**iPOS360X VX-CAN / CAT**
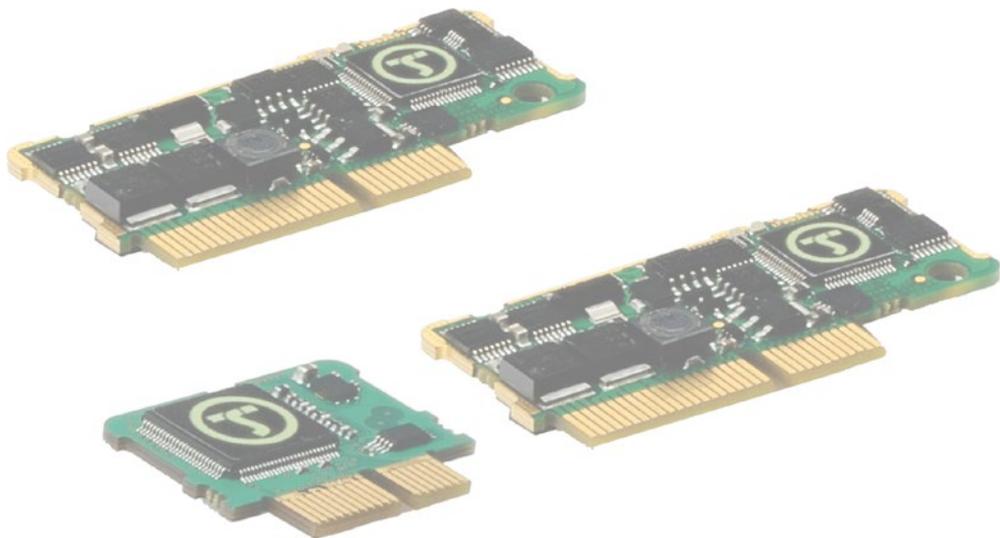
**Intelligent Servo Drive for Step, DC, Brushless DC and AC Motors**

TECHNOSOFT

**Intelligent Servo Drives**

**Technical Reference**

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# Read This First

Whilst Technosoft believes that the information and guidance given in this manual is correct, all parties must rely upon their own skill and judgment when making use of it. Technosoft does not assume any liability to anyone for any loss or damage caused by any error or omission in the work, whether such error or omission is the result of negligence or any other cause. Any and all such liability is disclaimed.

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The information in this document is subject to change without notice.

## About This Manual

This book is a technical reference manual for:

| Product Name | Part Number | Firmware | Description |
|---|---|---|---|
| **iPOS3602 VX-CAN** | P028.001.E001 | F509x | Standard version, CAN |
| **iPOS3602 VX-CAN** | P028.001.E001 | F524x | Linear Hall version, CAN |
| **iPOS3602 VX-CAT** | P028.001.E021 | F511x | Standard version + Linear Hall, EtherCAT |
| **iPOS3604 VX-CAN** | P028.002.E001 | F508x | Standard version, CAN |
| **iPOS3604 VX-CAN** | P028.002.E001 | F524x | Linear Hall version, CAN |
| **iPOS3604 VX-CAT** | P028.002.E021 | F510x | Standard version + Linear Hall, EtherCAT |

In order to operate the **iPOS360X** drives, you need to pass through 3 steps:
- ❏ **Step 1 Hardware installation**
- ❏ **Step 2 Drive setup** using Technosoft **EasySetUp** software for drive commissioning
- ❏ **Step 3 Motion programming** using one of the options:
  - ❏ A **CANopen master**[1] 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 **iPOS360X** hardware including the technical data, the connectors and the wiring diagrams needed for installation.

For Step 2 and 3, please consult the document *iPOS Single Loop drives Software reference*

*( 091.028.SL.Software.xxxx)*. It also includes the scaling factors between the real SI units and the drive internal units. For detailed information regarding the next steps, refer to the related documentation.

## Notational Conventions

This document uses the following conventions:

- **iPOS360X**– all products described in this manual
- **IU units** – Internal units of the drive
- **SI units** – International standard units (meter for length, seconds for time, etc.)
- **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 iPOS360x VX-CAN is set in CANopen mode

[2] when using and iPOS360x VX-CAT

[3] available only for CAN versions

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

## Related Documentation

***iPOS3602 VX-CAN Datasheet ( P028.001.E001.DSH)***

– describes the hardware connections of the iPOS3602 VX CAN intelligent servo drive including the technical data and connectors.

***iPOS3602 VX-CAT Datasheet ( P028.001.E021.DSH)***

– describes the hardware connections of the iPOS3602 VX EtherCAT® family of intelligent servo drives including the technical data and connectors.

***iPOS3604 VX-CAN Datasheet ( P028.002.E001.DSH)***

– describes the hardware connections of the iPOS3604 VX CAN intelligent servo drive including the technical data and connectors.

***ECAT-VX EtherCAT Interface Datasheet ( P038.022.E022.DSH )***

*– additional module needed for EtherCAT communication*

- describes the hardware connections between the ECAT-VX Interface and the iPOS EtherCAT® family of intelligent servo drives including the technical data and connectors.

***iPOS3604 VX-CAT Datasheet ( P028.002.E021.DSH)***

– describes the hardware connections of the iPOS3604 VX EtherCAT® family of intelligent servo drives including the technical data and connectors.

***iPOS Single Loop drives Software reference (091.028.SL.Software.xxxx)***

– describes the compatible software installation, drive software setup commissioning, introduction to TML motion programming, includes the scaling factors between the real SI units and the drive internal units.

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

***iPOS CANopen Programming*** **(part no. P091.063.iPOS.UM.xxxx)** – explains how to program the iPOS family of intelligent drives using **CANopen** protocol and describes the associated object dictionary for **CiA 301 v.4.2** application layer and communication profile and **CiA DSP 402 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

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

## *If you 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: contact@technosoftmotion.com |
| Ask questions about product operation or report suspected problems (see Note) | Fax: (41) 32 732 55 04 Email: hotline@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.**

For other certifications visit: http://technosoftmotion.com/en/quality-system

# 2  Product Overview

## 2.1  Introduction

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

Suitable for control of brushless DC, brushless AC (vector control), DC brushed motors and step motors, the iPOS360X drives accept as position feedback quadrature incremental encoders and digital 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 iPOS360X drives combine controller, drive and PLC functionality in a single compact unit and are capable to execute complex motions without requiring intervention of an external motion controller. Using the high-level Technosoft Motion Language (**TML**) the following operations can be executed directly at drive level:

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

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

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

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

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

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

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

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

[2] Available only for CAN drives

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

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

## 2.2   Product Features

- Fully digital servo drive suitable for the control of rotary or linear brushless, DC brush, and step motors
- Very compact design
- Standard PCIe 4x mating connector
- Sinusoidal (FOC) or trapezoidal (Hall-based) control of brushless motors
- Open or closed-loop control of 2 and 3-phase steppers
- Various modes of operation, including: torque, speed or position control; position or speed profiles, Cyclic Synchronous Position (CSP) for CANopen mode, external reference mode (analogue or encoder feedback) or sent via a communication bus
- Technosoft Motion Language (TML) instruction set for the definition and execution of motion sequences
- Standalone operation with stored motion sequences
- Motor supply: 9-36V
- Logic supply: 7-36V
- Output current:
  - iPOS3602 VX-CAN: 2A [2] continuous; 3.2A peak
  - iPOS3604 VX-CAN: 4A[3] continuous; 10A peak
- PWM switching frequency up to 120kHz
- Communication:
  - RS-232 serial up to 115kbits/s
  - CAN-bus 2.0B up to 1Mbit/s (for CAN drives)
  - Dual 100Mbps EtherCAT® interfaces, for use in daisy-chaining topologies (for CAT drives)
- Digital and analog I/Os:
  - 5 digital inputs: 5-24 V,  sourcing/NPN : 2 Limit switches, Enable and 2 general-purpose
  - 4 digital outputs : 5-36V, 0.5A, NPN open-collector: Ready, Error, 2 general-purpose
  - 2 analogue inputs: 12-bit, 0-5V (Reference, Feedback) or general-purpose
- Electro-Mechanical brake support: software configurable digital output to control motor brake
- Feedback devices:
  - Incremental encoder interface (single ended or differential)
  - Digital Hall sensor interface (single-ended and open collector)
  - Linear Hall sensor interface
  - Analogue Sin/Cos encoder interface (differential $1V_{pp}$)
- Various motion programming modes:
  - Position profiles with trapezoidal or S-curve speed shape
  - Position, Velocity, Time (PVT) 3$^{rd}$ order interpolation

---

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

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

- Position, Time (PT) 1<sup>st</sup> 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
- 35 Homing modes
- Software CAN selectable addresses
- Two CAN operation modes selectable by HW pin (only for CAN drives):
  - **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
- EtherCAT® with CAN application protocol over EtherCAT (CoE) for CAT drives
- 2K × 16 internal SRAM memory for data acquisition
- 4K × 16 E²ROM to store TML motion programs, cam tables and other user data
- Operating ambient temperature:
  - 0-70°C – iPOS360X VX-CAN
  - 0-40°C – iPOS360X VX-CAT
- Protections:
  - Short-circuit between motor phases
  - Short-circuit from motor phases to ground
  - Over-voltage
  - Under-voltage
  - Over-current
  - Communication error
  - Control error
  - Over-temperature
- Firmware on drive:
  - F508M+ or F523E+ for iPSO3604
  - F509M+ or F524E+ for iPSO3602

## 2.3   Identification Labels
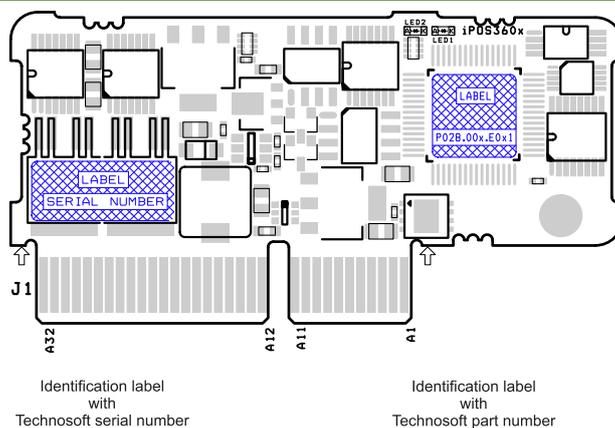


**Figure 2.3.1.** *iPOS360X VX-CAN identification labels*

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

| Product Name | Part Number | Firmware | Description |
|---|---|---|---|
| **iPOS3602 VX-CAN** | P028.001.E001 | F509x | Standard version, CAN |
| **iPOS3602 VX-CAN** | P028.001.E001 | F524x | Linear Hall version, CAN |
| **iPOS3602 VX-CAT** | P028.001.E021 | F511x | Standard version + Linear Hall, EtherCAT |
| **iPOS3604 VX-CAN** | P028.002.E001 | F508x | Standard version, CAN |
| **iPOS3604 VX-CAN** | P028.002.E001 | F524x | Linear Hall version, CAN |
| **iPOS3604 VX-CAT** | P028.002.E021 | F510x | Standard version + Linear Hall, EtherCAT |

## 2.4    Supported Motor-Sensor Configurations

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

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

## 2.5    iPOS360X I/O Evaluation board

A circuit board is available for evaluating the iPOS3602 or 3604 VX CAN or CAT. It comes with multiple types of connectors for easy access to the iPOS360X features.



ECAT VX adapter

iPOS360x VX-CAN/CAT

IO iPOS360x extension board
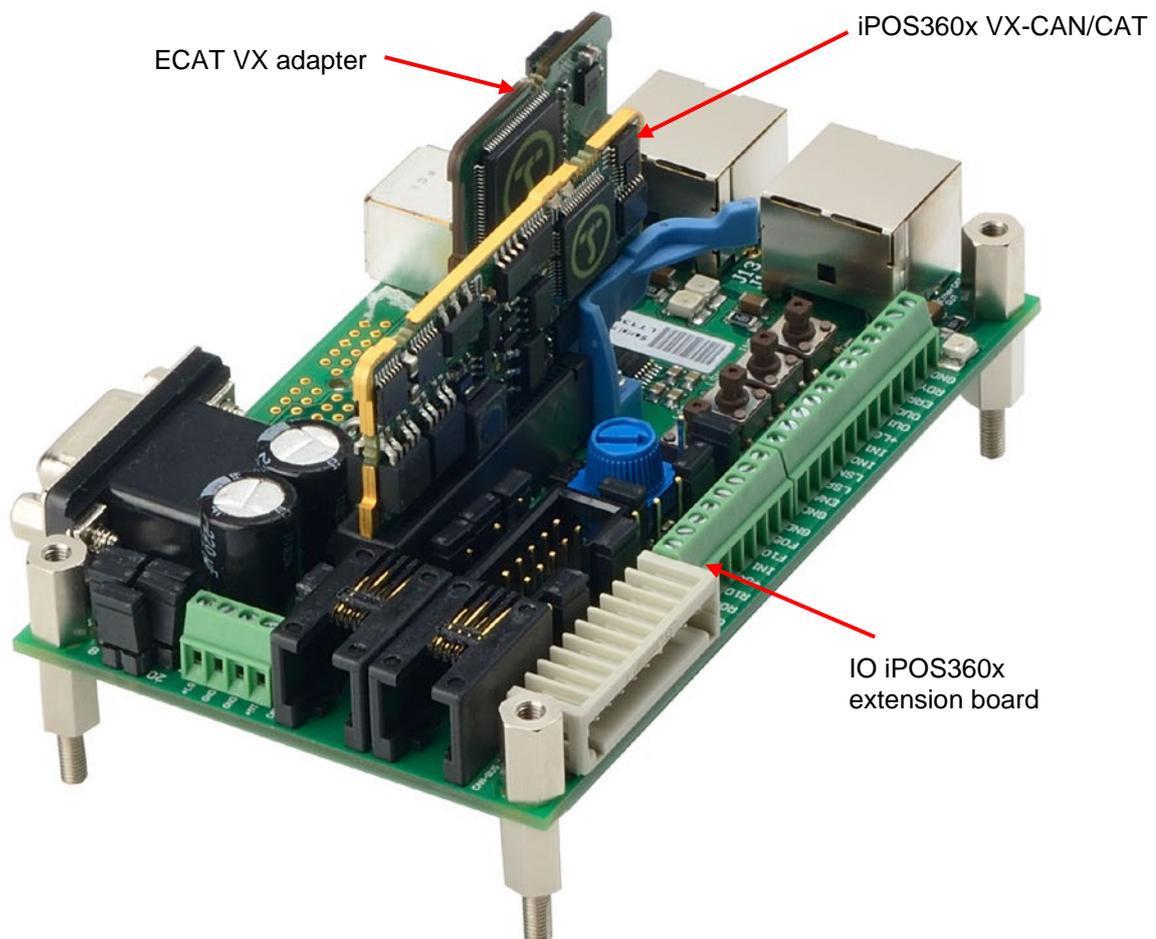
*Figure 2.5.1. iPOS360X VX-CAN/CAT mounted on the I/O iPOS360X extension board*

### 2.5.1 Starter Kit ordering information

| Part number | Description |
|---|---|
| P091.084.IO-iPOS360x.UM.xxxx | Evaluation board User Manual (available for download on our website) |
| P028.002.E880 | IO iPOS360X VX CAN extension board only (without ECAT connectors) |
| P028.002.E890 | IO iPOS360X VX CAT extension board only (with ECAT connectors) |
| P028.001.E800 | IO iPOS360X VX CAN + iPOS3602 VX-CAN drive (without motor) |
| P028.002.E800 | IO iPOS360X VX CAN + iPOS3604 VX-CAN drive (without motor) |
| P028.001.E810 | IO iPOS360X VX CAT + iPOS3602 VX-CAT drive (without motor) |
| P028.002.E810 | IO iPOS360X VX CAT + iPOS3604 VX-CAT drive (without motor) |
| P028.002.E801 | iPOS3604 VX-CAN Starter kit with brushless motor |
| P028.002.E811 | iPOS3604 VX-CAT Starter kit with brushless motor |
| P028.002.E802 | iPOS3604 VX-CAN Starter kit with stepper motor |
| P028.002.E812 | iPOS3604 VX-CAT Starter kit with stepper motor |

# 3 Hardware Installation

## 3.1 iPOS360X VX-CAN/CAT Board Dimensions



**Figure 3.1.1.** *iPOS360X VX-CAN drive dimensions*

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

## 3.2 ECAT-VX EtherCAT adapter dimensions



**Figure 3.2.1.** *ECAT-VX adapter dimensions*

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

## 3.3 Mechanical Mounting

The iPOS360X drive is intended to be mounted vertically or horizontally on a motherboard equipped with the recommended mating connectors, as specified in chapter *3.6.2 Mating Connectors*. Several drives can be hosted by a single motherboard.

For thermal calculations:

- the iPOS3604 VX-CAN drive can be assumed to generate 1 Watt (= 3.4 BTU/hour) at idle, and up to 3 Watt (= 10 BTU/hour) worst case while driving a motor.

- the iPOS3604 VX-CAT drive can be assumed to generate 1 Watt (= 3.4 BTU/hour) at idle, and up to 3 Watt (= 10 BTU/hour) worst case while driving a motor.

- the ECAT-VX adapter which connects to the iPOS360x VX-CAT drive can be assumed to generate up to 1.6 Watt (= 5.5 BTU/hour) worst case.

### 3.3.1 Vertical Mounting

When iPOS360x is mounted vertically, its overall envelope (size) including the recommended mating connector and an optional retainer is shown in *Figure 3.2* below. In absence of a fixing case h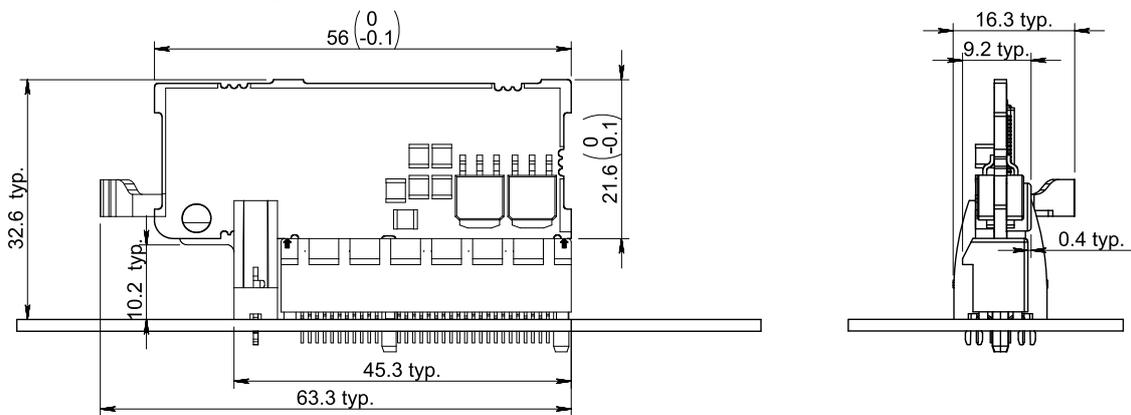olding the drive in the mating connector, the use of the retainers is strongly recommended, to avoid vibration and shock problems.



**Figure 3.2** Overall dimensions using recommended mating connector and retainer for the iPOS360x VX-CAN/CAT drive
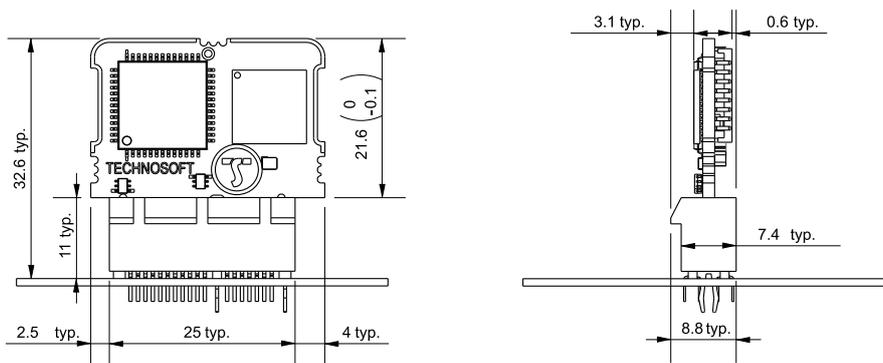


**Figure 3.3** Overall dimensions using recommended mating connector for the ECAT-VX adapter

All dimensions are in mm.

The ensemble motherboard + iPOS360x drive(s) can be cooled by natural convection. The motherboard can be mounted horizontally or vertically. In both cases, the air temperature must not exceed the limits indicated in *Figure 3.35* and *Figure 3.40*.

*Figure 3.5* shows the recommended spacing to assure proper airflow by natural convection, in the worst case – closed box done from a plastic (non-metallic) material with no ventilation openings.

Whenever possible, ventilation openings shall be foreseen on the top side wall or the box and at the bottom of the lateral walls. When using a horizontal motherboard considerably larger than the size of the hosted iPOS360x drives, it is recommended to provide ventilation holes also in the motherboard PCB.

**Remark:** In case of using a metallic box, with ventilation openings, all spacing values may be reduced substantially. With proper ventilation, keeping the air surrounding the iPOS360x inside the limits indicated in *Figure 3.35* and *Figure 3.40* the spacing values may be reduced down to the mechanical tolerance limits of *Figure 3.2*.
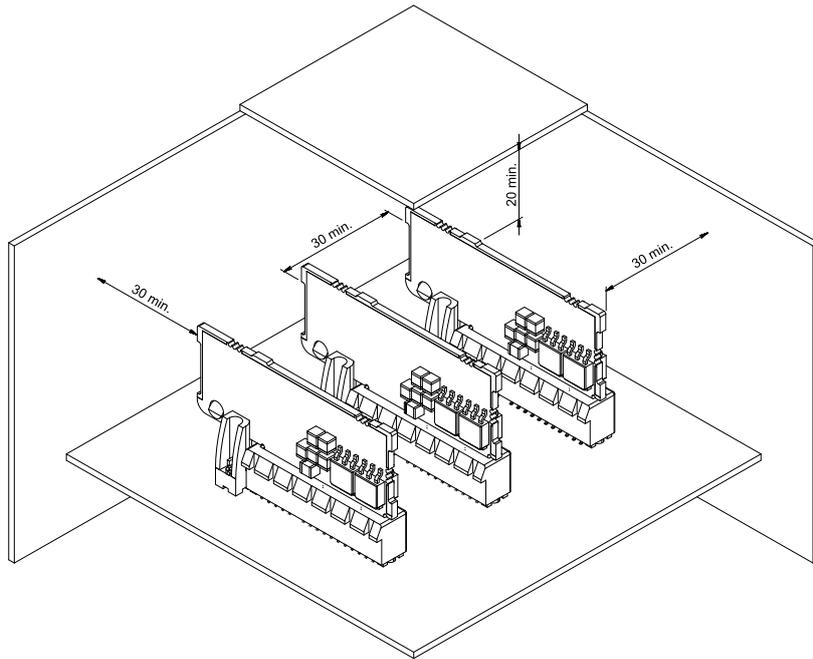


**Figure 3.4** Recommended spacing for vertical mounting, worst case: non-metallic, closed box

For ventilation holes / slots that pierce a metallic wall also used for EMI shielding, the maximum slot length d should be less than λ/16, where λ is the wavelength corresponding to maximum filtered frequency (ff):

$$d < \frac{\lambda}{16} = \frac{3 \cdot 10^8}{16 \cdot f_f}$$

If ventilation driven by natural convection is not enough to maintain the temperature surrounding the iPOS360x drive(s) inside the limits indicated in *Figure 3.35* and *Figure 3.40* then alternate forced cooling methods must be applied.

### 3.3.2 Horizontal Mounting

When iPOS360x is mounted horizontally, its overall envelope (size) including the recommended mating connector is shown in *Figure 3.6*. The iPOS360x has 6 fixing shoulders that may be used to secure the drive.
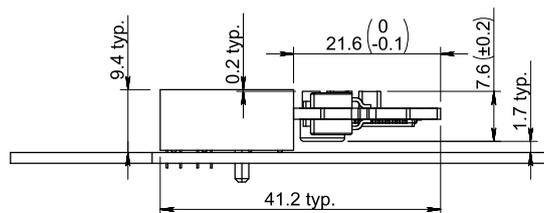


**Figure 3.5** iPOS360X VX-CAN/CAT Overall dimensions for horizontal mounting
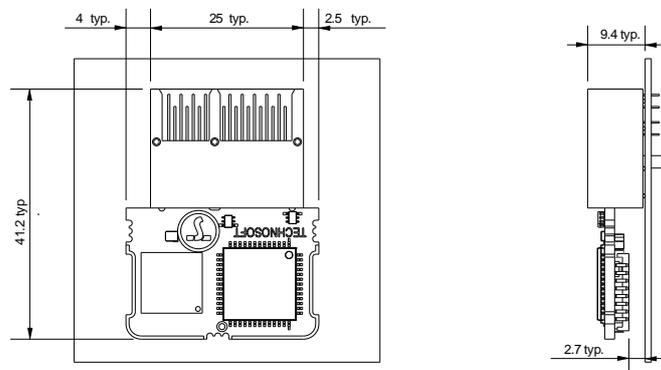


**Figure 3.6** ECAT-VX adapter overall dimensions for horizontal mounting

All dimensions are in mm.

*Figure 3.8* shows the recommended spacing to assure proper airflow by natural convection, in the worst case – closed box done from a plastic (non-metallic) material with no ventilation openings.

Whenever possible, ventilation openings shall be foreseen.

**Remark:** In case of using a metallic box, with ventilation openings, all spacing values may be reduced substantially. With proper ventilation, keeping the air surrounding the iPOS360x inside the limits indicated in *Figure 3.35* and *Figure 3.40* the spacing values may be reduced down to the mechanical tolerance limits of *Figure 3.2*.
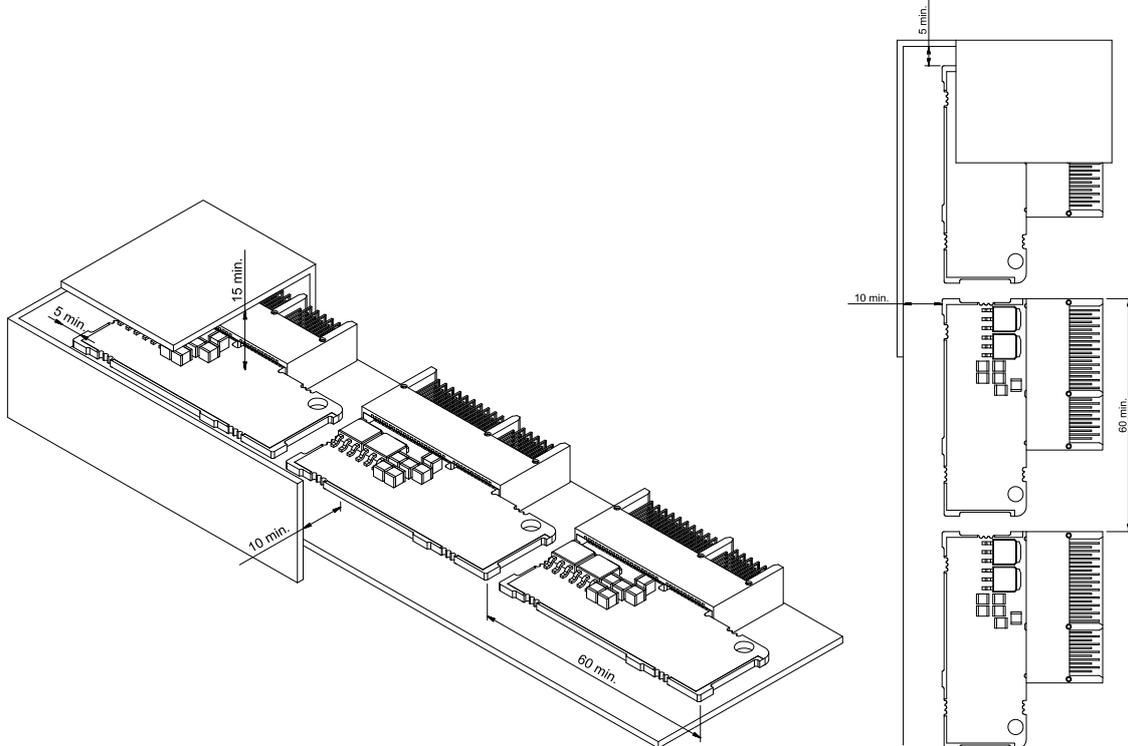


**Figure 3.7** iPOS360X VX-CAN Recommended spacing for horizontal mounting, worst case: non-metallic, closed box

## 3.4 Motherboard PCB Design

The iPOS360x drive, when plugged vertically into the recommended mating connector and retainer, has the following PCB footprint:
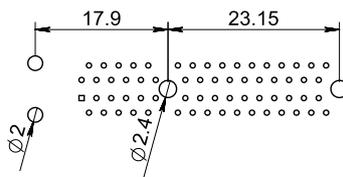


**Figure 3.8** PCB footprint of mating connector and retainer

It is recommended to use a multi-layer PCB for the motherboard, in order to have enough room for routing all the pins of the iPOS360X. Using a 2-layer PCB is possible when some of the iPOS360X pins remain un-connected.

Below is a list of recommendations for the PCB design of the motherboard:

- Motor supply and motor outputs: use islands / areas of copper to escape connector areas; this will maximize current capability. When using simple tracks, use at least 50mil cross section (35mil track width for 1oz/ft² copper thickness)

- Motor supply and ground return tracks between iPOS360X and the nearby $V_{MOT}$ decoupling capacitor are to be considered as EMI sources, and kept to a minimum length.

- Place the decoupling capacitors on $V_{MOT}$ and $V_{LOG}$ (see also 3.7.8 Power Supply Connection) as close as physically possible to the iPOS360X, to minimize EM radiated emissions. For un-shielded applications (no metallic box) and typical EMC regulations, the spacing between iPOS360X and capacitors must be less than 3 centimeters.

- In multi-axis applications (multiple iPOS360X drives on the same motherboard), it is preferable to have a separate decoupling capacitor for each drive's $V_{MOT}$. For $V_{LOG}$ it is acceptable to share one decoupling capacitor for two drives.

- For stringent EMI requirements, it may be necessary to add common-mode filtering on the motor and/or logic supply inputs. Be sure to use 3-phase EMC filters, not 2-phase filters, in order to fulfill the basic requirement of zero common-mode current through the filter. This is necessary because the ground negative return is shared between $V_{MOT}$ and $V_{LOG}$.

- Motor outputs shall be routed with parallel traces, and minimizing the loop area between these tracks. Avoid placing components above or below the motor output tracks, as these components may become effective antennas radiating EMI. If possible, route all 4 motor outputs in strip-line configuration (above or below a ground plane).

- For stringent EMI requirements, it may be necessary to add common-mode inductors on the motor outputs. Place these filters near the iPOS360X, not near the external connector, to reduce radiation from the PCB tracks.

- Motor outputs must be separated from any nearby track (on the same layer) by a guard ring / track / area connected to ground. It is recommended to use the same guarding precaution also for tracks on nearby layers, i.e. use intermediate guard layer(s) connected to ground. The motor outputs must be treated as first source of noise on the motherboard. Second source of noise is the current flow between each iPOS360X and its decoupling $V_{MOT}$ capacitor.

- For best EMC performance, it is strongly recommended to provide an un-interrupted ground plane on one of the inner layers.

- All GND pins of the iPOS360X are galvanically connected together on-board the iPOS360X. If the motherboard provides an uninterrupted ground plane, it is recommended to connect all GND pins to the ground plane, and use the ground plane to distribute GND wherever needed. If the motherboard does not provide an uninterrupted ground plane, it is best to distribute GND connections evenly across the 3 pins. This will create local "star point" ground connection on-board each iPOS360X. For a multi-axis motherboard with one common power supply for all motors, each motor power supply return track shall be routed separately for each iPOS360X, and star-point connected at the power supply terminal.

- The following signal pairs must be routed differentially, i.e. using parallel tracks with minimal loop area: A1, A1- ; B1+, B1- ; Z1+, Z1- ; CAN-Hi, CAN-Lo.

- CAN-Bus tracks must be routed with a bus topology, without branches / bifurcations, in a daisy-chain fashion. The bus ends must be at the termination resistor(s) and/or external connectors.

- When using $+5V_{OUT}$ as supply for external devices (like encoders, Hall sensors, etc.) provide extra filtering and protection: use series resettable (PTC) fuses to add short-circuit protection; use transient absorbers to protect against ESD and over-voltage; add high-frequency filtering to protect against external noise injected on $+5V_{OUT}$.

- The outer box / case / cabinet must be connected to the motherboard ground either galvanically (directly) or through high-frequency decoupling capacitors, rated at an appropriate voltage.

| ⚠ | CAUTION! | *WHEN THE iPOS360X IS SET IN TMLCAN MODE, IT STARTS TO EXECUTE AUTOMATICALLY AT POWER ON THE TML APPLICATION FROM ITS EEPROM. ADD ON THE MOTHERBOARD THE POSSIBILITY TO DISABLE THIS FEATURE AS SHOWN PAR. 3.7.11. THIS MIGHT BE NEEDED DURING DEVELOPMENT PHASE IN CASE THE EEPROM CONTENT IS ACCIDENTALLY CORRUPTED.* |
|---|---|---|
| [ESD symbol] | CAUTION! | *THE iPOS360X IS AN ELECTROSTATICALLY SENSITIVE DEVICE, WHICH WILL BE DAMAGED BY INCORRECT HANDLING. THEREFORE THE DRIVE SHALL BE REMOVED FROM ITS ORIGINAL PACKAGE ONLY IN AN ESD PROTECTED ENVIRONMENT!* |

## 3.5 EMC recommendations

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

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

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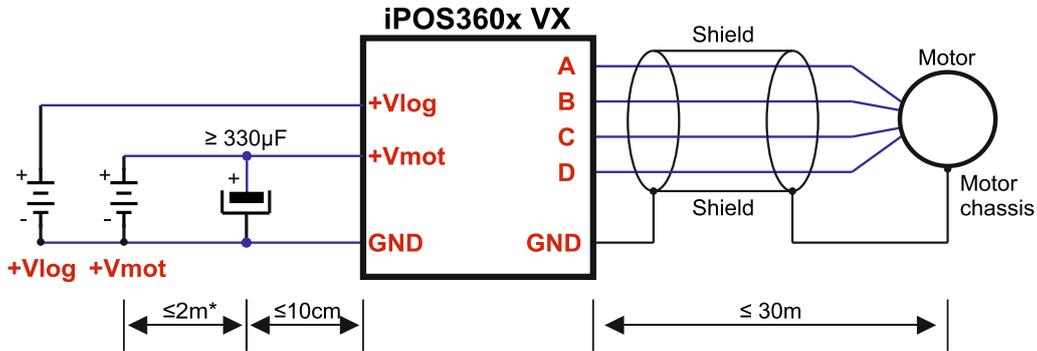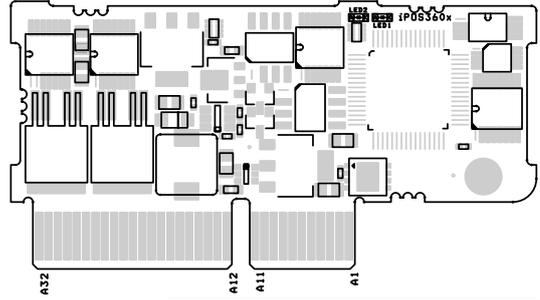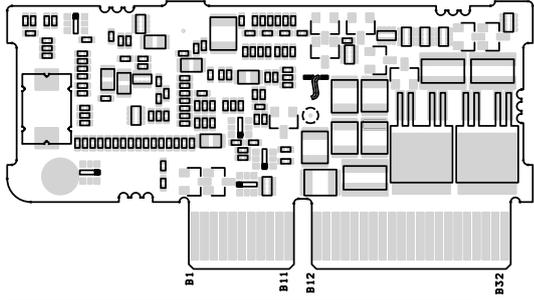


**Figure 3.9** EMC recommended connections

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

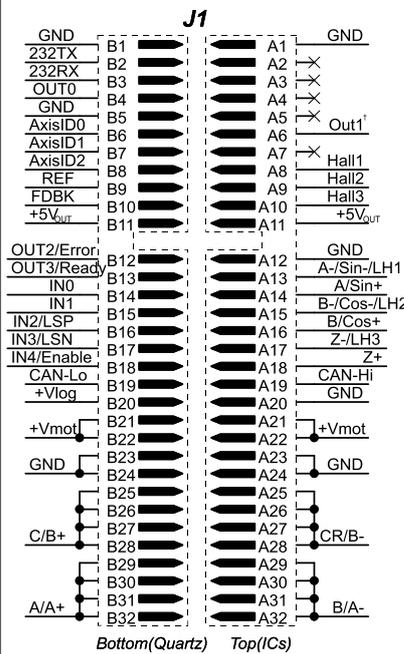* if +Vmot to capacitor wire length ≥ 20m, the capacitor value must be ≥ 2200 μF.

## 3.6 Connectors and Pinouts

### 3.6.1 Pinouts for iPOS360X VX-CAN



| Pin | Name | Description |
|---|---|---|
| B1 | GND | Return ground |
| B2 | 232TX | RS-232 Data Transmission |
| B3 | 232RX | RS-232 Data Reception |
| B4 | OUT0 | 5-36V 0.5A general-purpose digital output, NPN open-collector/TTL pull-up |
| B5 | GND | Return ground |
| B6 | AxisID 0 | Axis ID/Address input. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V |
| B7 | AxisID 1 | Axis ID/Address inputs. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V |
| B8 | AxisID 2 | Axis ID/Address input. 7 states: floating, strap to GND or +5V, resistor 4K7 or 22K to GND or +5V |
| B9 | REF | Analogue input, 12-bit, 0-5V. |
| B10 | FDBK | Analogue input, 12-bit, 0-5V. |
| B11 | +5VOUT | 5V output supply for I/O usage |
| B12 | OUT2/ Error | 5-36V 0.5A drive error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED. |
| B13 | OUT3/ Ready | 5-36V 0.5A drive ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED |
| B14 | IN0 | 5-36V digital input General-purpose |
| B15 | IN1 | 5-36V digital input |
| B16 | IN2/ LSP | 5-36V digital input Positive limit switch input |
| B17 | IN3/ LSN | 5-36V digital input Negative limit switch input |
| B18 | IN4/ Enable | 5-36V digital input Drive enable input |
| B19 | Can-Lo | CAN-Bus negative line      (dominant low) |
| B20 | +VLOG | Positive terminal of the logic supply: 7 to 36VDC |
| B21, B22 | +VMOT | Positive terminal of the motor supply: 9 to 36VDC |
| B23, B24 | GND | Return ground |
| B25-B28 | C / B+ | Phase C for 3-ph motors, B+ for 2-ph steppers |
| B29-B32 | A / A+ | Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors |



| Pin | Name | Description |
|---|---|---|
| A1 | GND | Return ground |
| A2 | reserved | Reserved, do not connect |
| A3 | reserved | Reserved, do not connect |
| A4 | reserved | Reserved, do not connect |
| A5 | reserved | Reserved, do not connect |
| A6 | OUT1† | 5-36V 0.5A general-purpose digital output, NPN open-collector/TTL pull-up |
| A7 | reserved | Reserved, do not connect |
| A8 | Hall 1 | Digital input Hall 1 sensor |
| A9 | Hall 2 | Digital input Hall 2 sensor |
| A10 | Hall 3 | Digital input Hall 3 sensor |
| A11 | +5V$_{OUT}$ | 5V supply for sensors - internally generated |
| A12 | GND | Return ground |
| A13 | A- / Sin- / LH1 | Incr. encoder A- differential input, or analogue encoder Sin- differential input, or linear Hall 1 input |
| A14 | A / A+ / Sin+ | Incr. encoder A single-ended, or A+ differential input, or analogue encoder Sin+ differential input |
| A15 | B- / Cos- / LH2 | Incr. encoder B- differential input, or analogue encoder Cos- differential input, or linear Hall 2 input |
| A16 | B / B+ / Cos+ | Incr. encoder B single-ended, or B+ differential input, or analogue encoder Cos+ differential input |
| A17 | Z- / LH3 | Incr. encoder Z- differential input, or linear Hall 3 input |
| A18 | Z / Z+ | Incr. encoder Z (index) single-ended, or Z+ differential input |
| A19 | Can-Hi | CAN-Bus positive line (dominant high) |
| A20 | GND | Negative return (ground) of the logic supply |
| A21, A22 | +VMOT | Positive terminal of the motor supply: 9 to 36VDC |
| A23, A24 | GND | Return ground |
| A25-A28 | CR / B- | Chopping resistor / Phase B- for step motors |
| A29-A32 | B / A- | Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors |

### 3.6.2 Mating Connectors for iPOS360X VX-CAN

| Producer | Part Number | Description | Images |
|---|---|---|---|
| Tyco | 2-1775801-4 | PCIe 4x vertical card edge connector,1.0mm pitch, 2x32 contacts | |
| FCI | 10018784-11101TLF | | |
| Tyco | 1761465-2 | PCIe 4x horizontal card edge connector,1.0mm pitch, 2x32 contacts | |
| Samtec | PCIE-064-02-F-D-RA | | |
| FCI | 10035591-001LF | Retainer for vertical PCIe card | |
| FCI | 10042618-002LF | | |

### 3.6.3 Pinouts for iPOS360X VX-CAT



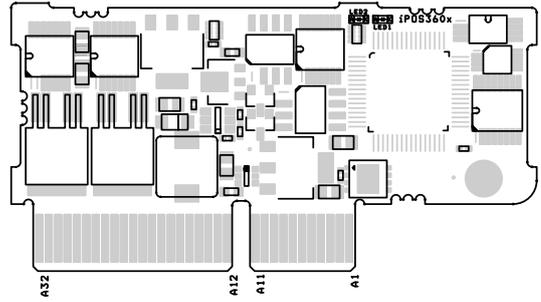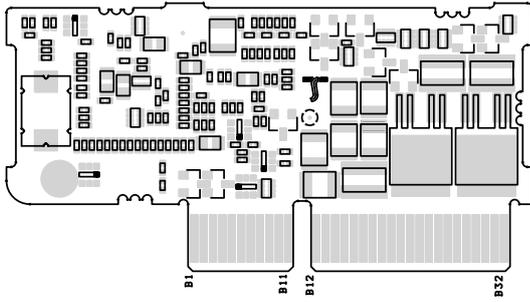| Pin | Name | Description |
|---|---|---|
| **B1** | **GND** | Return ground |
| B2 | 232TX | RS-232 Data Transmission |
| B3 | 232RX | RS-232 Data Reception |
| B4 | OUT0 | 5-36V 0.5A general-purpose digital output, NPN open-collector/TTL pull-up |
| **B5** | **GND** | Return ground |
| B6 | Interrupt | 3.3V digital input; for ECAT interface board |
| B7 | ECAT Ready | 3.3V digital input; for ECAT interface board |
| B8 | Sync | 3.3V digital input; for ECAT interface board |
| B9 | REF | Analogue input, 12-bit, 0-5V. |
| B10 | FDBK | Analogue input, 12-bit, 0-5V. |
| **B11** | **+5VOUT** | 5V output supply for I/O usage |
| B12 | OUT2/ Error | 5-36V 0.5A drive error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED. |
| B13 | OUT3/ Ready | 5-36V 0.5A drive ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED |
| B14 | IN0 | 5-36V digital input General-purpose |
| B15 | IN1 | 5-36V digital input |
| B16 | IN2/ LSP | 5-36V digital input Positive limit switch input |
| B17 | IN3/ LSN | 5-36V digital input Negative limit switch input |
| B18 | IN4/ Enable | 5-36V digital input Drive enable input |
| **B19** | **reserved** | Reserved, do not connect |
| B20 | +VLOG | Positive terminal of the logic supply: 7 to 36VDC |
| B21, B22 | +VMOT | Positive terminal of the motor supply: 9 to 36VDC |
| B23, B24 | GND | Return ground |
| B25-B28 | C / B+ | Phase C for 3-ph motors, B+ for 2-ph steppers |
| B29-B32 | A / A+ | Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors |

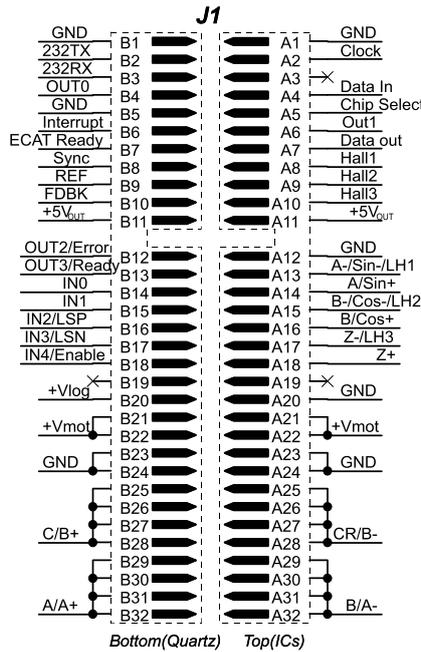| Pin | Name | Description |
|---|---|---|
| **A1** | **GND** | Return ground |
| A2 | Clock | 3.3V digital output; for ECAT interface board |
| **A3** | **reserved** | Reserved, do not connect |
| A4 | Data In | 3.3V digital output; for ECAT interface board |
| A5 | Chip select | 3.3V digital output; for ECAT interface board |
| A6 | OUT1 | 5-36V 0.5A general-purpose digital output, NPN open-collector/TTL pull-up |
| A7 | Data Out | 3.3V digital input; for ECAT interface board |
| A8 | Hall 1 | Digital input Hall 1 sensor |
| A9 | Hall 2 | Digital input Hall 2 sensor |
| A10 | Hall 3 | Digital input Hall 3 sensor |
| A11 | +5VOUT | 5V supply for sensors - internally generated |
| A12 | GND | Return ground |
| A13 | A- / Sin- / LH1 | Incr. encoder A- differential input, or analogue encoder Sin-differential input, or linear Hall 1 input |
| A14 | A / A+ / Sin+ | Incr. encoder A single-ended, or A+ differential input, or analogue encoder Sin+ differential input |
| A15 | B- / Cos- / LH2 | Incr. encoder B- differential input, or analogue encoder Cos- differential input, or linear Hall 2 input |
| A16 | B / B+ / Cos+ | Incr. encoder B single-ended, or B+ differential input, or analogue encoder Cos+ differential input |
| A17 | Z- / LH3 | Incr. encoder Z- differential input, or linear Hall 3 input |
| A18 | Z / Z+ | Incr. encoder Z (index) single-ended, or Z+ differential input |
| **A19** | **reserved** | Reserved, do not connect |
| A20 | GND | Negative return (ground) of the logic supply |
| A21, A22 | +VMOT | Positive terminal of the motor supply: 9 to 36VDC |
| A23, A24 | GND | Return ground |
| A25-A28 | CR / B- | Chopping resistor / Phase B- for step motors |
| A29-A32 | B / A- | Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors |

### 3.6.4 Mating Connectors for iPOS360X VX-CAT

| Producer | Part Number | Description | Images |
|---|---|---|---|
| Tyco | 2-1775801-4 | PCIe 4x vertical card edge connector,1.0mm pitch, 2x32 contacts |  |
| FCI | 10018784-11101TLF | | |
| Tyco | 1761465-2 | PCIe 4x horizontal card edge connector,1.0mm pitch, 2x32 contacts |  |
| Samtec | PCIE-064-02-F-D-RA | | |
| FCI | 10035591-001LF | Retainer for vertical PCIe card |  |
| FCI | 10042618-002LF | | |

### 3.6.5 ECAT-VX EtherCAT adapter pinouts

The ECAT-VX adapter is used to connect an iPOS Intelligent drive to the EtherCAT network.
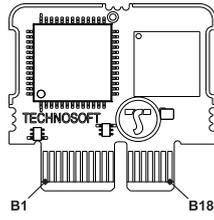


| Pin | Name | Description |
|-----|------|-------------|
| A18 | Pin3 Port0 | Connect to pin 3 of EtherCAT IN port |
| A17 | Pin6 Port0 | Connect to pin 6 of EtherCAT IN port |
| A16 | Pin1 Port0 | Connect to pin 1 of EtherCAT IN port |
| A15 | Pin2 Port0 | Connect to pin 2 of EtherCAT IN port |
| A14 | GND Port0 | Local ground for EtherCAT IN port |
| A13 | Pins 4,5 Port0 | Connect to pins 4,5 of EtherCAT IN port |
| A12 | Pins 7,8 Port0 | Connect to pins 7,8 of EtherCAT IN port |
| A11 | +3.3V | +3.3V for LEDs output |
| A10 | ACT0 LED | Link/Activity LED of EtherCAT IN port |
| A9 | ERR LED | EtherCAT error LED |
| A8 | ACT1 LED | Link/Activity LED of EtherCAT OUT port |
| A7 | RUN LED | EtherCAT Run LED |
| A6 | Sync | Sync0 signal |
| A5 | ECAT Ready | EtherCAT Ready LED |
| A4 | Interrupt | Communication interrupt |
| A3 | GND | Ground |
| A2 | Data In | Data In |
| A1 | Chip Select | Chip Select |

| Pin | Name | Description |
|-----|------|-------------|
| B18 | Pins 7,8 Port1 | Connect to pins 7,8 of EtherCAT OUT port |
| B17 | Pins 4,5 Port1 | Connect to pins 4,5 of EtherCAT OUT port |
| B16 | GND Port1 | Local ground for EtherCAT OUT port |
| B15 | Pin 2 Port1 | Connect to pin 2 of EtherCAT OUT port |
| B14 | Pin 1 Port1 | Connect to pin 1 of EtherCAT OUT port |
| B13 | Pin 6 Port1 | Connect to pin 6 of EtherCAT OUT port |
| B12 | Pin 3 Port1 | Connect to pin 3 of EtherCAT OUT port |
| B11 | Data Out | Data Out |
| B10 | +5V IN | +5V input |
| B9 | N.C. | Not Connected |
| B8 | Reserved | Reserved. Do not connect |
| B7 | Reserved | Reserved. Do not connect |
| B6 | GND | Ground |
| B5 | GND | Ground |
| B4 | Clock | Clock signal input |
| B3 | GND | Ground |
| B2 | GND | Ground |
| B1 | CS1 | Connect to +3.3V |
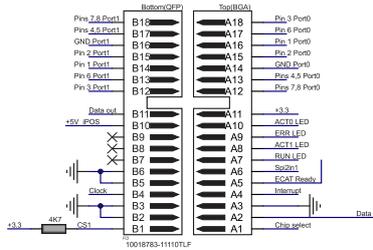
### 3.6.6 Mating Connectors for ECAT-VX adapter

| Producer | Part Number | Description | Images |
|----------|-------------|-------------|--------|
| Tyco | 1-1775801-4 | PCIe 1x vertical card edge connector,1.0mm pitch, 2x18 contacts |  |
| FCI | 10018784-11100TLF | | |
| Tyco | 1761465-1 | PCIe 1x horizontal card edge connector,1.0mm pitch, 2x18 contacts |  |
| Samtec | PCIE-036-02-F-D-RA | | |

### 3.6.7 EtherCAT VX adapter to iPOS360x interconnections

| ECAT VX pin | Signal Name | Direction | iPOS360x VX pin |
|-------------|-------------|-----------|-----------------|
| A2 | Data In | <- | A4 |
| B11 | Data Out | -> | A7 |
| B4 | Clock | <- | A2 |
| A1 | Chip Select | <- | A5 |
| A4 | Interrupt | -> | B6 |
| A6 | Sync | -> | B8 |
| A5 | ECAT Ready | -> | B7 |
| B1 | CS1 | <- | π |

π = Connect CS1 to ECAT VX pin A11(+3.3V)

### 3.6.8    ECAT-VX adapter to RS45 interface connection diagram
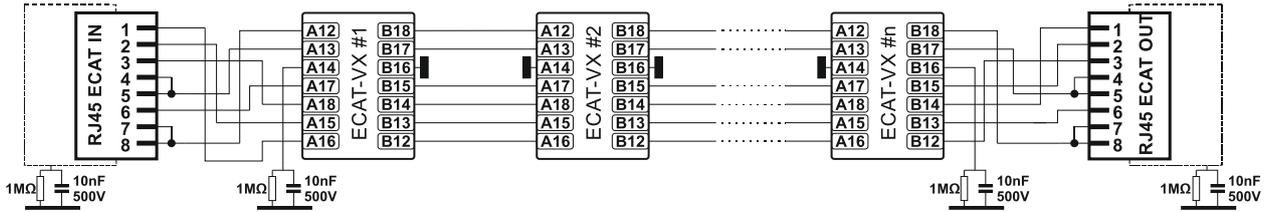


**Figure 3.10** ECAT-VX to RS45 interface connection diagram

## 3.7    Connection diagrams

### 3.7.1    iPOS360X VX-CAN connection diagram
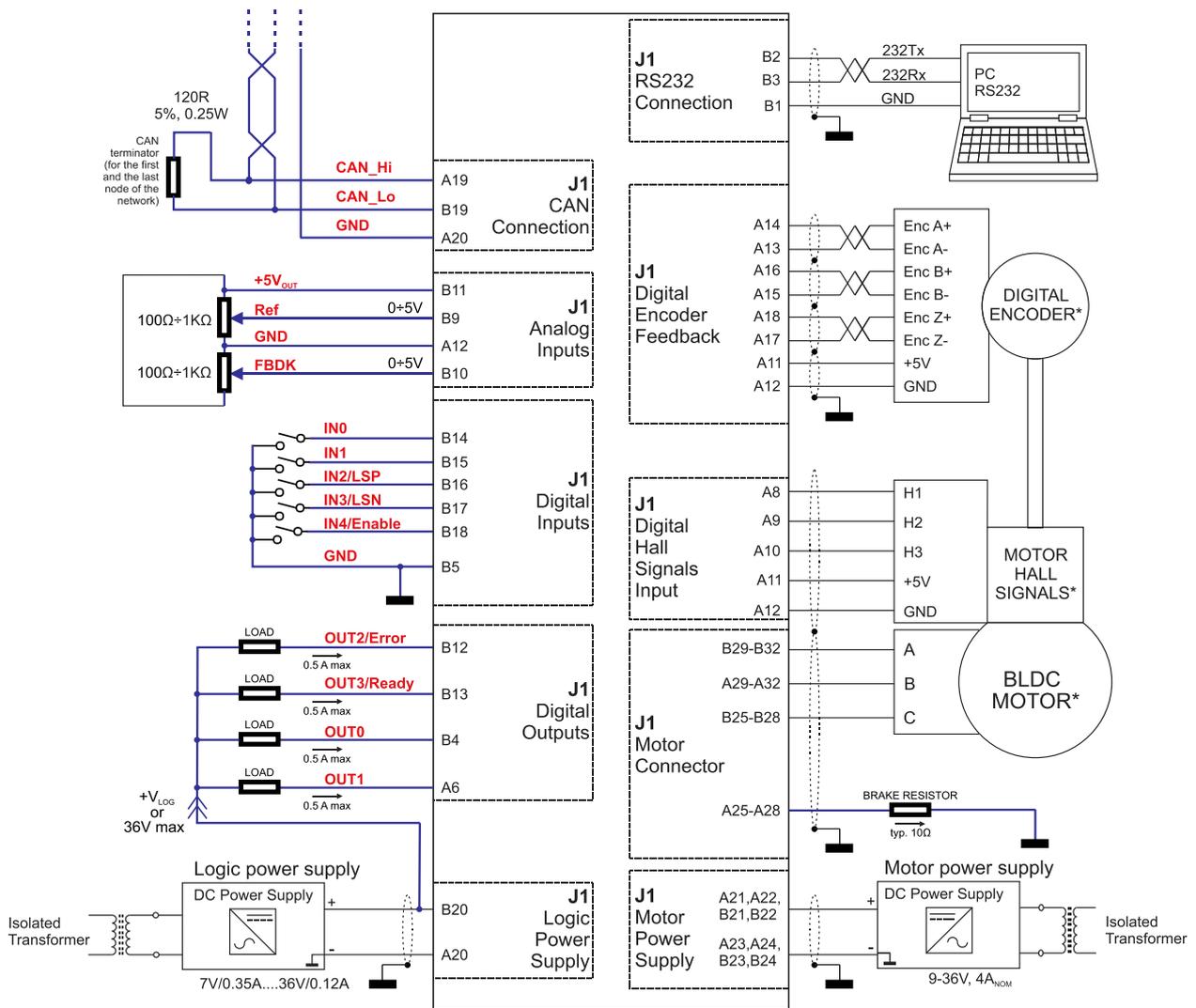


**Figure 3.11.** iPOS360X VX-CAN Connection diagram

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

## 3.7.2   iPOS360X VX-CAT connection diagram
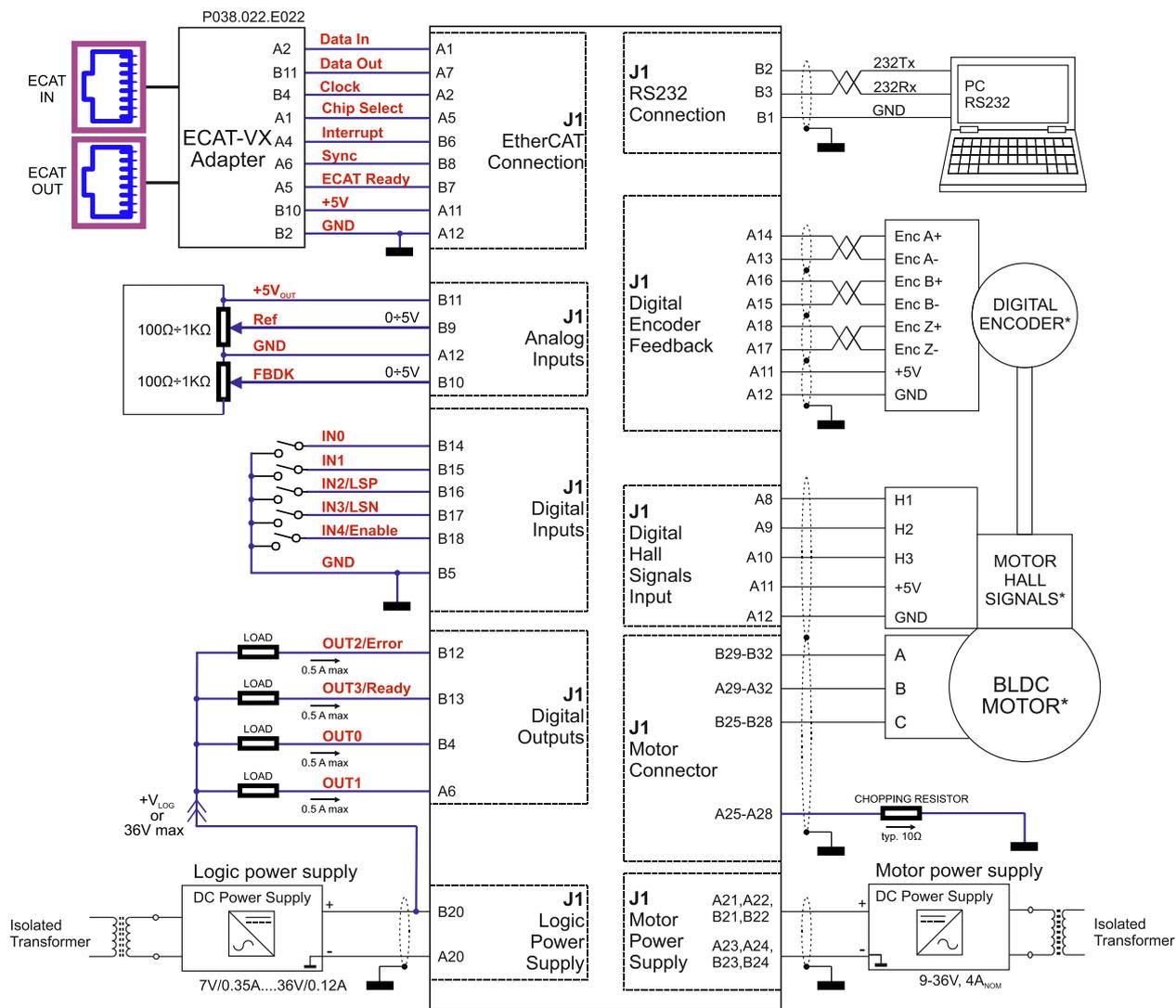


**Figure 3.12.** iPOS360X VX-CAT Connection diagram

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

## 3.7.3 24V Digital I/O Connection
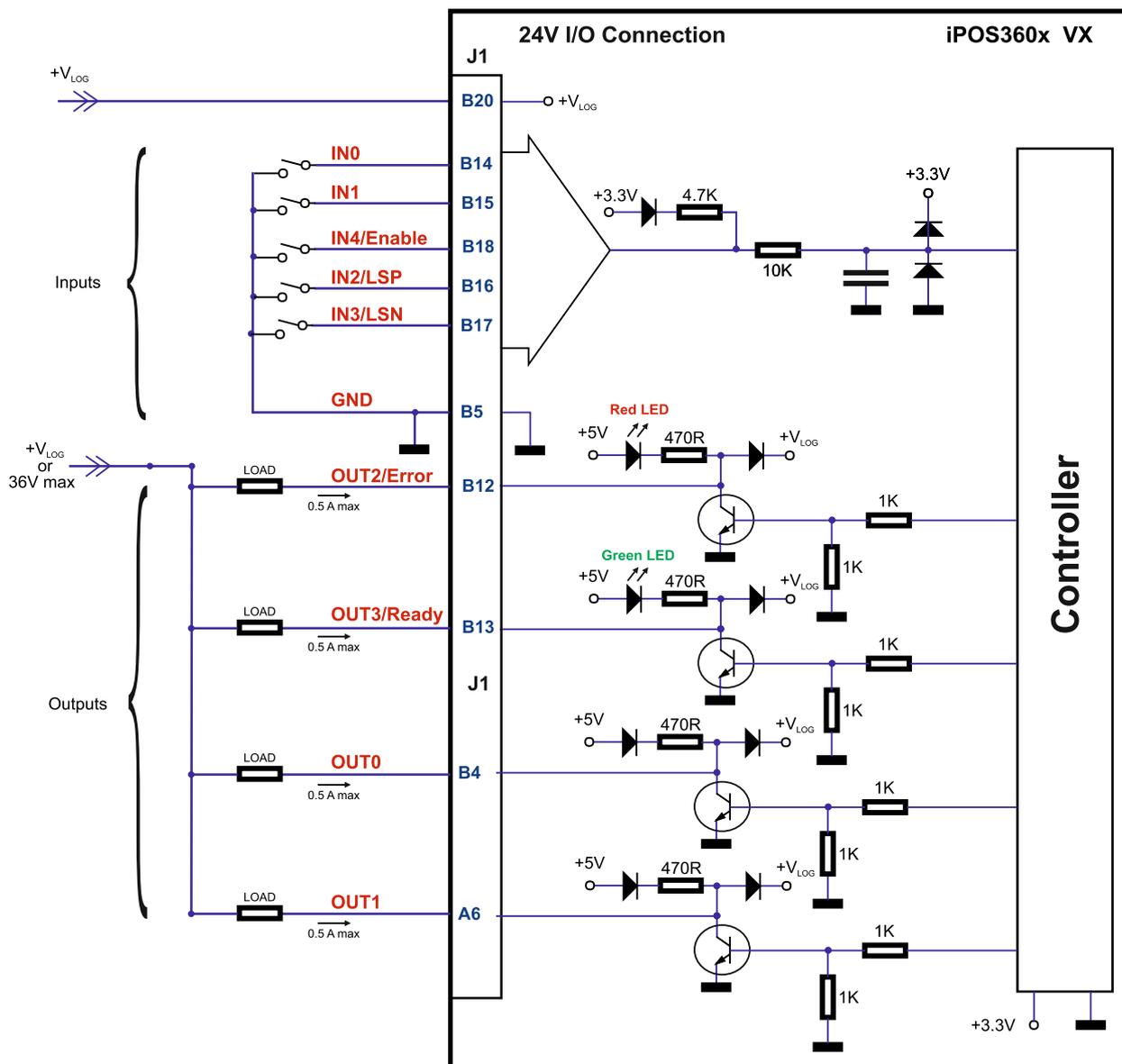


**Figure 3.13.** 24V Digital NPN Inputs connection

*Remarks:*

1. *The inputs are compatible with NPN type outputs (input must be pulled to GND to change its default state)*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
3. *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)*
4. *The maximum sink current is 0.5A continuous, up to 1A pulsed for less than 5 seconds*
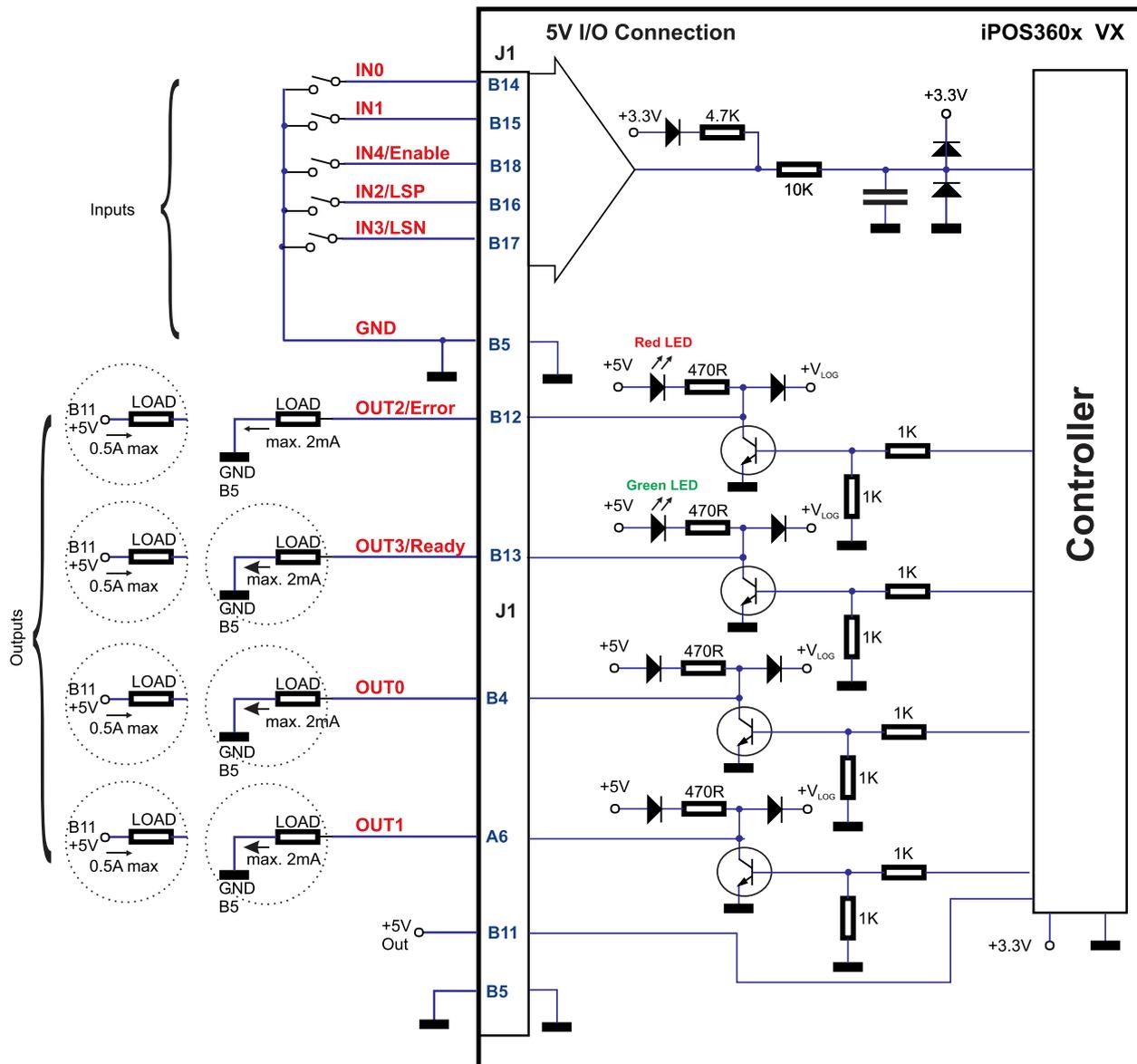
**Figure 3.14.** 5V Digital I/O connection

*Remarks:*

1.  *The inputs are compatible with TTL(5V), LVTTL(3.3V), CMOS and open collector outputs*
2.  *The outputs are compatible with TTL (5V)  and CMOS (5V) inputs*
3.  *The output loads can be individually and independently connected to +5V or to GND.*
4.  *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

### 3.7.5    Analog Inputs Connection

#### 3.7.5.1    0-5V Input Range
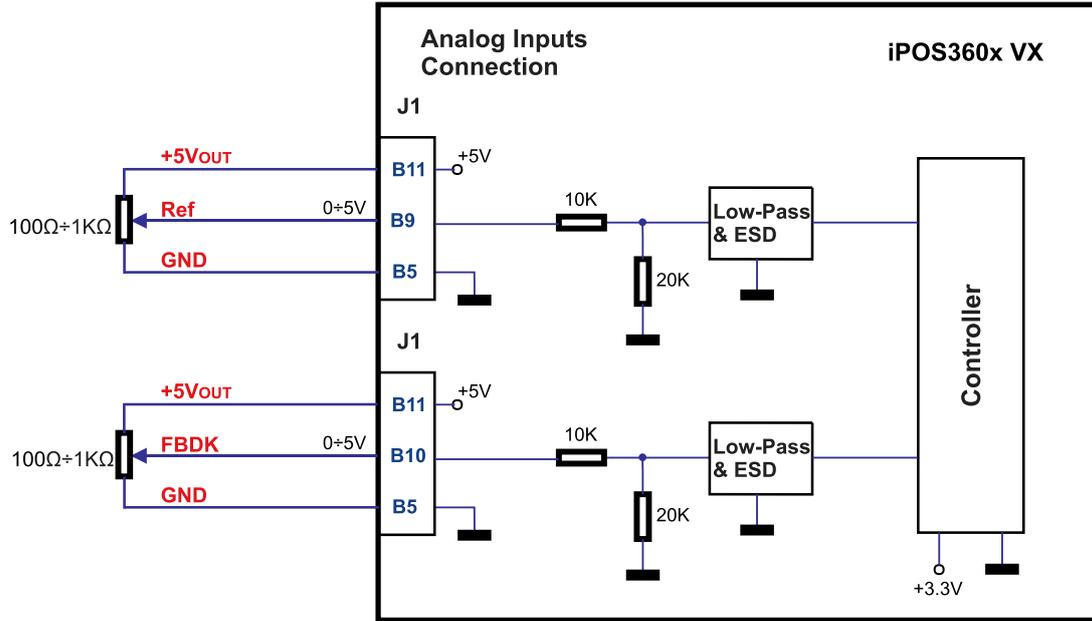


**Figure 3.15.** *0-5V* Analog inputs connection

***Remarks:***

1.  *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
2.  *Default input range for analog inputs is 0÷5 V for REF and FBDK. For a +/-10 V range, see* **Figure 3.17**.

#### 3.7.5.2    +/-10V to 0-5V Input Range Adapter
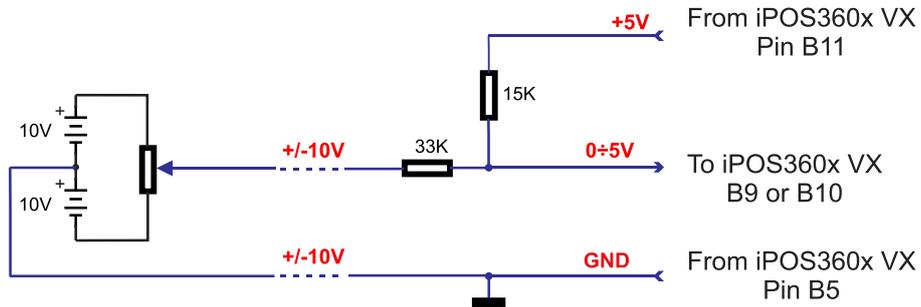


**Figure 3.16.** *+/-10V to 0-5V adapter*

#### 3.7.5.3    Recommendation for wiring

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

### 3.7.6 Motor connections

#### 3.7.6.1 Brushless Motor connection
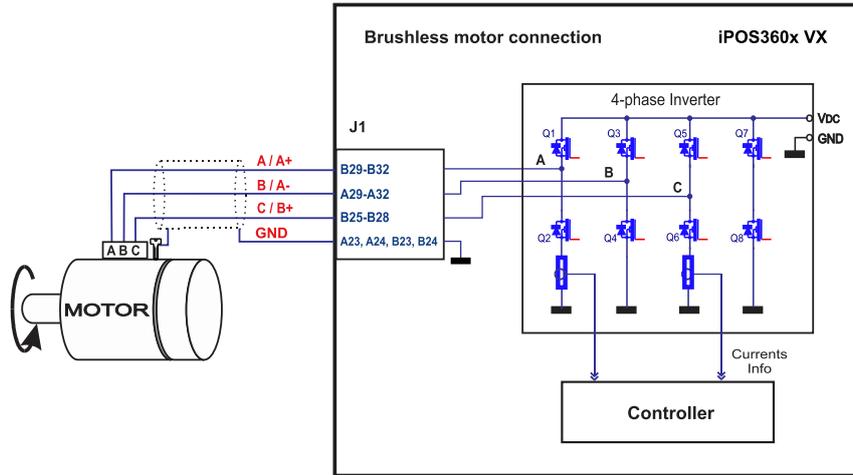


**Figure 3.17.** Brushless motor connection

#### 3.7.6.2 2-phase Step Motor connection
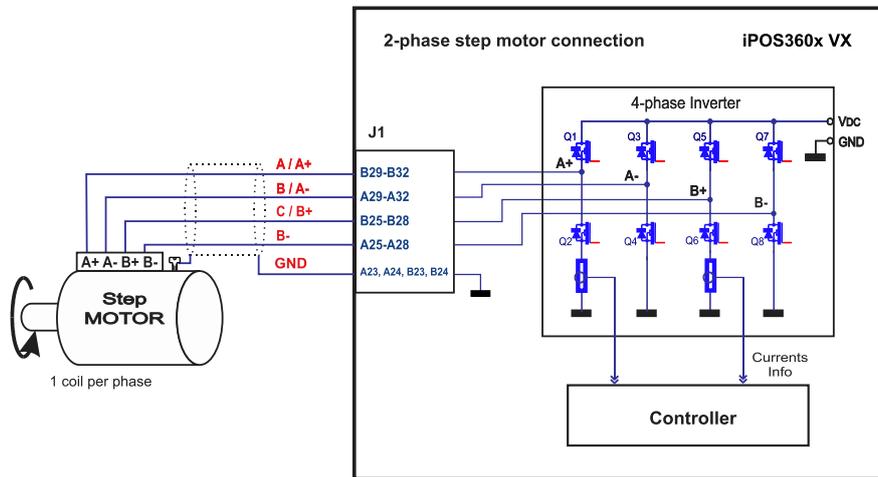


**Figure 3.18.** 2-phase step motor connection, one coil per phase
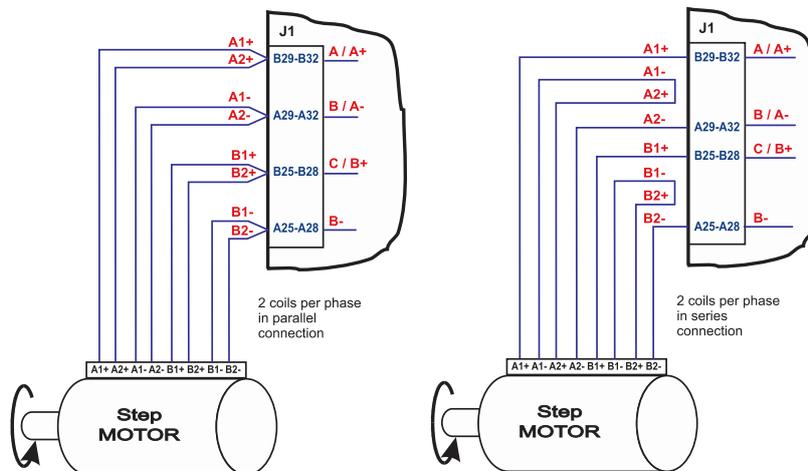


**Figure 3.19.** 2-phase step motor connection, two coils per phase

### 3.7.6.3    3-Phase Step Motor connection
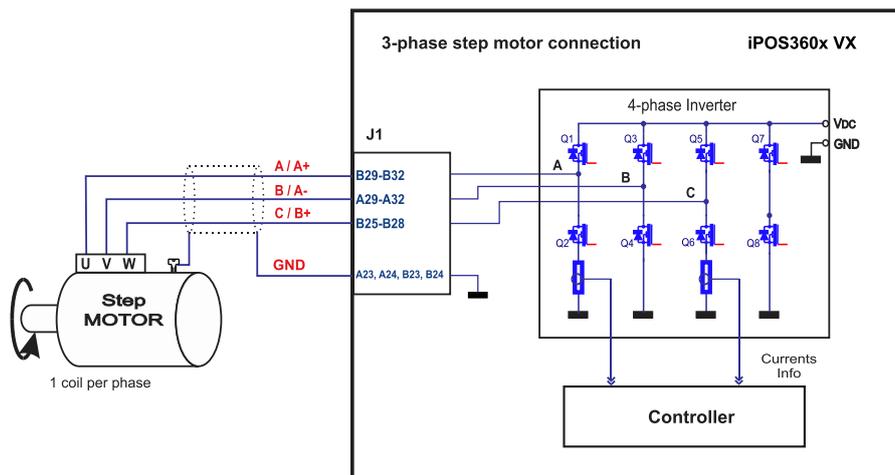


**Figure 3.20.** 3-phase step motor connection

### 3.7.6.4    DC Motor connection
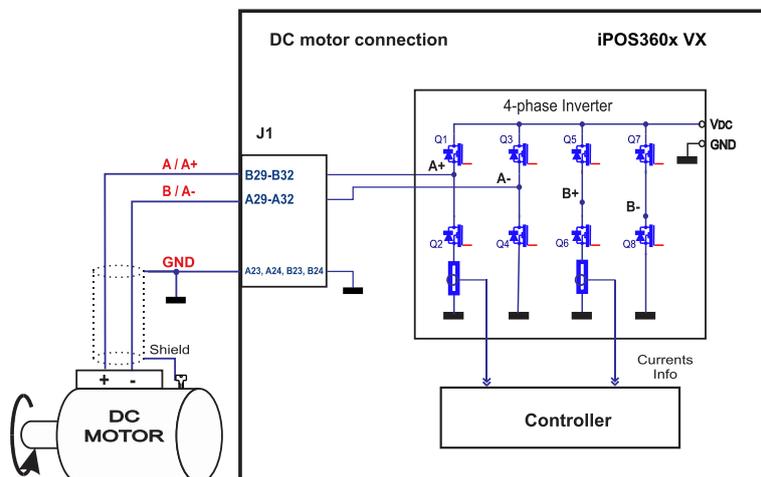


**Figure 3.21.** DC Motor connection

### 3.7.6.5    Recommendations for motor wiring

a)  Avoid running the motor wires in parallel with other wires for a distance longer than 2 meters. If this situation cannot be avoided, use a shielded cable for the motor wires. Connect the cable shield to the iPOS360X GND pin. Leave the other end disconnected.
b)  The parasitic capacitance between the motor wires must not bypass 10nF. If very long cables (tens of meters) are used, this condition may not be met. In this case, add series inductors between the iPOS360X outputs and the cable. The inductors must be magnetically shielded (toroidal, for example), and must be rated for the motor surge current. Typically the necessary values are around 100 µH.
c)  A good shielding can be obtained if the motor wires are running inside a metallic cable guide.

### 3.7.7    Feedback connections

#### 3.7.7.1    Single-ended Incremental Encoder Connection
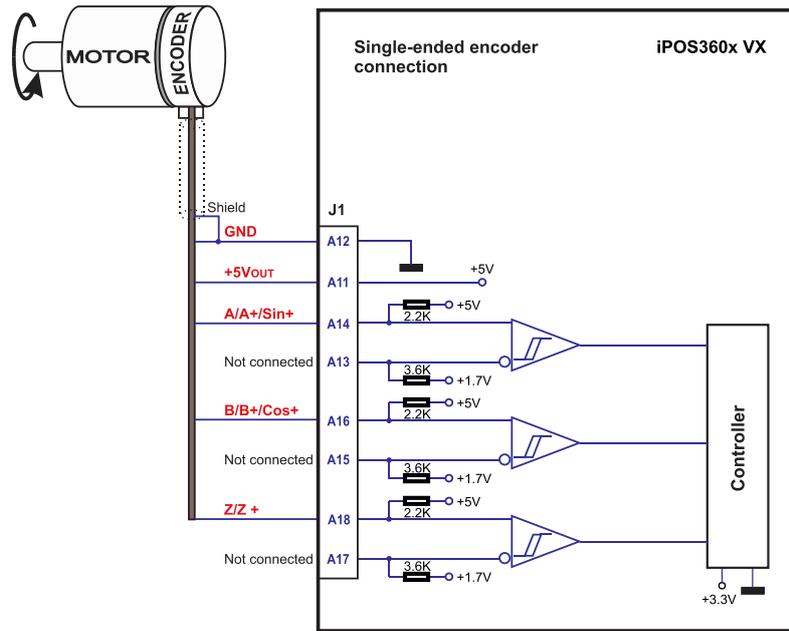


**Figure 3.22**. Single-ended incremental encoder connection

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

#### 3.7.7.2    Differential Incremental Encoder Connection
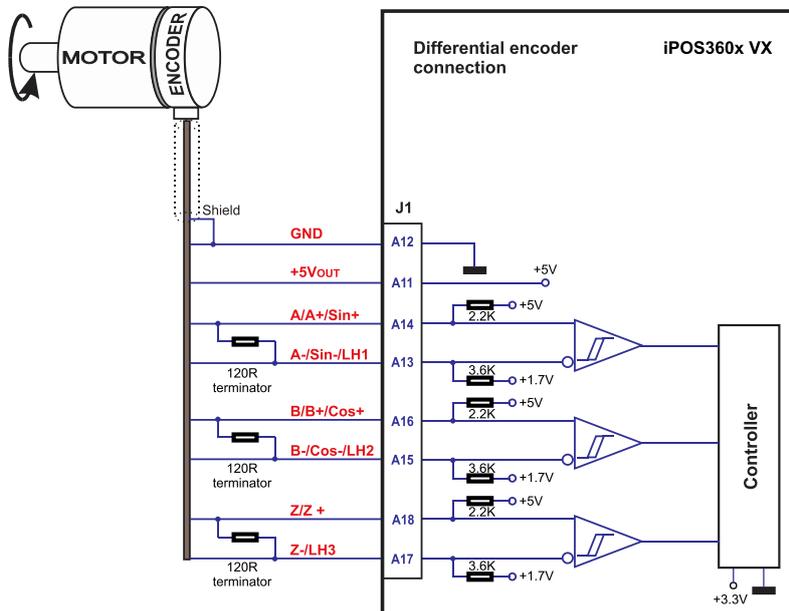


**Figure 3.23.** Differential incremental encoder connection

*Remarks:*

1. *For the encoder differential connection, external 120Ω (0.25W) terminators are required 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.*

### 3.7.7.3    Digital Hall Connection for Motor + Hall + Incremental Encoder
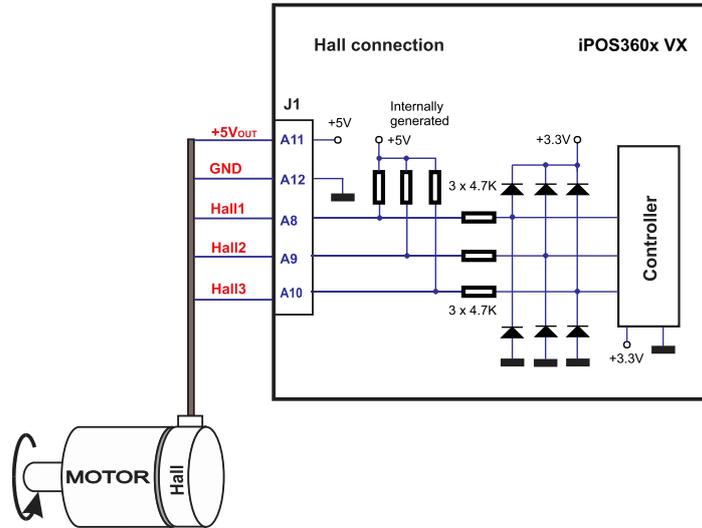


**Figure 3.24.** Digital Hall connection

*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.*

### 3.7.7.4    Digital Hall Connection for direct motor control without an encoder
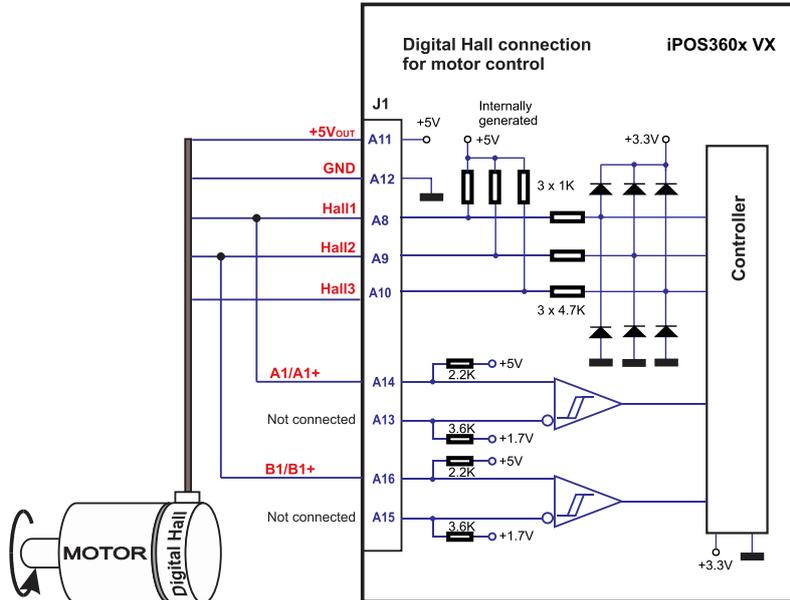


**Figure 3.25.** Digital Hall connection

*Remarks:*

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

### 3.7.7.5 Linear Hall Connection
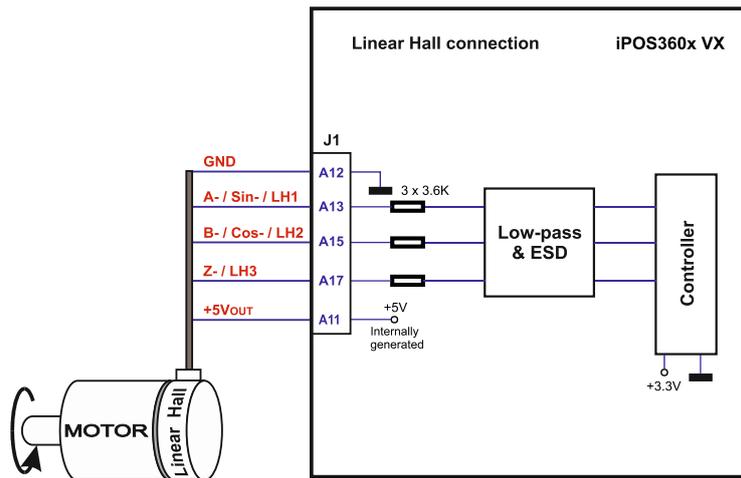


**Figure 3.26.** Digital Hall connection

### 3.7.7.6 Sin-Cosine Analog Encoder Connection
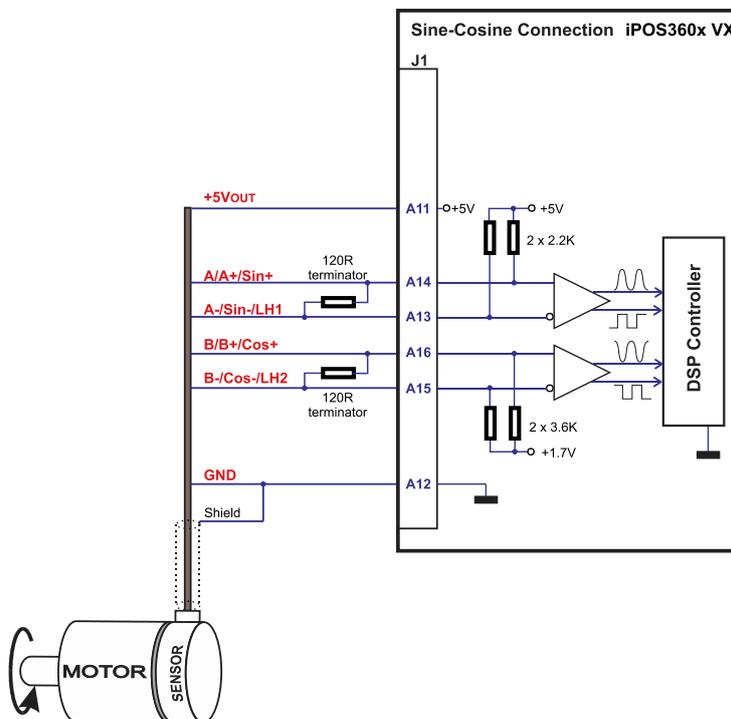


**Figure 3.27.** Digital Hall connection

### 3.7.7.7 Recommendations for wiring

a) Always connect both positive and negative signals when the position sensor is differential and provides them. Use one twisted pair for each differential group of signals as follows: A+/Sin+ with A-/Sin-/LH1, B+/Cos+ with B-/Cos-/LH2, Z+ with Z-/LH3. Use another twisted pair for the 5V supply and GND.

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

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

### 3.7.8 Power Supply Connection

#### 3.7.8.1 Supply Connection
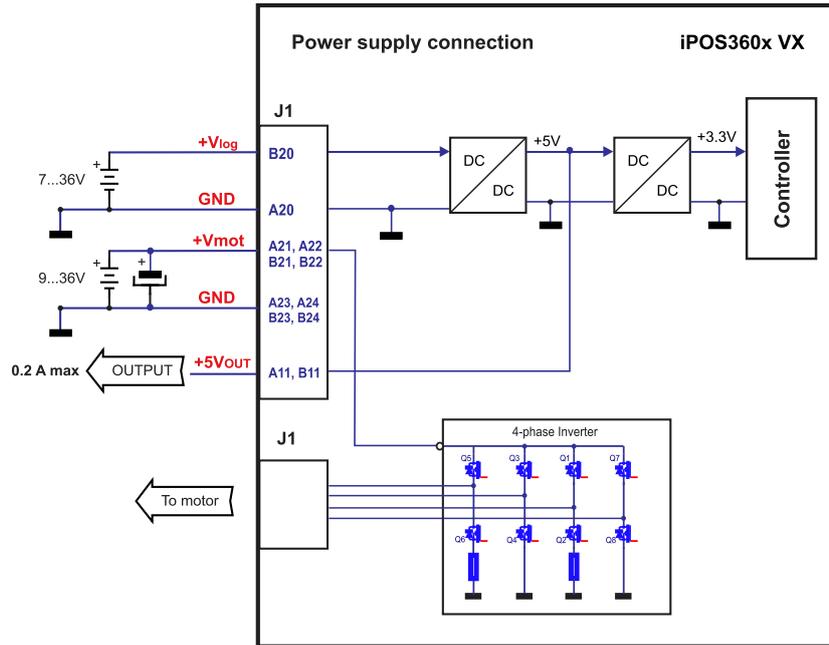


**Figure 3.28.** Supply connection

#### 3.7.8.2 Recommendations for Supply Wiring

Always provide a nearby capacitor on the motor supply lines. The capacitor should be located within 10cm of the iPOS360x edge connector, max. 20cm. The minimum recommended capacitance is 330µF for iPOS3604, or 220µF for iPOS3602, always rated at the appropriate voltage.

Use short, thick wires between the iPOS360x and the motor power supply. Connect power supply wires to all the indicated pins. If the wires are longer than 2 meters, use twisted wires for the supply and ground return. For wires longer than 20 meters, add a capacitor of at least 2,200µF (rated at an appropriate voltage) right on the terminals of the iPOS3604, respectively 1,000µF for the iPOS3602.

#### 3.7.8.3 Recommendations to limit over-voltage during energy regeneration

During abrupt motion decelerations or reversals the regenerative energy is injected into the motor power supply. This may cause an increase of the motor supply voltage (depending on the power supply characteristics). If the voltage bypasses 28V, the drive over-voltage protection is triggered and the drive power stage is disabled. In order to avoid this situation you have 2 options:

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

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

where:

$U_{MAX}$ = 28V is the over-voltage protection limit

$U_{NOM}$ is the nominal motor supply voltage

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

$$E_M = \frac{1}{2}(J_M + J_L)\varpi_M^2 + (m_M + m_L)g(h_{initial} - h_{final}) - 3I_M^2 R_{Ph} t_d - \frac{t_d \varpi_M}{2} T_F$$

$$\underbrace{\qquad\qquad}_{\text{Kinetic energy}} \quad \underbrace{\qquad\qquad\qquad}_{\text{Potential energy}} \quad \underbrace{\qquad}_{\text{Copper losses}} \; \underbrace{\qquad}_{\text{Friction losses}}$$

where:

$J_M$ – total rotor inertia [kgm$^2$]

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

$\varpi_M$ – 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 [$\Omega$]

$t_d$ – 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 $\varpi_M$ will become linear speed measured in [m/s] and the friction torque $T_F$ will become friction force measured in [N].

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

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

The chopping resistor option can be found in the Drive Setup dialogue within EasyMotion / EasySetup.
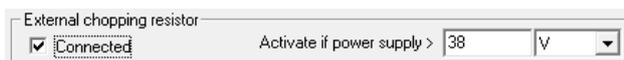


The chopping will occur when DC bus voltage increases over $U_{CHOP}$. This parameter ($U_{CHOP}$) should be adjusted depending on the nominal motor supply. Optimally (from a braking point of view), $U_{CHOP}$ should be a few volts above the maximum nominal supply voltage. This setting will activate the chopping resistor earlier, before reaching dangerous voltages – when the over-voltage protection will stop the drive. Of course, $U_{CHOP}$ must always be less than $U_{MAX}$ – the over-voltage protection threshold.

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

**Chopping resistor selection**

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

1.  to limit the maximum current below the drive peak current $I_{PEAK}$ = 10A

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

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 $I_{NOM}$=0.9A

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

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

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

***Remarks:***

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

   or C – the external capacitor on the motor supply

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

   interval between braking cycles must be increased

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

### 3.7.9 Serial RS-232 connection

#### 3.7.9.1 Serial RS-232 connection
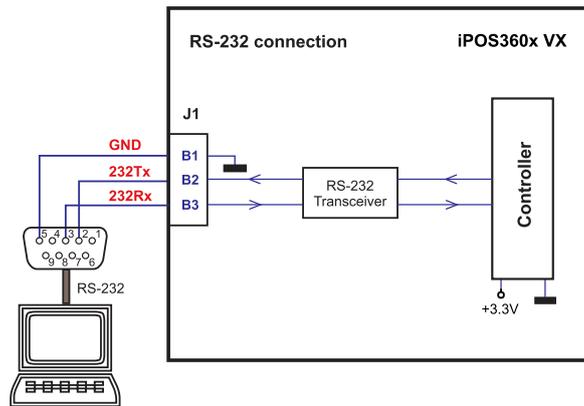


**Figure 3.29.** Serial RS-232 connection

#### 3.7.9.2 Recommendation for wiring

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

## 3.7.10 CAN-bus connection (for CAN drives only)

### 3.7.10.1 CAN connection
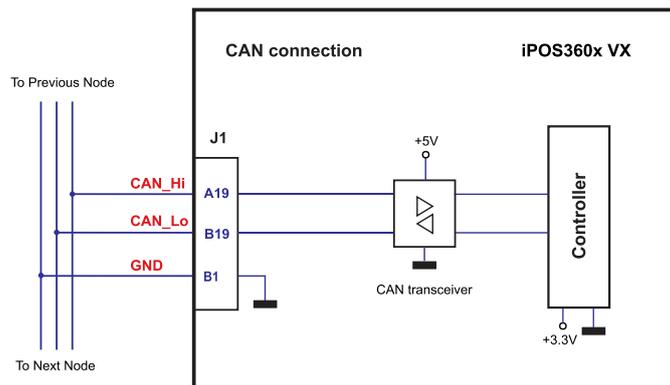


**Figure 3.30.** CAN connection

*Remarks:*

1. *The CAN network requires a 120-Ohm terminator. This is not included on the board. Figure 3.32 shows how to connect it on your network*
2. *CAN signals can sustain up to +/-58V without damage.*

### 3.7.10.2 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.
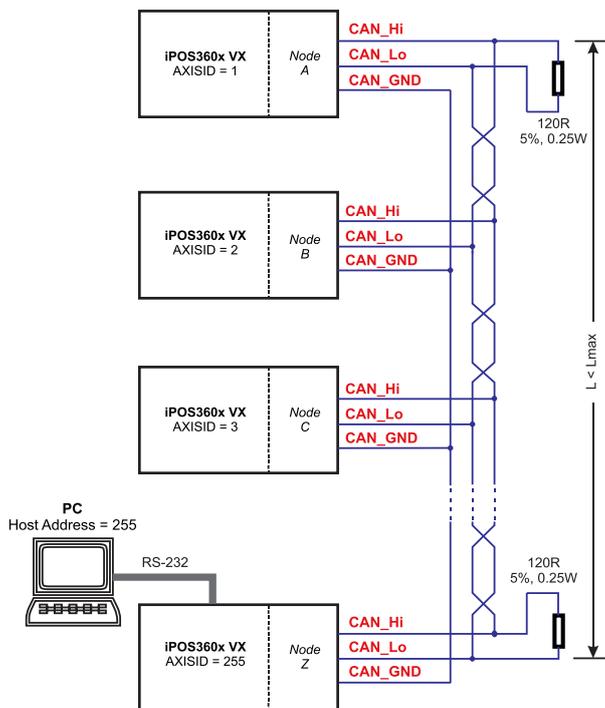


**Figure 3.31.** Multiple-Axis CAN network

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### 3.7.11 Disable of Autorun Mode (for CAN) / Disable Setup (for CAT)
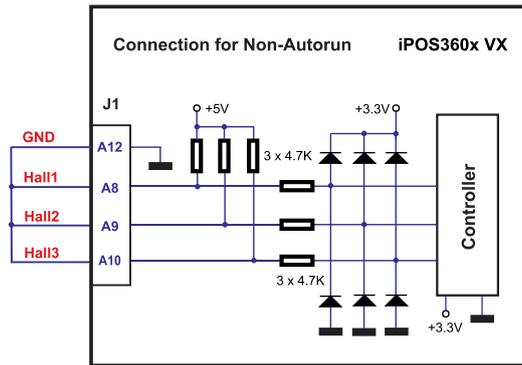


**Figure 3.32.** Temporary *c*onnection during power-on to disable the drive from Autorun mode

#### 3.7.11.1 For CAN drives

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

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

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

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

b) Hardware: connecting all digital Hall inputs to GND, as shown in *Figure 3.33*. This option is particularly useful when you are unable to establish communication with the drive.

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

#### 3.7.11.2 For EtherCAT drives

In some very rare cases, the setup table might be corrupted, leading to a loop where the drive resets continuously. This behavior can be noticed by seeing both the Ready and Error LED blinking for short periods of time continuously. To recover from this behavior, the setup table can be invalidated by connecting all digital Hall inputs to GND, as shown in *Figure 3.33*.

On the next power on, the drive will load setup default settings and the Motion Error Register (MER) bit 2 will be 1. 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.

## 3.8 Operation Mode and Axis ID Selection for CAT drives

For EtherCAT (CAT) drives, the Operation mode is always CoE protocol and cannot be changed.

The Axis ID selection can only be done by software setting, with Easy Motion Studio or Easy Setup.

The iPOS360x VX-CAT drives support all EtherCAT standard addressing modes. In case of device addressing mode based on node address, the iPOS drive sets the configured station alias address with its Axis ID value. The drive Axis ID value is set after power on only by software when setting via EasySetUp a specific Axis ID value in the range 1-255.

The hardware Axis ID pins from the CAN version are used to communicate with the ECAT-VX adapter.

The default Axis ID will be 255.

If the axis ID is selected as H/W in Setup, the axis ID will be 255.

If the Axis ID is 255, then the ECAT "configured station alias" will be 0. This setting allows certain EtherCAT masters to have multiple drives in a network having the same station alias (0).

If the Axis ID is set between 1 and 254, the "configured station alias" will be set accordingly.

**Remark:** Some EtherCAT masters consider having the same station alias (with non-zero values) on multiple drives as an Error.

It is recommended to use separate setup files on each drive with individual Axis IDs, to quickly determine the identity and location of each drive in the network.

## 3.9   Operation Mode and Axis ID Selection for CAN drives

The iPOS360x VX-CAN drives have 3 dedicated pins which choose the CAN operation mode and hardware Axis ID value.

These settings are done by setting different voltage levels on the inputs AxisID 0 (pin B6), AxisID 1(pin B7) and AxisID 2 (pin B8). Each input can be set to one of the following 7 levels:

| Level | Connection needed |
|---|---|
| L0 | Connect input directly to ground (for example pin B5) |
| L1 | Connect input through a 4.7KΩ resistor to ground |
| L2 | Connected input through a 22KΩ resistor to ground |
| L3 | Nothing connected – leave input open |
| L4 | Connect input through a 22KΩ resistor to +5Vdc (for example pin B11) |
| L5 | Connect input through a 4.7Kohm resistor to +5Vdc |
| L6 | Connect input directly to +5V |

The operation mode selection is done via AxisID 2:
- CANopen mode, if the input levels are: L0, L1 or L2
- TMLCAN mode, if the input levels are L3, L4, L5, L6

*Figure 3.34* shows how to set the 7 levels on the AxisID 0 input and the resulting axis ID values when AxisID 2 input level is set for **CANopen** operation. Chapter *3.9.1* shows how to set all possible values for axis ID in this mode of operation.

***Remarks:***

1. *AxisID is computed with formula: 49 x (AxisID2 - 3) + 7 x AxisID1 + AxisID0, where each AxisID can have one of the integer values: 0 to 6 (0 for L0, 1 for L1, 2 for L2, etc.)*
2. *If the resulting AxisID value is 0,  the axis ID will be set to 255*

*Figure 3.35* shows how to set the 7 levels on the AxisID 0 input and the resulting axis ID values when AxisID 2 input level is set for **TMLCAN** operation.  Chapter *3.9.2* shows how to set all possible values for axis ID in this mode of operation.

***Remarks:***

1. *AxisID is computed with formula: 49 x (AxisID2 - 3) + 7 x AxisID1 + AxisID0, where each AxisID can have one of the integer values: 0 to 6 (0 for L0, 1 for L1, 2 for L2, etc.)*
2. *If the resulting AxisID value is 0,  the axis ID will be set to 255*
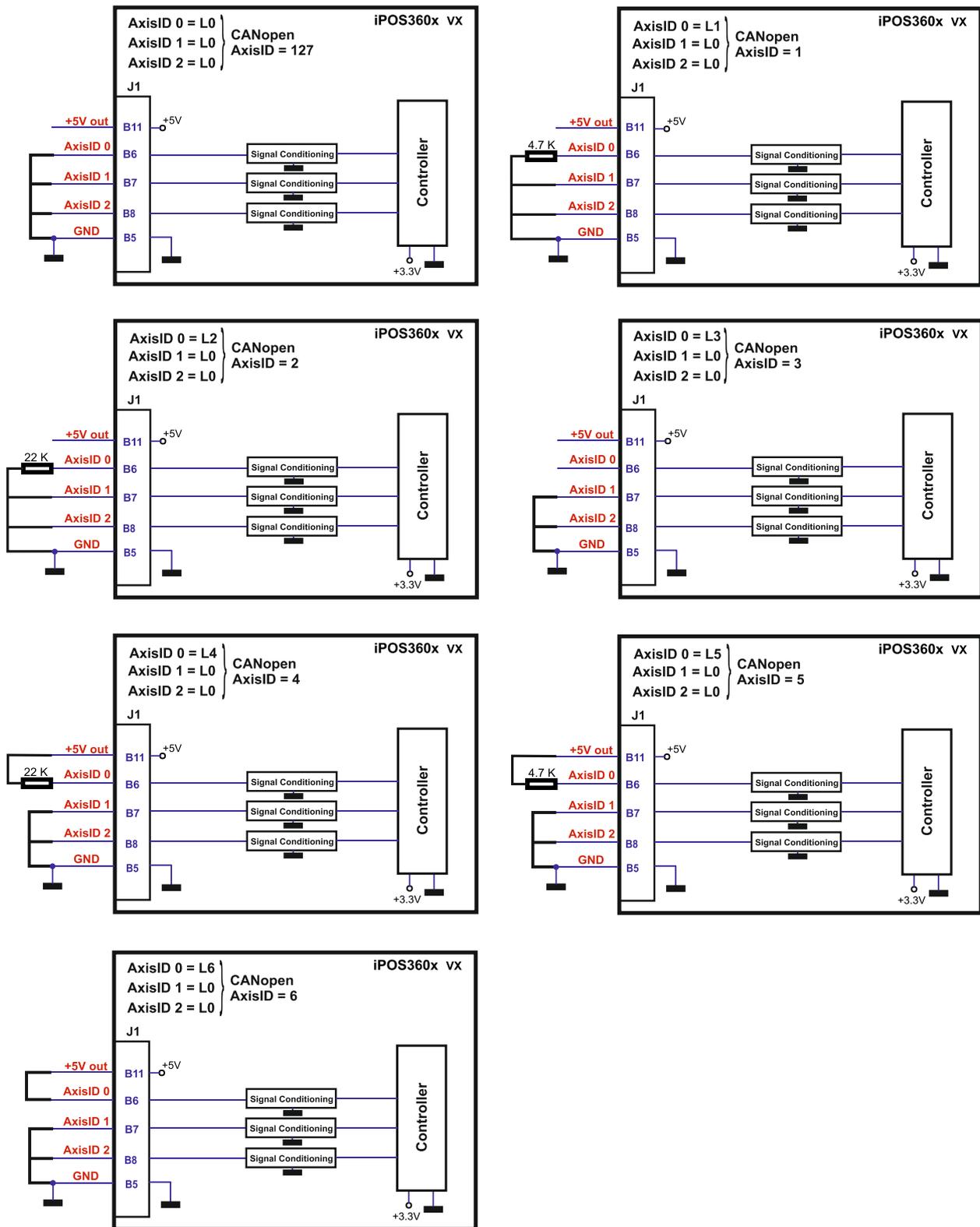
**Figure 3.33.** Axis ID Setting Examples. CANopen mode
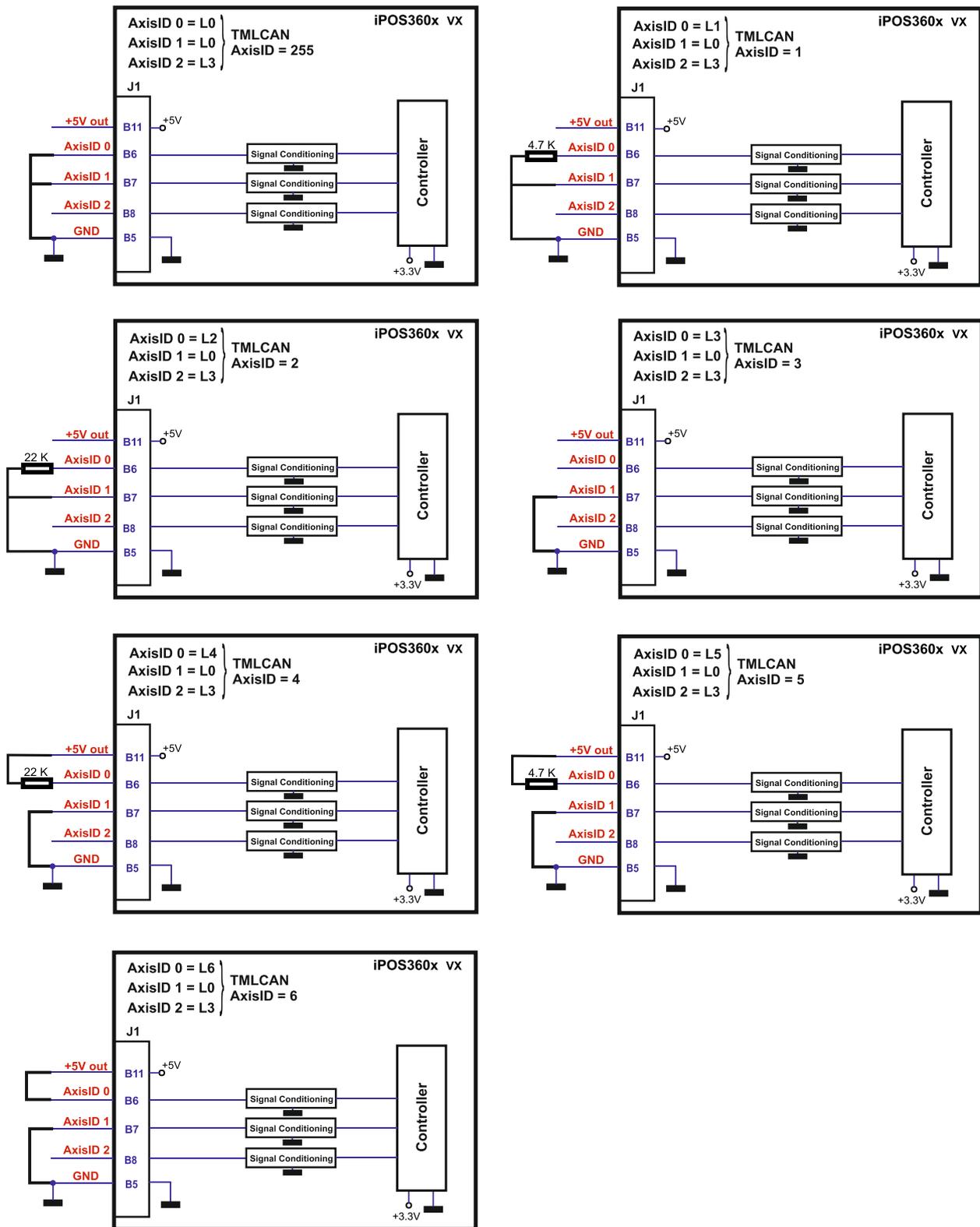
**Figure 3.34.** Axis ID Setting Examples. TMLCAN mode

### 3.9.1 Axis ID Settings for CAN drives and CANopen mode

| Axis ID 2 | Axis ID 1 | Axis ID 0 | ID CANopen |
|---|---|---|---|
| L0 | L0 | L0 | 127 |
| L0 | L0 | L1 | 1 |
| L0 | L0 | L2 | 2 |
| L0 | L0 | L3 | 3 |
| L0 | L0 | L4 | 4 |
| L0 | L0 | L5 | 5 |
| L0 | L0 | L6 | 6 |
| L0 | L1 | L0 | 7 |
| L0 | L1 | L1 | 8 |
| L0 | L1 | L2 | 9 |
| L0 | L1 | L3 | 10 |
| L0 | L1 | L4 | 11 |
| L0 | L1 | L5 | 12 |
| L0 | L1 | L6 | 13 |
| L0 | L2 | L0 | 14 |
| L0 | L2 | L1 | 15 |
| L0 | L2 | L2 | 16 |
| L0 | L2 | L3 | 17 |
| L0 | L2 | L4 | 18 |
| L0 | L2 | L5 | 19 |
| L0 | L2 | L6 | 20 |
| L0 | L3 | L0 | 21 |
| L0 | L3 | L1 | 22 |
| L0 | L3 | L2 | 23 |
| L0 | L3 | L3 | 24 |
| L0 | L3 | L4 | 25 |
| L0 | L3 | L5 | 26 |
| L0 | L3 | L6 | 27 |
| L0 | L4 | L0 | 28 |
| L0 | L4 | L1 | 29 |
| L0 | L4 | L2 | 30 |
| L0 | L4 | L3 | 31 |
| L0 | L4 | L4 | 32 |
| L0 | L4 | L5 | 33 |
| L0 | L4 | L6 | 34 |
| L0 | L5 | L0 | 35 |
| L0 | L5 | L1 | 36 |
| L0 | L5 | L2 | 37 |
| L0 | L5 | L3 | 38 |
| L0 | L5 | L4 | 39 |
| L0 | L5 | L5 | 40 |
| L0 | L5 | L6 | 41 |
| L0 | L6 | L0 | 42 |
| L0 | L6 | L1 | 43 |
| L0 | L6 | L2 | 44 |
| L0 | L6 | L3 | 45 |
| L0 | L6 | L4 | 46 |
| L0 | L6 | L5 | 47 |
| L0 | L6 | L6 | 48 |

| Axis ID 2 | Axis ID 1 | Axis ID 0 | ID CANopen |
|---|---|---|---|
| L1 | L0 | L0 | 49 |
| L1 | L0 | L1 | 50 |
| L1 | L0 | L2 | 51 |
| L1 | L0 | L3 | 52 |
| L1 | L0 | L4 | 53 |
| L1 | L0 | L5 | 54 |
| L1 | L0 | L6 | 55 |
| L1 | L1 | L0 | 56 |
| L1 | L1 | L1 | 57 |
| L1 | L1 | L2 | 58 |
| L1 | L1 | L3 | 59 |
| L1 | L1 | L4 | 60 |
| L1 | L1 | L5 | 61 |
| L1 | L1 | L6 | 62 |
| L1 | L2 | L0 | 63 |
| L1 | L2 | L1 | 64 |
| L1 | L2 | L2 | 65 |
| L1 | L2 | L3 | 66 |
| L1 | L2 | L4 | 67 |
| L1 | L2 | L5 | 68 |
| L1 | L2 | L6 | 69 |
| L1 | L3 | L0 | 70 |
| L1 | L3 | L1 | 71 |
| L1 | L3 | L2 | 72 |
| L1 | L3 | L3 | 73 |
| L1 | L3 | L4 | 74 |
| L1 | L3 | L5 | 75 |
| L1 | L3 | L6 | 76 |
| L1 | L4 | L0 | 77 |
| L1 | L4 | L1 | 78 |
| L1 | L4 | L2 | 79 |
| L1 | L4 | L3 | 80 |
| L1 | L4 | L4 | 81 |
| L1 | L4 | L5 | 82 |
| L1 | L4 | L6 | 83 |
| L1 | L5 | L0 | 84 |
| L1 | L5 | L1 | 85 |
| L1 | L5 | L2 | 86 |
| L1 | L5 | L3 | 87 |
| L1 | L5 | L4 | 88 |
| L1 | L5 | L5 | 89 |
| L1 | L5 | L6 | 90 |
| L1 | L6 | L0 | 91 |
| L1 | L6 | L1 | 92 |
| L1 | L6 | L2 | 93 |
| L1 | L6 | L3 | 94 |
| L1 | L6 | L4 | 95 |
| L1 | L6 | L5 | 96 |
| L1 | L6 | L6 | 97 |

| Axis ID 2 | Axis ID 1 | Axis ID 0 | ID CANopen |
|---|---|---|---|
| L2 | L0 | L0 | 98 |
| L2 | L0 | L1 | 99 |
| L2 | L0 | L2 | 100 |
| L2 | L0 | L3 | 101 |
| L2 | L0 | L4 | 102 |
| L2 | L0 | L5 | 103 |
| L2 | L0 | L6 | 104 |
| L2 | L1 | L0 | 105 |
| L2 | L1 | L1 | 106 |
| L2 | L1 | L2 | 107 |
| L2 | L1 | L3 | 108 |
| L2 | L1 | L4 | 109 |
| L2 | L1 | L5 | 110 |
| L2 | L1 | L6 | 111 |
| L2 | L2 | L0 | 112 |
| L2 | L2 | L1 | 113 |
| L2 | L2 | L2 | 114 |
| L2 | L2 | L3 | 115 |
| L2 | L2 | L4 | 116 |
| L2 | L2 | L5 | 117 |
| L2 | L2 | L6 | 118 |
| L2 | L3 | L0 | 119 |
| L2 | L3 | L1 | 120 |
| L2 | L3 | L2 | 121 |
| L2 | L3 | L3 | 122 |
| L2 | L3 | L4 | 123 |
| L2 | L3 | L5 | 124 |
| L2 | L3 | L6 | 125 |
| L2 | L4 | L0 | 126 |
| L2 | L4 | L1 | 255 |
| L2 | L4 | L2 | 255 |
| L2 | L4 | L3 | 255 |
| L2 | L4 | L4 | 255 |
| L2 | L4 | L5 | 255 |
| L2 | L4 | L6 | 255 |
| L2 | L5 | L0 | 255 |
| L2 | L5 | L1 | 255 |
| L2 | L5 | L2 | 255 |
| L2 | L5 | L3 | 255 |
| L2 | L5 | L4 | 255 |
| L2 | L5 | L5 | 255 |
| L2 | L5 | L6 | 255 |
| L2 | L6 | L0 | 255 |
| L2 | L6 | L1 | 255 |
| L2 | L6 | L2 | 255 |
| L2 | L6 | L3 | 255 |
| L2 | L6 | L4 | 255 |
| L2 | L6 | L5 | 255 |
| L2 | L6 | L6 | 255 |

## 3.9.2 Axis ID Settings for CAN drives and TMLCAN mode

| Axis ID 2 | Axis ID 1 | Axis ID 0 | ID TMLCAN | Axis ID 2 | Axis ID 1 | Axis ID 0 | ID TMLCAN | Axis ID 2 | Axis ID 1 | Axis ID 0 | ID TMLCAN | Axis ID 2 | Axis ID 1 | Axis ID 0 | ID TMLCAN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L3 | L0 | L0 | 255 | L4 | L0 | L0 | 49 | L5 | L0 | L0 | 98 | L6 | L0 | L0 | 147 |
| L3 | L0 | L1 | 1 | L4 | L0 | L1 | 50 | L5 | L0 | L1 | 99 | L6 | L0 | L1 | 148 |
| L3 | L0 | L2 | 2 | L4 | L0 | L2 | 51 | L5 | L0 | L2 | 100 | L6 | L0 | L2 | 149 |
| L3 | L0 | L3 | 3 | L4 | L0 | L3 | 52 | L5 | L0 | L3 | 101 | L6 | L0 | L3 | 150 |
| L3 | L0 | L4 | 4 | L4 | L0 | L4 | 53 | L5 | L0 | L4 | 102 | L6 | L0 | L4 | 151 |
| L3 | L0 | L5 | 5 | L4 | L0 | L5 | 54 | L5 | L0 | L5 | 103 | L6 | L0 | L5 | 152 |
| L3 | L0 | L6 | 6 | L4 | L0 | L6 | 55 | L5 | L0 | L6 | 104 | L6 | L0 | L6 | 153 |
| L3 | L1 | L0 | 7 | L4 | L1 | L0 | 56 | L5 | L1 | L0 | 105 | L6 | L1 | L0 | 154 |
| L3 | L1 | L1 | 8 | L4 | L1 | L1 | 57 | L5 | L1 | L1 | 106 | L6 | L1 | L1 | 155 |
| L3 | L1 | L2 | 9 | L4 | L1 | L2 | 58 | L5 | L1 | L2 | 107 | L6 | L1 | L2 | 156 |
| L3 | L1 | L3 | 10 | L4 | L1 | L3 | 59 | L5 | L1 | L3 | 108 | L6 | L1 | L3 | 157 |
| L3 | L1 | L4 | 11 | L4 | L1 | L4 | 60 | L5 | L1 | L4 | 109 | L6 | L1 | L4 | 158 |
| L3 | L1 | L5 | 12 | L4 | L1 | L5 | 61 | L5 | L1 | L5 | 110 | L6 | L1 | L5 | 159 |
| L3 | L1 | L6 | 13 | L4 | L1 | L6 | 62 | L5 | L1 | L6 | 111 | L6 | L1 | L6 | 160 |
| L3 | L2 | L0 | 14 | L4 | L2 | L0 | 63 | L5 | L2 | L0 | 112 | L6 | L2 | L0 | 161 |
| L3 | L2 | L1 | 15 | L4 | L2 | L1 | 64 | L5 | L2 | L1 | 113 | L6 | L2 | L1 | 162 |
| L3 | L2 | L2 | 16 | L4 | L2 | L2 | 65 | L5 | L2 | L2 | 114 | L6 | L2 | L2 | 163 |
| L3 | L2 | L3 | 17 | L4 | L2 | L3 | 66 | L5 | L2 | L3 | 115 | L6 | L2 | L3 | 164 |
| L3 | L2 | L4 | 18 | L4 | L2 | L4 | 67 | L5 | L2 | L4 | 116 | L6 | L2 | L4 | 165 |
| L3 | L2 | L5 | 19 | L4 | L2 | L5 | 68 | L5 | L2 | L5 | 117 | L6 | L2 | L5 | 166 |
| L3 | L2 | L6 | 20 | L4 | L2 | L6 | 69 | L5 | L2 | L6 | 118 | L6 | L2 | L6 | 167 |
| L3 | L3 | L0 | 21 | L4 | L3 | L0 | 70 | L5 | L3 | L0 | 119 | L6 | L3 | L0 | 168 |
| L3 | L3 | L1 | 22 | L4 | L3 | L1 | 71 | L5 | L3 | L1 | 120 | L6 | L3 | L1 | 169 |
| L3 | L3 | L2 | 23 | L4 | L3 | L2 | 72 | L5 | L3 | L2 | 121 | L6 | L3 | L2 | 170 |
| L3 | L3 | L3 | 24 | L4 | L3 | L3 | 73 | L5 | L3 | L3 | 122 | L6 | L3 | L3 | 171 |
| L3 | L3 | L4 | 25 | L4 | L3 | L4 | 74 | L5 | L3 | L4 | 123 | L6 | L3 | L4 | 172 |
| L3 | L3 | L5 | 26 | L4 | L3 | L5 | 75 | L5 | L3 | L5 | 124 | L6 | L3 | L5 | 173 |
| L3 | L3 | L6 | 27 | L4 | L3 | L6 | 76 | L5 | L3 | L6 | 125 | L6 | L3 | L6 | 174 |
| L3 | L4 | L0 | 28 | L4 | L4 | L0 | 77 | L5 | L4 | L0 | 126 | L6 | L4 | L0 | 175 |
| L3 | L4 | L1 | 29 | L4 | L4 | L1 | 78 | L5 | L4 | L1 | 127 | L6 | L4 | L1 | 176 |
| L3 | L4 | L2 | 30 | L4 | L4 | L2 | 79 | L5 | L4 | L2 | 128 | L6 | L4 | L2 | 177 |
| L3 | L4 | L3 | 31 | L4 | L4 | L3 | 80 | L5 | L4 | L3 | 129 | L6 | L4 | L3 | 178 |
| L3 | L4 | L4 | 32 | L4 | L4 | L4 | 81 | L5 | L4 | L4 | 130 | L6 | L4 | L4 | 179 |
| L3 | L4 | L5 | 33 | L4 | L4 | L5 | 82 | L5 | L4 | L5 | 131 | L6 | L4 | L5 | 180 |
| L3 | L4 | L6 | 34 | L4 | L4 | L6 | 83 | L5 | L4 | L6 | 132 | L6 | L4 | L6 | 181 |
| L3 | L5 | L0 | 35 | L4 | L5 | L0 | 84 | L5 | L5 | L0 | 133 | L6 | L5 | L0 | 182 |
| L3 | L5 | L1 | 36 | L4 | L5 | L1 | 85 | L5 | L5 | L1 | 134 | L6 | L5 | L1 | 183 |
| L3 | L5 | L2 | 37 | L4 | L5 | L2 | 86 | L5 | L5 | L2 | 135 | L6 | L5 | L2 | 184 |
| L3 | L5 | L3 | 38 | L4 | L5 | L3 | 87 | L5 | L5 | L3 | 136 | L6 | L5 | L3 | 185 |
| L3 | L5 | L4 | 39 | L4 | L5 | L4 | 88 | L5 | L5 | L4 | 137 | L6 | L5 | L4 | 186 |
| L3 | L5 | L5 | 40 | L4 | L5 | L5 | 89 | L5 | L5 | L5 | 138 | L6 | L5 | L5 | 187 |
| L3 | L5 | L6 | 41 | L4 | L5 | L6 | 90 | L5 | L5 | L6 | 139 | L6 | L5 | L6 | 188 |
| L3 | L6 | L0 | 42 | L4 | L6 | L0 | 91 | L5 | L6 | L0 | 140 | L6 | L6 | L0 | 189 |
| L3 | L6 | L1 | 43 | L4 | L6 | L1 | 92 | L5 | L6 | L1 | 141 | L6 | L6 | L1 | 190 |
| L3 | L6 | L2 | 44 | L4 | L6 | L2 | 93 | L5 | L6 | L2 | 142 | L6 | L6 | L2 | 191 |
| L3 | L6 | L3 | 45 | L4 | L6 | L3 | 94 | L5 | L6 | L3 | 143 | | | | |
| L3 | L6 | L4 | 46 | L4 | L6 | L4 | 95 | L5 | L6 | L4 | 144 | | | | |
| L3 | L6 | L5 | 47 | L4 | L6 | L5 | 96 | L5 | L6 | L5 | 145 | | | | |
| L3 | L6 | L6 | 48 | L4 | L6 | L6 | 97 | L5 | L6 | L6 | 146 | | | | |

## 3.10 Electrical Specifications

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

$T_{amb}$ = 0…70°C, $V_{LOG}$ = 24 $V_{DC}$; $V_{MOT}$ = 24$V_{DC}$; Supplies start-up / shutdown sequence: *-any-*
Load current (sinusoidal amplitude / continuous BLDC,DC,stepper) = 4A iPOS3604/ 2A iPOS3602

### 3.10.1 Operating Conditions

|  |  | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Ambient temperature | iPOS360X VX-CAN | 0 |  | +70 | ºC |
|  | iPOS360X VX-CAT | 0 |  | +40 |  |
| Ambient humidity | Non-condensing | 0 |  | 90 | %Rh |
| Altitude / pressure[1] | Altitude (referenced to sea level) | -0.1 | 0 ÷ 2.5 | [2] | Km |
|  | Ambient Pressure | 0 [2] | 0.75 ÷ 1 | 10.0 | atm |

### 3.10.2 Storage Conditions

|  |  | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Ambient temperature | iPOS360X VX-CAN | -40 |  | 105 | ºC |
|  | iPOS360X VX-CAT | -40 |  | 85 |  |
| 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 |

### 3.10.3 Mechanical Mounting

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

### 3.10.4 Environmental Characteristics

|  |  |  | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| iPOS360x VX-CAN/CAT Size ( Length x Width x Height ) | Without mating connector / retainer |  | 56 x 28.8 x 7.6 |  |  | mm |
|  |  |  | ~2.2 x 1.1 x 0.3 |  |  | inch |
|  | With recommended mating vertical connector and retainer. Height above PCB surface. |  | 63.3 x 32.6 x 16.3 |  |  | mm |
|  |  |  | ~2.5 x 1.3 x 0.64 |  |  | inch |
|  | With recommended mating horizontal connector. Height above PCB surface. |  | 56 x 41.2 x 7.6 |  |  | mm |
|  |  |  | ~2.2 x 1.6 x 0.3 |  |  | inch |
| ECAT-VX adapter Size ( Length x Width x Height ) | Without mating connector |  | 31.5 x 28.8 x 5.2 |  |  | mm |
|  |  |  | ~1.24 x 1.13 x 0.2 |  |  | inch |
|  | With recommended mating vertical connector. Height above PCB surface. |  | 31.5 x 32.6 x 8.8 |  |  | mm |
|  |  |  | ~1.24 x 1.28 x 0.35 |  |  | inch |
|  | With recommended mating horizontal connector. Height above PCB surface. |  | 31.5 x 41.2 x 9.4 |  |  | mm |
|  |  |  | ~1.24 x 1.62 x 0.37 |  |  | inch |
| Weight |  | iPOS360X VX-CAN/CAT | 10 |  |  | g |
|  |  | ECAT-VX adapter | 5 |  |  | g |
| Cleaning agents | Dry cleaning is recommended |  | Only Water- or Alcohol- based |  |  |  |
| Protection degree | According to IEC60529, UL508 |  | IP00 |  |  | - |

### 3.10.5 Logic Supply Input (+V$_{LOG}$)

|  |  | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Supply voltage | Nominal values | 7 | 24 | 36 | $V_{DC}$ |
|  | Absolute maximum values, drive operating but outside guaranteed parameters | 4.9 |  | 42 | $V_{DC}$ |
|  | Absolute maximum values, surge (duration ≤ 10ms) [†] | -1 |  | +45 | V |
| Supply current | +$V_{LOG}$ = 7V |  | 125 | 300 | mA |
|  | +$V_{LOG}$ = 12V |  | 80 | 200 |  |
|  | +$V_{LOG}$ = 24V |  | 50 | 125 |  |
|  | +$V_{LOG}$ = 40V |  | 40 | 100 |  |

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

### 3.10.6 Motor Supply Input (+V$_{MOT}$)

| | | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Supply voltage | Nominal values | | 9 | | 36 | V$_{DC}$ |
| | Absolute maximum values, drive operating but outside guaranteed parameters | | 8.5 | | 40 | V$_{DC}$ |
| | Absolute maximum values, surge (duration ≤ 10ms) † | | -1 | | 45 | V |
| Supply current | Idle | | | 1 | 5 | mA |
| | Operating | iPOS3604 | -10 | ±4 | +10 | A |
| | | iPOS3602 | -3.2 | ±2 | +3.2 | A |
| | Absolute maximum value, short-circuit condition (duration ≤ 10ms) † | iPOS3604 | | | 15 | A |
| | | iPOS3602 | | | 5 | A |

### 3.10.7 Motor Outputs (A/A+, B/A-, C/B+, BR/B-)

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

### 3.10.8 Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4/Enable)[1]

| | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Mode compliance | | TTL / CMOS / LVTTL (3.3V) / Open-collector / NPN / 24V outputs | | | |
| Default state | Input floating (wiring disconnected) | Logic HIGH | | | |
| Input voltage | Logic "LOW" | | 0 | 0.8 | V |
| | Logic "HIGH" | 2 | 5÷24 | | |
| | Floating voltage (not connected) | | 3 | | |
| | Absolute maximum, continuous | -10 | | +30 | |
| | Absolute maximum, surge (duration ≤ 1s) † | -20 | | +40 | |
| Input current | Logic "LOW"; Pulled to GND | | 0.6 | 1 | mA |
| | Logic "HIGH"; Internal 4.7KΩ pull-up to +3.3 | 0 | 0 | 0 | |
| | Logic "HIGH"; Pulled to +5V | | 0.15 | 0.2 | |
| | Logic "HIGH"; Pulled to +24V | | 2 | 2.5 | |
| Input frequency | | 0 | | 150 | kHz |
| Minimum pulse width | | 3.3 | | | µs |
| ESD protection | Human body model | ±2 | | | kV |

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

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

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

### 3.10.10 Digital Hall Inputs (Hall1, Hall2, Hall3)

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

### 3.10.11 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 | -1 | ±0.9 | +1 | mA |
| Interpolation resolution | Depending on software settings | 9 | | 13 | bits |
| Frequency | | 0 | | 4 | kHz |
| ESD protection | Human body model | ±1 | | | kV |

### 3.10.12 Analog  0..5V/ ±10V Input (REF/FDBK)

| | | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Input voltage | Operational range | 0..5V mode | 0 | | 4.95 | V |
| | Absolute maximum values, continuous | | -12 | | +18 | |
| | Absolute maximum, surge (duration ≤ 1s) † | | | | ±36 | |
| Input impedance | To GND | | | 30 | | kΩ |
| Resolution | | | | 12 | | bits |
| Integral linearity | | | | | ±2 | bits |
| Offset error | | | | ±2 | ±10 | bits |
| Gain error | | | | ±1% | ±3% | % FS[1] |
| Bandwidth (-3dB) | Software selectable | | 0 | | 1 | kHz |
| ESD protection | Human body model | | ±2 | | | kV |

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

### 3.10.13 Encoder Inputs (A+, A-, B+, B-, Z+, Z-,)[1]

| | | 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) | | 4.5 | | |
| 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 | | 2.5 | 3 | mA |
| | Logic "HIGH"; Internal 2.2KΩ pull-up to +5 | 0 | 0 | 0 | |
| Differential mode compliance | For full RS422 compliance, see [2] | 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.) | -7 | | +7 | |
| Input impedance, differential | A+ to A-, B+ to B- | 4.2 | 4.7 | | kΩ |
| | Z+ to Z- | 6.1 | 7.2 | | |
| Input frequency | Single-ended mode, Open-collector / NPN | 0 | | 500 | KHz |
| | 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 |

### 3.10.14 RS-232

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

### 3.10.15 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 | | | 40 | m |
| | 500Kbps | | | 100 | |
| | ≤ 250Kbps | | | 250 | |
| Resistor | Between CAN-Hi, CAN-Lo | none on-board | | | |
| Node addressing | Hardware ( CANopen selection pin) | 127 (CANopen); 255 (TMLCAN); | | | |
| | Software | 1 - 127 (CANopen); 1- 255 (TMLCAN) | | | |
| Voltage, CAN-Hi or CAN-Lo to GND | | -36 | | 36 | V |
| ESD protection | Human body model | ±15 | | | kV |

### 3.10.16 Supply Output (+5V)

| | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| +5V output voltage | Current sourced = 350mA | 4.8 | 5 | 5.2 | V |
| +5V output current | iPOS360X VX-CAN | 250 | 500 | 540 | mA |
| | iPOS360X VX-CAT with ECAT-VX adapter | 120 | 200 | 210 | mA |
| Short-circuit protection | | Yes / Drive resets at event | | | |
| Over-voltage protection | | NOT protected | | | |
| ESD protection | Human body model | ±1 | | | kV |

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[1] Encoder differential input pins do not have internal 120Ω termination resistors connected across

[2] For full RS-422 compliance, 120Ω termination resistors must be connected across the differential pairs, as close as possible to the drive input pins. See *Figure 3.16. Differential incremental encoder connection*

### 3.10.17 Ethernet ports (for CAT drives)

| | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Standard Compliance | | EtherCAT (IEC61158-3/4/5/6-12) | | | |
| | | Fast Ethernet 100BASE-TX (IEEE802.3u) | | | |
| | | Auto-negotiation for 100Mbps/s full-duplex | | | |
| | | Auto-detect MDI/MDI-X | | | |
| Power over Ethernet | NOT used by ECAT VX, separate 5V supply | compliant to IEEE802.3af mode A "Mixed DC & Data" | | | |
| | | NOT compliant to IEEE802.3af mode B "DC on Spares" | | | |
| Isolation GND0,GND1 | Requirement for motherboard PCB routing | 500 | | | $V_{rms}$ |
| | | 1.5 | | | kV |
| Maximum cable length | 2-pair UTP Cat5 | 100 | 150 | | m |
| ESD protection | Human body model | ±4 | | | kV |

### 3.10.18 Data communication signals between iPOS drive and ECAT-VX adapter

| | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| Voltage levels | | 3.3V low-voltage TTL | | | |
| Noise immunity | | | | 0.4 | V |
| Data protocol | | 4 wire SPI | | | |
| Data Rate | | 10 | | 15 | MHz |

### 3.10.19 LED signals of ECAT-VX adapter (for CAT drives)

| | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| LED connection | | Common anode to 3.3V output | | | |
| | | Direct, no series resistor | | | |
| LED current | | | 8 | 10 | mA |
| 3.3 output voltage | | 3.15 | 3.3 | 3.45 | V |
| 3.3 output current | | | | 60 | mA |

### 3.10.20 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.
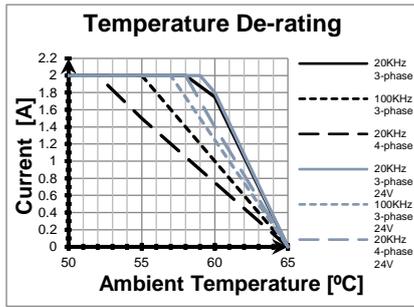
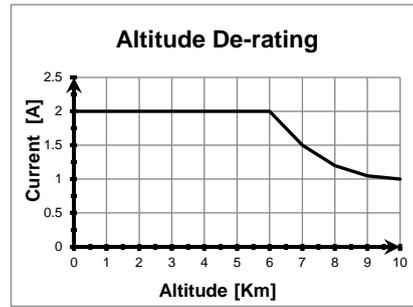**Figure 3.35** iPOS3602 VX De-rating with ambient temperature



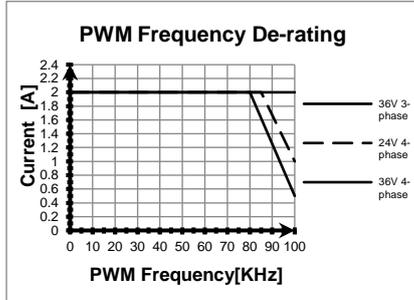**Figure 3.36** iPOS3602 VX De-rating with altitude



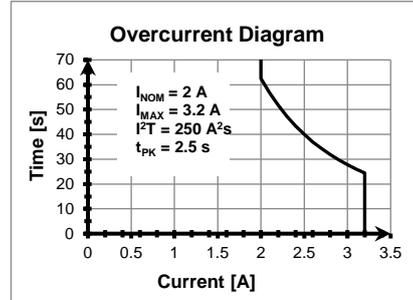**Figure 3.37** iPOS3602 VX Current De-rating with PWM frequency



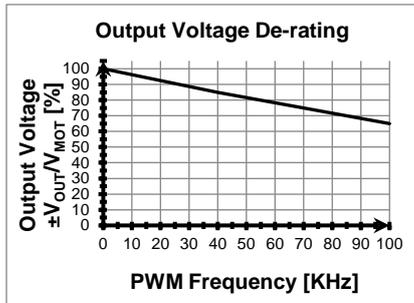**Figure 3.38** iPOS3602 VX Over-current diagram



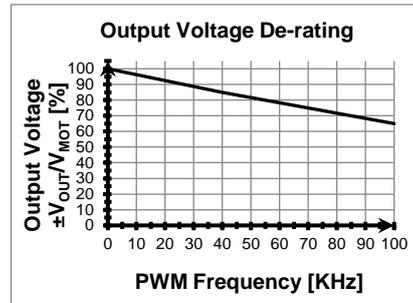**Figure 3.39.** iPOS360x VX Output Voltage De-rating with PWM frequency[1]



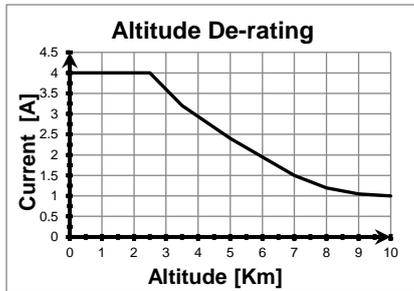**Figure 3.40.** iPOS3604 VX De-rating with ambient temperature
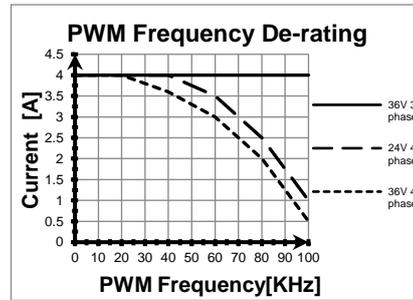


**Figure 3.41.** iPOS3604 VX De-rating with altitude

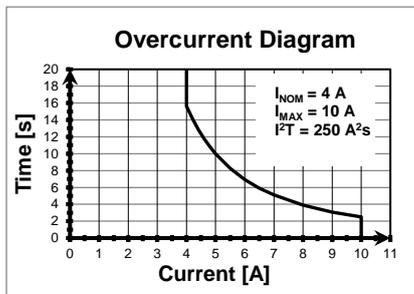

**Figure 3.42.** iPOS3604 VX Current De-rating with PWM frequency



⚠ **CAUTION!**

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



**Figure 3.43.** iPOS3604 VX Over-current diagram

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

# 4 Memory Map

iPOS360X VX has 2 types of memory available for user applications: 2K×16 SRAM and 4K×16 serial E$^2$ROM.

The SRAM memory is mapped in the address range: 9800h to 9FFFh. It can be used to download and run a TML program, to save real-time data acquisitions and to keep the cam tables during run-time.

The E$^2$ROM is mapped in the address range: 4000h to 4FFFh. It is used to keep in a non-volatile memory the TML programs, the cam tables and the drive setup information.

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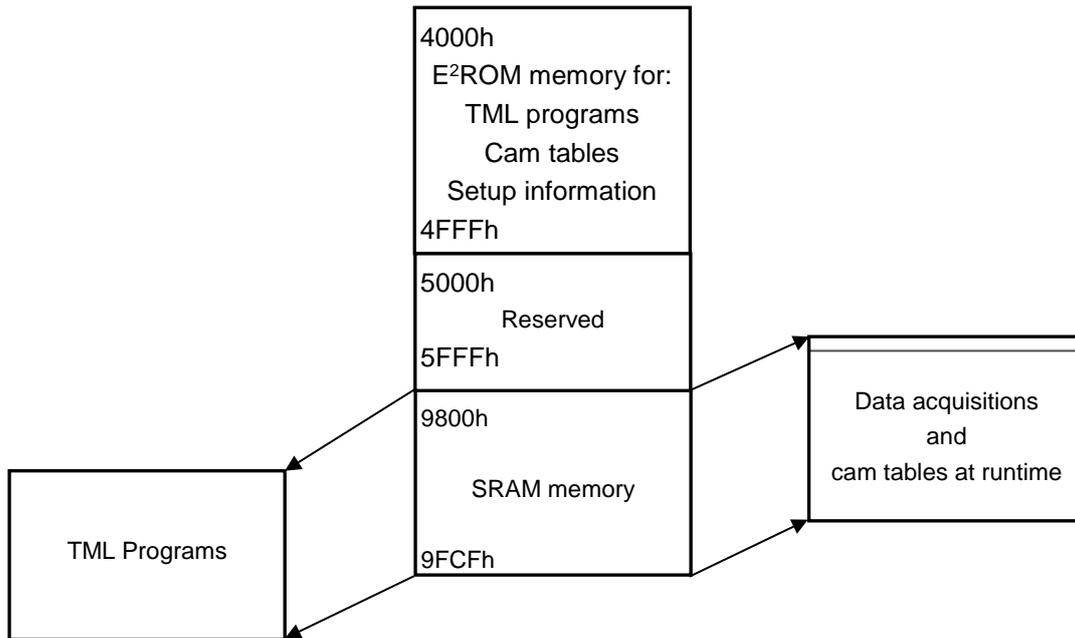


*Figure 4.1.* iPOS360X VX Memory Map

T E C H N O S O F T