iGVD71
BX-CAT

Intelligent Servo Drive for DC and Brushless Motors

TECHNOSOFT

Intelligent Servo Drives

Technical Reference

P025.027.iGVD71.CAT.UM.1123

1 Read This First

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

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2 About This Manual

This book is a technical reference manual for:

Product Name	Part Number	Output current		Communication
		Nominal	Peak	
iGVD71 BX-CAT	**P025.027.E221**	71 A_{RMS} / 100A amplitude	100 A_{RMS} / 140A amplitude	EtherCAT

In order to operate the **iGVD71** drives, you need to pass through 3 steps:

- **Step 1 Hardware installation**
- **Step 2 Drive setup** using Technosoft **EasySetUp** software for drive commissioning
- **Step 3 Motion programming** using one of the options:
  - An **EtherCAT® master**
  - The drives **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft **EasyMotion Studio** 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 **iGVD71 BX** hardware including the technical data, the connectors and the wiring diagrams needed for installation.

For Step 2 and 3, please consult the document **EasyMotion Studio – Quick Setup and Programming Guide**. For detailed information regarding the next steps, refer to the related documentation.

3 Notational Conventions

This document uses the following conventions:

- **iGVD71** – 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®

4 Trademarks

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

5 Related Documentation

iGVD71 BX-CAT Datasheet (P025.027.E221.DSH)

iGVD71 BX-CAT Connection Diagram (P025.027.E221.CDG)

– describes the hardware connections of the iGVD BX intelligent servo drive 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 – Quick Setup and Programming Guide (P091.034.ESM-Quick.Setup.and.Programming.Guide.UM.xxxx) – describes the compatible software installation, drive software setup commissioning, introduction to TML motion programming and motion evaluation tools.

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

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

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

6 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

7 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***

7.1 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***

7.2 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.

7.3 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/

8 Product Overview

8.1 Introduction

The **iGVD71** is part of the **iPOS** family of fully digital servo drives, based on the latest DSP technology, offering the highest density of power and intelligence.

Suitable for control of **brushless DC**, **brushless AC** (vector control) and **brushed DC** motors, the **iGVD71** accept as position feedback **incremental encoders** (differential or single-ended), **digital Hall** signals (differential or single-ended) and **absolute encoders** (BISS-C / SSI / EnDAT2.2 / 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 iGVD71 BX 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
- Sending commands to a group of axes (multicast). This includes the possibility to start simultaneously motion sequences on all the axes from the group
- Synchronizing all the axes from a network

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

For iGVD71 BX-CAT commissioning **EasySetUp** or **EasyMotion Studio** PC applications may be used.

EasySetUp is a subset of EasyMotion Studio, including only the drive setup part. The output of EasySetUp is a set of setup data that can be downloaded into the drive EEPROM or saved on a PC file. At power-on, the drive is initialized with the setup data read from its EEPROM. With EasySetUp it is also possible to retrieve the complete setup information from a drive previously programmed. EasySetUp shall be used for drive setup in all cases where the motion commands are sent exclusively from a master. Hence neither the iGVD71 TML programming capability nor the drive camming mode are used. **EasySetUp can be downloaded free of charge from Technosoft web page.**

EasyMotion Studio platform includes EasySetUp for the drive setup, and a **Motion Wizard** for the motion programming. The Motion Wizard provides a simple, graphical way of creating motion programs and automatically generates all the TML instructions. *With EasyMotion Studio you can execute complex motions, thanks to their built-in motion controller*s. EasyMotion Studio, may be used to program motion sequences in TML. This is the iGVD71 typical CAN operation mode when TMLCAN protocol is selected. EasyMotion Studio can also be used with the CANopen protocol, if the user wants to call TML functions stored in the drive EEPROM or to use the camming mode. With camming mode, EasyMotion Studio offers the possibility to quickly download and test a cam profile and also to create a **.sw** file with the cam data. The .sw file can be afterwards stored in a master and downloaded to the drive, wherever needed. **A demo version of EasyMotion Studio (with EasySetUp part fully functional) can be downloaded free of charge from Technosoft web page.**

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

8.2 Product Features

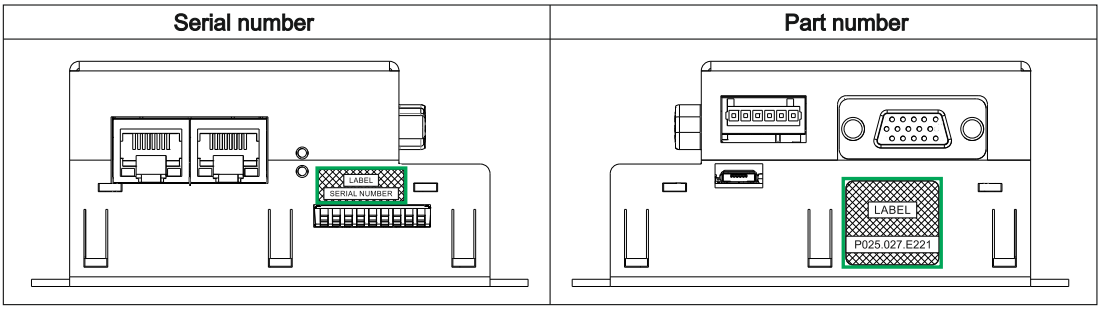
- Fully digital servo drive suitable for the control of **brushless DC**, **AC** and **brushed DC** motors
- **Motor supply**: 11-80V; **Logic supply**[1]: 9-36V
- **Output current**[2]:
  - **Nominal :** 71 A_{RMS} / 100A amplitude
  - **Peak :** 100 A_{RMS} / 140A amplitude
- **PWM** switching frequency up to 100kHz
- **Communication:**
  - Dual 100Mbps EtherCAT® interfaces, for use in daisy-chaining topologies
  - RS-232 (micro USB port)
- **Digital and analog I/O's:**
  - 2 x analogue inputs: 12-bit, 0-5V: Reference and Feedback (for tacho) or general purpose
  - 5 x opto-isolated digital inputs, 12-36V, PNP/NPN selectable: 2 for limit switches, 3 general-purpose
  - 4 x digital outputs, 0.2A PNP/ 0.3A NPN software selectable: Ready, Error, 2 general-purpose
  - 1 x PNP/NPN 2A software configurable motor brake digital output: Out0/Brake
- **Feedback devices (dual-loop support)**

  1st feedback devices supported:
  - Incremental encoder interface (single-ended or differential, selectable by DIP switch)
  - Analogue Sin/Cos encoder interface (differential $1V_{pp}$)

  2nd feedback devices supported:
  - Incremental encoder interface (single-ended or differential, selectable by DIP switch)
  - BISS / SSI / EnDAT / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki interface
- Digital Hall sensor interface (single-ended / open collector or differential, selectable by DIP switch)
- Pulse & direction reference (single-ended or differential) capability
- **Various motion programming modes:**
  - Position profiles with trapezoidal or S-curve speed shape
  - Position, Velocity, Time (PVT) 3rd order interpolation
  - Position, Time (PT) 1st order interpolation
  - Cyclic Synchronous Position (CSP)
  - Cyclic Synchronous Velocity (CSV)
  - Cyclic Synchronous Torque (CST)
  - Electronic gearing and camming
  - 40 Homing modes
- **32 h/w selectable Axis ID** addresses
- **STO**[3]: 2 safe torque-off inputs, 18-36V SELV/PELV supply, safety integrity level (SIL3/Cat3/PLe) acc. to EN61800-5-1;-2/ EN61508-3;-4/ EN ISO 13849-1.
- EtherCAT® supported protocols:
  - **CoE** - CAN application protocol over EtherCAT
  - **FoE** – File over EtherCAT – for setup/TML functions and firmware update
  - **EoE** – Ethernet over EtherCAT – for Easy Motion studio communication over EtherCAT
- **16K × 16 internal 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)
- **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] Nominal output current possible only with external radiator (not included) that can maintain lower plate temperature below 75ºC; The radiator is mounted under the drive using thermal paste or direct metal contact. Its size is application dependent
[3] The STO circuit must be supplied with minimum 18V to enable PWM output

8.3 Identification Labels



The iGVD71 BX family can have the following part numbers and names on the identification label:

p.n. **P025.027.E221** name iGVD71 BX-CAT – standard CAT execution

8.4 Supported Motor-Sensor Configurations

8.4.1 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
Incremental encoder / SinCos / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki			✓		✓
Incremental encoder / SinCos / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki	✓		✓	✓	
None	✓		✓		
None		✓			✓

8.4.2 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	Digital Halls	Tacho	Brushless PMSM[1]	Brushless BLDC[1]	Brushed DC Voice coils	Encoder[4]
Incremental encoder / SinCos			✓		✓	Incremental encoder / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki
Incremental encoder / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki						Incremental encoder / SinCos
Incremental encoder / SinCos	✓		✓	✓		Incremental encoder / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki
Incremental encoder / SSI / BISS-C / EnDAT2.2 / TAMAGAWA / Panasonic/ Nikon/ Sanyo Denki						Incremental encoder / SinCos
None	✓		✓			Incremental encoder / SinCos
None		✓			✓	Incremental encoder / SinCos

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

Example:

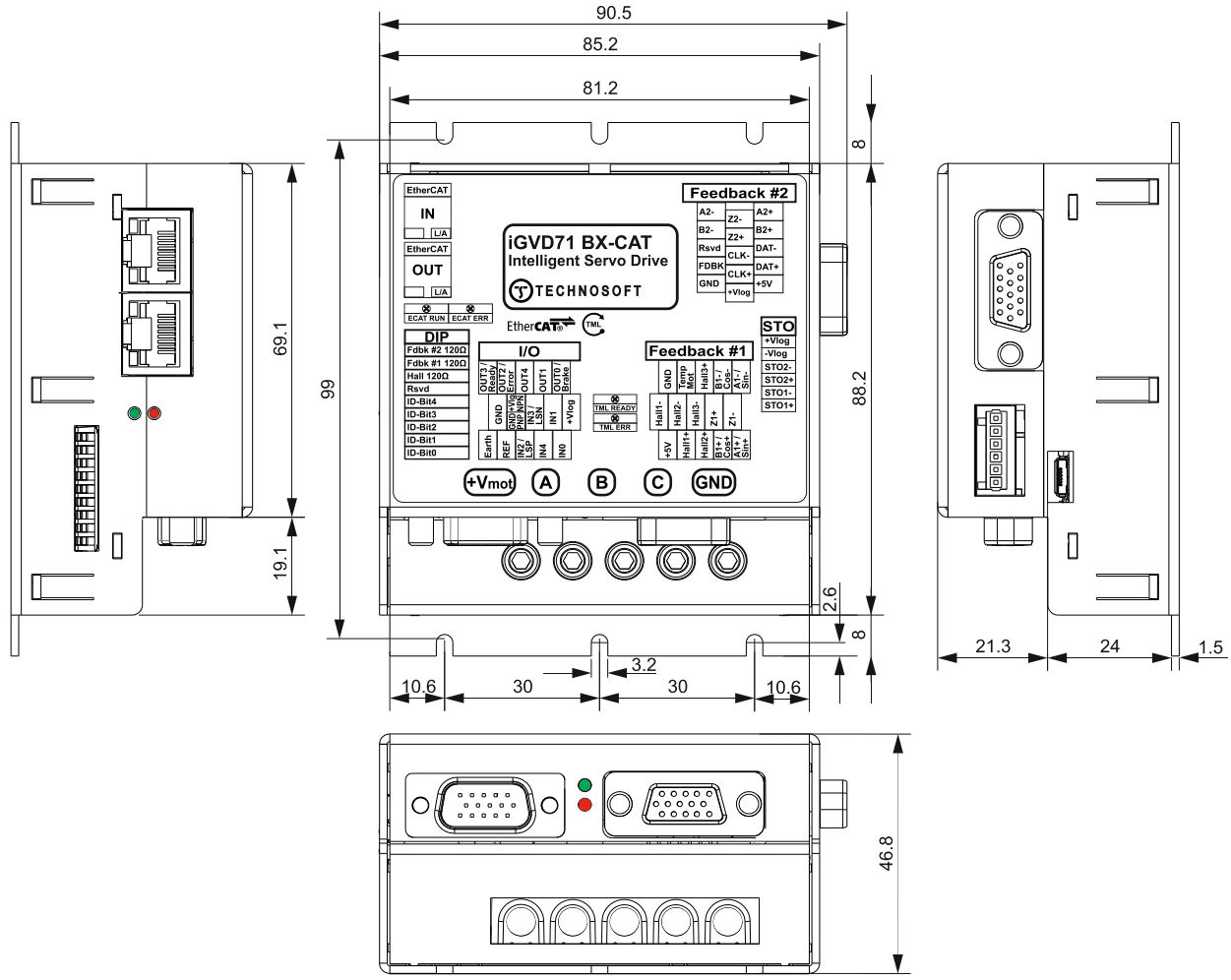
-PMSM motor with Incremental encoder (from feedback #1) on motor and Incremental encoder (from feedback#2) on load

-DC brush motor with BiSS C encoder (from feedback #2) on motor and Incremental encoder (from feedback #1) on load.

[1] Motor encoder can be either on Feedback 1 or on Feedback 2
[2] Sinusoidal. Brushless motor is controlled as PMSM using a field oriented control algorithm
[3] Trapezoidal. Brushless motor is controlled as a BLDC motor using Hall-based commutation.
[4] Load encoder is on Feedback 2 / 1, if motor encoder is on Feedback 1 / 2

9 Hardware Installation

9.1 iGVD71 BX-CAT Board Dimensions



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

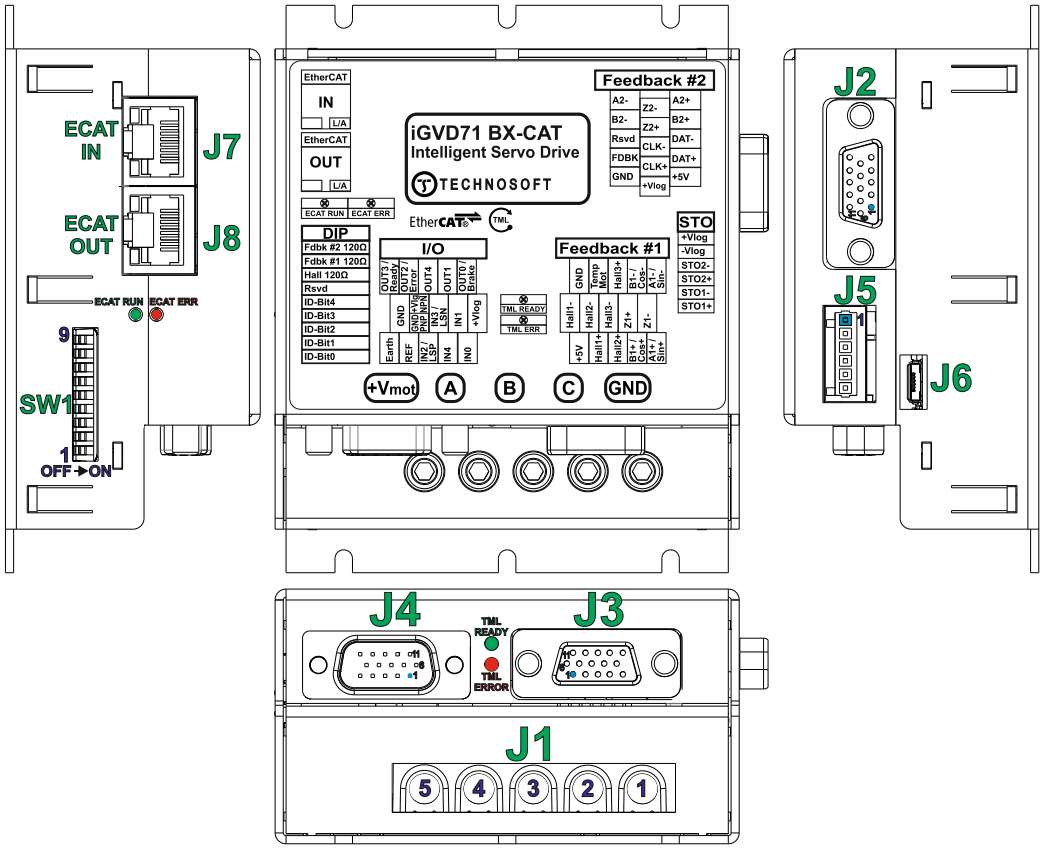
9.2 Mechanical Mounting

The iGVD71 BX drive is intended to be mounted horizontally on a metallic support using the provided mounting holes and the recommended inserts and screws:

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

The metallic support must act as a cooling heat sink.

9.3 Connectors and Pinouts



J1

Pin	Name	Description
1	GND	Negative return (ground) of the power supply
2	C	**Phase C** for 3-ph motors
3	B	**Phase B** for 3-ph motors, Motor- for DC brush motors
4	A	**Phase A** for 3-ph motors, Motor+ for DC brush motors
5	$+V_{MOT}$	Positive terminal of the motor supply: 11 to $80V_{DC}$

J2

Pin	Name	Description
1	$+5V_{OUT}$	5V output supply
2	Data+/ SL+	Data+ for SSI & EnDAT, or Slave+ for BiSS C; SW1 pin 9 can connect an 120Ω resistor between pins 2 and 3
3	Data-/ SL-	Data- for SSI & EnDAT,or Slave- for BiSS C; SW1 pin 9 can connect an 120Ω resistor between pins 2 and 3
4	B2+/ Dir+	Incr. encoder2 B+ diff. input, or Dir+; SW1 pin 9 can connect an 120Ω resistor between pins 4 and 14
5	A2+/ Pulse+	Incr. encoder2 A+ diff. input, or Pulse+; SW1 pin 9 can connect an 120Ω resistor between pins 4 and 14
6	$+V_{LOG}$	Positive terminal of the logic supply: 9 to $36V_{DC}$. Internally connected to other $+V_{LOG}$ pins.
7	CLK+/ MA+	Clock+ for SSI & EnDAT or Master+ for BiSS C; SW1 pin 9 can connect an 120Ω resistor between pins 7 and 8
8	CLK- /MA-	Clock- for SSI & EnDAT or Master- for BiSS C; SW1 pin 9 can connect an 120Ω resistor between pins 7 and 8
9	Z2+	Incr. encoder2 Z single-ended input, Z2+ diff. input; SW1 pin 9 can connect an 120Ω resistor between pins 9 and 10
10	Z2-	Incr. encoder2 Z- diff. input; SW1 pin 9 can connect an 120Ω resistor between pins 9 and 10
11	GND	Return ground for sensors supply
12	FDBK	Analogue input, 12-bit, 0-5V
13	Rsvd.	Reserved. Do not connect
14	B2-/ Dir-	Incr. encoder2 B- diff. input, or Dir-; SW1 pin 9 can connect an 120Ω resistor between pins 4 and 14
15	A2-/ Pulse-	Incr. encoder2 A- diff. input, or Pulse-; SW1 pin 9 can connect an 120Ω resistor between pins 5 and 15

LEDs

TML Error	RED	Turned on when the drive detects an error condition
TML Ready	GREEN	Lit after power-on when the drive initialization ends. Turned off when an error occurs.
ECAT Error	RED	EtherCAT® ERROR and RUN indicators shows the state of the EtherCAT® Status Machine
ECAT Run	GREEN	

J3

Pin	Name	Description
1	$+5V_{OUT}$	5V output supply
2	Hall 1+	Digital input Hall 1 sensor input or Hall1+ diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 2 and 6
3	Hall 2+	Digital input Hall 2 sensor input or Hall2+ diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 3 and 7
4	B1+/ Cos+	Incr. encoder1 B single-ended input, B1+ diff. input or analogue encoder Cos+ diff. input; SW1 pin 8 can connect an 120Ω resistor between pins 4 and 14
5	A1+/Sin+	Incr. encoder1 A single-ended input, A+ diff. input, or analogue encoder Sin+ diff. input; SW1 pin 8 can connect an 120Ω resistor between pins 5 and 15
6	Hall 1-	Digital input Hall 1- diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 2 and 6
7	Hall 2-	Digital input Hall 2- diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 3 and 7
8	Hall 3-	Digital input Hall 3- diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 13 and 8
9	Z1+	Incr. encoder1 Z single-ended input or Z+ diff. input; SW1 pin 8 can connect an 120Ω resistor between pins 9 and 10
10	Z1-	Incr. encoder1 Z- diff. input; SW1 pin 8 can connect an 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 analog temperature value
13	Hall 3+	Digital input Hall 3 sensor input or Hall3+ diff. sensor input; SW1 pin 7 can connect an 120Ω resistor between pins 13 and 8
14	B1-/Cos-	Incr. encoder1 B- diff. input, or analogue encoder Cos- diff. input; SW1 pin 8 can connect an 120Ω resistor between pins 4 and 14
15	A1- /Sin-	Incr. encoder1 A- diff. input, or analogue encoder Sin- diff. input; SW1 pin 8 can connect an 120Ω resistor between pins 5 and 15

SW1

Pin	Name	Position	Description
1	ID-Bit0	up (ON)	Hardware AxisID selection switches All switches ON – AxisID= 31 All switches OFF – AxisID = 255 When Axis ID is 255, the EtherCAT register called "configured station alias" will be 0.
2	ID-Bit1	up (ON)	
3	ID-Bit2	up (ON)	
4	ID-Bit3	up (ON)	
5	ID-Bit4	up (ON)	
6	Rsvd.	-	Reserved
7	Hall 120Ω	up (ON)	Internally connects 120Ω termination resistors between Hall signals
8	Fdbk #1 120Ω	up (ON)	Internally connects 120Ω termination resistors between Feedback #1 signals
9	Fdbk #2 120Ω	up (ON)	Internally connects 120Ω termination resistors between Feedback #2 signals

J4

Pin	Name	Description
1	IN0	12-36V general-purpose digital PNP/NPN opto-isolated input.
2	IN4	12-36V general-purpose digital PNP/NPN opto-isolated input.
3	IN2/LSP	12-36V digital PNP/NPN opto-isolated input. Positive limit switch function
4	REF	Analogue input, 12-bit, 0-5V
5	Earth	Earth connection; Internally connected to the metallic side of J2, J3 and J4
6	$+V_{LOG}$	Positive terminal of the logic supply: 9 to $36V_{DC}$. Internally connected to other $+V_{LOG}$ pins.
7	IN1	12-36V general-purpose digital PNP/NPN opto-isolated input.
8	IN3/LSN	12-36V digital PNP/NPN opto-isolated input. Negative limit switch function
9	GND +Vlog PNP NPN	PNP/NPN Inputs type selector. Connect to GND to use inputs as PNP; Connect to +Vlog to use inputs as NPN
10	GND	Return ground for I/O pins
11	OUT0/Brake	Digital output used for an electro-mechanical brake,12-36V, 2A PNP/ 2A NPN software selectable
12	OUT1	12-36V general-purpose digital output, 0.2A PNP/ 0.3A NPN, software selectable
13	OUT4	12-36V general-purpose digital output, 0.2A PNP/ 0.3A NPN, software selectable
14	OUT2/Error	12-36V drive Error digital output, 0.2A PNP/ 0.3A NPN, software selectable
15	OUT3/Ready	12-36V drive Ready digital output, 0.2A PNP/ 0.3A NPN, software selectable

J5

Pin	Name	Description
1	$+V_{LOG}$	Positive terminal of the logic supply input: 9 to $36V_{DC}$ from SELV/ PELV type power supply.
2	$-V_{LOG}$	Negative terminal of the logic supply input: 9 to $36V_{DC}$ from SELV/ PELV type power supply.
3	STO2-	Safe Torque Off input 2, negative return (opto-isolated, 18÷36V)
4	STO2+	Safe Torque Off input 2, positive input (opto-isolated, 18÷36V)
5	STO1-	Safe Torque Off input 1, negative return (opto-isolated, 18÷36V)
6	STO1+	Safe Torque Off input 1, positive input (opto-isolated, 18÷36V)

Apply between both STO1+, STO2+ and STO1-, STO2- minimum 18V DC from SELV/ PELV power supply for motor PWM output operation

J6

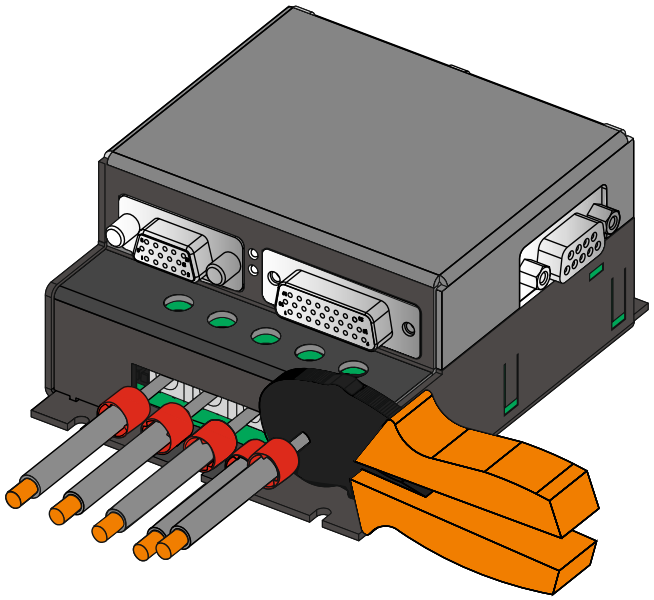
USB	Standard micro-USB port. Is identified in Windows as RS-232 COM port

9.3.1 Mating Connectors

Connector	Function	Component	Diagram
J1	Motor Phases Motor Supply	High AMP wire. 4mm HEX socket. Strip: - min 8 mm for cables with isolation diameter less than 6.5 mm; - min 12 mm/ max 15 mm for cables with isolation diameter bigger than 6.5 mm. AWG 6-16 wire gauge. **Avoid generating metal debris/ filings into drive from the wire leads!** **In case of multi-stranded wires, a proper crimp ferrule must be used as wire terminal.**	
J2, J3	Feedback #1 Halls Feedback #2	Generic 15-pin High Density Sub-D male connector.	
J4	Inputs Outputs	Generic 15-pin High Density D-Sub female	
J5	STO Logic Supply	Female connector; CAGE CLAMP®; 0.5 mm²; Pin spacing 2.5 mm; 6-pole	
J6	Communication	Standard Micro USB cable.	
J7, J8	EtherCAT	Standard 8P8C modular jack (RJ-45) male	

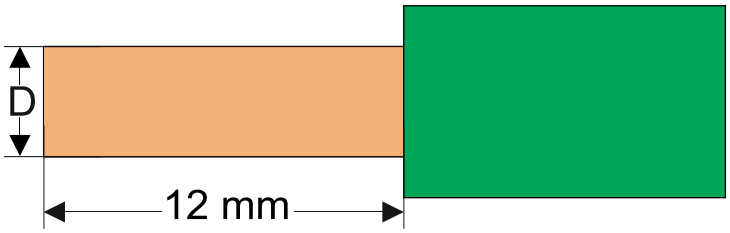
9.3.2 Recommendations for Motor Phases and Motor Power Supply wires

Torque Chart			
AWG 6-14 (mm^2 10 – 2.5)			
AWG	mm^2	In-lb	N-M
6	-	35	3.95
-	10		
8	-	25	2.82
-	6		
10	-	20	2.26
-	4		
12	-		
-	2.5		
14	-		



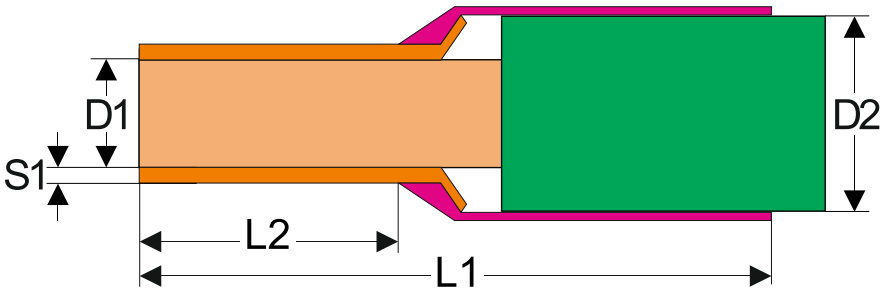
Cable connections

Solid wire or tinned strand wire



❖ D_{max} = 4.1 mm (AWG6)

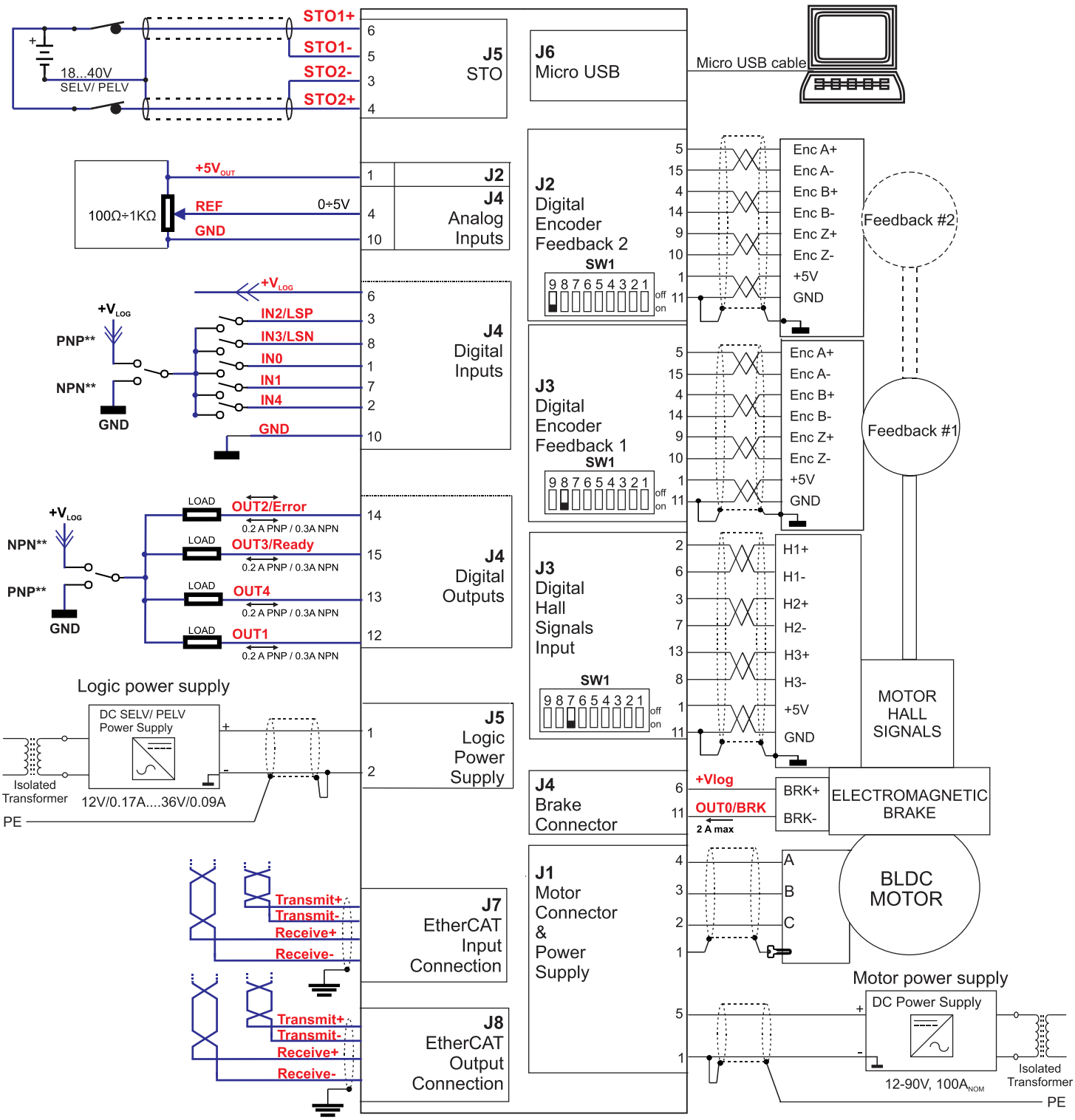
Strand wire with ferrule



❖ Options for industrial standard ferrules

French and German Code <Polypropylene insulated and tin-plated electrolytic copper>											
Model No		**Applicable wire**		**Style**	**Colour Code**		**Dimensions (mm)**				
French Code	**German Code**	**mm^2**	**AWG**		**French Code**	**German Code**	**L1**	**L2**	**D1**	**S1**	**D2**
FWE2.5-8	GWE2.5-8	2.50	14	I	Grey	Blue	14	8	2.2	0.15	4.2
FWE4-10	GWE4-10	4.00	12	I	Orange	Grey	17	10	2.8	0.2	4.8
FWE6-12	GWE6-12	6.00	10	I	Green	Black	20	12	3.5	0.2	6.3
FWE10-12	GWE10-12	10.0	8	I	Brown	Ivory	22	12	4.5	0.2	7.6

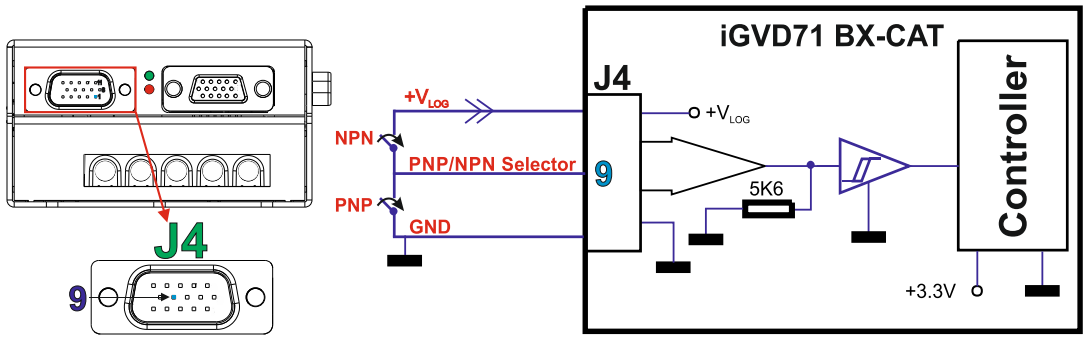
9.3.3 Connection diagram



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

9.4 Digital I/O Connection

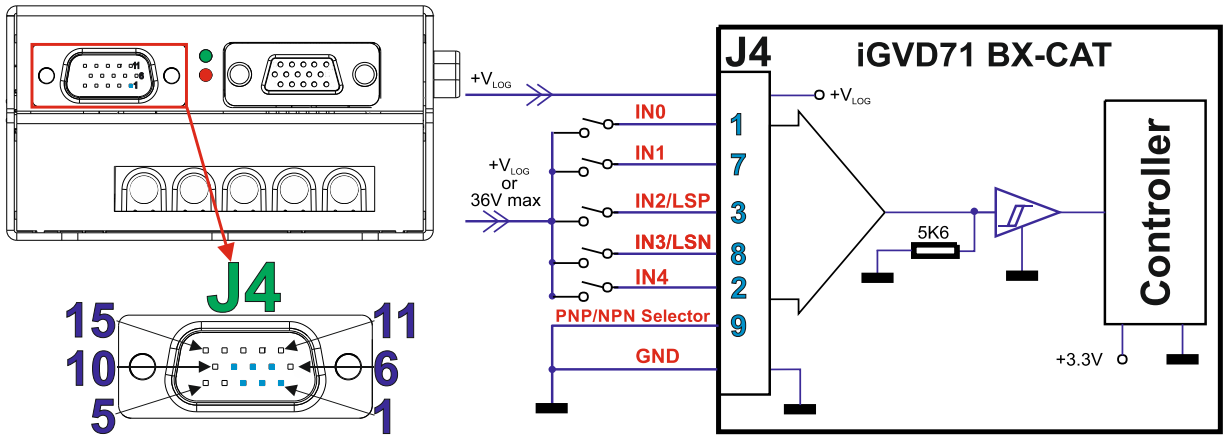
9.4.1 PNP/NPN Inputs selection



Remarks:

1. *Connect J4 pin 9 to GND to use inputs as PNP; Connect to $+V_{LOG}$ to use inputs as NPN.*
2. *If the hardware selection is not done (J4 pin 9 is not connected), the inputs state cannot be changed.*
3. *The inputs needs to be selected as PNP/ NPN also in the setup part, according to the hardware connection.*

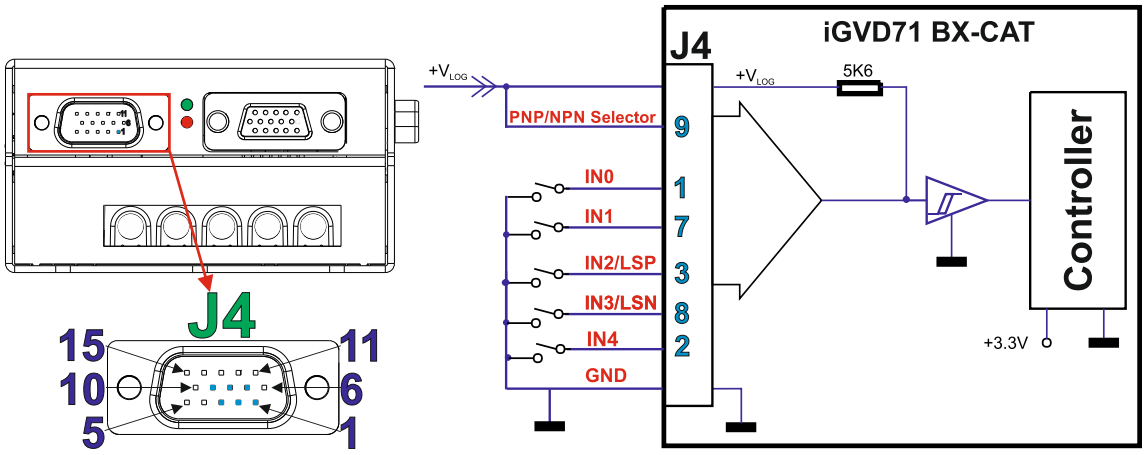
9.4.2 PNP inputs



Remarks:

1. *The PNP inputs are compatible with PNP outputs – the input must receive a positive voltage value: 12-36V to change its default state*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surge in industrial environment.*

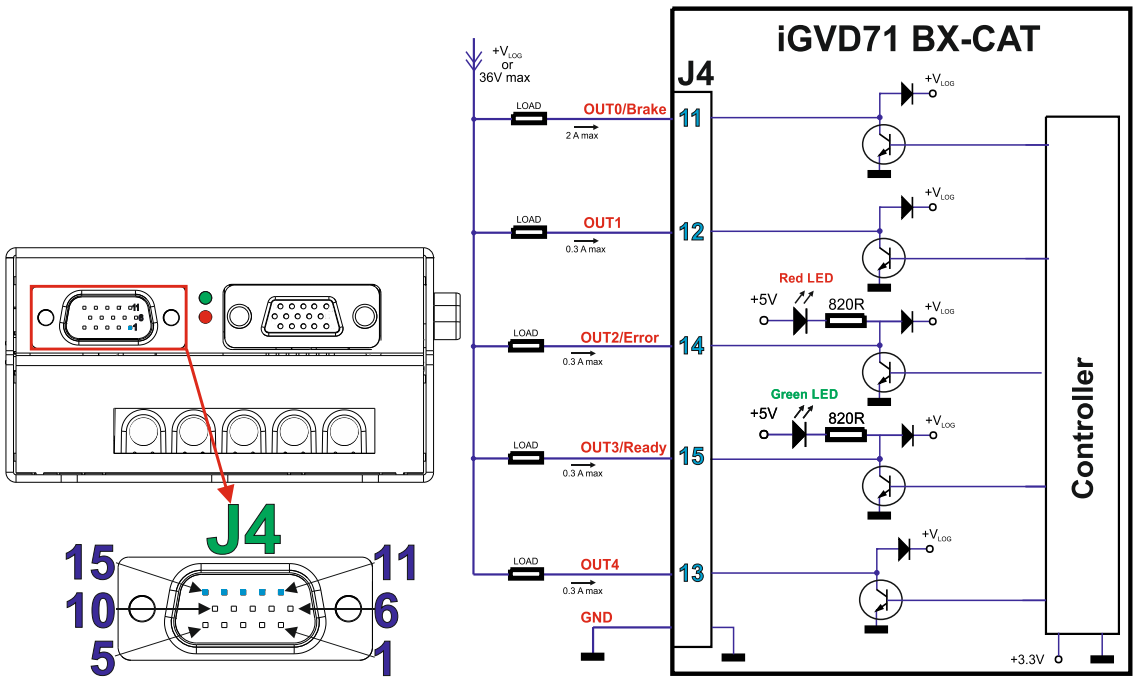
9.4.3 NPN inputs



Remarks:

1. *The NPN inputs are compatible with NPN outputs – the input must be pulled to GND to change its default state.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surge in industrial environment.*

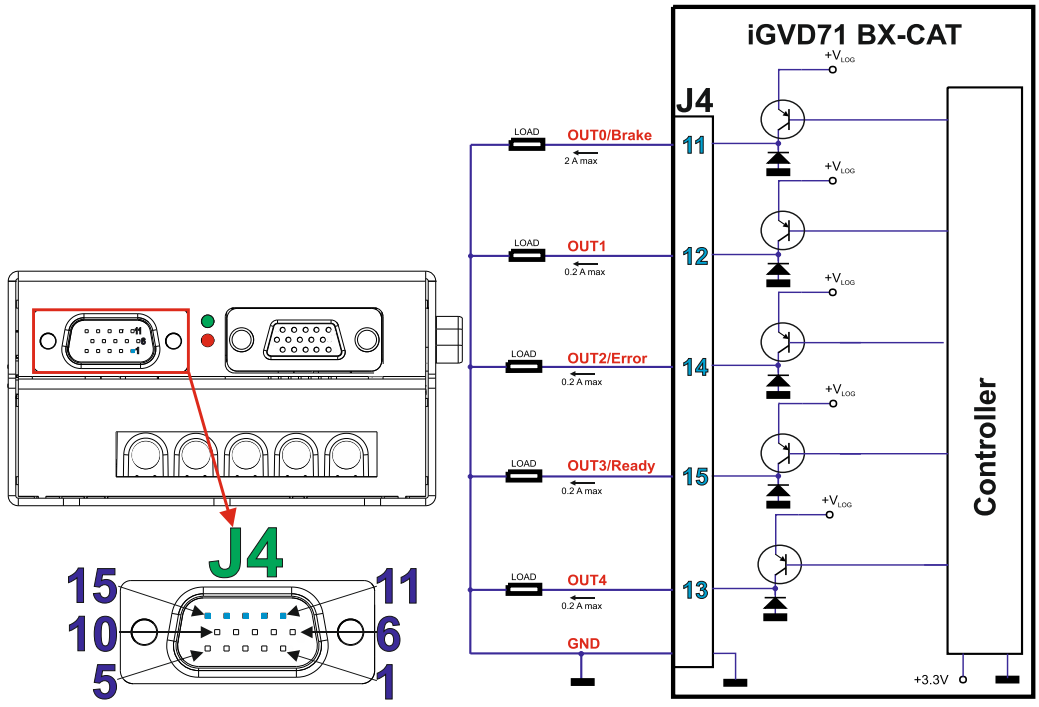
9.4.4 NPN Outputs



Remarks:

1. *The outputs are software selectable as PNP/NPN.*
2. *The NPN outputs are compatible with NPN inputs (load is tied to common $+V_{LOG}$, output pulls to GND when active and is floating when inactive*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

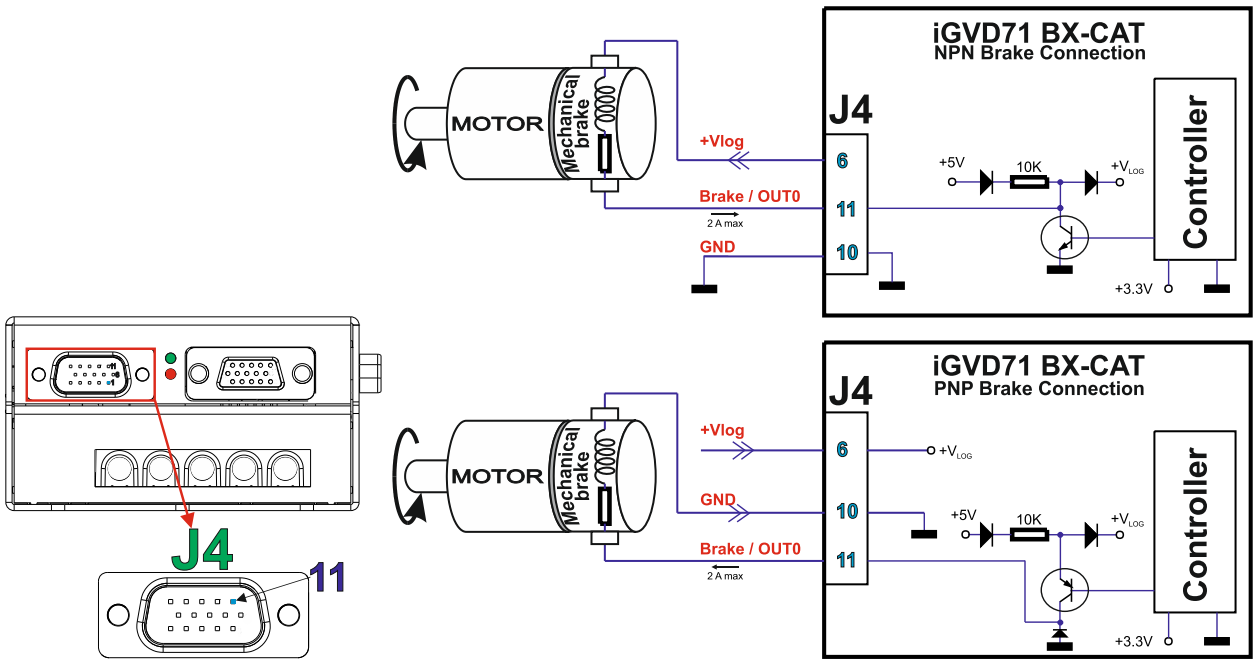
9.4.5 PNP Outputs



Remarks:

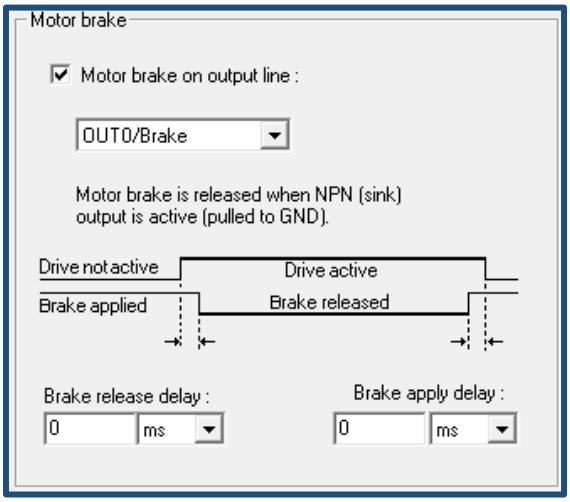
1. *The outputs are software selectable as PNP/NPN.*
2. *The PNP outputs are compatible with PNP inputs (load is tied to common $+V_{LOG}$, output pulls to GND when active and is floating when inactive*
3. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

9.4.6 Solenoid driver connection for motor brake (NPN/PNP)

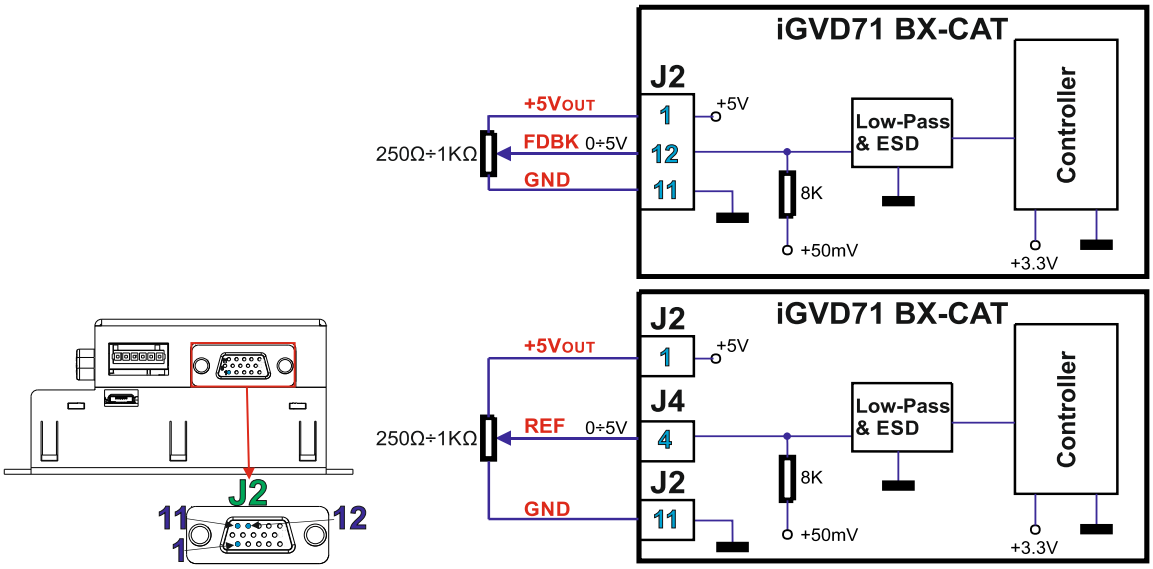


Remarks:

1. *The firmware can control the OUT0 output to automatically engage/disengage a mechanical brake when motor control is started/stopped.*
2. *The digital output can be used for an electro-mechanical brake, 12-36V, 2A PNP/ 2A NPN or as PNP/NPN general-purpose digital output.*
3. *The selection can be made by software. To enable the mechanical brake functionality select the checkbox from EasyMotion Studio:*



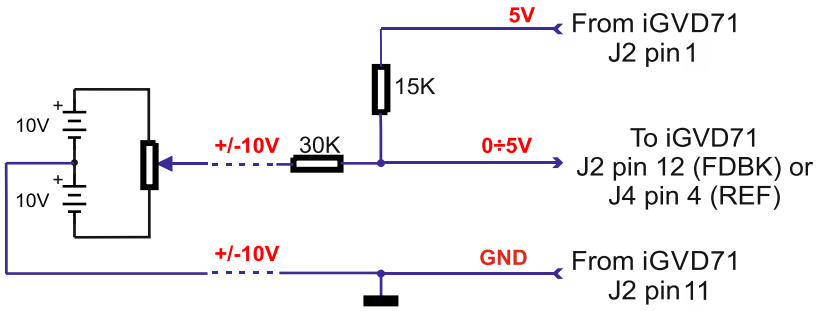
9.4.7 Analog Inputs Connection: REF, FDBK



Remark:

1. *Default input range for analog inputs REF and FDBK is 0÷5 V.*
2. *The inputs range can be modified via software to +/-10 V using only an external input range adapter.*
3. *The recommended values for RFGAIN and RFOFFSET parameters when using an the default input range, are: RFGAIN = 4240 and RFOFFSET = 37485.*
4. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

9.4.8 Analog Inputs Connection: +/- 10V Input Range adapter



Remark:

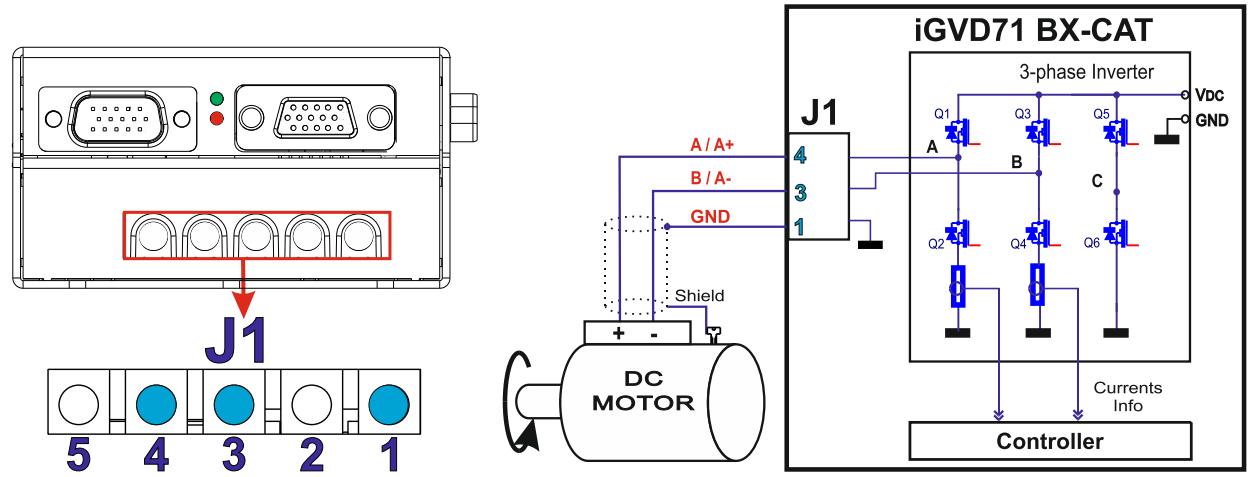
1. *The recommended values for RFGAIN and RFOFFSET parameters when using an +/-10V input range adapter are: RFGAIN = 1.078035 and RFOFFSET = 2000.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

9.4.8.1 Recommendation for wiring

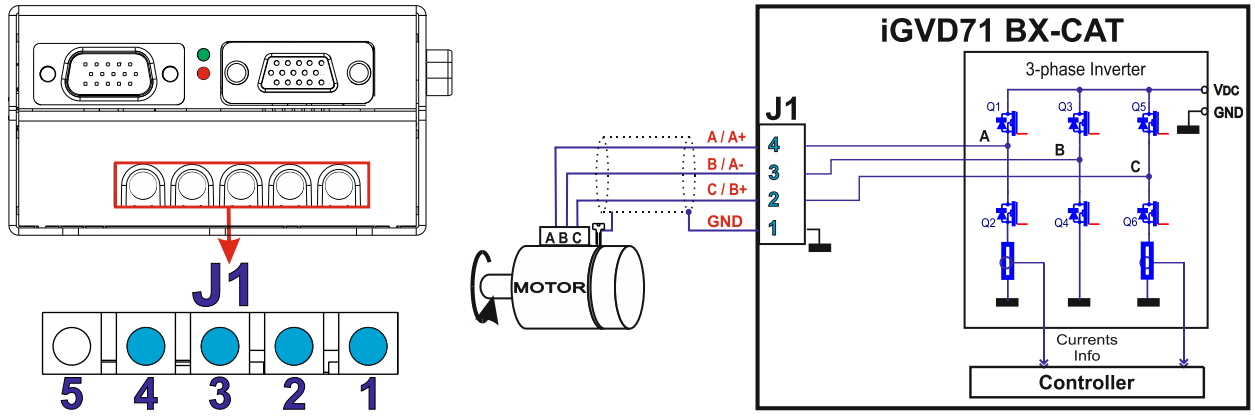
1. If the analogue signal source is single-ended, use a 2-wire twisted shielded cable as follows: 1st wire connects the live signal to the drive input; 2nd wire connects the source ground to the drive ground; shield will be connected to the drive ground terminal.
2. If the analogue signal source is differential 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.

9.5 Motor connections

9.5.1 DC Motor connection



9.5.2 Brushless Motor connection

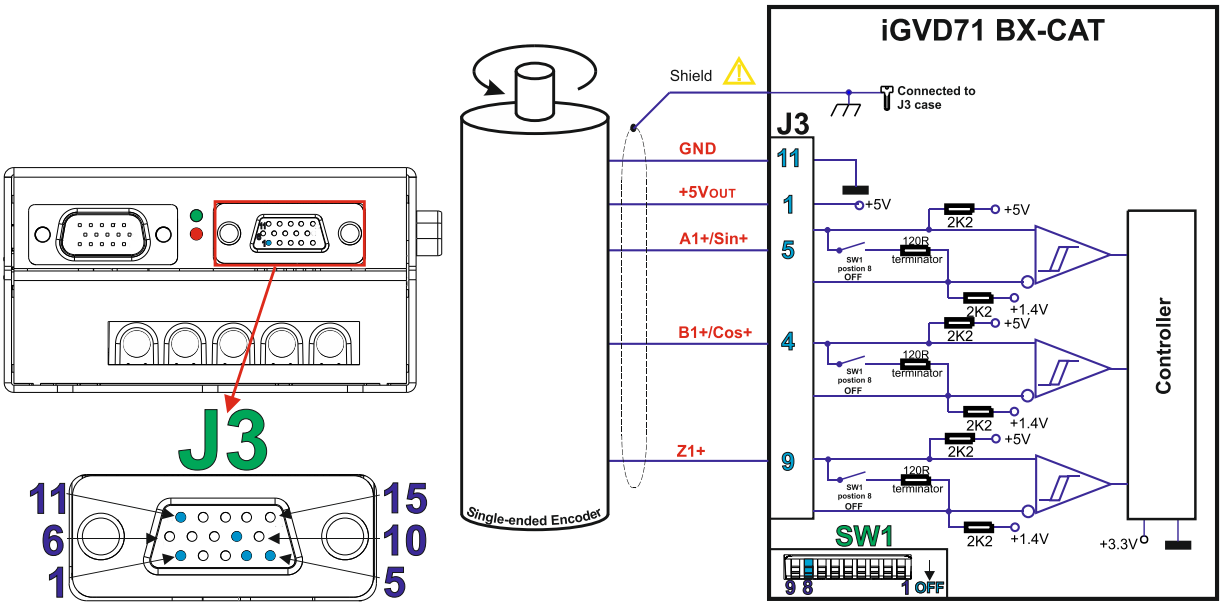


9.5.2.1 Recommendations for motor wiring

1. 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 GND pin. Leave the other end disconnected.
2. 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 iGVD71 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.
3. A good shielding can be obtained if the motor wires are running inside a metallic cable guide.

9.6 Feedback connections

9.6.1 Feedback #1 – Single-Ended Incremental Encoder Connection

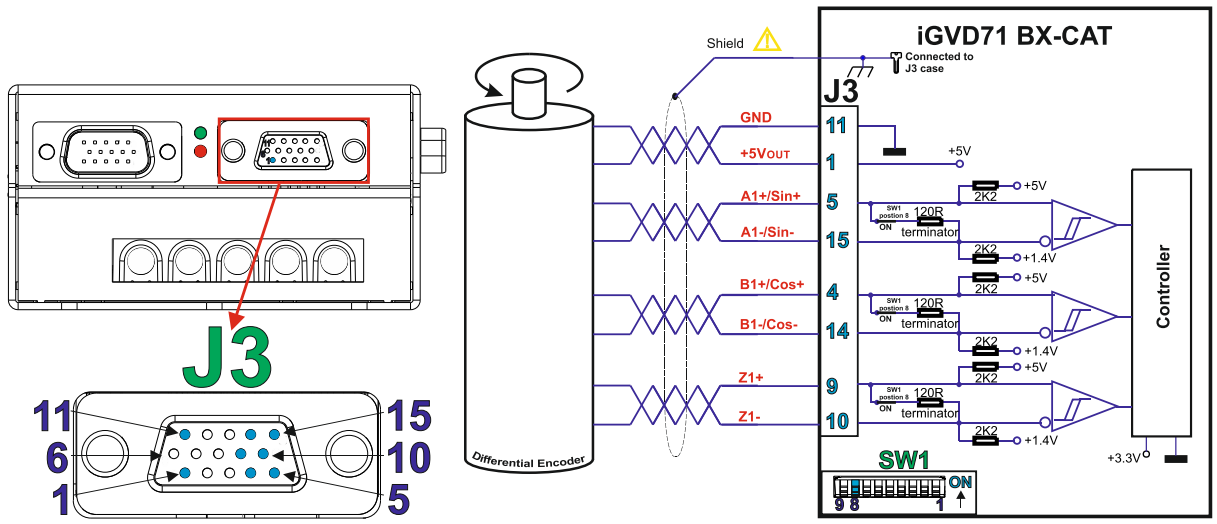


Remarks:

1. *For Feedback #1 single-ended connection, SW1 switch 8 must be OFF -120Ω (0.25W) terminators must be disconnected.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***DO NOT CONNECT UNTERMINATED WIRES TO PINS J3.14, J3.15 AND J3.10. THEY MIGHT PICK UP UNWANTED NOISE AND GIVE FALSE ENCODER READINGS.*** ***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.2 Feedback #1 - Differential Incremental Encoder Connection

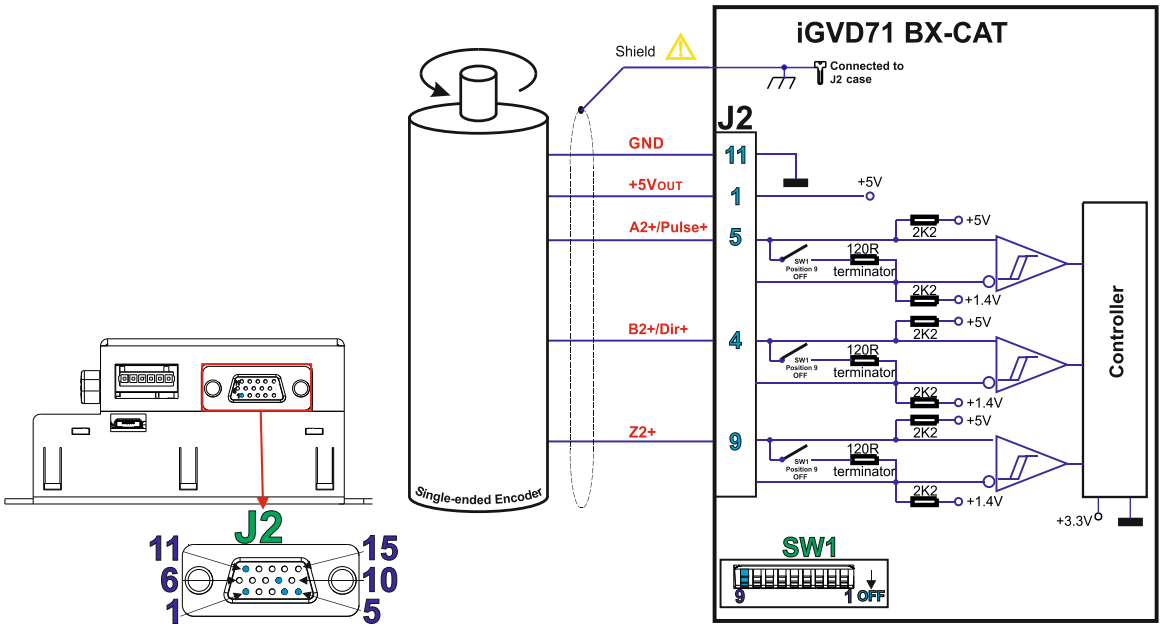


Remarks:

1. *For Feedback #1 differential connection, SW1 position 8 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.3 Feedback #2 – Single-Ended Incremental Encoder Connection

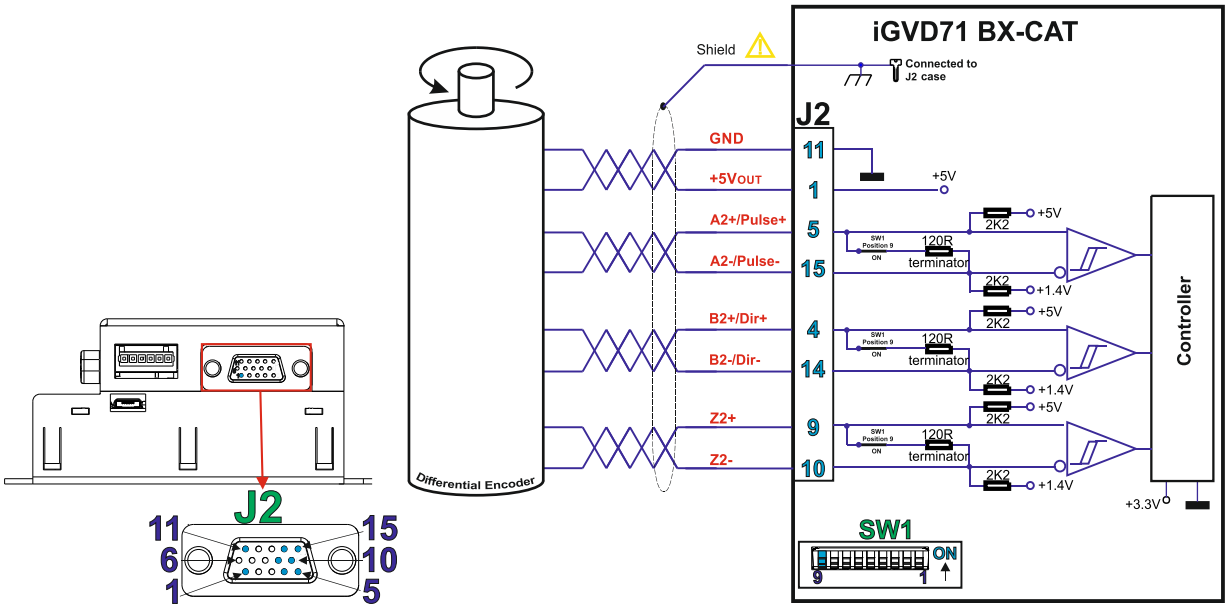


Remarks:

1. *For Feedback #2 differential connection, SW1 position 9 must be "OFF" - 120Ω (0.25W) terminators must be disconnected.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***DO NOT CONNECT UNTERMINATED WIRES TO PINS J2.14, J2.15 AND J2.10. THEY MIGHT PICK UP UNWANTED NOISE AND GIVE FALSE ENCODER READINGS.*** ***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.4 Feedback #2 - Differential Incremental Encoder Connection

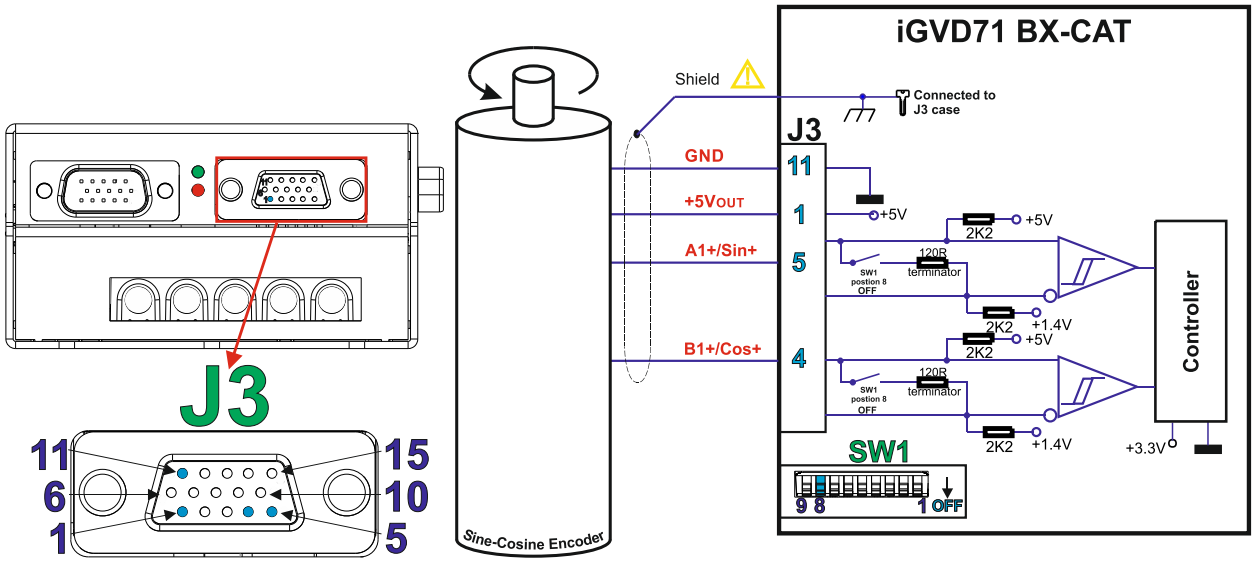


Remarks:

1. *For Feedback #2 differential connection, SW1 position 9 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.5 Feedback #1 – Single-Ended Sine-Cosine Encoder Connection

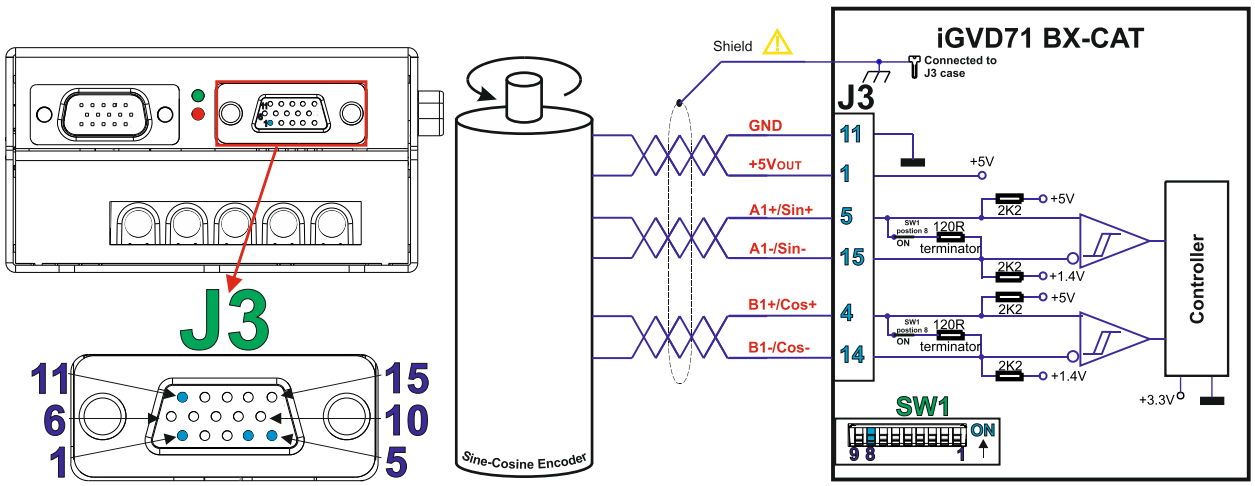


Remarks:

1. *For Feedback #1 single-ended connection, SW1 switch 8 must be OFF - 120Ω (0.25W) terminators must be disconnected.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

⚠	**CAUTION!**	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.6 Feedback #1 – Differential Sine-Cosine Encoder Connection

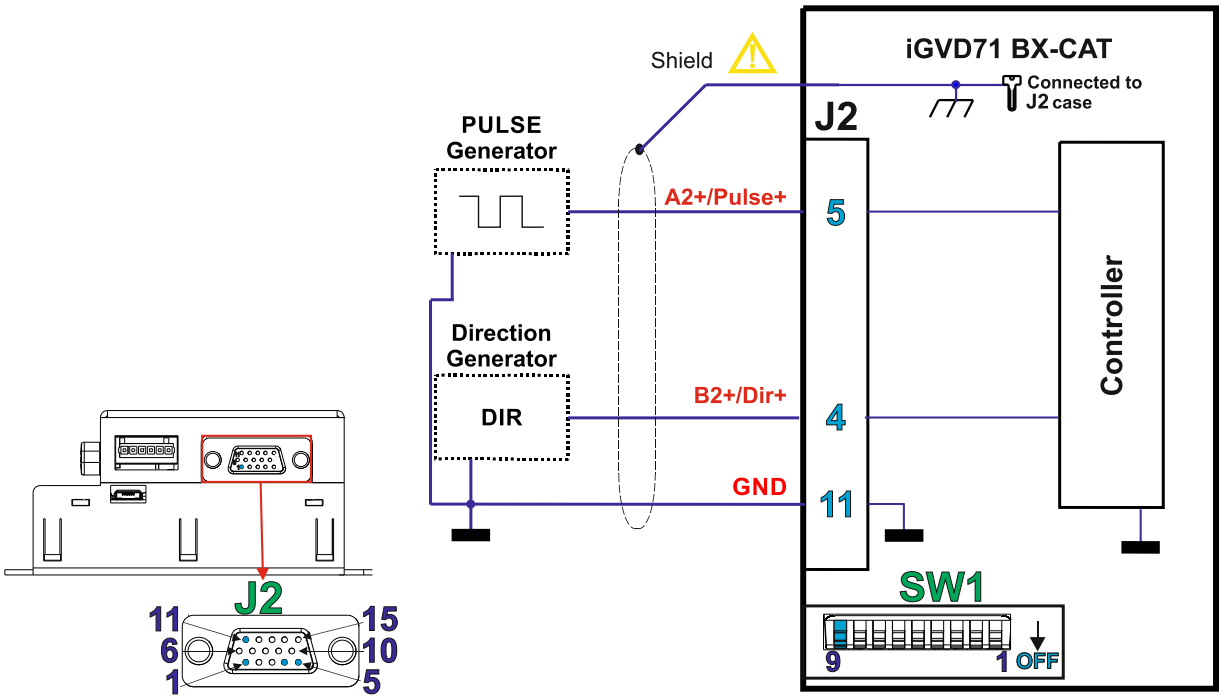


Remarks:

1. *For Feedback #2 differential connection, SW1 position 9 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

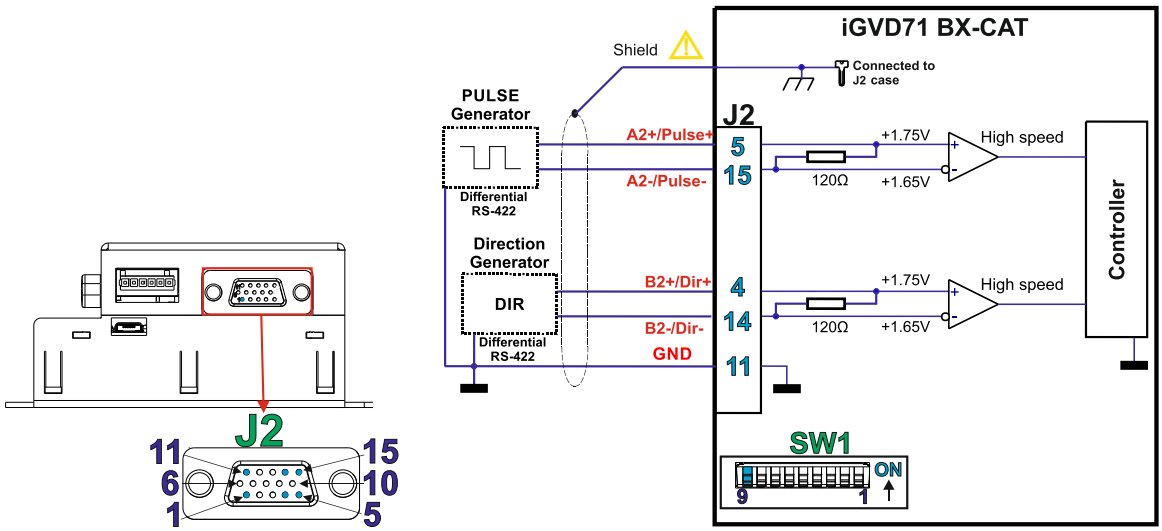
⚠	**CAUTION!**	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.7 Feedback #2 – Single-Ended Pulse and Direction Connection



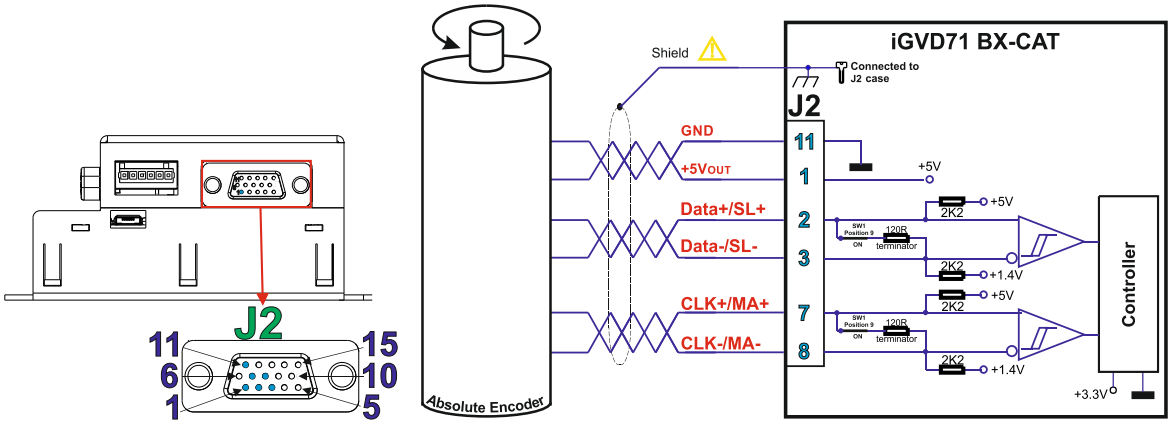
CAUTION!	*Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.*

9.6.8 Feedback #2 – Differential Pulse and Direction Connection



CAUTION!	*Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.*

9.6.9 Feedback #2 - Absolute Encoder Connection (SSI, BiSS-C, EnDAT 2.2)

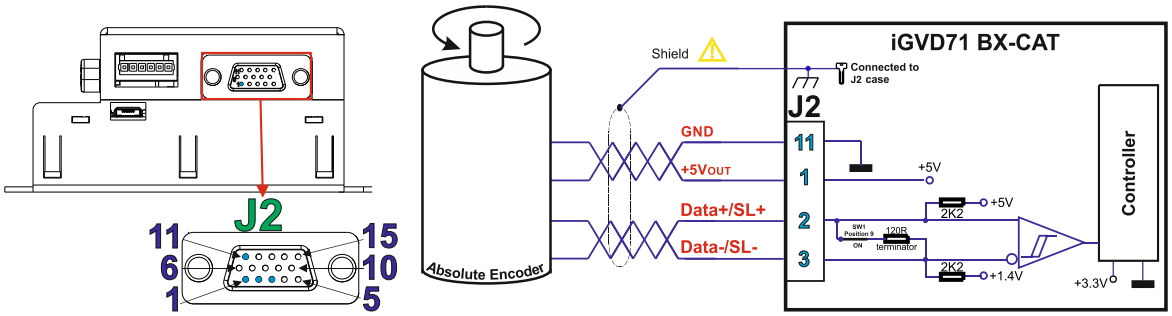


Remarks:

1. *For Feedback #2 absolute connection, SW1 position 9 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.6.10 Feedback #2 - Absolute Encoder Connection (Panasonic, Tamagawa, Nikon, Sanyo Denki)



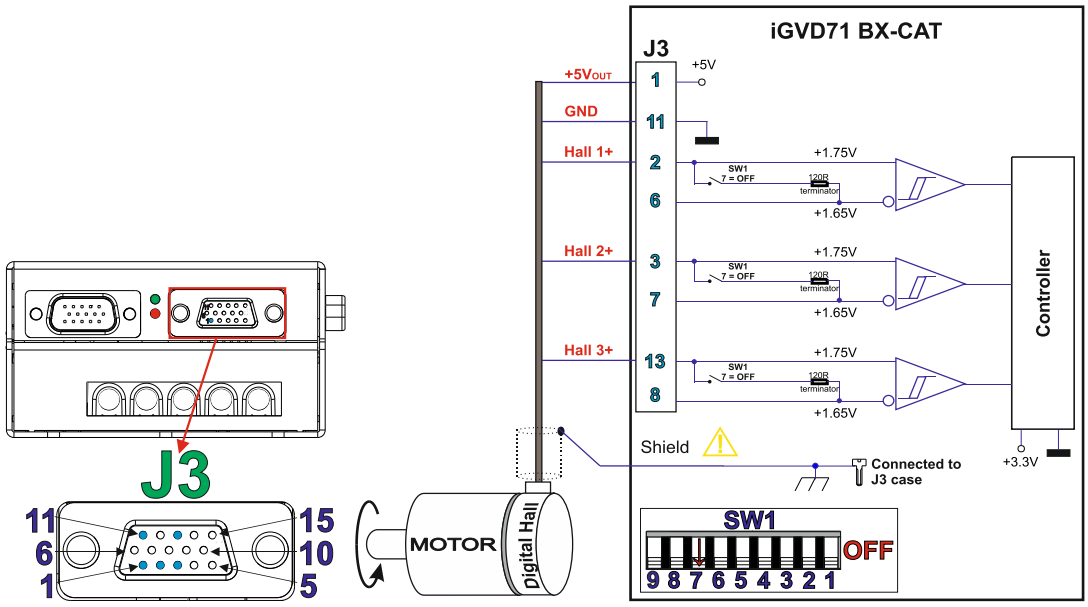
Remarks:

1. *For Feedback #2 absolute connection, SW1 position 9 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.7 Digital Hall Connection

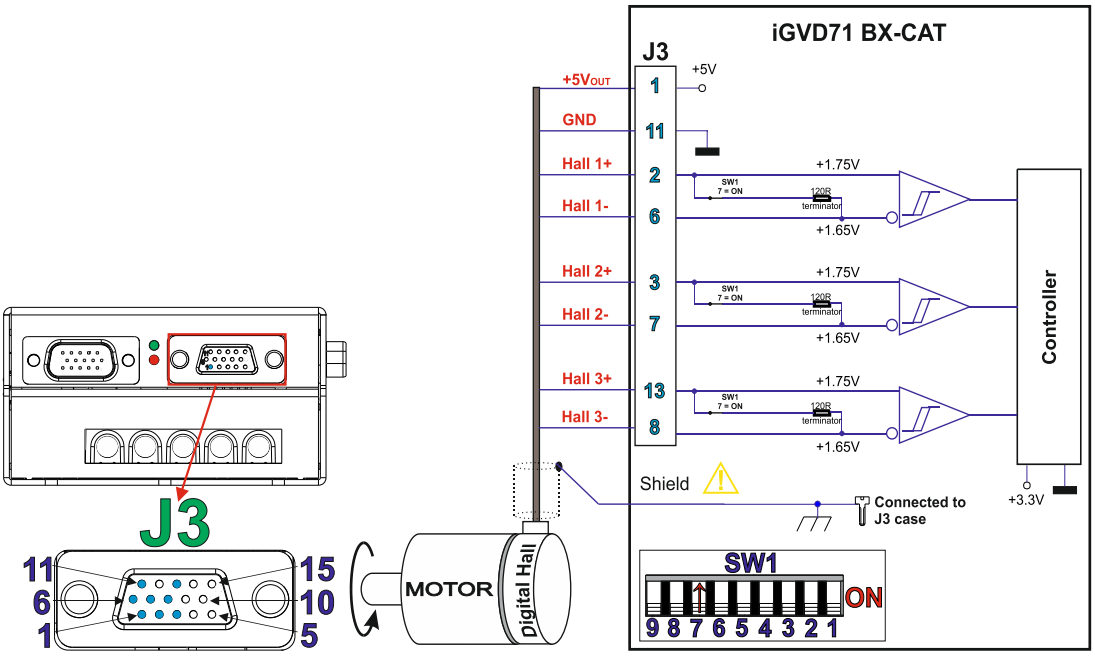
9.7.1 Single-Ended Digital Hall Connection



Remarks:

1. *For differential Hall connection, SW1 position 7 must be "OFF" - 120Ω (0.25W) terminators must be disconnected.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

9.7.2 Differential Digital Hall Connection



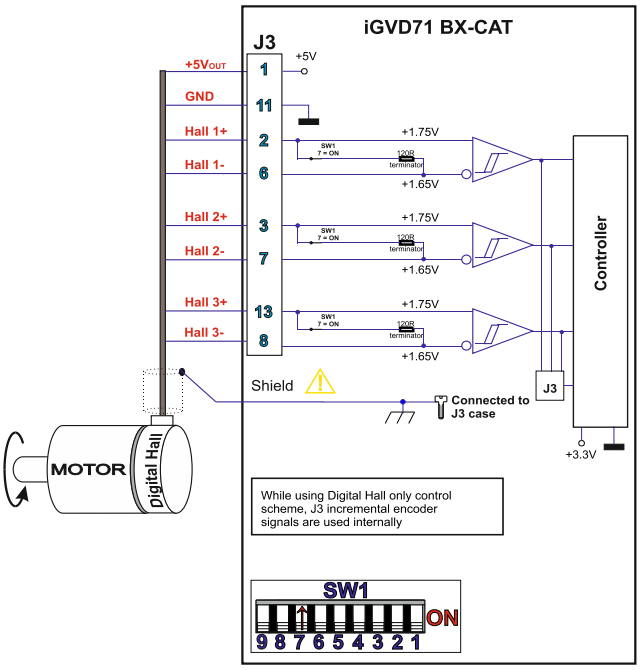
Remarks:

1. *For differential Hall connection, SW1 position 7 must be "ON" - 120Ω (0.25W) terminators must be internally connected between the differential pairs*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

CAUTION!	***Encoder cable shield must be connected to the connector case (PE) to avoid disturbances / noise induced by nearby cables.***

9.7.3 Digital Hall Connection for Motor Control

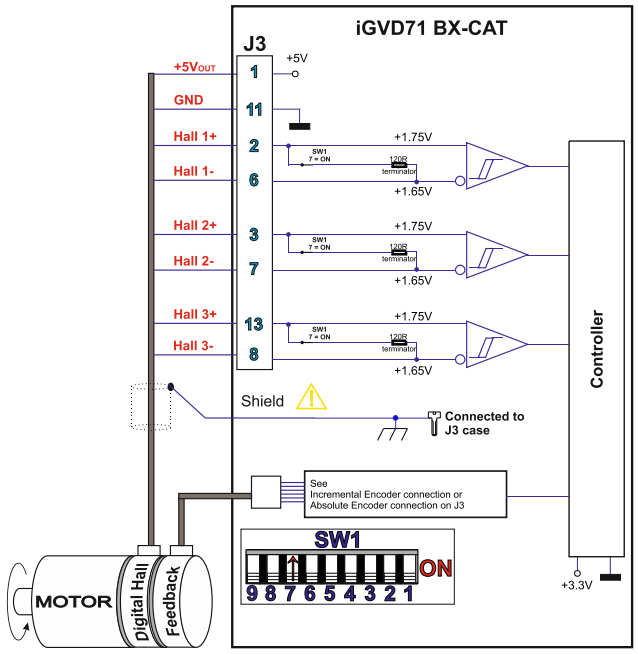
9.7.3.1 Digital Hall only control



Remarks:

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

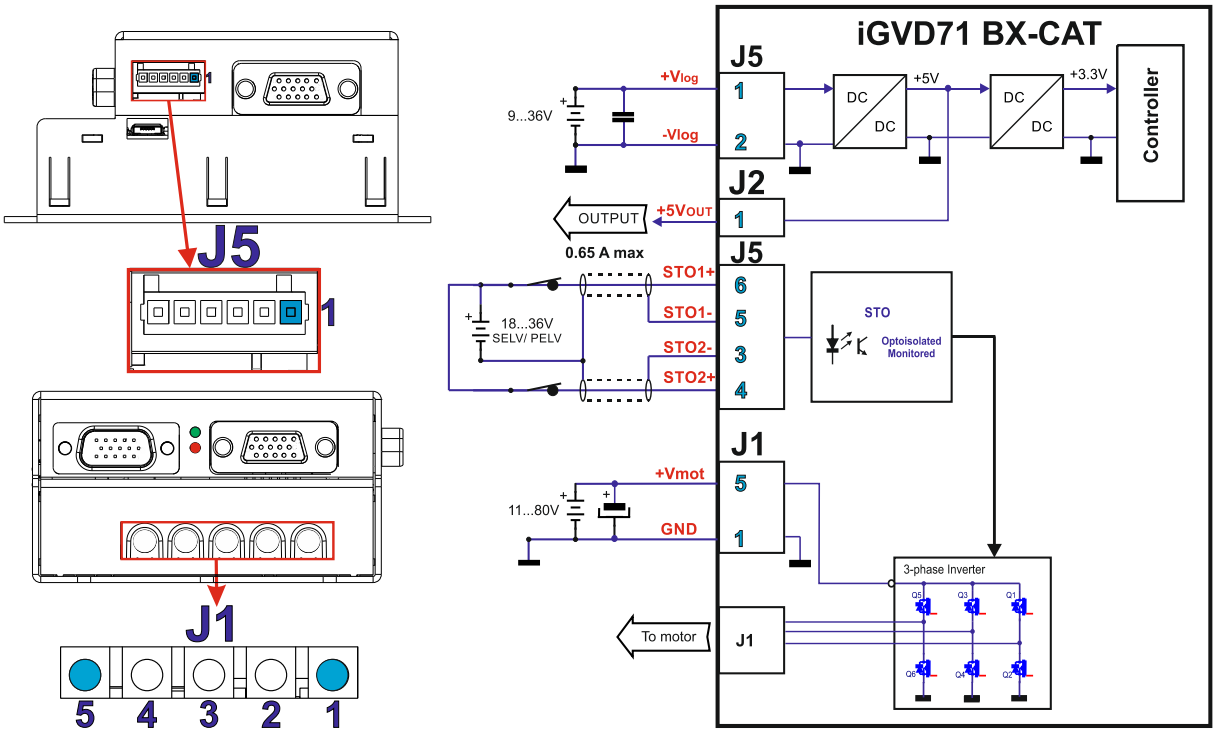
9.7.3.2 Digital Hall + Incremental or Absolute Encoder control



Remarks:

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

9.8 Power Supply Connection



Remarks:

1. *The iGVD71 BX-CAT 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. *Use short, thick wires between the iGVD71 and the motor power supply. If the wires are longer than 2 meters, use twisted wires for the supply and ground return.*
4. *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 iGVD71.*
5. *It is recommended to connect the negative motor supply return (GND) to the Earth protection near the power supply terminals.*

9.8.1 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 **86V**, the drive over-voltage protection is triggered and the drive power stage is disabled.

In order to avoid this situation ***a capacitor can be added 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} = 86V is the over-voltage protection limit

U_{NOM} is the nominal motor supply voltage

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

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

where:

J_M – total rotor inertia [kgm^2]

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

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

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

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

g – gravitational acceleration i.e. 9.8 [m/s^2]

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

h_{final} – final system altitude [m]

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

R_{Ph} – motor phase resistance [Ω]

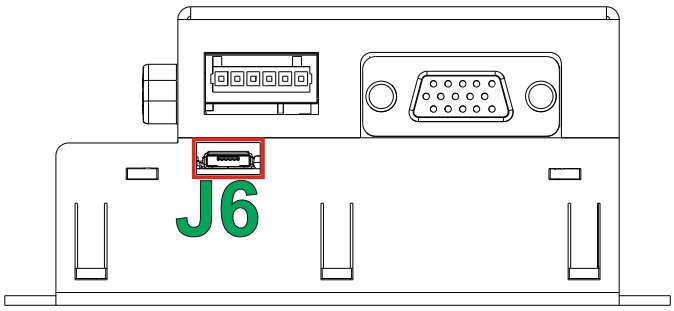
t_d – time to decelerate [s]

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

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

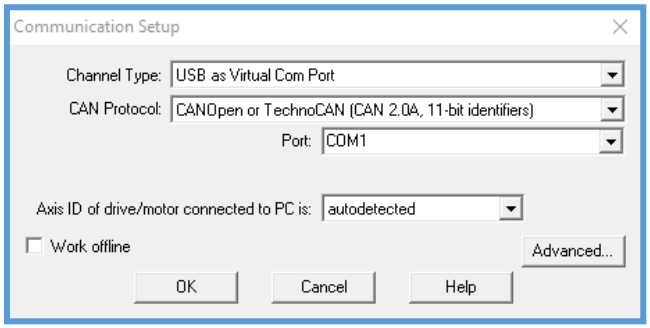
9.9 Communication connection

9.9.1 USB connection



Remarks:

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



9.9.2 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 J8 / OUT port of the last drive in the chain remains not connected. Master is connected to J7 / IN port of the first drive; J8 / OUT of the first drive is connected to J7 / IN of the following drive; J8 / OUT of the last drive remains unconnected.

   See Figure 1. EtherCAT network linear topology for a visual representation of the linear topology.
   - Ring, when the J8 / 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 J8 / OUT of the last drive.

   See Figure 2. 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.

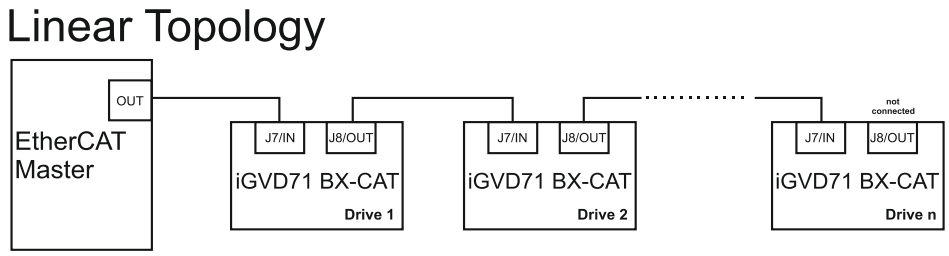


Figure 1. *EtherCAT network linear topology*

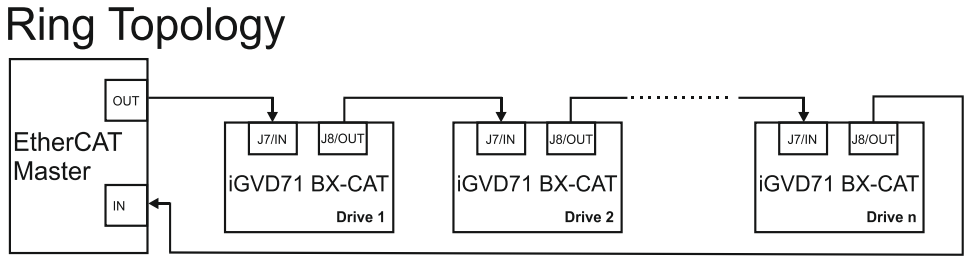


Figure 2. *EtherCAT network ring topology*

9.9.3 Disabling the setup table at startup

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

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

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

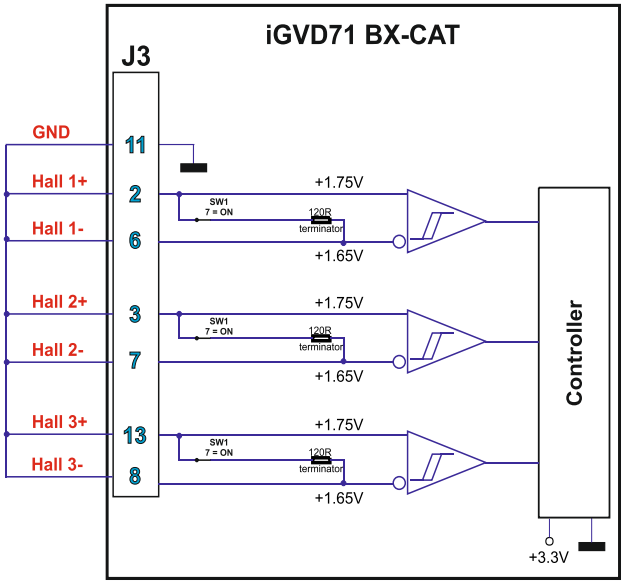
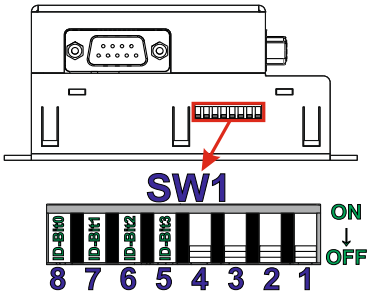


Figure 3. *Temporary connection during power-on to disable the setup table*

9.10 Axis ID Selection

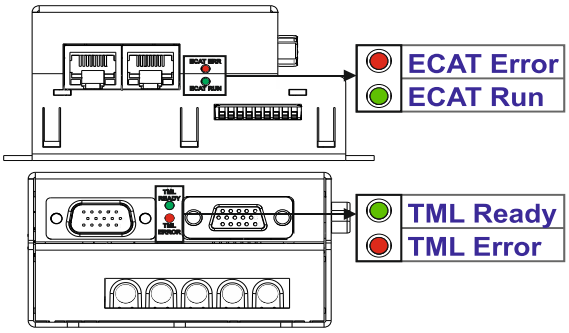


Pin	Name	Description
1	ID-Bit0	Hardware AxisID selection switches. Position: UP = ON = 1; DOWN = OFF = 0. They represent the first 5 LSB bits of an 8-bit Axis ID number. The AxisID can be computed using the formula: **AxisID = ID-Bit0 + 2 · ID-Bit1 + 4 · ID-Bit2 + 8 · ID-Bit3 +16 · ID-Bit4** When all switches are OFF then AxisID=255. When all switches are ON then AxisID=31.
2	ID-Bit1	
3	ID-Bit2	
4	ID-Bit3	
5	ID-Bit4	

Remarks:

1. *The drive axis/address number is set when H/W is selected in Drive Setup under AxisID field or when the Setup is invalid.*
2. *The axis ID is an 8-bit unsigned number. Its bits are controlled by the ID-bit0 to ID-bit4. In total, 32 axis ID HW values can result from the DIP switch combinations.*
3. *When the AxisID bits are all OFF, the drive Axis ID will be 255 and the EtherCAT register called “configured station alias” will be 0.*
4. *All pins are sampled at power-up, and the drive is configured accordingly.*

9.11 LED indicators



LED name	LED color	Function
TML Ready		Lit after power-on when the drive initialization ends. Turned off when an error occurs.
TML Error		Turned on when the drive detects an error condition.

9.11.1 EtherCAT® RUN and ERROR LED Indicators

The RUN states are displayed with a 180 degree phase shift to the ERROR states as noted in Figure 4. STATUS indicator Example.

The behavior of the RUN indicator is specified in Table 1. RUN Indicator States" and the behavior of the ERROR indicator specified in Table 2. ERROR Indicator States".

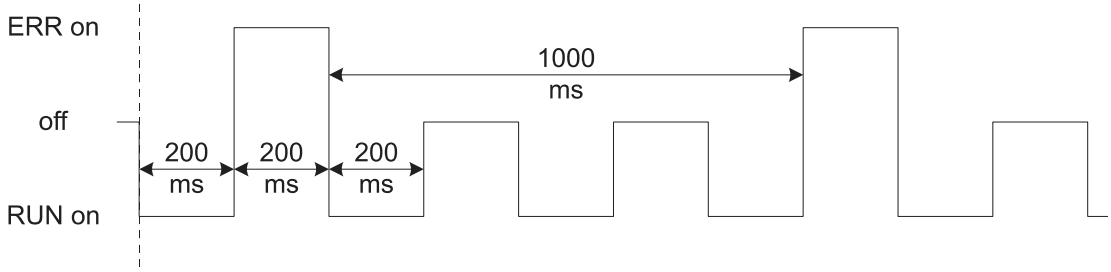


Figure 4. *STATUS indicator Example*

Table 1. *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 2. *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

10 Electrical Specifications

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

- V_{LOG} = 24 VDC; V_{MOT} = 80VDC; F_{PWM} = 20HZ
- Supplies start-up / shutdown sequence: -any-
- Load current (sinusoidal amplitude) = 100A

10.1.1 Operating Conditions

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

10.1.2 Storage Conditions

		Min.	Typ.	Max.	Units
Ambient temperature		-40		105	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

10.1.3 Mechanical Mounting

		Min.	Typ.	Max.	Units
External heatsink (cooling plate)	Current capability depends on heat transfer, heatsink dimension, cooling technique (natural or forced). Keep lower plate temperature at **maximum 75ºC**				

10.1.4 Environmental Characteristics

		Min.	Typ.	Max.	Units
Size (Length x Width x Height)	Without mating connectors		104.2 x 90.5 x 46.8		mm
			~4.1 x 3.56 x 1.84		inch
Weight	Without mating connectors		300		g
Power dissipation	Idle (no load)		3		W
	Operating		80÷100		
Efficiency			98		%
Cleaning agents	Dry cleaning is recommended		Only Water- or Alcohol- based		
Protection degree	According to IEC60529, UL508		IP20		-

10.1.5 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
Supply current	No encoder and no load on digital outputs	+V_{LOG} = 12V		170		mA
		+V_{LOG} = 24V		110		
		+V_{LOG} = 36V		90		
Utilization Category	Acc. to 60947-4-1 (I_{PEAK}<=1.05*I_{NOM})		DC-1			

10.1.6 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	-130	±100	+130	A
	Absolute maximum value, short-circuit condition (Duration ≤ 10ms) †			140	A
Utilization Category	Acc. to 60947-4-1 (I_{PEAK}<=4*I_{NOM})	DC-3			

10.1.7 Motor Outputs (A/A+, B/A-,C)

			Min.	Typ.	Max.	Units
Nominal current *As long as drive lower plate does not exceed 75ºC	PMSM motors sinusoidal amplitude				100	A
	PMSM motors sinusoidal RMS				71	A_{RMS}
	DC/BLDC motors continuous				86.6	A
Peak current	*As long as drive back plate does not exceed 75ºC		-135		+135	A
Short-circuit protection threshold					±140	A
Short-circuit protection delay			5	10		µs
On-state voltage drop	Nominal output current; including typical mating connector contact resistance			±0.3	±0.5	V
Off-state leakage current				±0.5	±1	mA
Motor inductance (phase-to-phase)	Recommended value, for current ripple max. ±5% of full range; +V_{MOT} = 60 V	F_{PWM}				µH
		20 kHz	300			
		40 kHz	150			
		60 kHz	100			
		80 kHz	75			
	Minimum value, limited by short-circuit protection; +V_{MOT} = 60 V	20 kHz	150			µH
		40 kHz	75			
		60 kHz	50			
		80 kHz	38			
Motor electrical time-constant (L/R)	Recommended value for ±5% current measurement error	20 kHz	250			µs
		40 kHz	125			
		60 kHz	100			
		80 kHz	63			

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

[2] iGVD71 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.

Current measurement accuracy (FS = Full scale accuracy)		±4	±8	%FS

10.1.8 Digital Inputs - opto-isolated - (IN0, IN1, IN2/LSP, IN3/LSN, IN4)

		Min.	Typ.	Max.	Units
Mode compliance	PNP (J4, pin9 connected to GND)	Connect digital input pin to +Vlog to change its state			
	NPN (J4, pin9 connected to +Vlog)	Connect digital input pin to GND to change its state			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input voltage	Logic LOW	0		5	V
	Logic HIGH	8		36	
	Absolute maximum	-5		50	
Input current	Logic LOW	0		14	mA
	Logic HIGH	0.6	5	6.6	
	Absolute maximum	0		7.5	
Input frequency			2		kHz
Minimum pulse			500		µs
ESD protection	Human body model	±15			kV

10.1.9 Digital Outputs (OUT0/Brake, OUT1, OUT2, OUT3, OUT4)

		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 = 0.2A		V_{LOG}-0.2	V_{LOG}-0.8	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	OUT1,2,3,4		0.2	A
		OUT0/Brake		2	
	Logic “HIGH”, source current, pulse ≤ 5 s	OUT1,2,3,4		0.4	A
		OUT0/Brake		3	
	Logic “LOW”, means High-Z				mA
Minimum pulse width		2			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 = 0.3A		0.2	0.8	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	OUT1,2,3,4		0.3	A
		OUT0/Brake		2	
	Logic “LOW”, sink current, pulse ≤ 5 s	OUT1,2,3,4		0.5	A
		OUT0/Brake		3	
	Logic “HIGH”, means High-Z				mA
Minimum pulse width		2			µs
ESD protection	Human body model	±15			kV

10.1.10 Brake output (OUT0/Brake)

			Min.	Typ.	Max.	Units
Out0/Brake: solenoid driver, 2A.						
Default state	Not supplied (+V_{LOG} floating or to GND)		High-Z (floating)			
	Immediately after power-up	Brake-	High-Z (floating)			
	Normal operation	Brake-	High-Z (floating)			
Output voltage	Logic “LOW” (Brake-)				0.2	V
	Logic “HIGH”; load present			+V_{LOG}		
	Logic “HIGH”, no load present			+5		
	Absolute maximum, continuous		-0.5		+V_{LOG} +0.3	
Output current	Logic “LOW”, sink current, continuous, Brake-				3	A
	Logic “HIGH”, leakage current; external load to +V_{LOG}; V_{OUT} = V_{LOG} max = 55V				0.2	mA

10.1.11 Digital Hall Inputs (Hall1+, Hall1-, Hall2+, Hall2-, Hall3+, Hall3-)[1]

			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)	H1+, H2+, H3+		4.4		
		H1-, H2-, H3-		1.8		
	Absolute maximum, surge (duration ≤ 1s) †		-10		+15	
Input current	Logic "LOW"; Pull to GND				1.2	mA
	Logic "HIGH"; Internal 4.7KΩ pull-up to +5		0	0	0	
Minimum pulse width			2			µs

					Units
Differential mode compliance	RS422 compliance	TIA/EIA-422-A			
Input voltage	Hysteresis	±0.06	±0.1	±0.2	V
	Differential mode	-14		+14	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential			120		Ω
Input frequency	Differential mode	0		10	MHz
Minimum pulse width	Differential mode	50			ns
ESD protection	Human body model	±5			kV

10.1.12 Encoder #1 and #2 Inputs (A1+, A1-, B1+, B1-, Z1+, Z1-, A2+, A2-, B2+, B2-, Z2+, Z2-)[2]

		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	
	Common-mode range (A+ to GND, etc.)	-11		+14	
Input impedance, differential	A1+/A1-, B1+/B1-, Z1+/Z1- & A2+/A2-, B2+/B2-, Z2+/Z2-		120		Ω
	Differential mode	0		10	MHz
	Differential mode	50			ns

10.1.13 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		18		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS[3]
Bandwidth (-3db)	Software selectable	0		1	kHz
ESD protection	Human body model	±5			kV

10.1.14 SSI, BiSS, EnDAT Encoder Interface

		Min.	Typ.	Max.	Units
Differential mode compliance (CLOCK, DATA)		TIA/EIA-422			
CLOCK Output voltage	Differential; 50Ω differential load	2.0	2.5	5.0	V
	Common-mode, referenced to GND	2.3	2.5	2.7	
CLOCK frequency	Software selectable	1000, 2000, 3000, 4000[4]			kHz
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	
	Software selectable	Single-turn / Multi-turn			
		Counting direction			
DATA resolution	Total resolution (single turn or single turn + multi turn)			56	bit
	If total resolution >31 bits, some bits must be ignored by software setting to achieve a max 31 bits resolution				
Protocol		BiSS C mode (sensor mode)			

10.1.15 Supply Output (+5V)

		Min.	Typ.	Max.	Units
Compliance		IEEE802.3, IEC61158			
Transmission line specification	According to TIA/EIA-568-5-A	Cat. 5e.UTP			
J7, J8 pinout	EtherCAT® supports MDI/MDI-X auto-crossover	TIA/EIA-568-A or TIA/EIA-568-B			
Software protocols compatibility		CoE, CiA402, IEC61800-7-301			
Node addressing*	By hardware sliding switch	1 ÷ 31, 255			-
	By software	1 ÷ 255			
MAC addressing		none			-
ESD protection	Human body model	±15			kV

Remark: When Axis ID is 255, the EtherCAT register called "configured station alias" will be 0.

[1] Differential input HALL pins have internal 120Ω termination resistors connected across when SW1 pins 1,2,3 are ON
[2] All differential input pins have internal 120Ω termination resistors connected across
[3] "FS" stands for "Full Scale"
[4] Availabile only for EnDAT and BiSS feedback options

10.1.16 Supply Output (+5V)

		Min.	Typ.	Max.	Units
+5V output voltage	Current sourced = 250mA	4.8	5	5.2	V
+5V output current		600	650		mA
Short-circuit protection		Protected			
Over-voltage protection		NOT protected			
ESD protection	Human body model 0.1nF 1.5 kΩ	±1			kV

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

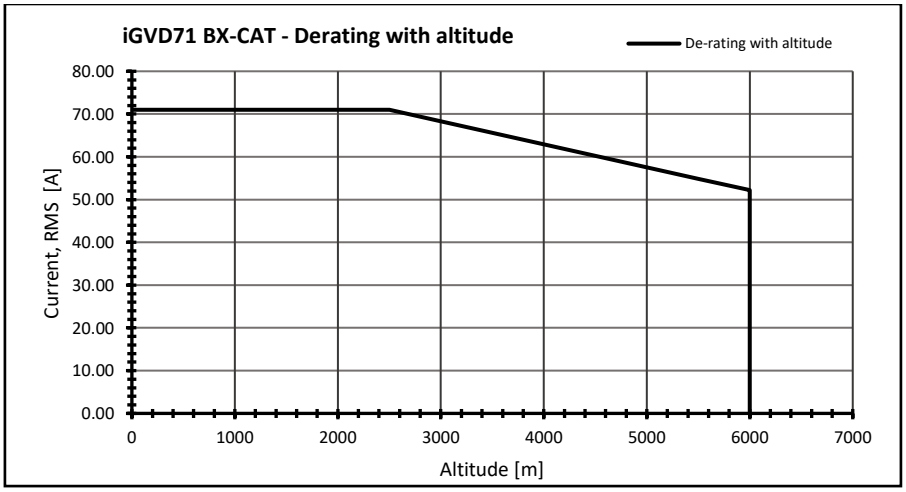
		Min.	Typ.	Max	Units
Safety function	According to EN61800-5-2	STO (Safe Torque OFF)			
EN 61800-5-1/ -2 and EN 61508-5-3/ -4 Classification	Safety Integrity Level	safety integrity level 3 (SIL3)			
	PFHd (Probability of Failures per Hour - dangerous)	$8*10^{-10}$	$hour^{-1}$ (0.8 FIT)		
EN13849-1 Classification	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	10	
Diagnosis	Ignored high-low-high			5	ms
Pulse duration	Accepted pulse			20	Hz
PWM operation delay	From external STO low-high transition to PWM operation enabled			30	ms
ESD protection	Human body model	±2			kV

10.1.18 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.

10.1.19 Derating curves



11 Memory Map

iGVD71 BX has 2 types of memory available for user applications: 16K×16 SRAM and up to 16K×24 serial E^{2}ROM.

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

The E^{2}ROM is mapped in the address range: 4000h to 7FFFh. It is used to keep in a non-volatile memory the TML programs, the cam tables and the drive setup information.

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