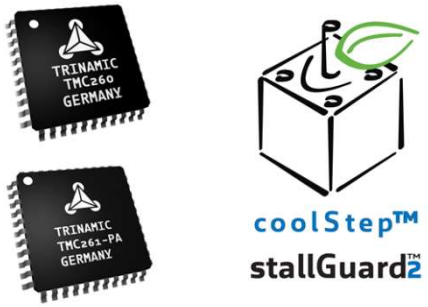

TRINAMIC
MOTION CONTROL

TMC260-PA / TMC261-PA
STEPPER MOTOR DRIVER

Product Training Module (PTM)



TMC260/TMC261 – GETTING STARTED

The TMC260 and TMC261 are drivers for two-phase stepper motors.

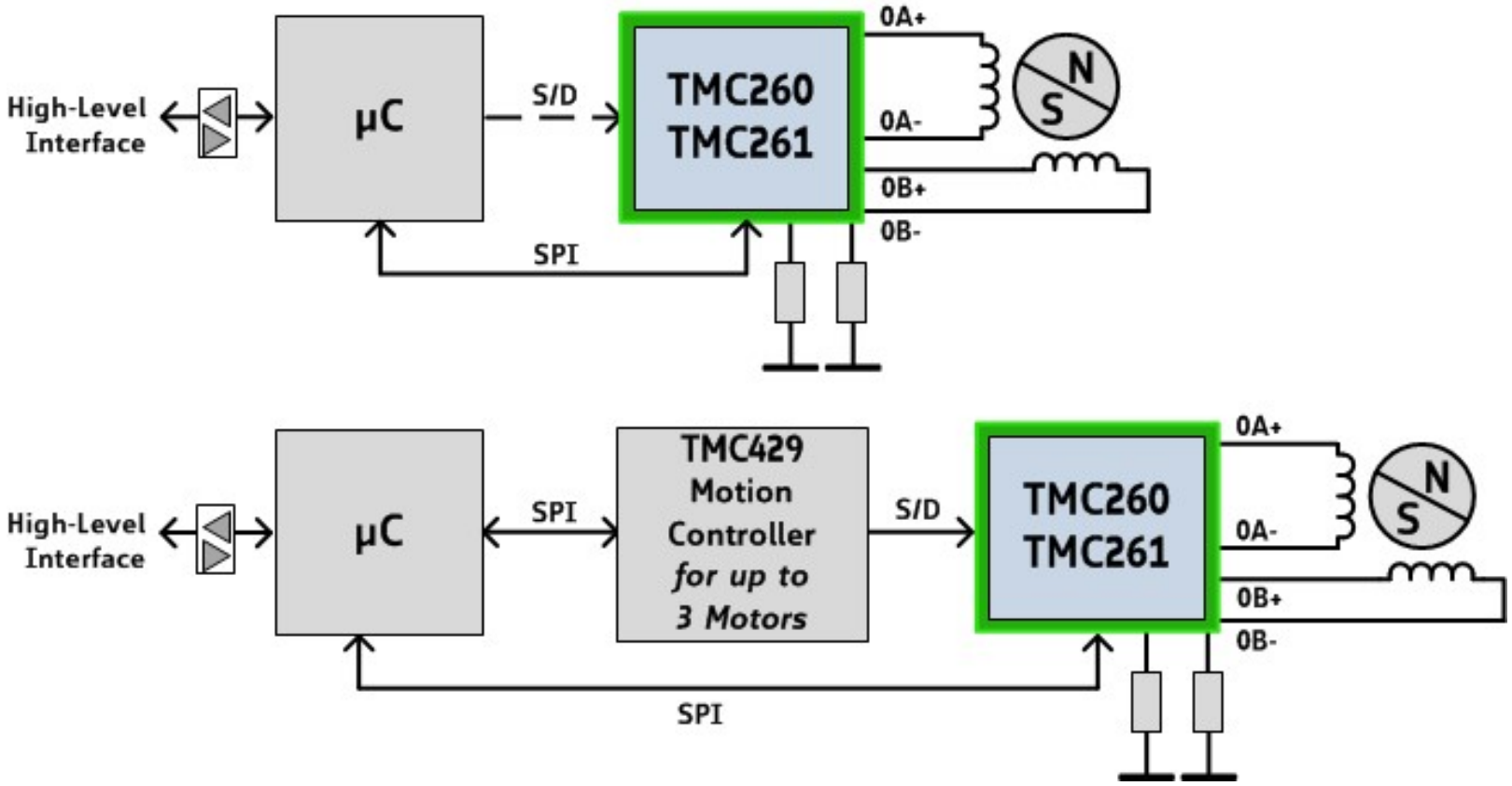
They offer an industry-leading feature set, including high-resolution micro-stepping, sensorless mechanical load measurement, load-adaptive power optimization, and low-resonance chopper operation. Standard SPI™ and STEP/DIR interfaces simplify communication.

The TMC260 and TMC261 integrate two complete MOSFET H-bridges for motor currents up to 2A and up to 40V (TMC260) or 60V (TMC261). Integrated protection and diagnostic features support robust and reliable operation.

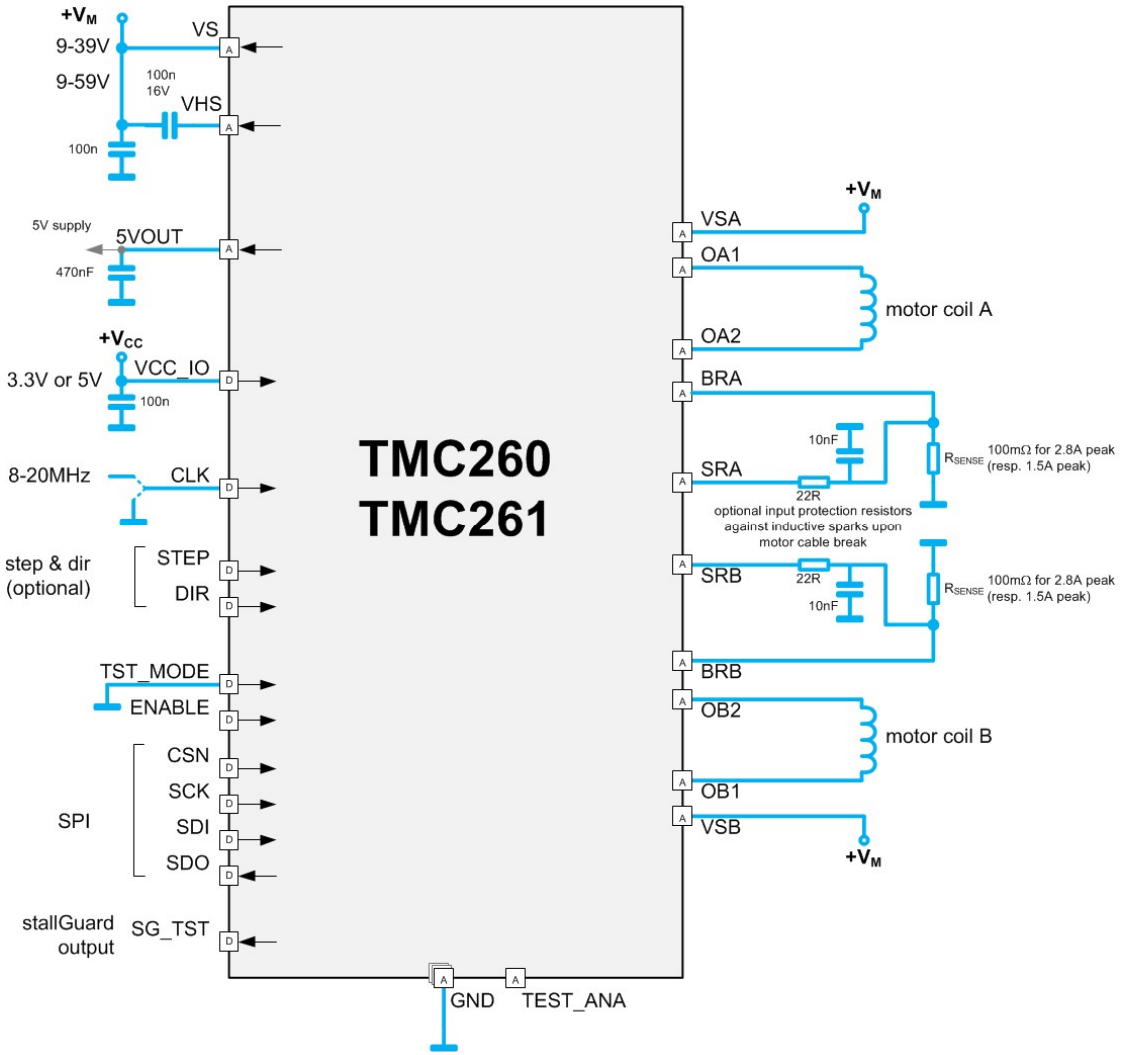
Typical applications:

Textile, Sewing Machines / Factory Automation / Lab Automation / Liquid Handling / Medical / Office Automation / Printer and Scanner / CCTV, Security / ATM, Cash recycler / POS / Pumps and Valves / Heliostat Controller / CNC Machines

GENERAL SYSTEM ARCHITECTURE



WHAT IS REQUIRED FOR A STANDARD SETUP?



HOW TO SELECT R_{SENSE}?

$$R_{sense} = \frac{248}{256} * \frac{(CS+1)}{32} * \frac{V_{FS}}{I_{rms}} * \frac{1}{\sqrt{2}}$$

$$P_{RSMAX} = \frac{\left(V_{FS} * \frac{CS+1}{32}\right)^2}{R_{SENSE}}$$

Use `CS = 31` and `VSENSE = 0` ($V_{FS} = 310mV$), and your required absolute maximum RMS current for calculation.

Example: $I_{RMS} = 1A$

$$\rightarrow R_{sense} \approx 220m\Omega$$

$$\rightarrow P_{RSMAX} = 0.22W$$

HOW TO SELECT MOSFETS?

1. No MOSFETs must be selected → the TMC260 and TMC261 have integrated power stages consisting of 8 MOSFETs = 2 full bridges

Use the TMC260/1 spreadsheet to calculate power dissipation of the TMC260/TMC261 driver *stage* with your application parameters: download link

INTERNAL OR EXTERNAL CLOCK?

- Internal CLK is ca.15 MHz / external CLK range: 4 MHz to 20 MHz
- Why using internal CLK ?
  - Standalone operation, save extra CLK source, good choice for most applications
- Why using external CLK ?
  - For well defined precise motor chopper operation, an external clock source with stable and known frequency is suggested
  - Higher CLK frequency allows for faster step rates, faster SPI operation, and higher chopper frequencies but may also cause more electromagnetic emission and more power dissipation.
  - Use same CLK base as other ICs in the application
  - Can be derived from a microcontroller, does not require extra part
- If the application can tolerate reduced motor velocity and increased chopper noise, a clock frequency of 4MHz to 10MHz should be considered.
- Generally, a system clock frequency of 10MHz to 16MHz should be sufficient for most applications.
- A chopper frequency > 16MHz is suggested when operating a motor at the highest velocities.

WHAT ELSE IS IMPORTANT?

The ICs offer a high driver current. Despite low switch ON resistance, cooling is essential.

Therefore

- Take care to make a thermally optimized layout (see example)
- Current reduction in motor standstill is required
- At highest current, check ambient temperature and self-heating to ensure a device temperature well below 150°C. Take into account the duty cycle of operation and any duty cycle limits which might apply.

TMC260 - BOM EXAMPLE

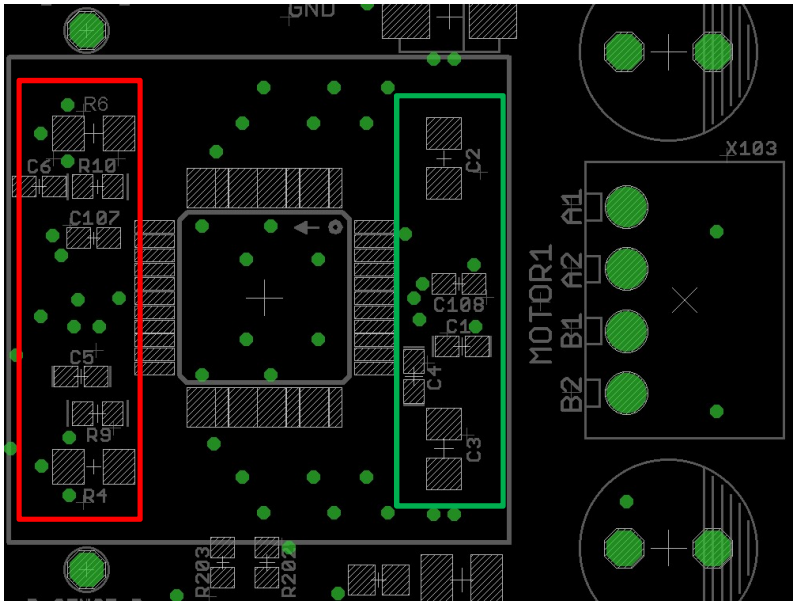
Typical Setup for 40V supply voltage and 1.4A (peak) Phase-Current

PCS	POS	Name/ Type	Value	Digi-Key Part #
1	IC1	TMC260-PA	-	1460-1042-ND
2	R4, R6	SMD Sense Resistor	220 mΩ, 0.25W, 1%, 1206	311-0.221ANTR-ND
1	C107	Ceramic Capacitor	0603, 470nF, 16V	399-4922-1-ND
1	C1,C4, C108	Ceramic Capacitor	0603,100nF, 100V	445-6938-2-ND
2	R9, R10 (optional)	SMD Resistor	0603, 22Ohm, 1%	P22.0HCT-ND
2	C5, C6	Ceramic Capacitor	0603,10nF, 50V	399-1092-1-ND
2	C2, C3	Ceramic Capacitor	1206,10µF,50V	1276-2876-2-ND
1-2	-	Electrolyte Capacitor	220µF/63V	P5194-ND

TMC260/261/2660 – SAMPLE LAYOUT

Placement:

- Sense resistors should be placed close to the driver (red square)
- Place filter capacitors as close as possible near the driver‘s interface pins (green square)
- Focus on a symmetric placement and layout for sense resistors (red square)

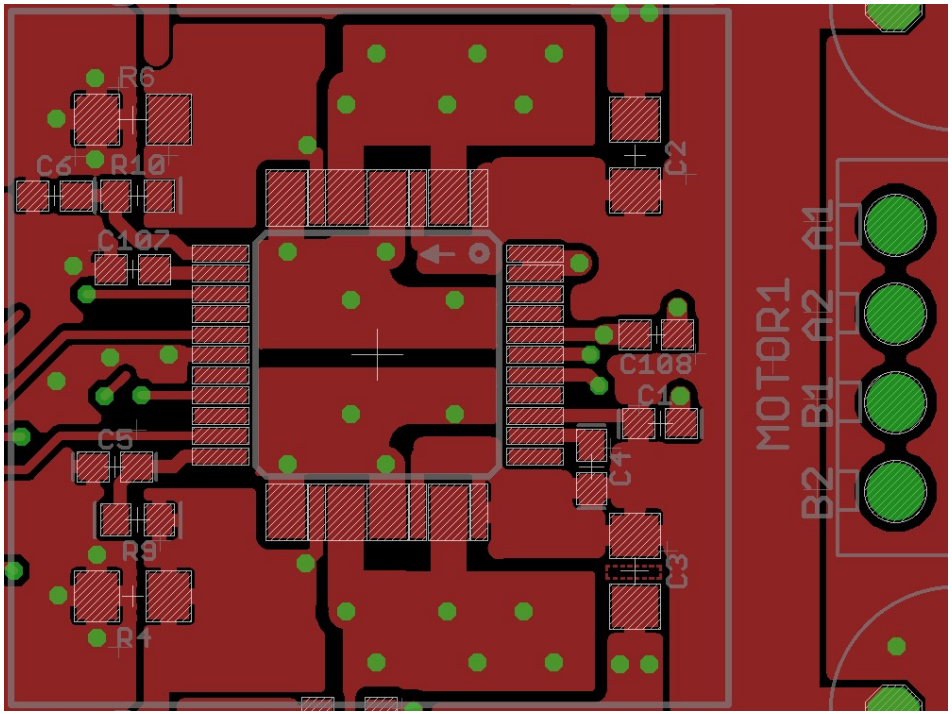


TMC260/261/2660 – SAMPLE LAYOUT

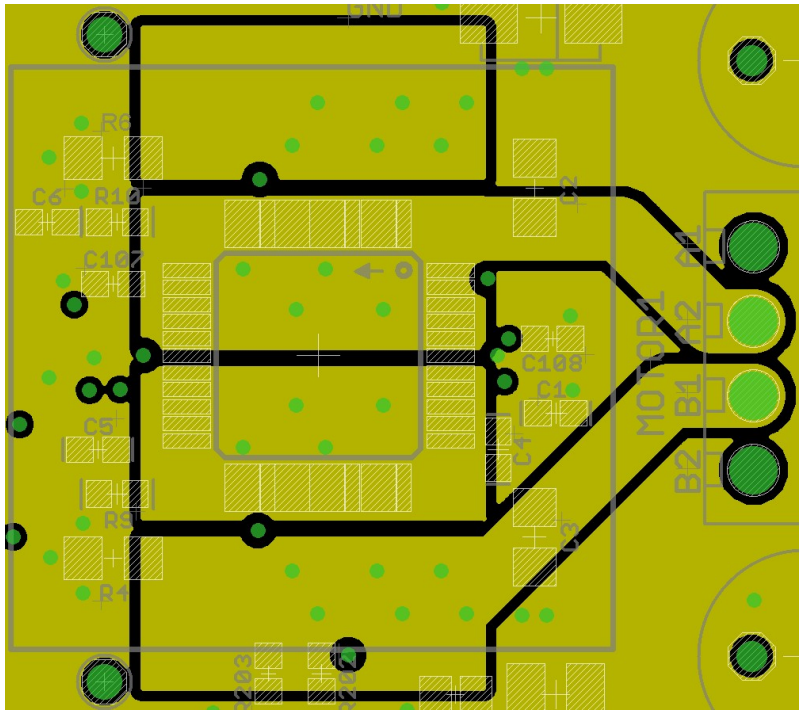
Ground connections

- For optimum cooling and ground connection a 4 Layer Design is recommended
- use one layer as solid GND plane (inner layer 2)
- Use top and inner layer 1 wide copper traces/areas for the motor phase connections for cooling (high current signals)

Top layer (assembly side, Copper cooling areas)



Inner layer 1 (OB1 / OA2 / Copper Cooling Areas)

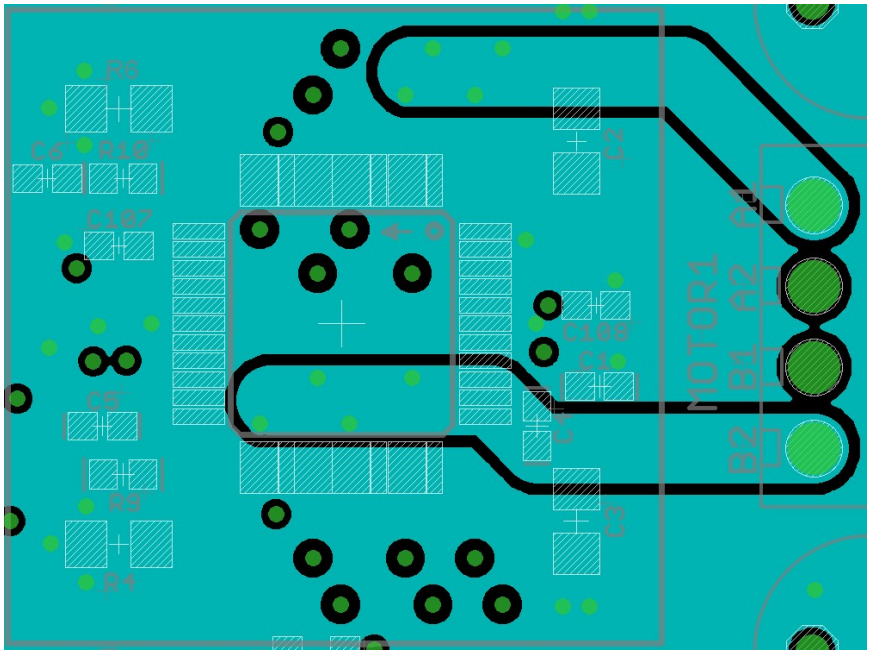


TMC260/261/2660 – SAMPLE LAYOUT

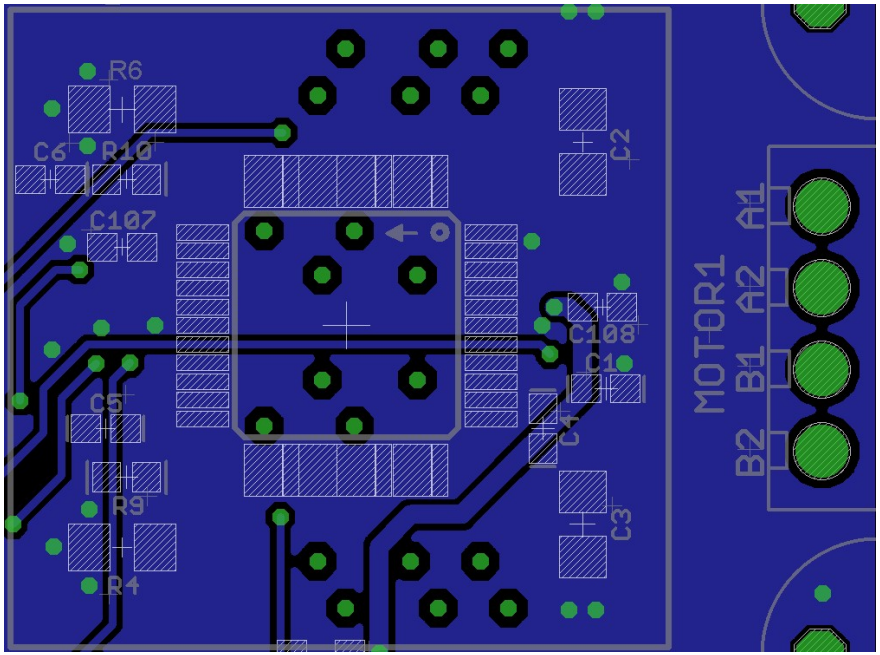
Sense Resistor Connection

- Use vias at sense resistor terminals to GND layer
- Use wide / short traces with only less bends to the full bridge foot points
- The two sense resistors should NOT share a common ground connection trace.
- No current other than the sense resistor currents should flow through their connections to ground

Inner layer 2 – GND flooded / OA1 / OB2

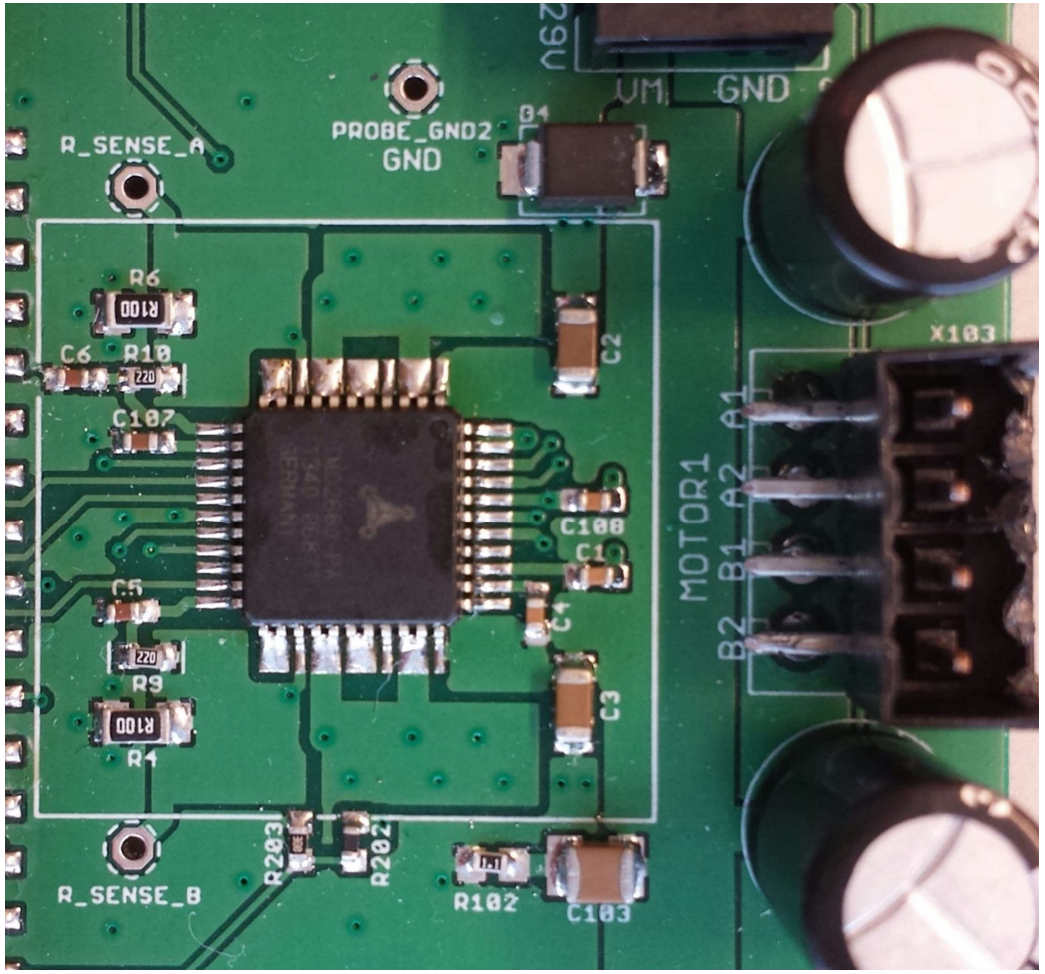


Bottom Layer (GND)



TMC260/261/2660 – SAMPLE LAYOUT

top layer
(assembly side)



TMC260/261/2660 – INITIAL CONFIGURATION

Chopper control register (CHOPCONF):

```
SPI = $901B4          // Use hysteresis mode chopper
```

stallGuard2 and current control register (SGCSCONF):

```
SPI = $D001F          // Current setting: $d001F (maximum current)
```

Driver control register (DRVCONF):

```
SPI = $EF010          // high gate driver strength, stallGuard read, SDOFF=0
```

Driver control register (DRVCTRL):

```
SPI = $00000          // 256 microstep setting
```

coolStep control register (SMARTEN):

```
SPI = $A8202          // enable coolStep with minimum current = ¼ of max. I
```