Evaluation Board User Guide

# TMC2241-EVKIT

TMC2241 Smart High-Performance Stepper Motor Controller and Driver IC

## General Description

The TMC2241-EVKIT is part of the ADI-Trinamic evaluation board system. The boards included in this kit, in combination with the TMCL-IDE, allow an uncomplicated first evaluation of the TMC2241, while also providing full control of all its features.

The TMC2241 is a smart, high-performance, stepper motor controller and driver IC with serial communication interfaces (SPI, UART) and extensive diagnostic capabilities. It combines a flexible, jerk-optimized ramp generator for automatic target positioning. It also features the industry's most advanced stepper motor driver based on a 256-microstep, built-in indexer and fully integrated 65V, 3.0$A_{MAX}$ H-bridges plus nondissipative integrated current sensing (ICS).

## Features

- 4.5V to 65V DC Single-Supply Voltage Range
- Current Ratings per H-Bridge (25°C, typ):
  - $I_{RMS}$ = 2$A_{RMS}$ (2.8A sine peak) at $V_S$ = 24V
  - $I_{RMS}$ = 1.7$A_{RMS}$ (2.4A sine peak) at $V_S$ = 48V
- SPI and Single-Wire UART
- Encoder Interface and Step/Dir Input
- Brake Output

## Table 1. TMC2241-EVKIT Contents

| ITEM | DESCRIPTION |
|---|---|
| TMC2241-EVAL | TMC2241-EVAL Board |
| Landungsbruecke | PC Interface Board |
| Eselsbruecke | Bridge Connection Board |

## Documents Needed

- TMC2241 Data Sheet

## Software Needed

- TMCL-IDE Evaluation Software

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

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## Getting Started

### Required Items

- TMC2241-EVAL (included)
- Landungsbruecke board (included)
- Eselsbruecke board (included)
- A compatible motor (e.g., a Qmot stepper motor)
- Power supply
- Cables to interface the motor, encoders, and power supply
- Latest *TMCL-IDE*
- Latest firmware for *TMC-EvalSystem*

### Precautions

- Do not exceed the board's maximum rated supply voltage.
- Do not connect or disconnect the motor while the board is powered.
- Make sure the used board, cables, and motor are in a good state before using them.
- Mind the used power supply voltage. Voltages greater than 50V are considered dangerous in some countries.
- Do not touch the power stage section of the board during operation as it can get hot.

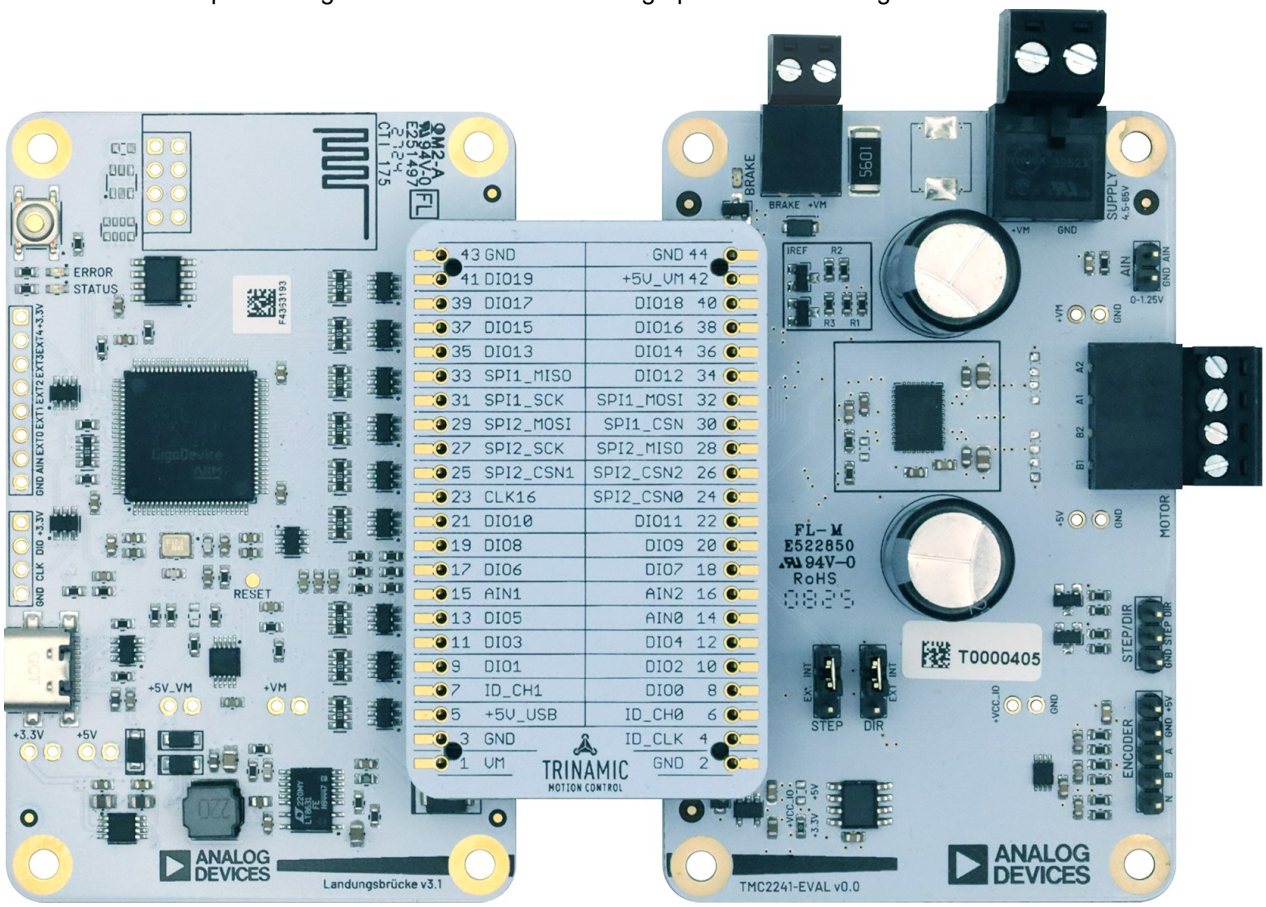



*Figure 1. Assembled TMC2241-EVKIT*

## Connecting the Peripherals

1. Interface the TMC2241-EVAL with the Landungsbruecke through the Eselsbruecke bridge board as shown in *Figure 1*. While connecting the boards together, both the Landungsbruecke and the TMC2241-EVAL must not be powered. Make sure that every pin in the connector is connected to its corresponding header. The working area is nonconductive to prevent shorting pins on the back side of the boards.
2. Plug the selected motor to connector J203, which is labelled as **MOTOR** on the board's silkscreen (*Figure 5*). Observe the correct order of the A1, A2, B1, and B2 motor phases.
3. (Optional) Plug the ABN encoder to pin header J204, which is labelled as **ENCODER**, on the board's silkscreen (*Figure 5*).
4. Connect the Landungsbruecke board to the computer through a USB cable.
5. Plug the power supply cable to connector J202, which is labelled as **SUPPLY**, on the board's silkscreen (*Figure 5*). Make sure the power supply is off before connecting it to the board and the polarity is correct.

**Note:** Voltages above 50V are considered dangerous in some countries. Keep the work area clean and do not touch the board while powered on. Keep in mind that the power stage section of the board can get 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

Verify that the latest version of the TMCL-IDE is installed on the computer. The latest version can be downloaded from *TMCL-IDE*. Upon opening the IDE, the board is detected automatically, and it appears in the *Device* tree (*Figure 2*). If the board is not automatically detected, manually select it by following the steps shown in *Figure 3*.

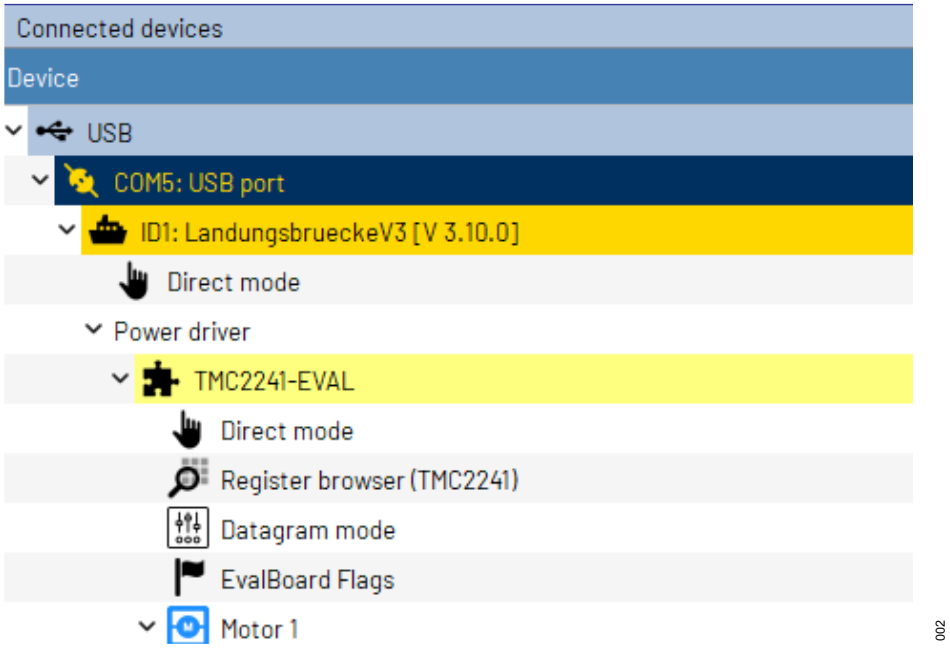



*Figure 2. TMCL-IDE Device Tree*

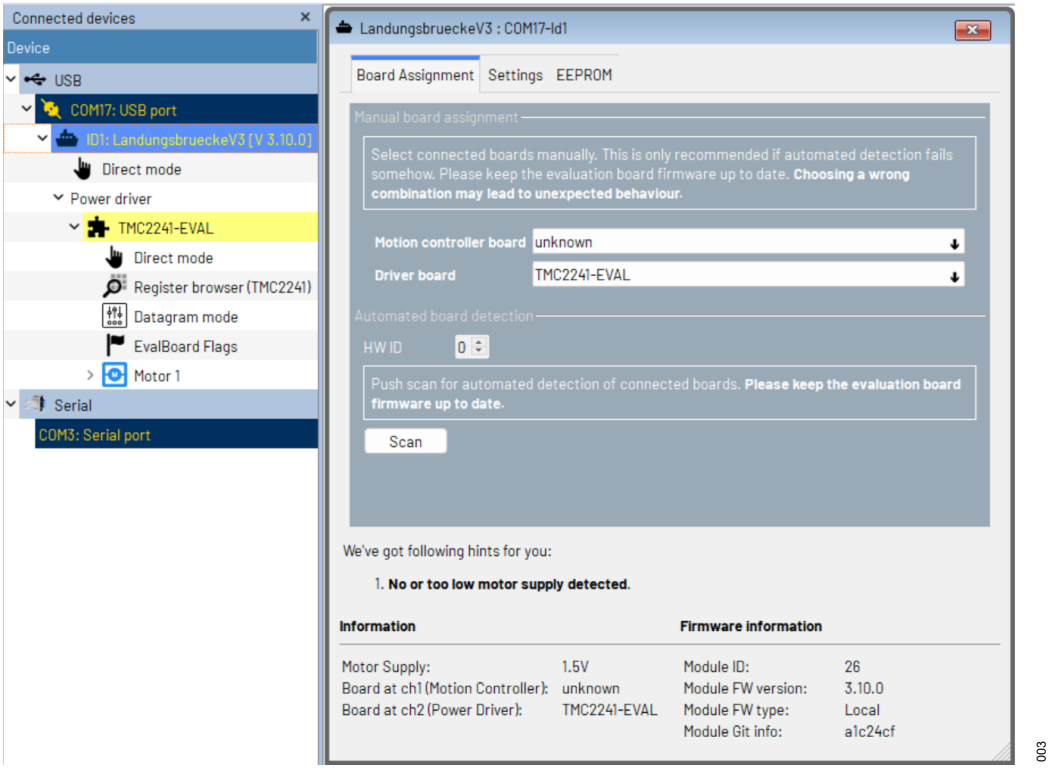



*Figure 3. TMCL-IDE, Manual Selection of a Board*

Turn on the power supply now.

A step-by-step guide to set up Stallguard2, StealthChop, or µStep is in the ***Wizard Pool***. Click the ***Tools*** menu on the menu bar and select ***Wizard Pool*** (*Figure 4*). The wizard provides an uncomplicated guide to set up the TMC2241 with the connected motor.

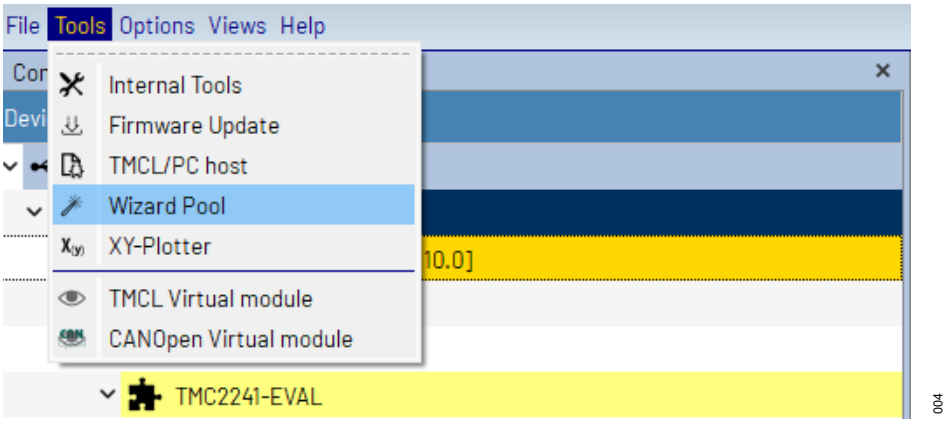



*Figure 4. TMCL-IDE Wizard Pool Selection*

Once the wizard launches, follow the steps it presents.

For further instructions and clarifications on how to use the IDE, see the ***TMCL-IDE Manual***, which can be accessed by clicking the ***Help*** menu on the menu bar.

## Detailed Description of Hardware

Download the above and use them as a reference alongside this section of the user guide. These files include a BOM, component placement drawings, schematics, and fabrication files.

### Component Placement Drawing

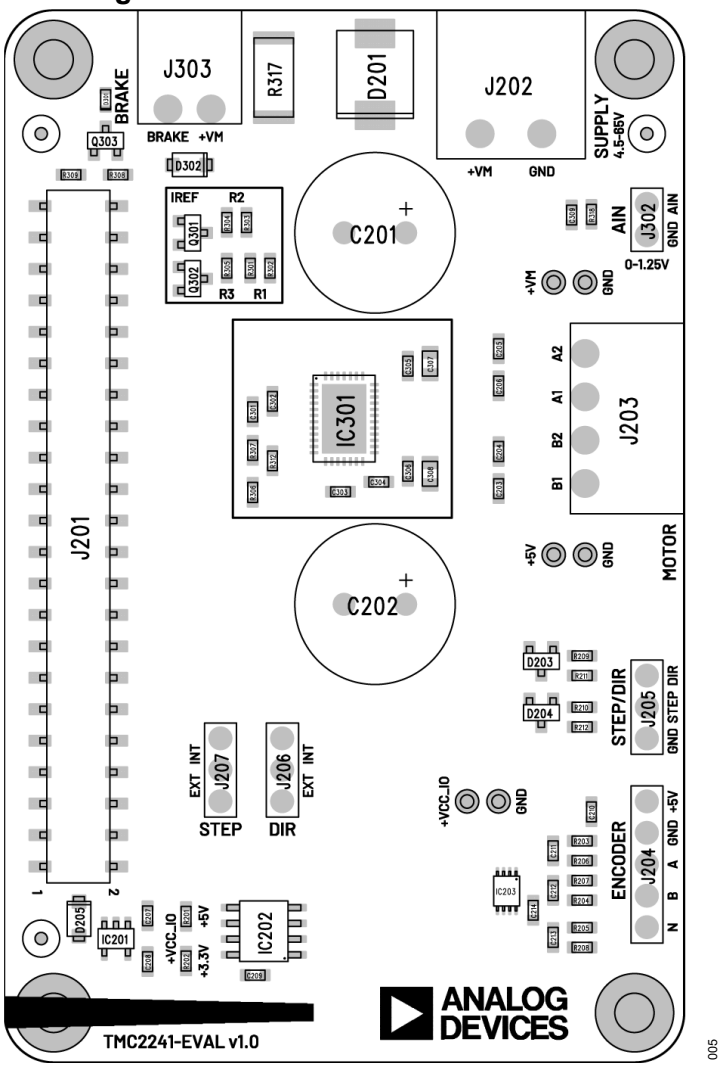



*Figure 5. TMC2241-EVAL Component Placement and Silkscreen*

### Onboard Connectors and Pin Headers

The TMC2241-EVAL has one power, one motor connector, and three pin headers. These can be found in the component placement drawing in *Figure 5* and are described in *Table 2*.

## Table 2. TMC2241-EVAL Available Connectors

| REFERENCE DESIGNATOR | CONNECTOR TYPE | DESCRIPTION |
|---|---|---|
| J201 | 2.54mm female pin header 22x2 (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 given in *Figure 6*. |
| J202 | Terminal block 2 pos. (Molex 395221002) | Connector for the main power supply input. |
| J203 | Terminal block 4 pos. (Molex 395221004) | Connector for the A1, A2, B1, and B2 phases of the motor. |
| J204 | 2.54mm pin header 5x1 | 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 VCC_IO level internally. |
| J205 | 2.54mm pin header 3x1 | Connector for the STEP/DIR inputs. It includes 4.7kΩ pull-down resistors on both inputs and a 1kΩ in-line resistor. The signal to TMC2241 is clamped to VCC_IO. |
| J302 | 2.54mm pin header 5x1 | Connector for general-purpose analog input signals. Input range 0V to 1.25V. |
| J303 | Terminal block 2 pos. (Molex 395021002) | Connector for the brake. This connector is rated for up to 8A. |

### Additional Connectors

In addition to the connectors shown in *Table 2*, some unpopulated THM test points are available in the TMC2241-EVAL. See the component placement drawing in *Figure 5*. The additional connectors are described in *Table 3*.

## Table 3. TMC2241-EVAL Additional Connectors

| REFERENCE DESIGNATOR | CONNECTOR TYPE | DESCRIPTION |
|---|---|---|
| PTH205 and PTH206 | Unpopulated THM test point. These are placed 2.54mm apart from each other so a standard pin header can also be mounted. | Test points for the main supply voltage and ground. They are labeled +VM and GND on the board's silkscreen. |
| PTH207 and PTH208 | Unpopulated THM test point. These are placed 2.54mm apart from each other so a standard pin header can also be mounted. | Test points for the 5V line and ground. They are labeled +5V and GND on the board's silkscreen. |
| PTH209 and PTH210 | Unpopulated THM test point. These are placed 2.54mm apart from each other so a standard pin header can also be mounted. | Test points for the selected IO supply voltage and ground. They are labeled +VCC_IO and GND on the board's silkscreen. |

## Landungsbruecke Connector

The Landungsbruecke connector section of the TMC2241-EVAL schematics is shown in *Figure 6*. Level-shifted control signals are interfaced through the Landungsbruecke (e.g., the DRV_ENABLE, SLEEP, and CLK input pins). The UART and SPI communication signals are linked through this connector, too.

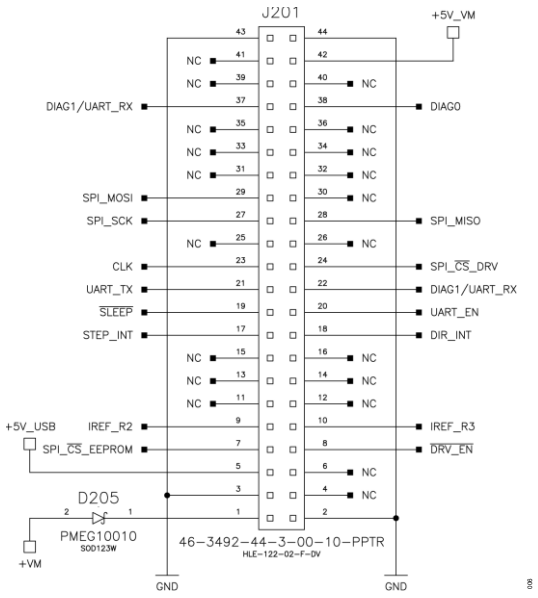



*Figure 6. TMC2241-EVAL Schematics Detail of the Landungsbruecke Connector*

## VCCIO Selection

The TMC2241-EVAL allows to select the input/output (IO) supply voltage as either 3.3V or 5V by mounting a 0Ω resistor on either R201 and R202. By default, the TMC2241-EVAL comes with R202 to supply 3.3V.

**Note:** Using an IO supply voltage of 3.3V is mandatory when the Landungsbruecke board is used as the main controller. However, if an IO supply voltage of 5V is needed for a standalone operation without the Landungsbruecke, unmount R202 and mount it back at R201. For reference, see the schematics detail in *Figure 7* and the TMC2241-EVAL design files.

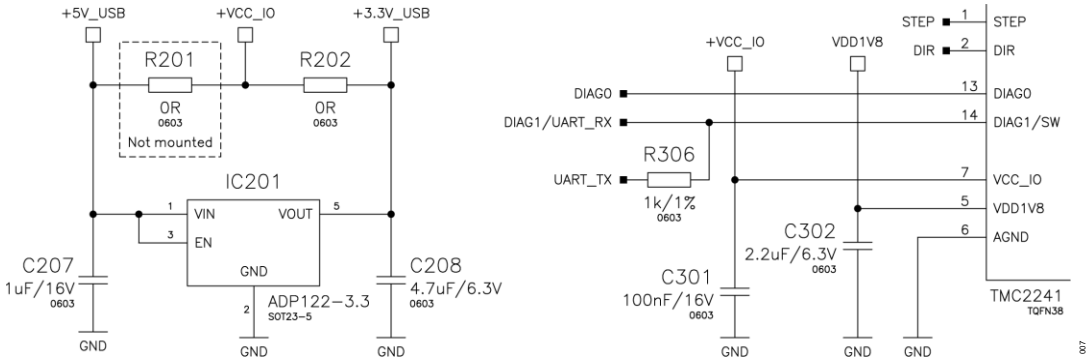



*Figure 7. TMC2241-EVAL Schematics Detail of the IO Supply Circuit with Reduced Pin Count at TMC2241*

## Current Selection

The TMC2241 supports output current range selection through an external reference resistor. For solderless evaluation of this feature, a changeable resistor is present on TMC2241-EVAL. With two control signals from the Landungsbruecke connector, multiple resistors can be placed in parallel as shown in *Figure 8*.

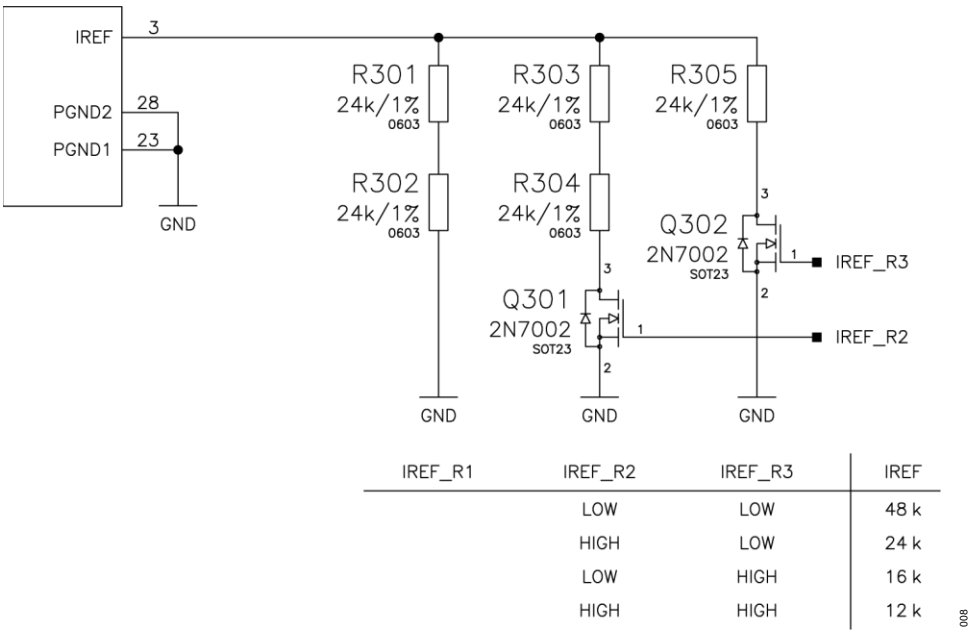



*Figure 8. TMC2241-EVAL Reference Resistor Selection Circuit with Reduced Pin Count at TMC2241*

## Ordering Information

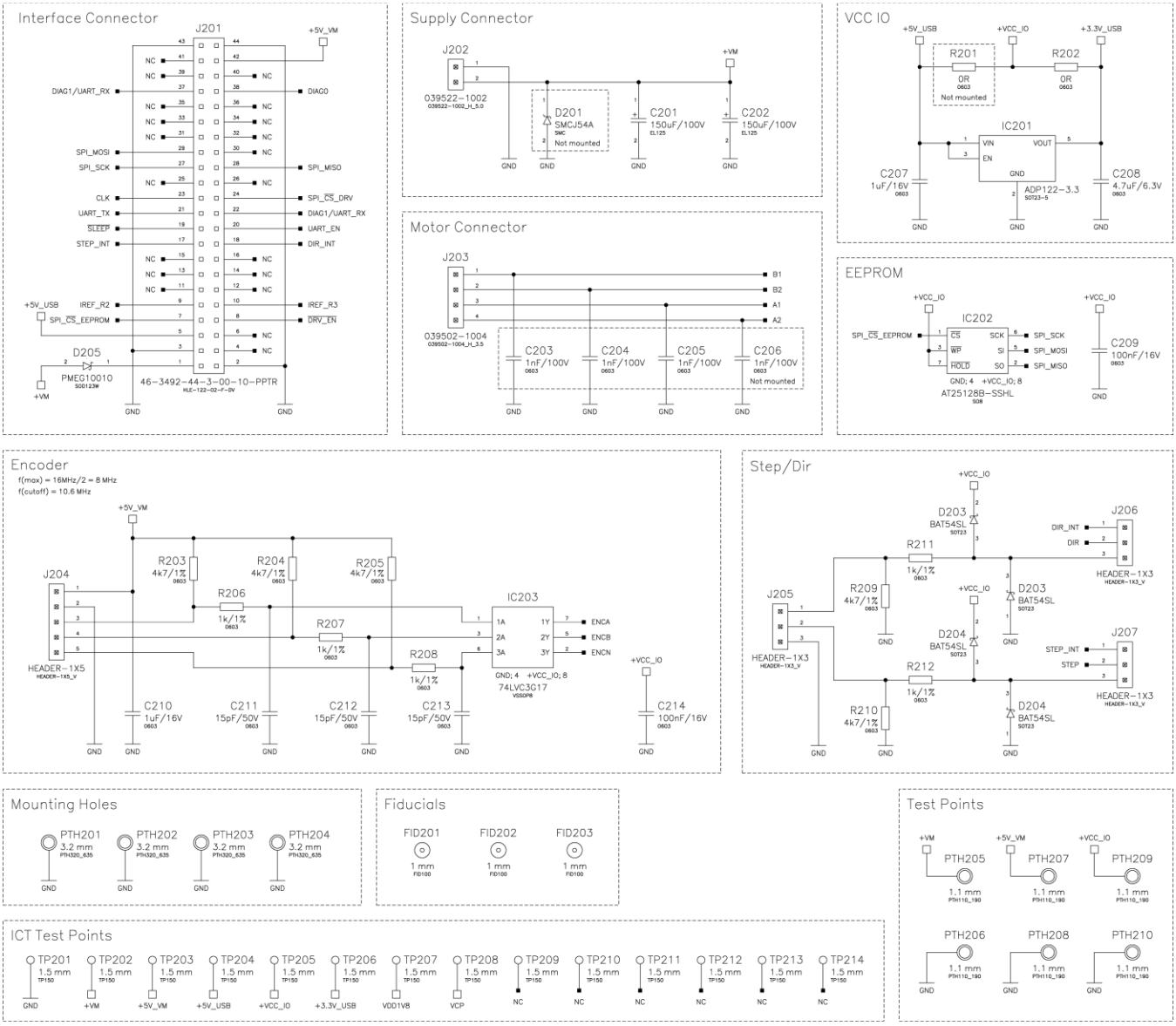
| PART | TYPE |
|---|---|
| TMC2241-EVKIT | Evaluation Kit |

*#Denotes RoHS compliance.*

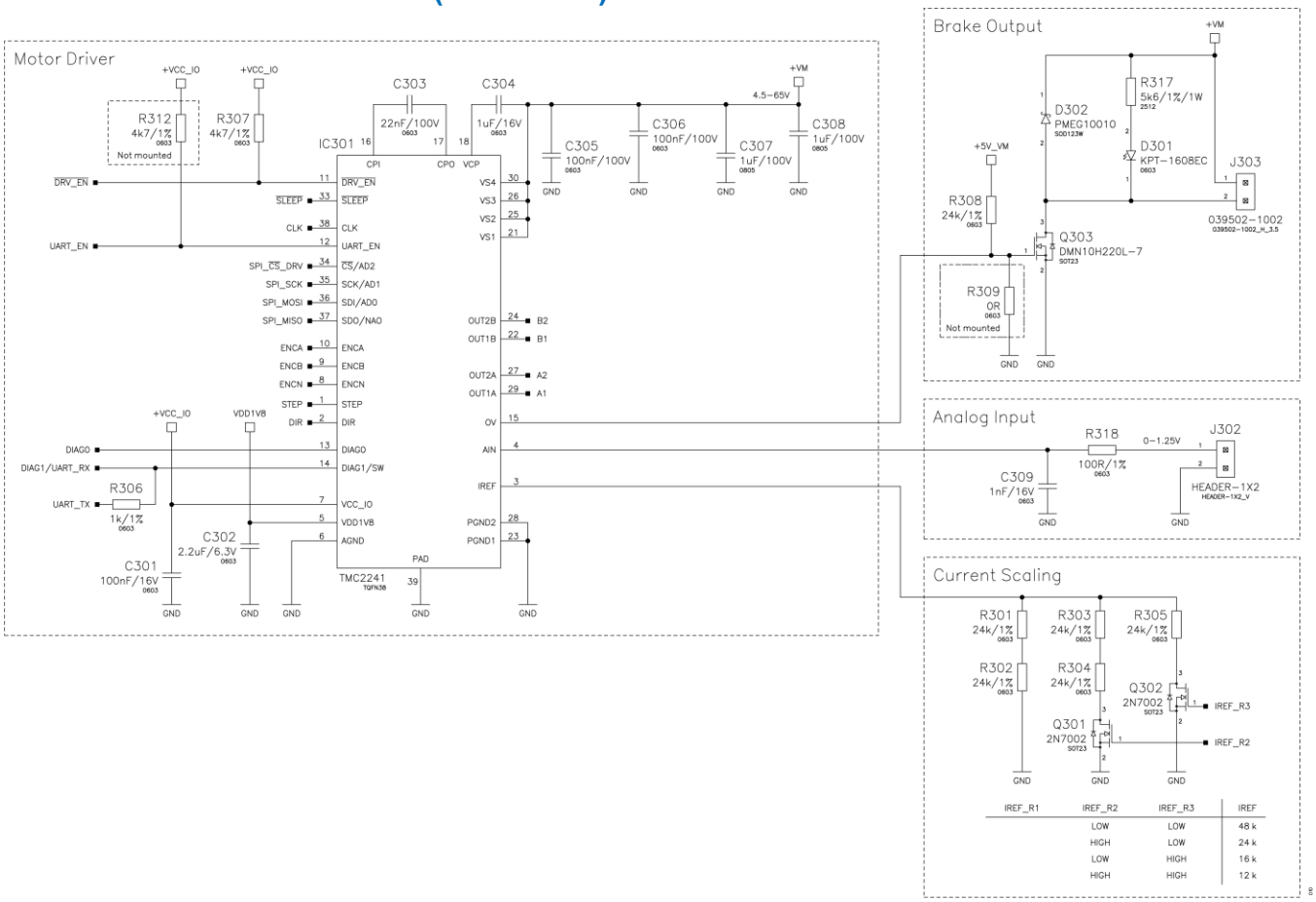
## TMC2241-EVKIT Bill of Materials

| PART | QTY | PACKAGE | MANUFACTURER | MANUFACTURER PN |
|---|---|---|---|---|
| C201, C202 | 2 | EL | PANASONIC COR | EEU-FS2A151 |
| C207, C210, C304 | 3 | 0603 | KEMET | C0603C105K4RAC7867 |
| C208 | 1 | 0603 | SAMSUNG GR | CL10B475KQ8NQNC |
| C209, C214, C301 | 3 | 0603 | AVX Corporation | 0603YC104K4Z2A |
| C211–C213 | 3 | 0603 | AVX Corporation | 06035A150KAT2A |
| C302 | 1 | 0603 | YAGEO | CC0603KRX7R5BB225 |
| C303 | 1 | 0603 | KEMET | C0603C223K1RACTU |
| C305, C306 | 2 | 0603 | TAIYO YUDEN | HMK107B7104KA-T |
| C307, C308 | 2 | 0603 | AVX Corporation | 08051C105K4T2A |
| C309 | 1 | 0603 | YAGEO | CC0603KRX7R7BB102 |
| D203, D204 | 2 | SOT-23-3 | ON SEMI | BAT54S |
| D205, D302 | 2 | SOD-123 | NEXPERIA | PMEG10010ELRX |
| D301 | 1 | 0603 | KINGBRIGHT | KPT-1608EC |
| IC201 | 1 | SOT-23-5 | ANALOG DEVICES | ADP122AUJZ-3.3-R7 |
| IC202 | 1 | SO-8 | MICROCHIP | AT25128B-SSHL-B |
| IC203 | 1 | VSSOP-8 | NEXPERIA | 74LVC3G17DC,125 |
| IC301 | 1 | SOT-23-3 | ANALOG DEVICES | TMC2241ATU+ |
| J201 | 1 | SMD | W+P PRODUCTS | 3492-44-3-00-10-PPTR |
| J202 | 1 | TH | MOLEX LLC | 395221002 |
| J203 | 1 | TH | MOLEX LLC | 395021004 |
| J204 | 1 | TH | BINDER GROUP | 087-1-005-S-XS0-1260 |
| J205–J207 | 3 | TH | WURTH ELE | 61300311121 |
| J302 | 1 | TH | WURTH ELE | 61300211121 |
| J303 | 1 | TH | MOLEX LLC | 395021002 |
| Q301, Q302 | 2 | SOT-23-3 | ON SEMI | 2N7002 |
| Q303 | 1 | SOT-23-3 | DIODES INCORP | DMN10H220L-7 |
| R202 | 1 | 0603 | ASJ COMPONENT | CR16-000-ZL |
| R203–R205, R209, R210, R307 | 6 | 0603 | PANASONIC CORP | ERJ-3EKF4701V |
| R206–R208, R211, R212, R306 | 6 | 0603 | TT ELECTRONICS | ASC0603-1K0FT5 |
| R301–R305, R308 | 6 | 0603 | PANASONIC COR | ERJ-3EKF2402V |
| R317 | 1 | 2512 | TE CONNECT | CRGCQ2512F5K6 |
| R318 | 1 | 0603 | VISHAY INTER | CRCW0603100RFKEA |
| C203–C206 | 4 | 0603 | KEMET CORP | C0603C102K1RACTU |
| D201 | 1 | DO-214AB | BOURNS INC. | SMCJ54A |
| R201, R309 | 2 | 0603 | ASJ COMP | CR16-000-ZL |
| R312 | 1 | 0603 | PANASONIC COR | ERJ-3EKF4701V |
| Connect to J202 | 1 | | Molex | 395200002 |
| Connect to J203 | 1 | | Molex | 395000004 |
| Connect to J303 | 1 | | Molex | 395000002 |

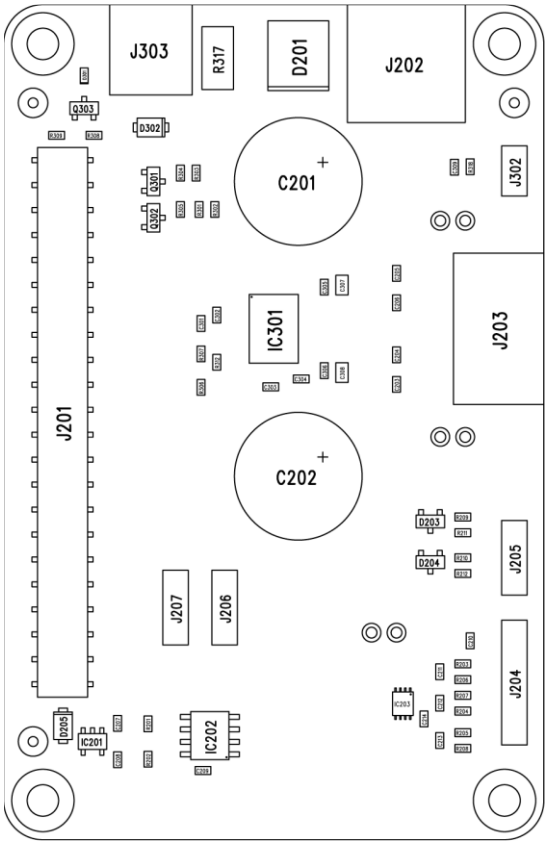
## TMC2241-EVKIT Schematic



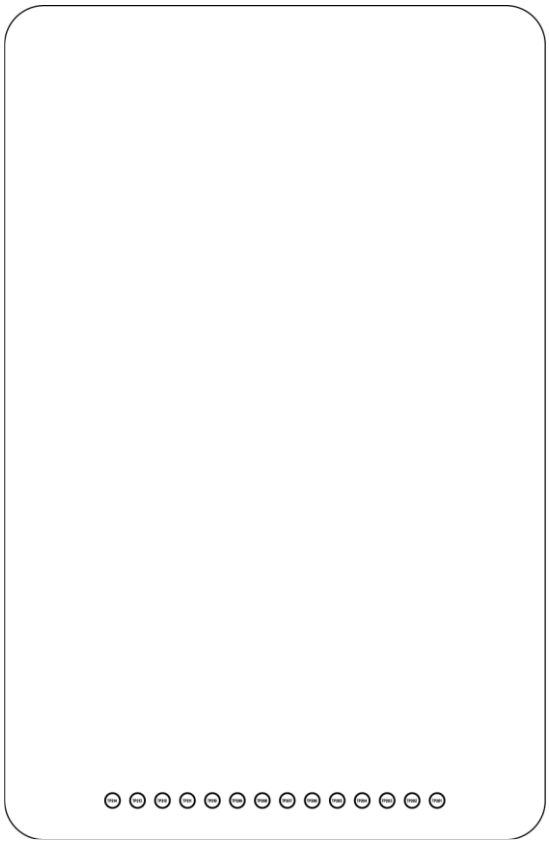
## TMC2241-EVKIT Schematic (continued)



## TMC2241-EVKIT PCB Layout




TMC2241-EVKIT Component Placement—Top Silkscreen



TMC2241-EVKIT Component Placement—Bottom Silkscreen

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 11/25 | Initial release | — |

## Notes

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