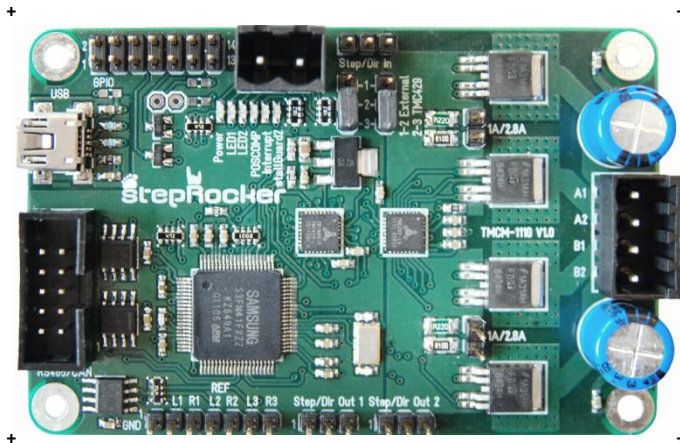


Hardware Version V1.1

HARDWARE MANUAL



1-axis stepper
controller / driver module
1A RMS / 2.8A RMS
24V DC
USB, RS485

UNIQUE FEATURES:



coolStep™

stallGuard2™

dcStep™
| | | | |

TRINAMIC Motion Control GmbH & Co. KG
Hamburg, Germany

www.trinamic.com



TRINAMIC
MOTION CONTROL

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1 Features

The TMC1110 stepRocker is a single axis motor controller/driver board for 2-phase bipolar stepper motors. It features the TRINAMIC controller/driver chain consisting of TMC429 and TMC262 in combination with a Samsung S3FN41F processor. The Module is intended to be a fully functional development platform. A stepRocker can be extended to a full 3-axes system using two additional boards, because the TMC1110 stepRocker board can be both, master or slave.

Software wise two different approaches are possible: it is possible to use the stepRocker with the TrinamicMotionControlLanguage TMCL™. The board comes with the preinstalled firmware. The integrated development environment TMCL-IDE for PC can be downloaded and used free of charge. It is possible to remote control the stepRocker or to write and download complete command sequences for standalone use.

The alternative is to write the firmware for the microcontroller using downloadable software tools and motion control libraries (refer to www.motioncontrol-community.org).

Applications

- Highly compact single axis stepper motor controller/driver board for 2-phase bipolar stepper motors
- 2- and 3-axis systems using additional boards as slaves

Electrical data

- Supply voltage: +24V DC (+10... +30V DC)
- Motor current: up to 1A RMS or 2.8A 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 (mini-USB connector)
- Step/Dir input (TTL level)
- Step/Dir outputs (TTL level) for multi axis applications
- 3 multi-purpose inputs (can be used for ABN-encoder)
- 2 limit switch inputs per motor
- 6 multi-purpose I/Os
- 2 open-drain outputs
- µC programming interface SWD (single wire debug / pads on PCB)
- Retro-fit option: CAN 2.0B communication interface

Features

- TMC429 stepper motor controller IC for on-the-fly alteration of many motion specific parameters
- TMC262 advanced stepper motor driver IC with stallGuard2™ and coolStep™ features. Using the spreadCycle chopper the µstep current sine wave is well formed with smooth zero crossing.
- Ready for dcStep™
- Up to 256 microsteps per fullstep through microPlyer technology
- 2 x end switch for all three axes.
- 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)

Please note that the TMC1110 stepRocker can be used with a special TMCL™ firmware version with its source codes in order to provide new developments, too. Here is your platform for individual TMCL™ extensions: www.motioncontrol-community.org or www.steprocker.com.

2 Order Codes

The standard version of the stepRocker has RS485 interface and USB interface.

The module is pre-programmed with TRINAMICS TMCL™ Firmware with all available features. For developing one's own firmware please refer to www.steprocker.com or www.motioncontrol-community.org.

Order code	Description	Size of unit [mm ³]
TMC-1110 stepRocker	The stepRocker is a 1-axes bipolar stepper motor controller/driver module with RS485 and USB	85 x 55 x 15

Table 2.1: TMC-1110 order codes

Order code	Description
CABLE-USB-MINI	USB-mini cable

Table 2.4: Related product

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.

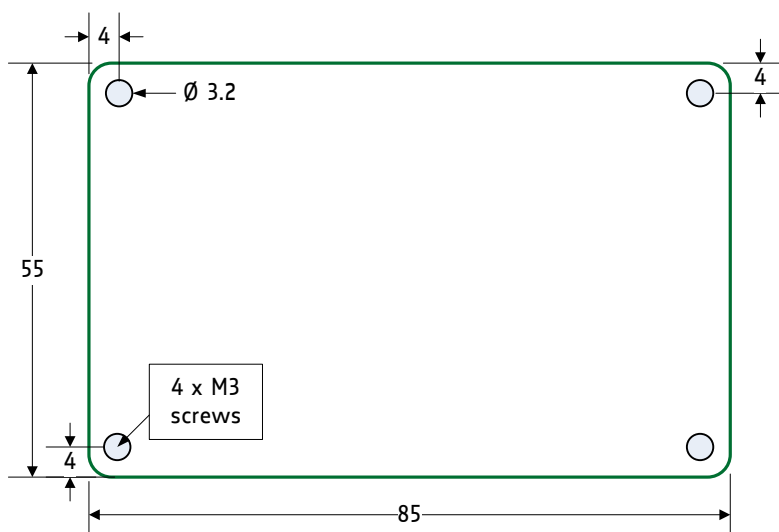


Figure 3.1: Board dimensions and position of mounting holes (all values in mm).

3.2 Connectors

The TMC-1110 stepRocker has nine connectors altogether. There are two screw connectors for power and motor and two interface connectors (mini-USB and RS485). Further, the stepRocker has one connector for reference switches for all three motors, the driver input connector (TTL level) for motor 0, two controller output connectors (TTL level) for motors 1 and 2 and the GPIO connector, which can be used e.g. for connecting an ABN-encoder.

Start with power supply OFF and do not disconnect the motor while the board is powered as this can destroy the transistors!

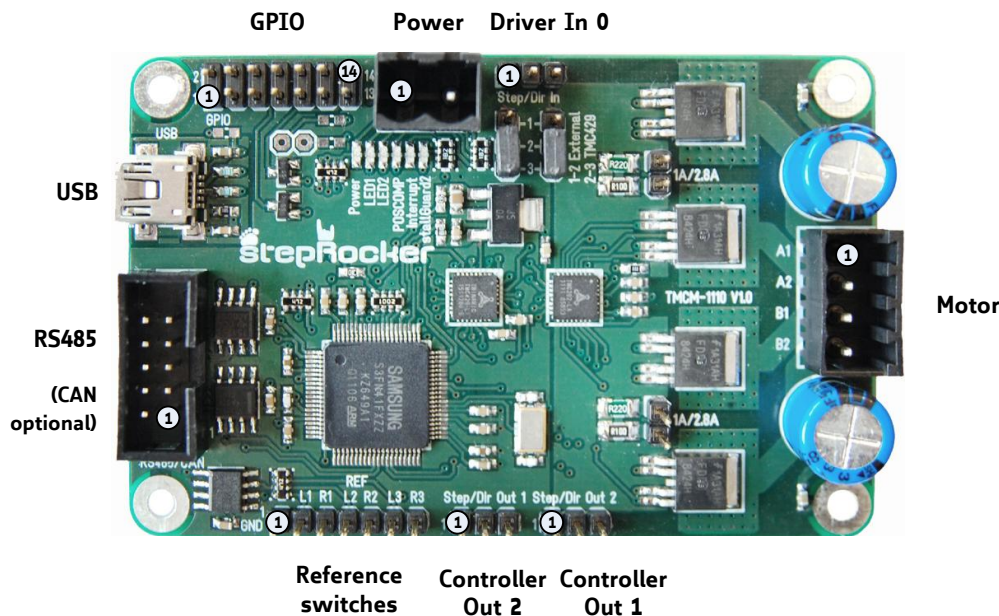


Figure 3.2: TCM-1110 stepRocker connectors

CONNECTORS OF TCM-1110 STEPROCKER

Label	Connector type	Mating connector type
Power	RIA 220-02, 2 pol., 5.08mm pitch, shrouded header	RIA 249-02, screw type terminal block, pluggable, centerline 5.08mm pitch
Motor	RIA 183-04, 4 pol., 3.5mm pitch, shrouded header	RIA 169-04, screw type terminal block, pluggable, centerline 3.5mm pitch
USB	USB-mini female connector	USB-mini male connector
RS485/CAN	Low profile box header without locking bar, type 8380, 10 pol., DIN 41651, 2.54mm pitch	Low profile IDC socket connector, 10pol., DIN41651, 2.54mm pitch
GPIO	Multi-pin-connector, 14 pol., 2.54mm pitch	Female connector with 2.54mm pitch
Ref. switches	Multi-pin-connector, 7 pol., 2.54mm pitch	Female connector with 2.54mm pitch
Driver In	Multi-pin-connector, 3 pol., 2.54mm pitch	Female connector with 2.54mm pitch
Controller Out 1, 2	Multi-pin-connector, 3 pol., 2.54mm pitch	Female connector with 2.54mm pitch

Table 3.1: Connectors and mating connectors

Because of the characteristic of the TCM-1110 stepRocker as development platform TRINAMIC offers its internal circuit diagram here: www.steprocker.com or www.motioncontrol-community.org. Please refer to the diagram in order to get further information about the pin assignments of μ C, TMC429, and TMC262.

3.2.1 Power Connector

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

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

Table 3.2: Power connector

3.2.2 I/O Connector to S3FN41F

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, <i>default: input</i>)
4	PWMU_0	in/out	General purpose I/O (+5V compatible, <i>default: output</i>)
5	PWMD_1	in/out	General purpose I/O (+5V compatible, <i>default: input</i>)
6	PWMU_1	in/out	General purpose I/O (+5V compatible, <i>default: output</i>)
7	PWMD_2	in/out	General purpose I/O (+5V compatible, <i>default: input</i>)
8	PWMU_2	in/out	General purpose I/O (+5V compatible, <i>default: output</i>)
9	AIN_0	in	Analog input (can be used as home switch) 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 3.3: I/O connector S3FN41F

3.2.3 Motor Connector

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

Do not connect or disconnect the motor while the board is powered as this can destroy the transistors!

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

Table 3.5: Motor connector

3.2.4 Reference Switch Connector to TMC429

Pin	Label	Direction	Description
1	GND	Power (GND)	Signal and system ground
2	L1	in	Input for left reference/limit switch of motor 0
3	R1	in	Input for right reference/limit switch of motor 0
4	L2	in	Input for left reference/limit switch of motor 1
5	R2	in	Input for right reference/limit switch of motor 1
6	L3	in	Input for left reference/limit switch of motor 2
7	R3	in	Input for right reference/limit switch of motor 2

Table 3.6: Reference switch connector

3.2.5 RS485 and CAN Connector

The standard TMC-1110 stepRocker uses the RS485 interface pins, only.

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 3.7: RS485/CAN connector

3.2.5.1 Prepare the stepRocker for CAN



**0.1 μ F capacitor
Housing: 0603**

**CAN transceiver
SN65HVD1050D
Housing: SOIC8**

The table above shows the pin configuration for CAN, too. Before starting with CAN it is necessary to solder a SN65HVD1050D CAN transceiver with housing SOIC8 and a 0.1 μ F capacitor with housing 0603 on the TMC-1110 stepRocker. Now, the stepRocker is ready for using the CAN interface.

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

Use firmware version V1.03 or higher with CAN interface!

It is not necessary to remove the RS485 transceiver.

3.2.6 USB Connector

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

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

3.2.7 Step/Dir Input Connector (Motor 0)

The TMC-1110 stepRocker is equipped with a step/dir input connector for motor 0. Via this connector an external motion controller can be used together with the on-board driver electronics. For selecting an external motion controller instead of the on-board TMC429 motion controller two jumpers have to be set (please refer to chapter 3.3).

Pin	Label	Direction	Description
1	GND	Power (GND)	Signal and System ground
2	Step In	in	Driver step input signal (+5V compatible)
3	Dir In	in	Driver direction input signal (+5V compatible)

Table 3.1: Step/dir input connector

3.2.8 Step/Dir Output Connectors (Motor 1 and Motor 2)

The TMC429 motion controller on the stepRocker is able to control up to three stepper motors. Its Step/Dir outputs (TTL level) for motor 1 and motor 2 are leaded through to connectors *Step/Dir Out 1* and *Step/Dir Out 2*. The TMC-1110 stepRocker can be extended to a complete motion controller/driver system for all three motors.

ATTENTION

Labels of the Step/Dir output connectors on the PCB are interchanged:

- *Step/Dir Out 1* is used for axis 2.
- *Step/Dir Out 2* is used for axis 1.



Controller OUT 2 Controller OUT 1

Pin	Label	Direction	Description
1	GND	Power (GND)	Signal and System ground
2	Step Out	out	Driver step output signal (+5V compatible)
3	Dir Out	out	Driver direction output signal (+5V compatible)

Table 3.2: Step/Dir Out connectors

NOTE

For setting the **step pulse length** global parameter **86** is used (available with firmware version 1.03 and higher). Adjust this parameter with the **SGP** command. Refer to the TMCL Firmware Manual of the stepRocker for further information.

3.2.9 μ C Programming Interface

The programming pads of the interface are on the backside of the module. There are possibilities for programming in two different modes: *debug mode* and *serial writing mode*. The selection of the programming mode depends on the chosen adapter. Further, it is possible to use the programming pads of the μ C interface by soldering adequate contacts directly on the programming pads.

Please refer to the datasheet of the S3FN41F microcontroller for further information.

http://www.samsung.com/global/system/business/semiconductor/product/2011/6/21/024872um_s3fn41f_rev10.pdf

PROGRAMMING PADS

Pin	Label	Description									
1	GND	Module and signal ground									
2	+5V	+5V DC supply									
3	nRST	Hardware reset input									
4	VPP	Connected to pin 14 of the processor (MODE0). VPP is used for mode setting ether to <i>debug mode</i> or to <i>flash serial writing mode</i>. <table border="1"> <thead> <tr> <th>Mode 1</th><th>Mode 0</th><th>Mode setting</th></tr> </thead> <tbody> <tr> <td>0</td><td>0</td><td>User normal/debug mode. (Used pins: SWDIO and SWDCLK.)</td></tr> <tr> <td>0</td><td>1</td><td>User flash serial writing mode. (Used pins: F_SDAT and PHASEA.)</td></tr> </tbody> </table> The user program mode for flash memory programming and sector erasing uses the internal high voltage generator, which is necessary for flash memory programming and sector erasing. In other words, the flash memory controller has an internal high voltage pumping circuit. Therefore, high voltage to VPP pin is not needed. To program the data into the flash ROM or sector erase in this mode, control registers should be used.	Mode 1	Mode 0	Mode setting	0	0	User normal/debug mode. (Used pins: SWDIO and SWDCLK.)	0	1	User flash serial writing mode. (Used pins: F_SDAT and PHASEA.)
Mode 1	Mode 0	Mode setting									
0	0	User normal/debug mode. (Used pins: SWDIO and SWDCLK.)									
0	1	User flash serial writing mode. (Used pins: F_SDAT and PHASEA.)									
5	PHASEA	Function: F_CLK – serial clock. Write speed: max 250kHz Read speed: max 3MHz									
6	F_SDAT	Serial Data pin (output for reading, input for writing) Input and push-pull output port can be assigned.									
7	SWDIO	Select/Serial Wire Data I/O. Internal pull-up									
8	SWDCLK	Serial wire clock									

Table 3.3: Programming pads

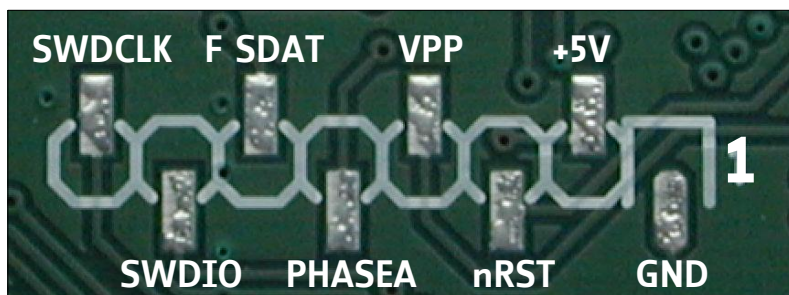


Figure 3.2: Programming pads

3.3 Jumper Settings

The TMC-1110 stepRocker offers possibilities for settings by jumper. Here, three adjustments are mentioned. *Select motion controller* and *select motor current* are basic. Jumpers on the GPIO connector are optional.

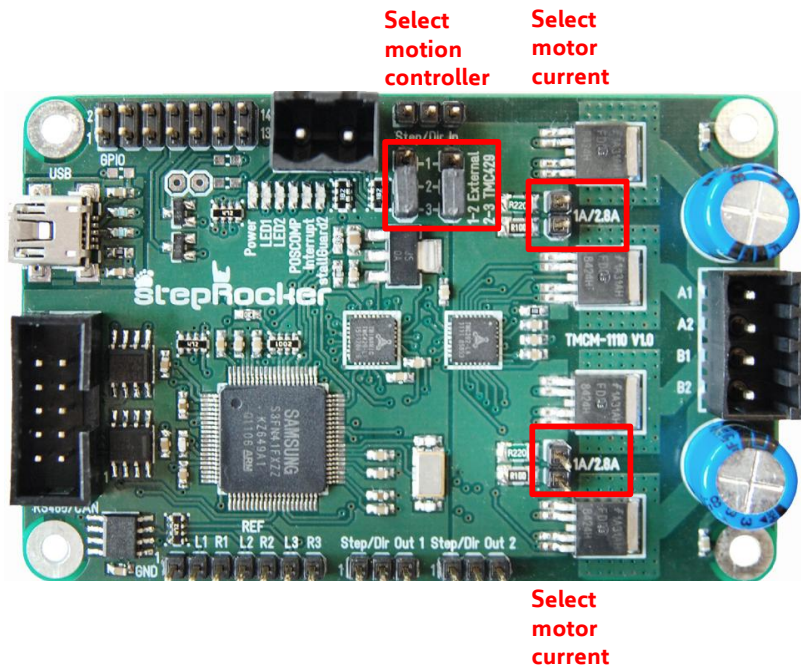


Figure 3.3: Jumper of TMC-1110 stepRocker

TMC-1110 STEPROCKER JUMPERS

Jumper	Label	Description	
Select motor current	1A/2.8A	Jumper plugged	motor current up to 2.8A RMS
		Jumper unplugged	motor current up to 1A RMS
Select motion controller	1-2 External 2-3 TMC429	Set jumpers to select motion controller TMC429 (on the module) or external, which have to be connected to Step/dir.	
		Jumper pins	Result
		1, 2	External motion controller selected. LEDs POSCOMP and interrupts are without statement
		2, 3	TMC429 selected

Table 3.4: Jumpers of TMC-1110 stepRocker

3.4 LEDs

LEDs OF THE TCM-1110 STEPRocker

Status	Label	Description
Power on	POWER	This orange LED lights up upon the power supply is working.
LED1 without defined function	LED1	This yellow LED is applicable and can be used customer specific. The LED is connected to pin 59 of the S3FN41F microcontroller.
LED2 without defined function	LED2	This yellow LED is applicable and can be used customer specific. The LED is connected to pin 58 of the S3FN41F microcontroller.
POSCOMP output used	POSCOMP	This yellow LED lights up if the POSCOMP output of the TMC429 is used. POSCOMP is available for triggering when moving over a programmable position.
Interrupt detected	Interrupt	This orange LED lights up upon interrupts. The LED is connected to the nIND_SDO_C pin of the TMC429.
stallGuard2™ detected	stallGuard2	This red LED light up upon stalling conditions. The LED is connected to the SG_TST pin of the TMC262.

Table 3.5: LEDs



Figure 3.4: LEDs of the stepRocker

3.5 Communication

3.5.1 RS485

For remote control and communication with a host system the TMC-1110 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.

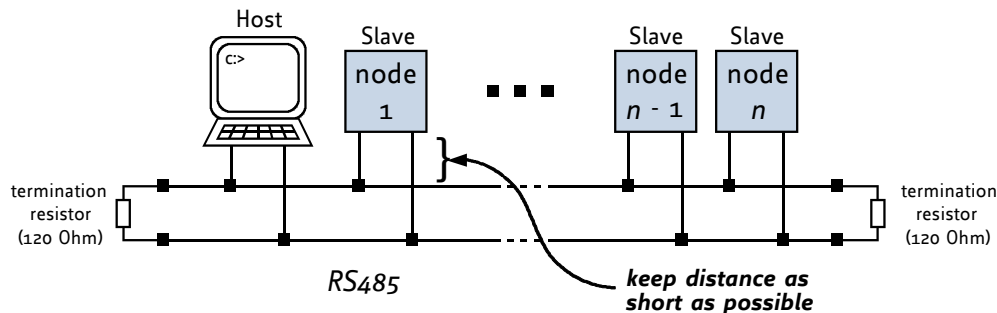


Figure 3.5: RS485 bus structure

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 TMC-1110 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-1110 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 as well defined logic levels. 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).

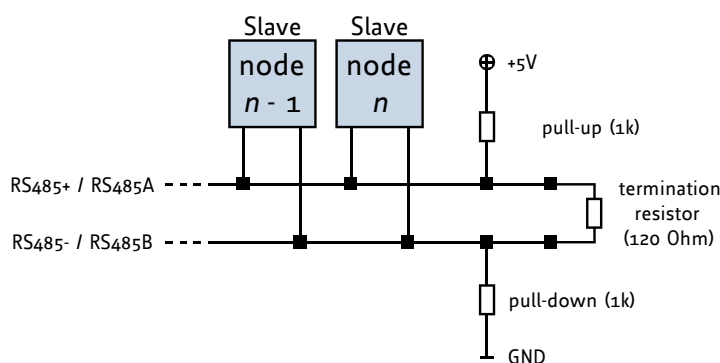


Figure 3.6: RS485 bus lines with resistor network

3.5.2 USB

For remote control and communication with a host system the TMC-1110 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-1110 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.

3.5.3 CAN (Retro-fit Option)

For remote control and communication with a host system the TMC-1110 stepRocker can be equipped with a CAN bus interface. *Please note, that it is necessary to prepare the board with a CAN transceiver and the according capacitor first (chapter 3.2.5.1).*

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.

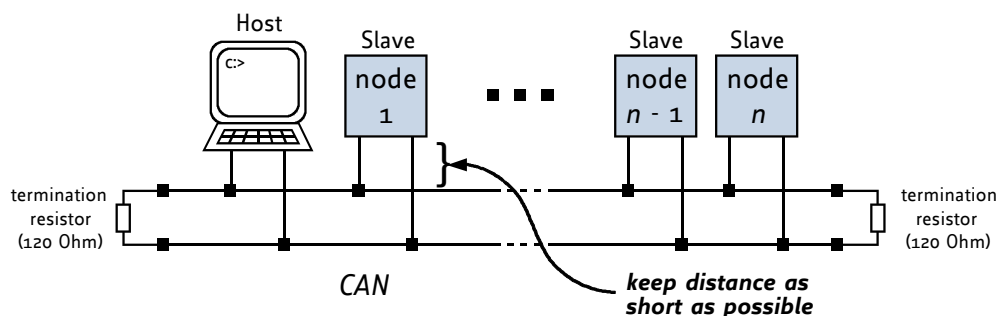


Figure 3.7: CAN bus structure

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 TMC-1110 does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus have to be added externally.

4 Functional Description

The TMC-1110 stepRocker is a highly integrated 1-axes controller/driver module. The TMC-1110 can be controlled via RS485 or USB serial interfaces (CAN *retro-fit option*).

The TMC-1110 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 normally 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 device with feedback is possible. The firmware of the module can be updated via any of the serial interfaces.

In case, you prefer developing your own TMCL™ commands for the stepRocker refer to www.steprocker.com. The TMCL™ boot loader on the board can be used for downloading new TMCL™ programs including such personal extensions, too.

The TMC-1110 module contains the following main components:

- ARM Cortex-M0 processor Core S3FN41F microcontroller with built-in up to 256 Kbytes program flash memory and up to 32 Kbytes SRAM. Processor is equipped with crystal (more precision for USB communication).
- TMC429 highly integrated 3 axes stepper motor controller. Step-/direction outputs for motor 0 connected to TMC262.
- TMC262 advanced stepper motor driver IC with stallGuard2™ and coolStep™ with integrated MOSFET driver transistors (4x power MOSFETs for 2-phase bipolar stepper option) for motor 0.
- RS485 and USB transceivers.
- On-board switching and linear voltage regulators for supply of on-board digital circuits

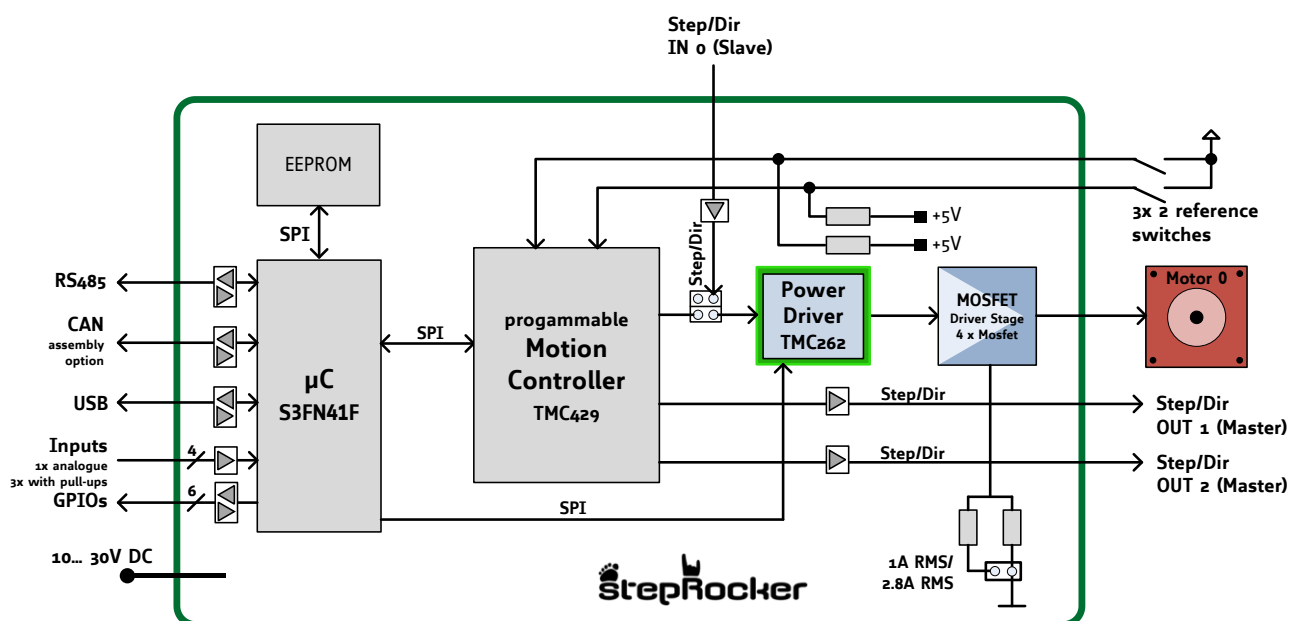


Figure 4.1: TCM-1110 stepRocker block diagram

4.1 Extensions of the TMC1110 stepRocker

The TMC1110 stepRocker provides the possibility for extension to full 3-axis systems. The stepRocker itself can be used as master or slave. An example for extensions is shown below.

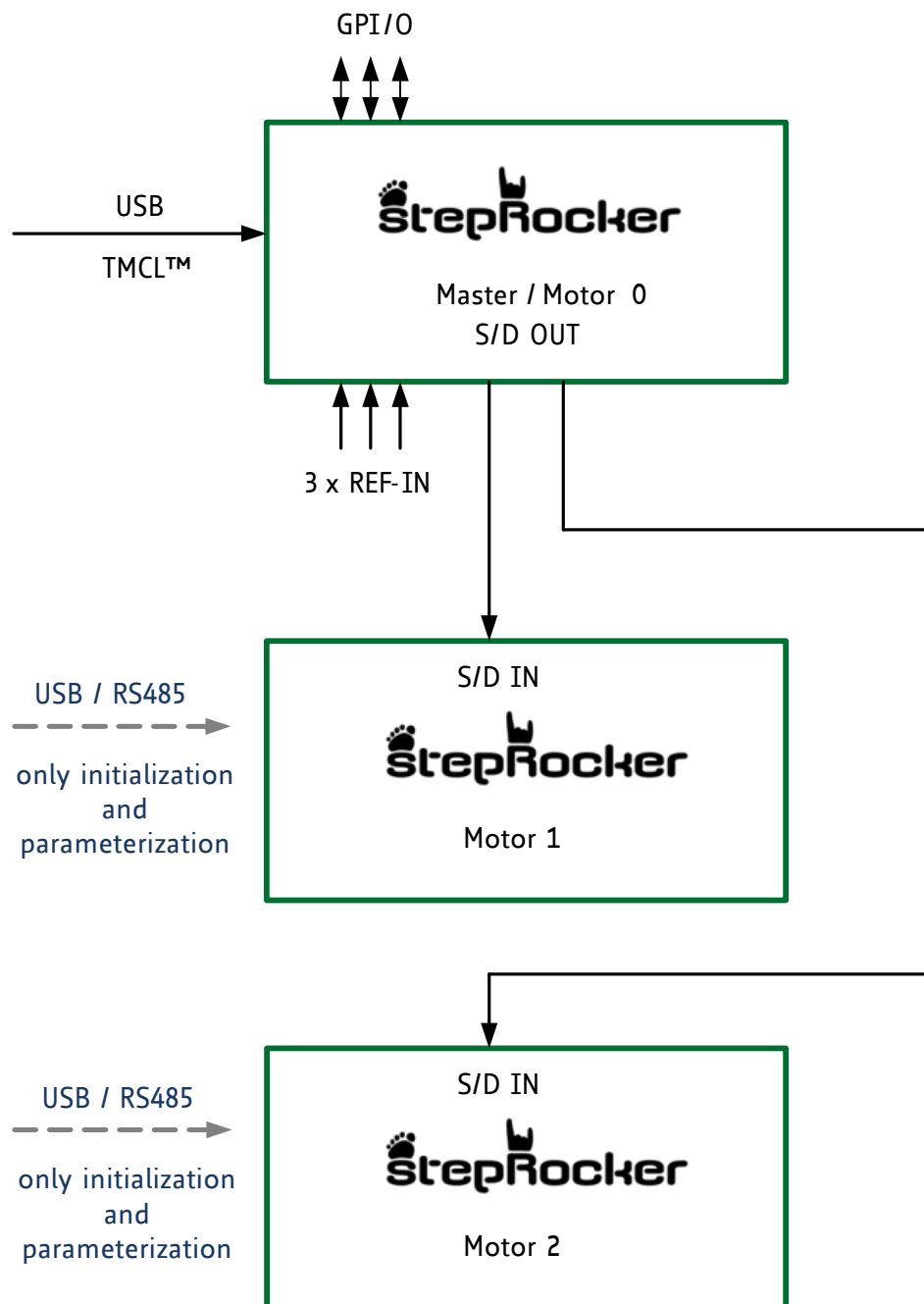


Figure 4.2: TMC1110 stepRocker extension

5 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.

Symbol	Parameter	Min	Typ	Max	Unit
V_{Power}	Power supply voltage	10	12... 24	30	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		1500 or 4000	mA
I_{MC}	Continuous motor current (RMS)	0		1000 or 2800	mA
T_{ENV}	Environment temperature at rated current (no forced cooling required)	-25	tbd	80	°C

Table 5.1: General operational ratings of the module

Symbol	Parameter	Min	Typ	Max	Unit
N_{RS485}	Number of nodes connected to single RS485 network			256	

Table 5.2: Operational ratings of RS485 interface

6 Life Support Policy

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

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

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Specifications are subject to change without notice.



7 Revision History

7.1 Document Revision

Version	Date	Author SD – Sonja Dwersteg GG – Guido Gandolfo	Description
1.00	2011-OCT-01	SD	First version
1.01	2011-OCT-04	GG	Minor changes
1.02	2011-OCT-05	SD	Minor changes
1.03	2011-OCT-27	SD	Minor changes
1.04	2011-OCT-31	SD	Minor changes
1.05	2011-DEC-21	SD	- Chapter 3.2.8 corrected: labels of Step/Dir Out 1 and Step/Dir Out 2 on PCB are interchanged. - Information about USB interface corrected (3.2.6)
1.06	2011-DEC-22	SD	I/O connector information updated (3.2.2).
1.07	2012-JAN-03	SD	Minor changes
1.08	2012-APR-04	SD	- Chapter 3.2.8 completed - Hint added in chapter 3.2.5.1

Figure 7.1: Document revision

7.2 Hardware Revision

Version	Date	Description
TMC-1110 V1.1	2011-SEP-02	Minor changes from version 1.0 to version 1.1

Figure 7.2: Hardware revision

8 References

[USB-2-485]	USB-2-485 interface converter manual available on http://www.trinamic.com
[TMC262]	TMC262 datasheet manual available on http://www.trinamic.com .
[TMC429]	TMC429 datasheet manual available on http://www.trinamic.com .
[S3FN41F]	S3FN41F processor manual available on www.samsung.com