

# TMCM-300

Version: 1.05  
October 1<sup>st</sup>, 2004



Sternstrasse 67  
D - 20357 Hamburg, Germany  
Phone +49-40-51 48 06 - 0  
FAX: +49-40-51 48 06 - 60  
<http://www.trinamic.com>

---

# Version

Version	Date	Author	Remarks
1.0	19.11.2001	Fittschen	
1.02	08.01.2002	Koettlitz	
1.03	19.02.2002	Fittschen	
1.04	5-Aug-03	OK	Error corrections, software description changed
1.05	1-Oct-04	OK	Font changed, address changed

# Table of contents

TMCM-300.....	1
1 Hardware Description.....	3
1.1 General Discription .....	3
1.2 Description of the architecture .....	3
1.2.1 Microcontroller .....	3
1.2.2 EEPROM .....	4
1.2.3 TMC428 .....	4
1.2.4 Drivers .....	4
1.2.5 Communications Interface.....	4
1.2.6 I/O Interface .....	4
1.3 Features and Maximum Rates.....	5
1.3.1 Operation Modes .....	5
1.3.2 Axes.....	5
1.3.3 Ramp Profiles .....	5
1.3.4 Stepping Frequency.....	6
1.3.5 Step Type .....	6
1.3.6 Current Control .....	7
1.3.7 Interfaces .....	7
1.3.8 Inputs .....	9
1.3.9 Outputs .....	11
1.3.10 Supply.....	11
1.3.11 Motor Drive Current .....	12
1.3.12 Motors.....	12
1.3.13 Temperature Range .....	13
1.3.14 Reference Switches.....	13
1.4 Microcontoller assignments .....	15
1.5 Connector assignments .....	16
1.5.1 ISP-Connector .....	16
1.5.2 Connector 1 .....	16
1.5.3 Connector 2 .....	17
1.5.4 Connector 3 .....	17
1.6 Mechanical Data .....	18
1.6.1 Dimensions .....	18
1.7 Base Board Connection .....	20
2 Software description.....	21
2.1 TMCL .....	21
2.2 C.....	21

# 1 Hardware Description

## 1.1 General Description

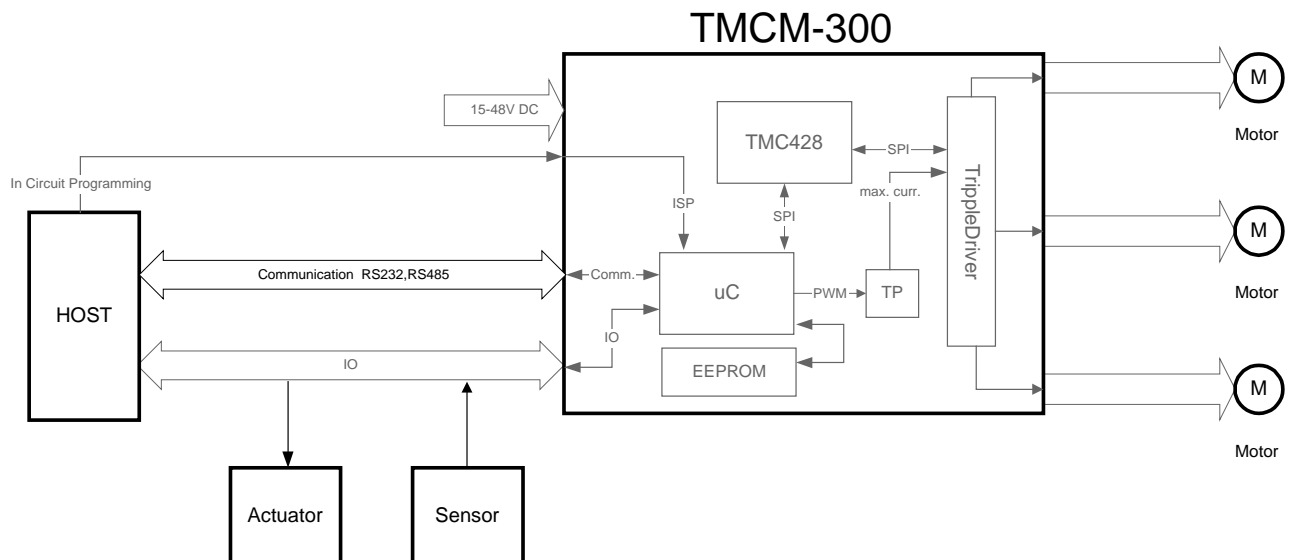
TMCM-300 is a triple axes step motor control, which can be controlled by a host, or can be operated in the Standalone-Mode.

The circuit can be integrated directly in one's own designs and thus there can be saving on expensive in-house development.

There is an option to control the module either via RS232 or RS485 interface or to allow a program stored in the micro controller to run independently.

## 1.2 Description of the architecture

The architecture of TMCM-300 includes the interface for communication, microcontroller, step motor controller TMC428 by TRINAMIC and the drivers for the motors. I/O-Interfaces can be used for querying analog and digital signals and for controlling the external components. The microcontroller can be programmed in the circuit and has a FlashROM and an EEPROM. If a unit is driven without a host, an additional EEPROM exists for the permanent storage of operating parameters or user applications.



**Figure 1 Architecture of TMCM-300**

### 1.2.1 Microcontroller

The microcontroller ( $\mu\text{C}$ ) Atmega323 controls the TMC428 and I/O lines and communicates with the host alternately via the RS232 or RS485 interface.

The  $\mu\text{C}$  can subsequently be programmed using the most up-to-date TMCM-300 Firmware in each case via the ISP interface (In System Programming). A software written by the user can likewise be loaded in the  $\mu\text{C}$ .

## 1.2.2 EEPROM

The TMCM-300 has an additional EEPROM with a capacity of 16384 Bytes, in which any data can be stored permanently. One application of this EEPROM is e.g. the command memory for the standalone mode or as coordinate memory. The EEPROM can be programmed by the host or by the microcontroller.

## 1.2.3 TMC428

The TMC428 as it's main function works out the speed profile from the given parameters maximum speed ( $v_{max}$ ), minimum speed ( $v_{min}$ ) and acceleration ( $a_{max}$ ) and generates the signals for the motor driver.

## 1.2.4 Drivers

The drivers supply power to the motors and limit it to the value specified by the TMC428. The maximum current is individually specified by the  $\mu C$  via a pulse-width modulation for each motor.

## 1.2.5 Communications Interface

The communications interface includes the RS232 and RS485 interfaces. The RS232 interface is used for the single and direct computer connection. The RS485 interface is a two-wire bus, on which 31 ( with repeater maximum 254 TMCM-300 modules) can be run. As a result of this, it is possible to control up to 762 step motors with one host.

.

## 1.2.6 I/O Interface

The I/O interface is used for the level change of the input signals and for providing sufficiently high currents for the outputs. The inputs are designed for TTL level but can be adjusted to 24 V according to customer requirement.

## 1.3 Features and Maximum Rates

Operation Modes:	Host controlled or standalone.
Axes	3
Ramp Profile	Automatic 3-phase ramps with programmable parameters for maximum velocity and acceleration for each channel, Alternatively user defined motion (e.g. Joystick control), Automatic reference search (reference switch)
Stepping Frequency:	Full step frequencies up to 15 kHz (3 axes).
Step Type:	64-times microstep, independent of stepping frequency
Current Control:	Programmable acceleration dependent motor current and stand-by current for current reduction
Interfaces:	RS 232 or RS 485
Inputs:	8 digital/analog (10 bit) inputs, 6 digital for reference, stop left and stop right switches. 2 additional digital inputs 24V (optional optical isolated).
Outputs:	7 Open Collector outputs with up to 100mA sink current per output with an external source; 5V supply (up to 50mA)
Supply:	15 to 48V DC, ca. 1W without load; max. ca. 4.5A, depending on motor type; 5V DC Out max.
Motor Driver Current:	Software configurable 200-1500 mA per motor (peak coil current).
Motors:	Bipolar 2-phase motors
Temperature Range:	0°C to 70°C (70°C with reduced current and additional heat sink)
Reference Switches:	Automatic reference search and travel switch checking. Supports 3 switches per axis.
Memory:	Up to 128kBit serial eeprom for any data.
Microcontroller:	Atmel Atmega323
Mechanical Data:	90mm x 85mm x 23mm ; 55gram

**Table 1** Characteristics and limits

### 1.3.1 Operation Modes

The module can be run from a host or as a standalone unit.

In the host operating mode, e.g. a PC takes over the control of the TMCM-300 via the RS232 or RS485 interface. The host then sends the commands for acceleration, movement, delay etc. and queries the current status.

The standalone operating mode is provided for the execution of programs which are written by the user himself and are loaded in the microcontroller.

### 1.3.2 Axes

The user has the option to simultaneously run up to three step-motors.

### 1.3.3 Ramp Profiles

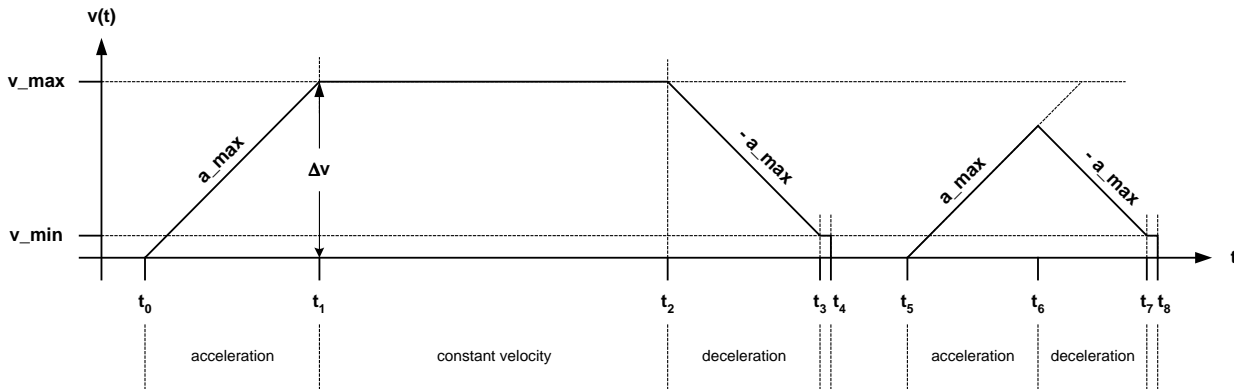
The speed profile is automatically worked out by TMCM-300 from the values for the minimum speed, maximum speed and acceleration specified by the user. Two modes of operation for the course of acceleration are available for selection.

- In the **Ramp-Mode** ( $a_{max}$ ), maximum ( $v_{max}$ ) and minimum ( $v_{min}$ ) speed and target position ( $x_{target}$ ) are specified for the acceleration. On giving the target position, TMCM-300 calculates the speed profile of each step motor from the current position and the specified parameters and immediately converts it in to a motion sequence.

In Figure 2 Velocity profile in ramp mode an example of the motion sequence is shown. Here the motor accelerates from  $t_0$  onwards with  $a_{max}$  till it reaches  $v_{max}$  in  $t_1$ , then it moves itself with  $v_{max}$  up to  $t_2$ , it

then slows down with  $a_{max}$  till it reaches  $v_{min}$  in  $t_3$  and then it travels with  $v_{min}$  till it reaches its target ( $x_{target}$ ) in  $t_4$ .

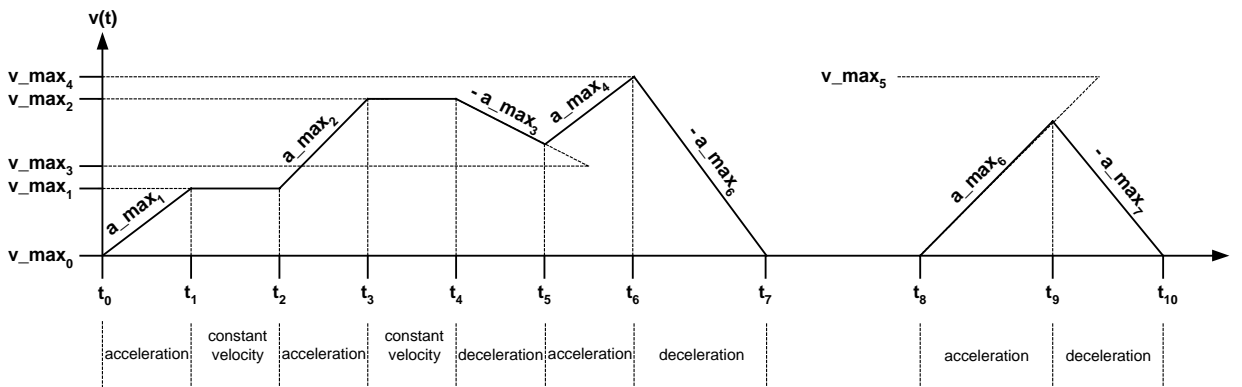
On the right side of the Figure it can be seen that  $v_{max}$  cannot be reached if  $a_{max}$  is too small or the target ( $x_{target}$ ) is too close.



**Figure 2 Velocity profile in ramp mode**

- In **Velocity-Mode** the acceleration and the maximum speed is specified in TMCM-300. Then the motor accelerates immediately with the specified value to the maximum speed and continues to run at constant speed till new values are available.

In Figure 3 Velocity profile in velocity mode the motion sequence for the velocity mode is shown as an example. Here the motor accelerates with  $a_{max}$  till it reaches  $v_{max}$  and then continues to run at constant speed with  $v_{max}$  till new  $a_{max}$  and  $v_{max}$  is specified. On the right side the  $v_{max}$  is not distinctly reached if a new parameter is prematurely given.



**Figure 3 Velocity profile in velocity mode**

A detailed explanation of the parameters and its calculation is given in the software description.

### 1.3.4 Stepping Frequency

Maximum full step frequency is 15kHz.

### 1.3.5 Step Type

Microstep operation with up to 64 steps for each full step.

### 1.3.6 Current Control

The motor current can be influenced using two modes. Both the modes are mutually exclusive.

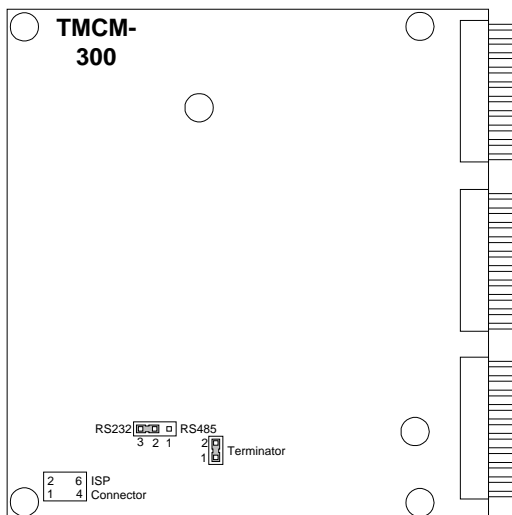
**TMC Mode:** Here the current for the acceleration, running and stationary condition can be scaled in eight steps. With the scaling of the current, the effective number of microsteps per full step reduces proportionally

**Time Mode:** Here the motor current for the stationary condition is reduced after a time which can be set to an adjustable value.

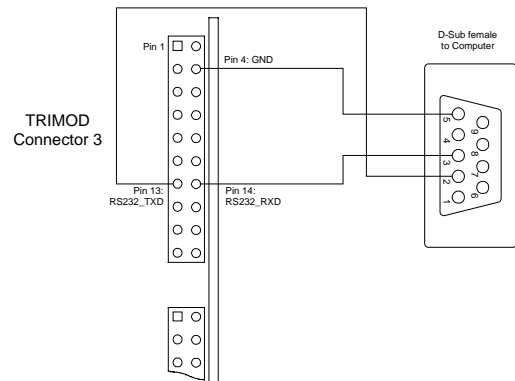
More detailed explanation in this regard is given in the software description.

### 1.3.7 Interfaces

One can select either RS232 or RS485 interface . The setting is done via a jumper. Figure 4 RS232/RS485 jumper on the circuit board shows its position on the right side of the plate. Connection to a computer via RS232 interface is shown in Figure 5 RS232 connection. Die RS232 interface is intended for direct and easy connection of TMCM-300 to a computer. The data transmission takes place in full duplex mode i.e. simultaneous sending and receiving is possible. This interface is suitable for cable lengths of up to 30m.



**Figure 4 RS232/RS485 jumper on the circuit board**



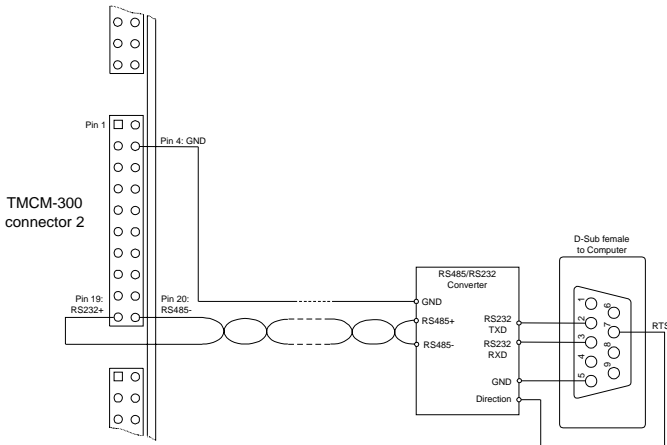
**Figure 5 RS232 connection**

With the RS485 interface (Figure 6 RS485 Connection) long distances can be bridged. Depending on the baud rate and cable used, lengths of up to 1200m are possible. For this, an appropriate driver module is connected to the serial interface of the computer and at both the ends of the bus to suppress the line reflections. A terminator of 120 Ohm can be connected to TMCM-300 via a jumper. Figure 6 RS485 Connection shows its position on the plate.

With the help of a corresponding software in TMCM-300, at this interface up to 31 TMCM-300 modules can be operated simultaneously, with the use of bus repeaters up to 254 modules are possible.

The data transmission takes place in half duplex mode i.e. it can be only sent or received alternately. Generally the switchover between sending and receiving takes place through RTS conductor of the serial interface of the computer. TRINAMIC Software correspondingly takes this into consideration.

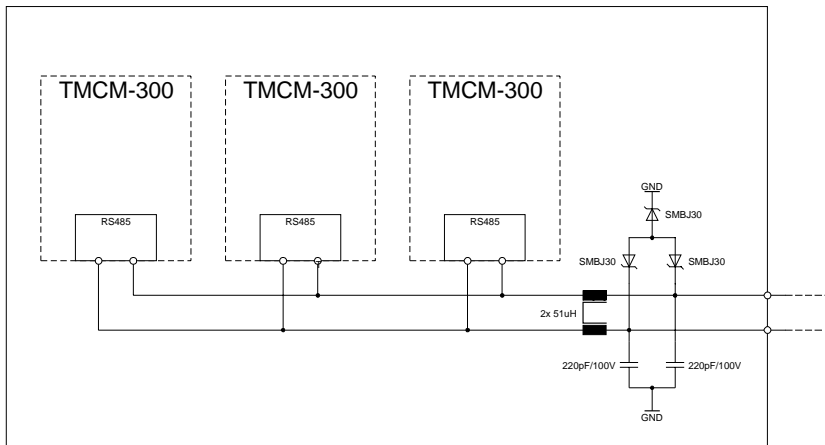
The protocol of TMCM-300 in case of both the interfaces consists of a starbit, eight databits and a stopbit at a baud rate of 19200 Baud. Baud rates up to 115 kBaud are possible. Detailed explanation concerning this is given in the software description.



**Figure 6 RS485 Connection**

For a EMC oriented device design with the TMCM-300 a corresponding filter and safety circuit for a low radiation and less sensitivity against radiation from outside is recommended according to Figure 7 EMC oriented RS485 output.

The inductance used is a current compensated double inductance from EPCOS order no.: B82790S0513N201.



**Figure 7 EMC oriented RS485 output**



### 1.3.8 Inputs

Eight inputs (ADIN0 - ADIN7) are available which can be optionally used as analog or digital. The input voltage range is from 0V - 5V or TTL level. In analogue operation the input resistor is of 100 MOhm and the signal is released with 10 Bit.

These inputs are continuously protected against voltages upto 8V. The connection is shown in Figure 8 Input circuit of ADIN0 to ADIN7 inputs. Optionally the input voltage range can be extended to 24V.

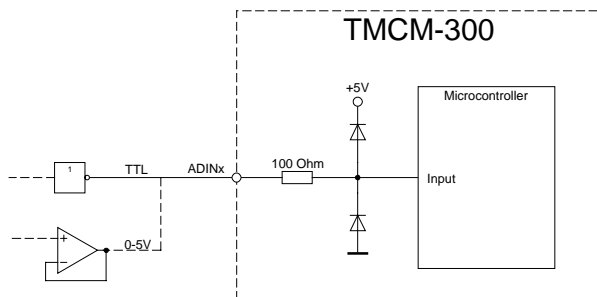


Figure 8 Input circuit of ADIN0 to ADIN7 inputs

Figure 9 Input circuit of REFxx inputs shows the internal connection of the TMCM-300 for reference switch inputs. Safety circuit to protect against excess voltage is done away with since only passive circuit elements are connected. Two other digital inputs are designed for 24V (Figure 10 Input circuit of OPTOx inputs). Overvoltage protection up to 35V input voltage is constantly ensured. Optionally a voltaic separation of inputs from the controls is achieved with the help of optocoupler.

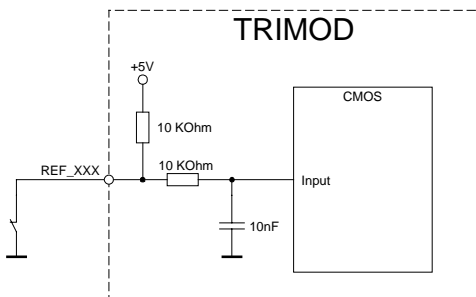


Figure 9 Input circuit of REFxx inputs

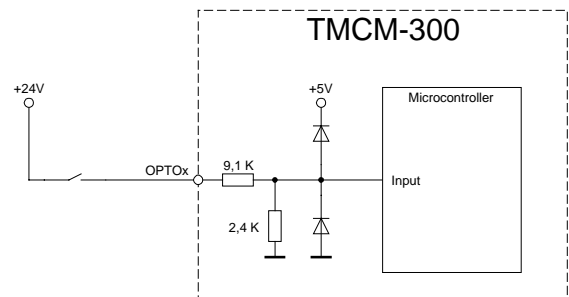


Figure 10 Input circuit of OPTOx inputs

An additional input to disable the motor drivers is available on connector 2 - pin 14 (shutdown). This input is TTL compatible and high active. Normally it is connected to ground.

---

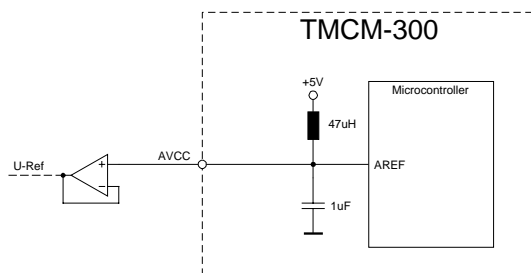
### 1.3.9 Outputs

For supply to small external TTL circuits, a 5V-voltage supply with a maximum loading capacity of 150mA is available. This voltage is available on connector 2 - pin 2. The 5V reference voltage of the analog-digital-converter on connector 2: pin 1 can be measured. The load of this source should not exceed 500uA and therefore should be buffered by an external amplifier as shown in Figure 11 Reference voltage output. Further seven open collector outputs are freely available. The loading capacity of an individual output is max. 100mA. The outputs are connected via a pull-up i.e. a serial circuit consisting of a diode and a 1 kOhm resistor to +5 Volt. Due to this connection it is also possible to connect loads, which are supplied externally with a voltage of up to 24V (Industry standard).

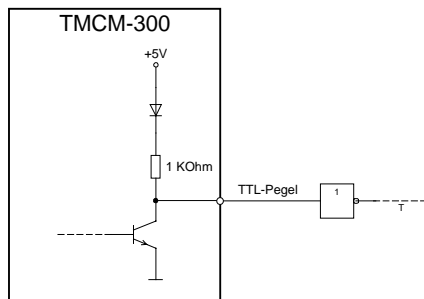
In Figure 12 and Figure 13, the connection variations are shown. The outputs DOUT0 - DOUT7 are available on connector 3: pin 5-11.

Another output with TTL level is the connection DOUT8 on connector 3: pin 12. This output is directly connected with the Portpin PC7 of the microcontroller.

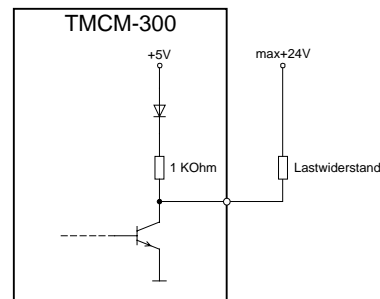
For the purpose of controlling, an LED is available on the TMCM-300 and can be freely used through software developed in-house. The LED is directly connected with the Portpin PB0 of the microcontroller.



**Figure 11 Reference voltage output**



**Figure 12 Output with TTL gate**



**Figure 13 Output with load resistor**

### 1.3.10 Supply

The supply voltage is permissible in the range of 15V to 48V direct voltage. TMCM-300 has a power consumption of approximately 1 Watt without motor load. The maximum current consumption should not exceed 4.5A and is dependent on the type of motor used.

The 5V voltage supply is generated internally from the supply voltage using a switching power supply modules and is displayed through an LED.

### 1.3.11 Motor Drive Current

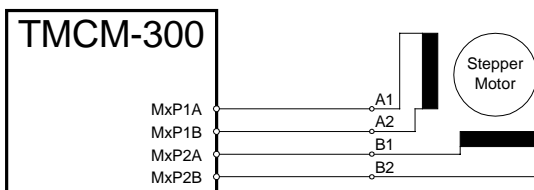
The motor current can be varied in the range of 200mA to 1.5A with the help of the software.

The maximum current per phase can be momentarily rise up to 1.5A. The average total motor current in continuous operation should not exceed 1A .

### 1.3.12 Motors

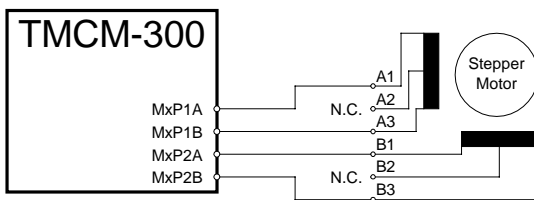
To achieve maximum RPM, motors with low inductance and less resistance should be selected. However, low resistance leads to reduction in torque. For this reason a motor type with low inductance should be selected, which fulfills the required torque at the maximum permissible total current. A high operating voltage of the TMCM-300 is reflected in high achievable RPMs of the step motors. A high resistance or a too low operating voltage leads to increased switching-on time of the chopper driver. A switching-on time of more than 50% can lead to very high noise in the motor. Primarily bipolar two phase motors are used.

Figure 14 shows the connection to the TMCM-300.

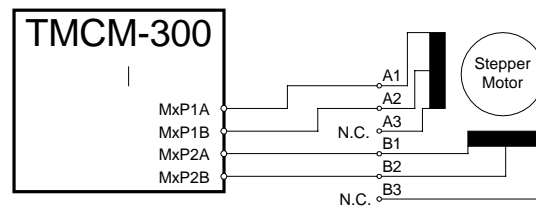


**Figure 14 Connection of a bipolar two-phase motor**

Unipolar motors can also be used, but depending on the type of connection these have the disadvantage of reduced torque or reduced speed. In Figure 15 and Figure 16 the circuit variations are shown. The circuit as per Figure 15 should be used if high torque is required at low speed. Figure 16 shows the variation for higher RPM, but then the torque is reduced.

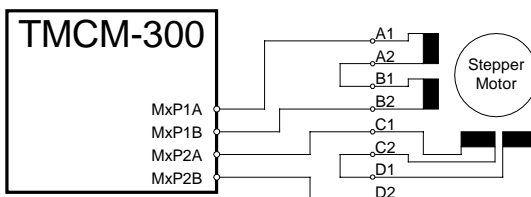


**Figure 15 Unipolar two-phase motor (low speed)**

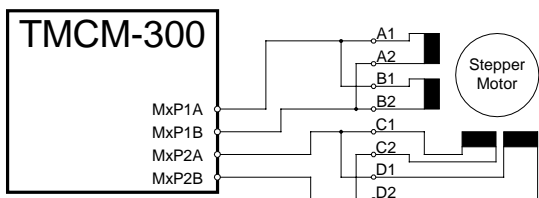


**Figure 16 Unipolar two-phase motor (high speed)**

Four phase motors with eight connections are better suited here since in both the types of connections all the phases are used. If at low RPM a high torque is required then the connection as per Figure 17 should be used. If maximum torque has to be achieved at high RPM then the connection as per Figure 18 is used.



**Figure 17 Bipolar motor with 8 connections (low speed)**



**Figure 18 Bipolar motor with 8 connections (high speed)**

### 1.3.13 Temperature Range

In the motor drivers of TMCM-300 an excess temperature protection is integrated, which switches off the driver if the temperature of the chip is too high and switches it on again once it cools down. This behaviour is dependent on the motor current and the ambient temperature. At the chip temperature of 165°C it switches off. At 150°C the driver switches on again.

TMCM-300 is suitable for ambient temperature of up to 70°C.

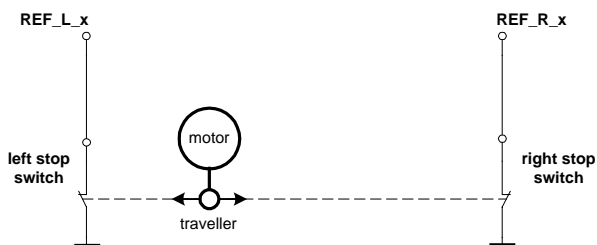
### 1.3.14 Reference Switches

The reference switch helps the TMCM-300 in calculating a reference point, which is used as zero point for all the subsequent movements. With the limit switches a mechanical overloading of the system is avoided if there is step loss e.g. due to overloading. The limit switches can also be used for determining a reference point.. The reference switch is as a result not absolutely necessary.

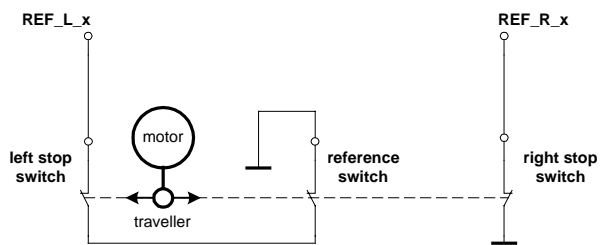
In Figure 19 the connection of the left and the right limit switch is shown. Figure 20 shows the connection of three switches as left and right limit switch and a reference switch for the reference point. The reference switch is connected in series with the left limit switch. The differentiation between the left limit switch and the reference switch is made through software.

Switches with open contacts (normally closed) are used.

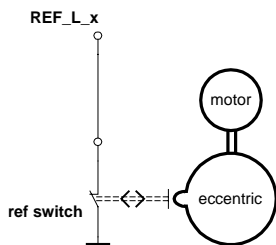
In circular systems there are no end points therefore only one reference switch is used for calculating the reference point (Figure 21).



**Figure 19 Left and right limit switches**



**Figure 20 Limit switch and reference switch**



**Figure 21 A reference switch**



## 1.4 Microcontroller assignments

The used microcontroller is an ATmega323 or Atmega32. A firmware update or self-developed software can be loaded via the RS232 interface using the TMCL-IDE on the PC (please see the TMCL reference manual for details). Table 2 shows the microcontroller pin assignment. The ISP connector is not to be used by the user!

Pin	In/Out	Use	
PA0	In	ADIN0	
PA1	In	ADIN1	Analog/ digital input
PA2	In	ADIN2	Analog/ digital input
PA3	In	ADIN3	Analog/ digital input
PA4	In	ADIN4	Analog/ digital input
PA5	In	ADIN5	Analog/ digital input
PA6	In	ADIN6	Analog/ digital input
PA7	In	ADIN7	Analog/ digital input
PB0	Out	Control LED	(Active Low)
PB1	In	Opto2	(Active High)
PB2	Out	EEPROM select	(Active Low)
PB3	Out	TMC428 select	(Active Low)
PB4	Out	RS485	High: Transmit ; Low: Receive
PB5	In	SPI: TMC428-SIN	/ ISP-MOSI
PB6	Out	SPI: TMC428-SOUT	/ ISP-MISO
PB7	Out	SPI: TMC428-SCLK	/ ISP-SCK
PC0	Out	DOUT1	inverts via ULN2003
PC1	Out	DOUT2	inverts via ULN2003
PC2	Out	DOUT3	inverts via ULN2003
PC3	Out	DOUT4	inverts via ULN2003
PC4	Out	DOUT5	inverts via ULN2003
PC5	Out	DOUT6	inverts via ULN2003
PC6	Out	DOUT7	inverts via ULN2003
PC7	Out	DOUT8	TTL level
PD0	In	RXD	Data input RS232/RS485
PD1	Out	TXD	Data output RS232/RS485
PD2	In	Opto1	Optional input for Opto1 (not connected)
PD3	In	Opto2	Optional input for Opto2 (not connected)
PD4	Out	Motor2 PWM	PWM output for Imax Motor 2
PD5	Out	Motor1 PWM	PWM output for Imax Motor 1
PD6	In	Opto1	(Active High)
PD7	Out	Motor3 PWM	PWM output for Imax Motor 3
AVCC	In	AD supply	+5V, non-interacting
AREF	In	AD reference	+5V, non-interacting
XTAL1	In	Oscillator	Processor speed 7.3728 MHz
XTAL2	Out	n.c.	
RESET	In	Reset	/ ISP-PROG

**Table 2 Microcontroller pin assignment**

## 1.5 Connector assignments

### 1.5.1 ISP-Connector

The ISP connector is normally not to be used by the user. The only exception is to link pins 1+2 to activate the boot loader for installing new firmware via the RS232 port using the TMCL-IDE.

PIN	Name	Limits	Function
1	MISO	TTL	SPI Master In Slave Out
2	VCC	5V	5V Supply
3	SCK	TTL	SPI clock
4	MOSI	TTL	SPI Master Out Slave In
5	RESET	TTL	Reset signal of the microcontroller, low active. Could be pulled to GND to raise a RESET.
6	GND		Supply Ground

**Table 3** ISP-Connector

### 1.5.2 Connector 1

Connector for the motors and the supply voltage of the TMCM-300.

PIN	Name	Limits	Function
1	M1P1A		Phase 1a of Motor 1
2	M1P1B		Phase 1b of Motor 1
3	M1P2A		Phase 2a of Motor 1
4	M1P2B		Phase 2b of Motor 1
5	GND		
6	GND		
7	M2P1A		Phase 1a of Motor 2
8	M2P1B		Phase 1b of Motor 2
9	M2P2A		Phase 2a of Motor 2
10	M2P2B		Phase 2b of Motor 2
11	GND		
12	GND		
13	M3P1A		Phase 1a of Motor 3
14	M3P1B		Phase 1b of Motor 3
15	M3P2A		Phase 2a of Motor 3
16	M3P2B		Phase 2b of Motor 3
17	GND		
18	GND		
19	VDD	15V – 48V	Supply voltage for the motors
20	VDD		

**Table 4** Connector 1



### 1.5.3 Connector 2

Connector for the analog or digital inputs, reference voltage output and RS485 interface.

PIN	Name	Limits	Function
1	AVCC	Max 500uA	5V internal Analog Reference Voltage
2	VCC	Max 50mA	5V source from the internal switching regulator
3	GND		
4	GND		
5	ADIN0	Digital: TTL Analog: 5V Ri=11.5kOhm	analog or TTL digital inputs. The analoge input voltage range could be extend to 24V (optional)
6	ADIN1		
7	ADIN2		
8	ADIN3		
9	ADIN4		
10	ADIN5		
11	ADIN6		
12	ADIN7		
13	GND		
14	SHUTDOWN	TTL	Input (High for Driver off)
15	GND_OP1		Ground for the optical isolated input 1 (optional)
16	GND_OP2		Ground for the optical isolated input 2 (optional)
17	OPTO1	24V	Optional optical isolated
18	OPTO2		Optional optical isolated
19	RS485+	RS485	RS485 interface pin
20	RS485-		RS485 interface pin

Table 5 Connector 2

### 1.5.4 Connector 3

Connector for supply voltage, reference switch, digital outputs and RS232 interface.

PIN	Name	Limits	Function
1	VDD	15V – 48V	Supply Voltage
2	VDD		
3	GND		
4	GND		
5	DOUT0	100mA	Digital Outputs driven by a ULN2003 and pulled up to 5V. These pins could be pulled up to 24V by the user.
6	DOUT1		
7	DOUT2		
8	DOUT3		
9	DOUT4		
10	DOUT5		
11	DOUT6		
12	DOUT7	TTL	Digital Output direct linked to the Microcontroller
13	RS232_TXD	RS232	RS232 TXD
14	RS232_RXD		RS232 RXD
15	REFL1	TTL	Motor 1 Reference Input Left
16	REFR1		Motor 1 Reference Input Right
17	REFL2		Motor 2 Reference Input Left
18	REFR2		Motor 2 Reference Input Right
19	REFL3		Motor 3 Reference Input Left
20	REFR3		Motor 3 Reference Input Right

Table 6 Connector 3

## 1.6 Mechanical Data

### 1.6.1 Dimensions

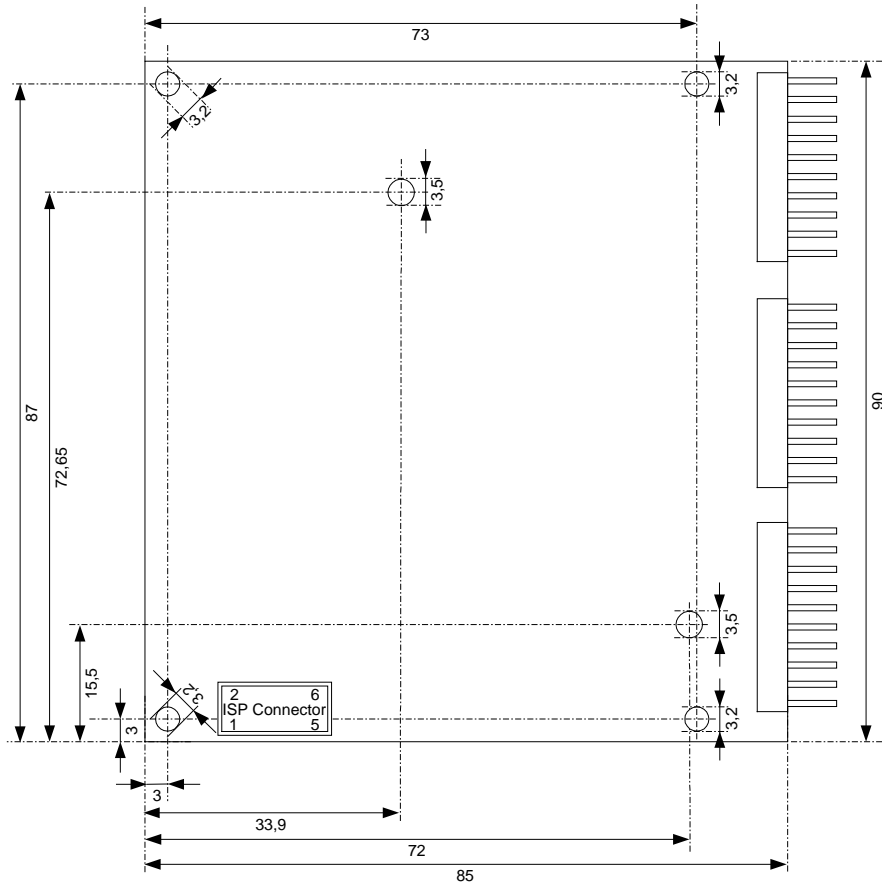


Figure 22 Top view

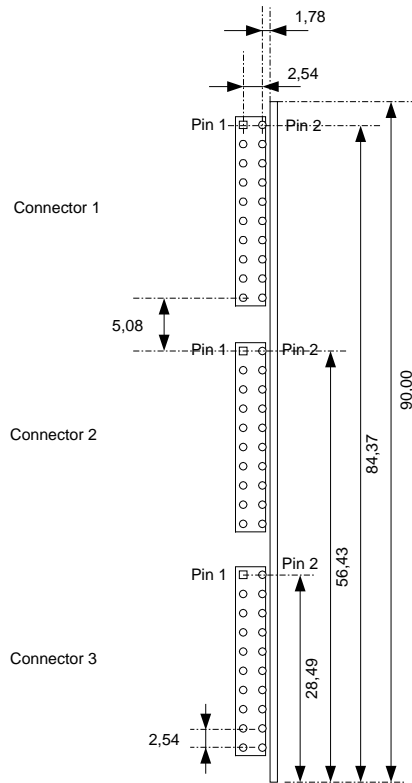


Figure 23 Connector size

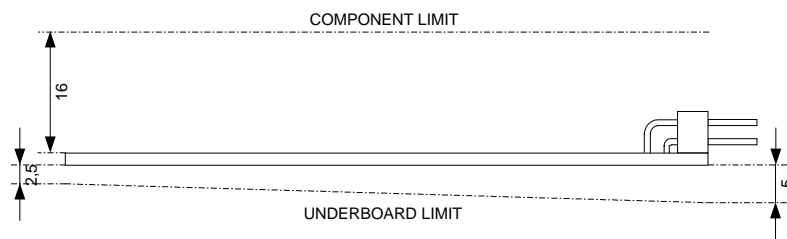


Figure 24 Overall height

## 1.7 Base Board Connection

For the development of proprietary systems with the TMCM-300 the base Board is available. It enables a fast test of own ideas. All ports of the TMCM-300 connected to screw clamps except the RS232 port, it is connected to a 9 PIN D-SUB Male (use null modem cable). To the inspection of the Power and communication respectively a LED is available.

Following points are to be noted for the undisturbed business (destruction danger):

- the TMCM-300 correctly around into the base Board (connector 1 in bushing 1 etc.) In correctly plugged module the component-side of the TMCM-300 shows towards the LEDs.
- Do not pull the TMCM-300 out of the base Board while the Supply is on.
- Do not disconnect the motors while the supply is on, because the motor driver can be destroyed.
- Avoid - short circuits at all connections. The outputs are not short circuit proof

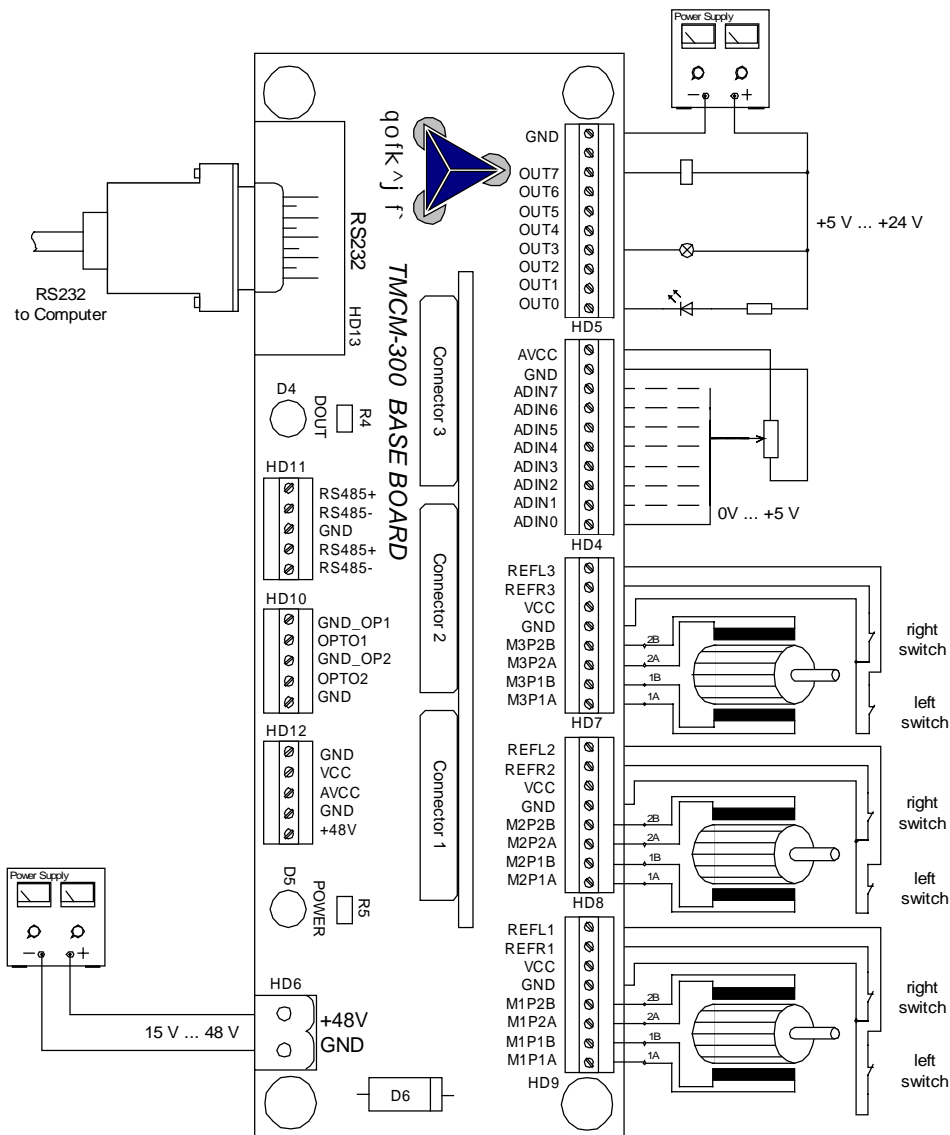


Figure 25 Base board connection

## 2 Software description

### 2.1 TMCL

Under normal circumstances, TMCL (Trinamic Motion Control Language) is used to program the module. TMCL commands can be given via the RS232 interface (direct mode) or stand alone applications written in TMCL can be downloaded into the EEPROM of the module and executed by the module in stand alone mode.

For developing TMCL programs, use the TMCL IDE (Integrated Development Environment). This is a program running under Windows 95/98/2000/NT/XP that also allows setting all the configuration parameters of the module. Please see the **TMCL Reference Manual** (version 2.00 or higher), which describes TMCL programming in detail. The TMCL operating system of the Trinamic Modules is constantly being developed further. Please check our website from time to time for new versions that you can download into the module via the RS232 interface, using the "Install OS" function of the TMCL IDE (never use an AVR ISP programmer for this purpose, as this will overwrite the licence code of the firmware!). Do the following to install an upgrade:

1. If you have a module with a firmware version prior to 3.00 and you want to upgrade to version 3.00 or higher, please contact Trinamic for installing the new licence code. If you already have version 3.00 or higher in your module, you can do it yourself (also if you have version 2.xx and want to upgrade to a version below 3.00).
2. Power off the module. Link the pins 1+2 of the ISP connector using a jumper. Power on again. The LED should not be flashing now. If it still flashes, please contact TRINAMIC.
3. Make sure that the module is connected to your PC via the RS232 interface.
4. On the PC, start the TMCL IDE. There, select "Install OS" from the "Setup" menu.
5. Click the "Load" button and select the HEX file that is to be installed.
6. Click the "Start" button. The new version is now being installed into the module. This task takes some minutes. Wait until it has finished.
7. Power off the module and remove the link between pins 1+2 of the ISP connector. Then, power on again and the LED should be flashing. The module can now be used with the new firmware version.

### 2.2 C

Under circumstances where TMCL should not meet your requirements, there is a possibility to develop applications in C. This means changing and extending the normal TMCL operating system of the module. This can be done by Trinamic or other Trinamic Certified Consultants or by yourself, using a special C library available at Trinamic and at least version 3.3 of the GNU C Compiler for AVR microcontrollers (can be downloaded at [www.avrfreaks.net](http://www.avrfreaks.net)). Please contact TRINAMIC for details.