MOOG

DS2000

USER'S MANUAL (rev.C)
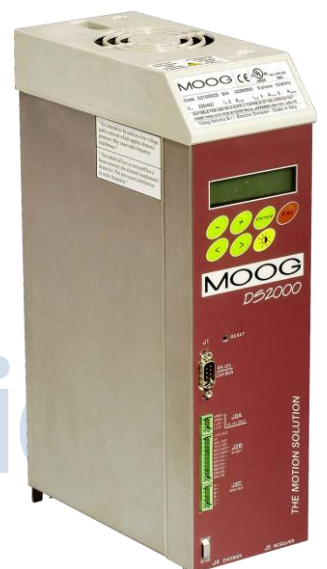
INDEX OF REVISIONS

Revision	Date	Description	Updated section
0	Jul 99	Preliminary	
1	Dec 99	Initial Release	
2	Jan 00	Correct errors	
3	Mar 00	Change fuses according UL, correct miscellaneous errors	
4	Jan 01	Changes of control board	All
5	May 02	Update on new drives sizes, error correction	All
6	Feb 04	Update on new SW release	Index, Section 3-4-7, Appendix
7	May 04	Update	All
8	Jul 04	New UL requirement	Table of contents
9	Oct 04	Deleted DSloader section, update	All
B	Jan 06	New size E, update section 8 – Restart Interlock Function, update new software releases, correct miscellaneous errors	All
C	Sep 06	G motor resolver connection, APHAPOS parameter, update figures Size E, update section 8 – Restart Interlock Function, correct miscellaneous errors	Par. 2.11.2.1, 2.11.3.2, 3.3.4, 6.2.1, 6.2.2, 6.3.1, 6.7.1.5 Fig. 2.4.1, 2.5, 2.6, 2.8, 2.8.1, 2.14, 3.5.1 Section 8

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I.1 INTRODUCTION

This manual refers to DS 2000 "The Motion Solution" drive, with SW Release 3.20X.

The manuals from 0 to 3 release refers to DS2000 drives and SW release below 2.00X.
The manuals from 4 to 5 release refers to DS2000 "The Motion Solution" drive, with SW release 3.00X and 3.10X.

New characteristics and added functionalities on DS2000 Software Release 3.200:
- **I2T IGBT Protection.** This functionality allows to protect IGBT modules from overheating, due to excessive phase current flowing (particularly at low frequencies or locked rotor). When the protection activates the drive can be disabled or the current flowing can be limited. This functionality can be activated or deactivated from menu. Activating this protection the Notch Filter will be automatically deactivated. I2T IGBT Protection and NOTCH FILTER cannot be used together.
- **Anti-Free-Wheeling (AFW).** This functionality allows to have an emergency motor stop in case of NO POWER, MOTOR OVERHEATING and DRIVE OVERHEATING. The motor will brake with the deceleration value eventually set in menu. This functionality can be activated or deactivated from menu.
- **Regen Resistor Protection.** Some customer applications have shown an intense continuous utilization of the regen resistor that sometimes ends with its damage or even breaking. To avoid this problem a new functionality has been developed within the new DS2000 Firmware Release 3.200: this algorithm estimates the growing of the resistor temperature and, depending on the manufacturer data (nominal power, maximum power and time at peak power), protects it from dangerous overheating.
- **FAS G Defluxing.** This modification improves motor performances at high speed introducing a defluxing component (sinusoidal current phase shifting) starting from a speed value and with a maximum angle value to be set in the menu. This functionality can be activated or deactivated from menu using its related parameter.
- **Dead Band on analog reference.** A dead Band on analog reference can be introduced (centered on zero crossing and symmetric in both directions) with an amplitude selected with the menu. It eliminates possible offsets that can cause slow motor shaft drift rotations. This functionality can be activated or deactivated from menu using its related parameter.
- **PTC/NTC Selection.** PTC/NTC motor thermal sensor can be selected using menu.
- **Automatic Current Offset Compensation.** This functionality automatically auto-activates when drive is disabled and it repeats its calculations until the drive is off. When the drive is enable, the last calculated offset value is memorized and used in current loop. When the drive is disabled again, this function activates and compensates also possible thermal drifts.

- **ENC/OUT Zero Marker Calibration.** This functionality is activated through the "ENC/OUT MARKER CALIBRATION" in the UTILITY menu and shifts the Zero Marker on the electric turn. It can be useful to align the ENC/OUT Marker with mechanical zero of the machine.
- **Digital speed reference parameter saving.** Digital speed reference parameter set in CURRENT LOOP PARAMETERS, SPEED LOOP menu can now be saved.
- **Parameter range modification: motor speed and motor Rw.**
  - Motor speed parameter range has been changed from 300/9999 to 100/9999;
  - Motor Rw parameter range has been changed from da 0/30.0 to 0/100.0;
  - IOFFS U and V parameter range has been changed from -100/100 to -500/500;
  - RECOVERY RESISTOR parameter has been changed from 5/100 to 3/100;

NOTE: *this software can be installed on the DS2000 with 3.xxx software version: please contact Moog service before update the drives.*

NOTE: *this software is totally compatible with the interface Windrive GUI; with 3.1xx or previous release use DSLoader interface.*

I.2 USING THE MANUAL

This manual provides the necessary information for a proper installation and use of the DS2000 servodrive.

The DS2000 was designed to be easily installed; it is not necessary any specific skill concerning servodrives to start it up.

Anyway, the installer should have basics of electronics/electrotechnics, of servodrives, and of safety.

The DS 2000 is a digital servodrive, which can be configured via software as a computer, according to the application requirements.

It is recommended to read carefully the manual before the installation.

After the installation, and before starting up the motor it is also recommended to check all the system parameters to ensure a correct system configuration.

Particular attention must be used to safety instructions.

I.3 ACCIDENT PROTECTION

The safety instructions provided in this Manual are included to prevent injury to personnel (**WARNINGS**) or damage to equipment (**CAUTIONS**).

WARNING: High Voltage. BUS BAR's can have voltage $\geq 810V_{dc}$ even after switching off (capacitive voltage). Discharge Time approx. 6 Minutes.

WARNING: High Voltage. The recovery resistor is connected to the BUS BAR's and can have voltage $\geq 810V_{dc}$.

WARNING: do not touch recovery resistor during operation to avoid scalds.

CAUTION: it is recommended to disconnect the drive and the EMC filters to carry out the AC Voltage Tests of EN 60204-1 (1997), par.19.4, in order to not damage the Y-type capacitors between phases and ground. Moreover the DC voltage dielectric test required by EN 50178 (1997), product family standard, has been carried out in factory as a routine test. The DC Insulation Resistance Tests of EN 60204-1 (1997), par.19.3, may be carried out without disconnecting the drive and the EMC filters.

CAUTION: when required for an emergency stop, opening U2-V2-W2 pins and closing motor phases to resistors, must be preceded by disabling the axis. The delay time must be at least 30 ms.

CAUTION: in case of repetitive switching on and off, waits 1 minute between off and on.

CAUTION: do not exceed the tightening torque of the table (but see proper data sheets for the tightening torque of input capacitors and power modules and see section 2 of this manual for the tightening torque of terminal blocks).

Screw thread	Tightening torque	
	[Nm]	[lb in]
M3	1.00	8.85
M4	3.00	26.55
M5	6.00	53.10
M6	8.00	70.80
M8	20.00	177.00

I.4 EC DECLARATION OF CONFORMITY

CENELEC Memorandum N°3

EC DECLARATION OF CONFORMITY

The undersigned, representing the following manufacturer

| MOOG ITALIANA S.r.l., Casella Site |
| Via Avosso 94, Casella (Genova), Italy |

herewith declares that the products

| Complete Drive Modules series: BRD-4S, DBC III, DBS, IDBS, DS2000, PDBS
Basic Drive Modules series: BRM-4S, DBM 03, DBM 04, IDBM 04, DBM 033
Feeding sections series: ADR, BRM-P1, BRM-P2, DBM 03-PS, DBM 04-PS, DBM 033-PS
Motor groups series: FAE F/K/N/T/W, FAS F/K/N/T/W, FC |

are in conformity with the provisions of the following EC directives
(including all applicable amendments)

ref. n°	title
73/23/EEC	Low Voltage Directive
89/336/EEC	EMC Directive

and that the following harmonized standards, or parts thereof, have been applied

nr	issue	title	parts
EN 60034-1	1998	Rotating electrical machines. Part 1: Rating and performance	
EN 60034-6	1993	Rotating electrical machines. Part 6: IC code	
EN 60034-7	1993	Rotating electrical machines. Part 7: IM code	
CEI EN 60204-1	1993	Safety of Machinery. Electrical Equipment of machines. Part 1: General requirements	par. 6.2.3, 20.3, 20.4
EN 60529	1991	IP code	
CEI EN 61800-3	1996	Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods	par. 1, 2, 3, 4, 5.3.2, 6.3.2, 7
EN 61800-3 /A11	2000	Amendment A11	

Other references or information required by the applicable EC directives:
The conformity of products is subjected to the installation of filters and to the procedures included in the proper "Installation Manual". The user has the primary EMC responsibility in following the recommendations of the manufacturer.

Last two digits of the year in which the CE marking was affixed: 97

Casella, 12/July/2005

A.Bozurro
A.Bazurro
PRODUCTION MANAGER

DEC_CEME Casella.DOC - MOD.176/PMA/9/96

I.5 EC REQUIREMENTS

- **Cautionary Marking.** See previous page.

- **Protection against electric shock.** Electronic Equipment intended for installation in closed electrical operating areas kept locked. Where Electronic Equipment requires manual intervention, 412.2.1 of HD 384.4.41 S2 shall be consulted.

- **Fixed connection for protection.** The equipment may have a continuous leakage current of more than A.C. 3.5 mA or D.C. 10 mA in normal use and a fixed ground connection is required for protection.

- **RCD.** When the protection in installations with regard to indirect contact is achieved by means of an RCD, their appropriate function/combination shall be verified. In any case only a residual-current-operated protective device (RCD) of Type B is allowed. In fact a D.C component can occur in the fault current in the event of a fault connection to earth.

- **Climatic Conditions.** Equipment intended to operate within its performance specification over the range of Class 3K3, as defined in table 1 of EN 60721-3-1, EN 60721-3-2, EN 60721-3-3, EN 60721-3-4, partly modified.

- **Pollution Degree 2 Installation.** The equipment shall be placed in a pollution degree 2 environment, where normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the electronic equipment is out of operation.

- **EMC Requirements.** The installer of the equipment is responsible for ensuring compliance with the EMC standards that apply where the equipment is to be used. Product conformity is subjected to filters installation and to recommended procedures, as from section 3 of this manual.

- **Second Environment (EMC).** Equipment intended to be connected to an industrial low-voltage power supply network, or public network that does not supply buildings used for domestic purposes (second environment, according to EMC Standards). It is not intended to be used on a low-voltage public network that supplies domestic premises (first environment). Radio frequency interference is expected if used on such a network.

- **Recovery Resistor Cable.** Shielding of the recovery resistor cable, provided in kit for test purposes, is recommended for ensuring compliance with the EMC standards.

- **Large-Scale Stationary Industrial Tools (WEEE, RoHS).** Equipment intended for installation as part of large-scale stationary industrial tools, covered by the exception of Annex IA, No.6, of the European Directives 2002/96/EC (WEEE) and 2002/95/EC (RoHS).

I.6 UL AUTHORIZATION (page 1)

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NOTICE OF AUTHORIZATION TO APPLY THE UL LISTING MARK

January 09th, 2006

Attn.: Ing. Daniele Rolla

MOOG Italiana S.r.l.
Casella Site
Via Avosso, 94
16015 Casella (Genova) - Italy

Fax Number: 010-9671283
E-mail: drolla@moog.it

Reference: File E194181 - Vol. 1, Sec. 1-2-3   Project   05CA22929   (P.O. Number 05IT0804)

Subject: Industrial Control Equipment,
               Listed – Power Conversion Equipment - (NMMS) (NMMS7) - cULus

- Revised Report for Open Type, Brushless Motor Servo-Drives "DS 2000 Series – Size E" (Vol.1 –Sec.1)

- Revised Report for Open Type, Brushless Motor Servo-Drives "DS 2100 Series – Size E" (Vol.1 –Sec.3)

- Revised Report for Open Type, Brushless Motor Servo-Drives "DBS Series – 100/320" (Vol.1 –Sec.2)

Dear Ing. Daniele Rolla,

    UL's investigation of your product has been completed under the above project number and the subject product was determined to comply with the applicable requirements.

    This letter temporarily supplements the UL Follow-Up Services Inspection Procedure and serves as authorization to apply the UL and C-UL Listing Mark (cULus), only at the factories under UL's Follow-Up Service Program, to the above products, which are constructed as described below:

- Identical to the subject model, which was submitted to UL for this investigation. The UL Records covering the product will be in the Follow-Up Services Procedure, <u>File E194181, Volume 1, Section 1 -2 - 3.</u>

    To provide the manufacturer with the intended authorization to use the UL and C-UL Listing Mark (cULus), the addressee must send a copy of this Notice and all attached material to each manufacturing location as currently authorized in the appropriate UL File Procedure.

    This authorization is effective from the date of this Notice and only for products at the indicated manufacturing locations. Records in the Follow-Up Services Procedure covering the product are now being prepared and will be sent to the indicated manufacturing locations in the near future. Please note that Follow-Up Services Procedures are sent to the manufacturers only unless the Applicant specifically requests this document.

An independent organization working for a safer world with integrity precision and knowledge

Sede legale e laboratorio: Z I Predda Niedda Nord st 18 I-07100 Sassari Italia
Iscritta al Reg. Impresa di Sassari al n. 8101/98 Iscritta alla CCIAA/REA di Sassari al n. 126205   C F e P IVA 01796660908

UL AUTHORIZATION (page 2)

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Please note: Within Canada, there are federal and local statutes and regulations requiring the use of bilingual product markings. It is the responsibility of the manufacturer (or distributor) to comply with this law. As such, the markings provided in the UL Follow-Up Service Procedure may include only the English version. Please contact us if you need assistance with translations or in determining which markings are appropriate for your product.

Products produced, which bear the UL Listing Mark, shall be identical to those evaluated by UL and found to comply with UL's requirements. If changes in construction are discovered, appropriate action will be taken for products not in conformance with UL's requirements and continued use of the UL Listing Mark may be withdrawn or products that bear the UL Listing Mark may have to be revised (in the field or at the manufacturer's facility) to bring them into compliance with UL's requirements.

Any information and documentation provided to you involving UL Mark services are provided on behalf of Underwriters Laboratories Inc.

Sincerely,

Giuseppe Redaelli
Senior Project Engineer
UL International Italia Slr
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I.7 UL REQUIREMENTS

- These Brushless Servo-Drives shall be assembled with the guidelines specified in this Manual. Only the configurations with the components tested and described in the UL Report, file E194181, Vol.1, Sec.1, Issue date 01-21-00 and following Revisions can bear the Listing Mark.

- These drives shall be used within their ratings, as specified in the marking of the equipment.

- **Cautionary Marking.** See Accident Protection page.

- **Surrounding Air Temperature.** "Maximum Surrounding Air Temperature 40°C". In the final installation considerations shall be given for the need of repeating Temperature test if the unit is mounted with a different Surrounding Air conditions.

- **Pollution degree 2 Installation.** The drive must be placed in a pollution degree 2 Environment.

- **Environmental designation.** "Open Type Equipment".

- **Short Circuit Ratings.**
  - DS2000 3/9, 4/12, 6/15, 8/22, 14/42, 20/45, 25/70, 35/90, 50/140: "Equipment suitable for use on a circuit capable of delivering not more than 5000 rms Symmetrical Amperes, 460 V_{ac} +10% maximum"
  - DS2000 60/180, 100/300: "Equipment suitable for use on a circuit capable of delivering not more than 10000 rms Symmetrical Amperes, 460 V_{ac} +10% maximum"

- **Branch Circuit Protection.** The Branch Circuit Protection for Short Circuit shall be provided in the end-use applications by external R/C Fuses (JFHR2), manufactured by Busman Div Cooper (UK) LTD, Semiconductor fuse type, rated 660 V_{ac}, 200 kA A.I.C., Mod. No. as follows:
  - DS2000 3/9, 4/12, 6/15, 8/22, 14/42: Mod. No. 50 FE, rated 50 Amps
  - DS2000 20/45, 25/70, 35/90: Mod. No. 100 FE, rated 100 Amps
  - DS2000 50/140, 60/180: Mod. No. 160 FEE, rated 160 Amps
  - DS2000 100/300: Mod. No, 315-FM, rated 315 Amps

- **Overspeed Protection.** The Power Conversion Equipment is incorporating an Overspeed Protection. See MV command in section 6.

- **Overvoltage Control.** In the equipment the Overvoltage is controlled by a Transient Suppressive device, with 1500 V Clamping Voltage and min 120 J (10x1000 us or 2 ms) Energy Handling Capability. See also "Bus not normal" protection in section 6.

- **Overload Protection.** The equipment does not incorporate internal overload protection for the motor load. The drive is intended to be used with motors that must have integral thermal protection through a PTC or NTC. The overtemperature fault of the drive will trip when the PTC reaches 2 kW or 6.5kW for the NTC. See J4 connector in section 2 of this manual for wiring.

- **Over-Current Protection.** The drive is provided with a current limiting circuitry. See ANALOG ILIMIT and I2T commands in section 6.

- **Wiring.** Wiring shall be made by stranded and/or solid, copper (Cu), 60/75°C (140/167°F) conductor only, and, for terminal blocks, the tightening torque values specified in section 2 of this manual shall be applied. These requirements do not pertain to control circuit terminals.

- **Wiring of Recovery Resistor.** The Dynamic Brake Unit Recovery Resistor, when external, shall have the connection wiring made with R/C (AVLV2) or insulated with R/C (YDPU2) or R/C (UZCW2) in the end-use installation.

- **Transient Suppression Devices.** Input power wiring, only for size A and B, shall be protected by external Transient Suppression Devices, such as varistors or transient voltage surge protections, evaluated to the component requirements in UL1449. the following devices are recommended:

Drive	Ref. Code	Manufacturer	TVSS Mod. No.	Rating				Qty
				Operating Voltage (V_{ac})	Clamping Voltage (V_{ac})	Maximum Energy (J)	Max Op. Temp	
A and B size	AS5046	Littelfuse Inc	V-575-LA-40-A	575 V_{rms} max	1500	120 (10x1000μs)	85°C	3
		Epcos Ohg	S14-K-550	550 V_{rms} max	1500	120 (2ms)	85°C	
			S20-K-550	550 V_{rms} max	1500	210 (2ms)	85°C	
		S A BC Components NV	2322 595.551	550 V_{rms} max	1500	160 (10x1000μs)	85°C	

I.8 ICEPI CERTIFICATE

i CE pi

Istituto Certificazione Europea Prodotti Industriali S.p.A.

ATTESTATO DI ESAME VOLONTARIO
VOLUNTARY EXAMINATION CERTIFICATE

05CM020602

■ Nome e indirizzo del detentore del certificato ❑ *Name and address of the holder of the certificate*	**MOOG Italiana S.r.l. sede di Casella** **Via Avosso, 94** **16015 CASELLA (GE)**
■ Costruttore ❑ *Manufacturer*	**MOOG Italiana S.r.l. sede di Casella** **Via Avosso, 94** **16015 CASELLA (GE)**
■ Genere prodotto ■ *Product designation*	**Servoazionamento digitale +** **circuito di interblocco al riavvio** *Digital servodrive +* *restart interlock circuit*
■ Serie \ Opzione ■ *Series \ Option*	**Servoazionamento serie DS2000 +** **scheda opzionale Restart Interlock Circuit** *Servodrive series DS2000 +* *optional board Restart Interlock Circuit*
■ Funzione di sicurezza ■ *Safety function*	**Interblocco al riavvio (protezione contro l'avvio inaspettato)** *Restart interlock (protection against unexpected start)*
■ Direttiva(e) CE \ Norma(e) armonizzata(e) ❑ *EC - Directive(s) \ Harmonized standard*	**98/37/CE (Macchine) \ UNI EN 954-1: 1998**

■ Risultato dell'esame ■ *Examination result*	L'esame del Fascicolo Tecnico permette di dichiarare che la funzione di sicurezza "interblocco al riavvio" del servoazionamento serie DS2000 con scheda opzionale Restart Interlock Circuit rispetta i requisiti della categoria 3 definita nella norma armonizzata UNI EN 954-1: 1998. I servoazionamenti devono essere installati come descritto nel Manuale di Uso (condizioni ambientali e interfaccia con il sistema di comando e controllo). *Following the examination of technical construction file we can declare that the safety function "restart interlock" of servodrive DS2000 series, with optional board Restart Interlock Circuit complies with the provisions of category 3 as defined in the harmonized standard UNI EN 954-1: 1998. Servodrives must be installed according to the instructions (environmental and interface with control and verification circuit) of the User's Manual.*

Piacenza, 06.02.2006

Il Direttore Generale
Ing. Andrea Guido Esposito

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I.9 SAFETY REQUIREMENTS (RESTART INTERLOCK FUNCTION)

- **Complete Standstill**. The Restart Interlock safety function prevents motor unexpectedly starting from standstill. This circuit can be used in the "Safe Standstill" machine function. When the motor is rotating, the switching-on of the Restart Interlock provides an uncontrolled stop (category 0 according to EN 60204-1:1997). When a controlled stop of category 1, according to EN 60204-1:1997, is requested, the condition of stopped motor must be assured. The final machine must be able to stop the motor.

  WARNING: The designer must evaluate the machine stopping time during the risk assessment even in case of failure. The machine can present a dangerous overrun in case of failure of the drive. Other protective measure are needed to achieve a safe condition.

- **Environmental Conditions.** Equipment intended to operate within the following environmental conditions:
  ◊ Ambient temperature: 0 to +40°C
  ◊ EMC immunity: according to EN 61800-3/A11:2000 (Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods). Second environment (industrial)
  ◊ Vibration immunity: 2 to 12Hz, 1.5 mm amplitude (peak); 12 to 200Hz, 1 g acceleration
  ◊ Shock immunity: 10 g, half sine, 11 ms, according to EN 60721-3-3:1995, Class 3M4

- **Enlosure.** Electronic Equipment intended for installation in an enclosure providing at least IP54 protection.

- **Pollution Degree 2.** The equipment shall be installed in a pollution degree 2 environment, where normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the electronic equipment is out of operation.

  WARNING: When the Restart Interlock Circuit is activated, the motor can no longer generate a torque. Motors which are not automatically clamped when powered down (e.g. vertical/inclined axes), must be clamped using a mechanical brake

I.10 LEGAL ASPECTS

This manual can be used only by final Customers/Users of the Moog product it describes and only for proper installation purposes.

This manual cannot be reproduced in whole or in part without the prior written consent of Moog.

No transmission or diffusion of this manual, under electronic, mechanical, or printed form, is allowed.

Moog issued this manual attempting to ensure a complete information; anyway, Moog shall not be liable for errors or omissions contained herein and for incidental or consequential damages due to the above mentioned errors and omissions.

Moog reserves the right to change and update this manual without notice.

This manual has a merely information purpose. There is no obligation for Moog as regard the correspondence of the product features described in the manual with the features of the real product purchased by the final Customer/User.

No statement or sentence contained in this manual implies further legal obligations different from the ones contained in each single sale or supply contract concerning Moog products.

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1. DESCRIPTION

1.1 INTRODUCTION

This section describes the DS2000 drive series, providing information about the coding system. Such data allow understanding the DS2000 characteristics and makes clear the necessary concepts to access the following sections.

1.2 PRODUCT RANGE

DS2000 is a full digital drive series for permanent magnet synchronous servomotors (hereinafter: brushless) and for vector control asynchronous servomotors (hereinafter: asynchronous).

The range is made up of 11 models, corresponding to 3, 4, 6, 8, 14, 20, 25, 30, 50, 60 and 100 A_{rms} nominal currents.

The standard transducers provided with the motor are the incremental encoder or the resolver (with its simulated encoder).

The recovery resistors are placed outside the drive; only the 3, 4, and 6 A models can be equipped with built-in recovery resistor (optional).

DS2000 drive is provided together with this manual and the Application Notes in the Appendix of DS2000 user's manual, for a deep understanding and the best use of the product.

1.3 GENERAL FEATURES

The DS2000 features provide the automation industry with the best response to the hardest requirements related to motion control:

FULL DIGITAL:
- Speed and current control loops and many other functions, as the DC BUS status monitoring, the soft-start and recovery circuit management, and the protections thresholds detection are carried out through numeric algorithms.
- The digital mode allows a maximum stability related to the aging, the temperature and the various application cases.
- Settings are carried out through numbers calculated by means of analytic models and do not depend upon analog calibrations.

FLEXIBLE:
- Any brushless motor can be very well driven by entering a maximum of 8 parameters which adjust the current loop and identify the motor electromechanical characteristics (peak current, electromotive force, inductance, resistor, poles number, voltage rating, speed).
- Any asynchronous motor can be very well driven by vector control, working as a brushless servomotor; by entering the magnetization current (ID) and the slip gain (frequency) additional parameters it is possible to use any kind of asynchronous motor. The other parameters, the ones in connection with the hardware features in common with brushless motors, remain active.
- The motor transducer can be both a resolver (2 to 24 poles) and an incremental encoder (1024 to 8192 pulses).
- It is possible to program the device in 2 different languages: Italian and English. The required language should be specified in the purchase order.
- The power supply voltage range can be from Three-phase 65 V_{ac} to 510 V_{ac} with no previous setup.
- With power supply voltages lower than 120 V_{ac} Three-phase, it is necessary to supply a 24 V_{dc} auxiliary voltage.

ADVANCED PERFORMANCE:

- The current loop, based on a traditional PI structure, is provided with automatic compensation algorithms of the EMF and of the KP/KI ratio, as a function of the motor characteristics.
- Hardware calibrations are not necessary for the current loop, but they are necessary for parameters setting.
- Current loops are closed at 10kHz.
- The speed loop is closed at 5kHz.
- Additional phase advance is provided.

1.4 TECHNICAL DATA

1.4.1 ELECTRICAL AND MECHANICAL SPECIFICATIONS

Three-phase input voltage rating:	$230V_{ac}$ to $460V_{ac}$ ±10%, 50/60 Hz
Min/max Three-phase input voltage	
- With 24 V_{dc} auxiliary input voltage:	65 / 510 V_{ac} (DC-BUS: 80 / 720 V_{dc})
- Without 24 V_{dc} auxiliary input voltage:	120 / 510 V_{ac} (DC-BUS: 150 / 720 V_{dc})
Auxiliary voltage:	24 V_{dc} ±10% , 1.5A
Configurable analog references:	3.2 to 10 V_{dc}
Max dynamic with encoder:	200 Hz
Switching frequency:	10 kHz
Speed adjustment:	0 to 9999 rpm
Anti-resonance low-pass filter:	20 to 800 Hz
Filter on reference:	1 to 800 Hz
Notch filter (programmable):	50 to 1500 Hz

Model	Output current			Mass (kg)	Size
	Nominal (A_{rms})	Max (A_{rms})	Peak (A)		
3/9	3	6.4	9	4.5	A
4/12	4	8.5	12	4.5	A
6/15	6	10.6	15	4.5	A
8/22	8	15.6	22	4.5	A
14/42	14	29.7	42	6	B
20/45	20	31.8	45	10	C
25/70	25	49.5	70	10	C
30/90	30	63.6	90	10	C
50/140	50	99.0	140	23	D
60/180	60	127.3	180	23	D
100/300	100	212.7	300	40	E

Tab. 1.0 – Mechanical and electrical characteristics

1.4.2 CLIMATIC CONDITIONS

1.4.2.1 AMBIENT TEMPERATURE
0°C to +40°C (exceeding EN 60204-1:1997, par.4.4.3).

1.4.2.2 AMBIENT HUMIDITY
5% to 85% with no condensation and no formation of ice (according to EN 50178:1997, weather protected site).

1.4.2.3 ALTITUDE
The electrical equipment is able to operating correctly at altitudes up to 1000m above sea level (according to EN 60204-1:1997, par.4.4.5)

1.4.2.4 TRANSPORTATION AND STORAGE
The electrical equipment withstands the effects of transportation and storage temperatures within a range of −25°C to +55°C and for short periods not exceeding 24 h at up to +70°C (according to EN 60204-1:1997, par.4.5).

1.4.2.5 POLLUTION
The equipment has been designed according to pollution degree 2, where normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the electronic equipment is out of operation.

1.4.3 OTHER MECHANICAL SPECIFICATIONS

1.4.3.1 IMMUNITY TO MECHANICAL VIBRATION
0.075mm amplitude from 10 Hz to 57 Hz, 1g acceleration from 57 Hz to 150 Hz (according to EN 50178:1997 and to IEC 68-2-6:1995, Fc test).

1.4.4 INTERFACES

- **Analog**
  - Speed (or current) reference differential input: 0 +/- 10V (adjustable scale)
  - Auxiliary input voltage: $24V_{dc}$ ±10%
  - Output Voltage: $15V_{dc}$
  - Analog output (configurable)
  - Tachometric signal (adjustable scale)
  - Peak current limit (trough adjustable analog signal)
  - Motor temperature (trough PTC or NTC)
  - Resolver interface
  - Sine Encoder Interface (optional)

- **Digital**
  - RS485 full-duplex serial link
  - Encoder input (incremental)
  - Encoder output (incremental)
  - Reset
  - Drive OK output
  - Drive enable input (torque)
  - Reference enable input (speed)
  - CAN BUS (optional)

1.4.5 PROTECTIONS

- Motor over temperature
- Drive over temperature
- Input voltage out of tolerance
- Encoder or resolver signal missed
- Encoder or resolver faulty connections
- Axis short circuit (motor and recovery resistor output)
- Recovery resistor missed (overvoltage)
- Recovery resistor overload (software selectable)
- Over speed in torque mode control (if speed is 12% above max set value).
- IGBT over temperature (software selectable)
- Anti-free-wheeling (software selectable)
- Safety – Restart interlock function (optional).

1.5 STANDARD VERSIONS CODES

DS2000 drives are marked by a code identifying both the current supplied by the Model and the eventual internal recovery resistor.
Codes correspond to:
- Standard Italian software drives
- 6 poles resolver (transformation ratio:0.29), ¼ marker configured, 1024 simulated encoder pulses
- External recovery resistor, provided with the drive together with mating connectors.

The following table summarizes the drive codes:

Model		Size
Code	Type	
CZ1000C0A	3/9	A
CZ1001C0A	4/12	A
CZ1002C0A	6/15	A
CZ1003C0A	8/22	A
CZ1008C0A	14/42	B
CZ1005C0A	20/45	C
CZ1006C0A	25/70	C
CZ1007C0A	30/90	C
CZ1009C0A	50/140	D
CZ1010C0A	60/180	D
CZ1011C0A	100/300	E

Tab. 1.1 – Standard versions codes

Besides the coding in Tab. 1.1, a new coding formed by a descriptive code has been introduced, which univocally and directly identifies a drive and its configuration.
Fig. 1.1 shows the new codifications .

1.6 SPECIAL VERSIONS CODES

For a limited braking power dissipation application, special versions of 3/9, 4/12, and 6/15 Size drives have been realized with built-in recovery resistor. Their codes are different, but all the other features and the operation remain the same.
Codes correspond to:

- Standard Italian software drives
- 6 poles resolver (transformation ratio:0.29), ¼ marker configured, 1024 simulated encoder pulses
- Mating connectors provided with the drive

The following table summarizes the drive codes:
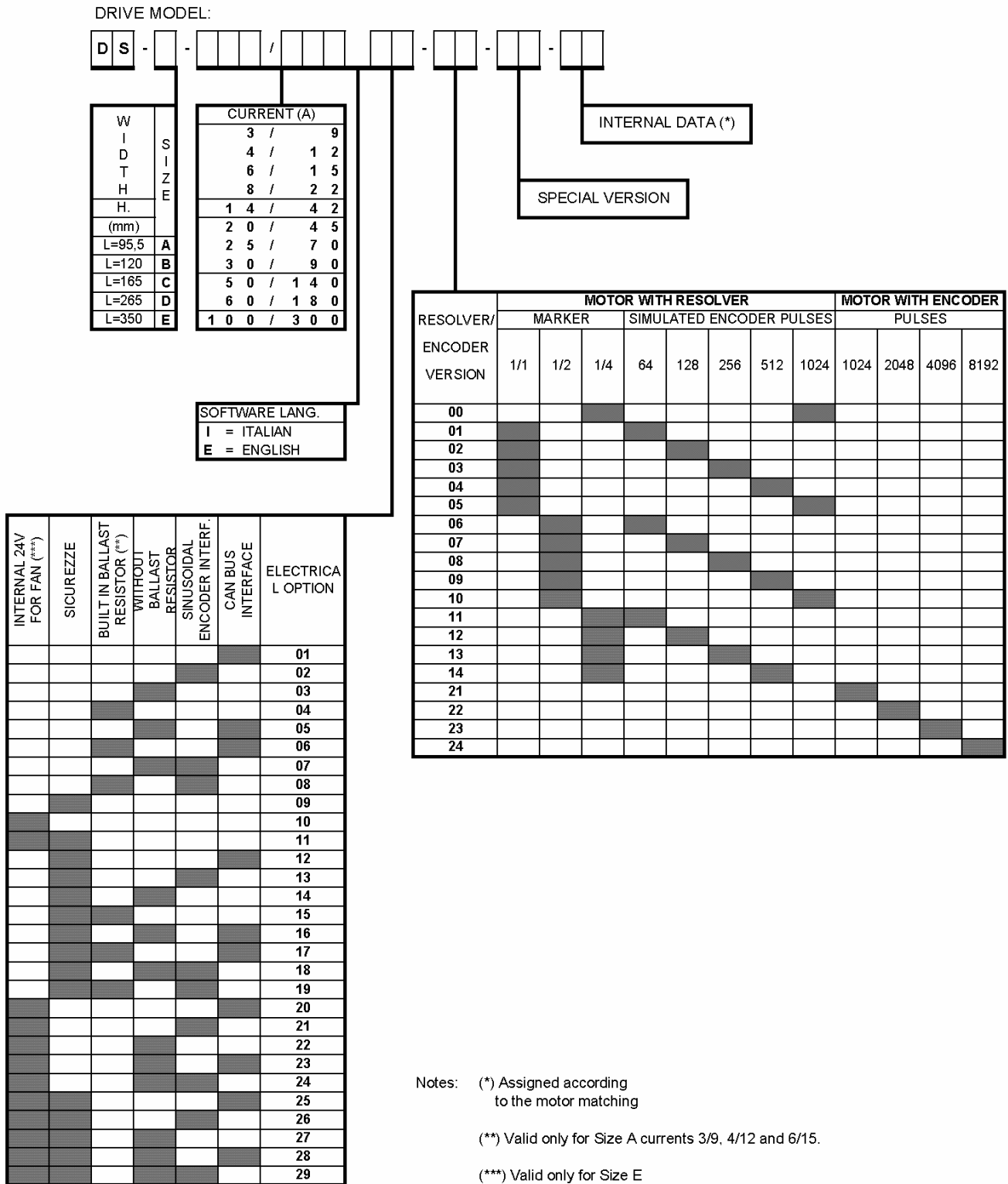
Model		Size
Code	**Type**	
CZ1100C0A	3/9	A
CZ1101C0A	4/12	A
CZ1102C0A	6/15	A

Tab. 1.2 – Special versions codes

Additional informations can be found in Section 2 and Section 5.

DRIVE MODEL:

DS - ☐ - ☐☐☐ / ☐☐☐ ☐☐ - ☐☐ - ☐☐ - ☐☐

WIDTH H. (mm)	SIZE
L=95,5	A
L=120	B
L=165	C
L=265	D
L=350	E

CURRENT (A)	
3 /	9
4 /	1 2
6 /	1 5
8 /	2 2
1 4 /	4 2
2 0 /	4 5
2 5 /	7 0
3 0 /	9 0
5 0 /	1 4 0
6 0 /	1 8 0
1 0 0 /	3 0 0

SOFTWARE LANG.
- **I** = ITALIAN
- **E** = ENGLISH

INTERNAL DATA (*)

SPECIAL VERSION

RESOLVER/ ENCODER VERSION	MOTOR WITH RESOLVER								MOTOR WITH ENCODER			
	MARKER			SIMULATED ENCODER PULSES					PULSES			
	1/1	1/2	1/4	64	128	256	512	1024	1024	2048	4096	8192
00			■					■				
01	■			■								
02	■				■							
03	■					■						
04	■						■					
05	■							■				
06		■		■								
07		■			■							
08		■				■						
09		■					■					
10		■						■				
11			■	■								
12			■		■							
13			■			■						
14			■				■					
21									■			
22										■		
23											■	
24												■

INTERNAL 24V FOR FAN (***)	SICUREZZE	BUILT IN BALLAST RESISTOR (**)	WITHOUT BALLAST RESISTOR	SINUSOIDAL ENCODER INTERF.	CAN BUS INTERFACE	ELECTRICAL OPTION
					■	01
				■		02
			■			03
		■				04
		■	■			05
		■		■		06
				■		07
	■					08
	■					09
■						10
■	■					11
■	■				■	12
■	■			■		13
■	■		■			14
■	■	■				15
■		■			■	16
■		■		■		17
■		■	■			18
■		■				19
■					■	20
■				■		21
■			■			22
■		■				23
■	■	■				24
■	■					25
■	■			■		26
■	■	■	■			27
■				■		28
						29

Notes:
(*) Assigned according to the motor matching

(**) Valid only for Size A currents 3/9, 4/12 and 6/15.

(***) Valid only for Size E

EXAMPLE:

D S - A - 4 / 1 2 E 0 3 - 0 1 - 0 0 - 1 0

- DS2000
- A SIZE
- CURRENT 4/12A
- ENGLISH SOFTWARE LANGUAGE
- WITHOUT BALLAST RESISTOR
- RESOLVER MARKER 1/1, SIMULATED ENCODER PULSES 64
- NO SPECIAL VERSION
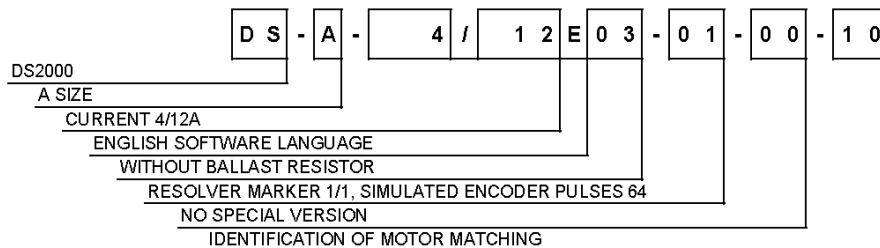- IDENTIFICATION OF MOTOR MATCHING

Fig. 1.1 – Table of DS2000 codification

1.7 OPTIONS

Optional devices can be built-in or separately supplied.
Built-in drive devices are:
- CAN BUS interface on speed reference (SW Release 4.X00)
- Safety – Restart interlock function
- 24V fans internal power supply (only size E)

Separately supplied devices are:
- RS232/422/485 Converter (Moog code CZ5200)
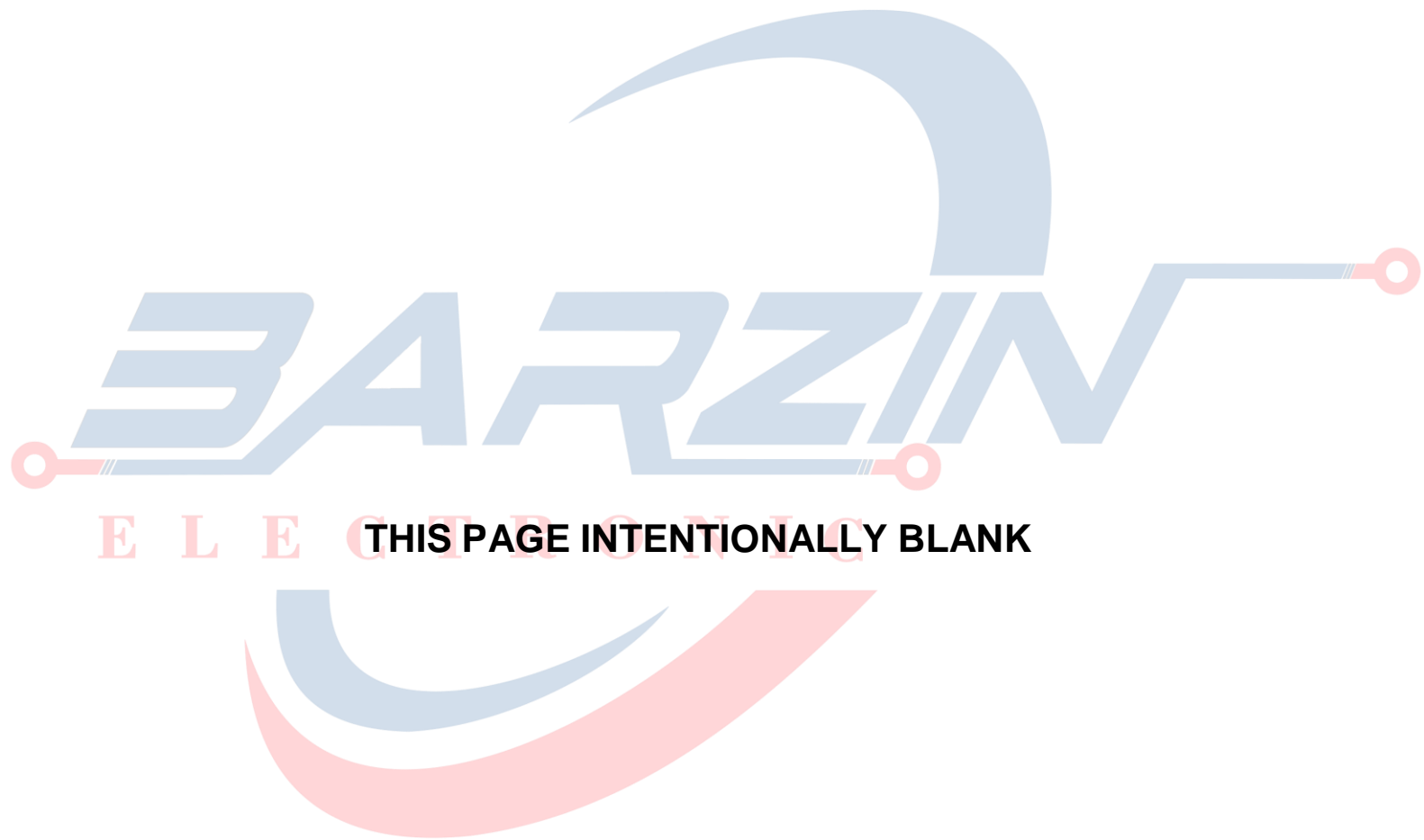
1.8 SERIAL NUMBER – NAMEPLATE

Each drive is provided with a serial number identifying the Model, any eventual option and the manufacturing date. This number is a useful tool to verify, through the Moog Database, the original software and firmware revision.
Using these data it is possible to carefully support the final Customers. It is recommended to take note of the serial number, which is present on each drive, before shipment.

CODE:	CZxxxxYYz	Product code
S/N:	AASSNNNNYYA	Serial number, where AA= year, SS= week, NNNN= progressive number, YYA= option (C0A= standard version)
Vin:	xxx V	Input voltage rating
Iin:	xxx Arms	Nominal effective input current
Iout:	xxx Arms	Nominal effective output current
Iout:	xxx Apeak	Output peak max current

Fig. 1.2 – Nameplate

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2. GENERAL INFORMATION

2.1 INTRODUCTION

This section describes the installation, wiring and cabling of the Moog DS2000 servo drive series. Such information allows the understanding of DS2000 functionality and makes clear the necessary concepts to access the following sections.
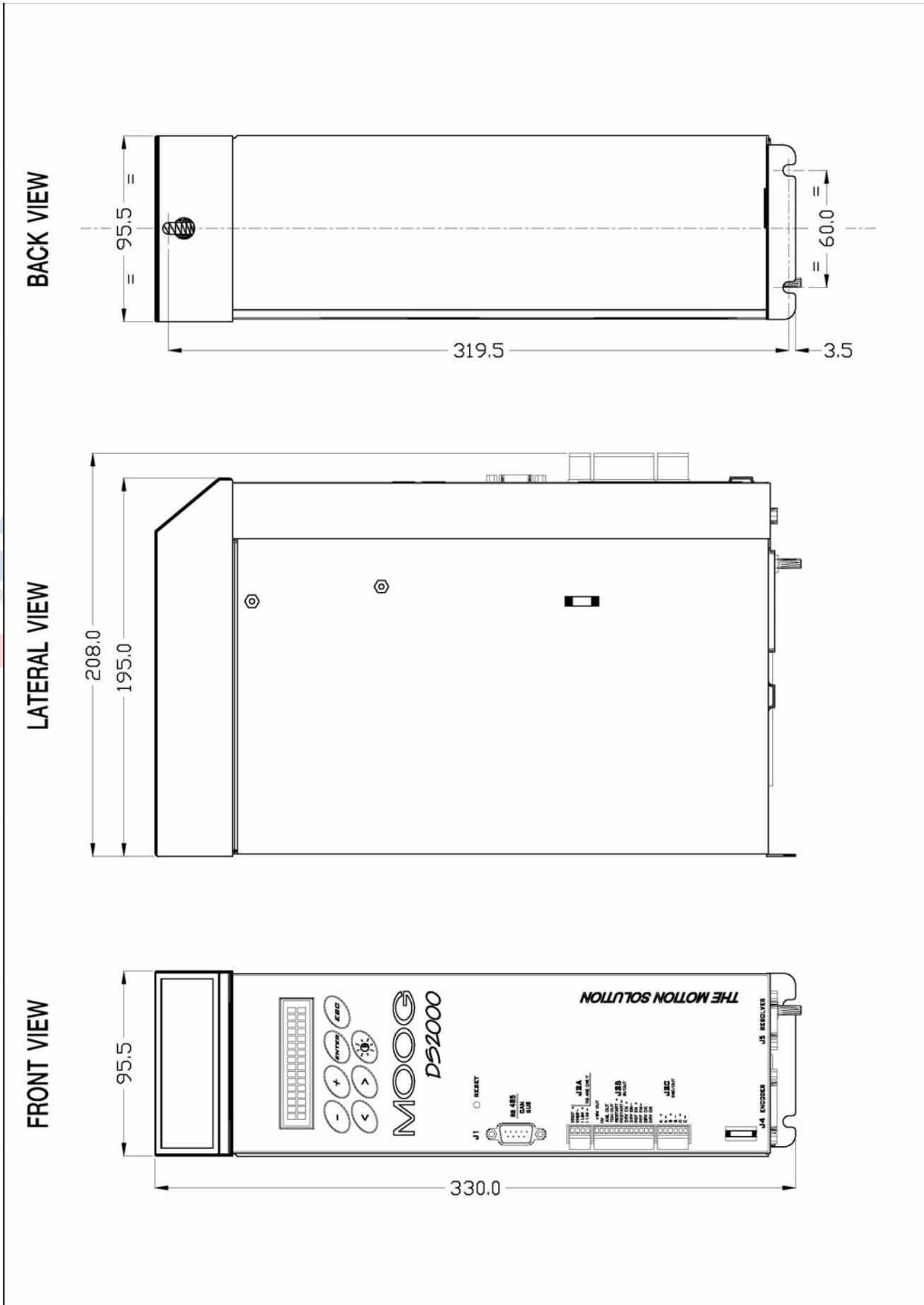
2.2 DIMENSIONS AND DRILLING JIG

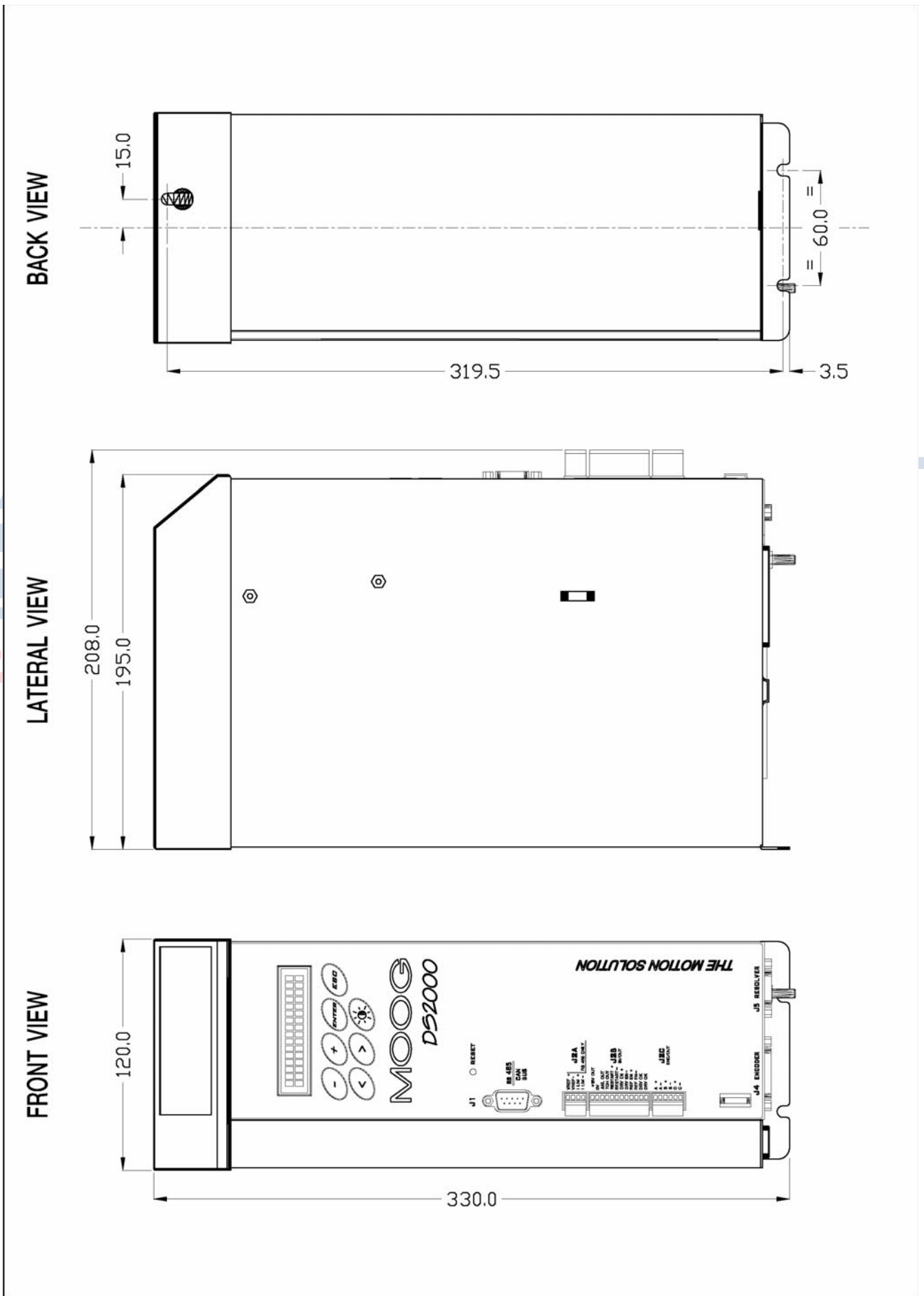Fig. 2.1 – Size A dimensions and drilling jig (mm)

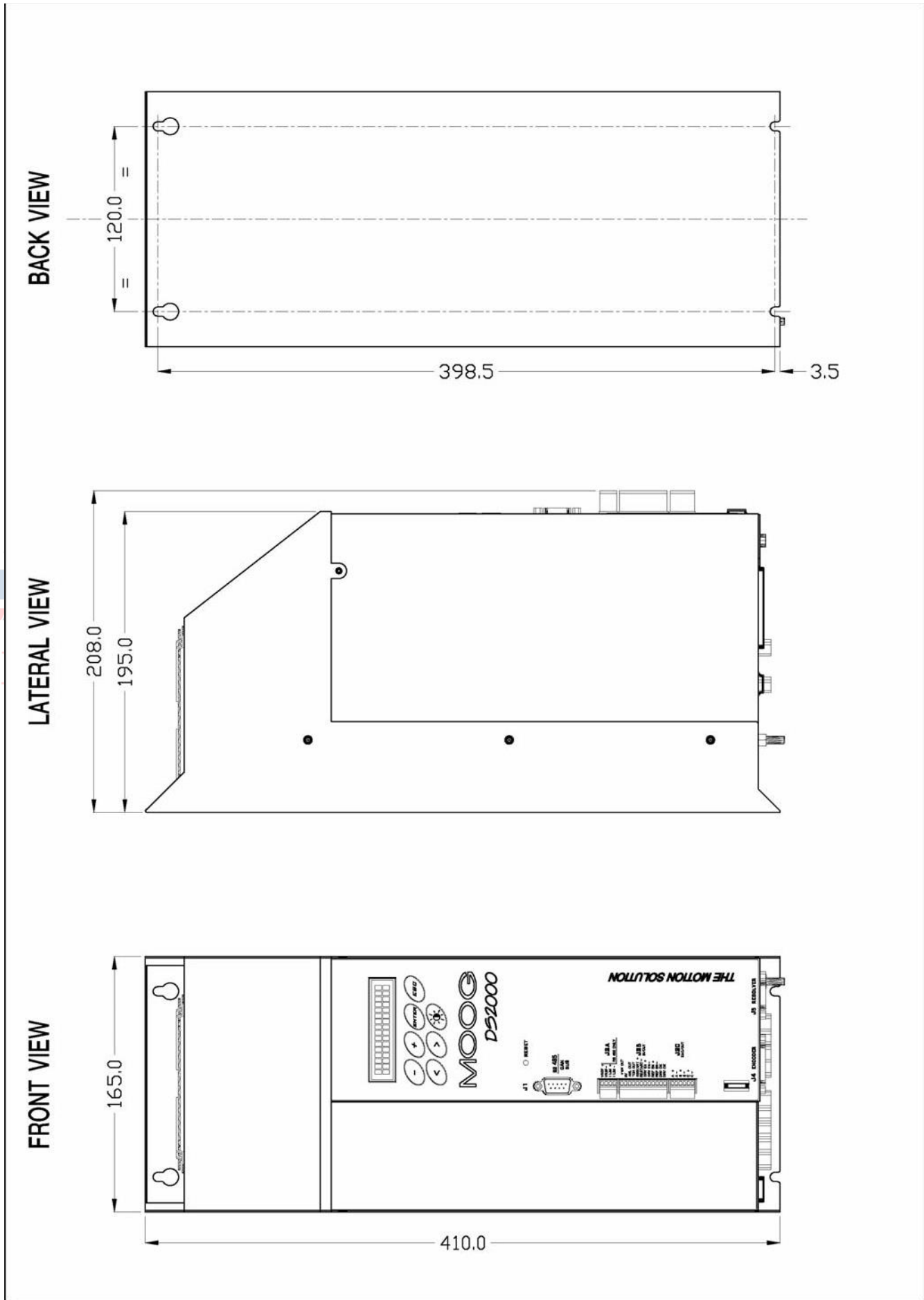Fig. 2.2 – Size B dimensions and drilling jig (mm)
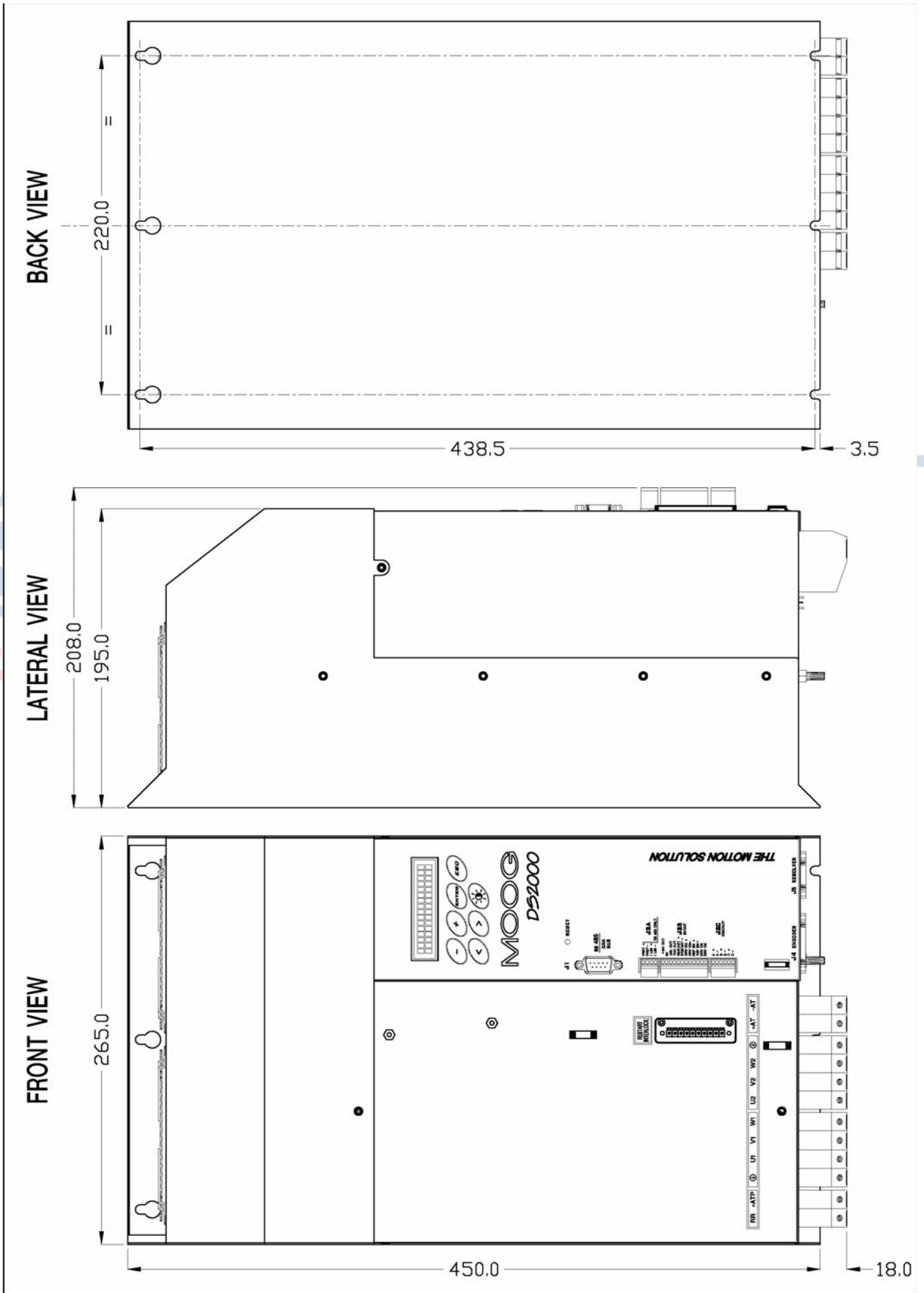
Fig. 2.3 – Size C dimensions and drilling jig (mm)

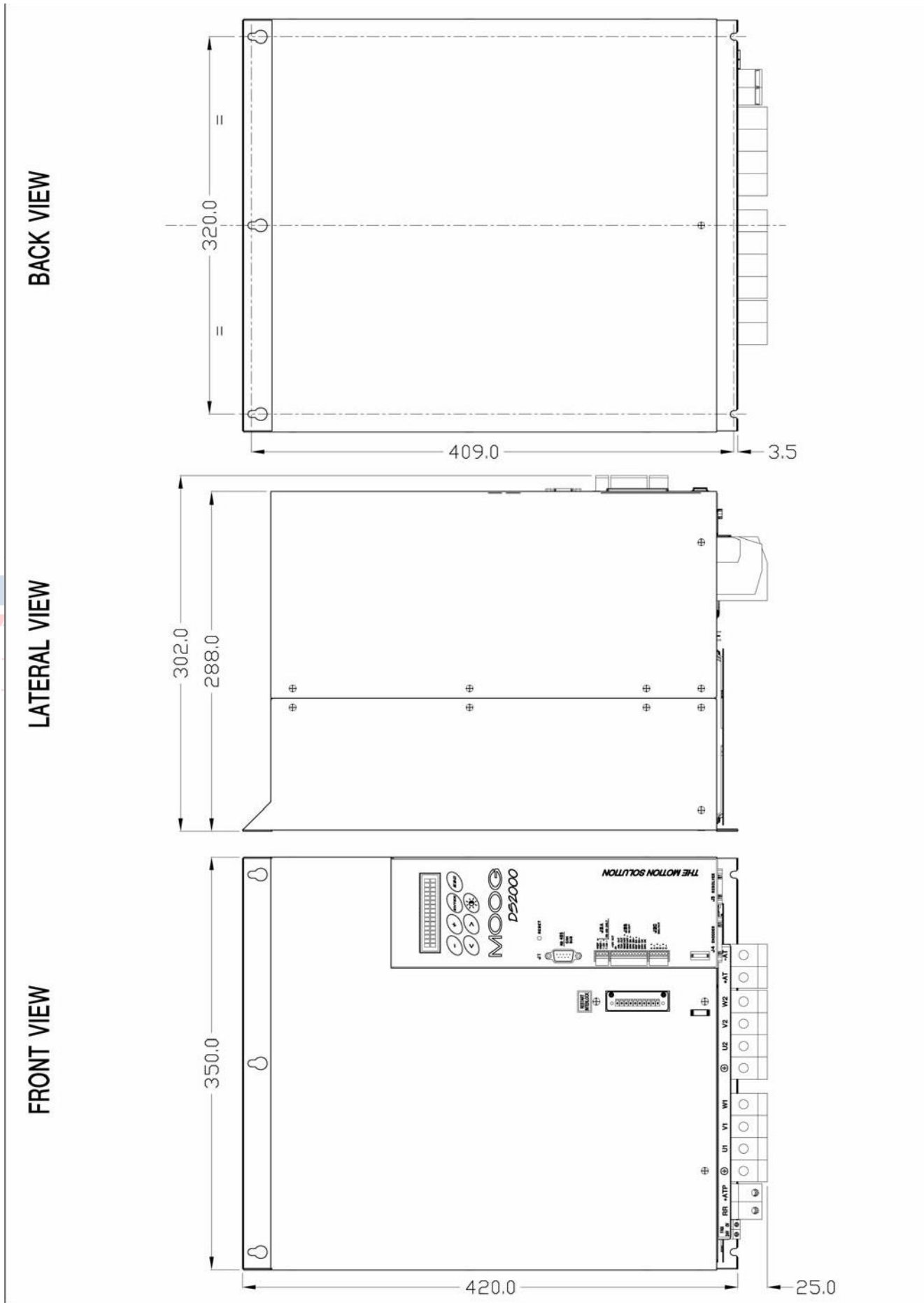Fig. 2.4 – Size D dimensions and drilling jig (mm)

Fig. 2.4.1 – Size E dimensions and drilling jig (mm)

2.3 EXTERNAL FUSES

It is recommended to use the Short Circuit protection in the final application with UL certified external fuses (cat. JFHR2), manufactured by Bussmann Div. Cooper (UK) Ltd, semiconductor type, 660 V_{ac}, 200 kA symmetrical A.I.C..

As alternate fuses by different manufacturers can be used but UL approved (cat. JFHR2) with the same data of the fuses shown in table taking care that the Peack-let-trough-current (A.I.C) and clearing I2T are equal or lower.

	DS2000 MODEL					Notes
	A size				**B size**	
	3/9	**4/12**	**6/15**	**8/22**	**14/42**	
Short Circuit Rating	5000 rms Amps symmetrical					
Power line fuse	50 – FE					Semiconductor
24 V_{dc} auxiliary power supply fuse	3A / 250V					Delayed

	DS2000 MODEL					Notes
	C size			**D size**		
	20/45	**25/70**	**30/90**	**50/140**	**60/180**	
Short Circuit Rating	5000 rms Amps symmetrical			5000 rms Amps symm.	10000 rms Amps symm.	
Power line fuse	100 – FE			160 – FEE		Semiconductor
24 V_{dc} auxiliary power supply fuse	3A / 250V					Delayed

	DS2000 MODEL	Notes
	E size	
	100/300	
Short Circuit Rating	10000 rms Amps symmetrical	
Power line fuse	315-FM	Semiconductor
24 V_{dc} auxiliary power supply fuse	3A / 250V	Delayed

Tab. 2.1 – Recommended fuses

2.4 POWER DISSIPATION

For the thermal sizing of the cabinet in which the drive is installed, it is necessary to refer to the table. If the application implies continuous braking, it is necessary to add the recovery resistor power dissipation (use the nominal power if the one required by the application is unknown).

DS2000 Model	Power
3/9	60W
4/12	75W
6/15	90W
8/22	110W
14/42	180W
20/45	250W
25/70	300W
30/90	400W
50/140	650W
60/180	800W
100/300	1200W

Tab. 2.2 – Power dissipation at nominal current

2.5 SOFT-START

The soft-start circuit (current limit at start-up) is included in the drive input stage. Additional data about the soft-start circuit can be found in the Section 5.

2.6 RECOVERY CIRCUIT

Standard recovery resistors are in the following table (see Section 5 for additional informations) :

Dynamic braking unit			
DS2000	Standard recovery resistor for 400/460 V_{ac} mains voltage		
Model	Resistor and power	Max Current	Max Duty Cycle
3/9 4/12	75Ω/100W (ext.)	10A	1.3%
6/15 8/22	51Ω/200W (ext.)	14.7A	1.8%
14/42	33Ω/250W (ext.)	22.7A	1.5%
20/45 25/70 30/90	12Ω/370W (ext.)	62.5A	0.8%
50/140 60/180	10Ω/750W (ext.)	75.0A	1.3%
100/300	3.9Ω/1000W (ext.)	192.3A	0.7%
3/9 4/12	82Ω/150W (int.)	9.1A	1.0%
6/15	56Ω/150W (int.)	13.4A	0.7%

Tab. 2.3 – Recovery resistor data

Dimensions declared by the supplier are in the following table:
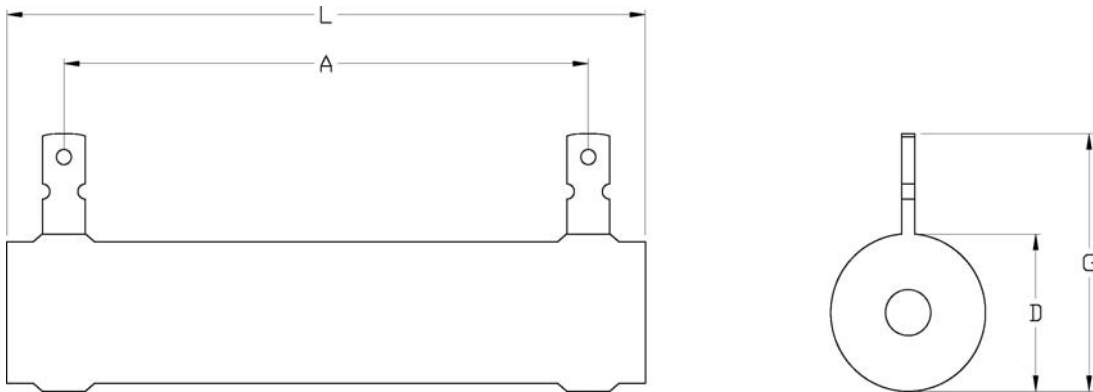
Model	75Ω/100W	51Ω/200W	33Ω/250W	12Ω/370W	10Ω/750W	3.9Ω/1000W
L [mm]	165 ± 2	215 ± 2.5	265 ± 3	265 ± 3	300 ± 5	400 ± 5
A [mm]	150 ± 2	200 ± 2.5	250 ± 3	241 ± 3	270 ± 5	370 ± 5
G [mm]	36 ± 2	46 ± 2	46 ± 2	53 ± 2	88 ± 2	88 ± 2
D [mm]	20.5 ± 1	30.5 ± 1	30.5 ± 1	39 ± 2	76 ± 2	76 ± 2

Tab. 2.4 – Mechanical data of recovery resistor

2.7 FANS

DS2000 ventilation is provided by one or more fans mounted over the drive and under only for size E. The fans input power is internally supplied except for size E (option "internal 24V")

CAUTION: A free air circulation must be ensured for a proper operation as per the following table..

DS2000 Size	Minimum Clearence Top (mm)	Minimum Clearence Bottom (mm)
A	60	100
B	60	100
C	80	160
D	100	200
E	200	300

Tab. 2.5A – Minimum Clearence around DS2000 Drives

2.8 RESET OR RESTART BUTTON

The reset (restart) button is on the drive front panel. It allows the digital control card re-initialization as well as the protections reset.

2.9 CONNECTION CABLES

Connection cables must have precise electric characteristics in order to ensure a proper operation of the servosystem. It is recommended to use copper (Cu) cables, 75°C, UL certified, according to the cross sections indicated in the table 2.5. The following table shows the cables specification for each single function.

Cable	DS2000 MODEL						Notes
	A Size	**B** Size	**C** Size	**D Size** 50/140	60/180	**E** Size	
Line power	14 AWG	12 AWG	8 AWG	6 AWG	4 AWG	1 AWG	
Protective bonding	6 AWG	6 AWG	6 AWG	6 AWG	4 AWG	1 AWG	
Motor power cable	14 AWG	12 AWG	8 AWG	6 AWG	4 AWG	1 AWG	Shielded
DC BUS (+/-AT)	14 AWG	12 AWG	8 AWG	6 AWG	4 AWG	1 AWG	Shielded
Recovery resistor	14 AWG	12 AWG	8 AWG	6 AWG	4 AWG	2 AWG	Shielded
24V fans cable						14 AWG	Shielded
Restart Interlock	22 AWG						Shielded
24V power supply	14 AWG						Shielded
Motor encoder	22/20 AWG						Shielded
Motor resolver	22/20 AWG						Shielded

Tab. 2.6 – Wiring size

CAUTION: *To connect more than one drive through the DC BUS (+/-HV), please ask the Service Center.*

2.10 AWG/mm² CONVERSION

AWG	mm²
22	0.3
20	0.5
18	0.8
16	1.3
14	2.1
12	3.3
10	5.3
8	8.4
6	13
4	21
3	27
2	34
1	42

Tab. 2.7 – AWG/mm² conversion

2.11 WIRING AND CONNECTORS

NOTE: Moog DS2000 drives are equipped with all the necessary connectors for a proper operation. It is not necessary to indicate the connectors, or the recovery resistor in the purchase order. All of them are included in the drive code.

All the drives (except D size and E size) are equipped with plug-in connectors to ensure a quick connection of the drive to the switchboard and for Service activities (if applicable).

2.11.1 POWER CONNECTORS

Connectors differ according to the different drive sizes: please, refer to the following descriptions and tables to detect the corresponding pin configuration; power connectors bear a pinout label which makes pin detection easier.

2.11.1.1 SIZE A and B POWER CONNECTOR
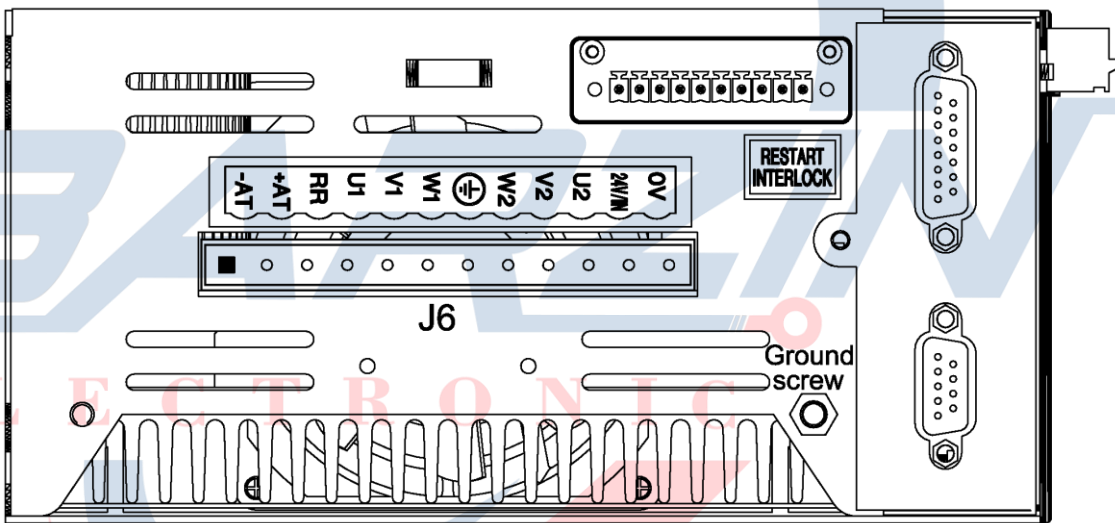
Note: Pin 1 is marked with the symbol "■"

Fig. 2.5 – Size A and B power connector

- **J6 connector**
- Mating connector: female. 12 pins, supplied with the drive, model Tyco 1-282960-2 or 1-796981-2 (Moog code AK4987).
  Wire stripping: 7 mm. Tightening torque: 0.5Nm.

Pos.	Name	Function
1 ■	-AT	- DC BUS AT
2	RR (+AT)	External recovery resistor and +AT of DC BUS
3	RR	External recovery resistor
4	U1	Phase "L1", three-phase voltage input 230/460V_{ac} ±10%
5	V1	Phase "L2", three-phase voltage input 230/460V_{ac} ±10%
6	W1	Phase "L3", three-phase voltage input 230/460V_{ac} ±10%
7	GND	Motor ground (see also Ground screw)
8	W2	Phase "W2", motor three-phase output
9	V2	Phase "V2", motor three-phase output
10	U2	Phase "U2", motor three-phase output
11	+24V	Auxiliary voltage inputs 24 V_{dc} ±10%, 2A
12	0V (24)	(pin 12 is connected to drive logic 0)

Tab. 2.8 – J6 connector, size A and B

- **Ground screw**

Use a lug for M5 screw.

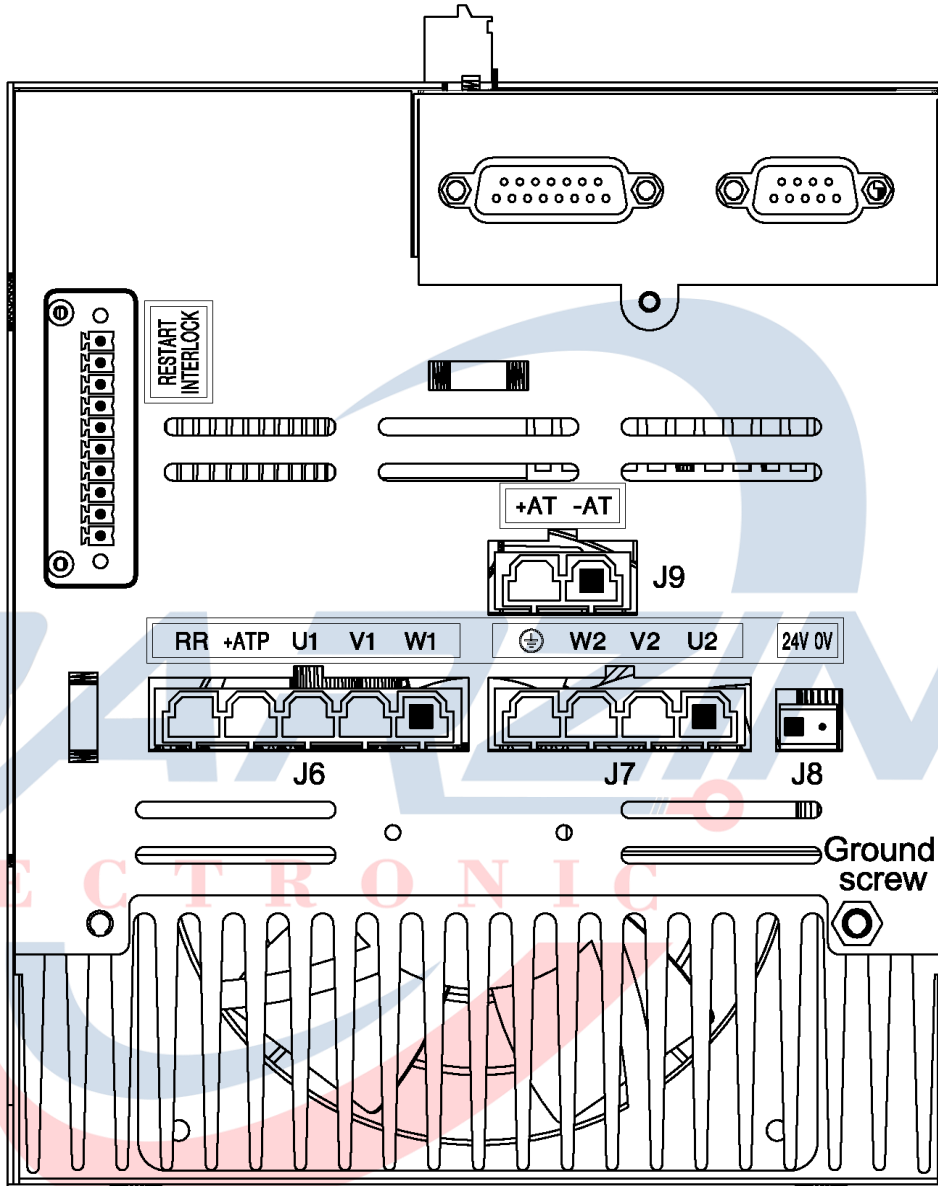| Pos.	Name	Function
Ground screw	GND	Equipotential protection circuit.

Tab. 2.9 – Ground screw, size A and B

NOTE: *In an especially noisy environment (from an electromagnetic point of view) it can be useful to connect the motor ground (pin 7 of J6 connector) to the ground screw.*

2.11.1.2 SIZE C POWER CONNECTOR

Note: Pin 1 is marked with the symbol "■"

Fig. 2.6 – Size C power connector

- **J6 connector**
- Mating connector: female, 5 pins, crimp, supplied with the drive, model Molex 42816-0512 (Moog code AK4991).

Pos.	Name	Function
1 ■	W1	Phase "L3", three-phase voltage input 230/460V_{ac} ±10%
2	V1	Phase "L2", three-phase voltage input 230/460V_{ac} ±10%
3	U1	Phase "L1", three-phase voltage input 230/460V_{ac} ±10%
4	RR (+ATP)	External recovery resistor and +HV of DC BUS
5	RR	External recovery resistor

Tab. 2.10 – J6 input power connector, size C

- **J7 connector**
- Mating connector: female, 4 pins, crimp, supplied with the drive, model Molex 42816-0412 (Moog code AK4990).

Pos.	Name	Function
1 ■	U2	Phase "U2", motor three-phase output
2	V2	Phase "V2", motor three-phase output
3	W2	Phase "W2", motor three-phase output
4	GND	Motor ground (see also Ground screw)

Tab. 2.11 – J7 output motor power connector, size C

- **J8 connector**
- Mating connector: female, 2 pins, supplied with the drive, model Wago 231-102/026-000 (Moog code AK4967).

Pos.	Name	Function
1 ■	+24V	Auxiliary voltage inputs 24 V_{dc} ±10%, 2A
2	0V (24V)	(pin 2 is connected to drive logic 0)

Tab. 2.12 – J8 auxiliary input power supply connector, size C

- **J9 connector**
- Mating connector: female, 2 pins, crimp, supplied with the drive, model Molex 42816-0212 (Moog code AK4989).

Pos.	Name	Function
1 ■	-AT	DC BUS (see Application Engineer for details)
2	+AT	

Tab. 2.13 – J9 DC BUS output connector, size C

- **Ground screw**
Use a lug for M5 screw.

Pos.	Name	Function
Ground screw	GND	Equipotential protection circuit.

Tab. 2.14 – Ground screw, size C

NOTE: In an especially noisy environment (from an electromagnetic point of view) it can be useful to connect the motor ground (pin 4 of J7 connector) to the ground screw.

• **WIRING NOTES FOR J6, J7, J9 CONNECTORS (SIZE C)**

The relevant contacts (Molex type 42815-0031) are supplied together with J6, J7, and J9 mating connectors for C size DS2000 drives. These contacts are sized for an 8 AWG (8.4 mm2) cable with a 10 mm wire stripping. It is recommended the use of a Molex crimping tool type 63814-0000, or Molex type 63811-1500, or equivalent. The crimping does not affect the insulating plastic tubing. As an alternative it is possible to sold the contacts, taking care of folding the contact wings.

After the crimping (or soldering), the contact must be inserted into the Mating connector following the proper direction and must be kept in position by the TPA (Terminal Position Assurance) jumper, according to Fig. 2.7.
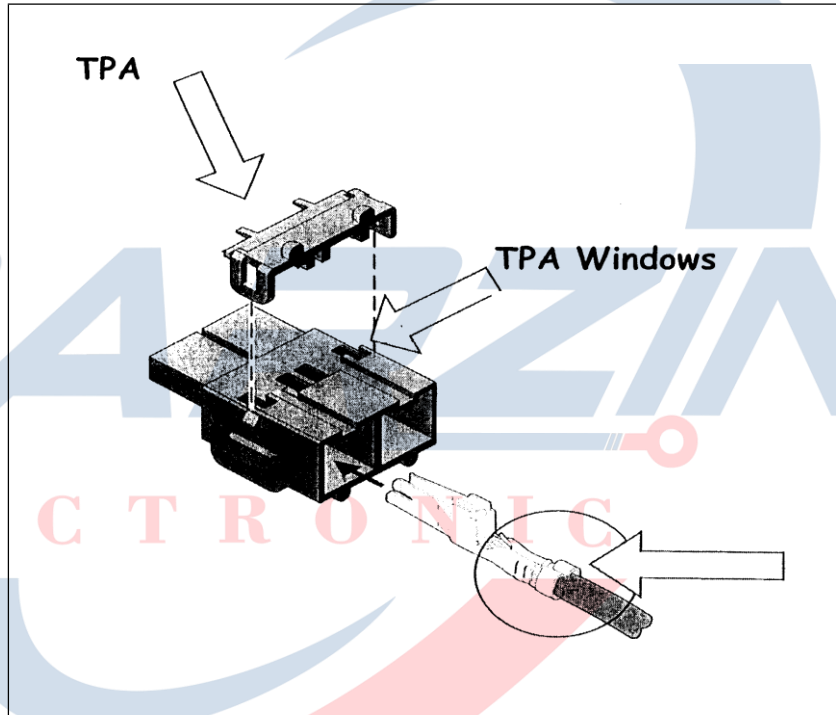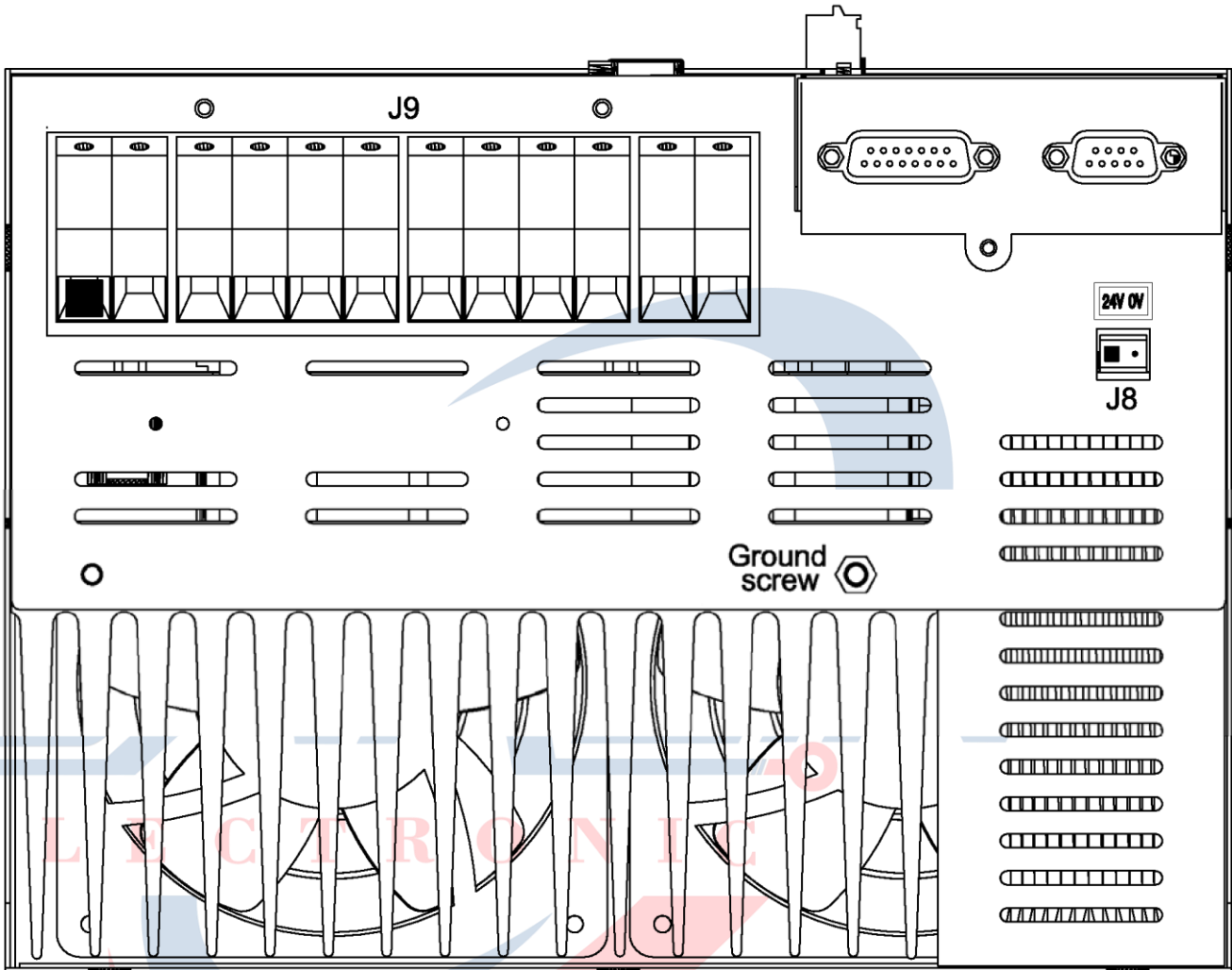

Fig. 2.7 – Fixing Molex connectors

2.11.1.3 SIZE D POWER CONNECTOR

Note: Pin 1 is marked with the symbol "∎"

Fig. 2.8 – Size D power connector

- **J8 connector**
- Mating connector: female, 2 pins, supplied with the drive, model Wago 231-102/026-000 (Moog code AK4967).

Pos.	Name	Function
1 ∎	+24V	Auxiliary voltage inputs 24 V_{dc} ±10%, 2A
2	0V (24V)	(pin 2 is connected to drive logic 0)

Tab. 2.14D – J8 auxiliary input power supply connector, size D

- **J9 Terminal block**
- Pos.1 to 12 Phoenix - HDFK16: Wire stripping: 16 mm. Tightening torque: 2 Nm.

Pos.	Name	Function
1 ■	RR	External recovery resistor
2	RR (+AT)	External recovery resistor and +HV of DC BUS
3	GND	Housing ground
4	U1	Phase "L1", three-phase voltage input 230/460V$_{ac}$ ±10%
5	V1	Phase "L2", three-phase voltage input 230/460V$_{ac}$ ±10%
6	W1	Phase "L3", three-phase voltage input 230/460V$_{ac}$ ±10%
7	U2	Phase "U2", motor three-phase output
8	V2	Phase "V2", motor three-phase output
9	W2	Phase "W2", motor three-phase output
10	GND	Motor ground
11	+AT	DC BUS (see Application Engineer for details)
12	-AT	

Tab. 2.15D – J9 power connector, size D

- **Ground screw**
Use a lug for M5 screw.

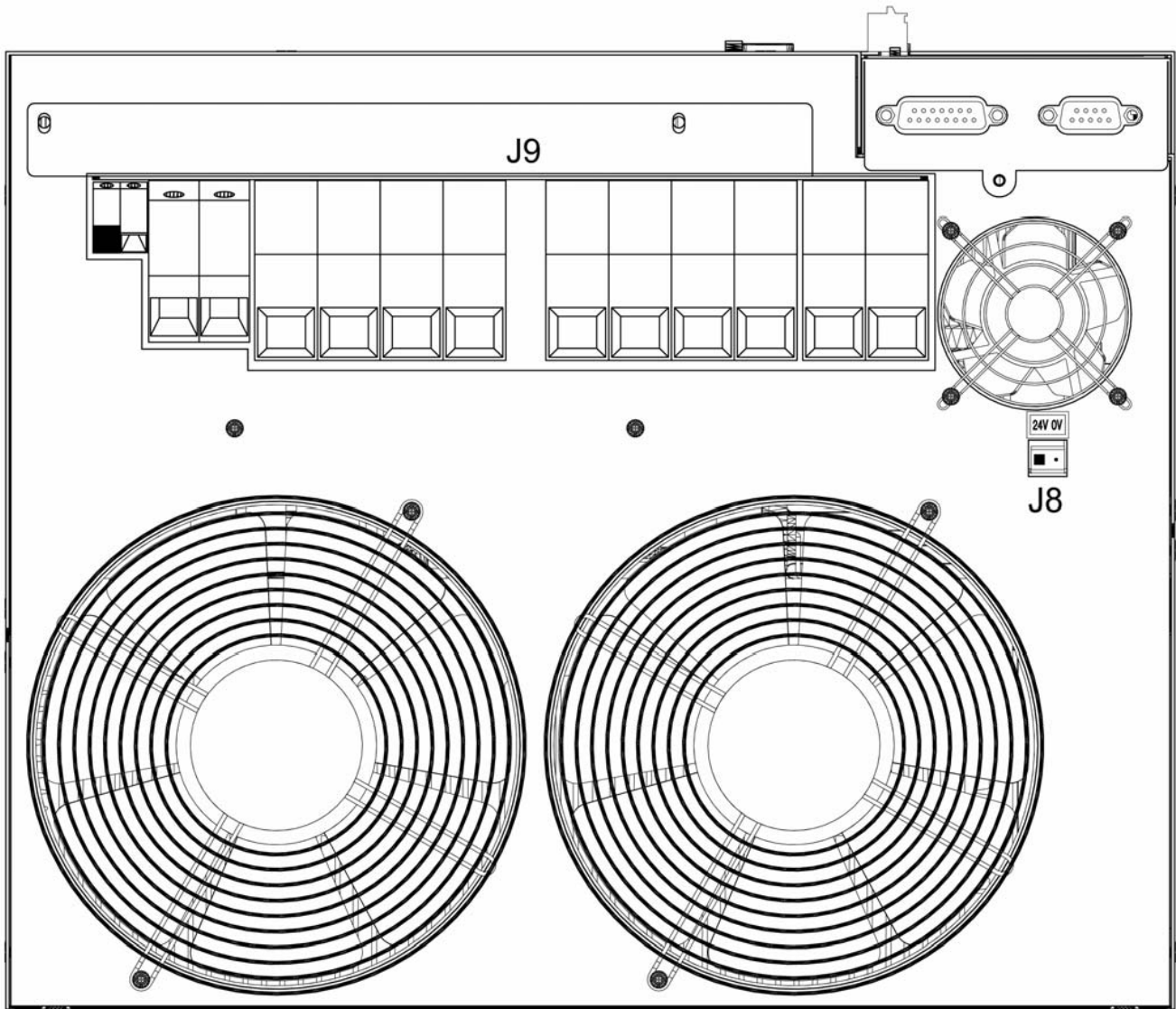| Pos.	Name	Function
Ground screw	GND	Equipotential protection circuit.

Tab. 2.16D – Ground screw, size D

NOTE: *In an especially noisy environment (from an electromagnetic point of view) it can be useful to connect the motor ground (terminal 10 of J9 connector) to the ground screw.*

2.11.1.3.1 SIZE E POWER CONNECTOR

Note: Pin 1 is marked with the symbol "■"

Fig. 2.8.1 – Size E power connector

- **J8 connector**
- Mating connector: female, 2 pins, supplied with the drive, model Wago 231-102/026-000 (Moog code AK4967).

Pos.	Name	Function
1 ■	+24V	Auxiliary voltage inputs 24 V_{dc} ±10%, 2A
2	0V (24V)	(pin 2 is connected to drive logic 0)

Tab. 2.14E – J8 auxiliary input power supply connector, size E

- **J9 Terminal block**
- Pos. 1,2   Phoenix – HDFK4   : Wire stripping: 9 mm. Tightening torque: 0.7 Nm.
- Pos. 3,4   Phoenix – HDFK25 : Wire stripping: 19 mm. Tightening torque: 4 Nm.
- Pos. 5 to 14 Phoenix – HDFK50 : Wire stripping: 24 mm. Tightening torque: 8 Nm.

Pos.	Name	Function
1 ■	24V fans	Voltage inputs $24V_{dc}$ fans ±10%, 2A
2	0V fans	
3	RR	External recovery resistor
4	RR (+AT)	External recovery resistor and +HV of DC BUS
5	GND	Housing ground
6	U1	Phase "L1", three-phase voltage input $230/460V_{ac}$ ±10%
7	V1	Phase "L2", three-phase voltage input $230/460V_{ac}$ ±10%
8	W1	Phase "L3", three-phase voltage input $230/460V_{ac}$ ±10%
9	GND	Motor ground
10	U2	Phase "U2", motor three-phase output
11	V2	Phase "V2", motor three-phase output
12	W2	Phase "W2", motor three-phase output
13	+AT	DC BUS (see Application Engineer for details)
14	-AT	

Tab. 2.15E – J9 power connector, size E

2.11.1.4 POWER WIRING NOTES

It is recommended to use motor phases wiring with low capacitance (max 500 pF/m).

CAUTION: do not parallel power connection cables to achieve requested section: this will increase the capacitance value at levels that may irreversibly damage the drive. If the value of capacitance of motor and cables, seen from drive output, exceeds 30 nF it is necessary to verify with Moog technicians the need of an adequate choke in series.
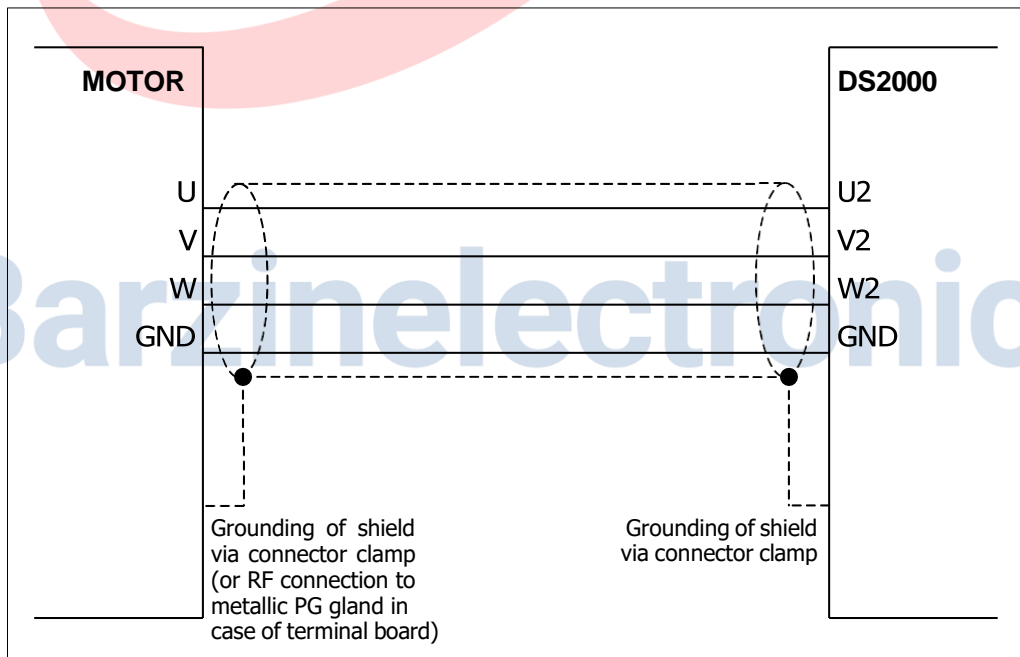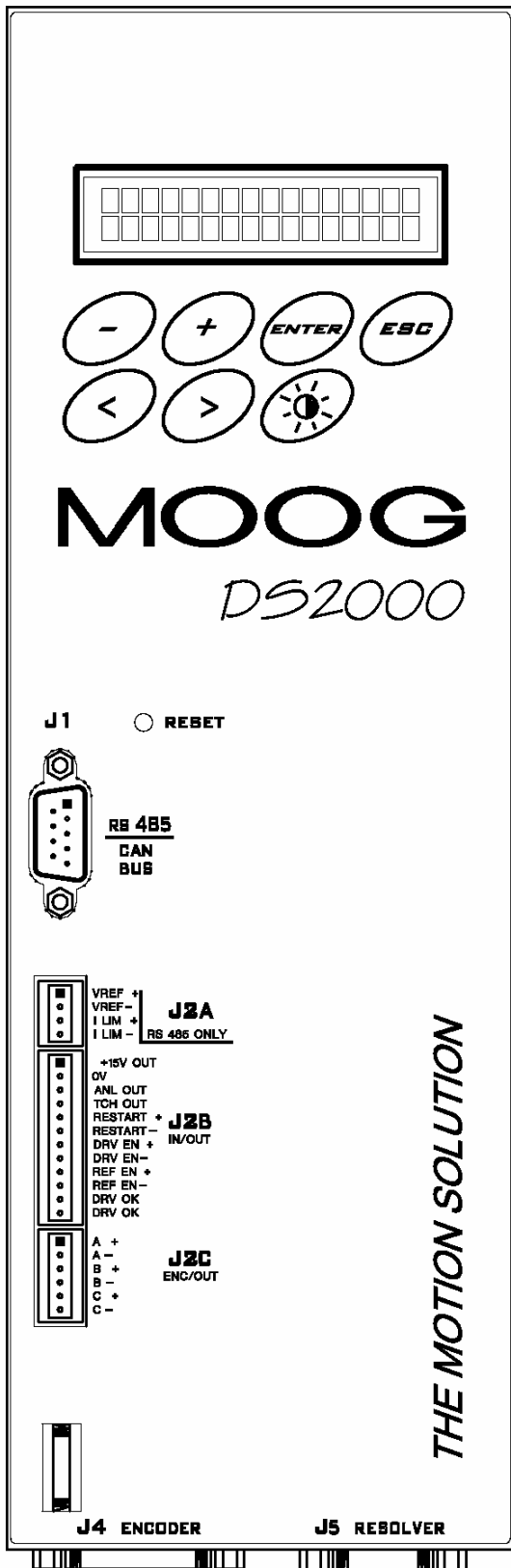

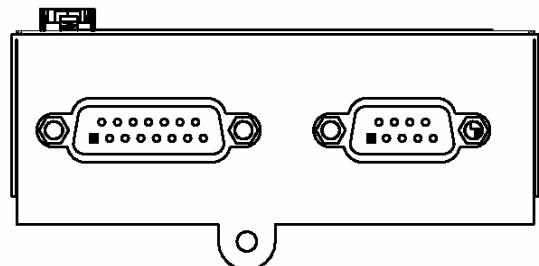Fig. 2.9 – Three phase motor supply wiring

2.11.2 CONTROL CONNECTORS

The connectors are common to all drives sizes and are all located on the control card.

Drive control panel – Frontal view   Drive control panel – bottom view

Note: Pin 1 is marked with the symbol "■"

Fig. 2.10 – Control card connectors

2.11.2.1 RS485 SERIAL LINK (CAN BUS OPTION) (J1)

RS485 serial interface signals are available on the J1 connector. Up to 63 drives can be connected through the RS 485 serial link (see Section 6 for additional data).
Please contact Service Center if more than 4 (up to 63) drives must be connected.
As an alternative to the serial interface, the J1 connector can contain the CAN BUS serial interface with the same external connector. For Can Option make reference to the applicative Can Open manual.

- Mating connector: female, Sub-D 9 pos. (Moog code AK4751)

| Pos.	Name	Function
1 ■	RX+	RX+ (RS485)
2	N.C.	Not Connected
3	TX+	TX+ (RS485)
4	N.C.	Not Connected
5	N.C.	Not Connected
6	RX-	RX- (RS485)
7	0V	Digital 0V
8	TX-	TX- (RS485)
9	N.C.	Not Connected

Tab. 2.16 – J1 RS485 serial link

2.11.2.2 INPUT REFERENCES CONNECTOR (J2A)

Analog references (speed and current limit references) are available on the J2A connector. The conductors are fastened by insertion, opening the connector using a screwdriver.

- Mating connector: insertion type, 4 poles (Moog code AK4714).

Pos.	Name	Function
1 ■	$V_{Ref}+$	Differential, non-inverted input of speed or torque reference signal (0÷ ±10V, corresponding to 0÷ ±Max input reference). The end of scale is adjustable via software from ±3.2 to ±10V in steps of 0.1V
2	$V_{Ref}-$	Differential, inverted input of speed or torque reference signal
3	$I_{limit}+$	Differential, non-inverted input of analog current limit (0÷ ±10V, corresponding to 0÷ 100%Max set current). The end of scale is adjust-able via software from ±3.2 to ±10V in steps of 0.1V
4	$I_{limit}-$	Differential, inverted input of analog current limit

Tab. 2.17 – J2A input references connector
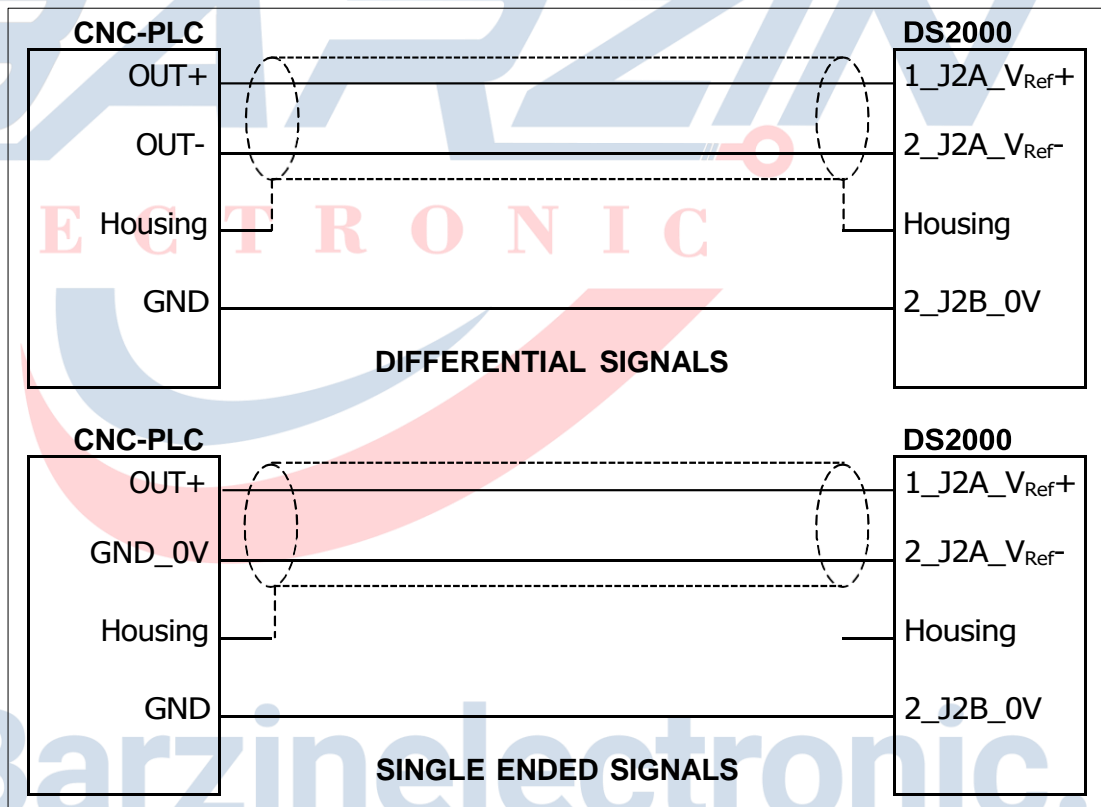
NOTE: J2A and J2B are two different (separate) connectors.
NOTE: shields of cables must be 360° clamped to the cabinet wall

Fig. 2.11 – Example of connections

2.11.2.3 DRIVE ENABLE CONNECTOR (J2B)

Drive enable, Drive OK signals, Tacho out, Analog out, and Reference enable are available on the J2B connector. The conductors are fastened by insertion, opening the connector using a screwdriver.

- Mating connector: insertion type, 12 pin (Moog code AK4722).

Pos.	Name	Function
1 ■	+15V OUT	+15V_{dc} output, max 100 mA
2	0V	Logic Zero
3	ANL OUT	Configurable output (see Analog out configuration)
4	TCH OUT	Tachometric signal output (0 ÷ ±10V, corresponding to 0 ÷ ± Max speed rpm). The end of scale is adjustable via software from ±5 to ±10V in steps of 0.1V
5	RESTART+	Opto-insulated Reset input (15 ÷ 24 V_{dc}/12mA)
6	RESTART-	By means of a > 20 ms duration pulse the re-initialization of the digital control card and the protections reset are carried out
7	DRV EN+	Opto-insulated Drive Enable input (15 ÷ 24 V_{dc}/12mA)
8	DRV EN-	When signal is missing the drive does not supply current
9	REF EN+	Opto-insulated Reference Enable input (15 ÷ 24 V_{dc}/12mA) When signal is missing the motor is in standstill position, at zero
10	REF EN-	speed if in speed control mode, it has zero torque if in torque control mode. This input can be used for emergency braking
11	DRV OK	Drive OK outputs. Contact closed (24V_{dc} relays, max 100 mA) indicates that Drive is OK.
12	DRV OK	*It is recommended to logically connect the DRIVE OK isolated output presence to the power contactor, so that the power supply is disabled in case of fault*

Tab. 2.18 – J2B drive enable connector
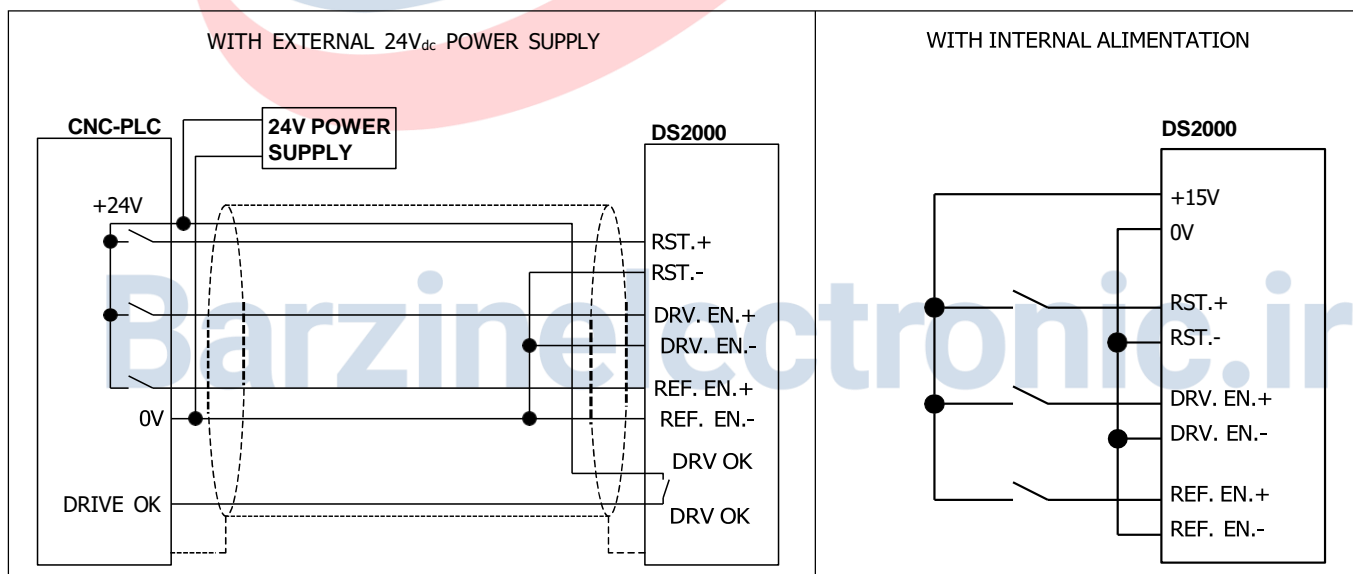
Fig. 2.12 – Example of wiring

2.11.2.4 ENCODER OUTPUT CONNECTOR (J2C)

Encoder simulated output are available on the J2C connector. The conductors are fastened by insertion, opening the connector using a screwdriver.

- Mating connector: insertion type, 6 pin (Moog code AK4716).

Pos.	Name	Function
1 ■	A+	Encoder output: A channel
2	A-	Encoder output: A channel denied
3	B+	Encoder output: B channel
4	B-	Encoder output: B channel denied
5	C+	Encoder output: C channel
6	C-	Encoder output: C channel denied

Tab. 2.19 – J2C encoder output connector

2.11.2.5 ENCODER INPUT CONNECTOR (J4)

NOTES: The motor control encoder is formed by two sections.
- The first one (UVW signals) only generates signals used by the drive to power the motor phases; this section is defined by the number of motor poles.
- The second one (ABC signals) generates reference signals also available for motion control through external CNC; the number of pulses in this section is defined according to final the Customer needs as well as to the application requirements.

All the motor encoder channels and the PTC/NTC for the motor temperature control must be connected to J4 connector located on the bottom side of the drive. The same incremental encoder signals are available as output on J2C connector.

The mating encoder connector at drive side is a Sub-D 15 pos., to be soldered (Moog code AK5221). It is recommended to use a low capacitance, multipolar cable with 22 AWG (0,30 mm2) or 20 AWG (0,50 mm2) conductors, shielded (with 85% min. coverage). Cable length should not exceed 40 m. It is recommended that the cable and the power connection cable must be separated through the use of independent duct and by a distance of 30 cm. It is also recommended not to make intermediate connections on the encoder cable.

Pos.	Name	Function
1 ■	+5V	+5 V_{dc} (max 100 mA) output
2	0V	Encoder ground and motor PTC/NTC
3	W-	Switching signal: W phase denied
4	W+	Switching signal: W phase
5	V+	Switching signal: V phase
6	V-	Switching signal: V phase denied
7	A+	A Channel
8	A-	A Channel denied
9	C+	C Channel
10	C-	C Channel denied
11	U+	Switching signal: U phase
12	U-	Switching signal: U phase denied
13	B-	B Channel denied
14	B+	B Channel
15	PTC_MOTOR	Motor PTC/NTC

Tab. 2.20 – J4 encoder input connector
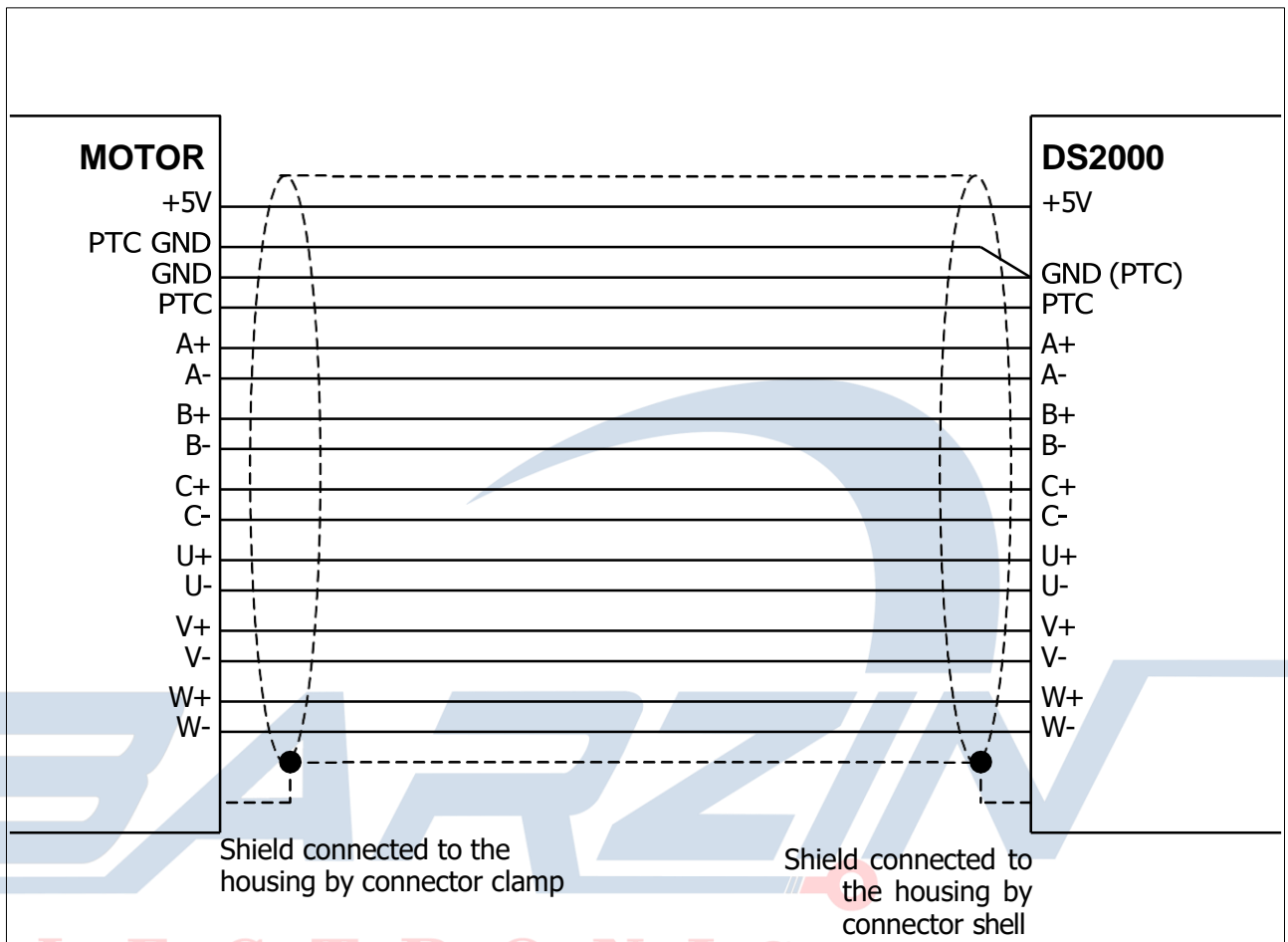
Fig. 2.13 – Encoder connections

2.11.2.5.1 LIMIT SWITCHES CONNECTOR (J4)

When the special software 3.203 is used , the J4 connector becomes the Limit Switches connector. An option card is needed together with this special software. The encoder cannot be used as transducer and the ENC/OUT calibration of zero motor function is removed.
See Appendix C for other informations

Pos.	Name	Function
1 ■	N.C.	Not Connected
2	N.C.	Not Connected
3	CW LS	Input for CW Limit Switches. Normally connected to +24Vdc. When the connection to +24Vdc is opened, the CW rotation is disabled.
4	N.C.	Not Connected
5	CCW LS	Input for CCW Limit Switches. Normally connected to +24Vdc. When the connection to +24Vdc is opened, the CCW rotation is disabled.
6	N.C.	Not Connected
7	Tc/Vc	Input for torque/speed control. When connected to +24Vdc the drive is in torque control. When connected to 0L the drive is in speed control.
8	N.C.	Not Connected
9	N.C.	Not Connected
10	Common	Common input for CW LS, CCW LS and Tc/Vc to be connected to 0L
11	N.C.	Not Connected
12	N.C.	Not Connected
13	N.C.	Not Connected
14	N.C.	Not Connected
15	N.C.	Not Connected

Tab. 2.20A – J4 Limit Switches connector

2.11.2.6 RESOLVER CONNECTOR (J5)

All the motor resolver cable and the PTC/NTC for the motor temperature control must be connected to J5 connector located on the bottom side of the drive.

The mating resolver connector is a male Sub-D 9 pos., to be soldered, provided together with the drive (Moog code AK5220). It is recommended to use low capacitance, multipolar cable with 22 AWG (0,30 mm2) or 20 AWG (0,50 mm2) conductors, each pair twisted and shielded, with an independent overall shield (with 85% min. coverage). Cable length should not exceed 30 m. It is recommended that the cable and the power connection cable be separated through the use of independent duct and by a distance of 30 cm. It is also recommended not to make intermediate connections on the resolver cable.

With the resolver interface it is possible to use the simulated encoder outputs to J2C connector. The standard pulse of the simulated encoder is 1024 (number of 64, 128, 256 or 512 is selectable via keypad). The standard width of the marker is 90° (width of 180° or 360° is selectable via keypad).

NOTE: DS2000 can be interface with resolvers with the following transformer ratios : 0.23, 0.26, 0.29, 0.47 e 0.50.

The two calibration resistors must have the correct value (the drive is pre-set in factory in according to the motor, see the trasformation rating in the information sheet-*Casella report*- of the drive).

In case of replacement/change of the application, verify the right calibration of DS2000.

If not please ask the Moog Service Center

| Pos.	Name	Function
1 ■	COS+	Differential COS signal non-inverted input amplifier proceeding from resolver windings.
2	COS-	Differential COS signal inverted input amplifier proceeding from resolver windings.
3	SHIELD	Shield (internally connected to 0V)
4	SEN+	Differential SEN signal non-inverted input amplifier proceeding from resolver windings.
5	SEN-	Differential SEN signal inverted input amplifier proceeding from resolver windings.
6	PTC_MOTOR	Motor PTC/NTC input
7	10kHz-	10 kHz, 20 V_{pp} sinusoidal "denied" output signal for supplying primary resolver winding.
8	PTC_MOTOR	Motor PTC/NTC input
9	10kHz+	10 kHz, 20 V_{pp} sinusoidal output signal for supplying primary resolver winding (carrier).

Tab. 2.21 – J5 resolver connector
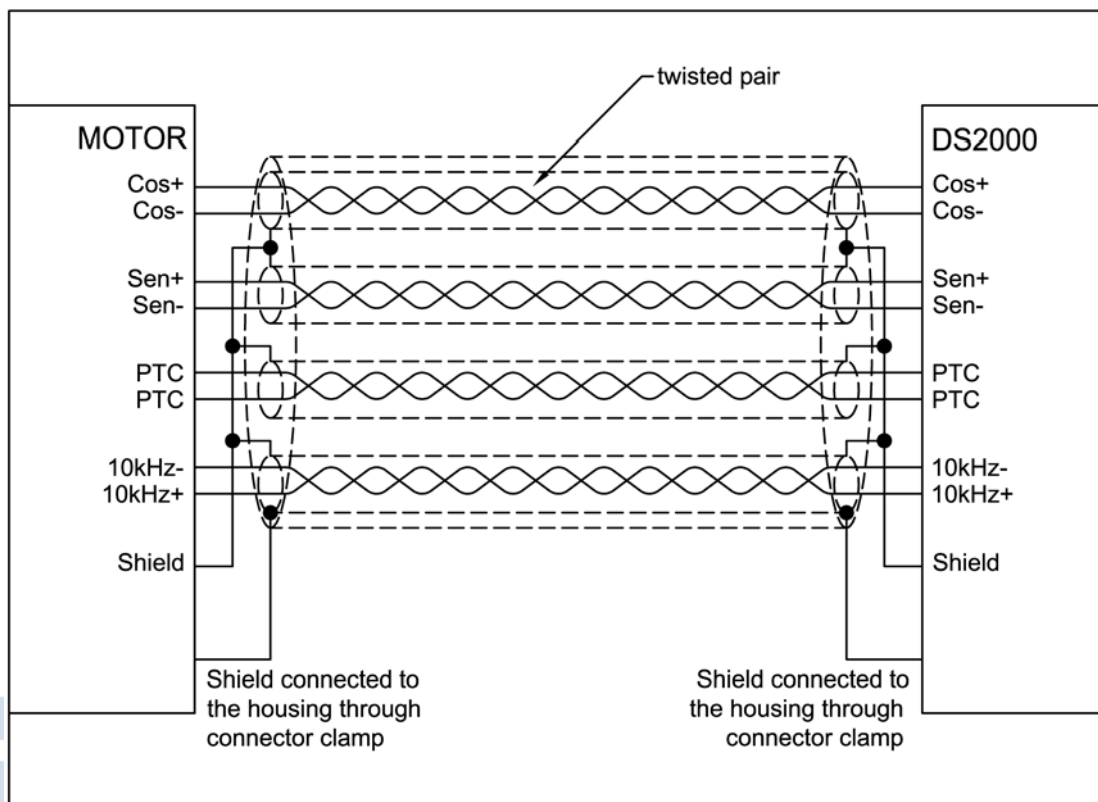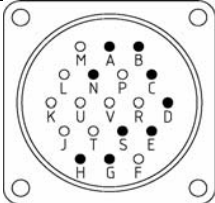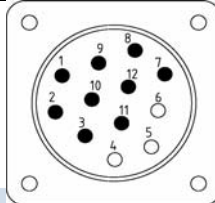
Fig. 2.14 – Resolver connections
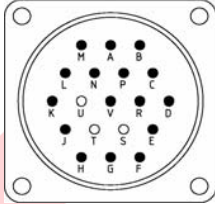
2.11.3 MOTOR CONNECTION
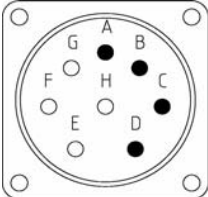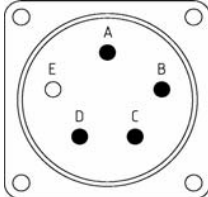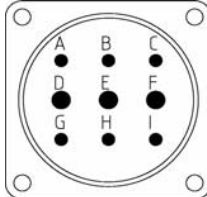
2.11.3.1 FAS T/FAS K/FAS N/FAS Y/FAE CONNECTION

MOTOR RESOLVER CONNECTOR		
SIGNAL TYPE		
COS-	E	2
COS+	C	1
SHIELD	S	3
SEN-	H	12
SEN+	G	11
PTC_MOTOR	N	8
10kHz-	B	7
PTC_MOTOR	A	9
10kHz+	D	10
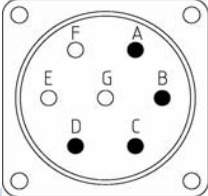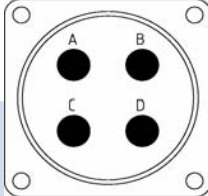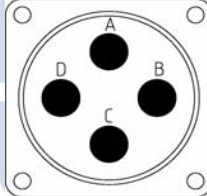
Tab. 2.22 – Resolver connectors

MOTOR ENCODER CONNECTOR	
SIGNAL TYPE	
+5V	A
0V	B and V
W-	C
W+	D
V+	E
V-	F
A+	G
A-	H
C+	J
C-	K
U+	L
U-	M
B-	N
B+	P
PTC_MOTOR	R

Tab. 2.23 – Encoder connector

MOTOR POWER CONNECTOR		
SIGNAL TYPE			
U	A	A	D
V	B	B	E
W	C	C	F
GND	D	D	G
PTC	-	-	H
PTC	-	-	I

MOTOR POWER CONNECTOR		
SIGNAL TYPE			
U	A	A	A
V	B	B	B
W	C	C	C
GND	D	D	D
PTC	-	-	-
PTC	-	-	-
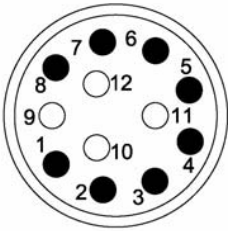
Tab. 2.24 – Power connectors

2.11.3.2 G MOTOR CONNECTION

To standardize the resolver connection it is recommended for the new applications to use the new resolver connection scheme of Tab.2.25A.

RESOLVER CONNECTION			
Drive resolver connector Pin No.	Name	Pin name on G motor	Motor resolver connector Pin No.
1 ■	COS+	S2	3
2	COS-	S4	4
3	SHIELD		
4	SEN+	S1	1
5	SEN-	S3	2
6	PTC_MOTOR	THERM 1	5
7	10kHz-	R2	8
8	PTC_MOTOR	THERM 2	6
9	10kHz+	R1	7
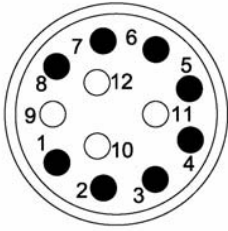
Tab.2.25A – New resolver connection scheme

The old resolver connection scheme shown in the previous revisions of this Manual and reprinted in Tab. 2.25B is still valid.
CAUTION: It is recommended not to change the old connections in case of retrofitting motors or drives.
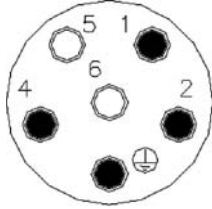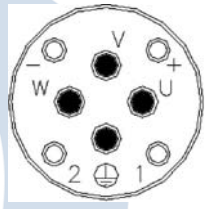
RESOLVER CONNECTION			
Drive resolver connector Pin No.	Name	Pin Name on G motor	Motor resolver connector Pin No.
1 ■	COS+	S4	4
2	COS-	S2	3
3	SHIELD		
4	SEN+	S3	2
5	SEN-	S1	1
6	PTC_MOTOR	THERM 1	5
7	10kHz-	R2	8
8	PTC_MOTOR	THERM 2	6
9	10kHz+	R1	7

Tab.2.25B – Old resolver connection scheme

The ground (pin 3, drive side) has to be connected to the motor connector housing.
Several motor G have as standard a NTC for thermal feedback, the DS2000 can manage PTC sensor or NTC sensor without any hardware change (see Section 6 for additional data).
The resolver is looked mechanically: the customer has to perform the AUTOPHASING with the drive utilities, checking that the value for the APHAPOS parameter is
−209 (±5Units) for 8 poles motor with 2 poles resolver or 45 (±5Units) for 12 poles motor with 2 poles resolver (see Section 6 for additional informations).

MOTOR POWER CONNECTOR			
DS2000			
GND	GND	GND	GND
U	2	U	U
V	4	V	V
W	1	W	W

Tab. 2.26 – Power connector

2.12 DRIVE STARTING SEQUENCE

In order to properly power and enable DS2000 "The Motion Solution" series drives, it is necessary to follow a start-up sequence, in which the minimum times to fall within are indicated in order to allow the internal circuits to reach the operating voltage levels and to make the internal devices ready for enabling.

The chart here below summarizes the start-up sequence and describes the possible reasons for delays:

- t_1 Time delay required for the following operations:
  - Switching on of the 24V power supplier and input voltages stabilization
  - Program loading and logic circuits initialisation
  - Internal protections check carried out by the internal microprocessor
- t_2 Reset pulse to allow the reading of reference voltages, as well as the internal offsets initialisation with already stabilized voltages.
- t_3 Time needed by the drive to allow the program start-up after the reset.
- t_4 Charge time of DC BUS capacitors determined by the soft-start circuit and DC BUS voltage stabilization in order to avoid start-up self induction currents
- t_5 Time for DRIVE OK acquisition by the control
- t_6 Time to allow the Drive to reach the torque and to check the proper operation of power stages.

The respect of the times indicated in Fig. 2.15 is important to avoid wrong FAULT indications by the drive.

NOTE: *The internal soft-start resistors are sized for a start-up occurring every 60 s. Lower times cause an excessive stress and can cause the breakdown of such resistors.*

2.13 STARTING SEQUENCE TIMES

$t_1 \geq 3$ s, $t_2 \geq 100$ ms., $t_3 \geq 1$ s, $t_4 = 3$ s, $t_5 \geq 100$ ms., $t_6 \geq 100$ ms.
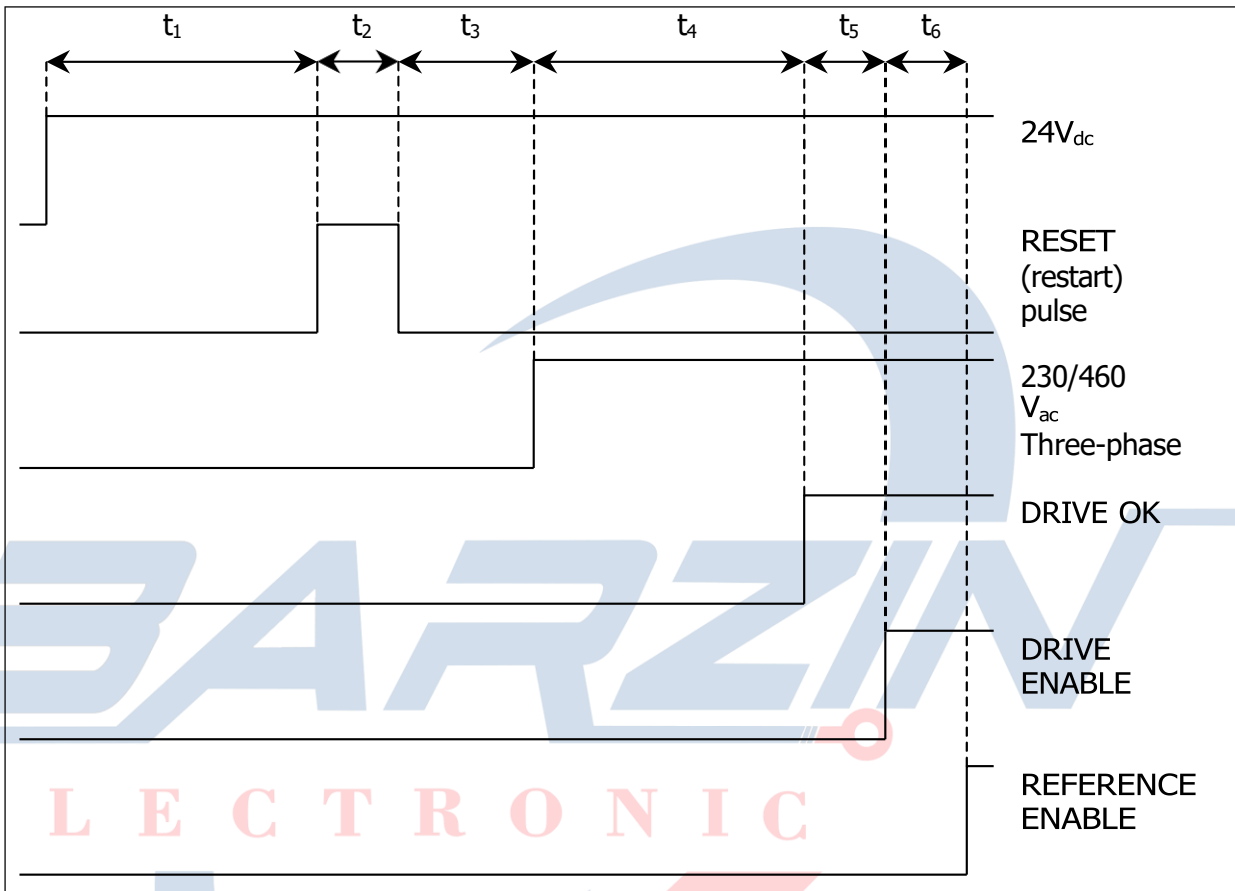
Fig. 2.15 – Starting sequence times

NOTES:

- Reset pulse generates a complete initialization of the card with all the voltages already stabilized; this allows a more careful reading of the voltages and a better compensation of internal offsets.
- In case the auxiliary voltage ($24V_{dc}$) is missing, give the RESET pulse (for a time greater than 100 ms) after at least 3 seconds from the moment in which the drive is supplied by three-phase voltage.
- RESET is necessary only after the first drive start-up or, in case of FAULT, to restore the proper operation of drive.
- DRIVE OK signal depends upon the three-phase voltage presence, in order to allow a quick and immediate enabling of motor torque.

2.14 DYNAMIC BRAKING

It is possible to execute a dynamic braking with the help of the motor torque, even in emergency condition, if the drive is not in FAULT conditions: it is necessary to follow the sequence times. At braking request, the REFERENCE ENABLE is removed and the motor brakes with all the available torque.

- t_1 after 100 ms (this time can be increased in case load inertia is much bigger than motor inertia) the DRIVE ENABLE can be removed

$t_1 = 100$ ms
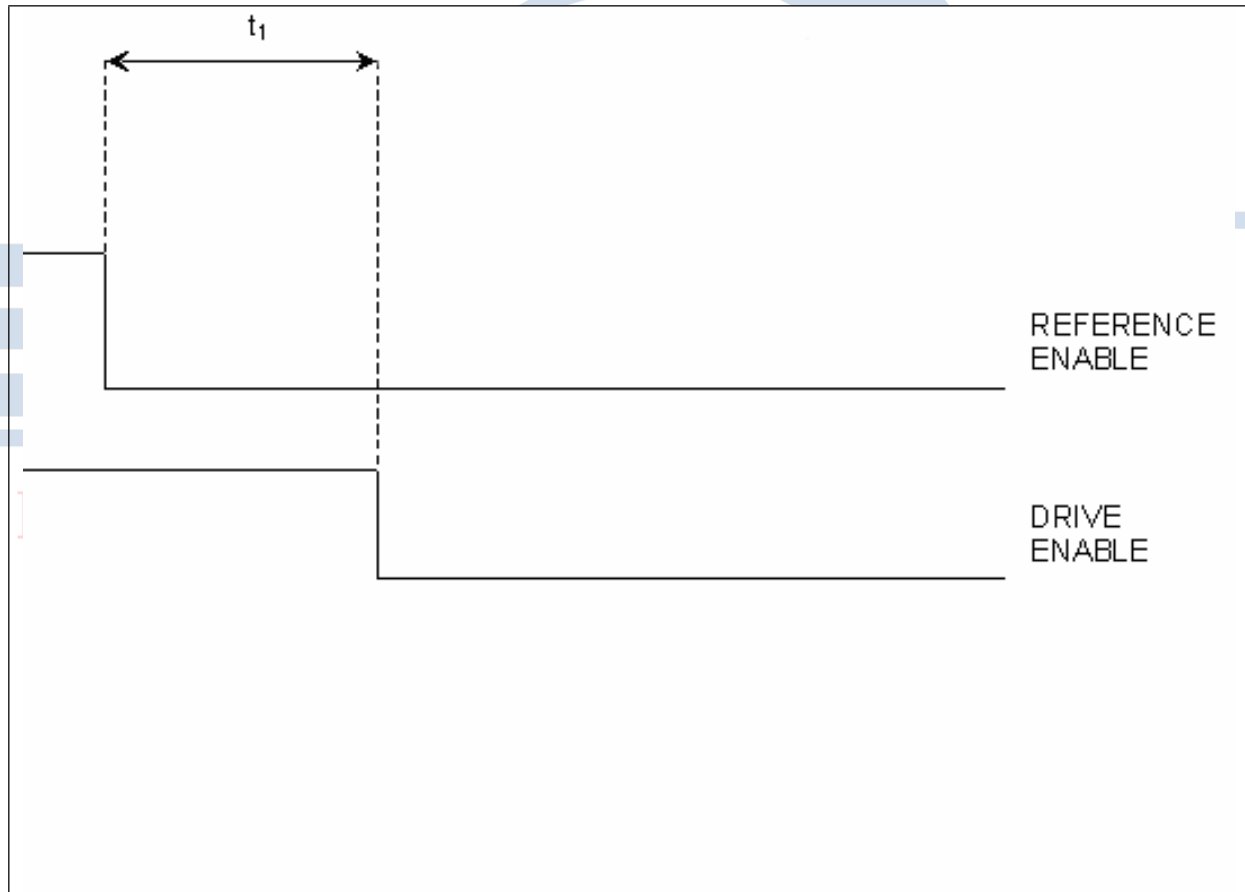
Fig. 2.16 – Dynamic braking sequence times

2.15 POWER OFF

It is necessary to follow the power-off sequence times.

- t_1 after 100 ms (this time can be increased in case load inertia is much bigger than motor inertia) the DRIVE ENABLE can be removed
- t_2 Three-phase input voltage release delayed time in order to avoid the undervoltage FAULT.
- t_3 DC BUS discharge time

t_1 = 100 ms, t_2 = 15 ms, t_3 = 6 min. (to access the drive).
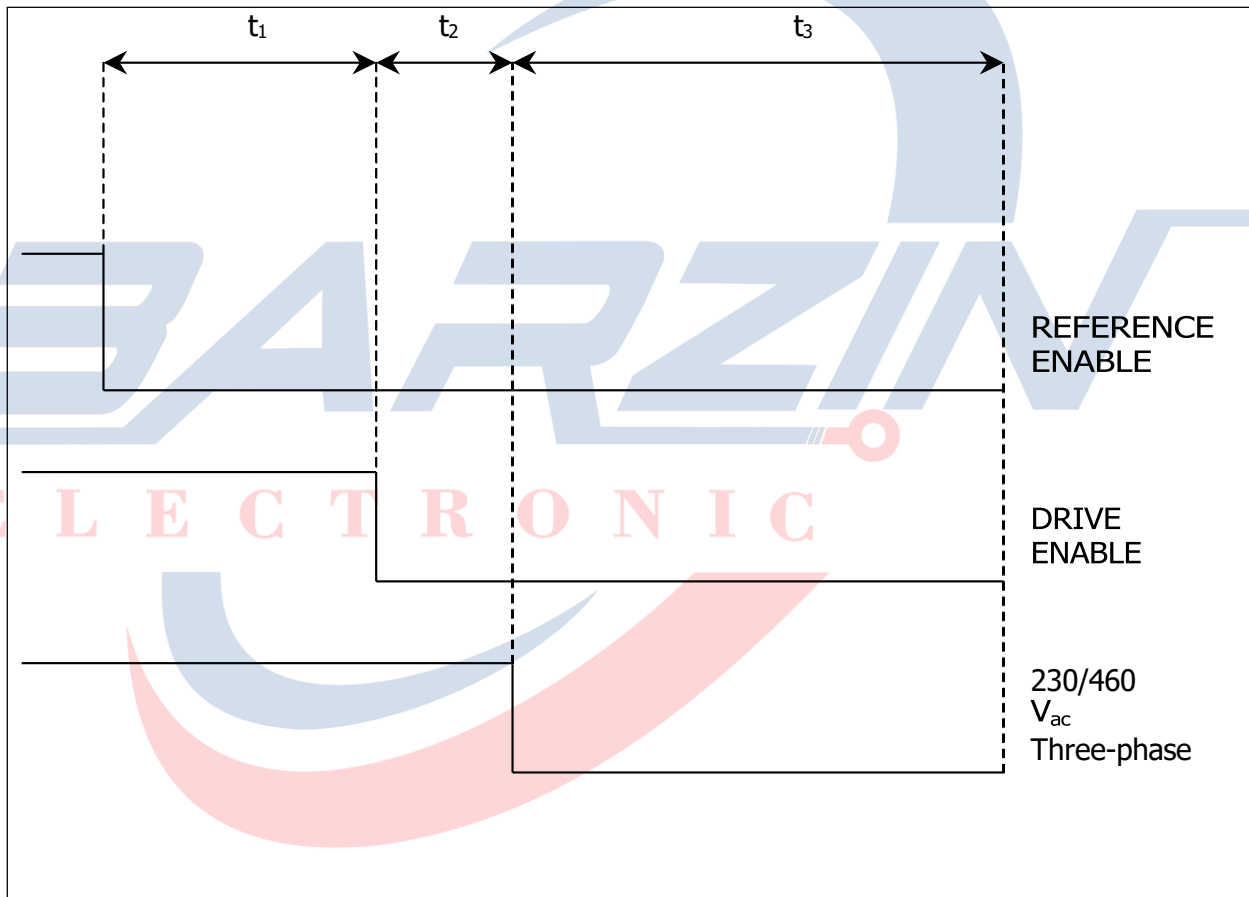
Fig. 2.17 – Power-off sequence times

2.16 MECHANICAL BRAKING

The FASTACT series motors have an optional electromagnetic brake with pressure springs to be supplied with 24 V_{dc} nominal voltage (24 to 26 V_{dc}) at the motor terminal.

CAUTION: the brake must be used only for standing (with motor at standstill). The use of this brake for dynamic braking seriously damages the brake and reduces the braking torque.

Note 1: $t_1 \geq 300$ ms, t_2 = application depending, $t_3 = 100$ ms, $t_4 \geq 200$ ms
Note 2: For FASTACT motors, size 3 and size 4, $t_1 \geq 1000$ ms
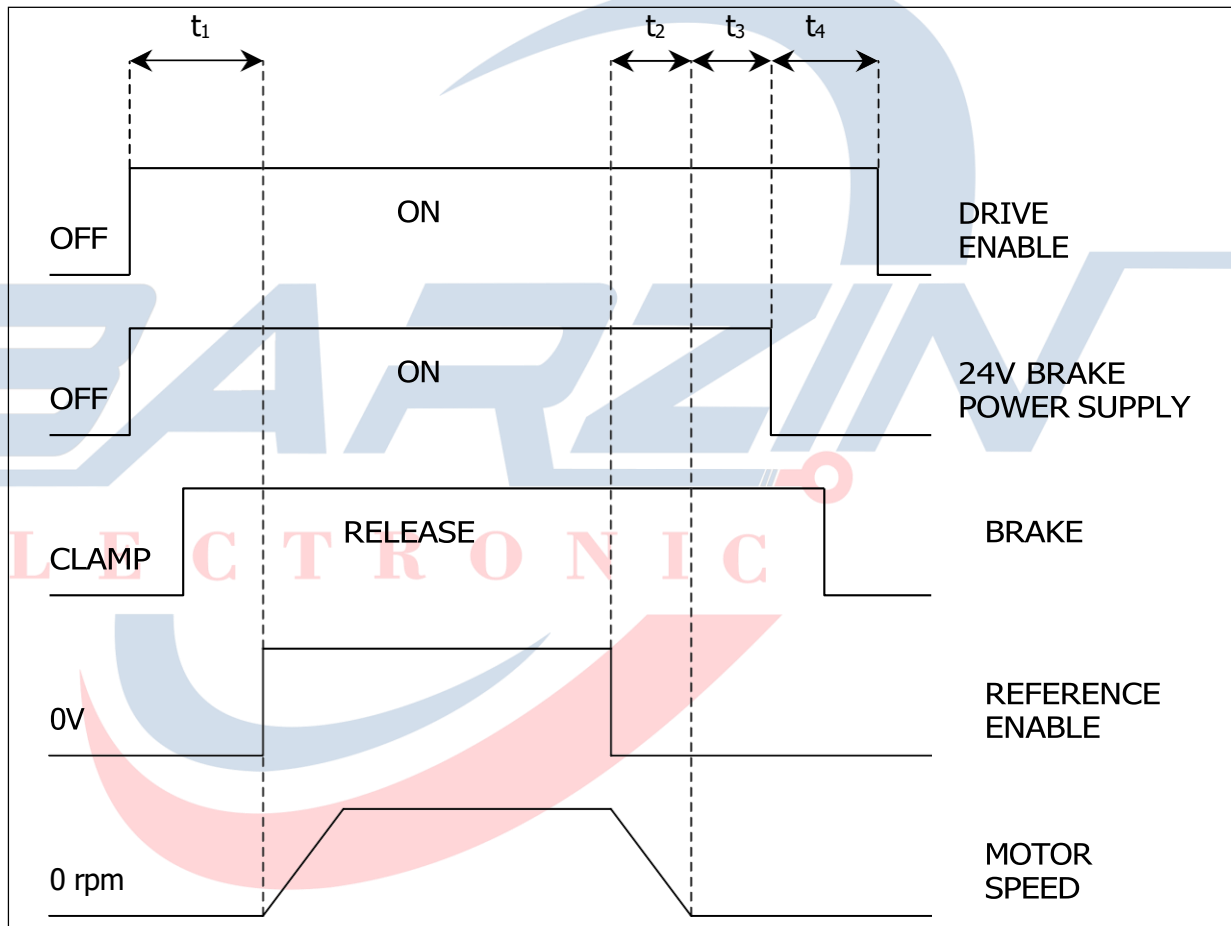
Fig. 2.18 – Mechanical braking sequence times

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3. ELECTROMAGNETIC COMPATIBILITY (EMC)

3.1 INTRODUCTION

In this section are described the recommended drive installation procedure following EMC standards. EMC filters are described in the 3.3 par. and the grounding and screening in the 3.4 par. and following. The installer of the drive is responsible for ensuring compliance with the EMC regulations that apply where the drive is to be used.

3.2 EUROPEAN DIRECTIVE (89/336/EEC)

Compliance with the European Directive 89/336/EEC is required for all electric and electronic products brought onto the European market after December 31st, 1995.
DS2000 drives meet the following EMC product standard related to the Directive:

EN 61800-3:1996 and EN 61800-3/A11:2000: "Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods".
Second environment (industrial) compatibility levels.

Tests have been made in an independent test house.

3.3 FILTERS

3.3.1 FILTER TYPES

Trade-mark	Rated current [A] at 50°C (40°C)	Max Voltage [V_{ac}] at 50°C	Drive type / input
Schaffner FN2070-3-06	(3)	250	$24V_{dc}$ input
Schaffner FN 258-7/07	7 (8.4)	3x480	DS2000 3/9 DS2000 4/12 DS2000 6/15 DS2000 8/22
Schaffner FN 258-16/07	16 (19.2)	3x480	DS2000 14/42
Schaffner FN 258-30/07	30 (36)	3x480	DS2000 20/45 DS2000 25/70 DS2000 30/90
Schaffner FN 258-42/07	42 (50.4)	3x480	DS2000 50/140
Schaffner FN 258-55/07	55 (66)	3x480	DS2000 60/180
Schaffner FN 258-100/35	100 (113)	3x480	DS2000 100/300

Tab. 3.1 – Filter types

3.3.2 FILTER SIZING

The filter/drive coupling in the previous table is a standard application coupling. The filter can be undersized according to the rms input current of the actual application. This should be done not only because, as a mat-ter of fact, undersizing the filter means less money, but because the undersized filter provides better performance to EMC.

3.3.3 FILTER DIMENSIONS

Top View   **Side View**
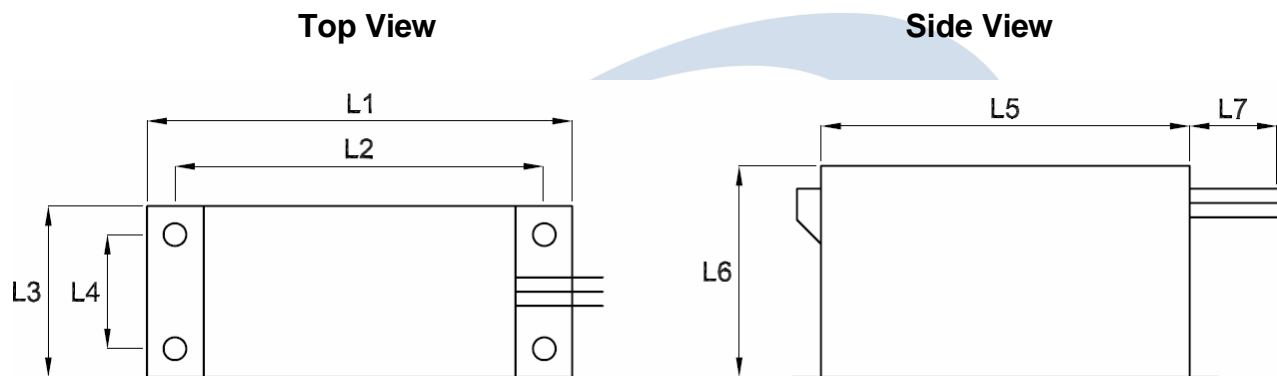
Trade-mark	Dimensions [mm]							Weight [kg]
	L1	L2	L3	L4	L5	L6	L7	
Schaffner FN2070-3-06*	85	75	54	0	65	40.3	faston	0.25
Schaffner FN 250-6/07*	85	75	54	0	65	30	300	0.24
Schaffner FN 250-12/07*	85	75	54	0	65	40	300	0.31
Schaffner FN 258-7/07	255	240	50	25	225 ±0.8	126 ±0.8	300	1.1
Schaffner FN 258-16/07	305	290	55	30	275 ±0.8	142 ±0.8	300	1.7
Schaffner FN 258-30/07	335	320	60	35	305	150	400	1.8
Schaffner FN 258-42/07	329	314	70	45	300	185	500	2.8
Schaffner FN 258-55/07	329	314	80	55	300	185	500	3.1
Schaffner FN 258-75/34	329	314	80	55	300	220	Terminal block	4
Schaffner FN 258-100/35	379 ±1.5	364	90 ±0.8	65	350 ±1.2	220 ±1.5	Terminal block	5.5

* = the FN2070-3-06 filter have faston at both sides

* = the FN250-6/07   filter have wiring leads (length=300mm) at both sides

* = the FN250-12/07 filter have wiring leads (length=300mm) at both sides

Tab. 3.2 – Filter dimensions

3.3.4 FILTER INSTALLATION

The filter must be mounted on the same drive panel.

CAUTION: leave a clear space at least 60mm around the filter for air circulation when the cabinet does not have forced ventilation.

The filter must be connected as close as possible to the cabinet input. If the separation between filter and drive exceeds around 30 cm (1 ft.) then a shielded cable should be used for the RF connection between filter and drive.

NOTE: when mounting the drive and the filter to the panel, it is essential that any paint or other covering material be removed before mounting the drive and the filter.

The maximum torque of mounting screws at terminal block is as follows:

FILTER	Max torque
FN 258 - 7/07	0.8 Nm
FN 258 - 16/07	0.8 Nm
FN 258 - 30/07	1.8 Nm
FN 258 - 42/07	1.8 Nm
FN 258 - 55/07	3.0 Nm
FN 258 - 75/34	3.0 Nm
FN 258 - 100/35	4.0 Nm

Tab. 3.3 – Maximum torque of mounting screws at terminal block

WARNING: the filter can produce high leakage currents (see Filter Data Sheets)

WARNING: the filter must be connected to ground before connecting the supply

WARNING: High Voltage - Discharge time approx. 10 seconds

3.4 WIRING AND GROUNDING

All the following cables must be shielded, with 85% minimum shielding coverage:

Power - Power motor cable
- External recovery resistor cable
- DC-BUS cable

Signal - Encoder cable (see Fig. 3.1)
- Resolver cable (see Fig. 3.1)
- RS485 / CAN BUS cable
- J2A, J2B, J2C cable
- 24V power supply cable
- Restart Interlock cable
- 24V fans cable (only size E)
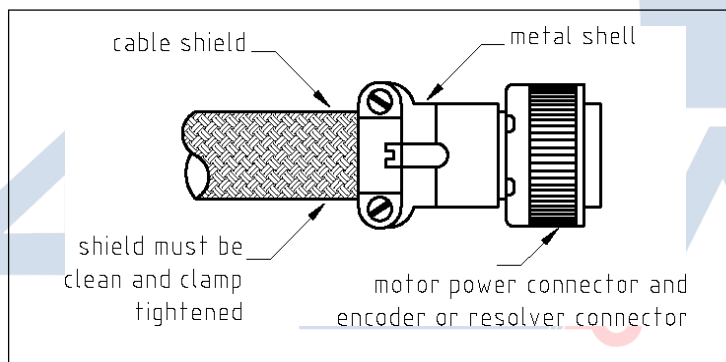
Fig. 3.1 – Grounding of shield to connectors at motor side

NOTES:
- If a power terminal board is used at motor side, the shield must be RF connected to a metallic PG gland.
- The shields of the cables must be connected at both ends to the proper housing via full circumferential bond to metallic connectors or hose clamps.
- In case of Sub-D connector, cable shield must be grounded to the metallic hood.
- When there is not metallic connector at drive side, a kit with stand-off, screws and metallic hose clamps is provided. The shield of the cable must be uncovered from insulation coating and RF connected to the stand-off through the metallic hose clamp, as in Fig.3.2.
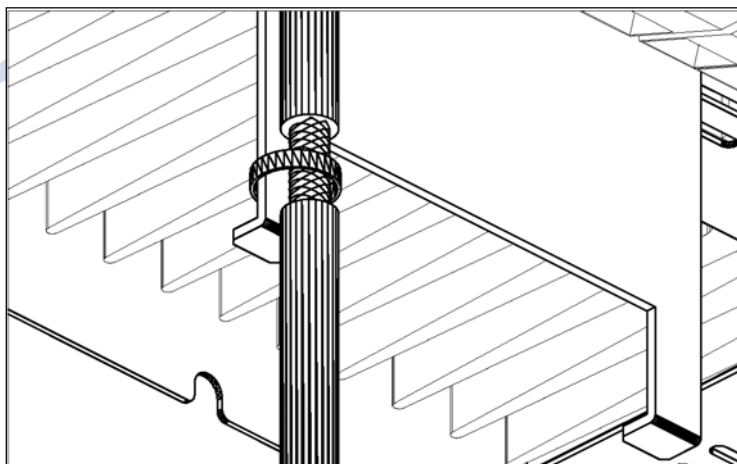
Fig. 3.2 – Grounding of shield without metallic connector
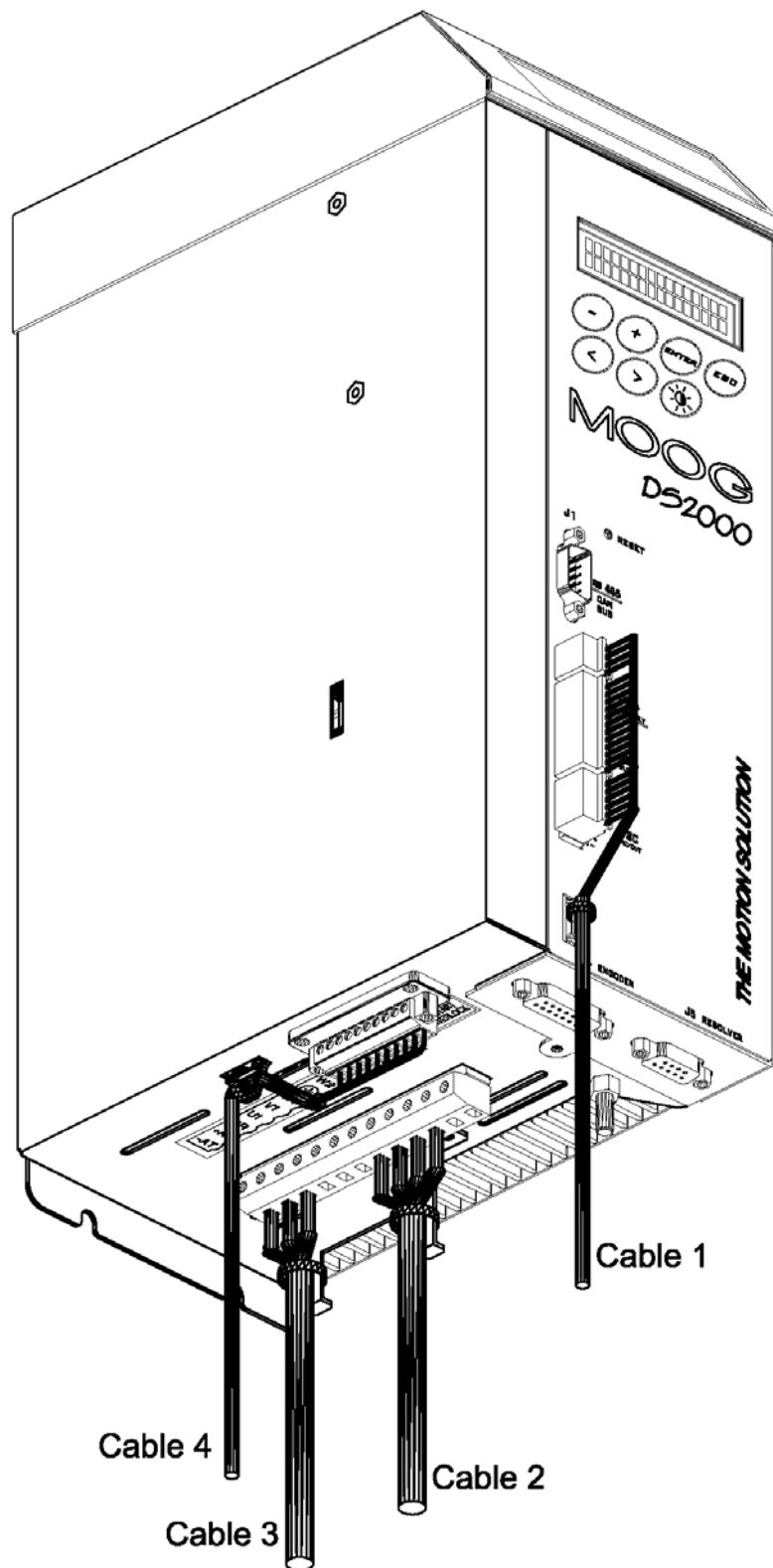
Fig. 3.3 – A and B size connections drive side

Cable 1 =   J2A, J2B, J2C
Cable 2 =   Motor power
Cable 3 =   Recovery resistor and –AT
Cable 4 =   Safety - Restart Interlock (optional)

NOTE:Unshielded (three-phase power supply) and Sub-D cables are not shown in the figure.*
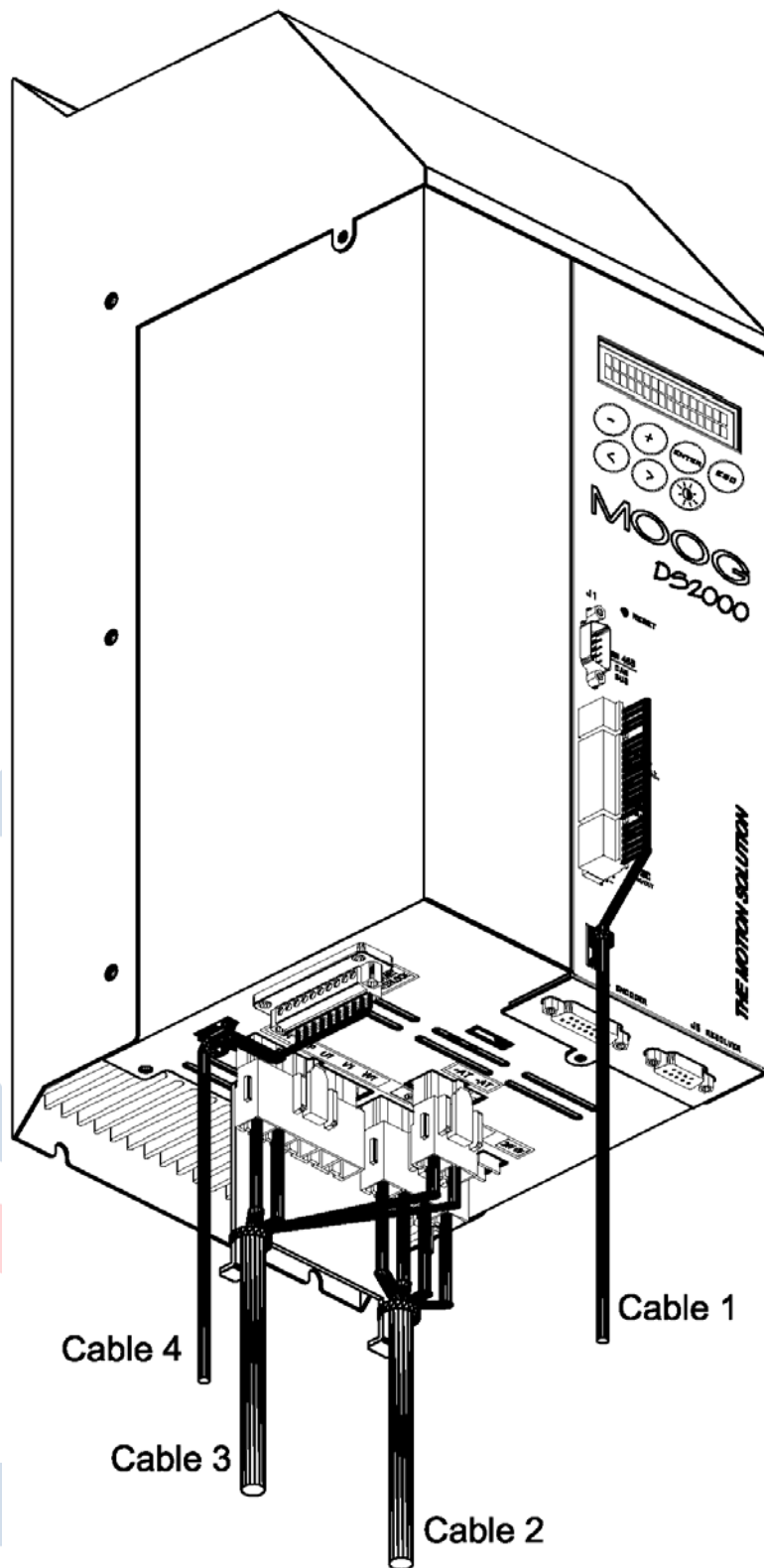
Fig. 3.4 – C size connections drive side

Cable 1 = J2A, J2B, J2C
Cable 2 = Motor power
Cable 3 = Recovery resistor and +/-AT
Cable 4 = Safety - Restart Interlock (optional)

NOTE: *Unshielded (three-phase power supply) and Sub-D cables are not shown in the figure.*
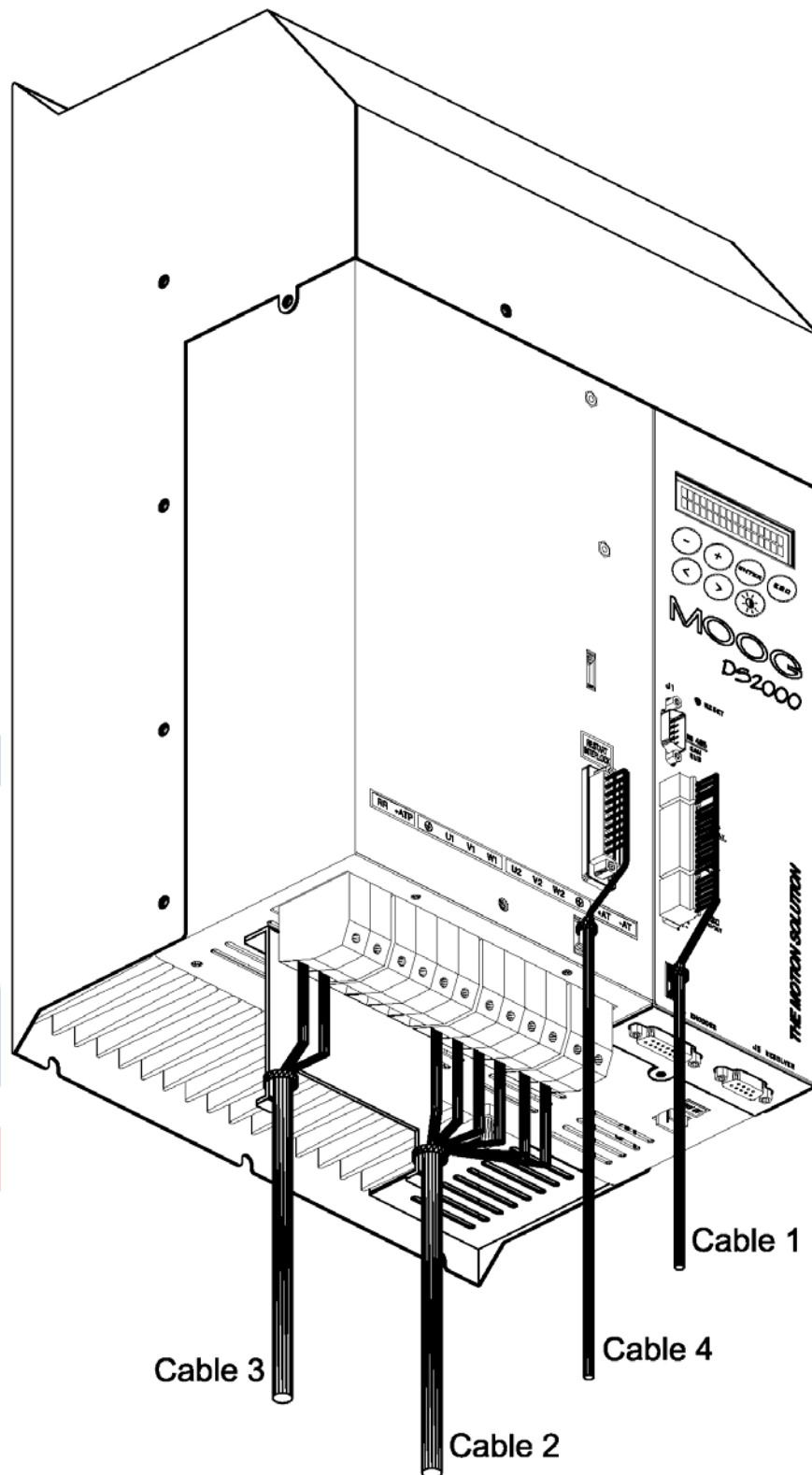
Fig. 3.5 – D size connections drive side

Cable 1 =   J2A, J2B, J2C
Cable 2 =   Motor power and +/-AT
Cable 3 =   Recovery resistor
Cable 4 =   Safety - Restart Interlock (optional)

NOTE: *Unshielded (three-phase power supply) and Sub-D cables are not shown in the figure.*
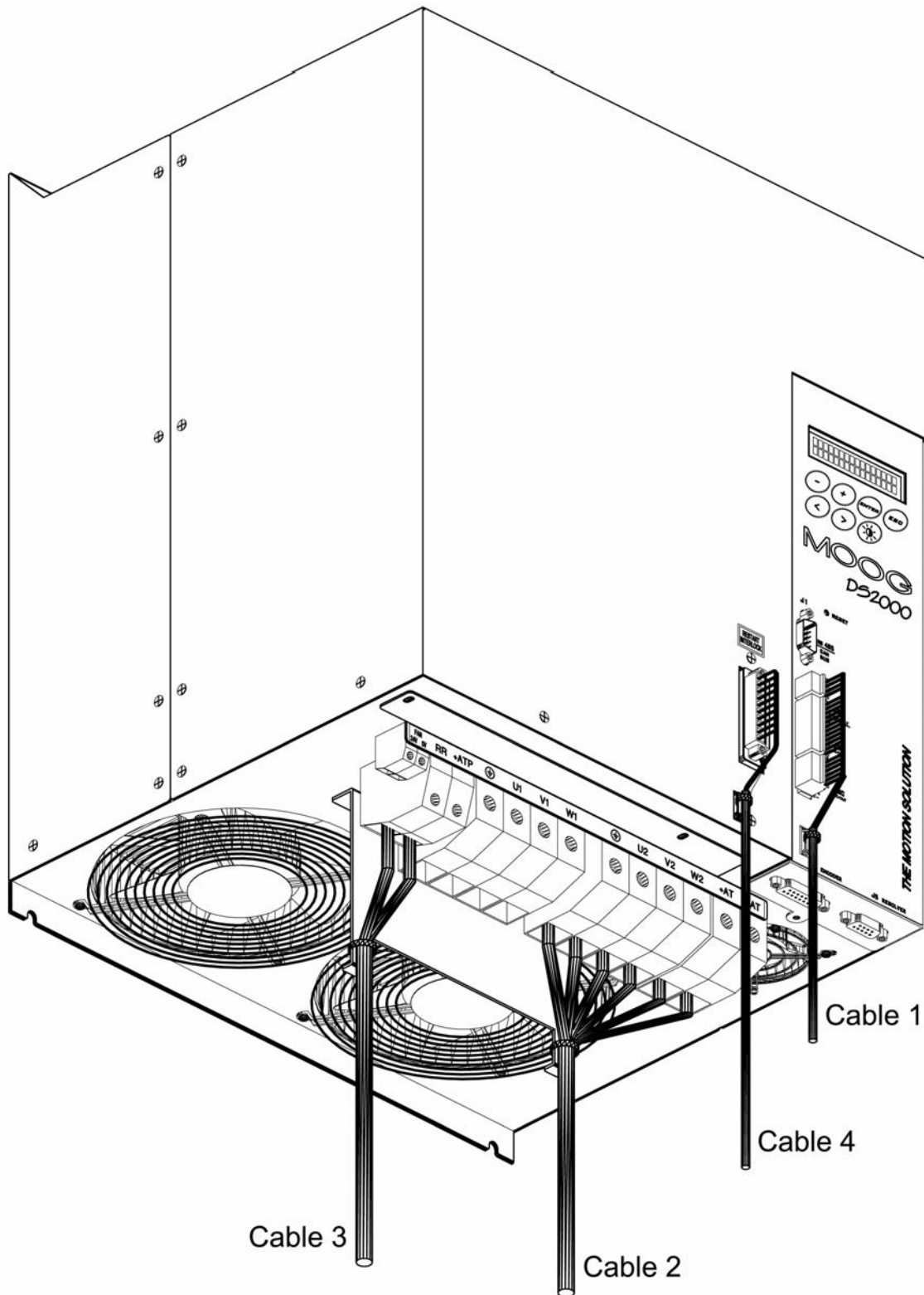
Fig. 3.5.1 – E size connections drive side

Cable 1 = J2A, J2B, J2C
Cable 2 = Motor power and +/-AT
Cable 3 = Recovery resistor
Cable 4 = Safety - Restart Interlock (optional)

NOTE: Unshielded (three-phase power supply) and Sub-D cables are not shown in the figure.

It is not necessary to shield the input power wires. A shielded cable should be used between filter and drive if the separation exceeds 30 cm.

The shields of cables inside the cabinet must be 360° clamped to the cabinet wall (see Fig. 3.6).
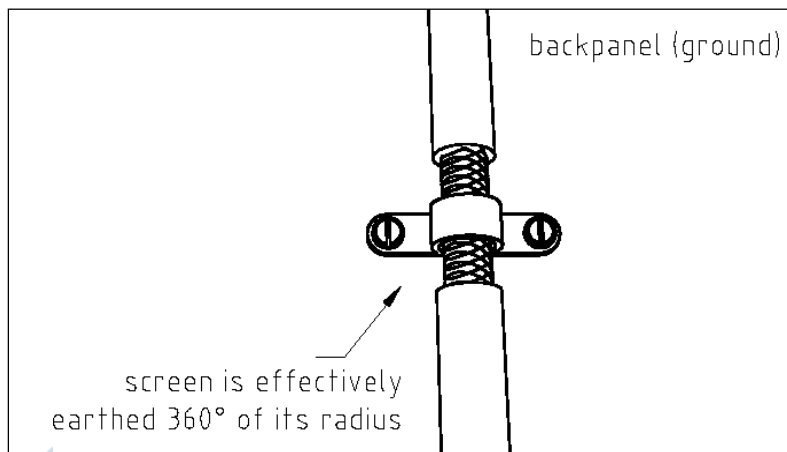
Fig. 3.6 – Backpanel connection

The power cables must be kept away from signal cables by at least 30 cm.
When the power cables cross the signal cables, this intersection must be done with angles as near to 90° as possible.

The crossing of the cabinet should be accomplished with a low impedance (RF) connection between cable shield and enclosure. If a connector is not involved, the shortest practical lengths of connecting strap should be used   (see Fig.3.7).
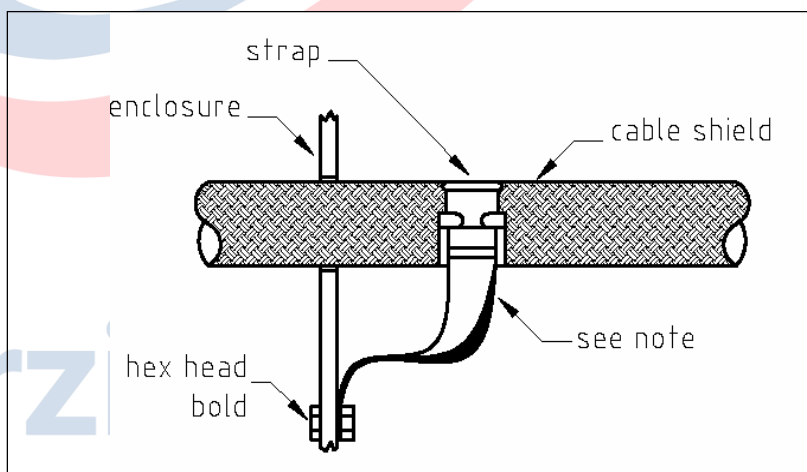
Fig. 3.7 – Partition penetration

3.5 RECOVERY RESISTOR

To meet the EMC Directive the enclosures containing the recovery resistors must be conductive. The recovery resistor cable must be shielded and the shield must be 360° clamped at both sides.

NOTE: before mounting the enclosure of recovery resistor to the panel make sure that any paint or other covering material be removed.

3.6 SCREENING

To effectively screening the system all the single screens (CNC, electronic cabinet, machine, motor housing, cables) must be connected together to effectively form one screen.

3.7 SAFETY ASPECTS

Noise suppression of motor and drive systems involves consideration of the grounding system, and its effective-ness at high frequencies. It should not be forgotten the safety aspect and that the safety must take priority over EMC.

To reduce the radiated emissions, the use of capacitance to ground is very effective. In fact, Schaffner filters have Y-type capacitors near the input power supply connector.
These capacitors leak current from phase to ground; this can be in the order of hundreds of milliamperes.

WARNING: appropriate safety measures should be taken to ensure that this potentially dangerous current flows to ground.

CAUTION: it is recommended to disconnect the drive and the EMC filters to carry out the AC Voltage Tests of EN 60204-1:1997, par.19.4, in order to not damage the Y-type capacitors between phases and ground. Moreover the DC voltage dielectric test required by EN 50178:1997, product family standard, has been carried out in factory as a routine test. The DC Insulation Resistance Tests of EN 60204-1:1997, par.19.3, may be carried out without disconnecting the drive and the EMC filters.

4. STARTING

4.1 INTRODUCTION

The purpose of this section is to provide a series of suggestions to make the first start-up of a DS2000 drive, connected to a Moog motor, easier.

All the information hereinafter are easy and descriptive, in order to be clearly understood even by personnel not skilled in servosystems installation.

Please, refer to the previous sections to search for any eventual missing information on cable connections.

Please, refer to Section 6 for a detailed description of motor and drive parameters.
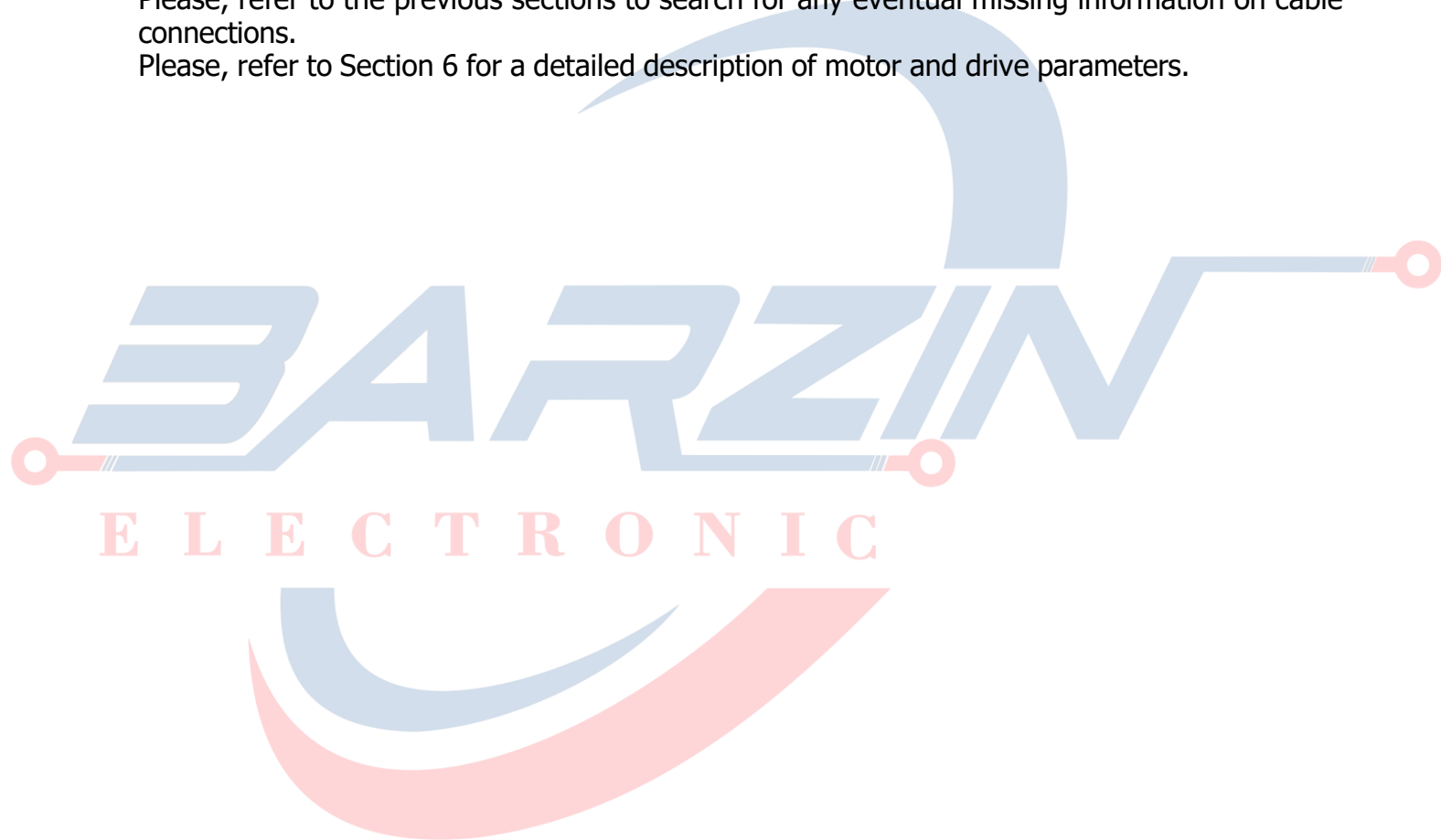
4.2 DRIVE SETTING UP INFORMATION

To set a drive it is necessary to search for some information, unless Moog already set them upon customer's request. It is necessary to know:

a) **Motor settings**
   1) Number of motor poles
   2) Motor max current
   3) Motor voltage rating
   4) Motor nominal speed
   5) Motor BEFM (at 1000 rpm)
   6) Motor resistance
   7) Motor inductance
   8) ID magnetization current (only for vectorial control asynchronous motors)
   9) SG slip (only for vectorial control asynchronous motors)
   10) Motor thermal feedback (PTC or NTC)
   11) Resolver or Encoder feedback
   12) Starting Speed for FASG algorithm (required only for G motor at high speed)
   13) Max phase angle for FASG algorithm (required only for G motor at high speed)
   14) Number of encoder pulses or number of resolver poles
   15) Number of pulses per electrical revolution needed by the CNC
       (for resolver interface only)
   16) Zero marker width (for resolver interface only)

NOTE: It is not possible to modify the number of output pulses and the zero marker width using the Encoder feedback. Such function is available only using resolver feedback.

b) **Drive settings**
   1) Remote control for drive enable
   2) Max speed requested to motor
   3) Max current supplied by the drive
   4) Speed or torque control; set speed control mode when drive is used for tests
   5) ACC/DEC value (only in speed control mode; function is disabled when set to 0)
   6) Reference analog control
   7) Digital (managed by drive) or analog (managed by control) current (torque) limit
   8) VKI and VKP (integral and proportional gain) according to the applied load
   9) LPF filter on error and reference, and Notch
   10) Anti Free wheeling function if required (perform a velocity stop if motor is in OVT, drive is in OVT, mains is lost)
   11) Protection on RR parameters if required
   12) Drive I2T protection parameters if required
   13) Dead band amplitude on analog references if required

CAUTION: The installation can be carried out also without some of the above information because it is possible to enter them later using the built-in keypad or the WinDrive GUI program.

NOTE:
The display shows immediate information about motor and drive status by means of lighting:
- *The display is lit with full light if no FAULTS are detected*
- *The display is lit with reduced intensity in case of FAULTS (refer to Section 6)*

4.3 FIRST START-UP (ON TEST BENCH, FOR TESTING PURPOSES)

First, connect the power supply (both in case of 24 Volt and alternating voltage option).
Connect the feedback (resolver or encoder) and motor power cable, to also control the motion.
Power the drive without giving the DRIVE ENABLE and the REFERENCE ENABLE.
The display must be lit, it is to say not in alarm condition; otherwise, check alarms in the appropriate menu.
Hand-rotate the motor shaft in order to check the proper reading of feedback information by the drive and eventually check the motor speed reading following the instructions contained in the Display menu described in Section 6.
To control also motor motion, supply the three-phase alternating voltage and give the DRIVE ENABLE and the REFERENCE ENABLE. It will be possible to move the motor with the given settings if connections are not wrong.
If movements are missing, refer to Section 7 (Troubleshooting).

4.3.1 FEEDBACK CONNECTION (ENCODER OR RESOLVER)

Feedback connection must always be made according to the specification in section 2 even if drive power supply is made only for testing purposes.
Inadequate connections (i.e.: unshielded cables) cause feedback and motor control errors.

4.3.2 "TEMPORARY" OR TEST POWER WIRING

In order to carry out a drive test, it is possible to supply the DS2000 with power in two ways:
- By a 24 VOLT, 1.5 A source
- By an alternating voltage (both single-phase and three-phase) between 120 and 510 V_{ac} (if the drive is supplied with a voltage lower than 120V_{ac} it is necessary to supply a 24 V_{dc} auxiliary voltage, as the internal power supplier cannot properly work).

The 24 Volt solution allows a safe setting and testing the signal connections without dangerous voltages.

NOTE: it is not possible to enable the output stages when DC BUS is not supplied with power giving a DRIVE ENABLE signal, otherwise the drive will signal a DC BUS UNDERVOLTAGE FAULT condition.

When drive is connected for test purposes only, it is possible to use a common, unshielded cable, both for power input and to connect the motor power.

4.3.3 TEMPORARY CONNECTIONS

The cross section of the cable connecting the drive to power line and to motor can be lower than the one recommended for drive size if drive peak current will not be supplied and the connection is made only for setting and checking purposes, and the motor is used at low speed and reduced torque.

Even if a soft-start circuit is always present and active on each drive, it is recommended to protect the power input line with fuses or a circuit breaker; anyway, the current absorbed by the drive during the soft-start is limited by a resistor.

NOTE: Remember to wait at least 60 s between two power switches in order to allow the internal soft-start resistor to properly dissipate the accumulated energy.

4.4 CONFIGURATION FOR INSTALLATION IN ELECTRICAL CABINET

Additional settings for installation in the electrical cabinet concern the torque remote enable setting in order to allow the CNC to control torque supply, when requested, giving the DRIVE ENABLE hardware signal.

Remember to eliminate the settings used on test bench that eventually limit performances.

5. COMPONENT DESCRIPTION

5.1 INTRODUCTION

This section provides descriptions for the DS2000 Series Drives.

5.2 HIGH POWER INPUT SECTION

The high power supply section has the following features:
- Three Phase AC Operation
- Direct Off-Line 230 V_{rms} to 460V_{rms} ±10% Operation
- Soft-start (AC Inrush Current Limiting)
- Input Varistor Transient Protection
- Drive Ready Relay (DROK)
- Provision for External Recovery Resistor
- Integral Heat Sink and Cooling Fans
- Input 24V Logic Backup
- Internal inductance only for size E

These features are described in the next sections.

WARNING: High Voltage. Bus Bar's can have voltage ≥810V_{dc} even after switching off (capacitive voltage). Discharge Time approx. 6 Minutes.

WARNING: High Voltage. The recovery resistor is connected to the Bus Bar's and can have voltage ≥810V_{dc}.

WARNING: do not touch recovery resistor during operation to avoid scalds.

5.2.1 CIRCUIT DESCRIPTION

The high power supply consists of four functional blocks:
- High voltage rectification and filtering
- Soft-start of AC mains power-on
- Low voltage control power supply
- Recovery circuit

5.2.1.1 HIGH VOLTAGE RECTIFICATION AND FILTERING

The AC mains input is rectified by a three-phase diode bridge and filtered by a bank of electrolytic capacitors to generate the internal DC BUS. This high power DC supply is unregulated and will vary in direct proportion with the AC mains input voltage magnitude.

Inductance only for size E
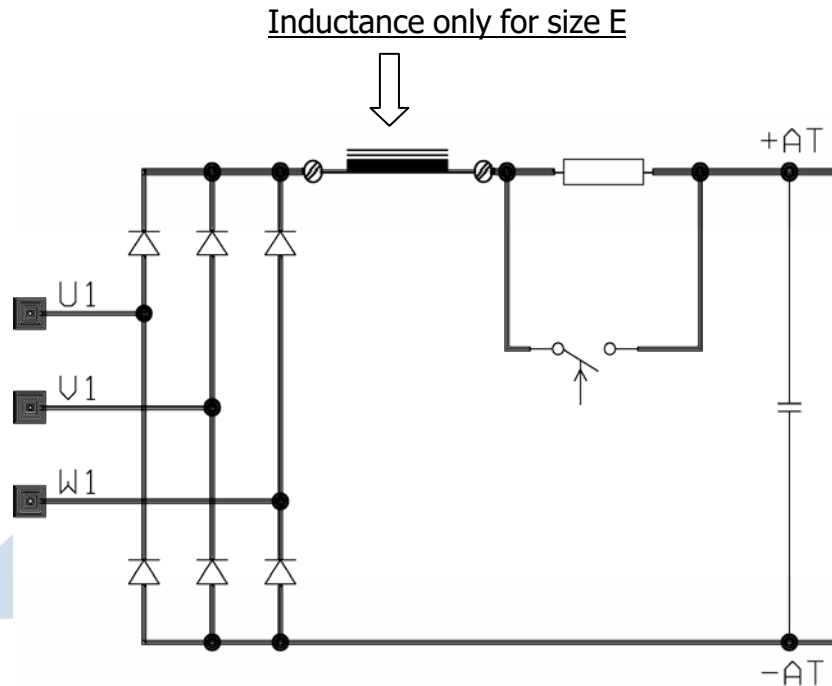
Fig. 5.1 – Power input section

5.2.1.2 SOFT START

Soft start is used to limit the inrush current to the DC BUS capacitor bank on application of AC mains power. This is intended to prevent blowing of line fuses on power-up.
The switch is a relay on DS2000 Series up to size B. It is an SCR on the other sizes.
The soft start switch will close when the monitoring circuit and associated control software determines that the high-voltage DC BUS has charged up and the DC BUS is at steady state.
If the DC BUS voltage suddenly changes at drive enable, it is possible that troubles are present on the three-phase power line (interrupted fuse, missing connection, or inadequate power supply) and the drive gives an error signal.

5.2.1.3 LOW VOLTAGE CONTROL POWER SUPPLY

Control power for the logic circuits is generated by a DC/DC converter, which provides control-circuitry power that is isolated from the mains input. This control voltage also powers the cooling fans.

5.2.1.4 RECOVERY CIRCUIT

Rapid motor deceleration or an overhauling load creates a situation in which energy is returned back into the DC BUS. This recovery energy will charge up the power supply DC BUS capacitors. To prevent capacitor overvoltage, a shunt regulator circuit senses when the DC BUS voltage exceeds the recovery cut-in voltage and via a recovery IGBT, switches a recovery resistor across the DC BUS to dissipate the recovery energy.

Hysteresis in the circuit keeps the recovery circuit active until the DC BUS voltage is reduced below the recovery cutout voltage.

The drive controls the braking circuit thresholds according to the different power supply voltages with no need for hardware calibration or setting.

WARNING: High Voltage. The recovery resistor is connected to the Bus Bar's and can have voltage $\geq 810V_{dc}$.

WARNING: do not touch recovery resistor during operation to avoid scalds.

CAUTION: In applications where the working cycle implies decelerations with high inertial loads, from high velocity in very short deceleration time, it is necessary to properly size the recovery resistor. In these cases, please contact Moog Service Centers.

5.2.1.4.1 RECOVERY RESISTOR PROTECTION

In order to thermally protect the recovery resistor a set of parameters has been provided in the menu. These parameters are:
- Resistor (RECOVERY RESIST. RESREC)
- Power (RECOVERY RESIST. POWER)
- And recovery coefficient (RECOVERY RESIST. COEFF)

The parameters to be set with the standard recovery resistors are shown in tab 5.1.

Drive Size	Max peak Current [A]	Resistor Value [Ω]	Resistor Power [W]	Coeff. Value
3/9	10.0	75 (ext.)	100	71
4/12	10.0	75 (ext.)	100	71
6/15	14.7	51 (ext.)	200	53
8/22	14.7	51 (ext.)	200	53
14/42	22.7	33 (ext.)	250	43
20/45	62.5	12 (ext.)	370	74
25/70	62.5	12 (ext.)	370	74
30/90	62.5	12 (ext.)	370	74
50/140	75.0	10 (ext.)	750	21
60/180	75.0	10 (ext.)	750	21
100/300	192.3	3.9 (ext.)	1000	17
3/9	9.1	82 (int.)	150	84
4/12	9.1	82 (int.)	150	84
6/15	13.4	56 (int.)	150	78

Tab. 5.1 – Setting protection coefficient of recovery resistor

With 230 V$_{ac}$ mains power supply a more efficient series of recovery resistors can be used. These optional resistors with the appropriate parameters are shown in tab 5.2.

Drive Size	Max peak Current [A]	Resistor Value [Ω]	Resistor Power [W]	Coeff. Value
3/9	10.0	47 (ext.)	100	69
4/12	10.0	47 (ext.)	100	69
6/15	14.7	33 (ext.)	250	45
8/22	14.7	33 (ext.)	250	45
14/42	22.7	22 (ext.)	240	69
20/45	62.5	6.8 (ext.)	370	63
25/70	62.5	6.8 (ext.)	370	63
30/90	62.5	6.8 (ext.)	370	63
50/140	75.0	5.6 (ext.)	750	19
60/180	75.0	5.6 (ext.)	750	19
100/300	192.3	2.2 (ext.)	1000	17
3/9	9.1	47 (int.)	150	87
4/12	9.1	47 (int.)	150	87
6/15	13.4	33 (int.)	150	80

Tab. 5.2 – Setting protection coefficient of recovery resistor

In applications where high or continuous recovery energy is anticipated, consult your Moog sales representative, requesting an application review. In case of different resistors, different parameters must be set.

5.3 HIGH POWER OUTPUT SECTION

The high power supply section has the following features:

- Three-phase output bridge
- PWM technology
- 10kHz switching frequency

5.3.1 CIRCUIT DESCRIPTION

5.3.1.1 HIGH POWER OUTPUT SECTION

The direct current energy available on the DC BUS is converted into current supplied to the motor by an output three-phase bridge formed by IGBT.

By means of PWM technology the output currents are generated with a high energy efficiency ratio.

The word PWM (Pulse Width Modulation) identifies a way of controlling the power devices in order to avoid any linear conduction status, and have only conduction and cut off status, to reduce the power dissipation. This way allows a high efficiency in energy conversion and, as a consequence, reduced energy losses.

The 10kHz switching frequency allows to limit the heating effects per current ripple inside the motor.

Each IGBT is individually protected from short circuit and overload and its protection is directly managed by the control card.
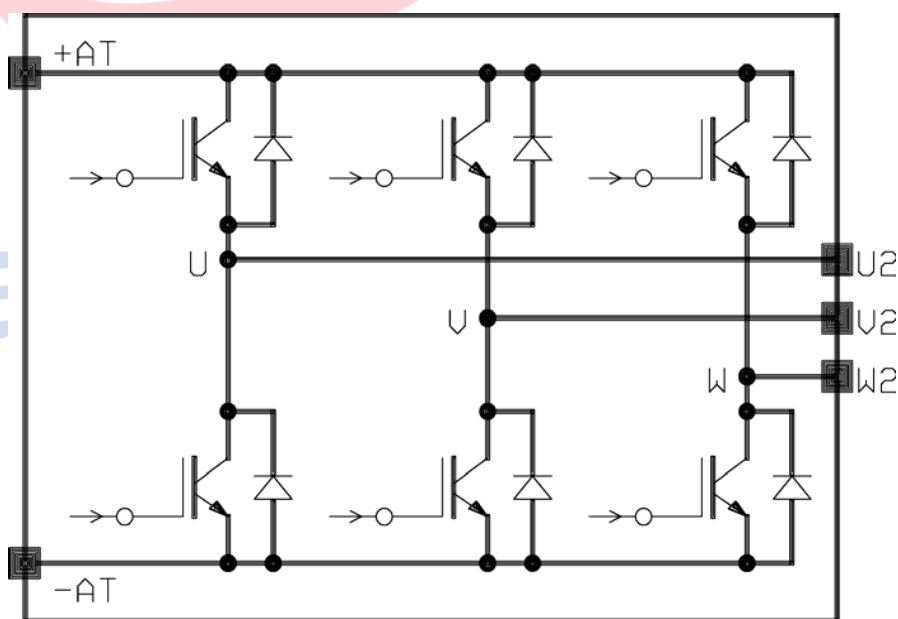
Fig. 5.2 – Power output section

5.4 CONTROL SECTION

The Control section has the following features:
• Speed loop
• Current loop
• Low-pass filters (LPF)
• Notch Filter

5.4.1 CIRCUIT DESCRIPTION

The Control Circuit consist of several functional blocks:
• Motor Feedback (size, voltage, rpm)
• Speed Feedback
• Speed loop (VKP, VKI)
• LPF Filter (frequency)
• Notch Filter (frequency, band, gain)
• Current Feedback
• Current Loop (Rw, Lw, E1000, ID, SG)
• PWM Amplifier (limit)
• Position Feedback (APHAPOS)
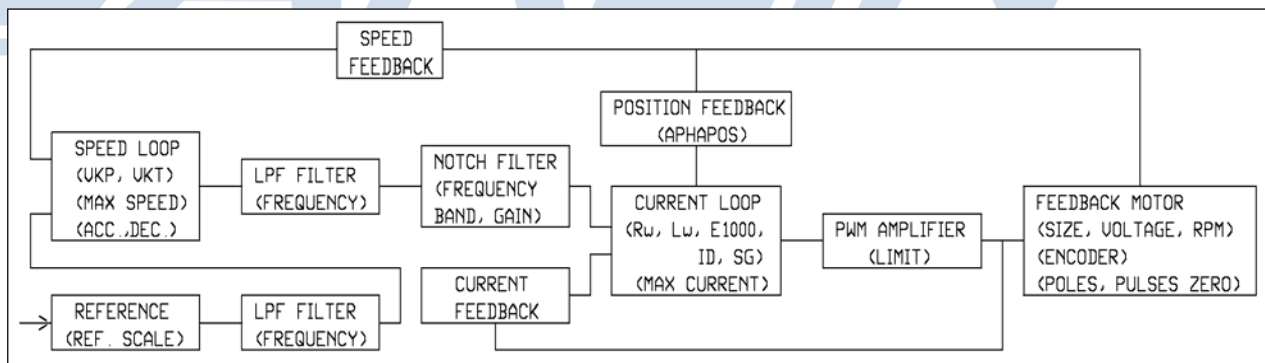
Fig. 5.3 – Servosystem block diagram

5.4.1.1 HIGH POWER OUTPUT SECTION

The drive checks the current angular position in order to always keep a 90° angle between the magnetic field generated by currents and the one generated by magnets on the motor rotor.
The motor position is given by the feedback signals coming from the encoder or from the resolver through an appropriate processing.
According to the information existing in the setting loop, the drive processes the information concerning current width, frequency and angular position, and properly commands the IGBT to supply the currents.
The current feedback is obtained by means of Hall sensors placed on U and V motor phases.
The position feedback can be both the resolver and the encoder; inside the drive the two signals are managed by two separate circuits in order to obtain the same final information for the speed loop.

LPF filters on the reference and on the speed error allow to adapt the servosystem (drive + motor) pass band to the application characteristics.

The Notch filter allows to eliminate or reduce any eventual oscillation on the machine mechanics be-cause of the limited rigidity of the motor transmission parts (mechanical transmissions, belts, etc.), specially in presence of high inertia ratios between motor and load (mismatching load condition).

5.4.1.1.1 LOW AND HIGH SPEED OPERATION

Current control loop has two different working conditions: Low speed and High speed. The difference is determined by motor voltage with respect to the available output voltage on motor phases.

At low speed, the voltage supplied by the drive is higher than the one generated by the motor, and the field generated by current is in phase with the field generated by magnets.

At high speed, the motor voltage can be compared to the voltage available from the drive; the relevant phase between the magnetic fields is automatically changed in order to keep such a voltage margin as to allow an optimal current adjustment.

This algorithm allows an optimal exploitation of motor characteristics, supplying the same peak torque both at low and high speed, with a higher peak power available for machinery motion.

It is also possible to wind the motors with a higher torque constant; thanks to this feature, in many applications, it is possible to use a drive supplying a lower current to obtain the same peak torque at motor output.

All the motors produced by Moog, are provided with this feature and give high performances at high rotation speed.

An additional phase shift is given by the G motors Algorithm, suggested mainly for motors having high poles number (8 or 12) and running at speed over 3000 rpm.

Standard Drive
Phase max V=1/2 Vbus

DS2000 Drive
Phase max V>1/2 Vbus
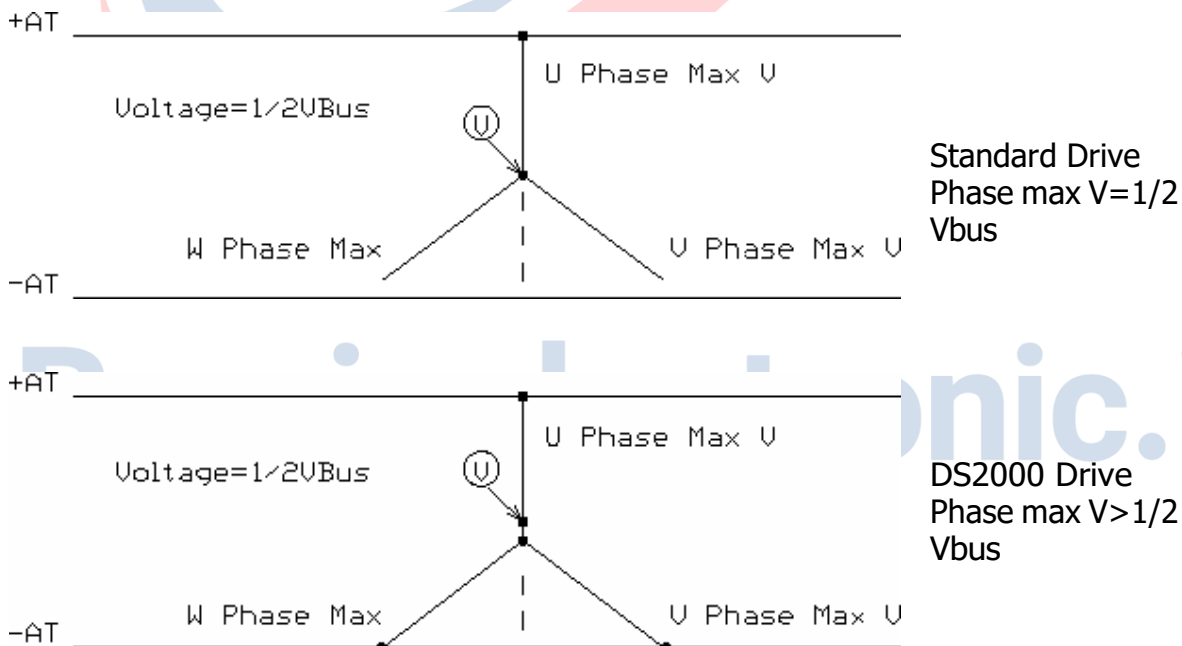
5.4.1.1.2 ENCODER/RESOLVER SIGNALS COHERENCE CONTROL

The drive carries out a control on the encoder high and low transition coherence and on the resolver phases sequence.

By manually rotating the motor, with drive supplied only with 24 V_{dc}, it is possible to carry out a control of the connection between feedback and drive; any eventual fault signal in dicates feedback problems (see Section 7).

5.4.1.2 CONTROL LOOPS

5.4.1.2.1 CURRENT LOOP

- The current loop is based on a PI structure with motor electromotive force (B.E.M.F.) compensation on speed variation.
- The implemented algorithms allow to adjust integral and proportional gains by entering data via keyboard or Windrive GUI with no drive instruments or test bench calibration.
- Only data concerning Electric Resistor (Rw), Motor inductance (Lw), and Motor electromotive force (B.E.M.F.) are needed to adapt the current loop frequency response to the motor characteristics.
- The electromotive force compensation allows the increase the peak current that can be supplied at high speeds because the loop compensates the voltage associated to the supplied current and to the current generated by motor, dephasing the currents position.
- The loop structure also compensates the phase shift introduced by the current sensors and by the interface circuits, allowing a null phase shift and a "flat" phase response between 0 and approx. 800 Hz, independently of the controlled motor model.
- The loop closing, at a frequency of 10 kHz, allows to dynamically compensate the inductance, resistor, and electromotive force variation of the motor at load and motor rotor angular position variation.

5.4.1.2.2 CURRENT LOOP OPTIMIZATION

The current loop optimization is automatically carried out by entering the motor physical characteristics: Resistor, Inductance, and Electromotive Force.

Such data must be entered in physical units: the Resistor in Ohm, the Inductance in mH (milliHenry) and the Electromotive Force in Volt at 1000 rpm.

The drive automatically adjusts the current loop gains and carries out the angular correction as a function of the motor rotation speed and of the torque requested to motor.

No other customer calibration is needed, except for entering the motor physical parameters.

Note: If the output current at high speed (max working speed) is too high, it is possible trying to reduce it, reducing the motor inductance value (-20 %) and reducing the motor BEMF value; the reason is linked to the motor reluctance, that change in the motor revolution

5.4.1.2.3 SPEED LOOP

- The speed loop has a simple PI structure.
- Through the KI and KP gains the servosystem response can be adapted to the applied load.
- The control loop is closed with a frequency of 5 kHz.
- The pass band is internally limited via software at 400 Hz; the phase shift is missing for the usable pass band.
- The loop allows the setting of the "higher frequency" of the pass band because it is proportional to VKI (axis rigidity at low speed).
- The VKP value allows to control the overshoot when set speed is reached (higher gain,higher control)
- A low-pass filter of the second order is placed on the speed error to limit the frequency response in case of device oscillation that cannot be compensated by changing CNC or drive gains.
- System excessive gains can cause a reduction of the supplied torque due to the excessive pass band and to the aliasing effect on the servo system main frequencies.

5.4.1.2.4 SPEED LOOP OPTIMIZATION

The speed loop optimization is carried out adjusting VKI and VKP parameters, which correspond, respectively, to the speed loop Integral and Proportional Gain, as well as properly adjusting the filters, if necessary. It is possible to minimize the error acting on VKI and VKP gains during the device operation thus obtaining the required response.

6. COMMANDS

6.1 INTRODUCTION

The six keys on the drive front panel allow the visualization of the whole menu as well as the relevant drive configuration. A further key allows the display contrast adjustment.
The keys can be divided according to their function:

- ENTER. This key allows to enter a menu and browse it. The variables scanning inside a menu is recursive. In some cases, this key activates a routine function (i.e. inside the "Utility" menu).
- < >. These keys allow the menu horizontal scrolling from right to left and vice versa.
- + -. These keys allow to increase and decrease a variable. Holding the key down approx. 5 s the fast forward starts.
- ESC. This key allows to go back inside the menu or terminate a function.
- ☼. Holding down the yellow key, it is possible to adjust the display contrast by means of the + / - keys. In order to keep the setting, it is necessary to save the parameters before switching off the drive.
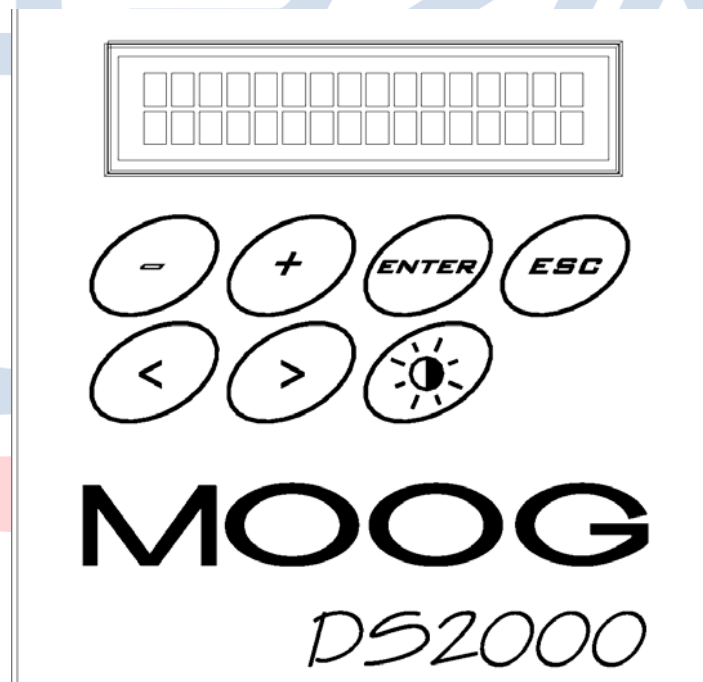
Fig. 6.1 – DS2000 front panel

NOTES:

- First screen at drive start-up show you the DS2000 size. The DRIVE ENABLE and REFERENCE ENABLE signals are shown in the start-up screen on the display by two stylized letters: "D" and "R" respectively.
- The first menu level can be accessed pressing ENTER. The first level is characterized by the two <> arrows which indicate the possibility of scrolling the menu from right to left. To access the menu, press ENTER. To go to the following parameter, press ENTER or < and > keys. The parameter scanning is recursive.
- To exit the menu, press ESC. Keep on pressing if the displayed parameter is not the first item of the menu.

- When the parameter to be modified is reached, press +/- to increase or decrease the variables.
- At start-up, after a reset, or a saving of parameters, the drive is in "locked keyboard" status in order to avoid parameters and system settings accidental modifications. To modify parameters it is necessary to unlock the keyboard. To unlock the keyboard it is necessary to activate the function "unlocked keyboard" inside the "Keyboard locked" menu (see cap. 6.8).
- In order to save the modified parameters the function "Save Parameters" inside the "Utility menu" should be used; the saving occurs only when drive is not enabled.
- In case of FAULT, the display light intensity is reduced.
- The main menu is not "circular"; when the bottom is reached, press ESC or < to go back. The Enter button can be used to go forward the menu.

6.2 MOTOR PARAMETERS MENU
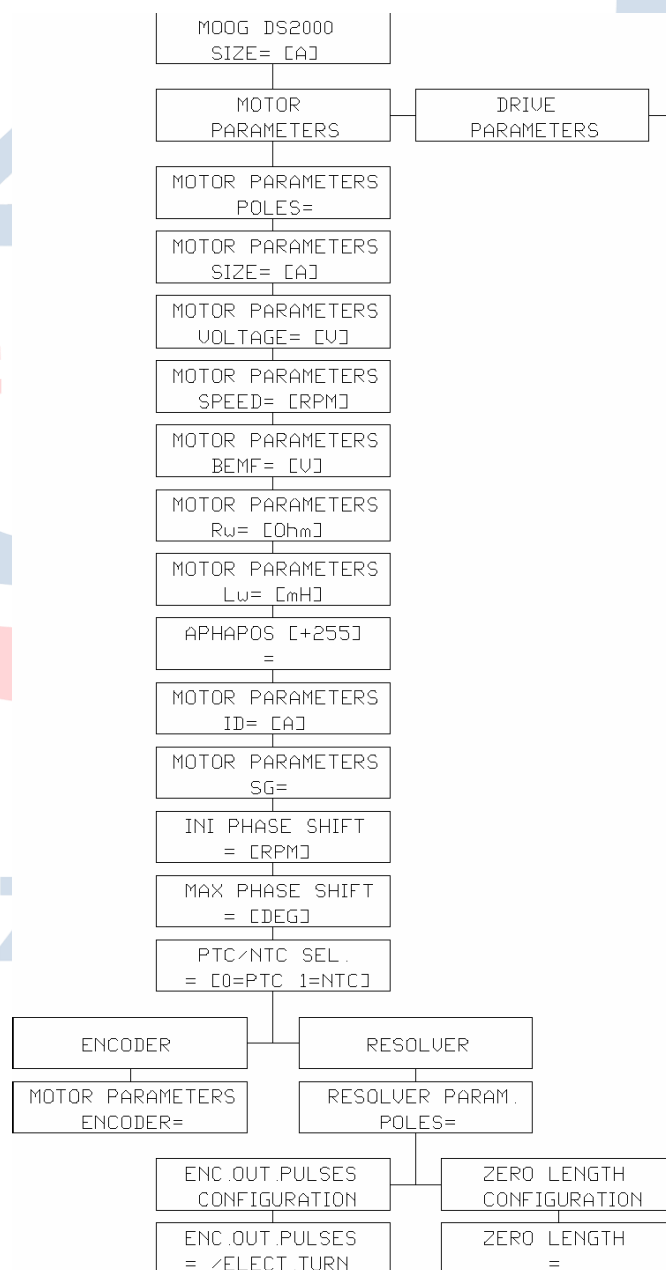
Fig. 6.2 – Motor parameters menu

6.2.1 MOTOR PARAMETERS MENU DESCRIPTION

MOTOR PARAMETERS POLES=	Description: it indicates the number of motor poles
Allowed values: from 2 to 24 in 2 unit steps	**Note:** set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue.

MOTOR PARAMETERS SIZE=	Description: it indicates the motor peak current value
Allowed values: from 1.0 A to the peak current supplied by the drive in 100mA steps	**Note:** If this value is not available, it is possible to obtain the peak current by means of the following formula: $I_{peak}=1.41*Tm/K_t$ where Tm is the max torque in Nm and Kt is the motor torque constant in Nm/A

MOTOR PARAMETERS VOLTAGE=	Description: it indicates the motor winding voltage rating value
Allowed values: • 230 V (for 230 V motors) • 400 V (for 400/460 V)	**Note:** set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue

MOTOR PARAMETERS SPEED=	Description: it indicates the nominal motor speed
Allowed values: from 100 rpm to 9999 rpm in 10 rpm steps	**Note:** set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue

MOTOR PARAMETERS BEMF=	Description: it indicates the motor generated back-electromotive force value at 1000 rpm.
Allowed values: from 0 V to 750 V in 1 unit steps	**Note:** the drive uses this information to optimize the current loop as a function of the motor rotation velocity. If this value is not available, it is possible to obtain the BEMF by means of the following formula: $BEMF=K_t*60.4$ where K_t is the motor torque constant in Nm/A

MOTOR PARAMETERS Rw=	Description: it indicates the motor resistance value, measured between phase and phase
Allowed values: from 0 Ω to 100 Ω in 0.1 unit steps	**Note:** set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue. If this value is not available, it is possible to obtain it using a multi-meter (set as an ohm-meter)

MOTOR PARAMETERS Lw=	Description: it indicates the motor inductance value, measured between phase and phase
Allowed values: from 0 mH to 200 mH in 0.1 unit steps	**Note:** set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue. If this value is not available, it is possible to obtain it using a multi-meter (set as an inductance-meter). **Attention:** for G motors use the L_q value instead of L_{tt}

APHAPOS=	**Description:** It indicates the phasing value correction between the position feedback (resolver or encoder) and the motor phases
Allowed values: from 0 to ±255 in 1 unit steps	**Note:** this value can be automatically modified by the PHASING procedure. **Note:** the APHAPOS value can be manually entered by the keyboard without the PHASING procedure. **Note:** the APHAPOS values follows: • APHAPOS = 0 for FAS T, FAS N, FAS K motors • APHAPOS = 125 only for FASK motor with 2 resolver poles • APHAPOS = -209 for G 8 poles motor with 2 resolver poles • APHAPOS = 45 for G 12 poles motor with 2 resolver poles

MOTOR PARAMETERS ID=	**Description:** it indicates the magnetization current value when using an asynchronous motor in vector control mode
Allowed values: from 0 to the peak current supplied by the drive in 100mA steps	**Note:** set the values indicated on the motor catalogue

MOTOR PARAMETERS SG=	**Description:** it indicates the slip frequency (gain) value for asynchronous motors control working in vector control mode
Allowed values: from 0 to 100 in 0.1 unit steps	**Note:** set the values indicated on the motor catalogue. If this value is not available, it is possible to obtain it analyzing the response to transients

INI PHASE SHIFT=	**Description:** it indicates the starting speed for the G motors algorithm, to improve phase shift at high speed mainly for motors having 8-12 poles and rotating over 3000 rpm
Allowed values: from 100 to max speed drive in 10 unit steps	**Note:** see related application notes for additional details

MAX PHASE SHIFT=	**Description:** it indicates in electrical degrees the max phase angle of the above algorithm
Allowed values: from 0 to 50 in 1 unit steps	**Note:** see related application notes for additional details

PTC/NTC SEL.=	**Description:** Allow the selection between PTC or NTC as thermal feedback
Allowed values: • 0 (for PTC thermal feedback) • 1 (for NTC thermal feedback)	**Note:** set the thermal feedback according to motor data

ENCODER<>RESOLVER	**Description:** it indicates the type of motor feedback
Allowed values: • ENCODER (for ENCODER feedback) • RESOLVER (for RESOLVER feedback)	**Note:**

6.2.2 RESOLVER PARAMETERS POLES

RESOLVER PARAM. POLES=	Description: it indicates the resolver poles number
Allowed values: from 2 to 24 in 2 unit steps	Note: set the values indicated on the nameplate of the motor or refer to the data indicated on the mo-tor catalogue Attention: available only with resolver feedback mode
ENC.OUT.PULSES CONFIGURATION=	Description: it indicates the number of encoder pulses output on J2C connector
Allowed values: from 64 to 1024 pulses for resolver polar couple in power of 2n	Note: drive generates output pulses dividing the input pulses anyway used for motor control Attention: - available only with resolver feedback mode - to set a new configuration it is necessary to save and reboot
ZERO LENGTH=	Description: it indicates the marker width for drive electric loop measurement output on J2C connector
Allowed values: • 90° • 180° • 360°	Note: drive generates output pulses dividing the input pulses anyway used for motor control Attention: - available only with resolver feedback mode - to set a new configuration it is necessary to save and reboot

6.2.3 ENCODER PARAMETERS DESCRIPTION

MOTOR PARAMETERS ENCODER=	Description: it indicates the number of motor encoder pulses
Allowed values: from 1024 to 8192 in 512 unit steps	Note: set the values indicated on the nameplate of the motor or refer to the data indicated on the motor catalogue. Attention: available only with encoder feedback mode

6.3 DRIVE PARAMETERS MENU
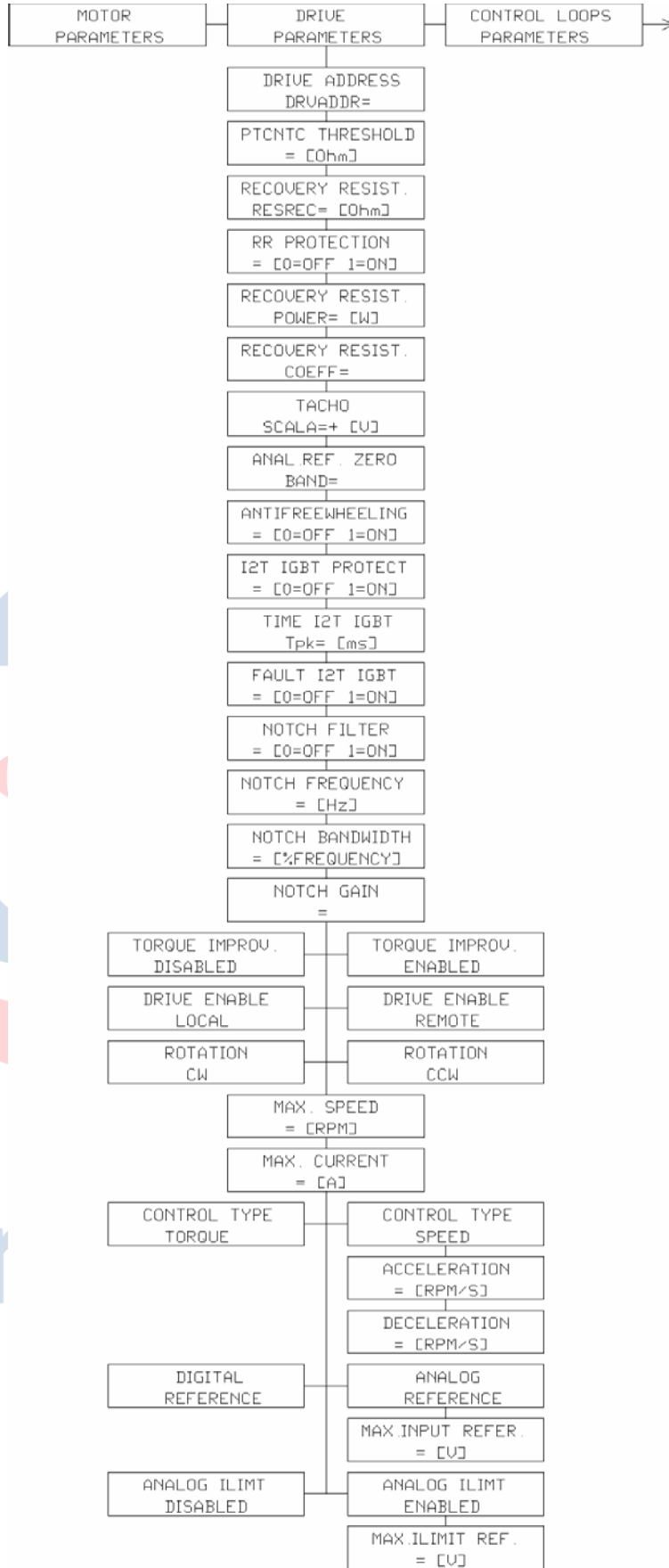
Fig. 6.3 – Drive parameters menu

6.3.1 DRIVE PARAMETERS MENU DESCRIPTION

DRIVE ADDRESS DRVADDR=	**Description:** it indicates drive address for serial communication
Allowed values: from 1 to 63	**Note:** set a progressive and different value per each drive to obtain only one serial line to interrogate all the drives existing in the machine
PTCNTC THRESHOLD=	**Description:** it indicates NTC/PTC threshold value used to protect motor from overtemperature
Allowed values: from 100 Ω to 10000 Ω in 1 unit steps	**Note:** set following value for Moog motor: • 1200 Ω for PTC thermal feedback • 6500 Ω for NTC thermal feedback
RECOVERY RESIST. RESREC=	**Description:** it indicates the recovery resistor value
Allowed values: from 3 Ω to 100 Ω in 1 unit steps	**Note:** set the value indicated on the drive label. If the precise value is not available, set the higher one. If the value is too high the drive will not be able to dissipate the recovered energy
RR PROTECTION	**Description:** protection against recovery resistor thermal overload
Allowed values: • 0 (for protection disabled) • 1 (for protection enabled)	**Note:** see section 7 for additional details on this function setup
RECOVERY RESIST. POWER=	**Description:** nominal resistor power, used for resistor thermal protection
Allowed values: from 10 W to 6400 W in 1 unit steps	**Note:** see section 7 for additional details on this function setup
RECOVERY RESIST. COEFF.=	**Description:** special parameter, used for resistor thermal protection
Allowed values: from 1 to 32000 in 1 unit steps	**Note:** see section 7 for additional details on this function setup
TACHO SCALE=	**Description:** it indicates the max tacho signal value obtained at max number of motor revolutions
Allowed values: from 5 V to 10 V in 100 mV unit steps	**Note:** setting 10 V for the max speed value allows to obtain a simple and direct ratio between read value and speed
ANAL.REF. ZERO BAND=	**Description:** set a dead band on the speed/torque analog reference. Under this value the input is not acquired
Allowed values: from 0 to 128 (128 units = 0.625 V) in 1 unit steps	**Note:** it is useful to cut random or too big offset from CNC. Set to 0 for normal operation

ANTIFREEWHEELING	**Description:** enable ANTIFREEWHEELING function in following conditions: • motor overtemperature • drive overtemperature • power lost The drive brakes until null velocity is reached. If recovered power is not enough the drive will shut down without reaching null velocity. DRIVE ENABLE signal has to be applied to activate this function
Allowed values: • 0 (for disabled) • 1 (for enabled)	**Note:** ACCELERATION and DECELERATION ramps are active for a proper operation and emergency stop

I2T IGBT PROTECT	**Description:** enable I2T protection on IGBT if output frequency is lower than 5kHz
Allowed values: • 0 (for disabled) • 1 (for enabled)	**Note:** enabling I2T IGBT PROTECT, NOTCH FILTER will be automatically disabled **Note:** when this protection is active, the letters I2T will appear on the main window (Moog DS2000) menu

TIME I2T IGBT=	**Description:** set a time for I2T trigger
Allowed values: from 100 ms to 1000 ms in 10 ms unit steps	**Note:** default value is 500 ms for all DS2000 drives

FAULT I2T IGBT	**Description:** enable the fault reaction on I2T IGBT drive condition
Allowed values: • 0 (for disabled) • 1 (for enabled)	**Note:** select the "reaction" following the application needs • if disabled, reduce the max output current to the rated drive current • if enabled, fault condition (alarm and torque disable)

NOTCH FILTER	**Description:** enable notch filter function to remove precise critical frequency
Allowed values: • 0 (for disabled) • 1 (for enabled)	**Note:** available only if I2T IGBT PROTECT is disabled

NOTCH FREQUENCY=	**Description:** it allows to insert in the speed adjustment loop a Notch filter which can be programmed in frequency
Allowed values: from 50 Hz to 1500 Hz in 1 unit steps	**Note:** set directly in Hz the filter attenuation frequency

NOTCH BANDWIDTH=	**Description:** it allows to program the Notch filter bandwidth
Allowed values: from 1% to 25% in 1 unit steps	**Note:** set the filter bandwidth directly in percentage

NOTCH GAIN=	**Description:** it allows to directly enter the Notch filter attenuation
Allowed values: from 0.01 to 1.00 (100%) in 0.01 unit steps	**Note:**

TORQUE IMPROV.	**Description:** it allows to set moment by moment the best angle between the supplied current vector and the magnet position in order to increase the peak torque at high speed
Allowed values: • DISABLED • ENABLED	**Note:** it is recommended to leave it enabled to get better performance at higher speed

DRIVE ENABLE	**Description:** it allows the torque supply control by keyboard or by external control
Allowed values: • LOCAL • REMOTE	**Note:** default setting is in local mode in order to allow the motor control by keyboard, under the operator control; set the remote enable after the first setting up phase. The drive have to be provided with the DRIVE ENABLE signal on the connector J2B also in case of local enable

ROTATION=	**Description:** it allows to reverse the motor rotation direction on the same applied reference signal
Allowed values: • CW (clockwise) • CCW (counterclockwise)	**Note:**

MAX. SPEED=	**Description:** it allows to limit the max motor speed at a lower value than the one set in the motor parameters
Allowed values: from 100 rpm to max motor speed in 1 unit steps	**Note:** Input analog reference remains diminished at this set value; setting 10 V input analog reference, the max set revolutions are obtained

MAX. CURRENT=	**Description:** it allows to limit the max supplied current to a lower value than the one set in the motor parameters
Allowed values: from 0 A to max current in 100 mA unit steps	**Note:** Input analog reference remains diminished at this set value; setting 10 V input analog reference, the max set revolutions are obtained

CONTROL TYPE=	Description: it allows to control the motor in torque or speed mode
Allowed values: • TORQUE • SPEED	Note: setting speed control mode the supplied torque is the one required by the load; setting torque control mode the set torque is supplied while the speed is a function of the applied load.

ACCELERATION=	Description: it allows to limit the max motor angular acceleration permitted
Allowed values: from 0 rpm/s to 9990 rpm/s in 10 unit steps	Note: function is disable when set to 0; in case of sudden accelerations the setting of a slope eliminates any eventual overshoots or control loops saturation Attention: function available only in speed control mode

DECELERATION=	Description: it allows to limit the max motor angular deceleration permitted
Allowed values: from 0 rpm/s to 9990 rpm/s in 10 unit steps	Note: function is disable when set to 0; in case of sudden decelerations the setting of a slope eliminates any eventual overshoots or control loops saturation Attention: function available only in speed control mode

REFERENCE	Description: it allows to control the motor by an analog signal or through the keyboard
Allowed values: • DIGITAL • ANALOG	Note: a direct correspondence between input analog reference and reached speed is obtained using the analog reference. When using digital reference it is possible to control the speed inside the CONTROL LOOPS menu

MAX.INPUT REFER.=	Description: it allows to select the max input reference value in order to reach the max speed set
Allowed values: from 3.2 V to 10.0 V in 0.1 V unit steps	Note: set the selected value on the numeric control to obtain a direct correspondence Attention: function available only with analog reference

ANALOG ILIMIT	Description: it allows to limit the current supplied by the drive
Allowed values: • DISABLED • ENABLED	Note: max current value set is reached with the max I limit reference. This function can be used each time it is necessary to limit the max torque supplied

MAX.ILIMIT REF.=	Description: it allows to select the max input reference value in order to reach the max current set
Allowed values: from 3.2 V to 10.0 V in 0.1 V unit steps	Note: set the selected value on the numeric control to obtain a direct correspondence Attention: function available only with analog I limit enabled

6.4 CONTROL LOOPS PARAMETERS MENU
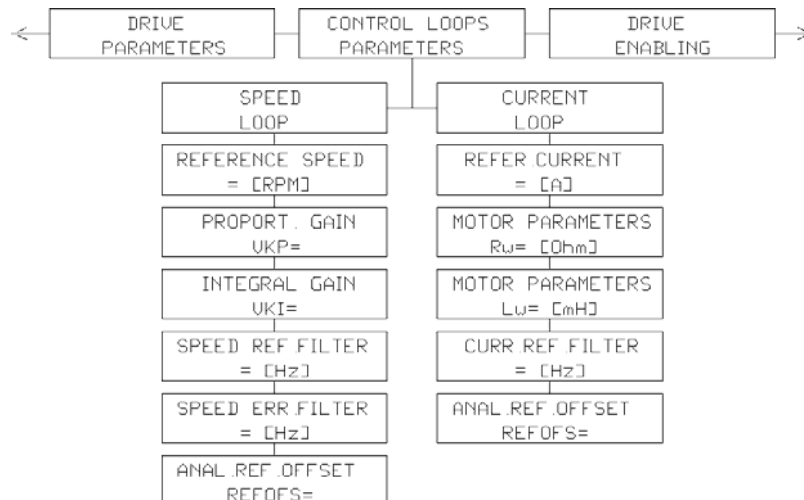
Fig. 6.4 – Control loops parameters menu

6.4.1 SPEED LOOP PARAMETERS MENU DESCRIPTION

REFERENCE SPEED=	**Description:** in digital reference mode it is possible to increase or decrease the motor speed using + and – keys
Allowed values: from 0 rpm to max drive speed in 1 unit steps	**Note:** in case of analog reference this value has no function **Attention:** the digital value can be saved in drive memory and ready at next start up
PROPORT. GAIN=	**Description:** it allows to set the proportional gain value to control the speed loop
Allowed values: from 0 to 30000 in 1 unit steps	**Note:**
INTEGRAL GAIN=	**Description:** it allows to set the integral gain value to control the speed loop
Allowed values: from 0 to 30000 in 1 unit steps	**Note:**
SPEED REF.FILTER=	**Description:** it allows to limit the speed reference band through of a low-pass digital filter
Allowed values: from 1 Hz to 800 Hz in 1 unit steps	**Note:** filter allows to limit the motion overshoots due to sudden variations of the reference signal
SPEED ERR.FILTER=	**Description:** it allows to limit the speed reference band through of a low-pass digital filter
Allowed values: from 20 Hz to 800 Hz in 1 unit steps	**Note:** filter allows to reduce the oscillations at high frequency due to high gain conditions, with high inertia ratios between load and motor
ANAL.REF.OFFSET=	**Description:** it allows to correct and cancel any eventual analog offset at speed reference input
Allowed values: from -50 to +50	**Note:**

6.4.2 CURRENT LOOP PARAMETERS MENU DESCRIPTION

REFER. CURRENT=	**Description:** in torque control mode it is possible to increase or decrease the current supplied to the motor using + and – keys
Allowed values: from 0 rpm to max drive current in 1 unit steps	**Note:** in case of analog reference this value has no function **Attention:** the digital value can be saved in drive memory and ready at next start up
MOTOR PARAMETERS Rw=	**Description:** it indicates the motor resistance value, measured between phase and phase
Allowed values: from 0 Ω to 100 Ω in 0.1 unit steps	**Note:**
MOTOR PARAMETERS Lw=	**Description:** it indicates the motor inductance value, measured between phase and phase
Allowed values: from 0 mH to 200 mH in 0.1 unit steps	**Note:**
CURR.REF.FILTER=	**Description:** it allows to limit the current loop band through a low-pass digital filter
Allowed values: from 0 Hz to 800 Hz in 1 unit steps	**Note:** filter allows to reduce current oscillations at high frequency due to high gains conditions in closed loop with high inertia ratios between load and motor
ANAL.REF.OFFSET=	**Description:** it allows to correct and cancel any eventual analog offset at speed reference input
Allowed values: from -50 to +50	**Note:**

6.5 DRIVE ENABLE MENU
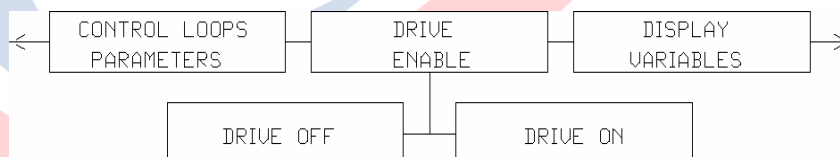
Fig. 6.5 – Drive enable menu

6.5.1 DRIVE ENABLE MENU DESCRIPTION

DRIVE ENABLE	**Description:** it allows to control the drive if in the DRIVE PARAMETER menu the DRIVE ENABLE is set in LOCAL mode
Allowed values: • DRIVE OFF • DRIVE ON	**Note:**

6.6 DISPLAY VARIABLES MENU
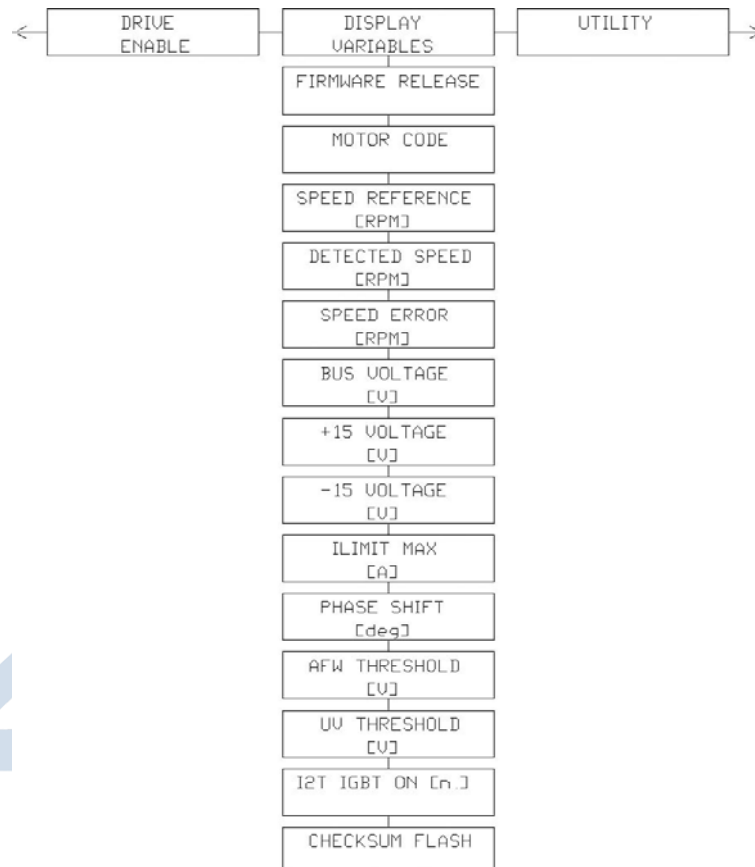
Fig. 6.6 – Display variables menu

6.6.1 DRIVE ENABLE MENU DESCRIPTION

FIRMWARE RELEASE	**Description:** it indicates the installed firmware version
MOTOR CODE	**Description:** Numeric code to identify motor type using Windrive GUI
SPEED REFERENCE	**Description:** it indicates the input speed reference value
DETECTED SPEED	**Description:** it indicates the motor detected speed **Attention:** the function is active even when the axis is disabled
SPEED ERROR	**Description:** it indicates the speed error between the speed reference and the detected speed
BUS VOLTAGE	**Description:** it indicates the DC BUS voltage detected by the drive; this value is used for the soft start and recovery circuit management
+15 VOLTAGE	**Description:** it indicates the +15 V voltage detected by the drive
-15 VOLTAGE	**Description:** it indicates the -15 V voltage detected by the drive
ILIMIT MAX	**Description:** it indicates the current limitation value set in the drive: • In digital limit mode the max current is indicate • In analog limit mode the analog limit is indicate
PHASE SHIFT	**Description:** it indicates the effective phase shift according to the motor load and velocity

AFW THRESHOLD	**Description:** it indicates the actual value for the AFW intervention, for power lost

UV THRESHOLD	**Description:** it indicates the actual value for the undervoltage intervention

I2T IGBT ON	**Description:** it indicates how many times the IGBT protection started after last power on

CHECKSUM FLASH	**Description:** it indicates the checksum calculated by the drive resident software *Attention: in case of mismatch between calculated value and mapped value the program resident on memory may be damaged. It is necessary to reload the program*

6.7 UTILITY MENU
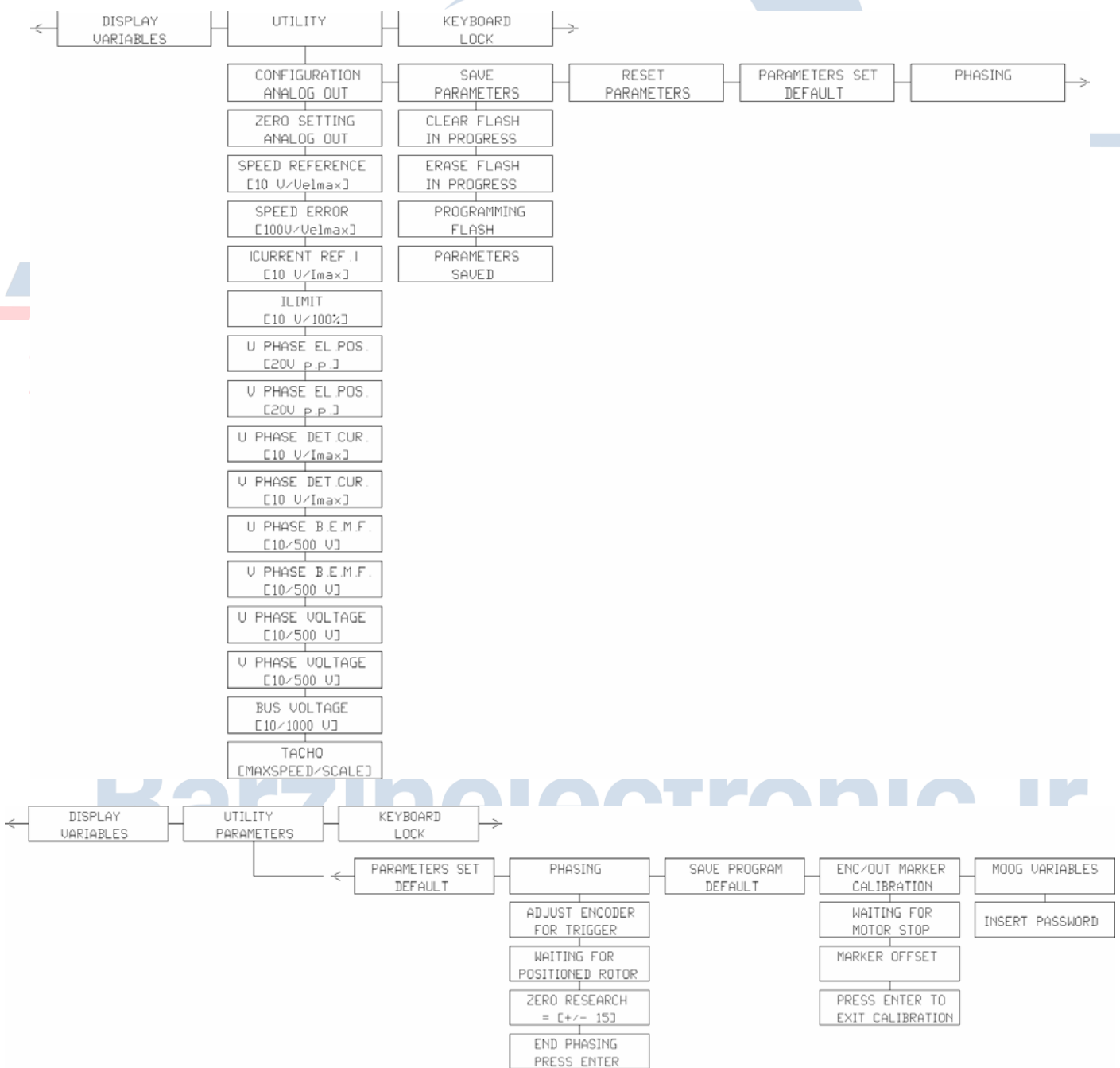
Fig. 6.7 – Utility menu

6.7.1 UTILITY MENU

6.7.1.1 UTILITY MENU - ANALOG OUT CONFIGURATION
The value set for Analog Out is the same in the J2 output.

ZERO SETTING ANALOG OUT	**Description:** it allows the setting to zero of the Analog Out preset value, the output is kept to zero
SPEED REFERENCE	**Description:** Analog Out is configured as the speed reference; it can be useful to verify how the reference signal sent by control is detected
SPEED ERROR	**Description:** Analog Out is configured as the speed error; it can be useful to verify the proper execution of the set trajectories
|CURRENT REF. |	**Description:** Analog Out is configured as the current reference module. The information can be useful to check the real load applied both by the drive and the motor
ILIMIT	**Description:** Analog Out is configured as the current analog limit set.
U PHASE EL. POS.	**Description:** Analog Out is configured as the U phase electric position; ±10 V output corresponds to U phase angular position, between 0° and 360° electrical degrees.
V PHASE EL. POS.	**Description:** Analog Out is configured as the V phase electric position; ±10 V output corresponds to V phase angular position, between 0° and 360° electrical degrees.
U PHASE DET. CUR.	**Description:** Analog Out is configured as the instant value of the current supplied by U phase. The analysis of the sinusoidal wave allows to point out any eventual control problem
V PHASE DET. CUR.	**Description:** Analog Out is configured as the instant value of the current supplied by V phase. The analysis of the sinusoidal wave allows to point out any eventual control problem
U PHASE B.E.M.F.	**Description:** Analog Out is configured as the instant value of the B.E.M.F. existing on the motor U phase; the analysis of the sinusoidal wave correct shape allows to point out any eventual control problem
V PHASE B.E.M.F.	**Description:** Analog Out is configured as the instant value of the B.E.M.F. existing on the motor V phase; the analysis of the sinusoidal wave correct shape allows to point out any eventual control problem
U PHASE VOLTAGE	**Description:** Analog Out is configured as the instant value of the U phase voltage (as a sum of B.E.M.F. and resistive drop). The analysis of the sinusoidal wave correct shape allows to point out any eventual control problem
V PHASE VOLTAGE	**Description:** Analog Out is configured as the instant value of the V phase voltage (as a sum of B.E.M.F. and resistive drop). The analysis of the sinusoidal wave correct shape allows to point out any eventual control problem

BUS VOLTAGE	**Description:** Analog Out is configured as the DC BUS instant value; it allows to verify any eventual line "gap" or the recovery resistor intervention
TACHO	**Description:** Analog Out is configured as the detected motor speed

6.7.1.2 UTILITY MENU - SAVE PARAMETERS

It allows to save drive configuration parameters inside the flash memory. The drive must be disabled.
Press ENTER to enable this function; the following messages are shown automatically on display:
- CLEAR FLASH IN PROGRESS
- ERASE FLASH IN PROGRESS
- PROGRAMMING FLASH
- PARAMETERS SAVED

The saving is followed by an automatic reset of the drive.

6.7.1.3 UTILITY MENU - RESET PARAMETERS

It allows restoring all the drive configuration parameters previously saved in the drive flash memory. The drive must be disabled. Press ENTER to enable this function.
The reset is followed by "locked keyboard" status.

6.7.1.4 UTILITY MENU - PARAMETERS SET DEFAULT

It allows to recall all the default parameters

6.7.1.5 UTILITY MENU - PHASING

The DS2000 Drive has a particular function allowing the feedback check and its eventual phasing.

Phasing is the definition of an angular reference position of stator and rotor poles by means of resolver or encoder stator positioning on the backside of the motor. The motors manufactured by Moog are already phased in the factory to be used with DS2000 Drives.

CAUTION: in this phase the motor can rotate for a revolution fraction, it is recommended to make sure it is free to rotate to avoid risk of friction, which could compromise phasing accuracy.

The procedure to use to phase a motor is the following:

1. Disconnect motor from load, so that the motor is free to rotate.
2. Place the motor near the drive, so that the display is visible.
3. Set the drive to local enable mode.
4. Open the backside of the motor where is placed the feedback.
5. Slacken the feedback screws (the feedback can rotate now).
6. Enable the AUTOPHASING function pushing ENTER.
7. If on the display appear the message "ADJUST ENCODER FOR TRIGGER" rotate the motor shaft until the message changes
8. On the display appear the message "WAITING FOR POSITIONED ROTOR", the drive supplies current on a Phase and divides it in half on the other two, keeping the rotor blocked in the reference position.
9. On the display appear the message "ZERO RESEARCH", positioning the feedback with the correct angle phasing and fix the feedback screws.
10. Press ENTER to exit the phasing procedure.

The procedure to use to check a phase of the motor is the following:

1. Disconnect motor from load, so that the motor is free to rotate.
2. Place the motor near the drive, so that the display is visible.
3. Set the drive to local enable mode.
4. Enable the AUTOPHASING function pushing ENTER.
5. If on the display appear the message "ADJUST ENCODER FOR TRIGGER" rotate the motor shaft until the message changes
6. On the display appear the message "WAITING FOR POSITIONED ROTOR", the drive supplies current on a Phase and divides it in half on the other two, keeping the rotor blocked in the reference position.
7. On the display appear the message "ZERO RESEARCH", verify the correct phase angle.
8. Press ENTER to exit the phasing procedure.

NOTE: the APHAPOS values follows:
- *APHAPOS = 0 for FAS T, FAS N, FAS K motors*
- *APHAPOS = 125 only for FASK motor with 2 resolver poles*
- *APHAPOS = -209 for G 8 poles motor with 2 resolver poles*
- *APHAPOS = 45 for G 12 poles motor with 2 resolver poles*

NOTE: Phasing value of motors with different "phasing" sequence could be in the range +/- 255 internal units (255 are related to 180° electrical angle).

NOTE: The Autophasing doesn't go automatically at the end; each step must be controlled by the user with the keyboard.

NOTE: Through the APHAPOS parameter it is possible to manually correct the motor phasing.

6.7.1.6 UTILITY MENU - SAVE PROGRAM

CAUTION: Please contact Service Center before using this feature.

6.7.1.7 UTILITY MENU - ENC/OUT CALIBRATION

This feature (available only with resolver feedback) gives the opportunity to "move" the "electrical" zero marker of the simulated encoder output (J2C connector).
Changing this variable, it is possible to fit the "electrical" zero (marker) with the machine homing position, if required by the Customer application. Parameter Range is 0-4096, in 1 unit step, and it is related to 1 electrical resolver revolution (360° electrical).
Can be executed only with axis disabled.
After calibration, save the acquired value.

NOTE: It is possible to disable this functionality and modify manually the offset values through a Moog VARIABLES menu parameter.

6.7.1.8 UTILITY MENU - MOOG VARIABLES

CAUTION: Please contact Service Center before using this feature.

6.8 KEYBOARD LOCK MENU

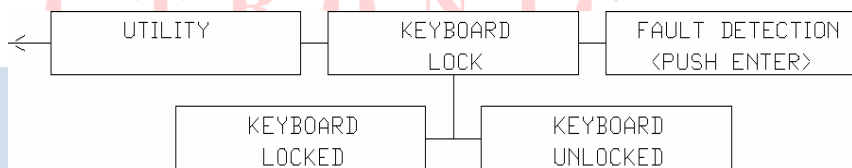
Fig. 6.8 – Keyboard lock menu

6.8.1 KEYBOARD LOCK MENU DESCRIPTION

KEYBOARD LOCK	**Description:** it allows to unlock the keyboard and change the drive parameters
Allowed values: • LOCKED • UNLOCKED	**Note:**

6.9 FAULT DETECTION MENU

```
          ┌──────────────┐      ┌──────────────────┐
    ←─────│   KEYBOARD   │──────│  FAULT DETECTION │
          │     LOCK     │      │   <PUSH ENTER>   │
          └──────────────┘      └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   U PHASE/HS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   V PHASE/HS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   W PHASE/HS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   U PHASE/LS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   V PHASE/LS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │   W PHASE/LS     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │    RECOVERY      │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │  BUS OVERVOLTAGE │
                                │    VBUS= [V]     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │ BUS UNDERVOLTAGE │
                                │    VBUS= [V]     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   UNSTABLE BUS   │
                                │    AT DRIVEON    │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │      NO BUS      │
                                │    VBUS= [V]     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │ BUS/MOT.VOLTAGE  │
                                │   UNCOMPATIBLE   │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │  RES.REC./MAIN   │
                                │   UNCOMPATIBLE   │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   SYSTEM ERROR   │
                                │  ON VBUS DETECT. │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   FLASH - ERROR  │
                                │  DEFAULT SETTING │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │  HEATSINK FAULT  │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   MOTOR FAULT    │
                                │ OVERTEMPERATURE  │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │  OVERCOME MAX.   │
                                │      SPEED       │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   UVW ENCODER    │
                                │ DETECTION ERROR  │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │  ENCODER PULSES  │
                                │ DETECTION ERROR  │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │      FAULT       │
                                │     RESOLVER     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │ +15 SUPPLY FAULT │
                                │    +V15= [V]     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │ -15 SUPPLY FAULT │
                                │    -V15= [V]     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │    FAULT SIZE    │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   FLASH ERROR    │
                                │    CHECKSUM=     │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │   IGBT FAULT     │
                                │  I2T PROTECTION  │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │      FAULT       │
                                │  RR PROTECTION   │
                                └──────────────────┘
                                          │
                                ┌──────────────────┐
                                │     END OF       │
                                │     SCANNING     │
                                └──────────────────┘
```
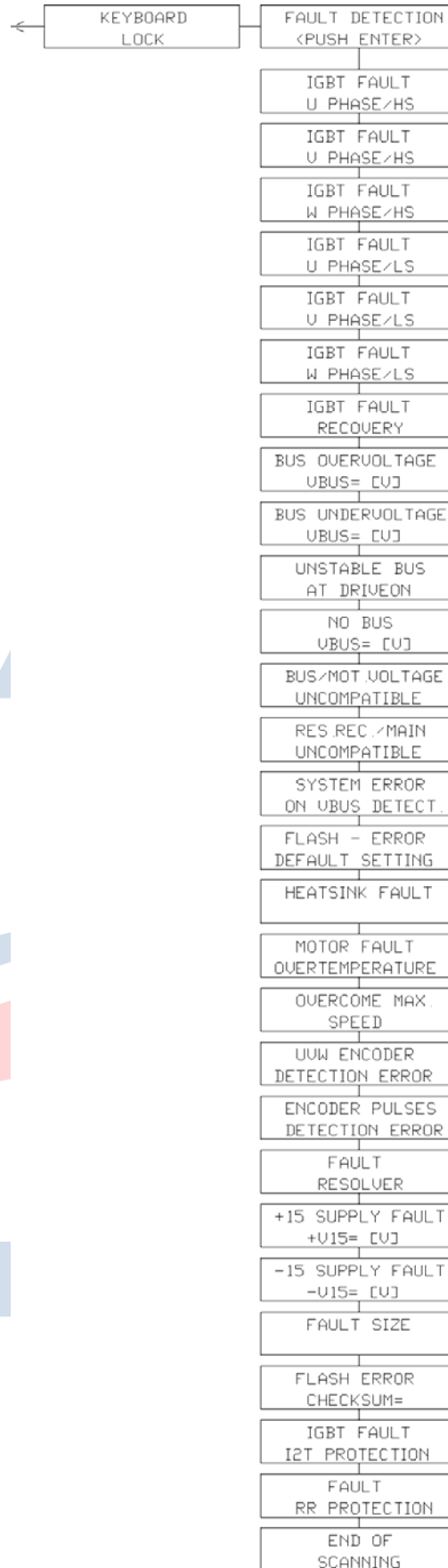
Fig. 6.9 – Fault detection menu

6.9.1 FAULT DETECTION MENU DESCRIPTION

TROUBLESHOOTING Section can provide additional information about Faults.

IGBT FAULT U PHASE/HS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT V PHASE/HS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT W PHASE/HS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT U PHASE/LS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT V PHASE/LS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT W PHASE/LS	**Description:** it detects the excess current or short circuit condition of the output IGBT three-phase bridge
IGBT FAULT RECOVERY	**Description:** it detects the excess current or short circuit condition of the recovery circuit IGBT
BUS OVERVOLTAGE	**Description:** it detects the DC BUS overvoltage condition; the drive cuts off the current. This can be due to a recovery resistor interruption or the resistor value is too high for the application and it cannot dissipate the energy recovered by the motor and the drive
BUS UNDERVOLTAGE	**Description:** it detects the DC BUS undervoltage condition; the drive cuts off the current. This can be due to a power line interruption or to an excessive current absorption by the drive with respect to the resistor
UNSTABLE BUS	**Description:** it detects the DC BUS variation at DRIVE ON when the supplied power is low (reduced or null speed). This could be due to a fuse interruption on the three-phase line
NO BUS	**Description:** It detects the lack of DC BUS or a value lower than 80 V (minimum default factory set value)
BUS/MOT.VOLTAGE UNCOMPATIBLE	**Description:** it detects the wrong setting of motor voltage rating with respect to the voltage detected on DC BUS
RES.REC./MAIN UNCOMPATIBLE	**Description:** it indicates the wrong value of the used recovery resistor in connection to the line voltage. A wrong Ohm-value (lower than the recommended one) causes a recovery IGBT damage due to overcurrent. **Attention:** A value higher than the recommended one can prevent braking in max supplied current condition at max speed
SYSTEM ERROR ON VBUS DETECT.	**Description:** it indicates an anomaly inside the voltage reading system on DC BUS. Try to switch the drive off and cut off the line. In case the FAULT persists, the drive is broken

FLASH-ERROR DEFAULT SETTING	**Description:** it indicates an error in the internal reading of the parameters memorized inside the drive; it is possible a reading error in the internal memory. Try to switch the drive off and cut off the line. In case the FAULT persists, try to re-set parameters and save all data again; if the error per-sists the section is damaged
HEATSINK FAULT	**Description:** it indicates the drive heatsink overtemperature; check the drive size; during the cycle an effective current higher than the one the drive can supply is absorbed. Check the drive fan works correctly
MOTOR FAULT OVERTEMPERATURE	**Description:** it indicates the motor overtemperature; check the application size, during the cycle an effective current higher than the one the motor can manage is absorbed
OVERCOME MAX. SPEED	**Description:** it indicates that the max speed set inside the drive has been exceeded more than 12%. Check that the speed control loop is properly calibrated and that the motor braking torque is sufficient with respect to the connected load
UVW ENCODER DETECTION ERROR	**Description:** it indicates the presence of errors on the connection signals inside the encoder section. In case of first start up check the wiring is properly made. In case of drive previously working, check that there are not wiring cuts and the encoder is properly working
ENCODER PULSES DETECTION ERROR	**Description:** it indicates the presence of errors on the connection signals inside the encoder section. In case of first start up check the wiring is properly made. In case of drive previously working, check that there are not wiring cuts and the encoder is properly working
FAULT RESOLVER	**Description:** it indicates the presence of errors on the connection signals inside the resolver section. In case of first start up check the wiring is properly made. In case of drive previously working, check that there are not wiring cuts and the resolver is properly working
+15 SUPPLY FAULT	**Description:** it indicates that the +15 V internal power value is out of tolerance
-15 SUPPLY FAULT	**Description:** it indicates that the -15 V internal power value is out of tolerance
FAULT SIZE	**Description:** it indicates a control cards exchange between two different size drives. To work out the problem return to the previous condition or save the new configuration
FLASH ERROR CHECKSUM	**Description:** it indicates an internal memory error; try to switch the drive off in order to verify the memory is correctly read and to save all data again after a further check. In case the problem persists, the internal memory is damaged
IGBT FAULT I2T PROTECTION	**Description:** it indicates that the IGBT protection begin active for excessive phase current at looked rotor or very low speed condition
FAULT RR PROTECTION	**Description:** it indicates an excessive estimated temperature of the recovery resistor
END OF SCANNING	Press ENTER for exit

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7. TROUBLESHOOTING

7.1 INTRODUCTION

This section lists typical troubleshooting conditions after a correct installation. A list of check/correct action recommendations are listed for each condition. These action recommendations are generally listed in order of decreasing likelihood for the stated conditions.

The drive should be returned to Moog Service Centers if after the check/correct action the troubleshooting condition persists. See also Chapter 6, par. 6.9 (Fault Detection Menu).

WARNING: Do not attempt to repair or make internal adjustments to the drive. Lethal voltages are present and changes to factory calibration can result in serious equipment and/or personnel risk.

7.2 FAULTS ON DRIVE POWER SUPPLY CIRCUIT

Condition	**Ventilation does not work and the display is off with only the 24 Volt power supply.**
Check/Correct	Check the 24 Volt power supply and its polarization

Condition	**Ventilation does not work and the display is off with only the mains power supply**
Check/Correct	- Supply the drive with 24 Volt power supply - Check the mains power supply

Condition	**Fault on the +/- 15 V**
Check/Correct	- Disconnect both the encoder cable and the J2B connector - Check wiring to J2B connector

7.3 FAULTS ON DRIVE OUTPUT SECTION

Condition	**IGBT Phase Fault (short circuit or overload).**
Check/Correct	- Disconnect the motor power supply cable - Disconnect the motor , drive side
Note	Shielded motor cables longer than 10-15 meters with a high specific capacity can cause disturbances that can be read as overload or short circuit by the drive.

7.4 FAULTS ON FEEDBACK SECTION

Condition	**Encoder Pulses Detection Error.**
Check/Correct	Check, if possible, that the problem is not present with another motor.

Condition	**Fault Resolver**
Check/Correct	Check, if possible, that the problem is not present with another motor.

7.5 CONTROL LOOPS TROUBLES

Condition	The motor has an excessive noise
Check/Correct	- Check the Information Sheet/Casella Report data - Check shielding and grounding as per Chapter 3 (EMC)

Condition	The motor oscillates at high frequency or noisy
Check/Correct	- Inspect for cyclical binding or looseness in mechanical power train - Check that VKI and VKP gains and motor parameters are properly set

Condition	The motor oscillates at low frequency (lower than 10 Hz).
Check/Correct	Check the speed loop and CNC position loop gains

7.6 MOTOR TROUBLES

Condition	Motor does not rotate / Runaway
Check/Correct	- Check wiring between motor and drive - Inspect for looseness in resolver mounting - Check motor phasing with the AUTOPHASING procedure (see Chapter 6) - Check the APHAPOS value (see Chapter 6)

Condition	Motor Fault Overtemperature (hot motor)
Check/Correct	- Check wiring between motor and drive - Review motor sizing - Inspect for looseness in resolver mounting - Check motor phasing with the AUTOPHASING procedure (see Chapter 6) - Check the APHAPOS value (see Chapter 6) - Check the set-up of the control loops - Inspect for cyclical binding or looseness in mechanical power train

WARNING: Power-off the drive before checking the motor temperature

Condition	Motor Fault Overtemperature (cold motor)
Check/Correct	- Check wiring between motor and drive - Check the PTC/NTC resistance - Check the "PTC/NTC Sel." parameter - Check "PTCNTC threshold" parameter - Remove signal cables, set PTC type, short-circuit pin 6 and pin 8 of J5 connector and check that the fault disappears - Check the software release (see Appendix)

*WARNING*: Power-off the drive before checking the motor temperature

7.7 RECOVERY RESISTOR TROUBLES

Condition	RR Protection Fault (hot resistor).
Check/Correct	- Check recovery resistor wiring - Check the correct sizing of the recovery resistor. If undersized, replace with a resistor with same resistance and higher power.

WARNING: Power-off the drive before checking the recovery resistor temperature

Condition	RR Protection Fault (cold resistor).
Check/Correct	- Check "Recovery Resist. Resrec", "Recovery Resist. Power" and "Recovery Resist. Coeff." parameters.

WARNING: Power-off the drive before checking the recovery resistor temperature
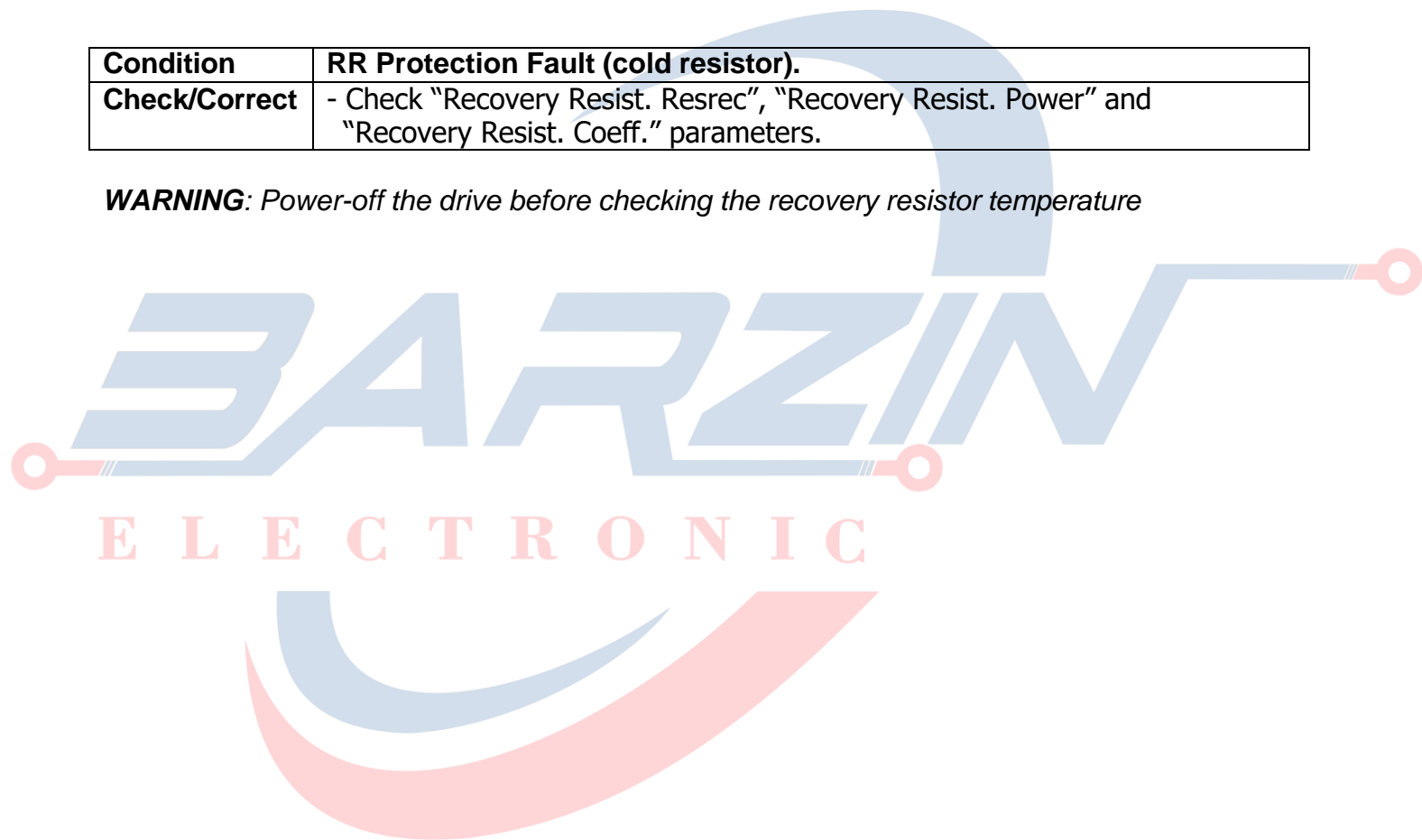
8. RESTART INTERLOCK CIRCUIT (Optional)

8.1 INTENDED APPLICATION

The safety function Restart Interlock is made by the internal board Restart Interlock Circuit (RIC) and can be requested as an option for size E, followed by all the other sizes.

The RIC optional card can be installed only on Moog drives DS2000 and DS2100 series. The installation of the card on other drives, or the use not according to this Manual is regarded as inappropriate use.

8.2 RESTART INTERLOCK FUNCTION

The restart interlock safety function by Moog has been validated compliant with the provisions of category 3 as defined in the harmonized standard EN-954-1:1996 by demonstrating that:
- a single fault does not lead to the loss of the safety function
- some, but not all, possible faults can be detected
- the accumulation of undetected faults can lead to the loss of the safety function

The remaining risk is in this case when two errors/faults occur simultaneously in the power section; the motor briefly rotates through a small angle (6-pole motor 60°, 8-pole motor 45°, 12-pole motor 30°, 16-pole motor 22.5°).

The drive controls the movements of an AC three-phase motor via the generation of a rotating magnetic field. To do this, the microprocessor generates a complex model of pulses, which are amplified and used to drive the power semiconductors.

The Restart Interlock function operates via hardware, with a relay with forcibly guided contacts which interrupts the auxiliary power supply to the IGBT drivers, and via software by blocking the generation of PWM pulses.

As a result of a risk analysis and evaluation which must be carried out according to the Machinery Directive 98/37/EC modified and referring to standards EN ISO 12100-1, EN ISO 12100-2, EN 954-1 (EN ISO 13849-1) and EN 1050 and, if it exists, the product standard (e.g. EN 775, safety requirements for robots), the machinery manufacturer must configure the safety circuit for the complete machine taking into account alI of the integrated components of the safety chain, including the electric drives.

The principle to achieve category 3 safety is mainly characterized by structure, which is strictly connected to the consequences of the loss of the safety function and to the risk of a specific application.

The greater the reduction of risk is dependent on the circuit parts, then the performance level of these parts is required to be higher.

To improve the reliability level of the safety function of the drive (one hardware channel and one software channel) or to discriminate the intervention of different protection systems on the machine by checking the NC contacts, on the RIC board there are two relays with forcibly guided contacts approved by TUV according to EN 50205, and both are able to interrupt the auxiliary power supply to the IGBT drivers.

For example, the product standard EN201/A2:2005 related to injection moulding machines with electrical axes, specifies for the axis for the horizontal movement of the platen (fig.G3) the use of both the relays in order to have two independent hardware channels in addition to the standard SW channel.

Moreover the architecture of all the circuit parts (external to the drive) which are involved in the safety function must be compliant with category 3 of EN 954-1 (EN ISO 13849-1).

The Restart Interlock function is included in the drive and allows to not power-off the drive and to skip the standard restart procedure.

The Restart Interlock safety function prevents motor unexpectedly starting from standstill. This circuit can be used in the "Safe Standstill" machine function. When the motor is rotating, the switching-on of the Restart Interlock provides an uncontrolled stop (category 0 according to EN 60204-1:1997).

When a controlled stop of category 1, according to EN 60204-1:1997, is requested, the condition of stopped motor must be assured. The external machine control must be able to stop the motor (see par.2.14).

When the intervention time of the safety devices can be set up, appropriate precautions must be adopted to limit the use only to qualified personnel. The intervention time of the restart interlock safety function must be higher than the bracking time of the deceleration ramp set by the drive with the maximum speed and the maximum load at the axis.

When active, the restart interlock function does not provide any more an output torque and the motor is free to rotate. Adequate protections must be provided when external forces act on the axis (e.g. gravity force on vertical axes), as a self-locking mechanical system or a weight equalization system.

The restart interlock function does not provide electrical isolation. It does not provide protection against "electric shock". The complete machine or system must always be electrically isolated from the line supply through the main disconnection device, secured on the open position, before any work is carried out on the machine or system, e.g. maintenance, service or cleaning work (refer to EN 60204-1:1997, par. 5.3). Personnel must be aware that Bus Bar's can have dangerous voltage even after switching off (capacitive voltage) and the discharge time is approx. 6 minutes.

When correctly used, the restart interlock function must be looped in the line contactor circuit in order to switch off the power supply of the axis in case of fault.
The associated drive must be electrically isolated from the supply if the restart interlock relay function is not plausible (input and output not compatible). Only after the fault has been removed, the restart interlock and the associated operating mode may be used again.

8.3 SAFETY REQUIREMENTS

- **Complete Standstill**. The Restart Interlock safety function prevents motor unexpectedly starting from standstill. This circuit can be used in the "Safe Standstill" machine function. When the motor is rotating, the switching-on of the Restart Interlock provides an uncontrolled stop (category 0 according to EN 60204-1:1997). When a controlled stop of category 1, according to EN 60204-1:1997, is requested, the condition of stopped motor must be assured.
  The final machine must be able to stop the motor.

  WARNING: The designer must evaluate the machine stopping time during the risk assessment even in case of failure. The machine can present a dangerous overrun in case of failure of the drive. Other protective measure are needed to achieve a safe condition.

- **Response time**. The maximum response time of the RI safety function is 100ms.

- **Environmental Conditions.** Equipment intended to operate within the following environmental conditions:
  ◊ Ambient temperature: 0 to +40°C
  ◊ EMC immunity: according to EN 61800-3/A11:2000 (Adjustable speed electrical power drive systems. Part 3: EMC product standard including specific test methods). Second environment (industrial)
  ◊ Vibration immunity: 2 to 12Hz, 1.5 mm amplitude (peak); 12 to 200Hz, 1 g acceleration
  ◊ Shock immunity: 10 g, half sine, 11 ms, according to EN 60721-3-3:1995, Class 3M4

- **Enclosure.** Electronic Equipment intended for installation in an enclosure providing at least IP54 protection.

- **Pollution Degree 2.** The equipment shall be installed in a pollution degree 2 environment, where normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the electronic equipment is out of operation.

  WARNING: When the Restart Interlock Circuit is activated, the motor can no longer generate a torque. Motors which are not automatically clamped when powered down (e.g. vertical/inclined axes), must be clamped using a mechanical brake

8.4 RESTART INTERLOCK CIRCUIT

The restart interlock is provided by redundant interlocking devices acting independently on the drivers of the power control devices.

8.4.1 HARDWARE CHANNELS

The hardware channels (channel 1 and channel 2) interrupt the auxiliary power supply to the IGBT drivers via two relays with forcibly guided contacts..

8.4.1.1 MONITORING CHANNEL 1

For monitoring the interlocking system the input signal "Channel 1" and the output signal "Channel 1 verification" must be checked to have the appropriate status under the following conditions:

Condition 1: "Channel 1" = 0   "Channel 1 verification" = 1
                 "Channel 1" = 0 -> 1   "Channel 1 verification"(after a delay of max 100ms) = 0
Condition 2: "Channel 1" = 1   "Channel 1 verification" = 0
                 "Channel 1" = 1->0   "Channel 1 verification"(after a delay of max 100ms) = 1

The check of condition 2 allows to find the short circuit on the wiring of the NC contact of the safety relay. When this check is not available it is necessary to follow the wiring procedures following listed.

When a wrong signal status is monitored, the line contactor must disconnect the drive supply, taking care of the the release time (max 100 ms) of the signal. An error message must be available to make the malfunction of the safety circuit visible.

WARNING: In case of malfunction the whole safety circuit need to be checked by qualified personnel taking into account the necessary safety procedures

8.4.1.2 MONITORING CHANNEL 2

As explained before, the second hardware channel can be requested by the product standard or can be used to improve the reliability of the safety category.

For monitoring the interlocking system the input signal "Channel 2" and the output signal "Channel 2 verification" must be checked to have the appropriate status under the following conditions:

Condition 1: "Channel 2" = 0   "Channel 2 verification" = 1
                 "Channel 2" = 0 -> 1   "Channel 2 verification"(after a delay of max 100ms) = 0
Condition 2: "Channel 2" = 1   "Channel 2 verification" = 0
                 "Channel 2" = 1->0   "Channel 2 verification"(after a delay of max 100ms) = 1

The check of condition 2 allows to find the short circuit on the wiring of the NC contact of the safety relay. When this check is not available it is necessary to follow the wiring procedures following listed.

When a wrong signal status is monitored, the line contactor must disconnect the drive supply, taking care of the the release time (max 100 ms) of the signal. An error message must be available to make the malfunction of the safety circuit visible.

WARNING: *In case of malfunction the whole safety circuit need to be checked by qualified personnel taking into account the necessary safety procedures*

8.4.2 SOFTWARE CHANNEL

The software channel interrupts the signal path to the IGBT drivers with the standard software procedure. To disable the axis, the input "Drive Enable" of the J2B connector (pin7 and 8) showed in Section 2, must become low (0V). See par.2.14 for the sequence times.

8.4.2.1 MONITORING SOFTWARE CHANNEL

A failure in the software channel operation cannot be detected by the drive. It is possible to define a cyclic test during the working conditions in order to find the failure of the software channel. For example, at the restarting after a stop it is possible to put the drive in the starting condition, to give a reference signal with only the SW channel active (Drive Enable OFF) and to verify that the motor does not rotate.
In case of fault the motor must be stopped via the hardware channel(s) and via the line contactor. The motor must not restart until the fault has been fixed.

WARNING: *In case of malfunction the whole safety circuit need to be checked by qualified personnel taking into account the necessary safety procedures*

Fig.8.1 – RESTART INTERLOCK CIRCUIT
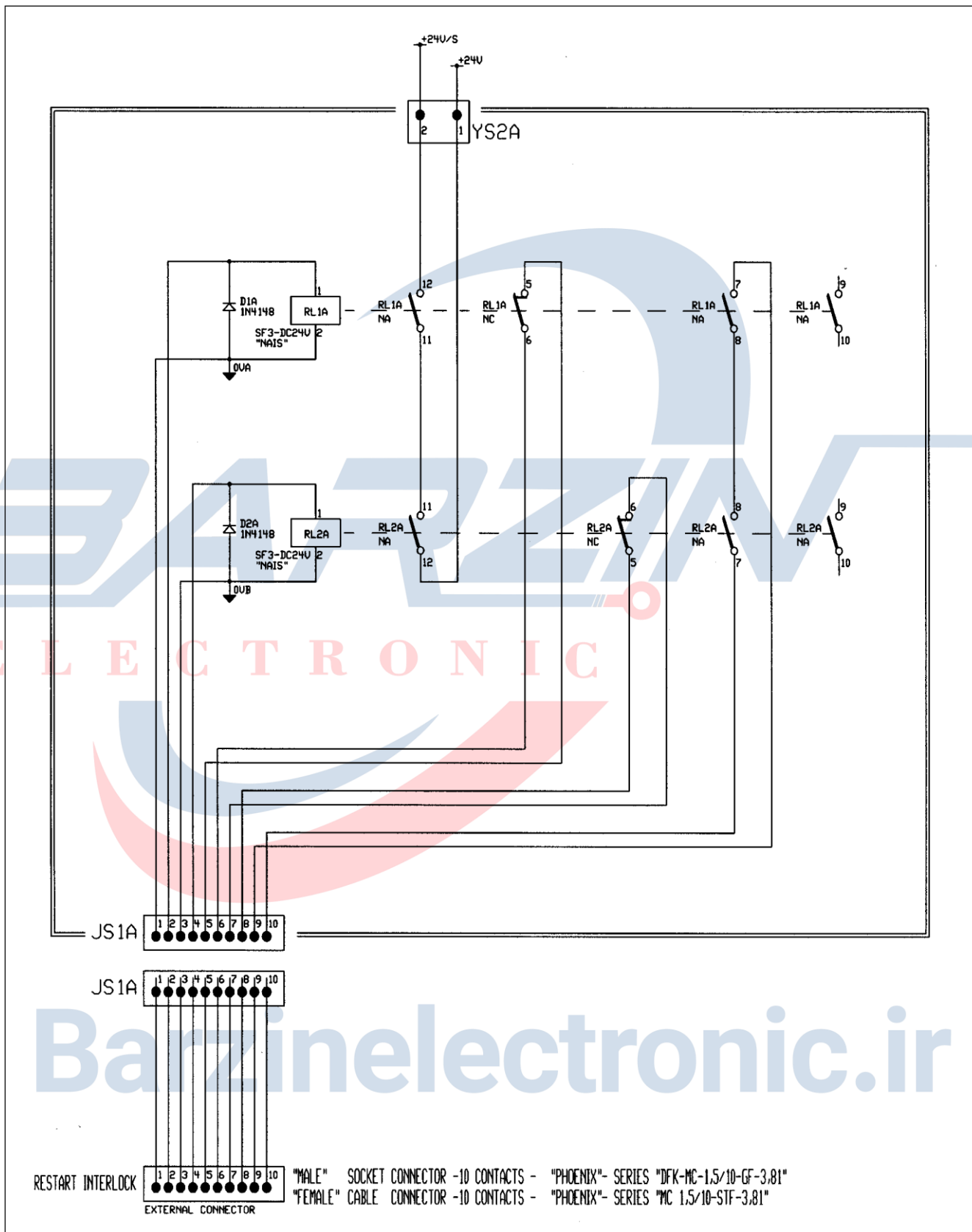
8.5 RESTART INTERLOCK CONNECTIONS

The hardware channels of the restart interlock circuit are controlled using the RESTART INTERLOCK connector.
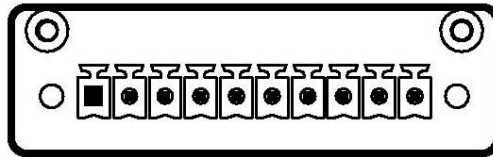
Note: pin 1 is marked with the symbol "■"

Fig.8.2 – Restart Interlock connector, panel side

Tab. 8.1 - RESTART INTERLOCK CONNECTOR

Mating connector: 10 contacts, series MC 1,5/10-STF-3,81 by Phoenix

Pin	Name	Function
1	- "Channel 1"	Input 0V to bobbin of RL1A Safety Relay of Channel 1 from door/gate
2	+ "Channel 1"	Input to bobbin of RL1A Safety Relay of Channel 1 from door/gate. With the door closed, this input must be high (+24Vdc). When the door is opened this input must change to low (0V).
3	- "Channel 2"	Input 0V to bobbin of RL2A Safety Relay of Channel 2 from door/gate
4	+ "Channel 2"	Input to bobbin of RL2A Safety Relay of Channel 2 from door/gate. With the door closed, this input must be high (+24Vdc). When the door is opened this input must change to low (0V).
5	"Channel 1 verification" NC contact	NC contact of RL1A Safety Relay of Channel 1. Feedback of RIC. When closed (high), the Restart Interlock function is active. The external verification system must monitor this output signal for plausibility with its input signal
6		
7	"Channel 2 verification" NC contact	NC contact of RL2A Safety Relay of Channel 2. Feedback of RIC. When closed (high), the Restart Interlock function is active. The external verification system must monitor this output signal for plausibility with its input signal
8		
9	NO contact	Series of NO contacts of RL1A and RL2A relays. User available.
10		

Wiring practice
The external cable to RESTART INTERLOCK connector must be protected against mechanical damages according to the safety requirements of EN ISO 13849-2:2003, tab. D.4 (prEN 954-2) in order to prevent short circuits.

The Restart Interlock relay of Channel 1 is controlled using the external +24Vdc (pin2 positive terminal, pin1 0V terminal).

When the RL1A relay is de-energized, the 5-6 pins are closed-circuit and the Restart Interlock Channel 1 is activated.

If the "Channel 2" is used, the Restart Interlock relay of Channel 2 is controlled using the external +24Vdc (pin4 positive terminal, pin3 0V terminal).When the RL2A relay is de-energized, the 7-8 pins are closed-circuit and the Restart Interlock Channel 2 is activated.

If the "Channel 2" is not used, the RL2A relay of "Channel 2" must be always powered using the external +24Vdc (pin4 positive terminal, pin3 0V terminal).

WARNING: *The circuit for auxiliary functions (NO contacts) must be externally protected against the welding of NO contacts using a delayed fuse rated 2 A or a fast fuse rated 3 A*

WARNING: *pins 1 and 3 must be connected to the protective bonding circuit against malfunctions in case of earth faults.*

Tab. 8.2 - J2B Connector – Software Channel
See Section 2

8.6 SAFETY RELAYS - TECHNICAL DATA

Input coil	Pnom = 500 mW Inom = 20.8 mA ($\pm$10%) Vnom = 24 Vdc Pick-up voltage = 14.4 Vdc Drop-out Voltage = 2.4 Vdc Resistance = 1.152 Ω Vmax = 28.8 Vdc
Contact	Rmax = 30 mΩ @ 6 Vdc, 1 A Imax = 3 Adc Vmax = 30 Vdc

8.7 APPLICATION EXAMPLE

Fig.8.3 – Example of Restart Interlock with controlled stop Category 1 according to EN 60204-1:1997
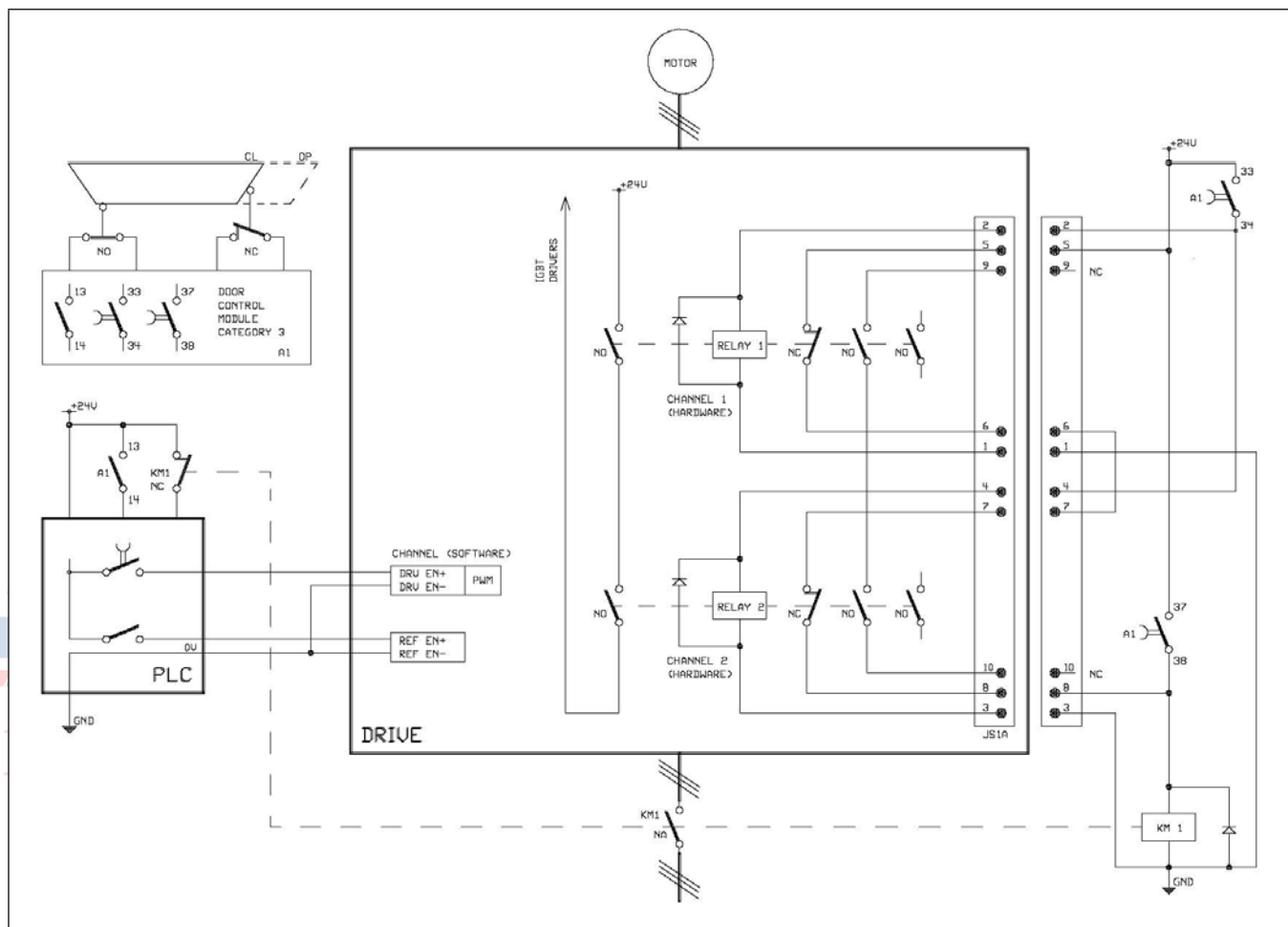
Description of the RESTART INTERLOCK FUNCTION

To get a controlled stop it is necessary to stop the motor before the activation of the HW and SW safety channels.

When the door is opened the output13-14 of the A1 module sends to PLC the stopping signal. Then the PLC turns low the REFERENCE ENABLE signal (inpur REF EN) in order to stop the motor with the maximum torque available.

After a t1 delay (see par.2.14) to let the axis stopped, it is possible the activation of the SW and HW channels.

The axis stopped status can be communicated to the PLC via the analog output TCH OUT, not shown in the figure (see par.2.11.2.3). It is possible to use this signal together with the above delay to disable the axis.

Software Channel
- When the door is opened, the door control module (output 13-14 of A1) activates the input of the PLC, which, after the t1 delay, disables the axis according to the sequence of par.8.4.2, by removing the DRIVE ENABLE signal (input DRV EN)
- The correct operation of the SW channel cannot be verified (but see also par.8.4.2.1).

Hardware Channel

- When the door is opened, the door control module (delayed output 33-34 of A1) opens, after a delay t1, the inputs of the hardware channels.
- If the NC contacts of the safety relays 1 and 2 do not close, the KM1 contactor is de-energized (delayed output 37-38 of A1) and the power supply to the drive is switched off
- If the drop-out time of the relays 1 and 2 (approx.100 ms) is less than the drop-out time of the KM1 contactor, the KM1 contactor will be de-energized at the opening of the doors. In this case it is possible to add a capacitor in parallel to the coil of KM1 or delay the intervention of output 37-38 of A1 in comparison with output 33-34 of A1, in order to avoid the de-energization when the door is opened.
- The application example checks the status of relays 1 and 2 only at the de-energization (NC contacts closed) and not at the energization (NC contacts opened). This way it is not possible to find a short circuit. Then, the cables must be mechanically protected.

Requirements

- The delayed output of the control module which drives the hardware channels (safety relays) and the PLC output which drives the SW channel must be set taking care that the intervention of the safety function should occur only with motor at standstill.
- When it is possible to stay with the complete human body inside the hazardous zone over the protective guards, the restart must be available only after a separate reset following the closure of the protective guards confirming that no personnel is inside the hazardous zone
- The door control module must be compliant with at least category 3 of EN 954-1.
- See par.8.6 for the technical data

8.8 SEQUENCE AND PROCEDURE USING THE RESTART INTERLOCK

The motor must be stopped before the hardware and software channels are inhibited and the Restart Interlock is activated.

WARNING: *If a fault occurs when actuating the Restart Interlock, then this fault must be removed before the mechanically isolating protective guards to the working zone of the machine or plant are opened. After the fault has been removed, this procedure must be repeated for the Restart Interlock. Under fault conditions, all of the drives, machine and plant must be shut down.*

If one of the following faults should occur with the contacts of the "hardware channel verification" opened (0V) and the protective guards withdrawn, then the EMERGENCY STOP must start immediately:

- The acknowledgement contact "Channel 1 verification" remains open after the intervention of the Restart Interlock.
- If also "Channel 2" is used: the acknowledgement contact "Channel 2 verification" remains open after the intervention of the Restart Interlock.
- There is a fault in the external control circuit itself.
- There is a fault in the signal lines of the verification contacts.

All the drives associated with the machine/plant must be disconnected and isolated from the line supply through the line contactor.

WARNING: *the line contactor must have a NC contact linked to safety NO contacts.*

If the Restart Interlock control has been correctly integrated into the external safety-related control and has been checked to ensure correct functioning, then the drives in the separate working zone of the machine are protected against undesirable starting, and personnel can enter or operate in the hazardous zone which has been defined.

CAUTION: *where the equipment requires manual intervention the relevant regulations must be taken into account*

8.9 CHECKING THE RESTART INTERLOCK

The following checks must always be made at the first start-up and when possible must be repeated at certain intervals during the operating lifetime. A check should also be made after longer production standstills. Each individuai drive must be checked.

The check must be made by qualified personnel taking into account the necessary safety procedures:

- Check that the motor is at standstill
- Inhibit the IGBT drivers by withdrawing the voltage at position 2 (Channel 1) of RESTART INTERLOCK connector. Furthermore, the acknowledge contacts 5-6 (Channel 1 verification) of RESTART INTERLOCK connector must be closed. The drive then does not provide output current.
- If also "Channel 2" is used: inhibit the IGBT drivers by withdrawing the voltage at position 4 (Channel 2) of RESTART INTERLOCK connector. Furthermore, the acknowledge contacts 7-8 (Channel 2 verification) of RESTART INTERLOCK connector must be closed. The drive then does not provide output current.
- Put the drive in the starting condition, with only the SW channel active (Drive Enable OFF). Send a reference signal to the motor velocity and verify that the motor does not rotate.
- Disable the protective devices, e.g. by opening the protective doors while the motor is running. If the stop is category 1 according to EN 60204-1:1997, check that the motor is braked in a controlled stop and that the Restart Interlock function will be activated after the stop. This must not result in a hazardous condition.
- AlI possible fault situations, which could occur, must be individually simulated in the signal paths between the verification contacts and the external control as well as the signal plausibility functions of this control, e.g. by disconnecting the Restart Interlock monitoring circuit at positions 5-6 of RESTART INTERLOCK connector (condition 1) or by simulating also the short circuit of the cable (condition 2) when this cannot be excluded.

For alI of the simulated fault situations, the line contactor must disconnect alI of the machine or plant drives from the line supply.

8.10 EXTERNAL PLAUSIBILITY TESTS

The following tests of plausibility must be made outside of the drive (e.g. by a PLC).

- **"Channel 1 verification"**
  The external system must monitor this output signal for plausibility with its input signal Channel 1 (see par.8.4.1.1).

- **"Channel 2 verification"** (if used)
  The external system must monitor this output signal for plausibility with its input signal Channel 2 (see par.8.4.1.2).

- **Monitoring by a standard Programmable Electronic System**

- **Minimum functional requirements**
  - The automatic monitoring shall, at discovered fault, disconnect the line contactor and prevent a new start until fault has been removed
  - The change of the monitoring signal shall be checked automatically:
    - at the start up and
    - during each stopping and starting sequence.

- **Wiring requirements to avoid common mode failures**
  The external cable to RESTART INTERLOCK connector must be protected against mechanical damages according to the safety requirements of EN ISO 13849-2:2003, tab. D.4 (prEN 954-2) in order to prevent short circuits.

- **Software verification**
  Following safety related principles, it is necessary to verify the software and give instructions on following revisions

- **Modification of software**
  The manufacturer shall write a warning in the software close to the part of program concerning the safety function that this part must not be deactivated or modified for safety reasons (see also clause 11.7.4 of EN ISO 12100-2)

- **Other requirements**
  The output of the PLC to the line contactor shall be periodically tested by monitoring the plausibility of the NC contact of the line contactor

- **Protection of program**
  - The program shall be monitored by e.g. a watchdog
  - The program shall be in permanent memory protected against electrical interference and shall be equipped with a start-up test procedure

8.11 INSTALLATION AND ROUTINE TEST

The restart interlock circuit (RIC) is installed and tested in Moog.

8.12 RIC IDENTIFICATION ON THE NAMEPLATE

The restart interlock circuit is identified by the words "Restart Interlock" on the nameplate

Fig.8.4 – Example of RIC identification

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APPENDIX A: Motor technical data

For motors technical data refer to motor Moog catalogues or contact the Moog Service Centers.

APPENDIX B: FC series technical data

The DS2000 drive can directly command FC series low rpm special motors.

Note: To increase the effective system resolution at very low speed, it is possible to scale some system parameters as in the following table:

	Condition	Resolver Poles	Motor Poles	Speed	Actual speed
Example 1	Real Value	6	12	100	100
	Scaled Value	2	4	300	100
Example 2	Real Value	12	12	100	100
	Scaled Value	2	2	600	100

The actual speed in the Real and Scaled Value remains the same.
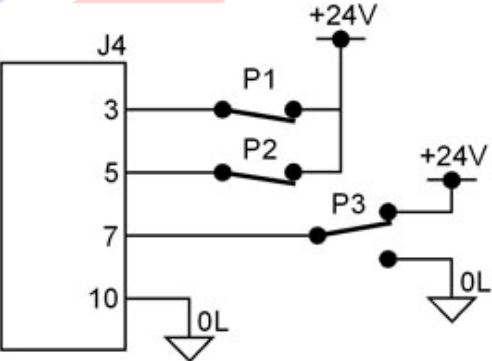
APPENDIX C: ACTIVE SOFTWARE RELEASE

Software release	Description
3.200	Standard software
3.201	Functionality added: • DRIVE OK signal is present also without DC BUS and NO BUS fault is activated only if trying to enable the drive Functionality removed: • None
3.202	Special software for particular calibration of the resolver Functionality added: • Special Phasing applied to every motor pole pair Functionality removed: • Phasing • Dead band on the analog reference signal • I2T IGBT protection • Antifreewheeling • ENC/OUT calibration of marker zero • RR protection
3.203	Special software able to manage the limit switches and torque/speed command change on the fly. Option card needed. Functionality added: • None Functionality removed: • Encoder feedback is not available (signal input used for the limit switches) • ENC/OUT calibration of marker zero
	  Note: P1 and P2 are normally closed switches Opening P1 disable CW rotation Opening P2 disable CCW rotation **Note:** If P3 connected to 0L the drive is in speed control If P3 connected to +24V the drive is in torque control

3.204	Functionality added: • DRIVE OK signal is present also without DC BUS and NO BUS fault is activated only if trying to enable the drive • NOTCH FILTER can be enabled with I2T PROTECTION active Functionality removed: • ACC/DEC features
3.205	Functionality added: - G motors algorithm always running, also while braking
3.206	Special software for the V/f control
3.207	Special software version for high performance applications. Option card needed. Functionality added: • Position resolution variable from 10 to 16 bits depending on the motor speed • External reference 14 bits A/D converted • Encoder simulated output from 64 to 16384 pulses Functionality removed: • Encoder feedback is not available • ENC/OUT calibration of marker zero
3.208	Special software designed for encoders without absolute U-V-W signals
3.209	Special software designed for 300A power stage size E drive
3.210	Special software designed for 300A power stage size E drive and to manage 4 different motor parameter sets selectable through 2 external inputs. Option card needed. Functionality added: • None Functionality removed: • Encoder feedback is not available • ENC/OUT calibration of marker zero • Notch filter
4.100	Special software used in CAN Open options (speed mode). Option card needed. Make reference to the CAN Open DS2000 manual (GB-4540).
4.100 NTC	Special software used in CAN Open options (speed mode). Option card needed. NTC motor sensor version. Make reference to the CAN Open DS2000 manual (GB-4540).

APPENDIX D: OBSOLETE SOFTWARE RELEASE

Software release	Thermal sensor	Drive sizes	Notes
3.100	PTC	Tutti	Replace by release 3.200
3.100NTC	NTC	Tutti	Included in release 3.200
3.100DGT	PTC	Tutti	Included in release 3.200
3.100AFW	PTC	Tutti	Included in release 3.200
3.100AFW	NTC	Tutti	Included in release 3.200
3.100LSW	NTC	Tutti	Included in release 3.200
3.100LSWNTC	PTC	Tutti	Included in release 3.200
3.100FSM	NTC	Tutti	Included in release 3.200
3.100Dband	PTC	Tutti	Included in release 3.200
3.101 PTC	PTC	Tutti	Replace by release 3.201
3.101AFW	PTC	Tutti	Included in release 3.201
3.101AFWNTC	NTC	Tutti	Included in release 3.201
3.000	PTC	A, B, C	Replace by release 3.100
3.000AFW	PTC	A, B, C	Replace by release 3.100AFW
3.000LSW	PTC	A, B, C	Replace by release 3.100LSW
3.001	PTC	A, B, C	Replace by release 3.101

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