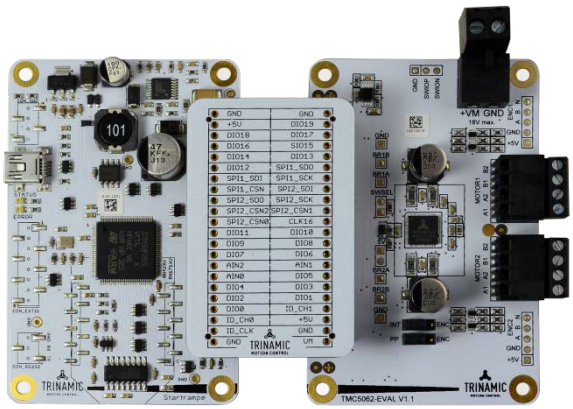
Hardware Version V1.00

TMC5062-EVAL EVALUATION BOARD MANUAL



coolStep™ dcStep™ stallGuard2™

Description

The TMC5062-EVAL is designed for evaluating all features of the TMC5062-LA. The evaluation board is part of TRINAMICs new user-friendly plug-in system for chip evaluation. Just connect the TMC5062-EVAL with STARTRAMPE, the associated base board. Therefore, use the dedicated connector board, called ESELSBRÜCKE. ESELSBRÜCKE offers test points for every connector pin.

TMC5062-EVAL Features

Single wire interface to CPU
SPI interface to CPU
Power connector
2x motor connector
2x retrofit option for encoder and reference switch connectors
Multi-pin connector to base board
Multiple test points

TMC5062-EVAL Software

PC demonstration software allowing access to all registers
Graphical view of position counter and motor velocity
Tools for stallGuard2, coolStep, dcStep, and chopper adjustments

TMC5062 Main Characteristics

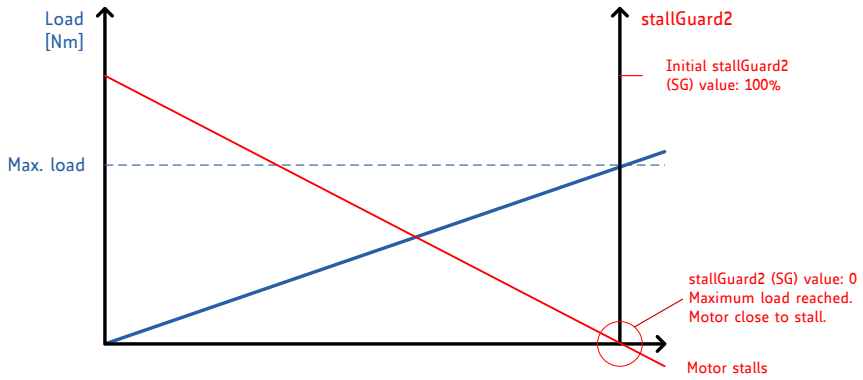
2-phase stepper motors
Drive Capability up to 2 x 1.1A coil current
Motion Controller with sixPoint™ ramp
Voltage Range 4.75... 20V DC
SPI & Single Wire UART
Dual ABN Encoder Interface
2x Ref.-Switch input per axis
Highest Resolution 256 microsteps per full step
Full Protection & Diagnostics
dcStep™ load dependent speed control
stallGuard2™ high precision sensorless motor load detection
coolStep™ load dependent current control for energy savings up to 75%
spreadCycle™ high-precision chopper for best current sine wave form and zero crossing with additional chopSync2™
Compact Size 7x7mm QFN48 package

TRINAMIC Motion Control GmbH & Co. KG
Hamburg, Germany

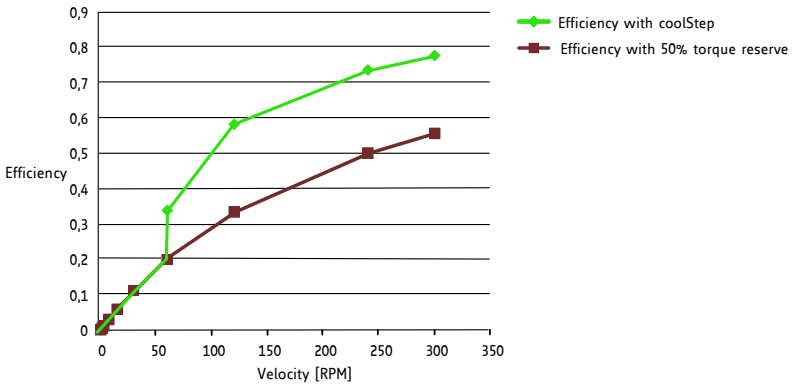
TRINAMIC MOTION CONTROL

TRINAMICs Unique Features

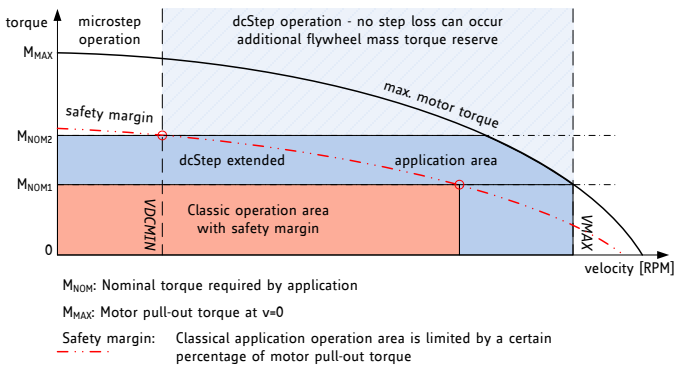
stallGuard2™ stallGuard2 is a high-precision sensorless load measurement using the back EMF on the coils. It can be used for stall detection as well as other uses at loads below those which stall the motor. The stallGuard2 measurement value changes linearly over a wide range of load, velocity, and current settings.



coolStep™ coolStep is an automatic current scaling based on the load measurement via stallGuard2 adapting the required current to the load. Energy consumption can be reduced by as much as 75%. coolStep allows substantial energy savings, especially for motors which see varying loads or operate at a high duty cycle. Even a constant-load application allows significant energy savings because coolStep automatically enables torque reserve when required.



dcStep™ dcStep is an automatic commutation mode for the stepper motor. It allows the stepper to run with its nominal velocity taken from the ramp generator as long as it can cope with the load. In case the motor becomes overloaded, it slows down to a velocity, where the motor can still drive the load. This way, the stepper motor never stalls and can drive heavy loads as fast as possible.



Order Codes

The TMC5062-EVAL is a controller/driver board. To have a complete system, the evaluation board needs to be connected to a baseboard with included microcontroller (STARTRAMPE) using a special connector board with test points on it, named ESELSBRÜCKE.

Order codes	Description	Size of unit [mm³]
TMC5062-EVAL-KIT	Evaluation board for TMC5062-LA two phase motor controller/driver including STARTRAMPE and ESELSBRÜCKE	

Table 1.1 Order Codes

Note
STARTRAMPE and ESELSBRÜCKE are baseboard and connector board designed for universal use within TRINAMICs new plug-in evaluation system. In near future, both can be used in combination with other EVAL boards (designed to suit to the system), too.

Table of Contents

1 Set-up and Features

The TMC5062-EVAL is part of an evaluation board system. Offering a very convenient handling for chip evaluation, TRINAMIC developed a plug-in system which consists of three parts: STARTRAMPE, ESELSBRÜCKE, and TMC5062-EVAL.

STARTRAMPE

STARTRAMPE is a baseboard. It is equipped with a STM32F ARM Cortex-M3 microcontroller (and EEPROM) and controls the TMC5062. The FLASH memory of the microcontroller holds a program for configuration of the TMC5062-LA. Further, STARTRAMPE controls the communication with the PC via USB or RS232 interface. For connecting STARTRAMPE to the PC, use the mini-USB interface connector on the board. Additionally, it is possible to communicate via the RS232 interface. Therefore, a connector can be soldered with little effort.

ESELSBRÜCKE

This small board forwards signals from STARTRAMPE to TMC5062-EVAL. ESELSBRÜCKE provides test points for different measurements.

TMC5062-EVAL

This evaluation board is designed for testing all features of the TMC5062-LA. The TMC5062-LA motion controller and driver IC is an intelligent power component interfacing between the CPU and up to two stepper motors. Several motion commands can be easily executed. The TMC5062-LA offers a number of unique enhancements which are enabled by the system-on-chip integration of driver and controller. The sixPoint ramp generator of the TMC5062-LA uses dcStep, coolStep, and stallGuard2 automatically in order to optimize every motor movement.

Using the software tool *TMC50xx-EVAL*, all features of the TMC5062-LA can be tried out.

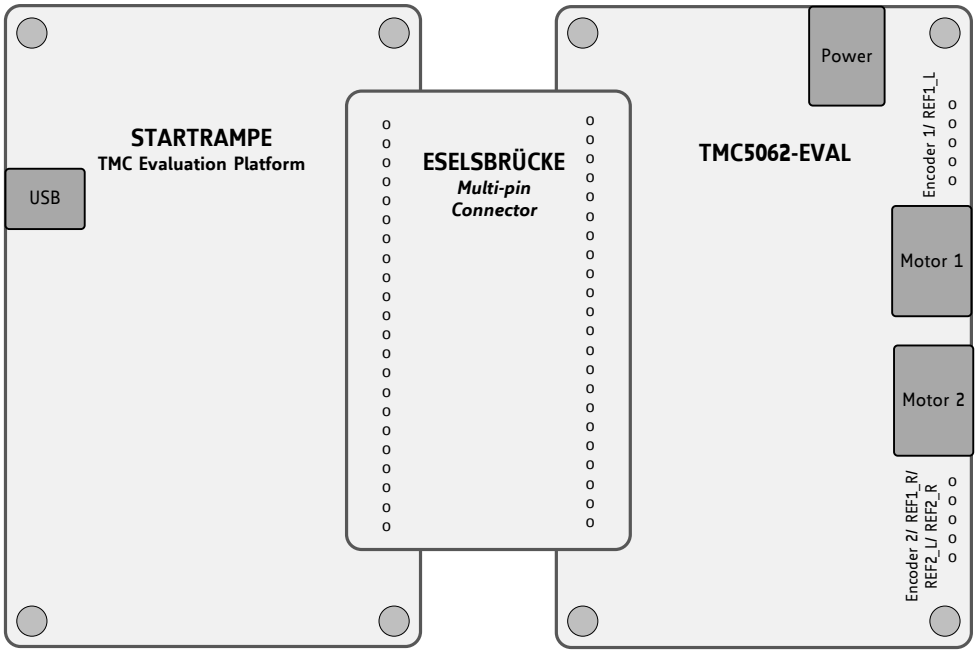


Figure 1.1 TMC5062-EVAL plug-in system set-up

TMC5062-EVAL FEATURES

Integrated Motion Controller	- Motion profile calculation in real-time. - On the fly alteration of motor parameters (e.g. position, velocity, acceleration).
Integrated Motor Driver for two Stepper Motors	- Up to 256 microsteps per full step. - High-efficient operation, low power dissipation. - Dynamic current control. - stallGuard2 feature for stall detection. - coolStep feature for reduced power consumption and heat dissipation. - dcStep feature for high velocity drive (related to the motor load). - spreadCycle chopper or classic chopper.
Electrical Data	- Motor current: up to 2x 1.1 A RMS nominal motor current. - Supply voltage: +4.5V… +20V DC operating voltage.
Interfaces	- USB (type B) - RS232 (connector can be retrofitted) - Native SPI™ of the TMC5062 - 2x encoder interface - 2x reference switch inputs per axis - Access to all signals of the TMC5062
Motor Type	- Two phase bipolar stepper motors
Safety Features	- Overcurrent - Short to GND - Undervoltage protection - Integrated diagnostics
Software	- PC demonstration software allowing access to all registers. - Graphical view of position counter and motor velocity. - Special tools for stallGuard2, coolStep, dcStep, and chopper adjustments.

2 TMC5062-EVAL-KIT Dimensions

2.1 Dimensions

2.1.1 Dimensions of TM5062-EVAL and STARTRAMPE

Board dimensions of both modules are 85mm x 55mm. There are four mounting holes suitable for M3 screws.

TMC5062-EVAL maximum component height (above PCB level) without mating connectors: 12mm.
STARTRAMPE maximum component height (above PCB level) without mating connectors: 11mm.

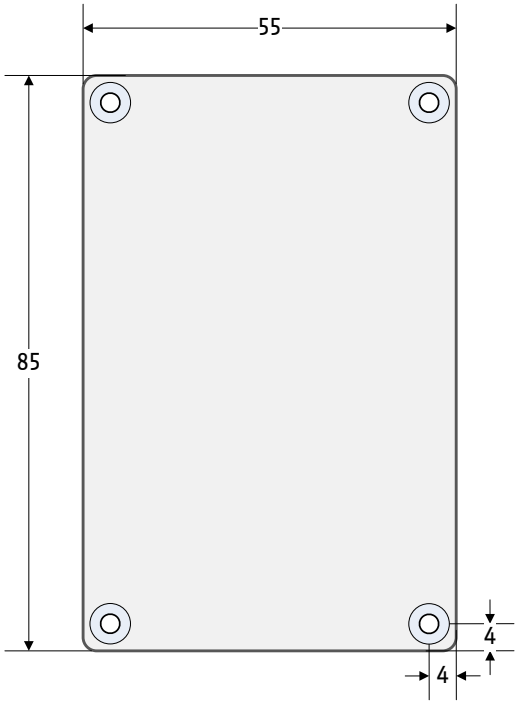


Figure 2.1 Dimensions: TMC5062-EVAL and STARTRAMPE

2.1.2 Dimensions of ESELSBRÜCKE

Board dimensions are 61mm x 38mm. Maximum component height (above PCB level) without mating connectors is 9.4mm.

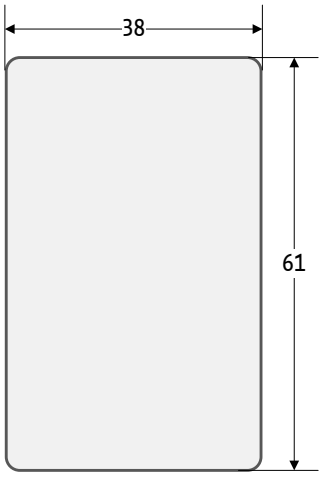


Figure 2.2 Dimensions of ESELSBRÜCKE

3 Evaluation Kit Connectors

3.1 TMC5062-EVAL Connectors

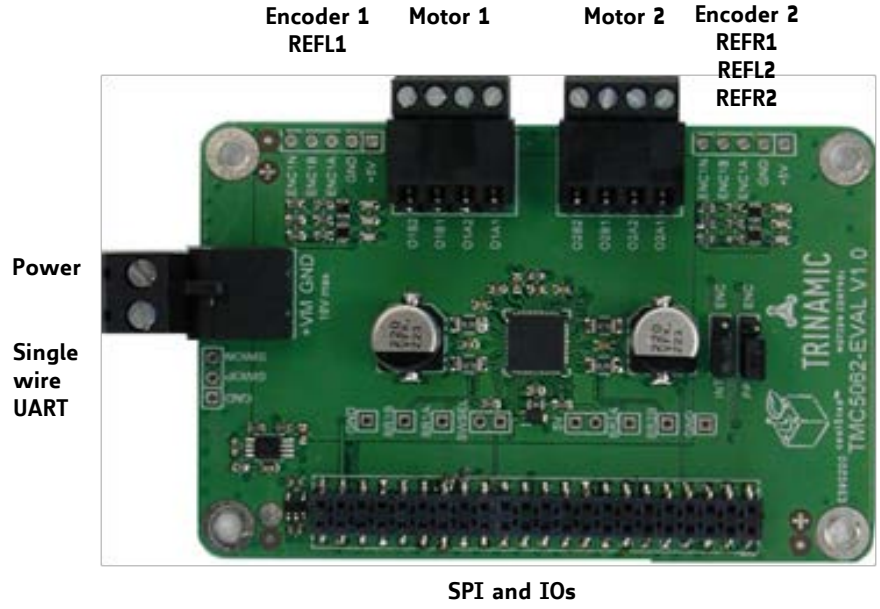


Figure 3.1 Connectors of TMC5062-EVAL

CONNECTORS OF TMC5062-EVAL		
Label (Key)	**Connector type**	**Mating connector type**
Power (X106)	RIA 330-02, 2 pol., 5mm pitch, shrouded header	RIA 349-2, screw type terminal block, pluggable, centerline 5 mm / 0.197 inches, wire entry parallel to plug direction
Motor 1 (X103) Motor 2 (X104)	RIA 182-04, 4 pol., 3.5mm pitch, shrouded header	RIA 169-04, screw type terminal block, pluggable, centerline 3.5 mm / 0.138 inches, wire entry parallel to plug direction
SPI and IOs (X101)	2 x 22 pol., 2.54mm pitch, pluggable female connector	2 x 22 pol., 2.54mm pitch, pluggable male connector
Encoder 1+2, switches (X114, X115)	Not soldered.	
Single wire UART	Not soldered.	

Table 3.1 Connectors

3.1.1.1 Power Connector

Pin	Label	Description
1	GND	Power supply and signal ground
2	+VM	Operational voltage: +7… +18V DC

Table 3.2 Power connector 2

3.1.2 Motor Connector Axis 1

Pin	Label	Description
1	O1A1	Motor coil A
2	O1A2	Motor coil A
3	O1B1	Motor coil B
4	O1B2	Motor coil B

Table 3.3 Connector for Step/Dir signals

3.1.3 Motor Connector Axis 2

Pin	Label	Description
1	O2A1	Motor coil A
2	O2A2	Motor coil A
3	O2B1	Motor coil B
4	O2B2	Motor coil B

Table 3.4 Connector for Step/Dir signals

3.1.4 Connector X114: Encoder 1 and REF1L (not soldered)

A plug for connecting the encoder for axis 1 and the left reference switch for axis 1 is not soldered but can be retrofitted.

Pin	Label	Description
1	+5V	+5V power supply
2	GND	System and module ground
3	ENC1A	Input A for incremental encoder 1
4	ENC1B	Input B for incremental encoder 1
5	REF1L ENC1N	Left reference switch axis 1 Zero channel for incremental encoder 1

Table 3.5 Encoder connector 1

3.1.5 Connector X115: Encoder 2 and REF1R/REF2L/REF2R (not soldered)

A plug for connecting the encoder for axis 2, the right reference switch for axis 1, and both switches for axis 2 is not soldered but can be retrofitted.

Pin	Label	Description
1	+5V	+5V power supply
2	GND	System and module ground
3	REFR1 ENC2A	Right reference switch for axis 1 Input A for incremental encoder 2
4	REFR2 ENC2B	Right reference switch for axis 2 Input B for incremental encoder 2
5	REF2L ENC2N	Left reference switch for axis 2 Zero channel for incremental encoder 2

Table 3.6 Encoder connector 2

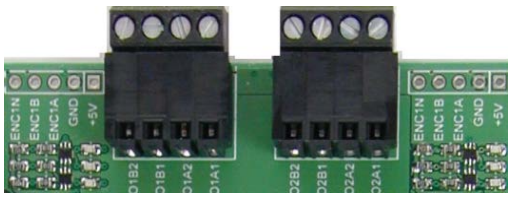


Figure 3.2 Encoder connectors for both motors can be soldered next to motor connectors.

3.1.6 ESELSBRÜCKE: SPI Interface, I/Os, and Test Points

The multi-pin connector ESELSBRÜCKE is used to connect STARTRAMPE and TMC5062-EVAL. Pin connections include the SPI interface, supply voltages, and IOs like driver enable (DRV_ENN), position compare (PP), interrupts (INT), and status flags. ESELSBRÜCKE offers test points for several measurements.

Avoid displacing ESELSBRÜCKE when operating! Otherwise STARTRAMPE and/or the TMC5062-EVAL can be damaged!

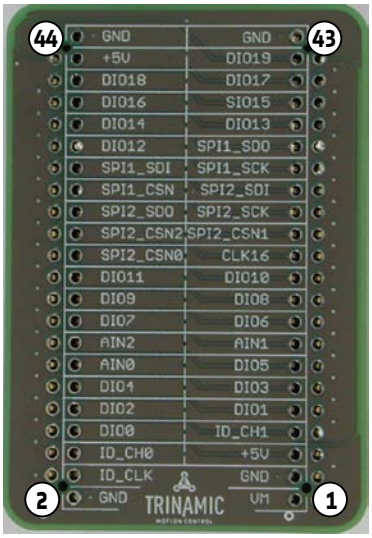


Figure 3.3 Eselsbrücke: pin assignment

Pin	Label ESELSBRÜCKE	Label TMC5062-EVAL	Description
1	+VM	+VM	Operational voltage: +4.5… 20V DC. STARTRAMPE: connected to µC (VM_MEAS) for voltage measurement.
2	GND	GND	System and module ground.
3	GND	GND	System and module ground.
4	ID_CLK	ID_CLK	STARTRAMPE: clock pulse test point. Timer mode 3 (general purpose) and timer mode 8 (advanced control) of the microcontroller are used. Both capture 4 channels.
5	+5V_USB	VCC_IO	Used to generate 3.3V (VCCIO).
6	ID_CH0	ID_CH0	ID channel 0. Used for automatic module detection.
7	ID_CH1	ID_CH1	ID channel 1. Used for automatic module detection. *Not used in combination with TMC5062-EVAL.*
8	DIO0	DRV_ENN	Enable (not) input for drivers (tie to GND). Switches off all motor outputs (set high for disable).
9	DIO1	-	STARTRAMPE: digital IOs. *Not used with TMC5062-EVAL.*
10	DIO2	-	
11	DIO3	-	
12	DIO4	-	
13	DIO5	ENC1A/INT	Input A for incremental encoder 1. Can be programmed to provide interrupt output based on ramp generator flags 4, 5, 6 & 7 and encoder null event status (*poscmp_enable*=1). *Please mind to set (or pull) the related jumper.*
14	AIN0	-	STARTRAMPE: analogue inputs. Not used with TMC5062-EVAL.
15	AIN1	-	
16	AIN2	-	

Pin	Label ESELSBRÜCKE	Label TMC5062-EVAL	Description
17	DIO6	ENC1B/PP	Input B for incremental encoder 1. Can be programmed to provide position compare output for motor 1 (*poscmp_enable*=1). *Please mind to set the related jumper.*
18	DIO7	-	STARTRAMPE: PWM or Step/Dir signals of µC motion controller. Can be used as digital IOs. *Not used with TMC5062-EVAL.*
19	DIO8	-	
20	DIO9	-	
21	DIO10	-	
22	DIO11	-	
23	CLK16	CLK	CLK input 16MHz.
24	SPI2_CSN0	-	STARTRAMPE: SPI2 with three CS lines for driver module. Can be used as digital IOs. *Not used with TMC5062-EVAL.*
25	SPI2_CSN1	-	
26	SPI0_SCN2	-	
27	SPI2_SCK	-	
28	SPI2_SDO	-	
29	SPI2_SDI	-	
30	SPI1_CSN	CSN/IO0	Chip select input of SPI interface, programmable IO in UART mode
31	SPI1_SCK	SCK/IO1	Serial clock input of SPI interface, programmable IO in UART mode
32	SPI1_SDI	SDI/IO2	Data input of SPI interface, programmable IO in UART mode
33	SPI1_SDO	SDO/IO3	Data output of SPI interface (Tristate, enabled with CSN=0), programmable IO in UART mode
34	DIO12	-	STARTRAMPE: reference switches and end switches. Can be used as digital IOs. *Not used with TMC5062-EVAL.*
35	DIO13	-	
36	DIO14	-	
37	DIO15	-	
38	DIO16	SWSEL	Interface selection input. Tie to GND for SPI mode, tie to VCC_IO for single wire UART mode.
39	DIO17	SWIOP1	Single wire UART interface I/O. Has internal 100K pull down resistor. Multi-purpose input in SPI mode.
40	DIO18	SWIOP2	
41	DIO19	SWION	Single wire UART interface inverted I/O for differential mode. Has internal 100K resistor to VCC and to GND. Leave open in non-differential mode when operating at 5V IO voltage or tie to desired threshold voltage. Multi-purpose input in SPI mode.
42	+5V…VM	-	+5V supply. Only available when VM applied, 700mA.
43	GND	GND	System and module ground
44	GND	GND	System and module ground

Table 3.7 ESELSBRÜCKE pinning

3.1.7 Further Test Points

Apart from ESELSBRÜCKE the evaluation system provides test points on the TMC5062-EVAL.

TEST POINTS ON TMC5062-EVAL		
TP_Number	**Label**	**Description**
TP_101	BR2A	Motor 2 bridge A negative power supply and current sense input.
TP_102	BR2B	Motor 2 bridge B negative power supply and current sense input.
TP_103	GND	Power ground for driver 2.
TP_104	BR1B	Motor 1 bridge B negative power supply and current sense input.
TP_105	BR1A	Motor 1 bridge A negative power supply and current sense input.
TP_106	GND	Power ground for driver 1.

Figure 3.4 Test points on TMC5062-EVAL

3.1.8 Connecting an External Microcontroller via Single Wire UART

For communication with an external device a single wire UART interface is available. This interface allows the control of the TMC5062 with any microcontroller UART. A connector can be retrofitted easily.

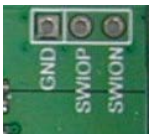


Figure 3.5 Retrofit option: UART connector

Pin	Label	Description
1	GND	System and module ground
2	SWIOP	Single wire UART interface I/O of the TMC5062-LA. Has internal 100K pulldown resistor.
3	SWION	Single wire UART interface inverted I/O for differential mode. Has internal 100K resistor to VCC and to GND. Leave open in non-differential mode when operating at 5V IO voltage or tie to desired threshold voltage.

Table 3.8 Single wire UART interface of TMC5062-LA

3.2 STARTRAMPE: Connectors on the Base Board

Please find information about the SPI interface and I/O connector ESELBRÜCKE in chapter 3. Here, only the interface connectors are mentioned.

Label (Key)	Connector type	Mating connector type
USB (X1)	Mini USB, type B, 5 pol., female	Mini USB, type B, 5 pol., male
SPI and IOs (Interface)	2 x 22 pol., 2.54mm pitch, pluggable female connector	2 x 22 pol., 2.54mm pitch, pluggable male connector
RS232 (Con_RS232)	not soldered	

Table 3.9 Connectors on the base board

3.2.1 USB Connector

Pin	Label	Description
1	+5V	+5V supply from host
2	USB-	Differential USB bus
3	USB+	Differential USB bus
4	GND	System and module ground
5	GND	System and module ground

Table 3.10 USB connector

3.2.2 RS232 Connector (not soldered)

Pin	Label	Description
1	GND	RS232 signal and system ground
2	RXD	Received data line
3	TXD	Transmitted data line

Table 3.11 RS232 connector

4 Jumper Settings on TMC5062-EVAL

In case an incremental encoder for motor 1 is needed, set two jumpers on the right side. If not, the position compare output (PP) and the interrupt output (INT) of the TMC5062-LA can be led through to the digital microcontroller inputs PE8 and PA5. Therefore, place the jumpers on the left side.

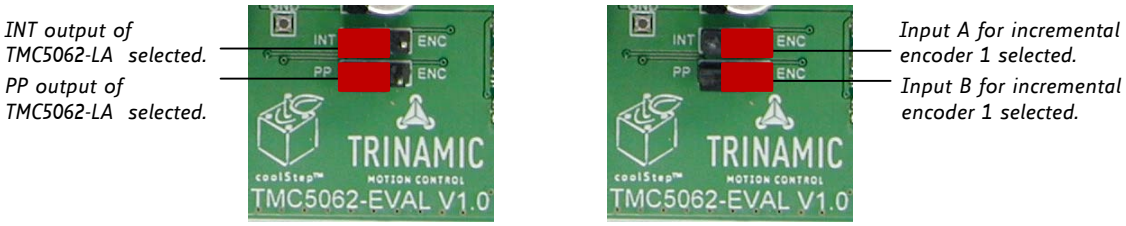


Figure 4.1 Jumper settings

5 System Status LEDs

STARTRAMPE has two LEDs. The green STATUS LED flashes constantly per default and indicates normal operation of the board. The red ERROR LED only lights up if an error occurred.

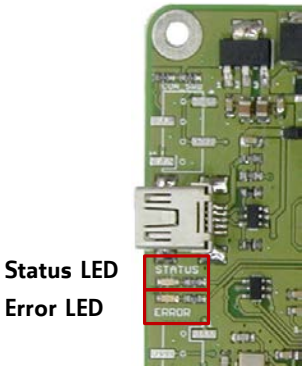


Figure 5.1 LEDs

LEDs of TMC5062-EVAL

Label	Color	Description
Status LED	green	Heartbeat of the module. Flashes constantly per default.
Error LED	red	Lights up in case of dysfunction, e.g., if VM is not available.

Table 5.1 LEDs

6 Operational Ratings of the TMC5062-EVAL-KIT

The operational ratings shown below should be used as design values. The maximum power supply current depends on the used motors and the supply voltage.

Do not exceed the maximum values during operation! Otherwise the TMC5062 will be damaged!

Symbol	Parameter	Min	Typ	Max	Unit
VM	Power supply voltage for operation	-0.5	12	20	V
VCCIO	Digital power supply (for external microcontroller)		3.3		V
+5V	Output of internal switch regulator		5	5.1	V
I_{SUPPLY}	Power supply current		0.2... 1.1	1.4	A
T_{ENV}	Environment temperature at rated current (no forced cooling required)		20°C		°C

Table 6.1 General operational ratings of the module

7 Getting Started

7.1 How to Connect the Board

You need

- TMC5062-EVAL
- STARTRAMPE
- ESELSBRÜCKE
- One or two stepper motors (e.g. QSH4218)
- USB interface
- Nominal supply voltage +12V DC (+7... +18V DC)
- *TMC50xx-EVAL* software and PC
- Cables for interface, motors, and power

Precautions

- Do not mix up connections or short-circuit pins.
- Avoid bounding I/O wires with motor wires.
- Do not exceed the maximum power supply of +20V DC!
- Do not connect or disconnect the motor while powered!
- START WITH POWER SUPPLY OFF!

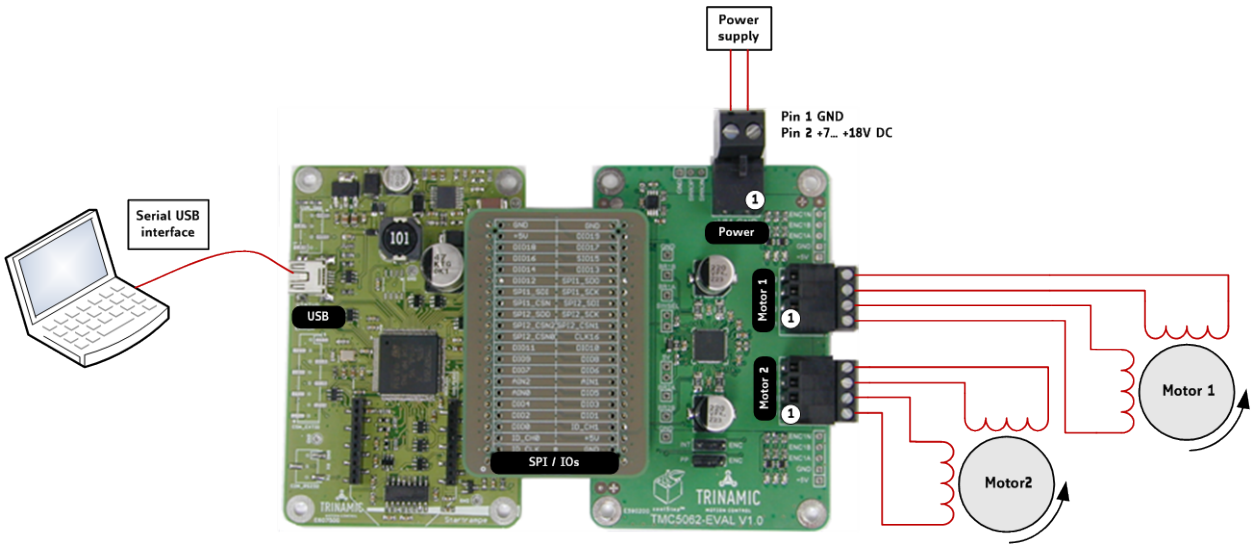


Figure 7.1 Getting started

7.2 Starting up

1. Connect the USB interface of STARTRAMPE. The evaluation board software *TMC50xx-EVAL* is designed to guide you through the installation of a virtual COM port for the USB interface. Please refer to chapter 7.3 for further information und follow the instructions.
2. Connect one or two motors.
3. Connect the power supply of module.
4. Turn power ON. The green LED for the heartbeat (STATUS) flashes and the red LED for ERROR is off. The motor is powered but in standstill now.
   If this does not occur, turn power OFF and check your connections and power supply!
5. Download and open the file *TMC50xx-EVAL*. If you are using the USB interface, the software will do the installation of the virtual COM port configuration file now.

USB Bus Powered Mode for Configuration

The TMC5062-EVAL-KIT supports both, USB self powered operation (when an external power is supplied via the power supply connector on the TMC5062-EVAL) and USB bus powered operation (only the USB interface is connected to the PC). On-board digital core logic will be powered via USB in case no other supply is connected. The digital core logic comprehends the microcontroller itself and also the EEPROM. The *USB bus powered operation mode* has been implemented to enable configuration, parameter settings, read-outs, etc. by just connecting an USB cable between module and host PC.
Motor movements are not possible in USB bus powered operation mode. Therefore, connect the power connector and change to *USB self powered operation mode*.

7.3 Installing the Virtual Com Port for USB Interface

1. Download the software application *TMC50xx-EVAL.exe* and the USB virtual COM port configuration file *TMC-EVAL.inf*.
2. Connect the USB interface (STARTRAMPE) and the power supply connector (TMC5062-EVAL) and switch power ON.
3. Start the *TMC50xx-EVAL.exe* application with a double click.
4. A hint appears on the screen. Click *OK*.

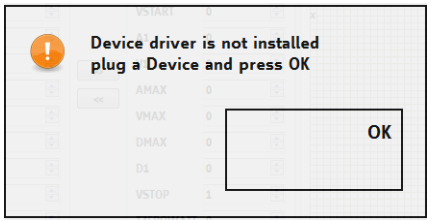


Figure 7.2 Hint related to device driver installation

5. Now, the software searches and installs the configuration file. You will be asked if you really like to install the unknown file. Answer yes to install it.

   In case for any reason this does not work, install the file TMC-EVAL.inf using the system control of your PC.

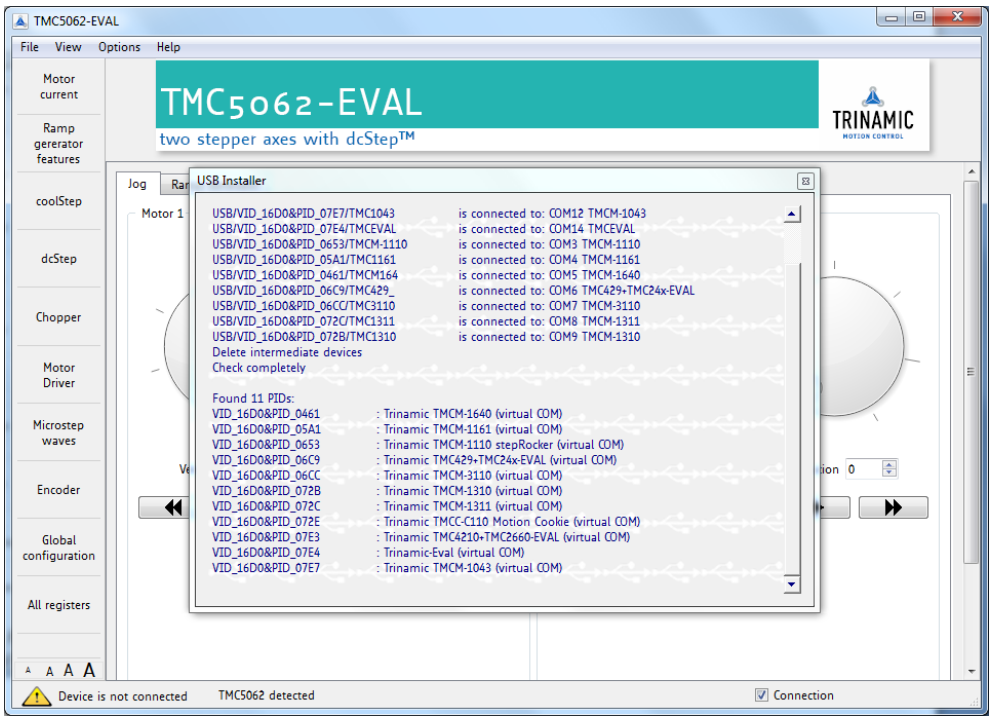
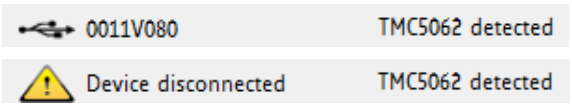


Figure 7.3 Install USB driver

Afterwards, check if your module is connected. Therefore, information is given at the bottom of the main window. If the TMC5062 is not connected, pull and plug the USB interface connector and/or click *Connection* at the bottom of the window two times.



Module is detected and connected properly.

Module is not connected properly.

Figure 7.4 Status information about device connection

From now on, the identification will be done automatically. Everything is ready to be used.

8 Evaluation Software Characteristics

The evaluation software *TMC50xx-EVAL.exe* is intended for customers who design own PCBs with the TMC5062-LA. In order to understand the settings, the TMC5062-LA datasheet needs to be referenced. The software is designed for adjusting and testing all settings of the TMC5062-LA by allowing direct register access. Optimized settings can be stored and exported.

The file *TMC50xx-EVAL.exe* can be downloaded from our website www.trinamic.com. The software is a PC application running under Windows XP, Vista, Windows 7, and Windows 8. Windows 3.x is not supported.

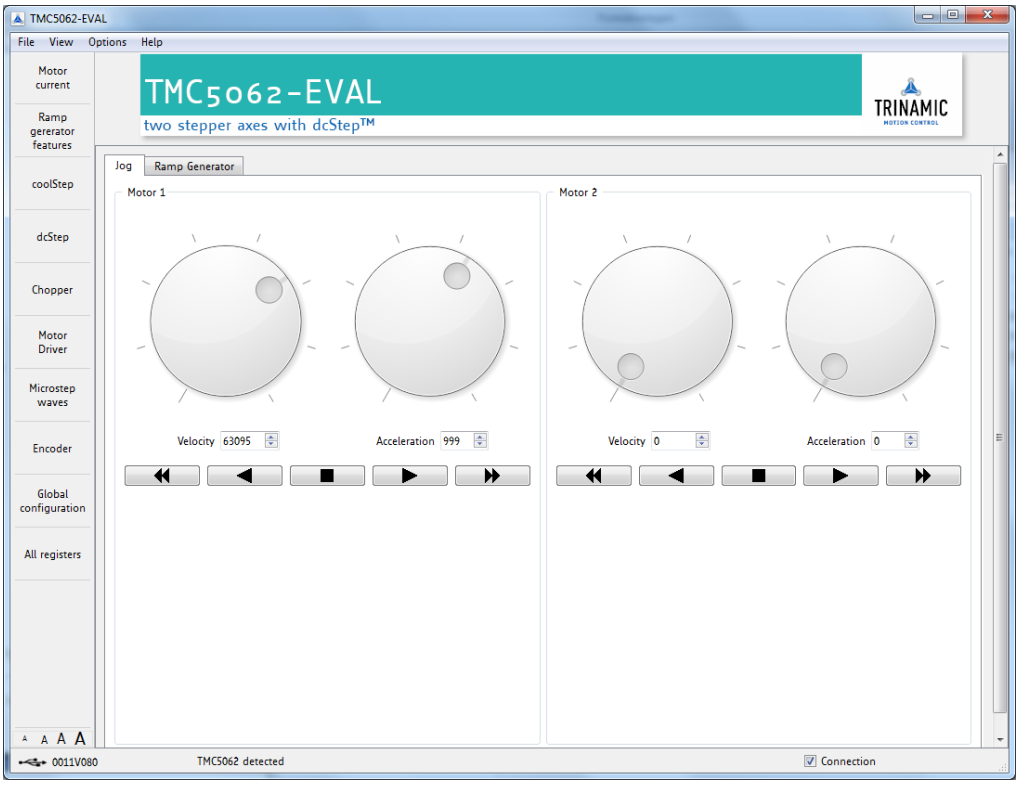


Figure 8.1 Main window with jog tab

8.1 Starting the Evaluation Software

- Double-click the file *TMC50xx-EVAL.exe*.
- Choose *Trinamic-Eval* and plug the evaluation board, if it is not connected yet. If you are testing just one module type, click *Remember me*. This way, the software will skip this part of the program next time.

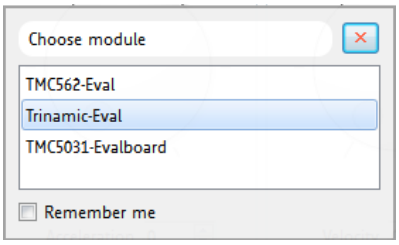


Figure 8.2 Choose module

- Click *Connection* to connect your board. Now, you can start your tests.

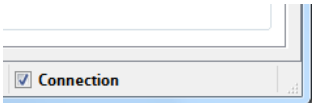


Figure 8.3 Connect module

Please note that the first steps differ in case a virtual COM port for the USB interface has to be installed first. In this case refer to chapter 7.3.

8.2 Main Dialogues

The evaluation software offers two main dialogues: the *jog dialogue* and the *ramp generator dialogue* on the next tab. Both dialogues offer separate data input fields for motor 1 and motor 2.

8.2.1 The Jog Tab

Use the rotary control switches with the left key or the small wheel of your computer mouse. Thus, velocity and acceleration for each motor can be set and/or changed. Both values increase/decrease according to a logarithmic function.

There are five keys for each motor. The keys with just one arrow are push-buttons. A motor moves as long as one of these is pressed (using the left mouse key). Acceleration and deceleration will always be adequate to your settings (or default settings), which can be read out using the *all registers dialogue*.

Figure 8.4 Jog tab keys for moving a motor

8.2.2 The Ramp Generator Tab

The design of the ramp generator tab correlates to the jog tab. Ramp generator settings for each motor can be done independently from the other motor. With this, comparisons of different settings are quite easy. The two motors can be driven simultaneously using the buttons for both below the diagram. All values can be calibrated on the fly while a drive is still active.

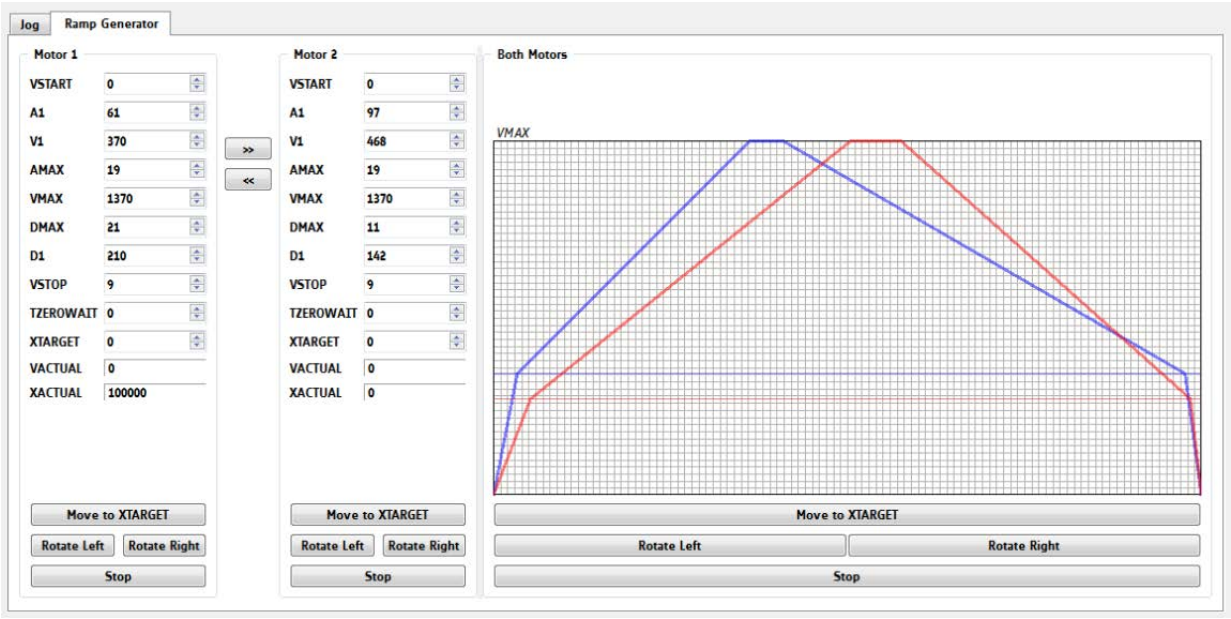


Figure 8.5 Ramp generator tab

A complete set of ramp generator values can be copied to the input data area of the other motor by clicking the buttons with two arrows. Afterwards the value sets can be adjusted individually for each motor.

Figure 8.6 Copy value set

8.3 Basic Functions

8.3.1 Load / Save / Export Settings

Module settings can be loaded, saved, and exported. Click *File* on top menu and choose the desired action.

Note that it is not possible to store settings permanently on the board!

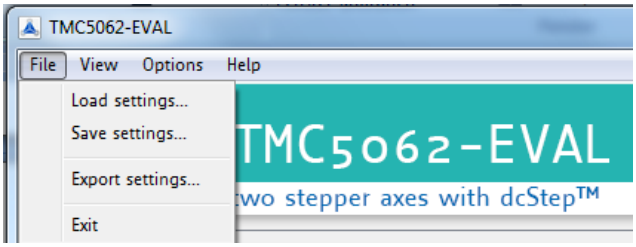


Figure 8.7 Load / save / export settings.

8.3.2 Options Menu

There are two special options related to the handling of this software tool:

- If you choose *Extra Style*, the software surface will be colored differently.
- *Remember Module* can be chosen if you are working with one module type at present and more than one type have been connected up to now. If you intend to test another IC evaluation board, it is necessary to remove the remember module command!

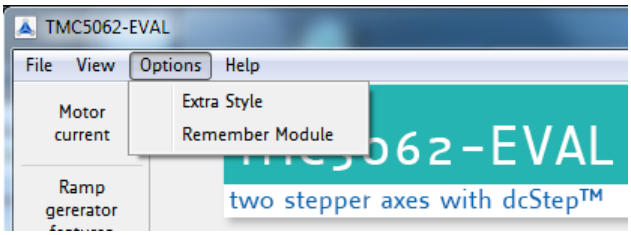


Table 8.1 Options menu

8.3.3 Get Firmware Version

To read out the firmware version, click *Help* on top menu and afterwards *About*. Now, the TMC50xx-EVAL software shows the version number and the build-ID.

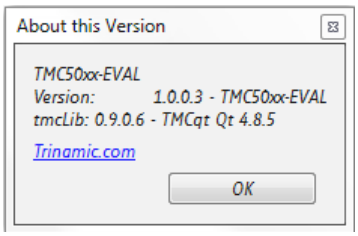


Figure 8.8 Firmware Version

8.3.4 Reset to Factory Defaults

Each time, the evaluation board is powered off and on again it will be reset to factory defaults. Thus, for a reset switch VM off (VM=0) and disconnect the USB interface.

8.4 Special Dialogues

Click *view* on top menu or the specific fields on the left side of the main window to open up dialogues for special settings. Note that dcStep and encoder are not provided by the TMC5062.

THE FOLLOWING SPECIAL DIALOGUES ARE PROVIDED:

- Motor current settings
- Ramp generator features
- coolStep
- dcStep
- Chopper
- Motor driver
- Microstep waves
- Encoder
- Global configuration
- All registers

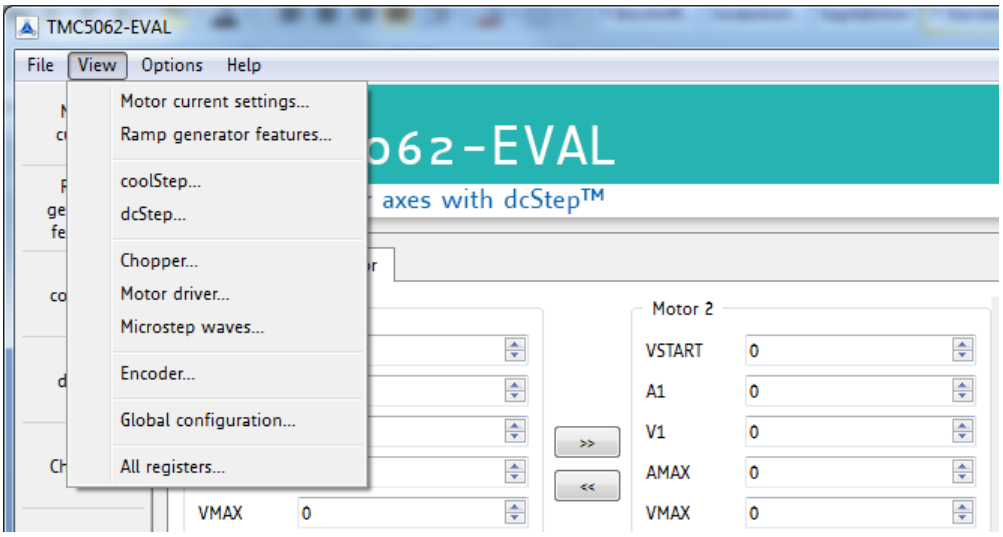
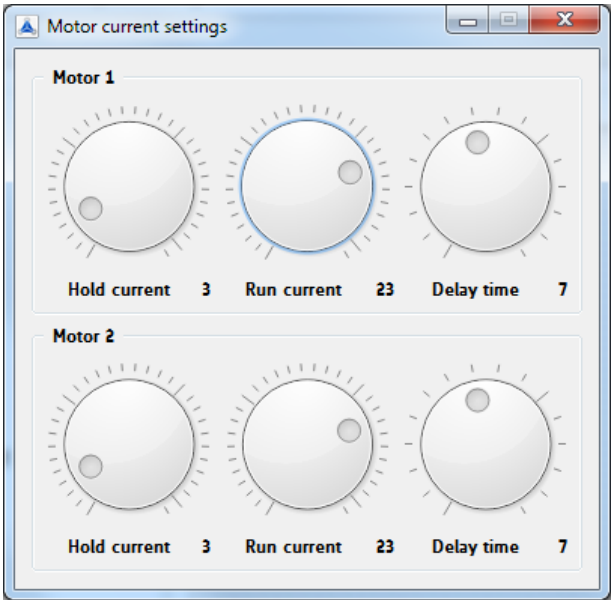


Figure 8.9 View dialogues

8.4.1 Motor Current Settings Dialogue

This dialogue makes the evaluation of the TMC5062 more comfortable. Motor current settings can be tried out by using rotary control switches.



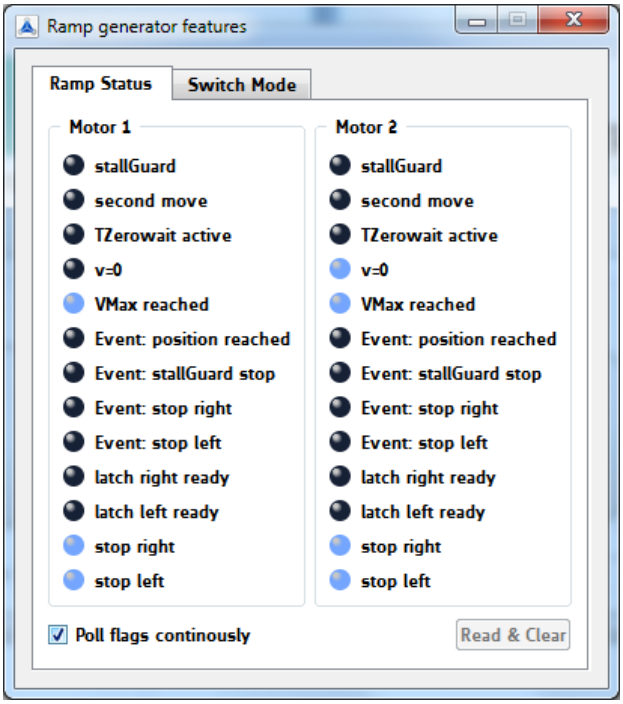
NOTE
Exact values can be read out and changed using the *all registers* dialogue.

Figure 8.10 Motor current settings

8.4.2 Ramp Generator Features Dialogue

This dialogue offers two tabs: the ramp status tab and the switch mode tab. These tabs correlate with each other.

8.4.2.1 Ramp Status Tab



Ramp status flags can be polled continuously or on demand. This status tab is designed to read out the RAMP_STAT register of the TMC5062
Blue marked flags are set.

If you use the push buttons for the reference switches of motor 2 on the evaluation board, the status can be read out here.

Figure 8.11 Ramp and reference switch status flags

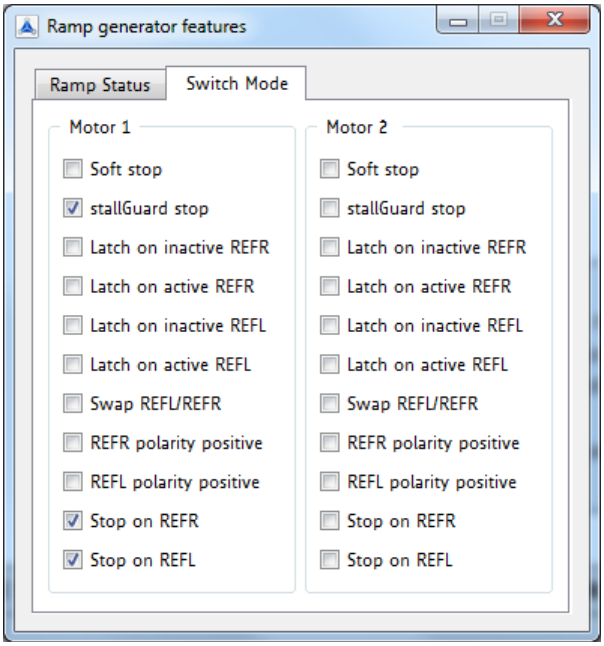
0x35, 0x55: RAMP_STAT – RAMP AND REFERENCE SWITCH STATUS REGISTER OF TMC5062			
R/W	**Bit**	**Name**	**Comment**
R	13	*status_sg*	1: Signals an active stallGuard2 input from the coolStep driver, if enabled. *Hint:* When polling this flag, stall events may be missed – activate *sg_stop* to be sure not to miss the stall event.
R+C	12	*second_move*	1: Signals that the automatic ramp requires moving back in the opposite direction, e.g. due to on-the-fly parameter change (Flag is cleared upon reading)
R	11	*t_zerowait_ active*	1: Signals, that *T_ZEROWAIT* is active after a motor stop. During this time, the motor is in standstill.
R	10	*vzero*	1: Signals, that the actual velocity is 0.
R	9	*position_ reached*	1: Signals, that the target position is reached. This flag becomes set while *X_ACTUAL* and *X_TARGET* match.
R	8	*velocity_ reached*	1: Signals, that the target velocity is reached. This flag becomes set while *V_ACTUAL* and *VMAX* match.
R+C	7	*event_pos_ reached*	1: Signals, that the target position has been reached (*pos_reached* becoming active). This bit is ORed to the *interrupt output* signal. (Flag is cleared upon reading)
R+C	6	*event_stop_ sg*	1: Signals an active StallGuard2 stop event. (Flag is cleared upon reading) This bit is ORed to the *interrupt output* signal.
R	5	*event_stop_r*	Signals an active stop right condition due to stop switch. This bit is ORed to the *interrupt output* signal.

0x35, 0x55: RAMP_STAT – RAMP AND REFERENCE SWITCH STATUS REGISTER OF TMC5062			
R/W	**Bit**	**Name**	**Comment**
	4	*event_stop_l*	1: Signals an active stop left condition due to stop switch. This bit is ORed to the *interrupt output* signal.
R+C	3	*status_latch_r*	1: Latch right ready (enable position latching using *SWITCH_MODE* settings *latch_r_active* or *latch_r_inactive*) This bit is ORed to the *interrupt output* signal. (Flag is cleared upon reading)
	2	*status_latch_l*	1: Latch left ready (enable position latching using *SWITCH_MODE* settings *latch_l_active* or *latch_l_inactive*) This bit is ORed to the *interrupt output* signal. (Flag is cleared upon reading)
R	1	*status_stop_r*	Reference switch right status (1=active)
	0	*status_stop_l*	Reference switch left status (1=active)

Table 8.2 RAMP_STAT register

8.4.2.2 Switch Mode Tab

With this tab, the SW_MODE register of the TMC5062 can be adjusted. Just tick the desired function to set it.



NOTE
If *stallGuard stop* is active and the motor stalls, deactivate the stallGuard event before going on with your tests. Otherwise the motor will not rotate.
For a further stallGuard test activate the stallGuard event again.

0x34, 0x54: SW_MODE – REFERENCE SWITCH AND STALLGUARD2 EVENT CONFIGURATION REGISTER		
Bit	**Name**	**Comment**
11	*en_softstop*	0: Hard stop 1: Soft stop The soft stop mode always uses the deceleration ramp settings *DMAX*, *V1*, *D1*, *VSTOP* and *TZEROWAIT* for stopping the motor. A stop occurs when the velocity sign matches the reference switch position (REFL for negative velocities, REFR for positive velocities) and the respective switch stop function is enabled. A hard stop also uses *TZEROWAIT* before the motor becomes released. *Attention: Do not use soft stop in combination with stallGuard2.*
10	*sg_stop*	1: Enable stop by stallGuard2. Disable to release motor after stop event.

0x34, 0x54: SW_MODE – REFERENCE SWITCH AND STALLGUARD2 EVENT CONFIGURATION REGISTER		
Bit	**Name**	**Comment**
		Attention: Do not enable during motor spin-up, wait until the motor velocity exceeds a certain value, where stallGuard2 delivers a stable result.
9	-	Reserved, set to 0
8	*latch_r_inactive*	1: Activates latching of the position to *XLATCH* upon an inactive going edge on the right reference switch input REFR.
7	*latch_r_active*	1: Activates latching of the position to *XLATCH* upon an active going edge on the right reference switch input REFR. *Hint:* Activate *latch_r_active* to detect any spurious stop event by reading *status_latch_r.*
6	*latch_l_inactive*	1: Activates latching of the position to *XLATCH* upon an inactive going edge on the left reference switch input REFL.
5	*latch_l_active*	1: Activates latching of the position to *XLATCH* upon an active going edge on the left reference switch input REFL. *Hint:* Activate *latch_l_active* to detect any spurious stop event by reading *status_latch_l.*
4	*swap_lr*	1: Swap the left and the right reference switch input
3	*pol_stop_r*	Sets the polarity of the right reference switch input (0=neg., 1=pos.)
2	*pol_stop_l*	Sets the polarity of the left reference switch input (0=neg., 1=pos.)
1	*stop_r_enable*	1: Enables automatic motor stop during active right reference switch input *Hint:* The motor restarts in case the stop switch becomes released.
0	*stop_l_enable*	1: Enables automatic motor stop during active left reference switch input *Hint:* The motor restarts in case the stop switch becomes released.

Table 8.3 SW_MODE register

8.4.3 coolStep Dialogue

This dialogue is designed for adjusting coolStep. The coolStep current is shown in red and the stallGuard2 load in blue. The coolStep current value increases/decreases adequate to the measured load on the axis. Energy savings can be optimized.

The input data area fields for the two motors are related to the COOLCONF register of the TMC5062.

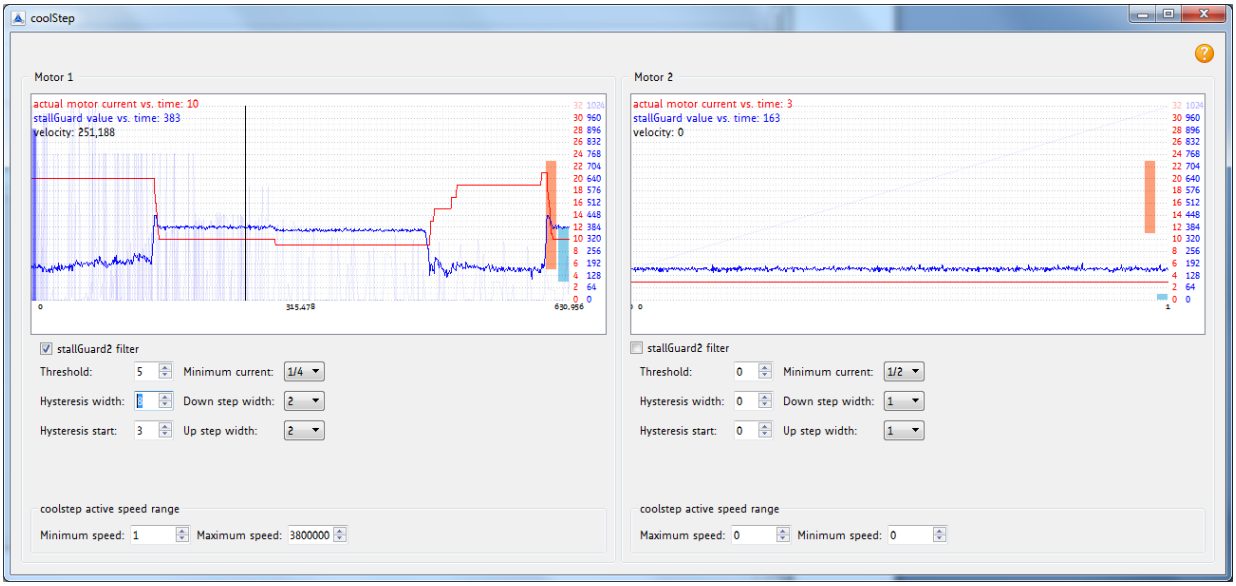
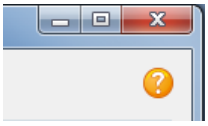


Figure 8.12 coolStep dialogue

0x6D, 0x7D: *COOLCONF* – SMART ENERGY CONTROL COOLSTEP AND STALLGUARD2			
Bit	**Name**	**Function**	**Comment**
24	*sfilt*	stallGuard2 filter enable	0 Standard mode, high time resolution for stallGuard2 1 Filtered mode, stallGuard2 signal updated for each four fullsteps only to compensate for motor pole tolerances
22 21 20 19 18 17 16	*sgt6* *sgt5* *sgt4* *sgt3* *sgt2* *sgt1* *sgt0*	stallGuard2 threshold value	This signed value controls stallGuard2 level for stall output and sets the optimum measurement range for readout. A lower value gives a higher sensitivity. Zero is the starting value working with most motors. -64 to +63: A higher value makes stallGuard2 less sensitive and requires more torque to indicate a stall.
15	*seimin*	minimum current for smart current control	0: 1/2 of current setting (*IRUN*) 1: 1/4 of current setting (*IRUN*)
14 13	*sedn1* *sedn0*	current down step speed	%00: For each 32 stallGuard2 values decrease by one %01: For each 8 stallGuard2 values decrease by one %10: For each 2 stallGuard2 values decrease by one %11: For each stallGuard2 value decrease by one
11 10 9 8	*semax3* *semax2* *semax1* *semax0*	stallGuard2 hysteresis value for smart current control	If the stallGuard2 result is equal to or above (*SEMIN*+*SEMAX*+1)*32, the motor current becomes decreased to save energy. %0000 … %1111: 0 … 15
6 5	*seup1* *seup0*	current up step width	Current increment steps per measured stallGuard2 value %00 … %11: 1, 2, 4, 8
3 2 1 0	*semin3* *semin2* *semin1* *semin0*	minimum stallGuard2 value for smart current control and smart current enable	If the stallGuard2 result falls below *SEMIN**32, the motor current becomes increased to reduce motor load angle. %0000: smart current control coolStep off %0001 … %1111: 1 … 15

Table 8.4 Abridgement of COOLCONF register

8.4.3.1 Useful Hints and Settings for a good work flow



For basic information about coolStep calibration, point with your computer mouse on the interrogation mark on the right side of the window. The following window appears on the screen.

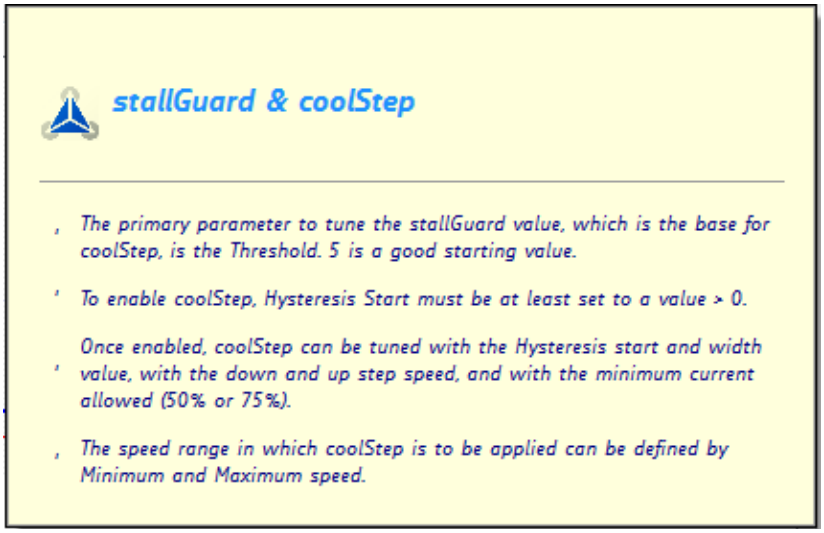


Figure 8.13 Basic stallGuard2 and coolStep information

Further, it is possible to choose settings for the tracing. Therefore, click on a diagram using the right mouse key. This way, context menus for motor 1 and motor 2 can be called up.

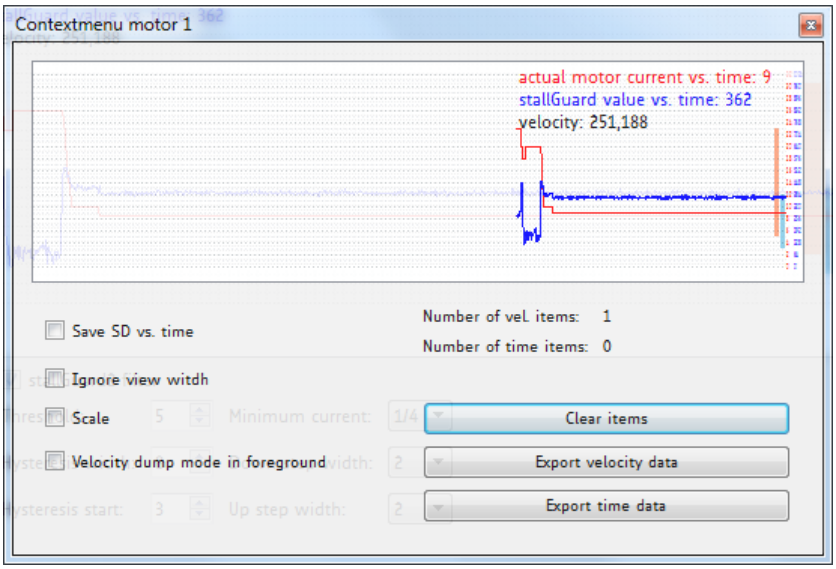


Figure 8.14 Context menu motor 1

DIFFERENT CONTEXT MENU SETTINGS CAN BE MADE:

Save SG vs. time	Set a tick here to export the stallGuard2 value versus time to an excel file.
Ignore view width	Set a tick here to get a horizontal bar which offers the possibility to view the complete recorded diagram.
Scale	Set a tick here to adapt the scaling to the window.
Velocity dump mode in foreground	Set a tick here to put in foreground the velocity dump mode graph. Remove the tick for scaling the values on time basis.
Export velocity data	Click here to export velocity data to an excel sheet.
Export time data	Click here to export time data to an excel sheet.
Clear items	Click here to clear velocity and time data.

8.4.4 dcStep Dialogue

dcStep requires only a few settings. It directly feeds back motor motion to the ramp generator, so that it becomes seamlessly integrated into the motion ramp, even if the motor becomes overloaded with respect to the target velocity. dcStep operates the motor in fullstep mode at the ramp generator target velocity *VACTUAL* or at reduced velocity if the motor becomes overloaded. It requires setting the minimum operation velocity *VDCMIN*. *VDCMIN* shall be set to the lowest operating velocity where dcStep gives a reliable detection of motor operation. The motor never stalls unless it becomes braked to a velocity below *VDCMIN*.

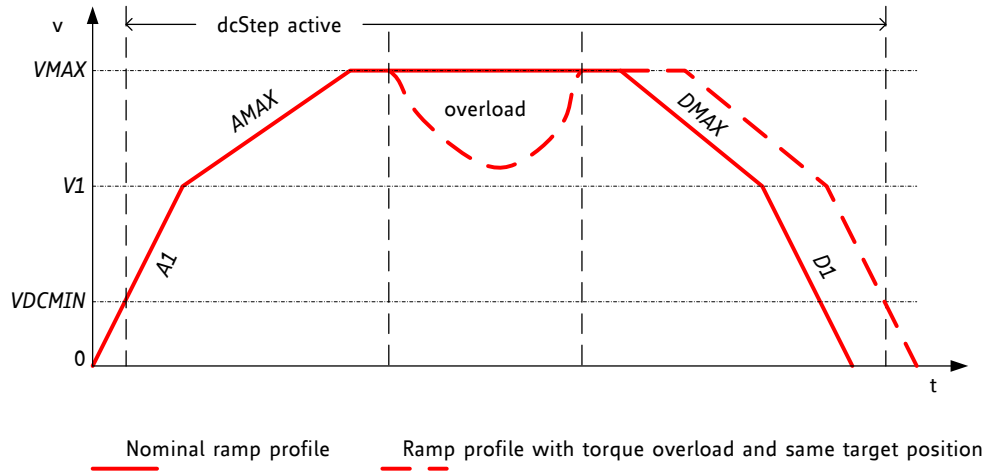


Figure 8.15 Velocity profile with impact by overload situation

While dcStep is able to decelerate the motor upon overload, it cannot avoid a stall in every operation situation. Once the motor is blocked, or it becomes decelerated below a motor dependent minimum velocity where the motor operation cannot safely be detected any more, the motor may stall and loose steps. In order to safely detect a step loss and avoid restarting of the motor, the stop on stall can be enabled (set flag *sg_stop*). In this case a status flag becomes set (*event_stop_sg*) once the motor is stalled. A stallGuard2 load value is not available during dcStep operation.

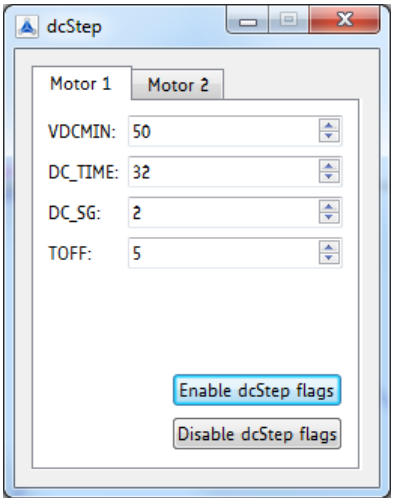


Figure 8.16 Dialogue for dcStep settings

Try different settings related to the hints in the table below.

Parameter	Description	Range	Comment
vhighfs & *vhighchm*	These chopper configuration flags in *CHOPCONF* need to be set for dcStep operation. As soon as *VDCMIN* becomes exceeded, the chopper becomes switched to fullstepping.	0 / 1	set to 1 for dcStep
TOFF	dcStep often benefits from an increased off time value in *CHOPCONF*. Settings >2 should be preferred.	2… 15	Settings 8…15 do not make any difference to setting 8 for dcStep operation.
VDCMIN	This is the lower threshold for dcStep operation. Below this threshold, the motor operates in normal microstep mode. Tune together with *DC_TIME* setting.	0… 2^22	0: Disable dcStep Set to the low velocity limit for dcStep operation.
DC_TIME	This setting controls the reference pulse width for dcStep. It needs to be set slightly higher than the effective blank time set by *TBL*. Check best setting under nominal operation conditions, and re-check under extreme operating conditions (e.g. lowest operation supply voltage, highest motor temperature, and highest supply voltage, lowest motor temperature).	0… 255	t_{BLANK} (as defined by *TBL*) in clock cycles + *n* with *n* in the range 1 to 10 (for a typical motor)
DC_SG	This setting controls stall detection in dcStep mode. A stall can be used as an error condition by issuing a hard stop for the motor. Check best setting under nominal operation conditions, and re-check under extreme operating conditions (e.g. lowest operation supply voltage, highest motor temperature, and highest supply voltage, lowest motor temperature). Enable *sg_stop* flag for stopping the motor upon a stall event. This way the motor will be stopped once it stalls.	0… 255	Set slightly higher than *DC_TIME*/16

Table 8.5 dcStep parameter and settings

8.4.5 Chopper Configuration Dialogue

This dialogue has two tabs, one for motor 1 and the other one for motor 2. First, it is necessary to specify the chopper mode: *spreadCycle* or *Classic*.

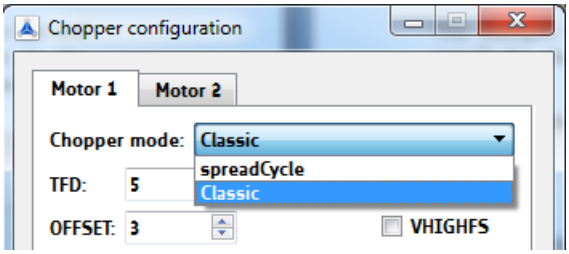


Figure 8.17 Choose chopper mode

spreadCycle (standard mode) and classic chopper (constant off time with fast decay time) have to be configured differently:

- For spreadCycle configuration the hysteresis has to be defined by setting a start value (HSTRT) and an end value (HEND).
- The classic chopper needs a fast decay time setting (TFD) and a specified offset (OFFSET).

Parameters with more than one bit have value fields; parameters with just one bit can be set by ticking them. Please refer to the chopper configuration register below for detailed information.

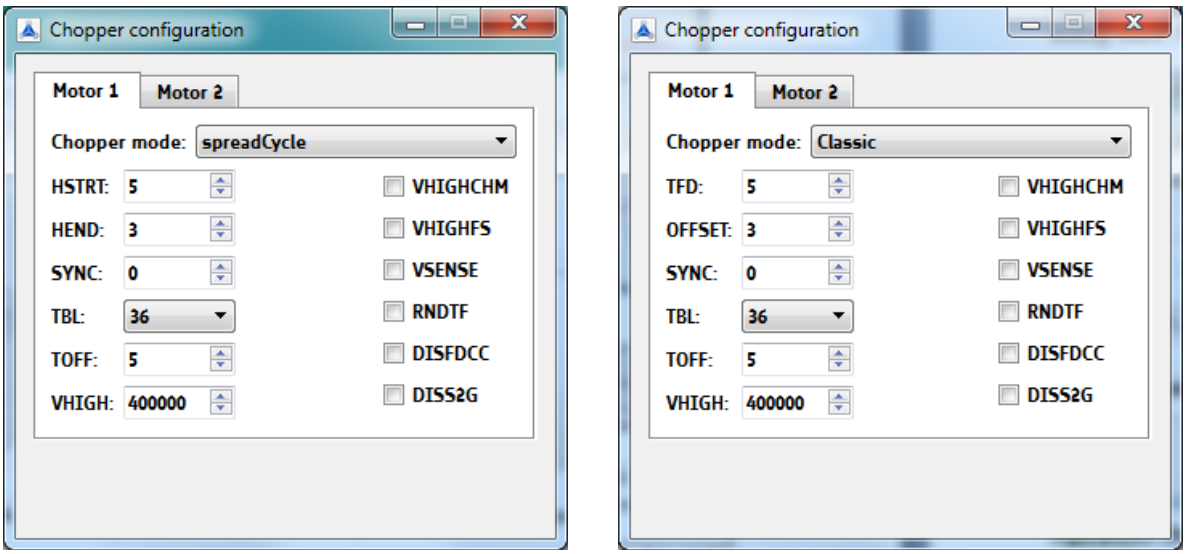


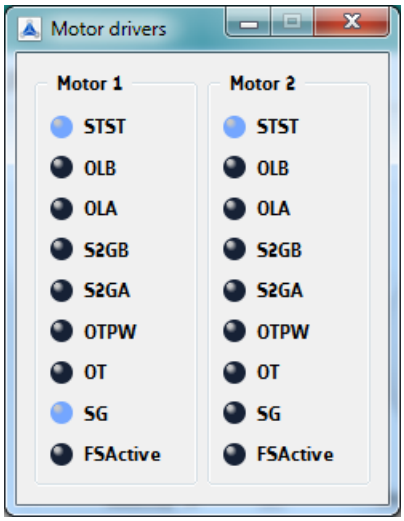
Figure 8.18 Chopper configuration dialogue (spreadCycle or classic)

0x6C, 0x7C: CHOPCONF – CHOPPER CONFIGURATION			
Bit	**Name**	**Function**	**Comment**
30	*diss2g*	short to GND protection disable	0: Short to GND protection is on 1: Short to GND protection is disabled
23	*sync3*	SYNC PWM synchronization clock	This register allows synchronization of the chopper for both phases of a two phase motor in order to avoid the occurrence of a beat, especially at low motor velocities. It is automatically switched off above VHIGH. %0000: Chopper sync function chopSync off %0001 … %1111: Synchronization with $f_{SYNC} = f_{CLK}/(sync*64)$ Hint: Set TOFF to a low value, so that the chopper cycle is ended, before the next sync clock pulse occurs. Set for the double desired chopper frequency for chm=0, for the desired base chopper frequency for chm=1.
22	*sync2*		
21	*sync1*		
20	*sync0*		

0x6C, 0x7C: CHOPCONF – CHOPPER CONFIGURATION				
Bit	**Name**	**Function**	**Comment**	
19	*vhighchm*	high velocity chopper mode	This bit enables switching to *chm*=1 and *fd*=0, when *VHIGH* is exceeded. This way, a higher velocity can be achieved. Can be combined with *vhighfs*=1. If set, the *TOFF* setting automatically becomes doubled during high velocity operation in order to avoid doubling of the chopper frequency.	
18	*vhighfs*	high velocity fullstep selection	This bit enables switching to fullstep, when *VHIGH* is exceeded. Switching takes place only at 45° position. The fullstep target current uses the current value from the microstep table at the 45° position.	
17	*vsense*	sense resistor voltage based current scaling	0: Low sensitivity, high sense resistor voltage 1: High sensitivity, low sense resistor voltage	
16 15	*tbl1* *tbl0*	TBL blank time select	%00 … %11: Set comparator blank time to 16, 24, 36 or 54 clocks Hint: %10 is recommended for most applications	
14	*chm*	chopper mode	0	Standard mode (spreadCycle)
			1	Constant off time with fast decay time. Fast decay time is also terminated when the negative nominal current is reached. Fast decay is after on time.
13	*rndtf*	random *TOFF* time	0	Chopper off time is fixed as set by *TOFF*
			1	Random mode, *TOFF* is random modulated by d_{NCLK}= -12 … +3 clocks.
12	*disfdcc*	fast decay mode	chm=1: disfdcc=1 disables current comparator usage for termination of the fast decay cycle	
11	*fd3*	*TFD* [3]	chm=1: MSB of fast decay time setting TFD	
10 9 8 7	*hend3* *hend2* *hend1* *hend0*	*HEND* hysteresis low value *OFFSET* sine wave offset	*chm*=0	%0000 … %1111: Hysteresis is -3, -2, -1, 0, 1, …, 12 (1/512 of this setting adds to current setting) This is the hysteresis value which becomes used for the hysteresis chopper.
			chm=1	%0000 … %1111: Offset is -3, -2, -1, 0, 1, …, 12 This is the sine wave offset and 1/512 of the value becomes added to the absolute value of each sine wave entry.
6 5 4	*hstrt2* *hstrt1* *hstrt0*	*HSTRT* hysteresis start value added to *HEND*	*chm*=0	%000 … %111: Add 1, 2, …, 8 to hysteresis low value *HEND* (1/512 of this setting adds to current setting) Attention: Effective *HEND+HSTRT* ≤ 16. Hint: Hysteresis decrement is done each 16 clocks
		TFD [2..0] fast decay time setting	*chm*=1	Fast decay time setting (MSB: *fd3*): %0000 … %1111: Fast decay time setting *TFD* with *NCLK*= 32**HSTRT* (%0000: slow decay only)
3 2 1 0	*toff3* *toff2* *toff1* *toff0*	*TOFF* off time and driver enable	Off time setting controls duration of slow decay phase *NCLK*= 12 + 32**TOFF* %0000: Driver disable, all bridges off %0001: 1 – use only with TBL ≥ 2 %0010 … %1111: 2 … 15	

Table 8.6 Abridgement of CHOPCONF register

8.4.6 Driver Status Information



This dialogue shows all driver error flags of the two motor drivers. The flags are related to the DRV_STATUS register. Blue marked flags are set.

Figure 8.19 Motor driver error flags

0x6F, 0x7F: DRV_STATUS – stallGuard2 value and driver error flags			
Bit	**Name**	**Function**	**Comment**
31	*stst*	standstill indicator	This flag indicates motor stand still.
30	*olb*	open load indicator phase B	1: Open load detected on phase A or B *Hint:* This is just an informative flag. The driver takes no action upon it. False detection may occur in fast motion and standstill. Check during slow motion, only.
29	*ola*	open load indicator phase A	
28	*s2gb*	short to ground indicator phase B	1: Short to GND detected on phase A or B The driver becomes disabled. The flags stay active, until the driver is disabled by software or by the ENN input.
27	*s2ga*	short to ground indicator phase A	
26	*otpw*	overtemperature pre-warning flag	1: Overtemperature pre-warning threshold is exceeded. The overtemperature pre-warning flag is common for both drivers.
25	*ot*	overtemperature flag	1: Overtemperature limit has been reached. Drivers become disabled until *otpw* is also cleared due to cooling down of the IC. The overtemperature flag is common for both drivers.
15	*fsactive*	full step active indicator	1: Indicates that the driver has switched to fullstep as defined by chopper mode settings and velocity thresholds.

Table 8.7 Abridgement of DRV_STATUS register

8.4.7 Microstep Wave Dialogue

The microstep wave dialogue has two tabs, one for motor 1 and the other one for motor 2. Each motor driver of the TMC5062 provides a programmable look-up table for storing the microstep current wave. Per default, the tables are pre-programmed with a sine wave, which is a good starting point for most stepper motors. Reprogramming the table to a motor specific wave allows improved microstepping. In order to minimize required memory and the amount of data to be programmed, only a quarter of the wave becomes stored. The internal microstep table maps the microstep wave from 0° to 90°. It becomes symmetrically extended to 360°.

The microstep wave dialogue for each motor has four input fields (a1, a3, a5, and a7) for amplitude settings. These values are used for the microstep wave calculation. All amplitude values normally should meet the condition a1 ›› a3 ›› a5 ›› a7 within the range 0.00… 1.00. The microstep wave calculation is done via Fourier synthesis.

Please refer to the MOTOR DRIVER REGISTER of the TMC5062 datasheet.

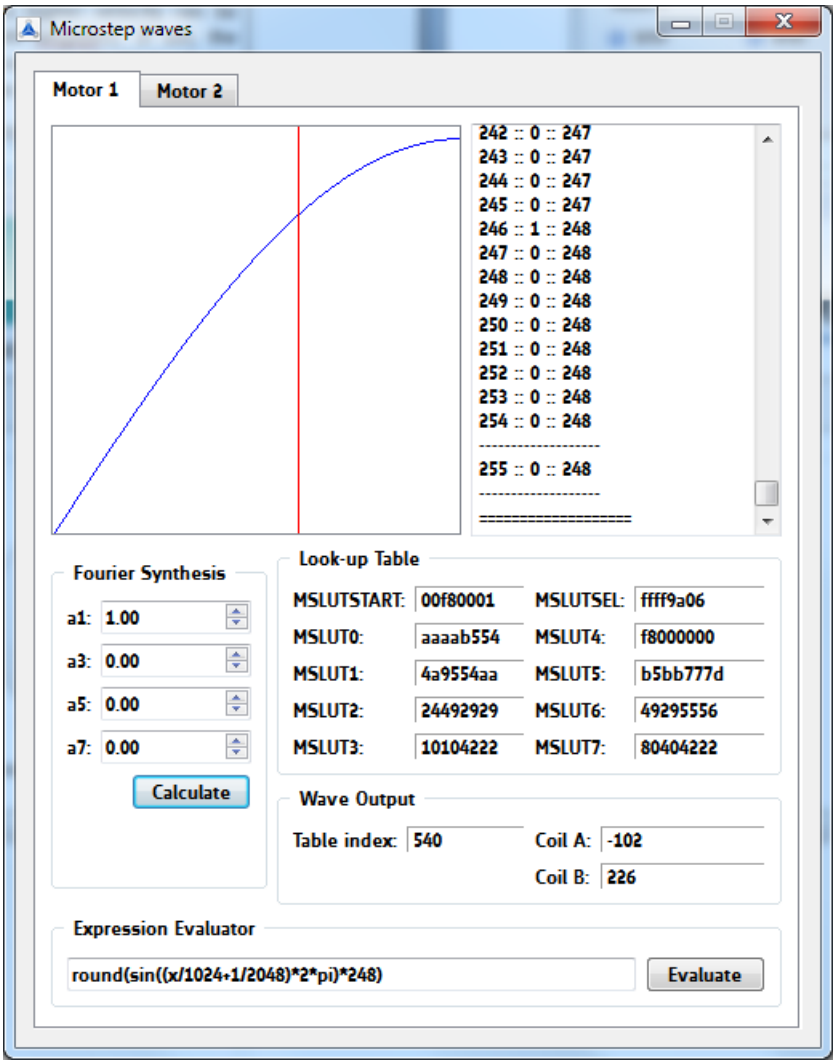


Figure 8.20 Microstep wave dialogue with sin wave (*default setting*)

The formula in the *expression evaluator* can be changed to optimize motor performance. Have a look at the following examples, please.

EXAMPLE 1: TRIANGULAR MICROSTEP CURVE

For a triangular curve, enter the following formula into the *expression evaluator*:

$$round\,\frac{x}{256} \times 248$$

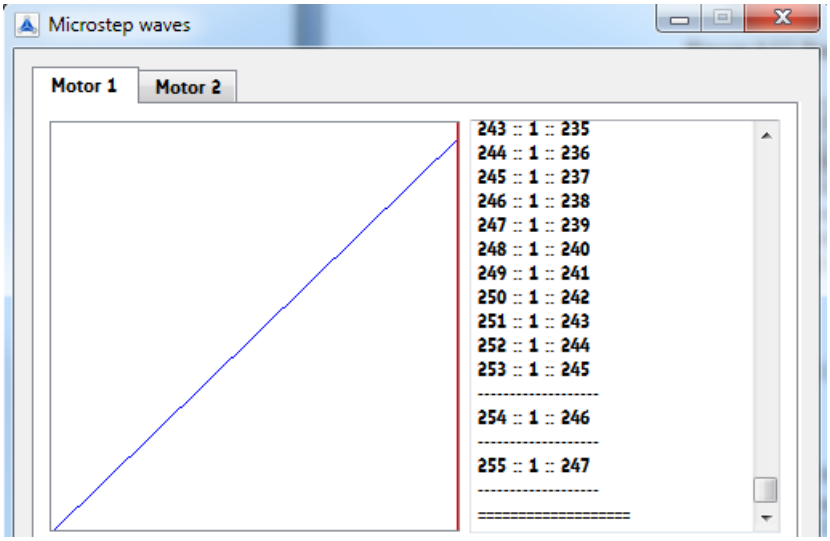


Figure 8.21 Triangular curve

EXAMPLE 2: MICROSTEP WAVE WITH LINEAR SCALED SINE WAVE AMPLITUDE

For a wave with linear scaled sine wave amplitude the following formula may fit:

$$round\left(\sin\left(\left(\frac{x}{1024}+\frac{1}{2048}\right)\times 2\times pi\right)\times\left(240+\left(\frac{256-x}{256}\right)\times 80\right)\right)$$

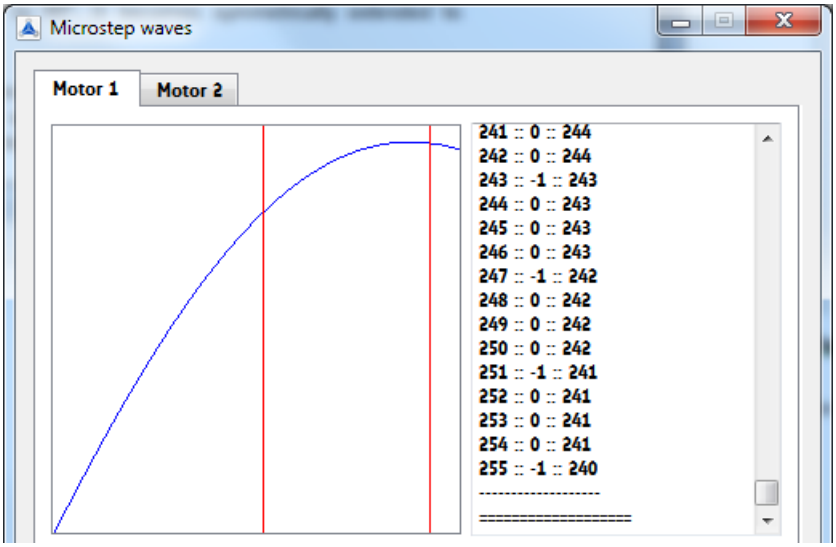


Figure 8.22 Example for microstep wave with linear scaled sine wave amplitude

MOTOR DRIVER REGISTER SET (MOTOR 1: 0X60…0X6F, MOTOR 2: 0X70…0X7F)					
R/W	**Addr**	**n**	***Register***	**Description *I bit names***	**Range [Unit]**
W	0x60 0x70	32	*MSLUT1[0]* *MSLUT2[0]* microstep table entries 0…31	Each bit gives the difference between microstep x and x+1 when combined with the corresponding *MSLUTSEL W* bits: 0: *W*= %00: -1 %01: +0 %10: +1 %11: +2 1: *W*= %00: +0 %01: +1 %10: +2 %11: +3 This is the differential coding for the first quarter of a wave. Start values for *CUR_A* and *CUR_B* are stored for *MSCNT* position 0 in *START_SIN* and *START_SIN90_120*. *ofs31*, *ofs30*, …, *ofs01*, *ofs00* … *ofs255*, *ofs254*, …, *ofs225*, *ofs224*	32x 0 or 1 *reset default= sine wave table*
W	0x61 … 0x67 0x71 … 0x77	7 x 32	*MSLUT1[1…7]* *MSLUT2[1…7]* microstep table entries 32…255		7x 32x 0 or 1 *reset default= sine wave table*
W	0x68 0x78	32	*MSLUTSEL1* *MSLUTSEL2*	This register defines four segments within each quarter *MSLUT* wave. Four 2 bit entries determine the meaning of a 0 and a 1 bit in the corresponding segment of *MSLUT*. *See separate table in TMC5062 datasheet.*	*0<X1<X2<X3* *reset default= sine wave table*
W	0x69 0x79	8 + 8	*MSLUTSTART*	bit 7… 0: *START_SIN* bit 23… 16: *START_SIN90_120* *START_SIN* gives the absolute current at microstep table entry 0. *START_SIN90_120* gives the absolute current for microstep table entry at positions 256. Start values are transferred to the microstep registers *CUR_A* and *CUR_B*, whenever the reference position *MSCNT*=0 is passed.	*START_SIN* *reset default =0* *START_SIN90_120* *reset default =247*

Table 8.8 Abridgement of motor driver register set

Please refer to the TMC5062 datasheet for detailed information about microstep table registers.

8.4.8 Global Configuration Dialogue

This dialogue shows global status flags on the front tab and global settings on the rear tab. These flags and settings are related to the GENERAL CONFIGURATION REGISTERS of the TMC5062. Flags can be pulled continuously or on demand. Blue marked flags are set.

Note that the direction of motor 2 is reversed per default. This way, both motors rotate in the same direction. In hardware, motor 2 is connected mirror-inverted.

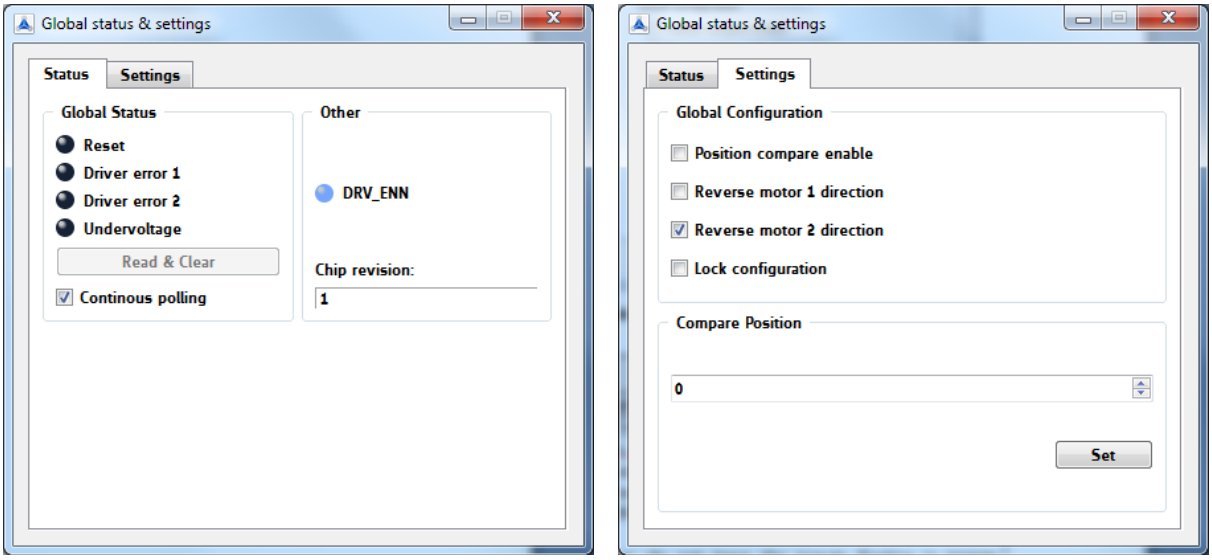


Figure 8.23 Global status tab and global settings tab

GENERAL CONFIGURATION REGISTERS (0X00...0X1F)					
R/W	**Addr**	**n**	***Register***	**Description *I bit names***	
RW	0x00	11	*GCONF*	**Bit**	***GCONF* – Global configuration flags**
				3	*poscmp_enable* 0: Outputs INT and PP are tristated. 1: Position compare pulse (PP) and interrupt output (INT) are available *Attention: do not leave the ouputs floating in tristate condition, provide an external pull-up or set this bit 1.*
				8	*shaft1* 1: Inverse motor 1 direction
				9	*shaft2* 1: Inverse motor 2 direction
				10	*lock_gconf* 1: GCONF is locked against further write access.
R+C	0x01	4	*GSTAT*	**Bit**	***GSTAT* – Global status flags**
				0	*reset* 1: Indicates that the IC has been reset since the last read access to *GSTAT.*
				1	*drv_err1* 1: Indicates, that driver 1 has been shut down due to an error since the last read access.
				2	*drv_err2* *1:* Indicates, that driver 2 has been shut down due to an error since the last read access.
				3	*uv_cp* 1: Indicates an undervoltage on the charge pump. The driver is disabled in this case.

GENERAL CONFIGURATION REGISTERS (0X00…0X1F)				
R/W	**Addr**	**n**	***Register***	**Description / *bit names***
W	0x05	32	*X_COMPARE*	Position comparison register for motor 1 position strobe. Activate *poscmp_enable* to get position pulse on output PP. *XACTUAL = X_COMPARE*: - Output PP becomes high. It returns to a low state, if the positions mismatch.

Table 8.9 Abridgement of general configuration registers

8.4.9 Encoder Dialogue

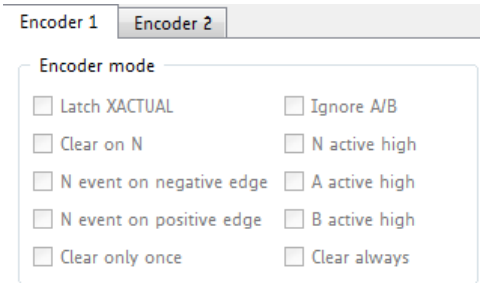
The TMC5062 is equipped with two incremental encoder interfaces for ABN encoders. The encoder inputs are multiplexed with other signals. Therefore, the basic selection of the peripheral configuration is set by the general configuration register *GCONF* of the TMC5062. The use of the N channel is optional, as some applications might use a reference switch or stall detection rather than an encoder N channel for position referencing. The encoders give positions via digital incremental quadrature signals (A and B) and a clear signal (N).

The TMC50xx-EVAL PC software tool provides an encoder dialogue which includes tow tabs, one for each encoder. The tabs are sub-divided into three parts: encoder mode, accumulation constant, and position.

GENERAL CONFIGURATION REGISTERS (0X00…0X1F)					
R/W	**Addr**	**n**	***Register***	**Description / *bit names***	
				Bit	***GCONF* – Global configuration flags**
RW	0x00	11	*GCONF*	3	*poscmp_enable* 0: Encoder 1 A and B inputs are mapped. 1: Position compare pulse (PP) and interrupt output (INT) are available, Encoder 1 is unused.
				4	*enc1_refsel* 0: N channel 1 mapped depending on interface to SWIOP (if SW_SEL=0) or IO0 (if SW_SEL=1). 1: N channel 1 mapped to REFL1.
				5	*enc2_enable* 0: Right reference switches are available. 1: Encoder 2 A and B signals are mapped to REFR1 and REFR2 inputs.
				6	*enc2_refsel* 0: N channel 2 mapped depending on interface to SWION (if SW_SEL=0) or IO1 (if SW_SEL=1). 1: N channel 2 mapped to REFL2.

Table 8.10 Encoder configuration bits of GCONF register

ENCODER MODE AREA



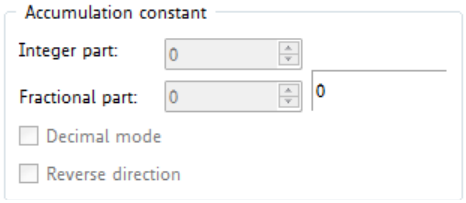
Here, different encoder settings related to the channel polarities and the N event can be chosen. Set a tick to select the feature.

Figure 8.24 Encoder mode selection

0x38, 0x58: ENCMODE – ENCODER REGISTER			
Bit	**Name**	**Comment**	
9	*latch_x_act*	1: Also latch *X_ACTUAL* position together with *X_ENC*. Allows latching the ramp generator position upon an N channel event as selected by *pos_edge* and *neg_edge*.	
8	*clr_enc_x*	0	Upon N event, *X_ENC* becomes latched to *ENC_LATCH* only
		1	Latch and additionally clear encoder counter *X_ENC* at N-event
7	*neg_edge*	***n p***	**N channel event sensitivity**
6	*pos_edge*	0 0	N channel event is active during an active N event level
		0 1	N channel is valid upon active going N event
		1 0	N channel is valid upon inactive going N event
		1 1	N channel is valid upon active going and inactive going N event
5	*clr_once*	1: Clear *X_ENC* on the next N event following the write access	
4	*clr_cont*	1: Always clear *X_ENC* upon an N event (once per revolution)	
3	*ignore_AB*	0	An N event occurs only when polarities given by *pol_N*, *pol_A* and *pol_B* match.
		1	Ignore A and B polarity for N channel event
2	*pol_N*	Defines active polarity of N (0=neg., 1=pos.)	
1	*pol_B*	Required B polarity for an N channel event (0=neg., 1=pos.)	
0	*pol_A*	Required A polarity for an N channel event (0=neg., 1=pos.)	

Table 8.11 ENCMODE register bits for *Encoder mode* selection settings

ACCUMULATION CONSTANT *ENC_CONST*



The encoder constant *ENC_CONST* is added to or subtracted from the encoder counter on each polarity change of the quadrature signals AB of the incremental encoder. Choose this constant and the software displays the integer part and the fractional part of it. The encoder constant *ENC_CONST* represents a signed fixed point number (16.16) to facilitate the generic adaption between motors and encoders.

Figure 8.25 Accumulation constant

In decimal mode, the lower 16 bits represent a number between 0 and 9999. Set a tick at *Decimal mode* to select it. For stepper motors equipped with incremental encoders the fixed number representation allows very comfortable parameterization. Additionally, mechanical gearing can easily be taken into account.

Take care that motor and encoder direction match to each other. Click *Reverse direction* in case the motor direction is inverted.

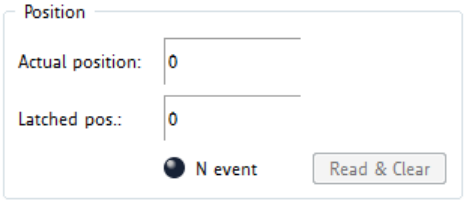
0x38, 0x58: *ENCMODE* – ENCODER REGISTER			
Bit	**Name**	**Comment**	
10	*enc_sel_decimal*	0	Encoder prescaler divisor binary mode: Counts *ENC_CONST(fractional part)* /65536
		1	Encoder prescaler divisor decimal mode: Counts in *ENC_CONST(fractional part)* /10000

Table 8.12 *enc_sel_decimal* bit

ENCODER REGISTER SET (MOTOR 1: 0X38...0X3C, MOTOR 2: 0X58...0X5C)					
R/W	**Addr**	**n**	***Register***	**Description *I bit names***	**Range [Unit]**
W	0x3A 0x5A	32	*ENC_CONST*	Accumulation constant (signed) 16 bit integer part, 16 bit fractional part *X_ENC* accumulates *+/- ENC_CONST I* (2^16**X_ENC*) (binary) or *+/-ENC_CONST I* (10^4**X_ENC*) (decimal)	binary: ± [µsteps/2^16] ±(0 ... 32767.9999847) decimal: ±(0 ... 32767.9999) *reset default = 1.0 (=65536)*

Table 8.13 *ENC_CONST*

POSITION



The encoder counter *X_ENC* holds the current encoder position ready for read out. The status flag for N event detection can be read out and cleared.

Figure 8.26 Position field

ENCODER REGISTER SET (MOTOR 1: 0X38...0X3C, MOTOR 2: 0X58...0X5C)					
R/W	**Addr**	**n**	***Register***	**Description *I bit names***	**Range [Unit]**
RW	0x39 0x59	32	*X_ENC*	Actual encoder position (signed)	-2^31... +(2^31)-1
R+C	0x3B 0x5B	1	*ENC_STATUS*	bit 0: *n_event* 1: Encoder N event detected. Status bit is cleared on read: Read (R) + clear (C) This bit is ORed to the *interrupt output* signal.	
R	0x3C 0x5C	32	*ENC_LATCH*	Encoder position *X_ENC* latched on N event	

Table 8.14 *X_ENC*, *ENC_LATCH*, AND *ENC_STATUS*

8.4.10 All Registers Dialogue

This dialogue shows all registers, which can be set and/or read out with the TMC50xx-EVAL software tool. Addresses, register names and actual values can be read. New values can be written in the specific data input fields. To copy an actual value into a new value field just double-click the actual value. New values can be changed on the fly while the motor is still rotating.

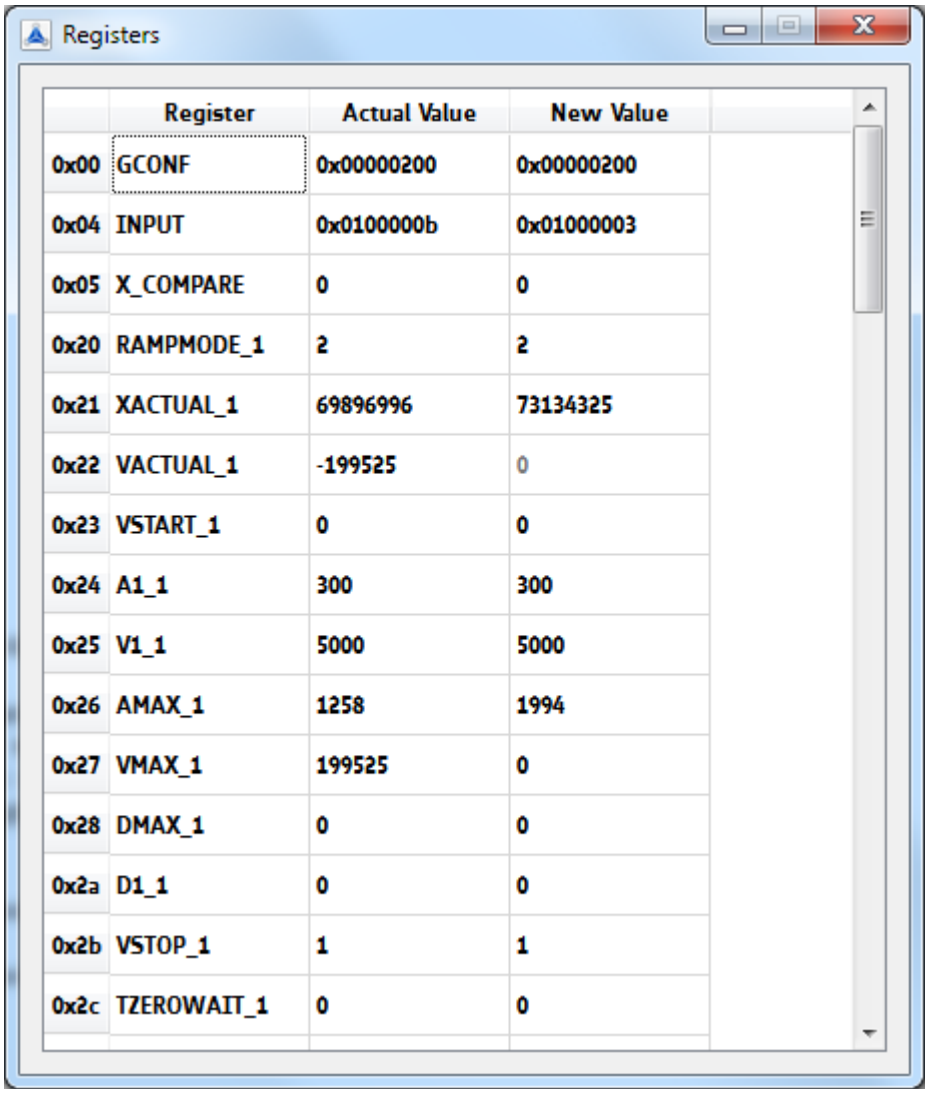


Figure 8.27 All registers dialogue

9 Life Support Policy

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.

10 Revision History

10.1 Firmware Revision

Version	Date	Author	Description
1.0.0.3	2014-FEB-21	OK, MJ, TE	Initial version for TMC5062-EVAL

Table 10.1: Firmware revision

10.2 Document Revision

Version	Date	Author SD – Sonja Dwersteg	Description
0.93	2014-MAY-13	SD	Initial version
1.00	2014-AUG-12	JP	Order Codes changed

Table 10.2 Document revision

11 References

[TMC5062-LA] TMC5062-LA Datasheet (please refer to http://www.trinamic.com)