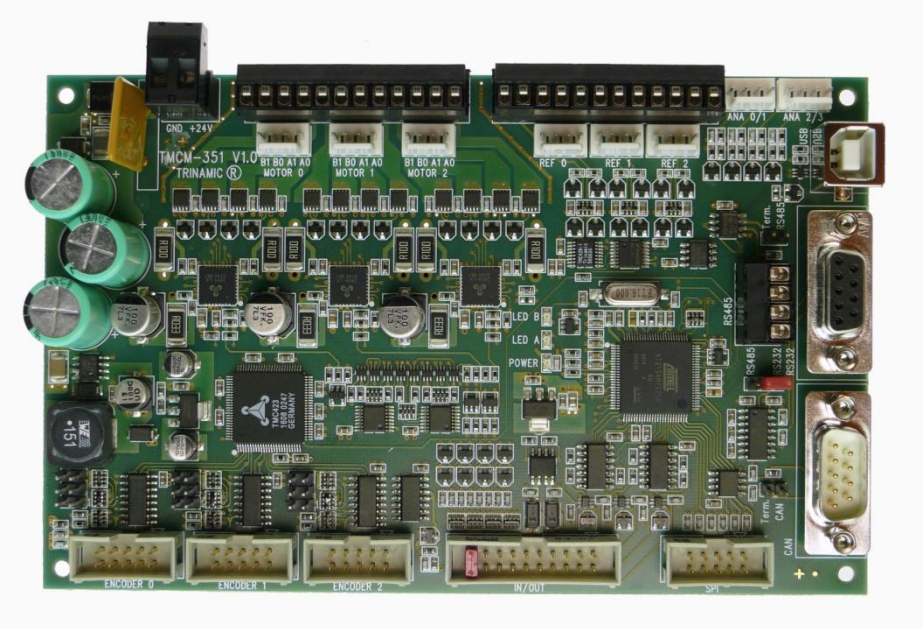
TMCM-351



Hardware Manual

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TRINAMIC
MOTION CONTROL

Trinamic Motion Control GmbH & Co KG
Sternstraße 67
D - 20 357 Hamburg, Germany
Phone +49-40-51 48 06 - 0
FAX: +49-40-51 48 06 - 60
http://www.trinamic.com

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2 Features

The TMCM-351 is a powerful three axes bipolar stepper motor controller / driver board with optional encoder interface for all three axes and a large number of general purpose digital and analogue input / outputs. Several different serial communication interfaces are available.

Electrical data

- Supply voltage: +24V DC nominal (28.5V DC max.)
- Motor current: up-to 2.8A RMS per axis (programmable)

Stepper motor data

- two phase bipolar stepper motors with up-to 2.8A RMS coil current
- optional incremental encoder interface (a/b/n), accepts differential or single ended input signals

Interfaces

- 2 reference switch inputs per motor axis (6 altogether, internal pull-up resistors, +24V compatible)
- 8 general purpose inputs (+24V compatible)
- 8 general purpose outputs incl. two power outputs (all open-collector)
- 1 shutdown input (enable / disable driver stage in hardware)
- 4 dedicated analogue inputs (programmable 3.3V / 10V input range)
- SPI connector with three chip select signals for I/O extension
- RS-232, RS-485, CAN and USB serial communication interfaces

Features

- High-efficient operation, low power-dissipation (TMC249 stepper driver with external MOSFETs)
- Dynamic current control
- Integrated Protection
- On the fly alteration of motor parameters (e.g. position, velocity, acceleration)
- Motion profile calculation in real-time (TMC428 motion controller)
- Each axis individually and independently programmable
- Supports up-to 64 microsteps per fullstep
- Integrated stallGuard™ for motor stall detection (e.g. elimination of end switches)
- Closed-loop operation with TMCL possible (when using the optional incremental encoder interface)

Software

- TMCL remote (direct mode) or stand-alone operation (memory for 2048 TMCL commands)
- Fully supported by TMCL-IDE (PC based integrated development environment)
- Optional CANopen firmware

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3 Order codes

The TMCM-351 is available with optional encoder interface and with standard TMCL firmware or CANopen firmware:

Order code	Description	Dimensions [mm²]
TMCM-351	TMCM-351 without encoder interface with TMCL firmware	160mm x 100mm
TMCM-351-CANopen	TMCM-351 without encoder interface with CANopen firmware	160mm x 100mm
TMCM-351-E	TMCM-351 with encoder interface and TMCL firmware	160mm x 100mm
TMCM-351-E-CANopen	TMCM-351 with encoder interface and CANopen firmware	160mm x 100mm

Table 3.1: Order codes

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4 Mechanical and Electrical Interfacing

4.1 Board size and mounting holes

The TMCM-351 three axes controller driver board has a board size of 160mm x 100mm (standard euro board format). There are four mounting holes altogether for M3 screws placed at a distance of 4mm from each corner of the board (Figure 4.1).

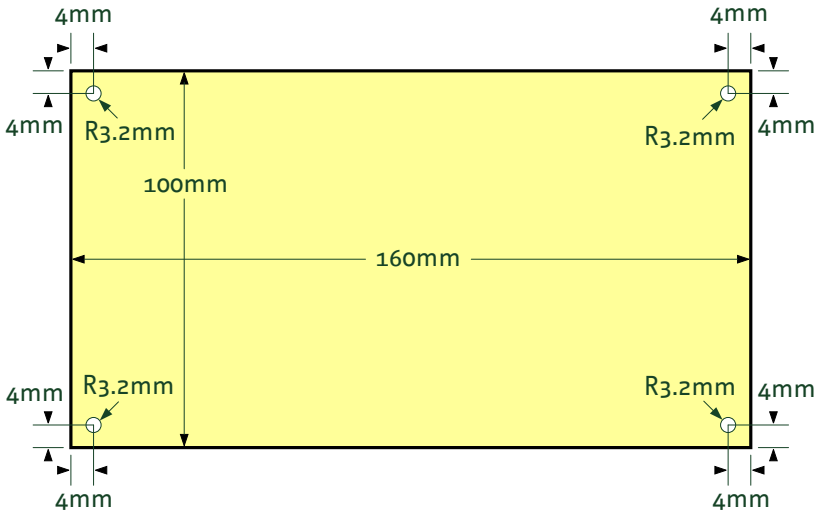

Figure 4.1 TMCM-351 controller / driver board

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4.2 Connectors

The TMCM-351 has connectors for three motors, related reference switches, three encoders (only with encoder option), analogue and digital inputs and outputs and several serial interfaces (RS232, RS485, CAN and USB).

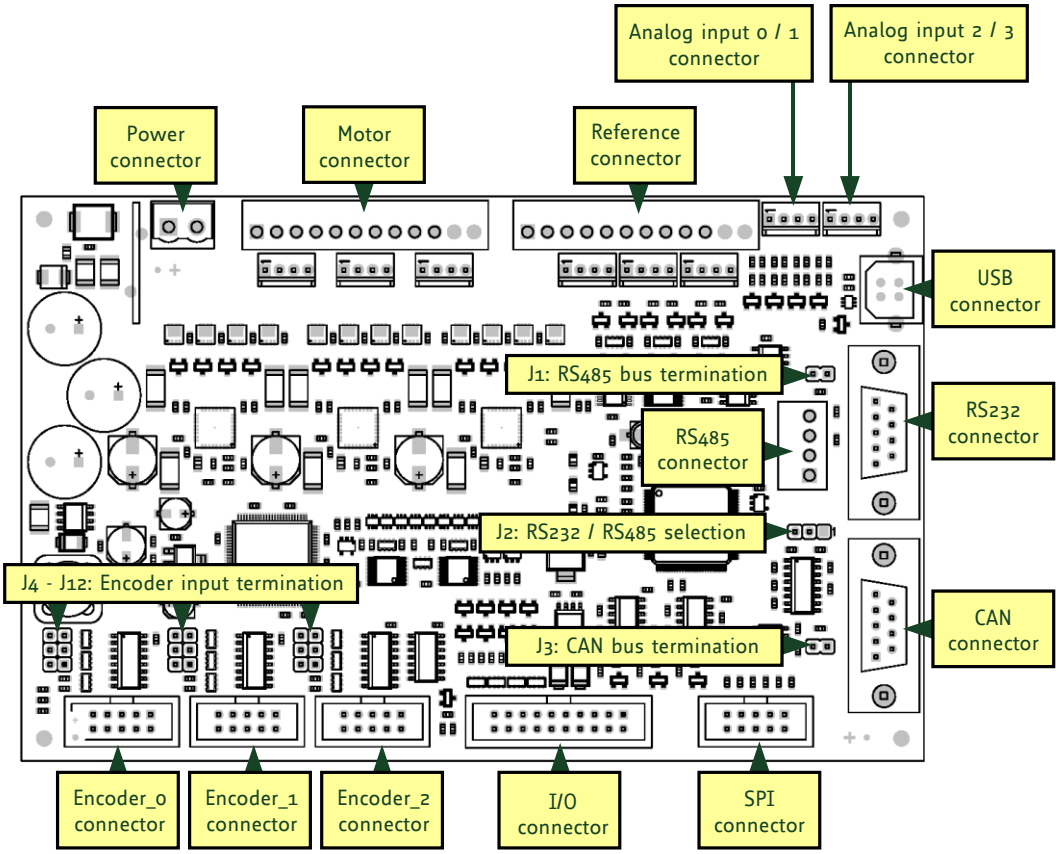

Figure 4.2 TMCM-351 connectors

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4.2.1 Power connector

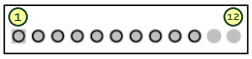
A 2-pin detachable screw connector is used for power supply.

Pin	Label	Description
1	GND	Module ground (power supply and signal ground)
2	VDD	Power supply input, nom. +24V DC (+7 .. +28.5V DC)

Table 4.1: Power connector

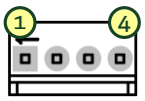
4.2.2 Motor connector

For the three motors there are two connector options: either one detachable screw connector (for prototyping, smaller series) or three separate crimp connectors (for higher volume series).



Pin	Label	Description
1	Motor_0_B-	Motor 0, coil B
2	Motor_0_B+	Motor 0, coil B
3	Motor_0_A-	Motor 0, coil A
4	Motor_0_A+	Motor 0, coil A
5	Motor_1_B-	Motor 1, coil B
6	Motor_1_B+	Motor 1, coil B
7	Motor_1_A-	Motor 1, coil A
8	Motor_1_A+	Motor 1, coil A
9	Motor_2_B-	Motor 2, coil B
10	Motor_2_B+	Motor 2, coil B
11	Motor_2_A-	Motor 2, coil A
12	Motor_2_A+	Motor 2, coil A

Table 4.2: Motor connector (detachable screw connector)



Pin	Label	Description
1	Motor_0/1/2_B-	Motor 0/1/2, coil B
2	Motor_0/1/2_B+	Motor 0/1/2, coil B
3	Motor_0/1/2_A-	Motor 0/1/2, coil A
4	Motor_0/1/2_A+	Motor 0/1/2, coil A

Table 4.3: Motor connector (crimp connector)

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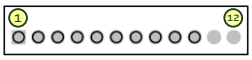
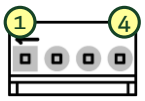
4.2.3 Reference connector

For the reference switch inputs (two reference switch inputs are supported for each motor) there are two connector options: either one detachable screw connector (for prototyping, smaller series) or three separate crimp connectors (for higher volume series).



Pin	Label	Description
1	REF_0_R	Motor 0, right reference / stop switch input
2	REF_0_L	Motor 0, left reference / stop switch input
3	GND	System / module ground
4	+5V	+5V supply output for active switches
5	REF_1_R	Motor 1, right reference / stop switch input
6	REF_1_L	Motor 1, left reference / stop switch input
7	GND	System / module ground
8	+5V	+5V supply output for active switches
9	REF_2_R	Motor 1, right reference / stop switch input
10	REF_2_L	Motor 1, left reference / stop switch input
11	GND	System / module ground
12	+5V	+5V supply output for active switches

Table 4.4: Reference connector (detachable screw connector)

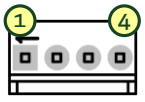


Pin	Label	Description
1	REF_0/1/2_R	Motor 0/1/2, right reference / stop switch input
2	REF_0/1/2_L	Motor 0/1/2, left reference / stop switch input
3	GND	System / module ground
4	+5V	+5V supply output for active switches

Table 4.5: Reference connector (crimp connector)

4.2.4 Analogue input connector

The board has four dedicated analogue inputs with programmable input range (either 0..+3.3V or 0..+10V). There are two connectors with two analogue inputs connected to each connector



Pin	Label	Description
1	Analogue_0/2	Analogue input 0 / 2
2	GND	System / module ground
3	Analogue_1/3	Analogue input 1/3
4	GND	System / module ground

Table 4.6: Analogue input connector

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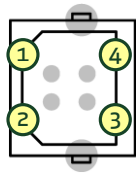
4.2.5 USB connector

The board includes a USB interface for serial communication. A standard USB type B connector is used for this purpose. USB is one out of four different interfaces available for communication with the board.

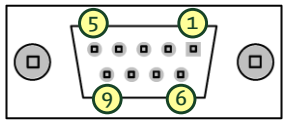


Pin	Label	Description
1	+5V	Board is self-powered – just use to detect availability of attached host system (e.g. PC)
2	USB-	Differential USB bus
3	USB+	Differential USB bus
4	GND	System / module ground

Table 4.7: USB connector

4.2.6 RS232 connector

The board includes an RS232 interface for serial communication. A standard DSUB 9-pin female connector is used for this purpose. RS232 is one out of four different interfaces available for communication with the board.



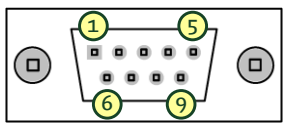
Pin	Label	Description
2	RS232_TxD	RS232 transmit serial data
3	RS232_RxD	RS232 receive serial data
5	GND	System / board ground
1, 4, 6, 7, 8, 9	n.c.	Pins not used / not connected

Table 4.8: RS232 connector

Attention: please verify setting of J2 (selection of RS232 / RS485 interface) for proper operation of the RS232 connection.

4.2.7 CAN connector

The board includes a CAN interface for serial communication. A standard DSUB 9-pin male connector is used for this purpose. CAN is one out of four different interfaces available for communication with the board.



Pin	Label	Description
2	CAN_L	CAN differential bus
7	CAN_H	CAN differential bus
3, 6	GND	System / board ground
	n.c.	Pins not used / not connected

Table 4.9: CAN connector

Attention: please verify setting of J3 (CAN bus termination) for proper operation of the CAN connection.

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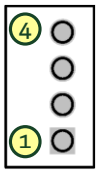
4.2.8 RS485 connector

The board includes an RS485 interface for serial communication. A 4-pin detachable screw connector is used for this purpose. RS485 is one out of four different interfaces available for communication with the board.



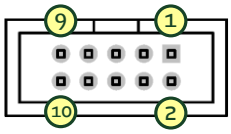
Pin	Label	Description
1	RS485+	RS485 differential bus (connected to pin 3)
2	RS485-	RS485 differential bus (connected to pin 4)
3	RS485+	RS485 differential bus (connected to pin 1)
4	RS285-	RS485 differential bus (connected to pin 2)

Table 4.10: RS485 connector

Attention: please verify settings of J1 (RS485 bus termination) and J2 (selection of RS232 / RS485 interface) for proper operation of the RS485 connection.

4.2.9 SPI connector

For extension of the available inputs and outputs an SPI interface is available. A standard 2.54mm pitch two row header is used as connector for the external SPI interface.

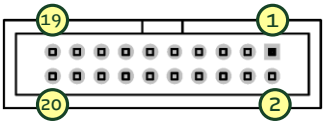


Pin	Label	Pin	Label
1	SPI_MOSI	2	GND
3	SPI_MISO	4	GND
5	SPI_CLK	6	GND
7	SPI_SEL0	8	SPI_SEL2
9	SPI_SEL1	10	+5V_output

Table 4.11: SPI connector

4.2.10 I/O connector

The I/O connector offers 8 digital and analogue inputs and 8 digital outputs. All inputs are +24V compatible. All outputs offer open collector driver stages. OUT_0/1/2/3/4/5 can sink up-to 100mA, OUT_6/7 are more powerful and can drive up-to 2A. A standard 2.54mm pitch two row header is used for this connector.
Attention: /Shutdown input pin has to be connected to supply voltage in order to enable driver stages for all three stepper motor axes. A jumper between pin 19 and pin 20 can be used to permanently enable drivers (see picture on front page).



Pin	Label	Pin	Label
1	OUT_0	2	OUT_1
3	OUT_2	4	OUT_3
5	OUT_4	6	OUT_5
7	OUT_6	8	OUT_7
9	+5V_output	10	GND
11	IN_0	12	IN_1
13	IN_2	14	IN_3
15	IN_4	16	IN_5
17	IN_6	18	IN_7
19	/Shutdown	20	VDD

Table 4.12: I/O connector

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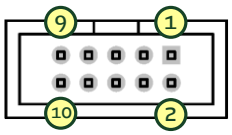
4.2.11 Encoder_0/1/2 connector

These three connectors (one encoder interface connector per axis) will be available only for boards with assembled encoder option. A standard 2.54mm pitch two row header is used for connecting an encoder. Differential and single ended incremental encoders with / without zero / index channel are supported.



Pin	Label	Pin	Label
1	GND	2	GND
3	Encoder_0/1/2_N+	4	Encoder_0/1/2_N-
5	Encoder_0/1/2_A+	6	Encoder_0/1/2_A-
7	+5V_output	8	+5V_output
9	Encoder_0/1/2_B+	10	Encoder_0/1/2_B-

Table 4.13: Encoder connector

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4.3 Jumpers

Most settings of the board are done through the software. Nevertheless, a few jumpers are available for configuration.

4.3.1 J1: RS485 bus termination

The board includes a 120 Ohm resistor for proper bus termination of the RS485 interface. When this jumper is closed, the resistor will be placed between the two differential bus lines RS485+ and RS485-.

4.3.2 J2: RS232 / RS485 interface selection

This 3-pin single row header is used for selecting one of two desired serial interfaces: RS232 or RS485 using a jumper:

RS232 interface selection

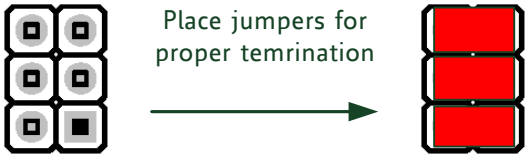
RS485 interface selection

4.3.3 J3: CAN bus termination

The board includes a 120 Ohm resistor for proper bus termination of the CAN interface. When this jumper is closed, the resistor will be placed between the two differential bus lines CAN_H and CAN_L.

4.3.4 J4 – J12: Encoder input termination

For enhanced reliability differential encoder signals should be terminated properly. The board offers termination resistors (120 Ohm) for all three encoder interface signals (a/b/n) for all three encoders. By setting jumpers, these resistors will be placed between the differential encoder signals. Do not set these jumpers in case encoders with single ended signals are used.



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5 Operational Ratings

The operational ratings shown below should be used as design values. In no case should the maximum values been exceeded during operation.

Symbol	Parameter	Min	Typ	Max	Unit
V_{DD}	Power supply voltage for operation	7	24	28.5	V
I_{COIL_peak}	Motor coil current for sine wave **peak** (chopper regulated, adjustable via software)	0		4	A
I_{COIL_RMS}	Continuous motor current (**RMS**)	0		2.8	A
I_{SUPPLY}	Power supply current		<< I_{COIL}	1.4 * I_{COIL}	A
T_{ENV}	Environment temperature at rated current (no forced cooling required)	-20		+40	°C
	Environment temperature at 80% of rated current or 50% duty cycle (no forced cooling required)	-20		+60	°C

Table 5.1: General operational ratings of the module

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6 Revision History

6.1 Document Revision

Version	Date	Author	Description
1.00	2008-10-22	GE	Initial version
1.01	2009-05-25	OE	Encoder input pinning corrected

Table 6.1: Document Revision

6.2 Hardware Revision

Version	Date	Description
1.00	2008-08-25	First prototypes

Table 6.2: Hardware Revision

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