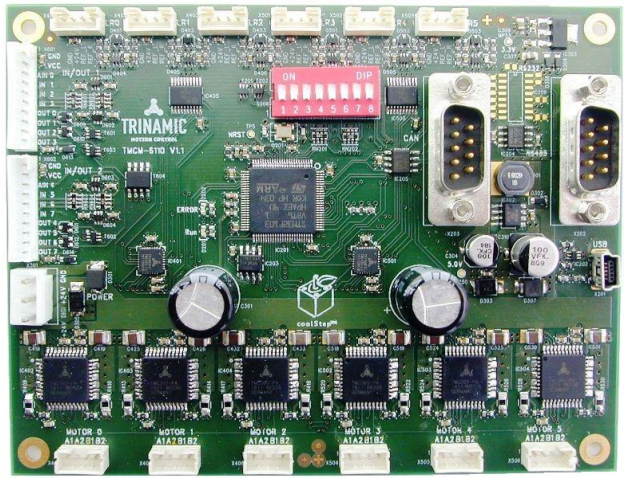
Hardware Version V1.10

HARDWARE MANUAL



TMCM-6110

6 Axes Stepper
Controller / Driver
1.1A RMS / 24V DC
USB, CAN, RS485 [or RS232]

coolStep™

stallGuard2™

TRINAMIC Motion Control GmbH & Co. KG
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TRINAMIC
MOTION CONTROL

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1 Features

The TMCM-6110 is a compact 6-axes stepper motor controller/driver standalone board. It supports up to 6 bipolar stepper motors with up to 1.1A RMS coil current. There are separate motor and reference/end switch connectors for each motor. In addition, the module offers 8 general purpose inputs and 8 general purpose outputs.

MAIN CHARACTERISTICS

Motion controller
- Motion profile calculation in real-time
- On the fly alteration of motor parameters (e.g. position, velocity, acceleration)
- High performance microcontroller for overall system control and serial 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
- stallGuard2™ feature for stall detection
- coolStep™ feature for reduced power consumption and heat dissipation

Interfaces
- Up to 8 multi-purpose inputs (+24V compatible, incl. 2 dedicated analog inputs)
- Up to 8 multi-purpose outputs (open-drain, incl. 2 outputs for currents up to 1A)
- RS485 2-wire communication interface
- USB 2.0 full speed (12Mbit/s) communication interface (mini-USB connector)
- CAN 2.0B communication interface (9pin D-SUB)

Features
- Uses TMC429 stepper motor controller for on-the-fly alteration of many motion specific parameters
- Uses TMC260 advanced stepper motor driver IC
- Up to 256 microsteps per fullstep
- Integrated protection: overtemperature/undervoltage

Software
- TMCL remote (direct mode) and standalone operation (memory for up to 2048 TMCL commands)
- Fully supported by TMCL-IDE (PC based integrated development environment)

Electrical data
- Supply voltage: +9V... +28V DC
- Motor current: up to 1.1A RMS (programmable) per axis

Mechanical data
- Board size: 130mm x 100mm, height 30mm max.
- 4 mounting holes for M3 screws

Please see separate TMCL Firmware Manual for additional information

2 Order Codes

Order code	Description	Size of unit
TMCM-6110-*option*	6-axes bipolar stepper motor controller and driver module	130mm x 100mm x 30mm

Table 2.1 TMCM-6110 order codes

The following options are available:

Firmware option	Description	Order code example:
-TMCL	Module pre-programmed with TMCL firmware	TMCM-6110-*TMCL*

Table 2.2 TMCM-6110 firmware options

A version with RS232 interface and 9pin female D-SUB connector instead of RS485 is available as assembly option upon request (please see chapter x.xx for adding RS232 interface option instead of RS485 to standard version for prototyping):

Interface option	Description	Order code example:
-232	Module with RS232 interface instead of RS485	TMCM-6110-*232*-TMCL

Table 2.3 TMCM-6110 interface options

A cable loom set is available for this module.

Order code	Description
TMCM-6110-CABLE	The cable loom for TMCM-6110 contains: - 1x Cable loom for power connector - 6x cable loom for reference switch connectors 0-5 - 6x cable loom for motor connector 0-5 - 2x cable loom for I/O connector 0+1 - 1x USB type A connector to mini-USB type B connector cable

Table 2.4 Cable loom order code

3 Mechanical and Electrical Interfacing

3.1 Size of Board

The board with the controller / driver electronics has an overall size of 130mm x 100mm and offers four mounting holes for M3 screws (3.2mm diameter). Maximum board height (without mating connectors and cable looms) is about 30mm (approx. 26mm above printed circuit board level).

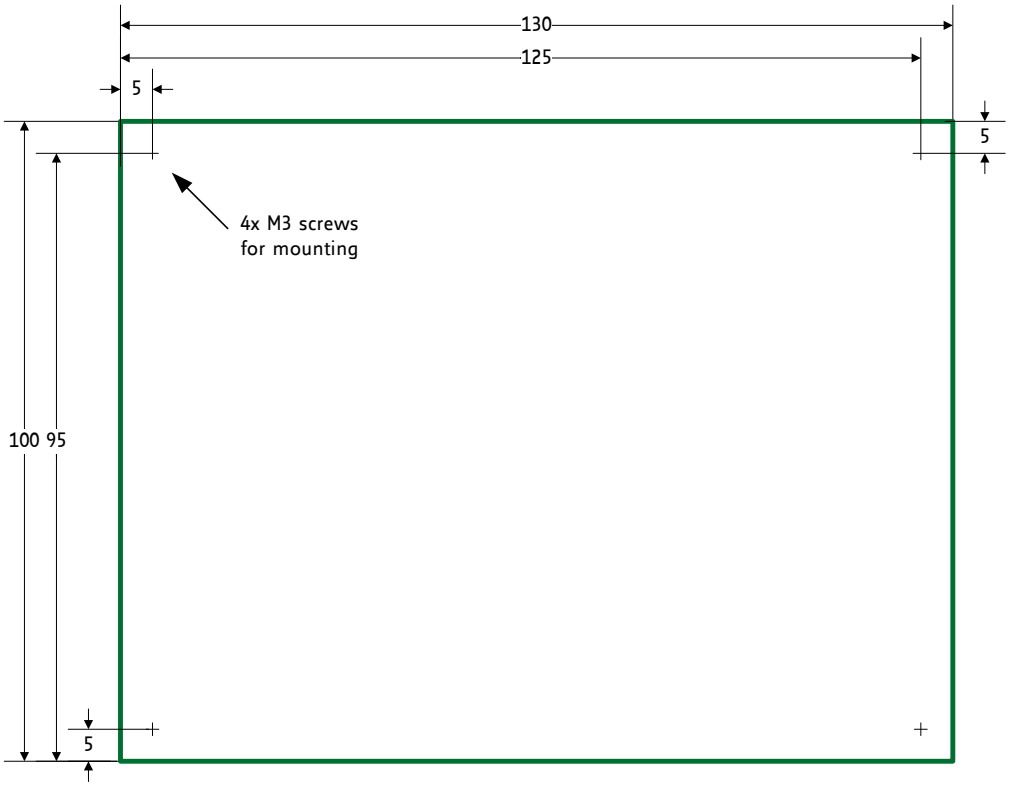


Figure 3.1 Board dimensions and position of mounting holes (all values in mm).

3.2 Board mounting considerations

The TMCM-6110 offers four metal plated mounting holes. All four mounting holes are connected to system and signal ground (same as power supply ground).
In order to minimize distortion of signals and radiation of HF signals (improve EMC compatibility) especially in sensitive / noisy environments it is important to ensure a solid ground connection within the system. In order to support this, it is recommended to connect all four mounting holes of the board in addition to the supply ground connection to system power supply ground.
Nevertheless, this might not always be an option e.g. in case the metal system chassis / TMCM-6110 mounting plate is already connected to earth and a direct connection between supply ground (secondary side) and mains supply earth (primary side) is not desired / not an option. In this case plastic (e.g. made of nylon) spacers / distance bolts should be used.

3.2.1 DIN Rail Mounting

The board has been designed in order to support DIN rail mounting. One dimension of the board has been limited to 100mm and there is a minimum border of approx. two millimeters alongside all four corners of the board free of any component. This way, a standard mounting carrier for DIN rails as it is available from several sources might be used as adapter for DIN rail mounting of the board.

EXAMPLE

Mounting carrier for DIN 35 rail from WAGO® (288-003) cut to the length of the TMCM-6110 board (130mm) with populated TMCM-6110.



Figure 3.2 DIN rail mounting

3.3 Connectors

The TMCM-6110 has 18 connectors altogether. There are 6 separate connectors for each motor and corresponding reference switches (Figure 4.4), two I/O connectors, one power connector and 3 connectors for communication incl. Mini-USB, RS485 and CAN.

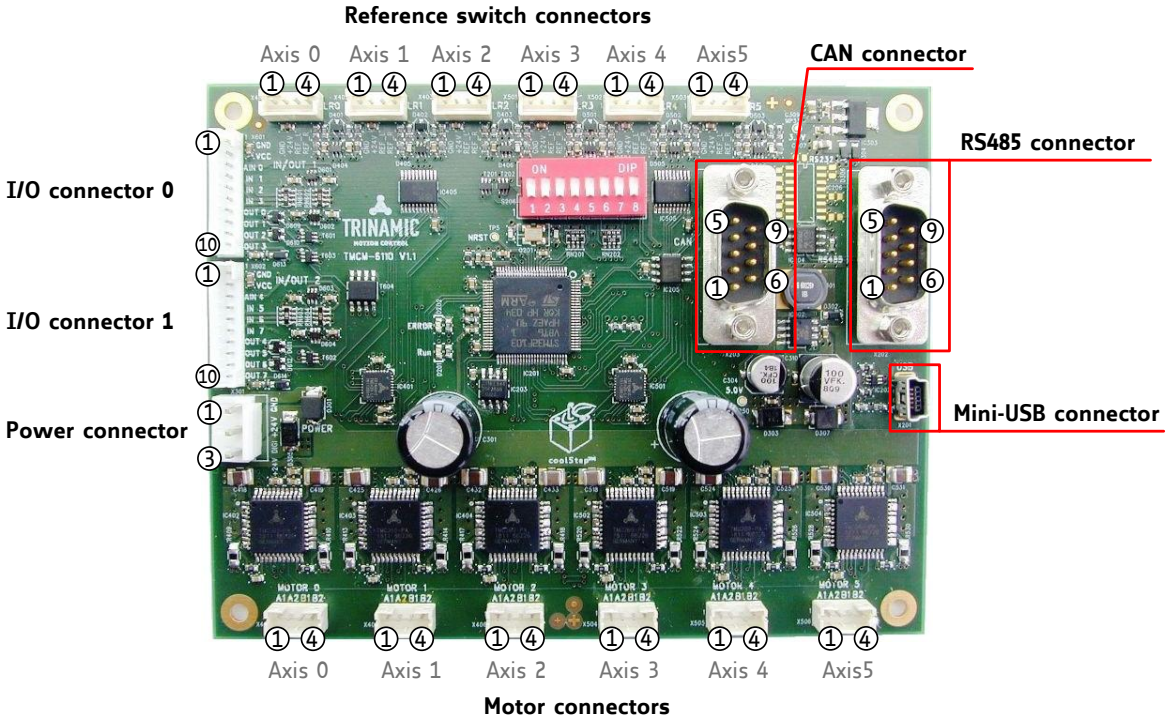


Figure 3.3 TMCM-6110 connectors

OVERVIEW OF CONNECTOR AND MATING CONNECTOR TYPES

Label	Connector type	Mating connector type
Power Connector	JST B3P-VH (JST VH series, 3pins, 3.96mm pitch)	Connector housing: JST VHR-3N Contacts: JST SVH-21T-P1.1 Wire: 0.83mm², AWG 18
Motor Connectors	CI0104P1VK0-LF CVIlux CI01 series, 4 pins, 2mm pitch	Connector housing CVIlux: CI01045000-A Contacts CVIlux: CI01T011PE0-A *or* Connector housing JST: PHR-4 Contacts JST: SPH-002T-P0.5S Wire: 0.22mm²
Reference Switch Connectors	CI0104P1VK0-LF CVIlux CI01 series, 4 pins, 2mm pitch	Connector housing CVIlux: CI01045000-A Contacts CVIlux: CI01T011PE0-A *or* Connector housing JST: PHR-4 Contacts JST: SPH-002T-P0.5S Wire: 0.22mm²
I/O Connector 0 + 1	CI01010P1VK0-LF CVIlux CI01 series, 10 pins, 2mm pitch	Connector housing CVIlux: CI010105000-A Contacts CVIlux: CI01T011PE0-A *or* Connector housing JST: PHR-10 Contacts JST: SPH-002T-P0.5S Wire: 0.22mm²
Mini-USB Connector	Molex 500075-1517 Mini USB Type B vertical receptacle	Any standard mini-USB plug
RS485 Connector	Tyco electronics 3-1634218-2 D-SUB socket with 4-40 female screwlocks	Any standard D-SUB female 9-pin
CAN Connector	Male D-SUB 9-pin	Any standard D-SUB female 9-pin

Table 3.1 Connectors and mating connectors, contacts and applicable wire

3.3.1 Power Connector

The module offers a single power connector with the option to have separate supply for driver electronics and digital controller part. A single supply voltage is sufficient, all further voltages required e.g. for the digital components are generated on-board.



Pin	Label	Direction	Description
1	GND	Power (GND)	Common system supply and signal ground
2	V_{DRIVER}	Power (Supply input)	Stepper driver supply voltage. Without this voltage stepper driver ICs and therefore any motor connected will not be energized
3	$V_{DIGITAL}$	Power (Supply input)	Supply voltage for everything else apart from the stepper motor driver ICs. On-board voltage regulator will generate the necessary voltages for the digital circuits from this supply. This pin can be left unconnected. In this case a diode between V_{DRIVER} and $V_{DIGITAL}$ will ensure supply of the digital parts. *Please note:* - *The diode has a current rating of 3A. As $V_{DIGITAL}$ is available at the I/O connectors and the reference switch connectors also, always connect this pin to positive supply voltage in case substantial amount of current is withdrawn from these pins for external circuits.* - *It is expected that $V_{DIGITAL}$ and V_{DRIVER} are connected to the same power supply output when both pins are used. Otherwise please ensure that $V_{DIGITAL}$ is always equal or higher than V_{DRIVER} when connected (due to the diode).*

Table 3.2 Power connector

3.3.2 I/O Connector 0

The module offers two I/O connectors. The number and type of inputs, outputs and supply is the same for both connectors. Therefore, if only half of the inputs / outputs etc. is required it will be sufficient to use just one of the two connectors and reduce / simplify cabling.



Pin	Label	Direction	Description
1	GND	Power (GND)	GND
2	$V_{DIGITAL}$	Power (Supply output)	Connected to $V_{DIGITAL}$ of Power connector
3	AIN_0	Input	Dedicated analog input, input voltage range: 0... +10V, resolution: 12bit (0... 4095)
4	IN_1	Input	Digital input (+24V compatible) Home switch input for motor 0
5	IN_2	Input	Digital input (+24V compatible) Home switch input for motor 1
6	IN_3	Input	Digital input (+24V compatible) Home switch input for motor 2
7	OUT_0	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
8	OUT_1	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
9	OUT_2	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
10	OUT_3	Output	Open-drain output (max. 1A) Integrated freewheeling diode

Table 3.3 I/O connector 0

3.3.3 I/O Connector 1

The module offers two I/O connectors. The number and type of inputs, outputs and supply is the same for both connectors. Therefore, if only half of the inputs / outputs etc. is required it will be sufficient to use just one of the two connectors and reduce / simplify cabling.



Pin	Label	Direction	Description
1	GND	Power (GND)	GND
2	$V_{DIGITAL}$	Power (Supply output)	Connected to $V_{DIGITAL}$ of Power connector
3	AIN_4	Input	Dedicated analog input, input voltage range: 0... +10V, resolution: 12bit (0... 4095)
4	IN_5	Input	Digital input (+24V compatible) Home switch input for motor 3
5	IN_6	Input	Digital input (+24V compatible) Home switch input for motor 4
6	IN_7	Input	Digital input (+24V compatible) Home switch input for motor 5
7	OUT_4	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
8	OUT_5	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
9	OUT_6	Output	Open-drain output (max. 100mA) Integrated freewheeling diode
10	OUT_7	Output	Open-drain output (max. 1A) Integrated freewheeling diode

Table 3.4 I/O connector 1

3.3.4 Motor Connector 0-5

For each stepper motor axis a separate 4 pin connector is available.



Pin	Label	Direction	Description
1	A1	Output	Pin 1 of motor coil A
2	A2	Output	Pin 2 of motor coil A
3	B1	Output	Pin 1 of motor coil B
4	B2	Output	Pin 2 of motor coil B

Table 3.5 Motor connector

3.3.5 Reference Switch Connector 0-5

For each stepper motor axis a separate reference / limit switch input connector is available.



Pin	Label	Direction	Description
1	GND	Power (GND)	Signal and system ground
2	$V_{DIGITAL}$	Power (Supply output)	Connected to $V_{DIGITAL}$
3	REF_L	Input	Input for reference / limit switch left
4	REF_R	Input	Input for reference / limit switch right

Table 3.6 Reference switch connector

3.3.6 CAN Connector

A CAN 2.0B interface is available via a standard 9-pin male D-SUB connector. Only three pins of this connector are used. Pin assignment of these three pins is according to CiA Draft Recommendation Part 1: cabling and connector pin assignment.

CAN interface will be de-activated in case USB is connected due to internal sharing of hardware resources.



Pin	Label	Direction	Description
1			
2	CAN_L	Bi-directional	Differential CAN bus signal (inverting)
3	GND	Power (GND)	Signal and system ground
4			
5			
6			
7	CAN_H	Bi-directional	Differential CAN bus signal (non-inverting)
8			
9			

Table 3.7 CAN connector

3.3.7 RS485 Connector

An RS485 interface is available via a 9-pin male D-SUB connector.



Pin	Label	Direction	Description
1			
2	RS485-	Bi-directional	Differential RS485 bus signal (inverting)
3	GND	Power (GND)	Signal and system ground
4			
5			
6			
7	RS485+	Bi-directional	Differential RS485 bus signal (non-inverting)
8			
9			

Table 3.8 RS485 connector

3.3.8 USB Connector

A USB interface is available via a Mini-USB connector. This module supports USB 2.0 Full-Speed (12Mbit/s) connections.

CAN interface will be deactivated as soon as USB is connected (VBUS voltage available)

On-board digital core logic (mainly processor and EEPROM) will be powered via USB in case no other supply is connected. This can be used to set parameters / download TMCL programs or perform firmware updates with the module connected via USB only or inside the machine while the machine is powered off.



Pin	Label	Direction	Description
1	VBUS	Power (+5V input)	+5V supply from Host
2	D-	Bi-directional	USB Data -
3	D+	Bi-directional	USB Data +
4	ID		Connected to signal and system ground
5	GND	Power (GND)	Signal and System ground

Table 3.9 USB connector

3.4 Power Supply

For proper operation care has to be taken with regard to power supply concept and design. The board offers 2000uF / 35V electrolytic buffer capacitors and additionally about 120uF / 35V ceramic capacitors for supply voltage filtering.

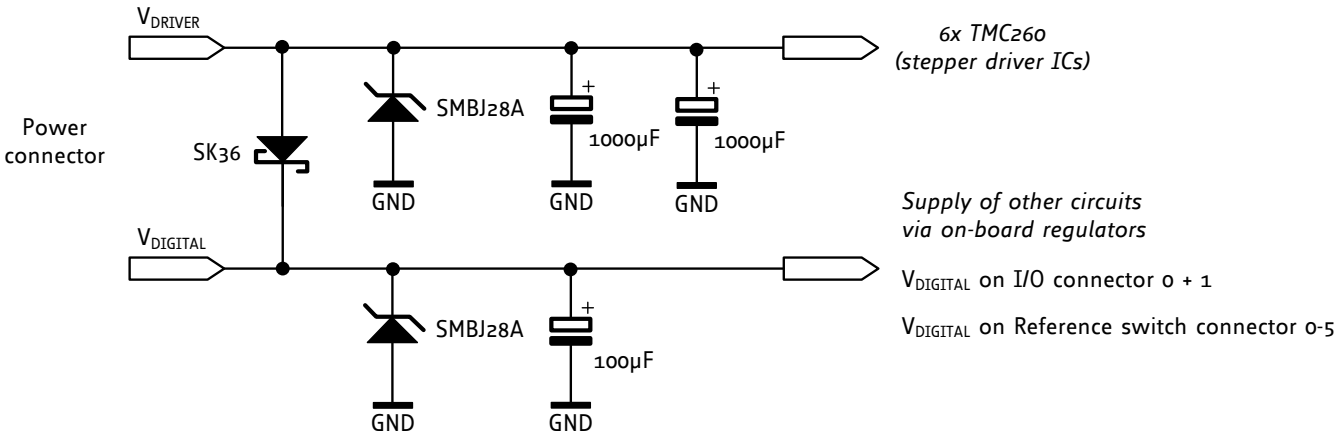


Figure 3.4 TMCM-6110 power supply concept

HINTS FOR POWER SUPPLY

- keep power supply cables as short as possible
- use large diameters for power supply cables

CAUTION!

	***Do not connect or disconnect motor during operation!*** 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 disconnect power supply before connecting / disconnecting the motor.
	***Keep the power supply voltage (V_{DRIVER} and $V_{DIGITAL}$) below the upper limit of 28V!*** Otherwise the driver electronics will seriously be damaged! Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended. Please refer to chapter 0 (operating values).
	***There is no reverse polarity protection!*** The module will short any reversed supply voltage due to internal diodes of the driver transistors.

3.5 Communication

3.5.1 RS485

For remote control and communication with a host system the TMCM-6110 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.

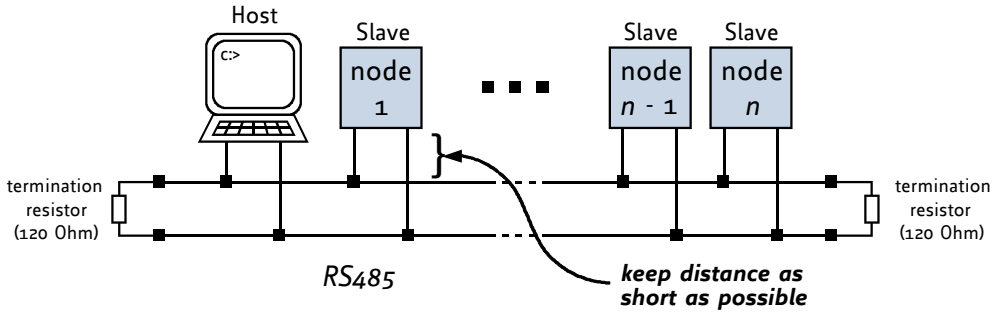


Figure 3.3: Bus structure

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-6110 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 transceiver used on the TMCM-6110 (SN65HVD3082ED) has a significantly reduced bus load and allows 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-6110 is 115200 bit/s. Factory default is 9600 bit/s. *Please see separate TMCM-6110 TMCL firmware manual for information regarding other possible communication speeds.*

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):

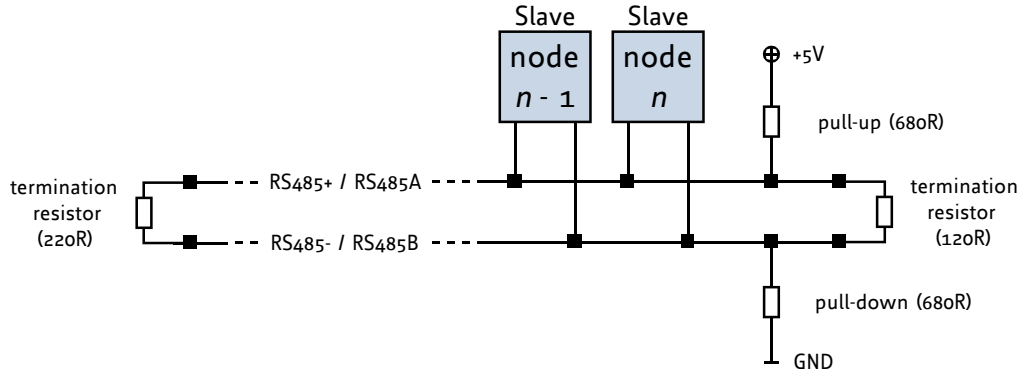


Figure 3.4: Bus lines with resistor (Bias) network on one side, only

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

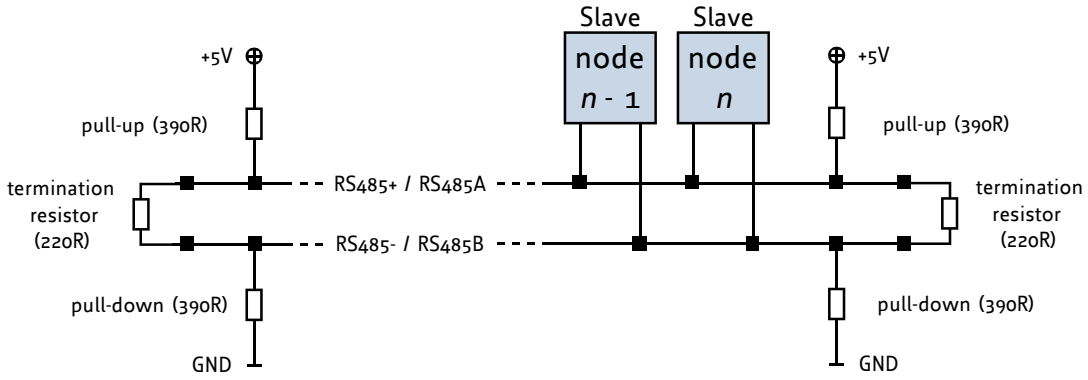


Figure 3.5: Bus lines with resistor (Bias) network at both ends

3.5.2 CAN

For remote control and communication with a host system the TMCM-6110 provides a CAN bus interface. Please note that the CAN interface is not available in case USB is connected. 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.

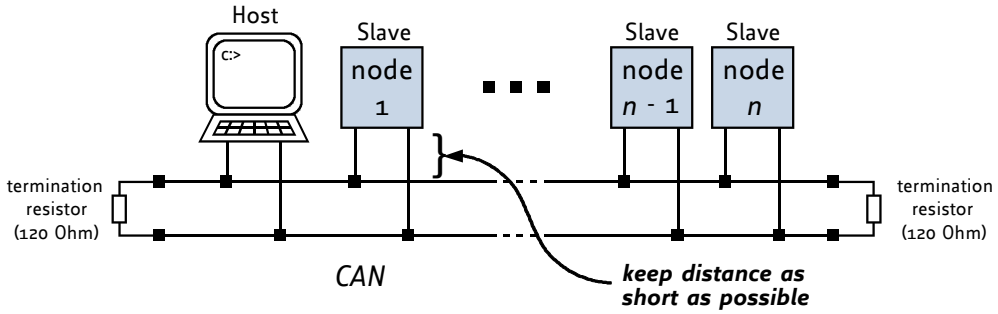


Figure 3.7 CAN bus structure

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-6110 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 bus transceiver used on the TMCM-6110 units (TJA1050T) supports at least 110 nodes under optimum conditions. Practically achievable number of nodes per CAN bus highly depends on bus length (longer bus -> less nodes) and communication speed (higher speed -> less nodes).

3.5.3 USB

For remote control and communication with a host system the TMCM-6110 provides a USB 2.0 full-speed (12Mbit/s) interface (mini-USB connector). As soon as a USB-Host is connected the module will accept commands via USB. The CAN interface will be de-activated then.
The TMCM-6110 support USB self powered operation (when an external power is supplied via the power supply connector) and USB bus powered operation, also (no external power supply via power supply connector). During USB bus powered operation, only the core digital circuit parts will be operational. That is, the microcontroller itself and also the EEPROM. Motor movements will not be possible. This mode has been implemented in order to enable configuration / parameter setting / read-out, firmware updates etc. by just

connecting a USB cable between the module and a host PC. No additional cabling / external devices as e.g. power supply etc. are required in that case.

Please note that the module might draw current from the USB +5V bus supply even in USB self powered operation depending on the voltage level of this supply.

3.6 Inputs and Outputs

3.6.1 Reference Switch Inputs

The six reference switch connectors – one for each stepper motor axis – offer two reference switch inputs each, REF_L and REF_R.
Both inputs offer the same input circuit with voltage resistor dividers, limiting diodes against over- and under-voltage and programmable 1k pull-ups to +5V. The programmable pull-ups can be switched on or off separately for the first three axes / first three reference switch connectors 0-2 and the second three axes / reference switch connectors 3-5.

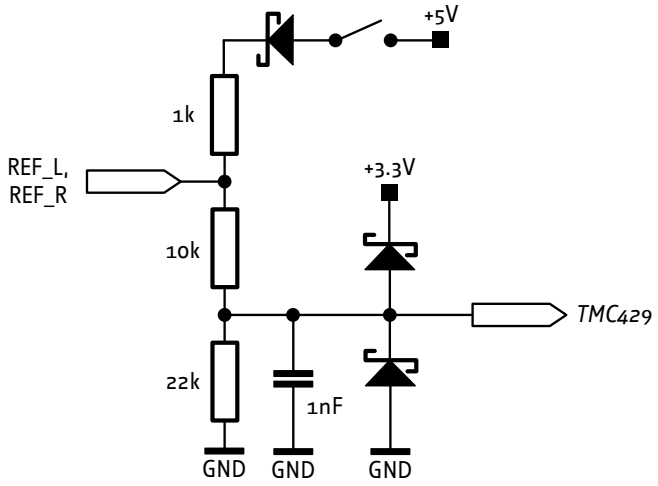


Figure 3.8 Reference switch input circuit (simplified diagram)

With TMCL firmware commands GAP 10, 0 and GAP 11, 0 can be used to read out the status of the reference switch inputs. See *TMCL Firmware Manual* chapter 5 about *Axis parameters* and *Reference search* for more details.

3.6.2 General Purpose Inputs

The TMCM-6110 offers two I/O connectors with 8 inputs altogether including two dedicated analog inputs. All inputs offer the same basic input protection circuit. The dedicated analog inputs have different input voltage dividers in order to support a full scale input voltage range of 0…+10V. The other digital inputs have been designed in order to be able to accept +5V and +24V signal levels.

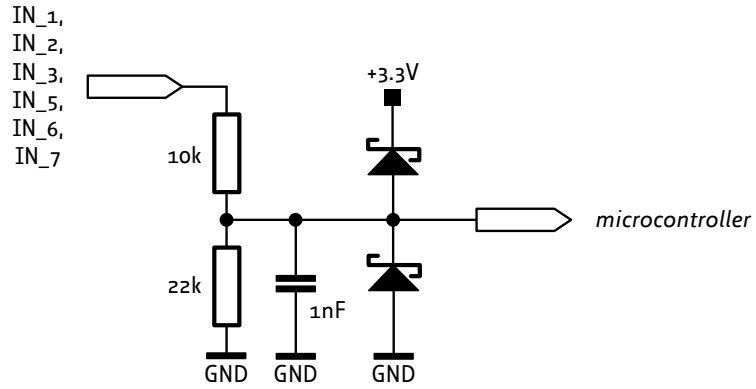


Figure 3.9 General purpose digital input circuit

With TMCL firmware command GIO <*n*>, *0* can be used to read out the status of the digital input <*n*>. See *TMCL Firmware Manual* command GIO for more details.

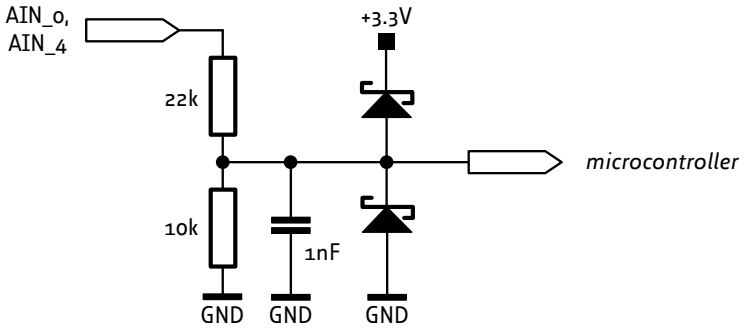


Figure 3.10 General purpose analog input circuit

With TMCL firmware command GIO *<n>*, *1* can be used to read out the analog / digital converted value of the analog input *<n>*. See *TMCL Firmware Manual* command GIO for more details.

The function of the inputs might differ depending on firmware version.

3.6.3 General Purpose Outputs

The TMCM-6110 offers two I/O connectors with 8 outputs altogether. All outputs are open-drain outputs. For all outputs a freewheeling diode (to V_{DIGTAL}) is already integrated.
Nevertheless, two output offer more powerful MOSFET driver transistors supporting currents up to 1A. All other have been designed for currents up to 100mA.

If $V_{DIGITAL}$ connection of the I/O connectors is used for supply of substantial current to any external circuit please make sure to connect $V_{DIGTIAL}$ in addition to V_{DRIVER} of the power supply connector.

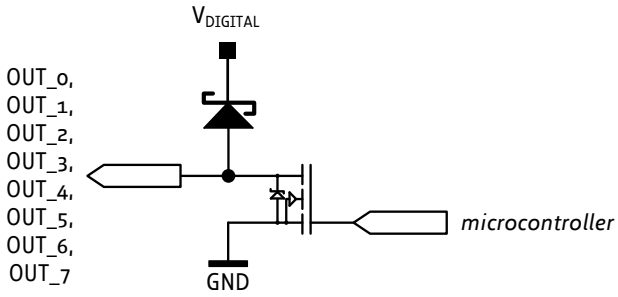


Figure 3.11 General purpose output (open-drain with freewheeling diode)

With TMCL firmware command SIO *<n>*, *2*, *1* can be used to set / pull-down the output *<n>*. See *TMCL Firmware Manual* command SIO for more details.

4 Motor driver current

The on-board stepper motor driver operates current controlled. The driver current may be programmed in software for motor coil currents up-to 1.1A RMS with 32 effective scaling steps in hardware (CS in table below).

Explanation of different columns in table below:

Motor current setting in software (TMCL) These are the values for TMCL axis parameter 6 (motor run current) and 7 (motor standby current). They are used to set the run / standby current using the following TMCL commands:

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

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

(read-out value with `GAP` instead of `SAP`. Please see separate TMCM-6110 firmware manual for further information)

Motor current I_{RMS} [A] Resulting motor current based on motor current setting

Motor current setting in software (TMCL)	Current scaling step (CS)	Motor current $I_{COIL\ PEAK}$ [A]	Motor current $I_{COIL\ RMS}$ [A]
0..7	0	0.052	0.036
8..15	1	0.103	0.073
16..23	2	0.155	0.109
24..31	3	0.206	0.146
32..39	4	0.258	0.182
40..47	5	0.309	0.219
48..55	6	0.361	0.255
56..63	7	0.413	0.292
64..71	8	0.464	0.328
72..79	9	0.516	0.365
80..87	10	0.567	0.401
88..95	11	0.619	0.438
96..103	12	0.670	0.474
104..111	13	0.722	0.510
112..119	14	0.773	0.547
120..127	15	0.825	0.583
128..135	16	0.877	0.620
136..143	17	0.928	0.656
144..151	18	0.980	0.693
152..159	19	1.031	0.729
160..167	20	1.083	0.766
168..175	21	1.134	0.802
176..183	22	1.186	0.839
184..191	23	1.238	0.875
192..199	24	1.289	0.912
200..207	25	1.341	0.948
208..215	26	1.392	0.984
216..223	27	1.444	1.021
224..231	28	1.495	1.057
232..239	29	1.547	1.094
240..247	30	1.598	1.130
248..255	31	1.650	1.167

In addition to the settings in the table the motor current may be switched off completely (free-wheeling) using axis parameter 204 (see TMCM-6110 firmware manual).

5 On-board LEDs

The board offers two LEDs in order to indicate board status. The function of both LEDs is dependent on firmware version.

With standard TMCL firmware the green LED should be slowly flashing during operation and the red LED should be off. Please see separate TMCM-6110 TMCL firmware manual for additional information.

When there is no valid firmware programmed into the board or during firmware update the red and green LEDs are permanently on.

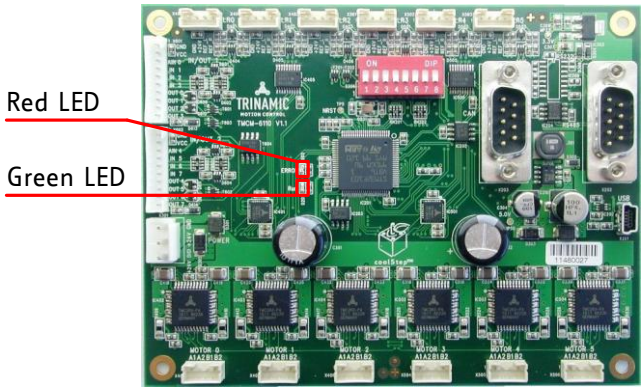


Figure 5.1 On-board LEDs

6 Reset to Factory Defaults

Since TMCL firmware version V1.13 it is possible to reset the TMCM-6110 module to factory default settings without establishing a communication link. This might be helpful in case communication parameters of the preferred interface have been set to unknown values or got accidentally lost.

PERFORM THE FOLLOWING STEPS:

1. Power supply off and USB cable disconnected
2. Short two pads as marked in Figure 6.1.
3. Power up board (power via USB is sufficient for this purpose)
4. Wait until the on-board red and green LEDs start flashing fast (this might take a while)
5. Power-off board (disconnect USB cable)
6. Remove short between pads
7. After switching on power-supply / connecting USB cable all permanent settings have been restored to factory defaults

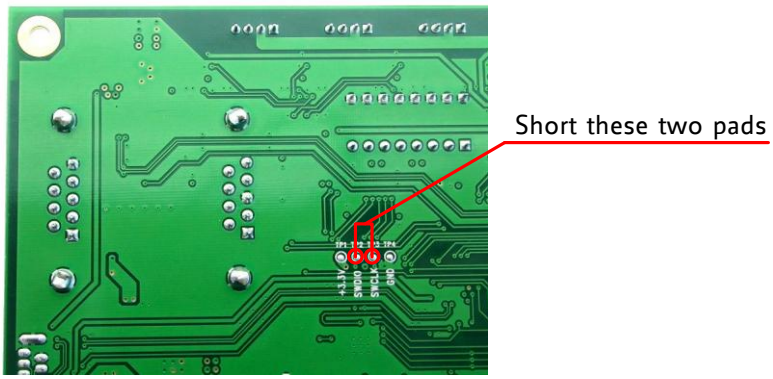


Figure 6.1 Reset to factory default settings

7 Functional Description

The TMCM-6110 is a highly integrated 6-axes controller / driver module. The TMCM-6110 can be controlled via CAN, RS485 or USB serial interfaces. The TMCM-6110 comes with the PC based software development environment TMCL-IDE for the Trinamic Motion Control Language (TMCL). Using predefined TMCL high level commands like *move to position* a rapid and fast development of motion control applications is guaranteed. Communication traffic is kept low since all time critical operations, e.g. ramp calculation are performed on board. Full remote control of device with feedback is possible. The firmware of the module can be updated via any of the serial interfaces.

The TMCM-6110 module contains the following main components (see figure below, also):

- Microcontroller running at 72MHz
- 16Kbytes EEPROM for storing configuration parameters and TMCL program storage (up to 2048 TMCL commands)
- 2x TMC429 [TMC429] highly integrated 3 axes stepper motor controller
- 6x TMC260 [TMC260] advanced stepper motor driver IC with stallGuard2™ and coolStep™ with integrated MOSFET driver transistors
- RS485, CAN and USB transceivers
- On-board switching and linear voltage regulators for supply of on-board digital circuits

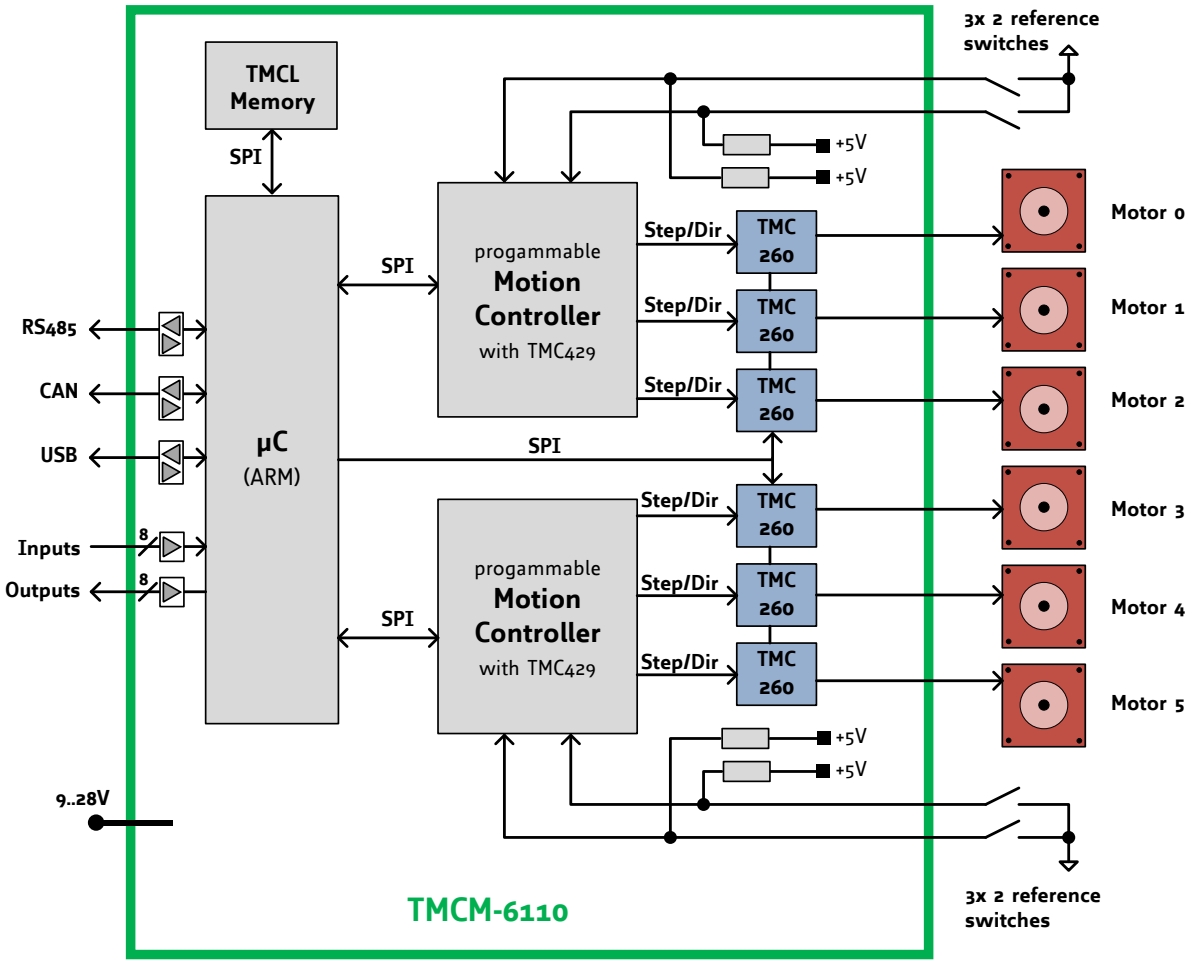


Figure 7.1: TMCM-6110 block diagram

Please refer to the TMCM-6110 Firmware Manual for more information about TMCL commands.

8 Using the RS232 assembly option instead of RS485

The TMCM-6110 V1.1 offers an RS232 interface as assembly option instead of the RS485 interface (default). As the RS232 interface is available upon request, only, this chapter describes how to modify the standard (RS485) version in order to use the RS232 interface. This modification is suitable for prototypes, only.

Please note: this modification is on your own risk and will void the warranty!

Remove (red cross in pcb assembly drawing):

- IC204 (RS485 transceiver)
- R215

Assemble (marked green in pcb assembly drawing)

- IC206 (SP202EEN or pin compatible e.g. MAX202I, RS232 transceiver)
- R214 (0603/1k/1%)
- C217, C218, C219, C220, C221 (0603/100nF/50V)

  Remark: some of the 0603 components may be already assembled

The RS232 assembly option expects a female 9pin D-SUB connector to be assembled instead of the male connector (X202) which is used for the RS485 option. This way the RS232 pin assignment will be correct and the RS232 female connector can be directly connected to the RS232 male connector of a PC etc.

Nevetheless, removing the male D-SUB connector in order to replace it with the female counterpart is not recommended as this might seriously damage the pcb. Instead an adapter cable might be made for prototypes.

The TMCM-6110 supports RS232 connections without flow control in hardware. Therefore, just 3 wire/signal connections have to be made: TxD, RxD and GND

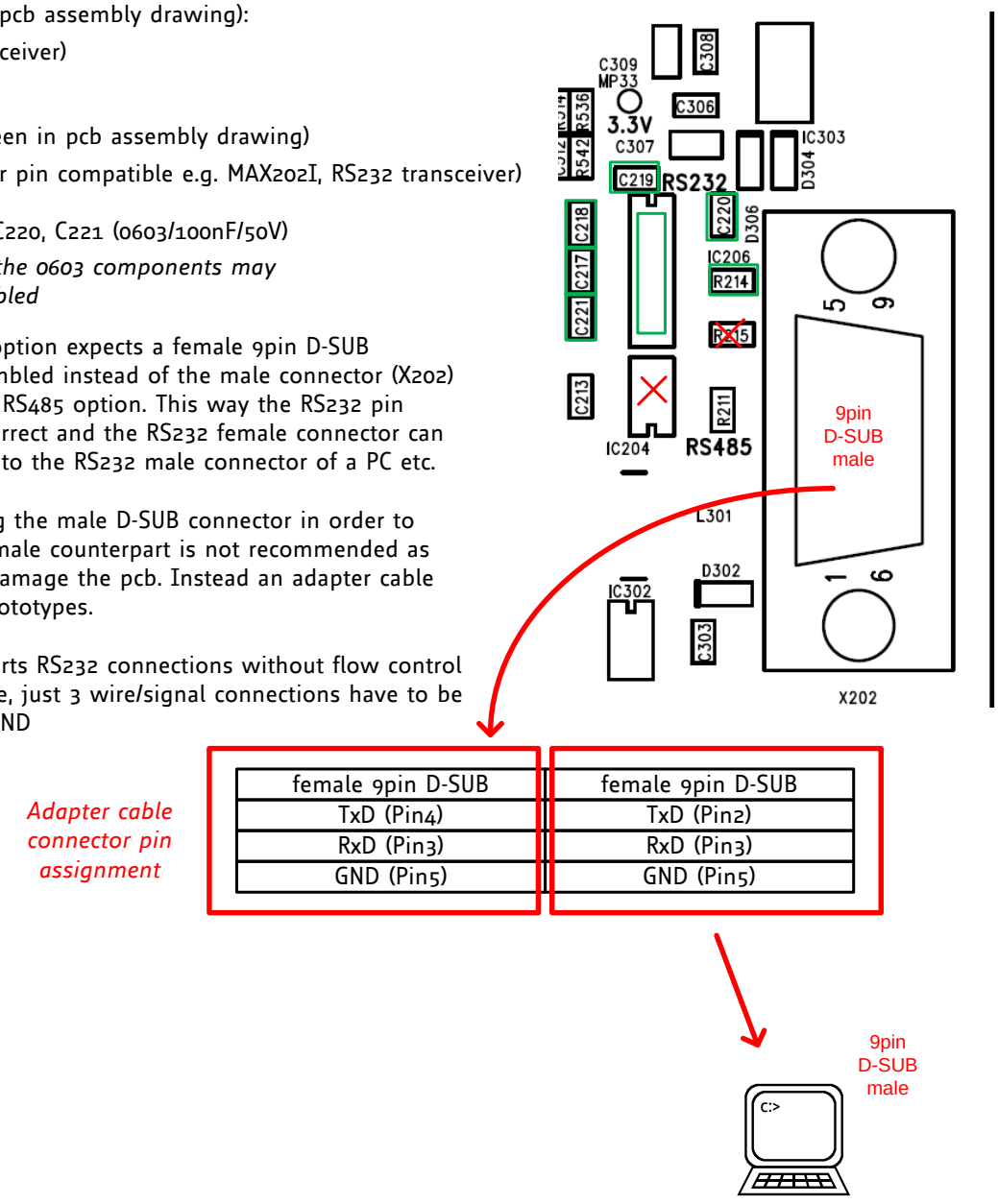


Figure 8.1: Using the RS232 assembly option instead of RS485

9 Position of connectors

The TMCM-6110 V1.1 offers several connectors of different type and pin count. The position of the connectors (pin1 of each connector) relative to pcb bottom-left is shown in the following drawing:

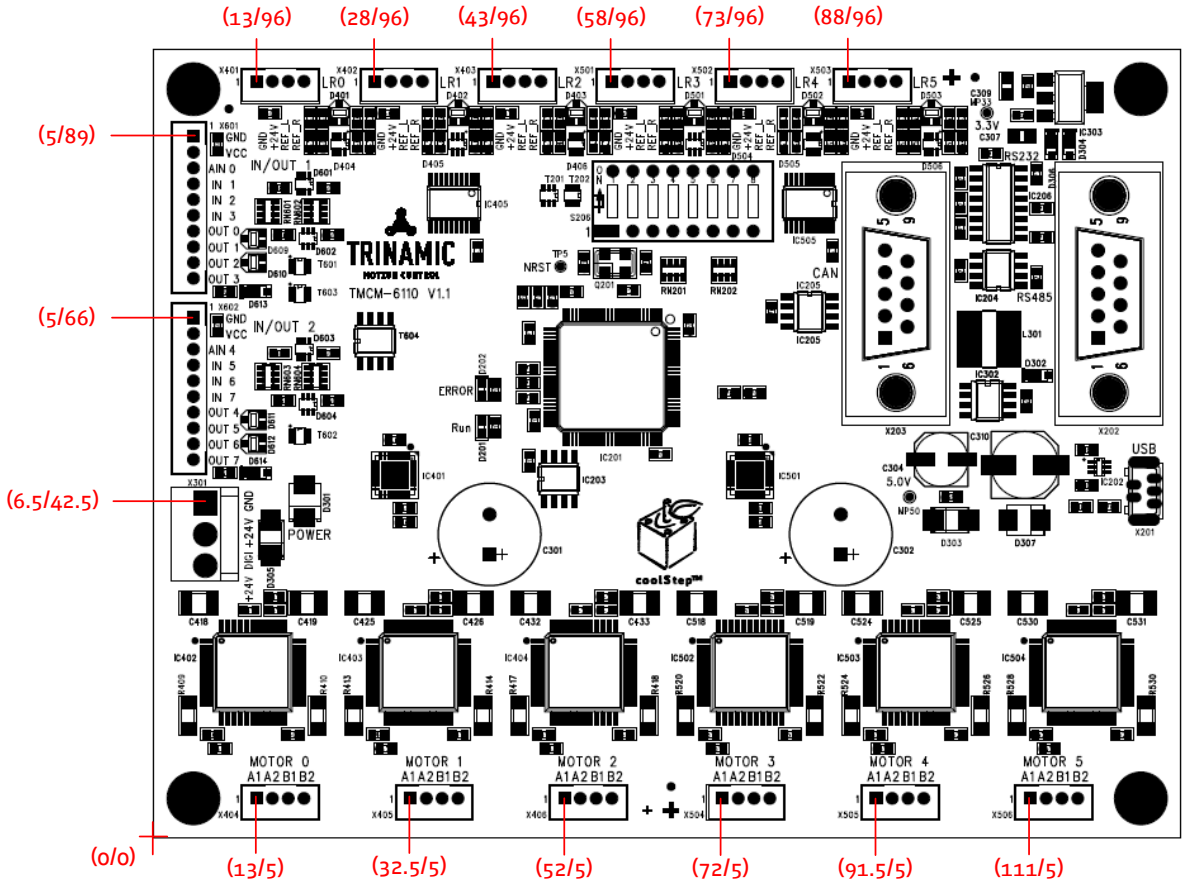


Figure 9.1: position of connectors

10 Operational Ratings

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

In no case shall the maximum values be exceeded.

GENERAL OPERATIONAL RATINGS

Symbol	Parameter	Min	Typ	Max	Unit
V_{DRIVER}	Power supply voltage for driver	9	12 ... 24	28	V
$V_{DIGITAL}$	Power supply voltage for controller (option, can be left unconnected)	V_{DRIVER}			V
V_{USB}	Power supply via USB connector		5		V
I_{USB}	Current withdrawn from USB supply when USB bus powered (no other supply connected)		85		mA
I_{COIL}	Motor coil current for sine wave **peak** (chopper regulated, adjustable via software)	0		1600	mA
I_{MC}	Continuous motor current (**RMS**)	0		1100	mA
I_S	Power supply current		<< 6x I_{COIL}	1.4x 6x I_{COIL}	A
T_{ENV}	Environmental temperature at maximum current (all six axes, no forced cooling)	-34*)		60	°C

Table 10.1 General operational ratings of the module

*) limited by test equipment. Includes power-up / cold start at this temperature. It can be expected that the module will work down to -40°C.

OPERATIONAL RATINGS OF REFERENCE SWITCH INPUTS

Symbol	Parameter	Min	Typ	Max	Unit
$V_{REF_L/R}$	Input voltage for reference switch inputs REF_L / REF_R	0		28	V
I_{REF_L/R_L}	Low level voltage for reference switch inputs REF_L / REF_R	0		1.1	V
I_{REF_L/R_H}	High level voltage for reference switch inputs REF_L / REF_R	2.9		28	V

Table 10.2 Operational ratings of the reference switch inputs

OPERATIONAL RATINGS OF MULTIPURPOSE I/OS

Symbol	Parameter	Min	Typ	Max	Unit
$V_{OUT_0..7}$	Voltage at open collector output	0		$V_{DIGITAL}$	V
$I_{OUT_0/1/2/4/5/6}$	Output sink current for OUT_0/1/2 and OUT_4/5/6			100	mA
$I_{OUT_3/7}$	Output sink current for OUT_3 and OUT_7			1	A
$V_{IN_\ 1/2/3/5/6/7}$	Input voltage for general purpose digital inputs IN_1/2/3 and IN_5/6/7	0		28	V
$V_{IN_1/1/2/3/5/6/7_L}$	Low level voltage for general purpose digital inputs IN_1/2/3 and IN_5/6/7	0		1.1	V
$V_{IN_1/2/3/5/6/7_H}$	High level voltage for general purpose digital inputs IN_1/2/3 and IN_5/6/7	2.9		28	V
$V_{AIN_0!4}$	Full scale input voltage range for analog voltage inputs	0		10	V

Table 10.3 Operational ratings of the general purpose I/Os

OPERATIONAL RATINGS OF RS485 INTERFACE

Symbol	Parameter	Min	Typ	Max	Unit
N_{RS485}	Number of nodes connected to single RS485 network			256	
f_{RS485}	Maximum bit rate supported on RS485 connection		9600	115200	bit/s

Table 10.4 Operational ratings of the RS485 interface

OPERATIONAL RATINGS OF CAN INTERFACE

Symbol	Parameter	Min	Typ	Max	Unit
N_{CAN}	Number of nodes connected to single RS485 network			> 110	
f_{CAN}	Maximum bit rate supported on CAN connection		1000	1000	kbit/s

Table 10.4 Operational ratings of the CAN interface

11 Life Support Policy

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12 Revision History

12.1 Document Revision

Version	Date	Author	Description
0.90	2011-AUG-17	GE	Preliminary version
1.00	2011-SEP-13	SD	First complete version, minor changes
1.01	2011-NOV-11	SD	Minor changes, T_{ENV} in chapter 0 added.
1.10	2012-JAN-25	GE	- DIN rail mounting option added - Basic description of on-board LEDs - Reset to factory default in hardware added - Lower environmental operating temperature added
1.11	2012-DEC-20	SD	Changes related to wording and design.
1.12	2013-JUL-22	SD	- Connector description updated - Information about power supply updated
1.13	2014-FEB-21	SD	- Reference switch connector 1-5: direction of pin 2 corrected. - I/O connector description updated.
1.14	2014-DEC-10	GE	- Chapter 7, *Using the RS232 assembly option instead of RS485* added - Chapter 8, *Position of connectors* added - Minor corrections / additions

Figure 12.1 Document revision

12.2 Hardware Revision

Version	Date	Description
TMCM-6110_V10	2011-MAY-12	Initial version
TMCM-6110_V11	2011-AUG-02	Several corrections and enhancement: - Corrected / modified clock concept - Connection of reference switch corrected - 8x DIP switch THT instead of 4x SMT - Separate power supplies for driver stage and other electronic

Figure 12.2 Hardware revision

13 References

[JST] JST connector
http://www.jst.com

[USB-2-485] USB-2-485 interface converter
Manual available on http://www.trinamic.com

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