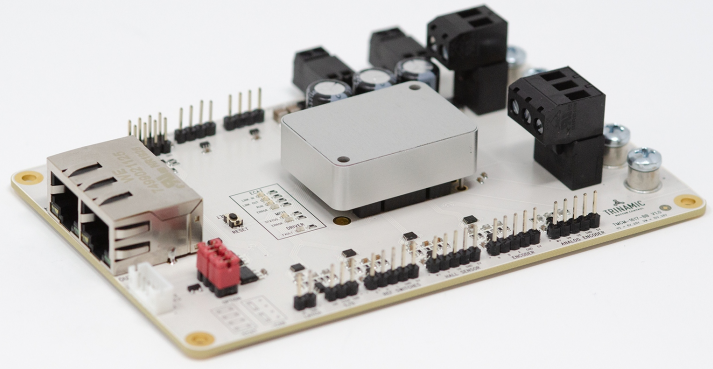
TMCM-1617-BB

Document Revision V1.00 • 2020-MAR-03

The TMCM-1617-BB is designed for evaluating all features of the TMCM-1617 Servo Drive. It comes with all required communication interface connectors and I/O headers. Motor power supply and motors can be connected via M4 screw terminals or screw terminal blocks. Digital supply is provided separately.



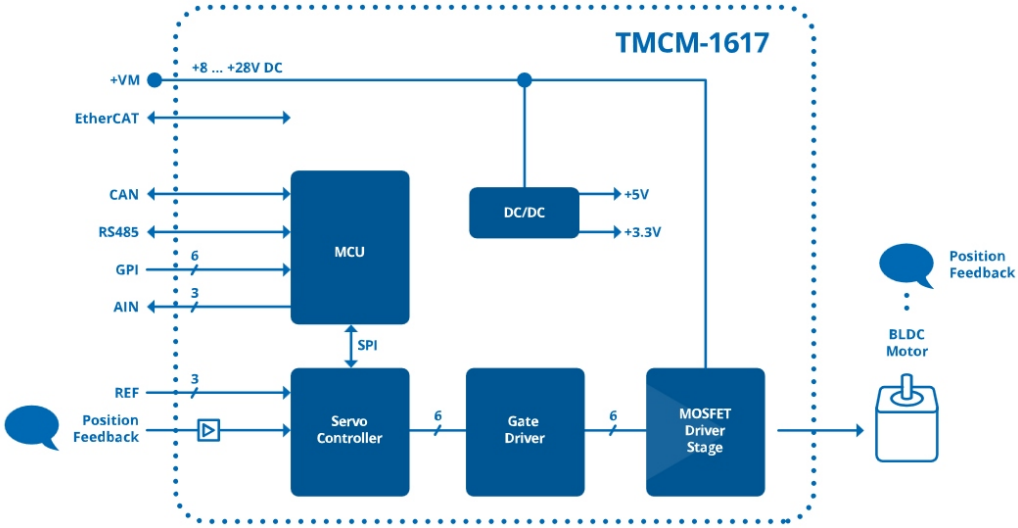
Features

- TMCM-1617 Servo Drive base board for evaluation
- Board supply voltage: +8V to +28V
- Screw terminals and standard connectors
- For EtherCAT and CAN version
- Connectors and headers for all board IOs
- CAD design files available for download on www.trinamic.com

Applications

- Laboratory Automation
- Drives
- Semiconductor Handling
- Robotics
- Factory Automation
- Connected Sensors

Simplified Block Diagram



Read entire documentation.

TRINAMIC
MOTION CONTROL

Contents

1 Getting Started

You need

- TMCM-1617-BB + TMCM-1617-xxx
- Regulated Power Supply for +24VDC
- Latest TMCL-IDE
- For TMCL and CAN firmware versions: USB-2-RS485 adapter or CAN adapters
  - TRINAMIC USB-2-485
  - CAN-USB/2 (ESD), or Leaf Light v2 (Kvaser), or IPEH-002021 (Peak), or Ixxat (USB-to-CAN V2 and USB-to-CAN V2 Compact) (Currently only in the Nightly Build)
- For EtherCAT hardware/firmware version:
  - RJ45 TPC cable
  - EtherCAT master system (Beckhoff TwinCAT, SOEM, Omron, Acontis...)
- 3-phase BLDC motor with appropriate feedback system

Precautions

- Do not mix up signals or short-circuit pins.
- Do not exceed the maximum rated supply supply voltage!
- **Start with power supply off!**

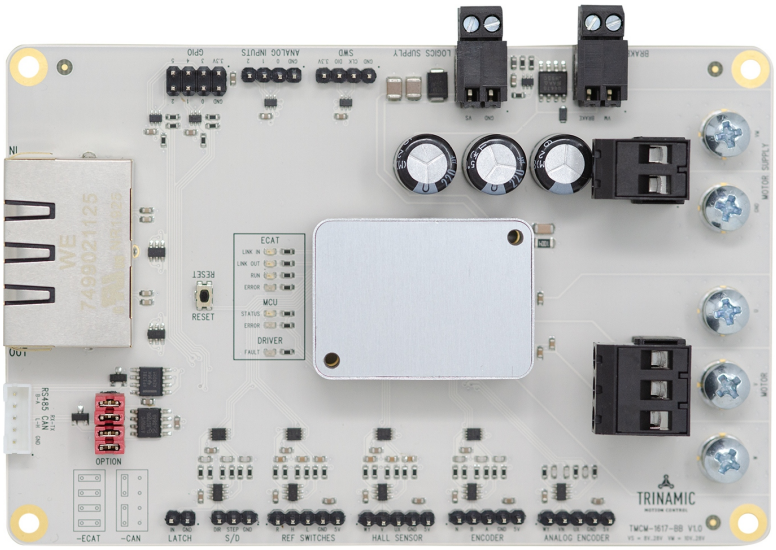


Figure 1: TMCM-1617-BB with mating connectors and assembled TMCM-1617 drive

NOTICE Both supplies (motor supply and logic supply) must be connected. They can be driven by the same source.

1.1 First Start-Up with TMCL-IDE

This section shows some first steps with a TMCM-1617 with TMCL™ firmware installed. To use the module with TMCL, you will need to have the latest version of the TMCL-IDE installed on your PC. The TMCL-IDE can be downloaded free of charge from Trinamic's website:
www.trinamic.com/support/software/tmcl-ide/.

1. With TMCL, the TMCM-1617 module can use either the RS-485 interface or the CAN bus interface. So you will either need an RS-485 interface or a CAN bus interface that is supported by the TMCL-IDE.
2. Connect the module either via RS-485 or via CAN bus. Please do not forget using termination resistors as otherwise the communication might work unreliable or might not work at all. For CAN bus, a 120R resistor is needed at each end of the bus. When using RS-485, either use an interface that is already equipped with a built-in termination network (for example the Trinamic USB-2-RS485 or the Expert EX-9531), or install a termination network as follows: 1K between +5V and RS485+, 1K between GND and RS485-, and 100R between RS485+ and RS485-.
3. When connecting via RS-485, choose the correct COM port in the device tree of the TMCL-IDE. In the connection plugin window which then appears on the screen, make sure that the baud rate and address setting are the same as the factory default settings of the TMCM-1617 module: 11500 baud, serial address 1, reply address 2. Click the *Connect* button, and the module will be found by the TMCL-IDE and will be shown in the module tree.
4. When connecting via CAN bus, choose the CAN interface from the device tree of the TMCL-IDE. In the connection plugin window which then appears on the screen, verify the connection settings. These should be 1MBit/s, module ID 1 and reply ID 2. Click the *Connect* button, and the module will be found by the TMCL-IDE and will be shown in the module tree.

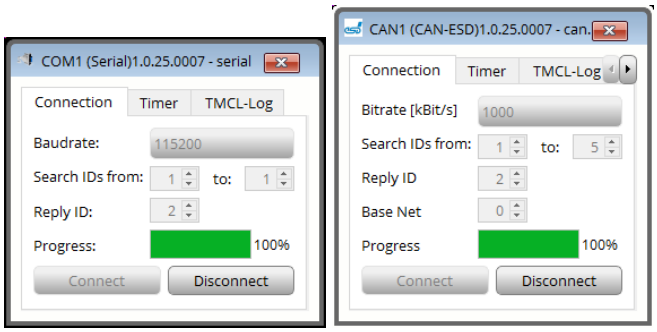


Figure 2: RS485 Connection Plugin and CAN Connection Plugin with correct Settings

5. After the connection has been established successfully (either via RS-485 or via CAN), the module will be shown in the device tree, and all available tools for this module will be shown underneath the module entry.

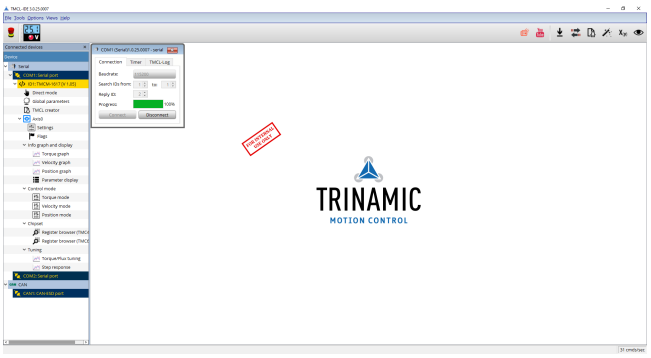


Figure 3: The TMCL-IDE with successfully connected TMCM-1617

6. Now, choose the *Settings* tool from the tool tree. Its windows will appear, and you can make all settings concerning the motor. For a first test, try to run the motor in open loop mode. To do this, choose commutation mode "Open Loop". This can be done on the first page of the *Settings* tool.
7. Next, also choose your motor type (mostly BLDC). This can be done on the second tab page of the *Settings* tool. Also, set up the current settings to fit the needs of your motor. Be careful with theses settings, as too high current values may destroy the motor.

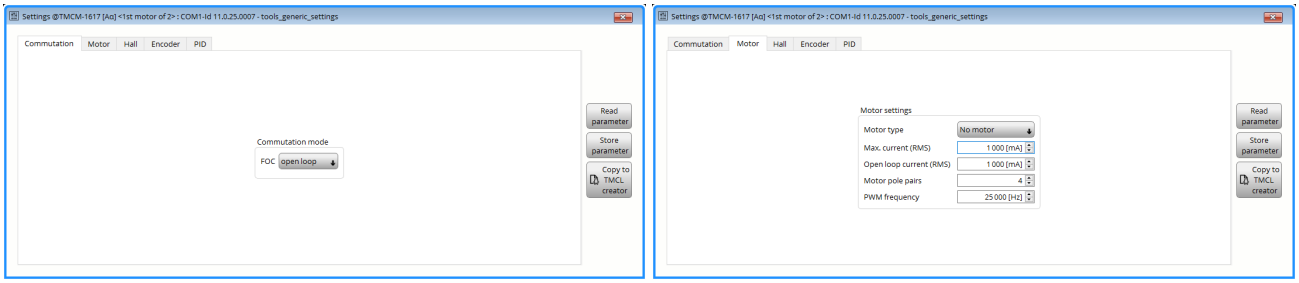


Figure 4: The Settings tool with Commuation and Motor Type Settings

8. Now you can try to run the motor in velocity mode. To do that, choose the *Velocity Mode* tool from the tool tree. Enter the desired speed (for example 500rpm), and use the arrow buttons to run the motor.

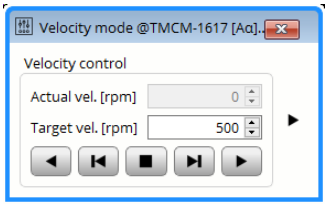


Figure 5: The Velocity Mode Tool

1.2 First Start-Up with CANopen

This section shows some first steps with a TMCM-1617 with CANopen® firmware installed. A CANopen bus master is usually required to control a CANopen slave. In this example the free TMCM-CANopen tool is used. The TMCM-CANopen tool can be downloaded free of charge from Trinamic's website: https://www.trinamic.com/support/software/

1. Get the CANopen tool from the Trinamic website and install it on your PC. In order to be able to use the Trinamic CANopen tool, you will need a PC CAN interface which is supported by the tool. The latest version of the Trinamic CANopen tool supports the same CAN interfaces as the TMCL-IDE does.
2. Connect the CAN interface of the baseboard to your PC CAN interface. Please do not forget using termination resistors (120 ohms) at each end of the CAN bus, as otherwise the CAN connection will not work.
3. Start the Trinamic CANopen tool. Choose the interface you are using. Check the bit rate and node ID settings (the default setting on the TMCM-1617 is 1000kBit/s and node ID 1) and click the *Connect* button.
4. After the module has been successfully found by the CANopen tool, the tool tree for the module will appear on the left side of its main window. Here you can choose different tools.
5. As a first test, choose the Object Browser. There, click on an object to see its contents. For example, click on object 1008_h and the name of the module (TMCM-1617) will be shown.

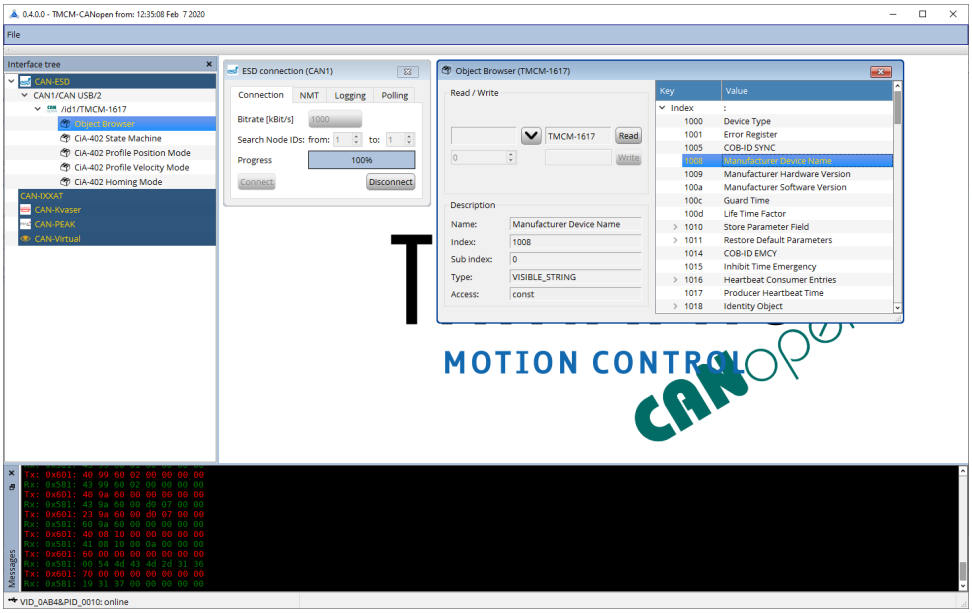


Figure 6: The TMCM-CANopen Tool with TMCM-1617 successfully connected

6. When this works and you have a motor connected to the board then you are ready to explore it further using CANopen. As an example, try to run the motor in open loop mode. To do that, first switch the commutation mode to open loop by writing 1 to object 2055_h. In the object browser, select object 2055_h. Then, enter the value and click the *Write* button. Also set the motor type (object 2050_h) according to the motor you are using (either 1 for single-phase DC motors or 3 for three-phase BLDC motors).

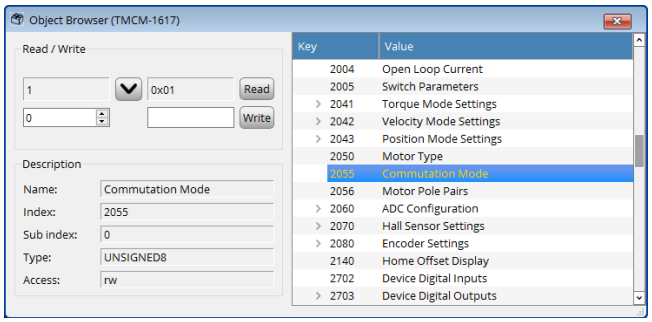


Figure 7: Select Open Loop Mode

7. Now, also set the open loop motor current and the maximum motor current to fit to your motor, by changing objects 2003_h and 2004_h according to your needs. Be careful with these settings, as too high current settings may destroy the motor.
8. Open the CiA-402 State Machine tool and go through the states by clicking the buttons until you have reached the *Operation enabled* state. Experienced CANopen users might also use direct writing to the control word (through the Object Browser) instead.

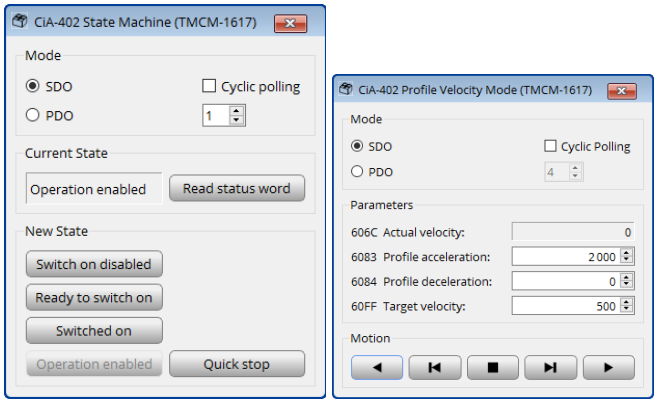


Figure 8: Enter Operation Enabled State and use the Profile Velocity Mode

9. Finally, you can try to run the motor in profile velocity (pv) mode. To try this, open the CiA 402 Profile Velocity Mode tool. Enter the desired acceleration, deceleration and velocity (rpm) and click one of the arrow buttons to run the motor. Experienced CANopen users might again use direct writing to the appropriate objects (through the Object Browser) instead.

1.3 First Start-Up with EtherCAT

This section shows some first steps with a TMCM-1617 with EtherCAT® CoE firmware installed. An EtherCAT® master is required to control such a device. In this example we show how to take some first steps with TwinCAT and the TMCM-1617. A free evaluation version of TwinCAT can be obtained from Beckhoff. Other EtherCAT® masters that can of course also be used (for example Acontis, OMRON or SOEM).

1. Get and install TwinCAT. Copy the ESI file (TMCM-1617.xml) to the directory TwinCAT\3.1\Config\Io\EtherCAT before starting TwinCAT.
2. Connect the TMCM-1617 module to your EtherCAT network and switch it on.
3. Create a new project in TwinCAT.

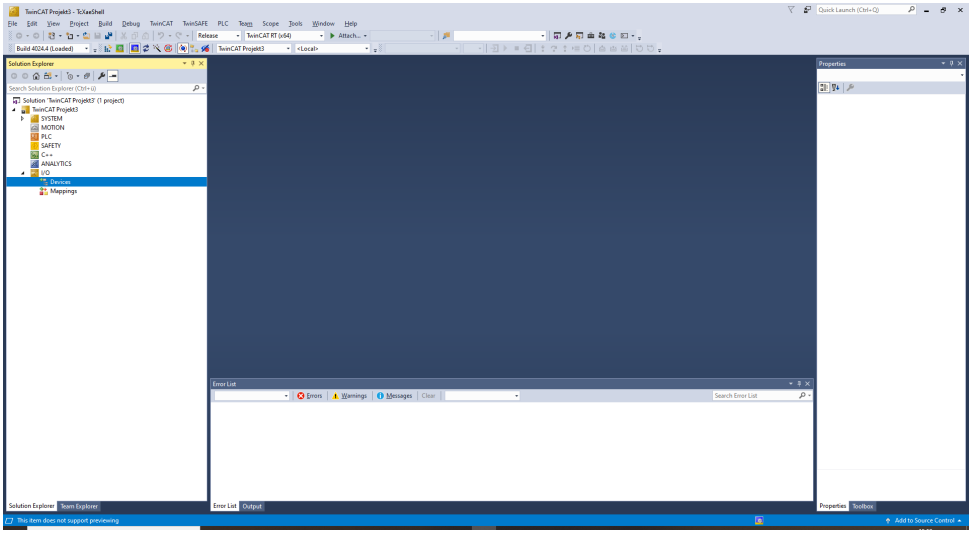


Figure 9: TwinCAT with New Project

4. In the TwinCAT project explorer, open the I/O entry (if not already opened). Click the right mouse button over the *Devices* entry. From the context menu, choose *Scan*.
5. TwinCAT now scans for network devices. Maybe you will have to pick the correct network devices from a list.

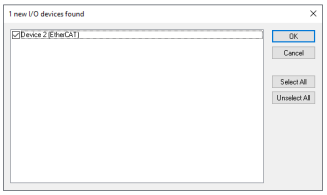


Figure 10: Pick the correct Ethernet device

6. TwinCAT now asks "Scan for boxes?". Click the "Yes" button.

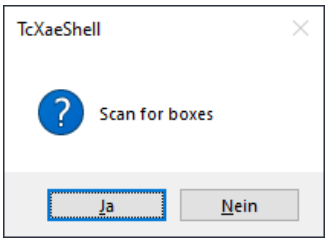


Figure 11: Scan for boxes

7. TwinCAT should now find the TMCM-1617 device and show it in the device tree of the project explorer.
8. TwinCAT now asks "Activate Free Run?". Answer with "Yes" to do this.

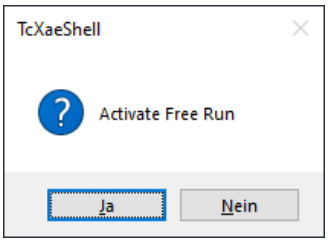


Figure 12: Activate Free Run

9. Now you are ready to use the module with TwinCAT. Click on the "Box 1 (TMCM-1617)" entry in the project explorer window. In the project view (in the middle of the screen) choose the "CoE Online" tab. There, the CoE objects and also the PDO entries can be seen.

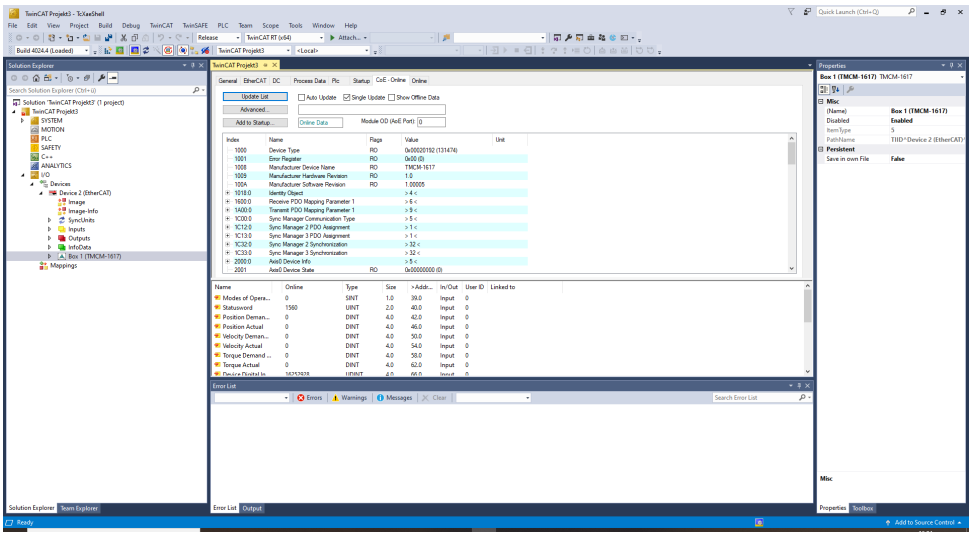


Figure 13: The Project View showing the CoE Objects

10. In the CoE online object view, scroll down to object 2055_h.

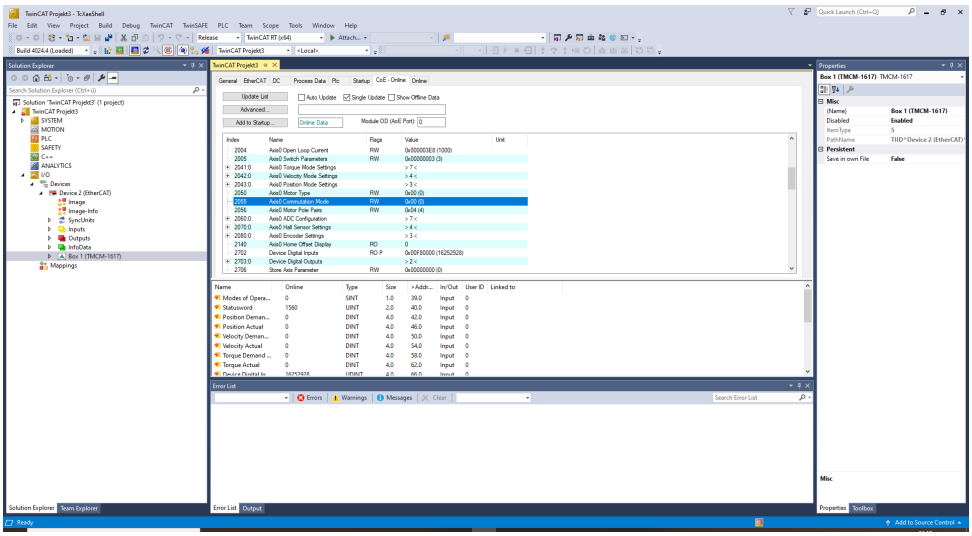


Figure 14: CoE Object 2055_h

11. Double click the object to modify it. Change the entry to 1 in order to switch to open loop mode.

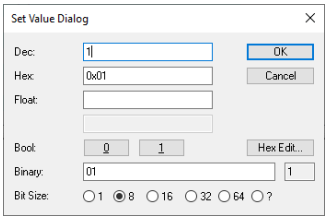


Figure 15: Modify object 2055_h

12. Now, also modify object 2055_h according to your motor type (1 for a single phase DC motor or 3 for a three phase BLDC motor).
13. Change objects 2003_h and 2004_h to the current needed by your motor. Be careful, as too high current settings may destroy the motor.
14. For running the motor, you will have to modify objects 6040_h and 6060_h. As these objects are mapped to the PDO it is not possible to modify them in the object view. Instead you will have to modify their values in the PDO view which is displayed underneath the object view.
15. Scroll down the PDO view so that "Modes of Operation", "Control Word" and "Target Velocity" can be seen. To modify a value, open the context menu over the entry and choose "Online Write".

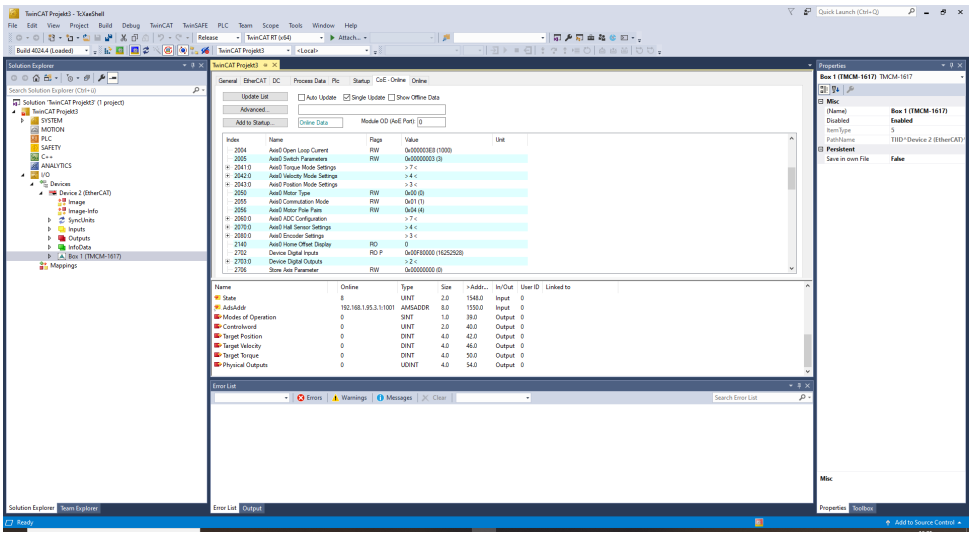


Figure 16: PDO view

16. To run a motor, first switch through the states of the DS-402 state machine. This can be done by writing 6, then 7 and then 15 to the Control Word. Then, write 3 to the Modes of Operation to select pv mode. Now, write the desired speed (rpm) to the Target Velocity.

2 Evaluation Board Sections and Connectors

Figure 18 top view of the TMCM-1617-BB shows the main connectors (green), signal pin headers (light blue), jumper options (red), communication interfaces (yellow), and TMCM-1617 socket (orange).
The tactile switch triggers a manual reset of the TMCM-1617 module.

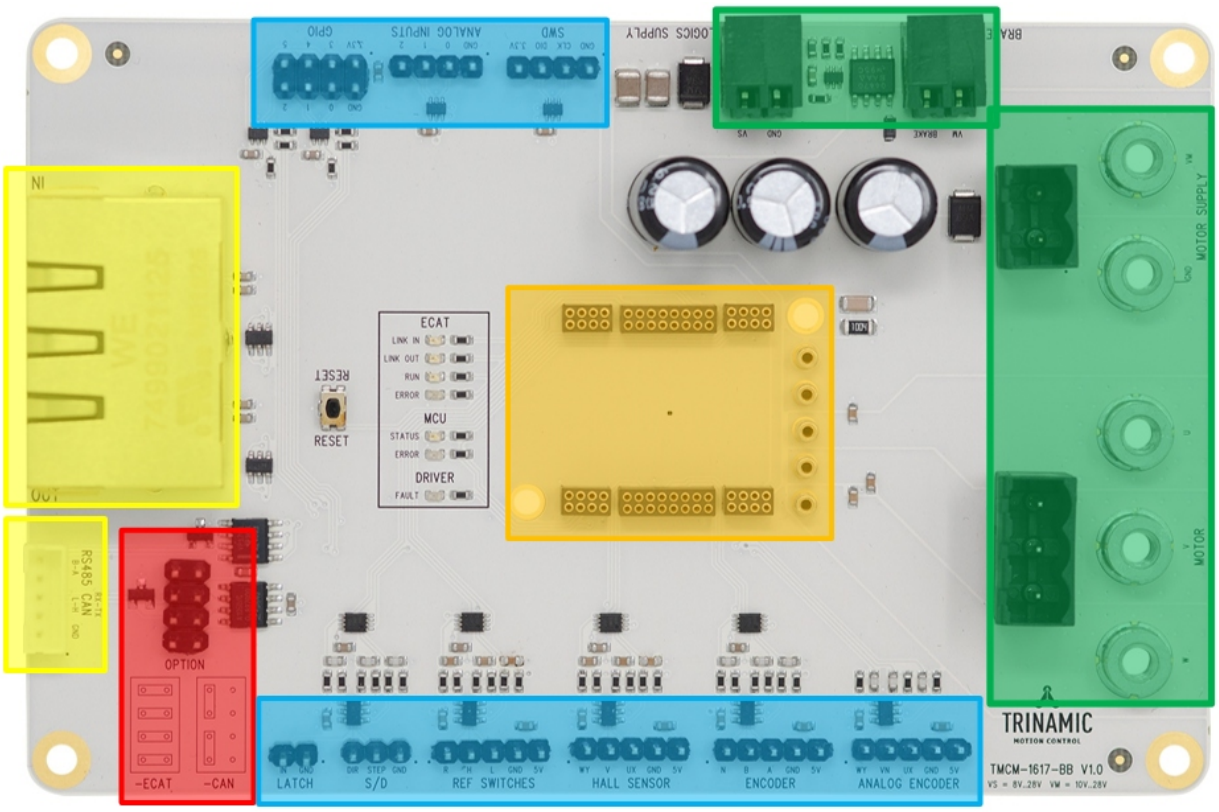


Figure 17: Top view of TMCM-1617-BB

Each connector has a small pin 1 mark on the top side of the PCB besides the individual pin description and connector label.

2.1 TMCM-1617 Socket

The socket adapter for the TMCM-1617 driver module is located in the center of the board. A TMCM-1617 unit can directly be plugged into it.

NOTICE	Care must be taken when plugging and removing a TMCM-1617 drive module since the module pins may bend or break if not properly aligned.

2.2 TMCM-1617 Version Jumper

The red section shows the jumper field which configures which hardware section of the TMCM-1617 module is used. Use 4 jumpers to configure for the TMCM-1617-COE hardware version. Use 2 jumpers to configure for the TMCM-1617-CANOPEN/TMCL version. This configuration switches between onboard or offboard CAN transceiver.

2.3 Evaluation Board Connectors

Connector ID	Description	Signal Level
Logic Supply Voltage	logic supply terminal block	+8...+28V
Motor Supply Voltage	motor supply terminal block and M4 screw connectors	+8...+28V
Motor Phase Connector	motor phases terminal block and M4 screw connectors	+8...+28V
Brake Control	external brake chopper terminal block	+8...+28V
EtherCAT	Double RJ45 twisted pair copper (TPC) connector to connect to the EtherCAT bus. 10/100BaseT with integrated transformers.	Ethernet
CAN/RS485	JST header for RS485 and CAN interface	CAN/RS485
SWD Header	TMCM-1617 debug only, Reset to factory defaults (see Section 2.6)	+3.3V
Analog Inputs Header	TMCM-1617 analog inputs	0...+3.3V
GPIO Header	TMCM-1617 general purpose IOs	+3.3V
Latch Input Header	Optional Latch signal input for TMCM-1617-COE hardware version	+3.3V
Step/Dir Header	reserved for future use, dnc	
Reference Inputs Header	Reference switch inputs header with +5V reference	+5V
Hall Sensor Header	Hall sensor feedback inputs with +5V supply	+5V
Encoder Header	Incremental encoder connector with +5V supply	+5V
Analog Encoder Header	reserved for future use, dnc	

Table 1: Connectors and pin header groups

Please check the online available design files and schematic data for additional information on the connectors' signal connections and pinning.

2.4 GPIO Header

The TMCM-1617 drive has dedicated general purpose inputs and outputs.
They are accessible on the 8-pin GPIO header.
The following table shows the pinout.

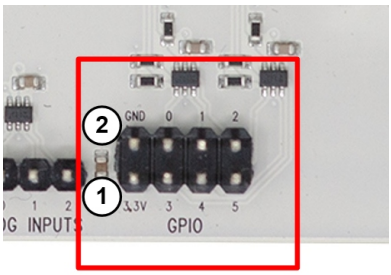


Figure 18: TMCM-1617-BB GPIO Header

Pin #	Signal Name	Description
1	+3.3V	IO reference voltage
2	GND	Ground reference
3	GPIO_3	Dedicated Output
4	GPIO_0	Dedicated Input
5	GPIO_4	Dedicated Output
6	GPIO_1	Dedicated Input
7	GPIO_5	Dedicated Output
8	GPIO_2	Dedicated Output

Table 2: TMCM-1617-BB GPIO header pin assignment

2.5 Evaluation Board LEDs

LED	Description
ECAT Link In	Input port link and activity indicator
ECAT Link Out	Output port link and activity indicator
ECAT Run	EtherCAT state machine status indicator
ECAT Error	EtherCAT state machine error status indicator
MCU Status	MCU/CANopen state machine status indicator
MCU Error	MCU/CANopen error status indicator
Driver Fault	Gate driver fault indicator

Table 3: TMCM-1617-BB LEDs

2.6 Reset to Factory Default

The SWD connector can also be used to reset a TMCM-1617 module to factory default settings. This is useful for example when the RS485 and/or CAN bit rate and ID settings of a module are not known. Do the following things to perform a reset to factory default settings:

1. Switch off the supply power.
2. Link together the pins CLK and DIO of the SWD connector (using a jumper).
3. Switch on the supply power.
4. Wait until the MCU status and error LED flash alternating.
5. Switch off the supply power.
6. Remove the link between the CLK and the DIO pin.
7. Switch on again. The module now runs with factory default settings.

3 Evaluation Board Design Files

All design files for the base board are available for free. We offer the original ECAD files, Gerber data, the BOM, and PDF copies.

- For the TMCM-1617-BB the ECAD files are in Mentor PADS DX Designer format.
- For the TMCM-1617 servo driver module itself the symbol and decal libraries are provided for KiCAD and Mentor PADS.

The files are available on Trinamic's website at https://www.trinamic.com/.

Note	If files are missing on the website or something is wrong please send us a note.

4 EtherCAT ESI File

The ESI file (TMCM-1617.xml) can be downloaded together with the TMCM-1617 EtherCAT® firmware from the Triamic website. The ESI file and the firmware files are supplied all together in a ZIP archive. If the EtherCAT® firmware is already installed on the TMCM-1617 module then you will only need to unpack the ESI file (TMCM-1617.xml) from the archive. In order to be able to use the module together with an EtherCAT® master, the ESI file has to be copied to the right place so that it can be found and used by the EtherCAT® master. Please see the documentation of the EtherCAT® master you are using for more information about this (or ask the manufacturer of your EtherCAT® master).

5 CANopen EDS File

The EDS file (electronic data sheet) for CANopen® can be downloaded together with the TMCM-1617 CANopen® firmware from the Trinamic website. The EDS file and the firmware file are supplied all togther in a ZIP archive. If the CANopen® firmware is already installed on the TMCM-1617 module then you will only need to unpack the EDS fie (TMCM-1617.eds) from the archive. In order to be able to use the module together with a CANopen® master it is necessary to copy the EDS file to the right place so that it can be found and loaded by the CANopen® master. Please see the documentation of the CANopen® master you are using for more information about this (or ask the manufacturer of your CANopen® master).
The Trinamic CANopen® tool already contains the TMCM-1617.eds file, so no further action will be necessary when using this tool.

6 Revision History

6.1 Document Revision

Version	Date	Author	Description
1.00	2020-03-03	SK, OK	Initial release version.

Table 4: Document Revision