

TMC2160 DATASHEET

Universal high voltage driver for two-phase bipolar stepper motor. stealthChop™ for quiet movement. External MOSFETs for up to 20A motor current per coil. With Step/Dir Interface and SPI.



APPLICATIONS

Robotics & Industrial Drives
Textile, Sewing Machines
Packing Machines
Factory & Lab Automation
High-speed 3D Printers
Liquid Handling
Medical
Office Automation
CCTV
ATM, Cash Recycler
Pumps and Valves

FEATURES AND BENEFITS

2-phase stepper motors up to 20A coil current (external MOSFETs)

Step/Dir Interface with microstep interpolation **microPlyer™**

Voltage Range 8 ... 60V DC

SPI Interface

Highest Resolution 256 microsteps per full step

stealthChop2™ for quiet operation and smooth motion

Resonance Dampening for mid-range resonances

spreadCycle™ highly dynamic motor control chopper

dcStep™ load dependent speed control

stallGuard2™ high precision sensorless motor load detection

coolStep™ current control for energy savings up to 75%

Passive Braking and freewheeling mode

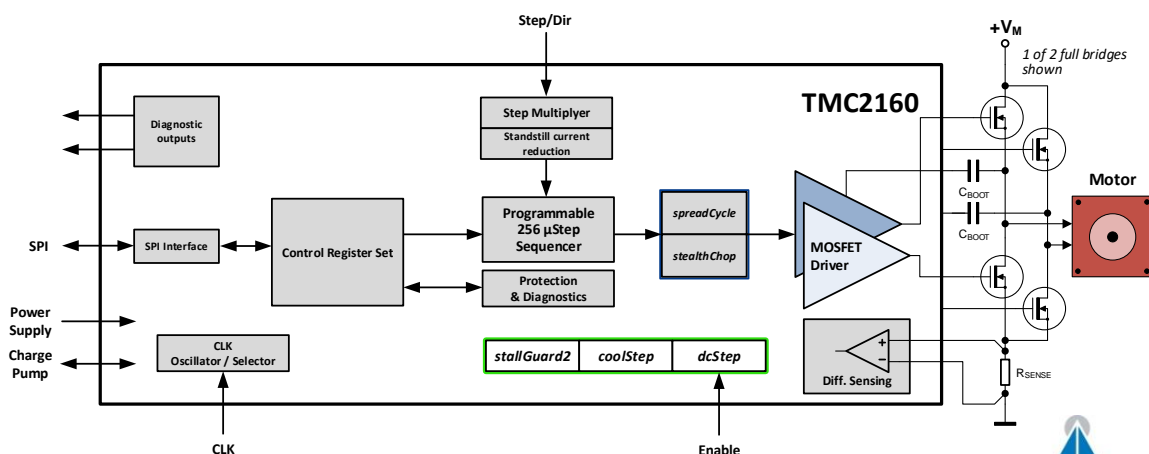
Full Protection & Diagnostics

Compact Size 9x9mm² TQFP48 package

DESCRIPTION

The TMC2160 is a high-power stepper motor driver IC with SPI interface. It features industries' most advanced stepper motor driver with simple Step / Direction interface. Using external transistors, highly dynamic, high torque drives can be realized. Based on TRINAMICs sophisticated spreadCycle and stealthChop choppers, the driver ensures absolutely noiseless operation combined with maximum efficiency and best motor torque. High integration, high energy efficiency and a small form factor enable miniaturized and scalable systems for cost effective solutions. The fully compatible TMC5160 offers an additional motion controller to make stepper motor control even easier.

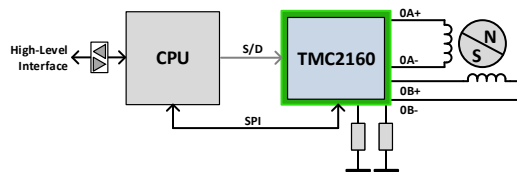
BLOCK DIAGRAM



APPLICATION EXAMPLES: HIGH VOLTAGE – MULTIPURPOSE USE

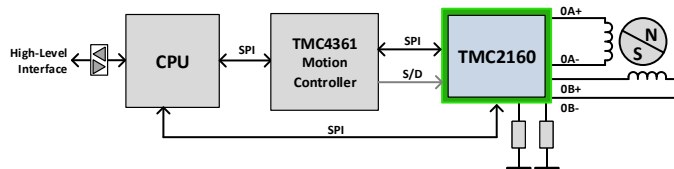
The TMC2160 scores with advanced motor commutation algorithms, combined with powerful external MOSFET driver stages, and high-quality current regulation. It offers a versatility that covers a wide spectrum of applications from battery powered, high efficiency systems up to embedded applications with 20A motor current per coil. Based on TRINAMICs unique features stallGuard2, coolStep, dcStep, spreadCycle, and stealthChop, the TMC2160 optimizes drive performance. It trades off velocity vs. motor torque, optimizes energy efficiency, smoothness of the drive, and noiselessness. The small form factor of the TMC2160 keeps costs down and allows for miniaturized layouts. Extensive support at the chip, board, and software levels enables rapid design cycles and fast time-to-market with competitive products. High energy efficiency and reliability deliver cost savings in related systems such as power supplies and cooling. For smaller designs, the compatible, integrated TMC2130 driver provides 1.4A of motor current.

MINIATURIZED DESIGN FOR ONE STEPPER MOTOR

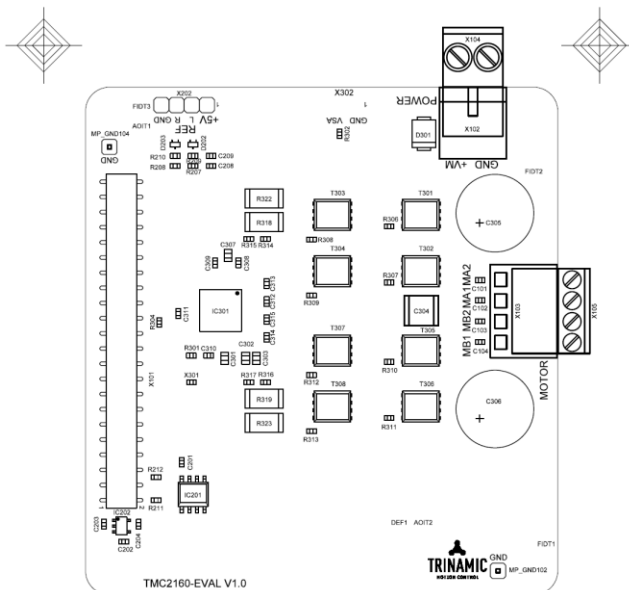


In this application, the CPU initializes the TMC2160 motor driver via SPI interface and controls motor movement by sending step and direction signals. A real time software realizes motion control.

DESIGN FOR DEMANDING APPLICATIONS WITH S-SHAPED RAMP PROFILES



The CPU initializes the TMC4361 motion controller and the TMC2160. Thereafter, it sends target positions to the TMC4361. Now, the TMC4361 takes control over the TMC2160. Combining the TMC4361 and the TMC2160 offers diverse possibilities for demanding applications including servo drive features.



Assembly Drawing Top

TMC2160-EVAL V1.0 04.06.2018

The TMC2160-EVAL is part of TRINAMICs universal evaluation board system which provides a convenient handling of the hardware as well as a user-friendly software tool for evaluation. The TMC2160 evaluation board system consists of three parts: LANDUNGSBRÜCKE (base board), ESELSBRÜCKE (connector board including several test points), and TMC2160-EVAL.

ORDER CODES

Order code	Description	Size [mm ²]
TMC2160-TA	stepper controller/driver for external MOSFETs; TQFP48	9 x 9
TMC2160-TA-T	-T denotes tape on reel packing	
TMC2160-EVAL	Evaluation board for TMC2160 two phase stepper motor controller/driver	85 x 55
LANDUNGSBRÜCKE	Baseboard for TMC2160-EVAL and further evaluation boards.	85 x 55
ESELSBRÜCKE	Connector board for plug-in evaluation board system.	61 x 38

Table of Contents

1	PRINCIPLES OF OPERATION	5	11	STALLGUARD₂ LOAD MEASUREMENT ...	68
1.1	KEY CONCEPTS.....	6	11.1	TUNING STALLGUARD ₂ THRESHOLD SGT	69
1.2	CONTROL INTERFACES.....	6	11.2	STALLGUARD ₂ UPDATE RATE AND FILTER	71
1.3	SOFTWARE.....	7	11.3	DETECTING A MOTOR STALL.....	71
1.4	MOVING THE MOTOR	8	11.4	HOMING WITH STALLGUARD.....	71
1.5	AUTOMATIC STANDSTILL POWER DOWN.....	8	11.5	LIMITS OF STALLGUARD ₂ OPERATION	71
1.6	STEALTHCHOP ₂ & SPREADCYCLE DRIVER.....	8	12	COOLSTEP OPERATION.....	72
1.7	STALLGUARD ₂ – MECHANICAL LOAD SENSING	9	12.1	USER BENEFITS.....	72
1.8	COOLSTEP – LOAD ADAPTIVE CURRENT		12.2	SETTING UP FOR COOLSTEP	72
	CONTROL.....	9	12.3	TUNING COOLSTEP.....	74
1.9	DCSTEP – LOAD DEPENDENT SPEED CONTROL	9	13	STEP/DIR INTERFACE.....	75
2	PIN ASSIGNMENTS.....	11	13.1	TIMING.....	75
2.1	PACKAGE OUTLINE.....	11	13.2	CHANGING RESOLUTION	76
2.2	SIGNAL DESCRIPTIONS	11	13.3	MICROPLYER AND STAND STILL DETECTION .	77
3	SAMPLE CIRCUITS	14	14	DIAG OUTPUTS.....	78
3.1	STANDARD APPLICATION CIRCUIT	14	15	DCSTEP	79
3.2	EXTERNAL GATE VOLTAGE REGULATOR.....	15	15.1	USER BENEFITS.....	79
3.3	CHOOSING MOSFETS AND SLOPE.....	16	15.2	DESIGNING-IN DCSTEP	79
3.4	TUNING THE MOSFET BRIDGE	18	15.3	STALL DETECTION IN DCSTEP MODE	80
4	SPI INTERFACE	21	15.4	DCSTEP WITH STEP/DIR INTERFACE	81
4.1	SPI DATAGRAM STRUCTURE	21	16	SINE-WAVE LOOK-UP TABLE.....	84
4.2	SPI SIGNALS.....	22	16.1	USER BENEFITS.....	84
4.3	TIMING	23	16.2	MICROSTEP TABLE	84
5	REGISTER MAPPING.....	24	17	EMERGENCY STOP	85
5.1	GENERAL CONFIGURATION REGISTERS	25	18	QUICK CONFIGURATION GUIDE.....	86
5.2	VELOCITY DEPENDENT DRIVER FEATURE		19	GETTING STARTED.....	90
	CONTROL REGISTER SET	31	19.1	INITIALIZATION EXAMPLES	90
5.3	MOTOR DRIVER REGISTERS.....	34	20	STANDALONE OPERATION	91
6	STEALTHCHOP™.....	44	21	EXTERNAL RESET	93
6.1	AUTOMATIC TUNING	44	22	CLOCK OSCILLATOR AND INPUT.....	93
6.2	STEALTHCHOP OPTIONS	47	22.1	USING THE INTERNAL CLOCK	93
6.3	STEALTHCHOP CURRENT REGULATOR.....	47	22.2	USING AN EXTERNAL CLOCK	93
6.4	VELOCITY BASED SCALING.....	49	23	ABSOLUTE MAXIMUM RATINGS	94
6.5	COMBINING STEALTHCHOP AND SPREADCYCLE..		24	ELECTRICAL CHARACTERISTICS	94
	51	24.1	OPERATIONAL RANGE.....	94
6.6	FLAGS IN STEALTHCHOP.....	53	24.2	DC AND TIMING CHARACTERISTICS.....	95
6.7	FREEWHEELING AND PASSIVE BRAKING	53	24.3	THERMAL CHARACTERISTICS.....	97
7	SPREADCYCLE AND CLASSIC CHOPPER ...	55	25	LAYOUT CONSIDERATIONS.....	99
7.1	SPREADCYCLE CHOPPER	56	25.1	EXPOSED DIE PAD.....	99
7.2	CLASSIC CONSTANT OFF TIME CHOPPER.....	59	25.2	WIRING GND	99
8	SELECTING SENSE RESISTORS.....	61	25.3	SUPPLY FILTERING.....	99
9	VELOCITY BASED MODE CONTROL.....	63	25.4	LAYOUT EXAMPLE	100
10	DIAGNOSTICS AND PROTECTION.....	65	26	PACKAGE MECHANICAL DATA.....	102
10.1	TEMPERATURE SENSORS	65			
10.2	SHORT PROTECTION.....	65			
10.3	OPEN LOAD DIAGNOSTICS.....	67			

26.1	DIMENSIONAL DRAWINGS TQFP48-EP.....	102	29	TABLE OF FIGURES	106
26.2	PACKAGE CODES	104	30	REVISION HISTORY.....	107
27	DISCLAIMER	105	31	REFERENCES	107
28	ESD SENSITIVE DEVICE.....	105			