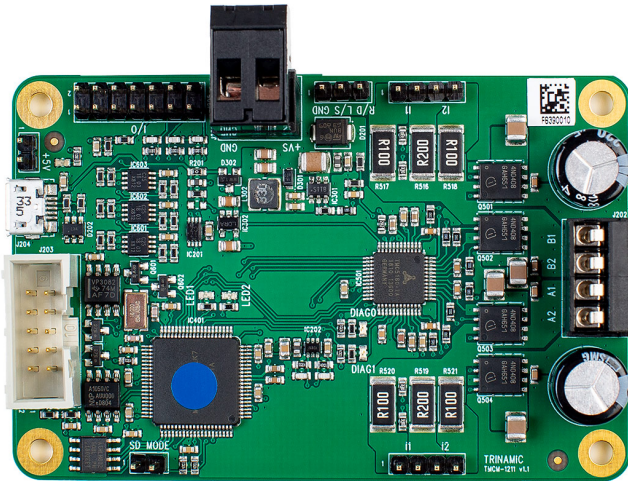


# TMCM-1211 StepRocker Hardware Manual

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**The TMCM-1211 StepRocker is a single axis motor controller/driver board for 2-phase bipolar stepper motors. It features the TRINAMIC motion controller/motor driver TMC5160 in combination with an ARM Cortex-M4™ (MK20DX128VLK7) processor. The module is intended to be a fully functional development platform.**



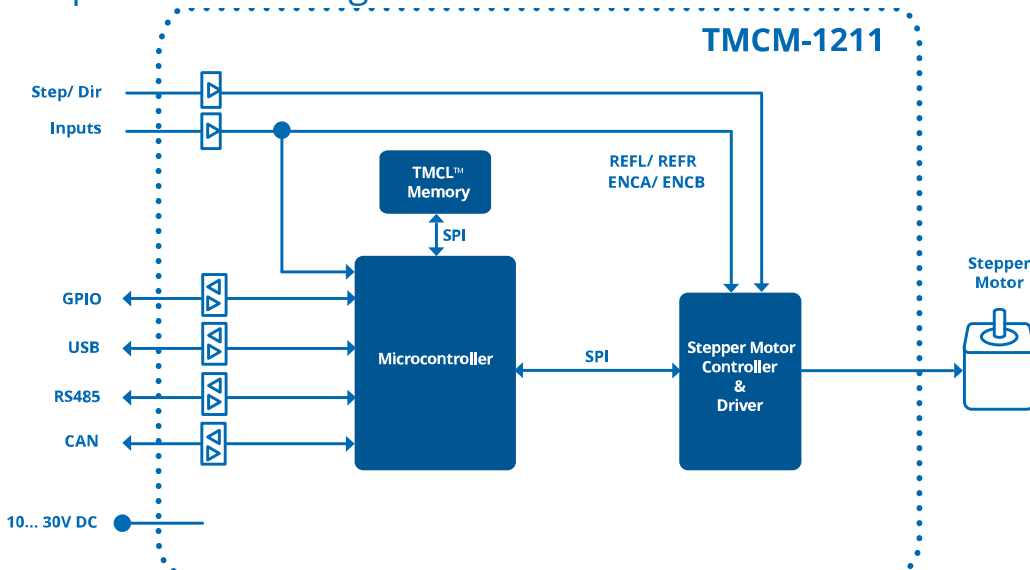
## Features

- Single axis controller/driver for 2-phase bipolar stepper motor
- +10...30V DC supply voltage
- Up to 5.7A RMS motor current
- RS485 & USB interface
- Multi-purpose inputs and outputs

## Applications

- Laboratory Automation
- Manufacturing
- Robotics
- Factory Automation
- Test & Measurement
- Technology evaluation
- First experiences with stepper motors
- Hobby applications

## Simplified Block Diagram



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# 1 Features

The TMC-1211 StepRocker is a single axis motor controller/driver board for 2-phase bipolar stepper motors. It features the TRINAMIC motion controller / motor driver TMC5160 in combination with an ARM Cortex-M4™ (MK20DX128VLK7) processor. The module is intended to be a fully functional development platform.

## Applications

- Highly compact single axis stepper motor controller/driver board for 2-phase bipolar stepper motors

## Electrical data

- Supply voltage: +24V DC (+10... +30V DC)
- Motor current: up to 1.1A RMS, 3.4A RMS or 5.7A RMS (can be selected with jumpers)

## Mechanical data

- Board size: 85mm x 55mm, height 15mm max. without mating connectors
- 4 mounting holes for M3 screws

## Interfaces

- RS485 host interface
- USB 2.0 host interface (USB micro-B connector)
- Step/Dir input (TTL level)
- 3 multi-purpose inputs (can be used for ABN-encoder)
- 2 limit switch inputs (shared with Step/Dir inputs)
- 6 multi-purpose I/Os
- 2 open-drain outputs
- 1 analog input (0...10V)
- $\mu$ C programming interface SWD (single wire debug / pads on PCB)
- Retro-fit option: CAN 2.0B communication interface

## Features

- TMC5160 integrated stepper motor controller and driver IC for 2-phase bipolar stepper motors
- StealthChop2™ for quiet movement
- SpreadCycle™ chopper for highly dynamic motor control
- StallGuard2™ sensorless motor load detection
- CoolStep™ current control for energy saving / reduced heat dissipation
- linear and sixPoint™ ramps with motion controller in hardware
- Up to 256 microsteps per fullstep
- EEPROM

## Software

- TMCL™ remote (direct mode) and standalone operation (memory for up to 1024 TMCL™ commands)
- Fully supported by TMCL-IDE (PC based integrated development environment)



## 2 Order Codes

The standard version of the TMC-1211 StepRocker has RS485 and USB interfaces (CAN transceiver **not** assembled).

The module is pre-programmed with TRINAMICs TMCL™ firmware with all available features.

TMC-1211 StepRocker Order Code		
Order Code	Description	Size (LxWxH)
TMC-1211 StepRocker	1-axis bipolar stepper motor controller/-driver module with RS485 and USB, 5.7A RMS, +24V	85mm x 55mm x 15mm

*Table 1: TMC-1211 StepRocker Order Code*



## 3 Mechanical and Electrical Interfacing

### 3.1 Size of board

The board with the controller/driver electronics has an overall size of 85mm x 55mm x 15mm without mating connectors. It offers four mounting holes for M3 screws (3.2mm diameter). All four mounting holes are connected to the ground plane (signal and supply ground) of the module.

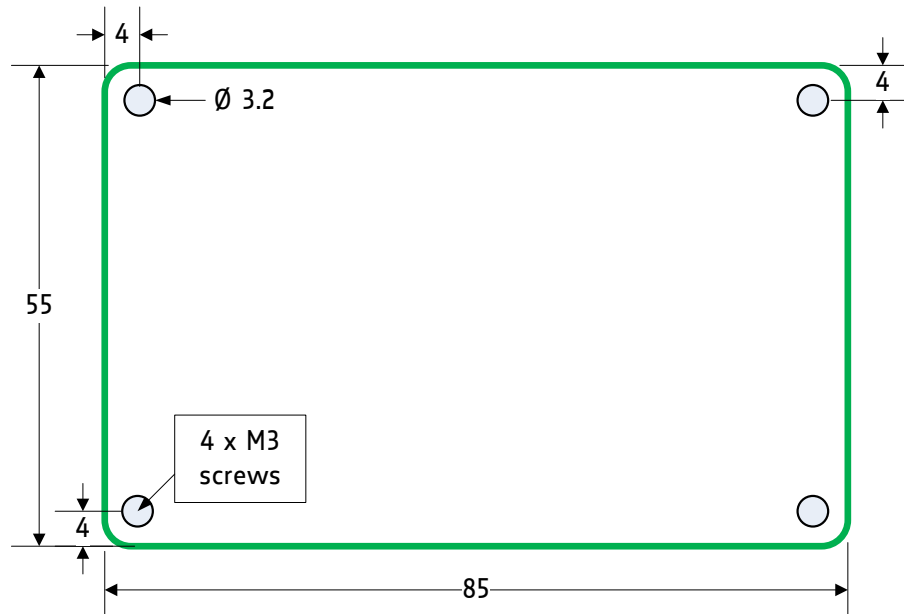


Figure 1: Board Dimensions and Positions of Mounting Holes (all Values in mm)



## 4 Connectors

The TMC2111 StepRocker has seven connectors altogether. There are two detachable screw connectors for power and motor and two interface connectors (micro-USB and RS485). Furthermore, the TMC2111 StepRocker offers one connector for step/direction and reference switch inputs, the GPIO connector, which can be used e.g. for connecting an ABN-encoder and one +5V supply output connector - e.g. for encoder or end switch supply.

### 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.

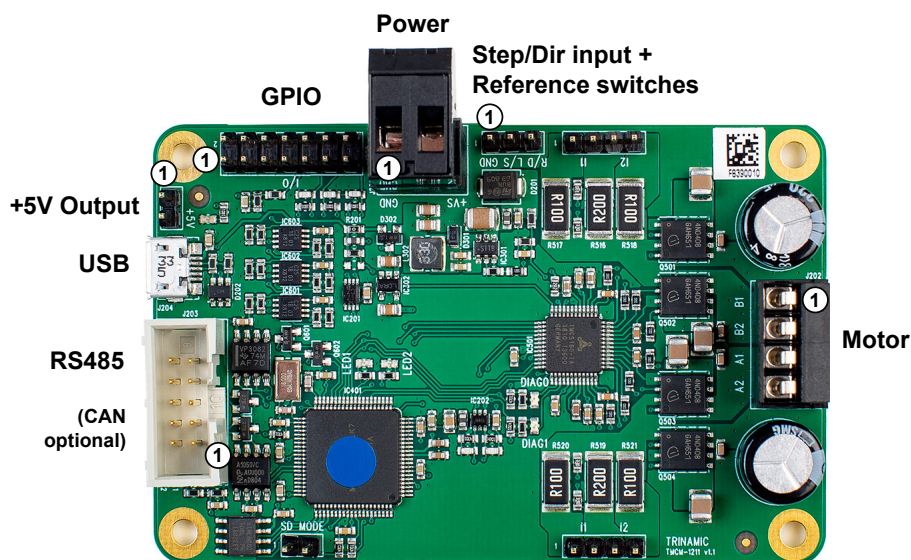


Figure 2: TMC2111 StepRocker connectors

Connector Types and Mating Connectors		
Connector	Connector type on-board	Mating connector type
Power	RIA 220-02, 2 pin, 5.08mm pitch, shrouded header	RIA 249-02, screw type terminal block, pluggable, centerline 5.08mm pitch
Motor	RIA 183-04, 4 pin, 3.5mm pitch, schrouded header	RIA 169-04, screw type terminal block, pluggable, centerline 3.5mm pitch
USB	USB-micro-B female connector	USB-micro male connector
RS485/CAN	Low profile box header without locking bar, type 8380, 10 pin, DIN 41651, 2.54mm pitch	Low profile IDC socket connector, 10 pin, DIN 41651, 2.54mm pitch



Connector	Connector type on-board	Mating connector type
GPIO	Header, 14 pin, 2.54mm pitch	Female connector with 2.54mm pitch
Step/Direction input and reference switches	Header, 3pin, 2.54mm pitch	Female connector with 2.54mm pitch
+5V output	Header, 2 pin, 2.54mm pitch	Female connector with 2.54mm pitch

Table 2: Connector Types and Mating Connectors of the TMCM-1211 StepRocker

## 4.1 Power Connector

Power Supply Connector Pin Assignment			
Pin	Label	Direction	Description
1	GND	Power (GND)	Common system supply and signal ground
2	10...30V	Power (input)	Power supply voltage

Table 3: 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!**

## 4.2 I/O Connector (Microcontroller)

The TMCM-1211 StepRocker offers an on-board ARM Cortex-M4™ microcontroller with +3V3 powered IOs and +5V tolerant inputs. In order to be compatible with previous generations (stepRocker™ TMCM-1110), +5V output level-shifters/buffers have been integrated on-board. This way, all general purpose IO pins configured as outputs will deliver +5V TTL signals.

I/O Connector Pin Assignment			
Pin	Label	Direction	Description
1	GND	Power (GND)	Supply and signal ground
2	GND	Power (GND)	Supply and signal ground
3	PWMD_0	in/out	General purpose I/O (+5V compatible, default: input)
4	PWMU_0	in/out	General purpose I/O (+5V compatible, default: output)



Pin	Label	Direction	Description
5	PWMD_1	in/out	General purpose I/O (+5V compatible, default: input)
6	PWMU_1	in/out	General purpose I/O (+5V compatible, default: output)
7	PWMD_2	in/out	General purpose I/O (+5V compatible, default: input)
8	PWMU_2	in/out	General purpose I/O (+5V compatible, default: output)
9	AIN_0	in	Analog input (also usable as home switch input). Input voltage range: 0...+10V Resolution: 12bit (0...4095)
10	PHASE_A	in	Encoder input channel A (+5V compatible, internal pull-up to +5V)
11	OpenDrain_1	out	Open-drain output (max. 100mA)
12	PHASE_B	in	Encoder input channel B (+5V compatible, internal pull-up to +5V)
13	OpenDrain_2	out	Open-drain output (max. 100mA)
14	PHASE_Z	in	Encoder input zero channel (+5V compatible, internal pull-up to +5V)

Table 4: I/O Connector Pin Assignment

### 4.3 Motor Connector

The motor has to be connected to the motor connector, one phase (phase A) between A1 and A2 and the second phase (phase B) between B1 and B2.

Motor Connector Pin Assignment			
Pin	Label	Direction	Description
1	B1	out	Pin 1 of motor coil B
2	B2	out	Pin 2 of motor coil B
3	A1	out	Pin 1 of motor coil A
4	A2	out	Pin 2 of motor coil A

Table 5: 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.

#### 4.4 Step/Dir Input + Reference Switches Connector

Step/Dir and Reference Switches Input Connector Pin Assignment			
Pin	Label	Direction	Description
1	GND	Power (GND)	Signal and system ground
2	REFL/STEP	in	Input for left reference/limit switch or driver step pulse signal
3	REFR/DIR	in	Input for right reference/limit switch or driver direction signal

Table 6: Step/Dir and Reference Switches Input Connector

#### 4.5 RS485 and CAN Connector

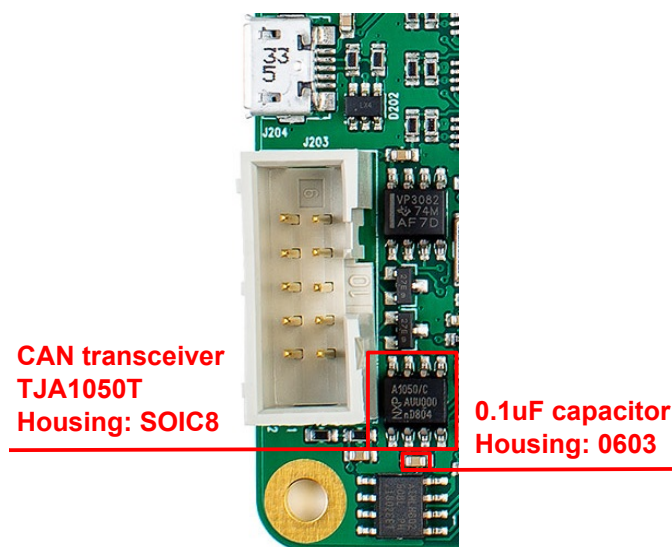
The standard TMC-1211 StepRocker offers the RS485 interface only.

RS485/CAN Connector Pin Assignment			
Pin	Label	Direction	Description
1			
2			
3	CAN_L	bi-directional	differential CAN bus signal (inverting) - retro-fit option
4	CAN_H	bi-directional	differential CAN bus signal (non-inverting) - retro-fit option
5	GND	Power (GND)	Signal and system ground
6	RS485+	bi-directional	differential RS485 bus signal (non-inverting)
7	RS485-	bi-directional	differential RS485 bus signal (inverting)
8			
9			
10			

Table 7: RS485/CAN Connector Pin Assignment



### 4.5.1 Upgrade the TCM-1211 StepRocker for CAN communication



The table above shows the pin configuration for CAN, too. Before starting with CAN it is necessary to solder a TJA1050T CAN transceiver with housing SOIC8 and a 0.1 $\mu$  capacitor with housing 0603 on the TCM-1211 StepRocker. Afterwards, the TCM-1211 StepRocker is ready for using the CAN interface.

Because of the pin assignment CAN and RS485 can be used at the same time.

Please note: it is not necessary to remove the RS485 transceiver.

## 4.6 USB Connector

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

USB Connector Pin Assignment			
Pin	Label	Direction	Description
1	VBUS	Power (+5V input)	+5V supply from the host
2	D-	bi-directional	USB Data-
3	D+	bi-directional	USB Data+
4	ID		not connected
5	GND	Power (GND)	Signal and system ground

Table 8: USB Connector Pin Assignment

## 4.7 Microcontroller Programming Interface

The programming pads for the microcontroller are located on the bottom side of the module. They are connected directly to the related processor pins - resp. GND or on-board generated +3V3 supply. These pins are used for programming of the bootloader and firmware during production + testing of the module.

Programming Pads		
Pin	Label	Description
1	GND	Module and signal ground
2	+3V3	+3V3 DC supply - generated on-board
3	nRST	Hardware reset input



Pin	Label	Description
4	SWDIO	Serial wire data I/O
5	SWDCLK	Serial wire clock

Table 9: Programming Pads on Bottom of the PCB

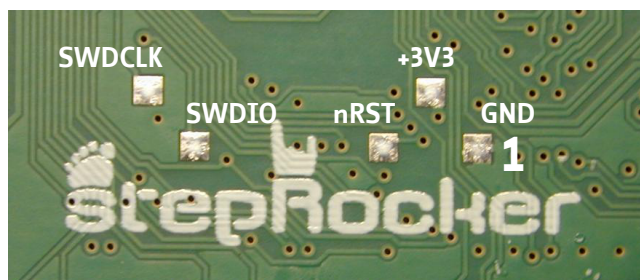


Figure 3: TCM-1211 StepRocker Programming Pads

## 5 Reset to Factory Default

It is possible to reset all settings of the TCM-1211 StepRocker to factory default without establishing a working communication connection. This might be helpful in case communication parameters of the preferred interface have been set to unknown values or got lost. To do this the following steps have to be performed:

1. Switch the supply power off and also disconnect the USB cable if connected.
2. Short the SWDIO pad with the SWDCLK pad (on the bottom side of the PCB, see figure 3).
3. Switch the supply power on again.
4. LED1 and LED2 are now flashing fast.
5. Switch the supply power off.
6. Remove the short between the two pads.
7. Switch the supply power on and wait until LED1 flashes normally again. The TCM-1211 StepRocker now runs with factory default settings.



## 6 Jumper Settings

The TMC-1211 StepRocker offers a number of jumpers for selection of different settings in hardware.

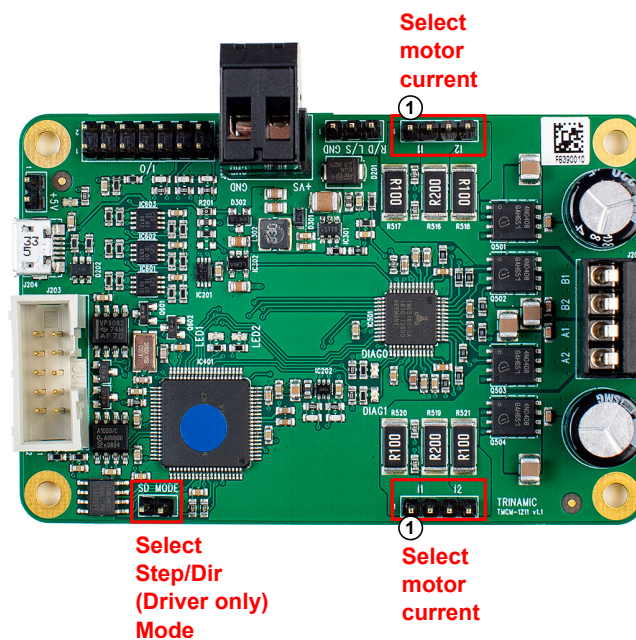


Figure 4: Jumper Settings of the TMC-1211 StepRocker

Jumpers of the TMC-1211 StepRocker		
Jumper	Label	Description
Select motor current	Jumper removed	Jumper removed: motor current up to 1.1A RMS
	Jumper pin 1-2	1 Jumper populated (pin 1-2): motor current up to 3.4A RMS
	Jumper pin 1-2 and 3-4	2 Jumper populated (pin 1-2 and pin 3-4): motor current up to 5.7A RMS
Select Step/Dir mode	Jumper removed	Remove jumper to enable on-board motion controller
	Jumper pin 1-2	Set jumpers to select external motion controller. Step/Dir Signals from external motion controller have to be connected to Step/Dir In

Table 10: Jumpers of the TMC-1211 StepRocker

## 7 LEDs

LED Description		
Status	Label	Description
Power on	+5V	This orange LED lights up upon the power supply is available
LED1 without pre-defined functionality	LED1	This yellow LED can be used customer specific. This LED is connected to PTA5 (pin 31) of the MK20DX128VLK7 microcontroller.
LED2 without pre-defined functionality	LED2	This yellow LED can be used customer specific. This LED is connected to PTE5 (pin 6) of the MK20DX128VLK7 microcontroller.
TMC5160 diagnosis output 0	DIAG_0	This green LED lights up if the DIAG 0 output of the TMC5160 is pulled low.
TMC5160 diagnosis output 1	DIAG_1	This green LED lights up if the DIAG 1 output of the TMC5160 is pulled low.

Table 11: LED Description

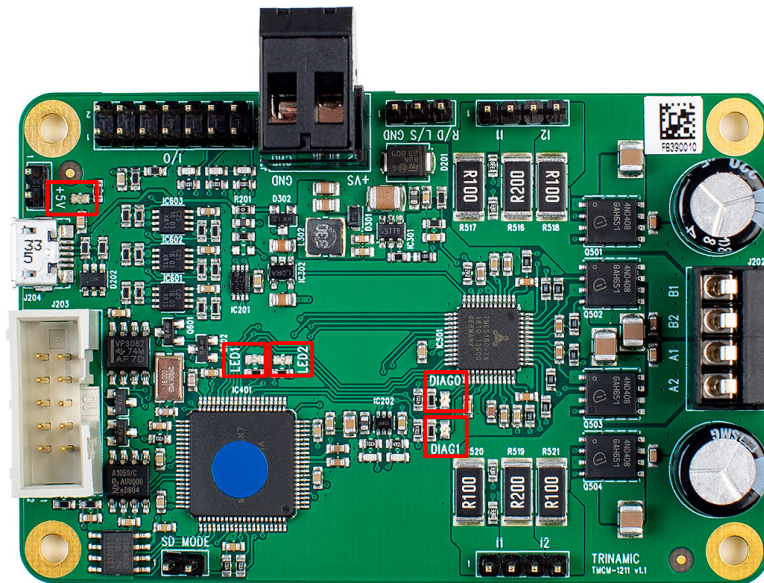


Figure 5: TCM-1211 StepRocker LEDs



## 8 Communication

### 8.1 RS485

For remote control and communication with a host system the TMC-1211 StepRocker 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.

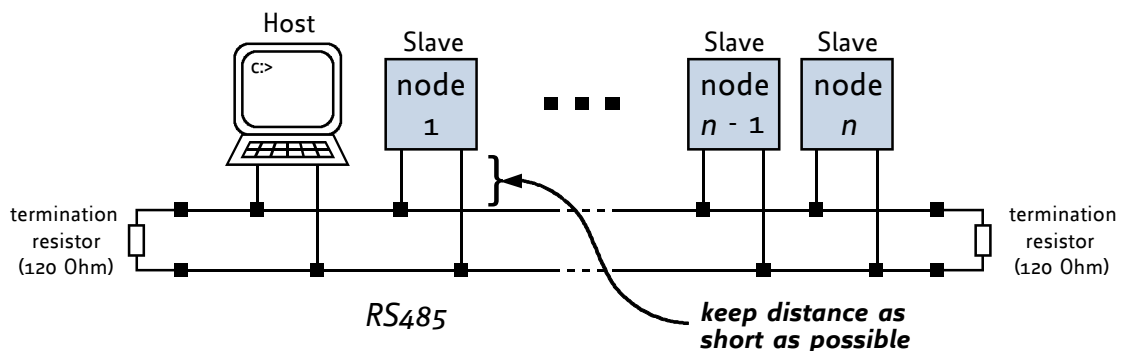


Figure 6: RS485 Bus Structure with Termination Resistors

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 TMC-1211 StepRocker 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 TMC-1211 StepRocker units (SN65HVD3082ED) has just 1/8th of the standard bus load and allows a maximum of 256 units to be connected to a single RS485 bus.

4. **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 GND resp. +5V. In contrast to the termination resistors this network is normally required just once per bus. Certain RS485 interface converters available for PCs already include these additional resistors (e.g. USB-2-485).



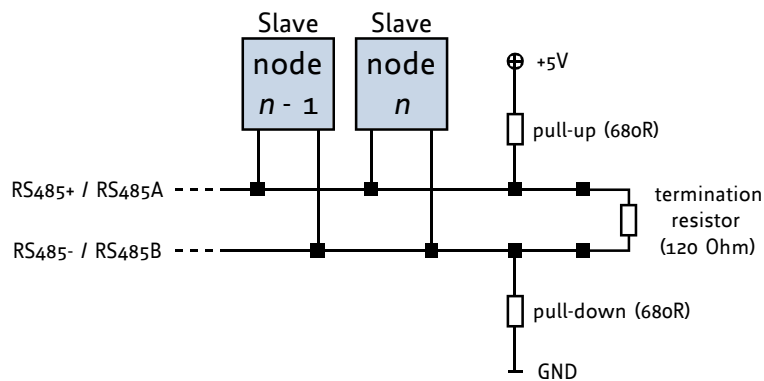


Figure 7: RS485 Bus Lines with Resistor Network

## 8.2 USB

For remote control and communication with a host system the TMC-1211 StepRocker 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 TMC-1211 StepRocker supports USB self powered operation (External power supplied via the power supply connector) and USB bus powered operation, also (no external power is supplied via the 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. Of course, any motor movement will not be possible in this mode. 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 other connection / additional power supply is required.

## 8.3 CAN (Retro-fit Option)

For remote control and communication with a host system the TMC-1211 StepRocker can be equipped with a CAN bus interface. Please note, that it is necessary to add CAN transceiver and filter capacitor first for the standard TMC-1211 StepRocker version (see 4.5.1).

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.

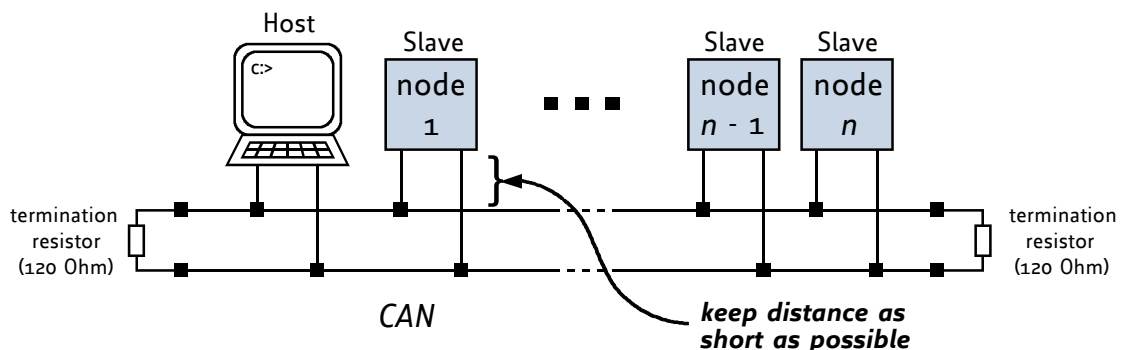


Figure 8: CAN Bus Structure with Termination Resistors



## 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-1211 StepRocker does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus have to be added externally.



## 9 Functional Description

The TCM-1211 StepRocker is a highly integrated single axis controller/driver module for stepper motors. It can be controlled via RS485 or USB serial interfaces (CAN retro-fit option) and 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.

Communication traffic is kept low since all time critical operations, e.g. ramp calculation, are performed 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.

**The TCM-1211 StepRocker module contains the following main components:**

- Microcontroller (ARM Cortex-M4™, MK20DX128VLK7), responsible for overall control and communication
- TMC5160 highly integrated stepper motor controller / driver. Step-/direction inputs, stop switch inputs and encoder inputs connected to TMC5160.
- MOSFET driver stage (8x NMOSFETs for bipolar stepper motor)
- RS485 and USB transceivers
- On-board voltage regulators (+5V and +3V3) required for supply of all on-board digital circuits

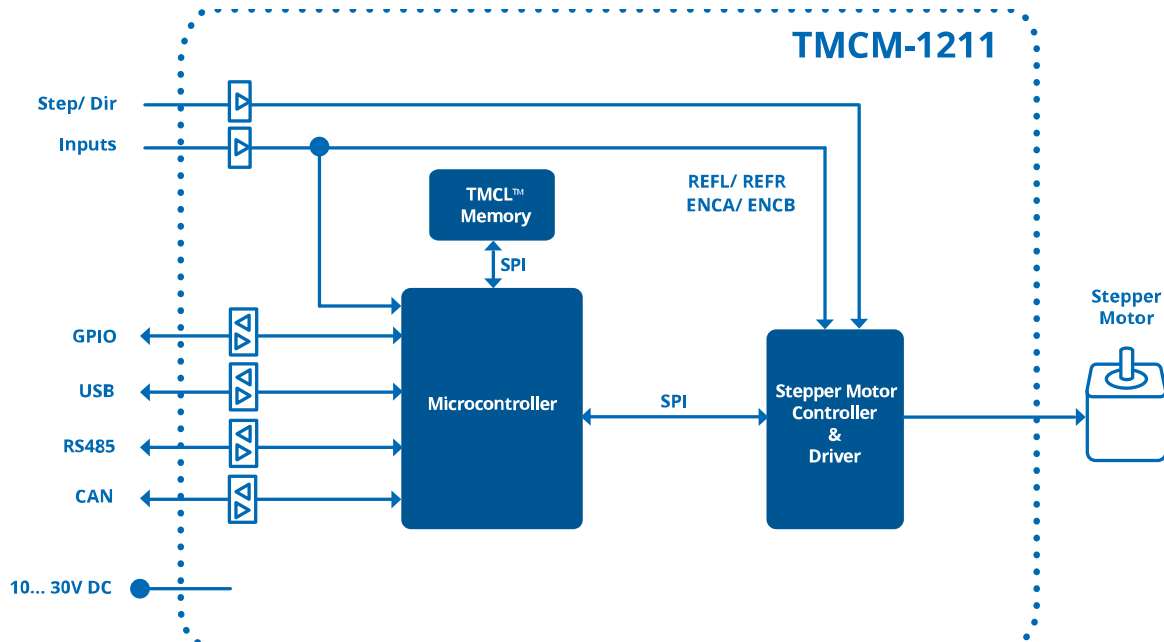


Figure 9: TCM-1211 StepRocker Block Diagram



## 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
$V_{\text{Power}}$	Power supply voltage	10	24	30	V
$V_{\text{USB}}$	Power supply via USB connector		5		V
$I_{\text{USB}}$	Current withdrawn from USB supply when USB bus powered (no other supply connected)		40		mA
$I_{\text{COIL}}$	Motor coil current for sine wave <b>peak</b> (chopper regulated, adjustable via software) with 0, 1 or 2 jumper set	0		1.6 or 4.8 or 8.1	A
$I_{\text{MC}}$	Continuous motor current ( <b>RMS</b> ) with 0, 1 or 2 jumper set	0		1.1 or 3.4 or 5.7	A
$T_{\text{ENV}}$	Environmental temperature at rated current (no forced cooling required)	-25		50	°C

Table 12: General Operational Ratings of the Module

Operational Ratings of the RS485 Interface					
Symbol	Parameter	Min	Typ	Max	Unit
$N_{\text{RS485}}$	Number of nodes connected to single RS485 network			256	

Table 13: Operational Ratings of the RS485 Interface



## 11 Abbreviations used in this Manual

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

*Table 14: Abbreviations used in this Manual*



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## 14 Supplemental Directives

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## 14.7 Collateral Documents & Tools

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



## 15 Revision History

### 15.1 Hardware Revision

Version	Date	Author	Description
V1.0	2018-JUN-21	MM	First version. Prototypes, only.
V1.1	2018-JUL-17	MM	Several corrections. Series version.

Table 15: Hardware Revision

### 15.2 Document Revision

Version	Date	Author	Description
1.00	2018-OCT-08	GE	First version.
1.10	2018-NOV-06	GE	Several corrections (incl. order codes etc.).
1.11	2020-SEP-07	OK	AIN_0 also usable as home switch input.
1.12	2021-MAR-26	OK	Added reset to factory default.

Table 16: Document Revision

