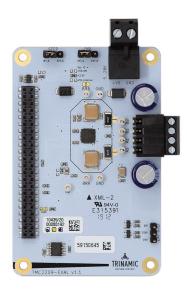
# TMC2209-EVAL Evaluation Board

Document Revision V1.0 • 2019-MAY-08

The TMC2209-EVAL allows evaluation of the TMC2209 in combination with the TRINAMIC evaluation board system, or as stand-alone-board. It uses the standard schematic and offers several options in order to test different modes of operation.



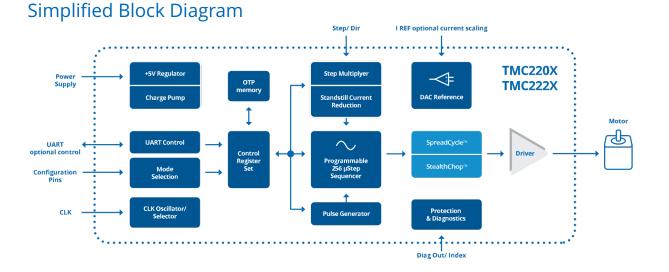
## **Features**

- 2-phase stepper motor up to 1.7A coil current (2.4A peak)
- Supply Voltage 5...28V DC
- UART
- 1...256 microsteps
- Step/Dir interface
- StealthChop<sup>™</sup> silent PWM mode
- **SpreadCycle**<sup>™</sup> smart mixed decay

## **Applications**

- Compatible Design Upgrade
- Office and home automation
- ATM, Cash recycler

- 3D Printers
- Printers, POS
- Textile, Sewing Machines
  - CCTV, Security
- HVAC





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# **1 Getting Started**

## You need

- TMC2209-EVAL
- Landungsbruecke with latest firmware. (The Startrampe does not support the UART interface.)
- Eselsbruecke bridge board
- Stepper motor (e.g. QMot line)
- USB interface
- Power Supply
- Latest TMCL-IDE V3.0 and PC
- Cables for interface, motors and power

## Precautions

- Do not mix up connections or short-circuit pins.
- Avoid bundling I/O wires with motor wires.
- Do not exceed the maximum rated supply supply voltage!
- Do not connect or disconnect the motor while powered!
- START WITH POWER SUPPLY OFF!

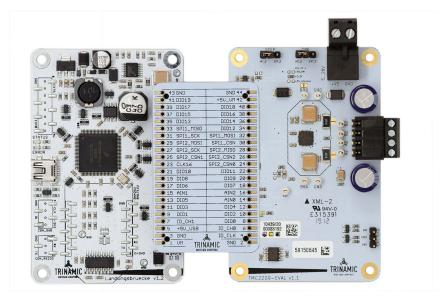


Figure 1: Getting started





#### **1.1 First Start-Up**

- 1. Make sure that the latest version of the TMCL-IDE 3.0 is installed. The TMCL-IDE can be downloaded from www.trinamic.com/support/software/tmcl-ide/.
- Open the TMCL-IDE and connect the Landungsbruecke or Startrampe via USB to the computer. For Windows 8 and higher is no driver needed, on Windows 7 machines the TMCL-IDE is installing the driver automatically.
- 3. Verify that the Landungsbruecke or Startrampe is using the latest firmware version. The firmware version is shown in the connected device tree.

🚴 TMCL-IDE 3.0				
<u>File T</u> ools <u>O</u> ptions Views <u>H</u> elp				
Connected devices ×				
Device				
V 🛶 USB				
🗸 🏹 COM6: USB port				
🗸 🌰 ID1: Landungsbruecke [V 3.01]				
🕛 Direct mode				

Figure 2: Firmware Version

- 4. The TMCL-IDE 3.0 needs room to show all important information and to provide a good overview. Therefore, arrange the main window related to your needs. We recommend using full screen. For evaluation boards it is essential to have access to the registers. Therefore open up the Register Browser (left side). For a better view click top right on the normal icon to get a maximized register browser window.
- 5. The TMCL-IDE includes a dialogue for diagnostic tasks. Further, the dialogue provides an overview of the connected motion controller and driver chips. A window pops up immediately after connecting the evaluation kit the first time. The window shows the actual status of the connections. The second tab of the dialogue offers the possibility to choose basic settings or to reset the module to factory defaults.

-	: VC1-Id 1	📥 Landungsbruecke : VC1-Id 1 🔤
Board Assignment	Settings	Board Assignment Settings
Automated board	detection	Reset
	tomated detection of connected boards. Please ion board firmware up to date.	You can reset the board settings to defaults here. Form most Trinamic chips It's a matter of firmware to restore defaults.
Scanning.	Scan	Please note that the default settings are not neccessarily the chip reset settings. The default
		O Motion controller board only
Manual board ass	ignment	Power driver board only     Reset boards to defaults
	boards manually. This is only recommended if ction fails somehow. Please keep the evaluation	Both
board firmware u	up to date. Choosing a wrong combination nexpected behaviour.	Driver Enable
Motion controlle	er Driver	Please disable drivers before plug/unplug a motor to a driver board. Otherwhise the driver may be damaged!
none	a none a	Enable drivers
Diagnostics		Diagnostics
	to be fine. Have Fun!	Diagnostics Everything seems to be fine. <b>Have Fun!</b>
	to be fine. Have Fun!	
Everything seems t	to be fine. Have Fun!	Everything seems to be fine. Have Fun!
Everything seems t		Everything seems to be fine. Have Funt
Everything seems t	0.0V on Controller): none	Everything seems to be fine. Have Funt Information Motor Supply: 0.0V

Figure 3: Landungsbruecke Dialogue



## 2 Hardware Information

All design files for our evaluation boards are available for free. We offer the original ECAD files (Eagle, Altium, or PADS), Gerber data, the BOM, and PDF copies. Please check schematics for Jumper settings and input/output connector description.

The files can be downloaded from the evaluation boards' website directly at out homepage: TRINAMIC Eval Kit homepage.

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

#### 2.1 Onboard Jumpers

The TMC2209-Eval board has two jumpers to select between Step/Direction source between MCU and external pin header (lower right corner).



## 3 Evaluation Features in the TMCL-IDE

This chapter gives some hints and tips on using the functionality of the TMCL-IDE, e.g. how to use the velocity mode or using the wizards.

**Note** In order to achieve good settings please refer to descriptions and flowcharts in the TMC2209-LA datasheet. The register browser of the TMCL-IDE provides helpful information about any currently selected parameter. Beyond that, the datasheet explains concepts and ideas which are essential for understanding how the registers are linked together and which setting will fit for which kind of application. For getting more familiar with the evaluation kit in the beginning of your examinations, drive the motor using velocity mode and/or positioning mode first. Beyond this, the direct mode function can be used. This way, TMCL commands can be sent to the evaluation board system.

### 3.1 Velocity Mode

To move the motor in velocity mode, open the velocity mode tool by clicking the appropriate entry in the tool tree. In the velocity mode tool you can enter the desired velocity and acceleration and then move the motor using the arrow buttons. The motor can be stopped at any time by clicking the stop button. Open the velocity graph tool to get a graphical view of the actual velocity.

Note

In order to get a more accurate graphical velocity view, close the register browser window when using the velocity graph.

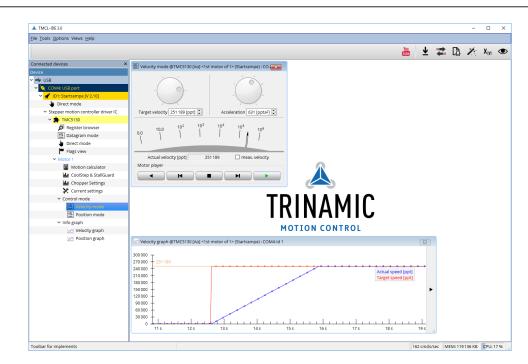


Figure 4: Driving the motor in velocity mode (TMCL-IDE provides similar view for TMC2209-EVAL)



### 3.2 **Position Mode**

To move the motor in position mode, open the position mode tool by clicking the appropriate entry in the tool tree. In the position mode tool you can enter a target position and then start positioning by clicking the Absolute or Relative Move button. The speed and acceleration used for positioning can also be adjusted here.

Open the position graph tool to get a graphical view of the actual position.

*Note* In order to get a more accurate graphical position view, close the register browser window when using the position graph.

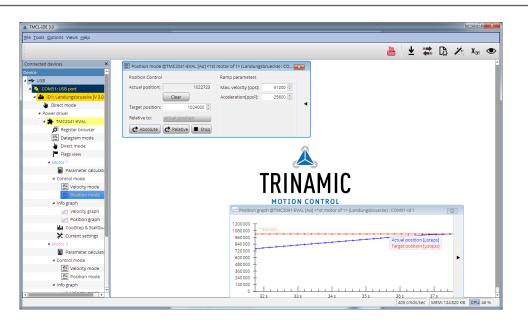


Figure 5: Driving the motor in position mode (TMCL-IDE provides similar view for TMC2209-EVAL)



### 3.3 StallGuard2<sup>™</sup> Tuning

To tune StallGuard2<sup>™</sup> properly you need to set the current for the motor first, e.g. 1A RMS. After that you specify the velocity to run the motor with. This could be 75 rpm as in this example. You can use the TMCL IDE to calculate the velocity with the "Parameter calculator" tool shown in the list on the left when connecting the board.

Parameter calculator @TMC26x : COM24-Id 1				
TMCL axis parameters		Motor parameters		
Velocity [pps]:	64000 🗘			
Acceleration [pps]:	65535 🜲	Full steps / rev.:	200 🗘	
Microsteps: 8 (2)	56x) 🔸			
Physical units				
Fullstep Frequency [pps]:	250.00000 ≑	Acceleration fullsteps [pps <sup>2</sup> ]:	255.99609 🖨	
Revolutions per sec.:	1.25000 🜲	Acceleration [RPS <sup>2</sup> ]:	1.27998 🜲	
Revolutions per minute:	75.00000 🔹	Acceleration [RPM/S]:	76.79883 🗘	
Time to reach velocity [s]:	0.97658			
Fullsteps to reach velocity:	122.07218			
Microsteps to reach velocity:	31250.47684			

Figure 6: TMCL IDE v3.0.20.0 Parameter calculator

In the TMCL IDE you can use the CoolStep<sup>™</sup> & StallGuard2<sup>™</sup> graph where the StallGuard2<sup>™</sup>value is shown in blue. There are two parameters that need tuning for proper StallGuard2<sup>™</sup> use. StallGuard2<sup>™</sup> Threshold (SGT), will need to be tuned by raising or lowering the SGT value. The goal of SGT it so have it hit 0 before a stall occurs. If the SGT is too high, a step loss will occur and you need to lower it. In the picture you see two regions. In the first region the SGT value was too high. It was set to 10 and with loading the motor you can see the value does not reach 0. In the second region the SGT value was set to 4 which results in hitting the 0 axis just short before the motor stalls.

actual motor current vs. time: 17 stallGuard value vs. time: 160 velocity: 65 535	32 10) 30 56 28 59 26 53 24 75 24 75
Region 1	Region 2 22 702
stallGuard2 coolStep TMCL	V V V V V V V V V V V V V V V V V V V
Filter enable	Run current: 17 [031] 💂
stall guard threshold:	Standby current: 5 [031] 🖨
stall velocity threshold: 0 [pps] 🗘	
Restart motor:	

Figure 7: CoolStep™ & StallGuard2™ window

With optimal StallGuard2<sup>™</sup> settings you can optionally activate CoolStep<sup>™</sup>.



## 3.4 CoolStep<sup>™</sup> Tuning

With the TMCL IDE and the EVAL-KIT you have a powerful tool to find your CoolStep<sup>™</sup> to run your motor most energy efficient and cool. To tune it, please open the CoolStep<sup>™</sup> & StallGuard2<sup>™</sup> window you'll find on the left of the IDE when you have connected the EVAL board. On the CoolStep<sup>™</sup> tab you will see below picture by default.

Lead CoolStep & StallGuard @TMC26x [Aα] <1st motor of 1> (Landungsbruecke) : COM24-Id 1										
coolStep & stallGuard           actual motor current vs. time: 17         30 960           stallGuard value vs. time: 160         28 986           valorite 65 525         26 882										
						velocity: 65 535 26 832 22 768 22 704 20 640 18 576				
			12 10	320						
2 64										
[			2	128 64						
			2	128						
			2	128 64						
stallGuard2 coolSt			2	128 64						
		Threshold speed:	2	128 64						
stallGuard2 cool51 Current minimum:	tep TMCL	Threshold speed:	0 [pps] ÷	128 64						
stallGuard2 coolSt	tep TMCL	,	2	128 64						
stallGuard2 cool51 Current minimum:	tep TMCL	Threshold speed: Deactivation threshold speed:	0 (pps) 🜩	128 64						
stallGuard2 cool51 Current minimum: Current down step:	tep TMCL 0 - 1/2 + 0 - slow +	Threshold speed:	0 [pps] ÷	128 64						
stallGuard2 coolSt Current minimum: Current down step: Current up step:	tep TMCL 0 - 1/2 + 0 - slow + 0 - tiny +	Threshold speed: Deactivation threshold speed:	0 (pps) 🜩	128 64						

Figure 8: TMCL IDE v3.0.20.0 Parameter calculator

CoolStep™ will get activated as soon as you change the "Hysteresis start" value higher than 0 and enter a "Threshold speed" value higher than 0.



actual motor current	t vs. time: 11		32 102
stallGuard value vs. t	ime: 192		30 960 28 896
velocity: 65 535			26 832 24 768 22 704
			22 704 20 640 18 576
			16 512
			L 12 384 10 320
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		──┌──
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
stallGuard2 coolS			
stallGuard2 coolS		Threshold speed:	u 1 <sub>0</sub> 0
stallGuard2 coolS Current minimum:	tep TMCL	r	200 [pps] 🐳
stallGuard2 coolS Current minimum:	itep TMCL	r	u 1 <sub>0</sub> 0
stallGuard2 coolS Current minimum: Current down step:	tep TMCL	Threshold speed: Deactivation threshold speed:	200 [pps] ÷
	tep TMCL 0-1/2 + 0-slow +	Threshold speed:	200 [pps] 🐳

Figure 9: CoolStep™ & StallGuard2™ window

The above values activate CoolStep<sup>™</sup> but the values can be fine tuned to make CoolStep<sup>™</sup> work reliable and in a way as you need it in your application. For that it is important to understand what each setting is doing.

- **Current minimum**: The current minimum setting will be the lowest current when CoolStep<sup>™</sup> is activated. With 1A RMS the current will either be reduced to a quarter or to the half of this current when no or less force is applied to the motor shaft.
- **Current down step**: Current down steps defines the speed of the current to drop down after load gets released from the motor shaft.
- **Current up step**: This setting defines the step height when hitting the lower StallGuard2<sup>™</sup> threshold (Hysteresis start).
- Hysteresis width: This setting defines the area of the StallGuard2<sup>™</sup> threshold (Hysteresis end).
- **Hysteresis start**: This setting defines the switching point, related to the StallGuard2<sup>™</sup> value, to boost up the current by one step.



# 4 Revision History

### 4.1 Document Revision

Version	Date	Author	Description
1.0	2019-MAY-08	ОМ	Initial release.

Table 1: Document Revision

