

General Description

The MAX20044F evaluation kit (EV kit) circuit demonstrates the MAX20044F automotive USB protector switch IC, featuring overvoltage protection (OVP), electrostatic discharge (ESD) protection, and undervoltage lockout (UVLO)/overcurrent protection (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 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 $\overline{\text{FAULT}}$ output signal.

The IC can pass high-speed USB differential (D+ and D-) signals up to 480Mbps and has a low 90m Ω $R_{\text{ON}}(\text{MAX})$ for the BUS and a 4 Ω $R_{\text{ON}}(\text{TYP})$ 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. The MAX20044F EV kit can also evaluate the MAX20042F and MAX20043F after IC replacement of U1.

Features

- Protects USB BUS, D+, and D- Signals from Overvoltages Up to 18V and ESD Events
- USB BUS Undervoltage Lockout
- 1.3A (typ) USB BUS Overcurrent-Protection Threshold
- 1ms Overcurrent Blanking Time
- Passes 480Mbps USB Data Signals
- Low On-Resistance
 - BUS: 0.14m Ω (max)
 - D+ and D-: 4 Ω (typ)
- $\overline{\text{FAULT}}$ Output Signal
- USB Powered
- Fully Assembled and Tested
- Evaluates the MAX20042F, MAX20043F, and MAX20044F ICs in a 16-Pin QSOP Package

Quick Start

Required Equipment

- MAX20044F 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 (MAX20044F switches 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) Connect the logic function generator output to the white D+ test point and the ground to the black SHIELD test point.
- 7) Enable both power-supply outputs.
- 8) Enable the function generator output.

Ordering Information appears at end of data sheet.

MAX20044F Evaluation Kit

Evaluates: MAX20042F/
MAX20043F/MAX20044F

- 9) Install a shunt on jumper JU1, pins 2-3 (MAX20044F switches 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 $\overline{\text{FAULT}}$ signal asserts a logic-low while the fault is present.

Detailed Description of Hardware

The MAX20044F EV kit circuit demonstrates the MAX20044F automotive USB 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 15kV (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 1.3A (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 $\overline{\text{FAULT}}$ PCB pad, pulled up to IN through resistor R1.

The IC can pass high-speed USB differential (D+ and D-) signals up to 480Mbps, and has a low 90m Ω $R_{\text{ON}}(\text{MAX})$ for BUS and a 4 Ω $R_{\text{ON}}(\text{TYP})$ 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 MAX20044F (U1) IC's automotive operating temperature range is from -40°C to 105°C.

Table 1. MAX20044F Enable (JU1)

SHUNT POSITION	EN PIN	MAX20044F SWITCHES
1-2	Connected to IN	Disabled
2-3	Connected to GND	Enabled
Not installed	Connected to EN PCB pad	EN externally controlled

Long USB wire lengths contribute to increased wiring inductance, resulting in slow di/dt and dV/dt during a “short to 18V” event. The IC includes internal circuitry that switches off the switch between the HVBUS and BUS during an overvoltage on the HVBUS for these long USB wire conditions. Energy stored in the wiring inductance can cause the HVBUS node to quickly increase. Zener diode D1 clamps this flyback voltage, absorbing the energy in wiring inductance.

Jumper Settings

Bus and Data Switch Enable (JU1)

Jumper JU1 on the EV kit enables the IC's BUS and data switches. PCB pads $\overline{\text{EN}}$ and GND are provided to control U1's enable signal with an external controller. Refer to the *Electrical Characteristics $\overline{\text{EN}}$ Input* section in the MAX20042F–MAX20044F IC data sheet for proper $\overline{\text{EN}}$ 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 IC'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. PCB pads VIN and GND are provided to supply the IC with an external 3V to 3.6V reference voltage. See [Table 2](#) for proper JU2 jumper settings.

Evaluating the MAX20042F and MAX20043F

The MAX20044F EV kit can also evaluate the MAX20042F and MAX20043F. Remove the MAX20044F (U1) and replace it with the desired device. The MAX20042F and MAX20043F are pin compatible with the MAX20044F. Refer to the MAX20042F–MAX20044F IC data sheet for additional information.

Optional Common-Mode Choke

PCB pads are provided on the EV kit for an optional common-mode choke (L1). Cut the traces shorting L1's PCB pads before installing a choke.

Table 2. MAX20044F IN Reference Voltage Selection (JU2)

SHUNT POSITION	IN PIN	EV KIT FUNCTION
1-2	Connected to the on-board 3.3V regulator	On-board reference provided by U2
2-3	Connected to the VIN PCB pad	External 3V to 3.6V reference

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	0.1 μ F $\pm$ 10%, 25V X7R ceramic capacitor (0603) Murata GRM188R71E104K
C2	0	Not installed, ceramic capacitor
C3, C4	2	3.3 μ F $\pm$ 10%, 16V X7R ceramic capacitors (0805) Murata GRM21BR71C335K
C5, C7	2	0.1 μ F $\pm$ 10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K
C6	1	10 μ F $\pm$ 20%, 25V X7R ceramic capacitor (0805) Murata GRM219R61E106KA12D
C8	1	100 μ F $\pm$ 20%, 6.3V X7S ceramic capacitor (1210) Murata GRM32EC80J107M
C9	1	10 μ F $\pm$ 20%, 25V X7R ceramic capacitor (1210) TDK C3225X7R1E106M
C14, C15	2	6pF $\pm$ 0.1pF, 50V C0G NP0 ceramic capacitors (0402) Murata GRM1555C1H6R0BZ01D
C16, C17	2	2pF $\pm$ 0.1pF, 50V C0G NP0 ceramic capacitors (0402) Murata GRM1555C1H2R0BZ01D

DESIGNATION	QTY	DESCRIPTION
D1	1	20V, 500mW zener diode (SOD123) Fairchild MMSZ5250B
GND1, GND2	2	Black multipurpose test points Keystone 5011
HVBUS, BUS	2	Red multipurpose test points Keystone 5010
J1, J2	2	USB type-A receptacles Assmann AU-Y1006-R
JU1, JU2	2	3-pin headers, 2.54mm Sullins PEC36SAAN
L1	1	Optional common-mode choke
L4, L5	2	12nH inductors Murata LQW15AN12NJ00D
L6, L7	2	4.7nH inductors Murata LQW15AN4N7D00D
R1, R2	2	100k Ω $\pm$ 5% resistors (0603)
U1	1	USB automotive protector (16 QSOP) Maxim MAX20044FEGEEA/V+
U2	1	3.3V automotive regulator (8 SO-EP*) Maxim MAX15007AASA+
—	2	Shunts Kycon SX1100-B
—	1	PCB: MAX20044 EVALUATION KIT#

/V denotes an automotive qualified part.

+Denotes a lead(Pb)-free/RoHS-compliant package.

*EP = Exposed pad.

MAX20044F Evaluation Kit

Evaluates: MAX20042F/
MAX20043F/MAX20044F

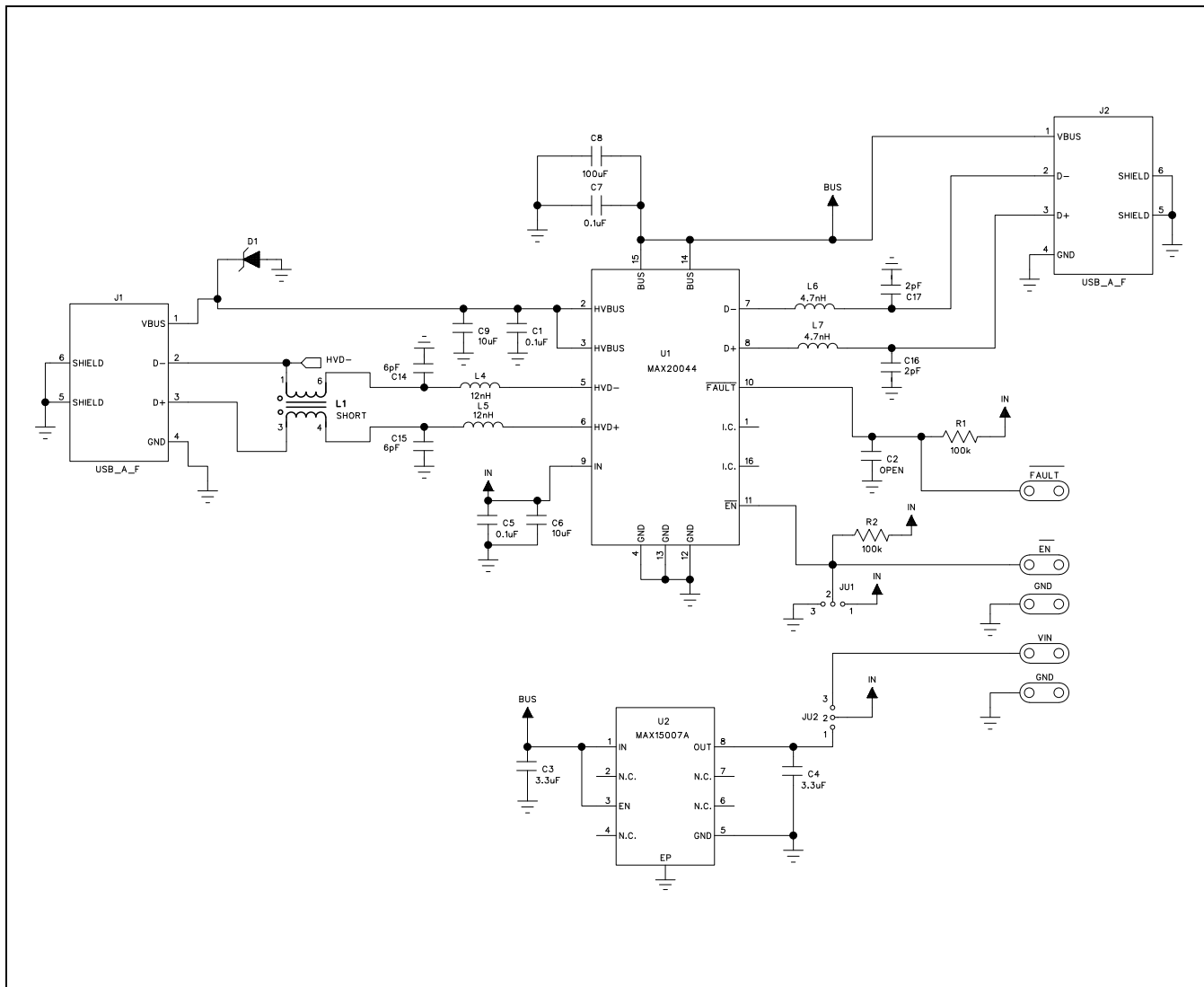


Figure 1. MAX20044F EV Kit Schematic

MAX20044F Evaluation Kit

Evaluates: MAX20042F/
MAX20043F/MAX20044F

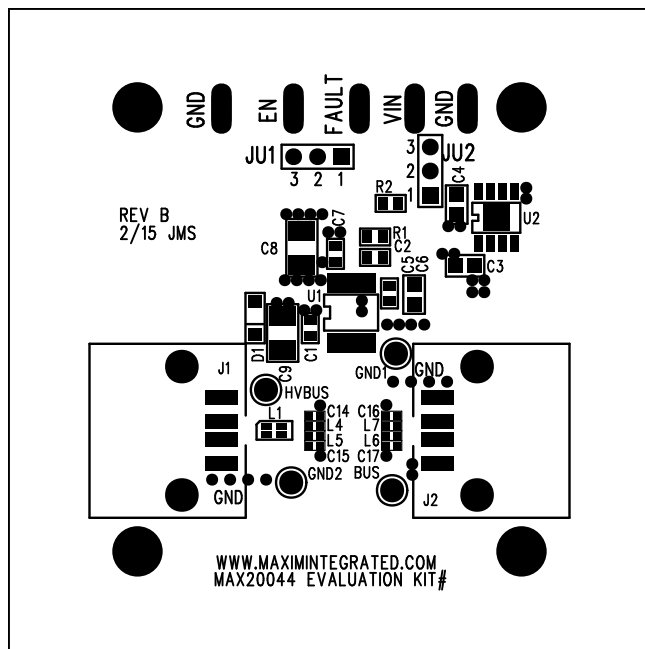


Figure 2. MAX20044F EV Kit—Component Side

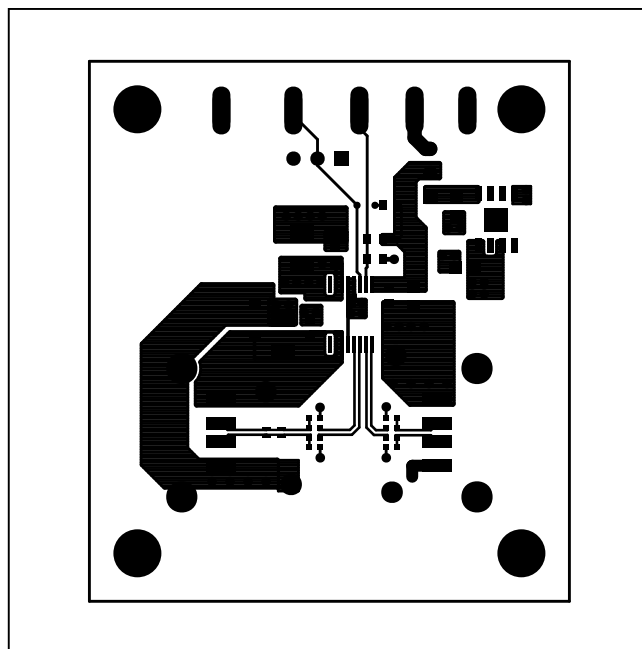


Figure 3. MAX20044F EV Kit PCB Layout—Component Side

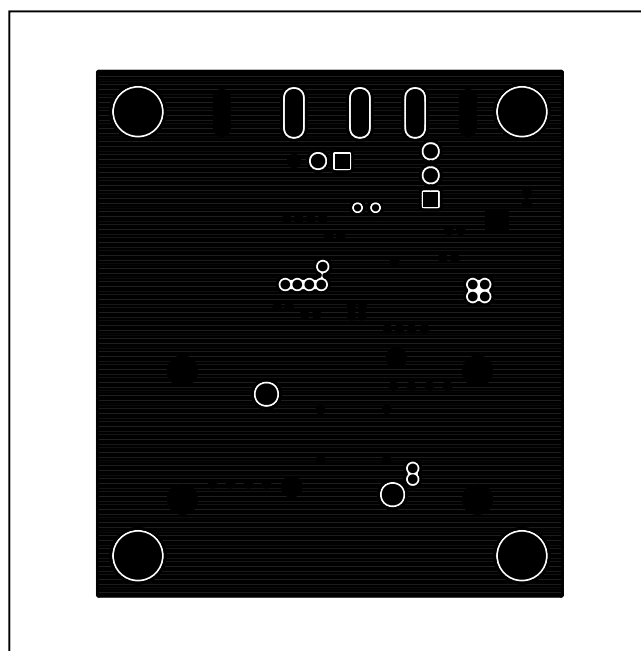


Figure 4. MAX20044F EV Kit PCB Layout—Layer 2

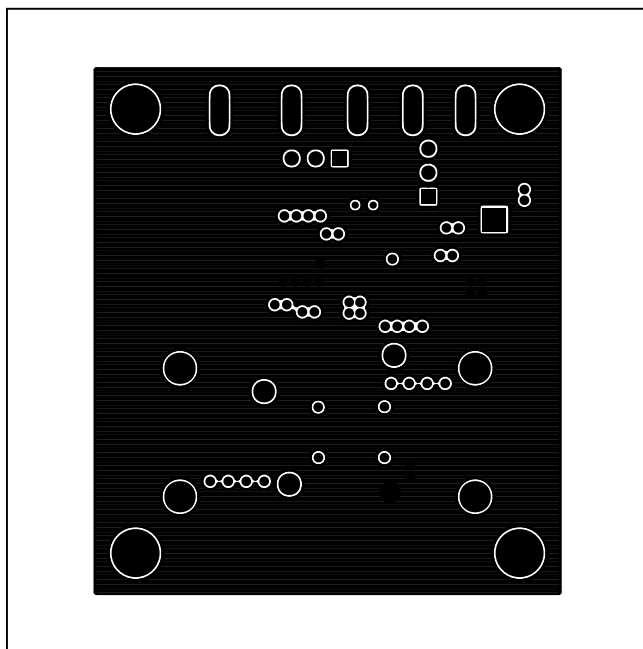


Figure 5. MAX20044F EV Kit PCB Layout—Layer 3

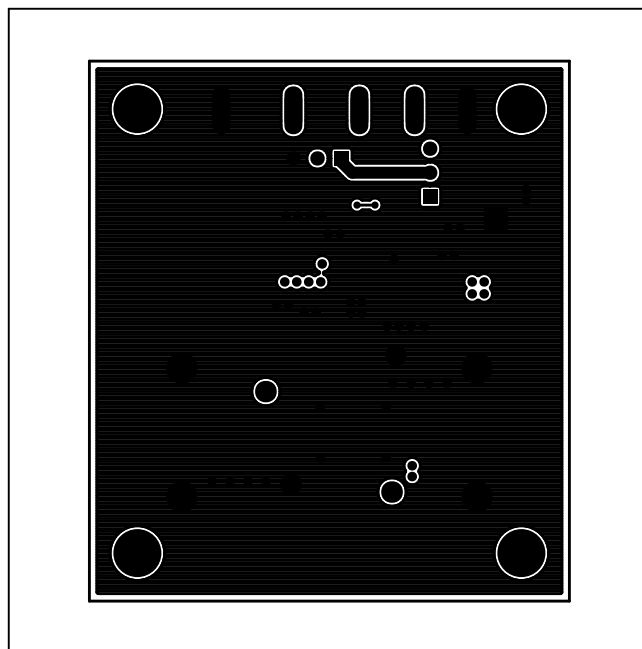


Figure 6. MAX20044F EV Kit PCB Layout—Solder Side

Ordering Information

PART	TYPE
MAX20044EVKIT#	EV Kit

#Denotes RoHS compliant.

MAX20044F Evaluation Kit

Evaluates: MAX20042F/
MAX20043F/MAX20044F

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/15	Initial release	—
1	12/16	Changed part numbers from MAX20042, MAX20043, and MAX20044 to MAX20042F, MAX20043F, and MAX20044F	1–7
2	2/17	Changed ordering part number in <i>Ordering Information</i> from MAX20044FEVKIT# to MAX20044EVKIT#	6

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.

Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time.