TMCM-6210 AND TMCM-6211 HARDWARE MANUAL

TMCM-6210/TMCM-6211 Hardware Version 1.10 •2015-OCT-26 | Document Rev. 1.00 • 2016-APR-20

The TMCM-6210 and TMCM-6211 are six axes controller/driver modules for 2-phase bipolar stepper motors with separate differential encoder and separate HOME STOP switch inputs for each axis (6x). Dynamic current control, and quiet, smooth and efficient operation are combined with stealthChop™, dcStep™, stallGuard™ and coolStep™ features. The modules offer four analog or digital inputs as well as four digital outputs in combination with a break chopper unit.



Figure 1: TMCM-6211 Product Photo

Features

- 6-Axes Stepper
- Controller / Driver
- Up-to 0.7 3A RMS / 24V DC
- Encoder / HOME / STOP
- 4x analog / digital inputs
- 4x digital outputs
- Brake chopper support
- CAN, RS485, USB (TMCM-6210)
- EtherCAT®, USB (TMCM-6211)

Applications

- Lab Automation
- Semiconductor
- Manufacturing
- Robotics
- Factory Automation
- CNC

Block Diagram: TMCM-6210 Interfaces & Features

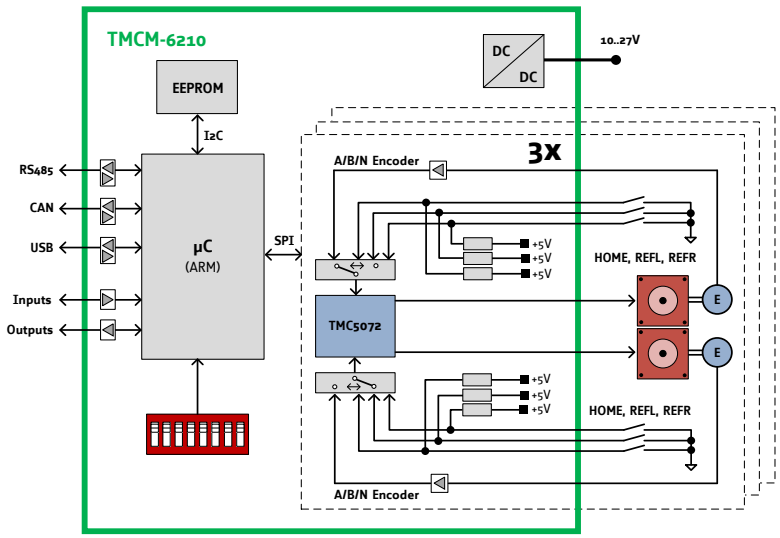


Figure 2: Block Diagram of TMCM-6210

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TRINAMIC MOTION CONTROL

Read entire documentation; especially the Supplemental Directives on page 41.

Functional Scope of TMCM-6210 and TMCM-6211

Shared Features of TMCM-6210 and TMCM-6211

TMCM-6210 and TMCM-6211 share many features, especially concerning motion control, bipolar stepper motor diver functions, etc., as presented below:

Motion Controller

Motion profile is calculated in real time. On the fly alterations of motor parameters (e.g. position, velocity and acceleration) are possible. Dedicated HOME, STOP_L, and <aSTOP_R switch inputs (with internal pull-ups) are available via differential encoder input motor axis (6x). A high performance microcontroller controls the overall system, and conducts communication protocol handling.

Bipolar Stepper Motor Driver

The bipolar stepper motor driver allows up to 256 microsteps per full step, and offers highly efficient operation — as well as low power dissipation. The bipolar stepper motor driver comes with dynamic current control and integrated protection. stealthChop functionality ensures quiet operation and smooth motion. Load-dependent speed control is made possible with dcStep features. Stall detection is carried out through the stallGuard2 feature set. The coolStep feature reduces power consumption and heat dissipation.

Electrical Data

Supply voltage ranges from nom. +12V to +24V; with +10V ... +27V supply voltage operating range. The motor current is up to 0.7A RMS (programmable). The brake chopper unit supports an external brake resistor that limits supply voltage when energy is fed back into the supply rail.

Digital and analog In- and Outputs

In combination with a brake chopper unit, four general purpose analog inputs (0..10V) or digital inputs (+24V signals) and four general purpose digital outputs (open-drain, 500mA each) are provided.

Specific Product Differences

Both products differ in different sets of interface options and different sets of firmware options, as shown in the table below:

Product differences between TMCM-6210 and TMCM-6211		
Scope	**TMCM-6210**	**TMCM-6211**
Interfaces	• CAN • RS485 • USB full speed (12M/bits) device interface: Micro-USB	• EtherCAT • USB full speed (12M/bits) device interface: Micro-USB
Firmware	• TMCL™ remote (direct mode) and standalone operation with memory for up to 1024 TMCL commands. • TMCM-3212: CANopen™ (CoE) firmware available	• CANopen™ (CoE) via EtherCAT™ firmware

Table 1: TMCM-6210 Interface Brick: Connectors and Mating Connectors

ℹ Please consult firmware documentation for TMCM-6210/TMCM-6211 for additional programming and communication protocol information.

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Order Codes: TMCM-6210

The TMCM-6210 unit is available with two different firmware options:

Order code	Description	Size
TMCM-6210-TMCL	6-axes controller / driver up-to 0.7A RMS / +24V, CAN + RS485 + USB with standard TMCL firmware	215mm x 100mm x 21mm
TMCM-6210-CANopen	6-axes controller / driver up-to 0.7A RMS / +24V, CAN + RS485 + USB with CANopen firmware	215mm x 100mm x 21mm

Table 2: Order Codes: TMC-6210

Order Codes: TMCM-6211

The TMCM-6211 unit is available with one firmware:

Order code	Description	Size
TMCM-6211-CoE	6-axes controller / driver up-to 0.7A RMS / +24V, EtherCAT™ + USB with CANopen over EtherCAT™ firmware	215mm x 100mm x 21mm

Table 3: Order Code: TMCM-6211

Order Codes: Cable Set

A cable set (G4-CABLE) is available for a range of TMCM products, as specified in the table below:

Order code	Description	Size
G4-CABLE *Contains:*	Cable loom for **TMCM-6210/6211**, TMCM-6212/6213, TMCM-3212/3213, TMCM-3214/3215, TMCM-3312/3313 and TMCM-3314/3315. 1x cable loom for RS485 connector *(3212)* 1x standard CAT5 cable with 2x RJ45 for CAN / EtherCAT™ *(3212/3213)* 1x RJ45-2-DSUB_G4_V10 adapter (for CAN RJ45 <-> D-SUB translation) (3212) 1x Micro-USB cable *(3212/3213)* 1x cable loom for INPUTs connector *(3212/3213)* 1x cable loom for OUTPUTs connector *(3212/3213)* 6x cable loom for MOTOR connector (small) *(3x required for 3212/3213)* 3x cable loom for MOTOR connector (big) 6x cable loom for ENCODER connector *(3x required for 3212/3213)* 6x cable loom for REF / HOME connector *(3x required for 3212/3213)* 1 cable loom for POWER connector (small) *(3212/3213)* 1x cable loom for POWER connector (big) 1x cable loom for CONTROL connector *(3212/3213)* 1x cable loom for RESISTOR connector *(3212/3213)*	

Table 4: Order Code: G4-CABLE

NOTE:

→ *The cable set with the order code G4-CABLE is made available for a range of different modules. The use of the above specified cables speeds up initial setup. The use of a cable is not required for all modules. The cables are assigned specifically to certain products with which they fit.* ***Only use as specified****!*

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TABLE OF CONTENTS

TMCM-6210 AND TMCM-6211 HARDWARE MANUAL 1
SHORT SPEC 1
Features 1
Applications 1
Block Diagram: TMCM-6210 Interfaces & Features 1
Functional Scope of TMCM-6210 and TMCM-6211 2
Order Codes: TMCM-6210 3
Order Codes: TMCM-6211 3
Order Codes: Cable Set 3
TABLE OF CONTENTS 4
FIRMWARE MANUAL 6
1. Mechanical and Electrical Interfacing 6
1.1. Dimensions and Mounting Holes 6
1.2. Board Mounting Considerations 7
2. Connectors of TMCM-6210 and TMCM-6211 8
2.1. TMCM-6210 Interface Brick 9
2.1.1. RS485 Connector 10
2.1.2. CAN Connector 11
2.1.3. USB Connector 11
2.1.4. Input Connector 12
2.1.5. Output Connector 13
2.2. TMCM-6211 Interface Brick 14
2.2.1. TMCM-6211 EtherCAT Connector 15
2.2.2. USB Connector 15
2.2.3. Input Connector 16
2.2.4. Output Connector 17
2.3. TMCM-6210 + TMCM-6211 Driver Brick 18
2.3.1. Motor Connector 19
2.3.2. REF / HOME Connector 20
2.3.3. Encoder Connector 21
2.4. TMCM-6210 and TMCM-6211 Power Supply Brick 22
2.4.1. Power Connector 23
2.4.2. Control Connector 24
2.4.3. Resistor Connector 25
2.5. Power Supply 26
2.6. TMCM-6210: RS485 27
2.7. CAN 29
2.7.1. CAN Adapter 30

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2.7.2. RJ45-2-DSUB SCHEMATIC and Connector Pin Assignment 30
3. Motor Driver Current 31
4. On Board LEDs 32
4.1. Power Supply Brick 32
4.2. TMCM-6210 Interface Brick 33
4.3. TMCM-6211 Interface Brick 34
5. Reset to Factory Default 35
6. Operational Ratings 36
7. TMCM-6210 Functional Description 38
8. TMCM-6211 Functional Description 39
9. REVISION HISTORY 40
9.1. Document Revision 40
9.2. Hardware Revision 40
9.3. References 40
APPENDICES 41
10. SUPPLEMENTAL DIRECTIVES 41
ESD-DEVICE INSTRUCTIONS 41
10.1. Tables Index 43
10.2. Figures Index 44

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FIRMWARE MANUAL

1. Mechanical and Electrical Interfacing

1.1. Dimensions and Mounting Holes

TMCM-6210 or TMCM-6211 driver boards are approximately 215mm x 100mm x 21mm. Maximum component height - without mating connectors - is around 17mm above PCB level and 2mm below PCB level. Altogether, 12 mounting holes are available - for the specified M3 screws (3.2mm diameter) - for mounting the PCB.

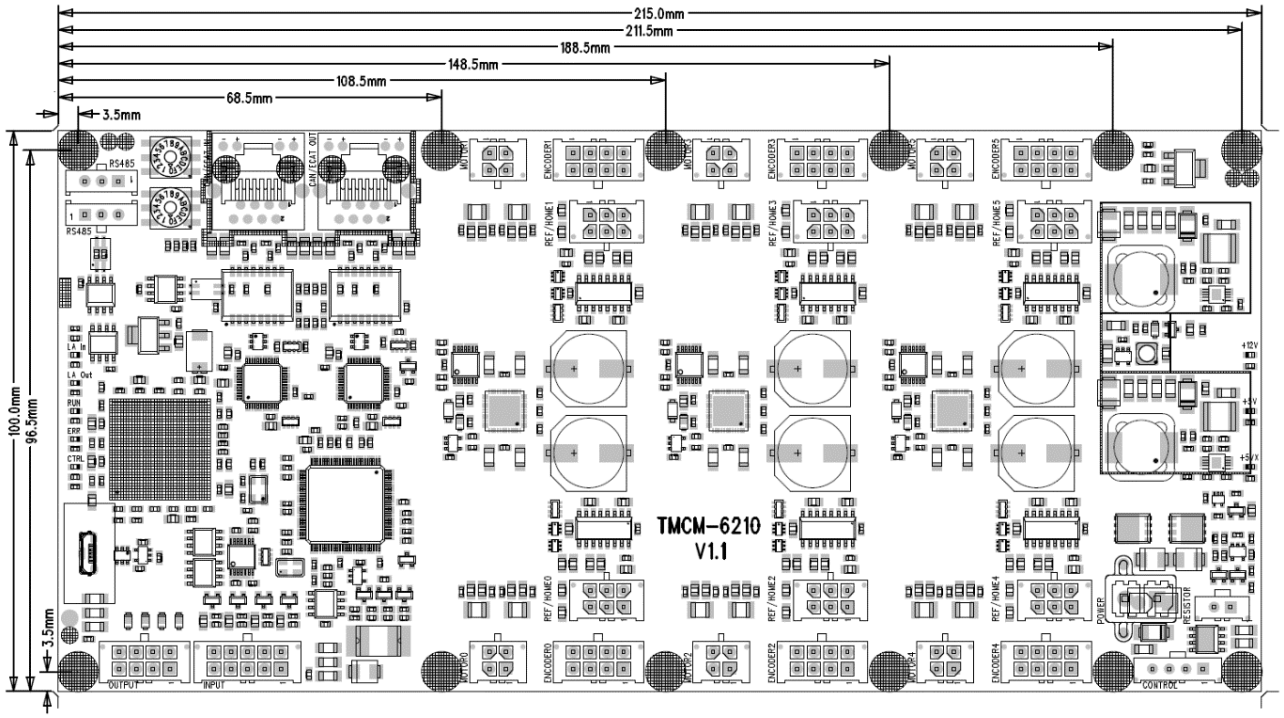


Figure 3: Dimension of TMCM-6210 / TMCM-6211 and Position of Mounting Holes

NOTE:

→ *TMCM-6210 and TMCM-6211 share the same PCB with different assembly options regarding the interface section. Dimensions, mounting holes and board mounting considerations (see chapter below) are the same for both boards.*

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1.2. Board Mounting Considerations

TMCM-6210/TMCM-6211 offer 12 metal-plated mounting holes. One hole (lower right) is connected to on-board system ground (connected to power supply input ground) via 1M (500VDC) || 1nF (1kV). The same combination or resistor and capacitor is used for connecting the RJ45 shield ground (connector enclosure) to power supply input ground (see figure 4.2).

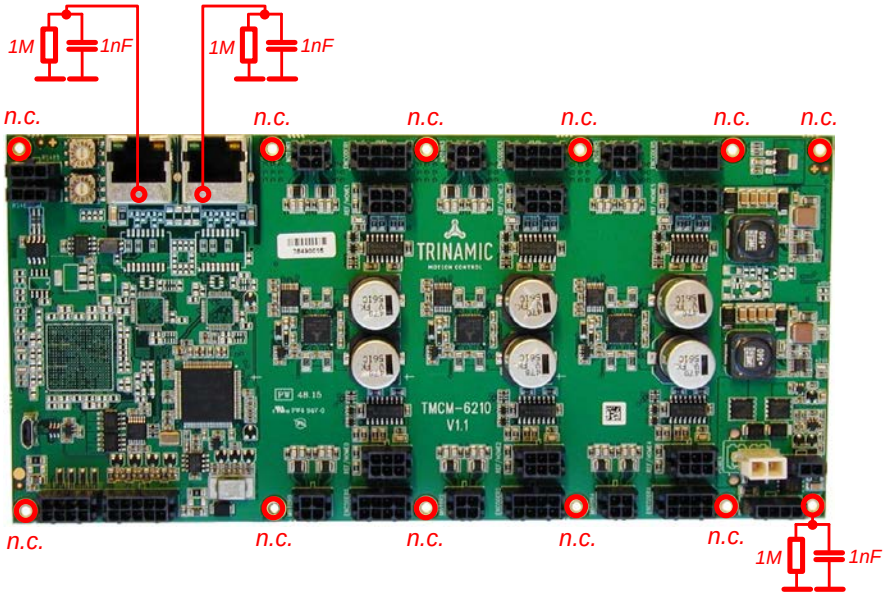


Figure 4: TMCM-6210 / TMCM-6211 Mounting Hole Connections

Configuration Overview

All other mounting holes are electrically isolated. Please take into consideration that not all holes must be used for mounting the PCB. It is recommended to use the mounting holes in all four corners and two in the middle (6 altogether), as a minimum. This will ensure adequate support of the PCB when inserting or removing connectors in order to avoid significant bending of the PCB.

NOTE:

→ *Please always remove or attach mating connectors carefully by supporting the PCB, if necessary!*

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2. Connectors of TMCM-6210 and TMCM-6211

TMCM-6210 and TMCM-6211 are two members of a new family of modules with a modular architecture, which are composed of so-called "bricks".

Functional Details

The TMCM-6210 and TMCM-6211 each consist of one interface brick, three dual-axes stepper motor controller / driver bricks and one supply brick. The TMCM-6210 interface brick offers CAN and RS485 interfaces while the TMCM-6211 is assembled with an EtherCAT™ option instead. All other bricks are the same for both modules.

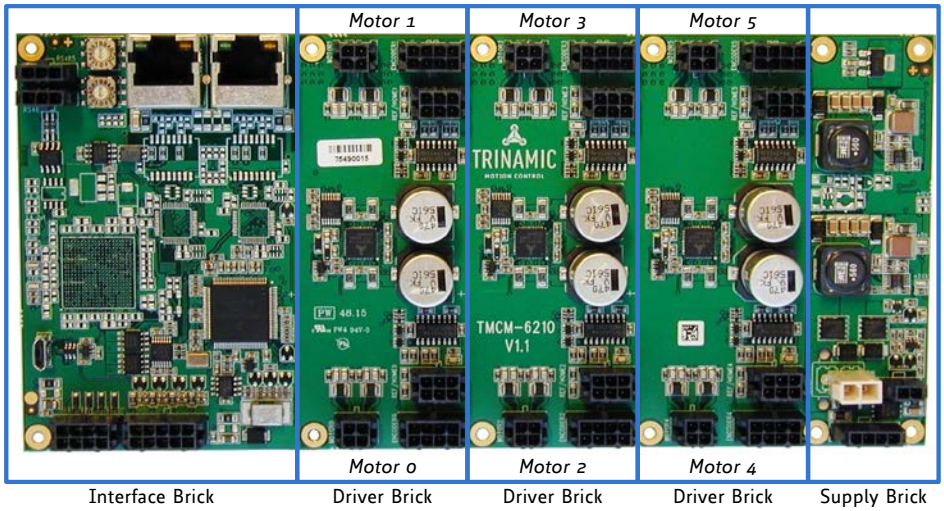


Figure 5: Different bricks used for the TMCM-6210 / TMCM-6211

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2.1. TMCM-6210 Interface Brick

The interface brick of the TMCM-6210 offers RS485, CAN and USB interfaces for communication, four general purpose analog inputs (which can be used as digital inputs as well) and four open- drain outputs.

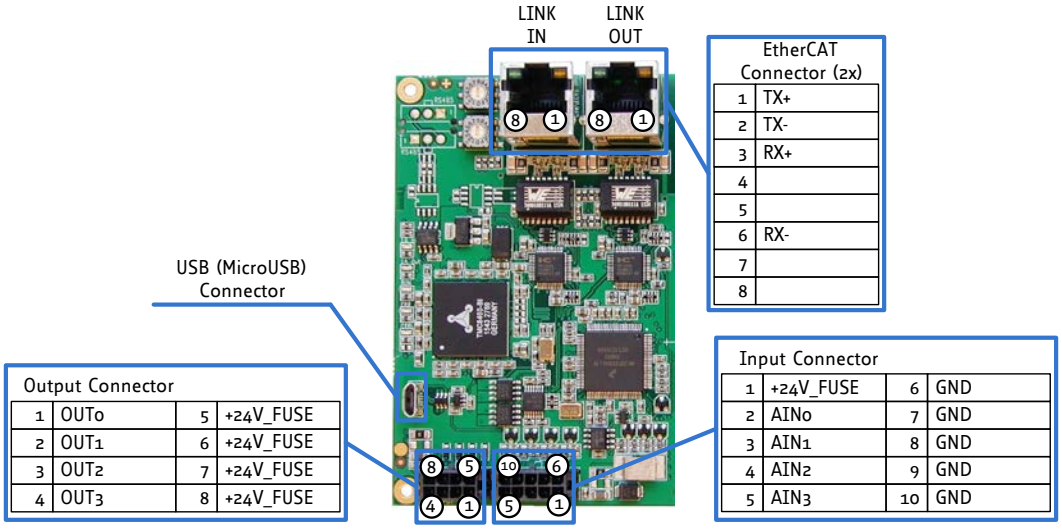


Figure 6: TMCM-6210 Interface Brick

Connector and Mating Connector Overview		
Label	**Connector Type**	**Mating Connector Type**
RS485	Molex MicroFit, 436500315 1x4 pin header, 3mm pitch	Molex MicroFit, Housing: 43645-0300 Contacts: 43030-0007
CAN	RJ45 plug connector	E.g. standard CAT 5/CAT 5e cables can be used
USB	Micro-USB connector, type B (USB device interface)	Standard Micro-USB
Inputs	Molex MicroFit, 430451012 2x5 pin header, 3mm pitch	Molex MicroFit, Housing: 43025-1000 Contacts: 43030-0007
Outputs	Molex MicroFit, 430450812 2x4 pin header, 3mm pitch	Molex MicroFit, Housing: 43025-0800 Contacts: 43030-0007

Table 5: TMCM-6210 Interface Brick: Connectors and Mating Connectors

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2.1.1. RS485 Connector

Two RS485 connectors with the same pin assignment are on the board; with direct pin connection between pins.

Functional Details

The second connector can be used for attaching a bus termination resistor to the RS485 bus (there is no termination resistor on-board) or for further distribution of the RS485 bus signals to other RS485 communication nodes while maintaining a proper bus structure.

A three pin Molex MicroFit connector (Molex part no. 436500315) is used for RS485 connection. Mating connector housing e.g. Molex 43645-0300, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for housing and contacts.

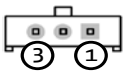
Interface RS485 Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	GND	Power	Supply and signal ground.
	2	RS485+	Bi-directional	RS485 interface, diff. signal (non-inverting).
	3	RS485-	Bi-directional	RS485 interface, diff signal (inverting).

Figure 7: Interface Brick: RS485 Connector

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2.1.2. CAN Connector

Two CAN connectors with the same pin assignment are on the board, with direct pin connection between pins.

Functional Details

The second one can be used for connecting a bus termination resistor to the RS485 bus (there is no termination resistor on-board); or for further distribution of the CAN bus signals to other CAN nodes while maintaining a proper bus structure.

A standard RJ45 plug connector is used for CAN communication. Standard CAT cables (e.g. CAT 5, non-crossing) might be used for connection. Pin assignment of the RJ45 is based on the CiA 303-1 recommendation.

Interface Brick: CAN Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	CAN_H	Bi-Directional	CAN interface, diff signal (non-inverting)
	2	CAN_L	Bi-directional	CAN interface, diff signal (inverting)
	3	GND	Power	Supply and signal ground
	4	n.c.		
	5	n.c.		
	6	n.c.		
	7	n.c.		
	8	n.c.		

Table 5.2 Interface Brick: CAN Connector

2.1.3. USB Connector

TMCM-6210/TMCM-6211 each offer a Micro USB connector (Type B, device interface) for communication.

USB high speed Support

The USB interface supports USB high speed communication (12Mbit/s). When USB-connected, the digital logic part of the TMCM-6210 / TMCM-6211 is supplied via USB (USB powered mode), if no main supply is available.

This mode can also be used for firmware-updates, TMCL-program download or parameter settings, etc. (requires USB connection, only).

NOTE:

→ *In USB stand-alone mode (main board supply available), the board can sometimes still draw current from the USB supply – depending on the voltage level of the USB +5V and the on-board generated +5V.*

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2.1.4. Input Connector

TMCM-6210 / TMCM-6211 offer four analog inputs (nom. 0..10V range), which can be used as digital inputs, also (+24V tolerant).

Molex Connector Housings

Four inputs are available via one 10-pin Molex MicroFit connector (Molex part no. 430451012). Mating connector housing e.g. Molex 43025-1000, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

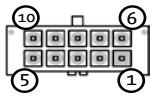
Interface Brick: Input Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +48V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	2	AIN0	Input	Analog input channel 0 (nom. 0..10V).
	3	AIN1	Input	Analog input channel 1 (nom. 0..10V).
	4	AIN2	Input	Analog input channel 2 (nom. 0..10V).
	5	AIN3	Input	Analog input channel 3 (nom. 0..10V).
	6	GND	Power	Supply and signal ground.
	7	GND	Power	Supply and signal ground.
	8	GND	Power	Supply and signal ground.
	9	GND	Power	Supply and signal ground.
	10	GND	Power	Supply and signal ground.

Figure 8: Interface Brick: Input Connector

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2.1.5. Output Connector

The TMCM-6210 / TMCM-6211 offer four digital outputs (open-drain).

Molex Connector Housings

Four outputs are available via one 8 pin Molex MicroFit connector (Molex part no. 43045-0812). Mating connector housing e.g. Molex 43025-0800, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

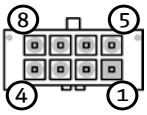
Interface Brick: Output Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	AOUT0	Output	Open-drain output.
	2	AOUT1	Output	Open-drain output.
	3	AOUT2	Output	Open-drain output.
	4	AOUT3	Output	Open-drain output.
	5	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	6	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	7	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	8	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).

Table 5.4: Interface Brick: Output Connector

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2.2. TMCM-6211 Interface Brick

The interface brick of the TMCM-6211 offers EtherCAT™ and USB interfaces for communication, four general purpose analog inputs (which can be used as digital inputs as well) and four open-drain outputs.

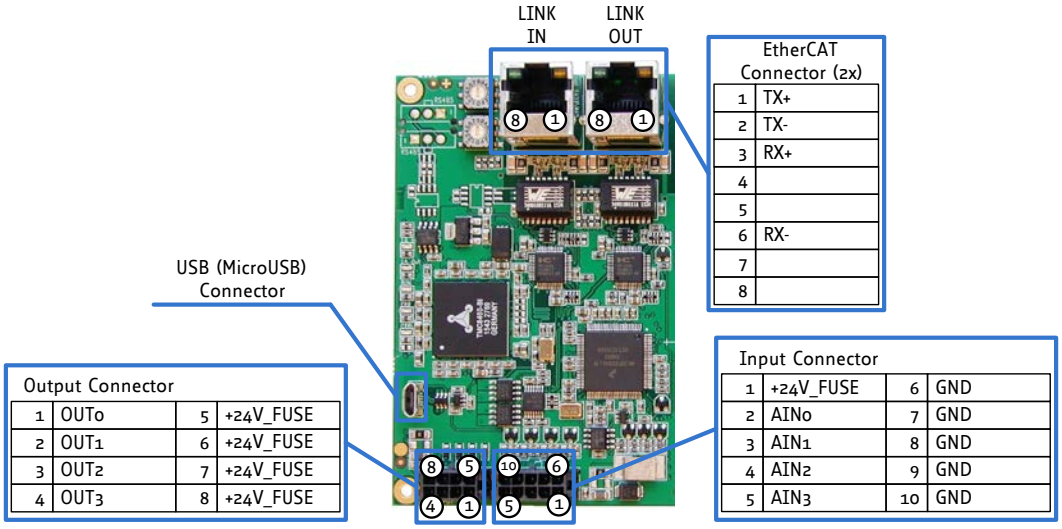


Figure 9: TMCM-xx Interface Brick

TMCM- 6211 Connector and Mating Connector Overview		
Label	**Connector type**	**Mating connector type**
EtherCAT™	RJ45 plug connector	E.g. standard CAT 5 / CAT 5e cables suitable for 100Mbit/s Ethernet
USB	Micro-USB connector, type B (USB device interface)	Standard Micro-USB
Inputs	Molex MicroFit, 43045-1012 2x5 pin header, 3mm pitch	Molex MicroFit Housing: 43025-1000 Contacts: 43030-0007
Outputs	Molex MicroFit™, 43045-0812 2x4 pin header, 3mm pitch	Molex MicroFit Housing: 43025-0800 Contacts: 43030-0007

Figure 10: TMCM-6211 Interface Brick: Connectors and Mating Connectors

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2.2.1. TMCM-6211 EtherCAT Connector

Two EtherCAT™ connectors are on the board: one for LINK IN (towards / coming from EtherCAT™ master) and one for LINK OUT (for connecting further slaves) connection.

Connection Options

A standard RJ45 plug connector (as used for 10/100Mbit/s Ethernet) is used for EtherCAT communication. Standard CAT cables suitable for 100Mbit/s Ethernet (e.g. CAT 5 / 5e etc.) can be used for connection.

The PHYs that are used on the TMCM-6211 support auto MDI-X. Therefore, TX and RX signals on the connector can be exchanged. For example, cables with straight-through pin assignment can be used.

TMCM-6211 Interface Brick: EtherCAT Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	TX+	Output	Transmit data output, differential, non-inverting
	2	TX-	Output	Transmit data output, differential, inverting
	3	RX+	Input	Receive data input, differential, non-inverting
	4			
	5			
	6	RX-	Input	Receive data input, differential, inverting
	7			
	8			

Figure 11: TMCM-6211 Interface Brick: EtherCAT Connector

2.2.2. USB Connector

The TMCM-6210/TMCM-6211 offers a Micro USB connector (Type B, device interface) for communication.

Functional Details

The USB interface supports USB high speed communication (12Mbit/s). When USB-attached, the digital logic part of the TMCM-6210/TMCM-6211 is supplied via USB (USB powered mode), if there is no main supply available.

This mode can be used for firmware-updates, TMCL-program download or parameter settings etc. (requires USB connection, only).

NOTE:

→ *In USB stand-alone mode (main board supply available) the board can still draw current from the USB supply – depending on the voltage level of the USB +5V and the on-board generated +5V.*

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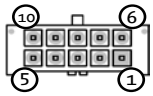
2.2.3. Input Connector

The TMCM-6210/TMCM-6211 offer four analog inputs (nom. 0..10V range), which can be used as digital inputs also (+24V tolerant).

Molex Connector Details

Four inputs are available via one 10-pin Molex MicroFit connector (Molex part no. 430451012). Mating connector housing e.g. Molex 43025-1000, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

Interface Brick: Input Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse protected).
	2	AIN0	Input	Analog input channel 0 (nom. 0..10V).
	3	AIN1	Input	Analog input channel 1 (nom. 0..10V).
	4	AIN2	Input	Analog input channel 2 (nom. 0..10V).
	5	AIN3	Input	Analog input channel 3 (nom. 0..10V).
	6	GND	Power	Supply and signal ground.
	7	GND	Power	Supply and signal ground.
	8	GND	Power	Supply and signal ground.
	9	GND	Power	Supply and signal ground.
	10	GND	Power	Supply and signal ground.

Interface Brick: Input Connector

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Read entire documentation; especially the "Supplemental Directives" (page 41)

2.2.4. Output Connector

TMCM-6210/ TMCM-6211 offer four digital outputs (open-drain).

Molex Connector Details

Four outputs are available via one 8-pin Molex MicroFit connector (Molex part no. 43045-0812). Mating connector housing e.g. Molex 43025-0800, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

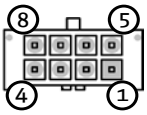
Interface Brick: Output Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	OUT0	Output	Open-drain output channel 0.
	2	OUT1	Output	Open-drain output channel 1.
	3	OUT2	Output	Open-drain output channel 2.
	4	OUT3	Output	Open-drain output channel 3.
	5	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	6	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	7	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).
	8	+24V_FUSE	Power output	Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output connector: 500mA / polyfuse-protected).

Figure 12: Interface Brick: Output Connector

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2.3. TMCM-6210 + TMCM-6211 Driver Brick

The driver brick of the TMCM-6210 and TMCM-6211 offers two outputs for bipolar stepper motors with up to 0.7A RMS/ 1.0A peak motor current (programmable).

Functional Details

Separate HOME + REFL and REFR inputs and encoder inputs (for incremental ABN encoders with differential signals) are available for each motor axes.

NOTE:

→ *Due to sharing of hardware resources, either REFL and REFR inputs or encoder inputs are available at a given point in time and may be used.*

The TMCM-6210 and TMCM-6211 each offer three such driver bricks, supporting 3 stepper motors altogether.

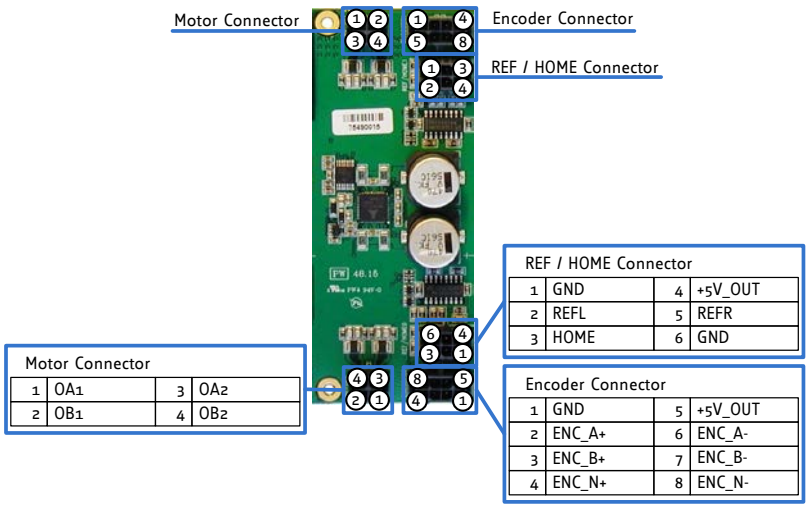


Figure 13: TMCM-6210+ TMCM-6211 Driver Brick

TMCM-6210 and TMCM-6211 Driver Brick: Connectors and Mating Connectors		
Label	**Connector type**	**Mating Connector Type**
Motor	Molex MicroFit Jr. 43045-0412 2x2 pin header, 3mm pitch	Molex MicroFit Jr. Housing: 43025-0400 Contacts: 43030-0007
REF / HOME	Molex MicroFit 43045-0612 2x3 pin header, 3mm pitch	Molex MicroFit Housing: 43025-0600 Contacts: 43030-0007
Encoder	Molex MicroFit 43045-0812 2x4 pin header, 3mm pitch	Molex MicroFit Housing: 43025-0800 Contacts: 43030-0007

Figure 14: TMCM-6210 versus TMCM-6211 Driver Brick: Connectors and Mating Connectors

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2.3.1. Motor Connector

As mentioned before, two bipolar stepper motors supported per single driver brick there are also two motor connectors per brick.

Available Molex Connector Housings

Each motor (with two coils A + B and four connecting wires) can be connected via one 4 pin Molex MicroFit connector (Molex part No. 43045-0412). Mating connector housing e.g. Molex 43025-0400, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

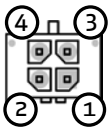
Driver Brick: Motor Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	OA1	Output	Motor coil A.
	2	OB1	Output	Motor coil B.
	3	OA2	Output	Motor coil A.
	4	OB2	Output	Motor coil B.

Figure 15: Driver Brick: Motor Connector

In case you need to connect or disconnect the motor:

CAUTION

Do not connect or disconnect motor during operation!

Always switch off or disconnect power supply before connecting or disconnecting the motor.

This will prevent excessive voltage spikes - caused by motor cable and motor inductivity - that can permanently damage driver MOSFETs.

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2.3.2. REF / HOME Connector

There is one REF / HOME connector per driver brick, which means that there is one for each motor axis.

Molex Connector Details

HOME, REFL and / or REFR switches may be connected via one 6 pin Molex MicroFit™ connector (Molex part no. 43045-0612). Mating connector housing e.g. Molex 43025-0600, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for mating housing and contacts.

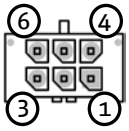
Driver Brick: REF/HOME Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	GND	Power	Supply and signal ground
	2	REFL	Input	REF left / Left stop switch input. Internal pull-up (5k6) to +5V. External switch to ground may be connected or up-to +5V push-pull signal.
	3	HOME	Input	Home switch input. Internal pull-up (5k6) to +5V. External switch to ground may be connected or up-to +5V push-pull signal.
	4	+5V_OUT	Power output	Connected to the on-board +5V auxiliary DC/DC converter. All +5V_OUT power supply outputs together on the 3 REF / HOME, 3 Encoder connectors and the Output connector may draw up-to 1A (e.g. 100mA per encoder and up-to 20mA per REF / HOME switch).
	5	REFR	Input	REF right / Right stop switch input. Internal pull-up (5k6) to +5V. External switch to ground may be connected or up-to +5V push-pull signal.
	6	GND	Power	Supply and signal ground

Figure 16: Driver Brick: REF / HOME Connector

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2.3.3. Encoder Connector

There is one Encoder connector per driver brick – one for each motor axis. Incremental A/B/N encoders with differential encoder signals are supported.

Available Configuration Options

The TMCM6210/TMCM-6211 each offer on-board differential line receivers (AM26LV32 or equivalent) with 120R termination resistor per differential signal pair. Differential encoder signals can be connected via one 8 pin Molex MicroFit connector (Molex part no. 43045-0812). Mating connector housing e.g. Molex 43025-0800, contacts Molex 43030-0007.

ℹ Alternative Molex options are available both for mating housing and contacts.

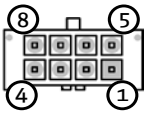
Driver Brick: Encoder Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	GND	Power	Supply and signal ground
	2	ENC_A+	Input	Differential input of encoder channel A, non-inverting input
	3	ENC_B+	Input	Differential input of encoder channel B, non-inverting input
	4	ENC_N+	Input	Differential input of encoder null / zero channel, non-inverting input
	5	+5V_OUT	Power output	Connected to the on-board +5V auxiliary DC/DC converter. All +5V_OUT power supply outputs together on the 3 REF / HOME, 3 Encoder connectors and the Output connector may draw up-to 1A (e.g. 100mA per encoder and up-to 20mA per REF / HOME switch).
	6	ENC_A-	Input	Differential input of encoder channel A, inverting input
	7	ENC_B-	Input	Differential input of encoder channel B, inverting input
	8	ENC_N-	Input	Differential input of encoder null / zero channel, inverting input

Table 6: Driver Brick: Encoder Connector

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2.4. TMCM-6210 and TMCM-6211 Power Supply Brick

The power supply brick of the TMCM-6210 and TMCM-6211 offers one main supply input via the Power connector.

Connection Details

Optionally, a separate logic supply input is made available. Also available: hardware driver stage enable input on the Control connector and connection for an external brake connector with the on-board brake chopper circuit.

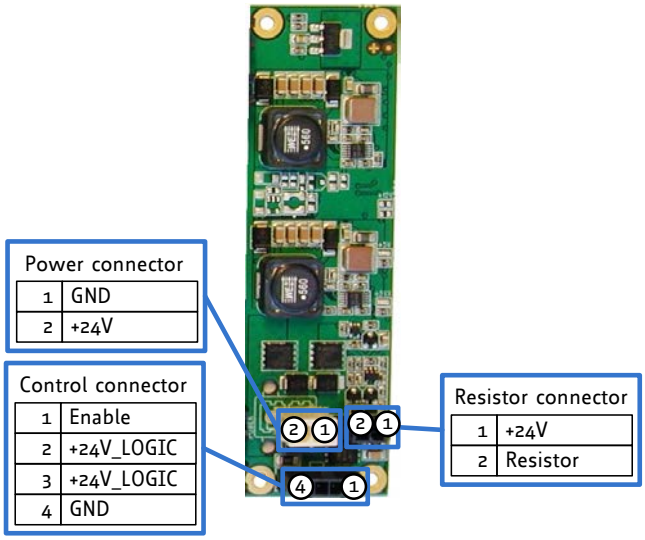


Figure 17: TMCM-6210 and TMCM-6211 Power Supply Brick

Connector and Mating Connector Overview		
Label	**Connector Type**	**Mating Connector Type**
Power	Molex MiniFit Jr. 39-28-1023 1x2 pin header, 4.2mm pitch	Molex MiniFit Jr. Housing: 39-01-2020 Contacts: 39-00-0039
Control	Molex MicroFit 43650-0415 1x4 pin header, 3mm pitch	Molex MicroFit Housing: 43645-0400 Contacts: 43030-0007
Resistor	Molex MicroFit 43650-0215 2x4 pin header, 3mm pitch	Molex MicroFit Housing: 43645-0200 Contacts: 43030-0007

Table 7: TMCM-6210 versus TMCM-6211 Power Supply Brick: Connectors and Mating Connectors

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2.4.1. Power Connector

A two-pin Molex MiniFit Jr. connector (Molex part no. 39-28-1023) is available for power supply connection. Mating connector housing, e.g. Molex 39-01-2020, contacts Molex 39-00-0039.

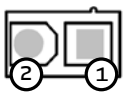
Power Supply Brick: Power Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	GND	Power	Supply and signal ground
	2	+24V	Power supply input	Power supply input. +24V ... +48V +/- 10% regulated power supply input. Supply input for all six motor driver stages and logic supply.

Table 8: Power Supply Brick: Power Connector

ℹ Alternative Molex options are available both for mating housing and contacts.

For proper module operation:

CAUTION

Keep power supply voltage (+24V) below upper limit of 27V!

Make use of regulated power supply.

This will prevent serious damage of driver electronics.

For proper logic power and main power supply:

CAUTION

Keep logic power supply voltage (+24V_*LOGIC*) above or equal to main power supply.

Make use of regulated power supply.

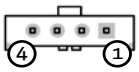
This will prevent serious damage to on-board electronics (diode connection between +24V main power supply input and +248V logic supply input).

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2.4.2. Control Connector

A four pin Molex MicroFit™ connector (Molex part no. 436500415) is used for the driver stage enable signal and optional separate logic supply input. Mating connector housing e.g. Molex 43645-0400, contacts Molex 43030-0007. Please note that there are alternative options available from Molex for both, housing and contacts.



Pin	Label	Direction	Description
1	GND	Power	Supply and signal ground
2	+24V_LOGIC	Power supply input	Separate logic supply input. May be used in order to keep digital / logic part alive while driver stage is not supplied (Power supply input via Power connector either switched off or disconnected).
3	+24V_LOGIC	Power supply input	Same as Pin 2.
4	ENABLE	Input	Driver stage enable input (logic high). Maybe connected to pin 3 / +48V_LOGIC in order to enable driver.

Table 9: Power Supply Brick: Control Connector

For proper module operation:

CAUTION

Keep digital logic power supply voltage (+24V_*LOGIC*) below upper limit of 27V!

Make use of regulated power supply.

This will prevent serious damage of driver electronics.

For proper logic power and main power supply:

CAUTION

Keep logic power supply voltage (+24V_*LOGIC*) above or equal to main power supply!

Make use of regulated power supply.

This will prevent serious damage to on-board electronics (diode connection between +24V main power supply input and +24V logic supply input).

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2.4.3. Resistor Connector

The TMCM-6210 and TMCM-6211 offer a brake chopper in hardware for limiting supply voltage in case energy is fed back from motor / driver stage into the supply rail.

Molex Connector Details

A two pin Molex MicroFit connector (Molex part No. 43650-0215) is used for connecting an external brake resistor. Mating connector housing e.g. Molex 43645-0200, contacts Molex 43030-0007.

ℹ Alternative Molex options are available, both for housing and contacts.

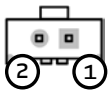
Power Supply Brick: Resistor Connector				
	**Pin**	**Label**	**Direction**	**Description**
	1	+24V	Power supply input	Connected to power supply input of Power connector.
	2	Resistor	Output	Brake chopper output. An external power resistor should be connected between Pin 1 and Pin 2 of this connector.

Figure 18: Power Supply Brick: Resistor Connector

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2.5. Power Supply

For proper operation the power supply concept and design must be fully understood.

Power Supply and Over-Voltage Protection

TMCM-6210/TMCM-6211 includes approx. 2800µF/35V of supply filter capacitors. In addition, the module includes a 24V suppressor diode for over-voltage protection.

NOTE:

→ *It is important to make sure that supply voltage never rises above the upper limit of +27V!*

→ *During motor deceleration the driver stage can feedback energy from the motor into the supply rail. Thus, supply voltage can increase. In order to limit the supply voltage a brake chopper circuit is included on the board. When activated in software and in combination with an external power resistor, this circuit then limits the supply voltage.*

For proper module operation:

⚠ CAUTION

Keep power supply voltage (+24V) below upper limit of 27V!

Make use of regulated power supply.

This will prevent serious damage of driver electronics.

For proper logic power and main power supply:

⚠ CAUTION

Keep logic power supply voltage (+24V_*LOGIC*) above or equal to main power supply.

Make use of regulated power supply.

This will prevent serious damage to on-board electronics (diode connection between +24V main power supply input and +24V logic supply input).

For proper digital logic power supply voltage:

⚠ CAUTION

Keep digital logic power supply voltage (+24V_*LOGIC*) below the upper limit of +27V!

Make use of regulated power supply.

This will prevent serious damage to on-board electronics (diode connection between +24V main power supply input and +24V logic supply input).

AREAS OF SPECIAL CONCERN

There is limited reverse protection only!
The module will short-circuit any reversed supply voltage.

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2.6. TMCM-6210: RS485

For remote control and communication with a host system, TMCM-6210 provides a two-wire RS485 bus interface.

Proper Operation of RS485 Network

For proper RS485 setup and operation, the following aspects must be taken into account:

Bus Structure

The network topology must follow a bus structure as closely as possible. This means that the connection between each node and the bus itself should be as short as possible. Basically, it should be short compared to the length of the bus. The TMCM-6210 offers two connectors, which are connected directly with each other and with the on-board RS485 transceiver. Using both connectors for passing through the bus will help maintain a proper bus topology.

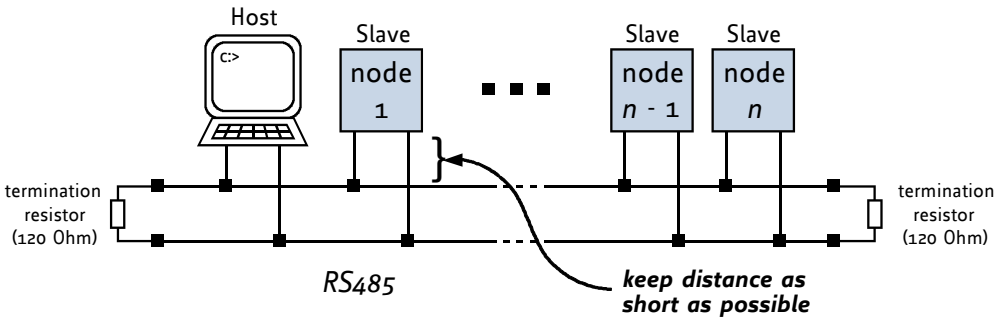


Figure 19: Bus Structure

Bus Termination

Especially for longer busses and/or multiple nodes connected to the bus and/or high communication speeds, the bus must be properly terminated at both ends. The TMCM-6210 does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus have to be added externally.

Number of Nodes

The RS485 electrical interface standard (EIA-485) allows up to 32 nodes to be connected to a single bus. The bus transceivers used on the TMCM-36210 units (SN65HVD1781D) have a significantly reduced bus load and allow a maximum connection of 255 units to a single RS485 bus; using TMCL firmware.

NOTE:

→ *Reliable communication cannot be established by making use of the maximum number of nodes connected to one bus and at the same time making use of maximum supported communication speed. Instead, a compromise has to be found between bus cable length, communication speed and number of nodes.*

Communication Speed

The maximum RS485 communication speed supported by the TMCM-6210 hardware is 1Mbit/s. Factory default is 9600 bit/s. Please see separate firmware manuals for information regarding other possible communication speeds below the upper limit in hardware.

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AREAS OF SPECIAL CONCERN

Always avoid floating bus lines when the host/master - or one of the slaves along the bus line - is transmitting data (all bus nodes are switched to receive mode).

No Floating BUS Lines

Floating bus lines may lead to communication errors. In order to ensure valid signals on the bus it is recommended to use a resistor network connecting both bus lines to well-defined logic levels.

Two options are recommended:

Make us of one Side of the Bus only

OPTION 1

Add resistor (Bias) network on **one** side of the bus, only (120R termination resistor still at **both** ends):

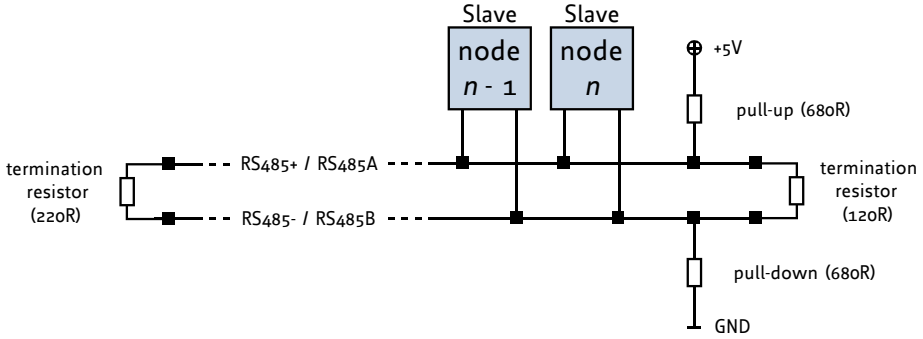


Figure 20: Bus Lines with Resistor (Bias) Network on one Side only

Make use of two Sides of the BUS

OPTION 2

Add resistor (Bias) network at **both** sides of the bus (like Profibus termination):

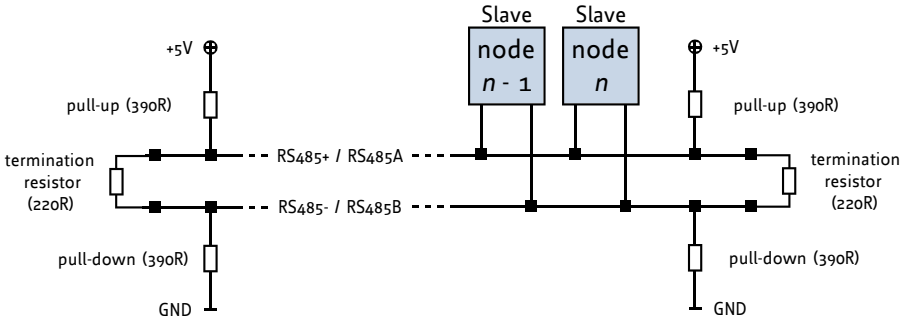


Figure 21: Bus Lines with Resistor (Bias) Network at both Sides

ℹ Certain RS485 interface converters available for PCs already include these additional resistors (e.g. USB-2-485 with bias network at one end of the bus).

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2.7. CAN

For remote control and communication with a host system, the TMCM-6210 provides a CAN bus interface.

Proper CAN Operation

For proper CAN network operation the following items must be taken into account:

Bus Structure

The network topology must follow a bus structure as closely as possible. This means that the connection between each node and the bus itself must be as short as possible; in relation to the length of the bus. The TMCM-6210 offers two connectors (RJ45), which are connected directly with each other, and with the on-board CAN transceiver. Using both connectors for passing through the bus will help maintain a proper bus topology.

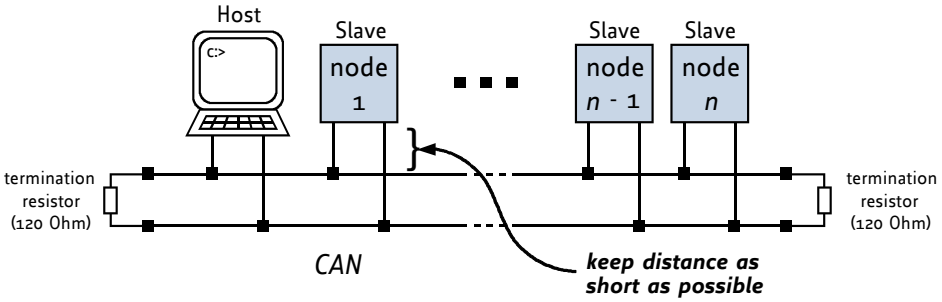


Figure 22: CAN Bus Structure

BUS Termination

Especially for longer busses and/or multiple nodes connected to the bus and/or high communication speeds, the bus must be properly terminated at both ends. The TMCM-6210 does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus must to be added externally.

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2.7.1. CAN Adapter

As part of the cable loom for the TMCM-6210 (G4-CABLE), an adapter PCB is available (RJ45-2-DSUB_G4_V10) for CAN bus connection via standard D-SUB connectors — instead of the RJ45 available on the TMCM-6210.

Other helpful Cables

A standard, ethernet cable, e.g. CAT5, can be used to connect the RJ45 connector on the TMCM-6210 with the RJ45 connector on the adapter PCB. The D-SUB connector on the adapter PCB can then be used to connect further slaves, or to connect the master with CAN D-SUB connectors.

NOTE:

→ *Maintain a proper bus structure while using the adapter PCB!*

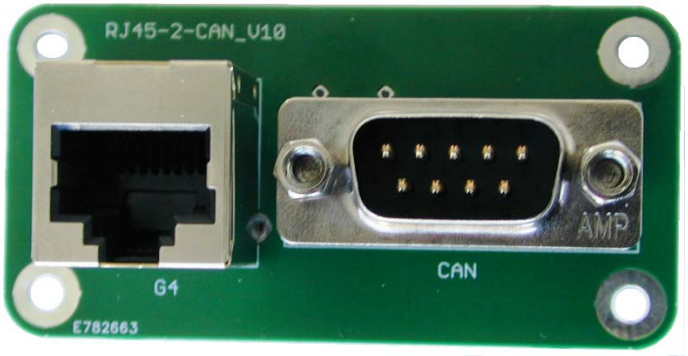


Figure 23: RJ45-2-DSUB PCB Top View

2.7.2. RJ45-2-DSUB SCHEMATIC and Connector Pin Assignment

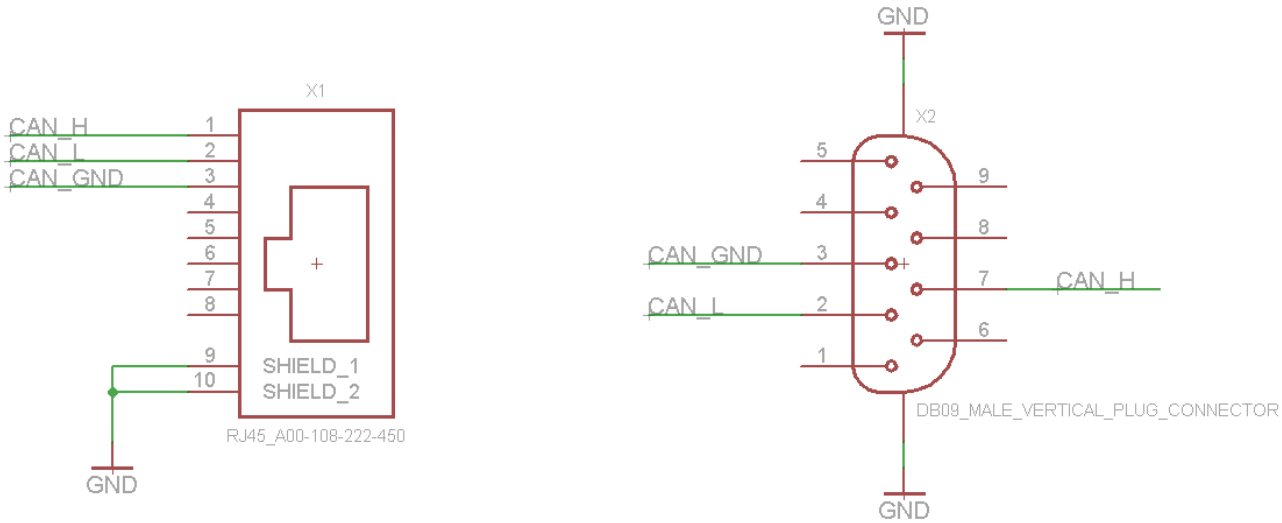


Figure 24: RJ45-2-DSUB schematic and Connector Pin Assignment

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3. Motor Driver Current

The stepper motor driver section of TMCM-6210/TMCM-6211 operates current-controlled.

Driver Current Programming

The driver current is programmed in software with 256 effective scaling steps in hardware up-to 7A RMS / 1A peak max. motor coil current.

NOTE:

→ *Motor current measured for one phase with max. current settings (100% e.g. "SAP 179, 0, 0" and "SAP 6, 0, 255") and 256 microsteps:*

→ *CH1 (yellow): motor current [100mV / A]*

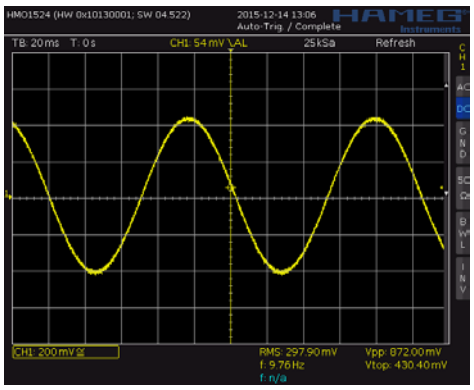


Figure 25: Motor Current Illustration as in Software Application

Motor Current Settings in Software (TMC)

In TMCL axis parameter 6 (motor run current) and 7 (motor standby current) can be used for motor current settings:

SAP 6, 0, <value> // set run current

SAP 7, 0, <value> // set standby current

For <value> numbers between 0 (minimum) and 255 (maximum) are supported. Motor current is scaled linearly up-to 7A RMS / 1A peak. Read-out value with GAP instead of SAP.

ℹ **Please see separate TMCM-6210 / TMCM-6211 firmware / software manual for further information)**

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4. On Board LEDs

On the board, several LEDs provide status information.

4.1. Power Supply Brick

Two available LEDs

For TMCM-6210 and TMCM-6211 two LEDs are available on the power supply brick part.

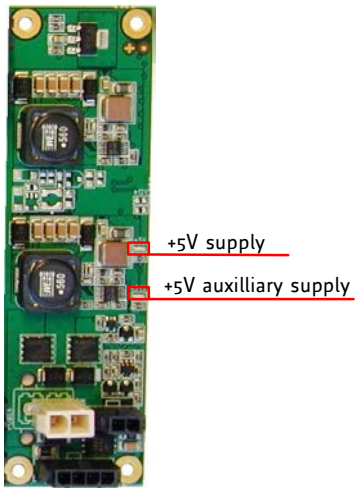


Figure 26: LEDs on Power Supply Brick

Available LEDs	
LED	**Description**
+5V supply	+5V available from on-board DC/DC converter for supply of on-board digital circuit
+5V auxiliary supply	+5V auxiliary supply available (can be switched on/off in software). +5V_OUT on REF/HOME and ENCODER connector.

Table 10: Available LEDs

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4.2. TMCM-6210 Interface Brick

For TMCM-6210 two LEDs (one green and one red) are available.

Connection Details

Both are connected to the on-board microcontroller; and function is firmware dependent. Used with TMCL firmware, the green LED is flashing slowly during operation. During firmware updates both LEDs are switched on.

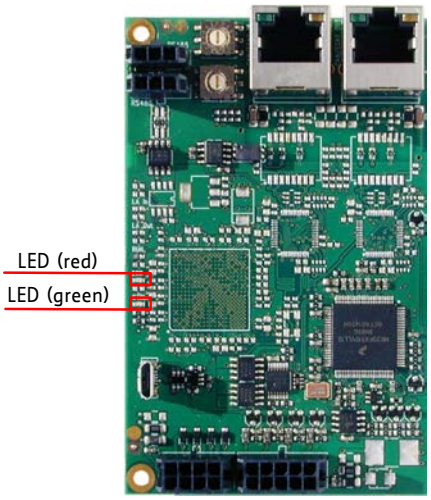


Table 11: LEDs on TMCM-6210 Interface Brick

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4.3. TMCM-6211 Interface Brick

Five LEDs are available for TMCM-6211.

Connection Details

Two LEDs are connected to the processor and three to the EtherCAT slave controller (ESC). In addition, one LED (ERROR) is connected to both: to the microcontroller and to the ESC.

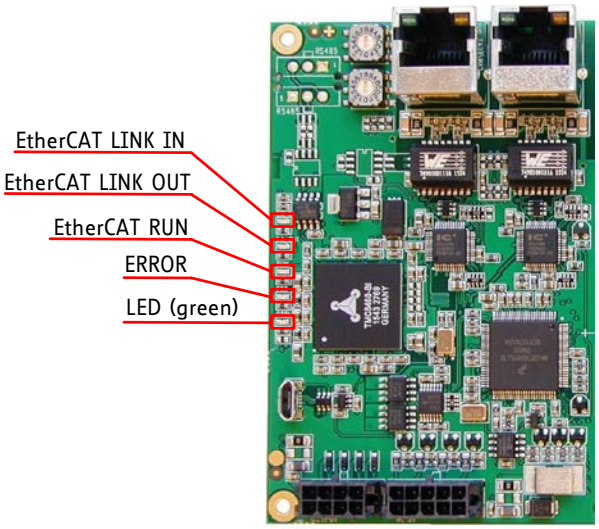


Figure 27: LEDs on TMCM-6211 Interface Brick

TMCM-6211: Interface Brick LEDs	
LED	**Description**
EtherCAT™ LINK IN	Signal LINK IN, connected to ESC
EtherCAT™ LINK OUT	Signal LINK OUT, connected to ESC
EtherCAT RUN	Indicating status of EtherCAT state machine, connected to ESC
ERROR	Connected to microcontroller and ESC – indicating Error
LED (green)	Connected to microcontroller – flashing slowly during normal operation

Table 12: TMCM-6211 Interface Brick LEDs

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5. Reset to Factory Default

Sometimes it is necessary to reset factory default settings, which is explained below.

Reset Configuration

In order to reset configuration to factory default, do as follows:

Action:

- 1. Switch OFF power supply.
- 2. Short two pads of programming connector pad-array (see figure 8.1).
- 3. Switch ON power supply
  (On-board LED should be flashing fast / faster than during normal operation).
- 4. Switch OFF power supply.
- 5. Remove short circuit.

Result:
Now, the factory default setting is reset.

Bottom View of PCB Interface Brick End

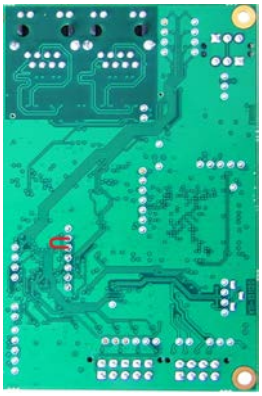


Figure 28: Reset to Factory Defaults

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6. Operational Ratings

The operational ratings show the intended or the characteristic ranges and should be used as design values.

NOTE:

→ *Maximum values must NOT be exceeded- in no case!*

General Operational Ratings of Module					
Symbol	**Parameter**	**Min**	**Type**	**Max**	**Unit**
+24V	Power supply voltage input	10	24	27	V
+24V_LOGIC	Power supply voltage for on-board digital / logic (if supplied separately)	Same as +24V supply input			V
I_{PEAK}	Motor coil current for sine wave **peak** (chopper regulated, adjustable via software)			1	A
I_{RMS}	Continuous motor current (**RMS**)			0.7	A
I_{+24V}	Power supply current for driver		<< 6 x I_{RMS}		A
T_{ENV}	Environmental temperature at 6x 0.7A RMS motor current (no forced cooling)	-30**)		+40***)	°C

Table 13: General Operational Ratings of Module

***) Limited by test equipment. Operation down to -40°C can be expected. Test included "cold" start at this temperature.*

****) Test setup / Test procedure: module is placed inside climate chamber (Binder MK53) with approx. 53l volume. Motor is placed outside chamber moving slowly with motor current set to maximum; supported by module (6x 0.A RMS). Test duration: 24h. Communication tested at beginning and end of test.*

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Operational Ratings of I/Os					
Symbol	**Parameter**	**Min**	**Type**	**Max**	**Unit**
V_{REFL/R_HOME}	Input voltage for stop / home switch inputs REFL / REFR and HOME	0		5.5	V
V_{REFL/R_HOME_L}	Low level voltage for stop / home switch inputs REFL / REFR and HOME	0		1.1	V
V_{REFL/R_HOME_H}	High level voltage for stop / home switch inputs REFL / REFR and HOME	3.3			V
$V_{OUT0...3}$	Voltage at open collector output OUT0...OUT3	0		Same as +24V supply input	V
$I_{OUT0...3}$	Output sink current for OUT0...OUT3			1*)	A
$V_{AIN0...3}$	Full scale input voltage range for analog inputs AIN0...AIN3	0		10**)	V

Table 14: Operational Ratings of I/Os

**) Please note: when using the +24V available at the output connector max. current is limited to 500mA for all outputs together due to on-board fuse (polyfuse)*

***) Nominal upper input voltage which can be measured without saturation of the ADC. Max. voltage at max. ADC value will be around 10.56V.*

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7. TMCM-6210 Functional Description

TMCM-6210 is a highly integrated controller/driver module for 6 stepper motor axes which can be controlled via several serial interfaces (CAN, RS485 and USB – depending on firmware).

Additional Functional Details

Communication traffic is kept low since all-time critical operations (e.g. ramp calculations) are performed on board. The nominal supply voltage of the unit is 12V or 24V DC. The module is designed for both, standalone operation and direct mode. Full remote control of device with feedback is possible. The firmware of the module can be updated via one of the serial interfaces (depending on module and firmware type).

Main Parts of TMCM-6210

In the figure below, the main parts of the TMCM-6210 are shown:

- Microcontroller, responsible for overall control - executes the firmware (either TMCL or CANopen® incl. the communication stack)
- 3 dual-axes motion controller and driver (based on the TMC5072) with calculation of ramps and speed profiles internally in hardware
- interface for an external (e.g. optical) incremental A/B/N encoder (differential RS422 signals) for each axis
- interface for HOME / REFL / REFR reference switches for each axis (either encoder interface or reference switches can be selected in software)
- 4 general purpose analog / digital inputs
- 4 general purpose digital (open-drain) outputs
- Three serial communication interfaces: CAN, RS485 and USB (Micro-USB-connector)

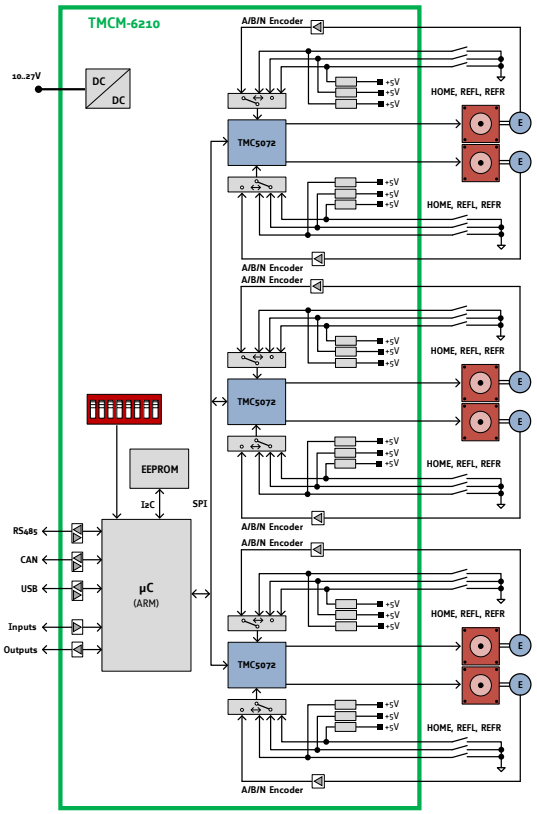


Figure 29: Main Parts of TMCM-6210

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8. TMCM-6211 Functional Description

TMCM-6211 is a highly integrated controller/driver module for 6 stepper motor axes, which offers an EtherCAT™ interface in addition to USB for communication.

Interface Details

The nominal supply voltage of the unit is 12V or 24V DC. Full remote control of the device with feedback is possible using the CANopen over EtherCAT (CoE) firmware. The firmware of the module can be updated via one of the serial interfaces.

Main Parts of TMCM-6211

In the figure below, the main parts of TMCM-6211 are shown:

- Microcontroller, responsible for overall control - executes the firmware (CANopen over EtherCAT, CoE)
- 3 dual-axes motion controller and driver (based on the TMC5072) with calculation of ramps and speed profiles internally in hardware
- interface for an external (e.g. optical) incremental A/B/N encoder (differential RS422 signals) for each axis
- interface for HOME / REFL / REFR reference switches for each axis (either encoder interface or reference switches can be selected in software)
- 4 general purpose analog / digital inputs
- 4 general purpose digital (open-drain) outputs
- EtherCAT™ and USB interfaces for communication

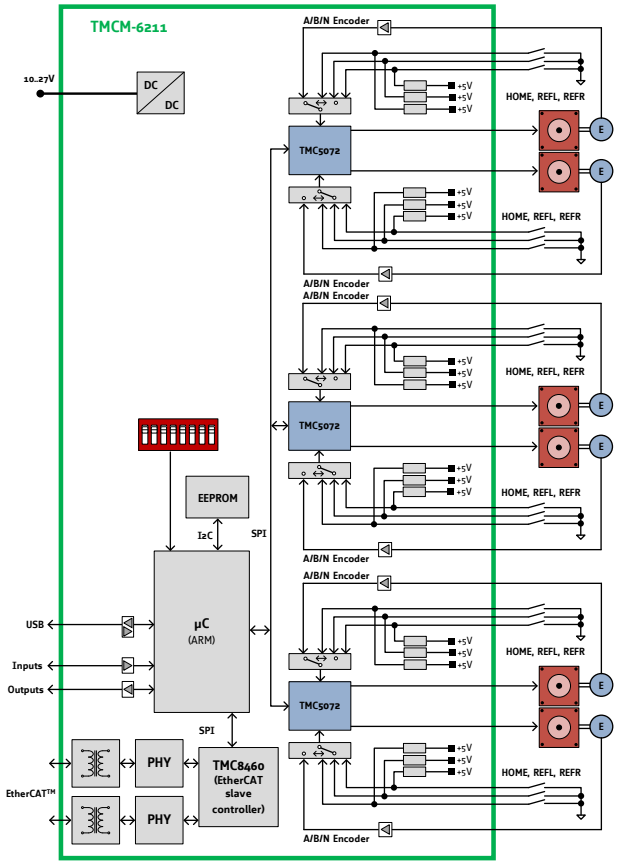


Figure 30: Main Parts of TMCM-6211

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9. REVISION HISTORY

9.1. Document Revision

Document Revision			
Version	**Date**	**Author**	**Description**
0.90	2015-DEC-17	GE	Initial version
0.91	2016-MAR-14	GE	• Cable loom added • Order Codes Connector corrected + updated • Block diagram added Remarks regarding RS485 and CAN added
0.92	2016-MAR-16	GE	• Description for on-board LEDs added • Description for factory default reset added • RJ45-2-D-SUB adapter description added Minor corrections
1.00	2016-APR-20	GE/SV	Layout Adaptations.

Table 15: Revision History: Document Revision

9.2. Hardware Revision

Hardware Revision		
Version	**Date**	**Description**
TMCM-6210_V09	2015-JAN-22	Initial version
TMCM-6210_V10	2015-APR-27	Major redesign (incl. processor change)
TMCM-6210_V11	2015-OCT-26	• Diff. encoder line-receiver will be disabled when REF switch inputs are enabled (circuit corrected) • 100nF input filter capacitors for HOME + REF switch inputs
TMCM-6211_V11	2015-OCT-26	Version with EtherCAT derived from TMCM-6210_V11

Table 16: Revision History: Hardware Revision

9.3. References

[MOLEX] MOLEX connector
http://www.molex.com

[TMC262] TMC262 datasheet
Manual available on http://www.trinamic.com.

[TMC4361] TMC4361 datasheet
Manual available on http://www.trinamic.com.

[TMCL-IDE] TMCL-IDE User Manual
Manual available on http://www.trinamic.com.

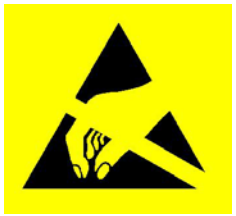
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APPENDICES

10. SUPPLEMENTAL DIRECTIVES

ESD-DEVICE INSTRUCTIONS



This product is an ESD-sensitive CMOS device. It is sensitive to electrostatic discharge.

- **Provide effective grounding to protect personnel and machines.**
- **Ensure work is performed in a non-static environment.**
- **Use personal ESD control footwear and ESD wrist straps, if necessary.**

Failure to do so can result in defects, damages and decreased reliability.

Producer Information

The producer of the products TMCM-6210 and TMCM-6211 is TRINAMIC GmbH & Co. KG in Hamburg, Germany; hereafter referred to as TRINAMIC. TRINAMIC is the supplier; and in this function provides the product and the production documentation to its customers.

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Target User

The documentation provided here, is for programmers and engineers only, who are equipped with the necessary skills and have been trained to work with this type of product.

The ***Target User*** knows how to responsibly make use of this product without causing harm to himself or others, and without causing damage to systems or devices, in which the user incorporates the product.

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Product Documentation Details

This ***Hardware User Manual*** contains the ***User Information*** for the ***Target User***.

The ***Short Spec*** forms the preface of the document and is aimed at providing a general product overview. The ***Main Manual*** provides detailed instructions.

Collateral Documents & Tools

This product documentation is related and/or associated with additional tool kits, firmware and other items, as provided on the product page at: www.trinamic.com.

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10.1. Tables Index

Table 1: TMCM-6210 Interface Brick: Connectors and Mating Connectors 2
Table 2: Order Codes: TMC-6210 3
Table 3: Order Code: TMCM-6211 3
Table 4: Order Code: G4-CABLE 3
Table 5: TMCM-6210 Interface Brick: Connectors and Mating Connectors 9
Table 6: Driver Brick: Encoder Connector 21
Table 7: TMCM-6210 versus TMCM-6211 Power Supply Brick: Connectors and Mating Connectors 22
Table 8: Power Supply Brick: Power Connector 23
Table 9: Power Supply Brick: Control Connector 24
Table 10: Available LEDs 32
Table 11: LEDs on TMCM-6210 Interface Brick 33
Table 12: TMCM-6211 Interface Brick LEDs 34
Table 13: General Operational Ratings of Module 36
Table 14: Operational Ratings of I/Os 37
Table 15: Revision History: Document Revision 40
Table 16: Revision History: Hardware Revision 40

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10.2. Figures Index

Figure 1: TMCM-6211 Product Photo 1
Figure 2: Block Diagram of TMCM-6210 1
Figure 3: Dimension of TMCM-6210 / TMCM-6211 and Position of Mounting Holes 6
Figure 4: TMCM-6210 / TMCM-6211 Mounting Hole Connections 7
Figure 5: Different bricks used for the TMCM-6210 / TMCM-6211 8
Figure 6: TMCM-6210 Interface Brick 9
Figure 7: Interface Brick: RS485 Connector 10
Figure 8: Interface Brick: Input Connector 12
Figure 9: TMCM-xx Interface Brick 14
Figure 10: TMCM-6211 Interface Brick: Connectors and Mating Connectors 14
Figure 11: TMCM-6211 Interface Brick: EtherCAT Connector 15
Figure 12: Interface Brick: Output Connector 17
Figure 13: TMCM-6210+ TMCM-6211 Driver Brick 18
Figure 14: TMCM-6210 versus TMCM-6211 Driver Brick: Connectors and Mating Connectors 18
Figure 15: Driver Brick: Motor Connector 19
Figure 16: Driver Brick: REF / HOME Connector 20
Figure 17: TMCM-6210 and TMCM-6211 Power Supply Brick 22
Figure 18: Power Supply Brick: Resistor Connector 25
Figure 19: Bus Structure 27
Figure 20: Bus Lines with Resistor (Bias) Network on one Side only 28
Figure 21: Bus Lines with Resistor (Bias) Network at both Sides 28
Figure 22: CAN Bus Structure 29
Figure 23: RJ45-2-DSUB PCB Top View 30
Figure 24: RJ45-2-DSUB schematic and Connector Pin Assignment 30
Figure 25: Motor Current Illustration as in Software Application 31
Figure 26: LEDs on Power Supply Brick 32
Figure 27: LEDs on TMCM-6211 Interface Brick 34
Figure 28: Reset to Factory Defaults 35
Figure 29: Main Parts of TMCM-6210 38
Figure 30: Main Parts of TMCM-6211 39

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