iPOS3602 HX-CAN/ iPOS3604 HX-CAN

Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors

T E C H N O S O F T

Intelligent Servo Drives

Technical Reference

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Read This First

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About This Manual

This book is a technical reference manual for:

Product Name	Part Number	Firmware	Description
iPOS3602 HX-CAN	P028.001.E501	F509x	2A, closed frame up plug, Differential encoder, CAN
	P028.001.E561	F509x	2A, closed frame up plug, Single-Ended encoder, CAN
	P028.001.E571	F524x	2A, closed frame up plug, Linear Hall sensors, CAN
iPOS3604 HX-CAN	P028.002.E501	F508x	4A, closed frame up plug, Differential encoder, CAN
	P028.002.E561	F508x	4A, closed frame up plug, Single-Ended encoder, CAN
	P028.002.E571	F523x	4A, closed frame up plug, Linear Hall sensors, CAN

In order to operate the **iPOS360x** drives, you need to pass through 3 steps:
- ❑ **Step 1 Hardware installation**
- ❑ **Step 2 Drive setup** using Technosoft **EasySetUp** software for drive commissioning
- ❑ **Step 3 Motion programming** using one of the options:
  - ❑ A **CANopen master**[1]
  - ❑ The drives **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft **EasyMotion Studio** software
  - ❑ A **TML_LIB motion library for PCs** (Windows or Linux) [2]
  - ❑ A **TML_LIB motion library for PLCs** [3]
  - ❑ A **distributed control** approach which combines the above options, like for example a host calling motion functions programmed on the drives in TML

This manual covers **Step 1** in detail. It describes the **iPOS360x** hardware including the technical data, the connectors and the wiring diagrams needed for installation.

For Step 2 and 3, please consult the document *EasyMotion Studio – Quick Setup and Programming Guide (P091.034.ESM-Quick.Setup.and.Programming.Guide.UM.xxxx)*. It also includes the scaling factors between the real SI units and the drive internal units. For detailed information regarding the next steps, refer to the related documentation.

Notational Conventions

This document uses the following conventions:

- **iPOS360X**– all products described in this manual
- **IU units** – Internal units of the drive
- **SI units** – International standard units (meter for length, seconds for time, etc.)
- **TML** – Technosoft Motion Language
- **CANopen** – Standard communication protocol that uses 11-bit message identifiers over CAN-bus
- **TMLCAN** – Technosoft communication protocol for exchanging TML commands via CAN-bus, using 29bit message identifiers

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[1] when the iPOS360x HX-CAN is set in CANopen mode

[2] available only for TMLCAN protocol

iPOS3602 HX-CAN Datasheet (P028.001.E501.DSH)

iPOS3602 HX-CAN Datasheet (P028.001.E561.DSH)

iPOS3602 HX-CAN Datasheet (P028.001.E571.DSH)

iPOS3604 HX-CAN Datasheet (P028.002.E501.DSH)

iPOS3604 HX-CAN Datasheet (P028.002.E561.DSH)

iPOS3604 HX-CAN Datasheet (P028.002.E571.DSH)

– describes the hardware connections of the iPOS360x HX intelligent servo drive including the technical data and connectors.

EasyMotion Studio – Quick Setup and Programming Guide (P091.034.ESM-Quick.Setup.and.Programming.Guide.UM.xxxx) – describes the compatible software installation, drive software setup commissioning, introduction to TML motion programming and motion evaluation tools.

Help of the EasySetUp software – describes how to use **EasySetUp** to quickly setup any Technosoft drive for your application using only 2 dialogues. The output of EasySetUp is a set of setup data that can be downloaded into the drive EEPROM or saved on a PC file. At power-on, the drive is initialized with the setup data read from its EEPROM. With EasySetUp it is also possible to retrieve the complete setup information from a drive previously programmed. **EasySetUp can be downloaded free of charge from Technosoft web page**

iPOS CANopen Programming **(part no. P091.063.iPOS.UM.xxxx)** – explains how to program the iPOS family of intelligent drives using **CANopen** protocol and describes the associated object dictionary for **CiA 301 v.4.2** application layer and communication profile and **CiA DSP 402_2 v4.1** device profile for drives and motion control now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards

Motion Programming using EasyMotion Studio (part no. P091.034.ESM.UM.xxxx) – describes how to use the EasyMotion Studio to create motion programs using in Technosoft Motion Language (TML). EasyMotion Studio platform includes **EasySetUp** for the drive/motor setup, and a **Motion Wizard** for the motion programming. The Motion Wizard provides a simple, graphical way of creating motion programs and automatically generates all the TML instructions. *With EasyMotion Studio you can fully benefit from a key advantage of Technosoft drives – their capability to execute complex motions without requiring an external motion controller, thanks to their built-in motion controller.* **A demo version of EasyMotion Studio (with EasySetUp part fully functional) can be downloaded free of charge from the Technosoft web page**

TML_LIB v2.0 **(part no. P091.040.v20.UM.xxxx)** – explains how to program in **C, C++,C#, Visual Basic or Delphi Pascal** a motion application for the Technosoft intelligent drives using TML_LIB v2.0 motion control library for PCs. The TML_lib includes ready-to-run examples that can be executed on **Windows** or **Linux** (x86 and x64).

TML_LIB_LabVIEW v2.0 **(part no. P091.040.LABVIEW.v20.UM.xxxx)** – explains how to program in **LabVIEW** a motion application for the Technosoft intelligent drives using TML_LIB_Labview v2.0 motion control library for PCs. The TML_Lib_LabVIEW includes over 40 ready-to-run examples.

TML_LIB_S7 **(part no. P091.040.S7.UM.xxxx)** – explains how to program in a PLC **Siemens series S7-300 or S7-400** a motion application for the Technosoft intelligent drives using TML_LIB_S7 motion control library. The TML_LIB_S7 library is **IEC61131-3 compatible**.

TML_LIB_CJ1 **(part no. P091.040.CJ1.UM.xxxx)** – explains how to program in a PLC **Omron series CJ1** a motion application for the Technosoft intelligent drives using TML_LIB_CJ1 motion control library for PLCs. The TML_LIB_CJ1 library is **IEC61131-3 compatible**.

TML_LIB_X20 **(part no. P091.040.X20.UM.xxxx)** – explains how to program in a PLC **B&R series X20** a motion application for the Technosoft intelligent drives using TML_LIB_X20 motion control library for PLCs. The TML_LIB_X20 library is **IEC61131-3 compatible**.

TechnoCAN **(part no. P091.063.TechnoCAN.UM.xxxx)** – presents TechnoCAN protocol – an extension of the CANopen communication profile used for TML commands

IO-iPOS360X (part no. P091.028.IO-iPOS360X.UM.xxxx) – describes the IO iPOS360x I/O extension board included in the **iPOS360X** Starter Kits.

If you want to …	Contact Technosoft at …
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Receive general information or assistance (see Note)	World Wide Web: http://www.technosoftmotion.com/ Email: sales@technosoftmotion.com
Ask questions about product operation or report suspected problems (see Note)	Tel: +41 (0)32 732 5500 Email: support@technosoftmotion.com
Make suggestions about, or report errors in documentation.	Mail: Technosoft SA Avenue des Alpes 20 CH-2000 Neuchatel, NE Switzerland

1 Safety information

Read carefully the information presented in this chapter before carrying out the drive installation and setup! It is imperative to implement the safety instructions listed hereunder.

This information is intended to protect you, the drive and the accompanying equipment during the product operation. Incorrect handling of the drive can lead to personal injury or material damage.

The following safety symbols are used in this manual:

	WARNING!	*SIGNALS A DANGER TO THE OPERATOR WHICH MIGHT CAUSE BODILY INJURY. MAY INCLUDE INSTRUCTIONS TO PREVENT THIS SITUATION*

	CAUTION!	*SIGNALS A DANGER FOR THE DRIVE WHICH MIGHT DAMAGE THE PRODUCT OR OTHER EQUIPMENT. MAY INCLUDE INSTRUCTIONS TO AVOID THIS SITUATION*

1.1 Warnings

	WARNING!	*TO AVOID ELECTRIC ARCING AND HAZARDS, NEVER CONNECT / DISCONNECT WIRES FROM THE DRIVE WHILE THE POWER SUPPLIES ARE ON*

	WARNING!	*THE DRIVE MAY HAVE HOT SURFACES DURING OPERATION.*

	WARNING!	*DURING DRIVE OPERATION, THE CONTROLLED MOTOR WILL MOVE. KEEP AWAY FROM ALL MOVING PARTS TO AVOID INJURY*

1.2 Cautions

	CAUTION!	*THE POWER SUPPLIES CONNECTED TO THE DRIVE MUST COMPLY WITH THE PARAMETERS SPECIFIED IN THIS DOCUMENT*

⚠	**CAUTION!**	*TROUBLESHOOTING AND SERVICING ARE PERMITTED ONLY FOR PERSONNEL AUTHORISED BY TECHNOSOFT*

1.3   Quality system, conformance and certifications

IQNet and **Quality Austria** certification about the implementation and maintenance of the Quality Management System which fulfills the requirements of Standard **ISO 9001:2015**.
Quality Austria Certificate about the application and further development of an effective **Quality Management System** complying with the requirements of Standard **ISO 9001:2015**

REACH Compliance - TECHNOSOFT hereby confirms that this product comply with the legal obligations regarding Article 33 of the European REACH Regulation 1907/2006 (Registration, Evaluation, Authorization and Restriction of Chemicals), which came into force on 01.06.2007.

RoHS Compliance - Technosoft SA here with declares that this product is manufactured in compliance with the RoHS directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

Technosoft SA hereby declares that this product conforms to the following European applicable directives:
2014/30/EU   Electromagnetic Compatibility (EMC) Directive
2014/35/EU   Low Voltage Directive (LVD)
93/68/EEC   CE Marking Directive
Conflict minerals statement - Technosoft declares that the company does not purchase 3T&G (tin, tantalum, tungsten & gold) directly from mines or smelters...
We have no indication that Technosoft products contain minerals from conflict mines or smelters in and around the DRC.

For other certifications visit: https://technosoftmotion.com/en/quality/

2   Product Overview

2.1   Introduction

The **iPOS360X** is a family of fully digital intelligent servo drives, based on the latest DSP technology and they offer unprecedented drive performance combined with an embedded motion controller.

Suitable for control of brushless DC, brushless AC (vector control), DC brushed motors and step motors, the iPOS360x HX-CAN drives accept as position feedback incremental encoders (quadrature or sine/cosine) and linear Halls signals.

All drives perform position, speed or torque control and work in single, multi-axis or stand-alone configurations. Thanks to the embedded motion controller, the iPOS360X drives combine controller, drive and PLC functionality in a single compact unit and are capable to execute complex motions without requiring intervention of an external motion controller. Using the high-level Technosoft Motion Language (**TML**) the following operations can be executed directly at drive level:

- ❑ Setting various motion modes (profiles, PVT, PT, electronic gearing[1] or camming[1], etc.)
- ❑ Changing the motion modes and/or the motion parameters
- ❑ Executing homing sequences
- ❑ Controlling the program flow through:
    - ▪ Conditional jumps and calls of TML functions
    - ▪ TML interrupts generated on pre-defined or programmable conditions (protections triggered, transitions on limit switch or capture inputs, etc.)
    - ▪ Waits for programmed events to occur
- ❑ Handling of digital I/O and analogue input signals
- ❑ Executing arithmetic and logic operations
- ❑ Performing data transfers between axes
- ❑ Controlling motion of an axis from another one via motion commands sent between axes
- ❑ Sending commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group
- ❑ Synchronizing all the axis in a network

By implementing motion sequences directly at drive level you can really distribute the intelligence between the master and the drives in complex multi-axis applications, reducing both the development time and the overall communication requirements. For example, instead of trying to command each movement of an axis, you can program the drives using TML to execute complex motion tasks and inform the master when these tasks are done. Thus, for each axis control the master job may be reduced at: calling TML functions stored in the drive EEPROM and waiting for a message, which confirms the TML functions execution completion.

All iPOS360X CAN drives are equipped with a serial RS232 and a CAN 2.0B interface that can be set by hardware pins to operate in 2 communication protocol modes:
- ❑ **CANopen**
- ❑ **TMLCAN**

When **CANopen** mode is selected, the iPOS360X conforms to **CiA 301 v4.2** application layer communication profile and **CiA DSP 402_2 v4.1** device profile for drives and motion control, now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards. In this mode, the iPOS360X may be controlled via a CANopen master. The iPOS drive offers the possibility for a CANopen master to call motion sequences/ functions, written in TML and stored in the drive EEPROM, using manufacturer specific objects. Also, the drives can communicate separately between each other by using non reserved 11 bit identifiers.

When **TMLCAN** mode is selected, the iPOS360X behaves as standard Technosoft intelligent drive and conforms to Technosoft protocol for exchanging TML commands via CAN-bus. When TMLCAN protocol is used, it is not mandatory to have a master. Any iPOS360X can be set to operate standalone, and may play the role of a master to coordinate both the network communication/synchronization and the motion application via TML commands sent directly to the other drives.

When higher level coordination is needed, apart from a CANopen master, the iPOS360X drives can also be controlled via a PC or a PLC using one of the **TML_LIB** motion libraries.

For iPOS360X commissioning **EasySetUp** or **EasyMotion Studio** PC applications may be used.

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[1] Available if the master axis sends its position via a communication channel, or by using the secondary encoder input

EasySetUp is a subset of EasyMotion Studio, including only the drive setup part. The output of EasySetUp is a set of setup data that can be downloaded into the drive EEPROM or saved on a PC file. At power-on, the drive is initialized with the setup data read from its EEPROM. With EasySetUp it is also possible to retrieve the complete setup information from a drive previously programmed. EasySetUp shall be used for drive setup in all cases where the motion commands are sent exclusively from a master. Hence neither the iPOS360X TML programming capability nor the drive camming mode are used. **EasySetUp can be downloaded free of charge from Technosoft web page.**

EasyMotion Studio platform includes EasySetUp for the drive setup, and a **Motion Wizard** for the motion programming. The Motion Wizard provides a simple, graphical way of creating motion programs and automatically generates all the TML instructions. *With EasyMotion Studio you can execute complex motions, thanks to their built-in motion controller*s. EasyMotion Studio, may be used to program motion sequences in TML. This is the iPOS360X typical CAN operation mode when TMLCAN protocol is selected. EasyMotion Studio can also be used with the CANopen protocol, if the user wants to call TML functions stored in the drive EEPROM or to use the camming mode. With camming mode, EasyMotion Studio offers the possibility to quickly download and test a cam profile and also to create a **.sw** file with the cam data. The .sw file can be afterwards stored in a master and downloaded to the drive, wherever needed. **A demo version of EasyMotion Studio (with EasySetUp part fully functional) can be downloaded free of charge from Technosoft web page.**

2.2 Product Features

- Fully digital servo drive suitable for the control of rotary or linear brushless, DC brush, and step motors
- Very compact design
- Sinusoidal (FOC) or trapezoidal (Hall-based) control of brushless motors
- Open or closed-loop control of 2 and 3-phase steppers
- Various modes of operation, including: torque, speed or position control; position or speed profiles, Cyclic Synchronous Position (CSP) for CANopen mode, external reference mode (analogue or encoder feedback) or sent via a communication bus
- Technosoft Motion Language (TML) instruction set for the definition and execution of motion sequences
- Standalone operation with stored motion sequences
- **Motor supply**: 9-36V
- **Logic supply**: 7-36V
- **Output current**:
    - **iPOS3602 HX-CAN**: 2A [2] continuous; 3.2A peak
    - **iPOS3604 HX-CAN**: 4A[3] continuous; 10A peak
- **PWM switching** frequency up to **100kHz**
- **Communication**:
    - RS-232 serial up to 115kbits/s
    - CAN-bus 2.0B up to 1Mbit/s
- **Digital and analog I/Os**:
    - 5 digital inputs: 5-36V, PNP or NPN software selectable: Enable, Limit switch +, Limit switch –, 2 general-purpose
    - 4 digital outputs : 5-36V, 0.5A, NPN open-collector: Ready, Error, 2 general-purpose
    - 1 analogue input: 12-bit, 0-5V (Reference or Feedback) or general-purpose
- **Electro-Mechanical brake support**: software configurable digital output to control motor brake
- **Feedback devices**:
    - Incremental encoder interface (single ended or differential depending on drive part number)
    - Digital Hall sensor interface (single-ended and open collector regardless of drive part number)
    - Linear Hall sensor interface (depending on drive part number)
    - Analogue Sin/Cos encoder interface (differential $1V_{pp}$ regardless of drive part number))
- **Various motion programming modes**:
    - Position profiles with trapezoidal or S-curve speed shape
    - Position, Velocity, Time (PVT) 3rd order interpolation
    - Position, Time (PT) 1st order interpolation
    - Cyclic Synchronous Position (CSP) for CANopen mode.
    - Electronic gearing and camming
    - 35 Homing modes

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[2] 2A cont. with DC, step and BLDC motors (trapezoidal), 2A amplitude ($1.41A_{RMS}$) for PMSM (sinusoidal)

[3] 4A cont. with DC, step and BLDC motors (trapezoidal), 4A amplitude ($2.82A_{RMS}$) for PMSM (sinusoidal)

- Hardware and Software CAN selectable addresses
- **Two CAN operation modes** selectable by jumper:
  - **CANopen** – conforming with **CiA 301 v4.2** and **CiA DSP 402_2 v4.1**
  - **TMLCAN** – intelligent drive conforming with Technosoft protocol for exchanging TML commands via CAN-bus
- **2K × 16 internal SRAM** memory for data acquisition
- **4K × 16 E²ROM** to store TML motion programs, cam tables and other user data
- **Operating ambient temperature**:
  - 0-40°C – iPOS360X HX-CAN
- **Protections**:
  - Short-circuit between motor phases
  - Short-circuit from motor phases to ground
  - Over-voltage
  - Under-voltage
  - Over-current
  - Communication error
  - Control error
  - Over-temperature
- **Firmware on drive**:
  - F508M+ or F523E+ for iPSO3604
  - F509M+ or F524E+ for iPSO3602

2.3   Identification Labels
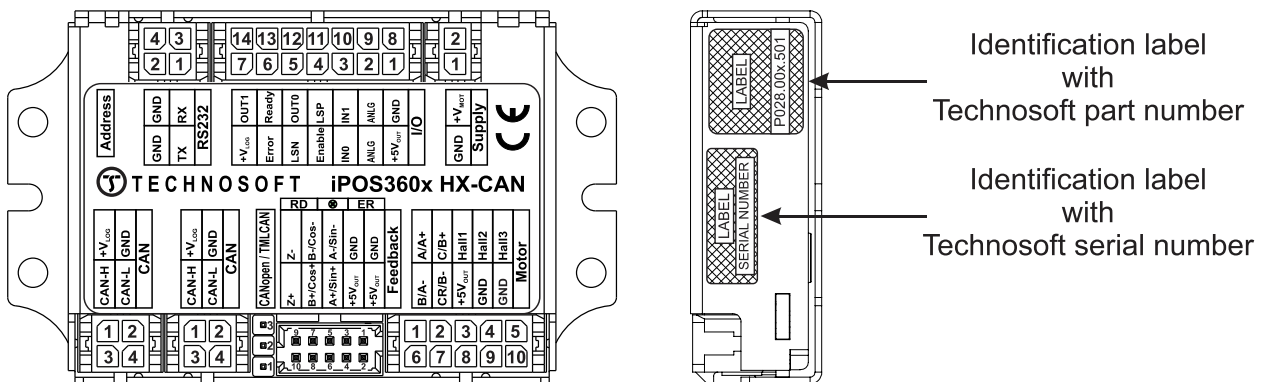
Figure 2.3.1. iPOS360X HX-CAN identification labels

The iPOS360X HX can has the following part number and name on the identification label:

Product Name	Part Number	Firmware	Description
iPOS3602 HX-CAN	P028.001.E501	F509x	2A, closed frame up plug, Differential encoder, CAN
	P028.001.E561	F509x	2A, closed frame up plug, Single-Ended encoder, CAN
	P028.001.E571	F524x	2A, closed frame up plug, Linear Hall sensors, CAN
iPOS3604 HX-CAN	P028.002.E501	F508x	4A, closed frame up plug, Differential encoder, CAN
	P028.002.E561	F508x	4A, closed frame up plug, Single-Ended encoder, CAN
	P028.002.E571	F523x	4A, closed frame up plug, Linear Hall sensors, CAN

2.4 Supported Motor-Sensor Configurations

The position and/or speed are controlled using one feedback sensor.

Motor / Sensor type	Brushless PMSM	Brushless BLDC	DC Brush	Stepper 2 phase	Stepper 3 phase
Incr. encoder***	Yes	-	Yes	Yes	-
Incr. encoder*** + Digital Hall	Yes	Yes	-	-	-
Sin-Cos encoder**	Yes	-	-		-
Digital halls only	Yes	-	-	-	-
Linear Halls*	Yes*	-	-	-	
Tacho	-	-	Yes	-	-
Open-loop (no sensor)	-	-	-	Yes	Yes
Open-loop (with step loss detection using incr. Encoder)	-	-	-	Yes	Yes
Open-loop with incr. encoder on load	-	-	-	Yes	Yes

*Linear Halls are supported with part number: P028.00x.**E571**
Sin-Cos encoder supported with part number: P028.00x. **E501
***Incremental encoder supported with part number: P028.00x. **E501** (differential) and P028.00x. **E561** (single-ended)

3 Hardware Installation

3.1 iPOS360X HX-CAN Board Dimensions
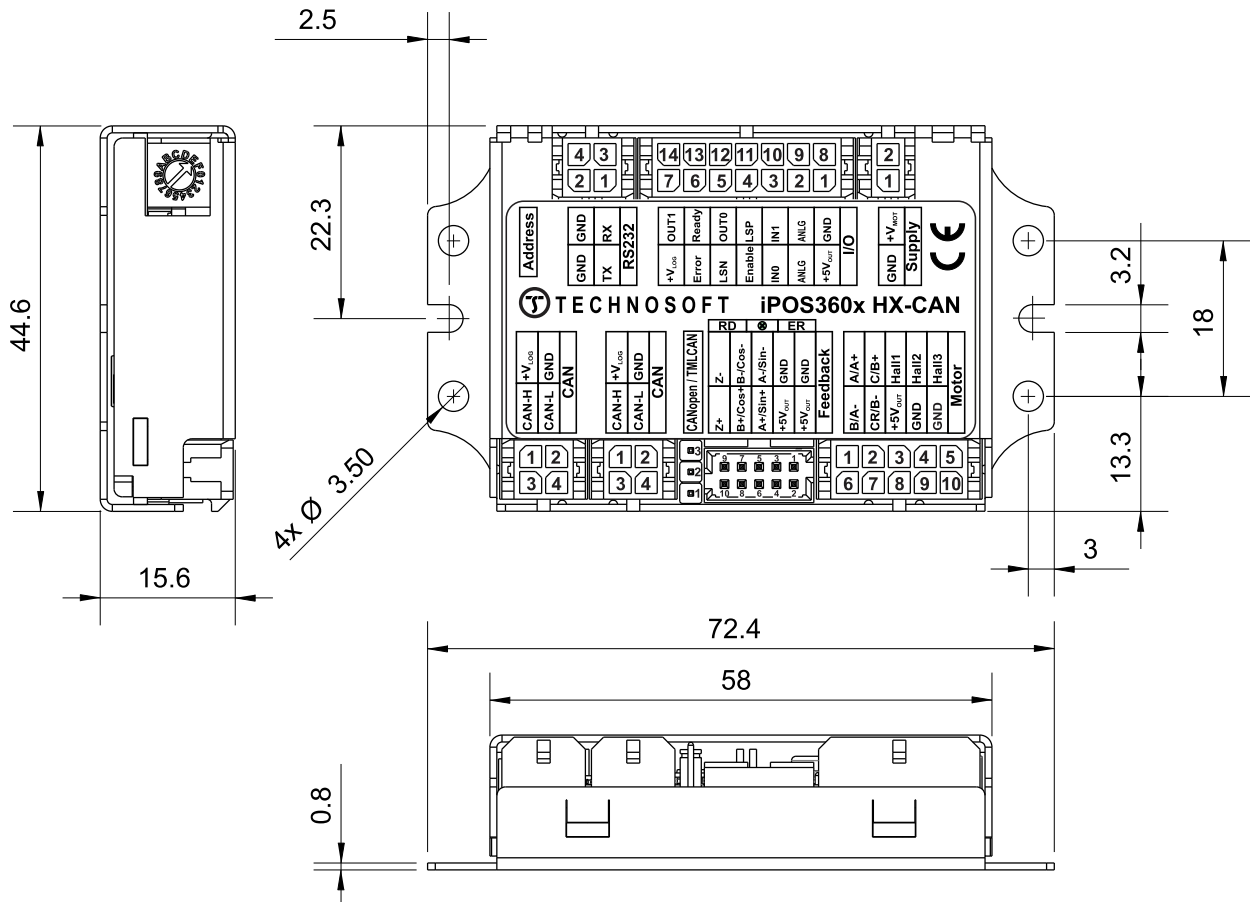
***Figure 3.1.1.** iPOS360X HX-CAN drive dimensions*

All dimensions are in mm. The drawings are not to scale.

3.2 Mechanical Mounting

The iPOS360x HX-CAN drive is intended to be mounted vertically or horizontally on a metallic support using the provided mounting holes and the recommended mating connectors.

For thermal calculations, each iPOS360x drive can be assumed to generate 1 Watt at idle, and up to 5 Watts (= 17 BTU/hour) worst case while driving a motor and using all digital outputs.

The iPOS360x HX-CAN drive(s) can be cooled by natural convection. The support shall be thermally conductive (metallic), and can be mounted vertically or horizontally.
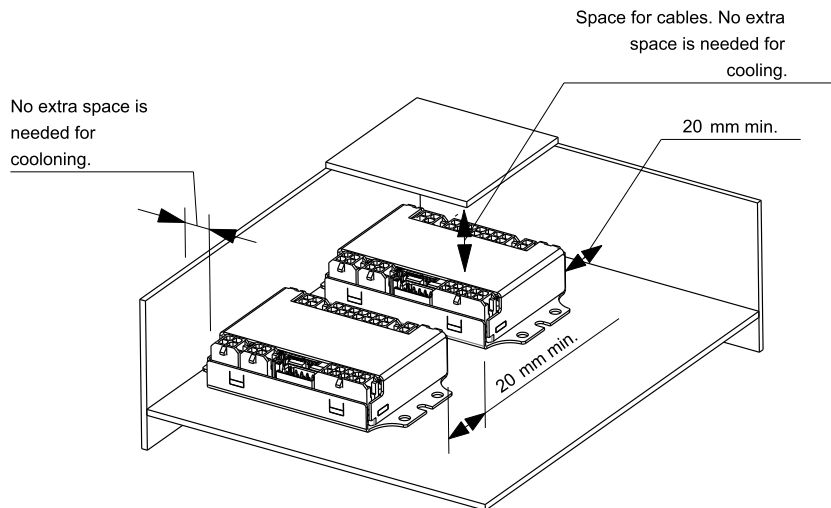
Figure 3.2.1. Recommended spacing go vertical and horizontal mounting, worst case: non-metallic, closed box

The figures above shows the minimum spacing to assure proper airflow by natural convection.

If closed completely in a box, ventilation openings shall be foreseen on the top and bottom sides.

If ventilation driven by natural convection is not enough to maintain the temperature surrounding the iPOS360x HX-CAN drive(s), then alternate forced cooling methods must be applied.

Remark: In case of using a metallic box, with ventilation openings, all spacing values may be reduced substantially. With proper ventilation, keeping the air surrounding the iPOS360x HX-CAN inside the limits indicated, the spacing values may be reduced down to zero.

3.3 EMC recommendations

The drive is compliant to the requirements of the following European directives, when installed as described in this User Manual:

- 93/68/EEC CE Marking Directive
- 2014/30/EU Electromagnetic Compatibility (EMC) Directive
- EN 61800-3:2012 Adjustable speed electrical power drive systems, Part3: EMC
- product standard

The drive shall be installed as shown in the Figure below, in order to meet the above EMC requirements:
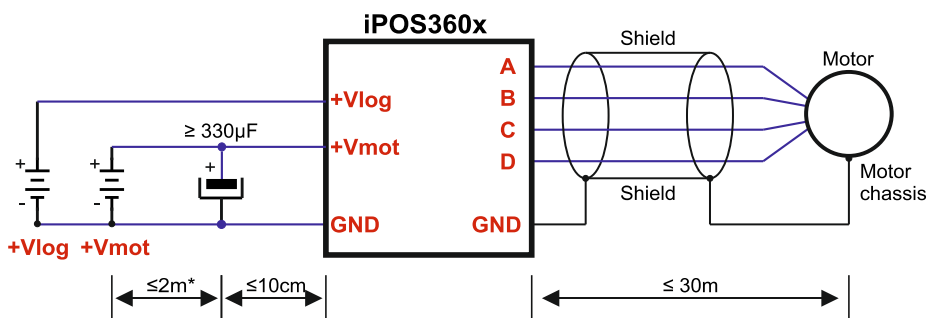
Figure 3.2.1 EMC recommended connections

* if +Vmot to capacitor wire length ≥ 2m, use twisted wires for the supply and ground return (Vmot and GND)

* if +Vmot to capacitor wire length ≥ 20m, the capacitor value must be ≥ 2200 μF.

3.4 Connectors and Pinouts

3.4.1 Pinouts for iPOS360x HX-CAN (differential encoder version; P028.00x.E501)

Pin	Name	Description
1	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$
2	GND	Return ground for CAN-Bus
3	Can-Hi	CAN-Bus positive line (dominant high)
4	Can-Lo	CAN-Bus negative line (dominant low)

JP1 Communication protocol selection

Position	Description
1-2	Select CANopen communication protocol
2-3	Select TMLCAN communication protocol

SW1 Axis ID selection

Switch	Position	Description
SW1	0..F	H/W Axis ID = 1 to 15 when switch is 1 to F Exception: SW1 = 0 -->Axis ID = 255.

Pin	Name	Description
1	232TX	RS-232 Data Transmission
2	GND	Return ground for RS-232 pins
3	232RX	RS-232 Data Reception
4	GND	Return ground for RS-232 pins

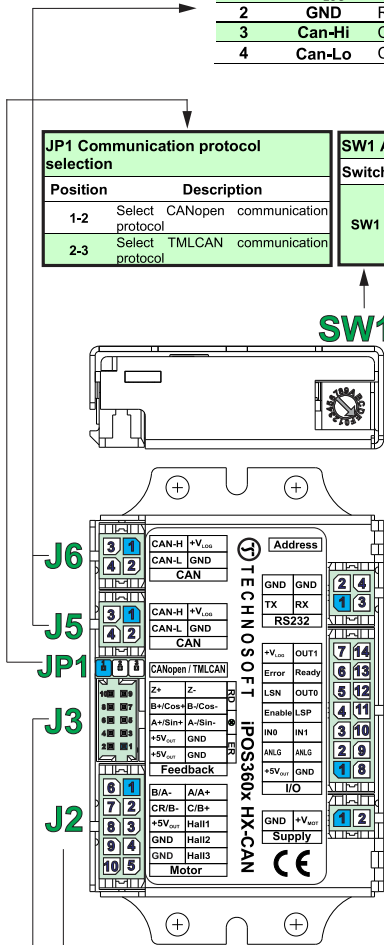| Pin	Name	Description
1	+5V$_{OUT}$	5V output supply for I/O usage
2	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
3	IN0	5-36V general-purpose digital PNP/NPN input
4	IN4/Enable	5-36V digital PNP/NPN input. Drive enable input
5	IN3/LSN	5-36V digital PNP/NPN input. Negative limit switch input
6	OUT2/Error	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
7	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$ / If not connected, the logic supply is automatically routed from J1 pin 2[1]
8	GND	Return ground for I/O pins
9	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
10	IN1	5-36V general-purpose digital PNP/NPN input
11	IN2/LSP	5-36V digital PNP/NPN input. Positive limit switch input
12	OUT0	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
13	OUT3/Ready	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
14	OUT1	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

Pin	Name	Description
1	GND	Negative return (ground) of the power supply
2	+V$_{MOT}$	Positive terminal of the motor supply: 9 to 36V$_{DC}$. Feeds the positive terminal of the logic supply if J4 pin 7 not connected separately

Pin	Name	Description
1	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
3	Hall 1	Digital input Hall 1 sensor
4	Hall 2	Digital input Hall 2 sensor
5	Hall 3	Digital input Hall 3 sensor
6	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
7	CR/B-	**Chopping resistor / Phase B-** for step motors
8	+5V$_{OUT}$	5V output supply - internally generated
9	GND	Negative return (ground) of the motor supply
10	GND	Negative return (ground) of the motor supply

Pin	Name	Description
1	GND	Return ground for sensors supply
2	+5V$_{OUT}$	5V output supply for I/O usage
3	GND	Return ground for sensors supply
4	+5V$_{OUT}$	5V output supply for I/O usage
5	A- /Sin-	Incr. encoder A- diff. input, or analogue encoder Sin- diff. input
6	A+/Sin+	Incr. encoder A+ diff. input, or analogue encoder Sin+ diff. input
7	B-/Cos-	Incr. encoder B- diff. input, or analogue encoder Cos- diff. input
8	B+/Cos+	Incr. encoder B+ diff. input, or analogue encoder Cos+ diff. input
9	Z-	Incr. encoder Z- diff. input
10	Z+	Incr. encoder Z+ diff. input

Pin	Name	Description
1	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$
2	GND	Return ground for CAN-Bus
3	Can-Hi	CAN-Bus positive line (dominant high)
4	Can-Lo	CAN-Bus negative line (dominant low)

JP1 Communication protocol selection

Position	Description
1-2	Select CANopen communication protocol
2-3	Select TMLCAN communication protocol

SW1 Axis ID selection

Switch	Position	Description
SW1	0..F	H/W Axis ID = 1 to 15 when switch is 1 to F. Exception: SW1 = 0 -->Axis ID = 255.

Pin	Name	Description
1	232TX	RS-232 Data Transmission
2	GND	Return ground for RS-232 pins
3	232RX	RS-232 Data Reception
4	GND	Return ground for RS-232 pins

Pin	Name	Description
1	+5V$_{OUT}$	5V output supply for I/O usage
2	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
3	IN0	5-36V general-purpose digital PNP/NPN input
4	IN4/Enable	5-36V digital PNP/NPN input. Drive enable input
5	IN3/LSN	5-36V digital PNP/NPN input. Negative limit switch input
6	OUT2/Error	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
7	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$ / If not connected, the logic supply is automatically routed from J1 pin 2[1]
8	GND	Return ground for I/O pins
9	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
10	IN1	5-36V general-purpose digital PNP/NPN input
11	IN2/LSP	5-36V digital PNP/NPN input. Positive limit switch input
12	OUT0	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
13	OUT3/Ready	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
14	OUT1	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

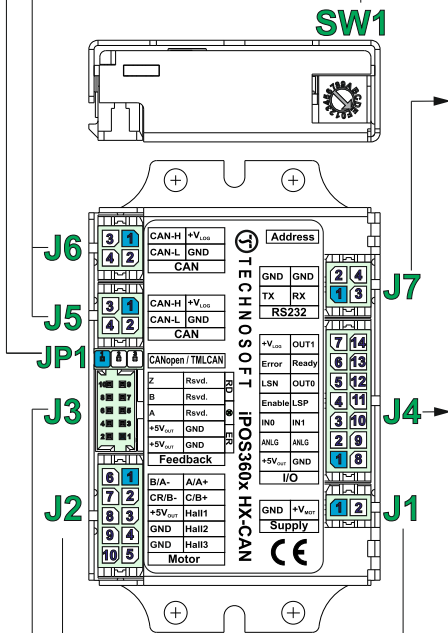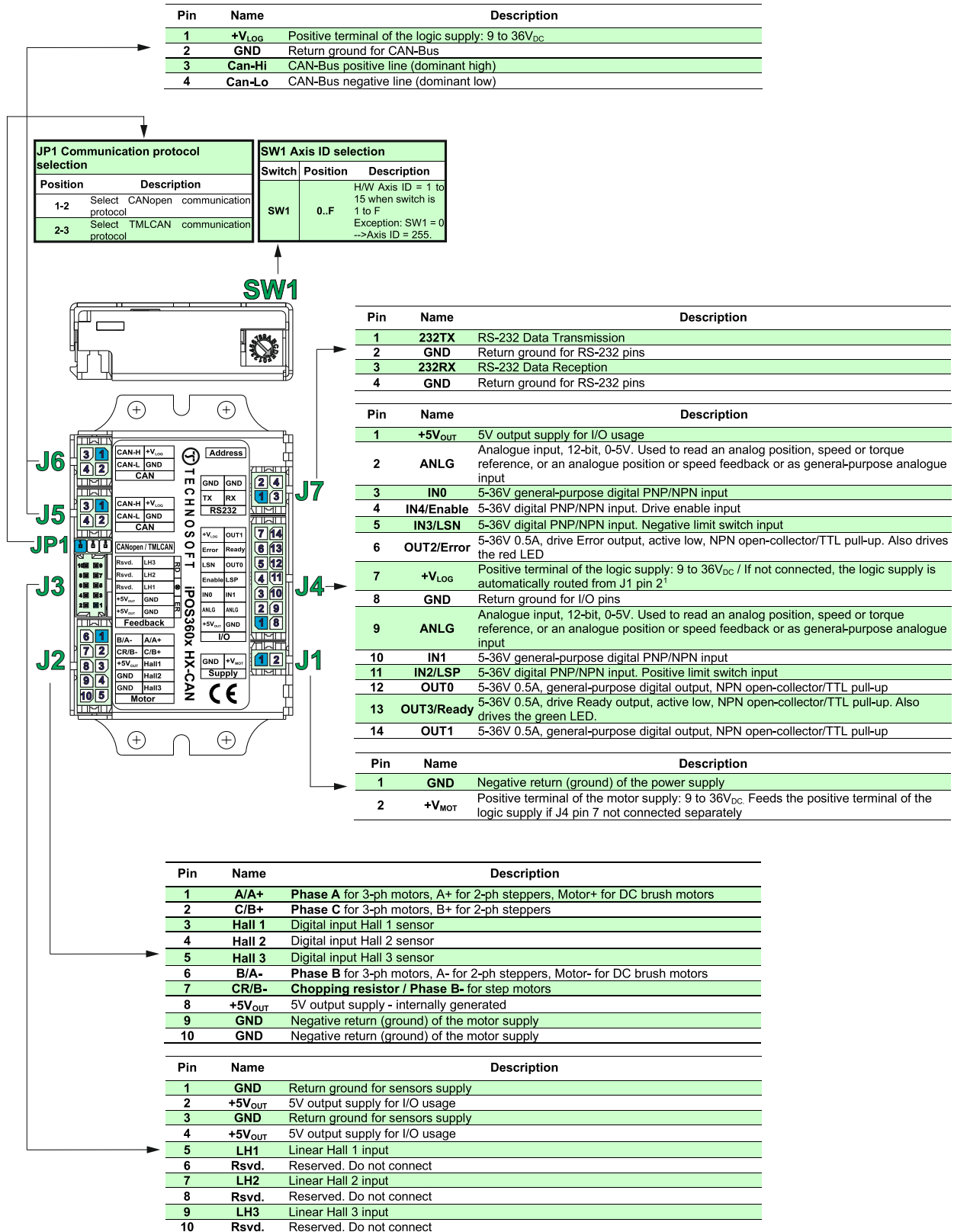| Pin	Name	Description
1	GND	Negative return (ground) of the power supply
2	+V$_{MOT}$	Positive terminal of the motor supply: 9 to 36V$_{DC}$. Feeds the positive terminal of the logic supply if J4 pin 7 not connected separately

Pin	Name	Description
1	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
3	Hall 1	Digital input Hall 1 sensor
4	Hall 2	Digital input Hall 2 sensor
5	Hall 3	Digital input Hall 3 sensor
6	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
7	CR/B-	**Chopping resistor / Phase B-** for step motors
8	+5V$_{OUT}$	5V output supply - internally generated
9	GND	Negative return (ground) of the motor supply
10	GND	Negative return (ground) of the motor supply

Pin	Name	Description
1	GND	Return ground for sensors supply
2	+5V$_{OUT}$	5V output supply for I/O usage
3	GND	Return ground for sensors supply
4	+5V$_{OUT}$	5V output supply for I/O usage
5	Rsvd.	Reserved. Do not connect
6	A	Incr. encoder A single-ended
7	Rsvd.	Reserved. Do not connect
8	B	Incr. encoder B single-ended
9	Rsvd.	Reserved. Do not connect
10	Z	Incr. encoder Z (index) single-ended

3.4.3 Pinouts for iPOS360x HX-CAN (linear halls encoder version; P028.00x.E571)

Pin	Name	Description
1	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$
2	GND	Return ground for CAN-Bus
3	Can-Hi	CAN-Bus positive line (dominant high)
4	Can-Lo	CAN-Bus negative line (dominant low)

JP1 Communication protocol selection	
Position	Description
1-2	Select CANopen communication protocol
2-3	Select TMLCAN communication protocol

SW1 Axis ID selection		
Switch	Position	Description
SW1	0..F	H/W Axis ID = 1 to 15 when switch is 1 to F Exception: SW1 = 0 -->Axis ID = 255.

Pin	Name	Description
1	232TX	RS-232 Data Transmission
2	GND	Return ground for RS-232 pins
3	232RX	RS-232 Data Reception
4	GND	Return ground for RS-232 pins

Pin	Name	Description
1	+5V$_{OUT}$	5V output supply for I/O usage
2	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
3	IN0	5-36V general-purpose digital PNP/NPN input
4	IN4/Enable	5-36V digital PNP/NPN input. Drive enable input
5	IN3/LSN	5-36V digital PNP/NPN input. Negative limit switch input
6	OUT2/Error	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
7	+V$_{LOG}$	Positive terminal of the logic supply: 9 to 36V$_{DC}$ / If not connected, the logic supply is automatically routed from J1 pin 2[1]
8	GND	Return ground for I/O pins
9	ANLG	Analogue input, 12-bit, 0-5V. Used to read an analog position, speed or torque reference, or an analogue position or speed feedback or as general-purpose analogue input
10	IN1	5-36V general-purpose digital PNP/NPN input
11	IN2/LSP	5-36V digital PNP/NPN input. Positive limit switch input
12	OUT0	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
13	OUT3/Ready	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
14	OUT1	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

Pin	Name	Description
1	GND	Negative return (ground) of the power supply
2	+V$_{MOT}$	Positive terminal of the motor supply: 9 to 36V$_{DC}$. Feeds the positive terminal of the logic supply if J4 pin 7 not connected separately

Pin	Name	Description
1	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
3	Hall 1	Digital input Hall 1 sensor
4	Hall 2	Digital input Hall 2 sensor
5	Hall 3	Digital input Hall 3 sensor
6	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
7	CR/B-	**Chopping resistor / Phase B-** for step motors
8	+5V$_{OUT}$	5V output supply - internally generated
9	GND	Negative return (ground) of the motor supply
10	GND	Negative return (ground) of the motor supply

Pin	Name	Description
1	GND	Return ground for sensors supply
2	+5V$_{OUT}$	5V output supply for I/O usage
3	GND	Return ground for sensors supply
4	+5V$_{OUT}$	5V output supply for I/O usage
5	LH1	Linear Hall 1 input
6	Rsvd.	Reserved. Do not connect
7	LH2	Linear Hall 2 input
8	Rsvd.	Reserved. Do not connect
9	LH3	Linear Hall 3 input
10	Rsvd.	Reserved. Do not connect

3.4.4 Mating Connectors

Image	Connector	Description	Manufacturer	Part Number	Image
	J1	MICRO-FIT receptacle housing, 2x1 way	MOLEX	43025-0200	
	J2	MICRO-FIT. receptacle housing, 2x5 way	MOLEX	43025-1000	
	J5, J6, J7	MICRO-FIT receptacle housing, 2x2 way	MOLEX	43025-0400	
	J4	MICRO-FIT receptacle housing, 2x7 way	MOLEX	43025-1400	
	J1,J2,J4, J5,J6,J7	CRIMP PIN, MICRO-FIT, 5A	MOLEX	43030-0007	
	J3	CRIMP PIN, MILLI-GRID	MOLEX	50394-8400	
	J3	MILLI-GRID receptacle housing, 2x5 way	MOLEX	51110-1056	

3.4.5 Cable Set

For a detailed description of iPOS 360x HX CAN cable sets please consult the ***P028.040.C09x.HX.DSH*** datasheet.

Ordering information			
Part No.	**Description**	**Package components**	**Connectors**
P028.040.C099	**CCS iPOS360x BXD** (Complete cable set, 100 cm with differential encoder cable)	1 x Motor & Hall cable	J2
		1 x Supply cable	J1
		2 x CAN cable / RS232 cable	J5, J6 / J7
		1 x I/O cable	J4
		1 x Differential Encoder cable	J3
P028.040.C098	**CCS iPOS360x BXE** (Complete cable set, 100 cm with single-ended encoder cable)	1 x Motor & Hall cable	J2
		1 x Supply cable	J1
		2 x CAN cable / RS232 cable	J5, J6 / J7
		1 x I/O cable	J4
		1 x Single-ended Encoder cable	J3

Accessories		
Part No.	**Name**	**Description**
P038.002.E306	**CAN terminator**	Molex MFIT 2x2 connector with 120 Ohms terminal resistor
P028.040.C232	**CA RS232 cable**	Molex 2x2 M-Fit to DB9 cable
P028.040.C030	**CAN interconnection**	CAN2CAN Cable 10cm Molex 2x2 M-Fit drive to drive
P038.001.E136	**RS232 - USB adapter**	Standard USB to RS232 adapter with FTDI chipset

3.5 Connection diagrams

3.5.1 iPOS360X HX-CAN connection diagram (differential encoder version; P028.00x.E501)
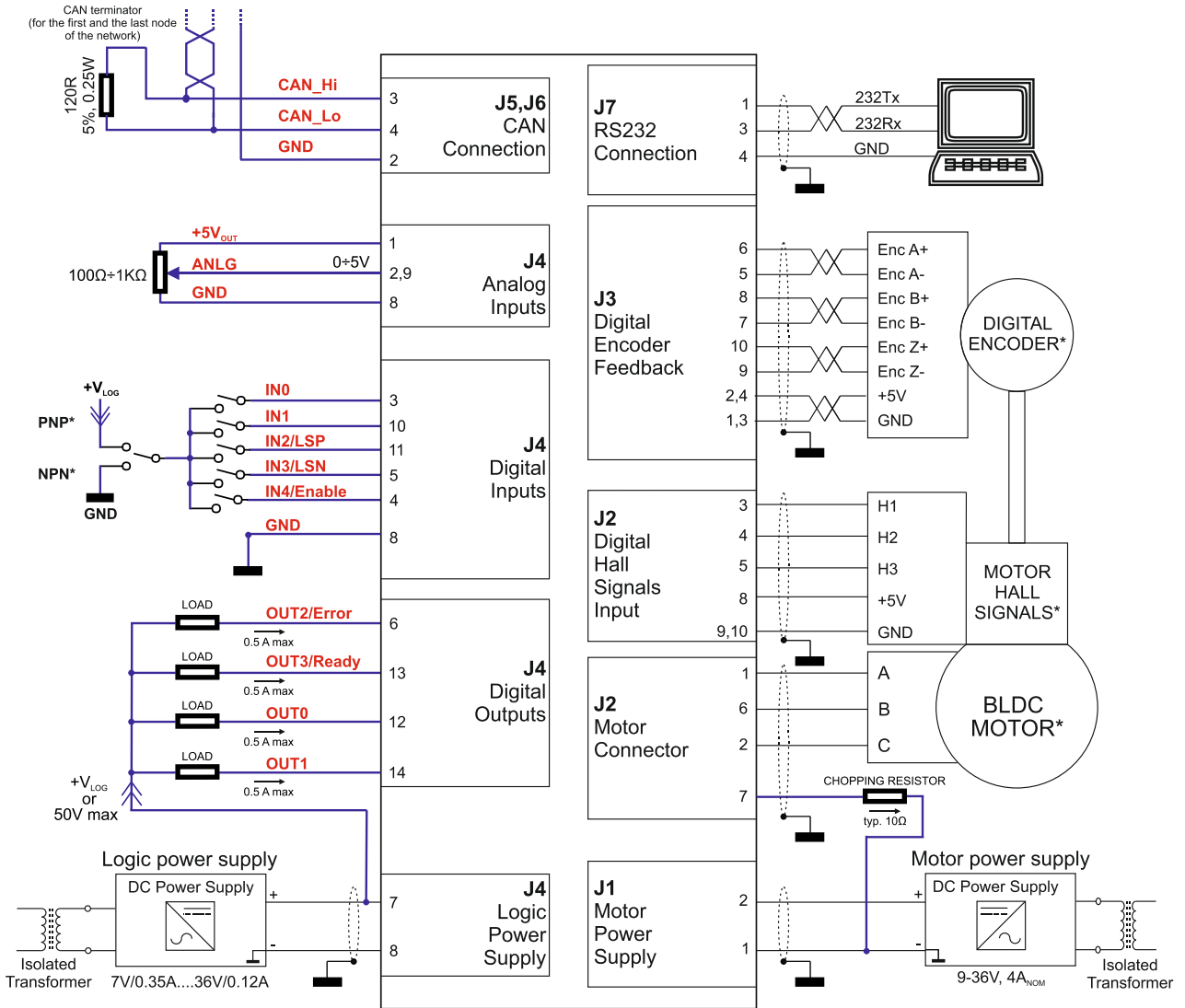

Figure 3.5.1. iPOS360X HX-CAN Connection diagram with a differential encoder

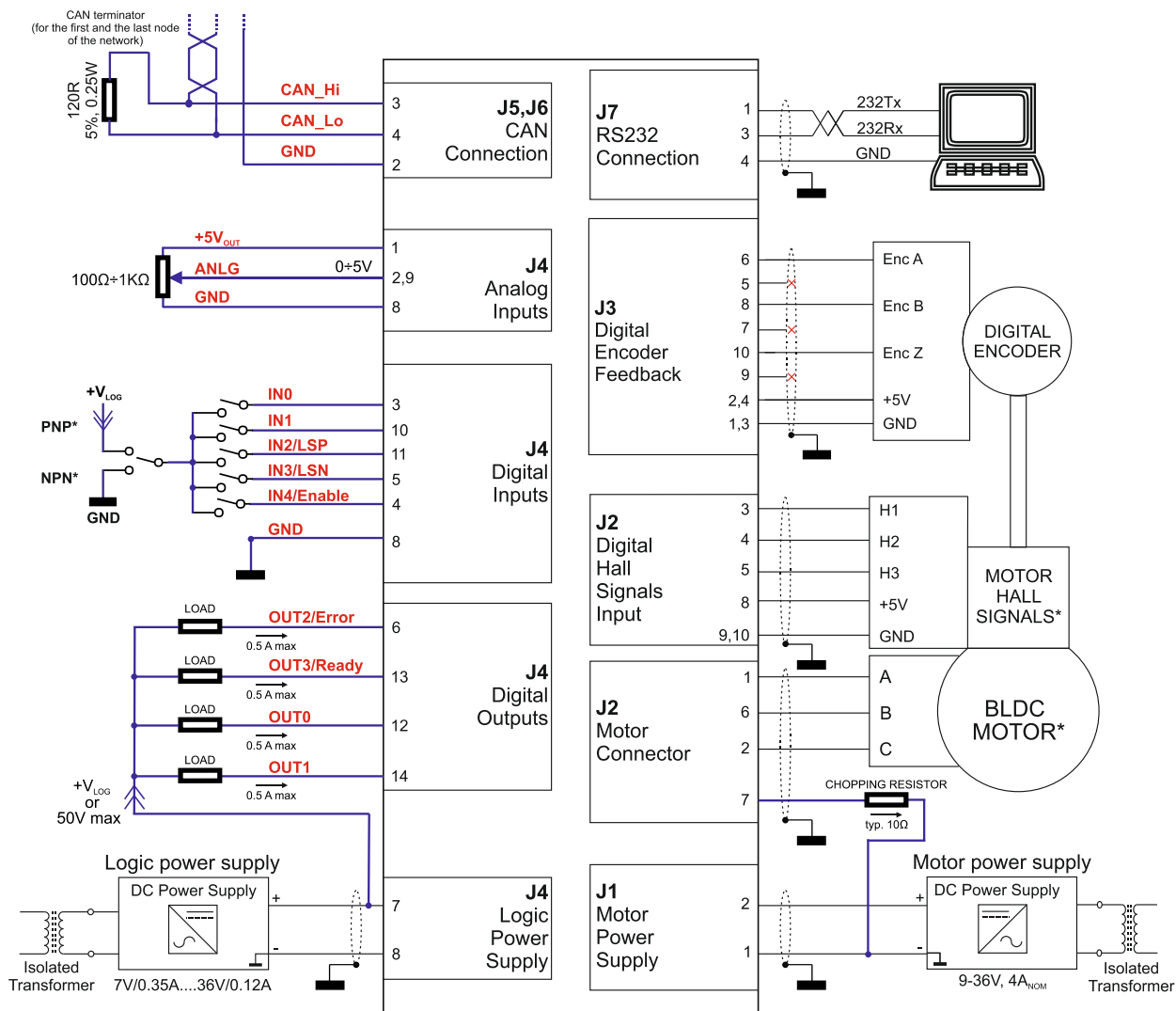* For other available feedback / motor options, check the detailed connection diagrams below

Figure 3.5.2 iPOS360X HX-CAN Connection diagram with a single-ended encoder

* For other available feedback / motor options, check the detailed connection diagrams below
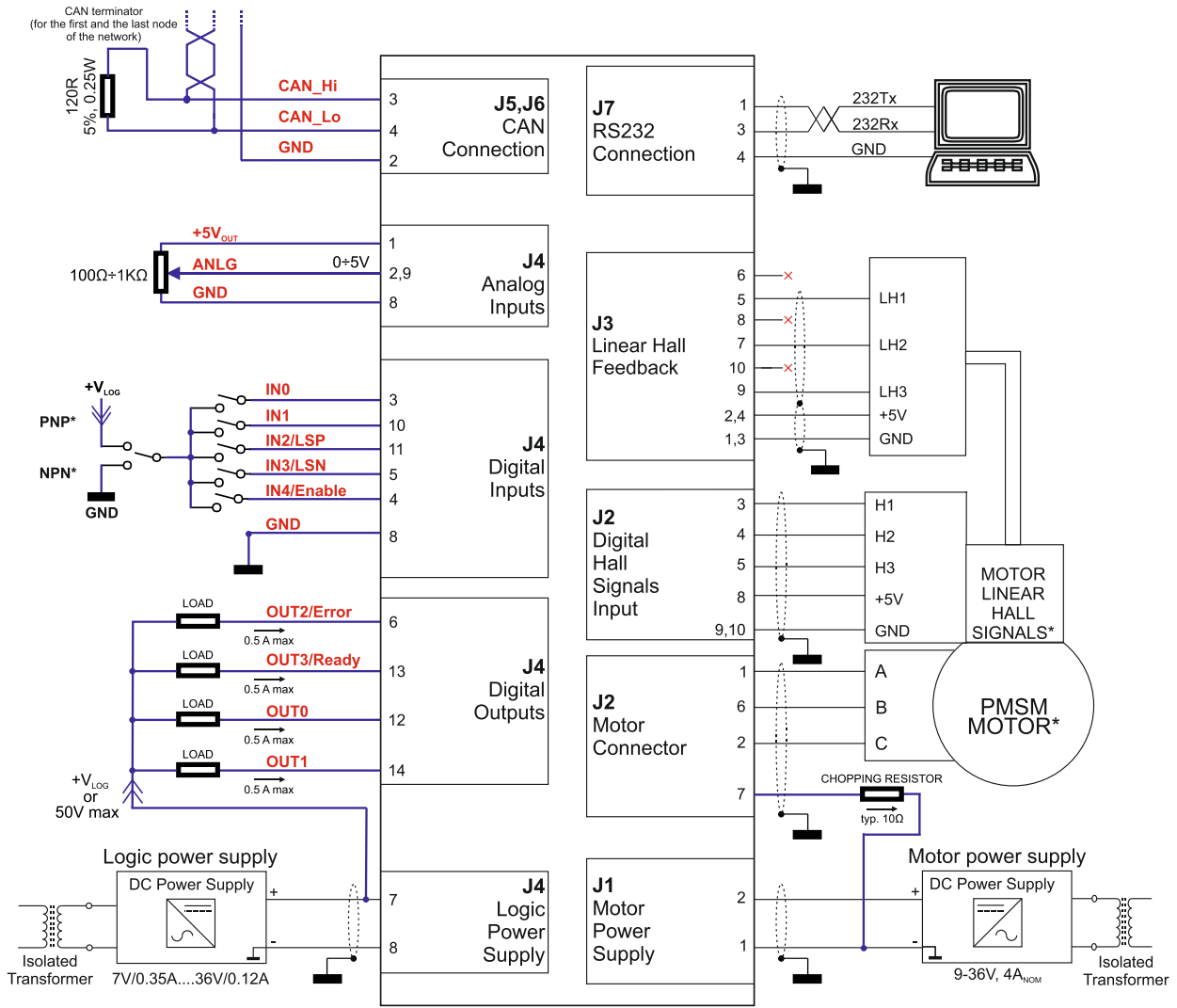
Figure 3.5.3 iPOS360X HX-CAN Connection diagram with a linear halls encoder

* For other available feedback / motor options, check the detailed connection diagrams below

3.5.4   24V Digital I/O Connection

3.5.4.1   PNP inputs
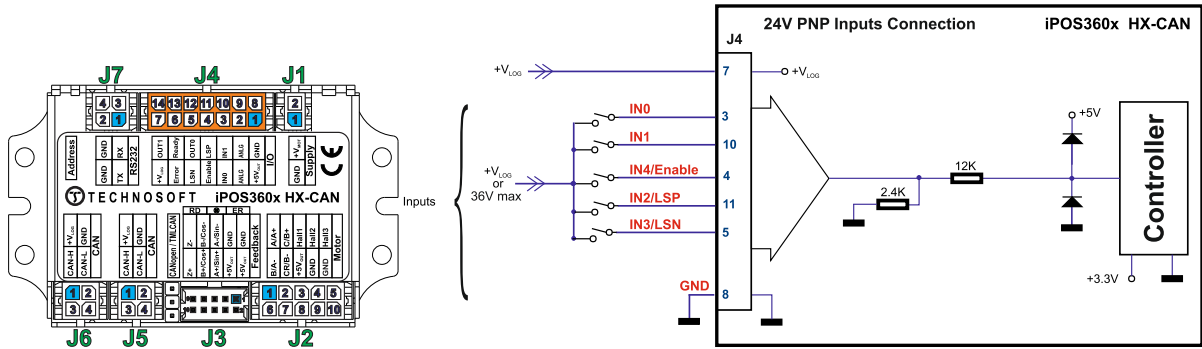

Figure 3.5.4.1 24V Digital PNP Inputs connection

Remarks:

1. *If Vlog is not supplied, the digital inputs will not work.*
2. *The inputs are selectable as PNP/ NPN by software.*
3. *When sets as PNP, the inputs are compatible with PNP type outputs (input must receive a positive voltage value (5-36V) to change its default state)*
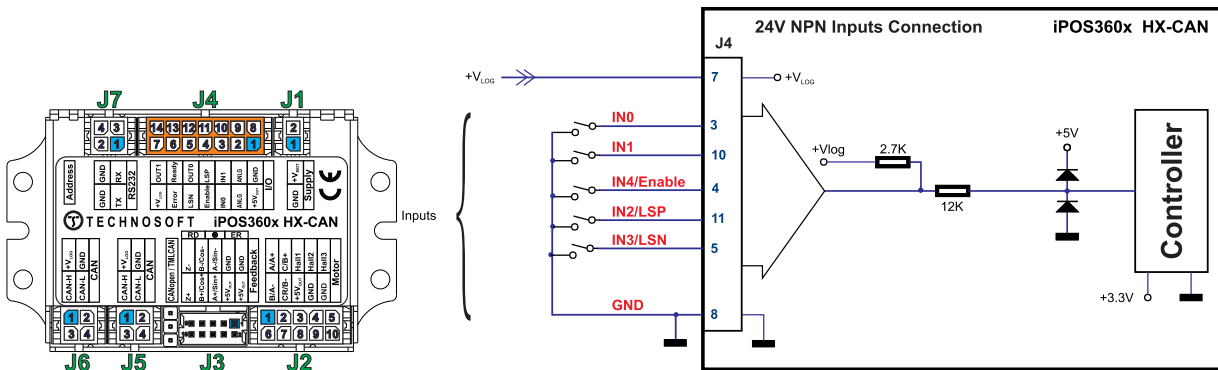
3.5.4.2   NPN inputs

Figure 3.5.4.2. 24V Digital NPN Inputs connection

Remarks:

1. *If Vlog is not supplied, the digital inputs will not work.*
2. *The inputs are selectable as PNP/ NPN by software.*
3. *When sets as NPN, the inputs are compatible with NPN type outputs (input must be pulled to GND to change its default state)*
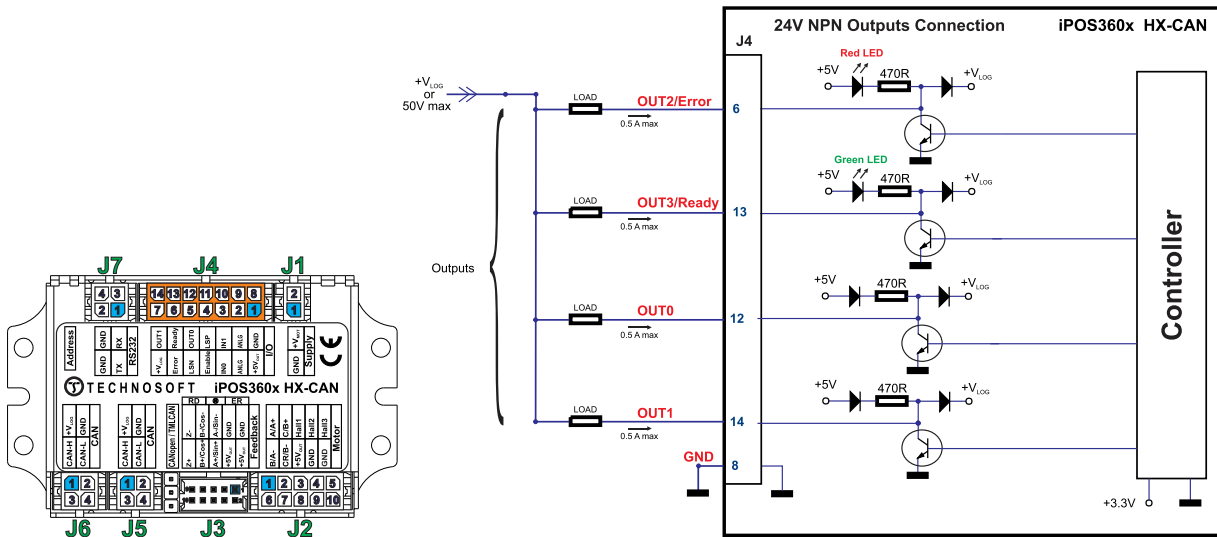
3.5.4.3 NPN outputs

Figure 3.5.4.3. 24V Digital NPN Outputs connection

Remarks:

1. *The outputs are compatible with NPN type inputs (load is tied to common +VLOG, output pulls to GND when active and is floating when inactive)*
2. *The outputs are NOT compatible with PNP inputs! Even if it seems to work, proper operation is NOT guaranteed!*
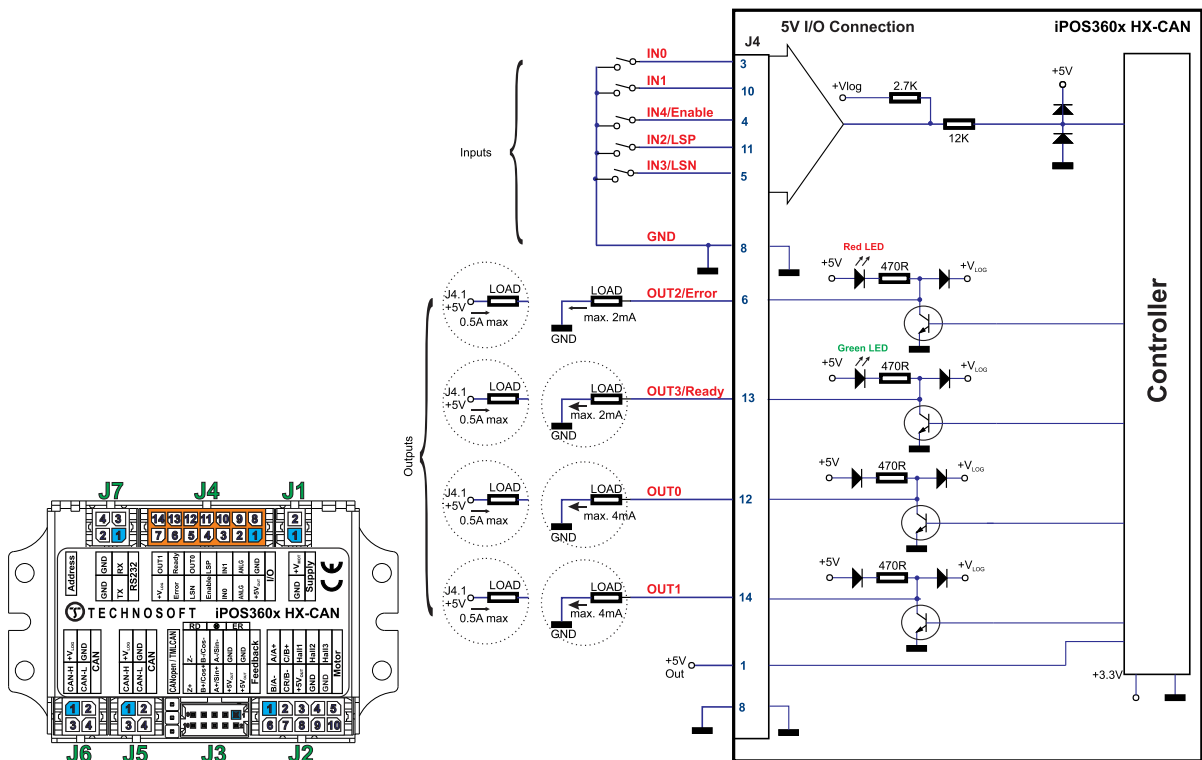
3.5.5 5V Digital I/O Connection

Figure 3.5.5.1 5V Digital I/O connection

Remarks:

1. *The inputs are selectable as PNP/ NPN by software. For this connection they are selected as NPN.*
2. *The inputs are compatible with TTL(5V), LVTTL(3.3V), CMOS and open collector outputs*
3. *The outputs are compatible with TTL (5V) inputs*
4. *The output loads can be individually and independently connected to +5V or to GND.*

3.5.6 Analog Inputs Connection
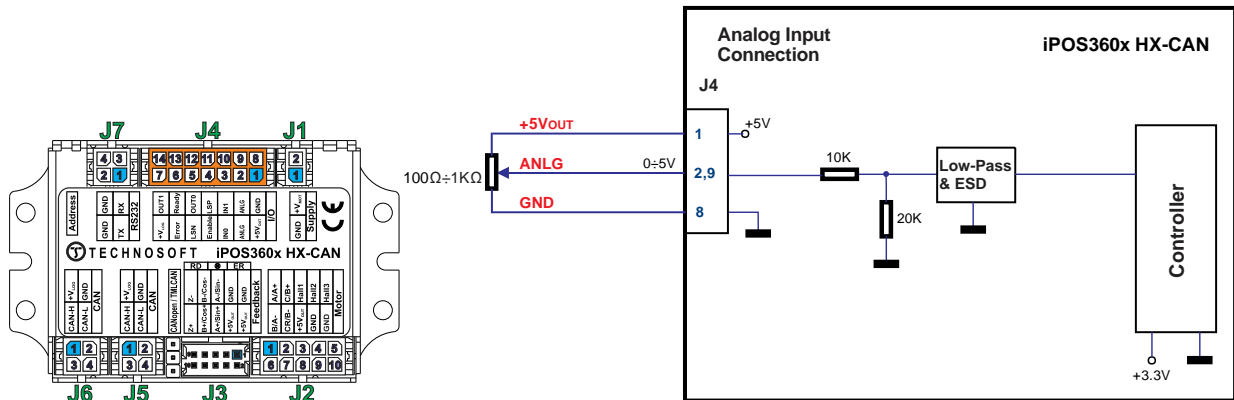
3.5.6.1 0-5V Input Range

Figure 3.5.6.1 *0-5V* Analog inputs connection

Remarks:

1. The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.
2. Default input range for analog inputs is 0÷5 V for REF and FBDK. For a +/-10 V range, see **Figure 3.7**.
3. Analog input is found in EasyMotion Studio as AD2 and AD5 variables.

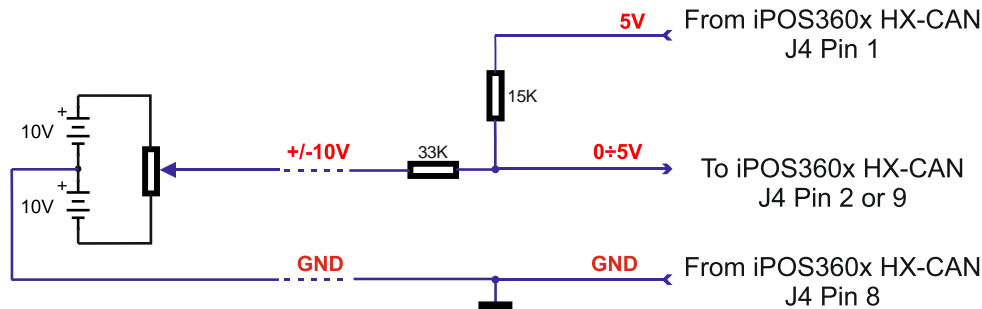#### 3.5.6.2 +/-10V to 0-5V Input Range Adapter

Figure 3.5.6.2. *+/-10V to 0-5V adapter*

Equivalent input impedance is 43Kohm. Floating input voltage is 3.3V. For best TML conversion, use the following parameters: RFOFSSET=3072=0x0C00; RFGAIN=34873=0x8839 in your project file.

3.5.6.3 Recommendation for wiring

a) If the analogue signal source is single-ended, use a 2-wire twisted shielded cable as follows: 1st wire connects the live signal to the drive input; 2nd wire connects the source ground to the drive ground; shield will be connected to the drive ground terminal.
b) If the analogue signal source is differential and the signal source ground is isolated from the drive GND, use a 2-wire twisted shielded cable as follows: 1st wire connects the source plus (positive, in-phase) to the drive analogue input; 2nd wire connects the source minus (negative, out-of-phase) to the drive ground (GND). Shield is connected only at the drive side, to the drive GND, and is left unconnected at the source side.
c) If the analogue signal source is differential and the signal source ground is common with the drive GND, use a 2-wire shielded cable as follows: 1st wire connects the source plus (positive, in-phase) to the drive analogue input; 2nd wire connects the source ground to the drive ground (GND); shield is connected only at the drive side, to the drive GND, and is left unconnected at the source side. The source minus (negative, out-of-phase) output remains unconnected.

3.5.7 Motor connections

3.5.7.1 Brushless Motor connection
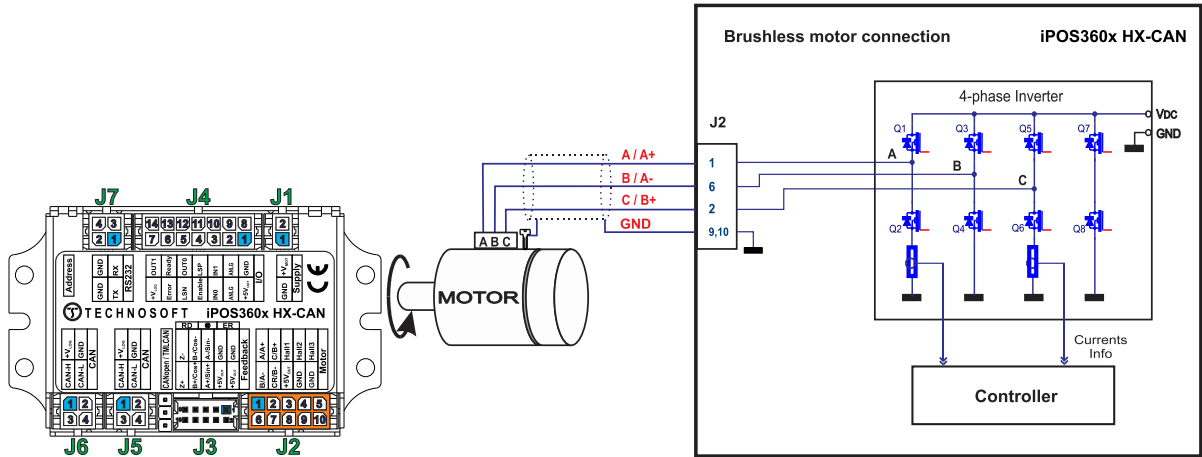

Figure 3.5.7.1. Brushless motor connection

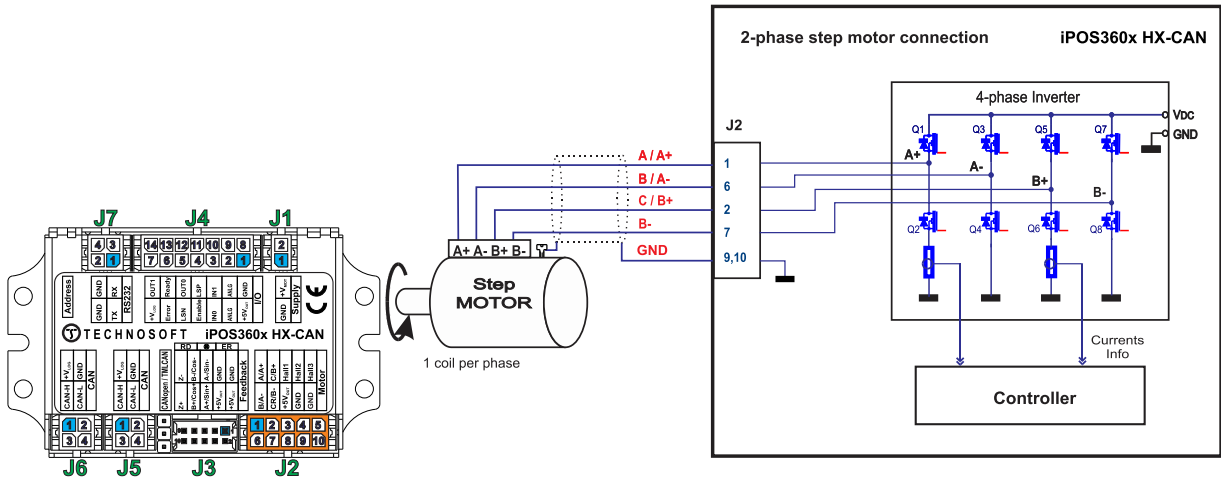#### 3.5.7.2 2-phase Step Motor connection

Figure 3.5.7.2. 2-phase step motor connection, one coil per phase
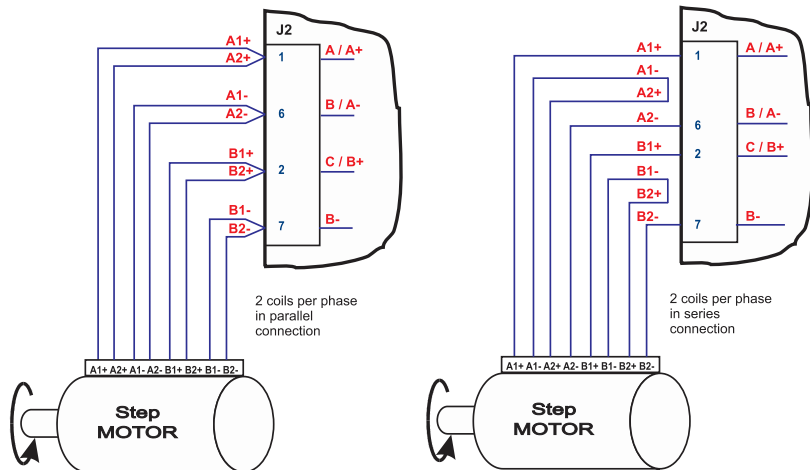

Figure 3.5.7.3 2-phase step motor connection, two coils per phase
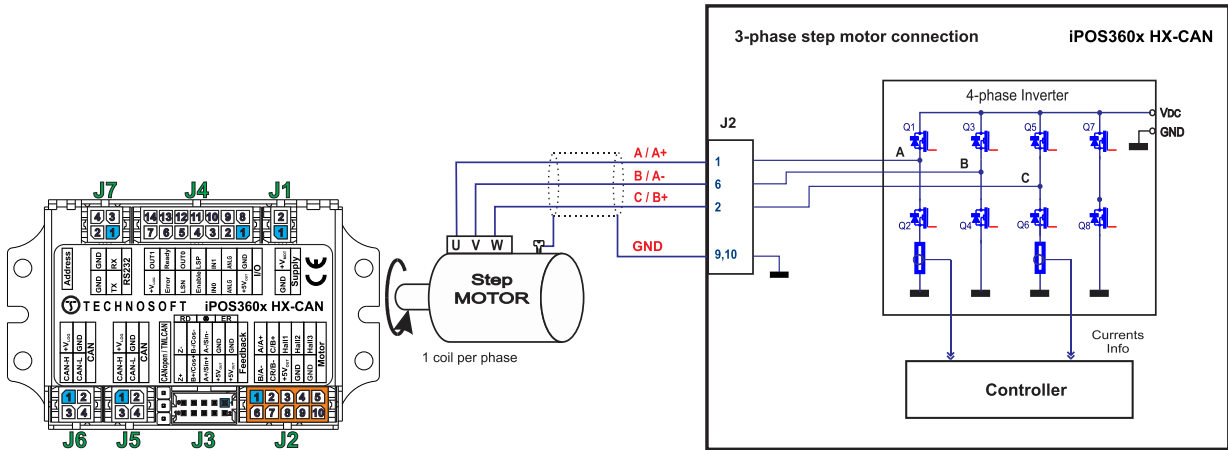
3.5.7.3   3-Phase Step Motor connection

Figure 3.5.7.4 3-phase step motor connection

3.5.7.4   DC Motor connection
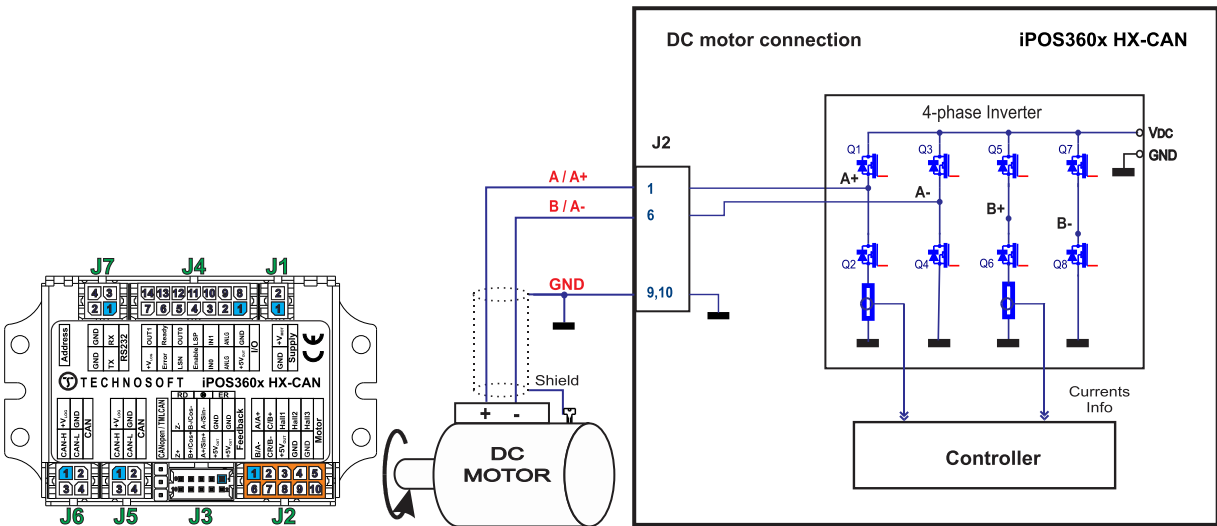
Figure 3.5.7.5 DC Motor connection

3.5.7.5   Recommendations for motor wiring

a) Avoid running the motor wires in parallel with other wires for a distance longer than 2 meters. If this situation cannot be avoided, use a shielded cable for the motor wires. Connect the cable shield to the iPOS360X GND pin. Leave the other end disconnected.

b) The parasitic capacitance between the motor wires must not bypass 10nF. If very long cables (tens of meters) are used, this condition may not be met. In this case, add series inductors between the iPOS360X outputs and the cable. The inductors must be magnetically shielded (toroidal, for example), and must be rated for the motor surge current. Typically the necessary values are around 100 µH.

c) A good shielding can be obtained if the motor wires are running inside a metallic cable guide.

3.5.8   Feedback connections

3.5.8.1   Single-ended Incremental Encoder Connection (only with P028.00x.E561)

Figure 3.5.8.1 Single-ended incremental encoder connection

*Optional resistors: value should match the current capability of the actual encoder outputs (please also consider the on-board existing 2K2). Lower resistance increases EMC immunity and robustness against electrical noise. Too low resistance can damage the encoder, and alter the logic-low voltage level.

⚠	CAUTION!	*DO NOT CONNECT UNTERMINATED WIRES. THEY MIGHT PICK UP UNWANTED NOISE AND GIVE FALSE ENCODER READINGS.*

3.5.8.2   Differential Incremental Encoder Connection (only with P028.00x.E501)
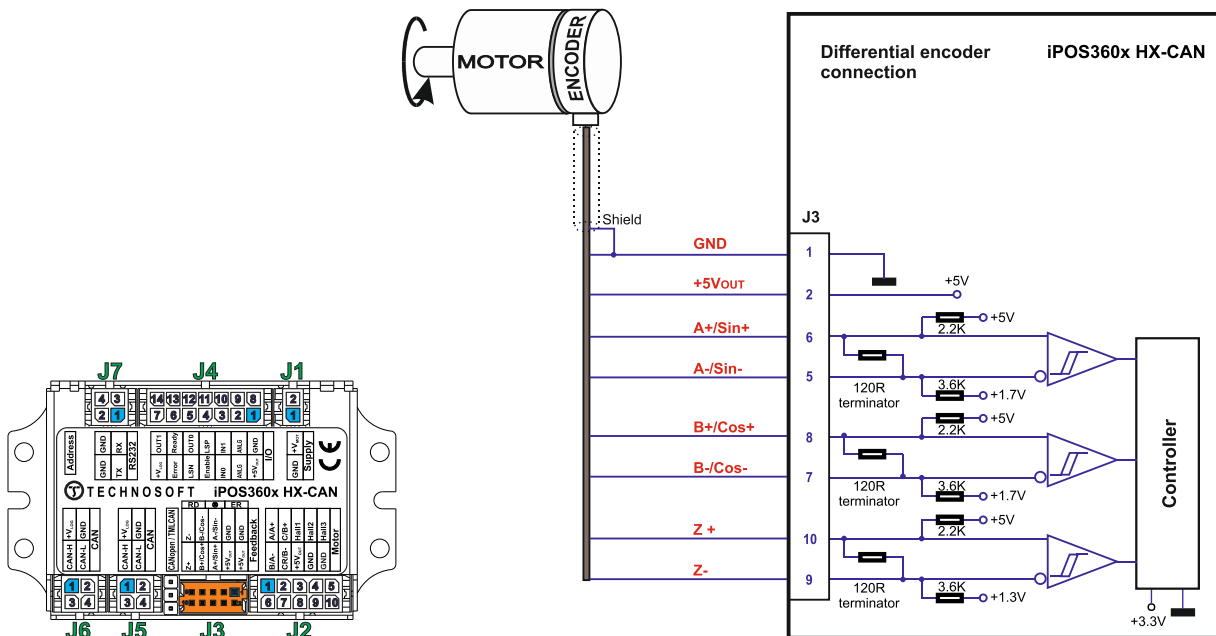
Figure 3.5.8.2. Differential incremental encoder connection

Remarks:

1. *For the encoder differential connection, 120Ω (0.25W) terminators are included in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.5.8.3 Digital Hall Connection for Motor + Hall + Incremental Encoder

Figure 3.5.8.3 Digital Hall connection + Incremental Encoder

Remarks:

1. *This connection is required when using Hall start method BLDC or PMSM and also for the Trapezoidal commutation method.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.5.8.4 Digital Hall Connection for direct motor control without an encoder (only with P028.00x.E561)

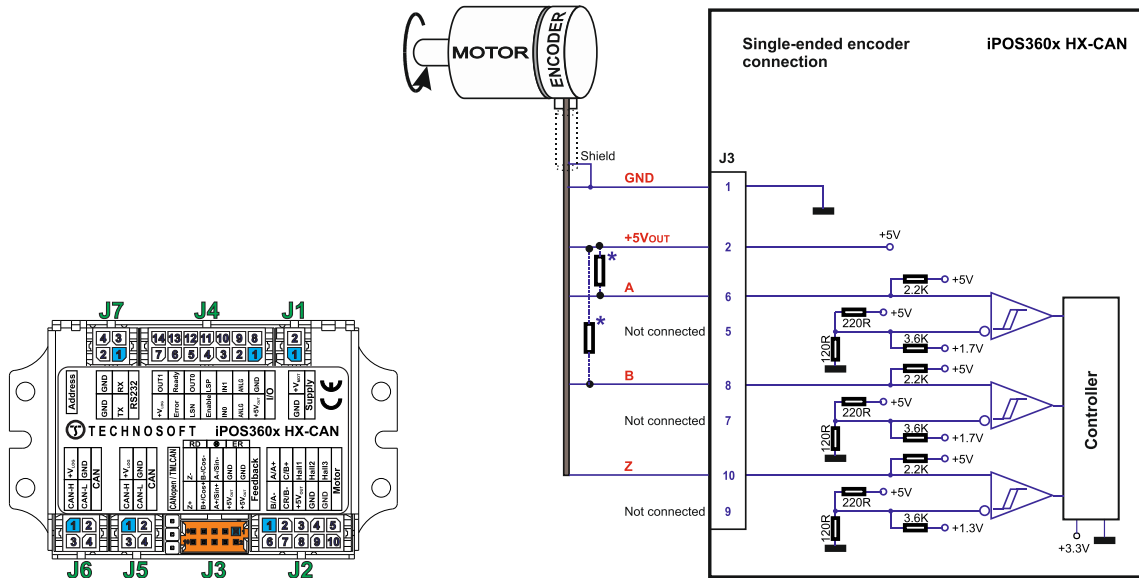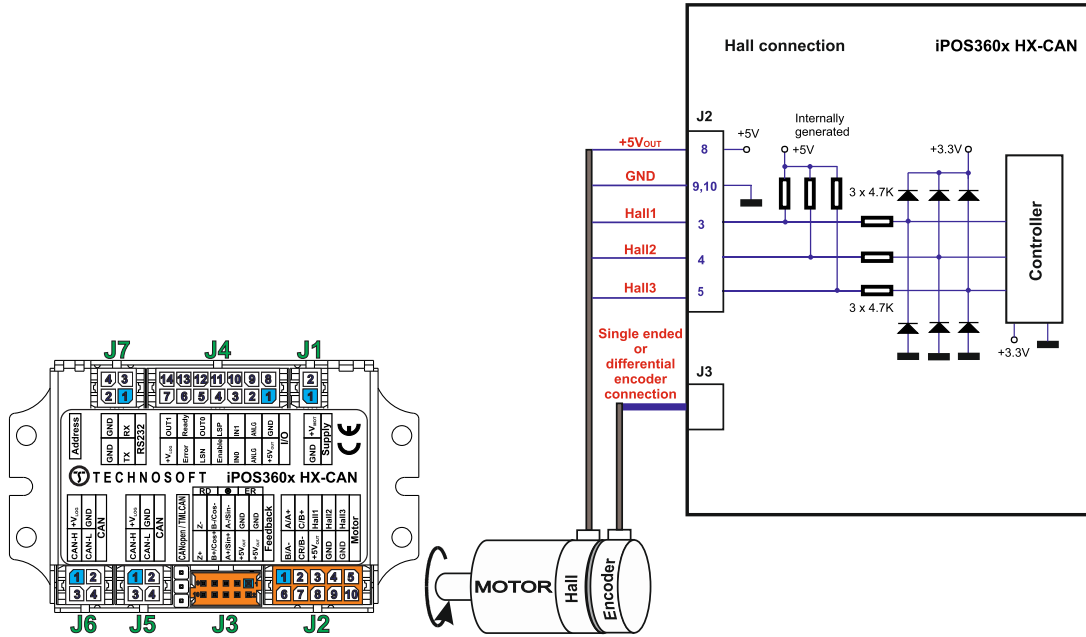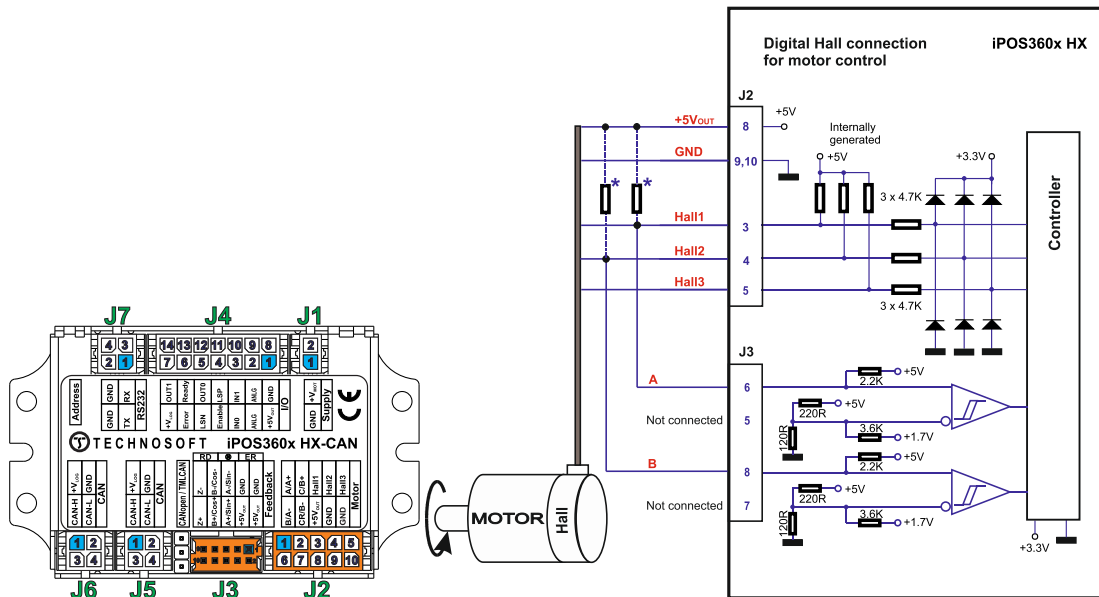**Figure 3.5.8.4** Digital Hall connection

*Optional resistors: value should match the current capability of the actual encoder outputs (please also consider the on-board existing 2K2 and 4K7). Lower resistance increases EMC immunity and robustness against electrical noise. Too low resistance can damage the encoder, and alter the logic-low voltage level.

Remarks:

1. *This connection is required when using only Digital hall signals as the main feedback device for motor control. In this case, no incremental encoder is needed.*
2. *Do not connect unterminated wires. They might pick up unwanted noise and give false encoder readings.*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
4. *For this type of motor control use firmware F523/F524 instead of F518x/F519x.*

3.5.8.5   Linear Hall Connection (only with P028.00x.E571)
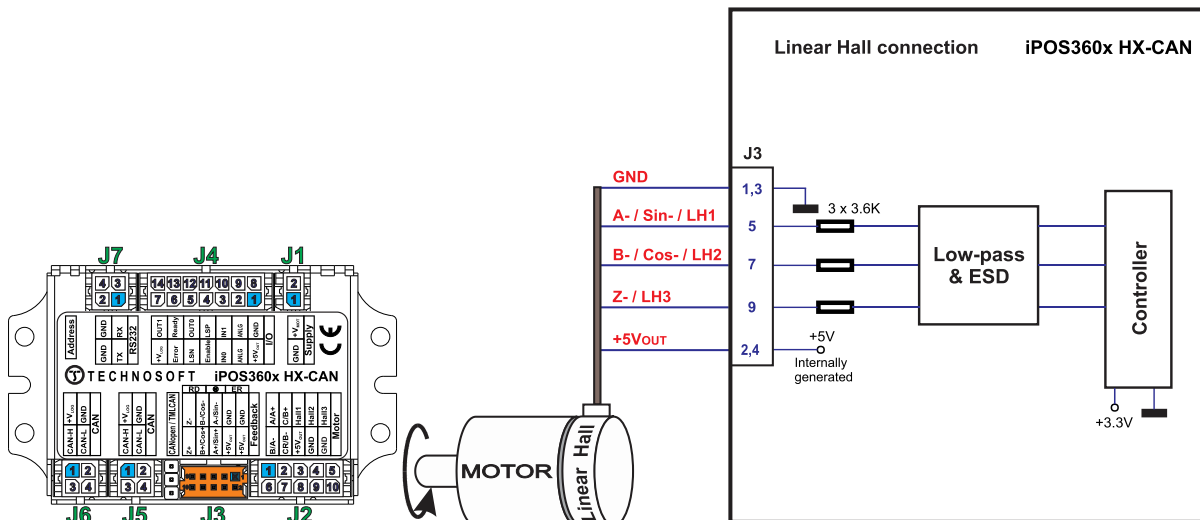
Figure 3.5.8.5 Linear Hall connection

3.5.8.6   Sin-Cosine Analog Encoder Connection (only with P028.00x.E501)
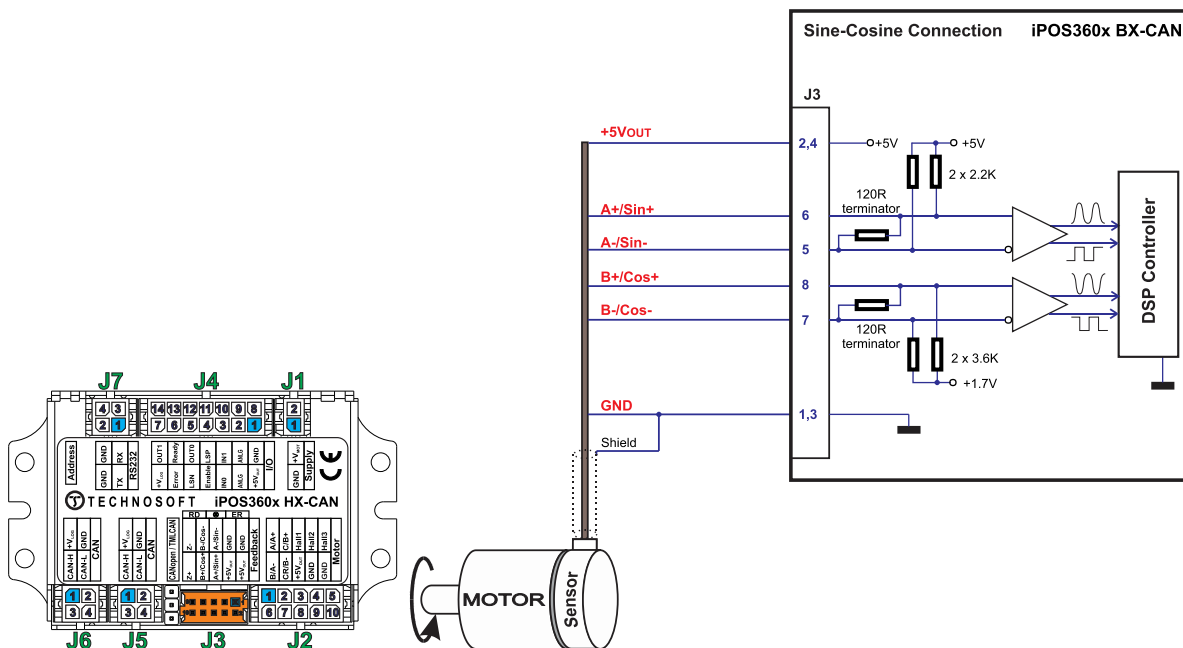
Figure 3.5.8.6 Sine-Cosine analog encoder connection

3.5.8.7   Recommendations for wiring

a) Always connect both positive and negative signals when the position sensor is differential and provides them. Use one twisted pair for each differential group of signals as follows: A+/Sin+ with A-/Sin-, B+/Cos+ with B-/Cos-, Z+ with Z-. Use another twisted pair for the 5V supply and GND.

b) Always use shielded cables to avoid capacitive-coupled noise when using single-ended encoders or Hall sensors with cable lengths over 1 meter. Connect the cable shield to the GND, at only one end. This point could be either the iPOS360x (using the GND pin) or the encoder / motor. Do not connect the shield at both ends.

c) If the iPOS360x 5V supply output is used by another device (like for example an encoder) and the connection cable is longer than 5 meters, add a decoupling capacitor near the supplied device, between the +5V and GND lines. The capacitor value can be 1...10 µF, rated at 6.3V

3.5.9 Power Supply Connection

3.5.9.1 Supply Connection

Figure 3.5.9.1 Supply connection

⚠	**CAUTION!**	*The logic power supply requires a minimum rising slew-rate of 75V/s in order to correctly sample the operation mode and AxisID settings. The drive starts to operate from 4.9V and samples correctly the AD circuit from 7V.*

3.5.9.2 Recommendations for Supply Wiring

Always provide a nearby capacitor on the motor supply lines. The capacitor should be located within 10cm of the iPOS360x edge connector, max. 20cm. The minimum recommended capacitance is 330µF for iPOS3604, or 220µF for iPOS3602, always rated at the appropriate voltage.
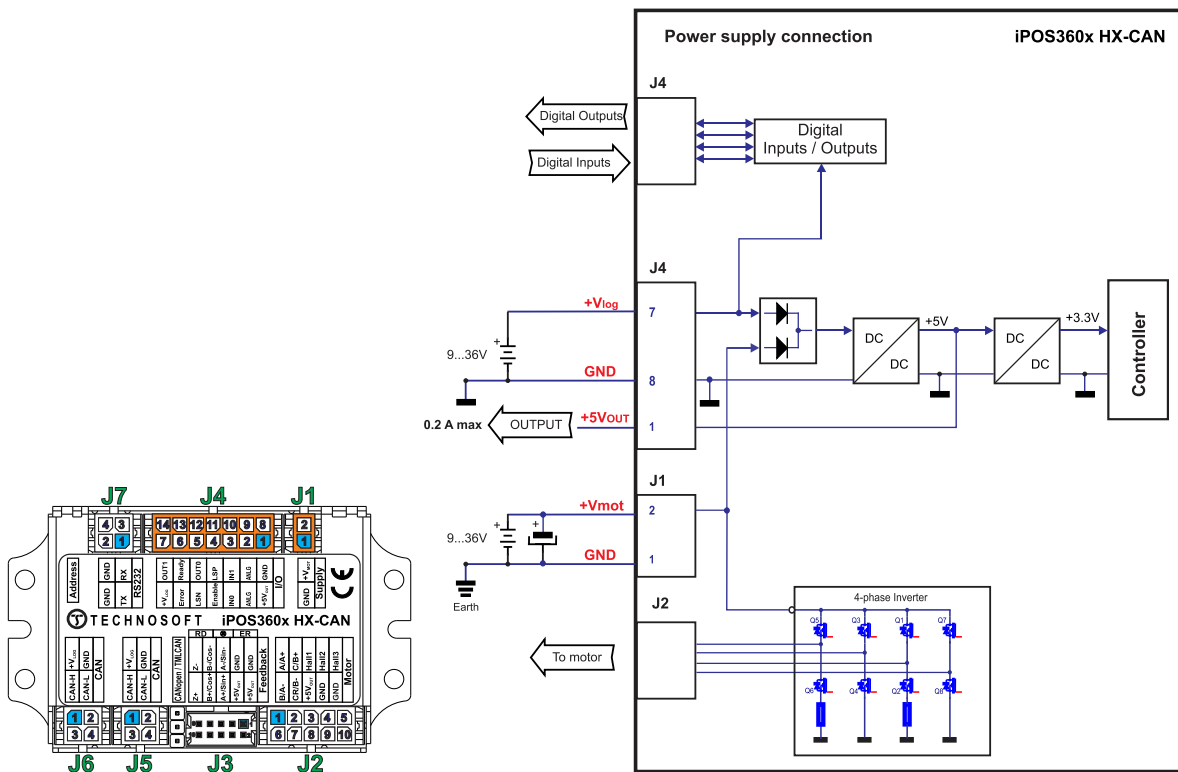
Use short, thick wires between the iPOS360x and the motor power supply. Connect power supply wires to all the indicated pins. If the wires are longer than 2 meters, use twisted wires for the supply and ground return. For wires longer than 20 meters, add a capacitor of at least 2,200µF (rated at an appropriate voltage) right on the terminals of the iPOS3604, respectively 1,000µF for the iPOS3602.

3.5.9.3 Recommendations to limit over-voltage during energy regeneration

During abrupt motion decelerations or reversals the regenerative energy is injected into the motor power supply. This may cause an increase of the motor supply voltage (depending on the power supply characteristics). If the voltage gets higher than 39V, the drive over-voltage protection is triggered and the drive power stage is disabled. In order to avoid this situation you have 2 options:

Option 1. Add a capacitor on the motor supply big enough to absorb the overall energy flowing back to the supply. The capacitor must be rated to a voltage equal or bigger than the maximum expected over-voltage and can be sized with the formula:

$$C \geq \frac{2 \times E_M}{U_{MAX}^2 - U_{NOM}^2}$$

where:

        U$_{MAX}$ = 40V is the over-voltage protection limit

        U$_{NOM}$ is the nominal motor supply voltage

E_M = the overall energy flowing back to the supply in Joules. In case of a rotary motor and load, E_M can be computed with the formula:

$$E_M = \frac{1}{2}\underbrace{(J_M + J_L)\varpi_M^2}_{\text{Kinetic energy}} + \underbrace{(m_M + m_L)g(h_{initial} - h_{final})}_{\text{Potential energy}} - \underbrace{3I_M^2 R_{Ph} t_d}_{\text{Copper losses}} - \underbrace{\frac{t_d \varpi_M}{2} T_F}_{\text{Friction losses}}$$

where:

J_M – total rotor inertia [kgm²]

J_L – total load inertia as seen at motor shaft after transmission [kgm²]

ϖ_M – motor angular speed before deceleration [rad/s]

m_M – motor mass [kg] – when motor is moving in a non-horizontal plane

m_L – load mass [kg] – when load is moving in a non-horizontal plane

g – gravitational acceleration i.e. 9.8 [m/s²]

$h_{initial}$ – initial system altitude [m]

h_{final} – final system altitude [m]

I_M – motor current during deceleration [ARMS/phase]

R_{Ph} – motor phase resistance [Ω]

t_d – time to decelerate [s]

T_F – total friction torque as seen at motor shaft [Nm] – includes load and transmission

In case of a linear motor and load, the motor inertia J_M and the load inertia J_L will be replaced by the motor mass and the load mass measured in [kg], the angular speed ϖ_M will become linear speed measured in [m/s] and the friction torque T_F will become friction force measured in [N].

Option 2. Connect a chopping resistor R_{CR} between phase CR/B- and ground, and activate the software option of dynamic braking (see below).

This option is not available when the drive is used with a step motor.

The chopping resistor option can be found in the Drive Setup dialogue within EasyMotion / EasySetup.
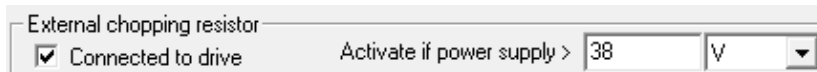
The chopping will occur when DC bus voltage increases over U_CHOP. This parameter (U_CHOP) should be adjusted depending on the nominal motor supply. Optimally (from a braking point of view), U_CHOP should be a few volts above the maximum nominal supply voltage. This setting will activate the chopping resistor earlier, before reaching dangerous voltages – when the over-voltage protection will stop the drive. Of course, U_CHOP must always be less than U_MAX – the over-voltage protection threshold.

Remark: *This option can be combined with an external capacitor whose value is not enough to absorb the entire regenerative energy E_M but can help reducing the chopping resistor size.*

Chopping resistor selection

The chopping resistor value must be chosen to respect the following conditions:

1. to limit the maximum current below the drive peak current I_PEAK = 3.2A for iPOS3602 and I_PEAK = 10A for iPOS3604.

$$R_{CR} > \frac{U_{MAX}}{I_{PEAK}}$$

2. to sustain the required *braking power*:

$$P_{CR} = \frac{E_M - \frac{1}{2}C(U_{MAX}^2 - U_{CHOP}^2)}{t_d}$$

where C is the capacitance on the motor supply (external), i.e:

$$R_{CR} < \frac{U_{CHOP}^2}{2 \times P_{CR}}$$

3. to limit the average current below the drive nominal current I_NOM=2A for iPOS3602 and 4A for iPOS3604

$$R_{CR} > \frac{P_{CR} \times t_d}{t_{CYCLE} \times I_{NOM}^2}$$

where t_{CYCLE} is the time interval between 2 voltage increase cycles in case of repetitive moves.

4.   to be rated for an average power $P_{AV} = \dfrac{P_{CR} \times t_d}{t_{CYCLE}}$ and a peak power $P_{PEAK} = \dfrac{U_{MAX}^2}{R_{CR}}$

Remarks:

1.   *If* $\dfrac{U_{MAX}}{I_{PEAK}} > \dfrac{U_{CHOP}^2}{2 \times P_{CR}}$ *the braking power P_{CR} must be reduced by increasing either t_d – the time to decelerate*
    or C – the external capacitor on the motor supply

2.   *If* $\dfrac{P_{CR} \times t_d}{t_{CYCLE} \times I_{NOM}^2} > \dfrac{U_{CHOP}^2}{2 \times P_{CR}}$ *either the braking power must be reduced (see Remark 1) or t_{CYCLE} – the time*
    interval between braking cycles must be increased

	WARNING!	*THE CHOPPING RESISTOR MAY HAVE HOT SURFACES DURING OPERATION.*

3.5.10   Serial RS-232 connection

3.5.10.1   Serial RS-232 connection
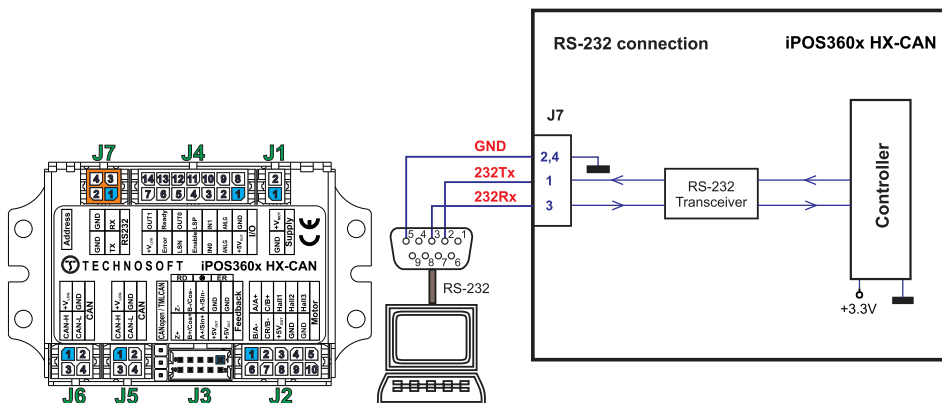
Figure 3.5.10.1. Serial RS-232 connection

3.5.10.2   Recommendation for wiring

a)   If you build the serial cable, you can use a 3-wire shielded cable with shield connected to BOTH ends. Do not use the shield as GND. The ground wire must be included inside the shield, like the 232Rx and 232Tx signals
b)   Always power-off all the iPOS360X supplies before inserting/removing the RS-232 serial connector
c)   Do not rely on an earthed PC to provide the iPOS360X GND connection! The drive must be earthed through a separate circuit. Most communication problems are caused by the lack of such connection

3.5.11   CAN-bus connection
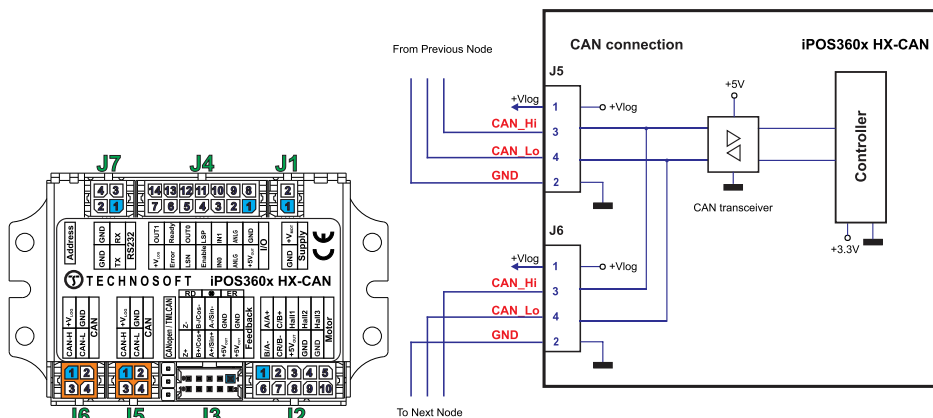
Figure 3.5.11.1 CAN connection

Remarks:

1. *The CAN network requires a 120-Ohm terminator. This is not included in the drive. Figure 3.26 shows how to connect it on your network*
2. *CAN signals can sustain up to +/-36V without damage.*

3.5.11.1 Recommendation for wiring

a) Build CAN network using cables with twisted wires (2 wires/pair), with CAN-Hi twisted together with CAN-Lo. It is recommended but not mandatory to use a shielded cable. If so, connect the shield to GND. The cable impedance must be 105 ... 135 ohms (120 ohms typical) and a capacitance below 30pF/meter.

b) Whenever possible, use daisy-chain links between the CAN nodes. Avoid using stubs. A stub is a "T" connection, where a derivation is taken from the main bus. When stubs can't be avoided keep them as short as possible. For 1 Mbit/s (worst case), the maximum stub length must be below 0.3 meters.

c) The 120Ω termination resistors must be rated at 0.2W minimum. Do not use winded resistors, which are inductive.
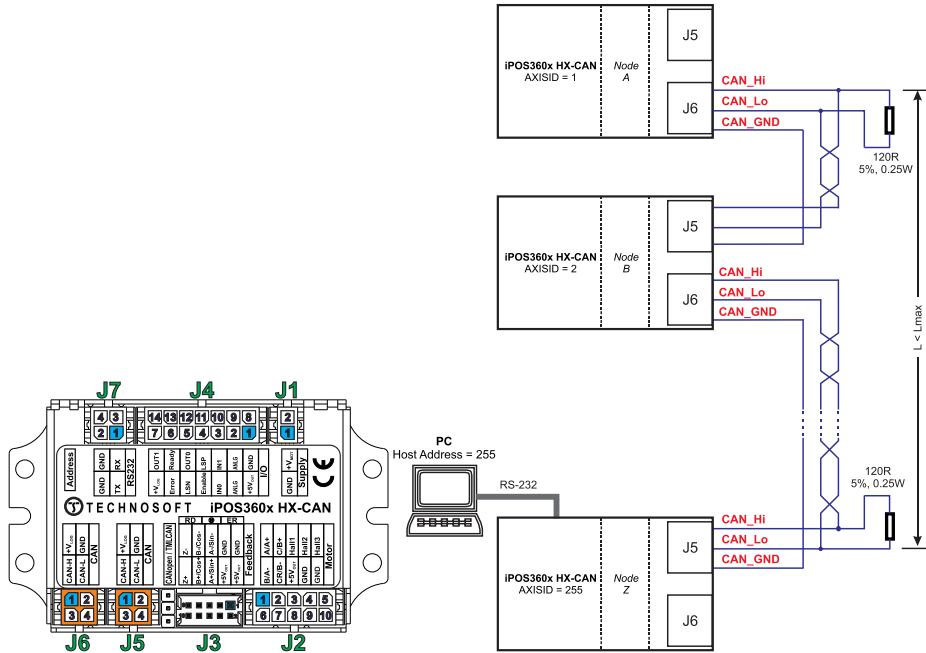
Figure 3.5.11.2 Multiple-Axis CAN network

3.5.12 Disable of Autorun Mode
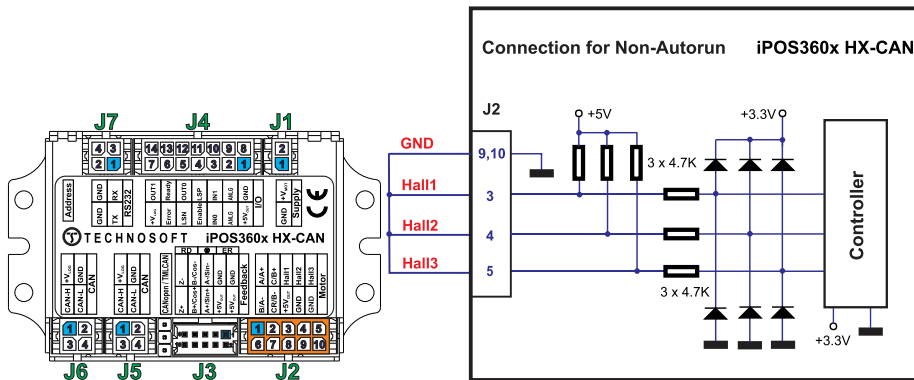
Figure 3.5.12.1 Temporary *c*onnection during power-on to disable the drive from Autorun mode

When the iPOS360x is configured for TMLCAN communication protocol, the default operation mode is *Autorun*. If a TML program is present in the EEPROM of the drive, the iPOS360x will start its execution.

In case the TML program becomes corrupted, i.e. due to strong electromagnetic fields, the *Autorun* mode can be disabled by:

a) Software: writing the value **1** in the first EEPROM location (address 0x4000). You can use the *Command Interpreter* from EasySetUp / EasyMotion Studio to execute the following instructions:

var_i1 = 0x4000; (var_i1), spi = 1;

b) Hardware:

    a. connecting all digital Hall inputs to GND, as shown in **Figure 3.23**. This option is particularly useful when you are unable to establish communication with the drive.

    b. temporarily connect JP1 in position 1-2 to switch to CANopen protocol. After a drive restart, the drive will not auto-run any program while in CANopen. Reconfigure the settings as needed and switch back to TMLCAN.

After the drive is set in *slave / non-Autorun* mode using the second method, the first one may be used to disable the TML application from the EEPROM. On next power on the drive will enter in the *slave / non-Autorun* mode independently of the digital Hall inputs status

3.6 CAN Operation Mode and Axis ID Selection

3.6.1 Selection of the Operation Mode

On iPOS360x HX-CAN, the selection of the operation mode CANopen or TMLCAN is done by setting the JP1 position:

- CANopen mode, JP1 = position 1-2
- TMLCAN mode, JP1 = position 2-3 or OFF
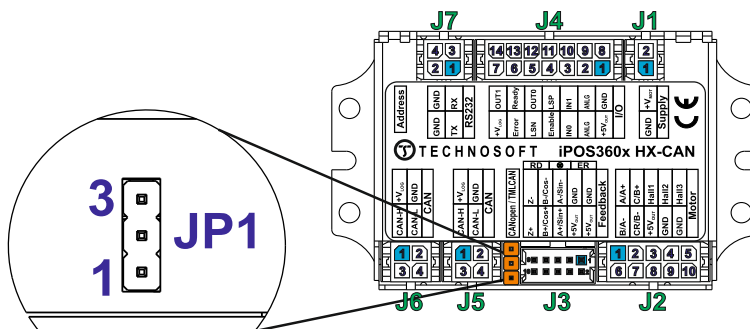
Figure 3.6.1.1 JP1 Location

3.6.2 Selection of the Axis ID

The Hardware Axis ID selection is done through the hex switch SW1. It contains numbers from 0x0 to 0xF. Depending on SW1 position, the axis ID will be:
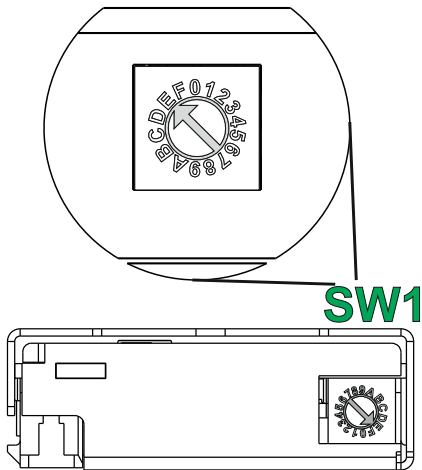
Figure 3.6.2.1 SW1 Location

SW1 position	AxisID
0x0	255
0x1	1
0x2	2
0x3	3
0x4	4
0x5	5
0x6	6
0x7	7
0x8	8
0x9	9
0xA	10
0xB	11
0xC	12
0xD	13
0xE	14
0xF	15

3.6.3 LED indicators
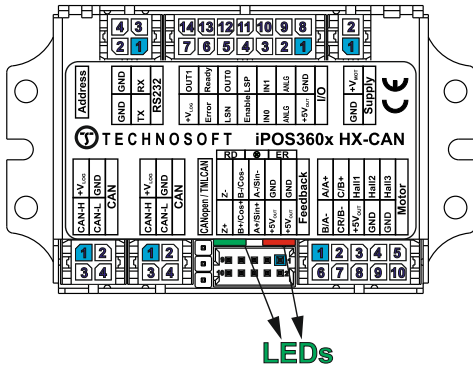
Figure **3.6.3.1 LED indicators**

*Table 3.6.3 – **LED indicators***

LED no.	LED name	LED color	Function
1	Drive Ready	green	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
2	Drive Error	red	Turned on when the drive detects an error condition or when OUT2/Error is set to +Vlog with OUT(2)=0 TML instruction.

3.7 Electrical Specifications

All parameters measured under the following conditions (unless otherwise specified):
T_{amb} = 0…40°C, V_{LOG} = 24 V_{DC}; V_{MOT} = 24V_{DC}; Supplies start-up / shutdown sequence: -*any*-
Load current (sinusoidal amplitude / continuous BLDC, DC ,stepper) = 4A iPOS3604/ 2A iPOS3602

3.7.1 Operating Conditions

		Min.	Typ.	Max.	Units
Ambient temperature	iPOS360X HX-CAN	0		+40	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[1]	Altitude (referenced to sea level)	-0.1	0 ÷ 2.5	[1]	Km
	Ambient Pressure	0 [1]	0.75 ÷ 1	10.0	atm

3.7.2 Storage Conditions

		Min.	Typ.	Max.	Units
Ambient temperature	iPOS360X HX-CAN	-40		85	ºC
Ambient humidity	Non-condensing	0		100	%Rh
Ambient Pressure		0		10.0	atm
ESD capability (Human body model)	Not powered; applies to any accessible part			±0.5	kV
	Original packaging			±15	kV

3.7.3 Mechanical Mounting

|		Min.	Typ.	Max.	Units
Airflow		natural convection, closed box			
Spacing required for vertical mounting	Between adjacent drives	30			mm
	Between drives and nearby walls	30			mm
	Between drives and roof-top	20			mm
Spacing required for horizontal mounting	Between adjacent drives	4			mm
	Between drives and nearby walls	5			mm
	Space needed for drive removal	10			mm
	Between drives and roof-top	15			mm
Insertion force	Using recommended mating connectors; without retainer		20	36	N
Extraction force		5	10		N

3.7.4 Environmental Characteristics

		Min.	Typ.	Max.	Units
iPOS360x HX-CAN Size (Length x Width x Height)	Without mating connectors		72.4 x 44.6 x 15.6		mm
			~2.85 x 1.75 x 0.61		inch
Weight			48		g
Power dissipation	Idle (no load)		1		W
	Operating		3	5	
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP00			-

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[1] iPOS360x can be operated in vacuum (no altitude restriction), but at altitudes over 2,500m, current and power rating are reduced due to thermal dissipation efficiency.

3.7.5 Supply Output (+5V)

		Min.	Typ.	Max.	Units
+5V output voltage	Current sourced = 350mA	4.8	5	5.2	V
+5V output current	iPOS360X HX-CAN	250	300		mA
Short-circuit protection		NOT protected			
Over-voltage protection		NOT protected			
ESD protection	Human body model	±1			kV

3.7.6 Logic Supply Input (+V_{LOG})

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	9	24	36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	5.9		39	V_{DC}
	Absolute maximum values, continuous	0		39	
	Absolute maximum values, surge (duration ≤ 10ms) †	0		+45	V
	Minimum power supply voltage rising slew-rate	75			V/s
Supply current	+V_{LOG} = 7V		125	300	mA
	+V_{LOG} = 12V		80	200	
	+V_{LOG} = 24V		50	125	
	+V_{LOG} = 40V		40	100	

3.7.7 Motor Supply Input (+V_{MOT})

			Min.	Typ.	Max.	Units
Supply voltage	Nominal values		9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters		8.5		40	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †		0		42	V
Supply current	Idle			1	5	mA
	Operating	iPOS3604	-10	±4	+10	A
		iPOS3602	-3.2	±2	+3.2	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †	iPOS3604			15	A
		iPOS3602			5	A

3.7.8 Motor Outputs (A/A+, B/A-, C/B+, CR/B-)

			Min.	Typ.	Max.	Units
Nominal output current, continuous	for DC brushed, steppers and BLDC motors with Hall-based trapezoidal control	iPOS3604			4	A
		iPOS3602			2	
	for PMSM motors with FOC sinusoidal control (sinusoidal amplitude value)	iPOS3604			4	
		iPOS3602			2	
	for PMSM motors with FOC sinusoidal control (sinusoidal effective value)	iPOS3604			2.82	
		iPOS3602			1.41	
Motor output current, peak	maximum 2.5s	iPOS3604	-10		+10	A
	maximum 24s	iPOS3602	-3.2		+3.2	
Short-circuit protection threshold	measurement range	iPOS3604		±13	±15	A
		iPOS3602		±4.3	±5	
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for ripple ±5% of measurement range; +V_{MOT} = 36 V	F_{PWM} = 20 kHz	250			µH
		F_{PWM} = 40 kHz	120			
		F_{PWM} = 60 kHz	100			
		F_{PWM} = 80 kHz	60			
		F_{PWM} = 100 kHz	45			
	Absolute minimum value, limited by short-circuit protection; +V_{MOT} = 36 V	F_{PWM} = 20 kHz	75			µH
		F_{PWM} = 40 kHz	25			
		F_{PWM} = 60 kHz	20			
		F_{PWM} = 80 kHz	10			
		F_{PWM} = 100 kHz	5			
Motor electrical time-constant (L/R)	Recommended value, for ±5% current measurement error due to ripple	F_{PWM} = 20 kHz	250			µs
		F_{PWM} = 40 kHz	125			
		F_{PWM} = 60 kHz	100			
		F_{PWM} = 80 kHz	63			
		F_{PWM} = 100 kHz	50			
Current measurement accuracy	FS = Full Scale			±4	±8	%FS

3.7.9 Analog 0..5V Input (ANLG)

			Min.	Typ.	Max.	Units
Input voltage	Operational range	0..5V mode	0		4.95	V
	Absolute maximum values, continuous		-12		+18	
	Absolute maximum, surge (duration ≤ 1s) [†]				±36	
Input impedance	To GND			30		kΩ
Resolution				12		bits
Integral linearity					±2	bits
Differential linearity	No missing codes				±1	bits
Offset error	Assuming parameter RFOFFSET=0			±2	±10	bits
Gain error	Assuming parameter RFGAIN=0x7EB8 (32440)			±1%	±3%	% FS[1]
Bandwidth (-3dB)	Software selectable		0		1	kHz
ESD protection	Human body model		±5			kV

3.7.10 Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4/Enable)

		Min.	Typ.	Max.	Units
Mode compliance	**PNP**				
Default state	Input floating (wiring disconnected)		Logic LOW		
Input voltage	Logic "LOW"		0	1.6	V
	Logic "HIGH"	1.8	24	39	
	Floating voltage (not connected)		0		
	Absolute maximum, continuous	-10		+39	
	Absolute maximum, surge (duration ≤ 1s) [†]	-20		+40	
Input current	Logic "LOW"; Pulled to GND		0		mA
	Logic "HIGH"		2.9	3.4	
Mode compliance	**NPN/ TTL / CMOS / LVTTL (3.3V) / Open-collector**				
Default state	Input floating (wiring disconnected)		Logic HIGH		
Input voltage	Logic "LOW"	2	5÷24		V
	Logic "HIGH"		3		
	Floating voltage (not connected)	-10		+30	
	Absolute maximum, continuous	-20		+40	
	Absolute maximum, surge (duration ≤ 1s) [†]	2	5÷24		
Input current	Logic "LOW"; Pulled to GND		0.6	9	mA
	Logic "HIGH"; Internal 2.7KΩ pull-up to +3.3	0	0	0	
	Logic "HIGH"; Pulled to +5V		0.15	0.2	
	Logic "HIGH"; Pulled to +24V		2	2.5	
Input frequency		0		150	kHz
Minimum pulse width		3.3			µs
ESD protection	Human body model	±2			kV

3.7.11 Digital Outputs (OUT0, OUT1, OUT2/Error, OUT3/ Ready)

			Min.	Typ.	Max.	Units
Mode compliance	All outputs (OUT0, OUT2/Error, OUT3/Ready)		TTL / CMOS / Open-collector / NPN 24V			
Default state	Not supplied (+V$_{LOG}$ floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0	Logic "HIGH"			
		OUT2/Error, OUT3/ Ready	Logic "LOW"			
	Normal operation	OUT0, OUT2/Error	Logic "HIGH"			
		OUT3/Ready	Logic "LOW"			
Output voltage	Logic "LOW"; output current = 0.5A			0.2	0.8	V
	Logic "HIGH"; output current = 0, no load	OUT2/Error, OUT3/ Ready	2.9	3	3.3	
		OUT0	4	4.5	5	
	Logic "HIGH", external load to +V$_{LOG}$		V$_{LOG}$			
	Absolute maximum, continuous		-0.5		V$_{LOG}$+0.5	
	Absolute maximum, surge (duration ≤ 1s) [†]		-1		V$_{LOG}$+1	
Output current	Logic "LOW", sink current, continuous				0.5	A
	Logic "LOW", sink current, pulse ≤ 5 sec.				1	A
	Logic "HIGH", source current; external load to GND; V$_{OUT}$ >= 2.0V	OUT2/Error, OUT3/ Ready			2	mA
		OUT0, OUT1			4	
	Logic "HIGH", leakage current; external load to +V$_{LOG}$; V$_{OUT}$ = V$_{LOG}$ max = 40V			0.1	0.2	mA
Minimum pulse width			2			µs
ESD protection	Human body model		±5			kV

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[1] "FS" stands for "Full Scale"

3.7.12 Digital Hall Inputs (Hall1, Hall2, Hall3)

		Min.	Typ.	Max.	Units
Mode compliance		TTL / CMOS / Open-collector			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"		0	0.8	V
	Logic "HIGH"	2	5		
	Floating voltage (not connected)		4.4		
	Absolute maximum, surge (duration ≤ 1s) †	-10		+15	
Input current	Logic "LOW"; Pull to GND			1.2	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +5	0	0	0	
Minimum pulse width		2			µs
ESD protection	Human body model	±5			kV

3.7.13 Linear Hall Inputs (LH1, LH2, LH3) for PN P028.00x.E571

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0	0.5÷4.5	4.9	V
	Absolute maximum values, continuous	-7		+7	
	Absolute maximum, surge (duration ≤ 1s)	-11		+14	
Input current	Input voltage 0…+5V	-1	±0.9	+1	mA
Interpolation resolution	Depending on software settings	9		13	bits
Frequency		0		4	kHz
ESD protection	Human body model	±1			kV

3.7.14 Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-) for PN P028.00x.E501

		Min.	Typ.	Max.	Units
Input voltage, differential	Sin+ to Sin-, Cos+ to Cos-		1	1.25	V$_{PP}$
Input voltage, any pin to GND	Operational range	-1	2.5	4	V
	Absolute maximum values, continuous	-7		+7	
	Absolute maximum, surge (duration ≤ 1s) †	-11		+14	
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos-	4.2	4.7		kΩ
	Common-mode, to GND		2.2		kΩ
Resolution with interpolation	Software selectable, for one sine/cosine period	2		10	bits
Frequency	Sin-Cos interpolation	0		450	kHz
	Quadrature, no interpolation	0		10	MHz
ESD protection	Human body model	±2			kV

3.7.15 Differential encoder inputs (A+, A-, B+, B-, Z+, Z-) for PN P028.00x.E501

		Min.	Typ.	Max.	Units
Differential mode compliance		TIA/EIA-422-A			
Input voltage, differential	Hysteresis	±0.06	±0.1	±0.2	V
	Operating range	-14		+14	
Input voltage, common-mode	Operating range (A+ to GND, etc.)	-11		+14	
Input impedance	A+, B+, Z+		120		Ω
	A-, B-, Z-	1.3		1.6	kΩ
	Differential mode	0		10	MHz
	Differential mode	50			ns
ESD protection	Human body model	±1			kV

3.7.16 Single-ended encoder inputs (A, B, Z) for PN P028.00x.E561

		Min.	Typ.	Max.	Units
Single-ended mode compliance	Leave negative inputs disconnected	TTL / CMOS / Open-collector			
Input voltage, single-ended mode A, B	Logic "LOW"			1.6	V
	Logic "HIGH"	1.8			
	Floating voltage (not connected)		4.5		
Input voltage, single-ended mode Z	Logic "LOW"			1.2	V
	Logic "HIGH"	1.4			
	Floating voltage (not connected)		4.7		
Input current, single-ended mode A, B, Z	Logic "LOW"; Pull to GND		2.5	3	mA
	Logic "HIGH"; Internal 2.2KΩ pull-up to +5	0	0	0	
Input frequency	Single-ended mode, Open-collector / NPN	0		500	KHz
Minimum pulse width	Single-ended mode, Open-collector / NPN	1			µs
Input voltage, any pin to GND	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1s) †	-11		+14	
ESD protection	Human body model	±1			kV

3.7.17 RS-232

		Min.	Typ.	Max.	Units
Standards compliance			TIA/EIA-232-C		
Bit rate	Depending on software settings	9600		115200	Baud
Short-circuit protection	232TX short to GND		Guaranteed		
ESD protection	Human body model	±2			kV

3.7.18 CAN-Bus

		Min.	Typ.	Max.	Units
Compliance			ISO11898, CiA-301v4.2, 402_2v4.1		
Bit rate	Software selectable	250		1000	Kbps
Bus length	1Mbps			40	
	500Kbps			100	m
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo		none on-board		
Node addressing	Hardware (CANopen selection pin)		127 (CANopen); 255 (TMLCAN);		
	Software		1 - 127 (CANopen); 1- 255 (TMLCAN)		
Voltage, CAN-Hi or CAN-Lo to GND		-26		26	V
ESD protection	Human body model	±15			kV

3.7.19 Conformity

EU Declaration	2014/30/EU (EMC), 2014/35/EU (LVD), 2011/65/EU (RoHS), 1907/2006/EC (REACH), 93/68/EEC (CE Marking Directive), EC 428/2009 (non dual-use item, output frequency limited to 590Hz)

† Stresses beyond values listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
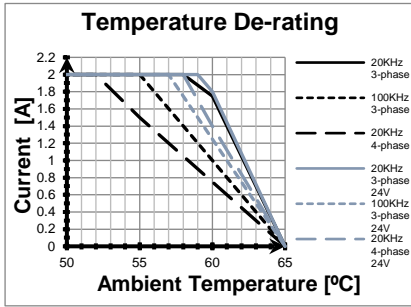
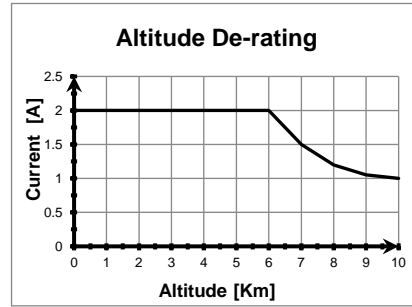**Figure 3.3** iPOS3602 HX De-rating with ambient temperature
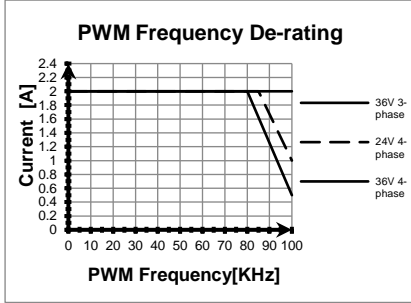

Figure 3.4 iPOS3602 HX De-rating with altitude

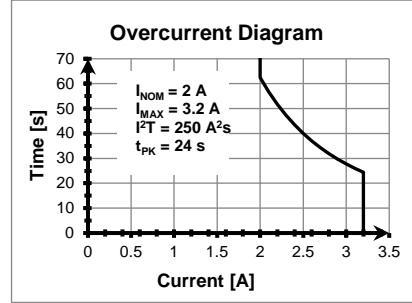*Figure 3.5 iPOS3602 HX Current De-rating with PWM frequency*
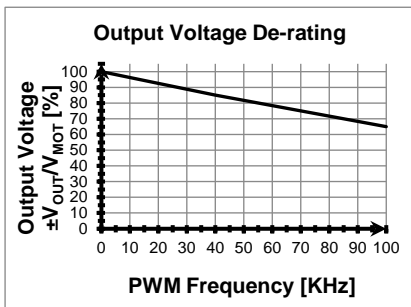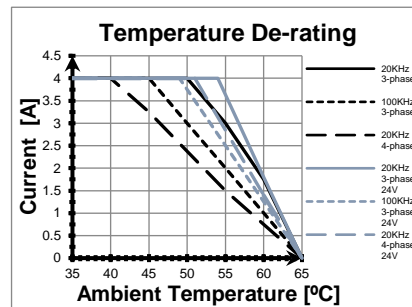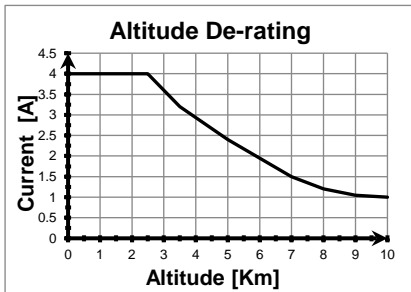

Figure 3.6 iPOS3602 HX Over-current diagram

Overcurrent Diagram values:
$I_{NOM} = 2\ A$
$I_{MAX} = 3.2\ A$
$I^2T = 250\ A^2s$
$t_{PK} = 24\ s$

Figure 3.7. iPOS360x HX Output Voltage De-rating with PWM frequency[1]

Figure 3.8. iPOS3604 HX De-rating with ambient temperature

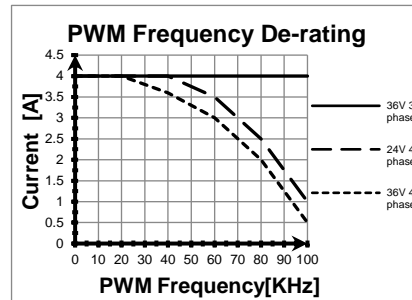
Figure 3.9. iPOS3604 HX De-rating with altitude

Figure 3.10. iPOS3604 HX Current De-rating with PWM frequency

Overcurrent Diagram values:
$I_{NOM} = 4\ A$
$I_{MAX} = 10\ A$
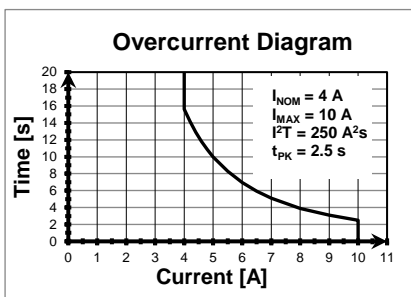$I^2T = 250\ A^2s$
$t_{PK} = 2.5\ s$

Figure 3.11. iPOS3604 HX Over-current diagram

⚠ **CAUTION!**

FOR PWM FREQUENCIES LESS THAN 20 KHZ, CORRELATE THE PWM FREQUENCY WITH THE MOTOR PARAMETERS IN ORDER TO AVOID POSSIBLE MOTOR DAMAGE.

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[1] V_{OUT} – the output voltage, V_{MOT} – the motor supply voltage

4   Memory Map

iPOS360X HX has 2 types of memory available for user applications: 2K×16 SRAM and 4K×16 serial E2ROM.
The SRAM memory is mapped in the address range: 9800h to 9FFFh. It can be used to download and run a TML program, to save real-time data acquisitions and to keep the cam tables during run-time.
The E2ROM is mapped in the address range: 4000h to 4FFFh. It is used to keep in a non-volatile memory the TML programs, the cam tables and the drive setup information.

Remark: EasyMotion Studio handles automatically the memory allocation for each motion application. The memory map can be accessed and modified from the main folder of each application
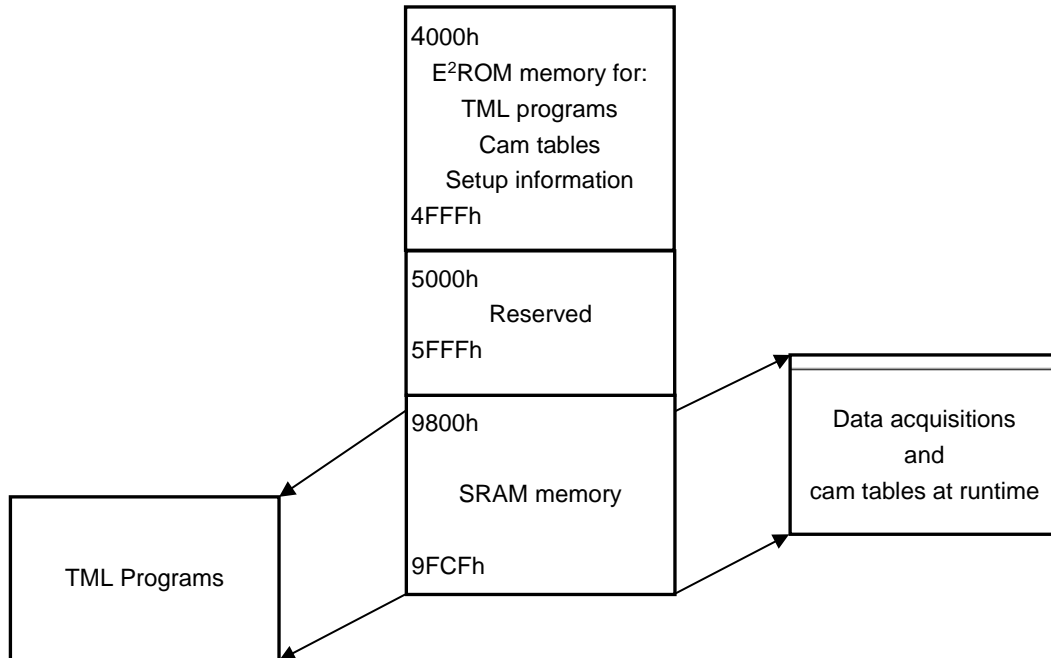

Figure 4.1. iPOS360X HX Memory Map