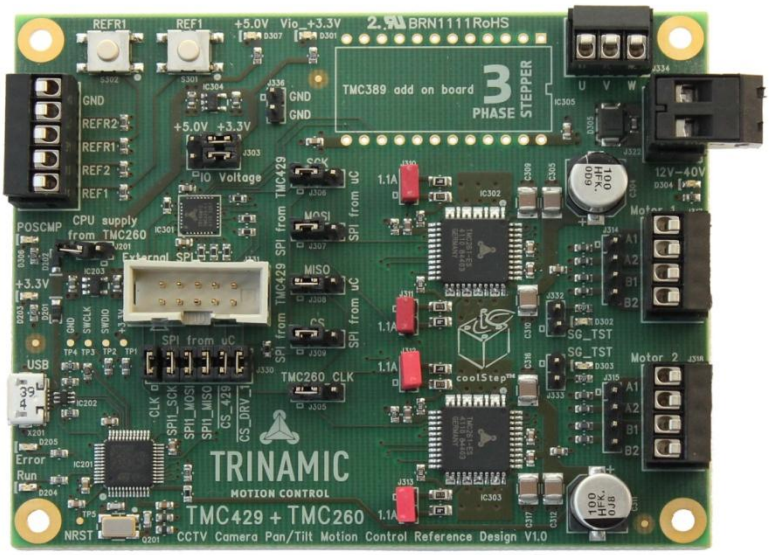
TMC429 + TMC260

CCTV Camera Pan/Tilt Motion Control Reference Design V1.0



Manual

draft / preliminary

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MOTION CONTROL

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1 Life support policy

TRINAMIC Motion Control GmbH & Co. KG does not authorize or warrant any of its products for use in life support systems, without the specific written consent of TRINAMIC Motion Control GmbH & Co. KG.

Life support systems are equipment intended to support or sustain life, and whose failure to perform, when properly used in accordance with instructions provided, can be reasonably expected to result in personal injury or death.

2 Features

The TMC429 + TMC260 CCTV board is a reference design for evaluation of the motion controller TMC429, the stepper motor driver TMC260 and the three phase stepper motor driver TMC389, designated for controlling CCTV cameras with Pan/Tilt function.

Applications
- CCTV camera motion control application with optional reference switches

Electrical data
- Supply voltage: Common supply voltages +12VDC to +40VDC
- Programmable motor current up to 1.2A RMS

Integrated bipolar stepper motor drivers TMC260 (optional TMC261)
- Up to 256 micro steps per full step
- Dynamic current control
- Integrated protection
- High precision sensorless motor load measurement stallGuard2™
- Automatic load dependent motor current adaptation for reduced power consumption and heat dissipation (coolStep™)

Option for evaluation of the integrated three phase stepper motor driver TMC389 using add-on board

Interfaces
- USB (USB-MicroB)
- external SPI™
- reference switch inputs
- stallGuard2™ signal outputs

Software
- PC-based stand-alone evaluation software available for free

3 Mechanical and electrical interfacing

3.1 TMC429 + TMC260 CCTV Reference Design V1.0 dimensions

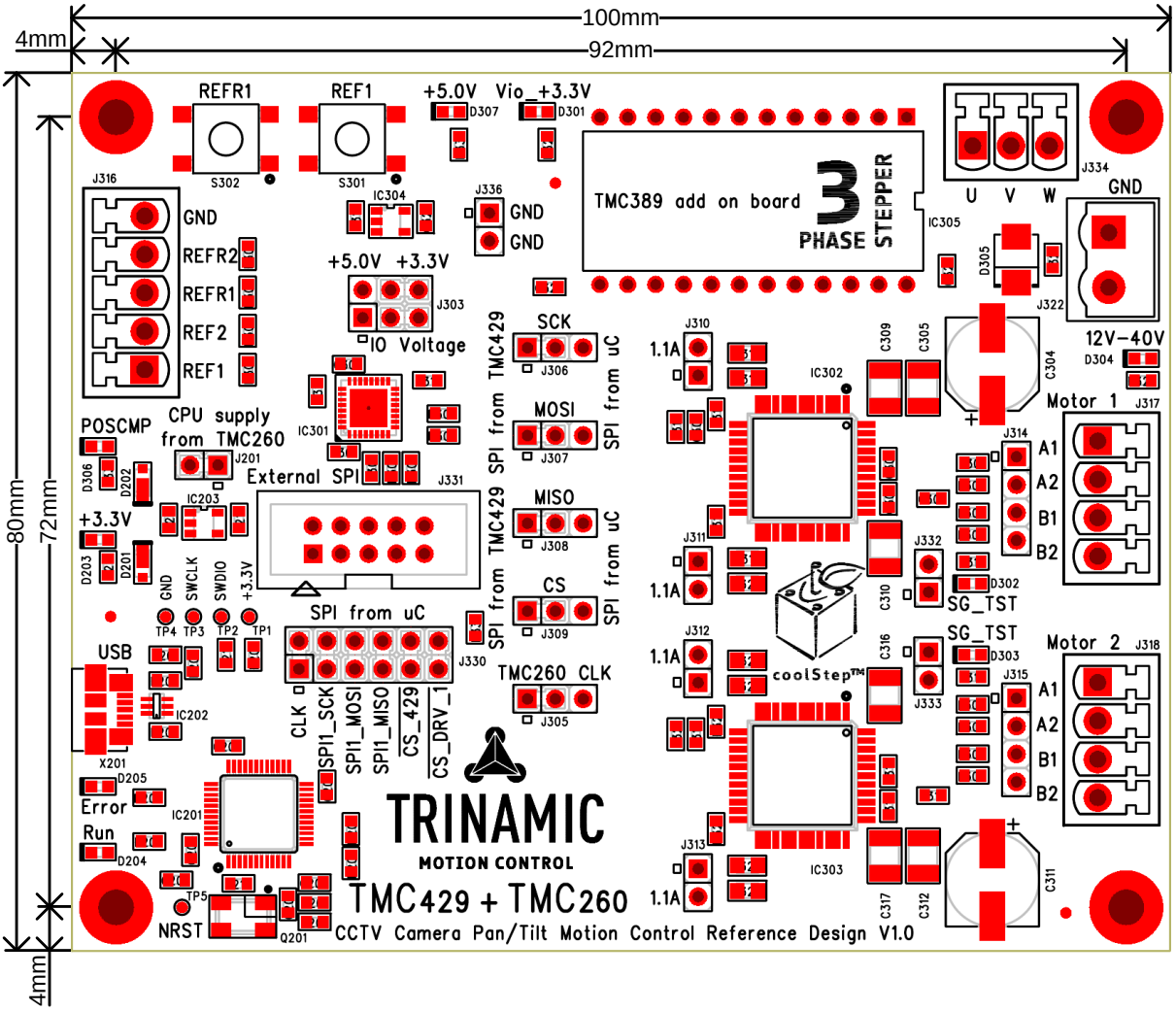


Figure 3.1 Dimensions of TMC429 + TMC260 CCTV Reference Design Board

4 Connectors & Keys

The TMC429 + TMC260 CCTV board can be used to evaluate the TMC429 motion controller, the stepper motor driver TMC260 and the three phase stepper motor driver TMC389 and is especially designed for the control of CCTV pan/tilt cameras.
It is also a reference for the output stage PCB layout which can affect the overall performance of a design.

The board offers two connectors for two phase stepper motors, one connector with reference switch inputs for the two phase motors and one connector for a three phase motor. An optional three phase motor is controlled from an add on board by a TMC389.
The external interfacing is given by a MicroB USB port and a connector for optional SPI communication from an external microcontroller.

The two reference switches for motor 1 can be simulated via REF1 (left reference switch of motor 1) and REFR1 (right reference switch of motor 1).

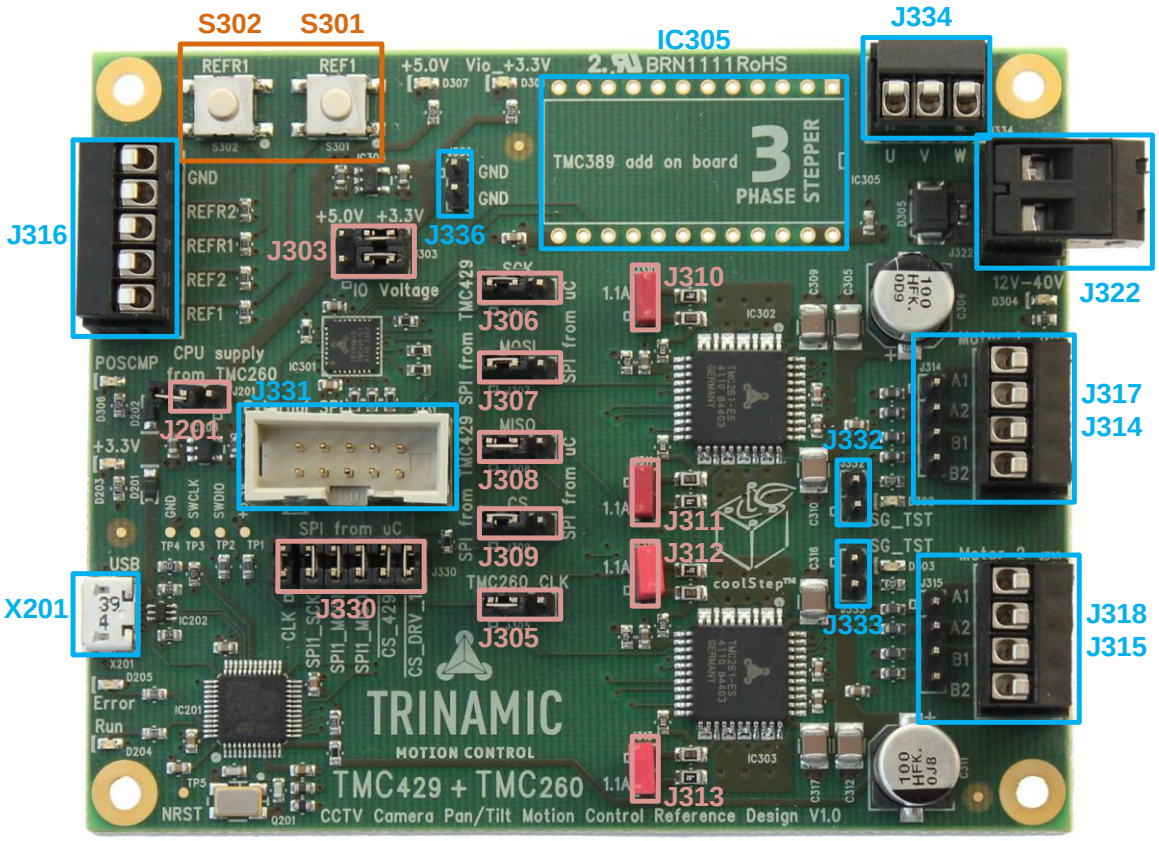


Figure 4.1 Connectors of TMC429+TMC26x-EVAL Evaluation Board

Key	Label	Description
S301	REF1	left reference switch for stepper motor 1
S302	REFR1	right reference switch for stepper motor 1

Table 4.1: Key overview

Connector	Label	Description
J322	12V-40V	standard power supply 12V ... 40V
J317 J314	Motor1 A1 A2 B1 B2	stepper motor 1 (two phase stepper)
J332	SG_TST	stallGuard™ output of motor driver 1 and ground pin
J318 J315	Motor2 A1 A2 B1 B2	stepper motor 2 (two phase stepper)
J333	SG_TST	stallGuard™ output of motor driver 2 and ground pin
IC305	TMC389 add on board	socket for the TMC389 add on board
J334	U V W	stepper motor 3 (three phase stepper)
J316	REF	reference switch inputs
J331	External SPI	external access to the SPI lines
X201	USB	USB-MicroB connector for PC connection
J336	GND	Two headers connected to ground for measurements

Table 4.2: Connector overview

Jumper	Label	Description
J201	CPU supply from TMC260	Enables power supply of the microcontroller if USB is unplugged. This jumper should always be set unless the SPI and clock signals are provided externally.
J330	SPI from uC	These six jumpers connect the SPI lines and the clock signal from the microcontroller to the TRINAMIC chipset. They should always be set unless these signals are provided externally.
J303	IO voltage	These two jumpers are used to set the IO voltage of the TRINAMIC chipset. They always have to be both at the same setting, either 3.3V or 5V. Unless an external microcontroller running at 5V is used, they have to be set to 3.3V.
J305	TMC260 CLK	Selects the clock source for the TMC260 between external clock from the microcontroller or J331 (1-2) and the internal clock generators (2-3)
J306	SCK	Selection of the source of the SPI signals to the TMC260. These jumpers have to be set equally either to "SPI from TMC429" (1-2) or to "SPI from uC" (2-3).
J307	MOSI	
J308	MISO	
J309	CS	
J310 J311	1.1A	Selection of current sense resistors for motor 1. Both jumpers have either to be open or closed.
J312 J313	1.1A	Selection of current sense resistors for motor 2. Both jumpers have either to be open or closed.

Table 4.3: Jumper overview

The naming scheme of the keys, connectors and jumpers is associated with the pages of the schematic – for example X**2**01 (USB) is on page **2** of the schematic, IC**3**05 is on page **3** of the schematic.

Connector Type	Vendor, WWW, Type, Order Number
Power	RIA-CON, http://www.ria-connect.net/en/home, Type 349, 2 way, 313 491 02
Motor (3 phase)	RIA-CON, http://www.ria-connect.net/en/home, Type 169, 3 way, 311 691 03
Motor (2 phase)	RIA-CON, http://www.ria-connect.net/en/home, Type 169, 4 way, 311 691 04
Reference switch input	RIA-CON, http://www.ria-connect.net/en/home, Type 169, 5 way, 311 691 05

Table 4.4: Connector types

4.1.1 Power supply

When using supply voltages near the upper limit, a regulated power supply is mandatory. Under normal conditions, with the relatively small motors used in CCTV systems, no special precautions are required. However, under certain conditions additional power filtering capacitors might be required in the system (2200µF or more recommended) in order to absorb mechanical energy fed back by the motor in stalling conditions.

The power supply should be able to supply the nominal motor voltage at the desired maximum motor power. ***In no case shall the supply voltage exceed the upper voltage limit.***

To ensure reliable operation of the unit, the power supply has to have a sufficient output capacitor and the supply cables should have a low resistance, so that the chopper operation does not lead to an increased power supply ripple directly at the unit. Power supply ripple due to the chopper operation should be kept at a maximum of a few 100mV.

Guidelines for power supply:

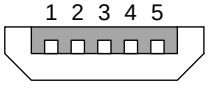
a) keep power supply cables as short as possible
b) use large diameters for power supply cables
c) add 2200µF or larger filter capacitors near the motor driver unit especially if the distance to the power supply is large (i.e. more than 2-3m)

Pin	Label	Description
1	GND	power ground
2	+12V ... +40V	power supply up to 40V

Table 4.5: Connector 12V-40V

4.1.2 USB connector (USB-MicroB)

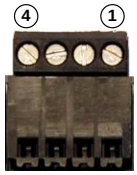
A 5-pin standard USB-MicroB connector is available on board.



Pin	Label	Description
1	VBUS	+5V power
2	D-	Data –
3	D+	Data +
4	ID	Pulled to Ground
5	GND	Ground

Table 4.6: USB-MicroB connector

4.1.3 Two phase stepper motor connectors



Pin	Label	Description
1	A1	Motor coil A
2	A2	Motor coil A
3	B1	Motor coil B
4	B2	Motor coil B

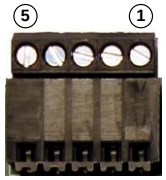
Table 4.7: Connector for two phase stepper motor

4.1.4 Three phase stepper motor connector

Pin	Label	Description
1	U	Motor phase U
2	V	Motor phase V
3	W	Motor phase W

Table 4.8: Connector for three phase stepper motor

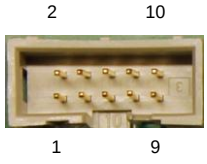
4.1.5 Reference switch connector



Pin	Label	Description
1	REF1	Left reference switch for motor 1
2	REF2	Left reference switch for motor 2
3	REFR1	Right reference switch for motor 1
4	REFR2	Right reference switch for motor 2
5	GND	Ground

Table 4.9: Connector for ABN incremental encoder

4.1.6 External SPI connector (on-board)



Pin	Label	Description
1	GND	Ground
2	CLK	Clock signal for TMC429 and TMC260
3	TMC_VIO	I/O voltage of the TRINAMIC chipset (TMC429, TMC260, TMC389)
4	SCK	SPI clock to the TRINAMIC chipset
5	POSCMP	POSCMP signal from the TMC429
6	MOSI	SPI data to the TRINAMIC chipset
7	nINT_SDO_C	Interrupt signal/SPI data from the TMC429
8	MISO	SPI data from the whole TRINAMIC chipset
9	nCS_DRV	Chip select signal for the TMC260 drivers
10	nCS_429	Chip select signal for the TMC429

Table 4.10: External SPI connector

5 Operational ratings

The operational ratings shown below should be used as design values. In no case should the maximum values been exceeded during operation.

The maximum power supply current need depends on the used motors and the supply voltage.

Symbol	Parameter	Min	Typ	Max	Unit
V12V40	Power supply voltage for operation	12	12, 24	40	V
I_{COIL_RMS}	Continuous motor current (**RMS**)	0.10		1.2	A
I_{SUPPLY}	Power supply current idle (drivers off)		50		mA
I_{SUPPLY}	Power supply current operating		<1 *)		A
T_{ENV}	Environment temperature at rated current (no forced cooling required)		tbd		°C

Table 5.1: General operational ratings of the module

*) Required current rating depends on the selected motors and the motor current. A typical small sized stepper motor comes with 2W to 7W of power dissipation. Taking into account driver efficiency, the required power increase by 10% to 20%.

Symbol	Parameter	Min	Type	Max	Unit
V_{REFSWT}	Input voltage for reference switches	0		3.3	V
V_{EXTSPI}	Input voltage for external SPI	0		3.3 or 5 Set by J303	V

Table 5.2: Operational ratings of IO signals

6 Functional description

The main parts of the TMC429 + TMC260 CCTV board are shown below. The board is equipped with a µC, TMC429 motion controller, and stepper motor drivers. The TMC260 stepper motor drivers are for two phase stepper motors, the TMC389 stepper motor driver (add on board) is for a three phase stepper motor.
The drivers can be controlled either in SPI mode or in Step/Direction mode. The TMC389 is always used in Step/Direction mode.

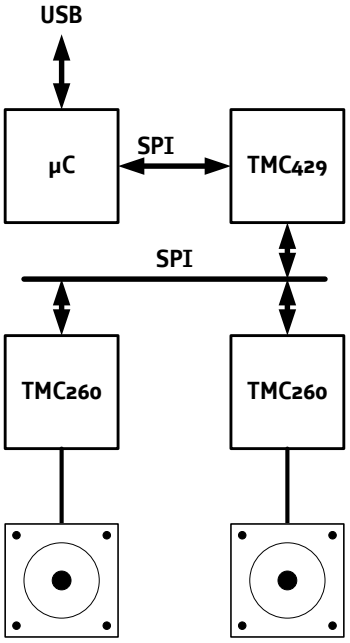


Figure 6.1: Functional block diagram of the TMC429 + TMC260 CCTV board V1.0 in SPI mode

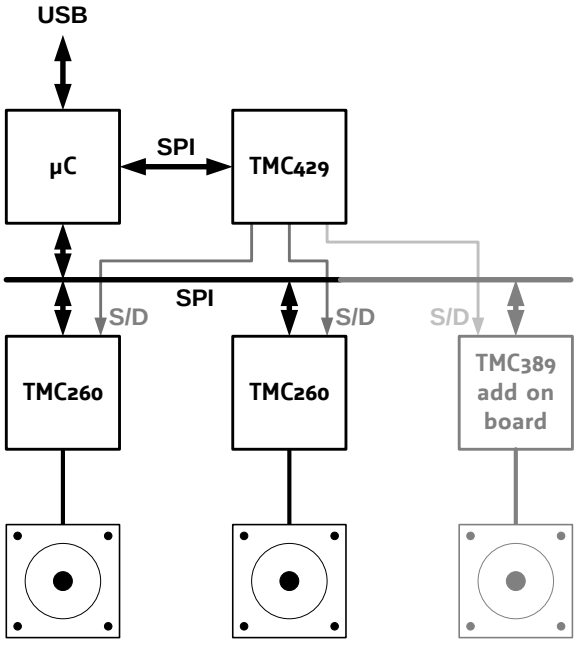


Figure 6.2: Functional block diagram of the TMC429 + TMC260 CCTV board V1.0 in Step/Dir mode

6.1 System architecture

The evaluation board is controlled by an evaluation software on a PC.

6.1.1 Microcontroller

On the evaluation board the ST STM32F103 is used for the configuration and control of the TRINAMIC chipset. The CPU has 64KB flash memory and a 20KB SRAM.

6.1.2 Difference between SPI and Step/Direction modes

There are two possibilities to control the two TMC260. In Step/Direction mode, the TMC429 sends step pulses and a direction signal to the two TMC260, which use their internal sine wave table to calculate the right phase current value for each step. In SPI mode, the TMC429 directly sends the current values for the two motor phases in an SPI datagram to the two TMC260. This allows an adaption of the sine wave to specific motor properties to obtain an undistorted sine wave as actual motor current.

7 Getting Started – How to run a Motor

Important Hint: *Never connect or disconnect a motor while it is powered or turning.* Connecting or disconnecting a motor while current flowing through a coil of the motor might damage the motor driver due to inductive high-voltage – no matter if the motor is at reset or turning. Turning a motor induces a voltage called Back-EMF (back electromagnetic force). Turning a motor externally (e.g. by a spring or flywheel mass) drives currents through the coils of the motor and this causes inductive high-voltage while connecting or disconnecting that might damage a motor driver.

7.1 Motor current setting

Three settings have influence on the final motor current

- The setting of the sense resistor jumpers
- The VSENSE bit in the TMC260
- The CS value in the TMC260

The board allows four maximum currents that can be scaled from 1/32 to 32/32 with the CS setting.

Sense resistor jumpers	Sense resistor value	VSENSE	Comparator voltage	Maximum current
open	0.47 Ohm	0	310mV	0.66A peak 0.47A RMS
closed	0.15 Ohm	0	310mV	2.07A peak 1.46A RMS **See Note below**
open	0.47 Ohm	1	165mV	0.35A peak 0.25A RMS
closed	0.15 Ohm	1	165mV	1.1A peak 0.78A RMS

Table 7.1: Motor current settings

Important Note: The second setting (jumpers closed, VSENSE=0) exceeds the rated maximum current for the TMC260 MOSFETs. The CS setting must be 26 or lower to stay in the operating range.

7.2 Evaluation Software Operation

To run a stepper motor, connect a stepper motor to connector M1. Then connect the power supply to connector **12V-40V** with a supply voltage in range 12V to 40V.

Then connect the USB cable from the PC to the board. If you connect the USB first time, you will be asked for the virtual com port configuration file TMCM-2111.inf that is required for configuration of a virtual com port.

Then start the CCTV.exe software and follow section **Fehler! Verweisquelle konnte nicht gefunden werden.** REF _Ref287638391 \h * MERGEFORMAT **Fehler! Verweisquelle konnte nicht gefunden werden.**, page **Fehler! Textmarke nicht definiert.**.

8 Revision history

8.1 Document revision

Version	Date	Author	Description
0.01	2011-APR-13	SL	Initial version

Table 8.1: Document revision

8.2 Hardware revision

Version	Date	Description
TMC429 + TMC260 CCTV Reference Design V1.0	2011-MAR-05	TMC429 + TMC260 CCTV Camera Pan/Tilt Motion Control Reference Design first version without TMC389 add on board

Table 8.2: Hardware revision

8.3 Firmware revision

Version	Date	Description

Table 8.3: Firmware revision

8.4 Software revision (PC Application Software Revision)

Version	Date	Description

Table 8.4: Software revision

9 References

[TMC260/TMC261/TMC260]	TMC262 / TMC261 / TMC260 Datasheet
[TMC429]	TMC429 Datasheet

Please refer to www.trinamic.com