Click here for production status of specific part numbers.

MAX17536EVKITBE# Evaluation Kit

Evaluates: MAX17536
5V Output-Voltage Application

General Description

The MAX17536EVKITBE# (EV kit) provides a proven design to evaluate this high-voltage, high-efficiency, synchronous step-down DC-DC converter. The EV kit is preset for a 5V output at load currents up to 4A and features a 450kHz switching frequency for optimum efficiency and component size. The EV kit features adjustable input, undervoltage lockout, adjustable soft-start, open-drain $\overline{\text{RESET}}$ signal, and external clock synchronization. The EV kit also provides a 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 MAX17536 data sheet.

Features

- Operates from a 6.5V to 60V Input Supply
- 5V Output Voltage
- Up to 4A Output Current
- 450kHz Switching Frequency
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold
- Adjustable Soft-Start Time
- MODE Pin to Select Among PWM, PFM, or DCM Modes
- Open-Drain $\overline{\text{RESET}}$ Output
- External Clock Synchronization
- Overcurrent and Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested
- Complies with CISPR22(EN55022) Class B Conducted and Radiated Emissions

Quick Start

Recommended Equipment

- MAX17536EVKITBE#
- 6.5V to 60V, 10A DC input power supply
- Load capable of sinking 4A
- Digital voltmeter (DVM)

Equipment Setup and Test 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 completed.

1) Set the power supply at a voltage between 6V and 60V. Disable the power supply.
2) Connect the positive terminal of the power supply to the VIN PCB pad and the negative terminal to the nearest PGND PCB pad. Connect the positive terminal of the 4A load to the VOUT PCB pad and the negative terminal to the nearest PGND PCB pad.
3) Connect the DVM across the VOUT PCB pad and the nearest PGND PCB pad.
4) Verify that shunt is installed across pins 1-2 on jumper JU1 (see Table 1 for details).
5) Select the shunt position on JU2 according to the intended mode of operation (see Table 2 for details).
6) Turn on the DC power supply.
7) Enable the load.
8) Verify that the DVM displays 5V.

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

319-100445; Rev 0; 1/20

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Detailed Description

The MAX17536EVKITBE# provides a proven design to evaluate the high-voltage, high-efficiency, synchronous step-down DC-DC converter. The EV kit is preset for a 5V output from a 6.5V to 60V input at load currents up to 4A and features a 450kHz switching frequency for optimum efficiency and component size.

The EV kit includes an EN/UVLO PCB pad and JU1 to enable the output at a desired input voltage. The SYNC PCB pad allows an external clock to synchronize the device. JU2 allows the selection of a particular mode of operation based on light-load performance requirements. An additional $\overline{\text{RESET}}$ PCB pad is available for monitoring when the converter output is in regulation.

Soft-Start Input (SS)

The EV kit offers an adjustable soft-start function to limit inrush current during startup. The soft-start time is adjusted by the value of external soft-start capacitor (C2) connected between SS and SGND. The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum value of C2, as shown by the following equation:

$$C2 \geq 28 \times 10^{-6} \times C_{SEL} \times V_{OUT}$$

The soft-start time (t_{SS}) is related to C2 by the following equation:

$$t_{SS} = C2/(5.55 \times 10^{-6})$$

For example, to program a 2.2ms soft-start time, C2 should be 12nF.

Enable/Undervoltage-Lockout (EN/UVLO) Programming

The MAX17536 offers an enable and an adjustable input undervoltage lockout feature. In this EV kit, for normal operation, leave the EN/UVLO jumper (JU1) open. When JU1 is left open, the MAX17536 is enabled when the input voltage rises above 6.4V. To disable the MAX17536, install a jumper across pins 2–3 on JU1. See Table 1 for JU1 settings. The EN/UVLO PCB pad on the EV kit supports external Enable/Disable control of the device. Leave JU1 open when external Enable/Disable control is desired. A potential divider formed by R1 and R2 sets the input voltage (V_{INU}) above which the converter is enabled when JU1 is left open.

Choose R1 to be 3.32MΩ (max), and then calculate R2 as follows:

$$R_2 = \frac{R_1 \times 1.215}{V_{INU} - 1.215}$$

where,

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

R1 and R2 are in kΩ.

For more details about setting the undervoltage lockout level, refer to the MAX17536 data sheet.

Mode Selection (MODE/SYNC)

The EV kit provides a jumper (JU2) that allows the MAX17536 to operate in PWM, PFM, and DCM modes. Refer to the MAX17536 data sheet for more details on the modes of operation. Table 2 shows the mode selection (JU2) settings that can be used to configure the desired mode of operation.

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

SHUNT POSITION	EN/UVLO PIN	MAX17536 OUTPUT
1-2*	Connected to V_{IN}	Enabled
Not installed	Connected to the center node of resistor-divider R1 and R2	Enabled, UVLO level set through the R1 and R2 resistors
2-3	Connected to SGND	Disabled

**Default position.*

Table 2. Mode Selection (JU2) Settings

SHUNT POSITION	MODE PIN	MAX17536 MODE
Not installed*	Unconnected	PFM mode of operation
1-2	Connected to SGND	PWM mode of operation
2-3	Connected to V_{CC}	DCM mode of operation

**Default position.*

External Clock Synchronization (MODE/SYNC)

The EV kit provides a MODE/SYNC PCB pad to synchronize the MAX17536 to an optional external clock. Leave the jumper (JU2) open when external clock signals are applied. In the presence of a valid external clock for synchronization, the MAX17536 operates in PWM mode only. For more details about external clock synchronization, refer to the MAX17536 data sheet.

Active-Low, Open-Drain Reset Output ($\overline{RESET}$)

The EV kit provides a $\overline{RESET}$ PCB pad to monitor the status of the converter. $\overline{RESET}$ goes high when V_{OUT} rises above 95% (typ) of its nominal regulated voltage. $\overline{RESET}$ goes low when V_{OUT} falls below 92% (typ) of its nominal regulated voltage.

Hot Plug-In and Long Input Cables

The MAX17536EVKITBE# PCB layout provides an optional electrolytic capacitor (CIN7 = 47µF/80V). This capacitor limits the peak voltage at the input of the MAX17536 when the DC input source is “hot-plugged” to the EV kit input terminals with long 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.

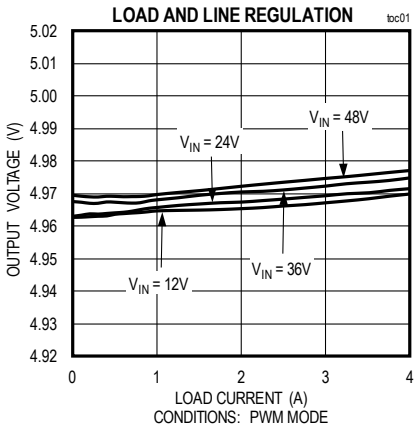
Electromagnetic Interference (EMI)

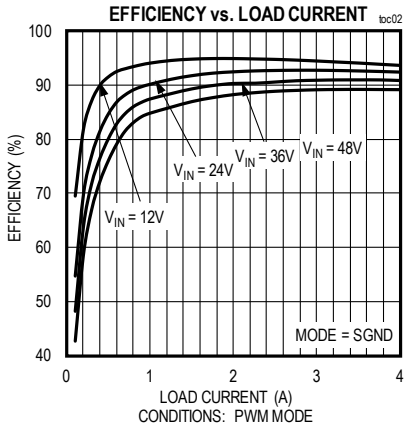
Compliance to conducted emissions (CE) standards requires an EMI filter at the input of a switching power converter. The EMI filter attenuates high-frequency currents drawn by the switching power converter and limits the noise injected back into the input power source.

The MAX17536EVKITBE# has designated footprints on the EV kit for placement of the EMI filter components. Use of these filter components results in lower conducted emissions below CISPR22 Class B limits. Cut open the trace at L2 before installing conducted EMI filter components. The MAX17536EVKITBE# PCB layout is also designed to limit radiated emissions from switching nodes of the power converter resulting in radiated emissions below CISPR22 Class B limits.

EV Kit Performance Report

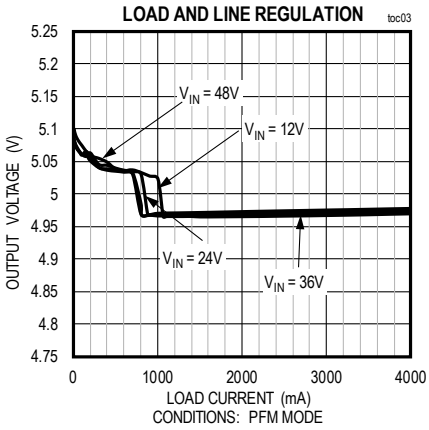
(V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 4A, f_{SW} = 450kHz, T_A = +25°C, unless otherwise noted.)

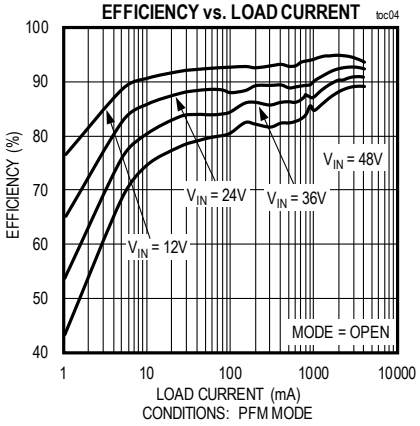


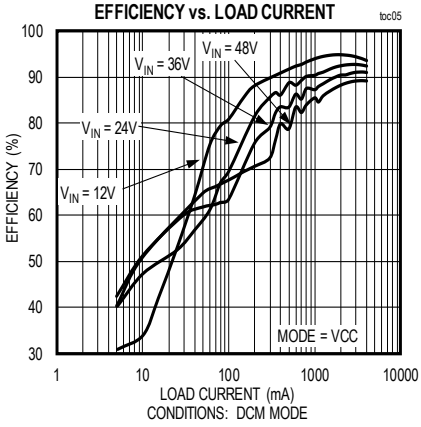


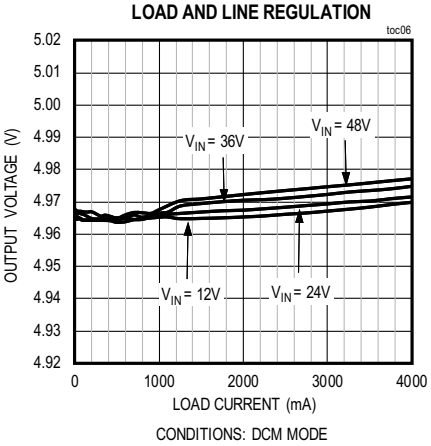
EV Kit Performance Report (continued)

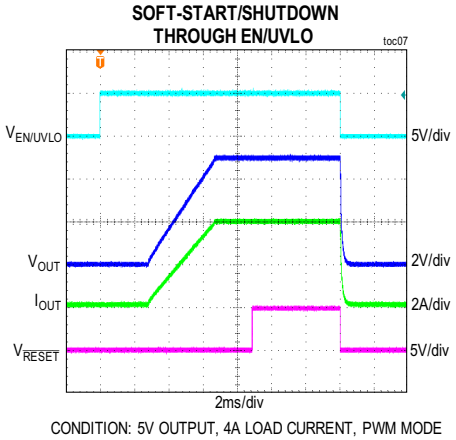
(V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 4A, f_{SW} = 450kHz, T_A = +25°C, unless otherwise noted.)



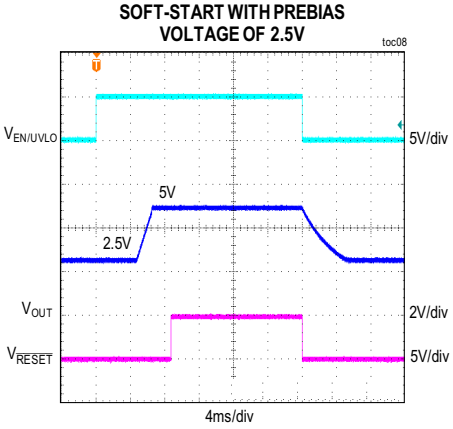








CONDITION: 5V OUTPUT, 4A LOAD CURRENT, PWM MODE
$\overline{RESET}$ IS PULLED UP TO V_{CC} WITH A 10kΩ RESISTOR

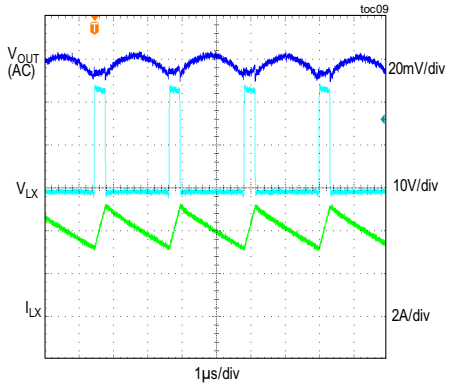


CONDITION: 5V OUTPUT, PWM MODE
$\overline{RESET}$ IS PULLED UP TO V_{CC} WITH A 10kΩ RESISTOR

EV Kit Performance Report (continued)

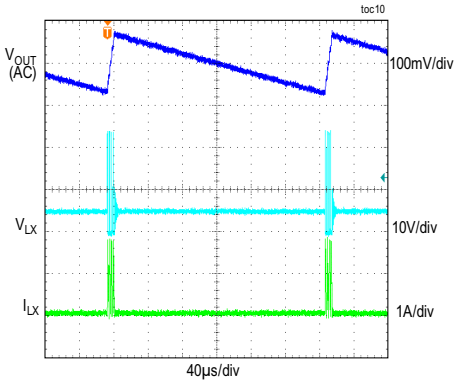
(V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 4A, f_{SW} = 450kHz, T_A = +25°C, unless otherwise noted.)

STEADY-STATE PERFORMANCE



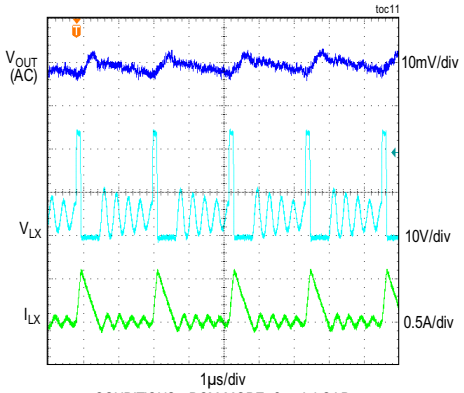
CONDITIONS: PWM MODE, 4A LOAD

STEADY-STATE PERFORMANCE



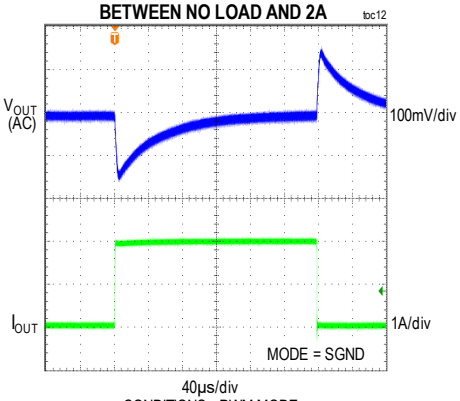
CONDITIONS: PFM MODE, 25mA LOAD

STEADY-STATE PERFORMANCE



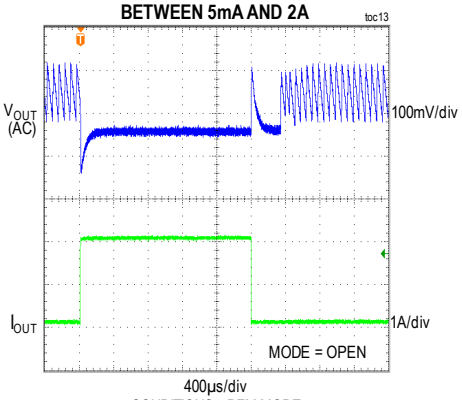
CONDITIONS: DCM MODE, 25mA LOAD

LOAD TRANSIENT RESPONSE BETWEEN NO LOAD AND 2A



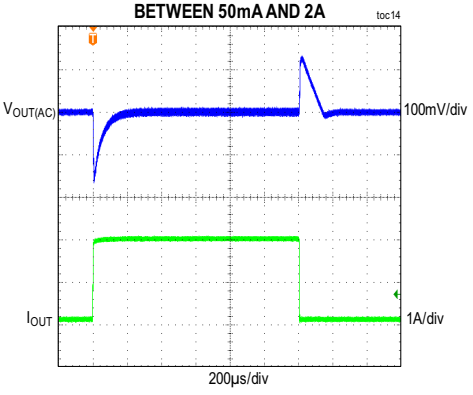
CONDITIONS: PWM MODE

LOAD TRANSIENT RESPONSE BETWEEN 5mA AND 2A



CONDITIONS: PFM MODE

LOAD TRANSIENT RESPONSE BETWEEN 50mA AND 2A

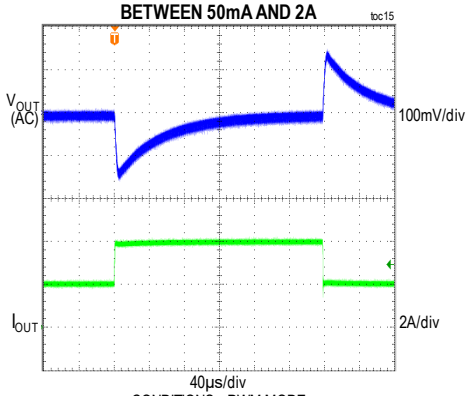


CONDITIONS: DCM MODE

EV Kit Performance Report (continued)

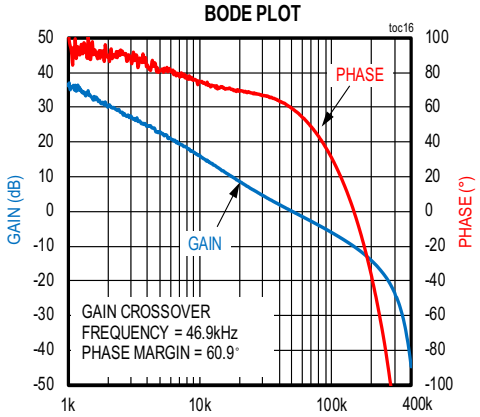
(V_{IN} = 24V, V_{OUT} = 5V, I_{OUT} = 4A, f_{SW} = 450kHz, T_A = +25°C, unless otherwise noted.)

LOAD TRANSIENT RESPONSE
BETWEEN 50mA AND 2A



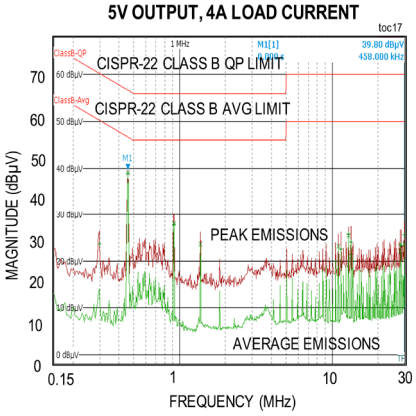
CONDITIONS: PWM MODE

BODE PLOT



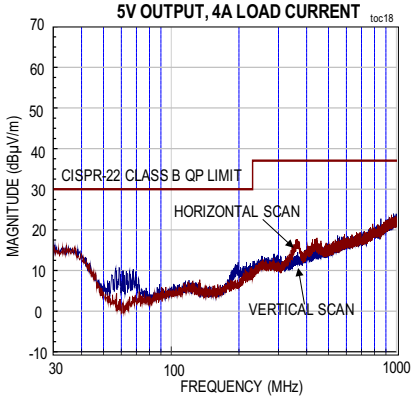
CONDITIONS: 5V OUTPUT, 4A LOAD

CONDUCTED EMISSIONS PLOT
5V OUTPUT, 4A LOAD CURRENT



L2 = 15µH, CIN4 = CIN9 = 4.7µF/100V/X7R/1206

RADIATED EMISSIONS PLOT
5V OUTPUT, 4A LOAD CURRENT



L2 = SHORT, CIN4 = CIN9 = OPEN

Component Suppliers

SUPPLIER	WEBSITE
Coilcraft, Inc.	www.coilcraft.com
TDK Corp.	www.tdk.com
Murata Americas	www.murata.com
Panasonic Corp.	www.panasonic.com
Vishay	www.vishay.com

Note: *Indicate that you are using the MAX17536 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17536EVKITBE#	EV Kit

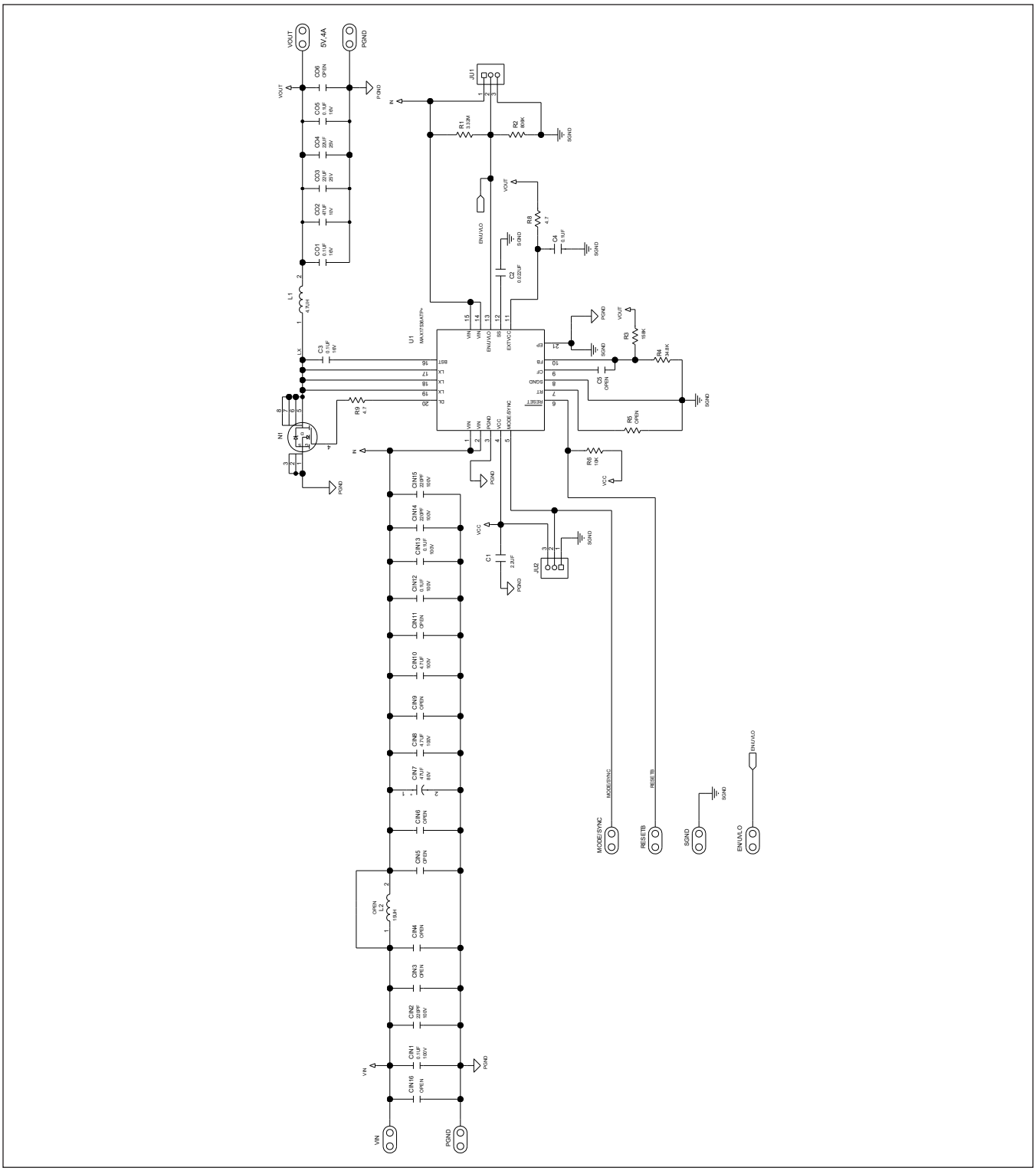
#Denotes RoHS compliant.

MAX17536EVKITBE# Bill of Materials

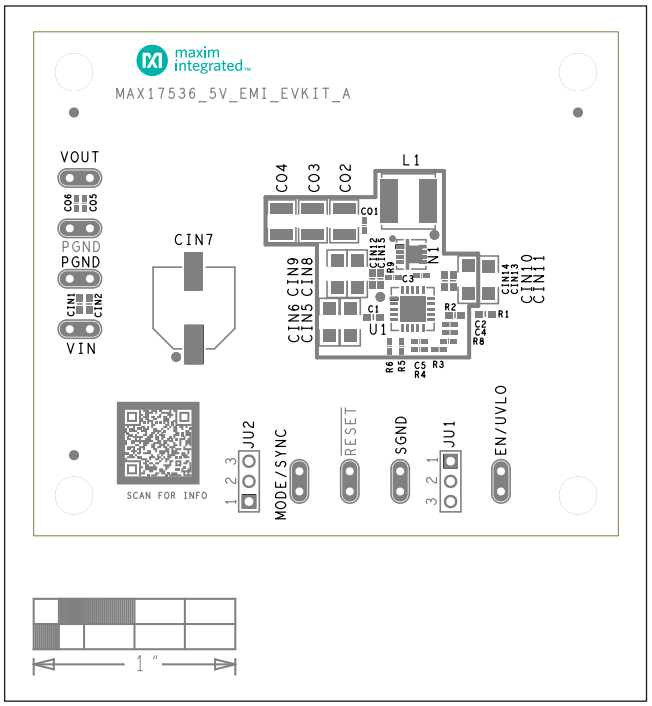
S.No	DESIGNATOR	DESCRIPTION	QUANTITY	MANUFACTURER PART NUMBER
1	C1	2.2µF, 10%, 10V, X7R, Ceramic capacitor (0603)	1	MURATA GRM188R71A225KE15
2	C2	0.022µF, 10%, 50V, X7R, Ceramic capacitor (0402)	1	MURATA GCM155R71H223KA55
3	C3, C4, CO1, CO5	0.1µF, 10%, 16V, X7R, Ceramic capacitor (0402)	4	TAIYO YUDEN EMK105B7104KV-F
4	CIN1, CIN12, CIN13	0.1µF, 10%, 100V, X7R, Ceramic capacitor (0603)	3	TAIYO YUDEN HMK107B7104KA-T
5	CIN2, CIN14, CIN15	220pF, 5%, 100V, COG, Ceramic capacitor (0603)	3	TDK C1608C0G2A221J080AA
6	CIN7	ALUMINUM-ELECTROLYTIC; 47UF; 80V; TOL=20%; MODEL=EEV SERIES	1	PANASONIC EEE-FK1K470P
7	CIN8, CIN10	4.7µF, 10%, 100V, X7R, Ceramic capacitor (1206)	2	MURATA GRM31CZ72A475KE11
8	CO2	47µF, 10%, 10V, X7R, Ceramic capacitor (1210)	1	MURATA GRM32ER71A476KE15
9	CO3, CO4	22µF, 10%, 25V, X7R, Ceramic capacitor (1210)	2	MURATA GRM32ER71E226ME15
10	L1	INDUCTOR, 4.7µH, 11A (6mm x 6mm)	1	COILCRAFT XAL6060-472ME
11	N1	N-CHANNEL 80V MOSFET (3.3mm x 3.3mm)	1	VISHAY SILICONIX SIS468DN-T1-GE3
12	R1	RES+, 3.32MΩ, 1% (0603)	1	VISHAY DALE CRCW04023M32FK
13	R2	RES+, 806KΩ, 1% (0603)	1	PANASONIC ERJ-3EKF8063
14	R3	RES+, 158KΩ, 1% (0402)	1	PANASONIC ERJ-2RKF1583
15	R4	RES+, 34.8KΩ, 1% (0402)	1	VISHAY DALE CRCW040234K8FK
16	R6	RES+, 10KΩ, 1% (0402)	1	PANASONIC ERJ-2RKF1002
17	R8, R9	RES+, 4.7Ω, 1% (0402)	2	VISHAY CRCW04024R70FK
18	U1	HIGH-EFFICIENCY; SYNCHRONOUS STEP-DOWN DC-DC CONVERTER; (TQFN20-EP 5mm x 5mm)	1	MAX17536ATP+
19	JU1, JU2	3-pin header (36-pin header 0.1” centers)	2	Sullins: PEC03SAAN
20	-	Shunts	2	SULLINS STC02SYAN
21	MH1-MH4	MACHINE SCREW; SLOTTED	4	EAGLE PLASTIC DEVICES P440.375
22	MH1-MH4	HEX STANDOFF #4-40 NYLON 3/8"	4	KEYSTONE ELECTRONICS 1902B
23	CIN4 , CIN9	OPTIONAL: 4.7µF, 10%, 100V, X7R, Ceramic capacitor (1206)	2	MURATA GRM31CZ72A475KE11
24	L2	OPTIONAL: INDUCTOR, 15µH, 2.8A (4mm x 4mm)	1	COILCRAFT XAL4040-153ME
25	CIN3, CIN5, CIN6, CIN11	OPEN: Capacitor (1206)	0	
26	CIN16	OPEN: Capacitor (0603)	0	
27	C5	OPEN: Capacitor (0402)	0	
28	CO6	OPEN: Capacitor (0402)	0	
29	R5	OPEN: Resistor (0402)	0	

DEFAULT JUMPER TABLE	
JUMPER	SHUNT POSITION
JU1	1 - 2
JU2	1

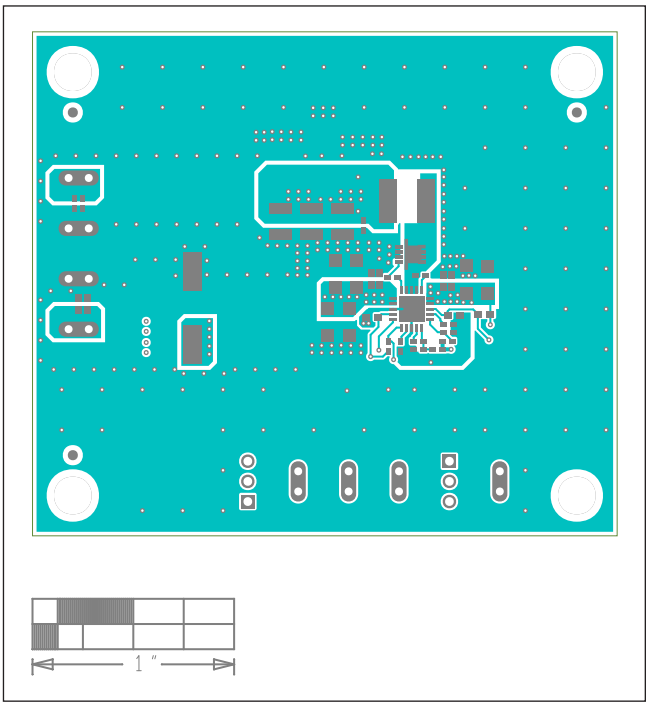
MAX17536EVKITBE# Schematic



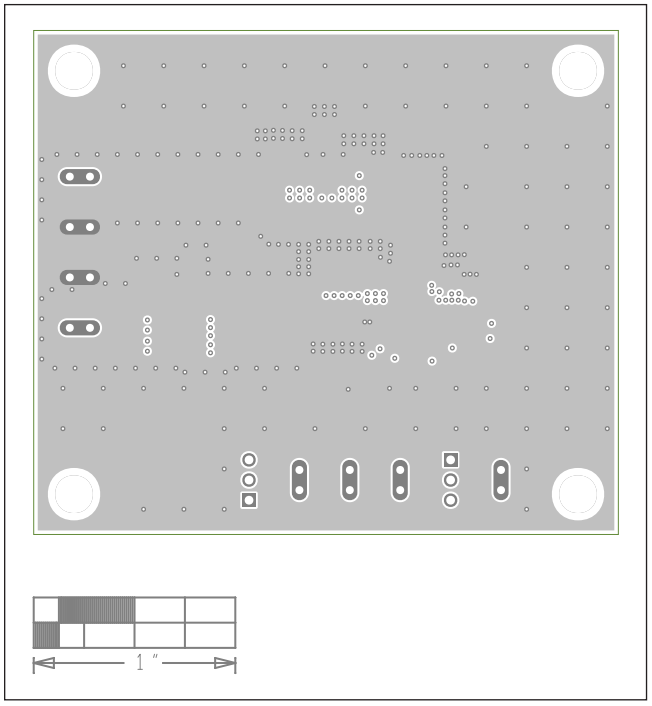
MAX17536EVKITBE# PCB Layout Diagrams



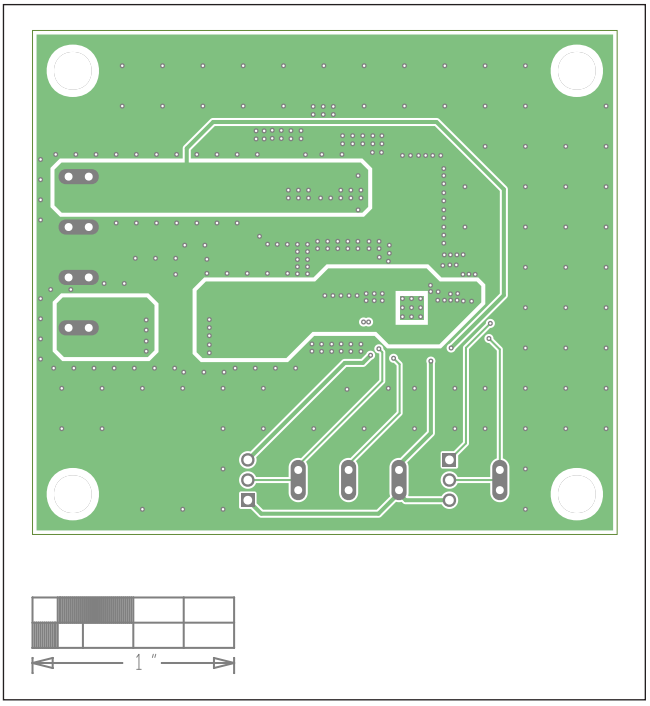
MAX17536EVKITBE# PCB Layout—Top Silkscreen



MAX17536EVKITBE# PCB Layout—Top Layer

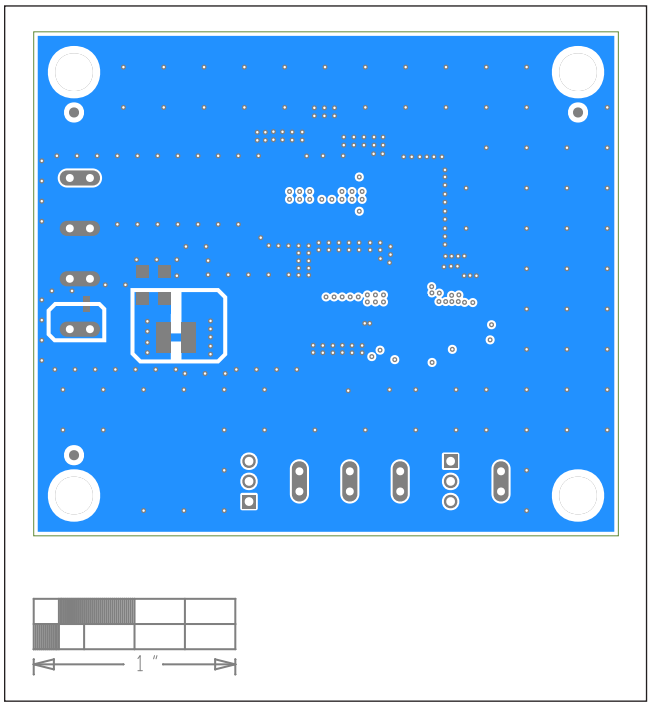


MAX17536EVKITBE# PCB Layout—Layer 2 Ground

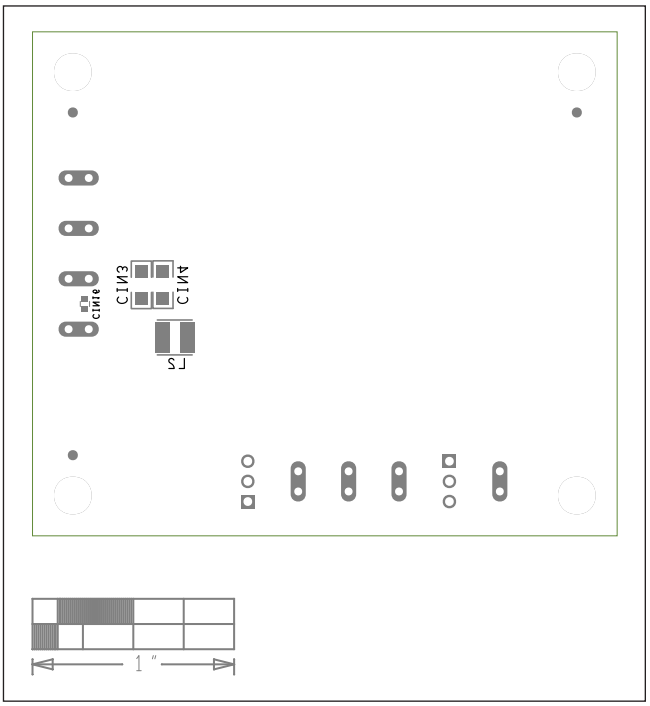


MAX17536EVKITBE# PCB Layout—Layer 3 Power

MAX17536EVKITBE# PCB Layout Diagrams (continued)



MAX17536EVKITBE# PCB Layout—Bottom Layer



MAX17536EVKITBE# PCB Layout—Silk Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/20	Initial release	—