# TMCM-6214 Hardware Manual

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The TMCM-6214 is a 6-axes motor controller/driver board for 2-phase bipolar stepper motors with up-to 1.9A RMS motor current and +24V supply. The motion controllers support 6-point ramps in addition to linear ramps in hardware. 3 encoder inputs for incremental a/b/n encoders are included. For communication either CAN, RS485, RS232 or USB may be selected. In addition, there are 6 general purpose digital inputs, 2 analog inputs and 8 general purpose outputs (protected). Two STO inputs are available together with an intergated power supply switch for the driver supply.
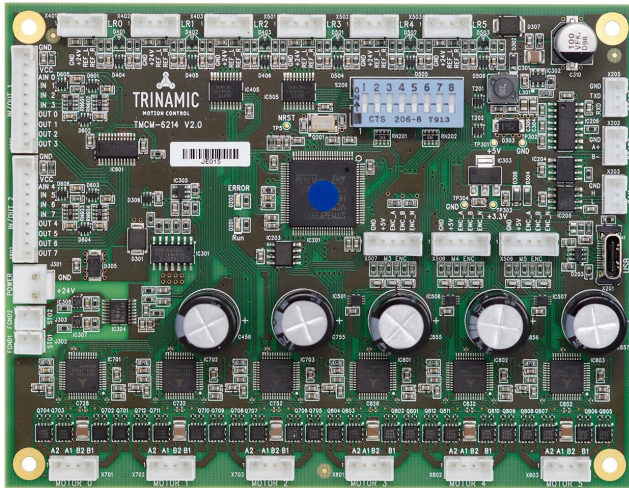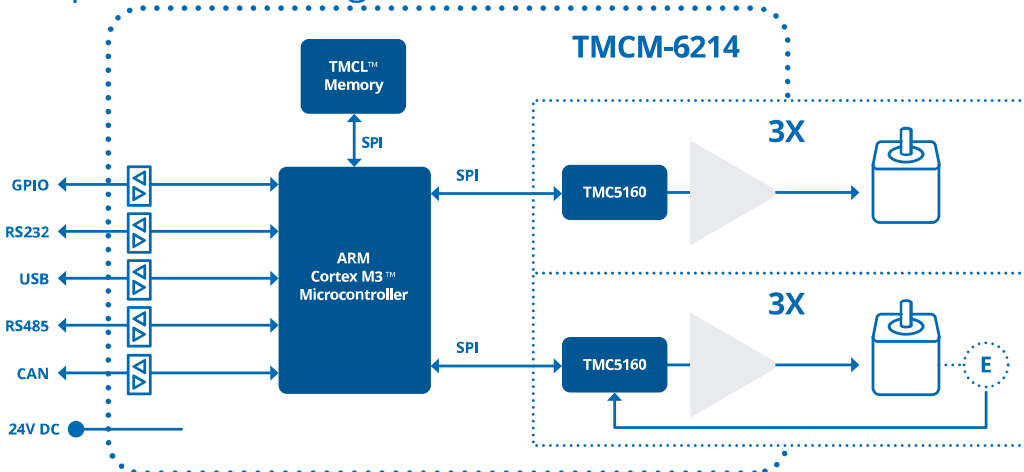
Features

- 6-axes controller/driver for 2-phase bipolar stepper motors
- Linear and SixPoint™ ramps
- +9…30V DC supply voltage
- Up to 1.9A RMS motor current
- RS485, CAN, RS232 & USB interfaces
- 3x A/B/N encoder inputs
- multi-purpose inputs and outputs (protected)
- STO with integrated power switch for the driver supply

Applications

- Laboratory Automation
- Manufacturing
- Semiconductor Handling
- Robotics
- Factory Automation
- Test & Measurement
- Life Science
- Biotechnology
- Liquid Handling

Simplified Block Diagram

Read entire documentation.

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Contents

1 Features

The TMCM-6214 is a 6-axis motor controller/driver board for 2-phase bipolar stepper motors with up to 2A RMS (2.8A peak) motor coil current and +24V nominal supply. It supports linear ramps and unique SixPoint™ ramps. Each motor axis has its own reference / stop switch input connector. Three axes (axis 3…5) offer encoder interfaces for incremental A/B/N encoders (either TTL +5V signals or open-drain outputs). For communication CAN, RS485, RS232 or USB may be used. There are six general purpose digital inputs, two analog inputs and eight outputs (open-drain, protected) available. Two isolated STO inputs are available. The TMCM-6214 offers an on-board smart high-side power switch for the driver supply voltage. The TMCM-6214 is available with standard TMCL™ or CANopen® firmware (supported via the CAN interface).

Motion Controller

- Motion profile calculation in real-time.

- On the fly alteration of motor parameters (e.g. position, velocity, acceleration).

- Linear and unique SixPoint™ ramp in hardware.

- Encoder interface (axis 3…5) and reference / stop switch inputs (axis 0…5).

Driver

- Motor current: up to 1.9A RMS (2.7A peak, programmable in software).

- Supply voltage: +24V DC (+10…+30V DC).

- 256 microsteps per fullstep.

- SpreadCycle™ highly dynamic current control chopper.

- StealthChop™ for quiet operation and smooth motion.

Encoder

- Programmable encoder scaling and support for motor stop on encoder deviation.

STO

- Two STO isolated inputs.

- On-board power switch for driver supply switching (smart high-side power switch).

- Driver enable in hardware.

- Driver current (sum of all six axes) and driver supply voltage can be measured.

Interfaces

- RS485 interface (up to 1Mbit/s).

- RS232 interface (up to 115200 bit/s).

- CAN interface (up to 1Mbit/s).

- USB 2.0 full speed (12Mbit/s) device interface (USB-C connector).

- Left and right stop switch inputs (switchable internal pull-ups to +5V, separate connector for each axis).

- Six general purpose digital inputs.

- Two analog inputs (nominal input range selectable: 0. . . 10V, 0. . . 20V or -10. . . +10V).

- Eight outputs (open-drain, protected).

- Three encoder inputs for incremental A/B/N encoder signals (axis 3. . . 5).

- Two STO inputs.

Mechanical data

- Board size: 130mm x 100mm, height 20mm max. without mating connectors

- 4 mounting holes for M3 screws

Software

- TMCL™ remote (direct mode) and standalone operation (memory for up to 2047 TMCL commands), fully supported by TMCL-IDE (PC based integrated development environment). Please see the TMCM-6214 TMCL firmware manual for more details

- CANopen® firmware with CANopen® standard protocol stack for the CAN interface. Please see the TMCM-6214 CANopen® firmware manual for more details.

2 Order Codes

The TMCM-6214 is pre-programmed with either TMCL™ firmware or CANopen® firmware.

Order Code	Description	Size (LxWxH)
TMCM-6214-TMCL	6-axes bipolar stepper motor controller/driver, up-to 2A RMS motor current, 24V nom. supply, 3x encoder inputs, 2 analog inputs, 6 digital inputs, 8 OD outputs, CAN, RS485, RS232 and USB interfaces, STO, TMCL	130mm x 100mm x 20mm
TMCM-6214-CANopen	6-axes bipolar stepper motor controller/driver, up-to 2A RMS motor current, 24V nom. supply, 3x encoder inputs, 2 analog inputs, 6 digital inputs, 8 OD outputs, CAN, RS485, RS232 and USB interfaces, STO, CANopen	130mm x 100mm x 20mm

Table 1: TMCM-6214 Order Codes

A cable loom set is available for this module:

Order Code	Description
TMCM-6214-CABLE	Cable loom for TMCM-6214: • 1x cable loom for power supply connector (cable length 200mm, 2pin JST VH connector at one end, open wires at the other end) • 2x cable loom for STO connectors (cable length 200mm, 2pin JST PH connector at one end, open wires at the other end) • 3x cable loom for RS485, RS232 and CAN connector (cable length 200mm, 3pin JST PH connector at one end, open wires at the other end) • 6x cable loom for motor connectors (cable length 200mm, 4pin JST PH connector at one end, open wires at the other end) • 6x cable loom for stop switch connectors (cable length 200mm, 4pin JST PH connector at one end, open wires at the other end) • 3x cable loom for encoder connectors (cable length 200mm, 5pin JST PH connector at one end, open wires at the other end) • 2x cable loom for general purpose input/output connectors (cable length 200mm, 10pin JST PH connector at one end, open wires at the other end) • 1x USB 2.0 A male to USB-C male cable

Table 2: TMCM-6214 Cable Loom

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 x 20mm without mating connectors. Maximum component height (height above PCB level) without mating connectors is around 15mm above PCB level and 3 mm below PCB level. There are four mounting holes (3.2mm diameter) for M3 screws.
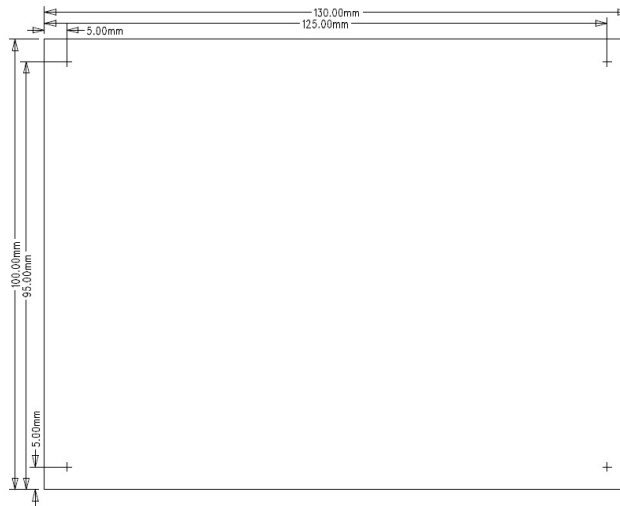
Figure 1: Board dimensions and position of mounting holes (all values in mm)

3.2 Board mounting considerations

The TMCM-6214 offers four metal plated mounting holes. All 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-6214 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 and screws should be used.

4 Connectors

The TMCM-6214 offers 24 connectors altogehter. There are 6 motor connectors and 6 reference / end-switch connectors - one for each axis. The three encoder inputs have separate connectors and for communication via RS485, CAN, RS232 or USB 4 connectors are available. The two STO inputs have individual connectors, also. Apart from the USB connector (USB-C) all these connectors are JST PH series types. For power supply input a 2 pin JST VH series connector is available.

NOTICE	**Start with power supply OFF and do not connect or disconnect motor during operation!** Motor cable and motor inductivity might lead to voltage spikes when the motor is (dis)connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch off / disconnect power supply or at least disable driver stage before connecting / disconnecting motor.
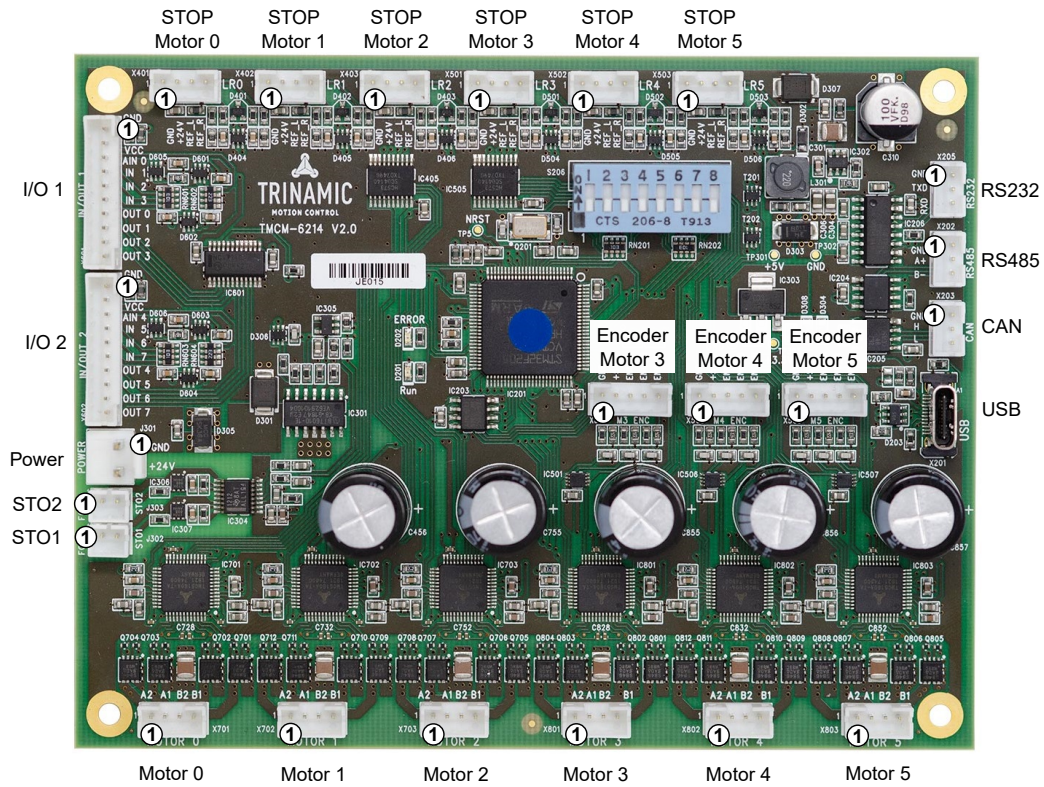
Figure 2: TMCM-6214 connectors

Connector Types and Mating Connectors		
Connector	Connector type on-board	Mating connector type
Power	JST B2P-VH (JST VH series, 2pins, 3.96mm pitch)	Connector housing: JST VHR-2N Contacts: JST SVH-21T-P1.1 Wire: 0.83mm2, AWG 18

Connector	Connector type on-board	Mating connector type
STO	JST B2B-PH-K-S (JST PH series, 2pins, 2mm pitch)	Connector housing: JST PHR-2 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
RS485	JST B3B-PH-K-S (JST PH series, 3pins, 2mm pitch)	Connector housing: JST PHR-3 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
RS232	JST B3B-PH-K-S (JST PH series, 3pins, 2mm pitch)	Connector housing: JST PHR-3 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
CAN	JST B3B-PH-K-S (JST PH series, 3pins, 2mm pitch)	Connector housing: JST PHR-3 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
Motor	JST B4B-PH-K-S (JST PH series, 4pins, 2mm pitch)	Connector housing: JST PHR-4 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
Stop	JST B4B-PH-K-S (JST PH series, 4pins, 2mm pitch)	Connector housing: JST PHR-4 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
Encoder	JST B5B-PH-K-S (JST PH series, 5pins, 2mm pitch)	Connector housing: JST PHR-5 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
I/O	JST B10B-PH-K-S (JST PH series, 10pins, 2mm pitch)	Connector housing: JST PHR-10 Contacts: JST SPH-002T-P0.5S Wire: 0.22mm2, AWG 24
USB	USB-C connector	USB-C connector

Table 3: Connector Types and Mating Connectors of the TMCM-6214

4.1 Power Supply Input Connector

The TMCM-6214 offers one power supply input connector (2pin JST VH series).

Power Supply Connector Pin Assigment			
Pin	Label	Direction	Description
1	GND	Power (GND)	Common system supply and signal ground
2	V$_{POWER}$	Power (input)	Main power supply input for the driver and on-board logic *10…30V*

Table 4: Power Supply Connector Pin Assignment

| NOTICE	**Do not connect or disconnect motor during operation!** Motor cable and motor inductivity might lead to voltage spikes when the motor is (dis)connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch off / disconnect power supply or at least disable driver stage before connecting / disconnecting motor.

NOTICE	**Take care of polarity, wrong polarity can destroy the board!**

NOTICE	The integrated power switch on the TMCM-6214 offers several protection features. Among temperature, overvoltage, undervoltage and short circuit protection it also switches off in case the inrush current is too high. This might be the case when using powerful switching mode power supplies.

In order to limit the start-up current in such a case you may insert for example a 0.5 Ohms resistor in the positive supply connection between the power supply and the TMCM-6214. The power rating of the resistor should be according to the supply current that is expected during normal operation of the TMCM-6214.

In case the power dissipation of the resistor is not acceptable for the application also a more elaborated circuit which usese a MOSFET in analog mode in order to limit the current at start-up can be used. Afterwards the MOSFET will be switched on completely and the power dissipation will be neglegible. Please note that this circuit will not work for very short power-on / off times as a capacitor has to be discharged in-between.
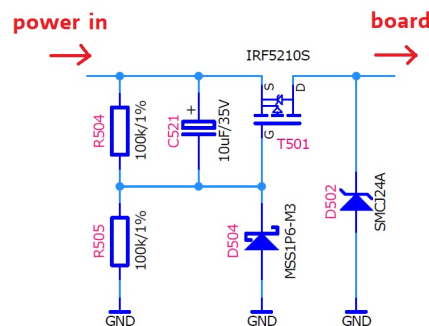
4.2   STO Input Connector

The TMCM-6214 offers two STO (torque-off) input connectors (2pin JST PH series).

	STO1 and STO2 connector pin assignment		
Pin	Label	Direction	Description
1	FGND		STO input ground (isolated from power supply GND)
2	STO1 / STO2	in	STO1 / STO2 +24V input signal

Table 5: STO Connector Pin Assignment

NOTICE	**Both STO inputs have to be connected to positive supply voltage (e.g. 24V, min. 15V) in order to enable all six motor driver stages!** No motor movement will be possible in case one or both of these inputs are left unconnected. If both STO inputs are not in the same state for more than 2.3 seconds the module will lock itself in torque-off mode. This state can only be reset by a power cycle.

4.3   RS485 Connector

The TMCM-6214 offers one RS485 interface connector (3pin JST PH series).

	RS485 connector pin assignment		
Pin	Label	Direction	Description
1	GND		signal ground (connected to power supply GND)
2	RS485+	in-out	differential RS485 bus signal (non-inverting)
3	RS485-	in-out	differential RS485 bus signal (non-inverting)

Table 6: RS485 connector pin assignment

4.4   CAN Connector

The TMCM-6214 offers one CAN interface connector (3pin JST PH series).

	CAN connector pin assignment		
Pin	Label	Direction	Description
1	GND		signal ground (connected to power supply GND)
2	CAN_H	in-out	differential CAN bus signal (non-inverting)
3	CAN_L	in-out	differential CAN bus signal (non-inverting)

Table 7: CAN connector pin assignment

4.5 RS232 Connector

The TMCM-6214 offers one RS232 interface connector (3pin JST PH series).

RS232 connector pin assignment			
Pin	Label	Direction	Description
1	GND		signal ground (connected to power supply GND)
2	RS232_TXD	out	RS232 transmit data output
3	RS232_RXD	in	RS232 receive data input

Table 8: RS232 connector pin assignment

4.6 Motor Connector

The TMCM-6214 offers 6 motor connectors (4pin JST PH series).

Motor connector pin assignment			
Pin	Label	Direction	Description
1	A2		Motor phase A
2	A1		Motor phase A
3	B2		Motor phase B
4	B1		Motor phase B

Table 9: Motor connector pin assignment

NOTICE	**Do not connect or disconnect motor during operation!** Motor cable and motor inductivity might lead to voltage spikes when the motor is (dis)connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch off / disconnect power supply or at least disable driver stage before connecting / disconnecting motor.

NOTICE	**Do not mix-up stop switch and motor connectors!**

4.7 Stop switch connector

The TMCM-6214 offers 6 stop switch connectors (4pin JST PH series) - one for each motor axis.

Stop switch connector pin assignment			
Pin	Label	Direction	Description
1	GND		Signal and supply GND
2	+24V	out	connected to +24V supply input for supply of end switches etc.
3	STOP_L	in	Stop left switch input. Interal pull-up to +5V

Pin	Label	Direction	Description
4	STOP_R	in	Stop right switch input. Internal pull-up to +5V

Table 10: Stop switch connector pin assignment

4.8 Encoder connector

The TMCM-6214 offers 3 encoder connectors (5pin JST PH series) for motor axis 3 to 5 (with axis numbering 0 to 5).

Encoder connector pin assignment			
Pin	Label	Direction	Description
1	GND		Signal and supply GND
2	+5V	out	for encoder supply. Max. 100mA per encoder / 300mA for all three encoders together.
3	ENC_A	in	Encoder A channel input. +5V TTL signals and open-drain signals (internal 4k7 pull-up to +5V) are accepted.
4	ENC_B	in	Encoder B channel input. +5V TTL signals and open-drain signals (internal 4k7 pull-up to +5V) are accepted.
5	ENC_N	in	Encoder N channel input (Null / Zero channel). +5V TTL signals and open-drain signals (internal 4k7 pull-up to +5V) are accepted.

Table 11: Encoder connector pin assignment

4.9 I/O connector

The TMCM-6214 offers 2 I/O connectors (10pin JST PH series).

I/O connector pin assignment			
Pin	Label	Direction	Description
1	GND		Signal and supply GND
2	+24V	out	connected to +24V supply input for supply of switches etc.
3	IN0/IN4	in	Analog input (0..+10V nom. input range)
4	IN1/IN5	in	digital input (internal pull-down, +24V compatible)
5	IN2/IN6	in	digital input (internal pull-down, +24V compatible)
6	IN3/IN7	in	digital input (internal pull-down, +24V compatible)
7	OUT0/OUT4	out	digital output (open-drain / low-side switch). Max. 100mA sink current. Over-load and -temperature protected
8	OUT1/OUT5	out	digital output (open-drain / low-side switch). Max. 100mA sink current. Over-load and -temperature protected
9	OUT2/OUT6	out	digital output (open-drain / low-side switch). Max. 100mA sink current. Over-load and -temperature protected

Pin	Label	Direction	Description
10	OUT3/OUT7	out	digital output (open-drain / low-side switch). Max. 100mA sink current. Over-load and -temperature protected

Table 12: I/O connector pin assignment

The digital inputs IN1, IN2, IN3 as well as IN5, IN6, IN7 are also used as HOME inputs.

HOME inputs	
Input	Motor
IN1	Motor 0 home switch input
IN2	Motor 1 home switch input
IN3	Motor 2 home switch input
IN5	Motor 3 home switch input
IN6	Motor 4 home switch input
IN7	Motor 5 home switch input

Table 13: HOME inputs

4.10   USB Connector

For serial communication the TMCM-6214 offers selection between RS485, CAN and USB interfaces. The USB interface via on-board USB-C connector is available for configuration and service of the board, mainly (e.g. parameter settings, firmware updates). The USB device interface supports full speed (12Mbit/s) communication and supports bus powered and self-powered operation. During bus-powered operation the low voltage logic part of the board will be powered, only. This includes the microcontroller and the non-volatile memory and therefore allows parameter settings and firmware updates of the board using a standard USB cable, only. Of course, for any motor movement main supply via supply input connector is required.

5 On-Board LEDs

The board offers two LEDs in order to indicate board status. The function of both LEDs is dependent on the firmware version. With standard TMCL firmware the green LED should be flashing slowly during operation and the red LED should be off. When there is no valid firmware programmed into the board or during firmware update the red and green LEDs are permanently switched on. During reset to factory default values the green LED will be flashing fast. With CANopen firmware both LEDs are switched on/off/flashing according to standard defintion.
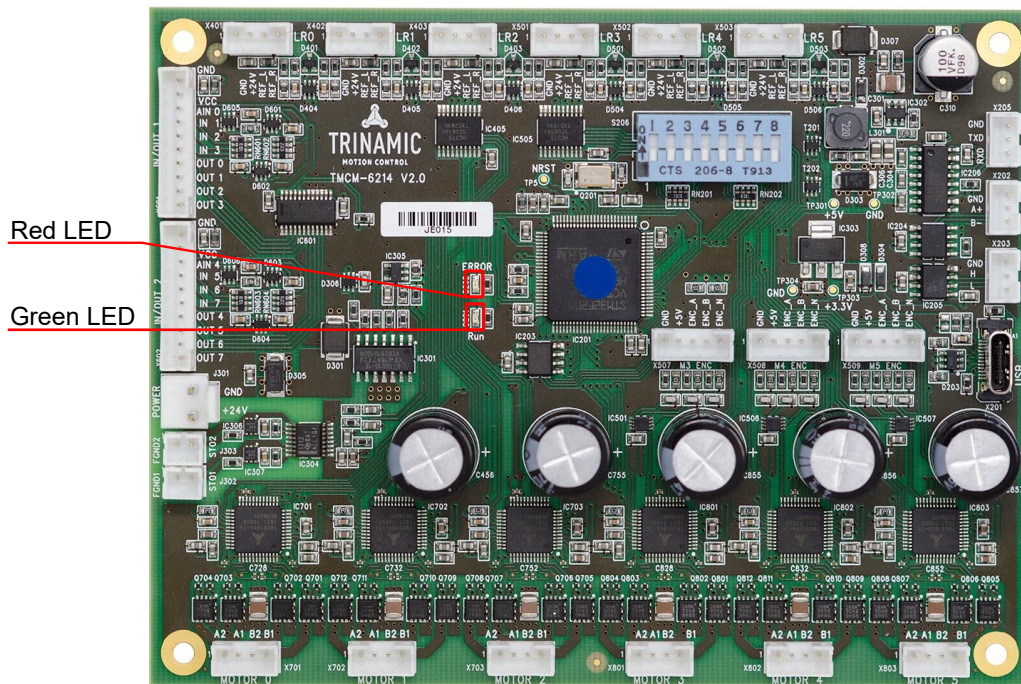

Figure 3: TMCM-6214 LEDs

6 On-Board DIP Switches

The DIP switches can be used to set the RS485 address and the CAN receive ID (or CANopen Node ID if CANopen firmware is installed) of the module. When all switches are in their OFF positions, the RS485 address and CAN receive ID / CANopen Node ID are taken from the settings stored in the EEPROM of the module. When at least one switch is in its ON position the value set by the DIP switches will be used as RS485 address, CAN receive ID or CANopen Node ID. The DIP switch settings will then be interpreted as a binary value, with switch #1 used as the lowest bit.

7 Communication

7.1 RS485

For remote control and communication with a host system the TMCM-6214 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.
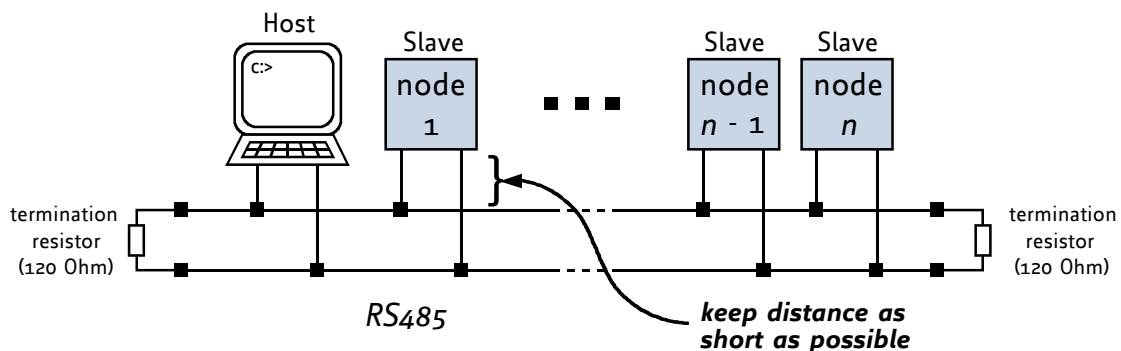

Figure 4: RS485 bus structure with termination resistors

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-6214 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 stadard (EIA-485) allows up to 32 nodes to be connected to a single bus. The bus transceiver used on the TMCM-6214 units (SN65HVD1781D) offers a significantly reduced bus load compared to the standard and allows a maximum of 255 units to be connected to a single RS485 bus using standard 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-6214 hardware is 1Mbit/s. Factory default is 9600 bit/s. Please see separate TMCM-6214 TMCL firmware manual for information regarding other possible communication speeds below the upper hardware limit.

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):
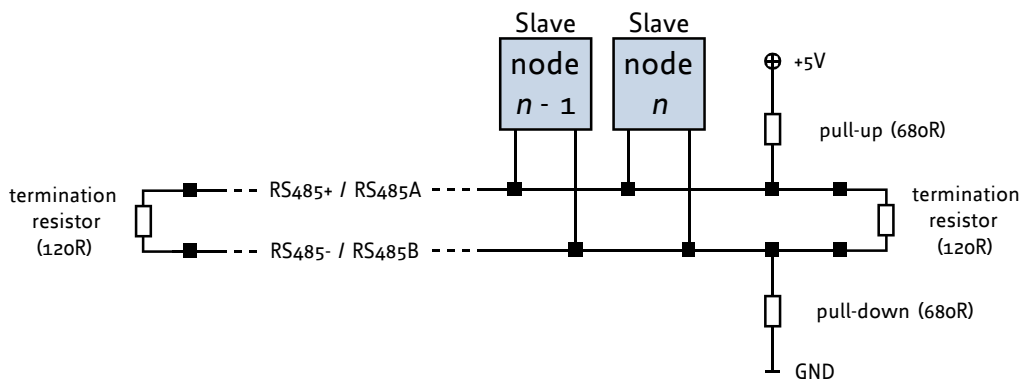
Figure 5: RS485 bus lines with resistor (bias) network on one side, only

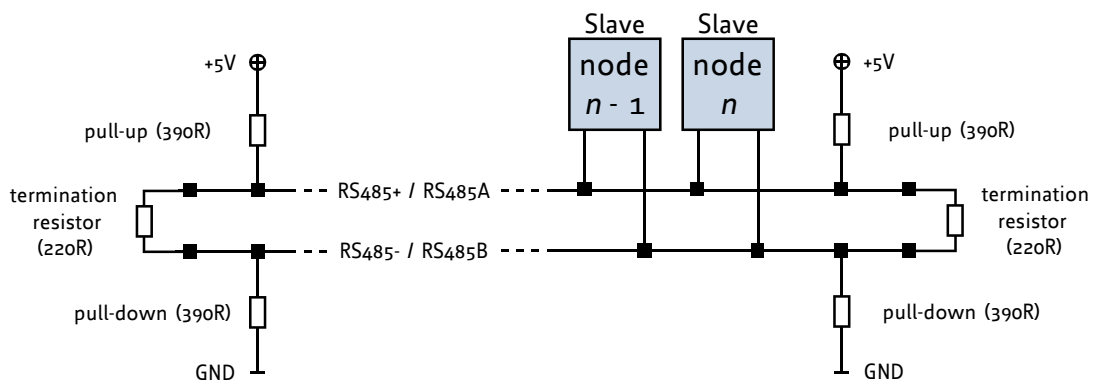Or add resistor network at both ends of the bus (like Profibus™ termination):

Figure 6: RS485 bus lines with Profibus™recommended line termination

7.2 CAN

For remote control and communication with a host system the TMCM-6214 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.
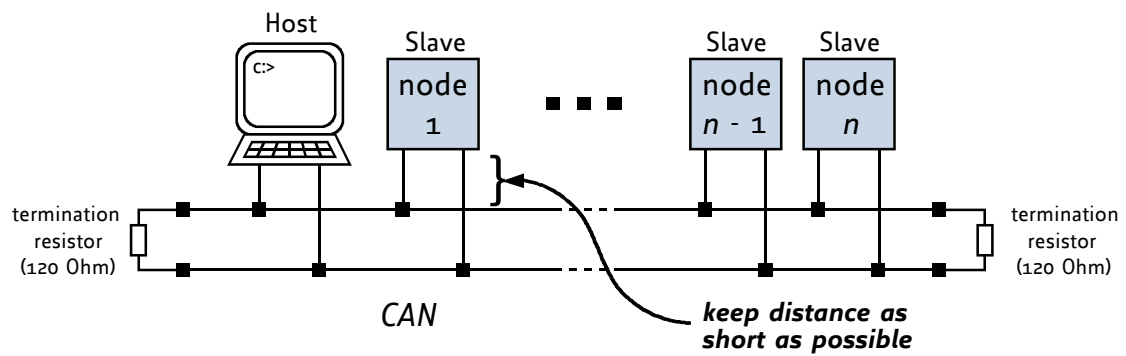
Figure 7: CAN bus structure with termination resistors

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-6214 does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus have to be added externally.

3. *BUS TERMINATION:*
   The bus transceiver used on the TMCM-6214 units (TJA1051T) supports at least 110 nodes under optimum conditions. Practically achievable number of nodes per CAN bus highly depend on bus length (longer bus -> less nodes) and communication speed (higher speed -> less nodes).

8   Motor driver current

The on-board stepper motor driver operates current controlled. The driver current may be programmed in software with 32 effective scaling steps in hardware.
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-6214 firmware manual for further information)

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

Motor Current Setting			
Motor current setting in software (TMCL)	Current scaling step (CS)	Motor current I_{COIL}[A] peak	Motor current I_{COIL}[A] RMS
0…7	0	0.085	0.06
8…15	1	0.169	0.12
16…23	2	0.254	0.18
24…31	3	0.339	0.239
32…39	4	0.423	0.299
40…47	5	0.508	0.359
48…55	6	0.592	0.419
56…63	7	0.677	0.479
64…71	8	0.762	0.539
72…79	9	0.846	0.598
80…87	10	0.931	0.658
88…95	11	1.016	0.718
96…103	12	1.100	0.778
104…111	13	1.185	0.838
112…119	14	1.270	0.898
120…127	15	1.354	0.958
128…135	16	1.439	1.017
136…143	17	1.523	1.077
144…151	18	1.608	1.137
152…159	19	1.693	1.197

Motor current setting in software (TMCL)	Current scaling step (CS)	Motor current $I_{COIL}[A]$ peak	Motor current $I_{COIL}[A]$ RMS
160…167	20	1.777	1.257
168…175	21	1.862	1.317
176…183	22	1.947	1.376
184…191	23	2.031	1.436
192…199	24	2.116	1.496
200…207	25	2.201	1.556
208…215	26	2.285	1.616
216…223	27	2.370	1.676
224…231	28	2.454	1.736
232…239	29	2.539	1.795
240…247	30	2.624	1.855
248…255	31	2.708	1.915

Table 15: Available motor current settings

In addition to the settings in the table the motor current may be switched off completely (free-wheeling) using axis parameter 204 (see TMCM-6214 firmware manual).

9   Functional Description

The TMCM-6214 is a highly integrated 6-axes controller/driver module for stepper motors with up-to 1.9A RMS / 2.7A peak motor coil current. The TMCM-6214 can be controlled via RS485, RS232, CAN or USB serial interfaces. It offers 6 digital inputs which accept 24V signals, 2 analog inputs with 0..10V nom. input range and 8 digital outputs (open-drain / low side switches) with protection and diagnostic functions. In additon, two STO (torque-off) inputs (isolated) are available driving the enable inputs of the 8 motor drivers and the on-board smart power switch for the motor driver supply.

The TMCM-6214 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. Whereas the boot loader is installed during production and testing at TRINAMIC and remains usually untouched throughout the whole lifetime, the firmware can be updated by the user via any serial interface.

Communication traffic is kept low since all time critical operations, e.g. ramp calculation, are perfomrmed on-board. Full remote control of the device with feedback is possible. The firmware of the module can be updated via any of the serial interfaces. As an alternative CANopen firmware is available.

The TMCM-6214 module contains the following main components:

- Microcontroller (ARM Cortex-M3™) for overall control and communication.

- Six highly integrated advanced stepper motor controllers supporting linear and unique 6-points ramps in hardware.

- Advanced stepper motor driver supporting spreadCycle™highly dynamic current control chopper and stealthChop™for quiet operation and smooth motion.

- RS485, RS232, CAN and USB transceivers.

- Six general purpose digital inputs, two analog input (also usable as digital inputs).

- Eight general purpose digital outputs (open-drain, protected, 100mA each).

- Three incremental A/B/N encoder interfaces (+5V TTL and open-collector).

- Two STO inputs (isolated), driver enable in hardware, smart power switch for driver supply voltage with measurement of driver supply current and voltage.

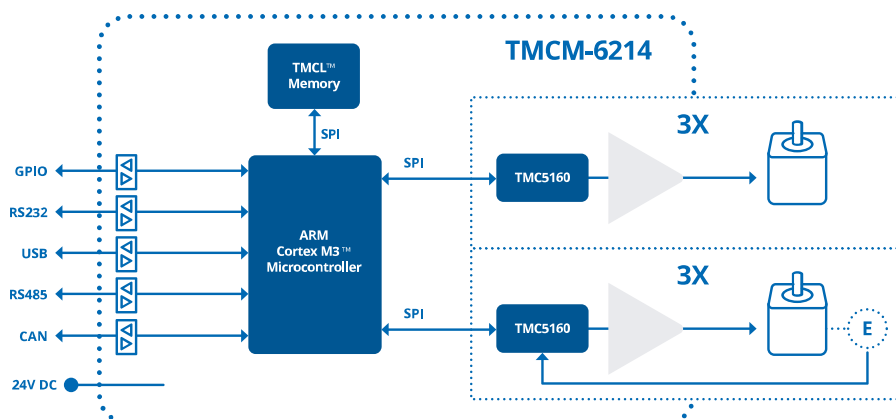- On-board voltage regulators (+5V and +3V3) for supply of all on-board digital circuits.

Figure 8: TMCM-6214 block diagram

10 Operational Ratings and Characteristics

NOTICE	**Never Exceed the absolute maximum ratings!** Keep the power supply voltage below the upper limit of +30V! Otherwise the board electronics will seriously be damaged! Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.

General Operational Ratings					
Symbol	Parameter	Min	Typ	Max	Unit
V_{Power}	Power supply voltage	9	12…24	30	V
I_{Power}	Power supply current		$<<I_{COIL\_RMS}$	$1.4 \times I_{COIL\_RMS}$	A
V_{USB}	Power supply via USB connector		5		V
I_{USB}	Current withdrawn from USB supply when USB bus powered (no other supply connected)		75		mA
I_{COIL_PEAK}	Motor coil current for sine wave **peak (chopper regulated, adjustable via software)**	0		2.7	A
I_{COIL_RMS}	Continuous motor current (**RMS**)	0		1.9	A
T_{ENV}	Environmental temperature at rated current (no forced cooling reaquired)	-30		40	°C

Table 16: General operational ratings of the module

Operational Ratings of the I/Os					
Symbol	Parameter	Min	Typ	Max	Unit
$V_{OUT0… OUT7}$	Voltage at open drain outputs (switched off)	0		36	V
$V_{OUT0… OUT7}$	Output clamp voltage (e.g. for inductive loads)	36	40	44	V
$I_{OUT0… OUT7}$	Output sink current of open drain outputs (switched on)		100		mA
$I_{OUT0… OUT7}$	Overload detection current of open drain outputs (switched on)	0.6		1.3	A
$V_{IN0… IN7}$	Input voltage for IN0… IN7	0	0…+24	+30	V
$V_{IN0, IN4}$	Measurement range for analog input IN0 and IN4	0		+10[1]	V
V_{IN_H}	High level voltage for IN1… IN3 and IN5… IN7 (digital inputs)	2.9			V
V_{IN_L}	Low level voltage for IN1… IN3 and IN5… IN7 (digital inputs)			1.4	V
V_{REF_L/R_H}	High level voltage for stop switch inputs	3.4			V

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[1] approx. 0…+10.56V at the analog input IN0 is translated to 0…4095 (12bit ADC, raw values). Above approx. +10.56V the analog input will saturate but, not being damaged (up-to +30V).

Operational Ratings of the I/Os					
Symbol	Parameter	Min	Typ	Max	Unit
V_{REF_L/R_L}	Low level voltage for stop switch inputs			1.4	V

Table 17: Operational ratings of I/Os

Operational Ratings of the STO inputs					
Symbol	Parameter	Min	Typ	Max	Unit
V_{IN_H}	High level voltage (enable driver)	15	24	30	V
V_{IN_L}	Low level voltage (disable driver)	0	0	5	V

Table 18: Operational ratings of STO inputs

Operational Ratings of the RS485 Interface					
Symbol	Parameter	Min	Typ	Max	Unit
N_{RS485}	Number of nodes connected to single RS485 network			256	
f_{RS485}	Max. speed for RS485 network			1Mbit/s	

Table 19: Operational ratings of the RS485 interface

Operational Ratings of the RS232 Interface					
Symbol	Parameter	Min	Typ	Max	Unit
f_{RS485}	Max. speed for RS232 connection			115200 bit/s	

Table 20: Operational ratings of the RS232 interface

Operational Ratings of the CAN Interface					
Symbol	Parameter	Min	Typ	Max	Unit
N_{CAN}	Number of nodes connected to single CAN network			>110	
f_{CAN}	Max. speed for CAN network			1Mbit/s	

Table 21: Operational ratings of the CAN interface

11   Abbreviations used in this Manual

Abbreviation	Description
IDE	Integrated Development Environment
LED	Light Emmitting Diode
RMS	Root Mean Square value
TMCL	TRINAMIC Motion Control Language

Table 22: Abbreviations used in this Manual

12   Figures Index

13 Tables Index

14   Supplemental Directives

14.1   Producer Information

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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.

15 Revision History

15.1 Hardware Revision

Version	Date	Author	Description
V1.0	2018-SEP-04		Initial version.
V1.1	2018-OCT-01		2 independent STO inputs, footprint of controller / driver TMC5161 corrected.
V1.2	2018-NOV-05		processor replaced for more memory for CANopen firmware support, +3V3 linear regulator replaced with more powerful one, STO input circuit isolated + optimized.
V1.3	2018-DEC-19		USB circuit correction, EEPROM and octal output switch on different SPI channels, polarity of STO inputs changed.
V2.0	2019-JUL-03		Driver circuit TMC5161 replaced with TMC5160 and discrete MOS-FETs. STO inputs: Low-pass filter added for test pulse suppression.

Table 23: Hardware Revision

15.2 Document Revision

Version	Date	Author	Description
1.00	2019-MAR-15	GE	Initial version.
1.10	2019-MAR-25	GE	Update for series version.
1.20	2019-OCT-07	GE	Updated for hardware revision 2.0
1.21	2020-APR-20	OK	Home inputs added.
1.22	2020-APR-24	OK	New block diagram.
1.23	2020-SEP-25	OK	Added information about DIP switches and inrush current limiting.

Table 24: Document Revision