INFRANOR

XtrapulsPac
Installation Guide

Digital drive for sinusoidal synchronous AC motors

WARNING

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

Please see also:

- **XtrapulsPac STO** for the Safe Torque Off function
- **XtrapulsPac User Guide** for the operation of the drive (commissioning, configuration, ...)
- **XtrapulsPac Templates** for the templates of target applications.
- **Gem Drive Studio software Quick Start** manual for the drive parameterization.
- **EtherCAT® fieldbus interface** manual for the XtrapulsPac-et version.
- **GDPS** manual, for the use of the GDPS power supply unit.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the drives 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 conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the drive 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 physical damage.
Wait for at least 5 minutes after power down before handling the drives (a residual voltage of several hundreds of volts may remain during a few minutes).

ESD INFORMATION (ElectroStatic Discharge)
INFRANOR drives are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the drives are not properly stored and handled.

STORAGE

- The drives 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 drive connectors and material with electrostatic potential (plastic film, polyester, carpet…).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the drives 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 any 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.

Issue: **2.7**

Content

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Chapter 1 - General

1.1 - INTRODUCTION

XtrapulsPac all-digital drives with sinusoidal PWM control are servo drives that provide the control of brushless AC motors with a position sensor.

The standard control interface can be:

- CANopen,
- EtherCAT®[1],
- analog,
- stepper motor emulation,
- logic I/Os.

But the XtrapulsPac range also offers more sophisticated functions such as:

- DS402 including position capture,
- Master/slave and electronic gearing,
- Positioner with motion sequencing.

All versions are delivered in standard with the integrated safety function **Safe Torque Off** (**STO) SIL 2**.

With its very small dimensions, the XtrapulsPac is available in various designs:

- stand-alone or multi-axis version,
- standard forced air or push-through cooling version.

Series XtrapulsPac drives are fully configurable in order to fit various applications. Both drive versions of the XtrapulsPac range are described below.

The XtrapulsPac version with CANopen interface can be used in the following application types:

- Axes controlled by CANopen fieldbus according to the DS402 protocol,
- Stand-alone operation as a motion sequencer with control by means of logic I/Os,
- Traditional analog speed drive with +/- 10 V command and position output by A, B, Z encoder signal emulation,
- Stepper motor emulation with PULSE and DIR command signals.

The XtrapulsPac version with EtherCAT® interface can be used in the following application types:

- Axes controlled by EtherCAT® fieldbus according to the DS402 protocol,
- Stand-alone operation as a motion sequencer with control by means of logic I/Os.

The configuration and parameterization software tool Gem Drive Studio allows a quick configuration of the XtrapulsPac drives according to the target application (template).

1.2 - DESCRIPTION / COMPLIANCE WITH THE STANDARDS

1.2.1 - GENERAL DESCRIPTION

The XtrapulsPac drive directly controls the motor torque and speed from of the information provided by a high resolution position sensor (**resolver** or **encoder**). The sinusoidal current commutation generated from the information of this high resolution position sensor ensures very smooth motor torque/force control.

The XtrapulsPac drive can be configured for the feedback of various position sensor types. The appropriate position sensor configuration is selectable by software and saved in the drive.

[1] *EtherCAT® is a registered trade mark and a patented technology of Company Beckhoff Automation GmbH, Germany.*

- 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 drive power up.
- With an **incremental encoder** only**,** a motor phasing procedure **(Phasing)** must be executed at each drive 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 drive power up.
- With an **absolute single-turn, multi-turn** or **linear encoder** using the **HIPERFACE®** communication protocol and fitted with incremental SinCos outputs, the servo-motor can also be immediately enabled after the drive powering.

Series XtrapulsPac drives have their own DC/DC converter to provide the voltages required for the drive operation with a 24 VDC +/- 15 % supply source which is generally available on machines. The auxiliary supply allows to keep the drive logic supplies after the power supply has been switched off. Thus, the position output can be kept without new initializations of the machine. 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 getting an "absolute" servo drive operation.

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

All control parameters are programmable via a serial link (e.g. RS-232) and saved in a memory. The auto-tuning and auto-phasing functions allow a quick and easy commissioning of the drive.

Thanks to the **Gem Drive studio** software tool, which is PC compatible with the WINDOWS® operating system, all drive parameters can be displayed and easily modified.

Gem Drive Studio also allows the quick configuration of the XtrapulsPac drive according to the application type: as an **Analog drive, Stepper motor emulation, Positioner, etc**.

The **Digital Oscilloscope** of this software tool ensures an easy and quick commissioning of the drive.

The **Gem Drive Studio** software also allows parameterization and diagnostic in a multi-axis configuration.

1.2.2 - REFERENCE TO THE STANDARDS: CE

Electromagnetic compatibility

According to the Directive 2004/108/EC, the actuators are complying with the Electromagnetic Compatibility standards regarding the power servos, referenced in the EN 61800-3 – Part 3 about "Electrical power servo systems with variable speed":

EMISSION
EN 61800-3:2004 – Part 3: section 6, 4-2 (C3 category equipment – tables 17 and 18).

IMMUNITY

EN 61000.4-2-3-4.5-6	**Expected use**: **Second environment** including other areas than those directly supplied with electricity by a public low-voltage mains network.

NOTE: Industrial areas and technical rooms are examples of second environment.

Category of the drive equipment: C3.

Security:

73/23/EEC modified by the directive 93/68/EEC:	Low voltage directive
EN 61800-5-1:	Electrical, Thermal and Energetic security requirements
EN 60204-1:	Safety of machinery: electrical equipments of machines
UL508C:	Power Conversion Equipment
UL840:	Insulation coordination for electrical equipment
EN 61800-5-2:	Adjustable speed electrical power drive systems: Safety requirements –Functional

1.2.3 – REFERENCE TO THE STANDARDS: UL

The 230 V range has been "cULus" listed according to UL508C and UL840 regarding the insulation.

XtrapulsPac series were 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° 14-10, dated February 2010 for the Canadian UL Listing (CNL).

1.3 - OTHER DOCUMENTS

- XtrapulsPac User guide.
- XtrapulsPac "Safe Torque Off" specification.
- XtrapulsPac Templates.
- Gem Drive Studio software Quick Start manual.
- EtherCAT® fieldbus interface.
- GDPS Power Supply Unit manual.

1.4 - ORDERING CODE

XtrapulsPac- xx – UUU / cc - xx - mm

Logic version
ak: Analog and CANopen interfaces
et: EtherCAT® interface

Voltage range
230: Voltage range 230 V
400: Voltage range 400 V

Current ratings for 230 V drives
05 = 5 Arms
11 = 11 Arms
17 = 17 Arms
Current rating for 400 V drives
08 = 08 Arms
20 = 20 Arms
45 = 45 Arms
100 = 100 Arms

Connector set
00: Without connector set
FC: With **power + motor** connector set
FL: With **command** connector set
FCL: With **power + motor + command** connector set

Mounting version *(for 400 V range only)*
ST: Standard version
PT: Push-through version
CP: Cold plate version

1.5 - ORDERING CODE FOR SEPARATE CONNECTOR SET

If the connector kit is separately ordered from the drive, please use the following reference:

FXX - Pac - rrr

Connector set type	
FL:	With **command** connector set
FC:	With **power + motor** connector set
FCL:	With **power + motor + command** connector set

Rating suffix (not required for FL set)	
230	Connector kit for 230 V drives
402	Connector kit for 400 V / 08 A and 20 A drives
404	Connector kit for 400 V / 45 A and 100 A drives

1.6 - CONNECTOR SET DESCRIPTION

Pac-FC

X8: 5 pin plug connector for the auxiliary 24 Vdc supply and for the motor brake.
X9: power plug connector for mains and motor.
X10: mains power plug connector for Pac 400 V / 08 A to 20 A

Pac-FL

X1: male 15 pin Sub D connector for the resolver, with the appropriate conducting cover.
X2: female 26 pin Sub D HD connector for the logic I/Os, with the appropriate conducting cover.
X3: male 26 pin Sub D HD connector for the encoder, with the appropriate conducting cover.
X5: female 9 pin Sub D connector for the RS232 / CAN link, with the appropriate conducting cover.

Pac-FCL

X1: male 15 pin Sub D connector for the resolver, with the appropriate conducting cover.
X2: female 26 pin Sub D HD connector for the logic I/Os, with the appropriate conducting cover.
X3: male 26 pin Sub D HD connector for the encoder, with the appropriate conducting cover.
X5: female 9 pin Sub D connector for the RS232 / CAN link, with the appropriate conducting cover.
X8: 5 pin plug connector for the auxiliary 24 Vdc supply and for the motor brake.
X9: power plug connector for mains and motor.
X10: mains power plug connector for Pac 400 V / 08 A to 20 A

Chapter 2 - Specifications

2.1 - MAIN TECHNICAL DATA

2.1.1 - XTRAPULSPAC-230/I

Design	Stand-alone
Available cooling version	Forced air (standard)
Operating power supply voltage According to Drive Service Voltage	110 to 230 Vac +/- 10% single-phase 50 - 60 Hz Grounded neutral system with balanced phase to ground voltage
Undervoltage threshold (default value)	100 Vdc
Braking threshold (default value)	390 Vdc
Overvoltage threshold (default value)	430 Vdc
EMC filter on the mains power supply	Fully integrated in the drive
Motor phase-to-phase output voltage	95 % of mains voltage
Integrated braking resistor	100 R / 35 W
External braking resistor	Minimum external resistor: 50 Ω Infranor ordering code: dp 50/200
Minimum phase-to-phase inductance	1 mH
Galvanic isolated auxiliary supply voltage	24 Vdc +/-15% - 300 mA (without motor brake)
Common mode filter on auxiliary supply	Integrated in the drive

OUTPUT CURRENT RATINGS

TYPE	Max. output current for 1 s (Arms) +/-5 % (230 Vac)	Rated output current (Arms) (230 Vac)	Power losses at rated current (W)	Rated input current (Arms) (230 Vac, 60 Hz)	Certified max. protection line circuit fuses A60Q	Mains short-circuit power	UL listed
Pac- 230/5	5	2.5	20	4.3	10 A	5 kA	yes
Pac -230/11	11	5.5	40	9.5	15 A	5 kA	yes
Pac -230/17	17	8.5	65	14.7	20 A	5 kA	yes

Maximum surrounding air temperature: 40°C.

OPERATING POWER RESTRICTION

Maximum continuous RMS power ensuring a capacitor lifetime of 20'000 hours:

- 650 W for ratings 230/05 and 230/11,
- 1000 W for rating 230/17.

Note:
In applications with higher continuous power, external capacitors (ref. CAPABOX 230) must be added or the DC busses must be paralleled (see “DC bus interfacing” application note).
The CAPABOX accessory is not UL listed.

2.1.2 - XTRAPULSPAC-400/08 AND 20 A

Design		Stand-alone
Available cooling version		- Forced air (standard) - Push-through - Cold Plate
Operating power supply voltage according to Drive Service Voltage		230 to 480 Vac +/- 10 % three-phase 50 - 60 Hz Grounded neutral system with balanced phase to ground voltage.
Undervoltage threshold (default value)		210 Vdc
Braking threshold (default value)		790 Vdc
Overvoltage threshold (default value)		910 Vdc
EMC filter on the mains power supply		Fully integrated in the drive
Motor phase-to-phase output voltage		95 % of mains voltage
Integrated braking resistor		400 R / 35 W
External braking resistor	XtrapulsPac 400/08	Minimum external resistor: 100 Ω Infranor ordering code: dp 100/100
	XtrapulsPac 400/20	Minimum external resistor: 50 Ω Infranor ordering code: dp 50/200
Minimum phase-to-phase inductance		2 mH
Galvanic isolated auxiliary supply voltage		24 Vdc +/-15% - 300 mA (without motor brake)
Common mode filter on auxiliary supply		Integrated in the drive

OUTPUT CURRENT RATINGS

TYPE	Max. output current for 1 s (Arms) +/-5 % (480 Vac)	Rated output current (Arms) (480 Vac)	Power losses at rated current (W)	Rated input current (Arms) (480 Vac, 60 Hz)	Certified max. protection line circuit fuses A60Q	Mains short-circuit power	UL listed
Pac400/08	8	4	65	4	10 A	5 kA	Pending
Pac -400/20	20	10	155	10	15 A	5 kA	Pending

Maximum surrounding air temperature: 40°C.

2.1.3 - XTRAPULSPAC-400/45 A AND 100 A

Design	Multi-axis
Available cooling versions	- Forced air (standard) - Push-through - Cold Plate
Operating power supply voltage (U_{DC}) according to Drive Service Voltage	100 to 800 V_{DC}
Undervoltage threshold (default value)	210 Vdc
Overvoltage threshold (default value)	910 Vdc
EMC filter on the mains power supply	External
Motor phase-to-phase output voltage	95 % × $U_{DC}/\sqrt{2}$ Vrms
Minimum phase-to-phase inductance	2 mH
Galvanic isolated auxiliary supply voltage	24 Vdc +/-15% - 500 mA (without motor brake)
Common mode filter on auxiliary supply	Integrated in the drive

OUTPUT CURRENT RATINGS

TYPE	Max. output current for 1 s (Arms) +/-5 % (480 V_{AC})	Rated output current (Arms) (480 V_{AC})	Power losses at rated current (W)	Rated input current (Arms) (680 V_{DC})	UL listed
Pac-400/45	45	22.5	345	27.5	Pending
Pac-400/100	100	35	535	42.9	Pending

Maximum surrounding air temperature: 40°C.

2.1.4 - TECHNICAL SPECIFICATIONS

Servo loops: current, speed, position	Digital
Position sensor	Transmitter resolver Sin and Cos tracks Incremental encoder (TTL or SinCos signals) Incremental encoder + Hall Effect sensors Absolute single-turn SinCos encoder Absolute Hiperface® encoder
Power protections	See section 3.1.1 - LEDs
Switching frequency	8 kHz
Analog input 1	0 to ±10 V (resolution: 12 bits)
Analog input 2	0 to ±10 V (resolution: 12 bits)
Speed and position regulators	Sampling period = 0.5 ms Anti-wind-up system of the integrator Anti-resonance 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 to 25'000 rpm
Drive reaction time (initialization delay before PWM on)	XtrapulsPac 230 V: 6.25 ms XtrapulsPac 400 V: 20 ms
Encoder position output for CANopen version. No encoder output available on EtherCAT® version	Quadrature signals A & B with Z marker pulse. RS 422 line transmitter: 20 mA per output Programmable resolution: 64 ppr to 16384 ppr (according to max. motor speed). Max. pulses frequency: 437 kHz Accuracy in arc minutes = (8 + 5400/resolution) Note: the total position accuracy must take into account the accuracy of the resolver used.
Resolver input	Software selectable: Transmitter resolver: Excitation frequency: 8 kHz Max. output current = 30 mA Transformation ratio: 0.3 to 0.5 (other values are factory set) SinCos tracks: 1 Vcc to 4 Vcc Sin and Cos signals

Encoder input	Software selectable: Quadrature signals A & B + one Z marker pulse per rev. Line receiver RS-422 Max. frequency of encoder pulses: 1 MHz Resolution: 500 to 10^6 ppr Incremental Sin/Cos encoder Heidenhain 1 Vcc Sin/Cos type or compliant Maximum signal frequency: 200 kHz Resolution: 500 to 10^6 ppr Interpolation factor: 256 Absolute single-turn Sin/Cos encoder Heidenhain ERN 1085 or compliant Maximum signal frequency: 200 kHz Resolution: 512 to 2048 ppr Interpolation factor: 256 Hiperface® standard with SinCos channels Maximum signal frequency: 200 kHz Resolution: 16 to 2048 ppr Interpolation factor: 256
Pulse & Direction input	Software re-configuration of 2 logic inputs for stepper motor emulation. 3 selectable channels: - Optocoupled 24 V logic (max. pulse frequency = 10 kHz) - Non optocoupled 5 V to 24 V (max. pulse frequency = 50 kHz) - RS422 differential receiver (max. pulse frequency = 1 MHz) Resolution (steps per motor revolution): programmable.
Hall sensors input	5 V to 24 V positive logic voltage accepted External HES supply voltage required if different from 5 V HES sequence error detection
7 opto-isolated logic inputs	5 software configurable logic inputs 2 inputs dedicated to the STO (Safe Torque Off) function
"Amp OK" output	"OptoMos" relay: output open if fault Umax = 50 V, Imax = 300 mA
Motor brake output	XtrapulsPac 230 V: not available / Use of the digital output XtrapulsPac 400 V / 08 to 20 A: 24 Vdc / 1.5 A XtrapulsPac 400 V / 45 to 100 A: 24 Vdc / 2.5 A
3 parameterizable logic outputs	Type PNP "high side" 24Vdc, max. 300 mA
Analog output	2.5 V +/-2.5 V, resolution: 8 bit, load: 10 mA Low-pass filter: 160 Hz, programmable output signal: all objects can be mapped.
Error display	Front panel LEDs + diagnostic via serial link or CAN bus
Motor and application parameterization	Serial link RS-232 or bus interface with CANopen communication protocol
CAN interface	CANopen Protocol (DS301, DSP402)
EtherCAT® interface	See **EtherCAT® Fieldbus Interface** manual
Automatic functions	Drive adjustment to the motor (AUTO-PHASING) Adjustment of the servos (AUTO-TUNING)
MTBF (Mean Time Between Failures)	> 100'000 hours

Maximum surrounding air temperature	- Operation: +5°C to +50°C: from 40°C, the rated current must be reduced by 3 % per additional Celsius degree - Storage: -20°C to +70°C
Altitude	1000 m
Moisture	< 50 % at 40°C and < 90 % at 20°C: EN 60204-1 standard **Condensation prohibited (storage and operation)**
Cooling	Natural ventilation or forced air according to the current rating. Check for free ventilation and no obstruction of the upper or lower 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	Pac-230/05, 11 and 17: 1.5 kg. Pac-400/08, and 20: 2.2 kg. Pac-400/45: 2.4 kg. Pac-400/100: 3.3 kg

2.1.5 - COLD PLATE SPECIFICATIONS

Heatsink requirements:

The heat transfer is ensured by an external heatsink that can work with various techniques (air, liquid…).
For a proper running of the drive the following specifications shall be fulfilled:

- The contact surface between the drive and the heatsink shall be at least as large as the drive plate.
- The planarity of the heatsink shall be better than 0.05 mm all over the rear of the drive.
- The temperature of the heatsink should never exceed 70°C.
- Maximum surrounding air temperature :
    - 50°C
    - From 40°C, the rated current must be reduced by 3% per Celsius degree.
- A short preview of the maximum values for the thermal resistor of the heatsink is given in the following table:

Continuous motor current (A)	Losses (W) at 400 V_{AC}	R_{TH} (K/W)
4	56	≤ 0.55
10	140	≤ 0.22
22.5	314	≤ 0.10
35	489	≤ 0.06

The file "Pac thermal utility" is available as free download on the Infranor website www.infranor.com for more detailed estimations.

Mounting instructions:

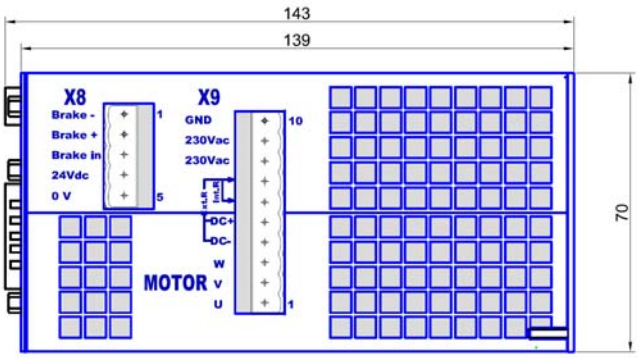
- Clean the contact surface of the heatsink with alcohol.
- Apply a thermal interface between the drive plate and the heatsink. Recommended thermal interfaces:
    - A thin layer of thermal paste on the drive (recommended reference: RHODORSIL Paste 340).
    - Phase change thermal interface (recommended reference: Bergquist, Hi-Flow 225F-AC, 150×50mm)
- Fasten the drive with 4 screws and tooth lock washers.

2.2 - DIMENSIONS AND CONNECTOR LOCATION

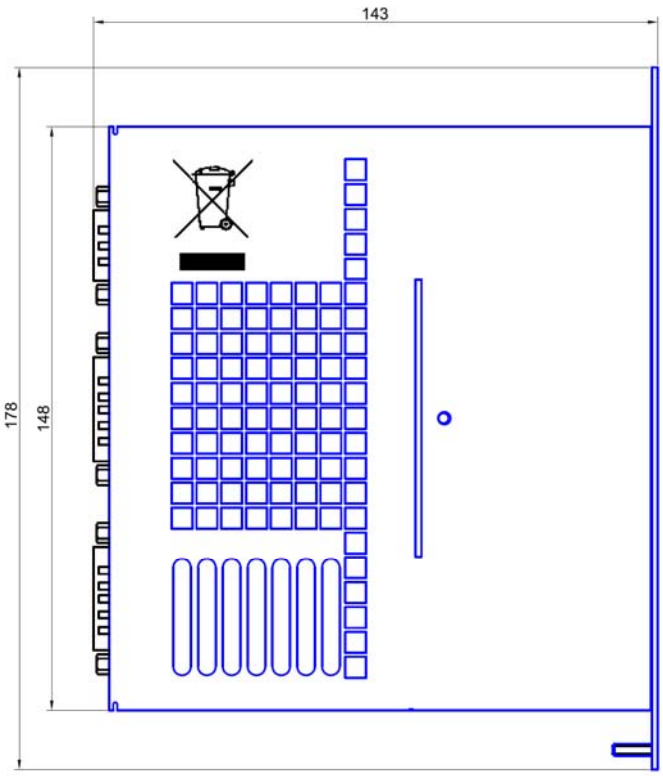
2.2.1 - XTRAPULSPAC 230 V DIMENSIONS

Dimensions are given in mm.

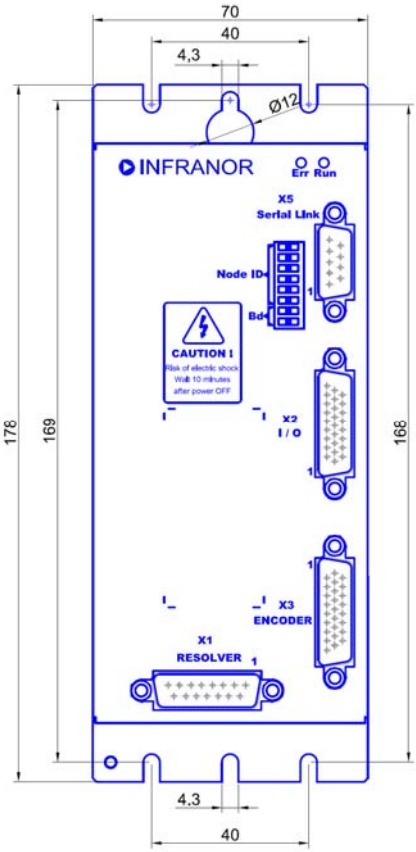
BOTTOM VIEW



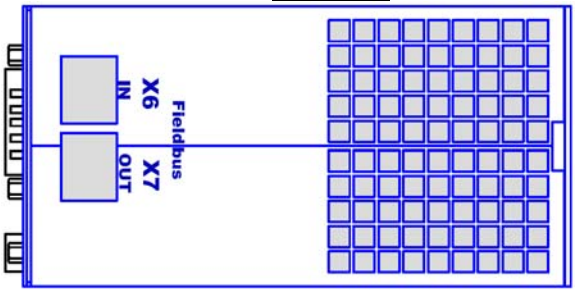
SIDE VIEW



FRONT VIEW



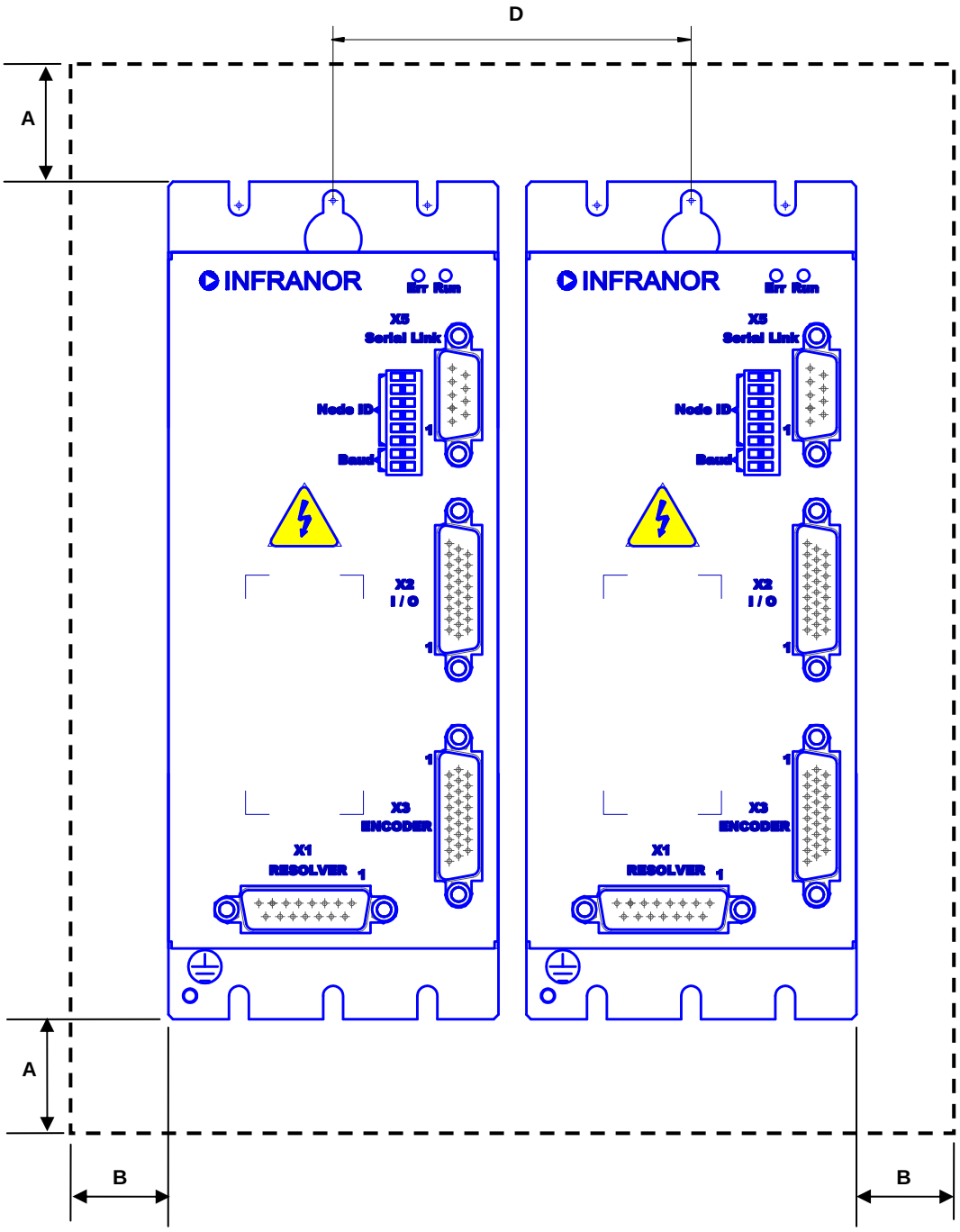
TOP VIEW



2.2.2 - XTRAPULSPAC 230 V: PANEL LAYOUT DIMENSIONS

Dimensions are given in mm

VERTICAL MOUNTING IS MANDATORY



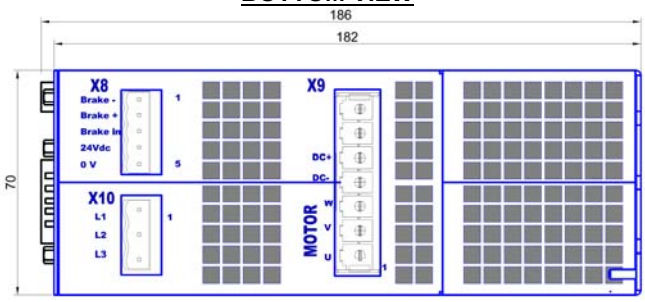
Description	Symbol	XtrapulsPac
Minimum top and bottom clearance	A	50
Minimum side clearance	B	10
Recommended pitch	D	80

2.2.3 - XTRAPULSPAC 400 V / 08 TO 45 A DIMENSIONS

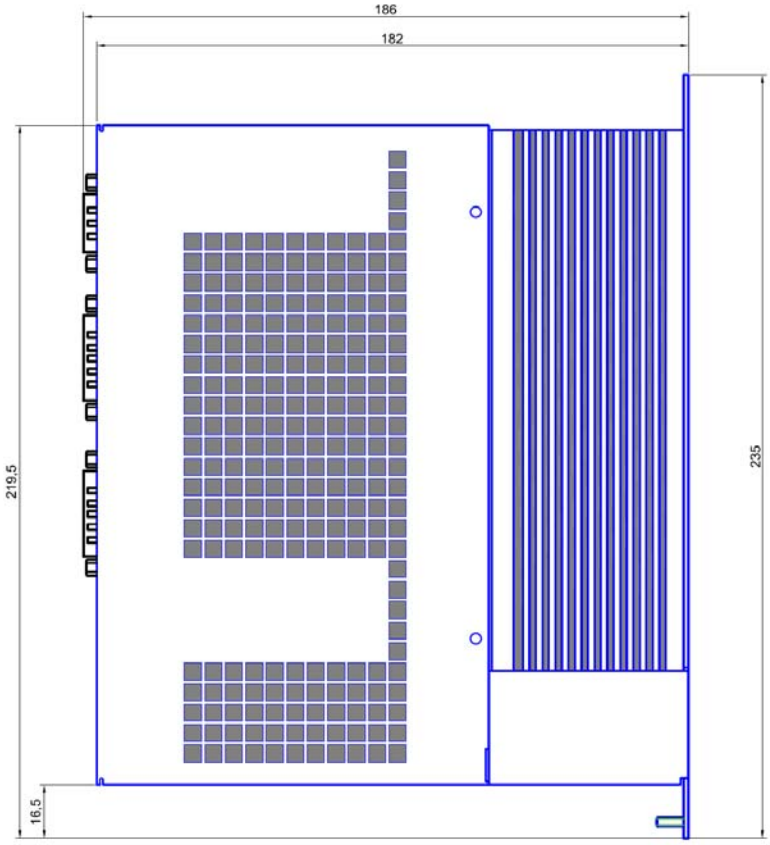
Dimensions are given in mm.

Standard version

BOTTOM VIEW



SIDE VIEW



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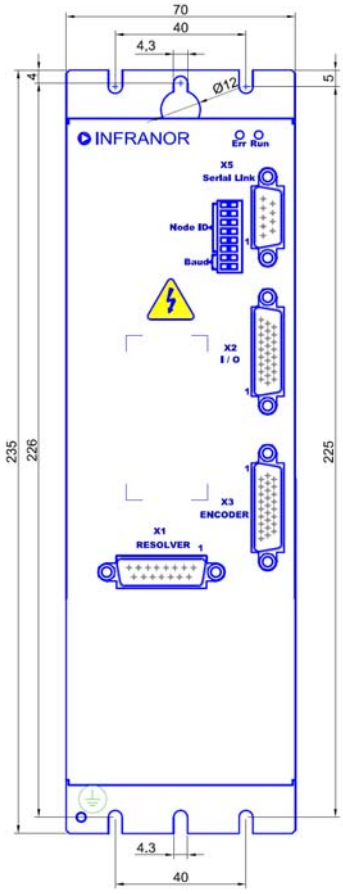
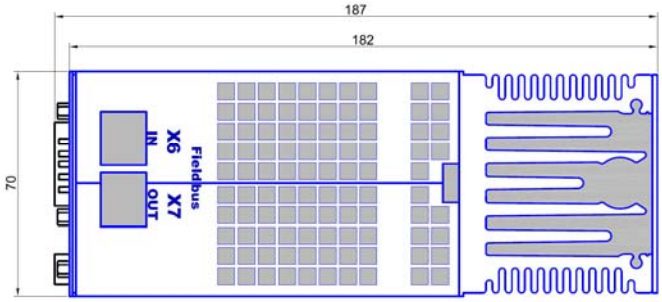
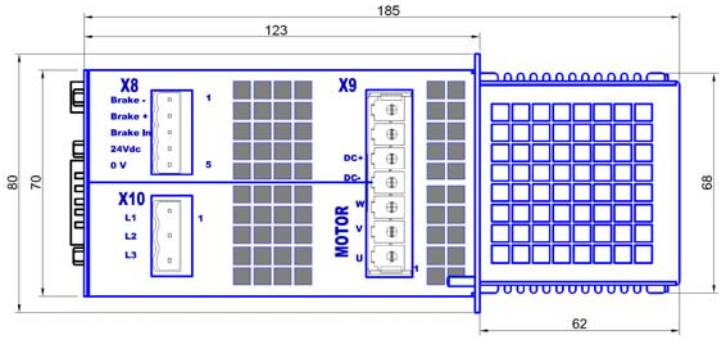


TOP VIEW

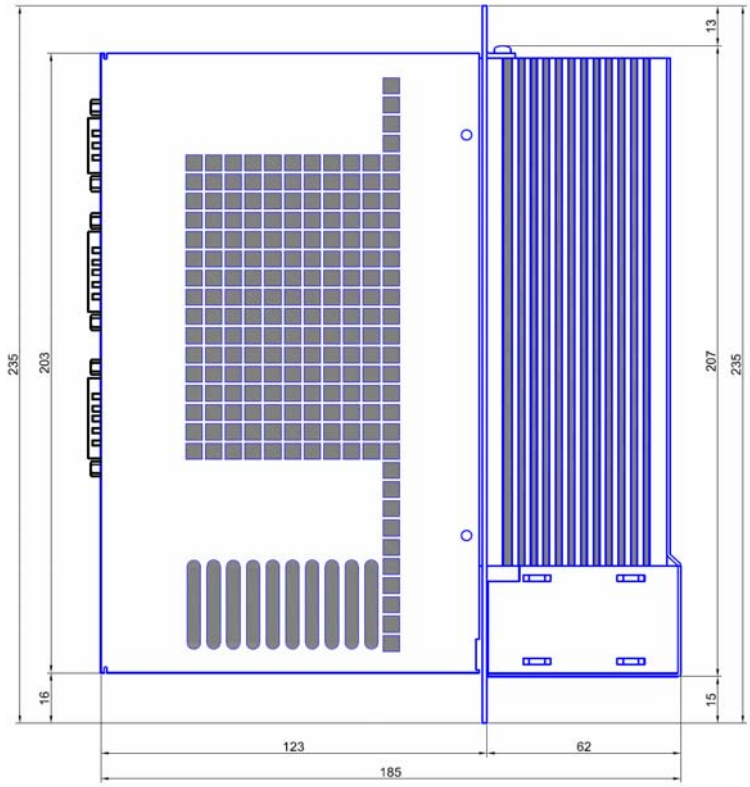


Push-through version

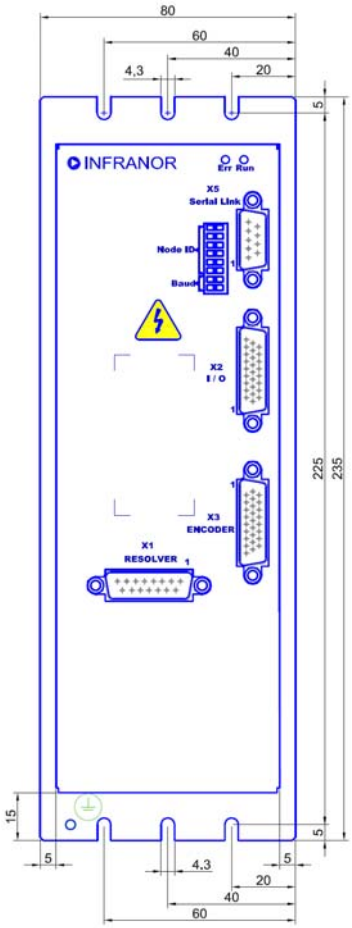
BOTTOM VIEW



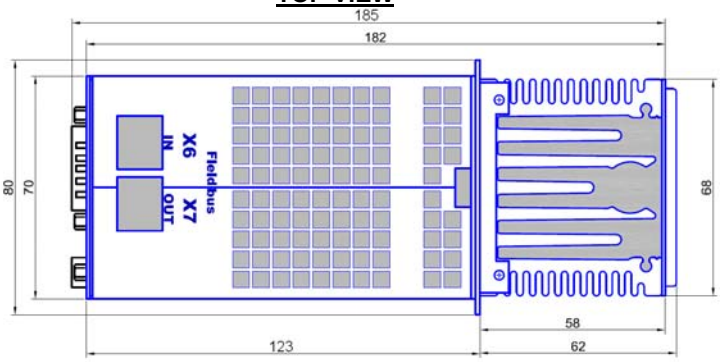
SIDE VIEW



FRONT VIEW



TOP VIEW

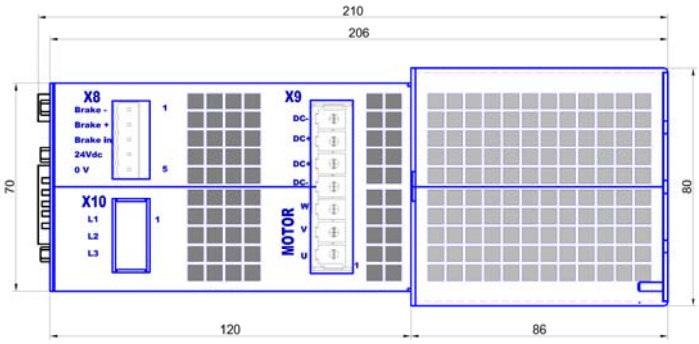


2.2.4 - XTRAPULSPAC 400 V / 100 A DIMENSIONS

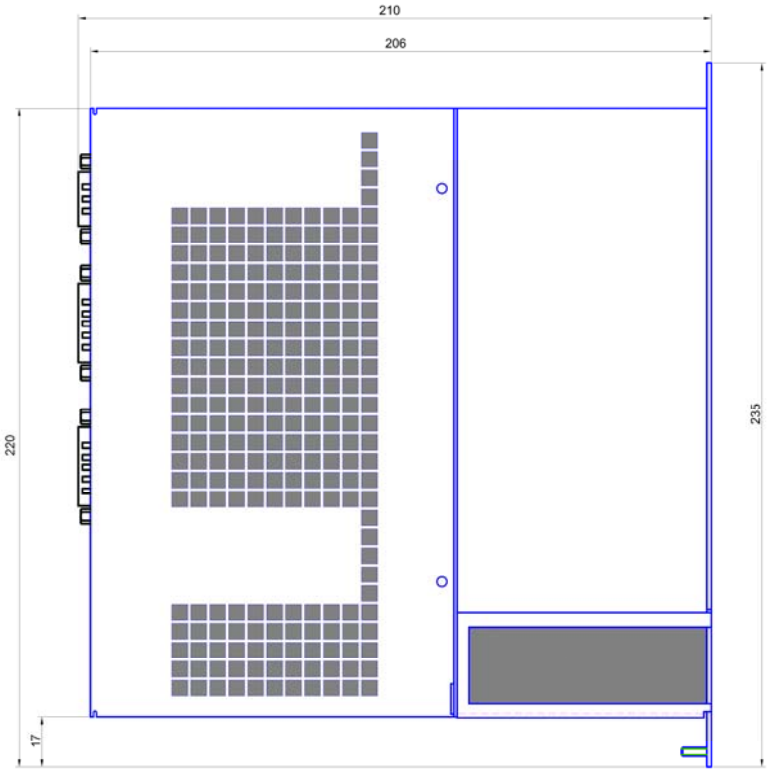
Dimensions are given in mm.

Standard version

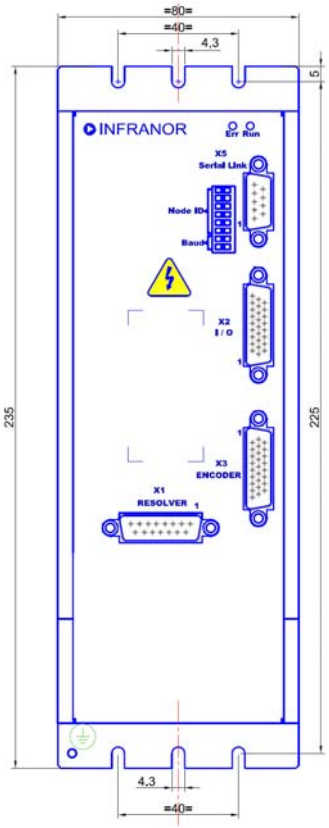
BOTTOM VIEW



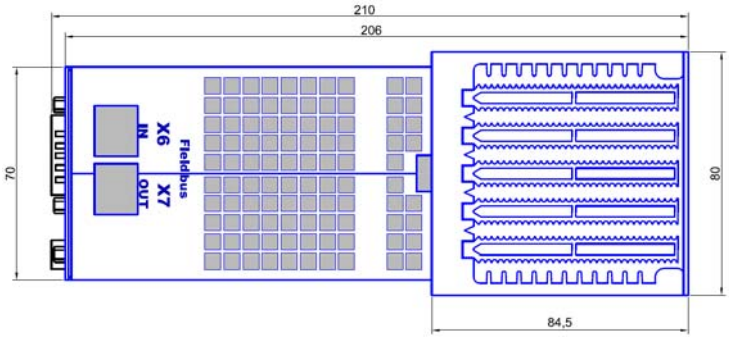
SIDE VIEW



FRONT VIEW

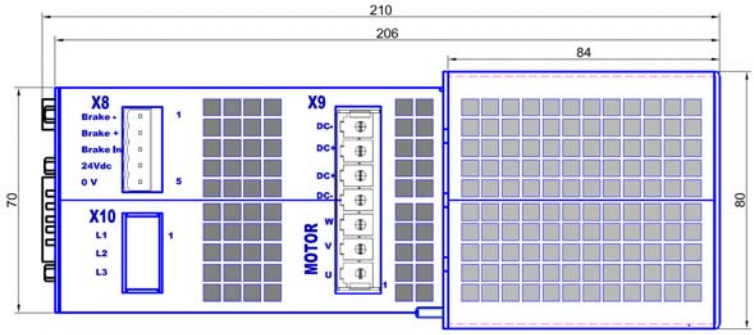


TOP VIEW

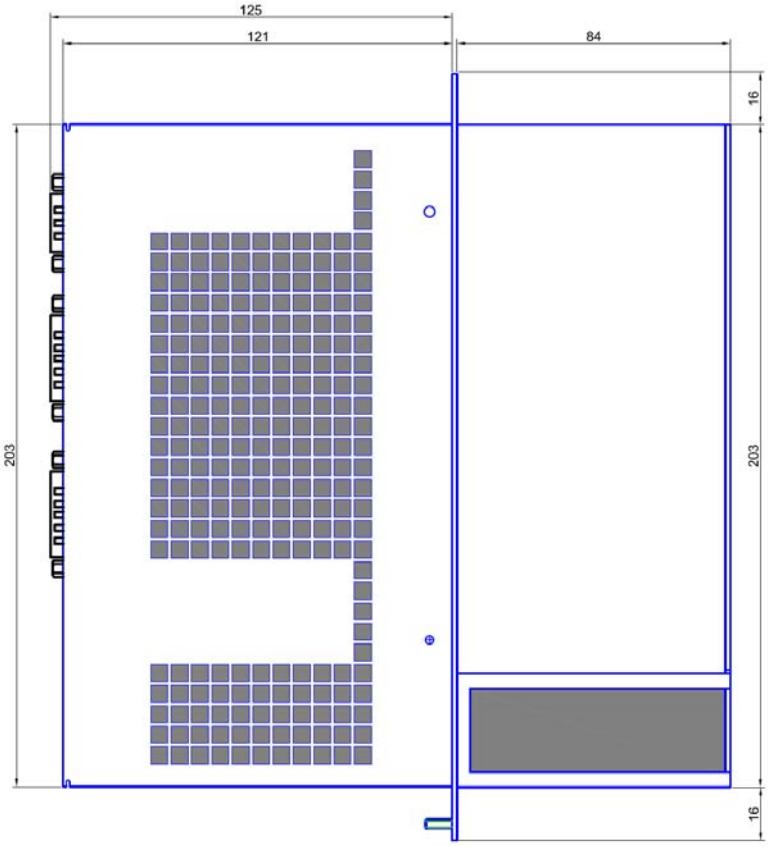


Push-through version

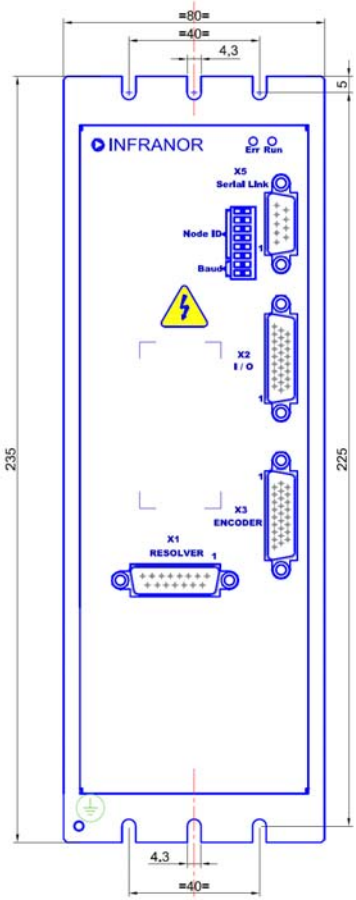
BOTTOM VIEW



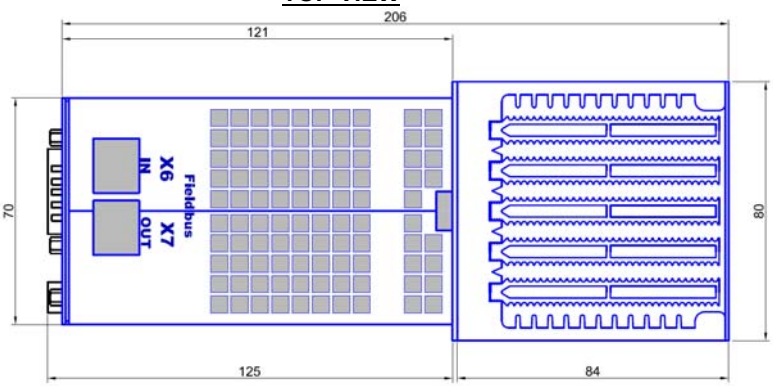
SIDE VIEW



FRONT VIEW



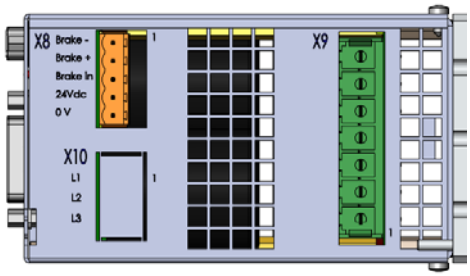
TOP VIEW



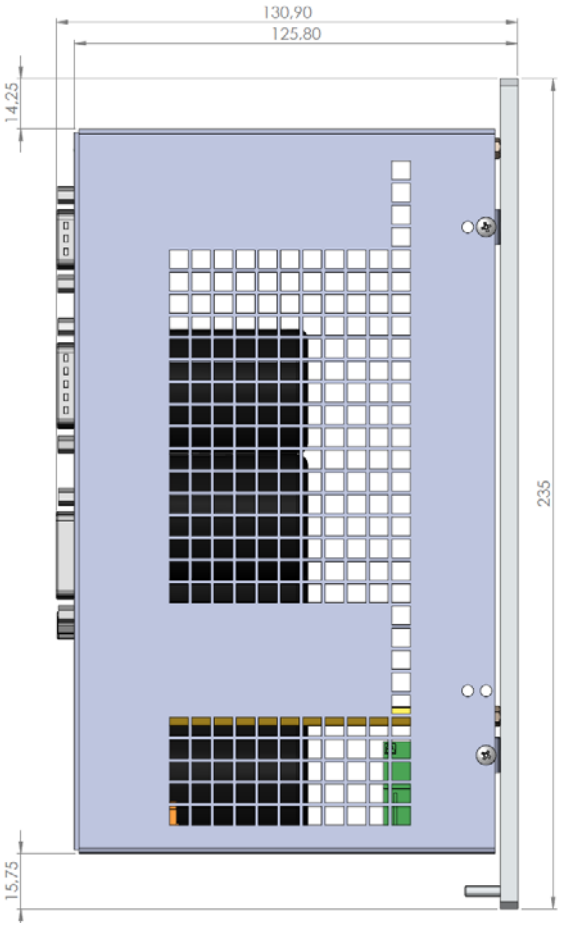
2.2.5 - XTRAPULSPAC 400 V / 8 TO 100 A COLD PLATE DIMENSIONS

Dimensions are given in mm.

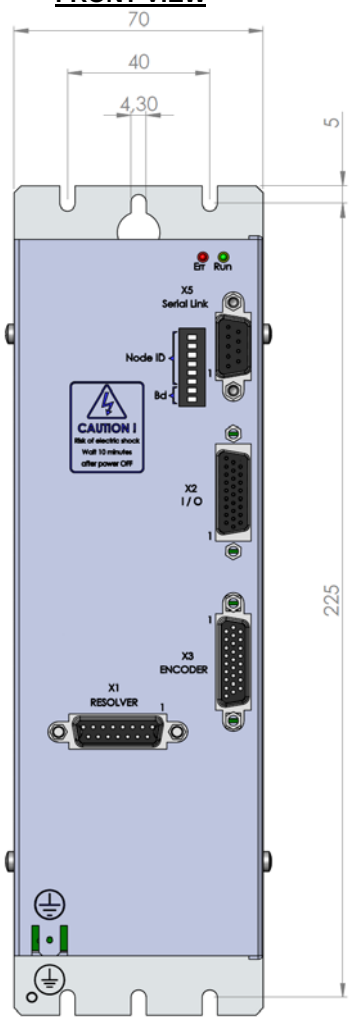
BOTTOM VIEW



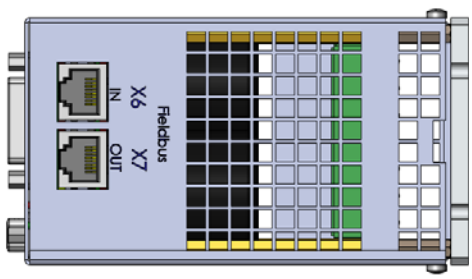
SIDE VIEW



FRONT VIEW



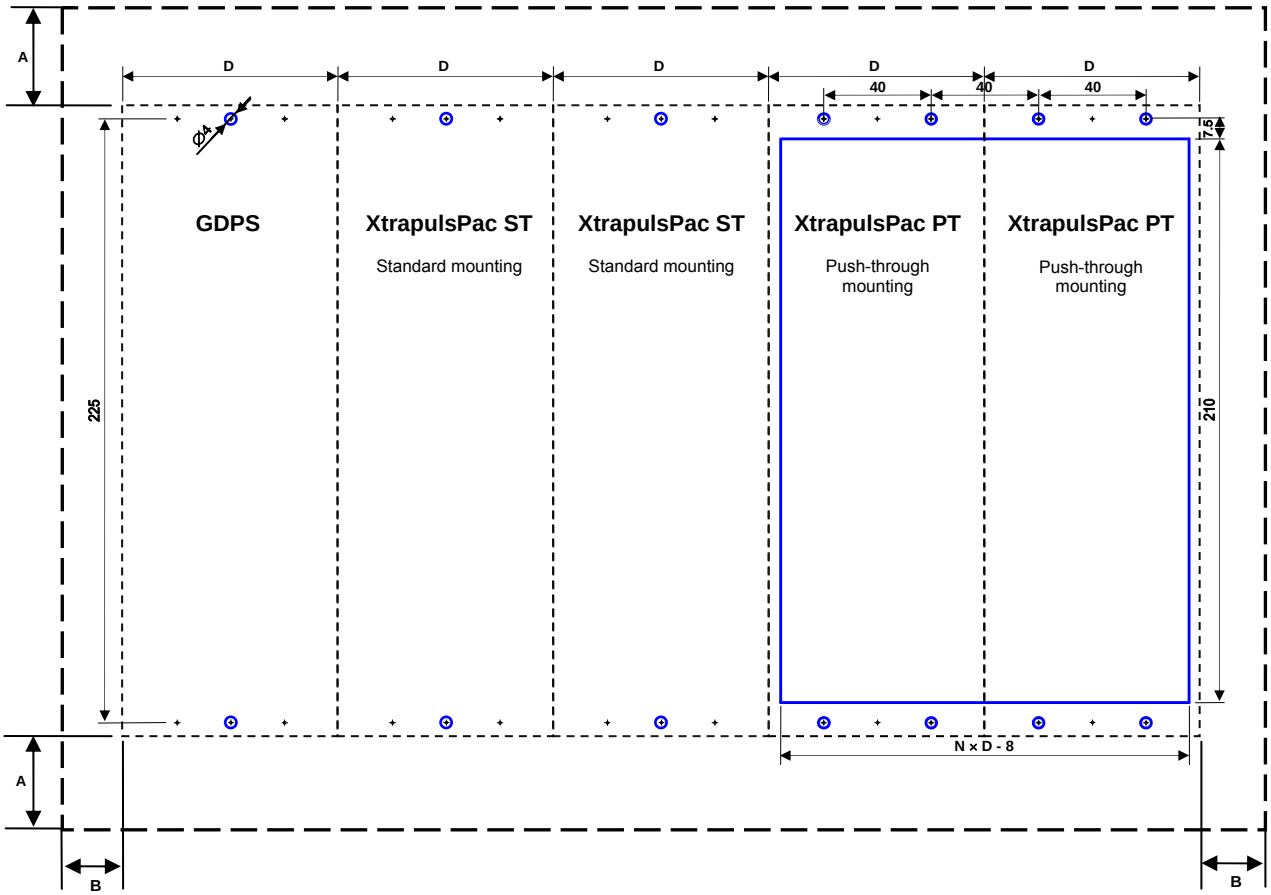
TOP VIEW



2.2.6 - XTRAPULSPAC 400 V: PANEL LAYOUT DIMENSIONS

Dimensions are given in mm.

VERTICAL MOUNTING IS MANDATORY



Description	Symbol	XtrapulsPac
Minimum top and bottom clearance	A	50
Minimum side clearance	B	10
Recommended pitch (ST, PT and CP)	D	80

Note:
Due to width tolerances and thermal consideration, it is recommended to avoid placing two XtrapulsPac 400 V / 100 A drives side by side.

Chapter 3 – Inputs - Outputs

3.1 - DISPLAY

3.1.1 - LEDS

RUN (green)

ERROR (red)

RUN: status of the CANopen or EtherCAT® communication bus connection (according to drive version)..

ERROR: faults grouped on the 'ERROR' LED: these errors are coded and can be displayed by means of the parameterization software tool via the serial link RS232 or the CANopen bus.

ERROR LED unlit if no fault.
ERROR LED flashing: 'UNDERVOLTAGE' error: no power supply voltage.
ERROR LED continuously lit: fault.

The **ERROR** LED groups the following faults:

- Power supply overvoltage.
- 24 Vdc logic supply < 17.5 Vdc.
- Motor phase / GND short-circuit.
- Braking system short-circuited or overheated, or braking resistor in open circuit.
- Motor phase / motor phase short-circuit, power stage overtemperature, defective IGBT module.
- Triggering of the I^2t protection.
- Counting error.
- Position following error
- EEPROM error.
- Procedure execution error (busy).
- Current offset error.
- Drive rating overcurrent.
- Motor temperature error.
- Resolver or encoder cable interruption.
- Hall sensors or absolute encoder error.

Notes

Any of these errors (except for the "Undervolt." error) involves:

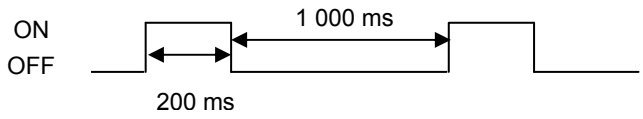
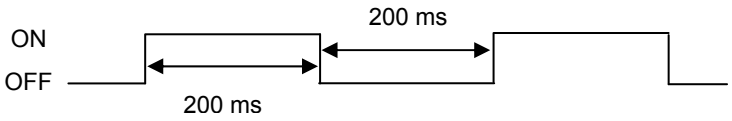
- The continuous lighting of the red **ERROR** LED,
- The drive disabling,
- The motor brake control if one of the logic outputs is configured as brake output,
- The opening of the **AOK** relay contact. This relay must be wired as described in Chapter 5, section 3, in order to switch-off the power supply and keep a zero type standstill.

The 'UNDERVOLTAGE' error (flashing **ERROR** LED) involves:

- The drive disabling,
- The motor brake control.

3.1.2 - XTRAPULSPAC-AK VERSION: CANOPEN COMMUNICATION BUS

RUN: The CANopen RUN LED indicates the status of the NMT state machine (see DS-301 – 9.52 NMT state machine):

CAN RUN LED	STATUS	
FLASHING	STOP	
BLINKING	PRE-OPERATIONAL	
ON	OPERATIONAL	

See "DR-303-3 Indicator specification" for more information.

3.1.3 - XTRAPULSPAC-ET VERSION: ETHERCAT® COMMUNICATION BUS

*See "**EtherCAT® Fieldbus interface**" manual.*

3.2 - DRIVE ADDRESSING: SELECTION OF THE TRANSMISSION SPEED

3.2.1 - PAC-AK VERSION: CANOPEN COMMUNICATION BUS

Each drive of the network must be configured with one single address.
A DIP8 switch accessible by the operator allows to configure the drive address as well as the communication speed of the **CANopen** bus.

- Addressing (6 selection bits):

Status of the cursors						Address
6	5	4	3	2	1	
OFF	OFF	OFF	OFF	OFF	OFF	0
OFF	OFF	OFF	OFF	OFF	ON	1
OFF	OFF	OFF	OFF	ON	OFF	2
...	...	...	...	...	...	...
ON	ON	ON	ON	ON	ON	63

- Communication speed (2 selection bits):

Status of the cursors		Speed
8	7	
OFF	OFF	1 Mbits
OFF	ON	500 Kbits
ON	OFF	250 Kbits
ON	ON	Reserved

Note:

- The "**00**" address configures the drive in **Local** mode.
- An address different from **00** configures the drive in **Remote** mode (use of the **CANopen** bus).

3.2.2 - PAC-ET VERSION: ETHERCAT® COMMUNICATION BUS

See manual "EtherCAT® fieldbus interface".

3.3 - RESOLVER CONNECTOR: X1

3.3.1 – X1 CONNECTOR FOR TRANSMITTER RESOLVER INPUT (SUB D 15 PINS FEMALE)

The Sub D 15 pin female connector is compatible with the XtrapulsGem and XtrapulsCD1 series.

The “Transmitter resolver” configuration is software selectable and saved in the drive EEPROM.

PIN	FUNCTION	I/O	DESCRIPTION
1	Shield connection	I	The shield must have a 360° connection on the connector metal cover. This connection can be completed by connecting the wires to pin 1.
12	TC (thermal sensor)	I	
13	TC (thermal sensor)	I	
2	S3 (cosine +)	I	Resolver signal
10	S1 (cosine -)	I	Resolver signal
11	S2 (sine +)	I	Resolver signal
3	S4 (sine -)	I	Resolver signal
5	R1 (reference +)	O	Resolver signal
4	R2 (reference -)	O	Resolver signal
6	Reserved		
7,8,9	Reserved		
14,15	Reserved		

For the connection of other resolver types, see Chapter 5, section 1.

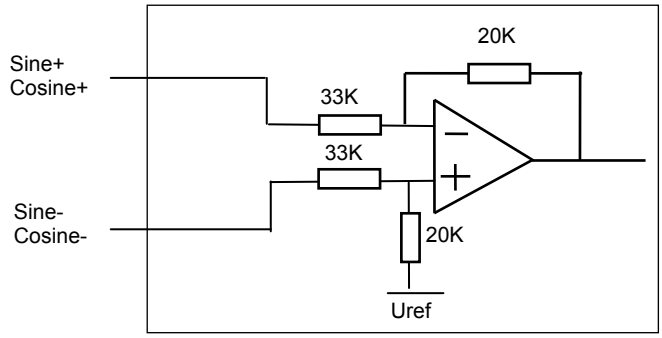
3.3.2 – X1 CONNECTOR FOR SINCOS TRACKS INPUT (SUB D 15 PINS FEMALE)

The “SinCos track” configuration is software selectable and saved in the drive EEPROM.

PIN	FUNCTION	I/O	DESCRIPTION
1	Shield connection	I	The shield must have a 360° connection on the connector metal cover. This connection can be completed by connecting the wires to pin 1.
12	TC (thermal sensor)	I	
13	TC (thermal sensor)	I	
2	Cosine +	I	SinCos tracks signal
10	Cosine -	I	SinCos tracks signal
11	Sine +	I	SinCos tracks signal
3	Sine -	I	SinCos tracks signal
7	5 V	O	Sensor supply voltage (max. current = 300 mA)
8	GND	O	Sensor supply GND
6*	External supply	O	Sensor supply voltage (if ≠ 5V). Supply to be provided via X2 connector, pin 3.
4,5,9	Reserved		
14,15	Reserved		

(*) Only for drives with mention "PPAC-16" in their reference.

SPECIFICATION OF THE SINE AND COSINE CHANNELS



3.4 - INPUTS-OUTPUTS CONNECTOR: X2

SUB D 26 PIN MALE HD CONNECTOR

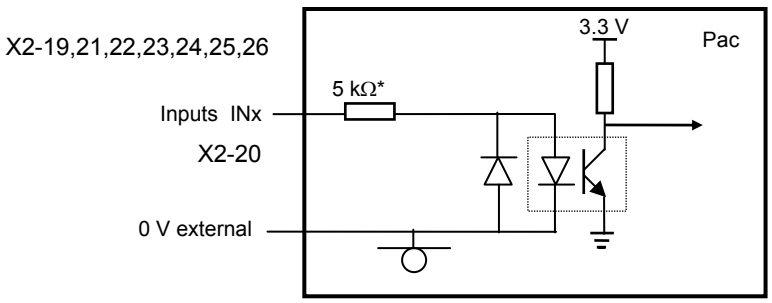
PIN	FUNCTION	I/O	DESCRIPTION
1	ANA1+	I	Analog input n° 1 Differential input +/-10 V * Input impedance: 20 kOhms
10	ANA1-	I	
2	GND		Non differential analog input n° 2 Direct input +/-10 V / GND reference
11	ANA2	I	
4	AOK-	O	OptoMos relay: high output impedance if fault Umax = 50 V , Imax = 300 mA Polarity must be observed: AOK+ = positive potential AOK- = negative potential
14	AOK+	O	
13	GND		External supply for Hall effect sensor, Hiperface® encoder or SinCos tracks sensor.
3	External supply: max. 24 Vdc / max.300 mA	I	
5	OUT1	O	Non optocoupled DRIVER PNP "high side" logic outputs 24 V / 300 mA
15	OUT2	O	
6	OUT3	O	
16	Differential encoder output Marker Z-	O	Differential encoder outputs available on the XtrapulsPac-ak version only. 5 V / 60 mA via channels A, B, Z
7	Differential encoder output Marker Z+	O	
17	Differential encoder output channel B-	O	
8	Differential encoder output channel B+	O	
18	Differential encoder output channel A-	O	
9	Differential encoder output channel A+	O	
19	STO2/	I	All logic inputs are optocoupled EGND = optocoupled input reference Vin voltage = 18 V < Vin < 27 V Input impedance Zin = 5 kOhms Turn-on delay = 20 µs** Turn-off delay = 15 µs**
20	EGND		
21	STO1/	I	
22	IN5 / PULSE (stepper motor emulation)	I	
23	IN4	I	
24	IN3 / DIR (stepper motor emulation)	I	
25	IN2	I	
26	IN1	I	
12	ANA-OUT	O	Analog output 2.5 V +/- 2 V - 8 bits. software configurable analog output

(*) For a non differential input signal, ANA1- (pin10) must be connected to GND (pin2) on the drive side

(**) For drives with serial number < 108210001: Zin = 2 kOhm, Turn-on delay = 2 µs, Turn-off delay = 40 µs.

NOTE: IN5 and IN3 inputs can be used as PULSE and DIRECTION logic inputs for stepper motor emulation with optocoupled 24 V interface.

3.4.1 - SPECIFICATION OF THE LOGIC INPUTS



(*) For drives with serial number < 108210001: Zin = 2 kOhms

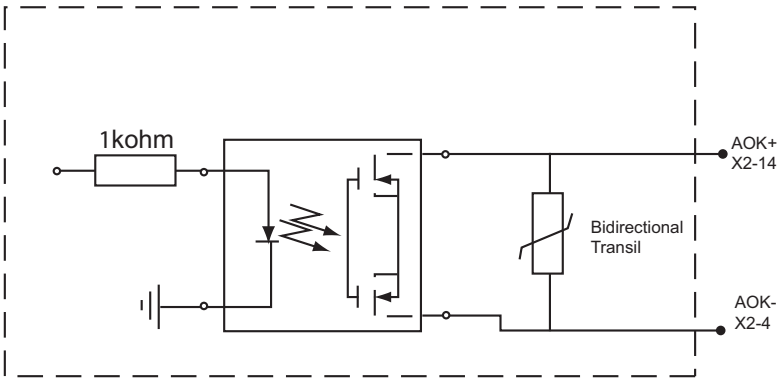
These optocoupled inputs are working in positive logic.

The input voltage corresponding to level 1 must be between 18 V and 27 V.

3.4.2 - SPECIFICATION OF THE LOGIC OUTPUT "AOK+/-" (POLARIZED OPTO-RELAY OUTPUT)

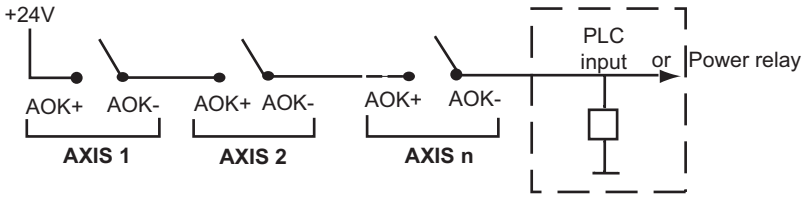
The use of the AOK output is mandatory in order to ensure the power supply connection.
It also ensures the protection of the electrical installation against the risk of fire in case of fatal failure of the power stage (e.g. transistor in short-circuit).

Attention: The opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the controller should be examined.

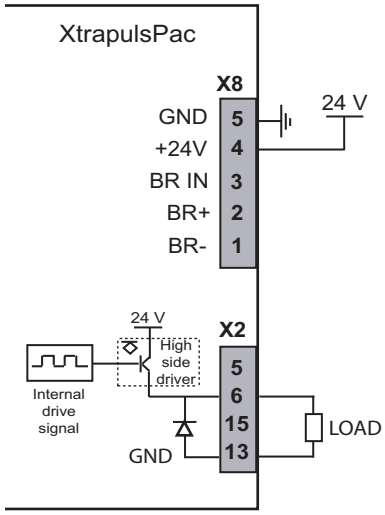


Polarized solid state output: closed if drive OK, open if fault.
Pmax = 10 W with Umax = 50 V – Imax = 300 mA.
For UL users, Umax = 42.4 V from an isolated power supply protected by a 3 A UL fuse.

The AOK output is a solid state output: polarity must be observed (see wiring diagram below).



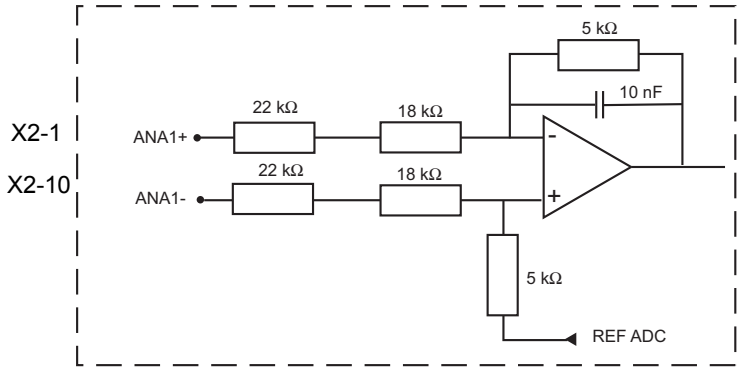
3.4.3 - SPECIFICATION OF THE LOGIC OUTPUTS OUT1 TO OUT3

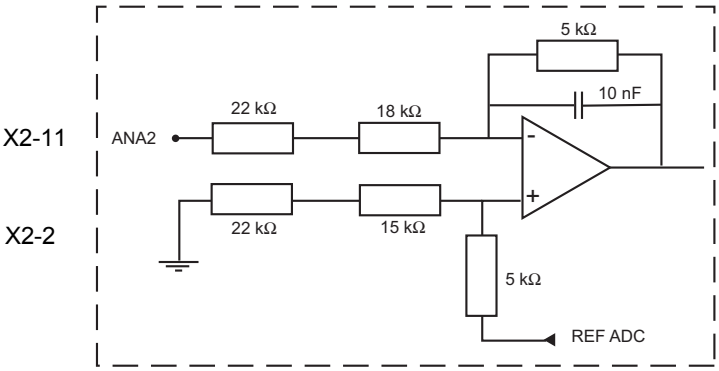


Digital outputs can be paralleled to increase the maximum output current.
Be careful to connect all paralleled outputs to the same drive signal.

Paralleled outputs	Output voltage	Maximum output current
1	24 V	300 mA
2	24 V	400 mA
3	24 V	600 mA

3.4.4 - SPECIFICATION OF THE ANALOG INPUTS ANA1+/- AND ANA2

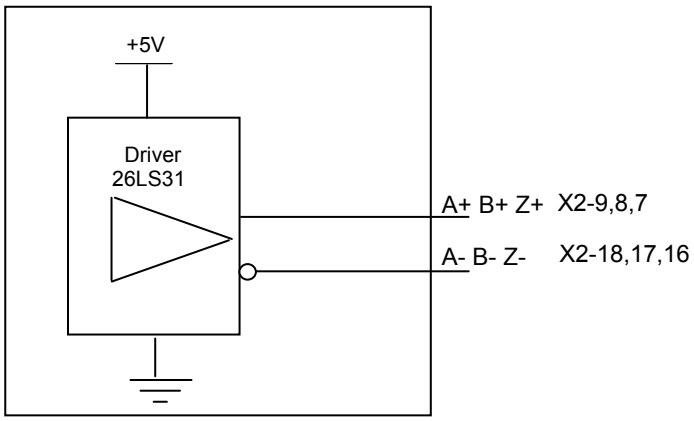




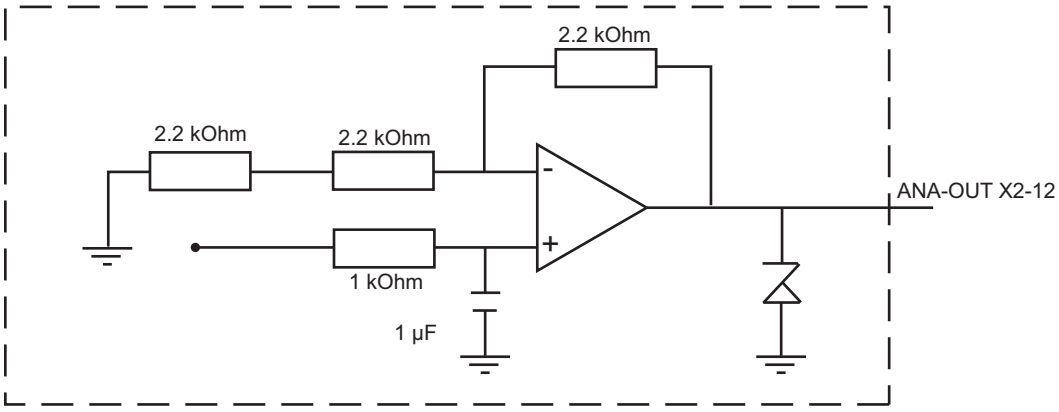
3.4.5 - SPECIFICATION OF THE ENCODER OUTPUT SIGNALS

Note: Available on the XtrapulsPac-ak version only

RS 422 line transmitter: 20 mA per output.



3.4.6 - SPECIFICATION OF THE ANALOG OUTPUT



3.5 - ENCODER CONNECTORS: X3

3.5.1 - X3 CONNECTOR FOR INCREMENTAL TTL & HES ENCODER INPUT (SUB D HD 26 PINS FEMALE)

The “Incremental TTL & HES encoder” configuration is software selectable and saved in the drive EEPROM.

PIN	FUNCTION	REMARKS
22	Z/ marker pulse	Differential input of the encoder marker pulse Z/
21	Z marker pulse	Differential input of the encoder marker pulse Z
3	Channel A/	Differential input of the encoder channel A/ (or PULSE/ for stepper emulation)
12	Channel A	Differential input of the encoder channel A (or PULSE for stepper emulation)
4	Channel B/	Differential input of the encoder channel B/ (or DIR/ for stepper emulation)
13	Channel B	Differential input of the encoder channel B (or DIR for stepper emulation)
7	+ 5 V	Encoder supply voltage (max. current = 300 mA)
16	GND	Encoder supply GND
6	HALL U	Hall sensor input signal phase U (or PULSE for stepper emulation)
15	HALL V	Hall sensor input signal phase V (or DIR for stepper emulation)
23	HALL W	Hall sensor input signal phase W
19*	+ 9.5 V	Hall sensor internal supply voltage 9.5 V +/- 0.5 V (150 mA max. output current)
24	External supply	Hall sensor supply voltage (if ≠ 5 Vdc or 10 Vdc). Supply to be provided via the X2 connector, pin 3.
16	GND	Hall sensors supply GND
14	TC+	Motor thermal sensor input
5	TC-	Motor thermal sensor input
Others	Reserved	

(*) Only for drives with mention "PPAC-16" in their ordering code.

Remark: This wiring ensures the motor parameters compatibility with the XtrapulsGem series.

NOTE 1: A and B channels can be used as PULSE and DIRECTION inputs for the stepper motor emulation with RS422 receiver interface.

NOTE 2: HALL U and HALL V inputs can be used as PULSE and DIRECTION logic inputs for the stepper motor emulation with 5 V to 24 V logic interface.

3.5.2 - X3 CONNECTOR FOR INCREMENTAL SIN/COS & HES ENCODER INPUT (SUBD HD 26 PINS FEMALE)

The “Incremental SinCos & HES encoder” configuration is software selectable and saved in the drive EEPROM.

PIN	FUNCTION	REMARKS
25	Mark- channel	Differential input for the reference pulse of the Sin/Cos encoder channel Mark-
26	Mark+ channel	Differential input for the reference pulse of the Sin/Cos encoder channel Mark+
17	Sin- channel	Differential input for Sin- channel of the Sin/Cos encoder
18	Sin+ channel	Differential input for Sin+ channel of the Sin/Cos encoder
8	Cos- channel	Differential input for Cos- channel of the Sin/Cos encoder
9	Cos+ channel	Differential input for Cos+ channel of the Sin/Cos encoder
7	+5 V	Encoder supply voltage (max. current = 300 mA)
16	GND	Encoder supply GND
6	HALL U	Hall sensors input signal phase U
15	HALL V	Hall sensors input signal phase V
23	HALL W	Hall sensors input signal phase W
19*	+ 9.5 V	Hall sensor internal supply voltage 9.5 V +/- 0.5 V (150 mA max. output current)
24	External supply	Hall sensor supply voltage (if ≠ 5 Vdc or 10 Vdc). Supply to be provided via the X2 connector, pin 3.
16	GND	Hall sensors supply GND
14	TC+	Motor thermal sensor input
5	TC-	Motor thermal sensor input
Others	Reserved	

(*) Only for drives with mention "PPAC-16" in their ordering code.

Remark: For the motor parameters compatibility with the XtrapulsGem series, use the following signal equivalence: Mark+=R, Mark-=R\, Sin+=B, Sin-=B\, Cos+=A, Cos-=A\.

3.5.3 - X3 CONNECTOR FOR "ABSOLUTE HIPERFACE® ENCODER" INPUT (SUB D HD 26 PINS FEMALE)

The Hiperface® absolute encoder configuration is software selectable and saved in the drive EEPROM.

PIN	FUNCTION	REMARKS
3	Data-	Differential input of the Hiperface® encoder Data- channel
12	Data+	Differential input of the Hiperface® encoder Data+ channel
17	Sin- channel	Differential input of the Hiperface® encoder Sin- channel
18	Sin+ channel	Differential input of the Hiperface® encoder Sin+ channel
8	Cos- channel	Differential input of the Hiperface® encoder Cos- channel
9	Cos+ channel	Differential input of the Hiperface® encoder Cos+ channel
19*	+ 9.5 V	Hall sensor internal supply voltage 9.5 V +/- 0.5 V (150 mA max. output current)
24	External supply	Hiperface® encoder supply voltage (if ≠ 10 V). Supply to be provided via the X2 connector, pin 3.
16	GND	Supply GND
14	TC+	Motor thermal sensor input
5	TC-	Motor thermal sensor input
Others	Reserved	

(*) Only for drives with mention "PPAC-16" in their ordering code.

Remark: This wiring ensures the motor parameters compatibility with the XtrapulsGem series.

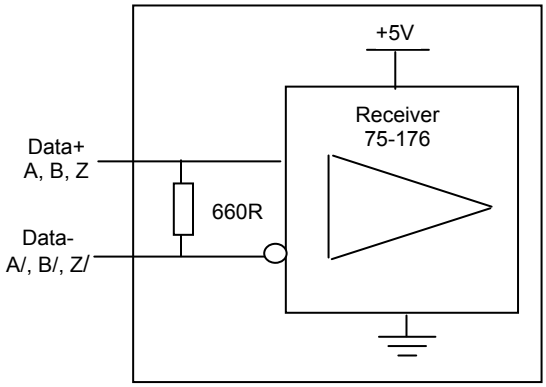
3.5.4 - X3 CONNECTOR FOR "SINGLE-TURN ABSOLUTE SINCOS ENCODER" INPUT (SUB-D HD 26 PINS FEMALE)

The single-turn absolute SinCos encoder configuration is software selectable and saved in the drive EEPROM.
This encoder configuration is only available for drives with mention "PPAC-16" in their ordering code.

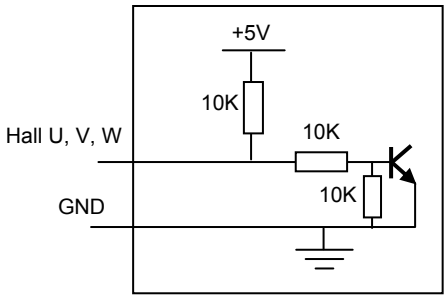
PIN	FUNCTION	DESCRIPTION
25	Marker R-	Differential input of the Sin/Cos encoder reference pulse R
26	Marker R+	Differential input of the Sin/Cos encoder reference pulse R
17	Channel A-	Differential input of the Sin/Cos encoder channel A
18	Channel A+	Differential input of the Sin/Cos encoder channel A
8	Channel B-	Differential input of the Sin/Cos encoder channel B
9	Channel B+	Differential input of the Sin/Cos encoder channel B
1	Channel C-	Differential input of the Sin/Cos encoder channel C
10	Channel C+	Differential input of the Sin/Cos encoder channel C
2	Channel D-	Differential input of the Sin/Cos encoder channel D
11	Channel D+	Differential input of the Sin/Cos encoder channel D
7	+5 V	Encoder supply voltage (max. current = 300 mA)
16	GND	Encoder supply GND
14	TC+	Motor thermal sensor input
5	TC-	Motor thermal sensor input
Others	Reserved	

Remark: This wiring ensures the motor parameters compatibility with the XtrapulsGem series.

SPECIFICATION OF THE INCREMENTAL TTL ENCODER INPUT LINES

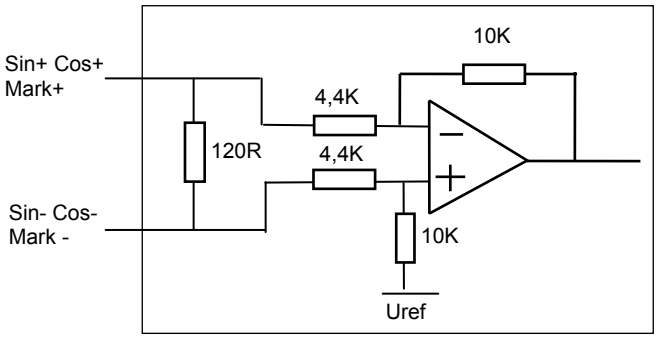


SPECIFICATION OF THE HALL SENSOR INPUT LINES



Positive logic voltage must be higher than 3.3 V
Negative logic voltage must be lower than 0.6 V

SPECIFICATION OF THE SIN/COS AND HIPERFACE® ENCODER SIGNALS



3.6 - FIELDBUS CONNECTORS: X6 AND X7

In order to ensure the best reliability and performances of the global system, it is recommended to use RJ45 Ethernet cables with a minimum level of category 5.

3.6.1 - XTRAPULSPAC-AK VERSION WITH CANOPEN BUS

RJ45 standard connector

X6-PIN / X7-PIN	SIGNAL	DESCRIPTION
1	CAN-H	Line CAN-H (dominant high)
2	CAN-L	Line CAN-L (dominant low)
3	CAN-GND	CAN Ground
4	Reserved	
5	Reserved	
6*	Internally connected	X6-pin 6 connected to X7-pin 6
7	GND	
8*	Internally connected	X6-pin 8 connected to X7-pin 8

(*) Only for drives with mention "PPAC-16" in their ordering code.

3.6.2 - XTRAPULSPAC-ET VERSION WITH ETHERCAT® BUS

RJ45 standard connector

PIN	SIGNAL	DESCRIPTION
1	Tx Data+	Differential signals
2	Tx Data-	
3	Rx Data+	Differential signals
6	Rx Data-	
Others		Reserved

For more information, see **EtherCAT® fieldbus Interface** manual.

3.7 - SERIAL LINK RS-232 CONNECTOR: X5

3.7.1 - XTRAPULSPAC-AK VERSION WITH CANOPEN BUS

SUB D 9 pin male connector (same as XtrapulsCD1 and XtrapulsGem series)

PIN	FUNCTION	REMARKS
5	GND	GND (shield connection if no 360° connection on the connector). 360° shield is strongly recommended.
3	TXD	Transmit data RS-232
2	RXD	Receive data RS-232

3.7.2 - XTRAPULSPAC-ET VERSION WITH ETHERCAT® BUS

SUB D 9 pin male connector

PIN	FUNCTION	REMARKS
5	GND	GND (shield connection if no 360° connection on the connector). 360° shield is strongly recommended.
3	TXD	Transmit data RS-232
2	RXD	Receive data RS-232
1	CAN-H	Line CAN-H (dominant high)
9	CAN-L	Line CAN-L (dominant low)
Others		Reserved

In the EtherCAT® version, the multi-axis parameter setting and monitoring using the *Gem Drive Studio* software can be performed via the CANopen bus connection on the X5 connector.

3.8 - 24 VDC AUXILIARY POWER SUPPLY AND MOTOR BRAKE CONNECTOR: X8

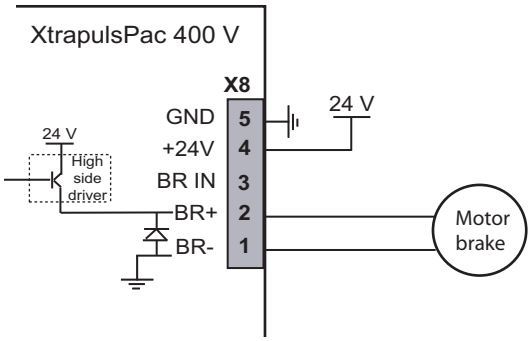
Manufacturer: Weidmüller
Type: BLZ 5.08 / 5
Reference: 152676
Tightening torque: 0.4 to 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	Brake-	O	Motor brake output	Grounded potential reference (GND reference)
2	Brake+	O	Motor brake output	24 Vdc motor brake output
3	Brake In	I	Signal connection for the motor brake supply wiring relay (optional)	Pins 2 and 3 internally connected on X8 for an easy wiring in case of external brake relay.
4	24 V	I	Mains isolated 24 Vdc auxiliary power supply 0 V input referenced to the GND potential on the drive housing	24 Vdc supply: +/- 10 % Consumption: 300 mA without brake UL: protection by means of a 3 A UL fuse
5	0V = GND	I		

3.8.1 - MOTOR BRAKE OUTPUT ON XTRAPULS PAC 400 V

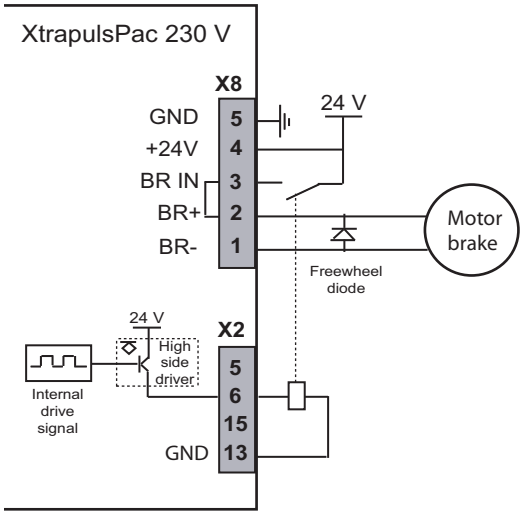
A high side driver output is provided to directly drive the motor brake.

Model	Rated output voltage	Maximum output current
XtrapulsPac-400/08	24 V	1.5 A
XtrapulsPac-400/20	24 V	1.5 A
XtrapulsPac-400/45	24 V	2.5 A
XtrapulsPac-400/100	24 V	2.5 A



3.8.2 - MOTOR BRAKE OUTPUT ON XTRAPULS PAC 230 V

A logic output must be software configured as motor brake output.
BR IN and BR + are internally connected together for convenience when wiring the external relay:
If the brake consumption is higher than the digital output specification, an external relay must be used to drive the motor brake.



3.9 - POWER CONNECTORS: X9 and X10

3.9.1 - XTRAPULSPAC 230 V: X9

Manufacturer: Weidmüller
Type: BLZ 5.08 / 10
Reference: 152956
Tightening torque: 0.4 to 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	U	O	Motor phase U	Shielded motor cable: - PE connection on the bottom plate, - 360° shield connection.
2	V	O	Motor phase V	
3	W	O	Motor phase W	
4	DC-	I/O	DC bus negative voltage output	For the DC bus paralleling in multi-axis applications or connection with an external capacitor box (ref. CAPABOX). The direct connection of external capacitor is forbidden. See “DC bus interfacing” application note for more details.
5	DC+	I/O	DC bus positive voltage output	
6	Rint	O	Internal 100 Ω / 35 W braking resistor	Two possible wirings: - Internal braking resistor: 100 Ω / 35 W max Connect pins 6 and 7 together with a bridge, - External braking resistor: Min. value = 50 Ω Connect the external resistor between pins 5 and 7.
7	DR	O	Braking transistor output	
8	L1	I	230 Vac single-phase mains input supply	230 Vac single-phase +10 % -15 % Fully integrated EMC mains filter.
9	L2	I		
10	GND		GND reference of the 230 Vac supply cable.	Reference potential of the drive housing. Connection to this pin is not required.

IMPORTANT

Motor and brake cables must be shielded.
The 360° shield connection must be ensured by metallic collars and connected to the ground reference potential.
The GND wire of the motor cable MUST be connected to the ground screw marked with the ground symbol on the housing bottom plate.
See section 4.5 for grounding and shielding precautions.

3.9.2 - XTRAPULSPAC 400 V 45 A AND 100 A: X9

Manufacturer: Phoenix Contact
Type: PC 5/ 7-STCL1-7.62
Reference: 1778117
Tightening torque: 0.7 to 0.8 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	U	O	Motor phase U	Shielded motor cable: - PE connection on the bottom plate, 360° shield connection.
2	V	O	Motor phase V	
3	W	O	Motor phase W	
4	DC-	I/O	DC bus negative voltage output	Input / Output to power drives. Recommended wire section: - AWG11 for Pac 400 V / 45 A - AWG8 for Pac 400 V / 100 A Maximum length between two devices: 200 mm
5	DC+	I/O	DC bus positive voltage output	
6	DC+	I/O	DC bus positive voltage output	
7	DC-	I/O	DC bus negative voltage output	

The DC+/DC- polarity between the multi-axis power supply unit and the drives MUST be observed.

3.9.3 - XTRAPULSPAC 400 V / 08 A AND 20 A: X10

Manufacturer: Weidmüller
Type: BLZ 7.62 / 3
Reference: 162339
Tightening torque: 0.4 to 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	L1	I	L1 mains phase	Three-phase mains inputs: 400 to 480 Vac +10% - 15%. Fully integrated EMC mains filter.
2	L2	I	L2 mains phase	
3	L3	I	L3 mains phase	

3.9.4 - XTRAPULSPAC 400 V / 08 A AND 20 A: X9

Manufacturer: Weidmüller
Type: BLZ 7.62 / 7
Reference: 162343
Tightening torque: 0.4 to 0.5 Nm

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	U	O	Motor phase U	Shielded motor cable: - PE connection on the bottom plate, - 360° shield connection.
2	V	O	Motor phase V	
3	W	O	Motor phase W	
4	DC-	I/O	DC bus negative voltage output	For the DC bus paralleling in multi-axis applications.
5	DC+	I/O	DC bus positive voltage output	
6	Rint	O	Connection of the internal 400 Ω / 35 W braking resistor	Two possible wirings: - Internal braking resistor: 400 Ω / 35 W max. Connect pins 6 an 7 together by a bridge, - External braking resistor: Min. value = 50 Ω Connect the external resistor between pins 5 and 7.
7	DR	O	Connection to the braking transistor	

3.10 – MAINS GROUND CONNECTION

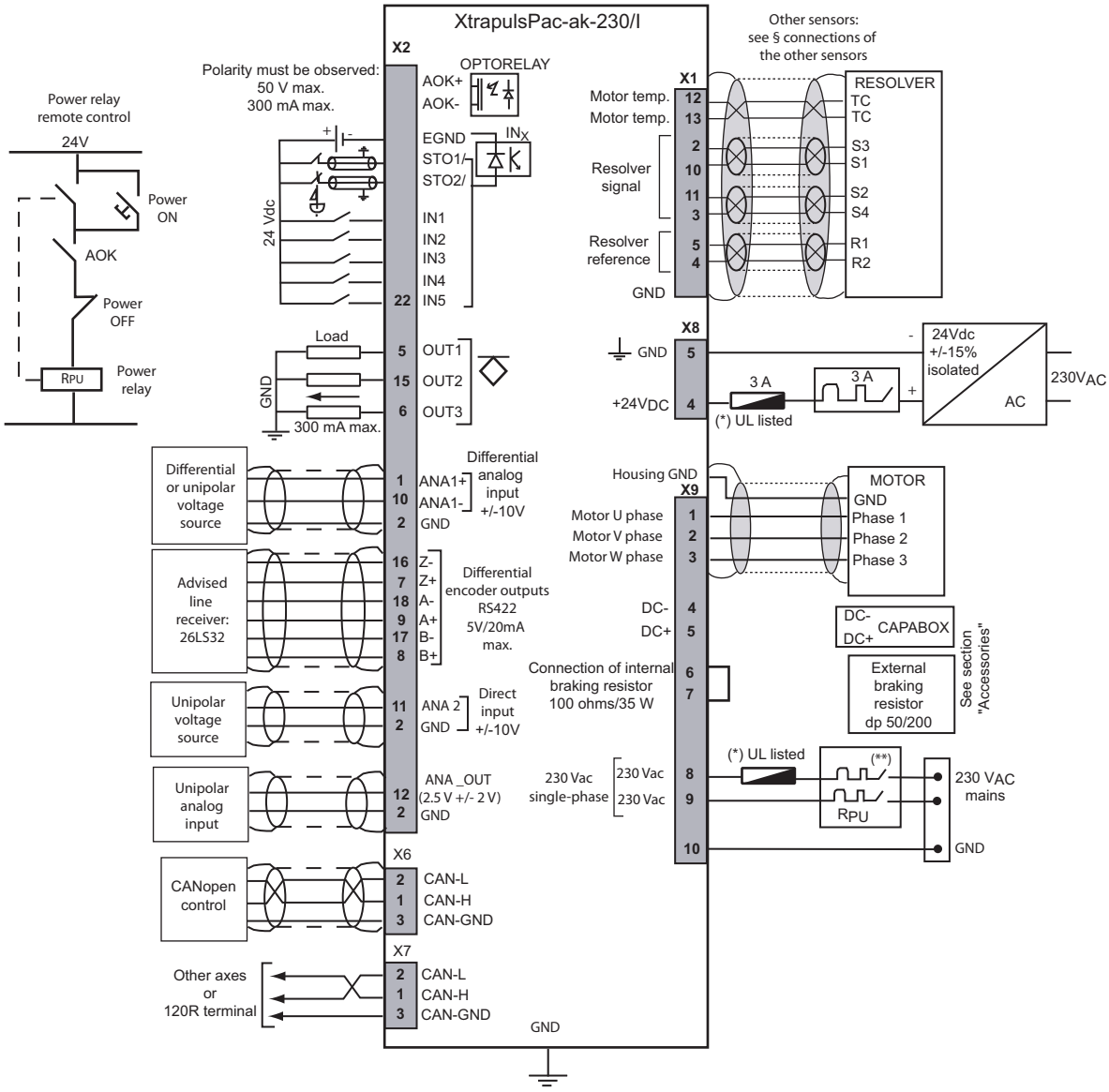
Type: Lug stud M4×10
Tightening torque: 2 N.m
Location: At the bottom left corner of the front panel.

Chapter 4 - Connections

4.1 - CONNECTION DIAGRAMS

4.1.1 - XTRAPULSPAC 230 V

CANopen version



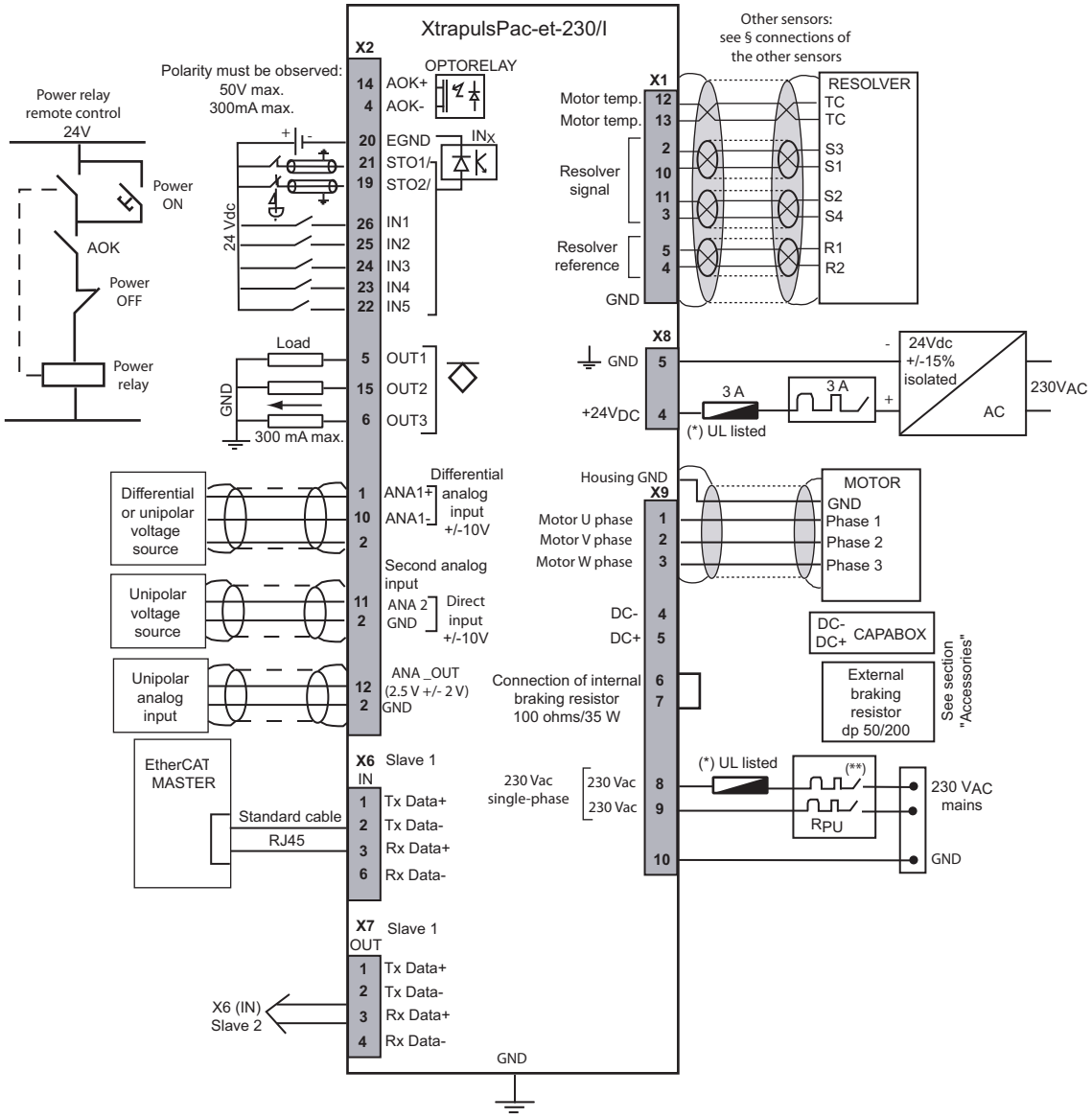
(*) See fuses table for the UL conformity.

(**) Curve D circuit-breaker
I1s = 10 x In
In = 10 A

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection on source side must be made by the user.

EtherCAT® version



(*) See fuses table for the UL conformity.

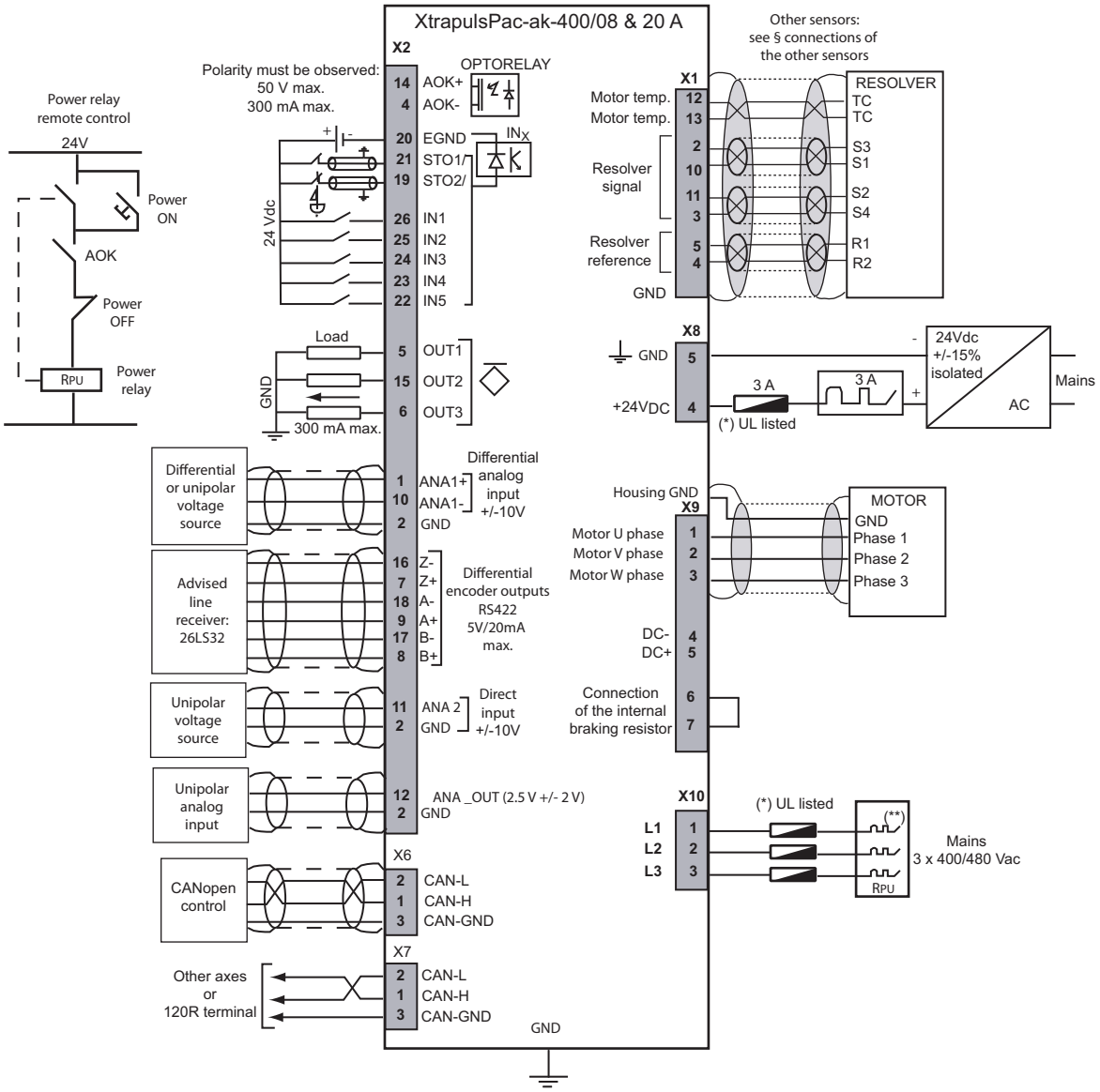
(**) Curve D circuit-breaker
I1s = 10 x In
In = 10 A

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection, on source side, must be made by the user.

4.1.2 - XTRAPULSPAC 400 V, 08 AND 20 A

CANopen version



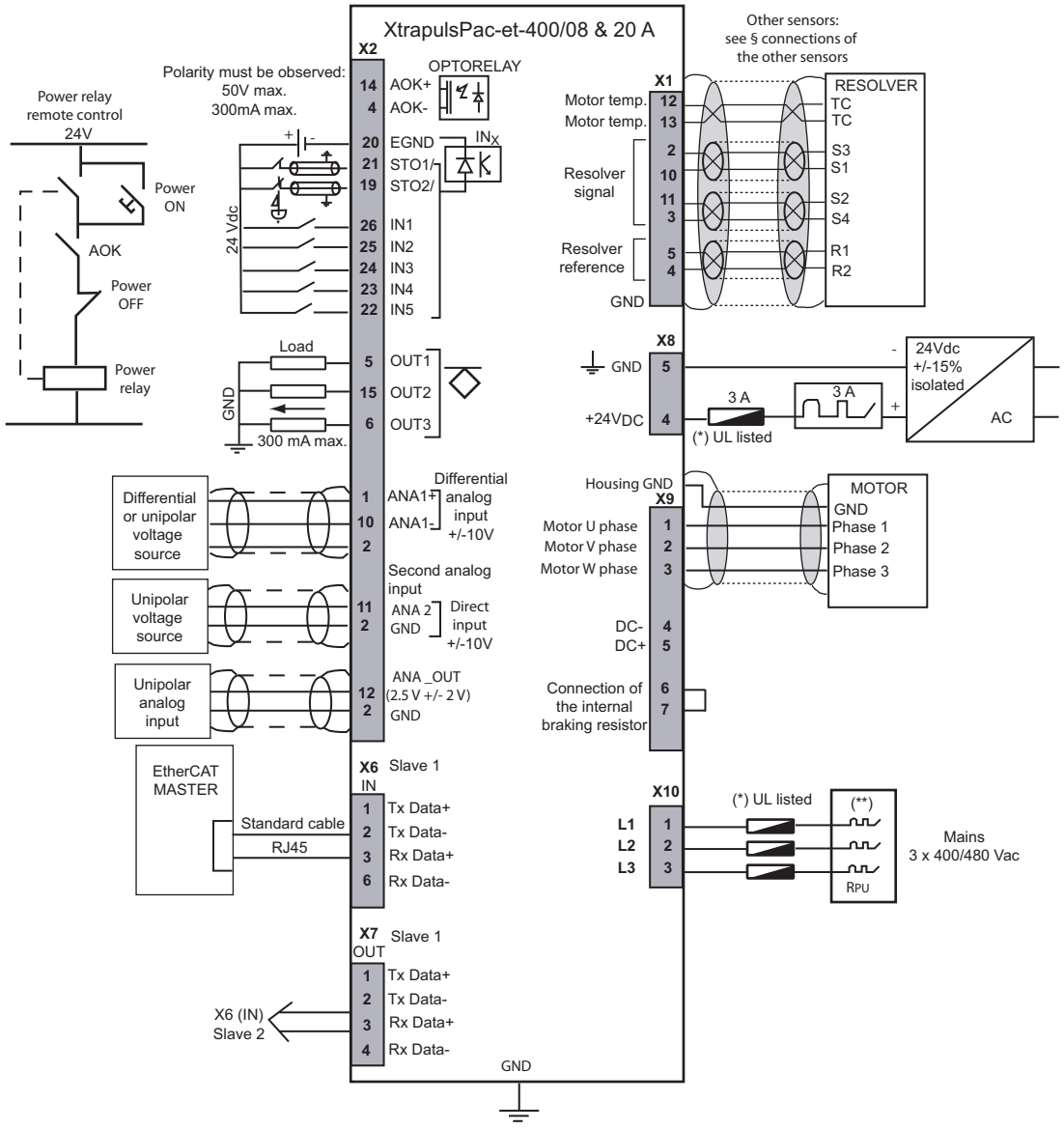
(*) See fuses table for the UL conformity.

(**) Curve D circuit breaker
I1s = 10 x In
In = 10 A

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection on source side must be made by the user.

EtherCAT® version



(*) See fuses table for the UL conformity.

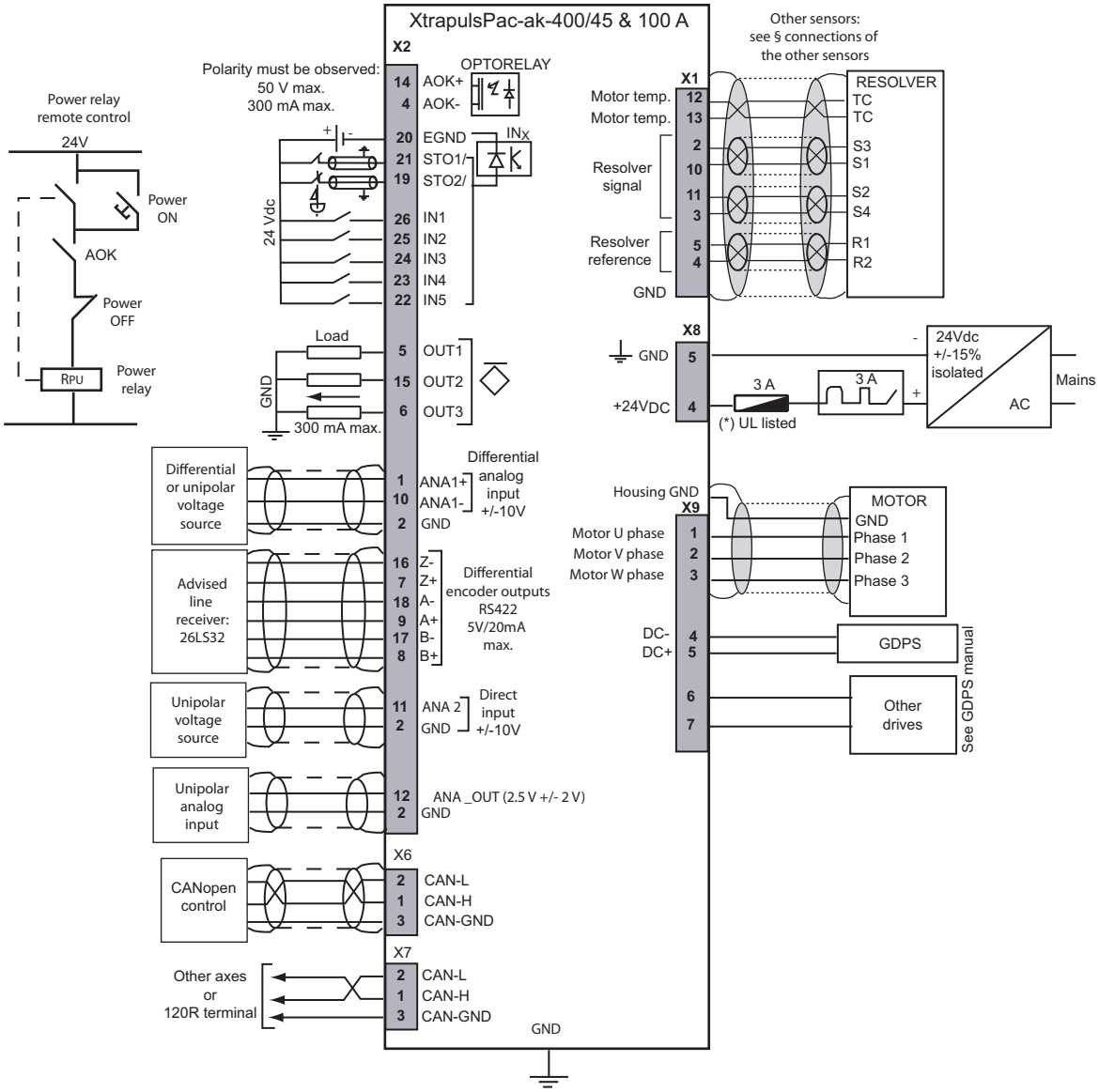
(**) Curve D circuit-braker
I1s = 10 x In
In = 10 A

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection, on source side, must be made by the user.

4.1.3 - XTRAPULSPAC 400 V, 45 AND 100 A

CANopen version

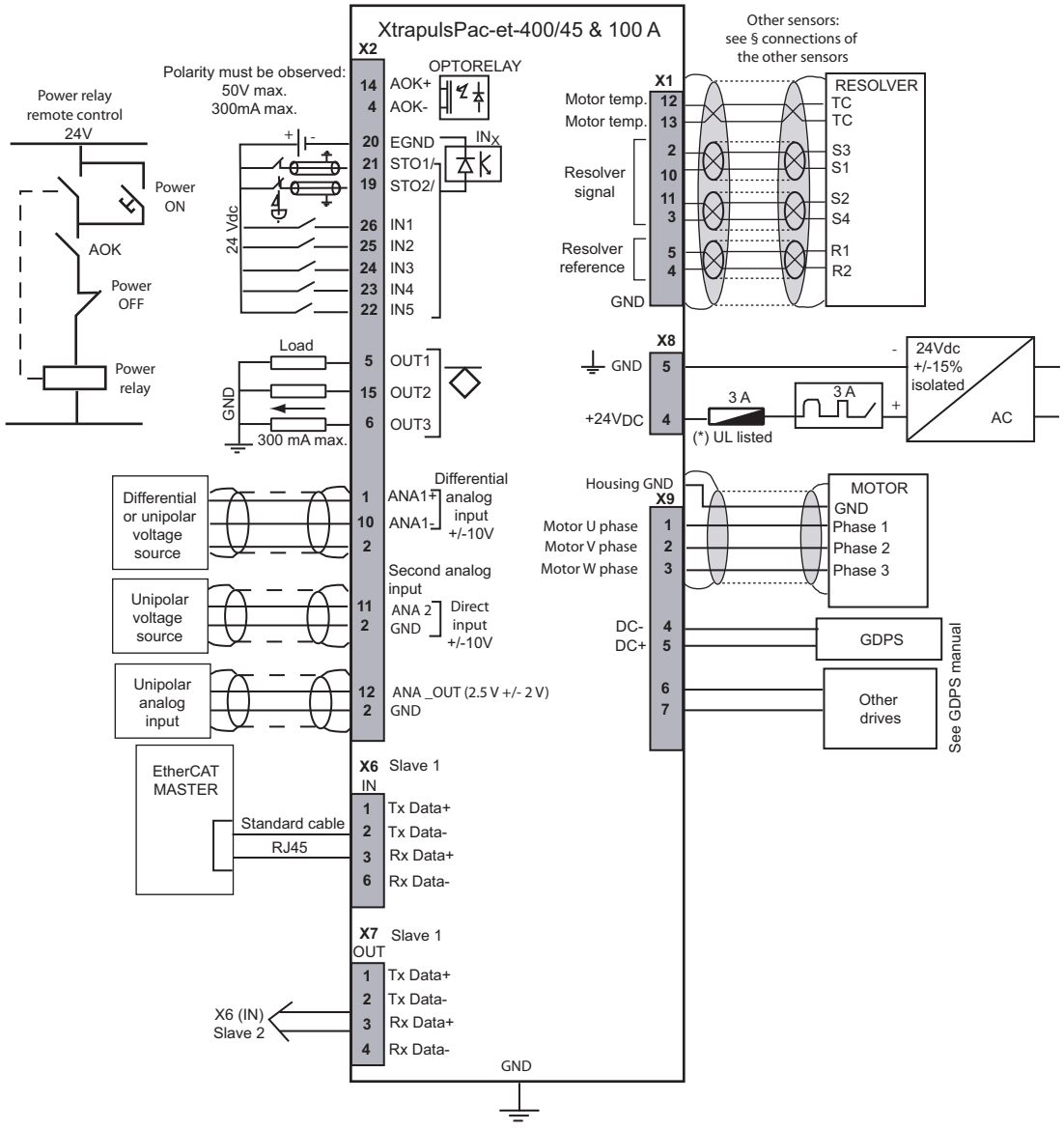


(*) See fuses table for the UL conformity.

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection, on source side, must be made by the user.

EtherCAT® version



(*) See fuses table for the UL conformity.

Use only copper conductors for the wiring terminations.
The torque values of the wiring terminations must comply with the certified bloc terminal.

Note: The 24 V and power supply protection, on source side, must be made by the user.

4.1.4 - UL STANDARD REQUIREMENTS

The UL listing requires the following conditions.

4.1.4.1 - 24 V supply

The final user has to provide an isolated auxiliary 24 Vdc +/-15% supply (e.g. with isolation transformer) for the auxiliary supply input, and protected by a 3 A UL certified fuse.

4.1.4.2 - Power supply and UL fuse ratings

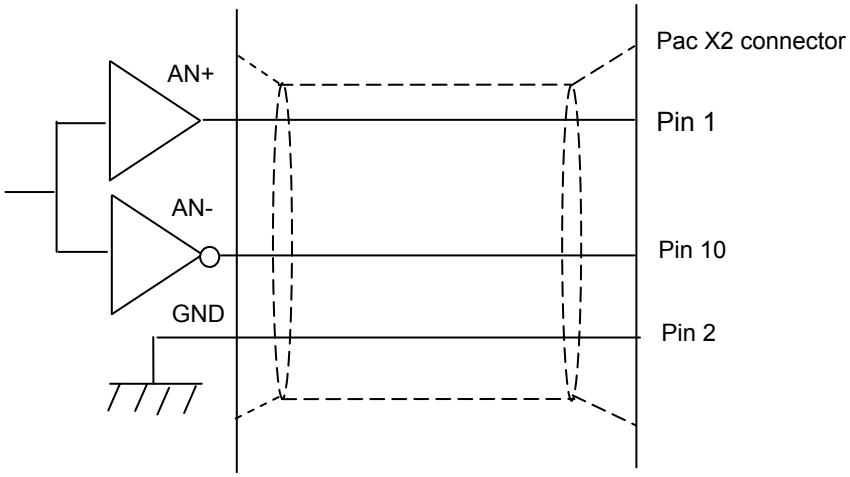
The recommended fuse model is a "semiconductor protection" type. The maximum mains short-circuit power must not exceed 5000 Arms, when protected by a UL fuse type A60Q.

On **XtrapulsPac** drives, the fuse rating must be the following:

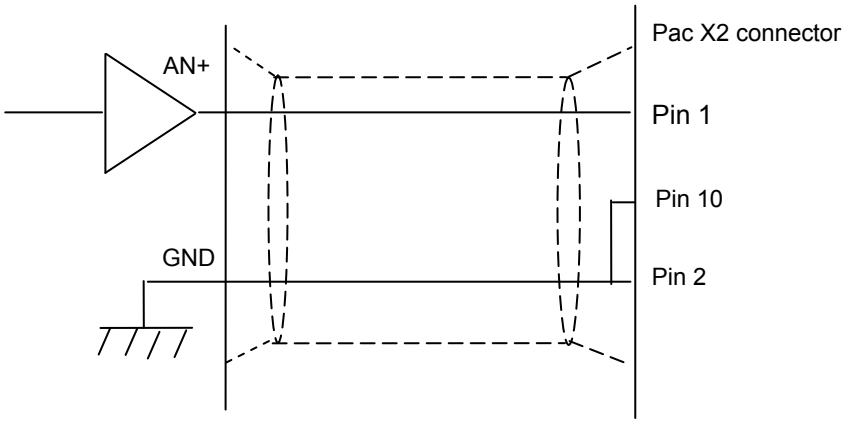
XtrapulsPac-ak	FERRAZ Type A60Q
230 V / 05 A	A60Q10-2
230 V / 11 A	A60Q15-2
230 V / 17 A	A60Q20-2
400 V / 08 A	A60Q10-2
400 V / 20 A	A60Q15-2
400 V / 45 A	See GDPS manual
400 V / 100 A	See GDPS manual

4.2 – ANALOG INPUTS CONNECTION

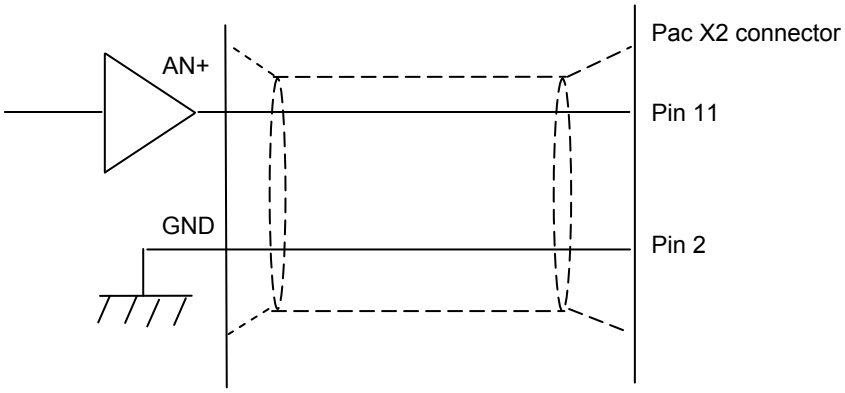
4.2.1 - ANA1 INPUT CONNECTION WITH A DIFFERENTIAL ANALOG SIGNAL SOURCE



4.2.2 - ANA1 INPUT CONNECTION WITH A NON DIFFERENTIAL ANALOG SIGNAL SOURCE

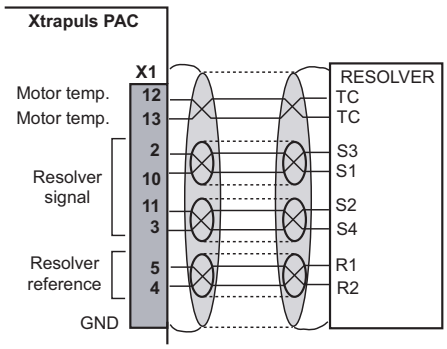


4.2.3 - ANA2 INPUT CONNECTION

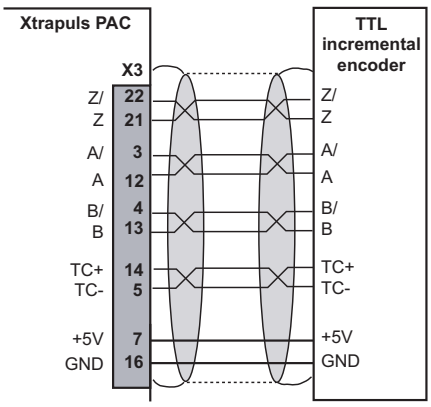


4.3 - CONNECTION TO VARIOUS SENSOR TYPES

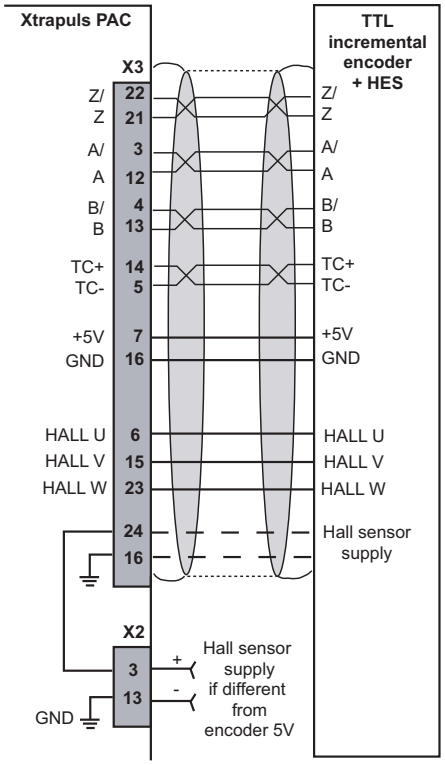
4.3.1 - CONNECTION TO A RESOLVER: X1 - SUB D 15 PIN FEMALE CONNECTOR



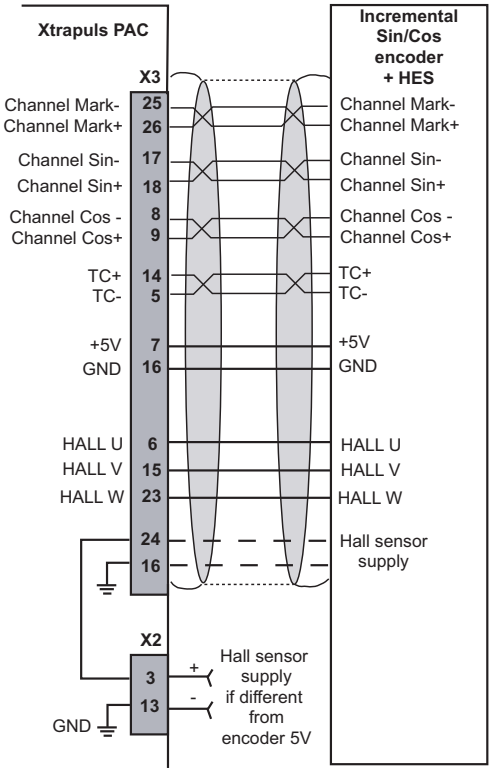
4.3.2 - CONNECTION TO AN INCREMENTAL TTL ENCODER: X3 - 26 PIN FEMALE HD CONNECTOR



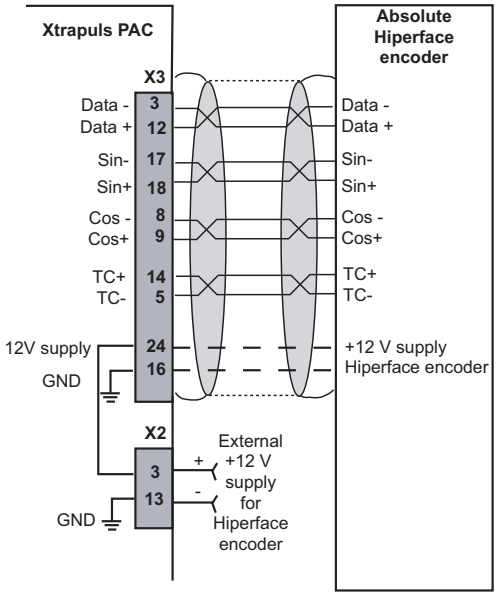
4.3.3 - CONNECTION TO AN INCREMENTAL TTL ENCODER WITH HALL SENSOR: X3 – 26 PIN FEMALE HD CONNECTOR



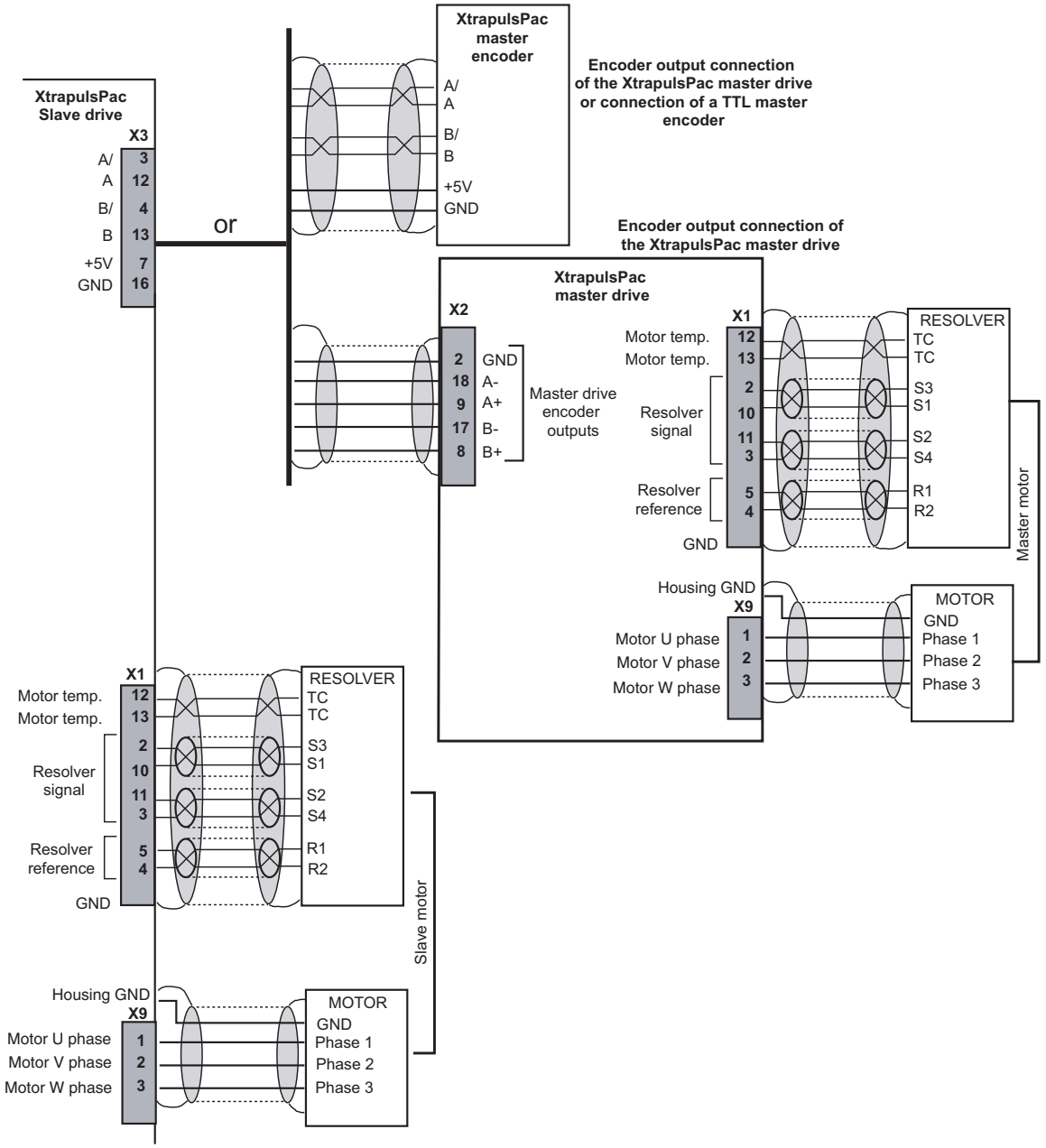
4.3.4 - CONNECTION TO AN INCREMENTAL SIN/COS ENCODER WITH HALL SENSOR: X3- 26 PIN FEMALE HD CONNECTOR



4.3.5 - CONNECTION TO AN ABSOLUTE HIPERFACE® ENCODER: X3 – 26 PIN FEMALE HD CONNECTOR



4.3.6 - CONFIGURATION OF THE XTRAPULSPAC DRIVE WITH "SOFTWARE GEARING" FUNCTION



In master/slave "software gearing" applications, the drive controls the slave motor shaft position with regard to the input command sent by the master axis.
The position input command issued from the master axis can be interfaced either:

- with a master encoder

- or with the encoder output of an XtrapulsPac master drive.

4.4 - ACCESSORIES AND CONNECTIONS

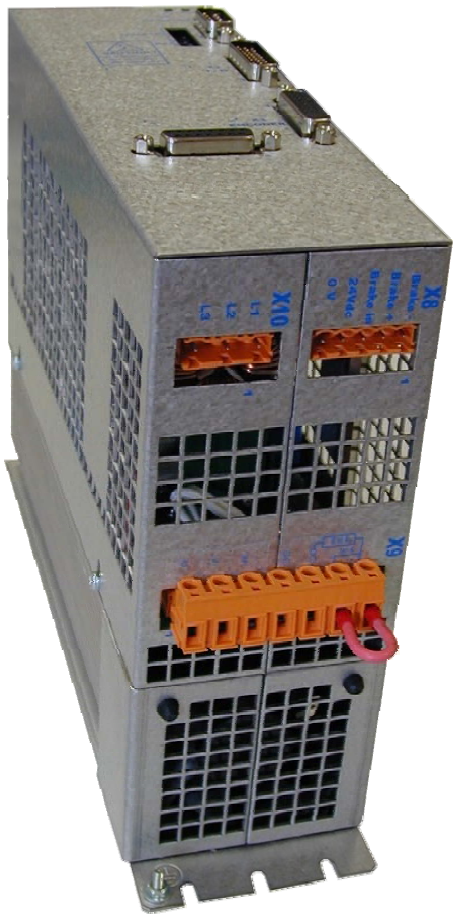
ENERGY RECUPERATION VIA A BRAKING RESISTOR

All XtrapulsPac stand-alone 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".

An electronic control of the dissipated power avoids the overload of the braking resistor. So, if the energy reflected to the drives is too high, the DC bus voltage will rise up to the release of the "**Overvoltage**" fault.

4.4.1 - CONNECTION OF THE INTERNAL BRAKING RESISTOR

XtrapulsPac 230 V



XtrapulsPac 400 V / 08 and 20 A

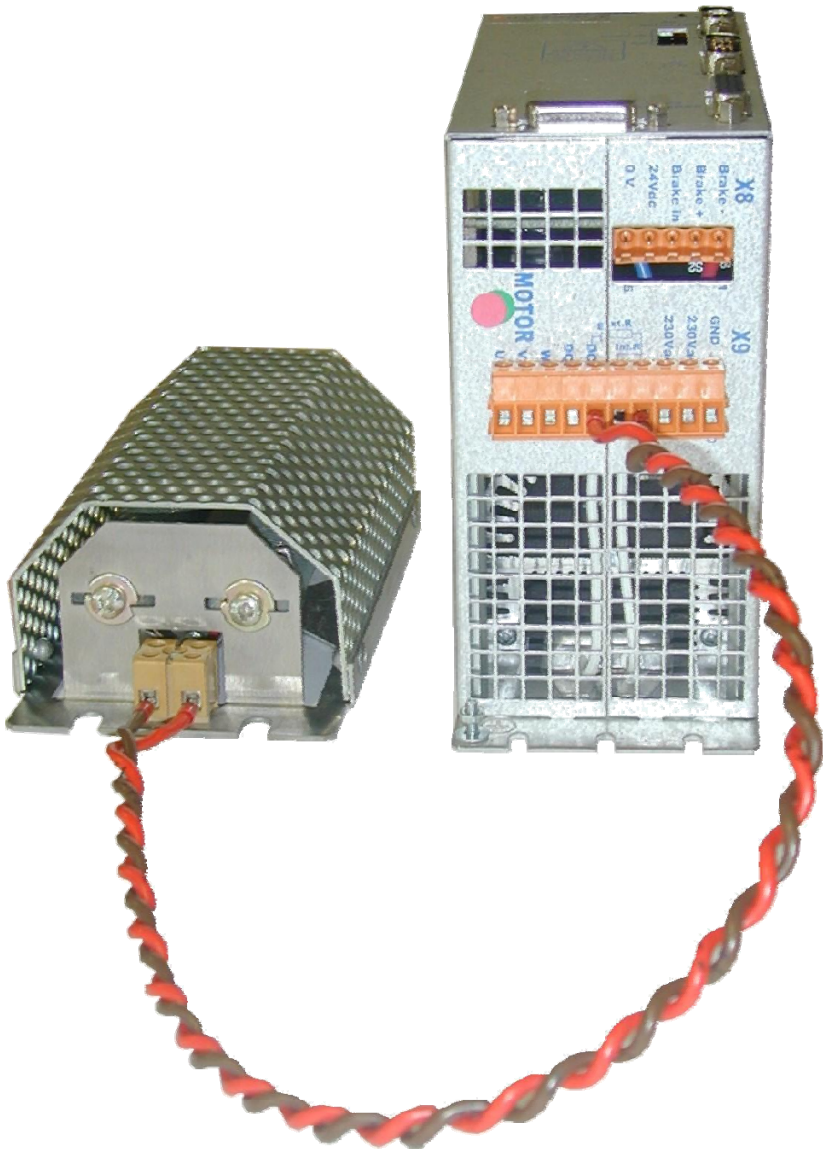
The XtrapulsPac drive in stand-alone version is equipped with an internal 35 W braking resistor.
Its connection is made by means of a wiring bridge between pins 6 and 7 of the X9 connector.
If the required rated power of the braking resistor is higher than 35 W or if the pulse power is higher than 1500 W, a larger external power resistor must be mounted (e.g. dp 50/200).

4.4.2 - CONNECTION OF THE EXTERNAL BRAKING RESISTOR

The braking resistor MUST be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

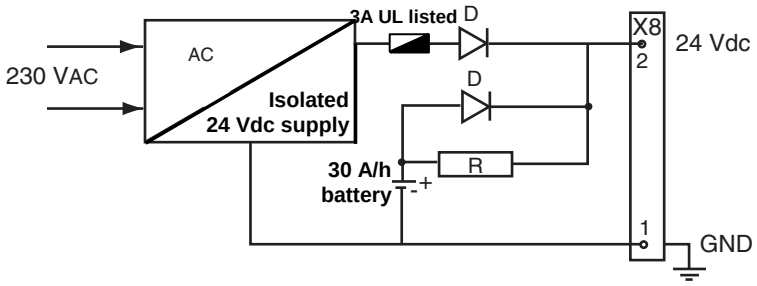
In order to avoid any EMC or electrical problem, some rules must be observed:

- heat must be evacuated,
- shielded cables or at least twisted wires must be used,
- wires must bear high voltage and high temperature (recommended type: UL1015, AWG 14)
- wires must be as short as possible (max. 1 m).



The external braking resistor must be connected between pins 5 and 7 of X9.
Its connection requires the inhibition of the internal braking resistor (removal of the wiring bridge between pins 6 and 7 of X9).

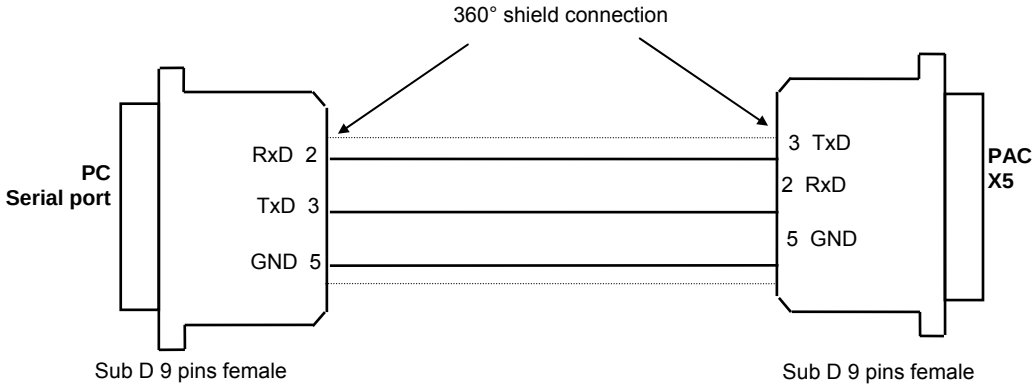
4.4.3 - CONNECTION OF A BACKUP BATTERY



The XtrapulsPac drive consumption is 300 mA with 24 Vdc. So, a 24 V / 30 A/h battery can keep the drive powered during e.g. a long 3-day week-end. 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.

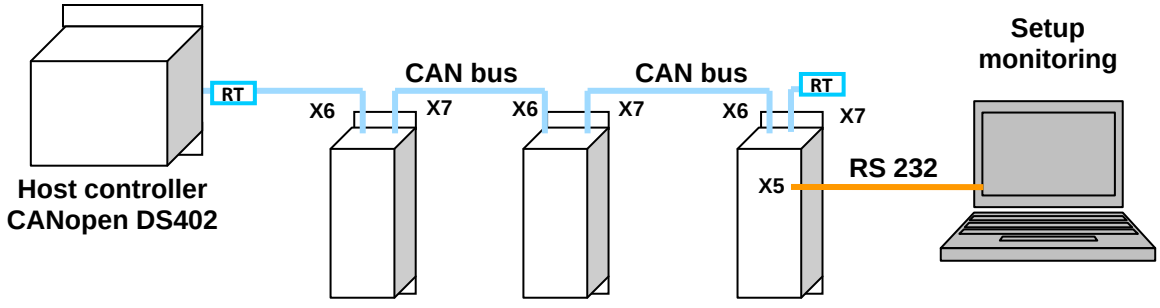
4.5 - CONNECTION TO THE "GEM DRIVE STUDIO" SOFTWARE TOOL

4.5.1 - CONNECTION OF THE SERIAL LINK TO THE X5 CONNECTOR



4.5.2 - MULTIAXIS CONNECTION OF THE SERIAL LINK

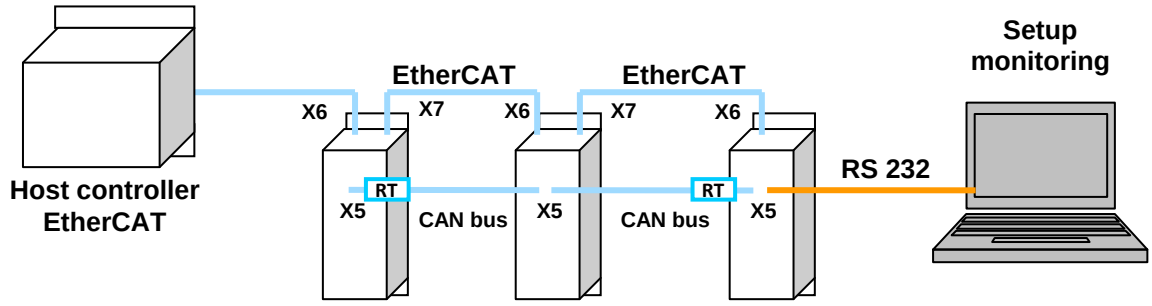
4.5.2.1 - XtrapulsPac drive in CANopen configuration



RT = 120 Ohm terminal resistor connected between CAN-L and CAN-H lines

The parameterization of all axes is made by one single connection to the first axis via the serial link RS232. The other axis are parameterized via the CAN bus.

4.5.2.2 - XtrapulsPac drive in EtherCAT® configuration



RT = 120 Ohm terminal resistor connected between CAN-L and CAN-H lines

In the EtherCAT® configuration, the RS232 and CAN communication is made via the SUB D 9 pins connector X5.
The multi-axis parameterization is then made according to the diagram above.

4.6 - WIRING INSTRUCTIONS

according to the EN61000.4-2-3-4-5 and EN55011 standards.

4.6.1 - GROUND CONNECTION

LEAKAGE CURRENT TO THE GROUND

The "Electronic Power Unit" equipment which includes the control, the drive, the motor and the sensors, generates a leakage current to the ground higher than 10 mA continuous: the protection conductor section must be **at least** 10 mm² (Cu) or 16 mm² (Al).

This product may generate a leakage current with a DC component.
If a Residual Current Device is used, it should be:
- type A in single-phase applications
- type B in three-phase applications

The use of a 300 mA trip current is recommended.

The PE wire of the mains cable MUST be connected to the ground screw marked with the ground symbol on the front of the drive.
Fastening torque of the ground screw: 0.77 Nm.

The reference potential must be the ground: 10 mm² section or ground braid to the reference potential.

If there is a potential reference, e.g. a chassis or cabinet with low impedance between its different elements, it should be used for connections to this potential which shall be grounded itself.

Reference potential loops (especially with the ground) are allowed **only** if these loops have a very low impedance (< 0.1 Ω). 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.

4.6.2 - SHIELD CONNECTION

CAUTION!
Each potential conducting element must be **shielded**. Several potential conductors **in one single sleeve** must be **twisted and shielded**.

A shield has no effect if it is not connected:

- to a reference potential,
- by a 360° shield connection at both ends. This means that the whole shield sleeve circumference must be directly in contact with the reference signal without any conductor insertion.

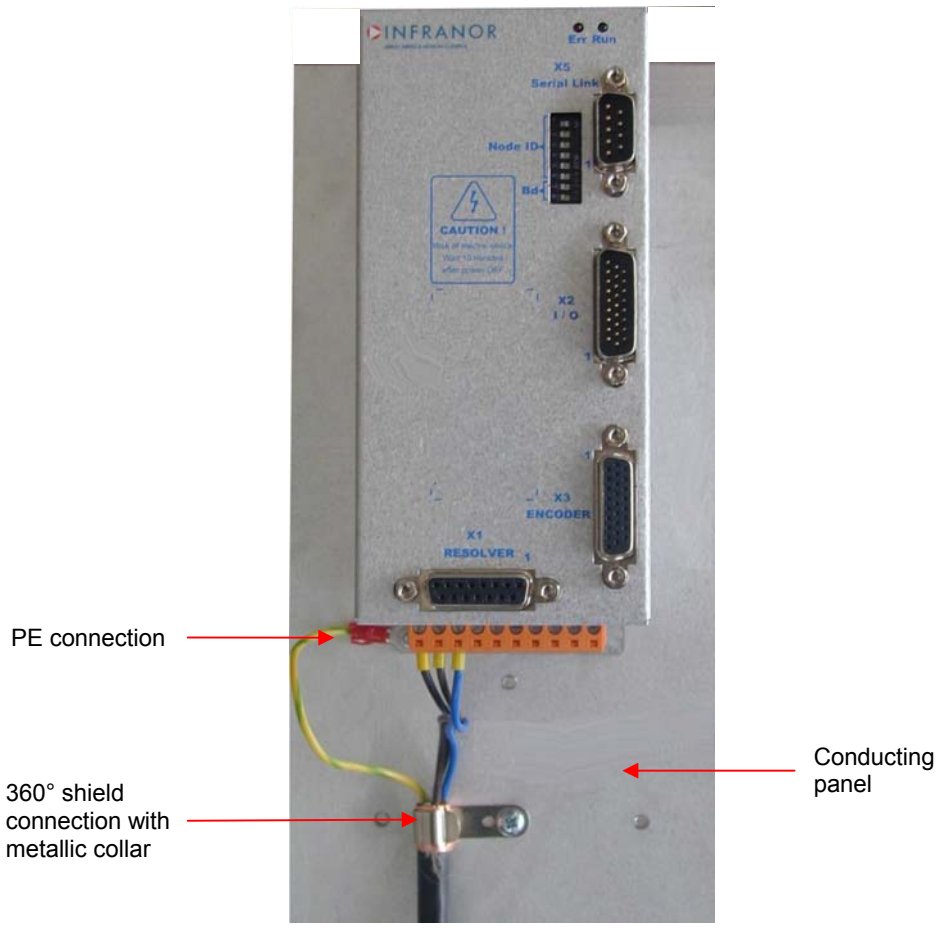
Cables with low potential should **never** run in the proximity of high power lines.

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

The shield of the motor and brake cable must be connected over 360°.
The 360° shield connection must be ensured by metallic collars and connected to the ground reference potential.

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

4.6.3 - EXAMPLE OF GROUND AND SHIELD CONNECTIONS



NOTE
The shield should never be interrupted or corrupted over the whole cable length. When the 360° shield connection is made by means of a collar, it is not necessary to connect an additional cable on the appropriate pin of the power connector.

4.6.4 - 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 pictures of section 4.5.2.

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 wire, it must be connected at one end to the GND pin of the connector on drive 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:

$$\Delta U[V] = 40.10^{-6}.\frac{Lc[m].I[mA]}{S[mm^2]}$$

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

Due to this voltage drop:

- an encoder with a wide power supply voltage range should be selected,
- if the encoder has 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 this drive).

Example

The application requires a linear Heidenhain encoder, supplied with 5 V ±5 % / 300 mA and 25 m cable length.
Supply voltage: 5 V ±5 % ⇨ ΔU_{max} = 0.25 V ⇨ Minimum section: S = 1.2 mm².

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

- either connect the SENSE feedback signal lines to the power supply lines, so the required wire section will be the half (0.6 mm²),
- or use the same encoder type but in a version which allows a power supply voltage from 3.6 to 5.25 V / 300 mA. Minimum power voltage 3.6 V ⇨ ΔU_{max} = 1.4 V ⇨ Min. section: S = 0.21 mm².

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

Maximum cable length: 100 m

For cable length > 25 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 for the motor cable. The reactance inductive value must be taken into account in the calculation of the current loops. The current rating of the reactance must be higher than or equal to 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 fan.

4.6.5 - SERIAL LINK AND CAN COMMUNICATION CABLES

Serial link and CAN communication cables must also be shielded according to the shield connection recommendations above.

CAUTION!
Control cables (resolver, serial link, CAN) and power cables must be connected and disconnected with the drive **turned OFF**.
Reminder:
The power voltage may remain several minutes at the power capacitor terminals.
A contact with high voltage may involve severe physical damage.

4.7 - FIRST POWERING OF THE DRIVE

4.7.1 - VERY IMPORTANT

Check the connections, especially of the 24 VDC and power supplies. Check that the housing serigraphy actually corresponds to the power connections.
The 400 Vac connection of a 230 V drive will destroy it!

If a logic input is configured by software with the Enable function, it must be disabled.

Check for the braking resistor specifications if connected in place of the internal braking resistor.
Check for the correct groundings as well as the 360° shield connections.

WARNING !
During the machine adjustments, drive connection or parameterization mistakes 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 operator's presence in the concerned area.

4.7.2 - CONNECTION OF THE 24 VDC SUPPLY

The red **Err** LED on the front panel must be flashing ("Undervolt." error).
The **AOK** signal (pins 4 and 14 of X2) is closed. The power voltage relay (Rpu) can then be controlled according to the recommendations of Chapter 4, section 1 (connection diagram). The connection must be made in compliance with the X8 connector serigraphy.

4.7.3 - CONNECTION OF THE MAINS POWER SUPPLY

The red **Err** front panel LED must be unlit.

Note: If a fault occurs, the red **Err** LED remains continuously lit.

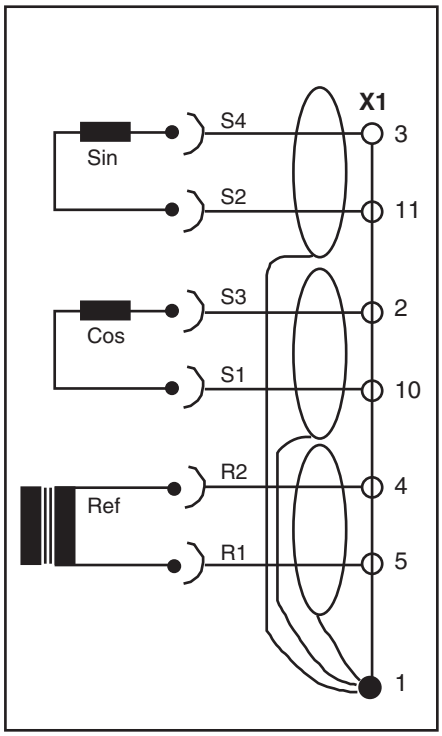
4.7.4 - STARTING PROCEDURE

See **XtrapulsPac – User Guide**

Chapter 5 - Appendix

5.1 - ADJUSTMENT TO VARIOUS RESOLVER TYPES

See following wiring diagram for the resolver connection to the X1 connector:



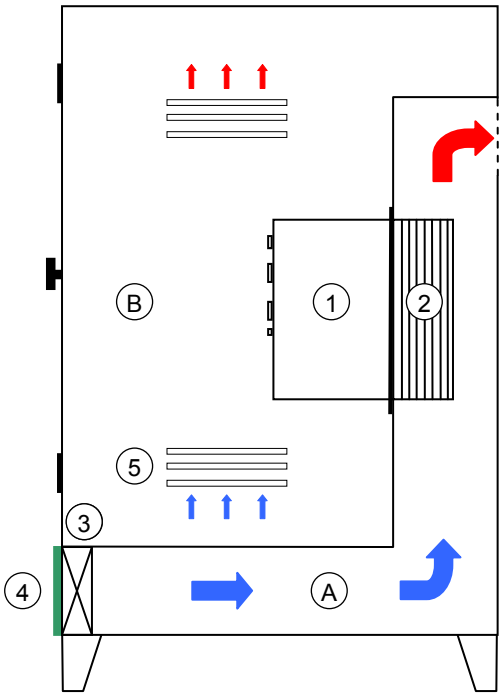
When using **resolvers** with **transformation ratios** out of the range 0.3 to 0.5, the adjustment must be factory set.

5.2 - CABINET EXAMPLE

The drive is IP20 classified (electronic part AND heatsink part). It must be mounted inside a housing protecting the drive from conducting dust and condensation (pollution degree 2 environment).

In order to take benefits of the push-through mounting, it is advised to use a cabinet with thermal boundary.

Recommended cabinet design when using the Push-Through version:



A: Thermal partition of the cabinet
1: Drive
2: Heatsink of the drive
3: Fan
4: Filter

B: Electronics partition
5: Natural air convection inlet

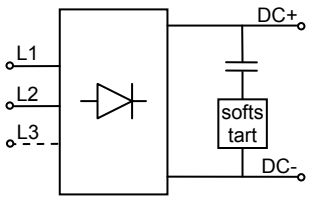
The thermal partition 'A' of the cabinet is cooled by forced air convection. The fresh air passes through a filter that needs to be periodically cleaned according to the pollution issued from the factory process.
The electronic partition 'B' of the cabinet is cooled by natural air convection.

5.3 – SOFT START SYSTEM

5.3.1 – INTRODUCTION

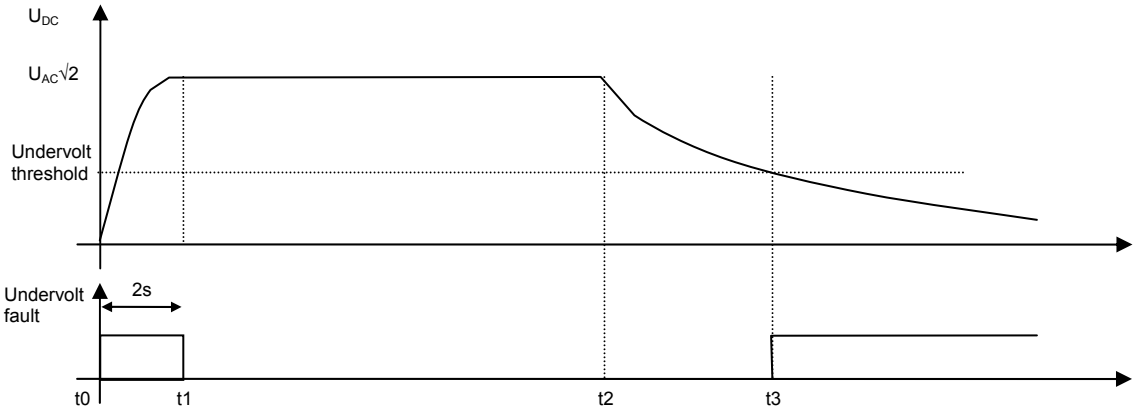
Due to the structure diodes rectifier followed by capacitors of the XtrapulsPac drive, it is necessary to limit the inrush current at power up.
The XtrapulsPac drive integrates a soft start system as described below:

XtrapulsPac



5.3.2 – INTEGRATION RECOMMENDATIONS

In order to maximize the lifetime of internal components of the XtrapulsPac drive and external electromechanical components, it is necessary to switch on only when the soft start system is enabled (Undervoltage fault displayed).



Details:

- At t0, the power supply of the drive is switched on. DC bus capacitors are charged via the soft start system.
- After a delay of 2 s at t1, the soft start system is disabled, and the undervoltage fault disappears. The drive is ready to switch on.
- Between t1 and t2, normal operations are performed by the drive.
- At t2, the drive power supply is switched off. The drive remains operational while the DC bus voltage is higher than the undervoltage threshold.
- The delay between t2 and t3 is much depending on the application (drive on/off, positive/negative motor power).
- At t3, the DC bus voltage becomes lower than the undervoltage threshold. The undervoltage fault is displayed, the drive is disabled and the soft start system is enabled.

5.4 - SIZING OF THE BRAKING SYSTEM

5.4.1 – INTRODUCTION

The braking I²t function defines the maximum allowable duty cycle of the braking transistor.
When working with the internal braking resistor, the maximum continuous power must be limited at 35W.
It can be performed by selecting "Internal braking resistor" in the "Power supply parameters" windows of Gem Drive Studio.

5.4.2 – METHOD FOR THE DESIGN OF THE BRAKING SYSTEM

Two different quantities are necessary to completely define an application:

- The peak power:
  - It defines the deceleration energy,
  - It is limited by the braking transistor current.
- The average power:
  - It defines the heat dissipation

1. Estimation of the regenerative power

The regenerative power must be calculated for each deceleration phase of each motor.

$$P_{LOAD} = \frac{J_{TOTAL}.(n_1^{\ 2} - n_2^{\ 2})}{180.t_{DEC}} - \frac{T_{LOAD}.(n_1 + n_2)}{19}$$

$$P_{MOTOR} = P_{LOAD}.\eta_{COUPLING}$$

$$P_{JOULE} = \frac{3}{2} R_{MOTOR}.I_{MOTOR}^{\ 2}$$

$$P_{ELEC} = P_{MOTOR} - P_{JOULE}$$

With: P_{LOAD}: Power regenerated by the load during the deceleration phase in W
J_{TOTAL}: Motor + load inertia of the axis reflected to the motor shaft in kg.m²
n_1: Rotation speed at the beginning of the deceleration phase in RPM
n_2: Rotation speed at the end of the deceleration phase in RPM
t_{DEC}: Deceleration time in s
T_{LOAD}: Torque applied by the load on the motor shaft at the beginning of the deceleration phase in Nm
P_{MOTOR}: Power regenerated on the motor shaft in W
$\eta_{COUPLING}$: Efficiency of the mechanical coupling (gearbox). If no gearbox is used, $\eta_{COUPLING} \approx 1$
P_{JOULE}: Losses in the motor windings in W
R_{MOTOR}: Winding resistance measured between two phases of the motor in Ω
I_{MOTOR}: Average current in one phase of the motor during the deceleration phase in A
P_{ELEC}: Average power managed by the drive during the deceleration phase in W

2. Choice of the ohmic value

$$R_{MIN} \leq R_{BRAKING} < \frac{U_{BRAKING}^2}{2.\hat{P}_{ELEC}}$$

With: R_{MIN}: Minimum braking resistor value in Ohm according to section "Main technical data".
$U_{BRAKING}$: Triggering threshold of the braking system in V.
$R_{BRAKING}$: Braking resistor in Ω.
$\hat{P}_{ELEC}$: Maximum of all P_{ELEC} calculated for all motors and for all deceleration phases in W.

3. Average power

The required average power must be calculated to correctly choose the size of the braking resistor and to take into account the heat dissipation effect into the near environment.

$$P_{AVERAGE} = \frac{\sum_{1,1}^{N,P} P_{ELEC}(n,p) \times T_{DEC}(n,p)}{T_{CYCLE}}$$

With: P_{ELEC}: Power managed by the drive axis n during the deceleration phase p in W

4. Braking I²t setup

$$P_{I^2t} = \frac{t_{ON}}{1000} . \frac{U_{BRAKING}^2}{R_{BRAKING}}$$

With: $P_{I²t}$: Maximum average power allowed by the braking I²t function in W
t_{ON}: Conduction time allowed by the braking I²t function in ms
$U_{BRAKING}$: Triggering threshold of the braking system in V
$R_{BRAKING}$: Braking resistor in Ω

5. Connection of the braking resistor

The braking resistor MUST be mounted out of range of heat sensitive and inflammable elements (plastic, cable sleeves, etc.).

In order to avoid any EMC or electrical problem, some rules must be observed:

- heat must be evacuated,
- shielded cable or at least twisted wires must be used,
- wires must bear high voltage and high temperature (recommended type: UL1015, AWG 14)
- wires must be as short as possible (max. 1 m).

5.5 - MAINTENANCE

5.5.1 – PROCEDURE AFTER A LONG TIME STORAGE

After a long time storage, the leakage current of electrolytic capacitors increases dramatically.
In order to avoid any risk of damage or explosion, DC bus capacitors must be reformed.
When the drive has been stored for 2 years or more, proceed as described below:

1. With a variable AC power supply, apply 25 % of the rated voltage on the mains input during 30 min,
2. With a variable AC power supply, apply 50 % of the rated voltage on the mains input during 30 min,
3. With a variable AC power supply, apply 75 % of the rated voltage on the mains input during 30 min,
4. With a variable AC power supply, apply 100 % of the rated voltage on the mains input during 30 min,

To avoid this procedure, the drive can also be powered at rated voltage every year for 1 hour.

5.5.2 – WARRANTY

The opening of the housing cancels the warranty.

5.6 - OPERATING ENVIRONMENT CONDITIONS

A - CLIMATIC CONDITIONS

1	-	Cooling fluid temperature	Air : 0°C to +40° C
2	-	Air temperature	+5°C to +40°C
3	-	Relative moisture	5 % to 85 % **without condensation**
4	-	Dust and particles	Clean air (pollution degree 2) Drive must be protected against conducting dust
5	-	Standstill periods	< 1 year: no restrictions > 1 year: re-format the power capacitors by supplying the drive with a voltage ≤ 50 % of the drive rated voltage during 30 minutes.

B - MECHANICAL INSTALLATION CONDITIONS

The drive must be mounted on a stiff surface, in rooms or additional housings without hindering the heatsink and the fan. The reliability may be increased by installing a cooling system (take care of condensation).
Other installation conditions must be specially analysed and subjected to a technical specification in agreement with INFRANOR.

Mechanical mounting

Vertical, on the cabinet rear wall.

Vibrations

Vibrations must remain within the limit values of the IEC 60721-3-3, class 3M1 standard for fixed equipment.

Frequency (Hz)	Amplitude (mm)	Acceleration (m/s^2)
$2 \leq f < 9$	0,3	not applicable
$g \leq f < 200$	not applicable	1

Vibrations which exceed these limits or the use on mobile equipment are considered as unusual operating conditions.

C - UNUSUAL OPERATING ENVIRONMENT CONDITIONS

The use of the power converter, of its pertaining control system and of the servo in conditions which are diverging from the usual ones defined by the IEC 60146-1-1 standard must be considered as abnormal. These abnormal operating conditions must be specified by the purchaser.

Abnormal operating conditions as those listed below may require a special construction or special protections. The conditions below must be notified if they are known or specified:

1. Exposure to corrosive gas.
2. Exposure to excessive moisture (relative moisture exceeding 85 %).
3. Exposure to excessive dust.
4. Exposure to abrasive dust.
5. Exposure to water steam or condensation.
6. Exposure to oil steam.
7. Exposure to explosive dust or gas mixtures.
8. Exposure to salt air.
9. Exposure to abnormal vibrations, shocks, jerking.
10. Exposure to inclemency or water dripping.
11. Exposure to unusual storing or freight conditions.
12. Exposure to sudden or rough temperature variations.
13. Abnormal exiguity of the available room.
14. Abnormal high nuclear radiations.
15. Altitude higher than 1000 m.
16. Long standstill periods.
17. Outdoor equipment.

D - INSTALLATION, COMMISSIONING AND OPERATION

Normal and abnormal operating conditions apply the same way to installation, commissioning and use.

E - EQUIPMENT STORAGE

At receipt, the equipment must be immediately stored under adequate shelter. The transport packing is not suited to outdoor or non-protected storing.

Climatic conditions

Equipments must be stored in the environment conditions specified by the IEC 60721-3-1 standard. This includes:

1 -	Room temperature: class 1K4	-25°C to +55°C
2 -	Relative moisture: class 1K3	5 % to 95 %

Modules and panels must be protected against condensation. Rough temperature and moisture variations should be avoided, as far as possible. If the temperature of the storing room is varying such as to subject the equipment to condensation or to frost, the equipment must then be protected by a reliable heating system which will keep it at a temperature slightly higher than the surrounding air temperature.
If the equipment has been subjected to a low temperature during a long time, it should not be unpacked before having reached the surrounding air temperature, in order to avoid condensation. Such a moisture in some parts of the equipment may involve a faulty electric insulation.

F - PARTICULAR STORING RISKS

The following risks must be carefully considered:

1. Water: The equipment must be protected against rain, snow, rime, etc…
2. Altitude: The equipment should not be stored at an altitude higher than 3000 m.
3. Corrosive agents: The equipment must be protected against salty sea spray, emanations of dangerous gasses or corrosive liquids, etc…
4. Duration: the specifications of the above mentioned items are only valid for a total transport and storing period of up to six months. Longer periods may require a special treatment (smaller surrounding air temperature range such as in class 1K3).
5. Rodents and mould: The storing conditions must avoid exposure to rodents and mould.

G - TRANSPORT

1 - Climatic conditions

The equipment can be transported in its standard packing in the environment conditions specified by class 2K3 of the IEC 60721-3-2. This includes:

a - Surrounding air temperature: -25°C to +70°C
NOTE: The surrounding air temperature is the temperature which is the nearest to the equipment, i.e. the inside of the container.

b - Relative moisture: 95 % at +40°C
NOTE: Some temperature and moisture combinations may cause condensation.

2 - Unusual climatic conditions

The possible transport of the equipment at temperatures lower than -25°C requires either a re-heating or the removal of components sensitive to low temperature.

3 - Mechanical conditions

The equipment may be transported in its standard packing in the conditions specified by class 2M1 of the IEC 60721-3-2 standard.
This includes vibrations and shocks (see tables below).

TABLE 4 – Vibration limits during the transport

Frequencies (Hz)	Amplitude (mm)	Acceleration (m/s^2)
$2 \leq f < 9$	3.5	-
$9 \leq f < 200$	-	10
$200 \leq f < 500$	-	15

TABLE 5 – Shock limits during the transport

Mass (kg)	Free fall height (m)
$M < 20$	0.25
$20 \leq M < 100$	0.25
$100 \leq M$	0.10

NOTE: If the equipment may be subjected to shocks or vibrations beyond these limits, it will require special packaging or transport conditions.