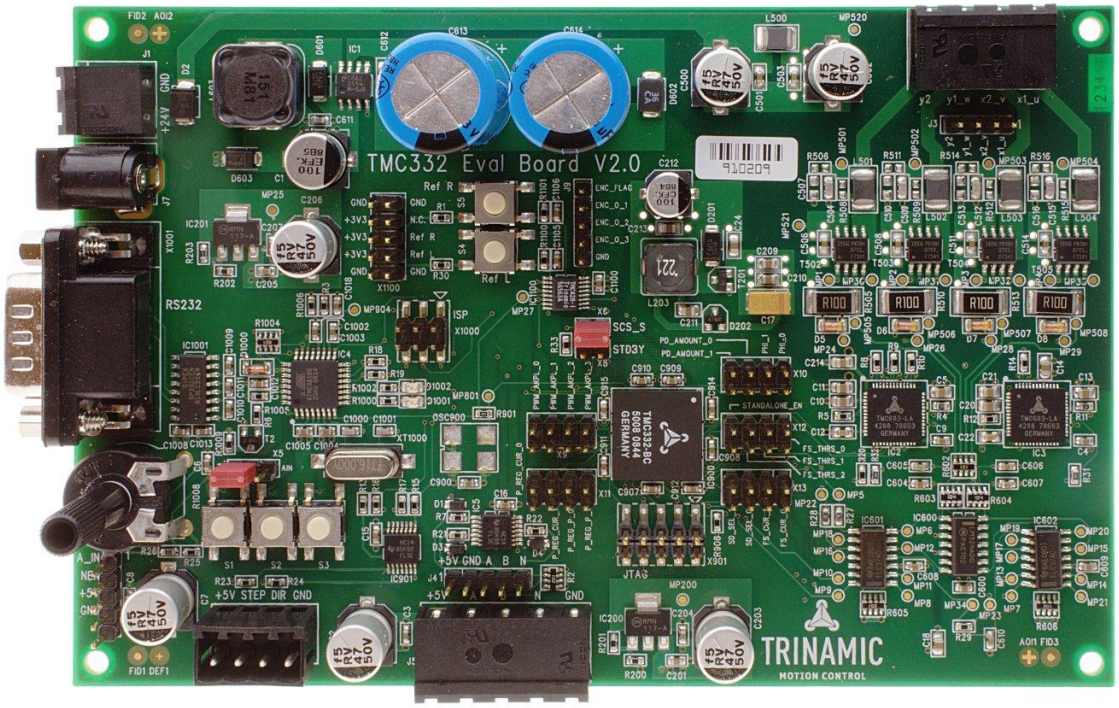
TMC332 Evaluation Board Manual



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1 Introduction

The TRINAMIC TMC332 evaluation board is a stepper motor driver module that is capable of driving either one two-phase bipolar stepping motor or one three-phase stepping motor with a maximum coil current of 3A.

The board is compatible with a modified version of the TMC428 evaluation software to access the TMC332 registers. Additionally, the board is equipped with three control keys and a potentiometer for stand-alone motor control and inputs for a step-direction interface and an ABN-Encoder.

The TMC332 is controlled by a TMC428. For the TMC428, the TMC332 is simply another SPI driver.

The TMC332 includes an SPI interface for the TMC428 SPI driver chain, an SPI interface for configuration, a high resolution micro step sequencer, three high resolution PWM units to control either four half bridges for two-phase stepper motors or three half bridges for three phase stepper motors.

The half bridges are driven by two TMC603.

The dimensions of the evaluation board are 153mm x 100mm. Four mounting holes with a diameter of 3.2mm are located at the corners of the board, with the centers located 3.5mm from the edges.

2 Electrical Characteristics

- Nominal operating voltage: 24V
- Operating voltage range: 15V to 36V
- Maximum allowed current: 3A peak
- Maximum motor current with regulation: 2.4A peak
- Input voltage for step/direction and ABN decoder inputs: 0V (low) to 5V (high)
- Input voltage range for analog input: 0V to 5V

3 Connectors

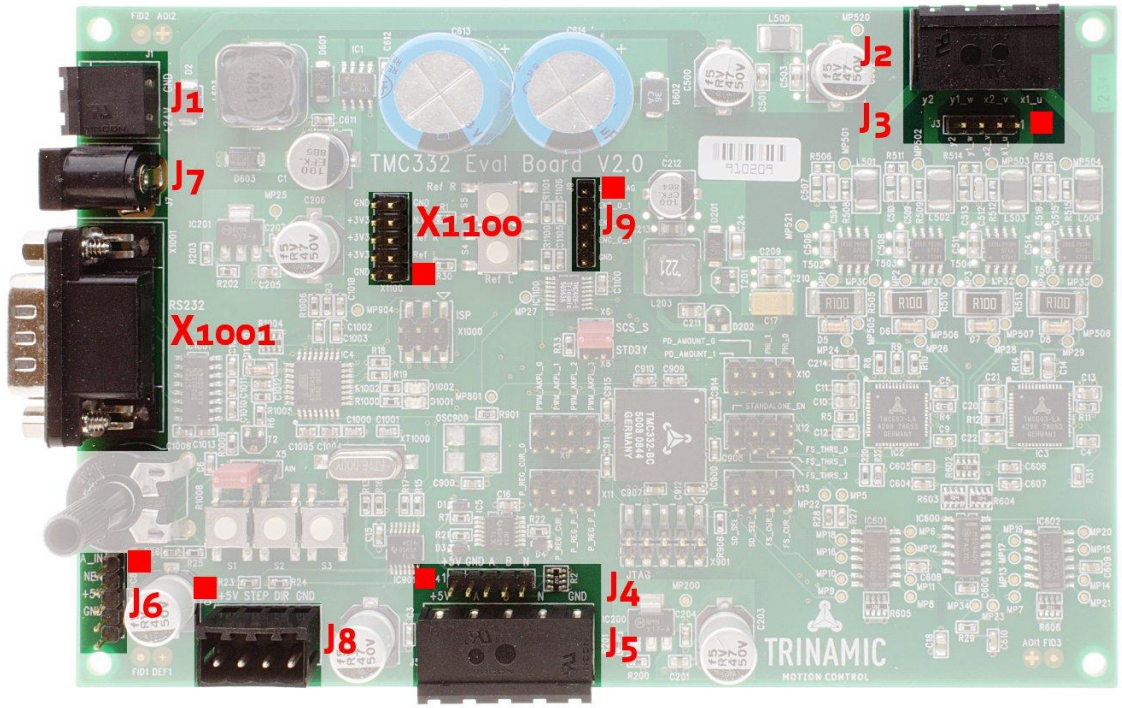


Figure 1: TMC332 Evaluation Board – connectors

Figure 1 shows the positions of the connectors. The red squares denote Pin 1 of the connectors.

3.1 Power connectors (J1, J7)

The TMC332 Evaluation Board has two connectors for Power supply. One RIACON connector with 5.08mm spacing (J1) and one connector (J7) that is compatible with notebook AC adapter (e.g. ThinkPad™ AC adapter, GND on the outside, supply voltage on the inside).

The nominal supply voltage of the board is 24V.

3.2 Motor connectors (J2, J3)

To connect the motor, one can either use the header with 2.54mm spacing (J3) or the 4-pin RIACON connector (J2).
The TMC332 evaluation board can control two and three phase stepper motors. Three phase stepper motors have to be connected to X1_U (red), X2_V (blue) and Y1_W (yellow). Two phase stepper motors have to be connected to X1_U, X2_V, Y1_W and Y2; phase X to X1_U and X2_V and phase Y to Y1_W and Y2.

Pin	Two phase stepper	Three phase stepper
1	x1	U
2	x2	V
3	y1	W
4	y2	n.c.

3.3 RS232 connector (X1001)

To use the eval software to change parameters on the board, the board has to be connected to a PC with a standard nullmodem cable, plugged into this connector.

Pin	Signal
2	RxD (data to the board)
3	TxD (data from the board)
5	GND

3.4 Encoder input connectors (J4, J5)

A default ABN incremental encoder with TTL or open collector output can be connected to this input. A 5-pin header (J4) or a 5-pin RIACON (J5) 5.08mm connector are available. These two connectors have different pin assignments:

Pin	Header	RIACON
1	+5V	+5V
2	GND	A
3	A	B
4	B	N
5	N	GND

3.5 Encoder compare outputs (J9)

The three encoder compare outputs of the TMC332 are available on this 5-pin header.

Pin	Header
1	n.c.
2	ENC_O_1
3	ENC_O_2
4	ENC_O_3
5	GND

3.6 Step/Direction input connector (J8)

With this input, Step/Direction signals (TTL level) can be applied to the TMC332. The connector is a 4 pin RIACON 3.5mm connector.

Pin	Signal
1	+5V
2	Step
3	Dir
4	GND

3.7 Reference switch connector (X1100)

This 10-pin header connector has inputs for two reference switches that can be used additionally to those on the board (S4, S5).

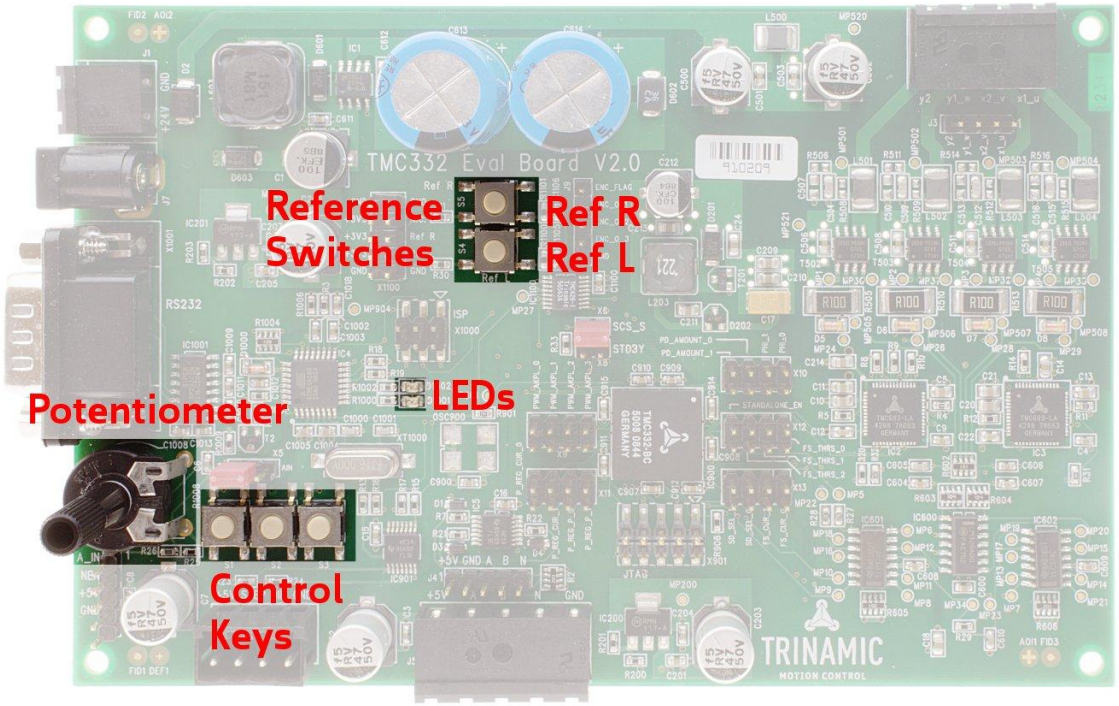
Pin	Signal
1	GND
2	GND
3	Ref L (S4)
4	+3.3V
5	Ref R (S5)
6	+3.3V
7	n.c.
8	+3.3V
9	GND
10	GND

3.8 Analog input/General purpose output connector (J6)

On this connector one 0V to 5V analog input and one general purpose output as well as connections to 5V and ground are available. The output is an open collector output with a 10k pull up resistor (R1009) to +5V.

Pin	Signal
1	A_IN
2	Output
3	+5V
4	GND
5	n.c.

4 Control Elements



4.1 Potentiometer

Depending on the selected mode, the potentiometer is used to define either a position or a speed. The mode is selected with the control key S2 (4.2, p. 7).

4.2 LEDs and Control Keys S1 & S2 & S3

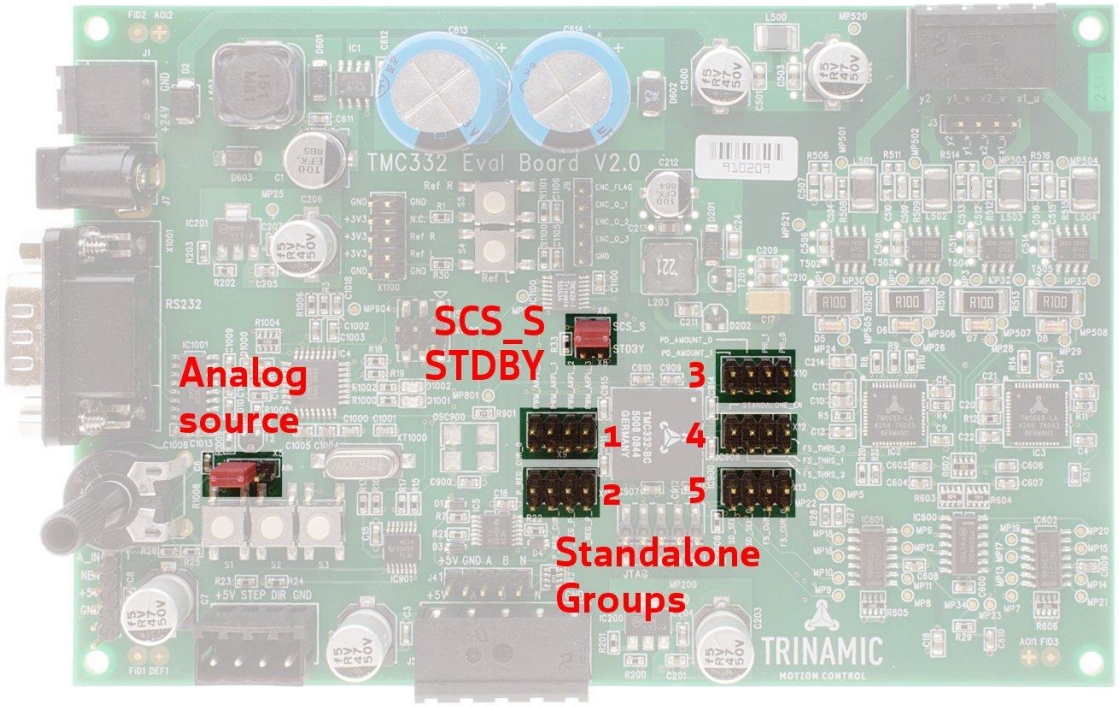
The two LEDs are used for showing the configured motor type (two or three phase) and the operating mode.
The three switches (S1 to S3 from left to right) have the following functions:
S1: Switch between two phase and three phase motor mode (the red LED is on when the two phase mode is active)
S2: Switch different functions depending on operating mode. When the motor is stopped, this button toggles the enable signal for the two TMC603 (enabled on power on). When the board is in velocity mode, this button toggles the direction of rotation of the motor by negating the velocity value. In positioning mode this button toggles between two positioning velocities.
S3: Switch between the operating modes. The active operating mode is shown via the green LED.

- Positioning mode (potentiometer controls the position, the green LED flashes with ~5Hz).
- Velocity mode (potentiometer controls the velocity, the green LED flashes with ~1Hz)
- Stop mode (power on default, the green LED flashes with ~0.5Hz)

4.3 Reference Switches RefL & RefR (S4 & S5)

The reference switches are processed by the TMC428 depending on its configuration. The default configuration is that both switches are used as stop switches.

5 Configuration Jumpers



5.1 Analog source selection

With this jumper, the source of the analog input on the microcontroller can be selected. If the jumper connects the left (Pot.) and the middle pin, the potentiometer is used as input. If the jumper connects the right (AIN) and the middle pin, the voltage on the A_IN pin of connector J6 is used. This input is capable of an input voltage between 0V and 5V.

5.2 SCS_S

This jumper connects the Slave chip select line from the TMC428 to the TMC332 and should only be removed when using the step/direction input of the board. When this jumper is open, the TMC428 does react to the evaluation software but no signals are passed on to the TMC332. The SPI access to the TMC332 register bank is unaffected by this jumper.

5.3 STDBY

This jumper connects the STDBY pin of the TMC332 to 3.3V to enable power down mode externally. In normal operation it should not been set.

5.4 Standalone configuration

The Jumpers for standalone configuration of the TMC332 are grouped as two row pin headers. The exact function of each pin is shown in the TMC332 manual.

5.4.1 Standalone Group 1

Jumper	Function
PWM_AMPL_0	Selects one PWM amplitude setting
PWM_AMPL_1	
PWM_AMPL_2	
PWM_AMPL_3	

5.4.2 Standalone Group 2

Jumper	Function
P_REG_CUR_0	Selects one regulator target current setting
P_REG_CUR_1	
P_REG_P_0	Selects one regulator P-parameter setting
P_REG_P_1	

5.4.3 Standalone Group 3

Jumper	Function
PD_AMOUNT_1	Selects one power down amount setting
PD_AMOUNT_0	
PHI_1	Selects one microstep table step width setting
PHI_0	

5.4.4 Standalone Group 4

Jumper	Function
STANDALONE_EN	**Enable standalone configuration**
FS_THRS_2	Selects one full step threshold setting
FS_THRS_1	
FS_THRS_0	

5.4.5 Standalone Group 5

Jumper	Function
SD_SEL_1	Selects one slow decay amount setting
SD_SEL_0	
FS_CUR_1	Selects one full step current setting
FS_CUR_0	

6 Recommended Motors

The recommendations are the default settings of the evaluation board. The recommended supply voltage for these settings is 24V. For other voltages and other motors these settings might have to be adjusted.

6.1 Three Phase Stepper Motor

JapanServo, Type KT42JM06-551
Recommended settings (PHI settings for full speed range (-2048..2047) without regulation):
PHI_INT = 1
PHI_FRAC = 0
PWM_AMPL = 31
Modulation = ON

For current regulated operation:
Tolerance = 1
P-parameter = 30
Target current = 85
PWM_AMPL = 255 (Limit)

If automatic fullstep switching is needed (with higher PHI setting):
FS Target Current = 10
FS Threshold = 40

6.2 Two Phase Stepper Motor

QMot, QSH-4218-41-10-035
Recommended settings (PHI settings for full speed range (-2048..2047) without regulation):
PHI_INT = 0
PHI_FRAC = 8388608 (2^23)
PWM_AMPL = 31
Modulation = ON

For current regulated operation:
Tolerance = 1
P-parameter = 30
Target current = 55
PWM_AMPL = 255 (Limit)

If automatic fullstep switching is needed (with higher PHI setting):
FS Target Current = 6
FS Threshold = 90

6.3 Changing the connected Motor

To change the motor, the board does not have to be switched off when following this procedure:

- Change into Stop Mode (Key **S2**)
- Disable the TMC603 drivers (Key **S1**)
- Change the motor
- Make sure, the settings (SPI registers or standalone configuration) fit the new motor
- If necessary, switch the motor type (Key **S3**)
- Enable the TMC603 (Key **S1**)
- Switch to the other operating modes (Key **S2**)

When changing the motor without disabling the TMC603, the bridge transistors might be destroyed.

7 TMC428 Eval Board Software V 1.45 for TMC332 Eval Board

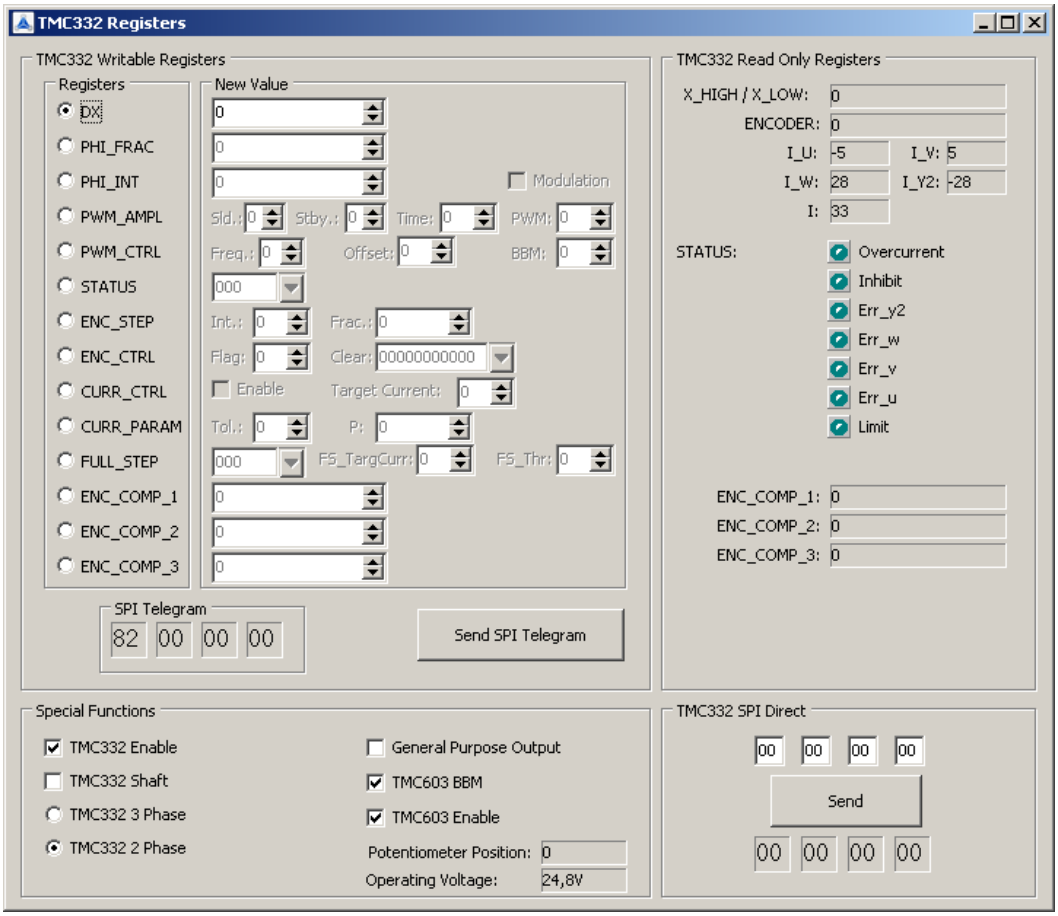


Figure 2: Screenshot of the evaluation software

The evaluation software gives access to every register of the TMC332. The registers for the standby current and the encoder compare registers are not available in the preliminary version of the TMC332, changing these has no effect. For the detailed description of the registers, see the TMC332 datasheet.

Important Hints:

- Be careful with the PWM_AMPL setting. Doubling the value of the PWM_AMPL register (default is 0x1F = 31) at a given motor supply voltage (e.g. 24V) doubles the coil current. When using the current regulator, the PWM_AMPL setting may be set to a higher value as it is used as the upper limit for the current regulator. Remember to decrease it again before switching off the current regulator.

- Take care of the BBM settings. After powering up the board, the BBM of the TMC603 is enabled. A value of 4 is configured as the default value in the TMC332. The BBM time of the TMC603 on this board equals a setting of approximately 9-10 in the TMC332. The switching losses in the transistors will be higher with the default setting of 4.

8 Quick start

8.1 Connections

First connect the motor to connector J2 or J3, use pins 1, 2 and 3 for three phase motors, pin 4 remains unconnected in this case. The firmware on the board is designed for a QMot QSH-4218-41-10-035 two phase stepper motor or a JapanServo KT42JM06-551 three phase stepper motor operated at 24V supply voltage. Other motors, especially ones with lower phase resistance may draw more current when switching on the evaluation board. For such motors another way of starting the board, described under 8.4, should be used and the motor should be left disconnected in this place.
Next connect an RS232 null modem cable from a serial port or a USB to serial converter to the RS232 connector X1001.
Now connect a DC power supply with 24V (15V to 36V are allowed but may result in bad performance or too high motor current) to either J1 or J7 and turn it on.
When using a three phase motor, press S1 once to switch to three phase motor mode (the red LED turns off).

8.2 Control via S1, S2, S3 and the potentiometer

The basic functions can be controlled with the on board controls. After power on, the board is in two phase motor (red LED on) positioning mode (green LED flashing fast) with a PWM amplitude of 31 and no current regulation. The potentiometer is used to preset a position, the motor drives to. Button S2 can be used to switch between two positioning speeds.
With button S1 the board can be set to three phase motor mode (red LED turned off).
Button S3 steps through the three operating modes, from positioning mode to velocity mode (green LED flashes slower), where the potentiometer controls the velocity of the motor and button S2 can toggle the direction using the sign of the velocity, not the shaft input.
From velocity mode, S3 steps to stop mode (green LED flashes very slow), where the motor is stopped and the two TMC603 can be disabled and enabled with button S2. From there, S3 changes to positioning mode again.

8.3 Starting the software

Start the evaluation software (Eval428_332.exe), select the COM port, the board is connected to and click "Open". Then click the "TMC332..." button that appeared to get the window shown in Figure 2.
Now the settings of the TMC332 and also some functions on the evaluation board are accessible.

8.4 Connection of special motors (low phase resistance)

When the board is powered up without a motor connected and the software is started, it takes some steps to connect the motor safely.

- Uncheck the checkbox "TMC603 Enable"
- Select the radiobutton "PWM_AMPL", check the checkbox "Modulation", set the value "PWM:" to 0 and click "Send SPI Telegram"
- Connect the motor to the evaluation board
- Check the checkbox "TMC603 Enable"
- Raise the value "PWM:" to a value for normal operation (the calculations of the phase current values are shown in the TMC332 manual). Changes have to be sent with "Send SPI Telegram". Alternatively the current regulator can be set up directly.
- continue to use the board normally

8.5 Using the TMC457-EVAL as Step/Direction signal generator

To use the TMC457-EVAL board to generate the Step and Direction signals, the SCS_S Jumper (section 5.2) has to be removed to disable signal evaluation from the TMC428. Three wires connect the two boards, using connector X2 on the TMC457-EVAL board and connector J8 on the TMC332-EVAL board.
On X2 of the TMC457-EVAL board, Pin 1 (DIR), 2 (STEP) and 6 (GND) are connected to the corresponding pins of J8 on the TMC332-EVAL board.

For proper pulse recognition, the width of the step pulses must be at least one clock cycle of the TMC332. Since the two boards are running on two different crystals, the pulse width in the TMCL program on the TMC457-EVAL board should be set to 2, this is achieved by setting the axis parameter 64 to 2:

```
SAP 64, 0, 2
```

References
TMC332 datasheet (see http://www.trinamic.com)

9 Version history

Version	Comment	Author	Description
1.0	04-Nov-2008	SL	Initial Version
2.0	08-Apr-2009	SL	Transfered to Board version V2.00 ; Jumper description ; Quick Start
2.1	08-Jan-2010	SL	Added information for TMC457-EVAL connection

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