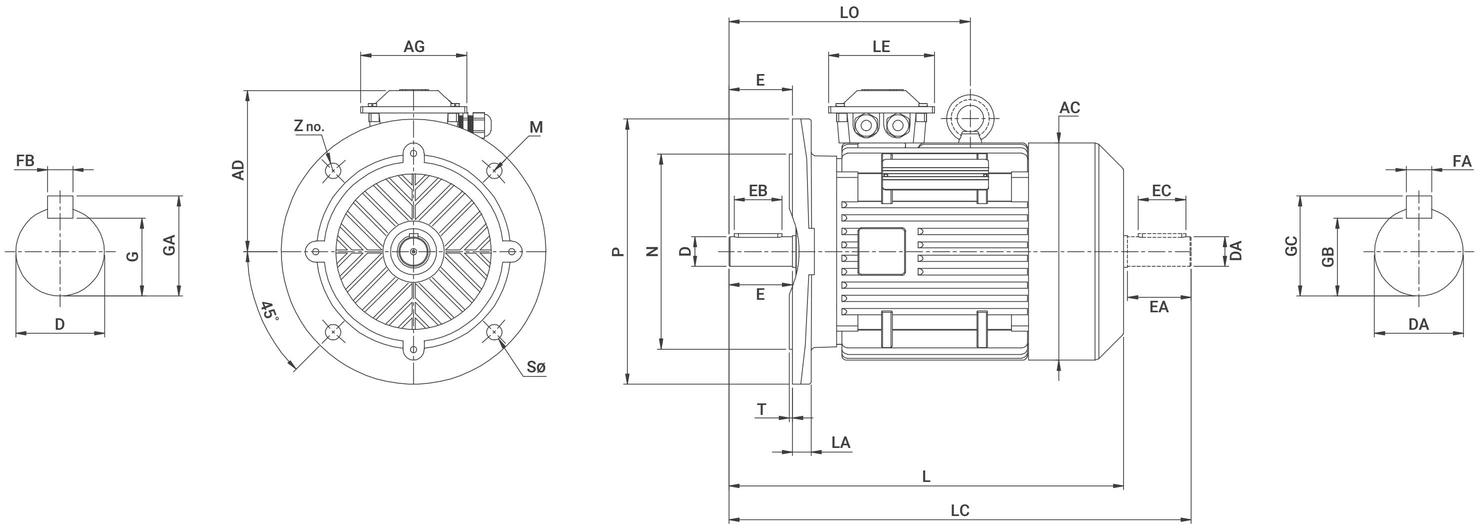
AMBER ENGG. ENTERPRISE 3-PHASE IND. MOTOR						IS : 325 IEC : 60034-1
AMB. 50°C IP 55		IN.CL. F	DUTY S1	WT. (kg.) 41.8		
FRAME 112M	BEAR. 6207 ZZ			6206 ZZ	%EFF. 63/78	
SR. No.			MODEL AN112MB3DS48			
KW/HP	V	Hz.	RPM	AMP.	CONN.	PF
1.1/1.5	415	50	700	3.8	⅄	0.66
2.2/3	415	50	1420	4.5	⅄	0.91
	±10%	±5%			MADE IN INDIA	

Motor Dimensions



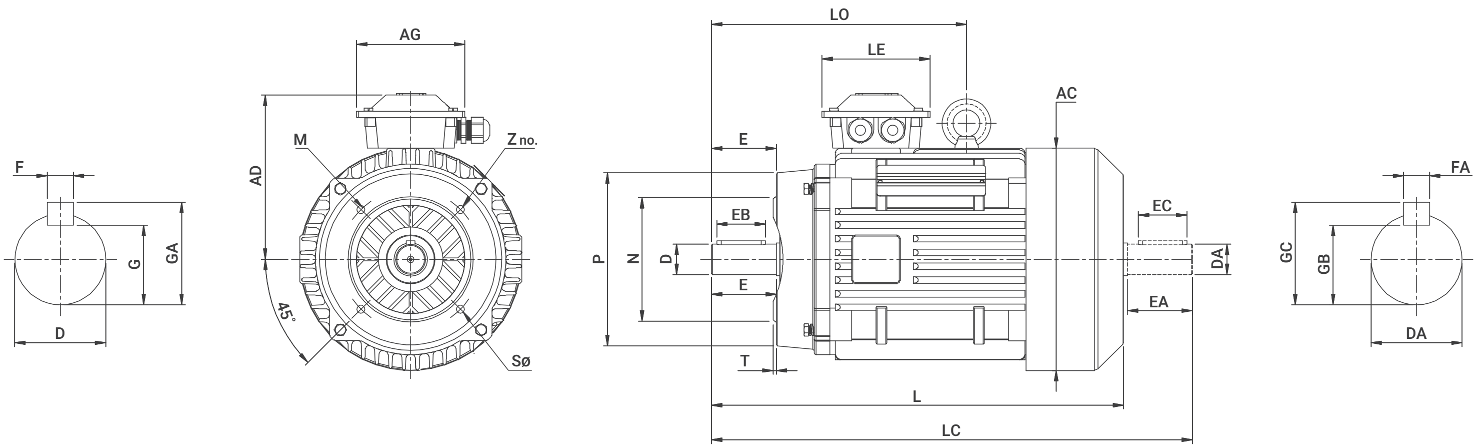
Dimension Chart B3

Type & Frame	A	B	C	L	K	LC	LO	H	HC	HD	HA	AC	AA	AB	BB	LE	AG	DRIVE END						NON DRIVE END					
																		D	E	EB	F	G	GA	DA	EA	EC	FA	GB	GC
AN71	112	90	45	240	7	275	-	71	135	175	8	135	32	135	115	90	90	14	30	25	5	11	16	14	30	25	5	11	16
AN80	125	100	50	280	10	325	-	80	165	205	9	155	32	150	125	90	90	19	40	35	6	15.5	21.5	19	40	35	6	15.5	21.5
AN90S	140	100	56	300	10	355	-	90	185	235	10	175	35	170	125	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN90L	140	125	56	325	10	380	-	90	185	235	10	175	35	170	150	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN100L	160	140	63	360	12	425	220	100	205	257	15	205	45	200	176	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN112M	190	140	70	390	12	455	215	112	224	276	15	230	46	235	180	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN132S	216	140	89	465	12	350	320	132	270	335	16	260	45	255	176	110	110	38	80	75	10	33	41	38	80	75	10	33	41
AN132M	216	178	89	506	12	590	320	132	270	335	16	260	45	255	215	110	110	38	80	75	10	33	41	38	80	75	10	33	41
AN160M	254	210	108	565	15	685	335	160	325	380	20	305	60	305	250	110	110	42	110	100	12	37	45	42	110	100	12	37	45
AN160L	254	254	108	610	15	730	335	160	325	380	20	305	60	305	295	110	110	42	110	100	12	37	45	42	110	100	12	37	45
AN180M	279	241	121	647	15	761	385	180	350	410	28	340	75	400	300	125	125	48	110	100	14	42.5	51.5	48	110	100	14	42.5	51.5
AN180L	279	279	121	685	15	800	385	180	350	410	28	340	75	400	340	125	125	48	110	100	14	42.5	51.5	48	110	100	14	42.5	51.5
AN200L	318	305	133	745	19	860	420	200	415	475	30	400	80	440	385	125	125	55	110	100	16	49	59	55	110	100	16	49	59



Dimension Chart B5

Type & Frame	P	M PCD	N ø	øS	ZNO	T	LA	LO	L	LC	AD	AC	LE	AG	DRIVE END						NON DRIVE END					
															D	E	EB	F	G	GA	DA	EA	EC	FA	GB	GC
AN71	160	130	110	10	4	3	9	-	250	285	110	135	90	90	14	30	25	5	11	16	14	30	25	5	11	16
AN80	200	165	130	12	4	3	10	-	290	335	130	155	90	90	19	40	35	6	15.5	21.5	19	40	35	6	15.5	21.5
AN90S	200	165	130	12	4	3	10	-	310	365	135	175	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN90L	200	165	130	12	4	3	10	-	335	390	135	175	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN100L	250	215	180	15	4	3.5	12	230	370	435	155	205	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN112M	250	215	180	15	4	3.5	12	250	400	465	165	230	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN132S	300	265	230	15	4	4	13	330	475	560	185	260	110	110	38	80	75	10	33	41	38	80	75	10	33	41
AN132M	300	265	230	15	4	4	13	330	510	595	185	260	110	110	38	80	75	10	33	41	38	80	75	10	33	41
AN160M	350	300	250	19	4	5	14	350	580	700	215	305	110	110	42	110	100	12	37	45	42	110	100	12	37	45
AN160L	350	300	250	19	4	5	14	350	625	745	215	305	110	110	42	110	100	12	37	45	42	110	100	12	37	45
AN180M	350	300	250	19	4	5	14	400	662	776	235	340	125	125	48	110	100	14	42.5	51.5	48	110	100	14	42.5	51.5
AN180L	350	300	250	19	4	5	14	400	700	815	235	340	125	125	48	110	100	14	42.5	51.5	48	110	100	14	42.5	51.5
AN200L	400	350	300	19	4	5	15	435	760	875	280	400	125	125	55	110	100	16	49	59	55	110	100	16	49	59



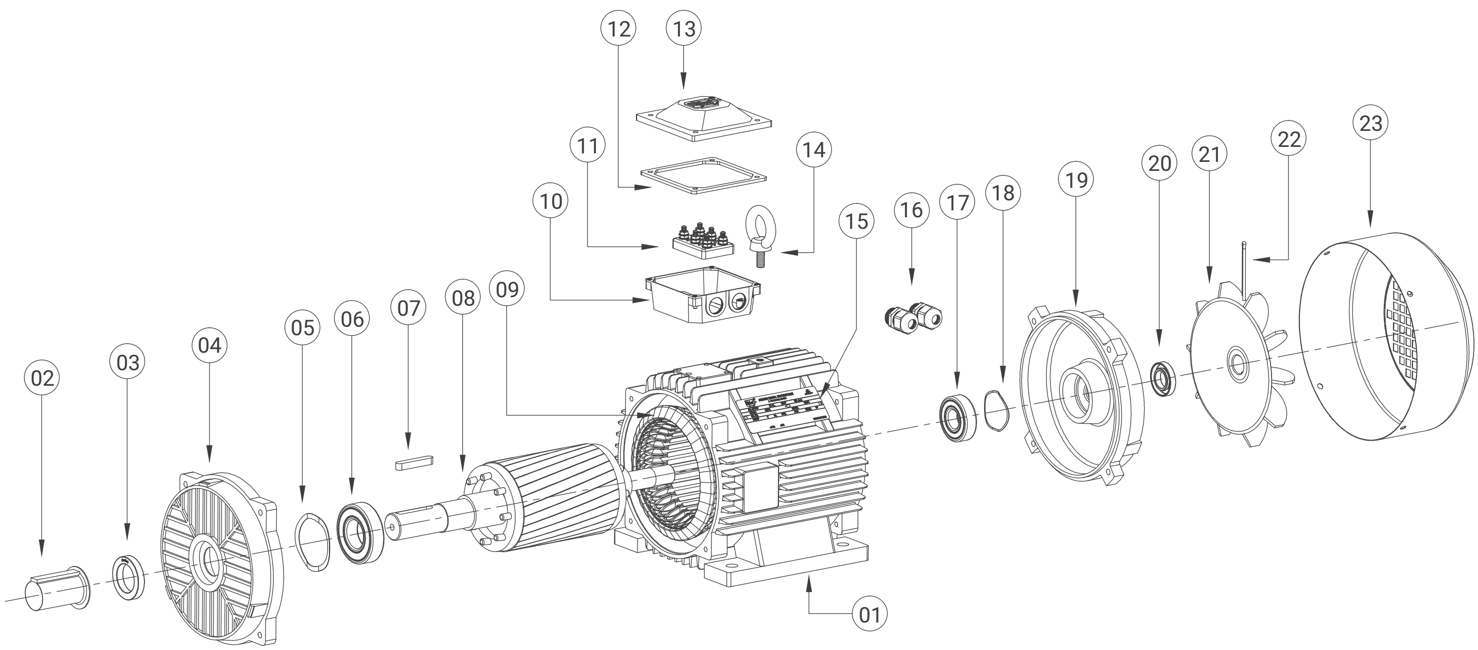
Dimension Chart B14

Type & Frame	P	M PCD	N ø	øS	ZNO	T	L	LC	LO	AD	AC	LE	AG	DRIVE END						NON DRIVE END					
														D	E	EB	F	G	GA	DA	EA	EC	FA	GB	GC
AN71	105	85	70	M6	4	3	255	290	-	110	135	90	90	14	30	25	5	11	16	14	30	25	5	11	16
AN80	120	100	80	M6	4	3	295	340	-	130	155	90	90	19	40	35	6	15.5	21.5	19	40	35	6	15.5	21.5
AN90S	140	115	95	M8	4	3	315	370	-	135	175	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN90L	140	115	95	M8	4	3	340	395	-	135	175	100	100	24	50	45	8	20	27	24	50	45	8	20	27
AN100L	160	130	110	M8	4	3.5	375	440	235	155	205	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN112M	160	130	110	M8	4	3.5	405	470	230	165	230	100	100	28	60	45	8	24	31	28	60	45	8	24	31
AN132S	200	165	130	M12	4	3.5	480	365	335	185	260	110	110	38	80	75	10	33	41	38	80	75	10	33	41
AN132M	200	165	130	M12	4	3.5	521	605	335	185	260	110	110	38	80	75	10	33	41	38	80	75	10	33	41

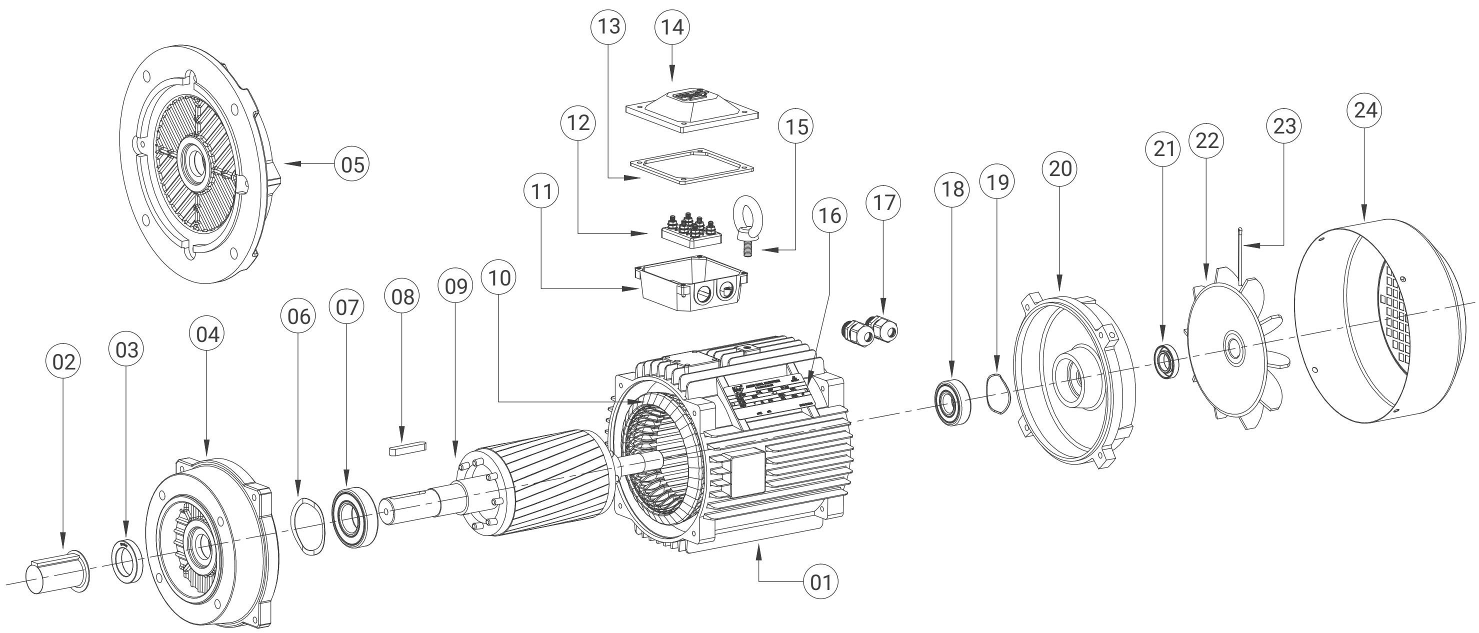
Packing & Shipping Dimensions

Frame Size	Body	Length (mm)	Breadth (mm)	Height (mm)	Gross weight (Kg.)	Type of Packing
63	Aluminium	260	170	200	8	Carton
71	Cast Iron	320	230	210	13	Carton
71	Aluminium	310	210	200	9	Carton
80	Cast Iron	370	270	230	21	Carton
80	Aluminium	350	270	220	12.5	Carton
90S	Cast Iron	360	290	240	26	Carton
90L	Cast Iron	390	300	240	28	Carton
90L	Aluminium	380	290	240	17.5	Carton
100L	Cast Iron	430	330	320	45	Carton
100L	Cast Iron	420	340	280	28	Carton
112M	Cast Iron	470	350	340	61	Wooden
132S	Cast Iron	540	390	400	85	Wooden
132L	Cast Iron	560	400	400	98	Wooden
160M	Cast Iron	630	500	400	148	Wooden
160L	Cast Iron	670	500	400	186	Wooden
180M	Cast Iron	700	550	500	200	Wooden
180L	Cast Iron	780	550	500	230	Wooden
200L	Cast Iron	800	560	600	270	Wooden

Exploded View & Parts Identification



1) Motor Body B3
2) Shaft Cap
3) DE Oil Seal
4) DE End Shield
5) DE Wave Washer
6) DE Bearing
7) Key
8) Shaft with Rotor
9) Wound Stator
10) Connection Box
11) Terminal
12) Rubber Gasket
13) Terminal Box Cover
14) Eye Bolt
15) Name Plate
16) Cable Gland
17) NDE Bearing
18) NDE Wave Washer
19) NDE End Shield
20) NDE Oil Seal
21) Cooling Fan
22) Cotter Pin
23) Fan Cover



1) Motor Body B5
2) Shaft Cap
3) DE Oil Seal
4) Face Mount End Shield
5) Flange Mount End Shield
6) DE Wave Washer
7) DE Bearing
8) Key
9) Shaft with Rotor
10) Wound Stator
11) Connection Box
12) Terminal
13) Rubber Gasket
14) Terminal Box Cover
15) Eye Bolt
16) Name Plate
17) Cable Gland
18) NDE Bearing
19) NDE Wave Washer
20) NDE End Shield
21) NDE Oil Seal
22) Cooling Fan
23) Cotter Pin
24) Fan Cover

Information Necessary for Ordering or Inquiring

Appropriate information is very important when a motor is ordered and it makes both purchasers and manufacturer's work much easier, faster and accurate. A Simple list of mandatory and non mandatory parameters to be mentioned while inquiring or ordering an Amber motor is as follows:

Information required	Mandatory	Non Mandatory
Rated output (KW/HP)	✓	
Phase	✓	
Rated Speed (RPM)	✓	
Insulation Class	✓	
Mounting	✓	
Body of Motor (Aluminium, Cast Iron or any other)	✓	
Application	✓	
Degree of Protection		✓
Duty Cycle	✓	
Method of Starting		✓
Torque		✓
Amb. Temperature & Altitude	✓	
Dimensions if non – standard	✓	
Operating Voltage & Frequency	✓	
VFD Application	✓	
Direction of Rotation		✓
Quantity	✓	
Overload & Earthing protections available		✓
Additional Accessories like thermal protection, power cables, etc required	✓	

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