Evaluation Board User Guide

MAX17760AAEVKIT#

Evaluates: MAX17760 in a 5V Output-Voltage Application with Hiccup Protection Disabled

General Description

The MAX17760AAEVKIT# evaluation board provides a proven design to evaluate the MAX17760A high-efficiency, high-voltage, synchronous step-down DC-DC converter in a thin dual flat no-lead (TDFN) package. The application circuit is configured to demonstrate optimal 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 7V to 76V input voltage range and can deliver up to 300mA load current.

The evaluation board features an adjustable input undervoltage lockout, adjustable soft-start, adjustable switching frequency, open-drain $\overline{\text{RESET}}$ signal, and external clock synchronization.

The *MAX17760 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 7V to 76V Input Supply
- Up to 300mA Load Current
- 5V Output Voltage
- 400kHz Switching Frequency
- Selectable PWM and PFM Modes of Operation
- Enable/UVLO Input, Resistor-Programmable Input Undervoltage Lockout (UVLO) Threshold
- Adjustable Soft-Start Time
- Open-Drain $\overline{\text{RESET}}$ Output
- External Clock Synchronization
- Overcurrent and Overtemperature Protection
- Proven Printed Circuit Board (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

Required Equipment

- 76V, 500mA DC power supply
- 2 Digital multimeters (DMM)
- Load capable of sinking up to 300mA

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 voltage to 5.5V.
2. Connect the positive terminal of the power supply to the VIN PCB pad and the negative terminal to the nearest PGND PCB pad.
3. Connect the positive terminal of the 300mA load to the VOUT PCB pad and the negative terminal to the nearest PGND PCB pad.
4. Connect one DMM across the VOUT PCB pad and the nearest PGND PCB pad, and the other DMM across the $\overline{\text{RESET}}$ PCB pad and SGND PCB pad.
5. Verify that the shunts are installed across pin 1 to pin 2 on jumper JU1 and JU2. See *Table 1* and *Table 2* or more details.
6. Turn on the input power supply.
7. Enable the load.
8. Verify that both the DMMs display approximately 0V.
9. Increase the input voltage to 7V, which is just above the EN/UVLO rising threshold.
10. Verify that the DMM across the VOUT PCB pad and the nearest PGND PCB pad displays 5V.
11. Verify that the DMM across the $\overline{\text{RESET}}$ PCB pad and the SGND PCB pad displays 5V.
12. The input voltage can be set at any voltage between 7V and 76V, and both the DMMs still read the same voltages.
13. Reduce the input voltage to 5V, which is below the EN/UVLO falling threshold, and verify that both the DMMs display approximately 0V
14. Disable the input power supply.

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MAX17760AAEVKIT# Configuration

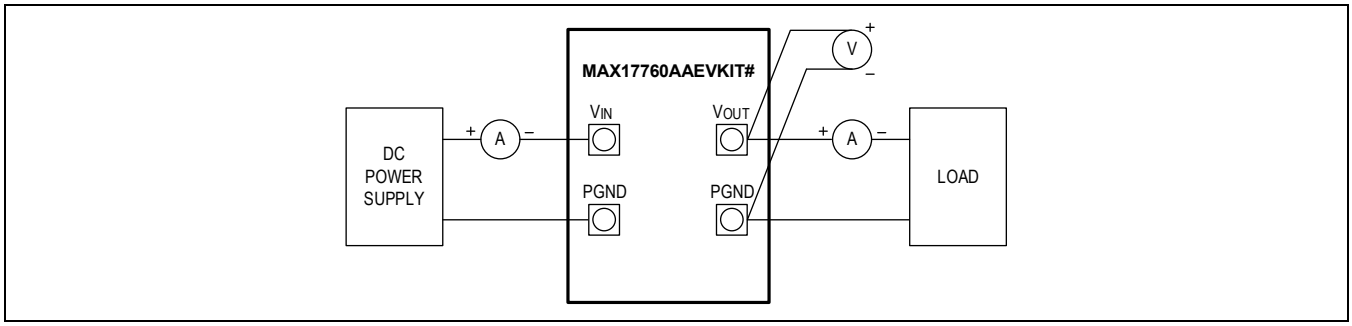
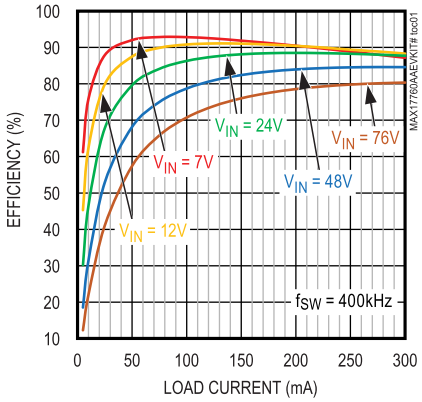


Figure 1. MAX17760AAEVKIT# Board Connections

Typical Performance Characteristics

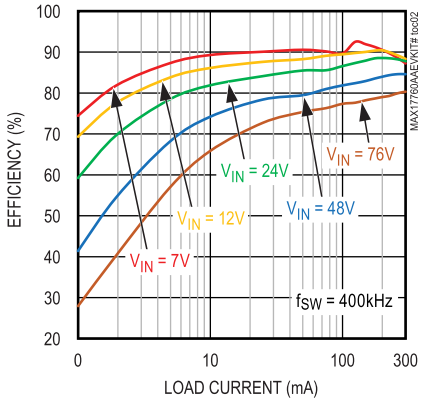
(V_{IN} = 24V, V_{OUT} = 5V, f_{SW} = 400kHz, T_A = +25°C, unless otherwise noted.)

EFFICIENCY vs. LOAD CURRENT



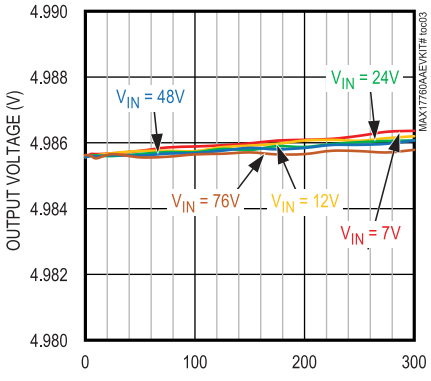
CONDITIONS: 5V OUTPUT, PWM MODE

EFFICIENCY vs. LOAD CURRENT



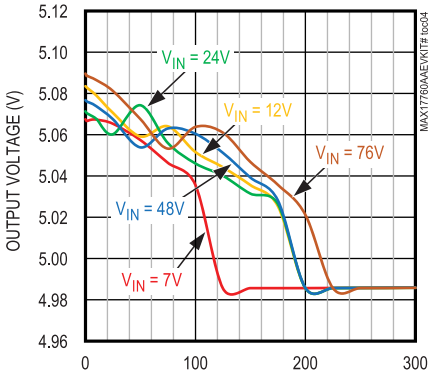
CONDITIONS: 5V OUTPUT, PFM MODE

LINE AND LOAD REGULATION



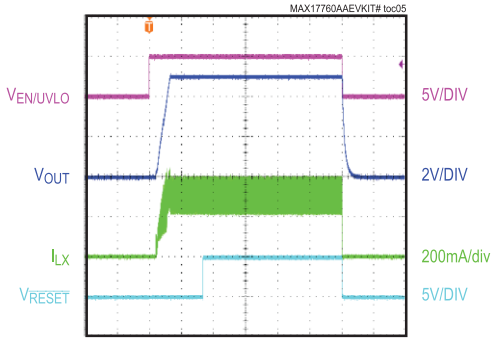
CONDITIONS: 5V OUTPUT, PWM MODE

LINE AND LOAD REGULATION



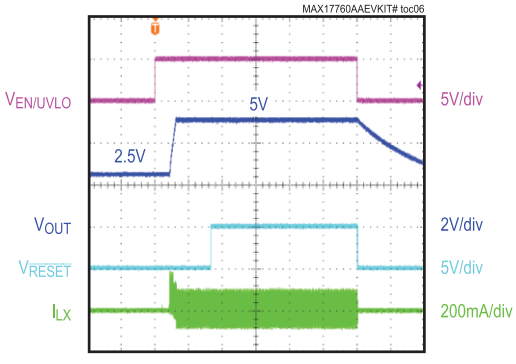
CONDITIONS: 5V OUTPUT, PFM MODE

SOFT-START/SHUTDOWN THROUGH EN/UVLO



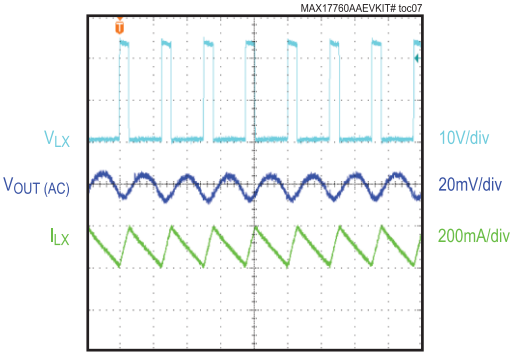
CONDITIONS: 5V OUTPUT, PWM MODE, 16.67Ω LOAD

SOFT-START WITH PREBIAS OF VOLTAGE 2.5V



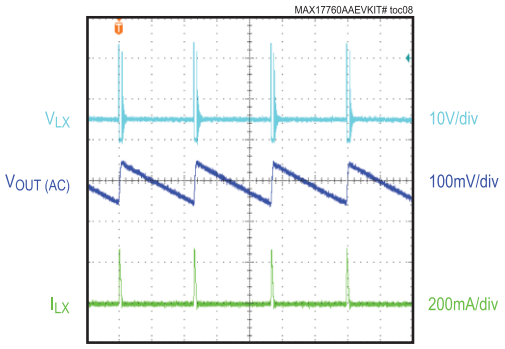
CONDITIONS: 5V OUTPUT, PWM MODE, 1000Ω LOAD

STEADY-STATE PERFORMANCE



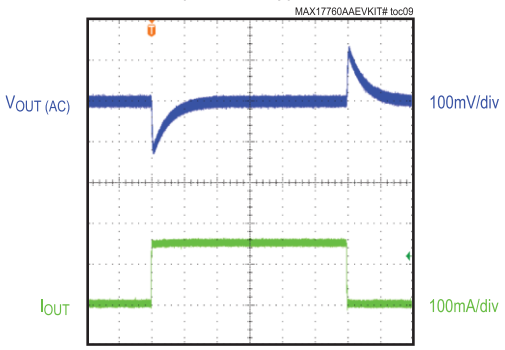
CONDITIONS: 5V OUTPUT, PWM MODE, 300mA LOAD

STEADY-STATE PERFORMANCE



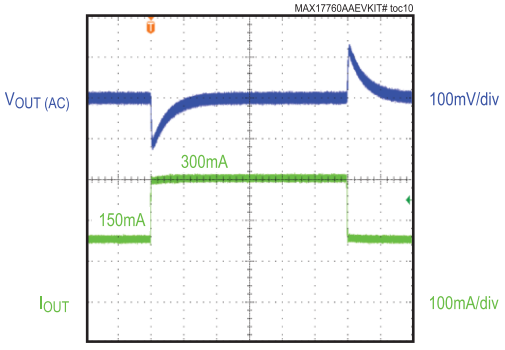
40µs/div
CONDITIONS: PWM MODE, 5mA LOAD

LOAD TRANSIENT BETWEEN 0mA AND 150mA



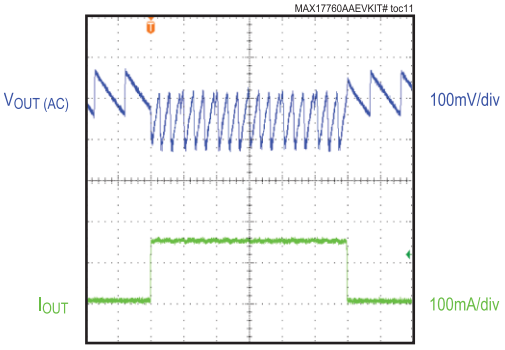
100µs/div
CONDITIONS: PWM MODE

LOAD TRANSIENT BETWEEN 150mA AND 300mA



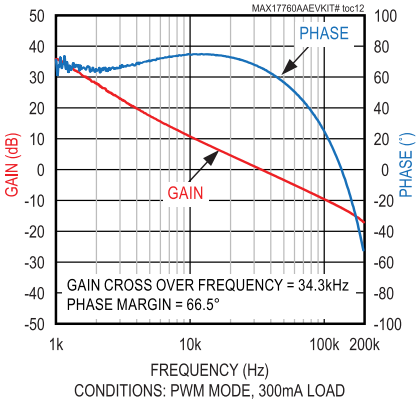
100µs/div
CONDITIONS: PWM MODE

LOAD TRANSIENT BETWEEN 5mA AND 150mA



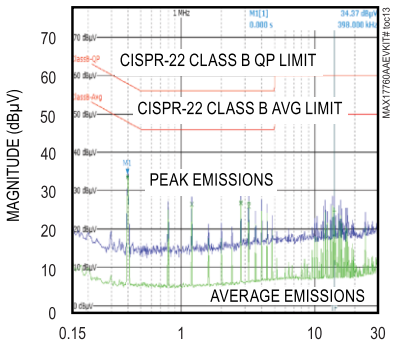
100µs/div
CONDITIONS: PFM MODE

BODE PLOT



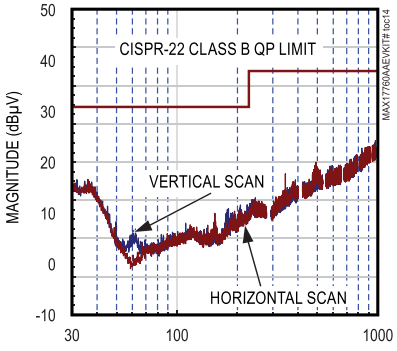
CONDITIONS: PWM MODE, 300mA LOAD

CONDUCTED EMISSIONS PLOT 5V OUTPUT, 300mA LOAD CURRENT



CONDITIONS: L2 = 22µH, C15 = 1µF/100V/X7R/1206, C16 = 4.7µF/100V/X7R/1206

RADIATED EMISSIONS PLOT 5V OUTPUT, 300mA LOAD CURRENT



CONDITIONS: L2 = SHORT, C15 = C16 = OPEN

Detailed Description

The MAX17760AAEVKIT# evaluation board is designed to demonstrate the salient features of the MAX17760A high-voltage, high-efficiency, synchronous step-down DC-DC converter. The evaluation board is preset for 5V output from 7V to 76V input, can deliver load current up to 300mA, and features a 400kHz switching frequency for optimum efficiency and component size.

Enable/Undervoltage Lockout (EN/UVLO) Programming

The evaluation board offers an enable and an adjustable input undervoltage-lockout feature. When jumper JU1 is left open, the MAX17760A is in always-on operation. To disable the MAX17639, install a shunt across pin 2 to pin 3 on jumper JU1. See *Table 1* for jumper settings. The EN/UVLO PCB pad on the evaluation board supports external Enable/Disable control of the device. Leave jumper 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 MAX17760A is enabled when a shunt is connected across pin 1 to pin 2 on jumper JU1. Refer to the *Setting the Input Undervoltage-Lockout Level* section in the *MAX17760* data sheet for more details.

Table 1. EN/UVLO Jumper (JU1) Settings

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

**Default position.*

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 C6. In this evaluation board, the default soft-start time is set to 0.9ms, which is achieved by using a 5600pF soft-start capacitor. To program a different soft-start time, refer to the *Soft-Start Capacitor Selection* section in the *MAX17760* data sheet to calculate the soft-start capacitor value.

Mode of Operation Selection (MODE)

The MAX17760A supports pulse-width modulation (PWM) and pulse-frequency modulation (PFM) modes of operation. Leave the jumper JU2 open for operating the converter in PFM mode at light load. Install a shunt across pin 1 to pin 2 on jumper JU2 to configure the converter in PWM mode. See *Table 2* for jumper JU2 settings. Refer to the *Mode Selection* section in the *MAX17760* data sheet for more details.

The mode of operation cannot be changed on-the-fly after power-up.

Table 2. Mode Selection Jumper (JU2) Settings

SHUNT POSITION	MODE PIN	MODE OF OPERATION
Not Installed	Unconnected	PFM
1 to 2*	Connected to SGND	PWM

**Default position.*

External Clock Synchronization (RT/SYNC)

The evaluation board provides an RT/SYNC PCP pad to synchronize the MAX17760A to an external clock signal. Short jumper JU3 when external clock signals are applied. See *Table 3* for jumper JU3 settings. In the presence of a valid external clock for synchronization, the MAX17760A operates in PWM mode only. Refer to the *Switching Frequency Selection and External Clock Synchronization (RT/SYNC)* section in the *MAX17760* data sheet for more details.

Table 3. External Clock Synchronization Jumper (JU3) Settings

SHUNT POSITION	MODE/SYNC PIN
Not Installed*	Not connected to RT/SYNC PCB pad
1 to 2	Connected to RT/SYNC PCB pad through a 22pF capacitor

**Default position.*

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

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

Hot Plug-In and Long input cables

The MAX17760A 5V output evaluation board provides an optional electrolytic capacitor C1 (22µF/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 the CISPR22 Class B limits. Manufacturer part numbers of the EMI filter components are listed as an optional bill of materials (BOM). The PCB layout is also designed to limit radiated emissions from switching nodes of the power converter, resulting in radiated emissions below the CISPR22 Class B limits. Further, capacitors placed near the input of the board help attenuate high-frequency noise.

Component Suppliers

SUPPLIER	WEBSITE
Murata Americas	www.murata.com
Coilcraft	www.coilcraft.com
Panasonic Corp.	www.panasonic.com
Yageo	www.yageo.com
Sullins Corp.	www.sullinscorp.com
Keystone	www.keyelco.com
TDK	www.tdk.com
Würth Elektronik	*www.we-online.com*
Taiyo Yuden	www.ty-top.com

***Note**: Indicate that you are using the MAX17760A when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17760AAEVKIT#	EV kit

#Denotes RoHS-compliant.

MAX17760AAEVKIT# Bill of Materials

ITEM	QTY	REFERENCE	DESCRIPTION	MANUFACTURER	PART NUMBER
1	1	C1	22µF, ±20%, 100V, Electrolytic capacitor	Panasonic	EEE-TG2A220UP
2	1	C2	1µF, ±10%, 100V, X7R, Ceramic capacitor (1206)	TDK	C3216X7R2A105K160AA
3	2	C3, C14	0.1µF, ±10%, 100V, X7R, Ceramic capacitor (0603)	Yageo	CC0603KRX7R0BB104
4	2	C4, C13	220pF, ±10%, 100V, C0G, Ceramic capacitor (0603)	Kemet	C0603C221K1GAC
5	1	C5	22pF, ±5%, 50V, C0G, Ceramic capacitor (0402)	Murata	GCM1555C1H220JA16
6	1	C6	5600pF, ±10%, 25V, X7R, Ceramic capacitor (0402)	Murata	GRM1555C1H562JE01
7	1	C7	0.1µF, ±10%, 50V, X7R, Ceramic capacitor (0402)	TDK	C1005X7R1H104K050BE
8	1	C8	1µF, ±10%, 6.3V, X7R, Ceramic Capacitor (0603)	Murata	GRM188R70J105KA01
9	1	C9	10µF, ±10%, 16V, X7R, Ceramic capacitor (0805)	Murata	GRM21BZ71C106KE15

ITEM	QTY	REFERENCE	DESCRIPTION	MANUFACTURER	PART NUMBER
10	1	C11	0.1µF, ±10%, 16V, X7R, Ceramic capacitor (0402)	Taiyo Yuden	EMK105B7104KV-F
11	1	L1	56µH, ±20%, 0.7A, Inductor	Würth Elektronik	74408943560
12	1	R1	649kΩ, ±1%, 1/10W, Resistor (0603)	Panasonic	ERJ-3EKF6493V
13	1	R2	127kΩ, ±1%, 1/10W, Resistor (0603)	Panasonic	ERJ-3EKF1273V
14	1	R3	95.3kΩ, ±1%, 1/16W, Resistor (0402)	Panasonic	ERJ-2RKF9532X
15	1	R4	18.2kΩ, ±1%, 1/16W, Resistor (0402)	Panasonic	ERJ-2RKF1822X
16	1	R5	69.8kΩ, ±1%, 1/16W, Resistor (0402)	Panasonic	ERJ-2RKF6982
17	1	R6	10kΩ, ±5%, 1/10W, Resistor (0402)	Panasonic	ERJ-2GEJ103X
18	1	R7	22Ω, ±5%, 1/16W, Resistor (0402)	Panasonic	ERJ-2GEJ220X
19	1	U1	3mm x 3mm, TDFN12-EP, Buck converter	Analog Devices	MAX17760AATC+
OPTIONAL CIRCUIT COMPONENTS					
20	1	C15	1µF, ±10%, 100V, X7R, Ceramic capacitor (1206)	Taiyo Yuden	HMK316B7105KL-T
21	1	C16	4.7µF, ±10%, 100V, X7R, Ceramic capacitor (1206)	Murata	GRM31CZ72A475KE11
22	1	L2	22µH, ±20%, 0.28A, Inductor	Coilcraft INC.	XPL2010-223ML
23	1	C10	Open, Ceramic capacitor (0805)	—	—
24	7	C12	Open, Ceramic capacitor (0402)	—	—
HARDWARE: FOR EVALUATION BOARD ONLY					
25	1	JU1	3 Pins, Male, Header Connector	Sullins	PEC03SAAN
26	2	JU2, JU3	2 Pins, Male, Header Connector	Sullins	PEC02SAAN
27	3	SU1, SU2, SU3	2 Pins, Female, Shunt Connector	Sullins	STC02SYAN
28	4	MH1-MH4	Round-thru hole spacer	Keystone Electronics	9032
29	9	EN/UVLO, MODE, RT/SYNC, $\overline{\text{RESET}}$, SGND, PGND, PGND1, VIN, VOUT	20AWG, Solid wire	—	9020 BUSS

MAX17760AAEVKIT# Schematic

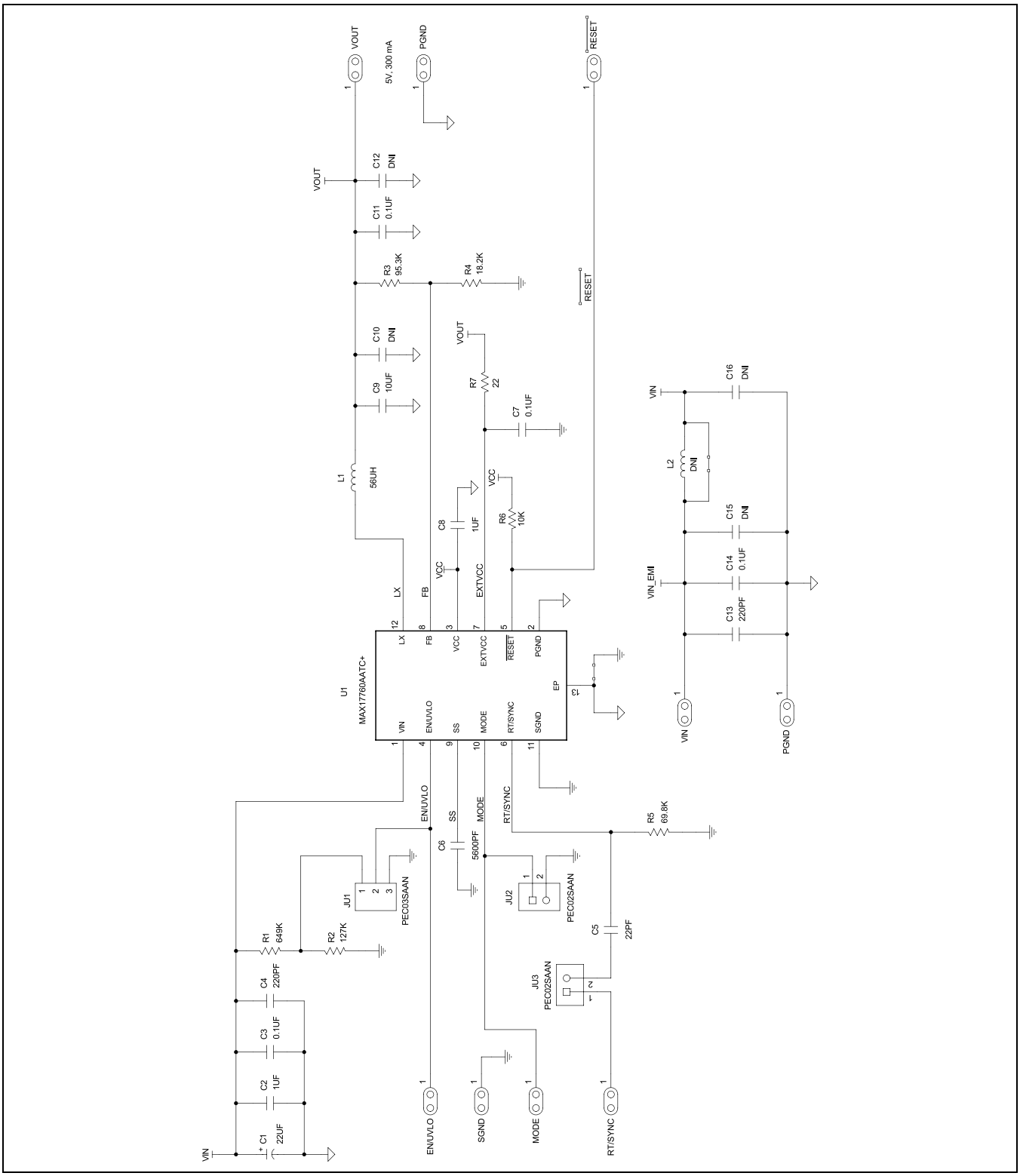


Figure 2. MAX17760AAEVKIT# Schematic Diagram

MAX17760AAEVKIT# PCB Layout Diagrams

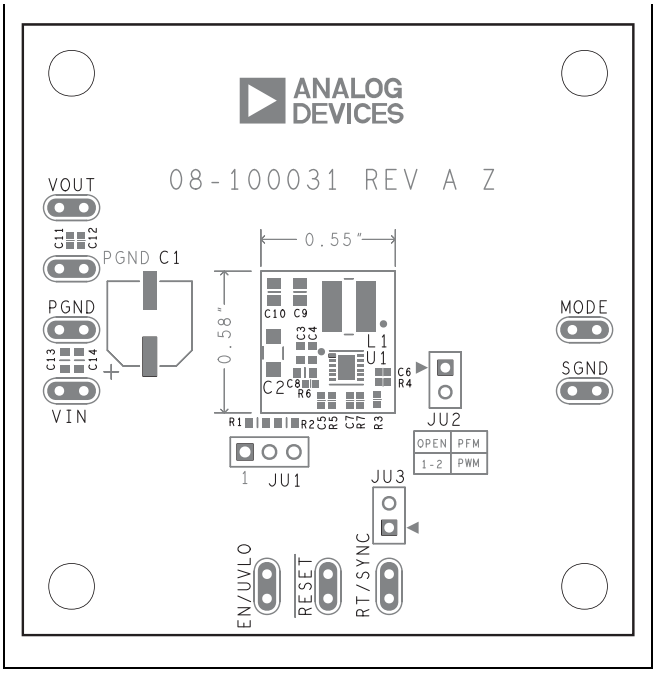


Figure 3. MAX17760AAEVKIT# Component Placement Guide—Top Silkscreen

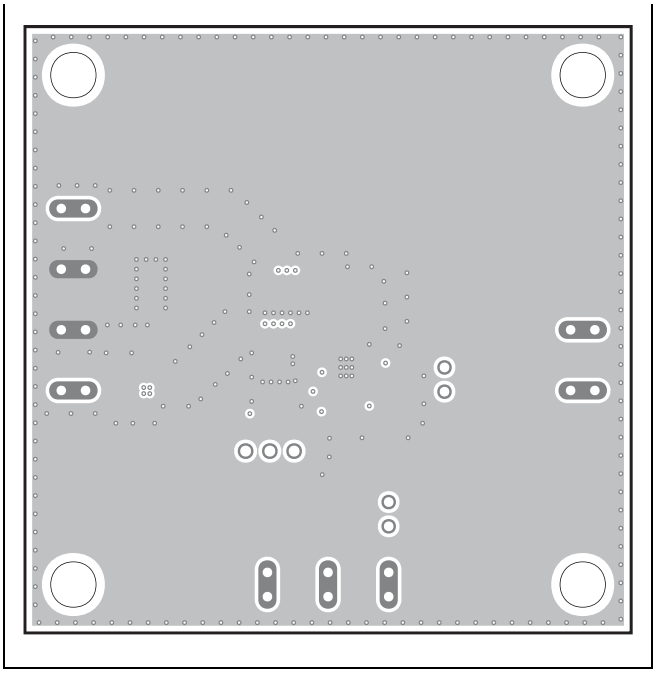


Figure 4. MAX17760AAEVKIT# PCB Layout—Layer 2

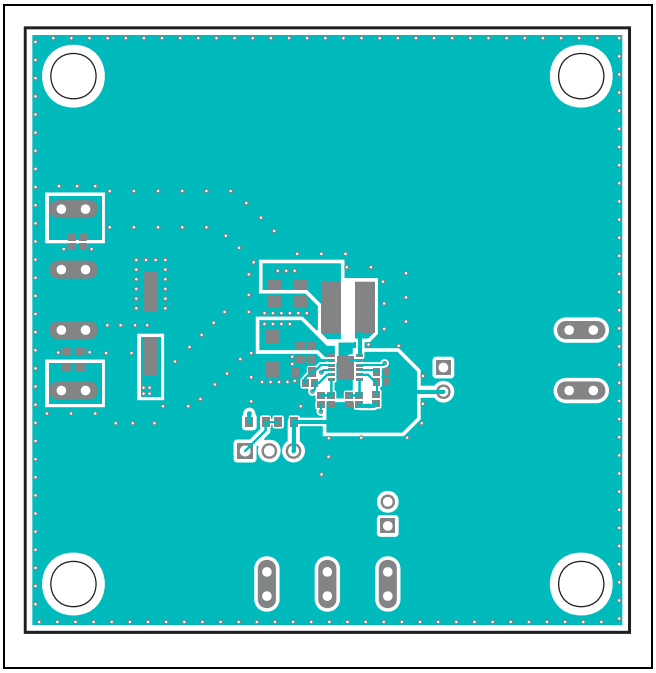


Figure 5. MAX17760AAEVKIT# PCB Layout—Top View

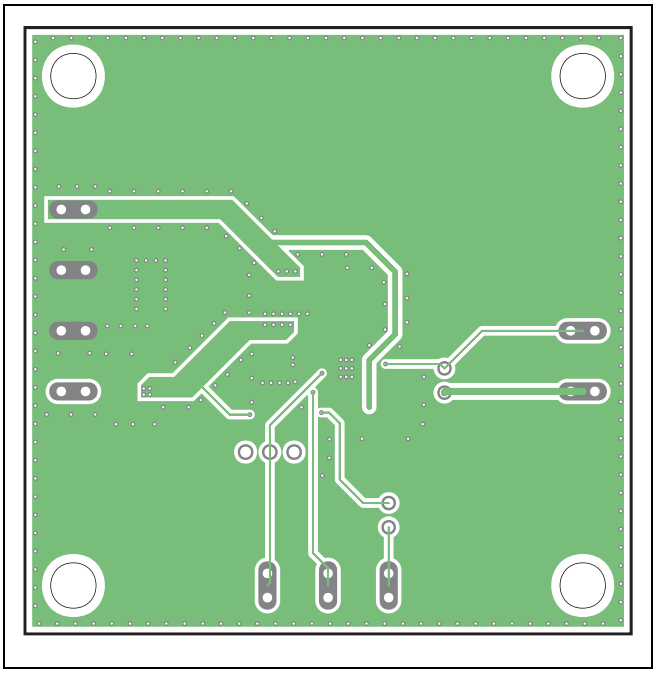


Figure 6. MAX17760AAEVKIT# PCB Layout—Layer 3

MAX17760AAEVKIT# EV Kit PCB Layout (continued)

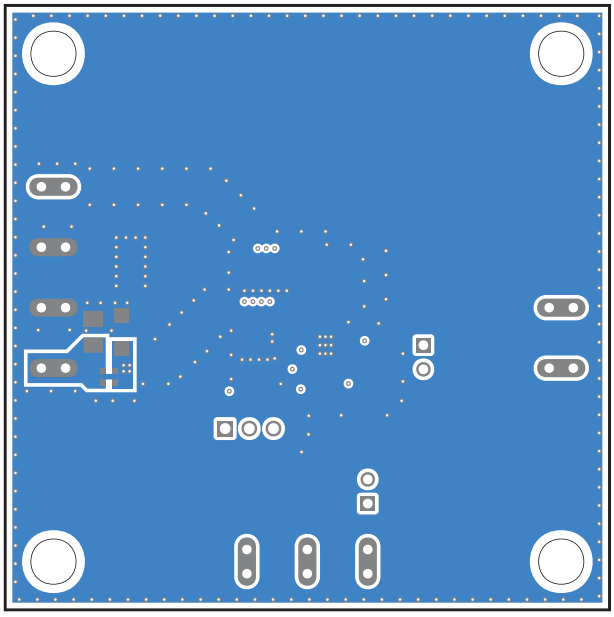


Figure 7. MAX17760AAEVKIT# PCB Layout—Bottom View

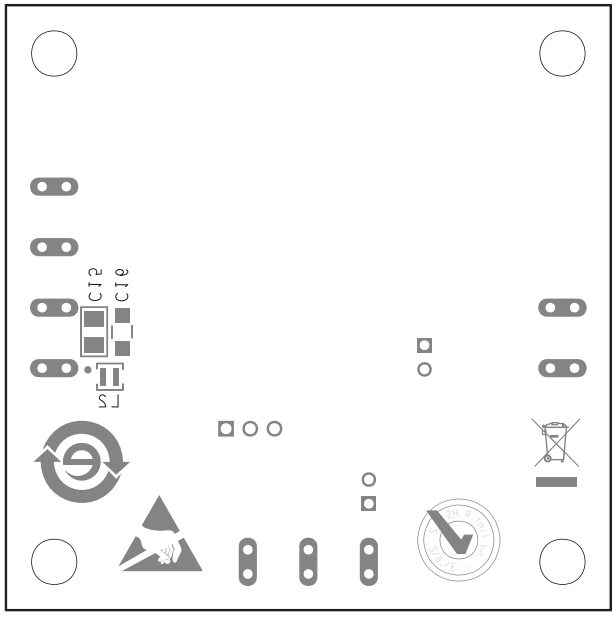


Figure 8. MAX17760AAEVKIT# Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/26	Initial release.	—
1	4/26	Updated front page title.	1

Notes

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