8 Selecting Sense Resistors

The TMC2160 provides several means to set the motor current: Sense resistors, *GLOBALSCALER* and currentscale *CS*. To adapt a drive to the motor, choose a sense-resistor value fitting or slightly exceeding the maximum desired current at 100% settings of the scalers. Fine-tune the current to the specific motor via the 8 bit *GLOBALSCALER*. Situation specific motor current adaptation is done by 5 bit scalers (actual scale can be read via *CS*), controlled by coolStep, run- and hold current (*IRUN*, *IHOLD*). This makes the *CS* control compatible to other TRINAMIC ICs.

Set the desired maximum motor current by selecting an appropriate value for the sense resistor. The following table shows the RMS current values which are reached using standard resistors.

CHOICE OF R_{SENSE} AND RESULTING MAX. MOTOR CURRENT WITH *GLOBALSCALER*=255		
R_{SENSE} [Ω]	***RMS current [A] (CS=31)***	***Sine wave peak current [A] (CS=31)***
0.22	1.1	1.5
0.15	1.6	2.2
0.12	2.0	2.8
0.10	2.3	3.3
0.075	3.1	4.4
0.066	3.5	5.0
0.050	4.7	6.6
0.033	7.1	10.0
0.022	10.6	15.0

Sense resistors should be carefully selected. The full motor current flows through the sense resistors. Due to chopper operation the sense resistors see pulsed current from the MOSFET bridges. Therefore, a low-inductance type such as film or composition resistors is required to prevent voltage spikes causing ringing on the sense voltage inputs leading to unstable measurement results. Also, a low-inductance, low-resistance PCB layout is essential. A massive ground plane is best. Please also refer to layout considerations in chapter 25.

The sense resistor sets the upper current which can be set by software settings *IRUN*, *IHOLD* and *GLOBALSCALER*. Choose the sense resistor value so that the maximum desired current (or slightly more) flows at the maximum current setting (*GLOBALSCALER* = 0 and *IRUN* = 31).

CALCULATION OF RMS CURRENT

$$I_{RMS} = \frac{GLOBALSCALER}{256} * \frac{CS+1}{32} * \frac{V_{FS}}{R_{SENSE}} * \frac{1}{\sqrt{2}}$$

The momentary motor current is calculated by:

$$I_{MOT} = \frac{GLOBALSCALER}{256} * \frac{CUR_{A/B}}{248} * \frac{CS+1}{32} * \frac{V_{FS}}{R_{SENSE}}$$

GLOBALSCALER is the global current scaler. A setting of 0 is treated as full scale (256).
CS is the current scale setting as set by the *IHOLD* and *IRUN* and coolStep.
V_{FS} is the full scale voltage (please refer to electrical characteristics, V_{SRT}).
$CUR_{A/B}$ is the actual value from the internal sine wave table.
248 is the amplitude of the internal sine wave table.

The sense resistor needs to be able to conduct the peak motor coil current in motor standstill conditions, unless standby power is reduced. Under normal conditions, the sense resistor conducts

less than the coil RMS current, because no current flows through the sense resistor during the slow decay phases.

CALCULATION OF PEAK SENSE RESISTOR POWER DISSIPATION

$$P_{RSMAX} = {I_{COIL}}^2 * R_{SENSE}$$

Hint
For best precision of current setting, it is advised to measure and fine tune the current in the application. Choose the sense resistors to the next value covering the desired motor current. Set *IRUN* to 31 corresponding 100% of the desired motor current and fine-tune motor current using *GLOBALSCALER*.

Attention
Be sure to use a symmetrical sense resistor layout and short and straight sense resistor traces of identical length. Well matching sense resistors ensure best performance.
A compact layout with massive ground plane is best to avoid parasitic resistance effects.

Parameter	Description	Setting	Comment
IRUN	Current scale when motor is running. Scales coil current values as taken from the internal sine wave table. For high precision motor operation, work with a current scaling factor in the range 16 to 31, because scaling down the current values reduces the effective microstep resolution by making microsteps coarser. This setting also controls the maximum current value set by coolStep.	0 … 31	scaling factor 1/32, 2/32, … 32/32
IHOLD	Identical to *IRUN*, but for motor in stand still.		
IHOLD DELAY	Allows smooth current reduction from run current to hold current. *IHOLDDELAY* controls the number of clock cycles for motor power down after *TZEROWAIT* in increments of 2^18 clocks: 0=instant power down, 1..15: Current reduction delay per current step in multiple of 2^18 clocks. *Example:* When using *IRUN*=31 and *IHOLD*=16, 15 current steps are required for hold current reduction. A *IHOLDDELAY* setting of 4 thus results in a power down time of 4*15*2^18 clock cycles, i.e. roughly one second at 16MHz.	0	instant *IHOLD*
		1 … 15	$1*2^{18}$ … $15*2^{18}$ clocks per current decrement
GLOBAL SCALER	Allows fine control of the motor current range setting	0 … 255	scales in 1/256 steps 0=full scale