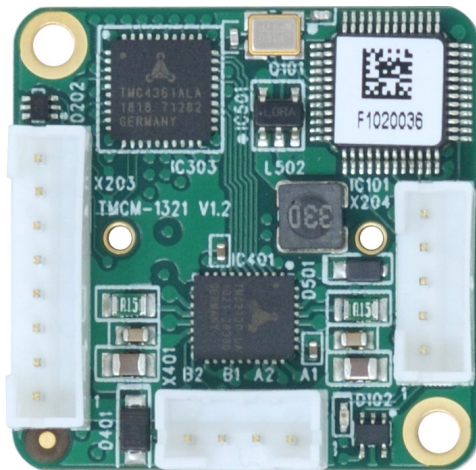


# TMCM-1321 Hardware Manual

Hardware Version V1.2 | Document Revision V1.00 • 2021-JAN-22

The TMCM-1321 is an easy to use, single axis controller/driver for 2-phase bipolar stepper motors with separate home and stop switch inputs. The built-in magnetic encoder can be used when a suitable magnet is attached to the motor axis, enabling also closed-loop operation. As an alternative, an optical encoder can be connected via digital ABN inputs. Different ramp shapes can be selected. Dynamic current control, and quiet, smooth and efficient operation are combined with StallGuard™ and CoolStep™ features.



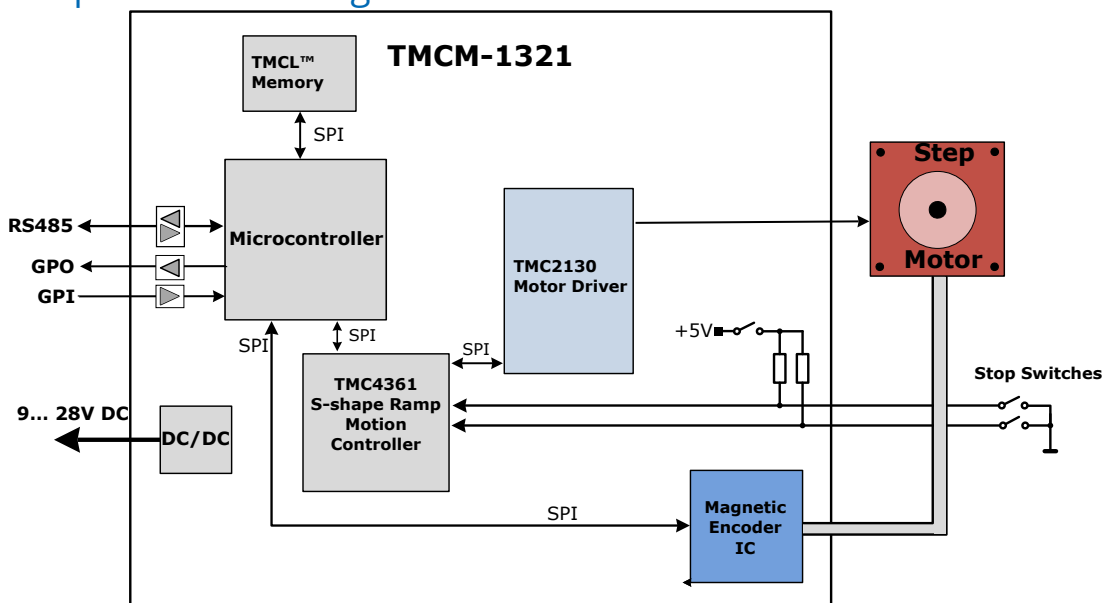
## Features

- Single axis stepper motor control
- Supply voltage 24V DC
- Up to 0.7A RMS (1A peak) motor current
- Hardware motion controller with different types of ramps
- Closed-loop operation possible
- RS485 interface
- General purpose inputs and outputs
- ABN encoder input
- Built-in magnetic encoder chip

## Applications

- Lab-Automation
- Robotics
- CNC
- Manufacturing
- Factory Automation
- Laboratory Automation

## Simplified Block Diagram



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# 1 Features

The TMC1321 is a highly integrated stepper motor driver and controller and includes a fully featured hardware motion controller and magnetic encoder chip. It drives up to 0.7A RMS motor phase current at 24V nominal. Configuration and control is possible via its RS485 bus interface. The module can directly be mounted on the back bell of standard NEMA11 stepper motors which are equipped with a diametrical 2-pole magnet in their rear shaft. As an alternative, an optical encoder (mounted directly on the motor shaft) can be used instead of the magnet.

## 1.1 General Features

### Main Characteristics

- Supply Voltage +24V nom. (+9V to +28V DC)
- Motor driver stage with 0.7A RMS phase current
- Highest micro step resolution, up to 256 micro steps per full step
- Magnet encoder chip (AS5047) with 14 bit resolution (16384cpr) for position feedback
- ABN encoder interface
- EEPROM for permanent onboard parameter storage
- Advanced s-shape ramps hardware motion controller (TMC4361A-LA)
- Home and stop switch inputs, also usable as general purpose inputs
- One general purpose output
- High performance SpreadCycle™ chopper mode
- High-precision sensorless load measurement using StallGuard2™
- Automatic current scaling algorithm CoolStep™ to save energy and keep your drive cool

### RS485 Bus Interface

- Standard RS485 Bus Interface for control and configuration
- Bit rates of up to 115200bps
- TMCL protocol
- Firmware update via RS485



## 2 Order Codes

Order Code	Description	Size (LxW)
TMCM-1321	Module, 0.7A RMS, +24V DC, RS485 Bus interface, TMCL firmware	28mm x 28mm

*Table 1: Order codes*

Order Code	Description
TMCM-1321-CABLE	Cable loom for TMCM-1321: <ul style="list-style-type: none"><li>• 1x cable loom for motor connector with 4-pin JST PH series connector</li><li>• 1x cable loom for encoder connector with 5-pin JST PH series connector</li><li>• 1x cable loom for power, interface and I/O connector with 8-pin JST PH series connector</li></ul>

*Table 2: Order codes cable loom*



### 3 Mechanical and Electrical Interfacing

#### 3.1 TCCM-1321 Dimensions

TCCM-1321 has a size of 28mm x 28mm with round-shaped corners. It has two M2.5 mounting holes that allow for easy assembly to the back bell of a standard NEMA11 stepper motor. Motor, Power and I/O connectors are placed on opposite edges of the board.

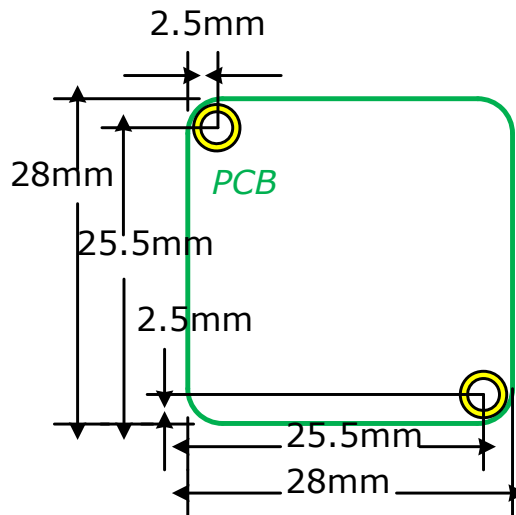


Figure 1: TCCM-1321 dimensions

#### 3.2 Mounting Considerations

The module can directly be mounted on the back bell of standard NEMA11 stepper motors. If the built-in magnetic encoder is to be used a diametrical two pole magnet has to be mounted onto the rear shaft of the motor. If an optical encoder is to be used the optical encoder has to be mounted to the motor shaft (without any gearing in between). The TCCM-1321 module has two metal plated mounting holes. Both mounting holes are connected to board supply ground. Please keep this in mind when mounting the board to the rear side of a motor.

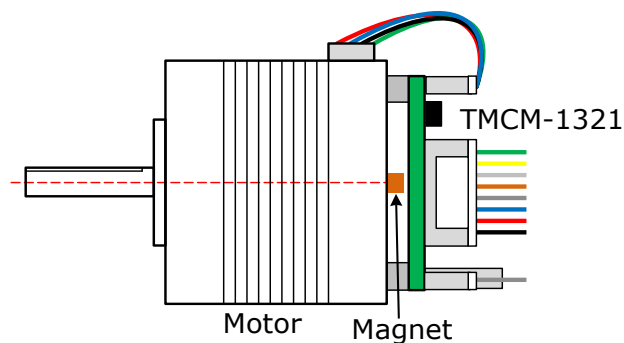


Figure 2: TCCM-1321 example motor assembly



## 4 Connectors and LEDs

The TMCM-1321 is equipped with three connectors – one 8-pin connector for power supply, communication (RS485) and I/O, one 5-pin connector for external ABN encoders and one 4-pin connector for connecting the stepper motor.

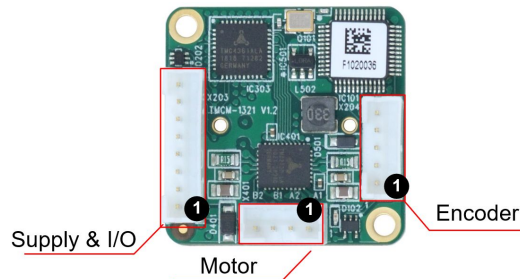


Figure 3: TMCM-1321 connectors

Overview of connector and mating connector types:

Label	Connector type	Mating connector type
Power supply and I/O connector	JST PH series, 8 pins, 0.1" pitch	Connector housing: JST PHR-8 Contacts, Wire: AWG 24
Encoder connector	JST PH series, 5 pins, 0.1" pitch	Connector housing: JST PHR-5 Contacts, Wire: AWG 24
Motor connector	JST PH series, 4 pins, 0.1" pitch	Connector housing: JST PHR-4 Contacts, Wire: AWG 24

Table 3: Connector and mating connectors

### 4.1 Power supply and I/O Connector

Pin no.	Pin name	Description
1	GND	Supply and signal ground connection
2	+24V	Supply voltage input (+6V to +28V DC)
3	RS485+	RS485 bus interface (non-inverting)
4	RS485-	RS485 bus interface (inverting)
5	OUT0	General purpose output, open drain
6	HOME / IN0	Home switch input, also usable as general purpose input (+24V compatible)
7	STOPL / IN1	Left stop switch input, also usable as general purpose input (+24V compatible)
8	STOPR / IN2	Right stop switch input, also usable as general purpose input (+24V compatible)

Table 4: TMCM-1321 Power supply and I/O connector pin assignment



**NOTICE** **Always keep the power supply voltage below the upper limit of 28V!** Otherwise the driver electronics will be seriously damaged. Especially, when the selected operating voltage is near the upper limit a regulated power supply is highly recommended.

**NOTICE** **Add external power supply capacitors!** It is recommended to connect an electrolytic capacitor of significant size (e.g. 470µF/35V) to the power supply lines next to the TMCM-1321!  
 Rule of thumb for size of electrolytic capacitor:  $C = \frac{1000\mu F}{A} \times I_{SUPPLY}$   
 In addition to power stabilization (buffer) and filtering this added capacitor will also reduce any voltage spikes which might otherwise occur from a combination of high inductance power supply wires and the ceramic capacitors. In addition it will limit slew-rate of power supply voltage at the module. The low ESR of ceramic-only filter capacitors may cause stability problems with some switching power supplies.

## 4.2 Motor Connector

Pin no.	Pin name	Description
1	A1	Motor phase A pin 1
2	A2	Motor phase A pin 2
3	B1	Motor phase B pin 1
4	B2	Motor phase B pin 2

Table 5: Motor connector pinning

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

## 4.3 Encoder Connector

Pin no.	Pin name	Description
1	GND	Supply and signal ground
2	+5V	+5V encoder supply output
3	A	Encoder A channel
4	B	Encoder B channel
5	N	Encoder null channel

Table 6: Motor connector pinning



## 4.4 RS485 Connection

For remote control and communication with a host system the TMCM-1321 provides a RS485 bus interface. For proper operation the following items should be taken into account:

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.

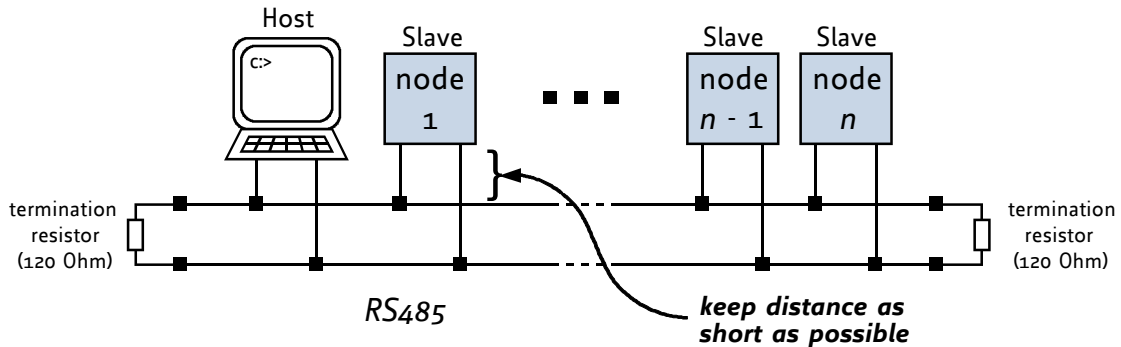


Figure 4: RS485 bus structure with termination resistors

2. **BUS TERMINATION:**

Especially for longer buses and/or multiple nodes connected to the bus and/or high communication speeds, the bus should be properly terminated at both ends. The TMCM-1321 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-1321 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-1321 hardware is 1Mbit/s. Factory default is 9600 bit/s. Please see separate TMCM-1321 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):





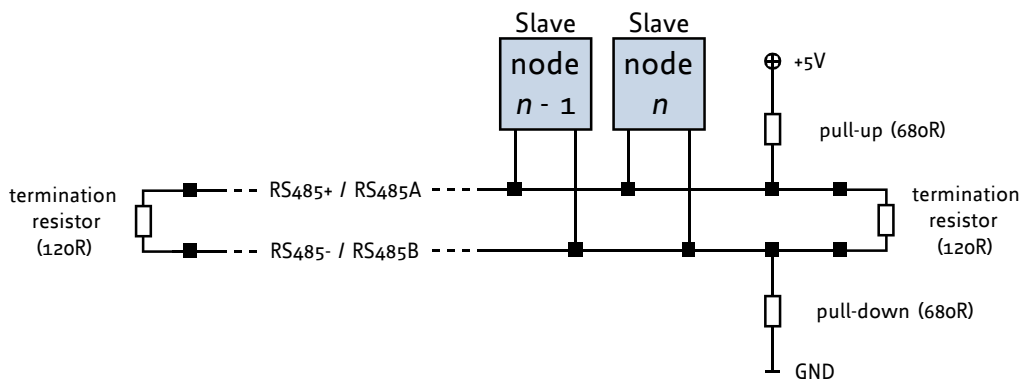


Figure 5: RS485 bus lines with resistor (bias) network on one side, only

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

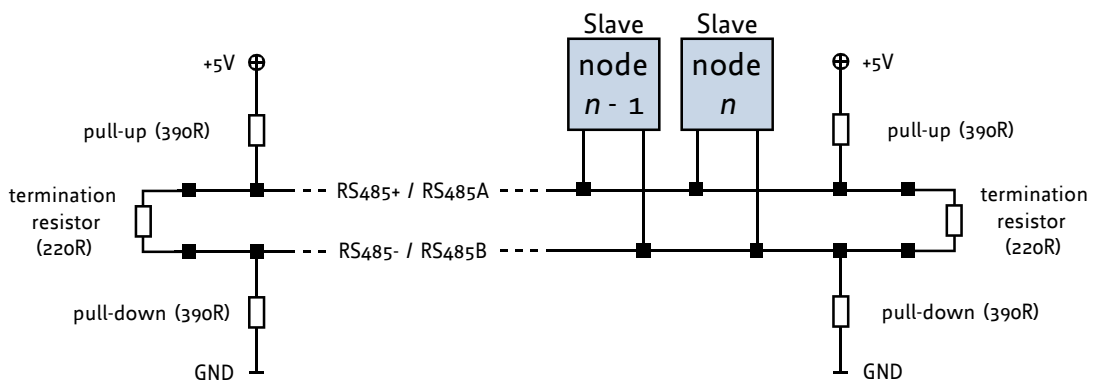


Figure 6: RS485 bus lines with Profibus™ recommended line termination

## 4.5 RS485 Bus Adapters

To quickly connect to the TMCM-1321 a PC based integrated development environment called TMCL-IDE is available. The latest release can be downloaded for free from our web site: [www.trinamic.com](http://www.trinamic.com) A number of common CAN interface adapters from different manufactures is supported from within this software. Please make sure to check our web site from time to time for the latest version of the software!

## 4.6 Status LED

The TMCM-1321 module is equipped with a green status LED. When in TMCL mode the LED is blinking. When in boot loader mode the LED is constantly on.



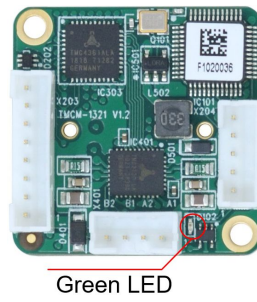


Figure 7: TMCM-1321 LED



## 5 Operational Ratings and Characteristics

### 5.1 Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply voltage	+9	+28	V
Working temperature	-30	+40	°C
Motor coil current / sine wave <b>peak</b>		1.0	A
Continuous motor current ( <b>RMS</b> )		0.7	A

#### NOTICE

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

### 5.2 Electrical Characteristics (Ambient Temperature 25° C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	$V_{DD}$	9	24	28	V
Motor coil current / sine wave <b>peak</b> (chopper regulated, adjustable via RS485 interface)	$I_{COILpeak}$	0		1.0	A
Continuous motor current ( <b>RMS</b> )	$I_{COILRMS}$	0		0.7	A

Table 8: Electrical Characteristics

### 5.3 I/O Ratings (Ambient Temperature 25° C)

Parameter	Symbol	Min	Typ	Max	Unit
Input voltage	$V_{IN}$		5	5.5	V
Low level voltage	$V_L$	0		1.75	V
High level voltage	$V_H$	3.25		5	V

Table 9: I/O ratings



## 5.4 Functional Characteristics

Parameter	Description / Value
Control	RS485 bus interface, four digital inputs, one configurable output
Communication	RS485 bus interface for control and configuration using TMCL protocol, up to 115200bps (default 9600bps)
Driving Mode	spreadCycle, constant $T_{off}$ chopper, adaptive current control via stallGuard2 and coolstep
Stepping Resolution	Full, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 step

Table 10: Functional Characteristics

## 5.5 Other Requirements

Specifications	Description or Value
Cooling	Free air
Working environment	Avoid dust, water, oil mist and corrosive gases, no condensation, no frosting
Working temperature	-30° C to +40° C

Table 11: Other Requirements and Characteristics



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## 8 Supplemental Directives

### 8.1 Producer Information

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## 9 Revision History

### 9.1 Hardware Revision

Version	Date	Author	Description
1.2	2021-01-22	TMC	First release.

*Table 12: Hardware Revision*

### 9.2 Document Revision

Version	Date	Author	Description
1.00	2021-01-22	TMC	First release.

*Table 13: Document Revision*

