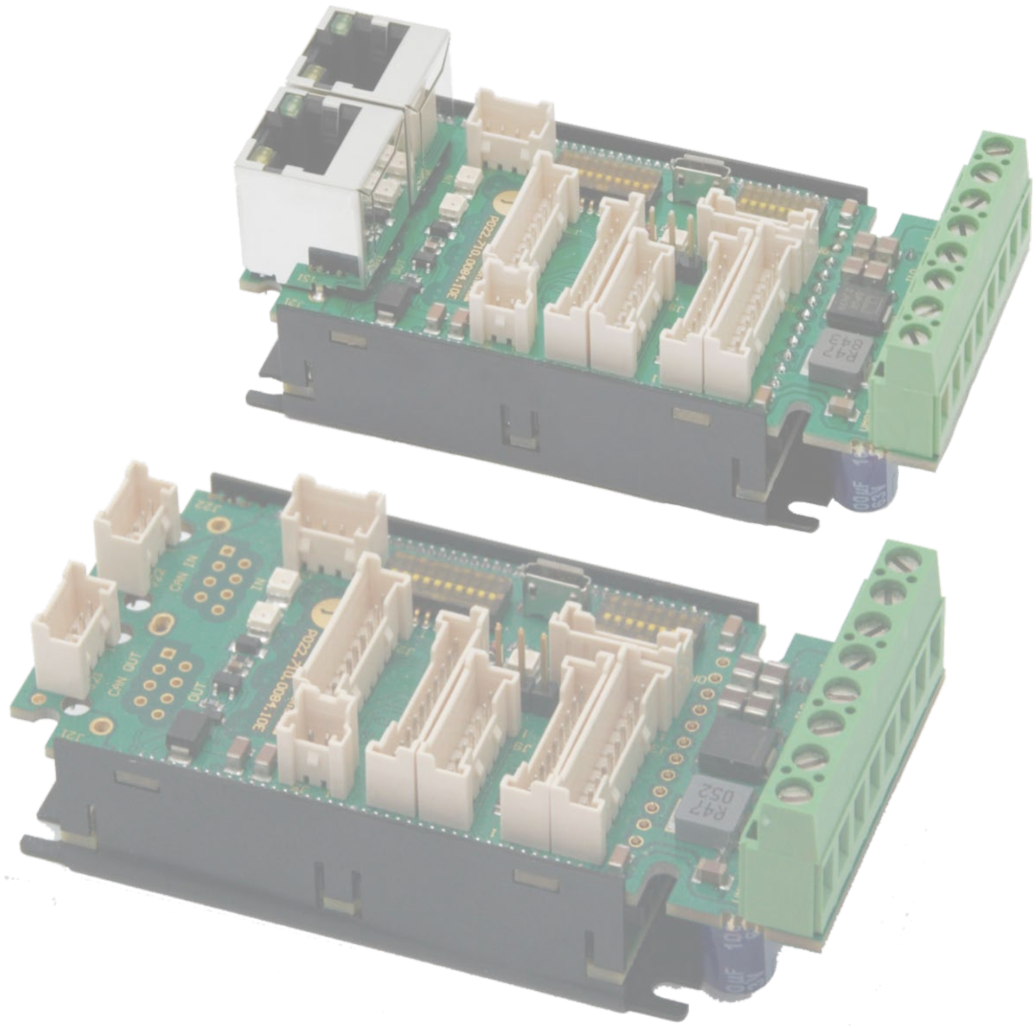
iPOS481x XZ

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

TECHNOSOFT

Intelligent Servo Drives



Technical Reference

P091.022.iPOS481x.XZ.UM.0624

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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	Output current		Communication
		Nominal	Peak	
iPOS4810 XZ-CAT	P022.825.E122	$10A_{RMS}$ / 14.1A	$28.3A_{RMS}$ / 40A	Serial RS-232; USB; EtherCAT®
iPOS4810 XZ-CAN	P022.825.E102			Serial RS-232; USB; CAN
iPOS4815 XZ-CAT	P022.826.E122	$15A_{RMS}$ / 21.2A		Serial RS-232; USB; EtherCAT®
iPOS4815 XZ-CAN	P022.826.E102			Serial RS-232; USB; CAN

In order to operate the **iPOS481x** 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] or an **EtherCAT® master**[2]
  - ❑ 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) [3]
  - ❑ 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 iPOS481x 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**. For detailed information regarding the next steps, refer to the related documentation.

Notational Conventions

This document uses the following conventions:

- **iPOS481x**– 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.)
- **STO** – Safe Torque Off
- **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
- **CoE** – CAN application protocol over EtherCAT®

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[1] when the iPOS481x XZ-CAN is set in CANopen mode

[2] when using and iPOS481x XZ-CAT

[3] available only for CAN versions

Trademarks

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Related Documentation

iPOS4810 XZ-CAT Datasheet (P022.825.E122.DSH)

iPOS4810 XZ-CAN Datasheet (P022.825.E102.DSH)

iPOS4815 XZ-CAT Datasheet (P022.826.E122.DSH)

iPOS4815 XZ-CAN Datasheet (P022.826.E102.DSH)

– describes the hardware connections of the iPOS481x XZ CAN family of intelligent servo drives including the technical data and connectors.

iPOS family Safe Torque Off (STO) Operating instructions (091.099.STO.Operating.Instructions.xxxx)

– describes the principles of STO function, the applied standards, the safety-related data and the electrical data. It presents the requested information for installation and commissioning of STO function

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, **CiA WD 305 v.2.2.13** layer settings services and protocols and **CiA DSP 402 v3.0** 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

CoE Programming **(part no. P091.064.UM.xxxx)** – explains how to program the Technosoft intelligent drives using **CAN application protocol over EtherCAT®** and describes the associated object dictionary.

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

If you Need Assistance …

If you want to …	Contact Technosoft at …
Visit Technosoft online	World Wide Web: http://www.technosoftmotion.com/
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***

CAUTION! ***Indicates areas SENSITIVE TO electrostatic discharges (ESD) WHICH REQUIRE HANDLING IN AN ESD PROTECTED ENVIRONMENT***

1.1 Warnings

WARNING! ***THE VOLTAGE USED IN THE DRIVE MIGHT CAUSE ELECTRICAL SHOCKS. DO NOT TOUCH LIVE PARTS WHILE THE POWER SUPPLIES ARE ON***

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***
CAUTION!	***THE DRIVE CONTAINS ELECTROSTATICALLY SENSITIVE COMPONENTS WHICH MAY BE DAMAGED BY INCORRECT HANDLING. THEREFORE THE DRIVE SHALL BE REMOVED FROM ITS ORIGINAL PACKAGE ONLY IN AN ESD PROTECTED ENVIRONMENT***

To prevent electrostatic damage, avoid contact with insulating materials, such as synthetic fabrics or plastic surfaces. In order to discharge static electricity build-up, place the drive on a grounded conductive surface and also ground yourself.

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.
	STO compliance – TUV SUD certifies that this product is SIL 3 / Cat 3 / PL e compatible and is in conformity with the following safety – related directives: **EN ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design** **EN 61800-5-1:2007 Adjustable speed electrical power drive systems — Safety requirements — Electrical, thermal and energy** **EN 61800-5-2:2007 Adjustable speed electrical power drive systems - Safety requirements –Functional** **EN 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems** **EN ISO 13849-1:2008 Safety of machinery - Safety-related parts of control systems** **EN 61326-3-1:2008 - General industrial applications - EMC - Immunity requirements for functional safety**

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

2 Product Overview

2.1 Introduction

The **iPOS481x** 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 iPOS481x drives accept as position feedback incremental encoders (quadrature or sine/cosine), absolute encoders (SSI, BiSS, Panasonic, Tamagawa, EnDAT, Nikon, Sanyo Denki) and linear Hall 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 iPOS481x XZ 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[2]
- Sending commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group[2]
- Synchronizing all the axes from 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 iPOS481x CAN drives are equipped with an USB and a CAN 2.0B interface that can be set by hardware pins to operate in 2 communication protocol modes:

- **CANopen**
- **TMLCAN**

The iPOS481x CAT drives support only the EtherCAT® communication protocol. They communicate through the USB interface for software commissioning and the EtherCAT® interface.

When **CANopen** mode is selected, the iPOS481x conforms to **CiA 301 v4.2** application layer communication profile and **CiA DSP 402 v4.1.1** 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 iPOS481x 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 iPOS481x 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 iPOS481x 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.

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

[2] Available only for CAN drives

When higher level coordination is needed, apart from a CANopen master, the iPOS481x drives can also be controlled via a PC or a PLC using one of the **TML_LIB** motion libraries.

For iPOS481x commissioning **EasySetUp** or **EasyMotion Studio** PC applications may be used.

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 iPOS481x 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 iPOS481x 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
- **STO**: 2 safe torque-off inputs, safety integrity level (SIL3/Cat3/PLe) acc. to EN61800-5-1;-2/ EN61508-3;-4/ EN ISO 13849-1. When left not connected will disable the motor outputs. This provides a dual redundant hardware protection that cannot be overdriven by the software or other hardware components.
- **Technosoft Motion Language (TML)** instruction set for the definition and execution of motion sequences
- Standalone operation with stored motion sequences
- **Motor supply:** 11-50V; **Logic supply:** 9-36V; **STO supply:** 18-40V; **PWM** switching frequency: up to 100kHz.
- **Motor current**
- ***iPOS4810 XZ*:**
    - **Nominal**: 10A_{RMS} / 14.1A amplitude
    - **Peak**: 28.3A_{RMS} / 40A amplitude
- ***iPOS4815 XZ*:**
    - **Nominal**: 15A_{RMS} / 21.2A amplitude
    - **Peak**: 28.3A_{RMS} / 40A amplitude
- **Communication**:
    - Serial RS-232;
    - USB;
    - For CAN executions: CAN-bus 2.0B up to 1Mbit/s (for CAN drives);
    - For CAT executions: Dual 100Mbps EtherCAT® interfaces, communication cycle time down to 10 kHz.
- **Digital and analog I/O's:**
    - 6 x digital inputs, 12-36V, PNP/NPN software selectable: for limit switches or general-purpose, 4 x general-purpose
    - 5 x digital outputs, 5-36V: 0.4A NPN / 0.3A PNP, polarity software selectable: Ready, Error or general-purpose
    - 1 x dedicated motor brake or general-purpose output (OUT0): 2A NPN / 1.5A PNP, polarity software selectable
    - 2 x analogue inputs software selectable: 12-bit 0-5V: Feedback and ±10V: Reference (REF+ and REF- signals), or general purpose
- **Thermal Protection**: The internal temperature sensor disables the PWM outputs if the measured temperature exceeds 105°C
- **NTC/PTC** analogue Motor Temperature sensor input
- **Feedback devices (dual-loop support)**

  1st feedback devices supported:
    - **Incremental A / B** (index Z available): differential or single-ended

- **Analog Sin/Cos** encoder interface (differential $1V_{PP}$)
- **Digital Hall** sensor interface (single-ended / open collector)
- **Linear Hall** sensors interface (single-ended)

2nd feedback devices supported:

- **Incremental A / B** (index Z available): differential
- **Absolute:** BISS / SSI / EnDAT / TAMAGAWA / Panasonic / Nikon / Sanyo Denki encoder interface

- **Pulse & direction** reference (single-ended or differential) capability
- **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 and EtherCAT® drives.
  - Cyclic Synchronous Velocity (CSV) only for EtherCAT® drives.
  - Cyclic Synchronous Torque (CST) only for EtherCAT® drives.
  - Electronic gearing and camming
  - 40 Homing modes
- **For CAN executions** - two CAN operation modes selectable by HW pin:
  - **CANopen** – conforming with **CiA 301 v4.2** and **CiA DSP 402 v3.0**
  - **TMLCAN** – intelligent drive conforming with Technosoft protocol for exchanging TML commands via CAN-bus
- **For CAT executions** - supported protocols:
  - **CoE** - CAN application protocol over EtherCAT
  - **FoE** – File over EtherCAT – for setup/TML functions and firmware update
  - **EoE** – Ethernet over EtherCAT – for Easy Motion studio communication over EtherCAT
- **16K × 16 SRAM** memory for data acquisition
- **24K × 16 E²ROM** to store TML motion programs, cam tables and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)
- Feature that **detects breakage** of **Hall wires** and/or of **incremental/absolute encoder wires**
- Protections:
  - Short-circuit between motor phases
  - Short-circuit from motor phases to ground
  - Over-voltage
  - Under-voltage
  - Over-current
  - Over-temperature
  - Communication error
  - Control error

2.3 Identification Labels

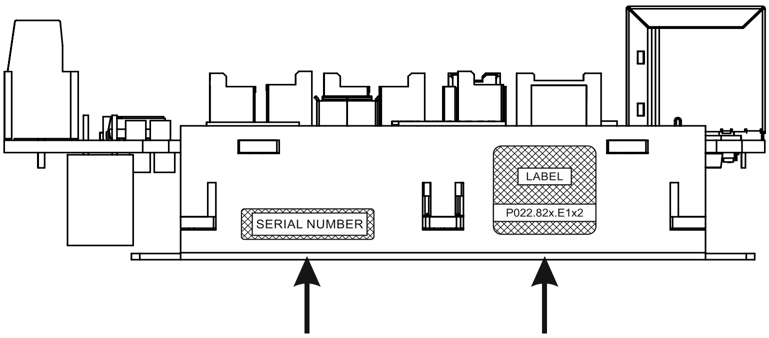


***Figure 1.** iPOS4851x XZ-CAX identification labels*

The iPOS481x XZ can have the following part numbers and names on the identification label:

- **P022.815.E122** name iPOS4810 XZ-CAT – standard EtherCAT execution
- **P022.815.E102** name iPOS4810 XZ-CAN – standard CAN execution
- **P022.816.E122** name iPOS4815 XZ-CAT – standard EtherCAT execution
- **P022.816.E102** name iPOS4815 XZ-CAN – standard CAN execution

2.4 Supported Motor-Sensor Configurations

2.4.1 Single loop configurations

The position and/or speed are controlled using one feedback sensor. The other available feedback sensor input can be used for External reference Position or Velocity, Pulse and Direction, Electronic Gearing or Camming.

Motor sensors				Motor types				
Encoder[1]	**Digital Halls[7]**	**Linear Halls[8]**	**Tacho**	**Brushless PMSM[2]**	**Brushless BLDC[3]**	**Brushed DC Voice coils**	**Stepper 2 phase**	**Stepper 3 phase**
Incremental encoder[4] / SinCos[5] / SSI / EnDAT2.2 / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]				✓		✓	✓	
Incremental encoder[4] / SinCos[5] / SSI / EnDAT2.2 / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]	✓			✓	✓			
None	✓			✓				
None		✓		✓				
None			✓			✓		
None							✓	✓

2.4.2 Dual loop configurations

The motor speed control loop is closed on one feedback connected on the motor while the motor position control loop is closed on the other available feedback which is placed on the load. There is usually a transmission between the load and the motor.

<table>
<tr><th colspan="4">Motor sensors</th><th colspan="5">Motor types</th><th>Load sensors</th></tr>
<tr><th>Encoder[1]</th><th>Digital Halls[7]</th><th>Linear Halls[8]</th><th>Tacho</th><th>Brushless PMSM[2]</th><th>Brushless BLDC[3]</th><th>Brushed DC Voice coils</th><th>Stepper 2 phase</th><th>Stepper 3 phase</th><th>Encoder[9]</th></tr>
<tr><td>Incremental encoder[4] / SinCos[5]</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2"></td><td>SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[5]</td></tr>
<tr><td>SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]</td><td>Incremental encoder[4] / SinCos[6]</td></tr>
<tr><td>Incremental encoder[4] / SinCos[5]</td><td rowspan="2">✓</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">✓</td><td rowspan="2">✓</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]</td></tr>
<tr><td>SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]</td><td>Incremental encoder[4] / SinCos[5]</td></tr>
<tr><td>None</td><td>✓</td><td></td><td></td><td>✓</td><td></td><td></td><td></td><td></td><td>Incremental encoder[4]/ SinCos[5]</td></tr>
<tr><td>None</td><td></td><td>✓</td><td></td><td>✓</td><td></td><td></td><td></td><td></td><td>Incremental encoder[4] / SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]</td></tr>
<tr><td>None</td><td></td><td></td><td>✓</td><td></td><td></td><td>✓</td><td></td><td></td><td>Incremental encoder[4]/ SinCos[5] / SSI / EnDAT / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki[6]</td></tr>
<tr><td>None</td><td></td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td>✓</td><td>None</td></tr>
</table>

Each defined motor type can have any combination of the supported feedbacks either on motor or on load.

Example:

-PMSM motor with Incremental encoder (from feedback #1) on motor and BISS (from feedback#2) on load

-DC brush motor with SSI encoder (from feedback #2) on motor and Sin/Cos encoder (from feedback #1) on load.

[1] Motor encoder can be either on Feedback 1 or on Feedback 2
[2] Sinusoidal. Brushless motor is controlled as PMSM using a field oriented control algorithm
[3] Trapezoidal. Brushless motor is controlled as a BLDC motor using Hall-based commutation.
[4] Single-ended or differential on Feedback 1. Only differential on Feedback 2 for iPOS481x XZ
[5] Sin/Cos is available only on Feedback #1
[6] SSI / EnDAT2.2 / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki are differential, but single-ended option is also accepted; Available only on Feedback #2
[7] Digital Halls are available only on Feedback #2
[8] Linear Halls are available only on Feedback #1
[9] Load encoder is on Feedback 2 / 1, if motor encoder is on Feedback 1 / 2

3 Hardware Installation

3.1 iPOS481x XZ-CAT Board Dimensions

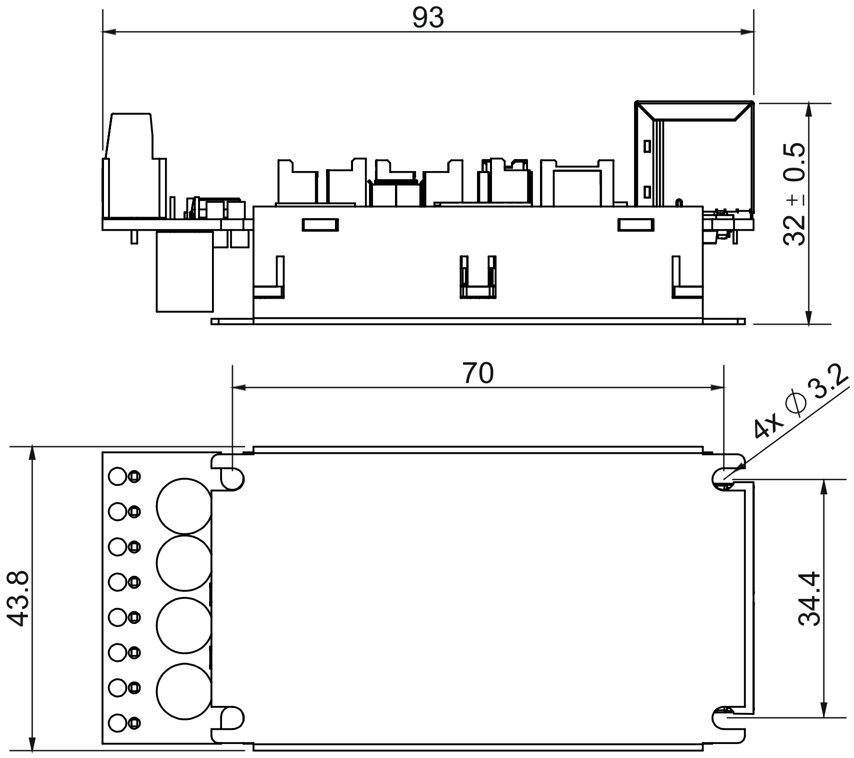


Figure 2. *iPOS481x XZ-CAT drive dimensions*

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

3.2 iPOS481x XZ-CAN Board Dimensions

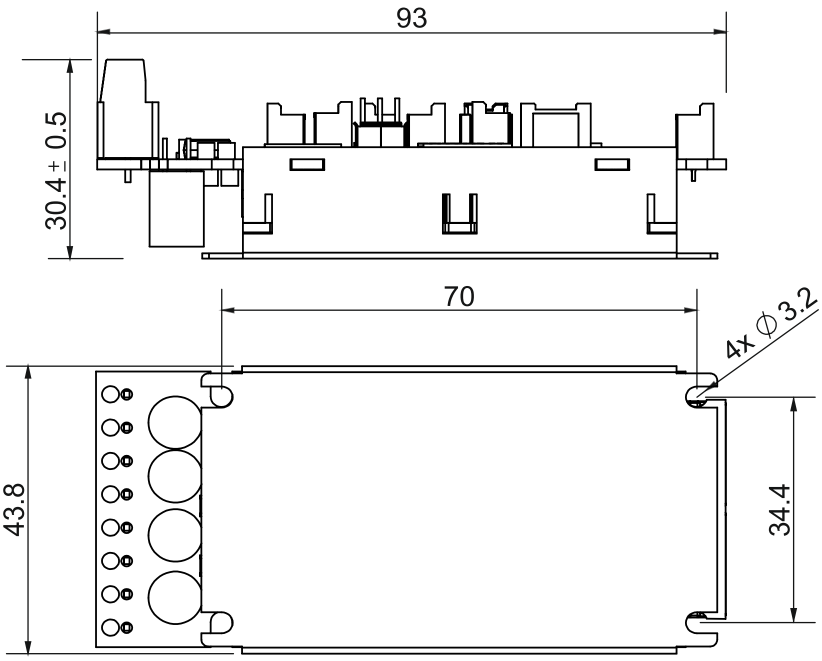
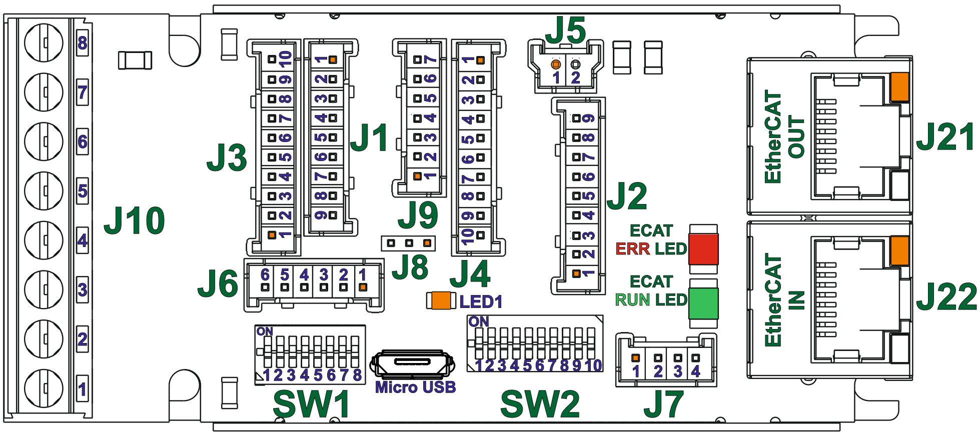


Figure 3. *iPOS481x XZ-CAN drive dimensions*

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

3.3 Connectors and Pinouts

3.3.1 Pinouts for iPOS481x XZ-CAT



J1 Feedback #1		
Pin	**Name**	**Description**
1	A1+/Sin+	Incr. encoder1 A single-ended, or A+ diff. input, or analogue encoder Sin+ diff. input
2	A1-/Sin-/LH1	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input if SW2 pin2= ON and pin3=OFF
		Linear Hall 1 input if SW2 pin2= OFF and pin3=ON
3	B1+/Cos+	Incr. encoder1 B single-ended, or B+ diff. input, or analogue encoder Cos+ diff. input
4	B1-/Cos-/LH2	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input if SW2 pin5= ON and pin6=OFF
		Linear Hall 2 input if SW2 pin5= OFF and pin6=ON
5	Z1+	Incr. encoder1 Z single-ended, or Z+ diff. input
6	Z1-/LH3	Incr. encoder1 Z- diff. input if SW2 pin8= ON and pin9=OFF
		Linear Hall 3 input if SW2 pin8= OFF and pin9=ON
7	$+5V_{OUT}$	5V output supply
8	PE	Protection Earth
9	GND	Return ground. Internally connected to all GND signals except STO GND.

J2 Digital Inputs		
Pin	**Name**	**Description**
1	GND	Return ground. Internally connected to all GND signals except STO GND.
2	IN0	12-36V general-purpose digital PNP/NPN input
3	IN1	12-36V general-purpose digital PNP/NPN input
4	IN4	12-36V general-purpose digital PNP/NPN input
5	IN5	12-36V general-purpose digital PNP/NPN input
6	IN2/LSP	12-36V digital PNP/NPN input. Positive limit switch input
7	IN3/LSN	12-36V digital PNP/NPN input. Negative limit switch input
8	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to 36V_{DC}. Internally connected to other $+V_{LOG}$ pins
9	GND	Return ground. Internally connected to all GND signals except STO GND.

J3 Feedback #2		
Pin	**Name**	**Description**
1	A2+/Pulse+/Data+/SL+	Incr. encoder2 A+ diff. input, or Pulse+, or Data+ for SSI, or Slave+ for BiSS; has internal 120Ω resistor between pins 11 and 12
2	A2- /Pulse-/Data-/SL-	Incr. encoder2 A- diff. input, or Pulse-, or Data- for SSI, or Slave- for BiSS; has internal 120Ω resistor between pins 11 and 12
3	B2+/Dir+/CLK+/MA+	Incr. encoder2 B+ diff. input, or Dir+, or Clock+ for SSI, or Master+ for BiSS; has internal 120Ω resistor between pins 9 and 10
4	B2-/Dir-/CLK-/MA-	Incr. encoder2 B- diff. input, or Dir-, or Clock- for SSI, or Master- for BiSS; has internal 120Ω resistor between pins 9 and 10
5	Z2+	Incr. encoder2 Z+ diff. input; has internal 120Ω resistor between pins 7 and 8
6	Z2-	Incr. encoder2 Z- diff. input; has internal 120Ω resistor between pins 7 and 8
7	$+5V_{OUT}$	5V output supply
8	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to 36V_{DC}. Internally connected to other $+V_{LOG}$ pins
9	PE	Protection Earth
10	GND	Return ground. Internally connected to all GND signals except STO GND.

J5 Logic supply input		
Pin	**Name**	**Description**
1	$-V_{LOG}$	Negative terminal of the logic supply input: 9 to 36V_{DC} from SELV/ PELV type power supply.
2	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to 36V_{DC} from SELV/ PELV type power supply.

J6 Digital Hall		
Pin	**Name**	**Description**
1	$+5V_{OUT}$	5V output supply
2	Hall 1	Digital input Hall 1 sensor
3	Hall 2	Digital input Hall 2 sensor
4	Hall 3	Digital input Hall 3 sensor
5	PE	Protection Earth
6	GND	Return ground. Internally connected to all GND signals except STO GND.

J4 Digital Outputs		
Pin	**Name**	**Description**
1	GND	Return ground. Internally connected to all GND signals except STO GND.
2	OUT0	12-36V general-purpose digital output, 1.5A PNP/ 2A NPN, software selectable
3	OUT1	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
4	OUT4	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
5	OUT5	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
6	OUT3/ Ready	12-36V Ready signal digital output, 0.3A PNP/ 0.4A NPN, software selectable
7	OUT2/ Error	12-36V Error signal digital output, 0.3A PNP/ 0.4A NPN, software selectable
8	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to 36V_{DC}. Internally connected to other $+V_{LOG}$ pins
9	PE	Protection Earth
10	GND	Return ground. Internally connected to all GND signals except STO GND.

J7 STO (Safe Torque Off)			
Pin	**Name**	**Description**	
1	STO1-	Safe Torque Off input 1, negative return (opto-isolated, 0V)	Apply between both STO1+, STO2+ and STO1-, STO2- 24V DC from SELV/ PELV power supply for motor PWM output operation
2	STO1+	Safe Torque Off input 1, positive input (opto-isolated, 18÷40V)	
3	STO2+	Safe Torque Off input 2, positive input (opto-isolated, 18÷40V)	
4	STO2-	Safe Torque Off input 2, negative return (opto-isolated, 0V)	

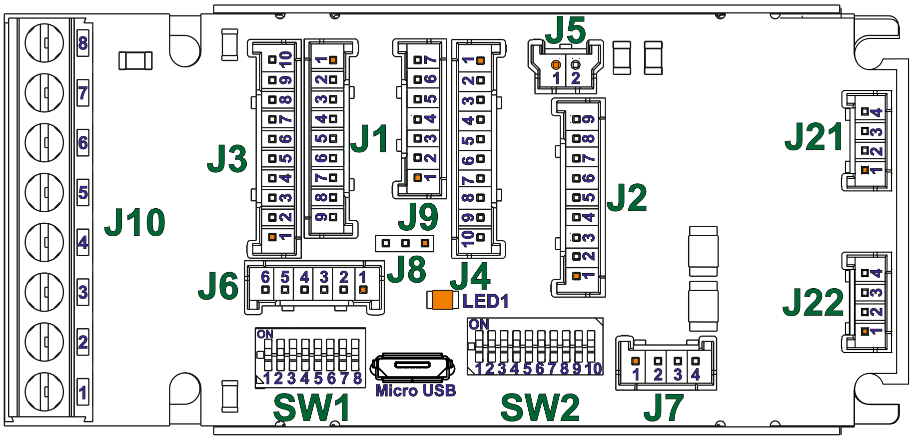
J8 Serial communication		
Pin	**Name**	**Description**
1	232TX	RS-232 Data Transmission.
2	GND	Return ground. Internally connected to all GND signals except STO GND.
3	232RX	RS-232 Data Reception.

J9 Analogue inputs			
Pin	**Name**	**Description**	
1	PE	Protection Earth	
2	FDBK	Analogue input, 12-bit, 0-5V. Reads an analogue feedback (tacho), or general purpose	
3	$+5V_{OUT}$	5V output supply	
4	Temp Mot	NTC/PTC 3.3V input. Used to read an analog temperature value	
5	GND	Return ground. Internally connected to all GND signals except STO GND.	
6	REF+	Analogue Input+, 11-bit for 0...10V	Found as variable **REF**
7	REF-	Analogue Input+, 11-bit for -10...0V	

J10 Power input and Motor outputs		
Pin	**Name**	**Description**
1	GND	Negative return (ground) of the power supply
2	CR/B-	**Chopping Resistor output/ Phase B-** for step motors
3	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
4	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
5	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
6	PE	Earth connection
7	PE	Earth connection
8	+Vmot	Positive terminal of the motor supply: 12 to 48V_{DC}.

J21 & J22 EtherCAT
EtherCAT standard RJ45 Ethernet IN/OUT ports.

3.3.2 Pinouts for iPOS481x XZ-CAN



J1 Feedback #1		
Pin	**Name**	**Description**
1	A1+/Sin+	Incr. encoder1 A single-ended, or A+ diff. input, or analogue encoder Sin+ diff. input
2	A1-/Sin-/LH1	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input if SW2 pin2= ON and pin3=OFF
		Linear Hall 1 input if SW2 pin2= OFF and pin3=ON
3	B1+/Cos+	Incr. encoder1 B single-ended, or B+ diff. input, or analogue encoder Cos+ diff. input
4	B1-/Cos-/LH2	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input if SW2 pin5= ON and pin6=OFF
		Linear Hall 2 input if SW2 pin5= OFF and pin6=ON
5	Z1+	Incr. encoder1 Z single-ended, or Z+ diff. input
6	Z1-/LH3	Incr. encoder1 Z- diff. input if SW2 pin8= ON and pin9=OFF
		Linear Hall 3 input if SW2 pin8= OFF and pin9=ON
7	+5V$_{OUT}$	5V output supply
8	PE	Protection Earth
9	GND	Return ground. Internally connected to all GND signals except STO GND.

J2 Digital Inputs		
Pin	**Name**	**Description**
1	GND	Return ground. Internally connected to all GND signals except STO GND.
2	IN0	12-36V general-purpose digital PNP/NPN input
3	IN1	12-36V general-purpose digital PNP/NPN input
4	IN4	12-36V general-purpose digital PNP/NPN input
5	IN5	12-36V general-purpose digital PNP/NPN input
6	IN2/LSP	12-36V digital PNP/NPN input. Positive limit switch input
7	IN3/LSN	12-36V digital PNP/NPN input. Negative limit switch input
8	+V$_{LOG}$	Positive terminal of the logic supply input: 9 to 36V$_{DC}$. Internally connected to other +V$_{LOG}$ pins
9	GND	Return ground. Internally connected to all GND signals except STO GND.

J3 Feedback #2		
Pin	**Name**	**Description**
1	A2+/Pulse+/Data+/SL+	Incr. encoder2 A+ diff. input, or Pulse+, or Data+ for SSI, or Slave+ for BiSS; has internal 120Ω resistor between pins 11 and 12
2	A2- /Pulse-/Data-/SL-	Incr. encoder2 A- diff. input, or Pulse-, or Data- for SSI, or Slave- for BiSS; has internal 120Ω resistor between pins 11 and 12
3	B2+/Dir+/CLK+/MA+	Incr. encoder2 B+ diff. input, or Dir+, or Clock+ for SSI, or Master+ for BiSS; has internal 120Ω resistor between pins 9 and 10
4	B2-/Dir-/CLK-/MA-	Incr. encoder2 B- diff. input, or Dir-, or Clock- for SSI, or Master- for BiSS; has internal 120Ω resistor between pins 9 and 10
5	Z2+	Incr. encoder2 Z+ diff. input; has internal 120Ω resistor between pins 7 and 8
6	Z2-	Incr. encoder2 Z- diff. input; has internal 120Ω resistor between pins 7 and 8
7	+5V$_{OUT}$	5V output supply
8	+V$_{LOG}$	Positive terminal of the logic supply input: 9 to 36V$_{DC}$. Internally connected to other +V$_{LOG}$ pins
9	PE	Protection Earth
10	GND	Return ground. Internally connected to all GND signals except STO GND.

J5 Logic supply input		
Pin	**Name**	**Description**
1	-V$_{LOG}$	Negative terminal of the logic supply input: 9 to 36V$_{DC}$ from SELV/ PELV type power supply.
2	+V$_{LOG}$	Positive terminal of the logic supply input: 9 to 36V$_{DC}$ from SELV/ PELV type power supply.

J6 Digital Hall		
Pin	**Name**	**Description**
1	+5V$_{OUT}$	5V output supply
2	Hall 1	Digital input Hall 1 sensor
3	Hall 2	Digital input Hall 2 sensor
4	Hall 3	Digital input Hall 3 sensor
5	PE	Protection Earth
6	GND	Return ground. Internally connected to all GND signals except STO GND.

J4 Digital Outputs		
Pin	**Name**	**Description**
1	GND	Return ground. Internally connected to all GND signals except STO GND.
2	OUT0	12-36V general-purpose digital output, 1.5A PNP/ 2A NPN, software selectable
3	OUT1	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
4	OUT4	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
5	OUT5	12-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable
6	OUT3/ Ready	12-36V Ready signal digital output, 0.3A PNP/ 0.4A NPN, software selectable
7	OUT2/ Error	12-36V Error signal digital output, 0.3A PNP/ 0.4A NPN, software selectable
8	+V$_{LOG}$	Positive terminal of the logic supply input: 9 to 36V$_{DC}$. Internally connected to other +V$_{LOG}$ pins
9	PE	Protection Earth
10	GND	Return ground. Internally connected to all GND signals except STO GND.

J7 STO (Safe Torque Off)			
Pin	**Name**	**Description**	
1	STO1-	Safe Torque Off input 1, negative return (opto-isolated, 0V)	Apply between both STO1+, STO2+ and STO1-, STO2- 24V DC from SELV/ PELV power supply for motor PWM output operation
2	STO1+	Safe Torque Off input 1, positive input (opto-isolated, 18÷40V)	
3	STO2+	Safe Torque Off input 2, positive input (opto-isolated, 18÷40V)	
4	STO2-	Safe Torque Off input 2, negative return (opto-isolated, 0V)	

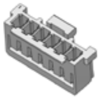
J8 Serial communication		
Pin	**Name**	**Description**
1	232TX	RS-232 Data Transmission.
2	GND	Return ground. Internally connected to all GND signals except STO GND.
3	232RX	RS-232 Data Reception.

J9 Analogue inputs			
Pin	**Name**	**Description**	
1	PE	Protection Earth	
2	FDBK	Analogue input, 12-bit, 0-5V. Reads an analogue feedback (tacho), or general purpose	
3	+5V$_{OUT}$	5V output supply	
4	Temp Mot	NTC/PTC 3.3V input. Used to read an analog temperature value	
5	GND	Return ground. Internally connected to all GND signals except STO GND.	
6	REF+	Analogue Input+, 11-bit for 0...10V	Found as variable **REF**
7	REF-	Analogue Input+, 11-bit for -10...0V	

J10 Power input and Motor outputs		
Pin	**Name**	**Description**
1	GND	Negative return (ground) of the power supply
2	CR/B-	**Chopping Resistor output/ Phase B-** for step motors
3	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
4	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
5	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
6	PE	Earth connection
7	PE	Earth connection
8	+Vmot	Positive terminal of the motor supply: 12 to 48V$_{DC}$.

J21 & J22 CAN		
Pin	**Name**	**Description**
1	PE	Earth connection
2	GND	Return ground. Internally connected to all GND signals except STO GND.
3	Can Lo	CAN-Bus negative line (dominant low)
4	Can Hi	CAN-Bus positive line (dominant high)

3.3.3 Mating Connectors for CAT and CAN versions

Image	Connector	Description	Manufacturer	Part Number	Image
	J1, J2	2.00mm Pitch Sherlock Housing, 9 Circuits	Molex	355070900	
	J3, J4	2.00mm Pitch Sherlock Housing, 10 Circuits	Molex	355071000	
	J5	2.00mm Pitch Sherlock Housing, 2 Circuits	Molex	355070200	
	J6	2.00mm Pitch Sherlock Housing, 6 Circuits	Molex	355070600	
	J7	2.00mm Pitch Sherlock Housing, 4 Circuits	Molex	355070400	
	J21, J22 (for CAN drives)	2.00mm Pitch Sherlock Housing, 4 Circuits	Molex	355070400	
	J9	2.00mm Pitch Sherlock Housing, 7 Circuits	Molex	355070700	
	J21,J22 (for CAT drives)	Standard 8P8C modular jack (RJ-45) male	-	-	
	J1, J2, J3, J4, J5, J7, J9, J21, J22	Hand Crimp Tool for 2.00mm Pitch Terminal, 24-30 AWG	Molex	638190500	
	J1, J2, J3, J4, J5, J7, J9, J21, J22	2.00mm Pitch, Micro-Latch Female Crimp Terminal, Tin (Sn) Plating, 24-30 AWG, Bag	Molex	502128100	
	J1, J2, J3, J4, J5, J7, J9, J21, J22	Pre-Crimped Lead Sherlock Female-to-Sherlock Female, Tin (Sn) Plating, 300.00mm Length, 26 AWG, Black	Molex	797581021	
	J10	M3 screws fixed with 0.5...1Nm using a 2.5mm x 0.3mm tip screwdriver. Wire AWG 12…30 ($0.5mm^2$ … $3.3mm^2$), strip length 6.5mm.			

3.3.4 Mechanical Mounting

The *iPOS481x-XZ* is intended to be mounted vertically or horizontally on a metallic support using the provided mounting holes and the recommended mating connectors.

The recommended inserts and screws are:

Image	Connector	Description	Manufacturer	Part Number
	-	Self-clinching nuts M3	PennEngineering® (PEM®)	KF2-M3-ET
	-	Screws M3x10	Bossard	BN610-M3x10

3.3.1 Cable sets

For an easier evaluation of the iPOS481x XZ drive, a complete cable set is available.
For orders, reference the following part numbers:

Part Number	Description
P038.020.C007	CCS iPOS481x ZX-CAT (Complete cable set 100 cm)
P038.020.C017	CCS iPOS481x ZX-CAN (Complete cable set 100 cm)

3.4 Connection diagrams

3.4.1 iPOS481x XZ-CAT connection diagram

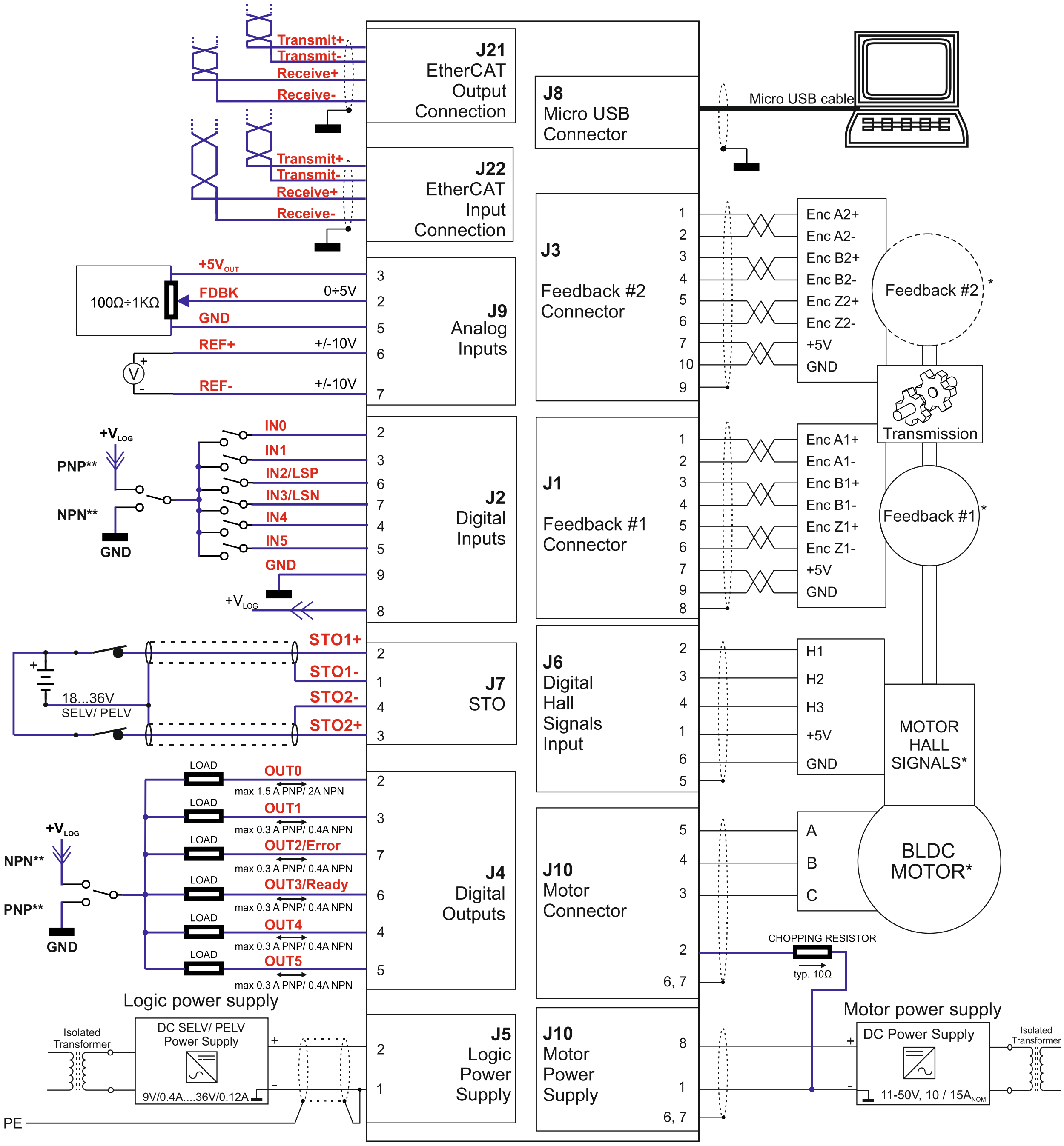


***Figure 4.** iPOS481x XZ-CAT Connection diagram*

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

** Pins are software selectable individually as NPN inputs/outputs

3.4.2 iPOS481x XZ-CAN connection diagram

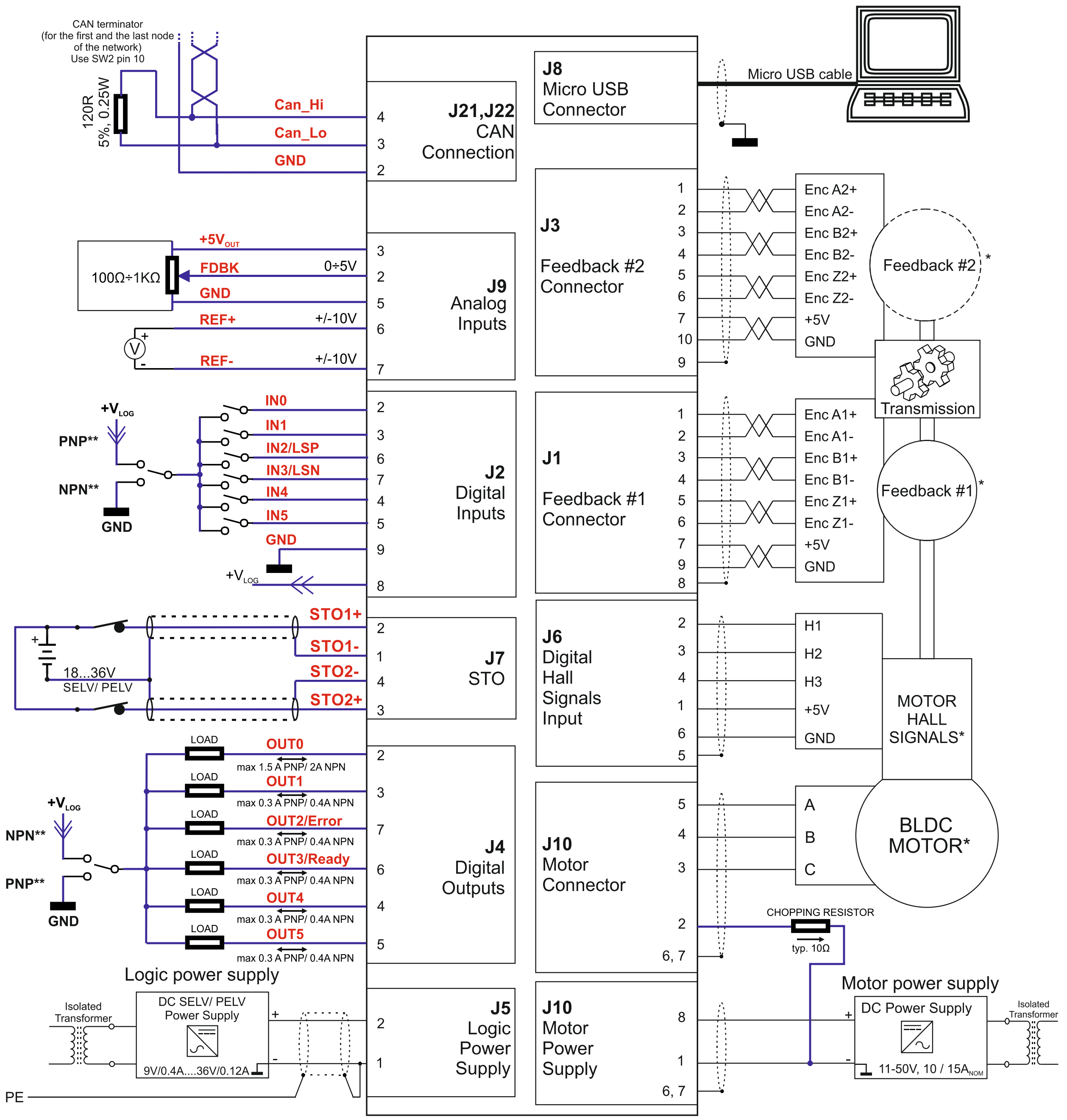


Figure 5. *iPOS481x XZ-CAN Connection diagram*

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

** Pins are software selectable individually as NPN inputs/outputs

3.5 24V Digital I/O Connection

3.5.1 PNP inputs

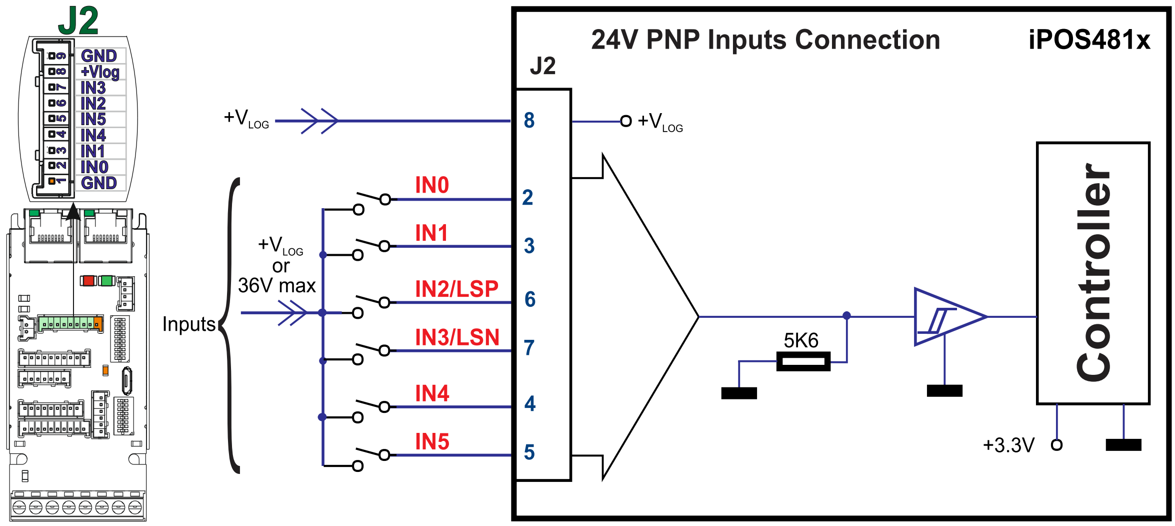


Figure 6. *24V Digital PNP Inputs connection*

Remarks:

1. *The inputs are selectable as PNP/ NPN by software.*
2. *The inputs are compatible with PNP type outputs (input must receive a positive voltage value (5-36V) to change its default state)*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surge in industrial environment.*

3.5.2 NPN inputs

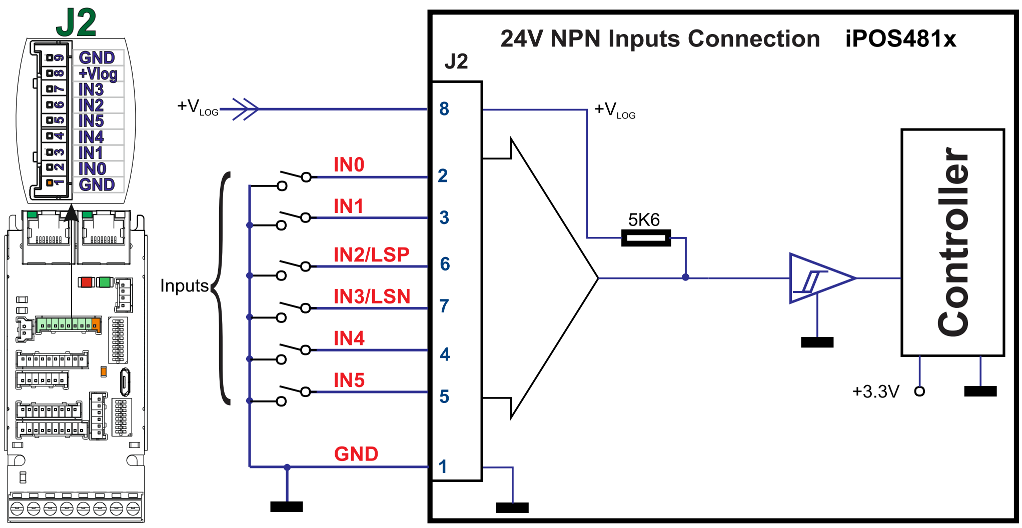


Figure 7. *24V Digital NPN Inputs connection*

Remarks:

1. *The inputs are selectable as PNP/ NPN by software.*
2. *The inputs are compatible with NPN type outputs (input must be pulled to GND to change its default state)*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.5.3 PNP outputs

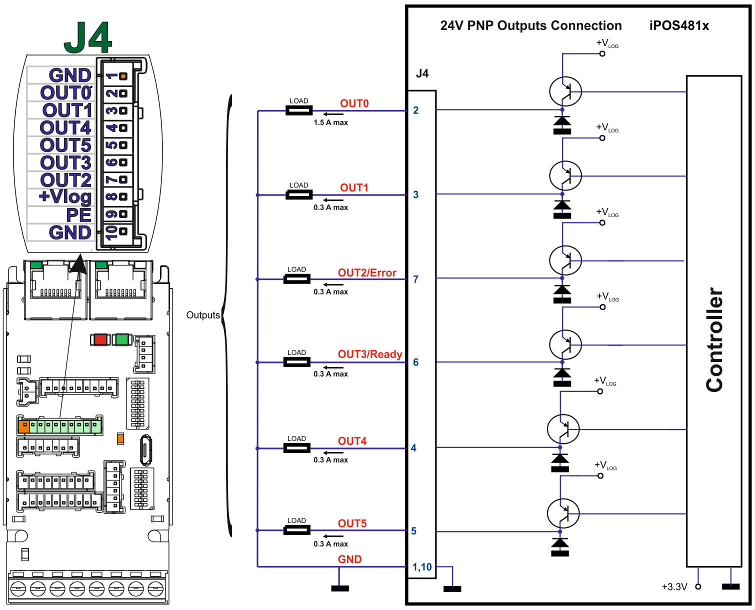


Figure 8. *24V Digital NPN Outputs connection*

Remarks:

1. *The outputs are selectable as PNP/ NPN by software.*
2. *The outputs are compatible with PNP type inputs (load is connected to GND, output pulls to +Vlog when active and is floating when inactive)*

3.5.4 NPN outputs

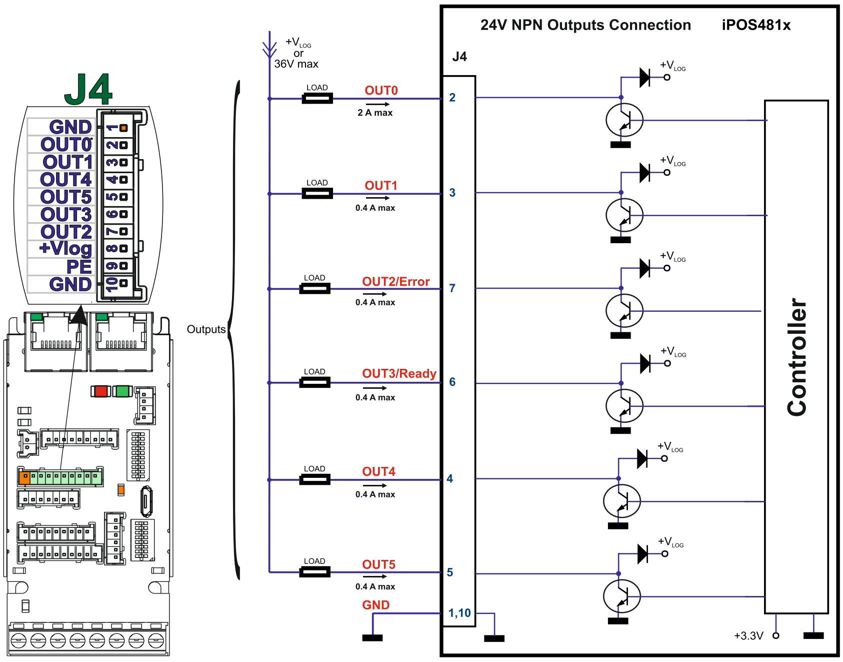


Figure 9. *24V Digital NPN Outputs connection*

Remarks:

1. *The outputs are selectable as PNP/ NPN by software.*
2. *The outputs are compatible with NPN type inputs (load is tied to common +V_{LOG}, output pulls to GND when active and is floating when inactive)*

3.5.5 Solenoid driver connection for motor brake

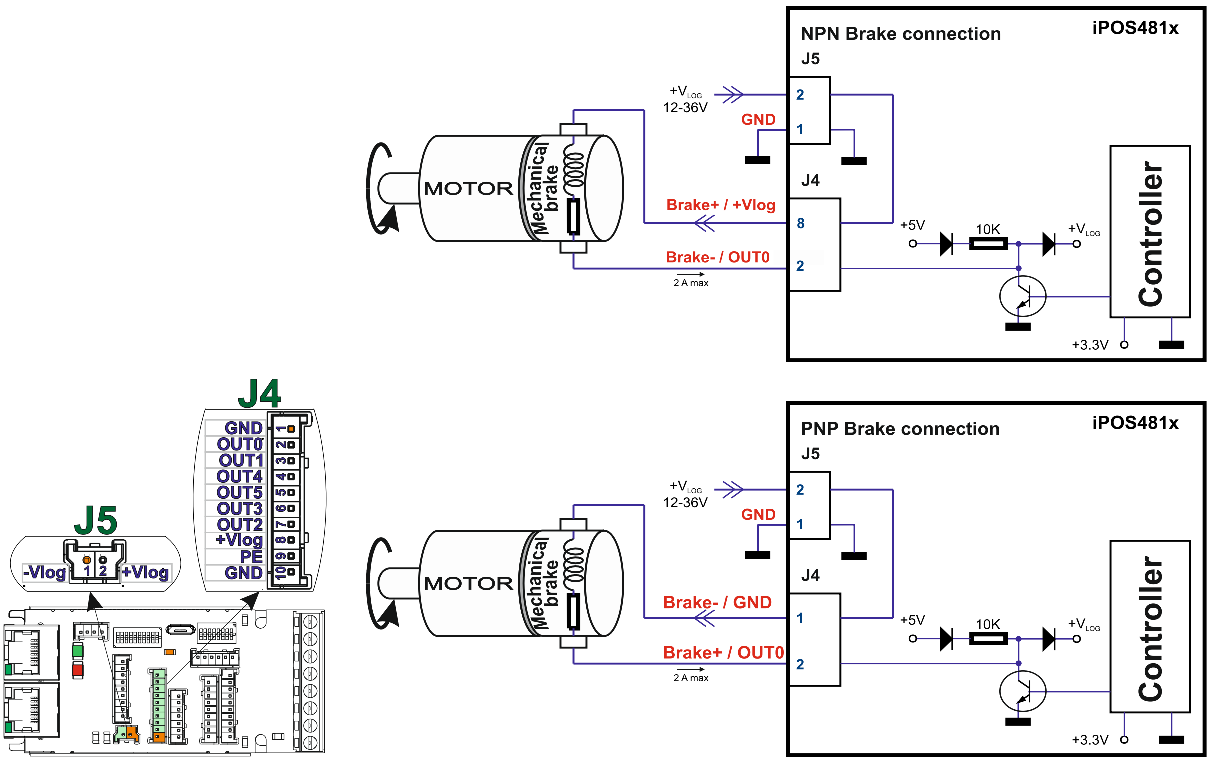


Figure 10. *Solenoid driver connection*

Remarks:

1. *The firmware can control the OUT0 output to automatically engage/disengage a mechanical brake when motor control is started/stopped.*
2. *The pin can also be used as the PNP or NPN general-purpose digital output.*
3. *To enable the mechanical brake functionality select the following checkbox from EasyMotion Studio:*

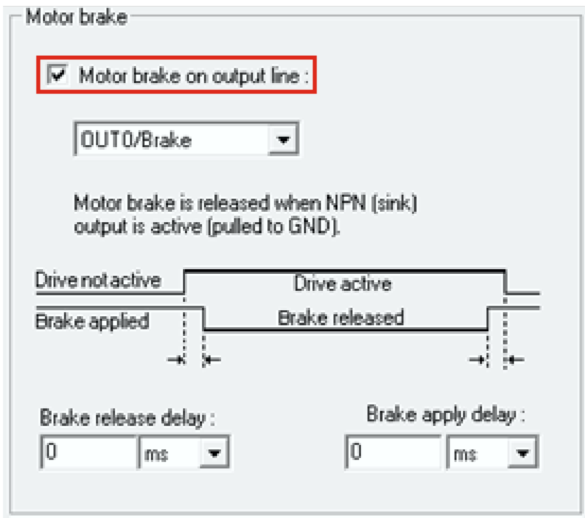


Figure 11. *Motor brake checkbox in EasyMotion Studio*

3.5.6 Analog Inputs Connection

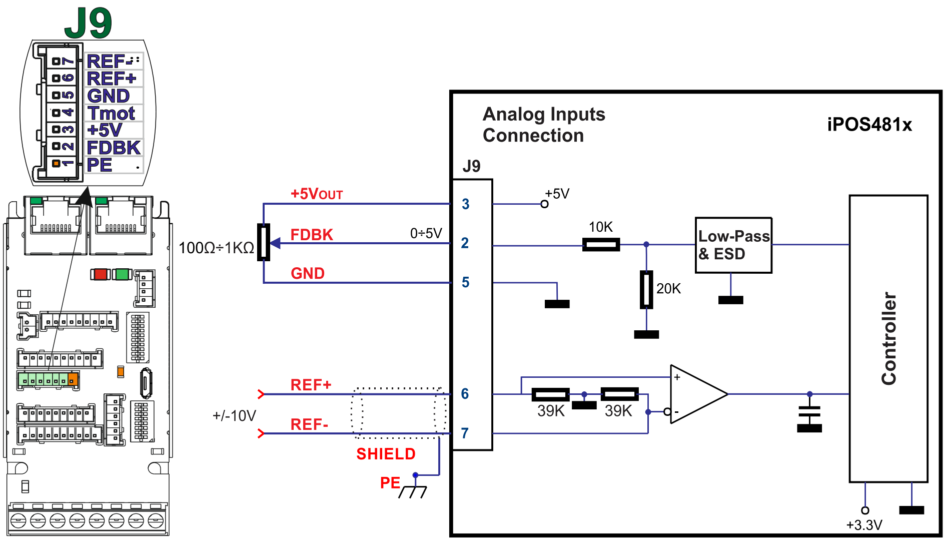


Figure 12. *0-5V Analog inputs connection*

Remarks:

1. *Default input range for analog inputs is 0÷5 V for FBDK and +/-10V for REF.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.5.6.1 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 PE, 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 PE, and is left unconnected at the source side. The source minus (negative, out-of-phase) output remains unconnected.

3.6 Motor connections

3.6.1 Brushless Motor connection

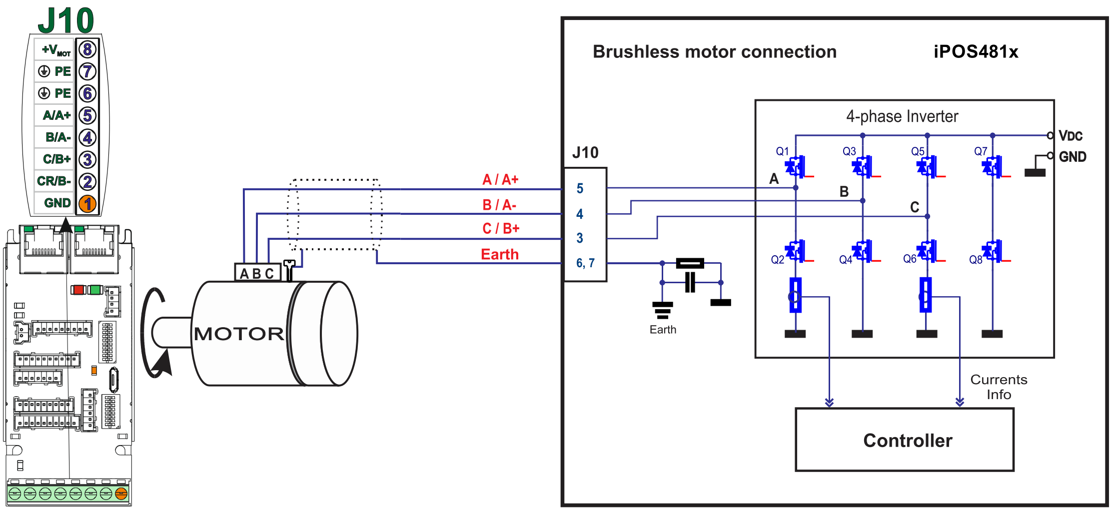


Figure 13. *Brushless motor connection*

Remark: *To hardware enable the motor outputs, the STO circuit must be supplied with minimum +18V.*

3.6.2 2-phase Step Motor connection

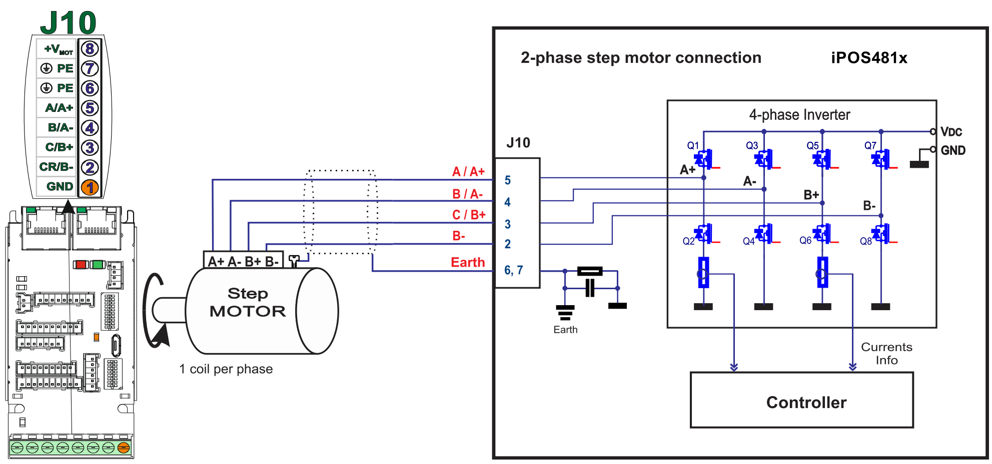


Figure 14. *2-phase step motor connection, one coil per phase*

Remark: *To hardware enable the motor outputs, the STO circuit must be supplied with minimum +18V.*

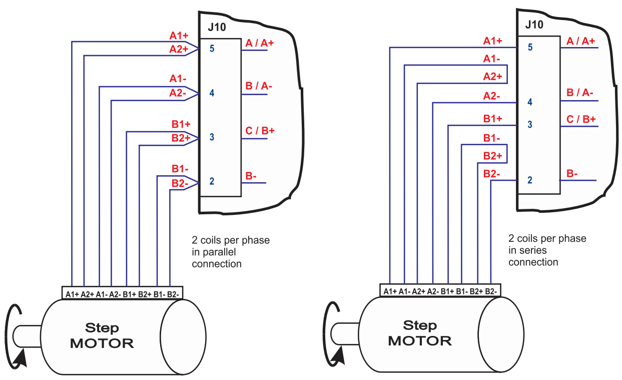


Figure 15. *2-phase step motor connection, two coils per phase*

3.6.3 3-Phase Step Motor connection

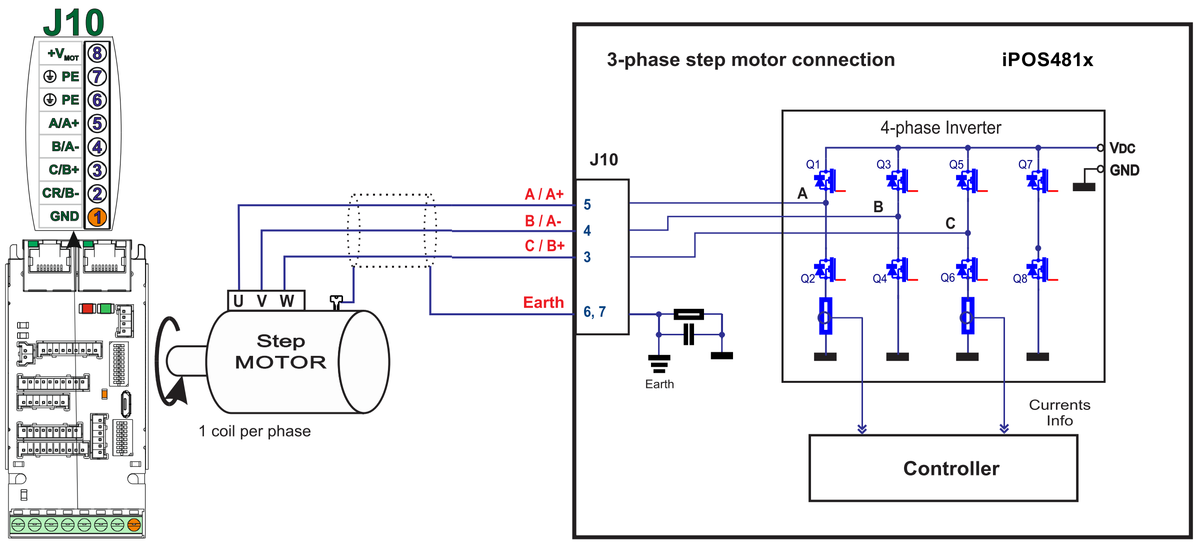


Figure 16. 3-phase step motor connection

Remark: *To hardware enable the motor outputs, the STO circuit must be supplied with minimum +18V.*

3.6.4 DC Motor connection

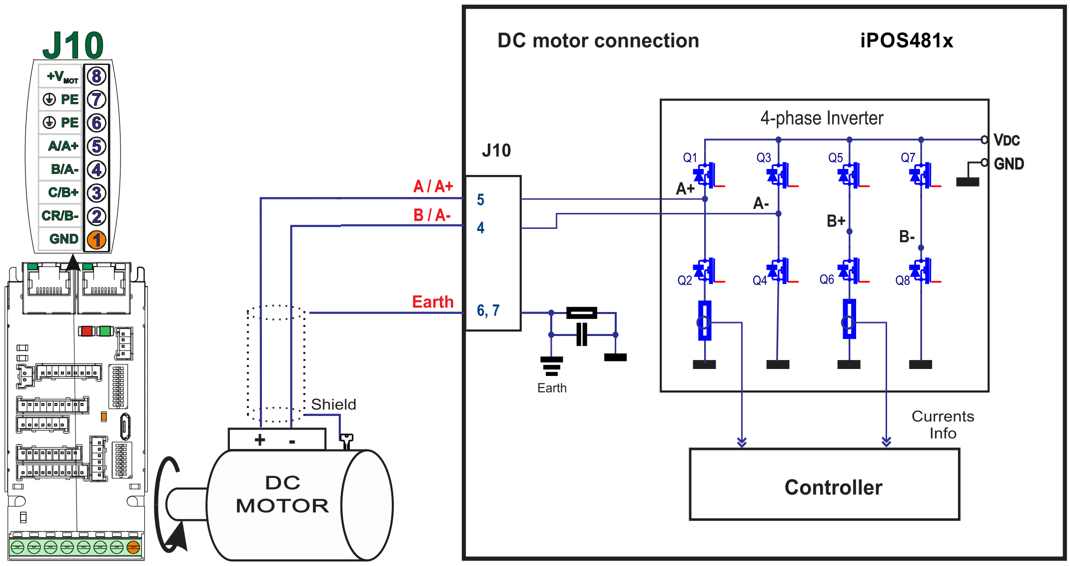


Figure 17. DC Motor connection

Remark: *To hardware enable the motor outputs, the STO circuit must be supplied with minimum +18V.*

3.6.4.1 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 iPOS481x PE pin and it is recommended to be connected also to the motor chassis.

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 iPOS481x 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.

3.7 Feedback connections

3.7.1 Feedback#1 – Single-ended Incremental Encoder connection

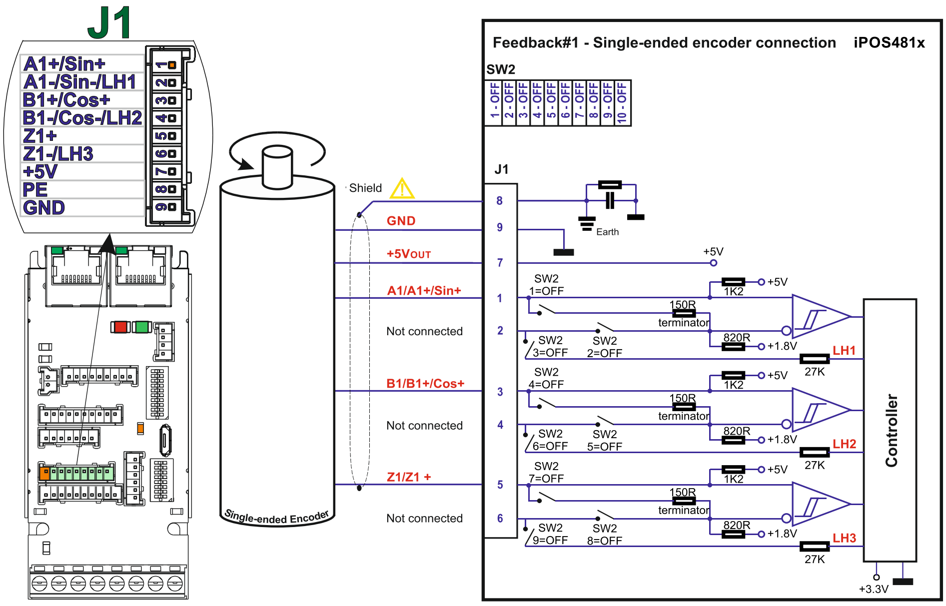


Figure 18. Feedback#1 – Single-ended Incremental Encoder connection

CAUTION!	***Do not connect unterminated wires to pins J1.2, J1.4 and J1.6. They might pick up unwanted noise and give false encoder readings.*** ***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

3.7.2 Feedback#1 – Differential Incremental Encoder connection

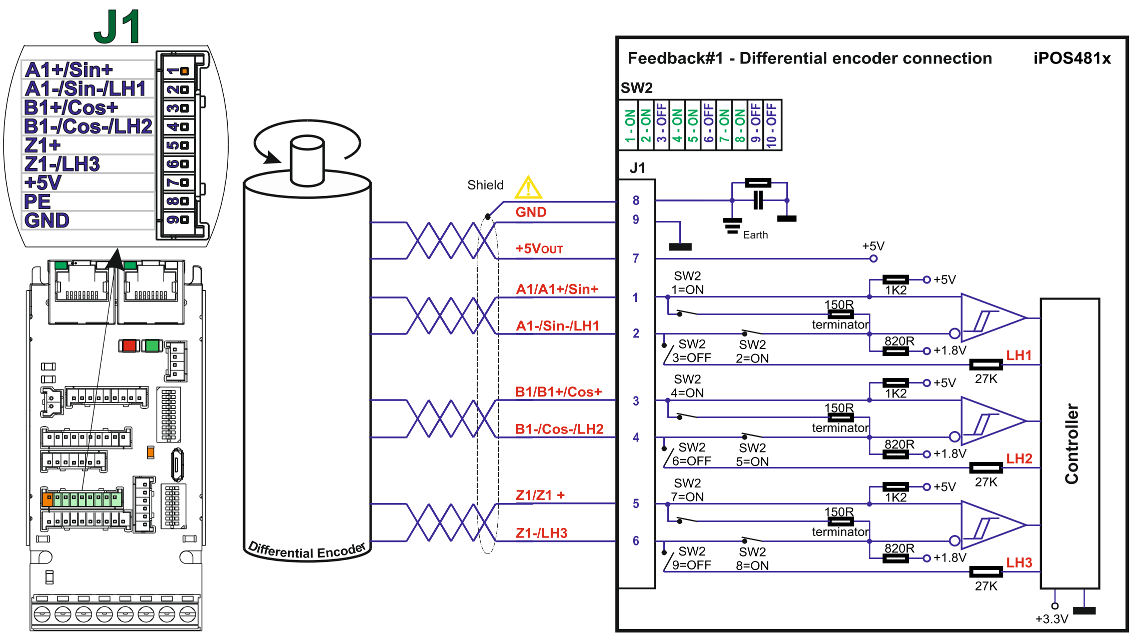


Figure 19. Feedback#1 – Differential Incremental Encoder connection

CAUTION!	***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

Remarks:

1. *For Feedback #1 - Differential connection, 120Ω (0.25W) terminators must be connected for long encoder cables, or noisy environments.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.7.3 Feedback#2 – Differential Incremental Encoder connection

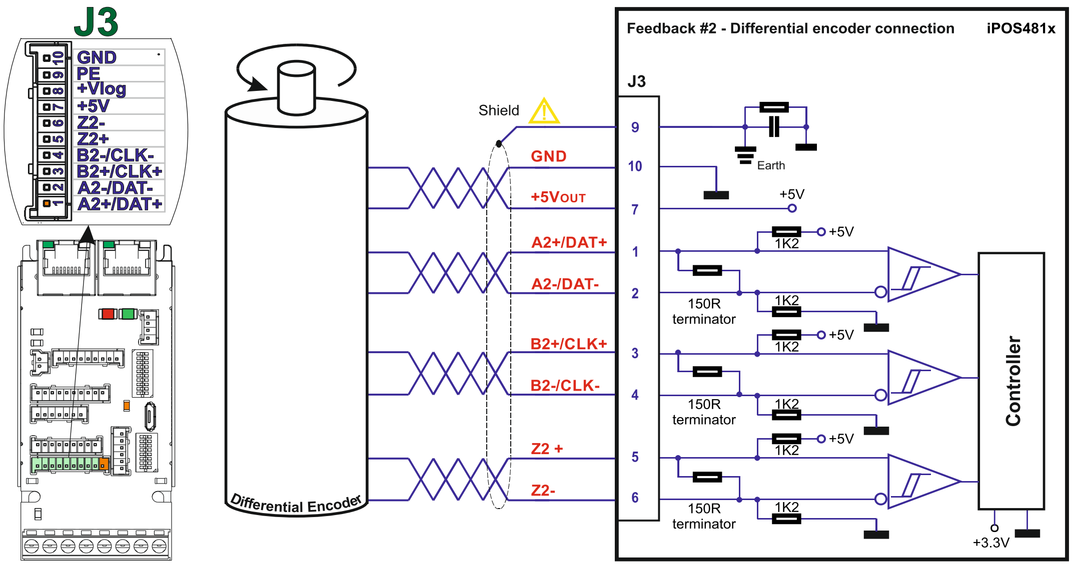


Figure 20. *Feedback#2 – Differential Incremental Encoder connection*

Remarks:

1. *Feedback #2 has internal terminators, equivalent to 120Ω (0.25W) , present in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

3.7.4 Feedback#1 – Sine-Cosine Encoder connection

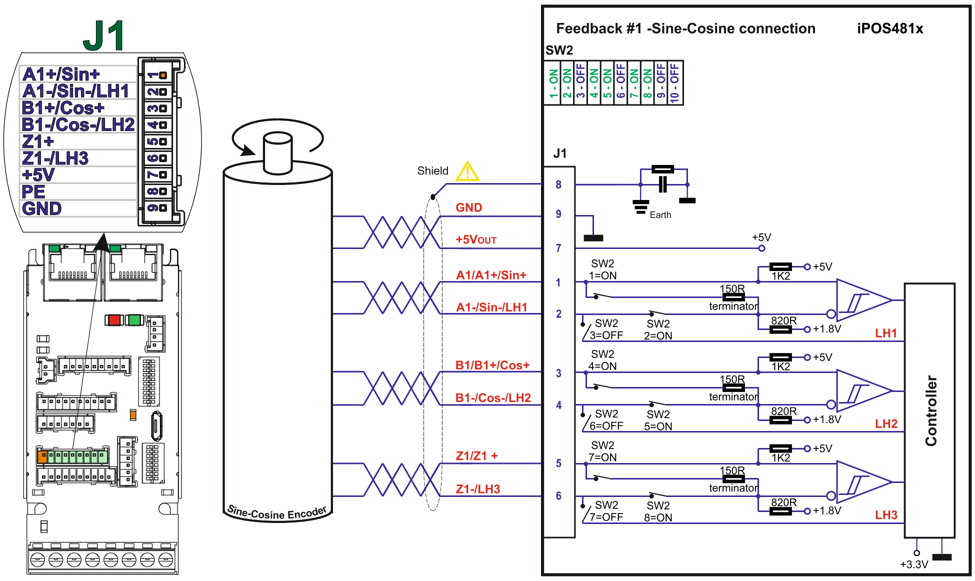


Figure 21. *Sine-Cosine analogue encoder connection*

CAUTION!	***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

3.7.5 Feedback#2 – Absolute Encoder connection: SSI, BISS-C, EnDAT

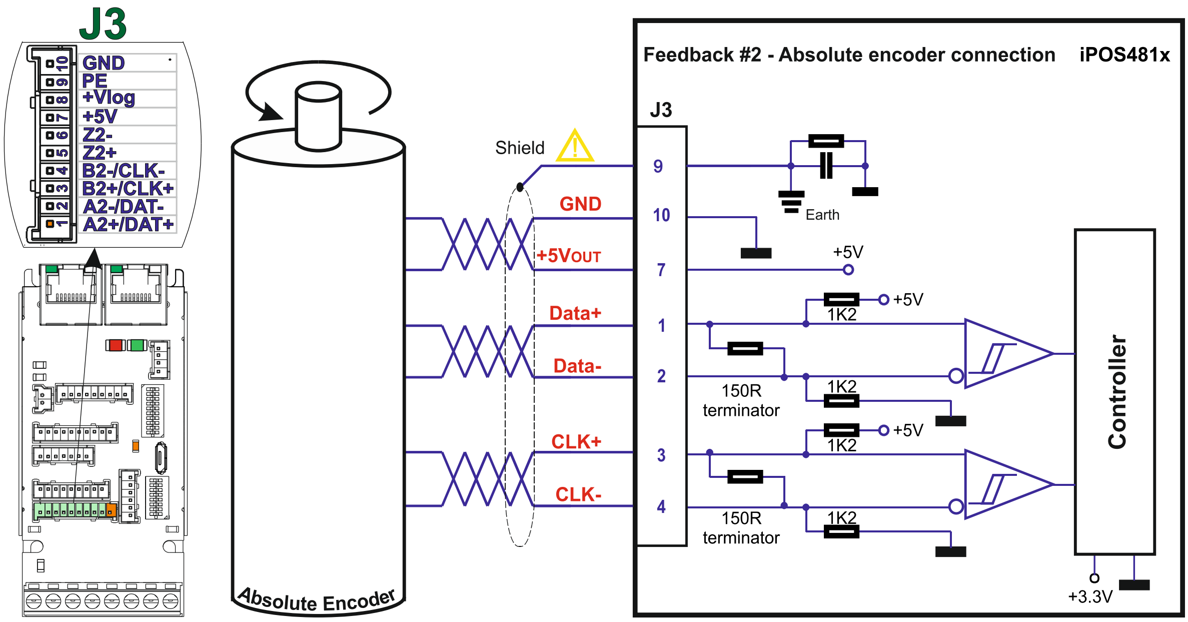


Figure 22. *Absolute encoder #2 connection: SSI, BISS-C, EnDAT*

Remarks:

1. *Feedback #2 has internal terminators, equivalent to 120Ω (0.25W) , present in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

3.7.6 Feedback#2 – Absolute Encoder connection: Nikon, Panasonic, Sanyo Denki, Tamagawa

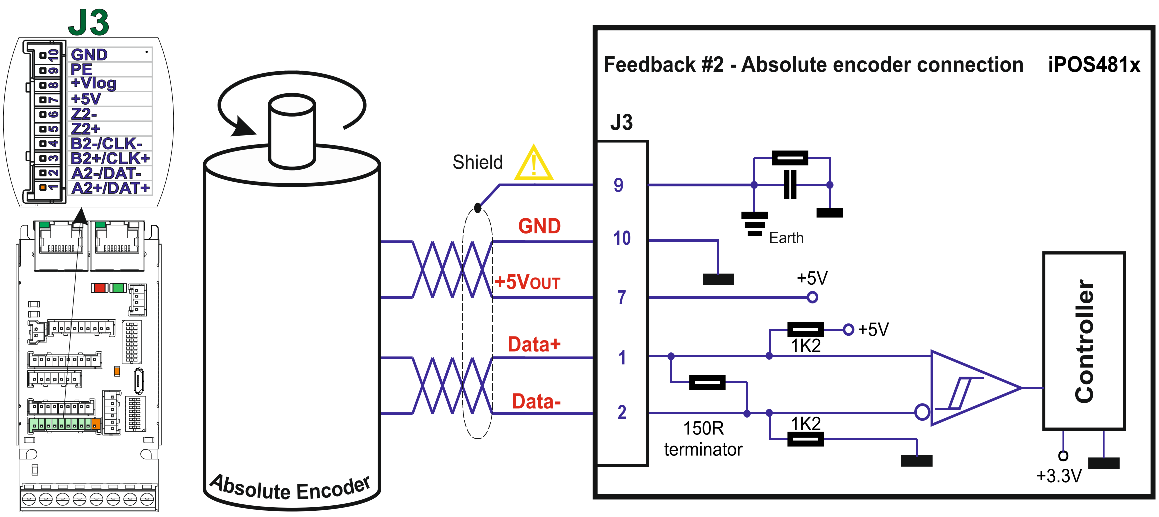


Figure 23. *Absolute encoder #2 connection: Nikon, Panasonic, Sanyo Denki, Tamagawa*

Remarks:

1. *Feedback #2 has internal terminators, equivalent to 120Ω (0.25W) , present in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to system PE to avoid disturbances / noise induced by nearby cables.***

3.7.7 Feedback#1 – Linear Hall connection

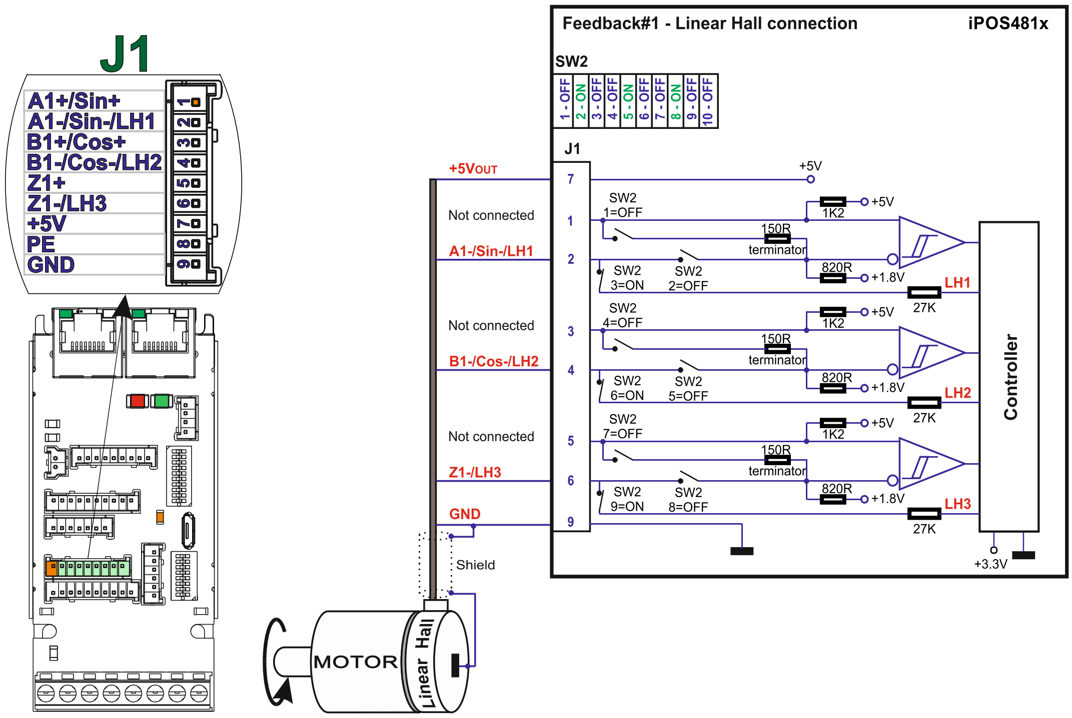


Figure 24. Linear Hall connection

CAUTION!	***Linear Hall cable shield must be connected to system GND to avoid disturbances / noise induced by nearby cables.***

3.7.8 Digital Hall Connection for Motor + Hall + Incremental Encoder

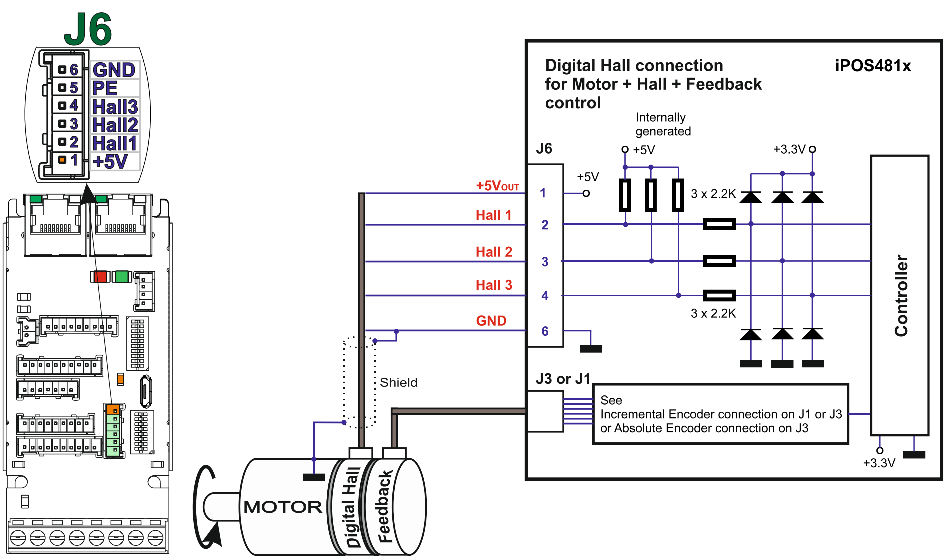


Figure 25. Digital Hall connection for Motor + Hall +Feedback control

Remarks:

1. *This connection is required when using Hall start method BLDC or PMSM and also for the Trapezoidal commutation method. The digital halls are not used in this case as a feedback measurement device. The actual motor control is done with an incremental encoder.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

⚠	**CAUTION!**	***Digital Hall cable shield must be connected to system GND to avoid disturbances / noise induced by nearby cables.***

3.7.9 Digital Hall Connection for direct motor control without an encoder

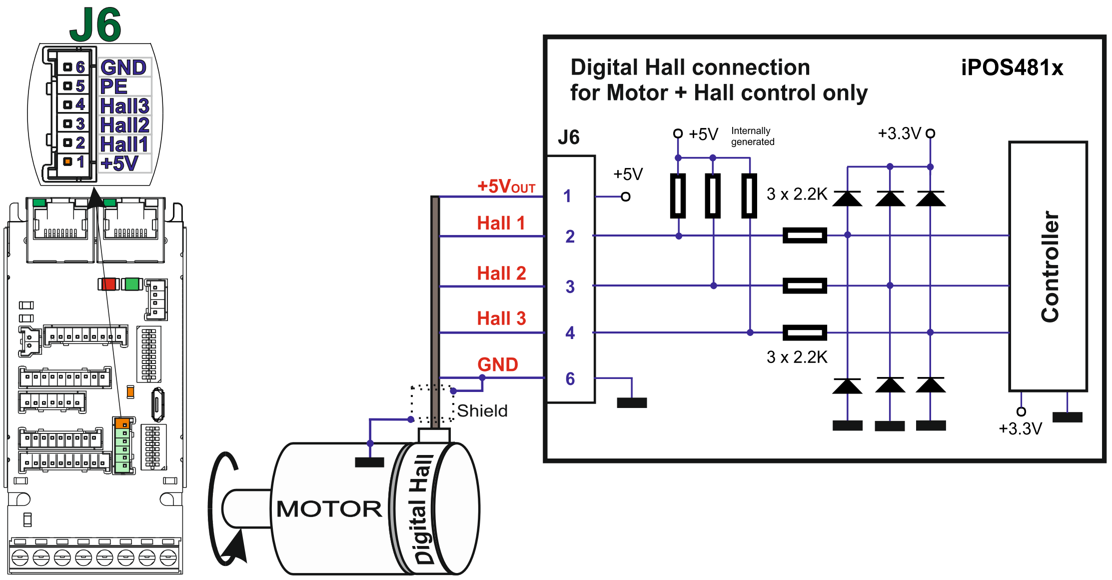


Figure 26. *Digital Hall connection for Motor + Hall control*

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. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

⚠	**CAUTION!**	***Digital Hall cable shield must be connected to system GND to avoid disturbances / noise induced by nearby cables.***

3.7.10 Digital Hall Connection for direct motor control without an encoder

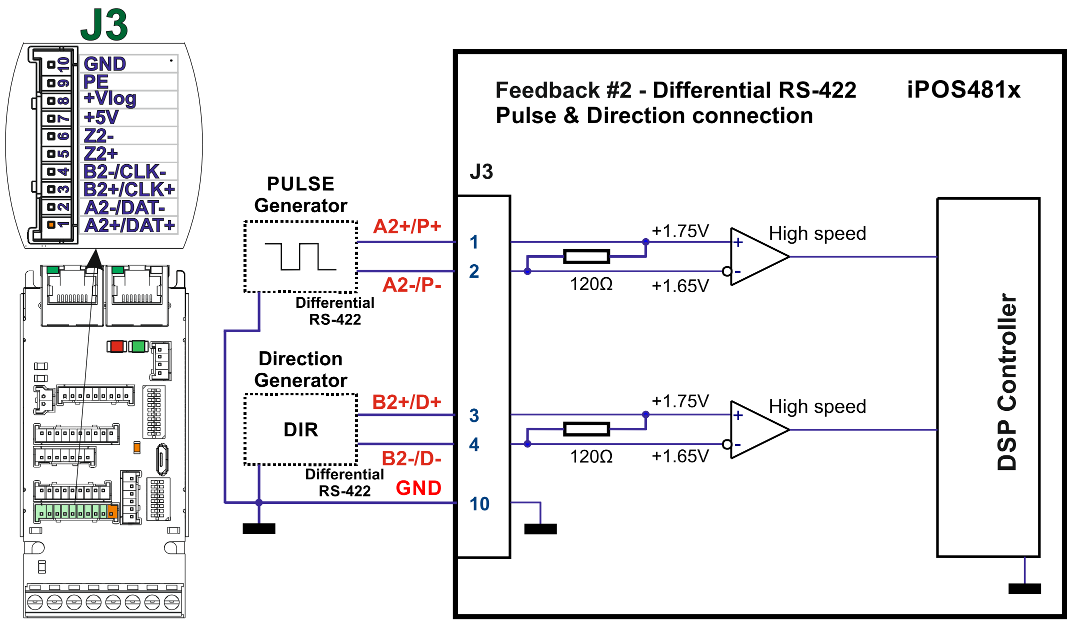


Figure 27. *Digital Hall connection for Motor + Hall control*

3.7.10.1 General recommendations for feedback 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.

c) If only a GND pin is available in feedback connector, the cable shield must be connected to the GND at both ends. If a PE (protective earth) pin is present, the cable shield must be connected to the PE at one end and it is recommended to also connect the other end to the motor chassis.

d) If the iPOS481x 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.

3.8 Power Supply and STO Connection

3.8.1 Supply Connection

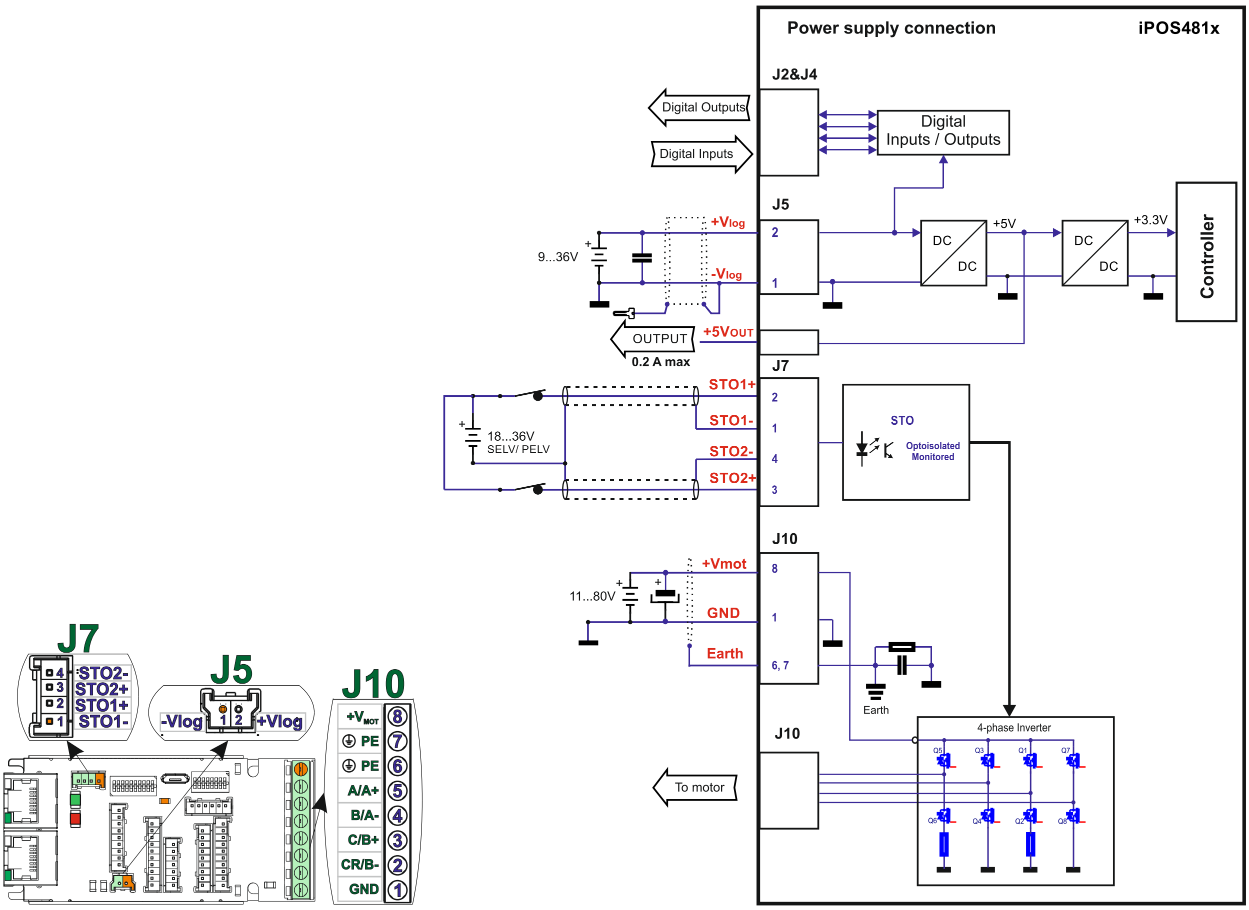


Figure 28. *Supply connection*

Remarks:

1. *The STO and +Vlog inputs can be supplied from the same power source as long as its output voltage is 18 to 36V DC from a SELV/ PELV power supply.*
2. *An external electrolytic capacitor may be added between +Vmot and GND, to help reduce over-voltage during load braking/ reversals. See paragraph 3.5.7.2 for details.*
3. *When the STO inputs are left unconnected, the motor outputs will be disabled. This provides a dual redundant hardware protection that cannot be overdriven by the software or other hardware components.*
4. *The STO circuit must be supplied with minimum 18V to enable PWM output.*

3.8.1.1 Recommendations for Supply Wiring

a) The iPOS481x always requires three supply voltages: +Vlog, +Vmot and STO. The STO and +Vlog inputs can be supplied from the same power source as long as its output voltage is 18 to 36V DC from a SELV/ PELV power supply.

b) Use short, thick wires between the iPOS481x 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 4,700μF (rated at an appropriate voltage) right on the terminals of the iPOS481x.

c) It is recommended to connect the negative motor supply return (GND) to the Earth protection near the power supply terminals.

d) The motor power supply cable shield must be connected to PE (Protective Earth) – J10 pins 6, 7 and it is recommended to be also connected to the motor chassis. The logic power supply cable shield must be connected to GND at both ends.

3.8.1.2 Recommendations to limit over-voltage during braking

During abrupt motion brakes 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 bypasses 53V, the drive over-voltage protection is triggered and the drive power stage is disabled. In order to avoid this situation you have 2 options:

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} = 53V 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:

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

where:

J_M – total rotor inertia [kgm^2]

J_L – total load inertia as seen at motor shaft after transmission [kgm^2]

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/s^2]

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

h_{final} – final system altitude [m]

I_M – motor current during deceleration [A_{RMS}/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].

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

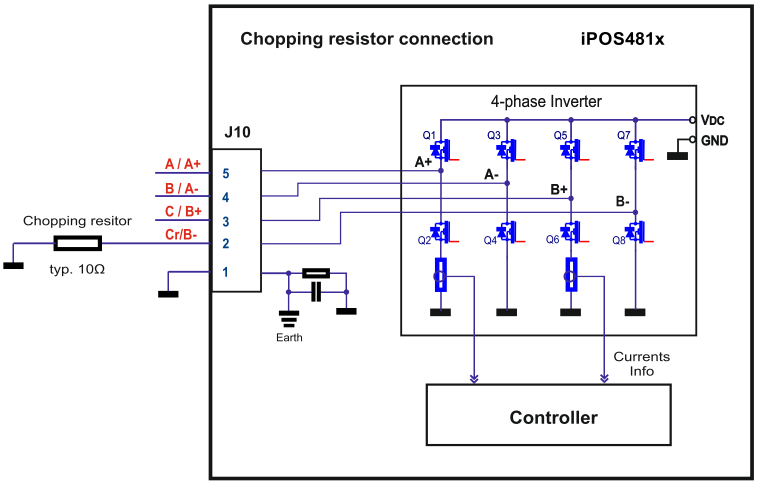


Figure 29. *Chopping resistor connection*

Remark: 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} = 20A

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

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}=8A

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

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 $P_{AV} = \frac{P_{CR} \times t_d}{t_{CYCLE}}$ and a peak power $P_{PEAK} = \frac{U_{MAX}^2}{R_{CR}}$

Remarks:

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

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

3.9 USB connection

3.9.1 USB connection

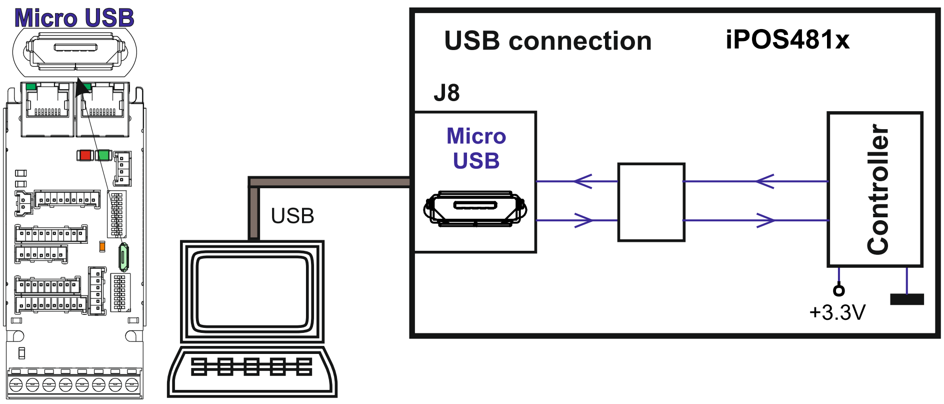


Figure 30. *USB connection*

For the USB connection a standard Micro USB cable is required.
The drivers are found automatically in Windows 10 and the device is identified as a COM port.
In Easy Motion studio, choose the following communication settings:

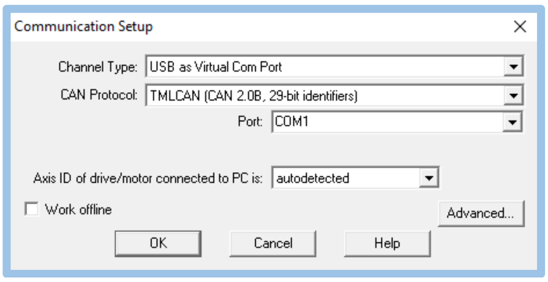


Figure 31. *USB connection*

Instead of COM1, choose the new COM value detected after the driver is installed.

Remark:

1. *EasyMotion Studio can communicate either with RS232 or USB communication (not both at the same time).*
2. *EasyMotion Studio can communicate in parallel with RS232/USB communication while CAN or EtherCAT communication is active.*

3.10 CAN-bus connection (for CAN drives only)

3.10.1 CAN connection

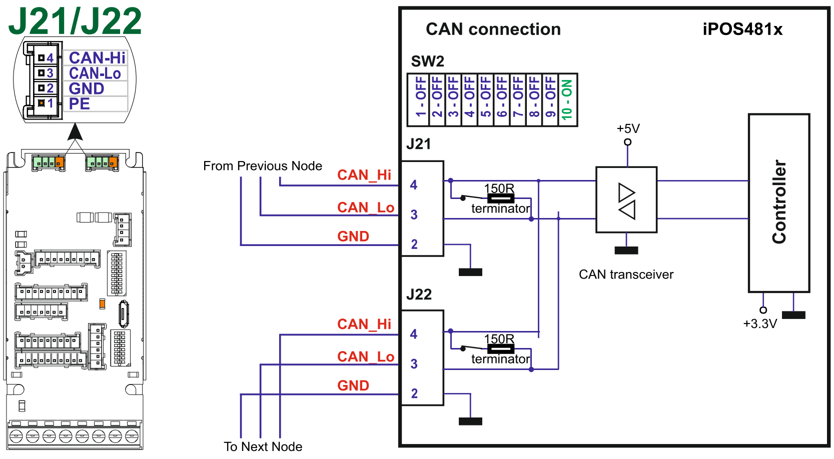


Figure 32. *CAN connection*

Remarks:

1. *For the CAN network, 120-Ohm terminators are internally present in the drive (SW2 pin10 – ON).*
2. *CAN signals are not insulated from other iPOS481x circuits.*
3. *EasyMotion Studio can communicate in parallel with RS232 or USB communication while CAN communication is active*

3.10.1.1 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) When using a printed circuit board (PCB) motherboard based on FR-4 material, build the CAN network using a pair of 12mil (0.012”) tracks, spaced 8 to 10mils (0.008”…0.010”) apart, placed over a local ground plane (microstrip) which extends at least 1mm left and right to the tracks.

c) 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.

d) The 120Ω termination resistors must be rated at 0.2W minimum. Do not use winded resistors, which are inductive.

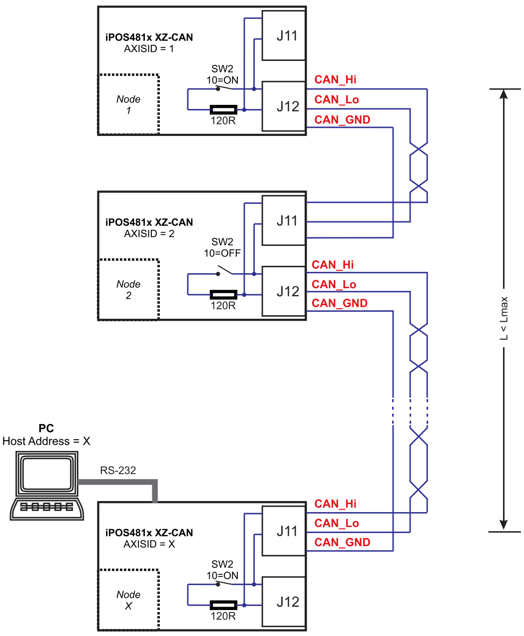


Figure 33. *Multiple-Axis CAN network*

3.11 Recommendations for EtherCAT Wiring (for CAT drives)

a) Build EtherCAT® network using UTP (unshielded twisted pair) cables rated CAT5E or higher (CAT6, etc.). Cables with this rating must have multiple characteristics, as described in TIA/EIA-568-B. Among these are: impedance, frequency attenuation, cross-talk, return loss, etc.
b) It is acceptable to use STP (shielded twisted pair) or FTP (foil twisted pair) cables, rated CAT5E or higher (CAT6, etc.). The added shielding is beneficial in reducing the RF (radio-frequency) emissions, improving the EMC emissions of the application.
c) The maximum length of each network segment must be less than 100 meters.
d) The network topology is daisy-chain. All connections are done using point-to-point cables. The global topology can be one of the two:
   - Linear, when the J7 / OUT port of the last drive in the chain remains not connected. Master is connected to J6 / IN port of the first drive; J7 / OUT of the first drive is connected to J6 / IN of the following drive; J7 / OUT of the last drive remains unconnected.

   See ***Figure 34.*** *EtherCAT network linear topology* for a visual representation of the linear topology.
   - Ring, when the J7 / OUT port of the last drive in the chain is connected back to the master controller, on the 2nd port of the master. This topology consists of the linear topology described above, plus an extra connection between the master, which has two RJ45 ports, to J7 / OUT of the last drive.

   See ***Figure 35.*** *EtherCAT network ring topology* for a visual representation of the ring topology.
e) Ring topology is preferred for its added security, since it is insensitive to one broken cable / connection along the ring (re-routing of communication is done automatically, so that to avoid the broken cable / connection)
f) It is highly recommended to use qualified cables, assembled by a specialized manufacturer. When using CAT5E UTP cables that are manufactured / commissioned / prepared on-site, it is highly recommended to check the cables. The check should be performed using a dedicated Ethernet cable tester, which verifies more parameters than simple galvanic continuity (such as cross-talk, attenuation, etc.). The activation of "Link" indicators will NOT guarantee a stable and reliable connection! This can only be guaranteed by proper quality of cables used, according to TIA/EIA-568-B specifications.

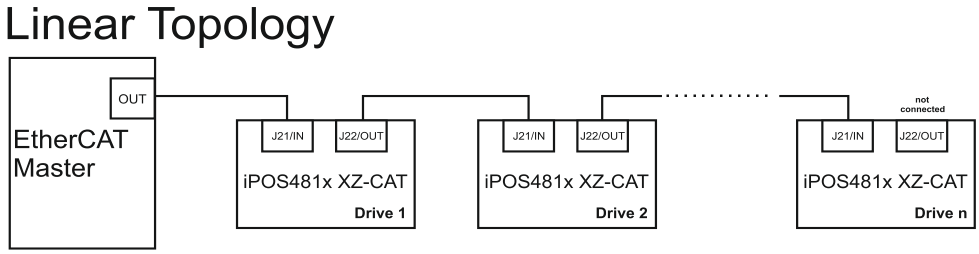


Figure 34. *EtherCAT network linear topology*

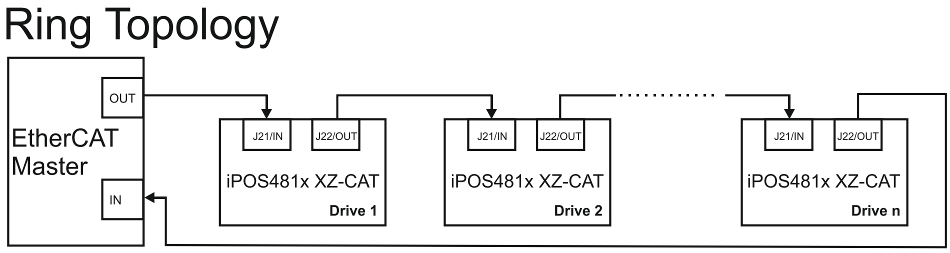


Figure 35. *EtherCAT network ring topology*

Remark: *EasyMotion Studio can communicate in parallel with RS232 or USB communication while EtherCAT communication is active.*

3.12 Disabling the setup table at startup (CAT drives); Disabling Autorun (CAN drives)

3.12.1 Disabling Autorun (for CAN drives)

When an iPOS481x XZ-CAN is set in TMLCAN operation mode, by default after power-on it enters automatically in Autorun mode. In this mode, if the drive has in its local EEPROM a valid TML application (motion program), this is automatically executed as soon as the motor supply V_{MOT} is turned on.

In order to disable Autorun mode, there are 2 methods:

a) Software - by writing value 0x0001 in first EEPROM location at address 0x2000

b) Hardware1 – set the drive temporarily in CANopen mode. While in CANopen state, no motion will autorun. Set SW1 pin8 in “ON” position.

c) Hardware2 – by temporary connecting all digital Hall inputs to GND, during the power-on for about 1 second, until the green LED is turned on, as shown in Figure 36. Temporary connection during power-on to remove the drive from Autorun mode or disable Setup”. This option is particularly useful when it is not possible to communicate with the drive.

After the drive is set in non-Autorun/slave mode using 2nd method, the 1st method may be used to invalidate the TML application from the EEPROM. On next power on, in absence of a valid TML application, the drive enters in the non-Autorun/slave mode independently of the digital Hall inputs status.

3.12.2 Disabling the setup table at startup (for CAT drives)

I In some very rare cases, the setup table might be corrupted, causing the drive to reset continuously. This state can be noticed by seeing both the Ready and Error LED blinking for short periods of time continuously.

To recover from this state, the setup table must be invalidated by connecting all digital Hall inputs to GND.

On the next power on, the drive will load the default settings and set bit 2 from Motion Error Register – “Invalid Setup Data ”. After a new valid setup table is loaded onto the drive, disconnect the hall sensors from GND and execute a new power off/ power on cycle.

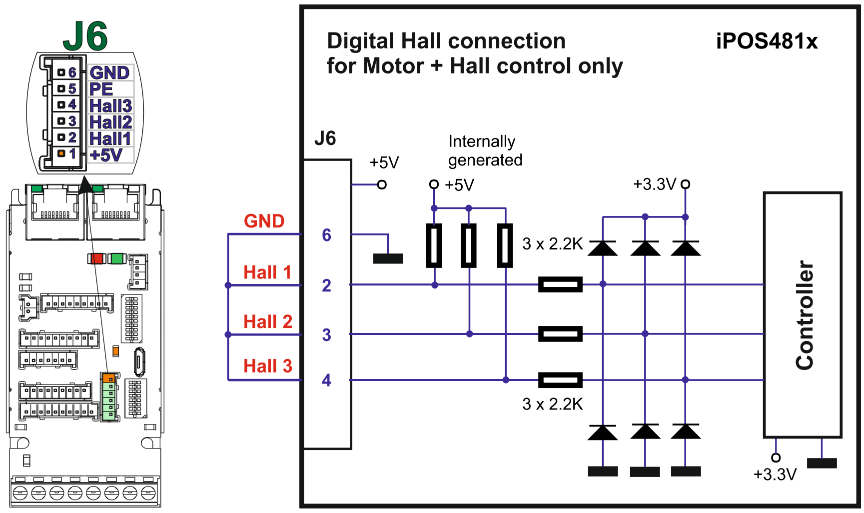


Figure 36. *Temporary connection during power-on to remove the drive from Autorun mode or disable Setup*

3.13 CAN Operation Mode and Axis ID Selection for CAN drives

The CAN Operation mode is selected by the DIP switch pin8:

- ON= CANopen mode
- OFF= TMLCAN mode

The drive AxisID value is set after power on by:

- Software, setting via EasySetUp or EasyMotion Studio a specific AxisID value in the range 1-255.
- Hardware, by setting h/w in Easy SetUp and configuring the AxisID using SW1 switch

The communication protocol as well as the Hardware Axis ID can be set by the SW1 switch.

- Switch ON -> Bit = 0
- Switch OFF -> Bit = 1

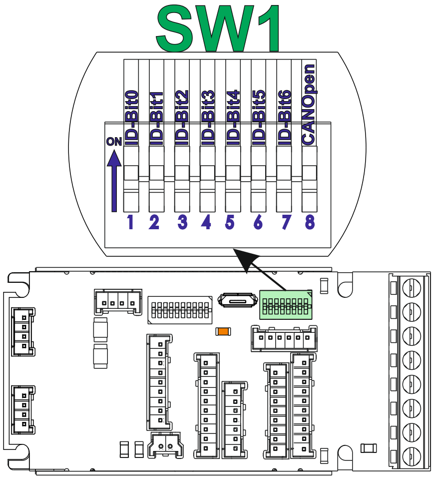


***Figure 37.** SW1 – DIP Switch settings*

- AxisID values: from 1 to 127 and 255 when all switches are ON.
- All pins are sampled at power-up, and the drive is configured accordingly.
- *In CANopen, when Axis ID is 255 the drive will be in "non-configured" state waiting for a CANopen master to configure it, using CiA-305 protocol. <u>A "non-configured" drive answers only to CiA-305 commands. All other CANopen commands are ignored and transmission of all other messages (including boot-up) is disabled.</u>*
- When the drive setup is invalid, the drive AxisID is set according to HW AxisID

3.13.1 LED indicators for CAN drives

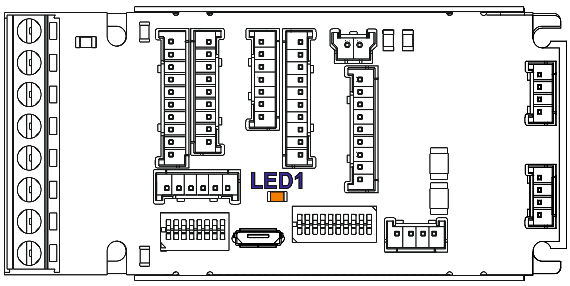


***Figure 38.** LED indicators*

***Table 1.** LED indicators description*

LED no.	LED name	LED color	Function
1	**LED1**	yellow	Indicates that logic supply is present.

3.14 AxisID Selection for CAT drives

The iPOS481x XZ-CAT drives support all EtherCAT standard addressing modes. In case of device addressing mode based on node address, the drive sets the EtherCAT register called “configured station alias” address with its AxisID value.
The drive AxisID value is set after power on by:

- Software, setting via EasySetUp or EasyMotion Studio a specific AxisID value in the range 1-255.
- Hardware, by setting h/w in Easy SetUp and configuring the AxisID using SW1 switch

The communication protocol as well as the Hardware Axis ID can be set by the SW1 switch.

- Switch ON -> Bit = 0
- Switch OFF -> Bit = 1

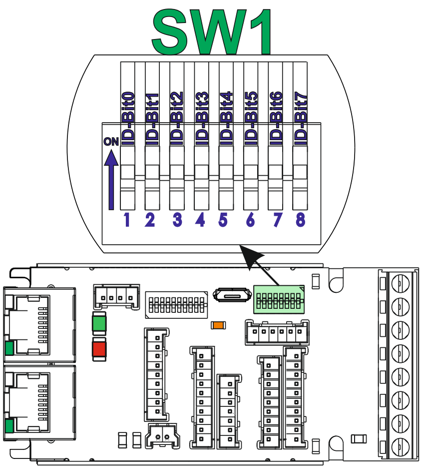


Figure 39. *SW1 – DIP Switch settings*

- AxisID values: from 1 to 255. AxisID = 255 also when all switches are ON.
- In EtherCAT, when Axis ID is 255, the register called “configured station alias” will be 0.
- All pins are sampled at power-up, and the drive is configured accordingly.
- When the drive setup is invalid, the drive AxisID is set according to HW AxisID

3.14.1 LED indicators for CAT drives

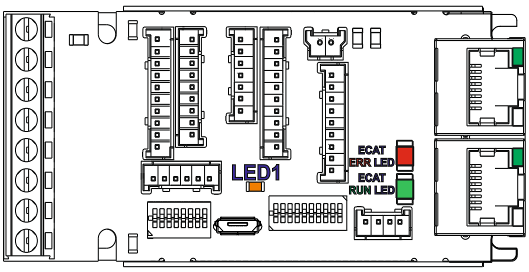


Figure 40. *LED indicators*

Table 2. *LED indicators description*

LED	LED name	LED color	Function
1	**LED1**	yellow	Indicates that logic supply is present.
2	**EtherCAT® RUN**	green	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
3	**EtherCAT® ERROR**	red	Turned on when the drive detects an error condition.
4	**EtherCAT® OUT Link/Activity**	green	Shows the state of the physical link and activity.

3.14.2 EtherCAT® RUN and ERROR LED Indicators

The RUN states are displayed with a 180 degree phase shift to the ERROR states as noted in Figure 41. STATUS indicator Example.

The behavior of the RUN indicator is specified in Table 3. RUN Indicator States" and the behavior of the ERROR indicator specified in Table 4. ERROR Indicator States".

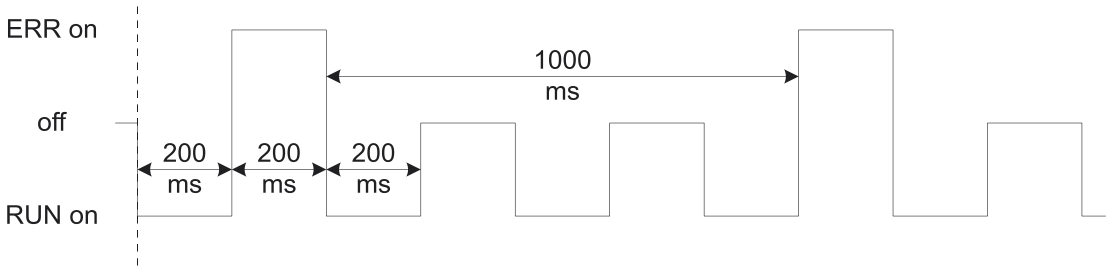


Figure 41. *STATUS indicator Example*

Table 3. *RUN Indicator States*

Indicator states	Slave State	Description
Off	INITIALISATION	The drive is in state INIT
Blinking	PRE-OPERATIONAL	The drive is in state PRE-OEPRATIONAL
Single Flash	SAFE-OPERATIONAL	The drive is in state SAFE-OPERATIONAL
On	OPERATIONAL	The drive is in state OPERATIONAL

Table 4. *ERROR Indicator States*

ERR state	Error name	Description
On	Application controller failure	An critical communication or application controller error has occurred
Double Flash	Process Data Watchdog Timeout/ EtherCAT Watchdog Timeout	An application watchdog timeout has occurred.
Single Flash	Local Error	Slave device application has changed the EtherCAT state autonomously, due to local error (see ETG.1000 part 6 EtherCAT State Machine). Error Indicator bit is set to 1 in AL Status register.
Blinking	Invalid Configuration	General Configuration Error
Flickering	Booting Error	Booting Error was detected. INIT state reached, but Error Indicator bit is set to 1 in AL Status register
Off	No error	The EtherCAT communication of the device is in working condition

For a more detailed description of EtherCAT® LED functionalities please read ETG.1300 S (R) V1.0.1 available at www.EtherCAT.org

3.15 Electrical Specifications

All parameters measured under the following conditions (unless otherwise specified):

- V_{LOG} = 24 VDC; V_{MOT} = 48VDC; F_{PWM} = 20kHZ
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude) = 14.1 A for iPOS4810 XZ and 21.2 A for iPOS4815 XZ

3.15.1 Operating Conditions

		Min.	Typ.	Max.	Units
Ambient temperature[1]		0		+40	ºC
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	Altitude (referenced to sea level)	-0.1	0 ÷ 2.5	[2]	Km
	Ambient Pressure	0 [2]	0.75 ÷ 1	10.0	atm

3.15.2 Storage Conditions

		Min.	Typ.	Max.	Units
Ambient temperature		-40		100	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

3.15.3 Mechanical Mounting

		Min.	Typ.	Max.	Units
Airflow		natural convection[3], 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

3.15.4 Environmental Characteristics

			Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Global size	iPOS481x XZ-CAT	93 x 43.8 x 32			mm
			~3.66 x 1.72 x 1.26			inch
		iPOS481x XZ-CAN	93 x 43.8 x 30.4			mm
			~3.66 x 1.72 x 1.2			inch
Weight		iPOS481x XZ-CAT	~80			g
		iPOS481x XZ-CAN				
Cleaning agents	Dry cleaning is recommended		Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508		IP20			-

3.15.5 Logic Supply Input (+V_{LOG})

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	9		36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8		40	V_{DC}
	Absolute maximum values, continuous	-0.6		42	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		+45	V
	+V_{LOG} = 12V		150		mA
	+V_{LOG} = 24V		100		
	+V_{LOG} = 40V		80		
Utilization Category	Acc. to 60947-4-1 (IPEAK<=1.05*INOM)	DC-1			

3.15.6 Motor Supply Input (+V_{MOT})

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	11		50	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	9		52	V_{DC}
	Absolute maximum values, continuous	-0.6		54	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		57	V
Supply current	Idle		1	5	mA
	Operating	-40	±10	+40	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			43	A
Utilization Category	Acc. to 60947-4-1 (IPEAK<=4.0*INOM)	DC-3			

[1] Operating temperature at higher temperatures is possible with reduced current and power ratings

[2] iPOS481x 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] In case of forced cooling (conduction or ventilation) the spacing requirements may drop down to mechanical tolerances as long as the ambient temperature is kept below the maximum operating limit

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

			Min.	Typ.	Max.	Units
Nominal current	PMSM motors sinusoidal amplitude	iPOS4810			14.1	A
		iPOS4815			21.2	
	PMSM motors sinusoidal RMS	iPOS4810			10	
		iPOS4815			15	
	DC/BLDC motors continuous	iPOS4810			12.2	
		iPOS4815			18.3	
Peak current	Maximum: - 1.56s for iPOS4810 MZ; - 12.5s for iPOS4815 MZ.		-40		+40	A
Short-circuit protection threshold	(sinusoidal amplitude value)			70		A
Short-circuit protection delay			1.5		3.3	µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			0.15		V
Voltage efficiency				100		%
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for ripple ±5% of measurement range; $+V_{MOT}$ = 48 V	F_{PWM} = 20 kHz	400			µH
		F_{PWM} = 40 kHz	200			
		F_{PWM} = 60 kHz	150			
		F_{PWM} = 80 kHz	100			
		F_{PWM} = 100 kHz	80			
	Absolute minimum value, limited by short-circuit protection; $+V_{MOT}$ = 48 V	F_{PWM} = 20 kHz	150			µH
		F_{PWM} = 40 kHz	50			
		F_{PWM} = 60 kHz	40			
		F_{PWM} = 80 kHz	20			
		F_{PWM} = 100 kHz	10			
Motor electrical time-constant (L/R)	Recommended value, for ±5% current measurement error due to ripple	F_{PWM} = 20 kHz	330			µs
		F_{PWM} = 40 kHz	170			
		F_{PWM} = 60 kHz	140			
		F_{PWM} = 80 kHz	80			
		F_{PWM} = 100 kHz	66			
Current measurement accuracy	FS = Full Scale		-9.3	+/- 3.4	+9.3	%FS

3.15.8 Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4, IN5)[1]

		Min.	Typ.	Max.	Units
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW"	-10	0	2.2	V
	Logic "HIGH"	6.3	24	36	
	Hysteresis	1.2	2.4	2.8	
	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"		8	10	
		Min.	**Typ.**	**Max.**	**Units**
Mode compliance		NPN			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"		0	2.2	V
	Logic "HIGH"	6.3	24	36	
	Hysteresis	1.2	2.4	2.8	
	Floating voltage (not connected)		15		
	Absolute maximum, continuous	-10		+39	
	Absolute maximum, surge (duration ≤ 1s) †	-20		+40	
Input current	Logic "LOW"; Pulled to GND		8	10	mA
	Logic "HIGH"; Pulled to +24V	0	0	0	
Input frequency		0		10	kHz
Minimum pulse width		6			µs
ESD protection	Human body model	±5			kV

3.15.9 Digital Outputs (OUT1, OUT2/Error, OUT3/ Ready, OUT4, OUT5) [2]

		Min.	Typ.	Max.	Units
Mode compliance		PNP 24V			
Default state	Not supplied ($+V_{LOG}$ floating or to GND)	High-Z (floating)			
	Normal operation	Logic "High"			
Output voltage	Logic "HIGH"; output current = 0.3A		V_{LOG}-1.0	V_{LOG}-2.0	V
	Logic "LOW"; output current = 0, no load	open-collector			
	Logic "HIGH", external load to GND		0		
	Absolute maximum, continuous	-0.3		V_{LOG}+0.3	
	Absolute maximum, surge (duration ≤ 1s) †	-0.5		V_{LOG}+0.5	
Output current	Logic "HIGH", source current, continuous			0.3	A
	Logic "HIGH", source current, pulse ≤ 5 s			0.4	A
	Logic "LOW", means High-Z			20	µA
Minimum pulse width		3	1.5		µs
ESD protection	Human body model	±15			kV

[1] The digital inputs are software selectable as PNP or NPN

[2] The digital outputs are software selectable as PNP or NPN

		Min.	Typ.	Max.	Units
Mode compliance		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)	High-Z (floating)			
	Normal operation	High-Z			
Output voltage	Logic "LOW"; output current = 0.4A		0.6	1.3	V
	Logic "HIGH"; output current = 0, no load	open-collector			
	Logic "HIGH", external load to +V_{LOG}		V_{LOG}		
	Absolute maximum, continuous	-0.3		V_{LOG}+0.3	
	Absolute maximum, surge (duration ≤ 1s) †	-0.5		V_{LOG}+0.5	
Output current	Logic "LOW", sink current, continuous			0.4	A
	Logic "LOW", sink current, pulse ≤ 5 s			0.5	A
	Logic "HIGH", means High-Z			20	µA
Minimum pulse width		5	1.8		µs
ESD protection	Human body model	±15			kV

3.15.10 Digital Outputs (OUT0) [1]

		Min.	Typ.	Max.	Units
Mode compliance		PNP 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)	High-Z (floating)			
	Normal operation	Logic "High"			
Output voltage	Logic "HIGH"; output current = 1.5A		V_{LOG}-0.4	V_{LOG}-0.7	V
	Logic "LOW"; output current = 0, no load	open-collector			
	Logic "HIGH", external load to GND		0		
	Absolute maximum, continuous	-0.3		V_{LOG}+0.3	
	Absolute maximum, surge (duration ≤ 1s) †	-0.5		V_{LOG}+0.5	
Output current	Logic "HIGH", source current, continuous			1.5	A
	Logic "HIGH", source current, pulse ≤ 5 s			2.0	A
	Logic "LOW", means High-Z			50	µA
Minimum pulse width		30	15		µs
ESD protection	Human body model	±15			kV
Mode compliance		NPN 24V			
Default state	Not supplied (+V_{LOG} floating or to GND)	High-Z (floating)			
	Normal operation	High-Z			
Output voltage	Logic "LOW"; output current = 2.0A		0.2	0.3	V
	Logic "HIGH"; output current = 0, no load	open-collector			
	Logic "HIGH", external load to +V_{LOG}		V_{LOG}		
	Absolute maximum, continuous	-0.3		V_{LOG}+0.3	
	Absolute maximum, surge (duration ≤ 1s) †	-0.5		V_{LOG}+0.5	
Output current	Logic "LOW", sink current, continuous			2.0	A
	Logic "LOW", sink current, pulse ≤ 5 s			2.5	A
	Logic "HIGH", means High-Z			50	µA
Minimum pulse width		30	10		µs
ESD protection	Human body model	±15			kV

3.15.11 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 1KΩ pull-up to +5	0	0	0	
Minimum pulse width		2			µs
ESD protection	Human body model	±5			kV

3.15.12 Linear Hall Inputs (LH1, LH2, LH3)

		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	0		0.2	mA
Interpolation Resolution	Depending on software settings			11	bits
Frequency		0		1	kHz
ESD protection	Human body model	±1			kV

3.15.13 Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-)[1]

		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	MXZ
ESD protection	Human body model	±2			kV

3.15.14 Encoder #1 Inputs (A1+, A1-, B1+, B1-, Z1+, Z1-,)[2]

		Min.	Typ.	Max.	Units
Single-ended mode compliance	Leave negative inputs disconnected	TTL / CMOS / Open-collector			
Input voltage, single-ended mode A/A+, B/B+	Logic "LOW"			1.6	V
	Logic "HIGH"	1.8			
	Floating voltage (not connected)		3.3		
Input voltage, single-ended mode Z/Z+	Logic "LOW"			1.2	V
	Logic "HIGH"	1.4			
	Floating voltage (not connected)		4.7		
Input current, single-ended mode A/A+, B/B+, Z/Z+	Logic "LOW"; Pull to GND		5.5	6	mA
	Logic "HIGH"; Internal 2.2KΩ pull-up to +5	0	0	0	
	For full RS422 compliance, see [3]	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	±0.06	±0.1	±0.2	V
	Common-mode range (A+ to GND, etc.)	-7		+7	
Input impedance, differential	A1+ to A1-, B1+ to B1-		1		kΩ
	Z1+ to Z1-		1		
Input frequency	Single-ended mode, Open-collector / NPN	0		5	MHz
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	0		10	MHz
Minimum pulse width	Single-ended mode, Open-collector / NPN	1			µs
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	50			ns
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

3.15.15 Encoder #2 Inputs (A2+, A2-, B2+, B2-, Z2+, Z2-)[4]

		Min.	Typ.	Max.	Units
Differential mode compliance		TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			150		Ω
	Differential mode	0		10	MHz
	Differential mode	50			ns
ESD protection	Human body model	±1			kV

3.15.16 Analog 0…5V Input (FDBK)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		28		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[5]
Bandwidth (-3dB)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV

[1] For many applications, a 120Ω termination resistor should be connected across SIN+ to SIN-, and across COS+ to COS-. See SW2 settings. Please consult the feedback device datasheet for confirmation.

[2] Encoder #1 differential input pins can have internal 120Ω termination resistors connected across, see SW2 settings

[3] For full RS-422 compliance, 120Ω termination resistors must be connected across the differential pairs using DIN switch SW2. See ***Figure 19. Feedback#1 – Differential Incremental Encoder connection*** for more details.

[4] Encoder #2 differential input pins have internal 120Ω termination resistors connected across

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

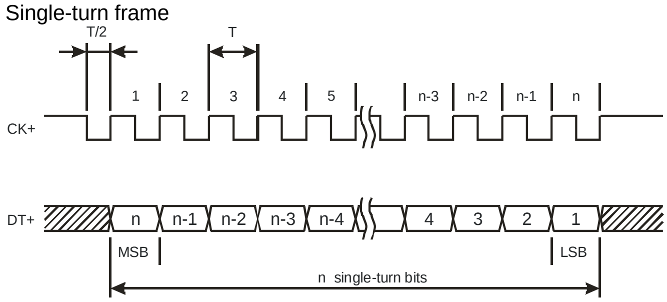
3.15.17 Analog +/- 10V Input (REF)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	-10		+10	V
	Absolute maximum values, continuous	-15		+15	
	Absolute maximum, surge (duration ≤ 1s) †			±20	
Input impedance	To GND		50		kΩ
	Differential		80		
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±10	±35	bits
Gain error			±2%	±5%	% FS[1]
Bandwidth (-3dB)	Software selectable	0		1	kHz
ESD protection	Human body model	±15			kV

3.15.18 Absolute Encoder Interface: SSI, BISS, EnDAT

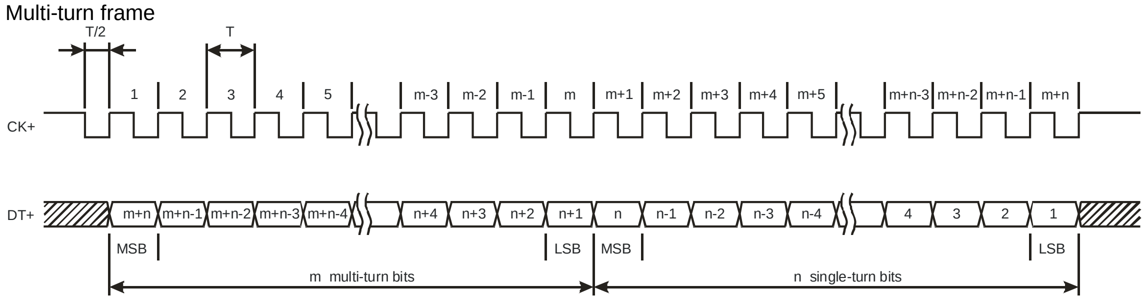
		Min.	Typ.	Max.	Units
Differential mode compliance (CLOCK, DATA)		TIA/EIA-422			
CLOCK Output voltage	Differential; 50Ω differential load	2.0	2.5	5.0	V
	Common-mode, referenced to GND	2.3	2.5	2.7	
CLOCK frequency	Software selectable	1000, 2000, 3000,4000			kHz
DATA Input hysteresis	Differential mode	±0.1	±0.2	±0.5	V
Data input impedance	Termination resistor on-board		150		Ω
DATA Input common mode range	Referenced to GND	-7		+12	V
	Absolute maximum, surge (duration ≤ 1s) †	-25		+25	
DATA format	Software selectable	Binary / Gray			
		Single-turn / Multi-turn			
		Counting direction			
DATA resolution	Single-turn			56	bit
	Multi-turn and single-turn			56	
	If total resolution >31 bits, some bits must be ignored by software setting to achieve a max 31 bits resolution				

Single-turn frame



CK- and DT- signals have the same form with CK+ and DT+, but with opposite polarity.

Multi-turn frame



CK- and DT- signals have the same form with CK+ and DT+, but with opposite polarity.

3.15.19 CAN-Bus (for CAN drives)

		Min.	Typ.	Max.	Units
Compliance	ISO11898, CiA-301v4.2, 402v3.0				
Bit rate	Software selectable	125		1000	125
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	Hardware: by H/W pins (SW1)	1 ÷ 127 & 255 (LSS non-configured) (CANopen); 1-127 & 255 (TMLCAN)			
	Software	1 ÷ 127 (CANopen); 1- 255 (TMLCAN)			
Voltage, CAN-Hi or CAN-Lo to GND		-36		36	V
ESD protection	Human body model	±15			kV

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

3.15.20 Supply Output (+5V)

		Min.	Typ.	Max.	Units
+5V output voltage	Current sourced = 250mA	4.95	5.11	5.25	V
+5V output current		360	450		mA
Short-circuit protection		NOT protected			
Over-voltage protection		NOT protected			
ESD protection	Human body model	±1			kV
Isolation PE (earth) – GND				±250	V

3.15.21 EtherCAT ports J21 and J22 (for CAT drives)

		Min.	Typ.	Max.	Units
Standards compliance		IEEE802.3, IEC61158			
Transmission line specification	According to TIA/EIA-568-5-A	Cat.5e.UTP			
J5, J6 pinout	EtherCAT® supports MDI/MDI-X auto-crossover	TIA/EIA-568-A or TIA/EIA-568-B			
Software protocols compatibility		CoE, CiA402, IEC61800-7-301			
Node addressing	By software, via EasySetUp	1 ÷ 255			-
	By hardware via SW1				-
MAC addressing	EtherCAT® uses no MAC address	none			-
ESD protection	Human body model	±15			kV

3.15.22 Safe Torque OFF (STO1+; STO1-; STO2+; STO2-)

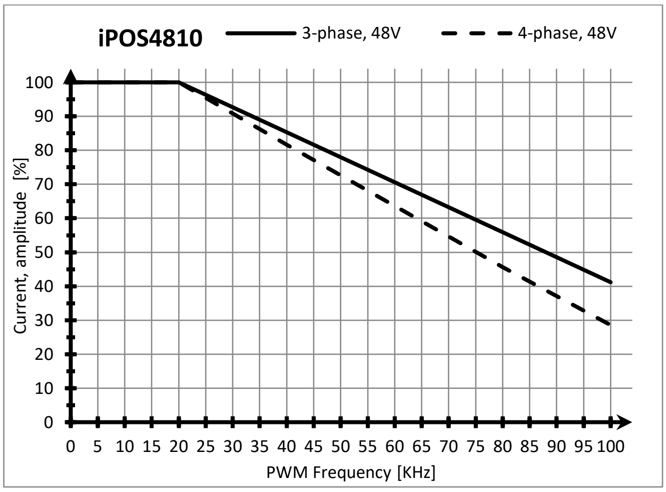
		Min.	Typ.	Max	Units
Safety function	According to EN61800-5-2	STO (Safe Torque OFF)			
EN 61800-5-1/ -2 and EN 61508-5-3/ -4 Classification	Safety Integrity Level	safety integrity level 3 (SIL3)			
	PFHd (Probability of Failures per Hour - dangerous)	$8*10^{-10}$	$hour^{-1}$ (0.8 FIT)		
EN13849-1 Classification	Performance Level	Cat3/PLe			
	MTTFd (meantime to dangerous failure)	377	years		
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW" (PWM operation disabled)	-20		5.6	V
	Logic "HIGH" (PWM operation enabled)	18		36	
	Absolute maximum, continuous	-20		+40	
Input current	Logic "LOW"; pulled to GND		0		mA
	Logic "HIGH", pulled to +Vlog		5	13	
Repetitive test pulses	Ignored high-low-high			5	ms
	-			20	Hz
Fault reaction time	From internal fault detection to register DER bit 14 =1 and OUT2/Error high-to-low			30	ms
PWM operation delay	From external STO low-high transition to PWM operation enabled			30	ms
ESD protection	Human body model	±2			kV

3.15.23 Conformity

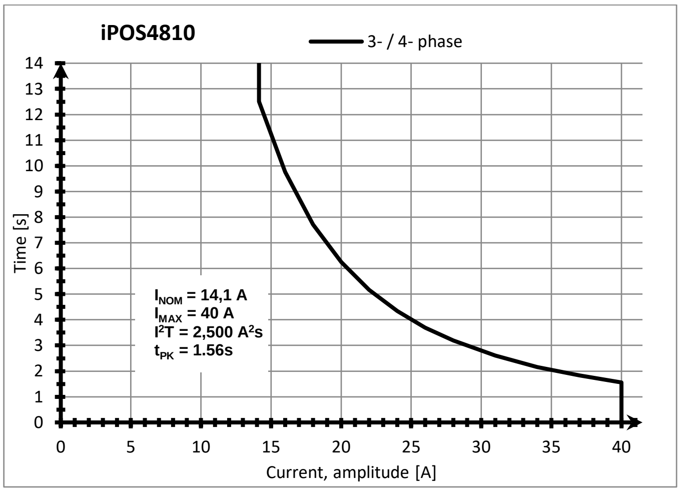
		Min.	Typ.	Max.	Units
EU Declaration	2014/30/EU (EMC), 2014/35/EU (LVD), 2011/65/EU (RoHS), 1907/2006/EC (REACH), 93/68/EEC (CE Marking Directive), EC 428/2009 (non dual-use item, output frequency limited to 590Hz)				

† 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.

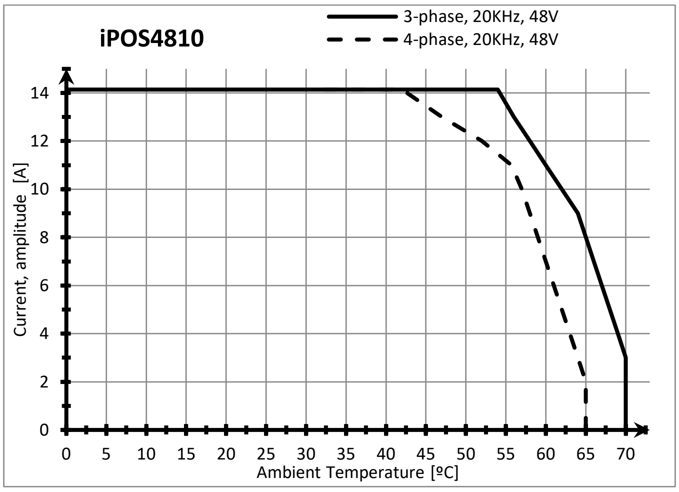
3.16 Derating curves



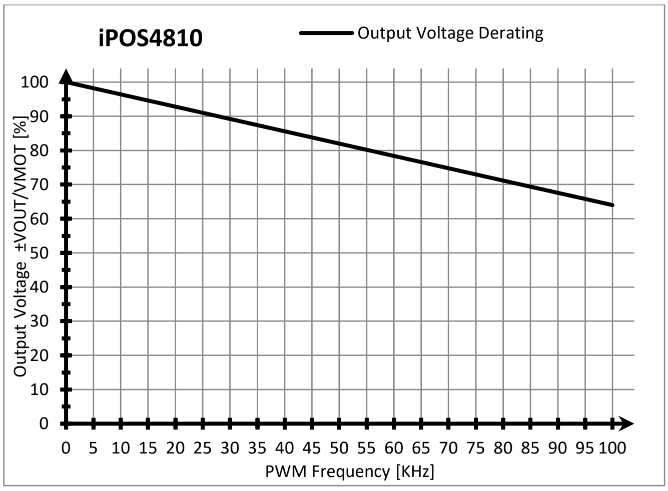
iPOS4810 – Current de-rating with PWM frequency



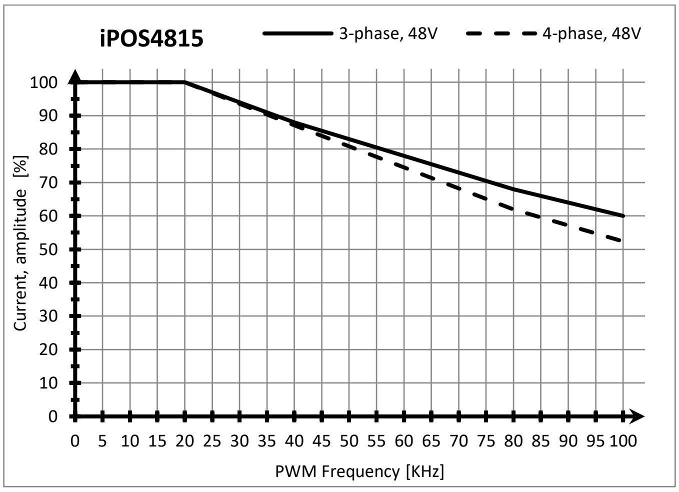
iPOS4810 – Over-current diagram (No heatsink)



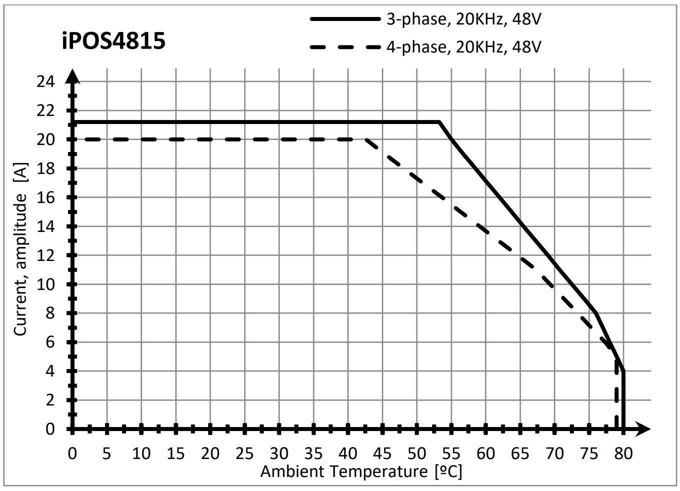
iPOS4810 – Current de-rating with ambient temperature



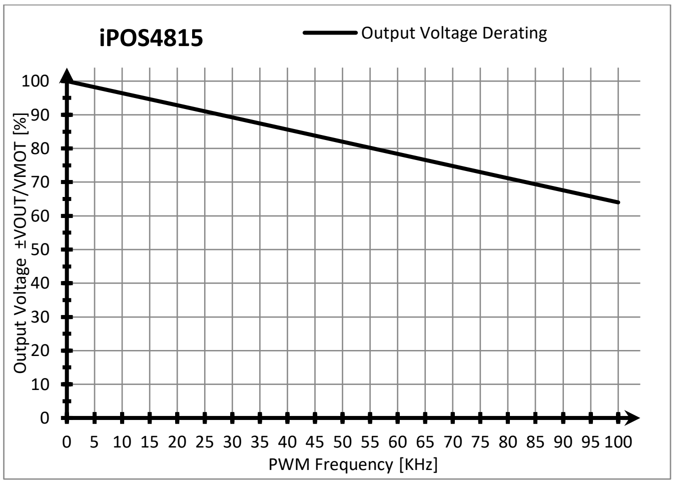
iPOS4810 – Output Voltage de-rating with PWM frequency



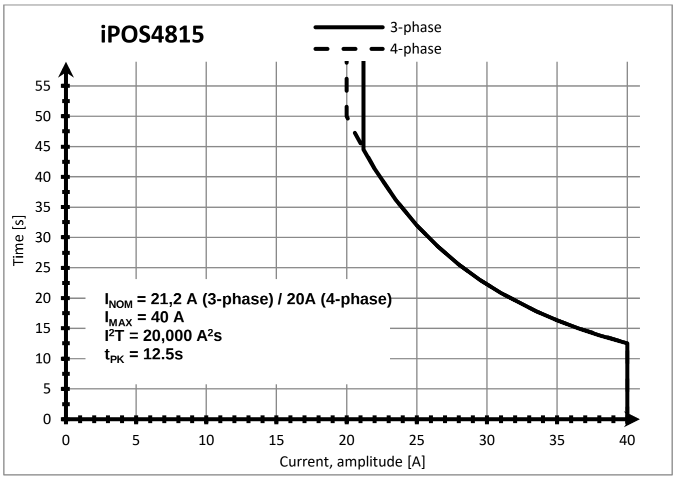
iPOS4815 – Current de-rating with PWM frequency



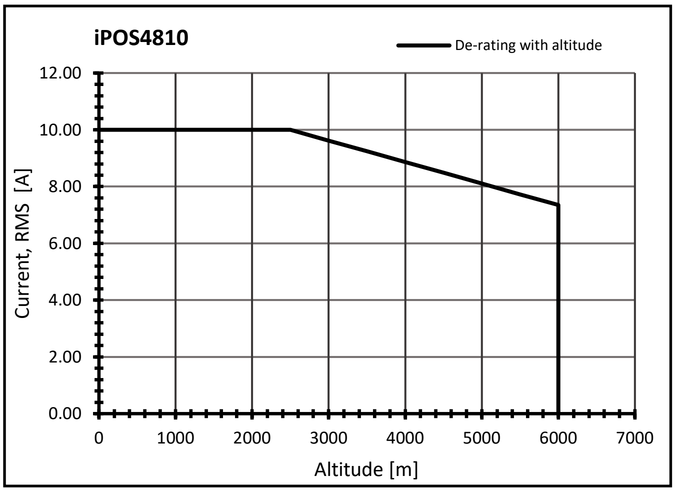
iPOS4815 – Current de-rating with ambient temperature



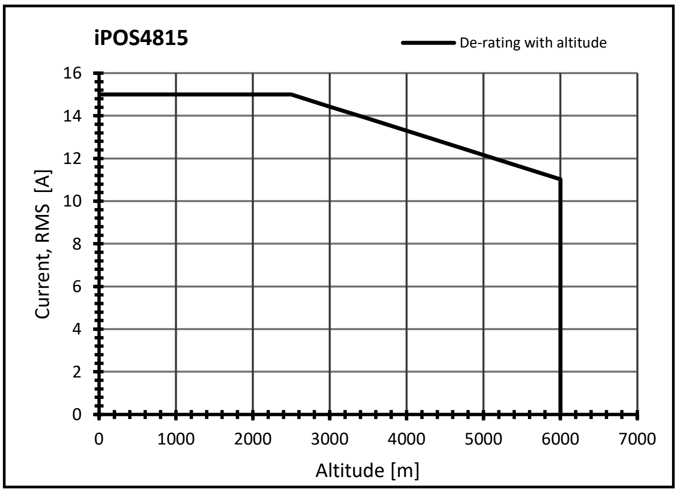
iPOS4815 – Output Voltage de-rating with PWM frequency



iPOS4815 – Over-current diagram (No heatsink)



iPOS4810 – De-rating with the altitude



iPOS4815 – De-rating with the altitude

4 Memory Map

iPOS481x has 2 types of memory available for user applications: 16K×16 SRAM and up to 24K×16 serial E^{2}ROM.

The SRAM memory is mapped in the address range: C000h to FFFFh. 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 E^{2}ROM is mapped in the address range: 2000h to 7FFFh. 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*

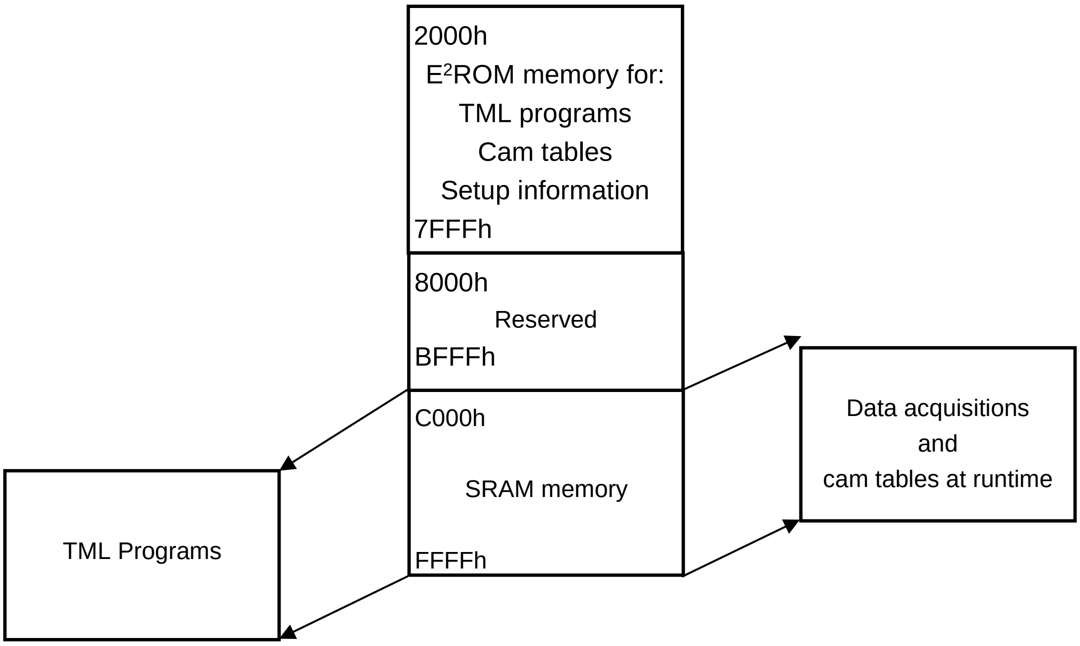


Figure 42. *iPOS481x XZ Memory Map*