MAX20096 Evaluation Kit/ MAX20096 Evaluation System

Evaluates: MAX20096

General Description

The MAX20096 evaluation kit (EV kit) provides a proven design to evaluate the MAX20096 dual-channel synchronous buck, high-brightness LED controller with and without SPI interface for high-power HB LED drivers. The EV kit is set up as a dual-buck LED driver and operates from a 4.5V to 65V DC supply voltage. The EV kit is configured to deliver up to 3A in each string of LEDs for both channels. The total voltage of the string can vary from 3V to 55V. The anode of the LED string should be connected to the LED+ terminal; the cathode should be connected to PGND.

Benefits and Features

- 4.5V to 65V Input Voltage
- Drives 1–16 LEDs in Each of the Dual Channels
- 0A to 3A LED Current
- Demonstrates SPI Interface Capability
- Demonstrates PWM Dimming and Analog Dimming Using the SPI Interface
- Demonstrates LED Open/Short Faults Monitoring Using the SPI Interface
- Monitors the LED Current Using the Graphical User Interface (GUI)
- Proven PCB and Thermal Design
- Fully Assembled and Tested

MAX20096 EV Kit Files

FILE	DESCRIPTION
MAX20096EVKit.exe	Windows® GUI Installer

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

Quick Start

Required Equipment

- MAX20096 EV kit
- MINIQUSB interface board and USB cable
- 5V to 65V, 4A DC power supply
- Four digital voltmeters
- Two series-connected HB LED strings rated to no less than 4A
- Two current probes to measure the HB LED current
- Small flat-blade screwdriver to turn the potentiometer wiper adjustment pin

Note: In the following sections, software-related items are identified by bolding. Text in **bold** refers to items directly from the EV kit software. Text in **bold and underlined** refers to items from the Windows operating system.

Procedure

1) Visit **www.maximintegrated/evkitsoftware** to download the latest version of the EV kit software, MAX20096EVKit.exe.
2) Install the EV kit software GUI on your PC by running the MAX20096EVKit.exe program. The EV kit software application will be installed with the required MINIQUSB drivers.
3) Connect the MINIQUSB board to J7 and J14 on the EV kit.
4) If connecting multiple EV kits in a daisy-chain, see the *Daisy-Chain Connections* section.
5) Verify jumper settings, as shown in Table 1 and Table 2.
6) Connect the power supply to the IN and GND1 terminals on the EV kit.
7) Connect the LED loads to the LED1+/GND1 and LED2+/GND2 terminals on the EV kit.
8) Connect the MINIQUSB board to the PC running the software with the provided USB cable.
9) For more details on how to use the GUI and all the features available, click on the GUI Help menu item.

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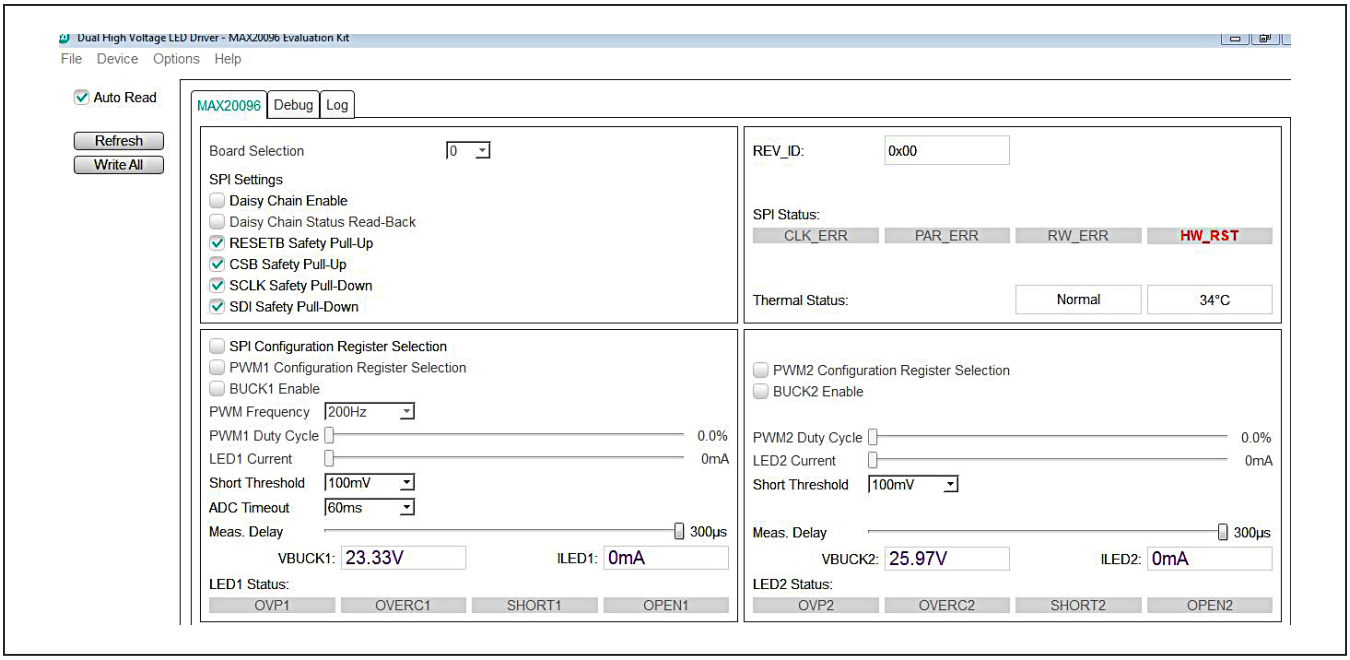


Figure 1. MAX20096 Evaluation Kit Software (GUI Screenshot)

Table 1. Jumper Settings (J1–J6, J12, J15)

JUMPER	SHUNT POSITION		
	1-2	2-3	OPEN
J1	LED2 analog current set by potentiometer	—	LED2 external analog current control on REFI2
J2	Single input supply (V_{IN})	—	Dual input supply (V_{IN} and V_{IN2})
J3	DIM2 pullup to V_{CC}	DIM2 pulldown to GND	DIM2 external control
J4	IC powered by IN	Bypass V_{CC} regulator, V_{IN} range is 4V to 5.5V	—
J5	DIM1 pullup to V_{CC}	DIM1 pulldown to GND	DIM1 external control
J6	LED1 analog current set by potentiometer	—	LED1 external analog current control on REFI1
J12	VIO provided by MINIQUSB board	—	External VIO supply
J15	RESETB pullup	—	No RESETB pullup

Table 2. Jumper Settings for Single Board and Daisy-Chain (J10, J11, J13)

JUMPER	SHUNT POSITION			
	SINGLE BOARD	DAISY-CHAIN (FIRST BOARD)	DAISY-CHAIN (MIDDLE BOARDS)	DAISY-CHAIN (LAST BOARD)
J10	1-2	1-2	2-3	2-3
J11	Open	1-2	Open	2-3
J13	1-2	2-3	2-3	2-3

Daisy-Chain Connections

When connecting multiple EV kits in a daisy-chain, only connect to the MINIQUSB board from the first EV kit. The other EV kits do not require the MINIQUSB boards; if present, they should not be connected through the USB. Connect J9 of the first EV kit to J8 of the next EV kit, then connect J9 of the second board to J8 of the next board, and so on. **Note:** Do not connect to J9 of the last board or to J8 of the first board. Configure the jumpers on these boards per Table 2.

The EV kit software automatically detects the daisy-chain configuration when it first starts up and connects. If this configuration is changed while the software is running, the user must reconnect by pressing F9 or selecting **Connect** from the **Device** menu bar. Select which board to be controlled by the software from the **Board Selection** drop-down list. The **0** corresponds to the first EV kit board in the daisy-chain; the highest numbered board is the last one in the daisy-chain.

Detailed Description

The MAX20096 EV kit demonstrates the MAX20096 dual-channel synchronous buck controller for high-power HB LED drivers with and without SPI interface. The IC consists of a dual-channel, fully synchronous step-down converter with external MOSFETs. The IC also includes the SPI interface, which can be used for PWM dimming, analog dimming, fault monitoring, turning on and off the dual channels individually, monitoring the LED output voltage, and reading the LED currents of each channel. The IC can drive a series string of LEDs at currents as high as 3A. The IC uses a proprietary average current-mode-control scheme to regulate the inductor current. This control method does not need any control-loop compensation, maintaining nearly constant switching frequency. Inductor current sense is achieved by sensing the current in the bottom synchronous n-channel MOSFET. The EV kit is configured to deliver up to 3A to a series LED string. The string-forward voltage can vary from 3V to 55V.

PWM Dimming

The GUI that comes with the EV kit communicates to the SPI interface of the IC so PWM dimming can be done. The dimming frequency can be varied from 200Hz to 2kHz through the GUI. The duty cycle can also be adjusted to control the brightness of the LEDs. Each of the dual channels can be dimmed separately and with different duty cycles. PWM dimming can be done without the SPI Interface as well. Keep jumpers J3 and J5 in the open position and connect an external signal to the DIM1 and DIM2 tests points. Analog PWM dimming can also be done using the DIM1/DIM2 test points. Force an external analog DC voltage from 0.2V to 3V to vary the duty cycle from 0% to 100%, respectively.

Analog Dimming

The LED currents on both channels can be adjusted through the GUI using the SPI interface. The LED current can be varied from 0A to 3A. If the current-sense resistors are chosen for a different full-scale current, use the GUI's **Options** menu bar and select **Change Design Values**, and then **RCS1** and **RCS2** to set the correct current-sense resistor value.

The LED currents can also be adjusted through the REFI pins. Close jumpers J1 and J6. Using the potentiometers (R5 and R23), LED currents of both channels can be varied. The REFI voltage can be changed from 0.2V to 1.25V. Below the 0.2V threshold, the LED currents are zero and when REFI voltage is adjusted higher than 1.25V, the internal REFI voltage is clamped for the full-scale LED current.

Fault Monitoring

Faults like LED Short, LED Open, LED overcurrent and overvoltage are reported in the GUI through the SPI interface. The Short LED threshold can be programmed from 100mV to 400mV in steps of 100mV.

LED Current Monitor and LED Output Voltage

The GUI reports the LED currents of each of the channels. The IC's IOUTV1 and IOUTV2 pins report a voltage proportional to the LED currents. The internal ADC converts this voltage to a digital value and reports it through the SPI interface, which can be read using the GUI. Similarly, the LED output voltage is also digitized and monitored through the GUI.

Ordering Information

PART	TYPE
MAX20096EVSYS#	EV System

#Denotes RoHS compliant.

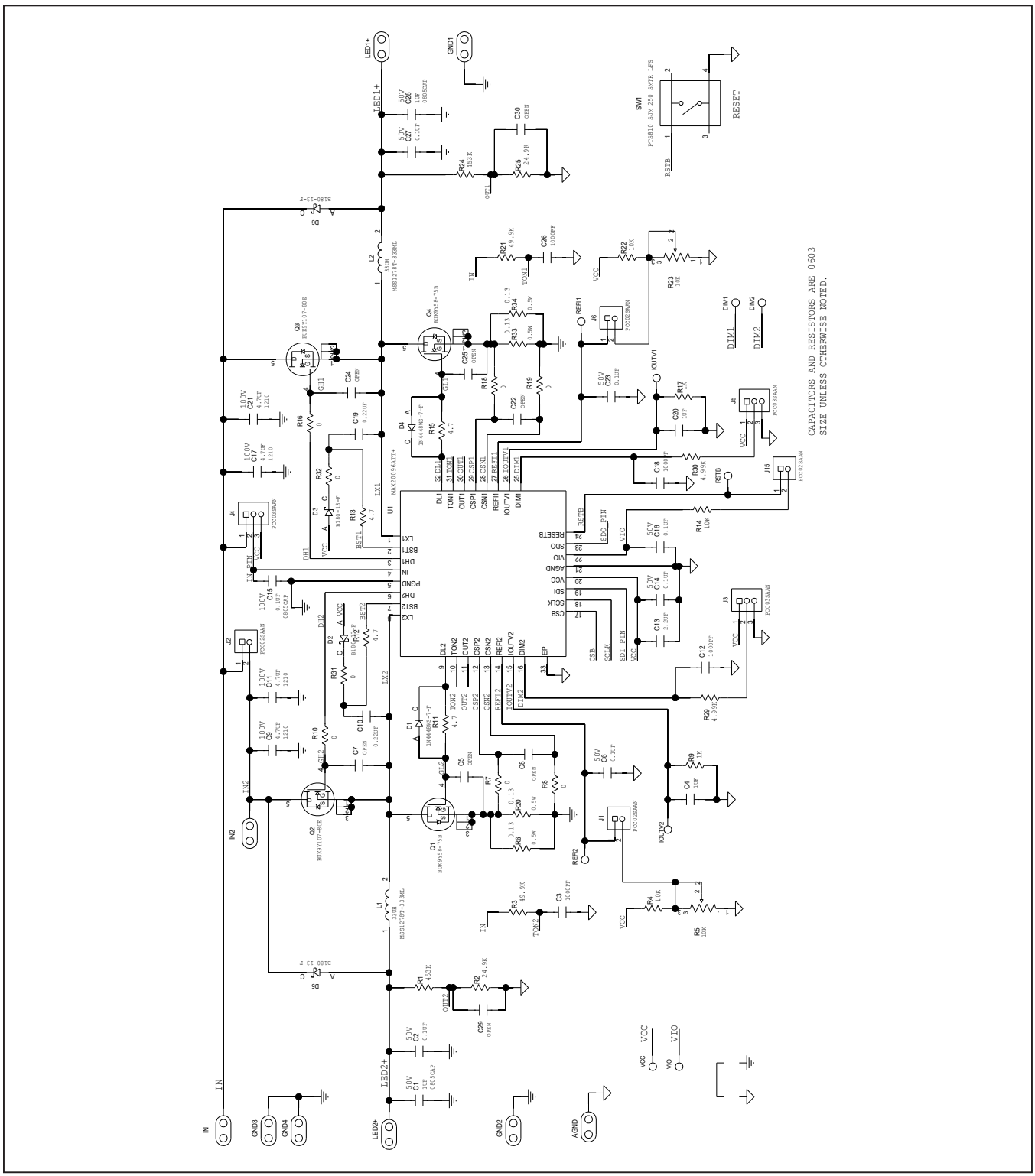
MAX20096 EV Kit Bill of Materials

REF DES	QTY	VALUE	DESCRIPTION	MFG PART #	MANUFACTURER
C1, C28	2	1UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 1UF; 50V; TOL=20%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	CGA4J3X7R1H105M125AB	TDK
C2, C6, C14, C16, C23, C27	6	0.1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 0.1UF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO; SOFT TERMINATION	CGA3E2X7R1H104K080AE	TDK
C3, C12, C18, C26	4	1000PF	CAPACITOR; SMT (0603); CERAMIC CHIP; 1000PF; 100V; TOL=5%; TG=-55 DEGC TO +125 DEGC; TC=C0G; AUTO	CGA3E2C0G2A102J080AA	TDK
C4, C20	2	1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 1UF; 35V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	CGA3E1X7R1V105K	TDK
C9, C11, C17, C21	4	4.7UF	CAPACITOR; SMT (1210); CERAMIC CHIP; 4.7UF; 100V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7S; AUTO	CGA6M3X7S2A475K200AE	TDK
C10, C19	2	0.22UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 0.22UF; 50V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	CGA3E3X7R1H224K080AB; GCM188R71H224KA49	TDK; MURATA
C13	1	2.2UF	CAPACITOR; SMT (0603); CERAMIC; 2.2UF; 6.3V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	CGA3E1X7R0J225K080AC	TDK
C15	1	0.1UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 0.1UF; 100V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO	CGA4J2X7R2A104K125AA	TDK
CS, SDI, SDO, VCC, VIO, DIM1, DIM2, RSTB, SCLK, REFI1, REFI2, IOUTV1, IOUTV2	13	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.35IN; BOARD HOLE=0.063IN; WHITE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH; RECOMMENDED FOR BOARD THICKNESS=0.062IN; NOT FOR COLD TEST	5007	KEYSTONE
D1, D4	2	1N4448WS-7-F	DIODE; SWT; SOD-323; PIV=75V; IF=0.5A	1N4448WS-7-F	DIODES INCORPORATED
D2, D3, D5, D6	4	B180-13-F	DIODE; SCH; SCHOTTKY BARRIER RECTIFIER; SMA; PIV=80V; IF=1A	B180-13-F	DIODES INCORPORATED
IN, IN2, AGND, GND1-GND4, LED1+, LED2+	9	MAXIMPAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG	9020 BUSS	WEICO WIRE
J1, J2, J6, J12, J15	5	PCC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 2PINS; -65 DEGC TO +125 DEGC	PCC02SAAN	SULLINS
J3-J5, J10, J11, J13	6	PCC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65 DEGC TO +125 DEGC	PCC03SAAN	SULLINS
J7	1	SSQ-108-23-G-S	CONNECTOR; FEMALE; THROUGH HOLE; SSQ SERIES; STRAIGHT; 8PINS	SSQ-108-23-G-S	SAMTEC

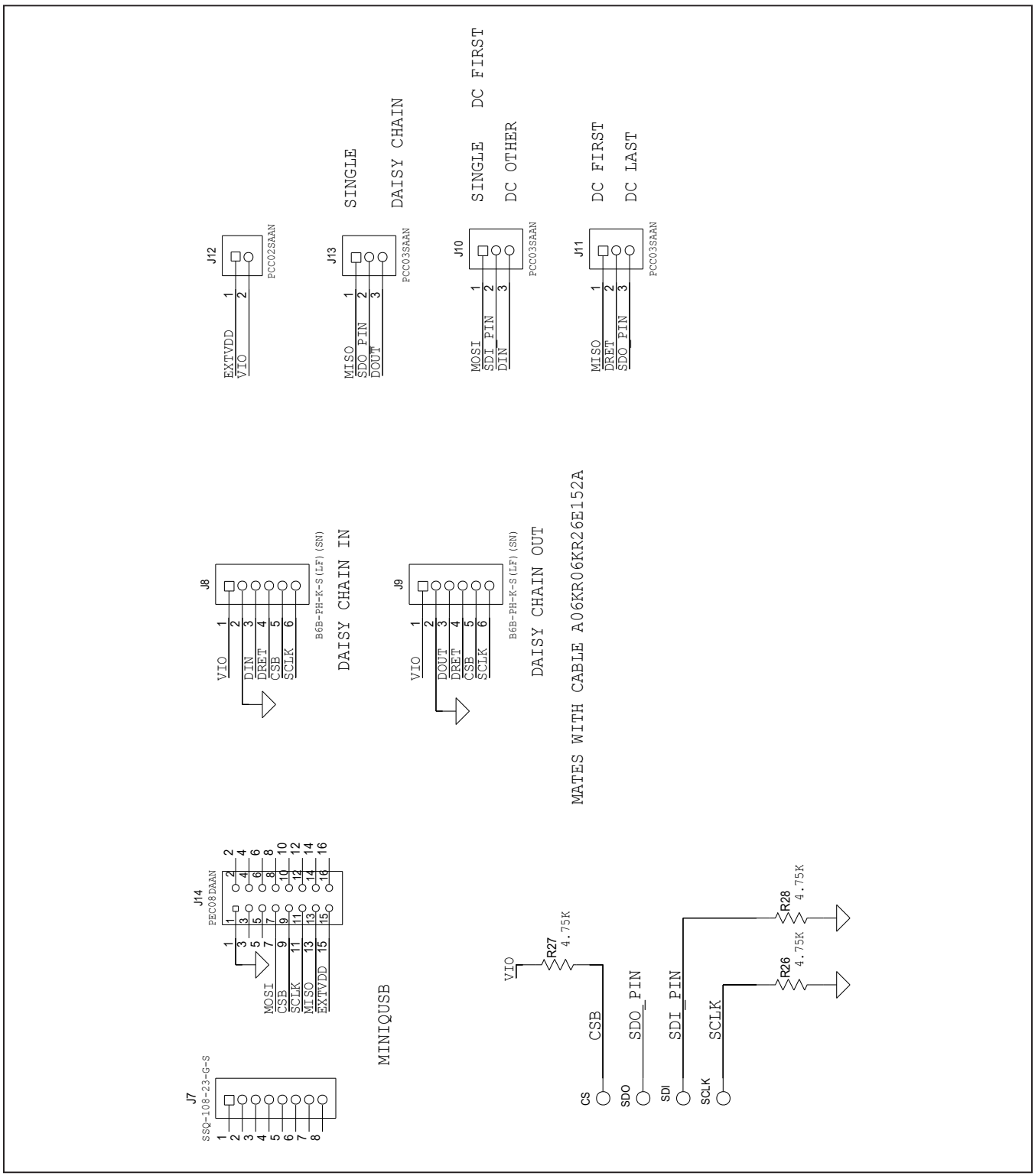
MAX20096 EV Kit Bill of Materials (continued)

REF DES	QTY	VALUE	DESCRIPTION	MFG PART #	MANUFACTURER
J8, J9	2	B6B-PH-K-S(LF)(SN)	CONNECTOR; MALE; THROUGH HOLE; PH SERIES; STRAIGHT; 6PINS	B6B-PH-K-S(LF)(SN)	JST MANUFACTURING
J14	1	PEC08DAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 16PINS; -65 DEGC TO +125 DEGC	PEC08DAAN	SULLINS ELECTRONICS CORP.
L1, L2	2	33UH	INDUCTOR; SMT; FERRITE BOBBIN CORE; 33UH; TOL=+/-20%; 3.1A; -40 DEGC TO +125 DEGC	MSS1278T-333ML	COILCRAFT
Q1, Q4	2	BUK9Y58-75B	TRAN; N-CHANNEL TRENCHMOS LOGIC LEVEL FET; NCH; LFPAK; PD-(60.4W); I-(20.7A); V-(75V)	BUK9Y58-75B	NEXPERIA
Q2, Q3	2	BUK9Y107-80E	TRAN; N-CHANNEL 80V; 107MOHM LOGIC LEVEL MOSFET; NCH; LFPAK; PD-(37W); I-(11.8A); V-(80V)	BUK9Y107-80E	NXP
R1, R24	2	453K	RESISTOR; 0603; 453K OHM; 1%; 100PPM; 0.10W; THICK FILM	ERJ-3EKF4533V	PANASONIC
R2, R25	2	24.9K	RESISTOR; 0603; 24.9K OHM; 1%; 100PPM; 0.10W; THICK FILM	CRCW060324K9FK	VISHAY DALE
R3, R21	2	49.9K	RESISTOR; 0603; 49.9K OHM; 1%; 100PPM; 0.10W; THICK FILM	CRCW060349K9FK; ERJ-3EKF4992V	VISHAY DALE/PANASONIC
R4, R14, R22	3	10K	RESISTOR; 0603; 10K; 1%; 100PPM; 0.10W; THICK FILM	CRCW060310K0FK; ERJ-3EKF1002	VISHAY DALE; PANASONIC
R5, R23	2	10K	RESISTOR; THROUGH-HOLE-RADIAL LEAD; 3296 SERIES; 10K OHM; 10%; 100PPM; 0.5W; SQUARE TRIMMING POTENTIOMETER; 25 TURNS; MOLDER CERAMIC OVER METAL FILM	3296W-1-103LF	BOURNS
R6, R20, R33, R34	4	0.13	RESISTOR; 1206; 0.13 OHM; 1%; 100PPM; 0.5W; THICK FILM	CSR1206FTR130	STACKPOLE ELECTRONICS INC
R7, R8, R10, R16, R18, R19, R31, R32	8	0	RESISTOR; 0603; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM	CRCW06030000ZS; MCR03EZPJ000; ERJ-3GEY0R00	VISHAY DALE/ROHM/PANASONIC
R9, R17	2	1K	RESISTOR; 0603; 1K; 1%; 100PPM; 0.10W; THICK FILM	CRCW06031001FK; ERJ-3EKF1001V	VISHAY DALE; PANASONIC
R11-R13, R15	4	4.7	RESISTOR; 0603; 4.7 OHM; 1%; 100PPM; 0.10W; THICK FILM	CRCW06034R70FN	VISHAY DALE
R26-R28	3	4.75K	RESISTOR; 0603; 4.75K; 1%; 100PPM; 0.10W; THICK FILM	CRCW06034K75FK; ERJ-3EKF4751	VISHAY DALE/PANASONIC
R29, R30	2	4.99K	RESISTOR; 0603; 4.99K; 1%; 100PPM; 0.10W; THICK FILM	CRCW06034K99FK; ERJ-3EKF4991V	VISHAY DALE/PANASONIC
SW1	1	PTS810 SJM 250 SMTR LFS	SWITCH; SPST; SMT; 16V; 0.05A;PTS 810 SERIES; MICROMINIATURE SMT TOP ACTUATED; GRAY ACTUATOR; RCOIL=0.5 OHM; RINSULATION=100M OHM; C&K COMPONENTS	PTS810 SJM 250 SMTR LFS	C&K COMPONENTS
U1	1	MAX20096ATI+	EVKIT PART-IC; DRV; DUAL CHANNEL HIGH VOLTAGE BUCK LED DRIVER WITH SPI INTERFACE; PACKAGE OUTLINE: 21-0140; PACKAGE CODE: T3255-6C; TQFN32-EP	MAX20096ATI+	MAXIM
—	1	PCB	PCB: MAX20096 EVKIT	MAX20096EVKIT#	MAXIM

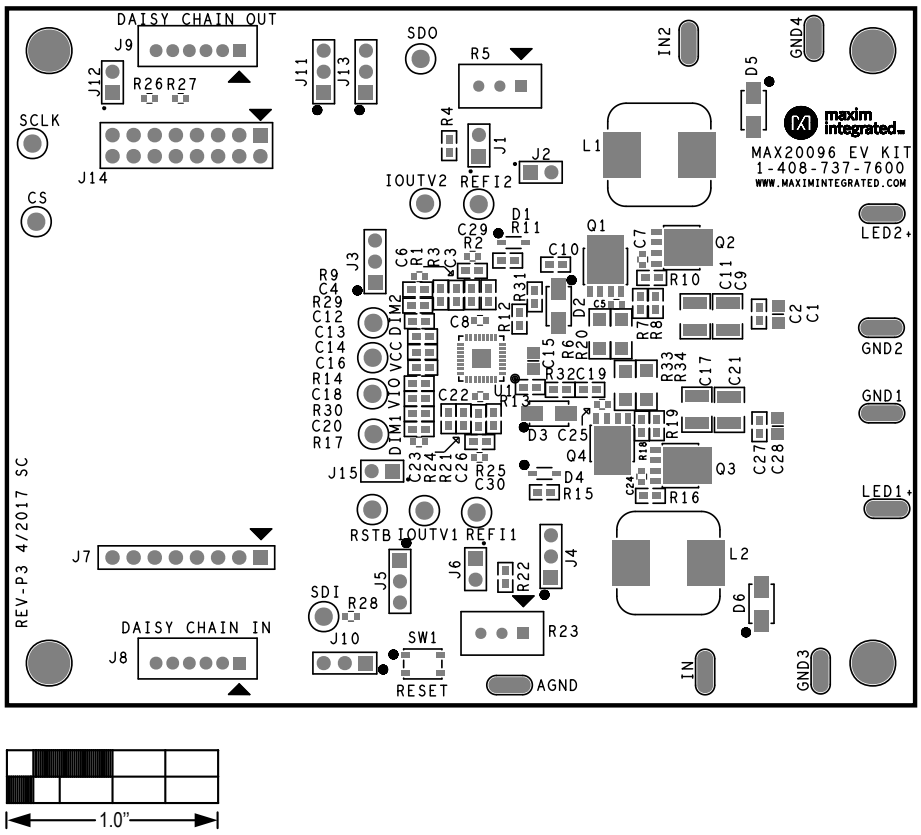
MAX20096 EV Kit Schematic



MAX20096 EV Kit Schematic (continued)

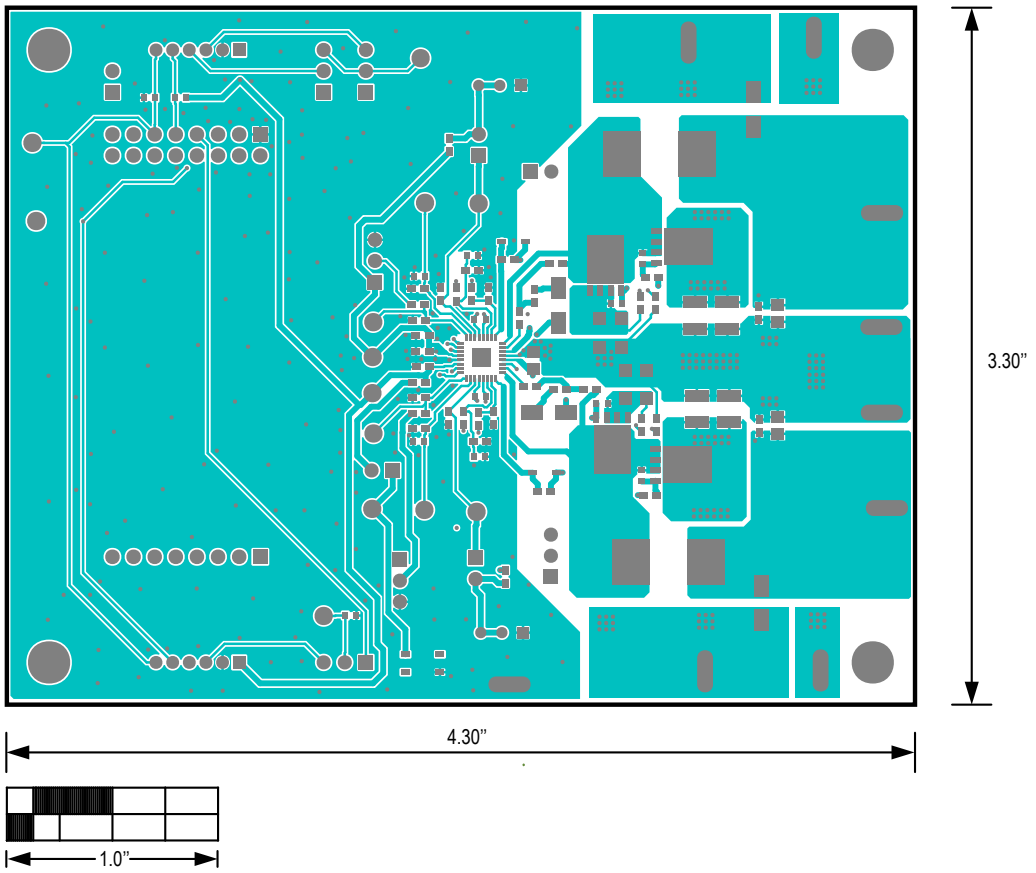


MAX20096 EV Kit PCB Layout Diagrams



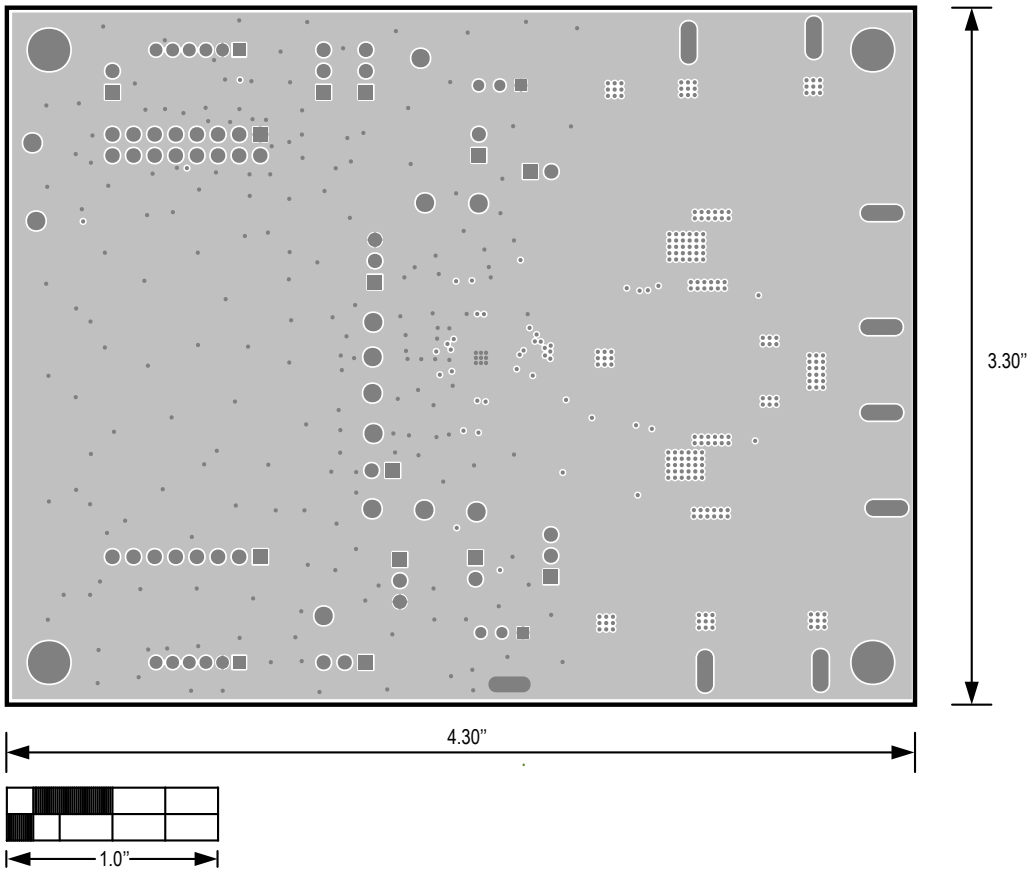
MAX20096 EV Kit Component Placement Guide—Component Side

MAX20096 EV Kit PCB Layout Diagrams (continued)



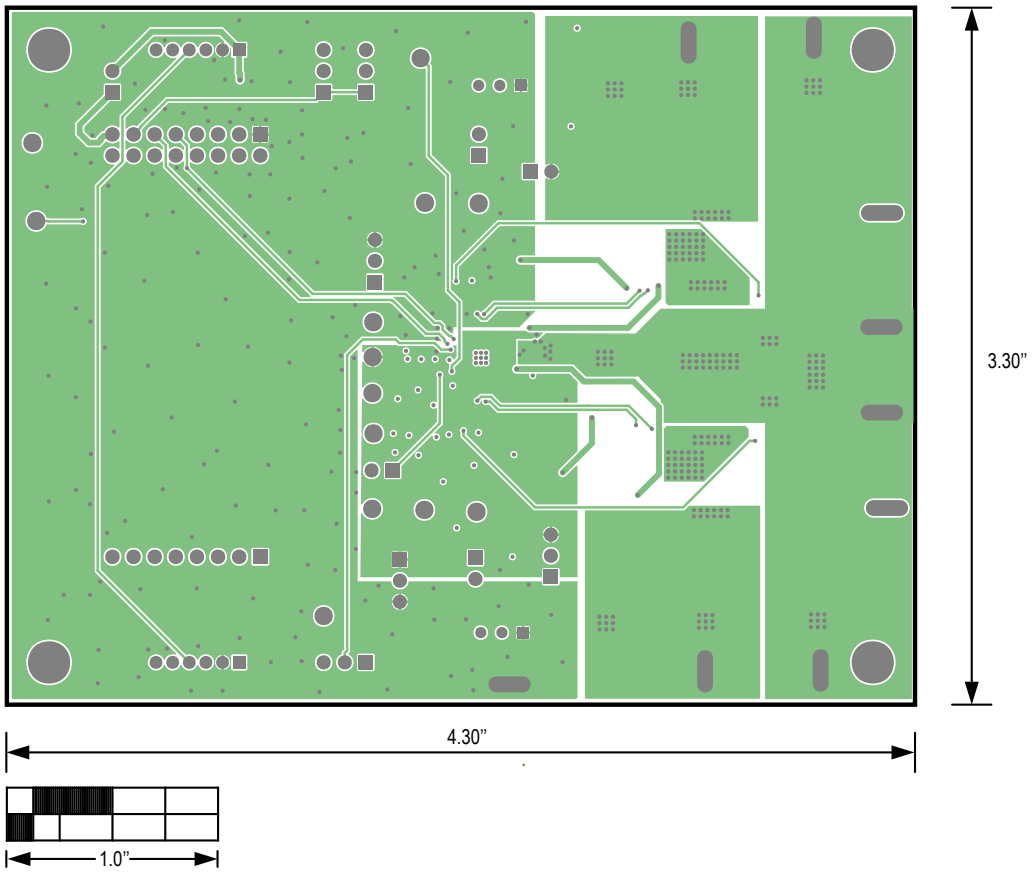
MAX20096 EV Kit PCB Layout—Top Layer

MAX20096 EV Kit PCB Layout Diagrams (continued)



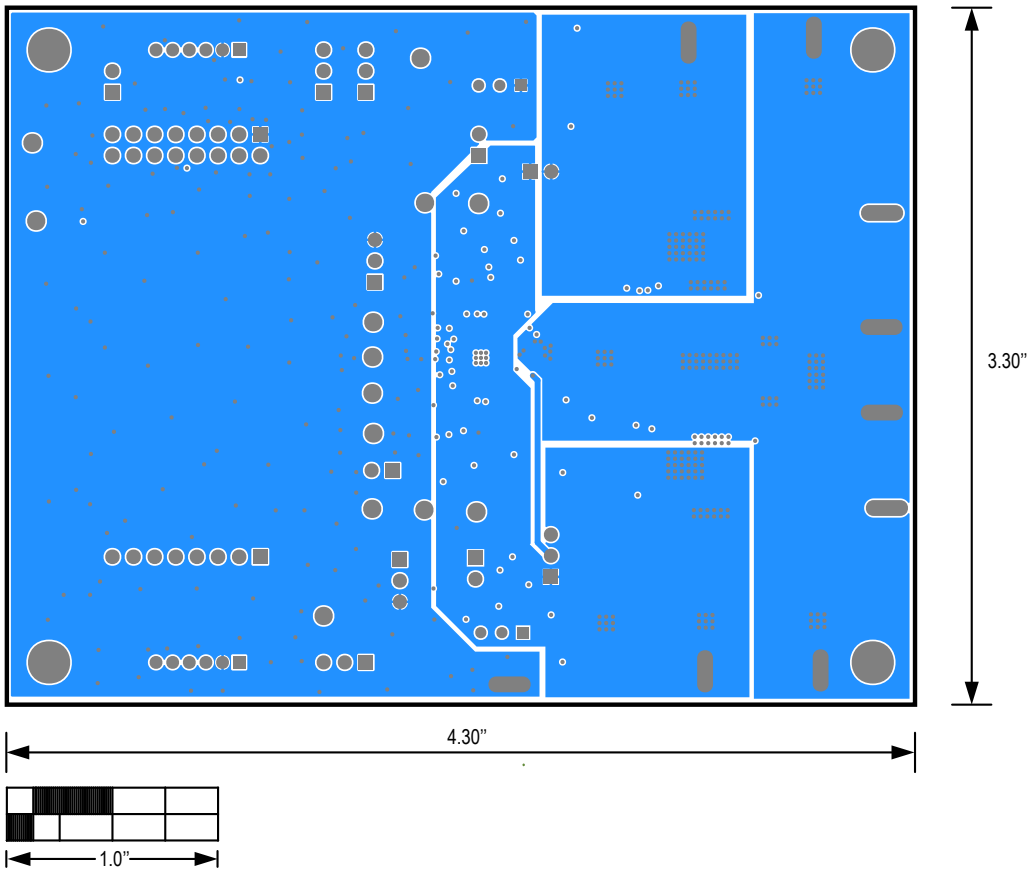
MAX20096 EV Kit PCB Layout—Inner Layer 1

MAX20096 EV Kit PCB Layout Diagrams (continued)



MAX20096 EV Kit PCB Layout—Inner Layer 2

MAX20096 EV Kit PCB Layout Diagrams (continued)



MAX20096 EV Kit PCB Layout—Bottom Layer

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/17	Initial release	—
1	1/18	Removed MAX20096 EV System from *Ordering Information*	3
2	1/18	Removed MAX20096 EV System from entire data sheet	1–13
3	6/19	Updated title to include MAX20096 Evaluation System, added MAX20096 EV System to *Ordering Information*	1–13

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