MAX17576EVKITB# Evaluation Kit

Evaluates: MAX17576 5V Output-Voltage Application

General Description

The MAX17576EVKITB# evaluation kit (EV kit) provides a proven design to evaluate the MAX17576 high-voltage, high-efficiency, synchronous step-down DC-DC converter. The EV kit is preset for 5V output at load currents up to 4A and features a 350kHz switching frequency for optimum efficiency and component size. The EV kit features adjustable input undervoltage lockout, adjustable soft-start, open-drain RESET signal, and external frequency 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 MAX17576 IC data sheet.

Features

- Operates from a 6.5V to 60V Input Supply
- 5V Output Voltage
- Up to 4A Output Current
- 350kHz Switching Frequency
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold
- Adjustable Soft-Start Time
- MODE/SYNC Pin to Select Either PWM, PFM, or DCM Mode
- Open-Drain $\overline{\text{RESET}}$ Output
- External Frequency Synchronization
- Overcurrent and Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested
- CISPR-22 Class B Compliant

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

Quick Start

Recommended Equipment

- MAX17576EVKITB#t
- 6.5V to 60V, 5A DC input power supply
- Load capable of sinking 4A
- Two digital voltmeters (DVM)

Equipment Setup and Test Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify the board operation. **Caution: Do not turn on power supply until all connections are completed.**

1) Set the power supply at a voltage of 6V. Then, 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 one DVM across the VOUT PCB pad and the nearest PGND PCB pad, and the other DVM across the $\overline{\text{RESET}}$ PCB pad and SGND PCB pad.
4) Verify that shunts are not installed across any pins on jumper JU1 (see Table 1 for details).
5) Turn on the DC power supply.
6) Enable the load.
7) Increase the input voltage to 6.4V, which is above the EN/UVLO rising threshold.
8) Verify that the DVM across the VOUT PCB pad and the nearest PGND PCB pad displays 5V.
9) Verify that the DVM across the $\overline{\text{RESET}}$ PCB pad and the nearest SGND PCB pad displays 5V.
10) The power supply voltage can be set at any voltage between 6.5V and 60V.
11) Reduce the input voltage to 5V, which is below the EN/UVLO falling threshold.
12) Verify that both the DVMs displays 0V.
13) Disable the input power supply.

319-100291; Rev 1; 9/20

maxim integrated™

.Detailed Description

The EV kit is designed to deliver 5V output at a load current up to 4A from a 6.5V to 60V input supply. The EV kit is programmed at 350kHz switching frequency for optimum efficiency and component size.

The EV kit includes an EN/UVLO PCB pad and jumper JU1 to enable the output at a desired input voltage. The MODE/SYNC PCB pad allows an external clock to synchronize the device. Jumper JU2 allows the selection of a particular MODE/SYNC of operation based on light-load performance requirements. An additional $\overline{RESET}$ PCB pad is available for monitoring whether the converter output is in regulation or not.

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 the external soft-start capacitor (C5) connected between SS and SGND. The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum value of C5, as shown by the following equation:

$$C5 \geq 28 \times 10^{-6} \times C_{SEL} \times V_{OUT}$$

The soft-start time (t_{SS}) is related to C5 by the following equation:

$$t_{SS} = C5/(5.55 \times 10^{-6})$$

For example, to program a 1ms soft-start time, C5 should be 5.6nF.

Enable/Undervoltage-Lockout Level (EN/UVLO) Programming

The MAX17576 offers an Enable and 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 MAX17576 is enabled after the input voltage rises above 6.4V. To disable the MAX17576, 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) then calculate R2 as follows:

$$R2 = \frac{1.215 \times R1}{(V_{INU} - 1.215)}$$

where, V_{INU} is the voltage at which the device is required to turn on, and R1 and R2 are in kΩ. For more details about setting the undervoltage lockout level, refer to the *MAX17576 data sheet*.

MODE Selection (MODE/SYNC)

The EV kit provides a jumper (JU2) that allows the MAX17576 to operate in PWM, PFM, and DCM modes. Refer to the *MAX17576 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.

External Clock Synchronization (MODE/SYNC)

The EV kit provides a MODE/SYNC PCB pad to synchronize the MAX17576 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 MAX17576 operates in PWM mode only. For more details about external clock synchronization, refer to the *MAX17576 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 VOUT rises above 95% (typ) of its nominal regulated output voltage. $\overline{RESET}$ goes low when VOUT falls below 92% (typ) of its nominal regulated voltage.

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

SHUNT POSITION	EN/UVLO PIN	MAX17576_ OUTPUT
1-2	Connected to VIN	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 Jumper (JU2) Settings

SHUNT POSITION	MODE/SYNC PIN	MAX17576_ MODE
Not installed	Unconnected	PFM mode of operation
2-3*	Connected to SGND	PWM mode of operation
1-2	Connected to V_{CC}	DCM mode of operation

**Default position.*

Electro-Magnetic 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 MAX17576EVKITB# PCB has designated footprints for the placement of conducted EMI filter components as per the optional Bill of Material (BoM). Use of these filter components results in lower conducted EMI, below CISPR22 Class B limits. Cut open the trace at L1 before installing EMI filter components. The MAX17576EVKITB# 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.

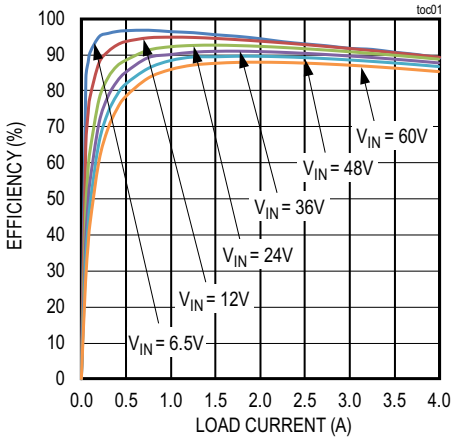
Hot Plug-In and Long Input Cables

The MAX17576EVKITB# PCB layout provides an optional electrolytic capacitor (CIN6 = 68µF/100V). This capacitor limits the peak voltage at the input of the MAX17576 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.

EV Kit Test Report

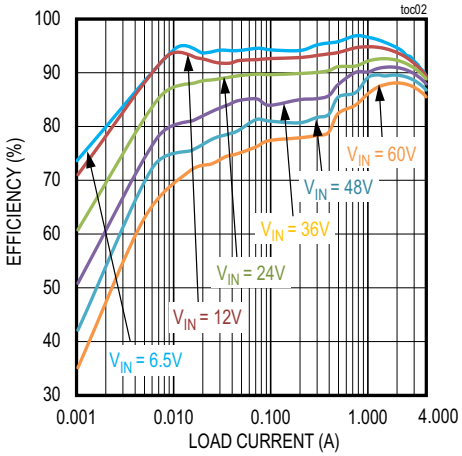
(V_{IN} = 24V, unless otherwise noted.)

EFFICIENCY vs. LOAD CURRENT



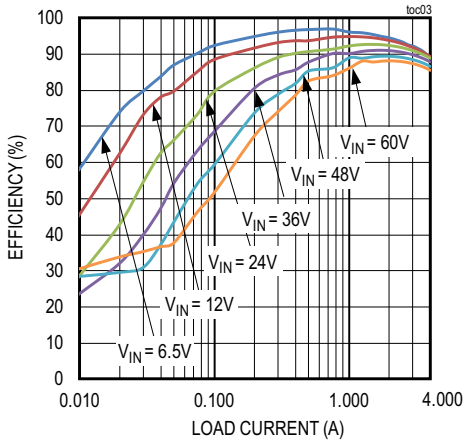
CONDITIONS: 5V OUTPUT, PWM MODE, f_{SW} = 350kHz

EFFICIENCY vs. LOAD CURRENT



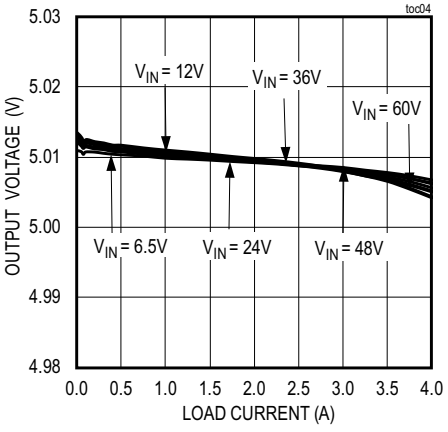
CONDITIONS: 5V OUTPUT, PFM MODE, f_{SW} = 350kHz

EFFICIENCY vs. LOAD CURRENT



CONDITIONS: 5V OUTPUT, DCM MODE, f_{SW} = 350kHz

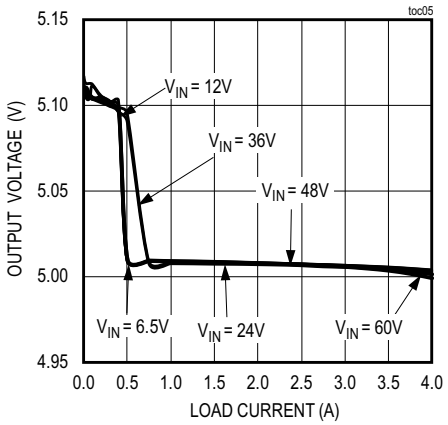
LOAD AND LINE REGULATION



CONDITIONS: 5V OUTPUT, PWM MODE

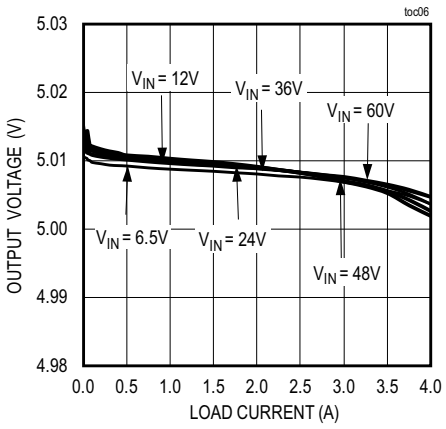
EV Kit Test Report (continued)

LOAD AND LINE REGULATION



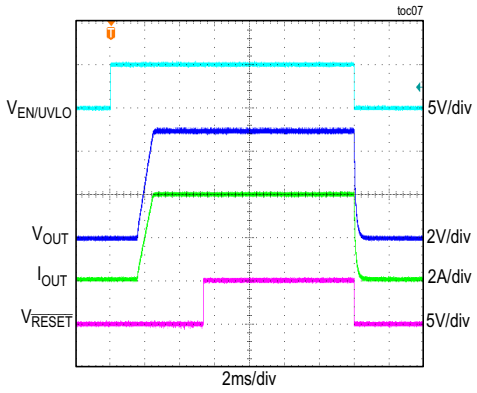
CONDITIONS: 5V OUTPUT, PFM MODE

LOAD AND LINE REGULATION



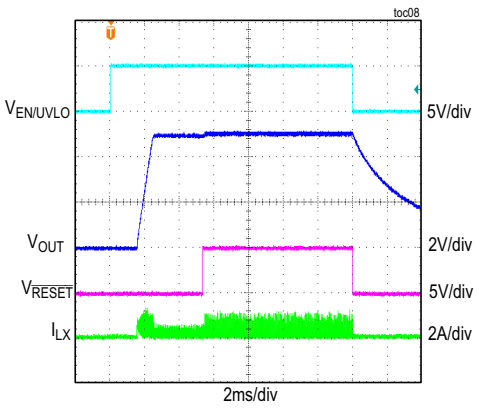
CONDITIONS: 5V OUTPUT, DCM MODE

SOFT-START/SHUTDOWN THROUGH EN/UVLO



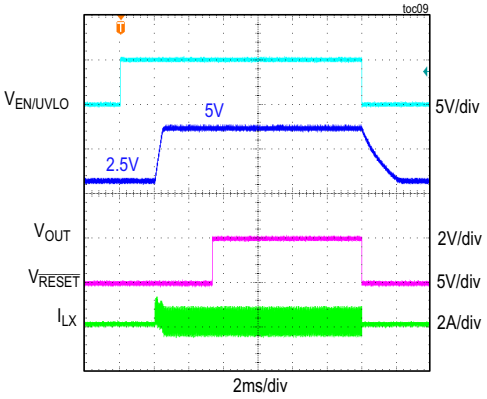
CONDITIONS: 5V OUTPUT, PWM MODE, 4A LOAD

SOFT-START/SHUTDOWN THROUGH EN/UVLO



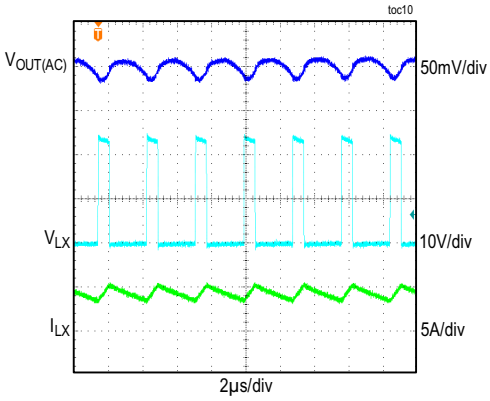
CONDITIONS: 5V OUTPUT, PFM MODE, 20mA LOAD

SOFT-START WITH PREBIAS VOLTAGE OF 2.5V



CONDITIONS: 5V OUTPUT, PWM MODE, 20mA LOAD
$\overline{RESET}$ IS PULLED UP TO V_{CC} WITH A 10kΩ RESISTOR

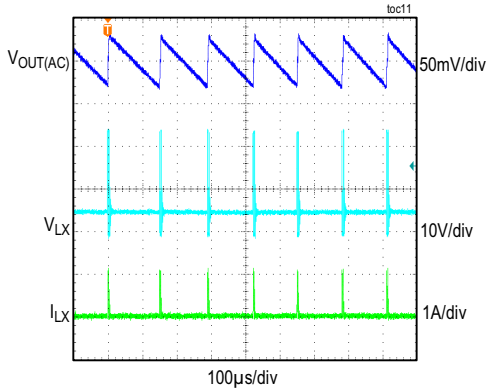
STEADY STATE PERFORMANCE



CONDITIONS: 5V OUTPUT, PWM MODE, 4A LOAD

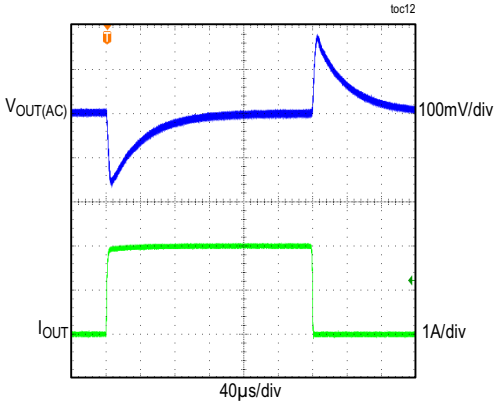
EV Kit Test Report (continued)

STEADY-STATE PERFORMANCE



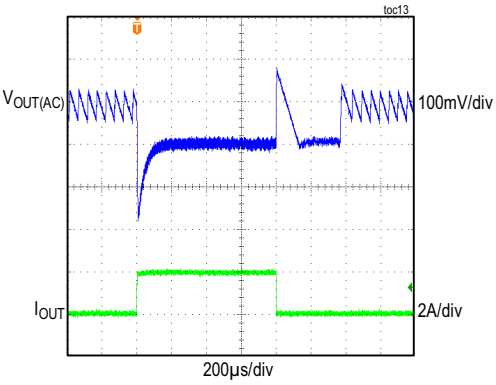
CONDITIONS: 5V OUTPUT, PFM MODE, 20mA LOAD

LOAD TRANSIENT BETWEEN 0A AND 2A



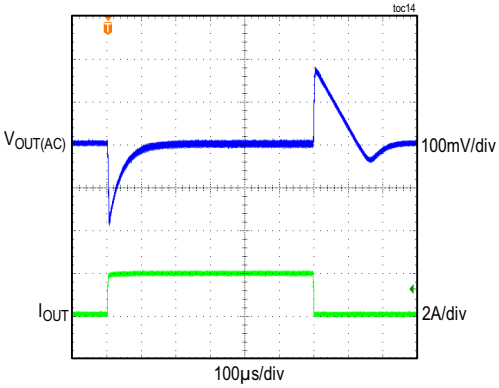
CONDITIONS: 5V OUTPUT, PWM MODE

LOAD TRANSIENT BETWEEN 50mA AND 2A



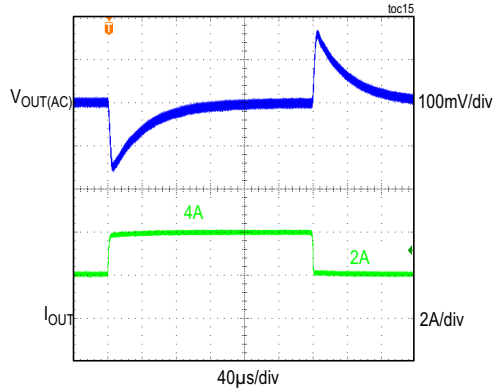
CONDITIONS: 5V OUTPUT, PFM MODE

LOAD TRANSIENT BETWEEN 80mA AND 2A



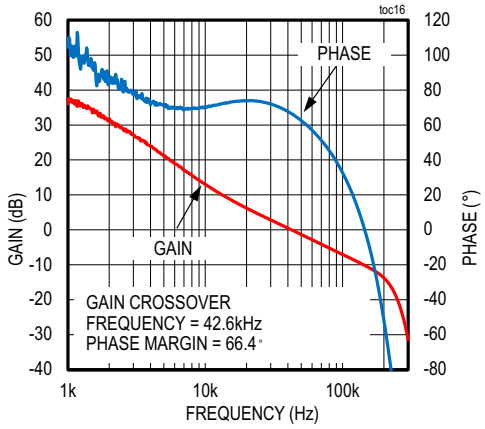
CONDITIONS: 5V OUTPUT, DCM MODE

LOAD TRANSIENT BETWEEN 2A AND 4A



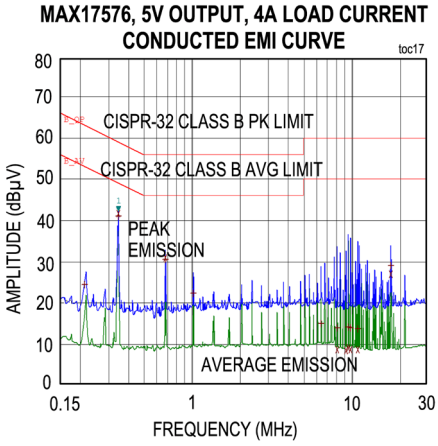
CONDITIONS: 5V OUTPUT, PWM MODE

CLOSED-LOOP BODE PLOT

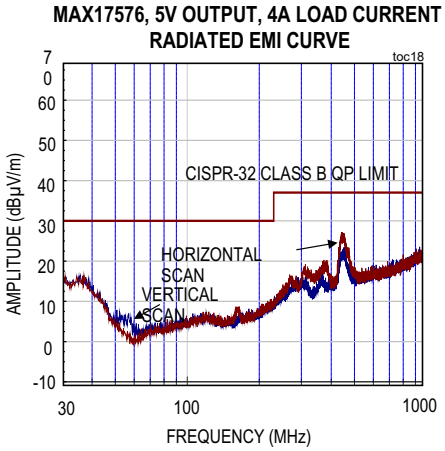


CONDITIONS: 5V OUTPUT, PWM MODE, 4A LOAD

EV Kit Test Report (continued)



CIN7 = CIN9 = 4.7µF/100V/X7R/1206, L1 = 22µH



CIN7 = CIN9 = OPEN, L1 = SHORT

Component Suppliers

SUPPLIER	WEBSITE
Coilcraft, Inc.	www.coilcraft.com
Murata Americas	www.murata.com
Panasonic Corp.	www.panasonic.com
TDK Corp.	www.tdk.com
Taiyo yuden Corp	www.ty-top.com

Note: *Indicate that you are using the MAX17576 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17576EVKITB#	EV Kit

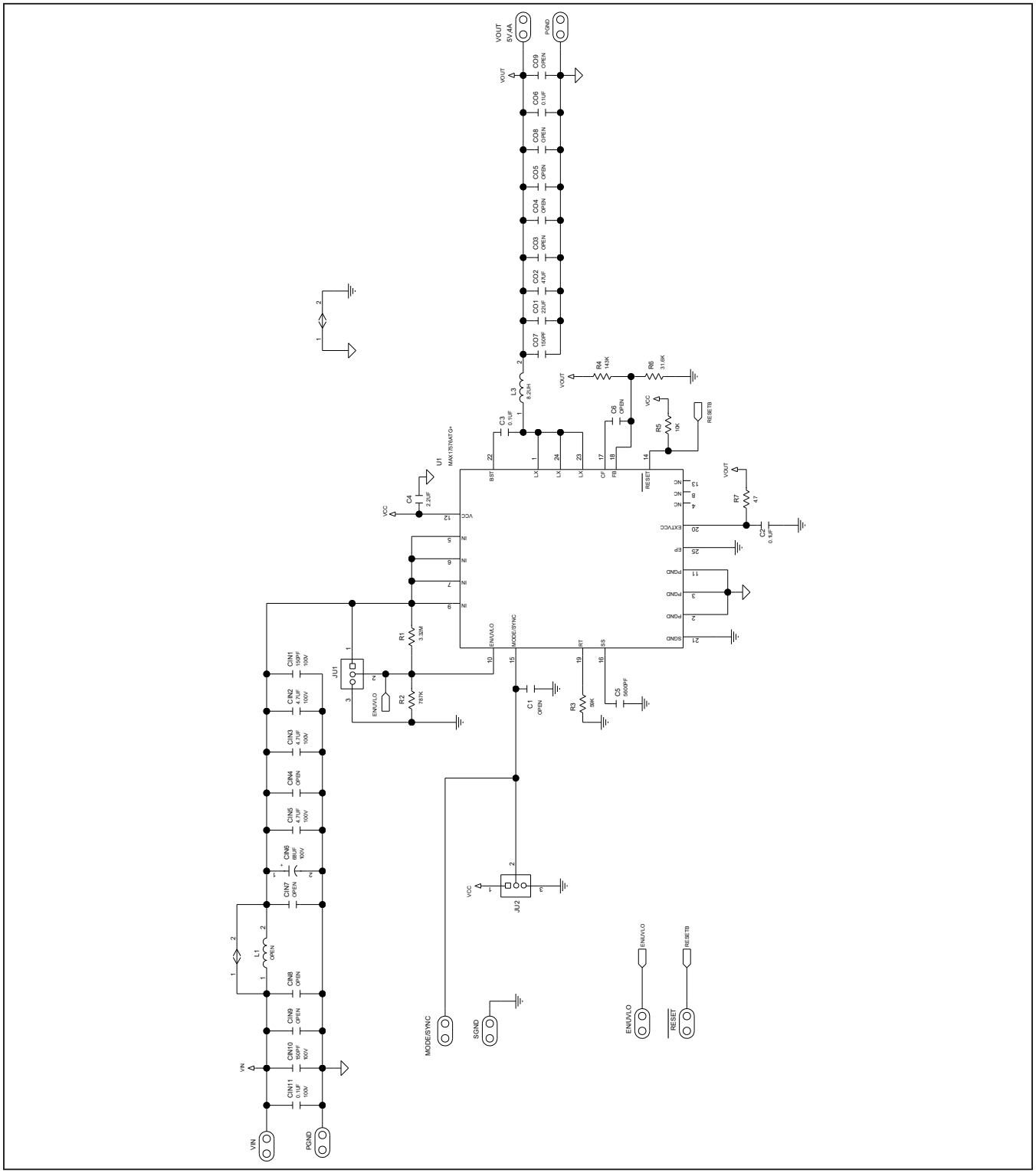
#Denotes RoHS compliant.

MAX17576EVKITB# Bill of Materials

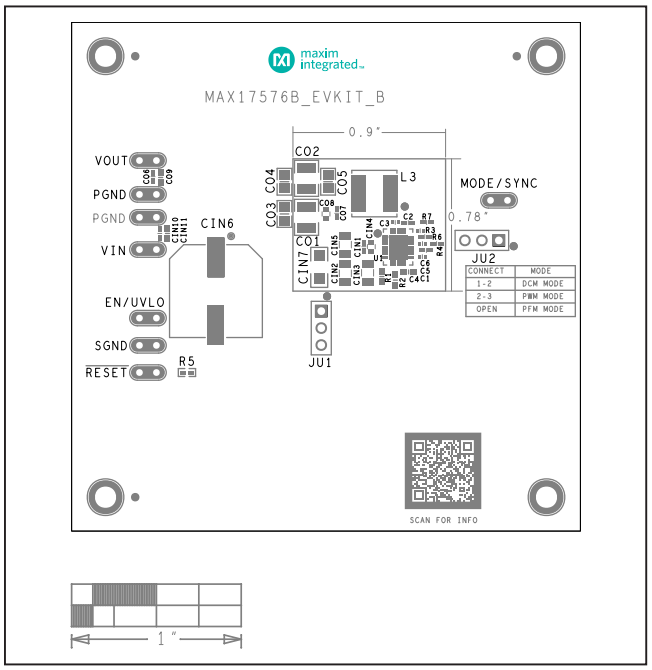
S.No	Designator	Description	Quantity	Manufacturer Part Number
1	C2, C3	0.1µF±10%; 16V; X7R; Ceramic Capacitor (0402)	2	MURATA GRM155R71C104KA88
2	C4	2.2µF± 10%; 10V; X7R; Ceramic Capacitor (0603)	1	MURATA GRM188R71A225KE15
3	C5	5600pF± 10%; 25V; X7R; Ceramic Capacitor (0603)	1	MURATA GRM1555C1H562GE01
4	CIN1, CIN10, CO7	150pF± 10%; 100V; COG; Ceramic Capacitor (0402)	3	TDK C1005C0G2A151J050BA
5	CIN2, CIN3, CIN5	4.7µF± 10%; 100V; X7R; Ceramic Capacitor (1206)	3	MURATA GRM31CZ72A475KE11
6	CIN6	68µF± 20%; 100V; Aluminum-Electrolytic Capacitor	1	PANASONIC EEV-FK2A680Q
7	CIN11	0.1µF±10%; 100V; X7R; Ceramic Capacitor (0603)	1	TAIYO YUDEN HMK107B7104KA
8	CO1	22µF± 20%; 25V; X7R; Ceramic Capacitor (1210)	1	MURATA GRM32ER71E226ME15
9	CO2	47µF± 20%; 10V; X7R; Ceramic Capacitor (1210)	1	MURATA GRM32ER71A476ME15
10	CO6	0.1µF±10%; 50V; X7R; Ceramic Capacitor (0402)	1	TDK C1005X7R1H104K050BE
11	JU1, JU2	3-pin header (36-pin header 0.1” centers)	2	SULLINS PEC03SAAN
12	L3	Inductor, 8.2µH, 9.9A (6.4mm x 6.6mm)	1	COILCRAFT XAL6060-822ME
13	R1	3.32MΩ, ±1%, 1/10W, Resistor (0603)	1	
14	R2	787kΩ, ±1%, 1/10W, Resistor (0603)	1	
15	R3	59kΩ, ±1%, 1/16W, Resistor (0402)	1	
16	R4	143kΩ, ±1%, 1/16W, Resistor (0402)	1	
17	R5	10kΩ, ±1%, 1/16W, Resistor (0402)	1	
18	R6	31.6kΩ, ±1%, 1/16W, Resistor (0402)	1	
19	R7	4.7Ω, ±1%, 1/16W, Resistor (0402)	1	
20	SU1, SU2	Shunt	2	Sullins STC02SYAN
21	U1	High-Efficiency, Synchronous Step-down DC-DC Converter (TQFN 4mm x 5mm)	1	MAXIM INTEGRATED MAX17576ATG+
22	CIN7, CIN9	OPTIONAL: 4.7µF ±10%, 100V, X7R, ceramic capacitor (1206)	2	MURATA GRM31CZ72A475KE11
23	L1	OPTIONAL: Inductor, 22µH, 2.2A (5mm x 5mm)	1	COILCRAFT XAL5050-223ME
24	CIN8	OPEN: Capacitor (1210)	0	N/A
25	CO9	OPEN: Capacitor (0603)	0	N/A
26	R7	OPEN: Resistor (0402)	0	N/A
27	C1, C6	OPEN: Capacitor (0402)	0	N/A
28	CIN4, CO8	OPEN: Capacitor (0603)	0	N/A
29	CO3-CO5	OPEN: Capacitor (0805)	0	N/A

DEFAULT JUMPER TABLE	
Jumper	Shunt Position
JU1	Open
JU2	2-3

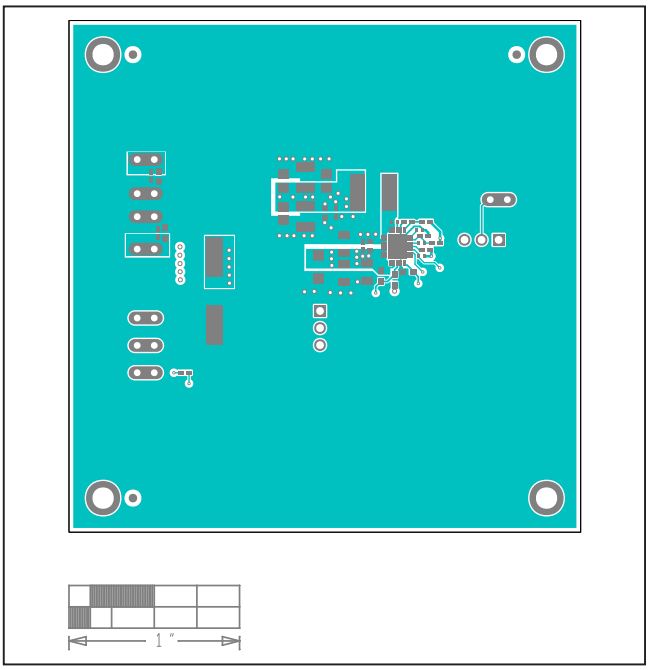
MAX17576EVKITB# Schematic



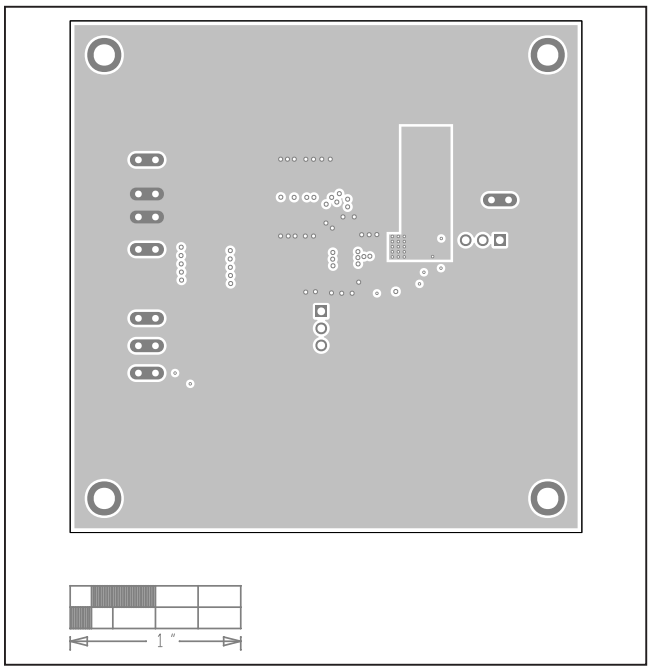
MAX17576EVKITB# PCB Layout



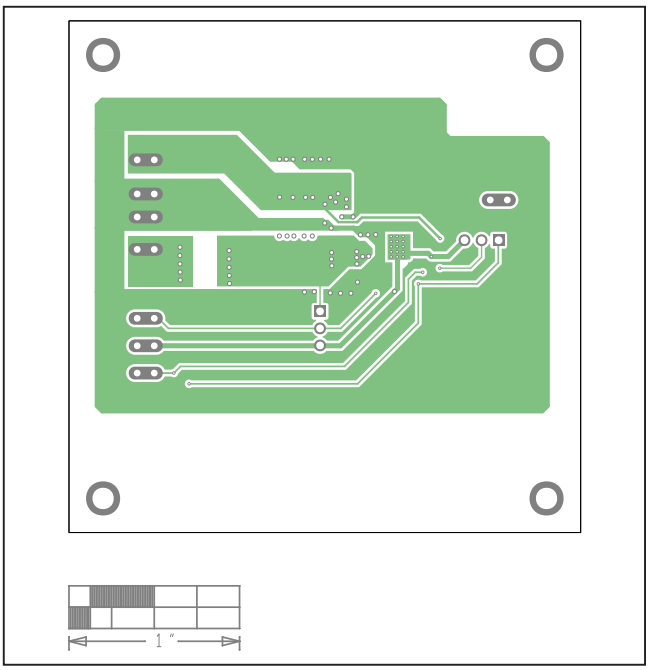
MAX17576 5V EV Kit—Top Silkscreen



MAX17576 5V EV Kit—Top

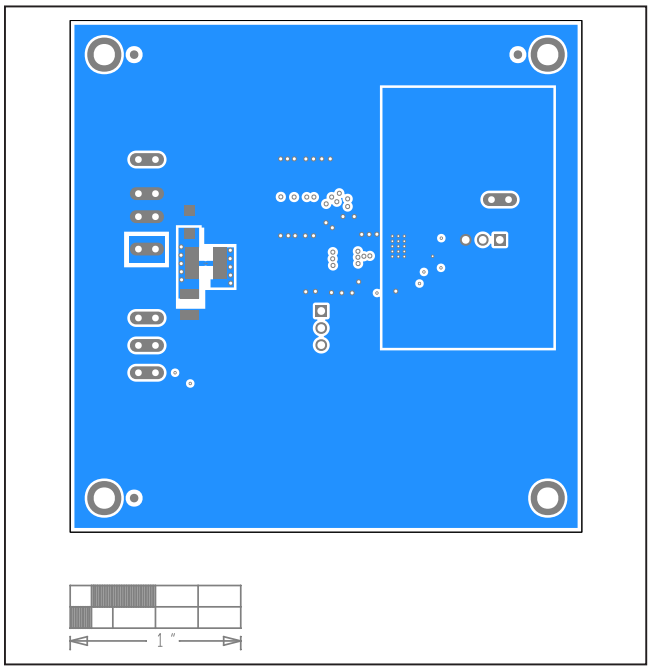


MAX17576 5V EV Kit—Layer 2 GND

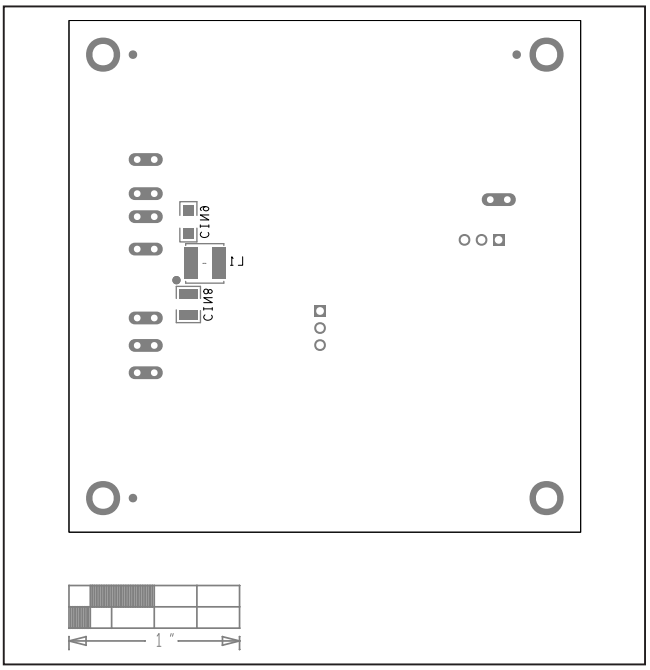


MAX17576 5V EV Kit—Layer 3 GND

MAX17576EVKITB# PCB Layout (continued)



MAX17576 5V EV Kit—Bottom



MAX17576 5V EV Kit—Silk Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	12/18	Initial release	—
1	9/20	Updated the title and the *General Description, Detailed Description, Soft-Start Input (SS), Hot Plug-In and Long Input Cables,* and *Component Suppliers* sections, and Table 1–2, TOC07–TOC09 and TOC15–TOC16; replaced the *Procedure, Regulator Enable/Undervoltage-Lockout Level (EN/UVLO), MODE Selection (MODE/SYNC), External Clock Synchronization (MODE/SYNC), MAX17576EVKITB# Bill of Materials, MAX17576EVKITB# Schematic,* and *MAX17576EVKITB# PCB Layout* sections; added the *Active-Low, Open-Drain Reset Output ($\overline{RESET}$)* section	1–10

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MAX17576EVKITB#