



# MAX1567 Step-Up Main Evaluation Kit

## General Description

The MAX1567 step-up main evaluation kit (EV kit) is a fully assembled and tested circuit that accepts input voltages of 1.5V to 3.2V and provides all the output voltages required for a typical digital still camera. The outputs consist of the main step-up output (3.3V), a step-down output (1.8V), a general-purpose 5V output, outputs for driving white LED backlighting, and outputs for charge-coupled device (CCD) and LCD bias. The EV kit comes with the MAX1567 installed, but can also be used to evaluate the MAX1566. For applications with a higher battery voltage, such as Li+ battery applications, another version of the EV kit is available with the main output configured as a step-down converter (MAX1567EVKIT).

## Features

- ◆ Up to 95% Efficient
- ◆ 1.5V to 3.2V Input Voltage Range
- ◆ Main Step-Up Output, 3.3V
- ◆ Step-Down Output, 1.8V
- ◆ 5V General-Purpose Output
- ◆ CCD and LCD Bias Outputs (+15V/-7.5V)
- ◆ Current-Regulated Output with Overvoltage Protection for White LED Backlighting
- ◆ 1 $\mu$ A Shutdown Mode
- ◆ Fully Assembled and Tested

## Ordering Information

PART	TEMP RANGE	IC PACKAGE
MAX1567SUMEVKIT	0°C to +70°C	40 Thin QFN 6mm x 6mm

## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C18	2	1 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitors (1206) TDK C3216X7R1E105K or equivalent
C2	1	0.1 $\mu$ F $\pm$ 10%, 16V X7R ceramic capacitor (0603) TDK C1608X7R1C104K or equivalent
C3	1	100pF $\pm$ 5%, 50V C0G ceramic capacitor (0603) TDK C1608C0G1H101J or equivalent
C4	1	0.01 $\mu$ F $\pm$ 10%, 16V X7R ceramic capacitor (0402) TDK C1005X7R1E103K or equivalent
C5, C9	2	4700pF $\pm$ 10%, 25V X7R ceramic capacitors (0402) Taiyo Yuden TMK105B472KW or equivalent
C6	1	6800pF $\pm$ 10%, 25V X7R ceramic capacitor (0402) Taiyo Yuden TMK105B682KW or equivalent

DESIGNATION	QTY	DESCRIPTION
C7	1	3300pF $\pm$ 10%, 50V X7R ceramic capacitor (0402) Taiyo Yuden UMK105BJ332KW or equivalent
C8	1	2200pF $\pm$ 10%, 50V X7R ceramic capacitor (0402) Taiyo Yuden UMK105BJ222KW or equivalent
C10, C14, C21	3	47 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitors (1812) Taiyo Yuden JMK432BJ476MM or equivalent
C11, C13	0	Not installed (0805)
C12, C15, C16	3	10 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitors (0805) Taiyo Yuden JMK212BJ106MG or equivalent
C17	1	1 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitor (0805) TDK C2012X7R1E105K or equivalent
C19	0	Not installed (0805)
C20	0	Not installed (1206)



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).

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Evaluates: MAX1566/MAX1567

## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
D1, D7, D10	3	Schottky diodes 20V, 500mA (SOD-123) Central CMHSH5-2L
D2–D5	4	White LEDs Nichia NSCW215T
D6	1	Schottky diode 40V, 500mA (SOD-123) Central CMHSH5-4
D8, D9	0	Not installed (SOD-123)
D11	1	Schottky diode 1A, 30V (SMA) Nihon EC10QS03
JU1–JU6	6	3-pin headers
JU8, JU9, JU11, JU13	0	Not installed Cut here—short
JU7, JU10, JU12	0	Not installed Cut here—open
L1	1	1.5 $\mu$ H inductor Sumida CDRH3D16-1R5
L2	1	1.5 $\mu$ H inductor TOKO A921CY-1R5M
L3	1	22 $\mu$ H inductor TOKO A921CY-220M
L4	1	10 $\mu$ H inductor Sumida CDRH8D28-100
L5	1	3.0 $\mu$ H inductor Sumida CDRH5D28-3R0
L6	1	10 $\mu$ H inductor Sumida CDRH5D28-100
L7	0	Not installed
N1, N2	2	N-channel MOSFETs (SOT23) Fairchild FDN337N
N3	0	Not installed (SOT23)
P1	1	P-channel MOSFET (SOT23) Fairchild FDN360P
R1	1	1M $\Omega$ $\pm$ 5% resistor (0603)
R2, R12, R14, R16, R18, R20	6	90.9k $\Omega$ $\pm$ 1% resistors (0603)

DESIGNATION	QTY	DESCRIPTION
R3	1	10 $\Omega$ $\pm$ 5% resistor (0603)
R4	1	51k $\Omega$ $\pm$ 5% resistor (0603)
R5	1	68k $\Omega$ $\pm$ 5% resistor (0603)
R6	1	47k $\Omega$ $\pm$ 5% resistor (0603)
R7	1	33k $\Omega$ $\pm$ 5% resistor (0603)
R8, R9	2	100k $\Omega$ $\pm$ 5% resistors (0603)
R10	1	8.2k $\Omega$ $\pm$ 5% resistor (0603)
R11	1	1M $\Omega$ $\pm$ 1% resistor (0603)
R13	1	549k $\Omega$ $\pm$ 1% resistor (0603)
R15	1	274k $\Omega$ $\pm$ 1% resistor (0603)
R17	1	150k $\Omega$ $\pm$ 1% resistor (0603)
R19	1	40.2k $\Omega$ $\pm$ 1% resistor (0603)
R21, R22, R23	3	100k $\Omega$ $\pm$ 5% resistors (0603)
R24–R29	0	Not installed (1206)
R30, R31	0	Not installed (0603)
T1	0	Transformer (not installed)
U1	1	MAX1567ETL (40-lead thin QFN)
None	6	Shunts
None	1	MAX1567 EV kit PC board

## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor	631-435-1110	www.centrasemi.com
Fairchild Semiconductor	408-721-2181	www.fairchildsemi.com
International Rectifier	310-322-3331	www.irf.com
Kamaya	260-489-1533	www.kamaya.com
Murata	814-237-1431	www.murata.com
Panasonic	714-373-7939	www.panasonic.com
Sumida	847-956-0666	www.sumida.com
Taiyo Yuden	408-573-4150	www.t-yuden.com
TDK	847-803-6100	www.component.tdk.com
TOKO	847-297-0070	www.toko.com
Vishay	402-563-6866	www.vishay.com

**Note:** Please indicate you are using the MAX1566/MAX1567 when contacting these component suppliers.

# MAX1567 Step-Up Main Evaluation Kit

## Quick Start

### Recommended Equipment

- Power supply capable of supplying 1.5V to 3.2V at 5A
- Voltmeter
- Load resistors or electronic loads

### Procedure

Follow the steps below to verify operation of the MAX1567 EV kit:

- 1) Preset the power supply to 1.5V to 3.2V.
- 2) Turn off the power supply. **Do not turn on the power supply until all connections are completed.**
- 3) Connect the power-supply positive lead to the pad on the EV kit board labeled BATT.
- 4) Connect the power-supply ground lead to the pad on the EV kit board labeled GND.
- 5) Connect loads from outputs VM, VSD, OUT1A, and OUT2 to GND. See Table 1 for maximum load currents.
- 6) Verify that the EV kit jumper JU1 has pins 2-3 shorted (to enable 5V step up).
- 7) Verify that jumpers JU2–JU6 have pins 1-2 shorted (to disable all other outputs).
- 8) Turn on the power supply.
- 9) Verify the VSU voltage is 5V using a voltmeter.
- 10) If desired, connect a load from VSU to GND.
- 11) To verify other outputs, move jumpers JU2–JU6 to short pins 2 and 3 to enable corresponding output, and verify the voltages with a voltmeter (see Table 1).

## Detailed Description

### Step-Up Output (VSU)

The main step-up output (VSU) powers the internal circuitry of the MAX1567 and must reach its regulation voltage (5V) before any other output can turn on. To enable VSU, short pins 2-3 of jumper JU1. When jumper JU1 is on pins 1-2, all outputs shut down and the IC is in low-current shutdown mode.

### Short-Circuit Flag (SCF)

SCF is an open-drain output that is high impedance when overload protection occurs. Under normal operation SCF pulls low. In the default configuration there is a 100k $\Omega$  pullup resistor (R23) from SCF to VM.

Table 1. Output Voltages and Maximum Currents

OUTPUT	VOLTAGE (V)	MAXIMUM CURRENT (mA)
VSU	5.0	350 (Note 1)
VM	3.3	600
VSD	1.8	350
OUT1A	15.0	40
OUT2	-7.5	-80
LEDOUT+ to LEDOUT-	15.0 max (Note 2)	20

**Note 1:** If both VSU and VSD are operating, subtract half the VSD load current from the maximum load capability of VSU.

**Note 2:** The LED outputs are current regulated to 20mA with overvoltage protection set to 15V.

### Main Step-Up Output (VM)

The main step-up output is set to 3.3V. To enable VM, short pins 2-3 of jumper JU2. To shut down VM, short pins 1-2 of JU2.

### Step-Down Output (VSD)

The step-down output (VSD) is set to 1.8V. To enable VSD, short pins 2-3 of jumper JU3. To shut down OUTSD, short pins 1-2 of JU3.

### Step-Down OK (SDOK)

The step-down OK output (SDOK) is an open-drain output that is pulled low until the step-down converter has completed soft-start. For more details on SDOK, refer to the MAX1567 data sheet.

### Auxiliary Output 1 OK (AUX1OK)

AUX1OK is an open-drain output that goes low when OUT1 has successfully completed soft-start. AUX1OK goes high impedance in shutdown, overload, and thermal limit.

### CCD/LCD Bias Outputs (OUT1A, OUT1B)

Output OUT1A provides a regulated +15V output. To enable OUT1A, short pins 2-3 of JU5. To turn OUT1A off, short pins 1-2 of JU5. In the standard configuration, OUT1A and OUT2 provide the +15V and -7.5V bias voltages for CCD and LCD. OUT1B is not used in the standard configuration of the EV kit.

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The outputs OUT1A and OUT1B can be configured to use a flyback transformer to provide both the +15V (OUT1A) and -7.5V (OUT1B) necessary for CCD and LCD bias. This is useful when using the MAX1566 where OUT2 is configured as a boost converter. See the *Flyback Transformer Configuration for OUT1A/OUT1B* section.

## Inverter Output (OUT2)

OUT2 is a regulated -7.5V output. To enable OUT2, connect pins 2-3 of jumper JU6. To shut down OUT2, connect pins 1-2 of JU6.

OUT2 can also be configured as a boost output when evaluating the MAX1566. See the *Evaluating the MAX1566* section.

## LED Outputs (OUT3+, OUT3-)

The outputs OUT3+ and OUT3- are for driving a series of white LEDs for display backlighting. The EV kit comes with four surface-mount white LEDs installed and is configured to drive the LEDs at a regulated 20mA. To protect against an open LED string, the overvoltage protection limits the maximum output voltage to 15V.

To evaluate with fewer than four LEDs, short the pads of the unused LEDs. To use LEDs other than the ones mounted on the board, break the string by removing one of the LEDs on the board, then connect a series array consisting of two to six white LEDs in series to the OUT3+ and OUT3- outputs. The anode side of the array connects to OUT3+, and the cathode side connects to OUT3-. To enable the LED outputs, short pins 2-3 of JU4. To turn the LED outputs off, short pins 1-2 of JU4. To adjust the LED brightness or overvoltage protection, see the *Adjusting the LED Brightness* section.

## Customizing the MAX1567 Evaluation Kit

### Adjusting the Step-Up Output (VSU)

The main step-up output (VSU) is adjustable from 2.7V to 5.5V using the following procedure:

- 1) Select a value for R16 between 10kΩ and 100kΩ.
- 2) Solve for R15 using:

$$R15 = R16 \times \left( \frac{V_{VSU}}{1.25} - 1 \right)$$

- 3) Install resistors R15 and R16.

Table 2. Jumper Functions

JUMPER	SHORT PINS 1-2	SHORT PINS 2-3
JU1	All outputs are shut down.	VSU enabled.
JU2	VM shut down.	VM enabled.
JU3	VSD shut down.	VSD enabled.
JU4	LEDs (OUT3+/OUT3-) shut down.	LEDs (OUT3+/OUT3-) enabled.
JU5	OUT1 shut down.	OUT1 enabled.
JU6	OUT2 shut down.	OUT2 enabled.

Table 3. PC Board Jumper Functions

JUMPER	FUNCTION	DEFAULT
JU7	Select the input power for the OUT2 converter. Short only one of these jumpers. Short JU7 to connect the OUT2 input power to BATT, or short JU8 to connect to VSU.	Open
JU8		Short
JU9	Connects the ground planes together. This must remain shorted for proper circuit operation.	Short
JU10	Select the input power for the step-down converter. Short only one of these jumpers. Short JU10 to connect the step-down input power to BATT, short JU11 for VSU, or short JU12 for VM.	Open
JU11		Short
JU12		Open
JU13	Selects topology for OUT1A/OUT1B. Short for OUT1A step-up, or open for OUT1A/OUT1B transformer flyback.	Short

### Adjusting the Main Step-Up Output (VM)

The main step-up output (VM) is adjustable from 2.7V to VSU using the following procedure:

- 1) Select a value for R18 between 10kΩ and 100kΩ.
- 2) Solve for R17 using:

$$R17 = R18 \times \left( \frac{V_{VM}}{1.25} - 1 \right)$$

- 3) Install resistors R17 and R18.

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## Configuring the Step-Down Output (VSD)

The input to the step-down converter (PVSD) on the EV kit comes connected to VSU, but the connection can be changed to either BATT or VM. To use BATT as the input to the step-down converter, cut the trace shorting JU11 and short the pads of JU10. To use VM as the input to the step-down converter, cut the trace shorting JU11, and short the pads of JU12. Make sure one—and only one—of JU10, JU11, and JU12 are shorted.

The step-down output voltage (VSD) is adjustable from 1.25V to  $V_{PVSD}$  using the following procedure:

- 1) Select a value for R20 between 10k $\Omega$  and 100k $\Omega$ .
- 2) Solve for R19 using:

$$R19 = R20 \times \left( \frac{V_{VSD}}{1.25} - 1 \right)$$

- 3) Install resistors R19 and R20.

## Adjusting the OUT1A Voltage

OUT1A can be set to a voltage above 1.25V. The upper limit depends on the ratings of the external components. Note that if the input voltage is greater than what OUT1A is set to, then OUT1A rises above its regulation voltage. Use the following procedure to set  $V_{OUT1A}$ :

- 1) Select a value for R12 between 10k $\Omega$  and 100k $\Omega$ .
- 2) Solve for R11 using:

$$R11 = R12 \times \left( \frac{V_{OUT1A}}{1.25} - 1 \right)$$

- 3) Install resistors R11 and R12.

## Configuring the Inverting Output (OUT2)

The input to the inverter is normally connected to VSU. To change this connection to BATT, cut trace shorting JU8 and short the pads of JU7. Note that the lower limit of inverter operation, when powered from BATT, depends on the external P-channel MOSFET threshold voltage.

To adjust the OUT2 voltage, use the following procedure:

- 1) Select a value for R13 between 10k $\Omega$  and 100k $\Omega$ .

- 2) Solve for R14 using:

$$R13 = R14 \times \left( - \frac{V_{OUT2}}{1.25} \right)$$

- 3) Install resistors R13 and R14.

## Adjusting the LED Brightness

Resistor R3 sets the regulation current of the LEDs as follows:

$$R3 = \frac{0.2V}{I_{LED}}$$

The overvoltage protection threshold for the LEDs is also adjustable. To ensure the LEDs are current regulated, this threshold ( $V_{OVP}$ ) must be set higher than the maximum forward voltage drop of the LED string.  $V_{OVP}$  should be set lower than the maximum voltage ratings of the capacitor, diode, and MOSFET (C1, D1, and N1) used in the LED driver circuit. Use the following procedure to set the overvoltage protection:

- 1) Select a value for R1 between 10k $\Omega$  and 100k $\Omega$ .
- 2) Solve for R2 using:

$$R1 = R2 \times \left( \frac{V_{OVP}}{1.25} - 1 \right)$$

- 3) Install resistors R1 and R2.

## Changing the Switching Frequency

The switching frequency of the MAX1567 is adjustable. Typically, frequencies from 400kHz to 500kHz provide a good compromise between efficiency and component size. To change the frequency, replace C3 and R4. Refer to the MAX1567 data sheet for information on selecting values for these components.

## Evaluating the MAX1566

To evaluate the MAX1566, first carefully remove U1 and replace it with the MAX1566. Free samples of the MAX1566 can be obtained from Maxim. The MAX1566 requires that OUT2 be configured as a boost converter.

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## Configuring OUT2 as a Boost Converter

To configure OUT2 as a boost converter, remove components C17, R13, R14, D7, and P1. Then add components C19, R30, R31, D8, L7, and N3. Refer to the MAX1566/MAX1567 data sheet for information on component selection. Table 4 shows typical components for generating +15V at up to 20mA.

**Table 4. Typical Components for OUT2 Boost Circuit**

DESIGNATION	QTY	DESCRIPTION
C19	1	1 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitor (0805) TDK C2012X7R1E105K
D8	1	Schottky diode 40V, 500mA (SOD-123) Central CMHSH5-4
L7	1	1.5 $\mu$ H inductor Sumida CDRH3D16-1R5
N3	1	N-channel MOSFET (SOT23) Fairchild FDN337N
R30	1	1M $\Omega$ $\pm$ 1% resistor (0603)
R31	1	90.9k $\Omega$ $\pm$ 1% resistor (0603)

## Flyback Transformer Configuration for OUT1A/OUT1B

OUT1 can be configured to provide two outputs using a transformer. This is usually done to generate CCD/LCD bias when using the MAX1566. To use a transformer, remove L2 and cut the trace shorting JU13. Install the transformer on the footprint (T1) that overlaps L2 and JU13. Refer to the MAX1566/MAX1567 data sheet for details on component selection. Table 5 shows typical components for generating +15V and -7.5V.

**Table 5. Typical Components for OUT1A/OUT1B Transformer Circuit**

DESIGNATION	QTY	DESCRIPTION
C18, C20	2	1 $\mu$ F $\pm$ 10%, 25V X7R ceramic capacitors (1206) TDK C3216X7R1E105K
D6	1	Schottky diode 40V, 500mA (SOD-123) Central CMHSH5-4
D9	1	Schottky diode 20V, 500mA (SOD-123) Central CMHSH5-2L
N2	1	N-channel MOSFET (SOT23) Fairchild FDN337N
R11	1	1M $\Omega$ $\pm$ 1% resistor (0603)
R12	1	90.9k $\Omega$ $\pm$ 1% resistor (0603)
T1	1	Transformer TDK 565630T

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

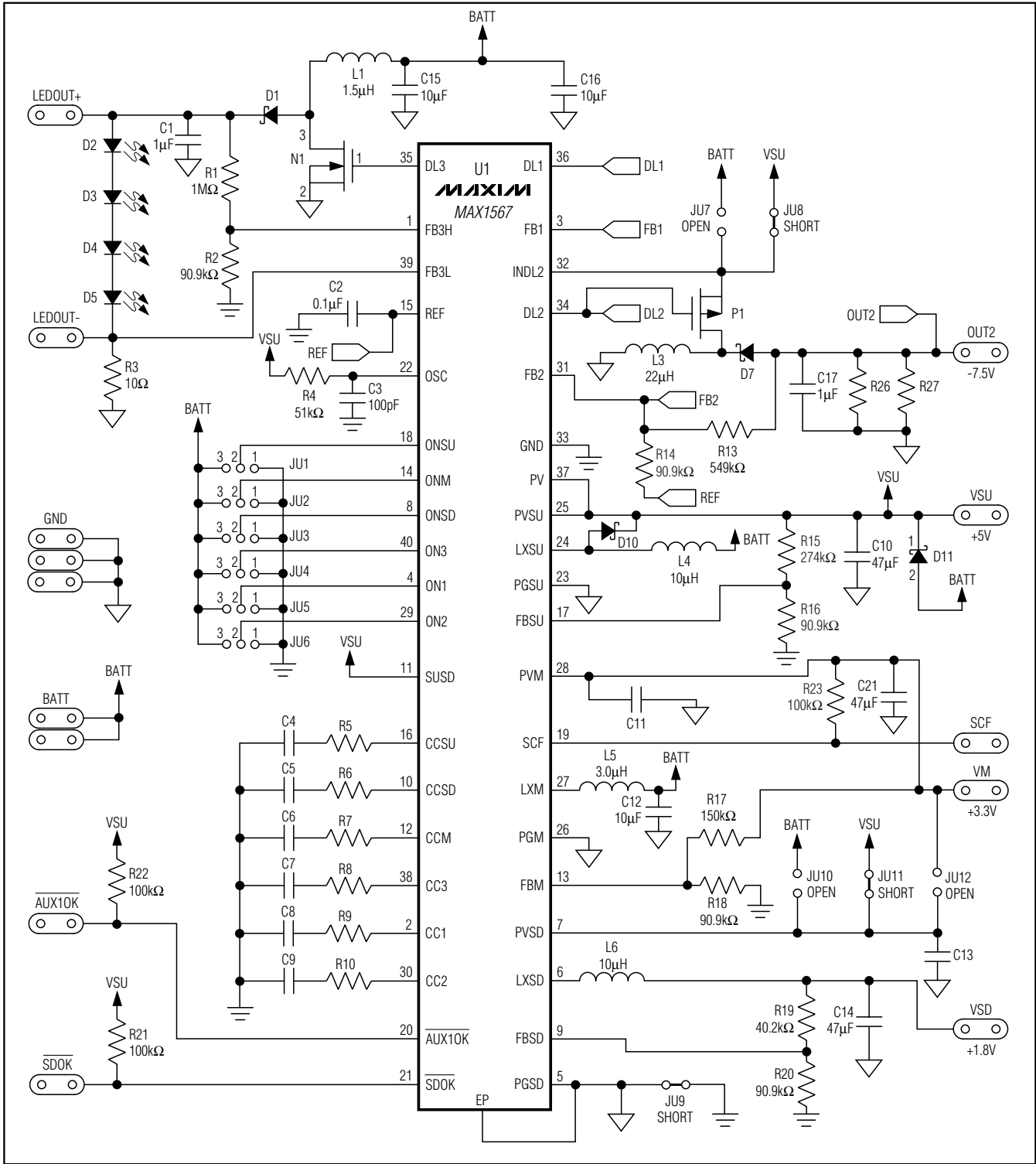


Figure 1. MAX1567 EV Kit Schematic (Sheet 1 of 2)

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

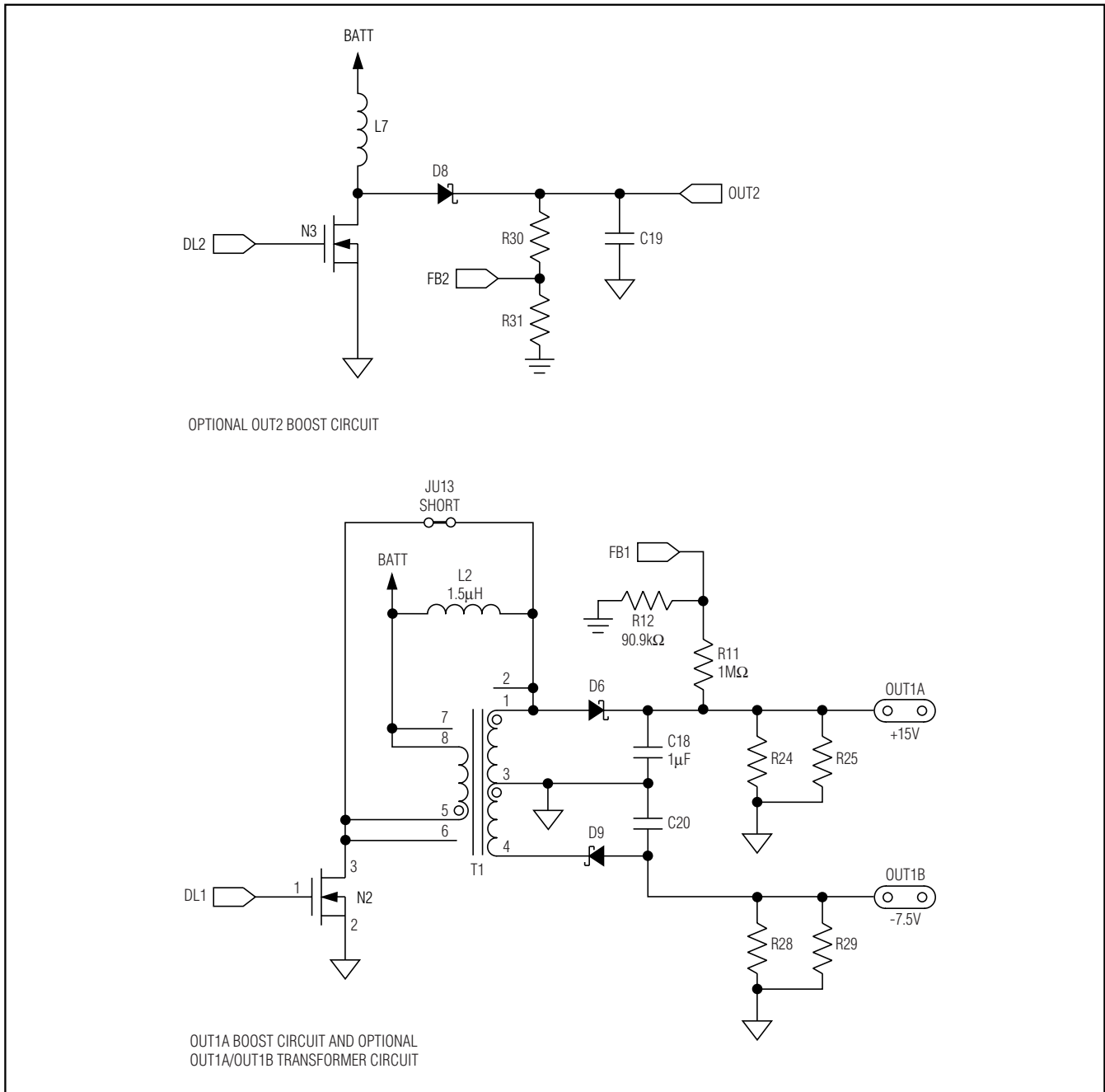


Figure 1. MAX1567 EV Kit Schematic (Sheet 2 of 2)



# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

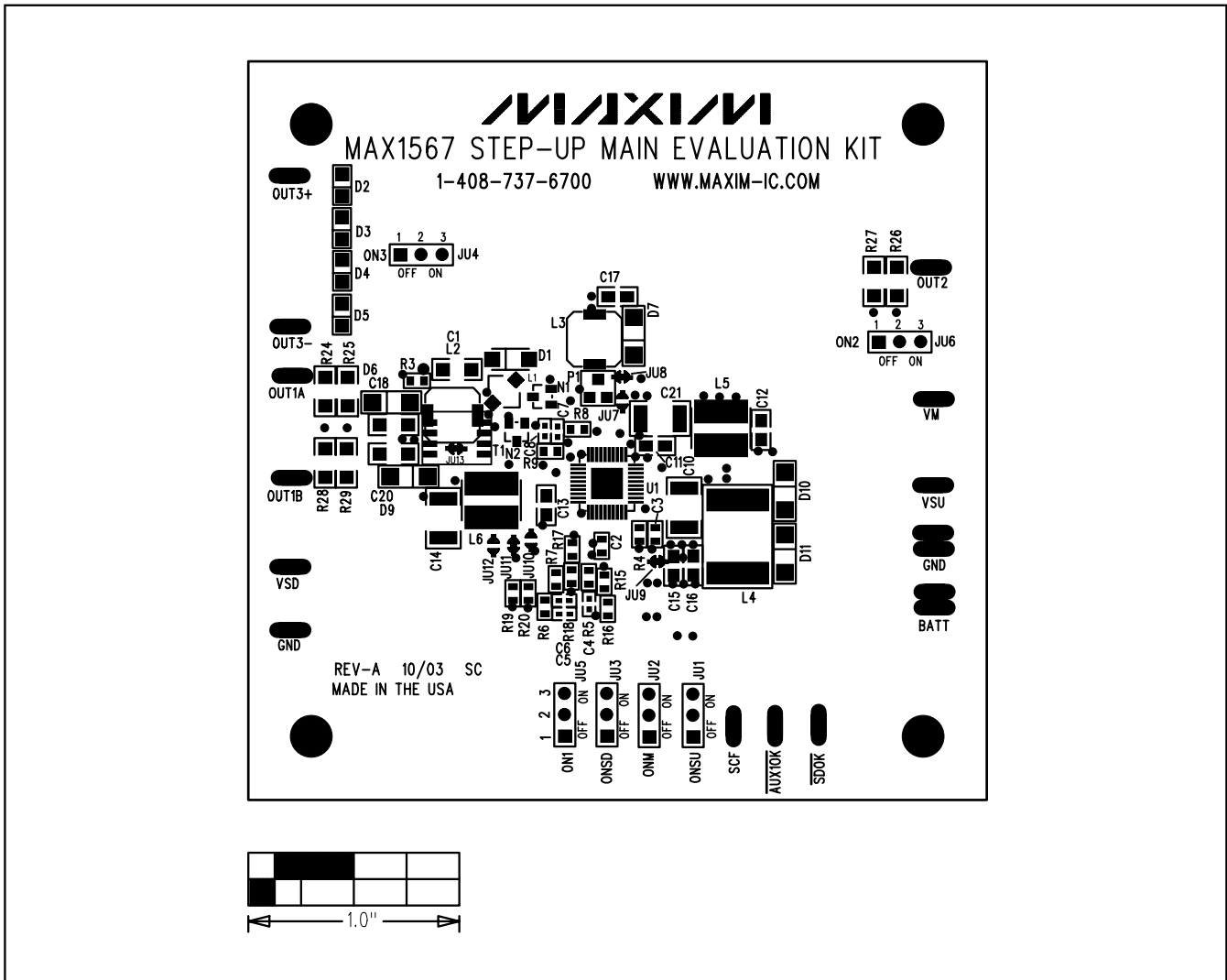


Figure 2. MAX1567 EV Kit Component Placement Guide—Component Side

# MAX1567 Step-Up Main Evaluation Kit

**Evaluates: MAX1566/MAX1567**

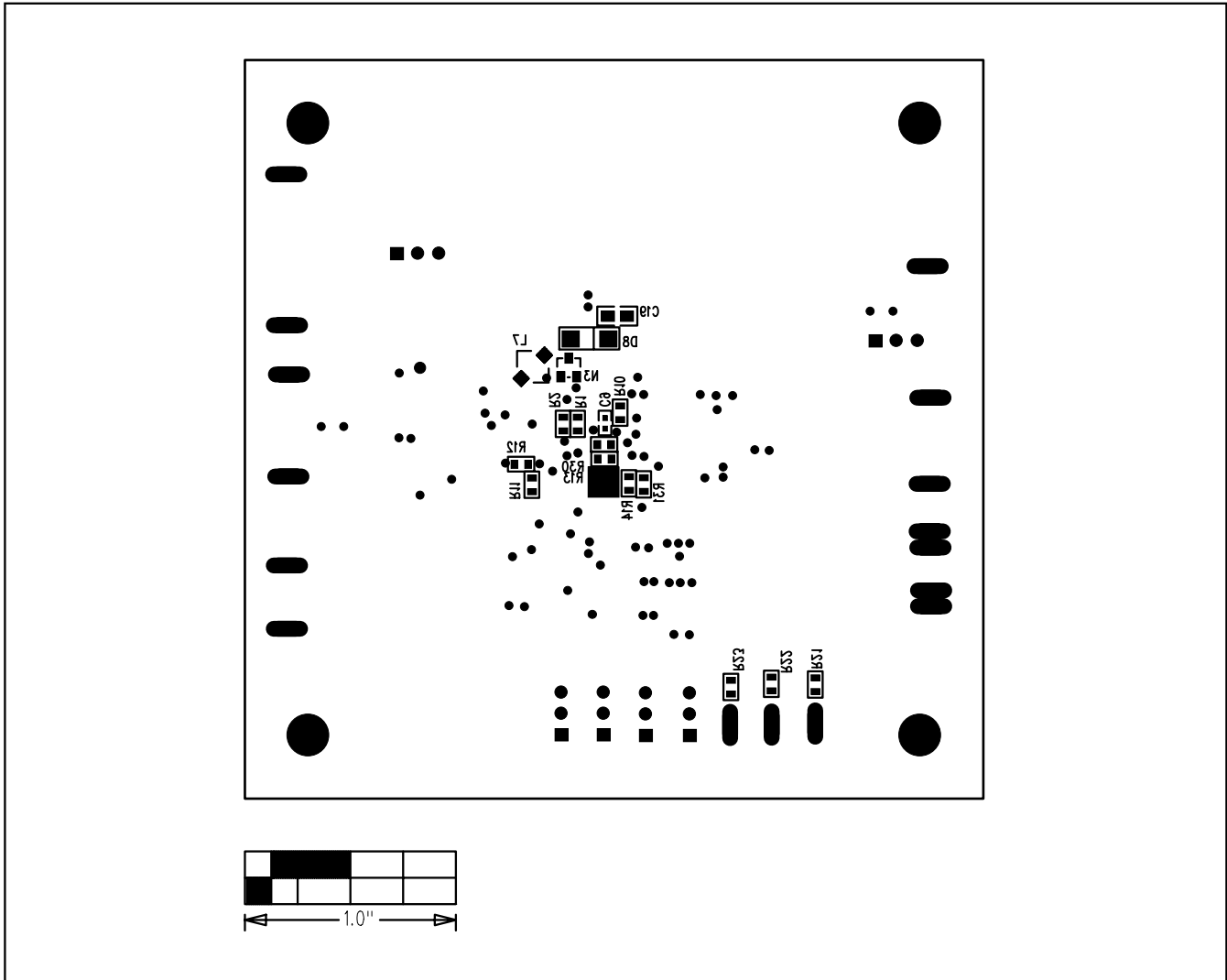


Figure 3. MAX1567 EV Kit Component Placement Guide—Solder Side

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

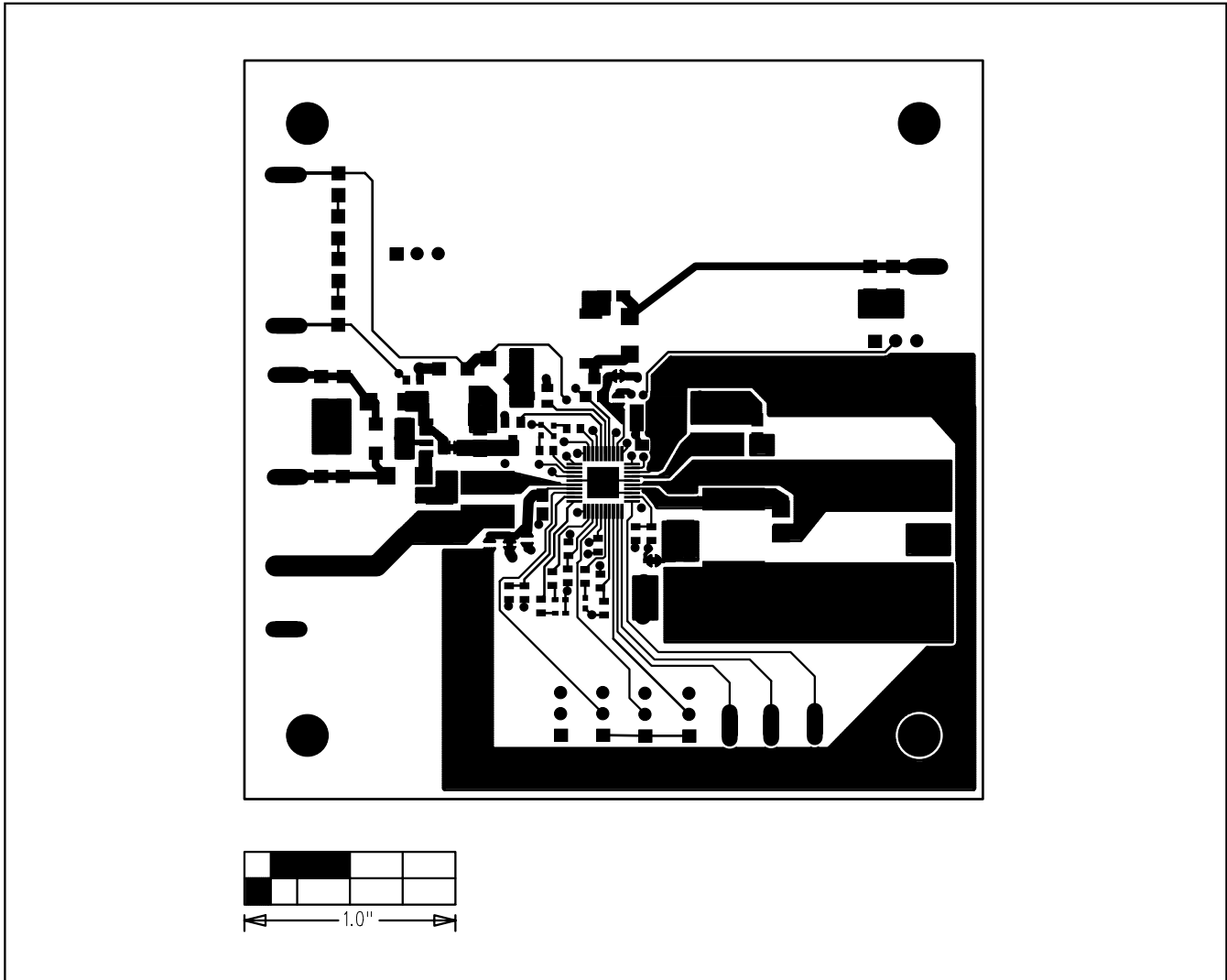


Figure 4. MAX1567 EV Kit PC Board Layout—Component Side

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

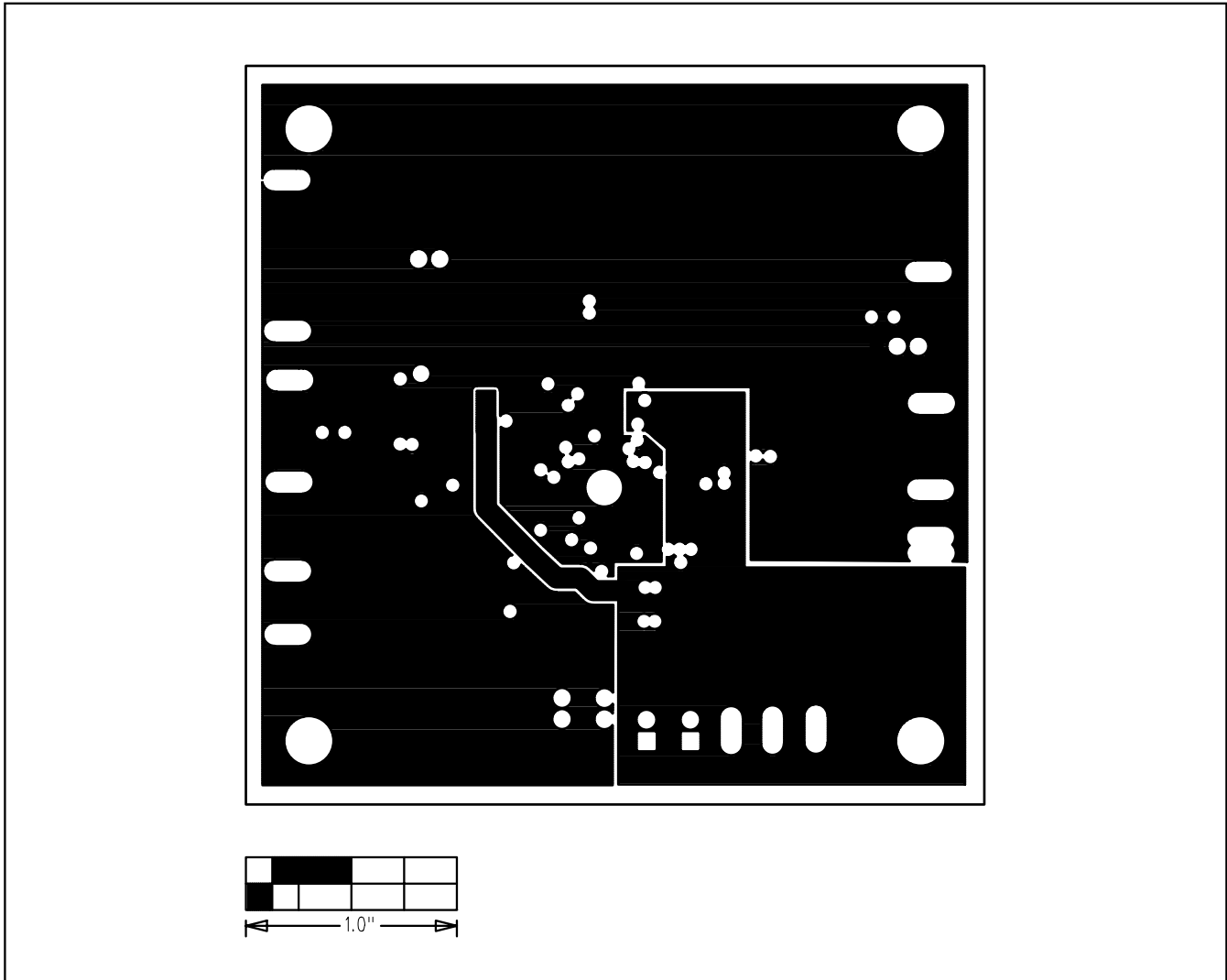


Figure 5. MAX1567 EV Kit PC Board Layout—Inner Layer 2

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

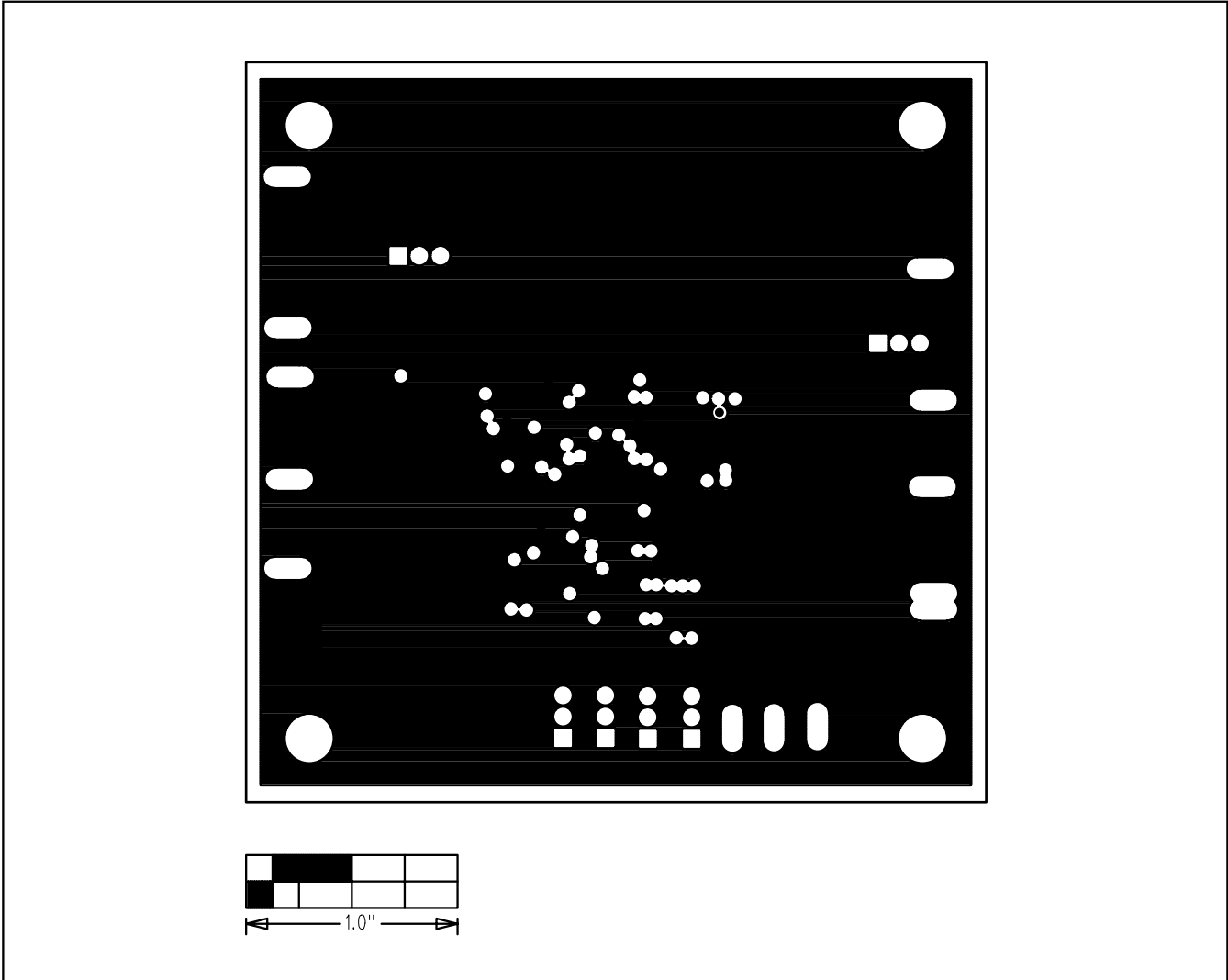


Figure 6. MAX1567 EV Kit PC Board Layout—Inner Layer 3

# MAX1567 Step-Up Main Evaluation Kit

Evaluates: MAX1566/MAX1567

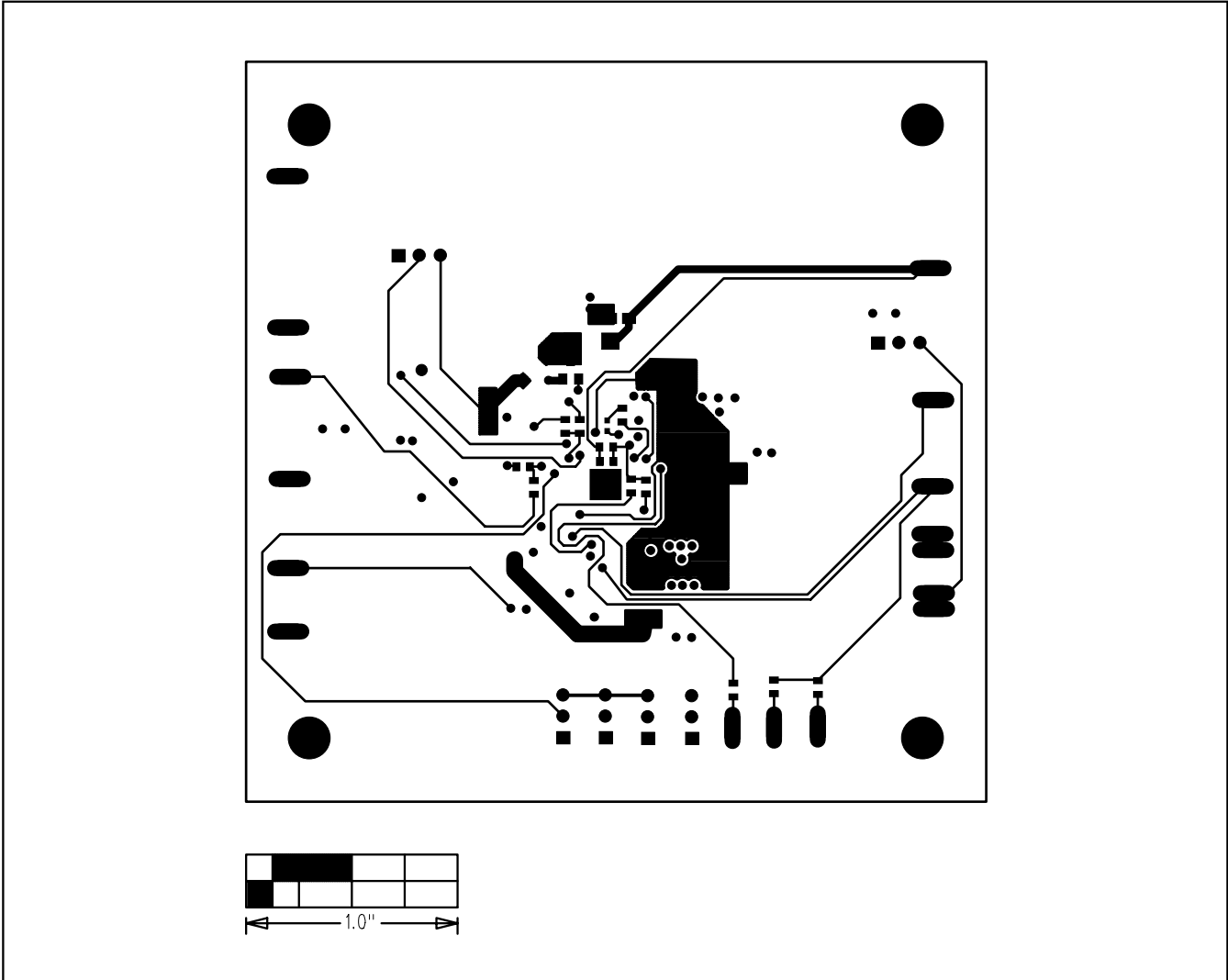


Figure 7. MAX1567 EV Kit PC Board Layout—Solder Side

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