iMOT line

Intelligent Motors

TECHNOSOFT

Intelligent Motors

Technical Reference

P091.042.iMOT.UM.06231

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Read This First

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About This Manual

This book is a technical reference manual for:

Product Name	Part Number	Description
iMOT171B TM-CAN	P042.111.E320	Brushless Nema 17, size 1, CAN version, IP66 connectors
iMOT171B TM-CAT	P042.111.E322	Brushless Nema 17, size 1, EtherCAT version, IP66 connectors
iMOT171B XM-CAN	P042.111.E120	Brushless Nema 17, size 1, CAN version, Molex connectors
iMOT172B TM-CAN	P042.121.E320	Brushless Nema 17, size 2, CAN version, IP66 connectors
iMOT172B TM-CAT	P042.121.E322	Brushless Nema 17, size 2, EtherCAT version, IP66 connectors
iMOT172B XM-CAN	P042.121.E120	Brushless Nema 17, size 2, CAN version, Molex connectors
iMOT173B TM-CAN	P042.131.E320	Brushless Nema 17, size 3, CAN version, IP66 connectors
iMOT173B TM-CAT	P042.131.E322	Brushless Nema 17, size 3, EtherCAT version, IP66 connectors
iMOT173B XM-CAN	P042.131.E120	Brushless Nema 17, size 3, CAN version, Molex connectors
iMOT172S TM-CAN	P036.121.E320	Stepper Nema 17, size 2, CAN version, IP66 connectors
iMOT172S TM-CAT	P036.121.E323	Stepper Nema 17, size 2, EtherCAT version, IP66 connectors
iMOT172S XM-CAN	P036.121.E120	Stepper Nema 17, size 2, CAN version, Molex connectors
iMOT232S XM-CAN	P036.222.E120	Stepper Nema 23, size 2, CAN version, Molex connectors
iMOT233S XM-CAN	P036.232.E120	Stepper Nema 23, size 3, CAN version, Molex connectors
iMOT232S TM-CAN	P036.222.E320	Stepper Nema 23, size 2, CAN version, IP66 connectors
iMOT232S TM-CAT	P036.222.E322	Stepper Nema 23, size 2, EtherCAT version, IP66 connectors
iMOT233S TM-CAN	P026.232.E320	Stepper Nema 23, size 3, CAN version, IP66 connectors
iMOT233S TM-CAT	P036.232.E322	Stepper Nema 23, size 3, EtherCAT version, IP66 connectors

In order to operate any of the **iMOT Intelligent Motors** you need to pass through 3 steps:

- **Step 1 Hardware installation**
- **Step 2 Drive setup** using Technosoft **EasySetUp / EasyMotion Studio** software for drive commissioning
- **Step 3 Motion programming** using one of the options:

  - The drive's **built-in motion controller** executing a Technosoft Motion Language (**TML**) program developed using Technosoft **EasyMotion Studio** software and stored in the local non-volatile memory
  - A **TML_LIB motion library for PCs** (Windows or Linux)
  - A **TML_LIB motion library for PLCs**[1]
  - A **CANopen master**[2] or an **EtherCAT master** – depending on the version of the iMOT
  - A **distributed control** approach which combines the above options, like for example a host handling the upper level of the machine application and calling motion functions pre-programmed on the drive in TML for lower level of the machine application

This manual covers **Step 1** in detail. It describes the various models of the **iMOT Intelligent Motors line** hardware including the technical data, the connectors and the wiring diagrams needed for installation.

For Step 2 and 3, please consult the related documentation.

[1] Available for **Siemens SIMATIC S7-300, OMRON CJ1,** and **X20CS1070** from **B&R**

[2] Available only for CAN versions, configured for CANOpen operation

Notational Conventions

This document uses the following conventions:

- **iMOT** – 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.)
- **TML** – Technosoft Motion Language
- **CANopen** – Standard communication protocol that uses 11bit message identifiers over CAN-bus and enables connection with different brand products
- **TMLCAN** – Technosoft's own communication protocol for exchanging TML commands only between Technosoft drives/motors via CAN-bus, using 29bit message identifiers
- **CoE** – CANopen over EtherCAT, CANopen application protocol via EtherCAT® layer

Trademarks

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. In this document it will be further referenced as EtherCAT.

Related Documentation

iMOT Intelligent Motors line Datasheets

– describes the hardware connections of the iMOT Intelligent Motors line including the technical data and connectors.

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

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

***CoE Programming* (part no. P091.064.EtherCAT.iPOS.UM.xxxx)** – explains how to program the Technosoft intelligent drives using **CAN application protocol over EtherCAT®** and describes the associated object dictionary. Since the iMOT Intelligent Motors are based on the iPOS family of drives, this manual also applies to them.

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

***TML_LIB v2.0* (part no. P091.040.v20.UM.xxxx)** – explains how to program in **C, C++,C#, Visual Basic or Delphi Pascal** a motion application for the Technosoft intelligent drives or motors using TML_LIB v2.0 motion control library for PCs. The TML_lib includes ready-to-run examples that can be executed on **Windows** or **Linux** (x86 and x64).

***TML_LIB_LabVIEW v2.0* (part no. P091.040.LABVIEW.v20.UM.xxxx)** – explains how to program in **LabVIEW** a motion application for the Technosoft intelligent drives or motors using TML_Lib_LabVIEW v2.0 motion control library for PCs. The TML_Lib_LabVIEW includes over 40 ready-to-run examples.

***TML_LIB_S7* (part no. P091.040.S7.UM.xxxx)** – explains how to program in a PLC **Siemens series S7-300 or S7-400** a motion application for the Technosoft intelligent drives or motors using TML_LIB_S7 motion control library. The TML_LIB_S7 library is **IEC61131-3 compatible**.

***TML_LIB_CJ1* (part no. P091.040.CJ1.UM.xxxx)** – explains how to program in a PLC **Omron series CJ1** a motion application for the Technosoft intelligent drives or motors using TML_LIB_CJ1 motion control library for PLCs. The TML_LIB_CJ1 library is **IEC61131-3 compatible**.

***TML_LIB_X20* (part no. P091.040.X20.UM.xxxx)** – explains how to program in a PLC **B&R series X20** a motion application for the Technosoft intelligent drives or motors using TML_LIB_X20 motion control library for PLCs. The TML_LIB_X20 library is **IEC61131-3 compatible**.

***TechnoCAN* (part no. P091.063.TechnoCAN.UM.xxxx)** – presents TechnoCAN protocol – an extension of the CANopen communication profile used for TML commands

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 intelligent motor installation and setup! It is imperative to implement the safety instructions listed hereunder.

This information is intended to protect you, the intelligent motor and the accompanying equipment during the product operation. Incorrect handling of the intelligent motor 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 INTELLIGENT MOTOR WHICH MIGHT DAMAGE THE PRODUCT OR OTHER EQUIPMENT. MAY INCLUDE INSTRUCTIONS TO AVOID THIS SITUATION.***

CAUTION! ***INDICATES AREAS SENSITIVE TO ELECTROSTATIC DISCHARGES (ESD) WHICH REQUIRE HANDLING IN AN ESD PROTECTED ENVIRONMENT.***

1.1 Warnings

WARNING! ***THE VOLTAGE USED IN THE INTELLIGENT MOTOR 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 INTELLIGENT MOTOR WHILE THE POWER SUPPLIES ARE ON.***

WARNING! ***THE INTELLIGENT MOTOR MAY HAVE HOT SURFACES DURING OPERATION.***

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

WARNING!	***IN A DOMESTIC ENVIROMENT THIS PRODUCT MAY CAUSE INTERFERENCE IN WHICH CASE SUPPLEMENTARY MITIGATION MEASURES MAY BE REQUIRED.***

1.2 Cautions

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

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

CAUTION!	***THE INTELLIGENT MOTOR CONTAINS ELECTROSTATICALLY SENSITIVE COMPONENTS WHICH MAY BE DAMAGED BY INCORRECT HANDLING. THEREFORE THE INTELLIGENT MOTOR SHALL BE REMOVED FROM ITS ORIGINAL PACKAGE ONLY IN AN ESD PROTECTED ENVIRONMENT***

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

1.3 Quality system, conformance and certifications

qualityaustria Succeed with Quality IQNet	**IQNet** and **Quality Austria** certification about the implementation and maintenance of the Quality Management System which fulfills the requirements of Standard **ISO 9001:2015**. **Quality Austria Certificate** about the application and further development of an effective **Quality Management System** complying with the requirements of Standard **ISO 9001:2015**
REACH	**REACH Compliance -** TECHNOSOFT hereby confirms that this product comply with the legal obligations regarding Article 33 of the European REACH Regulation 1907/2006 (Registration, Evaluation, Authorization and Restriction of Chemicals), which came into force on 01.06.2007.
ROHS	**RoHS Compliance -** Technosoft SA here with declares that this product is manufactured in compliance with the RoHS directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
CE	Technosoft SA hereby declares that this product conforms to the following European applicable directives: **2014/30/EU** **Electromagnetic Compatibility (EMC) Directive** **2014/35/EU** **Low Voltage Directive (LVD)** **93/68/EEC** **CE Marking Directive**
CONFLICT MINERALS	**Conflict minerals statement -** Technosoft declares that the company does not purchase 3T&G (tin, tantalum, tungsten & gold) directly from mines or smelters... We have no indication that Technosoft products contain minerals from conflict mines or smelters in and around the DRC.

The following technical standards have been applied in the design and qualification of the iMOT family:

EN61800-3: 2004 + Amendment 1: 2011

Adjustable Speed Electrical Power Drive Systems - EMC Requirements

BDM (Basic Drive Module) / Category C3: intended for use in Second Environment

EN61800-5-1: 2007 + Amendment 1: 2016

Adjustable Speed Electrical Power Drive Systems - Safety Requirements: Electrical, Thermal and Energy

BDM (Basic Drive Module) / DVC A, Pollution Degree 2, Over-voltage Category I

EN60529: 1992 + Amendment 2: 2013

Degree of protection provided by enclosure

IP00

EN55011: 2009 + Amendment 2: 2010

Radiated Radio Disturbance Characteristics of Industrial, Scientific and Medical Equipment

Class A / Group 1: 30MHz...1GHz, 50...60dBµV/m @10m (EN61800-3 Table 18)

EN55011: 2009 + Amendment 1: 2010

Conducted Mains Terminal Radio Disturbance Measurement

Class A / Group 1: Supply lines, 0.15MHz...30MHz, 46...66dB (EN61800-3 Table 17 <=100A)

EN61000-4-2: 2009

Electrostatic Discharge (ESD) Immunity

Level 2, Criteria A: +/-4KV Contact Discharge, Criteria A

Level 3, Criteria A: +/-8KV Air Discharge, Criteria A (EN61800-3 Table 12)

EN61000-4-3: 2006 + Amendment 2: 2011

Radiated Radiofrequency Electromagnetic Field Immunity

Level 3, Criteria A: 10V/m 80MHz...1GHz, 3V/m 1.4GHz...2GHz, 1V/m 2...2.7GHz

EN61000-4-4: 2004 + Amendment 1: 2010

Electrical Fast Transient / Burst Immunity

Level 3, Criteria A: Supply lines, +/-2KV, Galvanic coupling

Level 3, Criteria A: Signals lines, +/-1KV, Capacitive coupling

EN61000-4-5: 2014

Surge Immunity

Level 2, Criteria B: Supply lines, +/-1KV line-to-line

EN61000-4-6: 2009

Conducted Disturbances induced by Radiofrequency Fields Immunity

Level 3, Criteria A: Signal lines, 10V, 0.15MHz...80MHz

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

2 Product Overview

2.1 Introduction

The **iMOT line** of intelligent brushless and step motors combines an intelligent drive, a motor and a position sensor into a single unit. The result is a cost effective, compact solution that translates motion commands stored by the user in its own memory or received through a communication channel into mechanical motion.

All **iMOTs** perform position, speed or torque control and can be configured for either stand-alone or multi-axis operation. Beside the motor and position sensor, thanks to the intelligent drive, the **iMOTs** combine motion controller PID, power stage drive and PLC functionality in a single 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.)
- 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 the iMOT level you can really distribute the intelligence between the master and the iMOTs 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 iMOTs using TML to execute 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 iMOT's EEPROM and waiting for a message, which confirms the TML functions execution completion.

All iMOT Intelligent Motors are equipped with a serial RS232 and a CAN 2.0B / EtherCAT interface depending on the model. The CAN models can be set by hardware pins to operate in one of the 2 communication protocol modes:

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

When **CANopen** mode is selected, the iMOT conforms to **CiA 301 v4.2** application layer communication profile and **CiA DSP 402 v3.0** device profile for drives and motion control, now included in IEC 61800-7-1 Annex A, IEC 61800-7-201 and IEC 61800-7-301 standards. In this mode, it may be controlled via a CANopen master. The iMOT drive offers the possibility for a CANopen master to call motion sequences/ functions, written in TML and stored in the drive EEPROM, using manufacturer specific objects. Also, the intelligent motors can communicate separately between each other by using non reserved 11 bit identifiers (TechnoCAN protocol).

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

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

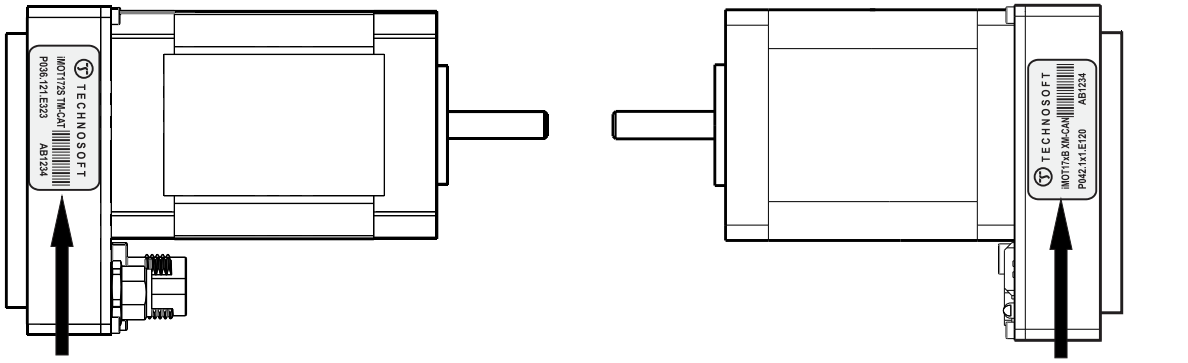
For the commissioning of the intelligent motors, **EasySetUp** or **EasyMotion Studio** PC applications may be used. **EasySetUp** is a subset of EasyMotion Studio, containing only the setup part (drive + motor). The output of EasySetUp is a set of setup data that can be downloaded into the iMOT EEPROM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

EasyMotion Studio platform includes EasySetUp for the system 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. Beside the setup and motion wizards, EasyMotion Studio contain also various tools for on-line monitoring and troubleshooting of the iMOT performance. EasyMotion Studio is usually the choice when it comes to the CAN versions of the iMOT that are going to be used in TMLCAN mode. However, it can also be used with the CANopen protocol, if the user wants to call TML functions stored in the drive EEPROM or to use the camming mode. With camming mode, EasyMotion Studio offers the possibility to quickly download and test a cam profile and also to create a **.sw** file with the cam data. The .sw file can be afterwards stored in a master and downloaded to the drive, wherever needed. **A demo version of EasyMotion Studio (with EasySetUp part fully functional) can be downloaded free of charge from Technosoft web page.**

2.2 Product Features

- Fully digital intelligent servo or stepper motor with embedded motion controller, drive and single turn absolute position sensor
- Very compact design
- 2 control options for stepper model: closed loop stepless servo / open loop microstepping (with steploss detection)
- Various modes of operation, including: torque, speed or position control; position or speed profiles, Cyclic Synchronous Position (CSP) for CANopen mode, external reference mode analogue or sent via a communication bus
- Technosoft Motion Language (TML) instruction set for the definition and execution of motion sequences
- Standalone operation with stored motion sequences
- Communication:
  - RS-232 serial up to 115kbits/s
  - CAN-bus 2.0B up to 1Mbit/s (for CAN drives)
  - EtherCAT up to 100Mbit/s (for EtherCAT motors)
- Digital and analog I/Os:
  - 4 digital inputs: 5-24V, programmable polarity: sourcing/NPN or sinking/PNP (5 digital inputs for the iMOT23xS models)
  - 2 digital outputs:
    - 5-24V, with 0.5A capacity, sinking/NPN open-collector (all motors)
    - programmable polarity: sourcing/NPN or sinking/PNP (iMOT23xS TM only)
  - 1 analogue input: 12 bits resolution, 0 … 5Vdc range
- Electro-Mechanical brake support: software configurable digital output to control motor brake
- Feedback device:
  - Integrated absolute single-turn position sensor offering a resolution of 4096 counts/rev
- 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) for CANopen/EtherCAT mode
  - Electronic gearing and camming
  - 35 Homing modes
- 16 h/w selectable addresses depending on model, otherwise 127/255 software selectable addresses (CANopen / TMLCAN)
- Two CAN operation modes selectable by HW pin (only for CAN motors):
  - **CANopen** – conforming with **CiA 301 v4.2** and **CiA DSP 402 v3.0**
  - **TMLCAN** – intelligent drive conforming with Technosoft protocol for exchanging TML commands via CAN-bus
- 2.5K × 16 internal SRAM memory for data acquisition
- 4K × 16 E^{2}ROM to store TML motion programs, cam tables and other user data
- Motor supply: 12-48V
- Logic supply: 15-36V.
- Operating ambient temperature: 0-40°C (over 40°C with derating)
- Protections:
  - Short-circuit between motor phases or between motor phases and ground
  - Over and under-voltage
  - Over-current and I^{2}t
  - Over-temperature
  - Communication error
  - Control error

2.3 Identification Labels



Identification label with Technosoft part number and serial number

Identification label with Technosoft part number and serial number

Figure 2.3.1. *iMOT intelligent motors identification labels*

The iMOT intelligent motors can have the following part numbers and names on the identification label:

Product Name	Part Number	Description
iMOT171B TM-CAN	P042.111.E320	Brushless Nema 17, size 1, CAN version, IP66 connectors
iMOT171B TM-CAT	P042.111.E322	Brushless Nema 17, size 1, EtherCAT version, IP66 connectors
iMOT171B XM-CAN	P042.111.E120	Brushless Nema 17, size 1, CAN version, Molex connectors
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iMOT232S TM-CAT	P036.222.E322	Stepper Nema 23, size 2, EtherCAT version, IP66 connectors
iMOT233S TM-CAN	P026.232.E320	Stepper Nema 23, size 3, CAN version, IP66 connectors
iMOT233S TM-CAT	P036.232.E322	Stepper Nema 23, size 3, EtherCAT version, IP66 connectors

3 Hardware Installation

3.1 iMOT17xB TM-CAN and TM-CAT models dimensions

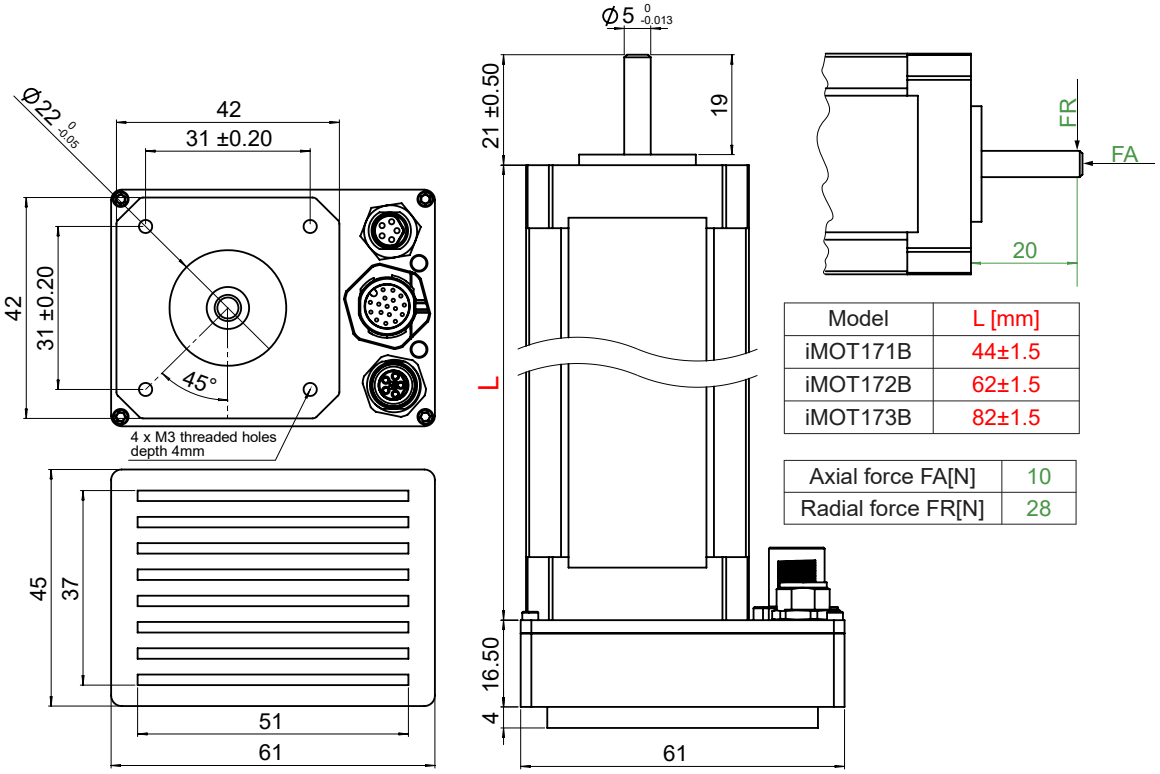


Figure 3.1. *iMOT17xB TM-CAN and TM-CAT models dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted).
TM-CAN model shown.

3.2 iMOT17xB XM-CAN models dimensions

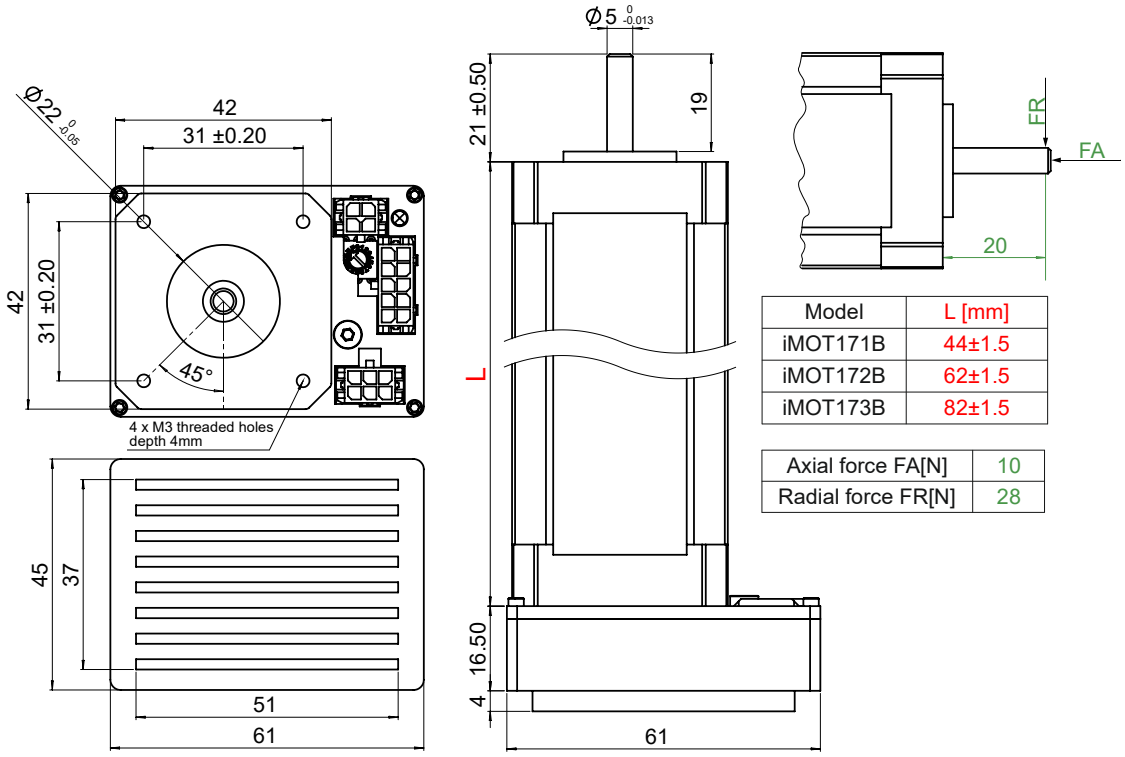


Figure 3.2. *iMOT17xB XM-CAN models dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted).

3.3 iMOT172S XM-CAN model dimensions

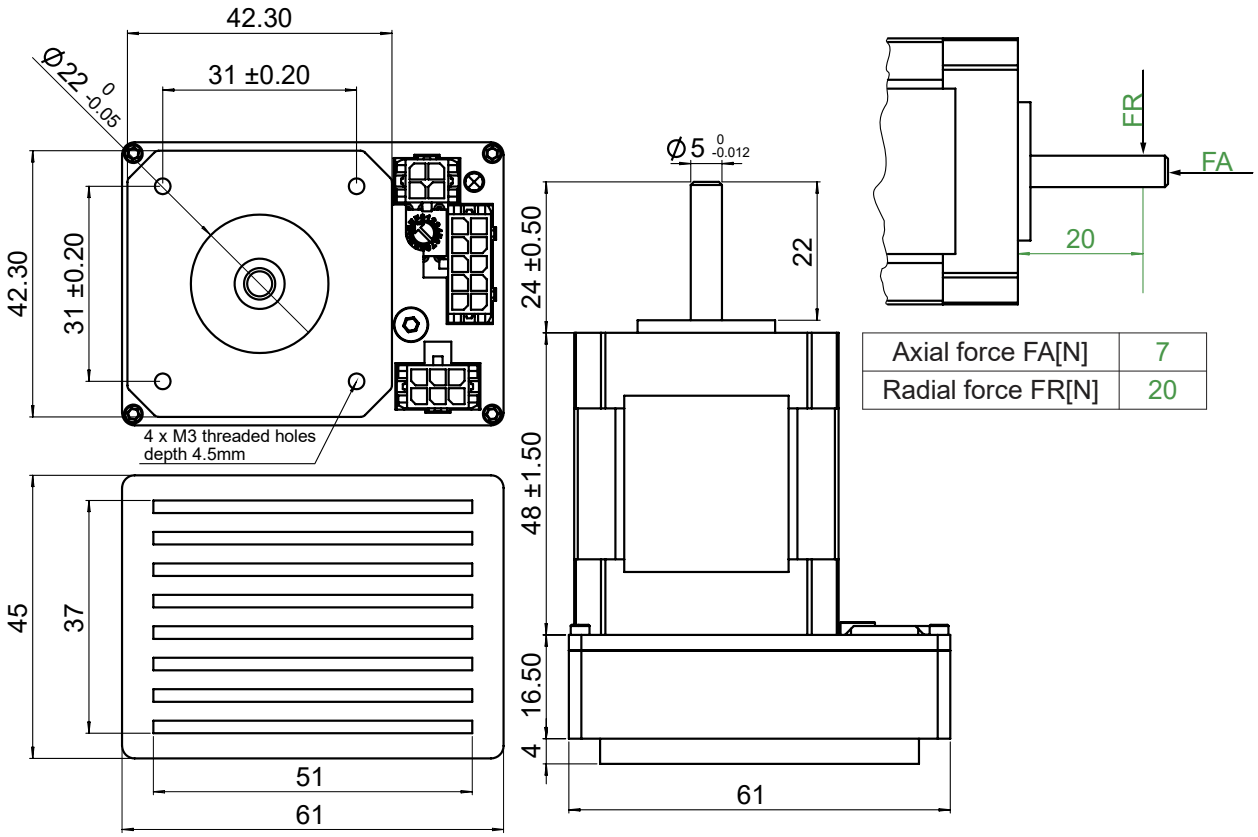


Figure 3.3. *iMOT172S XM-CAN model dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted).

3.4 iMOT172S TM-CAN and TM-CAT models dimensions

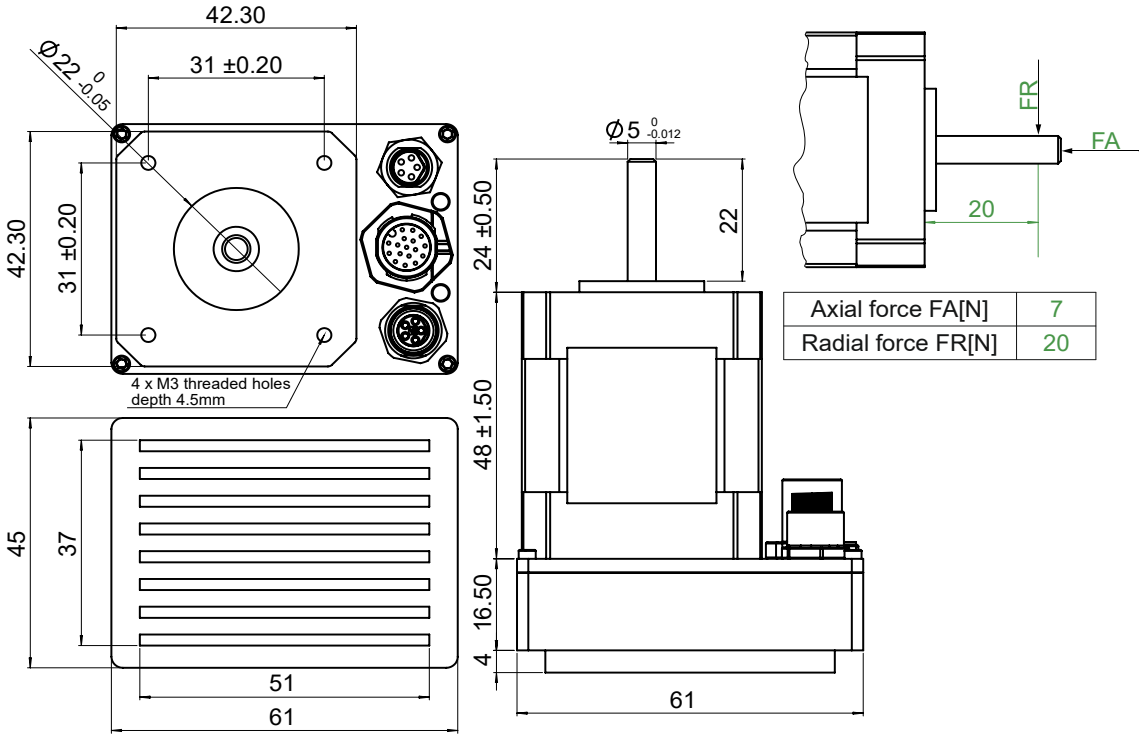


Figure 3.4. *iMOT172S TM-CAN and TM-CAT models dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted). TM-CAN model shown.

3.5 iMOT23xS XM-CAN models dimensions

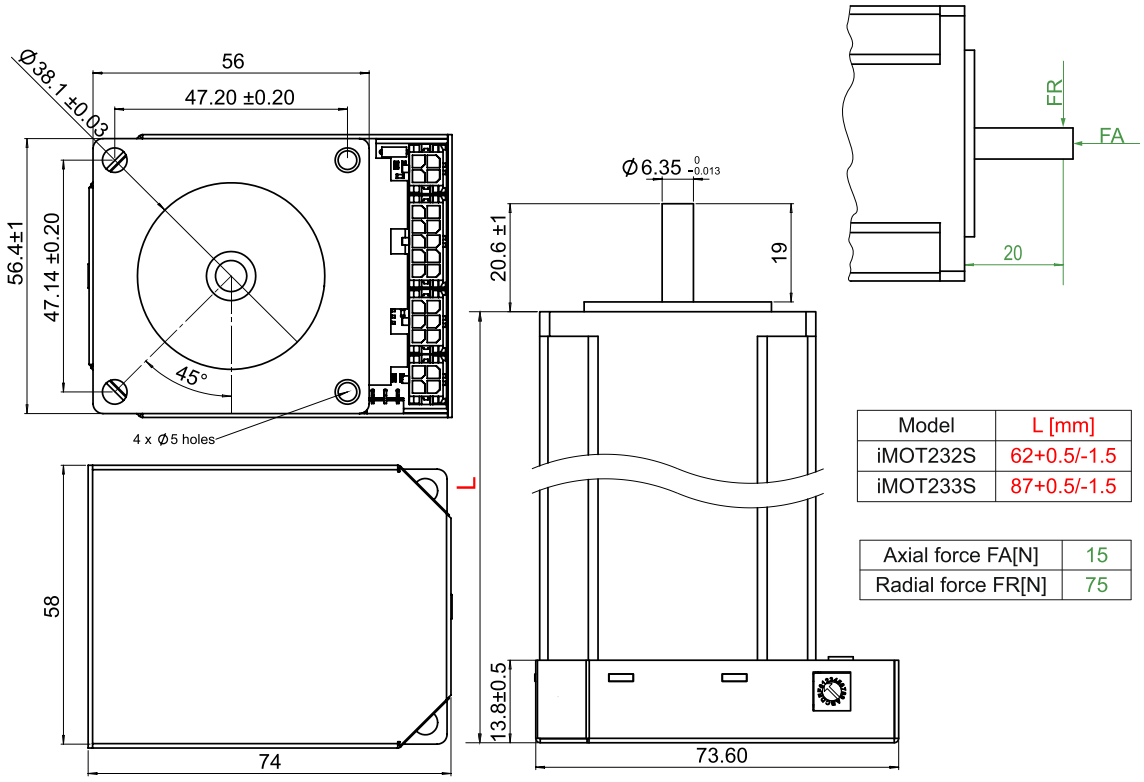


Figure 3.5. *iMOT23xS XM-CAN models dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted).

3.6 iMOT23xS TM-CAN and TM-CAT models dimensions

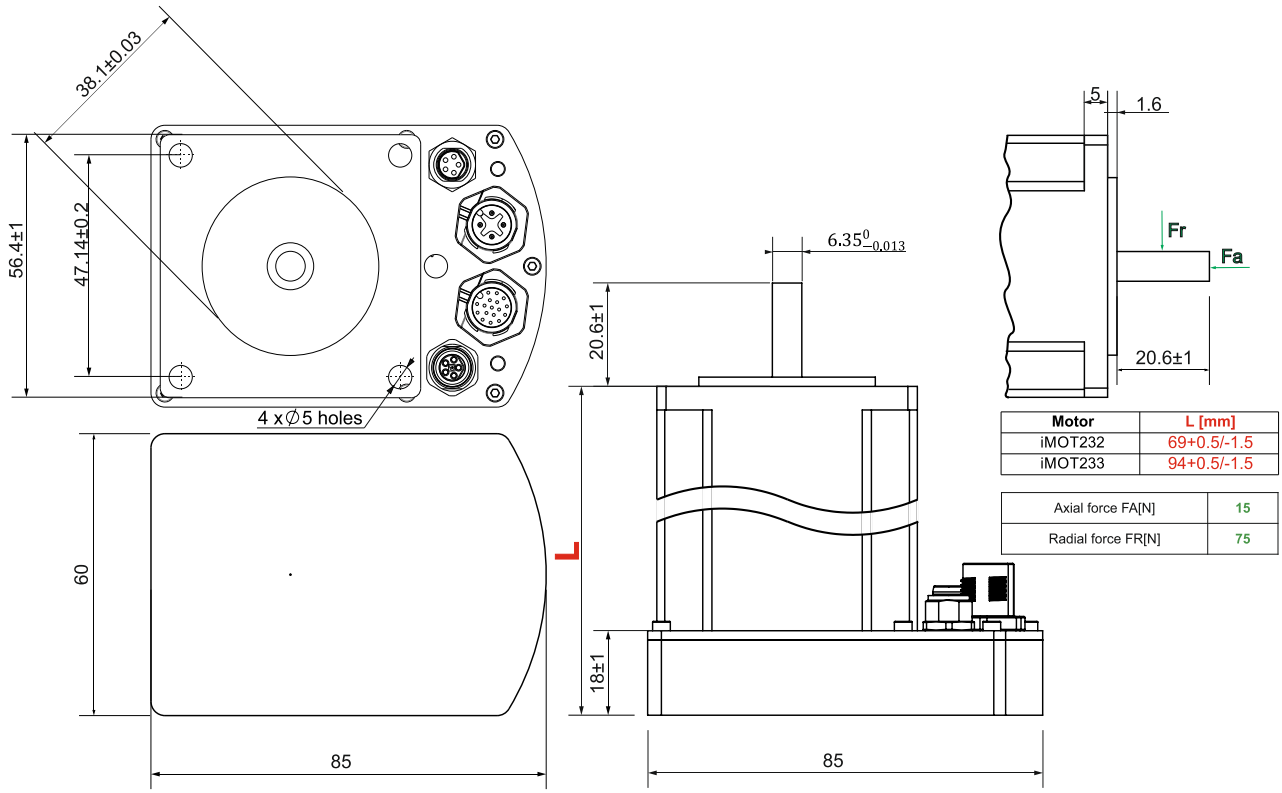
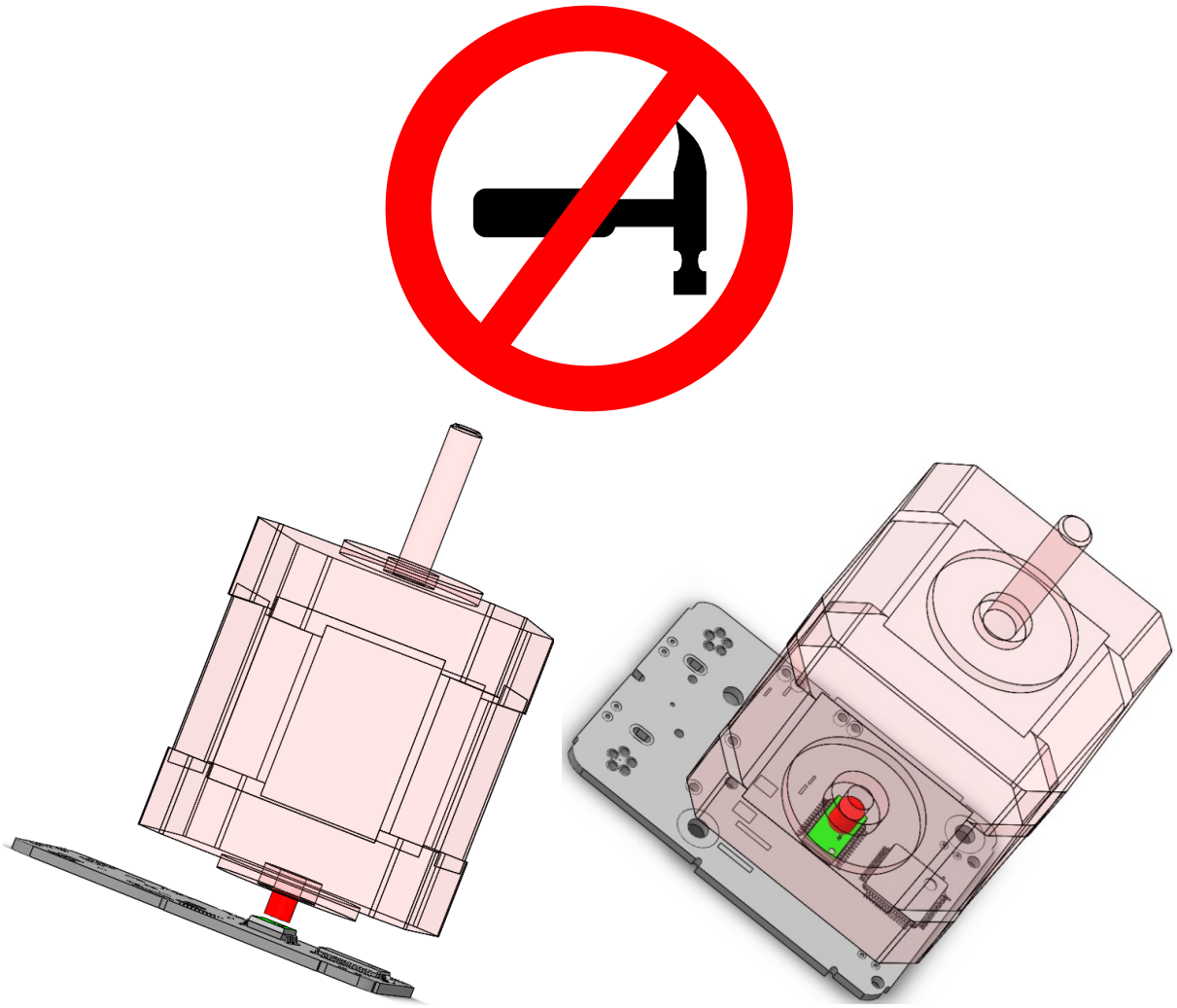


Figure 3.6. *iMOT23xS TM-CAN models dimensions*

All dimensions are in mm. The drawings are not to scale. Tolerance ±0.1mm (unless otherwise noted). TM-CAN model shown.

3.7 Mechanical Mounting



There are no restrictions to the mounting orientation of the iMOTs although **you must pay attention to the axial forces "FA" in Figure 3...Figure 3.** applied to the motor shaft during the installation procedure and on the final position. At the bottom of the motor shaft there's a small magnet (marked with red) that is positioned very close to the magnetic encoder circuit surface (marked with green). The motor housing allows axial movements of the shaft big enough to hit and destroy the magnetic encoder circuit if a hammer or sufficient force is used.

The motor is fixed by the screws on the mounting flange.

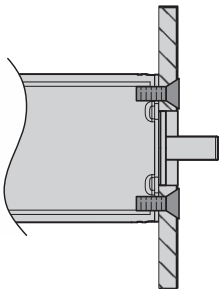


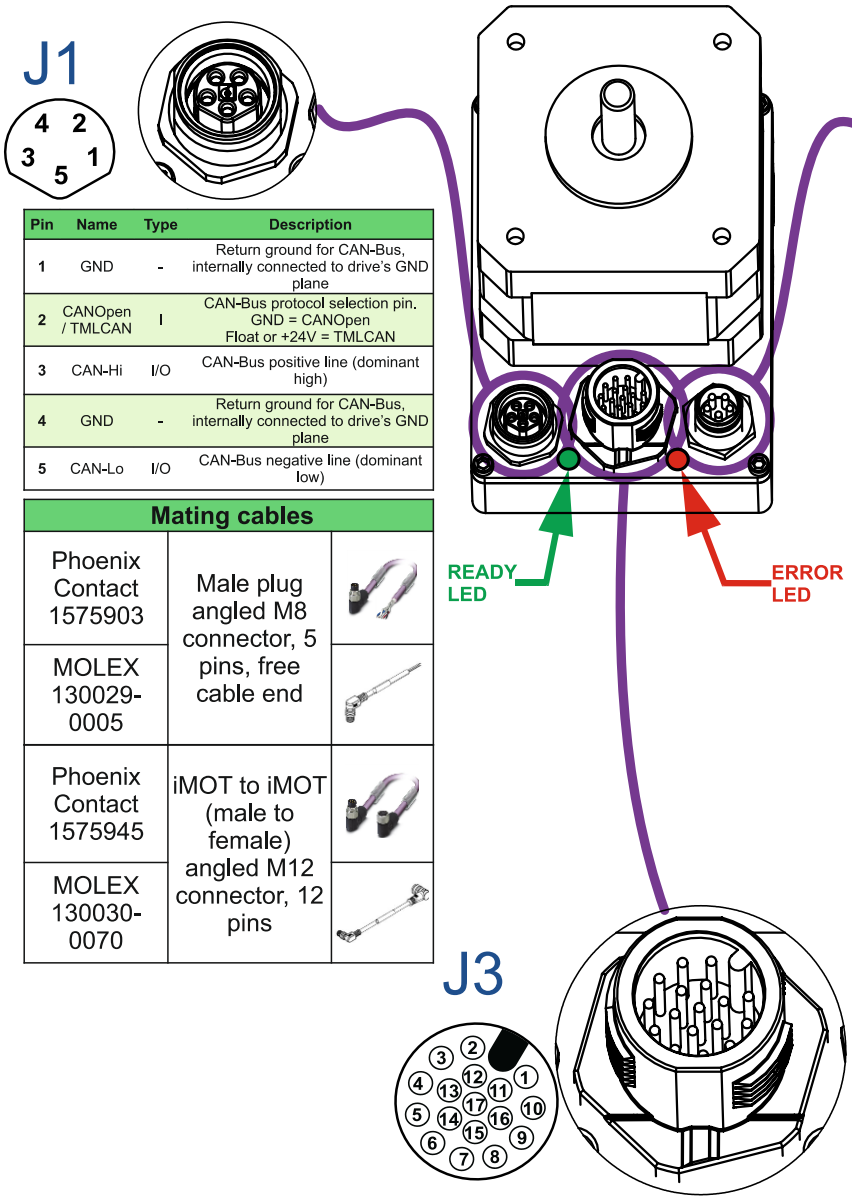
Figure 3.7. **Panel cut-out**

The IMOT intelligent motor was designed to be cooled by natural convection. It can be mounted horizontally or vertically. Always bolt the motor to a metallic surface, which will act as a heat sink. Use only the front plate for mounting.

Make sure the metallic surface is free from paint, eloxation, etc. and that the surface is part of a construction connected to earth (PE – protection earth). This will ensure proper EMC performance.

3.8 Connectors and Pinouts

3.8.1 Connectors and pinouts for iMOT17xB/iMOT172S TM-CAN models



Pin	Name	Type	Description
1	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
2	CANOpen / TMLCAN	I	CAN-Bus protocol selection pin. GND = CANOpen Float or +24V = TMLCAN
3	CAN-Hi	I/O	CAN-Bus positive line (dominant high)
4	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
5	CAN-Lo	I/O	CAN-Bus negative line (dominant low)

Mating cables

Phoenix Contact 1575903	Male plug angled M8 connector, 5 pins, free cable end	
MOLEX 130029-0005		
Phoenix Contact 1575945	iMOT to iMOT (male to female) angled M12 connector, 12 pins	
MOLEX 130030-0070		

Pin	Name	Type	Description
1	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
2	CANOpen / TMLCAN	I	CAN-Bus protocol selection pin. GND = CANOpen Float or +24V = TMLCAN
3	CAN-Hi	I/O	CAN-Bus positive line (dominant high)
4	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
5	CAN-Lo	I/O	CAN-Bus negative line (dominant low)

Mating cables

Phoenix Contact 1575916	Female plug angled M8 connector, 5 pins, free cable end	
MOLEX 130029-0002		
Phoenix Contact 1575945	iMOT to iMOT (male to female) angled M12 connector, 12 pins	
MOLEX 130030-0070		

Pin	Name	Type	Description
1	GND	-	Return ground, internally connected to drive's GND plane
2	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to 48V_{DC} Internally connected to $+V_{MOT}$ plane
3	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to 48V_{DC} Internally connected to $+V_{MOT}$ plane
4	OUT0	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
5	OUT1	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
6	IN3/LSN	I	generic or Limit Switch Negative* digital input, software configurable for either PNP* or NPN devices (max. 36V)
7	IN2/LSP	I	generic or Limit Switch Positive* digital input, software configurable for either PNP* or NPN devices (max. 36V)
8	IN4/EN	I	generic or Enable* digital input, software configurable for either PNP* or NPN devices (max. 36V)
9	$+V_{LOG}$	I	Positive terminal of the logic supply: 15 to 36V_{DC} Internally connected to $+V_{LOG}$ plane

Pin	Name	Type	Description
10	GND	-	Return ground, internally connected to drive's GND plane
11	GND	-	Return ground, internally connected to drive's GND plane
12	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to 48V_{DC} Internally connected to $+V_{MOT}$ plane
13	232TX	O	RS-232 Data Transmit signal, TIA/EIA - 232 - F compatible
14	232RX	I	RS-232 Data Receive signal, TIA/EIA - 232 - F compatbile
15	In0	I	generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
16	REF	I	12 bit, 0 to 5V analogue input used to read position/speed/current reference Can be used as generic analogue input
17	GND	-	Return ground, internally connected to drive's GND plane

* - default configuration

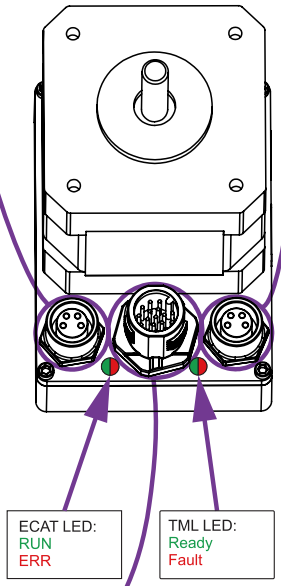
Mating cables

Phoenix Contact 1430323	Female plug angled M12 connector, 12 pins, free cable end	

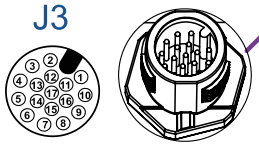
3.8.2 Connectors and pinouts for iMOT17xB/iMOT172S TM-CAT models

Pin	Name	Type	Description
1	Rx/Tx+	I/O	Receive/Transmit Positive Corresponds to pin 3 on RJ45/8P8C Ethernet plug
2	Tx/Rx+	I/O	Transmit/Receive Positive Corresponds to pin 1 on RJ45/8P8C Ethernet plug
3	Tx/Rx-	I/O	Transmit/Receive Negative Corresponds to pin 2 on RJ45/8P8C Ethernet plug
4	Rx/Tx-	I/O	Receive/Transmit Negative Corresponds to pin 6 on RJ45/8P8C Ethernet plug
SHIELD	Earth		Connected to iMOT chassis Galvanically isolated from GND, up to 100Vdc. Capacitively coupled to GND for EMC shielding, with discharge resistor

Mating cables		
Murr Elektronik 7000-89781-x	iMOT to ECAT Master angled 4pin M8 male to Rj45 8/4pin	
Murr Elektronik 7000-89721-x Phoenix Contact 1407352 Beckhoff ZK1090-3161-x	iMOT to ECAT Master straight 4pin M8 male to Rj45 8/4pin	
Murr Elektronik 7000-89771-x	iMOT to iMOT angled 4pin M8 male to male	
Murr Elektronik 7000-89701-x Phoenix Contact 1407348 Beckhoff ZK1090-3131-x	iMOT to iMOT straight 4pin M8 male to male	



While J1 & J2 connectors are identical, it's important that the "IN" and "OUT" functionality is observed. The EtherCAT Master must always be connected to J1 ECAT IN connector to ensure full EtherCAT functionality of the network



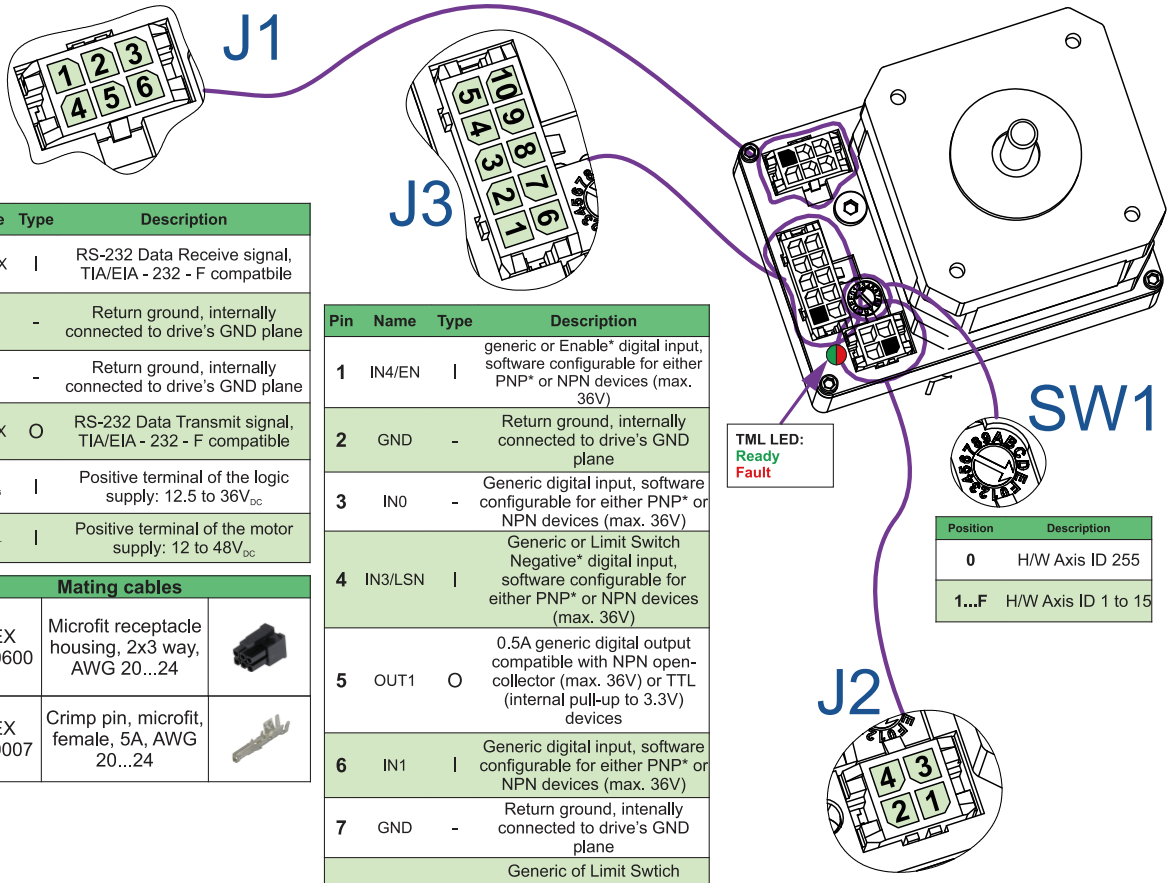
Pin	Name	Type	Description
1	GND	-	Return ground, internally connected to drive's GND plane
2	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $48V_{DC}$ Internally connected to $+V_{MOT}$ plane
3	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $48V_{DC}$ Internally connected to $+V_{MOT}$ plane
4	OUT0	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
5	OUT1	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
6	IN3/LSN	I	generic or Limit Switch Negative* digital input, software configurable for either PNP* or NPN devices (max. 36V)
7	IN2/LSP	I	generic or Limit Switch Positive* digital input, software configurable for either PNP* or NPN devices (max. 36V)
8	IN4/EN	I	generic or Enable* digital input, software configurable for either PNP* or NPN devices (max. 36V)

Pin	Name	Type	Description
9	$+V_{LOG}$	I	Positive terminal of the logic supply: 15 to $36V_{DC}$
10	GND	-	Return ground, internally connected to drive's GND plane
11	GND	-	Return ground, internally connected to drive's GND plane
12	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $48V_{DC}$ Internally connected to $+V_{MOT}$ plane
13	232TX	O	RS-232 Data Transmit signal, TIA/EIA - 232 - F compatible
14	232RX	I	RS-232 Data Receive signal, TIA/EIA - 232 - F compatbile
15	IN0	I	generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
16	REF	I	12 bit, 0 to 5V analogue input used to read position/speed/current reference Can be used as generic analogue input
17	GND	-	Return ground, internally connected to drive's GND plane

Mating cables		
Phoenix Contact 1430323	Female plug angled M12 connector, 17 pins, free cable end	

* - default configuration

3.8.3 Connectors and pinouts for iMOT17xB/iMOT172S XM-CAN models



Pin	Name	Type	Description
1	232RX	I	RS-232 Data Receive signal, TIA/EIA - 232 - F compatbile
2	GND	-	Return ground, internally connected to drive's GND plane
3	GND	-	Return ground, internally connected to drive's GND plane
4	232TX	O	RS-232 Data Transmit signal, TIA/EIA - 232 - F compatible
5	$+V_{LOG}$	I	Positive terminal of the logic supply: 12.5 to $36V_{DC}$
6	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $48V_{DC}$

Mating cables		
MOLEX 43025-0600	Microfit receptacle housing, 2x3 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

Pin	Name	Type	Description
1	IN4/EN	I	generic or Enable* digital input, software configurable for either PNP* or NPN devices (max. 36V)
2	GND	-	Return ground, internally connected to drive's GND plane
3	IN0	-	Generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
4	IN3/LSN	I	Generic or Limit Switch Negative* digital input, software configurable for either PNP* or NPN devices (max. 36V)
5	OUT1	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
6	IN1	I	Generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
7	GND	-	Return ground, intenally connected to drive's GND plane
8	IN2/LSP	I	Generic of Limit Swtich Positive* digital input, software configurable for either PNP* or NPN devices (max. 36V)
9	OUT0	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
10	REF	I	12 bit, 0 to 5V analogue input used to read position/speed/current reference Can be used as generic analogue input

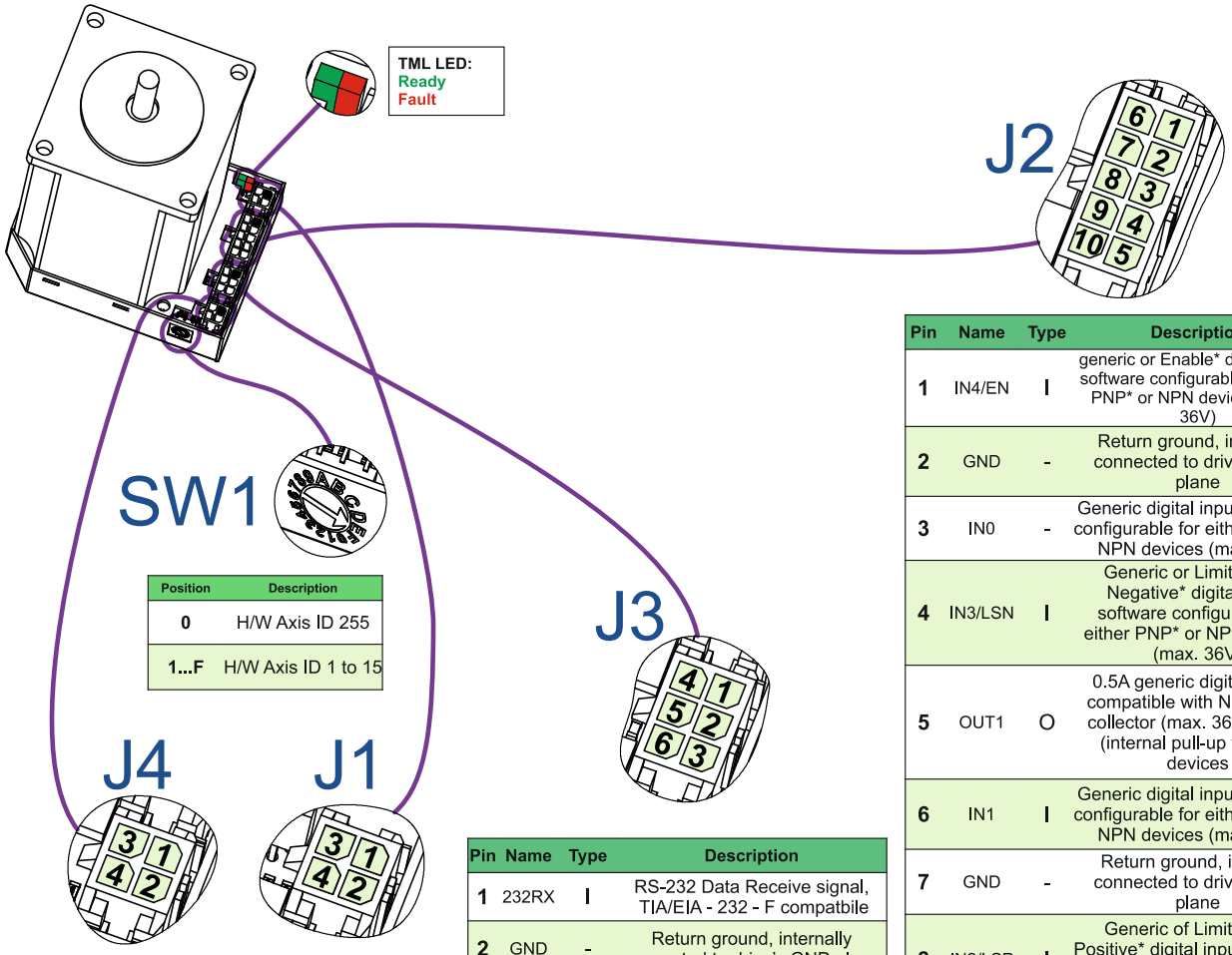
Mating cables		
MOLEX 43025-1000	Microfit receptacle housing, 2x5 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

Position	Description
0	H/W Axis ID 255
1...F	H/W Axis ID 1 to 15

Pin	Name	Type	Description
1	CANOpen / TMLCAN	I	CAN-Bus protocol selection pin. GND = CANOpen Float or +24V = TMLCAN
2	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
3	CAN-Hi	I/O	CAN-Bus positive line (dominant high)
4	CAN-Lo	I/O	CAN-Bus negative line (dominant low)

Mating cables		
MOLEX 43025-0400	Microfit receptacle housing, 2x2 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

3.8.4 Connectors and pinouts for iMOT23xS XM-CAN models



Position	Description
0	H/W Axis ID 255
1...F	H/W Axis ID 1 to 15

Pin	Name	Type	Description
1	CANOpen / TMLCAN	I	CAN-Bus protocol selection pin. GND = CANOpen Float or +24V = TMLCAN
2	GND	-	Return ground for CAN-Bus, internally connected to drive's GND plane
3	CAN-Hi	I/O	CAN-Bus positive line (dominant high)
4	CAN-Lo	I/O	CAN-Bus negative line (dominant low)

Pin	Name	Type	Description
1	232RX	I	RS-232 Data Receive signal, TIA/EIA - 232 - F compatbile
2	GND	-	Return ground, internally connected to drive's GND plane
3	GND	-	Return ground, internally connected to drive's GND plane
4	232TX	O	RS-232 Data Transmit signal, TIA/EIA - 232 - F compatible
5	$+V_{LOG}$	I	Positive terminal of the logic supply: 12.5 to $36V_{DC}$
6	$+V_{MOT}$	I	Positive terminal of the motor supply: 12 to $48V_{DC}$

Pin	Name	Type	Description
1	IN4/EN	I	generic or Enable* digital input, software configurable for either PNP* or NPN devices (max. 36V)
2	GND	-	Return ground, internally connected to drive's GND plane
3	IN0	-	Generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
4	IN3/LSN	I	Generic or Limit Switch Negative* digital input, software configurable for either PNP* or NPN devices (max. 36V)
5	OUT1	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
6	IN1	I	Generic digital input, software configurable for either PNP* or NPN devices (max. 36V)
7	GND	-	Return ground, intenally connected to drive's GND plane
8	IN2/LSP	I	Generic of Limit Swtich Positive* digital input, software configurable for either PNP* or NPN devices (max. 36V)
9	OUT0	O	0.5A generic digital output compatible with NPN open-collector (max. 36V) or TTL (internal pull-up to 3.3V) devices
10	REF	I	12 bit, 0 to 5V analogue input used to read position/speed/current reference Can be used as generic analogue input

Mating cables		
MOLEX 43025-0400	Microfit receptacle housing, 2x2 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

Mating cables		
MOLEX 43025-0600	Microfit receptacle housing, 2x3 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

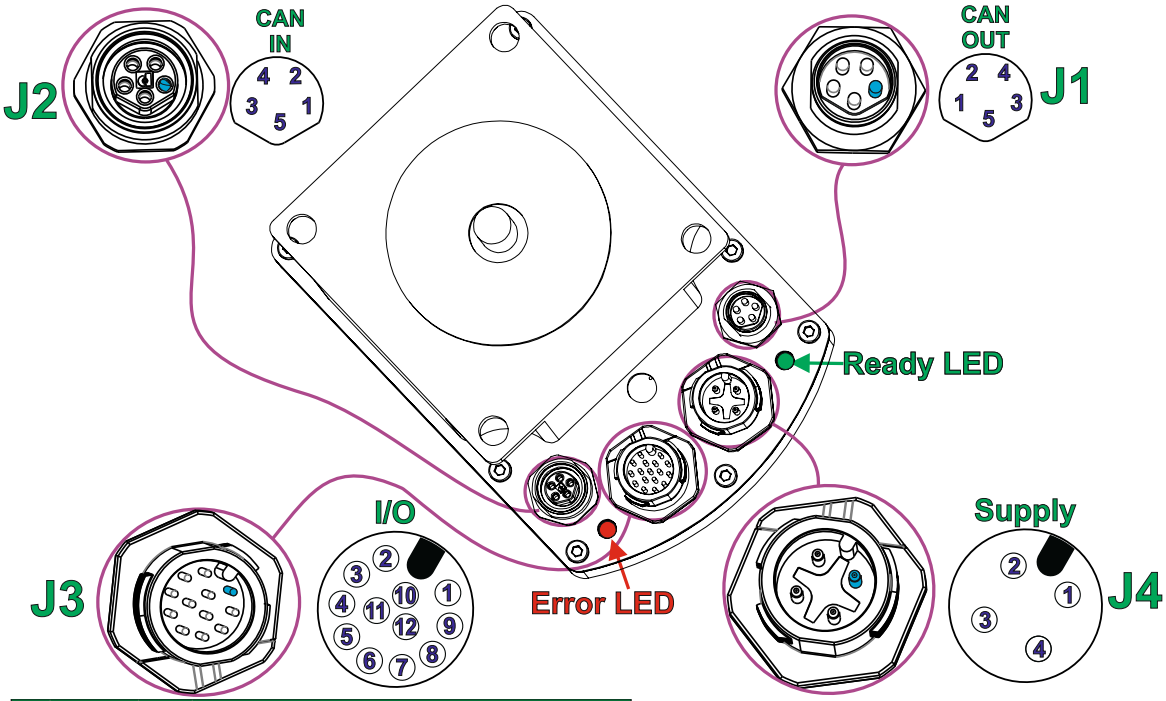
Mating cables		
MOLEX 43025-1000	Microfit receptacle housing, 2x5 way, AWG 20...24	
MOLEX 43030-0007	Crimp pin, microfit, female, 5A, AWG 20...24	

3.8.5 Connectors and pinouts for iMOT23xS TM-CAN models

Pin	Name	Type	Description
1	Earth	-	Earth connection
2	+V_{LOG}	I	Positive terminal of the logic supply: 12.5 to 36V_{DC} Internally connected to the other +V_{LOG} pin.
3	Can-Hi	I/O	CAN-Bus positive line (dominant high)
4	GND	-	Return ground for Motor supply; Internally connected to all GND pins.
5	Can-Lo	I/O	CAN-Bus negative line (dominant low)

J1 & J2 - Mating cables	
MOLEX 130029-0002	M8 Single-ended, 5 Poles, Female (90°), 1m
MOLEX 130029-0005	M8 Single-ended, 5 Poles, Male (90°), 1m

J1 & J2 - CAN terminator	
P038.002.E306	Molex MFIT 2x2 connector with 120 Ohms terminal resistor



Pin	Name	Type	Description
1	GND	-	Return ground for I/O pins; Internally connected to all GND pins
2	REF	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position/speed reference, or used as
3	Enable	I	5-36V digital PNP/NPN input. Enable input
4	+V_{LOG}	I	Positive terminal of the logic supply: 12.5 to 36V_{DC}.
5	IN3/LSN	I	5-36V digital PNP/NPN input. Negative limit switch
6	CANOpen	I	Connect to GND to enable CANopen protocol Leave unconnected for TMLCAN protocol
7	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
8	232RX	I	RS-232 Data Reception
9	232TX	O	RS-232 Data Transmission
10	IN0	I	5-36V general-purpose digital PNP/NPN input
11	IN2/LSP	I	5-36V digital PNP/NPN input. Positive limit switch
12	OUT0	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

J3 - Mating cable	
Phoenix Contact 1682906	M12 Single-ended, 4 Poles, Female (90°), 1.5m

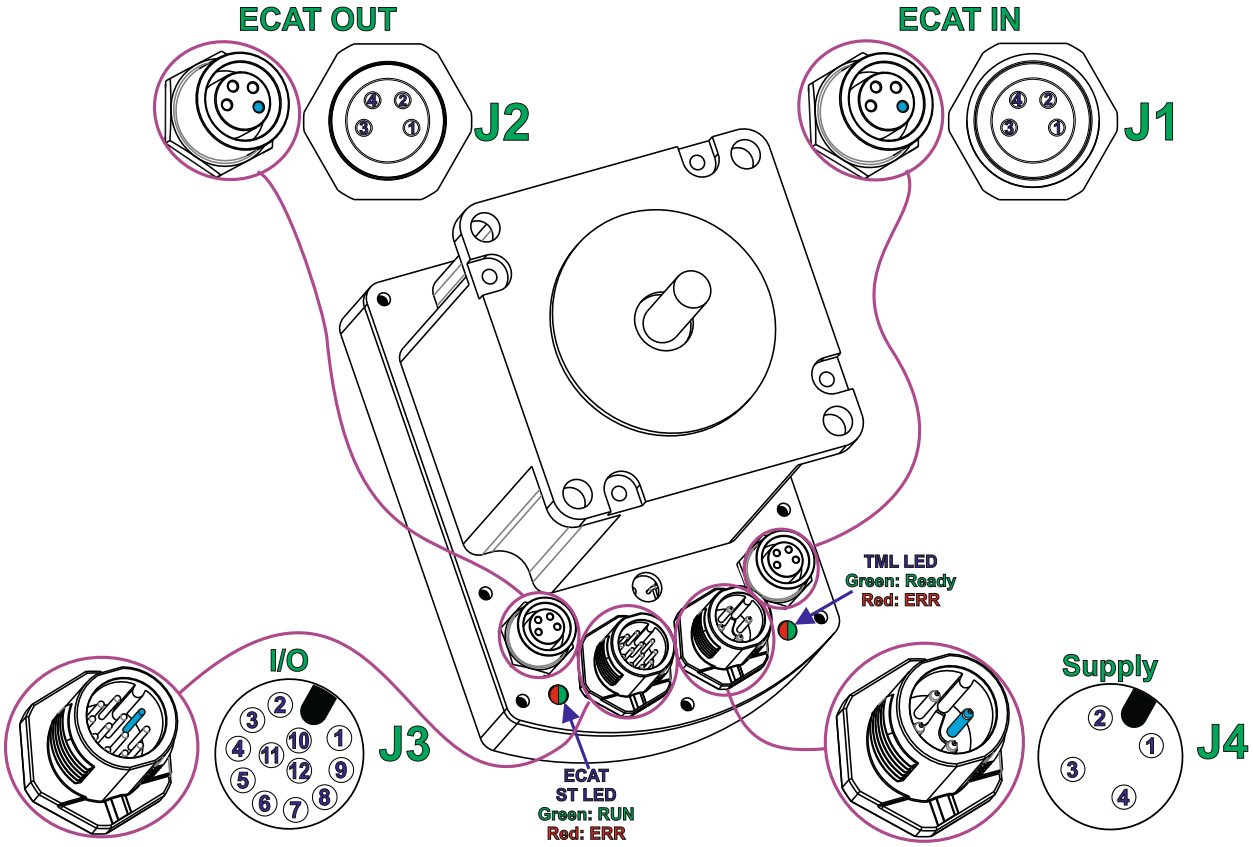
Pin	Name	Type	Description
1	GND	-	Return ground for Motor supply. Internally connected to all GND pins.
2	+V_{LOG}	I	Positive terminal of the logic supply: 12.5 to 36V_{DC}
3	+V_{MOT}	I/O	Positive terminal of the motor supply: 12 to 48V_{DC}
4	GND	-	Return ground for Motor supply; Internally connected to all GND pins.

J4 - Mating cable	
Phoenix Contact 1682906	M12 Single-ended, 4 Poles, Female (90°), 1.5m

3.8.6 Connectors and pinouts for iMOT23xS TM-CAT models

Pin	Name	Description
1	Rx/Tx+	Receive/Transmit Positive Corresponds to pin 3 on RJ45/8P8C Ethernet plug
2	Tx/Rx+	Transmit/ Receive Positive Corresponds to pin 1 on RJ45/8P8C Ethernet plug
3	Tx/Rx-	Receive/Transmit Positive Corresponds to pin 2 on RJ45/8P8C Ethernet plug
4	Rx/Tx-	Receive/Transmit Negative Corresponds to pin 6 on RJ45/8P8C Ethernet plug
SHIELD	Earth	Connected to motor chassis Galvanically isolated from GND, up to 200VDC isolation Capacitively coupled to GND for EMC shielding,with discharge resistor

J1 & J2 - Mating cables	
Murr Elektronik 7000-89771	Motor-to-motor, 4 pin male to male
Murr Elektronik 7000-08821	Motor-to-wire, 4 pin male
Murr Elektronik 7000-89781	Motor-to-RJ45, 4 pin male to 8 pin RJ45



Pin	Name	Type	Description
1	GND	-	Return ground for I/O pins; Internally connected to all GND pins
2	REF	I	Analogue input, 12-bit, 0-5V. Used to read an analogue position/speed reference, or used as general purpose analogue input
3	Enable	I	5-36V digital PNP/NPN input. Enable input
4	$+V_{LOG}$	I	Positive terminal of the logic supply: 12.5 to $36V_{DC}$. Internally connected to the other $+V_{LOG}$ pin
5	IN3/LSN	I	5-36V digital PNP/NPN input. Negative limit switch input
6	Rsvd.	-	Reserved
7	OUT1	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up
8	232RX	I	RS-232 Data Reception
9	232TX	O	RS-232 Data Transmission
10	IN0	I	5-36V general-purpose digital PNP/NPN input
11	IN2/LSP	I	5-36V digital PNP/NPN input. Positive limit switch input
12	OUT0	O	5-36V 0.5A, general-purpose digital output, NPN open-collector/TTL pull-up

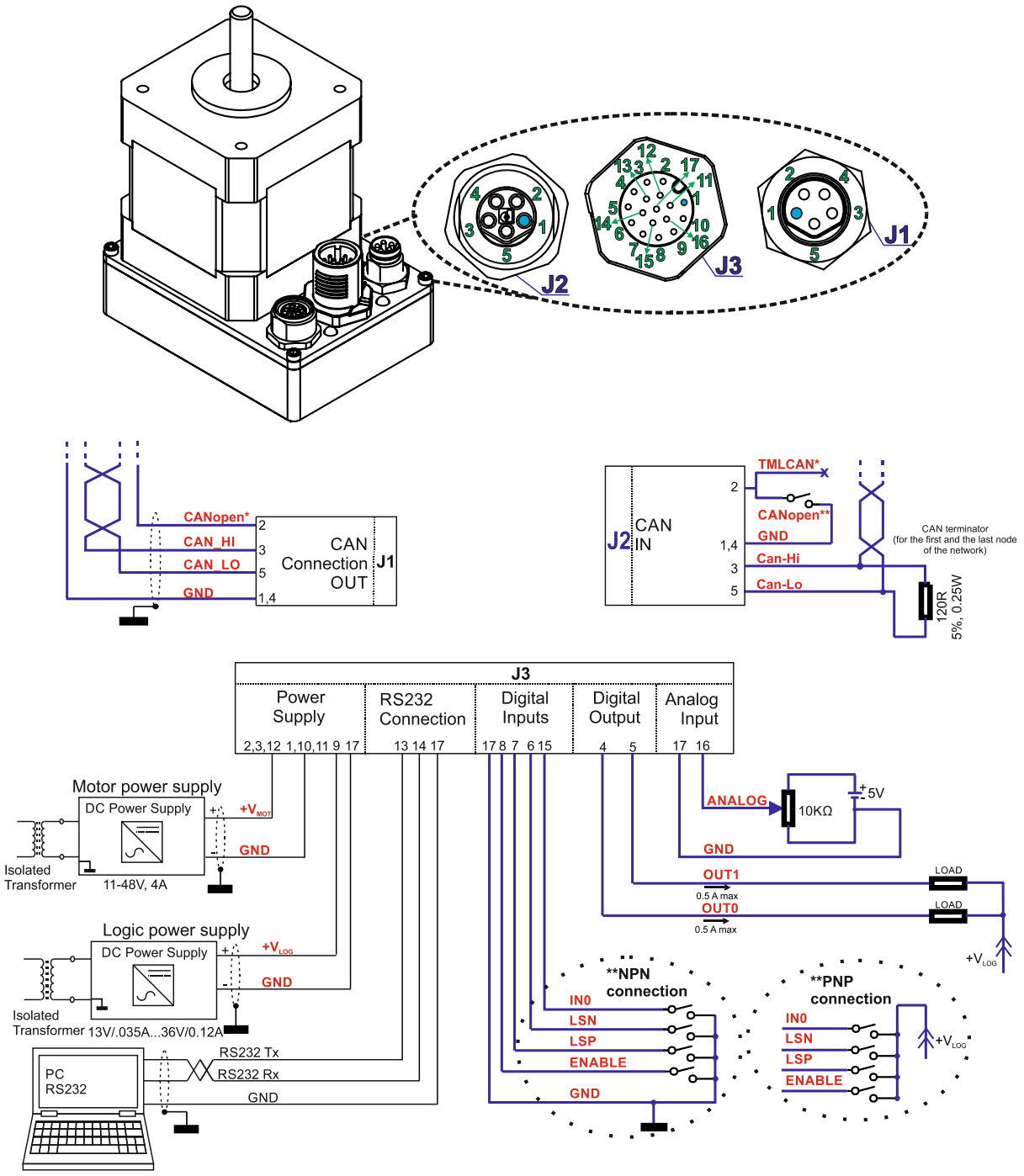
J3 - Mating cable	
Phoenix Contact 1682906	M12 Single-ended, 4 Poles, Female (90°), 1.5m

Pin	Name	Type	Description
1	GND	-	Return ground for Motor supply. Internally connected to all GND pins.
2	$+V_{LOG}$	I	Positive terminal of the logic supply: 12.5 to $36V_{DC}$
3	$+V_{MOT}$	I/O	Positive terminal of the motor supply: 12 to $48V_{DC}$
4	GND	-	Return ground for Motor supply; Internally connected to all GND pins.

J4 - Mating cable	
Phoenix Contact 1682906	M12 Single-ended, 4 Poles, Female (90°), 1.5m

3.9 Connection diagrams

3.9.1 iMOT17xB/iMOT172S TM-CAN connection diagram

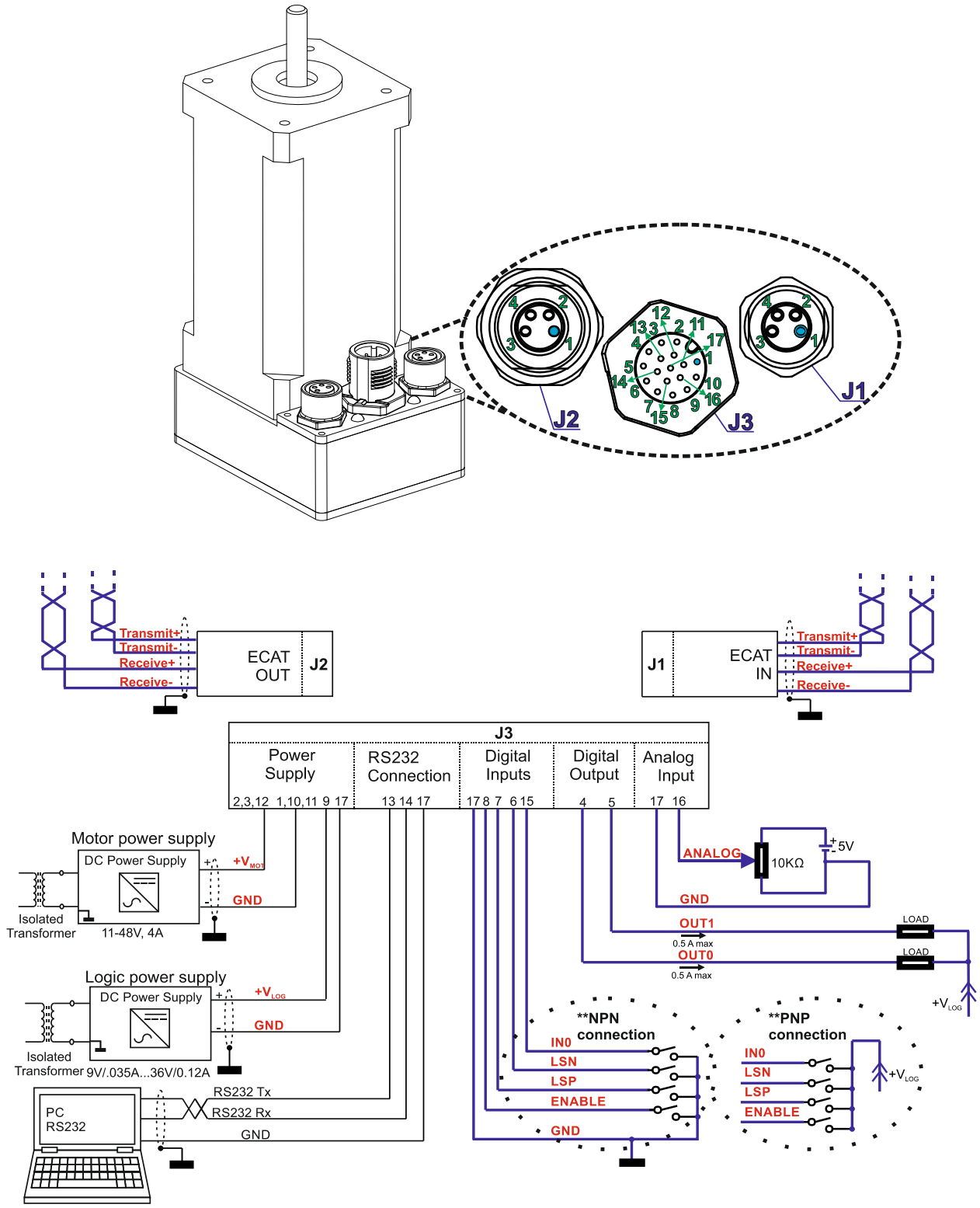


*To select the CANopen protocol, connect pin 2 of J2 to GND; for TMLCAN protocol connect to $+V_{LOG}$ or leave unconnected.

** A PNP connection is also possible. Software configurable in Setup.

Figure 3.9.1. **iMOT17xB/iMOT172S TM-CAN connection diagram**

3.9.2 iMOT17xB/iMOT172S TM-CAT connection diagram



** A PNP connection is also possible. Software configurable in Setup.

Figure 3.9.2. **iMOT17xB/iMOT172S TM-CAT connection diagram**

3.9.3 iMOT17xB/iMOT172S XM-CAN connection diagram

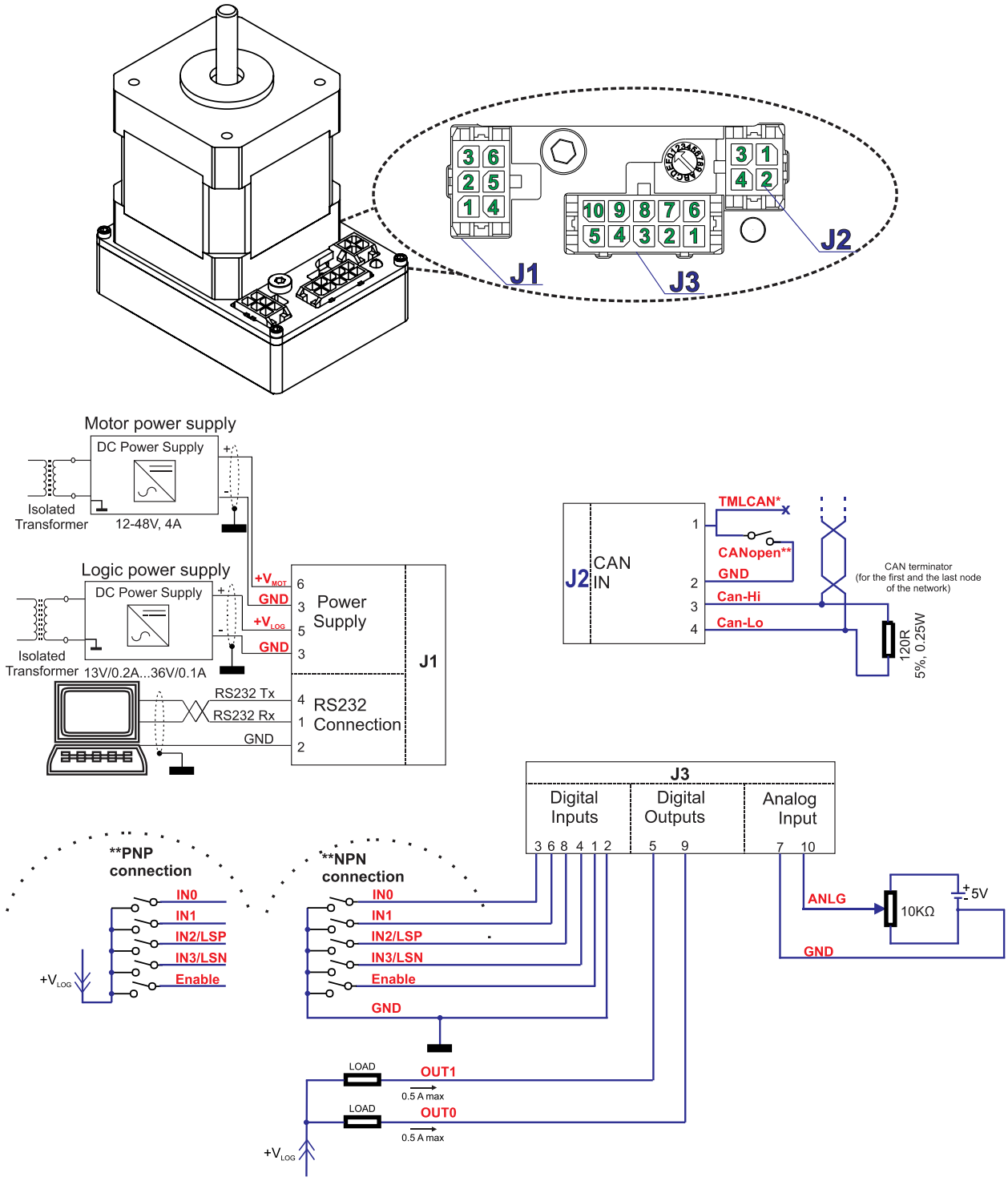


Figure 3.9.3. **iMOT17xB/iMOT172S XM-CAN connection diagram**

3.9.4 iMOT23xS XM-CAN connection diagram

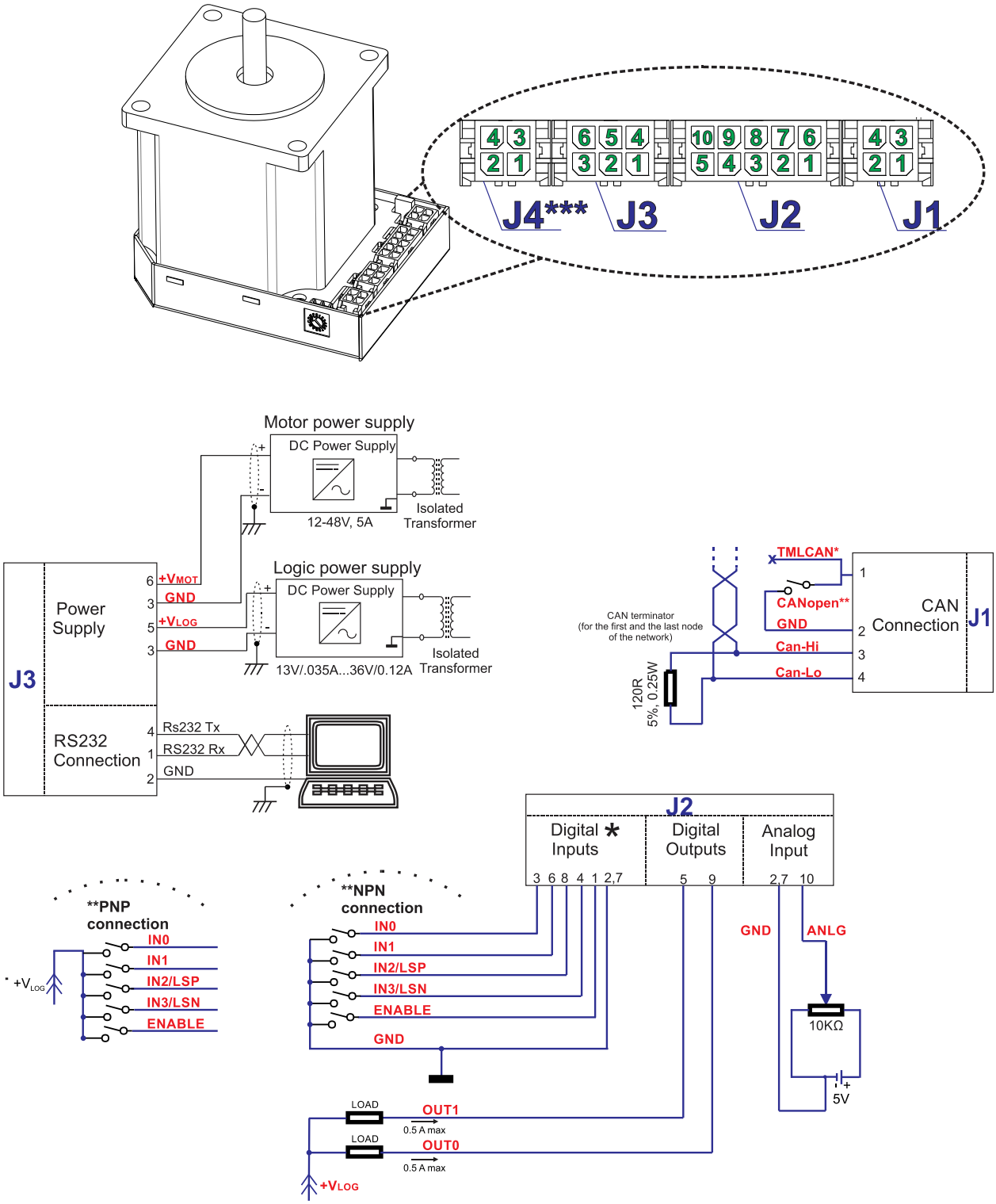


Figure 3.9.4. **iMOT23xS XM-CAN connection diagram**

3.9.5 iMOT23xS TM-CAN connection diagram

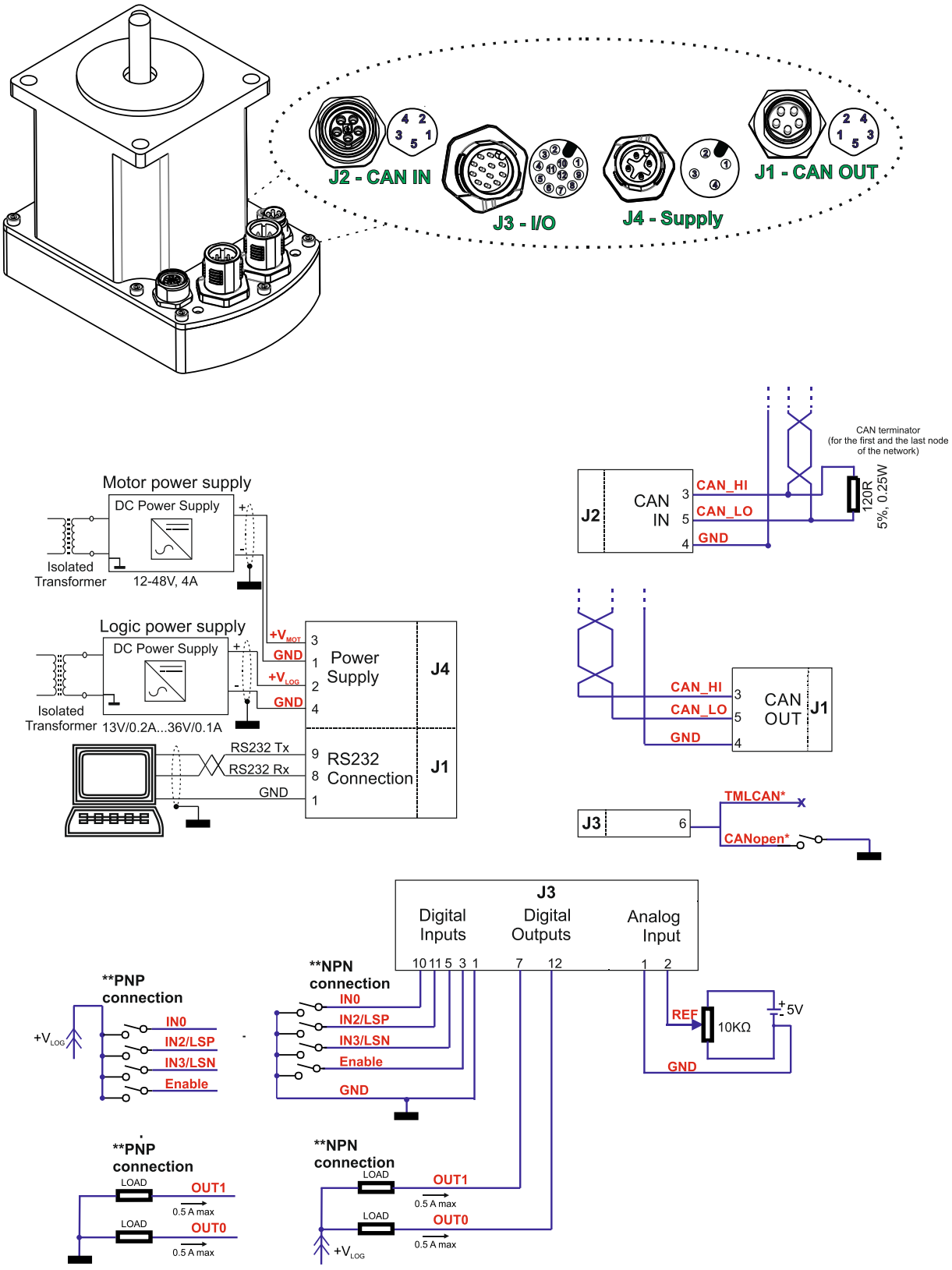


Figure 3.9.5. **iMOT23xS TM-CAN connection diagram**

3.9.6 iMOT23xS TM-CAT connection diagram

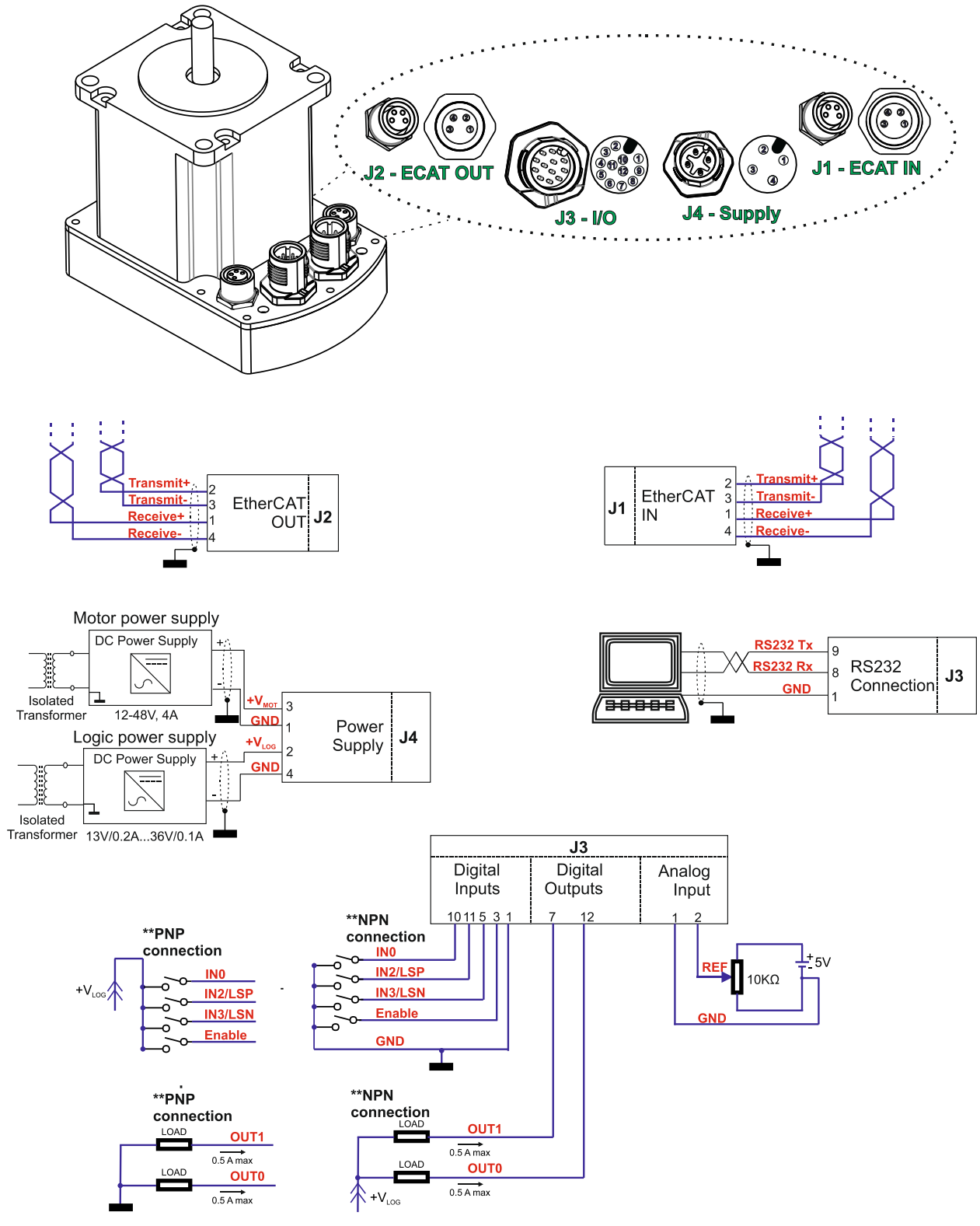


Figure 3.9.6. **iMOT23xS TM-CAT connection diagram**

3.9.7 Analog Inputs Connection Recommendations

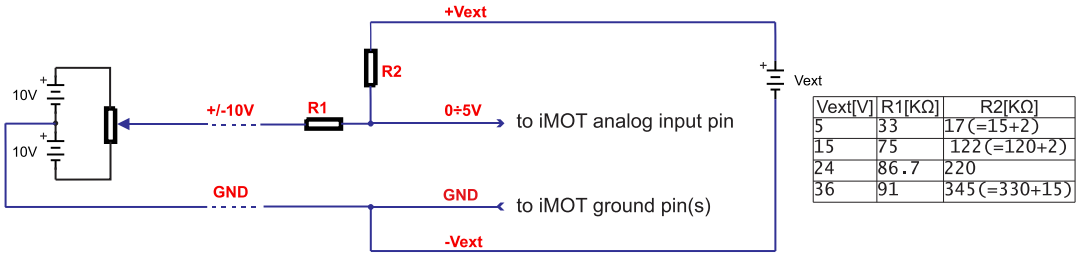
3.9.7.1 0-5V Input Range

The connection diagrams show the 0-5V analogue connection recommendation.

Remarks:

1. *Default input range for analog inputs is 0÷5 V for REF and FBDK. For a +/-10 V range, see Figure 3.7.*
2. *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.9.7.2 +/- 10V to 0-5V Input Range Adapter



Vext[V]	R1[KΩ]	R2[KΩ]
5	33	17(=15+2)
15	75	122(=120+2)
24	86.7	220
36	91	345(=330+15)

Figure 3.9.7.1. **+/-10V to 0-5V adapter**

Remark: *The length of the cables must be up to 30m, reducing the exposure to voltage surges in industrial environment.*

3.9.7.3 Recommendation for wiring

a) If the analogue signal source is single-ended, use a 2-wire twisted shielded cable as follows: 1st wire connects the live signal to the drive input; 2nd wire connects the source ground to the drive ground; shield will be connected to PE (protection earth, iMOT chassis), preferably at both ends.

b) If the analogue signal source is differential and the signal source ground is isolated from the drive GND, use a 2-wire twisted shielded cable as follows: 1st wire connects the source plus (positive, in-phase) to the drive analogue input; 2nd wire connects the source minus (negative, out-of-phase) to the drive ground. Shield is connected to PE (protection earth, iMOT chassis), preferably at both ends.

c) If the analogue signal source is differential and the signal source ground is common with the drive GND, use a 2-wire shielded cable as follows: 1st wire connects the source plus (positive, in-phase) to the drive analogue input; 2nd wire connects the source ground to the drive ground; shield is connected to PE (protection earth, iMOT chassis), preferably at both ends. The source minus (negative, out-of-phase) output remains unconnected.

3.9.8 Power Supply Connection Recommendations

3.9.8.1 Recommendations for Supply Wiring

Always provide a nearby capacitor on the motor supply lines. The capacitor should be located within 3m of the iMOT connector. The minimum recommended capacitance is 1000µF for iMOT, always rated at the appropriate voltage.

Use short, thick wires between the iMOT and the motor power supply. Connect power supply wires to all the indicated pins. Use preferably twisted wires for the supply and ground return. For wires longer than 20 meters, it may be necessary to use shielded twisted cable for supply wiring, in order to meet EMC requirements.

3.9.8.2 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 53V, the drive over-voltage protection is triggered and the drive power stage is disabled. In order to avoid this situation a*dd 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} = 53V 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]

ω_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 ω_M will become linear speed measured in [m/s] and the friction torque T_F will become friction force measured in [N].

3.9.9 Serial RS-232 connection Recommendations

a) If you build the serial cable, you can use a 3-wire shielded cable with shield connected to BOTH ends. Do not use the shield as GND. The ground wire must be included inside the shield, like the 232Rx and 232Tx signals
b) Always power-off all the iMOT supplies before inserting/removing the RS-232 serial connector
c) Do not rely on an earthed PC to provide the iMOT GND connection! The iMOT must be earthed through the front-plate metallic surface. Also, note that ground (GND) is isolated from PE (earth, motor chassis). Most communication problems are caused by the lack of such connection.

3.9.10 CAN-bus connection (for CAN motors only) Recommendations

a) Build CAN network using cables with twisted wires (2 wires/pair), with CAN-Hi twisted together with CAN-Lo. It is recommended but not mandatory to use a shielded cable. If so, connect the shield to PE (protection earth, iMOT chassis) – for model equipped with circular connectors (TM-CAN), or to GND for models equipped with rectangular connectors (XM-CAN). The cable impedance must be 105 ... 135 ohms (120 ohms typical) and a capacitance below 30pF/meter.

b) Whenever possible, use daisy-chain links between the CAN nodes. Avoid using stubs. A stub is a "T" connection, where a derivation is taken from the main bus. When stubs can't be avoided keep them as short as possible. For 1 Mbit/s (worst case), the maximum stub length must be below 0.3 meters.

c) The 120Ω termination resistors must be rated at 0.2W minimum. Do not use winded resistors, which are inductive.

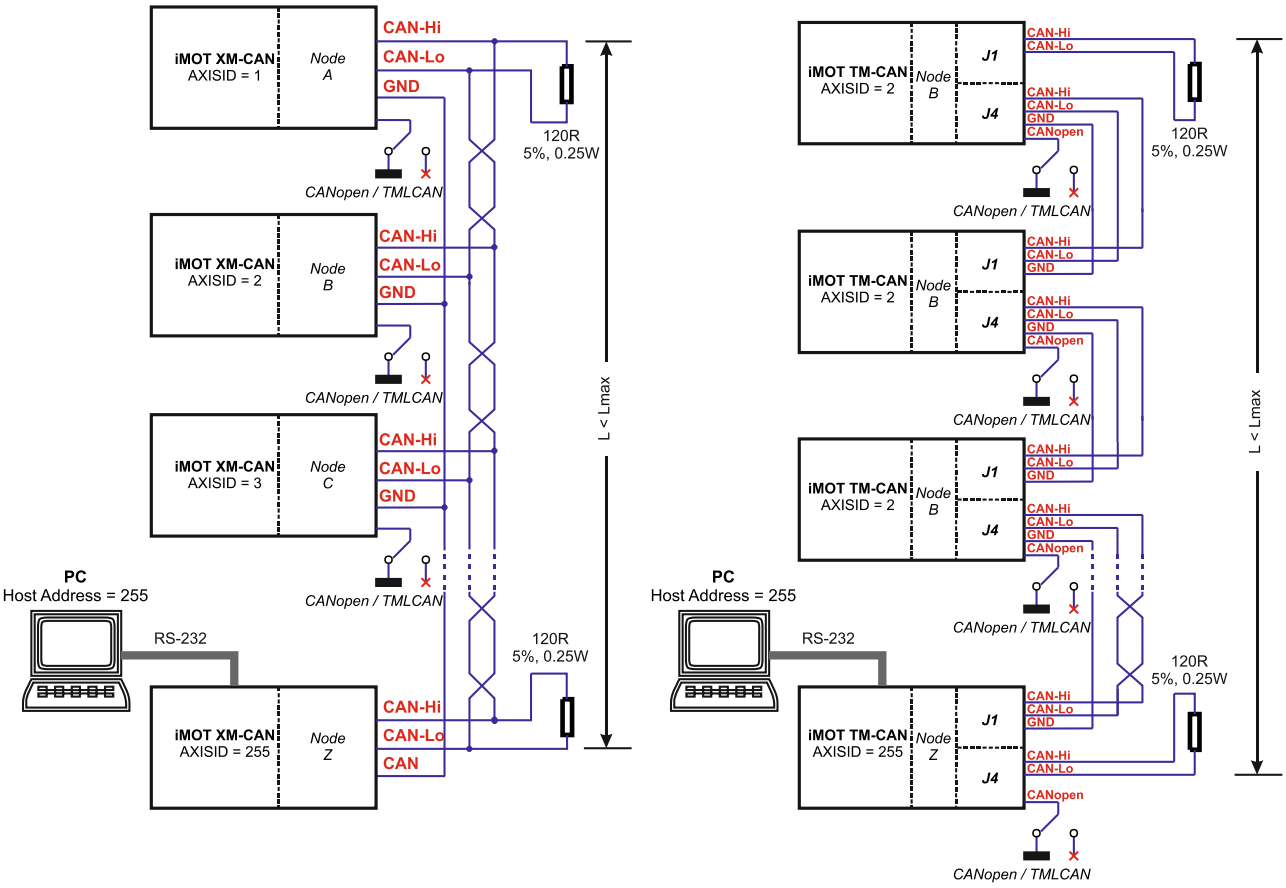


Figure 3.9.10. **Multiple-Axis CAN network**

For motors equipped with two CAN-bus connectors (iMOT23xS XM-CAN and iMOT 17xy TM-CAN), it is sufficient to connect only one of the selection pins. If using both selection pins (from both connectors), make sure the selection is identical (connected to GND for CANopen, floating or connector to +Vlog for TMLcan). It is recommended to implement the daisy-chain connection using 4 wires, including the selection signal, and the selection is done only at one bus end, as described in figure ...

CAN protocol selection for CAN motors can only be done through hardware, using the CANopen pin. It cannot be selected through software.

3.9.11 Removal from Autorun Mode for CAN motors

When the iMOT is set in TMLCAN operation mode, it enters by default after power on in *Autorun* mode, if the drive has in its local EEPROM a valid TML application (motion program), this is automatically executed as soon as the motor supply V_{MOT} is turned on.

In order to remove the drive from *Autorun*, you have 2 ways:

a) Software - by writing value 0x0001 in first EEPROM location, from address 0x4000;

b) Hardware – by temporary connecting CANopen pin to GND. The CANopen protocol does not execute a motion automatically. This option is particularly useful when it is not possible to communicate with the drive.

After the drive is set in *non-Autorun/slave* mode using 2nd method, the 1st method may be used to invalidate the TML application from the EEPROM. On next power on, in absence of a valid TML application, the drive enters in the *non-Autorun/slave* mode.

3.10 CAN Protocol Selection for CAN motors. TMLCAN/CANopen

The communication protocol can be chosen through the pin named CANopen of the CAN connector.

CANopen pin connected pin to GND = CANopen protocol selected

CANopen pin left disconnected or connect pin to +Vlog = TMLCAN protocol selected

3.11 Axis ID Selection for CAN motors(SW1 settings)

Position	Description
0	H/W Axis ID 255
1...F	H/W Axis ID 1 to 15

The Hardware Axis ID selection is done through the hex switch SW1. It contains numbers from 0x0 to 0xF. Depending on SW1 position, the axis ID will be:

SW1 position	AxisID in TMLCAN mode	AxisID in CANopen mode
0x0	255	127
0x1	1	1
0x2	2	2
0x3	3	3
0x4	4	4
0x5	5	5
0x6	6	6
0x7	7	7
0x8	8	8
0x9	9	9
0xA	10	10
0xB	11	11
0xC	12	12
0xD	13	13
0xE	14	14
0xF	15	15

AxisID setting can be done also though software, using EasySetup / EasyMotion. Software setting has precedence over hardware setting. In order to use hardware SW1 switch, leave the software setting as "H/W".

AxisID can be set by hardware switch SW1 only on models with rectangular connectors (XM-CAN). For models with circular connectors (TM-CAN), AxisID setting can only be done through software (EasySetup/EasyMotion). On these motors, if software setting is left as "H/W", this corresponds to a hardware setting (SW1) of 0x0, i.e.255 for TMLCAN / 127 for CANopen.

3.12 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 J2 / OUT port of the last drive in the chain remains not connected. Master is connected to J1 / IN port of the first drive; J2 / OUT of the first drive is connected to J1 / IN of the following drive; J2 / OUT of the last drive remains unconnected.

  See ***Figure 3.12.1*** for a visual representation of the linear topology.

- Ring, when the J2 / 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 J2 / OUT of the last drive.

  See ***Figure 3.2.*** 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.

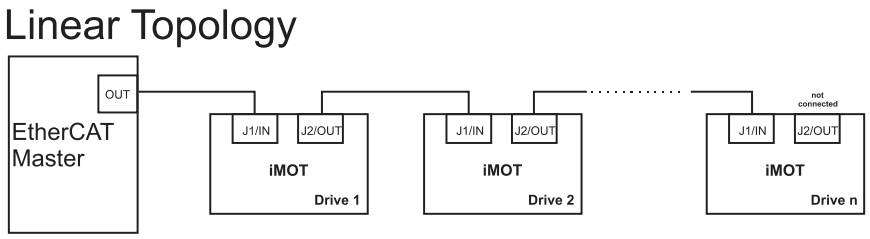


Figure ***3.12.1***. **EtherCAT® network linear topology**

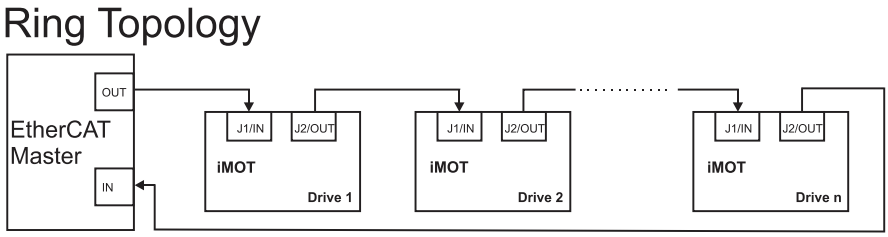


Figure ***3.12.2***. **EtherCAT® network ring topology**

3.13 EtherCAT® LED indicators

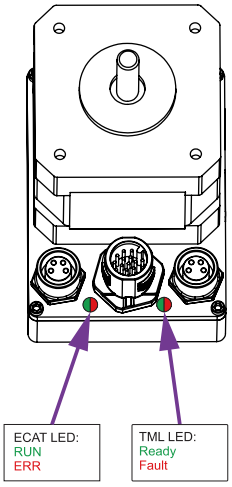


Figure 3.13. **LED indicators**

Table 3.13.1 – ***LED indicators***

LED name	LED color	Function
Drive Ready/ Error	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 or when the internal signal OUT2/Error is set to zero with OUT(2)=0 TML instruction.
EtherCAT® LED	red and green	EtherCAT® ERROR and RUN indicators combined. Shows the state of the EtherCAT® Status Machine

3.13.1 EtherCAT® LED indicator states

The STATUS indicator displays the RUN states with a 180 degree phase shift to the ERROR states. An example is noted in ***Figure 3.***.

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 3.** and the behavior of the ERROR indicator specified in **Table 3.**.

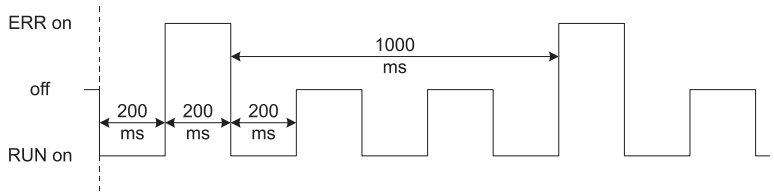


Figure 3.13.1. **STATUS indicator Example**

Table 3.13.2 ***– 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 3.13.3 ***– 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} = 48V_{DC}; Supplies start-up / shutdown sequence: *-any-*

Load current (sinusoidal amplitude / continuous BLDC,DC,stepper) = 8A iMOT

3.14.1 Operating Conditions

		Min.	Typ.	Max.	Units
Ambient temperature[1]		0		+40	°C
Ambient humidity	Non-condensing	0		90	%Rh
Altitude / pressure[2]	Altitude (referenced to sea level)	-0.1	0 ÷ 2.5	4[2]	Km
	Ambient Pressure	0.64 [2]	0.75 ÷ 1	10.0	atm
Magnetic field				20	mT

3.14.2 Storage Conditions

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

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

[2] iMOT 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.

3.14.3 Environmental Characteristics

			Min.	Typ.	Max.	Units
iMOT171B XM-CAN / iMOT171B TM-CAN	Size (Length x Width x Height)			64 x 61 x 45		mm
				~2.52 x 2.4 x 1.78		inch
	Weight			395		g
iMOT172B XM-CAN / iMOT172B TM-CAN	Size (Length x Width x Height)			82 x 61 x 45		mm
				~3.23 x 2.4 x 1.78		inch
	Weight			515		g
iMOT172B XM-CAN / iMOT172B TM-CAN	Size (Length x Width x Height)			98 x 61 x 45		mm
				~3.86 x 2.4 x 1.78		inch
	Weight			720		g
iMOT171B TM-CAT	Size (Length x Width x Height)			64.5 x 61 x 45		mm
				~2.52 x 2.4 x 1.78		inch
	Weight			405		g
iMOT172B TM-CAT	Size (Length x Width x Height)			82.5 x 61 x 45		mm
				~3.23 x 2.4 x 1.78		inch
	Weight			525		g
iMOT173B TM-CAT	Size (Length x Width x Height)			102.5 x 61 x 45		mm
				~4.02 x 2.4 x 1.78		inch
	Weight			730		g
iMOT172S XM-CAN	Size (Length x Width x Height)			68 x 61 x 45		mm
				~2.68 x 2.4 x 1.78		inch
	Weight			413		g
iMOT172S TM-CAN / iMOT172S TM-CAT	Size (Length x Width x Height)			67 x 61 x 45		mm
				~2.64 x 2.4 x 1.78		inch
	Weight			413		g
iMOT232 XM-CAN	Size (Length x Width x Height)			63 x 58 x 74		mm
				~2.48 x 2.28 x 2.91		inch
	Weight			750		g
iMOT233 XM-CAN	Size (Length x Width x Height)			87 x 58 x 74		mm
				~3.43 x 2.28 x 2.91		inch
	Weight			1100		g
iMOT232 TM-CAN / iMOT232 TM-CAT	Size (Length x Width x Height)			69 x 60 x 85		mm
				~2.71 x 2.36 x 3.35		inch
	Weight			740		g
iMOT233 TM-CAN / iMOT233 TM-CAT	Size (Length x Width x Height)			943 x 60 x 85		mm
				~3.70 x 2.36 x 3.35		inch
	Weight			1140		g
Cleaning agents	Dry cleaning is recommended			Only Water- or Alcohol- based		
Protection degree	According to IEC60529, UL508	XM Motors		IP20		-
		TM Motors		IP50		

3.14.4 Logic Supply Input ($+V_{LOG}$)

				Min.	Typ.	Max.	Units
Supply voltage	Nominal values		CAN	12.5	24	36	V_{DC}
			CAT	15	24	36	
	Absolute maximum values, drive operating but outside guaranteed parameters		CAN	5.9		39	V_{DC}
			CAT	12.5		39	
	Absolute maximum values, continuous			0		39	V_{DC}
	Absolute maximum values, surge (duration ≤ 10ms) †			0		+45	V
Supply current	CAN motors	$+V_{LOG}$ = 12.5V			80	200	mA
		$+V_{LOG}$ = 24V			47	120	
		$+V_{LOG}$ = 36V			36	100	
	EtherCAT motors	$+V_{LOG}$ = 15V			120	200	mA
		$+V_{LOG}$ = 24V			70	120	
		$+V_{LOG}$ = 36V			50	100	

3.14.5 Motor Supply Input ($+V_{MOT}$)

		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	24	48	V_{DC}
	Absolute maximum values, continuous	-0.3		50	V_{DC}
	Absolute maximum values, surge (duration ≤ 8ms)	-1		55	V_{DC}
Supply current	Idle		1	5	mA
	Operating	-13.6	±3	+13.6	A

3.14.6 Digital Inputs[1]

		Min.	Typ.	Max.	Units
Input voltage	Logic “LOW”		2.2	1.2	V
	Logic “HIGH”	4.8	3.8		
	Hysteresis	0.8	1.6	2.8	
	Absolute maximum, continuous	-36		+36	
	Absolute maximum, surge (duration ≤ 1s)†	-50		50	
	Floating voltage, PNP (not connected)		0		
	Floating voltage, NPN (not connected)		$+V_{LOG}$		
Input frequency		0		400	kHz
Minimum pulse		-15	1.2	0.9	ms
ESD protection	Human body model	±15			kV
Mode compliance	Internal 10 kΩ resistor to GND	PNP			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input current	Logic “LOW”;			0	mA
	Logic “HIGH”; pulled to +24V		6	8	
	Hysteresis		0.5		
Mode compliance	Internal 10 kΩ resistor to $+V_{LOG}$	NPN/ TTL / CMOS / Open-collector			
Default state	Input floating (wiring disconnected)	Logic LOW			
Input current	Logic “HIGH”			0	mA
	Logic “LOW”; pulled to GND		6	8	
	Hysteresis		0.5		

Input frequency		0		150	kHz
Minimum pulse width		3.3			µs
ESD protection	Human body model	±2			kV

3.14.7 Digital Outputs

			Min.	Typ.	Max.	Units
Mode compliance			TTL / CMOS / Open-collector / NPN 24V			
Default state	Not supplied ($+V_{LOG}$ floating or to GND)		High-Z (floating)			
	Normal operation	OUT0	Logic “HIGH”			
Output voltage	Logic “LOW”; output current = 0.5A			0.2	0.8	V
	Logic “HIGH”; output current = 0, no load		2.8	3	3.3	
	Logic “HIGH”, external load to $+V_{LOG}$			V_{LOG}		
	Absolute maximum, continuous		-0.5		V_{LOG}+0.5	
	Absolute maximum, surge (duration ≤ 1s) †		-1		V_{LOG}+1	
Output current	Logic “LOW”, sink current, continuous				0.5	A
	Logic “LOW”, sink current, pulse ≤ 5 s				1	A
	Logic “HIGH”, source current; external load to GND; V_{OUT} >= 2.0V				1	mA
	Logic “HIGH”, leakage current; external load to $+V_{LOG}$; $V_{OUT} = V_{LOG}$ max = 36V			0.1	0.2	mA
Minimum pulse width			2			µs
ESD protection	Human body model		±15			kV

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

3.14.8 Analog 0…5V Input (ANLG)

		Min.	Typ.	Max.	Units
Input voltage	Operational range	0		5	V
	Absolute maximum values, continuous	-8		+12	
	Absolute maximum, surge (duration ≤ 1s) †			±24	
Input impedance	To GND		33		kΩ
Resolution			12		bits
Integral linearity				±2	bits
Offset error			±2	±10	bits
Gain error			±1%	±3%	% FS.[1]
Bandwidth (-3dB)	Software selectable	0		250	kHz
ESD protection	Human body model	±5			kV

3.14.9 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	±15			kV

3.14.10 EARTH Connection

		Min.	Typ.	Max.	Units
EARTH to GND	Galvanic isolation	-100		+100	V_{DC}
	Capacitive coupling		200		nF
	Discharge resistor		300		kΩ
EARTH connection	Location	Front plate of motor, using 4x M3x4 threaded holes			
	Connection	Required for EMC compliance and thermal dissipation			

3.14.11 CAN-Bus (for CAN motors)

		Min.	Typ.	Max.	Units
Compliance		ISO11898, CiA-301v4.2, 402v3.0			
Bit rate	Software selectable	125		1000	Kbps
Bus length	1Mbps			25	m
	500Kbps			100	
	≤ 250Kbps			250	
Resistor	Between CAN-Hi, CAN-Lo	none on-board			
Node addressing	Hardware: by H/W means (where SW1 is available)	1 - 15 & 127 (CANopen); 1 - 15 & 255 (TMLCAN)			
	Software	1 ÷ 127 (CANopen); 1- 255 (TMLCAN)			
ESD protection	Human body model	±15			kV

3.14.12 EtherCAT (for CAT motors)

			Min.	Typ.	Max.	Units
Compliance			IEEE802.3, IEC61158			
Transmission line specification	According to TIA/EIA-568-5-A		Cat. 5e.UTP			
J1, J2 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	Software set in setup	Value of Axis ID set by software in Drive Setup	1 ÷ 254		255	
		Value of "Configured Station Alias" register	1 ÷ 254		0	
MAC addressing			none			
ESD protection	Human body model		±15			kV

3.14.13 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"

3.15 Torque – Speed characteristic

3.15.1 iMOT17xB XM/TM-CAN/CAT

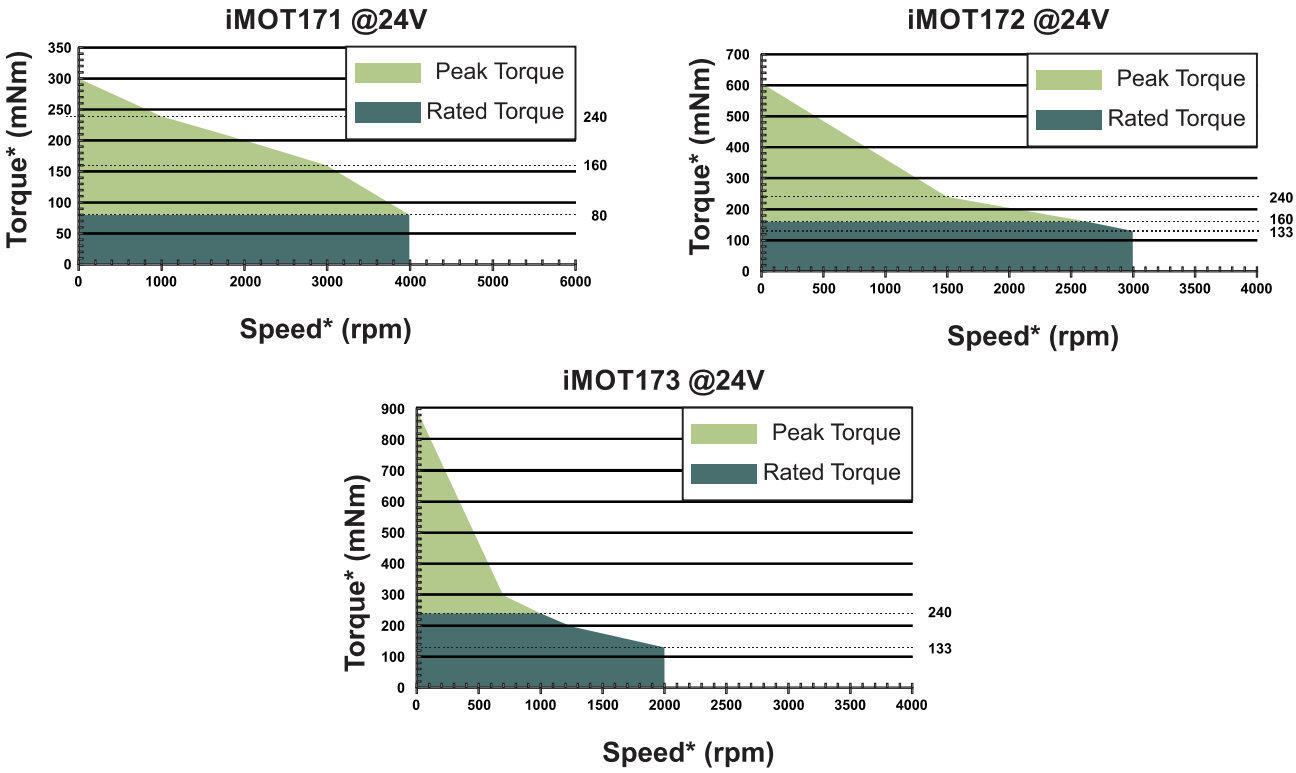


Figure 3.15.1. **iMOT17xB Torque-Speed characteristic**

3.15.2 iMOT172S XM/TM-CAN/CAT

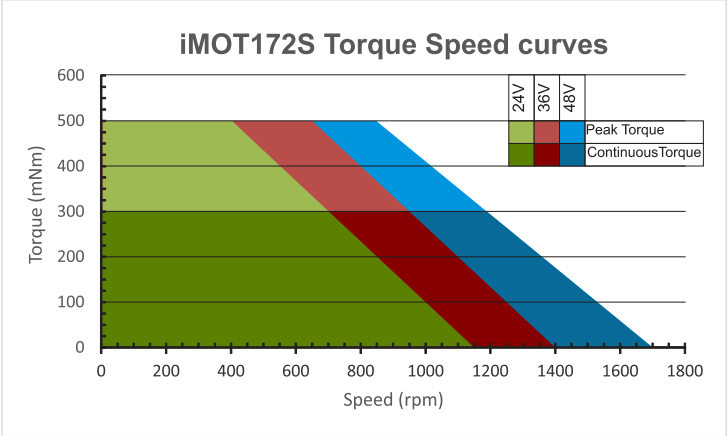


Figure 3.15.2. **iMOT172S Torque-Speed characteristic**

3.15.3 iMOT23xS XM-CAN/TM-CAN/CAT

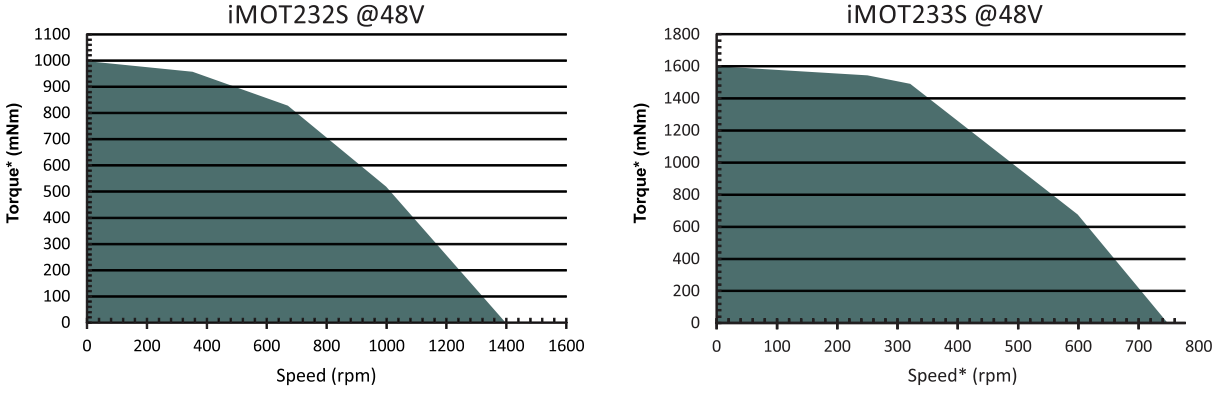


Figure 3.2.3. **iMOT172S Torque-Speed characteristic**

4 Memory Map

iMOT has 2 types of memory available for user applications: 2K×16 SRAM and up to 4K×16 serial E²ROM.

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

The E²ROM is mapped in the address range: 4000h to 4FFFh. It is used to keep in a non-volatile memory the TML programs, the cam tables and the drive setup information.

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

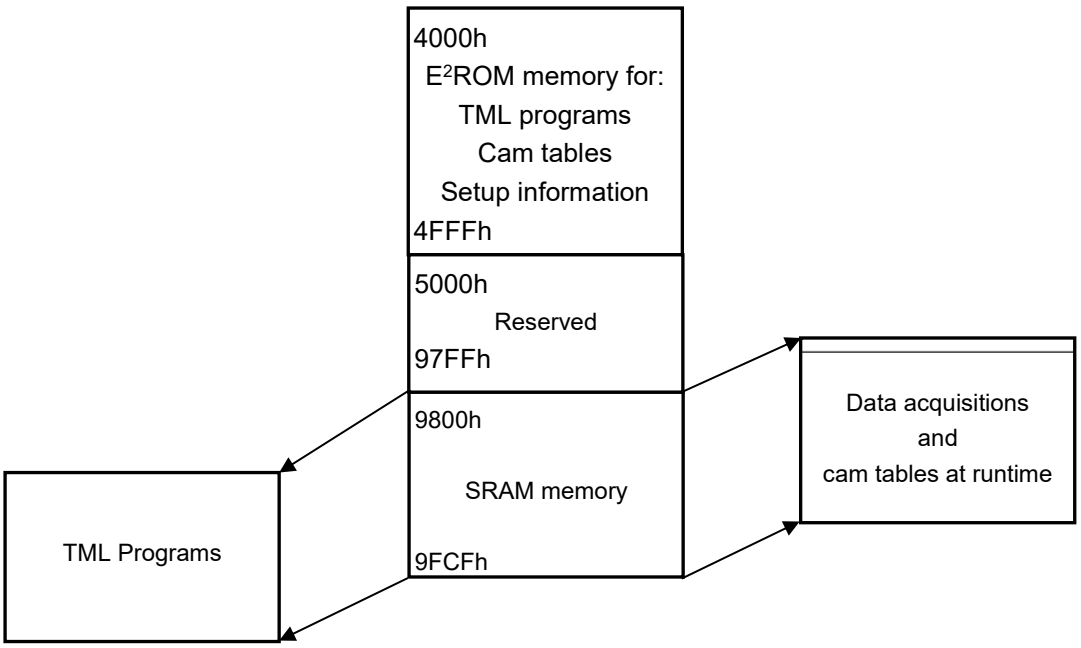


Figure 4.1. *iMOT Memory Map*