iPOS8015 MZ

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

TECHNOSOFT

MOTION TECHNOLOGY

Intelligent Servo Drives

Technical Reference

P091.022.iPOS8015.MZ.UM.0825

1. Table of contents

2. Read This First

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

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

3. About This Manual

This book is a technical reference manual for:

Product Name	Part Number	Output current		Communication
		Nominal[1]	Peak	
iPOS8015 MZ-CAT	P022.036.E122	$15A_{RMS}$ / 21.2A	$28.3A_{RMS}$ / 40A	LV-TTL UART; USB; EtherCAT®
iPOS8015 MZ-CAN	P022.036.E102			LV-TTL UART; USB; CAN

In order to operate the **iPOS8015 MZ** drives, you need to pass through 3 steps:

- ❑ **Step 1 Hardware installation**
- ❑ **Step 2 Drive setup** using Technosoft **EasyMotion Studio II** software for drive commissioning
- ❑ **Step 3 Motion programming** using one of the options:
  - ❑ A **CANopen master**[2] or an **EtherCAT® master**[3]
  - ❑ The drives **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft EasyMotion Studio II software
  - ❑ A **TML_LIB motion library for PCs** (Windows or Linux) [4]
  - ❑ A **TML_LIB motion library for PLCs** [4]
  - ❑ 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 **iPOS8015** 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 II – Quick Setup and Programming Guide.*** For detailed information regarding the next steps, refer to the related documentation.

4. Notational Conventions

This document uses the following conventions:

- **iPOS8015 MZ**– 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®

5. Trademarks

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

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[1] It is mandatory to mount the iPOS8015 MZ on a metallic support using the provided mounting holes. To achieve the rated current capability, the heat sink temperature must not exceed 75°C.
[2] when the iPOS8015 MZ-CAN is set in CANopen mode
[3] when using and iPOS8015 MZ-CAT
[4] available only for CAN versions

6. Related Documentation

iPOS8015 MZ-CAT Datasheet (P022.036.E122.DSH)

iPOS8015 MZ-CAN Datasheet (P022.036.E102.DSH)

– describes the hardware connections of the iPOS8015 MZ family of intelligent servo drives including the technical data and connectors.

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

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

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

Help of the EasyMotion Studio II software – **EasyMotion Studio II** simplifies the setup process for any Technosoft drive, enabling quick configuration. The software generates setup data that can be downloaded into the drive's EEPROM or saved as a file on a PC. Upon power-up, the drive initializes with the setup data read from its EEPROM. Additionally, EasyMotion Studio II allows retrieval of complete setup information from a previously programmed drive. The **LITE version of EasyMotion Studio II** is available for free download from the Technosoft website.

iPOS CANopen Programming **(part no. P091.063.iPOS.UM.xxxx)** – explains how to program the iPOS family of intelligent drives using **CANopen** protocol and describes the associated object dictionary for **CiA 301 v.4.2** application layer and communication profile, **CiA WD 305 v.2.2.13** layer settings services and protocols and **CiA DSP 402 v3.0** device profile for drives and motion control now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards

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

Motion Programming using EasyMotion Studio (part no. P091.034.ESM.UM.xxxx) – describes how to use the EasyMotion Studio to create motion programs using in Technosoft Motion Language (TML). *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**.

7. If you Need Assistance …

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

8. 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***

9. 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***

10. 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.

11. Quality system, conformance and certifications

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

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

12. Product Overview

12.1. Introduction

The **iPOS8015** 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 controlling brushless DC, brushless AC (vector control), DC brushed motors, and step motors, the iPOS8015 drives accept as position feedback incremental encoders (quadrature or sine/cosine), absolute encoders (SSI, BiSS, Panasonic, Tamagawa, EnDAT, Nikon, Sanyo Denki) and linear Hall signals.

All drives perform position, speed or torque control and work in single, multi-axis or stand-alone configurations. Thanks to the embedded motion controller, the iPOS8015 drives combine controller, drive and PLC functionality in a single compact unit and are capable to execute complex motions without requiring intervention of an external motion controller. Using the high-level Technosoft Motion Language (**TML**) the following operations can be executed directly at drive level:

- Setting various motion modes (profiles, PVT, PT, electronic gearing[1] or camming[1], etc.)
- Changing the motion modes and/or the motion parameters
- Executing homing sequences
- Controlling the program flow through:
  - Conditional jumps and calls of TML functions
  - TML interrupts generated on pre-defined or programmable conditions (protections triggered, transitions on limit switch or capture inputs, etc.)
  - Waits for programmed events to occur
- Handling of digital I/O and analogue input signals
- Executing arithmetic and logic operations
- Performing data transfers between axes
- Controlling motion of an axis from another one via motion commands sent between axes[2]
- Sending commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group[2]
- Synchronizing all the axes from a network

By implementing motion sequences directly at the drive level, intelligence can be effectively distributed between the master and the drives in complex multi-axis applications, significantly reducing both development time and overall communication requirements. For instance, rather than commanding each movement of an axis individually, the drives can be programmed using TML to execute complex motion tasks autonomously and notify the master upon completion. Consequently, the master's role in controlling each axis is minimized to simply calling TML functions stored in the drive's EEPROM and awaiting a confirmation message indicating the completion of these functions.

All iPOS8015 - CAT drives ae equipped with an EtherCAT® communication interface that provides support for:

- **FoE (File-over-EtherCAT)**
- **EoE (Ethernet-over-EtherCAT)**
- **CoE (CAN application protocol over EtherCAT)**

All iPOS8015 - CAN drives are equipped with a **CAN 2.0B** interface that can be set to operate in 2 communication protocol modes:

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

When **CANopen** mode is selected, the drive conforms to **CiA 301 v4.2** application layer communication profile, the **CiA WD 305 v2.2.13** and **CiA DSP 402 v4.1.1** device profile for drives and motion control, now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards. In this mode, the drive may be controlled via a CANopen master. The 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 unit 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 drive 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.

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

For higher-level coordination, besides a master, the iPOS8015 drives can also be controlled via a PC or PLC using one of the **TML_LIB motion libraries**.

For commissioning the iPOS8015, the EasyMotion Studio II PC application is available in two versions: LITE and FULL.

The LITE version simplifies the setup process for any Technosoft drive, enabling quick **commissioning**. It generates setup data that can be downloaded into the drive's EEPROM or saved as a file on a PC. Upon power-up, the drive initializes with the setup data from its EEPROM. Additionally, the LITE version allows for the retrieval of complete setup information from a previously programmed drive and is available for free download from the Technosoft website.

The **FULL version** of EasyMotion Studio II is built for **commissioning** and **advanced motion programming**. In addition to the features available in the Lite version, it enables the development of complex motion programs using TML, executed directly by the drive's integrated motion controller.

While the LITE version includes only the setup functionality, making it suitable for scenarios where motion programming is managed through a CANopen/EtherCAT master or a PC/PLC using Technosoft's TML_LIB motion libraries. It can be upgraded to the FULL version by entering a **license number** obtained from Technosoft.

12.2. Product Features

- Fully digital servo drive suitable for the control of rotary or linear brushless, DC brush, and step motors
- Very compact design
- **Sinusoidal (FOC)** or **trapezoidal (Hall-based)** control of brushless motors
- **Open or closed-loop** control of 2 and 3-phase steppers
- **STO**: 2 safe torque-off inputs, safety integrity level (SIL3/Cat3/PLe) acc. to EN61800-5-1;-2/ EN61508-3;-4/ EN ISO 13849-1. When left not connected will disable the motor outputs. This provides a dual redundant hardware protection that cannot be overdriven by the software or other hardware components.
- **Technosoft Motion Language (TML)** instruction set for the definition and execution of motion sequences
- Standalone operation with stored motion sequences
- **Motor supply:** 12-80V; **Logic supply:** 9-36V; **STO supply:** 18-40V; **PWM** switching frequency: up to 100kHz.
- **Motor current**
  - **Nominal**[1]: 15A_{RMS} / 21.2A amplitude
  - **Peak**: 28.3A_{RMS} / 40A amplitude
- **Communication**:
  - LV-TTL UART (RS-232 with external transceiver)
  - USB;
  - For CAN executions: CAN-bus 2.0B up to 1Mbit/s (for CAN drives);
  - For CAT executions:
    - EtherCAT® connection to standard RJ45: requires external magnetics (may be integrated into RJ45)
    - EtherCAT® connection between multiple MZ drives: direct 1:1 without any series components
- **Digital and analog I/O's:**
  - 6 x digital inputs, 12-36V, PNP/NPN software selectable: for limit switches or general-purpose, 4 x general-purpose
  - 5 x digital outputs, 5-36V: 0.4A NPN / 0.3A PNP, polarity software selectable: Ready, Error or general-purpose
  - 1 x dedicated motor brake or general-purpose output (OUT0): 2A NPN / 1.5A PNP, polarity software selectable
  - 2 x analogue inputs software selectable: 12-bit 0-5V: Reference, Feedback or general-purpose
- **Thermal Protection**: The internal temperature sensor disables the PWM outputs if the measured temperature exceeds 105°C
- **NTC/PTC** analogue Motor Temperature sensor input
- **Feedback devices (dual-loop support)**

  1st feedback devices supported:
  - **Incremental A / B** (index Z available): differential or single-ended
  - **Analog Sin/Cos** encoder interface (differential 1V_{PP})
  - **Digital Hall** sensor interface (single-ended / open collector)

[1] It is mandatory to mount the iPOS8015 MZ on a metallic support using the provided mounting holes. To achieve the rated current capability, the heat sink temperature must **not exceed 75°C.**

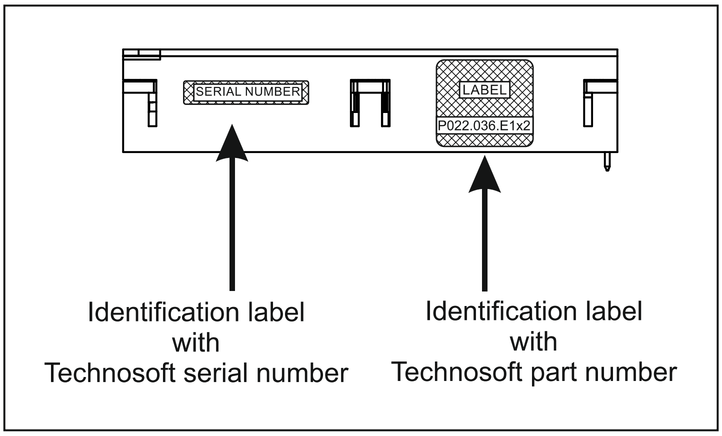
- **Linear Hall** sensors interface (single-ended)

2nd feedback devices supported:

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

- **Pulse & direction** reference (single-ended or differential) capability
- **Various motion programming modes**:
  - Position profiles with trapezoidal or S-curve speed shape
  - Position, Velocity, Time (PVT) 3rd order interpolation
  - Position, Time (PT) 1st order interpolation
  - Electronic gearing and camming
  - 40 Homing modes
  - **CAN version:** position or speed profiles, Cyclic Synchronous Position (CSP), Cyclic Synchronous Velocity (CSV), Cyclic Synchronous Torque (CST) and external reference mode (analogue or encoder feedback) or sent via a communication bus
  - **EtherCAT version:** position or speed profiles, Cyclic Synchronous Position (CSP), Cyclic Synchronous Velocity (CSV) and Cyclic Synchronous Torque (CST)
- **For CAN executions** - two CAN operation modes selectable by HW pin:
  - **CANopen** – conforming with **CiA 301 v4.2, CiA DSP 402 v3.0** and **CiA 305 v.2.2.13**
  - **TMLCAN** – intelligent drive conforming with Technosoft protocol for exchanging TML commands via CAN-bus
- **EtherCAT® supported protocols** for CAT systems:
  - **FoE** – File over EtherCAT – for setup/TML functions and firmware update
  - **EoE** – Ethernet over EtherCAT – for Easy Motion II communication over EtherCAT
  - **CoE –** CAN application protocol over EtherCAT - in conformance with CiA 402 device profile
- **16K** × **16 SRAM** memory for data acquisition
- **24K** × **16 E2ROM** to store TML motion programs, cam tables and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)
- Feature that **detects breakage** of **Hall wires** and/or of **incremental/absolute encoder wires**
- **Protections**:
  - Short-circuit between motor phases
  - Short-circuit from motor phases to ground
  - Over-voltage
  - Under-voltage
  - Over-current
  - Over-temperature
  - Communication error
  - Control error

12.3. Identification Labels



The iPOS8015 MZ can have the following part numbers and names on the identification label:

- p.n. **P022.036.E122** name iPOS8015 MZ-CAT
- p.n. **P022.036.E102** name iPOS8015 MZ-CAN

12.4. Supported Motor-Sensor Configurations

12.4.1. Single loop configurations

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

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

12.4.2. Dual loop configurations

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

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

12.4.3. Compatible products

To facilitate the evaluation of the iPOS8015 MZ drive, dedicated starter kits and standalone versions are available:

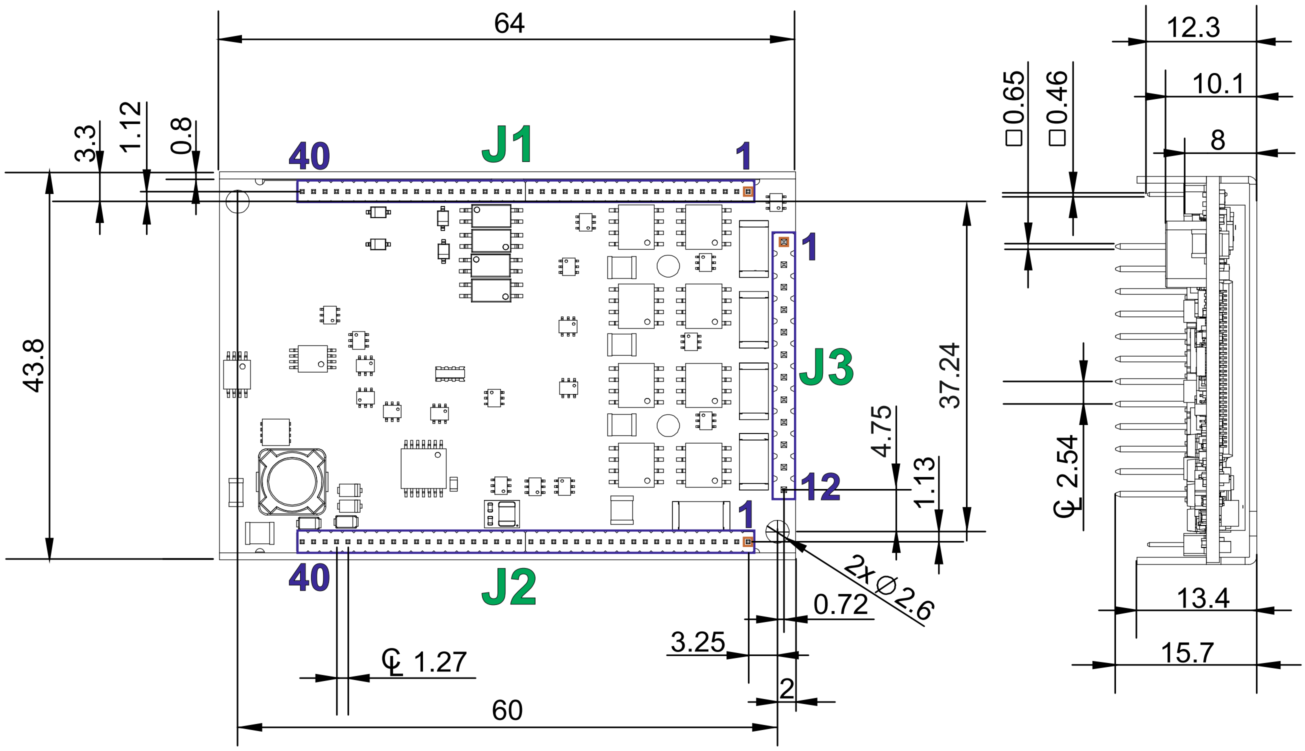
Product Name	Part Number
iPOS8015 XZ-CAT, standalone version	P022.836.E122
iPOS8015 XZ-CAN, standalone version	P022.836.E102
iPOS8015 MZ-CAN starter kit with brushless motor	P022.017.E804
iPOS8015 MZ-CAT starter kit EtherCAT with brushless motor	P022.017.E814
iPOS8015 MZ-CAN starter kit w/o motor	P022.017.E803
iPOS8015 MZ-CAT starter kit EtherCAT w/o motor	P022.017.E813
IPOS8015 I/O board	P022.016.E881

For details on the standalone version, see the 'P091.022.iPOS8015.XZ.UM' User Manual. For starter kits, refer to the 'P091.084.IO-iPOS481x & iPOS801x.UM' User Manual.

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

13. Hardware Installation

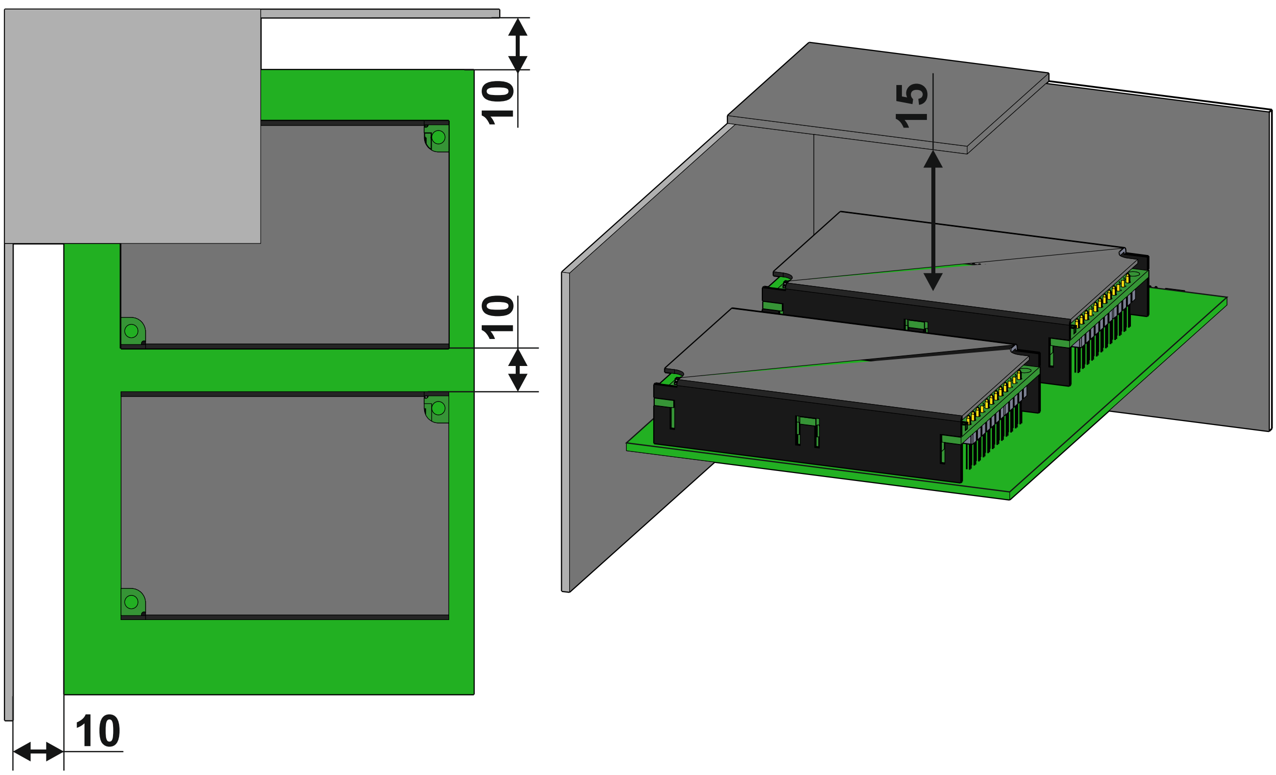
13.1. iPOS8015 MZ-CAN and iPOS8015 MZ-CAT Board Dimensions



All dimensions are in mm. The drawings are not to scale. View with pins facing upward.

13.2. Mechanical Mounting

The iPOS8015 MZ drive is intended to be mounted horizontally on a motherboard equipped with the recommended mating connectors – Chapter "Mating Connectors". It is also possible to directly solder the module into the mainboard.



The figures above shows the minimum spacing to assure proper airflow by natural convection. If closed completely in a box, ventilation openings shall be foreseen on the top and bottom sides. If ventilation driven by natural convection is not enough to maintain the temperature surrounding the drives, then alternate forced cooling methods must be applied.
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 drive inside the limits indicated, the spacing values may be reduced down to zero.
To secure the modules to the mainboard, it is recommended to have the mainboard equipped with 2 self-clinching nut inserts, with internal thread **M2.5**. The inserts will allow to use 2 screws M2.5x10, which will pull the module into the mainboard.
The recommended inserts and screws are:

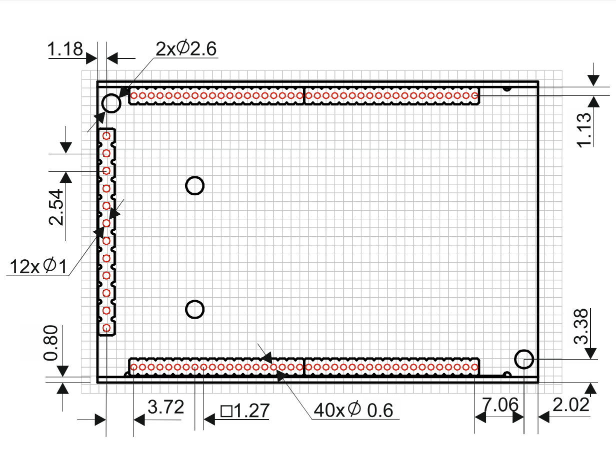
Image	Connector	Description	Manufacturer	Part Number
	-	Self-clinching nuts M2.5	PennEngineering® (PEM®)	KF2-M2.5-ET
	-	Screws M2.5x10	Bossard	BN610-M2.5x10

The fixing holes shall provide a means to pull the iPOS drive against the PCB. For example, use self-clinching nuts pressed onto the PCB on the bottom side. The iPOS drive shall be pressed against the PCB using 2 screws M2.5x10, with **head diameter not larger than 5mm** (such as hexsocket head cap screws, colloquially also called “Inbus”).

The fixing hardware shall be connected to system ground (GND), to improve thermal dissipation and EMC emissions.

13.2.1. PCB design

For **iPOS8015 MZ** motherboard PCB design, use the dimensional drawing:



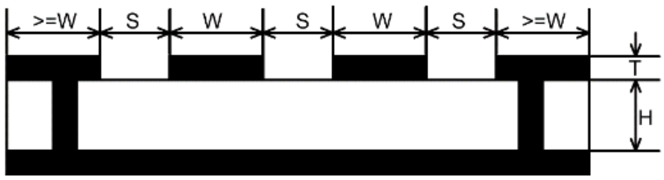
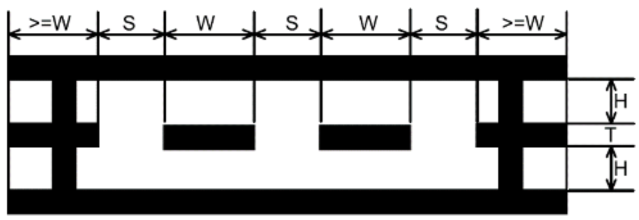
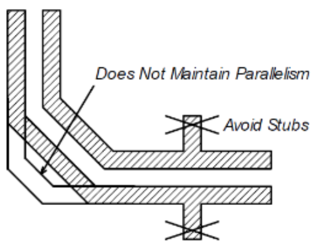
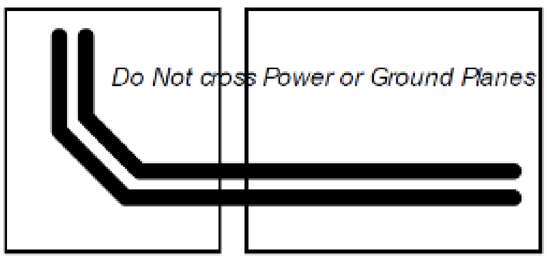
View with pins facing upwards.

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 area; this will maximize current capability. When using simple tracks, use at least 100mil cross section (75mil track width for $1oz/ft^2$ copper thickness).
- Motor supply and ground return tracks between the drive 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} as close as physically possible to the drive, to minimize EM radiated emissions. For un-shielded applications (no metallic box) and typical EMC regulations, the spacing between drive and capacitors must be less than 3 centimeters.
- In multi-axis applications, 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 3 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 drive, 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 drive and it's 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 drive are galvanically connected together on-board (except STO negative return signals). If the motherboard provides an uninterrupted ground plane, it is recommended to connect all GND pins to the ground plane, and use the ground plane to distribute GND wherever needed. If the motherboard does not provide an uninterrupted ground plane, it is best to use each GND pin for its intended purpose. This will create local "star point" ground connection on-board each drive.
- 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 drive, 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+/Sin+, A1-/Sin- ; B1+/Cos+, B1-/Cos- ; Z1+, Z1- ; A2+/DAT2+, A2-/DAT2- ; B2+/CLK2+, B2 /CLK2-; CAN-Hi, CAN-Lo (for CAN version) ; USB Data-, USB Data +.
- When using $+5V_{OUT}$ as supply for external devices (like encoders, Hall sensors, etc.) provide extra filtering and protection: use series resettable (PTC) fuses to add short-circuit protection; use transient absorbers to protect against ESD and over-voltage; add high-frequency filtering to protect against external noise injected on $+5V_{OUT}$.
- The outer box / case / cabinet must be connected to the motherboard ground either galvanically (directly) or through high-frequency decoupling capacitors, rated at an appropriate voltage.

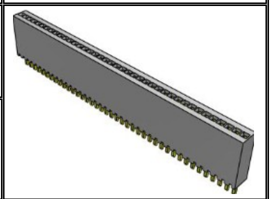
13.2.2. PCB electrical Wiring calculations

Microstrip Differential Impedance	
$Z_{DIFF} = \frac{174}{sqrt(1.41 + E_r)}\left(1 - 0.48e\left(-0.96\frac{S}{H}\right)\right)\ln\left(\frac{5.98H}{0.8W + T}\right)$	W = Width of the trace; H = Height of dielectric above the return plane; T = Trace thickness; S = Space between traces; E_r = Relative permittivity of the dielectric.
 	For Example: $\begin{cases} T = 17.5\ microns \\ H = 175\ microns \\ E_r = 4.8(FR4) \\ W = 8mil \\ S = 7\ mil \end{cases} \rightarrow Z_{DIFF} = 100.6\ \Omega$
Stripline Differential Impedance	
$Z_{DIFF} = \frac{200}{sqrt(E_r)}\left(1 - 0.347e\left(-2.9\frac{S}{H}\right)\right)\ln\left(\frac{1.9(2H + T)}{0.8W + T}\right)$	W = Width of the trace; H = Height of dielectric above the return plane; T = Trace thickness; S = Space between traces; E_r = Relative permittivity of the dielectric.
 	For Example: $\begin{cases} T = 17.5\ microns \\ H = 175\ microns \\ E_r = 4.8(FR4) \\ W = 4mil \\ S = 4\ mil \end{cases} \rightarrow Z_{DIFF} = 100.2\ \Omega$
  	

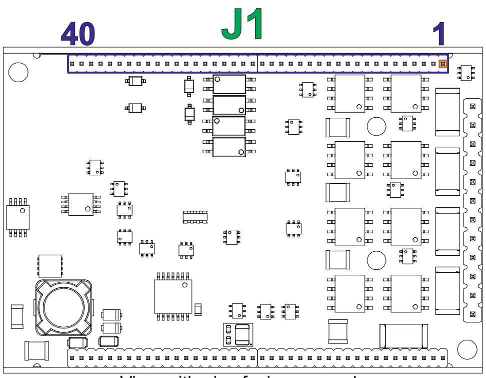
13.2.3. EtherCAT routing calculations

- High-speed signals (Tx/Rx 0/1 +/-) must be routed as differential pairs, with controlled impedance, microstrip or stripline.
- Microstrip and stripline pairs shall be guarded on the same layer as the differential pair, with outer traces connected to the return plane by vias. The guarding traces shall form preferably a closed ring, wherever possible.
- Use above formulae (or other method) to calculate microstrip or stripline differential impedance
- Avoid stubs, crossovers and vias on high-speed signals. Vias present impedance discontinuities and should be avoided. Route an entire differential pair trace on a single layer if possible.
- High-speed signals should not be run such that they cross a plane split. A signal crossing a plane split may cause unpredictable return path currents and would likely impact signal quality, also potentially creating EMI problems.
- The center tap of the magnetics isolated winding has a "Bob Smith" termination to chassis ground. "Bob Smith" termination is used to reduce noise resulting from common-mode current flows, as well as reduce susceptibility to any noise from unused wire pairs on the RJ45.
- "Bob Smith" termination is different depending on Power Over Ethernet (PoE) compliance. PoE carries up to 57V between pairs, which would destroy the 75ohm terminating resistors if DC blocking capacitors of 10nF are not in place.
- Capacitor 1nF 2KV must sustain 1.5KVrms for 1 minute as per IEEE802.3. The 1Meg discharge resistor may be destroyed during this hi-pot testing.
- For enhanced EMC immunity it is possible to add surge protectors on the high-speed signals, on the isolated side of the magnetics (not across pins, there is DC current flowing through windings). Check that signals are not affected by the added parasitic capacitance.
- Use magnetics with integrated common-mode choking devices. Use magnetics compatible with Auto MDI/MDI-X (with symmetrical windings). Use metal shielded connectors, and connect the shield to device chassis / PE.
- Do not run any signals under the magnetics - this could cause unwanted noise crosstalk. Likewise void the planes under magnetics, this will help prevent common-mode noise coupling.
- To save board space and reduce component count, RJ45 connectors with integrated magnetics may be used. Check the PoE compliance where applicable.

13.2.4. Mating connectors

<table>
<tr><th>Connector</th><th>Producer</th><th>Component</th><th>Part number</th><th>Diagram</th></tr>
<tr><td rowspan="3">J1, J2</td><td>Harwin</td><td>1x20 contacts, socket 1.27mm-pitch; 4 pcs needed for one drive.</td><td>M52-5012045</td><td></td></tr>
<tr><td rowspan="2">Samtec</td><td rowspan="2">1x40 contacts, socket 1.27mm-pitch; 2 pcs needed for one drive.</td><td>SMS-140-01-L-S</td><td rowspan="2"></td></tr>
<tr><td>SMS-140-01-G-S</td></tr>
<tr><td rowspan="2">J3</td><td rowspan="2">Mill-Max</td><td>1x12 contacts, High-current socket 2.54mm-pitch accepting 0.635mm square pin; 1 pc is needed for one drive; the current should not exceed 12.7A.</td><td>801-47-012-10-001000</td><td></td></tr>
<tr><td colspan="2">When J3 is plugged into the connector, maximum current should not exceed 12.7A Sine amplitude.</td><td rowspan="3"></td></tr>
<tr><td colspan="4">The pins can be also directly soldered onto a motherboard for increased current capability.</td></tr>
<tr><td colspan="4">When J3 is soldered directly onto a motherboard, the maximum current can exceed 13A Sine amplitude.</td></tr>
</table>

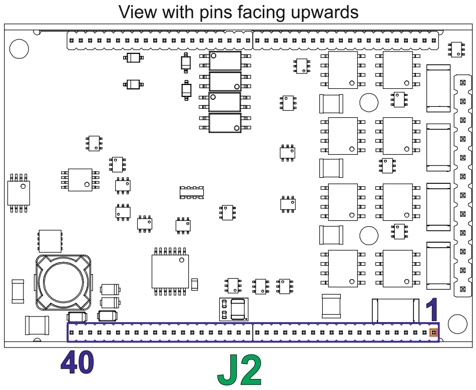
13.3. Connectors and Pinouts for iPOS8015 MZ



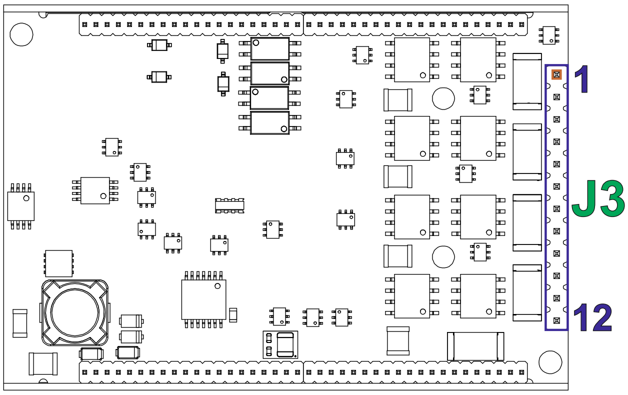
View with pins facing upwards

<table>
<tr><th rowspan="42">J1</th><th>Pin</th><th>Name</th><th colspan="3">Description</th></tr>
<tr><td>1</td><td>Temp Mot</td><td colspan="3">NTC/PTC 3.3V input. Used to read an analog temperature value.</td></tr>
<tr><td>2</td><td>TTL TX</td><td colspan="3">Low voltage TTL serial data transmission (0…3.3V)</td></tr>
<tr><td>3</td><td>TTL RX</td><td colspan="3">Low voltage TTL serial data reception (0…3.3V)</td></tr>
<tr><td>4</td><td>USB Data-</td><td colspan="3">USB Data negative.</td></tr>
<tr><td>5</td><td>USB Data+</td><td colspan="3">USB Data positive.</td></tr>
<tr><td>6</td><td>USB V+</td><td colspan="3">USB +5V input.</td></tr>
<tr><td>7</td><td>P1 LED</td><td colspan="2">ECAT OUT port LED.</td><td rowspan="2">Reserved for CAN version.</td></tr>
<tr><td>8</td><td>P0 LED</td><td colspan="2">ECAT IN port LED.</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">AxisID Bit7</td><td>CAN Drives</td><td colspan="2">CAT Drives</td></tr>
<tr><td>TMLCAN protocol, if pin is left unconnected.
CANopen protocol, if pin is connected to GND.</td><td colspan="2" rowspan="8">8-bit H/W Axis ID register
Pin 16 is Bit 0... Pin 9 is Bit 7 of the Axis value.
AxisID Register
MSB — LSB
Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0
9 | 10 | 11 | 12 | 13 | 14 | 15 | 16
J1
• Bit = 0, if pin is left unconnected.
• Bit = 1, if pin is connected to GND.
AxisID values: from 1 to 255. AxisID = 255 also when all pins are left unconnected.
In EtherCAT, when Axis ID is 255, the register called “configured station alias” will be 0.</td></tr>
<tr><td>10</td><td>AxisID Bit6</td><td rowspan="7">7-bit H/W Axis ID register
Pin 16 is Bit 0... Pin 10 is Bit 6 of the Axis value.
AxisID Register
MSB — LSB
Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0
10 | 11 | 12 | 13 | 14 | 15 | 16
J1
• Bit = 0, if pin is left unconnected.
• Bit = 1, if pin is connected to GND.
AxisID values: from 1 to 127 and 255 when all pins are left unconnected.
In CANopen, when Axis ID is 255 the drive will be in LSS inactive state.</td></tr>
<tr><td>11</td><td>AxisID Bit5</td></tr>
<tr><td>12</td><td>AxisID Bit4</td></tr>
<tr><td>13</td><td>AxisID Bit3</td></tr>
<tr><td>14</td><td>AxisID Bit2</td></tr>
<tr><td>15</td><td>AxisID Bit1</td></tr>
<tr><td>16</td><td>AxisID Bit0</td></tr>
<tr><td>17</td><td>RUN</td><td colspan="2">Anode of Run LED (EtherCAT status machine).</td><td rowspan="2">Reserved for CAN version.</td></tr>
<tr><td>18</td><td>ERR</td><td colspan="2">Anode of Error LED (EtherCAT status machine).</td></tr>
<tr><td>19…23</td><td>Reserved</td><td colspan="3">Reserved. Do not use</td></tr>
<tr><td>24</td><td>CT1_Rx</td><td colspan="2">Connect to center tap of OUT port magnetics PHY Rx.</td><td rowspan="12">Reserved for CAN version.</td></tr>
<tr><td>25</td><td>RX1-</td><td colspan="2">Receive/Transmit negative, OUT port. Connect to magnetics PHY RX1.</td></tr>
<tr><td>26</td><td>RX1+</td><td colspan="2">Receive/Transmit positive, OUT port. Connect to magnetics PHY RX1.</td></tr>
<tr><td>27</td><td>TX1-</td><td colspan="2">Transmit/Receive negative, OUT port. Connect to magnetics PHY TX1.</td></tr>
<tr><td>28</td><td>TX1+</td><td colspan="2">Transmit/Receive positive, OUT port. Connect to magnetics PHY TX1.</td></tr>
<tr><td>29</td><td>CT1_Tx</td><td colspan="2">Connect to center tap of OUT port magnetics PHY Tx.</td></tr>
<tr><td>30</td><td>CT0_Rx</td><td colspan="2">Connect to center tap of IN port magnetics PHY Rx.</td></tr>
<tr><td>31</td><td>RX0-</td><td colspan="2">Receive/Transmit negative, IN port. Connect to magnetics PHY RX0.</td></tr>
<tr><td>32</td><td>RX0+</td><td colspan="2">Receive/Transmit positive, IN port. Connect to magnetics PHY RX0.</td></tr>
<tr><td>33</td><td>TX0-</td><td colspan="2">Transmit/Receive negative, IN port. Connect to magnetics PHY TX0.</td></tr>
<tr><td>34</td><td>TX0+</td><td colspan="2">Transmit/Receive positive, IN port. Connect to magnetics PHY TX0.</td></tr>
<tr><td>35</td><td>CT0_Tx</td><td colspan="2">Connect to center tap of IN port magnetics PHY Tx.</td></tr>
<tr><td>36</td><td>GND</td><td colspan="3">Return ground. Internally connected to all GND signals except STO GND.</td></tr>
<tr><td>37</td><td>STO2-</td><td colspan="2">Safe Torque Off input 2, negative return (opto-isolated, 0V).</td><td rowspan="4">Apply minimum 18V DC from SELV/ PELV power supply to enable PWM operation.</td></tr>
<tr><td>38</td><td>STO2+</td><td colspan="2">Safe Torque Off input 2, positive input (opto-isolated, 18÷40V).</td></tr>
<tr><td>39</td><td>STO1-</td><td colspan="2">Safe Torque Off input 1, negative return (opto-isolated, 0V).</td></tr>
<tr><td>40</td><td>STO1+</td><td colspan="2">Safe Torque Off input 1, positive input (opto-isolated, 18÷40V).</td></tr>
</table>

View with pins facing upwards



	Pin	Name	Description	
J2	1	**LH1**	Linear Hall 1 input.	
	2	**LH2**	Linear Hall 2 input.	
	3	**LH3**	Linear Hall 3 input.	
	4	**FDBK**	Analogue input, 12-bit, 0-5V. Reads an analogue feedback (tacho), or general purpose.	
	5	**REF**	Analogue input, 12-bit, 0-5V. Reads analog reference, or general-purpose analogue input.	
	6	**Hall 3**	Digital input Hall 3 sensor.	
	7	**Hall 2**	Digital input Hall 2 sensor.	
	8	**Hall 1**	Digital input Hall 1 sensor.	
	9	**GND**	Return ground. Internally connected to all GND signals except STO GND.	
	10	**IN5**	12-36V general-purpose digital PNP/NPN input.	
	11	**IN4**	12-36V general-purpose digital PNP/NPN input.	
	12	**IN1**	12-36V general-purpose digital PNP/NPN input.	
	13	**IN0**	12-36V general-purpose digital PNP/NPN input.	
	14	**IN2/LSP**	12-36V digital PNP/NPN input. Positive limit switch input.	
	15	**IN3/LSN**	12-36V digital PNP/NPN input. Negative limit switch input.	
	16	**OUT3**	5-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable	
	17	**OUT2**	5-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable	
	18	**OUT5**	5-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable	
	19	**OUT4**	5-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable	
	20	**OUT1**	5-36V general-purpose digital output, 0.3A PNP/ 0.4A NPN, software selectable	
	21	**OUT0**	5-36V general-purpose digital output, 1.5A PNP/ 2A NPN, software selectable	
	22	**Z1+**	Incr. encoder1 Z single-ended, or Z+ diff. input.	
	23	**Z1-**	Incr. encoder1 Z- diff. input .	
	24	**B1+/Cos+**	Incr. encoder1 B single-ended, or B+ diff. input, or analogue encoder Cos+ diff. input.	
	25	**B1-/Cos-**	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input.	
	26	**A1+/Sin+**	Incr. encoder1 A single-ended, or A+ diff. input, or analogue encoder Sin+ diff. input.	
	27	**A1- /Sin-**	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input.	
	28	**Z2+**	Incr. encoder2 Z+ diff. input.	An 120Ω resistor is present between pins 28 and 29.
	29	**Z2-**	Incr. encoder2 Z- diff. input.	
	30	**B2-/Dir-/ CLK-/MA-**	Incr. encoder2 B- diff. input, or Dir--, or Clock- for SSI, or Master- for BiSS.	An 120Ω resistor is present between pins 30 and 31.
	31	**B2+/Dir+/ CLK+/MA+**	Incr. encoder2 B+ diff. input, or Dir+-, or Clock+ for SSI, or Master+ for BiSS.	
	32	**A2+/Pulse+/ Data+/SL+**	Incr. encoder2 A+ diff. input, or Pulse+, or Data+ for SSI, or Slave+ for BiSS.	An 120Ω resistor is present between pins 32 and 33.
	33	**A2- /Pulse-/ Data-/SL-**	Incr. encoder2 A- diff. input, or Pulse-, or Data- for SSI, or Slave- for BiSS.	
	34	**CAN-Lo**	CAN negative line.	Reserved for CAT version.
	35	**CAN-Hi**	CAN positive line.	
	36	**Reserved**	Reserved. Do not use.	
	37	**Reserved**		
	38	**$+5V_{OUT}$**	5V output supply for I/O usage.	
	39	**$-V_{LOG}$**	Negative terminal of the logic supply input: 9 to 36VDC from SELV/ PELV type power supply.	
	40	**$+V_{LOG}$**	Positive terminal of the logic supply input: 9 to 36VDC from SELV/ PELV type power supply.	



View with pins facing upwards

J3	Pin	Name	Description
	1, 2	GND	Return ground for motor. Internally connected to all GND signals except STO GND.
	3, 4	Cr/B-	Chopping resistor / Phase B- for 2-ph steppers.
	5, 6	C/B+	Phase C for 3-ph motors, B+ for 2-ph steppers.
	7, 8	B/A-	Phase B for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors.
	9, 10	A/A+	Phase A for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors.
	11, 12	$+V_{MOT}$	Positive terminal of the motor supply: 12 to $80V_{DC}$.

13.4. Connection diagrams

13.4.1. iPOS8015 MZ-CAT connection diagram

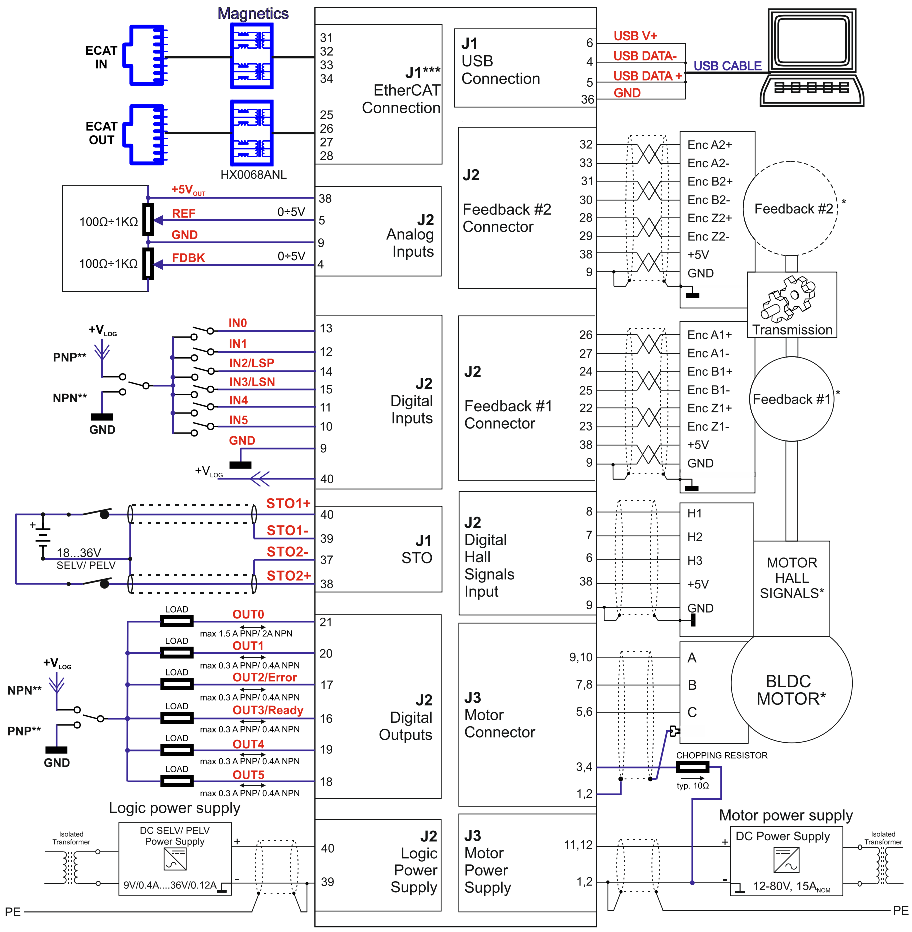


Figure 13.1. **iPOS8015 MZ-CAT Connection diagram**

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

** The PNP/NPN connection is configured by software

*** For a detailed EtherCAT bus connection diagram check the EtherCAT connection (for CAT drives) chapter.

13.4.2. iPOS8015 MZ-CAN connection diagram

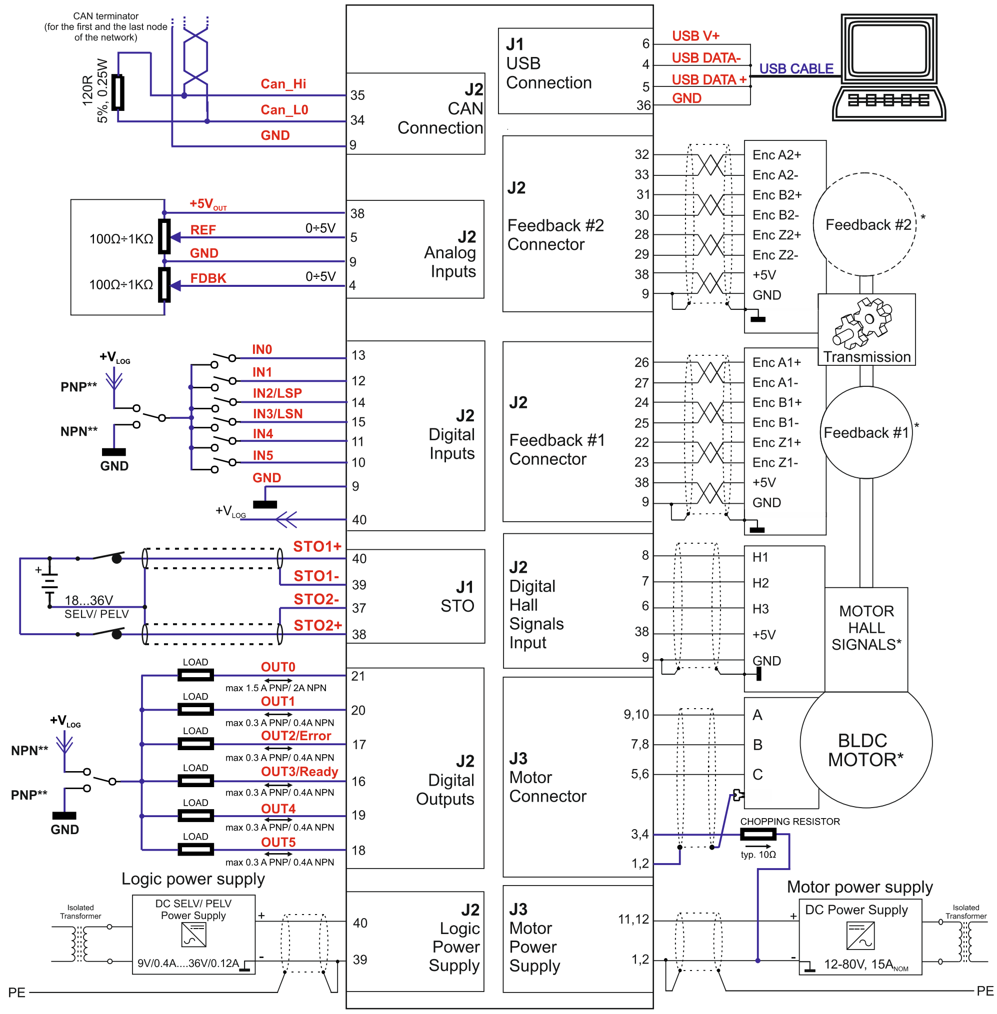


Figure 13.2. **iPOS8015 MZ-CAN Connection diagram**

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

** The PNP/NPN connection is configured by software

13.5. Digital I/O Connection

13.5.1. PNP inputs

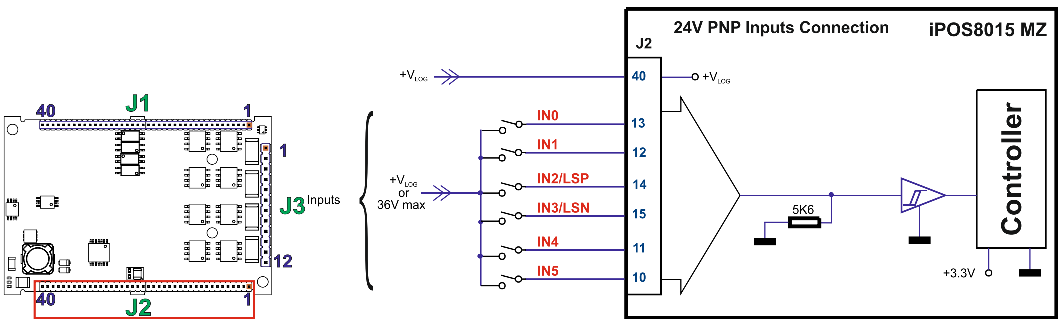


Figure 13.3. **24V Digital PNP Inputs connection**

Remarks:

1. *The inputs are selectable as PNP/ NPN by software.*
2. *The inputs are compatible with PNP type outputs (input must receive a positive voltage value (12-36V) to change its default state)*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surge in industrial environment.*

13.5.2. NPN inputs

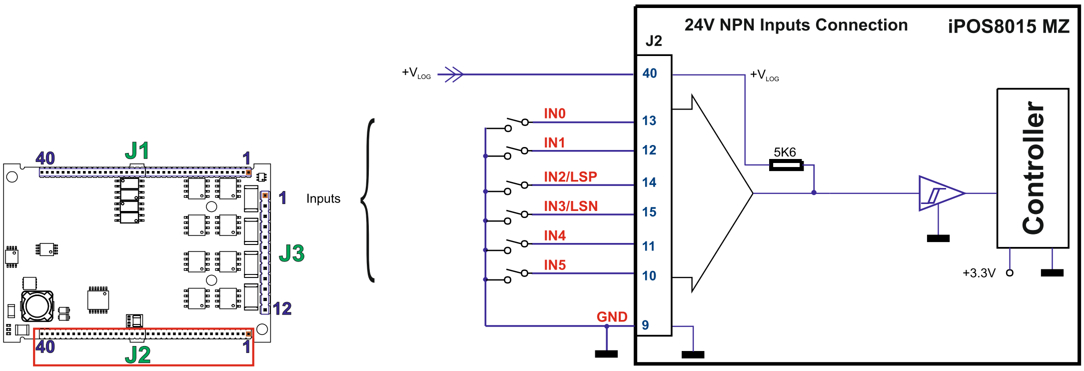


Figure 13.4. **24V Digital NPN Inputs connection**

Remarks:

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

13.5.3. PNP outputs

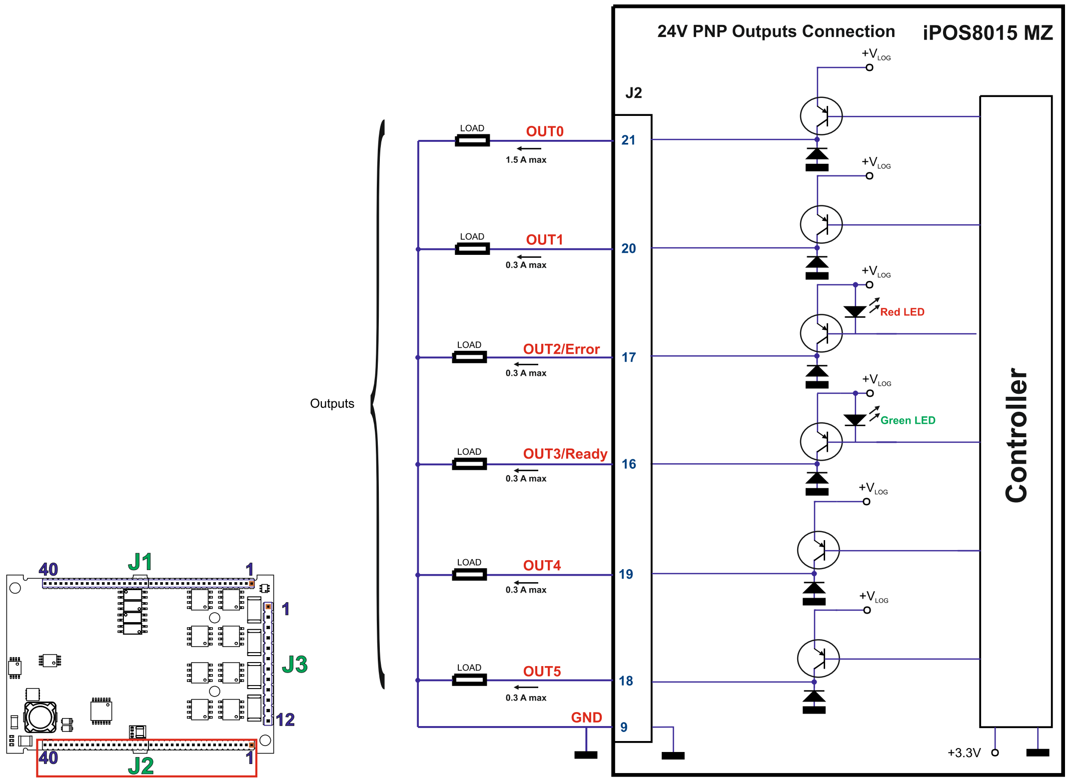


Figure 13.5. **24V Digital PNP Outputs connection**

Remarks:

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

13.5.4. NPN outputs

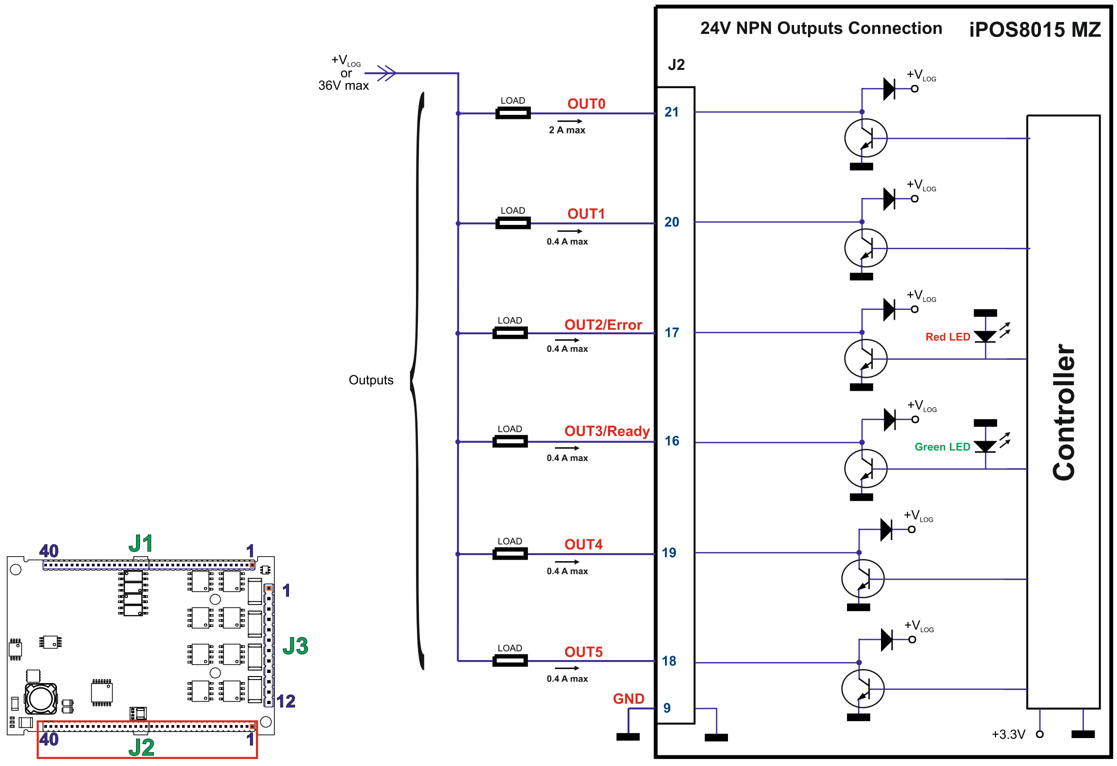


Figure 13.6. **24V Digital NPN Outputs connection**

Remarks:

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

13.5.5. Temperature sensor (Temp Mot)

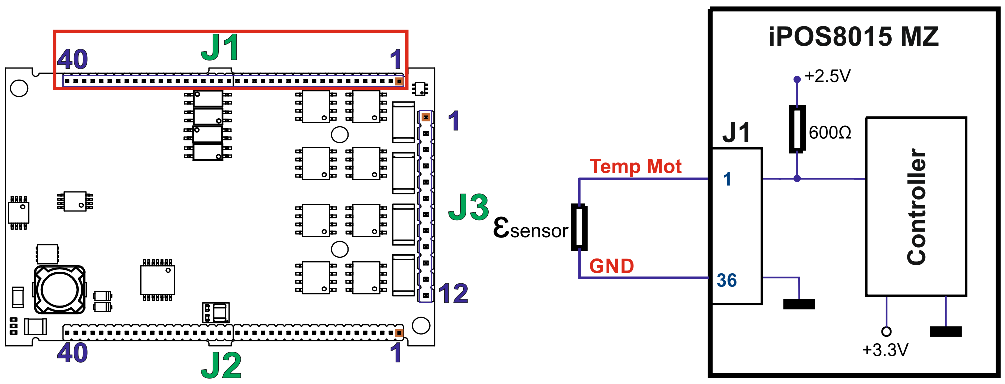


Figure 13.7. ***Temperature sensor connection***

Remarks:

1. *The temperature sensor can be either NTC or PTC (software selectable).*
2. *Using the internal resistor, the divider will create a voltage which is temperature-dependent. The voltage is read using an 12-bit ADC (analog-to-digital converter) with input range 0V … +3.3V.*
3. *The numerical result (AD8) is the following:*

$$AD8[0IU \dots 65520IU] = 65520 * Input\ Voltage[0V \dots 3.3V]/3.3V$$

$$InputVoltage[0V \dots 3.3V] = 2.5V * \mathcal{E}_{sensor} \ / \ (\mathcal{E}_{sensor} + 600\Omega)$$

4. *When the temperature protection is activated, the threshold is internally set to +1.65V.*

13.5.6. Analog Inputs Connection

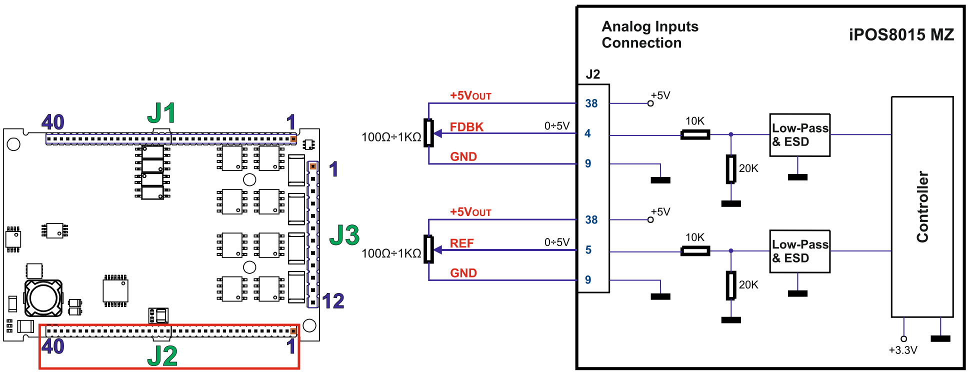


Figure 13.8. ***0-5V* Analog inputs connection**

Remarks:

1. *Default input range for analog inputs is 0÷5 V for REF and FDBK analogue input but an external circuit can be added to modify the range to ±10V .*
2. *Switching between the REF and FDBK signals can be configured through the Inputs/Outputs section within the Setup module of EasyMotion Studio II.*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

13.5.6.1. +/- 10V to 0-5V Input Range Adapter

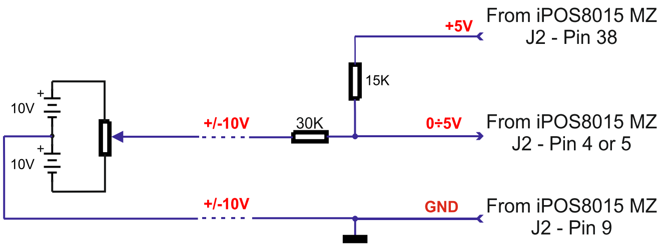


Figure 13.9. **+/-10V to 0-5V adapter**

Equivalent input impedance is 40Kohm. Floating input voltage is 3.28V. For best TML conversion, use the following parameters: RFOFSSET=0xFE90 (-368); RFGAIN=0x89FC (35324 / 1.078036) in your project file.
The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.

13.5.6.2. Recommendation for wiring

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

13.5.7. Solenoid driver connection for motor brake

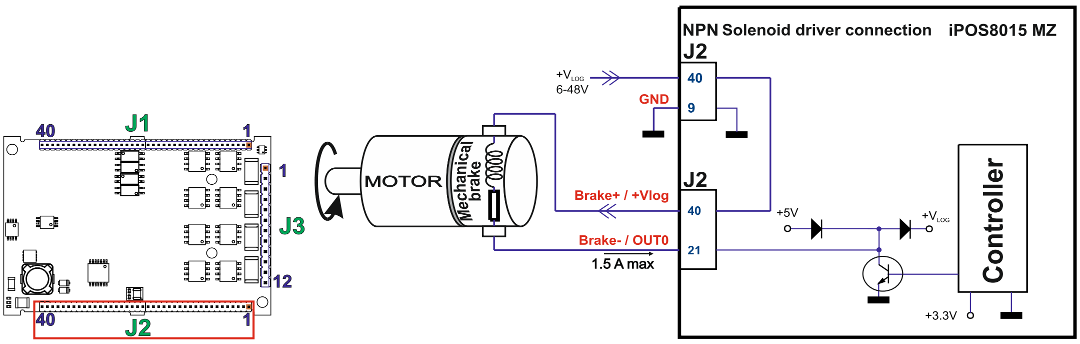


Figure 10 **Solenoid driver connection**

Remarks:

1. *The firmware can control the OUT0 output automatically to engage/disengage a mechanical brake when motor control is started/stopped.*
2. *To enable the mechanical brake functionality select the following checkbox from EasyMotion Studio II:*

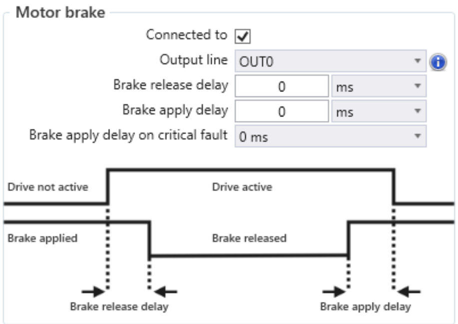


Figure 11 **Motor brake checkbox in EasyMotion Studio II**

13.6. Motor connections

13.6.1. Brushless Motor connection

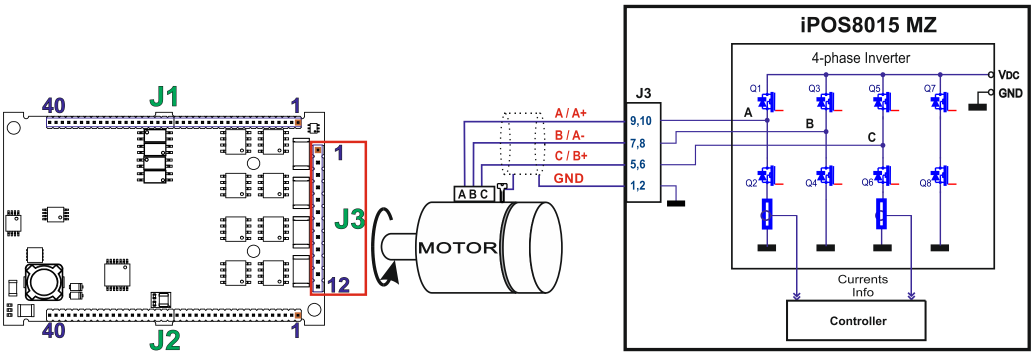


Figure 13.12. **Brushless motor connection**

13.6.2. 2-phase Step Motor connection

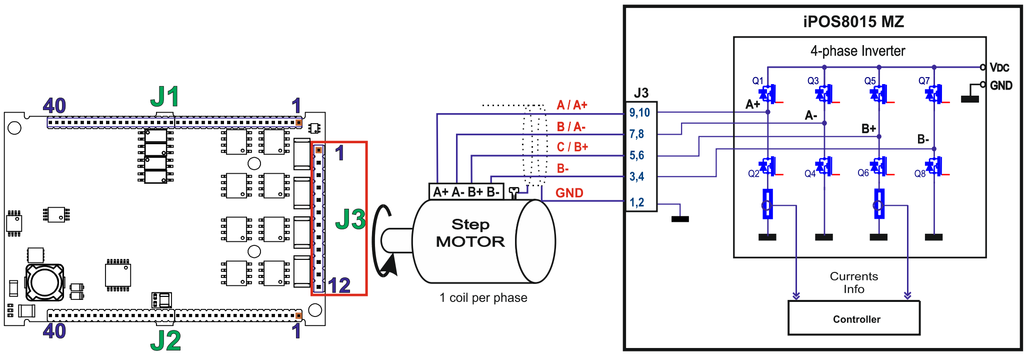


Figure 13.13. **2-phase step motor connection, one coil per phase**

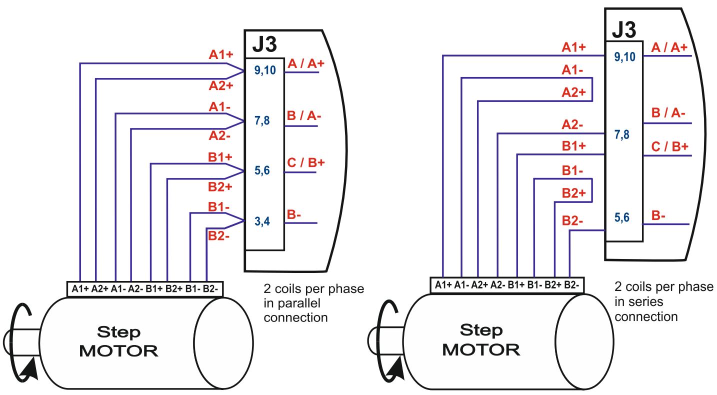


Figure 13.14. **2-phase step motor connection, two coils per phase**

13.6.3. 3-Phase Step Motor connection

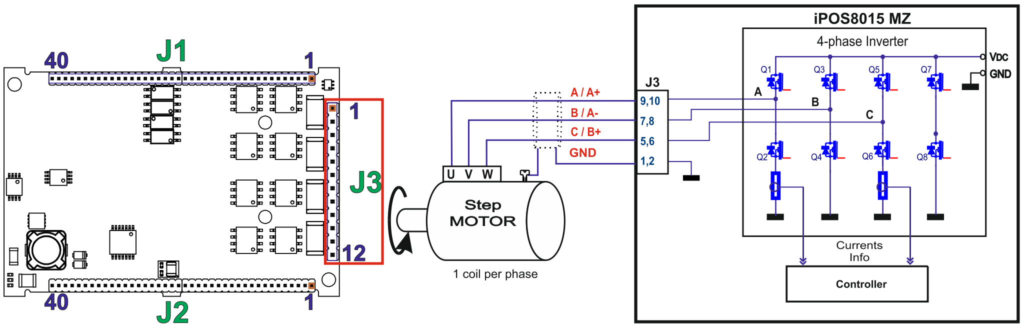


Figure 13.15. **3-phase step motor connection**

13.6.4. DC Motor connection

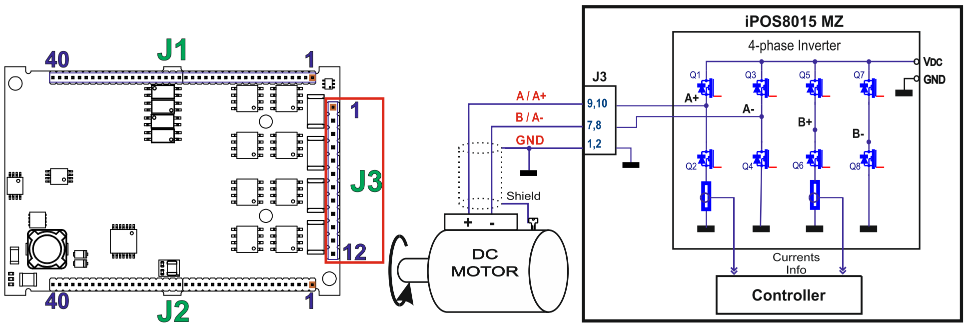


Figure 13.16. **DC Motor connection**

13.6.4.1. Recommendations for motor wiring

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

b) The parasitic capacitance between the motor wires must not bypass 10nF. If very long cables (tens of meters) are used, this condition may not be met. In this case, add series inductors between the iPOS8015 outputs and the cable. The inductors must be magnetically shielded (toroidal, for example), and must be rated for the motor surge current. Typically the necessary values are around 100 μH.

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

13.7. Feedback connections

13.7.1. Feedback #1 – Single-ended Encoder Connection

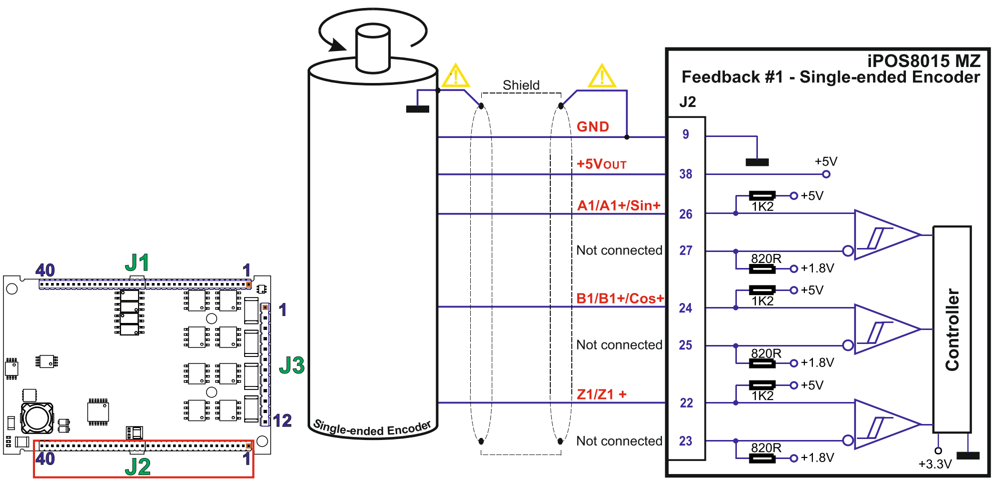


Figure 13.17. **Single-ended incremental encoder connection**

CAUTION!	***Do not connect unterminated wires to pins J2.27, J2.25 and J2.23. They might pick up unwanted noise and give false encoder readings. Encoder cable shield must be connected to system GND to avoid disturbances / noise induced by nearby cables.***

13.7.2. Feedback #1 – Differential Encoder Connection

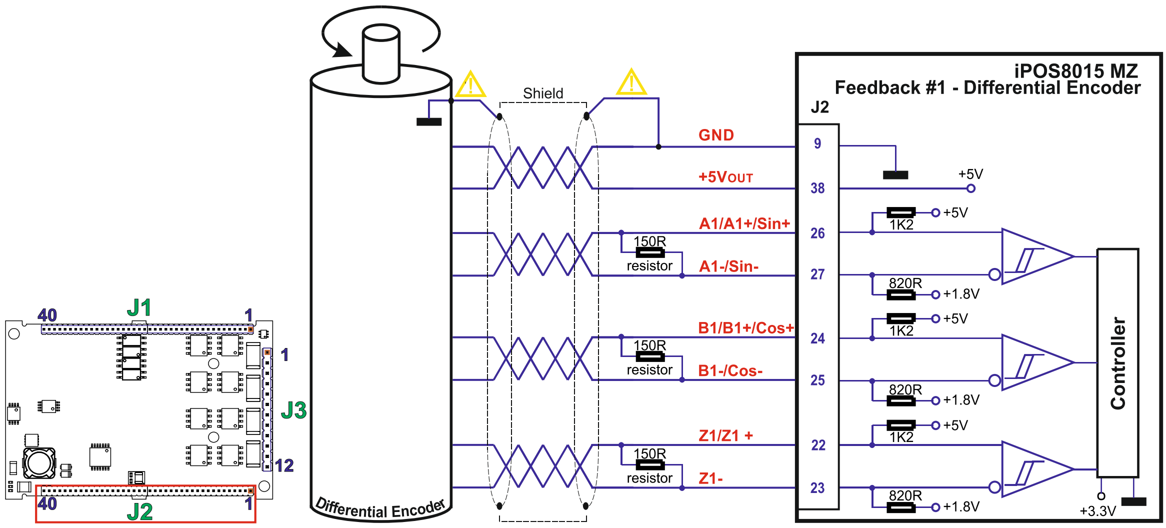


Figure 13.18. **Differential incremental encoder #1 connection**

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

Remarks:

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

13.7.3. Feedback #2 – Differential Encoder Connection

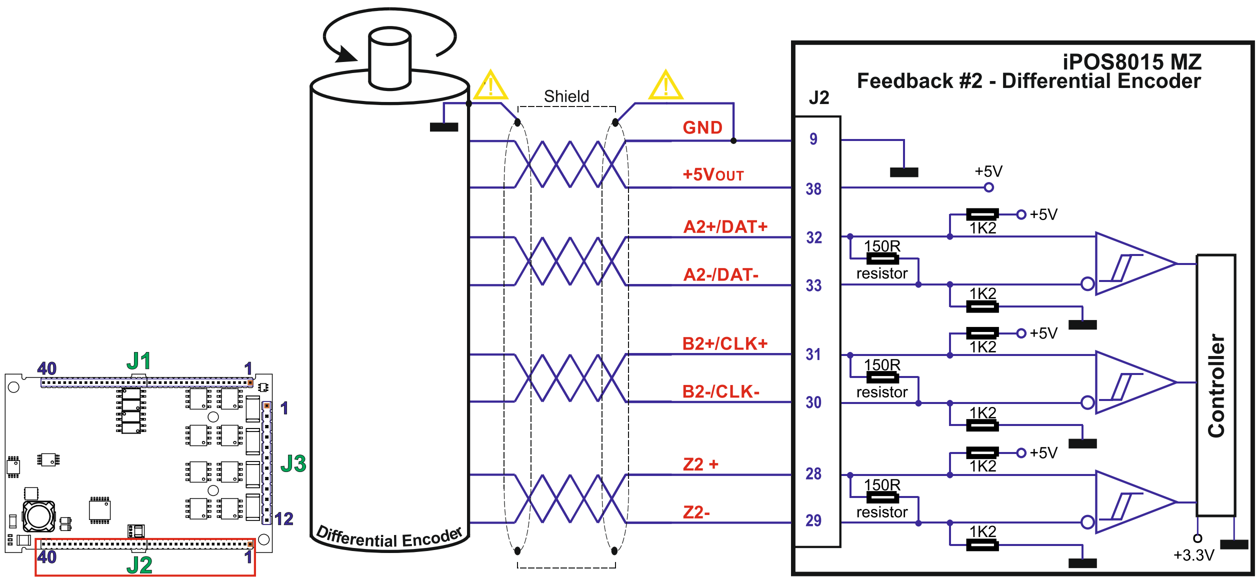


Figure 13.19. **Differential incremental encoder #2 connection**

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

Remarks:

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

13.7.4. Feedback #2 – Sine-Cosine Encoder Connection

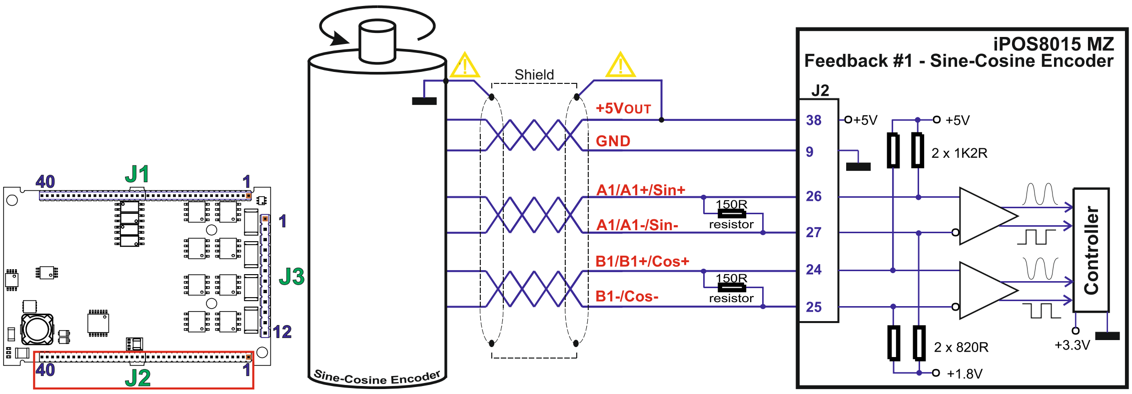


Figure 13.20. **Sine-Cosine analogue encoder connection**

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

Remarks:

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

13.7.5. Feedback #2 – Absolute Encoder Connection: SSI, BiSS, EnDAT

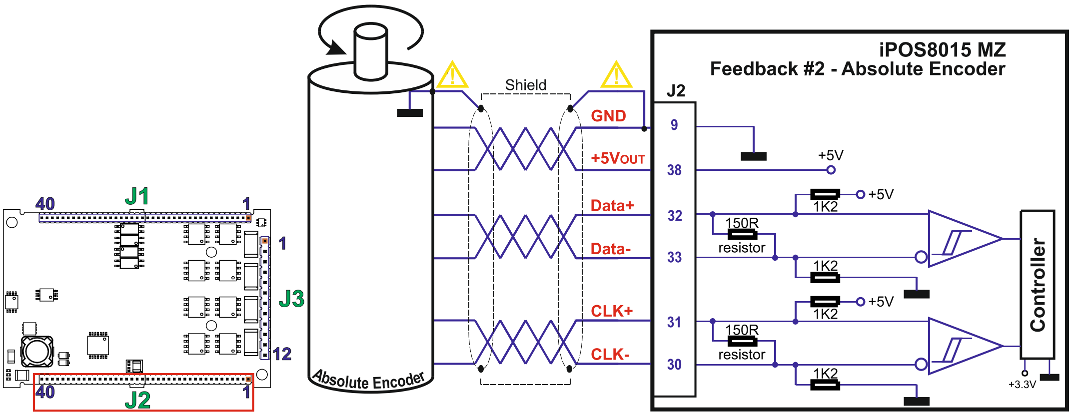


Figure 13.21. **Feedback #2 – Absolute Encoder Connection: SSI, BiSS, EnDAT**

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

Remarks:

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

13.7.6. Feedback #2 – Absolute Encoder Connection: Panasonic, Tamagawa, Nikon, Sanyo Denki

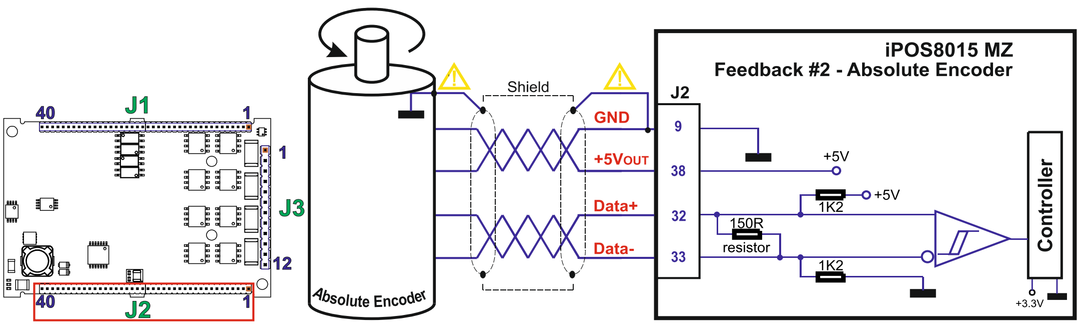


Figure 13.22. **Feedback #2 – Absolute Encoder Connection: Panasonic, Tamagawa, Nikon, Sanyo Denki**

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

Remarks:

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

13.7.7. Linear Hall Connection

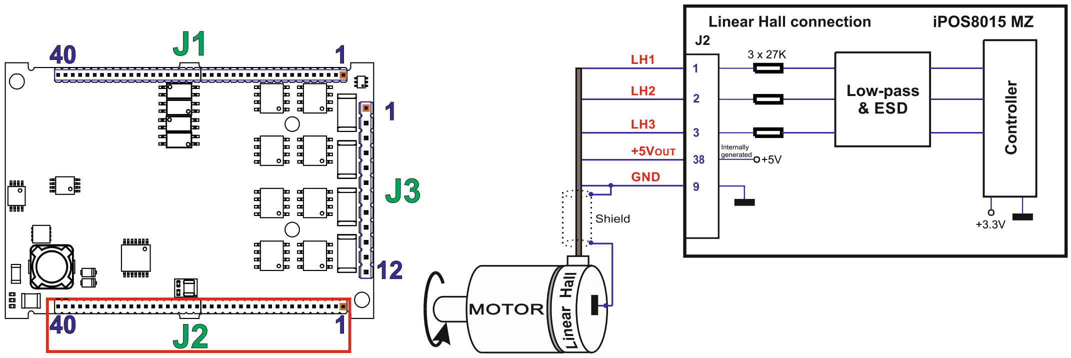


Figure 13.23. **Linear Hall connection**

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

13.7.8. Digital Hall Connection for Motor + Hall + Incremental Encoder

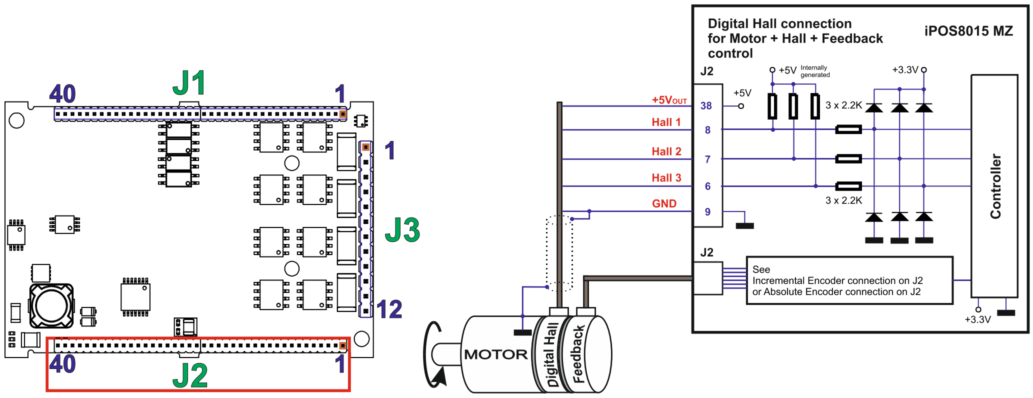


Figure 13.24. **Digital Hall connection**

Remarks:

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

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

13.7.9. Digital Hall Connection for direct motor control without an encoder

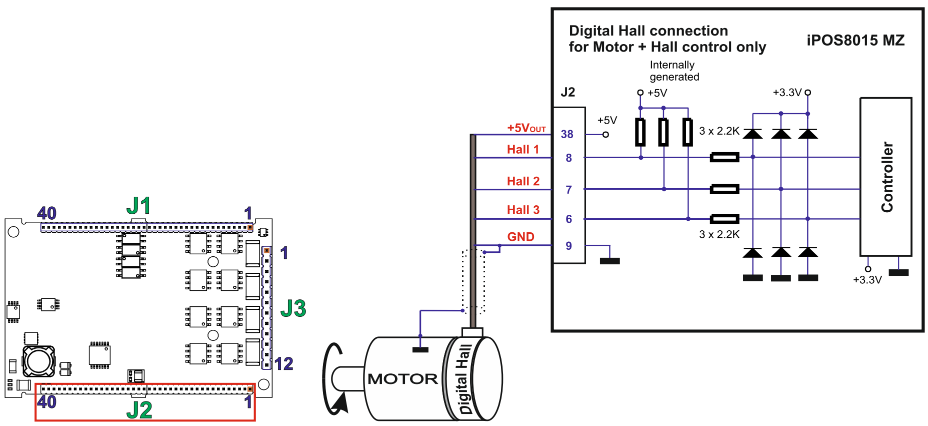


Figure 13.25. **Digital Hall connection**

Remarks:

1. *This connection is required when using only Digital hall signals as the main feedback device for motor control. In this case, no incremental encoder is needed.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

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

13.7.10. General recommendations for feedback wiring

a) Always connect both positive and negative signals when the position sensor is differential and provides them. Use one twisted pair for each differential group of signals as follows: A+/Sin+ with A-/Sin-, B+/Cos+ with B-/Cos-, Z+ with Z-. Use another twisted pair for the 5V supply and GND.
b) Always use shielded cables to avoid capacitive-coupled noise when using single-ended encoders or Hall sensors with cable lengths over 1 meter. Connect the cable shield to the GND, at both ends.
c) If the iPOS8015 5V supply output is used by another device (like for example an encoder) and the connection cable is longer than 5 meters, add a decoupling capacitor near the supplied device, between the +5V and GND lines. The capacitor value can be 1...10 µF, rated at 6.3V.

13.8. Power Supply and STO Connection

13.8.1. Supply Connection

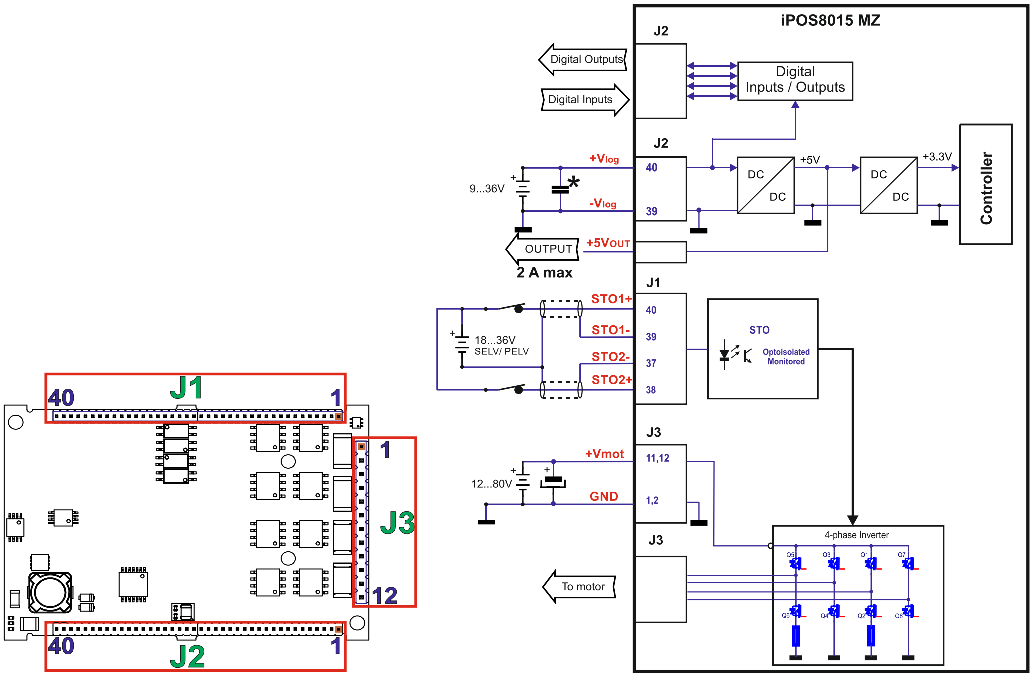


Figure 13.26. **Supply connection**

***Remarks**:*

1. The iPOS8015 MZ requires three supply voltages: V_{LOG}, V_{MOT} and STO.
2. The STO circuit must be supplied with minimum 18V to enable PWM output.
3. The STO and $+V_{log}$ inputs can be supplied from the same power source as long as its output voltage is 18 to 36V DC from a SELV/ PELV power supply.
4. An external electrolytic capacitor may be added between $+V_{mot}$ and GND, to help reduce over-voltage during load braking/ reversals.

13.8.2. Recommendations for Supply Wiring

a) Use short, thick wires between the iPOS8015 and the motor power supply. Connect power supply wires to all the indicated pins. If the wires are longer than 2 meters, use twisted wires for the supply and ground return. For wires longer than 20 meters, add a capacitor of at least 4,700µF (rated at an appropriate voltage) right on the terminals of the iPOS8015.
b) It is recommended to connect the negative motor supply return (GND) to the Earth protection near the power supply terminals.
c) The logic and motor power supply cables shield must be connected to GND at both ends.

13.8.3. Recommendations to limit over-voltage during braking

During abrupt motion brakes or reversals the regenerative energy is injected into the motor power supply. This may cause an increase of the motor supply voltage (depending on the power supply characteristics). If the voltage bypasses **84V**, the drive over-voltage protection is triggered and the drive power stage is disabled. In order to avoid this situation you have 2 options:

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

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

where:

U_{MAX} = 84V is the over-voltage protection limit

U_{NOM} is the nominal motor supply voltage

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

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

where:

J_M – total rotor inertia [kgm²]

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

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

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

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

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

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

h_{final} – final system altitude [m]

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

R_{Ph} – motor phase resistance [Ω]

t_d – time to decelerate [s]

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

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

2. Connect a chopping resistor R_{CR}

2.1. To the BC90100 BX module:

Codified as P038.100.E201, the brake chopper module is compatible with all Technosoft Intelligent Drives and supports currents **up to 100 A**[1]. The module must be connected to one of the drive's digital outputs. When the U_{CHOP} voltage threshold (configured in the Setup branch of EasyMotion II) is exceeded, the output is activated, triggering the BC90100 BX module. This action connects the chopping resistor directly across the DC bus, allowing excess regenerative energy to be safely dissipated.

This option allows dynamic braking without using the **CR / B-** phase, making it suitable for step motor applications.

2.1.1. Access the module datasheet, along with guidelines for selecting and sizing the chopping resistor and any additional heatsink required for the BC90100 BX braking module, by clicking here ➡ More information.

2.2. Between phase CR / B- and ground:

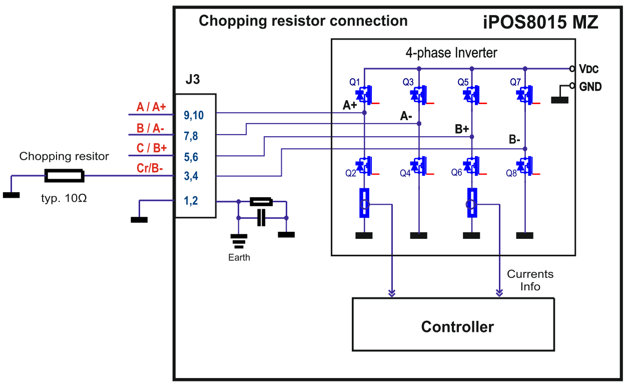
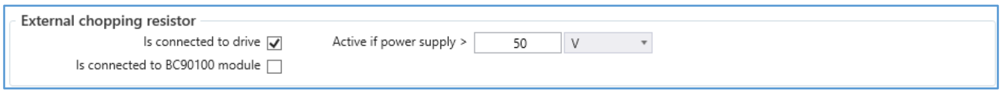


Figure 13.27. **Chopping resistor connection**

[1] Continuous rating, using a heatsink, with baseplate temperature maintained below 75 °C

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

The chopping resistor option is available in the Setup branch of EasyMotion II:



Chopping is triggered when the **DC bus voltage** exceeds the **U_{CHOP}** threshold. This parameter should be configured based on the **nominal motor supply voltage**. For optimal performance, **U_{CHOP}** should be set **a few volts above** the maximum nominal supply. This ensures early activation of the braking resistor — **before** dangerous voltage levels are reached that would trigger the **over-voltage protection** and disable the drive.

⚠ **Note:** U_{CHOP} must always be set **below U_{MAX}** (the over-voltage protection threshold).

Additional Tip: The chopping resistor can be used **in combination with an external capacitor**. While the capacitor alone may not absorb the full amount of regenerative energy (**EM**), it can help **reduce the size required** for the resistor.

2.2.1. 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} = 40A

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

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}=15 for iPOS8015

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

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

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

Remarks:

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

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

13.9. LV-TTL UART (RS-232 with external transceiver)

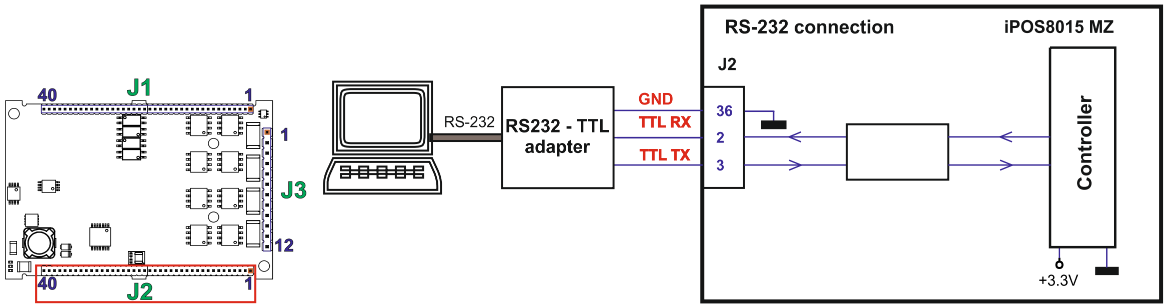


Figure 13.28. **Low level TTL connection**

Remark:.

1 *Do not connect directly to standard RS-232 serial connector!*
2 *For establishing serial communication with the iPOS8015 MZ, a RS232 – TTL adapter is necessary.*
3 *EasyMotion Studio II can communicate in parallel with serial RS232/USB communication while CAN or EtherCAT communication is active.*
4 *Always power-off all the iPOS8015 MZ supplies before inserting/removing the serial connector.*
5 *Do not rely on an earthed PC to provide iPOS8015 MZ GND connection! The drive must be earthed through a separate circuit. Most communication problems are caused by the lack of such connection.*

13.10. USB connection

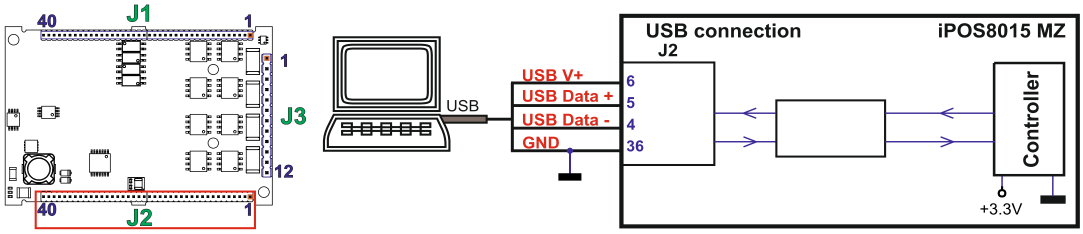


Figure 13.29. **USB connection**

Remark:

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

13.11. CAN-bus connection (for CAN drives only)

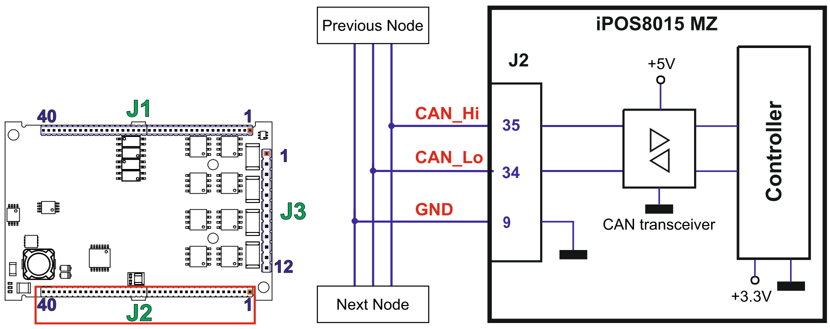


Figure 13.30. **CAN connection**

Remarks:

1. *The CAN network requires a 120-Ohm terminator. This is not included on the board. Figure 13.31 shows how to connect it on your network*
2. *CAN signals are not insulated from other iPOS8015 MZ circuits*
3. *The CANopen / TMLCAN selection is done via J1 – pin9*
4. *EasyMotion Studio II can communicate in parallel with RS232 or USB communication while CAN communication is active*

13.11.1. Recommendation for wiring

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

b) 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.

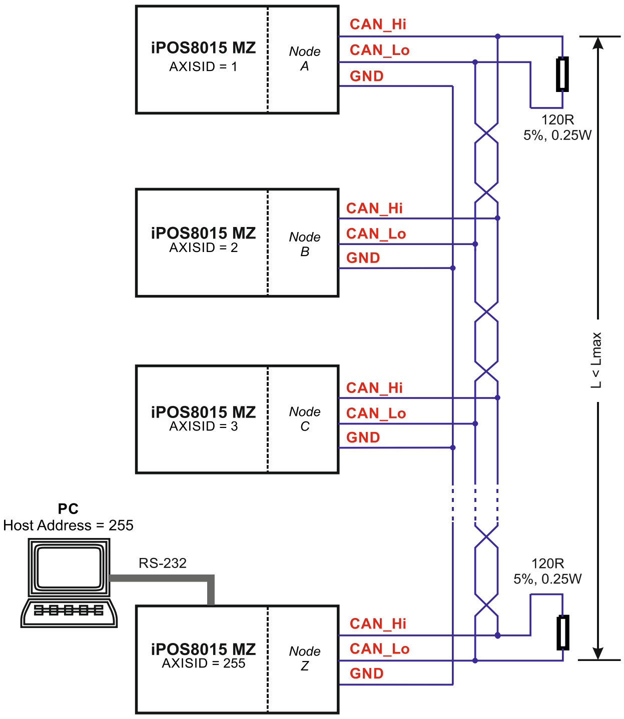


Figure 13.31. **Multiple-Axis CAN network**

13.12. EtherCAT connection (for CAT drives)

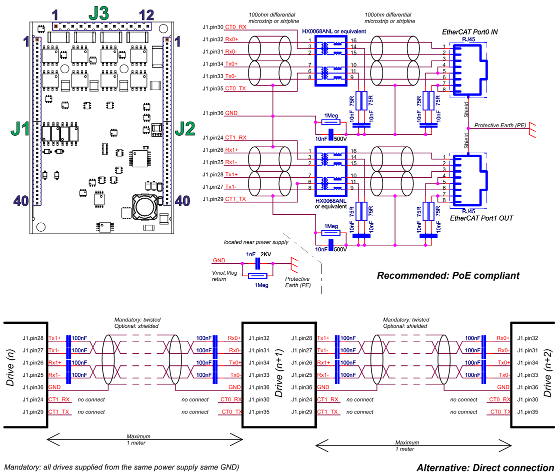


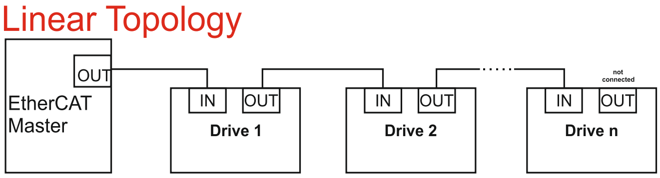
Figure 13.32. **EtherCAT bus to RJ45 connection PoE compliant**

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

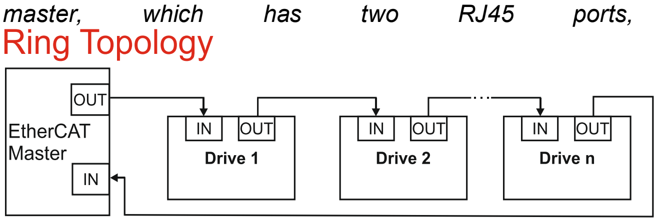
13.12.1. Recommendations for EtherCAT Wiring

- Build EtherCAT® network using UTP (unshielded twisted pair) cables rated CAT5E or higher (CAT6, etc.). Cables with this rating must have multiple characteristics, as described in TIA/EIA-568-B. Among these are: impedance, frequency attenuation, cross-talk, return loss, etc.

- It is acceptable to use STP (shielded twisted pair) or FTP (foil twisted pair) cables, rated CAT5E or higher (CAT6, etc.). The added shielding is beneficial in reducing the RF (radio-frequency) emissions, improving the EMC emissions of the application.
- The maximum length of each network segment must be less than 100 meters.
- The network topology is daisy-chain. All connections are done using point-to-point cables.
- The global topology can be:
- ***Linear****, when the OUT port of the last drive in the chain remains not connected. Master is connected to IN port of the first drive; OUT of the first drive is connected to IN of the following drive; OUT of the last drive remains unconnected.*



- ***Ring****, when the OUT port of the last drive in the chain is connected back to the master controller, on the 2nd port of the master. This topology consists of the linear topology described above, plus an extra connection between the master, which has two RJ45 ports, to OUT of the last drive.*



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

13.13. Disabling the setup table at startup (for CAT drives)

In rare instances, the setup table may become corrupted, causing the drive to continuously reset. This condition is indicated by both the Ready and Error LEDs blinking rapidly in succession.

To recover from this state, invalidate the setup table by connecting all digital Hall inputs to GND. Upon the next power-on, the drive will load the default settings and set bit 2 in the Motion Error Register, indicating “Invalid Setup Data.” Once a new valid setup table is loaded onto the drive, disconnect the Hall sensors from GND and perform another power cycle (power off and then on).

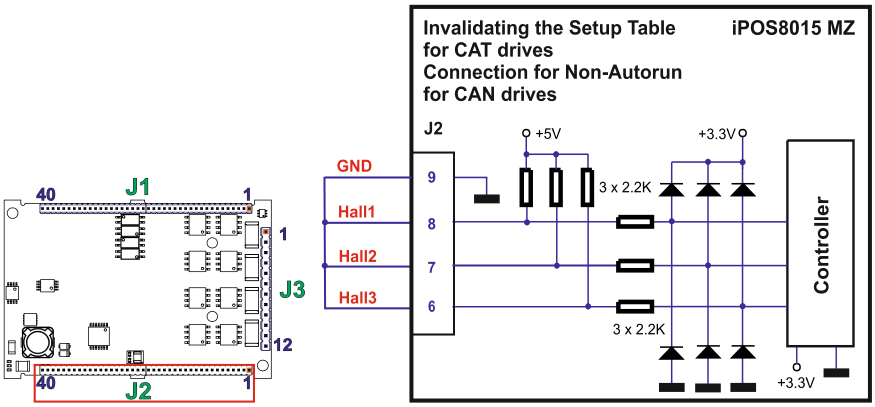


Figure 13.33. ***Temporary connection during power-on to remove the drive from Autorun mode or invalidate the Setup table***

13.14. Disabling Autorun (for CAN drives)

When the iPOS8015 MZ-CAN is configured in TMLCAN operation mode, it enters Autorun mode by default upon power-on. In this mode, if the drive contains a valid TML application (motion program) stored in its local EEPROM, the program will execute automatically as soon as the motor supply (V_{MOT}) is enabled.

To disable Autorun mode, there are three available methods:

a) Software – Write the value 0x0001 to the first EEPROM location at address 0x2000.
b) Hardware1 – Temporarily switch the drive to CANopen mode. In this state, Autorun is disabled and no motion will start automatically. This can be done by setting SW1 pin 1 to the down position.
c) Hardware2 –Temporarily connect all digital Hall inputs to GND during power-on, and hold this state for approximately 1 second, until the green LED turns on (as shown in ***Figure 13.33***). This method is especially useful when communication with the drive is not possible.

Once the drive is set to non-Autorun mode using the second hardware method, you may then use the software method (a) to invalidate the TML application stored in EEPROM. On the next power cycle, in the absence of a valid TML program, the drive will automatically remain in non-Autorun mode, regardless of the digital Hall input status.

13.15. CAN Operation Mode and Axis ID Selection for CAN drives (J1 pin settings)

The CAN operation mode is determined by pin 9 of connector J1:

- If pin 9 is connected to GND → CANopen protocol is selected
- If pin 9 is left unconnected → TMLCAN protocol is selected

The drive's AxisID value is set at power-on using either software or hardware methods:

1. Software Method - Using EasyMotion Studio II, set a specific AxisID value (1–255) via the AxisID settings under the Setup section.

2. Hardware Method - In EasyMotion Studio II, select the 'H/W' option in the AxisID settings under the Setup section. AxisID is then determined by the state of specific J1 pins:

- Bit = 0 → Pin is left unconnected
- Bit = 1 → Pin is connected to GND

A DIP switch can be used to connect these pins to GND on a custom user motherboard.

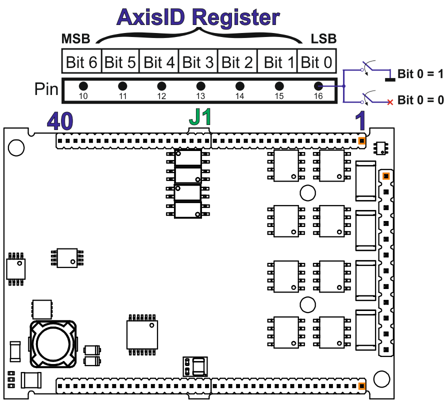


Figure 13.34. ***J1 – Axis ID pins for CAN drives***

- J1 pins are sampled at power-up, and the AxisID is set accordingly.
- In CANopen mode, valid AxisID values range from 1 to 127. If all pins are left unconnected, the AxisID defaults to 255, putting the drive into a "non-configured" state.
    - In this state, the drive waits to be configured by a CANopen master using the CiA-305 protocol.
    - While non-configured, the drive responds only to CiA-305 commands. All other CANopen commands are ignored, and no messages (including boot-up) are transmitted.
- If the drive configuration is invalid, it will fall back to using the hardware-defined AxisID.

13.16. Axis ID Selection for CAT drives (J1 pin settings)

The iPOS8015 MZ-CAT drives support all standard EtherCAT addressing modes. When using device addressing based on node address, the drive automatically sets the EtherCAT register Configured Station Alias Address using its assigned AxisID value.

The AxisID value is established at power-up through either software or hardware methods:

Software Configuration - Using EasyMotion Studio II, assign a specific AxisID value (range: 1–255) in the AxisID settings under the Setup section.

Hardware Configuration - In EasyMotion Studio II, select the 'H/W' option under the AxisID settings in the Setup section. Then, configure the AxisID pins physically by connecting specific J1 pins to GND.

- AxisID Bit = 0 → Pin is left unconnected
- AxisID Bit = 1 → Pin is connected to GND

To simplify hardware setup, an 8-pole DIP switch can be connected to these pins on a custom user motherboard.

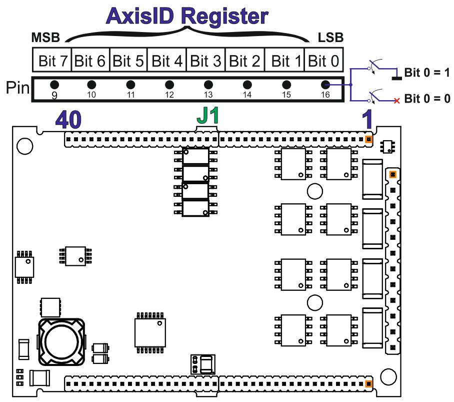


Figure 13.35. *J1 – Axis ID pins for CAT drives*

- Valid AxisID values: Range from 1 to 255. If all pins are left unconnected, the AxisID defaults to 255.
- In EtherCAT, when AxisID = 255, the Configured Station Alias register is set to 0.
- All AxisID pins are sampled at power-up, and the drive configures itself accordingly.
- If the drive setup is invalid, the drive will automatically use the hardware-defined AxisID.

14. Electrical Specifications

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

- V_{LOG} = 24 VDC; V_{MOT} = 80V_{DC}; F_{PWM} = 20kHZ
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude) = 21.2 A

14.1.1. Operating Conditions

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

14.1.2. Storage Conditions

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

14.1.3. Mechanical Mounting

		Min.	Typ.	Max.	Units
Airflow		natural convection[3], closed box			
Spacing required for vertical mounting.	Between adjacent drives	30			mm
	Between drives and nearby walls	30			mm
	Between drives and roof-top	20			mm
Spacing required for horizontal mounting.	Between adjacent drives	4			mm
	Between drives and nearby walls	5			mm
	Space needed for drive removal	10			mm
	Between drives and roof-top	15			mm
Insertion force	Using recommended mating connectors		12	8	N
Extraction force		8	10		N

14.1.4. Environmental Characteristics

		Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Global size	64 x 43.8 x 15.7			mm
		~2.52 x 1.72 x 0.62			inch
Weight		~34			g
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP20			-

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

[2] iPOS8015 can be operated in vacuum (no altitude restriction), but at altitudes over 2,500m, current and power rating are reduced due to thermal dissipation efficiency.

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

14.1.5. Logic Supply Input ($+V_{LOG}$)

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

14.1.6. Motor Supply Input ($+V_{MOT}$)

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	80	82	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	11		94	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		95	V
Supply current	Idle		1	5	mA
	Operating	-40	±20	+40	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			45	A
Utilization Category	Acc. to 60947-4-1 (I_{PEAK}<=4.0*I_{NOM})	DC-3			

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

			Min.	Typ.	Max.	Units
Nominal current with heat sink[1]	PMSM motors sinusoidal amplitude				21.2	A
	PMSM motors sinusoidal RMS				15	A_{RMS}
	DC/BLDC motors continuous				18.3	A
Nominal current without heat sink	PMSM motors sinusoidal amplitude				12	A
	PMSM motors sinusoidal RMS				8.5	A_{RMS}
	DC/BLDC motors continuous				10.4	A
Peak current	Maximum: 12.5s		-40		+40	A
Short-circuit protection threshold				70		A
Short-circuit protection delay			1.5		3.3	μs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			0.15		V
Voltage efficiency				100		%
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for ripple ±5% of measurement range; $+V_{MOT}$ = 80 V	F_{PWM} = 20 kHz	400			μH
		F_{PWM} = 40 kHz	200			
		F_{PWM} = 60 kHz	150			
		F_{PWM} = 80 kHz	100			
		F_{PWM} = 100 kHz	80			
	Absolute minimum value, limited by short-circuit protection; $+V_{MOT}$ = 80 V	F_{PWM} = 20 kHz	150			μH
		F_{PWM} = 40 kHz	50			
		F_{PWM} = 60 kHz	40			
		F_{PWM} = 80 kHz	20			
		F_{PWM} = 100 kHz	10			
Motor electrical time-constant (L/R)	Recommended value, for ±5% current measurement error due to ripple	F_{PWM} = 20 kHz	330			μs
		F_{PWM} = 40 kHz	170			
		F_{PWM} = 60 kHz	140			
		F_{PWM} = 80 kHz	80			
		F_{PWM} = 100 kHz	66			
Current measurement accuracy	FS = Full Scale		-9.3	+/- 3.4	+9.3	%FS

14.1.8. Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN, IN4, IN5)[2]

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

[1] It is mandatory to mount the iPOS8015 MZ on a metallic support using the provided mounting holes. To achieve the rated current capability, the heat sink temperature must not exceed **75°C**.

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

14.1.9. Digital Outputs (OUT1, OUT2/Error, OUT3/ Ready, OUT4, OUT5) [1]

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

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

14.1.10. Digital Outputs (OUT0) [1]

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

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

14.1.11. Digital Hall Inputs (Hall1, Hall2, Hall3)

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

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

14.1.12. Linear Hall Inputs (LH1, LH2, LH3)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0	0.5÷4.5	4.9	V
	Absolute maximum values, continuous	-7		+7	
	Absolute maximum, surge (duration ≤ 1s) †	-11		+14	
Input current	Input voltage 0…+5V	0		0.2	mA
Interpolation Resolution	Depending on software settings			11	bits
Frequency		0		1	kHz
ESD protection	Human body model	±1			kV

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

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

14.1.14. Encoder #1 Inputs (A1+, A1-, B1+, B1-, Z1+, Z1-)

		Min.	Typ.	Max.	Units
Single-ended mode compliance	Leave negative inputs disconnected	TTL / CMOS / Open-collector			
Input voltage, single-ended mode A/A+, B/B+	Logic "LOW"			1.6	V
	Logic "HIGH"	1.8			
	Floating voltage (not connected)		3.3		
Input voltage, single-ended mode Z/Z+	Logic "LOW"			1.2	V
	Logic "HIGH"	1.4			
	Floating voltage (not connected)		4.7		
Input current, single-ended mode A/A+, B/B+, Z/Z+	Logic "LOW"; Pull to GND		5.5	6	mA
	Logic "HIGH"; Internal 2.2KΩ pull-up to +5	0	0	0	
Differential mode compliance	For full RS422 compliance, see [2]	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	±0.06	±0.1	±0.2	V
	Common-mode range (A+ to GND, etc.)	-7		+7	
Input impedance, differential	A1+ to A1-, B1+ to B1-		1		kΩ
	Z1+ to Z1-		1		
Input frequency	Single-ended mode, Open-collector / NPN	0		5	MHz
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	0		10	MHz
Minimum pulse width	Single-ended mode, Open-collector / NPN	1			µs
	Differential mode, or Single-ended driven by push-pull (TTL / CMOS)	50			ns
Input voltage, any pin to GND	Absolute maximum values, continuous	-7		+7	V
	Absolute maximum, surge (duration ≤ 1s) †	-11		+14	
ESD protection	Human body model	±1			kV

14.1.15. Encoder #2 Inputs (A2+/Data+, A2-/Data-, B2+/Clk+, B2-/Clk-, Z2+, Z2-)[3]

		Min.	Typ.	Max.	Units
Differential mode compliance		TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential	A2+, B2+, Z2+ A2-, B2-, Z2-		150		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns

14.1.16. Analog 0…5V Inputs (REF, FDBK)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-12		+18	
	Absolute maximum, surge (duration ≤ 1s) †			±36	
Input impedance	To GND		28		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[4]
Bandwidth (-3db)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV

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

[2] For full RS-422 compliance, 120Ω termination resistors must be connected across the differential pairs. See *Figure 13.18. Differential incremental encoder #1 connection*

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

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

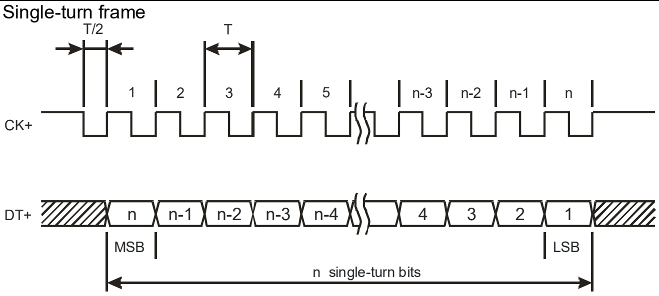
14.1.17. LV-TTL UART (RS-232 with external transceiver)

			Min.	Typ.	Max.	Units
TTL TX	Voltage level	Absolute maximum, surge (duration ≤ 1s)†	-0.3		+3.6	V
		Logic 0		0	0.4	
		Logic 1	2.4	3.3		
	Output current	Absolute maximum, surge (duration ≤ 1s)†	-5		+5	mA
		-	-2		+2	
TTL RX	Voltage level	Absolute maximum, surge (duration ≤ 1s)†	-0.3		+3.6	V
		Logic 0		0	0.4	
		Logic 1	2.4	3.3		
	Input current		-0.15		+0.15	mA
Bit rate		Default		9600		Baud
		Software selectable	9600		115200	
Short-circuit		TTL TX short to GND		-No-		
⚠	Do not connect directly to standard RS-232 serial connector!					
	Always power-off the drive supplies before inserting/removing the adapter					

14.1.18. SSI/BiSS/Panasonic/Tamagawa encoder interface common with Enc#2 pins

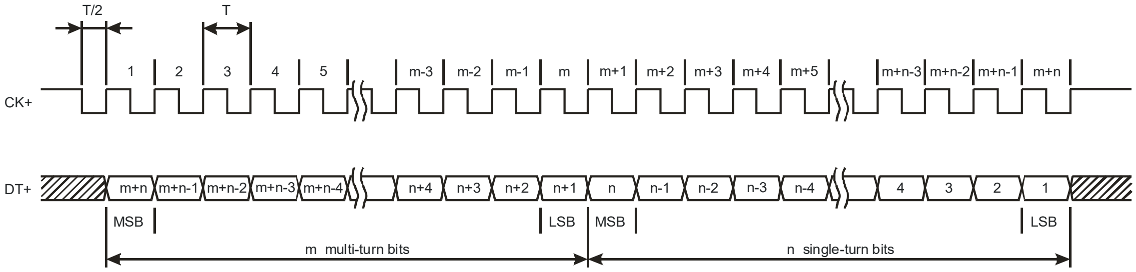
		Min.	Typ.	Max.	Units
Differential mode compliance (CLOCK, DATA)			TIA/EIA-422		
CLOCK Output voltage	Differential; 50Ω differential load	2.0	2.5	5.0	V
	Common-mode, referenced to GND	2.3	2.5	2.7	
CLOCK frequency	Software selectable		1000, 2000, 3000		kHz
DATA Input hysteresis	Differential mode	±0.1	±0.2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

Single-turn frame



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

Multi-turn frame



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

14.1.19. CAN-Bus (for CAN drives)

		Min.	Typ.	Max.	Units
Compliance	ISO11898, CiA-301v4.2, 402v3.0, 305 v.2.2.13				
Bit rate	Software selectable	125		1000	125
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo		none on-board		
Node addressing	Hardware: by H/W AxisID pins (J1)		1 ÷ 127 & 255 (LSS non-configured) (CANopen); 1-127 & 255 (TMLCAN)		
	Software		1 ÷ 127 & 255 (CANopen); 1- 255 (TMLCAN)		
Voltage, CAN-Hi or CAN-Lo to GND		-36		36	V
ESD protection	Human body model	±15			kV

14.1.20. Supply Output (+5V)

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

14.1.21. EtherCAT pins (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 the iPOS8015, requires separate +Vlog SELV/ PELV supply	compliant to IEEE802.3af mode A “Mixed DC & Data”			
		NOT compliant to IEEE802.3af mode B “DC on Spares”			
Isolation GND0, GND1	Requirement for motherboard PCB routing	500			V_{rms}
		1.5			kV_{peak}
Maximum cable length	2-pair UTP Cat5	100	150		m
ESD protection	Human body model	±4			kV
When the connections between drives is done directly, without magnetics (nonstandard, not conform to Ethernet IEEE802.3 100BASE-TX), it is imperative that the ground voltage difference between drives is kept to a minimum. The installation must provide a supplementary GND link between the drives. This link must have low inductance. Low inductance is best achieved by using large metal parts, such as a metallic chassis / baseplate, or using copper conductive tape.					

14.1.22. LED signals (for CAT drives)

	Min.	Typ.	Max.	Units
LED connection	Common cathode to GND			
	Direct, no series resistor			
LED current		0.7	1	mA

14.1.23. Safe Torque OFF (STO1+; STO1-; STO2+; STO2-)

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

14.1.24. 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.

14.2. Memory Map

iPOS8015 has 2 types of memory available for user applications: 16K×16 SRAM and up to 24K×16 serial E²ROM.

The SRAM memory is mapped in the address range: C000h to FFFFh. It can be used to download and run a TML program, to save real-time data acquisitions and to keep the cam tables during run-time.

The E²ROM is mapped in the address range: 2000h to 7FFFh. It is used to keep in a non-volatile memory the TML programs, the cam tables and the drive setup information.

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

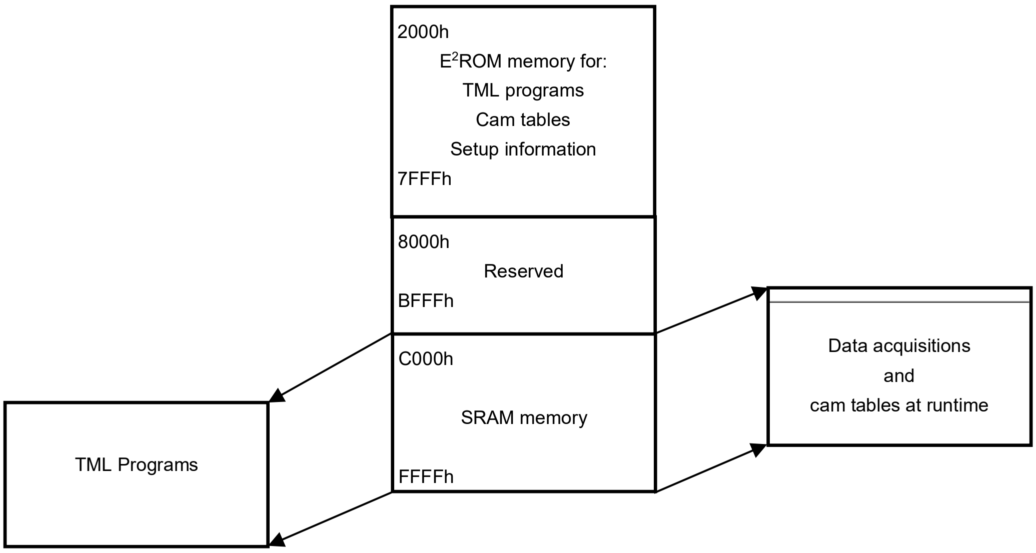


Figure 14.1 *iPOS8015 MZ Memory Map*