Click here to ask an associate for production status of specific part numbers.

Evaluates: MAX16984 (MAX16984R/ MAX16984S in CQFN package)

MAX16984L Evaluation Kit

General Description

The MAX16984L evaluation kit (EV kit) demonstrates the MAX16984L automotive high-efficiency step-down DC-DC converter with integrated USB protection and host charger adapter.

The MAX16984L features integrated host-charger port-detection circuitry adhering to the USB 2.0 BC1.2 battery charging specification and also features circuitry for Apple® iPod®/iPhone® 1.0A and iPad® 2.1A dedication charging modes.

The MAX16984L integrates high-side current sensing and voltage-adjustment circuitry that provides automatic USB voltage adjustment to compensate for voltage drops in captive cables associated with automotive applications.

The MAX16984L step-down DC-DC converter operates from a voltage of up to 28V continuous and is protected from load dump transients to 42V. The converter is resistor-programmable for frequencies from 220kHz to 2.2MHz and can deliver 2.1A continuously.

The EV kit is configured for 2.2MHz operation, and the included 3-meter USB cable allows for demonstration of the cable compensation capability of the MAX16984L. This EV kit has been tuned for optimal EYE quality at the end of the supplied USB cable; this tuning method is referred to as far-eye tuning. The USB 2.0 high-speed eye diagram for this EV kit is shown in Figure 1.

Features

- Configurable Charge Detection Modes
  - USB-IF BC1.2 CDP, DCP
  - Apple 2.1A, 1.0A
  - China YD/T1591-2009 Charging Specification
- Automatic USB Voltage Adjustment by Integrated DC-DC Converter (220kHz to 2.2MHz)
- Proven PCB Layout
- Fully Assembled and Tested

Quick Start

Required Equipment

The EV kit comes configured as follows:

- SW1: CD0 = 0, CD1 = 1: Set up to enumerate an iPad or USB2.0 BC1.2-compliant portable device
- SW2: BUCKEN = 1, SYNCEN = 0: HVBUS supply enabled
- Current limit: 2.3A: R7 = 4.22kΩ
- Switching frequency: 2.2MHz: R2 = 12.1kΩ
- Current sensing bandwidth: 114kHz: R7 = 4.22kΩ, C7 = 330pF
- Voltage adjustment bandwidth: 104kHz: R8 = 4.64kΩ, C9 = 330pF
- Voltage adjustment performance: 25%: FBPER pin pulled to ground with 0Ω jumper
- Maximum voltage adjustment: occurs at 2.1A: R8 (RFBMAX) = 4.64kΩ
- Forced-PWM: enabled: SYNC pin tied to 3.3V with jumper; remove jumper to enable SKIP mode

Battery-voltage input should be connected between the EXT_VBAT and GND2 test loops. The MAX16984L's DC-DC converter output voltage can be measured between HVBUS and GND1 nodes or between the ground and +5V pins of the USB connector. To disable the voltage-adjustment feature, connect the FBMAX node on JU1 to the ground. The $\overline{FAULT}$ output is active-high.

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

Apple, iPod, iPhone, and iPad are registered trademarks of Apple, Inc.

319-100836; Rev 1; 11/21

Evaluation Kit Setup

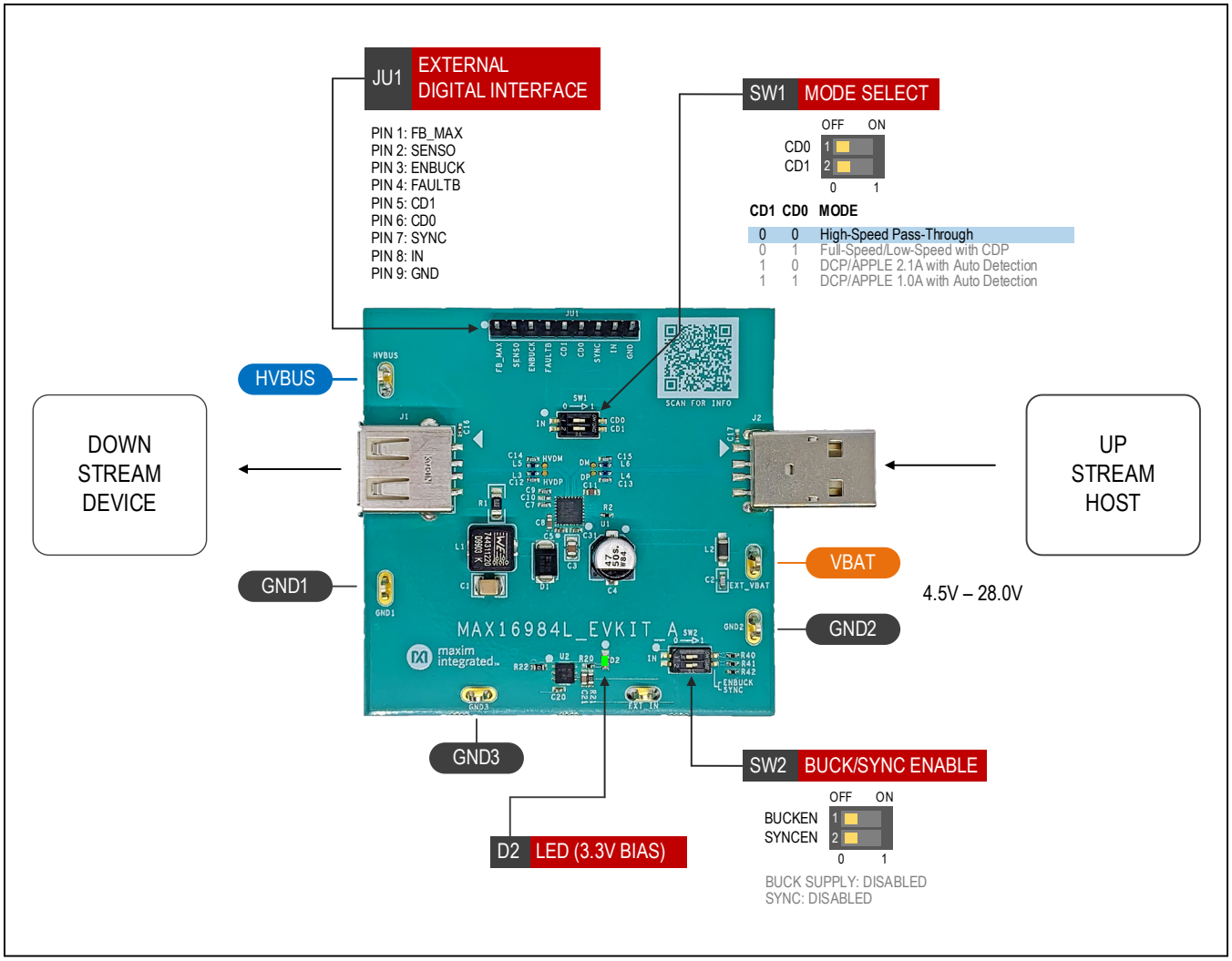


Figure 1. MAX16984L Evaluation Kit Configuration

External Digital Interface Header

Header JU1 is provided to allow access to the device control signals. Table 1 lists the individual pins and their functions.

SW1 controls the inputs for CD0 and CD1. The MAX16984L charge detection modes can be selected by enabling or disabling the appropriate DIP switch. Table 2 shows the switch configuration for the different charge modes.

JU1 pins 5 and 6 can also be used to control the charge mode externally.

SW2 controls the inputs for the MAX16984L BUCKEN and SYNC pins. The switch selections are shown in Table 3. Header JU1 pin 3 allows external control of the ENBUCK input, and JU1 pin 7 may be used to externally control the SYNC pin.

Table 1. External Digital Interface

JU1 PIN	NAME	DESCRIPTION
1	FBMAX	Voltage-adjustment feedback (output)
2	SENSO	Current sense (output)
3	ENBUCK	Active-low enable for buck regulator
4	FAULT	Active-high FAULT (output)
5	CD1	Charge-detection configuration bit 1 (input)
6	CD0	Charge-detection configuration bit 0 (input)
7	SYNC	Buck regulator SYNC (input)
8	IN	Evaluation kit 3.30V bias (input)
9	GND	Evaluation kit ground

Evaluating Buck SKIP Mode

Equipment Required

- MAX16984L evaluation kit
- Bench power supply able to source 14VDC/4A
- Digital voltmeter
- Oscilloscope

Procedure

1) Configure SW1 and SW2.
2) Setup test equipment as shown in Figure 3.
3) Observe the oscilloscope waveform is similar to Figure 4.

Table 2. SW1 Charge Mode Configuration

CD1	CD0	MODE
0	0	High-speed pass-through
0	1	Full-speed/low-speed with CDP
1	0	DCP/Apple 2.1A with auto detection
1	1	DCP/Apple 1.0A with auto detection

Table 3. SW2 Buck Supply Enable and SYNC Pin Direction

SW2	STATE	DESCRIPTION
PINS 1-4	0	BUCKEN: Buck supply DISABLED
	1	BUCKEN: Buck supply ENABLED
PINS 2-3	0	SYNC: DISABLED | Buck SKIP Mode ENABLED
	1	SYNC: ENABLED | Buck in FORCED PWM mode

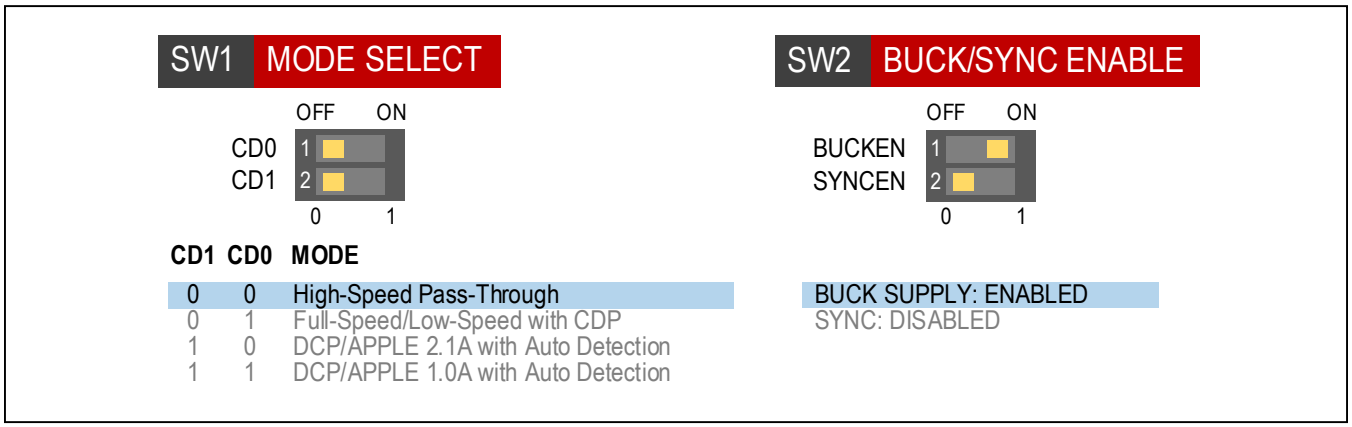


Figure 2. DIP Switch Selections for Buck SKIP Mode

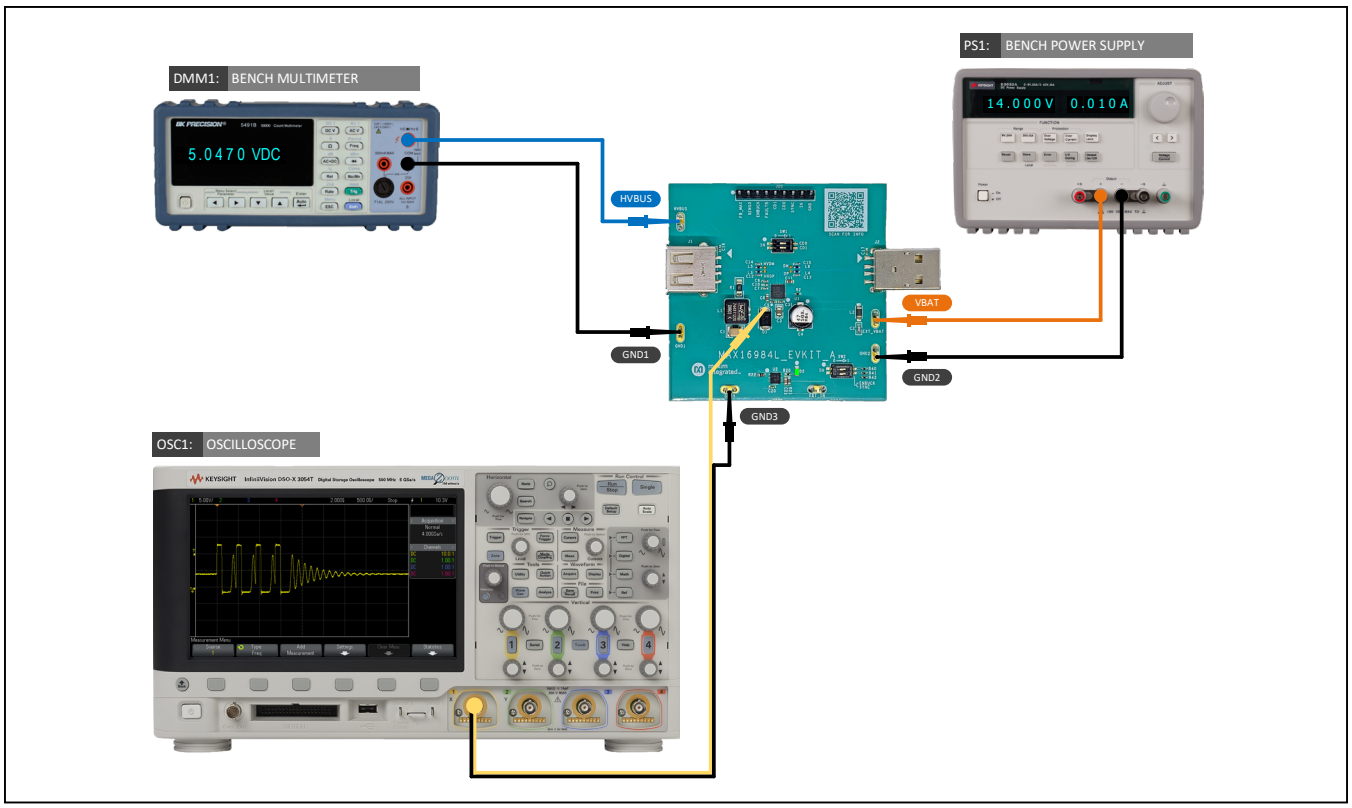


Figure 3. Test Setup for Buck SKIP Mode

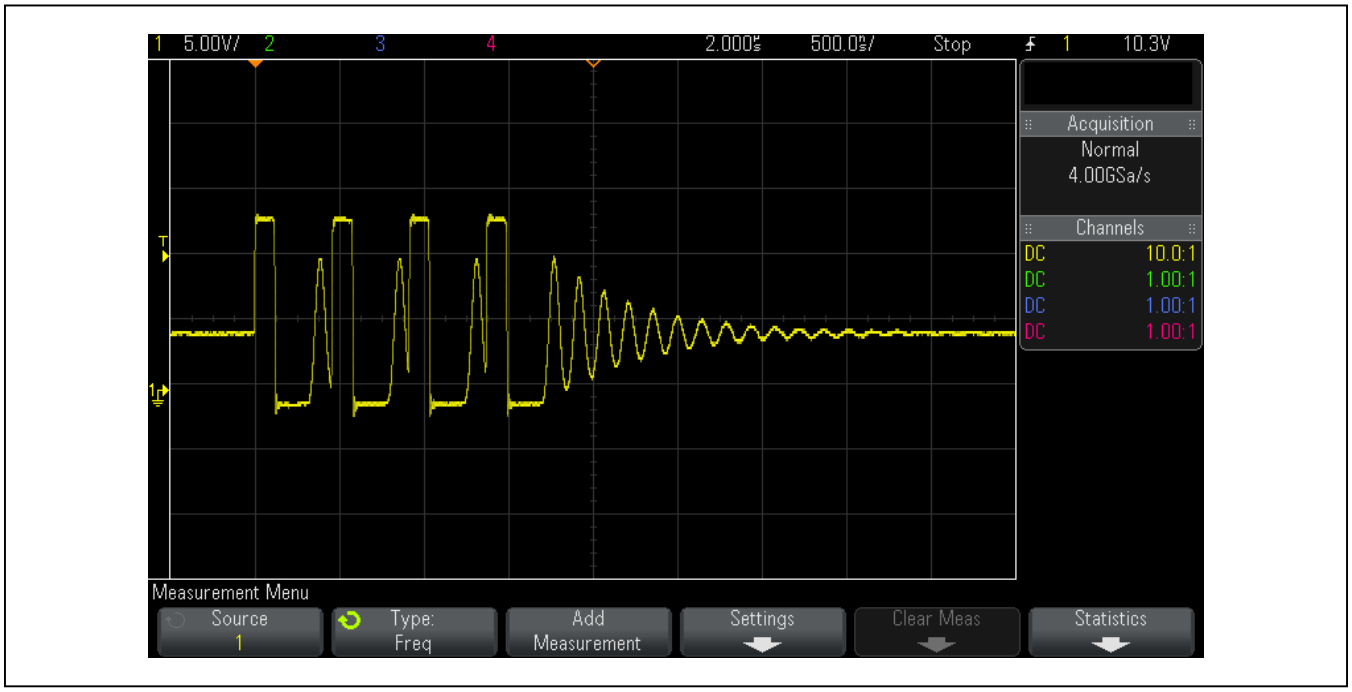


Figure 4. Oscilloscope Measurement for Buck SKIP Mode

Evaluating Buck Forced PWM Mode

Equipment Required

- MAX16984L evaluation kit
- Bench power supply able to source 14VDC/4A
- Digital voltmeter
- Oscilloscope

Procedure

1) Configure SW1 and SW2 as depicted in Figure 5.
2) Setup test equipment as shown in Figure 6, with PS1 DISABLED.
3) Set bench power supply PS1 to 14V, and ENABLE the output.
4) Observe that the oscilloscope waveform is similar to that shown in Figure 7.

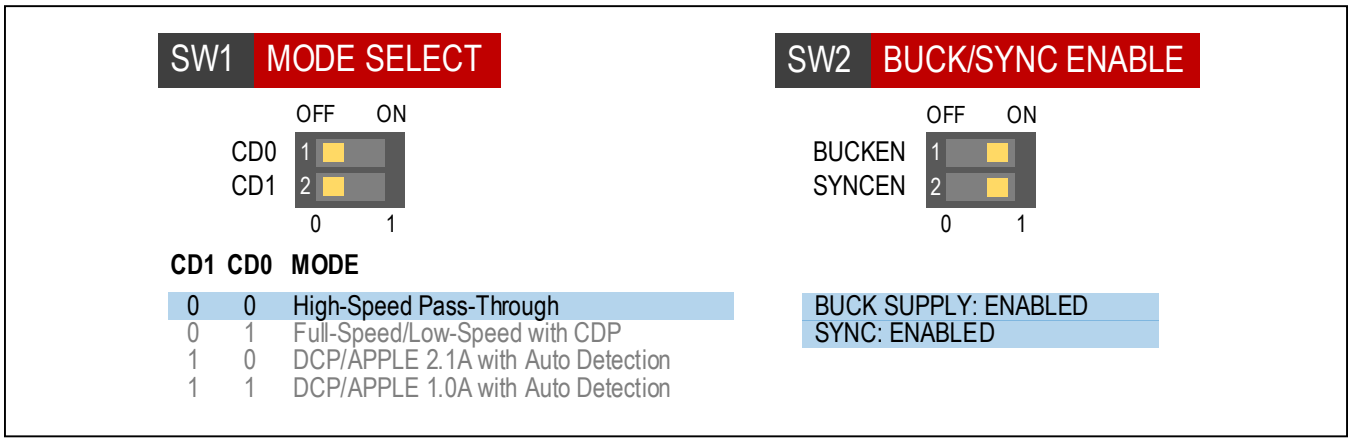


Figure 5. DIP Switch Selections for Buck Forced PWM Mode

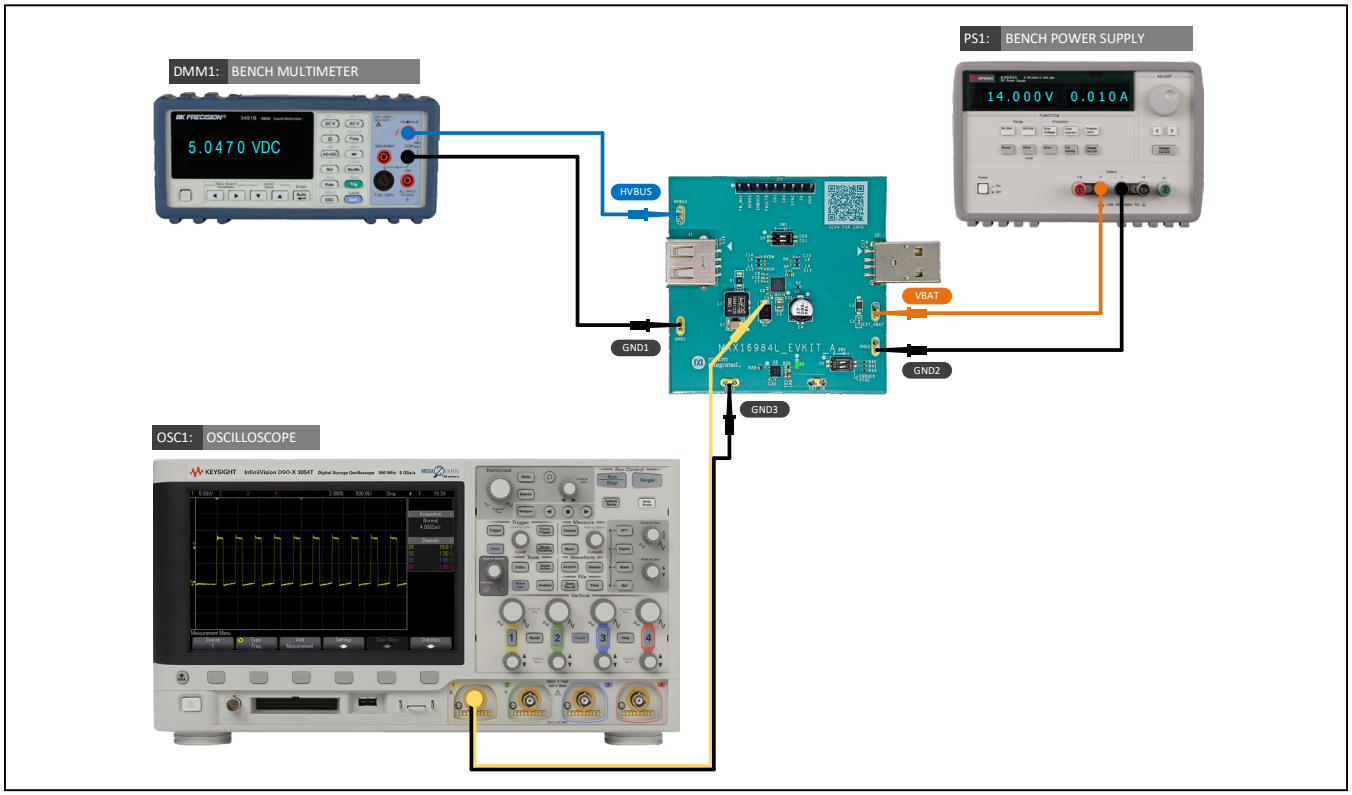


Figure 6. Test Setup for Buck FORCED PWM Mode

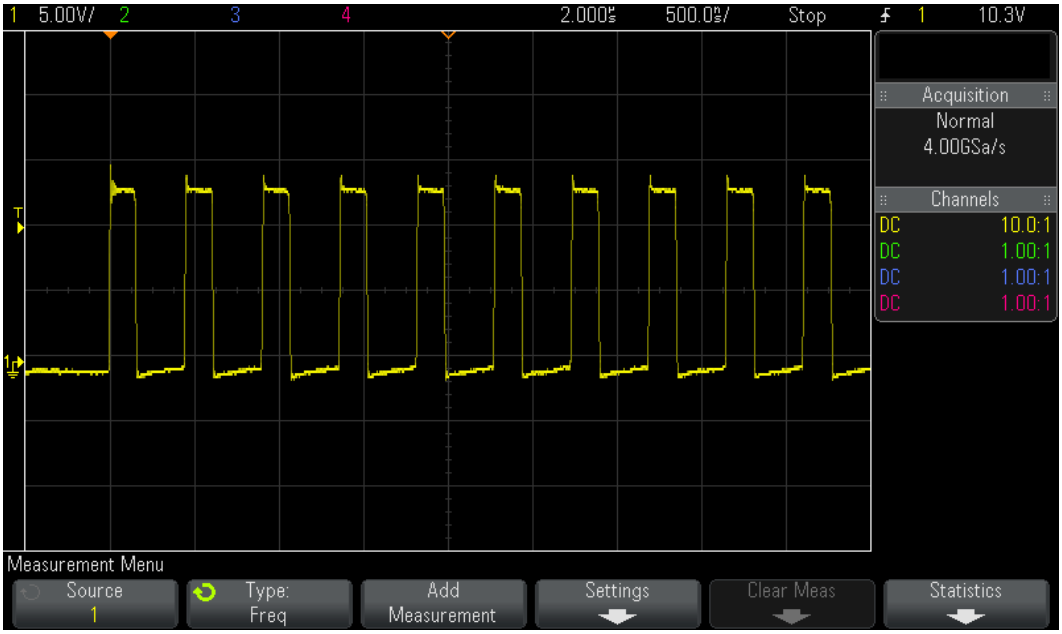


Figure 7. Oscilloscope Measurement for Buck FORCED PWM Mode

Evaluating Cable Compensation

Equipment Required

- MAX16984L evaluation kit
- Bench power supply able to source 14VDC/4A
- 2x digital voltmeters
- 2-meter USB extension cable, Type-A (male) to Type-A (female)
- 2.5Ω/20W load resistor connected between the VBUS and GND pins of a USB-A plug (male)

Procedure

1) Set DIP switches SW1 and SW2 as shown in Figure 8.
2) Setup test equipment as shown in Figure 9 with PS1 DISABLED and the 2.5Ω load resistor unplugged.
3) ENABLE PS1 and observe that the DC voltage measured by both DMM1 and DMM2 are approximately 5.1V.
4) Insert the USB-A plug with the 2.5Ω load resistor at the far end of the 2-meter extension cable.
5) Observe that the DC voltage measured by DMM1 (HVBUS on the evaluation kit) is approximately 6.05V, and the DC voltage measured by DMM2 (across the 2.5Ω load resistor at the far end of the extension cable) is approximately 5.25V.

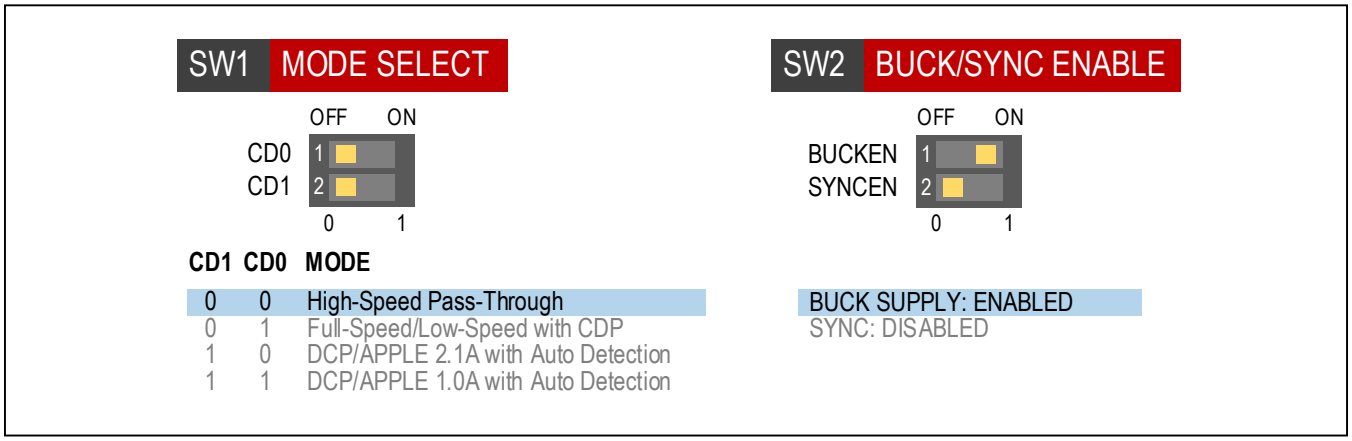


Figure 8. SW1 and SW2 Selections for SKIP Mode

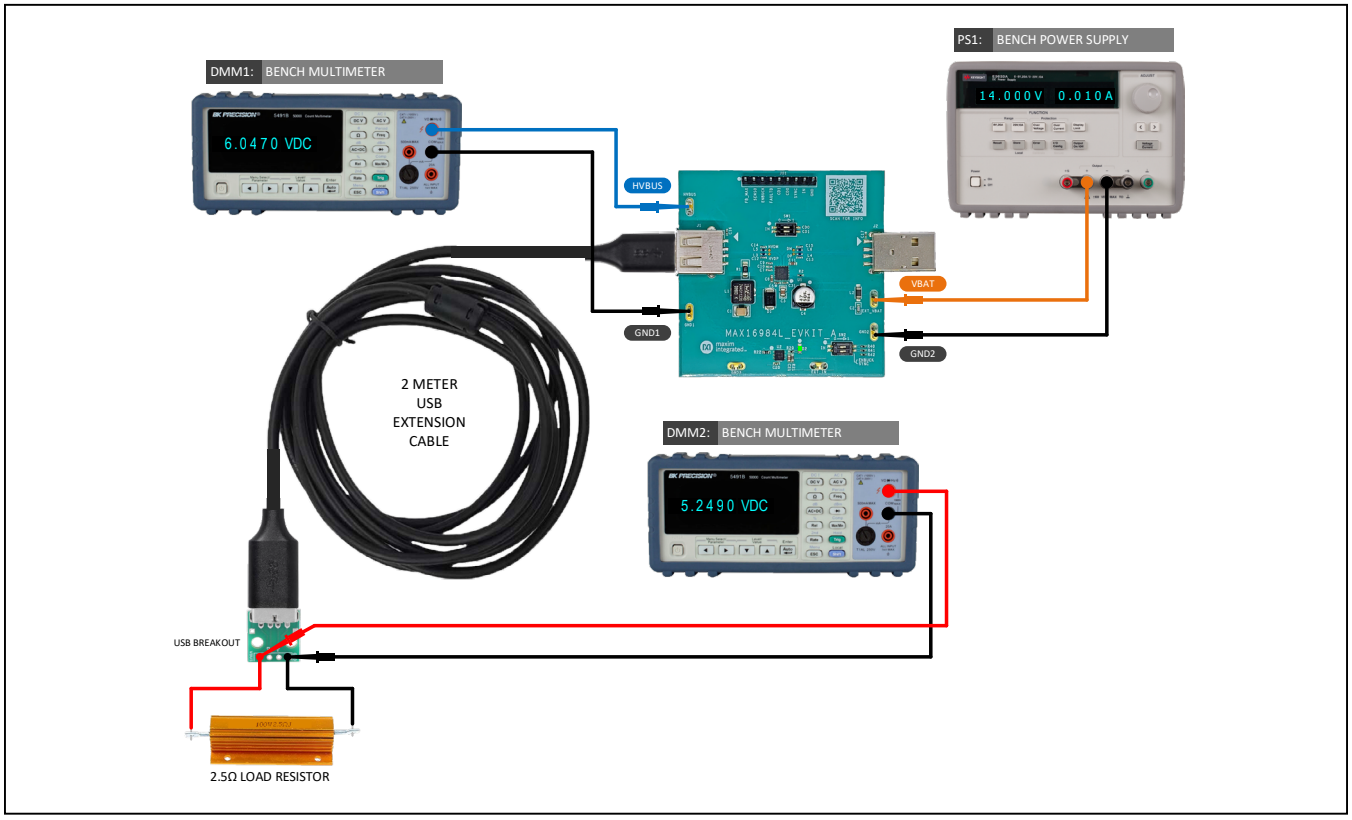


Figure 9. Setup for Evaluating Cable Compensation

Ordering Information

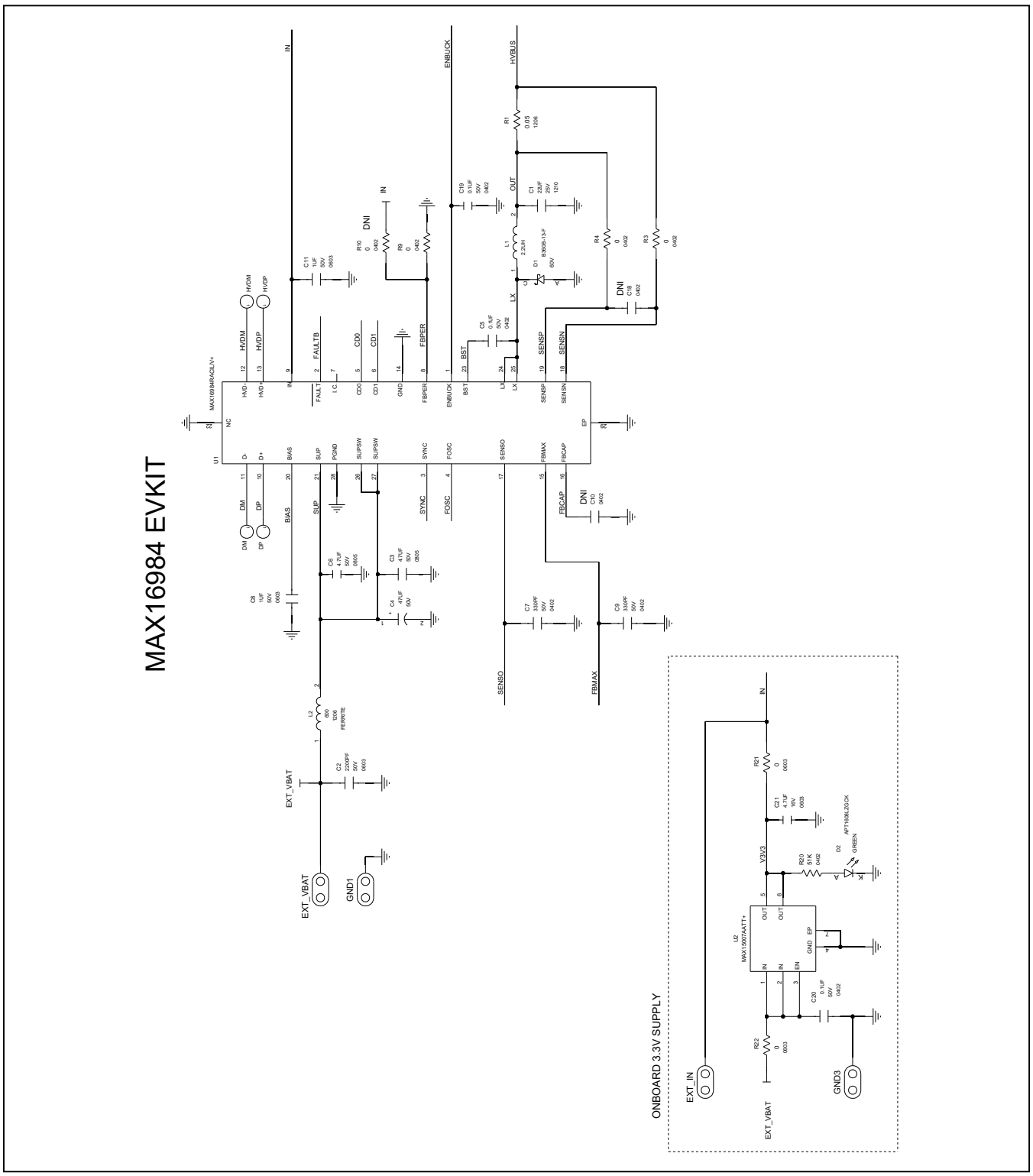
PART	TYPE
MAX16984LEVKIT#	EV Kit

#Denotes RoHS compliance.

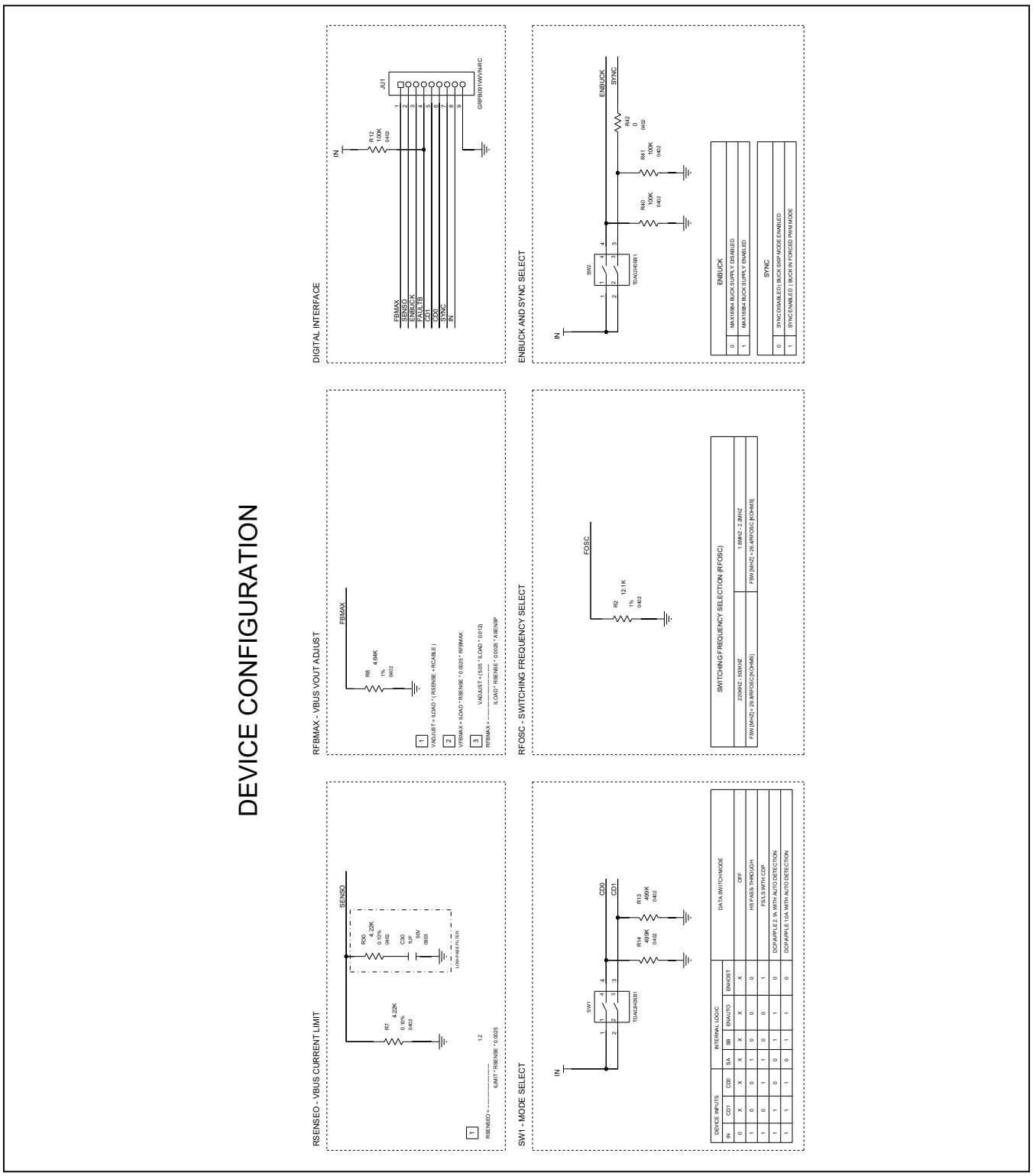
MAX16984L EV Kit Bill of Materials

QTY	REF DES	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
4	BUMPER1-BUMPER4	SJ-5306(CLEAR)	3M ELECTRONIC SOLUTIONS DIVISION	SJ-5306(CLEAR)	BUMPER PAD
1	C1	GRM32ER71E226M	MURATA;MURATA;TDK	22UF	SMT CERAMIC CAPACITOR, 25V, X7R, 1210
1	C2	GRM1885C1H222JA01	MURATA	2200PF	SMT CERAMIC CAPACITOR, 50V, 0603
2	C3, C6	C2012X5R1H475K125AB	TDK	4.7UF	SMT CERAMIC CAPACITOR, 50V, X5R, 0805
1	C4	EEE-1HA470XP	PANASONIC	47UF	SMT ALUMINUM-ELECTROLYTIC CAPACITOR, 50V, CASE D8
6	C5, C10, C17-C19, C31	CGA2B3X7R1H104K050BB	TDK;MURATA;TDK	0.1UF	SMT CERAMIC CAPACITOR, 50V, X7R, 0402
2	C7, C9	GRM1555C1H331FA01	MURATA	330PF	SMT CERAMIC CAPACITOR, 50V, 0402
3	C8, C11, C30	UMK107BJ105KA	TAIYO YUDEN;TDK;SAMSUNG;MURATA	1UF	SMT CERAMIC CAPACITOR, 50V, X5R, 0603
2	C12, C14	GRM1555C1H6R0BA01	MURATA	6PF	SMT CERAMIC CAPACITOR, 50V, 0402
2	C13, C15	C1005C0G1H020B050	TDK;MURATA	2PF	SMT CERAMIC CAPACITOR, 50V, 0402
1	C16	CGA2B1X7R1V224K050BE	TDK	0.22UF	SMT CERAMIC CAPACITOR, 35V, X7R, 0402
1	C20	C1005X7R1H104K050BB	TDK;MURATA;TDK;TAIYO YUDEN	0.1UF	SMT CERAMIC CAPACITOR, 50V, X7R, 0402
1	C21	GRM188Z71C475KE21	MURATA	4.7UF	SMT CERAMIC CAPACITOR, 16V, X7R, 0603
1	D1	B360B-13-F	DIODES INCORPORATED	B360B-13-F	SMB, SCHOTTKY BARRIER DIODE, PIV=60V, Io=3A
1	D2	APT1608LZGCK	KINGBRIGHT	APT1608LZGCK	SMT LED, GREEN, 0603
1	J1	KUSBX-SMT-AS1N-W30	KYCON	KUSBX-SMT-AS1N-W30	USB A-TYPE RECEPTACLE (FEMALE), RIGHT ANGLE
1	J2	KUSBX-SMT2AP5S-W	KYCON	KUSBX-SMT2AP5S-W	USB A-TYPE PLUG (MALE), RIGHT ANGLE
1	JU1	PEC09SAAN	SULLINS ELECTRONICS CORP	PEC09SAAN	HEADER, 100MIL SPACING, 9PINS
1	L1	744311220	WURTH ELECTRONICS INC.	2.2UH	SMT INDUCTOR, SHIELDED
1	L2	74279218	WURTH ELECTRONICS INC.	600	SMT FERRITE BEAD, 1206
2	L3, L5	LQW15AN12NH00	MURATA	12NH	SMT INDUCTOR, 0402
2	L4, L6	LQW15AN2N2C10	MURATA	2.2NH	SMT INDUCTOR, 0402
1	L7	BLM41PG600SN1	MURATA	60	SMT FERRITE BEAD, 1806
1	R1	WSLP1206R0500F	VISHAY	0.05	SMT RESISTOR, 1206, 1%
1	R2	CRCW040212K1FK	VISHAY DALE	12.1K	SMT RESISTOR, 0402, 1%
5	R3, R4, R9, R10, R42	ERJ-2GE0R00	PANASONIC	0	SMT RESISTOR, 0402
2	R7, R30	RT0402BRB074K22L	YAGEO PHICOMP	4.22K	SMT RESISTOR, 0402, 0.10%
1	R8	CR0402-16W-4641FT	VENKEL LTD.	4.64K	SMT RESISTOR, 0402, 1%
3	R12, R40, R41	RMCP0402FT100K	STACKPOLE ELECTRONICS INC.	100K	SMT RESISTOR, 0402, 1%
2	R13, R14	CRCW0402499KFK	VISHAY DALE	499K	SMT RESISTOR, 0402, 1%
1	R20	ERJ-2RKF5102	PANASONIC	51K	SMT RESISTOR, 0402, 1%
2	R21, R22	RC0603FR-070RL	YAGEO	0	SMT RESISTOR, 0603, 1%
2	SW1, SW2	TDA02H0SB1	C&K COMPONENTS	TDA02H0SB1	ULTRA-MINIATURE SURFACE MOUNT DIP SWITCH
1	U1	MAX16984RACIL/V+	MAXIM	MAX16984RACIL/V+	AUTOMOTIVE BUCK CONVERTER WITH USB CHARGE DETECTION
1	U2	MAX15007AATT+	MAXIM	MAX15007AATT+	AUTOMOTIVE LINEAR REGULATOR

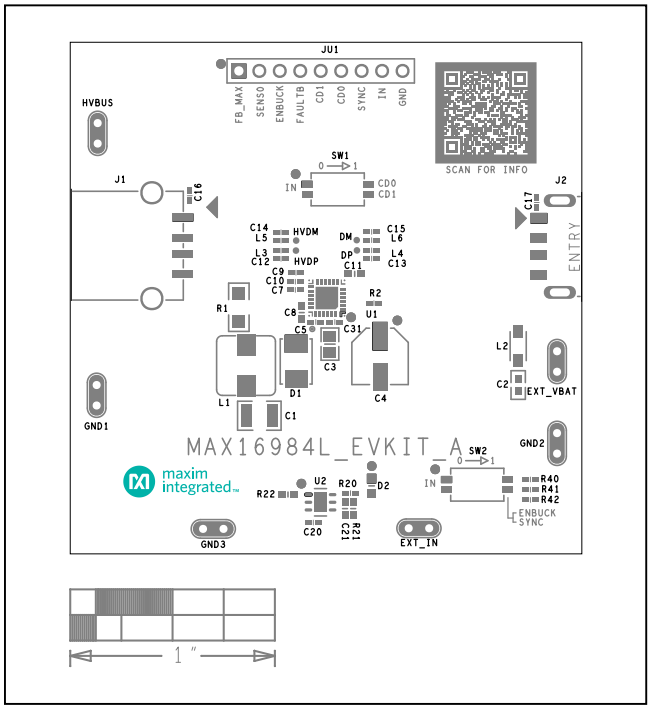
MAX16984L EV Kit Schematic



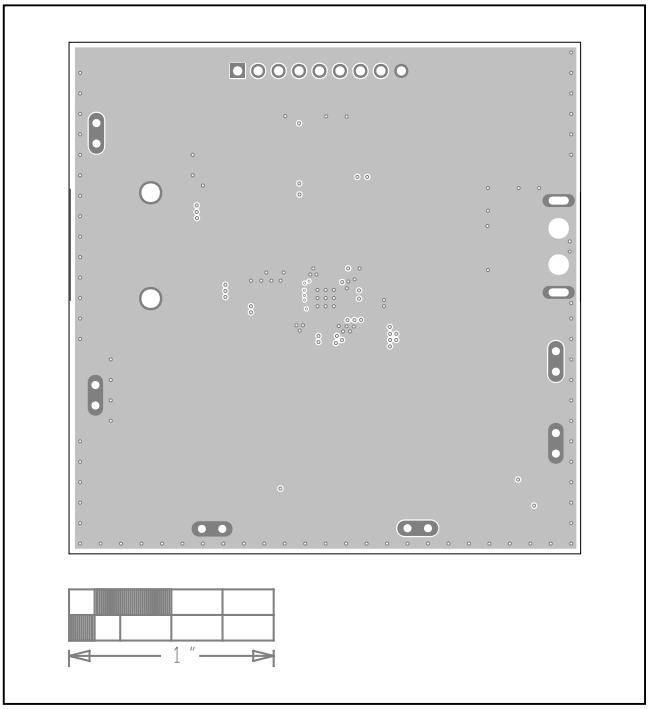
MAX16984L EV Kit Schematic (continued)



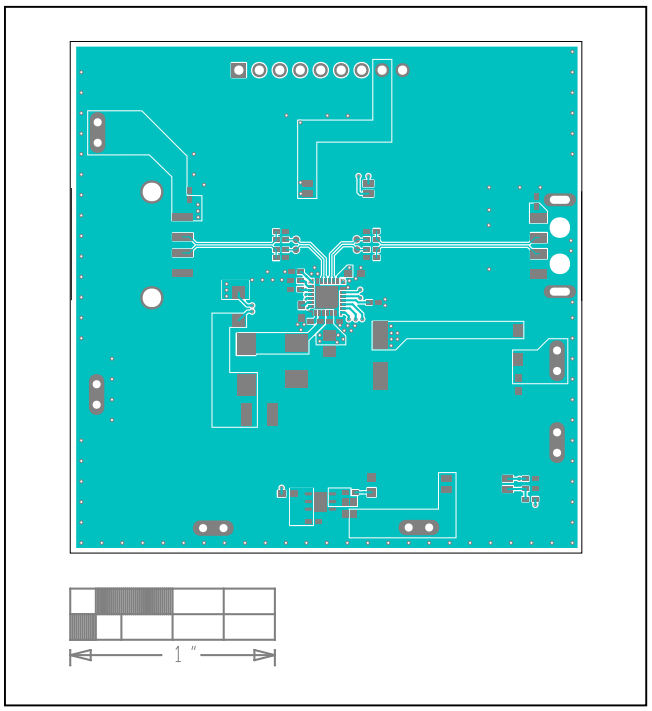
MAX16984L EV Kit PCB Layout Diagrams



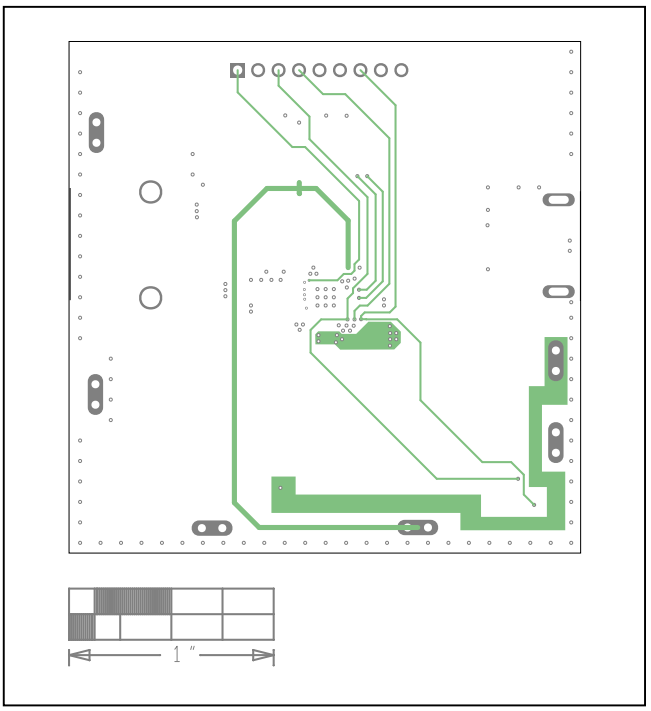
MAX16984L EV Kit PCB Layout—Silk Top



MAX16984L EV Kit PCB Layout—Layer1

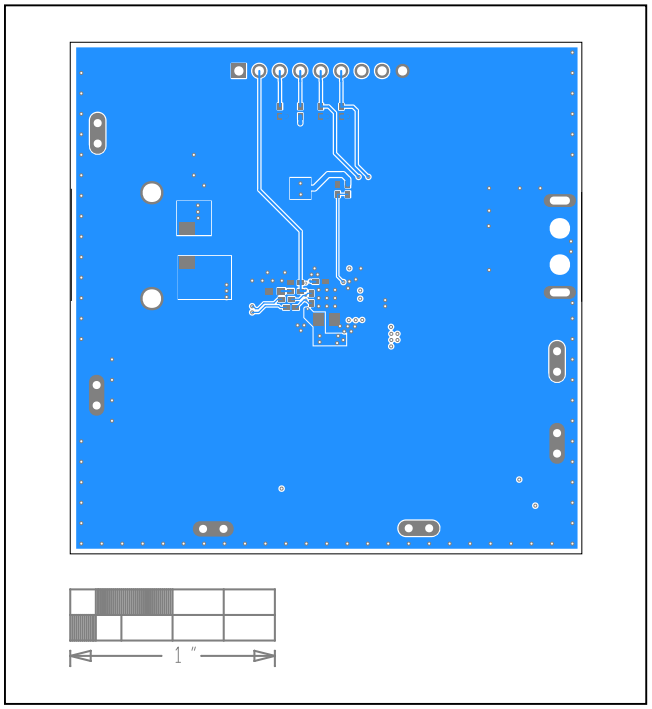


MAX16984L EV Kit PCB Layout—Top

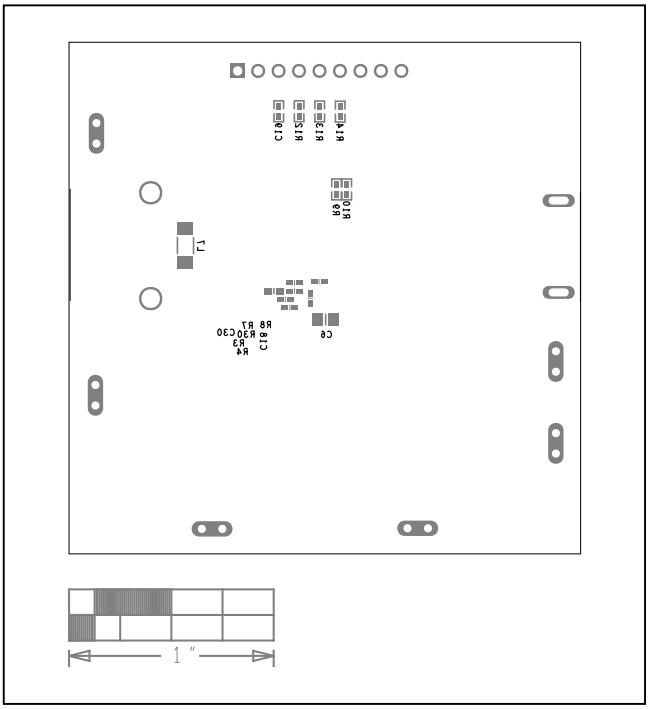


MAX16984L EV Kit PCB Layout—Layer2

MAX16984L EV Kit PCB Layout Diagrams (continued)



MAX16984L EV Kit PCB Layout—Bottom



MAX16984L EV Kit PCB Layout—Silk Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/21	Initial release	—
1	11/21	Updated *Ordering Information* table	7