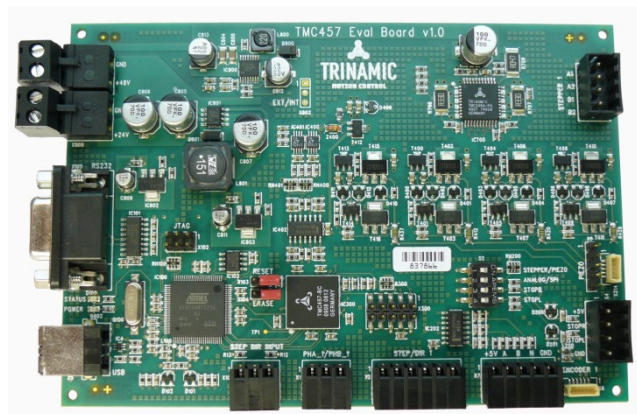


TMC457-EVAL V1.0

Manual

Evaluation board for the TMC457 motion controller
with Stepper Motor driver and Piezo motor driver and
TMCL



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1 Features

The TMC457-EVAL is designed to evaluate the TMC457 high-end motion control chip in combination with a TMC246 stepper motor driver or with a Piezo LEGS® piezo motor from PiezoMotor®.

Features

- The board combines an ARM7 processor with the TMC457 motion controller
- Stepper motor driver TMC246A with StallGuard™ sensorless stall detection and ChopSync™ operation for up to 1A RMS motor current
- Sub-micrometer positioning using piezo motor (Motor not provided)
- Active stabilization with incremental encoder and fast PID regulator
- Motor operation with up to 2048 microsteps via 8192 entry 12 bit table
- Optional incremental encoder feedback operation
- Supply voltage 12 to 34V, with internal 48V step up converter for piezo motor (optional use)

Interface

- USB 2.0 interface
- Optional RS232 interface (use 1:1 cable)
- Step / Direction input and output (3.3V level)
- 2 or 3-channel incremental encoder (5V) input
- Two stop or reference switch inputs

Software

- Evaluation software for exploring of the TMC457 with direct register access
- Optional TMCL software allows comfortable and simple writing of stand-alone test applications
- USB driver provided
- Source code of the ARM7 processor software is provided to allow access to TMC457 via PC

Highlights

- S-shaped and linear ramps with on-the-fly alteration of all parameters
- Programmable high resolution sequencer with (12 bit, 8192 entry) micro step look-up table
- Incremental encoder interface with flexible up- and down scaling to match drive resolution
- Fast and stable easyPID™ PID controller
- 32 bit registers – from mHz to MHz / from nanometer to meter
- Reference switch processing / virtual stop switches (programmable soft limits)
- Step / direction output (with programmable timing)
- Position pulse output to trigger external events
- Synchronization of multiple axis via scalable step / direction input
- Direct interface for TMC246/TMC249 family stepper motor drivers supports StallGuard™ (pat.)
- ChopSync™ (pat. fil.) built in for best motor velocity range
- Analog high resolution motor driver control via external dual 12 bit DAC
- Automatic load angle dependent current control for energy saving

Types of Motors

- Two phase stepper motors (direct support via on-board TMC246 with up to 1.5A)
- PiezoMotors (direct sequencer support for PiezoMotors PiezoLEGS® motor)
- Any type of motor via step/direction interface (3.3V digital outputs)

2 Life support policy

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3 Electrical and Mechanical Interfacing

3.1 Pinning and dimensions

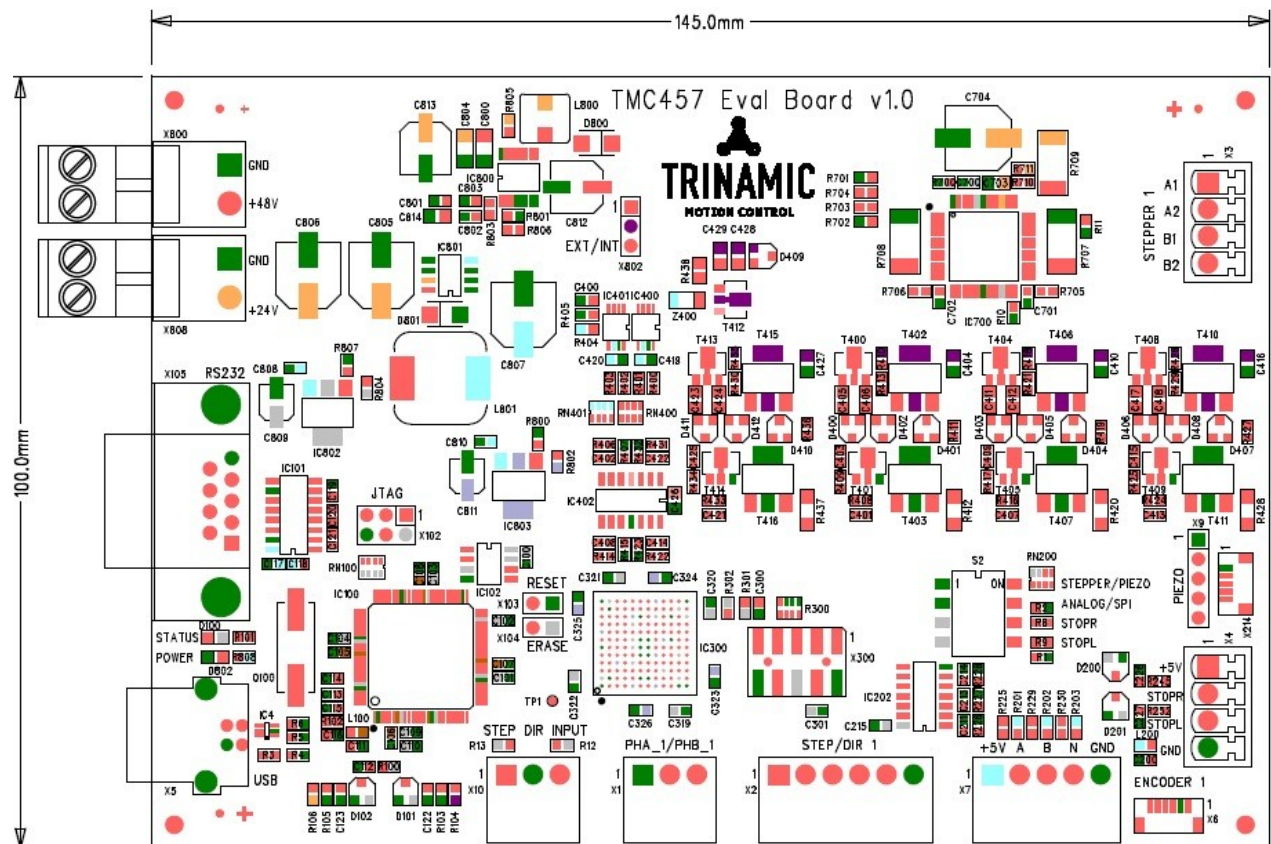


Figure 1: Connectors and components on TMC457-EVAL

3.2 Connectors

3.2.1 Power supply connectors

| Pin | Number | Function |
|------|--------|--|
| GND | 1 | GND |
| +48V | 2 | 48V power supply input (only used if jumper X802 is set to "external") |

Table 1: Connector X800: Optional 48V power supply for piezo motor driver

| Pin | Number | Function |
|------|--------|--|
| GND | 1 | GND |
| +24V | 2 | +24V power supply input for processor system and stepper motor driver (12V to 34V possible). A 1A minimum power supply is recommended. |

Table 2: Connector X808: +24V power supply

Connector types:
Ria 349-02 5mm type

3.2.2 Piezo motor supply jumper

| Pin setting | Function | Description |
|-------------|-----------|---|
| Open | piezo off | Piezo motor driver is not supplied |
| 1-2 | internal | Piezo motor driver is supplied via internal step up converter from 24V supply |
| 2-3 | external | Piezo motor driver is supplied via external 48V supply input |

Table 3: Jumper X802: Piezo motor supply source Ext / Int / Off

3.2.3 RS232 interface

| Pin | Number | Function |
|-----|--------|-----------------------|
| TXD | 2 | TXD output (to host) |
| RXD | 3 | RXD input (from host) |
| GND | 5 | GND |

Table 4: Connector X105: RS232 interface

Connector type: 9 pin DSUB, female (use 1:1 extension cable)

3.2.4 Piezo motor connector

The piezo motor driver supplies 4 phase and direction shifted output signals with an amplitude of 1V to 46V for driving each one leg of piezo motor. The output is short circuit protected against short to GND.

| Pin | Number | Function |
|---------|--------|----------------|
| GND | 1 | GND |
| Phase 4 | 2 | Phase 4 output |
| Phase 3 | 3 | Phase 3 output |
| Phase 2 | 4 | Phase 2 output |
| Phase 1 | 5 | Phase 1 output |

Table 5: Connector X9 + X214: Piezo Motor

Connector type:

5 pin 2.54 mm header or JST-BM05-SRSS 1mm JST connector (optional use)

3.2.5 Stepper motor connector

A two phase stepper motor can be connected to this connector.

| Pin | Number | Function |
|-----|--------|-------------------|
| A1 | 1 | Coil A terminal 1 |
| A2 | 2 | Coil A terminal 2 |
| B1 | 3 | Coil B terminal 1 |
| B2 | 4 | Coil B terminal 2 |

Table 6: Connector X3: Stepper Motor

Connector type:

RIA183-04

3.2.6 Encoder connector

| Pin | Number | Function |
|-----|--------|--|
| +5V | 1 | +5V output, max. 200mA |
| A | 2 | Encoder channel A input (5V CMOS level with Schmitt trigger input) |
| B | 3 | Encoder channel A input (5V CMOS level with Schmitt trigger input) |
| N | 4 | Encoder channel N input (5V CMOS level with Schmitt trigger input), polarity can be set via software |
| GND | 5 | GND |

Table 7: Connector X7: Incremental Encoder

Connector type:
RIA183-05

| Pin | Number | Function |
|-----|--------|--|
| N | 1 | Encoder channel N input (5V CMOS level with Schmitt trigger input), polarity can be set via software |
| GND | 2 | GND |
| +5V | 3 | +5V output, max. 200mA |
| B | 4 | Encoder channel A input (5V CMOS level with Schmitt trigger input) |
| A | 5 | Encoder channel A input (5V CMOS level with Schmitt trigger input) |

Table 8: Connector X6: Incremental Encoder (optional connector)

Connector type:
JST BM06B-SRSS 1mm JST connector

3.2.7 Stop / reference switch connector

Connector for stop switches (mechanical or photo-interrupter)

| Pin | Number | Function |
|-------|--------|--|
| +5V | 1 | +5V output, max. 200mA |
| STOPL | 2 | Left stop input, high active or low active (internal pull-up or pull-down resistor can be selected via switch) |
| STOPR | 3 | Left stop input, high active or low active (internal pull-up or pull-down resistor can be selected via switch) |
| GND | 4 | GND |

Table 9: Connector X4: Stop input

Connector type:
RIA183-04

3.2.8 Step / direction input

Optional external step input for synchronization of multiple boards.

| Pin | Number | Function |
|------|--------|-------------------|
| STEP | 1 | STEP input (3.3V) |
| GND | 2 | GND |
| DIR | 3 | DIR input (3.3V) |

Table 10: Connector X10: Step / Dir input

Connector type:
RIA183-03

3.2.9 Step / direction output

Step and direction output interface from TMC457 for attachment of external power drivers and / or synchronization of multiple boards by tying to a step/dir input (3.3V).

| Pin | Number | Function |
|-------|--------|--------------------------|
| DIR | 1 | Dir output from TMC457 |
| STEP | 2 | Step output from TMC457 |
| XSTEP | 3 | XStep output from TMC457 |
| HIRES | 4 | Hires output from TMC457 |
| STDBY | 5 | STDBY output from TMC457 |
| GND | 6 | GND |

Table 11: Connector X7: Step/Direction Output

Connector type:
RIA183-06

3.2.10 PHA / PHB output

Optional full-step output signals.

| Pin | Number | Function |
|-----|--------|---------------------------------------|
| PHA | 1 | Fullstep output signal phase A (3.3V) |
| PHB | 2 | Fullstep output signal phase B (3.3V) |
| GND | 3 | GND |

Table 12: Connector X10: Step / Dir input

Connector type:
RIA183-03

3.2.11 Operation mode switch

Dip switch.

| Switch | Number | Function |
|---------------|--------|---|
| Stepper/Piezo | 1 | ON=Stepper, OFF=Piezo motor; Select option before board power on. |
| Analog/SPI | 2 | ON=Analog phase current control for TMC246: gives highest resolution OFF=SPI phase current control |
| STOPR PU | 3 | ON= pull-up resistor on STOPR input, OFF= pull-down resistor |
| STOPL PU | 4 | ON= pull-up resistor on STOPL input, OFF= pull-down resistor |

Table 13: Connector X3: Stepper Motor

4 Operational Ratings

The operational ratings show the intended / the characteristic range for the values and should be used as design values. In no case shall the maximum values be exceeded.

| Symbol | Parameter | Min | Typ | Max | Unit |
|-------------------|--|------|----------------|------------------|--------------|
| V_{S24} | Power supply voltage for operation | | 12 ... 34 | 34 | V |
| I_{S24} | Power supply current for operation (no motor operated) | | 0.1 | | A |
| I_{S24} | Power supply current for operation | | $\ll I_{COIL}$ | $1.4 * I_{COIL}$ | A |
| V_{S48} | Optional 48V power supply voltage for piezo motor operation | 46 | 48 | 52 | V |
| I_{S48} | 48V power supply current for operation (draw via step up converter if 48V is not supplied) | | 0.1 | 0.3 | A |
| U_{5VOUT} | 5V power supply output for encoder and reference switches | 4.75 | 5 | 5.25 | V |
| I_{5VOUT} | 5V power supply output for encoder and reference switches | | | 0.3 | A |
| I_{COIL} | Motor coil current for sine wave peak (chopper regulated, adjustable via software) | | 0.2 ... 1.5 | | A |
| I_{MC} | Continuous motor current (RMS) | | 0.2 ... 1.1 | | A |
| f_{CHOP} | Motor chopper frequency (actual frequency depends on operation mode) | | 20 to 50 | 100 | kHz |
| $V_{IN3V3LOW}$ | Input low voltage for STEP, DIR | -0.3 | | 0.8 | V |
| $V_{IN3V3HI}$ | Input high voltage for STEP, DIR | 2.0 | | 3.6 | V |
| $V_{IN3V3HIPROT}$ | Input high voltage for STOPL, STOPR (protected via resistor and diodes) | 2.0 | | 5.5 | V |
| V_{INLOW} | Input low voltage for encoder pins ENCA, ENCB, ENCN | -10 | 0 | 2.0 | V |
| V_{INH1} | Input high voltage for encoder pins ENCA, ENCB, ENCN | 4.0 | 5 | 15 | V |
| R_{PU} | Pull up resistor for ENCA, ENCB, ENCN and STOPL, STOPR | | 10 | | k Ω |
| R_{PD} | Optional pull down resistor for STOPL, STOPR (select via switch) | | 20 | | k Ω |
| f_{Step} | Full step frequency for integrated stepper driver | | 0..10 | 100 | kHz |
| T_{ENV} | Operating environment temperature | -25 | | 70 | $^{\circ}$ C |
| T_{STG} | Storage temperature | -25 | | 85 | $^{\circ}$ C |

Table 14: Operational Ratings

4.1 Motor Choice

For the stepper motor, a 1A RMS, 2 phase motor can be used. When using a motor for lower current, please be aware, that it is important to set the motor current to a lower value by using either the TMCL function, or the evaluation board software.

4.1.1 Motor current control

The stepper motor current is scaled via the TMC457 settings in TMC246 ANALOG control mode only. This allows adapting the driver current to different motors, and to switch to a reduced standby current. It also gives the highest microstep resolution. In SPI mode, the current is always the maximum current (i.e. 1A RMS)!

5 Functional Description

5.1 Software installation

Before using the USB connection, an USB driver has to be installed. When prompted for, select the USB driver from the disk.

5.2 Software

You can use the TMCL-IDE for control of the board. An appendix containing the TMCL commands will be finished soon. For using the RS232 interface, you need to set your TMCL-IDE to 110kBaud setting. This is the default setting of the evaluation board.

For a more direct exploring of the features, you find the software EVAL457.exe. Please refer the TMC457 manual for a description of the register set and its functionality.

5.2.1 Uploading your own microstep table

The demonstration software allows uploading microstep tables into the module. The data format required is ASCII, with comma separated values and each 16 values (0 to 8191) per line. Hexadecimal values can be declared by preceding them with \$ or 0x. In order to get the actual table as an example, you can press the READ button and afterwards SAVE it.

5.2.2 Modifying the microstep resolution

In the TMCL IDE, SAP 27,0,n sets the microstep resolution (n=0: 2048, n=1: 1024, n=2: 512... for a stepper motor). SAP 29,0,n sets an offset for the microstep table, in order to optimize zero crossing current regulation for stepper motors.

6 Revision History

6.1 Documentation Revision

| Version | Date / Author | Description |
|---------|-----------------|---|
| 1.00 | BD | First release – please see website for TMCL description |
| 1.01 | BD | added information about stepper motor current control |
| 1.02 | BD | Minor Error correction |
| 1.03 | 15.06.2009 / LL | Table 11: Connector X7: Step/Direction Output, page 5: labeling corrected |

Table 15: Documentation Revisions

6.2 Firmware Revision

| Version | Comment | Description |
|---------|-----------------|---------------------------------------|
| 1.00 | Initial Release | TMCL and direct interface implemented |
| | | |
| | | |
| | | |

Table 16: Firmware Revisions

7 References

[TMCL]

TMCL manual (see <http://www.trinamic.com>)

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