General Description

The MAX20078 evaluation kit (EV kit) provides a proven design to evaluate the MAX20078 synchronous buck controller for high-power, high-brightness (HB) LED drivers. The EV kit is set up as a buck LED driver and operates from a 4.5V to 65V DC supply voltage. The EV kit is configured to deliver up to 2A to one string of LEDs. 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 and the cathode of the LED string connected to PGND.

Features

- 4.5V to 65V Input Voltage
- Drives 1 to 16 LEDs
- 0A to 2A LED Current
- Demonstrates UVLO, Output Short Protection, and Overload
- Demonstrates Current-Limit and Thermal-Shutdown Features
- Proven PCB Layout and Thermal Design
- Fully Assembled and Tested

Quick Start

Required Equipment

- MAX20078 EV kit
- 5V to 65V, 4A DC power supply
- Two digital voltmeters (DVM1, DVM2)
- Series-connected HB LED string rated to no less than 2.5A
- Current probe to measure the HB LED current
- Potentiometer
- Small flat-blade screwdriver to turn the potentiometer wiper-adjustment pin

Procedure

The EV kit is fully assembled and tested. Follow the steps below to verify board operation. **Caution: Do not turn on the power supply until all connections are complete.**

1) Verify that all jumpers (J1, JU1–JU4) are in their default positions, as shown in Table 1.
2) Connect the HB LED string anode to the LED+ PCB pad and the cathode to the PGND PCB pad.
3) Connect DVM1 across the LED+ and PGND PCB pads.
4) Connect DVM2 across the REFI and AGND test points.
5) Connect the power supply to the VIN PCB pad and the power supply's ground to the PGND PCB pad.
6) Clip the current probe across the wire connecting the HB LED string to the EV kit.
7) Turn on the power supply and set to a voltage greater than the maximum HB LED string voltage, but less than the 65V maximum input voltage.
8) Use the screwdriver to turn the potentiometer until DVM2 reads 1.2V.
9) Measure the HB LED current using the current probe and verify that current is 2A.
10) Verify DVM1 shows the expected LED string voltage.
11) Use the screwdriver to turn the potentiometer until DVM2 reads 0.7V.
12) Measure the HB LED current using the current probe and verify that current is 1A.

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

19-8972; Rev 0; 3/17

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Table 1. MAX20078 EV Kit Jumper Descriptions (J1, JU1–JU4)

JUMPER	SHUNT POSITION	DESCRIPTION
J1	1-2	Allows the connection of an external 5V (4.5V to 5.5V) supply to V_{CC}. The internal LDO is not used.
	2-3*	The internal V_{CC} LDO is powered from the input voltage applied on IN pin of the device.
	Open	V_{CC} unconnected. Do not leave J1 open.
JU1	1-2*	REFI pin is now connected to a voltage-divider from V_{CC} to ground. Adjusting R8 allows programming the LED current from 0 to 2.2A.
	Open	Disconnects the REFI pin of the device from the external voltage-divider on the V_{CC} pin. Allows the user to apply an external voltage to set the LED current level.
JU2	Open*	No HUD application. Turning on Q3 does not short the output.
	1-2	Allows testing of the device in HUD applications. Allows shorting the output by turning on Q3.
JU3	1-2*	DIM pin pulled up to V_{CC} through a 10kΩ resistor.
	2-3	DIM pin pulled up to V_{IN} through a 10kΩ resistor.
	Open	DIM pin of the device not connected.
JU4	Open*	DIM pin of the device not synchronized to HUD_PWM signal.
	1-2	DIM pin of the device synchronized to HUD_PWM signal.

**Default position.*

Detailed Description

The MAX20078 EV kit demonstrates the MAX20078 synchronous buck controller for high-power HB LED drivers. The buck controller consists of a fully synchronous step-down converter with external MOSFETs, and can drive a series string of LEDs at currents as high as 30A. The buck controller uses a proprietary average current-mode-control scheme to regulate the inductor current. This control method does not need any control-loop compensation, while maintaining nearly constant switching frequency. Inductor current sense is achieved by sensing the current in the bottom synchronous n-channel MOSFET. It does not require any current sense at high voltages. The buck controller offers both analog and PWM dimming. The EV kit is configured to deliver up to 2A to a series LED string. The string forward voltage can vary from 3V to 55V.

Analog Dimming Control (ICTRL)

The EV kit demonstrates the analog dimming feature of the buck controller. R7 and R8 form a resistor-divider between V_{CC} and AGND. R7 is a 10kΩ resistor and R8 is a 10kΩ potentiometer, with the wiper shorted to the high side of the potentiometer. Install the shunt on JU1 (see Table 1 for jumper descriptions). Using a flat-blade screwdriver, turn the wiper-adjustment pin clockwise to increase the voltage on the REFI input. Turn the wiper-adjustment pin counterclockwise to decrease the voltage on the REFI input. The REFI input allows for analog dimming of the HB LED string. A REFI input voltage of ≤ 0.2V turns off the LED driver, an input voltage between 0.2V and 1.2V provides linear dimming of the HB LED string, and an input voltage > 1.2V sets the HB LED string current to maximum current (based on the current-sense resistor).

Alternatively, the analog dimming input can be set with a power supply. Remove the shunt on JU1 and connect an external power supply directly to the REFI PCB pad to perform analog dimming with a power supply. Do not violate the absolute maximum voltage rating of V_{CC} + 0.3V (refer to the *Absolute Maximum Ratings* section in the MAX20078 IC data sheet).

Pulse-Dimming Input (DIM)

The EV kit demonstrates the PWM dimming feature of the buck controller. Install a shunt across pins 1-2 on JU3; JU3 pins 2-3 should be open. Connect a PWM signal to the PWM PCB pad. Vary the duty cycle to increase or decrease the intensity of the HB LED string. The DIM input of the device has a 2V (max) rising threshold and a 0.8V (min) falling threshold, and is compatible with 3.3V and 5V logic-level signals. The DIM input is pulled up to V_{CC} through the external 10kΩ resistor on the EV kit when JU3 is installed across pins 1-2. The DIM input can also be pulled up to V_{IN} by moving the jumper on JU3 to pins 2-3 (see Table 1 for jumper descriptions).

Fault Indicator

The EV kit demonstrates the fault-protection features of the buck controller, which offer shorted-LED, open-LED, and overtemperature protection. The $\overline{FLT}$ output is an open-drain, active-low fault indicator. Refer to the *$\overline{FLT}$ Flag* section in the MAX20078 IC data sheet for more information.

Current Monitor Output

The EV kit also demonstrates the current-monitor output feature of the buck controller. Refer to the *Current Monitor* section in the MAX20078 IC data sheet for more information.

External V_{CC} input

The EV kit demonstrates operation of the buck controller with an external V_{CC} input. In this case, the internal LDO is not used. Move the shunt to pins 1-2 on J1 (the IN and V_{CC} pins of the buck controller are shorted together). Apply an external power supply between 4.6V and 5.5V on the VCC PCB pad to allow switching of the device.

HUD Applications

The EV kit can also be tested for HUD applications. Remove capacitor C17 and any pulsating signals on the DIM PCB pad and install a shunt across pins 1-2 on JU2. The output capacitor is now reduced to 0.1µF. The LEDs can be turned on and off extremely fast by applying the PWM signal on the HUD_PWM PCB pad instead of the DIM PCB pad. The jumper on JU3 should be placed across pins 2-3. The DIM input of the device can be synchronized to the leading edge of the HUD_PWM signal by installing a jumper across pins 1-2 on JU4 (see Table 1 for jumper descriptions).

Ordering Information

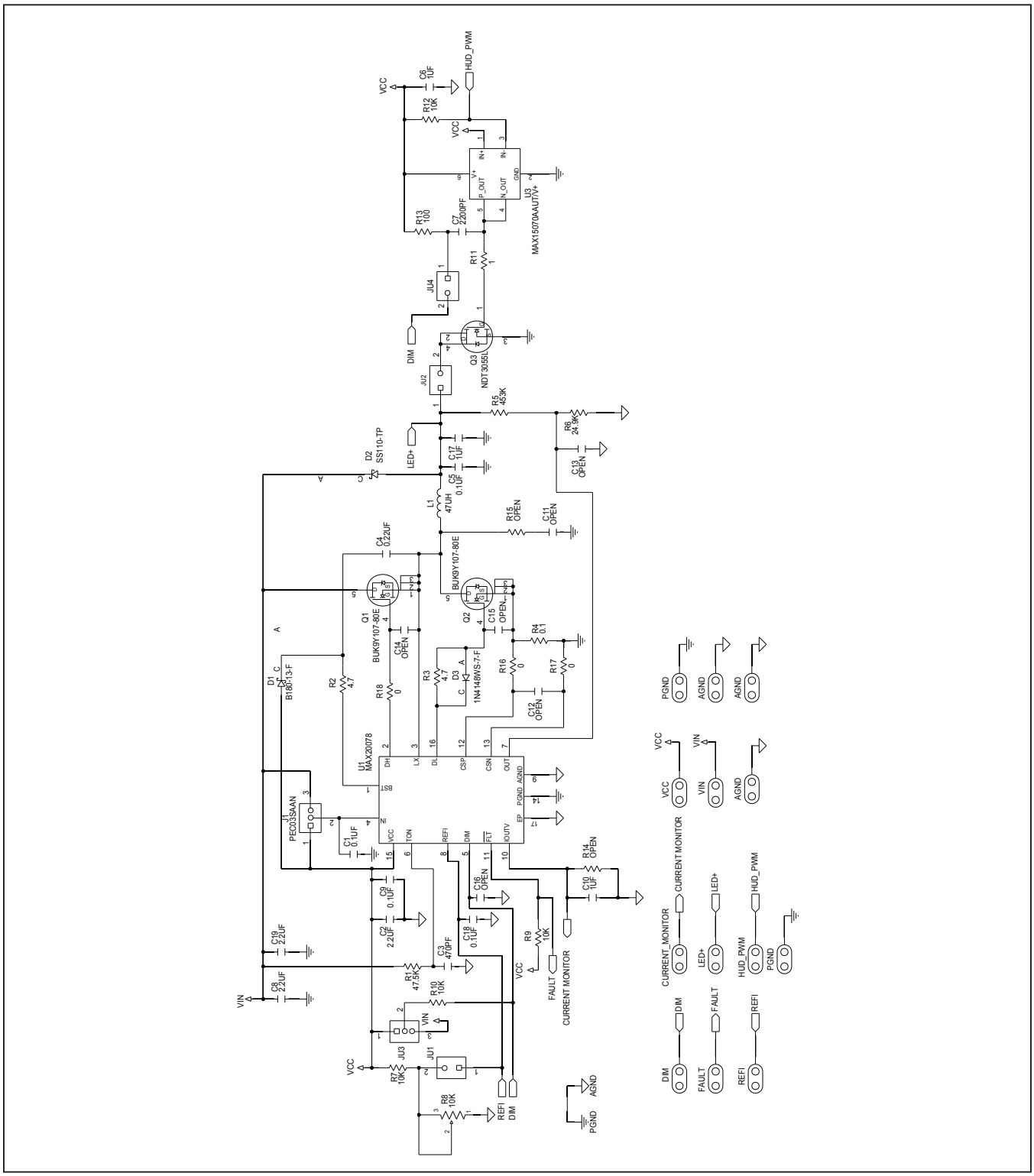
PART	TYPE
MAX20078EVKIT#	EV Kit

#Denotes RoHS compliant.

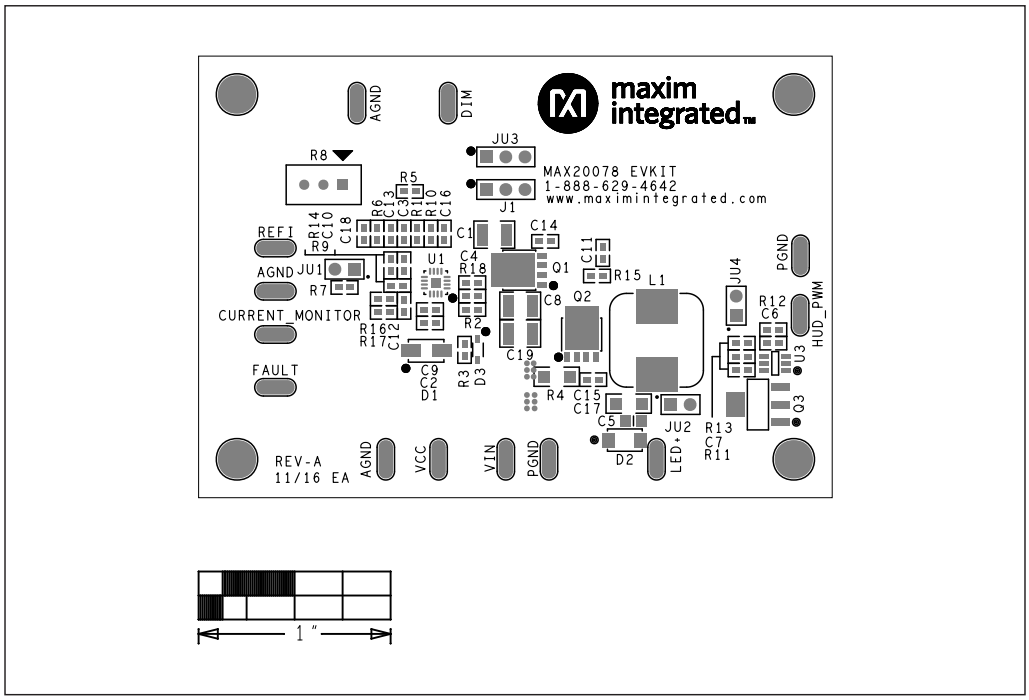
MAX20078 EV Kit Bill of Materials

DESIGNATION	QTY	DESCRIPTION
C1	1	0.1uF ±10%, 250V X7R ceramic capacitors (1210) Murata GRM32DR72E104KW01L
C2	1	2.2uF ±10%, 10V X7R ceramic capacitor (0603)
C3	1	470pF ±5%, 50V C0G ceramic capacitor (0603) AVX 06035A471JAT2A
C4	1	0.22uF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H224K080
C5	1	0.1uF ±10%, 100V X7R ceramic capacitors (0805)
C6, C10	2	1.0uF ±10%, 10V X7R ceramic capacitor (0603)
C7	1	2200pF ±10%, 50V X7R ceramic capacitors (0603)
C8, C19	2	2.2uF ±10%, 100V X7R ceramic capacitors (1210) Murata GRM32ER72A225KA35 TDK CGA6N3X7R2A225K230
C9, C18	2	0.1uF ±10%, 50V X7R ceramic capacitors (0603)
C11, C12, C13, C14, C15	0	Not installed capacitor (0603)
C17	1	1.0uF ±10%, 100V X7R ceramic capacitor (1206) Murata GRM31CR72A105KA01 TDK C3216X7R2A105K160
D1	1	80V, 1A schottky diode (SMA) Diodes Inc. B180-13-F
D2	1	100V, 1A schottky diode (DO-214) Micro Commercial Components SS110-TP
D3		75V, 0.3A Diode (SOD-323) Diodes Inc 1N4148WS-7-F
J1, JU3	2	3 pin header
JU1, JU2, JU4	3	2 pin header
L1	1	47 uH, 5.4A ferrite core inductor Coilcraft MSS1278T-473ML
Q1, Q2	2	80V, 0.107 ohm Logic Level MOSFET (LFPAK) NXP BUK9Y107-80E
Q3	1	60V, 4A N-channel Logic Level MOSFET (SOT-223) Fairchild Semiconductor NDT3055L
R1	1	47.5k ±1% resistor (0603)
R2, R3	2	4.7ohm ±5% resistor (0603)
R4	1	0.1 ±1% sense resistor (1206) Panasonic ERJ8BWFR100
R5	1	453k ±1% resistor (0603)
R6	1	24.9k ±1% resistor (0603)
R7, R9, R10, R12	4	10k ±1% resistor (0603)
R8	1	10k potentiometer, through hole radial lead Bourns 3296W-1-103LF
R11	1	1.0 ohm ±1% resistor (0603)
R13	1	100 ohm ±5% resistor (0603)
R14, R15	0	Not installed resistor (0603)
R16, R17, R18	3	0ohm jumper (0603)
U1	1	Synchronous Buck Controller for High-Power HB LED Drivers (TQFN16-EP) Maxim MAX20078ATE/V+
U3	1	7A Sink, 3A Source, 12ns, SOT23 MOSFET Drivers (SOT23-6) Maxim MAX15070AAUT/V+
—	5	Shunts
—	1	PCB: MAX20078 EVKIT

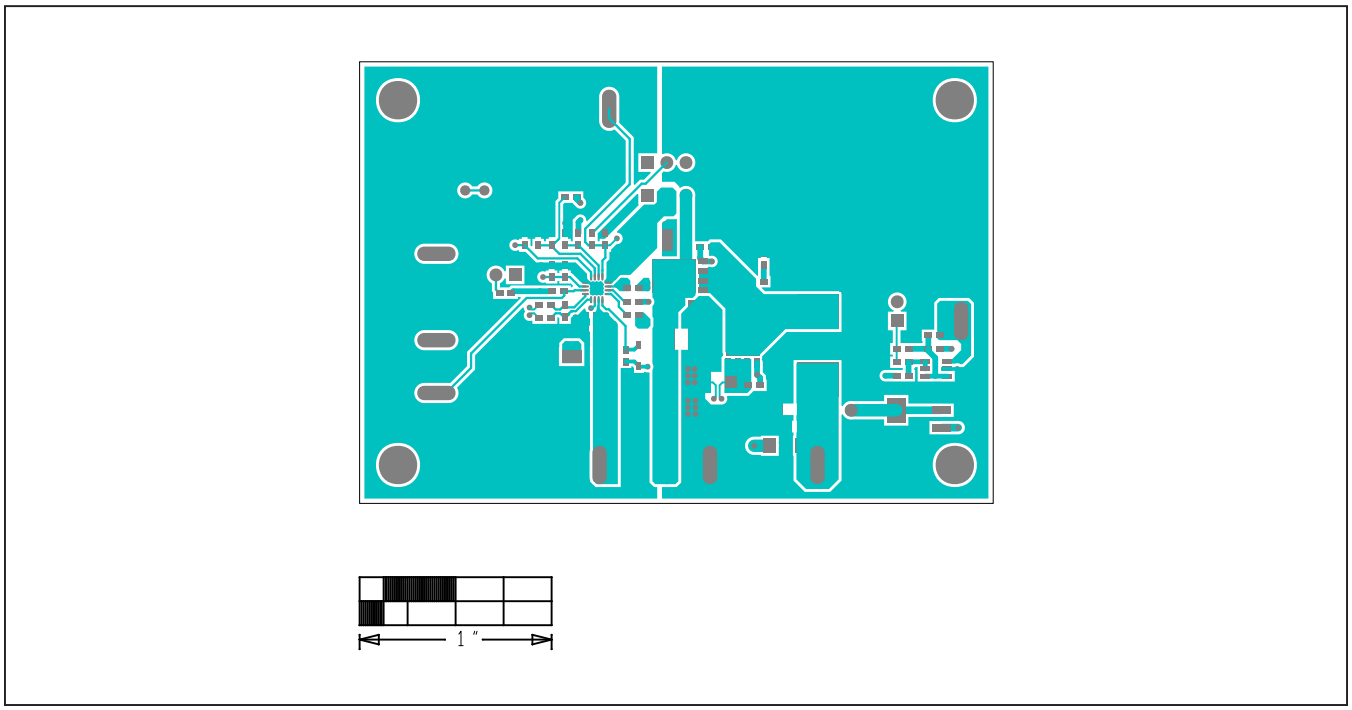
MAX20078 EV Kit Schematic



MAX20078 EV Kit PCB Layouts

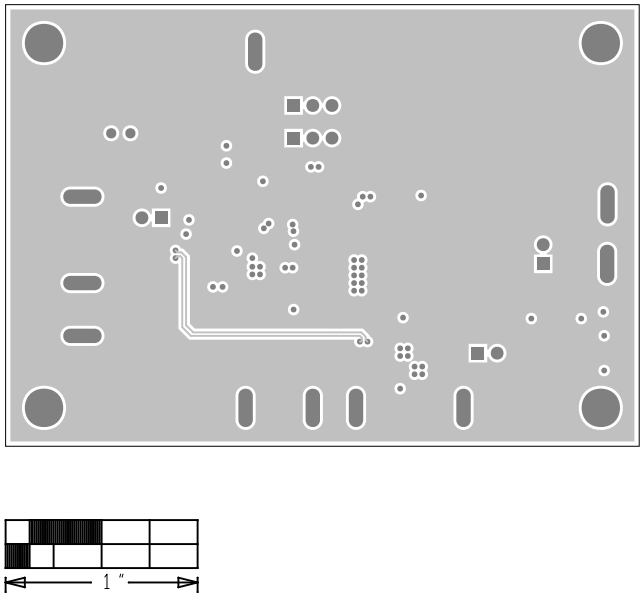


MAX20078 EV Kit Component Placement Guide—Component Side

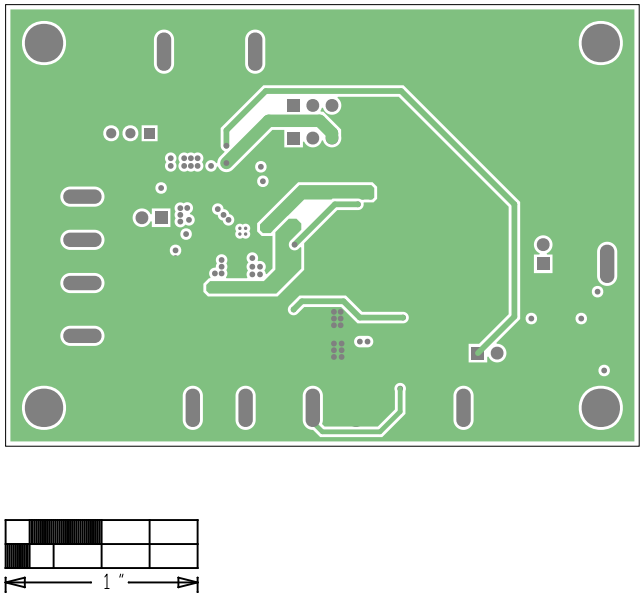


MAX20078 EV Kit PCB Layout—Component Side

MAX20078 EV Kit PCB Layouts (continued)

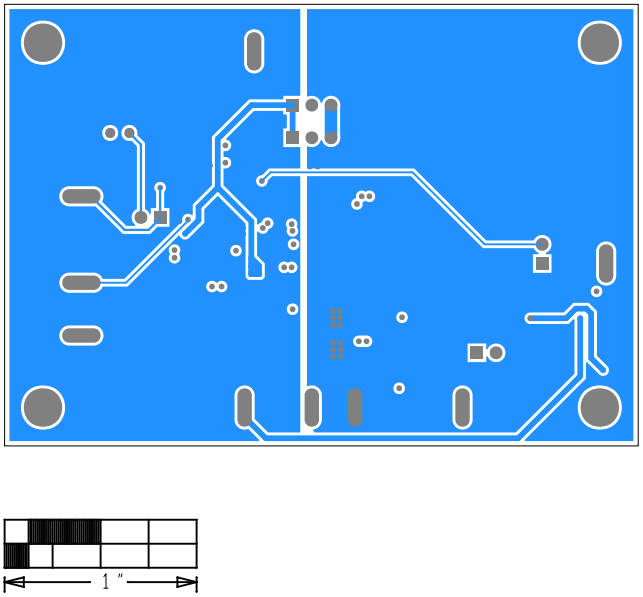


MAX20078 EV Kit PCB Layout—AGND Layer 2



MAX20078 EV Kit PCB Layout—Layer 3

MAX20078 EV Kit PCB Layouts (continued)



MAX20078 EV Kit PCB Layout—Solder Side

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/17	Initial release	—

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