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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



Hardware Version V 1.10

# HARDWARE MANUAL

**TMCM-6210****TMCM-6211**

6-Axes Stepper  
Controller / Driver  
Up-to 0.7A 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)

**dcStep™**  
| | | | | | | |



**stallGuard2™**

TRINAMIC Motion Control GmbH & Co. KG  
Hamburg, Germany

[www.trinamic.com](http://www.trinamic.com)

**TRINAMIC**  
MOTION CONTROL

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# 1 Life support policy

TRINAMIC Motion Control GmbH & Co. KG does not authorize or warrant any of its products for use in life support systems, without the specific written consent of TRINAMIC Motion Control GmbH & Co. KG.

Life support systems are equipment intended to support or sustain life, and whose failure to perform, when properly used in accordance with instructions provided, can be reasonably expected to result in personal injury or death.

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Specifications are subject to change without notice.



## 2 Features

The TMCM-6210 / TMCM-6211 is a six axes controller/driver module for 2-phase bipolar stepper motors with separate encoder (differential) and HOME / STOP switch inputs for each axis. CAN, RS485 and USB (Micro-USB) interfaces are available on the TMCM-6210 and EtherCAT™ together with USB (Micro-USB) on the TMCM-6211 for communication. Furthermore the modules offer four analog / digital inputs and four digital outputs together with a brake chopper unit (supporting an external brake resistor) for supply voltage limitation when energy is fed back into the supply rail.

### MAIN CHARACTERISTICS

#### Motion controller

- Motion profile calculation in real-time
- On the fly alteration of motor parameters (e.g. position, velocity, acceleration)
- Dedicated HOME + STOP switch inputs (internal pull-ups)
- High performance microcontroller for overall system control and communication protocol handling

#### Bipolar stepper motor driver

- Up to 256 microsteps per full step
- High-efficient operation, low power dissipation
- Dynamic current control
- Integrated protection
- stealthChop™ for quiet operation and smooth motion
- dcStep™ feature for load dependent speed control
- stallGuard2™ feature for stall detection
- coolStep™ feature for reduced power consumption and heat dissipation

#### Interfaces

- TMCM-6210: CAN + RS485
- TMCM-6211: EtherCAT™
- USB full speed (12Mbit/s) device interface (Micro-USB)
- Differential encoder input per motor axis (6x)
- HOME, STOP\_L, STOP\_R switch inputs with internal pull-ups per motor axis (6x)
- 4 general purpose analog inputs (0..10V) or digital inputs (accept +24V signals)
- 4 general purpose digital outputs (open-drain, 500mA each)

#### Software

- TMCL™ remote (direct mode) and standalone operation with memory for up to 1024 TMCL commands
- TMCM-6210: CANopen firmware available
- TMCM-6211: CoE (CANopen over EtherCAT™) firmware available

#### Electrical data

- Supply voltage: nom. +12V and +24V with +10V ... +27V supply voltage operating range
- Motor current: up to 0.7A RMS (programmable)

#### Mechanical data

- Board size: 215mm x 100mm, overall height 21mm max. (incl. pcb but, without mating connectors and cables)
- 12x M3 mounting holes (optional)

*Please see separate TMCM-6210 / TMCM-6211 Software / Firmware documentation for additional information regarding programming and communication protocol.*

### 3 Order codes

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

| Order code        | Description   | Size of unit         |
|-------------------|---|----------------------|
| 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 3.1: TMCM-6210 order code**

The TMCM-6211 unit is available as:

| Order code    | Description  | Size of unit         |
|---------------|--|----------------------|
| 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 3.2: TMCM-6211 order code**

A cable loom is available, also:

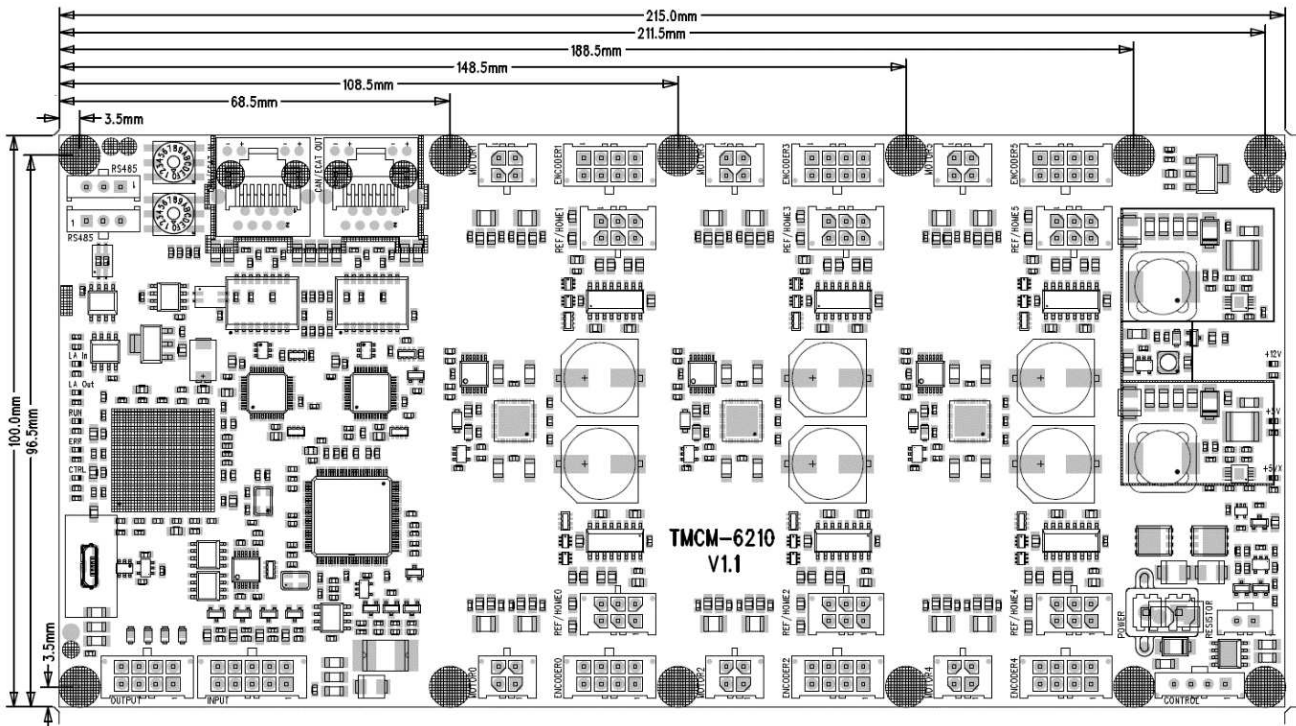
| Order code | Description   |
|------------|---|
| G4-CABLE   | <p>Cable loom for <b>TMCM-6210/6211</b>, TMCM-6212/6213, TMCM-3212/3213, TMCM-3214/3215, TMCM-3312/3313 and TMCM-3314/3315. Contains:</p> <ul style="list-style-type: none"> <li>- 1x cable loom for RS485 connector <b>(6210)</b></li> <li>- 1x standard CAT5 cable with 2x RJ45 for CAN / EtherCAT <b>(6210/6211)</b></li> <li>- 1x RJ45-2-DSUB_G4_V10 adapter (for CAN RJ45 &lt;-&gt; D-SUB translation) <b>(6210)</b></li> <li>- 1x Micro-USB cable <b>(6210/6211)</b></li> <li>- 1x cable loom for INPUTs connector <b>(6210/6211)</b></li> <li>- 1x cable loom for OUTPUTs connector <b>(6210/6211)</b></li> <li>- 6x cable loom for MOTOR connector (small) <b>(6210/6211)</b></li> <li>- 3x cable loom for MOTOR connector (big)</li> <li>- 6x cable loom for ENCODER connector <b>(6210/6211)</b></li> <li>- 6x cable loom for REF / HOME connector <b>(6210/6211)</b></li> <li>- 1 cable loom for POWER connector (small) <b>(6210/6211)</b></li> <li>- 1x cable loom for POWER connector (big)</li> <li>- 1x cable loom for CONTROL connector <b>(6210/6211)</b></li> <li>- 1x cable loom for RESISTOR connector <b>(6210/6211)</b></li> </ul> |

*Please note: there is one cable loom available for a complete family of modules in order to speed-up initial setup of these modules. The family consists of these currently planned / available modules: TMCM-6210/6211, TMCM-6212/6213, TMCM-3212/3213, TMCM-3214/3215, TMCM-3312/3313 and TMCM-3314/3315. Not all cables are required for all modules – some cable will fit or will be helpful for some modules, only. Module numbers in parenthesis behind each cable in the table above indicate whether the particular part of the cable loom can be used with the TMCM-6210 and / or TMCM-6211.*

## 4 Mechanical and Electrical Interfacing

### 4.1 Dimensions and Mounting Holes

The dimensions of the TCM-6210 and TCM-6211 controller/driver board are approx. 215mm x 100mm x 21mm. Maximum component height (height above PCB level) without mating connectors is around 17mm above PCB level and 2mm below PCB level. There are 12 mounting holes for M3 screws (3.2mm diameter) altogether for mounting the PCB.

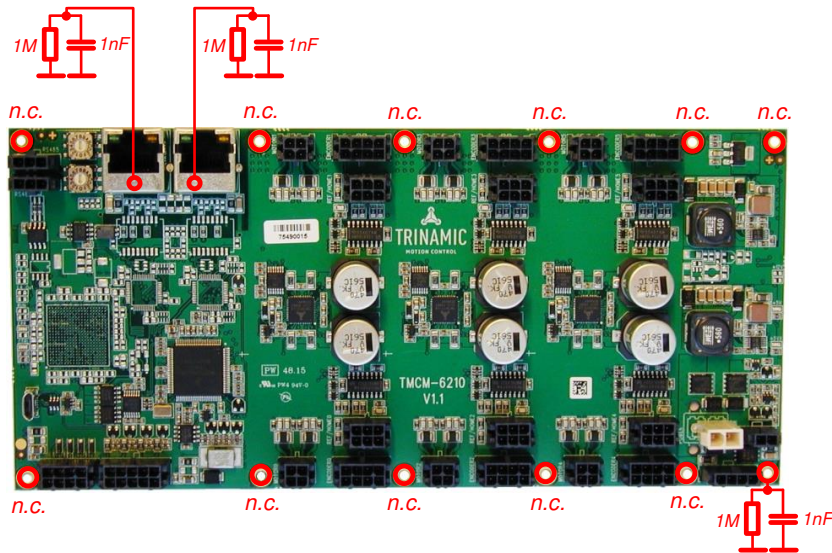


**Figure 4.1 Dimension of TCM-6210 / TCM-6211 and position of mounting holes**

Please note: TCM-6210 and TCM-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.

## 4.2 Board mounting considerations

The TMC6210 / TMC6211 offer 12 metal plated mounting holes. One hole (lower right) is connected to on-board system ground (connected to power supply input ground) via  $1M$  ( $500VDC$ )  $\parallel$   $1nF$  ( $1kV$ ). The same combination of resistor and capacitor is used for connecting the RJ45 shield ground (connector enclosure) to power supply input ground (see figure 4.1).



**Figure 4.2 TMC6210 / TMC6211 mounting hole connections**

All other mounting holes are electrically isolated. Please note that not all holes have to be used for mounting the pcb. At least the mounting holes in all four corners and two in the middle (6 altogether) should be used to ensure adequate support of the pcb when inserting / removing connectors in order to avoid significant bending of the pcb.

In any case: please remove / attach mating connectors carefully – supporting the pcb if necessary!



## 5 Connectors of TMCM-6210 and TMCM-6211

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

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

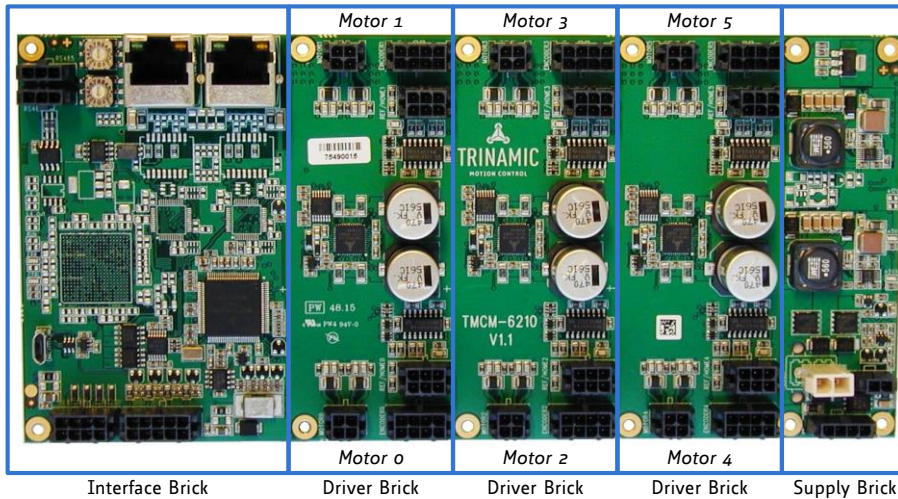


Figure 5.1 different bricks used for the TMCM-6210 / TMCM-6211

### 5.1 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.

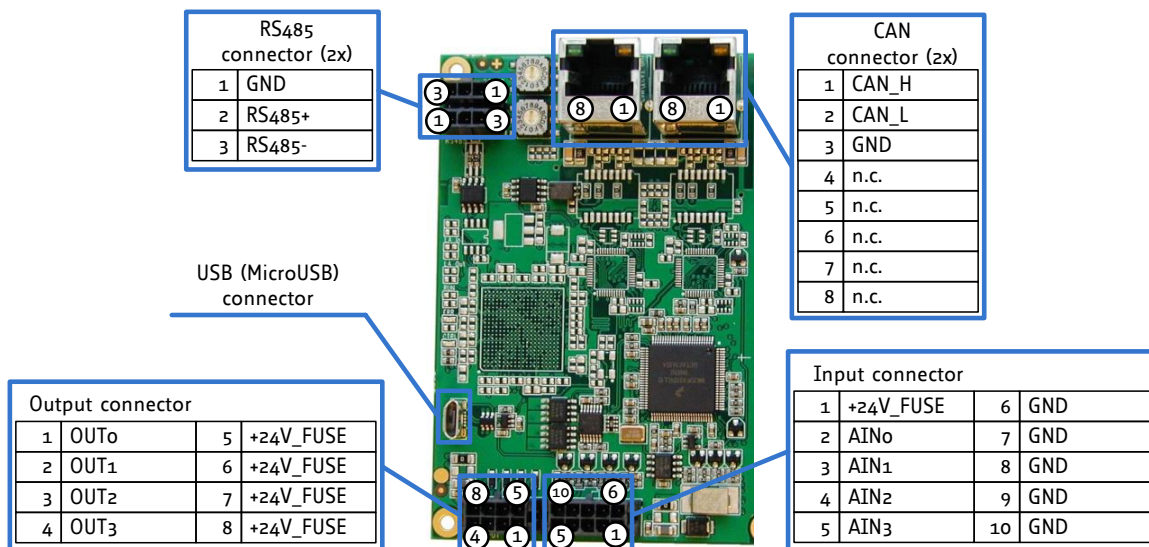


Figure 5.2 TMCM-6210 interface brick

Connector and mating connector overview:

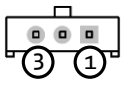
| Label                    | Connector type  | Mating connector type   |
|--------------------------|---|---|
| RS485 connector (2x)     | Molex MicroFit™, 436500315<br>1x4 pin header, 3mm pitch | Molex MicroFit™,<br>Housing: 43645-0300<br>Contacts: 43030-0007 |
| CAN connector (2x)       | RJ45 plug connector                                     | e.g. Standard CAT 5 / CAT 5e<br>cables may be used              |
| USB (MicroUSB) connector | Micro-USB connector, type B<br>(USB device interface)   | Standard Micro-USB  |
| Input connector          | Molex MicroFit™, 430451012<br>2x5 pin header, 3mm pitch | Molex MicroFit™,<br>Housing: 43025-1000<br>Contacts: 43030-0007 |
| Output connector         | Molex MicroFit™, 430450812<br>2x4 pin header, 3mm pitch | Molex MicroFit™,<br>Housing: 43025-0800<br>Contacts: 43030-0007 |

**Table 5.1 TMCM-6210 interface brick: connectors and mating connectors**

### 5.1.1 RS485 connector

There are two RS485 connectors on the board with the same pin assignment – pins directly connected to each other. The second connector may 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. 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   | RS485+ | Bi-directional | RS485 interface, diff. signal (non-inverting) |
|   | 3   | RS485- | Bi-directional | RS485 interface, diff signal (inverting)      |

**Table 5.1: Interface Brick: RS485 connector**

### 5.1.2 CAN connector

There are two CAN connectors on the board with the same pin assignment – pins directly connected to each other. The second one may 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 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.

|  | 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**

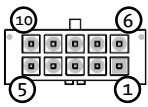
### 5.1.3 USB connector

The TMCM-6210 / TMCM-6211 offers a Micro USB connector (Type B, device interface) for communication. The USB interface supports USB high speed communication (12Mbit/s). With USB attached the digital logic part of the TMCM-6210 / TMCM-6211 will be supplied via USB (USB powered mode) if there is no main supply available. This mode may be used for firmware-updates, TMCL-program download or parameter settings etc. (requires USB connection, only). Please note that in USB stand-alone mode (main board supply available) the board might still draw current from the USB supply – depending on the voltage level of the USB +5V and the on-board generated +5V.

### 5.1.4 Input connector

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

The 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.



| 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   |

Table 5.3: Interface Brick: Input connector

### 5.1.5 Output connector

The TMCM-6210 / TMCM-6211 offer four digital outputs (open-drain). The 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.

| Pin | Label     | Direction    | Description  |
|-----|-----------|--------------|--|
| 1   | OUT0      | Output       | Open-drain output  |
| 2   | OUT1      | Output       | Open-drain output  |
| 3   | OUT2      | Output       | Open-drain output  |
| 4   | OUT3      | 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

## 5.2 TMCM-6211 Interface Brick

The interface brick of the TMCM-6210 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.

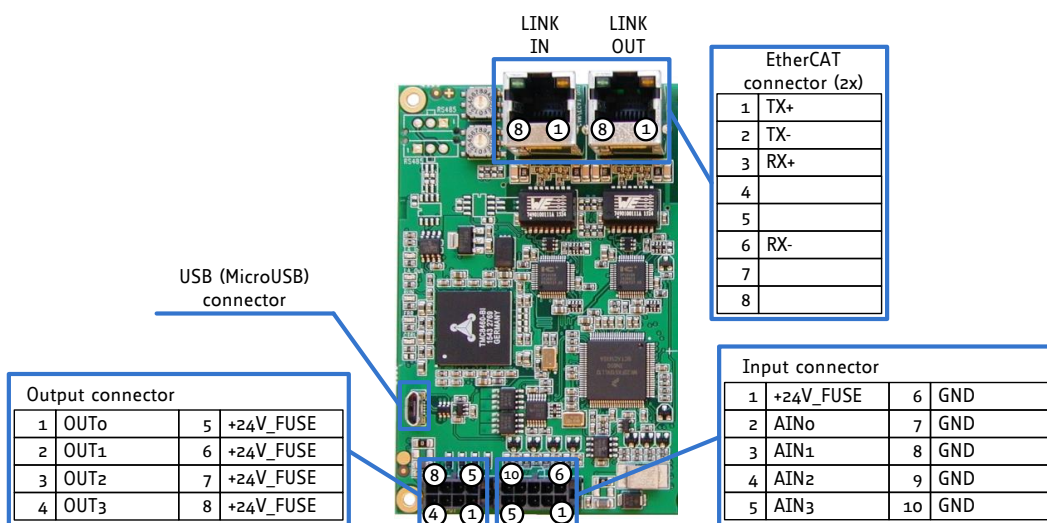


Figure 5.3 TMCM-6211 interface brick

Connector and mating connector overview:


| Label                    | Connector type  | Mating connector type   |
|--------------------------|---|---|
| EtherCAT™ connector (2x) | RJ45 plug connector                                   | e.g. Standard CAT 5 / CAT 5e cables suitable for 100Mbit/s Ethernet |
| USB (MicroUSB) connector | Micro-USB connector, type B (USB device interface)    | Standard Micro-USB  |
| Input connector          | Molex MicroFit™, 43045-1012 2x5 pin header, 3mm pitch | Molex MicroFit™, Housing: 43025-1000 Contacts: 43030-0007           |
| Output connector         | Molex MicroFit™, 43045-0812 2x4 pin header, 3mm pitch | Molex MicroFit™, Housing: 43025-0800 Contacts: 43030-0007           |

**Table 5.5: TMCM-6211 interface brick: connectors and mating connectors**

### 5.2.1 EtherCAT™ connector

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

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.) might be used for connection. The PHYs used on the TMCM-6211 support auto MDI-X – therefore, TX and RX signals on the connector might be exchanged – e.g. cables with straight-through pin-assignment can be used.

|   | 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   |       |           |   |

**Table 5.6: TMCM-6211 Interface Brick: EtherCAT™ connector**

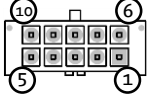
### 5.2.2 USB connector

The TMCM-6210 / TMCM-6211 offers a Micro USB connector (Type B, device interface) for communication. The USB interface supports USB high speed communication (12Mbit/s). With USB attached the digital logic part of the TMCM-6210 / TMCM-6211 will be supplied via USB (USB powered mode) if there is no main supply available. This mode may be used for firmware-updates, TMCL-program download or parameter settings etc. (requires USB connection, only). Please note that in USB stand-alone mode (main board supply available) the board might still draw current from the USB supply – depending on the voltage level of the USB +5V and the on-board generated +5V.

### 5.2.3 Input connector

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

The 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.

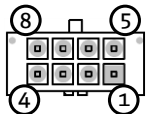


| Pin | Label     | Direction    | Description  |
|-----|-----------|--------------|--|
| 1   | +24V_FUSE | Power output | Connected via fuse (polyfuse) to power supply input (+24V_LOGIC supply input on power control connector). Max. output current (together with all +24V_FUSE supply outputs on output 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   |

Table 5.7: Interface Brick: Input connector

## 5.2.4 Output connector

The TMC6210 / TMC6211 offer four digital outputs (open-drain). The 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.



| 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) |

Table 5.8: Interface Brick: Output connector

### 5.3 TMC6210 + TMC6211 Driver Brick

The driver brick of the TMC6210 and TMC6211 offers two outputs for bipolar stepper motors with up-to 0.7A RMS / 1.0A peak motor current (programmable), separate HOME + REFL and REFR inputs and encoder inputs (for incremental ABN encoders with differential signals) for each motor axes. Please note that 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 TMC6210 and TMC6211 offer three such driver bricks, supporting 6 stepper motors altogether.

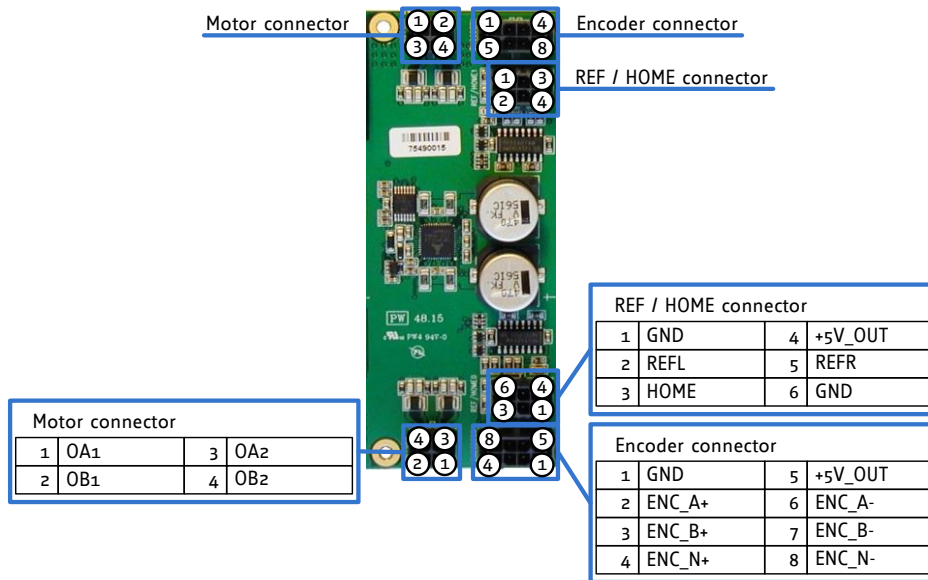


Figure 5.4 TMC6210 + TMC6211 Driver Brick

| Label                | Connector type   | Mating connector type   |
|----------------------|--|---|
| Motor connector      | Molex MicroFit Jr.™, 43045-0412<br>2x2 pin header, 3mm pitch | Molex MicroFit Jr.™,<br>Housing: 43025-0400<br>Contacts: 43030-0007 |
| REF / HOME connector | Molex MicroFit™, 43045-0612<br>2x3 pin header, 3mm pitch     | Molex MicroFit™,<br>Housing: 43025-0600<br>Contacts: 43030-0007     |
| Encoder connector    | Molex MicroFit™, 43045-0812<br>2x4 pin header, 3mm pitch     | Molex MicroFit™,<br>Housing: 43025-0800<br>Contacts: 43030-0007     |

Table 5.9 TMC6210 and TMC6211 Driver brick: connectors and mating connectors

#### 5.3.1 Motor connector

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

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. Please note that there are alternative options available from Molex for both, mating housing and contacts.

|  | 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 |

Table 5.10: Driver Brick: Motor connector

| CAUTION   |  |
|---|--|
| <b>Do not connect or disconnect motor during operation!</b>   |  |
| Motor cable and motor inductivity might lead to voltage spikes when the motor is disconnected / connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch off and / or disconnect power supply before connecting / disconnecting the motor. |  |

### 5.3.2 REF / HOME connector

There are two REF / HOME connectors per single driver brick – one for each motor axis. 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.

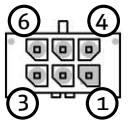
|  | Pin | Label   | Direction    | Description  |
|--|-----|---------|--------------|--|
|  | 1   | GND     | Power        | Supply and signal ground   |
|  | 2   | REFL    | Input        | REF left / Left stop switch input. Internal pull-up (5k6) to +5V. External switch to ground may be connected or 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 6 REF / HOME and 6 Encoder connectors 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   |

Table 5.11: Driver Brick: REF / HOME connector

### 5.3.3 Encoder connector

There are two Encoder connectors per single driver brick – one for each motor axis. Incremental A/B/N encoders with differential encoder signals are supported. The TMCM-6210 / TMCM-6211 offer on-board differential line receivers (AM26LV32 or equivalent) with 120R termination resistor per differential signal pair. Differential encoder signals may 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. Please note that there are alternative options available from Molex for both, mating housing and contacts.



| 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 6 REF / HOME and 6 Encoder connectors 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   |

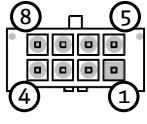


Table 5.12: Driver Brick: Encoder connector

### 5.4 TMCM-6210 + 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, separate logic supply input as an option and a hardware driver stage enable input on the Control connector and connection for an external brake connector with the on-board brake chopper circuit.

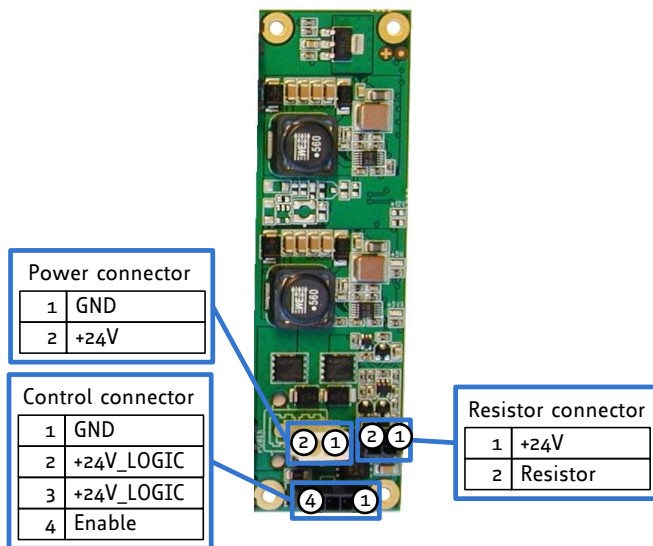


Figure 5.5: TMCM-6210 + TMCM-6211 Power supply Brick

Connector and mating connector overview:

| Label              | Connector type  | Mating connector type  |
|--------------------|---|--|
| Power connector    | Molex MiniFit Jr.™, 39-28-1023<br>1x2 pin header, 4.2mm pitch | Molex MiniFit Jr.™,<br>Housing: 39-01-2020<br>Contacts: 39-00-0039 |
| Control connector  | Molex MicroFit™, 43650-0415<br>1x4 pin header, 3mm pitch      | Molex MicroFit™,<br>Housing: 43645-0400<br>Contacts: 43030-0007    |
| Resistor connector | Molex MicroFit™, 43650-0215<br>2x4 pin header, 3mm pitch      | Molex MicroFit™,<br>Housing: 43645-0200<br>Contacts: 43030-0007    |

Table 5.13 TMCM-6210 and TMCM-6211 Power supply brick: connectors and mating connectors

### 5.4.1 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. Please note that there are alternative options available from Molex for both, housing and contacts.

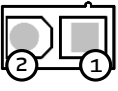
|  | Pin  | Label              | Direction  | Description              |
|---|------|--------------------|--|--------------------------|
|   | 1    | GND                | Power  | Supply and signal ground |
| 2   | +24V | Power supply input | Power supply input. +12V ... +24V +/- 10% regulated power supply input. Supply input for all six motor driver stages and logic supply. |                          |

Table 5.14: Power supply Brick: Power connector

| CAUTION  |
|--|
| <p><b>Always keep the power supply voltage (+24V) below the upper limit of 27V!</b><br/>           Otherwise the driver electronics will be seriously damaged. Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.</p> |
| <p><b>Always keep the logic power supply voltage (+24V_LOGIC) above or equal to the main power supply!</b><br/>           Otherwise the on-board electronics (diode connection between +24V main power supply input and +24V logic supply input) might be seriously damaged.</p>           |

### 5.4.2 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.

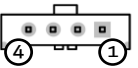
|  | Pin    | Label      | Direction  | Description   |
|---|--------|------------|--|---|
|   | 1      | GND        | Power  | Supply and signal ground  |
|   | 2      | +24V_LOGIC | Power supply input   | Separate logic supply input. May be used in order to keep digital / logic part alive while driver 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 / +24V_LOGIC in order to enable driver. |   |

Table 5.15: Power supply brick: Control connector

| CAUTION   |
|---|
| <p><b>Always keep the digital logic power supply voltage (+24V_LOGIC) below the upper limit of 27V!</b><br/>           Otherwise the on-board electronics might be seriously damaged. Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.</p> |
| <p><b>Always keep the logic power supply voltage (+24V_LOGIC) above or equal to the main power supply (on the Power supply connector)!</b><br/>           Otherwise the on-board electronics (diode connection between +24V main power supply input and +24V logic supply input) might be seriously damaged.</p>  |

### 5.4.3 Resistor connector

The TMC-6210 and TMC-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. 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. Please note that there are alternative options available from Molex for both, housing and contacts.


|  | 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. |

Table 5.16: Power supply brick: Resistor connector

## 5.5 Power supply

For proper operation care has to be taken with regard to power supply concept and design. The TMC-6210 / TMC-6211 includes about 2800µF/35V of supply filter capacitors. In addition, the module includes a 24V suppressor diode for over-voltage protection. Nevertheless, it is important to make sure that supply voltage will not rise beyond the upper limit of +27V! Please note: during motor deceleration the driver stage might feedback energy from the motor into the supply rail and supply voltage might increase. In order to limit the supply voltage a brake chopper circuit has been included on the board. When activated in software and together with an external power resistor this circuit will limit the supply voltage.

#### CAUTION

**Always keep the power supply voltage (+24V) below the upper limit of 27V!**

Otherwise the on-board electronics might be seriously damaged. Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended. In addition, the on-board brake chopper may be used together with an external power resistor connected to the Resistor connector in order to limit supply voltage.

**Always keep the digital logic power supply voltage (+24V\_LOGIC) below the upper limit of 27V!**

Otherwise the on-board electronics might be seriously damaged. Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.

**Always keep the logic power supply voltage (+24V\_LOGIC) above or equal to the main power supply (on the Power supply connector)!**

Otherwise the on-board electronics (diode connection between +24V main power supply input and +24V logic supply input) might be seriously damaged.

**There is limited reverse polarity protection, only!**

The module will short any reversed supply voltage.

## 5.6 RS485

For remote control and communication with a host system the TMC-6210 provides a two wire RS485 bus interface. For proper operation the following items should be taken into account when setting up an RS485 network:

1. **BUS STRUCTURE:**

The network topology should follow a bus structure as closely as possible. That is, 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 TMC-6210 offers two connectors which are connected directly to each other and the on-board RS485 transceiver. Using both connectors for passing through the bus will help with keeping a proper bus topology.

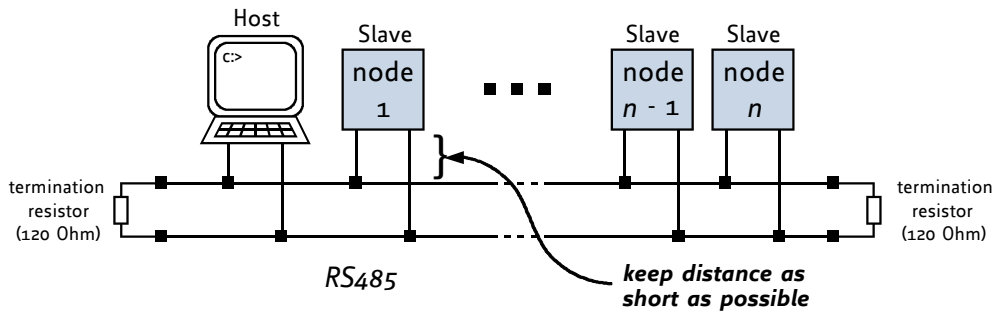


Figure 5.3: Bus structure

2. **BUS TERMINATION:**  
Especially for longer busses and/or multiple nodes connected to the bus and/or high communication speeds, the bus should 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.
3. **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-6110 units (SN65HVD1781D) have a significantly reduced bus load and allow a maximum of 255 units to be connected to a single RS485 bus using TMCL firmware. *Please note: usually it cannot be expected to get reliable communication with the maximum number of nodes connected to one bus and maximum supported communication speed at the same time. Instead, a compromise has to be found between bus cable length, communication speed and number of nodes.*
4. **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.*
5. **NO FLOATING BUS LINES:**  
Avoid floating bus lines while neither the host/master nor one of the slaves along the bus line is transmitting data (all bus nodes switched to receive mode). 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.

There are actually two options which can be recommended:  
Add resistor (Bias) network on **one** side of the bus, only (120R termination resistor still at **both** ends):

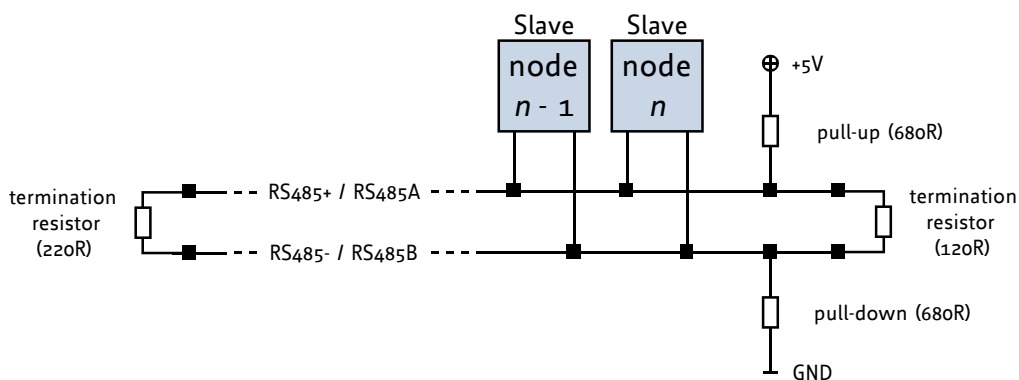
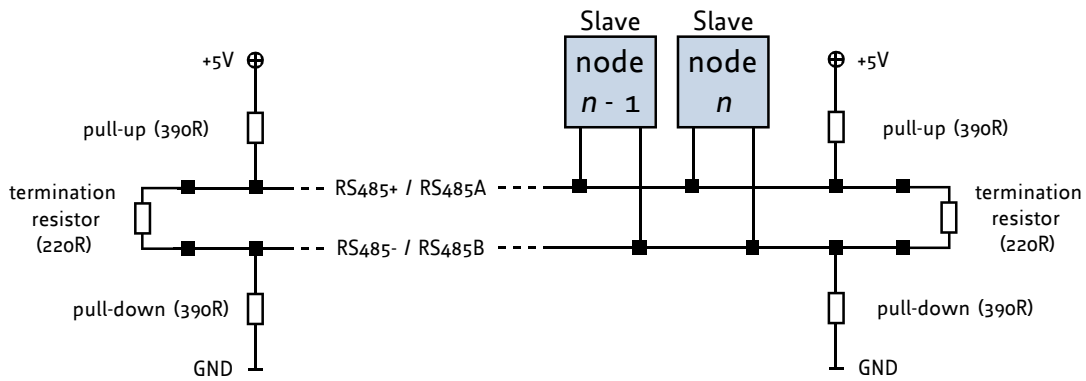


Figure 4.4: Bus lines with resistor (Bias) network on one side, only

Or add resistor (Bias) network at **both** ends of the bus (like Profibus™ termination):



**Figure 4.5: Bus lines with resistor (Bias) network at both ends**

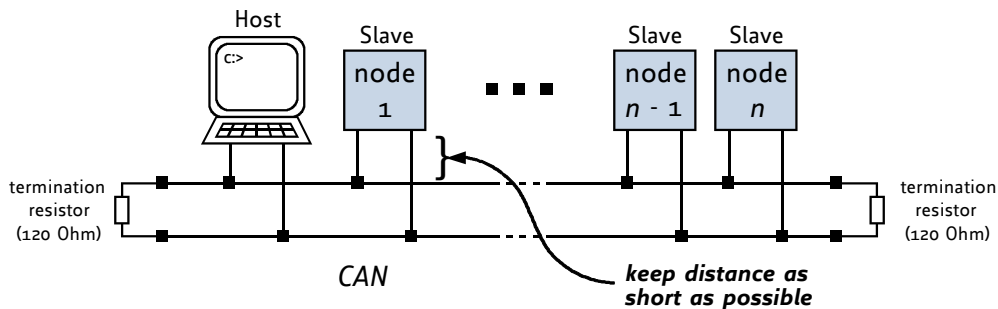
Certain RS485 interface converters available for PCs already include these additional resistors (e.g. USB-2-485 with bias network at one end of the bus).

## 5.7 CAN

For remote control and communication with a host system the TMCM-6210 provides a CAN bus interface. For proper operation the following items should be taken into account when setting up a CAN network:

1. **BUS STRUCTURE:**

The network topology should follow a bus structure as closely as possible. That is, 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 (RJ45) which are connected directly to each other and the on-board CAN transceiver. Using both connectors for passing through the bus will help with keeping a proper bus topology.



**Figure 5.6: CAN bus structure**

2. **BUS TERMINATION:**

Especially for longer busses and/or multiple nodes connected to the bus and/or high communication speeds, the bus should 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.

### 5.7.1 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 making CAN bus connection via standard D-SUB connectors instead of the RJ45 available on the TMCM-6210. A standard e.g. CAT5 ethernet cable might 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 might then be used to connect further slaves or the master with CAN D-SUB connectors. Please make sure to maintain a proper bus structure while using the adapter pcb.

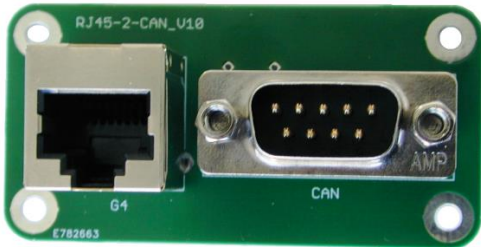


Figure 5.6: RJ45-2-DSUB PCB top view

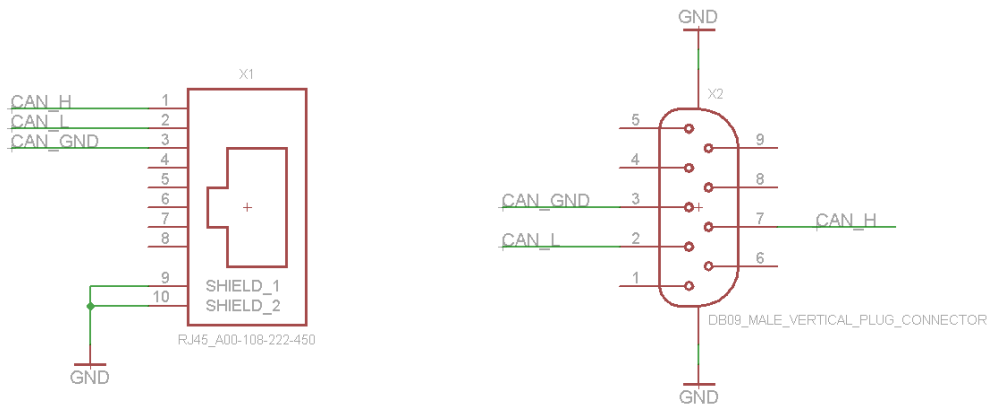
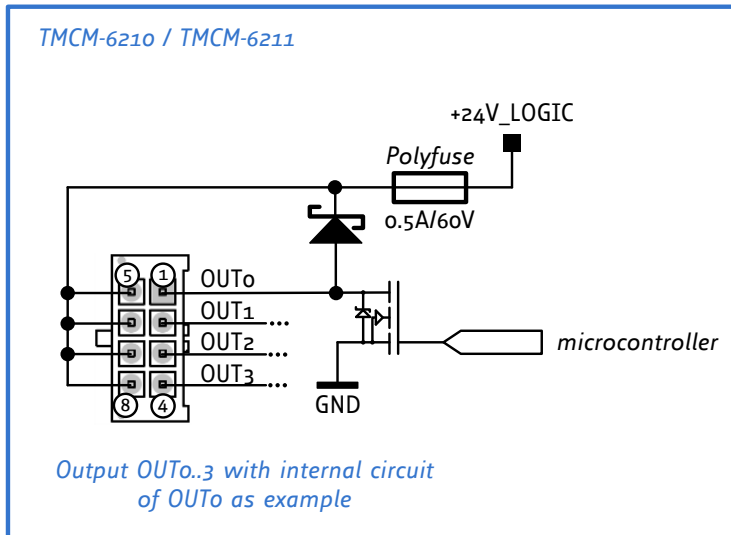


Figure 5.7: RJ45-2-DSUB schematic / connector pin assignment

## 5.8 General purpose outputs OUTo..3

The TMC6210 and TMC6211 offer 4 open-drain (N-channel MOSFET) general purpose outputs available at the output connector of the interface brick part. The internal connection of the N-channel MOSFETs together with a flyback / freewheeling diode can be seen in figure 5.8. When activating the MOSFET the related output will be pulled low (sometimes called npn-style switch). Please note the internal fuse limiting the current that can be drawn from the output connector.



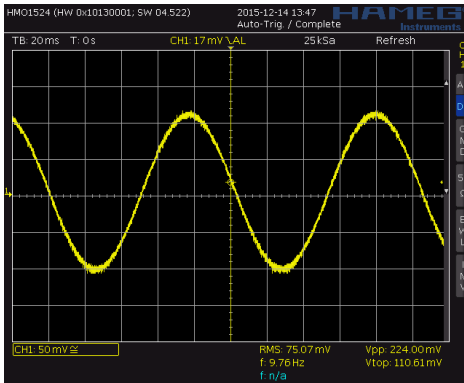
**Figure 5.8: General purpose output – internal circuit (simplified)**

## 6 Motor driver current

The stepper motor driver section of the TMCM-6210 + TMCM-6211 operates current controlled. The driver current may be programmed in software with 256 effective scaling steps in hardware up-to 0.7A RMS / 1A peak max. motor coil current.

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

*CH1 (yellow): motor current [50mV / A]*



### **Motor current setting in software (TMC)**

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

```
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 0.7A RMS / 1A peak. (read-out value with GAP instead of SAP. Please see separate TMCM-6210 / TMCM-6211 firmware / software manual for further information)



## 7 On Board LEDs

There are a number of LEDs on-board indicating status.

### 7.1 Power supply brick

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

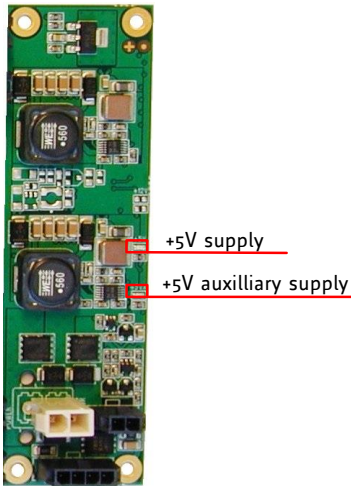


Figure 7.1: LEDs on power supply brick

| 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. |

### 7.2 TMCM-6210 Interface Brick

With the TMCM-6210 there are two LEDs (one green and one red) available. Both are connected to the on-board microcontroller and function is firmware dependent. With TMCL firmware the green LED is flashing slowly during operation. During firmware updates both LEDs are switched on.

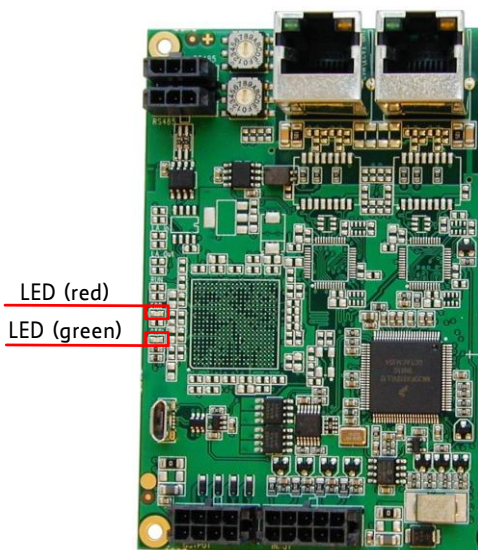


Figure 7.2: LEDs on TMCM-6210 interface brick

### 7.3 TMCM-6211 Interface Brick

With the TMCM-6211 there are five LEDs available. Two LEDs are connected to the processor and three to the EtherCAT™ slave controller (ESC). In addition, one LED (ERROR) is connected to both, the microcontroller and the ESC.

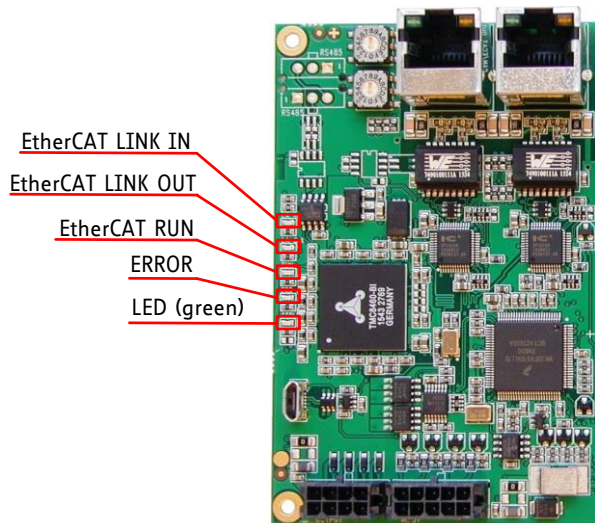


Figure 7.3: LEDs on TMCM-6211 interface brick

| 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 |

## 8 Reset to Factory Default

For reset to factory default values please follow instructions below:

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.

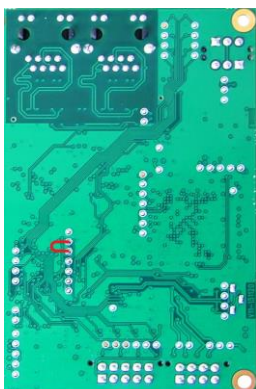


Figure 8.1 Reset to factory defaults (bottom view of pcb – interface brick end)