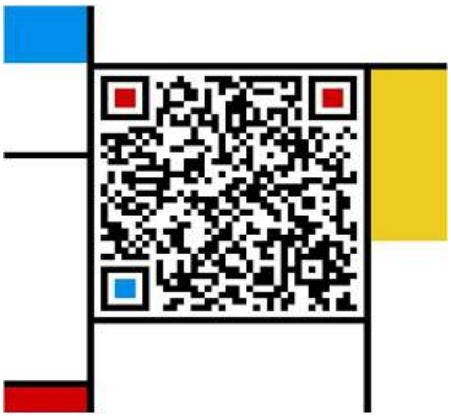
V1.0 版本

TRINAMIC 芯片快速使用指导

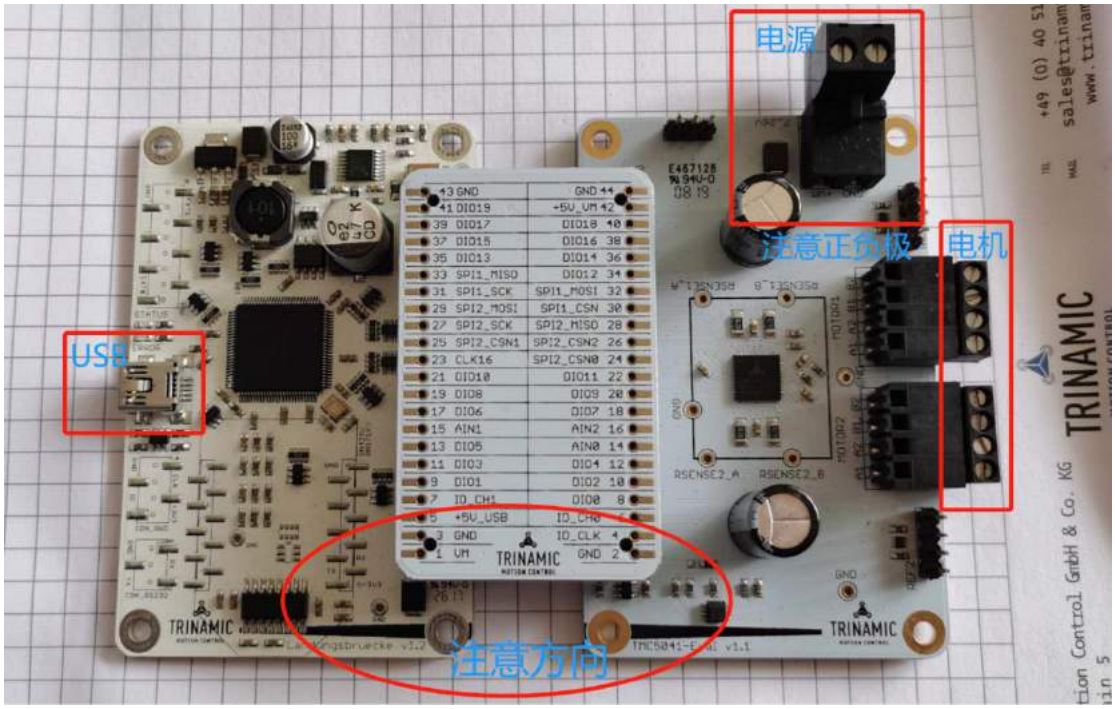


目　　录

一：硬件准备

1. 请将 MCU 板，转接板和 TMC5041-EVAL 按照下图装配一起，请注意方向
2. 将电机线，USB 线接好
3. 正确连接电源线，确认好正负极，电源接反会烧坏开发板

上电之后 MCU 板显示闪烁绿灯。

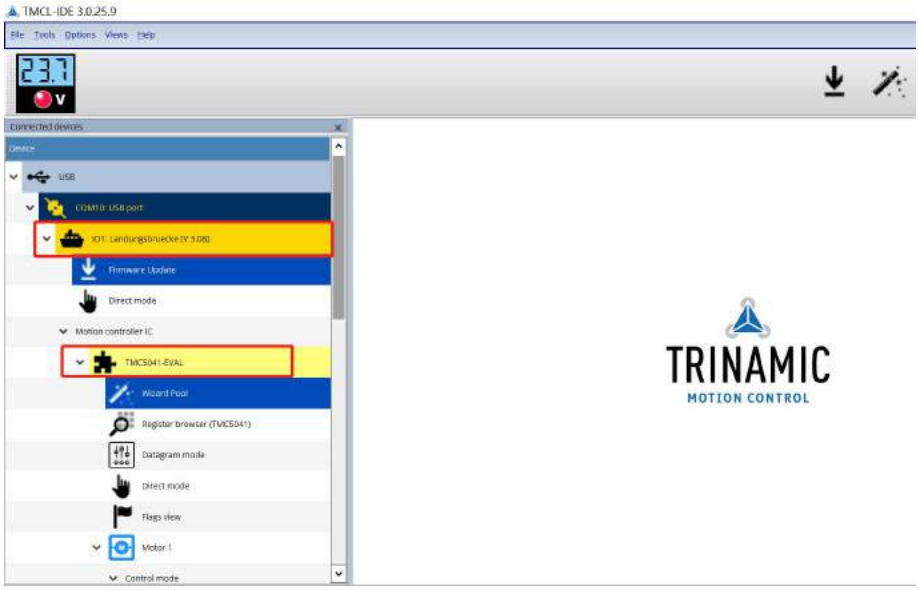


二：**TMCL-IDE 软件**

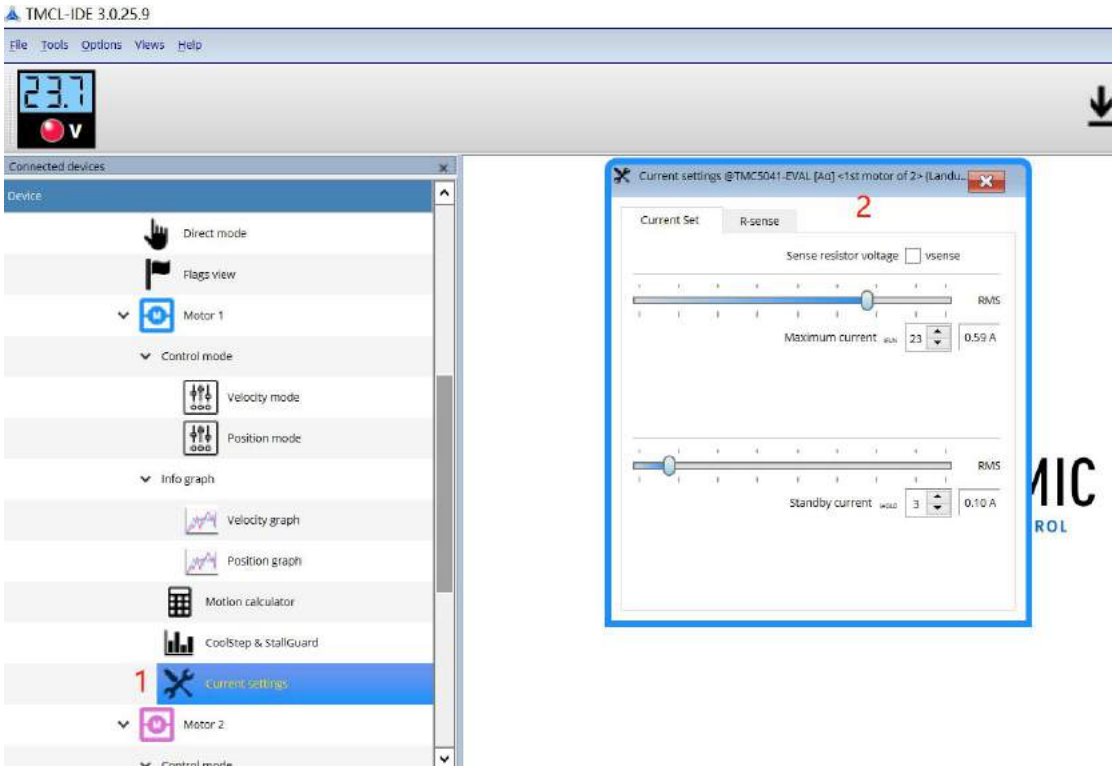
安装 TMCL-IDE 软件，软件下载链接

https://www.trinamic.com/support/software/tmcl-ide/

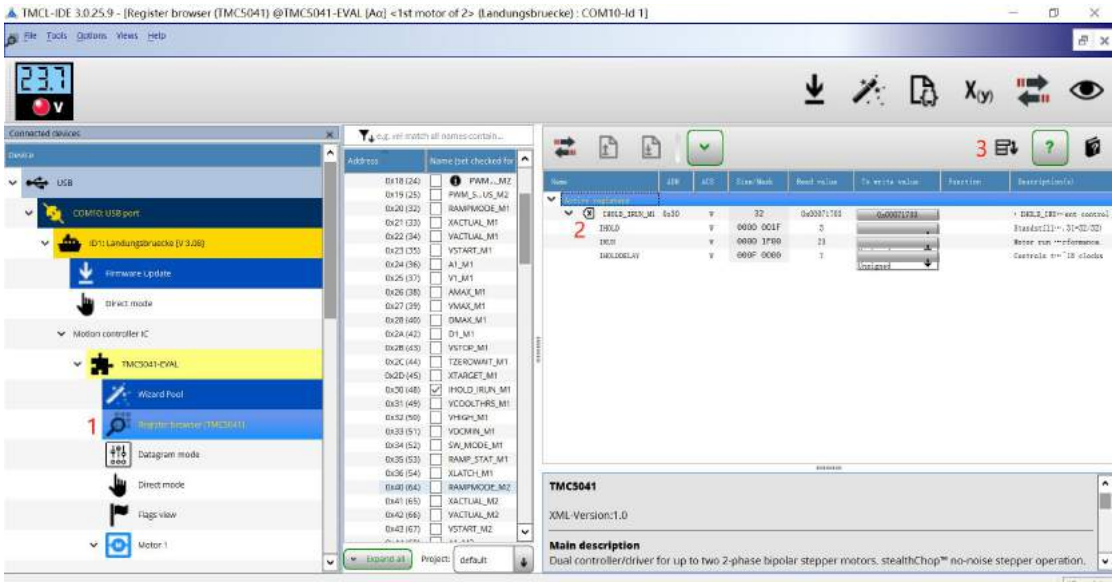
1. 开发板的 USB 驱动会自动安装，打开 TMCL-IDE 软件后会自动识别所连接的型号，如下



2. **设置运行电流和静止电流**，根据电机的电流设置运行电流 Maximum Current 和静止电流 Standby Current 如下图



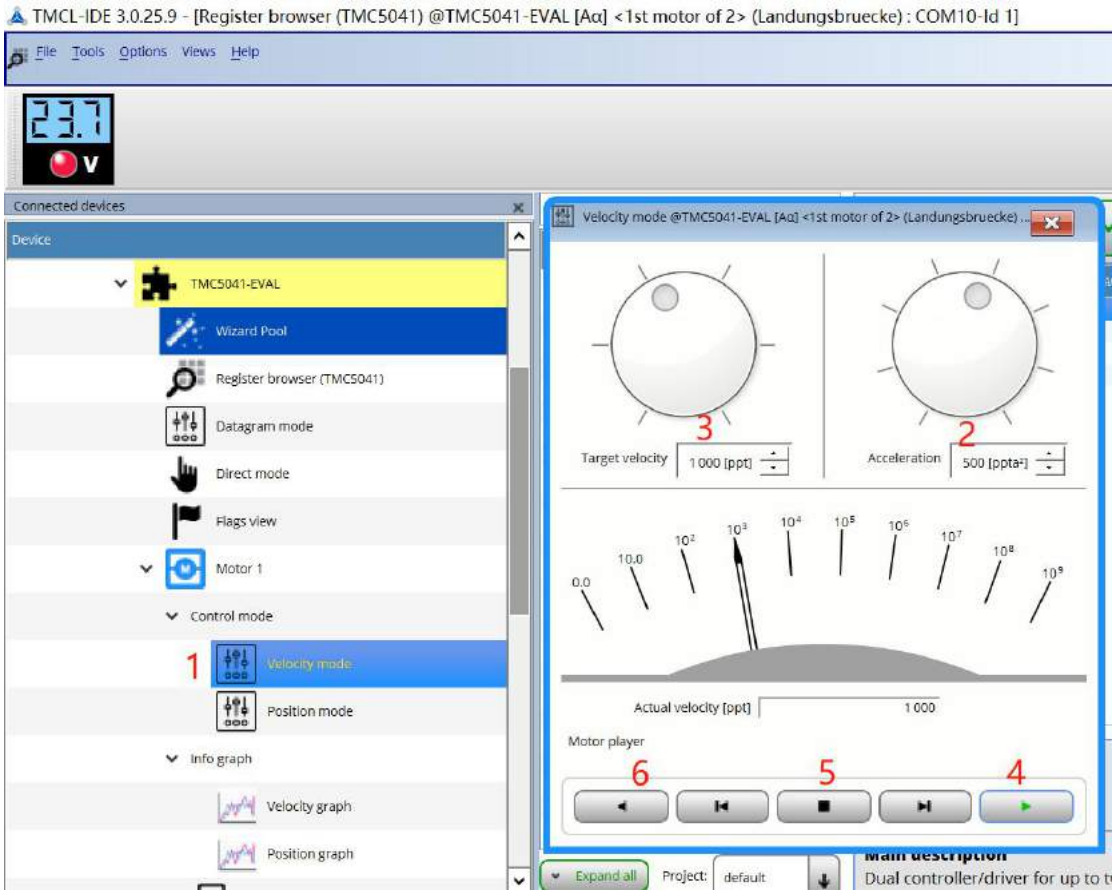
设置电流的寄存器 0x30：按照下图 1-2-3 完成电流设置。



以上二者操作其中一个即可完成配置，建议两者配合方便熟悉寄存器。

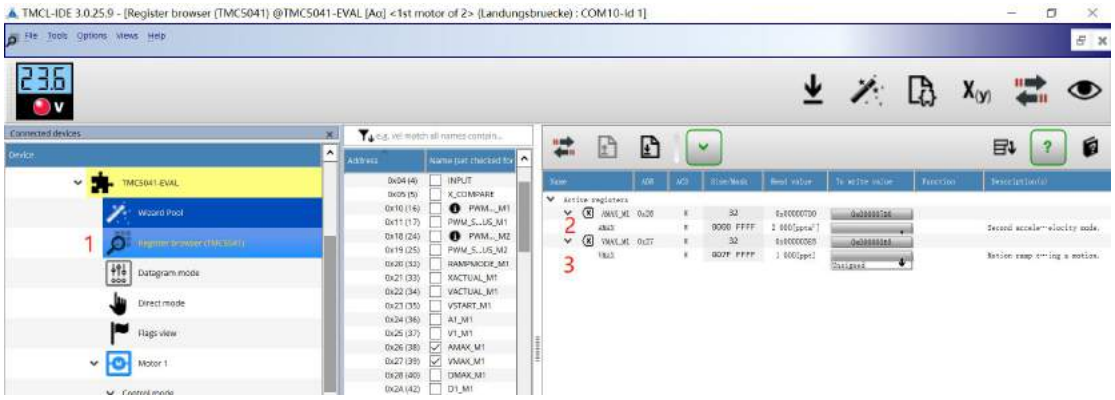
3. 控制电机运行-速度模式

- 在 Control mode 中快速操作，按照以下步骤 1-2-3-4-5，设置最大加速度和最大速度，方向。



- 如下为在寄存器中配置速度模式

配置加速度寄存器 0x26 :AMAX ;最大速度寄存器 0x27: Vmax

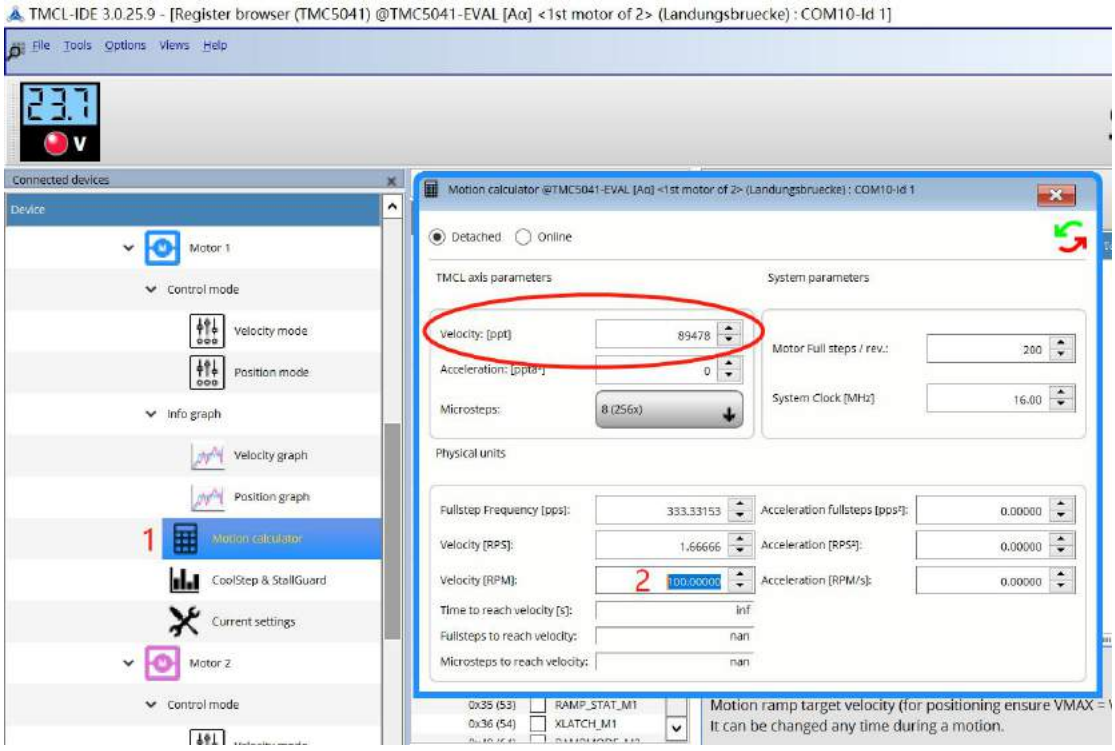


- 换算实际速度快速方法

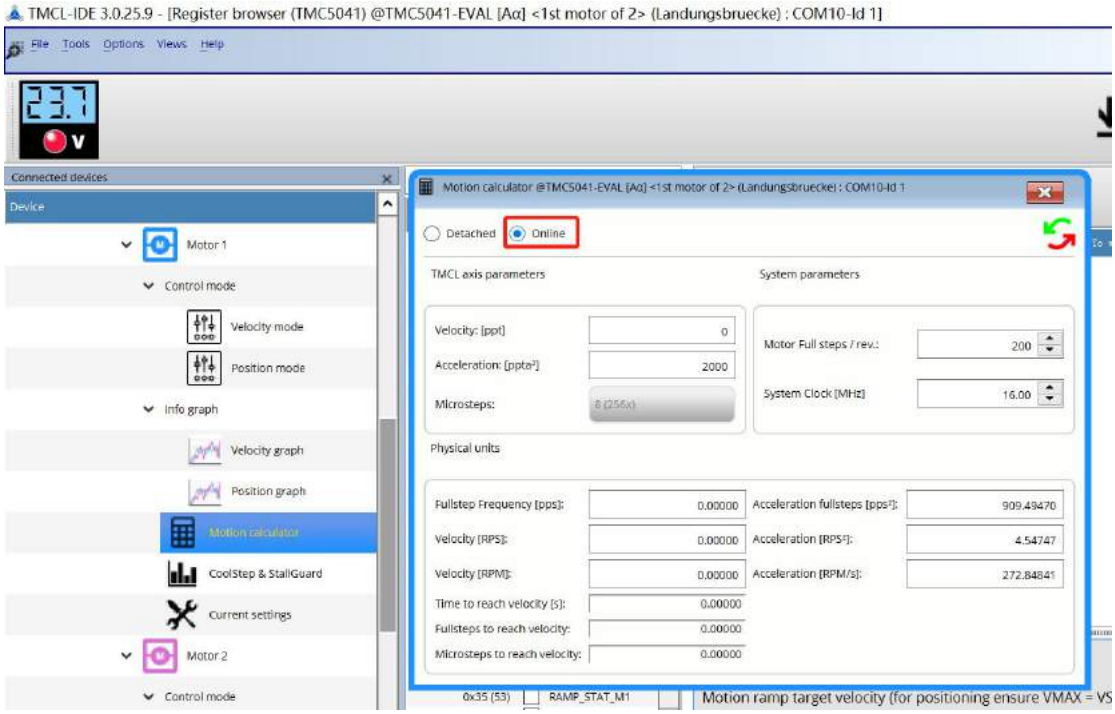
单击

选择细分

可以从上面的 TMCL Axis Parameters 的配置推导到下面的实际速度 Physical units 也可以在 Physic unitss 设置实际目标速度推到上上面的速度和加速度配置，然后将推导出来的设置设到最大速度或加速度寄存器里面

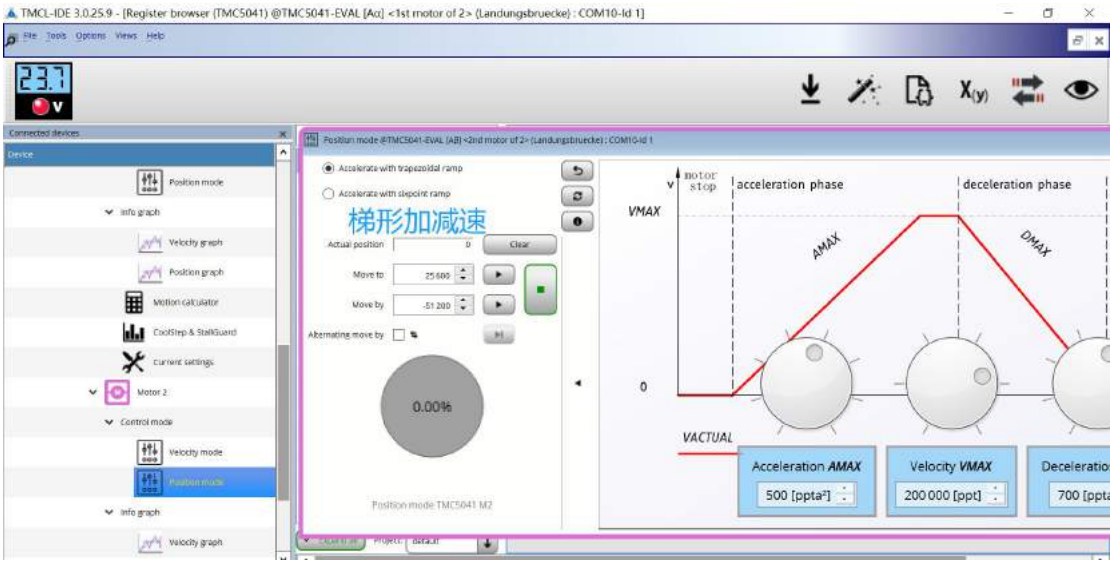


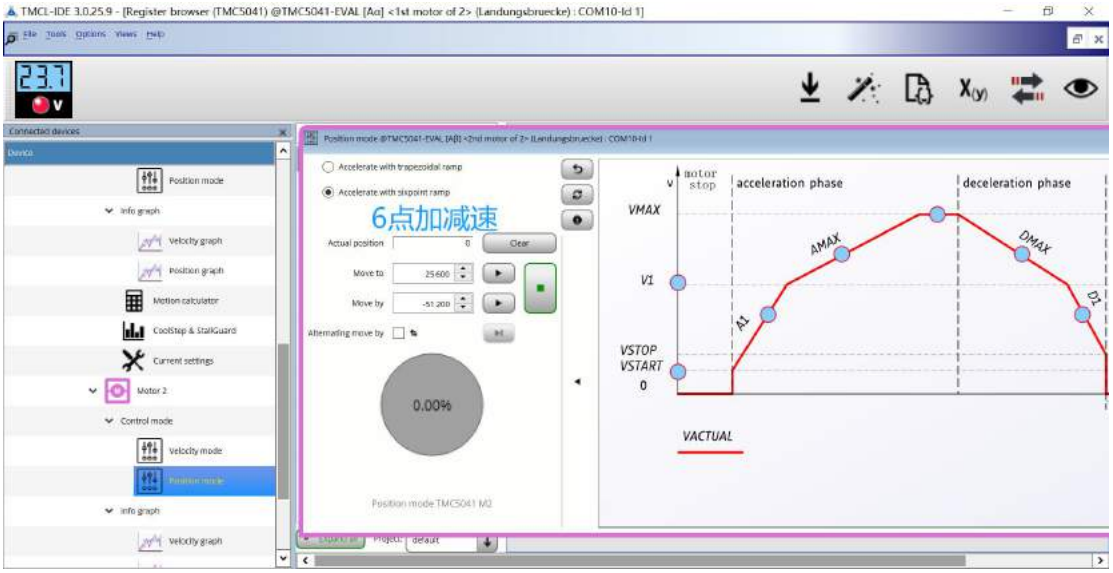
当选择了 Online 之后，会在电机运行过程中实时显示速度



4. 控制电机运行-位置模式

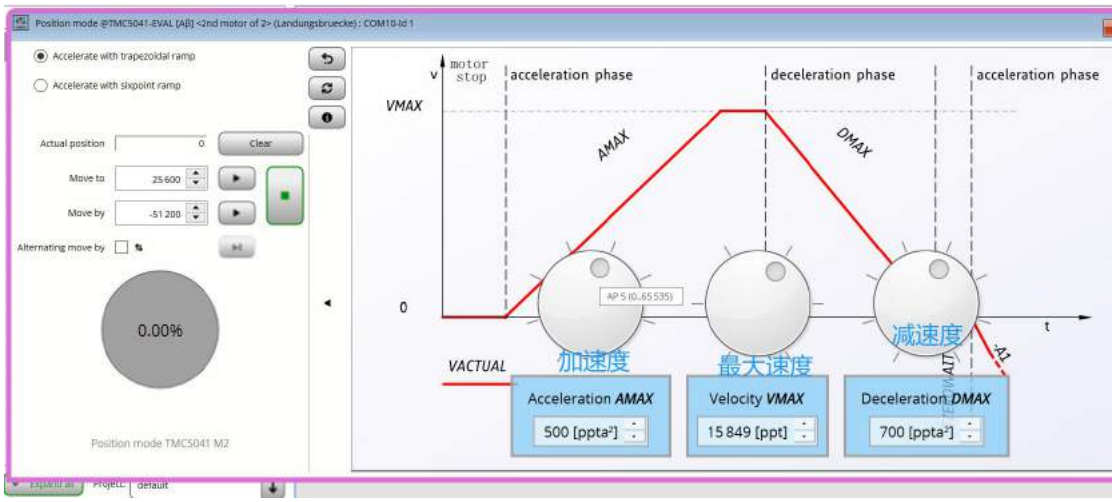
TRINAMIC 的带有运动控制的芯片如 TMC5041/5072/5130/5160/5161…..在位置模式中有 2 种轨迹曲线 梯形加减速和 Six Point 六点加减速





- **快速配置梯形加减速：**

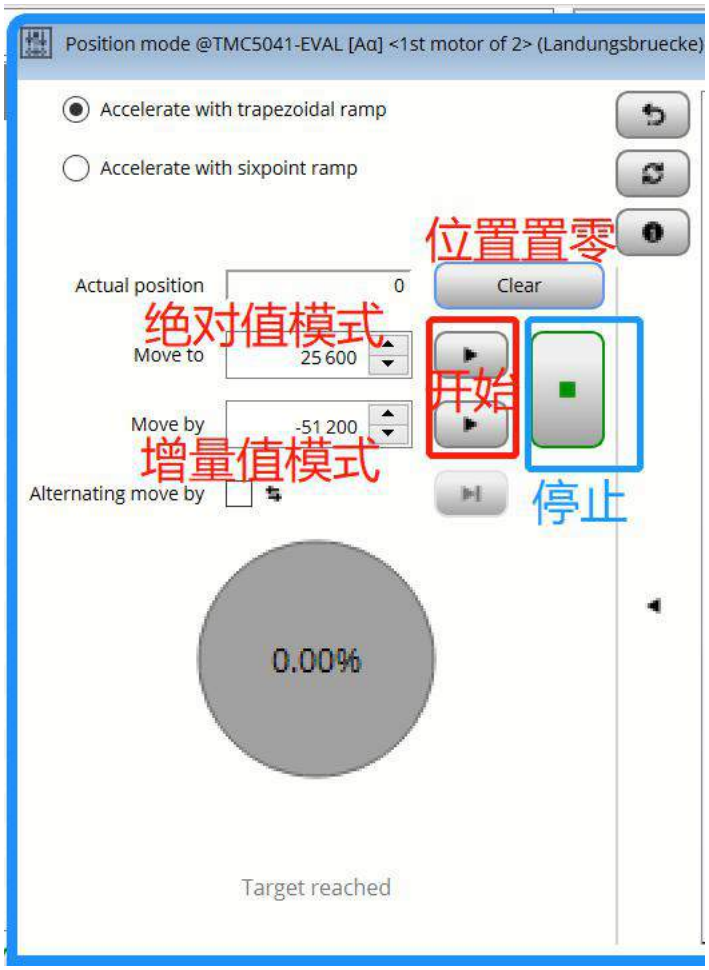
通过手动选择最大速度，加速度和减速度，如下



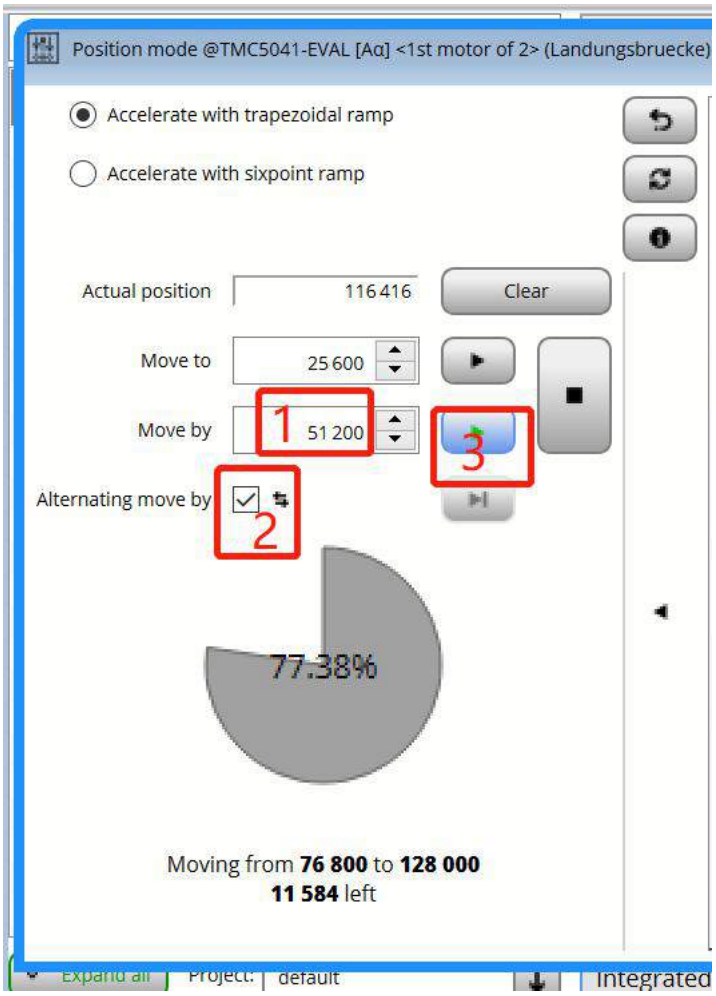
通过左侧设置目标位置

Move to：绝对值位置模式　后面的数值相对零点来运行

Move By:增量位置模式，后面的所在位置的起点相对于上一个位置结束点来说



如果选择以下 1-2-3 配置后电机会来回重复运行。



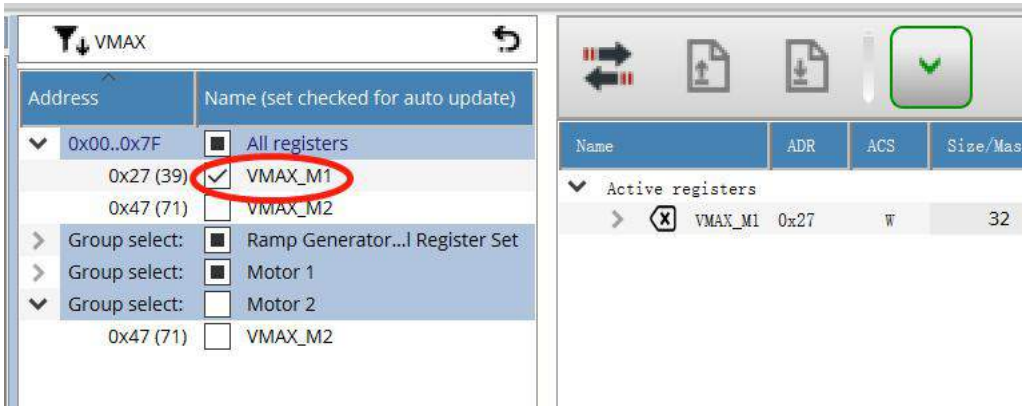
- **在寄存器中配置梯形加减速：**

在寄存中找到最大速度 Vmax,加速度 AMAX 和 DMAX

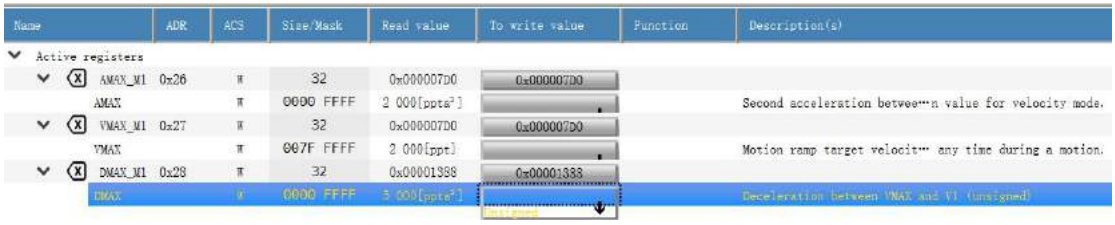
VMAX:0x27; 加速度 AMAX:0x26;减速度 DMAX:0x28

可以在下图中快速搜索，将搜索的想要配置的寄存器前面选择上✓


TMCL-IDE 3.0.25.9 - [Register browser (TMC5041) @TMC5041-EVAL [Aα] <1st moto
File Tools Options Views Help
在此输入搜索
Connected devices
VMAX
Regist...C5041)
Datagram mode
Direct mode
Flags view
Motor 1
Control mode
Vel...ode
Po...de
Info graph
Address
Name (set checked for auto update)
0x00..0x7F All registers
0x27 (39) VMAX_M1
0x47 (71) VMAX_M2
Group select: Ramp Generator...l Register Set
Group select: Motor 1
Group select: Motor 2
0x47 (71) VMAX_M2

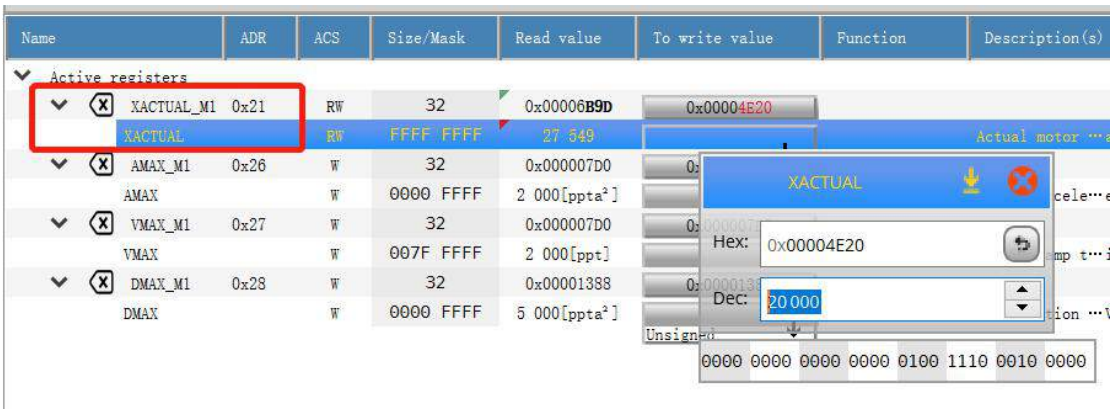

VMAX
Address
Name (set checked for auto update)
0x00..0x7F All registers
0x27 (39) VMAX_M1
0x47 (71) VMAX_M2
Group select: Ramp Generator...l Register Set
Group select: Motor 1
Group select: Motor 2
0x47 (71) VMAX_M2
Name
ADR
ACS
Size/Mas
Active registers
VMAX_M1 0x27 W 32

VMAX:0x27; 加速度 AMAX:0x26;减速度 DMAX:0x28



设置完上述的速度，加减速之后，在目标位置寄存器设置目标位置之后电机就会按照上述的速度和加减速运行到目标位置，

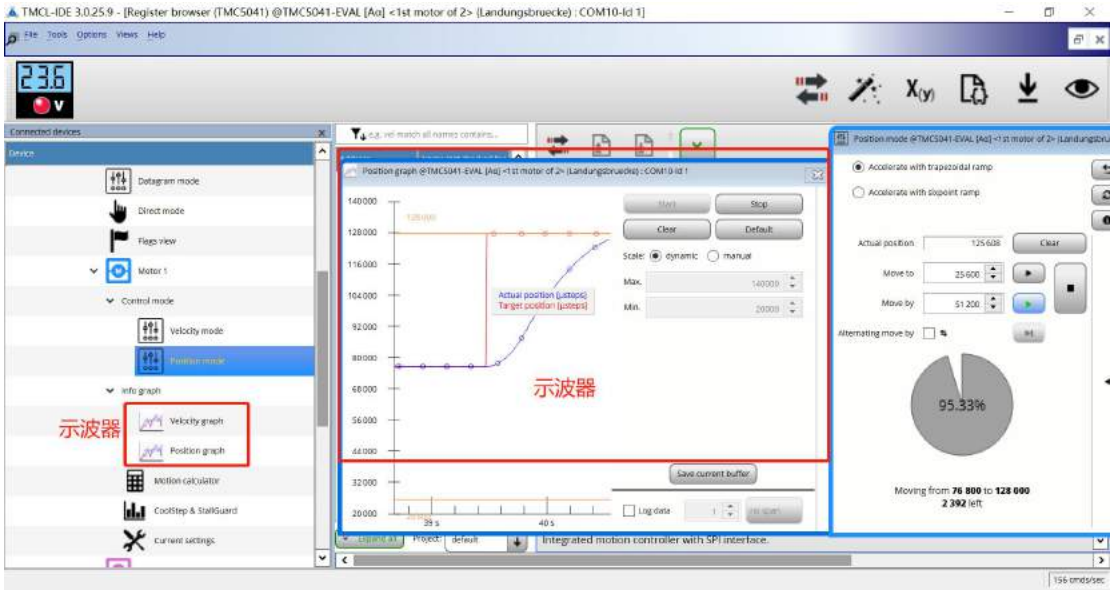
目标位置寄存器是 XACTUAL 0x21



以上介绍了梯形加减速的位置控制的 2 种配置模式，对于 Six Point 加减速曲线模式方法一样，在这里就不多叙述。

5. 示波器功能：

在左侧的 Info graph 中打开示波器功能，可以实时显示电机的速度或者位置，而且可以将数值导出。



6. 不同斩波模式的切换

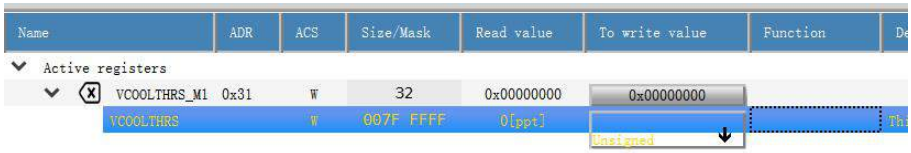
TMC 的芯片会有三种斩波模式低速 Stealthchop,中速 Spreadcycle(适应 Coolstep)和高速模式(High speed 整步模式)，模式的切换是通过配置速度自动完成，不同芯片会有差异

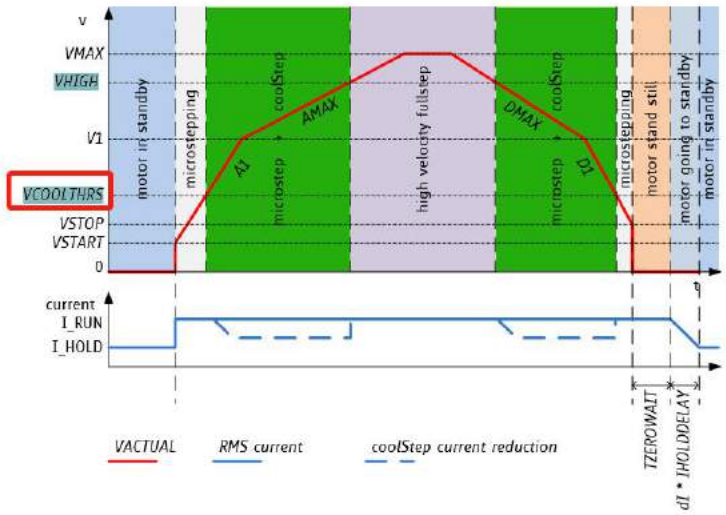
(1)如 TMC5041/TMC5072/TMC5130 是通过配置速度参数 VCOOLTHRS 和 VHIGH

实际速度 VACT ≤VCOOLTHRS 时 Stealthchop 才能在配置之后起作用

当 VHIGH ≥ |VACT| ≥ VCOOLTHRS 时，Spreadcycle 起作用，只有在这个范围内才可以启动 Coolstep,Stallguard(注第四代的 Stallguard 和 Coolstep 不受这些限制，可以和 Stealthchop 同时使用比如 TMC2209 等)

当实际速度 VACT>VHIGH 时 电机工作在高速模式，此时是整步模式运行。

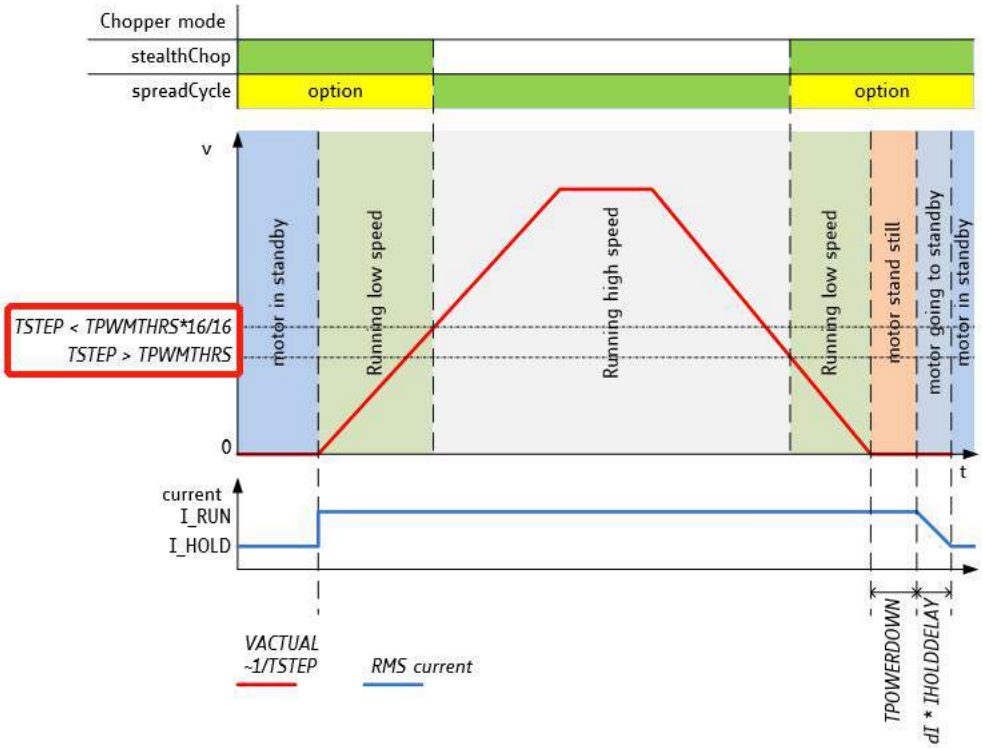




(3) 如 TMC5160/5161/2208/2209 是通过配置时间参数 TPWMTHRS 和 THIGH

TPWMTHRS 用来控制 Stealthchop 模式的最高速度阀值

THIGH 用来控制 Stallguard,coolstep 模式的最高速度阀值和高速 High speed 的开始阀值



将电机以速度模式运行到所希望的转速此时读去 TSTEP 寄存器（两个细分之后微步的时间值）

当 TSTEP ≥ TPWMTHRS 如果 Stealchop 模式被配置之后就会起作用

当 TCOOLTHRS ≥ TSTEP ≥ THIGH CoolStep 起作用，如果被配置之后；Stealthchop 不起作用

当 TCOOLTHRS ≥ TSTEP 当 Stallguard 被配置后在过载时电机会自动停止，并且有信号输出

当 TSTEP ≤ THIGH 时 CoolStep 和 Stealthchop 不起作用，如果 vhighfS 被配置电机会工作在整步模式

Parameter	Description	Setting	Comment
stst	This flag indicates motor stand still in each operation mode. This occurs 2^20 clocks after the last step pulse.	0/1	Status bit, read only
TPOWER DOWN	This is the delay time after stand still (*stst*) of the motor to motor current power down. Time range is about 0 to 4 seconds.	0..*255*	Time in multiples of 2^18 t_{CLK}
TSTEP	Actual measured time between two 1/256 microsteps derived from the step input frequency in units of 1/fCLK. Measured value is (2^20)-1 in case of overflow or stand still.	0... 1048575	Status register, read only. Actual measured step time in multiple of t_{CLK}
TPWMTHRS	*TSTEP* ≥ *TPWMTHRS* - stealthChop PWM mode is enabled, if configured - dcStep is disabled	0... 1048575	Setting to control the upper velocity threshold for operation in stealthChop
TCOOLTHRS	*TCOOLTHRS* ≥ *TSTEP* ≥ *THIGH*: - coolStep is enabled, if configured - stealthChop voltage PWM mode is disabled *TCOOLTHRS* ≥ *TSTEP* - Stop on stall and stall output signal is enabled, if configured	0... 1048575	Setting to control the lower velocity threshold for operation with coolStep and stallGuard
THIGH	*TSTEP* ≤ *THIGH*: - coolStep is disabled (motor runs with normal current scale) - stealthChop voltage PWM mode is disabled - If *vhighchm* is set, the chopper switches to *chm*=1 with *TFD*=0 (constant off time with slow decay, only). - If *vhighfs* is set, the motor operates in fullstep mode and the stall detection becomes switched over to dcStep stall detection.	0... 1048575	Setting to control the upper threshold for operation with coolStep and stallGuard as well as optional high velocity step mode

7. **Stallgurad** 无传感器负载检测功能，由于 Stallguard 是利用电机运行起来之后的反电势推算外部负载，因此 Stallguard 不适应电机的速度太低或者太高情况。

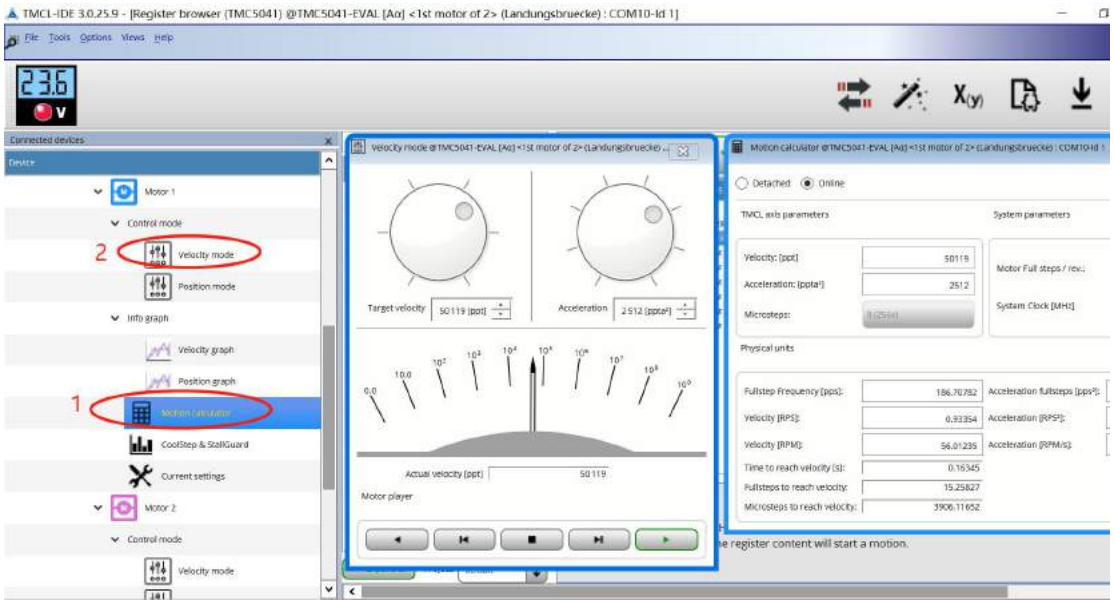
Stallguard 的配置步骤以及方法如下：

7-1：设置目标速度

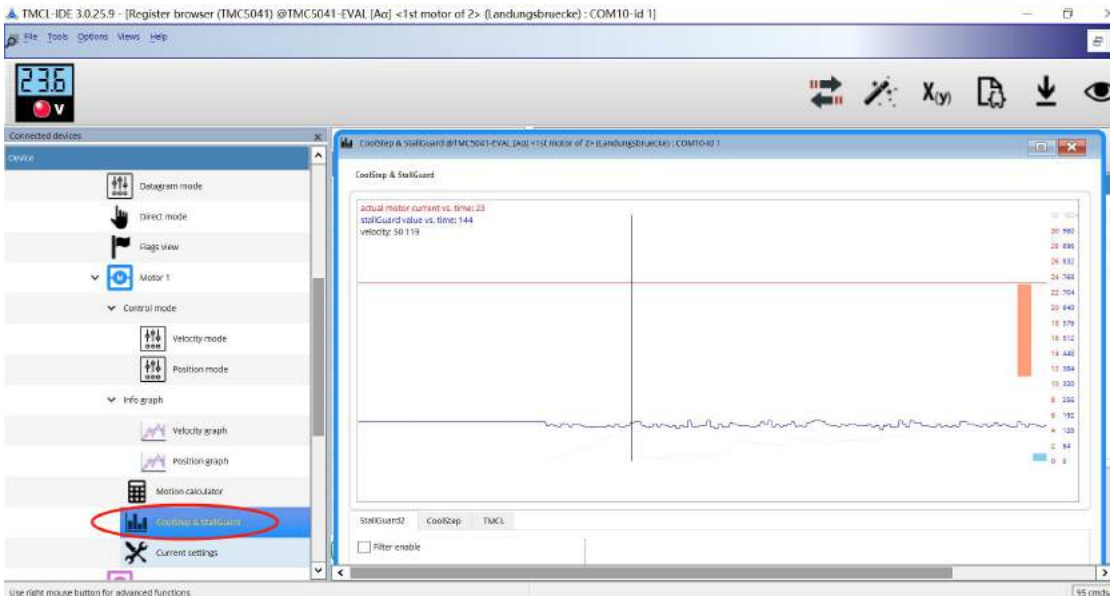
打开 

和 

使电机工作在目标的速度模式



7-2：单击 Coolstep & StallGuard



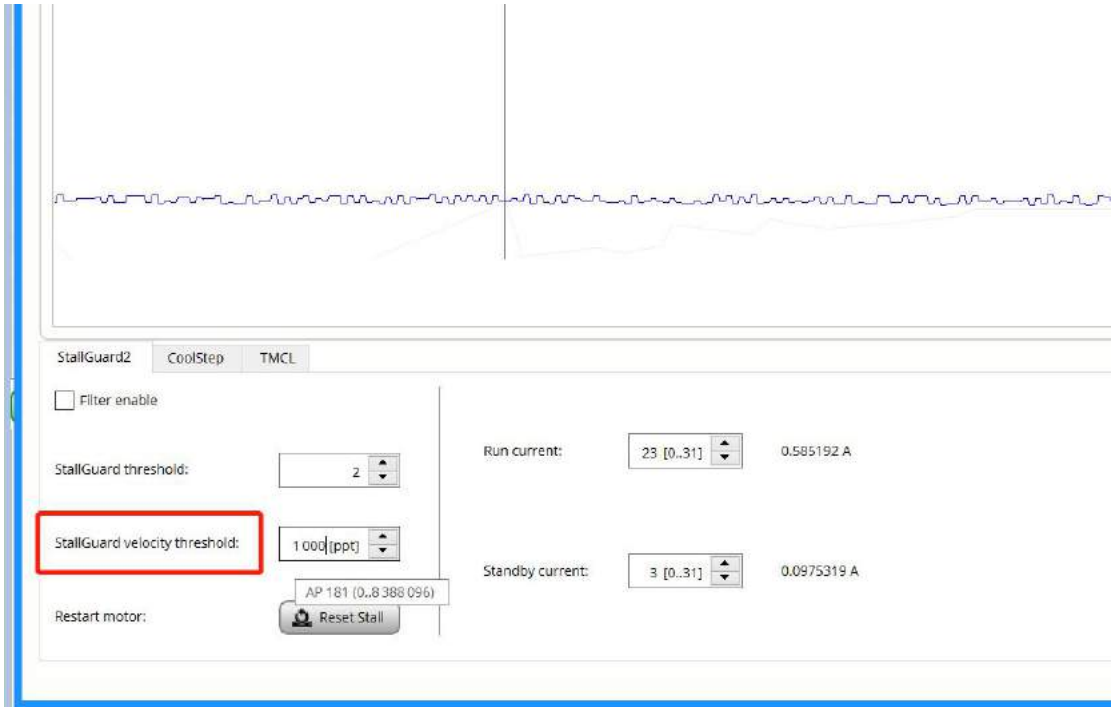
Stallguard 的原来是是设置一个对外部力的敏感度 通过 Stallguard threShold(寄存器 COOLCONF_M1 06D sgt) 该数值越小灵敏度越高，该数值越大灵敏度越低 区别就是外部

增大负载之后，Stallguard Value 数值变化，注意：Stallguard Value(寄存器 0x6F SG_RESULT)的反馈数值和实际外部负载力相反，也就是外部力越大的时候，Stallguard value 数值越接近于 0，Stallguard threshould 数值越小的时候 越灵敏 Stallguard Value 越接近于 0 ；

当下面中 Stallguard Velocity threshold 中数值为非 0 的时候，而外部的负载大到使 Stallguard value 等于 0 时候，此时电机会自动停止。

Stallguard Velocity threshold 是启动自动停止的速度阀值 当速度超过这个速度的时候，Stallguard Value=0 的时候 电机才会停止，否则电机不会停止。

SatllGuard Velocity Threshold 由 VCOOLTHRS 0x31 配置



				of 2^18 clocks
W	0x31 0x51	23	*VCOOLTHRS*	This is the lower threshold velocity for switching on smart energy coolStep and stallGuard feature. Further it is the upper operation velocity for stealthChop. (unsigned) Set this parameter to disable coolStep at low speeds, where it cannot work reliably. The stop on stall function (enable with *sg_stop* when using internal motion controller) becomes enabled when exceeding this velocity. It becomes disabled again once the velocity falls below this threshold. This allows for homing procedures with stallGuard by blanking out the stallGuard signal at low velocities (will not work in combination with stealthChop). *VHIGH* ≥ |*VACT*| ≥ VCOOLTHRS: - coolStep and stop on stall are enabled, if configured - Voltage PWM mode stealthChop is switched off, if configured (Only bits 22..8 are used for value and for comparison)

详情参考各个芯片的 dataSheet

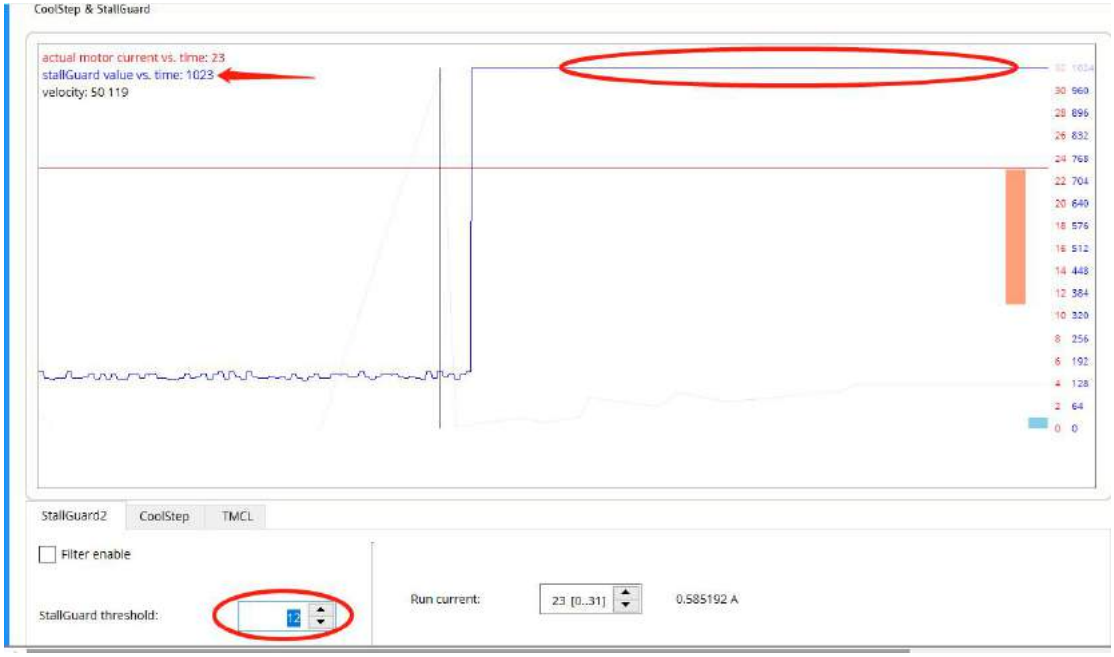
Parameter	Description	Setting	Comment
SGT	This signed value controls the stallGuard2 threshold level for stall detection and sets the optimum measurement range for readout. A lower value gives a higher sensitivity. Zero is the starting value working with most motors. A higher value makes stallGuard2 less sensitive and requires more torque to indicate a stall.	0	indifferent value
		+1… +63	less sensitivity
		-1… -64	higher sensitivity
sfilt	Enables the stallGuard2 filter for more precision of the measurement. If set, reduces the measurement frequency to one measurement per electrical period of the motor (4 fullsteps).	0	standard mode
		1	filtered mode
Status word	**Description**	**Range**	**Comment**
SG	This is the *stallGuard2 result*. A higher reading indicates less mechanical load. A lower reading indicates a higher load and thus a higher load angle. Tune the *SGT* setting to show a *SG* reading of roughly 0 to 100 at maximum load before motor stall.	0… 1023	0: highest load low value: high load high value: less load

In order to use stallGuard2 and coolStep, the stallGuard2 sensitivity should first be tuned using the SGT setting!

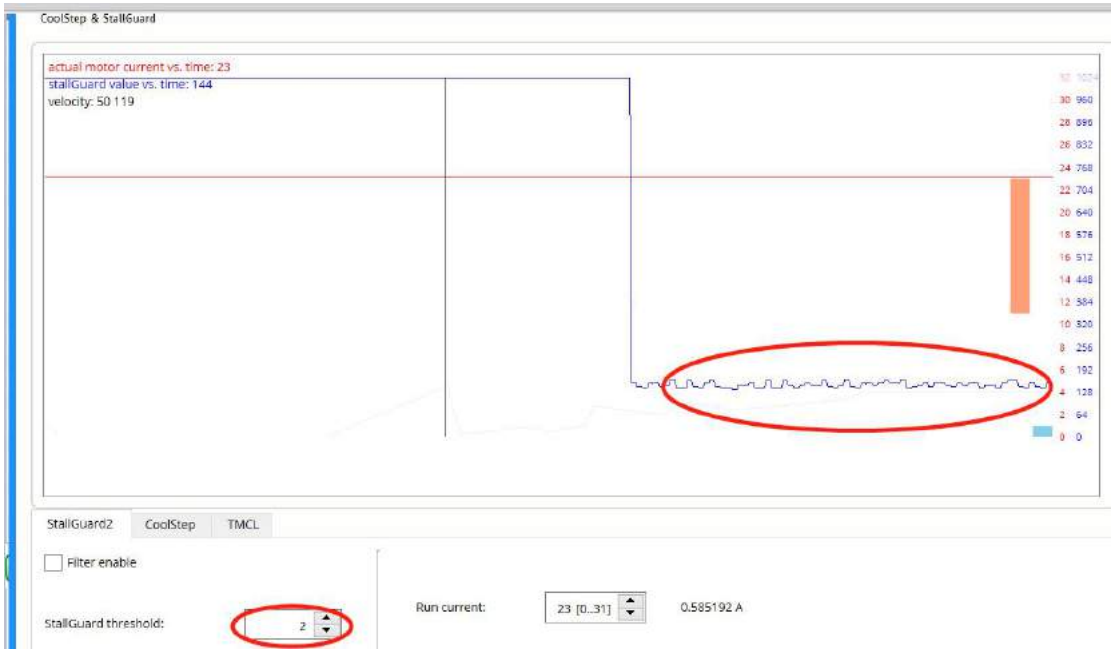
6.2.2.1 *SW_MODE* – Reference Switch & stallGuard2 Event Configuration Register

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. *Attention: Do not enable during motor spin-up, wait until the motor velocity exceeds a certain value, where stallGuard2 delivers a stable result, or set VCOOLTHRS to a suitable value.*

把速度设置为目标速度之后可以调整灵敏度参数 Stallguard threshold 来配置外部需要多少力才可以让电机停止 也就是使用 Stallguard value=0
下图为同一速度 不同 Stallguard threShold 下的 Stallguard value(蓝色曲线反应外部力情况，负载越大值越小)



Stallguard threshold=12



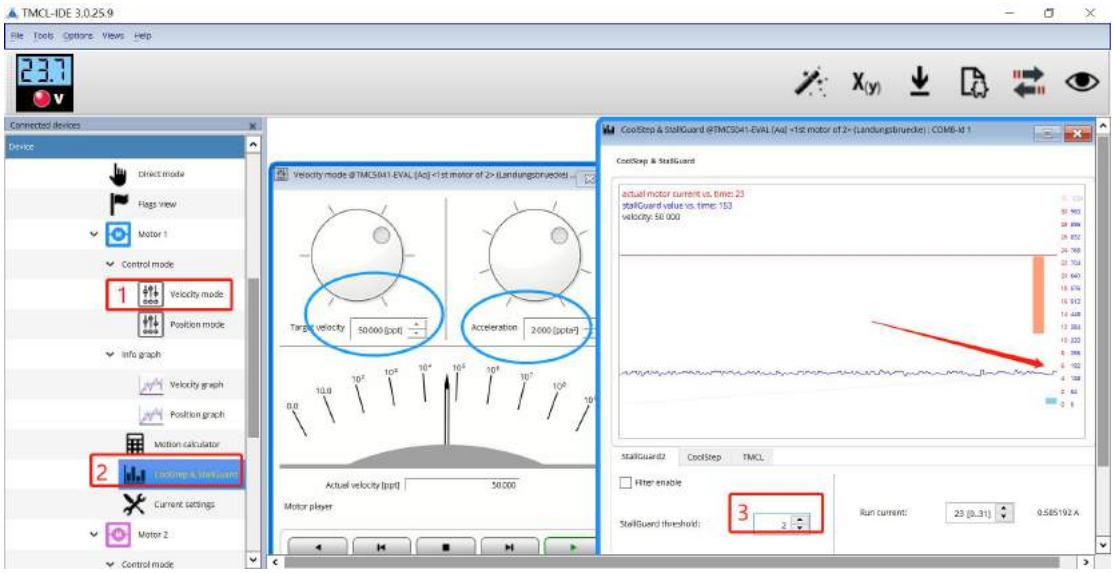
上图为 Stallguard threShold=2 此时只要外部施加少许力电机就会停止（因为此时的 Stallguard value 更接近于 0）。

Stallguard 功能可以实现不需要力传感器情况下的力控制，比如压力控制，无传感器回零等。

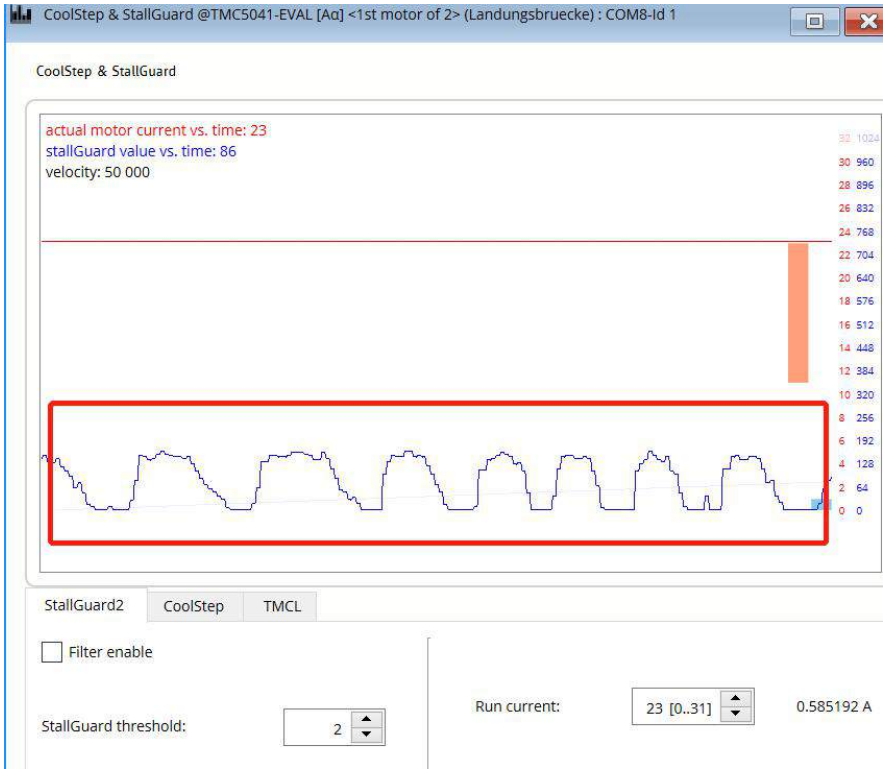
8. **Coolstep 配置**　相比如传统的步进电机是恒流驱动，为了不使电机丢步，只能把驱动电流设置的很高，这样会带来功耗比较大，电机容易发热，容易产生剩磁震动等问题.Coolstep 是基于电机的反电动势动态控制输出电流，负载大的时候电流自动增加，负载小的时候电流自动下降，相比传统的恒流驱动 Coolstep 可以节省 80%的能量。

Coolstep 是在调节好 Stallguard 的基础上来配置的，需要首先配置 SGT Stallguard threShold(寄存器 COOLCONF_M1　0x6D　sgt)

8-1. 通过下图的 1-2-3 设置加速度，速度和灵敏度参数 StallGuard threshold 寄存器 0x6D 下图为 2

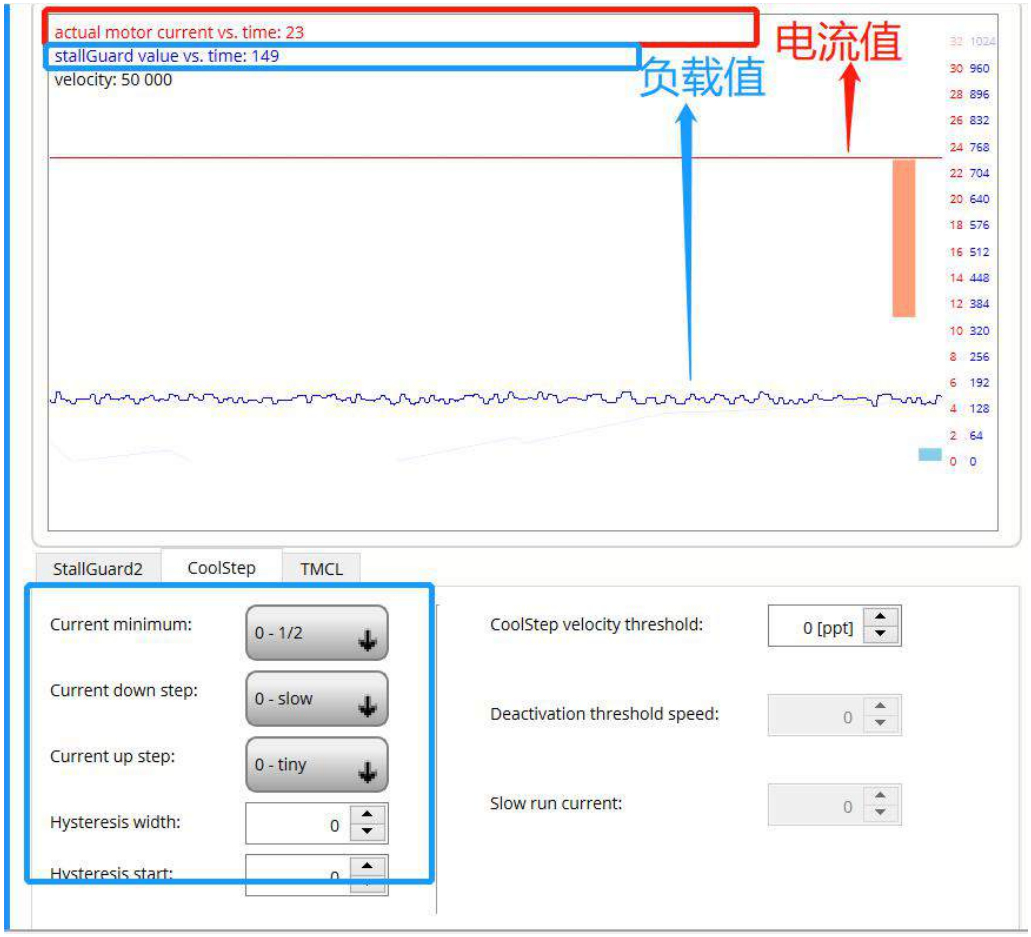


保证增大负载时候 Stallguard value(寄存器 0x6F SG_RESULT)下将，负载减小时 Stallguard Value 上升



8-2

切换到 Coolstep 栏

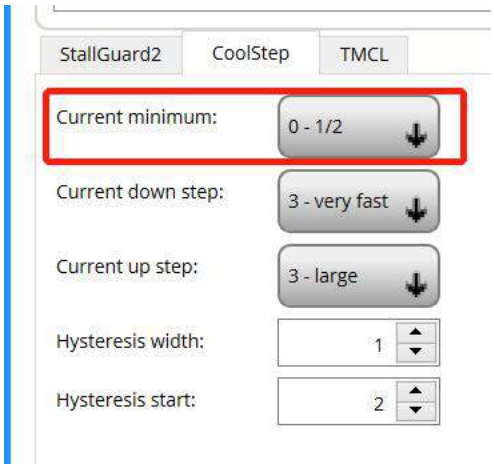


8-2-1

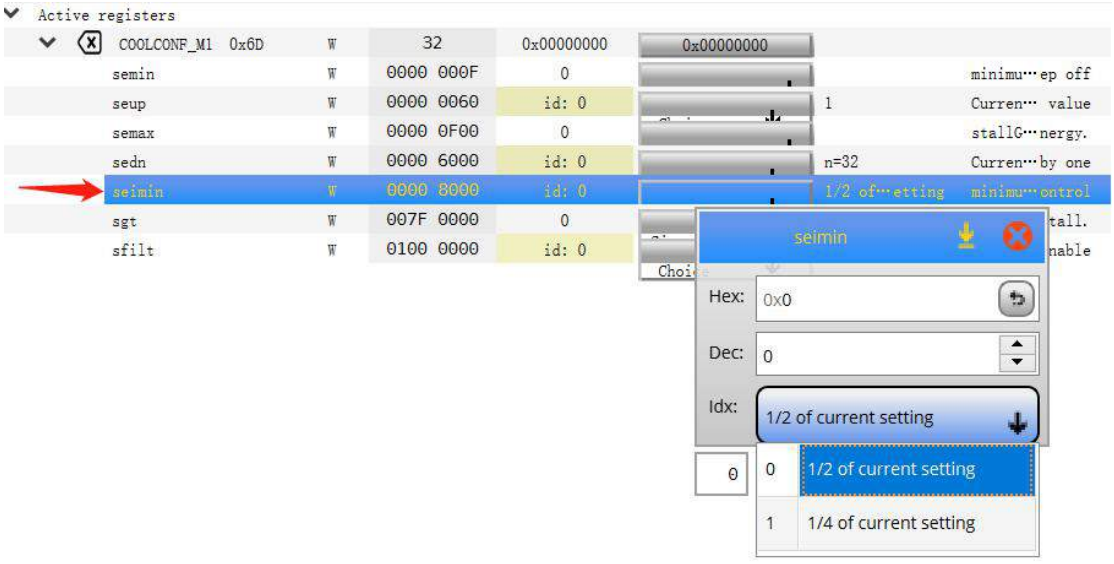
Coolstep Velocity threshold 设置 Coolstep 功能起作用的速度阀值，当实际速度高于该数值的时候 Coolstep 不起作用，该寄存器由 0x31 VCOOLTHRS 决定

例如目前电机速度是 50000 当 Coolstep velocity threshold 大于 50000 时 Coolstep 不起作用

8-2-2 Current minimum 设置电流的最小值（当负载小的时候 电流到达的数值为最大电流的 1/2 或 1/4）



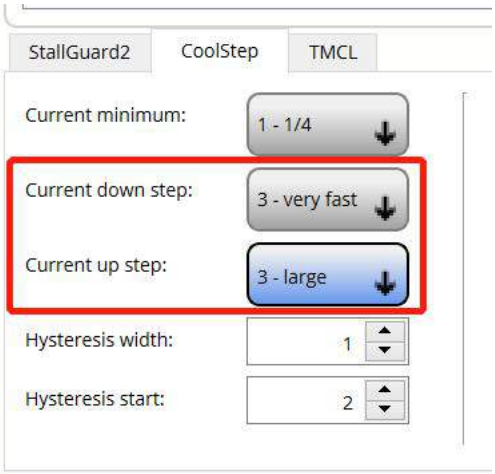
Current Minimum 所对应的寄存器如下 0x6D-seimin



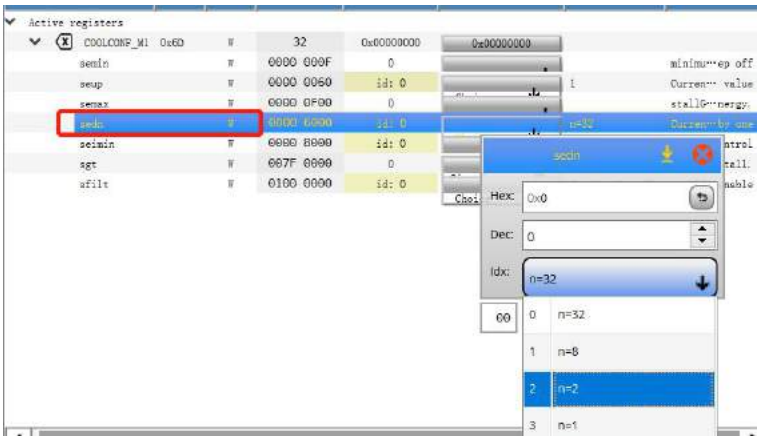
下图为 Current minimun 为 1/2 和 1/4 最小电流的对比

8-2-3： current down step: 电流下降过程的幅度

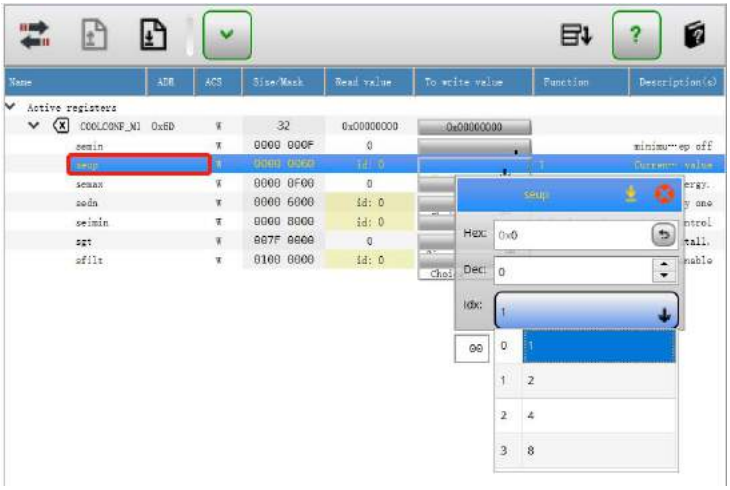
Current up step:电流上升的幅度



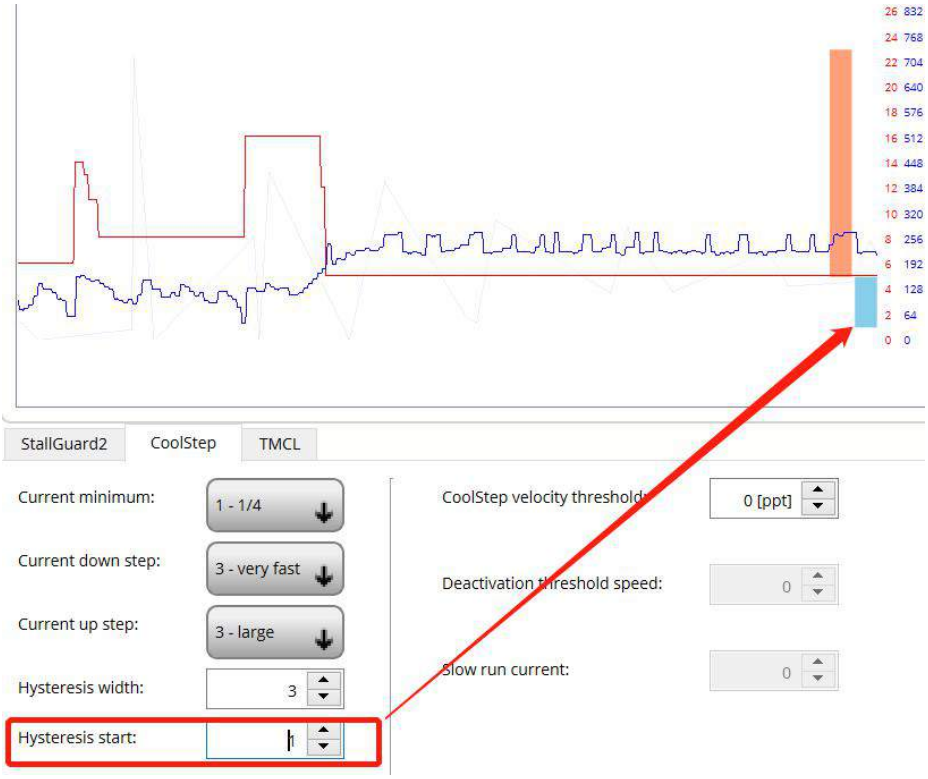
Current down step 对应的寄存器为 COOLCONF_M1 - 0x6D-sedn 如下图



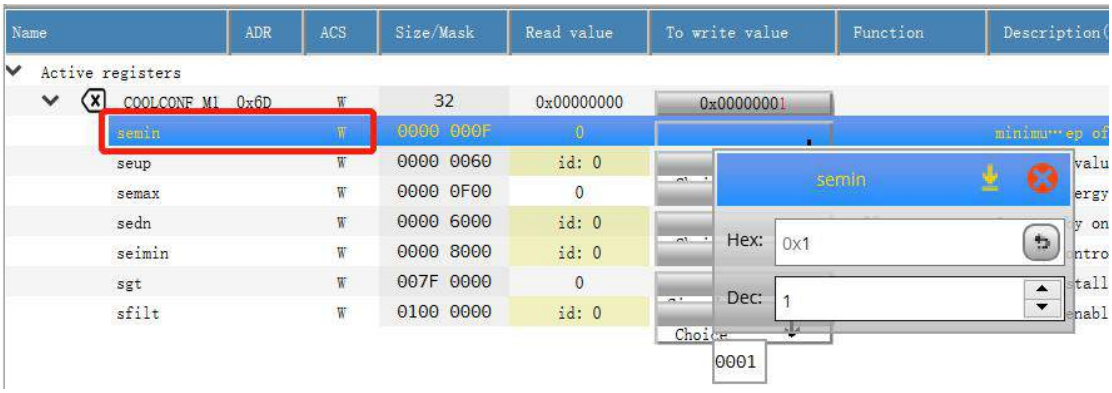
Current up step 对应的寄存器为 COOLCONF_M1 - 0x6D-seup 如下图



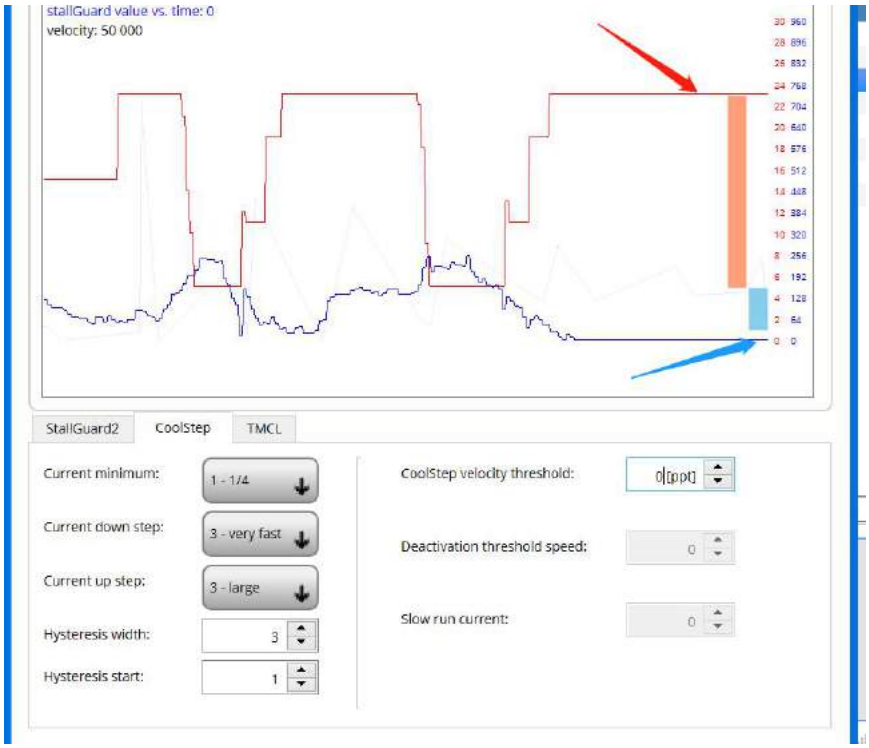
8-2-4：Hysteresis Start:当 Stallguard Value(寄存器 0x6F SG_RESULT)下图蓝色曲线低于该数值的时候电流增加至最大电流。



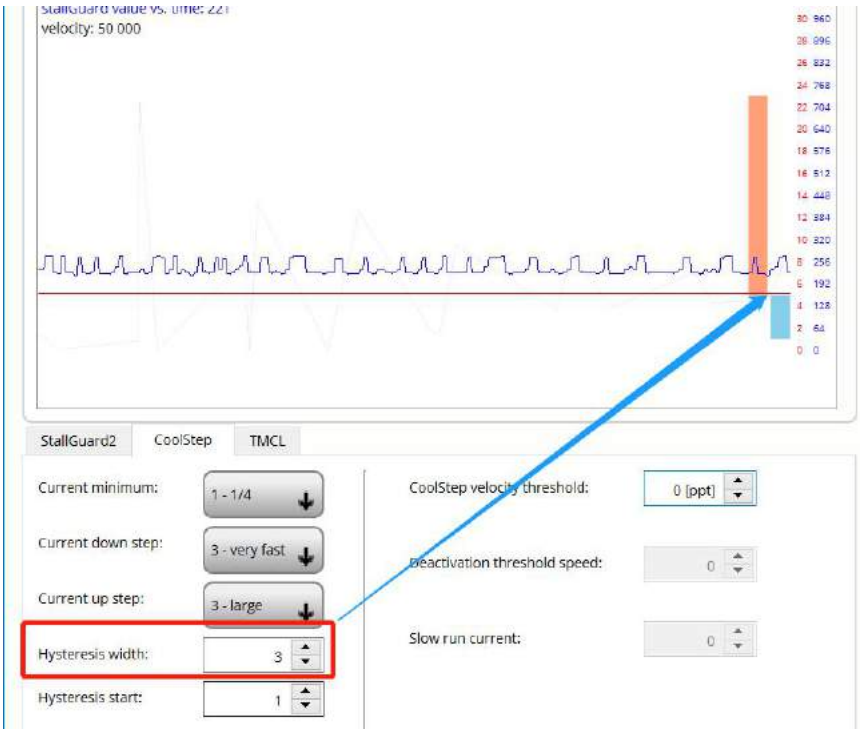
Hysteresis Start 对应的寄存器为 COOLCONF_M1 - 0x6D-semin 如下图



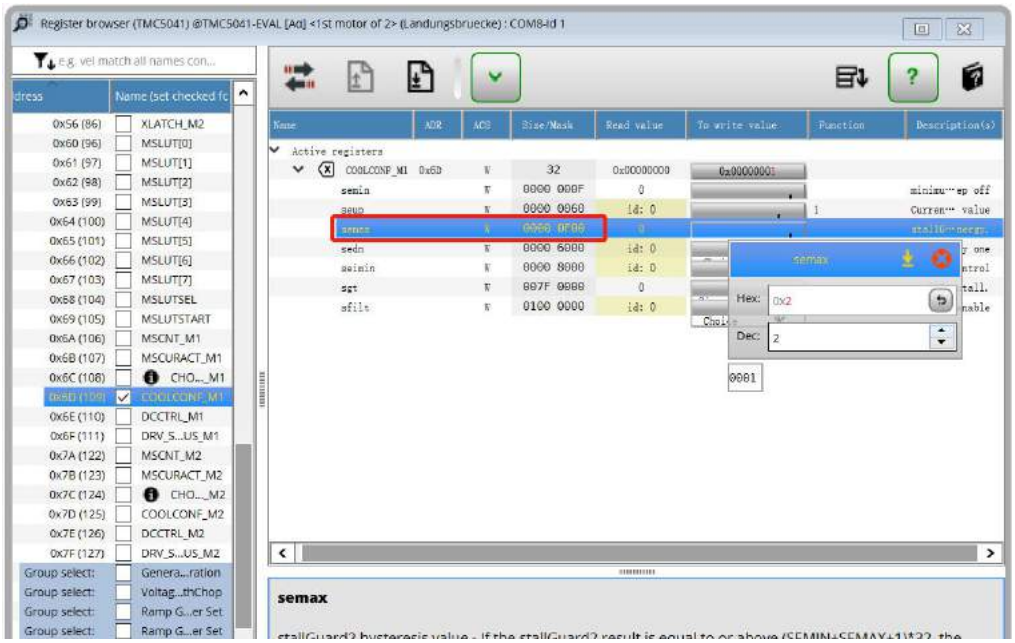
如下图所示当 Stallguard Value 蓝色曲线低于 Hysteresis Start 蓝色柱型底部，表示外部负载很大；电流就会自动升至最大值 以克服外部的负载 红色曲线所示。



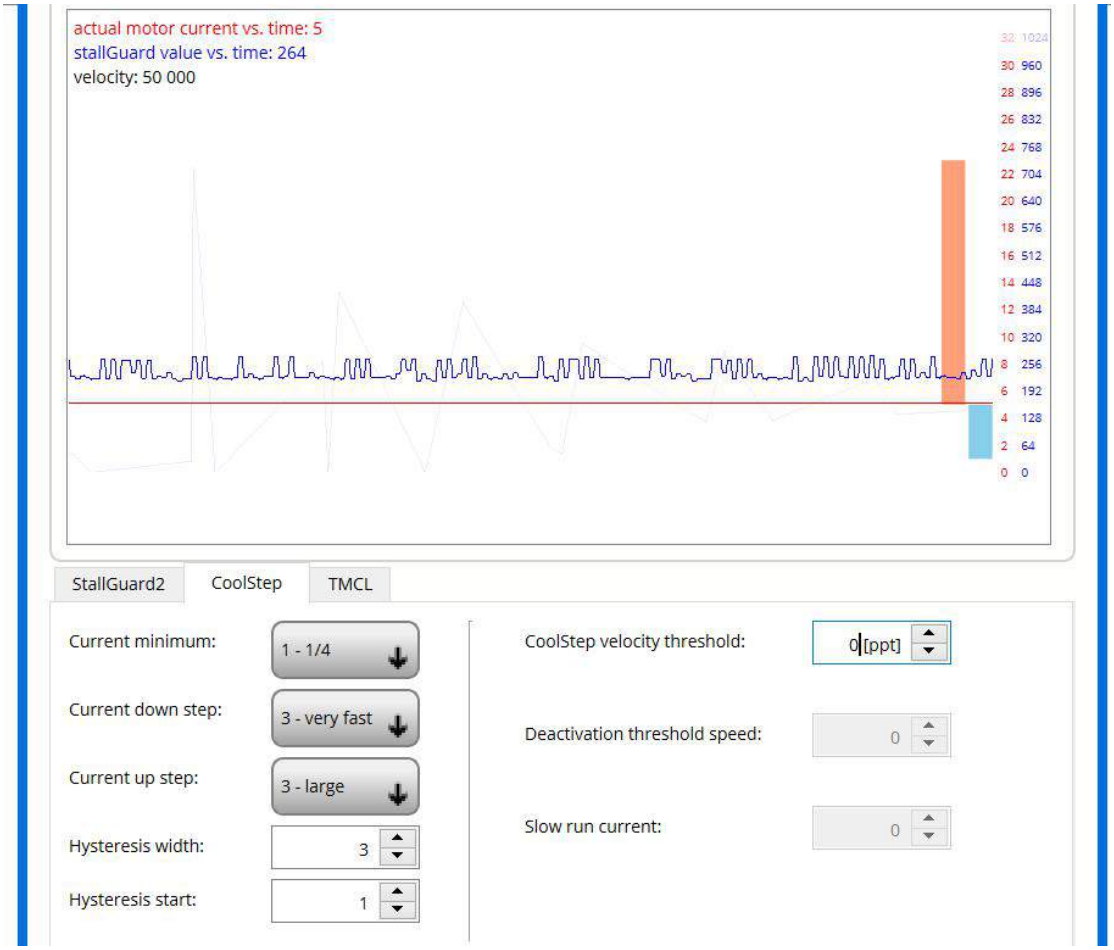
Hysteresis width:当 Stallguard Value(寄存器 0x6F SG_RESULT)下图蓝色曲线等于或高于该数值（蓝色柱型顶部）的时候电流会自动下降至最小电流值。



Hysteresis width 对应的寄存器为 COOLCONF_M1 - 0x6D-semax 如下图



如下图当 Stallguard value 高于或等于 Hysteresis width（蓝色柱状顶部）表示外部的负载很小，此时电流会自动下降至最小电流



如下图电流会根据 Stallguard 的数值（反应的是外部负载）自动调节电流，以实现最佳能耗

9. **Stealthchop 配置**

TRINAMIC 的静音斩波 Stealthchop 到目前一共有 2 代

早期的 TMC5130/2100/2130/5041/5072 是第一代 Stealthchop

之后的 TMC5160/5161/2208/2209/2160/2225 是第二代的，区别是第二代的 Stealthchop 可以自动配置 AUTOTUNING

（1） 第一代 Stealthchop

Stealthchop 是电压的斩波模式 可实现低速静音，平稳运行。高速时候切换到 Spreadcycle 模式的切换是通过不同的速度来实现，VCOOLTHRS(0x31)寄存器用来选择模式

该参数是使能 Coolstep 的最低速度值，是使能 Stealthchop 的最高速度值

如果 Coolstep 配置的话当 VHIGH ≥ |VACT 实际速度| ≥ VCOOLTHR 时 Coolstep 起作用

W	0x31 0x51	23	VCOOLTHRS	This is the lower threshold velocity for switching on smart energy coolStep and stallGuard feature. Further it is the upper operation velocity for stealthChop. (unsigned) Set this parameter to disable coolStep at low speeds, where it cannot work reliably. The stop on stall function (enable with *sg_stop* when using internal motion controller) becomes enabled when exceeding this velocity. It becomes disabled again once the velocity falls below this threshold. This allows for homing procedures with stallGuard by blanking out the stallGuard signal at low velocities (will not work in combination with stealthChop). *VHIGH* ≥ |*VACT*| ≥ VCOOLTHRS: - coolStep and stop on stall are enabled, if configured - Voltage PWM mode stealthChop is switched off, if configured (Only bits 22..8 are used for value and for comparison)

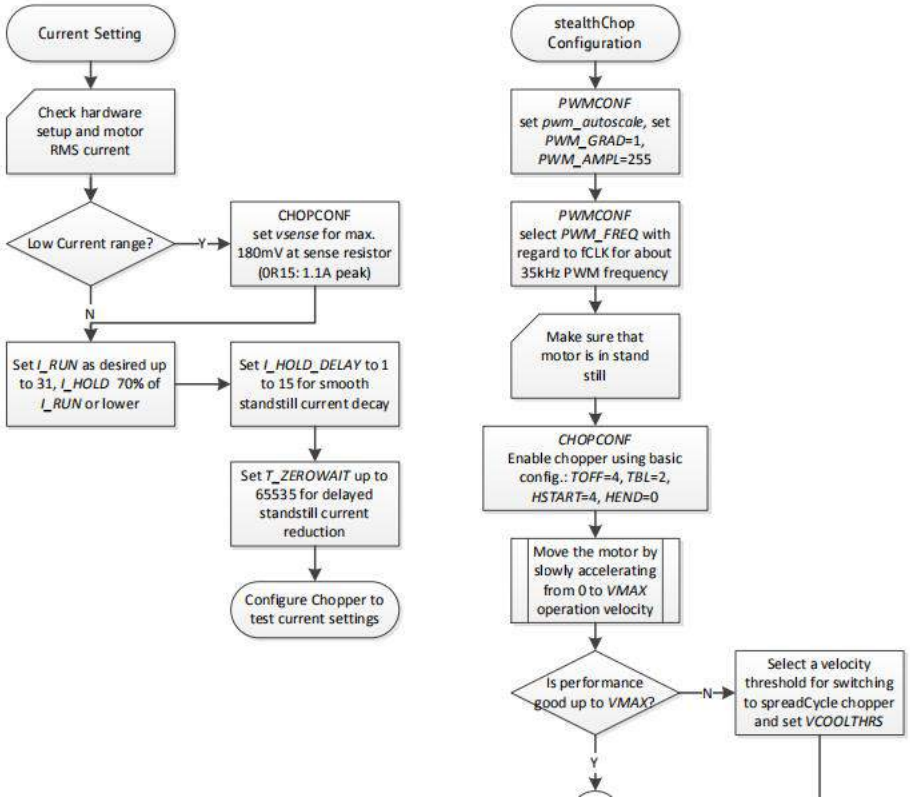
当 Stealthchop 配置时 ， |VACT 实际速度| ≤ VCOOLTHR 时 Stealthchop 起作用

每款芯片的 datasheet 会包括 Quick Configuration Guide 里面有详细如何逐步配置 Stealthchop 和 Spreadcyc

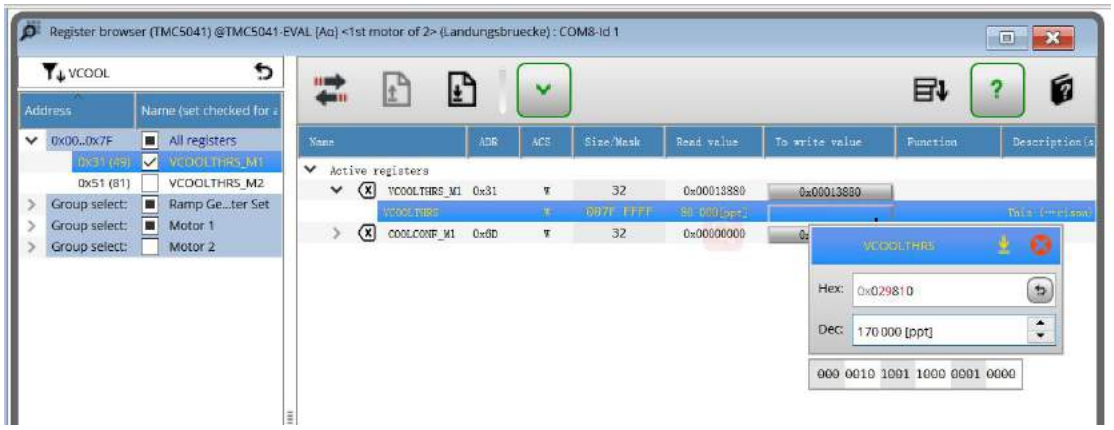
14 Quick Configuration Guide

This guide is meant as a practical tool to come to a first configuration and do a minimum set of measurements and decisions for tuning the driver. It does not cover all advanced functionalities, but concentrates on the basic function set to make a motor run smoothly. Once the motor runs, you may decide to explore additional features, e.g. freewheeling and further functionality in more detail. A current probe on one motor coil is a good aid to find the best settings, but it is not a must.

CURRENT SETTING AND FIRST STEPS WITH STEALTHCHOP



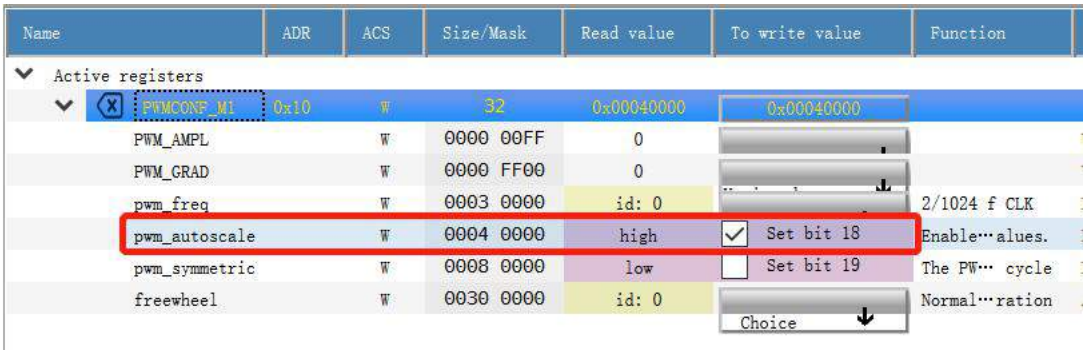
9-1： 将 VCOOLTHRS 0x31 设为 1700000 因此只有实际速度低于 1700000pps Stealthchop 才起作用。



9-2：配置 PWM_Autoscale

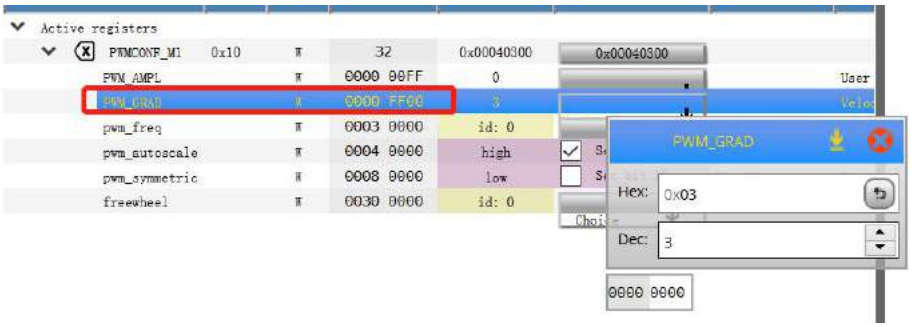
19	-	reserved	Set to 0	
18	*pwm_autoscale*	PWM automatic amplitude scaling	0	User defined PWM amplitude. The current settings have no influence.
			1	Enable automatic current control *Attention: When using a user defined sine wave table, the amplitude of this sine wave table should not be less than 244. Best results are obtained with 247 to 252 as peak values.*

将 PWM_Autoscale 设为 high



9-3：配置 PWM_GRAD 此处设置为 3

PWM_GRAD	Global enable and regulation loop gradient when *pwm_autoscale*=1.	0	Do not use stealthChop
		1 ... 15	stealthChop enabled



注意：当 PWM_GRAD=0 的时候 Stealthchop 不起作用

9-4：配置 PWM_AMPL 用于配置 Stealthchop 速度变化时候由于相序跳变时候带来的电流过流

7.2.2 PWM_AMPL for Using stealthChop and spreadCycle

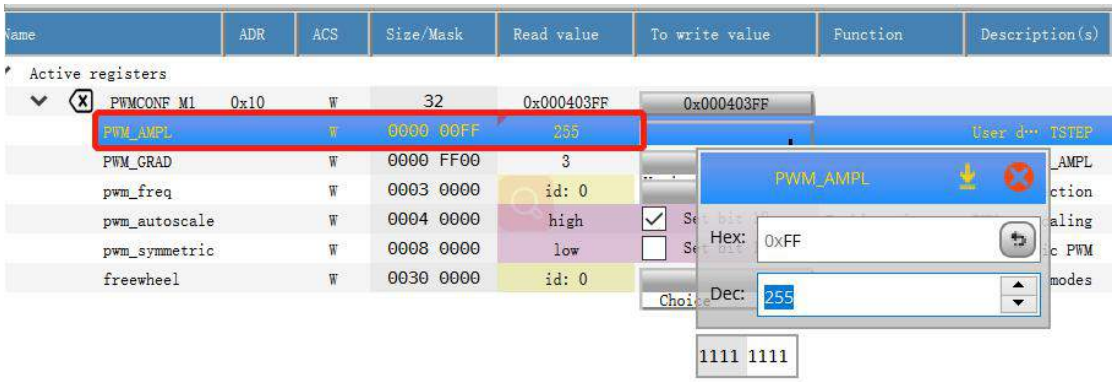
When combining stealthChop with spreadCycle or constant off time classic PWM, a switching velocity can be chosen using *VCOOLTHRS*. With this, stealthChop is only active at low velocities. Often, a very low velocity in the range of 1 to a few 10 RPM fits best. In case a high switching velocity is chosen, special care should be taken for switching back to stealthChop during deceleration, because the phase jerk can produce a short time overcurrent. (Refer to chapter 7.4 for more details about combining stealthChop with other chopper modes.)

To avoid a short time overcurrent and to minimize the jerk, the initial amplitude for switching back to stealthChop at sinking velocity can be determined using the setting *PWM_AMPL*. Tune *PWM_AMPL* to a value which gives a smooth and safe transition back to stealthChop within the application. As a thumb rule, ½ to ¾ of the last *PWM_SCALE* value which was valid after the switching event at rising velocity can be used. For high resistive steppers as well as for low transfer velocities (as set by *VCOOLTHRS*), *PWM_AMPL* can be set to 255 as most universal setting.

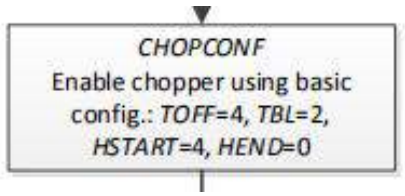
Note
The autoscaling function only starts up regulation during motor standstill. After enabling stealthChop and setting all parameters, be sure to wait until *PWM_SCALE* has reached a stable state before starting a motion. Failure to do so will result in zero motor current!

In case the automatic scaling regulation is instable at your desired motion velocity, try modifying the chopper frequency divider *PWM_FREQ*. Also adapt the blank time *TBL* and motor current for best result.

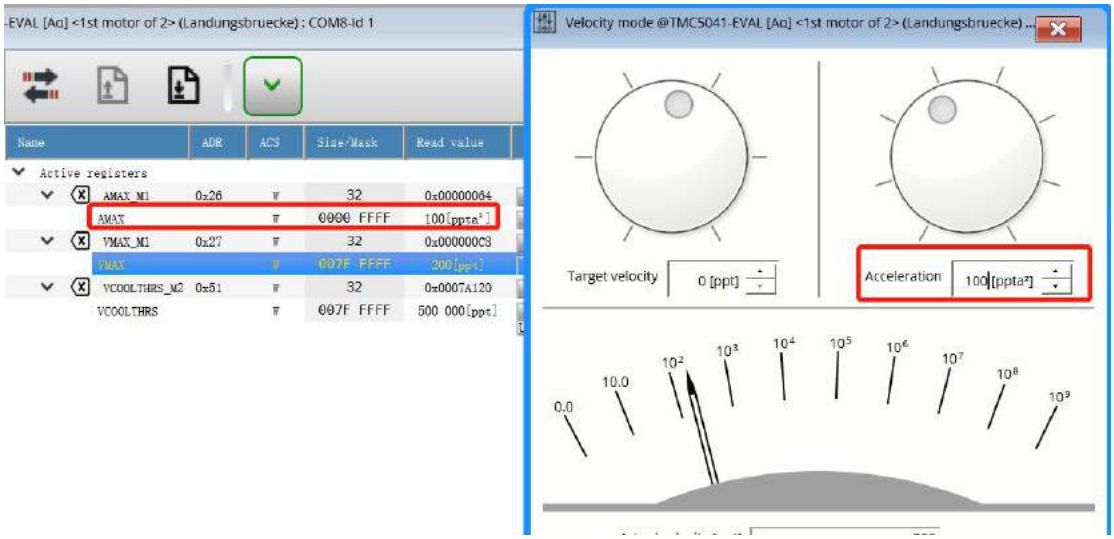
对于高阻值的电机 PWM_AMPL 可以设置为
255



9-5：配置按照下图配置 CHOPCONF　对于寄存器 Ox6C



9-6：在这之前请保证电机是静止状态。
在调试 Stealthchop 的时候原则是先设置一个很小的加速度然后慢慢提高速度



（2） 第二代 Stealthchop 用 TMC5161 来测试，如果有条件的话最好配备一个电流探头使用示波器检测线圈电流，每款芯片的 datasheet 里面都会有如下快速配置指导

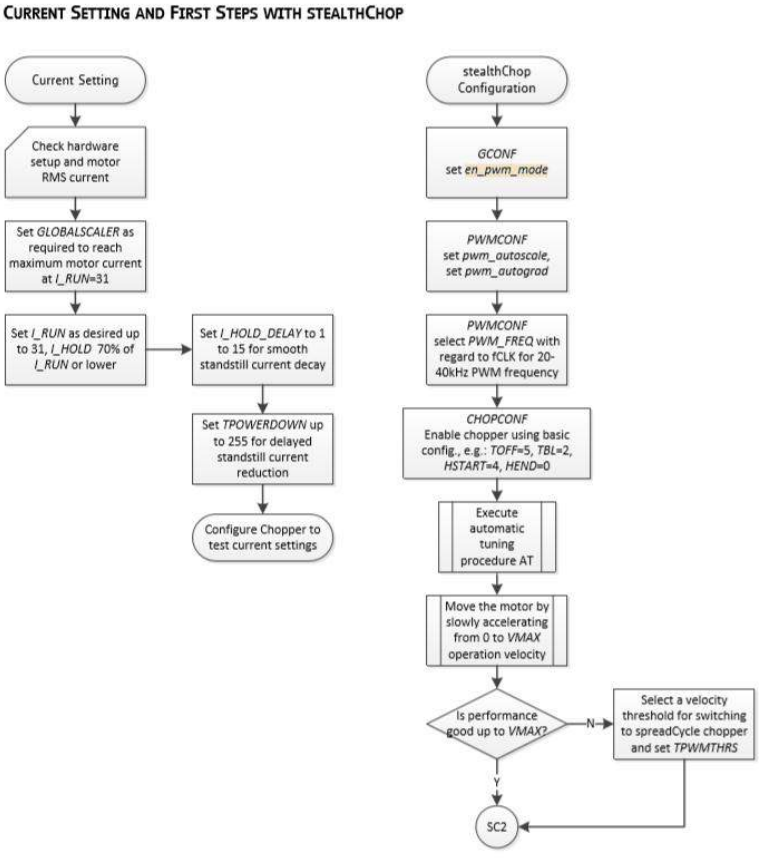
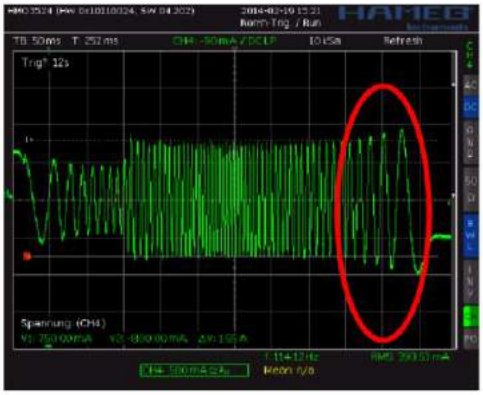


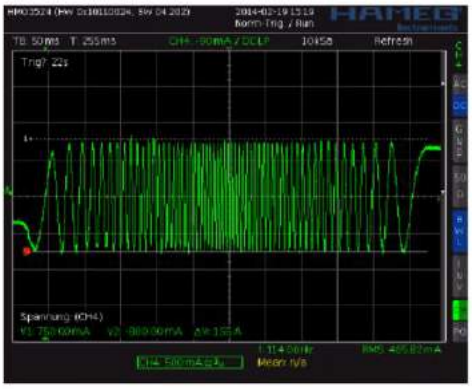
Figure 22.1 Current setting and first steps with stealthChop

用电流探头检测电机线圈电流如果电流波形如第一个图的时候表示 Stealthchop 没有调试好，电流在加速和减速的时候有滞后现象，容易引起过流保护。下图的 After Tuning 是 Stealthchop 配置成功后的电流波形。

Before Tuning



After Tuning



配置步骤如下：

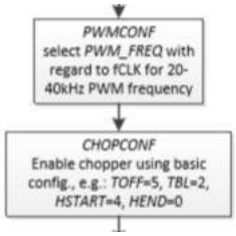
(1)使能 En_PWM_mode 为 High 对应 0x00 寄存器 如下图

Name	ADR	ACS	Size/Mask	Read value	To write value	Function
Active registers						
GCONF	0x00	RW	32	0x0000000C	0x0000000C	
recalibrate		RW	0000 0001	low	Set bit 0	
faststandstill		RW	0000 0002	low	Set bit 1	Normal…clocks
en_pwm_mode		RW	0000 0004	high	Set bit 2	1: ste… only.
multistep_filt		RW	0000 0008	high	Set bit 3	Enable…source

(2)使能 PWM_autoscale 和 PWM_autograd 为 High 对应 0x70 寄存器，如下图

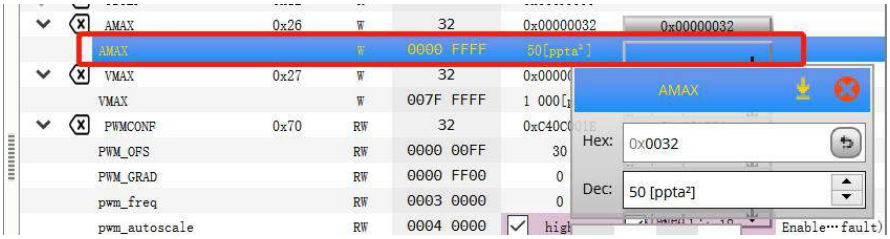
PWMCONF	0x70	RW	32	0xC40C001E	0xC40C001E	
PWM_OFS		RW	0000 00FF	30		User d…RUN).
PWM_GRAD		RW	0000 FF00	0		Veloci…_GRAD.
pwm_freq		RW	0003 0000	0		%00: f…=2/410
pwm_autoscale		RW	0004 0000	high	Set bit 18	Enable…fault)
pwm_autograd		RW	0008 0000	high	Set bit 19	Automa…otion.
freewheel		RW	0030 0000	0		Stand …ivers.

（3）配置下面 2 个寄存器

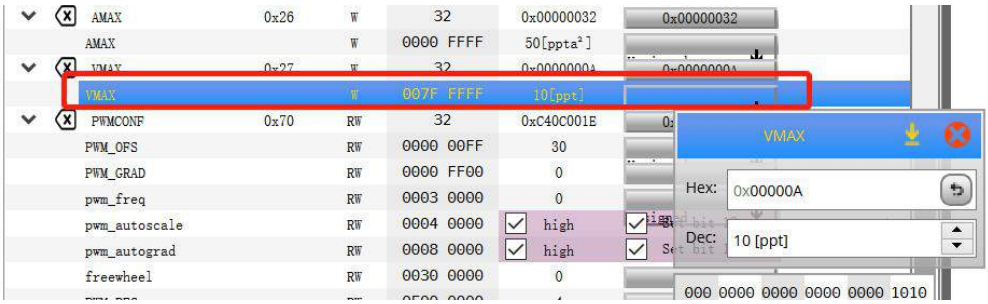


(4)开始 AutoTuning

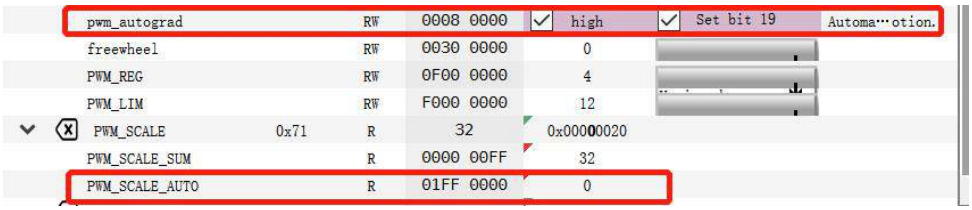
在电机停止时候（需要电机待机情况下超过 130ms），设置非常小的加速度 AMAX 0x26 设置为 50 设置更小



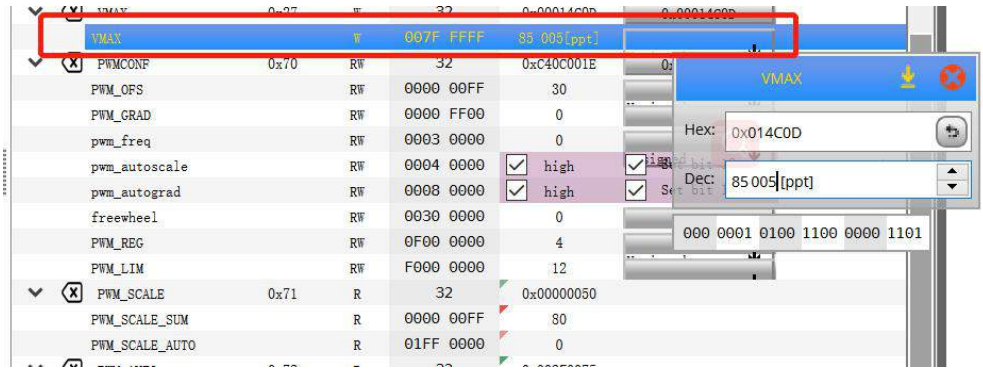
设置非常小的速度 VMAX 对应 0x27 寄存器设置为 10



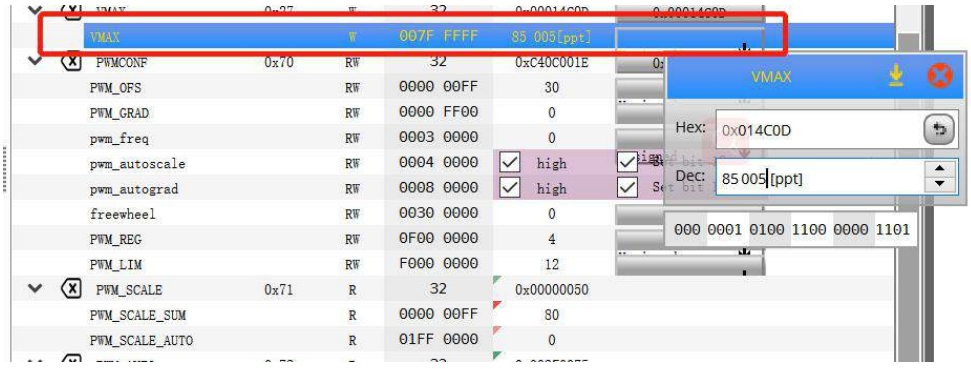
在电机运动过程中确认 PWM_SCALE_AUTO 等于 0，如果等于 0 的话 PWM_SCALE_AUTO 会被自动写入 PWM_GRAD_AUTO



然后逐步提供最大速度 Vmax 和重复确认 PWM_SCALE_AUTO



直至加速到某个速度下电机会出现抖动，此时需要配置读取 TSTEP 参数将其设置到 TPWMTHRS 寄存器，目的是切换至 Spreadcycle 模式



可以在每次开机回原点过程完成 AUTO TUNING.

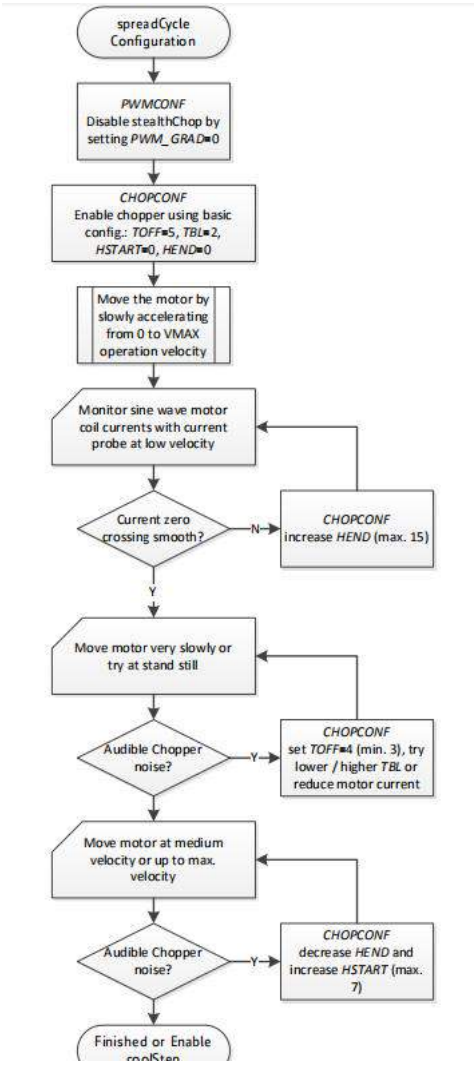
10. **Spreadcycle** 是高速运行模式

如果 Stealthchop 和 Spreadcycle 一起用的话，通过 VCOOLTHRS 来切换，低速时候用 Stealthchop 高速时候用 Spreadcycle 模式

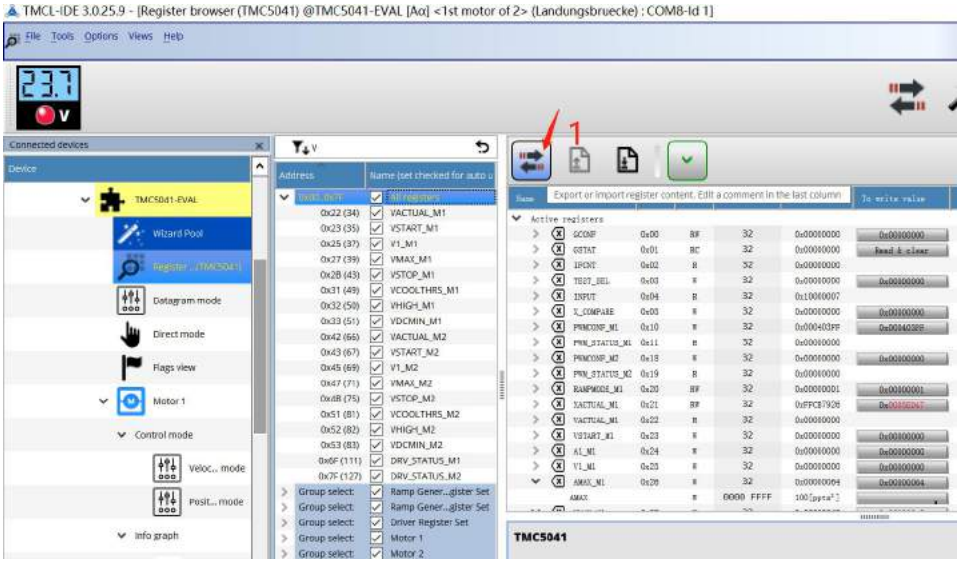
W	0x31 0x51	23	*VCOOLTHRS*	This is the lower threshold velocity for switching on smart energy coolStep and stallGuard feature. Further it is the upper operation velocity for stealthChop. (unsigned) Set this parameter to disable coolStep at low speeds, where it cannot work reliably. The stop on stall function (enable with *sg_stop* when using internal motion controller) becomes enabled when exceeding this velocity. It becomes disabled again once the velocity falls below this threshold. This allows for homing procedures with stallGuard by blanking out the stallGuard signal at low velocities (will not work in combination with stealthChop). *VHIGH* ≥ |*VACT*| ≥ VCOOLTHRS: - coolStep and stop on stall are enabled, if configured - Voltage PWM mode stealthChop is switched off, if configured (Only bits 22..8 are used for value and for comparison)

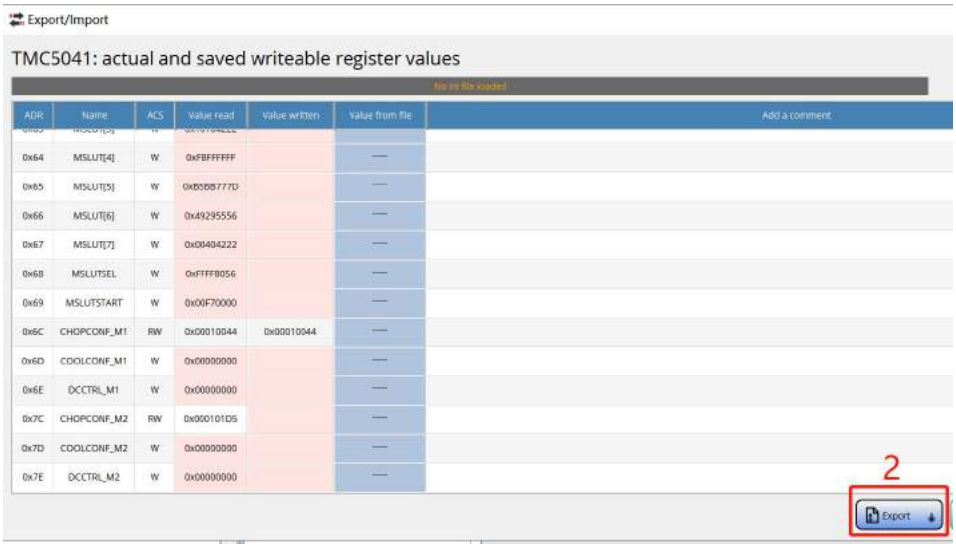
如果是单独工作在 Spreadcyc 模式的话

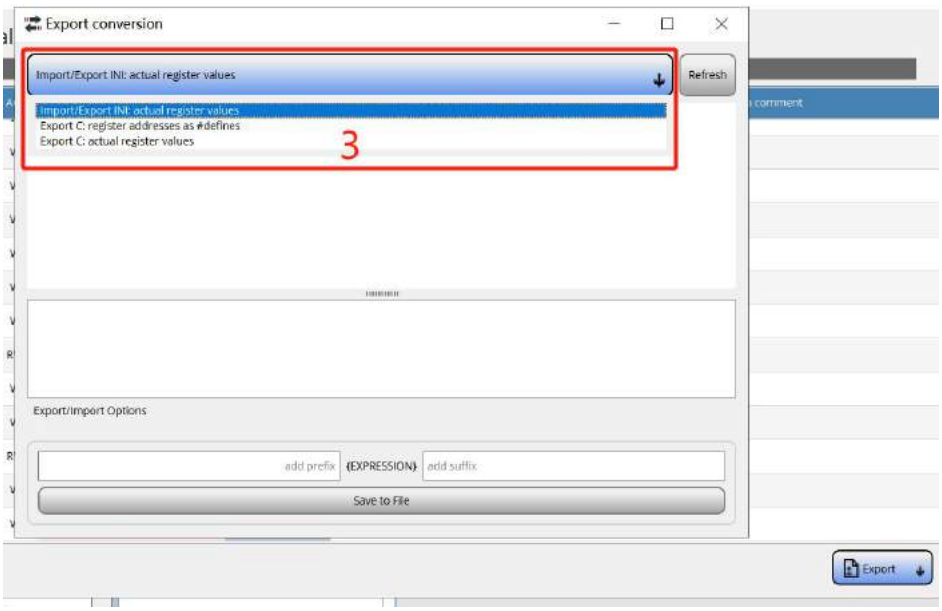
参照以下步骤，详情参照 Datasheet 第 14 章节



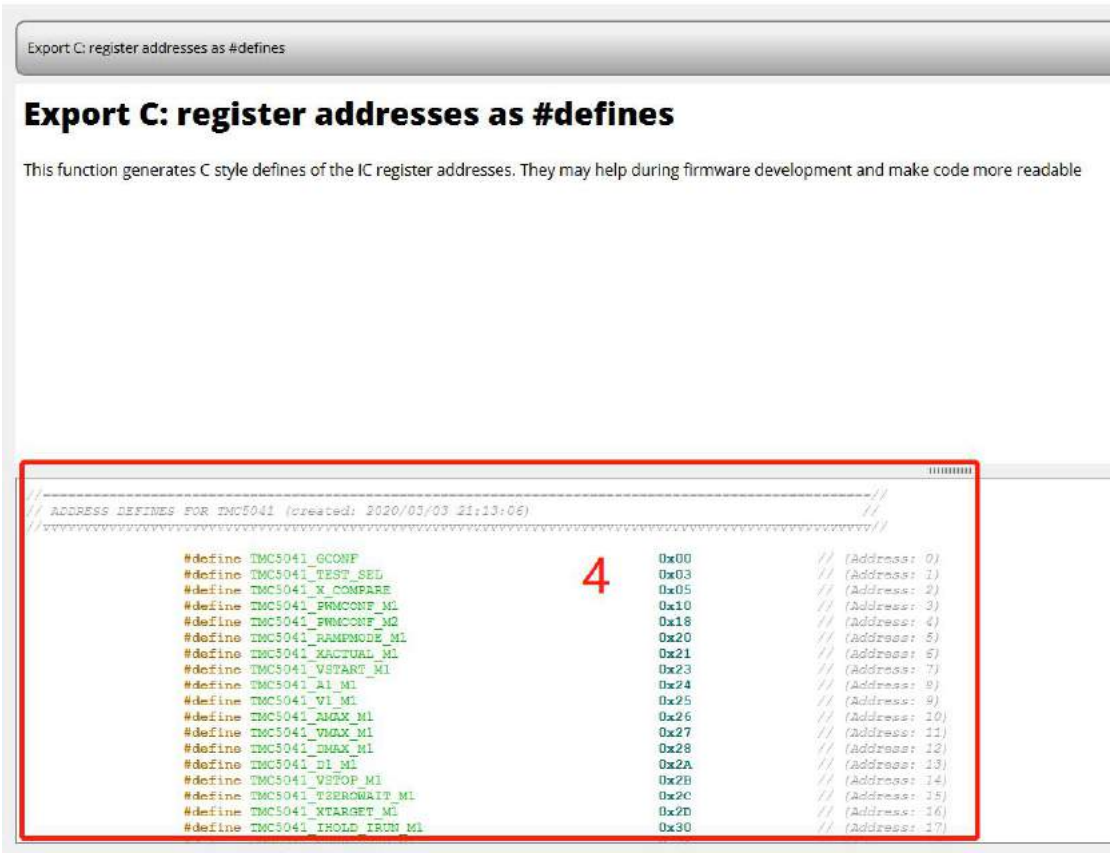
11. 如何将开发板的配置快速移植到自己的 MCU 里？





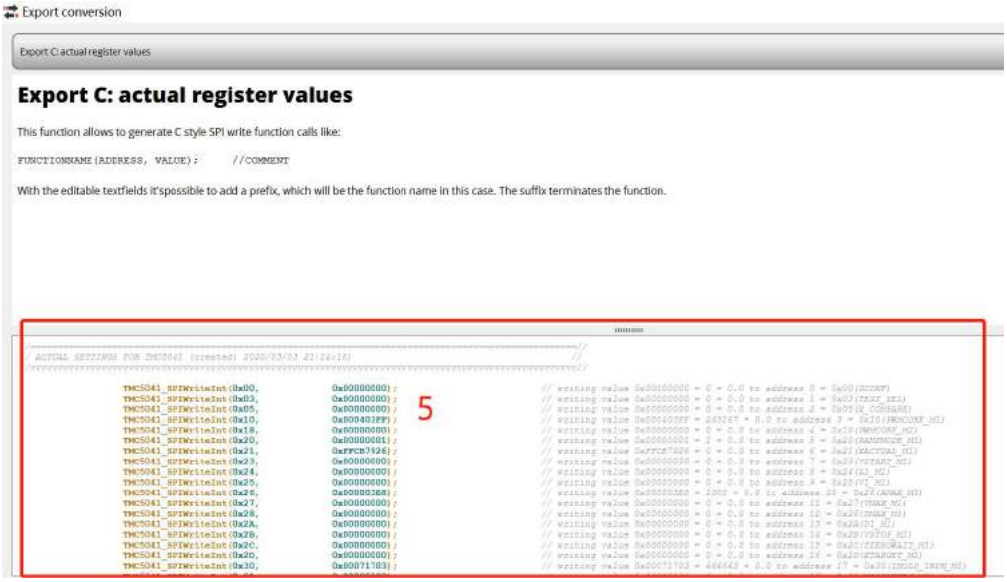


将下面 4 的代码复制到自己的 MCU 里面



或

将下面格式的代码复制到自己的 MCU 里面



TRINAMIC
MOTION CONTROL