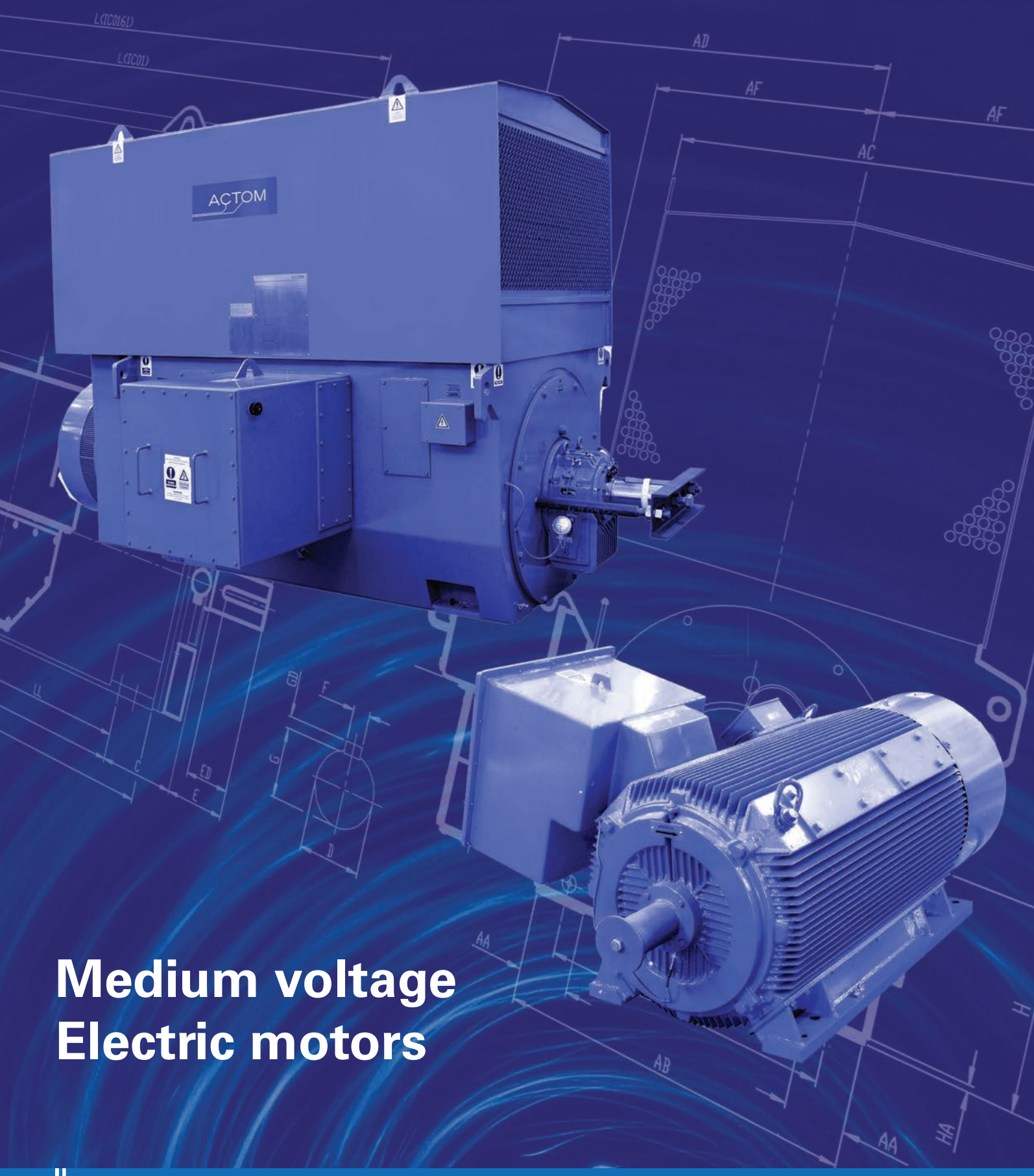


Medium voltage
Electric motors

ACTOM

UNIBOX

MS4 Medium Voltage High Efficiency

ELECTRICAL MACHINES
UNIBOX & MS4

ACTOM

1903
British General Electric Company (GEC), manufacturers of all electrical machinery, supplies and accessories, opened offices in Cape Town.

1908
First power plant supplied by GEC was in Uitenhage, followed by Oudtshoorn, Queenstown and Stellenbosch.

1910
One of the first hydro-electric stations, equipped with GEC plant, was commissioned at Ceres.

1919
British Thompson Houston Company (BTH), suppliers of traction substation equipment and generating sets; and English Electric, suppliers of medium voltage switchgear and transformers, registered their first companies in Cape Town.

1925
British Westinghouse, later Metropolitan Vickers (Metvick), the leader in supplying generating plant, mine winding equipment and electric locomotives set up a subsidiary in South Africa.

1935
Louis Jacobson started Alpha Electrical Company in Johannesburg to recondition electrical machinery. This was renamed First Electric in 1945 with a factory at Knights (site of present head office)

1948
English Electric built its first new factory, outside the UK, in Benoni – now the site for Electrical Machines.

1958
Merger of Metvick and BTH under the Associated Electrical Industries (AEI) banner.

1962
English Electric's new MinEEsub fully tested and ready for the market.

1967–1969
Takeover of AEI by GEC, and subsequent merger with English Electric.

1970–1972
Reorganisation and consolidation of former South African businesses GEC, AEI, English Electric and First Electric into seven factories and six regional offices.

1972
Duvha Power Station order placed with GEC, followed by Tutuka in 1979 and Majuba in 1985. ALSTHOM / MAN secured most of the other six-pack power station orders for turbine generators plus the Koeberg nuclear station.

1978
GEC sold 50% of the equity and management control to Barlow Rand, later unbundled to Reunert Ltd.

1988
Establishment of a vacuum-bottle manufacturing facility at Knights for the supply of MV Switchgear.

1989
The ALSTHOM group; including companies such as MAN Energie, SPRECHER Energie and Cegelec, merged with GEC's power systems businesses. This merger was duplicated in South Africa and the local company gained access to ALSTHOM's technology.

1992
GEC ALSTHOM South Africa and Siemens merged their electric motor manufacturing businesses, and four years later GEC ALSTHOM South Africa gained 100% control.

1994
GEC ALSTHOM purchased Cullinan Power Projects, which allowed the company to expand its transmission, distribution and projects divisions.

1996
GEC ALSTHOM South Africa introduced a comprehensive black economic empowerment (BEE) policy, and began a phased transformation of four key areas: equity, management and skills development, procurement, enterprise development and social responsibility.

1999
GEC ALSTHOM's name changed to ALSTOM and the company listed on the Paris, London and New York stock exchanges. Local group renamed ALSTOM South Africa – in October became a wholly owned subsidiary with the exit of Reunert. ALSTOM South Africa also purchased Conelectric, which further strengthened the group's transmission and distribution division.

2001
ALSTOM South Africa made further key acquisitions to its transmission and distribution portfolio and extended their power division when they acquired Bonar Long, Cutler Hammer, John Thompson Africa and Meissner Power Systems.

2002
For the first time the control shifted to local shareholders. ALSTOM SA (Pty) Ltd was formed, which brought together the technology providers, BEE partners, management and the finance providers.

2004
ALSTOM's global operations sold its transmission and distribution division to AREVA. The local transition saw AREVA taking over half of ALSTOM's equity stake and the technology licensing and distribution agreements.

2008
Investment by new majority shareholders, Actis and Old Mutual, and significant reinvestment by all existing BEE shareholders.

2009
Renewal of co-operation and partnership agreements with partners ALSTOM and AREVA T&D.

Index - Medium Voltage Motor Series

Who is ACTOM

ACTOM (Pty) Ltd currently is the largest manufacturer and distributor of electrical equipment in South Africa, employing about 6 000 people and with an annual order intake in excess of R5bn. ACTOM is a BEE compliant black owned company currently with 33 operating units, 27 production facilities and 28 distribution centres throughout South Africa. Continual organic evolution is seeing ACTOM grow on an annual basis, providing both impressive economy's of scale coupled an ever growing pool of technological products and services.

ACTOM Electrical Machines has it's head office and manufacturing plant located in Benoni South Africa, from where all aspects of design, development and manufacturing operations are conducted.

ACTOM partners Alstom France for environmental equipment and in serving the maintenance, upgrade and retrofit market for larger boilers, as well as for railway transport activities.

ACTOM holds exclusive distribution, technology and representation rights for Alstom Grid (formerly the Transmission business of Areva T&D) in Southern Africa and maintains management, technical and commercial links to Alstom Grid business units in Europe.

Following the acquisition by Schneider Electric of the global Distribution business of Areva T&D, the distribution, technology and representation agreements that existed between ACTOM and Areva will remain in place until such time as a new agreement has been concluded.

ACTOM formerly traded under the name Alstom South Africa and re-branded to ACTOM in September 2009.

UNIBOX SERIES FABRICATED FRAME MV MOTORS

CONCEPT

This heavy duty rugged UNIBOX large frame motor series is designed in Benoni South Africa for applications typically in the Power Station, Mining and heavy industrial market sectors. The design is suitable for both Cage and Slipring Induction motor formats.

FRAME SIZES

The UNIBOX motor series is available in all standard motor shaft heights ranging from 355mm to 1000mm with international standard foot or flange fixing arrangements. Non standard dimensioned products are available on request.

OUTPUTS

UNIBOX output ratings are designed to suit client specific requirements and applications at ratings up to 15MW.

ELECTRICAL SUPPLY

UNIBOX windings are designed as standard for 3,3kV, 6,6kV 11kV and 15kV at 50Hz. Other international voltage supply standards can be accommodated on request.

A large frame 7MW 11kV UNIBOX Slipring Mill motor being crated and prepared for export.

STANDARDS AND SPECIFICATIONS

The UNIBOX motor series is electrically and mechanically designed in accordance to the IEC60034. Every effort is made to accommodate client specific requirements in addition to the standard design logic.

DUTY AND RATING

The most frequent UNIBOX design requirement is for a continuous running duty cycle S1, in accordance with IEC 60034. Other duties can be accommodated to suit special applications. ACTOM engineers are able to advise clients in respect of the correct matching of the machine against intended duty parameters.

STARTING

Cage rotor induction motors are designed to take account of the driven machinery torque and speed characteristics, ensuring that adequate accelerating torque is available, whilst still limiting the starting currents and resultant heat build up in the stator windings. Wound rotor induction motors are designed to provide enhanced starting characteristics off relatively limited supply systems.

A small frame UNIBOX series motor with sleeve bearings and an inlet silencer.

MOUNTING

UNIBOX standard mounting configurations are IM1001, IM1002, IM3001 and IM3801 as defined in IEC60034-7. The frame designs are suitable for either holding down bolts or foundation bolts. Vertical jacking points are provided in close proximity to these fixing points to facilitate easier shimming on installation for alignment.

DIMENSIONS

UNIBOX shaft extensions, frame and foot fixing dimensions are in accordance with the requirements of IEC60072-2. Whilst these are standard build configurations ACTOM is able to build custom frames to suit inter-changeability requirements where replacement of existing dated plant is required.

A IP22 IC01 3MW UNIBOX featuring a top mounted inlet cooling housing and a bottom exit design for the hot air. This design reached a performance efficiency of over 97%.

PROTECTION AND COOLING

The UNIBOX enclosure is designed in accordance with IEC60034-5, to both protect personnel from danger and to protect the machine from harmful ingress of solid matter or water as may be expected or specified in terms of conditions at site.
Cooling methods are defined in accordance with IEC60034-6, with those commonly used being air cooled, water cooled, drip proof, and force ventilated.

VIBRATION

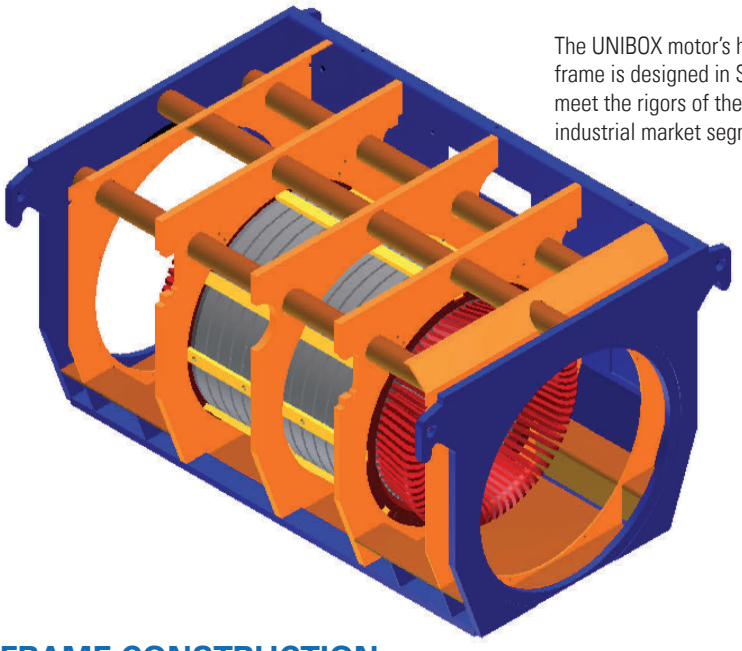
The UNIBOX rigid design and construction, together with the attention given to achieving good dynamic balance characteristics results in achievable vibration levels of grade "B" limiting values given in IEC60034-14.

NOISE LEVELS

UNIBOX noise levels will not exceed the limits given in IEC60034-9. If required, lower levels can be attained by fitting additional silencers.

A super quiet UNIBOX motor designed with inlet and outlet silencers. This design can return noise levels as low as 82db on 2 pole speed machines, and lower on slower design speeds.

FRAME CONSTRUCTION



The UNIBOX motor's heavy duty ridged frame is designed in South Africa to meet the rigors of the heavy mining and industrial market segments.

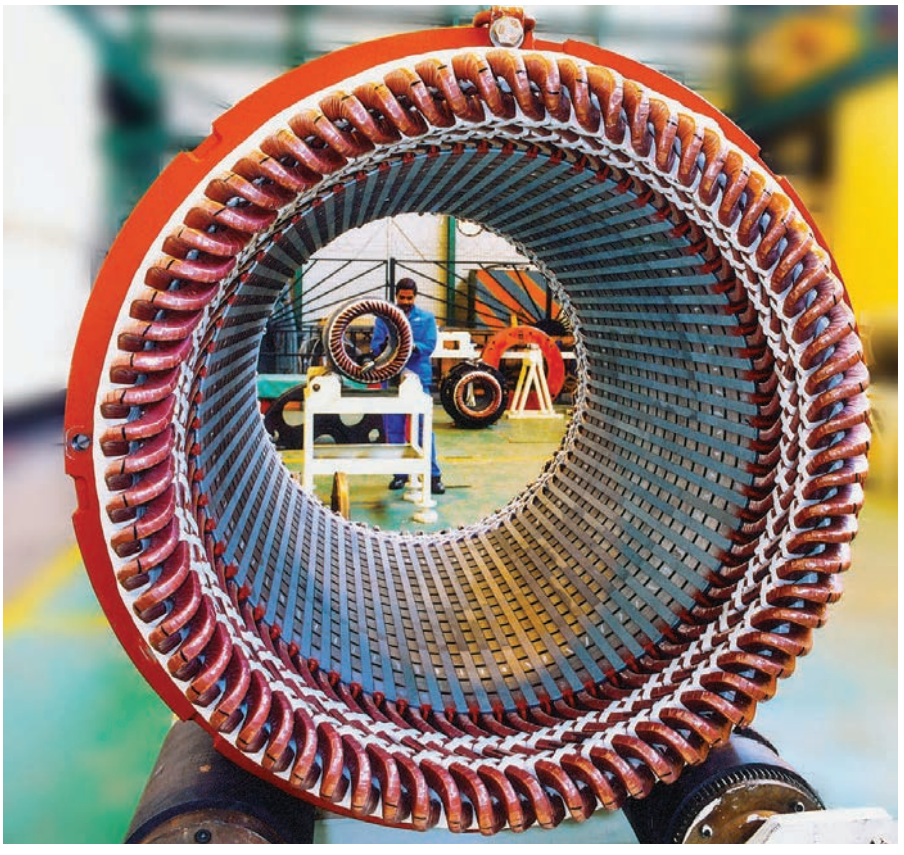
FRAME CONSTRUCTION

The UNIBOX motor has a robust, box type, heavy gauge mild steel plate fabricated frame. The machine lifting points are integral with the end plates to which the end shields and flange mounted bearings are fitted. Foot fixings are integral within the frame. This heavy duty frame construction reduces flexing, vibration, noise levels and provides the support for the plug-in stator core pack. The welded frame is stress relieved prior to machining.

Jacking screws, suitable for vertical height adjustment are provided on the motor feet.

Both end shields are provided with inspection plugs at the appropriate diameter, which when removed provide access for air gap measurement.

The frame is fitted on final assembly with a comprehensive stainless steel rating plate, that includes all connection schematics, bearing details with lubrication as well as key motor specification data.



7Mw UNIBOX stator core ready for vacuum impregnation.

STATOR CORE

The UNIBOX stator core consists of packets of laminations separated by radial ventilating ducts. The laminations are manufactured from low loss, non-grain orientated silicon steel. These laminations are manufactured in a ring format for machines up to a 710mm frame and in a segmental format for larger frame machines.

STATOR WINDINGS

The stator coils are formed from annealed copper strip. All the coils are insulated with the appropriate number of layers of mica tape prior to the application of the dielectric and armour finishing tapes. The coils are subjected to elevated impulse voltage, inter-turn insulation tests before they are fitted into the stator slots and again after all coils have been placed in the fully lined stator slots.

The coils are wedged along the full length of the core. When required for higher efficiency designs, the wedges are made from a magnetically permeable material. A high voltage test is carried out after wedging.

Each end winding is securely braced to epoxy resin bonded glass fibre rings made from braided glass fibre sleeving, to which the outer end of each coil is lashed with woven glass and or polyester tape. This ensures that the coil ends form a rigid self supporting structure, which is capable of withstanding the mechanical forces produced by full voltage direct on line starting, or from reconnecting to an alternative supply. All coil insulation, slot liners, separators and

ROTOR CONSTRUCTION

wedges etc meet class F insulation requirements.
Once the winding connections are completed, the entire winding is vacuum pressure impregnated (VPI) using a solventless epoxy resin. This globally impregnated Resivac system produces void free insulation. The fully impregnated wound core is the cured in a rotary process to ensure retention of resin in the slots and overhangs. All of these processes are PLC controlled to ensure consistency of product integrity.
The completed VPI wound core is heat shrunk into the UNIBOX frame, it is further secured by retaining "horse shoe" pieces fitted over the core bars and then welded into the frame.

ROTOR CONSTRUCTION

Cylindrical UNIBOX rotors are constructed as either cage or wound rotor design variants.

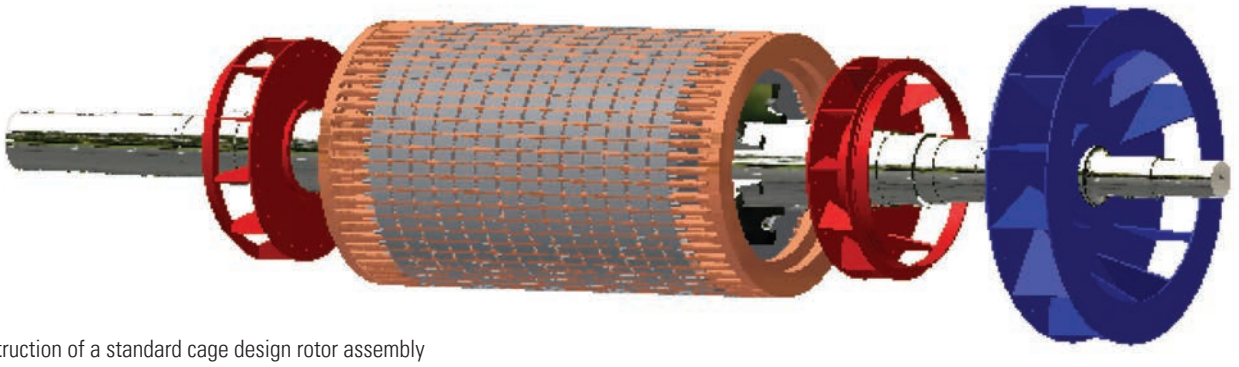
ROTOR CORES

The UNIBOX rotor core is built up from either segmental laminations which are dovetailed and keyed directly onto the spider, or from ring type laminations depending on the rotor diameter.
The rotor core consists of packets of laminations that are separated by radial cooling ducts, similar to and aligned with those formed in the stator core pack construction.
Ring type lamination cores are built up between end plates on a keyed mandrel compressed and clamped prior to heat shrinking onto the shaft or spider, ensuring an interference fit, thus eliminating radial movement of the core when in operation and limiting vibration forces. The shaft is provided with a full length key for positive location of the core assembly.
The core assembly is located axially at both ends by means of heavy section keys fitted and welded into grooves on the shaft ribs. This facilitates core removal from either end.

WOUND ROTORS

The winding is of the bar-wave type, using copper strip, appropriately insulated and firmly wedged into semi-closed slots. The end windings are secured with several layers of resin impregnated glass banding onto support collars to prevent any movement due to rotational forces.
The rotor winding leads are threaded into equally spaced radial holes, directly under the rotor overhang and along a suitably sized, centrally bored hole to the end of the shaft.
The fibreglass overhang banding is first cured and then the entire wound rotor is impregnated using the VPI process. All insulation and banding are at least Class F material with the temperature rise at rated output limited to within Class B. Rotor leads are connected to studs attached to the phosphor bronze or stainless steel sliprings, keyed to the shaft.
The complete slipring assembly is external of the end shield mounted bearing at the non dive end, and separately enclosed to prevent carbon dust from being drawn into the motor. Enclosure protection of the slipring housing can be made the

Construction of a standard wound rotor assembly.



Construction of a standard cage design rotor assembly

BEARINGS AND LUBRICATION

same as that of the main machine, or to a lower degree of protection as required. The slipring housing covers have windows for easy visual inspection, in addition to large hinged doors and easily removable covers that provide free access to the brush gear for more detailed inspection and maintenance purposes.
The brushes are fitted with constant pressure brush holders for optimum contact between brushes and sliprings that are both continuously rated. The sliprings can be spiral grooved for improved surface cooling and improved brush life where peripheral speed exceeds 20 m/s.
Additional features that may be included on wound rotors are tacho generator or encoder fitments for variable speed control and either manual or automatic brush lifting equipment and continuously rated sliprings for those applications where extended slipring / brush life is required.

CAGE ROTORS

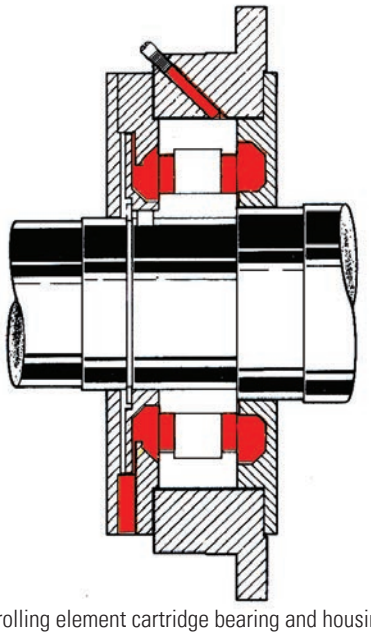
The squirrel cage construction is normally constructed from high conductivity copper rotor bars and end rings. The specific matching of torque requirements to the load is achieved by the use of various rotor bar sections, and where necessary for increased torque, either a double cage or high-resistance copper alloy variation is used.
Accurately sized rotor bars are drifted through the rotor slots ensuring a tight fit and are brazed to the end rings to form the cage. On all two pole motors and for the larger rotors subject to higher centrifugal forces the end rings are forged and end butt brazed to the bars, which are scarved at each end to a point within the slot to allow for thermal flexing during brazing. The brazing quality is checked and the entire assembly is dynamically balanced after the rotor diameter has been machined and sized in relation to the final air gap dimension, with balance weights added to the shaft arm ends or to the balance rings as appropriate.

BEARINGS AND LUBRICATION

UNIBOX motors are supplied with either grease lubricated rolling element or oil lubricated sleeve bearings. All rolling element bearings have cartridge bearing housings. The housings are spigotted onto the motor end shields that are of the rigid flat disc type, generally both the non-drive and drive end bearings are insulated in both sleeve and rolling element bearing styles. The drive end bearing is earthed, thereby preventing shaft currents in the motor. Grease lubricated ball and roller bearings are used, up to the limit of loading dictated by shaft speed and bearing loading. Sleeve bearings are fitted above this limit out of necessity but are also available as a preference option on any machine.

ROLLING ELEMENT BEARINGS

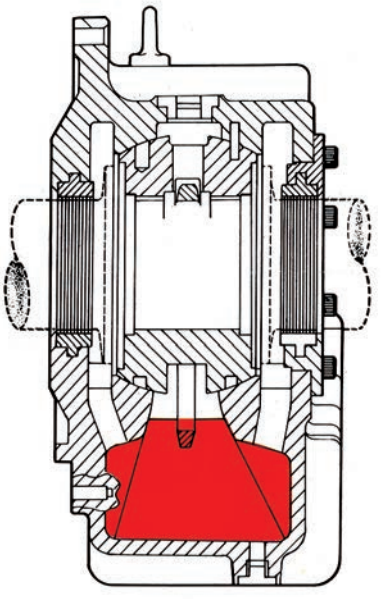
The rolling element cartridge bearing housings are so designed that in the event of the rotor being removed from the stator, the bearings and cartridges can be left on the shaft. This feature reduces the incidence of damage or of foreign bodies contaminating the grease during maintenance. The standard arrangement for rolling element bearings, with grease lubrication, is a roller bearing at the drive end and a ball bearing at the non-drive end. All rolling element bearings used on the range have C3 clearances and the calculated design bearing life (L1oh) is not less than 40 000 hours.
All grease lubricated bearings have grease relief features, preventing over greasing and permitting re-greasing while the motor is in operation. New lubricant is supplied to the inboard side of the bearing and old excess grease is discharged to the opposite side into the catcher located outside the frame and underneath the bearing housing.



A rolling element cartridge bearing and housing.

SLEEVE BEARINGS

Sleeve bearings are oil ring lubricated, spherically seated with a cylindrical bore bearing journal. Floating labyrinth seals are fitted. The housings are finned for cooler operation at the highest speeds and diameters in a 40 degree C ambient with natural cooling. Bearing temperature monitoring devices can be accommodated as required.
When requested or when ambient temperature and / or shaft speed demands, the bearings can be supplied suitable for flood lubrication with cooling oil being supplied from an external source. Alternatively the bearings can be water cooled by an external water flow system.



Sleeve bearing with oil ring lubrication.

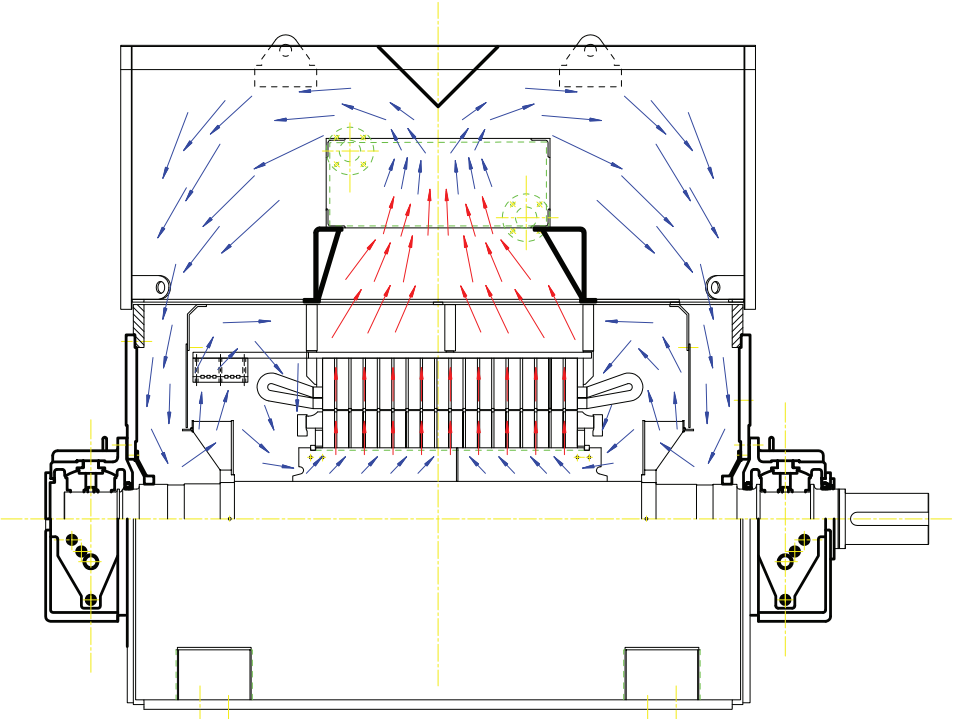
VENTILATION SYSTEMS

The UNIBOX ventilation system is described as "single or double ended radial" depending on the size of the machine. Although total movement of air is axial from one end of the motor to the other in the case of a single ended fan, the main cooling of the core is by radial ducts. The temperature distribution across the machine is uniform resulting in reduced temperature gradients and thus longer insulation life. Designs are proven by a complex equivalent thermal network program used to predict temperatures in different parts of the core.

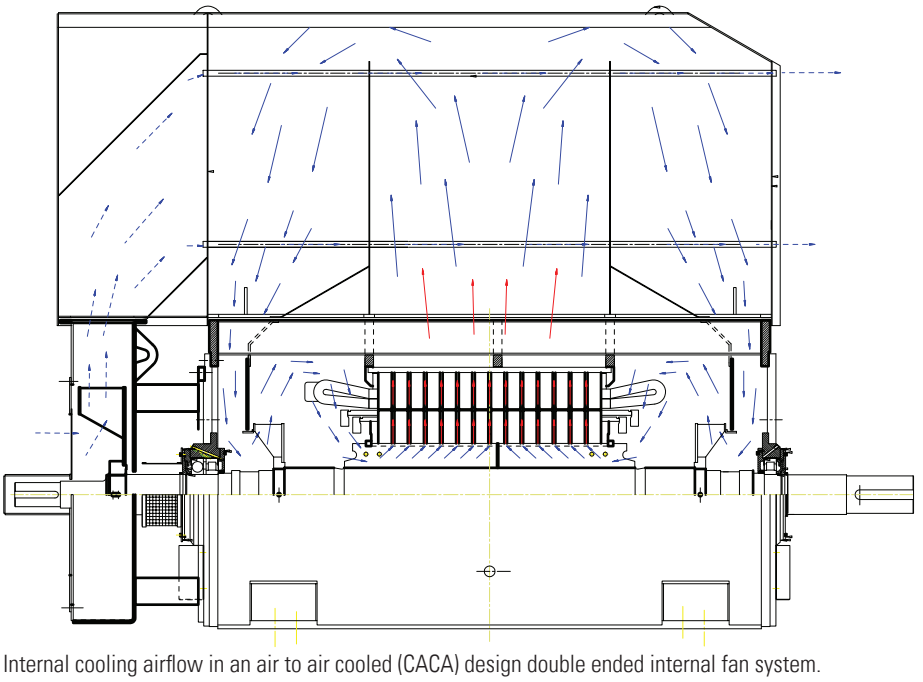
With single ended internal fan machines, the cooling air whether external or from the heat exchanger, is drawn down from the non-drive end of the top cover where it divides into two main paths. One path takes cooling air over the end winding and along both the air gap and the shaft spider, and then through the radial ducts in the rotor and stator cores. The other main path bypasses the core ducts and takes air axially along the outer diameter of the stator core. Here the air progressively mixes with and cools the air from the radial ducts before passing over and cooling the drive end which directs it into the top cover.

For double ended internal fan machines, the top cover, stator and rotor are split into two symmetrical air circuits. Cooling air is drawn down from the top cover into the fans at each end of the machine. The air is then forced into the machine core where it divides into two main paths, one taking cooling air over the end winding, along the air gap and through the stator radial ducts back to the top mounted cooler. The second path takes cooling air axially into the shaft spider and then through the shafts radial ducts into the air gap where is mixes with the air on the other path, via the stator radial ducts and back to the top mounted cooler.

The top cover of the UNIBOX machine is either open to atmosphere, as in the case with a C-Type machine (IC01) or alternatively consists of an integral air to air (CACA) or water cooled (CACW) heat exchanger in the case of D-Type machines.



Internal cooling airflow in a water cooled (CACW) design double ended internal fan system.



Internal cooling airflow in an air to air cooled (CACA) design double ended internal fan system.

SCREEN PROTECTED / DRIP PROOF Heat exchangers (IP22, ICO1)

The UNIBOX stator frame in this design format has an open top, covered by an IP appropriate louvered or screen protected top cover assembly. This design is also adaptable to suit other design fittings for example those applications that require ducted ventilation extraction.

AIR TO AIR Heat exchangers (CACA, IP55, ICO161)

The top mounted UNIBOX heat exchanger is in the form of an air to air cooler incorporating aluminium cooling tubes that are expanded into steel end plates within the cooler housing

to form the top cover that encloses and seals the internal air circuit. The external air cooling circuit is provided by a shaft mounted fabricated fan.

AIR TO WATER Heat exchangers (CACW,IP55,ICW37A81)

This heat exchanger radiator is incorporated into the UNIBOX top cover. Stainless steel cooler tubes are expanded into suitable manifolds located within either end of the cooler. Leak detection devices are also incorporated in to these designs as standard.

NEMA II (IPW24/44, IC01)

This enclosure is designed generally to meet the requirements of NEMA II. The enclosure is designed to give protection corresponding to IPW24 (without filters) or IPW44 (with filters). The stator frame has a top mounted fabricated steel cover, with three 90 degree baffles and screen protected inlet and outlet openings.

FANS

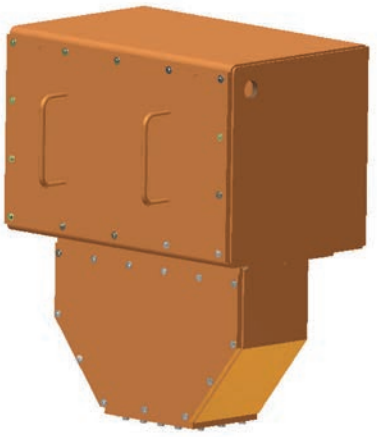
All fans are fabricated from steel and are fitted by means of a key and an interference fit directly onto the motor shaft. Designs are available for bi-directional as well for uni-directional rotation.

FAN COWLS

The fan cowls on D-TYPE UNIBOX machines are manufactured from fabricated steel with internal baffles to accurately guide the airflow. Necessary inlet screens are provided as standard.

TERMINAL BOXES AND TERMINATIONS

The standard position of the UNIBOX terminal box is on the right hand of the motor looking from the drive side shaft end, but this can be positioned on the opposite side should client specifics require. Insulated stud type terminal arrangements are



A steel fabricated termination box with a Trifurcating extension box (Fabel).

available to suit various requirements pertaining to differing operating environments, system fault capacity, supply voltages, as well as a variety of terminal box mounted auxiliary equipment and cable types. Whilst the neural point is usually internal, it is possible to bring out the neutral star point to either a separate termination box, or alternatively include it within the main termination box.
An earth terminal is provided as standard on the motor frames adjacent to the main terminal box.
UNIBOX terminal boxes are fitted with suitable gland plates as required by specification, or with trifurcating boxes equipped with cables glands, in either straight or angled variants to facilitate easier cabling.
The option exists for either Fabel or Makulu design phase insulated termination boxes. These are fabricated boxes incorporating a pressure relief

A large volume format standard fabricated termination box (Makulu).

diaphragm and desiccators for supplies up to 15kV. These box designs are fault tested for through fault currents up to 45kA for 0,25 seconds.
Box designs are weather protected and are suitable for Zone 2 areas.
All auxiliary boxes, as required by specification are fabricated from steel.

NOISE REDUCTION

The UNIBOX motor has been designed with low overall noise levels and particular attention has been paid to the three basic sources of noise: Bearing, electromagnetic and fan noise.
Bearing housing and lubrication system designs are such that allow for easy maintenance reducing the chances of noise being produced as a result of inadequate lubrication.
Noise from the magnetic circuit is minimised by electrical designs using comprehensive computer programmes to analyse noise generating harmonics. Rigid cores and frames in conjunction with the use of vacuum impregnation minimise the risk of core and tooth vibration by raising their resonant frequencies well above those of the exciting forces.
The UNIBOX internal and external high pressure low aspect ratio centrifugal fans are optimized to provide the most efficient ratio of cooling air volumes to mechanical noise levels. The number of fan blades is selected to minimize the risk of harmonic interference between the magnetic noise and the fan blade passing frequency.

SILENCERS

When required to meet the needs of stringent noise specifications the D Type UNIBOX motor can be equipped with a purpose designed cowl extension silencer. This design can also be effectively used to silence the air outlet circuit when necessary. C type UNIBOX motors silencers are contained within the inlet and / or outlet of the standard top cover.

PAINT SYSTEM

The paint system chosen for the standard UNIBOX is the result of extensive testing and evaluation of many specially developed systems. The standard system offering is as follows:

1 Polyurethane & Epoxy external coating

After cleaning and shot blasting a self etching red oxide primer is applied to a minimum dry film thickness of 10 microns. The intermediate coat, an epoxy primer, is then applied with a minimum dry film thickness of 40 microns. Finally a finishing coat of polyurethane enamel is applied with a minimum dry film thickness of 65 microns. The total dry film thickness resulting from these three layers will be a minimum of 115 microns.

2 Standard internal coating

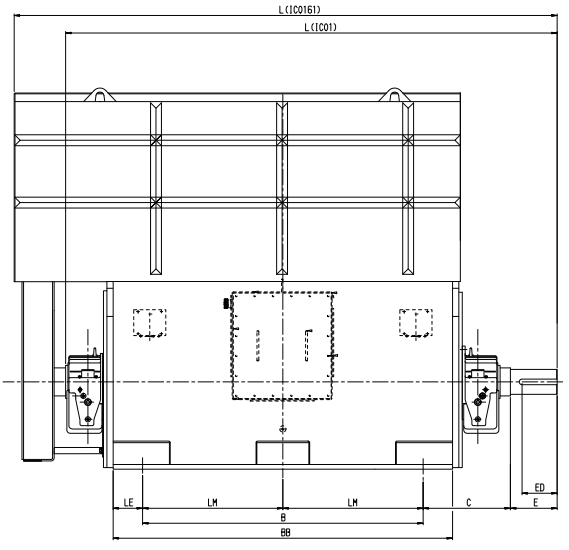
After cleaning and shot blasting a self etching red oxide primer as well as a finishing coat of red oxide insulating paint is applied.

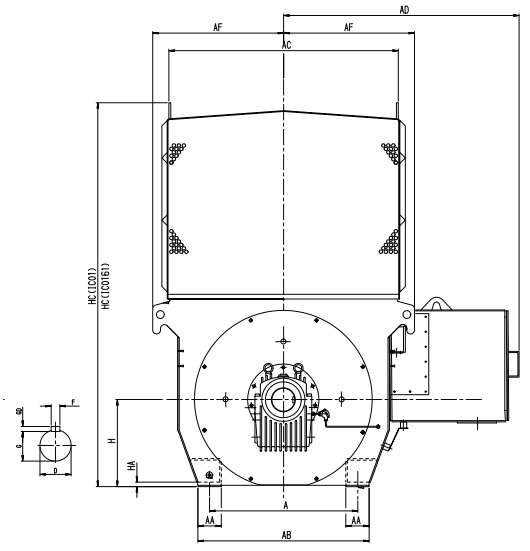
UNIBOX FABRICATED SERIES MOTORS DIMENSION DATA*

Frame Size	Pole	A	AA	AB	AC	AD	AF	B	BA	BB	C		D	D	
											Ball & Roller	Sleeve	Nom	Tolerances	
500/125	4-UP	850	100	950	1354	1023	777	1250	730	1676	335	530	140	+0,040	+0.015
500/160	4-UP	850	100	950	1354	1023	777	1600	730	2026	335	530	140	+0.040	+0.015
560/140	4-UP	950	150	1100	1482	1087	841	1400	740	1782	335	560	160	+0.040	+0.015
560/180	4-UP	950	150	1100	1482	1087	841	1800	740	2182	335	560	160	+0.040	+0.015
630/160	4-UP	1060	150	1210	1642	1161	921	1600	840	2062	375	600	180	+0.040	+0.015
630/200	4-UP	1060	150	1210	1642	1161	921	2000	840	2462	375	600	180	+0.040	+0.015
710/180	4-UP	1180	150	1330	1802	1247	1001	1800	900	2190	N/A	630	200	+0.046	+0.017
710/224	4-UP	1180	150	1330	1802	1247	1001	2240	900	2630	N/A	630	200	+0.046	+0.017
800/200	4-UP	1320	150	1470	1972	1332	1086	2000	1000	2470	N/A	670	225	+0.046	+0.017
800/250	4-UP	1320	150	1470	1972	1332	1086	2500	1000	2970	N/A	670	225	+0.046	+0.017
900/224	4-UP	1500	200	1700	2218	1455	1209	2240	1100	2654	N/A	710	250	+0.046	+0.017
900/280	4-UP	1500	200	1700	2218	1455	1209	2800	1100	3214	N/A	710	250	+0.046	+0.017
1000/250	4-UP	1700	200	1900	2474	1583	1337	2500	1250	2994	N/A	750	280	+0.052	+0.020
1000/315	4-UP	1700	200	1900	2474	1583	1337	3150	1250	3644	N/A	750	280	+0.052	+0.020

Frame Size	Pole	E	ED	F	G	GD	H	HA	HC (ICO 1)	HC (ICO 161)	L (ICO 1) Ball & Sleeve	L (ICO 1) Roller	L (ICO 161) Ball & Sleeve	L (ICO 161) Roller	LM	LE	LM	Mass Approx
500/125	4-UP	250	200	36	128	20	500	30	1650	2232	2165	2525	2742	2937	625	213	*	7630
500/160	4-UP	250	200	36	128	20	500	30	1650	2232	2515	2875	3092	3287	800	213	*	9160
560/140	4-UP	300	225	40	147	22	560	30	1750	2430	2400	2744	2944	3149	700	191	*	9800
560/180	4-UP	300	225	40	147	22	560	30	1750	2430	2800	3144	3344	3549	900	191	*	11400
630/160	4-UP	300	225	45	165	25	630	36	1930	2675	2663	3071	3281	3506	800	231	*	13280
630/200	4-UP	300	225	45	165	25	630	36	1930	2675	3063	2471	3681	3306	1000	231	*	15160
710/180	4-UP	350	250	45	185	25	710	36	2058	*	N/A	3330	N/A	*	900	195	*	18140
710/224	4-UP	350	250	45	185	25	710	36	2058	*	N/A	3770	N/A	*	1120	195	1120	20700
800/200	4-UP	350	300	50	208	28	800	48	2315	*	N/A	3675	N/A	*	1000	235	1000	22330
800/250	4-UP	350	300	50	208	28	800	48	2315	*	N/A	4175	N/A	*	1250	235	1250	25410
900/224	4-UP	450	400	56	230	32	900	48	2497	*	N/A	4035	N/A	*	1120	207	1120	28070
900/280	4-UP	450	400	56	230	32	900	48	2497	*	N/A	4475	N/A	*	1400	207	1400	31710
1000/250	4-UP	500	500	63	257	32	1000	48	2728	*	N/A	4475	N/A	*	1250	247	1250	36720
1000/315	4-UP	500	500	63	257	32	1000	48	2728	*	N/A	5125	N/A	*	1575	247	1575	41300

* Non standard dimensions are available across the range on UNIBOX motors to suit older plant replacements and other special applications.





MS4 SERIES CAST IRON FRAME MV MOTORS

CONCEPT

The MS4 compact series cast iron frame medium voltage motors have been developed to suit local requirements. This compact MV motor series is derived from the previous medium voltage motor series manufactured in Benoni. Due to advancements in insulation systems, laminations and other key materials coupled with greatly improved computer controlled manufacturing processes ensures the MS4 motor will remain a robust, reliable and highly efficient motor choice for many years to come.
This robust MV motor series is well suited to the arduous service requirements encountered in our mining and heavy industrial environments. The MS4 design concept centres around an economical life time ownership profile whilst providing high performance, high efficiency and low maintenance requirements.

A typical MS4 series motor with separate phase and star point terminal boxes.

ACTOM MS4 series motor with a standard large volume fabricated terminal box.

GENERAL SPECIFICATION

Standards: In accordance with IEC 60034.
Voltage Range: 400 up to 11000V
kW ratings: to 1200kW depending on the voltage and application duty
Enclosure: TEFC, IP23 IC01 to IP65, IC411 Ribbed cast iron frame.
Frame sizes: 355, 400 and 450mm cast Iron (500mm Fabricated).
Mountings: IMB3 - Horizontal & IMV1 - Vertical
Insulation: Class "F" VPI RESIVAC Processed
Rating performance: Suitable as standard at 1650 masl at 40°C ambient with Class "B" rise.
Bearing designs: Ball, Roller and sleeve options to suit application
Rotor Design: Die cast aluminium cage standard with copper cage option available where suitable
Termination boxes: Fabricated boxes with multi mount options
Cooling: External & internal fans, steel or fibreglass cowls
Noise**:** Low noise levels are standard, additional silencer systems are available
Corrosion protection: Epoxy paint for long term corrosion protection of all parts

FRAME CONSTRUCTION & COOLING

The motor rigid frame and end shields are made from cast iron in respect of frames 355mm to 450mm. Frames sized at 500mm are generally fabricated from mild steel but they retain die cast end shields. All castings are ribbed internally and externally to maximize their cooling surface areas.
Totally enclosed IP55 or higher IC411 designs lose the majority of their heat via the frame and end shields,

this frame is cooled externally by the external cooling fan that with the cowl directs air along the frames cooling ribs. This cooling process is assisted via the use of an internal cooling circuit fan.
This internal fan draws the turbulent internal air through the ventilation holes in the rotor to the non drive end where the air is cooled and returned along the internal air ducts to the drive end in the same direction as the external cooling air. This heat dissipation circuit is designed to effectively offer long motor service life by keeping the bearing and winding temperatures both constant and low.
The Open Type IP23 IC01 motor design also has a dual air circuit cooling system. The external fan at the non drive end blows cooling air both along the outside of the stator frame along the cooling ribs, as well as through the vents in the non drive end motor end shield. This internal air circuit forces cooling air through the rotor ventilation holes and well as along the four ducts in the motor frame. The internal fan at the drive end boosts the air flow and forces the warmed air out of the drive side endshield.

FAN DESIGNS

All MS4 series motors use the same fan design type on IP23 through to IP65 Motors. External fans are typically bi-directional on 4 pole and slower designs and normally comprise a single piece polypropylene moulding, whilst 2 pole speed motors typically use hub mount bladed uni-directional cooling fans. Internal cooling / circulation fans are cast aluminium and are always bi-directional. MS4 series motors are particularly quiet, this is due in part to the fan design but also due to the steel or fibreglass cowl design. Where noise requirements are particularly stringent, sound reduction modules are available. These consist of damper silenced cowls or outlet dampers (IP 23 motors).

STATOR DESIGN

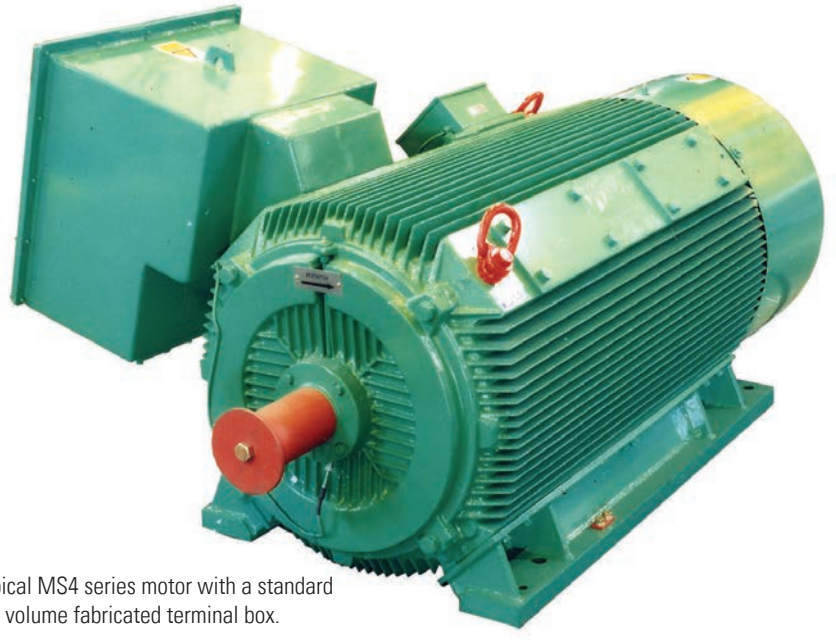
The MS4 stator is constructed from non grain orientated silicon steel laminations having semi closed slots for mush windings and open slots for pulled diamond windings. Two thick laser cut mild steel compression end plates prevent spreading of the core. The stacked stator core pack is cleated under compression and is shrunk into the frame with an interference fit.
With voltage applications less than 1000V mush type windings are typically used, the coils are pre-formed using synthetic enamel, Class "H", grade 2, covered copper wire. The slots are lined with high quality durable insulation liners, and the coils are then firmly wedged over their full slot length. Insulation materials used depend upon the specification requirements of the specific motor. Once the overhang is securely braced, the entire core is vacuum impregnated.
For high voltage applications the coils are of the pulled diamond type. These are made using mica insulated copper strip, which is further insulated using tapes suitable for the applied voltage and design duty requirements. Individual coils are tested before and after being wound into the core pack. The end connections are then completed and tested prior to the wound core being Vacuum Pressure Impregnated. This process produces a void free insulation, which will is sealed from outside contamination.

ROTOR DESIGN

The MS4 cage is generally made using die cast aluminium. Copper rotor bars and end ring designs are possible where the design configurations allow. The MS4 rotor designs are optimized to offer low stray losses (high efficiency), low axial thrusts and favourable torque characteristics to match the desired starting requirements.

BEARING DESIGN

The MS4 series motors are normally fitted with rolling element bearings. When the application limits are exceeded sleeve bearings are used.
With IMB3 type motor constructions the locating bearings is usually located at the drive end and the floating bearing at the non drive end. The locating bearing is a double bearing, consisting of a roller bearing for the radial load and a ball bearing for the axial load.
With IMV1 type motor constructions an angular contact ball bearing at the non drive end acts as the support



A typical MS4 series motor with a standard large volume fabricated terminal box.

bearing, and a zero end float spring loaded bearing to guide the rotor at the drive end. The bearings are fitted directly into the end shield or in a separate bearing housing, according to the size of the motor.

All rolling element bearings are sealed with felt seals and a V ring which runs with the shaft. This provides protection against the ingress of dust and water jets (IP55), resulting in both longer bearing life and longer greasing intervals.

The bearings are lubricated with lithium soap grease by way of a re-lubricating facility with a self sealing lubricating nipple. A generously designed grease chamber for spent grease is provided in the outer bearing cover.

Sleeve bearings are fitted where the design conditions require it, or by specific client request. The bearings are of the flanged type and are suitable without modification for both directions of rotation. According to the design bearing load they will have either oil ring lubrication with natural cooling by radiation and convection or they will be provided suitable for a forced oil lubrication system. These bearings are constructed as floating bearings. The rotor must be located axially by way of a limited end float coupling on the driven machine.

TERMINAL ARRANGEMENTS

External connection leads can be connected to the motor either by cable lugs or connection stems via a variety of generously proportioned multi positional fabricated terminal box options with proven designs. The terminal boxes incorporate pressure relief vents that assist in dissipating resultant fault pressure rises in a safe manner.

ACCESSORIES

The following standard accessories can be included when required:

- Single phase anti-condensation heaters, wired to external separate auxiliary terminal boxes.
- Embedded temperature detectors (RTD), thermocouples or thermistors can be equipped into each phase of the stator winding, again the leads are wired to external separate auxiliary terminal boxes.
- Calibrated bearing RTDs in a stainless steel sheath again the leads are wired to external separate auxiliary terminal boxes.
- Surge suppressors or provision for them.

UNIBOX series motors awaiting delivery in the factories despatch bay.

ACTOM MS4 series motors awaiting despatch at the factory test facility.

DIMENSIONS OF FRAMES

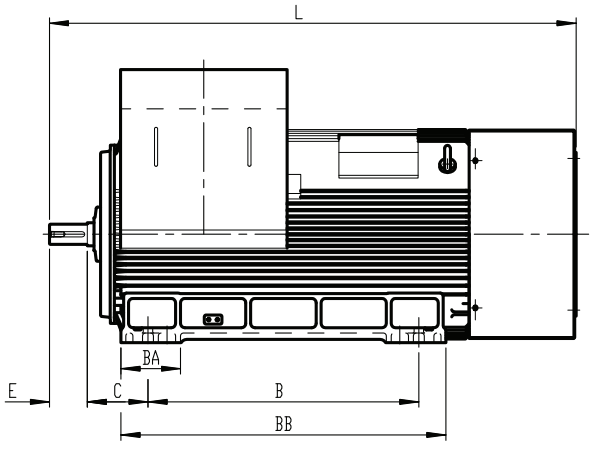
DIMENSIONS OF STANDARD MS4 FRAME MOTORS *

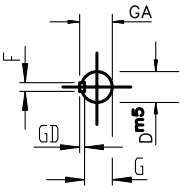
		DIMENSIONS MS4 - Low Friction Bearings																	
Frame	Poles	A	AB	AD	B	BB	C	D	E	F	G	H	HA	HD	HC	K	L	BA	AC	AD
355	2	610	730	490	900	1070	200	65	140	18	69	355	44	945	702	28	1815	180	347	869
	4	610	730	490	900	1070	200	85	170	22	90	355	44	945	702	28	1845	180	347	869
	6	610	730	490	900	1070	200	90	170	25	95	355	44	945	702	28	1845	180	347	869
	8																			
400	2	686	836	536	1000	1200	224	75	140	20	79,5	400	55	1018	787	35	1945	220	387	897
	4	686	836	536	1000	1200	224	95	170	25	100	400	55	1018	787	35	1975	220	387	897
	6	686	836	536	1000	1200	224	100	210	28	106	400	55	1018	787	35	1975	220	387	897
	8	686	836	536	1000	1200	224	100	210	28	106	400	55	1018	787	35	2015	220	387	897
450	2	750	900	600	1120	1320	254	85	170	22	90	450	34	1104	883	35	2125	N/A	433	932
	4	750	900	600	1120	1320	254	110	210	28	116	450	34	1104	883	35	2165	N/A	433	932
	6	750	900	600	1120	1320	254	120	210	32	127	450	34	1104	883	35	2165	N/A	433	932
	8	750	900	600	1120	1320	254	120	210	32	127	450	34	1104	883	35	2165	N/A	433	932
	10	750	900	600	1120	1320	254	120	210	32	127	450	34	1104	883	35	2165	N/A	433	932
	12	750	900	600	1120	1320	254	120	210	32	127	450	34	1104	883	35	2165	N/A	433	932
500	2	850	1030	670	1250	1490	280	120	210	32	127	500	34	1189	979	42	2345	N/A	479	968
	4	850	1030	670	1250	1490	280	130	250	32	137	500	34	1189	979	42	2385	N/A	479	968
	6	850	1030	670	1250	1490	280	130	250	32	137	500	34	1189	979	42	2385	N/A	479	968
	8	850	1030	670	1250	1490	280	130	250	32	137	500	34	1189	979	42	2385	N/A	479	968
	10	850	1030	670	1250	1490	280	130	250	32	137	500	34	1189	979	42	2385	N/A	479	968
	12	850	1030	670	1250	1490	280	130	250	32	137	500	34	1189	979	42	2385	N/A	479	968

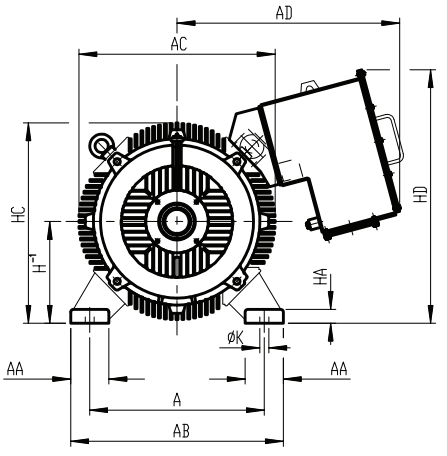
		DIMENSIONS MS4 - Sleeve Bearings																	
Frame	Poles	A	AB	AD	B	BB	C	D	E	F	G	H	HA	HD	HC	K	L	BA	AC	AD
355	2	610	730	490	900	1070	†	65	140	18	69	355	44	945	702	28	†	180	347	869
	4	610	730	490	900	1070	†	85	170	22	90	355	44	945	702	28	†	180	347	869
	6	610	730	490	900	1070	†	90	170	25	95	355	44	945	702	28	†	180	347	869
	8																			
400	2	686	836	536	1000	1200	375	75	140	20	79,5	400	55	1018	787	35	2095	220	387	897
	4	686	836	536	1000	1200	375	95	170	25	100	400	55	1018	787	35	2245	220	387	897
	6	686	836	536	1000	1200	†	100	210	28	106	400	55	1018	787	35	†	220	387	897
	8	686	836	536	1000	1200	†	100	210	28	106	400	55	1018	787	35	†	220	387	897
450	2	750	900	600	1120	1320	400	85	170	22	90	450	34	1104	883	35	2270	N/A	433	932
	4	750	900	600	1120	1320	425	110	210	28	116	450	34	1104	883	35	2500	N/A	433	932
	6	750	900	600	1120	1320	425	120	210	32	127	450	34	1104	883	35	2500	N/A	433	932
	8	750	900	600	1120	1320	425	120	210	32	127	450	34	1104	883	35	2500	N/A	433	932
	10	750	900	600	1120	1320	425	120	210	32	127	450	34	1104	883	35	2500	N/A	433	932
	12	750	900	600	1120	1320	425	120	210	32	127	450	34	1104	883	35	2500	N/A	433	932
500	2	850	1030	670	1250	1490	450	120	210	32	127	500	34	1189	979	42	2690	N/A	479	968
	4	850	1030	670	1250	1490	450	130	250	32	137	500	34	1189	979	42	2690	N/A	479	968
	6	850	1030	670	1250	1490	500	130	250	32	137	500	34	1189	979	42	2780	N/A	479	968
	8	850	1030	670	1250	1490	500	130	250	32	137	500	34	1189	979	42	2780	N/A	479	968
	10	850	1030	670	1250	1490	500	130	250	32	137	500	34	1189	979	42	2780	N/A	479	968
	12	850	1030	670	1250	1490	500	130	250	32	137	500	34	1189	979	42	2780	N/A	479	968

† **Available on request if design parameters allow**

* Non standard dimension applications can be accommodated by the inclusion of adaptor bases







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