I N F R A N O R

OPERATING MANUAL

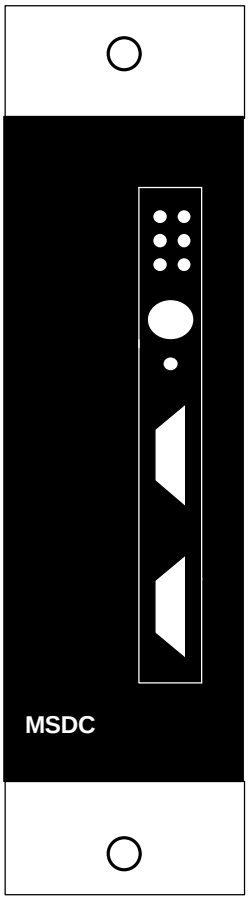
SERIES MSDC

BRUSHLESS SERVO CONTROLLERS

WITH CAN BUS PROTOCOL

(Trapezoidal Type)

Version 1.0



This is a general manual describing a series of single axis DC trapezoidal Servo amplifiers having output capability suitable for driving DC brushless Servo motors. This manual may be used in conjunction with appropriate and referenced drawings pertaining to the various specific models. Maintenance procedures should be attempted only by highly skilled technicians using proper test equipment. Read your warranty provision carefully before attempting to adjust or service the unit.

RECEIVING AND HANDLING

Upon delivery of the equipment, inspect the shipping containers and contents for indications of damages incurred in transit. If any of the items specified in the bill of lading are damaged, or the quantity is incorrect, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt.

Claims for loss or damage in shipment must not be deducted from your invoice, nor should payment be withheld pending adjustment of any such claims.

Store the equipment in a clean, dry area. It is advisable to leave the equipment in its shipping container until ready for use. Each amplifier is checked carefully before shipment. However, upon receipt, the user should make sure that the amplifier received corresponds to or is properly rated in terms of rated voltage and current for the type of motor which is to be driven. The descriptive label affixed to the amplifier specifies electrical ratings.

OPERATING MANUAL
INFRANOR
SERIES MSDC
PWM BRUSHLESS SERVO CONTROLLERS
(March 1999)

1.0.0 GENERAL

1.1.0 Introduction

The MSDC servo modules are extremely compact PWM servo amplifiers that provide 4 quadrant speed control of any trapezoidal servo motor with Hall-effect feedback. The MSDC Series amplifiers are designed for regulation of brushless DC motors. The MSDC power supply transforms ac voltage into dc voltage. From dc voltage the amplifier produces the current for the motor. Hall sensors produce necessary information concerning rotor position. Output current is PWM controlled and due to high chopper frequency a large bandwidth and dynamics are obtained.

Relations for the operation of the motor:

- Torque is proportional to output current
- Speed is proportional to frequency of output current
- Direction of rotation corresponds to sense of rotation of the output current

1.2.0 General description of the MSDC Series

The MSDC Series amplifier modules for DC brushless motors consist of:

- one power stage card
- one logic card to be adapted to any DC brushless motor having Hall sensor devices
- one single or three phase power supply
- one shunt regulator circuit with an internal resistor

Each MSDC module has its own DC/DC converter to provide appropriate logic voltage to the module without the need for an additional input voltage. The rated input voltage is 90 or 175VAC rms between phases, which provides a DC Bus voltage of 125 or 240 VDC.

The MSDC module requires an isolation transformer. A rectifier and a shunt regulator are also included in the MSDC module. The braking resistor is mounted internally to the unit.

2.0.0 SPECIFICATIONS

2.1.0 MSDC specifications

Model	I_{max} (A)	I_{eff} (A)	*Input voltage*	*Output voltage*	*Heatsink*
MSDC 1204	8	4	45-90VAC	120VDC	No
MSDC 1208	16	8	45-90VAC	120VDC	No
MSDC 1210	20	10	45-90VAC	120VDC	No
MSDC 2404	8	4	65-175VAC	240VDC	No
MSDC 2408	16	8	45-175VAC	240VDC	No
MSDC 2410	20	10	45-175VAC	240VDC	Yes

Powerstage

Model	**MSDC 12 xx**	**MSDC 24 xx**
Input voltage *****	45-**90** VAC	45-**175** VAC
Output voltage	120 VDC	240 VDC
Overvoltage	159 VDC	320 VDC
Sunt regulator on	152 VDC	307 VDC
Shunt regulator off	147 VDC	297 VDC

PWM chopper frequency	16 KHz
Protection	Over current Over voltage Short-circuit Over temperature

***** Isolation transformer required

Speed regulator

Input command	CAN - Bus
Velocity feedback	Encoder TTL quadrature
Parameter setup	CAN - Bus
Controller type	Proportional / Integral
Speed control range	1: 1000 300- 3000 (6000) rpm ± 0,5 % 1-300 rpm ± 1.5 %
Sampling time	500uS

Position regulator

Input command	CAN – Bus
Postion feedback	Encoder TTL quadrature
Encoder type	5VDC TTL with line driver
Resolution	250 – 2048 ppr
Sampling time	1mS

Current regulator

Compensation network	PI
Current limit 1	I_{max} adjustment with potentiometer
Current limit 2	I_{eff} adjustment wiith potentiometer
Band width	1 KHz

CAN Protocol - Interface

CAN	ISO/DIS 11898, max 1Mb/sec
Protocol	INFRANOR
Service channel	Service data objects (SDO), transfer of data witout real time demand
Process channel	Process data odjects (PDO, dynamic transfer of real time data
Cycle time	1 – 20mS
Setup interface	RS-232 – BPCW (Infranor)
Parameter saving	EEPROM non volatile

Safety features

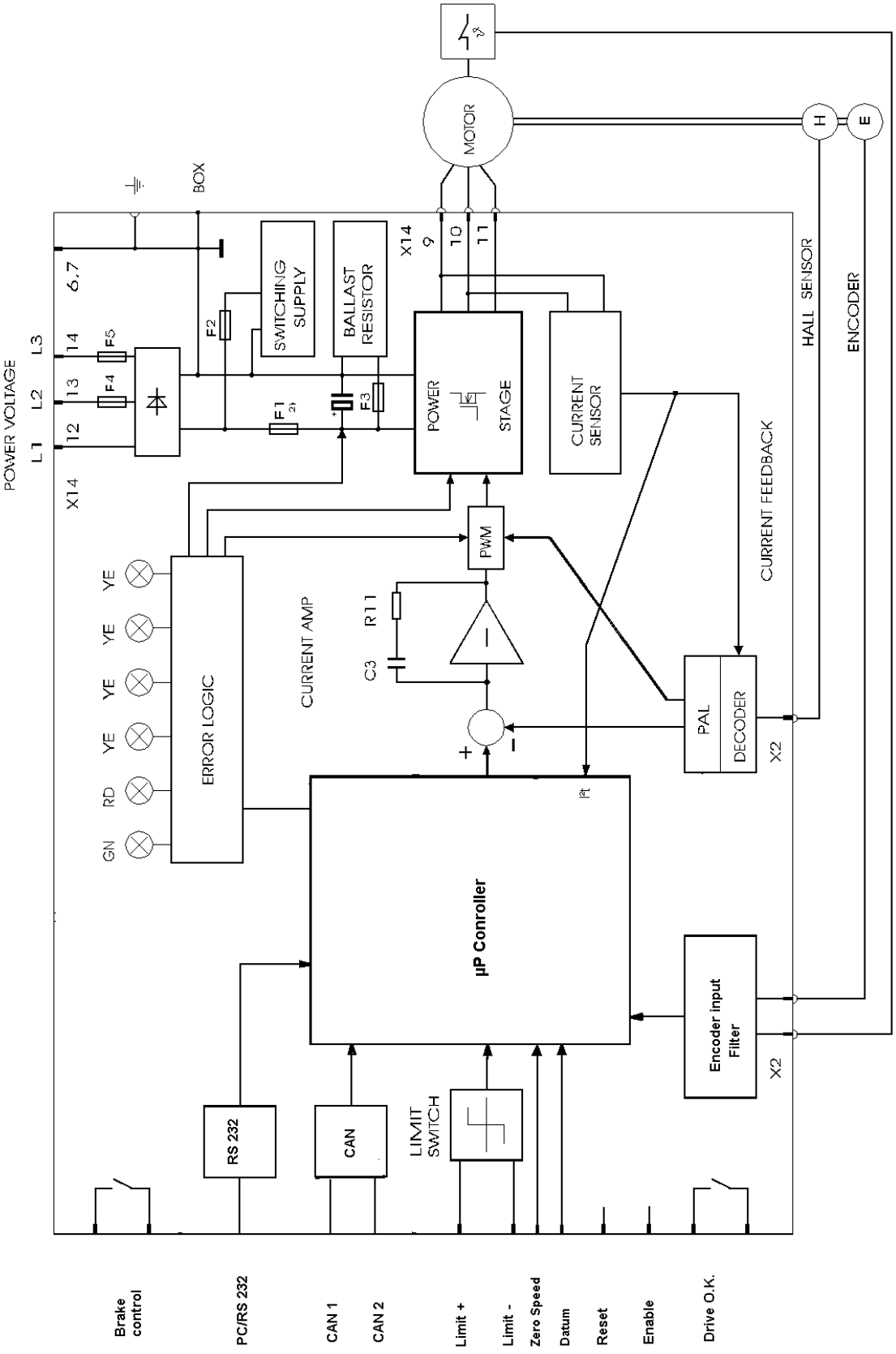
RMS current limit	Disable drive or current limitation
Motor over temperature	Disable drive
Encoder error	Disable drive
EEPROM error	Disable drive
CAN – Bus error	Disable drive
Processor error	Disable drive

General specifications

Operating temperature	0....45 °C
Storage temperature	-10 to + 60 °C
Cooling	Air convection or fan (see table)
Humidity	65 % relative humidity max.
Isolation	VDE 0110 class C
Dimensions (mm)	220 x 58 (80) x 204
Weight (lbs)	3.2 – 4.2
Amplifier ready	Dry relay contatct 100V, 20mA
Brake output	Dry relay contatct 100V, 20mA

3.0.0 PRINCIPAL OF OPERATION

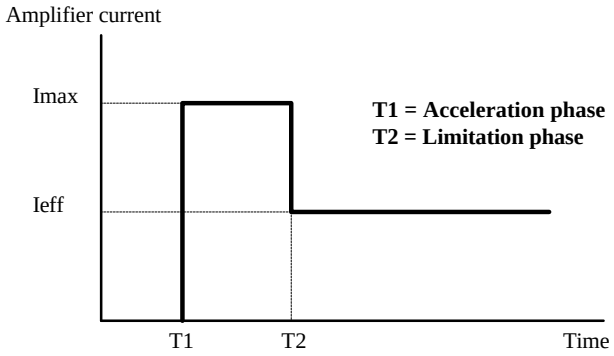
3.1.0 Block diagram



3.2.0 Armature Current Measurement

Armature current is measured by means of a shunt placed in series with the armature circuit. The voltage produced can be measured at the “I-Monitor“ test point. 10Volts output corresponds to the maximum current of the amplifier.

Eff - Function I_{Arms}



The Ieff value of the armature current is constantly simulated with the aid of an electronic qudrant network. Irrespective of the cycle or the shape of current wave form, a potentiometer ensures that the Ieff value is not exceeded by lowering the maximum current threshold. This functional response is indicated by a yellow LED.

3.3.0 Limit Switch Inputs

Connecting 24 VDC to the terminals for negative and positive limit switch will enable the corresponding motor direction. Two yellow LED will indicate the limit switch status.

3.4.0 Isolation power transformer

An isolation transformer is necessary to power the MSDC Series. If a three phase isolation transformer is to be used, do not connect the neutral to earth ground. This would result in a power stage failure.

4.0.0 INPUTS / OUTPUTS

4.1.0 X1 Input - Output command connector (Sub-D 25 points male)

Pin	Function	I / O	REMARKS
1	Limit switch +	I	Positive logic (+15…24VDC)
2	NC		
3	NC		
4	NC		
5	NC		
6	NC		
7	NC		
8	NC		
9	NC		
10	Reference switch	I	Positive logic (+15…24VDC)
11	0 Volts		
12	Emergency stop	I	Positive logic (+15…24VDC)
13	Reset	I	Amplifier reset (contact between 13 and 11)
14	Limit switch -	I	Positive logic (+15…24VDC)
15	0 Volts	I	
16	Brake control	O	Relay contact: closed if brake active
17	Brake control	O	Umax = 100 V or Imax = 10 mA
18	Amplifier ready	O	Relay contact: closed if amplifier OK, open if fault.
19	Amplifier ready	O	Umax = 100 V or Imax = 10 mA
20	ENABLE	I	Positive logic (+15…24VDC)
21	+ 15 V	O	10 mA maximum output current
22	- 15 V	O	10 mA maximum output current
23	0 Volts		
24	0 Volts		
25	0 Volts		

4.1.0 X2 Motor sensor signal connector (Sub-D 25 points female)

Pin	Function	I / O	REMARKS
1	Marker Z	I	Differential input of the encoder marker pulse
2	Channel A	I	Differential input of the encoder channel A
3	Channel B	I	Differential input of the encoder channel B
4	0 Volts		
5	+5 Volts [1]	O	Max 50mA output
6	Limit switch +	I	Positive logic (+15…24VDC)
7	Limit switch -	I	Positive logic (+15…24VDC)
8	Hall sensor 1	I	+15 Volts (+5 Volts) input sensor
9	+ 15 V	O	5 mA maximum output current
10	+ 15 V	O	5 mA maximum output current
11-13	NC		
14	Marker Z/	I	Differential input of the encoder marker pulse /
15	Channel A /	I	Differential input of the encoder channel A /
16	Channel B /	I	Differential input of the encoder channel B /
17	0 Volts		
18	+5 Volts [1]	O	Max 50mA output
19	Hall sensor 3	I	+15 Volts (+5 Volts) input sensor
20	Hall sensor 2	I	+15 Volts (+5 Volts) input sensor
21	- 15 V	O	10 mA maximum output current
22	Motor temperature sensor	I	NTC or PTC input sensor (see section 6.3.0)
23	I-monitor	O	±10V = Imax
24	0 Volts		
25	NC		

4.3.0 X14 Motor and Supply connector (14 pins Weidmuller type)

Pin	Function	I / O	REMARKS
1	NC		
2	- 15 V	O	10 mA maximum output current
3	+ 15 V	O	10 mA maximum output current
4	Limit switch +	I	Positive logic (+15…24VDC)
	(Tach monitor)	O	Optional output 0 to ± 10V
5	Limit switch +	I	Positive logic (+15…24VDC)
	(Current monitor)	O	Optional output 0 to ± 10V
6	0 Volts		0 Volts power
7	0 Volts		0 Volts temperature sensor
8	Motor temperature sensor	I	NTC or PTC input sensor (see section 6.3.0)
9	Motor phase 1	O	Motor output three phases (phase U)
10	Motor phase 2	O	Motor output three phases (phase V)
11	Motor phase 3	O	Motor output three phases (phase W)
12	Input power voltage phase 1	I	Input AC seconday transformer (90 or 175VAC)
13	Input power voltage phase 2	I	Input AC seconday transformer (90 or 175VAC)
14	Input power voltage phase 3	I	Input AC seconday transformer (90 or 175VAC)

4.4.0 RS-232 connector (IBM PS2 8 points)

Pin	Function	REMARKS
4	0 V	GND (connection of the shield if no "360°" connection on the connector)
3	TXD	Transmit data RS 232
5	RXD	Receive data RS 232

4.5.0 CAN Connector (Sub-D 9 points)

Pin	Function	REMARKS
2	CAN_L	Line CAN_L (dominant low)
3	CAN_GND	CAN earth (ground)
7	CAN_H	Line CAN_H (dominant high)

- Link without insulation.
- In conformity with standard ISO/DIS 11898.
- In conformity with the recommendation DS-102, version 2.0 of the CAN in Automation Association.
- One connector sub-D 9 points male and one connector sub-D 9 points female on each amplifier.

5.0.0 WIRING RECOMMENDATIONS (IEC 801 AND EN 55011)

5.1.0 GND wiring and grounding

The reference potential is the **earth (ground).** Motors and sensors are grounded via their housing. If a reference of potential exist, like a main chassis or a cabinet, with a low impedance between the different elements, it should be used to connect ALL reference to it and also connect this reference to the earth (ground).

Long reference potential connections are suitable ONLY if these connections have a very low impedance (< 0.1Ω). Cables with low potential must NEVER run in the proximity of power lines.
Each conductor cable (carrying a potential) must be shielded. Several wires in the same sleeve must be twisted and shielded.

According to the IEC 801 standard, the connectors must be metallic or metal plated and must have a 360° shield connection (see chapter 8.6.0).

5.2.0 Motor, sensors and encoder cables

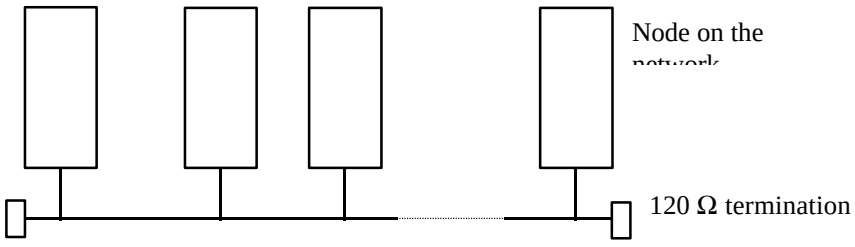
Cable ends should have a metallic collar allowing a 360° shielded connection.
Motor cables (four wires) must be shielded to avoid common mode effects (Mavilor p/n 410-0051, 410-0052, Belden p/n 9367).
The recommended encoder cable is a three pair twisted with an individual shield on each pair (Mavilor p/n 410-0053, Belden p/n 9728, Oflex p/n 34252). Hall sensors cable should be shielded as well.

CAUTION: The command cables (input command, Hall sensors, encoder) as well as the power cables MUST only be connected and/or disconnected with the amplifier TURNED OFF.

5.3.0 CAN and serial link cables

The CAN bus signal cable must be a pair twisted and shielded one. The cable specification must be about 120 Ω and both bus ends and must be connected to a 120 Ω load resistor.

The shield connection must be made over "360°" via metallic connectors at both cable ends.

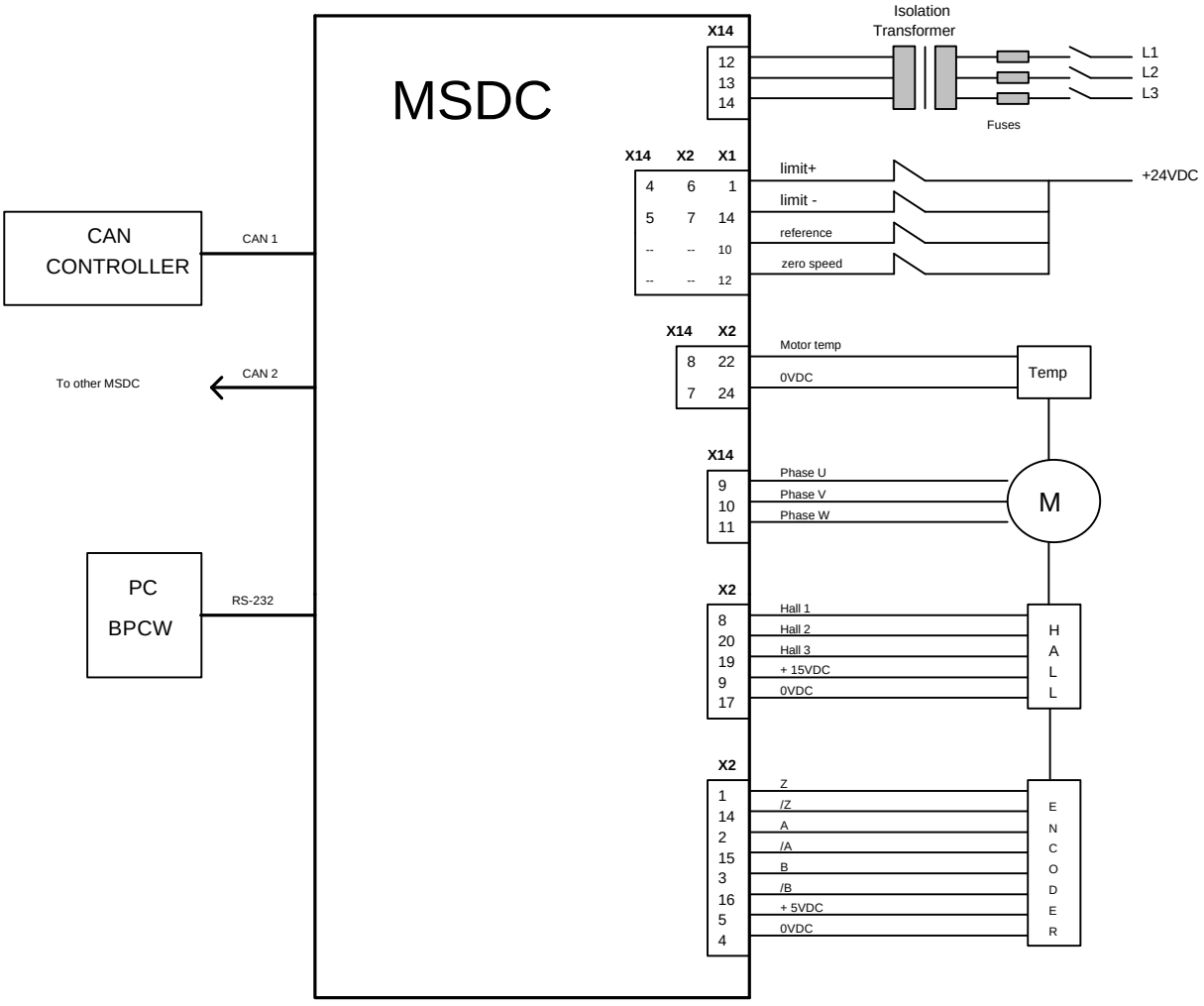


The serial link cable must also be shielded according to the above mentioned shielding recommendations.

Note: Never plug in or unplug any connectors on the amplifier when power is applied. A time of discharge of 3 minutes must be considered

6.0.0 COMMISSIONING

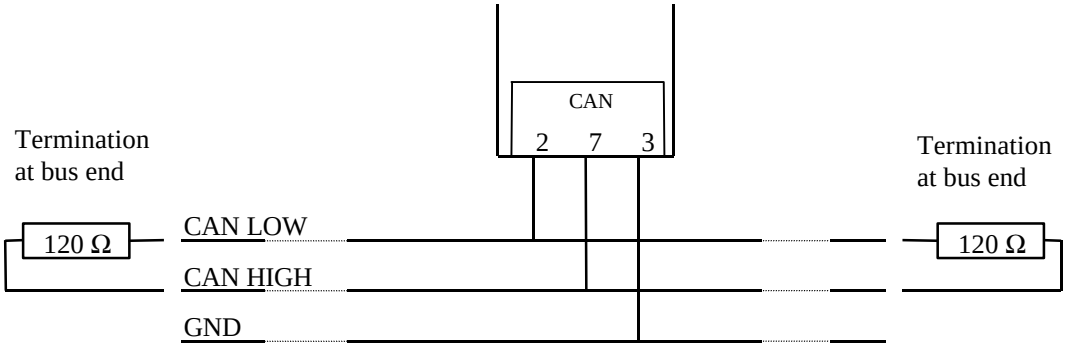
6.1.0 MSDC Module connection



The adjustment of hall sensors and tachometer is made at the factory. Setting of the amplifier for another motor is possible (contact factory) . Hall sensor with 60ø and 120ø can be used.

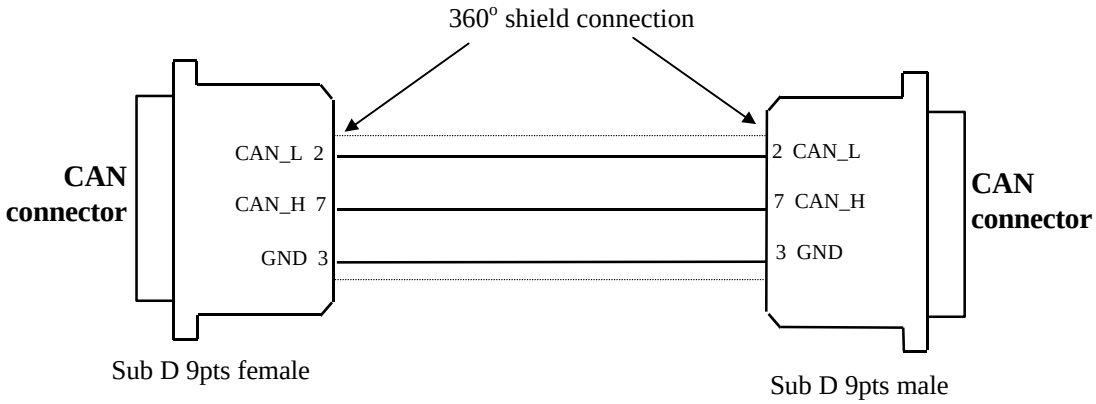
6.2.0 CAN INTERFACE CONNECTION

For each amplifier connected to the network:

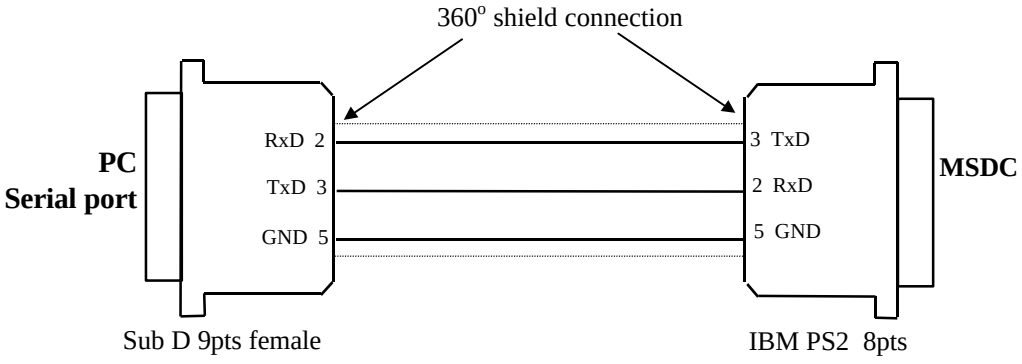


The cable specification is about 120 Ω.
The whole cable length must not exceed 40 m at 1 Mbit.
Both cable ends must be connected to a 120 Ω load resistor.

Cable required for the connection between 2 nodes:



6.3.0 RS 232 serial link connection



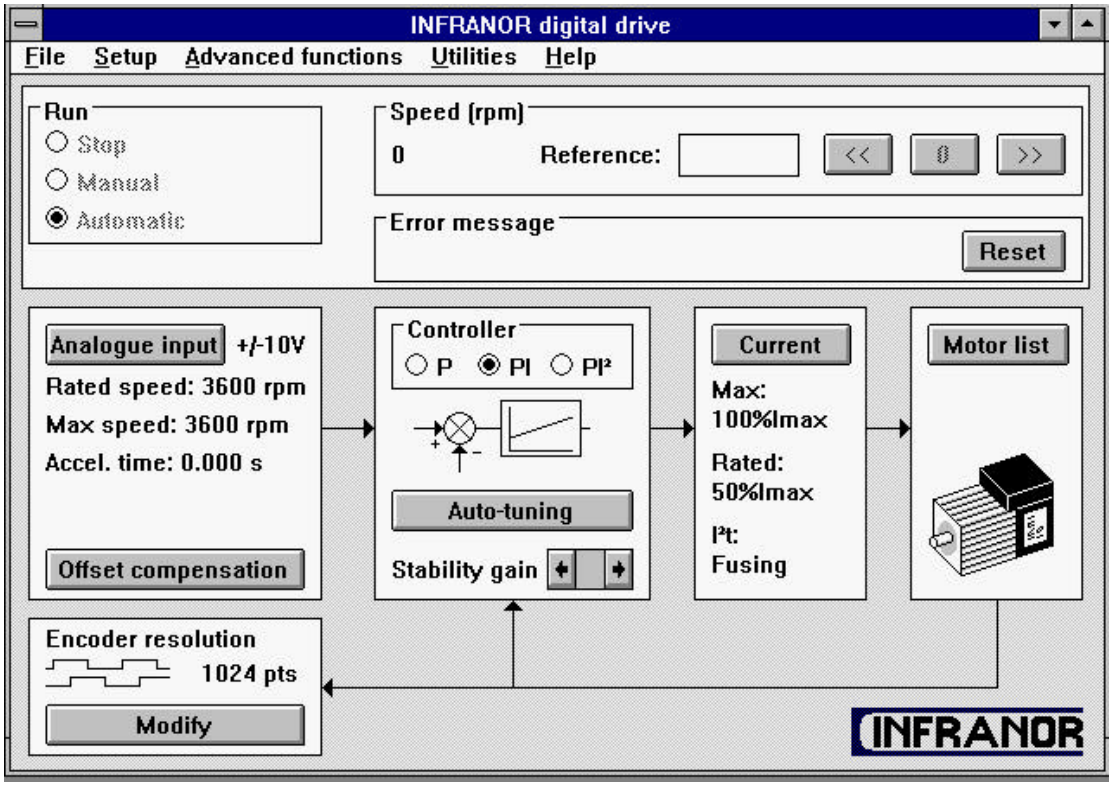
7.0.0 RS-232 SERIAL LINK SOFTWARE OPERATIONS

The MSDC amplifier is part of the INFRANOR digital servo amplifier product family. It is designed to work in machines controlled via the same CAN bus protocol as the SMTBD1/h series
The control via CAN bus guaranties the full functionality of the MSDC amplifier. Some setting and parameter functions can be realised also via the RS 232 serial interface.
There are two possibilities of interfacing the MSDC amplifiers with the RS-232 serial interface

7.1.0 BPCW Software (WINDOWS® compatible)

This is the standard recommended interfacing procedure realised with a PC and the standard INFRANOR BPCW software which guaranties the use of most of the functionality's of the MSDC amplifier.

Remark: Designed as a general software tool for an INFRANOR product range, there are some software functions (parameters or procedures) which are not implemented into the MSDC. Selecting one of the **functions** not used for the MSDC will indicate a "**Procedure error**" and the function will not be executed.
Trying to modify a **parameter** which has no functional influence on the MSDC amplifier (for example: „Resolver offset") will be accepted and acknowledged as executed for compatibility reason.



The INFRANOR Digital Drive graphic window has an adjustment panel, a control panel and functions accessible via menus. This presentation allows a quick adjustment of the system's main parameters during the commissioning and the adjustment phases.

7.1.1 Control panel

This panel allows the direct control of the motor by means of the PC during the commissioning phase. The **RUN** and **SPEED** functions must be confirmed by means of the Software control function in the Setup menu of the BPCW software.

RUN: This function starts and stops the amplifier and the motor during the commissioning and adjustment phases.

- **STOP**: The amplifier is disabled and the motor is not under power.
- **MANUAL**: A digital speed input command is directly entered by the **SPEED** function of the PC.
- **AUTOMATIC**: CAN input command control mode

SPEED: This function allows the control of the motor speed by means of the PC during the commissioning and adjustment phases.

- The digital speed input command value (in rpm) is entered into the **Reference** block.
- The three buttons in the **Speed** block give a positive (>>), negative (<<) or zero (0) speed input command.

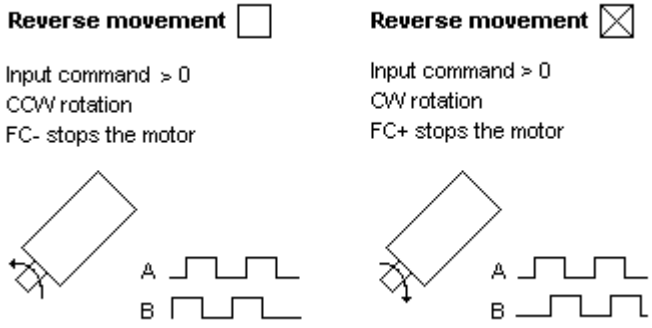
ERROR MESSAGE: This function displays the error information. The stored errors can be canceled by the **Reset** function.

7.1.2 Adjustment panel

The main adjustable parameters as well as the automatic commissioning aid functions are accessible in the adjustment panel. The whole system is represented as a block diagram for a better display of the parameters.

ANALOG INPUT: This module concerns the adjustable parameters for motor speed input command.

- The **Max speed** parameter defines the maximum motor rotation. The adjustment range is between 100 and 14000 rpm. This parameter is automatically calculated with regard to the rated speed value (Rated speed) entered by the operator.
- The **Accel time** parameter defines the motor acceleration or deceleration time between 0 and the **max speed** value defined above. The adjustment range is between 0 and 30 s.
- The **Reverse movement** function allows the reversal of the motor rotation according to the speed input command CV polarity. The encoder position output signals with regard to the motor rotation are not modified. The following diagram shows the standard configuration of the MAVILOR motors according to the wiring set by the manufacturer.



CONTROLLER: This module allows the adjustment of the amplifier digital speed regulator.

- The choice of the regulator type (**P**, **PI** or **PI²**) is programmable in the upper part of the **CONTROLLER** block.
  P: the speed regulator is only a proportional regulator.
  PI: the speed regulator is a proportional and integral regulator.
  PI²: Not active for the MSDC

- Both **Stability Gain** buttons at the bottom of the **CONTROLLER** module allow to increase (➔) or decrease (🡐) the loop gain.

CURRENT: This module allows the adjustment of the amplifier current limitation.

- The amplifier type is selected in the **Drive list** table.
- The fan type is selected in the **Fan** list table.
- The amplifier rated current limitation mode is selected in the part $\mathbf{I^2t}$ mode. In **Fusing** position, the amplifier is disabled when the current limitation threshold is reached. In **Limiting** position, the current is only limited at the value defined by the parameter **Rated current** when the limitation threshold is reached.
- **Maximum current** (%) parameter defines the maximum current of the amplifier. It can vary from 0% to 100% of the amplifier current rating. This parameter is defined according to the amplifier and motor specifications (see chapter 2.1.0).
- **Rated current** (%) parameter defines the threshold of the amplifier RMS current limitation ($\mathbf{I^2t}$). It can vary from 20 % to 50 % of the amplifier current rating. This threshold is defined according to the amplifier and motor specifications (see chapter 2.1.0).

MOTOR LIST Not active for the MSDC.

ENCODER RESOLUTION concerns the amplifier encoder output. The **Modify** function allows to define the specifications of the A, B and Z signals that are available on the X2 connector.

- The **Encoder resolution** parameter defines the number of pulses on channels A and B for one revolution of the motor shaft. Binary and decimal values are both accepted. The maximum resolution per revolution is limited by the motor speed as shown in the table below:
- **Number of zero pulse** Not active for the MSDC
- **Zero pulse origin shift** Not active for the MSDC
- **Zero pulse width** Not active for the MSDC
- **Programmation** function modifies the encoder output memory according to the new parameters entered by the operator.

7.1.3 Parameter file menu (Files)

Save parameter file function saves all amplifier parameters in a file [Name].PAR.

Load parameters file function loads all amplifier parameters from a file [Name].PAR stored in the PC.

Save parameters to eeprom function saves all parameters in the amplifier EEPROM. These parameters are kept in the amplifier even after power off. They are automatically loaded in the BPCW software when starting the amplifier. Only the parameters of the **Encoder resolution** module are automatically stored in the amplifier EEPROM, after modification and saving.

The **Exit** function allows leaving the BPCW software and returning to WINDOWS® . If you do not want to save the parameter modifications, leave the software without saving the parameters in the amplifier EEPROM. After switching off and reapplying power, the amplifier is initialized with the previous EEPROM parameters. When starting the BPCW software again, the parameters of the amplifier are automatically loaded in the software.

7.1.4 Software configuration menu (Setup)

Communication menu allows the definition of the PC communication port connected to the amplifier (COM1 or COM2) as well as the transmission speed of the serial link.

- The communication port (**Com. port**) is selected in the left part of the Communication setup block. The port number can be stored in the PC via the **Save configuration** function.

- The transmission speed (**Baud rate**) is selected in the right part of the Communication setup block. When an amplifier is connected, the BPCW software automatically acquires the communication speed saved in the amplifier. This default transmission value is set at 19200 bauds.

Save configuration function saves the serial port configuration in the PC file *BPCW.CFG* for a quicker restarting of the BPCW software.

Verify hardware option visualize the amplifier hardware options and the software firmware version.

Software control menu allows direct control of the amplifier by means of the PC via the functions **RUN** and **SPEED** during the commissioning phase.

7.1.5 Advanced functions menu

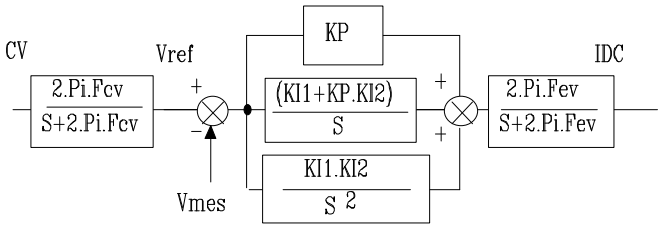
AUTO-PHASING PROCEDURE Not active for the MSDC

MOTOR PARAMETERS DEFINED BY USER Not active for the MSDC

CURRENT PHASE LEAD CALCULATION Not active for the MSDC

Controller parameters

The structure of the speed regulator is shown below:



Adjustable gain parameters

- **Error low pass filter** parameter defines the cut off frequency at - 3 db (Fev) of the first order filter (speed error). The value of this parameter depends on the selected band width.

- **Proportional gain** parameter defines the proportional gain (KP) of the regulator (speed error). The adjustment range is between 0.06 and 4095.

- **Integral 1 gain** parameter defines the first integral gain (KI1) of the regulator (speed error). The adjustment range is between 0.004 and 255.

- **Integral 2 gain** parameter defines the second integral gain (KI2) of the regulator (speed error). The adjustment range is between 0.000015 and 1.

7.2.0 ASCII parameter setting instructions

These instructions allow the set up and diagnosis of the amplifiers by a host system (DNC, PLC, PC working as RS 232 terminal) without installing the INFRANOR software. In this case the customer himself develops and integrates in his system the parameter software. The ASCII instructions described in the manual are not covering the full functionality of the BPCW software.

Remark: As the BPCW software the ASCII instructions are also a part of the INFRANOR software concept that means they are compatible to all INFRANOR amplifiers of the SMTBD1 series. The handling of the MSDC specific instructions is depending of their functionality. There are the following categories of MSDC specific instructions:
Instructions which are implemented into MSDC with specifically value limitations: the instruction will be executed taking care to the specific value limitation and acknowledged (example: **RC**- Encoder resolution).
Instructions which are implemented only into MSDC: this instructions (example: see instruction **SA**- Set amplifier Address and **MT**- Set type of motor temperature sensor) are not supported in the actual version of the BPCW software and they can executed only with the help of an ASCII terminal software.

The customer has to develop himself the host system software for the amplifier parameter setting. This software is not developed by INFRANOR who accepts no responsibility for the "program/operating system/machine interface" compatibility or for any technical support for this work. All the instructions accessible via the BPCW software have no equivalent instructions listed in this manual. Therefore, the access to some functions is only possible via the BPCW software.
INFRANOR reserves the right to modify and/or complete the list of parameters and ASCII instructions without notice.
The OEM or the end user assumes the final responsibility for the use of parameter setting software others than BPCW. INFRANOR disclaims any responsibility for physical damage caused by the use of any parameter setting software other than BPCW.

7.2.1 Communications

The specifications of the MSDC amplifier serial link communication are listed below:

8 Data bits
1 Stop bit
No parity
19200 Bauds (default).

The parameters can be sent to the amplifier by an ASCII terminal using the instruction list given in this manual. Each instruction is coded as 2 ASCII characters with or without parameter.
There are two instruction types:
Variables: these instructions allow to modify or to read the value of a variable. If there is a parameter, the variable corresponding to the instruction will take this value. Otherwise, the amplifier will send back the actual variable value via the serial link.
Procedures: these instructions execute some specific functions of the amplifier.

- Each instruction (which can be followed by an hexadecimal 16 bit parameter) sent to the amplifier must end with a **carriage return** character (ASCII code 13).
- All these characters, except for the **carriage return**, will be sent back by the amplifier (echo).
- The amplifier answer starts with a separation character **:** (ASCII code 58) possibly followed by an hexadecimal 16 bit value. The amplifier will then send a **carriage return**, a **line feed** and >.

Notes
If the amplifier does not know the instruction, it will send back **?** instead of **:**.
Some instructions are only valid when the amplifier is disabled. If the entered parameter is out of the appropriate variable range or if the restrictive condition (amplifier disabled) is not answered, the parameter will not be taken into account (the amplifier will keep the former variable value).
The parameters are always in hexadecimal and in an amplifier standard format. Conversions have to be made by the operator.

Communications examples:

The PC sends the IM instruction (maximum current):
IM4000

and a **carriage return** character (ASCII code 13) for ending the instruction.

The amplifier will answer with: IM:

>

: indicates that the instruction has actually been decoded. The value 4000 is stored in the variable corresponding to the maximum current. After the character **carriage return**, the amplifier will also send the **>** character in order to indicate that it has taken the instruction into account.

If the PC sends the instruction: IM
The amplifier will answer with: IM: 4000

>

As there is no parameter, the amplifier sends back the value of the variable defining the maximum current (in this case: 4000 corresponding to 50% of Imax of the amplifier) after the characters IM and **:**.

7.2.2 Instructions list

Current limitation parameters

Maximum current	Variable
Instruction	IM
Parameter	Possible values: between 0 and 7FFF
Conversion	3.051850948e-3 (for getting the amplifier max. current value in percent)
Condition	
Remarks	7FFF corresponds to 100 % of the amplifier max. current (according to its current rating)

Rated current	Variable
Instruction	IN
Parameter	Possible values: between 0 and 4000, If IM < 4000 hexa, then IN < IM
Conversion	3.051850948e-3 (for getting the amplifier max. current value in percent)
Condition	
Remarks	*4000* corresponds to 50 % of the amplifier max. current (according to its current rating)

I 2 t mode	Variable
Instruction	I P
Parameter	0 or 1
Conversion	IP <> 0 --> mode fusing and IP = 0 --> mode limiting
Condition	
Remarks	The value is = 0 or <> 0

Regulator parameters

Proportional gain of the speed loop	Variable
Instruction	KP
Parameter	Possible values: between 0 and FFFF
Conversion	1/16
Condition	
Remarks	This term is used in P, Pl and position mode

Integral 1 gain of the speed loop	Variable
Instruction	Kl
Parameter	Possible values: between 0 and FFFF
Conversion	1/256
Condition	
Remarks	This term is used in Pl and position mode

Proportional gain of the position loop Variable

Instruction	KE
Parameter	Possible values: between 0 and FFFF
Conversion	1/65536
Condition	
Remarks	This term is used in position mode

Feedforward term of the position loop Variable

Instruction	KV
Parameter	Possible values: between 0 and FFFF
Conversion	
Condition	
Remarks	This term is used in position mode

Maximum speed Variable

Instruction	VL
Parameter	Possible values: between 0 and 1DDE
Conversion	1.8310546875 (for getting the speed in rpm, 14 000 rpm -> 1DDE)
Condition	Amplifier disabled
Remarks	The maximum speed also depends on the motor. Check the compatibility.

Reverse movement Variable

Instruction	IV
Parameter	0 or 1
Conversion	
Condition	Amplifier disabled
Remarks	The read value is 0 or <> 0

Encoder resolution Variable

Instruction	RC
Parameter	Depends on the used encoder resolution (standard 1000 I/R, 03E8h)
Conversion	
Condition	Amplifier disabled
Remarks	The new value is not stored into the EEPROM (see instruction FE). This parameter must be set in accordance with the incremental encoder which is mounted on the motor. The MSDC software limits the resolution from 500 up to 4096 I/R.

Encoder output programming Procedure

Instruction	FE
Parameter	
Conversion	
Condition	Amplifier disabled
Remarks	See instruction RC for setting the encoder resolution

Following error Variable

Instruction	ET
Parameter	0 to 7FFF
Conversion	Value in encoder edges (encoder resolution x 4)
Condition	
Remarks	The value in degrees depends on the encoder resolution (RC)

Miscellanous instructions

Amplifier Fault code Variable

Instruction	ER
Parameter	Reading only
Conversion	The fault code is a 16 bit word (see below)
Condition	

Each bit corresponds to a fault defined below (1 = fault, 0 = no fault):

Bit	Error
0	
1	I2t: Action: • Fusing mode: disables the amplifier • Limiting mode: limits the output current of the amplifier to the programmed value Reset: software/ hardware (power OFF/ON, reset switch)
2	
3	Position following error: Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
4	EEPROM: see also remark below Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
5	CAN Reference error: see also remark below Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
6	
7	Procedure execution error: Action: no action
8	
9	Power stage fault (power overvoltage, output short-circuit): Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
10	HALL encoder error: Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
11	Power undervoltage: Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
12	Amplifier thermal sensor: disables the amplifier
13	Motor thermal sensor: Action: disables the amplifier Reset: software/ hardware (power OFF/ON, reset switch)
14	
15	

Remarks:
EEPROM error can occur in the following cases:
After power ON:

- EEPROM checksum test failed: EEPROM read error, new not programmed EEPROM implemented or EEPROM not implemented.
  In this case the set of default parameters will be loaded in the amplifier which can used in most cases to work with the amplifier. After setting up or loading of the right parameters they must be saved to the EEPROM.

  After „Save parameters to EEPROM“ or „Save encoder resolution“ sequences started by RS 232 or CAN: the writing of the parameters to EEPROM is failed.
  In this case the parameters were not saved correctly into the EEPROM, the amplifier can work with the actual parameters but after power off they are loss.

  Hardware error can occur after the power ON sequence when the processor hardware test sequence (EPROM checksum, register initialisation, ALU test,...) is failed. This error is signalised by blinking of the red and green LED-s on the front.
  In this case the amplifier is not ready to operate and must repaired.
  CAN Reference error can occur by trying to put into the operation the amplifier with the software enable function (through RS 232 or CAN interface) having the CAN input activated without sending the CAN synchro messages.

Logic inputs Variable

Instruction	Ll
Parameter	Reading only
Conversion	
Condition	
Remarks	This variable indicates the status of the logic inputs of the amplifier (see below)

Status of the logic inputs

Bit	Function	Remark
0		
...		
3	Logic	0=positiv, 1=negativ
4	Limit switch +	0=not activated, 1=activated
5	Limit switch -	0=not activated, 1=activated
6		
7	Speed zero	0=not activated, 1=activated
...		
15		

System indicators Variable

Instruction	SS
Parameter	Reading only
Conversion	
Condition	
Remarks	This variable gives the indicators for the amplifier operation mode

Coding of the system indicators

Bit	Meaning
10	Pl speed mode.
11	Specific option control mode (CAN: position loop)
12	P speed mode
13	PI2 speed mode (not implemented for MSDC)

P speed mode Procedure

Instruction	MU
Parameter	No parameter
Conversion	
Condition	Amplifier disabled
Remarks	Switching into P speed mode

PI speed mode Procedure

Instruction	MV
Parameter	No parameter
Conversion	
Condition	Amplifier disabled
Remarks	Switching into Pl speed mode

PI 2 speed mode Procedure

Instruction	MW
Parameter	No parameter
Conversion	
Condition	Amplifier disabled
Remarks	Switching into PI2 speed mode (option not activated reserved for further developments)

Enable/ disable specific option		Procedure
Instruction	Ml	
Parameter	No parameter	
Conversion		
Condition	Amplifier disabled	
Remarks	Switching into PFF position mode (Amplifier with CAN input)	

Speed monitor		Variable
Instruction	VM	
Parameter	Reading only. -1DDE to 1DDE	
Conversion	1.8310546875 (for getting the speed in rpm)	
Condition		
Remarks	This instruction sends back the motor speed on 16 bits (sign included)	

Current monitor		Variable
Instruction	IA (from EPROM version 1.0)	
Parameter	Reading only. -7FFF to 7FFF	
Conversion	3.051850948e-3 (for getting the amplifier current in percent)	
Condition		
Remarks	This instruction sends back the amplifier current on 16 bits (sign included)	

Amplifier software version		Variable
Instruction	VE	
Parameter	Reading only	
Conversion	The amplifier software version is coded as 8 hexadecimal characters	
Condition		
Remarks	Actual version = 00000602 (hexadecimal)	

Reset amplifier faults		Procedure
Instruction	RZ	
Parameter		
Conversion		
Condition		
Remarks		

Parameter storage in the EEPROM		Procedure
Instruction	ST	
Parameter		
Conversion		
Condition	Amplifier disabled	
Remarks	All amplifier parameters are stored into the EEPROM	

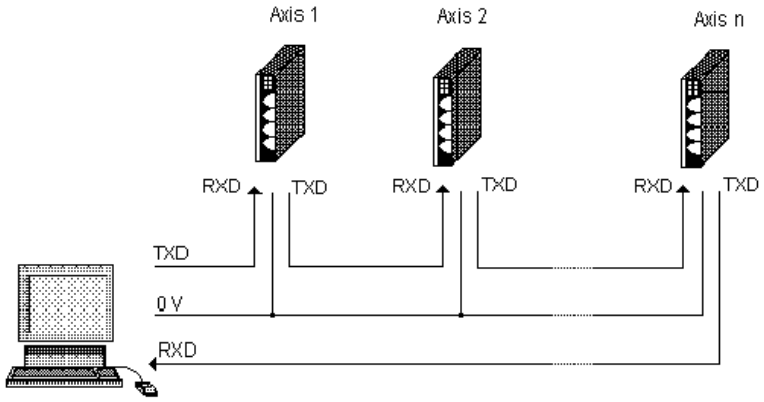
Addressing		Variable
Instruction	AD	
Parameter	0 to F	
Conversion		
Condition		
Remarks	Initialise the communication with an amplifier in the multi-axis configuration	

Set amplifier address		Variable
Instruction	SA	
Parameter	0 to F	
Conversion		
Condition		
Remarks	Sets the software address of the amplifier. The new address must be saved into the EEPROM.	

Set motor temperature sensor type		Variable
Instruction	MT	
Parameter	=0 NC type sensor <>0 NO type sensor	
Conversion		
Condition		
Remarks	Sets the type of the motor temperature sensor. The new sensor type must be saved into the EEPROM.	

7.2.3 Multiaxis configuration

When the MSDC amplifiers are operating in a multi-axis rack, it is interesting to make the parameter setting of these amplifiers by means of a single host system without the need to connect and disconnect the serial link on each axis.
The MSDC amplifiers allow a multi -axis connection with RS-232 serial link according to the connections presented below:



The connection of the various units (computer or amplifiers) is made as a ring: the transmission signal (TxD) of each unit is connected to the reception signal (RxD) of the next unit.
Each amplifier has a software address (1...15) assigned which is stored into the EEPROM memory of the amplifier. The amplifiers on a ring must have different addresses.

7.2.4 Selecting an amplifier for communication

An address in multi-axis configuration must have a value between 1 and F (hex). The 0 address corresponds to the standard configuration (no addressing).
The connection with an amplifier with address **x** requires the instruction ADx (see this instruction in 0). The connection with another amplifier with address **y** requires to send the instruction ADy which is disconnecting the amplifier **x** an connecting the amplifier **y**.
After the connection, it is possible to dialogue with the amplifier via the instructions described in the paragraph regarding the parameter setting.

The amplifiers are delivered with the default software address (8). In order to change the software address of an amplifier from **x** to **y** the following instruction sequence is to be realized:

>ADx↵	select amplifier **x** for communication
>SAy↵	set the new software address of the amplifier
>ADy↵	select amplifier **y** for communication
>ST↵	store into the EEPROM the new software address

8.0.0 CAN COMMUNICATION PROTOCOL

8.1.0 General Description

Main characteristics :
The rhythm of the data transfers is controlled by the NC up to 500 Hz.
Axis synchronization per amplifier group and by means of synchro messages.
Each amplifier has a switch defined address from 1 to 15 belonging to 2 possible synchro groups.
The 0 address is assigned to the host of the network (the NC).

Several possible control modes of the amplifier (speed / incremental position / absolute position).
The operation of this amplifier is governed by the messages exchanges on the CAN bus. There are 2 types of communication messages:

synchronous messages,
asynchronous messages.

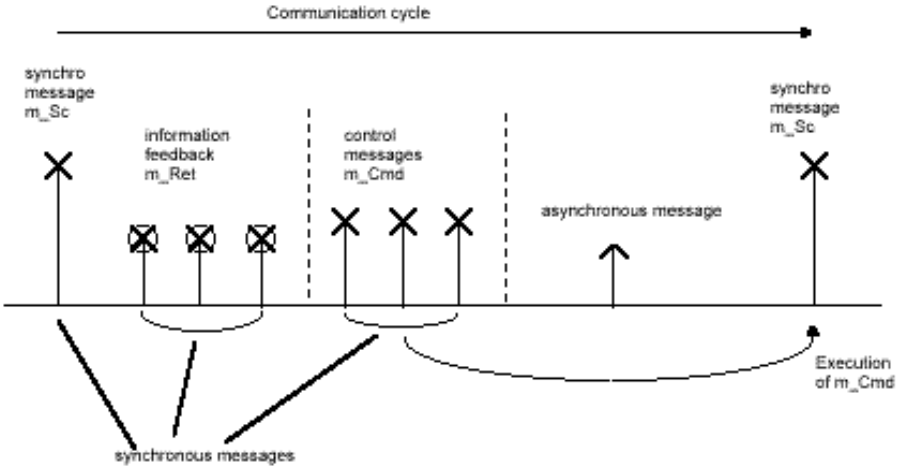
The synchronous messages control the amplifier and the asynchronous messages allow the amplifier parameter setting.

CAUTION
This manual corresponds to the amplifier software versions 1.0

8.2.0 Synchronous messages

These are periodic messages such as position controls or position feedback. These messages control the amplifier.
There are 3 types of synchronous messages:

synchro message (m_Sc),
control message (m_Cmd),
feedback message (m_Ret).



At constant time intervals (cycle time), the NC sends a synchro message m_Sc and the amplifiers of the same synchronisation group acquire their position and send the messages containing their position (m_Ret). After the reception of the positions, the NC sends the input command messages (m_Cmd) to the amplifiers of this same synchro group.

8.2.1 Synchro messages

The synchro message contains no data. It synchronises the various axes on the network and defines the data transfer rhythm.
There are 2 synchro groups defined by the amplifiers addresses:
group 0 (G0) : addresses 1 to 7
group 1 (G1) : addresses 8 to 15

The synchro message is emitted by the NC and is received by all amplifiers of a same group.
There are 2 types of synchro messages :

Control synchro m_Sc: this message triggers:

Returning of the information feedback message (m_Ret) if it has been programmed,

Taking into account of the input command (m_Cmd) transmitted before.

Feedback synchro m_Sr :

The feedback synchro message triggers the returning of the information feedback message (m_Ret). This message makes it possible to get position feedbacks at a rhythm different from the one of the controls.

There is one control synchro message and one feedback synchro message for each amplifier group.

8.2.2 Control messages

There is one control message per axis. In this message, it is possible to define, for each axis:

Absolute position input command (32 bits) or an incremental position input command (16 bits),

Speed input command,

Torque input command.

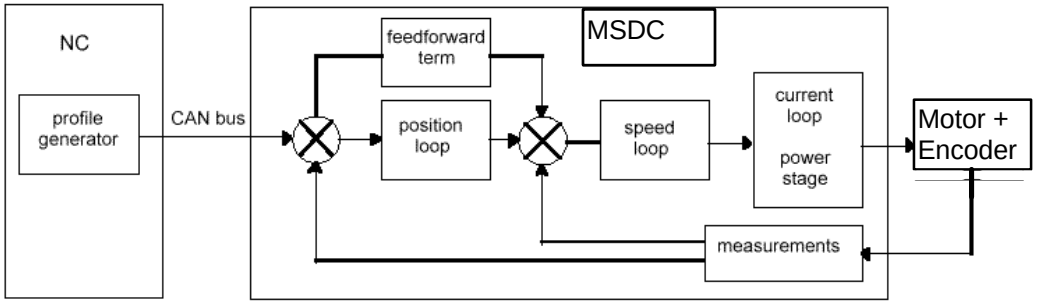
Position input command mode

In this mode, the amplifiers periodically receive the position input command by the NC. The profile generator is in the NC; this allows the axes synchronisation.

The amplifier cycle time is 500 µs. The position input command interpolation is linear.

The position input command can be:

absolute (32 bits),
or incremental (16 bits).



Notes:

- The position feedback is optional. This allows to reduce the traffic on the bus.
- There is also a particular mode for the absolute position input command:
- In this mode, a control message can contain 2 absolute position input commands for 2 amplifiers.
- The addresses of both amplifiers must be sequential. For the first amplifier which address is [ABC0], the control is in the bytes 1 to 4 of the message. For the second amplifier which address is [ABC1], the control is in the bytes 5 to 8 of the message.
- This mode makes it possible to reduce the number of messages used.

8.2.3 Feedback messages

There is one feedback message per axis. In this message, it is possible to define, for each amplifier:
an absolute position feedback (32 bits) or an incremental position feedback (16 bits),

Speed monitor,

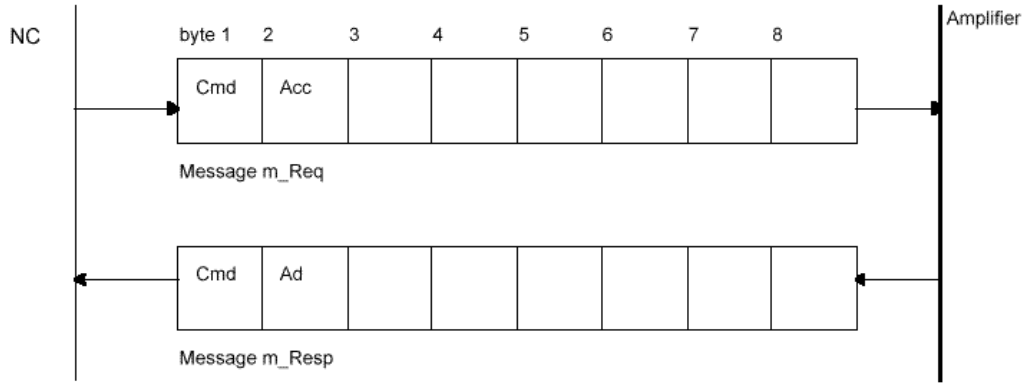
Torque monitor,

Amplifier error code.

8.3.0 Asynchronous messages

These messages are used for the parameter transmission between NC and amplifiers.

The master sends a message m_Req in order to initialize a transfer. The transfer direction is defined by the bit L/E. The appropriate slave answers with a message m_Resp, except for the case where bit T = 1 (see diagram below).



Message m_Req :

Byte 1 : Transfer command

Byte 2 : access mode:

7	6	5	4	3	2	1	0
L/E	T	0	0	Ad3	Ad2	Ad1	Ad0

L/E = 0 Reading of a parameter
L/E = 1 Writing of a parameter
T = 0 Concerns one single amplifier which address is defined by „Ad3 Ad2 Ad1 Ad0“.
T = 1 All axes are concerned. „Ad3 Ad2 Ad1 Ad0“ are not taken into account.
Bytes 3 to 8 : parameters.

Message m_Resp :

Byte 1 : Transfer command

Byte 2 : address of the questioned amplifier:

7	6	5	4	3	2	1	0
0	0	0	0	Ad3	Ad2	Ad1	Ad0

„Ad3, Ad2, Ad1, Ad0“ : slave address (amplifier).
Bytes 3 to 8 : parameters.
Note :
In the case of 16 or 32 bit data, the low weight bytes are stored before the high weight bytes.

8.4.0 Instructions list

1 word = 2 bytes.
All parameter setting commands are not buffered.
The execution time of a command is about 1 to 2 ms (except for procedures which execution time is not known in advance).
During the execution of a procedure, the execution of another command can be delayed.

Operation Parameters

Amplifier mode

Command	40 (0x28) defines the amplifier operation mode (position / speed or torque)
Parameters	1 byte =1 torque mode =2 speed mode with PI regulator =4 position mode =8 speed mode with P regulator =16 speed mode with PI 2 regulator (not implemented, reserved for further developments)
Conversion	
Limitation	
Execution	During the execution of this command, the amplifier must generally be disabled. Only the switching on to torque mode or from torque mode can be made with enabled amplifier. The torque input command must be available (see configuration of control and feedback messages - Command 42)
Remarks	

Cycle time

Command	41 (0x29) defines the cycle time of the NC. This value is necessary for the interpolation of the position input command.
Parameters	1 word. This value is in µs and is between 1000 and 20000
Conversion	
Limitation	
Execution	Amplifier disabled
Remarks	

Configuration of the command and feedback message

Command	42 (0x2A) defines the command (m_Cmd) and feedback (m_Ret) messages configuration
Parameters	2 bytes
Conversion	
Limitation	The number of bytes for this command or feedback message is 8. The configuration of these messages must take into account this limitation. When a synchro message (command or feedback) contains several information (position, speed, current...), the sequence of these information in the message - if they are there - is: position speed current status
Execution	Amplifier disabled
Remarks	

The 2 first bytes:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	TR	FR	SR	0	PR	AR	DR	EF	TF	0	SF	CF	PF	AF	F

TR torque input command (16 bits) in torque mode.
FR speed feedforward.
SR speed input command (16 bits) in speed mode.
PR position input command in position mode (absolute or incremental).
AR absolute position input command (32 bits).
DR double position input command (absolute 32 bits).
EF amplifier status feedback (16 bits).
TF current monitor feedback (16 bits).
SF speed monitor feedback (16 bits).
CF position feedback by external encoder instead of the resolver (not implemented).

PF position feedback (absolute or relative).
AF absolute position feedback 32 bits.
F authorizes a feedback message (m_Ret) in response to a command synchro message (m_ScGx).

The position input command and feedback are applied by means of the same scale factor (see command 50). The maximum position value depends on the position resolution = -32768 x Resolution at 32767 x Resolution.

Input:	bit 10 (PR)	bit 9 (AR)	
Feedback:	bit 2 (PF)	bit 1 (AF)	
	1	0	relative position 16 bits
	1	1	absolute position 32 bits
	0	1	absolute position 16 bits
	0	0	no position

Bit DR allows to define 2 32 bits position input commands for 2 amplifiers in the same message, or 4 16 bits position input commands for 4 amplifiers in the same message.

The amplifiers addresses must be:

32 bits position:
For the first amplifier which address is [Ad3 Ad2 Ad1 0], the command is contained in bytes 1 to 4 of the message.
For the second amplifier which address is [Ad3 Ad2 Ad1 1], the command is contained in bytes 5 to 8 of the message.

16 bits position:
For the first amplifier which address is [Ad3 Ad2 0 0], the command is contained in bytes 1 and 2.
For the second amplifier which address is [Ad3 Ad2 0 1], the command is contained in bytes 3 and 4.
For the third amplifier which address is [Ad3 Ad2 1 0], the command is contained in bytes 5 and 6.
For the fourth amplifier which address is [Ad3 Ad2 1 1], the command is contained in bytes 7 and 8.

The speed command and feedback vary between -32768 and 32767 and correspond to the maximum application speed defined by command 61.

The torque command and feedback vary between -32768 and 32767 and correspond to the maximum current defined by command 76.

When bit FR is set at 1, the regulator uses the speed input command (this must be programmed in the same message) as feedforward term instead of the one calculated by the regulator (see drawing 0).

The amplifier status is defined as follows :

Bit (0-15)	Meaning
0	Amplifier fault
1	Limit switch +
2	Limit switch -
3	CI (not implemented)
4	INDEX
5	ENABLE (Hardware input)
6	Amplifier enabled (software)
7	Auto-tuning procedure (not implemented)
8	Index research procedure
9	Procedure execution
10	Procedure cancelled
11	Procedure has succeeded
12	Procedure ended because of an error
13	Position captured on transition inactive-active of CI (not implemented)
14	Position captured on transition active-inactive of CI (not implemented)

Error threshold of the CAN bus

Command	43 (0x2B) defines the time after which the amplifier triggers the CAN reference error when the control synchro message (m_Sc) or the input command message (m_Cmd) are missing
Parameters	1 word the recommended value is 500 or 1000
Conversion	The parameter value corresponds to the time in µs
Limitation	
Remarks	The CAN reference error is triggered by the absence of synchro message m_Sc or input command message m_Cmd

Position resolution

Command	50 (0x32) defines the position resolution (Encoder resolution x 4)
Parameters	1 word
Conversion	
Limitation	From 500 to 4000, depending on the resolution of the used encoder
Execution	Amplifier disabled
Remarks	This position resolution consequently defines the position input command and position feedback format.

Hardware configuration

Command	51 (0x33) Indicates the optional amplifier configuration
Parameters	1 word Bit (0 - 15) Meaning 0 Non volatile RAM (option CT-EMF, not available for MSDC) 3 RAM (always at 1 if bit 0 is at 1, not available for MSDC) 4 Option „auxiliary encoder input“ (not available for MSDC 5 Option „logic inputs/outputs (not available for MSDC 7 CAN interface available (always at 1 for MSDC)
Conversion	
Limitation	Reading only
Execution	
Remarks	

Version

Command	52 (0x34)
Parameters	6 bytes 1 word : version number of the amplifier software. 4 bytes : identification code of the manufacturer: MESA
Conversion	
Limitation	Reading only
Execution	

Amplifier status

Command	53 (0x35)
Parameters	3 words (see below)
Conversion	
Limitation	Reading only
Execution	
Remarks	When a procedure is called, the bits 13, 14 and 15 of the procedure status are set at 0. During the procedure execution, the corresponding bit is set at 1. At the end of the procedure, this bit is reset at 0, and one or two of bits 13, 14, 15 are set at 1. The amplifier fault RESET command (command 93) allows to cancel any procedure during its execution. If the amplifier is disabled after a fault, the fault RESET command cancels the fault but does not enable the amplifier. To enable the amplifier, use command 91 „ENABLE“.

1st word: Amplifier fault.

Bit (0-15)	Fault
0	
1	I 2 t
2	Resolver-digital conversion
3	Position following error
4	EEPROM
5	CAN input command
6	
7	Procedure execution error
8	
9	Power stage fault : power overvoltage, short-circuit,
10	Resolver cables interrupted
11	Power undervoltage
12	Amplifier thermal probe
13	Motor thermal probe
14	
15	

2nd word: Status of the amplifier logic inputs.

Bit (0-15)	Meaning
0	Encoder input marker pulse statement (not implemented)
1	
2	
3	0= positive logic (always)
4	0 = Limit switch + ON, 1 = Limit switch + OFF
5	0 = Limit switch- ON, 1 = Limit switch- OFF
6	0 = CI ON, 1 = CI OFF
7	0 = Index ON, 1 = Index OFF
8	0 = Enable input ON, 1 = Enable input OFF
9	
10	
11	
12	0 = Software Enable ON, 1 = Software Enable OFF
13	
14	1 = A position is captured by the Inactive-Active transition of the CI input (not implemented)
15	1 = A position is captured by the Active-Inactive transition of the CI input (not implemented)

3rd word: indicates the statement of a procedure.
A procedure is an action of the amplifier during which the amplifier does not answer the NC input command. A procedure is executed by the amplifier in an autonomous way.

Bit (0-15)	Meaning
0	Auto-phasing procedure phase 1 (not implemented)
1	Auto-phasing procedure phase 2 (not implemented)
2	Cogging torque acquisition procedure phase 1 (not implemented)
3	Cogging torque acquisition procedure phase 2 (not implemented)
4	Auto-tuning procedure (not implemented)
5	Index research procedure
6	
7	
8	EEPROM saving procedure

9	Encoder output programming procedure
10	
11	
12	
13	Procedure cancelled
14	Procedure correctly executed
15	Procedure over because of an error

Speed/current monitor

Command	54 (0x36)
Parameters	2 words 1 word: speed monitor. 1 word: current monitor.
Conversion	
Limitation	
Execution	Reading only
Remarks	The formats of the speed monitor or the current monitor are 16 bits full scaling, that is 32767 for maximum speed (defined by command 61 : max. application speed) or maximum current (defined by the amplifier sizing). These formats are also used for the speed and current input commands.

Masking of the amplifier faults

Command	55 (0x37)
Parameters	1 word Each bit of this word is corresponding to an amplifier fault. The meaning of these bits is given by command 53. Bit = 0: the corresponding fault is masked. Bit = 1: the fault will disable the amplifier.
Conversion	
Limitation	Only the following error and CAN input command faults can be masked
Execution	
Remarks	When an error has occurred and when the corresponding fault is masked by this command, the amplifier is not stopped, but only the fault is displayed (command 53 „amplifier status“).

Logic inputs / outputs

Command	56 (0x38) Allows the reading of the logic inputs of the amplifier
Parameters	1 word
Conversion	
Limitation	Reading only
Execution	
Remarks	This variable indicates the status of the logic inputs of the amplifier (see below)

Status of the logic inputs

Bit	Function	Remark
0		
...		
3	Logic	0=positiv, 1=negativ
4	Limit switch +	0=not activated, 1=activated
5	Limit switch -	0=not activated, 1=activated
6		
7	Speed zero	0=not activated, 1=activated
...		
15		

Reversal of the rotation direction

Command	60 (0x3C) This command allows the reversal of the rotation direction with regard to the input command. It also reverses the position feedback. The second byte allows to reverse the position counting of the encoder input, if available.
Parameters	1 word 1st byte = 0 : normal. <>0 : reversed. 2nd byte = 0 : normal. <>0 : reversed.
Conversion	
Limitation	
Execution	Amplifier disabled
Remarks	

Maximum application speed

Command	61 (0x3D) defines the maximum speed (as well as the speed scaling) of the application
Parameters	1 word
Conversion	For getting the speed in rpm: x 1.8310546875
Limitation	This parameter varies between 55 (100 rpm) and 7446 (14000 rpm)
Execution	Amplifier disabled
Remarks	

Absolute position measurement

Command	62 (0x3E)	Allows the reading of the motor position
Parameters	32 bits	
Conversion	See position resolution	
Limitation	Reading only	
Execution		
Remarks		

Position reset

Command	63 (0x3F)	Resets the position sent back by the amplifier
Parameters	none	
Conversion		
Limitation	Writing only	
Execution	Amplifier disabled	
Remarks		

Reading of the position error

Command	64 (0x40)	Allows the reading of the position error
Parameters	32 bits	
Conversion	See position resolution	
Limitation	Reading only	
Execution		
Remarks		

Position error threshold

Command	65 (0x41)	Defines the position error triggering threshold
Parameters	1 word	
Conversion	See position resolution	
Limitation		
Execution		
Remarks		

Reading of the position captured on Inactive-Active transition

Command	66 (0x42) Allows to read the value of the motor position captured by the Inactive-Active transition of the CI input (this option is not available for MSDC)
Parameters	Position: 32 bits Capture indicator: 16 bits
Conversion	See position resolution
Limitation	Reading only
Execution	
Remarks	Bit 0 of the indicator indicates if the position has just been captured; this bit will be reset at 0 by the amplifier after the reading. This bit is the same as bit 15 of the amplifier status in the synchronous message feedback (see also command 42). If the CI input is configured in positive logic, the Inactive-Active transition corresponds to the up edge of the signal. The active level duration must be higher than 50 ms.

Reading of the position captured on Active-Inactive transition

Command	67 (0x43) Allows to read the value of the motor position captured by the Active-Inactive transition of the CI input (this option is not available for MSDC)
Parameters	Position : 32 bits. Capture indicator: 16 bits.
Conversion	See position resolution
Limitation	Reading only
Execution	
Remarks	Bit 0 of the indicator indicates if the position has just been captured; this bit will be reset at 0 by the amplifier after the reading. If the CI input is configured in positive logic the Inactive-Active transition corresponds to the down edge of the signal. The inactive level duration must be higher than 50 m.

Filtering of the CI input

Command	68 (0x44)
Parameters	1st word: filter parameter. 2nd word: acceptance threshold
Conversion	1st word: x 50 ms. 2nd word: see position resolution
Limitation	
Remarks	The first parameter defines the signal filter per 50 ms pitch. This filter allows to cancel disturbing pulses. The signal duration must then be higher than this parameter x 50 ms. This parameter can vary between 1 and 32767. The second parameter defines the minimum signal width (in position). This parameter can be 0 (no limitation) or between 1 and 32767 (same format than the position).

Bandwidth

Command	69 (0x45) This parameter defines the position error threshold in which the position loop is open
Parameters	1 word
Conversion	See position resolution
Limitation	

Absolute position input command

Command	70 (0x46)
Parameters	2 words: absolute position input command in 32 bits
Conversion	See position resolution (parameter 50)
Execution	
Remarks	This command allows to initialise the absolute position input command. It is useful in relative position input command mode 16 bits or absolute position input command 16 bits; it is not interesting absolute position input command mode 32 bits. In absolute mode 16 bits, it is necessary, at power up, to read the amplifier absolute position in 32 bits (parameter 62) and to then initialise the absolute input command (parameter 70) with the same value.

Motor parameters

Synchronous motor parameters

Command	71 (0x47) defines the parameters necessary for the driving of a synchronous motor. These parameters can be calculated by the auto-phasing procedure
Parameters	2 words + 1 byte 1st word: Motor phase: corresponds to the phases order (U, V, W) of the motor connection. 2nd word: Resolver adjustment: phase shift between resolver and motor rotor. 3rd word: Number of motor pole pairs (1 to 12).
Conversion	Motor phase: 2 possible values (0x5555 or 0xAAAA) Resolver adjustment: 5.4931640625e-3* (number of pole pairs). The resulting value is the shift in electrical degree
Limitation	
Execution	Amplifier disabled
Remarks	This option is not available for MSDC

Phase lead factor

Command	72 (0x48)
Parameters	16 bits. (55-7446)
Conversion	4.57771654e-5 (electrical degree / 1000 rpm)
Limitation	
Execution	
Remarks	This option is not available for MSDC

Encoder output marker pulse

Command	73 (0x49)
Parameters	1st word: number of marker pulses (1). 2nd word: phase shift with regard to the resolver zero (0). 3rd word: marker pulse width (1).
Conversion	
Limitation	Number of marker pulses: 1 Phase shift with regard to the resolver zero: 0 Marker pulse width: 1
Execution	
Remarks	This parameters cannot be changed because they are depending on the incremental encoder which is used.

Encoder output resolution

Command	74 (0x4A) defines the encoder output resolution
Parameters	1 word: encoder resolution
Conversion	
Limitation	The encoder resolution is limited by the maximum application speed. Max. speed Max. encoder resolution 100 - 900 8192 900 - 3600 4096 3600 - 14000 1024
Execution	Amplifier disabled
Remarks	This parameter must be set up with care because it must be equal to resolution of the incremental encoder which is used.

Cogging torque compensation

Command	75 (0x4B)
Parameters	1 word =0 disables the compensation <>0 enables the compensation
Conversion	
Limitation	The **CT-EMF** option must be available and the cogging torque identification procedure must be executed before (command 100).
Execution	
Remarks	This option is not available for MSDC

Curent limitations parameters

Maximum current

Command	76 (0x4C) defines the maximum current limitation in the motor
Parameters	1 word
Conversion	in percent of the amplifier current sizing: x 3.051850948e-3
Limitation	6554 (20%) to 32767 (100 %)
Execution	
Remarks	This parameter is to be set according to the amplifier and motor specifications.

Rated current

Command	77 (0x4D) defines the rated current limitation in the motor
Parameters	1 word
Conversion	in percent of the amplifier current sizing : x 3.051850948e-3.
Limitation	6554 (20 %) to 16384 (50 %)
Execution	
Remarks	This parameter is to be set according to the amplifier and motor specifications.

I2t mode

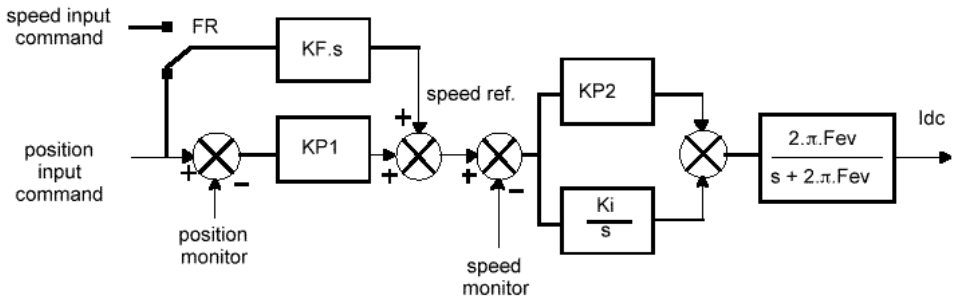
Command	78 (0x4E)
Parameters	1 word =0 limiting mode =1 fusing mode
Conversion	
Limitation	
Execution	
Remarks	For the $I^2 t$ operation mode, see the hardware manual of the MSDC amplifier.

Current limitation

Command	79 (0x4F) defines the current limitation in the motor with regard to the value defined by the command 76 (maximum current)
Parameters	1 word
Conversion	
Limitation	0 to 32767 (100 % Imax)
Execution	
Remarks	

Regulator parameters (Position and speed)

The structure of the regulator is shown below:



Proportional gain of the speed loop

Command	81 (0x51) defines the proportional gain (KP2) of the regulator, that is acting on the speed error
Parameters	1 word
Conversion	1/16
Limitation	0 to 65535
Execution	
Remarks	

Integral gain of the speed loop

Command	82 (0x52) defines the integral gain (KI) of the regulator, that is acting on the speed error
Parameters	1 word
Conversion	1/256
Limitation	0 to 65535
Execution	
Remarks	

Proportional gain of the position loop

Command	83 (0x53) defines the proportional gain that is acting on the position error (KP1)
Parameters	1 word
Conversion	1/65536
Limitation	0 to 65535
Execution	

Feedforward

Command	84 (0x54) defines the feedforward amplitude (KF) corresponding to the apriori speed input command (derivation of the position input command). This feedforward term allows to reduce the following error during the motor acceleration and deceleration phases.
Parameters	1 word
Conversion	1/65536
Limitation	0 to 65535
Execution	

Acceleration ramp

Command	85 (0x55) defines the acceleration or deceleration time of the motor, that is corresponding to the maximum speed
Parameters	1 word
Conversion	in second: x 0.0005
Limitation	1 (without acceleration ramp) to 65535 (# 30 s)
Execution	
Remarks	This parameter is not used in the actual software of the MSDC amplifier

Current control low pass filter

Command	86 (0x56) defines the cut-off frequency at -3dB (Fev) of the first order filter that is acting on the current control. The value of this parameter is depending on the selected bandwidth.
Parameters	1 word
Conversion	Frequency (Hz) = 1000/p*Ln (65536/parameter)
Limitation	This parameter can have a value between 2832 (1000 Hz) and 61545 (20 Hz).
Execution	
Remarks	This parameter is not used in the actual software of the MSDC amplifier

Enable/disable the anti resonance filter

Command	87 (0x57)
Parameters	1 word =0 disables the anti resonance filter. <>0 enables the anti resonance filter.
Execution	
Remarks	This parameter is not used in the actual software of the MSDC amplifier

Stability gain adjustment

Command	89 (0x59)
Parameters	1 word = -1 reduces the gains. = +1 increases the gains.
Execution	
Remarks	This command allows to increase or reduce the gains while maintaining the speed and position loop stability.

Parameters “Utility functions”

Enabling

Command	91 (0x5B) Enables the amplifier with a time delay of the brake relay output
Parameters	1 word This parameter gives, in ms, the time between the enabling and the disabling of the brake relay output. enabling of the amplifier time delay disabling of the brake relay output.
Conversion	
Limitation	Writing only. The maximum time is 16 s.
Execution	
Remarks	The amplifier can only be enabled by this command. The ENABLE signal is a necessary but not sufficient condition. In standard, the amplifier is disabled at power on. If the parameter is <> 0, the end of the time delay is indicated by bit 14 of the procedures status (command 53).

Disabling

Command	92 (0x5C) Disables the amplifier with a time delay of the brake relay output.
Parameters	1 word This parameter gives, in ms, the time between the enabling of the brake relay output and the disabling of the amplifier. enabling of the brake relay output. time delay disabling of the amplifier.
Conversion	
Limitation	Writing only. The maximum time is 16 s.
Execution	
Remarks	When the parameter is <> 0, the end of the time delay is displayed by bit 14 of the procedures status (command 53).

Amplifier fault RESET

Command	93 (0x5D)
Parameters	None
Conversion	
Limitation	Writing only
Execution	
Remarks	The fault RESET command also cancels any procedure during its execution.

Saving in the EEPROM

Command	94 (0x5E) Saves all amplifier parameters in the EEPROM.
Parameters	None
Limitation	Writing only
Execution	Amplifier disabled
Remarks	All parameters modified by the other commands mentioned in this manual are not stored. This command must be executed in order to definitely store them in the amplifier.

Auto-phasing

Command	95 (0x5F)
Parameters	None
Limitation	Writing only
Execution	
Remarks	This procedure is not available for the actual MSDC version. The amplifier will respond with procedure error.

Auto-tuning

Command	96 (0x60) This procedure identifies the motor and load specifications and calculates the regulator gain parameters.
Parameters	1 word 0 = low bandwidth 1 = medium bandwidth 2 = high bandwidth 3 = low bandwidth with antiresonance filter 4 = medium bandwidth with antiresonance filter 5 = high bandwidth with antiresonance filter
Limitation	
Execution	
Remarks	This procedure is not available for the actual MSDC version. The amplifier will respond with procedure error.

Index research procedure

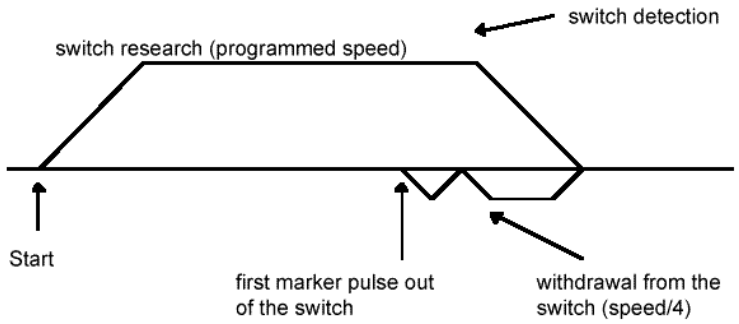
Command	97 (0x61)
Parameters	see below
Limitation	
Execution	With enabled amplifier and in position mode (command 40).
Remarks	When bit 0 of the first byte is set at 1, bit 3 must be = 0; this means that it is not possible to start the procedure and send a „pre-set“ position at the same time. The parameter must be the speed and Time Out. During the procedure execution, the NC must always send the synchronous message and the input command message. When the index position has been found, the motor is standing still. Bit 5 of the procedures status (command 90) remains at 1 and bit 14 is set at 1. The NC must readjust the position input command message according to the new position sent by the amplifier and leave the index research procedure (bit 1 of the first byte of command 97 = 0). Bit 5 of the procedures status is switching on to 0. The amplifier will then follow again the position input command of the NC. It is possible to „force“ the position counter with a value given by the value „0x01“ in the command byte, that is neither switch nor marker pulse. In this special case, the amplifier does not need to be enabled.

1 byte: command

Bit (0 - 7)	Meaning
0	=0: Leaves index research procedure =1: Starts the procedure
1	Index research with switch
2	Index research on marker pulse Combination of bits 1 and 2: 01: with switch 10: on marker pulse 11: with switch and on marker pulse 00: position reset
3	=0: positive direction =1: negative direction
4	=0: parameter = displacement speed + Time Out =1: parameter = index position
5	=1: cancels the index research procedure. The motor will be stopped: leave the index research the mode by means of bit 0.
6	
7	

1 word: displacement speed defined in percentage of the maximum speed defined by command 61. A value of 32767 corresponds to the maximum speed.
1 word: Time Out. Limited procedure time in seconds (max. 32767 s)
or 1 word: 32 bits. Position „pre-set“ . This value will be allocated to the index position found. Same format as the 32 bit position (see command 42). In standard, this value is 0.

Procedure diagram:



Encoder programming

Command	98 (0x62) This procedure saves the encoder resolution into the EEPROM which is set by means of the parameters defined by the command 74.
Parameters	
Limitation	Writing only
Execution	Amplifier disabled
Remarks	This parameter must be set up with care because it must be equal to resolution of the incremental encoder which is used.

Manual brake relay control

Command	99 (0x63) This command allows to enable or disable the brake.
Parameters	1 word =0 disables the brake relay output (relay closed). <>0 enables the brake relay output (relay open).
Conversion	
Limitation	Writing only
Execution	
Remarks	

Cogging torque identification procedure

Command	100 (0x64) This command triggers the motor cogging torque identification procedure.
Parameters	
Conversion	
Limitation	Writing only
Execution	
Remarks	This procedure is not available for the actual MSDC version. The amplifier will respond with procedure error.

Standard parameters reset

Command	101 (0x65)
Parameters	None
Conversion	
Limitation	writing only
Execution	
Remarks	This command resets ALL parameters at their standard value (see below). It must be used carefully because the parameter have „usual“ values but cannot fit to any application.

Standard parameters:

Parameters	**Value**	**Meaning**
40 (0x28)	0x08	Amplifier mode (P-speed loop)
41 (0x29)	0x07D0	Cycle time (2 ms)
42 (0x2A)	0x1000	Messages configuration (ref = speed, no feedback)
43 (0x2B)	0x03E8	CAN bus error threshold (1 ms)
50 (0x32)	0x0FA0	Position resolution (4000)
55 (0x37)	0xFFFF	Amplifier faults masking (no masking)
60 (0x3C)	0x0000	Rotation reversal (no reversal)
61 (0x3D)	0x1DDD	Max. application speed (14000)
65 (0x41)	0x7FFF	Position error threshold (32767)
69 (0x45)	0x0000	Bandwidth (0)
74 (0x4A)	0x03E8	Encoder resolution (1000)
76 (0x4C)	0x7FFF	Maximum current (100%)
77 (0x4D)	0x4000	Rated current (50%)
78 (0x4E)	0x0008	I2t mode (fusing)
79 (0x4F)	0x7FFF	Current limitation (100%, not stored)
81 (0x51)	0x00A0	Proportional speed loop gain (10.00)
82 (0x82)	0x0300	Integral speed loop gain (3.00)
83 (0x83)	0x051F	Proportional position loop gain (0.020)
84 (0x84)	0x0000	Feedforward term (0.000)
	0x0008	Amplifier address (8)
	0x2300	CAN Bit timing register (1 Mbit)
	0x0000	Motor ID number (no type selected)
	0x4B00	RS 232 baud rate (19200)

8.5.0 Messages identifiers

8.5.1 Synchronous messages

- Synchro messages :
  m_ScG0: Identifier = 16 (010h)
  m_ScG1: Identifier = 48 (030h)
  m_SrG0: Identifier = 32 (020h)
  m_SrG1: Identifier = 64 (040h)

  Length of the message: 0 byte.

- Command messages : **m_Cmd**
  Identifier:

10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	1	1	0	Ad3	Ad2	Ad1	Ad0

[Ad3 Ad2 Ad1 Ad0] is the amplifier address (1 to 15).

Length of the message: programmable.

- Information feedback messages : **m_Ret**
  Identifier:

10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	1	1	1	Ad3	Ad2	Ad1	Ad0

[Ad3 Ad2 Ad1 Ad0] is the amplifier address (1 to 15).

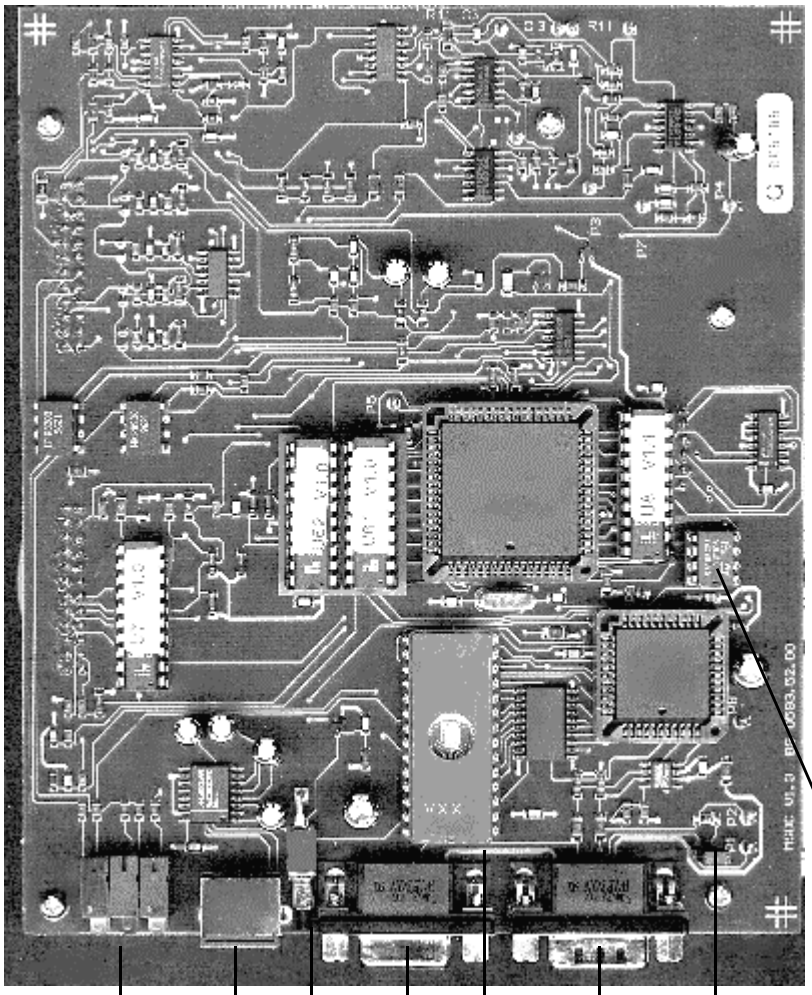
Length of the message: programmable.

8.5.2 Asynchronous messages

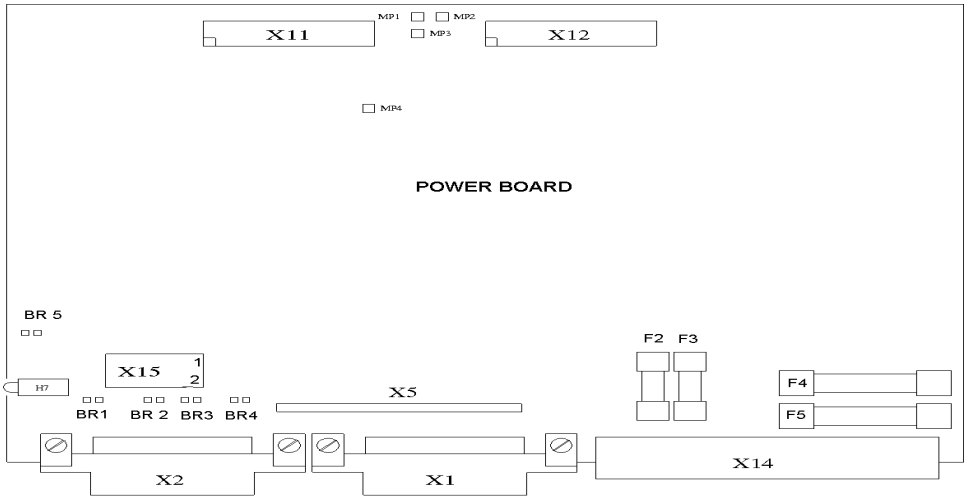
- Message **m_Req** :
  Identifier = 160 (0A0h)
- Message **m_Res** :
  Identifier = 176 (0B0h)

9.0.0 DIMENSIONS AND DRAWINGS

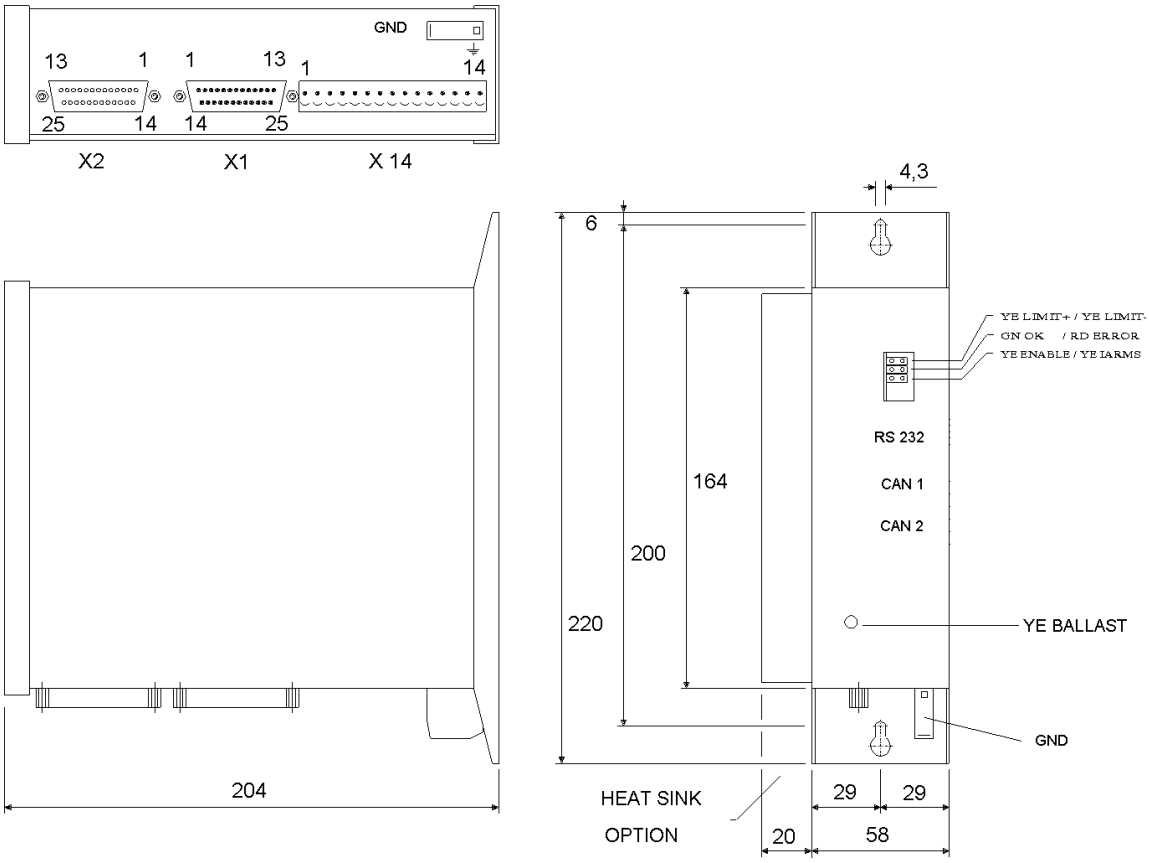
9.1.0 Logic card components location



9.2.0 Fuse location



9.3.0 MSDC Dimensions



Dimensions are in mm

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