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Evaluates: MAX15162 (TQFN)

MAX15162ATG Evaluation Kit

General Description

The MAX15162ATG evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board that contains all components necessary to evaluate the MAX15162ATG+/MAX15162AATG+ dual-channel circuit breaker IC for power amplifier system. The IC is in compact 24-pin, 4mm x 4mm TQFN package. 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 MAX15162ATG+/MAX15162AATG+, 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 (0.8~1.5A) 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 Turn-on Resistance 200mΩ
- 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 (MAX15162ATG+)
- Auto-Retry in a Fault Event with Programmable Auto-Retry Time (MAX15162AATG+)
- Built-in Thermal Shutdown Protection
- Proven PCB Layout
- Fully Assembled and Tested

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

319-100478; Rev 3; 11/22

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Quick Start

Required Equipment

- MAX15162ATG 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 power supply off (x = 1, 2):
   a) **Independent Mode:** Leave R20 uninstalled (to disconnect IMON1 and IMON2); R23 and R19 configure OC limit of channel 1 and channel 2 separately. Leave R11 uninstalled to disconnect EN1 and EN2. Pull up pin 1 of J8 to enable channel 1; pull up pin 1 of J9 to enable channel 2. Leave J5 open.
   b) **Parallel Mode:** Install R20 = 0Ω to tie IMON1 and IMON2 together. The parallel of R19 and R23 set up the total OC limit of two channels. Install R11 = 0Ω to tie EN1 and EN2 together. Pull up pin 1 of J8 or J9 to enable both channels. Install shunt at J5 to short $\overline{ALRT1}$ and $\overline{ALRT2}$.
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 the OUT1+ (OUT2+) and OUT1- (OUT2-).

Detailed Description of Hardware

The MAX15162ATG EV kit is a fully assembled and tested board to evaluate the performance of the MAX15162ATG+/MAX15162AATG+ 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 MAX15162ATG+/MAX15162AATG+ is well suited for telecommunication Power Amplifier systems. The EV kit features components and circuits that demonstrate the full functionality of the MAX15162ATG+/MAX15162AATG+ in both independent mode and parallel mode.

Mode Configuration

The MAX15162ATG+/MAX15162AATG+ device detects 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 R20 uninstalled. To configure the device in parallel mode, install R20 = 0Ω to tie IMONx together.

Enable Input (ENx)

The dual channels of the MAX15162ATG+/MAX15162AATG+ 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 ENx pins to be pulled up by external DC bias power supply.

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

Table 1. Operating Mode Setting

CONFIG RESISTOR	SHUNT POSITION	FUNCTION
R11	0Ω	Parallel mode: tie EN1 and EN2
	Open	Independent mode
R20	0Ω	Parallel mode: tie IMON1 and IMON2
	Open	Independent mode
R33	0Ω	Parallel mode: tie OUT1 and OUT2
	Open	Independent mode

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

Overcurrent Protection Delay (RDLY)

The EV kit configures the overcurrent protection response delay time by connecting the 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 ($\overline{ALRTx}$)

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 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
Wurth Elektronik	www.we-online.com

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

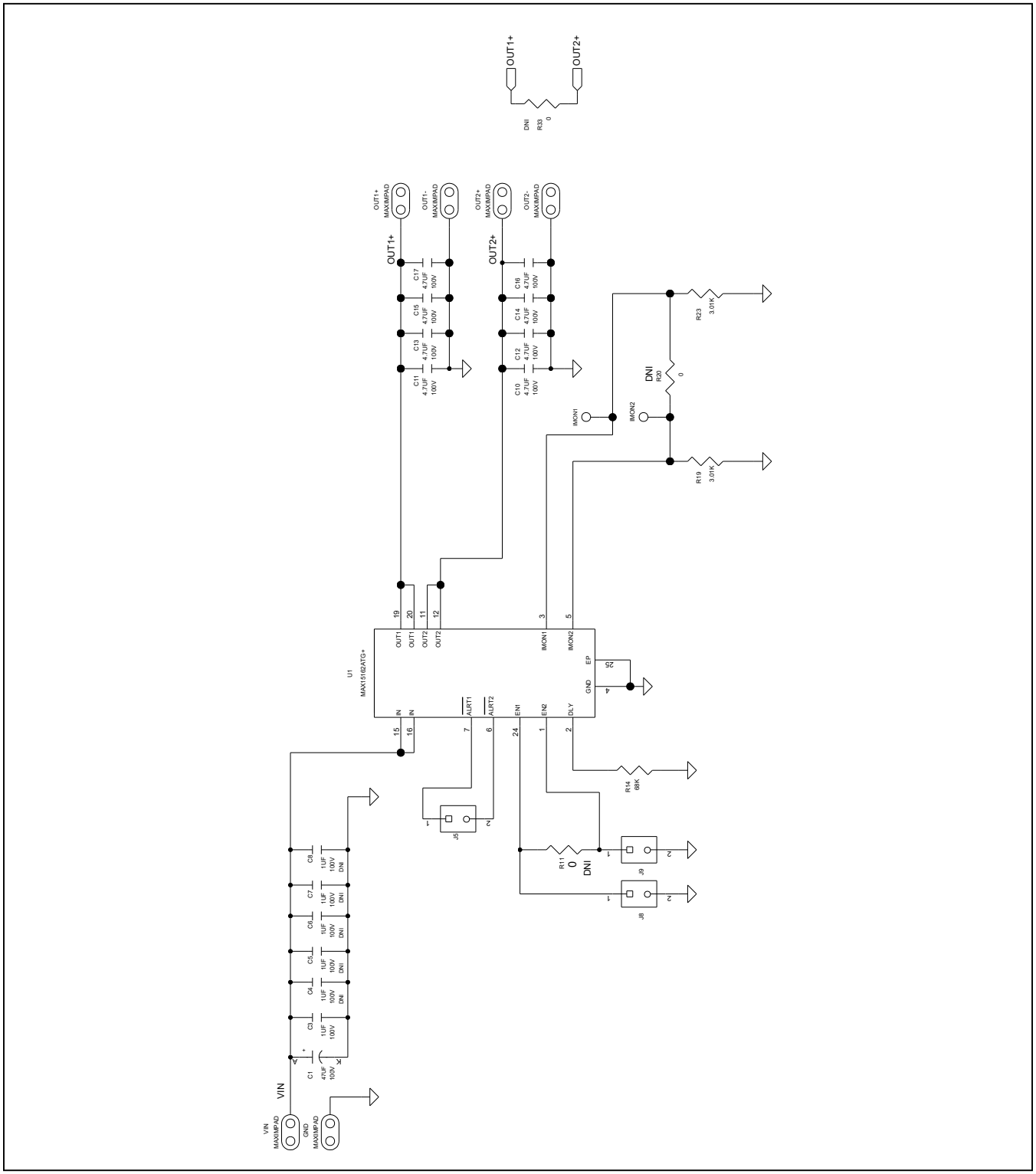
Ordering Information

PART	TYPE
MAX15162TAEVKIT#	MAX15162 TQFN (Autoretry)
MAX15162TLEVKIT#	MAX15162 TQFN (Latched off)

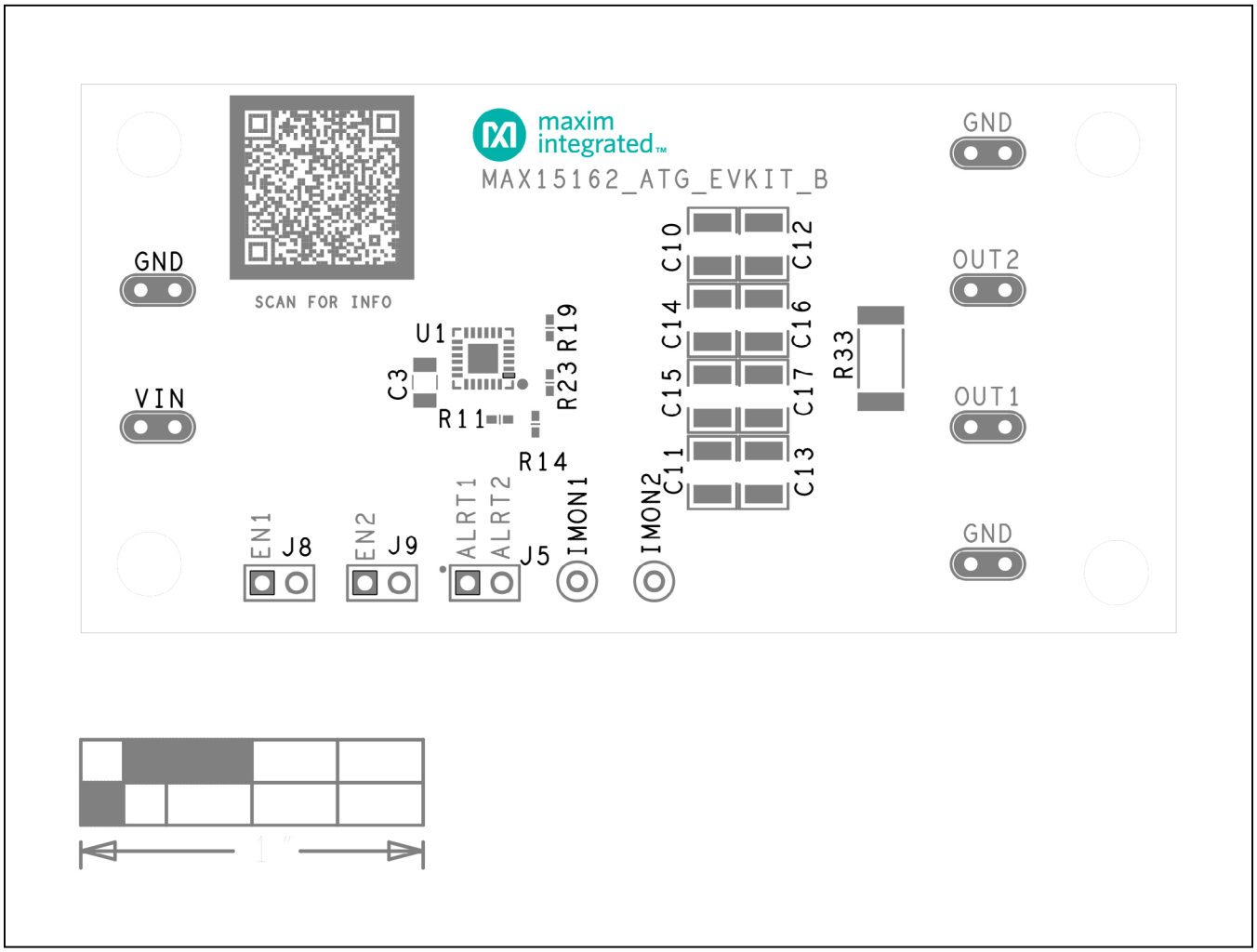
MAX15162ATG EV Kit Bill of Materials

PART	QTY	DESCRIPTION
C1	1	47MF ±20%, 100V; ALUMINUM ELECTROLYTIC CAPACITOR (CASE H13) PANASONIC EEE-FK2A470AQ
C10–C17	8	4.7MF ±10%, 100V X7S CERAMIC CAPACITOR (1210) TDK C3225X7S2A475K200AB
C3	1	1MF ±10%, 100V X7R CERAMIC CAPACITOR (1206) MURATA GRM31CR72A-105KA01
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
J5, J8, J9	3	BREAKAWAY CONNECTOR, MALE, THROUGH HOLE, 3 PINS, SULLINS, PBC03SAAN
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, TQFN-24, MAX15162/MAX15162AATG+
PCB	1	PCB:MAX15162ATG+/MAX15162AATG+ EVKITB#
C4–C8	DNP	1MF ±10%, 100V X7R CERAMIC CAPACITOR (1206) MURATA GRM31CR72A105KA01
R11, R20	DNP	0Ω ±0% RESISTOR (0402) VISHAY CRCW04020000Z0EDHP
R33	DNP	0Ω ±0% RESISTOR (2512) VISHAY CRCW25120000Z0EGHP

MAX15162ATG EV Kit Schematic

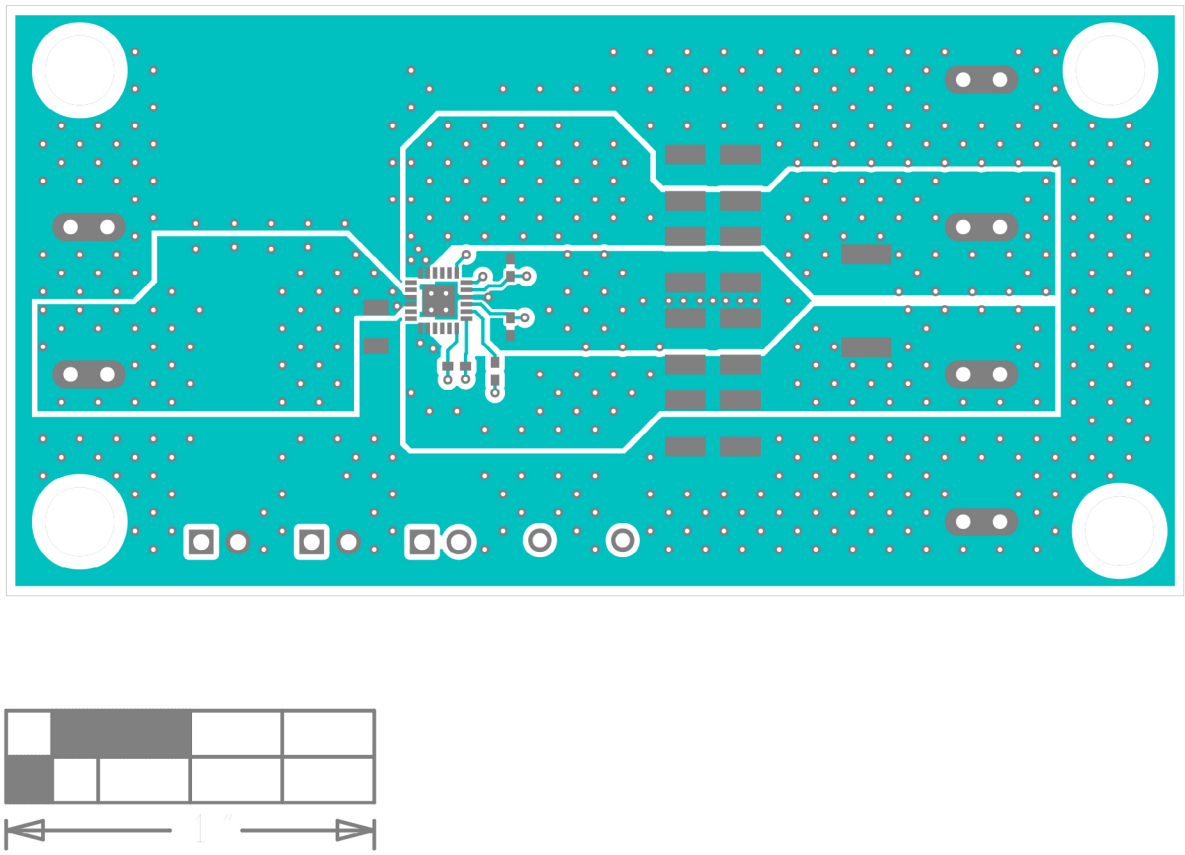


MAX15162ATG EV Kit PCB Layout Diagrams



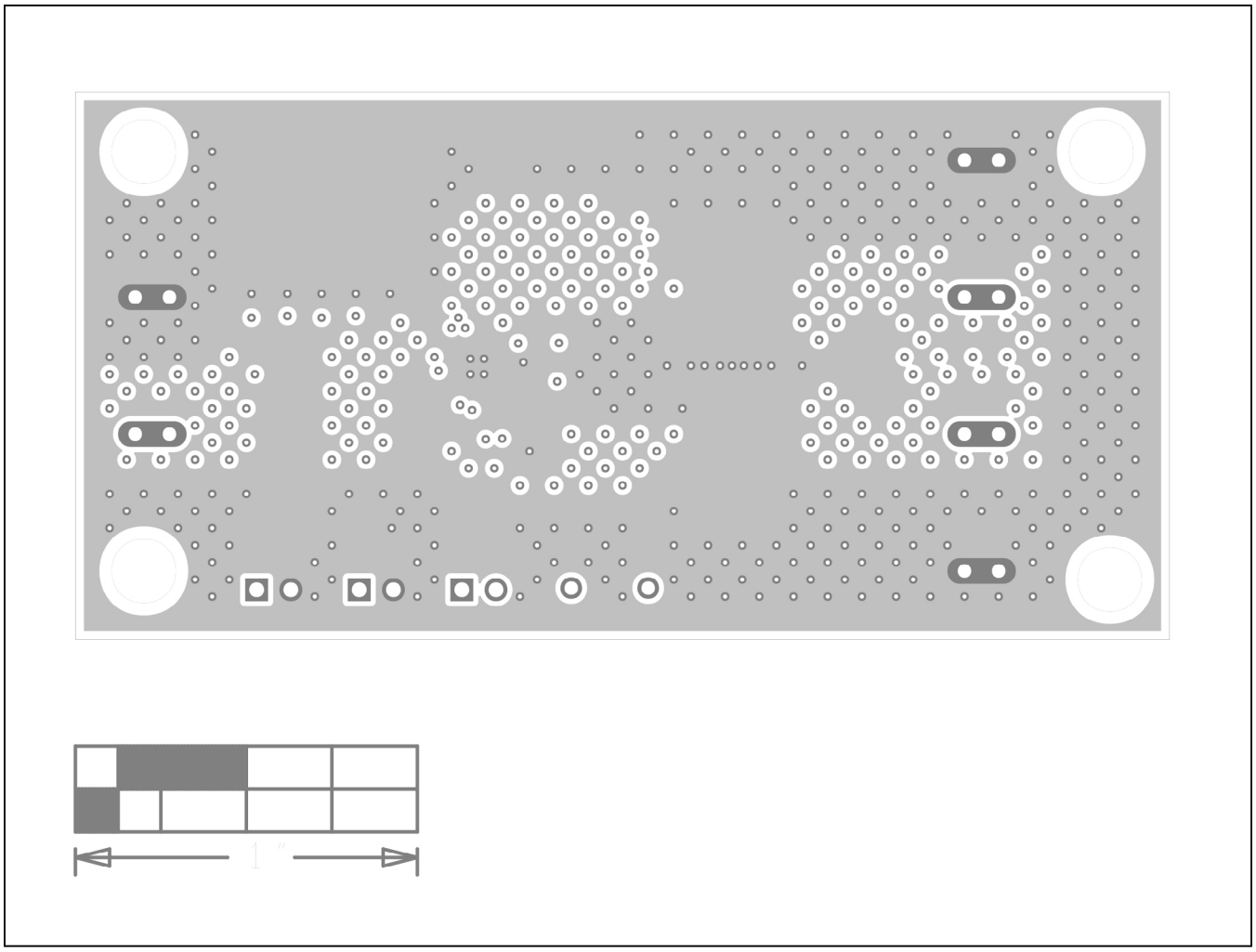
MAX15162ATG EV Kit PCB — Silkscreen Top Side

MAX15162ATG EV Kit PCB Layout Diagrams (continued)



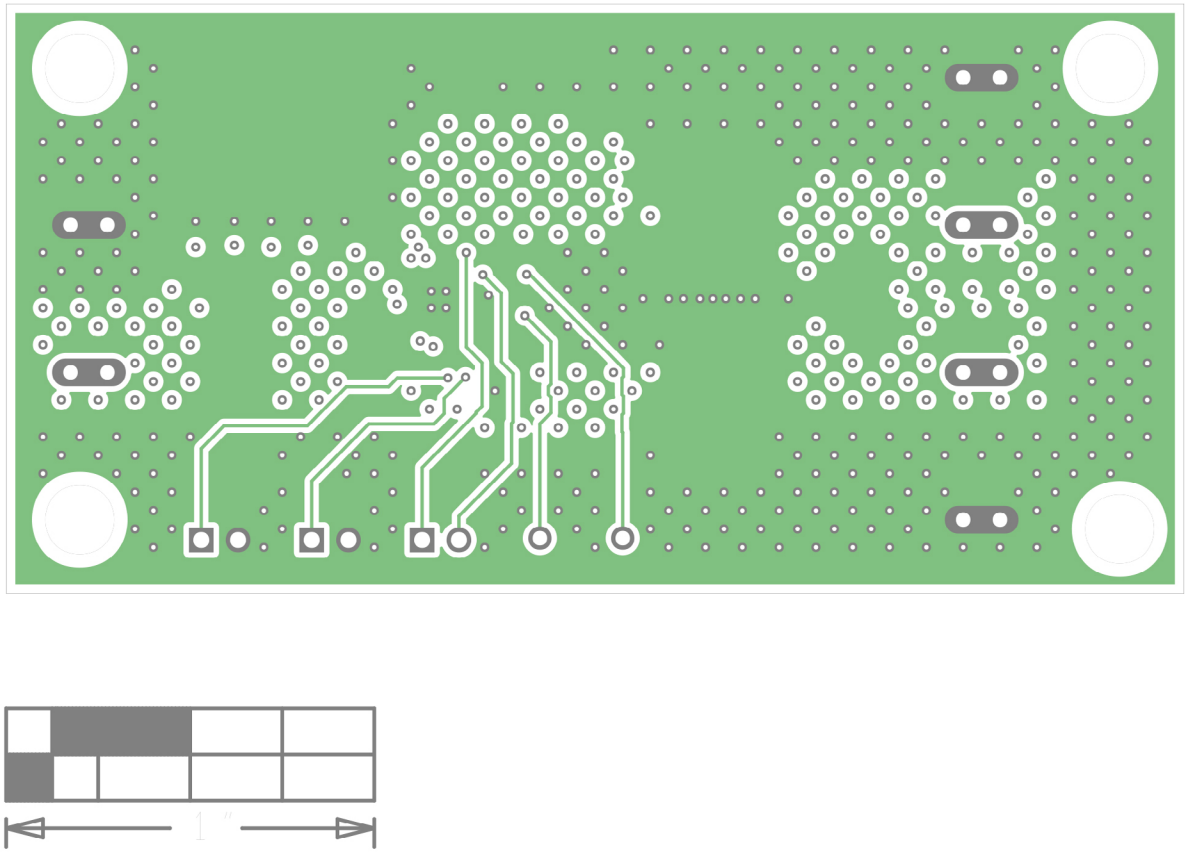
MAX15162ATG EV Kit PCB — Silkscreen Top Side

MAX15162ATG EV Kit PCB Layout Diagrams (continued)



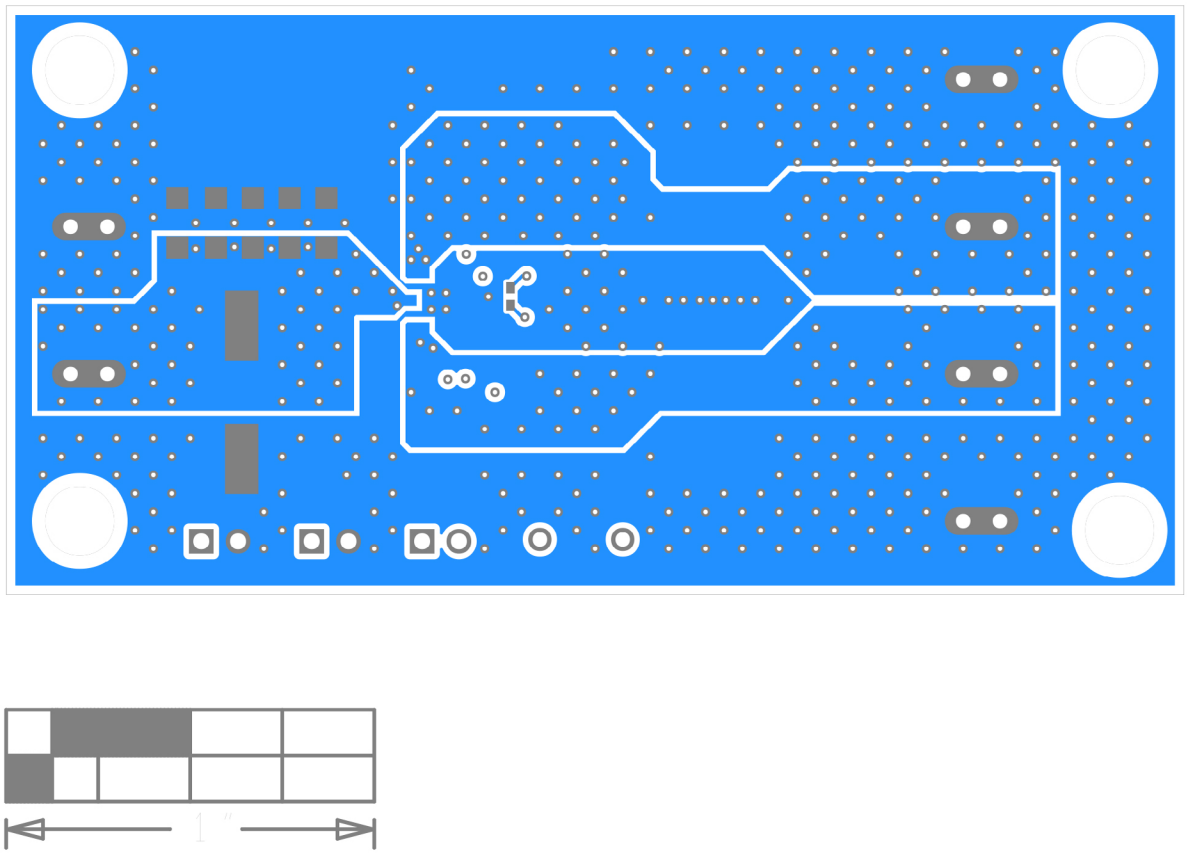
MAX15162ATG EV Kit PCB — Internal Layer 2

MAX15162ATG EV Kit PCB Layout Diagrams (continued)



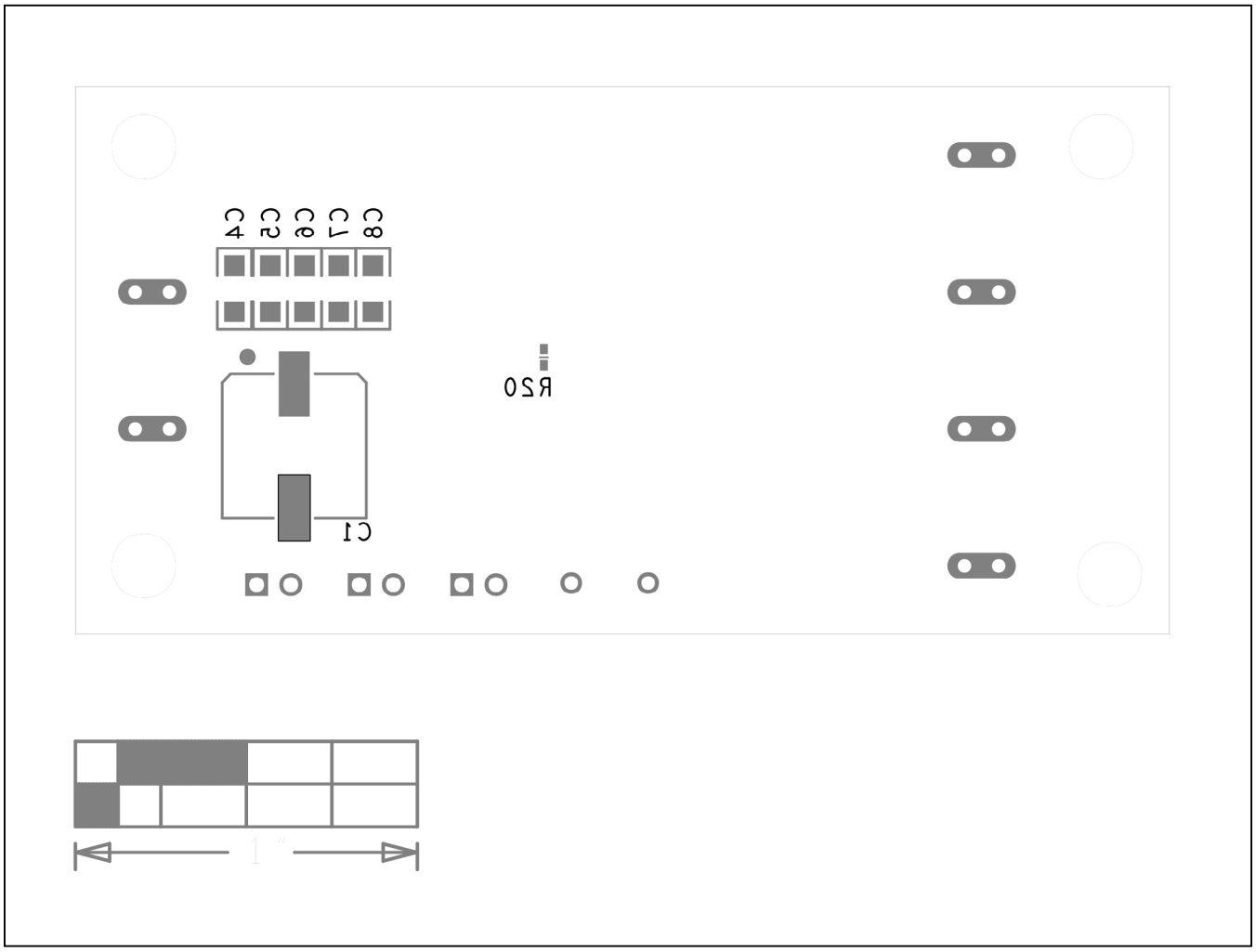
MAX15162ATG EV Kit PCB — Internal Layer 3

MAX15162ATG EV Kit PCB Layout Diagrams (continued)



MAX15162ATG EV Kit PCB — Bottom Side

MAX15162ATG EV Kit PCB Layout Diagrams (continued)



MAX15162ATG EV Kit PCB — Silkscreen Bottom Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/20	Initial release	—
1	10/20	Change to Rev B EV kit	2–13
2	10/21	Changed title to indicate TQFN	All
3	11/22	Updated resistors and jumpers to match hardware	2–4, 6