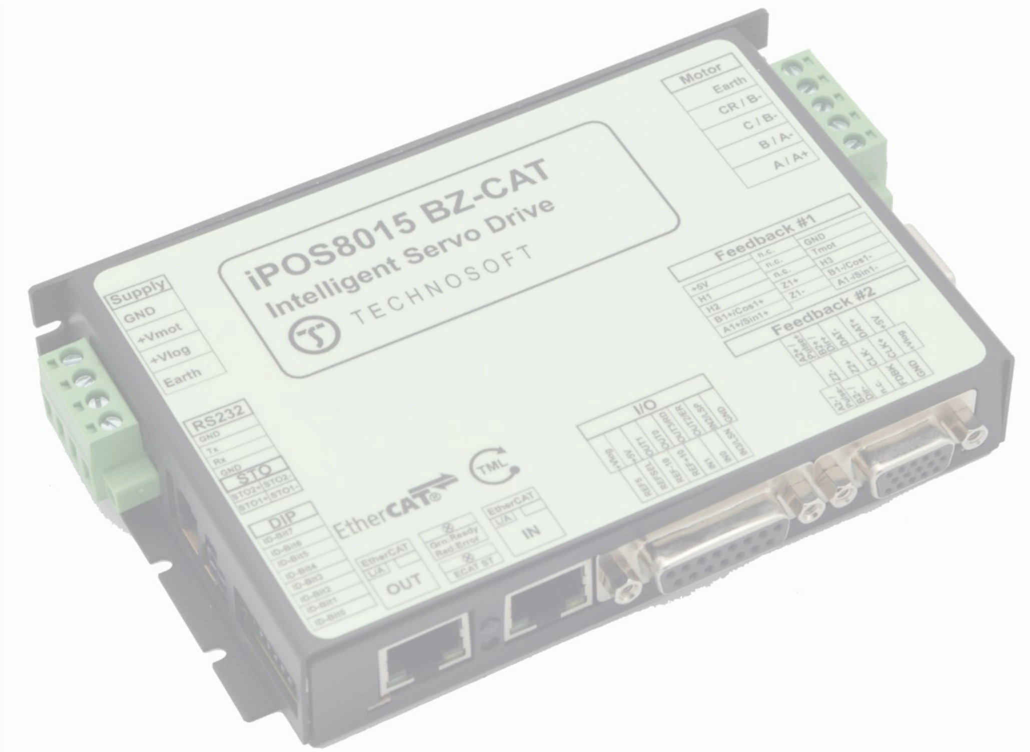
iPOS8015 BZ

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

TECHNOSOFT
MOTION TECHNOLOGY

Intelligent Servo Drives



Technical Reference

P091.023.iPOS8015.BZ.UM.0325

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Read This First

About This Manual

This book is a technical reference manual for:

Product Name	Part Number	Output current		Communication	STO
		Nominal	Peak		
iPOS8015 BZ-CAT	P023.026.E221	$15A_{RMS}$ / 21.2A	$28A_{RMS}$ / 40A	Serial RS-232; EtherCAT®	✓

In order to operate the **iPOS8015** 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:
  - ❑ An **EtherCAT® master**
  - ❑ The drives **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft **EasyMotion Studio II** software
  - ❑ 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.

Notational Conventions

This document uses the following conventions:

- **iPOS8015**– 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
- **CoE** – CAN application protocol over EtherCAT®

Trademarks

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

Related Documentation

iPOS8015 BZ-CAT Datasheet (P023.026.E221.DSH.xxxx) *– describes the hardware connections of the iPOS8015 BZ-CAT family of intelligent servo drives including the technical data and connectors.*

iPOS family Safe Torque Off (STO) Operating instructions (P091.099.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 CoE Programming (part no. P091.064.UM.xxxx) *– describes how to program the Technosoft intelligent drives equipped with EtherCAT® communication interface. These drives support CAN application protocol over EtherCAT® (CoE) in conformance with CiA 402 device profile. The manual presents the object dictionary associated with this profile. The manual also explains how to combine the Technosoft Motion Language and the CoE commands in order to distribute the application between the EtherCAT® master and the Technosoft drives.*

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

If you Need Assistance …

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

1 Safety information

Read carefully the information presented in this chapter before carrying out the drive installation and setup! It is imperative to implement the safety instructions listed hereunder.
This information is intended to protect you, the drive and the accompanying equipment during the product operation. Incorrect handling of the drive can lead to personal injury or material damage.

The following safety symbols are used in this manual:

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

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

1.1 Warnings

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

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

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

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

1.2 Cautions

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

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

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

1.3 Quality system, conformance and certifications

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

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

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

Technosoft SA hereby declares that this product conforms to the following European applicable directives:

2014/30/EU	**Electromagnetic Compatibility (EMC) Directive**
2014/35/EU	**Low Voltage Directive (LVD)**
93/68/EEC	**CE Marking Directive**

Conflict minerals statement - Technosoft declares that the company does not purchase 3T&G (tin, tantalum, tungsten & gold) directly from mines or smelters...
We have no indication that Technosoft products contain minerals from conflict mines or smelters in and around the DRC.

STO compliance – TUV SUD certifies that this product is SIL 3 / Cat 3 / PL e compatible and is in conformity with the following safety – related directives:

EN ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 61800-5-1:2007 Adjustable speed electrical power drive systems — Safety requirements — Electrical, thermal and energy
EN 61800-5-2:2007 Adjustable speed electrical power drive systems - Safety requirements –Functional
EN 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems
EN ISO 13849-1:2008 Safety of machinery - Safety-related parts of control systems
EN 61326-3-1:2008 - General industrial applications - EMC - Immunity requirements for functional safety

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

2 Product Overview

2.1 Introduction

The **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 control of brushless DC, brushless AC (vector control), DC brushed motors and step motors, the iPOS8015 BZ drive accept as position feedback incremental encoders (quadrature or sine/cosine) and absolute encoders (SSI, BiSS-C, EnDAT, TAMAGAWA, Panasonic, Nikon, Sanyo Denki).

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 or camming, etc.)
- ❑ Switching between motion modes and adjusting motion parameters.
- ❑ Executing homing sequences
- ❑ Controlling the program flow through:
  - Conditional jumps and calls of TML functions
  - TML interrupts triggered by pre-defined or programmable conditions (e.g., protection triggers, limit switch transitions, or capture inputs)
  - Waits for programmed events to occur
- ❑ Managing digital I/O and analog input signals.
- ❑ Executing arithmetic and logic operations

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

The iPOS8015 BZ drive is equipped with an EtherCAT® communication interface that provides support for:

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

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 designed for **commissioning** and **advanced motion programming**. It supports the development of complex motion programs using TML, which are executed locally 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 an EtherCAT master, it can be upgraded to the FULL version by entering a **license number** obtained from Technosoft.

2.2 Product Features

- Fully digital servo drive suitable for the control of rotary or linear brushless, DC brush, and step motors
- **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:** 12-90V; **Logic supply[1]:** 12-36V; **STO supply[2]:** 18-40V;
- **PWM** switching frequency: up to 100kHz;
- **Motor current:**
  - Nominal: 15A_{RMS} / 21A amplitude;
  - Peak: 28A_{RMS} / 40A amplitude.
- **Communication:**
  - RS-232 serial up to 115kbits/s
  - Dual 100Mbps EtherCAT® interfaces, for use in daisy-chaining topologies
- **Digital and analog I/O's:**
  - 4 x digital inputs, 12-36V, PNP/NPN programmable: 2 for limit switches, 2 general-purpose
  - 3 x digital outputs, 5-36V, 0.5A, NPN open-collector: Ready, Error, OUT1
  - 1 x dedicated motor brake or general-purpose output: 5-36V, 2A, NPN open-collector
  - 2 x analogue inputs:
    - 1 x 12-bit, 0-5V: Feedback (for Tacho) or general-purpose
    - 1 x 12-bit, +/-10V or 0-5V hardware selectable: Reference or general-purpose
- **Feedback devices** (dual-loop support)

  1st feedback devices supported:
  - Incremental encoder interface (differential)
  - Digital Hall sensor interface (single-ended and open collector)
  - Analog sin/cos encoder interface (differential 1V_{PP})

  2nd feedback devices supported:
  - Incremental encoder interface (differential only)
  - BISS / SSI / EnDAT / TAMAGAWA / Panasonic / Nikon/ Sanyo Denki encoder interface
- **NTC/PTC** analogue Motor Temperature sensor input
- Various motion programming modes:
  - Position profiles with trapezoidal or S-curve speed shape
  - Position, Velocity, Time (PVT) 3rd order interpolation
  - Position, Time (PT) 1st order interpolation
  - Cyclic Synchronous Position (CSP)
  - Cyclic Synchronous Velocity (CSV)
  - Cyclic Synchronous Torque (CST)
  - Electronic gearing and camming
  - 40 Homing modes
- 255 h/w selectable addresses
- **EtherCAT® supported protocols** for CAT systems:
  - **FoE** – File over EtherCAT – for setup/TML functions and firmware update
  - **EoE** – Ethernet over EtherCAT – for Easy Motion communication over EtherCAT
  - **CoE –** CAN application protocol over EtherCAT - in conformance with CiA 402 device profile
- **16Kwords SRAM** memory per axis for data acquisition
- **24Kwords E2ROM** per axis to store setup data, TML motion programs, cam tables and other user data
- Operating ambient temperature: 0-40°C (over 40°C with derating)
- Operating ambient temperature: 0-40°C (over 40°C with derating)
- 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

[1] Logic supply must be SELV/ PELV type (Safety Extra Low Voltage / Protective Extra Low Voltage)
[2] The STO circuit must be supplied with minimum 18V to enable PWM output

2.3 Identification Labels

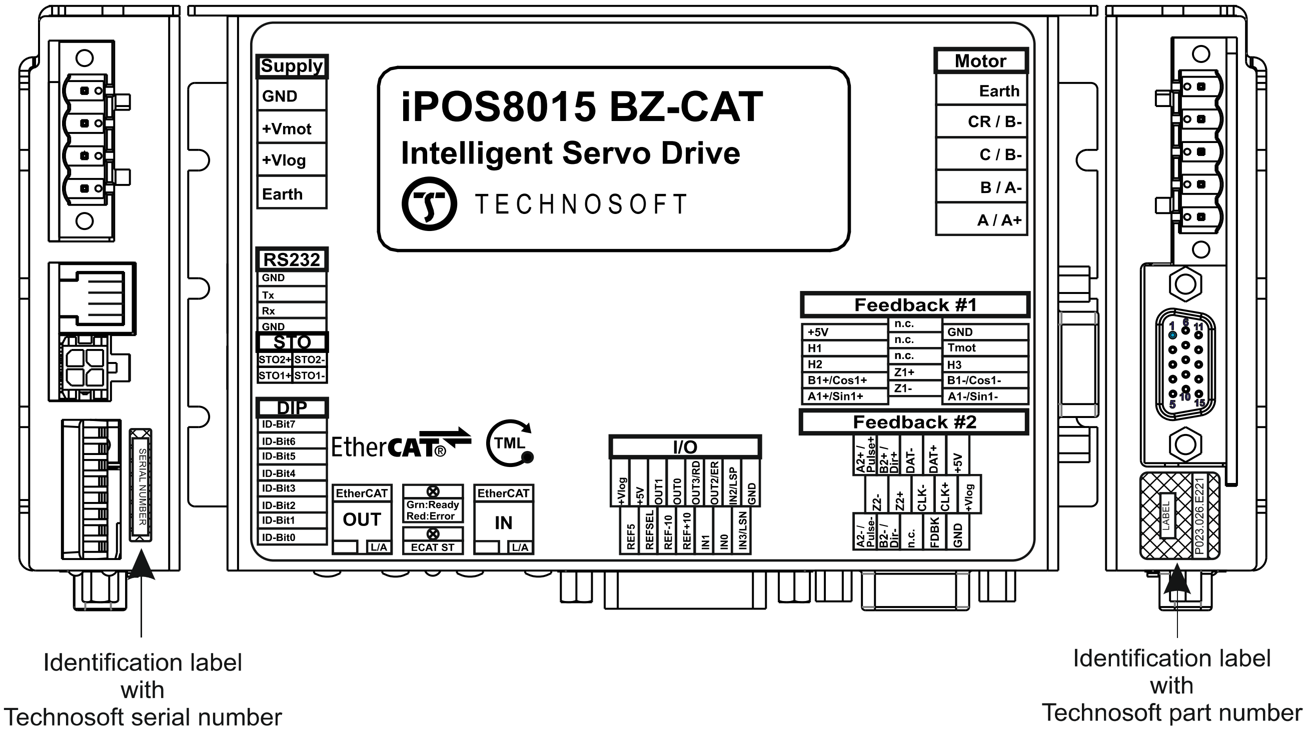


Figure 1. *iPOS8015 BZ-CAT identification labels*

The iPOS8015 BZ-CAT is identified by the following part number and name on its label:

- P023.026.E221: iPOS8015 BZ-CAT – EtherCAT® version, 80V, 15A.

2.4 Supported Motor-Sensor Configurations

2.4.1 Single loop configurations

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

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

2.4.2 Dual loop configurations

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

[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] Only differential connection is available.
[5] Sin/Cos is available only on Feedback #1
[6] SSI / EnDAT2.2 / BiSS-C / Tamagawa / Panasonic / Nikon / Sanyo Denki are available only on Feedback #2

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

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

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

3 Hardware Installation

3.1 iPOS8015 BZ-CAT Board Dimensions

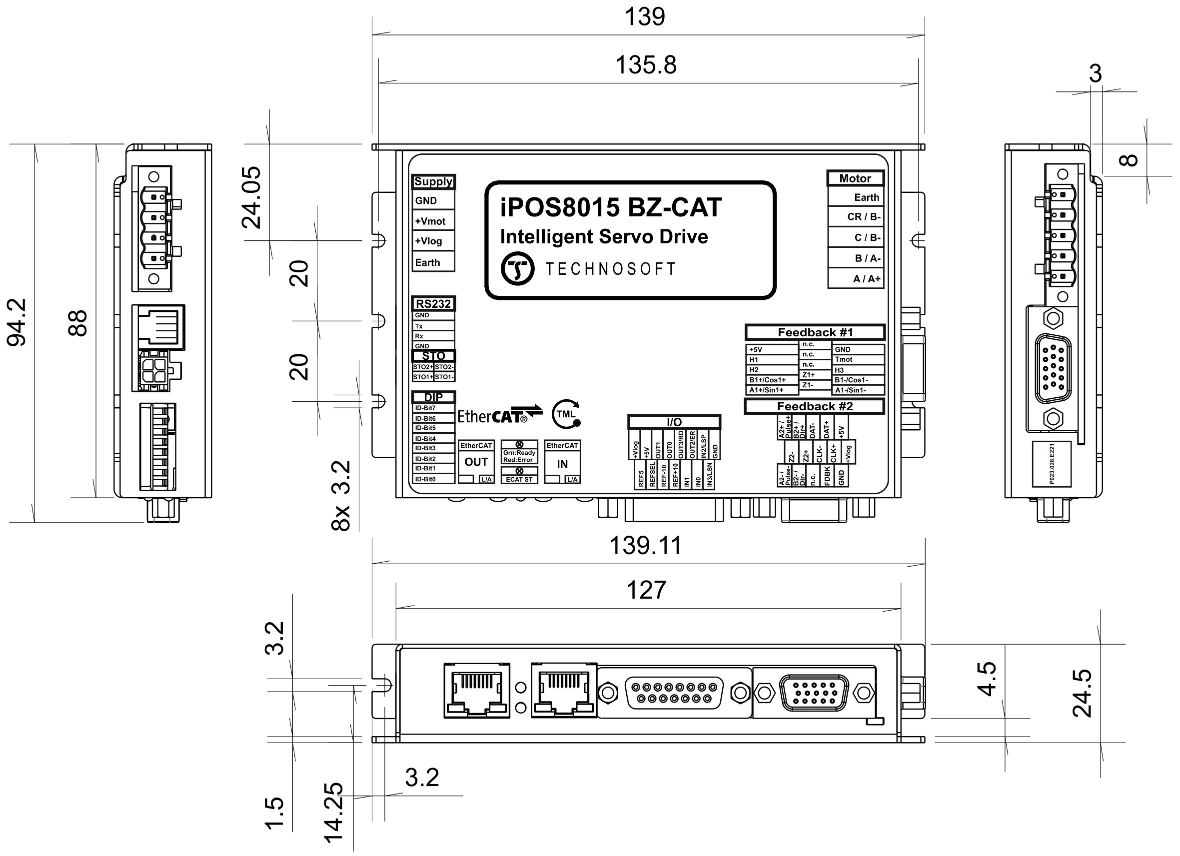


Figure 2. iPOS8015 BZ-CAT drive dimensions

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

3.2 Mechanical Mounting

The iPOS8015 BZ drive is designed for horizontal mounting, which means the bottom of the drive (the largest face without a label) should be in direct thermal contact with a metallic surface. This metallic surface will act as a cooling heat sink to ensure proper thermal management.

We do not recommend vertical mounting, where the narrow face of the drive (without connectors) is in contact with a metallic surface. For optimal performance, the drive should be mounted on the metallic support using the provided mounting holes and the recommended mating connectors.

Make sure to use the specified inserts and screws for securing the drive:

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

For thermal calculations: the iPOS8015 can be assumed to generate 2 Watt (=6.8 BTU/hour) at idle, and up to 8 Watt (=27.3 BTU/hour) worst case while driving a motor.

The figures below 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.
On the sides of the drives where a D-Sub male connector is located, ensure a clearance of 50mm to accommodate the connector mounting.

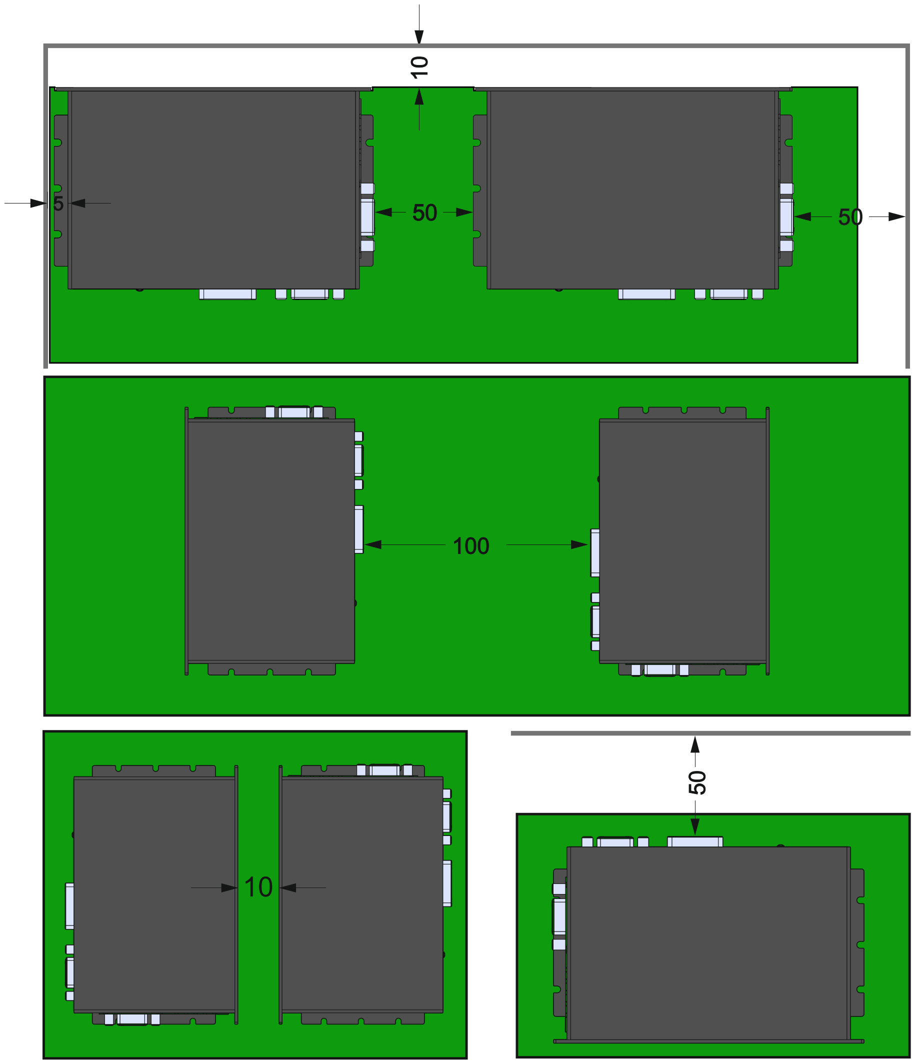


Figure 3. *Recommended spacing - horizontal mounting, worst case: non-metallic, closed box*
(All dimension are expressed in mm)

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

3.3 Connectors and Pinouts

3.3.1 Mating Connectors

Image	Connector	Description	Manufacturer	Part Number	Image
	J1	Supply input, 4x5.08 female counter part for cable	Camden	CTBA9208/4FL	
	J2	Motor power, 5x5.08 female counter part for cable	Camden	CTBA9208/5FL	
	J3,J4	Feedback #1 +Hall & Feedback #2		generic 15-pin High Density D-Sub male	
	J9	RS232		generic RJ10-4/4 phone plug	
	J5	I/O ; Analog		generic 15-pin D-Sub male, DB15	
	J8	MICROFIT RECEPTACLE HOUSING, 2x2 WAY	MOLEX	43025-0400	
	J8	CRIMP PIN, MICRO-FIT, 5A	MOLEX	43030-0007	
	J6,J7	Standard 8P8C modular jack (RJ-45) male	-	-	
-	J8	Hand Crimp Tool for Micro-Fit 3.0 Terminals, 20-30 AWG	MOLEX	63819-0000	

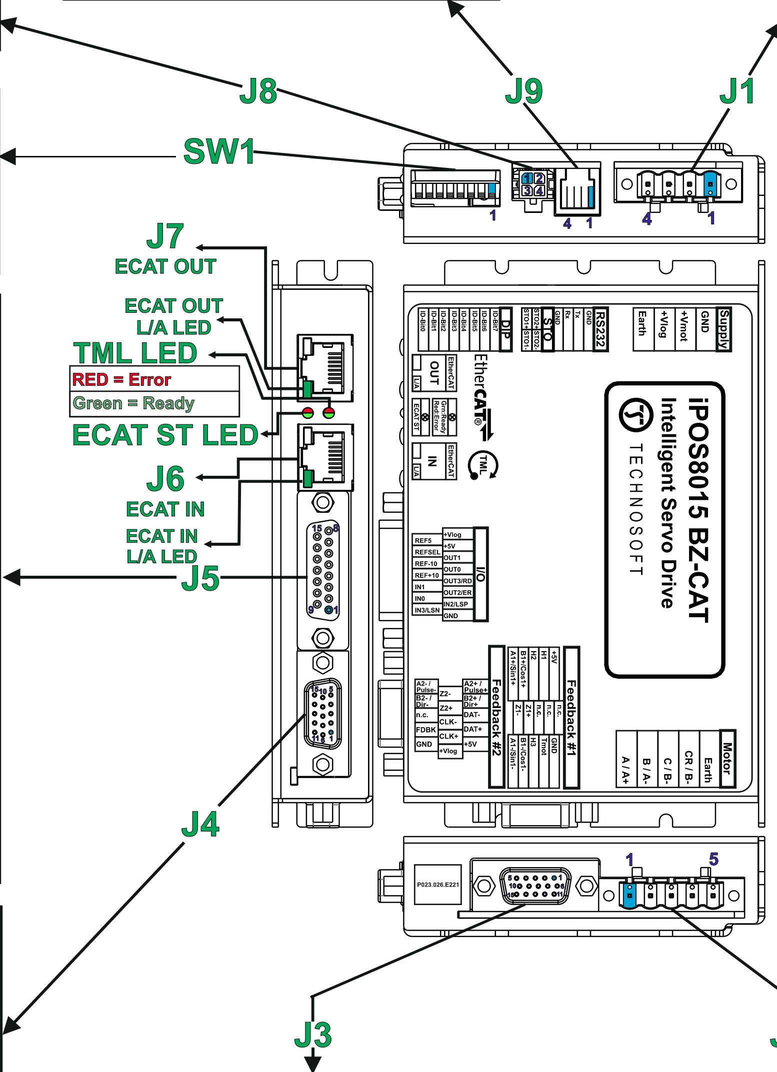
3.3.2 Pinouts for iPOS8015 BZ-CAT

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

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

Pin	Name	Description
1	GND	Negative return (ground) of the power supply
2	$+V_{MOT}$	Positive terminal of the motor supply: 12 to $80V_{DC}$.
3	$+V_{LOG}$	Positive terminal of the logic supply input: 12 to $36V_{DC}$
4	Earth	Earth connection

Pin	Name	Description
1	ID-Bit7	8-bit H/W Axis ID register Switch 8 is Bit 0... Switch 1 is Bit 7 of the Axis value. Switch UP -> Bit = 0 Switch DOWN -> Bit = 1 AxisID values: from 1 to 255. AxisID = 255 also when all switches are up. In EtherCAT, when Axis ID is 255, the register called "configured station alias" will be 0.
2	ID-Bit6	
3	ID-Bit5	
4	ID-Bit4	
5	ID-Bit3	
6	ID-Bit2	
7	ID-Bit1	
8	ID-Bit0	



Pin	Name	Description
1	GND	Return ground for I/O pins
2	IN2/LSP	12-36V digital PNP/NPN input. Positive limit switch input
3	OUT2/Error	5-36V 0.5A, drive Error output, active low, NPN open-collector/TTL pull-up. Also drives the red LED
4	OUT3/Ready	5-36V 0.5A, drive Ready output, active low, NPN open-collector/TTL pull-up. Also drives the green LED.
5	OUT0	5-36V 2A, software selectable general-purpose or brake digital output, NPN open-collector/TTL pull-up
6	OUT1	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
7	$+5V_{OUT}$	5V output supply for I/O usage
8	$+V_{LOG}$	Positive terminal of the logic supply input: 12 to $36V_{DC}$
9	IN3/LSN	12-36V digital PNP/NPN input. Negative limit switch input
10	IN0	12-36V general-purpose digital PNP/NPN input
11	IN1	12-36V general-purpose digital PNP/NPN input
12	REF10+	Analogue input, 12-bit, positive 0V…+10V input. Used to read an analog position, speed or torque reference.
13	REF10-	Analogue input, 12-bit, negative -10V…0V input. Used to read an analog position, speed or torque reference. Connected to GND when REF5 is used.
14	REFSEL	Analogue reference selection. Connected to GND for 0…5V input range, using REF5 analogue input pin. Left unconnected for +/-10V input range, using REF10+ and REF10- analogue input pins.
15	REF5	Analogue input, 12-bit, 0-5V input. Used to read an analog position, speed or torque reference.

Pin	Name	Description
1	$+5V_{OUT}$	5V output supply for I/O usage
2	Data+/SL+	Data+ for SSI, or Slave+ for BiSS C; has 120Ω resistor between pins 2 and 3
3	Data-/SL-	Data- for SSI, or Slave for BiSS C; has 120Ω resistor between pins 2 and 3
4	B2+/Dir+	Incr. encoder2 B+ diff. input, or Dir+; has 120Ω resistor between pins 4 and 14
5	A2+/Pulse+	Incr. encoder2 A+ diff. input, or Pulse+; has 120Ω resistor between pins 5 and 15
6	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to $36V_{DC}$
7	CLK+/MA+	Clock+ for SSI, or Master+ for BiSS C
8	CLK-/MA-	Clock- for SSI, or Master- for BiSS C
9	Z2+	Incr. encoder2 Z+ diff. input
10	Z2-	Incr. encoder2 Z- diff. input
11	GND	Return ground for sensors supply
12	FDBK	Analog input, 12-bit, 0-5V. Used to read an analog position or speed feedback (as tacho), or used as general-purpose analog input
13	n.c.	Not connected
14	B2-/Dir-	Incr. encoder2 B- diff. input, or Dir-; has 120Ω resistor between pins 4 and 14
15	A2- /Pulse-	Incr. encoder2 A- diff. input, or Pulse-; has 120Ω resistor between pins 5 and 15

Pin	Name	Description
1	$+5V_{OUT}$	5V output supply for I/O usage
2	Hall 1	Digital input Hall 1 sensor
3	Hall 2	Digital input Hall 2 sensor
4	B1+/Cos+	Incr. encoder1 B+ diff. input, or analogue encoder Cos+ diff. input; has 120Ω resistor between pins 4 and 14
5	A1+/Sin+	Incr. encoder1 A+ diff. input, or analogue encoder Sin+ diff. input; has 120Ω resistor between pins 5 and 15
6...8	n.c.	Not connected
9	Z1+	Incr. encoder1 Z+ diff. input; has 120Ω resistor between pins 9 and 10
10	Z1-	Incr. encoder1 Z- diff. input; has 120Ω resistor between pins 9 and 10
11	GND	Return ground for sensors supply
12	Temp Mot	Analogue input, 12-bit, 0-3.3V. Used to read an analogue temperature value
13	Hall 3	Digital input Hall 3 sensor
14	B1-/Cos-	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input; has 120Ω resistor between pins 4 and 14
15	A1- /Sin-	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input; has 120Ω resistor between pins 5 and 15

Pin	Name	Description
1	A/A+	**Phase A** for 3-ph motors, A+ for 2-ph steppers, Motor+ for DC brush motors
2	B/A-	**Phase B** for 3-ph motors, A- for 2-ph steppers, Motor- for DC brush motors
3	C/B+	**Phase C** for 3-ph motors, B+ for 2-ph steppers
4	CR / B-	**Chopping Resistor output/ Phase B-** for step motors
5	Earth	Earth connection

LEDs		
TML LED	Green	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
	Red	Turned on when the drive detects an error condition.
EtherCAT® ST	Green	EtherCAT® ERROR and RUN indicators combined.
	Red	Shows the state of the EtherCAT® Status Machine
EtherCAT® OUT Link/Activity	Green	Shows the state of the physical link and activity.
EtherCAT® IN Link/Activity	Green	Shows the state of the physical link and activity.

3.4 Connection diagrams

3.4.1 iPOS8015 BZ-CAT connection diagram

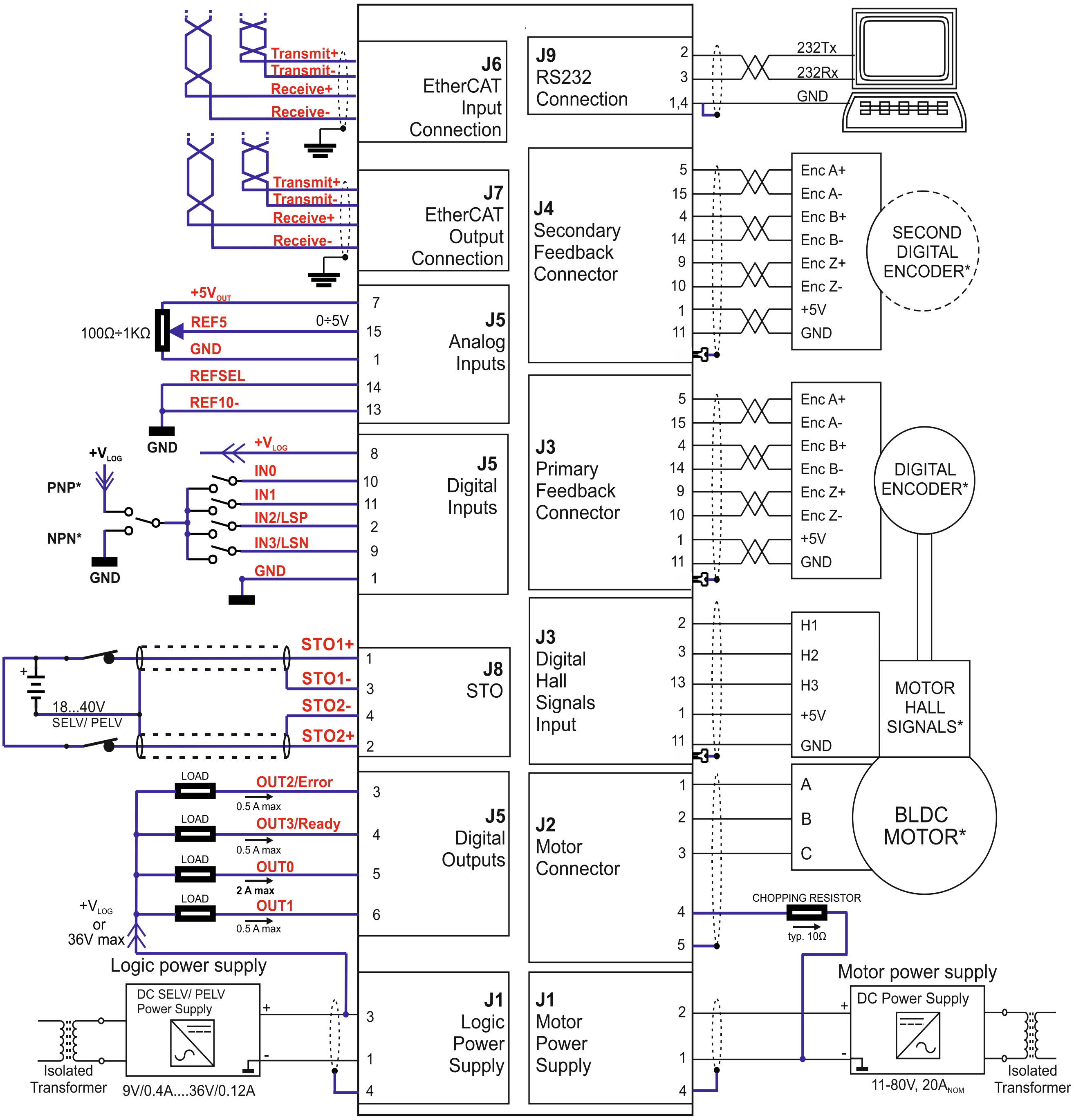


Figure 4. *iPOS8015 BZ-CAT Connection diagram*

* The digital inputs can be configured as PNP/NPN type in software setup

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

3.5 Digital I/O Connection

3.5.1 PNP inputs

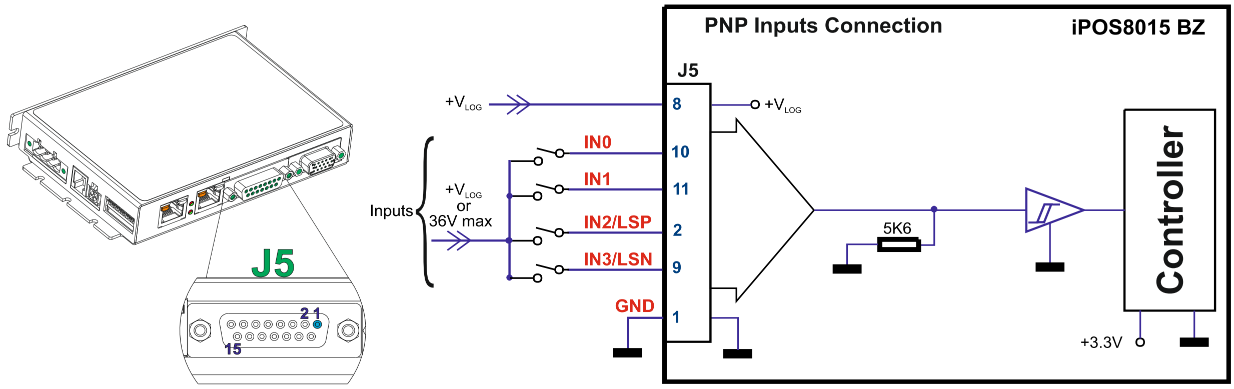


Figure 5. *24V Digital PNP Inputs connection*

Remarks:

1. *The inputs are software selectable as PNP/ NPN.*
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.*

3.5.2 NPN inputs

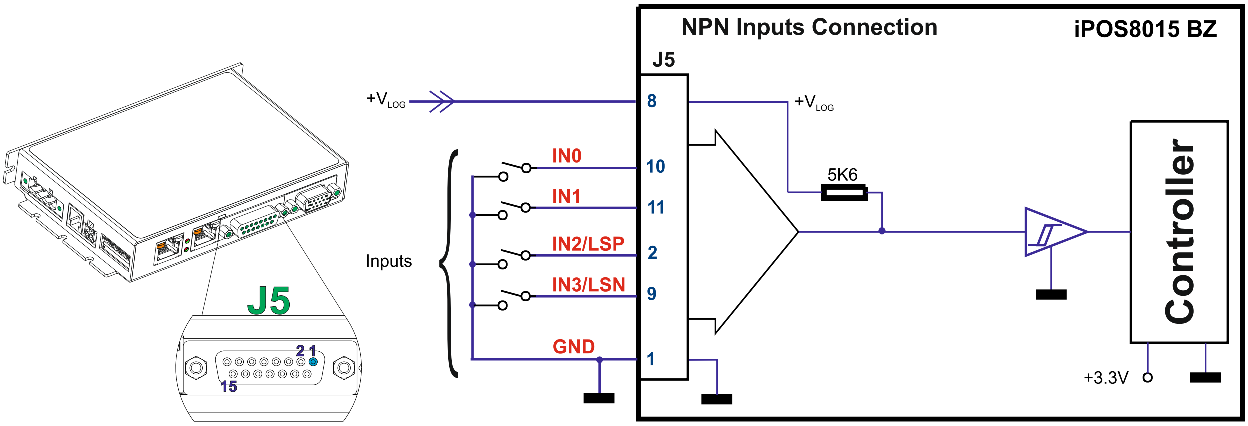


Figure 6. *24V Digital NPN Inputs connection*

Remarks:

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

3.5.3 NPN outputs

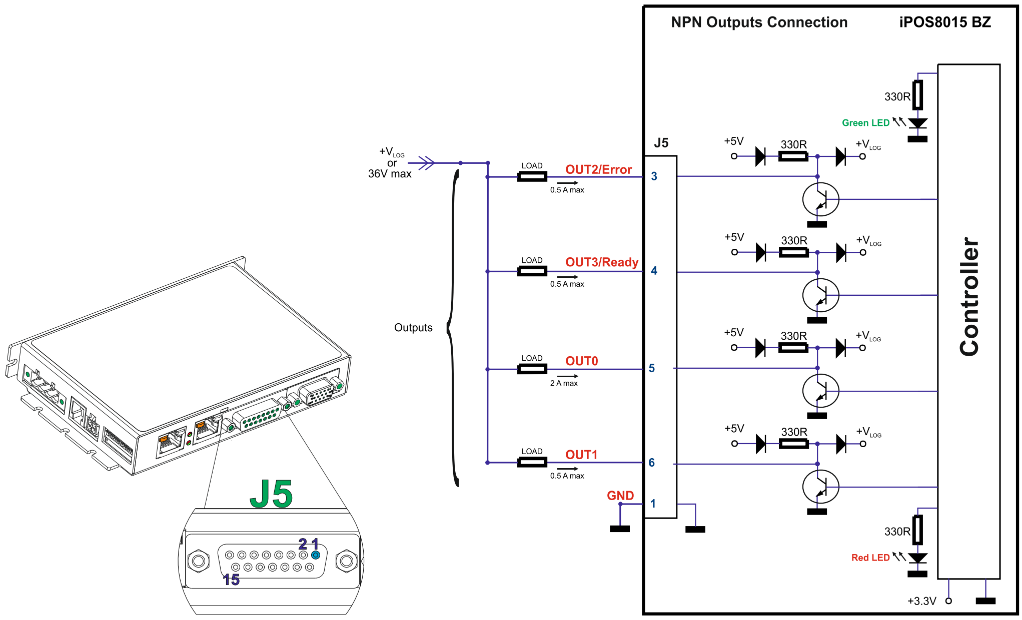


Figure 7. *24V Digital NPN Outputs connection*

Remark: *The outputs are compatible with NPN type inputs (load is tied to common +V_{LOG}, output pulls to GND when active and is floating when inactive).*

3.5.4 Solenoid driver connection for motor brake

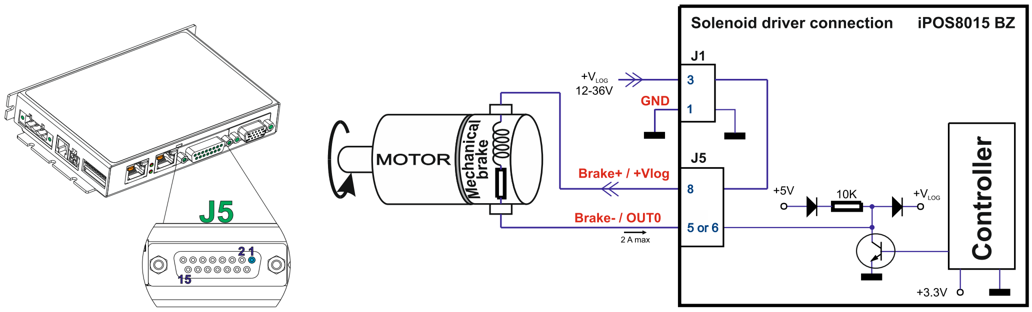


Figure 8. *Solenoid driver connection*

Remarks:

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

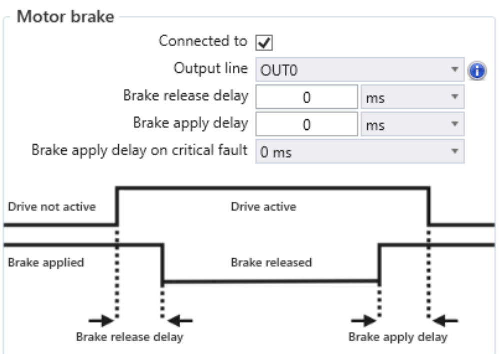


Figure 9. *Motor brake checkbox in EasyMotion Studio II*

3.6 Analog Inputs Connection

3.6.1 0-5V Input Range

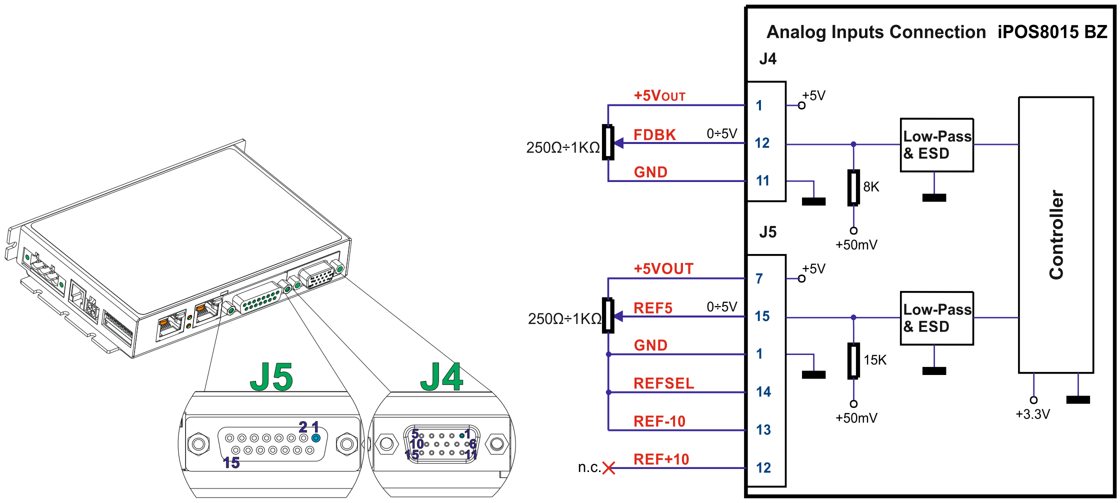


Figure 10. *0-5V Analog inputs connection*

Remark:

1. *The default input range for the feedback input is 0-5V.*
2. *The input range of the reference is hardware selectable via J5 pin 14 – REFSEL.*
3. *If REFSEL is connected to GND, 0…5V input range will be selected and REF5 analogue input pin shall be used. Also, the "REF10-" pin must be connected to GND when REF5 is used.*
4. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
5. *The switching between REF and FDBK signals can be done using the Inputs / Outputs section in EasyMotion Studio II.*

3.6.2 +/- 10V Input Range

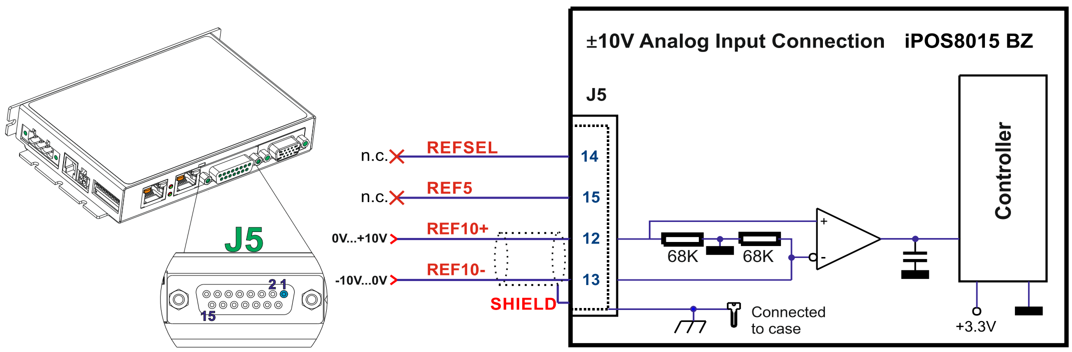


Figure 11. *±10V Analog inputs connection*

Remarks:

1. *The input range of the reference is hardware selectable via J5 pin 14 – REFSEL.*
2. *If REFSEL is left unconnected, the +/-10V input range will be selected and REF10+ and REF10- analogue input pins shall be used.*
3. *The input range for REF10+ pin is 0V…+10V.*
4. *The input range for REF10- pin is -10V…0V*
5. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
6. *The switching between REF and FDBK signals can be done using the Inputs / Outputs section in EasyMotion Studio II.*

3.6.3 Recommendation for wiring

a) If the analog signal source is single-ended, use a 2-wire shielded cable as follows: 1st wire connects the live signal to the drive positive input (+); 2nd wire connects the signal ground to the drive negative input(-).

b) If the analog signal source is differential and the signal source ground is isolated from the drive GND, use a 3-wire shielded cable as follows: 1st wire connects the signal plus to the drive positive input (+); 2nd wire connects the signal minus to the drive negative input (-) and 3rd wire connects the source ground to the drive GND

c) If the analog 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 signal plus to the drive positive input (+); 2nd wire connects the signal minus to the drive negative input (-)

d) For all of the above cases, connect the cable shield to the drive GND and leave the other shield end unconnected to the signal source. To further increase the noise protection, use a double shielded cable with inner shield connected to drive GND and outer shield connected to the motor chassis (earth).

3.7 Motor connections

3.7.1 Brushless Motor connection

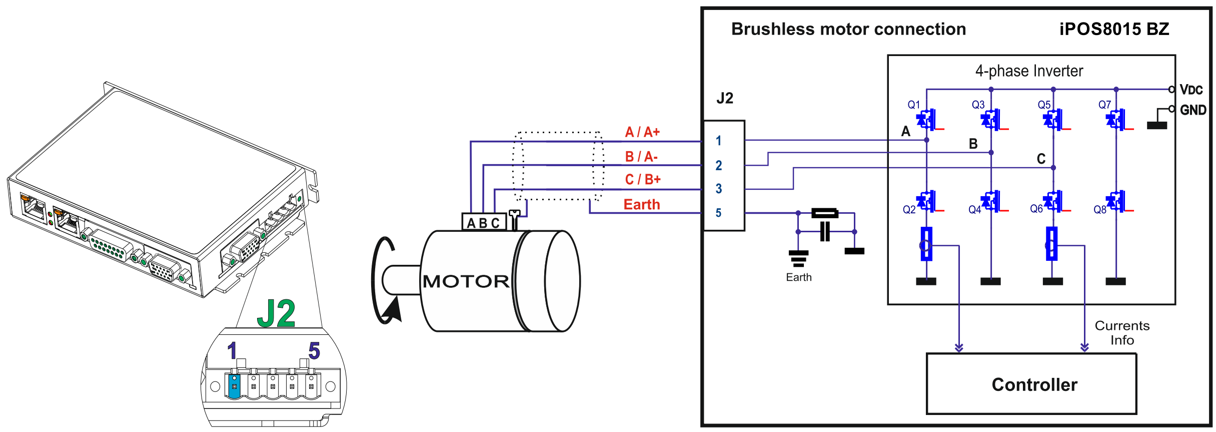


Figure 12. *Brushless motor connection*

3.7.2 2-phase Step Motor connection

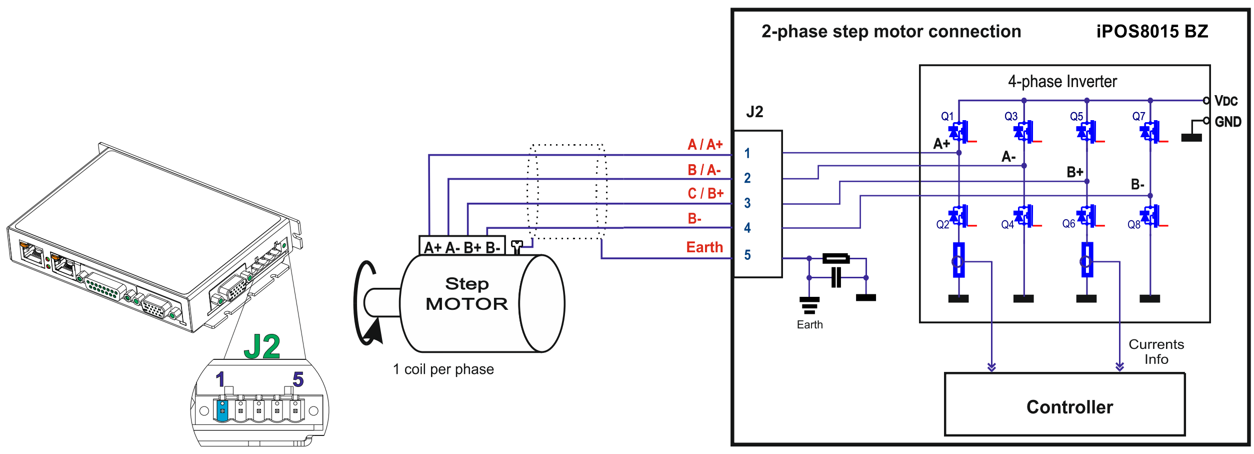


Figure 13. *2-phase step motor connection, one coil per phase*

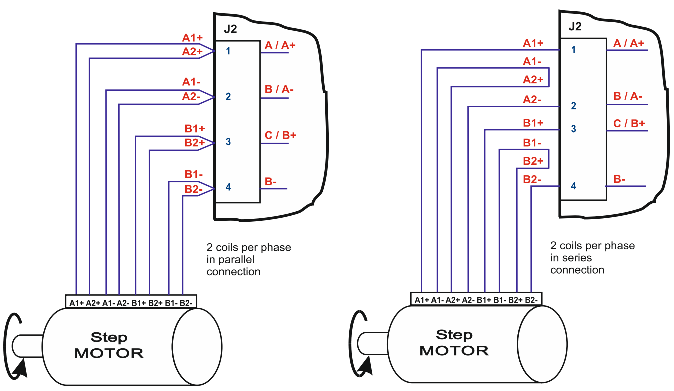


Figure 14. *2-phase step motor connection, two coils per phase*

3.7.3 3-Phase Step Motor connection

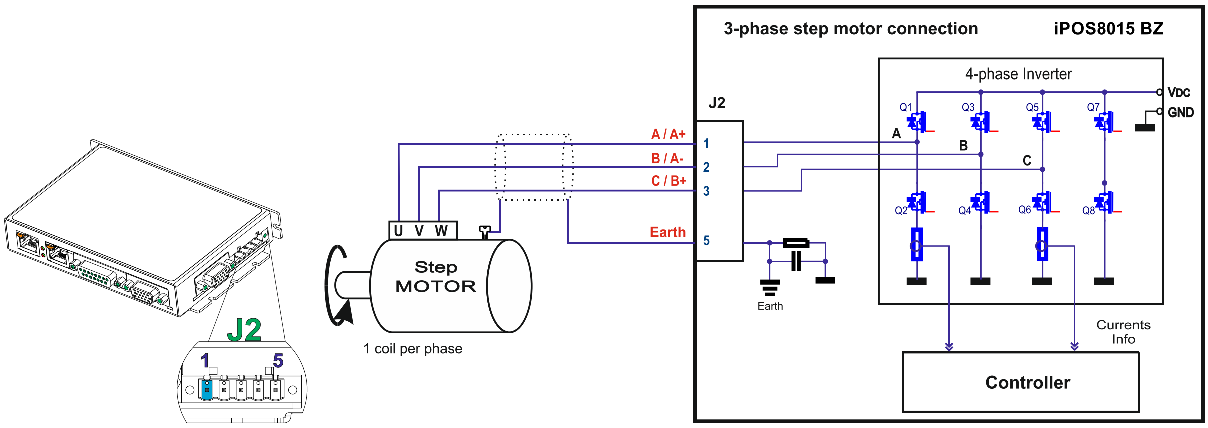


Figure 15. *3-phase step motor connection*

3.7.4 DC Motor connection

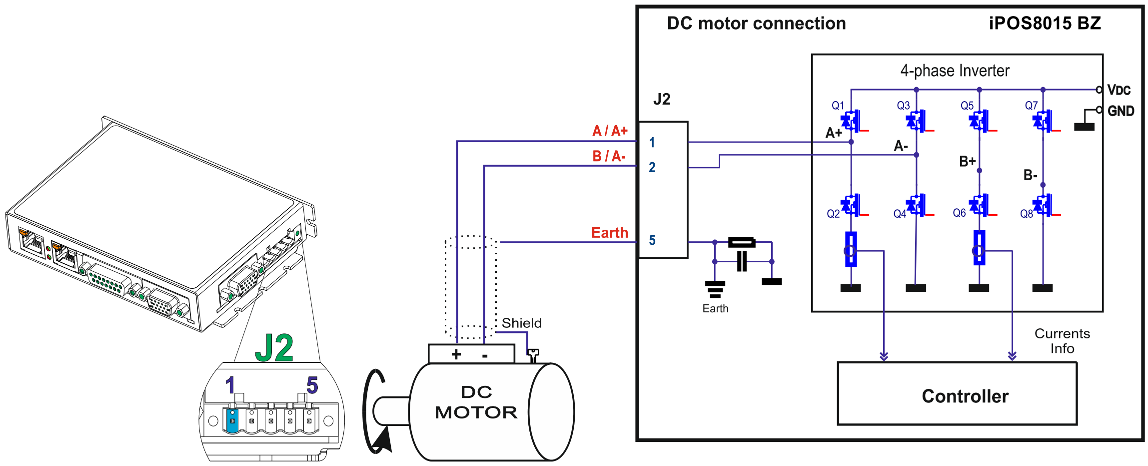


Figure 16. *DC Motor connection*

3.7.4.1 Recommendations for motor wiring

a) Avoid running the motor wires in parallel with other wires for a distance longer than 2 meters. If this situation cannot be avoided, use a shielded cable for the motor wires. Connect the cable shield to the iPOS8015 BZ PE pin and it is recommended to connect the other end to the motor chassis.

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

3.8 Feedback connections

3.8.1 Feedback #1 - Differential Incremental Encoder Connection

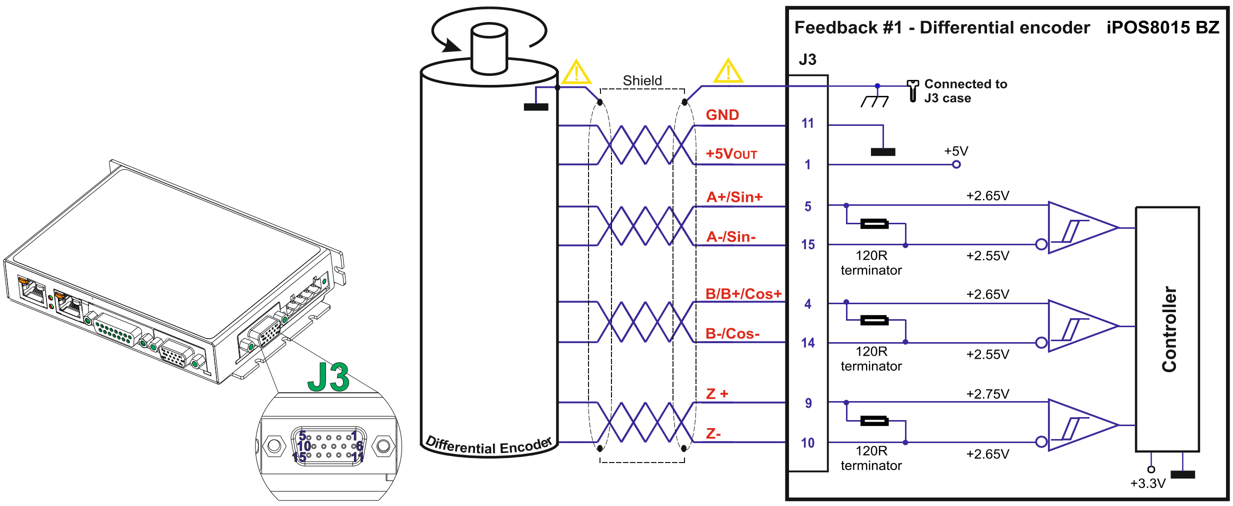


Figure 17. *Feedback #1 - Differential Incremental Encoder Connection*

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

Remarks:

1. *For Feedback #1 - Differential connection, 120Ω (0.25W) terminators are internally present in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.8.2 Feedback #2 - Differential Incremental Encoder Connection

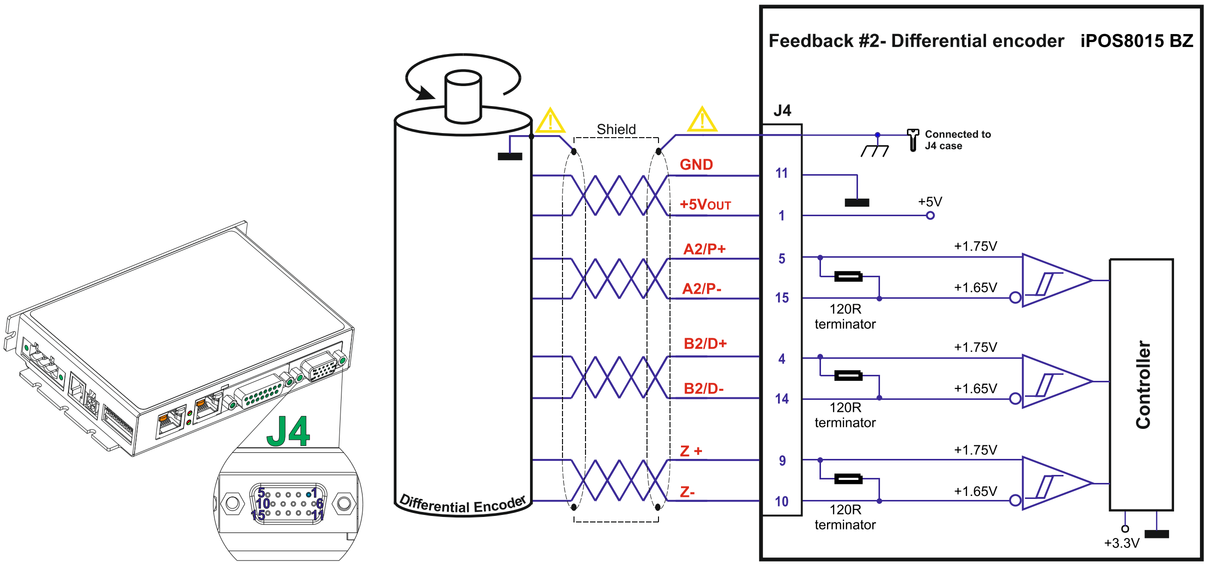


Figure 18. *Feedback #2 - Differential Incremental Encoder Connection*

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

Remarks:

1. *For Feedback #2 - Differential connection 120Ω (0.25W) terminators are internally present in the drive.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

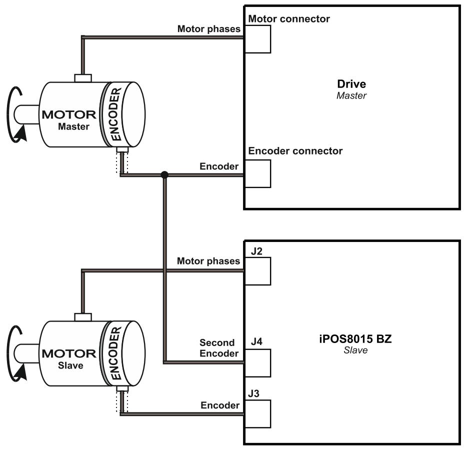


Figure 19. *Feedback #2 – Master-Slave Connection*

3.8.3 Feedback #2 - Pulse and direction connection

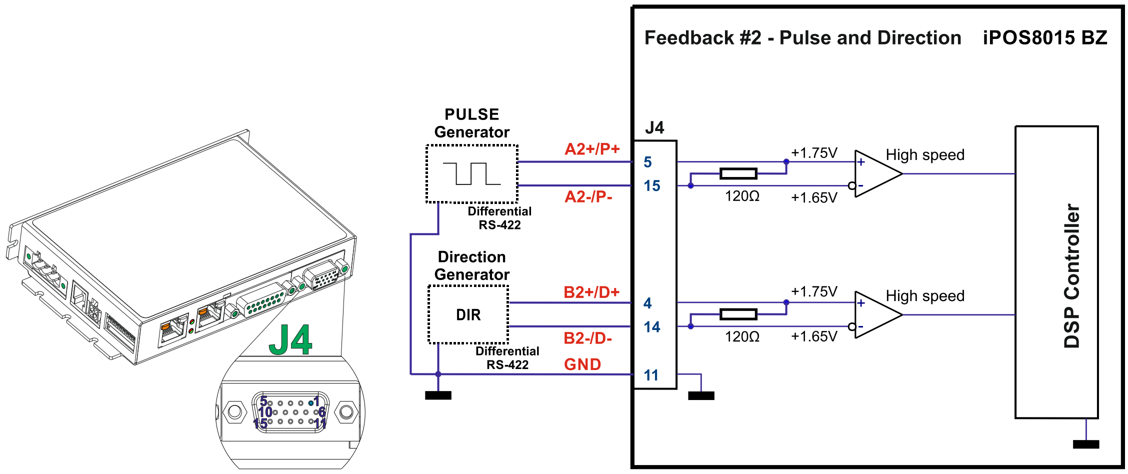


Figure 20. *Pulse and direction connection*

Remark: *The same pulse and direction connection can be done on J3 - Feedback#1 using the same pin numbers as for Feedback#2.*

3.8.4 Feedback #1 - Sine-Cosine Analog Encoder Connection

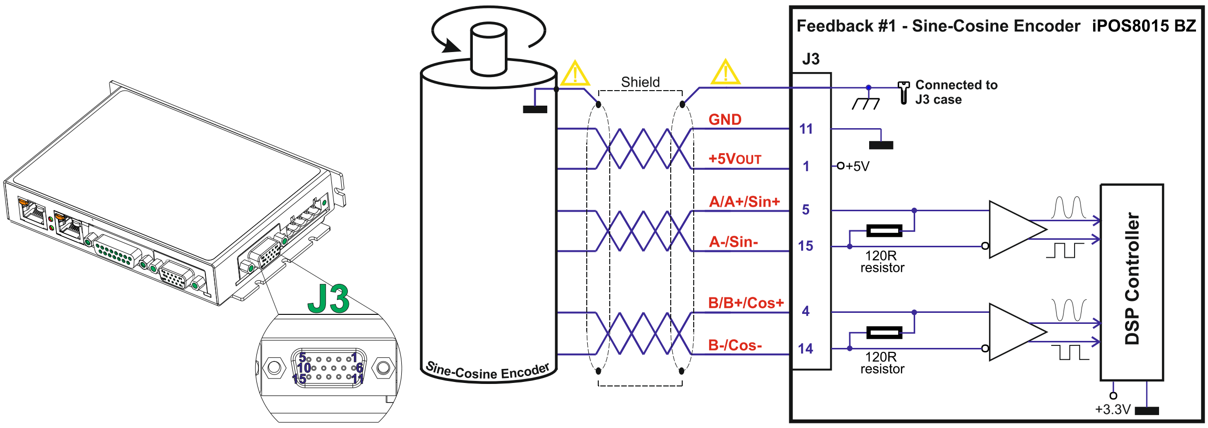


Figure 21. *Feedback #1 - Sine-Cosine analogue encoder connection*

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

Remarks:

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

3.8.5 Feedback #1 – Digital Hall Connection for Motor + Hall + Incremental or Absolute Encoder

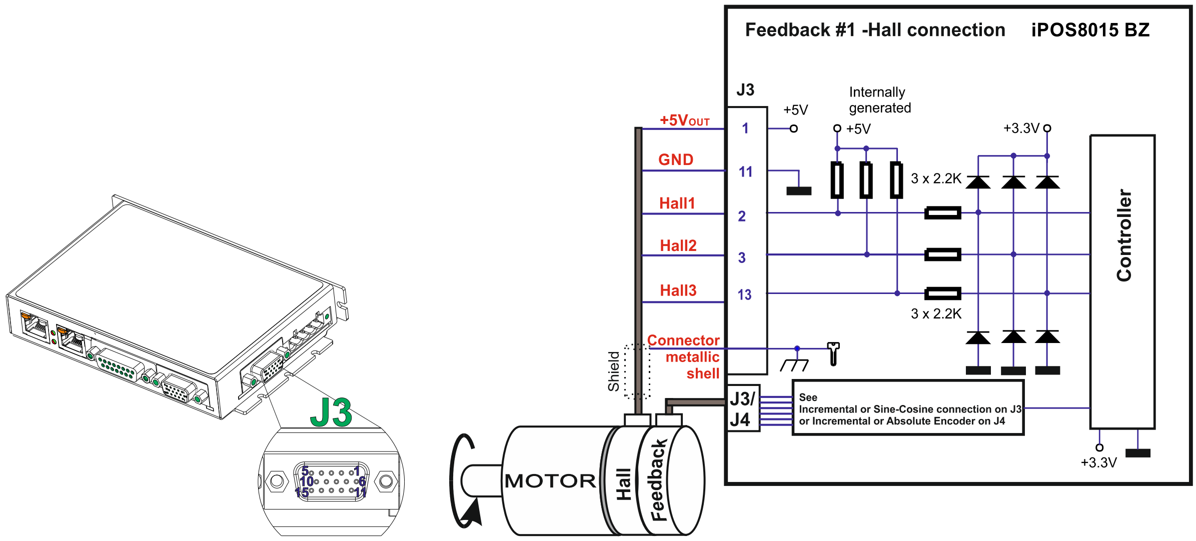


Figure 22. *Feedback #1 - Digital Hall Only connection for Motor + Hall + Incremental or Absolute Encoder*

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

Remarks:

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

3.8.6 Feedback #1 – Digital Hall Connection for Motor + Digital Hall only control

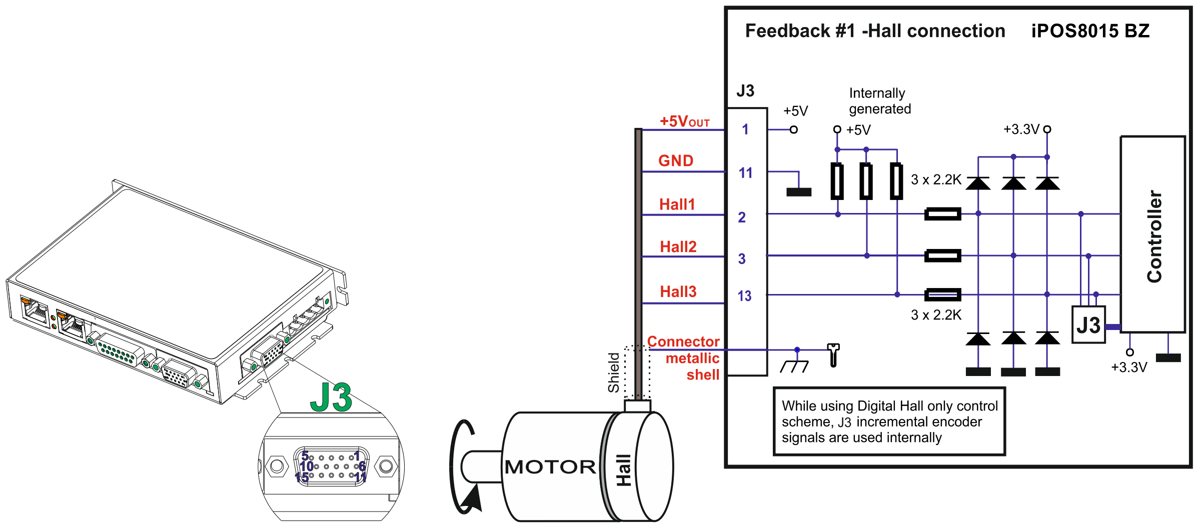


Figure 23. *Feedback #1 - Digital Hall Connection for Motor + Digital Hall only control*

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

Remarks:

1. *This connection is required when using the digital Halls as the only feedback device for the motor control.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*
3. *While using this control scheme, the incremental encoder signals from J3 are used internally by the drive*

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

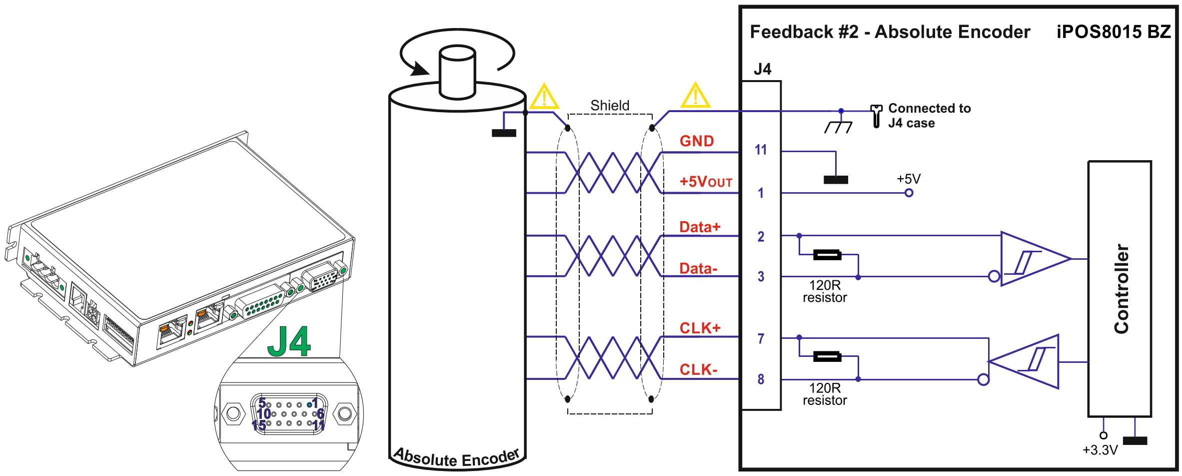


Figure 24. *Feedback #2 – Absolute Encoder Connection*

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

Remarks:

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

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

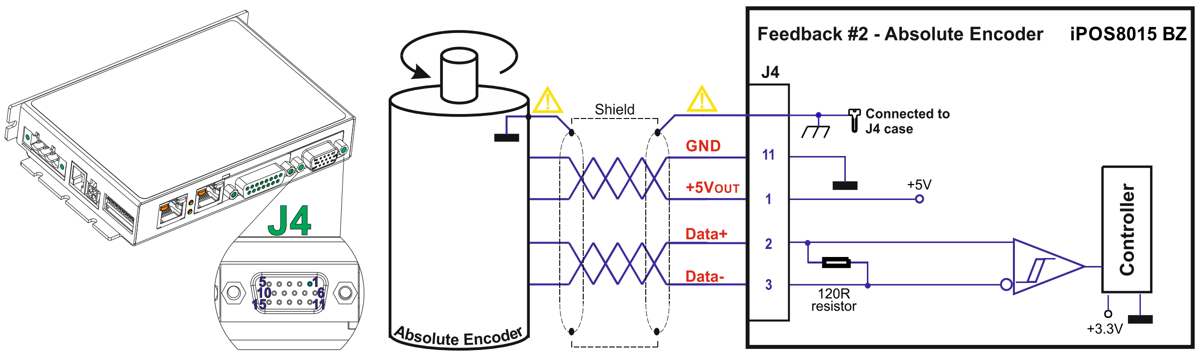


Figure 25. *Feedback #2 – Absolute Encoder Connection*

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

Remarks:

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

3.9 Power Supply and STO Connection

3.9.1 Supply Connection

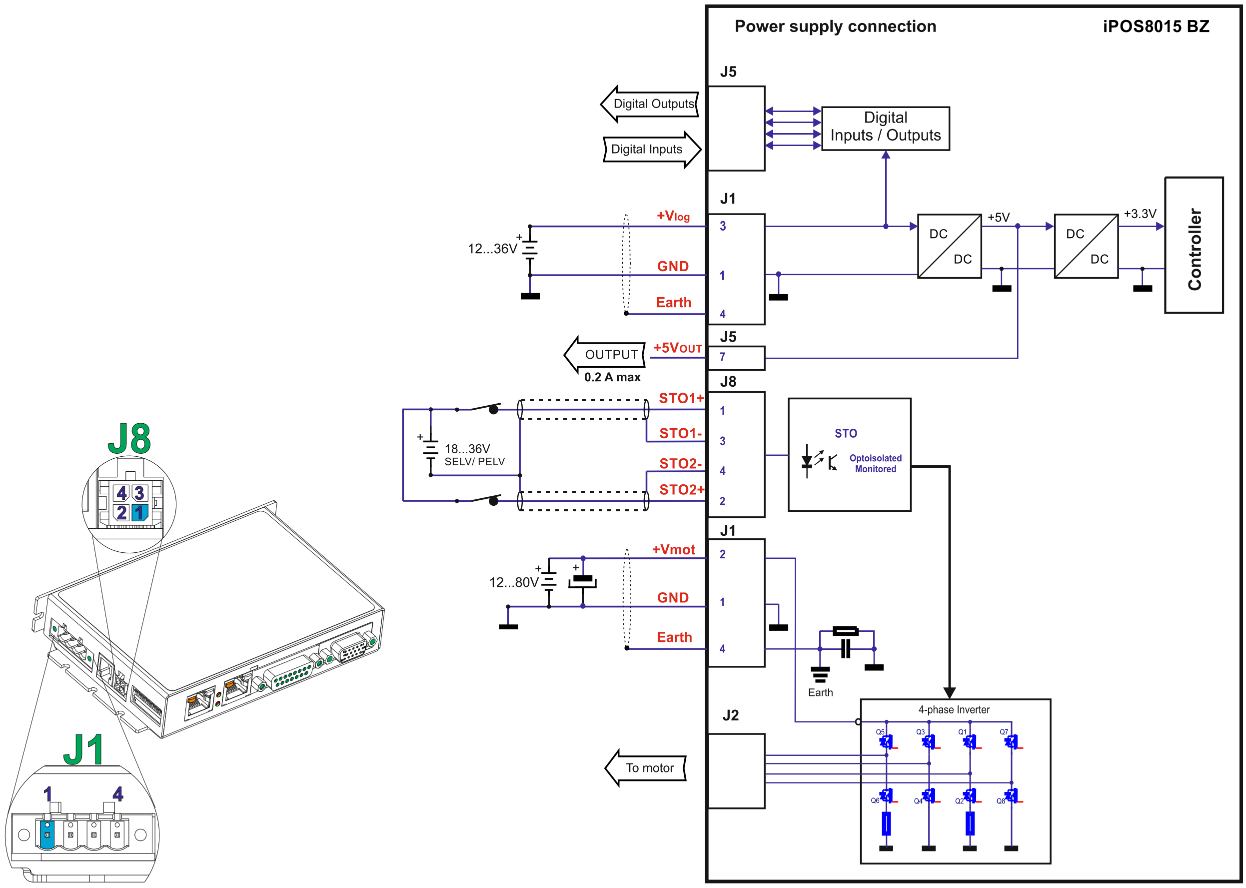


Figure 26. *Supply connection*

Remarks:

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

3.9.1.1 Recommendations for Supply Wiring

a) The iPOS8015 always requires three supply voltages: +Vlog, +Vmot and STO. The STO and +Vlog inputs can be supplied from the same power source as long as its output voltage is 18 to 36V DC from a SELV/ PELV power supply.
b) Use short, thick wires between the 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.
c) It is recommended to connect the negative motor supply return (GND) to the Earth protection near the power supply terminals.
d) The motor and logic power supply cables shield must be connected to PE (Protective Earth) – J1 pin 4 and it is recommended to be also connected to the motor chassis.

3.9.2 Recommendations to limit over-voltage during braking

During abrupt motion brakes or reversals the regenerative energy is injected into the motor power supply. This may cause an increase of the motor supply voltage (depending on the power supply characteristics). If the voltage bypasses **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:

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

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

where:

U_{MAX} = 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:

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

where:

J_M – total rotor inertia [kgm²]

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

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

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

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

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

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

h_{final} – final system altitude [m]

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

R_{Ph} – motor phase resistance [Ω]

t_d – time to decelerate [s]

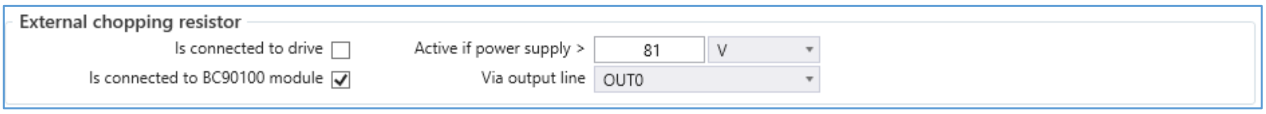
T_F – total friction torque as seen at motor shaft [Nm] – includes load and transmission

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].

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

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

The chopping resistor option can be found in the Drive Setup dialogue within EasyMotion Studio II:



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

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

Chopping resistor selection

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

1. to limit the maximum current below the drive peak current I_{PEAK} = 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}=21.15A

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

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

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

Remarks:

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

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

3.10 Communication

3.10.1 Serial RS-232 connection

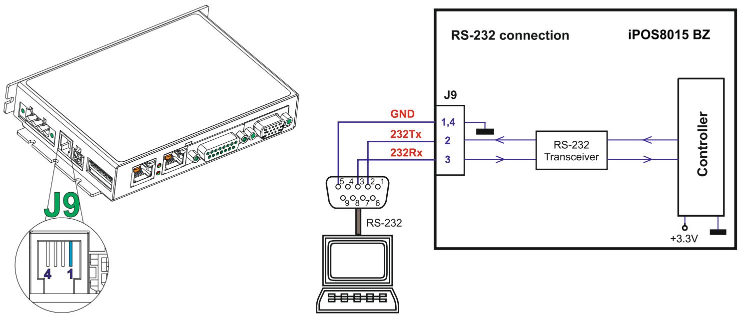


Figure 27. *Serial RS-232 connection*

3.10.1.1 Recommendation for wiring

a) If you build the serial cable, you can use a 3-wire shielded cable with shield connected to BOTH ends. Do not use the shield as GND. The ground wire (pin 1 or 4 of J9) must be included inside the shield, like the 232Rx and 232Tx signals. All metallic connector shells are connected internally to the Earth connector J1 pin 4.

b) Always power-off all the iPOS8015 BZ supplies before inserting/removing the RS-232 serial connector
c) Do not rely on an earthed PC to provide the iPOS8015 BZ GND connection! The drive must be earthed through a separate circuit. Most communication problems are caused by the lack of such connection

CAUTION!	***Do NOT CONNECT/DISCONNECT THE RS-232 CABLE WHILE THE DRIVE IS POWERED ON. THIS OPERATION CAN DAMAGE THE DRIVE***

3.10.2 Recommendations for EtherCAT Wiring

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

  See Figure *28*. EtherCAT network linear topology for a visual representation of the linear topology.
- Ring, when the J7 / OUT port of the last drive in the chain is connected back to the master controller, on the 2nd port of the master. This topology consists of the linear topology described above, plus an extra connection between the master, which has two RJ45 ports, to J7 / OUT of the last drive.

  See Figure *29*. EtherCAT network ring topology for a visual representation of the ring topology.

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

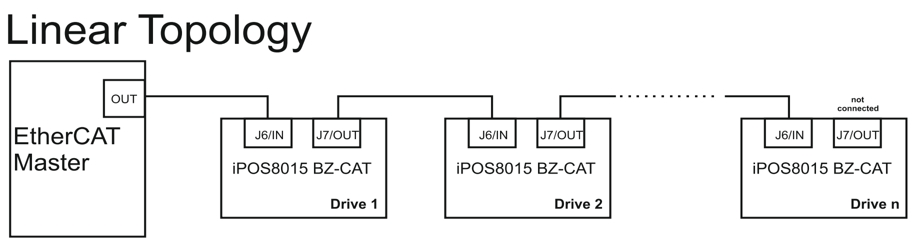


Figure 28. *EtherCAT network linear topology*

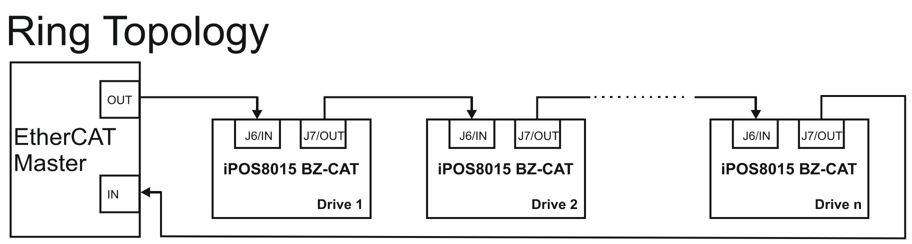


Figure 29. *EtherCAT network ring topology*

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

3.11 Disabling the setup table at startup

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).

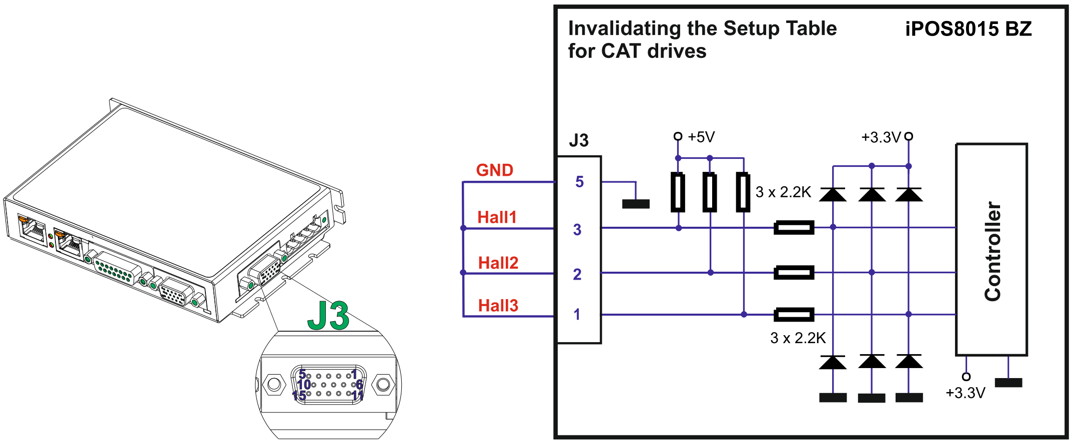


Figure 30. *Temporary connection during power-on to invalidate the Setup table*

3.12 Axis ID Selection

The iPOS8015 BZ-CAT support all EtherCAT standard addressing modes. In case of device addressing mode based on node address, the drive sets the configured station alias address with its AxisID value. The drive's AxisID value is configured after power-on by one of the following methods:

- **Software**, using EasyMotion Studio II, set a specific AxisID value in the range of 1-255 within the AxisID settings under the setup section.
- **Hardware**, in EasyMotion Studio II, select the 'H/W' option under AxisID settings in the setup section, then set **SW1** (8 pole DIN switch):
    - Switch UP -> Bit = 0
    - Switch DOWN -> Bit = 1

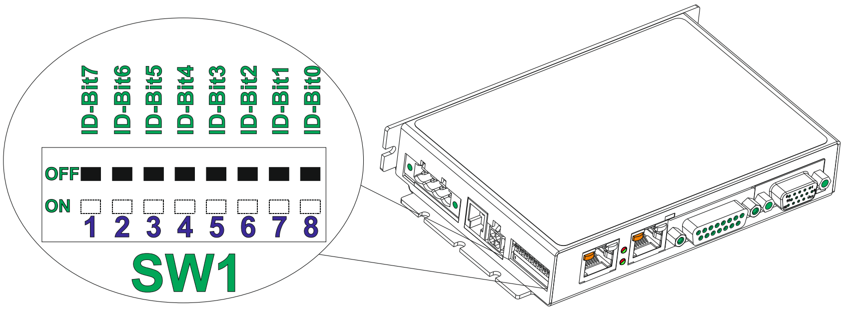


Figure 31. *Axis ID pins for EtherCAT*

Remarks:

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

3.13 LED indicators

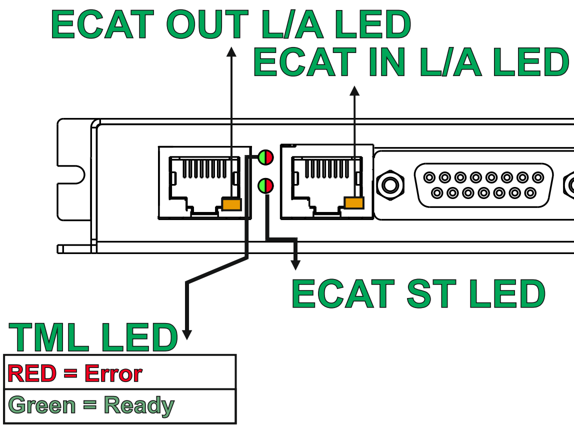


Figure 32. *LED indicators*

Table 1. *LED indicators*

LED no.	LED name	LED color	Function
1	TML LED	green	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
		red	Turned on when the drive detects an error condition.
2	EtherCAT® ST	red and green	EtherCAT® ERROR and RUN indicators combined. Shows the state of the EtherCAT® Status Machine
3	EtherCAT® OUT Link/Activity	green	Shows the state of the physical link and activity.
4	EtherCAT® IN Link/Activity	green	Shows the state of the physical link and activity.

3.13.1 EtherCAT® ST LED indicator

The STATUS indicator displays the RUN states with a 180 degree phase shift to the ERROR states. An example is noted in Figure *33.* STATUS indicator Example.

In case of a conflict between turning the indicator on green versus red, the indicator shall be turned to red. Apart from this situation, the bi-color STATUS indicator combines the behavior of the RUN indicator specified in Table 2. RUN Indicator States and the behavior of the ERROR indicator specified in Table 3. ERROR Indicator States.

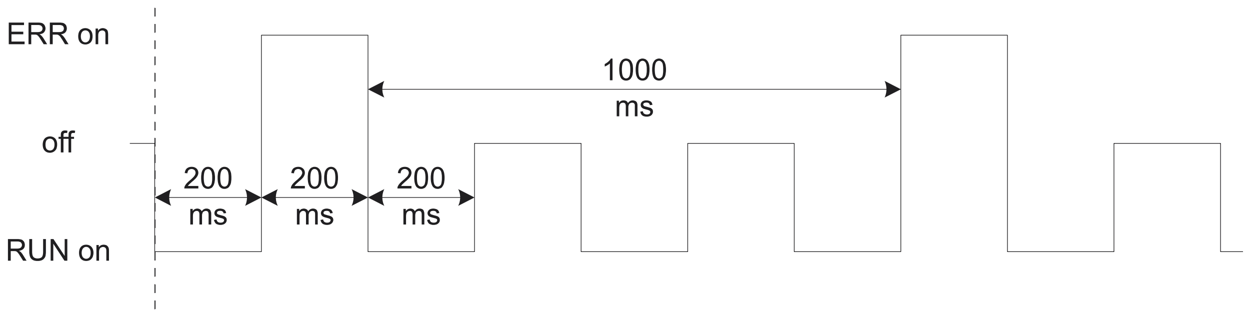


Figure 33. *STATUS indicator Example*

Table 2. *RUN Indicator States*

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

Table 3. *ERROR Indicator States*

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

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

3.14 Electrical Specifications

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

T_{amb} = 0…40°C, V_{LOG} = 24 V_{DC}; V_{MOT} = 80V_{DC}; Supplies start-up / shutdown sequence: -*any*-

Load current (sinusoidal amplitude / continuous BLDC, DC, stepper) = 15A RMS

3.14.1 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	2	Km
	Ambient Pressure	0 [2]	0.75 ÷ 1	10.0	atm

3.14.2 Storage Conditions

		Min.	Typ.	Max.	Units
Ambient temperature		-40		+85	ºC
Ambient humidity	Non-condensing	0		100	%Rh
Ambient Pressure		0		10.0	atm

3.14.3 Mechanical Mounting

			Min.	Typ.	Max.	Units
Airflow		natural convection, closed box				
Spacing required for horizontal mounting	drive facing the wall	on the connector side, with a D-SUB connector facing the wall	50			mm
		on the connector side, with a D-SUB connector away from the wall	5			
		on the side without connectors	10			
	between adjacent drives	with both drives facing each other on the sides with a D-SUB connector	100			
		with both drives facing each other, one side having a D-SUB connector and the other without	50			
		with both drives facing each other on the sides without connectors	10			

3.14.4 Environmental Characteristics

		Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Global size without mating connectors	139 x 94.2 x 24.5			mm
		~5.47 x 3.7 x 0.97			inch
Weight		253			g
Voltage Efficiency	F_{PWM} = 20 kHZ		95.2		%
	F_{PWM} = 100 kHZ		75.13		
Surface temperature	Idle (I_{MOT} = 0A)		55		ºC
	Full power (I_{MOT} = nominal)			100	
Cleaning agents	Dry cleaning is recommended	Only Water- or Alcohol- based			
Protection degree	According to IEC60529, UL508	IP20			-
Power dissipation	Idle (I_{MOT} = 0A)		2		W
	Full power (I_{MOT} = nominal)		8		

3.14.5 Logic Supply Input (+V_{LOG})

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	24	36	V_{DC}
	Absolute maximum values, drive operating but outside guaranteed parameters	8	24	40	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †	-1		+45	V
	+V_{LOG} = 12V		270	280	mA
	+V_{LOG} = 24V		160	170	
	+V_{LOG} = 36V		125	130	
Utilization category	Acc. to 60947-4-1 (I_{PEAK}<=1.05*I_{NOM})	DC-1			

[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.

3.14.6 Motor Supply Input (+V_{MOT})

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	80	90	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	±22	+40	A
	Absolute maximum value, short-circuit condition (duration ≤ 10ms) †			45	A
Voltage measurement error			±0.3	±0.5	V
Utilization category	Acc. to 60947-4-1 (I_{PEAK}<=4.0*I_{NOM})	DC-3			

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

				Min.	Typ.	Max.	Units
Nominal current (without heatsink)	PMSM motors sinusoidal amplitude					18.4	A
	PMSM motors sinusoidal RMS					13	A_{RMS}
	DC/BLDC/STEP motors continuous					16	A
Nominal current (with heatsink)	PMSM motors sinusoidal amplitude					21	A
	PMSM motors sinusoidal RMS					15	A_{RMS}
	DC/BLDC/STEP motors continuous					22	A
Peak current	Maximum 10s			-40		+40	A
Short-circuit protection threshold		20A peak range				±22.5	A
		40A peak range				±45	
Short-circuit protection delay				5	10		μs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance				±0.3	±0.5	V
Off-state leakage current					±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value to avoid spurious short-circuit protection, triggered by ripple	Fast loop[1]	V_{MOT}				μH
		50μs	48V		133		
		100μs	48V		266		
		50μs	24V		66		
		100μs	24V		133		
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	Crt Scale = 40A	Noise (I<=5A)			±25	±35	mA
		Noise (I>=5A)			±110	±130	
	Crt Scale = 20A	Noise (I<=2.5A)			±15	±25	
		Noise (I>=2.5A)			±60	±70	

3.14.8 Digital Inputs (IN0, IN1, IN2/LSP, IN3/LSN)[2]

		Min.	Typ.	Max.	Units
Mode compliance		PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic "LOW"	-36	0	2.4	V
	Logic "HIGH"	7.5	24	36	
	Hysteresis	1.2	2.4	2.8	
	Floating voltage (not connected)		0		
	Absolute maximum, continuous	-36		+39	
	Absolute maximum, surge (duration ≤ 1s) †	-50		+50	
Input current	Logic "LOW"; Pulled to GND		0		mA
	Logic "HIGH"; Pulled to 24V		9	10	

		Min.	Typ.	Max.	Units
Mode compliance		NPN			
Default state	Input floating (wiring disconnected)	Logic HIGH			
Input voltage	Logic "LOW"	-36	0	2.2	V
	Logic "HIGH"	7.5		36	
	Hysteresis	1.2	2.4	2.8	
	Floating voltage (not connected)		23		
	Absolute maximum, continuous	-36		+39	
	Absolute maximum, surge (duration ≤ 1s) †	-50		+50	
Input current	Logic "LOW"; Pulled to GND		8	10	mA
	Logic "HIGH"; Pulled to +24V	0	0	0.4	
Input frequency		0		150	kHz
Minimum pulse width		3.3			μs
ESD protection	Human body model	±2			kV

3.14.9 Supply Output (+5V)

		Min.	Typ.	Max.	Units
+5V output voltage	Current sourced = 250mA	4.8	5	5.2	V
+5V output current		350	400		mA
Short-circuit protection		NOT protected			
Over-voltage protection		NOT protected			
ESD protection	Human body model	±2			kV

[1] Fast loop period of 50μs is not possible with all feedback device types.

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

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

			Min.	Typ.	Max.	Units
Mode compliance	All outputs (OUT0, OUT1, OUT2/Error, OUT3/Ready)		NPN 24V			
Load type			Resistive, Inductive			
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	OUT0, OUT1, OUT2/ Error, OUT3/ Ready	Logic "HIGH"			
	Normal operation	OUT0, OUT1, OUT2/Error	Logic "HIGH"			
		OUT3/Ready	Logic "LOW"			
Output voltage	Logic "LOW"; output current = 2A for OUT0/ 0.5A for the other digital outputs				0.8	V
	Logic "HIGH"; output current = 0, no load	OUT0, OUT1, OUT2/Error, OUT3/ Ready	4	4.5	5	V
	Logic "HIGH", external load to +V_{LOG}			V_{LOG}		
	Absolute maximum, continuous		-0.5		V_{LOG}+0.5	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic "LOW", sink current, continuous	OUT1, OUT2, OUT3			0.5	A
		OUT0			2	A
	Logic "HIGH", source current; external load to GND; V_{OUT} >= 2.0V	OUT0, OUT1, OUT2/Error, OUT3/ Ready			7	mA
	Logic "HIGH", leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 40V			0.05	0.7	mA
Minimum pulse width			0.5			µs
ESD protection - Human body model			±15			kV

3.14.11 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"	1.8			V
	Floating voltage (not connected)		4.5		V
	Absolute maximum, surge (duration ≤ 1s) †	-10		+15	V
Input current	Logic "LOW"; Pull to GND		5	3	mA
	Logic "HIGH"; Internal 1KΩ pull-up to +5	0	0	0	mA
Minimum pulse width		2			µs
ESD protection	Human body model	±5			kV

3.14.12 Encoder Inputs (A1+, A1-, B1+, B1-, Z1+, Z1-,)

		Min.	Typ.	Max.	Units
Differential mode compliance	For full RS422 compliance, see [1]	TIA/EIA-422-A			
Input voltage, differential mode	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	V
	Common-mode range (A+ to GND, etc.)	-11		+14	V
Input impedance, differential	A1+, A2+, B1+, B2+, Z1+, Z2+		2.2		kΩ
	A1-, A2-, B1-, B2-, Z1-, Z2-		1.6		kΩ
	Differential mode	0		10	MHz
	Differential mode	50			ns
ESD protection	Human body model	±3			kV

3.14.13 Sin-Cos Encoder Inputs (Sin+, Sin-, Cos+, Cos-)

		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	V
	Absolute maximum, surge (duration ≤ 1s) †	-11		+14	V
Input impedance	Differential, Sin+ to Sin-, Cos+ to Cos-	4.2	4.7		kΩ
	Common-mode, to GND		2.2		kΩ
Resolution with interpolation	Software selectable, for one sine/cosine period	2		10	bits
Frequency	Sin-Cos interpolation	0		450	kHz
	Quadrature, no interpolation	0		10	MHz
ESD protection	Human body model	±2			kV

3.14.14 Absolute encoder interface: SSI, BiSS-C, EnDAT, Nikon, Sanyo Denki, Panasonic, Tamagawa

		Min.	Typ.	Max.	Units
Differential mode compliance (CLOCK, DATA) [1]		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	V
Output Short-circuit protection	Yes, protected			±160	mA
CLOCK frequency – Software selectable	Nikon, Sanyo Denki	2.5, 4			MHz
	Panasonic, Tamagawa	2.5			MHz
	SSI	1, 2, 3			MHz
	BiSS-C	1, 2, 3, 4			MHz
	EnDAT	2, 3, 4			MHz
DATA Input hysteresis	Differential mode	±0.1	±0.2	±0.5	V
Data input impedance	Termination resistor on-board		120		Ω
DATA Input common mode range	Referenced to GND	-7		+12	V
	Absolute maximum, surge (duration ≤ 1s) †	-25		+25	V
DATA format	Software selectable	Binary / Gray			
		Single-turn / Multi-turn			
		Counting direction			
DATA resolution	Single-turn			56	bit
	Multi-turn and single-turn				
If total resolution >31 bits, some bits must be ignored by software setting to achieve a max 31 bits resolution					

[1] All differential input pins have internal 120 Ω termination resistors connected across

3.14.15 Analog 0…5V Inputs (REF, FDBK)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-0.5		+9.5	
	Absolute maximum, surge (duration ≤ 1s) †	-1		±10	
Input impedance	To GND		10		kΩ
Resolution			12		bits
Integral linearity				±4	LSB
Differential Linearity	No missing codes			±1	LSB
Offset error				200	mV
Gain error			±1%	±3%	% FS[1]
Bandwidth (-3dB)	Software selectable	0		600	Hz
ESD protection	Human body model	±2			kV

3.14.16 Analog ±10V Input (REF)

		Min.	Typ.	Max.	Units
Differential voltage range			±10		V
Common-mode voltage range	Referenced to GND	-12	0…10	+50	V
Input impedance	Differential		40		kΩ
Common-mode impedance	Referenced to GND		20		kΩ
Resolution			12		bits
Integral linearity				±4	LSB
Differential Linearity	No missing codes			±1	LSB
Offset error	Common-mode voltage = 0…10 V			1	V
Gain error	Common-mode voltage = 0…10 V		±10	±12	%FS[1]
Bandwidth (-3dB)	Depending on software settings		600		Hz

3.14.17 RS-232

		Min.	Typ.	Max.	Units
Standards compliance		TIA/EIA-232-C			
Bit rate	Depending on software settings	9600		115200	Baud
Short-circuit protection	232TX short to GND	Guaranteed			
ESD protection	Human body model	±2			kV
Output voltage		±5	±7.8		V
Input voltage	Absolute maximum, continuous	-30		+30	V

3.14.18 EtherCAT ports J6 and J7

		Min.	Typ.	Max.	Units
Compliance		IEEE802.3, IEC61158			
J6, J7 pinout	EtherCAT® supports MDI/MDI-X auto-crossover	TIA/EIA-568-A or TIA/EIA-568-B			
Software protocols compatibility		CoE, CiA402, IEC61800-7-301			
Transmission line	According to TIA/EIA-568-5-A	5	5e	6	Category
		UTP	FTP	STP	Shield
Auto	swap + / - inside a pair	Yes (MLT3 encoding)			
	swap Rx / Tx pairs	Yes (auto-MDI/MDIX)			
	Swap port0(IN) / port1(OUT)	NO (EtherCAT requirement)			
Node addressing	By hardware DIP switch	1 ÷ 255			-
	By software				
MAC addressing		none			-
ESD protection	Human body model	±15			kV

3.14.19 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 $+V_{log}$		5	13	
Repetitive test pulses (high-low-high)	Ignored high-low-high			5	ms
				20	Hz
Fault reaction time	From internal fault detection to register DER bit 14 =1 and OUT2/Error high-to-low			30	ms
PWM operation delay	From external STO low-high transition to PWM operation enabled			30	ms
ESD protection	Human body model	±2			kV

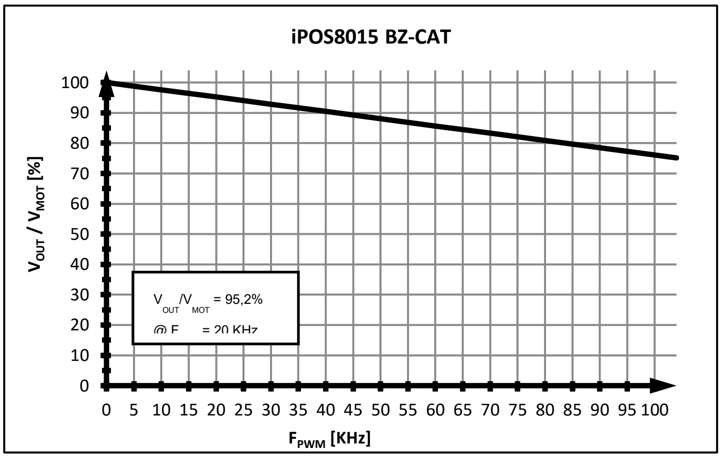
3.14.20 Conformity

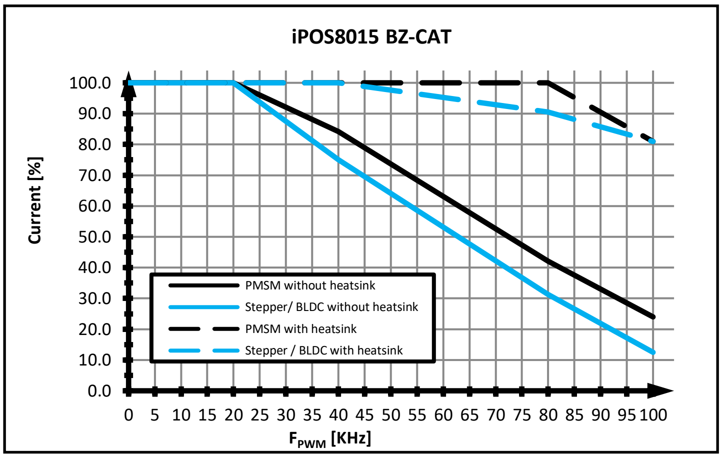
		Min.	Typ.	Max.	Units
EU Declaration	2014/30/EU (EMC), 2014/35/EU (LVD), 2011/65/EU (RoHS), 1907/2006/EC (REACH), 93/68/EEC (CE Marking Directive), EC 428/2009 (non dual-use item, output frequency limited to 590Hz)				

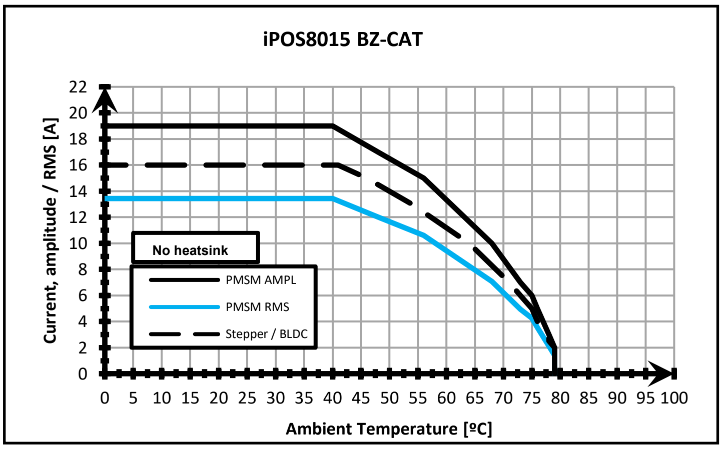
† Stresses beyond values listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

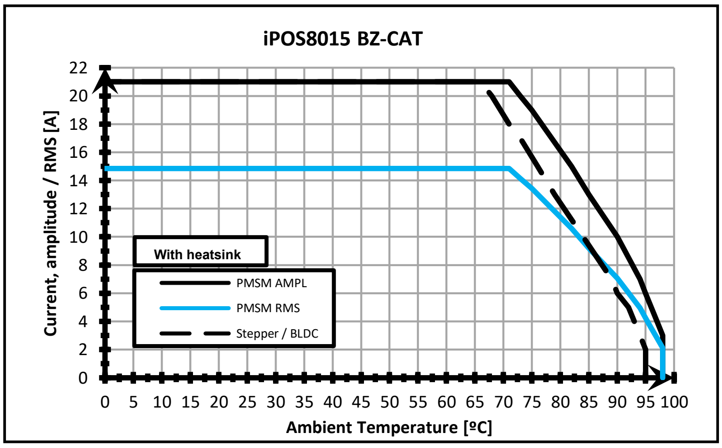
[1] "FS" stands for "Full Scale"

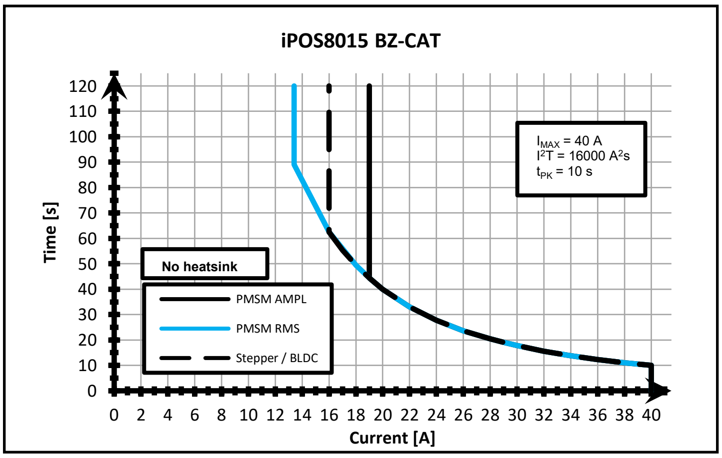
3.14.21 Derating curves

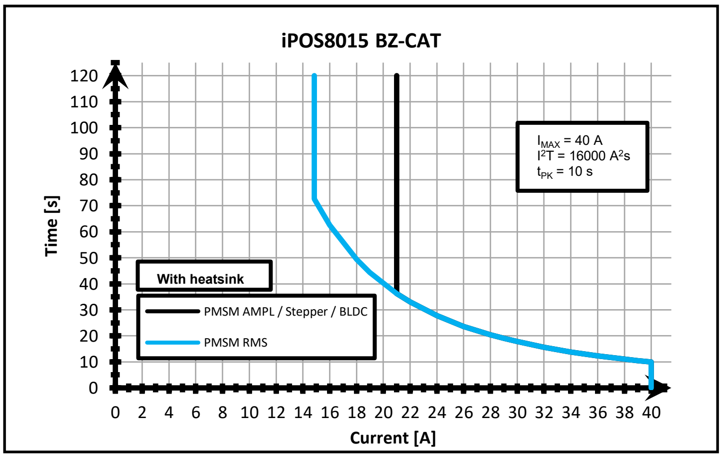


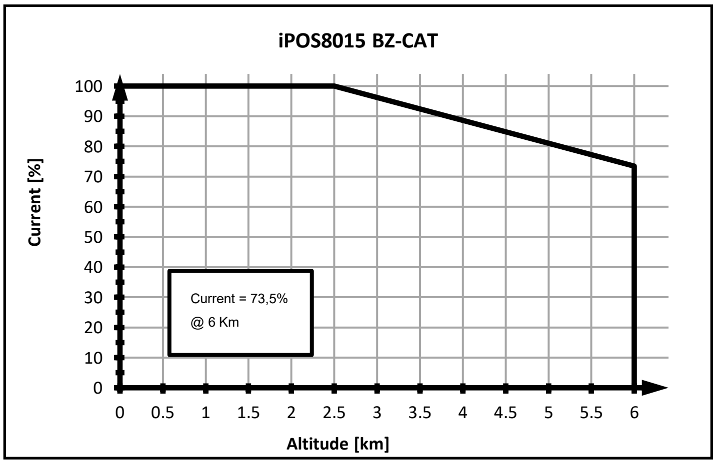












4 Memory Map

iPOS8015 BZ has 2 types of memory available for user applications: 16K×16 SRAM and up to 24K×16 serial E^2ROM.
The SRAM memory is mapped in the address range: C000h to FFFFh. It can be used to download and run a TML program, to save real-time data acquisitions and to keep the cam tables during run-time.
The E^2ROM 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 "Memory Settings" dialogue of each application*

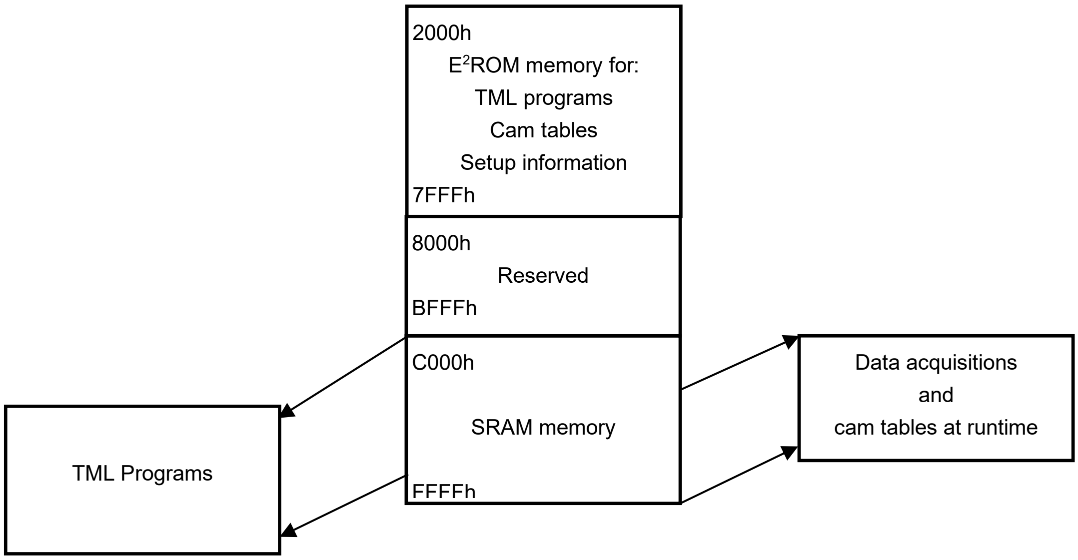


Figure 34. *iPOS8015 BZ Memory Map*