

CD1-a_{gb}

CD1-a digital drive for AC sinusoidal brushless motors



WARNING

This is a general manual describing a series of servo amplifiers having output capability suitable for driving AC brushless sinusoidal servo motors.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the amplifiers operational.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The compliance with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the amplifier manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.



Any contact with electrical parts, even after power down, may involve severe physical damage. Wait for at least 5 minutes after power down before handling the amplifiers (a residual voltage of several hundreds of volts may remain during a few minutes).

**ESD INFORMATION (ElectroStatic Discharge)**

INFRANOR amplifiers are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the amplifiers are not properly stored and handled.

STORAGE

- The amplifiers must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the amplifier connectors and material with electrostatic potential (plastic film, polyester, carpet...).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the amplifiers must be handled via their metal housing.
- Never get in contact with the connectors.

**ELIMINATION**

In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all INFRANOR devices have got a sticker symbolizing a crossed-out wheel dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that INFRANOR devices must be eliminated by selective disposal and not with standard waste.

INFRANOR does not assume any responsibility for physical or material damage due to improper handling or wrong descriptions of the ordered items.

Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

Infranor reserves the right to change any information contained in this manual without notice.

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Chapter 1 - General description

1- INTRODUCTION

Series **CD1-a** all-digital servo modules are PWM servo amplifiers that provide speed control for AC sinusoidal motors (brushless) equipped with a position sensor.

The **CD1-a** system is available as a stand-alone single-axis block including all supplies as well as the mains filters, and is 230 VAC or 400/480 VAC mains operated.

2 - DESCRIPTION / COMPLIANCE WITH THE STANDARDS

2.1 - GENERAL DESCRIPTION

The **CD1-a** amplifier directly controls the motor torque and speed by means of the information provided by a high resolution position sensor (resolver or encoder). The sinusoidal current commutation based on this high resolution position sensor provides very smooth motor torque/force control.

The **CD1-a** amplifier can be configured for the feedback of various position sensor types. The appropriate position sensor configuration is selectable by software and saved in the amplifier.

- With a resolver sensor feedback, the motor absolute position value over one revolution is available and the servo motor can immediately be enabled after the amplifier power up.
- With an absolute single-turn SinCos encoder feedback (Heidenhain ERN 1085 or compliant), the servo motor can also immediately be enabled after the amplifier power up.
- With an incremental encoder only, a motor phasing procedure must be executed at each amplifier power up before the motor enabling.
- With an incremental encoder + Hall Effect Sensors (HES) feedback, the motor phasing procedure is no more necessary and the servo motor can immediately be enabled after the amplifier power up.

The motor speed or torque input command is an analog voltage (± 10 V). The rotor position monitor is available as two channels A and B in quadrature, and one marker pulse per revolution.

The resolution is programmable. All the values between 64 pulses per revolution and 16384 pulses per revolution (ppr) can be programmed according to the motor speed limitation. The main errors are displayed on the amplifier front panel.

All command parameters are programmable by means of a serial RS-232 link (or RS-422 optional) and saved in an EEPROM. The auto-phasing and auto-tuning functions allow the easy and quick commissioning of the amplifier.

The **CD1-a** amplifiers have their own DC/DC converter to provide appropriate logic voltage to the modules. An auxiliary 24VDC ± 15 % supply is generally available on all machines and supplies a DC/DC converter with all logic supplies required by the amplifier. The auxiliary supply allows to keep the amplifier logic supplies, after the power supply has been switched off, in order to keep the position output without initializing the machine all over again. A 24 VDC battery supply with specific wiring allows to keep the position even after switching off the auxiliary 24 VDC supply. This wiring can be used for "absolute" operation with the CD1-a amplifier ([see chapter 4: Connections](#)).

The power supply is depending on the amplifier type:

- CD1-a-230/I: 230 VAC single-phase mains operation power supply or three-phase via a transformer or an autotransformer or three-phase mains operation if there are three-phase mains available in 200 to 230 VAC.
- CD1-a-400/I: 400 to 480 VAC three-phase mains operated power supply.

A soft start system of the power supply limits the inrush current at power on.

The very small dimensions of the CD1-a amplifier allow an optimum integration in 300 mm deep cabinets (connectors included).

The **VISUAL DRIVE SETUP** software, which is PC compliant with the WINDOWS® operating system, allows the display and easy modification of all amplifier parameters. The commissioning of the drive is quick and easy thanks to the "digitizing oscilloscope" function included in this software.

2.2 - REFERENCE TO THE STANDARDS: "CE" CERTIFICATION

Series **CD1-a** amplifiers have been approved for their conformity with the EMC standards regarding the power servos referenced in the EN 61800.3 standard concerning "electrical power servos with variable speed":

- EN 55011, Group 1, Class A regarding conducted and radiated radioelectric disturbances,
- EN 61000.4-2-3-4-5 regarding immunity.

Standard to be applied to the electrical equipments of industrial machines: EN 60204.1.

The amplifiers have been "CE" marked since year 2000.

2.3 - REFERENCE TO THE STANDARDS: "UL" LISTING

CD1-a series have been « cUL_{us} » listed according to UL508C and UL840 regarding the insulator.

This product was evaluated to:

- the Third Edition of UL508C, the UL Standard for Power Conversion Equipment, dated May 2002 for the UL Listing (USL),
- the CSA Standard for Industrial Control Equipment, C22.2 N° 14-95, dated August 1995 for the Canadian UL Listing (CNL).

Providing that the manual is specifying that the end user has to provide an isolated power supply, for 24 VDC auxiliary input protected by a 4 A UL Listed fuse, the power board is considered within a limited voltage/current circuit per section 31.4 of UL508C. Therefore, spacings on the power board are not required to be evaluated per section 31.2 of UL508C and were evaluated according to UL 840.

Per UL 840 (Second Edition, dated May 20, 1993) requirements, spacings are limited to 2.5 mm assuming pollution degree 2 environment.

Ground connection is fixed in the frame of the device by a rivet, Avibulb masse, BN10-5168. The connector complies with standard dimensions given in table 6.2 of UL 310, the standard for Electrical Quick connect terminals.

Chapter 2 - Specifications

1 - TECHNICAL SPECIFICATIONS

1.1 - CD1-a-230/I AMPLIFIER

Mains operating power supply	230 VAC +10 % / -15 %, 1~ or 3~, 50 - 60 Hz
Isolated galvanic auxiliary supply voltage	24 VDC +/- 15 % - 320 mA
Motor phase-phase output voltage	200 Vrms
Integrated braking system	External 100 Ohm / 100 W resistor (dp 100/100) Minimum resistance: 50 Ohm (dp 50/200)
Minimum inductance between phases	1 mH

Amplifier output current ratings

Amplifier type	Max. output current (Arms) for 1 sec. +/- 5 % (230 VAC)	Rated output current (Arms) (230 VAC)	Power losses (W)	Rated input current (Arms) (230 VAC, 60 Hz)	Max. protection fuses for line circuit RK5 listed (Bussman / Littelfuse)	Short-circuit power of the mains	UL listed
CD1-a-230/2.25	2.25	1.1	25	1.1	6 A	5 kA	yes
CD1-a-230/4.5	4.5	2.25	30	2.25	6 A	5 kA	yes
CD1-a-230/7.5	7.5	3.75	44	3.75	6 A	5 kA	yes
CD1-a-230/10.5	10.5	5.25	55	5.25	6 A	5 kA	yes
CD1-a-230/16.5	16.5	8.25	66	8.25	9 A	5 kA	yes

Maximum room temperature = 40° C.

1.2 - CD1-a-400/I AMPLIFIER

Mains operating power supply voltage	400 to 480 VAC + 10 %/- 15 % 3~, TN or TT system with earthed neutral point, 50 - 60 Hz (Phase/Ground voltage must be balanced)
Isolated auxiliary supply voltage	24 VDC +/- 15 % - 320 mA
Motor phase-phase output voltage	380 to 460 Vrms depending on the mains
Integrated braking system	CD1-a-400/1.8 to 7.2 A: External 200 Ω/100 W resistor (dp 200/100) CD1-a-400/14: External 50 Ω/200 W resistor (dp 50/200) CD1-a-400/30 and 45: External 33 Ω/280 W resistor (dp 33/280)
Minimum inductance between phases	2 mH

AMPLIFIER OUTPUT CURRENT RATINGS

Output voltage range for 400-480 VAC (rms) three-phase mains

Output current range: 1.8 A, 2.7 A, 5.1 A, 7.2 A, 14 A, 30 A, 45 A (rms)

Amplifier type	Max. output current (Arms) for 1 sec. +/- 5 % (480 VAC)	Rated output current (Arms) (480 VAC)	Power losses (W)	Rated input current (Arms) (480 VAC, 60 Hz)	Max. protection fuses for line circuit RK5 listed (Bussman / Littelfuse)	Short-circuit power of the mains	UL listed
CD1-a-400/1.8	1.8	0.9	35	0.9	2 A	5 kA	yes
CD1-a-400/2.7	2.7	1.35	43	1.35	2 A	5 kA	yes
CD1-a-400/5.1	5.1	2.55	71	2.55	4 A	5 kA	yes
CD1-a-400/7.2	7.2	3.6	93	3.6	4 A	5 kA	yes
CD1-a-400/14	14	7	200	7	8 A	5 kA	yes
CD1-a-400/30	30	15	400	15	20 A	5 kA	yes
CD1-a-400/45	45	20	560	20	20 A	5 kA	yes

Maximum room temperature = 40° C.

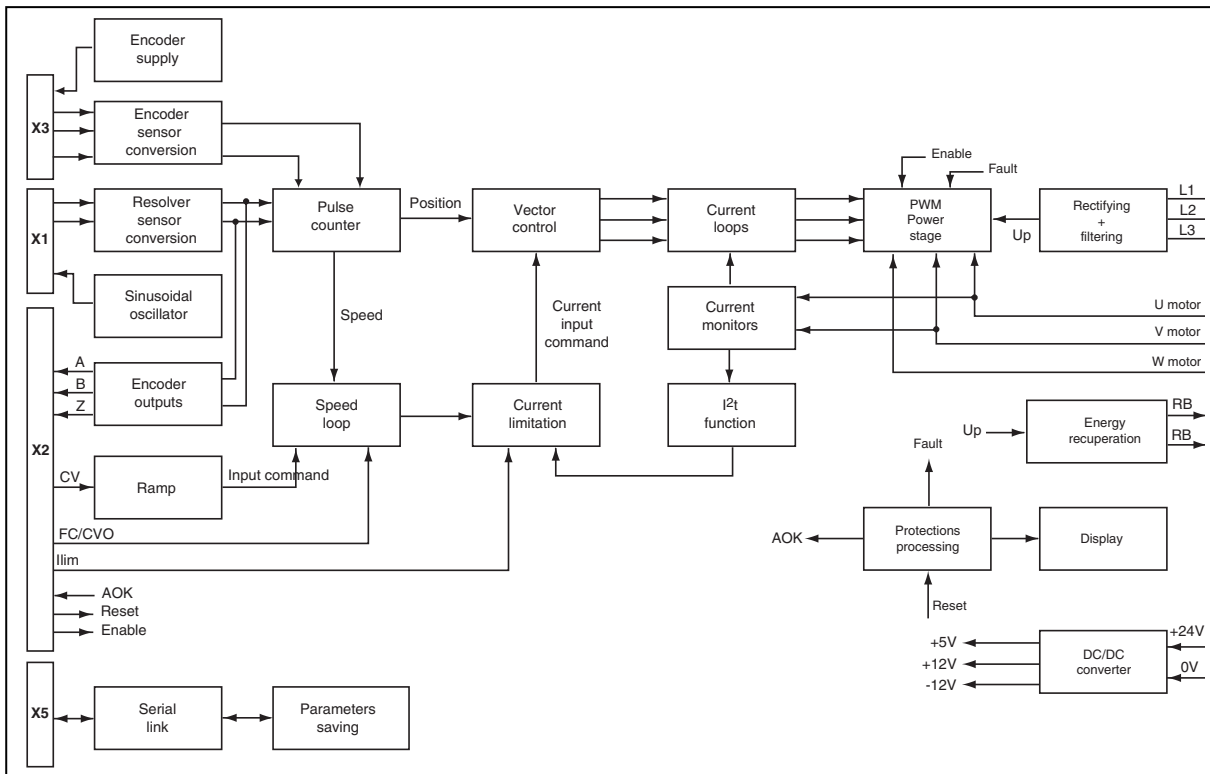
1.3 COMMON SPECIFICATIONS TO BOTH AMPLIFIER VERSIONS CD1-a-230/I AND CD1-a-400/I

Regulation loops: current, speed, position	Digital
Mains filter on power supply	Integrated in the amplifier
Common mode filter on auxiliary supply	Integrated in the amplifier
Position sensor	Transmitter resolver Absolute single-turn encoder (ERN1085 or compliant) Incremental encoder (TTL or SinCos signals) Incremental encoder + Hall Effect Sensors
Power stage protections	See section 3 "Main protections"
PWM switching frequency	8 kHz
Internal current limitation	I _{max} : 20 % to 100 % and I _{rated} : 20 % to 50 % I _{max} duration = 1 second
External current limitation	0 to 10 V (resolution = 13 bits) 100 to 0 % of the internal I _{max} limitation Limitation polarity selectable by software: * 0 V to 10 V (no limitation for 0 Volt) * 10 V to 0 V (no limitation for 10 Volt)
Analog speed input command CV	±10 V, resolution = 14 bits
Motor accel/decel ramp range	Between 0 and 30 s from zero speed to max. speed
Speed and position regulator	Sampling period = 0,5 ms Anti-wind-up system of the integrator Antiresonance filter Adjustable digital gains
Speed loop bandwidth	Selectable cut-off frequency for 45° phase shift : 50 Hz, 75 Hz or 100 Hz
Current loop bandwidth	Cut-off frequency for 45° phase shift: 1000 Hz
Max. motor speed	Adjustable from 100 rpm to 25000 rpm
Speed range	1 : 8192 with 14 bits input command resolution

Encoder position output	<p>Two A and B channels in quadrature with 1 marker pulse per revolution. RS422 line driver. Programmable resolution between 64 ppr and 16384 ppr (according to the motor maximum speed) Arc minute accuracy = $(8 + 5400/\text{Resolution})$</p> <p>Note: The total position accuracy must take into account the accuracy of the resolver used.</p>
Resolver input	<p>Resolution: 65536 ppr (16 bit) Excitation frequency: 8 kHz Transformation ratio: 0.3 to 0.5 (other values need factory-set adjustment)</p>
Encoder input	<p>Software selectable:</p> <p>Quadrature signals A & B with Z marker pulse RS 422 line receiver Maximum pulse frequency: 1 MHz Resolution: 500 to 10^6 ppr</p> <p>Incremental Sin/Cos encoder Heidenhain 1Vcc Sin/Cos type or compliant Maximum signal frequency: 200 kHz Resolution: 500 to 10^6 ppr Interpolation factor : 1024</p> <p>Absolute single-turn Sin/Cos encoder Heidenhain ERN 1085 or compliant Maximum signal frequency: 200 kHz Resolution: 2048 or 512 ppr Interpolation factor : 1024</p>
PULSE and DIRECTION input	<p>Re-configuration of the encoder input for stepper motor emulation: Line receiver RS-422 Maximum pulse frequency: 1 MHz Resolution: 200 to 10^6 pitch/revolution</p>
Hall sensors input	<p>Selectable by software : 120° or 60° HES type 5 V or 12 V supply voltage HES sequence error detection</p>
Logic inputs	<p>Enable / Disable: ENABLE Limit switch +: FC+ Limit switch - : FC- Current command: CI Zero speed input command / Phasing command: CV0 Fault RESET</p>
Logic outputs	<p>"AOK" relay contact U_{max} = 50 V, I_{max} = 100 mA, P_{max} = 10 W "AOK": closed if amplifier OK, open if fault</p> <p>Motor BRAKE control 1.5 A maximum with 24 Vdc. Open collector protected against short circuits. The brake is controlled when the motor is enabled: ENABLE activated and no fault displayed.</p>
Analog output	<p>+/-10V, resolution: 8 bit, load: 10 mA, linearity: 2%, low pass filter: 170 Hz, programmable output signal: Channel 1 of the digital oscilloscope (current, speed or position) or "Phasing OK" output (for incremental encoder without HES)</p>
Error display	<p>LED on front panel and diagnostic by serial link</p>

Parameter setting	Serial link RS-232 as standard (RS-422 optional)
Automatic functions	Amplifier adjustment to the motor (AUTOPHASING) Automatic regulator adjustment (AUTOTUNING) Offset compensation on analog input
Conformity with the standards: CE certification "360°" shield; equipotential according to the wiring rules.	EMC standards: - Immunity: EN 61000.4-2-3-4-5 - Conducted and radiated disturbances: EN 55011, Group 1, class A Electrical standards for industrial machines: - EN 60204.1: - Insulator: 1500 VAC/1 min. - Leakage current > 30 mA (EMI filters)
Conformity with the standards: UL listing "360°" shield; equipotential according to the wiring rules.	CD1-a series have been "cUL _{us} " listed according to UL508C and UL840 regarding the insulator. This product was evaluated to: - the Third Edition of UL508C, the UL Standard for Power Conversion Equipment, dated May 2002 for the UL Listing (USL), - the CSA Standard for Industrial Control Equipment, C22.2 N° 14-95, dated August 1995 for the Canadian UL Listing (CNL).
Temperature - storage - 20°C to + 70°C - operation 5°C to +40°C	From 40°C on, the rated currents must be reduced of 3 % per additional °C. Max. temperature: 50°C
Altitude	1000 m
Moisture	< 50 % at 40°C and < 90 % at 20°C: (EN 60204.1 standard) Condensation prohibited (storage and operation)
Cooling	Forced air (fan integrated in the CD1-a amplifier) Check for free ventilation and no upper or lower obstruction of the air admissions
Environment	Open chassis to be mounted in a housing protecting the drive from conducting dust and condensation (pollution degree 2 environment)
Mounting position	Vertical
Mounting location	Closed cabinet without any conducting and/or corroding agents and according to the room temperature requirements. Condensation prohibited.
Weight	CD1-a-230/I: approx. 1 kg CD1-a-400/1.8 to 7.2 A: approx. 1.5 kg CD1-a-400/14 : approx. 3 kg CD1-a-400/30 and 45: approx. 4.8 kg

2 - BLOCK DIAGRAM



3 - MAIN PROTECTIONS

3.1 - STORED PROTECTIONS

PROTECTION	ERROR DISPLAY	LED
Amplifier rated current overload (see Chapter 8, part 3.2)	$I^2 t$	● ○ ○ ○
Position feedback cable interruption (resolver or encoder)	Feedback	○ ● ○ ○
Hall Effect Sensors sequence error or cable interruption / Absolute single-turn encoder commutation channel error	HES	● ● ○ ●
Power stage fault	Power stage	● ● ○ ○
Encoder pulses counting error / Resolver position conversion error	Counting / RDC	○ ○ ● ○
Power supply undervoltage (non stored fault)	Undervolt.	○ ● ● ○
Motor overtemperature	°C motor	● ● ● ○
Speed or position following error	Following err.	○ ○ ○ ●
Amplifier parameter storage memory error	EEPROM	● ○ ● ●
- Procedure execution error - Initialization phase execution error	Busy	● ● ● ●
24 VDC auxiliary supply out of tolerances 19 V < 24 VDC < 29 V	24 V	○ ● ○ ●

○ : LED is unlit

● : LED is lit.

NOTE

The power stage error includes the following faults:

- power supply overvoltage
- internal switch protection
- short-circuit between motor phases or between motor phase and earth
- amplifier overtemperature (on CD1-a-400/I only)
- fan system error
- PWM control error
- power stage supply error
- braking system error

The detail of the "Power stage" fault can be displayed in the **Visual drive Setup** software.

All these faults are stored in the amplifier except for the "Undervolt." fault.

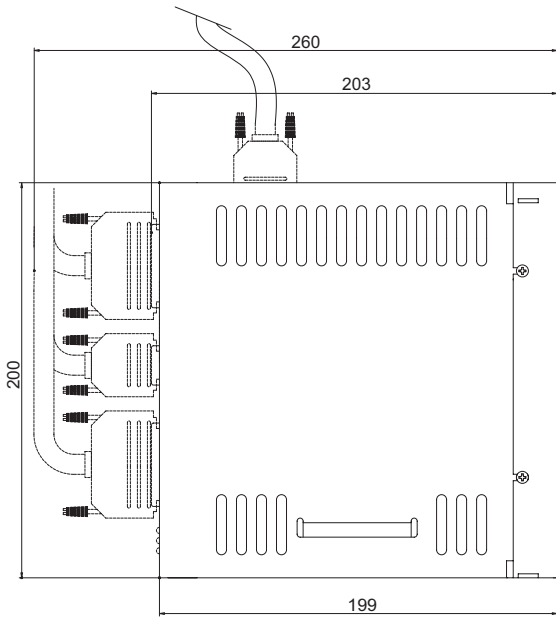
The reset of a stored fault can be made:

- by means of the RESET function in the **VISUAL DRIVE SETUP** software
- via the fault RESET input (pin 13 of the X2 connector)
- by switching off the amplifier power supply.

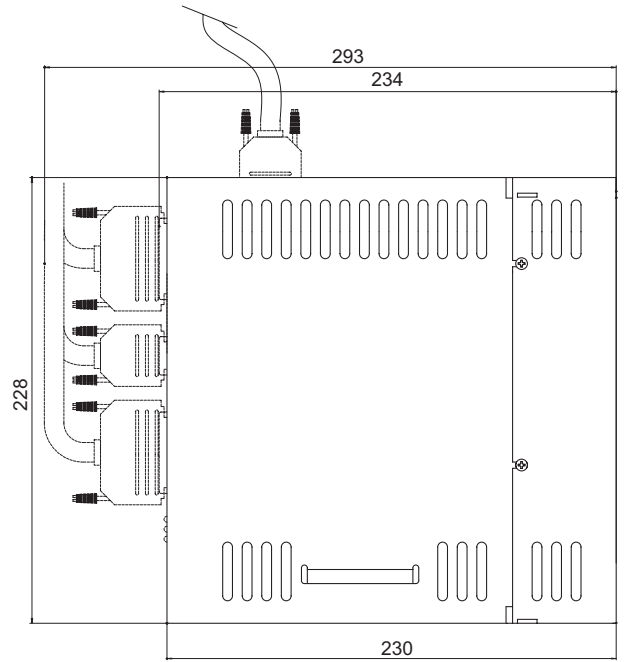
All faults release the amplifier disabling. All faults, except for "Undervolt.", also release the opening of the AOK relay contact. The "Undervolt." fault must be configured by software to release the opening of the AOK relay contact.

4 - DIMENSIONS

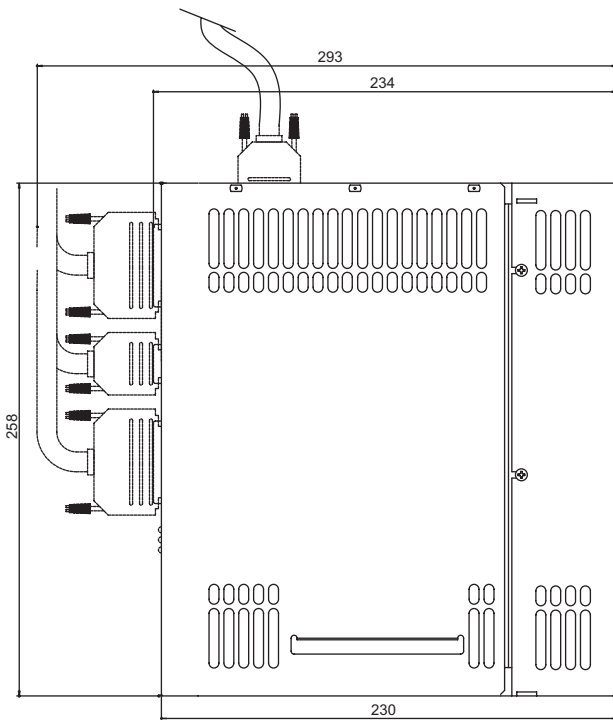
4.1 - CD1-a-230/I AMPLIFIER



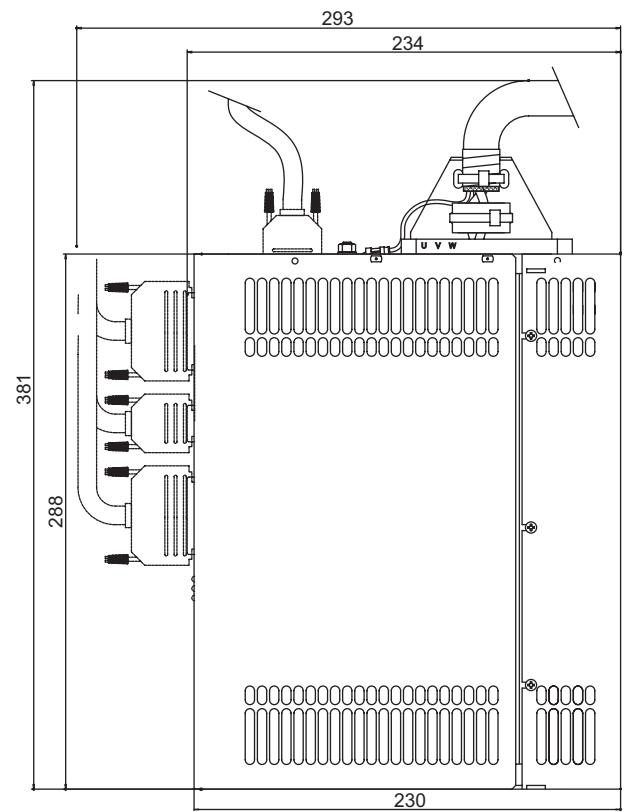
4.2 - CD1-a-400/1,8 to 7,2 A AMPLIFIER



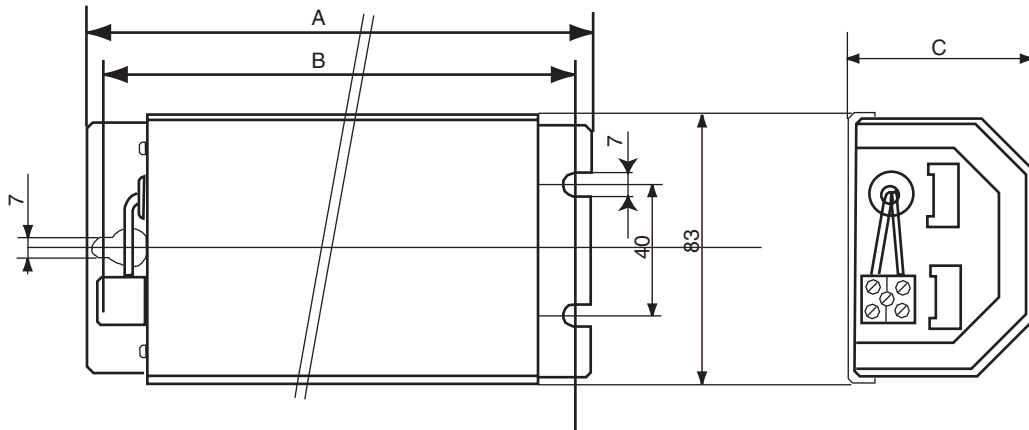
4.3 - CD1-a-400/14 A AMPLIFIER



4.4 - CD1-a-400/30 and 45 A AMPLIFIER



4.5 - BRAKING RESISTORS dp 100/100, dp 200/100, dp 50/200 and dp 33/280

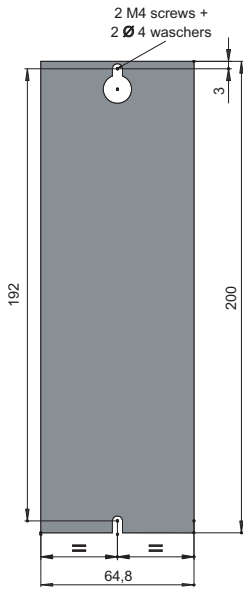


DIMENSIONS	dp 50/200, dp 100/100 and dp 200/100	dp 33/280
Size A	157 mm	290 mm
Size B	145 mm	278 mm
Size C	52 mm	57 mm

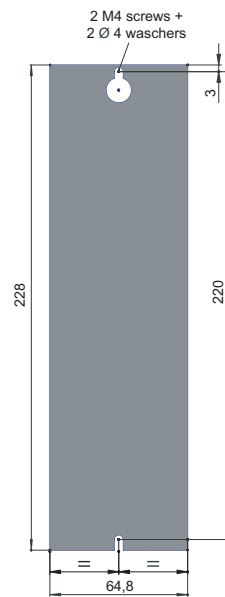
5 - FASTENING

VERTICAL MOUNTING IS MANDATORY

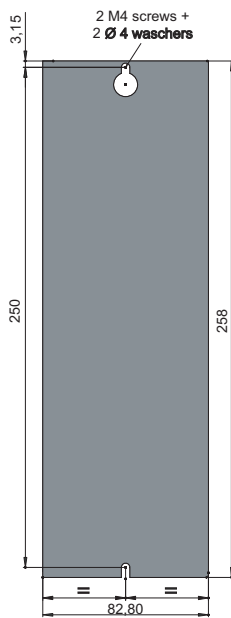
5.1 - CD1-a-230/I AMPLIFIER



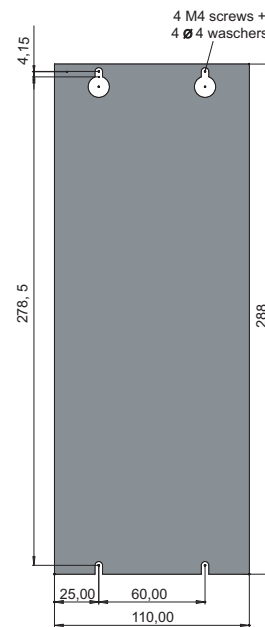
5.2 - CD1-a-400/1.8 to 7.2 A AMPLIFIER



5.3 - CD1-a-400/14 A AMPLIFIER

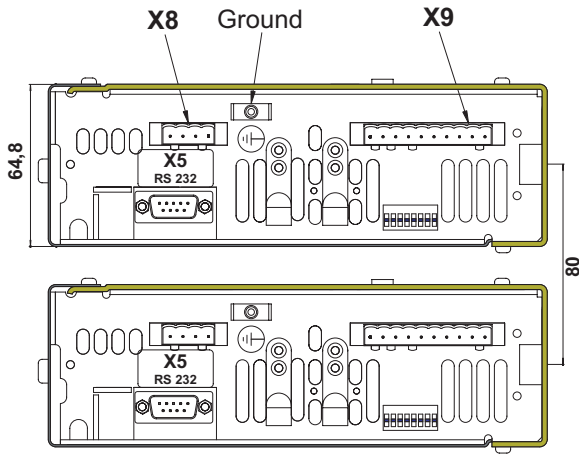


5.4 - CD1-a-400/30 and 45 A AMPLIFIER

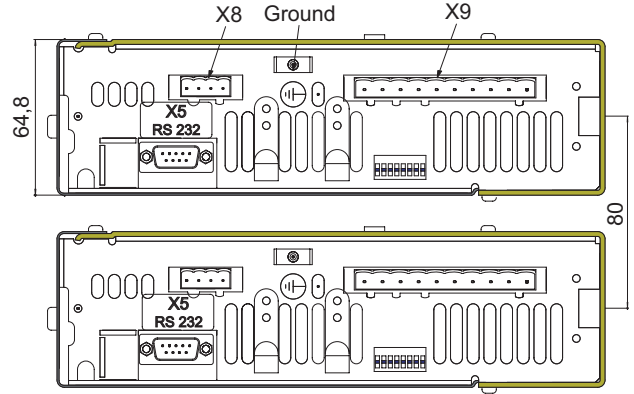


6 – MULTIAXES CABINET MOUNTING

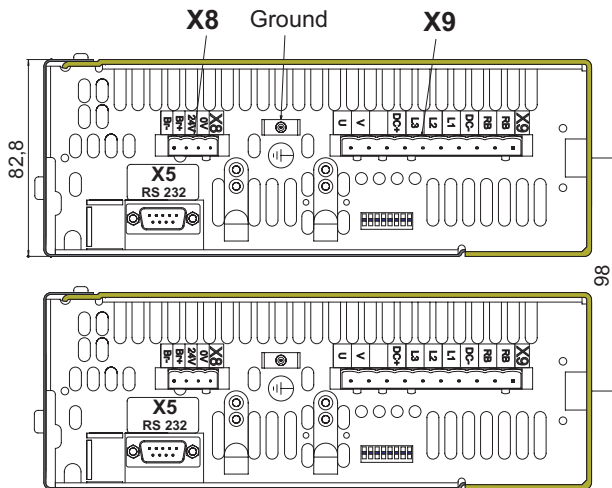
6.1 - CD1-a-230/I AMPLIFIER



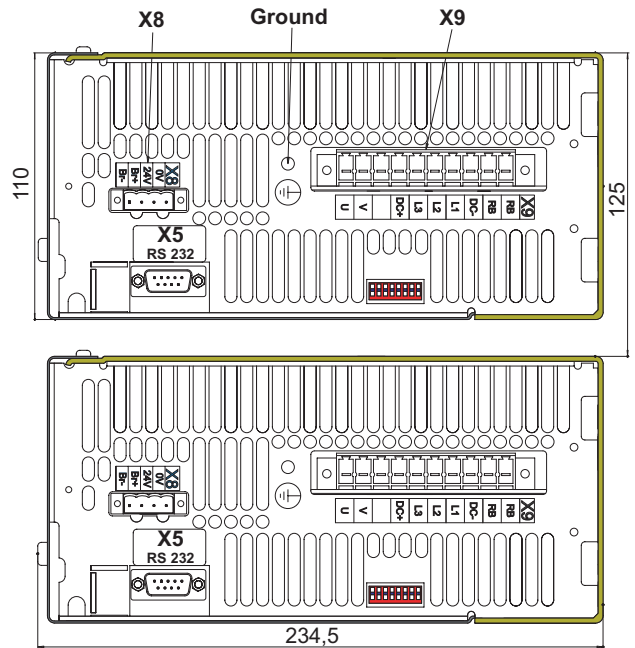
6.2 - CD1-a-400/1.8 to 7.2 AMPLIFIER



6.3 – CD1-a-400/14 AMPLIFIER



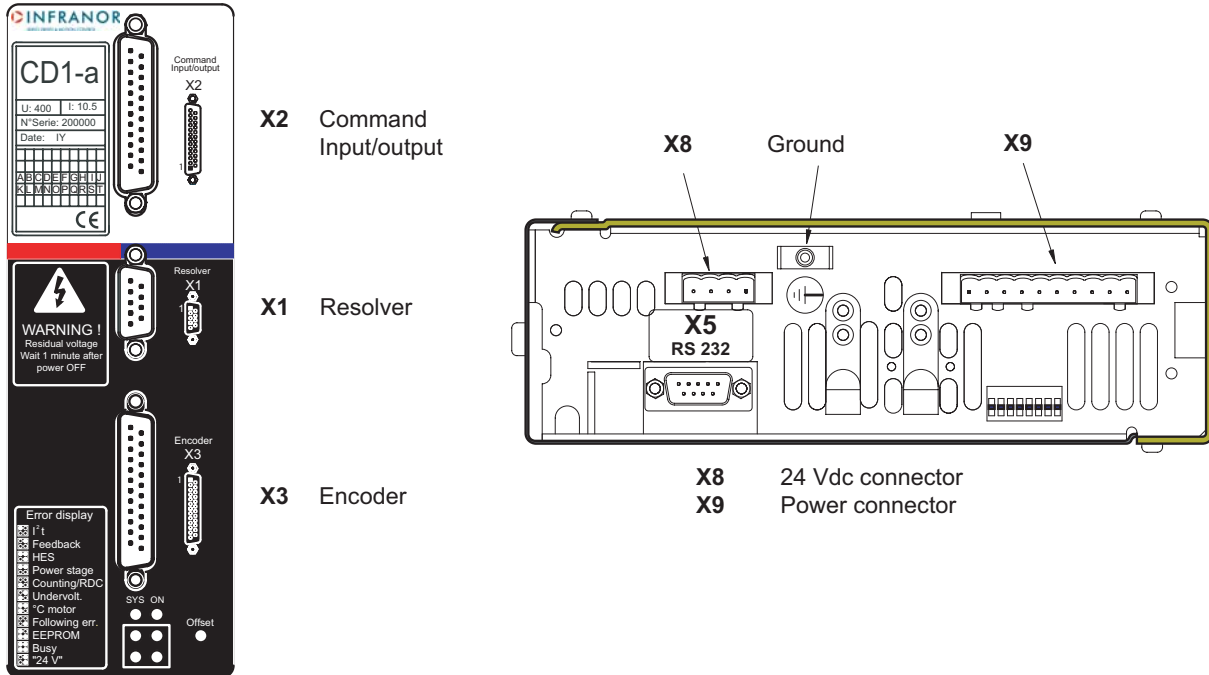
6.4 - CD1-a-400/30 AND 45 A AMPLIFIER



Chapter 3 - Inputs-Outputs

1 - CONNECTORS LOCATION

1.1 - AMPLIFIER CONNECTORS



2 - X1: RESOLVER CONNECTOR (Sub D 9 pins female)

Same connector for both 230 V and 400 V ranges.

PIN	FUNCTION	REMARKS
1	TC (thermal sensor)	If thermal switch connected to X1
6	Shield connection	If no "360°" connection on the connector
2	TC (thermal sensor)	If thermal switch connected to X1
7	S1 (cosine-)	Resolver connector
3	S3 (cosine+)	Resolver connector
8	S4 (sine-)	Resolver connector
4	S2 (sine+)	Resolver connector
9	R2 (reference-)	Resolver connector
5	R1 (reference+)	Resolver connector

For other resolver connections, see [chapter 8 \(Appendix\), section 2](#).

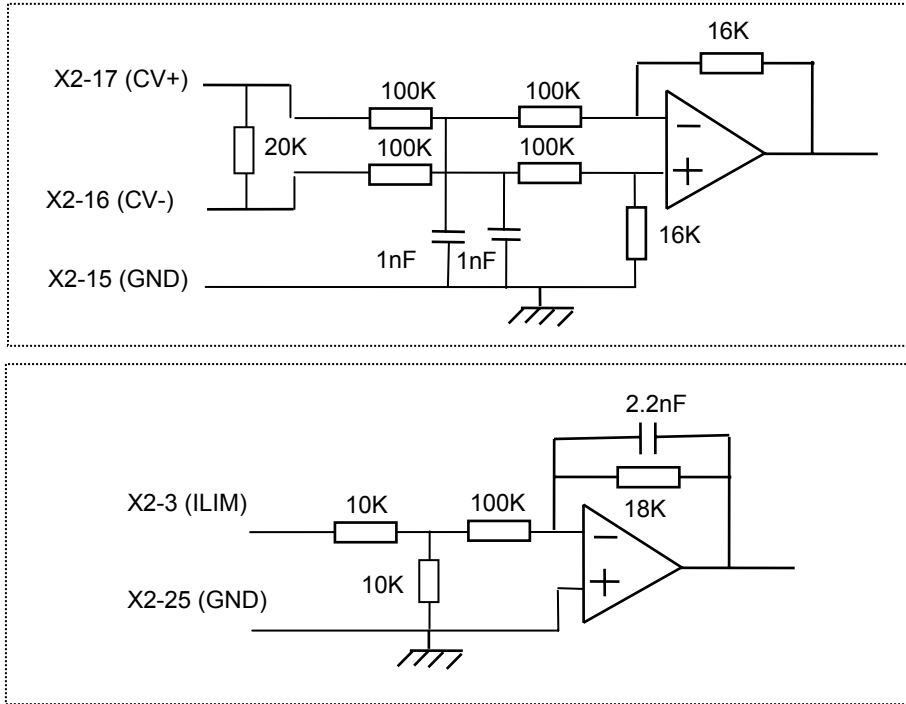
3 – X2: COMMAND CONNECTOR, LOGIC INPUTS-OUTPUTS AND ENCODER (Sub D 25 pins male)

Same connector for both 230 V and 400 V ranges.

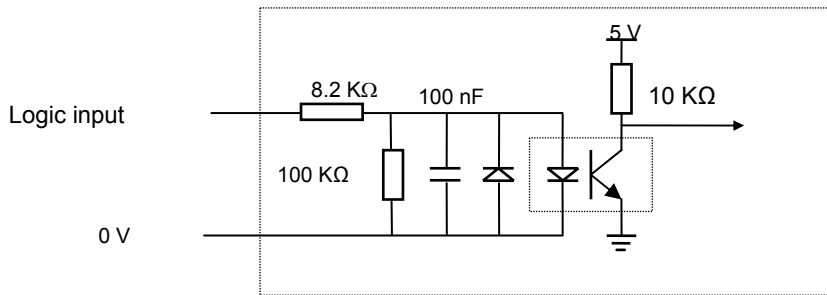
Pin	Function	I / O	REMARKS
1	FC+: Limit switch +	I	Positive logic, optocoupled input, galvanic insulation
14	FC-: Limit switch -	I	Positive logic, optocoupled input, galvanic insulation
24	Ref. inputs	I	Supply reference of the galvanic insulated logic inputs
20	ENABLE	I	Positive logic, optocoupled input, galvanic insulation
23	Ref. inputs	I	Supply reference of the galvanic insulated logic inputs
2	Current command CI	I	Positive logic, optocoupled input, galvanic insulation
10	CV0 Zero speed / Motor phasing input command	I	Positive logic, optocoupled input, galvanic insulation
25	GND	I	GND reference of the grounded amplifier
13	RESET	I	Positive logic, optocoupled input, galvanic insulation Inhibition of the faults memory stored in the amplifier
12	Ref. inputs (0 Volt)	I	Supply reference of the galvanic insulated logic inputs.
17	CV+ Input command CV +	I	± 10 V speed input command for max. speed
16	CV- Input command CV -	I	or ± 10 V current input command for I _{max} with "CI" input active
15	GND	I	GND reference of the earthed amplifier
3	I limit current limitation	I	Analog input for external max. current limitation 0 to 10 V for 100 % to 0 % of I _{max}
11	Analog output	O	+/-10V, resolution: 8 bit, load: 10 mA, linearity: 2%, low pass filter: 170 Hz, programmable output signal: Channel 1 of the digital oscilloscope (current, speed or position) or Phasing OK output (from 0 V to 10 V when the motor phasing is OK for an incremental encoder without HES)
18, 19	AOK: amplifier ready	O	Relay contact: closed if amplifier OK, open if fault. Protection against overvoltages by bidirectional TRANSIL P _{max} = 10 W with U _{max} = 50 V or I _{max} = 100 mA
21	+ 12 Volts	O	Output impedance: 9 Ohms. Max. 150 mA available ⁽¹⁾
22	- 12 Volts	O	Output impedance: 47 Ohms. Max. 50 mA available
4	Z/	O	Differential output of Z/ encoder marker pulse (max. 5 V, 20 mA)
5	Z	O	Differential output of Z encoder marker pulse (max. 5 V, 20 mA)
6	A/	O	Differential output of encoder A/ channel (max. 5 V, 20 mA)
7	A	O	Differential output of encoder A channel (max. 5 V, 20 mA)
8	B/	O	Differential output of encoder B/ channel (max. 5 V, 20 mA)
9	B	O	Differential output of encoder B channel (max. 5 V, 20 mA)

(1): The sum of the currents consumed by both X2 connector, pin 21 and X3 connector, pin 10 must not exceed 150 mA.

3.1 - SPECIFICATION OF THE ANALOG INPUTS: CV+, CV-, Ilim

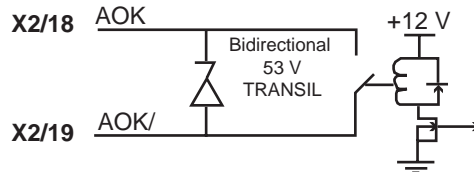


3.2 - SPECIFICATION OF THE LOGIC OPTOCOUPLED INPUTS: ENABLE, FCP, FCN, RESET, CVO, CI



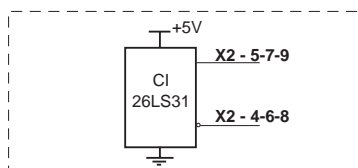
The input voltage corresponding to level 1 is between 18 V and 30V.

3.3 - SPECIFICATION OF THE "AOK" RELAY OUTPUT



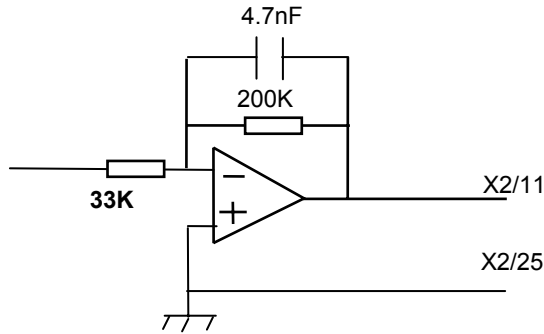
Relay contact open if any fault except for the "Undervolt." fault.
Pmax = 10 W with Umax = 50 V and Imax = 100 mA

3.4 - SPECIFICATION OF THE ENCODER OUTPUTS



Recommended receiver: 26LS32

3.5 - SPECIFICATION OF THE ANALOG OUTPUT



4 - X3 ENCODER INPUT

Same connector for both 230 V and 400 V ranges.

4.1 - X3 CONNECTOR FOR TTL INCREMENTAL ENCODER & HES INPUT (Sub D 25 pins female)

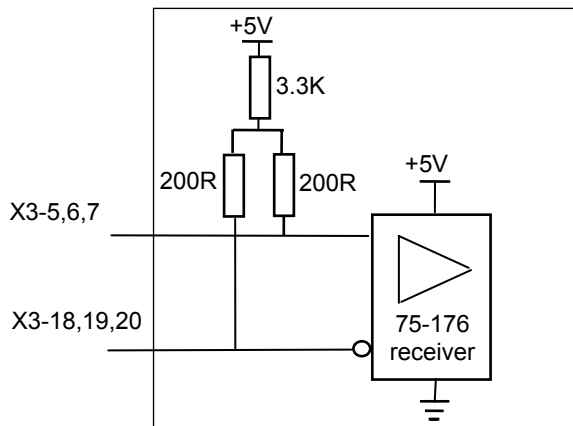
The “TTL incremental encoder & HES” configuration is selectable by software and stored into the amplifier EEPROM.

The corresponding X3 connector pin functions are described below.

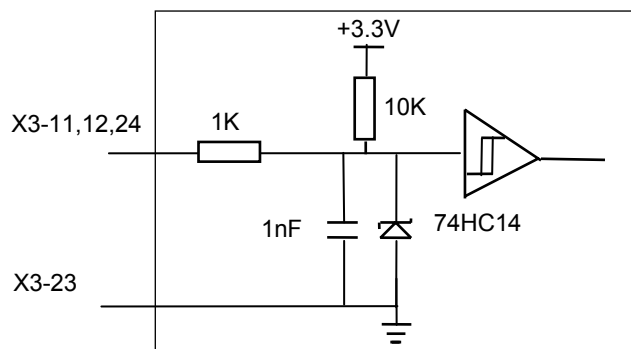
PIN	FUNCTION	REMARKS
18	Marker Z/	Differential input of the encoder marker pulse Z/
5	Marker Z	Differential input of the encoder marker pulse Z
19	Channel A/	Differential input of the encoder channel A/
6	Channel A	Differential input of the encoder channel A
20	Channel B/	Differential input of the encoder channel B/
7	Channel B	Differential input of the encoder channel B
8	+5 V	Encoder supply voltage (300 mA max. current)
21	GND	Encoder supply GND
11	HALL U	Hall sensor input signal phase U
24	HALL V	Hall sensor input signal phase V
12	HALL W	Hall sensor input signal phase W
10	+12 V	Hall sensors supply voltage: output impedance = 9 Ω, max 150 mA available ⁽¹⁾
23	AGND	Hall sensors supply GND
9	TC+	Motor thermal sensor input
22	TC-	Motor thermal sensor input
others	reserved	

(1): The sum of the currents consumed by both X2 connector, pin 21 and X3 connector, pin 10 must not exceed 150 mA.

ENCODER INPUT LINES SPECIFICATION



HALL SENSORS INPUT LINES SPECIFICATION



4.2 - X3 CONNECTOR FOR SinCos INCREMENTAL ENCODER & HES INPUT (Sub D 25 pins female)

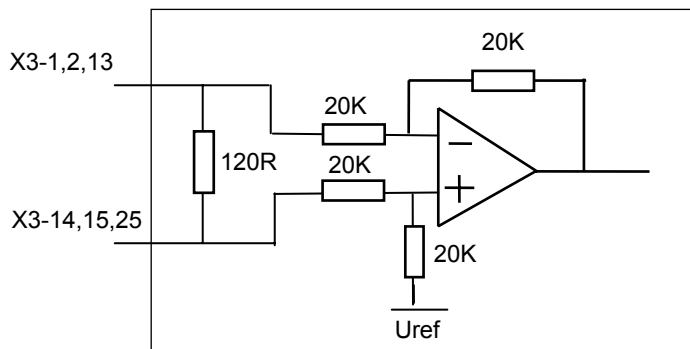
The “SinCos incremental encoder & HES” configuration is selectable by software and stored in the amplifier EEPROM.

The corresponding X3 connector pin functions are described below.

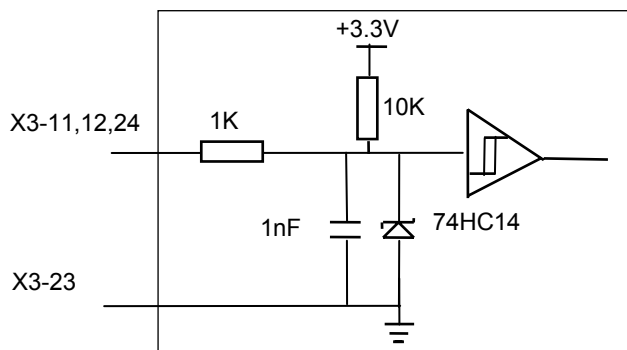
PIN	FUNCTION	REMARKS
25	Marker R/	Differential input of the Sin/Cos encoder reference pulse R/
13	Marker R	Differential input of the Sin/Cos encoder reference pulse R
14	Channel A/	Differential input of the Sin/Cos encoder channel A/
1	Channel A	Differential input of the Sin/Cos encoder channel A
15	Channel B/	Differential input of the Sin/Cos encoder channel B/
2	Channel B	Differential input of the Sin/Cos encoder channel B
8	+5V	Encoder supply voltage (300 mA max. current)
21	GND	Encoder supply GND
11	HALL U	Hall sensor input signal phase U
24	HALL V	Hall sensor input signal phase V
12	HALL W	Hall sensor input signal phase W
10	+12V	Hall sensors supply voltage: output impedance = 9 Ω, max 150 mA available ⁽¹⁾
23	AGND	Hall sensors supply GND
9	TC+	Motor thermal sensor input
22	TC-	Motor thermal sensor input
others	reserved	

(1): The sum of the currents consumed by both X2 connector, pin 21 and X3 connector, pin 10 must not exceed 150 mA.

SIN/COS ENCODER CHANNELS SPECIFICATION



HALL SENSORS INPUT LINES SPECIFICATION



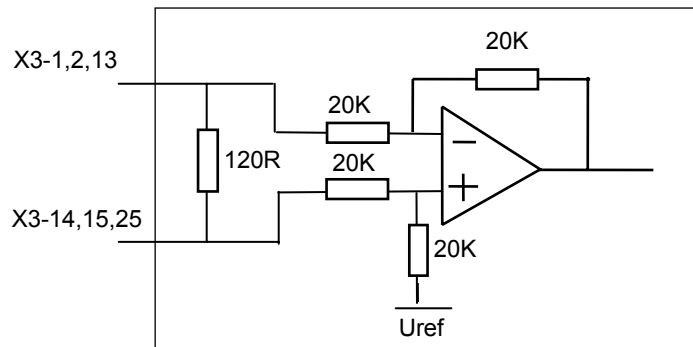
4.3 - X3 CONNECTOR FOR ABSOLUTE SINGLE-TURN SinCos ENCODER (Sub D 25 pins female)

The “ Absolute single-turn SinCos Encoder” configuration (Heidenhain ERN 1085 or compliant) is selectable by software and stored in the amplifier EEPROM.

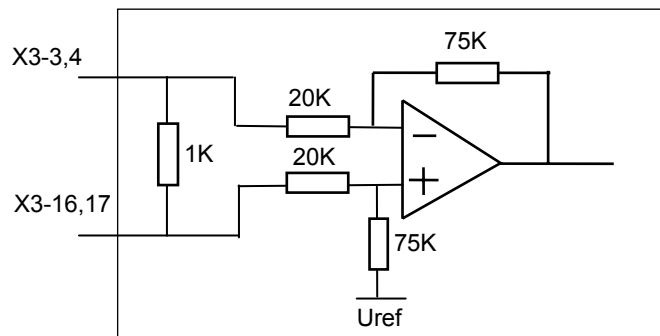
The corresponding X3 connector pin functions are described below.

PIN	FUNCTION	REMARKS
25	Marker R/	Differential input of the Sin/Cos encoder reference pulse R/
13	Marker R	Differential input of the Sin/Cos encoder reference pulse R
14	Channel A/	Differential input of the Sin/Cos encoder channel A/
1	Channel A	Differential input of the Sin/Cos encoder channel A
15	Channel B/	Differential input of the Sin/Cos encoder channel B/
2	Channel B	Differential input of the Sin/Cos encoder channel B
16	Channel C/	Differential input of the Sin/Cos encoder channel C/
3	Channel C	Differential input of the Sin/Cos encoder channel C
17	Channel D/	Differential input of the Sin/Cos encoder channel D/
4	Channel D	Differential input of the Sin/Cos encoder channel D
8	+5V	Encoder supply voltage (300 mA max. current)
21	GND	Encoder supply GND
9	TC+	Motor thermal sensor input
22	TC-	Motor thermal sensor input
others	reserved	

SIN/COS ENCODER CHANNELS SPECIFICATION



SIN/COS COMMUTATION CHANNELS SPECIFICATION



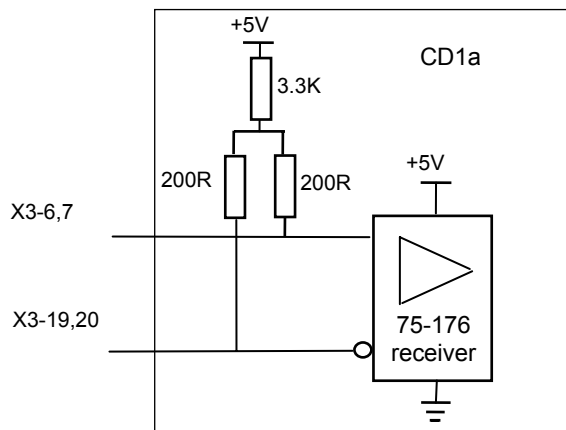
4.4 - X3 CONNECTOR FOR STEPPER MOTOR EMULATION (Sub D 25 pins female)

The "Stepper motor emulation" is software configurable and stored in the amplifier EEPROM.

The corresponding X3 connector pin functions are described below.

PIN	FUNCTION	REMARKS
19	PULSE/	Differential input of the PULSE/ channel
6	PULSE	Differential input of the PULSE channel
20	DIR A/	Differential input of the DIR/ channel
7	DIR	Differential input of the DIR channel
others	reserved	

SPECIFICATION OF THE PULSE AND DIRECTION SIGNALS



5 - X5 SERIAL LINK (Sub D 9 pins male)

Same connector for both 230 V and 400 V ranges.

PIN	FUNCTION	REMARKS
5	0 Volt	GND (connection of the shield if no "360°" connection on the connector)
3	TXD	Transmit data RS-232
2	RXD	Receive data RS-232
6	TXH	Transmit data RS-422
7	TXL	Transmit data RS-422
8	RXL	Receive data RS-422
9	RXH	Receive data RS-422

6 - X8: AUXILIARY SUPPLY CONNECTOR

Same connector for both 230 V and 400 V ranges.

4 pins male connector (with 5.08 mm pitch) - Female connector supplied

Fastening torque of the connector screws: 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	GND	I	Potential reference of the 24 VDC supply	GND = earthed potential reference
2	+24 VDC	I	24 VDC auxiliary supply mains isolated	24 VDC +/-15 % - 0.320 A (without brake control) Regulation with load: 3 %
3	Brake+ 24 V	O	Motor brake supply with 24 Vdc	Powerless brake : 24 Vdc / 1.5 A
4	Brake-	O	Direct motor brake control I _{max} = 1.5 A	Grounded load output protected against short circuits

7- X9 POWER CONNECTOR: MAINS, MOTOR, BRAKING RESISTOR (CD1-a-230 V AND 400 V)

CD1-a-230/I: 10 pins male connector (with 5.08 mm pitch) - Female connector supplied

CD1-a-400/I: 10 pins male connector (with 7.62 mm pitch) - Female connector supplied

Fastening torque of the connector screws: 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	RB	O	Power feedback during the motor deceleration with high inertia and speed	CD1-a-230/I: 100 Ohms/100W (dp 100/100) CD1-a-400/1.8 to 7.2: 200 Ohms/100W (dp 200/100) CD1-a-400/14: 50 Ohms/200 W (dp 50/200) CD1-a-400/30 and 45: 33 Ohms/280W (dp 33/280) (Braking resistors must be ordered separately)
2	RB	O		
3	DC-	I/O	Parallel connection of the DC bus	
4	L1	I	Mains input	CD1-a-230/I 230 VAC 1~ or 3~ CD1-a-400/I 400 to 480 VAC 3~
5	L2	I	Mains filter integrated in the amplifier	
6	L3	I		
7	DC+	I/O	Parallel connection of the DC bus	
8	W	O	Motor phase W	Motor cable with earthed connection by means of Faston socket and 360° shield connection on earthed collar
9	V	O	Motor phase V	
10	U	O	Motor phase U	

IMPORTANT: The motor cable must be shielded and connected over 360° on collars mounted for this purpose on the housing. The ground wire of the motor cable **MUST** be connected to the Faston socket marked with the GND sign.

The ground reference must also be connected on the second Faston socket.

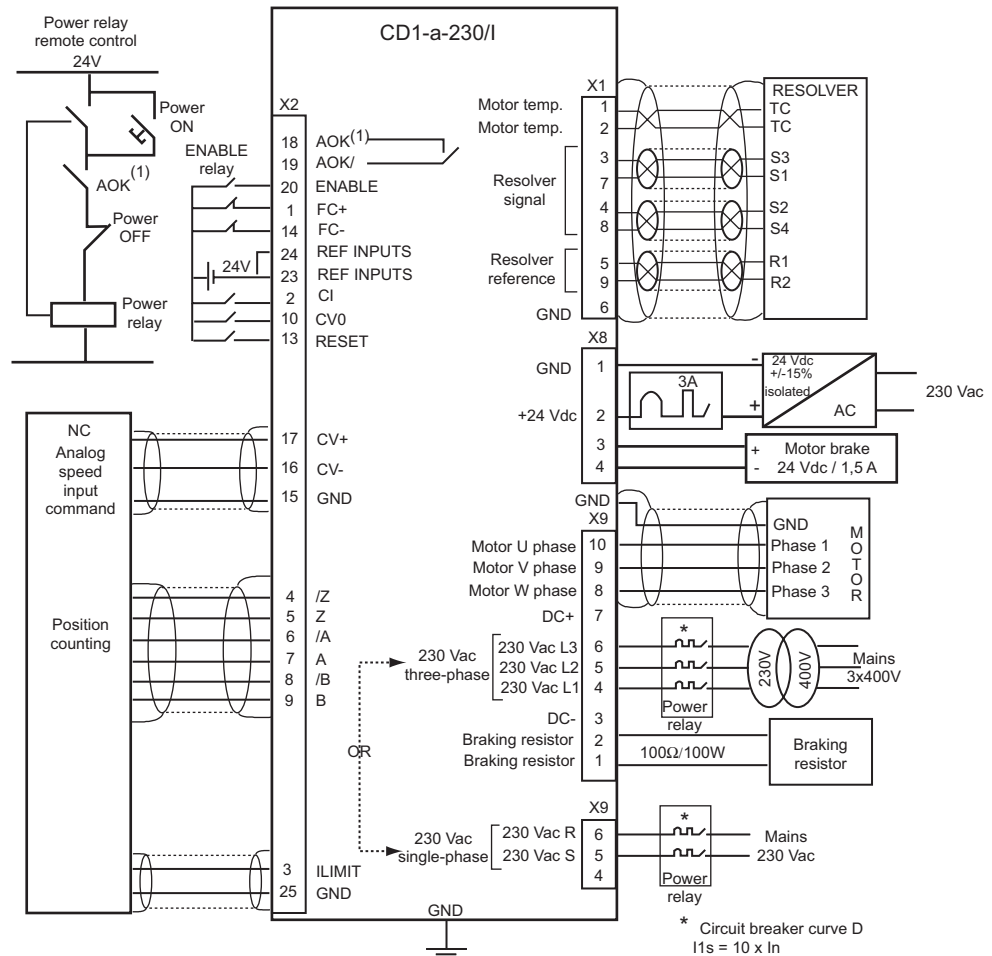
- The installer of the drives has to use a UL Listed Quick connect for ground connection (0.250 inches or 6.35 mm wide nominal).
- Field wiring terminals have to use copper conductors only.
- Torque value for field wiring terminals: value to be according to the Recognized terminal block used.

Chapter 4 - Connections

1 - CONNECTION DIAGRAMS

1.1 - CD1-a-230/I AMPLIFIER

(For the UL certified connection, see [chapter 4, section 3.4](#)).

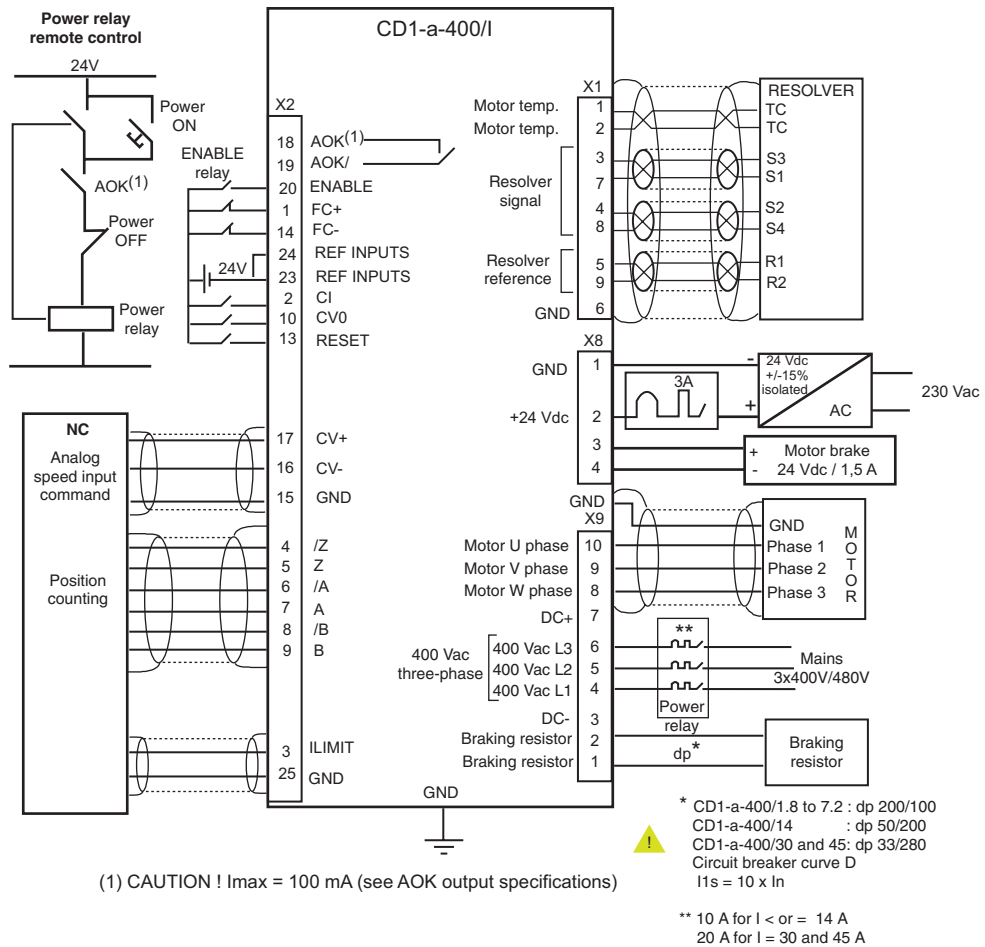


(1) CAUTION ! I_{max} = 100 mA (see AOK output specifications)

The protection, on source side, of both 24 V and power supplies must be made by the user.

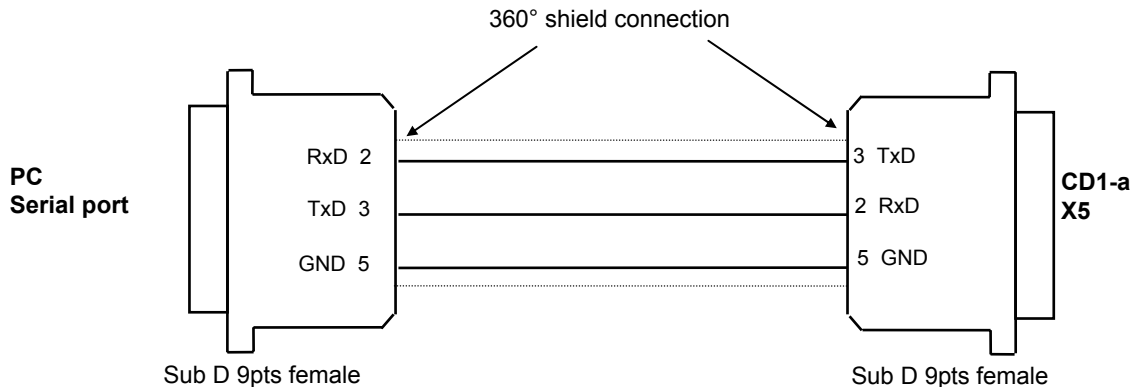
1.2 - CD1-a-400/I AMPLIFIER

(See chapter 4, section 3.5 for the UL compliant connection).

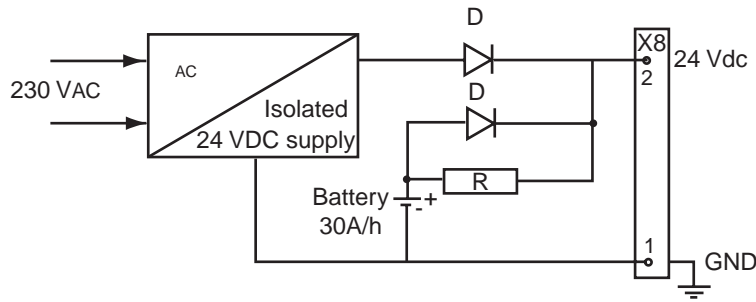


The protection, on source side, of both 24 V and power supplies must be made by the user.

1.3 - SERIAL LINK CONNECTION

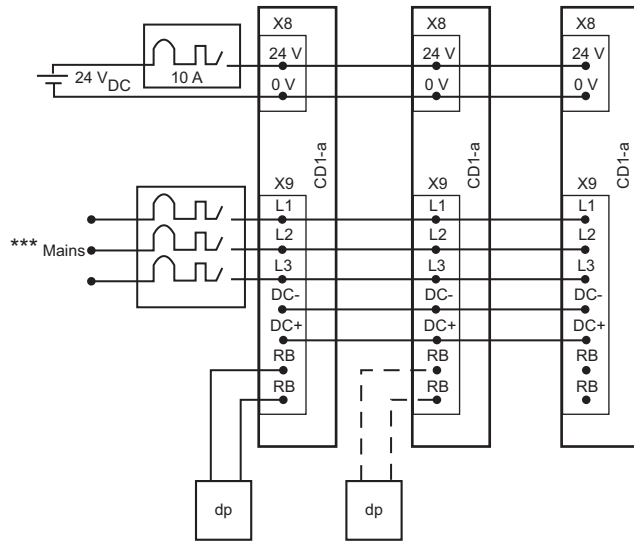


1.4 - CONNECTION OF A BACKUP BATTERY FOR THE 24 VDC AUXILIARY SUPPLY



The CD1-a amplifier consumption is 320 mA with 24VDC. So, a 24 V / 30 A/h battery can keep the amplifier on during i.e. a long 3 days week-end or during a mains cut-off without losing the machine initialization. This backup method is very interesting for saving the machine initialization as well as the axis position even when moving with the mains switched off. An ASCII command allows to send the axis position to the digital host system.

1.5 – CONNECTION EXAMPLE FOR A MULTIAxis APPLICATION



*** CD1-a-230/l : 3 x 230 V
 CD1-a-400/l : 3 x 400 V
 Circuit breaker curve D
 $I_{1s} = 10 \times I_n$

For a multi-axis application with n drives, the circuit breaker rating is given by the formula:

$$I_n = 0,3 \sum_1^n I_{\text{rated amplifier}}$$

But, the current rating of the circuit breaker must not exceed:

- 20 A on 230 V drives,
- 20 A on 400 V / 1,8 to 14 A drives,
- 40 A on 400 V / 30 A and 45 A drives.

2 - WIRING

(according to EN61000.4-2-3-4-5 and EN55011 standards - see [diagram "Shield connection on the connectors"](#) – [chapter 4, section 2.2](#)).

2.1 - GROUND WIRING AND GROUNDING

CAUTION !

Each potential conducting element must be shielded. Several potential conductors in the same sleeve must be twisted and shielded.

A shield has no effect if it is not connected:

- to a reference potential,
- by a connection as short as possible (a few centimeters; 10 centimeters are prohibited),
- by a "360°" shield connection. This means that the whole circumference of the shield sleeve must be connected to the reference conductor via a metal collar.

The connectors used for the compliance with the EN61000.4 standard must be made of metal or metallized and must allow the 360° shield connections.

Reference potential loops (especially with the ground) are recommended **only** if these loops have a very low impedance ($< 0,1 \Omega$). Any shield that is not used as a conductor can be connected at both ends under the condition to be connected over 360° at both ends by means of metal links in order to ensure the shield continuity.

The preferred reference potential must be the earth.

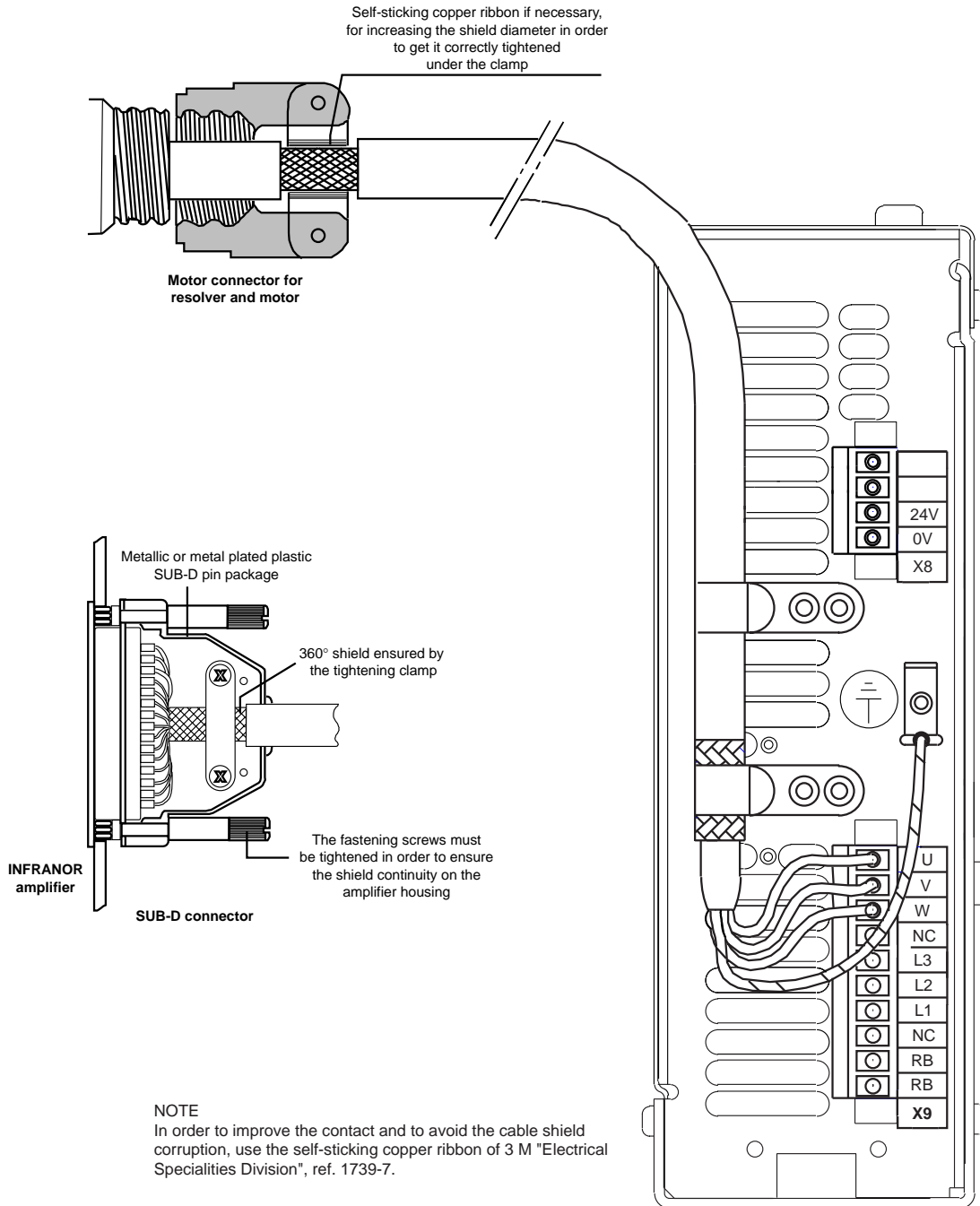
Cables with low potential should **never** run in the proximity of power lines.

If there is a potential reference, i.e. a main chassis or cabinet with a low impedance between its various elements, it should be used for short connections to it and also be grounded itself.

2.2 - CONNECTORS SHIELD CONNECTION

RULE

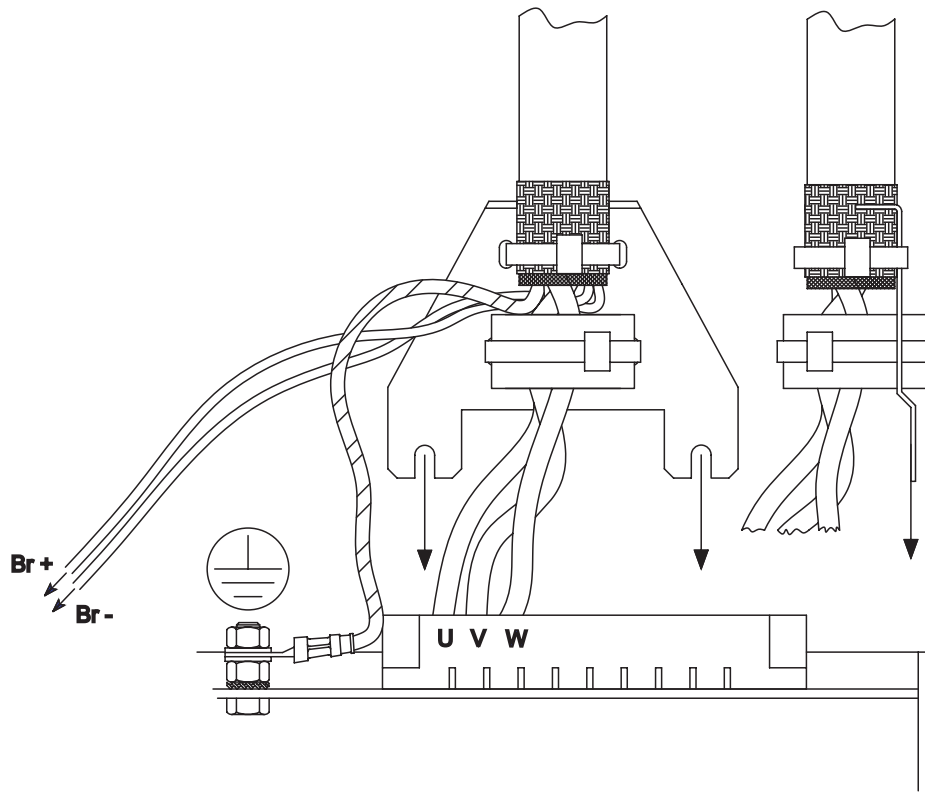
The shield should never be interrupted or corrupted over the whole cable length.



NOTE

When the 360° shield connection is made by means of a collar, it is not necessary to connect a cable on the appropriate pin of the SUB-D connector.

2.3 - CONNECTION VUE OF CD1-a-400/30 AND 45



2.4 – MOTOR, RESOLVER AND ENCODER CABLES

Motors, resolvers and encoders are grounded via their housing.

Cable inputs must be made by means of metal connectors with collars allowing the 360° shield connection.

The resolver cable must be pair twisted and shielded (sin, cos, ref.). Motor cables **MUST** also be shielded and connected over 360° at both ends as shown on the shield connection diagram.

The encoder inputs A, B, C, D, Z and R require pair twisted and shielded cables. The shield must have a "360°" connection via metallic collars at both ends. If the shield is connected by means of a pig tail, it must be connected at one end to the GND pin of the connector on the amplifier side with a connection as short as possible.

Check that the voltage drop in the power supply lines of the encoder cable is complying with the technical specifications of the encoder. The voltage drop value for a given cable is calculated as follows:

$$\Delta U[V] = 40 \cdot 10^{-6} \cdot \frac{Lc[m] \cdot I[mA]}{S[mm^2]}$$

with

ΔU:	voltage drop in volts
Lc:	cable length in meters
I:	encoder current in milliamps (see technical specifications)
S:	cross section in square millimeters

Due to this voltage drop:

- an encoder with a large power supply voltage range should be preferred,
- if the encoder has got power supply SENSE feedback lines, they can be connected to the power supply lines in order to reduce the voltage drop by the half (the SENSE feedback signal is not used in the CD1 range),
- if none of both solutions above can be used, the user has to supply the encoder by means of an external power supply.

Example

The application requires an Heidenhain linear encoder supplied by 5 V \pm 5 % / 300mA with 25 m cable length.

Min. power voltage: 5 V \pm 5 % $\Rightarrow \Delta U_{\max} = 0.25$ V \Rightarrow . Min. cross section: S = 1.2 mm².

Such a large cross section is difficult to obtain, so the user can:

- either connect the SENSE feedback signal lines with power supply lines, while the needed wires cross section will be the half (0.6 mm²),
- or use the same encoder type but the version which allows its power supply voltage from 3.6 V to 5.25V / 300mA. Min power voltage 3.6V $\Rightarrow \Delta U_{\max} = 1.4$ V \Rightarrow . Min. cross section : S = 0.21mm²

The cables of brake equipped motors must also have their brake cables shielded in order to be EMC compliant.

Maximum cable length: - resolver: ≤ 100 m
 - encoder: ≤ 25 m
 - motor: $25 \text{ m} \leq d \leq 100 \text{ m}$.

We advise:

- to use the maximum cable section allowed by the connectors,
- to mount a reactance with an inductive value between 1% and 3% of the motor inductive value. The reactance inductive value must be taken into account in the calculation of the current loops. The current rating of the reactance must be equal to or higher than the drive rating. The reactance must be mounted at the drive output. Due to the use of a reactance, a shielded cable is not mandatory anymore. A more complex sinus filter type FN510 by Schaffner may also be mounted instead of the reactance.

UNDESIRABLE EFFECTS OF MOTOR CABLES LONGER THAN 25 m:

- Heating of the power module, the motor and the cable.
- High overvoltages on the motor windings involving a shortening of their life time.

The reactance reduces the undesirable effects on motor and drive but it may be quite heated. This requires an appropriate cooling.

2.5 - INPUT COMMAND AND SERIAL LINK CABLES

The analog input command signal CV requires a pair twisted and shielded cable. The shield must have a "360°" connection via metallic connectors at both cable ends.

The input command (CV) wiring must be made according to the polarity between the controller and the amplifier (CV+ on "diff high" of the controller). The logic 0 Volt is directly connected to the amplifier housing. The ground connection continuity is ensured by the fastening screws of the front panel sub-D connectors. **But the amplifier 0 Volt and the controller 0 Volt MUST be connected together by means of a wire. The shield MUST NEVER be used as a conductor of the 0 Volt potential.**

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

CAUTION !

The command cables (input command, serial link, position, resolver, encoder) as well as the power cables MUST be connected and disconnected with the amplifier TURNED OFF.

Reminder: The power voltage may remain several minutes on the capacitors terminals. A contact under high voltage may involve severe physical damage.

2.6 - CONNECTION CABLES OF THE BRAKING RESISTOR

The connection cable to the braking resistor housing must be able to bear high voltage and temperature such as 600 V and 105° C.

Recommended cable = UL 1015 Gauge 14.

Fastening torque on the housing connector: dp = 0.9 Nm.

3 - REQUIREMENTS OF COMPLIANCE WITH THE UL STANDARDS

This UL listing requires some conditions to be fulfilled by the installer of the drives.

3.1 - CONNECTION BY MEANS OF FASTON SOCKET

The installer must use a UL listed quick connect for ground connections (0.250 inches or 6.35 mm wide nominal) on all drives equipped with FASTON sockets.

On drives equipped with a screwed ground connector, the connection must be made via UL listed sockets.

3.2 - 24 V SUPPLY

The end user has to provide a 24 VDC isolated power supply (e.g. with isolation transformer) for the auxiliary supply input, protected by a 4 A UL listed fuse.

3.3 - POWER SUPPLY AND UL FUSE RATINGS

The fuse type recommended for motor applications is class RK5. The maximum short-circuit power of the mains must not exceed 5000 Arms at a voltage of 480 V, when protected by a UL fuse of type RK5.

On CD1a-400/I drives, the fuse ratings must be the following:

CD1-a	400/1.8 to 7.2	400/14	400/30 and 45	Multiaxis
BUSSMANN Class RK5 Type FRS-R	FRS-R-4	FRS-R-8	FRS-R-20	$0,3 \times \sum_1^N I_{\text{rated amplifier}}$
LITTELFUSE Class RK5 Type FLSR-ID	FLSR2ID	FLSR8ID	FLSR20ID	$0,3 \times \sum_1^N I_{\text{rated amplifier}}$

In a multiaxis application with N drives, the fuse rating is calculated by the formula given in the table above. But a rating of 20 A must not be exceeded on 400/1.8 A to 14 A drives and 40 A must not be exceeded on 400/30 and 45A (see [chapter 4, section 3.5](#)).

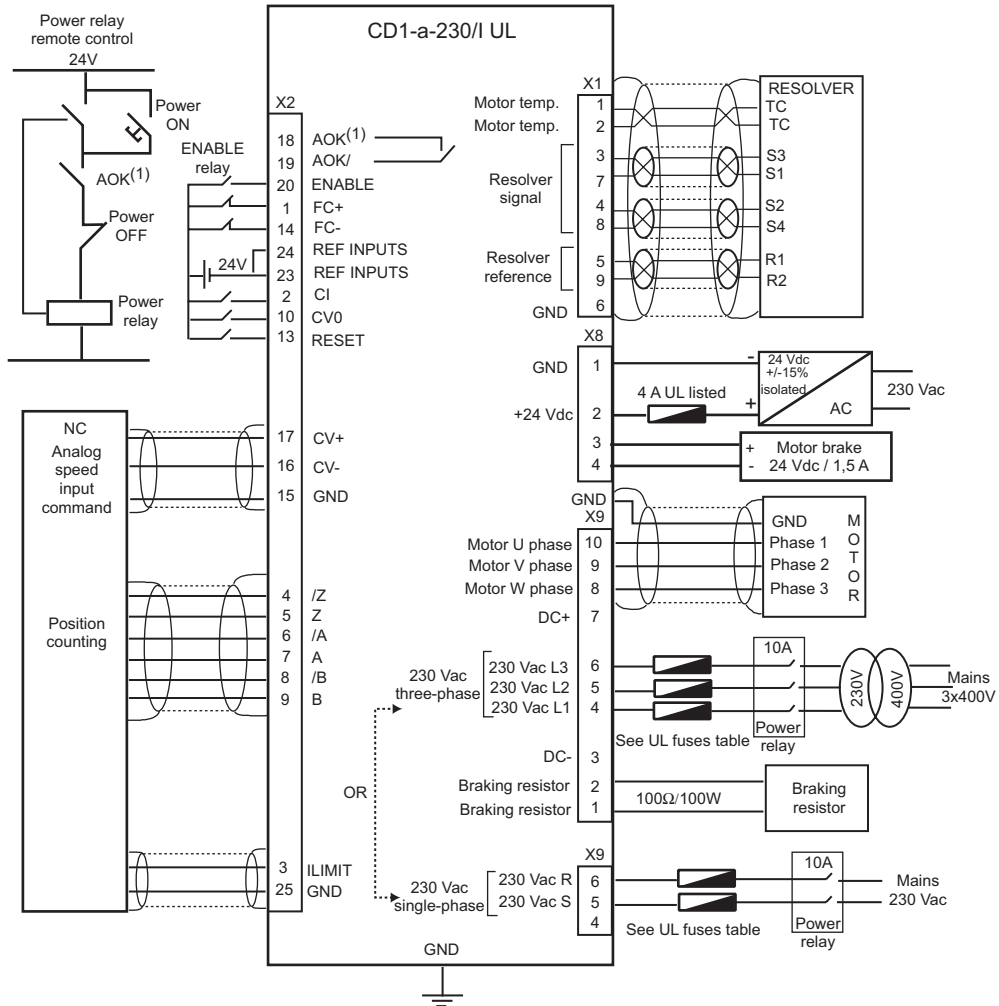
On CD1a-230/I drives, the fuse ratings must be the following:

CD1-a	230/2.25 to 10.5	230/16.5	Multiaxis
BUSSMANN Class RK5 Type FRN-R	FRN-R-6	FRN-R-9	$0,3 \times \sum_1^N I_{\text{rated amplifier}}$
LITTELFUSE Class RK5 Type FLNR-ID	FLNR6ID	FLNR9ID	$0,3 \times \sum_1^N I_{\text{rated amplifier}}$

In a multiaxis application with N drives, the fuse rating is calculated by the formula given in the table above. But a rating of 20 A must not be exceeded on 230 V drives (see [chapter 4, section 3.5](#)).

3.4 – CD1-a-230/I DRIVE: CONNECTION DIAGRAM WITH PROTECTIONS BY "UL" FUSES

(according to the table in section 3.3 of this chapter)



(1) CAUTION ! I_{max} = 100 mA (see AOK output specifications)

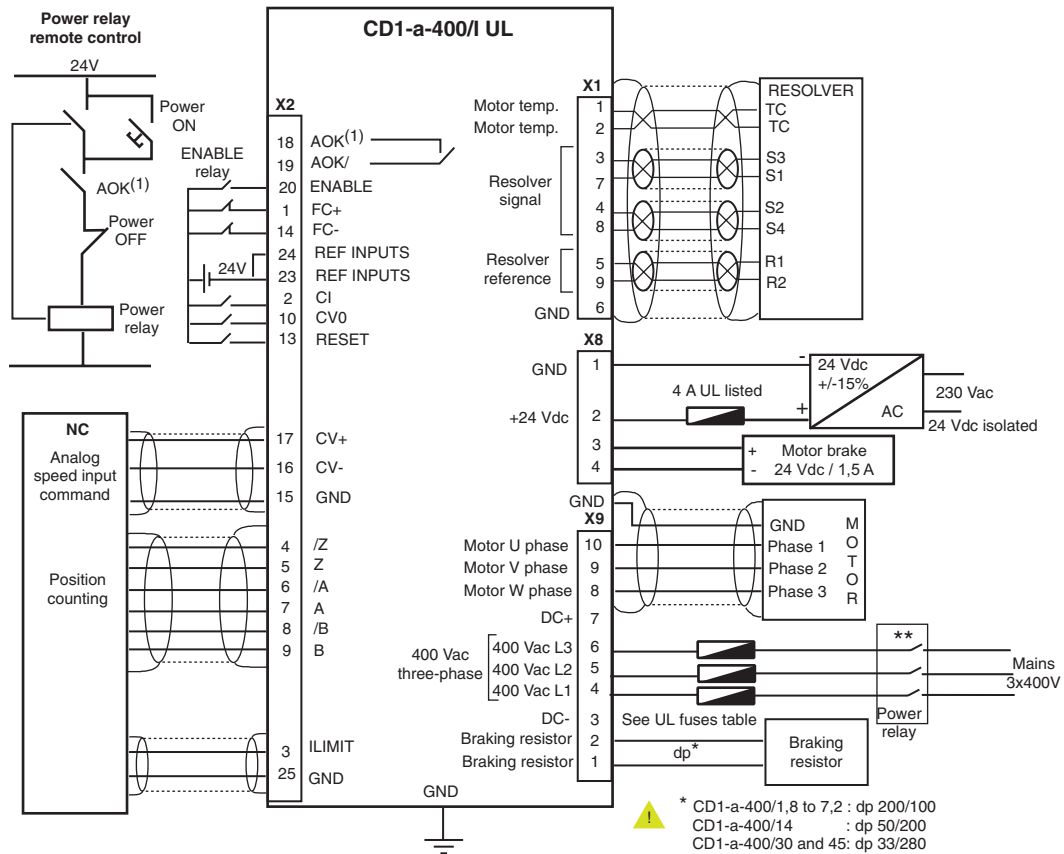
IMPORTANT

The installer of the drives has to use a UL listed quick connect for ground connection (0.250 inches or 6.35 mm wide nominal).

Field wiring terminals must use copper conductors only.

Torque value for field wiring terminals: according to the Recognized terminal block used.

3.5 - CD1-a-400/I DRIVE: CONNECTION DIAGRAM WITH PROTECTIONS BY "UL" FUSES
 (according to the table in section 3.3 of this chapter)



(1) CAUTION ! $I_{max} = 100 \text{ mA}$ (see AOK output specifications) ** 10 A for $I < \text{or} = 14 \text{ A}$
 20 A for $I = 30 \text{ and } 45 \text{ A}$

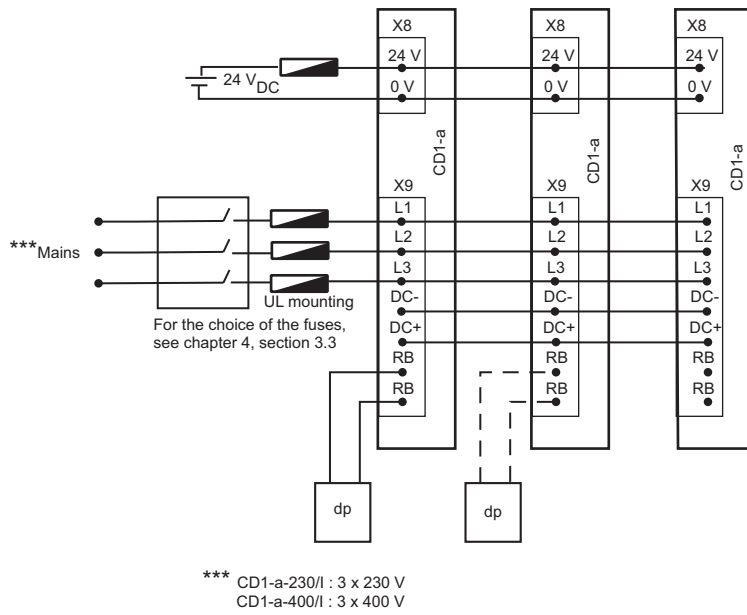
IMPORTANT

The installer of the drives has to use a UL listed quick connect for ground connection (0.250 inches or 6.35 mm wide nominal).

Field wiring terminals must use copper conductors only.

Torque value for field wiring terminals: according to the Recognized terminal block used.

3.6 - CONNECTION EXAMPLE FOR A UL COMPLIANT MULTIAXIS APPLICATION



Chapter 5 - Parameter setting

The parameter setting software **VISUAL DRIVE SETUP**, which is PC compatible with the WINDOWS® operating system, allows an easy modification of all amplifier parameters.

Please, see Web Site www.infranor.fr for downloading the **VISUAL DRIVE SETUP** software.



WARNING

The auto-tuning procedure should be executed by the PC in control mode and at standstill. If the auto-tuning procedure must be executed with the drive controlled by the analog command input CV, the value of the input command **MUST** be 0 Volt. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the auto-tuning procedure.

Chapter 6 – Commissioning

1 - AMPLIFIER STANDARD CONFIGURATION

The **CD1-a** amplifier hardware configuration is made for MAVILOR motors.
Resolver ratio: 0.5.

See [Chapter 8, parts 2, 3 and 4](#) for the amplifier adjustment to other motor or resolver types.

2 - FIRST POWERING OF THE CD1-a AMPLIFIER

2.1 - VERY IMPORTANT

Check the connections, particularly of the 24 VDC and power supplies. There are two different amplifier voltage versions: 230 VAC and 400 VAC. Check for the appropriate label on the amplifier. It must be in accordance with the power connections. **The 400 VAC connection of a 230 V amplifier will destroy it.**

Check for the braking resistor sizing:

- dp 100/100 for 230 VAC
- dp 200/100 for 400 VAC and current ratings 1.8 to 7.2.
- dp 50/200 for 14 A current rating.
- dp 33/280 for 30 and 45 A current ratings

Any braking resistor value lower than 200 Ω for the CD1-a-400/1.8 to 7.2 A amplifier will definitely damage the braking system.

The ENABLE signal (X2 connector, pin 20) must be disabled and the CV analog command input (X2 connector, pins 16/17) must be short-circuited.

Check for the correct groundings and 360° shield connections.



WARNING

During the machine adjustments, some drive connection or parameter setting errors may involve dangerous axis movements. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the operators' presence in the concerned area.

2.2 - SWITCH ON THE 24 VDC SUPPLY

The green front panel "ON" Led must light up.

The "Undervolt." fault must be displayed.

The "AOK" relay contact (pins 18 and 19 of X2) is closed. It is then possible to control the power relay according to the recommendations of [Chapter 4, section 1: Connection diagrams](#).

2.3 – SWITCH ON THE 230 VAC OR 400 VAC SUPPLY (according to the amplifier type).

Use the power supplies connection drawing while taking into account the AOK relay signal. The red UNDERVOLT. Led must go out after a few seconds.

The amplifier is ready for commissioning by means of the **VISUAL DRIVE SETUP** software (see next section).

The amplifier must be switched on in following order:

- 24 V supply on
- AOK relay contact closing
- Power on

Otherwise, it may cause physical and material damage.



WARNING

It is mandatory to wait for at least 30 seconds between switching off and on again the drive

3 - AMPLIFIER COMMISSIONING AND ADJUSTMENT



The amplifier command cables (input command, serial link, resolver, encoder, HES) as well as the power cables must be connected and disconnected with the amplifier turned off.

3.1 - COMMUNICATION VIA THE SERIAL LINK

Connect the serial link RS 232 between the PC and the amplifier.

The "ENABLE" input must be disabled and the analog input command CV short-circuited.

Turn the amplifier on and start the **VISUAL DRIVE SETUP** PC software under WINDOWS®.

If the message "**No serial communication found**" appears on the screen, click on **OK** and check following points:

- the amplifier is on (green LED **ON** must lit),
- the amplifier and the PC are correctly connected via the RS 232 link,
- the software configuration (**Com. port and Baudrate**) is correct.

3.2 – SENSOR FEEDBACK CONFIGURATION

The amplifier feedback sensor configuration is selectable by software and stored into the amplifier EEPROM.

Resolver sensor feedback is the standard amplifier configuration. For a motor equipped with an encoder position sensor proceed as described below:

- ◆ Select first the appropriate encoder type in the **Feedback configuration** menu.
- ◆ Select then **Encoder feedback** and validate the selection.

If the motor is using Hall Effect Sensors: check that the ENABLE input is disabled and the amplifier turned on and move the motor manually over one revolution, or one pole pitch for a linear motor. If the **HES** error is displayed, turn off the amplifier and check the following points before turning it on again:

- ◆ The HES are correctly wired on the amplifier X3 connector (if 60° type HES are used, check the various HES signals wiring combinations to find the right wiring order).
- ◆ The HES supply voltage value is correct.
- ◆ The **Motor encoder resolution** parameter value is correct.

If the motor HES are not working correctly, select the appropriate **Incremental encoder** type (without HES) in the **Feedback configuration** menu and start the amplifier commissioning in this configuration.

If the motor is using an absolute single-turn Sin/Cos encoder (Heidenhain ERN 1085 or compliant), check that the ENABLE input is disabled and the amplifier turned on and move the motor manually over one revolution. If the **HES** error is displayed, turn off the amplifier and check the following points before turning it on again:

- ◆ The Sin/Cos encoder commutation channels are correctly wired on the amplifier X3 connector.
- ◆ The Sin/Cos encoder supply voltage value is correct.
- ◆ The **Motor encoder resolution** parameter value is correct.

Carry out the command **Save parameters to EEPROM** before switching off the amplifier in order to save the feedback configuration.

3.3 - AMPLIFIER ADJUSTMENT

- ◆ Select the appropriate motor type in the **Motor List**.
- ◆ Check for the compliance of the **Current Limitation** parameters with the motor and amplifier specifications. For the commissioning, the I²t "fusing" mode is recommended. (see [chapter 8, section 3.2](#)).
- ◆ If the **Incremental encoder** configuration **without HES** is selected for the feedback sensor, start the motor **Phasing** procedure.
The motor **Phasing** procedure can be released in the command window of the **VISUAL DRIVE SETUP** software or by the activation of the **CV0** input.
- ◆ If the motor used in the application is not mentioned in the **Motor List**, select the **New motor** command and follow the instructions.
- ◆ Check that the **Speed limitation** parameters are compatible with the motor specifications.
- ◆ Select the **Encoder output resolution** to close the position loop with the NC.
- ◆ Couple the motor to its load and select the speed regulator (P, PI or PI²). In the case of an axis with vertical load, see section 3.3.
- ◆ Start the **Auto-tuning** procedure while checking that the motor shaft rotation over one revolution is not dangerous for the operator.



WARNING

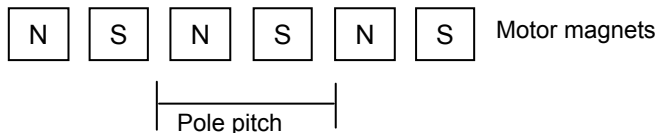
The auto-tuning procedure should be executed by the PC in control mode and at standstill. If the auto-tuning procedure must be executed with the drive controlled by the analog command input CV, the value of the input command MUST be 0 Volt. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the auto-tuning procedure.

In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings). If necessary, start the **Auto-tuning** procedure while selecting a **lower** bandwidth. If the problem remains, renew the **Auto-tuning** while activating the **antiresonance filter**.

- ◆ Start the **Offset compensation** function or start the offset compensation by means of the **Offset** push-button on the amplifier front panel.
- ◆ Check that the motor is correctly running in both directions in **Digital speed input command** mode. If necessary, readjust the speed regulator parameters by means of the **Stability** button.

3.4 - PARAMETERS ADJUSTMENT TO A LINEAR MOTOR

The **Motor encoder resolution** parameter is calculated as described below:



$$\text{Motor encoder resolution} = 1000 \times \frac{\text{Motor pole pitch (mm)}}{\text{Encoder signal pitch (\mu m)}}$$



1 encoder signal pitch = 4 counting increments

The motor **Maximum speed** parameter value in rpm is calculated according to following formula:

$$\text{Maximum speed (rpm)} = 60 \times \frac{1000}{\text{Motor pole pitch (mm)}} \times \text{Maximum motor speed (m/s)}$$

The linear speed value in m/s is calculated according to following formula:

$$\text{Linear speed (m/s)} = \frac{\text{Motor speed (rpm)}}{60} \times \frac{\text{Motor pole pitch (mm)}}{1000}$$

3.5 - SPEED LOOP ADJUSTMENT WITH VERTICAL LOAD



In the case of an axis with unbalanced load (constant torque due to the gravity effect on a vertical axis), the **incremental encoder** configuration **without HES** is not valid because the motor phasing procedure at power up cannot be executed.

Start the **Auto-tuning** procedure with the **motor uncoupled from its mechanical load** in order to initialize the speed loop gains. Select the **limiting** mode of the I²t function (see [chapter 8, section 3.2](#)). Then select the speed regulator (**PI** or **PI²**). Couple the motor to the load again and move the shaft by means of the digital speed input command until its stall position where **the shaft rotation over one revolution is not dangerous for operator and machine**.

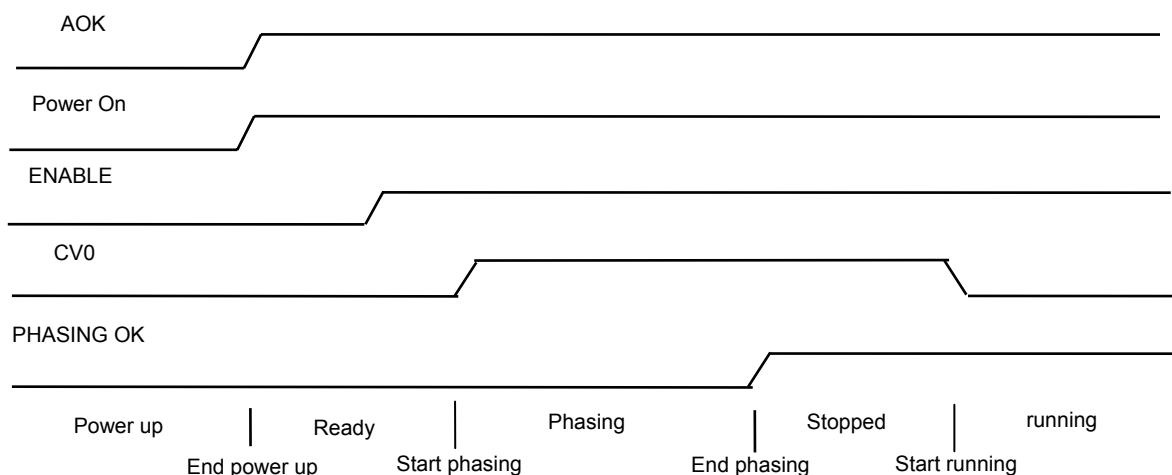
Then execute the **Auto-tuning** command with the motor **enabled at its stall position** (zero speed input command). In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings). If necessary, start the **Auto-tuning** procedure while selecting a **lower** bandwidth. If the problem remains, renew the **Auto-tuning** while activating the **antiresonance filter**.

3.6 - AMPLIFIER PARAMETERS SAVING

Save all parameters in the amplifier EEPROM by means of the function **Save parameters to EEPROM**.

3.7 - MOTOR PHASING AT POWER UP

In the **Incremental encoder** configuration **without HES**, the motor **Phasing** procedure must be executed according to the following diagram at each amplifier power up:





In the case of an axis with unbalanced load (constant torque due to the gravity effect on a vertical axis), the motor phasing procedure is not valid. The motor must be equipped with an incremental encoder + HES or an absolute Sin/Cos encoder.

The analog output on the X3 connector can be configured in the **Setup** menu of the **VISUAL DRIVE SETUP** software in order to get the **Phasing OK** output signal (output voltage from 0 V to 10 V when the motor phasing is OK) .

Remark: In the **Incremental encoder** configuration **without HES**, the motor **Phasing** procedure must be carried out again after a **Feedback** fault release or a **Counting** fault release. The motor **Phasing** procedure must also be carried out again after the modification of the motor or the encoder parameter value.

3.8 - APPLICATION OF THE STEPPER MOTOR EMULATION

The stepper motor emulation is only possible on motors equipped with a resolver. The **Pulse** and **Direction** signals are received via the input of the second amplifier position sensor, on the TTL encoder input pins.

- Select **Stepper emulation** in the **Position sensor configuration** window.
- Launch the **Autotuning** procedure by selecting the **Position** mode.

Note: The position loop stability can be tested with the **PI²** speed mode because the **Feedback** gains are identical to the **Position** mode.

- Enter the value of the **Position resolution** parameter in the **Scaling** window as shown below:

Position resolution = 2 x number of pulses issued by the controller for one motor revolution

- Set at 0 the value of the **Position deadband** parameter. This parameter is only useful for applications with high transmission backlashes or with high axis frictions. In those cases, when the position error value at standstill is lower than the **Position deadband** parameter value, the proportional gain of the position loop is set at 0.
- Enable the amplifier and check the axis displacement during the execution of the controller program.
- If the axis does not move, check that the **CV0** input is disabled.
- If there is a loud noise in the motor during the axis displacement, the **Feedforward acceleration** gain must be set at 0.
- If the motor is moving in the wrong direction, select the **Reverse movement** command in the **Speed limit** window.

3.9 - SOFTWARE GEARING APPLICATION

The software gearing application requires the use of the amplifier second position sensor for measuring the displacements of the master axis.

- If the motor is equipped with a resolver, select the encoder type for the input of the second sensor in the **Encoder input configuration** part of the **Position sensor configuration** window.
- When using a master SinCos encoder, adjust the **Position scaling factor** parameter in the **Second sensor** window for increasing the resolution of the position measurement. Otherwise, set at 1 the value of the **Position scaling factor** parameter.
- Execute the **Autotuning** command by selecting the **Position** mode.

Note: The position loop stability can be tested in **PI²** speed mode because the **Feedback** gains are identical to the **Position** mode.

- When using a master encoder, enter the value of the **Position resolution** parameter in the **Scaling** window, as described below:

Position resolution = (4 x number of encoder pulses/channel for one axis revolution of the master encoder x **Position scaling factor**) / reduction ratio.

Reduction ratio = Motor speed / Master encoder speed

- When using a master resolver, enter the value of the **Position resolution** parameter in the **Scaling** window, as described below:

Position resolution = (65536 x **Position scaling factor**) / Reduction ratio

Reduction ratio = Motor speed / Master resolver speed

- Set at 0 the value of the **Position deadband** parameter. This parameter is only useful in applications with high transmission backlashes or applications with high axis frictions. In those cases, when the position error value at standstill is lower than the value of the **Position deadband** parameter, the proportional gain of the position loop is set at 0.
- Enable the amplifier and check that the slave axis actually follows the displacement of the master axis with the correct reduction ratio.
- If the slave axis does not follow the displacement of the master axis, check the **CV0** input. It must be disabled.
- If there is a loud noise in the motor during the axis motion, set at 0 the **Feedforward acceleration** gain. If using a SinCos master encoder, check also that the **Pulse interpolation** command is enabled in the **Second sensor** window.
- If the motion direction is not correct, select the **Reverse position** command in the **Second sensor** window or the **Reverse movement** dans la fenêtre "**Speed limit**".

Chapter 7 – Troubleshooting

1 - FAULTS

1.1 - SYSTEM FAULT

If the red **SYS** led is lit when the amplifier is on, the logic board is not operational.

- Check that the 4 error leds are blinking. In this case, load the amplifier firmware via the serial link by using the **CD1 updater** software.
- Check for the possible presence of any conducting dust that may involve short-circuits on the amplifier logic board.

1.2 - "BUSY" FAULT

- If the BUSY fault is continuously displayed after turning on the amplifier, the **AUTOTEST** procedure has failed and the amplifier is not ready for operation. **Check that the power voltage is not on before the 24 V auxiliary supply** (see connection diagrams in [Chapter 4, section 1](#))
- If the BUSY fault is continuously displayed after the execution of the motor **PHASING** procedure by **CVO** at power up (**Incremental encoder** configuration **without HES**), the procedure has failed because of an external cause and the calculated phase value is wrong. Check for the correct **Motor encoder resolution** parameter value. Check for the correct **Motor parameters (Pole pairs and Phase order)** values. Check that the **ENABLE** input is activated. Check that the limit switches inputs are not activated. Check that the motor is not locked and the shaft movement free during the procedure execution.
- If the BUSY fault is continuously displayed after the execution of the **AUTO-PHASING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is open. Check that the limit switch inputs are not active. Then check that the motor is unloaded and the shaft movement free during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **AUTO-TUNING** function, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is open. Check that the limit switch inputs are not active. Then check that the motor shaft is free during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **OFFSET COMPENSATION** function, the offset is exceeding 0.5 Volt. Check the voltage on the CV input during the procedure.
- If the BUSY fault is continuously displayed after the execution of the **COGGING TORQUE ACQUISITION** procedure, the procedure has failed because of an external cause and the cogging torque acquisition is not valid. Check that the **ENABLE** input is activated. Check that the **CI** and **CVO** inputs are not activated. Check that the limit switches inputs are not activated. Check that the encoder is providing one marker pulse per motor revolution. Check that the motor is unloaded and the shaft movement free during the procedure. Check that the motor current value corresponding to the cogging torque effect is lower than 5 % of the amplifier current rating.

1.3 - "EEPROM" FAULT

- Check for the presence of the EEPROM and its correct orientation.
- If the fault remains, the EEPROM is not correctly initialized (**CHECKSUM**) or is not complying with the amplifier software version.

1.4 - "°C MOTOR" FAULT

- If the failure occurs when starting the amplifier:
 - Modify the thermal sensor type (CTP or CTN) by means of the **VISUAL DRIVE SETUP** software. Make a fault RESET by means of the **VISUAL DRIVE SETUP** software. The "°C MOTOR" fault display must go out.
 - Check the connection between the thermal sensor and the amplifier on the front panel X1 connector.

➤ If the failure occurs during the operation:

- Check the motor temperature and look for the reason of this overheating (mechanical shaft overload, duty cycle too high, motor type too small with regard to the machine cycle...).

1.5 - "UNDERVOLT" FAULT (non stored)

When switching on the auxiliary 24 VDC supply, the CD1-a amplifier always displays the UNDERVOLT. fault. The UNDERVOLT. Led will go out when switching on the power voltage, after a few seconds time delay that corresponds to the soft start of the power capacitors. If the fault display remains after switching on the power supply:

- Check that the power supply is actually on.

1.6 - "POWER STAGE" FAULT

- The POWER STAGE fault groups all faults of the power stage:
 - Power supply overvoltage.
 - Phase-ground short-circuit.
 - Phase-phase short-circuit.
 - Fan.
 - Power stage short-circuit.
 - Power stage overtemperature (on CD1-a-400/I only).
 - PWM control error.
 - Power stage supply.
 - Braking system error: transistor short-circuit or cycle too high.

The VISUAL DRIVE SETUP software allows to identify the "Power stage" fault.

➤ If the failure occurs when starting the amplifier:

- Check the AC voltage on the L1 - L2 - L3 inputs of the X9 connector.

CD1-a-230/I amplifier: 196 VAC < VAC < 253 VAC
CD1-a-400/I amplifier: 340 VAC < VAC < 528 VAC

➤ If the failure occurs during the operation:

- Check the braking system during the deceleration phases.
- Check the sizing of the braking resistor with regard to the motor deceleration phases.
- Check the amplifier current cycle with regard to the current table (see [chapter 2, section 1](#)).
- Check for no short-circuit in the motor wiring and at the motor terminals.
- Check for no short-circuit between one motor phase and the ground.

1.7 - "FEEDBACK" FAULT IN THE RESOLVER FEEDBACK CONFIGURATION

- Check the resolver connection on the amplifier X1 connector according to the connector descriptions.
- Check for the correct resolver type with regard to the amplifier specifications.
- Check the connections between resolver and amplifier.

1.8 - "RDC " FAULT IN THE RESOLVER FEEDBACK CONFIGURATION

- If the failure occurs when starting the amplifier:
 - Check for the correct resolver type with regard to the amplifier specifications.
- If the failure occurs during the operation:
 - Check that the connections between the resolver and the amplifier are complying with the shield wiring recommendations.

1.9 - "FEEDBACK" FAULT IN THE ENCODER FEEDBACK CONFIGURATION

- Check the encoder supply connection on the amplifier X3 connector.
- Check the encoder A channel and B channel connections on the amplifier X3 connector.

Remark: In the **Incremental encoder** configuration **without HES**, the motor **Phasing** procedure must be carried out again after a **Feedback** fault release.

1.10 - "COUNTING" FAULT IN THE ENCODER FEEDBACK CONFIGURATION

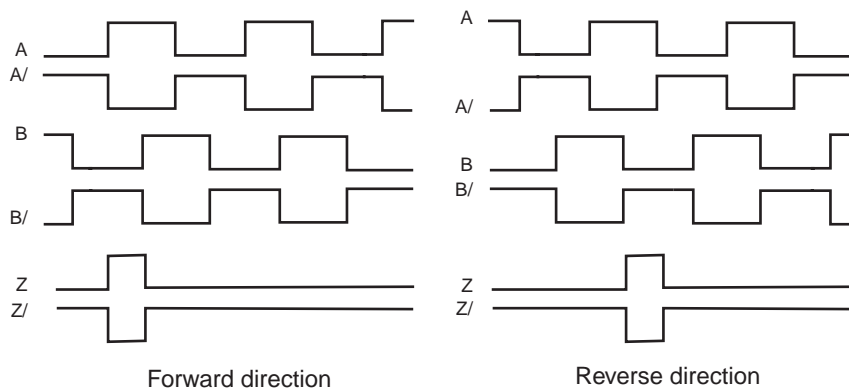
Check the marker pulse connection on the amplifier X3 connector. If the motor encoder is not providing a marker pulse channel output, the amplifier marker pulse channel must be disabled in order to cancel the **Counting** fault. The amplifier marker pulse channel can be disabled by setting at 0 the **Zero mark pitch** parameter.



When the amplifier marker pulse channel has been disabled, the encoder counting protection is no more active. In this case, encoder pulse noises may involve uncontrolled motor movements that may be dangerous for operator and machine.

For the **TTL incremental encoder** configuration:

- Check for the correct encoder supply voltage value
- Check for the correct encoder-amplifier-motor ground and shield connections with regard to the recommendations of [chapter 4](#).
- Check for the correct encoder A channel, B channel and Z marker signal waveforms.



- Check that the following conditions are answered for taking into account the maximum value of the encoder pulse frequency at the maximum motor speed value :
 Max. motor speed (rpm) <math>< 60 \times 10^6 / \text{Number of encoder pulses per revolution}</math>
 Max. motor speed (rpm) <math>< 60 \times \text{Encoder pulse frequency limit (Hz)} / \text{Number of encoder pulses per revolution}</math>
- Check that the **Motor encoder resolution** and the **Zero mark pitch** parameter values are correct.
- Check that the number of encoder pulses between two successive Z marker pulses is equal to the **Motor encoder resolution** value multiplied by the **Zero mark pitch** parameter value. If this condition is not fulfilled, the encoder counting protection must be disabled in order to cancel the **Counting** fault. The encoder counting protection can be disabled by setting at 0 the **Zero mark pitch** parameter.
- For a linear motor with only one marker pulse over the entire motor travelling range, the parameter **Zero mark pitch** must be set at 15. In this case the encoder counting protection is checking that the measured encoder position has always got the same value when the marker pulse is activated (no position measurement drift).

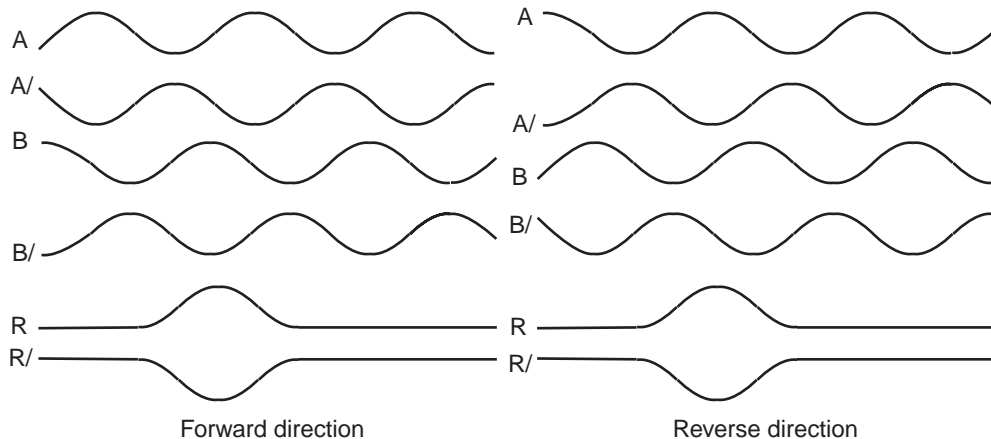


When the encoder counting protection has been disabled, the amplifier is only checking that the encoder pulses frequency is lower than 1.5 times the maximum encoder frequency. The maximum encoder frequency is calculated into the amplifier according to the **Motor encoder resolution** parameter value and the **Maximum speed** parameter value. In this case, encoder pulse noises at a frequency lower than 1.5 times the maximum encoder frequency may involve uncontrolled motor movements that may be dangerous for operator and machine.

Remark: In the **TTL incremental encoder** configuration **without HES**, the motor **Phasing** procedure must be executed again after a **Counting** fault release.

For the **Sin/Cos encoder** configuration:

- Check for the correct encoder supply voltage value
- Check for the correct encoder-amplifier-motor ground and shield connections with regard to the recommendations of **chapter 4**.
- Check for the correct encoder A channel, B channel and R reference signal waveforms.



- Check that the **Motor encoder resolution** and the **Zero mark pitch** parameter values are correct.
- Check that the number of encoder pulses between two successive R reference signals is equal to the **Motor encoder resolution** value multiplied by the **Zero mark pitch** parameter value. If this condition is not fulfilled, the encoder counting protection must be disabled in order to cancel the **Counting** fault. The encoder counting protection can be disabled by setting at 0 the **Zero mark pitch** parameter.
- For a linear motor with only one R reference signal over the entire motor travelling range, the **Zero mark pitch** parameter must be set at 15. In this case the encoder counting protection is checking that the encoder measured position has always got the same value when the R reference signal is activated (no position measurement drift).



When the encoder counting protection has been disabled, the amplifier is only checking that the encoder pulses frequency is lower than 1.5 times the maximum encoder frequency. The maximum encoder frequency is calculated into the amplifier according to the **Motor encoder resolution** parameter value and the **Maximum speed** parameter value. In this case, encoder pulse noise at a frequency lower than 1.5 times the maximum encoder frequency may involve uncontrolled motor movements that may be dangerous for operator and machine.

Remark: In the **Sin/Cos encoder** configuration **without HES**, the motor **Phasing** procedure must be executed again after a **Counting** fault release.

1.11 - "HES" FAULT

For the **Incremental encoder & HES** configuration:

- Check that the HES are correctly wired on the amplifier X3 connector (with 60° type HES, check the various wiring combinations to find the right wiring order).
- Check for the correct HES supply voltage value.
- Check for the correct **Motor encoder resolution** parameter value.
- Check that the HES-amplifier-motor ground connections and shields answer the requirements of **chapter 4**.

For the **Absolute single-turn Sin/Cos encoder** configuration:

- Check that the Sin/Cos encoder commutation channels are correctly wired on the amplifier X3 connector.
- Check for the correct Sin/Cos encoder supply voltage value.
- Check for the correct Sin/Cos encoder C channel and D channel signal amplitude value.
- Check that the **Motor encoder resolution** parameter value is correct.
- Check that the encoder-amplifier-motor ground connections and shield answer the requirements of [chapter 4](#).

1.12 - "I²T" FAULT

- Check the amplifier rated current value required with regard to the current table ([chapter 2, section 1](#)).
- Check the rated current of the amplifier defined in the **Rated current** parameter with regard to the current required for the operation cycle.

1.13 - FOLLOWING ERROR

Amplifier in SPEED MODE (P, PI, PI²)

The FOLLOWING ERROR fault corresponds to a following error of the speed loop.

- Check that the load is adjusted to motor and amplifier types.
- Reduce the accelerations/decelerations.
- Check that the axis is not positioned on a mechanical stop.
- Check that the value of the parameter **Speed following error threshold** is complying with the operation cycle. If necessary, increase the value of this parameter.

Amplifier in POSITION MODE

The FOLLOWING ERROR fault corresponds to a following error of the position loop.

- Check that the load is adjusted to motor and amplifier types.
- Reduce the accelerations/decelerations.
- Check that the axis is not positioned on a mechanical stop.
- Check the position loop adjustment.
- Check that the value of the parameter **Speed following error threshold** is complying with the motion cycle. If necessary, increase the value of this parameter.

2 - OPERATING PROBLEMS

2.1 - MOTOR DOES NOT MOVE

- Check that the amplifier is on (24 VDC auxiliary supply on).
- Check that the power supply is on.
- Check the motor connection.
- Check the logic wiring of the signals FC+, FC- and ENABLE ([chapter 8, section 4](#)).

2.2 - MOTOR SUPPLIED, BUT NOT TORQUE

- Check that the **Maximum current** and **Rated current** parameters have no zero value.
- Check that the amplifier is not operating in torque mode (CI command active on X4) with zero input command.

2.3 - SHAFT LOCKED, ERRATIC OSCILLATIONS OR ROTATION AT MAXIMUM SPEED

- Check the resolver or encoder wiring on the amplifier connector and the mechanical mounting of the position feedback sensor on the motor.
- Check the proper motor choice in the **MOTOR LIST** module.

- Check the value of the **Motor parameters** in the **Advanced Functions** menu and execute the **AUTO-PHASING** command again, with unloaded motor, if necessary (see [chapter 6, section 3](#)).

2.4 - DISCONTINUOUS MOTOR ROTATION WITH ZERO TORQUE POSITIONS

- Check the connection of the 3 phase cables between motor and amplifier.

2.5 - MOTOR DRIFT WITH ANALOG INPUT COMMAND AT ZERO SPEED

- Check that the input command wiring between the controller and the amplifier is complying with the recommendations of chapter 4 (CV- at diff. low of the NC and 0 Volt cable).
- Check the offset compensation and, if necessary, execute the **Offset compensation** command.

2.6 - LOUD CRACKLING NOISE IN THE MOTOR AT STANDSTILL

- Check that the motor-amplifier-controller ground connections are complying with the [recommendations of chapter 4](#).
- Check that the CV speed input command wiring between controller and amplifier are complying with the recommendations of chapter 4 and check the shield connection of the resolver cables on motor side and amplifier side.

2.7 - LOUD NOISE IN THE MOTOR AT STANDSTILL AND WHEN RUNNING

- Check the rigidity of the mechanical transmission chain between motor and load (backlash and elasticity in the gears and couplings).
- Execute the **AUTOTUNING** command again by choosing a lower bandwidth (**Medium** or **Low**).
- If the problem remains, renew the **AUTO-TUNING** procedure by activating the antiresonance filter (**Filter = Antiresonance**).

2.8 - POSITION CONTROL NOT POSSIBLE WITH THE NC

- Check for the presence of the A, B and Z signals on the amplifier X2 connector by turning manually the motor shaft and check the wiring between NC and amplifier.
- Check the counting direction of the NC with regard to the polarity of the speed input command. If there is a reversal, use the **Reverse Movement** function in the **VISUAL DRIVE SETUP** software to recover a correct operation.

3 - SERVICE AND MAINTENANCE

When exchanging an amplifier on a machine, proceed as follows:

- Plug the **parameter EEPROM** (or a copy of it) of the old amplifier on the new one.
- Apply a zero speed input command on the CV input and start the automatic **offset compensation** procedure by means of the push-button on the amplifier front panel.

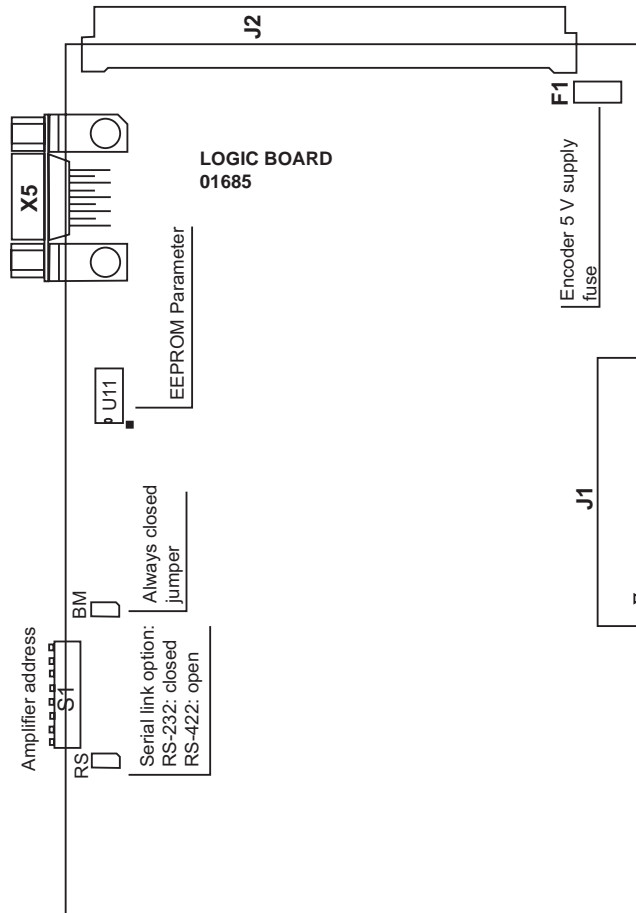
The new amplifier is now configured like the old one.

Chapter 8 - Appendix

1 - HARDWARE ADJUSTMENTS

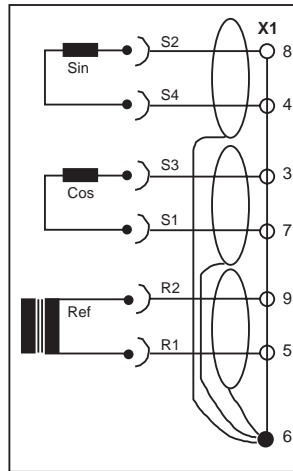
All hardware adjustments of the CD1-a amplifier module are located on the hardware location diagram below.

HARDWARE LOCATION DIAGRAM



2 - ADJUSTMENT TO VARIOUS RESOLVER TYPES

For the connection of resolvers, see following wiring diagram of the **X1** connector as well as the manufacturer's diagram:



For the use of **resolvers** with **transformation ratios** out of the range 0.3 to 0.5, the adjustment must be factory set by INFRANOR.

Note

When using resolvers with a number of pole pairs $N > 1$, all speed values displayed in the amplifier are equal to N times the motor rotation speed.

3 - ADJUSTMENT TO VARIOUS MOTOR TYPES

3.1 - MOTOR THERMAL SENSOR

The thermal sensor is connected to the **X1** resolver connector, pins 1 and 2.

The motor can be equipped either with a **CTN** sensor (Ohmic resistance = decreasing function of T°) or with a **CTP** sensor (Ohmic resistance = increasing function of T°).

The **Motor T° error threshold** parameter allows to enter the ohmic value (kOhm) of the sensor corresponding to the desired temperature value for the triggering of the **T° motor** protection.

The **Motor T° warning threshold** parameter allows to enter the ohmic value (kOhm) corresponding to the desired temperature value for the warning of the **T° motor** protection.

When the warning temperature is reached, the fault is displayed on the amplifier front panel. When the triggering temperature is reached, the amplifier is disabled.

Note:

When using a **CTN** sensor, the ohmic warning value will be higher than or equal to the ohmic triggering value.

When using a **CTP** sensor, the ohmic warning value will be lower than or equal to the ohmic triggering value.

Default values of the thermal probe parameters for MAVILOR motors:

- **PTC** sensor: the triggering will occur at a value of about 3.3 kOhms of the thermal sensor resistor, that is about 140°C .
- **NTC** sensor: the triggering will occur at a value of about 3.3 kOhms of the thermal sensor resistor, that is about 140°C .

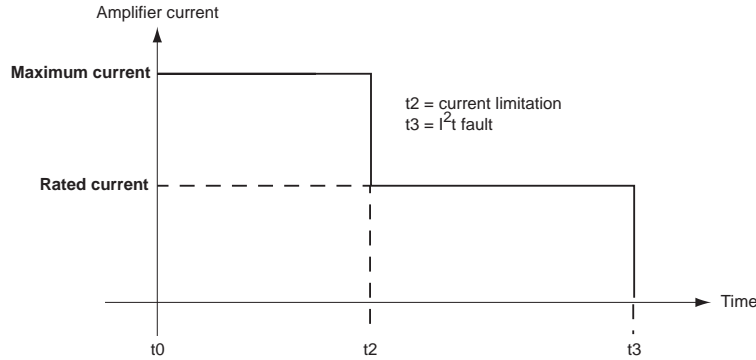
3.2 - I²t PROTECTION

Current limitation in **Fusing** mode

If the RMS current as not dropped below 85 % of the **Rated current** after 1 second, the I²t fault is released and the amplifier disabled.

When the amplifier RMS current (I²t) reaches the **Rated current** value, the I²t protection limits the amplifier current at this value.

The amplifier current limitation diagram in an extreme case (motor overloaded or shaft locked) is shown below:



The maximum current duration before limitation at the rated current is depending on the value of the **Rated current** and **Maximum current** parameters.

$$T_{max} \text{ (second)} = (t_2 - t_0) = 4 \times [\text{Rated current (A)}]^2 / [\text{Maximum current (A)}]^2$$

The current limitation duration before the release of the protection is depending on the value of the **Rated current** and **Maximum current** parameters:

$$T_{lim} \text{ (second)} = (t_3 - t_2) = 1 - 0.7 \times [\text{Rated current (A)}]^2 / [\text{Maximum current (A)}]^2$$

NOTE

- These formula are correct for a **Maximum current / Rated current** ratio > 1.5.
- When the **Maximum current / Rated current** ratio = 1, there is no interruption and the current is maintained at the rated current value.
- The I²t signal can be displayed by means of the digitizing oscilloscope available in the **Visual Drive Setup** software.

$$\text{Rated current (\%)} = 100 \times \text{Rated current (A)} / \text{Amplifier current rating (A)}$$

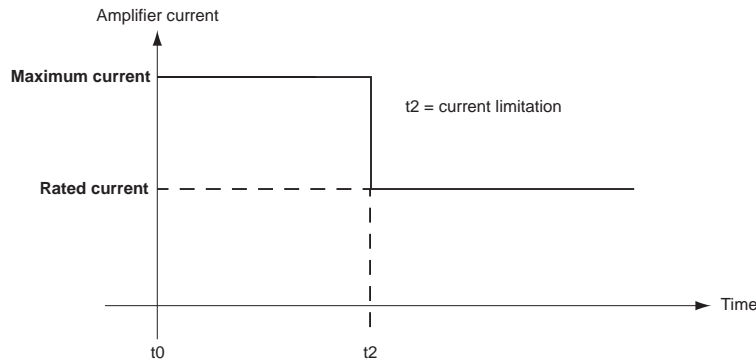
$$\text{Current limitation threshold (\%)} = [\text{Rated current (\%)}]^2 / 50$$

$$\text{Amplifier RMS current (Arms)} = [(I^2t \text{ signal value (\%)} \times 50)^{1/2} \times \text{Amplifier current rating (A)}] / 100$$

Current limitation in **Limiting** mode

When the amplifier RMS current (I²t) reaches the **Rated current** value, the I²t protection limits the amplifier current at this value.

The amplifier current limitation diagram is shown below.



The maximum current duration before limitation at the rated current (t₂ - t₀) is calculated the same way as for the **Fusing** mode.

3.3 - ENCODER COUNTING PROTECTION

When servo motors are equipped with an encoder feedback, any error in the encoder pulses counting is generating a rotor position measurement error and may involve uncontrolled motor movements that may be dangerous for operator and machine. The encoder counting protection available in the CD1-a amplifier range allows the detection of pulse counting errors and immediately disables the amplifier for safety reasons.

The encoder counting protection is checking that the number of encoder pulses between two successive Z marker pulses (or R reference signals) is equal to the **Motor encoder resolution** value multiplied by the **Zero mark pitch** parameter value. The encoder counting protection is also checking that the encoder pulses frequency is lower than 1.5 times the maximum encoder frequency. The maximum encoder frequency is calculated in the amplifier according to the **Motor encoder resolution** parameter value and the **Maximum speed** parameter value.

The **Motor encoder resolution** parameter value defines the number of encoder pulses (or encoder signal periods) per motor revolution (for a rotary motor) or per motor pole pairs (for a linear motor).

The **Zero mark pitch** parameter value defines the number of motor revolutions (for a rotary motor) or of motor pole pairs (for a linear motor) between two successive Z marker pulses (or R reference signals).

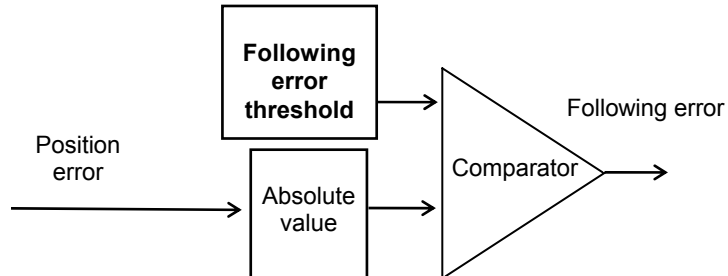
For a rotary motor, the **Zero mark pitch** parameter is generally equal to 1 because the encoder has got one Z marker pulse (or R reference signal) per motor revolution.

For a linear motor with only one marker pulse over the entire motor travelling range, the parameter **Zero mark pitch** must be set at 15. In this case the encoder counting protection is checking that the measured encoder position has always got the same value when the marker pulse is activated (no position measurement drift).

Remark: In the **Incremental encoder** configuration **without HES**, after a **Counting** fault release, it is necessary to renew the motor **Phasing** procedure because the current rotor position reference for the motor commutation is not correct.

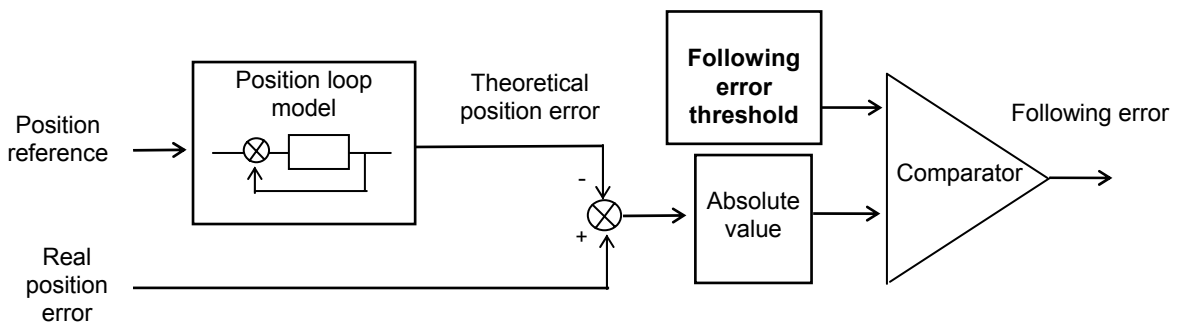
3.4 - POSITION FOLLOWING PROTECTION

The operation of the position following protection when selecting the **Absolute** mode in the **Safety limits** window is described below.



The position loop error value is continuously compared with the value of the **Following error threshold** parameter. When its value is exceeding the one of the **Following error threshold** parameter, the following error is released.

The operation of the position following protection when selecting the **Relative to dynamic model** mode in the **Safety limits** window is described below.



The real value of the position loop error is continuously compared with the theoretical value of the position loop error given by a calculation model. When the difference is exceeding the value of the **Following error threshold** parameter, the following error is released. In this configuration, when the position loop adjustment is made without anticipative speed term (**Feedforward speed gain** = 0) for getting a positioning without overshooting in "Stepper motor emulation" applications, a very low threshold of the **Following error threshold** parameter can nevertheless be adjusted in order to detect the smallest error on the axis.

4 - USE OF THE "LIMIT SWITCH" INPUTS

Response time = 500 μ s.

During the amplifier operation in speed mode (**CI** logic input inactive) or in torque mode (**CI** logic input active), the enabling of the **FC+** limit switch inhibits any CW motor rotation and the enabling of the **FC-** limit switch inhibits any CCW motor rotation. The motor is decelerating with the amplifier **Maximum current** value in order to get the shortest possible braking time.



Positive and negative directions depend on the position feedback sensor (encoder or resolver) wiring and also on the motor wiring. So, before mounting and wiring the limit switches, it is recommended to define the positive and negative directions of the motor.

5 - USE OF THE "CV0" INPUT

Response time = 500 μ s.

During the amplifier operation in speed mode (**CI** logic input inactive), the activation of the **CV0** input stops the axis rotation (the deceleration time is depending on the value of the **Accel/Decel time** parameter). During the amplifier operation in torque mode (**CI logic** input active), the enabling of the **CV0** input applies a zero current input command and the current reference is maintained at zero as long as the **CV0** input is active.

6 - USE OF THE "AOK" OUTPUT

If any fault occurs, the amplifier is disabled.

If a fault occurs (except for the "Undervolt." fault) the **AOK** relay contact opens.

Use the **AOK** relay contact as described in [chapter 3, section 3.3](#) in order to allow the power voltage to be switched on after the initialization phase.

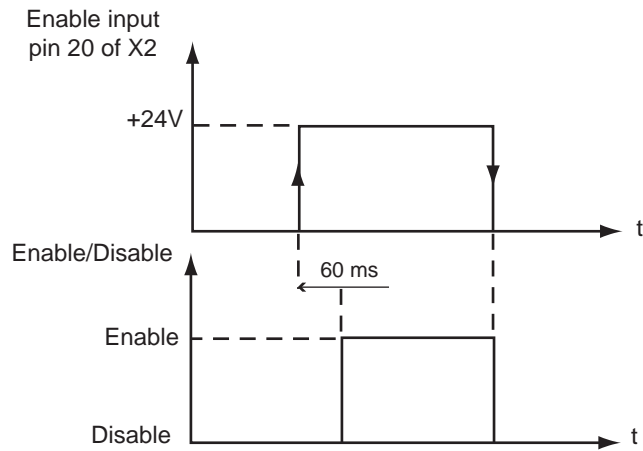
Remark: The "Undervolt." fault can be configured in the **Setup** menu of the **VISUAL DRIVE SETUP** software to open the AOK relay contact.

7 - USE OF THE "RESET" INPUT

If the position initialization references must be kept when a stored fault is released on the amplifier or when the power supply is cut-off, it must be possible to reset the faults via pin 13 of X2 without switching off the auxiliary 24 VDC supply or to backup the 24 VDC supply by means of a 24 VDC battery (see [chapter 4](#)).

8 - USE OF THE "ENABLE" INPUT

The **Enable** input ensures the amplifier enabling/disabling as shown on the timing diagram below:

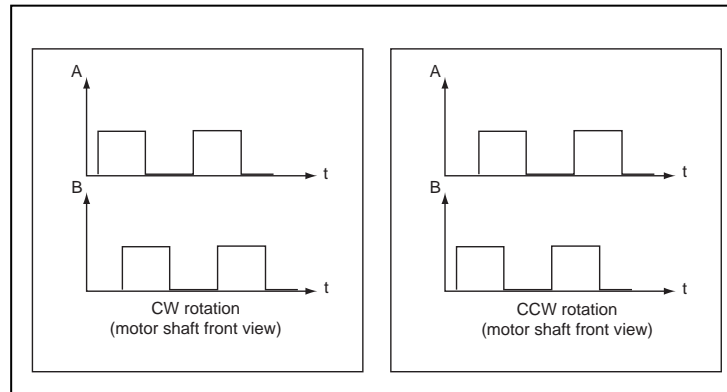


9 - USE OF THE "BRAKE" OUTPUT

The motor powerless brake type is controlled when the motor is enabled (ENABLE activated and no fault displayed).

10 - INCREMENTAL ENCODER OUTPUTS

Two A and B channels in quadrature with one Z marker pulse per revolution allow to close the position loop via the NC.



The **Output encoder resolution** parameter is chosen according to following table:

Maximum motor speed (rpm)	up to 1600	up to 3200	up to 6400	up to 12800	up to 25000
Encoder output resolution (ppr)	512 to 16384	512 to 8192	512 to 4096	512 to 2048	512 to 1024

The resolution value defined in the **Output encoder resolution** parameter can be divided by 2, 4 or 8 by selecting the **Resolution division ratio** parameter.

The **Output encoder deadband** parameter introduces a deadband at standstill around the current resolver position in order to avoid oscillations of +/- 1 encoder edge on channels A and B. The value 4095 corresponds to 1/16 of the motor shaft revolution.

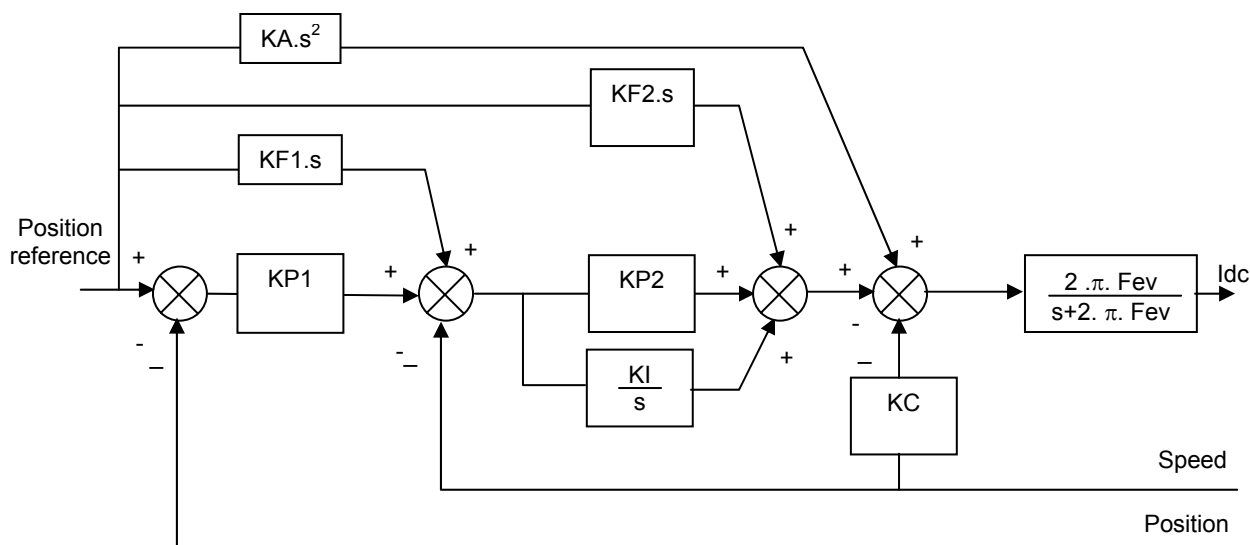
The **Zero pulse origin shift** parameter allows to shift the marker pulse position on channel Z with regard to the resolver zero position. The value 32767 corresponds to one motor shaft revolution. The marker pulse width is equal to 1/4 of the A and B channels period.

11 - USE OF THE "EXTERNAL CURRENT LIMITATION" INPUT

When **Analog current limit reversal** is selected in the **Current limit** menu, the maximum torque is available for a 10 V voltage applied on the **I limit** input and there is no torque in the motor for a 0 V voltage applied on the **I limit** input.

The default configuration is **Analog current limit reversal** unselected. In this case, there is no torque limitation for 0 V applied on the **I limit** input, so the maximum torque is available with the **I limit** input is not connected.

12 – SERVO CONTROLLER STRUCTURE



Speed error low-pass filter (Fev): defines the cut-off frequency at -3dB of the first order filter which acts on the current command (I_{dc}). This value is calculated by the amplifier during the auto tuning procedure and depends on the selected bandwidth and the selected filter type.

Proportional speed gain (KP2): defines the proportional gain of the controller which acts on the speed error. Its value is calculated by the amplifier during the auto tuning procedure. It can then be modified by the user if required.

Integral speed gain (KI) : defines the integral gain of the controller which acts on the speed error. Its value is calculated by the amplifier during the auto tuning procedure. It can then be modified by the user if required

Damping gain (KC): defines the proportional gain of the controller which acts only on the speed feedback. Its value is calculated by the amplifier during the auto tuning procedure. It can then be modified by the user if required.

Proportional position gain (KP1): defines the proportional gain of the controller which acts on the position error. Its value is calculated by the amplifier during the auto tuning procedure. It can then be modified by the user if required.

Feedforward speed 1 gain (KF1); defines the feedforward speed amplitude corresponding to the speed input command. This term allows to reduce the following error during the motor acceleration and deceleration phases. Its value is set at 1 after the auto tuning procedure if minimum following error is required. It can then be modified by the user if required.

Feedforward speed 2 gain (KF2): defines the feedforward speed amplitude corresponding to the viscous frictions. This term allows to reduce the viscous frictions effect during the motor acceleration and deceleration phases. The gain value is equal to the damping gain value + the viscous friction compensation term. After the auto tuning procedure, the feedforward speed 2 gain is set equal to the damping gain value if minimum following error is required. The viscous friction compensation term can be calculated by measuring the current / speed ratio at various motor speed values.

Feedforward acceleration gain (KA): defines the feedforward acceleration amplitude corresponding to the acceleration input command. This term allows to reduce the following error during the motor acceleration and deceleration phases. Its value is calculated by the amplifier during the auto tuning procedure if minimum following error is required. It can then be modified by the user if required.

The auto tuning procedure identifies the characteristics of motor and load and calculates the controller gains. During the procedure, various choice are available to the user.

The choice of the time interval for speed measurement (speed measurement filter) allows to select the speed measurement resolution value according to the position sensor resolution value: speed resolution (rpm) = 60000 / position sensor resolution / time interval (ms). The higher the time interval value, the better the resolution, but also the lower the servo loop gains because of the increased speed measurement delay.

The choice of the anti-resonance filter is necessary in case of loud noise in the motor due to the motor/load coupling elasticity.

The choice of the maximum stiffness filter allows to get the maximum stiffness on the motor shaft with regard to the torque disturbances. However, this choice is only possible without any resonance due to the motor/load coupling elasticity.

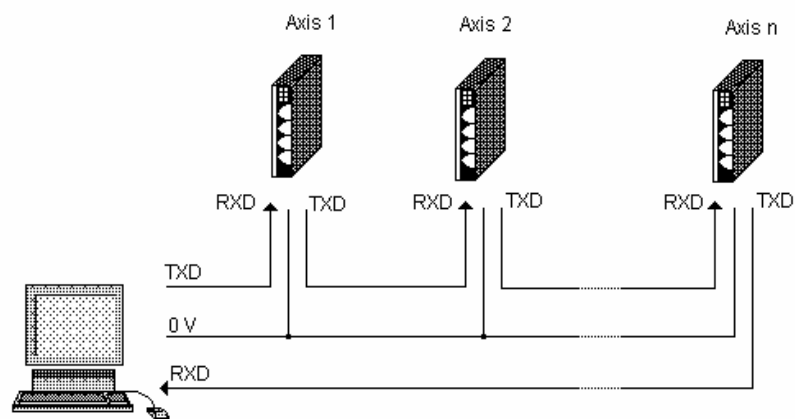
The choice of the speed loop bandwidth defines the cut-off frequency value of the closed loop frequency response (Low = 50 Hz, Medium = 75 Hz, High = 100 Hz).

The choice "minimum following error" allows to get an accurate following of the position reference value during the entire motor displacement. In this case, all feedforward gain values are calculated.

The choice "minimum position overshoot" allows to get a motor positioning without any overshoot of the target position. In this case, all the feedforward gain values are set at 0, and the motor position is lagging with regard to the position reference value during the entire motor displacement.

13 - AMPLIFIER ADDRESSING VIA RS-232

The CD1-a amplifiers allow a multi-axis connection with a host PC via the RS-232 serial link according to following connection diagram.

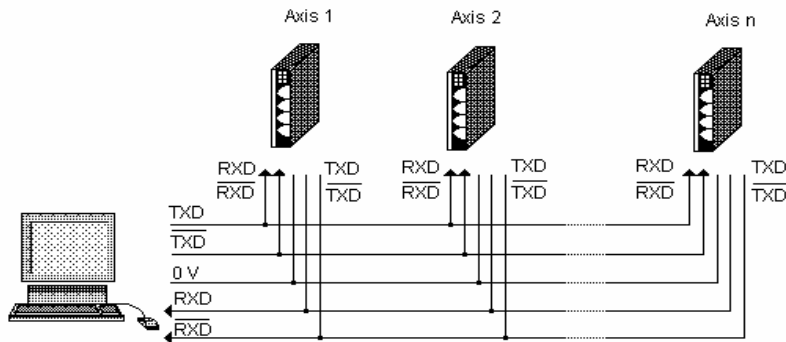


The connection of the various units (host PC and amplifiers) is made as a ring: the transmission signal (TxD) of each unit is connected to the reception signal (RxD) of the next unit. Each CD1-a amplifier has got 4 micro-switches allowing an address assignment. The CD1-a amplifiers inside the ring must have different addresses. An address in multi-axis configuration must have a value between 1 and 15. The 0 address corresponds to the single-axis communication configuration (no addressing).

The connection with an amplifier with address "X" is made by selecting the amplifier address "X" in the **Setup** menu of the **VDSetup** software.

14 - AMPLIFIER ADDRESSING VIA RS-422

The CD1-a amplifiers allow a multi-axis connection with a host PC via the RS-422 serial link according to the following connection diagram.



All amplifiers are parallel connected to the computer.

- The amplifiers reception signals (RxD) are connected to the computer transmission signal (TxD).
- The amplifiers transmission signals (TxD) are connected to the computer reception signal (RxD).

Each CD1a amplifier has 4 micro-switches allowing an address assignment. The CD1a amplifiers connected to the computer must have different addresses. An address in multi-axis configuration must have a value between 1 and 15. The 0 address corresponds to the single-axis communication configuration (no addressing).

The connection with an amplifier with address "X" is made by selecting the amplifier address "X" in the **Setup** menu of the **VDSetup software**.

15 - COGGING TORQUE COMPENSATION

The cogging torque in brushless permanent magnet rotary motors or the cogging force in brushless permanent magnet linear motors result from the interaction between the rotor magnets and the stator slots. This disturbance is due to the difference of reluctance between the copper of the windings and the iron of the stator teeth. For a given motor, the cogging can be easily evaluated by simply moving the motor manually when the amplifier is disabled. The **Cogging compensation** option available in the CD1 amplifier range allows to cancel the motor cogging effects for specific applications where torque accuracy or force accuracy higher than 1 % are required.

CD1 amplifiers must get the factory set cogging compensation option (reference CD1a-U/I-CT). Check for the presence of the cogging compensation option (**CT-CD1**) in the VDSetup Hardware option menu. In this case, the **Cogging torque compensation** menu can be selected in the **Servo loop** module.



For a brushless motor equipped with an incremental encoder, the Cogging torque compensation is only available if the encoder is providing one marker pulse per motor revolution.

The cogging torque acquisition procedure is started by means of the **Start** button. The motor must be uncoupled from its load and the shaft must not be disturbed during the procedure. Before starting the acquisition, switch the drive on manual mode and then disable it (Drive control = Off). Then, start the **Auto-tuning** procedure with following selections: Regulator = PI², filter = Max. stiffness and bandwidth = High. At the end of the cogging torque acquisition procedure, the amplifier parameter file (*.PAR) can be uploaded again in order to recover the initial adjustments.

The **Enable cogging torque compensation** function allows the commissioning of the motor cogging torque compensation. This function is saved in the amplifier EEPROM.

The **Save cogging torque data into a file** function allows to store in a PC the cogging torque value corresponding to a motor after the acquisition procedure (*.COG file).

The **Write cogging torque data into the drive** function allows to upload in the amplifier the cogging torque value corresponding to a motor, if this value has previously been stored in the PC (*.COG file).



For a brushless motor equipped with an incremental encoder, at the amplifier power up the cogging torque compensation is only effective after the detection of the first encoder marker pulse.

Note 1:

The motor cogging torque value is checked at the amplifier power up. If it contains some errors (storage problems in the amplifier memory), the EEPROM error is displayed and the **Enable cogging torque compensation** function is disabled.

Note 2:

When exchanging an amplifier on an axis, the file of the adjustment parameters (*.PAR) as well as the cogging torque file (*.COG) corresponding to the motor must be uploaded again.

Note 3:

When exchanging the motor or when disassembling the resolver sensor, the acquisition procedure must be renewed.

16 - SYSTEM OF POWER FEEDBACK VIA A BRAKING RESISTOR

All CD1 drives are equipped with the power feedback system. When the motor is decelerating with high inertia and high speed, the mechanical braking energy is reflected to the drive. This energy is dissipated inside a resistor called "braking resistor".

In order to avoid heat dissipation inside the drive, the braking resistor is **ALWAYS** mounted outside. It **MUST** be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

For an optimum power feedback by the drives in a multi-axis application, the DC bus (DC+ and DC-) can be parallel connected (see diagram in chapter 4, section 1.5).

In this case, the mains input must also be parallel wired in order to balance the current load inside the AC/DC converters.

It is recommended to mount the braking resistor on the drive with highest current rating.

An electronic control of the dissipated power avoids the overloading of the braking resistor. So, if the energy reflected to the drives with parallel mounted DC busses is too high, the DC bus voltage will rise up to the triggering of the **"Overvoltage"** fault. A second resistor must then be mounted on the second axis.

17 - AMPLIFIER ORDER CODE

