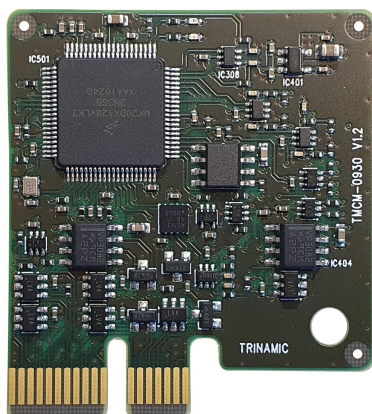


TMCM-0930-TMCL Hardware Manual

Hardware Version V1.2 | Document Revision V1.00 • 2020-NOV-19

The **TMCM-0930-TMCL** is a slot type microcontroller module that can control up to four Trinamic slot type motor driver modules using TMCL commands. The stepper and/or BLDC motor modules are controlled by TMCM-0930-TMCL on a special slot type baseboard while using RS485 bus and some control signals throughout the whole system. TMCM-0930-TMCL is equipped with additional RS485 interface, a CAN bus interface, and a USB interface for external communication. The TMCM-0930-TMCL can also store and execute TMCL programs.



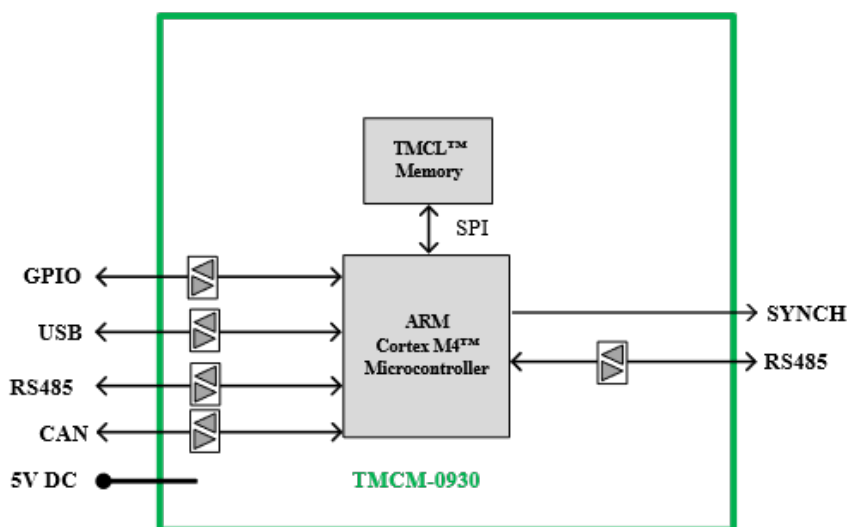
Features

- Controller module for up to four Trinamic slot type motor driver modules
- Supply voltage +5V DC
- TMCL™ firmware
- Host interfaces: RS485, CAN, USB
- Additional GPIOs and control features depending on connected driver module

Applications

- Laboratory Automation
- Manufacturing
- Semiconductor Handling
- Robotics
- Factory Automation
- Test & Measurement
- Life Science
- Biotechnology
- Liquid Handling

Simplified Block Diagram



Contents

1 Features	3
2 Order Codes	4
3 Mechanical and Electrical Interfacing	5
3.1 Size of the board	5
4 Connectors	6
5 Reset to Factory Defaults	8
6 I/Os	9
6.1 Analog inputs	9
6.2 Digital inputs	9
6.3 Digital outputs	9
6.4 Enable and Sync outputs	9
6.5 Interrupt inputs	9
7 Communication	10
7.1 RS485	10
7.2 CAN	11
8 Operational Ratings and Characteristics	13
9 Abbreviations used in this Manual	14
10 Figures Index	15
11 Tables Index	16
12 Supplemental Directives	17
12.1 Producer Information	17
12.2 Copyright	17
12.3 Trademark Designations and Symbols	17
12.4 Target User	17
12.5 Disclaimer: Life Support Systems	17
12.6 Disclaimer: Intended Use	17
12.7 Collateral Documents & Tools	18
13 Revision History	19
13.1 Hardware Revision	19
13.2 Document Revision	19



1 Features

The TMCM-0930-TMCL is a slot type microcontroller module that can controls up to four Trinamic slot type motor driver modules using TMCL commands. The stepper and/or BLDC motor modules are controlled by TMCM-0930-TMCL on a special slot type baseboard while using RS485 bus and some control signals throughout the whole system. TMCM-0930-TMCL is equipped with additional RS485 interface, a CAN bus interface, and a USB interface for external communication. The TMCM-0930-TMCL can also store and execute TMCL programs.

Motor control capabilities, through special Slot Type Baseboard, depend on the motor driver module that is connected to this MCU module.

Main characteristics of TMCM-0930:

- ARM/Cortex-M4 main MCU
- Interfaces
 - RS485 bus to other slot modules.
 - Synchronization signals to other slot modules.
 - RS485 interface to host.
 - CAN bus interface to host.
 - Four general-purpose digital inputs (GPIs).
 - Four general purpose digital outputs (GPOs).
 - Two dedicated analog inputs (AINs).

Software

TMCL remote controlled operation via RS485, USB or CAN interface and/or stand-alone operation via TMCL programming. PC-based application development software TMCL-IDE available for free.

Electrical data

- Supply voltage: +5V DC.

For module start-up and use please see also the separate Firmware Manual.



2 Order Codes

The standard version of the TMCM-0930 is pre-programmed with either TRINAMIC TMCL™ firmware.

Order Code	Description	Size
TMCM-0930-TMCL	Slot-Type controller module, +5V nom. supply, control signals for up to 4 driver boards, 2 analog inputs, 4 digital inputs, 4 digital outputs, CAN and RS485 interfaces	45mm x 40mm (connector length: 20mm)

Table 1: TMCM-0930 Order Codes



3 Mechanical and Electrical Interfacing

3.1 Size of the board

The board has an overall size of 45mm x 40mm together with the connector section of the PCB. The thickness of the board with components is max. 7mm. There is one 4mm diameter mounting hole.

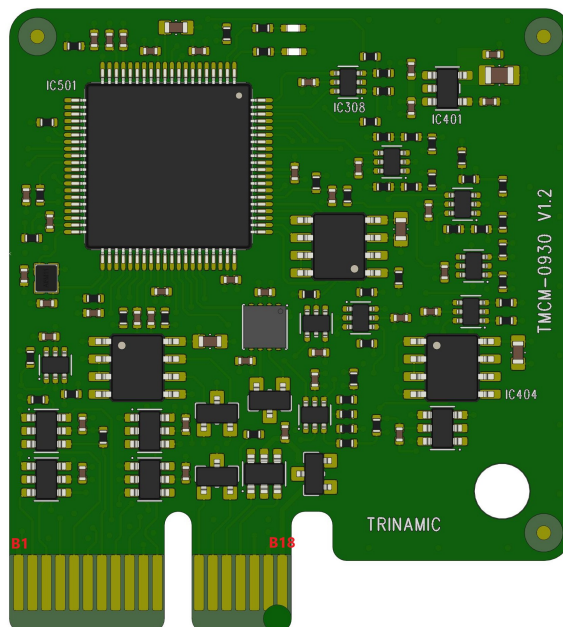


Figure 1: Front side of TCM-0930 with marked copper pads B1-B18

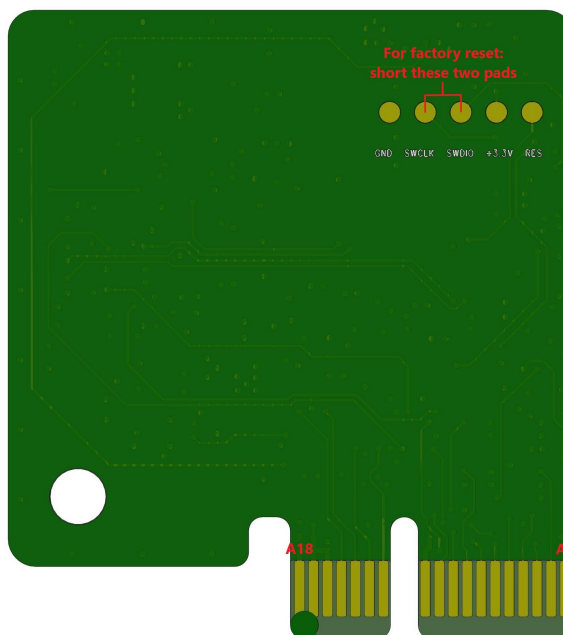


Figure 2: Bottom side of TCM-0930 with marked copper pads A1-A18

4 Connectors

The TMCM-0930-TMCL is equipped with a 36-pad Slot-Type connection solution. As a dedicated connector on the Slot Type Baseboards a **36-pin PCIe slot connector** should be used. All significant external signals of the MCU module and also the whole Slot Type system are routed via the slot type connector. These are the supply voltages, the CAN/RS485 interfaces, general purpose inputs/outputs and all other driver control signals. The pins located on the top side of the module PCB are labeled B1...B18 and the pins located on the bottom side of the PCB are labeled A1...A18.

For trying out the TMCM-0930-TMCL for the first time we recommend using a Trinamic Slot Type Baseboard (BB1 or BB4). Alternatively custom-made baseboard can also be designed and used by the end user.

NOTICE

Start with power supply OFF and do not connect or disconnect motor during operation! Motor cable and motor inductivity might lead to voltage spikes when the motor is (dis)connected while energized. These voltage spikes might exceed voltage limits of the driver MOSFETs and might permanently damage them. Therefore, always switch off / disconnect power supply or at least disable driver stage before connecting / disconnecting motor.

NOTICE

Connector type: The connector type required is a PCIe type connector from mechanical point of view. Nevertheless, the signal/pin assignment is NOT related to PCIe!

Slot Type MCU Module Connector Pin Assignment (PCB Top Side)			
Pin	Label	Direction	Description
B1	GND	—	Power and signal ground
B2	AIN0	input	General purpose analog/digital input #0
B3	AIN1	input	General purpose analog/digital input #1
B4	IN0	input	General purpose digital input #0
B5	IN1	input	General purpose digital input #1
B6	IN2	input	General purpose digital input #2
B7	IN3	input	General purpose digital input #3
B8	OUT0	output	General purpose digital output #0
B9	OUT1	output	General purpose digital output #1
B10	OUT2	output	General purpose digital output #2
B11	OUT3	output	General purpose digital output #3
B12	RS485_A	in/out	External RS485+ (non-inverted) signal
B13	RS485_B	in/out	External RS485- (inverted) signal
B14	USB_DM	in/out	Negative half of USB diff. signal
B15	USB_DP	in/out	Positive half of USB diff. signal
B16	USB_5V	input	+5V USB supply for +3.3V Regulator
B17	+5V	input	Logic supply voltage



Pin	Label	Direction	Description
B18	+5V	input	Logic supply voltage

Table 2: Top Side Slot Connector Pin Assignment

Slot Type Connector Pin Assignment (PCB Bottom Side)			
Pin	Label	Direction	Description
A1	GND	—	Power and signal ground
A2	DRV1_EN	output	Enable signal for Driver 1 motor coil
A3	DRV1_IRQ	input	Interrupt input signal for Driver 1
A4	DRV2_EN	output	Enable signal for Driver 2 motor coil
A5	DRV2_IRQ	input	Interrupt input signal for Driver 2
A6	DRV3_EN	output	Enable signal for Driver 3 motor coil
A7	DRV3_IRQ	input	Interrupt input signal for Driver 3
A8	DRV4_EN	output	Enable signal for Driver 4 motor coil
A9	DRV4_IRQ	input	Interrupt input signal for Driver 4
A10	SYNC	output	Synchronization output for whole driver system
A11	GND	—	Power and signal ground
A12	RS485_A	in/out	Internal RS485+ (non-inverted) signal
A13	RS485_B	in/out	Internal RS485- (inverted) signal
A14	CAN_L	in/out	CAN bus low
A15	CAN_H	in/out	CAN bus high
A16	GND	—	Power and signal ground
A17	GND	—	Power and signal ground
A18	GND	—	Power and signal ground

Table 3: Bottom Side Slot Connector Pin Assignment

NOTICE

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

NOTICE

Do not remove or plug in the module while the base board is powered!



5 Reset to Factory Defaults

It is possible to reset all settings in firmware for the TMCM-0930-TMCL to factory defaults without establishing a working communication connection. This might be helpful in case communication parameters of the preferred interface have been set to unknown values or got lost.

For this procedure two pads on the top side of the module have to be shorted (electrically connected with each other) during power-on.

Please perform the following steps:

1. Switch power supply OFF.
2. Short SWCLK and SWDIO pads of programming pads on bottom of pcb (see figure 2).
3. Switch power supply ON again.
4. Wait a few seconds.
5. Switch power supply OFF again.
6. Remove the short between the two pads.
7. After switching power supply ON again all permanent settings have been restored to factory defaults.



6 I/Os

The slot connector offers two analog inputs, four digital inputs and four digital outputs. Plus dedicated control signals for each connected driver module. All inputs can be used for different purposes explained in more detail in the following subsections.

6.1 Analog inputs

The TMCM-0930-TMCL is equipped with two analog inputs (AIN0 and AIN1). The analog input voltage range is approx. 0...+5V. For voltages above +5V saturation takes place, but voltages of up-to 30V are tolerated without destroying the input. For analog to digital conversion the integrated ADC of the on-board microcontroller is used. Resolution of this converter is 12bit (0..4095).

The analog inputs can also be used as digital inputs.

6.2 Digital inputs

The TMCM-0930-TMCL offers four digital inputs (IN0, IN1, IN2 and IN3). Their input voltage range is 0...+5V. Higher voltages (up to 30V) are also tolerated without destroying the input. Voltages above 1V are recognized as logical '1' and below 1V as logical '0'.

6.3 Digital outputs

The TMCM-0930-TMCL is equipped with four digital outputs (OUT0, OUT1, OUT2, OUT3). It is a +5V level TTL output.

6.4 Enable and Sync outputs

The TMCM-0930-TMCL offers four dedicated pins for four separate driver Enable outputs (DRV1_EN, DRV2_EN, DRV3_EN, DRV4_EN) which are used for enabling the function of each motor coil. The SYNC signal is used for the whole Slot-Type module system synchronization purposes between the TMCM-0930-TMCL and the driver boards (TMCM-1230, TMCM-1231, TMCM-1637, TMCM-1638).

6.5 Interrupt inputs

The TMCM-0930-TMCL includes four dedicated pins for four separate driver interrupt signals (DRV1_IRQ, DRV2_IRQ, DRV3_IRQ, DRV4_IRQ), meant for feedback from each motor driver module.



7 Communication

7.1 RS485

For remote control and communication with a host system the TMC-0930-TMCL 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.

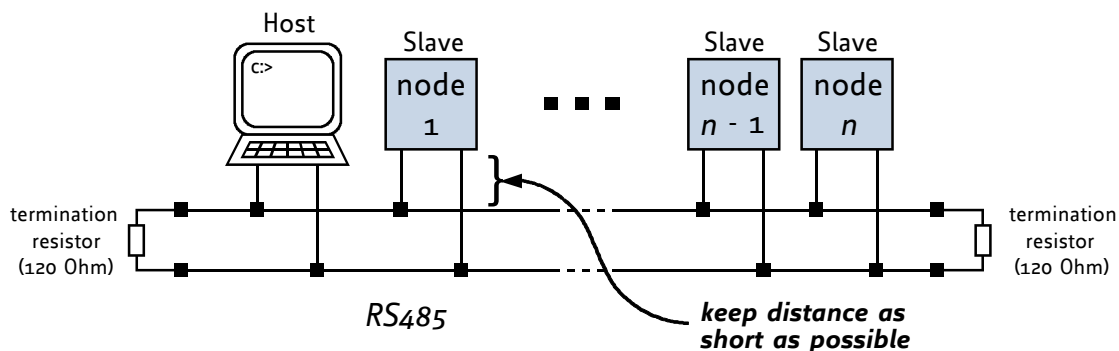


Figure 3: RS485 bus structure with termination resistors

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-0930-TMCL 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-0930-TMCL 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 TMC-0930-TMCL hardware is 1Mbit/s. Factory default is 9600 bit/s. Please see separate TMC-0930-TMCL 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):



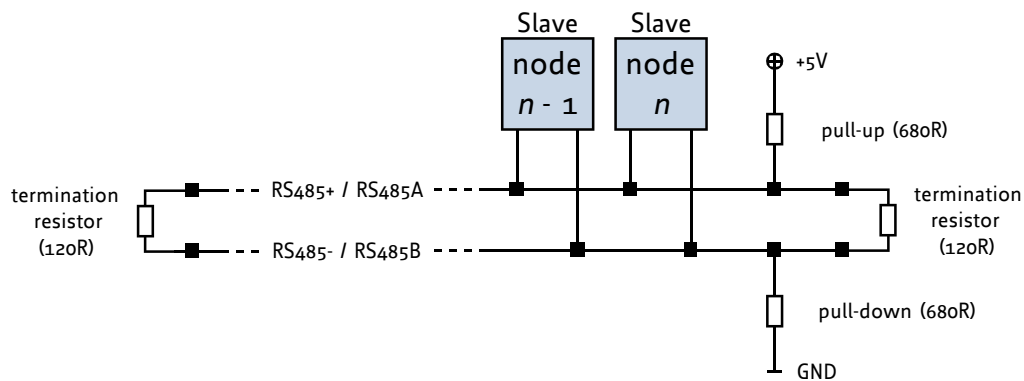


Figure 4: RS485 bus lines with resistor (bias) network on one side, only

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

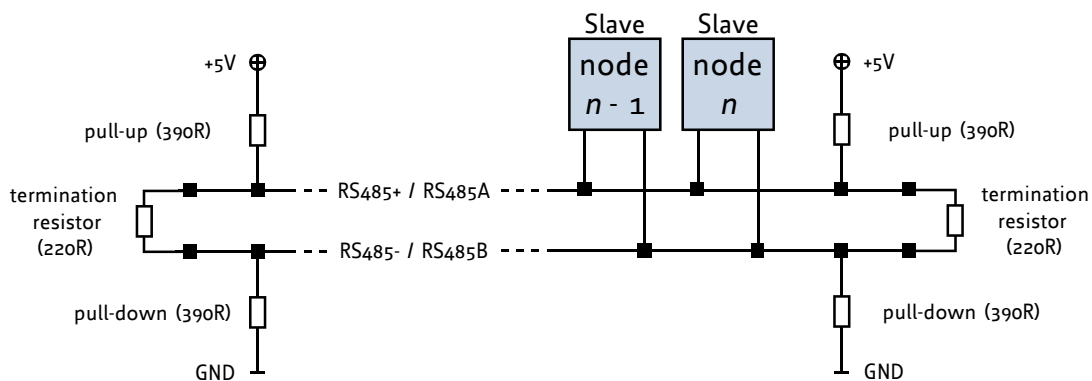


Figure 5: RS485 bus lines with Profibus™ recommended line termination

7.2 CAN

For remote control and communication with a host system the TMC-0930-TMCL provides a CAN bus interface. Please note that the CAN interface is not available in case USB is connected. 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.



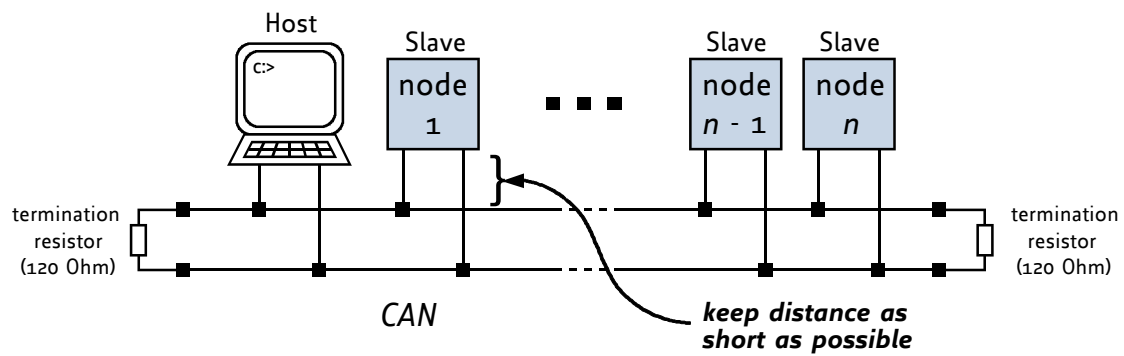


Figure 6: CAN bus structure with termination resistors

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-0930-TMCL does not integrate any termination resistor. Therefore, 120 Ohm termination resistors at both ends of the bus have to be added externally.

3. **BUS TERMINATION:**

The bus transceiver used on the TMC-0930-TMCL units (TJA1051T) supports at least 110 nodes under optimum conditions. Practically achievable number of nodes per CAN bus highly depend on bus length (longer bus -> less nodes) and communication speed (higher speed -> less nodes).



8 Operational Ratings and Characteristics

General Operational Ratings					
Symbol	Parameter	Min	Typ	Max	Unit
V_{Logic}	Logic power supply voltage		5		V
I_{Logic}	Logic power supply current		tbd		mA
T_{ENV}	Environmental temperature at rated current (no forced cooling required)	-30		60	°C

Table 4: General operational ratings of the module

Operational Ratings of the I/Os					
Symbol	Parameter	Min	Typ	Max	Unit
V_{OUT}	Voltage at digital outputs	0		5	V
I_{OUT}	Current through digital outputs			20	mA
$V_{\text{IN}0/1/2/3}$	Input voltage for inputs IN0...IN3	0	0...5	5	V
$V_{\text{OUT}0/1/2/3}$	Output voltage for outputs OUT0...OUT3	0	5		V
$V_{\text{AIN}0/1}$	Measurement range for analog inputs IN0, IN1	0		5	V
$V_{\text{IN}0...3_L}$	Low level voltage for IN0...IN3 (digital inputs)			1	V
$V_{\text{IN}0...3_H}$	High level voltage for IN0...IN3 (digital inputs)	2.9			V

Table 5: Operational ratings of I/Os

Operational Ratings of the RS485 Interface					
Symbol	Parameter	Min	Typ	Max	Unit
N_{RS485}	Number of nodes connected to single RS485 network			256	
f_{RS485}	Max. speed for RS485 network			1Mbit/s	

Table 6: Operational ratings of the RS485 interface

Operational Ratings of the CAN Interface					
Symbol	Parameter	Min	Typ	Max	Unit
N_{CAN}	Number of nodes connected to single CAN network			>110	
f_{CAN}	Max. speed for CAN network			1Mbit/s	

Table 7: Operational ratings of the CAN interface



9 Abbreviations used in this Manual

Abbreviation	Description
IDE	Integrated Development Environment
LED	Light Emitting Diode
RMS	Root Mean Square value
TMCL	TRINAMIC Motion Control Language

Table 8: Abbreviations used in this Manual



10 Figures Index

1	Front side of TMCM-0930 with marked copper pads B1-B18	5	4	RS485 bus lines with resistor (bias) network on one side, only	11
2	Bottom side of TMCM-0930 with marked copper pads A1-A18	5	5	RS485 bus lines with Profibus™ recommended line termination	11
3	RS485 bus structure with termination resistors	10	6	CAN bus structure with termination resistors	12



11 Tables Index

1	TMC-0930 Order Codes	4	6	Operational ratings of the RS485 inter- face	13
2	Top Side Slot Connector Pin Assignment	7	7	Operational ratings of the CAN interface	13
3	Bottom Side Slot Connector Pin As- signment	7	8	Abbreviations used in this Manual . .	14
4	General operational ratings of the module	13	9	Hardware Revision	19
5	Operational ratings of I/Os	13	10	Document Revision	19



12 Supplemental Directives

12.1 Producer Information

12.2 Copyright

TRINAMIC owns the content of this user manual in its entirety, including but not limited to pictures, logos, trademarks, and resources. © Copyright 2020 TRINAMIC. All rights reserved. Electronically published by TRINAMIC, Germany.

Redistributions of source or derived format (for example, Portable Document Format or Hypertext Markup Language) must retain the above copyright notice, and the complete Datasheet User Manual documentation of this product including associated Application Notes; and a reference to other available product-related documentation.

12.3 Trademark Designations and Symbols

Trademark designations and symbols used in this documentation indicate that a product or feature is owned and registered as trademark and/or patent either by TRINAMIC or by other manufacturers, whose products are used or referred to in combination with TRINAMIC's products and TRINAMIC's product documentation.

This Hardware Manual is a non-commercial publication that seeks to provide concise scientific and technical user information to the target user. Thus, trademark designations and symbols are only entered in the Short Spec of this document that introduces the product at a quick glance. The trademark designation /symbol is also entered when the product or feature name occurs for the first time in the document. All trademarks and brand names used are property of their respective owners.

12.4 Target User

The documentation provided here, is for programmers and engineers only, who are equipped with the necessary skills and have been trained to work with this type of product.

The Target User knows how to responsibly make use of this product without causing harm to himself or others, and without causing damage to systems or devices, in which the user incorporates the product.

12.5 Disclaimer: Life Support Systems

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.

Information given in this document is believed to be accurate and reliable. However, no responsibility is assumed for the consequences of its use nor for any infringement of patents or other rights of third parties which may result from its use. Specifications are subject to change without notice.

12.6 Disclaimer: Intended Use

The data specified in this user manual is intended solely for the purpose of product description. No representations or warranties, either express or implied, of merchantability, fitness for a particular purpose



or of any other nature are made hereunder with respect to information/specification or the products to which information refers and no guarantee with respect to compliance to the intended use is given.

In particular, this also applies to the stated possible applications or areas of applications of the product. TRINAMIC products are not designed for and must not be used in connection with any applications where the failure of such products would reasonably be expected to result in significant personal injury or death (safety-Critical Applications) without TRINAMIC's specific written consent.

TRINAMIC products are not designed nor intended for use in military or aerospace applications or environments or in automotive applications unless specifically designated for such use by TRINAMIC. TRINAMIC conveys no patent, copyright, mask work right or other trade mark right to this product. TRINAMIC assumes no liability for any patent and/or other trade mark rights of a third party resulting from processing or handling of the product and/or any other use of the product.

12.7 Collateral Documents & Tools

This product documentation is related and/or associated with additional tool kits, firmware and other items, as provided on the product page at: www.trinamic.com.



13 Revision History

13.1 Hardware Revision

Version	Date	Author	Description
V1.2	2020-JUN-15	HH	Initial release version.

Table 9: Hardware Revision

13.2 Document Revision

Version	Date	Author	Description
1.00	2020-NOV-19	HH	Initial version.

Table 10: Document Revision

