Click here for production status of specific part numbers.

MAX17521EVKITE# Evaluation Kit

Evaluates: MAX17521 in 5V and 3.3V Output-Voltage Application

General Description

The MAX17521EVKITE# evaluation kit (EV kit) provides a proven design to evaluate the MAX17521 high-efficiency, high-voltage, Himalaya synchronous step-down dual DC-DC converter. The EV kit is preset to generate 5V and 3.3V output voltages, at load currents up to 1A per converter. The switching frequency of the EV kit is preset to 560kHz for optimum efficiency and component size. The EV kit features programmable enable and input undervoltage lockout (EN/UVLO), programmable soft-start (SS), open-drain status ($\overline{\text{RESET}}$) output and external clock synchronization (SYNC). The EV kit also provides good layout example, which is optimized for conducted, radiated EMI, and thermal performance. For more details about the IC *Benefits and Features*, refer to the MAX17521 IC data sheet.

Features

- Operates from a 7V to 60V Input Supply
- Dual-Output Voltage: 5V and 3.3V
- Up to 1A Output Current per Converter
- 560kHz Switching Frequency
- EN/UVLO Input, Resistor-Programmable UVLO Threshold
- Mode Selection Jumper to Select Between PWM and PFM Modes
- Capacitor Programmable Soft-Start Time
- External Clock Synchronization Input
- Open-Drain $\overline{\text{RESET}}$ Output
- Overcurrent Protection
- Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested
- Complies with CISPR32(EN55032) Class B Conducted and Radiated Emissions

Quick Start

Recommended Equipment

- MAX17521EVKITE#
- 60V, 2A DC input power supply
- Two loads capable of sinking 1A
- Four digital voltmeters (DVM)

Equipment Setup and Test Procedure

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

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

1) Set the power supply at a voltage between 7V and 60V. Disable the power supply.
2) Connect the positive terminal of the power supply to the VIN1 PCB pad and the negative terminal to the nearest PGND PCB pad. Connect the positive terminal of one of the 1A load to the VOUT1 PCB pad and the negative terminal to the nearest PGND PCB pad. Connect the positive terminal of another 1A load to the VOUT2 PCB pad and the negative terminal to the nearest PGND PCB pad.
3) Connect two DVMs across the VOUT1 PCB pad and the nearest PGND PCB pad, VOUT2 PCB pad, and the nearest PGND PCB pad.
4) Verify that shunts are not installed across pins on jumpers JU1 and JU2. (See Table 1 and Table 2 for details).
5) Select the shunt position on jumpers JU3 and JU4 according to the intended mode of operation. (See Table 3 and Table 4 for details).
6) Turn on the DC power supply.

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

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7) Enable the loads.
8) Ensure the input voltage to be above 6.6V which is the EN rising threshold.
9) Verify that the DVMs display 5V and 3.3V.
10) Connect the other two DVMs across $\overline{\text{RESET1}}$ pad and SGND, $\overline{\text{RESET2}}$ pad and SGND. Verify that the DVMs display 5V.
11) Reduce the input voltage to 5V which is below the EN/UVLO falling threshold.
12) Verify that the DVMs across the VOUT1 pad and nearest PGND, VOUT2 pad and nearest PGND display 0V.
13) Verify that the DVMs across the $\overline{\text{RESET1}}$ pad and nearest SGND, $\overline{\text{RESET2}}$ pad and nearest SGND display 0V.
14) Disable the input.

Detailed Description

The MAX17521EVKITE# provides a proven design to evaluate the MAX17521 high-efficiency, high-voltage, Himalaya synchronous step-down Dual DC-DC converter. The EV kit generates 5V and 3.3V outputs, at load currents up to 1A per converter, from a 7V to 60V input supply. The EV kit features a 560kHz fixed switching frequency for optimum efficiency and component size.

The EV kit includes an EN/UVLO PCB pads and jumpers JU1, JU2 to enable the two outputs at a desired input voltage. The SYNC PCB pad and jumper JU5 allow an external clock to synchronize the converters. The EV kit features mode selection jumper, programmable soft-start time, open-drain $\overline{\text{RESET}}$ output for each converter.

Enable/Undervoltage Lockout (EN/UVLO) Programming

The MAX17521 offers an adjustable enable and input undervoltage lockout level for each converter. In this EV kit, for the normal operation of the converters, leave EN/UVLO jumpers, JU1 and JU2 (for the converter 1 and converter 2, respectively) in the open position. When JU1 and JU2 are left open, the MAX17521 converters are enabled when the input voltage rises above 6.6V. To disable the converter 1 and converter 2, install a jumper across pins 2-3 on JU1 and JU2, appropriately. See Table 1 and Table 2 for jumper settings. The EN/UVLO1 and EN/UVLO2 PCB pads on the EV Kit support external enable/disable control of the converters. Leave JU1 and JU2 open when external enable/disable control is desired. Set the voltage at which the converter turns on with a resistive voltage-divider connected from the respective input (VIN1 and VIN2) to ground (SGND).

Choose R_{TOP} to be 3.3MΩ max, and then calculate R_{BOT} as follows:

$$R_{BOT} = \frac{R_{TOP} \times 1.215}{(V_{INU} - 1.215)}$$

Where,

V_{INU} is the voltage at which the converter is required to turn on.

R_{TOP} and R_{BOT} are in kΩ,

For more details about *Setting the Enable and Undervoltage Lockout Level*, refer to the MAX17521 IC data sheet.

Table 1. Converter 1 EN/UVLO1 Jumper (JU1) Settings

SHUNT POSITION	EN/UVLO1 PIN	MAX17521 CONVERTER 1
Not Installed*	Connected to the center node of resistor divider R1 and R2	Enabled, UVLO level set through the R1 and R2 resistors
1-2	Connected to VIN1	Enabled
2-3	Connected to SGND	Disabled

**Default position*

Table 2. Converter 2 EN/UVLO2 Jumper (JU2) Settings

SHUNT POSITION	EN/UVLO2 PIN	MAX17521 CONVERTER 2
Not Installed*	Connected to the center node of resistor divider R9 and R10	Enabled, UVLO level set through the R9 and R10 resistors
1-2	Connected to VIN2	Enabled
2-3	Connected to SGND	Disabled

**Default position*

Soft-Start Input (SS)

The EV kit offers programmable soft-start function for each converter to limit inrush current during startup. Capacitors connected from the SS pins (C_{SS}) to SGND program the soft-start time for the corresponding output voltages. The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum required soft-start capacitor as follows:

$$C_{SS} \geq 56 \times 10^{-6} \times C_{SEL} \times V_{OUT}$$

The soft-start time (t_{SS}) is related to the capacitor (C_{SS}) connected at SS pin by the following equation:

$$t_{SS} = \frac{C_{SS}}{5.55 \times 10^{-6}}$$

For example, to program a 1ms soft-start time, a 5.6nF capacitor should be connected from the SS pin to SGND.

Mode Selection (MODE1, MODE2)

The EV kit provide jumpers (JU3 and JU4, for the converter 1 and converter 2, respectively) that allow the MAX17521 converters to operate in PWM and PFM modes. Refer to the MAX17521 data sheet for more details on the *Mode of Operation Selection*. Table 3 and Table 4 shows the mode selection (JU3 and JU4) settings that can be used to configure the desired mode of operation for each converter.

External Clock Synchronization (SYNC)

The EV kit provides SYNC PCB pad to synchronize the MAX17521 converters to an optional external clock. Leave Jumper JU5 (See Table 5) open when external clock signal is applied. In the presence of a valid external clock for synchronization, the MAX17521 converters operate in PWM mode only. For more details about the *External Clock Synchronization*, refer to the MAX17521 IC data sheet.

Table 3. Converter 1 MODE1 Jumper (JU3) Settings

SHUNT POSITION	MODE1 PIN	MAX17521 CONVERTER 1 MODE
1-2	Connected to SGND	PWM
Not installed*	Unconnected	PFM

**Default position*

Table 4. Converter 2 MODE2 Jumper (JU4) Settings

SHUNT POSITION	MODE2 PIN	MAX17521 CONVERTER 2 MODE
1-2	Connected to SGND	PWM
Not installed*	Unconnected	PFM

**Default position*

Table 5. External Clock Synchronization Jumper (JU5) Settings

SHUNT POSITION	SYNC PIN	MAX17521 CONVERTERS
1-2	Connected to test loop on PCB	Frequency can be synchronized with an external clock
2-3*	Connected to SGND	SYNC feature unused

**Default position*

Active-Low, Open-Drain Reset Output (RESET1 and RESET2)

The EV kit provides RESET1 and RESET2 PCB pads to monitor the status of the converters. RESET1 and RESET2 goes high respectively after 1024 switching cycles, when VOUT1 and VOUT2 rise above 95.5% (typ) of their nominal regulated voltage. RESET1 and RESET2 goes low when VOUT1 and VOUT2 falls below 92.5% (typ) of their nominal regulated voltage.

Converter 2 Input Supply (VIN2) Connection

By default, the converter 2 input supply is derived from the converter 1 input supply, through a jumper resistor connection RIN1. The MAX17521EVKITE# PCB layout has also the provision at VIN2 PCB pad, to power up the converter 2 through a second supply by removing RIN1 and placing a jumper resistor on RIN2. Table 6 shows the converter 2 input supply connection settings.

Hot Plug-In and Long Input Cables

The MAX17521EVKITE# PCB layout provides an optional electrolytic capacitor (C8 = 22µF/100V). In the default EV kit configuration (RIN2 in open position), this capacitor limits the peak voltage at the inputs of the MAX17521 converters when the DC input source is Hot-plugged to the EV kit input terminals with input cables. The equivalent series resistance (ESR) of the electrolytic capacitor dampens the oscillations caused by interaction of the inductance of the long input cables, and the ceramic capacitors at the buck converter input.

Electromagnetic Interference (EMI)

Compliance to conducted emissions (CE) standards requires an EMI filter at the input of a switching power converter. The EMI filter attenuates high-frequency currents drawn by the switching power converter, and limits the noise injected back into the input power source.

The MAX17521EVKITE# PCB has designated footprints on the EV kit for placement of EMI filter components. Use of these filter components results in lower conducted EMI, below CISPR32 Class B limits. Cut open the trace at L3 before installing EMI filter components. The MAX17521EVKITE# PCB layout is also designed to limit radiated emissions from switching nodes of the power converters, resulting in radiated emissions below CISPR32 Class B limits.

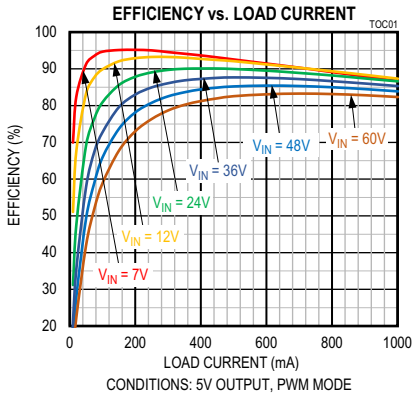
Table 6. Converter 2 Input (VIN2) Connection Settings

RIN1 CONNECTION	RIN2 CONNECTION	CONVERTER 2 INPUT (VIN2) CONNECTION
Jumper Resistor*	Open*	Derived from VIN1
Open	Jumper Resistor	Through a supply connected at VIN2 PCB Pad

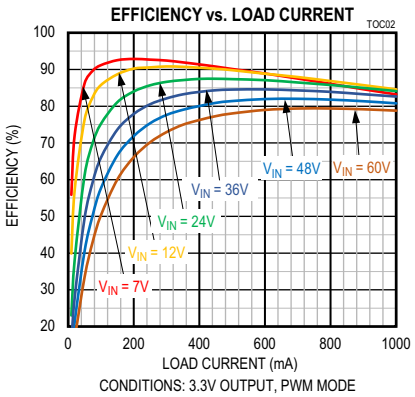
**Default position*

MAX17521EVKITE# Performance Report

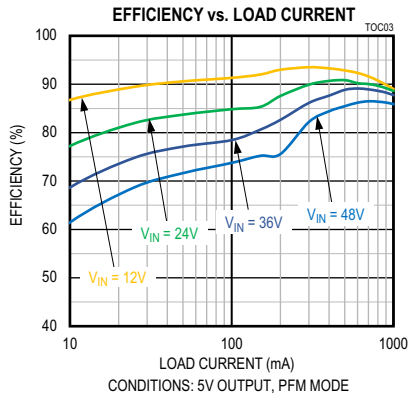
(V_{IN1} = V_{IN2} =24V, RIN1 = 0Ω, f_{SW} = 560kHz, T_A = +25°C, unless otherwise noted).



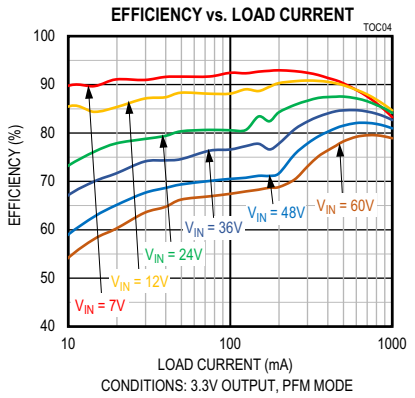
CONDITIONS: 5V OUTPUT, PWM MODE



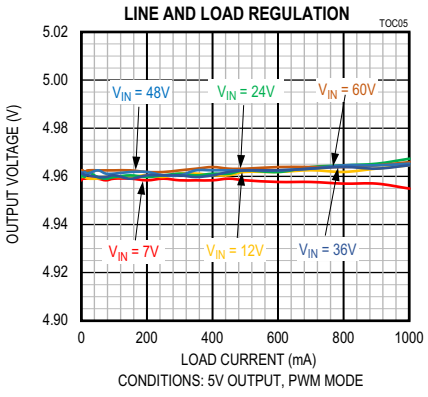
CONDITIONS: 3.3V OUTPUT, PWM MODE



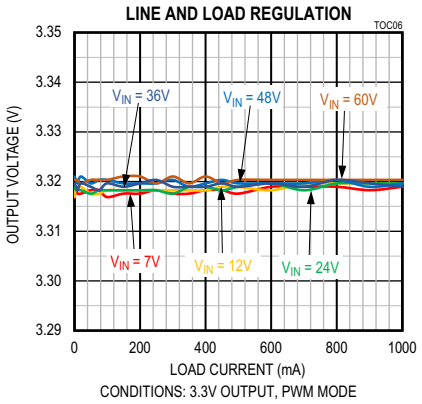
CONDITIONS: 5V OUTPUT, PFM MODE



CONDITIONS: 3.3V OUTPUT, PFM MODE



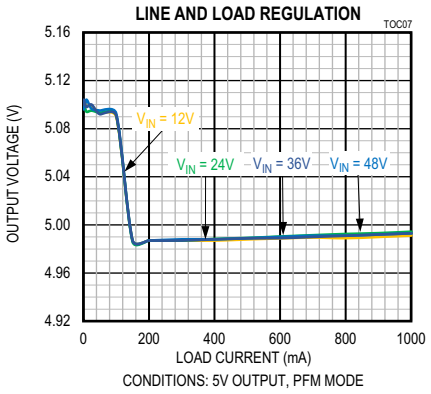
CONDITIONS: 5V OUTPUT, PWM MODE



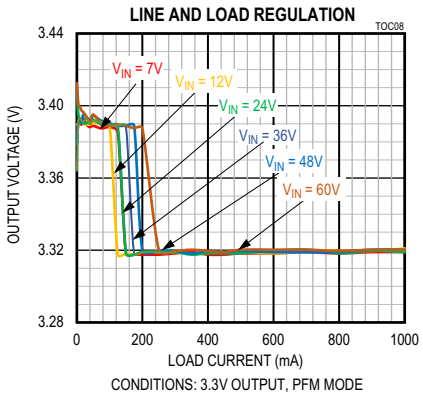
CONDITIONS: 3.3V OUTPUT, PWM MODE

MAX17521EVKITE# Performance Report (continued)

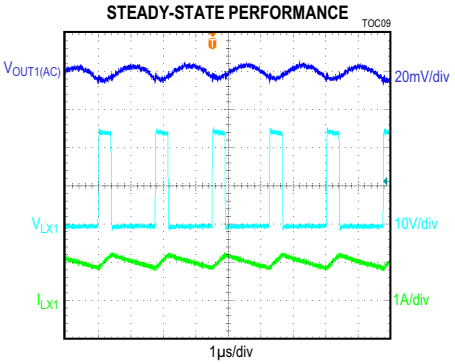
(V_{IN1} = V_{IN2} =24V, RIN1 = 0Ω, f_{SW} = 560kHz, T_A = +25°C, unless otherwise noted).



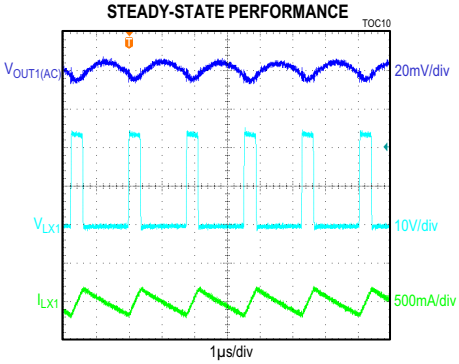
CONDITIONS: 5V OUTPUT, PFM MODE



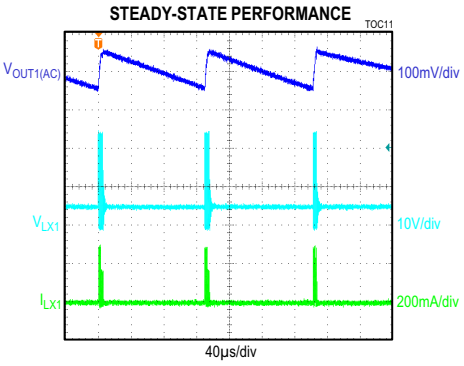
CONDITIONS: 3.3V OUTPUT, PFM MODE



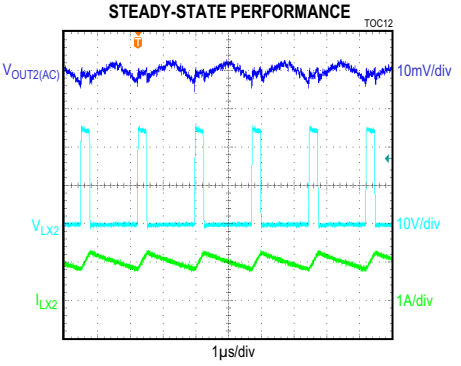
CONDITIONS: 5V OUTPUT, PWM MODE, 1A LOAD



CONDITIONS: 5V OUTPUT, PWM MODE, NO-LOAD



CONDITIONS: 5V OUTPUT, PFM MODE, 5mA LOAD

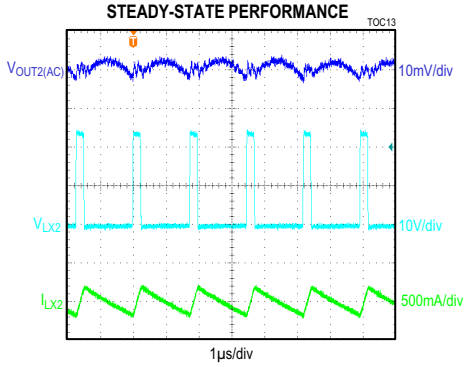


CONDITIONS: 3.3V OUTPUT, PWM MODE, 1A LOAD

MAX17521EVKITE# Performance Report (continued)

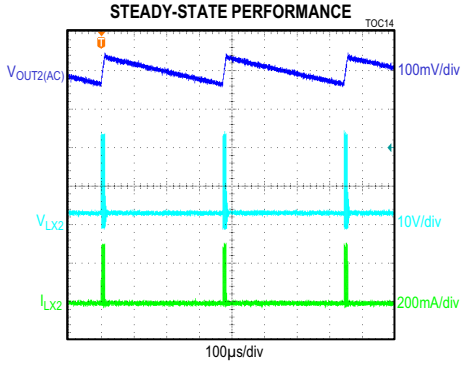
(V_{IN1} = V_{IN2} =24V, RIN1 = 0Ω, f_{SW} = 560kHz, T_A = +25°C, unless otherwise noted).

STEADY-STATE PERFORMANCE



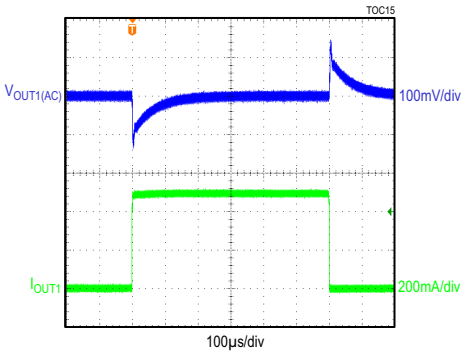
CONDITIONS: 3.3V OUTPUT, PWM MODE, NO-LOAD

STEADY-STATE PERFORMANCE



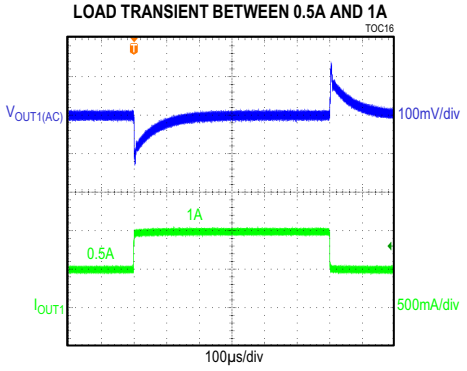
CONDITIONS: 3.3V OUTPUT, PFM MODE, 5mA LOAD

LOAD TRANSIENT BETWEEN 0A AND 0.5A



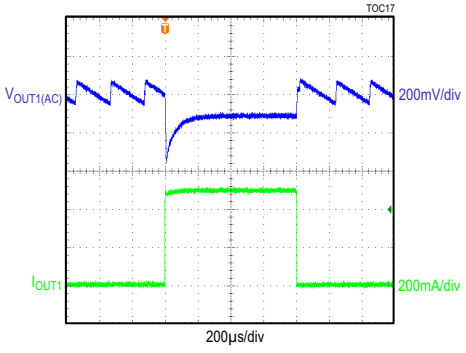
CONDITIONS: 5V OUTPUT, PWM MODE

LOAD TRANSIENT BETWEEN 0.5A AND 1A



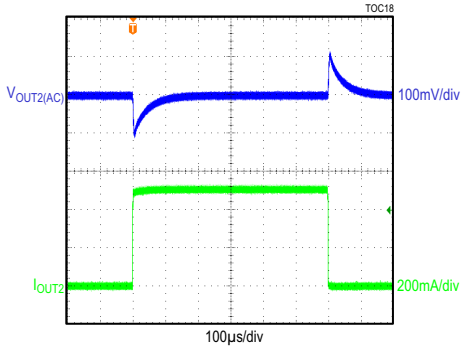
CONDITIONS: 5V OUTPUT, PWM MODE

LOAD TRANSIENT BETWEEN 5mA AND 0.5A



CONDITIONS: 5V OUTPUT, PFM MODE

LOAD TRANSIENT BETWEEN 0A AND 0.5A

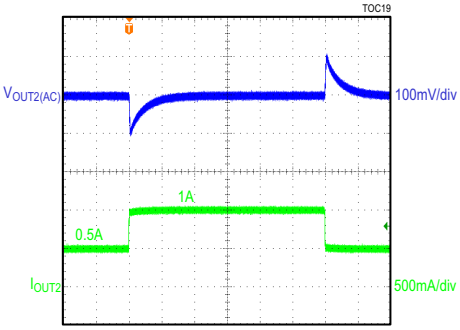


CONDITIONS: 3.3V OUTPUT, PWM MODE

MAX17521EVKITE# Performance Report (continued)

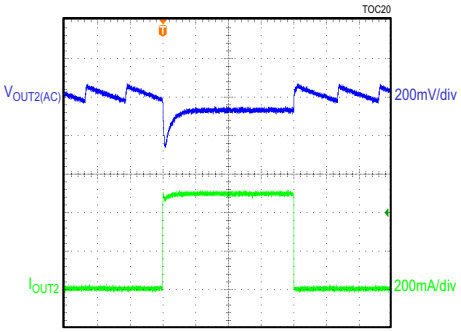
(V_{IN1} = V_{IN2} =24V, RIN1 = 0Ω, f_{SW} = 560kHz, T_A = +25°C, unless otherwise noted).

LOAD TRANSIENT BETWEEN 0.5A AND 1A



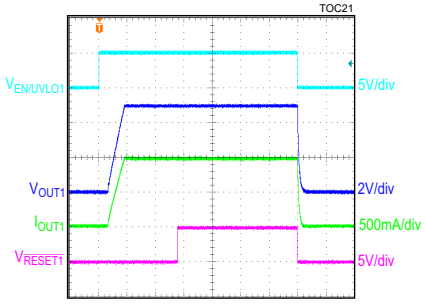
CONDITIONS: 3.3V OUTPUT, PWM MODE

LOAD TRANSIENT BETWEEN 5mA AND 0.5A



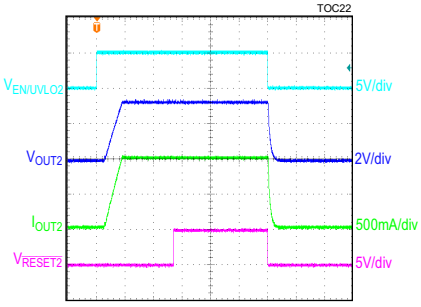
CONDITIONS: 3.3V OUTPUT, PFM MODE

STARTUP AND SHUTDOWN THROUGH EN/UVLO



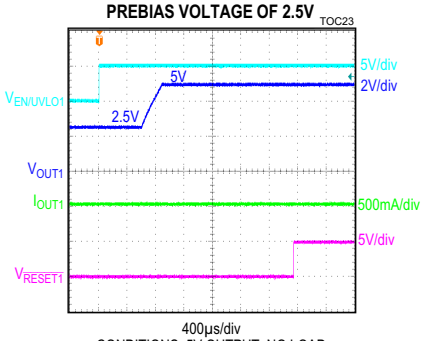
CONDITIONS: 5V OUTPUT, LOAD = 5Ω

STARTUP AND SHUTDOWN THROUGH EN/UVLO



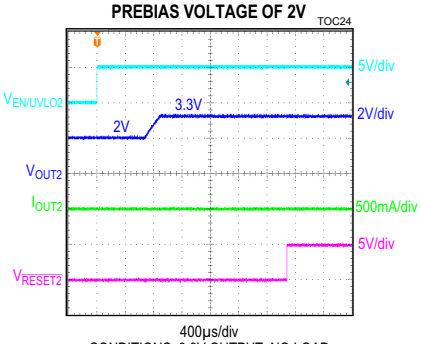
CONDITIONS: 3.3V OUTPUT, LOAD = 3.3Ω

STARTUP WITH
PREBIAS VOLTAGE OF 2.5V



CONDITIONS: 5V OUTPUT, NO LOAD

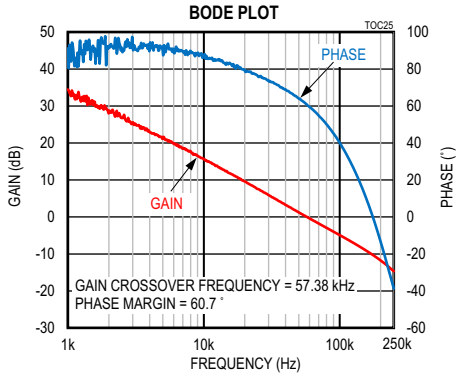
STARTUP WITH
PREBIAS VOLTAGE OF 2V



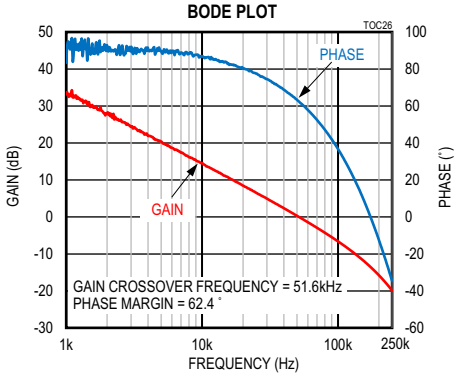
CONDITIONS: 3.3V OUTPUT, NO LOAD

MAX17521EVKITE# Performance Report (continued)

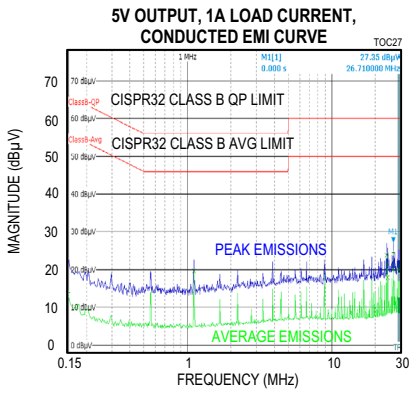
(V_{IN1} = V_{IN2} =24V, RIN1 = 0Ω, f_{SW} = 560kHz, T_A = +25°C, unless otherwise noted).



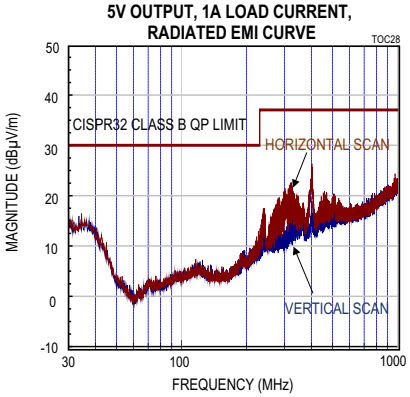
CONDITIONS: 5V OUTPUT, PWM MODE, LOAD = 5Ω



CONDITIONS: 3.3V OUTPUT, PWM MODE, LOAD = 3.3Ω



CONDITIONS: L3 = 15µH, C5 = C6 = 4.7µF/100V/X7R/1210



Component Suppliers

SUPPLIER	WEBSITE
Coilcraft, Inc.	www.coilcraft.com
Murata Americas	www.murataamericas.com
Panasonic Corp.	www.panasonic.com
SullinsCorp	www.sullinscorp.com
TDK	www.tdk.com

Note: *Indicate that you are using the MAX17521 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17521EVKITE#	EV Kit

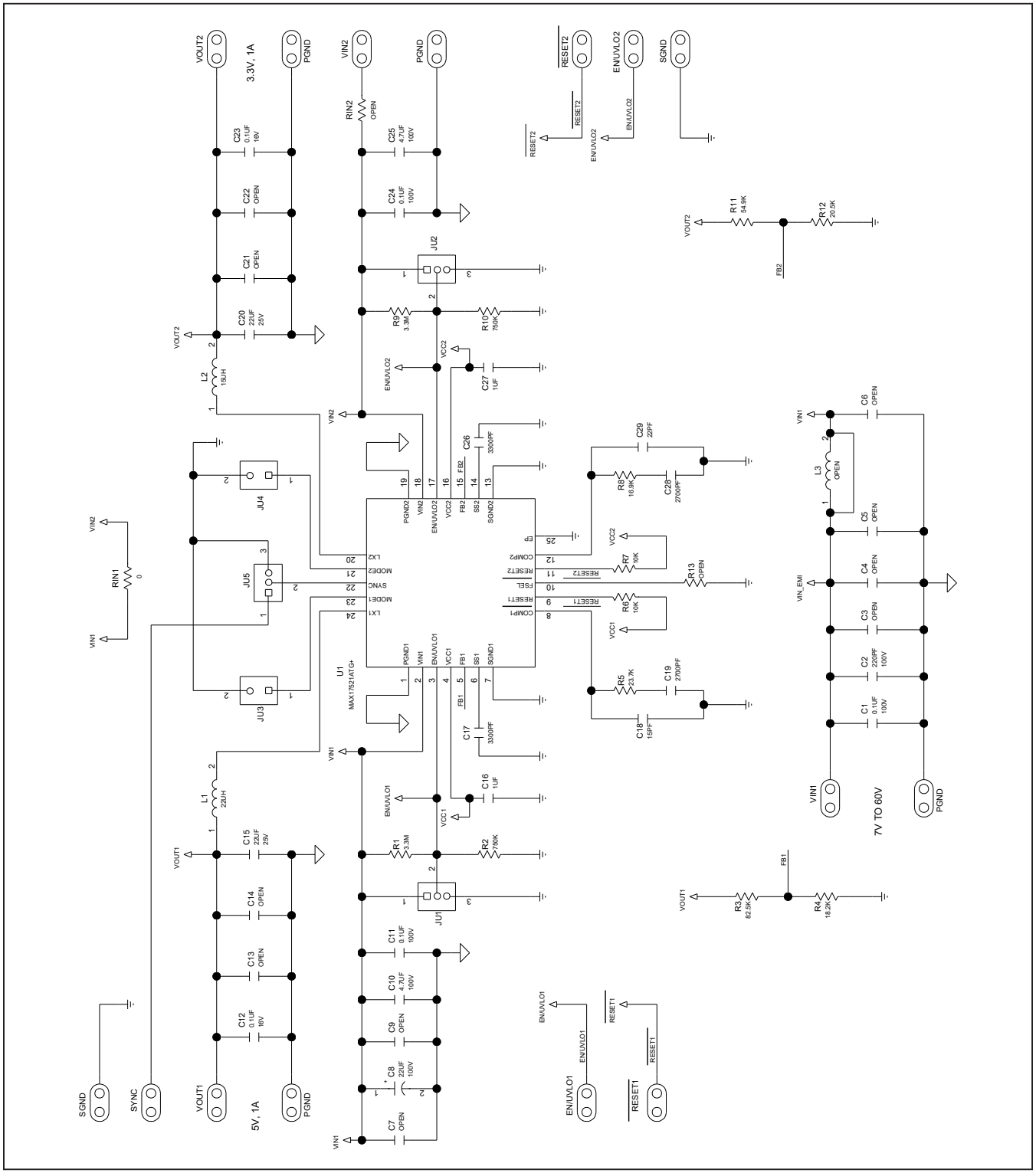
#Denotes RoHs compliance.

MAX17521EVKITE# Bill of Materials

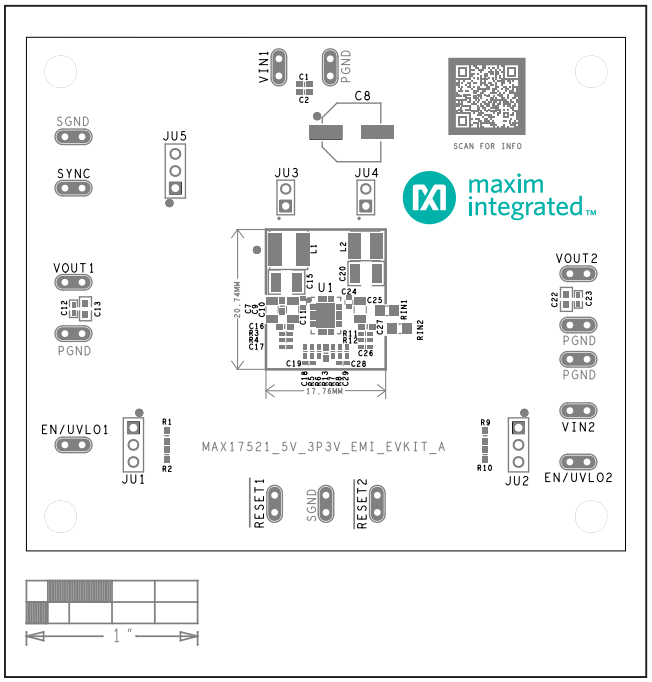
S. No	DESIGNATOR	DESCRIPTION	QUANTITY	MANUFACTURER PART NUMBER
1	C1, C11, C24	0.1µF, 10%, 100V, X7R, Ceramic capacitor (0603)	3	MURATA GRM188R72A104KA35
2	C2	220pF, 5%, 100V, COG, Ceramic capacitor (0603)	1	TDK C1608C0G2A221J080AA
3	C8	22uF, 20%, 100V, Electrolytic capacitor	1	PANASONIC EEE-TG2A220UP
4	C10, C25	4.7µF, 10%, 100V, X7R, Ceramic capacitor (1206)	2	MURATA GRM31CZ72A475KE11
5	C12, C23	0.1µF, 10%, 16V, X7R, Ceramic capacitor (0402)	2	MURATA GRM155R71C104KA88
6	C15, C20	22µF, 20%, 25V, X7R, Ceramic capacitor (1210)	2	MURATA GRM32ER71E226ME15
7	C16, C27	1µF, 10%, 16V, X7R, Ceramic capacitor (0603)	2	MURATA GRM188R71C105KA12
8	C17, C26	3300pF, 2%, 50V, COG, Ceramic capacitor (0402)	2	MURATA GRM1555C1H332GE01
9	C18	15pF, 5%, 50V, COG, Ceramic capacitor (0402)	1	MURATA GRM1555C1H150JA01
10	C19, C28	2700pF, 2%, 50V, COG, Ceramic capacitor (0402)	2	MURATA GRM1555C1H272GE01
11	C29	22pF, 5%, 50V, COG, Ceramic capacitor (0402)	1	MURATA GRM1555C1H220JA01
12	L1	Inductor, 22µH, 3.6A (5.3mm x 5.5mm)	1	COILCRAFT XAL5050-223ME
13	L2	Inductor, 15µH, 2.8A (4mm x 4mm)	1	COILCRAFT XAL4040-153ME
14	R1, R9	3.3MΩ, 1%, 1/10W, Resistor (0603)	2	
15	R2, R10	750kΩ, 1%, 1/10W, Resistor (0603)	2	
16	R3	82.5KΩ, 1%, 1/16W, Resistor (0402)	1	
17	R4	18.2KΩ, 1%, 1/16W, Resistor (0402)	1	
18	R5	23.7KΩ, 1%, 1/16W, Resistor (0402)	1	
19	R6, R7	10KΩ, 1%, 1/16W, Resistor (0402)	2	
20	R8	16.9KΩ, 1%, 1/16W, Resistor (0402)	1	
21	R11	54.9KΩ, 1%, 1/16W, Resistor (0402)	1	
22	R12	20.5KΩ, 1%, 1/16W, Resistor (0402)	1	
23	RIN1	0Ω, ±5%, 1/2W, Resistor (0805)	1	
24	U1	High-Efficiency Synchronous Step-Down Dual DC-DC Converter (TQFN24-EP 4mm x 5mm)	1	MAX17521ATG+
25	JU1, JU2, JU5	3-pin header (36-pin header 0.1” centers)	3	Sullins PEC03SAAN
26	JU3, JU4	2-pin header (36-pin header 0.1” centers)	2	Sullins PEC02SAAN
27	C5, C7	OPTIONAL: 4.7µF, 10%, 100V, X7R, Ceramic capacitor (1206)	2	MURATA GRM31CZ72A475KE11
28	L3	OPTIONAL: INDUCTOR, 10µH, 1A (2.8mm x 2.8mm)	1	WURTH ELECTRONICS 744025100
29	C3, C9, C13, C22	OPEN: Capacitor (0603)	0	
30	C4, C14, C21	OPEN: Capacitor (0402)	0	
31	C6	OPEN: Capacitor (1206)	0	
32	R13	OPEN: Resistor (0603)	0	
33	RIN2	OPEN: Resistor (0805)	0	

DEFAULT JUMPER TABLE	
JUMPER	SHUNT POSITION
JU1, JU2	Not Installed
JU3, JU4	Not Installed
JU5	2-3

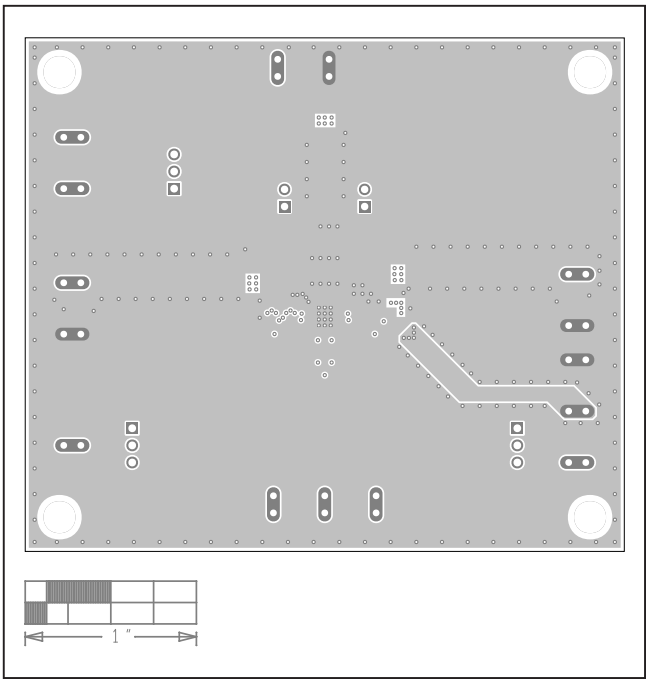
MAX17521EVKITE# Schematic



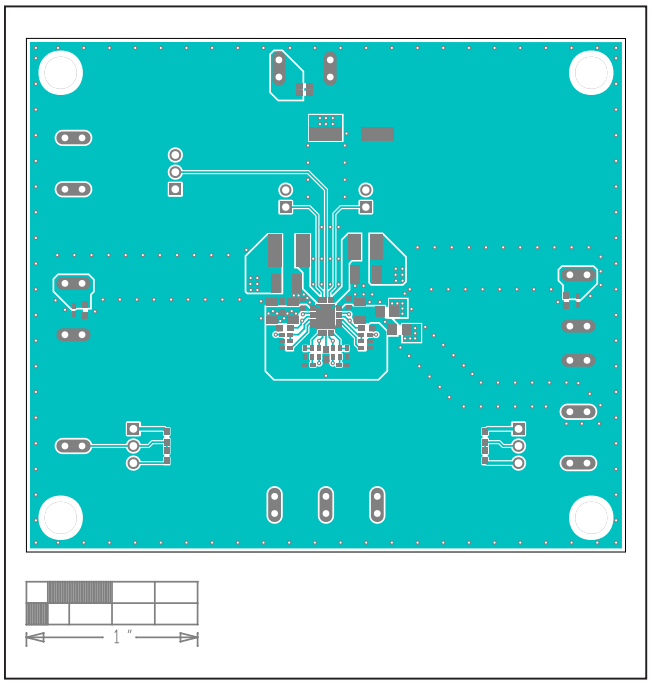
MAX17521EVKITE# PCB Layouts



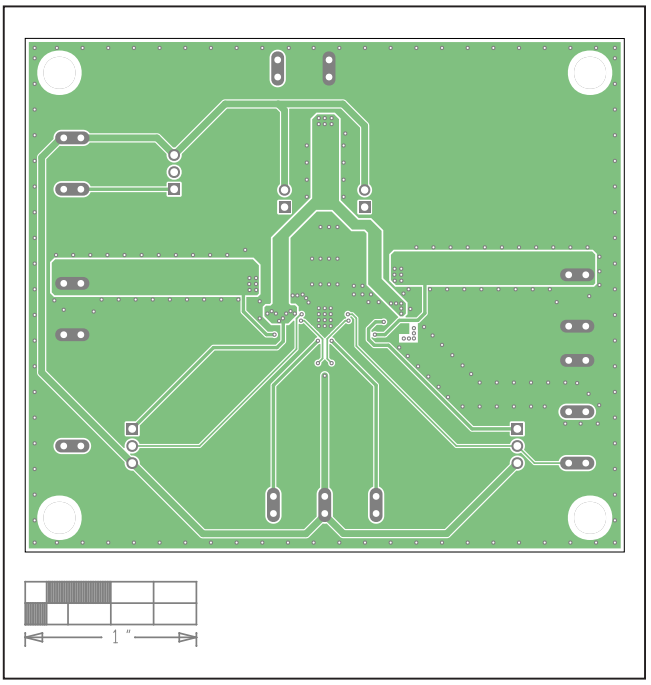
MAX17521EVKITE# Component Placement Guide—Top Silkscreen



MAX17521EVKITE# PCB Layout—Layer 2

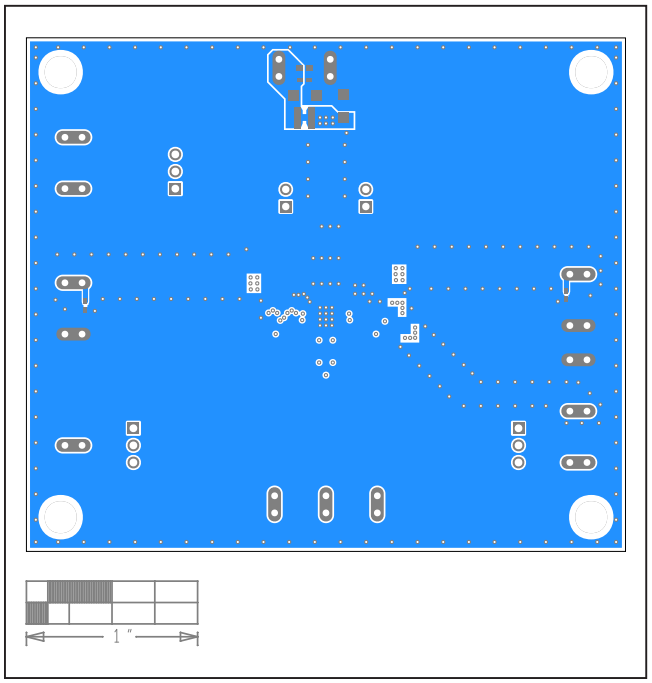


MAX17521EVKITE# PCB Layout—Top Layer

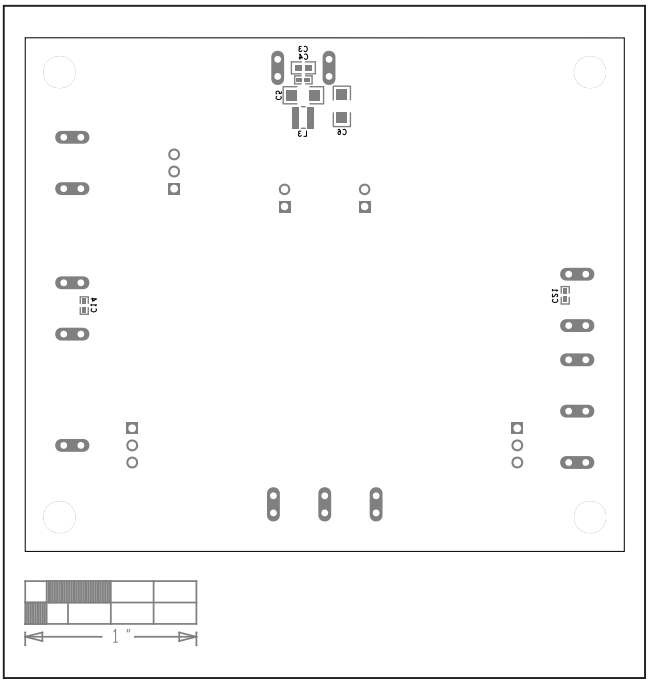


MAX17521EVKITE# PCB Layout—Layer 3

MAX17521EVKITE# PCB Layouts (continued)



MAX17521EVKITE# PCB Layout—Bottom Layer



MAX17521EVKITE# Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	9/20	Initial release	—