MAX17673AEVKIT# Evaluation Kit

Evaluates: MAX17673A 5V, 3.3V, 1.8V Output Applications

General Description

The MAX17673AEVKIT# evaluation kit (EV kit) provides a proven design to evaluate the MAX17673A 60V, 1.5A high efficiency, synchronous buck converter with integrated, dual 5.5V, 1A buck converters. The EV kit is preset for 5V output at a load current of up to 1.5A from the high-voltage (HV) buck converter, and 3.3V and 1.8V outputs at load currents up to 1A each from the low-voltage (LV) buck converters. The HV buck converter is programmed to operate at 400kHz, and the LV buck converters are programmed to operate at 2MHz, for optimum efficiency and component sizes. The output of the HV buck converter is connected to the input of the LV buck converters. The EV kit features adjustable input undervoltage lockout and soft-start for the HV buck converter, and power-OK (POK_) signals for all three buck converters. The MAX17673/MAX17673A IC data sheet provides a complete description of the part that should be read in conjunction with this data sheet prior to operating the EV kit.

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

Features

- Three Synchronous DC-DC Buck Converter Outputs from a Single HV Input
- Wide 7V to 60V Input Range for HV Buck Converter
- Optional External Supply Input Connections for LV Buck Converters (4.5V to 5.5V for LVA, and 2.7V to 5.5V for LVB)
- Programmed 5V/1.5A Output for HV Buck Converter and 3.3V/1A and 1.8V/1A Output for LV Buck Converters
- 400kHz Switching Frequency for HV Buck Converter and 2MHz Switching Frequency for LV Buck Converters
- High 93% Efficiency (V_{INH} = 12V, V_{OUT} = 5V at 0.45A) for HV Buck Converter; 94% Efficiency (V_{IN} = 5V, V_{OUT} = 3.3V at 0.5A) for LV Buck Converters
- Enable/UVLO Input, Resistor-Programmable UVLO Threshold for HV Buck Converter
- Programmed 1ms Soft-Start Time for HV Buck Converter, and Internal 4096 Clock Cycles Soft-Start Time for LV Buck Converters
- Selectable PWM and PFM Modes of Operation
- External Clock Synchronization
- Independent Power-OK (POK_) Outputs for the Three Buck Converters
- Overcurrent and Overtemperature Protection
- Low-Profile, Surface-Mount Components
- Proven PCB Layout
- Fully Assembled and Tested
- Complies with CISPR 22 (EN 55022) Class B Conducted and Radiated Emissions Limits

EV kit specifications, settings, benefits and features are highlighted. For full MAX17673A features, benefits and parameters, refer to the MAX17673/MAX17673A data sheet.

Quick Start

Required Equipment

- One MAX17673AEVKIT# EV kit
- One 0V to 60V DC, 3A power supply
- One load resistor capable of sinking up to 0.3A at 5V
- Two load resistors capable of sinking up to 1A at 3.3V and 1.8V, respectively
- Digital multimeters (DMM)

Equipment Setup and 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 input power supply at a voltage between 7V and 60V. Disable the power supply.
2) Connect the positive terminal of the power supply to the VIN pad, and the negative terminal to the nearest PGND pad on the EV kit. The output of the HV buck converter (OUT) is connected to the LV buck input using jumpers JU2 and JU3 (see Table 1 for details).
3) Connect a 1A resistive load across OUTA (3.3V) and its nearest PGND pad.
4) Connect a 1A resistive load across OUTB (1.8V) and its nearest PGND pad.
5) Connect a 0.3A resistive load across OUT (5V) and its nearest PGND pad.
6) Select the shunt position on jumper JU1 according to the intended mode of operation (see Table 2 for details).
7) Connect digital multimeters (in voltage measurement mode) across the OUT, OUTA, OUTB pads and their nearby PGND pads.
8) Turn on the input power supply.
9) Verify that the DMMs display 5V across the OUT terminal, 3.3V across the OUTA terminal, and 1.8V across the OUTB terminal with respect to PGND.

Detailed Description

The MAX17673A EV kit is designed to demonstrate the salient features of the MAX17673A 60V, 1.5A high-efficiency, synchronous buck converter with integrated, dual 5.5V, 1A buck converters. The EV kit includes jumper JU1 to operate the MAX17673A in PWM mode or PFM mode, based on light-load performance requirements. Jumpers JU2 and JU3 connect the LV buck converter inputs to either the HV buck converter output (OUT), or to external INA and INB inputs. POKH, POKA, or POKB pads are available for monitoring the status of output voltages.

On the bottom layer of the EV kit, additional footprints for optional components are included to ease board modification for different input and output configurations. Placeholders are also available on the bottom layer for placement of EMI filter components.

Setting Switching Frequency

Selection of the switching frequency must consider the input voltage range, desired output voltages, $t_{ON(MIN)}$ of the three buck converters in the MAX17673A, and ambient temperature. To optimize efficiency and component size, a 400kHz switching frequency is chosen for the 5V HV buck converter, and 2MHz switching frequency is chosen for the 3.3V and 1.8V LV buck converters. Resistor R5 connected between the RT and SGND plane programs the desired switching frequency of LV buck converters. The HV buck converter switching frequency is derived as a fraction of the LV buck converters switching frequency by placing resistor R10 between the FDIV and SGND pins. Use the Switching Frequency Selection section of the MAX17673/MAX17673A data sheet to choose different values of R5 and R10. In the EV kit, R5 is left open, and R10 is set to 0Ω.

Soft-Start Programming

The EV kit offers an adjustable soft-start function on the MAX17673A HV buck converter to limit inrush current during startup. The soft-start time is adjusted by changing the value of C13, the external capacitor from the SSH pin to SGND. The selected output capacitance (C_{SEL}) and the HV buck converter output voltage (V_{OUT}) determine the minimum value of C13, as shown by the following equation:

$$C13 \geq 56 \times 10\text{-}6 \times C_{SEL} \times V_{OUT}$$

Where C_{SEL} is the sum output capacitance, in μF, connected at the output of the HV buck converter (includes C21, C23, C25, C27, C4, C5, C6, and C7 on the EV kit), and V_{OUT} is the output voltage in volts.

The soft-start time (t_{SS}) is related to the soft-start capacitor C13 by the following equation:

$$t_{SS} = C13 / (5.55 \times 10^{-6})$$

For example, in order to program a 1ms soft-start time, C13 should be 5600pF.

Enable/Undervoltage Lockout (ENH) Programming

The MAX17673A EV kit includes a resistive voltage-divider, formed by R18 and R19, connected from VIN to SGND to turn on the device when the input voltage is more than

7V. Adjusting R19 creates different input voltage turn-on threshold levels. For the HV buck enable description, see the Table 3 JU4 settings.

Choose R18 to be 3.3MΩ and then calculate R19 as follows:

$$R19 \geq \frac{3.3 \times 1.2}{(V_{INU} - 1.2)}$$

where R19 is in MΩ.

For MAX17673A to turn on at 7.0V input, R19 is calculated to be 715kΩ.

The MAX17673A EV kit offers jumpers JU5 and JU6 to individually enable/disable the LV bucks. See Table 4 for settings.

Mode Selection and External Clock Synchronization

The MAX17673A EV kit offers jumper JU1 to program the device to operate in PWM and PFM modes. Connecting the MODE/SYNC pin to the SGND plane operates the part in PWM operation. Connecting the MODE/SYNC pin to V_{CC}, or leaving the MODE/SYNC pin open, enables the part to operate in PFM mode. The chosen operating mode applies to all the three regulators. Table 2 shows the EV kit jumper (JU1) settings that can be used to configure the desired mode of operation.

The MAX17673A offers external clock synchronization. The internal oscillator of the device can be synchronized to an external clock signal applied on the MODE/SYNC pin. The external synchronization frequency must be between 0.9 x f_{SW_LV} and 1.1 x f_{SW_LV}, where f_{SW_LV} is the LV buck converter frequency programmed by the RT resistor. The MAX17673A operates in PWM mode when synchronized to an external clock.

Adjusting Output Voltage

The MAX17673A EV kit offers independent control of output voltages, by allowing individual sense and feedback inputs. Adjusting the output voltages in the three buck converters requires redesign and appropriate selection of input capacitors, output capacitors, and feedback resistive dividers. Refer to the MAX17673/MAX17673A data sheet for more details regarding selection of input and output capacitors, and programming the output voltage.

EXTVCC Linear Regulator

Powering the MAX17673A from OUT through EXTVCC increases the efficiency at higher input voltages. The MAX17673A EV kit includes resistor R17 to connect EXTVCC to OUT, by default. To disable this feature, uninstall resistor R17, and install a 0Ω resistor at R15.

Hot Plug-In and Long Input Cables

The MAX17673A EV kit PCB provides an optional electrolytic capacitor (C1, 10µF/100V). This capacitor limits the peak voltage at the input of the MAX17673A 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 input cable inductance, and input ceramic capacitors.

Table 1. Input Selection for LV Buck Converters (JU2 and JU3)

POSITION	INA/INB PIN
2-3*	Connected to HV buck output
1-2	Connected to INA/INB terminals

**Default position.*

Table 2. Mode of Operation (JU1)

POSITION	MODE PIN
1-2*	PWM mode of operation
Not Installed	PFM mode of operation

**Default position.*

Table 3. HV Buck Enable (ENH) Description (JU4)

POSITION	ENH PIN	MAX17673A HV BUCK OUTPUT
1-2	Connected to VIN	Enabled
Not Installed*	Connected to the center node of resistor-dividers R18 and R19	Enabled, UVLO level set through the R18 and R19 resistors
2-3	Connected to SGND	Disabled

**Default position.*

Table 4. LV Buck Enable (ENA/ENB) Description (JU5/JU6)

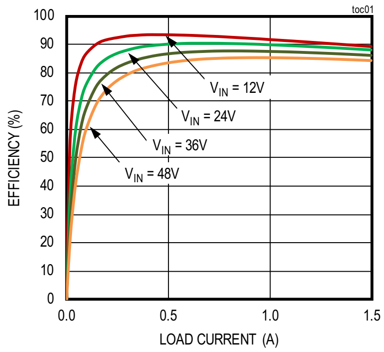
POSITION	ENA/ENB PIN	MAX17673A LV BUCK OUTPUT
1-2*	Connected to INA/INB	Enabled
2-3	Connected to SGND	Disabled

**Default position.*

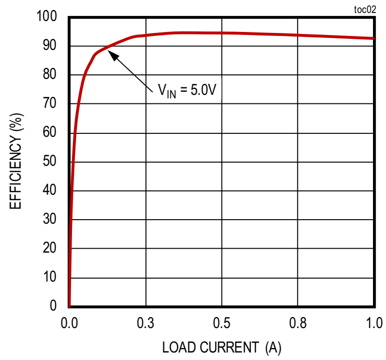
EV Kit Performance Report

(V_{INH} = 24V, V_{INA} = V_{INB} = 5V, f_{SW_LV} = 2MHz, f_{SW_HV} = 400kHz, T_A = 25°C, unless otherwise noted.)

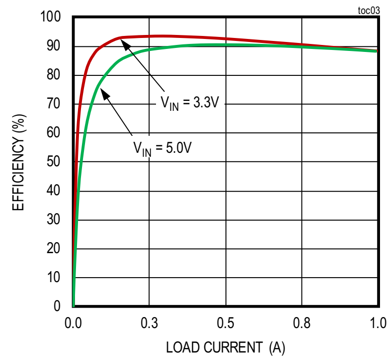
HV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 5.0V, MODE = PWM, f_{SW} = 400kHz)



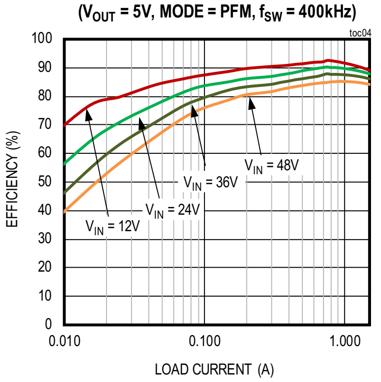
LV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 3.3V, MODE = PWM, f_{SW} = 2MHz)



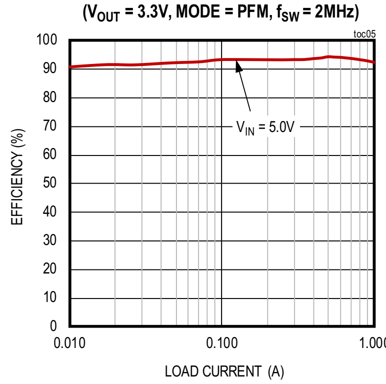
LV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 1.8V, MODE = PWM, f_{SW} = 2MHz)



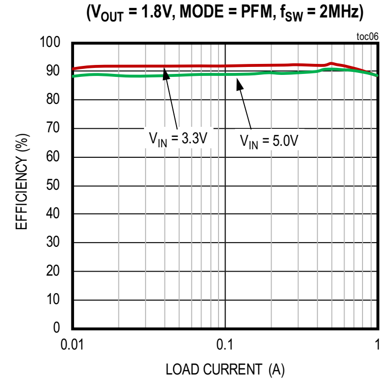
HV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 5V, MODE = PFM, f_{SW} = 400kHz)



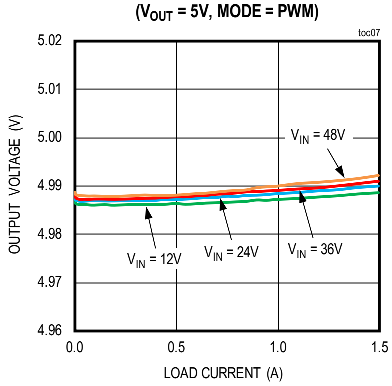
LV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 3.3V, MODE = PFM, f_{SW} = 2MHz)



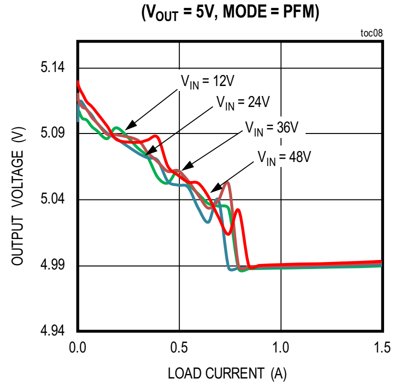
LV BUCK EFFICIENCY vs. LOAD CURRENT (V_{OUT} = 1.8V, MODE = PFM, f_{SW} = 2MHz)



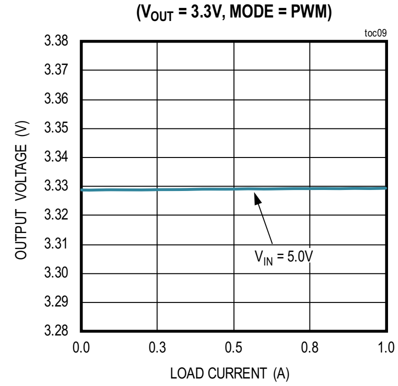
HV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 5V, MODE = PWM)



HV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 5V, MODE = PFM)



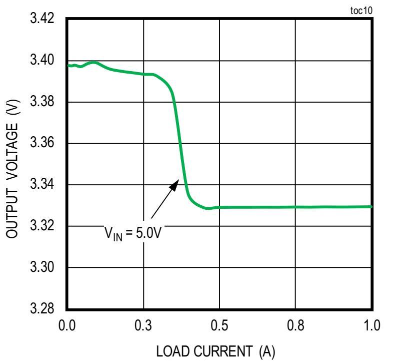
LV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 3.3V, MODE = PWM)



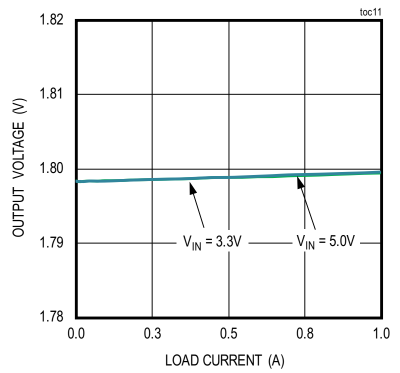
EV Kit Performance Report (continued)

(V_{INH} = 24V, V_{INA} = V_{INB} = 5V, f_{SW_LV} = 2MHz, f_{SW_HV} = 400kHz, T_A = 25°C, unless otherwise noted.)

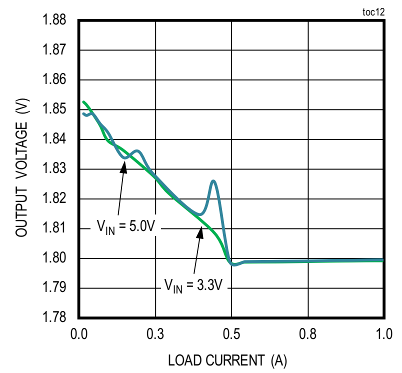
LV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 3.3V, MODE = PFM)



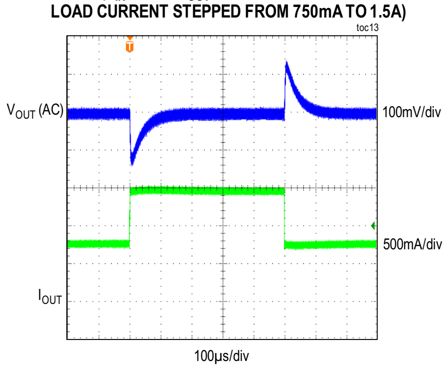
LV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 1.8V, MODE = PWM)



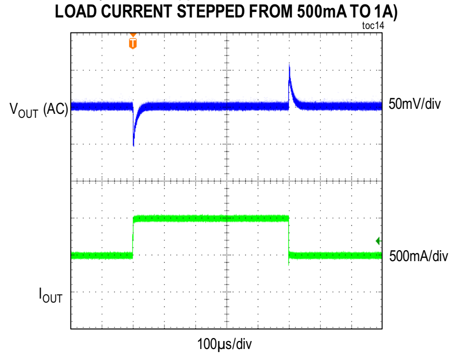
LV BUCK OUTPUT VOLTAGE vs. LOAD CURRENT (V_{OUT} = 1.8V, MODE = PFM)



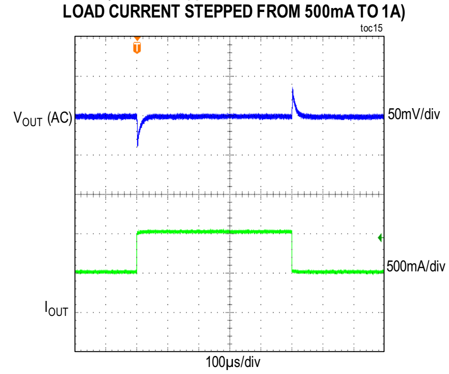
HV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 24V, V_{OUT} = 5V, MODE = PWM, LOAD CURRENT STEPPED FROM 750mA TO 1.5A)



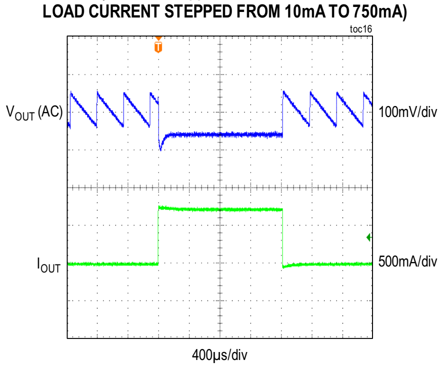
LV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PWM, LOAD CURRENT STEPPED FROM 500mA TO 1A)



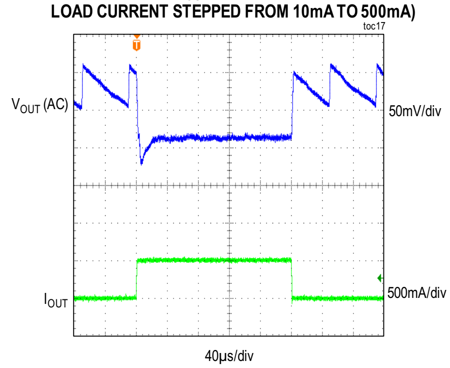
LV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PWM, LOAD CURRENT STEPPED FROM 500mA TO 1A)



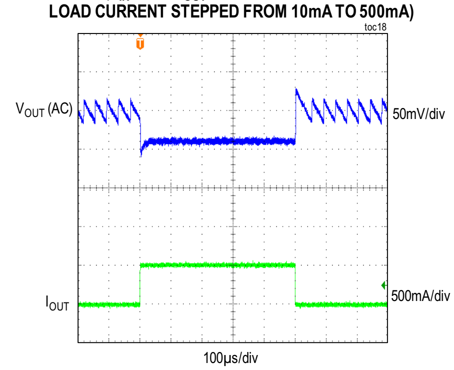
HV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 24V, V_{OUT} = 5V, MODE = PFM, LOAD CURRENT STEPPED FROM 10mA TO 750mA)



LV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PFM, LOAD CURRENT STEPPED FROM 10mA TO 500mA)



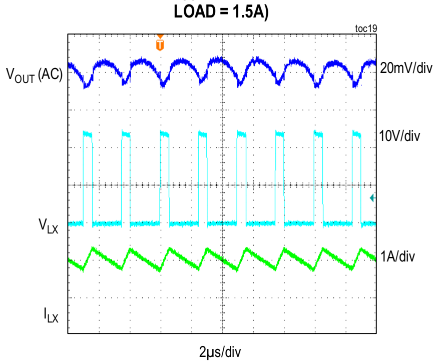
LV BUCK LOAD-TRANSIENT RESPONSE (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PFM, LOAD CURRENT STEPPED FROM 10mA TO 500mA)



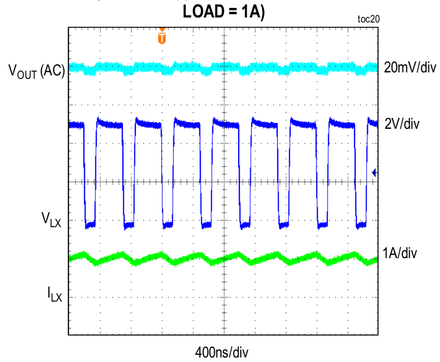
EV Kit Performance Report (continued)

(V_{INH} = 24V, V_{INA} = V_{INB} = 5V, f_{SW_LV} = 2MHz, f_{SW_HV} = 400kHz, T_A = 25°C, unless otherwise noted.)

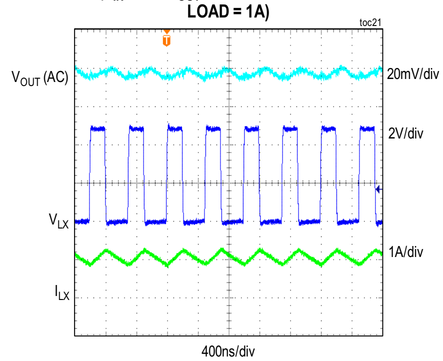
HV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 24V, V_{OUT} = 5V, MODE = PWM, LOAD = 1.5A)



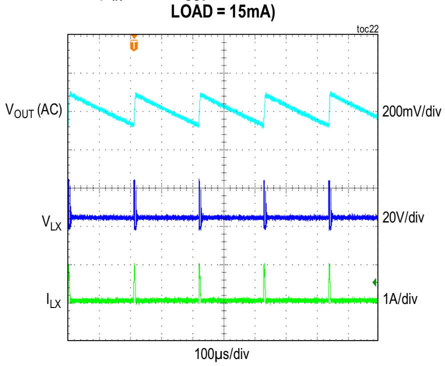
LV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PWM, LOAD = 1A)



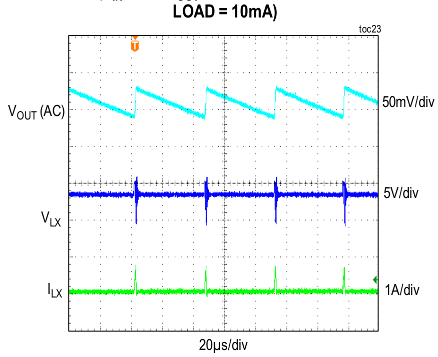
LV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PWM, LOAD = 1A)



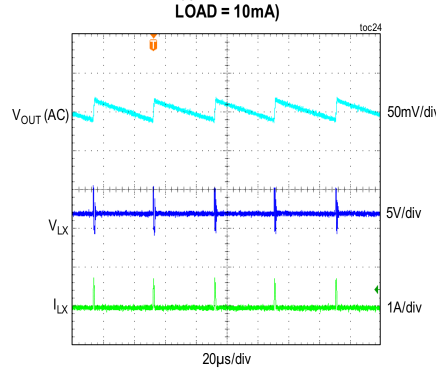
HV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 24V, V_{OUT} = 5V, MODE = PFM, LOAD = 15mA)



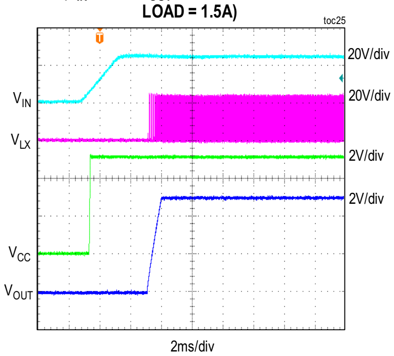
LV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PFM, LOAD = 10mA)



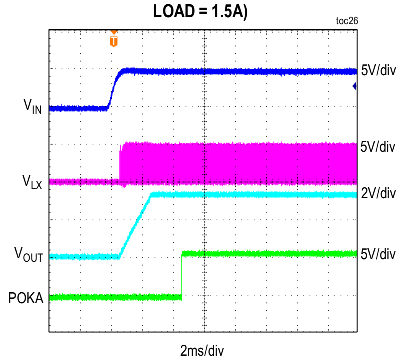
LV BUCK STEADY-STATE SWITCHING WAVEFORMS (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PFM, LOAD = 10mA)



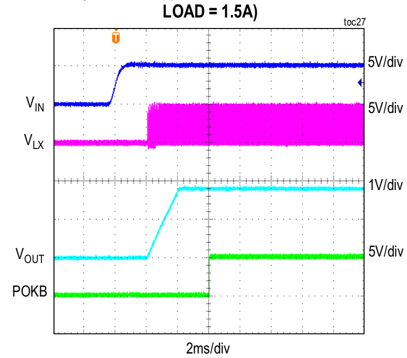
HV BUCK STARTUP FROM INPUT (V_{IN} = 24V, V_{OUT} = 5V, MODE = PWM, LOAD = 1.5A)



LV BUCK STARTUP FROM INPUT (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PWM, LOAD = 1.5A)



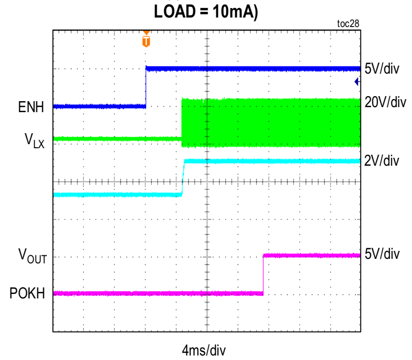
LV BUCK STARTUP FROM INPUT (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PWM, LOAD = 1.5A)



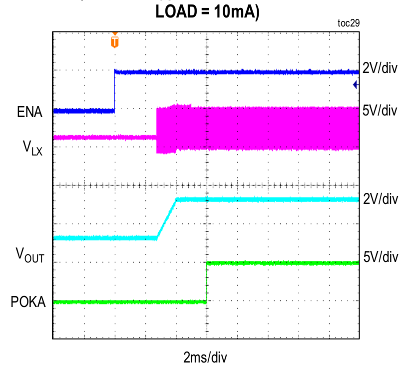
EV Kit Performance Report (continued)

(V_{INH} = 24V, V_{INA} = V_{INB} = 5V, f_{SW_LV} = 2MHz, f_{SW_HV} = 400kHz, T_A = 25°C, unless otherwise noted.)

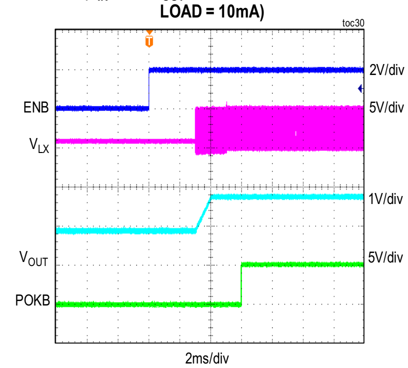
HV STARTUP THROUGH ENABLE, 3.3V PREBIAS (V_{IN} = 24V, V_{OUT} = 5V, MODE = PWM, LOAD = 10mA)



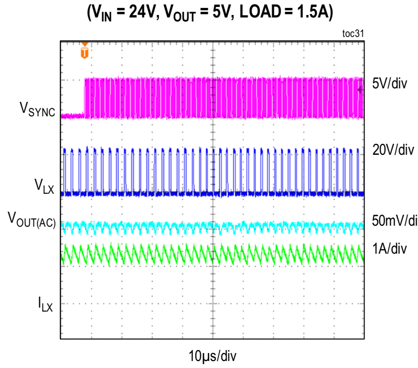
LV STARTUP THROUGH ENABLE, 1.5V PREBIAS (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PWM, LOAD = 10mA)



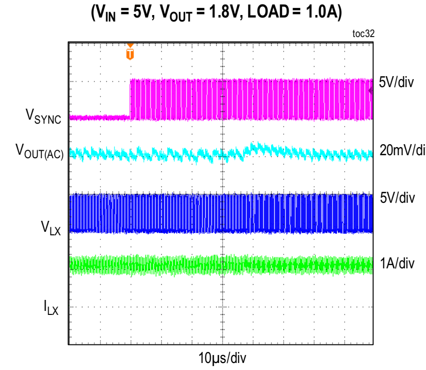
LV STARTUP THROUGH ENABLE, 0.9V PREBIAS (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PWM, LOAD = 10mA)



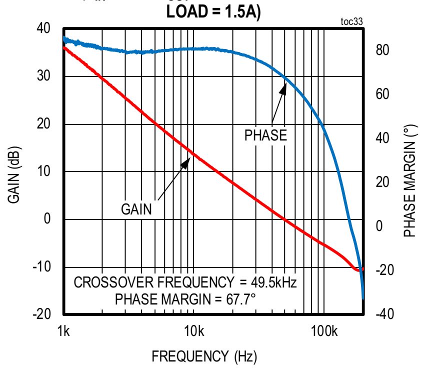
EXTERNAL CLOCK SYNCHRONIZATION (V_{IN} = 24V, V_{OUT} = 5V, LOAD = 1.5A)



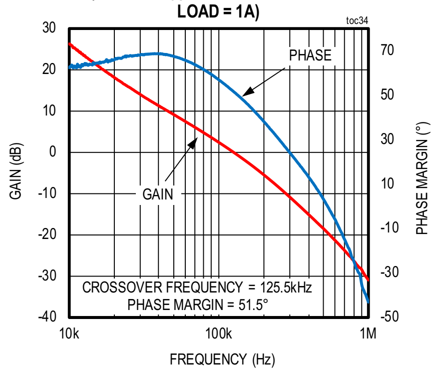
EXTERNAL CLOCK SYNCHRONIZATION (V_{IN} = 5V, V_{OUT} = 1.8V, LOAD = 1.0A)



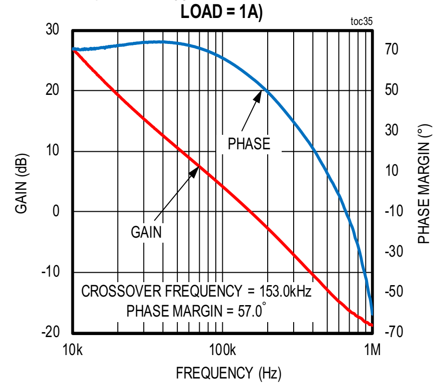
HV BUCK BODE PLOT (V_{IN} = 24V, V_{OUT} = 5.0V, MODE = PWM, LOAD = 1.5A)



LV BUCK BODE PLOT (V_{IN} = 5V, V_{OUT} = 3.3V, MODE = PWM, LOAD = 1A)



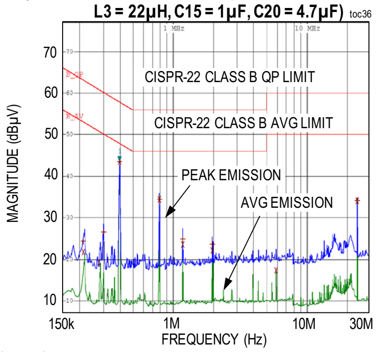
LV BUCK BODE PLOT (V_{IN} = 5V, V_{OUT} = 1.8V, MODE = PWM, LOAD = 1A)



EV Kit Performance Report (continued)

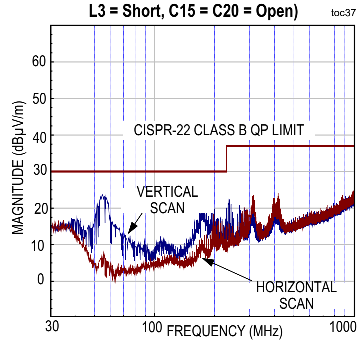
(V_{INH} = 24V, V_{INA} = V_{INB} = 5V, f_{SW_LV} = 2MHz, f_{SW_HV} = 400kHz, T_A = 25°C, unless otherwise noted.)

CONDUCTED EMISSION PLOT (WITH FILTER: C12,C19 = 220pF, C27,C28,C29 = 150pF, L3 = 22µH, C15 = 1µF, C20 = 4.7µF) toc36



CONDITION: V_{IN} = 24V, V_{OH} = V_{INA} = V_{INB} = 5V, I_{OH} = 0.37A, I_{OA} = I_{OB} = 1A FROM MAX17673AEVKIT#

RADIATED EMISSION PLOT (C12, C19 = 220pF, C27, C28, C29 = 150pF, L3 = Short, C15 = C20 = Open) toc37



CONDITIONS: V_{IN} = 24V, V_{OH} = V_{INA} = V_{INB} = 5V, I_{OH} = 0.37A, I_{OA} = I_{OB} = 1A FROM MAX17673AEVKIT#

Component Suppliers

SUPPLIER	WEBSITE
Murata Americas	www.murata.com
Coilcraft	www.coilcraft.com
Vishay	www.vishay.com
TDK Corp.	www.component.tdk.com

Note: *Indicate that you are using the MAX17673/MAX17673A when contacting these component suppliers.*

Ordering Information

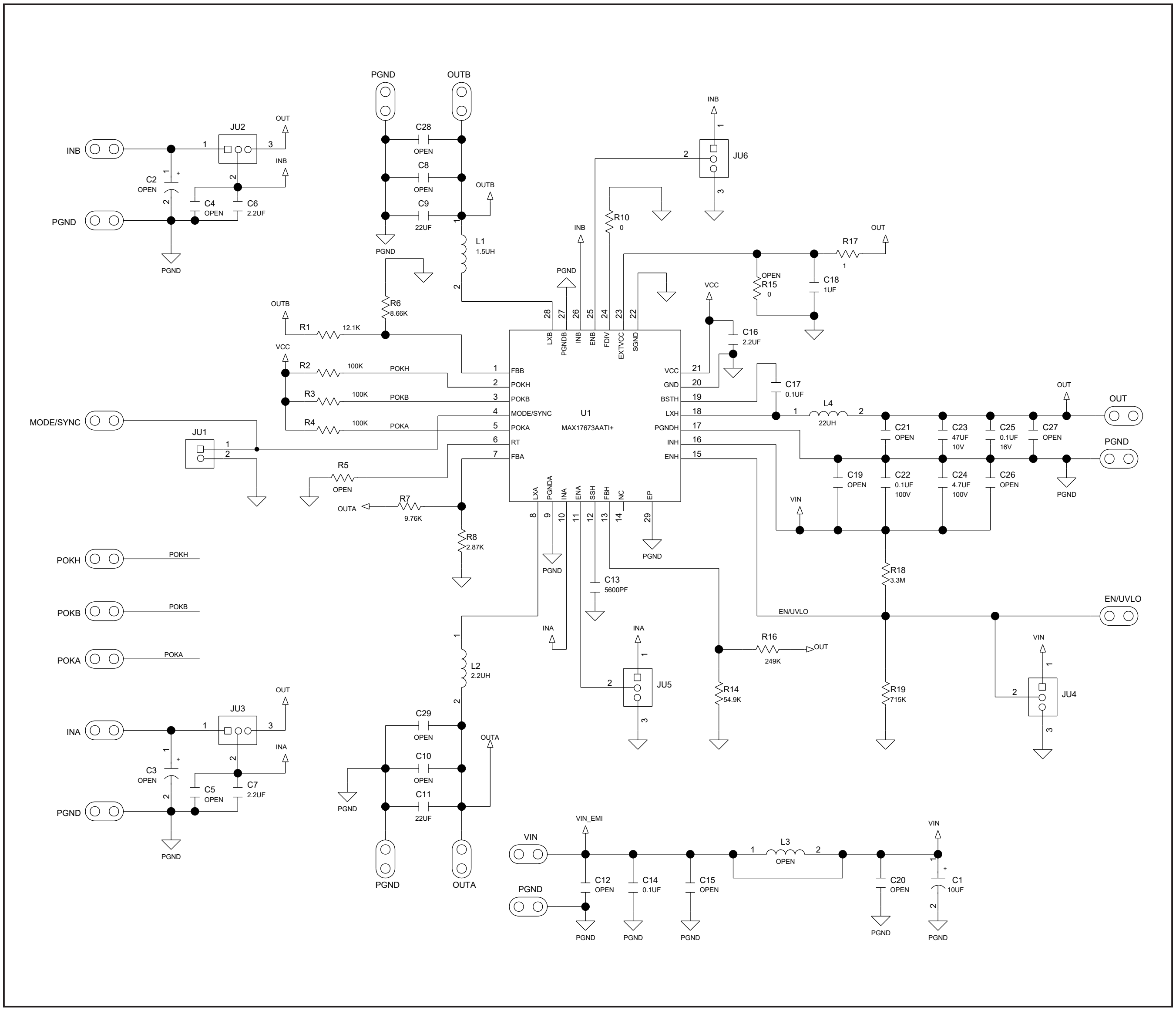
PART	TYPE
MAX17673AEVKIT#	EV Kit

#Denotes RoHS compliant.

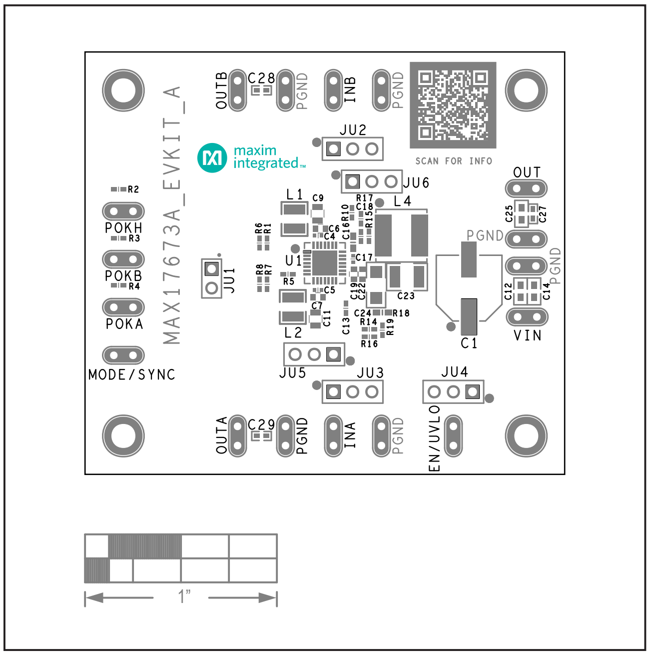
MAX17673A EV Kit Bill of Materials

ITEM	QTY	REF DES	DESCRIPTION	MANUFACTURER PART NUMBER -1	MANUFACTURER PART NUMBER -2
1	1	C1	10µF±20%,100V, Aluminum Capacitor	EEE-TG2A100P	
2	3	C6, C7, C16	2.2uF±10%, 10V, X7R Ceramic Capacitor (0603)	MURATA GRM188R71A225KE15;	TDK C1608X7R1A225K080AC
3	2	C9, C11	22uF±20%, 6.3V, X7R Ceramic Capacitor (0805)	MURATA GRM21BZ70J226ME44	
4	1	C13	5600pF±10%, 25V, X7R Ceramic Capacitor (0402)	MURATA GRM155R71E562KA01	VENKEL LTD C0402X7R250-562KNE
5	2	C14, C22	0.1uF±10%, 100V, X7R Ceramic Capacitor (0603)	MURATA GCJ188R72A104KA01	YAGEO CC0603KRX7R0BB104
6	1	C17	0.1uF±10%, 16V, X7R Ceramic Capacitor (0402)	TDK C1005X7R1C104K050BC	AVX 0402YC104KAT2A
7	1	C18	1uF±10%, 6.3V, X7R Ceramic Capacitor (0402)	MURATA GRM155R70J105KA12	SAMSUNG ELECTRONICS CL05B105KQ5NQNC
8	1	C23	47uF±10%, 10V, X7R Ceramic Capacitor (1210)	MURATA GRM32ER71A476KE15	
9	1	C24	4.7uF±10%, 100V, X7R Ceramic Capacitor (1206)	MURATA GRM31CZ72A475KE11	
11	1	L1	1.5uH±20%, SMD Inductor, 2.43A	VISHAY DALE IHHP1008ABER1R5M01	
12	1	L2	2.2uH±20%, SMD Inductor, 2.0A	VISHAY DALE IHHP1008ABER2R2M01	
13	1	L4	22uH±20%, SMD Inductor, 5.0A	COILCRAFT XAL6060-223ME	
14	1	R1	12.1kΩ ±1%, Resistor (0402)	Generic	
15	3	R2-R4	100kΩ ±1%, Resistor (0402)	Generic	
16	1	R6	8.66kΩ ±1%, Resistor (0402)	Generic	
17	1	R7	9.76kΩ ±1%, Resistor (0402)	Generic	
18	1	R8	2.87kΩ ±1%, Resistor (0402)	Generic	
19	3	R10, R12, R13	0Ω, Resistor (0402)	Generic	
20	1	R14	54.9kΩ ±1%, Resistor (0402)	Generic	
21	1	R16	249kΩ ±1%, Resistor (0402)	Generic	
22	1	R17	1Ω ±1%, Resistor (0402)	Generic	
23	1	R18	3.3MΩ ±1%, Resistor (0603)	Generic	
24	1	R19	715kΩ ±1%, Resistor (0402)	Generic	
26	1	U1	MAX17673AATI+, 28 pin TQFN, 5mm x 5mm	MAX17673AATI+	

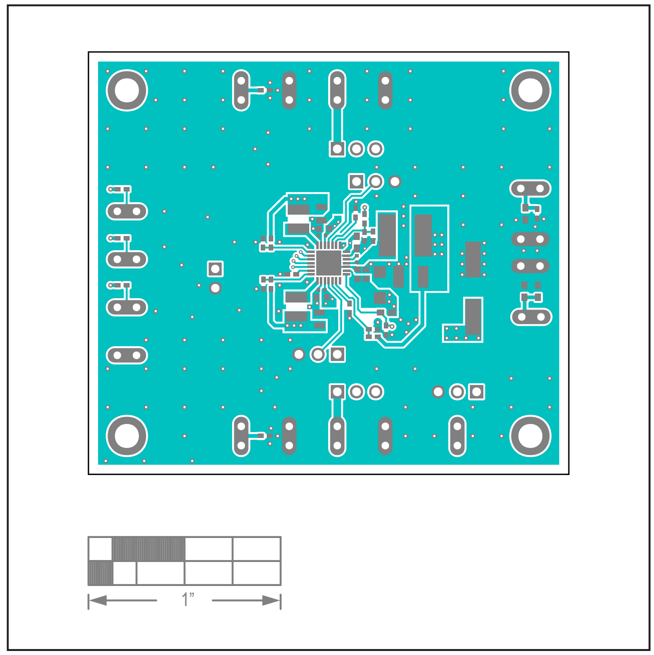
MAX17673A EV Kit Schematic



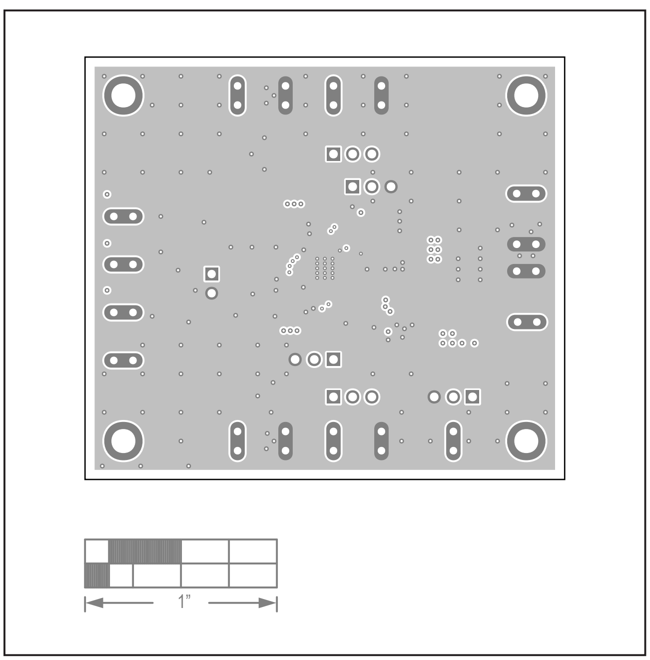
MAX17673A EV Kit PCB Layout



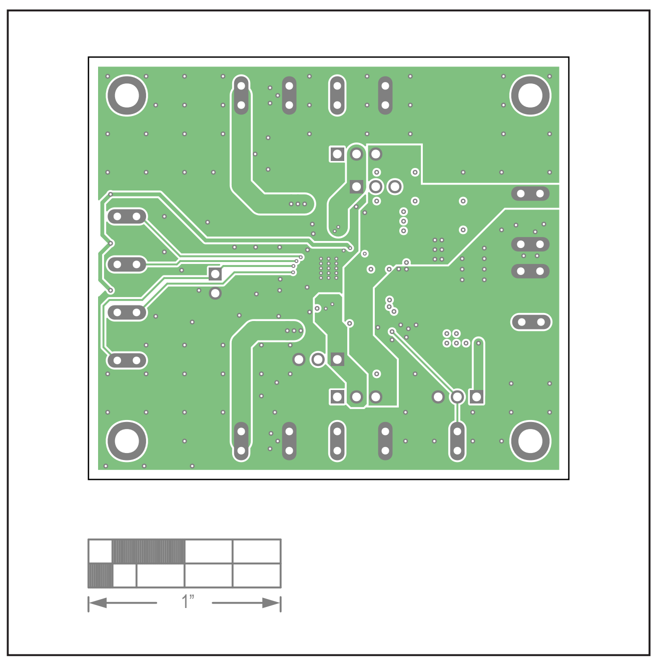
MAX17673A EV Kit—Top Silkscreen



MAX17673A EV Kit—Top Layer

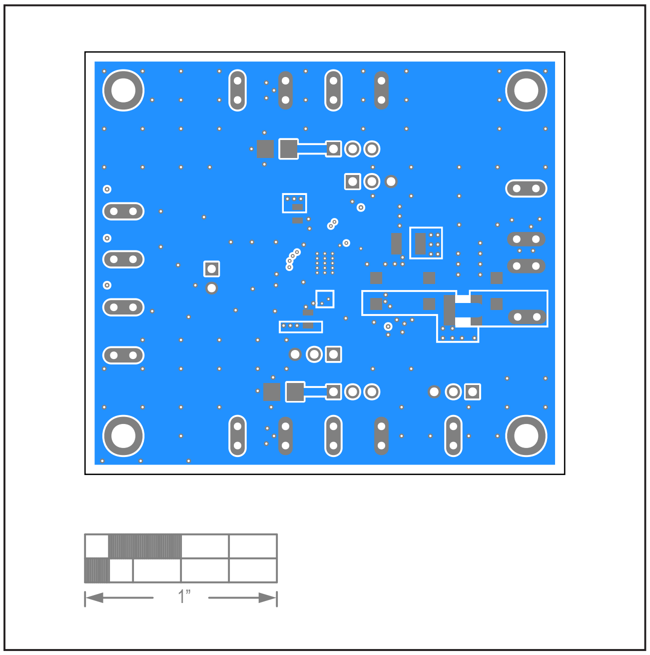


MAX17673A EV Kit—Layer-2

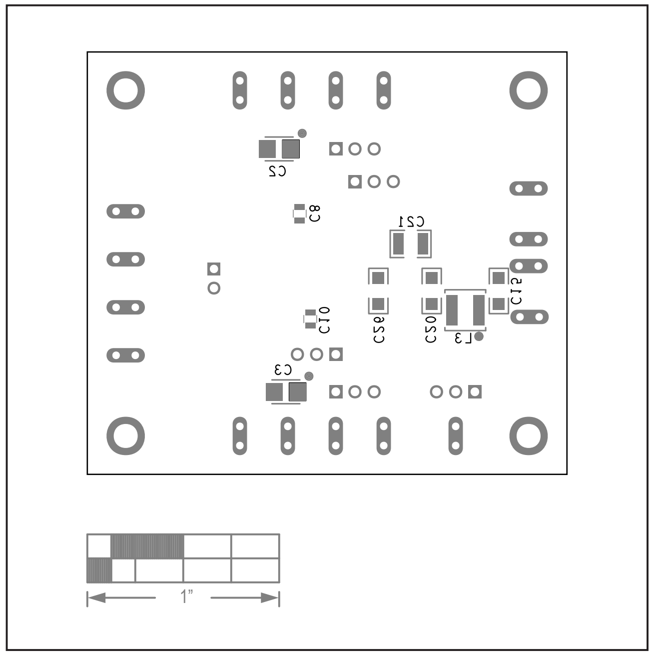


MAX17673A EV Kit—Layer-3

MAX17673A EV Kit PCB Layout (continued)



MAX17673A EV Kit—Bottom Layer



MAX17673A EV Kit—Bottom Silkscreen

Revision History

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

