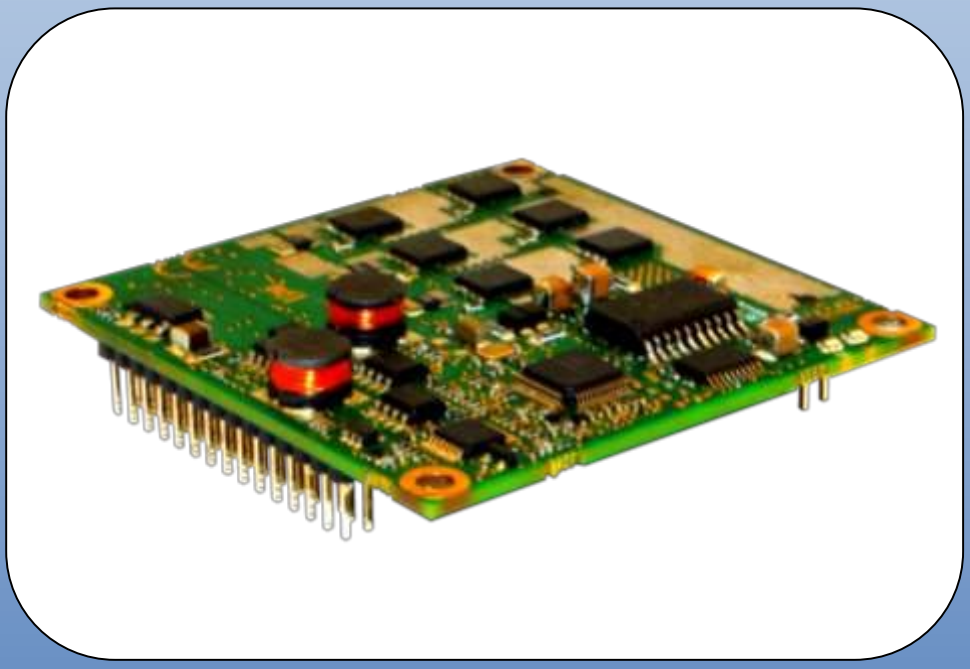
DIGITAL SERVO DRIVES FOR BRUSHLESS AC MOTORS



XtrapulsEasy™ 60VDC
Embedded module

Installation Guide

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:

- **XtrapulsEasy™ User Guide** for the operation of the drive (commissioning, configuration, ...)
- **XtrapulsEasy™ DB STO** for the Safe Torque Off function
- **Gem Drive Studio software Quick Start** manual for the drive parameterization.

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 at least 10 minutes after power down before handling the drives (a residual voltage of several hundreds of volts may remain during a few minutes).

Caution: Hot surface, risk of burns (wait for cooling after power down).

ESD INFORMATION (ElectroStatic Discharge)
Our drives are designed for being 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 packaging.
- When taken out of their packaging, 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

- Never get in contact with the connectors.

WASTE DISPOSAL
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 devices are labelled with a sticker symbolizing a crossed-out dustbin as shown in Appendix IV of the 2002/96/EC Directive.
This symbol indicates that devices shall be eliminated by selective disposal and not with household waste.

We 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.

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

Content

Chapter 1 - General

1.1 - INTRODUCTION

XtrapulsEasy™ all-digital drives with sinusoidal PWM control are servo drives that provide the control of brushless AC motors.

The standard control interface can be:

- CANopen®[1],
- Analog.

Series XtrapulsEasy™ drives are dedicated to basic applications that do not have a high level of requirements in terms of functionalities and where cost effectiveness is very important.

The XtrapulsEasy™ drive can be used in following typical applications:

- Axes controlled by CANopen® fieldbus according to the DS402 protocol,
- Stand-alone operation as a sequencer with control by means of logic I/Os,
- Traditional analog speed drive with +/- 10V command and A, B, Z encoder output for the position feedback.

The configuration and parameterization software tool *Gem Drive Studio* allows a quick configuration of the XtrapulsEasy™ drives according to the target application.

Thanks to its pluggable module layout, the XtrapulsEasy™ DB drive - allows the user optimizing the global solution in terms of size, weight, and functionalities integration.

1.2 - DESCRIPTION / COMPLIANCE WITH THE STANDARDS

1.2.1 - General description

The XtrapulsEasy™ drive can be configured in 4 feedback modes:

- Resolver or analog Hall (SinCos tracks)
- TTL encoder with or without Hall effect sensors
- Hall effect sensors only
- Sensorless

The appropriate position sensor configuration is software selectable and saved in the drive.

When using a high resolution position sensor, this sensor ensures a high dynamic motor torque/force control and full torque/force is available at low speed and at standstill.

➨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 only a Hall effect Sensor (HES) feedback, the position resolution is low, involving reduced dynamic performances.

➨In **sensorless** mode, a motor phasing procedure is automatically executed at the drive enabling.

[1] *CANopen® is a registered Community Trademark of CAN in Automation e.V, Germany.*

Series XtrapulsEasy™ drives have their own DC/DC converter to provide the voltages required for the drive operation with a $24V_{DC}$ +/- 15 % supply source which is generally available on machines. The auxiliary supply allows keeping 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 $24V_{DC}$ battery supply with specific wiring allows keeping the position even after switching off the auxiliary $24V_{DC}$ supply. This wiring can be used for getting an "absolute" servo drive operation.

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 XtrapulsEasy™ drive according to the application type.

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	**C1 category equipment** – table 14
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.

Security:

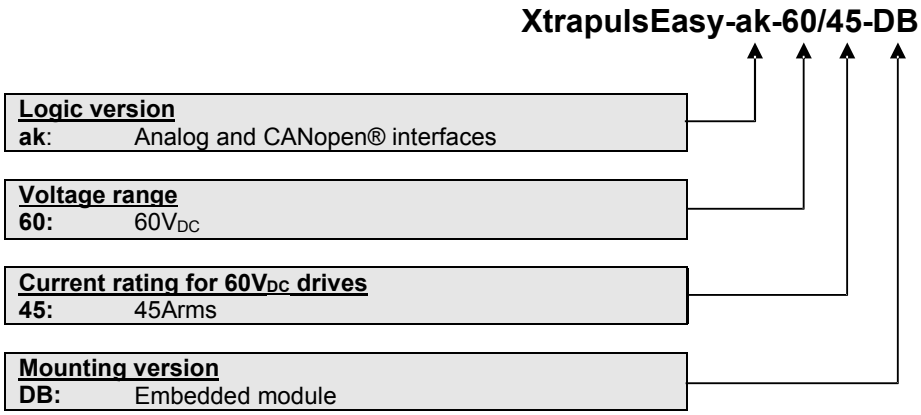
73/23/EEC modified by the directive 93/68/EEC:	Low voltage directive
EN 60204-1:	Safety of machinery: electrical equipment of machines
EN 61800-5-2:	Adjustable speed electrical power drive systems: Safety requirements - Functional

EC conformity of the XtrapulsEasy™ drive

1.3 - OTHER DOCUMENTS

- XtrapulsEasy™ User guide.
- XtrapulsEasy™ DB STO manual.
- Gem Drive Studio software Quick Start manual.

1.4 - ORDERING CODE



1.5 - ACCESSORIES

Ordering code: **Easy-dev01**
This product provides external connectors identical to XtrapulsEasy™ 60V$_{DC}$ standard series (see section 5.1).

Chapter 2 - Specifications

2.1 - MAIN TECHNICAL DATA

2.1.1 - XtrapulsEasy™-ak-60/45-DB

Design	Pluggable module
Operating power supply voltage (1)	24 to 60V_{DC} +/- 10 % Grounded reference voltage
Undervoltage threshold (1)	25V_{DC}
Overvoltage threshold (1)	85V_{DC}
Motor phase-to-phase output voltage	95% of power supply voltage
Braking system	No braking system integrated
Minimum phase-to-phase inductance (1)	0.2mH
Galvanic isolated auxiliary supply voltage	24V_{DC} +/-15% - 100mA (without output loads) Grounded reference voltage.

(1) These values correspond to the default configuration of the drive. For lower operating voltage, see section 5.2 "Low operating voltage".

OUTPUT CURRENT RATINGS

TYPE	Max. output current for 3 s (Arms) (1)	Rated output current (Arms)	Power losses at rated current (W)	Rated input current (Arms)	Maximum protection line circuit fuses	Short-circuit current
Easy-ak-60/45-DB	45	13	6,5	15,9	16	5kA

Maximum surrounding air temperature: 40°C.

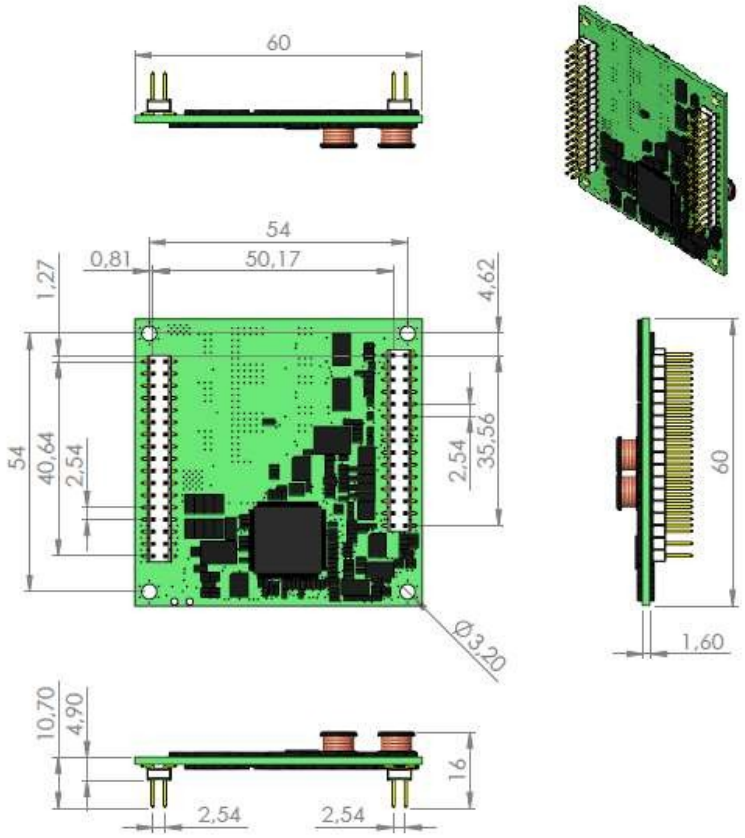
2.1.2 - Technical specifications

Servo loops: current, speed, position	Digital
Position sensor	SinCos tracks (analog Hall) Transmitter resolver TTL Incremental encoder TTL Incremental encoder + Hall Effect sensors Hall Effect Sensors only
Power protections	See section 3.1.1 - LEDs
Switching frequency	8 kHz, 16kHz
Analog input 1	±10V (resolution: 12bit)
Speed and position regulators	Sampling period = 0.5ms Anti-wind-up system of the integrator Anti-resonance filter Adjustable digital gains

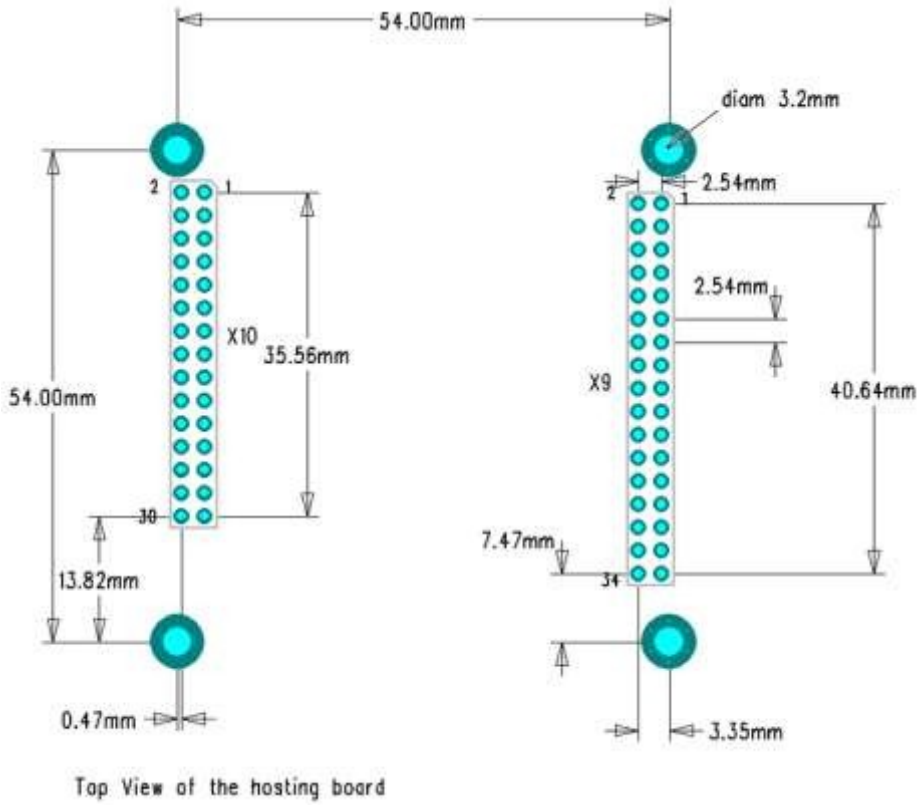
Speed loop bandwidth	Selectable cut-off frequency for 45° phase shift: 50 Hz (low), 75 Hz (medium) or 100 Hz (high)
Current loop bandwidth	Cut-off frequency for 45° phase shift: 500 Hz (low) or 1000 Hz (high)
Max. motor speed	Adjustable from 100 to 25'000 rpm
Drive reaction time (initialization delay before PWM on)	6.25ms
Encoder position output	Encoder output is only available if TTL encoder is connected.
Resolver input	Software selectable: Transmitter resolver: Excitation frequency: 8kHz Max. output current = 30mA Transformation ratio: 0.3 to 0.5 (other values are factory set) SinCosos tracks: 1Vpp to 4Vpp Sin and Cos signals
Encoder input	Software selectable: Quadrature signals A& B + one Z marker pulse per revol. Line receiver RS-422 Max. frequency of encoder pulses: 400kHz Resolution: 500 to 10^6ppr
Hall sensors input	5V to 24V positive logic voltage accepted External HES supply voltage required if different from 5V HES sequence error detection
Logic inputs	4 GND referenced logic inputs: - 3 software configurable logic inputs - Response time: 500µs - 1 input dedicated to the STO/INHIBIT function Response time: < 50ms
Capture input	1 programmable input (IN1, IN2 or IN3) Response time: 62.5µs
Logic outputs	2 software configurable logic outputs type PNP "high side" $24V_{DC}$, max. 500mA Response time: 500µs
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)
Automatic functions	Drive adjustment to the motor (AUTO-PHASING) Adjustment of the servo loops (AUTO-TUNING)
MTBF (Mean Time Between Failures)	> 100'000 hours
Maximum surrounding air temperature	- Operation: -25°C to +50°C: from 40°C, the rated current must be reduced by 3% per additional Celsius degree - Storage: -25°C to +70°C
Altitude	1000m

Moisture	< 50% at 40°C and < 90% at 20°C: EN 60204-1 standard **Condensation prohibited (storage and operation)**
Cooling	Natural air convection Check for free air convection and for no obstruction of the upper or lower air admissions.
Environment	The hosting printed circuit board must be mounted inside a cabinet protecting the drive from conducting dust and condensation (pollution degree 2 environment) and according to the room temperature requirements.
Pollution degree of the drive	IP20
Weight	0,026kg

2.2 - DIMENSIONS AND MOTHERBOARD FOOTPRINT



The mechanical layout to be implemented on the motherboard is shown below:



Top View of the hosting board

Chapter 3 - Inputs - Outputs

3.1 - DISPLAY

3.1.1 - Leds

RUN (green)

ERROR (red)

RUN: status of the CANopen® communication bus connection.

ERROR: faults grouped on the 'ERROR' LED: these errors are coded and can be displayed by means of the parameter setting software.

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.
- $24V_{DC}$ logic supply < $17.5V_{DC}$.
- Motor phase / GND short-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:

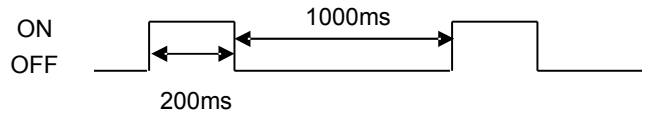
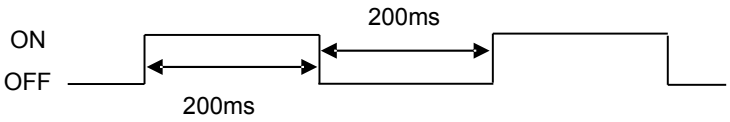
- The continuous lighting of the red **ERROR** LED,
- The drive disabling,
- The motor brake control,
- The disabling of the **AOK** output. This output must be wired as described in the connection diagram of section 4.5, in order to switch-off the power supply.

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

- The drive disabling,
- The motor brake control.

3.1.2 - 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.

Note:
Each drive of the network must be configured with one single address.
The factory-set addressing is address 1 and the default communication speed is 1Mbit.

3.2 - X10 CONNECTOR: FEEDBACK / CAN / TTL HALL / I/O

The feedback and I/O connector is a 2.54mm pitch 2x15 pins header.
Recommended mating references are listed below:

Manufacturer	REFERENCE
FCI	87606-315LF
HARWIN	M20-7831546
SAMTEC	SSQ-115-01-G-D
E-TEC	BL2-030-S842-55

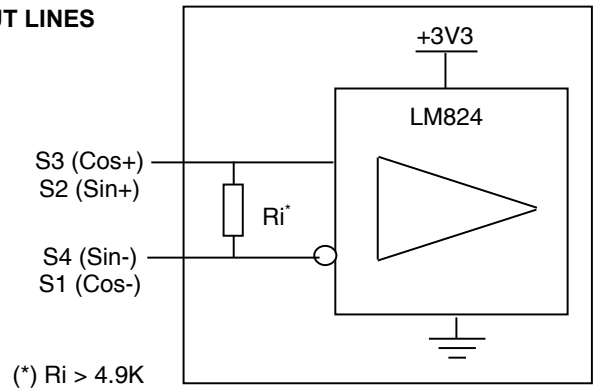
The pinout of this connector is described below.

3.2.1 - Resolver feedback

PIN	FUNCTION	I/O	DESCRIPTION
1	RS232 TX	O	Transmit data RS-232
3	RS232 RX	I	Receive data RS-232
2	CAN H	IO	Line CAN-H (dominant high)
4	CAN L	IO	Line CAN-L (dominant low)
12	+24V	I	$24V_{DC}$ supply: +/- 15% Consumption: 100mA without digital output loads
6	GND		
14	GND		
17	GND		
30	GND		
8	OUT1	O	"high side" logic outputs 24V / 500mA
10	OUT2	O	
19	IN1 (configurable)	I	All logic inputs are referenced to GND Vin voltage = 18V < Vin < 27V Input impedance Zin = 10kΩ IN4 input is dedicated to STO
21	IN2 (configurable)	I	
23	IN3 (configurable)	I	
25	IN4 (STO / Inhibit)	I	
15	+5V	O	Encoder supply voltage (max. current = 300mA)
26	R1 (reference +)	O	Resolver signal
24	R2 (reference -)	O	Resolver signal
16	S3 (cosine +)	I	Resolver signal
18	S1 (cosine -)	I	Resolver signal
20	S2 (sine +)	I	Resolver signal
22	S4 (sine -)	I	Resolver signal
29	IN_ANA1+	I	Analog input nr. 1 Differential input +/-10V *
27	IN_ANA1-	I	
28	TM+	I	Motor thermal sensor input. The valid measurement range is between 100Ω and 44kΩ measured between TM+ and GND
9	HALL_U	I	Hall sensor input signal phase U
11	HALL_V	I	Hall sensor input signal phase V
13	HALL_W	I	Hall sensor input signal phase W
Others	Reserved		

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

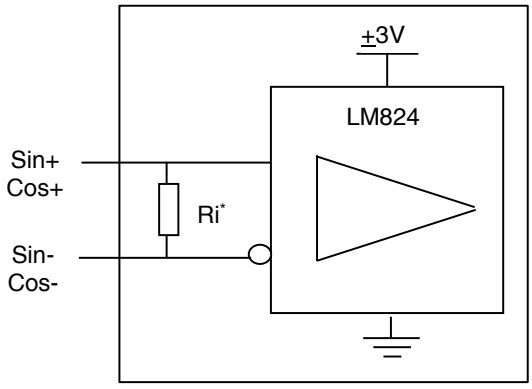
SPECIFICATION OF THE RESOLVER INPUT LINES



3.2.1 - SinCos tracks feedback

PIN	FUNCTION	I/O	DESCRIPTION
1	RS232 TX	O	Transmit data RS-232
3	RS232 RX	I	Receive data RS-232
2	CAN H	IO	Line CAN-H (dominant high)
4	CAN L	IO	Line CAN-L (dominant low)
12	+24V	I	$24V_{DC}$ supply: +/- 15% Consumption: 100mA without digital output loads
6	GND		
14	GND		
17	GND		
30	GND		
8	OUT1	O	"high side" logic outputs 24V / 500mA
10	OUT2	O	
19	IN1 (configurable)	I	All logic inputs are referenced to GND Vin voltage = 18V < Vin < 27V Input impedance Zin = 10kΩ IN4 input is dedicated to STO
21	IN2 (configurable)	I	
23	IN3 (configurable)	I	
25	IN4 (STO / Inhibit)	I	
15	+5V	O	Encoder supply voltage (max. current = 300mA)
16	cosine +	I	Sin cos track signal
18	cosine -	I	Sin cos track signal
20	sine +	I	Sin cos track signal
22	sine -	I	Sin cos track signal
29	IN_ANA1+	I	Analog input nr. 1 Differential input +/-10V *
27	IN_ANA1-	I	
28	TM+	I	Motor thermal sensor input. The valid measurement range is between 100Ω and 44kΩ measured between TM+ and GND
9	HALL_U	I	Hall sensor input signal phase U
11	HALL_V	I	Hall sensor input signal phase V
13	HALL_W	I	Hall sensor input signal phase W
Others	Reserved		

SPECIFICATION OF THE SIN COS TRACKS INPUT LINES



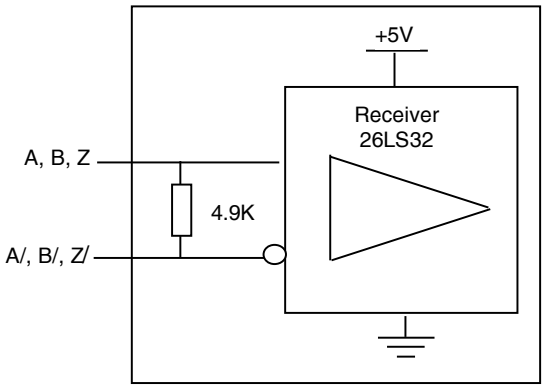
(*) Ri > 4.9K

3.2.2 - Encoder feedback

PIN	FUNCTION	I/O	DESCRIPTION
1	RS232 TX	O	Transmit data RS-232
3	RS232 RX	I	Receive data RS-232
2	CAN H	IO	Line CAN-H (dominant high)
4	CAN L	IO	Line CAN-L (dominant low)
12	+24V	I	$24V_{DC}$ supply: +/- 15% Consumption: 300 mA without digital output loads
6	GND		
14	GND		
17	GND		
30	GND		
8	OUT1	O	"high side" logic outputs 24V / 500mA
10	OUT2	O	
19	IN1 (configurable)	I	All logic inputs are referenced to GND Vin voltage = 18V < Vin < 27V Input impedance Zin = 10kΩ IN4 input is dedicated to STO
21	IN2 (configurable)	I	
23	IN3 (configurable)	I	
25	IN4 (STO / Inhibit)	I	
15	+5V	O	Encoder supply voltage (max. current = 300mA)
18	A channel	I	Differential input of the encoder channel A
16	A/ channel	I	Differential input of the encoder channel A/
22	B channel	I	Differential input of the encoder channel B
20	B/ channel	I	Differential input of the encoder channel B/
5	Z/ marker pulse	I	Differential input of the encoder marker pulse Z/
7	Z marker pulse	I	Differential input of the encoder marker pulse Z
29	IN_ANA1+	I	Analog input nr. 1 Differential input +/-10V *
27	IN_ANA1-	I	
28	TM+	I	Motor thermal sensor input. The valid measurement range is between 100Ω and 44kΩ measured between TM+ and GND
9	HALL_U	I	Hall sensor input signal phase U
11	HALL_V	I	Hall sensor input signal phase V
13	HALL_W	I	Hall sensor input signal phase W
Others	Reserved		

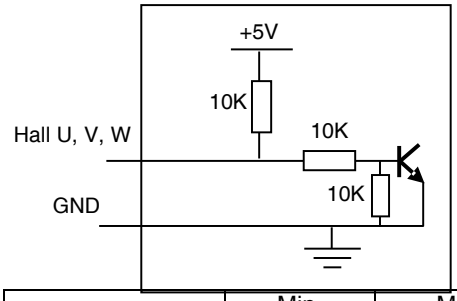
(*) For a non differential input signal, ANA1- must be connected to GND on the drive side

SPECIFICATION OF THE INCREMENTAL TTL ENCODER INPUT LINES



3.2.3 Equivalent input/output circuits

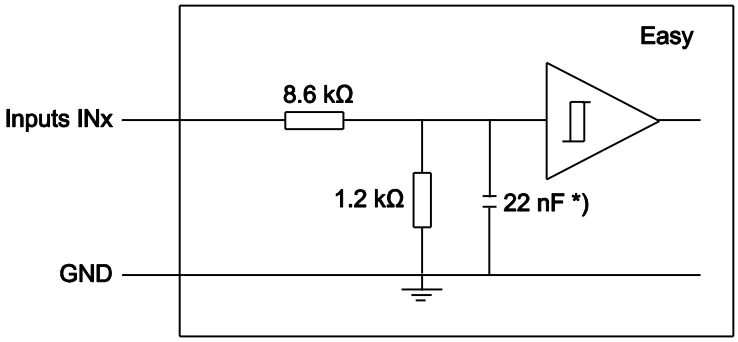
SPECIFICATION OF THE HALL SENSOR INPUT LINES



	Min.	Max.
High input voltage	3.3 V	24 V + 15 %
Low input voltage	0 V	0.6 V

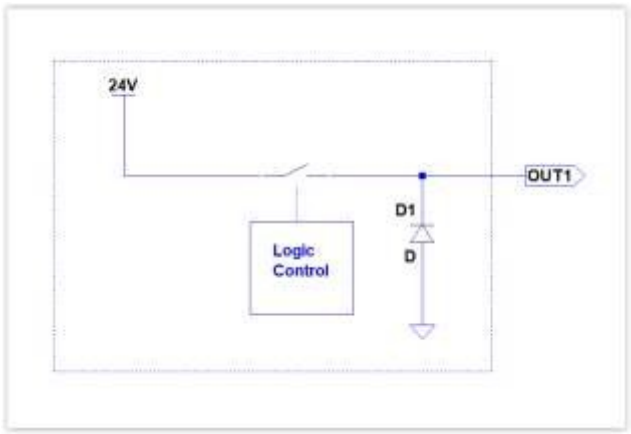
Hall inputs are compatible with open collector outputs, without any external component.

Specification of the logic input



	Minimum	Recommended	Maximum
High input voltage	18V	24V	27V
Low input voltage	0V	0V	5V

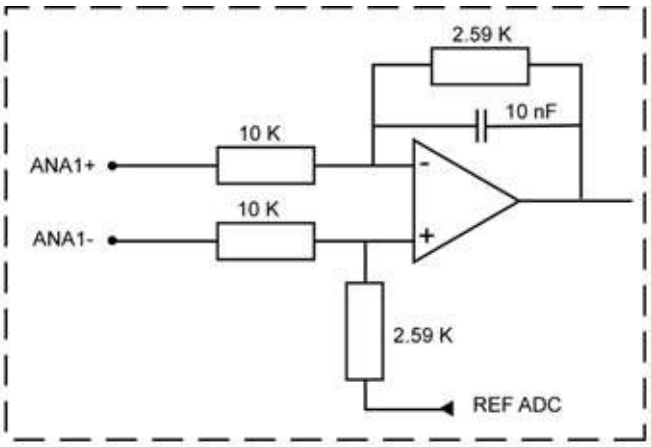
Specification of the logic outputs OUT1 and OUT2



Digital outputs can be paralleled in order 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	24V	500mA
2	24V	900mA

Specification of the analog inputs ANA1+/-



3.3 - X9: POWER CONNECTORS

The power connector is a 2,54mm pitch 2x17 header.

Recommended mating references are listed below

MANUFACTURER	REFERENCE
FCI	87606-317LF
HARWIN	M20-7831746
SAMTEC	SSQ-117-01-G-D
E-TEC	BL2-034-S842-55

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	U	O	Motor phase U	Motor cable shield must be connected over 360°.
2				
3				
4				
5				
6				
7	V	O	Motor phase V	
8				
9				
10				
11				
12				
13	W	O	Motor phase W	
14				
15				
16				
17				
18				
19	DC-	IO	Negative DC bus voltage	DC- is internally connected to GND
20				
21				
22				
23				
24				
25				
26				

27 28 29 30 31 32 33 34	DC+	IO	Positive DC bus voltage	24V to 60V power supply

IMPORTANT
Motor cable 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
See section 4.1 for grounding and shielding precautions.

3.4 - MECHANICAL MOUNTING

Four 3,2mm holes are provided to allow mechanical fasten of the drive.
Recommended spacer length is 12mm.

Chapter 4 - Design recommendations

4.1 - MOTHERBOARD DESIGN

4.1.1 - Copper section

The copper section for motor phases U V W and power source must be **at least 0.3mm²** on external layers.

However, in order to optimize the thermal behaviour (temperature rise less than 10°C), we recommend to maximize the current ability of the design by:

- Using at least 4-layer PCBs and at least 35µm finished copper thickness,
- Using maximum trace width according to the connector pitch = 7mm.

Note: External layers allow a current 3 times higher than internal layers, thanks to natural convection.

On a multi-layer PCB, power trace patterns should be stacked to avoid coupling problems.

4.1.2 - Power and signal separation

Best practice is to keep a physical separation between power and low voltage signals on all stacked layers at the same time:

- It allows thermal separation,
- It allows electrical separation.

To avoid coupling between low level signals and power traces, the following rules must be observed:

- Never route together the power phases and the feedback signals.
- Keep a GND trace between the power phases (or power source) and logic signals.
- Differential signals (ex: CANOpen, Resolver) must be routed in respect of differential state of the art rules.

4.1.3 - External capacitors and decoupling

4.1.3.1 - 24V supply

A 220µF 35V aluminum capacitor placed on the host PCB near each drive is recommended for a proper +24V decoupling.

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

4.1.3.2 - DC Bus Capacitors

At least, a 470µF /100V capacitor must be placed at the nearest of each drive.

If the DC bus power supply is provided by a battery, the energy reflected by the motor during deceleration phases will recharge it.
Check the battery can support the max current reflected.

If the DC bus power supply is provided by a no current-reversible power supply (e.g. switch-mode power supply), additional capacitors will be necessary.
Proceed by increasing the total amount of the DC bus capacitor bank until the overvoltage fault does not appear anymore during deceleration phases.

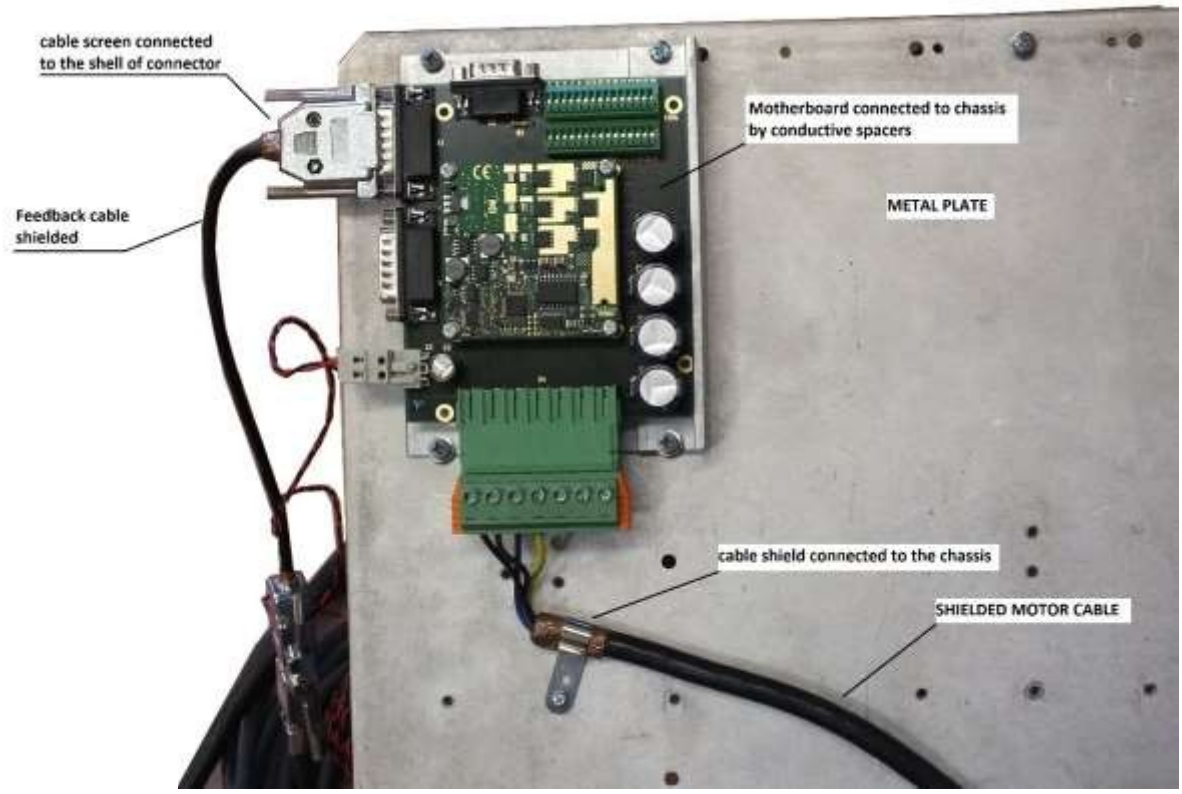
Note: Emergency stops are generally the most regenerative phase since all axes decelerate simultaneously. A protection diode may be necessary to avoid overvoltage on non-reversible supply.

4.1.4 - Shielding and grounding

A good shielding and ground connection of the cables is mandatory for ensuring a proper operation.
To ensure the correct EMC grounding of the whole system (drive-cable-motor), the following rules must be observed:

- If possible, use an aluminum chassis as voltage reference (a closed metal case is even better)
- The motor cable shield must be connected to the chassis.
- Connecting DC- and the PE conductor together will improve EMC behaviour.

A mounting example is shown below:



4.1.5 - Impedance matching resistor

- 120 Ohm resistors should be provided between encoder lines.
- A 120 Ohm resistor must be placed across CAN lines at the end of the CAN daisy chain.

4.2 - PROTECTIONS

4.2.1 - Auxiliary power supply

The final user has to provide an isolated auxiliary 24V_{DC} +/-15% supply (e.g. with isolation transformer) for the auxiliary supply input, protected by a 3A fuse or circuit breaker.

4.2.2 - Power supply

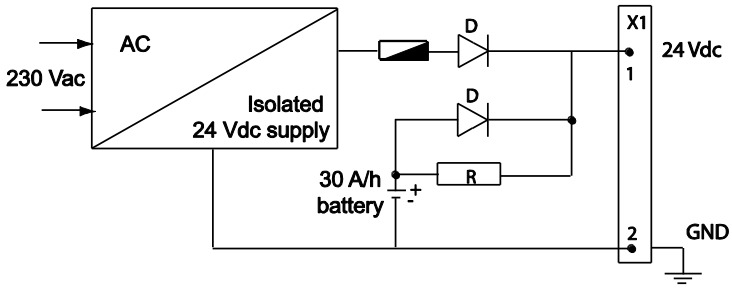
The recommended protection is a D-type: current for 1s = 10 x rated current.
The maximum power supply short-circuit power must not exceed 5000Arms.

On **XtrapulsEasy™** drives, the recommended fuse or circuit breaker rating is:

	Recommended D-type protection rating
Easy-ak-60/45-DB	16A

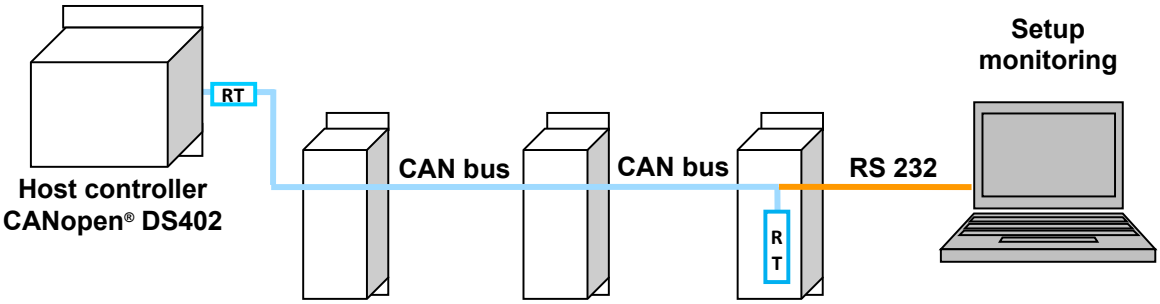
4.3 - ACCESSORIES AND CONNECTIONS

4.3.1 - Connection of a backup battery



The XtrapulsEasy™ drive consumption is less than 100mA with 24V_{DC}. So, a 24V / 30A/h battery can keep the drive powered during approx. 10 days. This backup method is interesting for saving the machine initialization as well as the axis position even when moving with the mains switched off.

4.3.2 - Multi-axis connection of the serial link



RT = 120Ω 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.

4.4 - WIRING INSTRUCTIONS

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

4.4.1 - 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.

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.

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 millimetres

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).

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

Maximum cable length: 100m.

For cable length > 25m, we advise:

- the use of the maximum cable section allowed by the connectors,
- the mounting of 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 B84143V x R127 by company Epcos may also be mounted instead of the reactance.

UNDESIRABLE EFFECTS OF MOTOR CABLES LONGER THAN 25M:

- Heating of the power module, the motor and the cable.
- High overvoltage on the motor windings, involving a shortening of their lifetime.

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

4.4.2 - 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.

4.4.3 - Very important

Check the connections, especially of the $24V_{DC}$ and power supplies. Check that the housing serigraphy actually corresponds to the power connections.

Check that the STO/INHIBIT input is powered.

Check for the correct groundings as well as the 360° shield connections.

WARNING !
During the machine adjustments, drive connection or parameterization errors may involve dangerous axis movements. It is the user's responsibility to take all necessary steps in order to reduce the risk of uncontrolled axis movements during the operator's presence in the pertaining area.

4.4.4 - Connection of the $24V_{DC}$ supply

The red **Err** LED on the front panel must be flashing ("Undervolt." error).
The **AOK** signal is high. The power voltage relay (Rpu) can then be controlled according to the recommendations of section 4.1.4.

4.4.5 - Connection of the DC Bus

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

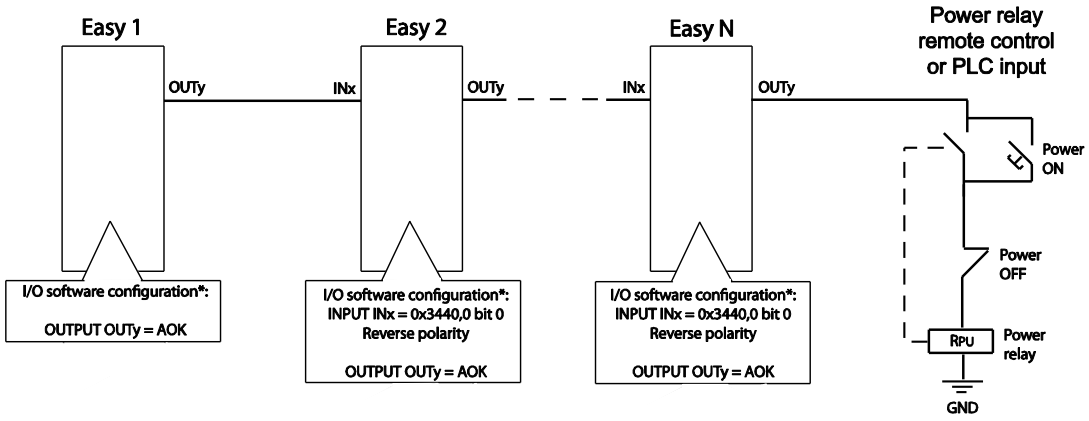
Note: If a fault occurs, the red **Err** LED remains continuously lit.

4.4.6 - Starting procedure

See **XtrapulsEasy™ – User Guide.**

4.5 - CHAINING DRIVES

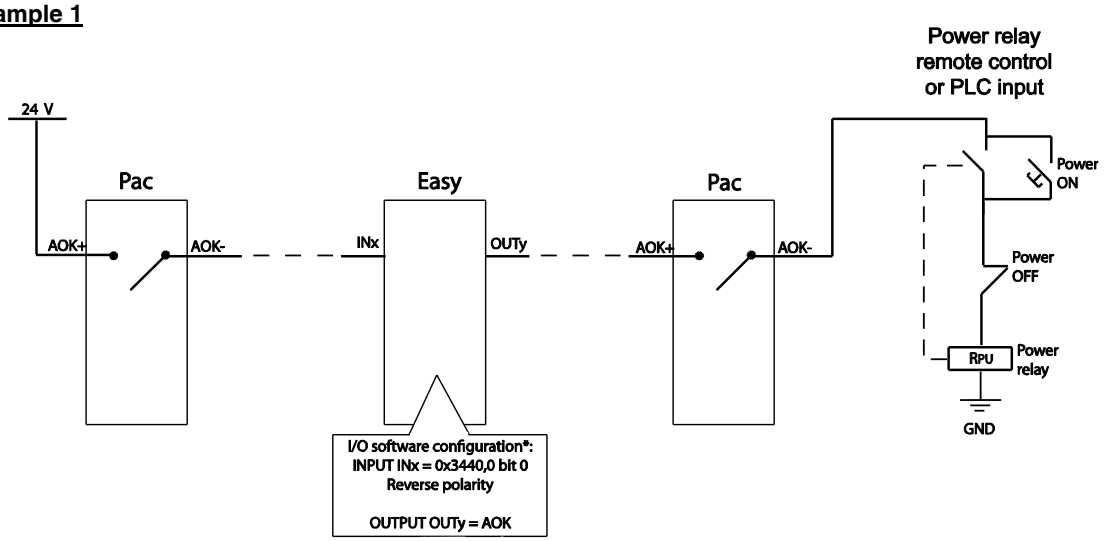
4.5.1 - AOK chaining with XtrapulsEasy™ drives only



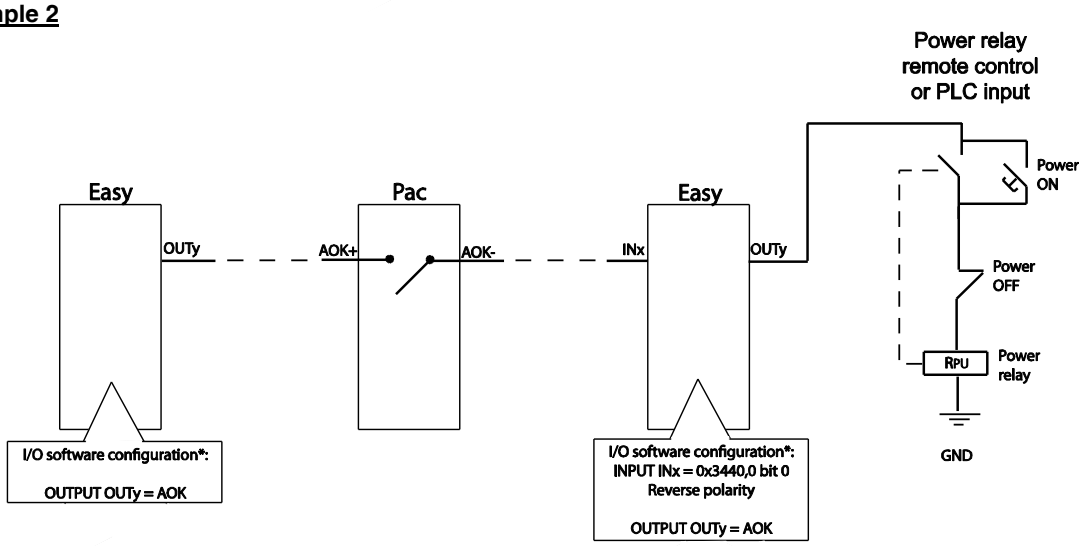
Note: Maximum delay for the power relay deactivation: number of XtrapulsEasy™ drives x 1ms.

4.5.2 - AOK chaining with XtrapulsEasy™ and XtrapulsPac drives together

Example 1



Example 2



(*) INx = IN1 or IN2 or IN3 and OUTy = OUT1 or OUT2.
XtrapulsEasy™ inputs and outputs must be configured according to the wiring diagram.
Note: Maximum delay for the power relay deactivation: number of XtrapulsEasy™ drives x 1ms.

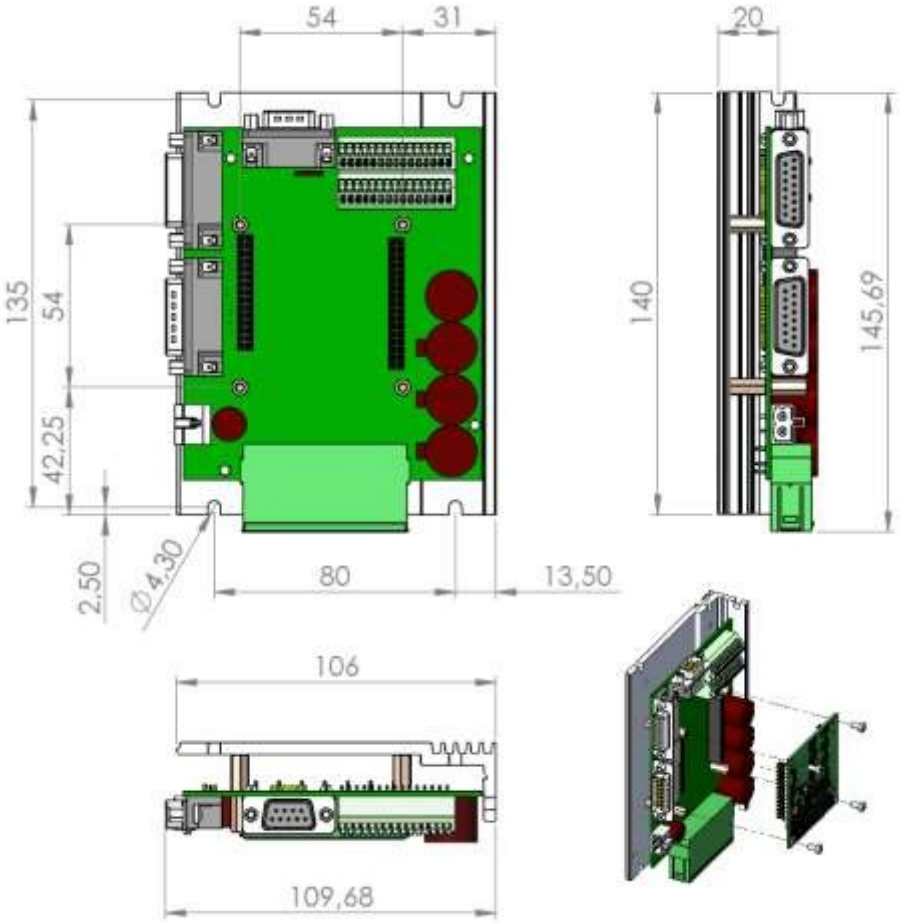
Chapter 5 - Appendix

5.1 - DEVELOPMENT KIT "DEV01"

The purpose of the development kit is to evaluate the drive performance before designing your own board.
It provides extend connectors identical to XtrapulsEasy™ 60V Standard series.

5.1.1 - Overview of the development kit

The following drawing shows the development kit with its associated connectors and options.



5.1.2 - Connector details

5.1.2.1 - X1 connector: Feedback

SUB D 15 PIN FEMALE CONNECTOR

A - Resolver feedback

PIN	FUNCTION	I/O	DESCRIPTION
12	TC-	I	Motor thermal sensor inputs. The valid measurement range is between 100Ω and 44kΩ.
13	TC+	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
Others	Reserved		

B – Sin cos track feedback

PIN	FUNCTION	I/O	DESCRIPTION
12	TC-	I	Motor thermal sensor inputs. The valid measurement range is between 100Ω and 44kΩ.
13	TC+	I	
2	S3 (cosine +)	I	Sin cos tracks
10	S1 (cosine -)	I	Sin cos tracks
11	S2 (sine +)	I	Sin cos tracks
3	S4 (sine -)	I	Sin cos tracks
Others	Reserved		

C - Encoder feedback

PIN	FUNCTION	I/O	DESCRIPTION
9	Z/ marker pulse	I	Differential input of the encoder marker pulse Z/
1	Z marker pulse	I	Differential input of the encoder marker pulse Z
2	A/ channel	I	Differential input of the encoder channel A/
10	A channel	I	Differential input of the encoder channel A
11	B/ channel	I	Differential input of the encoder channel B/
3	B channel	I	Differential input of the encoder channel B
7	+5 V	O	Encoder supply voltage (max. current = 300mA)
8	GND	O	Encoder supply GND
6	HALL U	I	Hall sensor input signal phase U
14	HALL V	I	Hall sensor input signal phase V
15	HALL W	I	Hall sensor input signal phase W
12	TC-	I	Motor thermal sensor input. The valid measurement range is between 100 Ω and 44kΩ.
13	TC+	I	
Others	Reserved		

5.1.2.2 - X2 connector: Input / Output

SUB D 15 PIN MALE CONNECTOR

PIN	FUNCTION	I/O	DESCRIPTION
1	IN1 (configurable)	I	All logic inputs are referenced to GND Vin voltage = 18V < Vin < 27V Input impedance Zin = 10kΩ IN4 input is dedicated to STO
2	IN2 (configurable)	I	
3	IN3 (configurable)	I	
4	IN4 (STO/INHIBIT)	I	
15	Differential encoder output channel A+	O	Differential encoder outputs Signals directly provided by the TTL encoder.
8	Differential encoder output channel A-	O	
14	Differential encoder output channel B+	O	
7	Differential encoder output channel B-	O	
13	Differential encoder output marker Z+	O	
6	Differential encoder output marker Z-	O	
9	OUT1	O	"high side" logic outputs 24V / 500mA
10	OUT2	O	
11	GND	O	
12	ANA1+	I	Analog input nr. 1 Differential input +/-10V *
5	ANA1-	I	

(*) For a non-differential input signal, ANA1- must be grounded on the drive side.

5.1.2.3 - X3 connector: +24 V

Manufacturer: Wago
Type: Midi connector
Reference: 721-102/026-000

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	24V	I	Mains isolated $24V_{DC}$ auxiliary power supply 0V input referenced to the GND potential on the drive housing	$24V_{DC}$ supply: +/- 15% Consumption: 300mA without digital output loads
2	0V = GND	I		

5.1.2.4 - X4 connector: Motor phases and power supply

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

PIN	SIGNAL	I/O	FUNCTION	DESCRIPTION
1	U	O	Motor phase U	Shielded motor cable with 360° shield connection.
2	V	O	Motor phase V	
3	W	O	Motor phase W	
4	GND	I/O	GND reference and PE connection	Connect GND signal of the chassis and PE cable of the motor to this pin.
5	DC-	I/O	DC bus negative voltage	
6	DC+	I/O	DC bus positive voltage	
7	NC	-	Not used	

IMPORTANT
Motor 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 pin 4 of the X4 connector.
See section 4.1.4 for grounding and shielding precautions.

5.1.2.5 - X5 connector: CAN & RS232

SUB D 9 pin male connector

PIN	FUNCTION	REMARKS
1	Termination resistor	Connect X5.1 to X5.7 to enable the termination resistor
2	CAN-L	Line CAN-L (dominant low)
3	GND	GND signal for CAN communication
4	TXD	Transmit data RS-232
5	GND	GND (shield connection if no 360° connection on the connector). 360° shield connection is highly recommended.
6		Reserved
7	CAN-H	Line CAN-H (dominant high)
8	RXD	Receive data RS-232
9		Reserved

Default parameters for the CANopen® bus are:

- Transmission speed of 1Mb/s,
- Address set at 1,

Please see **Gem Drive Studio Software Quick Start manual** for detailed information on changing this configuration.

5.1.2.6 - X10A connectors

PHOENIX n°1989874 connectors
Direct connection to wire with AWG between 20 and 24

PIN	FUNCTION	I/O	DESCRIPTION
1	RS232 TX	O	Transmit data RS-232
3	RS232 RX	I	Receive data RS-232
2	CAN H	IO	Line CAN-H (dominant high)
4	CAN L	IO	Line CAN-L (dominant low)
12	+24V	I	$24V_{DC}$ supply: +/- 15% Consumption: 300mA without digital output loads
17	GND		
6	GND		
14	GND		
30	GND		
8	OUT1	O	"high side" logic outputs 24V / 500mA
10	OUT2	O	
19	IN1 (configurable)	I	All logic inputs are referenced to GND Vin voltage = 18V < Vin < 27V Input impedance Zin = 10kΩ IN4 input is dedicated to STO
21	IN2 (configurable)	I	
23	IN3 (configurable)	I	
25	IN4 (STO / Inhibit)	I	
15	+5V	O	Encoder supply voltage (max. current = 300mA)
26	R1 (reference +)	O	Resolver signal
24	R2 (reference -)	O	Resolver signal
16	S3 (cosine +) Encoder A/	I	Resolver signal / Encoder signal
18	S1 (cosine -) Encoder A	I	Resolver signal / Encoder Signal
20	S2 (sine +) Encoder B/	I	Resolver signal / Encoder Signal
22	S4 (sine -) Encoder B	I	Resolver signal / Encoder Signal
29	IN_ANA1+	I	Analog input nr. 1 Differential input +/-10V *
27	IN_ANA1-	I	
28	TM+	I	Motor thermal sensor input. The valid measurement range is between 100Ω and 44 kΩ measured between TM+ and GND
9	HALL_U	I	Hall sensor input signal phase U
11	HALL_V	I	Hall sensor input signal phase V

13	HALL_W	I	Hall sensor input signal phase W
7	Encoder Z	I	
5	Encoder Z/	I	

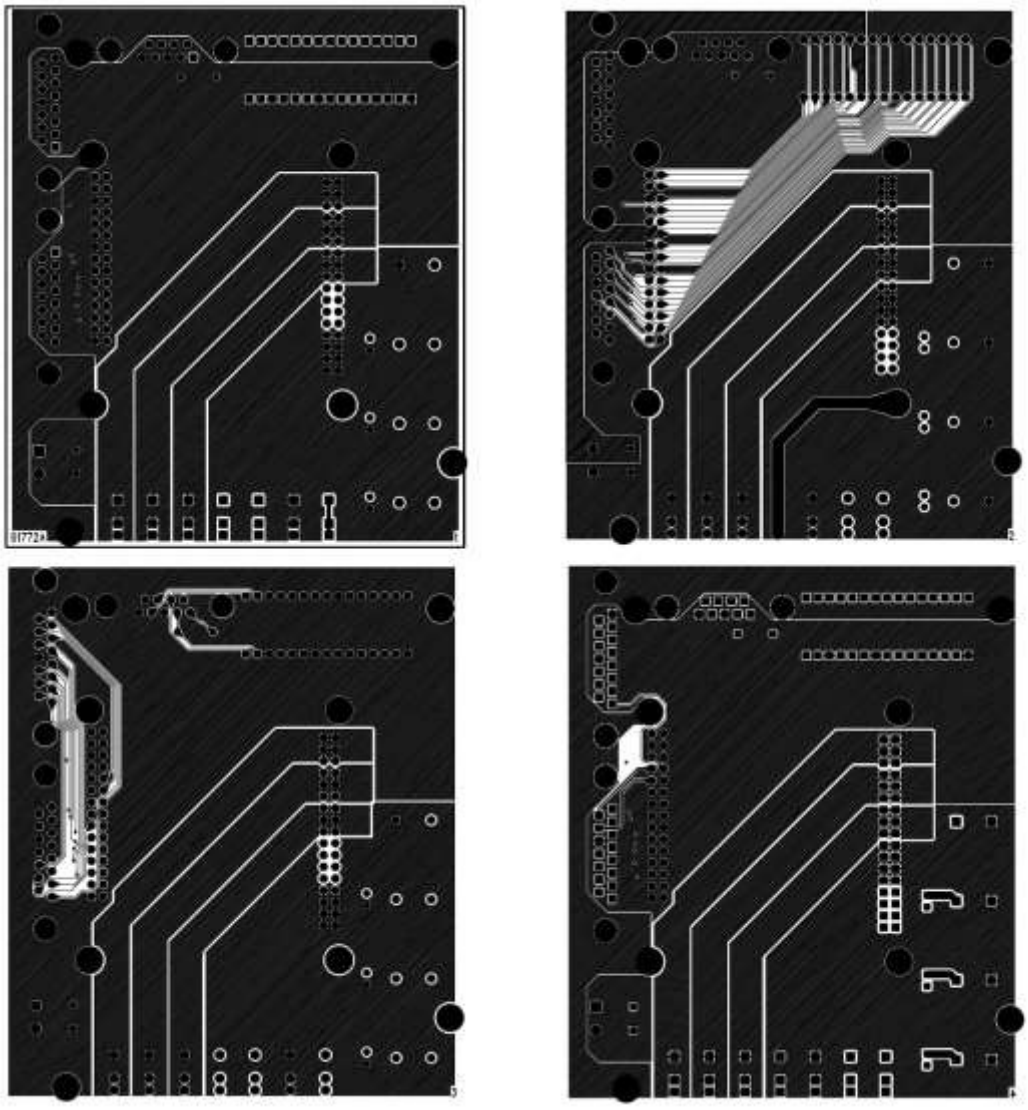
5.1.3 - Jumper configuration of the capacitor bus

Three jumpers allow the user choosing the bus capacitor value between 470µF and 1880µF.
These jumpers are J2,J3, J4. See chapter 5.1.1 for their location.
The following table gives the capacitor value according to the jumper configuration.

Capacitor value	Jumper config.
470µF	NO Jumpers
940µF	1 jumper SET
1410µF	2 jumpers SET
1880µF	J2 J3 J4 SET

5.1.4 - Layout

The layout of the development kit PCB **Easy-Dev01** is presented below.



5.2 - LOW OPERATING VOLTAGE

XtrapulsEasy™ drives offer the possibility to change the operating voltage.
Thanks to this feature, XtrapulsEasy™ drives are able to work within a wide voltage range, from $24V_{DC}$ / $17V_{AC}$ up to $60V_{DC}$ / $42V_{AC}$.

Please note that the drive specifications are depending on the operating voltage, as shown in the table below:

		Operating voltage		
		$24V_{DC}$	$48V_{DC}$	$60V_{DC}$
Minimum inductance	8kHz	0.08mH*	0.15mH	0.2mH
	16kHz	0.04mH*	0.08mH*	0.1mH
Undervoltage threshold		$17V_{DC}$	$20V_{DC}$	$25V_{DC}$
Overvoltage threshold		$35V_{DC}$	$70V_{DC}$	$85V_{DC}$

(*): For a motor inductance lower than 0.1mH, the current loop gains must be manually calculated as follows:
a) perform the automatic gain calculation for an inductance of 0.1mH
b) apply to all the gains found (Id gains and Iq gains) the ratio between the current inductance and 0.1mH.

Example: Gains found with 0.1mH are Id_proportional = 27, Id_integral = 51 Iq,_proportional = 27, Iq_integral = 51
The current inductance is 0.05mH, so the correction factor is 0.05mH / 0.1mH = 0.5
Set the gains at Id_proportional = 27*0.5 = 13 and Iq_proportional = 27*0.5 = 13
Id_integral = 51*0.5 = 25 and Iq_integral = 51*0.5 = 25

IMPORTANT

The use of XtrapulsEasy™ drives at very low operating voltage suffers from several limitations:

- Voltage below $+15V_{DC}$ cannot be accurately measured on the DC link.

- The capacitors bank is optimized for operation at rated voltage. The energy stored in the capacitors is proportional to the square of the voltage. At very low voltage, the storage ability of regenerative energy is limited. Extra storage (capacitors, battery, …) can be required to assume proper operations during high dynamic deceleration phases.

5.3 - MAINTENANCE

5.3.1 - Periodical checking

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.

Risk of electric shock
Any contact with electrical parts, even after power down, may involve physical damage. Wait for at least 10 minutes after power down before handling the drives

Hot surfaces
- Ensure that any contact with hot surfaces is avoided.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity of hot surfaces
- Verify that the product has sufficiently cooled down before handling it.

Damage	Action	Periodicity
Cooling	Check the room temperature of the drive	Every year
Dust	Check connectors, and cabinet cooling system	Every year
Corrosion	Check housing and electrical connection	Every year
Mechanical mounting	- Check the correct drive fastening - Check the tightening of the electrical connection	Every year

5.3.2 - Warranty

Any intervention on the board will cancel the warranty

5.4 - OPERATING ENVIRONMENT CONDITIONS

A - CLIMATIC CONDITIONS

1	-	Cooling fluid temperature	Air : -25°C to +40° C
2	-	Air temperature	-25°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	-	Storage periods	no restriction

B - MECHANICAL INSTALLATION CONDITIONS

The drive must be mounted on a stiff surface, in rooms or additional housings without hindering the heatsink.
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 Stegmaier-Haupt.

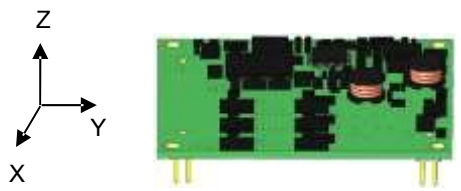
Vibration level for XtrapulsEasy™-ak-60/45-DB

The XtrapulsEasy™-ak-60/45-DB drive can be integrated in mobile equipment which vibration level is up to 6g.

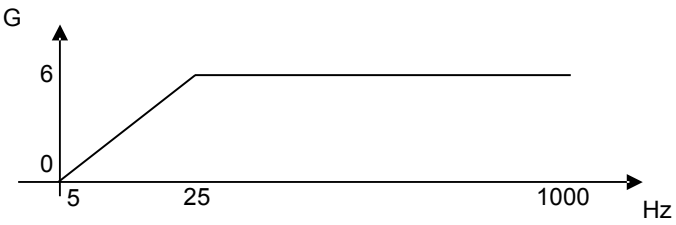
Frequency (Hz)	Amplitude (mm)	Acceleration (g)	Norm
5 ≤ f < 25	4,95	not applicable	IEC60068-2-6
25 ≤ f < 1000	not applicable	6	

The validation profile is shown below:

Definition of the stress axes:



Endurance template:
16 sweeps during 2 hours in each axis



Shock level for XtrapulsEasy™-ak-60/45-DB

Level applied	conditions	Norm
20g / 11ms half sinus	6 shocks per axis 3 per direction Device operating	IEC60068-2-27

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 storage 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 packaging 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 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 3000m.

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 storage period of up to six months. Longer periods may require a special treatment (smaller surrounding air temperature range such as in class 1K3).

G - TRANSPORT

1 - Climatic conditions

The equipment can be transported in its standard packaging 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 packaging 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/s²)
$2 \leq f < 9$	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.

Contact

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