ANALOG DEVICES

Evaluation Board User Guide

MAX17795EVKITA

Evaluates: MAX17795 in 5V Output-Voltage Application

General Description

The MAX17795 5V output evaluation board provides a proven design to evaluate the MAX17795 high-voltage, high-efficiency, synchronous step-down DC-DC converters. The application circuit is configured to demonstrate optimum performance and component sizes in the evaluation board. The evaluation board also provides a good layout example, optimized for conducted, radiated electromagnetic interference (EMI), and thermal performance.

The evaluation board is configured to operate at 400kHz switching frequency over a 6.5V to 80V input voltage range and deliver up to 5A load current.

The evaluation board features an adjustable input undervoltage-lockout, adjustable soft-start, open-drain $\overline{\text{RESET}}$/TJ, die temperature monitor, external clock synchronization, thermal shutdown, and selectable mode of operation [pulse-width modulation (PWM) or switching frequency modulation (SFM)].

The *MAX17795 converter data sheet* provides a complete description of the part that should be read in conjunction with this user guide before operating the evaluation board.

Features and Benefits

- Operates from a 6.5V to 80V Input Supply
- Up to 5A Load Current
- 5V Output Voltage
- 400kHz Switching Frequency
- High 92% Efficiency (V_{IN} = 48V, I_{OUT} = 5A)
- Selectable PWM and SFM Modes of Operation
- Die Temperature Monitor
- Enable/UVLO Input, Resistor-Programmable Input Undervoltage Lockout (UVLO) Threshold
- Adjustable Soft-Start Time
- Open-Drain $\overline{\text{RESET}}$ Output
- External Frequency Synchronization
- Overcurrent and Overtemperature Protection
- Proven Printed Circuit Board (PCB) Layout
- Fully Assembled and Tested
- Complies with CISPR 32 (EN55032) Class B Conducted and Radiated Emissions

Quick Start

Required Equipment

- 80V, 5A DC power supply
- Digital multimeter (DMM)
- Load capable of sinking up to 5A

Procedure

The evaluation board is fully assembled and tested. Follow the steps below to verify the board operation:

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

1. Disable the power supply and set the input-power supply at a voltage between 6.5V to 80V.
2. Connect the positive terminal of the power supply to the V_{IN} PCB pad and the negative terminal to the nearest PGND PCB pad.
3. Connect the positive terminal of the 5A load to the V_{OUT} PCB pad and the negative terminal to the nearest PGND PCB pad.
4. Connect the DMM across the V_{OUT} PCB pad and the nearest PGND PCB pad.
5. Verify that the shunts are not installed across pins on jumper JU1. See *Table 1* for more details.
6. Verify that the shunts are installed properly across pins on jumper JU2. See *Table 2* for more details.
7. Verify that the shunts are installed properly across pins on jumper JU3. See *Table 3* for more details.
8. Turn on the input-power supply.
9. Enable the load.
10. Verify that the DMM displays the expected terminal voltage with respect to PGND.

Ordering Information *appears at end of data sheet.*

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MAX17795EVKITA Configuration

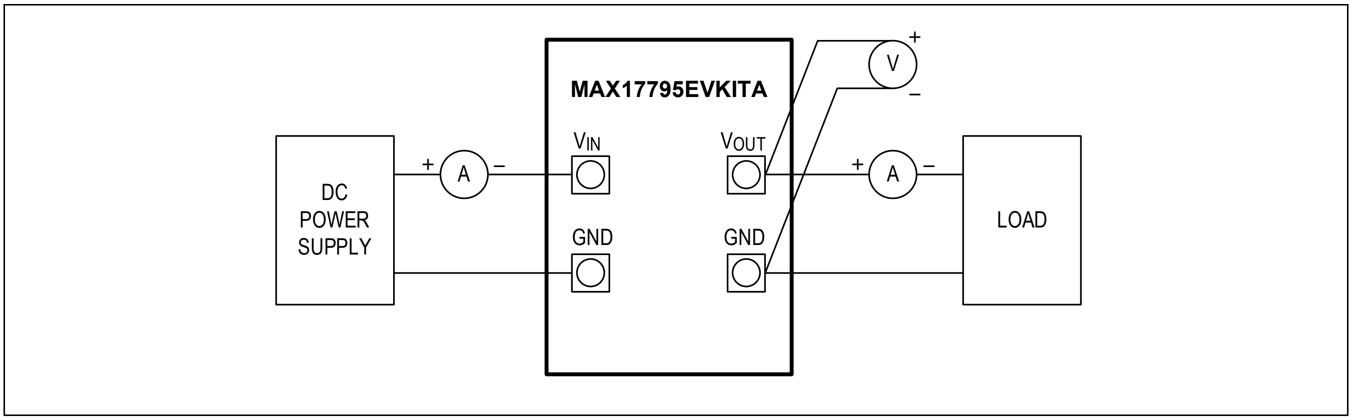


Figure 1. MAX17795EVKITA Board Connections

TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = $V_{EN/UVLO}$ = 48V, C_{INTVCC} = 2.2µF, V_{SGND} = V_{PGND} = 0V, V_{EXTVCC} = V_{OUT}, C_{BST} = 0.1µF, C_{SS} = 8.2nF, T_A = +25°C, unless otherwise noted.)

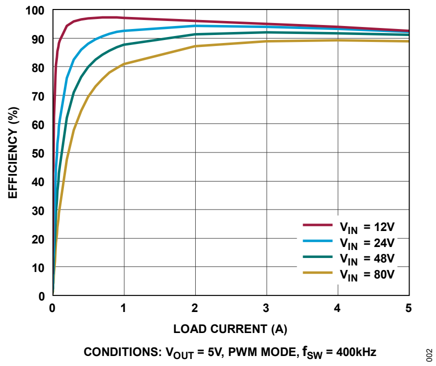


Figure 2. Efficiency vs. Load Current

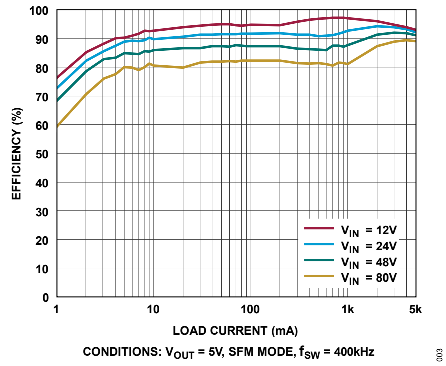


Figure 3. Efficiency vs. Load Current

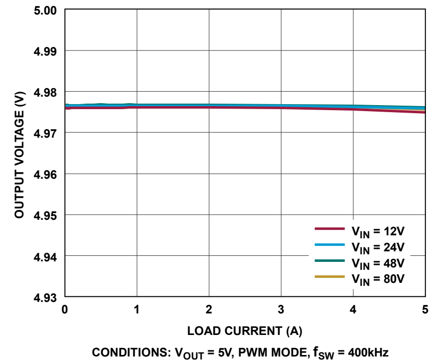


Figure 4. Output Voltage vs. Load Current

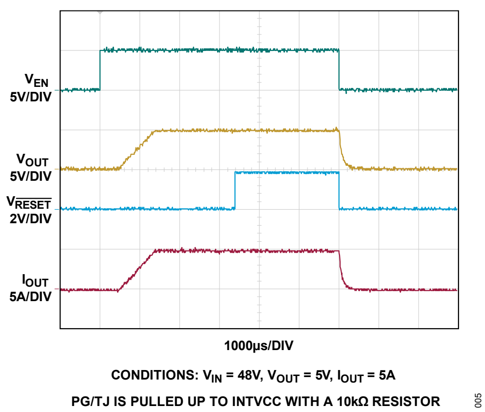


Figure 5. Start-up/Shutdown Through EN/UV

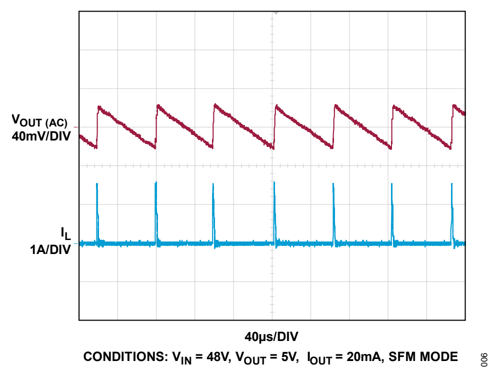


Figure 6. Steady-State Switching Waveform

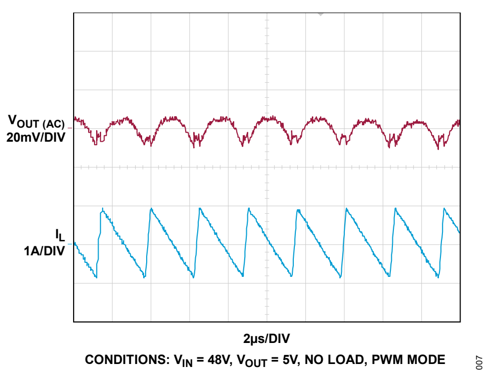


Figure 7. Steady-State Switching Waveform

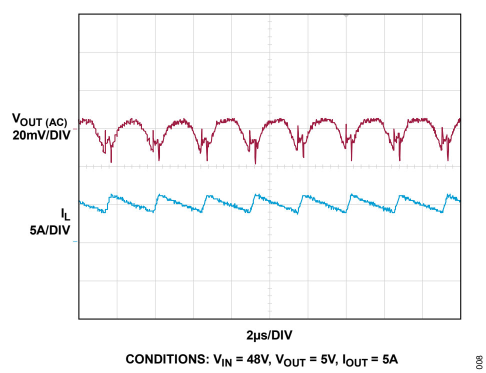


Figure 8. Steady-State Switching Waveform

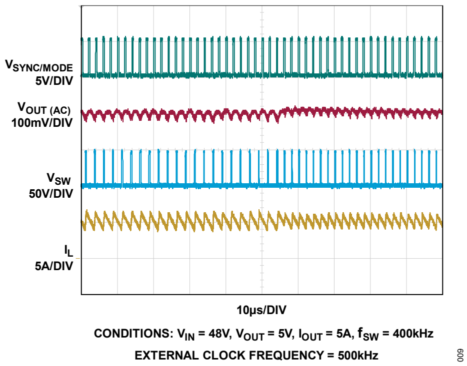


Figure 9. External Clock Synchronization

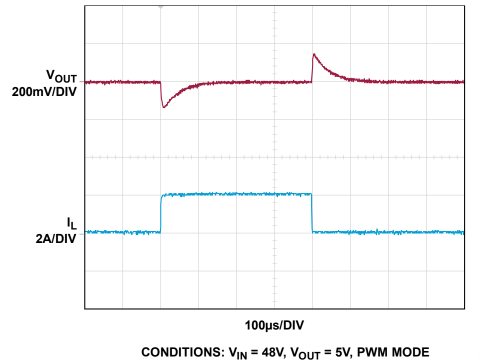


Figure 10. Load Current Stepped from 10mA to 2A

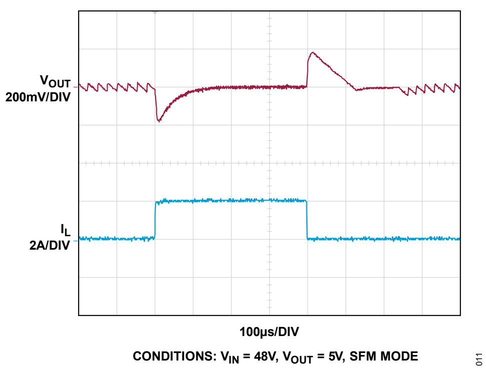


Figure 11. Load Current Stepped from 10mA to 2A

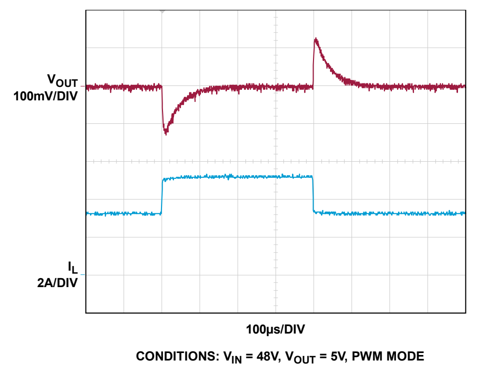


Figure 12. Load Current Stepped from 3A to 5A

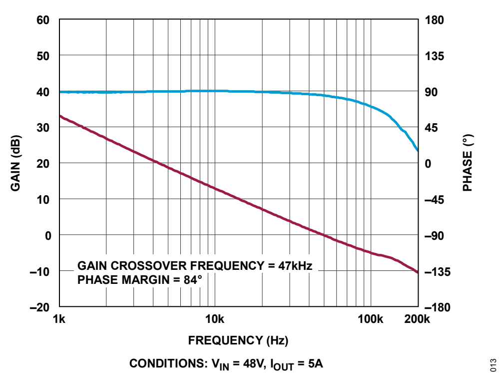


Figure 13. Gain/Phase vs. Frequency

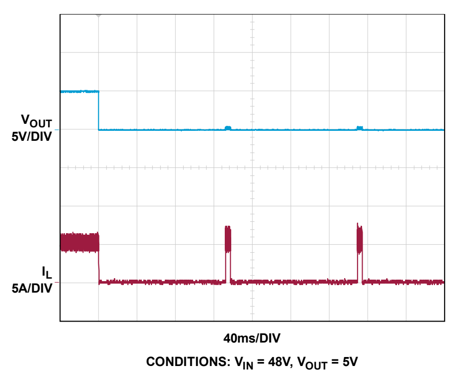


Figure 14. Output Short

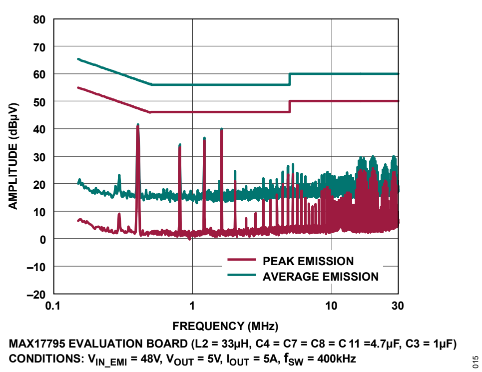


Figure 15. Conducted Emission Plot

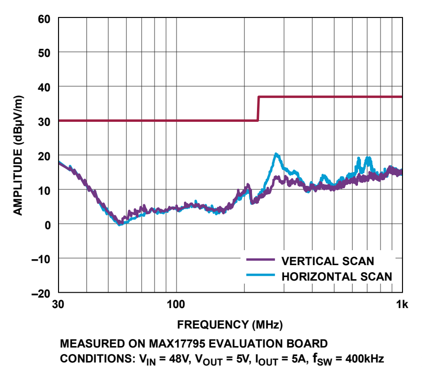


Figure 16. Radiated Emission Plot

Detailed Description

The MAX17795 5V output evaluation board is designed to demonstrate the salient features of the MAX17795 high-voltage, high-efficiency, synchronous step-down DC-DC converter. The evaluation board is preset for 5V output from 6.5V to 80V input, can deliver load current up to 5A and features a 400kHz switching frequency for optimum efficiency and component size.

Enable/Undervoltage Lockout (EN/UVLO) Programming

The evaluation board offer an adjustable input undervoltage-lockout feature. When jumper JU1 is left open, the MAX17795 is enabled when the input voltage rises above 6.5V. To disable the MAX17795, install a shunt across pins 2–3 on jumper JU1. See *Table 1* for jumper settings. Refer to the *Setting the Undervoltage Lockout Level* section in the *MAX17795 data sheet* for more details.

If the EN/UVLO pin is driven from an external signal source, it is recommended that a series resistance of a minimum of 1kΩ is placed between the signal source output and the EN/UVLO pin to reduce voltage ringing on the line.

Table 1. EN/UVLO Jumper Description (JU1)

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

**Default Position*

MODE Selection and External Clock Synchronization

The MAX17795 supports PWM and SFM modes of operation. Leave the jumper JU2 open for operating the converter in SFM mode at light load. Install shunt across the 1-2 position to configure the converter in PWM mode. See *Table 2* for jumper JU2 settings.

The internal oscillators of the converter can be synchronized to an external clock signal on the MODE/SYNC pin when powered up in PWM or SFM mode. The external synchronization clock frequency must be between 1.1 x f_{SW} and 1.4 x f_{SW}, where f_{SW} is the frequency programmed by the resistor R5 connected to the RT pin. The minimum on-time pulse width of the external clock should be more than 100ns and the minimum off-time pulse width of the external clock should be more than 100ns. The application circuits also support on-the-fly mode change among PWM and SFM modes. Refer to the *Mode Selection and External Clock Synchronization (MODE/SYNC)* section in the *MAX17795 data sheet* for more details.

Table 2. Mode Jumper Description (JU2)

SHUNT POSITION	MODE/SYNC PIN	OPERATING MODE
Not Installed*	Unconnected	SFM mode of operation
1-2	Connected to GND	PWM mode of operation

**Default Position*

Setting Switching Frequency

The switching frequency of the MAX17795 can be programmed from 300kHz to 1.5MHz by using a resistor connected from the RT pin to SGND. Resistor R5 programs the desired switching frequency. When no resistor is used, the frequency is programmed to 400kHz. To optimize performance and component size in the evaluation board, a 400kHz switching frequency has been chosen. Use the *Switching Frequency* section of the *MAX17795 data sheet* to choose different values of resistors for programming the required switching frequency.

Soft-Start Capacitor Selection

The evaluation board offers an adjustable soft-start function to limit inrush current during startup. The soft-start time is adjusted by changing the value of capacitor C19. In this evaluation board, the default soft-start time is set to 1ms, which is achieved by using an 8200pF soft-start capacitor. To program a different soft-start time, refer to the *Soft-Start Capacitor Selection section* in the MAX17795 data sheet to calculate the soft-start capacitor value.

Adjusting Output Voltage

The MAX17795 supports a 0.6V to (0.9 x V_{IN}) V adjustable output voltage. The MAX17795 evaluation board is configured to 5V output. The output voltage is programmed using the resistor dividers R3 and R4. Refer to the *Adjusting Output Voltage* section in the MAX17795 data sheet for more details.

Input Capacitor Selection

The input capacitors C12 and C13, reduce current peaks drawn from the input power supply and reduce the switching frequency ripple at the input. Refer to the *Input Capacitor Selection* section in the MAX17795 data sheet to choose input capacitance. The input capacitors are chosen to be 4.7μF.

Output Capacitor Selection

X7R ceramic capacitors are preferred due to their stability over the temperature in industrial applications. The output capacitors C21 and C22 are chosen as 22μF/25V. Refer to the *Output Capacitor Selection* section in the MAX17795 data sheet for more details.

Linear Regulator (INTVCC and EXTVCC)

Powering INTVCC from EXTVCC increases the efficiency of the converter at higher input voltages. If the applied EXTVCC voltage is greater than 2.3V (typ), internal V_{CC} is powered from EXTVCC. If EXTVCC is lower than 2.3V(typ), internal V_{CC} is powered from V_{IN}. In this evaluation board, EXTVCC is connected to V_{OUT}.

$\overline{\text{RESET}}$ Output and Die Temperature Monitor ($\overline{\text{RESET}}$/TJ)

The MAX17795 offers a $\overline{\text{RESET}}$/TJ pin that can be used to monitor either the output voltage status or the die temperature. Install shunt across pins 1-2 on jumper JU3 for monitoring the converter output status. Install shunt across pins 2-3 on jumper JU3 for monitoring the die temperature. See Table 3 for jumper settings. Refer to the *$\overline{\text{RESET}}$ Output and Die Temperature Monitor ($\overline{\text{RESET}}$/TJ)* section in the MAX17795 data sheet for more details.

Table 3. $\overline{\text{RESET}}$/TJ Jumper Description (JU3)

SHUNT POSITION	$\overline{\text{RESET}}$/TJ PIN	$\overline{\text{RESET}}$/TJ FUNCTIONALITY
1-2*	Connected to INTVCC	$\overline{\text{RESET}}$
2-3	Connected to GND	Die temperature monitor

**Default Position*

Hot Plug-In and Long input cables

The MAX17795 5V output evaluation board provides an optional electrolytic capacitor C9 (33μF/100V) to dampen input voltage peaks and oscillations arising during hot-plug-in and/or due to long input cables. These capacitors limit the peak voltage at the input of the DC-DC converters when the evaluation board is powered directly from a precharged capacitive source or an industrial backplane PCB. Long input cables between an input power source and the evaluation board circuit can cause input-voltage oscillations due to the inductance of the cables. The equivalent series resistance (ESR) of the electrolytic capacitor helps damp out the oscillations caused by long input cables.

Electromagnetic Interference (EMI)

Compliance with 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 use of EMI filter components as shown in the evaluation board schematic, results in lower conducted emissions below CISPR32 Class B limits. Manufacturer part numbers of the EMI filter components are listed as optional BOM. The PCB layout is also designed to limit radiated emissions from switching nodes of the power converter, resulting in radiated emissions below CISPR32 Class B limits. Further, capacitors placed near the input of the board help attenuate high-frequency noise.

Component Suppliers

SUPPLIER	WEBSITE
Murata	www.murata.com
Coilcraft	www.coilcraft.com
Vishay	www.vishay.com
Panasonic Corp.	www.panasonic.com
Yageo	www.yageo.com

***Note**: Indicate that you are using the MAX17795 when contacting these component suppliers.*

Ordering Information

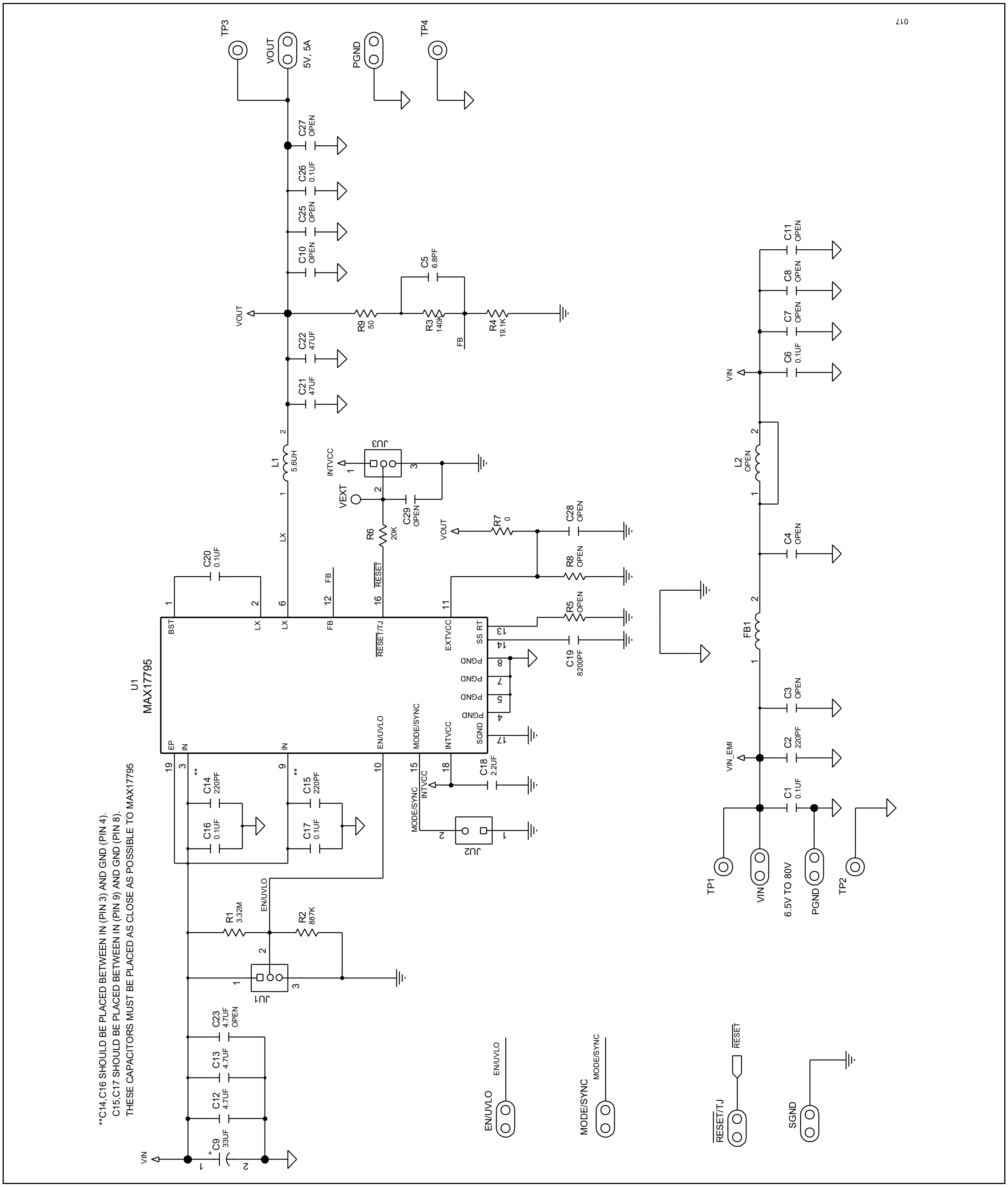
PART	TYPE
MAX17795EVKITA#	EV Kit

#Denotes RoHS-compliance.

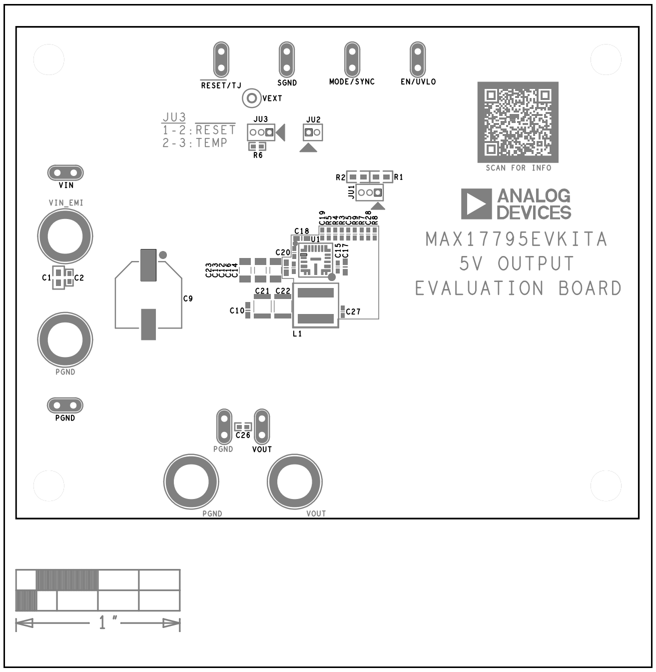
MAX17795EVKITA Bill of Materials

ITEM	QTY	REF DES	DESCRIPTION	MFG PART #
1	4	C1, C6, C16, C17	0.1µF, 10%, 100V, X7R, Ceramic Capacitor (0603)	Murata: GRM188R72A104KA35
2	3	C2, C14, C15	220pF, 10%, 100V, X7R, Ceramic Capacitor (0402)	Murata: GRM155R72A221KA01
3	1	C5	6.8pF, 25V, C0G, Ceramic Capacitor (0402)	Murata: GRM1555C1E6R8CA01
4	1	C9	33µF, 20%, 100V, Electrolytic Capacitor	Panasonic: EEE-TG2A330P
5	2	C12, C13	4.7µF, 10%, 100V, X7R, Ceramic Capacitor (1206)	Murata: GRM31CZ72A475KE11
6	1	C18	2.2µF, 10%, 10V, X7R, Ceramic Capacitor (0603)	Murata: GRM188R71A225KE15
7	1	C19	8200pF, 10%, 16V, X7R, Ceramic Capacitor (0402)	Murata: GRM155R71C822KA01
8	2	C20, C26	0.1µF, 10%, 16V, X7R, Ceramic Capacitor (0402)	Murata: GRM155R71C104KA88
9	2	C21, C22	47µF, 10%, 6.3V, X7R, Ceramic Capacitor (1210)	Murata: GRM32ER70J476KE20
10	1	FB1	Ferrite-Bead, 180Ω, Tol = 25%, 4A	Murata: BLM21SP181BH1
11	1	L1	Inductor, 5.6µH, 20%, 12.6A	Coilcraft: XGL6060-562ME
12	1	R1	3.32MΩ, 1%, 0.1W, Resistor (0603)	Vishay: CRCW06033M32FK
13	1	R2	887kΩ, 1%, 0.1W, Resistor (0603)	Vishay: CRCW0603887KFKEA
14	1	R3	140kΩ, 1%, 1/16W, Resistor (0402)	Vishay: CRCW0402140KFKED
15	1	R4	19.1kΩ, 1%, 1/16W, Resistor (0402)	Vishay: CRCW040219K1FK
16	1	R6	20kΩ, 1%, 1/16W, Resistor (0402)	Vishay: CRCW040220K0FK
17	1	R7	0Ω, 1%, 1/16W, Resistor (0402)	Vishay: CRCW04020000Z0ED
18	1	R9	50Ω, 2%, 1/16W, Resistor (0402)	Yageo: RT0402BRE0750RL
19	1	U1	Analog Devices: MAX17795AFN+	*MAX17795*
20	1	L2	Optional: Inductor 33µH	Coilcraft: XGL5050-333
21	6	C3	Optional: Open (0805)	-
22	5	C4, C7, C8, C11, C23	Optional: Open (1206)	-
23	1	C10	Optional: Open (0603)	-
24	4	C25, C27-C29	Optional: Open (0402)	-
25	2	R5, R8	Optional: Open (0402)	-

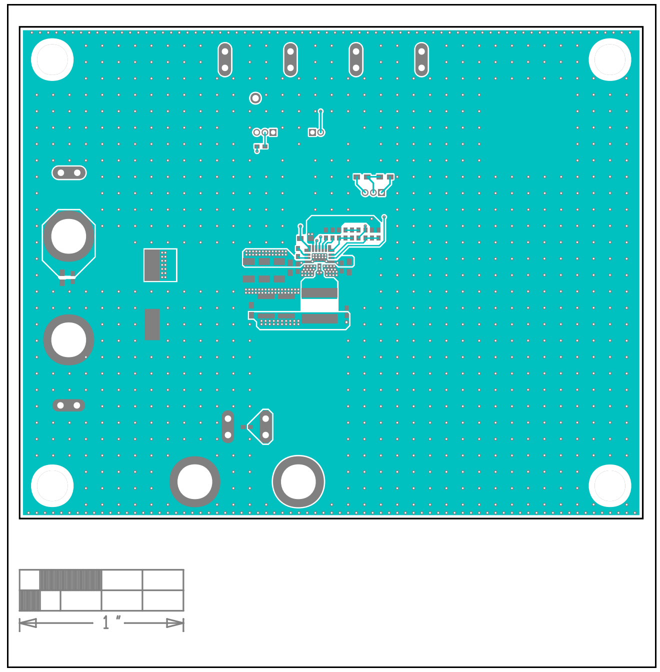
MAX17795EVKITA Schematic



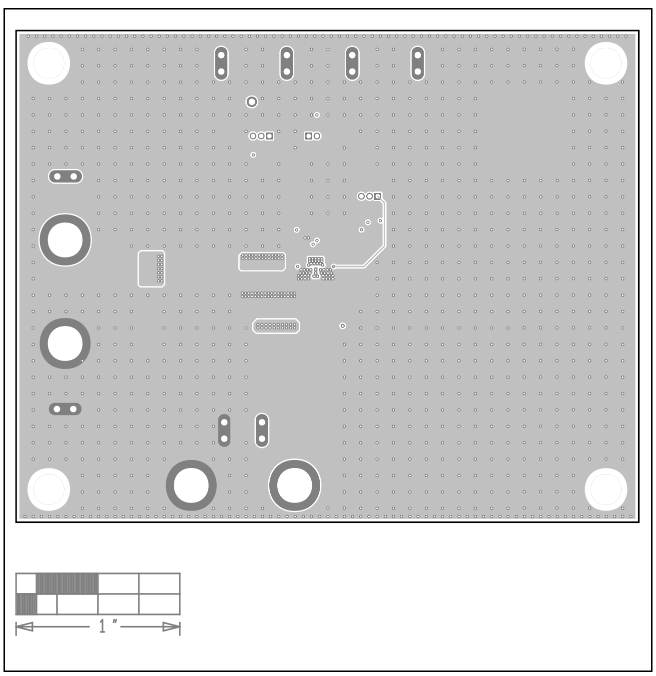
MAX17795EVKITA PCB Layouts



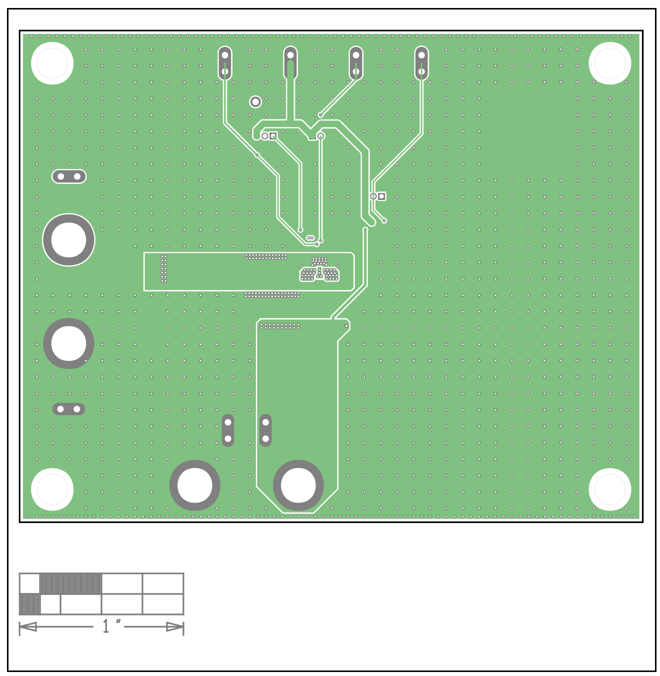
MAX17795EVKITA Component Placement Guide—Top Silkscreen



MAX17795EVKITA PCB Layout—Top

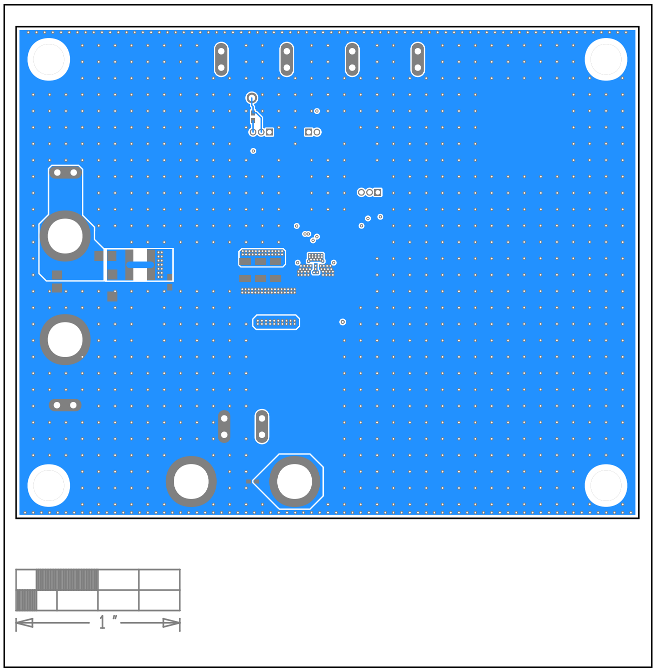


MAX17795EVKITA PCB Layout—Layer 2

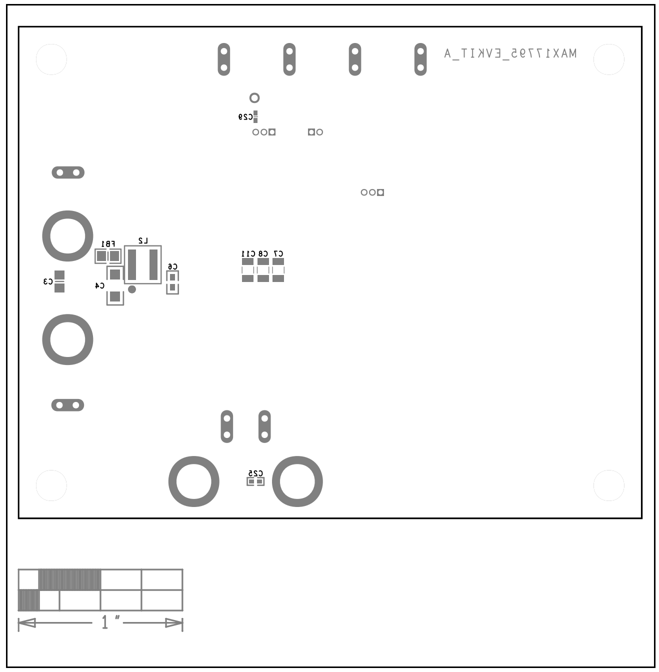


MAX17795EVKITA PCB Layout—Layer 3

MAX17795EVKITA PCB Layouts (continued)



MAX17795EVKITA PCB Layout—Bottom



MAX17795EVKITA Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/25	Initial release	—

Notes