OPERATION AND MAINTENANCE MANUAL

MAC-HS MOTORS



VASCAT

www.vascat.com

CONTENTS

1. LEGAL NOTES AND SAFETY INSTRUCTIONS 5
1.1 Justification 5
1.2 Target readership and purpose 5
1.3 Hazards and warning signs 6
1.4 Intended use 7
1.5 Skilled personnel 7
1.6 Disclaimer 8
1.7 Scope of the documentation and external references 8

2. DECLARATIONS OF CONFORMITY 9

3. PRODUCT DESCRIPTION 12
3.1 General information 12
3.2 Reference standards 13
3.3 Definitions 14
3.3.1 Duty 14
3.3.2 Types of construction 15
3.3.3 Degree of protection IP 16
3.3.4 Cooling Methods 17
3.3.5 Vibration grade 18
3.3.6 Insulation class 19
3.3.7 Stress category severity 19
3.3.8 Heating limits 19
3.4 Nameplate 21
3.5 General specifications 22
3.5.1 Motor code 22
3.5.2 Ambient conditions 22
3.5.3 Duty 22
3.6 Mechanical specifications 24
3.6.1 Mounting 24
3.6.2 IP protection rating 24
3.6.3 Cooling Method 25
3.6.4 Balancing and vibration grade 25
3.6.5 Bearings 26
3.7 Electrical specifications 27

3.7.1 Windings and insulation 27
3.7.2 Connections 27
3.7.3 Power-supply conditions 28
3.7.4 Standard thermal protection 29
3.7.5 Thermal sensors 30
3.7.6 Anti-condensation heaters 31
3.7.7 Fan and pressure gauge 31
3.8 Accessories 32
3.8.1 Feedback sensors 32
3.8.2 Provision for torque flange assembly 33
3.8.3 Blocking device 33
3.8.4 Provision for accelerometer assembly 34
3.8.5 Noise level 34

4. SHIPMENT, RECEPTION, TRANSPORT AND STORAGE 35
4.1 Shipment 35
4.2 Reception 35
4.3 Transport 36
4.4 Storage 37

5. INSTALLATION AND START-UP 38
5.1 Motor installation 38
5.1.1 Site 38
5.1.2 Mounting 39
5.1.3 Machine coupling 40
5.2 Electrical connections 42
5.2.1 Connection strips and terminals 43
5.2.2 Connection diagrams 44
5.2.3 Power cables 46
5.2.4 Connections for the fan, thermal sensors and accessories 48
5.2.5 Final checks 48
5.3 Start-up 49
5.3.1 Preliminary checks 49
5.3.2 Start-up 50

6. MAINTENANCE 52
6.1 Safety instructions 52
6.2 Maintenance operations and frequency 52
6.2.1 Basic inspection 53
6.2.2 Cleaning of the fan and air filter 53
6.2.3 Replacement of bearings 54
6.3 Replacing the encoder 57
6.3.1 Solid shaft encoder 57
6.4 Original spares 58
6.5 Operating faults 60
6.5.1 Electrical faults 60
6.5.2 Mechanical faults 62
6.6 Technical support and service 63

1. LEGAL NOTES AND SAFETY INSTRUCTIONS

1.1 Justification

VASCAT motors contain low-voltage parts and rotating elements that make them hazardous; they also contain hot surfaces. Users must take notice of all the hazard warning signs described in this manual (see section 1.3).

All tasks related to the transport, connection, commissioning and maintenance must be performed by responsible, skilled personnel (in accordance with the EN 50110-1 (VDE 0105-100) and IEC 60364 standards). Inappropriate procedures may cause serious personal injury and material damages.

VASCAT motors may only be used for the purposes specified in Section 1.4.

Furthermore, the site conditions must meet all the requirements given on the motor nameplate and in this document.

1.2 Target readership and purpose

The purpose of the operation manual is to provide all the information required for the appropriate mounting, commissioning and maintenance of the MAC HS motors and avoid hazards that may cause serious injury. The manual is targeted for any person or individual who handles or is responsible for operation of the motors dealt with in the manual.

All the individuals working with MAC HS three-phase motors must have this manual at their disposal and they must follow the relevant instructions and indications.

The operation and maintenance instructions must be read carefully before operating the machine. This will guarantee proper operation free from hazards and complications and will extend the service life of the machine.

These service instructions provide a description of the machine and information for its proper handling and operation from delivery to the end of its service life.

This manual must always be complete and perfectly legible.

1.3 Hazards and warning signs

The manual contains the information required for personnel safety and the prevention of material damages. All information related to personnel safety is highlighted in general with a warning triangle; however, the hints (to avoid only material damages) are not. Depending on the hazard level, the signs indicate hazards from major to minor as follows:

 **DANGER**
If no appropriate measures are taken, the result will be death or serious injury.

 **WARNING**
If no preventive measures are adopted, the result may be death or serious injury.

 **CAUTION**
If no appropriate measures are taken, the result may be serious injury.

PRECAUTION
If no appropriate measures are taken, the result may be material damages.

NB
The result may be an unwanted condition or situation if the corresponding safety instruction is not observed.

If several hazard levels are present at the same time, the most stringent instruction for each case will apply. If a safety instruction with a warning triangle warns of personal injury, the same instruction may also contain a warning of possible material damages.

Signs indicating the type of danger Warning or Caution in the manual that may be used together with the pictograms above are as follows:

 **VOLTAGE**
Indicates the presence of voltage on connection terminals or live parts.

 **HOT SURFACE**
Indicates the possibility of the contact surface having a very high temperature with the consequent risk of burns.

 **MOVING ROTATING PARTS**
Indicates the possibility of injury and trauma caused by contact with shafts and other rotating parts.

1.4 Intended use

WARNING

VASCAT motors have been designed for industry plants. They comply with the requirements of the harmonised standards of the EN 60034 series.

Such pieces of equipment are devices designed to be mounted in machines in accordance with the current Machinery Directive. Commissioning is not allowed until the end product is checked and found to be compliant with said Directive (please see, among others, the EN 60204-1 standard).

VASCAT MAC HS motors must be used only for the applications provided in the catalogues and the related technical documentation.

If third-party products and parts are used, they must be previously approved by VASCAT.

Proper and safe operation of the products requires their proper transportation, storage, installation, mounting, assembly, operation and maintenance.

Allowed ambient conditions must be observed. The use of MAC HS motors in hazardous areas is strictly prohibited unless they have been designed specifically for said circumstance, in which case the indications and warnings given in the related documentation must be observed.

1.5 Skilled personnel

WARNING

VASCAT motors must be installed and operated in accordance with the specifications given in this document. Only skilled personnel in the context of the manual, i. e. individuals who have the required technical know-how and skills for handling, commissioning and starting the motors according to safety standards, shall be allowed to operate the motors.

Skilled personnel refers to those individuals who are capable of recognising the risks related to their field of activity and avoiding the related hazards.

1.6 Disclaimer

The indications given in the manual describe the product features, but no warranty is implied.

VASCAT declines all liability for damages and operating faults caused by the following:

- Failure to follow the operating instructions.
- Damages caused by inappropriate motor handling.
- Changes made to motors without prior authorisation.
- Operating errors.
- Carrying out inappropriate work on and with the motors.

The indications that refer to procedures and the connection details provided in the manual must be considered only as proposals and whether or not they are applicable must be studied for each case in particular. VASCAT does not guarantee their appropriateness in any case.

The data given in this manual is reviewed regularly and subsequent editions are published when corrections are necessary.

1.7 Scope of the documentation and external references

The manual contains all the information required for the correct handling, installation (electrical and mechanical), commissioning and subsequent maintenance of MAC HS series motors, together with the accessories required for proper operation.

It also describes the safety instructions to guarantee that no personal injuries or material damages will be caused during the entire process.

If the motor design includes any special features (considered as non-standard), additional documentation may be necessary. In those cases, the customer must check with VASCAT to make sure that he has all the relevant information.

This document provides no information about the technical data sheets or the specific technical data of the various MAC HS models or their characteristic curve.

To obtain said information, please log on to the VASCAT website at http://www.vascat.com.

2. DECLARATIONS OF CONFORMITY

VASCAT	CE CONFORMITY DECLARATION MAC HS4 MOTORS

VASCAT, S.A., CONFORMITY DECLARATION

The company VASCAT S.A., with registered offices in C/ Esquirol s/n – 08570 Torelló –Spain

DECLARES

The motors of the series MAC HS4 100 to MAC HS4 250 comply with the basic requirements set forth in the following Directives:

2006/95/CE – Low Voltage Directive
2006/46/CE – Machinery Directive
89/336/CEE & 92/31/CEE – Electromagnetic Compatibility Directive
93/68/CEE – CE Marking Directive

These motors have been manufactured in compliance with the following standards:

- UNE-EN 60034-1
- UNE-EN 60034-5
- UNE-EN 60034-8
- UNE-EN 60034-9

In consequence to the above-mentioned standards, this declaration will no longer be valid when changes are made without our prior consent.

The specified product shall be installed as a part of a machine only. Commissioning of the product is not allowed until it has not been checked that the end product complies with above mentioned operation standards.

Torelló 24th April 2014

J.L.García Bujía
General Manager

VASCAT	**CE CONFORMITY DECLARATION** **MAC HS2 MOTORS**

VASCAT S.A., CONFORMITY DECLARATION

The company VASCAT S.A., with registered offices in C/ Esquirol s/n - 08570 Torelló-SPAIN

DECLARES

The motors of the serie MAC HS2 250 comply with the basic requirements set forth in the following Directives:

2014/35/CE – Low Voltage Directive
2006/42/CE- Machinery Directive
2014/30/UE & 92/31/CEE – Electromagnetic Compatibility Directive
93/68/CEE – CE Marking Directive

These motors have been manufactured in compliance with the following standards:

- UNE-EN 60034-1
- UNE-EN 60034-5
- UNE-EN 60034-8
- UNE-EN 60034-9

In consequence to the above-mentioned standards, this declaration will no longer be valid when changes are made without our prior consent.

The specified product shall be installed as a part of a machine only. Commissioning of the product is not allowed until it has not been checked that the end product complies with above mentioned operation standards.

Torelló 09th June 2016

Josep Torras Homs
General Manager

VASCAT *Departament de R+D*	DECLARACIÓN DE CONFORMIDAD CON LAS DIRECTIVAS 2011/65/UE RoHS, 2012/19/UE WEEE Y REGLAMENTO 1907/2006/CE REACH *DECLARATION OF COMPLIANCE WITH THE EUROPEAN DIRECTIVES 2011/65/EU, 2012/19/EU WEEE AND EUROPEAN REGULATION 1907/2006/CE REACH*	Página 1/1 Fecha 08/05/17

Torelló, 08 de mayo de 2017

La firma VASCAT, S.A. con domicilio en C/ Esquirol s/n - 08570 Torelló

DECLARA

Que los productos fabricados por VASCAT,S.A. –Motores eléctricos de CC o CA para aplicaciones de velocidad variable - así como sus accesorios standard –Electroventiladores, Dinamos tacométricas, encóderes y frenos- , son conformes a la **Directiva Europea 2011/65/UE sobre restricciones a la utilización de determinadas sustancias peligrosas en aparatos eléctricos y electrónicos,** la **Directiva Europea 2012/19/UE sobre residuos de aparatos eléctricos y electrónicos** en lo concerniente al contenido en Plomo(Pb), Mercurio(Hg), Cadmio(Cd), Cromo Hexavalente (Cr 6+), Polibromobifenilos (PBB) y Polibromodifeniléteres (PBDE) y al **Reglamento Europeo 1907/2006/CE relativo al uso de sustancias SVHC en cantidades no superiores al 0.1% (REACH) en todo su proceso de fabricación aun siendo usuarios intermedios y no estando sujetos al registro**.

Torelló, May 08th 2017

VASCAT, S.A. with address in C/ Esquirol s/n - 08570 Torelló

DECLARE

That the products manufactured by VASCAT,S.A. –Electric DC and AC motors for variable speed operation- and their standard accessories – Electric blowers, tachodinamos, encoders and brakes -, are in compliance with ***European Directives 2011/65/EU about Restrictions of hazardous substances in waste from electrical and electronic equipment – RoHS,*** *the* ***European Directives 2012/19/EU about waste of electrical and electronic equipment – WEEE –*** *as related to the content of Lead(Pb), Mercury(Hg), Cadmium(Cd), Hexavalent Chromium (Cr 6+), Polybrominated biphenyls(PBB) and Polybrominated Diphenilethers (PBDE) and the* ***European Regulation 1907/2006/CE about SVHC substances in quantity not higher 0.1% (REACH) throughout its manufacturer process although being downstream user which are not summited to registration activity.***

Josep Torras Homs
Gerente / *General Manager*
VASCAT, S.A.

3. PRODUCT DESCRIPTION

VASCAT MAC HS motors are asynchronous AC electrical machines with a squirrel-cage rotor, square laminated steel frame and forced cooling. They have been specially designed to operate in high-dynamics applications that require speed variation. They must be powered exclusively by frequency converters.

3.1 General information

The following table shows the standard technical specifications of the MAC-HS series:

Technical specifications	Description
Motor type	***Three-phase asynchronous motor with squirrel-cage rotor***
Frame sizes (Shaft heights)	***100, 132, 160, 200 and 250 mm***
No. of poles	***MAC-HS4 series: 4 poles*** ***MAC-HS2 series: 2 poles***
Protection rating (According to the IEC/EN 60034-5 standard)	***MAC-HS series: IP23***
Type of cooling (According to the IEC/EN 60034-6 standard)	***MAC-HS series: IC06***
Power-supply voltage	***Up to 500 VAC (other voltages on request)***
Insulation class (According to the IEC/EN 60034-1 standard)	***Materials Class H - Operating temperature Class F***
Mounting type (According to the IEC/EN 60034-7 standard)	***IM B3 or B35 (other types of assembly optional)***
Thermal protection (According to the IEC/EN 60034-11 standard)	***PTC140 and Pt100 probes on stator winding and Pt100 on the bearings (other sensors optional)***
Installation altitude (According to the IEC/EN 60034-1 standard)	***<1000 m above sea level***
Operating temperature (According to the IEC/EN 60034-1 standard)	***0 to +40ºC***
Vibration level (According to the IEC/EN 60034-14 standard)	***Class B***
Shaft and flange types (According to the IEC/EN 60072-1 standard)	***Solid shaft without keyway and B5 flange (other setups optional)***
Bearings	***High speed hybrid ceramic spindle bearings***
Paint	***Epoxy resin RAL 7035 colour (other types optional)***
Feedback sensors (optional)	***Incremental optical TTL, HTL and Sin/Cos 1 Vpp 1024 or 2084 ppr encoder (Other types of sensors available on request)***
Provision for torque flange assembly (optional)	***Assembly according to customer's requirements***
Blocking device (optional)	***Available with torque flange provision only***
Provision for accelerometers (optional)	***Assembly according to customer's requirements***

Table 1: General specifications of MAC-HS motors

On many occasions, VASCAT, S.A. adapts its motors to the specific requirements of each customer/application. Therefore, the above table must be understood as a general reference only. The exact specifications of each motor can be found on the corresponding technical data sheet and the additional documentation provided to the customer (where applicable).

3.2 Reference standards

The MAC-HS motors are designed and manufactured according to the Low Voltage Directive 2006/95/CE and they have been designed for their use in industrial applications as an incomplete machine or as a machine component as provided for in the 2006/46/CE Machinery Directive.

The following table summarises the main reference technical standards that have been taken into account for the design of these motors:

Standard	Description
IEC/EN 60034-1	*Rating and performance*
IEC/EN 60034-2	*Standard methods for determining losses*
IEC/EN 60034-5	*Degrees of protection*
IEC/EN 60034-6	*Cooling*
IEC/EN 60034-7	*Classification of construction types*
IEC/EN 60034-8	*Terminal markings and direction of rotation*
IEC/EN 60034-9	*Noise limits*
IEC/EN 60034-11	*Thermal protection*
IEC/EN 60034-14	*Mechanical vibration levels*
IEC/EN 60034-18	*Functional evaluation of insulation systems*
TS 60034-25	*Guidance for the design and performance of a.c. motors specifically designed for converter supply*
IEC/EN 60072-1	*Power series and dimensions of rotating electrical machines*

Table 2: Reference standards

In accordance with the current Machinery Directive, the commissioning of these motors is prohibited in the European Union until conformity of the installation has been confirmed in which the machine is to be installed (see EN 60204-1). If the electrical machine is to be used outside the European Union, the specific laws of the country in which it is located will apply. Furthermore, safety standards, local installation and industry-specific standards must be applied.

The data given in all the documentation provided by VASCAT includes tolerances in accordance with the IEC/EN 60034-1 standard and they are based on test procedures as provided in the IEC 60034-2 standard. The table shows the tolerances for some of the most relevant parameters:

Power	Efficiency	Power factor	Slip	Maximum torque	Inertia	Noise level
Pn < 150 kW	*-15% (1-η)*	*-1/6 (1-cos φ)*	*+/-20%*	*-10%*	*+/-10%*	*+3 dB*
Pn > 150 kW	*-10% (1-η)*	*-1/6 (1-cos φ)*	*+/-20%*	*-10%*	*+/-10%*	*+3 dB*

Table 3: Tolerances

3.3 Definitions

3.3.1 Duty

Three-phase induction motors are usually designed to deliver their rated power in continuous service with no overheating problems. However, most motors operate under a non-continuous type of service. Some motors are switched on for a few moments only, others work all day, but they only charge up briefly, etc. The EN 60034-1 standard defines 10 main service types and those summarised in the table below apply to MAC HS motors:

Duty	Description	Definition
S1	*Continuous duty*	*Operation under constant load, for a time duration enough to reach thermal balance.*
S2	*Short-time duty*	*Operation under constant load, for a time period shorter than required to reach thermal balance, followed by a standby period that is sufficient to cool down to ambient temperature.*
S3	*Intermittent periodic duty*	*A series of identical duty cycles consisting of a constant-load period followed by a stillstand period.*
S5	*Temporary intermittent duty with starting and electric braking*	*A series of identical duty cycles consisting of a start period, a constant-load period and an electric braking period, followed by a stillstand period.*
S6	*Continuous operation periodic duty under intermittent load*	*A series of identical duty cycles consisting of a constant-load period followed by a no-load operation period.*
S7	*Continuous operation periodic duty under intermittent load with electric braking*	*A series of identical duty cycles consisting of a start period, a constant-load period, a no-load period and an electric braking period.*

Table 4: Duty types

3.3.2 Types of construction

The following are some of the mounting types applicable to the MAC HS motors, labelled in accordance with the IEC/EN 60034/7 standard.

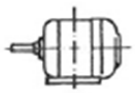
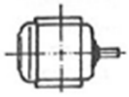
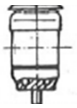
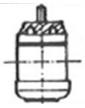
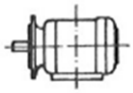
Mounting	Diagram	Assembly	Mounting	Diagram	Assembly
IM B3 IM1001		*Foot-mounting on lower horizontal plane*	IM V1 IM3011		*With flange shaft down (through-holes)*
IM B5 IM3001		*With horizontal flange (through-holes)*	IM V3 IM3031		*With flange shaft up (through-holes)*
IM B6 IM1051		*Foot-mounting on vertical plane shaft left*	IM V5 IM1011		*Foot-mounting on vertical plane shaft down*
IM B7 IM1061		*Foot-mounting on vertical plane (shaft right)*	IM V6 IM1031		*Foot-mounting on vertical plane shaft up*
IM B8 IM1071		*Foot-mounting on upper horizontal plane*	IM V18 IM3611		*With flange shaft down (threaded holes)*
IM B14 IM3601		*With flange (threaded holes)*	IM V19 IM3631		*With flange shaft up (threaded holes)*
IM B35 IM2001		*Flange-mounting (through-holes) and feet*	IM V15 IM2011		*Flange-mounting (through-holes), shaft down and feet*
			IM V36 IM2031		*Flange-mounting (through-holes), shaft up and feet*

Table 5: Types of construction

3.3.3 Degree of protection IP

The degree of protection of electrical machines is defined in accordance with IEC/EN 60034-5. Said standard specifies the degree of protection of each machine using an 'IP' code, which comprises two digits:

- First digit: Indicates the degree of protection for contact and solid bodies.
- Second digit: Indicates the degree of protection for water.

The table below shows the meaning of each digit:

First digit	Protection offered	Second digit	Protection offered
0	*No special protection against contacts. No protection against the penetration of solid foreign bodies.*	0	*No special protection against water.*
1	*Protection against casual contacts of large surfaces, e.g. a hand. Protection against the penetration of solid foreign bodies with a diameter of more than 50 mm.*	1	*Protection against drops of water that fall vertically.*
2	*Protection against contact with fingers. Protection against the penetration of solid foreign bodies with a diameter of more than 12mm.*	2	*Protection against drops of water falling at an angle of up to 15º from the vertical axis.*
3	*Protection against contacts with tools, wires, etc. with a diameter of more than 2.5 mm. Protection against the penetration of solid foreign bodies with a diameter of more than 2.5mm.*	3	*Protection against water sprayed at an angle of more than 60° from the vertical axis.*
4	*Protection against contacts with tools, wires, etc. with a diameter of more than mm. Protection against the penetration of solid foreign bodies with a diameter of more than 1mm.*	4	*Protection against water sprayed in any direction*
5	*Full protection against contacts. Protection against damaging dust deposits.*	5	*Protection against jets of water in any direction.*
6	*Full protection against contacts. Full protection against the penetration of dust.*	6	*Protection against the beating of the sea.*
		7	*Protection against temporary immersion under a specified pressure and for a specified time.*
		8	*Protection against prolonged immersion.*

Table 6: IP code

For example, a machine defined as IP54 indicates complete protection against contact and water spraying from any direction.

3.3.4 Cooling Methods

The cooling methods used in electrical machines are regulated by the IEC/EN 60034-6 standard. In order to identify the cooling method used in each motor, it is also given a code similar to the IP protection rating. There are two types of code: complete code (e.g. IC9A7W7) and short code (e.g. IC97W). Both begin with the initials IC (International Cooling).

The table below shows the most common cooling methods for MAC HS motors:

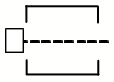
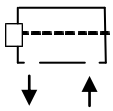
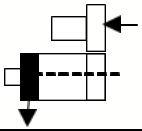
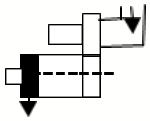
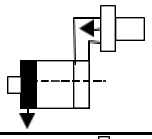
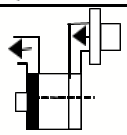
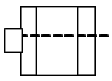
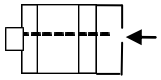
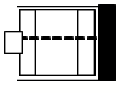
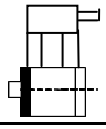
SHORT CODE	COMPLETE CODE	EN60034-6	DESCRIPTION
IC00	IC0A0		*Free circulation using the surrounding medium by means of free convection*
IC01	IC0A1		*Self-ventilated with integral fan cooling, Cooling air is blown through the motor by a fan mounted on the shaft*
IC06	IC0A6		*Separate ventilation with radial fitted fan unit, Cooling air is blown through the motor by a separately excited fan motor. The inlet side may be equipped with an air filter.*
IC16	IC1A6		*Circulation via pipe or duct, Cooling medium is supplied by external part*
IC17	IC1A7		*Single pipe ventilated, Cooling air is blown across the motor through the pipe connection with a separate customer provided external blower fan and discharges on the other side to open space.*
IC37	IC3A7		*Double pipe ventilated, Cooling air is blown across the motor through a pipe connecting by means of a separate customer provided external blower fan and discharges on the other side's pipe connecting.*
IC410	IC4A1A0		*Totally-enclosed nonventilated, Cooling without using a fan, only by natural ventilation and radiation on the totally enclosed motor surface.*
IC411	IC4A1A1		*Totally-enclosed fan-cooled, Cooling air is blown over the totally enclosed motor surface by a fan mounted on the shaft.*
IC416	IC4A1A6		*External surface cooling, Cooling air is blown over the totally enclosed motor surface by an separately excited fan motor.*
IC97W	IC9A7W7		*Cooling using an independent heat exchanger by means of liquid coolant or remote fluid*

Table 7: Cooling methods

3.3.5 Vibration grade

The EN 60034-14 international standard specifies the factory acceptance vibration test procedures and vibration limits for certain electrical machines under specified conditions, when uncoupled from any load or prime mover.

The standard defines two vibration grades: Grade 'A' (machines with no special vibration requirements); and Grade 'B' (machines with special vibration requirements).

The table below shows the limits of maximum vibration magnitude in displacement, velocity and acceleration (RMS) for shaft height (H):

Vibration grade	Shaft height (mm)	56 ≤ H ≤ 132			132 < H ≤ 280			H > 280		
	Mounting	Displacement µm	Vel. mm/s	Accel. m/s²	Displacement µm	Vel. mm/s	Accel. m/s²	Displacement µm	Vel. mm/s	Accel. m/s²
A	*Free suspension*	*25*	*1.6*	*2.5*	*35*	*2.2*	*3.5*	*45*	*2.8*	*4.4*
	Rigid mount	*21*	*1.3*	*2*	*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 mount				*14*	*0.9*	*1.4*	*24*	*1.5*	*2.4*

Table 8: Limits of maximum vibration magnitude

When no grade is specified, machines complying with this standard shall be grade "A".

3.3.6 Insulation class

The insulation thermal class rating of an electrical machine is identified on the motor nameplate by means of a letter in accordance with the IEC/EN 60034-18 international standard.

The table below summarises the maximum allowed temperature in the insulation system of a winding in accordance with its insulation thermal class rating:

Thermal class rating	Thermal class
A	*105ºC*
E	*120ºC*
B	*130ºC*
F	*155ºC*
H	*180ºC*

Table 9: Thermal classes

3.3.7 Stress category severity

The table below describes the four stress categories defined in the IEC 6034-18-41 international standard:

Stress category	Overshoot Factor (OF) Up/Ua	Impulse Risetime
A – Benign	OF ≤ 1,1	0,3 µs
B – Moderate	1,1 < OF ≤ 1,5	
C – Severe	1,5 < OF ≤ 2,0	
D – Extreme	2,0 < OF ≤ 2,5	

Table 10: Phase-to-ground stress categories

3.3.8 Heating limits

The IEC60034-1 international standard defines the maximum admissible heating (temperature rise) for the windings as specified in the table below:

Thermal Class	Coolant temperature	Heating (per element)	Operating temperature
B (130ºC)	< 40ºC	< 80ºC	< 120ºC
F (155ºC)	< 40ºC	< 105ºC	< 145ºC
H (180ºC)	< 40ºC	< 125ºC	< 165ºC

Table 11: Heating limits

In this regard the rated working conditions of the motor must be such that the operating temperature on the windings is always below the temperature specified by the insulation class of its composing materials. Therefore, the working thermal class of a motor can correspond to the following:

a) **The same thermal insulation class**. This would be the case of a motor built with **Class F** insulation (155°C) with a maximum working temperature of 140°C, corresponding to a **Class F**.

b) **A thermal class lower than the insulation class**. This would be the case of a motor built with **Class H** insulation (180°C) with a maximum working temperature of 140°C, corresponding to a **Class F**.

3.4 Nameplate

All MAC-HS motors are provided with the following nameplate:

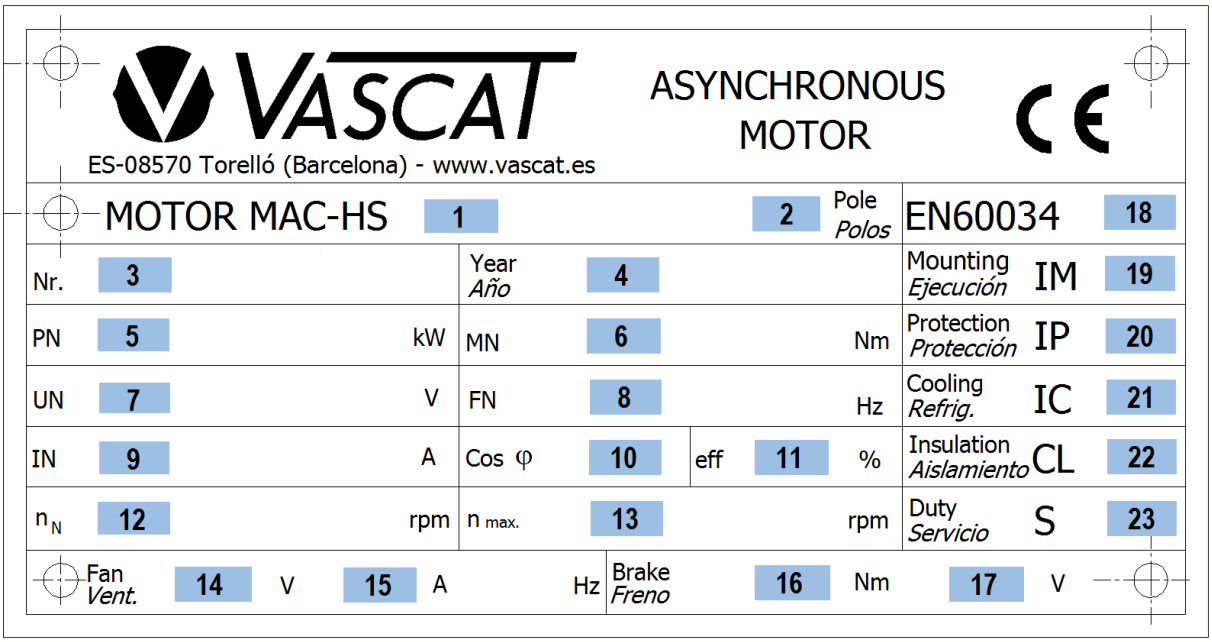


Figure 1: MAC-HS motor specifications plate

The table below describes the included motor nameplate data:

Pos.	Description	Pos.	Description
1	*Motor type*	2	*No. of poles*
3	*Serial No.*	4	*Year of manufacture*
5	*Rated power PN in kW*	6	*Rated torque MN in Nm*
7	*Rated voltage UN in V*	8	*Rated frequency FN in Hz*
9	*Rated current IN in A*	10 / 11	*Power factor Cos φ / Efficiency in %*
12	*Rated speed n_N in rpm*	13	*Maximum mechanical speed n_{max} in rpm*
14 / 15	*Voltage (V) and Current (A) of the axial fan(*)*	16 / 17	*Torque (Nm) and Voltage (V) of the brake (**)*
18	*EN60034 family of reference standards*	19	*Mounting type Code IM (EN60034-7)*
20	*Protection rating IP code (EN60034-5)*	21	*Cooling method IC code (EN60034-6)*
22	*Winding working temperature CL code (EN60034-1)*	23	*Duty S code (EN60034-1)*

Table 12

(*) positions ***14 / 15*** are checked only if there is an axial fan.
(**) Positions ***16 / 17*** are checked only if there is a parking brake.

3.5 General specifications

3.5.1 Motor code

MAC-HS series motors are coded as follows:

MAC	*HS*	*200*	*M*	*H41*
Motor type	***Series***	***Size***	***Length***	***Winding***
MAC Asynchronous Motor for Inverter Duty IP23 – IC06	***HS4*** 4 pole / High-speed	***100*** ***132*** ***160*** ***200*** ***250*** Shaft height (mm)	***S*** ***M*** ***L*** ***P*** ***X***	Defines the rated motor speed
MAC Asynchronous Motor for Inverter Duty IP23 – IC06	***HS2*** 2 pole / High-speed	***250*** Shaft height (mm)	**L**	Defines the rated motor speed

Table 13: MAC-HS motor codes

3.5.2 Ambient conditions

In their standard version, MAC HS motors are not suitable for working in saline or corrosive atmospheres or for installation outdoors.

3.5.3 Duty

The rated power assigned for continuous service (S1 duty type) assumes an ambient temperature between -20º and +40ºC and altitudes of up to 1000 m.

If the working conditions are different from those above, a derating factor (K1) must be applied to the rated torque and power (See table below):

Altitude	Temperature			
	30ºC	40ºC	50ºC	55ºC
1000 [m]	*1*	*1*	*0.92*	*0.86*
2000 [m]	*1*	*0.93*	*0.85*	*0.77*
3000 [m]	*0.93*	*0.85*	*0.76*	*0.69*
4000 [m]	*0.86*	*0.78*	*0.67*	*0.6*

Table 14: Declassing factors

If the motor does not work in continuous service (S1), but rather in an S2 Short-time duty type, a multiplication factor must be applied (K2) to the torque and power specified on the nameplate (S1 Service) to determine the torque available for this service. The K2 factor is determined by the duration of the service according to the graph below.

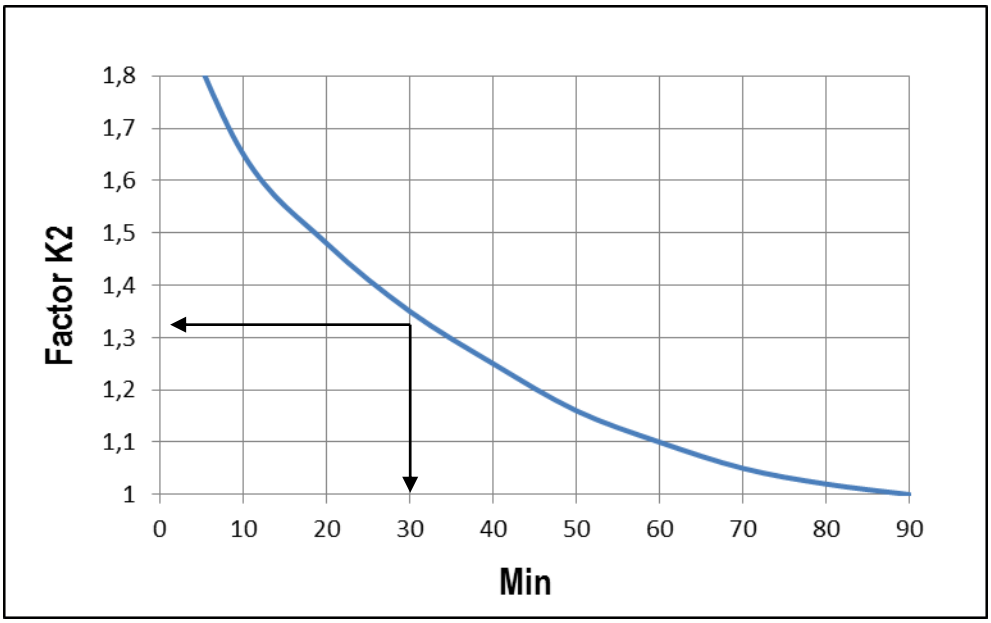


Figure 2: Derating factor for an S2-type service

3.6 Mechanical specifications

3.6.1 Mounting

Available construction types for MAC HS motors are detailed in the table below:

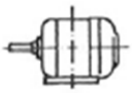
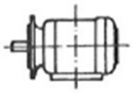
EN 60034-7		FRAME SIZES				
		100	132	160	200	250
	IM B3 IM 1001	*OK*	*OK*	*OK*	*OK*	*OK*
	IM B3/B5 IM 2001	*OK*	*OK*	*OK*	*OK*	*OK*

Table 15 Available construction types for MAC-HS motors

Other assembly types, such as 'trunnion' (double flange), available on request.

3.6.2 IP protection rating

MAC-HS series motors are defined with the following IP degrees:

Motor	Standard version	Optional ratings
MAC-HS	*IP23*	*IP54*

Table 16: Protection rating of MAC-HS motors

The motors defined as IP23 must take some precautions if they are installed in environments that are dusty, damp or subject to adverse weather.

3.6.3 Cooling Method

The table below summarises the available cooling methods for the MAC HS motors:

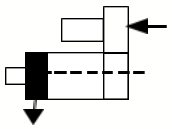
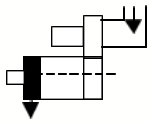
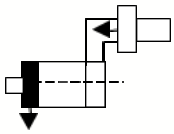
COOLING	EN60034-6	PROTECTION
IC06		IP23
IC16		IP23
IC17		IP23

Table 17: cooling types available for MAC-HS motors

3.6.4 Balancing and vibration grade

MAC-HS motors are defined as B-grade vibration level machines (according to EN 60034-14) or G1.6 (according to ISO1940/1).

3.6.5 Bearings

MAC-HS motors include different bearings types depending on their frame size (shaft height). The table below summarises the bearings considered standard for each of them:

Motor type	Bearing		n	L10h	C	P max
			rpm	h	N	N
MAC-HS 100	*D.E.*	*Deep grove ball bearing*	3000	20000	***16600***	1083
	N.D.E.	*Deep grove ball bearing*	3000	20000	***16000***	1044
MAC-HS 132	*D.E.*	*High speed hybrid spindle bearing*	3000	20000	***21600***	1409
	N.D.E.	*High speed hybrid spindle bearing*	3000	20000	***21600***	1409
MAC-HS 160	*D.E.*	*High speed hybrid spindle bearing*	3000	20000	***17300***	1129
	N.D.E.	*High speed hybrid spindle bearing*	3000	20000	***17300***	1129
MAC-HS 200	*D.E.*	*High speed hybrid spindle bearing*	3000	20000	***19600***	1279
	N.D.E.	*High speed hybrid spindle bearing*	3000	20000	***19600***	1279
MAC-HS 250	*D.E.*	*High speed hybrid spindle bearing*	3000	20000	***19600***	1279
	N.D.E.	*High speed hybrid spindle bearing*	3000	20000	***19600***	1279

Table 18: Technical specifications of MAC HS motor bearings

N.D.E. = Rear / Non Drive End DE = Front / *Drive End*

TERMINOLOGY:

n = Reference speed for calculating L10h service life
L10h = Bearing service life, in h
C = Rated dynamic load of bearing
max P = Radial load admissible on bearing for L10h and n
All bearings mounted in MAC-HS motor series are greased for life
The specific bearing reference is given in each motor test report

MAC-HS motors include as standard an SGR shaft grounding ring and galvanic insulation on bearings to prevent problems caused by bearing currents.

A motor may need some type of special execution (considered as non-standard) that includes a bearing different to those specified above. In said case, the customer must check with VASCAT to make sure that he has all the relevant information.

3.7 Electrical specifications

3.7.1 Windings and insulation

MAC-HS motor coil windings are made up of copper wires with two coats of polyamide varnish > 220°C and/or THEIC-Polyesterimide with Amide-Imide > 200°C, rated with H-type insulation class.

They are impregnated or encapsulated using single-component epoxy resins that polymerise on the basis of temperature, also class H.

The windings are insulated from the stator core using NMN sandwich-type paper (Nomex-Mylar-Nomex). The outer parts of the sandwich (Nomex) are fibres, whereas the core (Mylar) is a plastic film of polyethylene terephthalate. Special care is also taken with the insulation between each phase.

This insulation system guarantees appropriate dielectric resistance for the motor to work with frequency converters, even on the most critical applications.

3.7.2 Connections

The connections between the windings and the terminal box are made using a flexible cable coated with ETFE capable of withstanding up to 150°C. The connections are welded using a FUSBAT650 rod. The welds of the contacts are also protected by a double layer of fibreglass insulation pipe with class-H acrylic impregnation.

3.7.3 Power-supply conditions

MAC-HS motors are designed to work with a power supply via frequency converters and they can withstand BUS DC voltages (after rectifying the mains voltage) up to 700 VDC (500 VAC).

With regard to admissible voltage surges, MAC HS motors can withstand a B-type peak voltage on terminals, as described in the following graph from technical specification TS 60034-25 of the IEC:

Voltage impulse isolation class	Admissible operation voltage peak to peak	
	Phase / Phase C	*Phase / Ground B*
IVIC C/B	*5,9 [U_N]*	*3,1 [U_N]*

Table 19: Maximum allowable operating voltage at machine terminals

Furthermore, the drive switching frequency connected to a MAC HS motor must be at least as summarised in the table below:

Power	Working frequency	Switching frequency
P > 100kW	f > 40 Hz	*4 kHz*
	f ≤ 40 Hz	*2 kHz*

Table 20: Admissible switching frequency

Otherwise, the rated features of the motor, shown on its nameplate, must be derated. Please check with VASCAT to determine the resulting values.

3.7.4 Standard thermal protection

MAC HS motors include a PTC140-type thermistor on their stator windings. It is a solid-state device whose resistance varies significantly with temperature and provides a *Contact Open (OFF) / Contact Closed (ON)* type logical signal depending on whether or not the temperature of the motor windings exceeds the reference temperature of the sensor, in this case 140°C.

Its operation curve is as follows:

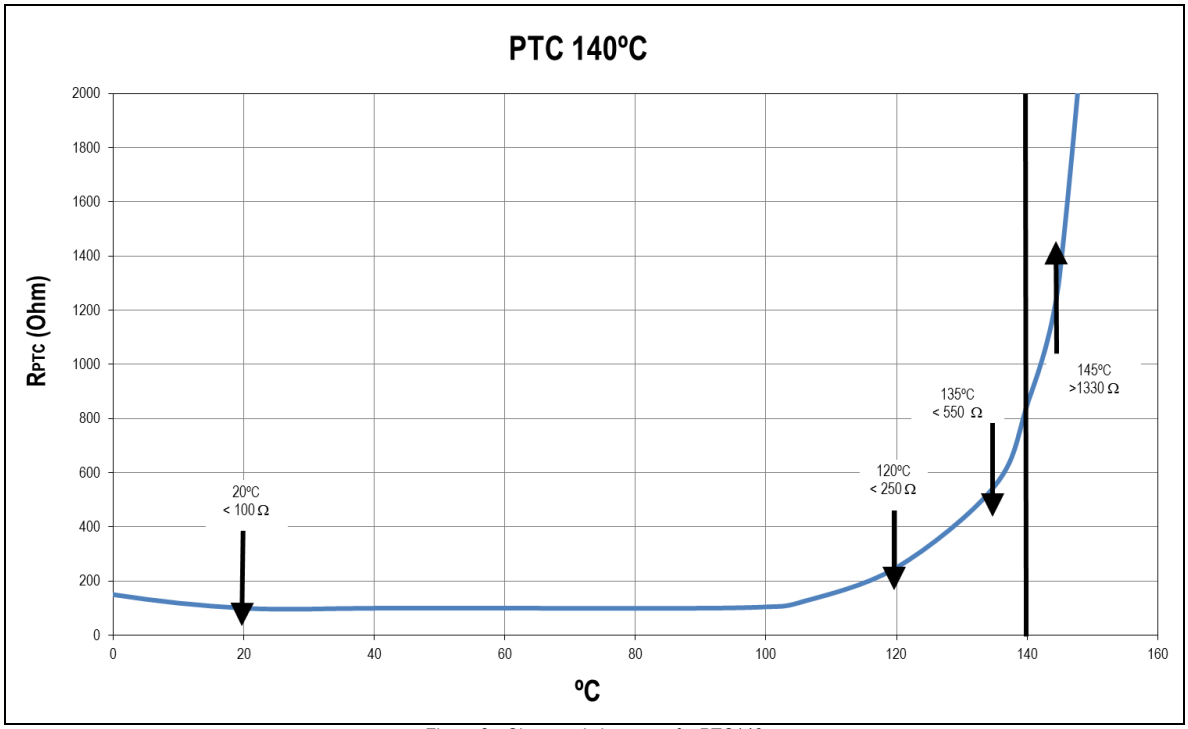


Figure 3: Characteristic curve of a PTC140

Said ON/OFF logical signal can be used by an external control circuit to process an alarm system to prevent the motor from overheating.

3.7.5 Thermal sensors

MAC HS motors also include the following linear probes: 1xPt100 (on the winding) and 2xPt100 (one on each bearing) which would monitor the operating temperature at all times. Alternatively KTY84-130 probe can be also installed on the windings. The following graphs correspond to said sensors.

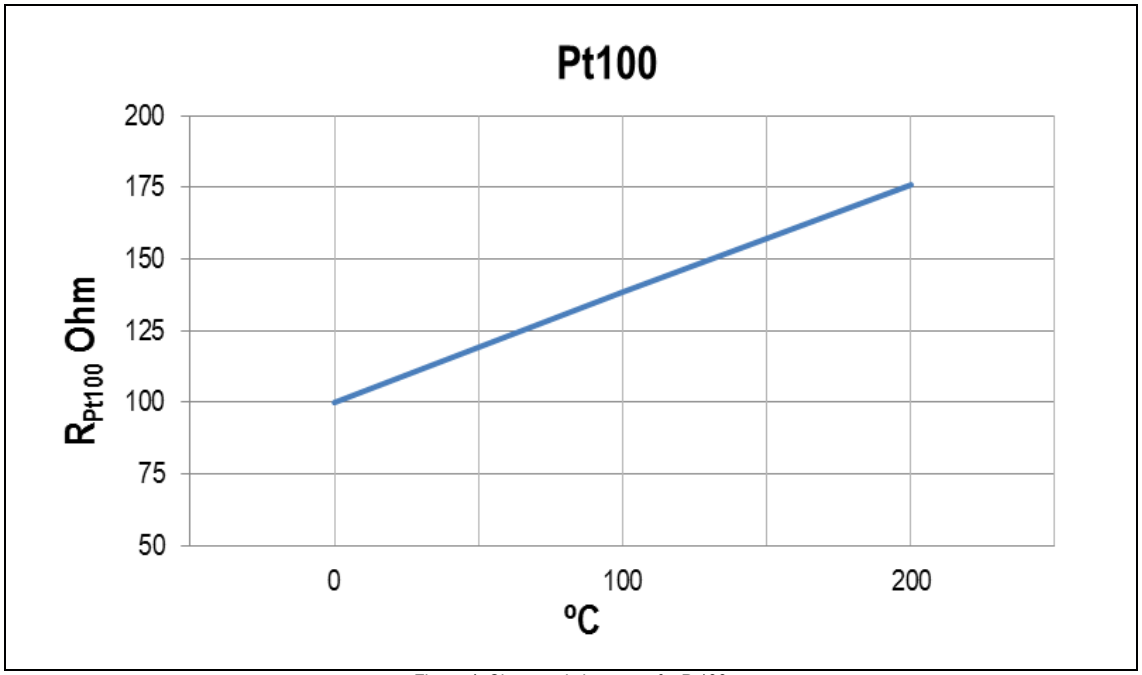


Figure 4: Characteristic curve of a Pt100

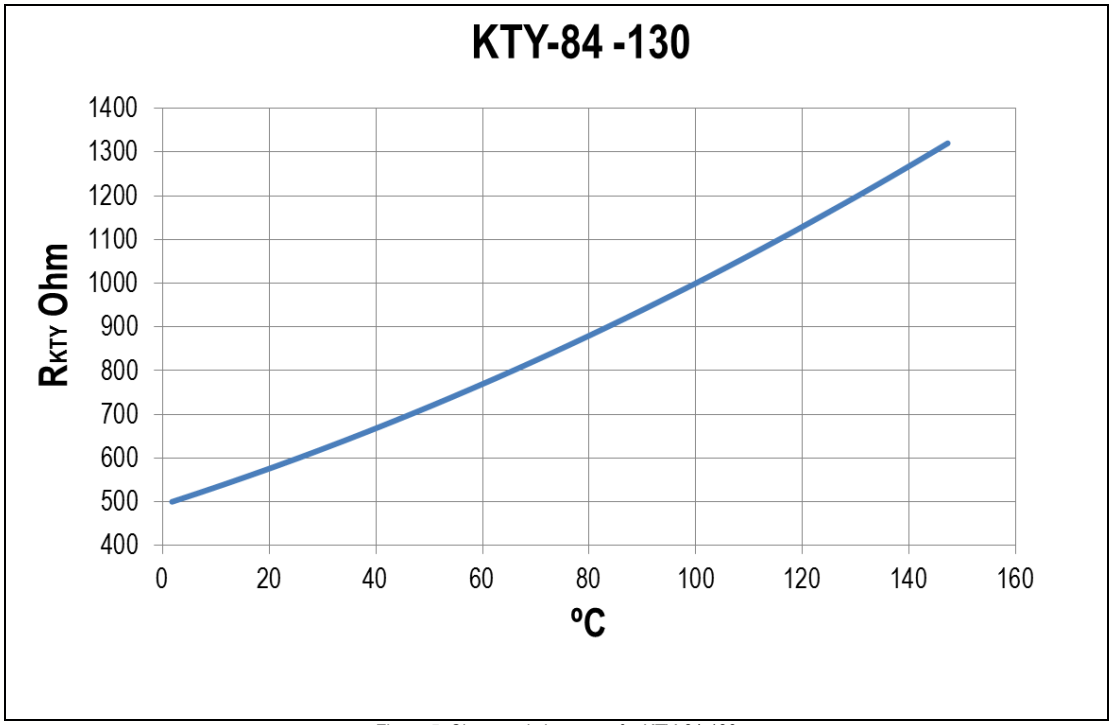


Figure 5: Characteristic curve of a KTY-84-130

Please check with VASCAT for each specific case.

3.7.6 Anti-condensation heaters

As an option (on request), one or two heating elements can be installed on the winding heads to prevent condensation on the motor windings when the motor is to be installed at a site with high relative humidity (> 85%).

The standard VASCAT type is 50 W 230 VAC.

3.7.7 Fan and pressure gauge

MAC-HS series motors are air-cooled using a forced ventilation system that includes one or two electric fan powered independently from the motor.

The fan on the MAC-HS series motors can be installed in the following positions:

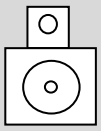
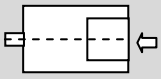
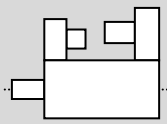
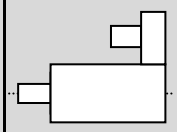
Motor	Shaft height	Circulation direction	No. fan units	Standard position	Optional positions
MAC-HS4	*100* *132* *160 S, M*	*Blowing*	*1*	*Top* 	*Side* 
MAC-HS4 MAC-HS2	*160 L, P* *200* *250* *250*	*Blowing*	*2*	*Top* 	*Top/Side* 

Table 21: Fan position

Other mounting options are possible on request.

The standard versions of these units are powered with single-phase or three-phase alternating current (see motor technical data sheet for more information). Other ventilation methods can be studied on request.

Radial electric fans incorporate a washable filter to prevent incoming particles from damaging the motor. This filter requires regular maintenance (see subsequent sections). This type of fan can include, (on request) an anemostatic relay (pressure gauge) with a set of NC/NA contacts that open/close when the airflow is insufficient.

3.8 Accessories

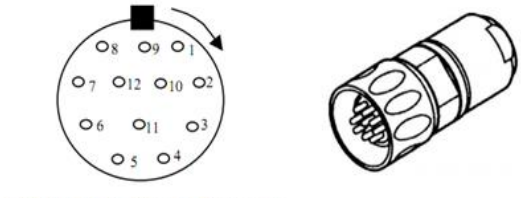
3.8.1 Feedback sensors

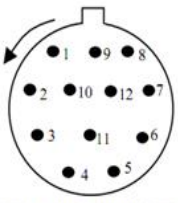
MAC-HS series motors can be fitted with different types of feedback sensors. As standard models, VASCAT offers the following incremental optical encoders:

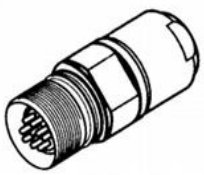
Specifications	Type A	Type B	Type C
Number of pulses per revolution	*1024 / 2048*	*1024 / 2048*	*1024 / 2048*
VDC power supply voltage	*5*	*10 ÷ 30*	*5*
Output logic	*RS422 TTL Line driver*	*Push-Pull HTL*	*Sin/Cos 1Vpp*
Output voltage High level	*> 2.5 V*	*> VDC- 3 V*	*-*
Low level	*< 0.5 V*	*< 2.8 V*	*-*
Max. output frequency	*300 kHz*	*300 kHz*	*450 kHz*
Load capacity	*120 mA*	*150 mA*	*120 mA*
Maximum cable length	*100 m*	*100m*	*150m*
Short-circuit protection	*No*	*Yes*	*Yes*
Operating temperature	*-10 / 100ºC*		
Protection rating	*IP64*		
Hollow shaft diameter	*12mm*		
Male connector (encoder side)	*CONIN M23 12 poles with anticlockwise numbering*		

PINS

PIN No.	Signal
1	B'
2	VDC sensor
3	N
4	N'
5	A
6	A'
7	N.C.
8	B
9	N.C. (*)
10	0V supply
11	0V sensor
12	VDC supply









*Cable screen on cable + connector versions.

Table 22: Standard feedback sensors on MAC-HS motors

Solid shaft encoders are used with a coupling flange on the stator and an elastic coupling on the shaft, with thermal and galvanic insulation.

When specifically requested by the customer, other types of encoders and/or feedback sensors can be fitted. Please check with VASCAT for each specific case.

3.8.2 Provision for torque flange assembly

As an option, motors in the MAC-HS series can be adapted for the direct assembly of a torque flange or torque meter. The assembly type is adapted according to each customer's specific requirements. The following figure shows one possible design:

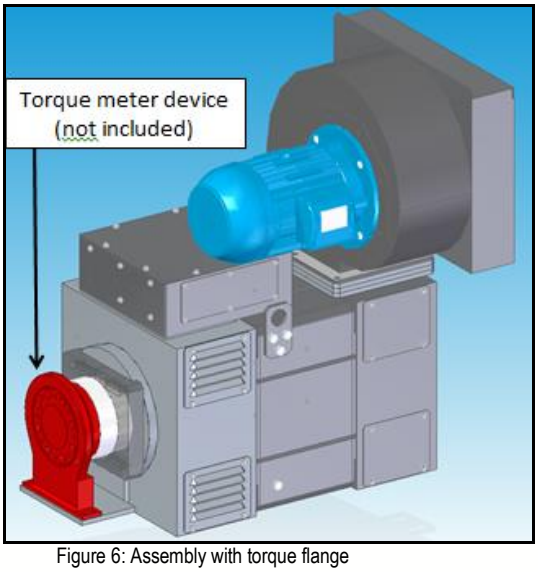


Figure 6: Assembly with torque flange

3.8.3 Blocking device

As an option, MAC-HS series motors can be fitted with a rotor blocking device, which may be necessary for calibrating certain torque sensors. The design of this device can be adapted to each customer's requirements. The following figure shows one possible design:

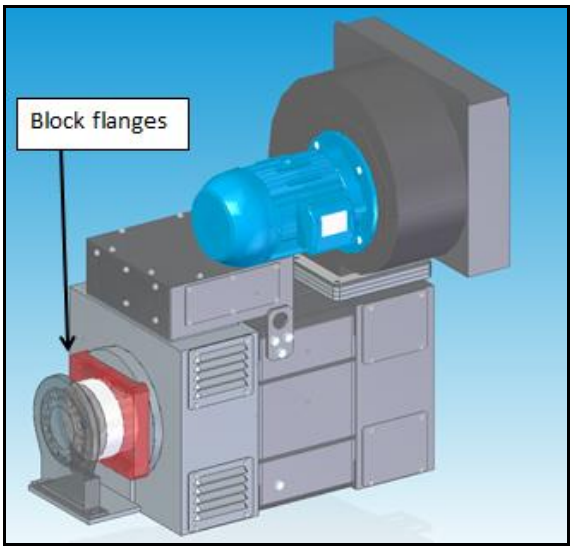


Figure 7: Assembly with blocking device

3.8.4 Provision for accelerometer assembly

As an option and according to the customer's specifications, motors in the MAC-HS series can be adapted for accelerometer assembly. This type of sensor provides information about the vibrations in the motor. Accelerometers can be fitted at different places on the motor according to each customer's requirements. The following figure shows one possible setup:

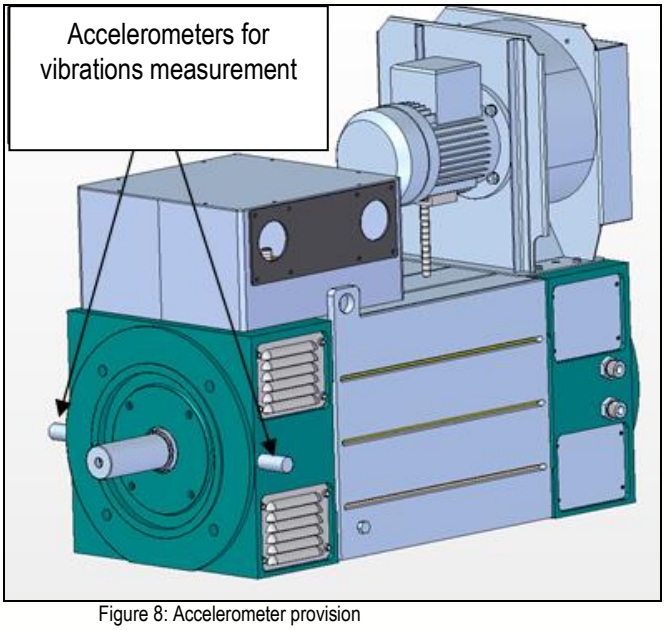


Figure 8: Accelerometer provision

3.8.5 Noise level

The technical data sheets VASCAT provides for each motor show the noise level in dB issued by each model.

Optionally, motors can be fitted with a kit to reduce the level of noise emissions. Please check with VASCAT for more details.

The machines directive specifies a noise level of 80 dB at work posts. The user is responsible for guaranteeing said level using the installation of external absorption devices if necessary.

4. SHIPMENT, RECEPTION, TRANSPORT AND STORAGE

4.1 Shipment

MAC-HS motors are shipped in completely closed packaging, including a wooden pallet that has been given phytosanitary treatment. The specific type of packaging may vary according to the destination and the type of transport used.

In general, for road transport, the packaging consists of a box of dual-layer corrugated cardboard, clipped and tied with a heat-sealed strap on the palate; for transport by sea or air, it consists of a wooden box that has been given phytosanitary treatment fastened to the pallet using nails or screws.

By request, other types of packaging may be considered according to the customer's specifications.

Please check with VASCAT for more details of each shipment.

4.2 Reception

When the goods have been received, the customer is responsible for checking that the packaging has not been damaged and is in perfect condition. If that is not the case, the circumstance must be recorded on the haulier's delivery documentation and a claim must be filed immediately with the haulage company for the damages that have been caused.

When it has been removed from the packaging, the material must be checked to ensure that it has been delivered in accordance with the details on the documents sent with the shipment, together with the fact that it is in a correct state of repair. Otherwise, a claim must be filed immediately with VASCAT for the faults that have been seen or for an incomplete shipment.

VASCAT declines all responsibility for damages claimed thereafter.

NB
Do not start up a machine that has been damaged under any circumstances.

4.3 Transport

The machine must be transported always in accordance with the following instructions:

WARNING

Transport and lifting of the machine by the eyebolts only

For the correct handling of the motor, several eyebolts have been fitted on the top of the housing exclusively for said purpose. Therefore, do not lift the motor using the shaft or the fan casing under any circumstances.

To lift the machine, use guide devices (cables, chains or slings) with safety hooks on the ends. See diagram:

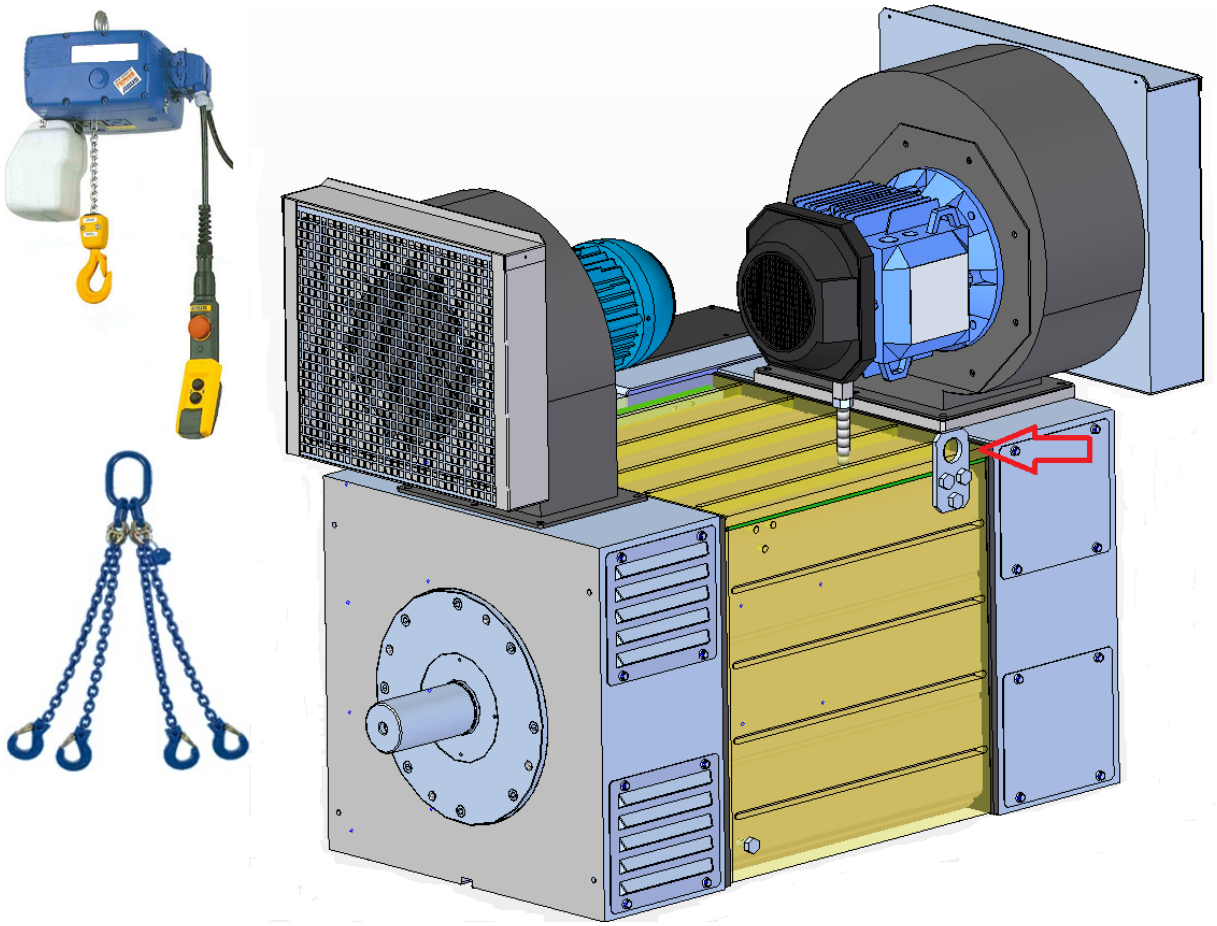


Figure 9:Transport and lifting of the motor

The lifting apparatus and guide devices must have sufficient load capacity to lift the machine. Please see that technical data sheet for the motor to know how much each model weighs.

Sudden movements and knocks must be avoided during transport.

4.4 Storage

MAC-HS motors can be stored for long periods (up to 2 years) without their specifications being affected. They must be stored in a dry, dust-free place with no aggressive atmosphere or vibrations and no sudden temperature changes.

PRECAUTION
Damages caused by outdoor storage The machine may be damaged if it is stored outdoors.

The machine must be stored only in indoor areas that meet the following conditions:

- They must be dry, dust-free, icing proof and have no vibrations. The relative humidity of the air must be below 60%; in accordance with EN 60034-1, the temperature must not be below -15ºC.
- It must be well ventilated.
- It must provide protection against extreme bad weather.
- The ambient air must not contain aggressive gases.

The machine must be protected against knocks and humidity and its entire surface must be appropriately covered.

If the machine cannot be stored in a dry place, the following measures must be adopted:

- Cover the machine using a plastic film or similar with a drying material (silica gel) inside.
- Package the unit in a sealed box.
- Place several bags of drying agents in the sealed box. Check the drying product regularly and replace it as necessary.
- Control the humidity level in the sealed packaging by placing indicators that show the air humidity level in the packaging at different levels.

If the machine is to be stored for a relatively long period (more than 6 months), it must be checked regularly (every 3 months) to ensure that it is in a perfect state of repair and that there are no faults. The required maintenance work must be carried out and the storage enclosure must be climate-controlled.

PRECAUTION
Damage caused by condensation water Condensation water may gather in the machine owing to important variations in ambient temperature, direct sunlight or high air humidity levels during storage. If the stator winding is damp, its insulation resistance is reduced. This leads to disruptive discharges that can destroy the winding. Furthermore, condensation water may form oxide or mould inside the machine. This is why it is important to follow VASCAT's storage recommendations to the letter.

5. INSTALLATION AND START-UP

The following describes the conditions that are necessary for the installation and start-up of the machine.

5.1 Motor installation

5.1.1 Site

A correct site is essential for guaranteeing a long motor service life. The use of the motor in an incorrect site could shorten its service life considerably. The following are some points to bear in mind when choosing the correct site for the motor:

a) The chosen site must comply with the ambient temperature range and altitude for which the motor was selected (for more details, see section 3.5.3).



HOT SURFACE

The exterior surface of the motors can reach temperatures of more than 60°C and, therefore, the appropriate precautions must be taken to avoid accidental contact (the motor bears a plate indicating said circumstance).

b) The site must have a humidity level of less than 85% to prevent condensation appearing on the surface. If the humidity levels at the site exceed 85%, the motor must be fitted with anti-condensation heaters (see section 3.7.6).

c) The air inlet and outlet must not be blocked. There must be no recirculation of hot air from the outlet to the inlet.

PRECAUTION

Damages caused to the motor by blocking the airflow at the motorised fan inlet

Damages may be caused to the motor if there is an insufficient airflow at the motorised fan inlet due to the selection of an incorrect site for the machine. If the machine does not have sufficient cooling airflow, the windings may overheat and the corresponding consequences may arise.

5.1.2 Mounting

Correct mounting is essential to guarantee a long service life for the motor. The following are essential issues that need to be taken into account when anchoring the motor correctly:

IM B3 Foot-mounting:

a) Ensure that the support base is correctly levelled: the motors must be mounted on a solid, flat base that is perfectly level. If the base is not made up of one single compact surface, the motor feet support services must be on the same level. To level the machine correctly, the feet may have to be gauged using steel plates to avoid the appearance of mechanical tension.

PRECAUTION
Damages caused to the motor by the incorrect levelling of the support base The incorrect levelling of the motor reduces the service life of the bearings and other parts of the transmission.

b) Use an appropriate base for the assembly work: Make sure that the base on which the motor is to be located meets the following specifications:

- The dimensions of the base correspond to those of the motor feet. Make sure that the entire area of each of the 4 motor feet rests perfectly on a solid base.
- Make sure that the base is capable of supporting the weight of the motor without problem. If the base were to go out of shape over time, the motor may not be level, which would reduce the service life of the motor substantially, especially the bearings.
- Make sure that the base is sufficiently heavy-duty to counter the torque provided by the motor without noticeable deformation.
- Make sure that the base is sufficiently rigid for there to be no resonances in the motor operation speed range.

c) Make sure that there are no additional loads on the motor: Consideration must be given to the weight of the couplings and pulleys and the resulting axial and radial loads to ensure that the motor bearings are dimensioned correctly (the maximum admissible radial loads for each motor are specified in the Table 18).

d) Fastening the feet: When the motor has been installed on a base that meets all the aforementioned, the motor must be firmly fastened in position using the 4 holes machined on the feet (for said purpose) and bolts of the appropriate size for said holes. The diameter of the holes machined on the motor feet comply with the motor shaft height according to the EN 60072 standard. The leg bolts must be selected according to the loads applied to the motor and in compliance with the ISO 898-1 standard, which defines the mechanical properties of the bolts according to their quality.

Fastening using IM B5 or IM B14 flanges:

a) Remove the anti-rust varnish: First of all, clean the surface of the flange before fastening.

b) Connect and fastened the counter-flange: For correct fastening, use bolts with an appropriate diameter in accordance with the dimensions of the flange as per the EN 60072 standard.

c) Make sure of the perpendicularity of the machine shaft and the counter-flange plane: Perpendicularity errors must be below 0.05 mm.

d) Make sure that the counter-flange is appropriate: In accordance with section b) of the IM B3 assembly.

NB
Application of additional loads on the flange The motor flange is dimensioned only to support its own weight. If there are additional loads, the flange may not be sufficiently heavy duty and, therefore, faults may occur that affect the motor and the machine to which it is coupled.

5.1.3 Machine coupling

The motor must be coupled to the machine very carefully since it is fundamental in order to ensure the correct service life of the motor.

Clean carefully the shaft surface before mounting the coupling.

PRECAUTION
Damages to the motor bearings Prevent solvent from entering the interior of the bearings since they could be damaged.

If the motor works with a direct drive (coupled directly to the load), the appropriate coupling must be used to compensate the alignment errors and radial forces that are applied. Please check with VASCAT in case of doubt.

In any case, make sure that the alignment between the motor shaft and that of the machine corresponds to the coupling between both parts.

PRECAUTION
Damages to the shaft and bearings Excessive misalignment can cause overloads on the bearings and break the shaft or cause the bearings to seize up through fatigue. The customer is responsible for ensuring the correct alignment of both shafts.

VASCAT motors and rotors are dynamically balanced (in accordance with the 60034-14 standard). To ensure the correct balance of the entire transmission unit, all the parts of the transmission system must also be balanced (pulleys, couplings, etc.).

The installation of the coupling or the transmission element must be made gently without knocking, previously heating the pulley or using an appropriate tool (please see Figure 10).

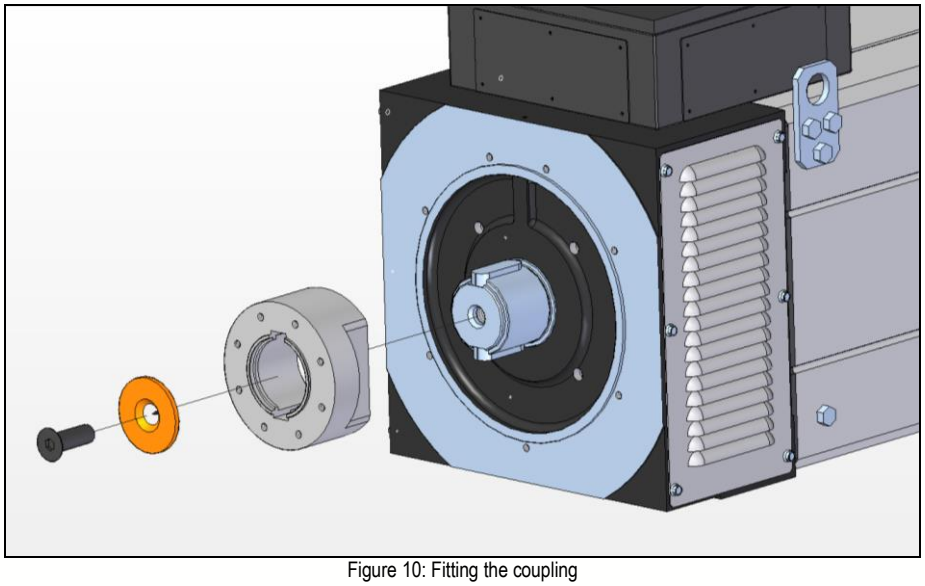


Figure 10: Fitting the coupling

PRECAUTION
Damages to the motor bearings If the motor shaft is knocked, the bearings may be damaged.

If belts are used for the transmission of the torque or a gear with radial load, make sure that the admissible radial load is not exceeded on the motor shaft. The specific data for the admissible radial loads for each size of motor can be found in the Table 18 description of the bearings given in previous sections.

5.2 Electrical connections

WARNING

All the work must be performed by responsible, skilled personnel and when the motors are completely stopped and isolated from the mains. Always check that there is no voltage!

PRECAUTION

Damage to the windings

Before the connection, check the status of the insulation elements of the windings with regard to earth, since long or inappropriate storage or transport may have caused the motor to absorb humidity, which affects the capacity for insulation.

The insulation reference values considered safe by VASCAT are as follows:

Parameters	Reference values
Recommended measurement voltage	***500 V***
Minimum insulation resistance with new or repaired windings	***60 MΩ***

Table 23: Insulation reference values for MAC-HS motors

If the humidity or dirt returns a value below the specified figure, the windings must be cleaned or dried until measurements in the safe range are obtained.

WARNING

Dangerous voltage

When measuring the resistance of the winding insulation and just after the measurement, the terminals are live. Contact with any live part may cause serious injury or even death.

Do not touch the terminals during the measurement process or immediately afterwards. Before any contact, discharge the terminals to earth using an insulated cable.

Grounding points are located inside the terminal box and also on motor sides. Each of them are identified by the corresponding sign ⏚

5.2.1 Connection strips and terminals

The motor has a terminal box with the corresponding electrical connection strip and connection bolts for the current of each motor.

The following table summarises the different types of terminal boxes, strips and terminals that correspond to the standard execution of each axle height of the MAC-HS motors.

MOTOR	TERMINAL STRIP	TIGHTENING TORQUE	TERMINAL BOX
MAC-HS 100	M6	4Nm	120x120x45
MAC-HS 132	M8	8Nm	180x180x60
MAC-HS 160	M12	20Nm	300x300x120
MAC-HS 200	M12 bars	40Nm	380x380x210
MAC-HS 250	M12 bars	40Nm	460x460x250

Table 24: Standard terminals and boxes on MAC-HS motors

By request, modifications can be made to the values specified in the table.

The motor power connections must be made with a cable section that corresponds to the rated current of the motor and in accordance with the schematic provided on the interior of the terminal box cover of each motor.

In addition to the main power terminal box, some MAC HS motors also include an additional terminal box for the connection of sensors. Then specific connection diagram for sensors is located in the interior of this terminal box.

5.2.2 Connection diagrams

The connection schematics of the terminals in the terminal box for standard versions of the MAC-HS motors are as follows:

XX1 windings (Star)

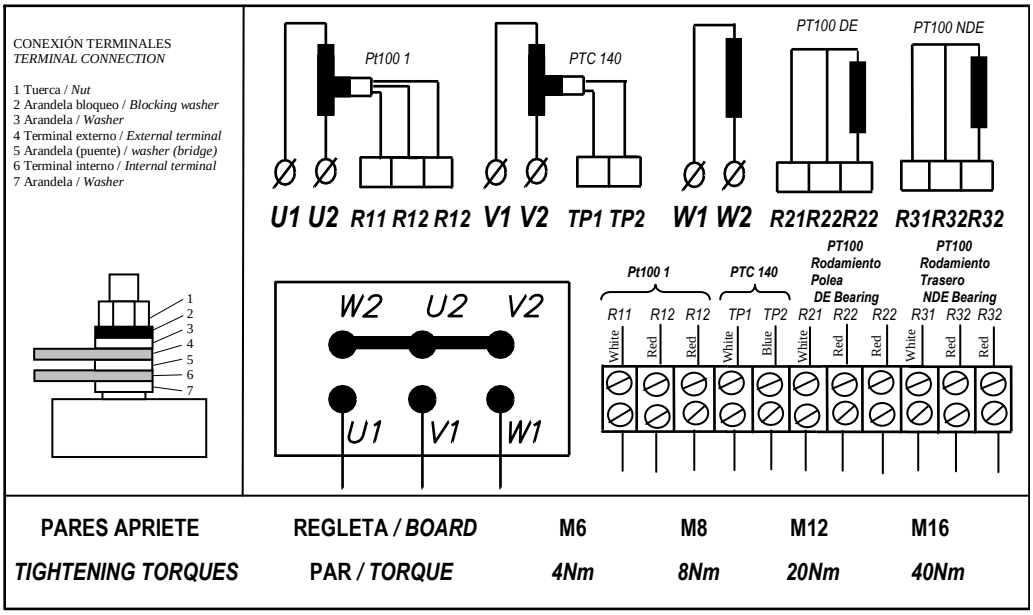


Figure 11: Motor connection schematics with star-type windings

XX2 windings (Delta)

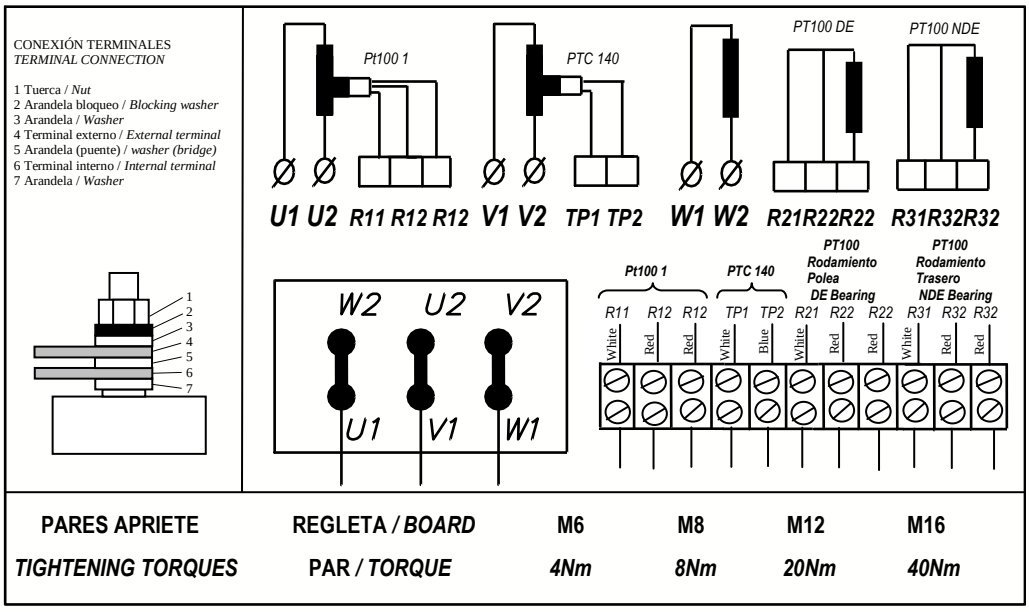


Figure 12: Motor connection schematics with Delta-type windings

The connection schematics of the terminals in the sensor auxiliary terminal box for standard versions of the MAC-HS motors are as follows:

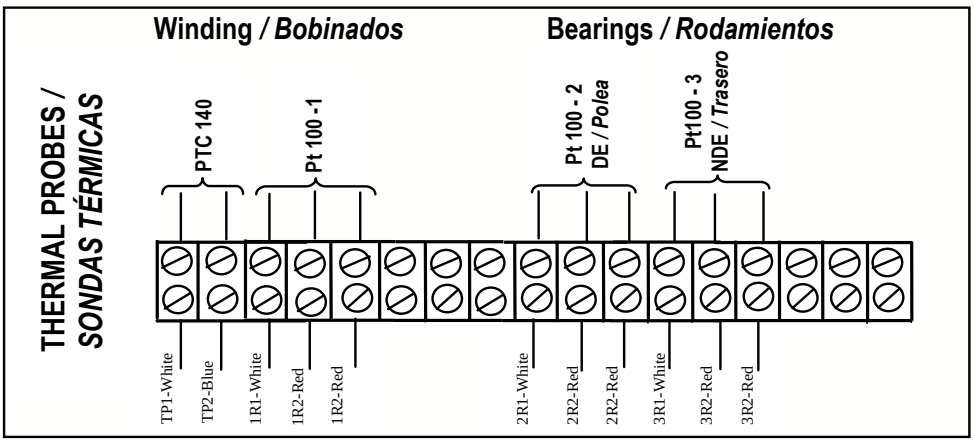


Figura 13: Esquema de conexionado de sondas térmicas

When other optional elements are incorporated (e.g. additional sensors, anti-condensation heaters, etc.), these schematics may vary slightly.

5.2.3 Power cables

The inputs of the power cables that are to be connected on the motor terminal box strip and the converter terminals must comply with current regulations. For the protection rating, type of cable-laying, allowed cable diameter, connection, etc., VASCAT recommends the use of symmetrical structure screened cables in accordance with technical specification IEC TS 60034-25.

The cable screen must be made up of the maximum possible number of individual conductors and it must have good conductivity. Twisted copper or aluminium screens are particularly suitable.

The following shows a schematic with the various examples of screened cables and their connections:

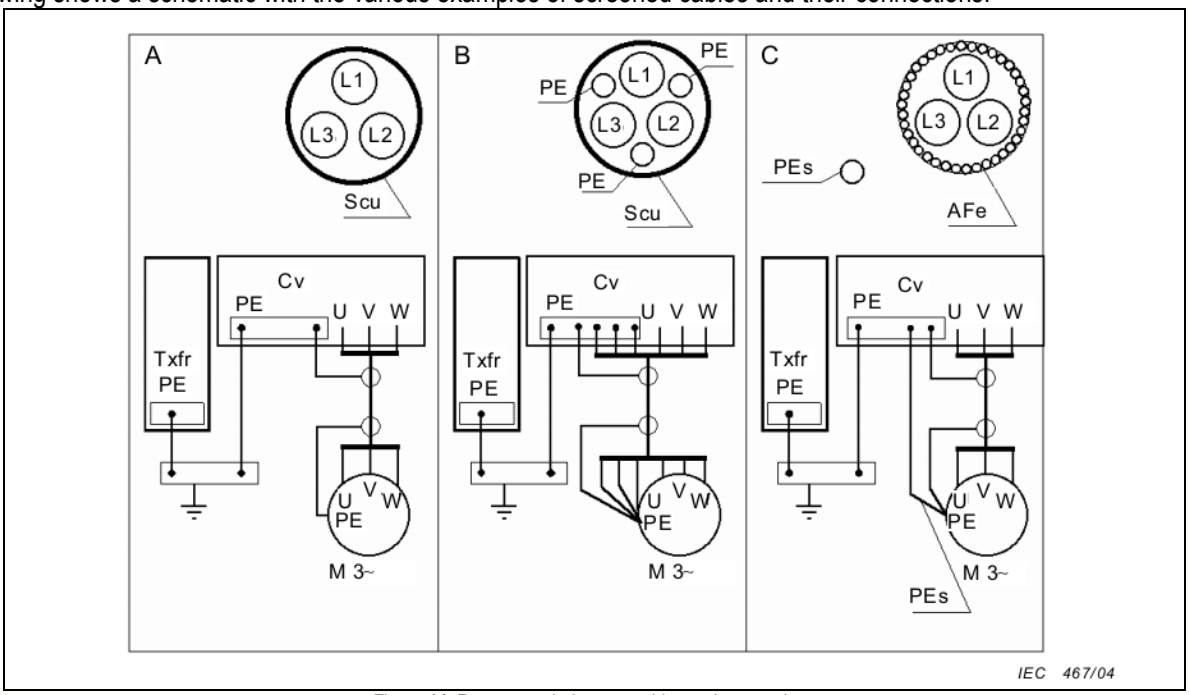


Figure 14: Recommended power cables and connections

Scu - Copper or aluminium screen AFe -Steel structure Txfr - transformer Cv – Converter PEs – Separate earth cable

As shown in the above figure, the power cable screen must be connected on both sides (motor and converter).

The screen connections must be made bearing in mind that they must cover a wide surface of the screen to create a 360° contact using gland boxes for low impedance through a wide range of power levels. Make sure that the screen is HF (for high frequencies). All the foregoing effectively reduces the voltages of the shaft and the housing, creating good derivation of the high frequency currents. This will reduce the currents that will pass through the bearings. Consideration must be given to the fact that the ends of the unscreened cable must be kept as short as possible.

PRECAUTION
Damages to the motor bearings If the distribution of the earth conductors is not appropriate, current may flow through the bearings and deteriorate the parts of the bearing in only a few months.

The following two figures show the recommended terminations for screened cables:

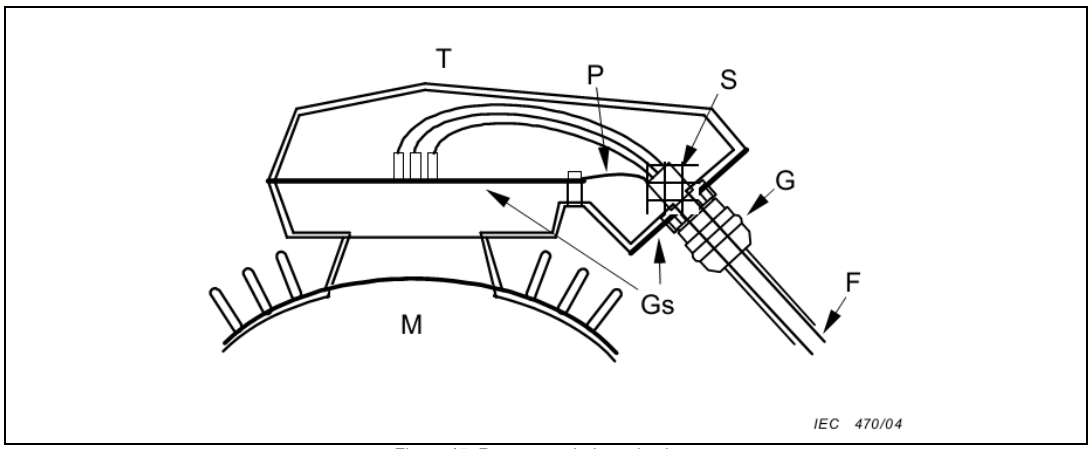


Figure 15: Recommended terminations

T – Conductor material terminal box S – Cable screen P – Earth cable M – Motor body
Gs – Conductor seals G – EMC gland seal F – Continuous Faraday box

The connection between the power cable screen and the motor terminal box must be made using either of the two methods shown in the following figures (on the left with an EMC gland seal and, on the right, with the screen connected to the terminal box using a clamp):

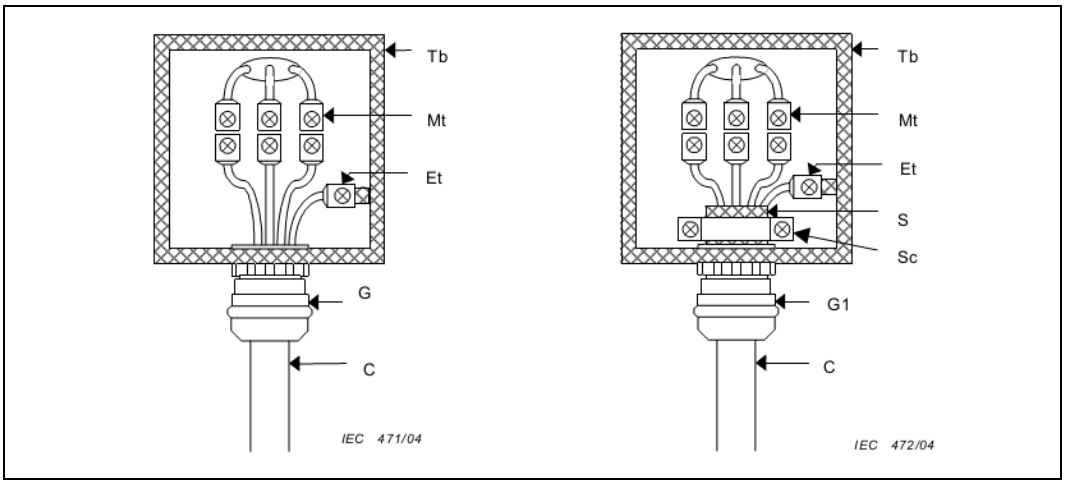


Figure 16: Recommended connections in the terminal box

Tb – Terminal box Mt – Motor terminals Et – Earth terminal S – Cable screen
Sc – Screen bracket G – EMC gland seal G1 – NON-EMC GLAND SEAL C - Cable

The earth protection conductor must be connected to the terminal indicated for said function.

DANGER

A poor earth connection involves a severe risk of electrocution through accidental contact with the motor surface.

5.2.4 Connections for the fan, thermal sensors and accessories

Where necessary, the motor fan cables must be connected in accordance with the voltage specified on the fan motor specifications plate.

To connect the thermal sensors, use terminals of 1.5 mm^2on the tip and connect them to the corresponding nylon strip as shown in the diagram attached to the inside of the terminal box cover.

Where necessary, connect the encoder according to the schematic provided on the interior of the terminal box.

5.2.5 Final checks

Before closing the terminal box, check that:

- The electric connections in the terminal box are fastened tight in accordance with the above and the fastening torques given in Table 24.
- There are no protruding wire ends.
- The power cable screens are correctly connected.
- The interior of the terminal box is clean and free from leftover cables.
- All the seals and blanking surfaces are intact.
- The connection cables are positioned in such a way that they leave a certain amount of room for movement and that none of the cables are tight or connected in a ‘forced’ way.
- The connections between the terminals and the cables are correct.
- The inputs that are not used are fully closed.

After closing the terminal box cover:

- Make sure that the closing elements are fastened tight.

5.3 Start-up

5.3.1 Preliminary checks

Before starting the motor, check the following:

- The motor is correctly aligned, fastened and coupled (the belt tension is correct in the case of belt transmission or the radial profile and tooth flank profile is adequate in the case of gear transmission).
- All the necessary measures are in place to prevent direct contact with moving or live parts.
- Service conditions correspond to the information provided on the motor specifications plate.
- The earth and equipotential connections have been made correctly.
- The electrical connections are tightly bolted.
- All the power cables and their respective shields are correctly connected.
- The other cables (cables from the encoder and fan, etc.) are also correctly connected.
- The frequency converter configuration guarantees that the maximum rotation speed shown on the motor nameplate will not be exceeded.
- The machine cooling system operates correctly (rotation direction, rpm, etc.). Also check that the air inlet and outlet are unblocked.
- If there is a brake, check that it works correctly.
- The motor is connected to operate in the correct rotation direction.
- There is a correct reading of the motor safety devices (thermal sensors).
- The frequency converter is correctly configured: Check the drive configuration data with the motor nameplate and the technical datasheet.

5.3.2 Start-up

WARNING

Skilled personnel

All the preliminary work must be carried out by skilled personnel and when the motors are completely stopped and isolated from the mains. Always check that there is no voltage!

If the mains power cables are connected make sure there is no voltage and that no power voltage can be applied in any way.

PRECAUTION

Damage to the motor

Before starting up the motor, check that there are no elements blocking the rotation of the motor.

MOVING ROTATING PARTS

During start-up and while the motor is in operation, the customer is responsible for taking precaution to avoid accidental contact with the rotating parts.

Proceed as follows to start up the motor:

1- Start-up the drive auto-tuning procedure so that it can recognise the motor (see drive documentation for more details).

2- If the auto-tuning procedure is completed successfully, start the motor rotating at low speed in both directions. Check that the motor behaves satisfactorily and that there are no strange noises or vibrations.

3- Perform the bearings run-in according to the manufacturer's specifications or as follows:

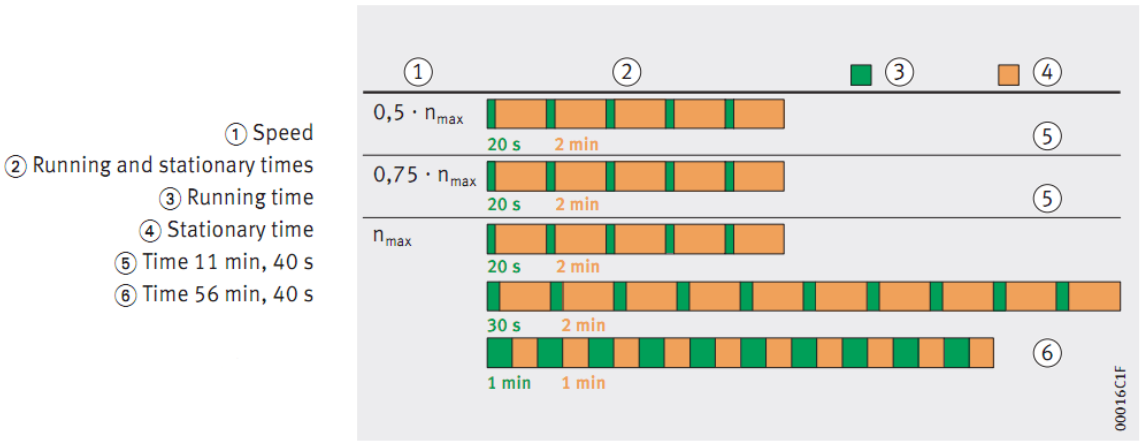


Table 25: Grease distribution cycle for spindle bearings

4- In case of the motor remains stopped for more than 12 hours it is recommended to perform a short bearing run-in process consisting in 3 cycles of each cycle described in the section no.3.

5- After several hours in operation, check that the thermal behaviour of the motor corresponds to the motor service type. If in doubt, please contact VASCAT.

6- When the motor is stopped, leave the cooling system in operation as long as necessary to bring the windings below 80°C.

PRECAUTION
Damages to the motor bearings To avoid the premature wear and tear of the grease in the bearings, they must be maintained at a temperature of below 80°C at all times.

7- In the case of long stops of more than fifteen days, repeat the bearings run-in procedure as described in sections 2 and 3.

6. MAINTENANCE

This chapter describes the preventive maintenance operations for MAC-HS motors. VASCAT declines all responsibility for faulty maintenance performed by the end user.

6.1 Safety instructions

WARNING

Skilled personnel

All the cleaning and maintenance work must be carried out by skilled personnel in observance of the safety regulations that apply to the machine coupled to the motor and when the motors are completely stopped and isolated from the mains.

Always check that there is no voltage! If the mains power cables are switched-on, make sure there is no power voltage and that no voltage can be applied in any way.

6.2 Maintenance operations and frequency

Activities	Service intervals and terms
Basic inspection	*Every 500 service hours or at least every 6 months*
Cleaning of the fan and air filter	*Depending on the level of local and environmental dirt*
Replacement of bearings	*Replacement after 10,000 service hours*

Table 26: Maintenance activities

NB

Damages to motor and fan

If the fan air filter is not cleaned correctly or sufficiently regularly, the motor may not be cooled correctly, which will lead to the corresponding breakdowns.

Furthermore, the fan wheel must be in a good state of repair and perfectly clean; otherwise, it could be in permanent imbalance when it rotates, leading to a breakdown.

NB

Damages to the motor bearings

The bearings have a specific service life. When they have reached the end of their service life, they must be replaced by new bearings that are equivalent to the originals. Otherwise, the motor may be seriously damaged.

6.2.1 Basic inspection

After assembling the motor or after repairing a breakdown, the motor must be inspected approximately every 500 operating hours or at least every six months.

This inspection must consist of basically the following:

With the machine on:

- Check that the motor works according to its rated mechanical and electrical values and that there are no strange noises, vibrations or irregular rotation.

With the machine off:

- Check that no cracks appear in the motor fastening elements.
- Check that the connection terminals in the terminal box maintain an adequate fastening torque as specified in the table 24 .
- If faults are found during the inspection, they must be corrected immediately.

Besides this basic inspection, a number of maintenance tasks must be carried out to ensure that the motor has a long service life. The maintenance operations recommended by VASCAT are as follows:

6.2.2 Cleaning of the fan and air filter

It is important to keep the fan wheel as clean as possible. To do so, apply compressed air to its surface on a regular basis to ensure that there are no unwanted particles deposited on it.

The frequency of the cleaning process will depend on the local and environmental conditions that affect the motor, as well as the frequency with which the motor is used.



MOVING ROTATING PARTS

During the motor fan wheel cleaning operation, the customer is responsible for taking the necessary precautions to avoid accidental contact with the rotating parts.

MAC-HS series motors are fitted with a particle filter of the NGB 290/4 type in the air inlet, which requires regular cleaning. The frequency of this operation will depend on the environment in which the motor is located and the frequency with which it is used.

To wash the filter, it must be removed from the fan and cleaned using compressed air or washed with water and detergent, depending on the type of dirt in the environment. The filter must be replaced after 4 or 5 washes by one that is the same as or equivalent to the original.

6.2.3 Replacement of bearings

Both the bearings that have been greased for all their service life and those that need to be greased regularly, as well as hermetic parts that are subjected to wear and tear (seals and joints, etc.), where applicable, must be replaced after 10,000 operating hours.

Bearings of the same type as the originals must be installed. Standard bearings for each motor type may be consulted on the test sheet provided to the customer with the motor.

The procedure for replacing bearings must be carried out as follows:

1. Disassemble the motor from its location and place it in a safe and clean place.
2. Remove the accessories (brake and/or encoder, where applicable) from the motor very carefully so as not to damage them and then remove the rear fan. See following sections for more details.
3. Remove the bearing temperature sensors, where applicable.
4. Position the motor vertically and unscrew the 6 bolts on the front bushing.

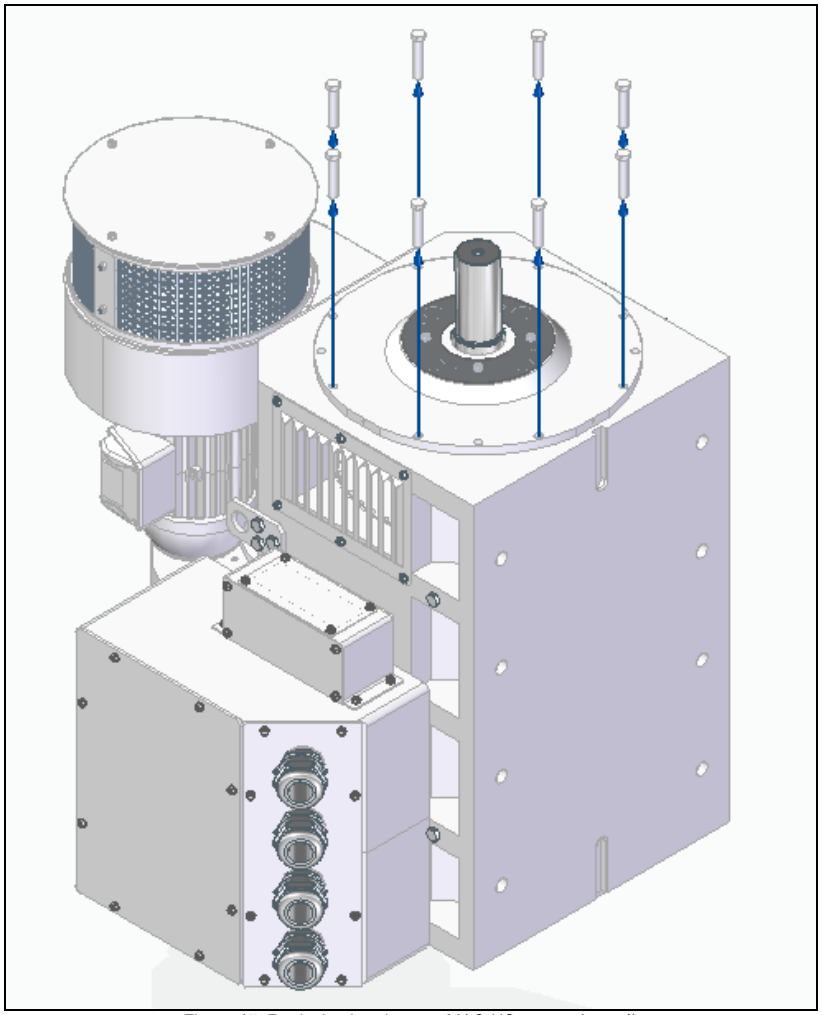


Figure 17: Replacing bearings on MAC-HS motors (step 4)

5. Use an eye-bolt to remove the rotor from the interior of the stator, taking care not to damage the windings.

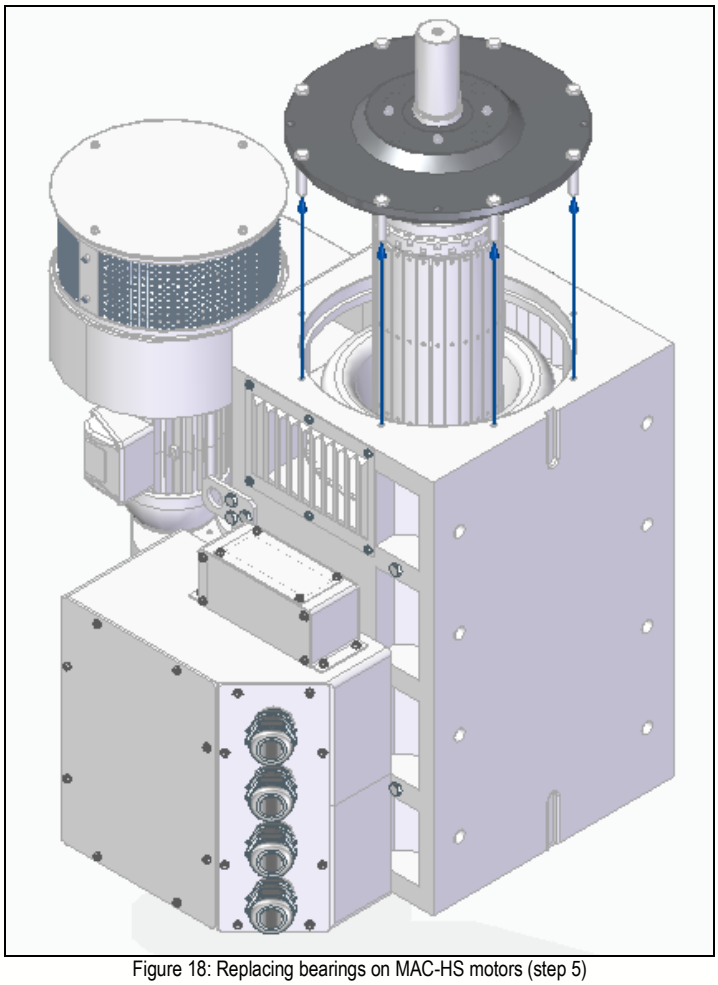


Figure 18: Replacing bearings on MAC-HS motors (step 5)

6. Put the rotor in horizontal position in a stable place so that it does not turnover.

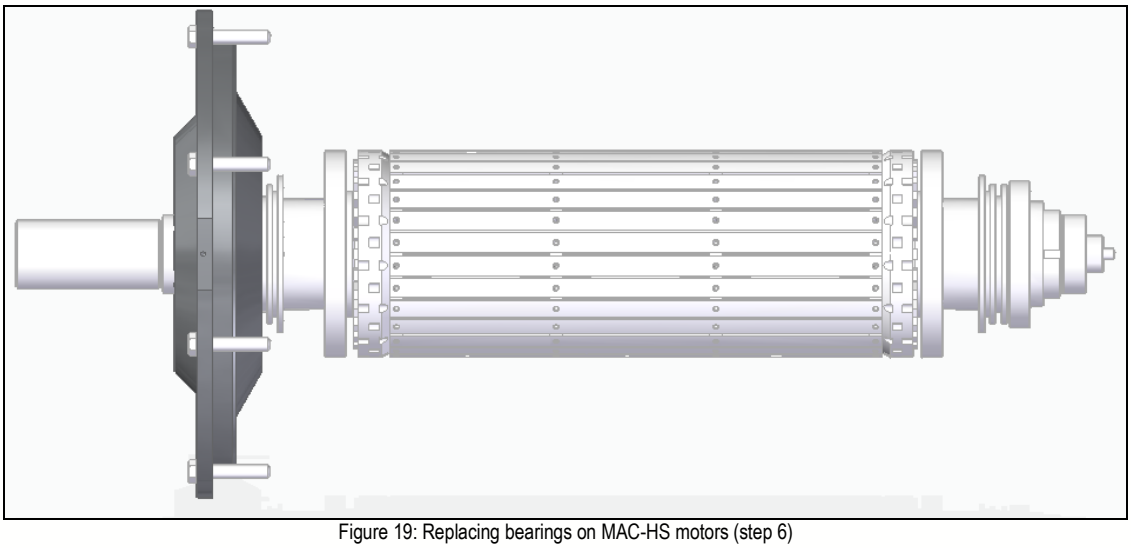


Figure 19: Replacing bearings on MAC-HS motors (step 6)

7. Remove the bushing.

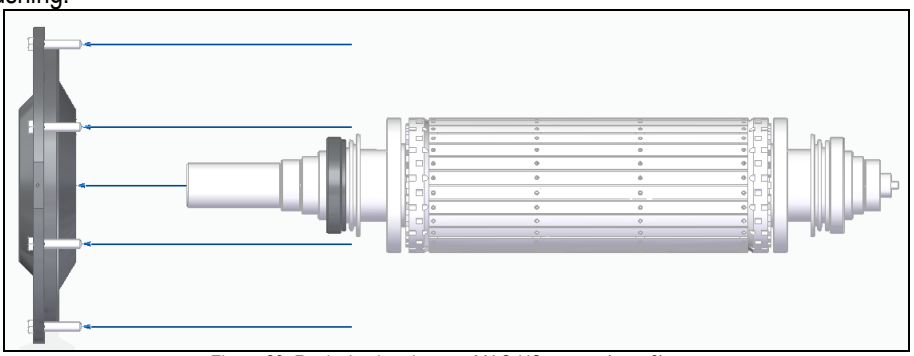


Figure 20: Replacing bearings on MAC-HS motors (step 6)

8. Remove the bearing from the shaft using a thrust extractor and taking care not to damage the shaft, pushing it with the corresponding bushing.

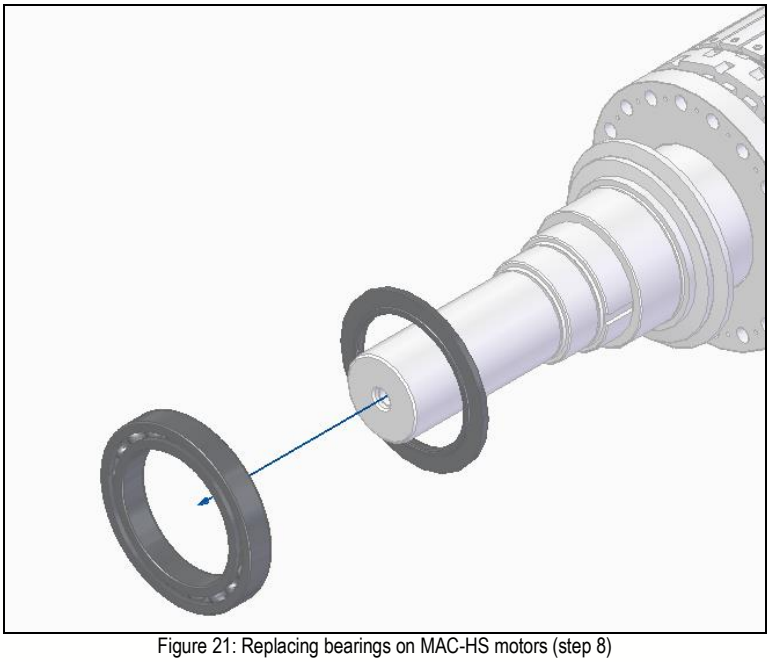


Figure 21: Replacing bearings on MAC-HS motors (step 8)

9. Heat the new pair of bearings to 70°C to make them dilate and easier to insert in the shaft.

10. Insert the new bearings in the axle, taking into account their positioning as regards each other (same as the previous assembly). The hot bearings must be inserted fully up to the extractor ring without the need for hitting them. This operation must be performed as quickly as possible. Do not let the bearing cool down.

11. Refit the front bushing on the rotor and attach the seal to it.

12. Re-insert the rotor in the stator, taking care not to damage the windings.

13. Fit and bolt the front bushing on the Drive End shield.

14. Refit the motor accessories.

6.3 Replacing the encoder

The procedure for replacing the encoder must be carried out as follows, depending on the type:

6.3.1 Solid shaft encoder

1. Remove the protection (a)
2. Loosen the elastic coupling (b) that connects the shafts
3. Remove the stator flange (c)
4. Remove the encoder (d) from the flange

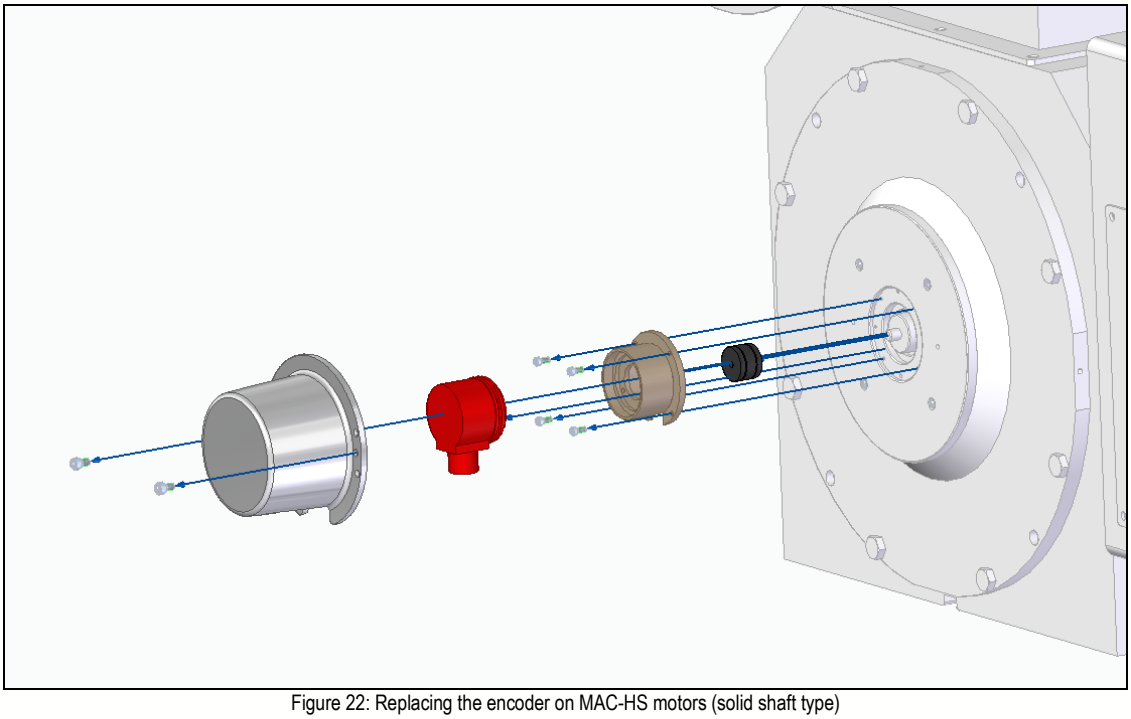


Figure 22: Replacing the encoder on MAC-HS motors (solid shaft type)

6.4 Original spares

VASCAT supplies subunits of the full motor as original spares for MAC-HS motors.

The spare subunits that are available are listed in the following table:

Spares	Subunits
1	*Stator subunit*
2	*Rotor subunit*
3	*Covers*
4	*Bushings*
5	*Terminal box unit*
6	*Fan (DE and NDE)*
7	*Protections unit*

Table 27: Spare subunits

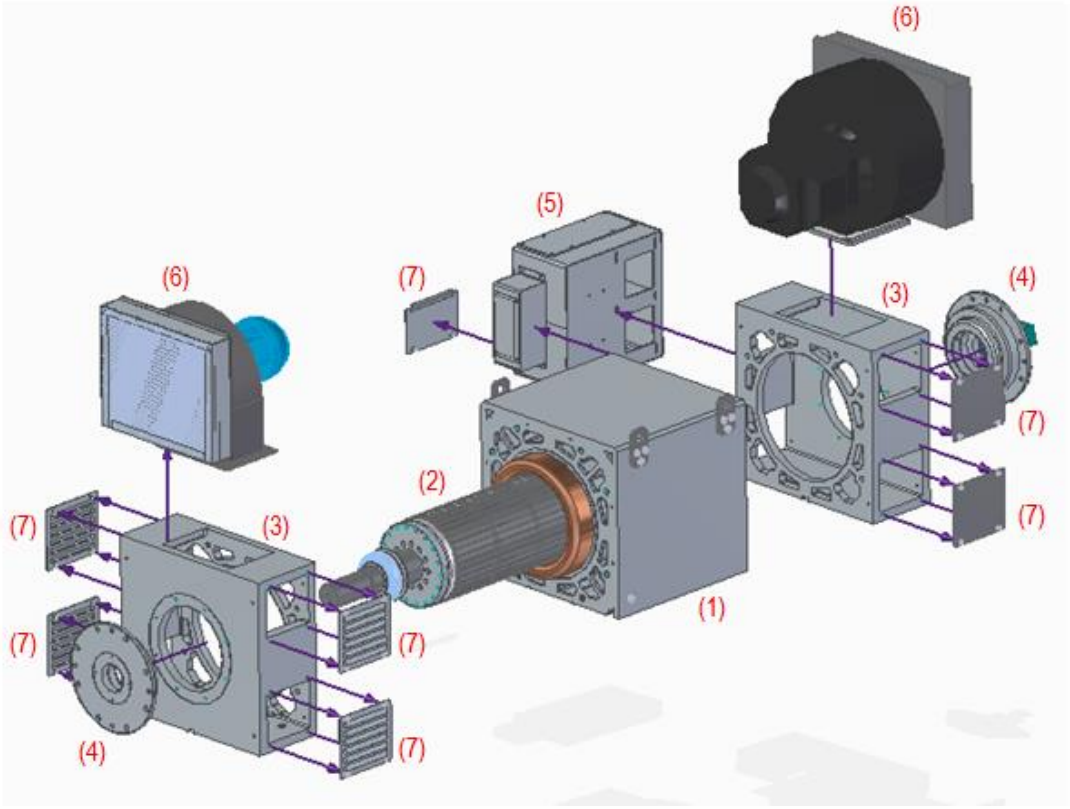


Figure 23: Spare subunits

When a specific original spare is required for a motor from the MAC-HS series, the following information must be provided:

1. Motor type (by default, MAC).
2. Standard (HS).
3. Size (in reference to shaft height).
4. Length (S, M, L, P or X).

These initial 4 points refer to the name of the motor and are summarised in the following table:

MAC	*HS*	*200*	*M*
Motor type	***Series***	***Size***	***Length***

Table 28: MAC-HS motor codes

Besides the initial 4 points, the following must also be specified:

5. Motor serial number.
6. Year of manufacture.

All the information can be found on the motor nameplate.

6.5 Operating faults

If faults appear during the operation of the motor, first of all check the possibility of the errors given in the following tables. If the fault cannot be eliminated with any of the following measures, please contact the technical service at VASCAT.

VOLTAGE
All the work must be carried out with no voltage connected.
HOT SURFACE
Hot motor surfaces. Therefore, cooling times must be observed.

6.5.1 Electrical faults

Fault	Probable cause	Corrective action
Motor doesn't start	Excessive load	Reduce load
	Power connection problems	Check the frequency converter, power cables and phase sequence.
	Problems with encoder connections	Check encoder cables and converter alarms
	Converter disabled	Check message on converter
Motor starts up with difficulty	Excessive load	Reduce load
	Power connection problems	Check the frequency converter, power cables and phase sequence.
	Short-circuit between turns or phase short-circuit on stator winding.	Check the elements of each winding phase (milliohmmeter) and the insulation elements (between phases and between phases and earth using a megaohmmeter at 250 V). Repair the winding after consulting VASCAT.
Incorrect motor rotation direction.	Change of motor power cable polarity	Swap two motor connection phases
Buzzing noise on start-up	Interruption of a phase in the power cable after connection	Check the frequency converter and power cables
	Short-circuit between turns or phase short-circuit on stator winding.	Check the elements of each winding phase (milliohmmeter) and the insulation elements (between phases and between phases and earth using a megaohmmeter at 250 V). Repair the winding after consulting VASCAT.
Buzzing noise during operation	Overload	Reduce load
	Interruption of a phase in the power cable after connection	Check the frequency converter and power cables
	Short-circuit between turns or phase short-circuit on stator winding.	Check the elements of each winding phase (milliohmmeter) and the insulation elements (between phases and between phases and earth using a megaohmmeter at 250 V). Repair the winding after consulting VASCAT.

Table 29: Electrical faults (1)

Fault	Probable cause	Corrective action
Overheating during load-free operation	Converter output voltage too high, frequency too low	Check adjustments on frequency converter and perform auto-tuning
	Motor designed to be connected in star format but is connected in triangle format	Correct connection in terminal box
	Fans stopped or turning in opposite direction	Connect fan. Invert phase sequence in case of inverse rotation.
	Excessive harmonic distortion of current waves	Increase drive switch frequency
	Fan broken down or airflow insufficient due to blocked channels	Repair fan or clean filter
	Cooling air is preheated	Ensure the entry of fresh air
Overheating with load	Excessive load	Reduce load
	Converter output voltage too high, frequency too low	Check adjustments on frequency converter and perform auto-tuning
	Power connection problems	Check the frequency converter and power cables
	Excessive harmonic distortion of current waves	Increase drive switch frequency
	Motor designed to be connected in star format but is connected in triangle format	Correct connection
	Fan stopped	Connect fan
	Fan broken down or airflow insufficient due to blocked channels	Repair fan or clean filter
	Cooling air is preheated	Ensure the entry of fresh air
Overheating on certain winding sections	Short-circuit between turns or phase short-circuit on stator winding.	Determine the winding elements and insulation elements. Repair them after checking with manufacturer

Table 30: Electrical faults (2)

NB: Because the machine is powered from a frequency converter, please also check the frequency converter service instructions in the event of electrical faults.

6.5.2 Mechanical faults

Fault	Probable cause	Corrective action
Rubbing noise	Rotating parts are rubbing together	Determine the cause and readjust the parts
	Foreign bodies in the motor	If so, repair by manufacturer
	Damage to bearings	Change bearings
Excessive radial vibrations	Rotor imbalance	Uncouple rotor and rebalance it
	Non-concentric rotor, shaft bent	Contact factory
	Non-concurrent shaft alignment	Align motor-machine system.
	Imbalance on coupled machine	Rebalance coupled machine
	Vibrations transmitted by gear	Correct gear
	Resonance with foundations	Reinforce foundations after checking with factory
	Changes to foundations	Determine cause and eliminate it. Realign machine
Excessive axial vibrations	Faulty angular alignment	Align group of machines and check alignment
	Blows transmitted by coupled machine	Examine coupled machine
	Vibrations transmitted by gear	Correct gear
	Resonance with foundations	Reinforce foundations after checking with factory
	Changes to foundations	Determine cause and eliminate it. Realign machine

Table 31: Mechanical faults

6.6 Technical support and service

For more information or specific technical support, please contact:

VASCAT, S.A.
P.I. Mas les Vinyes, C/ De l'Esquirol, s/n
Apartado 142
08570 Torelló (Barcelona)

Tel. +34 93 850 49 38
Fax: +34 93 859 31 31
www.vascat.es
vascat@vascat.es

Zona Industrial Pont de les Vinyes • C/ del Esquirol, s/n • 08570 Torelló (Barcelona) SPAIN
Tel. +34 938 504 938 • Fax +34 938 593 131
www.vascat.com • vascat@vascat.es