*Click here to ask an associate for production status of specific part numbers.*

**Evaluates: MAX15162 (WLP)**

# MAX15162AWE Evaluation Kit

## General Description

The MAX15162AWE evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board that contains all components necessary to evaluate the MAX15162AWE+ and MAX15162AAWE+ dual-channel circuit breaker IC for power amplifier system. The IC is in an extremely compact, 16-bump, 2mm x 2mm WLP. The EV kit is powered from an 8V to 60V DC supply and can be configured as two independent single-channel or one parallel dual-channel circuit breaker. The EV kit provides multilevel overcurrent limit protection and pin-strap programmable current-limit level up to 1.5A for each channel.

The EV kit demonstrates the full functionality of the MAX15162AWE+/MAX15162AAWE+, such as IN-OUT short protection during startup, inrush current control, input undervoltage lockout (UVLO), programmable overcurrent shutdown delay time and fast large overcurrent protection. The EV kit also features current monitoring/reporting with ±3% accuracy (0.8A~1.5A) on individual channel and overcurrent/overtemperature fault status indication.

***Warning:*** *The EV kit is designed to operate with high voltages. Dangerous voltages are present on this EV kit and on equipment connected to it. Users who power up this EV kit or power the sources connected to it must be careful to follow safety procedures appropriately to work with high-voltage electrical equipment.*

*Under severe fault or failure conditions, this EV kit may dissipate large amounts of power, which could result in the mechanical ejection of a component or of component debris at high velocity. Operate this kit with care to avoid possible personal injury.*

## Features

- 8V to 60V Wide Input Voltage Range
- Integrated Dual-Power MOSFET with Low Turn-on Resistance 150mΩ
- Dual-Channel Independent or Parallel Mode Configuration
- Undervoltage Lockout
- Enable Input for Individual Channel
- Constant Power Control at Startup
- Startup Watchdog Timer
- Startup IN-to-OUT Short Protection
- Overcurrent and Overtemperature Fault Status Indication on Individual Channel
- ±3% Accuracy Current Reporting on Individual Channel
- Multilevel Overcurrent Limit Protection
- Programmable Current-Limit Level
- Programmable Overcurrent Shutdown Delay Time
- Latch in a Fault Event (MAX15162AWE+)
- Auto-Retry in a Fault Event with Programmable Auto-Retry Time (MAX15162AAWE+)
- Built-in Thermal Shutdown Protection
- Proven PCB Layout
- Fully Assembled and Tested

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

*319-100526; Rev 3; 11/22*



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## Quick Start

### Required Equipment

- MAX15162AWE EV kit
- 8V to 60V, 5A capable DC power supply
- 3.3V DC power supply
- Two loads capable of supporting 60V and sinking 3A
- Digital voltmeters
- 100MHz dual-trace oscilloscope

### Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation:

**Caution: Do not turn on the power supply until all connections are completed.**

1) Configure IMONx and ENx pins with the power supply off (x = 1, 2):
   a. **Independent Mode:** Leave R24 uninstalled to disconnect IMON1 and IMON2; R23 and R19 configure OC limit of channel 1 and channel 2 separately. Leave R40 uninstalled to disconnect EN1 and EN2. Pull up pin 1 of J8 to enable channel 1, pull up pin 1 of J4 to enable channel 2. Leave J5 open.
   b. **Parallel Mode:** Install R24 = 0Ω to tie IMON1 and IMON2 together. The parallel of R19 and R23 set up the total OC limit of two channels. Install R40 = 0Ω to tie EN1 and EN2 together. Pull up pin 1 of J4 or J8 to enable both channels. Install a shunt at J5 to short $\overline{\text{ALRT1}}$ and $\overline{\text{ALRT2}}$.
2) Connect electronic loads to the output:
   a. **Independent Mode:** Connect two 1A electronic loads to OUT1+/OUT1- and OUT2+/OUT2- banana jack connectors individually. Disable the load.
   b. **Parallel Mode:** Solder R33 (0Ω) to connect OUT1+ and OUT2+. Connect one 2A electronic load to OUT1+ and OUT1- banana jack connectors and disable the load.
3) Connect the external DC power supply to VIN and GND banana jack connectors. Turn on VIN at 0V and ramp it up to 8V or higher.
4) Using voltmeters, verify that the external 3.3V power supply provides EN = 3.3V and VOUT = VIN (VIN - VOUT < 700mV) across OUT1+ (OUT2+) and OUT1- (OUT2-).

## Detailed Description of Hardware

The MAX15162AWE EV kit is a fully assembled and tested board to evaluate the performance of the MAX15162AWE+/MAX15162AAWE+ integrated dual-channel circuit breaker. With the wide range of input voltage (from 8V to 60V), inrush current control, and programmable overcurrent protection limit level, the MAX15162AWE+/MAX15162AAWE+ is well suited for telecommunication power amplifier systems. The EV kit features components and circuits that demonstrate the full functionality of the MAX15162AWE+/MAX15162AAWE+ in both independent mode and parallel mode.

### Mode Configuration

The MAX15162AWE+/MAX15162AAWE+ devices detect IMONx (x = 1, 2) pins connection during initialization process and determines the operation mode. To configure the device in independent mode on the EV kit, leave R24 uninstalled. To configure the device in parallel mode, install R24 = 0Ω to tie IMONx together. See Table 1 for operating mode settings.

### Enable Input (ENx)

The dual channels of the MAX15162AWE+/MAX15162AAWE+ can be individually enabled or disabled through the ENx (x = 1, 2) by driving it above or below the enable threshold voltage. The EV kit allows the ENx pins to be pulled up by an external DC bias power supply.

## Table 1. Operating Mode Setting

| CONFIG RESISTOR | SHUNT POSITION | FUNCTION |
|---|---|---|
| R40 | 0Ω | Parallel mode: tie EN1 and EN2 |
| | Open | Independent mode |
| R24 | 0Ω | Parallel mode: tie IMON1 and IMON2 |
| | Open | Independent mode |
| R33 | 0Ω | Parallel mode: tie OUT1 and OUT2 |
| | Open | Independent mode |

### Current-Limit Thresholds and Current Monitor (IMONx)

The EV kit configures overcurrent limit threshold through the IMONx pins for each channel. Connect a resistor between IMONx and GND to program the overcurrent limit threshold in the device. In independent mode, configure R23 and R19 individually. The following equation is used to calculate the current-limit setting resistor:

$$R_{IMON}\ (\Omega) = 1.125 \times C_{IRATIO}/ILIM\ (A)$$

In parallel mode, connect IMON1 and IMON2 pins together with one resistor to GND. Use the following equation to calculate the current-limit setting resistor:

$$R_{IMON}\ (\Omega) = 1.125 \times C_{IRATIO}/ILIM\ (A)/2$$

where ILIM is the desired current limit, and $C_{IRATIO}$ is the ratio of current mirror. See Table 2 and Table 3 for current-limit resistor settings in independent mode and parallel mode.

At the same time, the voltage on the IMONx pin monitors the OUT current in each channel with the following relationship:

$$I_{OUT}\ (A) = V_{IMON}\ (V) \times C_{IRATIO}/R_{IMON}\ (\Omega)$$

In independent mode, $I_{OUT}$ in above equation represents the current from individual channel. In parallel mode, while connecting the IMON1 and IMON2 pins together, $I_{OUT}$ represents the sum of current of two channels.

### Overcurrent Protection Delay (RDLY)

The EV kit configures the overcurrent protection response delay time by connecting DLY pin and GND through resistor R14, as shown in Table 4. When the current through the device reaches the overcurrent limit threshold, the internal delay timer begins to count. If the current drops back below the overcurrent limit within the delay time $T_{DLY}$, the MOSFET remains on. If the current stays higher than the overcurrent limit, the MOSFET turns off after $T_{DLY}$ elapses.

### Fault Status Indication ($\overline{ALRT}$x)

The EV kit indicates fault status through the ALRTB pin in each channel. ALRTB is pulled low when the following faults occur:

- MOSFET is not turned on.
- Input voltage drops to UVLO level.
- Overcurrent limit is triggered.
- Overtemperature level is reached.
- Startup watchdog times out.
- IMONx pins are open.

## Table 2. Overcurrent Limit Resistor Selection in Independent Mode

| CONFIG RESISTOR | RESISTOR VALUE (kΩ) | OVERCURRENT LIMIT/ CHANNEL (A) | FAST OCP LIMIT/ CHANNEL (A) |
|---|---|---|---|
| R19, R23 | 9.09 | 0.50 | 0.66 |
| | 6.04 | 0.75 | 0.99 |
| | 4.53 | 0.99 | 1.32 |
| | 3.01 | 1.50 | 1.99 |

## Table 3. Overcurrent Limit Resistor Selection in Parallel Mode

| CONFIG RESISTOR | RESISTOR VALUE (kΩ) | OVERCURRENT LIMIT/ CHANNEL (A) | FAST OCP LIMIT/ CHANNEL (A) |
|---|---|---|---|
| R19, R23 | 4.53 | 0.50 | 0.66 |
| | 3.01 | 0.75 | 1.00 |
| | 2.26 | 0.99 | 1.33 |
| | 1.50 | 1.50 | 2.00 |

## Table 4. DLY Pin-Strap Configuration

| R14 (kΩ) | DELAY TIME | AUTORETRY TIME |
|---|---|---|
| 0 | 12µs | 0.6ms |
| 27 | 100µs | 6ms |
| 47 | 1ms | 60ms |
| 68 | 10ms | 600ms |

## Component Suppliers

| SUPPLIER | WEBSITE |
|---|---|
| Analog Devices | www.analog.com |
| CoilCraft | www.coilcraft.com |
| Comchip | www.comchiptech.com |
| Diodes Incorporated | www.diodes.com |
| Emerson Network Power | www.vertivco.com |
| Fairchild Semiconductor | www.onsemi.com |
| Kemet | www.ir.kemet.com |
| Keystone | www.keyelco.com |
| Lite-On Electronics | www.us.liteon.com |
| Murata | www.murata.com |
| On Semiconductor | www.onsemi.com |
| Panasonic | www.panasonic.com |
| Pulse Electronics | www.pulseelectronics.com |
| Renesas Technology Group | www.renesas.com |
| Samsung Electronics | www.samsung.com |
| Stackpole Electronics | www.seielect.com |
| Sumida | www.sumida.com |
| Taiyo Yuden | www.yuden.co.jp |
| TDK | www.us.tdk.com |
| TE Connectivity | www.te.com |
| Texas Instruments | www.ti.com |
| Vishay Dale | www.vishay.com |
| Würth Elektronik | www.we-online.com |

***Note:*** *Indicate that you are using the MAX15162AWE when contacting these component suppliers.*

## Ordering Information

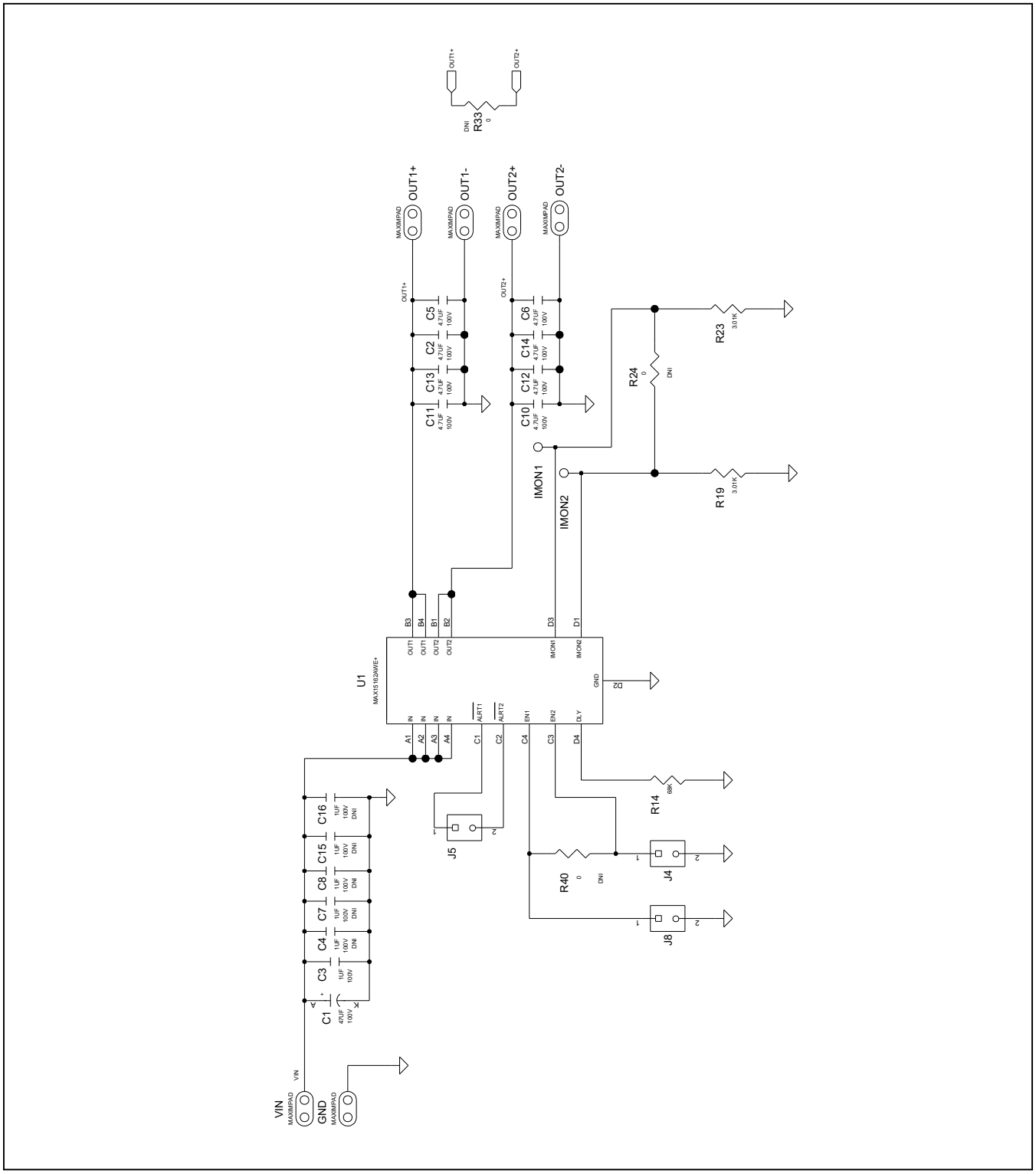
| PART | TYPE |
|---|---|
| MAX15162WAEVKIT# | MAX15162 WLP (Auto-retry) |
| MAX15162WLEVKIT# | MAX15162 WLP (Latched off) |

*#Denotes RoHS compliant.*

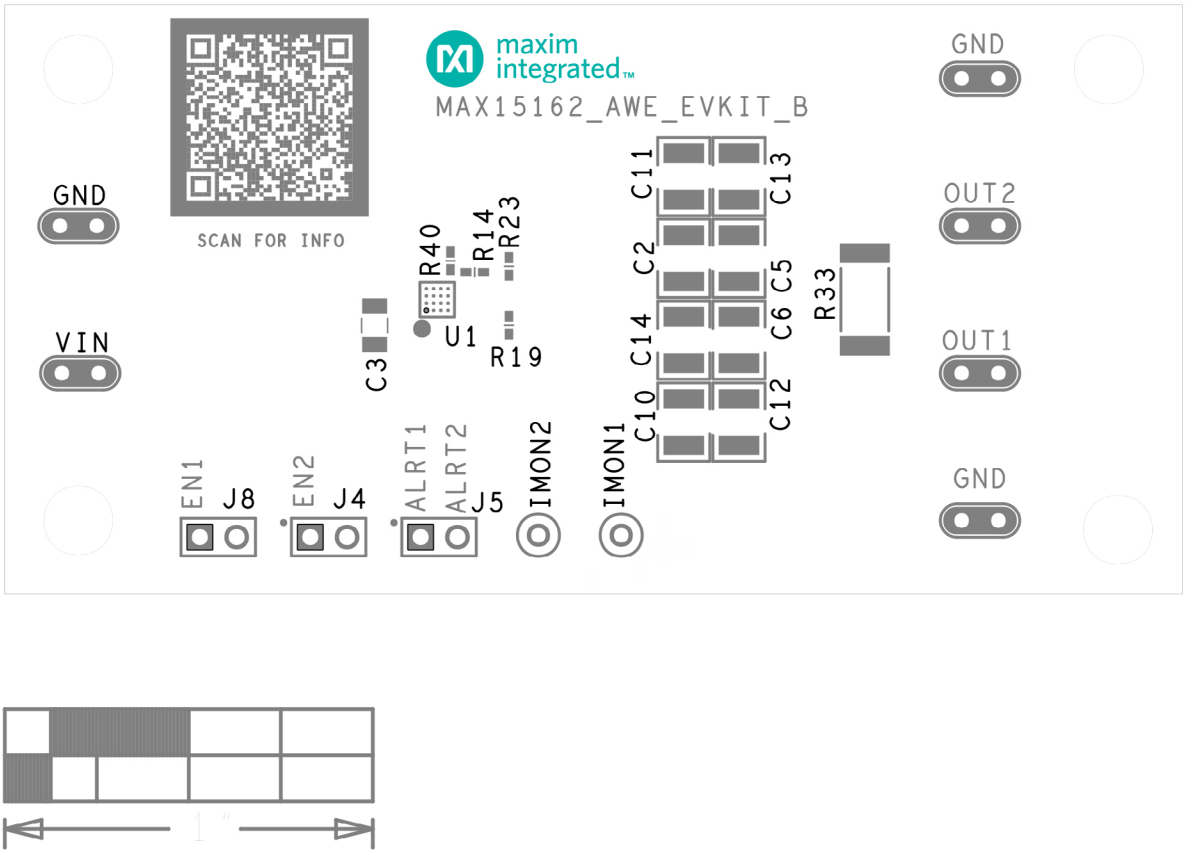
## MAX15162 WLP EV Kit Bill of Materials

| PART | QTY | DESCRIPTION |
|---|---|---|
| C1 | 1 | 47µF ±20%, 100V; aluminum electrolytic capacitor (Case H13) Panasonic EEE-FK2A470AQ |
| C2, C5, C6, C10-C14 | 8 | 4.7µF ±10%, 100V X7S ceramic capacitor (1210) TDK C3225X7S2A475K200AB |
| C3 | 1 | 1µF ±10%, 100V X7R ceramic capacitor (1206) Murata GRM31CR72A105KA01 |
| GND, OUT1+, OUT1-, OUT2+, OUT2-, VIN | 6 | Soft Drawn Bus TYPE-S, 20AWG, Weico Wire, 9020 BUSS |
| IMON1, IMON2 | 2 | Test Point; PIN DIA = 0.1 inch; Total Length = 0.3 inch; Board Hole = 0.04 inch; RED; Keystone 5000 |
| J4, J5, J8 | 3 | Breakaway Connector, Male, Through Hole, 2 Pins, Sullins, PEC03SAAN |
| R14 | 1 | 68kΩ ±1% Resistor (0402) Vishay CRCW040268K0FK |
| R19, R23 | 2 | 3.01kΩ ±1% Resistor (0402) Vishay CRCW04023K01FK |
| U1 | 1 | Integrated Dual-Channel Circuit Breaker, WLP-16, MAX15162/MAX15162AAWE+ |
| PCB | 1 | PCB:MAX15162AWE+/MAX15162AAWE+ |
| C4, C7, C8, C15, C16 | DNP | 1µF ±10%, 100V X7R ceramic capacitor (1206) Murata GRM31CR72A105KA01 |
| R24, R40 | DNP | 0Ω ±0% Resistor (0402) Vishay CRCW04020000Z0EDHP |
| R33 | DNP | 0Ω ±0% Resistor (2512) Vishay CRCW25120000Z0EGHP |

## MAX15162AWE EV Kit Schematic

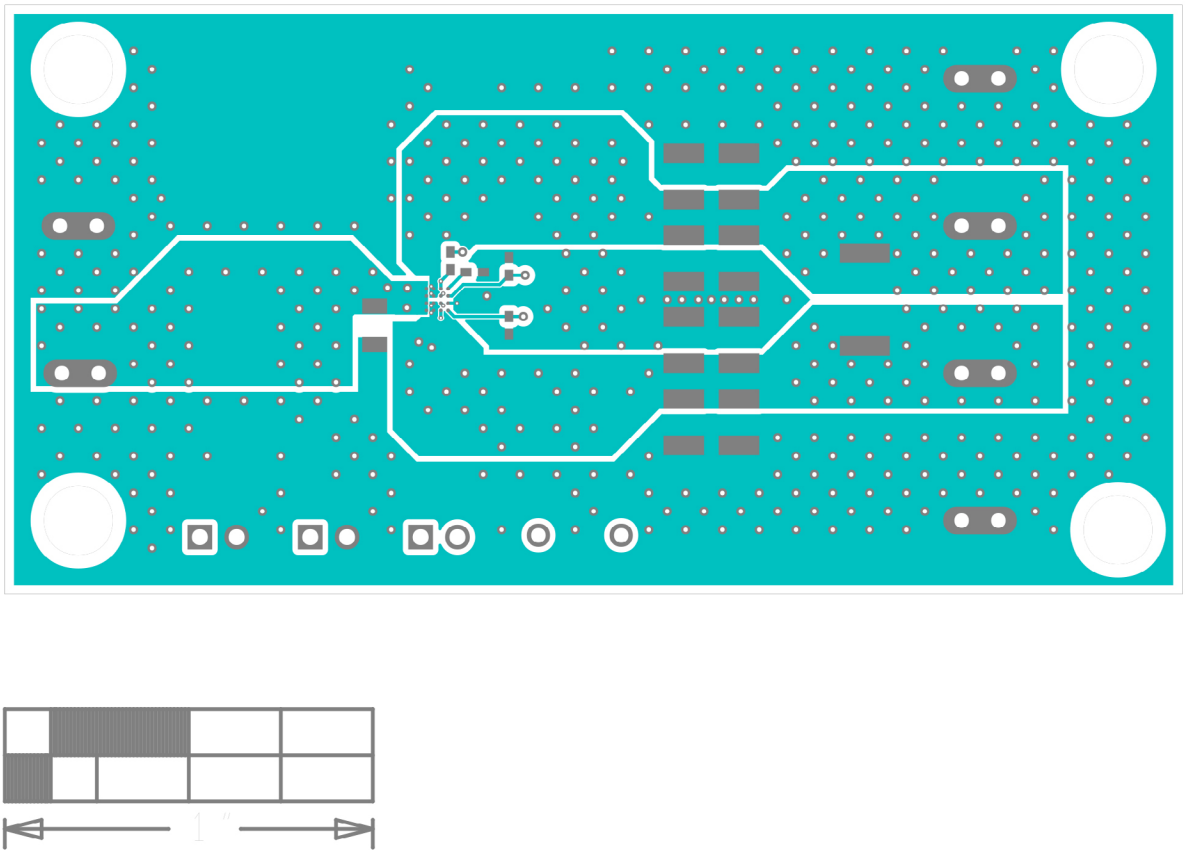


## MAX15162AWE EV Kit PCB Layout Diagrams



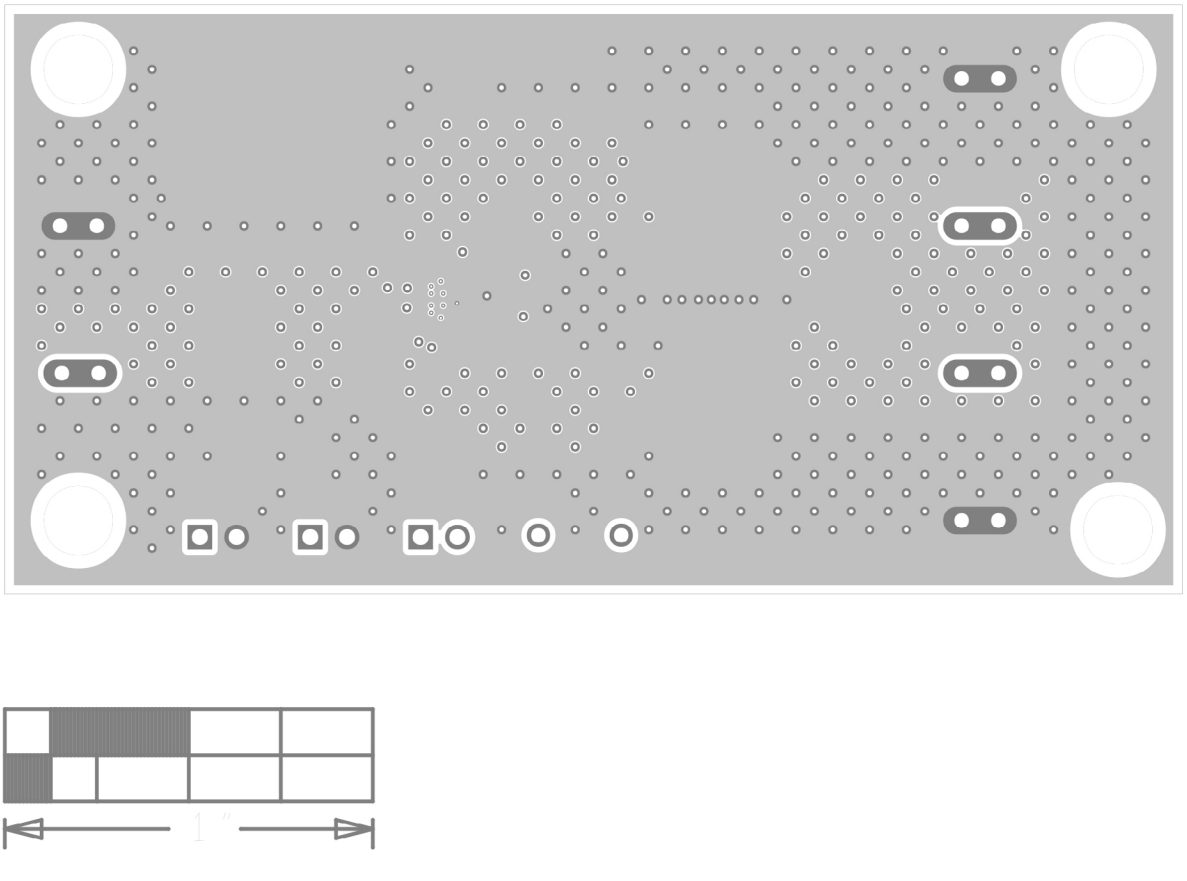

*MAX15162AWE EV Kit PCB—Silkscreen Top Side*

## MAX15162AWE EV Kit PCB Layout Diagrams (continued)



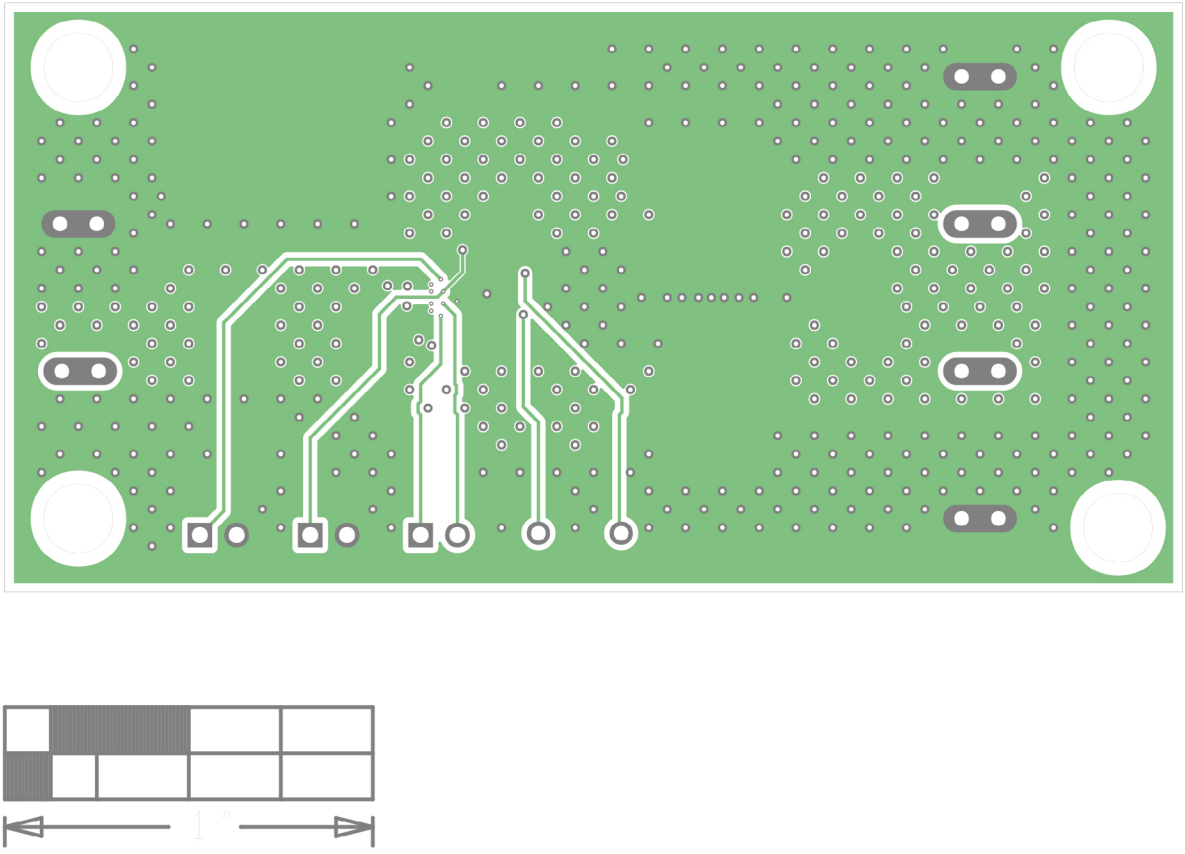
*MAX15162AWE EV Kit PCB—Top Side*

## MAX15162AWE EV Kit PCB Layout Diagrams (continued)



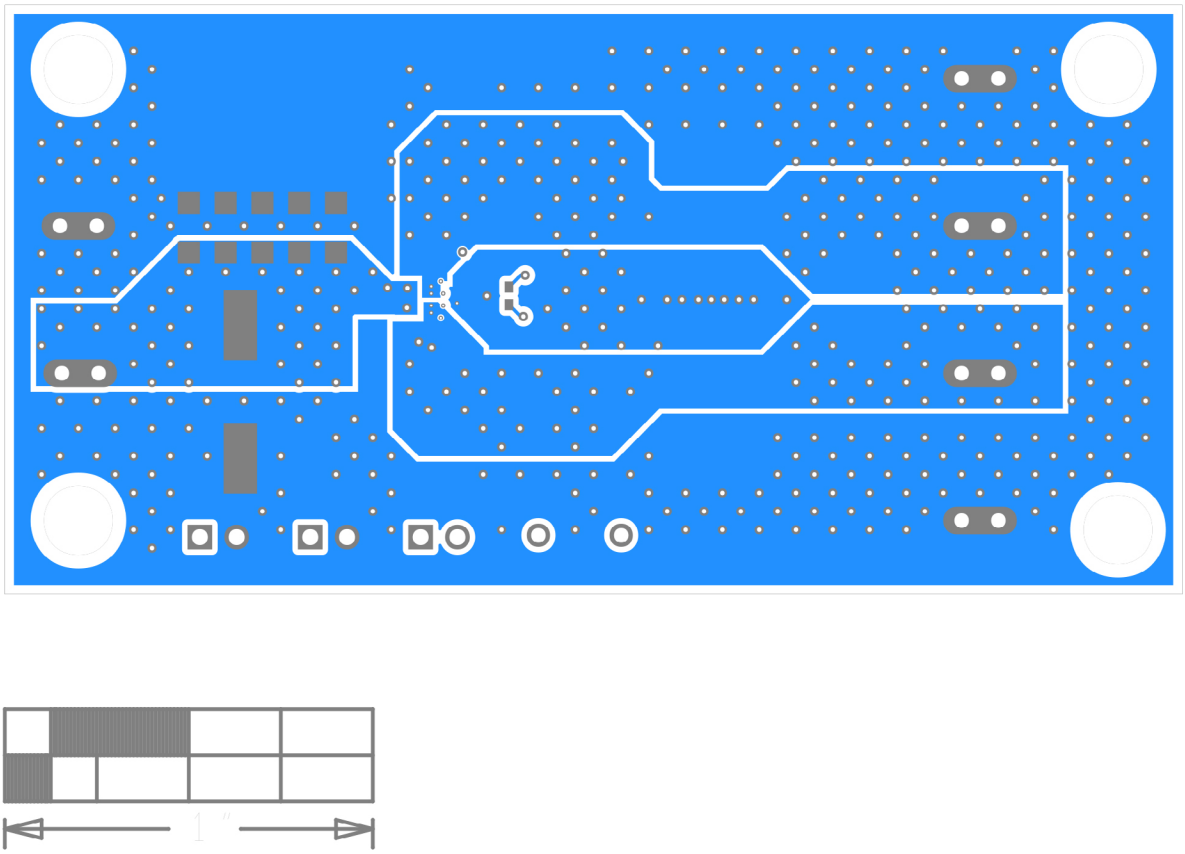
*MAX15162AWE EV Kit PCB—Internal Layer 2*

## MAX15162AWE EV Kit PCB Layout Diagrams (continued)



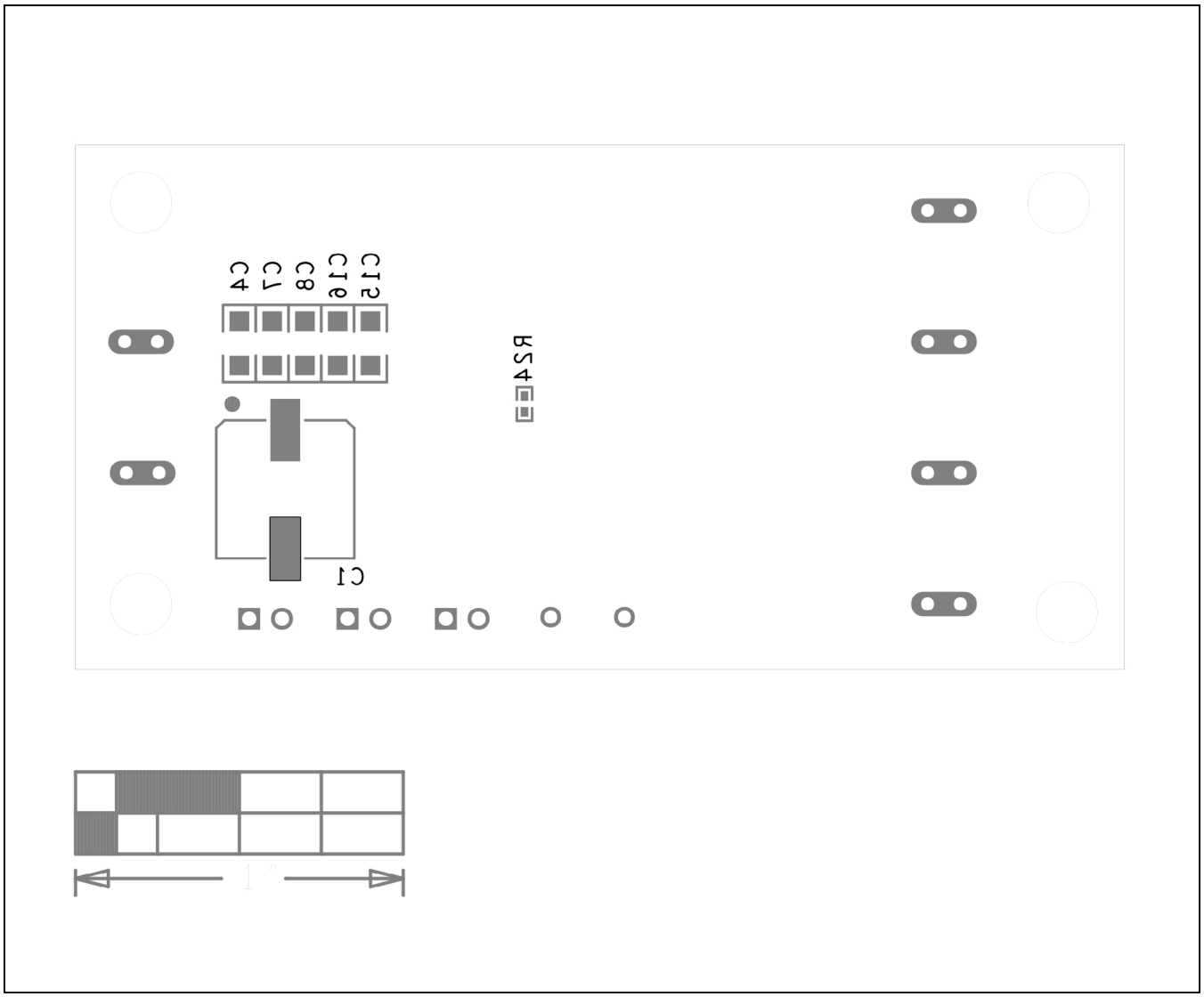
*MAX15162AWE EV Kit PCB—Internal Layer 3*

## MAX15162AWE EV Kit PCB Layout Diagrams (continued)



*MAX15162AWE EV Kit PCB—Bottom Side*

## MAX15162AWE EV Kit PCB Layout Diagrams (continued)




*MAX15162AWE EV Kit PCB—Silkscreen Bottom Side*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 11/19 | Initial release | — |
| 1 | 10/20 | Change to Rev B EV kit | 2–12 |
| 2 | 10/21 | Changed title to indicate WLP | All |
| 3 | 11/22 | Updated to match hardware | 3, 5 |