Evaluation Board User Guide

TMC3241-EVKIT

Evaluation Kit for TMC3241 – A Fully-Integrated Smart 3-Phase Stepper Motor Controller and Driver

General Description

The TMC3241-EVKIT includes the TMC3241-EVAL board, the Eselsbruecke, and Landungsbruecke interface boards, which operate together as part of the ADI Trinamic™ TMCL ecosystem.

The *TMC3241* is a smart, high-performance, single-axis 3-phase stepper motor controller and driver IC. It fully integrates three 65V H-bridges, capable of driving motors with up to $4.2A_{RMS}$ ($5.94A_{FS}$) current, together with lossless integrated current sensing (ICS), eliminating the need for external MOSFETs and current-sense resistors. The resulting compact solution reduces system complexity and printed circuit board (PCB) area.

The integrated EightPoint Ramp motion controller enables smooth, minimized-jerk motion profiles, and simplified trajectory generation. Together with 171-microsteps, 1024-point sine-wave generation, StallGuard™, CoolStep™, and SpreadCycle™, it optimizes motion quality, efficiency, and motor performance.

The device supports control through SPI and STEP/DIR, feedback through an incremental encoder interface, and extensive diagnostic, monitoring, and protection functions.

The TMC3241-EVAL board enables the use of the TMC3241 as part of the ADI Trinamic™ evaluation board system, for example, in combination with the *TMCL-IDE*, or together with the PyTrinamic™ Python package.

Features and Benefits

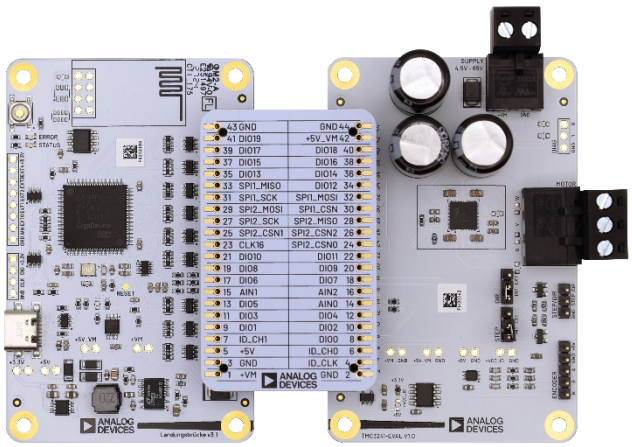
- Highly Integrated 3-Phase Stepper Motor Driver SoC
  - 4.5V to 65V DC Supply Voltage Range
  - Up to $4.2A_{RMS}$ and $5.94A_{FS}$ Current Capability
  - Integrated 65V H-Bridges with low RDS (ON) (HS + LS): 0.08Ω (typ) (T_A = 25°C)
  - Integrated Lossless Current Sensing (ICS)
- Advanced Motion and Motor Control
  - EightPoint Ramp for Minimized-Jerk Motion
  - 171-Microsteps with 1024-Point Sine Wave
  - StallGuard, CoolStep, and SpreadCycle
- Flexible Control, Configuration, and Feedback Interfaces
  - SPI Interface for Position/Velocity Commands, Configuration, and Diagnostics
  - STEP/DIR and Incremental Encoder Interfaces
- Integrated Protection and Diagnostics

TMC3241-EVKIT Contents

ITEM	DESCRIPTION
TMC3241-EVAL	TMC3241 Evaluation Board
Landungsbruecke	PC Interface Board
Eselsbruecke	Bridge Connection Board

***Ordering Information* appears at end of user guide.**

Evaluation Kit Photo



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Getting Started

Required Items

- TMC3241-EVAL (included)
- Landungsbruecke board (included) with the latest *TMC-EvalSystem* firmware
- Eselsbruecke board (included)
- A compatible motor (3-phase stepper motor)
- Power supply (4.5V to 65V; power connector included in the kit)
- Cables to interface the motor, encoders, and the power supply
- USB-C data cable
- PC with the latest *TMCL-IDE* (the integrated development environment for ADI Trinamic modules)
- *TMC3241* data sheet

Precautions

- Follow the safe electrostatic discharge (ESD) practices.
- Ensure the working area is nonconductive to prevent shorting of exposed pins on the underside of circuit boards.
- Do not exceed the board's maximum rated supply voltage.
- Do not connect or disconnect the motor while power is applied to the board.
- Make sure that the used board, cables, and motor are in a good condition before use.
- Follow appropriate high-voltage safety practices and use suitable protective equipment. In some regions, voltages greater than 50V are classified as hazardous.
- Do not touch the power stage section of the board during operation, as it may reach high temperatures.
- Do not touch the IC on the board.

Connecting the Peripherals

To connect the peripherals and first power on, do the following steps:

1. Unpack and inspect the Landungsbruecke, Eselsbruecke, and TMC3241-EVAL boards for shipping damage. The boards include preinstalled motor-output and power-supply connectors and pin-header jumpers.
2. Interface the TMC3241-EVAL with the Landungsbruecke through the Eselsbruecke bridge board, as shown in *Evaluation Kit Photo*. Do not power the Landungsbruecke and the TMC3241-EVAL while connecting the boards. Ensure that every connector pin connects to its corresponding header. Keep the working area nonconductive to prevent shorting of pins on the back of the boards.
3. Configure the STEP/DIR interface. To route the STEP and DIR signals from the Landungsbruecke to the TMC3241, install the jumpers between Pin 2 and Pin 3 of headers J303 (DIR) and J304 (STEP), labelled as DIR and STEP on the board's silkscreen (*Figure 4*). To use externally generated STEP/DIR signals, move both jumpers to Pin 1 and Pin 2 of J303 and J304, and connect the external signals through header J302, labelled as STEP/DIR on the board's silkscreen (*Figure 4*). Ensure that the external signal source and evaluation board share a common ground. The STEP and DIR inputs operate at the V_{CC_IO} logic level, which is typically 3.3V.
4. Plug the selected motor to connector J203, which is labelled as MOTOR on the board's silkscreen (*Figure 4*). Observe the correct order of the motor phases.
5. (Optional) Plug the ABN Encoder to pin header J204, which is labelled as ENCODER on the board's silkscreen (*Figure 4*).
6. Connect the Landungsbruecke board to the computer through a USB cable.
7. Plug the power supply cable to Connector J202, which is labelled as SUPPLY on the board's silkscreen (*Figure 4*). Turn off the power supply and verify the cable polarity before connecting it to the board.

Note: In some regions, voltages greater than 50V are classified as hazardous. Keep the work area clean and do not touch the board while it is powered on. Note that the power stage section of the board can become hot during operation.

The board is now ready for the next steps. Continue with the following section, but do not turn on the power supply yet.

TMCL-IDE Quick Start

To quick start the *TMCL-IDE*, do the following steps:

1. Ensure that the latest version of the TMCL-IDE is installed on the computer. If necessary, download the latest version from *TMCL-IDE*. Open the IDE, which automatically detects the board and displays it in the **Device** tree (*Figure 1*). If the IDE does not detect the board automatically, follow the steps shown in *Figure 2* to select it manually.

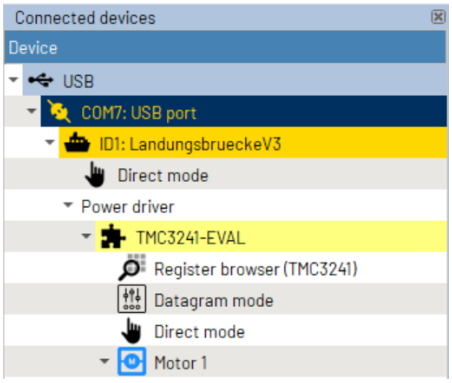


Figure 1. TMCL-IDE Device Tree

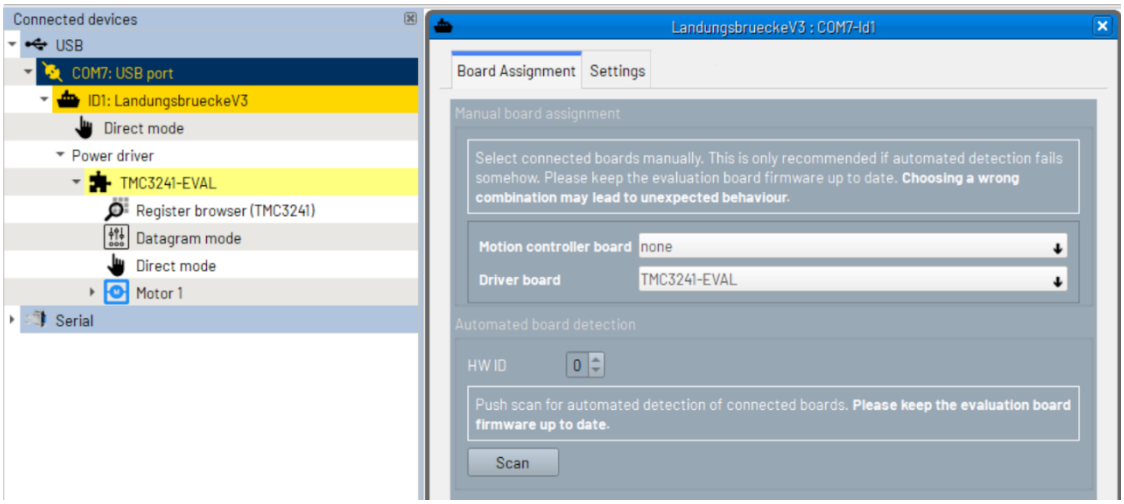


Figure 2. TMCL-IDE, Manual Selection of a Board

2. Turn on the power supply.
3. Open the basic motor configuration modules: **Current settings**, **Chopper settings**, and **CoolStep and StallGuard**. Click the entries, as shown in *Figure 3*, to configure the *TMC3241* for the connected motor.

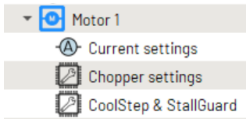


Figure 3. TMCL-IDE Module Selection

For additional instructions and information about using the IDE, refer to the **TMCL-IDE Manual** by selecting **Help** from the menu bar.

Detailed Hardware Description

When reviewing this section, refer to the *Appendix*, which contains the TMC3241-EVAL bill of materials (BOM), schematics, mechanical dimensions, and PCB layout.

Component Placement Drawing

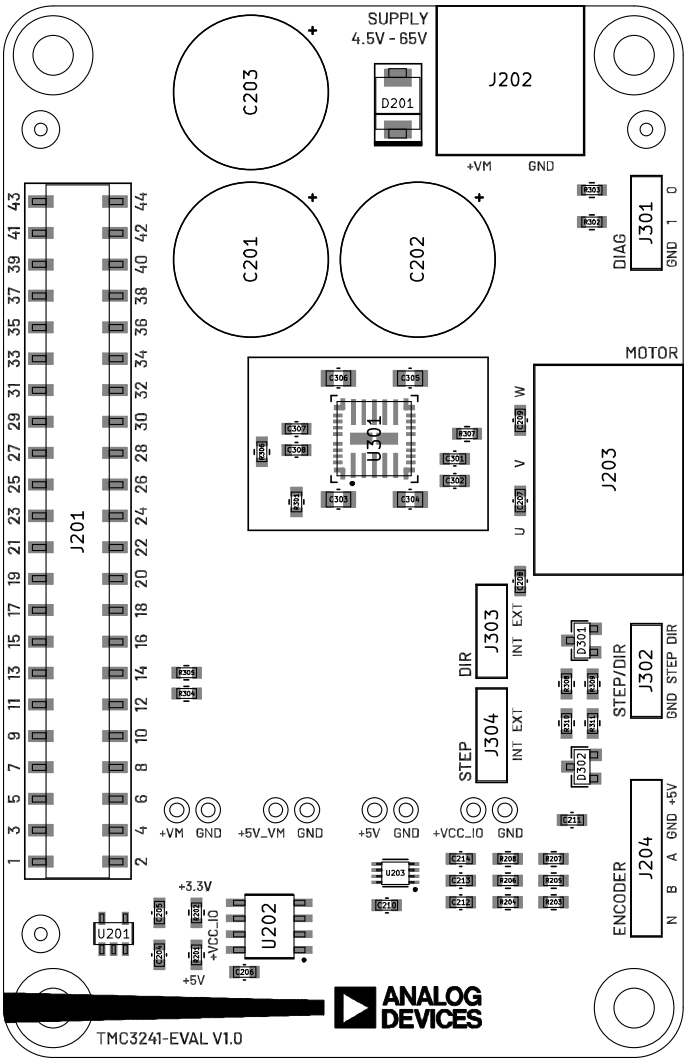


Figure 4. TMC3241-EVAL Component Placement and Silkscreen

Onboard Connectors and Pin Headers

The TMC3241-EVAL provides one power, one motor connector, and 3-pin headers. The component placement drawing in *Figure 4* shows the connectors and pin headers, and *Table 1* provides the detailed descriptions.

Table 1. TMC3241-EVAL Available Connectors

REF_DES	SILKSCREEN LABEL	CONNECTOR TYPE	DESCRIPTION
J201	N/A	2.54mm female pin header 22 × 2 (W+P 46-3492-44-3-00-10-PPTR)	Main IO connector to interface with the Landungsbruecke through the Eselsbruecke bridge board. A detailed view of this connector is shown in *Figure 5*.
J202	SUPPLY	Terminal block 2-position (Molex 395221002)	Connector for the main power supply input.
J203	MOTOR	Terminal block 3-position (Molex 395221003)	Connector for the U, V, and W phases of the motor.
J204	ENCODER	2.54mm pin header 5 × 1	Connector for the ABN encoder. This connector is always referenced to 5V and includes 4.7kΩ pull-up resistors on all its inputs. The input signals get translated into the appropriate IO level.
J301	DIAG	2.54mm pin header 3 × 1	Connector for DIAG output.
J302	STEP/DIR	2.54mm pin header 3 × 1	Connector for the external STEP/DIRECTION input. This connector is referenced to VCC_IO and includes 4.7kΩ pull-down resistors on all its inputs.
J303	DIR	2.54mm pin header 3 × 1	Jumper selection for DIRECTION input between INTERNAL (Landungsbruecke Connector) and EXTERNAL (J302)
J304	STEP	2.54mm pin header 3 × 1	Jumper selection for STEP input between INTERNAL (Landungsbruecke Connector) and EXTERNAL (J302)

N/A means not applicable.

Additional Connectors

In addition to the connectors shown in *Table 1*, some unpopulated THM test points are available in the TMC3241-EVAL. For more details, see the component placement drawing in *Figure 4*. *Table 2* shows the additional connectors.

Table 2. TMC3241-EVAL Additional Connectors

REF_DES	SILKSCREEN LABEL	CONNECTOR TYPE	DESCRIPTION
PTH205 and PTH206	+VM and GND	Unpopulated THM test point. Place the test points 2.54mm apart to accommodate a standard pin header.	Test points for the main supply voltage and ground.
PTH207 and PTH208	+5V_VM and GND	Unpopulated THM test point. Place the test points 2.54mm apart to accommodate a standard pin header.	Test points for the 5V_VM line and ground.
PTH209 and PTH210	+5V and GND	Unpopulated THM test point. Place the test points 2.54mm apart to accommodate a standard pin header.	Test points for the 5V line and ground.
PTH211 and PTH212	+VCC_IO and GND	Unpopulated THM test point. Place the test points 2.54mm apart to accommodate a standard pin header.	Test points for the selected IO supply voltage and ground.

Landungsbruecke Connector

Figure 5 shows the Landungsbruecke connector section of the TMC3241-EVAL schematics. The Landungsbruecke interfaces the level-shifted control signals, including the nDRV_EN, nSLEEP, and CLK input signals. This connector also provides the UART and SPI communication signals.

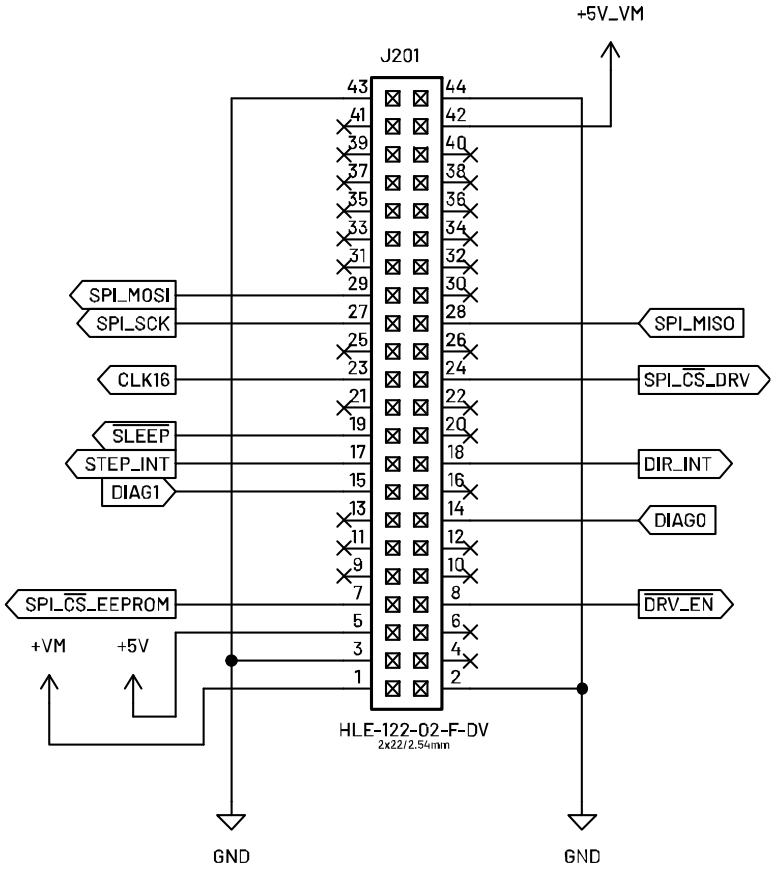


Figure 5. TMC3241-EVAL Schematics Detail of the Landungsbruecke Connector

V_{CC_IO} Selection

The TMC3241-EVAL allows selection of a 3.3V or 5V input/output (IO) supply voltage by mounting a 0Ω resistor at R201 or R202. By default, the TMC3241-EVAL R202 is connected to the 3.3V supply.

Set the IO supply voltage to 3.3V when using the Landungsbruecke board as the main controller. However, for a standalone operation at 5V IO supply voltage without the Landungsbruecke board, move the 0Ω resistor from R202 to R201. For reference, see *Figure 6* and the TMC3241-EVAL design files.

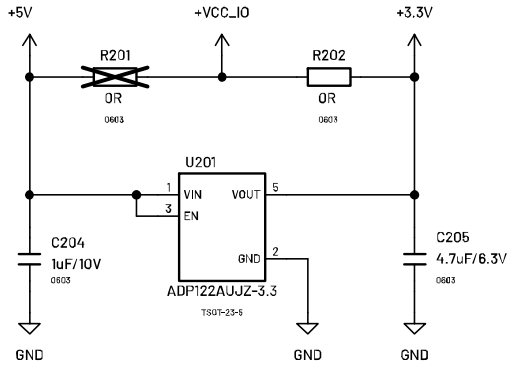


Figure 6. TMC3241-EVAL Schematics Detail of the IO Supply Circuit

Ordering Information

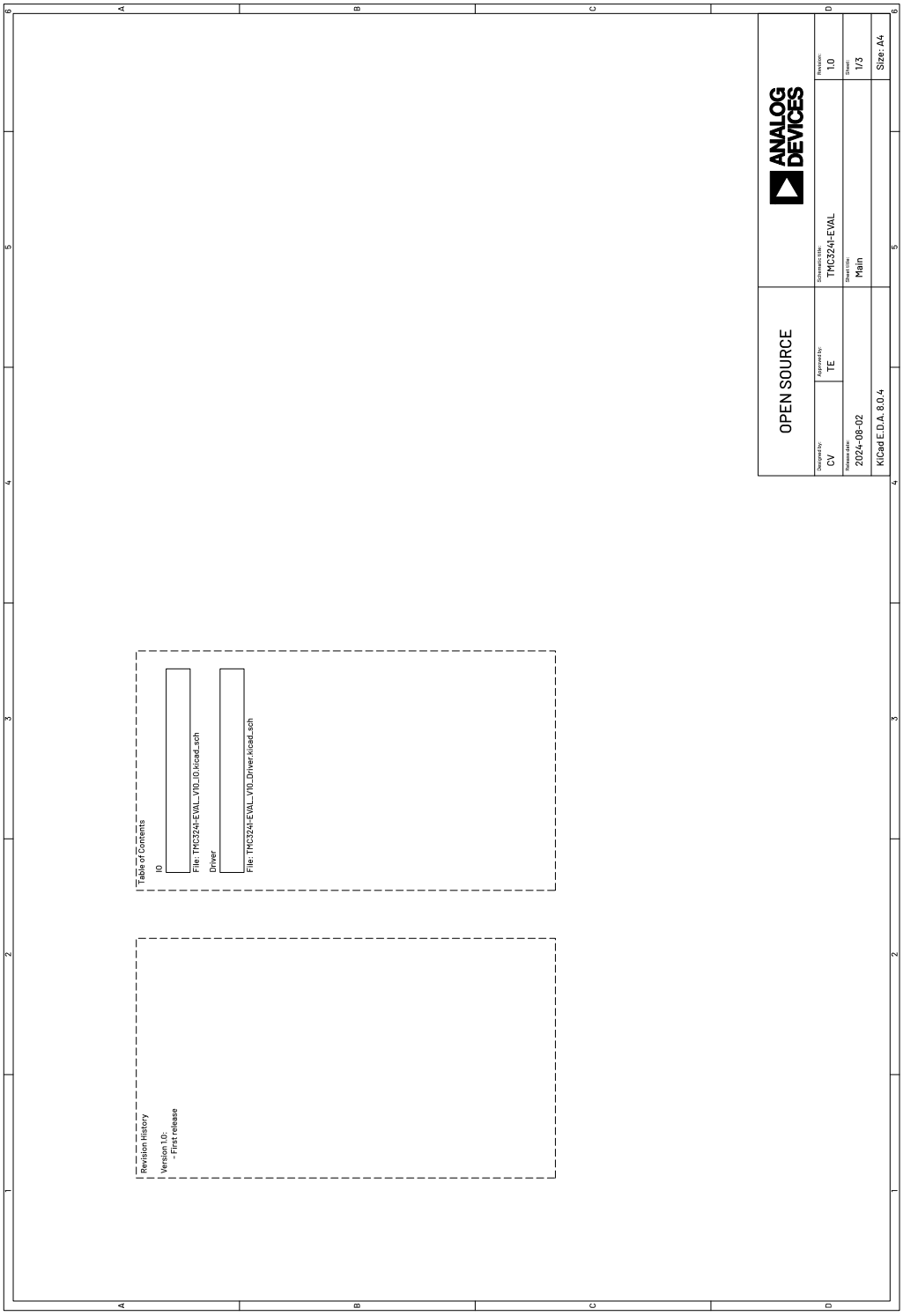
PART	TYPE
TMC3241-EVKIT	Evaluation Kit

Appendix

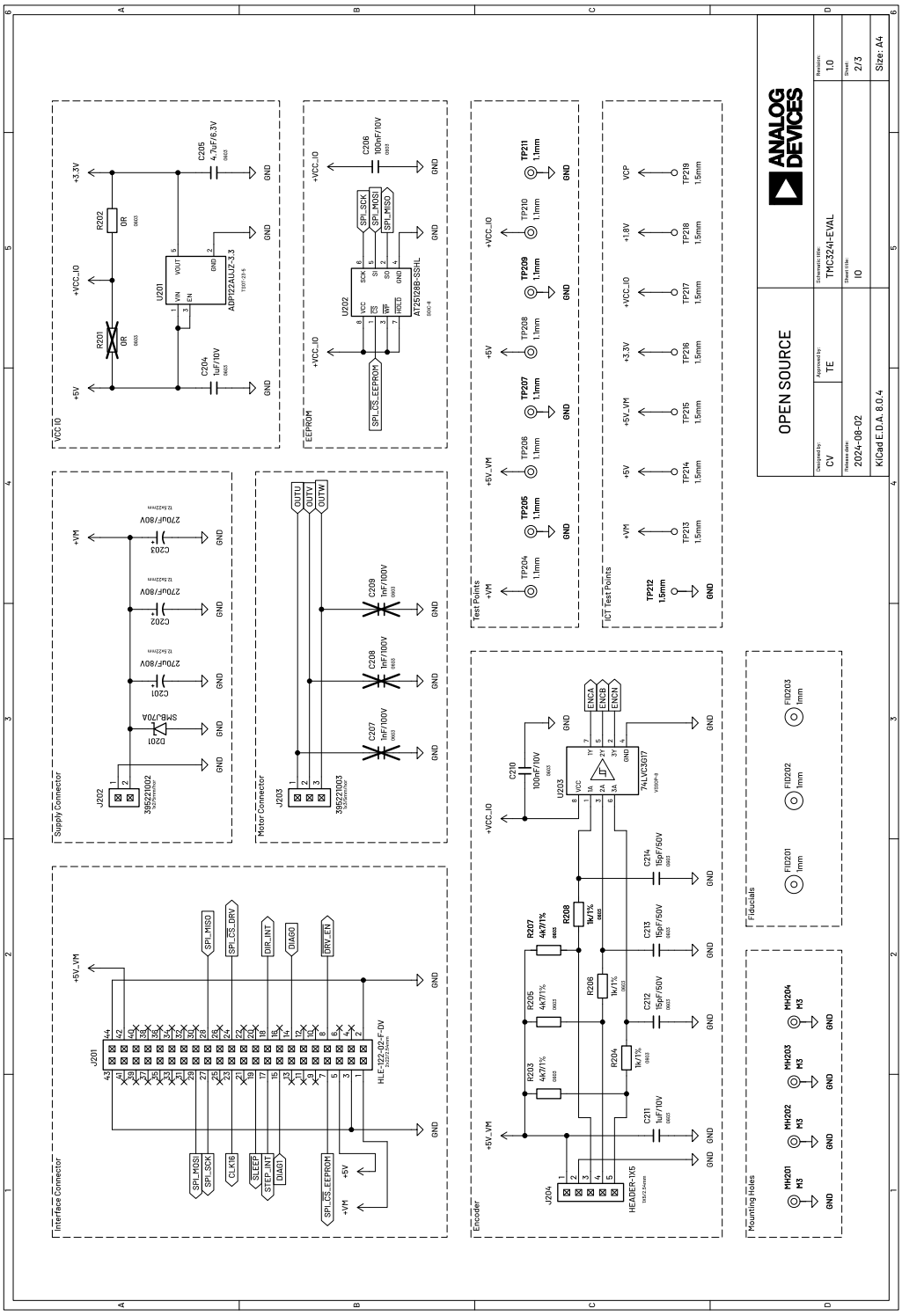
TMC3241-EVAL Bill of Materials

ITEM	REF_DES	QTY	MFG PART #	MANUFACTURER	DESCRIPTION
1	C201, C202, C203	3	EEUFS1K271	Panasonic Corp.	Aluminum electrolytic capacitors, through hole, 270µF, 80V, 20%
2	C204, C211, C302	3	0603ZD105KAT2A	AVX Corp.	Ceramic capacitors, SMD, 1µF, 10V, 10%, X5R, 0603
3	C205	1	CL10B475KQ8NQNC	Samsung Corp.	Ceramic capacitor, SMD, 4.7µF, 6.3V, 10%, X7R, 0603
4	C206, C210, C307	3	C0603C104K8RACAUTO	Kemet Corp.	Ceramic capacitors, SMD, 100nF, 10V, 10%, X7R, 0603
5	C212, C213, C214	3	06035A150KAT2A	AVX Corp.	Ceramic capacitors, SMD, 15pF, 50V, 5%, C0G/NP0, 0603
6	C301	1	C0603C223K1RACTU	Kemet Corp.	Ceramic capacitor, SMD, 22nF, 100V, 10%, X7R, 0603
7	C303, C304, C305, C306	4	08051C105K4T2A	AVX Corp.	Ceramic capacitors, SMD, 1µF, 100V, 10%, X7R, 0805
8	C308	1	CC0603KRX7R5BB225	Yageo Corp.	Ceramic capacitor, SMD, 2.2µF, 6.3V, 10%, X7R, 0603
9	D201	1	SMBJ70A-13-F	Diodes Inc.	TVS diode, 113V breakdown voltage, 5.3A, DO-214AA
10	D301, D302	2	BAT54S	On Semiconductor Corp.	Schottky diodes array, series configuration, 30V, 0.2A, SOT-23-3
11	J201	1	3492-44-3-00-10-PPTR	W+P Products GMBH	Receptacle connector, vertical, shrouded, 44 positions, 2 rows, 2.54mm pitch, SMD
12	J202	1	395221002	Molex LLC.	Header connector, right-angle, shrouded, 2-positions, 5.0mm pitch, through hole
13	J203	1	395221003	Molex LLC.	Header connector, right-angle, shrouded, 3-positions, 5mm pitch, through hole
14	J204	1	087-1-005-S-XS0-1260	Binder Group	Header connector, vertical, 5-positions, 2.54mm pitch, through hole
15	J302, J303, J304	4	61300311121	Wurth Electronik Group	Header connectors, vertical, 3-positions, 2.54mm pitch, through hole
16	R202, R304, R305	5	CR16-000-ZL	ASJ Components	Resistors, SMD, 0Ω, 0.1W, 0603
17	R203, R205, R207, R301, R309, R311	8	ERJ-3EKF4701V	Panasonic Corp.	Resistors, SMD, 4.7kΩ, 1%, 0.1W, 0603, automotive grade
18	R204, R206, R208	3	ASC0603-1K0FT5	TT Electronics PLC	Resistors, SMD, 1kΩ, 1%, 0.1W, 0603, automotive grade
19	R306	1	CR16-1202-FK	ASJ Components	Resistor, SMD, 12kΩ, 1%, 0.1W, 0603
20	R308, R310	2	ERJ-3EKF1501V	Panasonic Corp.	Resistors, SMD, 1.5kΩ, 1%, 0.1W, 0603, automotive grade
21	U201	1	ADP122AUJZ-3.3-R7	Analog Devices, Inc.	Linear voltage regulator, fixed output, 3.3V, 300mA, TSOT-23-5
22	U202	1	AT25128B-SSHL-B	Microchip Technology Inc.	EEPROM memory, 128Kb, SPI interface, 20MHz, SO-8
23	U203	1	74LVC3G17DC,125	Nexperia	Noninverting buffer, 74LVC family, push-pull output, 5.5V, 3 channels, VSSOP-8
24	U301	1	TMC3241AFV+	Analog Devices, Inc.	IC, stepper motor driver, 4.5V to 65V supply, SPI interface, FCQFN-30

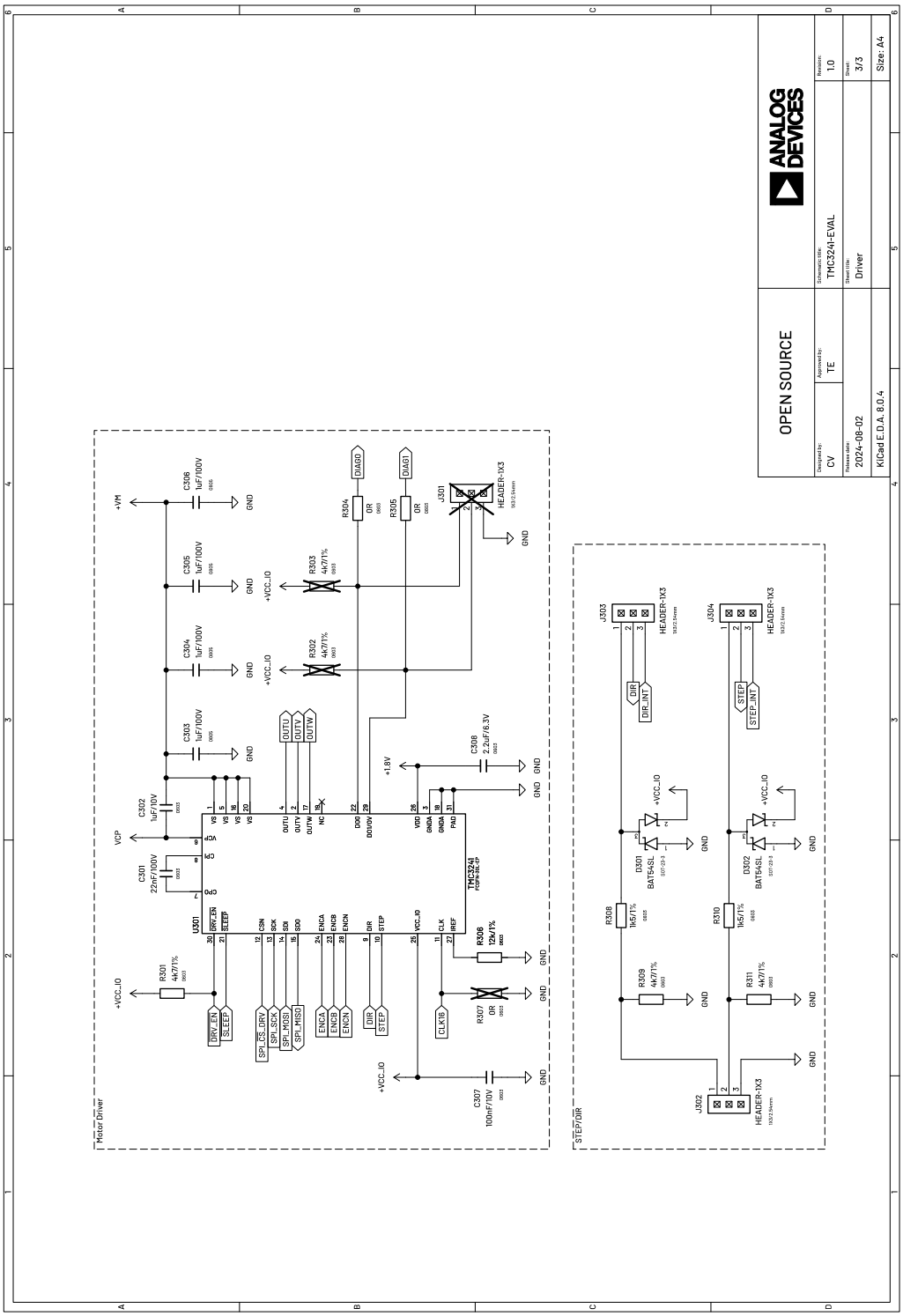
TMC3241-EVAL Schematics



TMC3241-EVAL Schematics (continued)



TMC3241-EVAL Schematics (continued)



TMC3241-EVAL Mechanical Dimensions

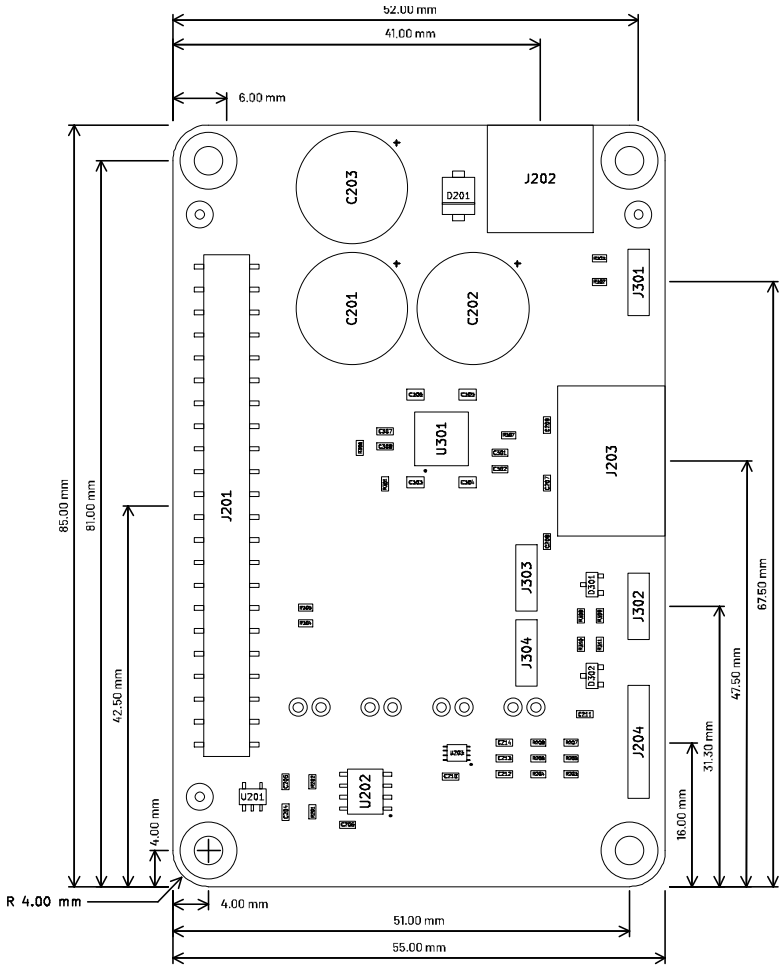


Figure 7. TMC3241-EVAL Mechanical Dimensions

TMC3241-EVAL PCB Layout

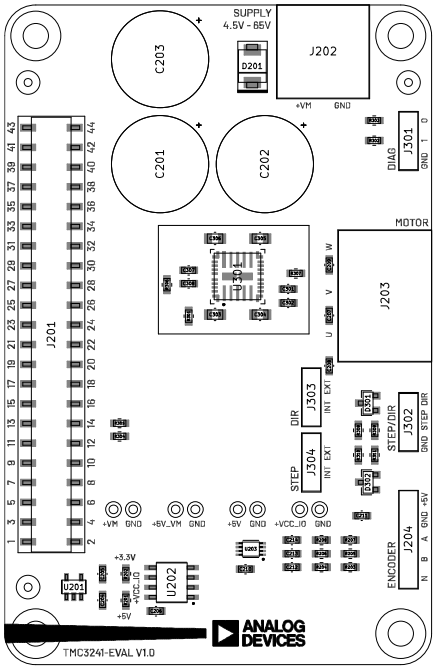


Figure 8. TMC3241-EVAL Component Placement Guide—Top Silkscreen

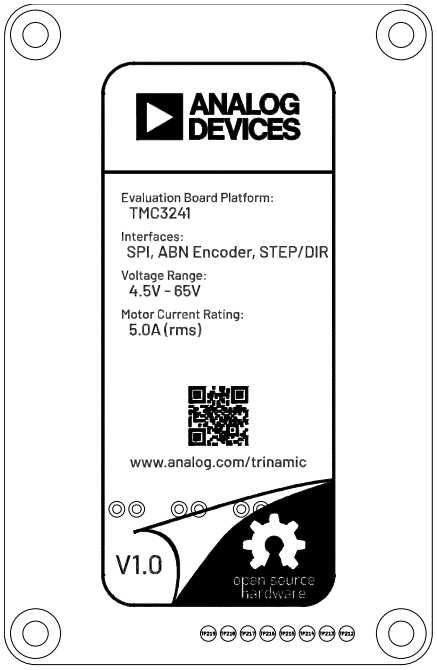


Figure 9. TMC3241-EVAL Component Placement Guide—Bottom Silkscreen

Note that *Figure 9* incorrectly specifies the Motor Current Rating; the correct rating is 4.2A_{RMS}.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/26	Initial release	—

Notes

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