

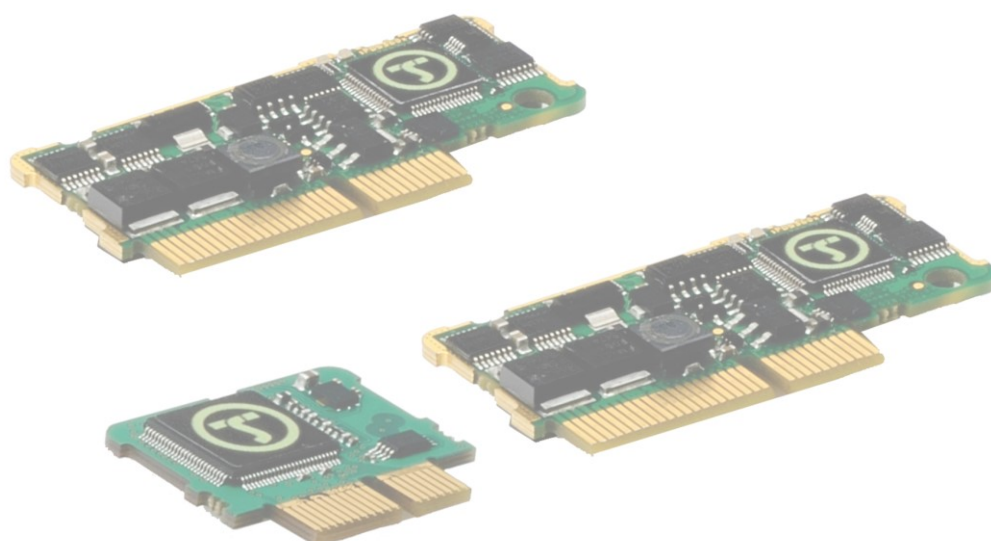
# iPOS360X VX- CAN / CAT

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



T E C H N O S O F T

Intelligent Servo Drives



## Technical Reference

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## Read This First

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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
<b>iPOS3602 VX-CAN</b>	P028.001.E001	F509x	Standard version, CAN
<b>iPOS3602 VX-CAN</b>	P028.001.E001	F524x	Linear Hall version, CAN
<b>iPOS3602 VX-CAT</b>	P028.001.E021	F511x	Standard version + Linear Hall, EtherCAT
<b>iPOS3604 VX-CAN</b>	P028.002.E001	F508x	Standard version, CAN
<b>iPOS3604 VX-CAN</b>	P028.002.E001	F524x	Linear Hall version, CAN
<b>iPOS3604 VX-CAT</b>	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**<sup>1</sup> or an **EtherCAT® master**<sup>2</sup>
  - ☐ 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)<sup>3</sup>
  - ☐ A **TML\_LIB motion library for PLCs**<sup>3</sup>
  - ☐ A **distributed control** approach which combines the above options, like for example a host calling motion functions programmed on the drives in TML

This manual covers **Step 1** in detail. It describes the **iPOS360X** hardware including the technical data, the connectors and the wiring diagrams needed for installation.

For **Step 2 and 3**, please consult the document **EasyMotion Studio – Quick Setup and Programming Guide**. 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®

<sup>1</sup> when the iPOS360x VX-CAN is set in CANopen mode

<sup>2</sup> when using and iPOS360x VX-CAT

<sup>3</sup> available only for CAN versions

## Trademarks

**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.

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

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

**iPOS CANopen Programming (part no. P091.063.iPOS.UM.xxxx)** – explains how to program the iPOS family of intelligent drives using **CANopen** protocol and describes the associated object dictionary for **CiA 301 v.4.2** application layer and communication profile and **CiA DSP 402 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: <a href="http://www.technosoftmotion.com/">http://www.technosoftmotion.com/</a>
Receive general information or assistance (see Note)	World Wide Web: <a href="http://www.technosoftmotion.com/">http://www.technosoftmotion.com/</a> Email: <a href="mailto:sales@technosoftmotion.com">sales@technosoftmotion.com</a>
Ask questions about product operation or report suspected problems (see Note)	Tel: +41 (0)32 732 5500 Email: <a href="mailto:support@technosoftmotion.com">support@technosoftmotion.com</a>
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: <https://technosoftmotion.com/en/quality/>



## 2 Product Overview

### 2.1 Introduction

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

Suitable for control of brushless DC, brushless AC (vector control), DC brushed motors and step motors, the iPOS360X 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<sup>1</sup> or camming<sup>1</sup>, 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<sup>2</sup>
- ☐ Sending commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group<sup>2</sup>
- ☐ 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.

<sup>1</sup> Available if the master axis sends its position via a communication channel, or by using the secondary encoder input

<sup>2</sup> 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 controllers.* 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

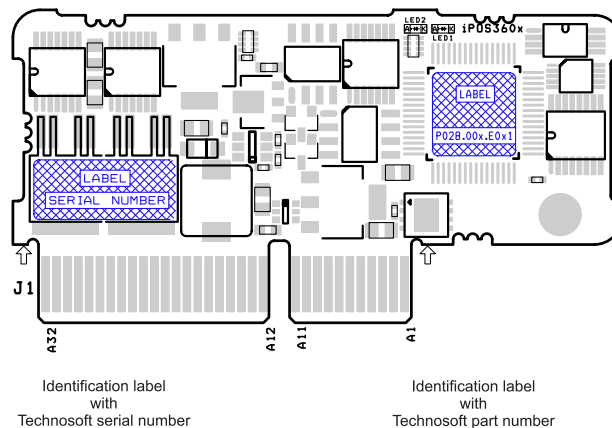
- Fully digital servo drive suitable for the control of rotary or linear brushless, DC brush, and step motors
- Very compact design
- Standard PCIe 4x mating connector
- Sinusoidal (FOC) or trapezoidal (Hall-based) control of brushless motors
- Open or closed-loop control of 2 and 3-phase steppers
- 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<sup>2</sup> continuous; 3.2A peak
  - iPOS3604 VX-CAN: 4A<sup>3</sup> 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<sub>pp</sub>)
- Various motion programming modes:
  - Position profiles with trapezoidal or S-curve speed shape
  - Position, Velocity, Time (PVT) 3<sup>rd</sup> order interpolation

<sup>2</sup> 2A cont. with DC, step and BLDC motors (trapezoidal), 2A amplitude (1.41A<sub>RMS</sub>) for PMSM (sinusoidal)

<sup>3</sup> 4A cont. with DC, step and BLDC motors (trapezoidal), 4A amplitude (2.82A<sub>RMS</sub>) 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 E<sup>2</sup>ROM 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
<b>iPOS3602 VX-CAN</b>	P028.001.E001	F509x	Standard version, CAN
<b>iPOS3602 VX-CAN</b>	P028.001.E001	F524x	Linear Hall version, CAN
<b>iPOS3602 VX-CAT</b>	P028.001.E021	F511x	Standard version + Linear Hall, EtherCAT
<b>iPOS3604 VX-CAN</b>	P028.002.E001	F508x	Standard version, CAN
<b>iPOS3604 VX-CAN</b>	P028.002.E001	F524x	Linear Hall version, CAN
<b>iPOS3604 VX-CAT</b>	P028.002.E021	F510x	Standard version + Linear Hall, EtherCAT

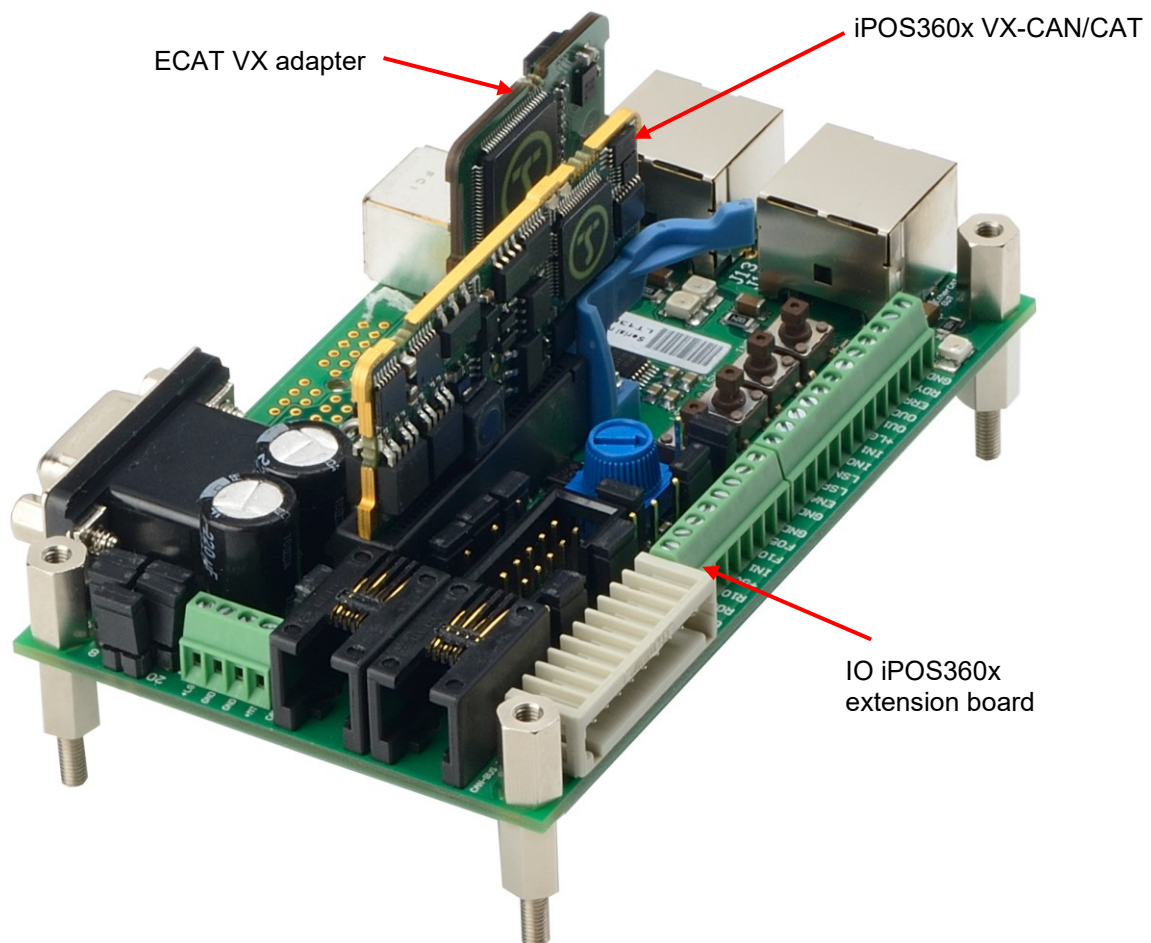
## 2.4 Supported Motor-Sensor Configurations

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.



**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

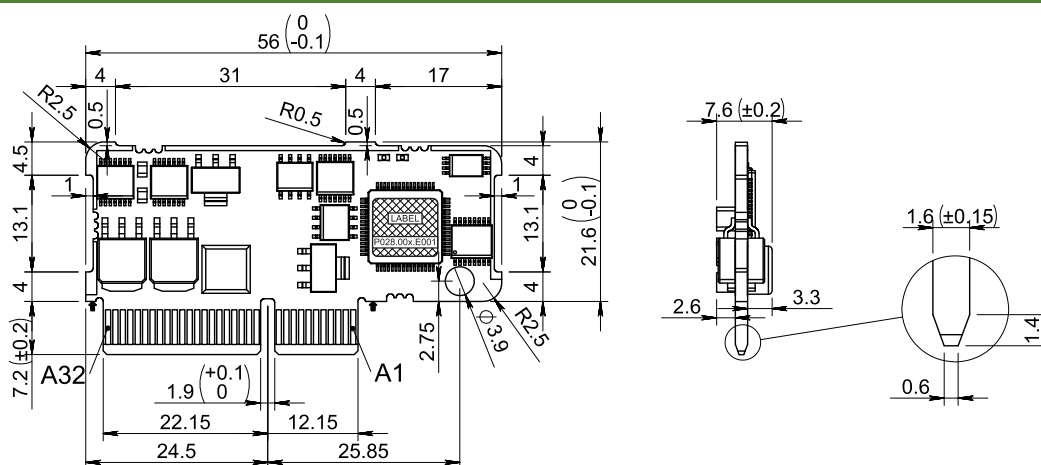


Figure 3.1.1. iPOS360X VX-CAN drive dimensions

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

### 3.2 ECAT-VX EtherCAT adapter dimensions

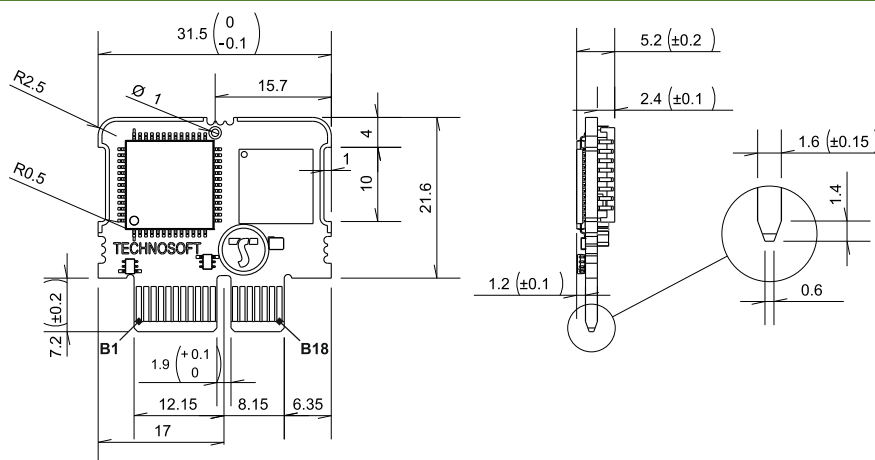


Figure 3.2.1. ECAT-VX adapter dimensions

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

### 3.3 Mechanical Mounting

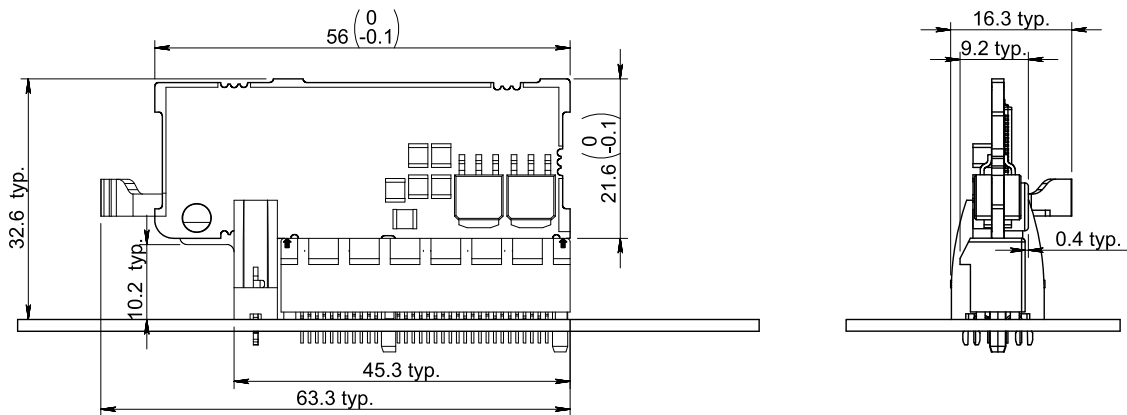
The iPOS360X drive is intended to be mounted vertically or horizontally on a motherboard equipped with the recommended mating connectors, as specified in chapter [3.6.2 Mating Connectors](#). Several drives can be hosted by a single motherboard.

For thermal calculations:

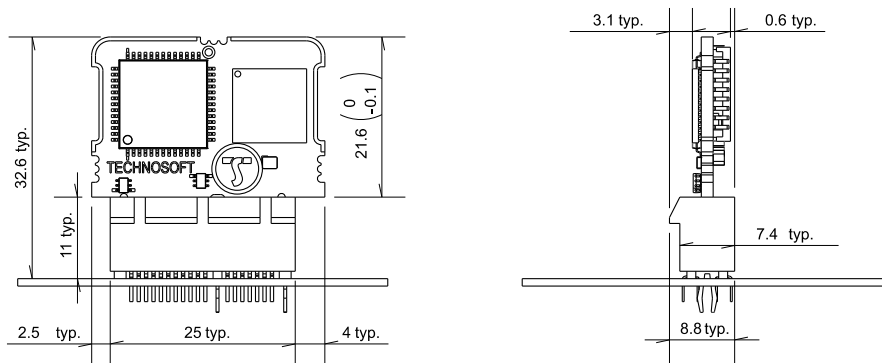
- the iPOS3604 VX-CAN drive can be assumed to generate 1 Watt (= 3.4 BTU/hour) at idle, and up to 3 Watt (= 10 BTU/hour) worst case while driving a motor.
- the iPOS3604 VX-CAT drive can be assumed to generate 1 Watt (= 3.4 BTU/hour) at idle, and up to 3 Watt (= 10 BTU/hour) worst case while driving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

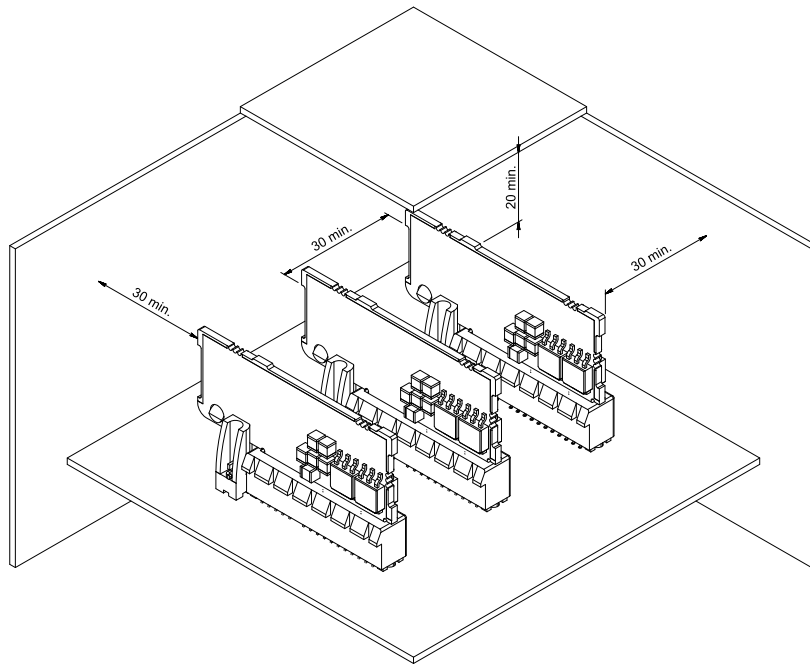
All dimensions are in mm.

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

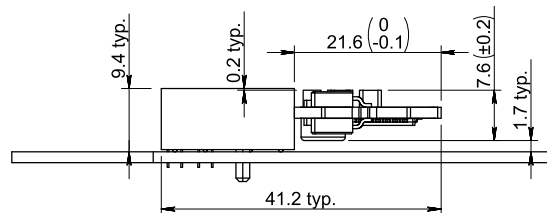
For ventilation holes / slots that pierce a metallic wall also used for EMI shielding, the maximum slot length  $d$  should be less than  $\lambda/16$ , where  $\lambda$  is the wavelength corresponding to maximum filtered frequency ( $f_f$ ):

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

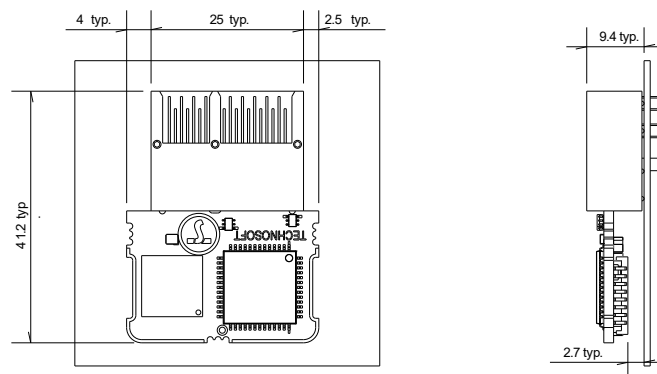
If ventilation driven by natural convection is not enough to maintain the temperature surrounding the iPOS360x drive(s) inside the limits indicated in **Figure 3.35** and **Figure 3.40** then alternate forced cooling methods must be applied.

### 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 3.6** iPOS360X VX-CAN/CAT Overall dimensions for horizontal mounting



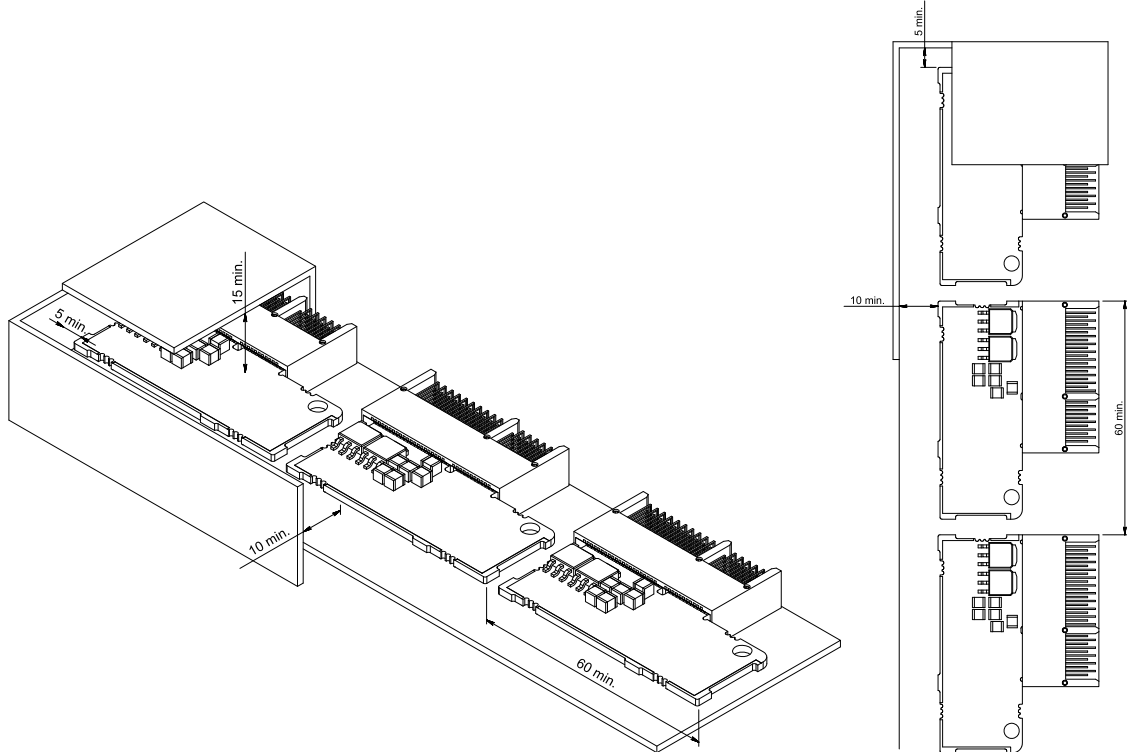
**Figure 3.7** ECAT-VX adapter overall dimensions for horizontal mounting

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.

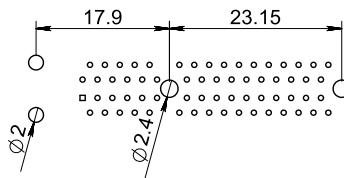
**Remark:** In case of using a metallic box, with ventilation openings, all spacing values may be reduced substantially. With proper ventilation, keeping the air surrounding the iPOS360x inside the limits indicated in **Figure 3.35** and **Figure 3.40** the spacing values may be reduced down to the mechanical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



**Figure 3.8** 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 3.9** 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/ft<sup>2</sup> 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 connections 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<sub>OUT</sub> 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<sub>OUT</sub>.
- 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.**



**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:

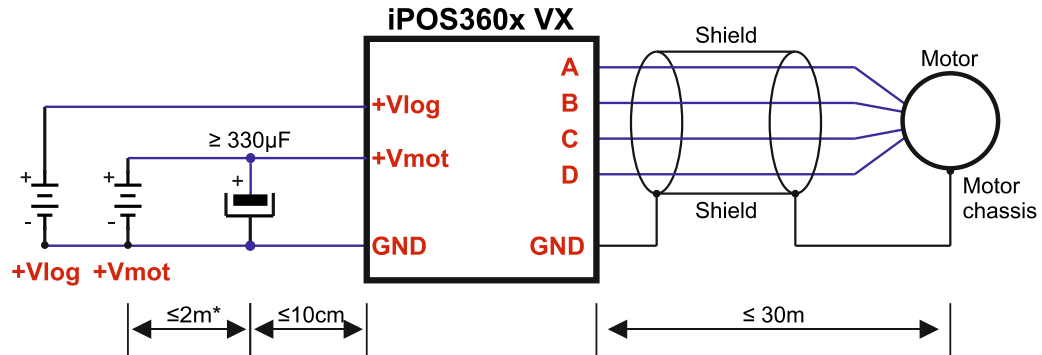


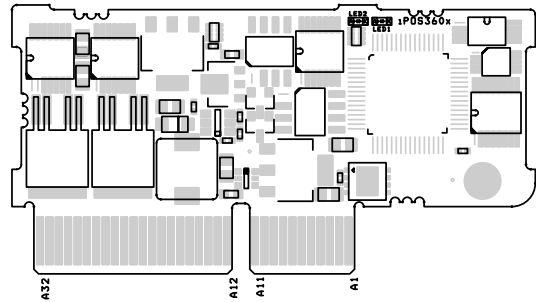
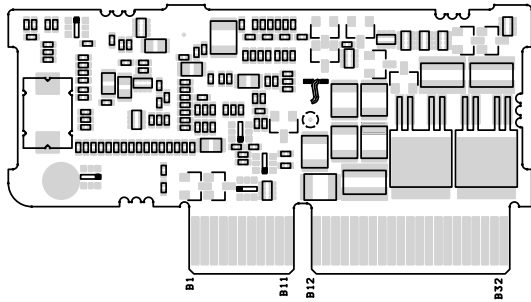
Figure 3.10 EMC recommended connections

\* if +Vmot to capacitor wire length  $\geq 2\text{m}$ , use twisted wires for the supply and ground return (Vmot and GND)

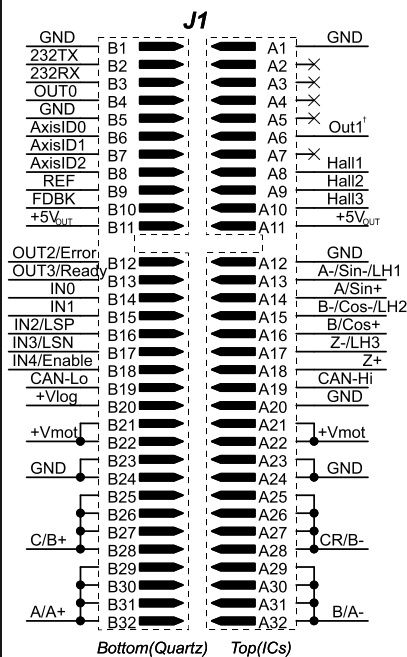
\* if +Vmot to capacitor wire length  $\geq 20\text{m}$ , the capacitor value must be  $\geq 2200\mu\text{F}$ .

## 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

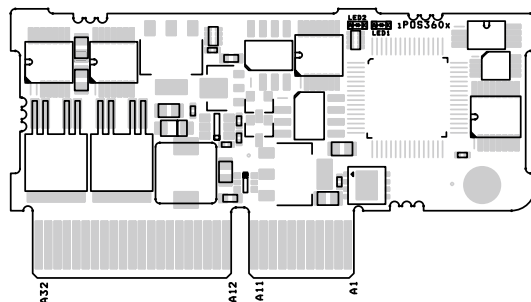
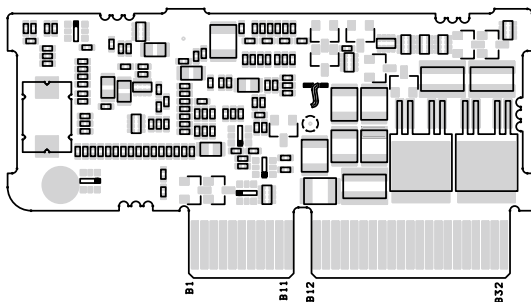


Pin	Name	Description
A1	GND	Return ground
A2	reserved	Reserved, do not connect
A3	reserved	Reserved, do not connect
A4	reserved	Reserved, do not connect
A5	reserved	Reserved, do not connect
A6	OUT1†	5-36V 0.5A general-purpose digital output, NPN open-collector/TTL pull-up
A7	reserved	Reserved, do not 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	+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	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

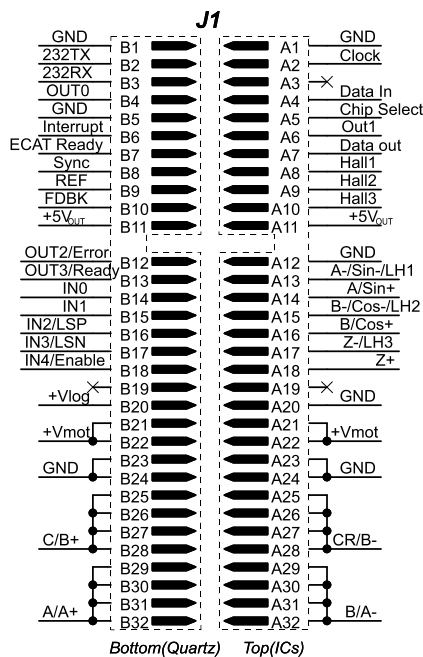
### 3.6.2 Mating Connectors for iPOS360X VX-CAN

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	+5V <sub>OUT</sub>	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

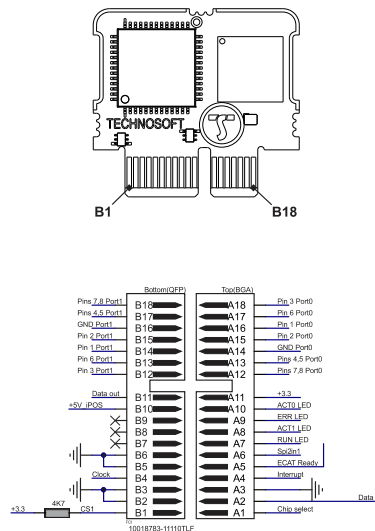
### 3.6.4 Mating Connectors for iPOS360X VX-CAT

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

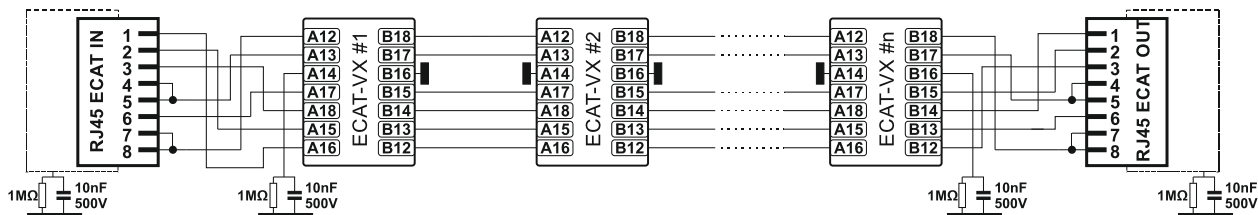


Figure 3.11 ECAT-VX to RS45 interface connection diagram

## 3.7 Connection diagrams

### 3.7.1 iPOS360X VX-CAN connection diagram

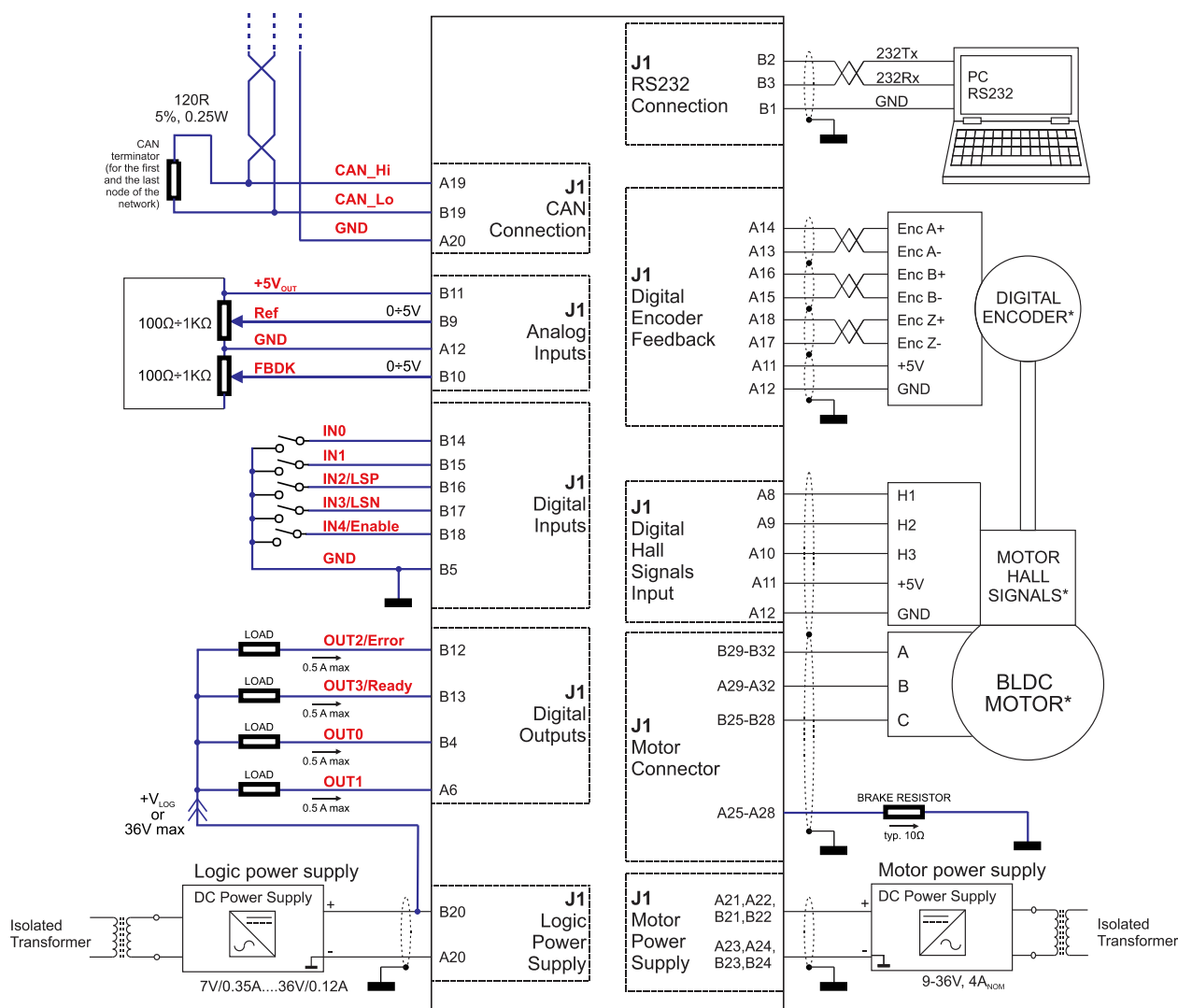


Figure 3.12. iPOS360X VX-CAN Connection diagram

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

### 3.7.2 iPOS360X VX-CAT connection diagram

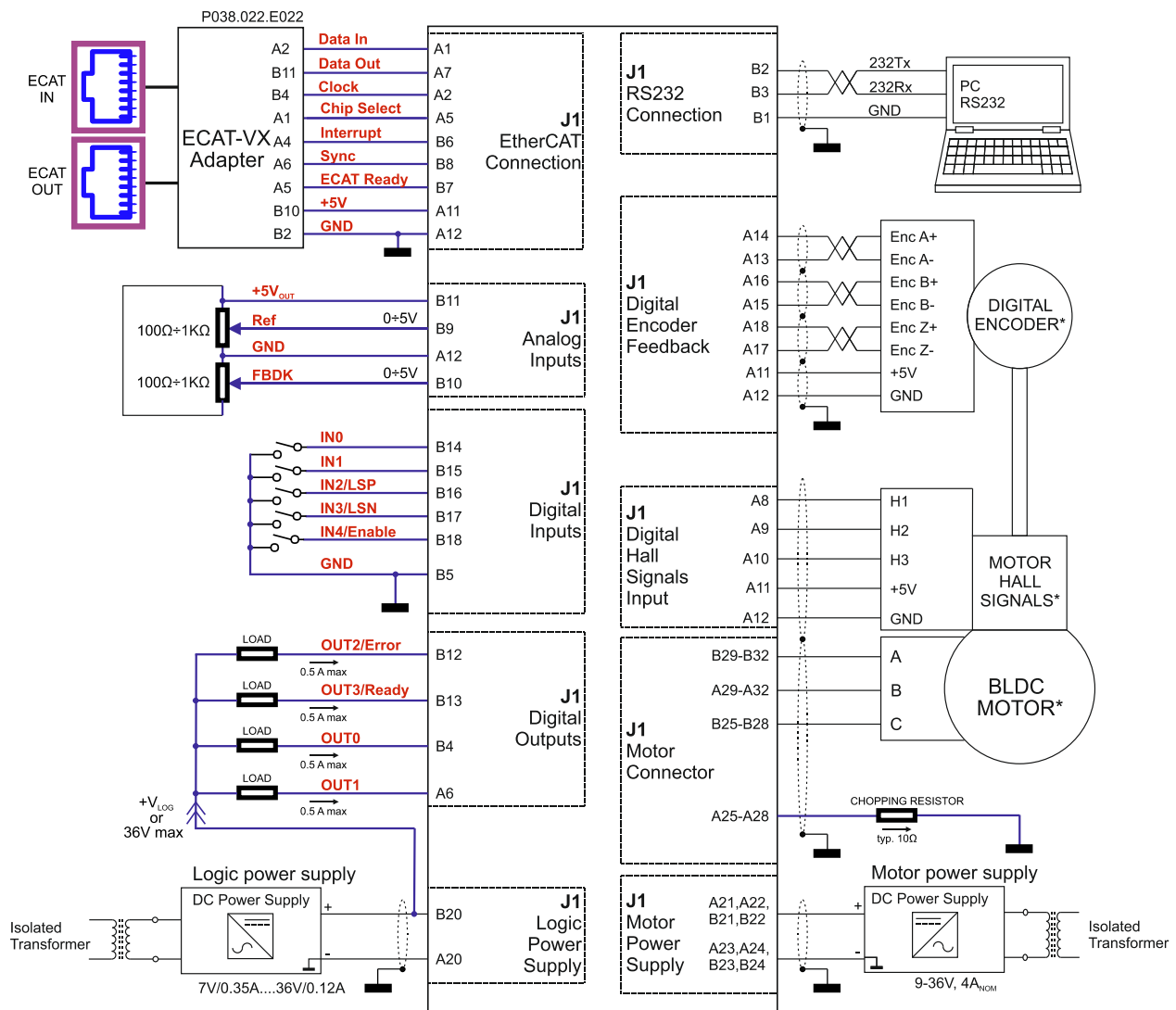


Figure 3.13. iPOS360X VX-CAT Connection diagram

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



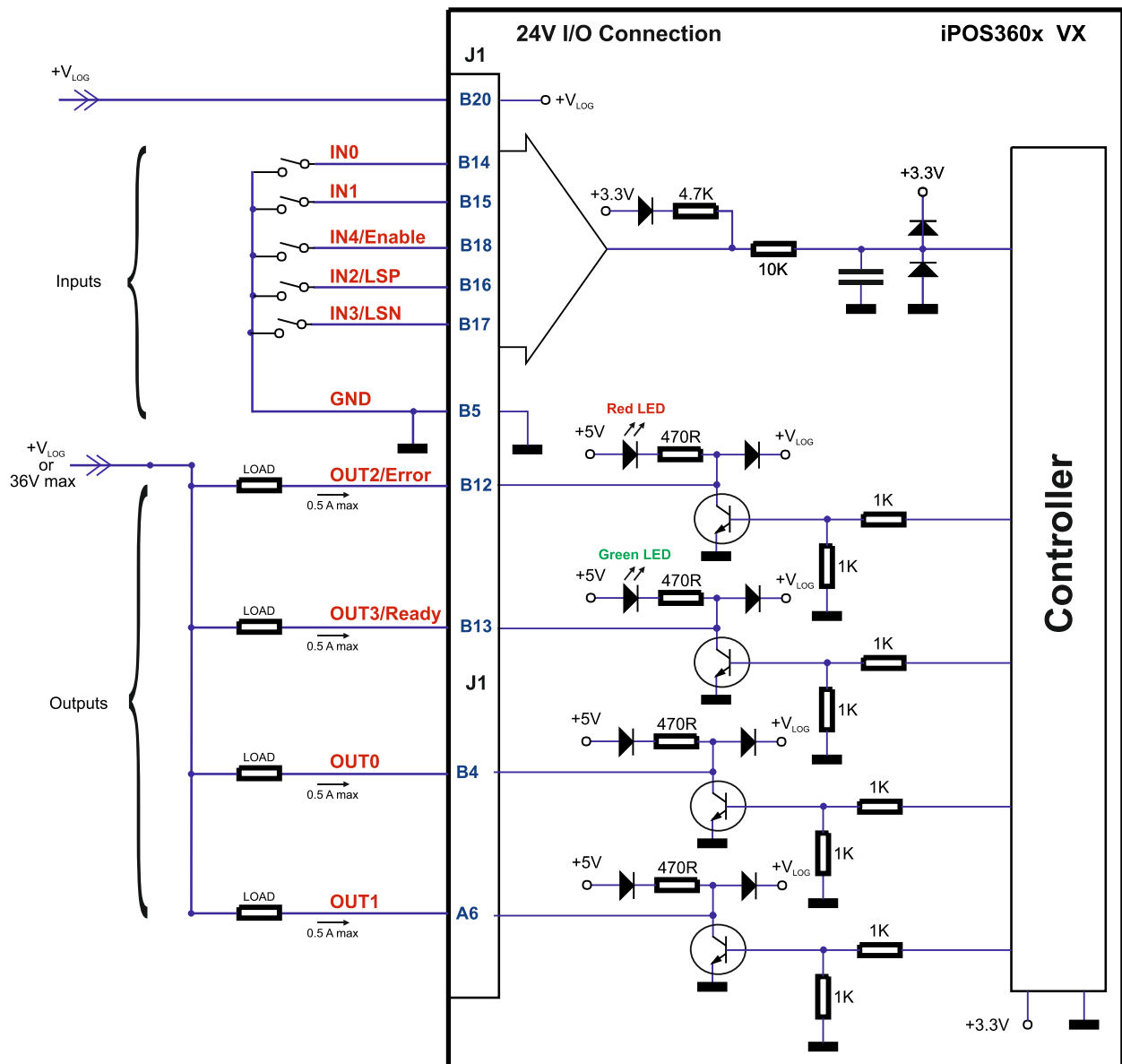


Figure 3.14. 24V Digital NPN Inputs connection

**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 +VLOG, 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

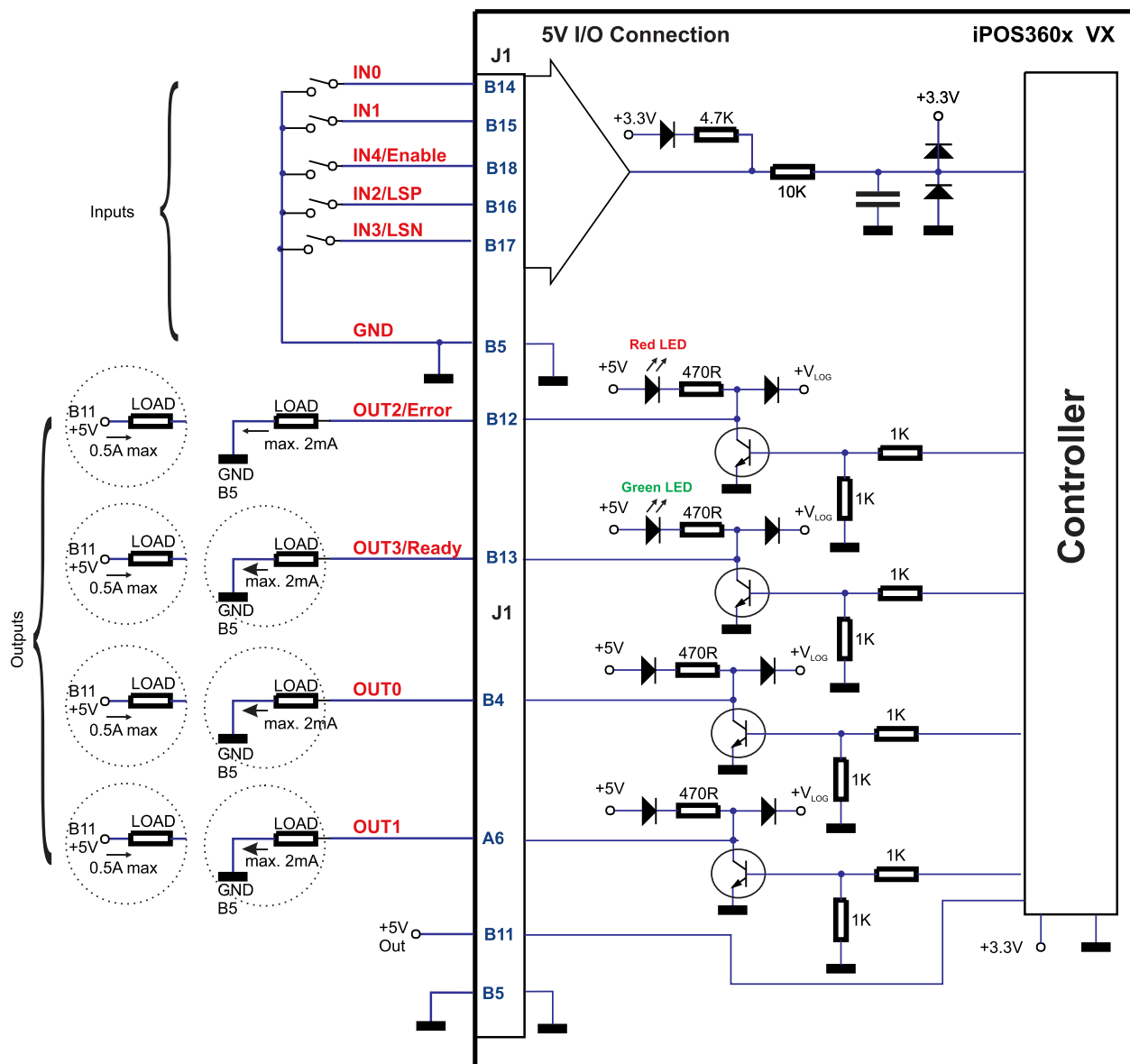


Figure 3.15. 5V Digital I/O connection

**Remarks:**

1. The inputs are compatible with TTL(5V), LVTTTL(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

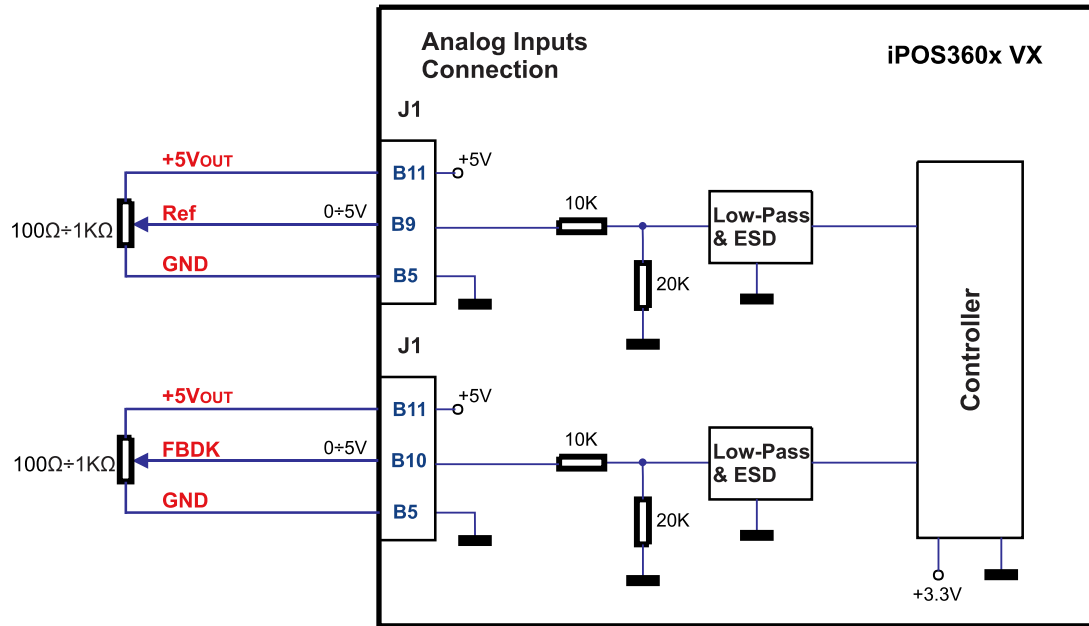


Figure 3.16. 0-5V Analog inputs connection

**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

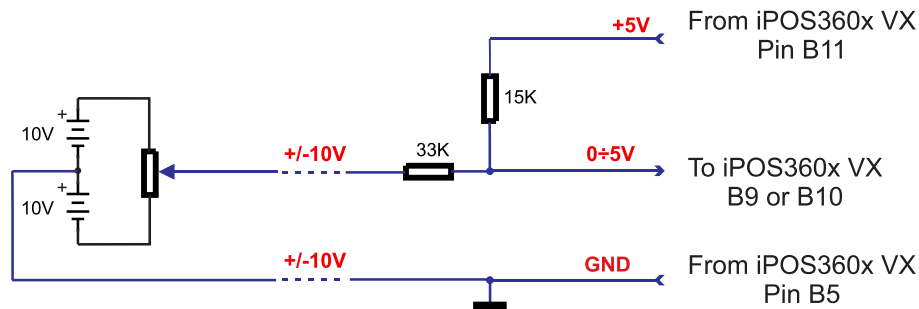


Figure 3.17. +/-10V to 0-5V adapter

#### 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: 1<sup>st</sup> wire connects the live signal to the drive input; 2<sup>nd</sup> 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: 1<sup>st</sup> wire connects the source plus (positive, in-phase) to the drive analogue input; 2<sup>nd</sup> 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: 1<sup>st</sup> wire connects the source plus (positive, in-phase) to the drive analogue input; 2<sup>nd</sup> 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

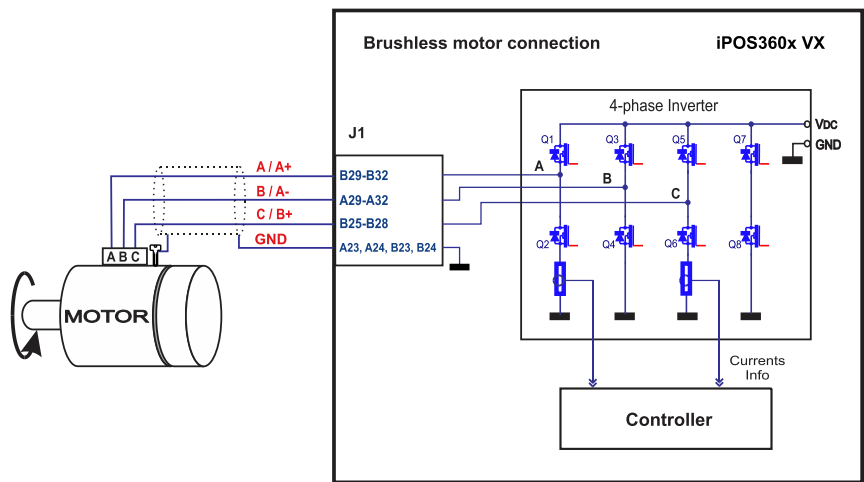


Figure 3.18. Brushless motor connection

3.7.6.2 2-phase Step Motor connection

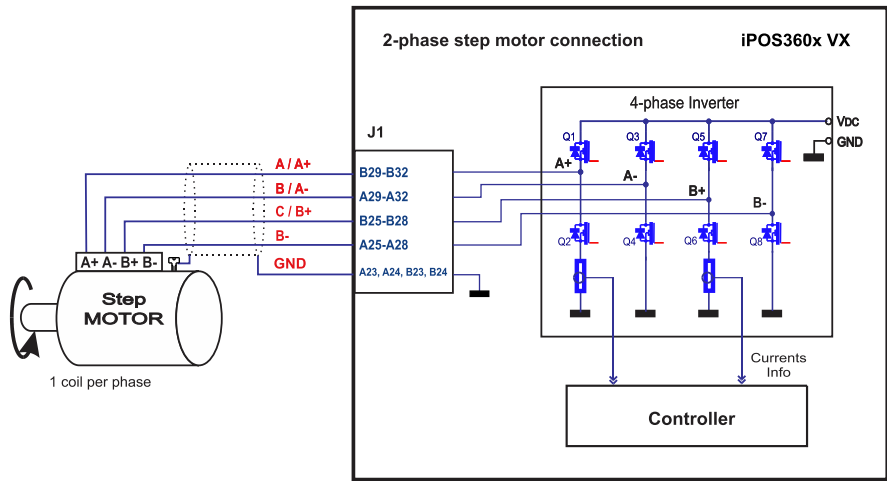


Figure 3.19. 2-phase step motor connection, one coil per phase

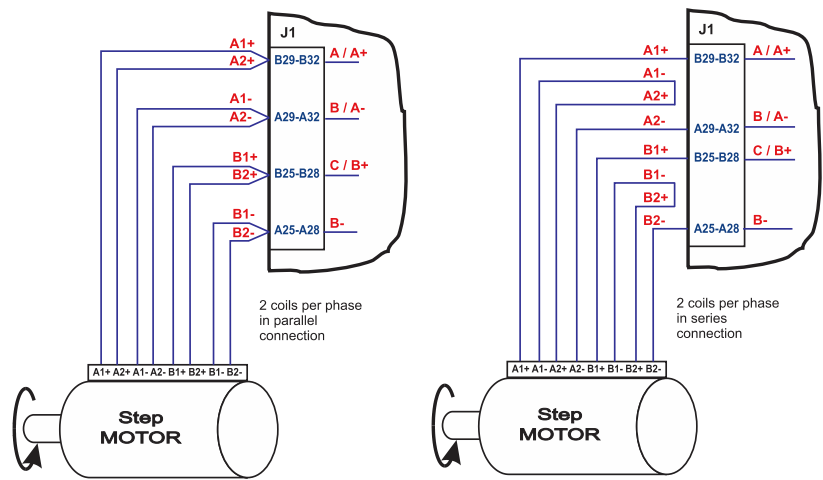


Figure 3.20. 2-phase step motor connection, two coils per phase

### 3.7.6.3 3-Phase Step Motor connection

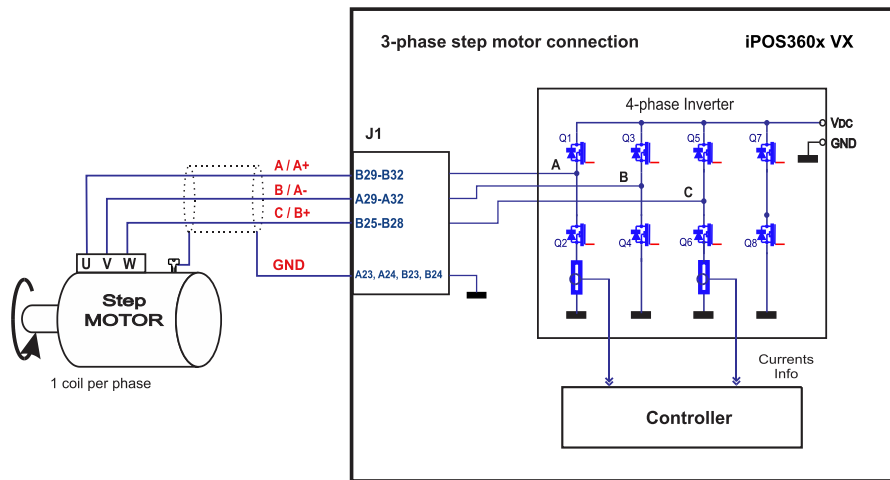


Figure 3.21. 3-phase step motor connection

### 3.7.6.4 DC Motor connection

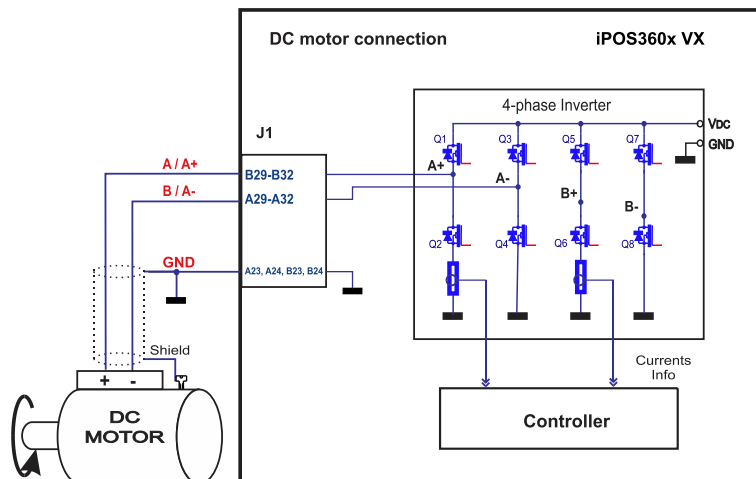


Figure 3.22. DC Motor connection

### 3.7.6.5 Recommendations for motor wiring

- 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.
- 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  $\mu$ H.
- 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

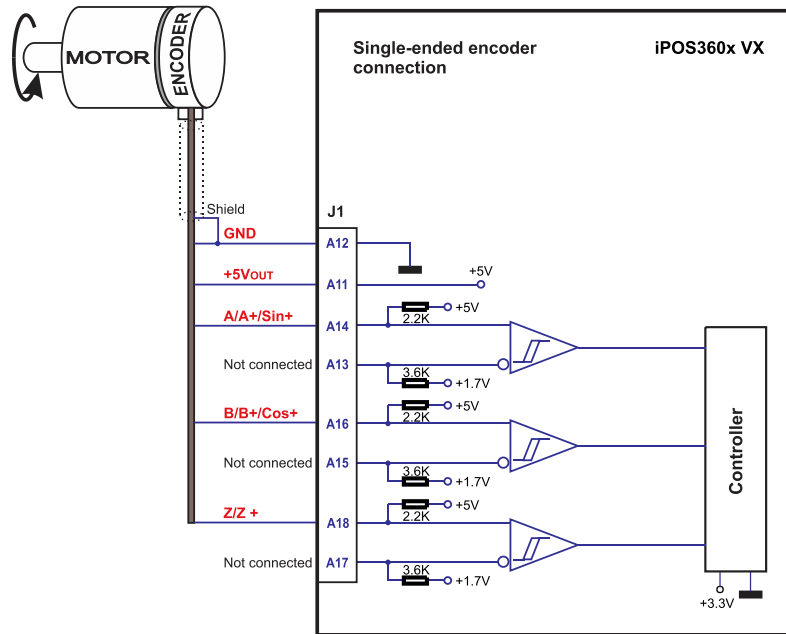


Figure 3.23. Single-ended incremental encoder connection



**CAUTION!**

**DO NOT CONNECT UTERMINATED WIRES. THEY MIGHT PICK UP UNWANTED NOISE AND GIVE FALSE ENCODER READINGS.**

#### 3.7.7.2 Differential Incremental Encoder Connection

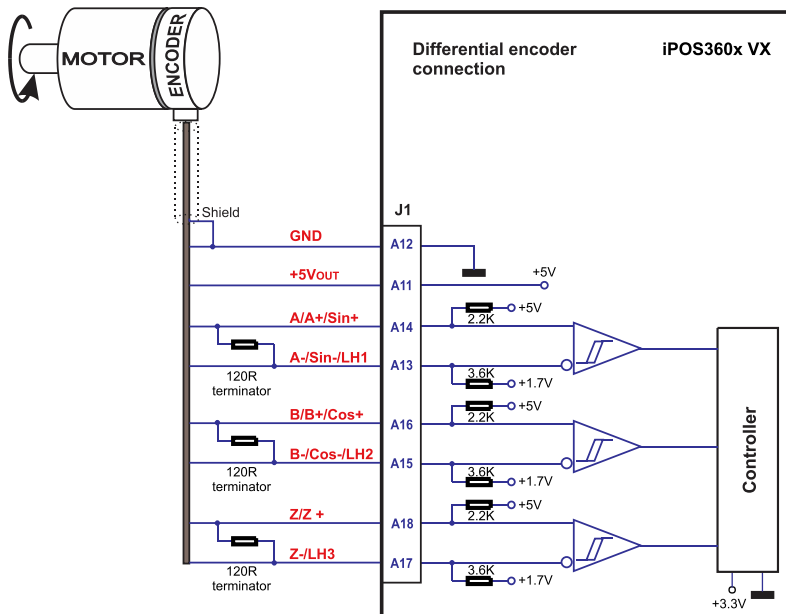


Figure 3.24. Differential incremental encoder connection

**Remarks:**

1. For the encoder differential connection, external 120 $\Omega$  (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

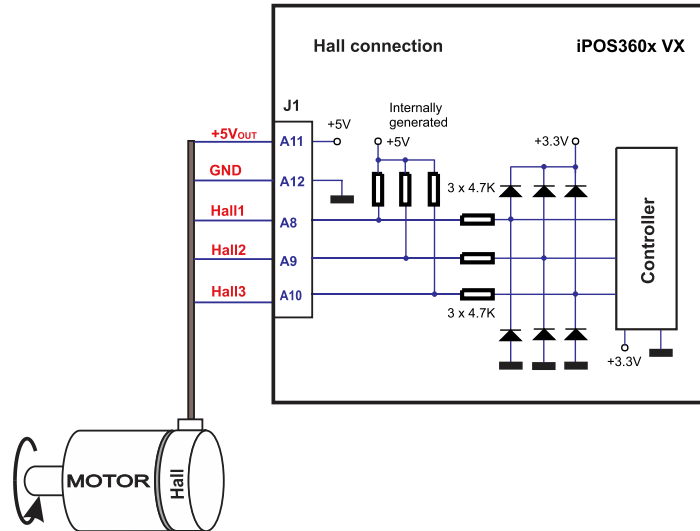


Figure 3.25. Digital Hall connection

#### 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

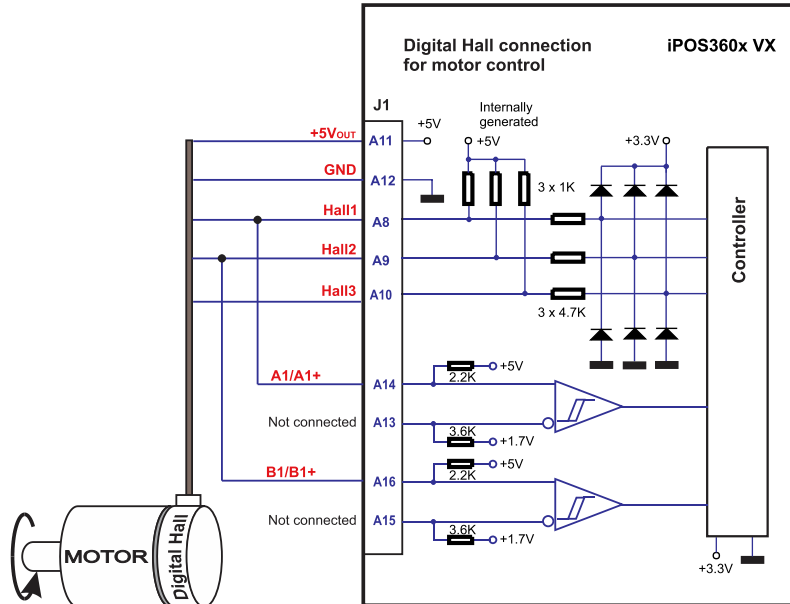


Figure 3.26. Digital Hall connection

#### 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

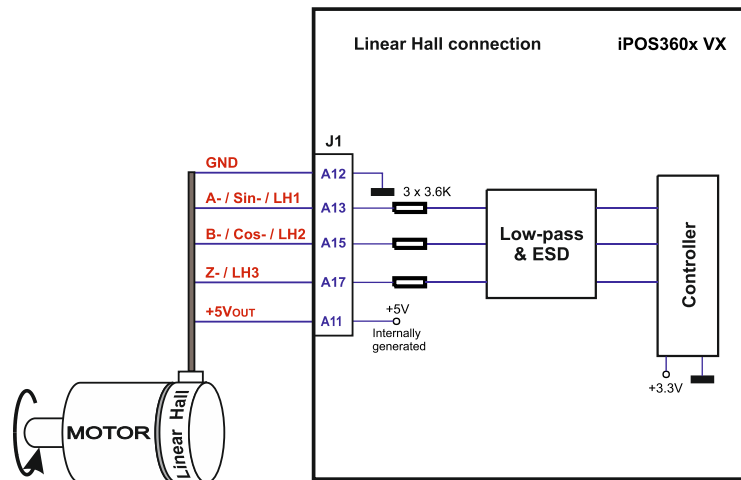


Figure 3.27. Digital Hall connection

### 3.7.7.6 Sin-Cosine Analog Encoder Connection

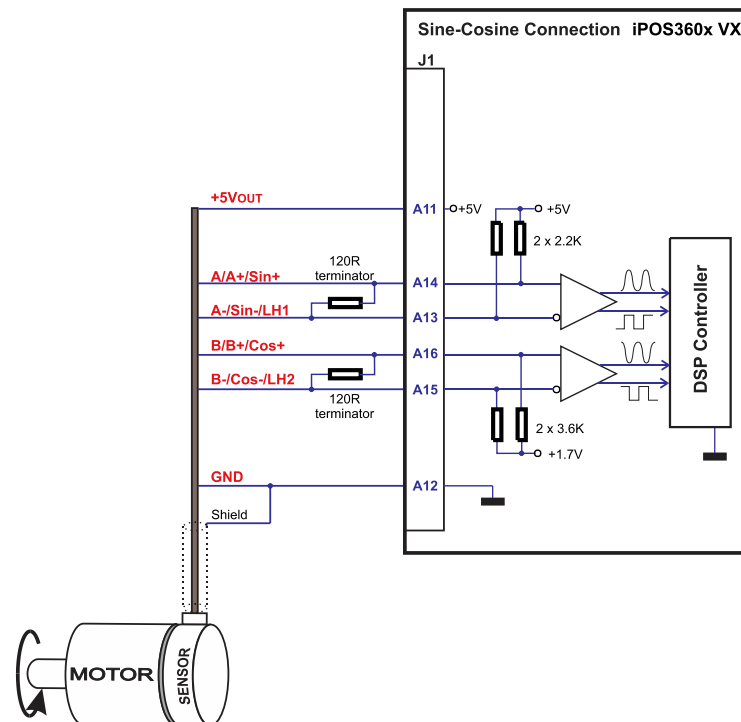


Figure 3.28. Digital Hall connection

### 3.7.7.7 Recommendations for wiring

- 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.
- 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.
- 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  $\mu\text{F}$ , rated at 6.3V

### 3.7.8 Power Supply Connection

#### 3.7.8.1 Supply Connection

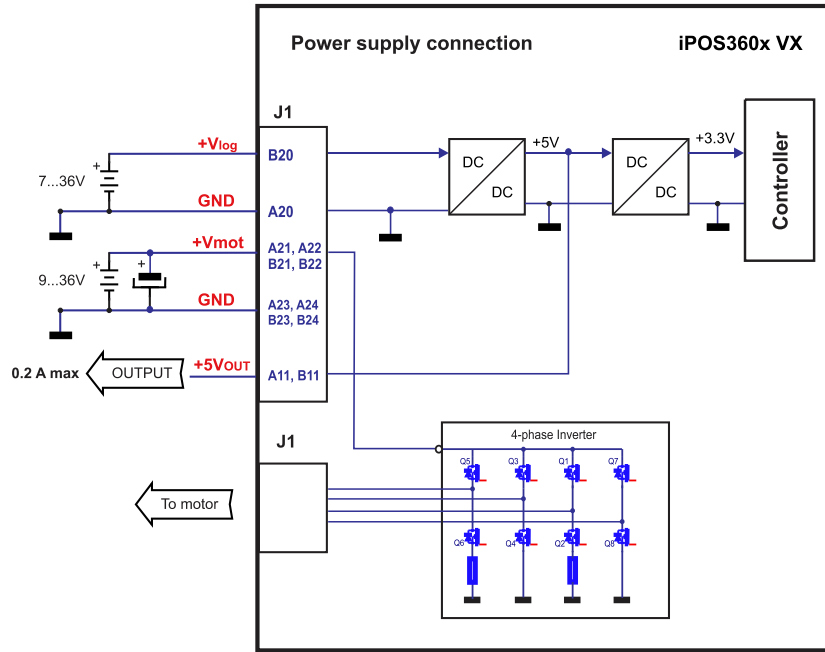


Figure 3.29. Supply connection

#### 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:

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

where:

$J_M$  – total rotor inertia [kgm<sup>2</sup>]

$J_L$  – total load inertia as seen at motor shaft after transmission [kgm<sup>2</sup>]

$\omega_M$  – 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<sup>2</sup>]

$h_{initial}$  – 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]

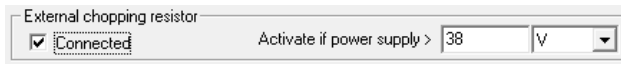
$T_F$  – total friction torque as seen at motor shaft [Nm] – includes load and transmission

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

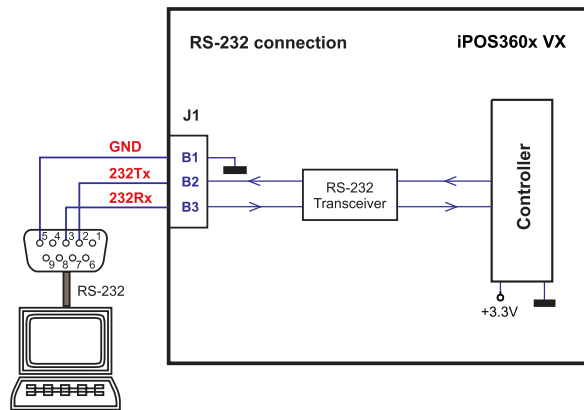
**Remarks:**

1. If  $\frac{U_{MAX}}{I_{PEAK}} > \frac{U_{CHOP}^2}{2 \times P_{CR}}$  the braking power  $P_{CR}$  must be reduced by increasing either  $t_d$  – the time to decelerate or  $C$  – the external capacitor on the motor supply
2. If  $\frac{P_{CR} \times t_d}{t_{CYCLE} \times I_{NOM}^2} > \frac{U_{CHOP}^2}{2 \times P_{CR}}$  either the braking power must be reduced (see Remark 1) or  $t_{CYCLE}$  – the time interval between braking cycles must be increased

	<b>WARNING!</b>	<b>THE CHOPPING RESISTOR MAY HAVE HOT SURFACES DURING OPERATION.</b>
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### 3.7.9 Serial RS-232 connection

#### 3.7.9.1 Serial RS-232 connection



**Figure 3.30.** 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

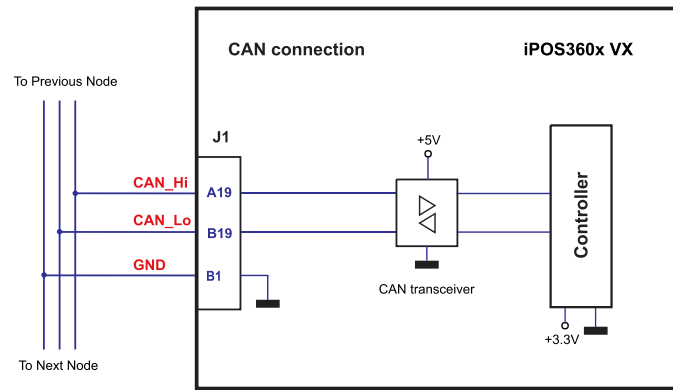


Figure 3.31. CAN connection

#### 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.

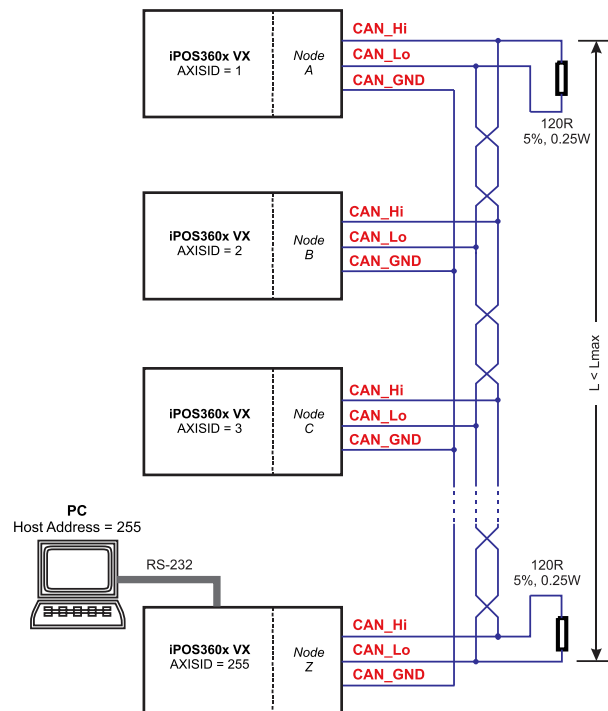


Figure 3.32. Multiple-Axis CAN network

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

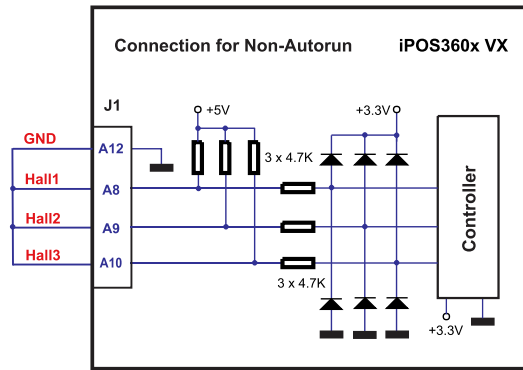


Figure 3.33. Temporary connection during power-on to disable the drive from Autorun mode

#### 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:

- 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;`**

- 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:  $49 \times (\text{AxisID2} - 3) + 7 \times \text{AxisID1} + \text{AxisID0}$ , 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:  $49 \times (\text{AxisID2} - 3) + 7 \times \text{AxisID1} + \text{AxisID0}$ , 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



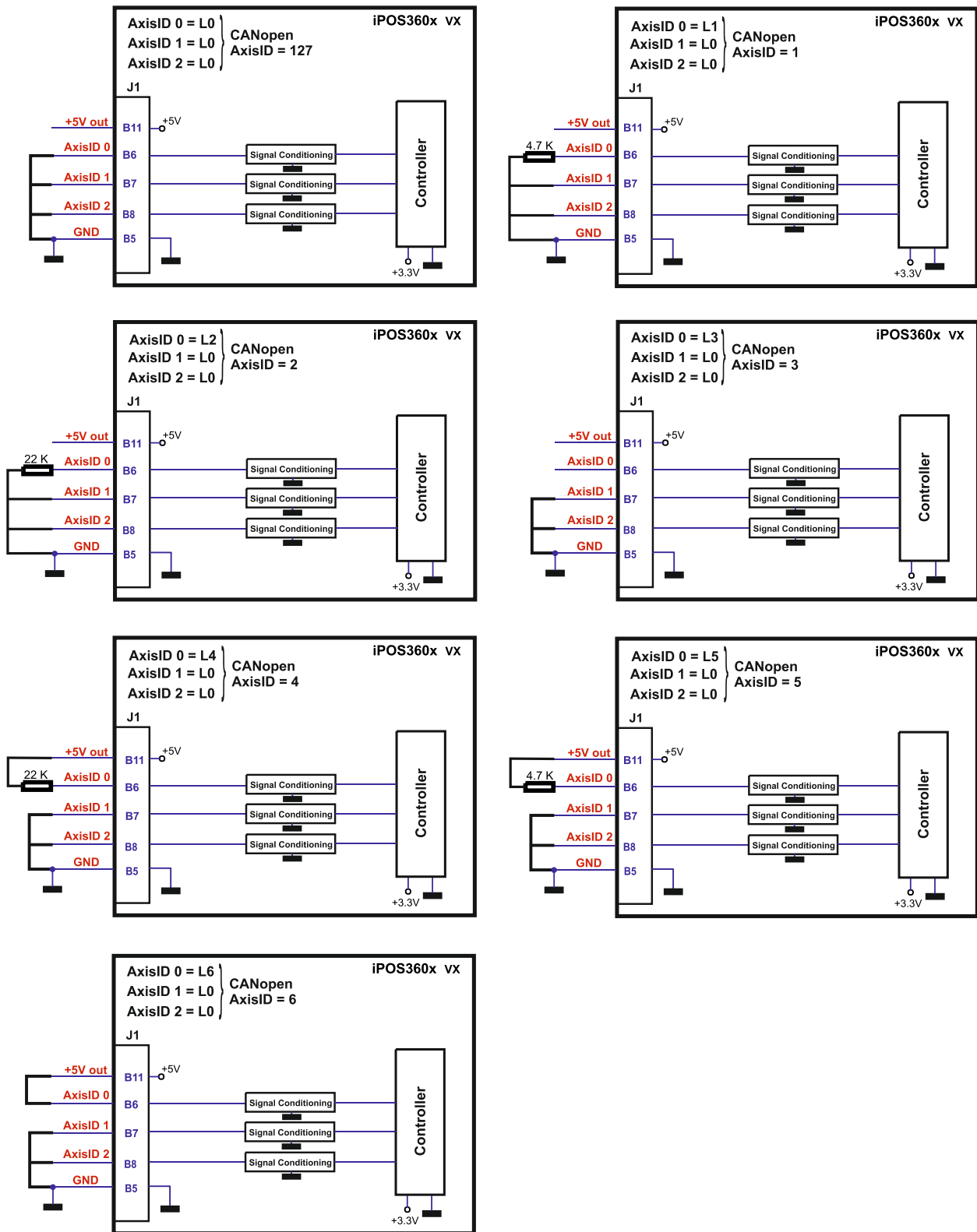


Figure 3.34. Axis ID Setting Examples. CANopen mode

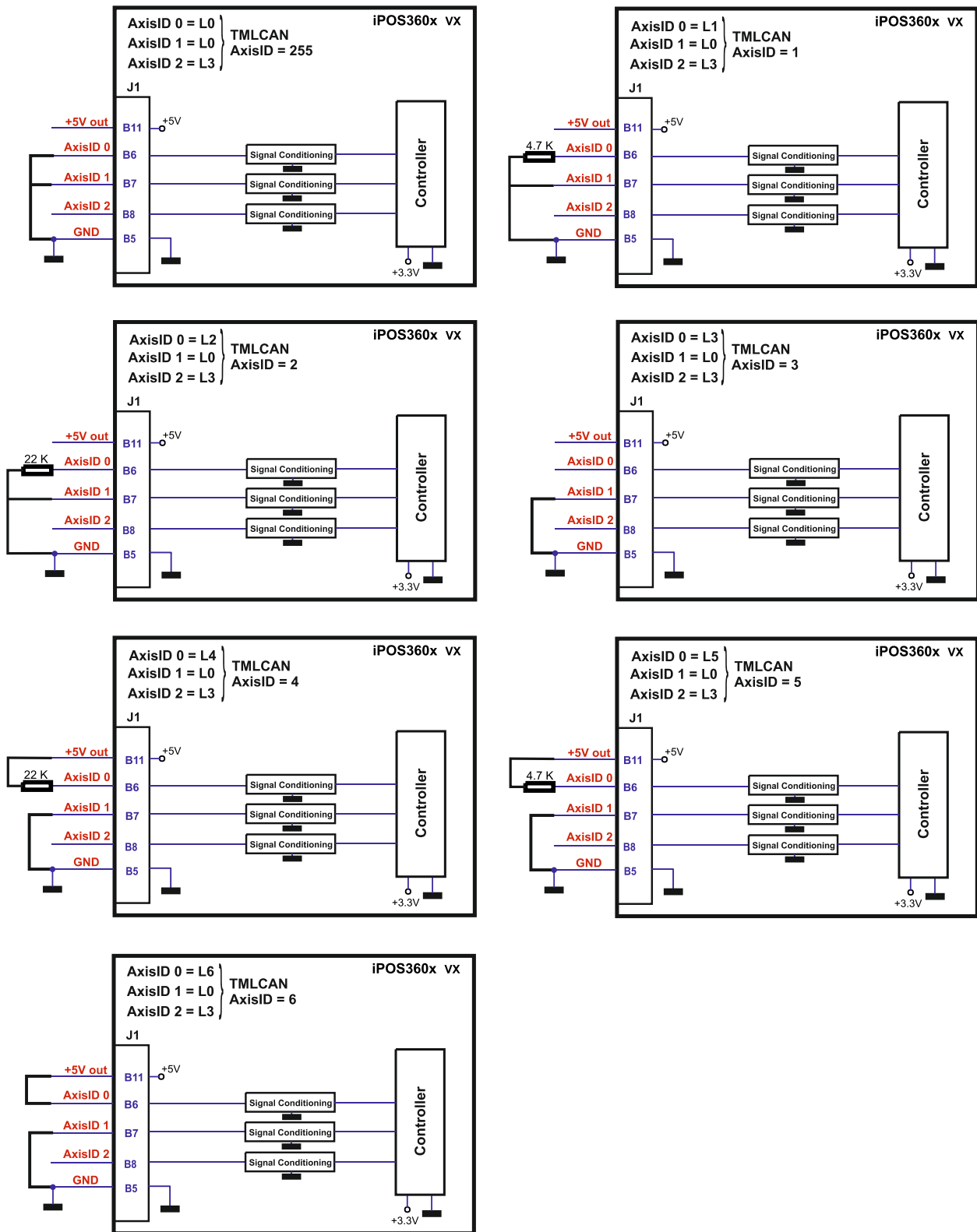


Figure 3.35. Axis ID Setting Examples. TMLCAN mode

### 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
L3	L0	L0	255
L3	L0	L1	1
L3	L0	L2	2
L3	L0	L3	3
L3	L0	L4	4
L3	L0	L5	5
L3	L0	L6	6
L3	L1	L0	7
L3	L1	L1	8
L3	L1	L2	9
L3	L1	L3	10
L3	L1	L4	11
L3	L1	L5	12
L3	L1	L6	13
L3	L2	L0	14
L3	L2	L1	15
L3	L2	L2	16
L3	L2	L3	17
L3	L2	L4	18
L3	L2	L5	19
L3	L2	L6	20
L3	L3	L0	21
L3	L3	L1	22
L3	L3	L2	23
L3	L3	L3	24
L3	L3	L4	25
L3	L3	L5	26
L3	L3	L6	27
L3	L4	L0	28
L3	L4	L1	29
L3	L4	L2	30
L3	L4	L3	31
L3	L4	L4	32
L3	L4	L5	33
L3	L4	L6	34
L3	L5	L0	35
L3	L5	L1	36
L3	L5	L2	37
L3	L5	L3	38
L3	L5	L4	39
L3	L5	L5	40
L3	L5	L6	41
L3	L6	L0	42
L3	L6	L1	43
L3	L6	L2	44
L3	L6	L3	45
L3	L6	L4	46
L3	L6	L5	47
L3	L6	L6	48

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

Axis ID 2	Axis ID 1	Axis ID 0	ID TMLCAN
L5	L0	L0	98
L5	L0	L1	99
L5	L0	L2	100
L5	L0	L3	101
L5	L0	L4	102
L5	L0	L5	103
L5	L0	L6	104
L5	L1	L0	105
L5	L1	L1	106
L5	L1	L2	107
L5	L1	L3	108
L5	L1	L4	109
L5	L1	L5	110
L5	L1	L6	111
L5	L2	L0	112
L5	L2	L1	113
L5	L2	L2	114
L5	L2	L3	115
L5	L2	L4	116
L5	L2	L5	117
L5	L2	L6	118
L5	L3	L0	119
L5	L3	L1	120
L5	L3	L2	121
L5	L3	L3	122
L5	L3	L4	123
L5	L3	L5	124
L5	L3	L6	125
L5	L4	L0	126
L5	L4	L1	127
L5	L4	L2	128
L5	L4	L3	129
L5	L4	L4	130
L5	L4	L5	131
L5	L4	L6	132
L5	L5	L0	133
L5	L5	L1	134
L5	L5	L2	135
L5	L5	L3	136
L5	L5	L4	137
L5	L5	L5	138
L5	L5	L6	139
L5	L6	L0	140
L5	L6	L1	141
L5	L6	L2	142
L5	L6	L3	143
L5	L6	L4	144
L5	L6	L5	145
L5	L6	L6	146

Axis ID 2	Axis ID 1	Axis ID 0	ID TMLCAN
L6	L0	L0	147
L6	L0	L1	148
L6	L0	L2	149
L6	L0	L3	150
L6	L0	L4	151
L6	L0	L5	152
L6	L0	L6	153
L6	L1	L0	154
L6	L1	L1	155
L6	L1	L2	156
L6	L1	L3	157
L6	L1	L4	158
L6	L1	L5	159
L6	L1	L6	160
L6	L2	L0	161
L6	L2	L1	162
L6	L2	L2	163
L6	L2	L3	164
L6	L2	L4	165
L6	L2	L5	166
L6	L2	L6	167
L6	L3	L0	168
L6	L3	L1	169
L6	L3	L2	170
L6	L3	L3	171
L6	L3	L4	172
L6	L3	L5	173
L6	L3	L6	174
L6	L4	L0	175
L6	L4	L1	176
L6	L4	L2	177
L6	L4	L3	178
L6	L4	L4	179
L6	L4	L5	180
L6	L4	L6	181
L6	L5	L0	182
L6	L5	L1	183
L6	L5	L2	184
L6	L5	L3	185
L6	L5	L4	186
L6	L5	L5	187
L6	L5	L6	188
L6	L6	L0	189
L6	L6	L1	190
L6	L6	L2	191

### 3.10 Electrical Specifications

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

$T_{amb} = 0 \dots 70^{\circ}\text{C}$ ,  $V_{LOG} = 24\text{ V}_{DC}$ ;  $V_{MOT} = 24\text{V}_{DC}$ ; 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	$^{\circ}\text{C}$
	iPOS360X VX-CAT	0		+40	
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure <sup>1</sup>	Altitude (referenced to sea level)	-0.1	$0 \pm 2.5$	<sup>2</sup>	Km
	Ambient Pressure	$0^2$	$0.75 \pm 1$	10.0	atm

#### 3.10.2 Storage Conditions

		Min.	Typ.	Max.	Units
Ambient temperature	iPOS360X VX-CAN	-40		105	$^{\circ}\text{C}$
	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			$\pm 0.5$	kV
	Original packaging			$\pm 15$	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
		$\sim 2.2 \times 1.1 \times 0.3$			inch
	With recommended mating vertical connector and retainer. Height above PCB surface.	63.3 x 32.6 x 16.3			mm
		$\sim 2.5 \times 1.3 \times 0.64$			inch
	With recommended mating horizontal connector. Height above PCB surface.	56 x 41.2 x 7.6			mm
		$\sim 2.2 \times 1.6 \times 0.3$			inch
ECAT-VX adapter Size ( Length x Width x Height )	Without mating connector	31.5 x 28.8 x 5.2			mm
		$\sim 1.24 \times 1.13 \times 0.2$			inch
	With recommended mating vertical connector. Height above PCB surface.	31.5 x 32.6 x 8.8			mm
		$\sim 1.24 \times 1.28 \times 0.35$			inch
	With recommended mating horizontal connector. Height above PCB surface.	31.5 x 41.2 x 9.4			mm
		$\sim 1.24 \times 1.62 \times 0.37$			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<sub>LOG</sub>)

		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 $\leq 10\text{ms}$ ) <sup>†</sup>	-1		+45	V
Supply current	+V <sub>LOG</sub> = 7V		125	300	mA
	+V <sub>LOG</sub> = 12V		80	200	
	+V <sub>LOG</sub> = 24V		50	125	
	+V <sub>LOG</sub> = 40V		40	100	

<sup>†</sup> 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<sub>MOT</sub>)

				Min.	Typ.	Max.	Units
Supply voltage	Nominal values			9		36	V <sub>DC</sub>
	Absolute maximum values, drive operating but outside guaranteed parameters			8.5		40	V <sub>DC</sub>
	Absolute maximum values, surge (duration ≤ 10ms) <sup>†</sup>			-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) <sup>†</sup>	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	A
		iPOS3602		±4.3	
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 <sub>MOT</sub> = 36 V	F <sub>PWM</sub> = 20 kHz	250		μH
		F <sub>PWM</sub> = 40 kHz	120		
		F <sub>PWM</sub> = 80 kHz	60		
		F <sub>PWM</sub> = 60 kHz	100		
		F <sub>PWM</sub> = 100 kHz	45		
	Absolute minimum value, limited by short-circuit protection; +V <sub>MOT</sub> = 36 V	F <sub>PWM</sub> = 20 kHz	75		μH
		F <sub>PWM</sub> = 40 kHz	25		
		F <sub>PWM</sub> = 60 kHz	20		
		F <sub>PWM</sub> = 80 kHz	10		
		F <sub>PWM</sub> = 100 kHz	5		
Motor electrical time-constant (L/R)	Recommended value, for ±5% current measurement error due to ripple	F <sub>PWM</sub> = 20 kHz	250		μs
		F <sub>PWM</sub> = 40 kHz	125		
		F <sub>PWM</sub> = 60 kHz	100		
		F <sub>PWM</sub> = 80 kHz	63		
		F <sub>PWM</sub> = 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)<sup>1</sup>

		Min.	Typ.	Max.	Units
Mode compliance		TTL / CMOS / LVTTTL (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

<sup>1</sup> 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 <sub>LOG</sub> floating or to GND)	High-Z (floating)			
	Immediately after power-up	Logic "HIGH"			
		Logic "LOW"			
	Normal operation	Logic "HIGH"			
Output voltage	Logic "LOW"; output current = 0.5A		0.2	0.8	V
	Logic "HIGH"; output current = 0, no load	2.9	3	3.3	
	OUT2/Error, OUT3/ Ready OUT0, OUT1	4	4.5	5	
	Logic "HIGH", external load to +V <sub>LOG</sub>		V <sub>LOG</sub>		
	Absolute maximum, continuous	-0.5		V <sub>LOG</sub> +0.5	
	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>	-1		V <sub>LOG</sub> +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 <sub>OUT</sub> ≥ 2.0V			2	mA
	OUT2/Error, OUT3/ Ready OUT0, OUT1			4	
	Logic "HIGH", leakage current; external load to +V <sub>LOG</sub> ; V <sub>OUT</sub> = V <sub>LOG</sub> 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) <sup>†</sup>	-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		4.95	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1s) <sup>†</sup>			±36	
Input impedance	To GND		30		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS <sup>1</sup>
Bandwidth (-3dB)	Software selectable	0		1	kHz
ESD protection	Human body model	±2			kV

<sup>1</sup> "FS" stands for "Full Scale"

### 3.10.13 Encoder Inputs (A+, A-, B+, B-, Z+, Z-,)<sup>1</sup>

		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 2.2K $\Omega$ pull-up to +5	0	0	0	
Differential mode compliance	For full RS422 compliance, see <sup>2</sup>	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	$\pm 0.06$	$\pm 0.1$	$\pm 0.2$	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		k $\Omega$
	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			$\mu$ s
	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 $\leq 1$ s) <sup>†</sup>	-11		+14	
ESD protection	Human body model	$\pm 1$			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	$\pm 2$			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	350		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	$\pm 1$			kV

<sup>1</sup> Encoder differential input pins do not have internal 120 $\Omega$  termination resistors connected across

<sup>2</sup> For full RS-422 compliance, 120 $\Omega$  termination resistors must be connected across the differential pairs, as close as possible to the drive input pins. See *Figure 3.24. 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"			
Isolation GND0,GND1	Requirement for motherboard PCB routing	NOT compliant to IEEE802.3af mode B "DC on Spares"			
		500			V <sub>rms</sub>
		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.

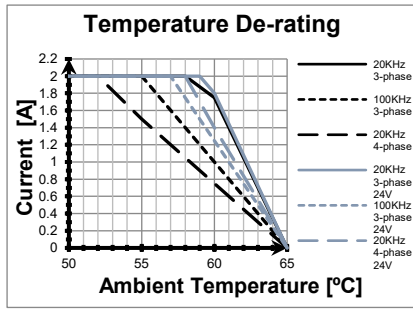


Figure 3.35 iPOS3602 VX De-rating with ambient temperature

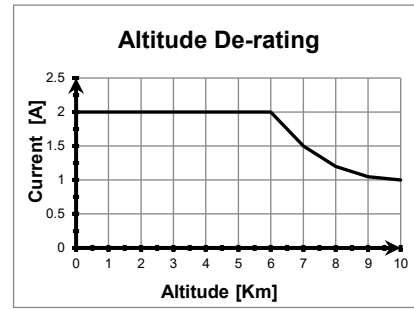


Figure 3.37 iPOS3602 VX De-rating with altitude

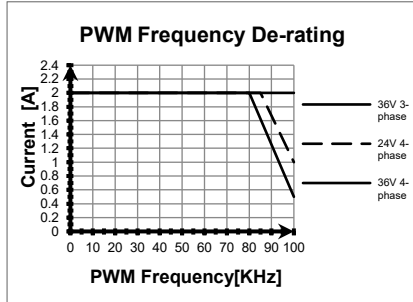


Figure 3.38 iPOS3602 VX Current De-rating with PWM frequency

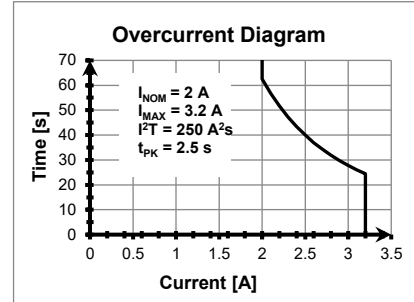


Figure 3.39 iPOS3602 VX Over-current diagram

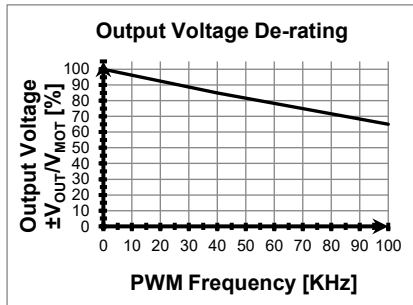


Figure 3.40. iPOS360x VX Output Voltage De-rating with PWM frequency<sup>1</sup>

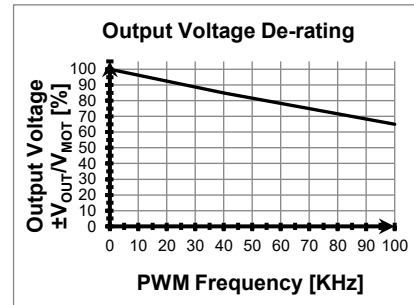


Figure 3.40. iPOS3604 VX De-rating with ambient temperature

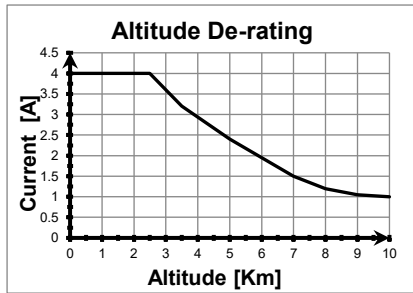


Figure 3.42. iPOS3604 VX De-rating with altitude

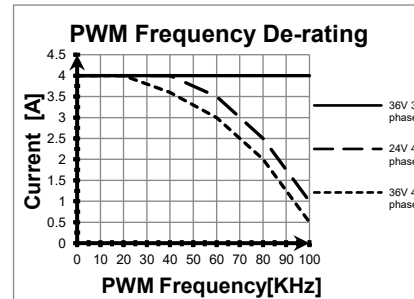


Figure 3.43. iPOS3604 VX Current De-rating with PWM frequency

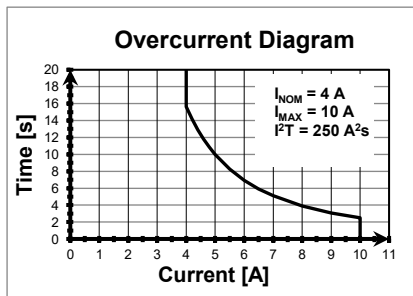


Figure 3.44. iPOS3604 VX Over-current diagram



**CAUTION!**

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

<sup>1</sup>  $V_{OUT}$  – the output voltage,  $V_{MOT}$  – the motor supply voltage

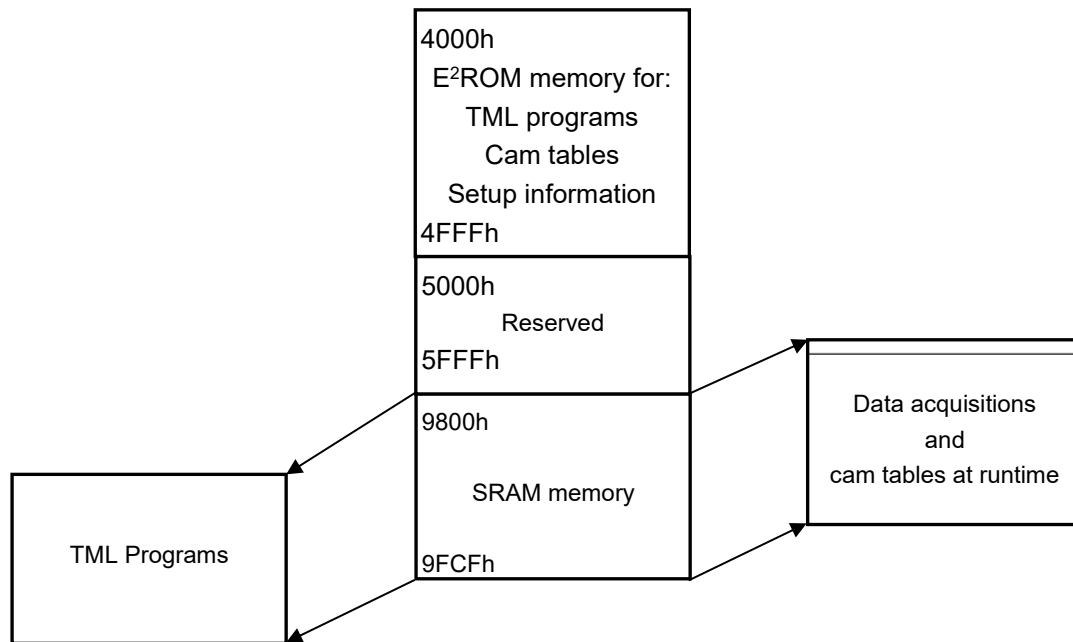
## 4 Memory Map

iPOS360X VX has 2 types of memory available for user applications: 2K×16 SRAM and 4K×16 serial E<sup>2</sup>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<sup>2</sup>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