*Click here for production status of specific part numbers.*

# MAX25611 Evaluation Kit

# Evaluates: MAX25611A/MAX25611B/ MAX25611C/MAX25611D

## General Description

The MAX25611 evaluation kit (EV kit) provides a proven design to evaluate the MAX25611A/MAX25611B/ MAX25611C/MAX25611D automotive high-voltage, high-brightness LED (HB LED) controller. The EV kit is set up for boost and buck-boost configurations and operates from a 6V to 18V DC supply voltage. The EV kit is configured to deliver up to 0.88A to one string of LEDs. The total voltage of the string can vary from 3V to 36V. The anode of the LED string should be connected to the LED+ terminal. The cathode of the LED string can be connected either to GND (boost mode) or IN (buck-boost mode). In the case of boost mode, the input voltage should not exceed the LED string voltage.

## Benefits and Features

- Configured for Boost and Buck-Boost Application
- Analog Dimming Control
- Proven PCB Layout
- Fully Assembled and Tested Feature

***Ordering Information* appears at end of data sheet.**

## Quick Start

### Required Equipment

- MAX25611 EV kit
- 12V, 5A DC power supply
- A series-connected LED string rated at least 1A
- Oscilloscope with a current probe

### Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on power supply until all connections are made.**

1) Verify that all jumpers (J1, J2, and J7) are in their default positions, as shown in Table 1.
2) Connect the positive terminal of the 12V supply to the VIN PCB pad and the negative terminal to the nearest GND PCB pad.
3) Connect the LED string across the LED+ and LED- PCB pads on the EV kit for buck-boost configuration. For boost configuration, connect the LED string across the LED+ and GND PCB pads on the EV kit. The LED string voltage should be higher than the input voltage in this configuration.
4) Clip the current probe on the wire connected to the LED string.
5) Turn on the DC power supply.
6) Verify that the LEDs turn on.
7) Verify that the oscilloscope displays approximately 0.88A.



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## Detailed Description

The MAX25611 EV kit provides a proven design to evaluate the MAX25611A/MAX25611B/MAX25611C/MAX25611D high-voltage HB LED driver with integrated high-side current sense. The EV kit is set up for boost and buck-boost configurations and operates from a 6V to 18V DC supply voltage. The string-forward voltage can vary from 3V to 36V. The EV kit is optimized for 0.8A and a series of 8 LEDs in a string. Other configurations may require changes to component values.

## Analog Dimming Control (REFI)

When J2 is installed across pins 1-2, the LED current is set at the maximum current. The REFI pin is connected to VCC and in this case, the LED current is given by the following equation:

$$I_{LED} = \frac{220mV}{R14}$$

In the case of the EV kit, $I_{LED}$ is set to 0.88A.

When J2 is installed across pins 2-3, the REFI pin is connected to the voltage-divider of R1 and R2, which sets the REFI voltage. If $V_{REFI}$ < 1.2V, then $V_{REFI}$ sets the LED current level.

$$I_{LED} = \frac{\left(V_{REFI} - 0.2V\right)}{5 \times R14}$$

Alternatively, the analog dimming can be controlled by removing the shunt on J2 and applying a voltage between 0 and 5.5V on the REFI test point on the EV kit. REFI voltages above 1.3V are limited to an equivalent of 1.3V inside the IC.

## Pulse-Dimming Input (PWMDIM)

The EV kit demonstrates the PWM dimming feature of the buck controller using either an external PWM signal, or a DC voltage at the DIM pin.

**Analog-to-PWM dimming:** Install a shunt across J1 (1-2). Adjust the potentiometer R18 to set a DC voltage on the PWMDIM pin. The PWM dimming duty cycle is set by the voltage at PWMDIM between 0.2V (0% duty) and 3V (100% duty). Alternatively, drive the PWMDIM testpoint with an external DC source. PWMDIM voltages above 3V set the dimming duty cycle to 100%.

**Direct PWM dimming:** Leave J1 open and connect a PWM signal to the PWMDIM testpoint. Vary the duty cycle to increase or decrease the intensity of the HB LED string. The PWMDIM input of the device has a 2V (max) rising threshold and a 0.8V (min) falling threshold and is compatible with 3.3V and 5V logic-level signals. Uninstall C2 to achieve fast PWMDIM rise and fall edges at the IC pin.

## Table 1. MAX25611 EV Kit Jumper Descriptions

| JUMPER | SHUNT POSITION | DESCRIPTION |
|---|---|---|
| J1 | 1-2* | Connects the PWMDIM pin of the device to VCC through a voltage divider formed by R13 and R18. The dimming duty cycle is adjusted from 0% to 100% for PWMDIM level between 0.2V and 3V. The dimming frequency is internally set at 200Hz. |
| | 2-3 | Connects the PWMDIM pin to ground to disable the analog dimming function and keep the IC off. |
| | Open | Connect an external function generator to drive the PWMDIM pin with a signal from 0 to 3.3V or higher. PWMDIM pulse width should be at least above one switching period.<br>Recommended PWMDIM frequency range is from 200Hz to 2kHz for visible LEDs.<br>IR LEDs can operate at lower frequencies where flicker is not visible. |
| J2 | 1-2* | Connects VCC to the REFI pin. LED current is at the maximum value of 0.88A in this configuration. |
| | 2-3 | Connects the REFI pin of the device to VCC through a voltage divider formed by R1 and R2. Adjusting R2 allows programming the LED current from 0 to 0.88A for REFI levels from 0.2V to 1.3V. For REFI voltages above 1.3V, the LED current is limited at 0.88A. |
| | Open | Connect an external voltage source to set the LED current from 0 to 0.88A for REFI levels from 0.2V to 1.3V. For REFI voltages above 1.3V, the LED current is limited at 0.88A. |
| J7 | 1-2* | Connects the IN pin to the same input supply as the boost power stage through a 10Ω filter resistor. |
| | Open | Connect an external supply voltage greater than 4.7V to J7 pin 2 to bias the IC IN pin. |

**Default position.*

## 2.2MHz Operation

The EV kit can be used to evaluate 2.2MHz operation. To test the 2.2MHz application:

- Change the IC to MAX25611B (provided).
- Change L2 to 2.2µH.
- Change C9 to 0.22µF. R6 remains at 50Ω.
- Output capacitance can be reduced to 1x 4.7µF. Note that short pulse widths at low frequencies benefit from having higher total output capacitance to counter leakage currents that discharge the output voltage before the next pulse.
- Change other components as required (e.g., MOSFET, FET current sense R9, LED current sense R14).

## High-Beam/Low-Beam Application

The EV kit can be used to evaluate high-beam/low-beam switching applications. Connect the low-beam LED string across LED+ and HB_LED+, and the high-beam LED string across HB_LED+ and GND. Use a function generator or a DC source to drive the HIGHBEAM_OFF pad to 5V or GND to disabled or enable the high-beam LEDs. Slew rate control of the driving signal, or adjustment of R19 and C17 values can be used to control the transition of the Q3 shunting FET to minimize surge currents through the low-beam LEDs.

## Latch Circuit

The latch circuit proves HB+LED+ short-to-battery protection by disabling the shunt FET gate. This prevents the shunt FET from shorting out the battery. The latch is reset by removing power to recycle VCC.

## Voltage Regulator Configuration

The EV kit can be reconfigured as a voltage regulator using R27 and R28 as the voltage feedback resistor divider, after removing R14.

$$V_{OUT} = \frac{\left(V_{REFI} - 0.2\right)}{5} \times \frac{(R27 + R28)}{R27}$$

Setting $V_{REFI}$ = 1.2V selects a large feedback signal for better accuracy and noise immunity. For simplicity, select R27 to match the programmed regulation voltage across ISENSEP and ISENSEN. For example, with $V_{REFI}$ = 1.2V, V(ISENSEP - ISENSEN) = 200mV, and R27 should be 200Ω. This makes 1mV per Ω or 1mA down the resistor string, minimizing the error due to ISENSEN leakage current. The calculation for R28 is then simplified to (VOUT - 0.2) x 1000.

The following components should also be changed:

- Power stage components (Q1, L2, D1, R9 and output capacitance) as required for the application (voltage, current rating, etc).
- COMP components (R6, C9, C16) to match the application requirements.
- Remove C14, R17, and Q2.

## Ordering Information

| PART | TYPE |
|---|---|
| MAX25611EVKIT# | EV Kit |

*#Denotes RoHS compliance.*

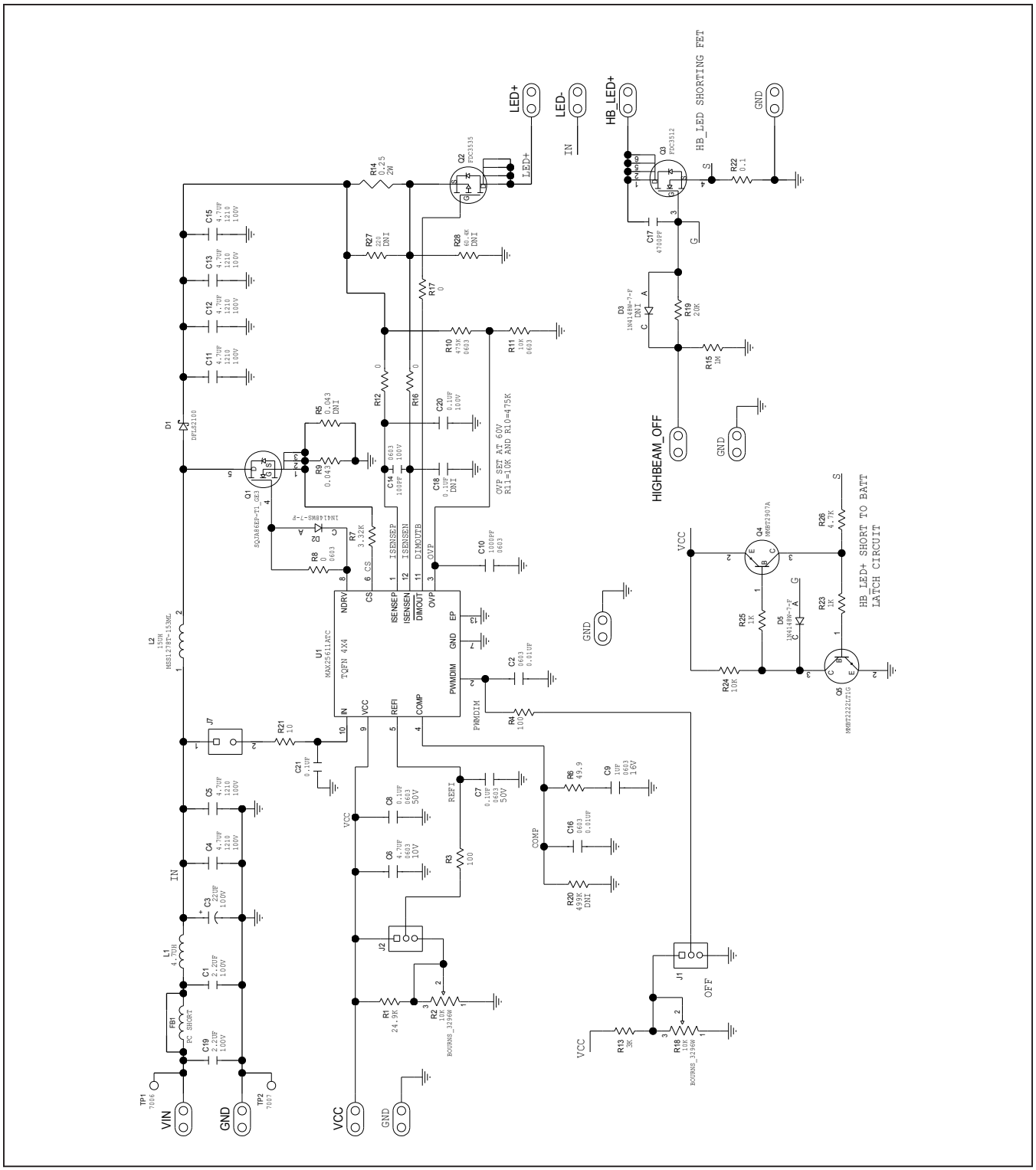
## MAX25611 EV Kit Bill of Materials

| ITEM | REF_DES | DNI/DNP | QTY | MFG PART # | MANUFACTURER | VALUE | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 1 | C1, C19 | — | 2 | GRM32ER72A225KA35; CGA6N3X7R2A225K230; CC1210KKX7R0BB225 | MURATA;TDK; YAGEO | 2.2UF | CAPACITOR; SMT (1210); CERAMIC CHIP; 2.2UF; 100V; TOL = 10%; MODEL = GRM SERIES; TG = -55°C to +125°C; TC = X7R |
| 2 | C2, C16 | — | 2 | CGA3EANP02A103J080AC | TDK | 0.01UF | CAPACITOR; SMT (0603); CERAMIC CHIP; 0.01UF; 100V; TOL = 5%; MODEL = MULTILAYER CERAMIC CHIP CAPACITOR; TC = NPO |
| 3 | C3 | — | 1 | EEE-TG2A220UP | PANASONIC | 22UF | CAPACITOR; SMT (CASE_F); ALUMINUM-ELECTROLYTIC; 22UF; 100V; TOL = 20%; MODEL = TG SERIES; TG = -40°C TO +125°C |
| 4 | C4, C5, C11-C13, C15 | — | 6 | CGA6M3X7S2A475K200AE; CGA6M3X7S2A475K200AB | TDK;TDK | 4.7UF | CAPACITOR; SMT (1210); CERAMIC CHIP; 4.7UF; 100V; TOL = 10%; TG = -55°C TO +125°C; TC = X7S; AUTO |
| 5 | C6 | — | 1 | C1608X6S1A475K | TDK | 4.7UF | CAPACITOR; SMT (0603); CERAMIC CHIP; 4.7UF; 10V; TOL = 10%; TG = -55°C TO +105°C; TC = X6S |
| 6 | C7, C8 | — | 2 | GCJ188R71H104KA12; GCM188R71H104K; CGA3E2X7R1H104K080AA | MURATA; MURATA;TDK | 0.1UF | CAPACITOR; SMT (0603); CERAMIC CHIP; 0.1UF; 50V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R; AUTO |
| 7 | C9 | — | 1 | GCM188R71C105KA64; CGA3E1X7R1C105K080AC | MURATA;TDK | 1UF | CAPACITOR; SMT (0603); CERAMIC CHIP; 1UF; 16V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R; AUTO |
| 8 | C10 | — | 1 | GRM1885C1H102JA01; C1608C0G1H102J080 | MURATA;TDK | 1000PF | CAPACITOR; SMT (0603); CERAMIC CHIP; 1000PF; 50V; TOL = 5%; TG = -55°C TO +125°C |
| 9 | C14 | — | 1 | C0603C101K1GAC | KEMET | 100PF | CAPACITOR; SMT (0603); CERAMIC CHIP; 100PF; 100V; TOL = 10%; MODEL = C0G; TG = -55°C TO +125°C; TC = + |
| 10 | C17 | — | 1 | C0603X472J1GAC | KEMET | 4700PF | CAPACITOR; SMT (0603); CERAMIC CHIP; 4700PF; 100V; TOL = 5%; MODEL = FT-CAP; TG = -55°C TO +125°C; TC = C0G |
| 11 | C20 | — | 1 | C0805C104J1RAC | KEMET | 0.1UF | CAP; SMT (0805); 0.1UF; 5%; 100V; X7R; CERAMIC CHIP |
| 12 | C21 | — | 1 | CGA3E3X7S2A104K080AB | TDK | 0.1UF | CAPACITOR; SMT (0603); CERAMIC CHIP; 0.1UF; 100V; TOL = 10%; TG = -55°C TO +125°C; TC = X7S |
| 13 | D1 | — | 1 | DFLS2100 | DIODES INCORPORATED | DFLS2100 | DIODE; SCH; SMT (POWERDI-123); PIV = 100V; IF = 2A |
| 14 | D2 | — | 1 | 1N4148WS-7-F | DIODES INCORPORATED | 1N4148WS-7-F | DIODE; SWT; SMT (SOD-323); PIV = 75V; IF = 0.3A |
| 15 | D5 | — | 1 | 1N4148W-7-F | DIODES INCORPORATED | 1N4148W-7-F | DIODE; SWT; SMT (SOD-123); PIV = 100V; IF = 0.3A; -65°C TO +150°C |
| 16 | FB1 | — | 1 | HF70ACB322513 | TDK | 52 | INDUCTOR; SMT (1210); FERRITE-BEAD; 52; TOL = ±25%; 0.4A; -40°C TO +125°C |
| 17 | GND, HB_LED+, HIGHBEAM_OFF, J3-J6, LED+, LED-, VCC, VIN | — | 11 | 9020 BUSS | WEICO WIRE | MAXIMPAD | EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG |
| 18 | J1, J2 | — | 2 | PCC03SAAN | SULLINS | PCC03SAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65°C TO +125°C |
| 19 | J7 | — | 1 | PCC02SAAN | SULLINS | PCC02SAAN | CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 2PINS; -65°C TO +125°C |
| 20 | L1 | — | 1 | MSS1278T-472ML | COILCRAFT | 4.7UH | INDUCTOR; SMT; FERRITE BOBBIN CORE; 4.7UH; TOL = ±0.2; 6.2A; -40°C TO +125°C |
| 21 | L2 | — | 1 | MSS1278T-153ML | COILCRAFT | 15UH | INDUCTOR; SMT; FERRITE; 15UH; 20%; 4.9A |
| 22 | MH1-MH4 | — | 4 | 9032 | KEYSTONE | 9032 | MACHINE FABRICATED; ROUND-THRU HOLE SPACER; NO THREAD; M3.5; 5/8IN; NYLON |
| 23 | Q1 | — | 1 | SQJA86EP-T1_GE3 | VISHAY SILICONIX | SQJA86EP-T1_GE3 | TRAN; NCH; SO-8L; PD-(48W); I-(30A); V-(80V) |
| 24 | Q2 | — | 1 | FDC3535 | FAIRCHILD SEMICONDUCTOR | FDC3535 | TRAN; P-CHANNEL POWER TRENCH MOSFET; PCH; SSOT-6; PD-(1.6W); I-(-2.1A); V-(-80V) |

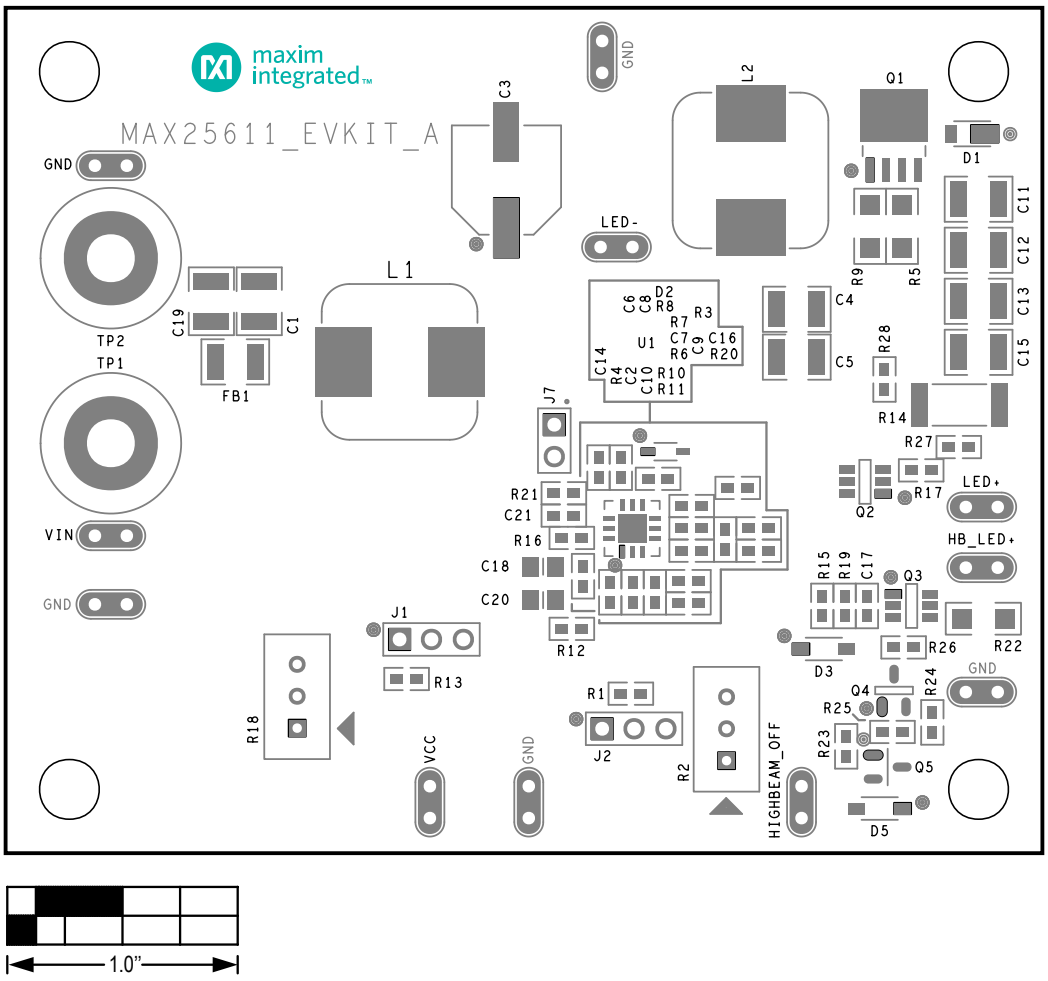
## MAX25611 EV Kit Bill of Materials (continued)

| ITEM | REF_DES | DNI/DNP | QTY | MFG PART # | MANUFACTURER | VALUE | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 25 | Q3 | — | 1 | FDC3512 | ON SEMICONDUCTOR | FDC3512 | TRAN; N-CHANNEL POWERTRENCH MOSFET; NCH; SUPERSOT-6; PD-(1.6W); I-(3A); V-(80V) |
| 26 | Q4 | — | 1 | MMBT2907A | FAIRCHILD SEMICONDUCTOR | MMBT2907A | TRAN; SMALL SIGNAL TRANSISTOR; PNP; SOT-23; PD-(0.35W); IC-(-0.6A); VCEO-(-60V) |
| 27 | Q5 | — | 1 | MMBT2222LT1G | ON SEMICONDUCTOR | MMBT2222LT1G | TRAN; NPN; SOT-23; PD-(0.225W); I-(0.6A); V-(30V) |
| 28 | R1 | — | 1 | CRCW060324K9FK | VISHAY DALE | 24.9K | RESISTOR; 0603; 24.9KΩ; 1%; 100PPM; 0.10W; THICK FILM |
| 29 | R2, R18 | — | 2 | 3296W-1-103LF | BOURNS | 10K | RESISTOR; THROUGH-HOLE-RADIAL LEAD; 3296 SERIES; 10KΩ; 10%; 100PPM; 0.5W; SQUARE TRIMMING POTENTIOMETER; 25 TURNS; MOLDER CERAMIC OVER METAL FILM |
| 30 | R3, R4 | — | 2 | CRCW0603100RFK; ERJ-3EKF1000; RC0603FR-07100RL | VISHAY DALE; PANASONIC | 100 | RESISTOR; 0603; 100Ω; 1%; 100PPM; 0.10W; THICK FILM |
| 31 | R6 | — | 1 | CRCW060349R9FK | VISHAY DALE | 49.9 | RESISTOR; 0603; 49.9Ω; 1%; 100PPM; 0.10W; THICK FILM |
| 32 | R7 | — | 1 | CRCW06033K32FK | VISHAY DALE | 3.32K | RESISTOR; 0603; 3.32K; 1%; 100PPM; 0.10W; THICK FILM |
| 33 | R8, R12, R16, R17 | — | 4 | CRCW06030000ZS; MCR03EZPJ000; ERJ-3GEY0R00 | VISHAY DALE;ROHM; PANASONIC | 0 | RESISTOR; 0603; 0Ω; 0%; JUMPER; 0.10W; THICK FILM |
| 34 | R9 | — | 1 | ERJ-8CWFR043 | PANASONIC | 0.043 | RESISTOR; 1206; 0.043Ω; 1%; 75PPM; 1W; THICK FILM |
| 35 | R10 | — | 1 | CRCW0603475KFK | VISHAY DALE | 475K | RESISTOR; 0603; 475KΩ; 0.1%; 100PPM; 0.1W; THICK FILM |
| 36 | R11 | — | 1 | CRCW060310K0FK; ERJ-3EKF1002 | VISHAY DALE; PANASONIC | 10K | RESISTOR; 0603; 10K; 1%; 100PPM; 0.10W; THICK FILM |
| 37 | R13 | — | 1 | CRCW06033K00FK | VISHAY DALE | 3K | RESISTOR; 0603; 3KΩ; 1%; 100PPM; 0.10W; THICK FILM |
| 38 | R14 | — | 1 | LRC-LR2512LF-01-R250F | TT ELECTRONICS | 0.25 | RESISTOR; 2512; 0.25Ω; 1%; 100PPM; 2W; THICK FILM |
| 39 | R15 | — | 1 | CRCW06031M00JN | VISHAY DALE | 1M | RESISTOR; 0603; 1MΩ; 5%; 200PPM; 0.10W; METAL FILM |
| 40 | R19 | — | 1 | CRCW060320K0JN | VISHAY DALE | 20K | RESISTOR; 0603; 20KΩ; 5%; 200PPM; 0.10W; METAL FILM |
| 41 | R21 | — | 1 | ERA-V15J100V | PANASONIC | 10 | RESISTOR; 0603; 10Ω; 5%; 1500PPM; 0.063W; METAL FILM |
| 42 | R22 | — | 1 | LRC-LR1206LF-01-R100-F | TT ELECTRONICS | 0.1 | RESISTOR; 1206; 0.1Ω; 1%; 100PPM; 0.5W; THICK FILM |
| 43 | R23, R25 | — | 2 | ERJ-3GEYJ102V | PANASONIC | 1K | RESISTOR; 0603; 1KΩ; 5%; 200PPM; 0.10W; THICK FILM |
| 44 | R24 | — | 1 | 301-10K-RC | XICON | 10K | RESISTOR, 0603, 10KΩ, 5%, 200PPM, 1/16W, THICK FILM |
| 45 | R26 | — | 1 | ERJ-3GEYJ472V | PANASONIC | 4.7K | RESISTOR; 0603; 4.7KΩ; 5%; 200PPM; 0.10W; THICK FILM |
| 46 | SU1-SU3 | — | 3 | S1100-B;SX1100-B | KYCON;KYCON | SX1100-B | TEST POINT; JUMPER; STR; TOTAL LENGTH = 0.24IN; BLACK; INSULATION = PBT;PHOSPHOR BRONZE CONTACT = GOLD PLATED |
| 47 | TP1 | — | 1 | 7006 | KEYSTONE | 7006 | CONNECTOR; PANELMOUNT; BINDING POST; STRAIGHT THROUGH; 1PIN; RED |
| 48 | TP2 | — | 1 | 7007 | KEYSTONE | 7007 | CONNECTOR; PANELMOUNT; BINDING POST; STRAIGHT THROUGH; 1PIN; BLACK |
| 49 | U1 | — | 1 | MAX25611ATC | MAXIM | MAX25611ATC | EVKIT PART - IC; MAX25611ATC; PACKAGE OUTLINE DRAWING: 21-0139; LAND PATTERN DRAWING: 90-0068; TQFN16-EP |
| 50 | PCB | — | 1 | MAX25611 | MAXIM | PCB | PCB:MAX25611 |
| 51 | C18 | DNP | 0 | C0805C104J1RAC | KEMET | 0.1UF | CAP; SMT (0805); 0.1UF; 5%; 100V; X7R; CERAMIC CHIP |
| 52 | D3 | DNP | 0 | 1N4148W-7-F | DIODES INCORPORATED | 1N4148W-7-F | DIODE; SWT; SMT (SOD-123); PIV = 100V; IF = 0.3A; -65°C TO +150°C |
| 53 | R5 | DNP | 0 | ERJ-8CWFR043 | PANASONIC | 0.043 | RESISTOR; 1206; 0.043Ω; 1%; 75PPM; 1W; THICK FILM |
| 54 | R20 | DNP | 0 | CRCW0603499KFK | VISHAY DALE | 499K | RESISTOR; 0603; 499KΩ; 1%; 100PPM; 0.1W; THICK FILM |
| 55 | R27 | DNP | 0 | CRCW0603220RFK | VISHAY DALE | 220 | RESISTOR; 0603; 220Ω; 1%; 100PPM; 0.10W; THICK FILM |
| 56 | R28 | DNP | 0 | CRCW060360K4FK | VISHAY DALE | 60.4K | RESISTOR, 0603, 60.4KΩ, 1%, 100PPM, 0.1W, THICK FILM |
| TOTAL | | | 80 | | | | |

## MAX25611 EV Kit Schematics

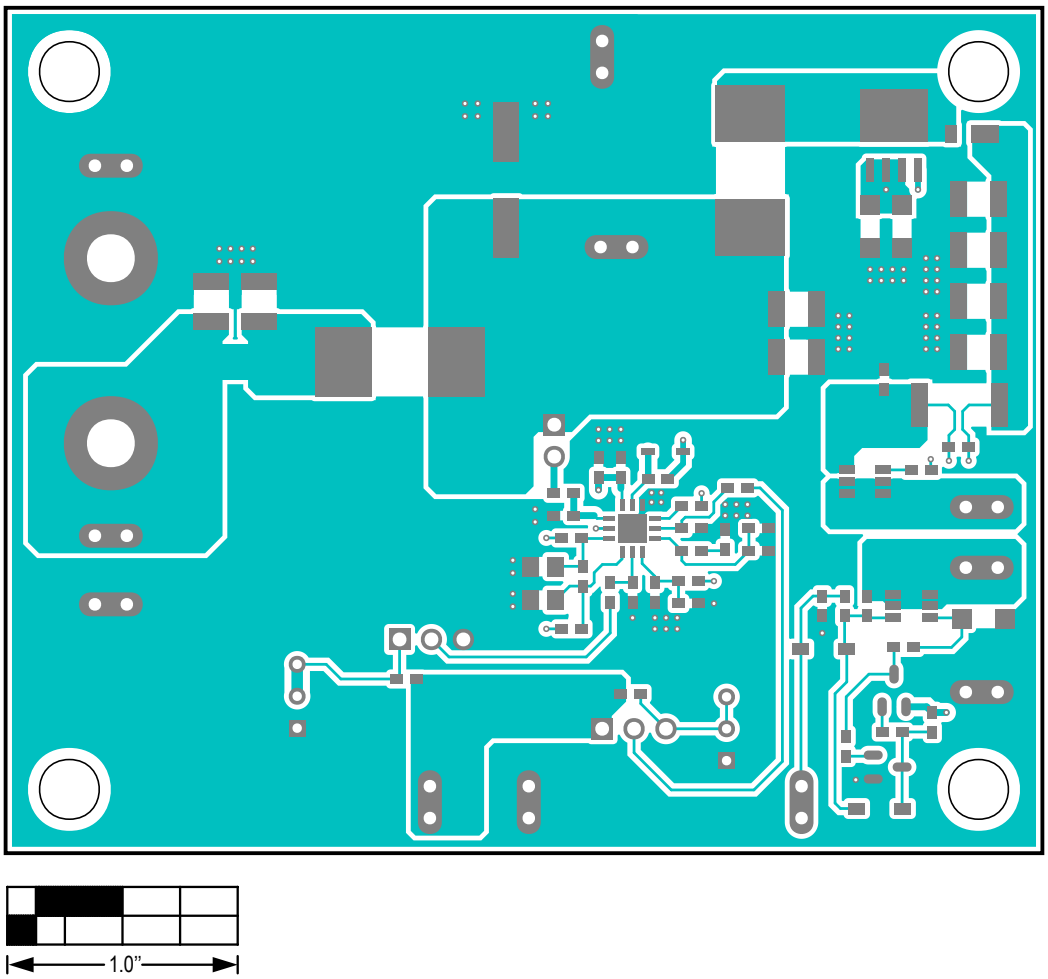


## MAX25611 EV Kit PCB Layout Diagrams



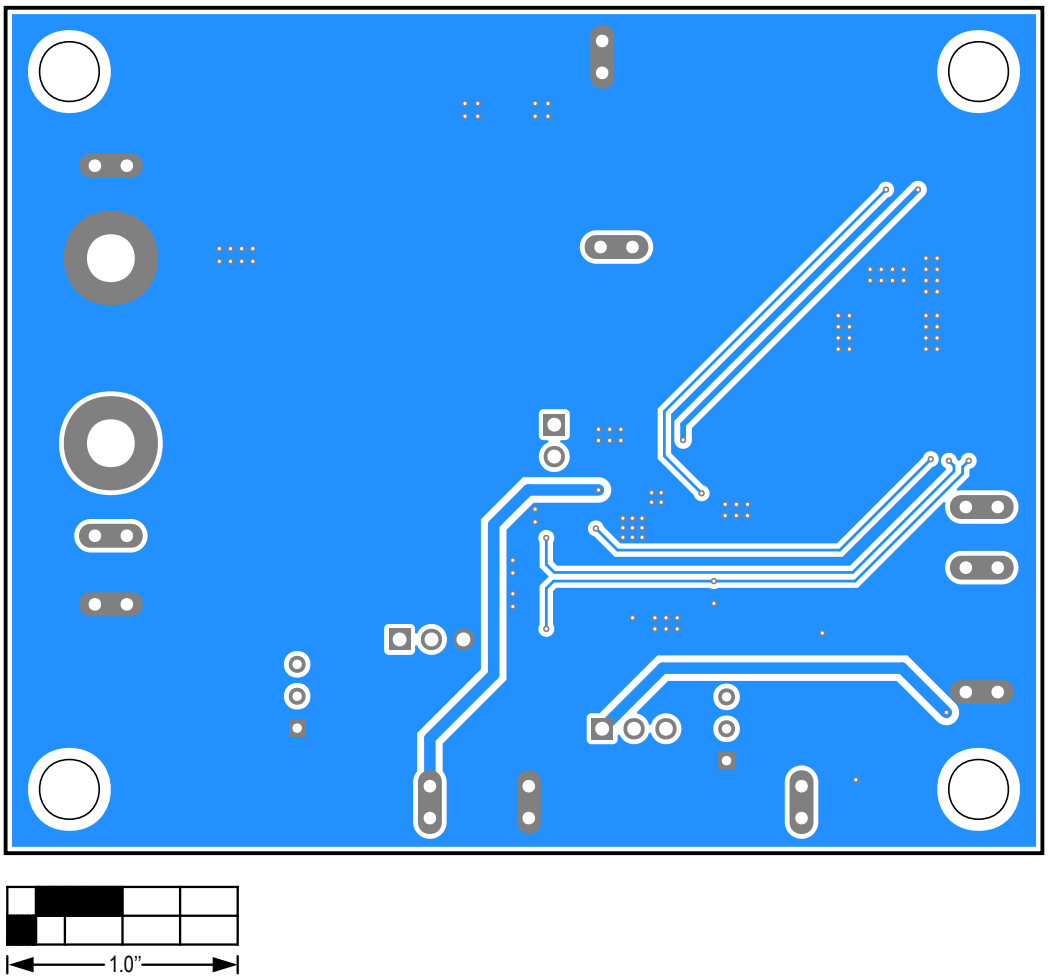

*MAX25611 EV Kit Component Placement Guide—Top Silkscreen*

## MAX25611 EV Kit PCB Layout Diagrams (continued)



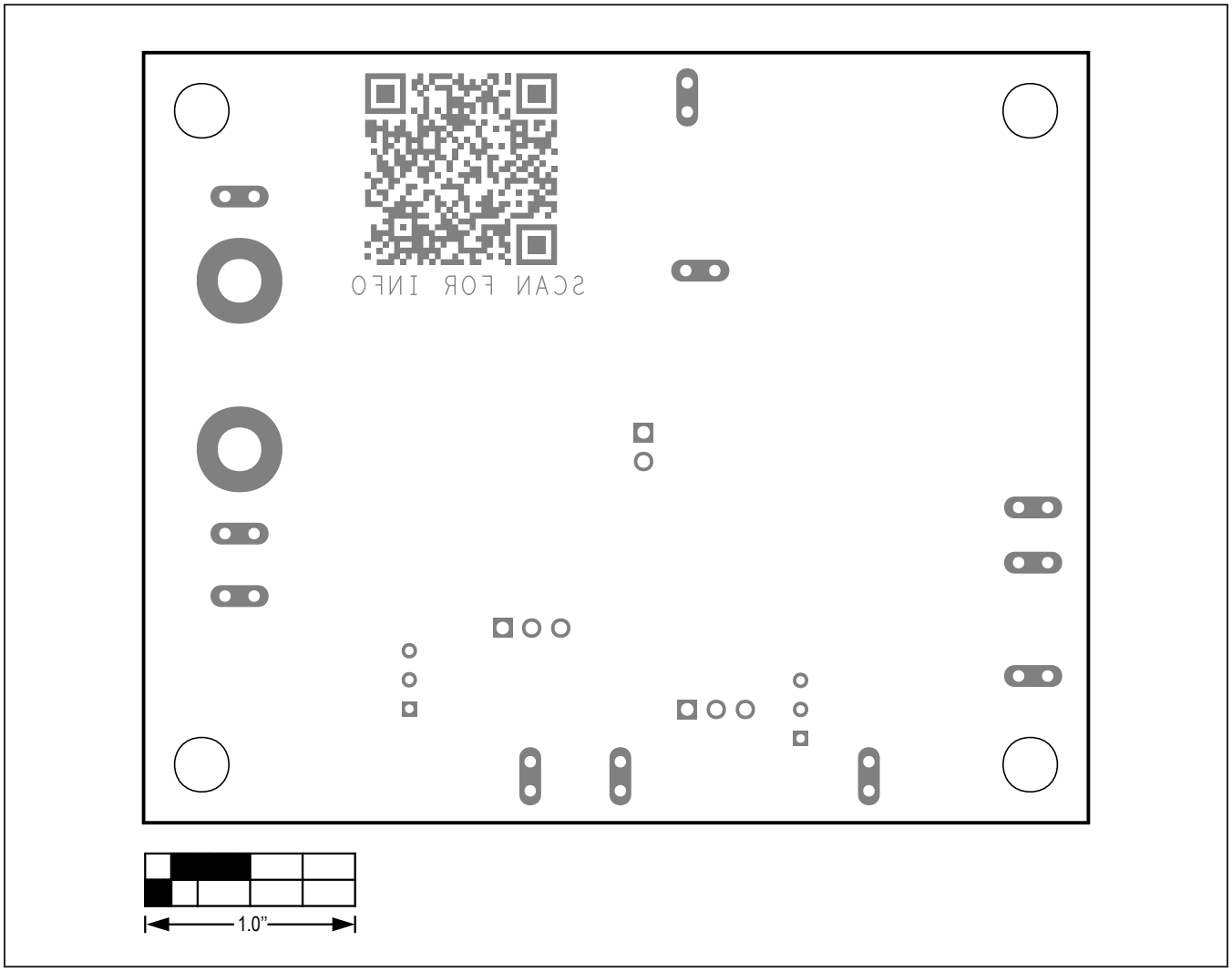

*MAX25611 EV Kit PCB Layout—Top View*

## MAX25611 EV Kit PCB Layout Diagrams (continued)




*MAX25611 EV Kit PCB Layout—Bottom View*

## MAX25611 EV Kit PCB Layout Diagrams (continued)




*MAX25611 EV Kit Component Placement Guide—Bottom Silkscreen*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 3/19 | Initial release | — |
| 1 | 3/19 | Updated parts evaluated to MAX25611A/MAX25611B | 1–11 |
| 2 | 9/19 | Updated parts evaluated to MAX25611A/MAX25611B/MAX25611C/MAX25611D | 1–11 |