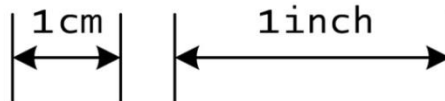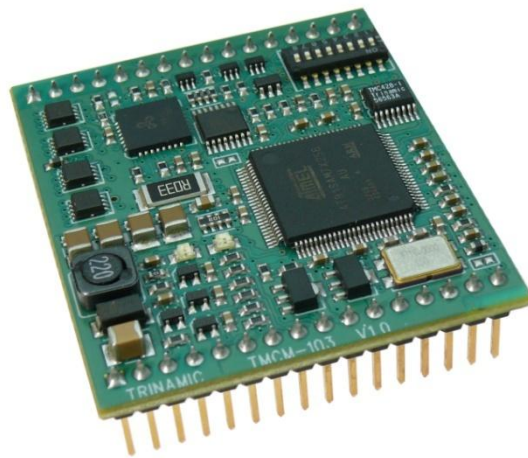# TMCM-103

Single Axis Controller / Driver Module
With Encoder Feedback
(2A RMS / 28.5V)

Manual

Version: 1.03
August 03, 2009

Table of Contents

1 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.

© TRINAMIC Motion Control GmbH & Co. KG 2008

Information given in this data sheet is believed to be accurate and reliable. However no responsibility is assumed for the consequences of its use or for any infringement of patents or other rights of third parties, which may result from its use.

Specifications are subject to change without notice.

2 Features

The TMCM-103 is a complete one axis stepper motor controller / driver with incremental encoder feedback.

Applications

- Very compact single-axis stepper motor solutions
- Encoder feedback for high reliability operation

Highlights

- Supply voltage: +24V DC (nominal)
- Internal +5V DC switching regulator for logic + encoder supply
- Motor current: up-to 2A RMS (programmable)
- High-efficient operation, low power-dissipation (TMC249 stepper driver with external MOSFETs)
- Integrated Protection
- Motion profile calculation in real-time (TMC428 motion controller)
- Up-to 64 microsteps
- incremental encoder inputs (a/b/n) supporting differential and single ended encoder signals
- Two general purpose inputs and two general purpose outputs
- CAN (2.0B up-to 1Mbit/s) and RS-232 communication interfaces
- TRINAMIC TMCL interpreter (remote control and stand-alone operation)
- Optional: CANopen (CiA 301 + CiA 402 (homing mode, profile position mode, velocity mode))
- 8 dip switches for CANopen address setting

The BB-103 baseboard [BB-103] is available for this unit

Order code	Description	Dimensions [mm³]
TMCM-103-TMCL	1-axis stepper motor controller / driver with TMCL	49.53mm x 43.00mm
TMCM-103-CANopen	1-axis stepper motor controller / driver with CANopen	49.53mm x 43.00mm

Table 2.1: Order codes

3 Mechanical and Electrical Interfacing

3.1 Size of board

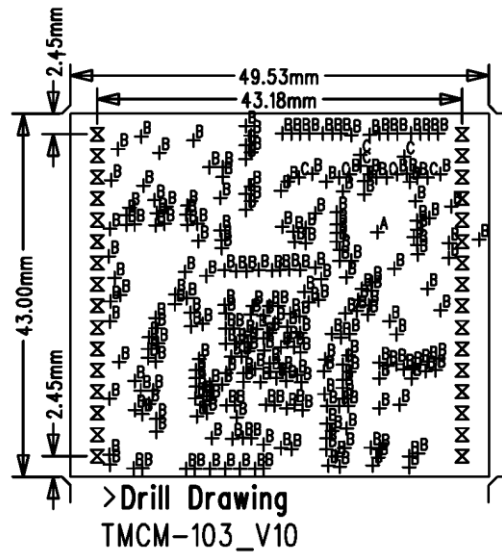The TMCM-103 has a size of 49.53mm x 43.00mm.

Figure 3.1 TMCM-103 size and position of mounting holes

3.2 Connector

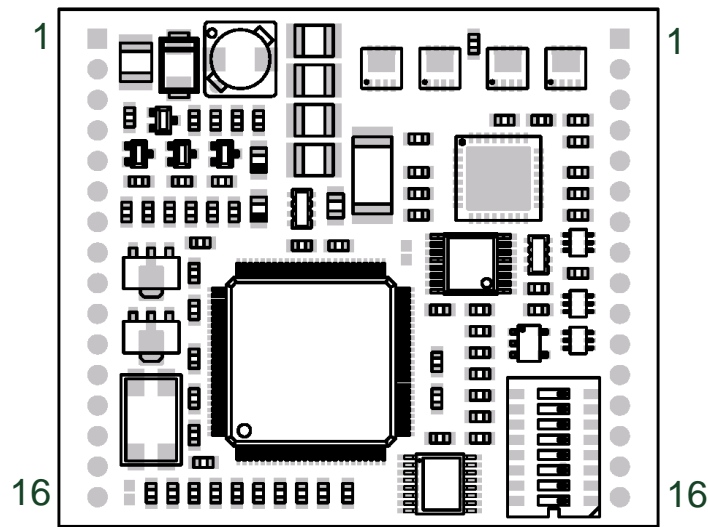The TMCM-103 has two rows of header pins with 16 pins each.

Figure 3.2 TMCM-103 connectors

Pin	Label	Description	Pin	Label	Description
1	Vcc	Supply voltage +24V DC (nom.)	1	OA1	Motor coil A
2	GND	System ground	2	OA2	Motor coil A
3	+5V	+5V DC output	3	OB1	Motor coil B
4	IN0	Analog input 1	4	OB2	Motor coil B
5	n.c.		5	GND	System ground
6	n.c.		6	n.c.	
7	Enable	Enable driver input	7	n.c.	
8	LSP	Left stop switch input	8	n.c.	
9	RSP	Right stop switch input	9	ENC_A+	Encoder input signal a (single ended and differential)
10	/OUT1	Digital output (open collector)	10	ENC_B+	Encoder input signal b (single ended and differential)
11	OUT0	Digital output (open collector)	11	ENC_N+	Encoder input signal n (single ended and differential)
12	CAN_H	CAN bus (positive signal)	12	ENC_A-	Encoder input signal a (differential)
13	CAN_L	CAN bus (negative signal)	13	ENC_B-	Encoder input signal b (differential)
14	GND	System ground	14	ENC_N-	Encoder input signal n (differential)
15	RS232_TxD	RS232 transmit data output	15	IN1	Analog input 2
16	RS232_RxD	RS232 receive data input	16	n.c.	

n.c. = pin not connected / do not connect (may be used in later versions)

Table 3.1 TMCM-103 connectors pin assignment

3.3 Input / Output Circuits

Both analog inputs available on this unit have internal voltage dividers in order to accept input voltages up-to +24V DC.
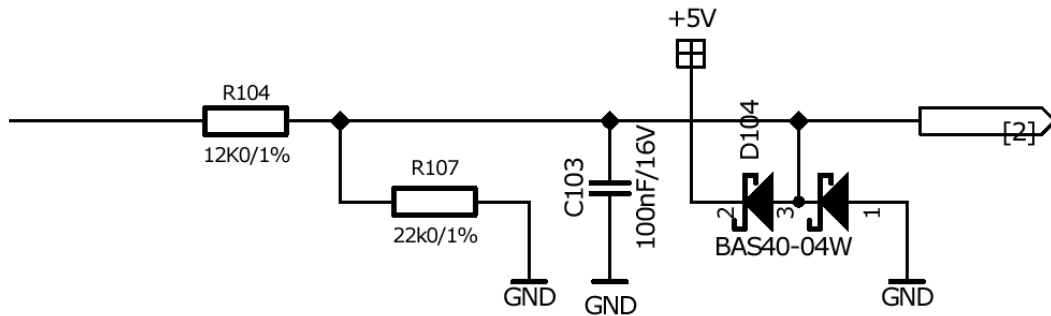
Figure 3.3 Analog Inputs (IN0 and IN1)

All three digital inputs available on this unit (Enable, LSP, RSP) have internal 4k7 pull-up resistors (Figure 3.4). They accept input voltages up-to +24V DC.
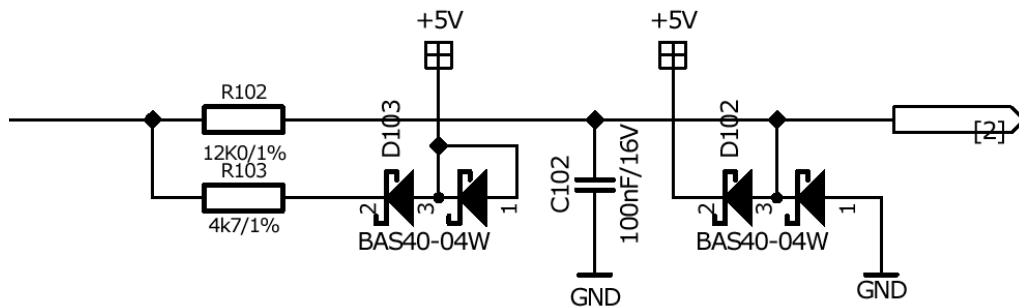
Figure 3.4 Digital Inputs (Enable, LSP, RSP)

Both outputs available on this unit are open collector outputs (Figure 3.5). A 470 Ohm resistor at the outputs make sure, the output is not floating while the transistor is switched off.

Figure 3.5 Outputs (OUT0, OUT1)

The encoder inputs accept either single ended (using A+ ,B+, N+) or differential input signals (using A+, A-, B+, B-, N+, N-) (Figure 3.6).

Figure 3.6 Encoder Inputs

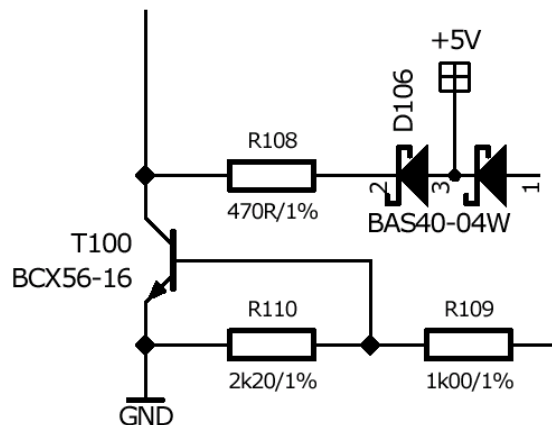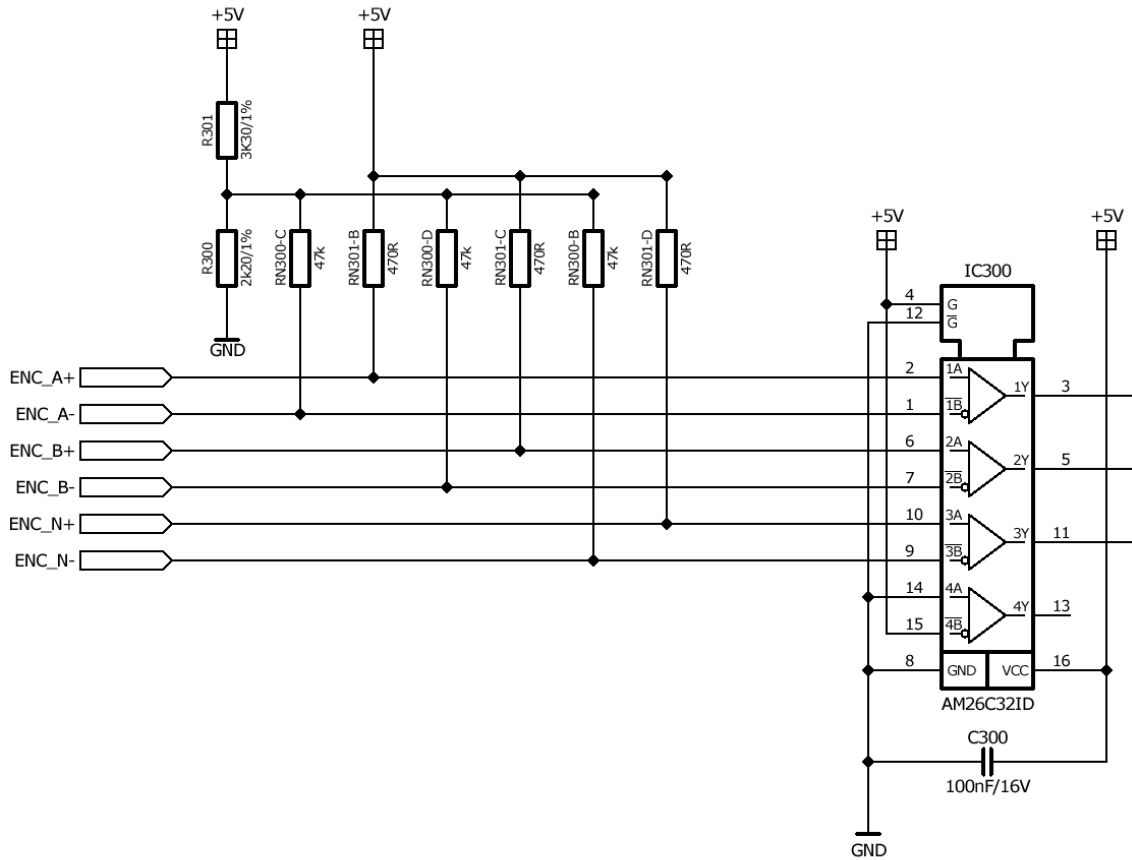# 4 Firmware

Currently, there are two different firmwares available for the TMCM-103. Standard firmware supplied with this module is TMCL. Please refer to the TMCL reference manual for more details [TMCL]. In addition, there is also CANopen as firmware available. This firmware supports the CiA 301 and CiA 402 profiles with support for homing mode, profile position mode and velocity mode. For more details please refer to the CANopen manual [CANopen].

With regard to the TMCL firmware the functionality of the TMCM-103 is very similar to the TMCM-101 or TMCM-102. This chapter explains the special functions of the TMCM-103 and their usage in TMCL.

4.1 Encoder interface

4.1.1 Encoder resolution and special functions

Like on most TMCM modules that support an encoder interface, the position of the encoder can be read using the command GAP 209, 0. The encoder position can also be changed using SAP 209, 0, <NewValue>.
Axis parameter #210 (SAP 210, 0, <p<>) controls the pre-scaler and some special functions of the encoder interface.
To select a pre-scaler, the following values can be used for <p>:

Value for <p>	Resulting pre-scaler	SAP command for motor 0 SAP 210, M0, <p>	Resulting steps per rotation for a 400 line (1600 quadrate count) encoder
32	0.0625	SAP 210, 0, 32	100
64	0.125	SAP 210, 0, 64	200
128	0.25	SAP 210, 0, 128	400
256	0.5	SAP 210, 0, 256	800
512	**1**	**SAP 210, 0, 512**	**1600**
1024	2	SAP 210, 0, 1024	3200
2048	4	SAP 210, 0, 2048	6400
4096	8	SAP 210, 0, 4096	12800
8192	16	SAP 210, 0, 8192	25600
16384	32	SAP 210, 0, 16384	51200
32768	64	SAP 210, 0, 32768	102400

Table 4.1: TMCL – Pre-scaler values

Formula for resulting steps per rotation:
StepsPerRotation = LinesOfEncoder * 4 * PreScaler

Other pre-scaler values than those given in the table are also possible, but they must always be a multiple of 32 (because the bits 0..4 of parameter 210 are used for the encoder special function bits). The resulting pre-scaler is Value/512 (e.g. a value of 768 will result in a pre-scaler of 1.5). Please note that the fractional part of the pre-scaler must be a multiple of 1/256.

There are some special functions that can also be configured using these values. To select these functions just add the following values to <p>:

Adder for <p>	SAP command for motor 0 SAP 210, M0, <p>
1	Encoder Channel A polarity for Null channel event (0=negative, 1=positive)
2	Encoder Channel B polarity for Null channel event (0=negative, 1=positive)
4	Clear encoder with next null channel event
16	Encoder Channel N polarity for encoder clearing (0=negative, 1=positive)

Table 4.2: Special encoder functions

Add up both values <p> from this tables to get the required value for the SAP210 command.

Encoder configuration example
For using a pre-scaler of 2 and zeroing the encoder on the next null channel event with active high null channel, the resulting configuration value would be 1024+16+4=1044 (1024 for pre-scaler 2, 16 for positive encoder null channel polarity and 4 to activate the "clear on next null channel event" function).

4.1.2 Stopping a motor on deviation (encoder vs. set position)

A motor can be stopped automatically when the tolerance between encoder position register and motor position register gets too high. This happens for example when the motor is obstructed. To use this feature, the maximum tolerance must be set. For this purpose, the axis parameter #212 is used. Setting the maximum tolerance to zero turns off this feature, as such a low tolerance is not possible. So to set the maximum tolerance for axis #3 to 20, use the command SAP 212, 3, 20. To turn off this feature for axis #2 use SAP 212, 2, 0. When the maximum tolerance value is set to a positive value, the motor will be hard stopped if the maximum tolerance is exceeded. The maximum tolerance can also be set to a negative value. The motor will then be decelerated using the maximum acceleration value when the absolute value of this maximum tolerance is exceeded.
The maximum tolerance that can be used depends on the maximum velocity that is used. If the maximum speed is high the maximum tolerance must also be higher. If the motor is stopped even if it has not stalled the maximum tolerance value is set too low.
Before you can use this feature, first make sure that motor and encoder have the same resolution and are running in the same direction. You can adapt the resolutions by changing the encoder pre-scaler or by changing the microstep resolution.

4.1.3 Recovering from a deviation error

After the motor has been stopped because the maximum tolerance has been exceeded, the motor will be stopped and the display displays the number of this motor. To recover from such a situation, you first have to set the value of the motor position register and the value of the encoder position register to the same value again.
  * Query the encoder value using GAP 209
  * Set the motor position to this value using SAP 1
Alternatively, you can do it the other way round:
  * Query the motor position register using GAP 1
  * Set the encoder position register to this value using SAP 209
Another alternative would be to set both registers to some other (but the same) value.
After the motor and encoder register are set to the same value again, you can move the motor again using the normal motion commands.

4.2 Additional inputs and outputs

Like on most other TMCM modules, the additional inputs and outputs can be read or set using the GIO and SIO commands. The following inputs and outputs are supported:

Name	Pin	Related [TMCL] command	Characteristics
IN0	4	GIO 0, 0	Read input 0 as a digital input (returns 0 or 1).
IN1	15	GIO 1, 0	Read input 1 as a digital input (returns 0 or 1).
IN0	4	GIO 0, 1	Read input 0 as an analogue input (returns 0..1023).
IN1	15	GIO 1, 1	Read input 1 as an analogut input (returns..1023).
OUT0	10	SIO 0, 2, x	Digital user controlled output (<x> must be 0 or 1).
OUT1	11	SIO 1, 2, x	Digital user controlled output (<x> must be 0 or 1).

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
Vcc	+24 DC input		24V	28.5	V
V_{+5V}	+5V DC output (max. 200mA)	4.75	5.0	5.25	V
V_{INPROT}	Input voltage for Enable, LSP, RSP (internal protection diodes)	-24	0 … +24	24	V
V_{ANA}	ANA1/2 analog measurement range		0 … +24V		V
V_{INLO}	Enable, LSP, RSP low level input	-24	0	0.9	V
V_{INHI}	Enable, LSP, RSP high level input (integrated 4k7 pull-up to +5V)	2	5 .. 24	24	V
I_{OUTI}	/Error, /Ready max. sink current		0.5	1.0	A
T_{ENV}	Environment temperature at rated current (no cooling)	-40		+40	°C

Table 5.1: Operational Ratings

6 Revision History

6.1 Document Revision

Version	Date	Author	Description
1.00	08-May-08	GE	Initial version
1.01	30-Jul-08	OK	Encoder and I/O functionality added
1.02	01-Sep-08	GE	Order code for CANopen version added
1.03	03-Aug-09	OE	Changed the max T_{env}

Table 6.1: Document Revision

6.2 Firmware Revision

Version	Comment	Description
4.07	First version	First TMCL firmware version
4.09		Encoder functionality extended
4.11	01-Sep-08	Encoder interface update corrected + TMCL processing speed improved

Table 6.2: Firmware Revision

6.3 Hardware Revision

Version	Comment	Description
1.00	First version	
1.01	Series version	

Table 6.3: Hardware Revision

7 References

[TMCL]   TMCL Reference and Programming Manual (see http://www.trinamic.com)
[BB-103]   BB-103 Manual (see http://www.trinamic.com)
[CANopen]   CANopen Manual (see http://www.trinamic.com)