

9 Velocity Based Mode Control

The TMC2160 allows the configuration of different chopper modes and modes of operation for optimum motor control. Depending on the motor load, the different modes can be optimized for lowest noise & high precision, highest dynamics, or maximum torque at highest velocity. Some of the features like coolStep or stallGuard2 are useful in a limited velocity range. A number of velocity thresholds allow combining the different modes of operation within an application requiring a wide velocity range.

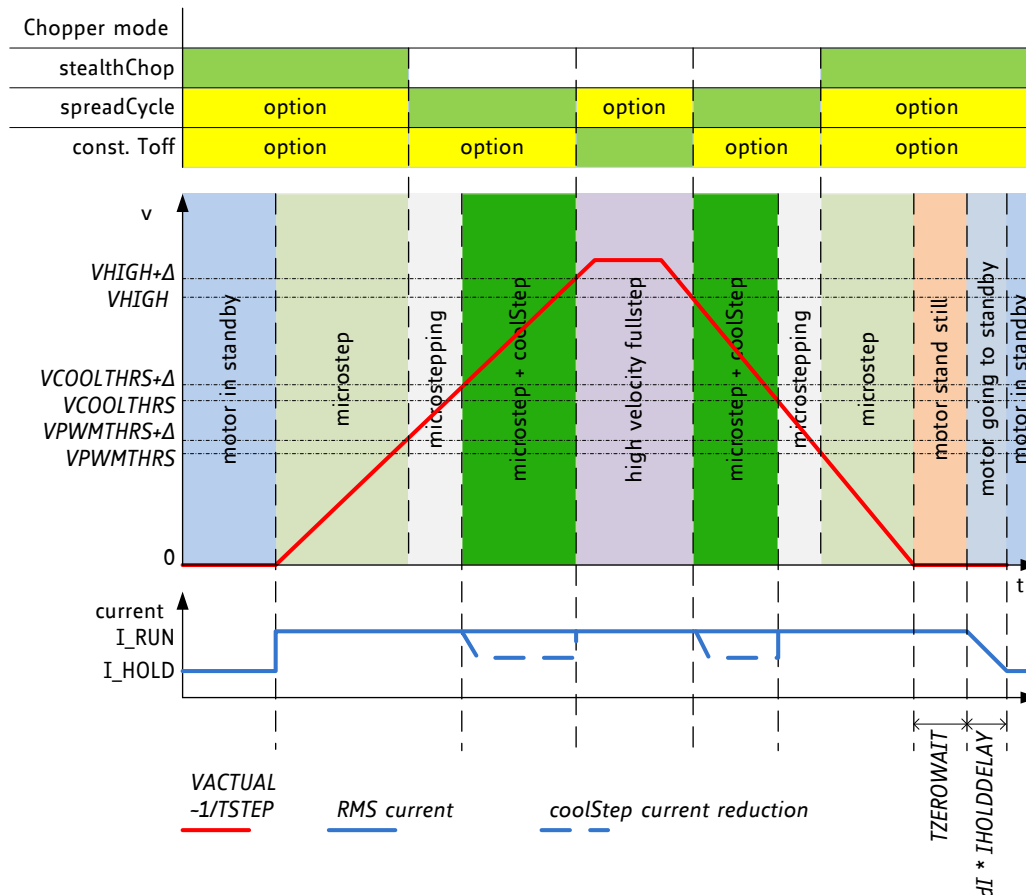


Figure 9.1 Choice of velocity dependent modes

Figure 9.1 shows all available thresholds and the required ordering. $V_{PWMTHRS}$, V_{HIGH} and $V_{COOLTHRS}$ are determined by the settings $TPWMTHRS$, $THIGH$ and $TCOOLTHRS$. The velocity is described by the time interval $TSTEP$ between each two step pulses. This allows determination of the velocity when an external step source is used. $TSTEP$ always becomes normalized to 256 microstepping. This way, the thresholds do not have to be adapted when the microstep resolution is changed. The thresholds represent the same motor velocity, independent of the microstep settings. $TSTEP$ becomes compared to these threshold values. A hysteresis of $1/16 TSTEP$ resp. $1/32 TSTEP$ is applied to avoid continuous toggling of the comparison results when a jitter in the $TSTEP$ measurement occurs. The upper switching velocity is higher by $1/16$, resp. $1/32$ of the value set as threshold. The stealthChop threshold $TPWMTHRS$ is not shown. It can be included with $V_{PWMTHRS} < V_{COOLTHRS}$. The motor current can be programmed to a run and a hold level, dependent on the standstill flag *stst*.

Using automatic velocity thresholds allows tuning the application for different velocity ranges. Features like coolStep will integrate completely transparently in your setup. This way, once parameterized, they do not require any activation or deactivation via software.

Parameter	Description	Setting	Comment
<i>stst</i>	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
<i>TPOWER DOWN</i>	This is the delay time after stand still (<i>stst</i>) of the motor to motor current power down. Time range is about 0 to 4 seconds.	0...255	Time in multiples of $2^{18} t_{CLK}$
<i>TSTEP</i>	Actual measured time between two 1/256 microsteps derived from the step input frequency in units of $1/f_{CLK}$. 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}
<i>TPWMTHRS</i>	$TSTEP \geq TPWMTHRS$ <ul style="list-style-type: none"> stealthChop PWM mode is enabled, if configured dcStep is disabled 	0...1048575	Setting to control the upper velocity threshold for operation in stealthChop
<i>TCOOLTHRS</i>	$TCOOLTHRS \geq TSTEP \geq THIGH$: <ul style="list-style-type: none"> coolStep is enabled, if configured stealthChop voltage PWM mode is disabled $TCOOLTHRS \geq TSTEP$ <ul style="list-style-type: none"> 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
<i>THIGH</i>	$TSTEP \leq THIGH$: <ul style="list-style-type: none"> coolStep is disabled (motor runs with normal current scale) stealthChop voltage PWM mode is disabled If <i>vhighchm</i> is set, the chopper switches to <i>chm</i>=1 with <i>TFD</i>=0 (constant off time with slow decay, only). If <i>vhighfs</i> 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
<i>small_hysteresis</i>	Hysteresis for step frequency comparison based on <i>TSTEP</i> (lower velocity threshold) and $(TSTEP*15/16)-1$ respectively $(TSTEP*31/32)-1$ (upper velocity threshold)	0	Hysteresis is 1/16
		1	Hysteresis is 1/32
<i>vhighfs</i>	This bit enables switching to fullstep, when <i>VHIGH</i> 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.	0	No switch to fullstep
		1	Fullstep at high velocities
<i>vhighchm</i>	This bit enables switching to <i>chm</i> =1 and <i>fd</i> =0, when <i>VHIGH</i> is exceeded. This way, a higher velocity can be achieved. Can be combined with <i>vhighfs</i> =1. If set, the <i>TOFF</i> setting automatically becomes doubled during high velocity operation in order to avoid doubling of the chopper frequency.	0	No change of chopper mode
		1	Classic const. Toff chopper at high velocities
<i>en_pwm_mode</i>	stealthChop voltage PWM enable flag (depending on velocity thresholds). Switch from off to on state while in stand still, only.	0	No stealthChop
		1	StealthChop below <i>VPWMTHRS</i>