General Description

The MAX20046 evaluation kit (EV kit) demonstrates the MAX20046 automotive Hi-Speed USB 2.0 protector switch IC, featuring overvoltage protection (OVP), electrostatic discharge (ESD) protection, and undervoltage lockout (UVLO)/overcurrent protection (OCP) for automotive USB applications.

The device protects the USB BUS, D+, and D- data lines from overvoltage conditions, such as a short-to-battery and ESD events. UVLO protects the BUS against low-voltage conditions such as a short-to-ground. The BUS OCP uses a blanking period allowing momentary BUS shorts to be ignored. All faults can be monitored using the $\overline{FAULT}$ output signal.

The device can pass high-speed USB differential (D+ and D-) signals up to 480Mbps and has a low 500mΩ R_{ON} (max) for the BUS and a 3.3Ω R_{ON} (typ) for the D+ and D- lines. The EV kit is powered by the USB BUS. An on-board MAX15007A automotive regulator provides the IN reference voltage. If a 60mA/120mA current threshold is desired, the MAX20046GTC/V+ can be ordered and interchanged with U1.

Benefits and Features

- Protects USB BUS, D+, and D- Signals from Overvoltages Up to 18V and ESD Events
- USB BUS Undervoltage Lockout
- 23mA/45mA (typ) USB BUS Overcurrent-Protection Threshold
- 1ms Overcurrent Blanking Time
- Passes 480Mbps USB Data Signals
- Low On-Resistance
  - BUS: 500mΩ (max)
  - D+ and D-: 3.3Ω (typ)
- $\overline{FAULT}$ Output Signal
- USB Powered
- Fully Assembled and Tested
- Evaluates the MAX20046 IC in a 12-Pin TQFN Package

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

Quick Start

Required Equipment

- MAX20046 EV kit
- 5V, 2A DC power supply (Supply A)
- 18V, 2A DC power supply (Supply B)
- Logic function generator
- Oscilloscope

Procedure

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

1) Verify that shunts are installed as follows:
   - JU1: Pins 1-2 (MAX20046 BUS switch disabled)
   - JU2: Pins 1-2 (IN connected to on-board 3.3V reference)
2) Set the Supply A output to 5V, the Supply B output to 18V, and disable both outputs.
3) Set the logic function generator as follows: $3V_{P-P}$, 1.5V DC offset square wave, 500kHz, and disable the output.
4) Connect the Supply A positive output to the red BUS test point on the EV kit and connect the supply ground to the nearby black GND test point.
5) Connect the Supply B ground to the GND test point close to the HVBUS test point on the EV kit. Connect a voltage probe test lead to the Supply B positive output for later use.
6) Using a Type A USB receptacle inserted into J3, connect the logic function generator to D+ and GND.
7) Enable both power-supply outputs.
8) Enable the function generator output.
9) Install a shunt on jumper JU1, pins 2-3 (MAX20046 BUS switch enabled).
10) Use the oscilloscope to probe the HVBUS and HVD+ test points.
11) Verify that HVBUS is 5V and that the waveform on HVD+ is a 500kHz square wave and is approximately $3V_{P-P}$.
12) Momentarily touch the HVBUS test point on the EV kit with the voltage probe from the Supply B positive output. The $\overline{FAULT}$ signal asserts a logic-low while the fault is present.

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Detailed Description of Hardware

The MAX20046 EV kit demonstrates the MAX20046 automotive Hi-Speed USB 2.0 protector switch IC, featuring OVP, ESD protection, UVLO protection, and OCP for automotive USB applications.

The IC protects the USB BUS, D+, and D- data lines from overvoltage conditions, such as a short-to-battery up to 18V and ESD events up to 25kV (air) and 8kV (contact). The OVP feature protects the D+ and D- lines against high-voltage conditions such as a short-to-BUS. The UVLO feature protects the BUS line against low-voltage conditions such as a short-to-ground. The BUS OCP threshold is fixed at 23mA/45mA (typ). A 1ms blanking period allows momentary BUS shorts to be ignored, such as those created by hot-swapping a capacitive load. All faults can be monitored using the $\overline{FAULT}$ PCB pad, pulled up to IN through resistor R1.

The device can pass high-speed USB differential (D+ and D-) signals up to 480Mbps, and has a low 500mΩ R_{ON} (max) for BUS and a 3.3Ω R_{ON} (typ) for the D+ and D- data lines. The EV kit is powered by the USB BUS. The 3.3V automotive regulator (U2, MAX15007A) provides an on- board IN reference voltage. A user can provide a 3V to 3.6V IN reference voltage across the VIN and GND PCB pads. The MAX20046 (U1) IC's automotive operating temperature range is from -40°C to +105°C.

Long USB wire lengths contribute to increased wiring inductance, resulting in slow di/dt and dV/dt during a "short to 18V" event. The device includes internal circuitry that turns off the switch between HVBUS and BUS during an overvoltage on HVBUS; however, energy stored in the wiring inductance can cause the HVBUS node voltage to quickly increase. The RC snubber network limits the positive voltage spike caused by wiring inductance.

Jumper Settings

BUS Switch Enable (JU1)

Jumper JU1 on the EV kit enables the device's BUS switch. Test points $\overline{EN}$ and GND are provided to control U1's enable signal with an external controller. Refer to the $\overline{EN}$ Input section in the *Electrical Characteristics* table in the MAX20046 IC data sheet for proper $\overline{EN}$ logic levels when using an external controller. See Table 1 for proper JU1 jumper settings.

IN Reference Voltage Selection (JU2)

Jumper JU2 on the EV kit selects the reference voltage for the device's IN pin. IN can either be supplied by the USB BUS through the on-board automotive 3.3V regulator (U2, MAX15007A), or by a user-supplied reference voltage. Test points VIN and GND are provided to supply the device with an external 3V to 3.6V reference voltage. See Table 2 for proper JU2 jumper settings.

ISET OCP Threshold Selection (JU3)

Jumper JU3 on the EV kit selects the current threshold for OCP (overcurrent protection). With pins 1-2 shorted, the current threshold is 45mA. With pins 2-3 shorted, the current threshold is 23mA. See Table 3 for proper JU3 jumper settings.

Table 1. MAX20046 Enable (JU1)

SHUNT POSITION	$\overline{EN}$ PIN	BUS SWITCH
1-2	Connected to IN	Disabled
2-3	Connected to GND	Enabled
Not installed	Connected to EN PCB pad	$\overline{EN}$ externally controlled

Table 2. MAX20046 IN Reference Voltage Selection (JU2)

SHUNT POSITION	IN PIN
1-2	Connected to on-board LDO
2-3	Connected to IN test point
Not installed	Unconnected

Table 3. MAX20046 EV Kit ISET OCP Threshold Selection (JU3)

SHUNT POSITION	ISET PIN	CURRENT THRESHOLD
1-2	Connected to IN	45mA
2-3	Connected to GND	23mA
Not installed	Internal pulldown	23mA

Ordering Information

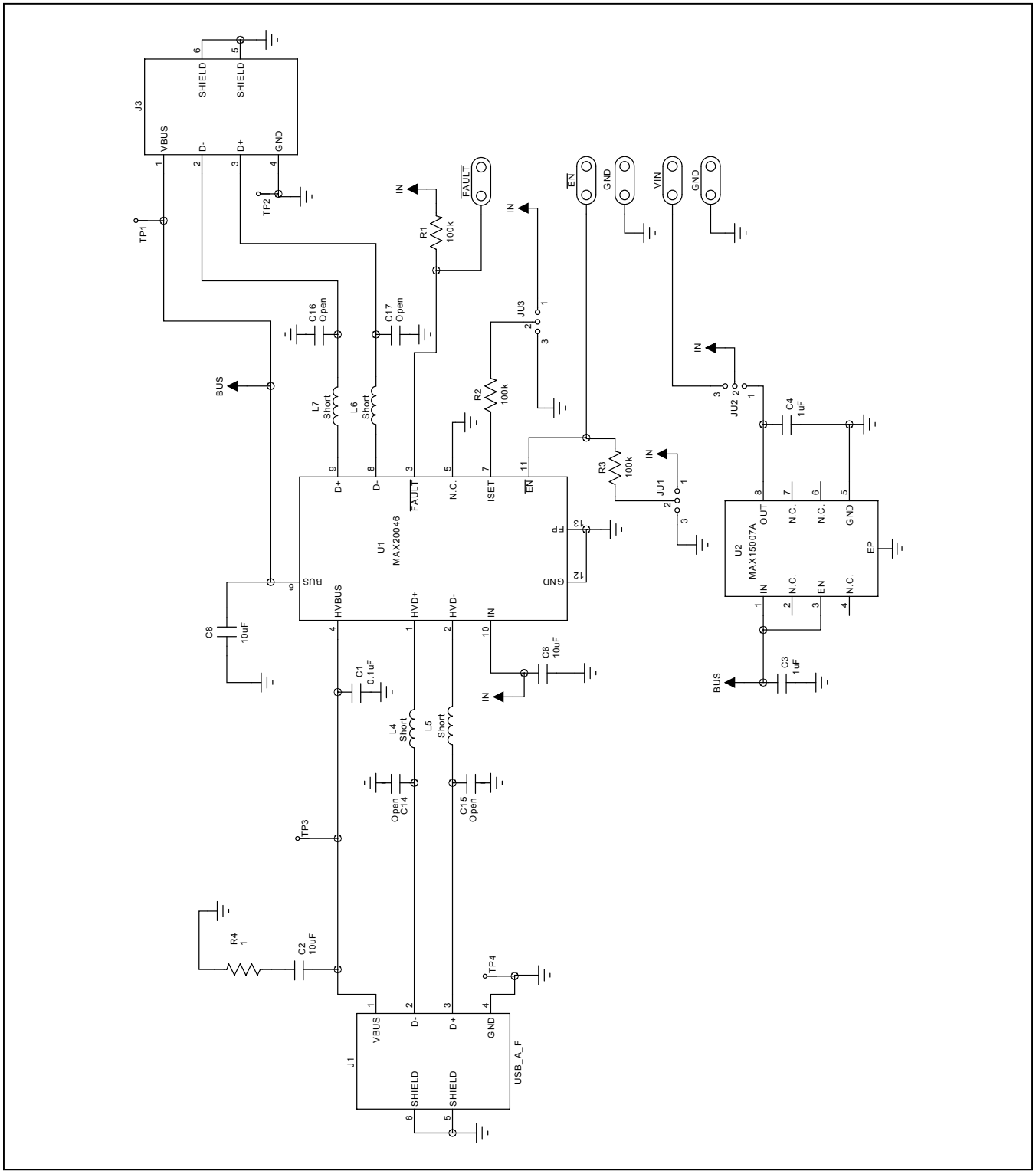
PART	TYPE
MAX20046EVKIT#	EV Kit

#Denotes RoHS compliant.

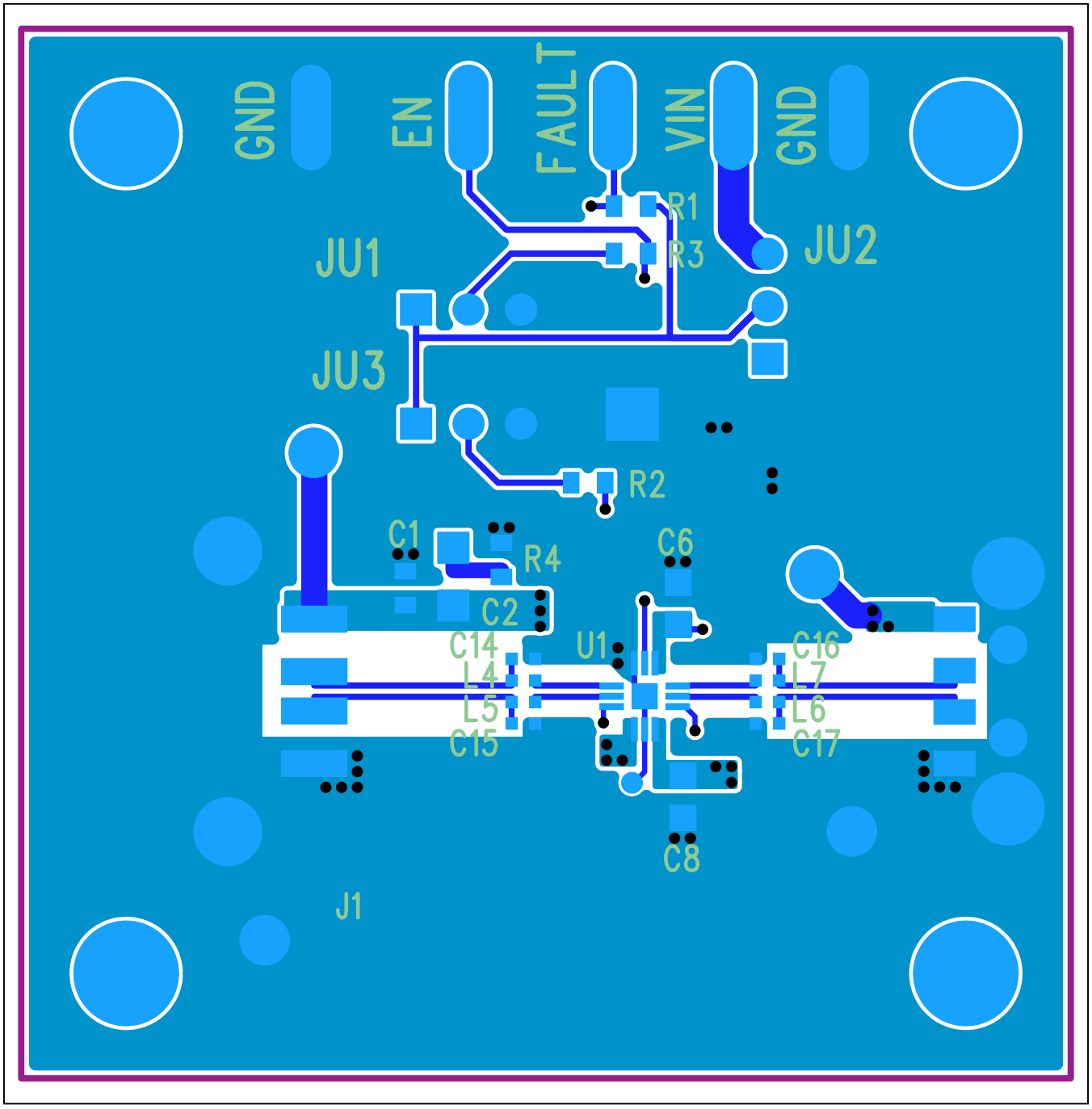
MAX20046 EV Bill of Materials

QTY	REFERENCE	DESCRIPTION	MANUFACTURER	MFG PART NO.
1	C1	0.1uF 0603 50V X7R 10%	Murata	GRM188R71H104KA93D
2	C2, C6	10uF 0805 25V X5R 20%	Murata	GRM219R61E106KA12D
2	C3, C4	1uF 0805 16V X7R 10%	Murata	GRM21BR71C105KA01K
1	C8	10uF 0805 6.3V X7R 20%	Murata	GRM21BR70J106ME76L
4	C14 - C17	OPEN		
1	J1	USB A receptacle	KYCON	KUSBX-SMT-AS1N-B30
1	J3	USB A plug	KYCON	KUSBX-SMT2AP5S-B30
4	L4 - L7	0Ω Resistor 0402	Any (Yageo)	RC0402JR-070RL
3	JU1, JU2, JU3	100 mil header	TE Connectivity	4-103327-0
5	EN, FAULT, GND, VIN	Wire Loop (18 or 20 gauge wire)		
3	R1, R2, R3	100k 0603 0.1W 5%	KOA	RK73B1JTTD104J
1	R4	1Ω 0603 0.1W 1%	Yageo	RC0603FR-071RL
1	U1	USB Protection IC	Maxim	MAX20046GTCA/V+
1	U2	3.3V Linear Voltage Regulator	Maxim	MAX15007AASA+
1	—	PCB: MAX20046 EVALUATION KIT#	Maxim	—

MAX20046 EV Kit Schematics

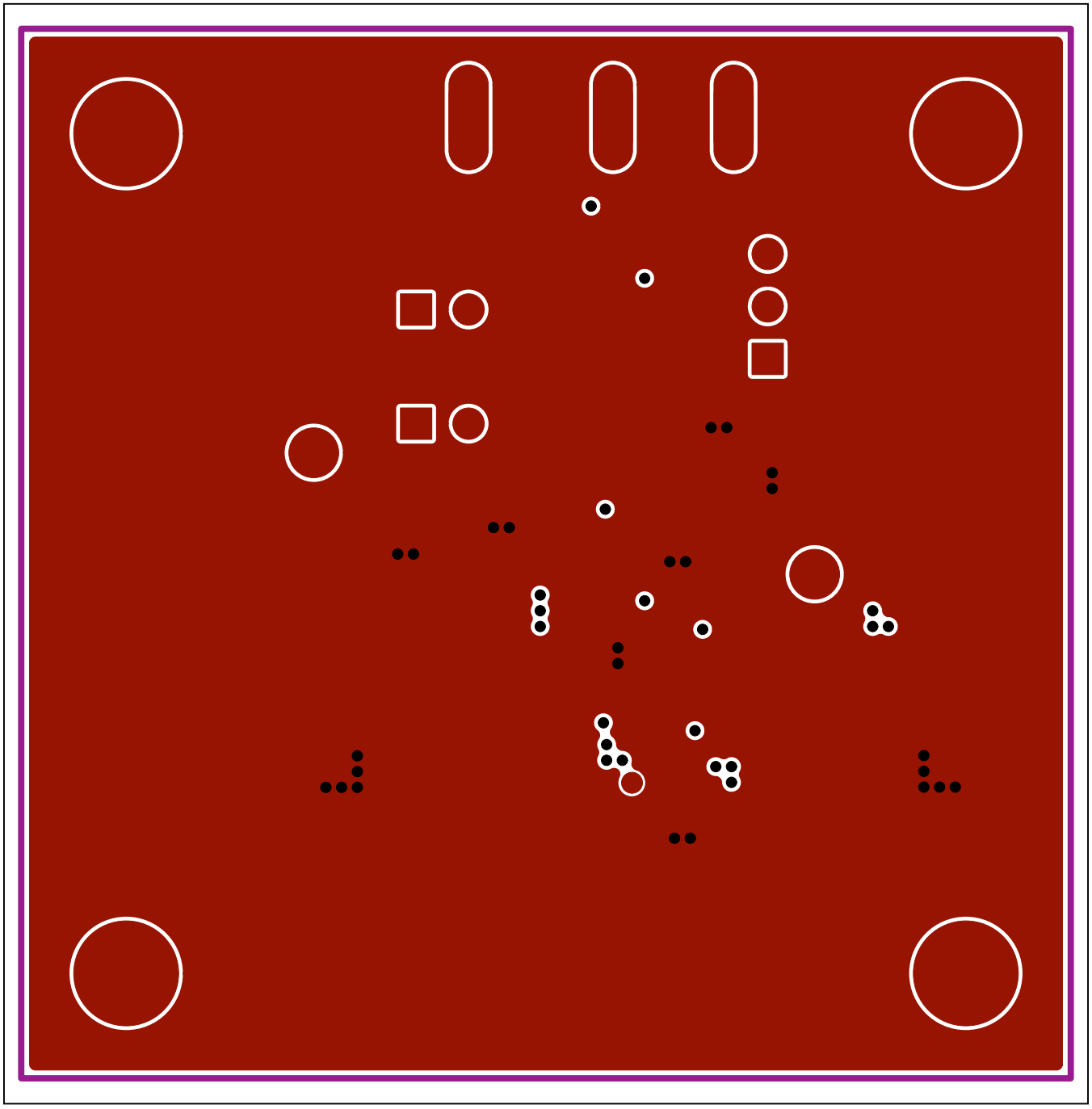


MAX20046 EV Kit PCB Layouts



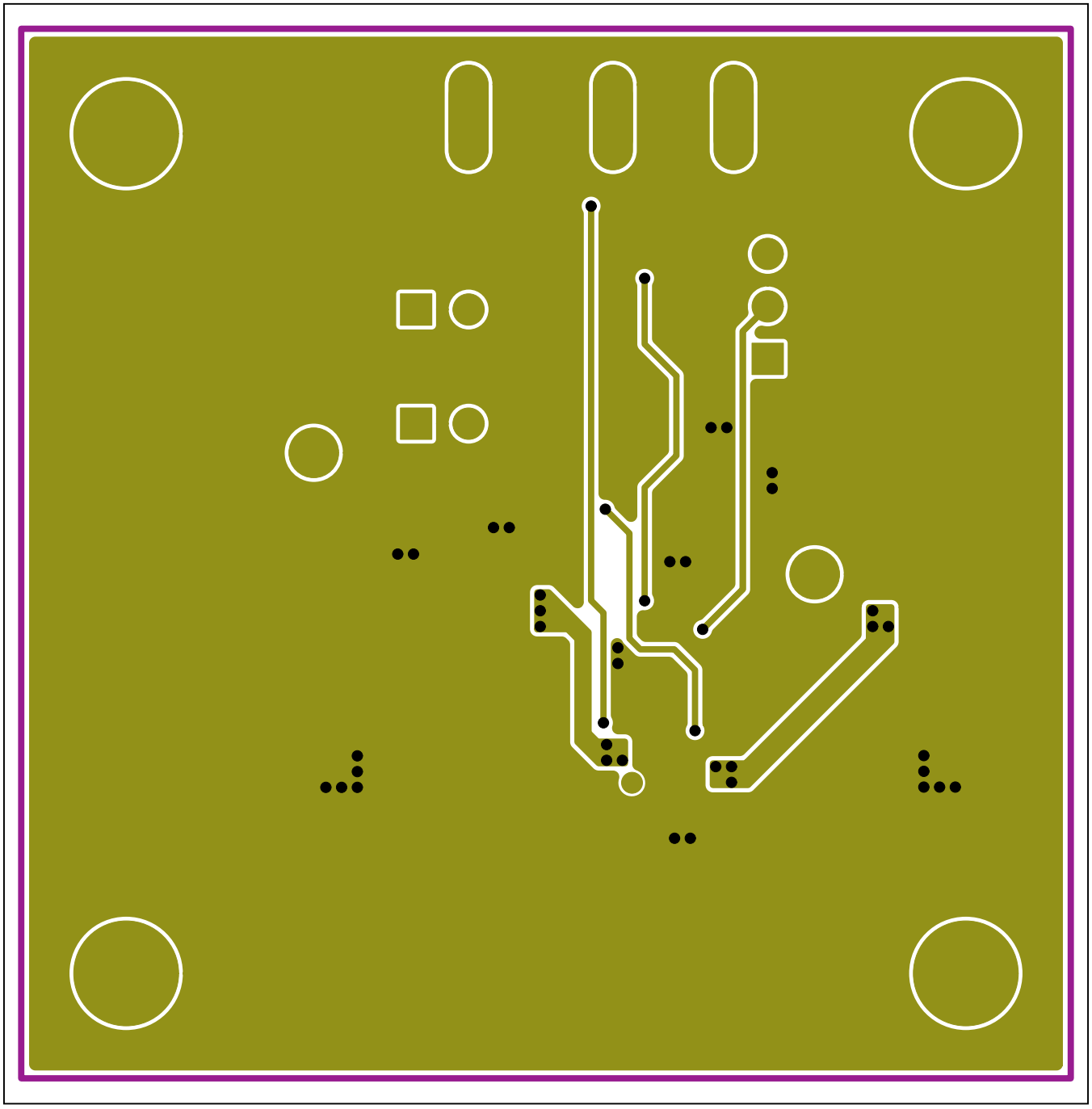
MAX20046 EV Kit Component Placement Guide—Top

MAX20046 EV Kit PCB Layouts (continued)



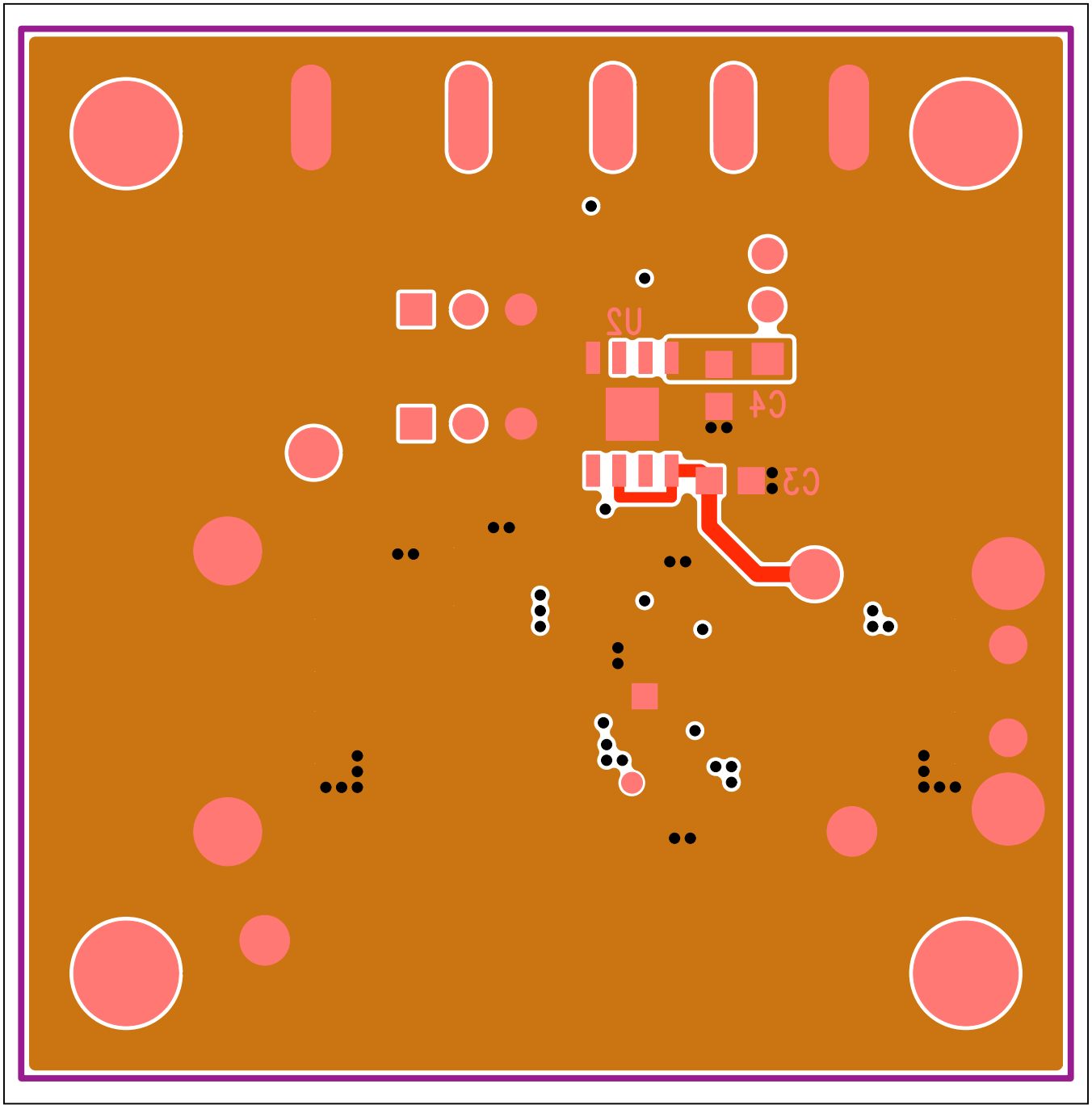
MAX20046 EV Kit PCB Layout—Layer 2

MAX20046 EV Kit PCB Layouts (continued)



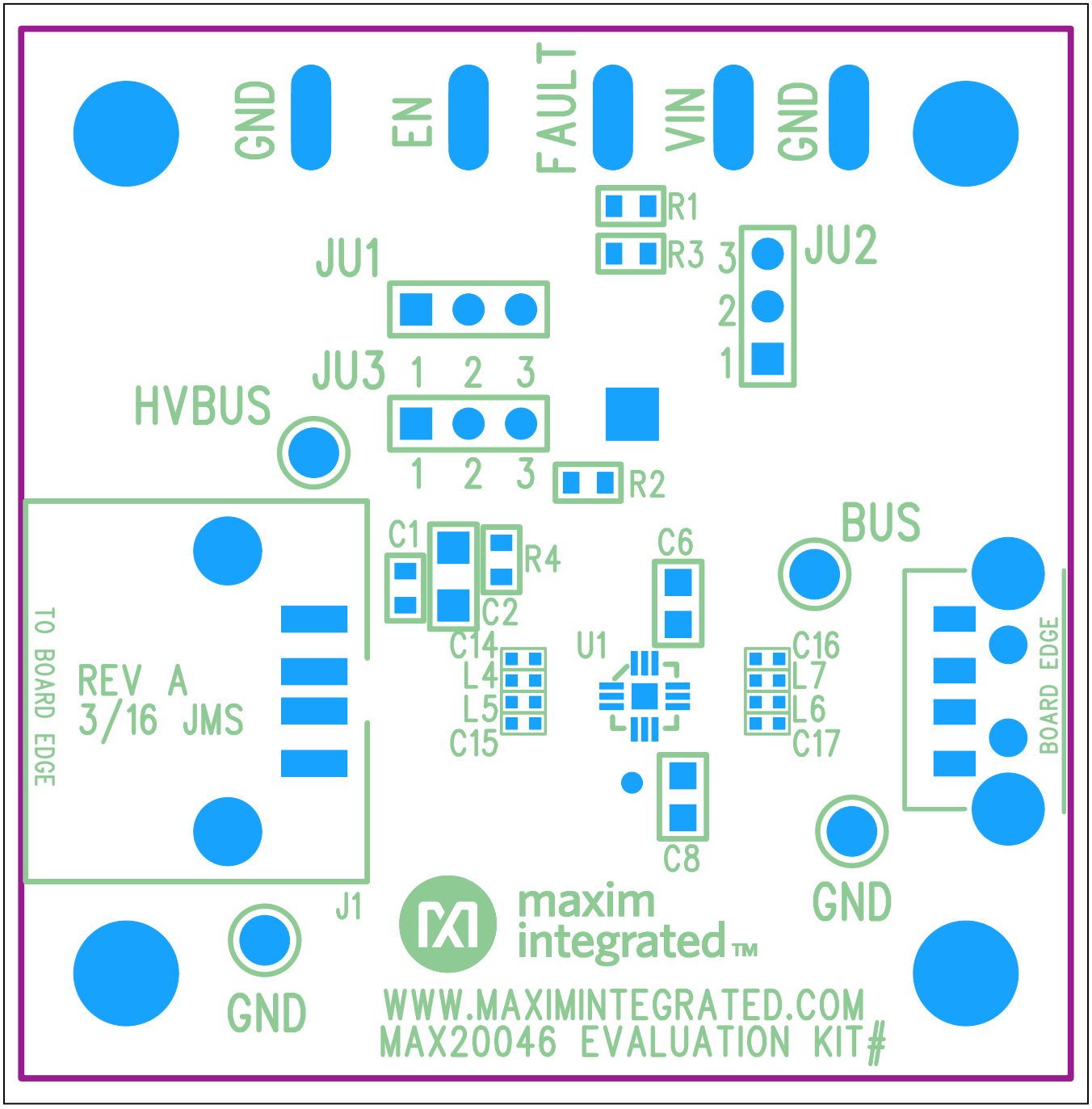
MAX20046 EV Kit PCB Layout—Layer 3

MAX20046 EV Kit PCB Layouts (continued)



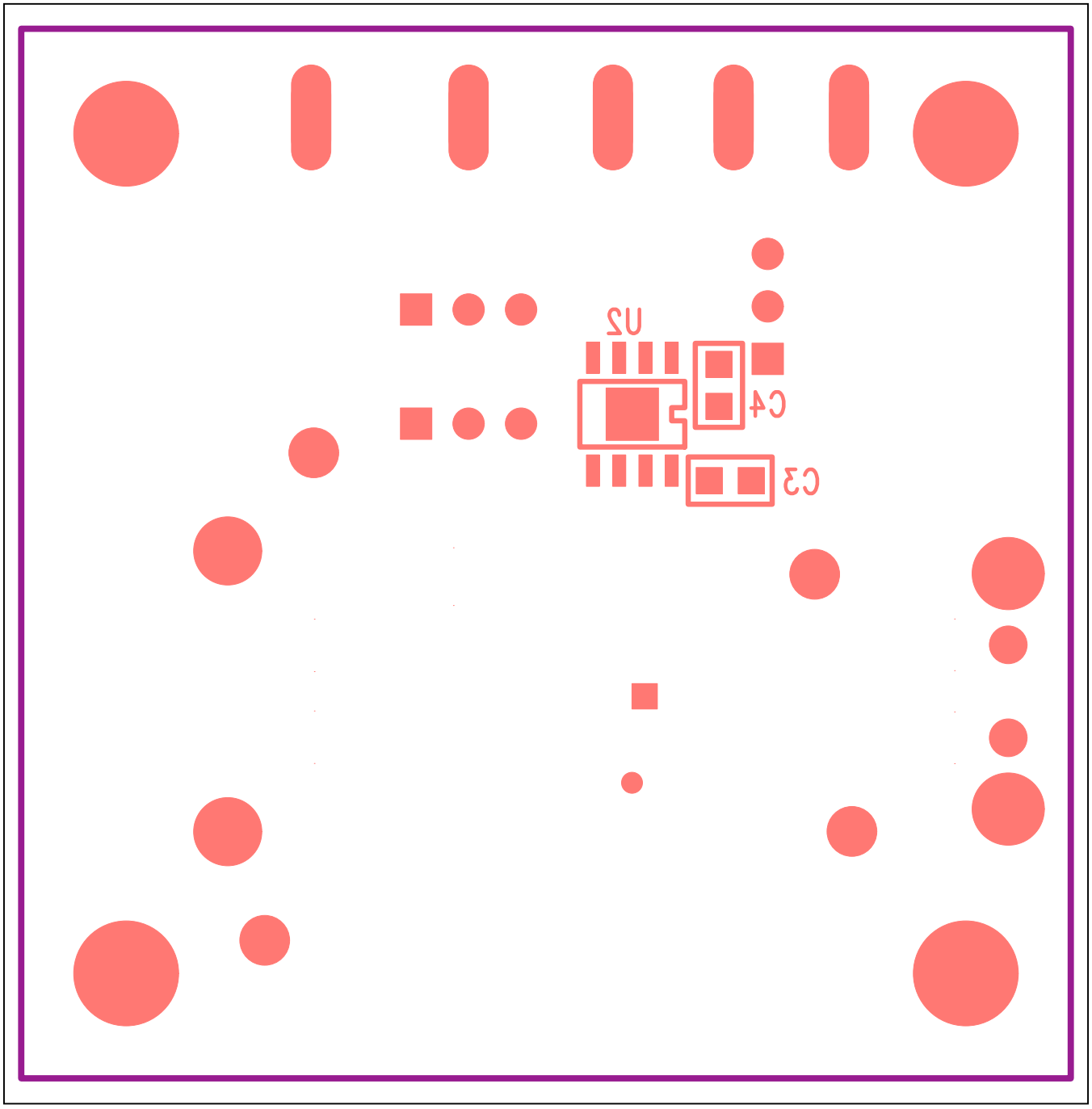
MAX20046 EV Kit PCB Layout—Bottom

MAX20046 EV Kit PCB Layouts (continued)



MAX20046 EV Kit Component Placement Guide—Top Silkscreen

MAX20046 EV Kit PCB Layouts (continued)



MAX20046 EV Kit Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	1/17	Initial release	—

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

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