GENERAL INSTRUCTIONS

CAGE INDUCTION MOTORS
TOTALLY ENCLOSED

GENERAL-PURPOSE INDUSTRIAL USE

GAMAK

IEC Frame sizes
56...355

C O N T E N T S

GENERAL

These instructions deal with TOTALLY-ENCLOSED, LOW-VOLTAGE CAGE INDUCTION MOTORS complying with the recommendations of IEC standards.

The motors are generally designed for continuous running duty (S1) at cooling-air temperatures in the range of -20 ^{0}C ... +40 ^{0}C and at site altitudes not exceeding 1000m above sea-level.

The standard range of motors have a Degree of Protection to IP 55 (IEC 34-5). Motors above this requirement can be supplied on request. The IP reference is indicated on the name-plate.

The construction and mounting arrangements of motors are as per DIN IEC 34-7 and are listed in our catalogue. Again the designation is indicated on the name plate.

During the installation of Electric Motors in heavy industrial applications there is a danger of live electrical parts and rotatino shafts. Therefore, to prevent injury and/or damage the basic planning work for installation, transport, assembly, commissioning etc... needs to be done and checked by authorized and competent personnel only.

Since these instructions cannot cover every eventuality of installation, operation and maintenance, the following points should however be considered and checked.

- The technical data and information on permissible use such as assembly, connection, ambiend and operating conditions given in the related catalogue, operating instructions, name-plate and other production documentation
- The general erection and safety regulations.
- The local and plant-particulars relative to specifications/requirements.
- The proper use of transport, lifting devices and tools.
- The use of personal protective equipment.

When a motor is used in a non-industrial area, additional on site protective measures have to be provided.

TRANSPORT

Frame size 132 has two integrally cast eyebolts. Frame sizes 160 ... 355 are provided with a lifting eyebolt.

Individual Motors should only be lifted by the eye-bolt provided. The lifting gear used must have the carrying capacity of the motor weight (please refer to catalogue). When transporting a machine set with a base plate, do NOT lift the set by the eye-bolt provided on the motor. The eye bolt on the base plate should be the ones used.

Motors with cylindrical roller bearings or angular contact ball bearings are protected against bearing damage during transport by means of a locking device which has to be removed before putting the motor into operation.

The vertical mounting type motors with single angular contact ball bearings should be transported in the vertical position.

STORAGE

Motors must be kept in a dry and vibration free, clean, well-ventilated room if they have to be stored for a long period. The insulation resistance must be checked and the windings must be dried if necessary before the motors are taken into operation (Please refer to maintenance section).

GENERAL

VENTILATION / COOLING

Motors of frame size 56 have no cooling-fan (IC 410, DIN IEC 34-6).

Motors of frame sizes 63 ... 355 are surface cooled by means of an external radial flow cooling-fan (IC 411, DIN IEC 34-6) which is protected by a steel cowl with standard test-finger proof openings for sufficient air-flow. The cooling-fan is fixed onto the non-drive end of the motor shaft and ventilated the motor irrespective of rotation. The cooling-fans are injection mould high grade polyamide. The plastic fans have two integrally moulded tongues which engage with the circumferential groove of the shaft to provide axial fixing. Fans are positively fixed radially by means of key which is also integrally moulded.

To dismantle the fans, the tongues must be disengaged and held in the open position by means of inserted shim plates. Always use the appropriate tools for fitting or removing fans.

The distance between air intake and wall or other machinery must be at least $d^{\varnothing}/4$ of the air intake opening. The warm exhaust air leaving the motor must not be drawn in again. The air-inlet opening at the top of vertical motors should be protected by a canopy to prevent the ingress of water and foreign bodies.

The air openings of the fan-cover should be cleaned regularly (where necessary) by blowing oil-free compressed air outward away from the motor.

WATER DRAIN HOLES

The water drain holes, closed off with plugs when provided, must be at the lowest point of the enclosure depending on the type of construction and mounting arrangement of motor and kept clean. When these plugs are removed, the degree of protection will be reduced nominally to IP44.

RADIO INTERFERENCE AND SUPPRESSION

The motors meet the requirements of grade G to VDE 0875 which is sufficient for industrial applications. If, for use in residential areas, interference grades N (normal) or K (low) are specified, it is recommended to carry out interference measurements locally and to install adequate suppression equipment.

ADDITIONAL FEATURES OR ATTACHMENTS

Various features or attachments such as:

* Increased degree of protection
* Tropic proof
* Special paints (Weather protective - Arduous conditions)
* PTC Thermistors
* Thermostats
* Anti-condensation heaters
* Bearing temperature thermocouples
* Canopy
* Electro-mechanical brakes

may be provided if ordered.

INSTALLATION AND OPERATION

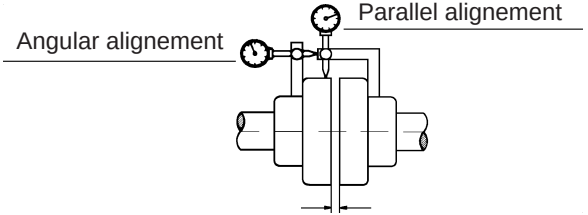
MOUNTING

The motors should always be mounted on a plane, vibration-free base. All motor feet must rest positively on their entire surface.

⚠ Temperatures up to and exceeding 100^{O}C may arise under unfavourable operating conditions on the frame parts so that touching should be prevented or avoided. Temperature sensitive parts such as normal cables or electronic components should not be in contact with or mounted to these hot parts.

ALIGNEMENT

⚠ Motors must always be accurately aligned, and this applies especially where they are directly coupled. incorrect alignment can lead to bearing failure, vibration and even shaft fracture. As soon as bearing failure or vibration is detected, the alignment should be checked.



When the motor is coupled to the driven machine, the shafts must be aligned both radially and axially to each other by means of dial gauges. Measurements to be taken at 4 points displaced by 90^{O} each while both coupling halves are turned simultaneously.

⚠ It is further recommended to re-check the alignement at the thermal equilibrium temperature of the machines.

TRANSMISSION COUPLINGS AND PULLEYS (SHAFT FITMENTS)

The permissible mechanical forces given in the catalogue should not be exceeded when using Shaft Fitments which exert radial or axial shaft loads during operation. Flexible couplings only should be used as the rigid couplings will necessitate a special bearing design.

⚠ Shaft Fitments should be fitted and removed only by means of suitable devices. The bearings must by no means be subjected to any pressure or shock. Statistics show that some 70% of motor faults are due to bearing defects, and many of these can be traced back to mistreatment during the mounting of a coupling or pulley.

If a belt drive is used, install the motor on slide-rails to permit the correct belt tension to be adjusted. With belt drive, the shafts must be parallel, the pulleys must be in line and the lower part of the belt must be pulling.

Please refer to catalogue for selection of SLIDE-RAILS and BELT-PULLEYS.

Excessive belt tension may cause damage to shaft and bearings.

BALANCING

All standard motors manufactured from the January 1st 1997 have Shaft and Rotor assemblies dynamically balanced with HALF SHAFT KEY to the limits of Normal Mechanical Vibration class quoted in DIN ISO 2373. The face of the Drive End Shaft will be marked with the letter “H” for a period of two years. However, due to size of the shaft on 71 frame and below, it is not practical to mark the letter “H” and therefore the face of the Drive End Shaft will be colour coded with an orange paint.

Shaft Fitments must be balanced likewise to prevent undue vibration and adverse effects on bearing life.

Motors produced before January 1st 1997 have Shaft and Rotor assemblies with FULL-KEY balance and do not have the above described identification.

⚠ The keys fitted to the shaft extensions are hold by plastic tape only to prevent them falling out during transportation or handling. The shaft key should be secured against flying out, when the motor is operated prior to the couplings etc ... being fitted to the shaft extension.

INSULATION RESISTANCE

New or newly rewound motors normally have very good insulation resistance, but unfavourable transport, storage or standstill conditions may lower the insulation resistance to an undesirable low level due to dampness and/or dirt.

Before an electric motor is commissioned for the first time or after a long storage/standstill period, the insulation resistance of each phase to the earth should be measured with 500 Volt DC for 1 minute max. until the final resistance value is indicated.

During and immediately after measuring, the terminals must not be touched as they may carry residual dangerous voltages. Furthermore, if power cables are connected, make sure that the main supply is clearly disconnected. This applies both to the main and auxiliary circuits and particularly to the anti-condensation heating circuits.

Although the limit value for a minimum insulation resistance can not be stated, the following table may serve as a guide for measurement at a winding temperature of 25^{o}C.

	Limit values at rated voltage < 2kV
Measuring voltage	500 V, DC
Min. insulation resistance of new, cleaned or repaired windings	10 MΩ
Critical specific insulation resistance after long periods of operation	0.5 MΩ/kV

Dry windings ar new have insulation resistance values much higher than the above given limits of 10MΩ. If the insulation resistance value is around or below the minimum value, severe damp and/or dirt in the winding may be suspected. The motor must not be allowed to be aperated until appropriate precautions are taken. The first step is to clean and dry the surfaces of the insulating parts, leads and board terminals. If the re-measured insulation resistance is still low, the windings are probably damp and they must be dried by applying heat which must not exceed 80^{o}C and the temperature rise should not exceed 5K per hour during heating. Drying can be done by means of space or any other heater or by applying a low voltage of 5 ... 10% of motor rated voltage and a current of 20 ... 30% of motor rated current to the stator terminals U1 and V1 via an auto-transformer. The rotor must be removed when an AC is used. Always make sure that the ventilation is good enough to allow the moisture to be well dispersed. After the windings are cleaned/dried, the insulation resistance should only be measured when the winding is cooled down to room temperature of about 25^{o}C as the insulation resistance of warm windings is lower.

INSTALLATION AND OPERATION

TERMINAL-BOX

All the terminal boxes comply with the degree of protection to IP 55, and are placed to the front and on top of motor frames, allowing an easy cable entry from both sides. In the basic design, the motors have six fixed terminals, and are fitted with an earthing-screw inside the terminal-box. A connection diagram is provided in the cover of each terminal box. The supply-cable conductors must be connected in accordance with the connection diagram. Always ensure that the power supply matches with the name-plate data. The cross-section of a supply cable should be selected as required on the basis of rated current and plant specific conditions. Connection of the supply cables must be secured with special care to ensure a permanent and reliable contact. Locknuts are provided on terminal pins in order that connections remain permanently tight (Loose connections can cause excessive heat and lead to motor failures). All cable suppüorts have to be mounted properly to prevent sagging or twisting of the supply cable. Unused entry openings should be closed off firmly by plugs. Check all sealings and surfaces are fitted correctly and are in perfect condition. Replace if damaged.

TERMINAL CONNECTIONS AND STARTING

Number of poles	Outputs ranges in kW at the rated voltage 380V, 50Hz or 400V, 50 Hz 220V (Δ) / 380V Y 220-240V (Δ) / 380-415V Y	 380V (Δ) 380-415V (Δ)
2 and 4	≤ 3 kW	≥ 4 kW
6	≤ 2.2 kW	≥ 3 kW
8	≤ 1.5 kW	≥ 2.2 kW
Methods of starting	Direct-on-line	Direct-on-line Y / Δ or others

Direct on line starting:

The simplest way to start a cage induction motor is to connect the mains supply to the motor directly. The only starting equipment required is a direct-on-line starter. Although this is the most preferred method, due to high starting current the limitations and regulations of the Electricity Board should be considered.

Star/Delta (Y / Δ) Starting:

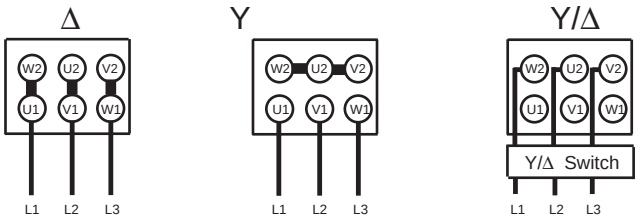
If the starting current of the motor is bigger than the limit of power supply a Y / Δ starting can be used. A motor wound 380 or 400V (Δ) is started with the winding Y connected. This method reduces the starting current and torque to about 1/3 of the value for direct starting. In order to limit current and torque surges during switchover from Y to Δ , switchover should be carried-out when the motor reaches as close as possible (93...95%) to its rated speed.

Soft Starting:

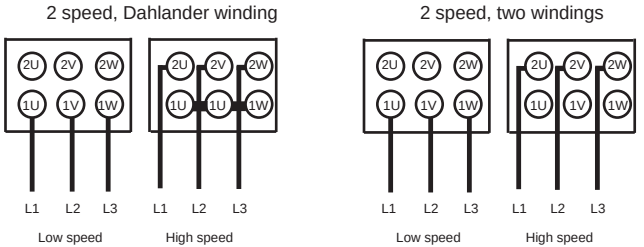
On occasion some motors need to be started smoothly and where the starting current is not so important, a suitable soft-starter may be used. A soft-starter permits the starting time to be set for a smooth start and the operation of motor to be monitored continuously so that the voltage can be adjusted according to the demand, which minimize the losses. However, the torque characteristic of the motor must conform to the requirements of the dirven machine, when a soft-starter is used.

INSTALLATION AND OPERATION

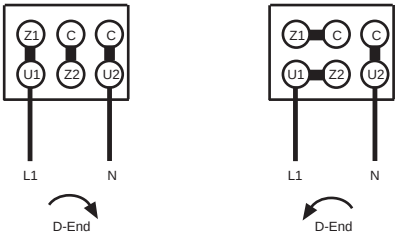
3-Phase, Single speed



3-Phase, Multi speed



Single-phase, Single speed



DIRECTION OF ROTATION

All motors are suitable to be operated in both directions of rotation.

When viewed from the Drive-End, the motor will rotate clockwise if the power supply phase conductors: L1, L2, L3 are connected to terminals U1, V1, W1. If the connections to any two terminals are reversed, the motor will rotate anticlockwise.

Check the direction of rotation, by switching quickly ON/OFF prior to coupling the motor.

MOTOR PROTECTION

The terminal protection of the stator windings should be chosen as an optimum in respect of the operating conditions. Apart from the use of circuit-breakers with thermally delayed (bi-metal release) over-current protection, motors can also be thermally protected against over-loads by means of thermistors (semiconductor temperature sensors) of thermostant (bi-metal switches) embedded in the winding. Thermal motor protection provides a higher degree of protection because the temperature is controlled in the winding which is the most critical point and independent of outside influences or type of duty, etc...

Fuses alone, normally protect only the system, but not the motor.

COMMISSIONING

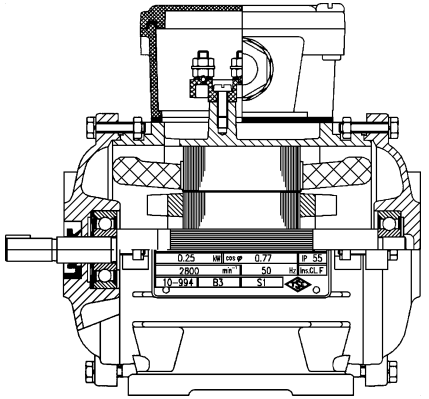
The following checks/tests should be performed after installation:

- Insulation and operating conditions comply with the name-plate data.
- Machine correctly installed and aligned.
- Shaft Fitments properly fitted.
- Insulation resistance to be satisfactory.
- Direction of rotation.
- Cooling air-flow not obstructed.
- Ensure rotor rotates freely.
- Ensure all fastening elements and electrical connections are tight.
- Earthing connections properly made.
- Proper lubrication of bearings.
- Additional attachments are fitted, properly connected, and serviceable.
- All protective precautions against contact with moving or live parts, are taken.
- Any built-on brake properly fitted connected and serviceable.
- Start up the motor at no-load until full speed is reached.
- Noises and vibrations at the bearings/endshields.
- Disconnect the motor if it does not run smoothly or any unusual noises are experienced. Determine the cause of defect as it decelerates, during which if the defect is eliminated, the cause will be of a magnetic or electrical nature. Otherwise, the cause is mechanical.
- Motor is loaded at its rated output, if it performs satisfactorily. Observe the running smoothness, and record the supply voltage as well as performance data of motor.
- The temperature of winding, bearing etc... until the thermal equilibrium is reached.
- To shut down the motor, switch-off the circuit breaker and let to come to rest without braking and switch-on the anti-condensation heater, if equipped.

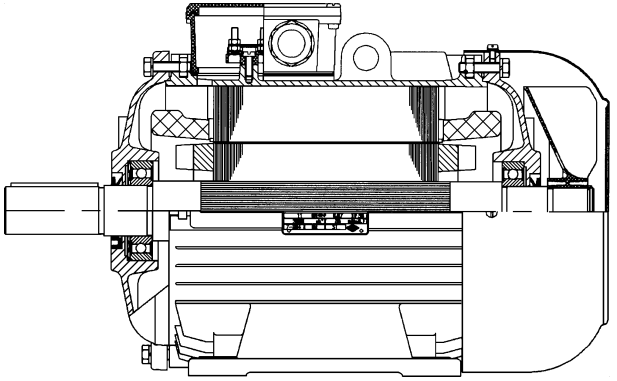
To avoid any damage or injury, when the thermal protection system responds during the cooling down of the drive unit, temperature sensors should be connected and controlled in such a way that any unexpected automatic restarting of the motor is prevented.

The above check list cannot cover every possible eventuality or commissioning. Therefore, further measures may have to be taken by the installation/ commissioning engineer that recognizes the particular plant/site conditions and associoted supplementary instructions.

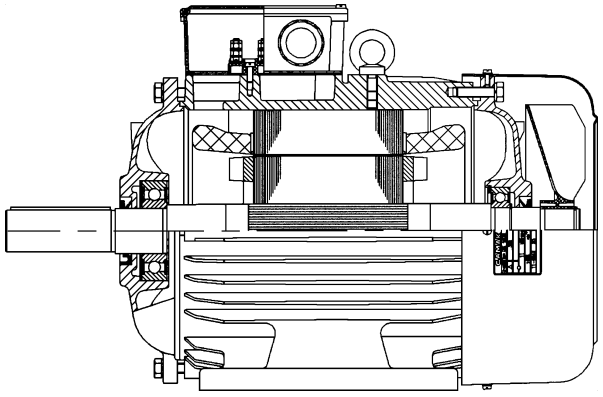
GENERAL DESIGN OF TOTALLY ENCLOSED CAGE INDUCTION MOTORS



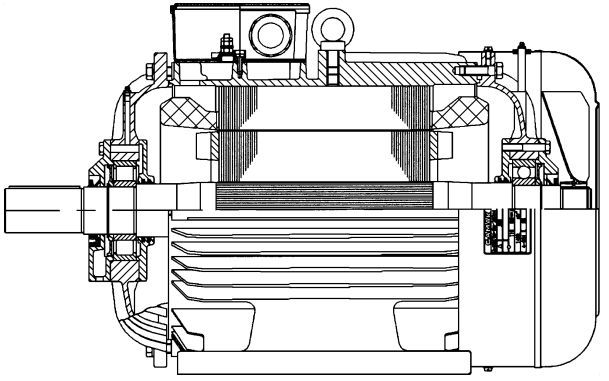
Frame size 56 D-End: Floating Ball Bearing (Spring-loaded)
N-End: Floating Ball-Bearing



Frame size 63...132 D-End: Floating Ball Bearing (Spring-loaded)
N-End: Floating Ball-Bearing



Frame size 160...280/2 D-End: Floating Ball Bearing (Spring-loaded)
N-End: Fixed Ball-Bearing



Frame size 280/4-6-8...355 D-End: Roller Bearing
N-End: Fixed Ball-Bearing

MAINTENANCE

BEARINGS

Motors of frame size 56...280/2 have double shielded ball-bearings which are factory greased and sealed for life. In the unlikely event of a bearing of this type, being faulty, the bearing needs to be replaced. It cannot be regreased.

Motors of frame size 280/4-6-8...355 have open type bearings and are equipped with greasing nipples for re-lubrication during operation.

In request, motors of frame size 160...280/2 may also be supplied with open type ball or roller bearings and greasing nipples.

Initally, grease type of SHELL ALVANIA R3 is used for lubrication during assembly of motors.

The type/size of bearings for motor sizes and the permissible mechanical forces are listed in the catalogue.

RELUBRICATION OF MOTORS EQUIPPED WITH GREASING NIPPLES

These motors are fitted with a lubrication plate indicating the type of grease, quantity and lubricating interval.

The relubrication intervals given in the table below apply for normal continuous conditions i.e. operation at the rated load/speed, vibration free running, coupling operation, temperature of cooling medium 40ºC and use of high grade rolling contact bearing greases of the following selection table.

K3K GREASES	K3N GREASES (Higher temp.)
BP/ENERGREASE LS3	SHELL/ALVANIA G3
MOBIL/MOBILUX 3	SHELL/ALVANIA R3
ARAL/ARALUB HL3	ARAL/ARALUB 4340
ELF/ROLEXA 3	ESSO/BEACON/3

The regreasing intervals given below refer to a bearing temperature of 70ºC. In case of increased thermal load e.g. belt drive, these intervals are reduced, and in case of reduced thermal load e.g. lower ambient temperature, they are extended.

As an approach, the regreasing interval is halved or doubled respectively if the bearing temperature is increased or reduced by 15K. However, irrespective of the operation hours, the grease should be changed after 3 years of operation at the latest due to againg. For recharging with grease, the motor should be dismantled to the necessary extent, the bearings thoroughly cleaned or replaced and charged with new grease. Fill the hollow spaces of the bearings with grease, flush with the outside faces. To avoid excessive grease in bearing assemblies, bearing caps should not be charged with grease.

The grease recommended, have lithium soap as thickener and mineral oil as the basic oil which contains oxidation and corrosion inhibitors. (Antifriction bearing greases K3N DIN 51 825).

The amount of grease to be filled in the bearing should be around 1/3 of its internal volume. Rule of thumb, the inner diameter of the bearing in mm corresponds to the minimum amount of grease to be used in gram.

In general, different brands/types of grease must not be mixed. Mixing grease with different type of thickeners may destroy its composition and physical properties. Even if the thickeners are of the same type, possible differences in the additive may cause detrimental effects.

To allow the new grease to be evenly distributed inside the bearing, the bearings need to be regreased whilst the motor is running. Initially the bearing temperature will rise significantly and then will drop to its normal value after the excess grease has been displaced from the bearing.

Relubrication intervals in operating hours of motors equipped with greasing nipples

	Frame size			
No. of pole	160-180	200-225	250-280	315-355
2	5.000	4.000	3.000	3.000
4	10.000	8.000	6.000	3.000
≥ 6	15.000	12.000	9.000	5.000

- All above values are for 50Hz. They must be reduced by 20% for 60Hz.

MAINTENANCE

BEARING REPLACEMENT

Remove ball-bearings by means of an extraction device after slightly heating the inner ring. Never use a hammer. The inner ring of cylindrical roller bearings should be heated quickly by means of a torch and be levered-off by a screw driver. If after taking this action it still does not come off, grind a V-shaped groove into the inner ring and break it. Before installing the bearings, make sure that the shaft mounted parts inside the bearings are in place before installation. Use extreme care and ensure clean conditions during installation and assemly. Heat the ball-bearings or the inner ring of the roller bearings in oil or air to a temperature of approx. 80ºC and slip them onto the shaft. Heavy blows will damage the bearings and must definitely be avoided. Fill the bearings with the grease previously specified.

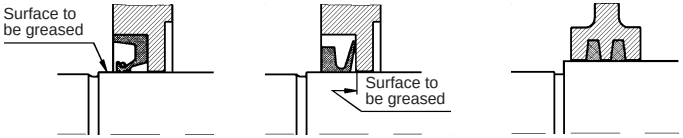
When installing single angular contact ball bearings, make sure that the broad shoulder of the inner ring and the narrow shoulder of the outer ring in operating position points at the direction opposite to that of the axial thrust.

Care must be taken during assemly to see that the sealing rings are fitted properly.

BEARING SEALS

Before new felt sealing rings are installed into the bearing caps, they must first be impregnated in 80ºC hot high-viscosity lubricating oil to DIN 51 517-C100. The rings should be so dimensioned that shaft slides easily in, yet is also well enclosed by them.

V-ring dust seals and radial shaft seals (Oil-seals) are pushed into place by means of an appropriate assembly tool. Contact faces of both sealings should be slightly greased. The correct axial position of V-ring dust sealings has to be attained to prevent damage due to excessive friction.



OIL-SEALS V-RING FELT SEALING

FAULTS, POSSIBLE CAUSES, REMEDIES

MECHANICAL FAULTS							POSSIBLE CAUSES	REMEDIES
Bearing overheats	Bearing screaches	Bearing knocks	Rubbing noise	Excessive temperature	Radial oscillation	Axial oscillation		
■							Bearing overgreased	Remove grease excess
■							Bearing dirty	Clean or replace, inspect sealings
■							Felt sealing rings pressing on shaft	Install felt rings better into their grooves, or replace
■							Excessive belt tension	Reduce belt tension
■							Coupling misaligned	Improve alignement
■							Ambient temperature > 40^{o}C	Use special grease for high temperature
■	■						Insufficient lubrication	Lubricate according to instructions
■	■						Bearing clearance too small	***** Replace bearing having higher clearance
■	■						Bearing corroded	Replace bearing, inspect sealings
■	■	■					Bearing tilted	Check mounting conditions. Install outer ring with loose fit.
		■					Bearing clearance excessive	***** Replace bearing having smaller clearance
		■					Foreign bodies in bearing	Clean or replace
		■					Scratches/scores on bearing raceway	Replace bearing. Avoid vibration when motor is at rest.
			■				Rotating parts rubbing	Eliminate its cause by realining.
				■			Insufficient cooling	Inspect openings of fan cover motor surface and fan if required
					■		Rotor unbalance	Rebaiance the rotor of the motor
					■		Wobbling rotor due to distorted shaft	Consult manufacturer
					■		Shaft fitments out of balance	Rebalance the coupled shaft fitments
					■	■	Incorrect alignement	Accurately realign motor/driven machine at thermal equilibrium
					■	■	Mismatched transmission, e.g. gearing	Check and eliminate its cause
					■	■	Unstable mounting substructure Check and eliminate its cause	
						■	Impulses from coupled driven machine	Check and eliminate its cause

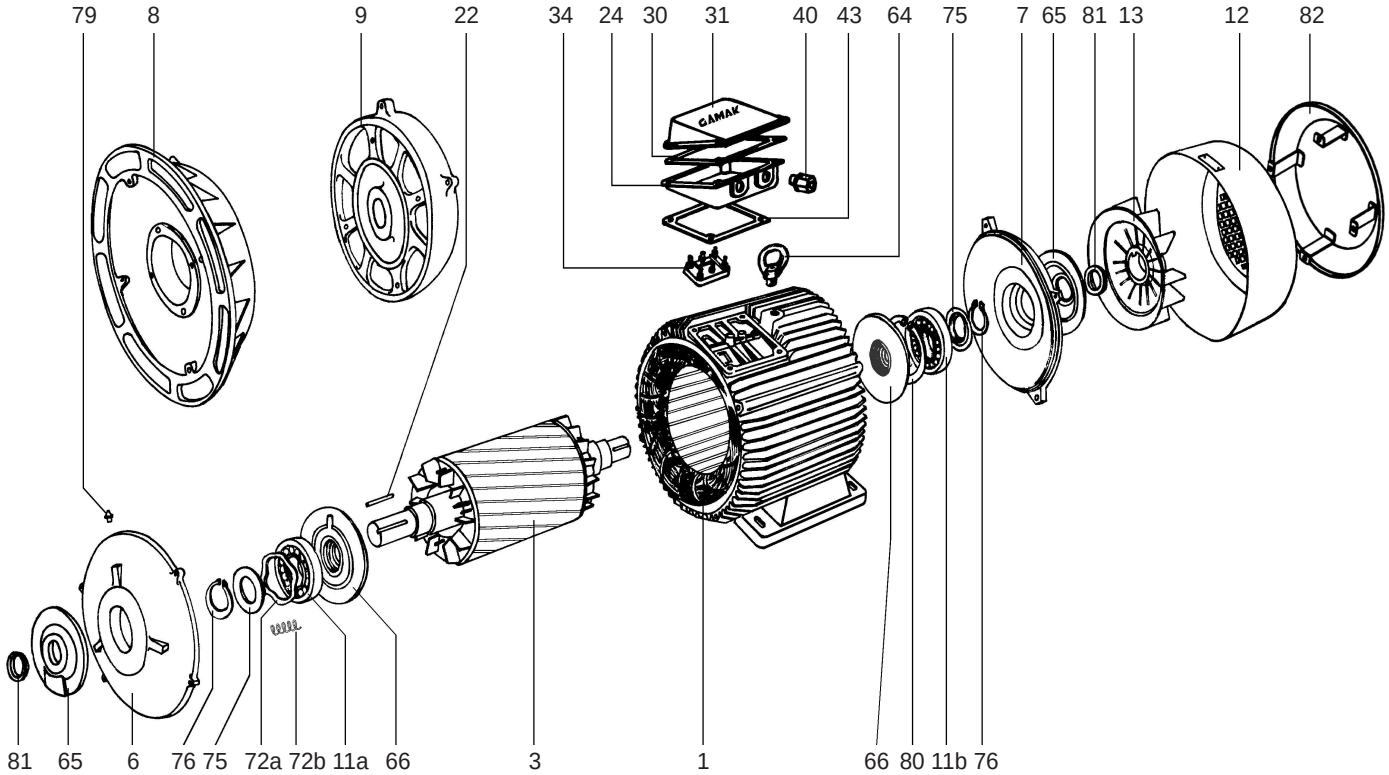
Bearing damage is ofter difficult to detect. When in doubt, replace the bearing

***** Consult manufacturer

FAULTS, POSSIBLE CAUSES, REMEDIES

ELECTRICAL FAULTS										POSSIBLE CAUSES	REMEDIES
Motor fails to start	Motor accelerates reluctantly	Humming noise during start-up	Humming noise during operation	Humming noise in rythm of double-slip freq.	Excessive temperature at no-load running	Excessive temperature at full-load running	Individual winding sections overheat	Speed drops under load	Protective device trips		
■	■		■			■		■	■	Overload	Reduce load or select a higher output motor
■						■		■		Excessive starting and/or pull-up torque	Reduce torque or use a motor with higher starting performance
■	■							■		Low supply voltage, high frequency	Correct supply conditions
					■	■				High supply voltage, low frequency	Correct supply conditions
■	■	■	■			■		■	■	Phase failure	Check switchgear and supply circuits
■	■	■	■				■	■	■	Wrong connection of stator windings	Check winding connections
	■	■	■				■		■	Interturn or phase short circuit in stator winding	Check winding and insulation resistance. Consult manufacturer
■				■						Poor cage-winding connection	Consult manufacturer
						■				Excessive starting frequency	Reduce starting frequency or recalculate motor specification
	■					■			■	Excessive starting time	Provide an easier start or recaculate motor specification
■										Faulty contact in control gear	Renew faulty contacts
■										Capacitor failure	Check capacitor voltage, replace if necessary

SPARES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11a
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80
11b
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SPARES

The spare-parts are fully interchangeable as they are designed and manufactured to fine limits of their dimensional tolerances. Please state motor type, serial number, type of construction/mounting arrangement and, part number with full description when ordering spare parts.

Part No	Description	
1	Stator complete with winding, varnished and fitted in the frame	
3	Rotor complete with shaft, finish machined and balanced (Excluding keys)	
6	End shield Drive-end B3 mounting	
7	End-shield Non Drive-end	
8	D-Flange (Form A)	DIN 42 948
9	C-Face Flange (Form C)	DIN 42 948
11a	Bearing Drive-end (Ball or Roller)	DIN 625 or DIN 5412
11b	Ball-bearing Non Drive-end	DIN 625
12	Fan cover (63 to 355)	
13	Fan (63 to 355)	
22	Shaft key	DIN 6885
24	Terminal-box	
30	Terminal-box to lid gasket	
31	Terminal-box lid	
34	Terminal board complete with terminal links, nuts and washers	DIN 46 294
40	Cable-gland	DIN 46 320
43	Terminal-box to frame gasket	
64	Eye bolt (160 to 355)	DIN 580
65	External bearing cap (motors with greasing nipples)	
66	Internal bearing cap (motors with greasing nipples)	
72a	Corrugated disc spring for preloading ball-bearing (56 to 280)	
72b	Helical compression spring (315 - 355)	
75	Grease retaining disc (motors with greasing nipples)	
76	External circlip for retaining ball-bearing and grease retaining disc on the shaft (At DE, N.DE of motors with greasing nipples, and at N.DE of frames 160 to 280)	DIN 471
79	Greasing nipple (315 and 355 standard, 160 to 280 optional)	DIN 71 412
80	Internal circlip for retaining ball-bearing at Non Drive-end shield (160 to 280)	DIN 472
81	V-Ring (Oil-Seal)	(DIN 3760 Form “A”)
82	Canopy	

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