

TMCM-1617 Hardware Manual

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The TMCM-1617 is a low-weight miniaturized single axis servo drive for 3-phase BLDC motors with up to 18A RMS motor current and +24V supply. With CAN, RS485, and EtherCAT® it offers various communication options. TMCM-1617 supports incremental encoders, analog encoders, and digital hall sensors as position feedback. Customization and different housing options are possible.



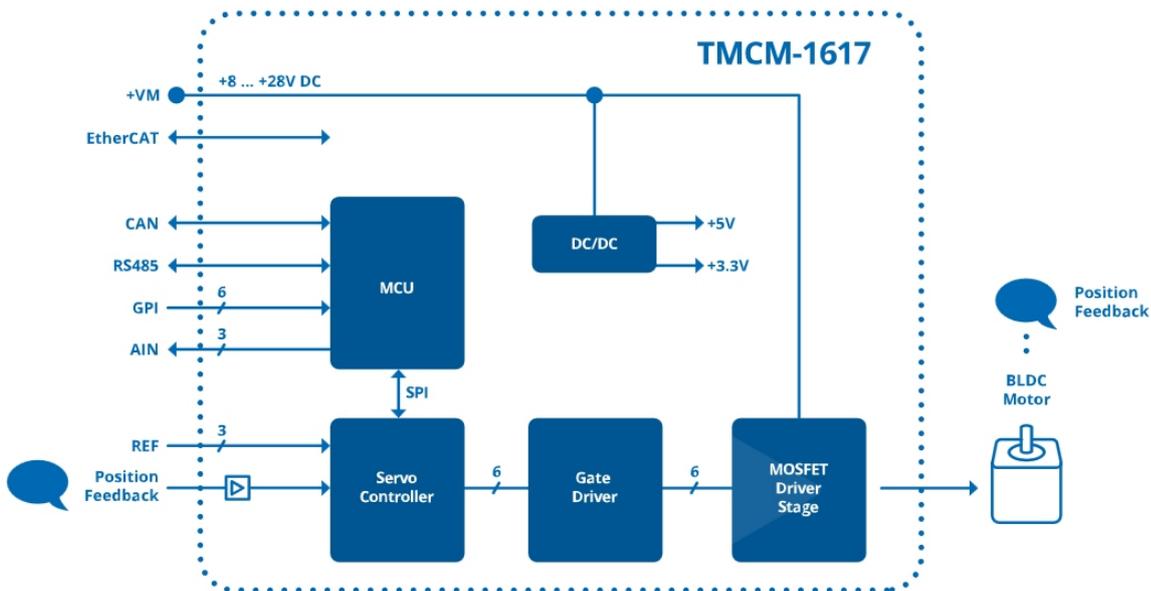
Features

- Servo drive for 3ph/BLDC motors
- +8...28V DC supply voltage
- Up to 18A RMS max. motor current
- RS485, CAN & EtherCAT® interfaces
- Incremental encoder feedback
- Digital HALL sensor feedback
- Analog encoder feedback
- Reference Switch Inputs
- Cooling via aluminum housing
- L/W/H: 36.8mm x 26.8mm x 11.1mm
- Weight: ca. 24g
- Customization options

Applications

- Robotics
- Laboratory Automation
- Manufacturing
- Factory Automation
- Servo Drives
- Low Inductance Motors

Simplified Block Diagram



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1 Features

The TMC-1617 is a low-weight miniaturized single axis servo drive for 3-phase BLDC motors with up to 18A RMS motor current (short time peak) and +24V supply. With CAN, RS485, and EtherCAT® it offers various interfaces for communication. TMC-1617 supports incremental encoders, analog encoders, and digital hall sensors as position feedback. Customization and different housing options are possible.

Controller & Driver

- Motor current: up to 18A RMS short time peak (depends on duty cycle, temperature, and cooling)
- Motor current: 4A RMS continuous at room temperature without forced cooling
- Supply voltage: +8...+28V DC, (+24V nominal)
- Field Oriented Control in hardware with up to 100kHz PWM and current control loop
- Temperature rating: -30...+60° (standard version)

Position Feedback

- Incremental encoder (ABN)
- Digital Hall sensors
- +5V supply for sensors and feedback systems

IO

- 2x general purpose digital inputs (0...+3.3V input range)
- 4x general purpose digital outputs (0...+3.3V input range)
- 3x analog inputs (0...+3.3V input range)
- 3x reference switch inputs (0...+3.3V input range, left/right/home)
- +3.3V provided for signal conditioning on a base board or as reference

Interfaces

- Digital RS485 interface with up-to 1Mbit/s (external transceiver needed on base board)
- Digital CAN interface with up-to 1Mbit/s (external transceiver needed on base board)
- EtherCAT interface (100Mbit Ethernet PHYs included in the module) with EtherCAT LED indicator outputs

Mechanical data

- Max. dimension: 36.8mm x 26.8mm x 11.1mm (L/W/H)
- Weight: ca. 24g
- 2 mounting holes for M2.5 screws
- Forced cooling via housing, mount heat sink to bottom side
- Optional no housing and no potting, bare PCB stack
 - Weight: ca. 14g
 - Max. dimension: 35.9mm x 25.9mm x 11.1mm (L/W/H)
 - Forced cooling via bottom side PCB



Software

- TMCL™ remote (direct mode) and standalone operation (memory for up to 1024 TMCL™ commands), fully supported by TMCL-IDE (PC based integrated development environment). Further information given in the TMCM-1617 TMCL firmware manual.
- CANopen firmware with CANopen standard protocol stack for the CAN interface. Further information given in the TMCM-1617 CANopen firmware manual.
- CANopen-over-EtherCAT (COE) with DS402 standard protocol stack. Please see TMCM-1617 COE firmware manual for more details.

2 Order Codes

Order Code	Description	Size (LxWxH)
TMCM-1617-TMCL	Miniaturized Servo Drive, TMCL firmware, housing & potted, standard temperature rating	36.8mm x 26.8mm x 11.1mm
TMCM-1617-CANOPEN	Miniaturized Servo Drive, CANopen firmware, housing & potted, standard temperature rating	36.8mm x 26.8mm x 11.1mm
TMCM-1617-COE	Miniaturized Servo Drive, CANopen-over-EtherCAT firmware, housing & potted, standard temperature rating	36.8mm x 26.8mm x 11.1mm
TMCM-1617-BB	TMCM-1617 base board, white	130mm x 85mm

Table 1: TMCM-1617 Order Codes



3 Mechanical and Electrical Interfacing

3.1 Module Size

The TCCM-1617 comes potted inside an aluminum housing with an overall size of 36.8mm (length) x 26.8mm (width) x 11.1mm (height). The module has 2 additional mounting holes for M2.5 screws to screw it to a carrier board.

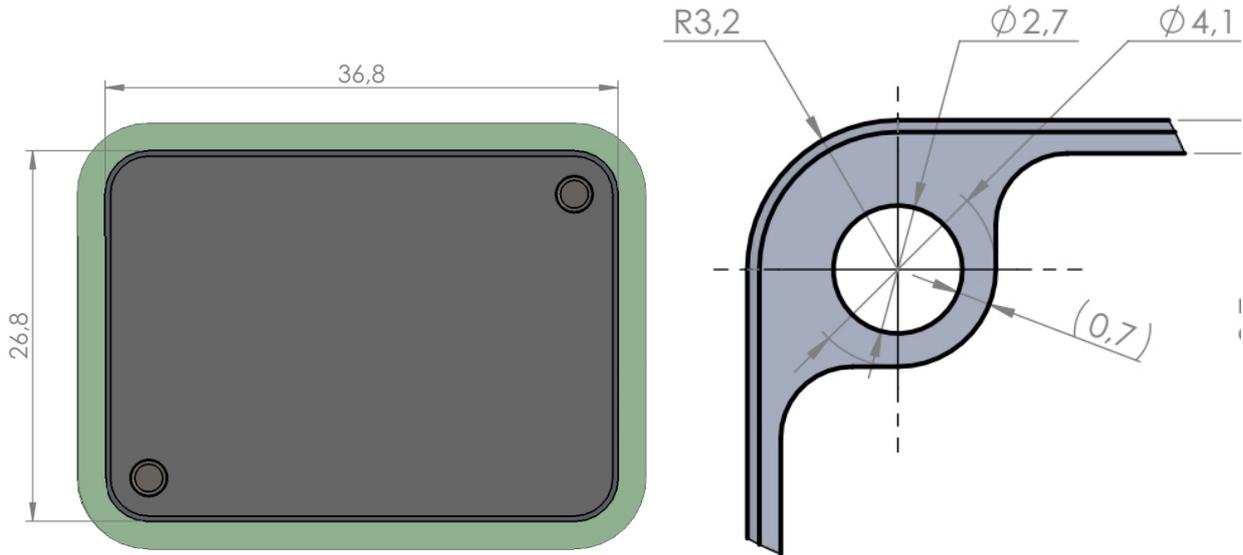


Figure 1: Board dimensions and position of mounting holes (all values in mm)

3.2 Board Mounting Considerations

3.2.1 Soldering the Module onto a Baseboard

The TCCM-1617 is intended to be soldered onto a base PCB via its THT connectors. For easy integration into own designs a PCB library including symbol and footprint is provided for selected CAD tools (Mentor PADS, KiCAD).

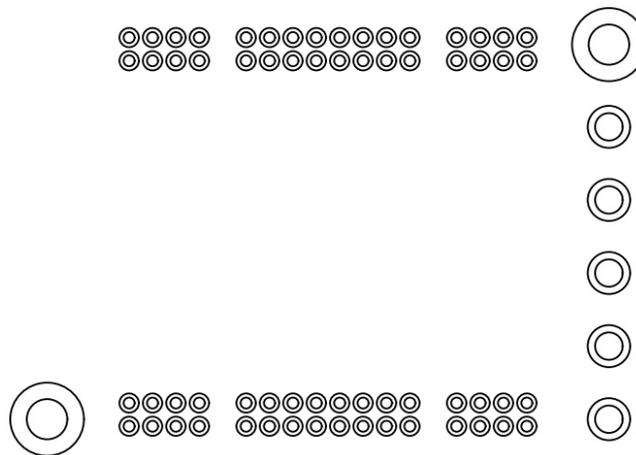


Figure 2: TCCM-1617 PCB footprint as seen on the top side of a base/carrier PCB



3.2.2 Plugging the Module onto a Baseboard

If required, the TMCM-1617 can also be plugged onto a base PCB using special mating connectors. Thereby, the module is replaceable. The mating connectors fit into the same PCB footprint as shown in the previous section.

The following table show the mating connector types required for plugging the module. The images show the top view of Trinamic’s baseboard for the TMCM-1617 and the positions of the respective mating connectors.

Connector #	Connector Type	Sourcing (example)
J301...J305	Mill-Max 9354-0-15-15-18-27-10-0 or Mill-Max 9357-0-15-80-18-27-10-0	DigiKey ED1047-ND or DigiKey ED10171-ND0
J315, J317, J318, J320	Mill-Max 853-41-008-10-001000	Mouser 575-8534100810001000
J316, J319	Mill-Max 853-41-016-10-001000	Mouser 575-8534101610001000

Table 2: TMCM-1617 mating connectors for plugging onto a baseboard

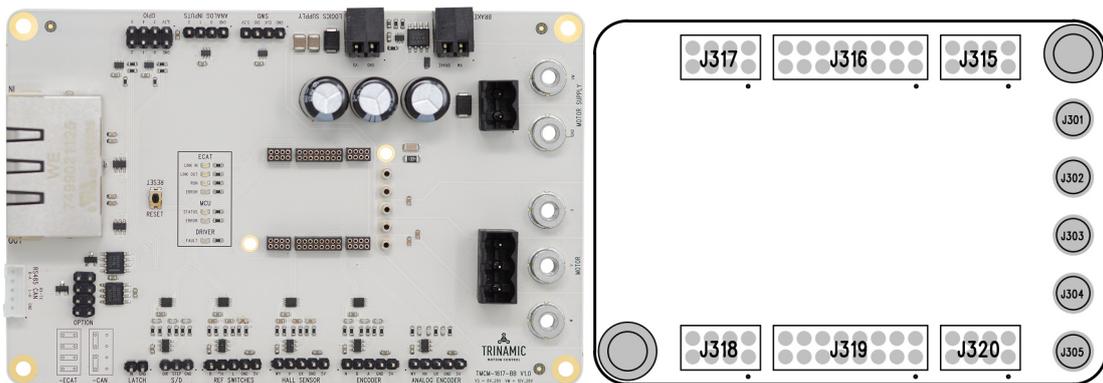


Figure 3: TMCM-1617 baseboard mating connector positions

NOTICE Please note that when plugged into the mating connectors the maximum power rating of the connection between TMCM-1617 power input and motor phase outputs and PCB might be lower compared to soldering TMCM-1617 directly into a PCB.

3.2.3 TMCM-1617 Baseboard

The TMCM-1617 baseboard is an additional product that can be used for evaluation of the TMCM-1617. The full CAD data (Mentor PADS) and Gerber files for the TMCM-1617 baseboard is available as reference and can be used for own designs.

The CAD data and additional information can be downloaded from Trinamic’s website www.trinamic.com.



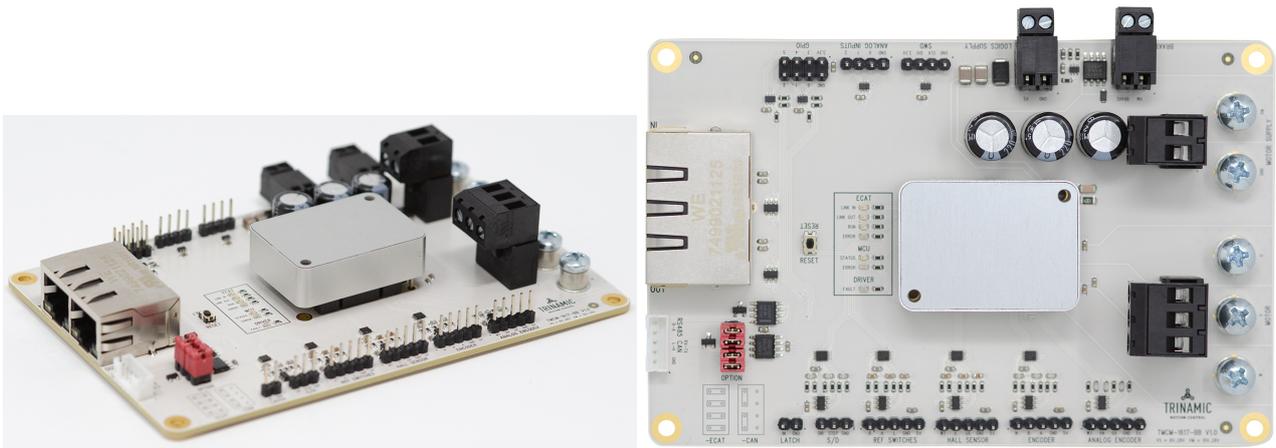


Figure 4: Side and top view on TMCM-1617 baseboard complete with TMCM-1617 module and mating connectors

3.2.4 Mounting a Heat Sink

The aluminum housing of TMCM-1617 has 2 mounting holes for M2.5 screws/bolts to be able to further fixate it to a baseboard. These mounting holes also allow for mounting a heat sink connected to the bottom side of the housing.

A thermal gap pad (electrically isolating) is recommended between the housing and the heat sink for proper heat transfer.

The heat sink requires M2.5 threaded screw holes at the same positions as highlighted in Section 3.1

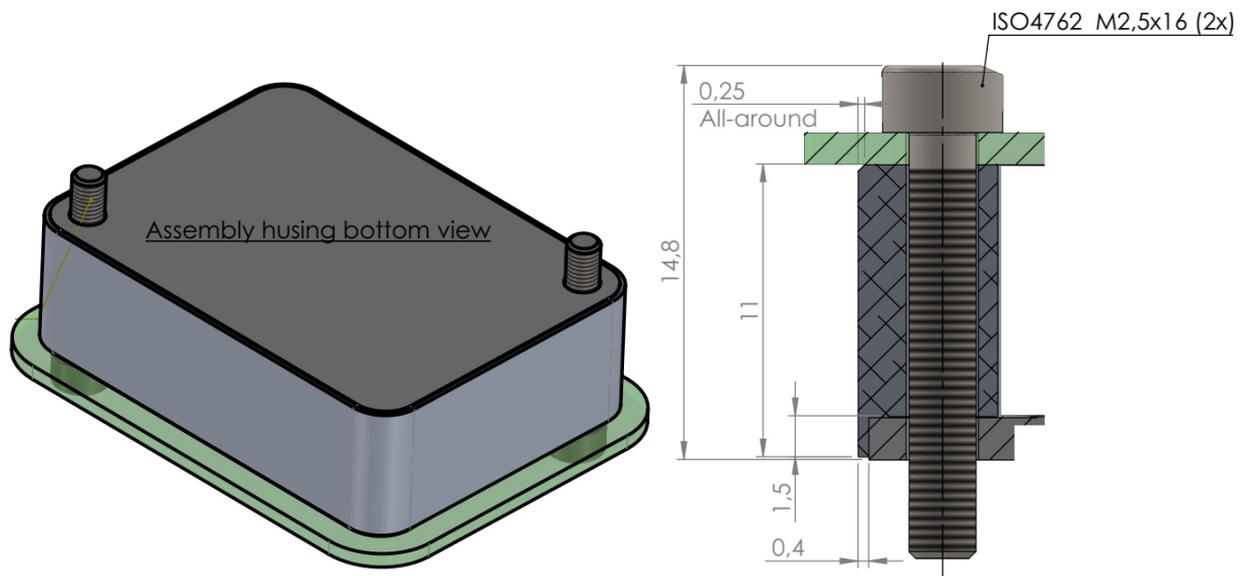


Figure 5: Heat sink mounting



3.3 Supply Buffering

TMC-1617 includes only limited onboard capacitance. For high current applications additional capacitors must be placed close to the module power input to stabilize power supply. In addition, a regulated power supply is highly recommended.

NOTICE

Depending on your application make sure to add sufficient capacitors to the driver input to stabilize supply.

Low ESR electrolyte caps are recommended.

It is recommended to connect electrolytic capacitors of significant size to the power supply lines next to the TMC-1617 !

Rule of thumb for size of electrolytic capacitor: $C = 1000 \frac{\mu F}{A} * I_{SUPPLY}$

The capacitors should be selected with regard to high ripple current rating. 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 Connectors and Signals

The TMC-1617 has 11 connectors altogether. There are 6 low voltage & I/O connectors (J315...J320) and 5 motor & supply connectors (J301...J305). The black dots in the image below are pin 1 marks.

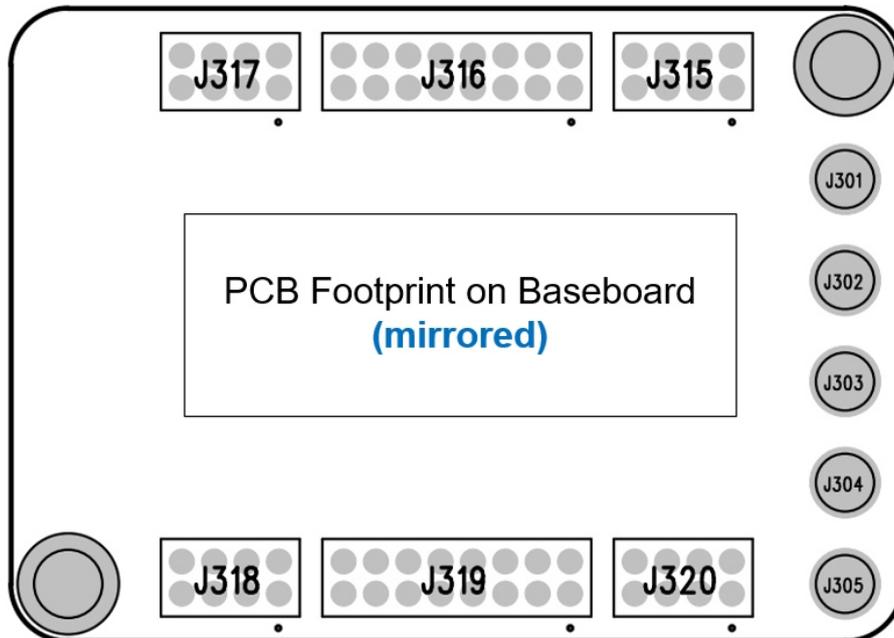


Figure 6: TCM-1617 connectors as seen on the baseboard footprint (mirrored compared to top side of TCM-1617 itself)

NOTICE

Start with power supply OFF and do not connect or disconnect motor during operation! Motor cable and motor inductance 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

Take care of polarity, wrong polarity can destroy the board!



4.1 TMCM-1617 TMCL and CANopen Version

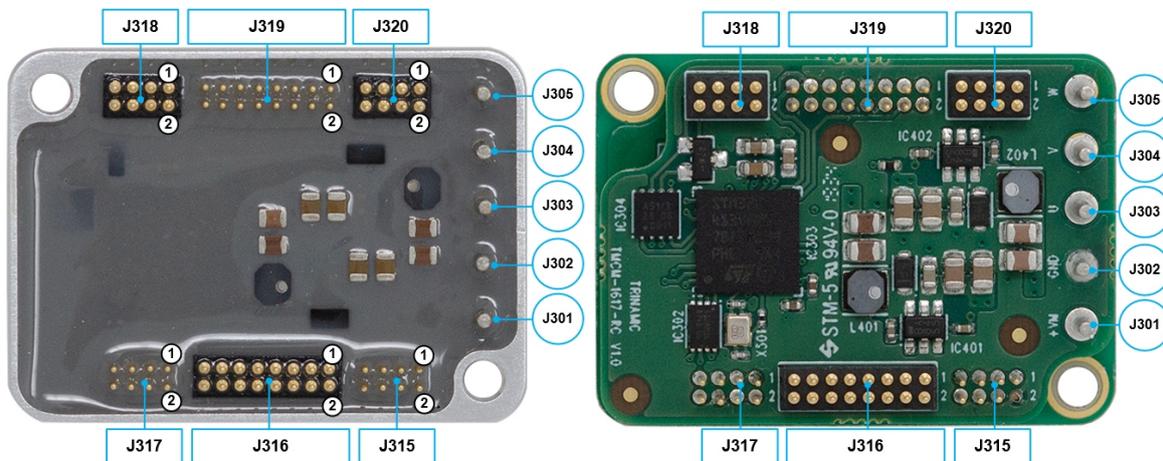


Figure 7: TMCM-1617 connectors and signals for TMCL/CANopen version (potted and open module)

4.1.1 Motor & Supply Connectors J301...J305

Connector	Signal	Description
J301	+VM	Motor supply voltage, +24V
J302	GND	Signal and supply ground
J303	U	Motor phase U
J304	V	Motor phase V
J305	W	Motor phase W

Table 3: Motor & supply connectors J301...J305

NOTICE

The TMCM-1617 does not contain a suppressor diode or other over-voltage protection at the supply input. On the baseboard a proper suppressor diode must be provided for protection if required. For example a suppressor of type SMBJ26A.

NOTICE

The TMCM-1617 only contains minimum onboard capacitance to stabilize the supply voltage and minimize current ripple. Depending on your application make sure to add sufficient capacitors to the driver input. Low ESR electrolyte caps are recommended, especially for higher current applications. See Section 3.3 for more information.



4.1.2 Low Voltage & I/O connector J315

Pin	Signal	Description
1	+3.3V_OUT	+3.3V output rail for used on the baseboard, 50mA max.
2	GND	Common system supply and signal ground
3	REF_R	Right reference switch input, +3.3V level
4	-dnc-	do not connect
5	REF_H	Home reference switch input, +3.3V level
6	-dnc-	do not connect, reserved for future use
7	REF_L	Left reference switch input, +3.3V level
8	-dnc-	do not connect, reserved for future use

Table 4: Low voltage & I/O connector J315

4.1.3 Low Voltage & I/O connector J316

Pin	Signal	Description
1	-dnc-	do not connect
2	GND	Common system supply and signal ground
3	-dnc-	do not connect
4	GND	Common system supply and signal ground
5	-dnc-	do not connect
6	GND	Common system supply and signal ground
7	-dnc-	do not connect
8	AIN0	Analog input 0, 0...+3.3V
9	-dnc-	do not connect
10	AIN1	Analog input 1, 0...+3.3V
11	-dnc-	do not connect
12	AIN2	Analog input 2, 0...+3.3V
13	-dnc-	do not connect
14	GND	Common system supply and signal ground
15	-dnc-	do not connect
16	GND	Common system supply and signal ground

Table 5: Low voltage & I/O connector J315



4.1.4 Low Voltage & I/O connector J317

Pin	Signal	Description
1	-dnc-	do not connect
2	-dnc-	do not connect
3	-dnc-	do not connect
4	nRESET	external reset line, low active, +3.3V level
5	-dnc-	do not connect
6	GND	Common system supply and signal ground
7	-dnc-	do not connect
8	-dnc-	do not connect

Table 6: Low voltage & I/O connector J317

4.1.5 Low Voltage & I/O connector J318

Pin	Signal	Description
1	-dnc-	do not connect
2	RS485_RX	RS485 interface digital RX line, +3.3V level, connect to external transceiver
3	RUN_LED	Control signal for MCU/CANopen status LED, +3.3V level
4	RS485_TX	RS485 interface digital TX line, +3.3V level, connect to external transceiver
5	ERR_LED	Control signal for MCU/CANopen error LED, +3.3V level
6	RS485_DIR	RS485 interface direction control line, +3.3V level, connect to external transceiver
7	CAN_H	CAN physical bus interface, positive line from internal transceiver
8	CAN_L	CAN physical bus interface, negative line from internal transceiver

Table 7: Low voltage & I/O connector J318



4.1.6 Low Voltage & I/O connector J319

Pin	Signal	Description
1	-dnc-	do not connect, reserved for future use
2	-dnc-	do not connect, reserved for future use
3	-dnc-	do not connect, reserved for future use
4	BRAKE	Digital PWM brake chopper output, +3.3V level
5	+5V_OUT	+5V output rail from TMC-1617 to be used for sensor/encoder supply and/or external signal conditioning, 100mA max.
6	ENC_N	Digital quadrature/incremental encoder input, index channel, +3.3V level
7	GND	Common system supply and signal ground
8	ENC_B	Digital quadrature/incremental encoder input, B channel, +3.3V level
9	GPIO_1	Dedicated general purpose input 1, +3.3V level
10	ENC_A	Digital quadrature/incremental encoder input, A channel, +3.3V level
11	GPIO_2	Dedicated general purpose output 2, +3.3V level
12	HALL_WY	Digital Hall sensor input, +3.3V level
13	DRV_FAULT	Driver stage fault indicator
14	HALL_V	Digital Hall sensor input, +3.3V level
15	-dnc-	do not connect
16	HALL_UX	Digital Hall sensor input, +3.3V level

Table 8: Low voltage & I/O connector J319

4.1.7 Low Voltage & I/O connector J320

Pin	Signal	Description
1	GND	Common system supply and signal ground
2	+VS	Digital and logic supply input, +24V, can be combined with +VM
3	-dnc-	do not connect
4	GPIO_2	Dedicated general purpose output 2, +3.3V level
5	-dnc-	do not connect
6	GPIO_3	Dedicated general purpose output 3, +3.3V level
7	GPIO_0	Dedicated general purpose input 0, +3.3V level
8	GPIO_5	Dedicated general purpose output 5, +3.3V level

Table 9: Low voltage & I/O connector J320



4.1.8 LED Signals

The TMCM-1617 has no on-boards LEDs due to the way it is mounted. Nevertheless it has dedicated digital outputs to drive LEDs located on the baseboard. The following table summarizes these driver signals and gives baseboard recommendations.

All LED control signals are +3.3V level outputs.

(Connector & pin numbers when looking onto the TMCM-1617 from top / see Sections 4.1 and 4.2.)

Signal Name	Connector (Pin)	Description	Comment
RUN_LED	J318 (3)	MCU/CANopen status LED	use a green LED
ERR_LED	J318 (5)	MCU/CANopen error LED	use a red LED

Table 10: TMCM-1617 digital LED output signals



4.2 TMCM-1617 EtherCAT Version

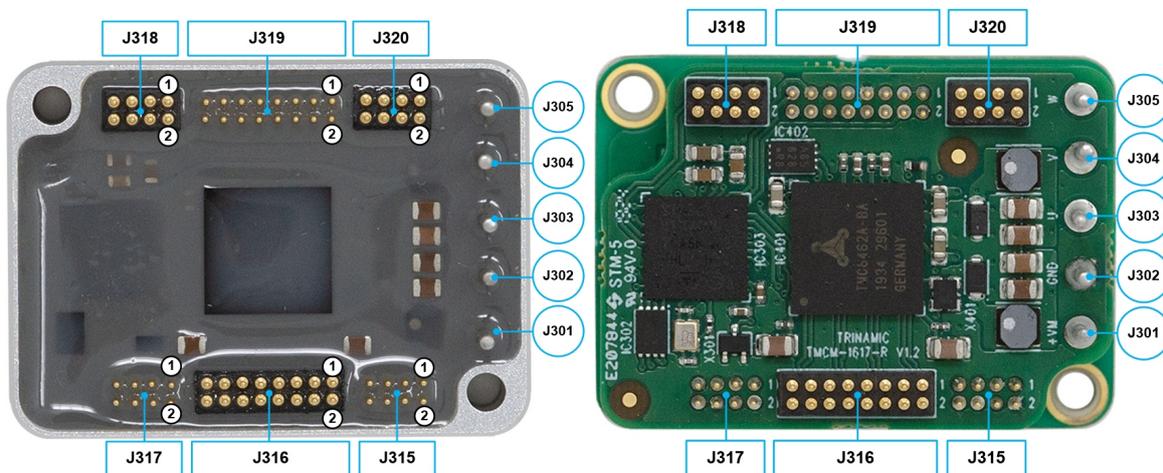


Figure 8: TMCM-1617 connectors and signals for CoE version (potted and open module)

4.2.1 Motor & Supply Connectors J301...J305

Connector	Signal	Description
J301	+VM	Motor supply voltage, +24V
J302	GND	Common system supply and signal ground
J303	U	Motor phase U
J304	V	Motor phase V
J305	W	Motor phase W

Table 11: Motor & supply connectors J301...J305

NOTICE

The TMCM-1617 does not contain a suppressor diode or other over-voltage protection at the supply input. On the baseboard a proper suppressor diode must be provided for protection if required. For example a suppressor of type SMBJ26A.

NOTICE

The TMCM-1617 only contains minimum onboard capacitance to stabilize the supply voltage and minimize current ripple. Depending on your application make sure to add sufficient capacitors to the driver input. Low ESR electrolyte caps are recommended, especially for higher current applications. See Section 3.3 for more information.



4.2.2 Low Voltage & I/O connector J315

Pin	Signal	Description
1	+3.3V_OUT	+3.3V output rail for used on the baseboard, 50mA max.
2	GND	Common system supply and signal ground
3	REF_R	Right reference switch input, +3.3V level
4	-dnc-	do not connect
5	REF_H	Home reference switch input, +3.3V level
6	-dnc-	do not connect, reserved for future use
7	REF_L	Left reference switch input, +3.3V level
8	-dnc-	do not connect, reserved for future use

Table 12: Low voltage & I/O connector J315

4.2.3 Low Voltage & I/O connector J316

Pin	Signal	Description
1	ECAT_TP_OUT	EtherCAT OUT port physical interface TX
2	ECAT_LINK_IN_LED	Control signal for EtherCAT link IN status and activity LED, +3.3V level
3	ECAT_TN_OUT	EtherCAT OUT port physical interface TX
4	ECAT_LINK_OUT_LED	Control signal for EtherCAT link OUT status and activity LED, +3.3V level
5	ECAT_RP_OUT	EtherCAT OUT port physical interface RX
6	GND	Common system supply and signal ground
7	ECAT_RN_OUT	EtherCAT OUT port physical interface RX
8	AIN0	Analog input 0, 0... +3.3V
9	ECAT_TP_IN	EtherCAT IN port physical interface TX
10	AIN1	Analog input 1, 0... +3.3V
11	ECAT_TN_IN	EtherCAT IN port physical interface TX
12	AIN2	Analog input 2, 0... +3.3V
13	ECAT_RP_IN	EtherCAT IN port physical interface RX
14	ECAT_RUN_LED	Control signal for EtherCAT state machine RUN LED, +3.3V level
15	ECAT_RN_IN	EtherCAT IN port physical interface RX
16	ECAT_ERR_LED	Control signal for EtherCAT state machine ERR LED, +3.3V level

Table 13: Low voltage & I/O connector J315



4.2.4 Low Voltage & I/O connector J317

Pin	Signal	Description
1	-dnc-	do not connect
2	-dnc-	do not connect
3	-dnc-	do not connect
4	nRESET	external reset line, low active, +3.3V level
5	-dnc-	do not connect
6	GND	Common system supply and signal ground
7	-dnc-	do not connect
8	-dnc-	do not connect

Table 14: Low voltage & I/O connector J317

4.2.5 Low Voltage & I/O connector J318

Pin	Signal	Description
1	ECAT_LATCH0	EtherCAT external DC latch input 0, +3.3V level, apply appropriate external filter to avoid noise and glitches
2	RS485_RX	RS485 interface digital RX line, +3.3V level, connect to external transceiver
3	RUN_LED	Control signal for MCU/CANopen status LED, +3.3V level
4	RS485_TX	RS485 interface digital TX line, +3.3V level, connect to external transceiver
5	ERR_LED	Control signal for MCU/CANopen error LED, +3.3V level
6	RS485_DIR	RS485 interface direction control line, +3.3V level, connect to external transceiver
7	CAN_TX	CAN interface digital TX line, +3.3V level, connect to external transceiver
8	CAN_RX	CAN interface digital RX line, +3.3V level, connect to external transceiver

Table 15: Low voltage & I/O connector J318



4.2.6 Low Voltage & I/O connector J319

Pin	Signal	Description
1	-dnc-	do not connect, reserved for future use
2	-dnc-	do not connect, reserved for future use
3	-dnc-	do not connect, reserved for future use
4	BRAKE	Digital PWM brake chopper output, +3.3V level
5	+5V_OUT	+5V output rail from TMC-1617 to be used for sensor/encoder supply and/or external signal conditioning, 100mA max.
6	ENC_N	Digital quadrature/incremental encoder input, index channel, +3.3V level
7	GND	Common system supply and signal ground
8	ENC_B	Digital quadrature/incremental encoder input, B channel, +3.3V level
9	GPIO_1	Dedicated general purpose input 1, +3.3V level
10	ENC_A	Digital quadrature/incremental encoder input, A channel, +3.3V level
11	GPIO_2	Dedicated general purpose output 2, +3.3V level
12	HALL_WY	Digital Hall sensor input, +3.3V level
13	DRV_FAULT	Driver stage fault indicator
14	HALL_V	Digital Hall sensor input, +3.3V level
15	-dnc-	do not connect
16	HALL_UX	Digital Hall sensor input, +3.3V level

Table 16: Low voltage & I/O connector J319

4.2.7 Low Voltage & I/O connector J320

Pin	Signal	Description
1	GND	Common system supply and signal ground
2	+VS	Digital and logic supply input, +24V, can be combined with +VM
3	-dnc-	do not connect
4	GPIO_3	Dedicated general purpose output 3, +3.3V level
5	-dnc-	do not connect
6	GPIO_4	Dedicated general purpose output 4, +3.3V level
7	GPIO_0	Dedicated general purpose input 0, +3.3V level
8	GPIO_5	Dedicated general purpose output 5, +3.3V level

Table 17: Low voltage & I/O connector J320



4.2.8 LEDs Signals

The TMCM-1617 has no on-boards LEDs due to the way it is mounted. Nevertheless it has dedicated digital outputs to drive LEDs located on the baseboard. The following table summarizes these driver signals and gives baseboard recommendations.

All LED control signals are +3.3V level outputs.

(Connector & pin numbers when looking onto the TMCM-1617 from top / see Sections 4.1 and 4.2.)

Signal Name	Connector (Pin)	Description	Comment
RUN_LED	J318 (3)	MCU status LED	use a green LED
ERR_LED	J318 (5)	MCU error LED	use a red LED
ECAT_LINK_IN_LED	J316 (2)	EtherCAT link IN status and activity	use a green LED, close to IN port
ECAT_LINK_OUT_LED	J316 (4)	EtherCAT link OUT status and activity	use a green LED, close to OUT port
ECAT_RUN_LED	J316 (14)	EtherCAT state machine RUN LED	use a green LED, do not mix up with MCU RUN LED, mark accordingly
ECAT_ERR_LED	J316 (16)	EtherCAT state machine ERR LED	use a red LED, do not mix up with MCU ERR LED, mark accordingly

Table 18: TMCM-1617 digital LED output signals



5 Communication

The following sections give some guidelines and best practices when setting up the different communication bus systems supported by TMCM-1617.

5.1 RS485

For remote control and communication with a host system the TMCM-1617 provides a digital interface to RS485 bus transceivers on a baseboard. 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.

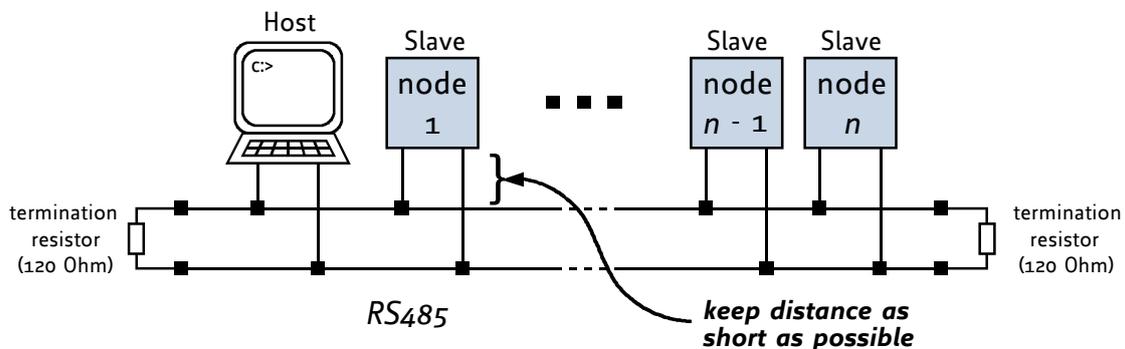


Figure 9: RS485 bus structure with termination resistors

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-1617 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 baseboard of TMCM-1617 (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-1617 hardware is 1Mbit/s. Factory default is 9600 bit/s. Please see separate TMCM-1617 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):

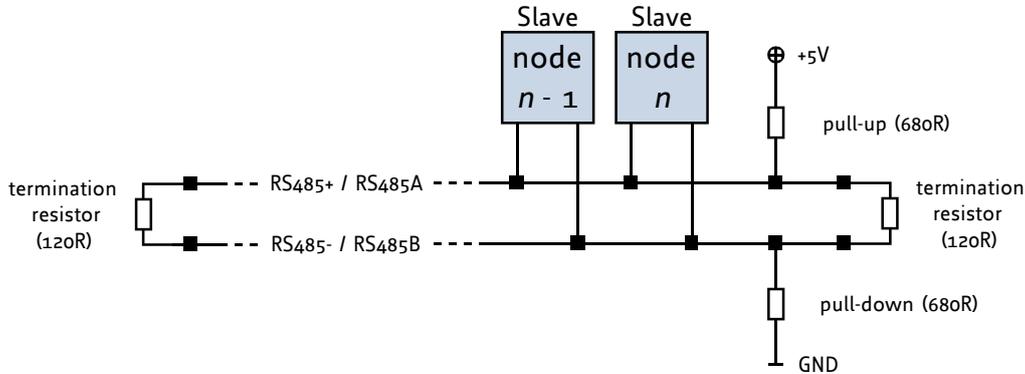


Figure 10: RS485 bus lines with resistor (bias) network on one side, only

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

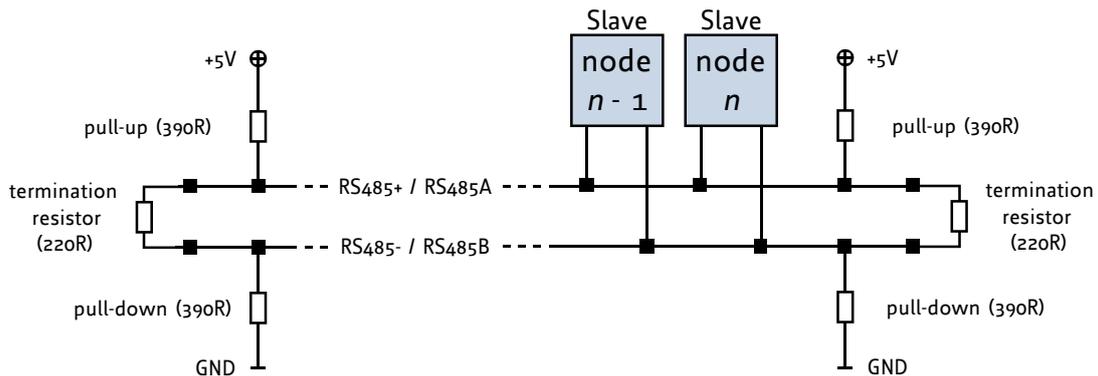


Figure 11: RS485 bus lines with Profibus™ recommended line termination

5.2 CAN

For remote control and communication with a host system the TMCM-1617 provides a CAN bus interface. TMCM-1617-CANOPEN and TMCM-1617-TMCL have the CAN transceiver integrated. TMCM-1617-COE only provides the digital CAN interface and requires an external CAN transceiver on a baseboard if this interface is required as well.

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.



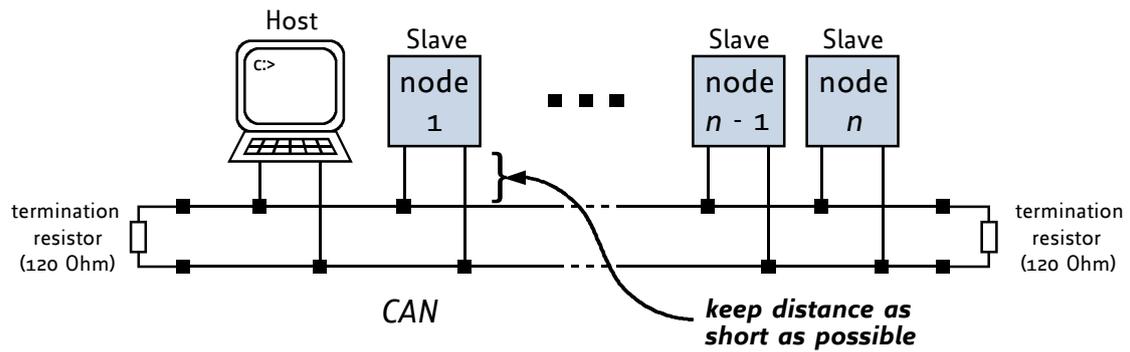


Figure 12: CAN bus structure with termination resistors

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-1617 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 TMCM-1617-TMCL/-CANOPEN units or on the base board (TJA1051TK/3) 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).

5.3 EtherCAT

For remote control and communication with an EtherCAT master system the TMCM-1617COE provides an EtherCAT bus interface. The required Ethernet PHYs and the EtherCAT Slave Controller are integrated on the TMCM-1617 -COE. Only the transformer circuit, line protection, and physical connector's need to be integrated on the baseboard.

For more information on EtherCAT and how it works please check our website:

<https://www.trinamic.com/technology/architecture/interfaces/ethercat/>



6 Operational Ratings and Characteristics

6.1 Absolute Maximum Ratings

Parameter	Symbol	Min	Abs. Max	Unit
Motor Supply voltage	$+VM$	+8	+28	V
Digital Supply voltage	$+VS$	+8	+28	V
Motor phase current RMS (phase peak)	$I_{phase,MAX}$		18.0 (25.0) ¹	A
Working temperature	T_A	-30	+60	°C
Max current at +5V_OUT	$I_{OUT+5V,MAX}$		100	mA
Max current at +3.3V_OUT	$I_{OUT+3.3V,MAX}$		50	mA

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.

6.2 Digital I/O Ratings (Ambient Temperature 25°C)

The digital I/O ratings refer to the following pin groups/functions: Incremental encoder inputs (ENCx), HALL sensor inputs (HALLx), General purpose inputs (GPIx), Drive fault indicator output (DRV_FAULT), Reference switch inputs (REFx), all LED control outputs (xLED), RS485 digital interface (RS485x), Brake control output (BRAKE), Reset input (nRESET).

Information on the CAN interface signals is given in the next subsection.

Parameter	Symbol	Min	Typ	Max	Unit
I/O Voltage	V_{CCIO}		3.3		V
Input voltage for digital inputs and reference switch inputs	V_{IN}	0	+3.3	+3.6	V
Low level voltage for digital inputs and reference switch inputs	V_L	0		+0.8	V
High level voltage for digital inputs and reference switch inputs	V_H	+2			V
Voltage range for the analog inputs	V_{AIN}	0		+3.3	V

Table 20: Digital I/O ratings

¹ This is the maximum current rating. This is not for continuous operation but depends on duty cycle, ambient temperature, and cooling.



6.3 CAN Communication Interface (Ambient Temperature 25°C)

Both hardware versions of TMCM-1617 (CAN/TMCL and EtherCAT) support a CAN interface. While the TMCM-1617-TMCL/CAN includes an on-board CAN transceiver, the TMCM-1617-COE does not include the CAN transceiver. The TMCM-1617-COE requires an additional external CAN transceiver on the base board (only if CAN should be used as well with that model). Thus, the interface specification is different.

For the CAN interface pins on the TMCM-1617-COE follow the I/O ratings as defined in Section 6.2.

For the CAN interface pins on the TMCM-1617-CAN/TMCL follow the I/O ratings given in the table below:

Parameter	Symbol	Min	Typ	Max	Unit
Voltage on pin CANH	V_{CANH}			+24	V
Voltage on pin CANL	V_{CANL}			+24	V

Table 21: TMCM-1617-CAN/TMCL CAN interface I/O ratings

6.4 Analog Inputs Interface (Ambient Temperature 25°C)

These ratings are valid for the analog inputs pins AIN0, AIN1, and AIN2.

Parameter	Symbol	Min	Typ	Max	Unit
Voltage on pins AINx	V_{AIN}	0		+3.3	V

Table 22: Analog input ratings

6.5 Other Requirements

Specifications	Description or Value
Cooling	Free air or heat sink mounted depending on use case and required power
Working environment	Avoid dust, water, oil mist and corrosive gases, no condensation, no frosting
Working temperature	-30° C to +60° C (standard version)

Table 23: Other Requirements and Characteristics



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9 Supplemental Directives

9.1 Producer Information

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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.



10 Revision History

10.1 Hardware Revision

Version	Date	Author	Description
V1.20	2019-10-22	MM/SK	V1.2 ES Samples

Table 24: Hardware Revision

10.2 Document Revision

Version	Date	Author	Description
V1.00	2020-02-27	SK	First version.

Table 25: Document Revision

