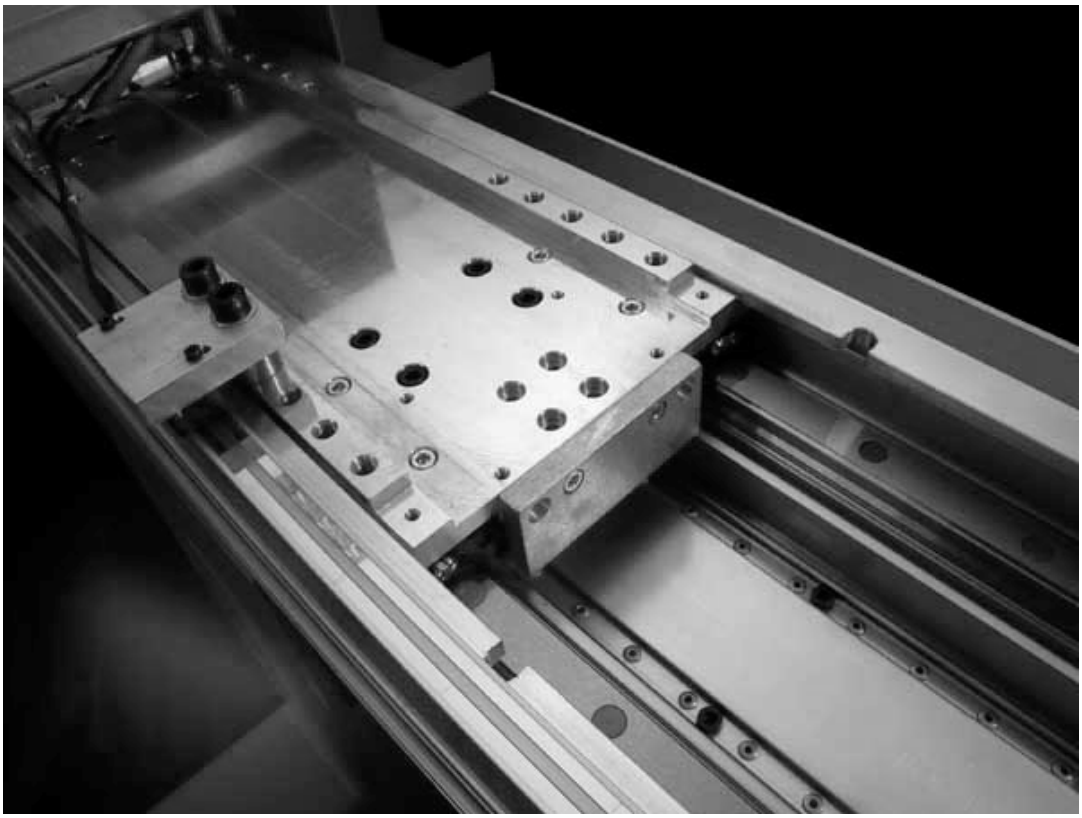
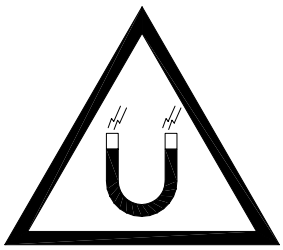
WAVE Linear Motor

Installation Manual
Rev. 1.1 - 18/11/2002



WARNING!!! Rotor plates are covered with permanent magnets with high energy product and exercise a strong attraction each other and towards ferromagnetic materials. Always handle only one plate at a time and keep a safety distance of 100 mm from steel objects.



1 SUMMARY

2 Safety Instruction

⚠ Handling, installation and maintenance of WAVE motors can be performed only by personnel specifically prepared for these activities (IEC 364). Incorrect handling and/or installation may cause damage and personal injury.

⚠ WARNING!!! Rotor plates are covered with permanent magnets with high energy product and exercise a strong attraction each other and towards ferromagnetic materials. Always handle only one plate at a time and keep a safety distance of 100 mm from steel objects..

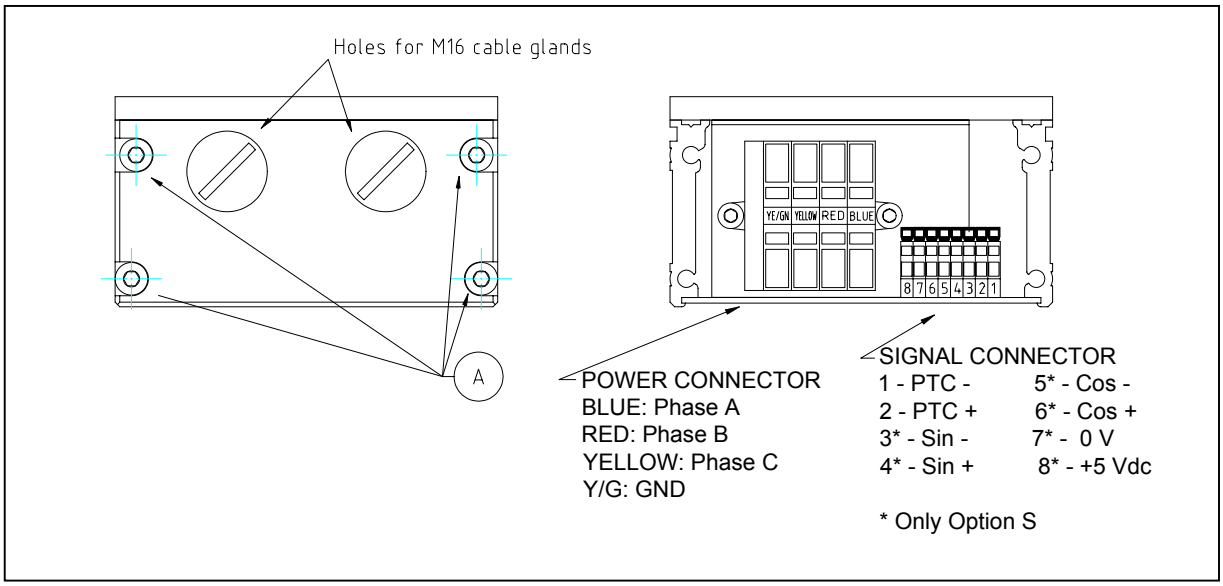
⚠ Before installation verify that motors are exempt from any damage due to transportation which could reduce electrical safety.

⚠ Motors can have internal parts hot also when power supply is switched off. Normal working temperature can reach 100 °C.

⚠ Motors may have internal parts with dangerous voltage also when the motor is stopped. Do never touch power and signal terminals before switching the main power supply off.

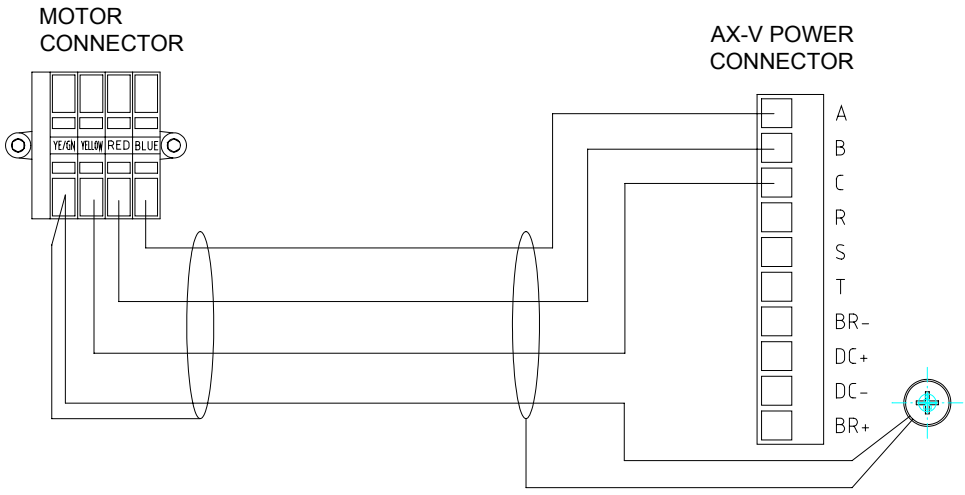
3 Electrical connections

To access power and signal terminals open the front panel by removing the four screws A.
For cables inlet use a cable gland with M16 thread which can warranty a proper cable relief and protection from aggressive agents.



3.1 Power connections

For power connection use a three phase cable + PE with overall shield and section adequate for the nominal current of the motor. For information about the motor phase sequence refer to paragraph "Integrated position sensor" of this manual.
To connect with AX-V drives use the following scheme:



3.2 Signals connection

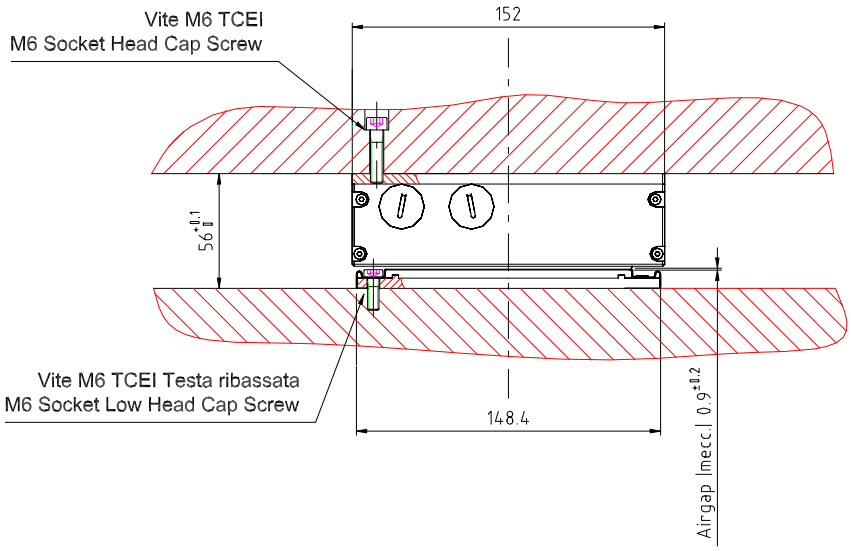
This cable carries the thermal protection (PTC) and integrated SINE/COSINE position sensor signals (only motors with Option S).
For this connection use a cable with twisted pairs AWG24 and overall shield. For cable length above 20 m a cable with individually shielded pairs is recommended. To connect with Phase Motion Control AX-V family drives refer to the following schematic:

4 Mechanical installation

⚠ *NOTE* ⚠

*In this manual we will refer to magnetic plates as **rotor** and to active part (windings pad) as **stator** regardless the actual configuration of the machine.*

4.1 Installation sequence



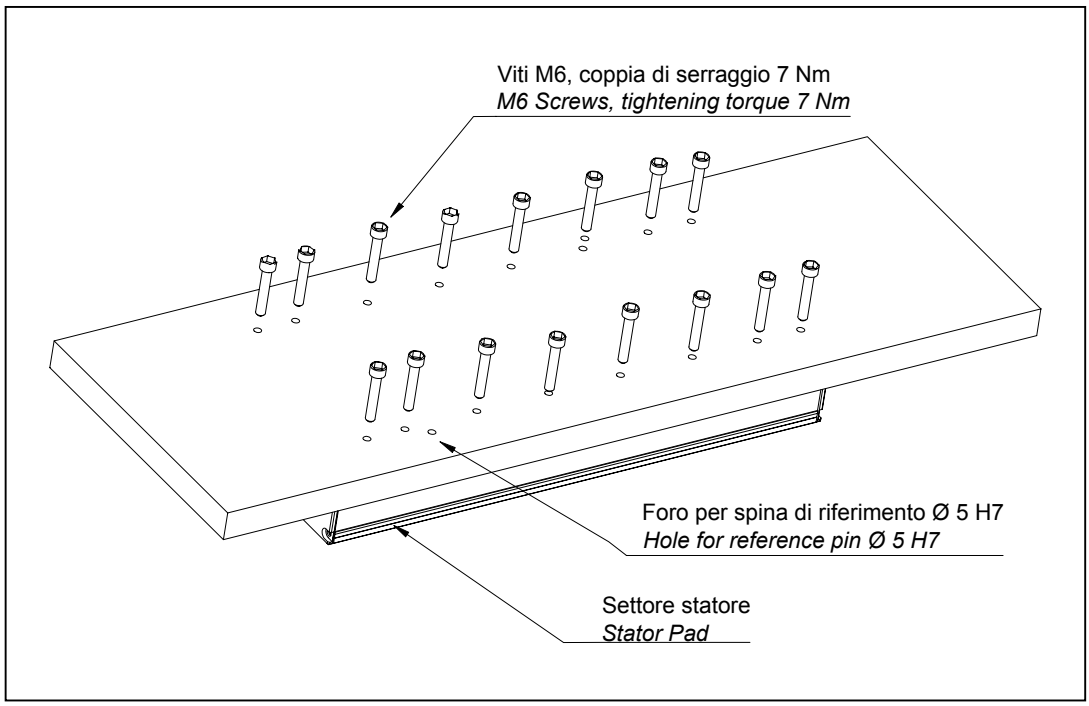
The ROTOR/STATOR mounting sequence, is determined depending on the machine configuration.
If the disassembly of stator support from the machine is possible, the suggested sequence is:

I) ROTOR PLATES INSTALLATION
II) SATOR INSTALLATION

If the disassembly of stator support from the machine is not possible and/or the stroke covers more than one rotor plate, the suggested sequence is:

I) STATOR PAD INSTALLATION
II) POSITION THE STATOR SLIDER CLOSE TO ONE LIMIT
III) ROTOR PLATES INSTALLATION

4.2 Stator installation



Preliminary check

- Check that the planarity of the stator pad mating surface is within 0.1 mm.
- Check that the position of the mounting holes is within specified tolerance (0.1 mm).

⚠
- Be sure that the mounting screws do not enter in the stator pad for a depth > 5 mm

Stator pad installation (single pad configuration)

- Fix the stator pad with M6 screws with tightening torque of 7 Nm, taking care that they don't enter in the stator pad for more than 5 mm.

⚠
- Use a thread locking compound to prevent from undesired unscrewing

Stator pad installation (multiple paralleled pads)

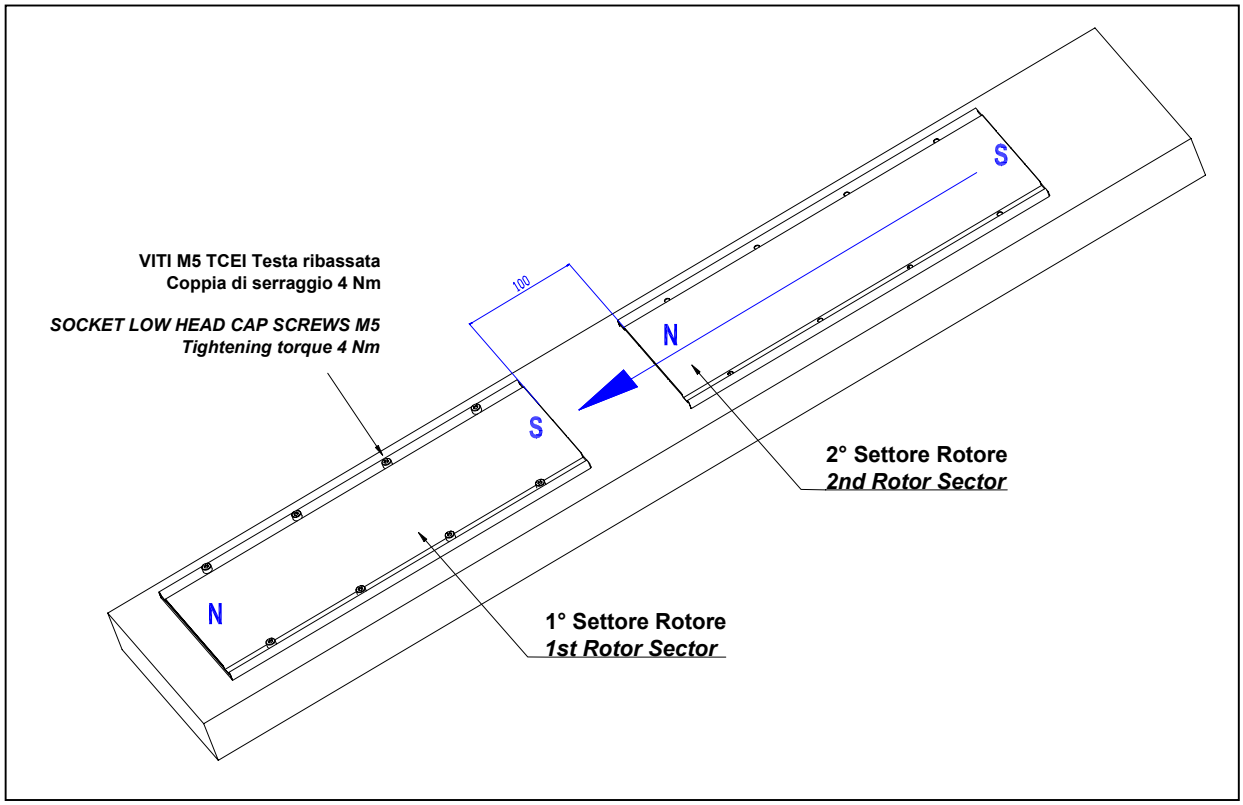
- Two or more stator pads can be connected in parallel and share the same rotor plates (or also different rotor plates in a gantry configuration) and the same position sensor in order to get an equivalent motor with higher thrust. In this case, the distance between stator pads must be equal to: *n* x 40 mm (± 0.1 mm) where *n* is any integer number. In this case to have a good position reference it is recommended to use the reference pins (two dedicated holes are machined in each stator pad). Note that the mechanical coupling between stator pads must be absolutely stiff.

- For mounting instruction see case Ia.

4.3 Rotor installation

⚠ *WARNING* ⚠

Rotor plates are covered with permanent magnets with high energy product and exercise a strong attraction each other and towards ferromagnetic materials. Extract from the package only one plate at a time and install it.



Preliminary check

⚠

- Check that the distance between stator pad and rotor plates mating surfaces is within specified tolerance in the full stroke (56 mm ±0.1).
- Check that parallelism of the two surfaces is < 0.2 mm.
- Check that the positioning of M5 holes is within specified tolerance of 0.1 mm (for nominal positions see the technical dwg of your motor model)
- The mounting direction of rotor plates is independent from stator pad mounting direction.

1st rotor plate installation

- Fix the rotor plate by means of Torx screws or low head M5 screws with tightening torque of 4 Nm.
- Use a thread locking compound to prevent from undesired unscrewing

Installation of following plates

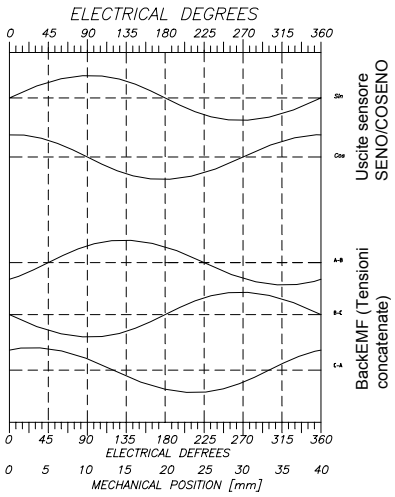
⚠ NOTE ⚠

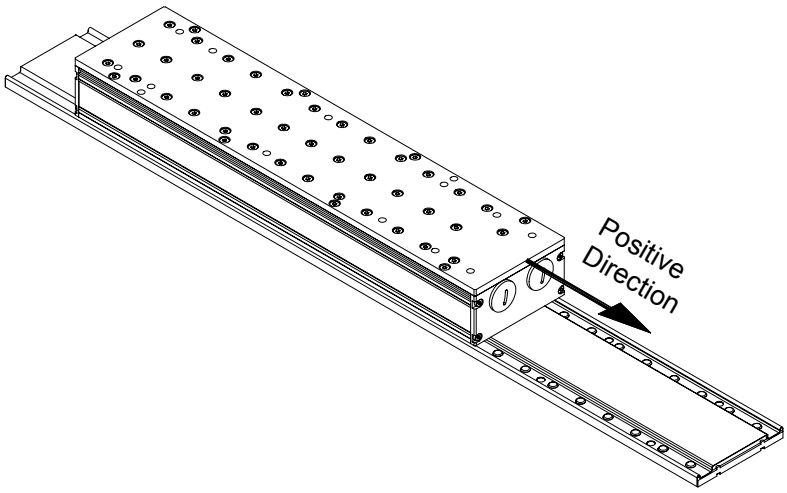
Rotor segmets must be installed with respect of their magnetisation direction (see figure above). If properly installed rotor plates attract one close to each other in position.

- Lean the rotor plate on the mating surface at a distance of about 100 mm from the previous plate, then slide it carefully until they touch each other. NOTE: when the distance is less that 20 mm the plates will attract each other with a force of about 30 N. A side reference (perpendicular to direction of movement) is not required as the specified tolerance of ± 0.5 mm is warranted by the fixing holes position (0,1 mm).

5 Integrated position sensor (option S)

Linear encoders usually adopted with linear motors do not provide an absolute position information.
Consequently, at start-up it is necessary to activate a phasing routine to detect the absolute electrical position. This routine is automatically activated in Phase Motion Control digital drives.
While this routine is active, the motor is moved of a few encoder counts, consequently it must be free to move. **If this is not possible (i.e. vertical or unbalanced axes), the motor must be equipped with option S which provide to the drive the absolute electrical position also at first motor start-up.**
Option S consists of a SINE/COSINE position sensor integrated in the motor. The accuracy of this sensor is ± 0.2 mm.
Following figure shows the phase relation between motor backEMF and integrated SINE/COSINE signals.





MOVING IN POSITIVE DIRECTION (See figure)

NOTE: for Wave motors with integrated position sensor (option S), it is necessary that the whole stator surface is always covered by the magnetic slides in any position (and not only the Magnetic Overlap part SM as in standard motors)

6 Recommendations for the installation of an external position sensor

A linear motor is an instantaneous thrust generator with negligible inertia. The final performance of the system are determined directly by the quality of the position feedback device coupled with the motor.
The choice of the linear sensor should consider the following points:

- Precision: Sensor precision is the same of application.
- Resolution: interpolated resolution should be at least 10 times better then required precision. **If a highly dynamic and very stiff closed loop performance is required the resolution must be < 1 um to prevent from axis vibration**;
- Sensitivity to dust and moisture: usually the sensor is much more affected by pollution than motor, mainly optical encoders;
- Sensitivity to air gap variation and misalignment: check that they are compatble with machine mounting tolerances.

As general rules, during installation it is recommended to verify the following points:

- ⚠ *For a proper use with AX-V family digital drives, the positive counting direction of the encoder must be coherent with the positive direction of the motor (see figure of previous paragraph).*

- Check that the alignment between tape and scanning head is within encoder manufacturer specification.

- Check the stiffness of encoder head support as it is determinant to get high closed loop performance. The eigenfrequency of the support should be at least three times higher than desired closed loop bandwidth.

7 AX-V drives parameterisation

For a proper use of WAVE motors with AX-V digital drives, it is necessary to adjust a few parameters by means of configuration software AX-V Cockpit. For detailed information about Cockpit software usage, please refer to *AX-V Cockpit User Manual*.
Specifically, the following table shows the rules to properly set the *Motor and Encoder* configuration parameters.

Parameter	Value to set	Function
N_POLES	2	Number of magnetic poles in 1 revolution.*
CY_REV	Number of encoder counts in 40 mm	Number of encoder counts in 1 revolution.*
ENC_TYPE	**Analogue 2 tracks** = External incremental encoder with analogue sine/cosine signals. **Sincos** = External incremental encoder with analogue sine/cosine signals + internal Sine/Cosine single turn absolute sensor (option S).* **Digital 2 tracks** = External incremental encoder with line driver 5V signals. **Sincos + Digital** = External incremental encoder with line driver 5V signals + internal Sine/Cosine single turn absolute sensor (option S).*	Specify the type of encoder installed. NOTE: If encoder with only incremental signals are adopted, at every first enable signal after power on , the drive will activate an auto-phasing routine to identify the electrical position. This routine require the motor is free to move a few encoder counts.

* The definition of revolution for linear motors is arbitrary. By convention, in all Phase Motion Control software, it is assumed that 1 "revolution" corresponds to 1 electrical cycle (40 mm).

Furthermore, it is also necessary to configure a few system parameters (for details about System Parameters, please refer to *AX-V User Manual*).

Parameter	Value to set	Function
SYS_IC_P_FAK	255*L where L is motor inductance in mH	Proportional gain of current loop.
SYS_IC_I_FAK	SYS_IC_P_FAK / 2	Integral gain of current loop.
SYS_IC_D_FAK	SYS_IC_I_FAK / 2	Derivative gain of current loop.
SYS_HI_RES_PHASE	Off	Disable the commutation of field orientation on incremental signals after first reference mark. This function should be enabled again

		after measuring the electrical position of reference mark.
SYS_INDEX_ALARM	Off	Disable the reference mark position alarm. This control can be left active (default) if only 1 reference mark is emitted in the full range of movement. If the encoder provide multiple reference mark with a period different from 1 motor revolution it would trigger a reference mark position error.
SYS_AD_GAIN2	2	Only for motors with option S Reduce the gain of A/D converter of Sine/Cosine absolute signals.

8 Technical data summary

Only main data are listed here. For further details please refer to our web site www.phase.it or contact our customer service at e-mail address support@phase.it

8.1 WVS motors

	WVS.20.6.3	WVS.40.6.3	WVS.80.6.3	
Reference Data				***Units***
Nominal thrust S1, 0 speed	184	368	736	*Nrms*
Nominal speed	6	6	6	*m/s*
peak thrust, duty cycle 10%	415	829	1657	*Nrms*
Physical Data				
Stator mass	2,95	5,40	10,30	*kg*
rotor mass/m				
Rotor to stator magnetic attraction	1250	2500	5000	*N*
Electrical data				
Pole pitch	20	20	20	*mm*
Connection	Y	Y	Y	
Thrust constant, 20 C	58	70	70	*N/Arms*
Winding resistance, 20 C	3,2	2,4	1,2	*Ohm*
windings inductance, 1000 Hz	51	38	19	*mH*
Nominal voltage	256	312	312	*Vrms*
Nominal current, 0 speed	3,20	5,23	10,45	*Arms*
Peak current	9,61	15,70	31,40	*Arms*
Suggested wire section	1,0	1,0	2,5	*mmq*

8.2 WMS motors

	WMS.050.6.3	WMS.100.6.3	WMS.200.6.3	
Reference Data				*Units*
Nominal thrust S1, 0 speed	495	983	1967	*Nrms*
Nominal speed	6	6	6	*m/s*
peak thrust, duty cycle 10%	1116	2216	4432	*Nrms*
Physical Data				
Stator mass	6,25	11,45	21,84	*kg*
rotor mass/m	7,3	7,3	7,3	*kg/m*
Rotor to stator magnetic attraction	3000	6000	12000	N
Electrical data				
Pole pitch	20	20	20	*mm*
Connection	Y	Y	Y	
Thrust constant, 20 C	70	84	84	*N/Arms*
Winding resistance, 20 C	1,6	1,2	0,6	*Ohm*
windings inductance, 1000 Hz	31	23	11	*mH*
Nominal voltage	320	386	386	*Vrms*
Nominal current, 0 speed	7,09	11,64	23,29	*Arms*
Peak current	21,29	34,98	69,96	*Arms*
Suggested wire section	2,5	2,5	8,0	*mmq*

9 Compliance with EC directives

General: the EC directive

The EC Directives are issued by the European Council and are intended for the determination of common technical requirements and certification procedures within the European Community. The Directives establish guidelines that are or will be converted in national laws in the member states. The certification issued in any state member guarantees free access in all the European Community without further testing.

The conformity of a product or component is certified by the CE marking on the product. In the case of variable speed drives, or PDS, motors are considered components; the only directive which applies to components is the Low Voltage Directive 73/23/CEE amended by 93/68/CEE. The CE mark on the WAVE motors is referred to compliance to the LVD.

As for the EMCD, compliance is required at system level and not at component level, as EMI emission depends critically on system composition and wiring. In order to help the user to comply with the EMD directive, the WAVE motors have been tested and compliance was verified in a CE verified typical system, driven by a AX-V series drive. The system is described in the AX-V product documentation.

The Low Voltage Directive

The LVD applies to all electrical components operating between 50 and 1000 Vac or 75 to 1500 V DC in under normal ambient conditions. Explosive atmospheres or passenger lifts are excepted.

The objective of the low voltage directive is to ensure that only that electrical equipment that does not endanger the safety of humans or the preservation of material assets is marketed.

The Wave servomotors are intended for the powering of industrial equipment. The entire drive systems may only be commissioned after compliance withthe EMC directive 89/336/CEE and the machinery directive 98/37/CEE has
been verified. The motors are conformal to LVD 73/23/CEE. The technical data stated in the nameplate and in the product documentation must be observed.

The units must be installed and cooled according to the product documentation. When the unit is operated, the valid national regulations for the prevention of accidents must be observed.
The electrical installation must comply with the applicable regulations (cable sections, fuses, protections).
When using current operated protective devices, please note that most drive are equipped with an internal mains rectifier, which can lead to a potential DC leakage current, which may impair the correct operation of some current operated protective device. Protective devices which are insensitive to DC fault currents must be specified. Additionally, EMC filters inside most drive create a leakage current to ground which must be considered
while selecting the protective devices. The opportune value inductances ε 1 mH have to be applied when welding
cables between driving and motor have length superior than 20 meters.

Please note that, irrespective of the CE marking on the motors, the conformity of the drive system to the EMC directive is the responsibility of the manufacturer of the system or machine. Useful recommendations on wiring and filtering, along with a CE compliance typical system, are described in the product documentation or can be obtained by the manufacturer.

EC EX "conformità EC" Declaration of Conformity for the purpose of the EC Low Voltage Directive 73/23/CEE

The WAVE brushless servo motor series were designed, manufactured and tested in conformity to the EC Low Voltage Directive 73/23/CEE under the sole responsibility of:
Phase Motion Control s.r.l., Via Adamoli 461, 16141 Genova, Italy
The considered standards are:
IEC 72/1, 34/1, 34/5, 34/11
EN 60034-1 + VAR A1 + VAR A2
EN 60529
EN 50262
CEE 73/23