Evaluation Board User Guide

MAX17639EVKITA

Evaluates: MAX17639, MAX17638, and MAX17636 in 5V Output-Voltage Application

General Description

The MAX17639 5V output evaluation board provides a proven design to evaluate the MAX17639 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 with the MAX17639 device at 400kHz switching frequency over a 6.5V to 36V input voltage range and can deliver up to 10A load current. The evaluation board can also be used to evaluate the MAX17636 and MAX17638 devices. Refer to the IC data sheet for guidance when modifying the schematic.

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 *MAX17639 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 36V Input Supply
- Up to 10A Load Current
- 5V Output Voltage
- 400kHz Switching Frequency
- 95.6% Peak Efficiency
- 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

- 36V, 10A DC power supply
- Digital multimeter (DMM)
- Load capable of sinking up to 10A

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 36V.
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 10A 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.
1. Verify that the shunts are not installed across pins on jumper JU1. See *Table 1* for more details.
2. Verify that the shunts are installed properly across pins on jumper JU2. See *Table 2* for more details.
3. Verify that the shunts are installed properly across pins on jumper JU3. See *Table 3* for more details.
4. Turn on the input-power supply.
5. Enable the load.
6. 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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MAX17639EVKITA Configuration

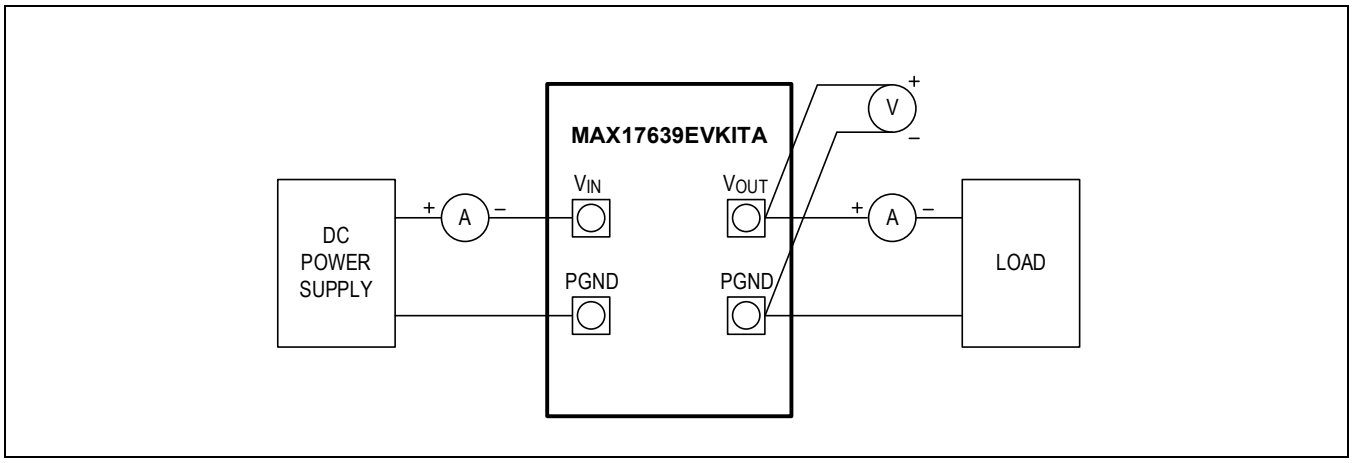

Figure 1. MAX17639EVKITA Board Connections

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Typical Performance Characteristics

(V_{IN} = $V_{EN/UVLO}$ = 24V, C_{INTVCC} = 4.7µF, V_{SGND} = V_{PGND} = 0V, V_{EXTVCC} = V_{OUT}, C_{BST} = 0.1µF, C_{SS} = 8200pF, T_A = +25°C, unless otherwise noted.)

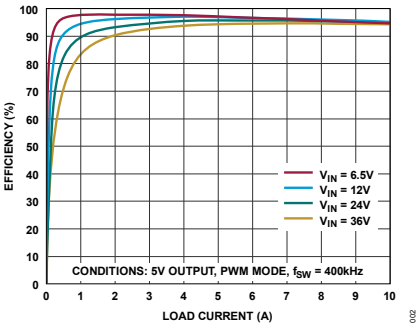

Figure 2. Efficiency vs. Load Current

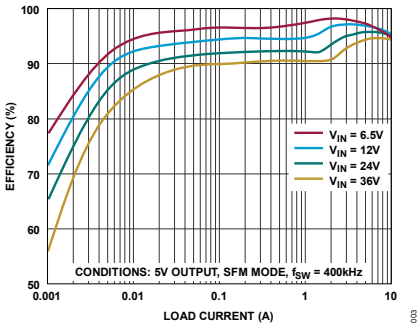

Figure 3. Efficiency vs. Load Current

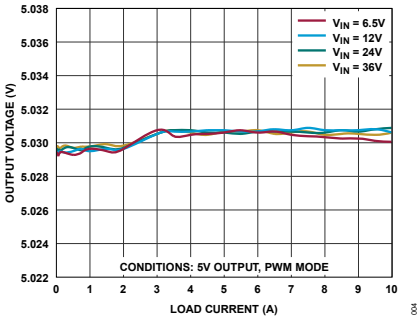

Figure 4. Output Voltage vs. Load Current

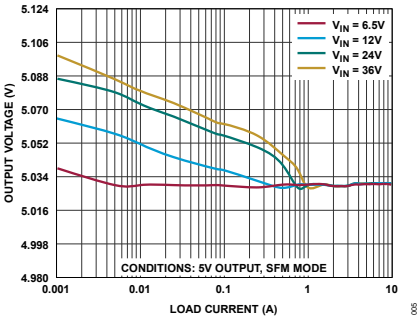

Figure 5. Output Voltage vs. Load Current

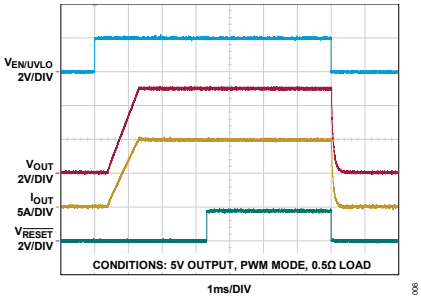

Figure 6. Soft-Start/Shutdown Through EN/UVLO

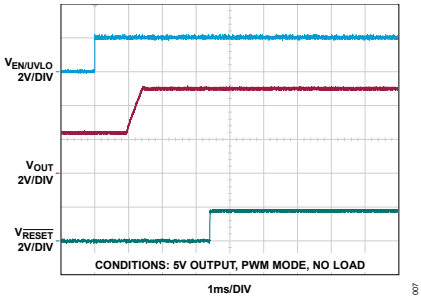

Figure 7. Soft-Start with Prebias Voltage of 2.5V

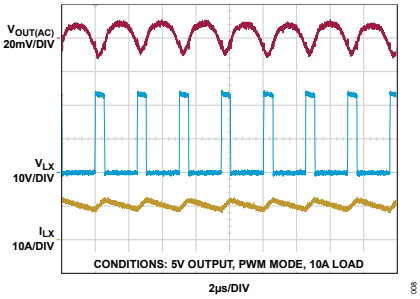

Figure 8. Steady-State Performance

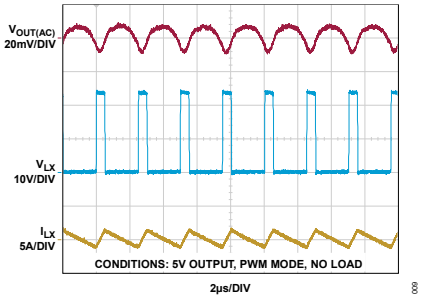

Figure 9. Steady-State Performance

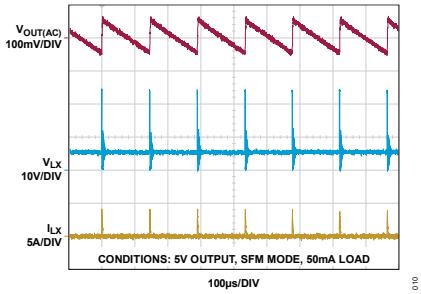

Figure 10. Steady-State Performance

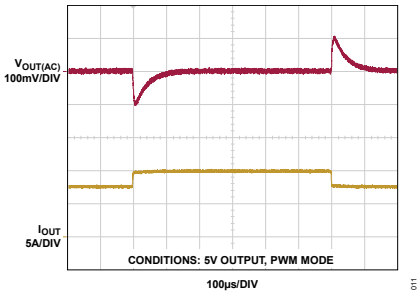

Figure 11. Load Transient Between 7.5A and 10A

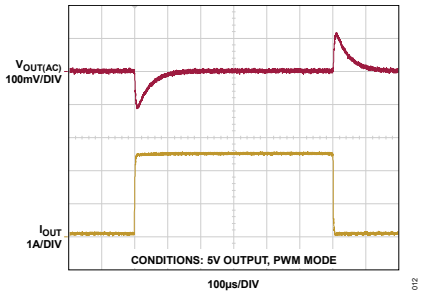

Figure 12. Load Transient Between 10mA and 2.5A

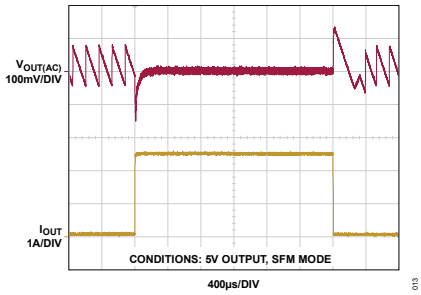

Figure 13. Load Transient Between 50mA and 2.5A

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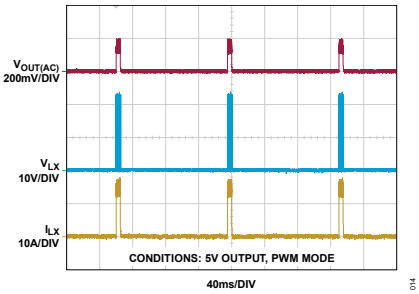


Figure 14. Overload Protection

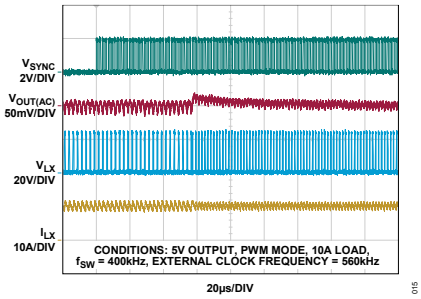


Figure 15. External Clock Synchronization

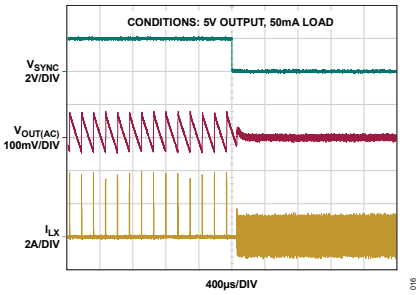


Figure 16. Dynamic Mode Change

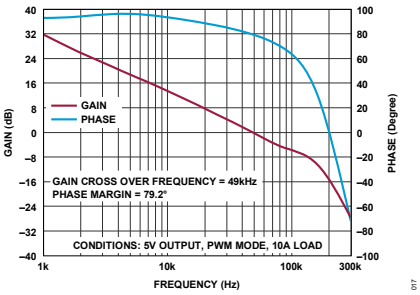


Figure 17. Gain/Phase vs. Frequency

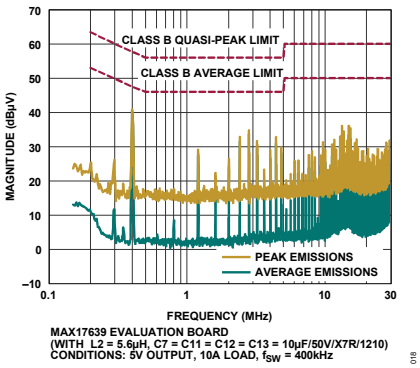


Figure 18. CISPR 32 Conducted Emission Test with Class B Limits

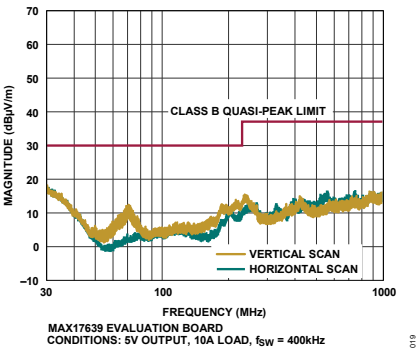
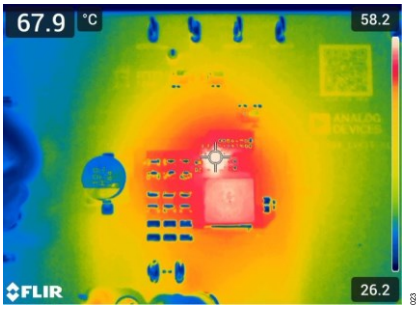


Figure 19. CISPR 32 Radiated Emission Test with Class B Limits



MAX17639 EVALUATION BOARD
CONDITIONS: 5V OUTPUT, 10A LOAD, f_{SW} = 400kHz

Figure 20. Thermal Performance with 24V Input

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Detailed Description

The MAX17639 5V output evaluation board is designed to demonstrate the salient features of the MAX17639 high-voltage, high-efficiency, synchronous step-down DC-DC converter. The evaluation board is preset for 5V output from 6.5V to 36V input, can deliver load current up to 10A, 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 MAX17639 is enabled when the input voltage rises above 6.5V. To disable the MAX17639, 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 *MAX17639* 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 be 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 MAX17639 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 R9 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 *MAX17639* 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 SGND	PWM Mode of Operation

**Default position.*

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Setting Switching Frequency

The switching frequency of the MAX17639 can be programmed from 400kHz to 2.2MHz by using a resistor connected from the RT pin to SGND. Resistor R9 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. Refer to the *Setting the Switching Frequency (RT)* section in the *MAX17639* 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 C37. 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 *MAX17639* data sheet to calculate the soft-start capacitor value.

Adjusting Output Voltage

The MAX17639 supports a 0.6V to (0.9 x V_{IN})V adjustable output voltage. The MAX17639 evaluation board is configured to a 5V output. The output voltage is programmed using the resistor dividers R6 and R7. Refer to the *Adjusting Output Voltage* section in the *MAX17639* data sheet for more details.

Input Capacitor Selection

The input capacitors 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 *MAX17639* data sheet to choose input capacitance. The input capacitors C10, C17–C20, and C38 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 C25, C26, and C27 are chosen as 47µF/10V. Refer to the Output capacitor selection section in the *MAX17639* 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 2.2V(typ), internal V_{CC} is powered from V_{IN}. In this evaluation board, EXTVCC is connected to V_{OUT}.

Output-Voltage Status and Die Temperature Monitor ($\overline{RESET}$/TJ)

The MAX17639 offers a $\overline{RESET}$/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 *Output-Voltage Status and Die Temperature Monitor ($\overline{RESET}$/TJ)* section in the *MAX17639* data sheet for more details.

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

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

**Default position.*

Hot Plug-In and Long input cables

The MAX17639 5V output evaluation board provides an optional electrolytic capacitor C16 (100µF/50V) 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.

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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 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 the CISPR32 Class B limits. Further, capacitors placed near the input of the board help attenuate high-frequency noise.

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Component Suppliers

SUPPLIER	WEBSITE
Murata Americas	www.murata.com
Coilcraft	www.coilcraft.com
Vishay	www.vishay.com
Panasonic Corp.	www.panasonic.com
Venkel Ltd.	www.venkel.com
Yageo	www.yageo.com
Sullins Corp.	www.sullinscorp.com
Keystone	www.keyelco.com
TDK	www.tdk.com
Wurth Elektronik	www.we-online.com
Kyocera AVX	www.kyocera-avx.com

***Note**: Indicate that you are using the MAX17639 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17639EVKITA#	EV Kit

#Denotes RoHS-compliance.

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MAX17639EVKITA Bill of Materials

ITEM	QTY	REFERENCE	DESCRIPTION	MANUFACTURER	PART NUMBER
REQUIRED CIRCUIT COMPONENTS					
1	3	C1, C21, C23	0.1µF, ±10%, 100V, X7R, Ceramic Capacitor (0603)	MURATA	GRM188R72A104KA35D
2	1	C2	150pF, ±5%, 100V, C0G, Ceramic Capacitor (0402)	TDK	C1005C0G2A151J050BA
3	6	C10, C17, C18, C19, C20, C38	4.7µF, ±10%, 50V, X7R, Ceramic Capacitor (1206)	MURATA	GRM31CR71H475KA12L
4	2	C15, C33	0.1µF, ±10%, 16V, X7R, Ceramic Capacitor (0402)	MURATA	GRM155R71C104KA88
5	1	C16	100µF, ±20%, 50V, Electrolytic Capacitor	PANASONIC	EEETG1H101UP
6	3	C25, C26, C27	47µF, ±20%, 10V, X7R, Ceramic Capacitor (1210)	MURATA	GRM32ER71A476ME15
7	1	C36	4.7µF, ±20%, 10V, X7R, Ceramic Capacitor (0603)	MURATA	GRM188Z71A475ME15D
8	1	C37	8200pF, ±10%, 50V, X7R, Ceramic Capacitor (0402)	VENKEL LTD.	C0402X7R500822KNP
9	1	C9	1.5pF, ±0.1pF, 50V, C0G, Ceramic Capacitor (0402)	AVX	04025U1R5BAT2A
10	1	FB1	100Ω, ±25%, 8A, Ferrite Bead (0805)	WURTH ELEKTRONIK	74279226101
11	1	L1	3.3µH, ±20%, 26A, Inductor	COILCRAFT INC.	XGL1010-332MED
12	1	R1	3.32MΩ, 1%, 1/16W, Resistor (0402)	VISHAY	CRCW04023M32FK
13	1	R2	845kΩ, 1%, 1/16W, Resistor (0402)	VISHAY	CRCW0402845KFKED
14	1	R3	20kΩ, 1%, 1/16W, Resistor (0402)	VISHAY	CRCW040220K0FK
15	1	R4	0Ω, 1%, JUMPER, 1/16W, Resistor (0402)	YAGEO	RC0402FR-070RL
16	1	R5	0Ω, 1%, JUMPER, 1/10W, Resistor (0402)	PANASONIC	ERJ-2GE0R00
17	1	R6	249kΩ, 1%, 1/16W, Resistor (0402)	VISHAY	CRCW0402249KFK
18	1	R7	34kΩ, 1%, 1/16W, Resistor (0402)	VISHAY	CRCW040234K0FKED
19	1	R9	75kΩ, 1%, 1/16W, Resistor (0402)	YAGEO	CRCW040275K0FK
20	1	U1	4mm x 4mm, FC2QFN18-EP, IC Regulator	ANALOG DEVICES	MAX17639AFN+
OPTIONAL CIRCUIT COMPONENTS					
21	4	C7, C11, C12, C13	10µF, ±10%, 50V, X7R, Ceramic Capacitor (1210)	TDK	C3225X7R1H106K250AC
22	1	L2	5.6µH, ±20%, 8A, Inductor	COILCRAFT INC.	XGL5050-562MED
23	4	C4, C32, C34, C35	Open, Ceramic Capacitor (0402)	—	—

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24	7	C5, C6, C8, C14, C28, C29, C30	Open, Ceramic Capacitor (1210)	—	—
25	2	C22, C24	Open, Ceramic Capacitor (0603)	—	—
26	1	C31	Open, Ceramic Capacitor (0805)	—	—
27	2	C39, C40	Open, Ceramic Capacitor (1206)	—	—
28	1	R10	Open, Resistor (0402)	—	—
HARDWARE: FOR EVALUATION BOARD ONLY					
29	2	JU1, JU3	3 Pins, Male, Header Connector	SULLINS	GRPB031VWVN-RC
30	1	JU2	2 Pins, Male, Header Connector	SULLINS	GRPB021VWVN-RC
31	3	SU1, SU2, SU3	2 Pins, Female, Shunt Connector	SULLINS	NPB02SVAN-RC
32	1	VEXT	Pin Dia = 0.1in, Total Length = 0.4in, Test Point	KEYSTONE ELECTRONICS	5001
33	4	PGND, PGND1, VIN, VOUT	5.2mm Dia X 5.5mm Length, Banana Jack	KEYSTONE ELECTRONICS	575-4
34	4	MECH1-MECH4	Round-Thru Hole Spacer	KEYSTONE ELECTRONICS	9032
35	8	EN/UVLO, MODE/SYNC, RESET, SGND, PGND, PGND1, VIN_EMI, VOUT	20AWG, Solid Wire	WEICO WIRE AND CABLE INC	9020 BUSS

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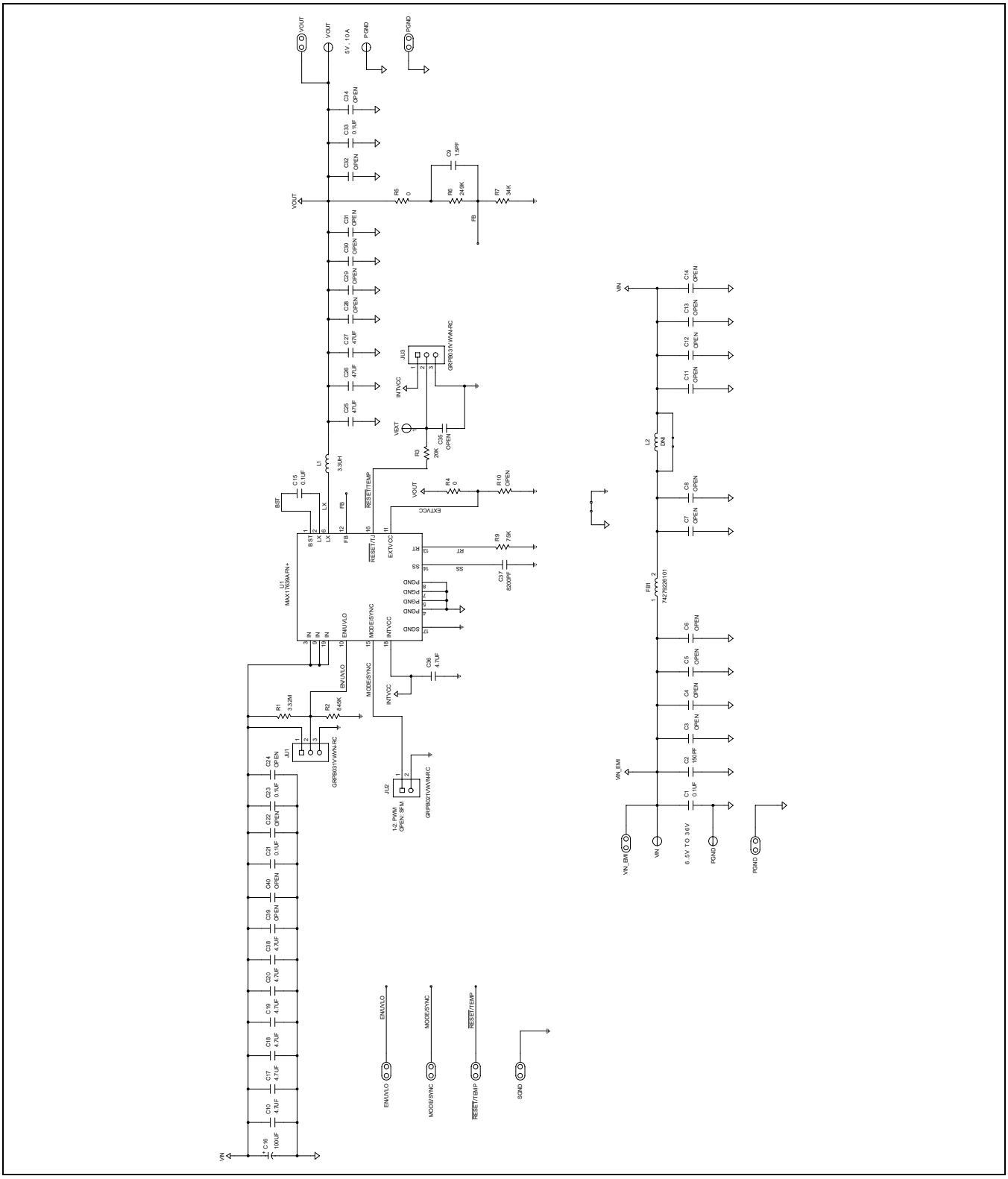
MAX17639EVKITA Schematic



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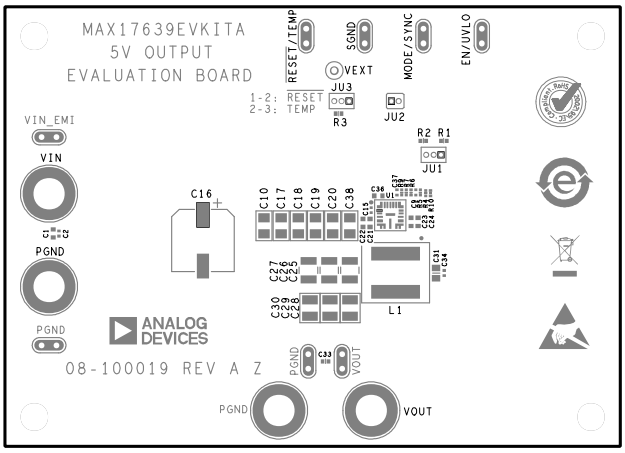
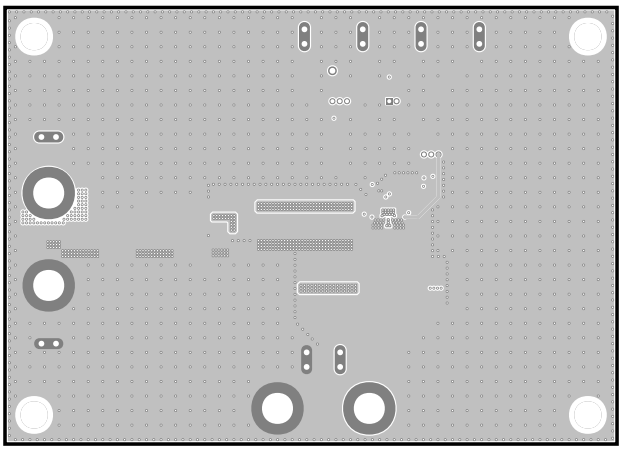
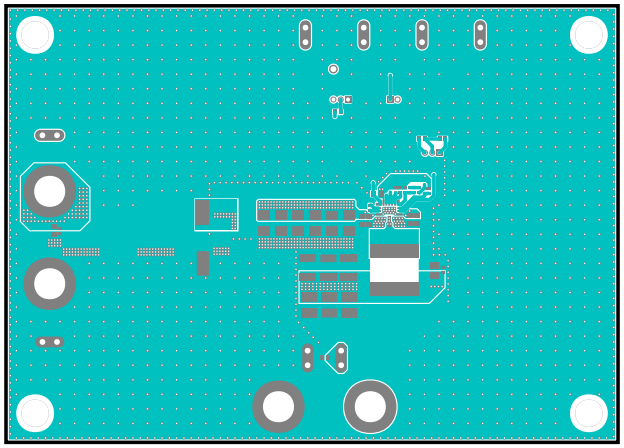
MAX17639EVKITA PCB Layout



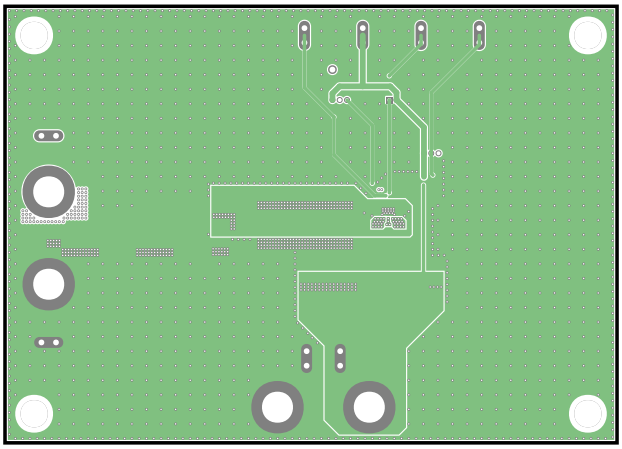
MAX17639EVKITA Component Placement Guide—Top Silkscreen



MAX17639EVKITA PCB Layout—Layer 2



MAX17639EVKITA PCB Layout—Top



MAX17639EVKITA PCB Layout—Layer 3

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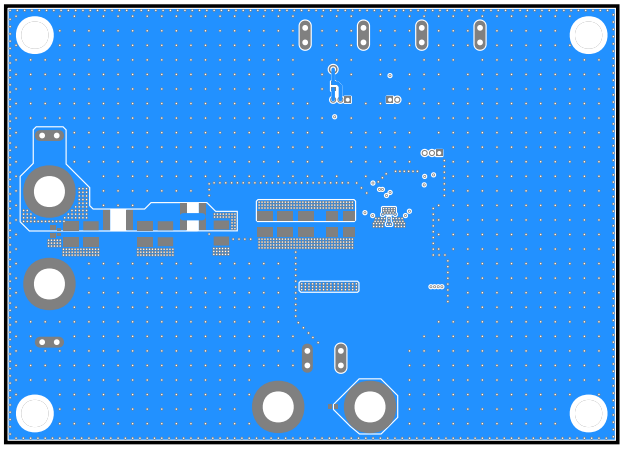
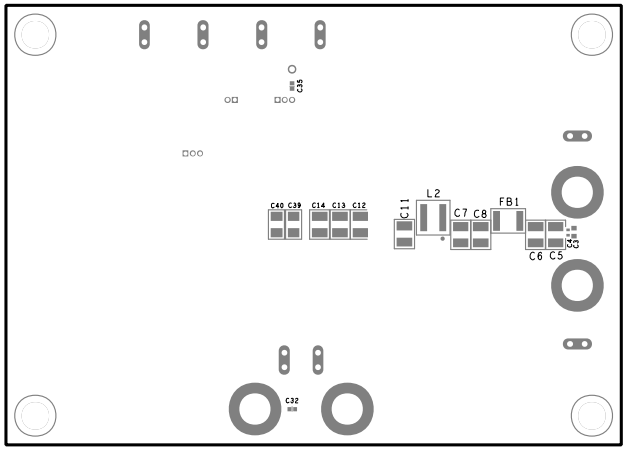
MAX17639EVKITA PCB Layout (continued)



MAX17639EVKITA PCB Layout—Bottom



MAX17639EVKITA Component Placement Guide—Bottom Silkscreen

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/25	Initial Release	—
1	4/26	Updated General Description section	1
2	6/26	Added MAX17638 and MAX17636 to the title	1

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Notes

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