MAX17632C5EVKITE# Evaluation Kit

Evaluates: MAX17632 5V Output-Voltage Application

General Description

The MAX17632C5EVKITE# evaluation kit (EV kit) provides a proven design to evaluate the MAX17632C high-efficiency, synchronous step-down DC-DC converter. The EV kit provides 5V/2A at the output from a 6.5V to 36V input supply. The switching frequency of the EV kit is preset to 400kHz 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 MAX17632 IC data sheet.

Features

- Operates from a 6.5V to 36V Input Supply
- 5V Output Voltage
- Delivers Up to 2A Output Current
- 400kHz Switching Frequency
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold
- Adjustable Soft-Start Time
- Open-Drain $\overline{\text{RESET}}$ Output
- Overcurrent and Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested
- Complies with CISPR-22(EN55022) Class B Conducted and Radiated Emissions

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

Quick Start

Recommended Equipment

- MAX17632C5EVKITE# EV kit
- 6.5V to 36V, 2A DC-input power supply
- Load capable of sinking 2A
- Digital voltmeter (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 between 6.5V and 36V. 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 2A 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 shunts are installed across pins 1-2 on jumper JU1 (see Table 1 for details) and pins 2-3 on jumper JU2 (see Table 2 for details)
5) Turn on the DC power supply.
6) Enable the load.
7) Verify that the DVM displays 5V.

Detailed Description

The EV kit is designed to deliver 5V at load current up to 2A at the output from a 6.5V to 36V input supply. The switching frequency of the EV kit is configured at 400 kHz by leaving RT resistor open.

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 and jumper JU2 allow an external clock to synchronize the device. Jumper JU2 allows the selection of the mode of operation based on light load-performance requirements. An additional $\overline{\text{RESET}}$ 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 the startup. The soft-start time is adjusted by the value of external soft-start capacitor (C3) connected between SS and SGND. The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum value of C3, as shown by the following equation:

$$C3 \geq 28 \times 10^{-6} \times C_{SEL} \times V_{OUT}$$

The soft-start time (t_{SS}) is related to the soft-start capacitor C3 by the following equation:

$$t_{SS} = \frac{C3}{\left(5.55 \times 10^{-6}\right)}$$

For example, in order to program a 1ms soft-start time, C3 should be 5600pF.

Enable/Undervoltage-Lockout (EN/UVLO) Programming

The MAX17632 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 MAX17632 is enabled when the input voltage rises above 6.4V. To disable the MAX17632, 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 and then calculate R2 as follows:

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

where V_{INU} is voltage at which the device is required to turn on, and R1 and R2 are in kΩ.

Mode Selection (MODE/SYNC)

The EV kit provides a jumper (JU2) that allows the MAX17632 to operate in PWM, PFM, and DCM modes. Refer to the MAX17632 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	MAX17632C OUTPUT
1-2*	Connected to VIN	Enabled
Not installed	Connected to the center node of resistor-divider R1 and R2	Enabled, UVLO level is set by the resistor-divider between VIN and SGND
2-3	Connected to SGND	Disabled

**Default position.*

Table 2. MODE Selection Jumper (JU2) Settings

SHUNT POSITION	MODE/SYNC PIN	MAX17632C OUTPUT
1-2	Connected to V_{CC}	DCM mode of operation
2-3*	Connected to SGND	PWM mode of operation
Not installed	OPEN	PFM mode of operation

**Default position.*

External Clock Synchronization (MODE/SYNC)

The EV kit provides a MODE/SYNC PCB pad, to synchronize the MAX17632 to an optional external clock. Leave Jumper (JU2) open when the external clock signals are applied. In the presence of a valid external clock for synchronization, the MAX17632 operates in PWM mode only. For more details about external clock synchronization, refer to the MAX17632 data sheet.

Active-Low, Open-Drain Reset Output (RESET)

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

Hot Plug-In and Long Input Cables

The MAX17632C5EVKITE# PCB layout provides an optional electrolytic capacitor (C6 = 47μF/50V). This capacitor limits the peak voltage at the input of the MAX17632C IC 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 MAX17632C5EVKIT# PCB has designated footprints on the bottom side for placement of 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 EMI filter components. The MAX17632C5EVKIT# 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.

Component Suppliers

SUPPLIER	WEBSITE
Coilcraft	www.coilcraft.com
Murata Americas	www.murata.com
Panasonic	www.panasonic.com
TDK Corp.	www.tdk.com
Taiyo Yuden	www.ty-top.com
SullinsCorp	www.sullinscorp.com

Note: *Indicate that you are using the MAX17632C when contacting these component suppliers.*

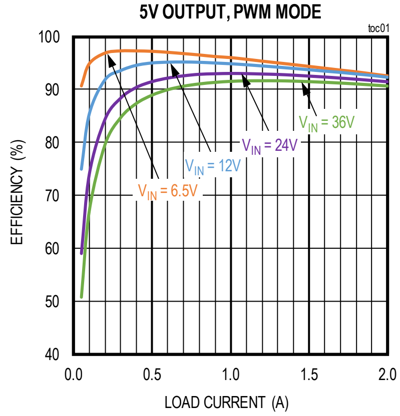
Ordering Information

PART	TYPE
MAX17632C5EVKITE#	EVKIT

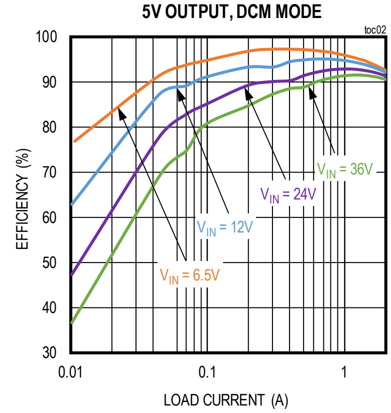
MAX17632C EV Kit Performance Report

(V_{IN} = 24V, L = 10μH (XAL5050-103ME) for PWM/DCM mode, 15μH (XAL6060-153ME) for PFM mode, unless otherwise noted.)

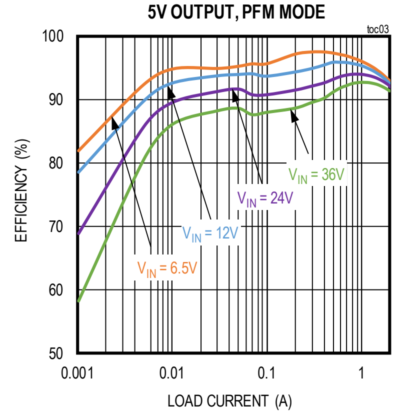
EFFICIENCY vs. LOAD CURRENT
5V OUTPUT, PWM MODE



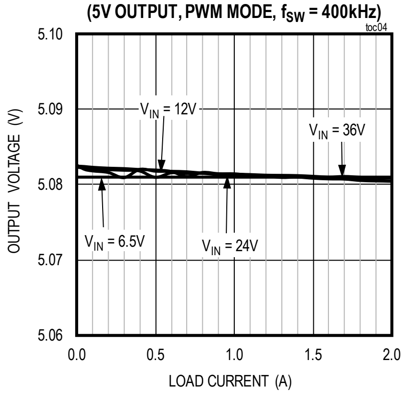
EFFICIENCY vs. LOAD CURRENT
5V OUTPUT, DCM MODE



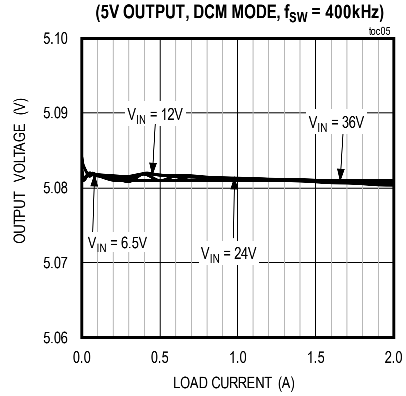
EFFICIENCY vs. LOAD CURRENT
5V OUTPUT, PFM MODE



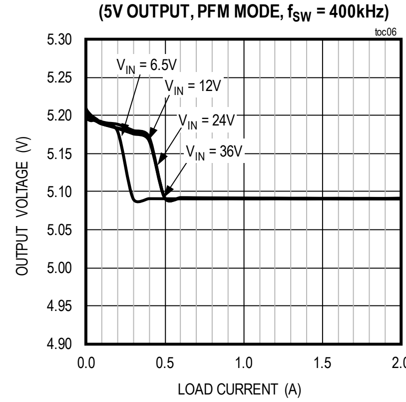
LOAD AND LINE REGULATION
(5V OUTPUT, PWM MODE, f_{SW} = 400kHz)



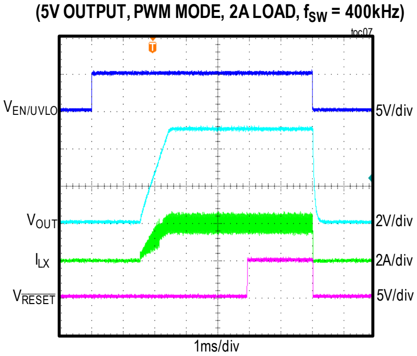
LOAD AND LINE REGULATION
(5V OUTPUT, DCM MODE, f_{SW} = 400kHz)



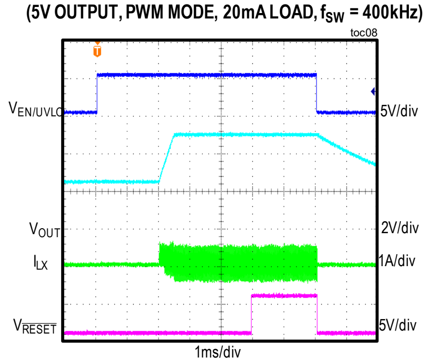
LOAD AND LINE REGULATION
(5V OUTPUT, PFM MODE, f_{SW} = 400kHz)



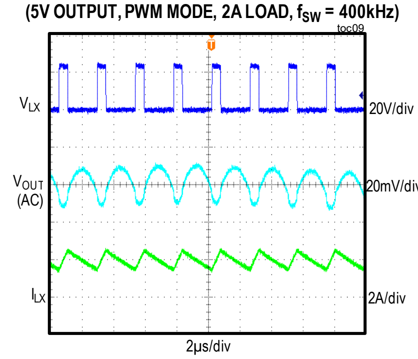
SOFT-START/SHUTDOWN THROUGH EN/UVLO
(5V OUTPUT, PWM MODE, 2A LOAD, f_{SW} = 400kHz)



SOFT-START WITH PREBIAS VOLTAGE OF 2.5V
(5V OUTPUT, PWM MODE, 20mA LOAD, f_{SW} = 400kHz)



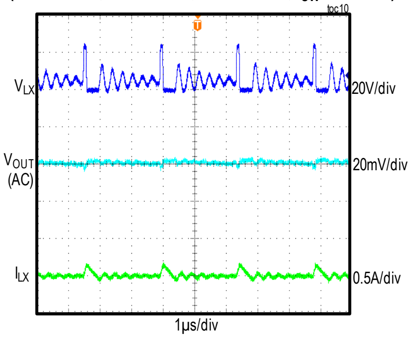
STEADY STATE
(5V OUTPUT, PWM MODE, 2A LOAD, f_{SW} = 400kHz)



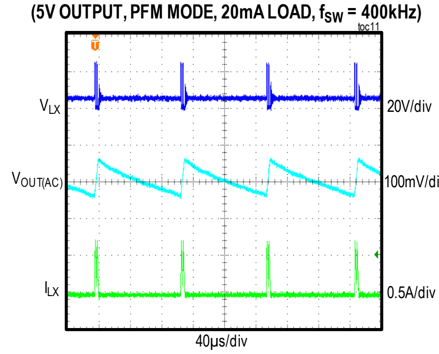
MAX17632C EV Kit Performance Report (continued)

(V_{IN} = 24V, L = 10µH (XAL5050-103ME) for PWM/DCM mode, 15µH (XAL6060-153ME) for PFM mode, unless otherwise noted.)

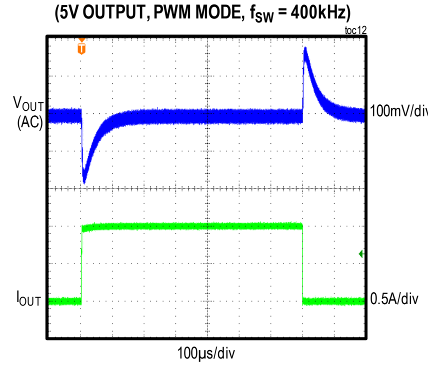
STEADY STATE
(5V OUTPUT, DCM MODE, 20mA LOAD, f_{SW} = 400kHz)



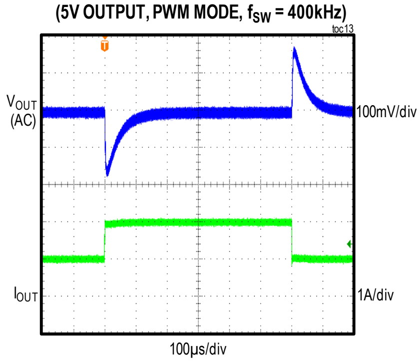
STEADY STATE
(5V OUTPUT, PFM MODE, 20mA LOAD, f_{SW} = 400kHz)



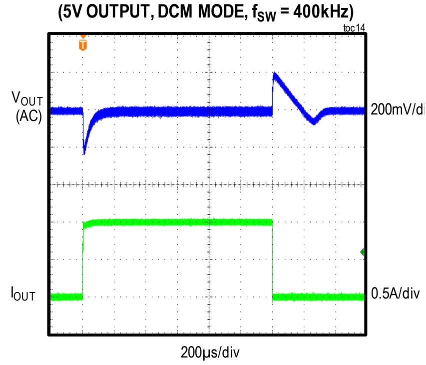
LOAD TRANSIENT BETWEEN 0A AND 1A
(5V OUTPUT, PWM MODE, f_{SW} = 400kHz)



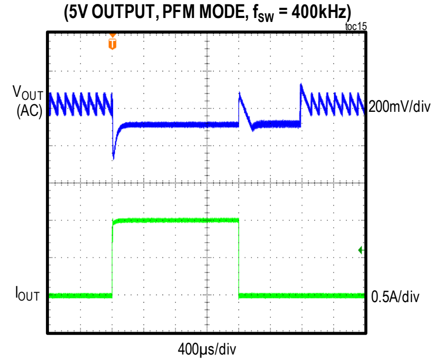
LOAD TRANSIENT BETWEEN 1A AND 2A
(5V OUTPUT, PWM MODE, f_{SW} = 400kHz)



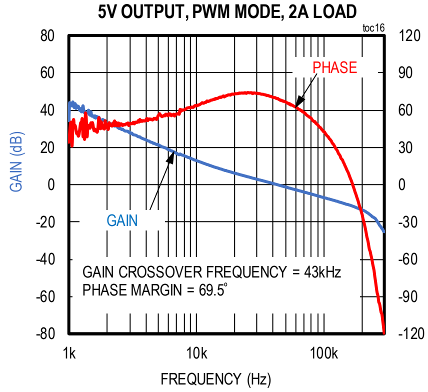
LOAD TRANSIENT BETWEEN 20mA AND 1A
(5V OUTPUT, DCM MODE, f_{SW} = 400kHz)



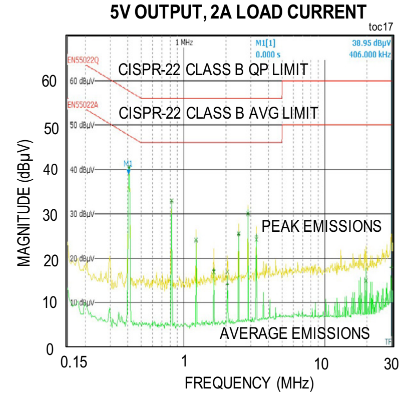
LOAD TRANSIENT BETWEEN 20mA AND 1A
(5V OUTPUT, PFM MODE, f_{SW} = 400kHz)



BODE PLOT
5V OUTPUT, PWM MODE, 2A LOAD

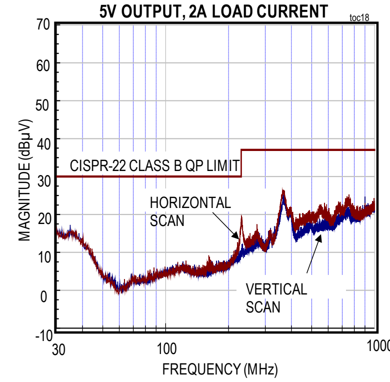


CONDUCTED EMISSIONS PLOT
5V OUTPUT, 2A LOAD CURRENT



L2 = 15µH, C13 = C14 = 4.7µF/50V/X7R/1210

RADIATED EMISSIONS PLOT
5V OUTPUT, 2A LOAD CURRENT



L2 = SHORT, C13 = C14 = OPEN

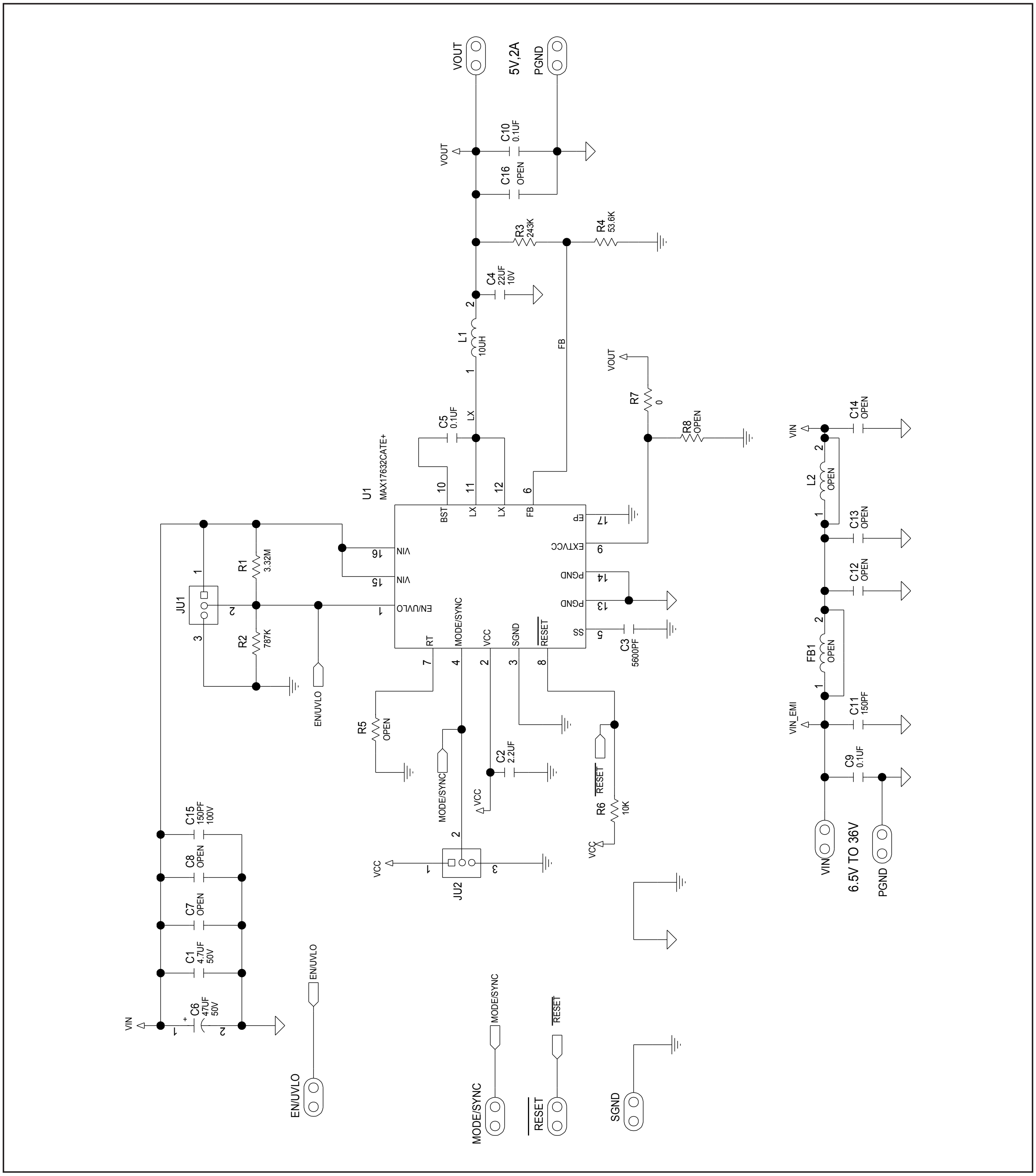
MAX17632C5EVKITE# Kit Bill of Materials

No.	Designator	Description	Quantity	Part Number
1	C1	4.7µF, 10%, 50V, X7R,Ceramic capacitor (1206)	1	MURATA GRM31CR71H475KA12
2	C2	2.2µF, 10%, 10V, X7R, Ceramic capacitor (0603)	1	MURATA GRM188R71A225KE15
3	C3	5600pF, 10%, 25V, X7R, Ceramic capacitor (0402)	1	MURATA GRM155R71E562KA01
4	C4	22µF, 10%, 10V, X7R,Ceramic capacitor (1210)	1	MURATA GRM32ER71A226K
5	C5,C10	0.1µF, 10%, 16V, X7R,Ceramic capacitor (0402)	2	TAIYO YUDEN EMK105B7104KV
6	C6	47uF, 20%, 50V, Electrolytic capacitor	1	PANASONIC EEE-TG1H470UP
7	C11,C15	150pF, 5%, 100V, X7R, Ceramic capacitor(0402)	2	TDK C1005C0G2A151J050BA
8	C9	0.1µF, 10%, 50V, X7R, Ceramic capacitor (0402)	1	TDK C1005X7R1H104K050BE
10	L1	INDUCTOR, 10µH, 4.9A (5mm x 5mm)	1	COILCRAFT XAL5050-103ME
11	R1	RES+, 3.32MΩ, 1% (0402)	1	VISHAY DALE CRCW04023M32FK
12	R2	RES+, 787KΩ, 1% (0402)	1	VISHAY DALE CRCW0402787KFK
13	R3	RES+, 243kΩ, 1% (0402)	1	PANASONIC ERJ-2RKF2433
14	R4	RES+, 53.6kΩ, 1% (0402)	1	VISHAY DALE CRCW040253K6FK
16	R6	RES+, 10kΩ, 1% (0402)	1	VISHAY DALE CRCW040210K0FK
15	R7	RES+, 0Ω (0402)	1	PANASONIC ERJ-2GE0R00
17	U1	HIGH-EFFICIENCY; SYNCHRONOUS STEP-DOWN DC-DC CONVERTER ;(TQFN16-EP 3mm x 3mm)	1	MAXIM MAX17632CATE+
18	JU1, JU2	3-pin header (36-pin header 0.1" centers)	2	SULLINS PEC03SAAN
19	-	Shunts	2	SULLINS STC02SYAN
20	C13, C14	OPTIONAL: 4.7µF, 10%, 50V, X7R, Ceramic capacitor (1210)	2	TAIYO YUDEN UMK325B7475KMHP
21	L2	OPTIONAL: INDUCTOR, 10µH, 4.9A (4mm x 4mm)	1	COILCRAFT XAL4040-153ME
22	C7, C8, C12, C16	OPEN: Capacitor (0402)	0	N/A
23	R5, R8	OPEN: RESISTOR (0402)	0	N/A
24	FB1	OPEN: Ferrite Bead (0805)	0	N/A

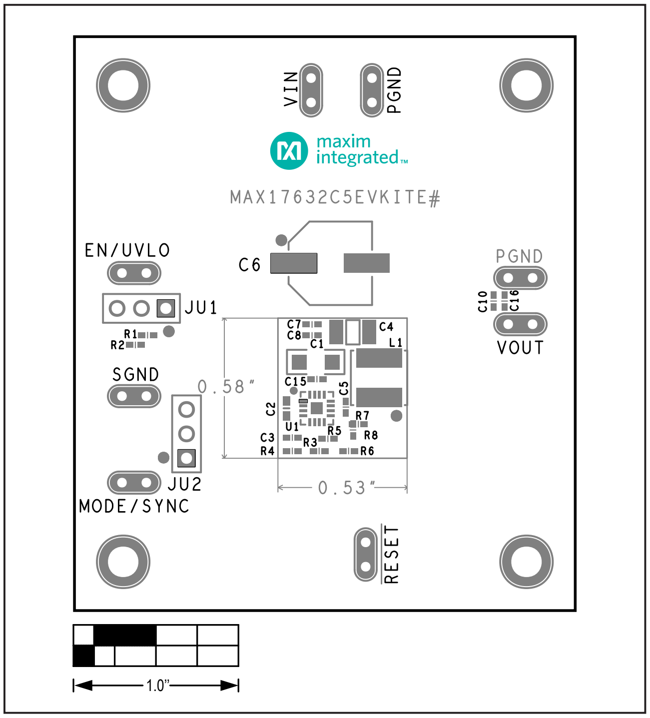
DEFAULT JUMPER TABLE	
JUMPER	**SHUNT POSITION**
JU1	1- 2 SHORT
JU2	2- 3 SHORT

JUMPER TABLE	
JUMPER	**SHUNT POSITION**
JU1	1, 2 short
JU2	2, 3 short

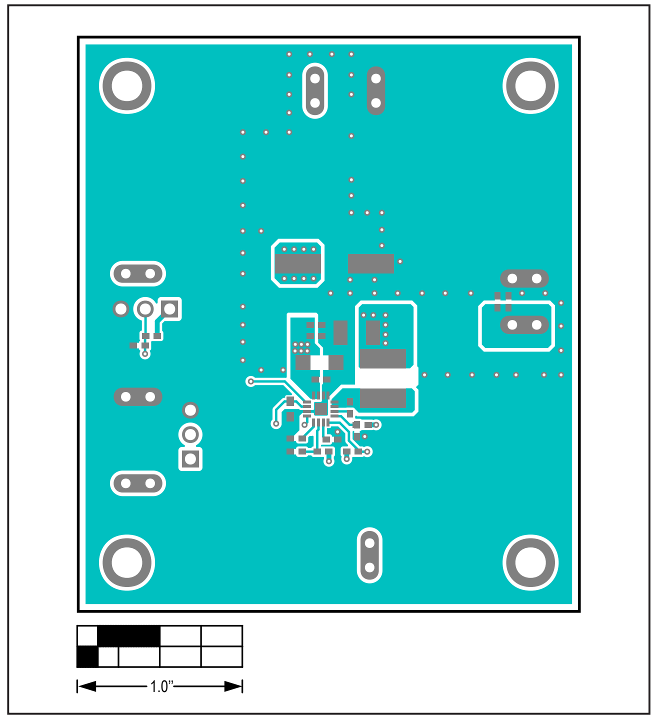
MAX17632C5EVKITE# Kit Schematic



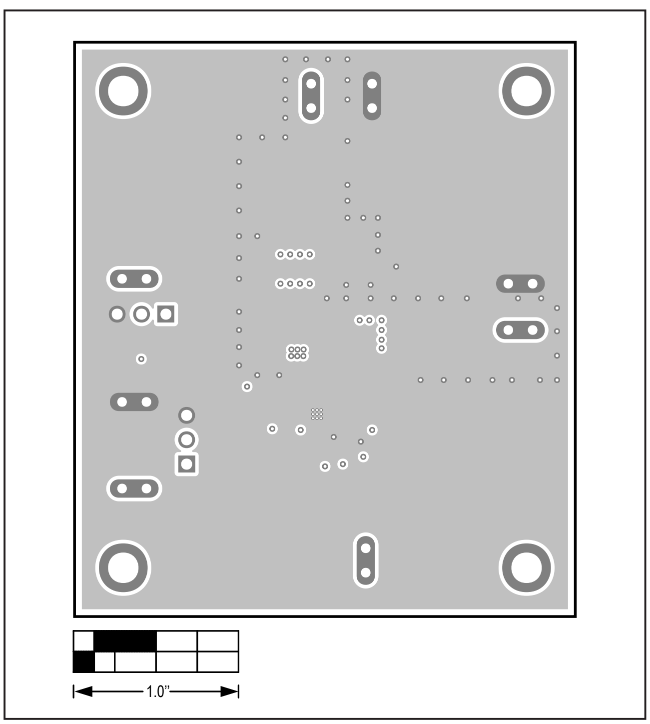
MAX17632C5EVKITE# Kit PCB Layout



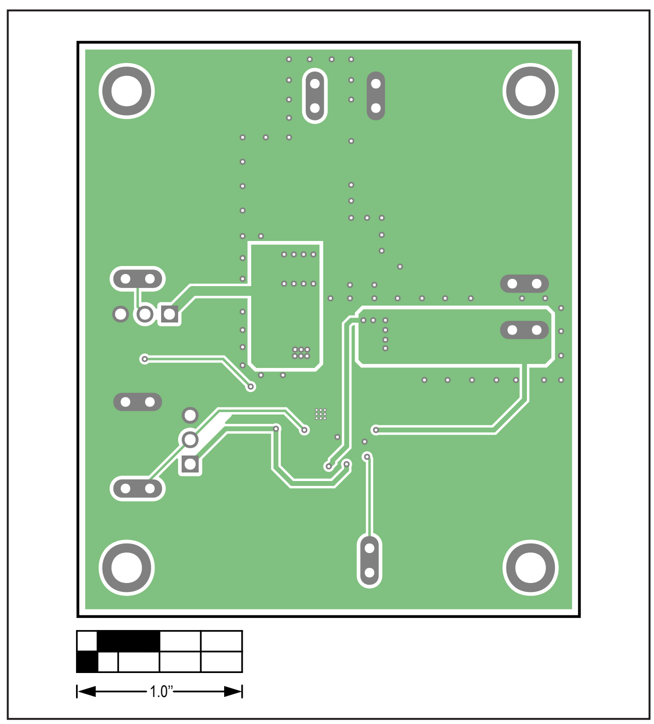
MAX17632C 5V EV Kit—Top Silkscreen



MAX17632C 5V EV Kit—Top Layer

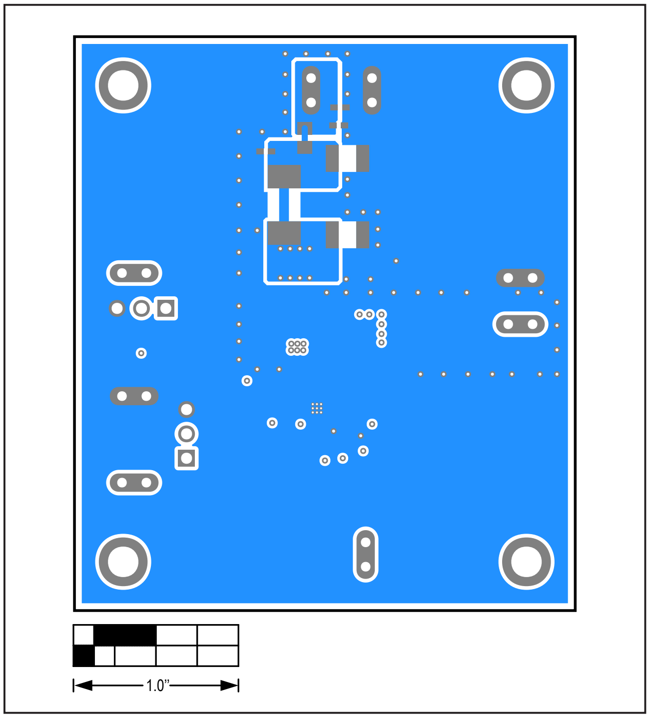


MAX17632C 5V EV Kit—Layer 2_GND

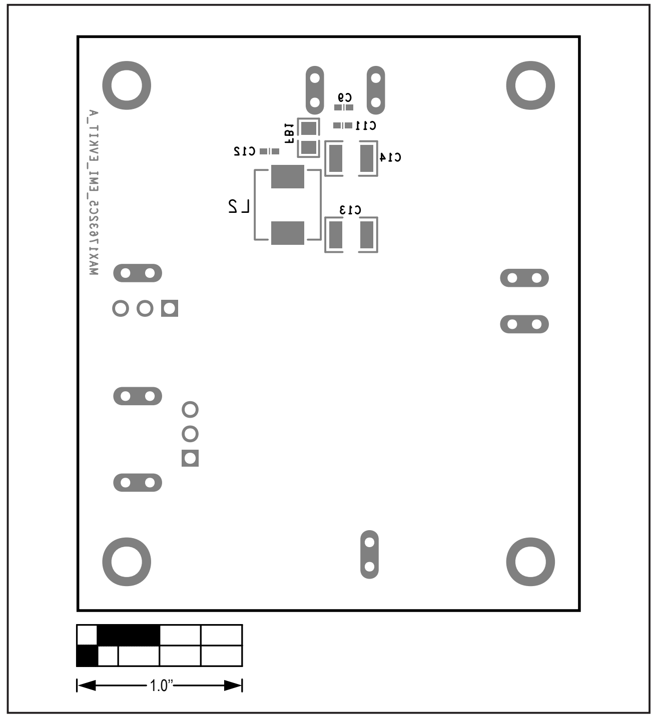


MAX17632C 5V EV Kit—Layer 3_GND

MAX17632C5EVKITE# Kit PCB Layout (continued)



MAX17632C 5V EV Kit—Bottom Layer



MAX17632C 5V EV Kit—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/19	Initial release	—

