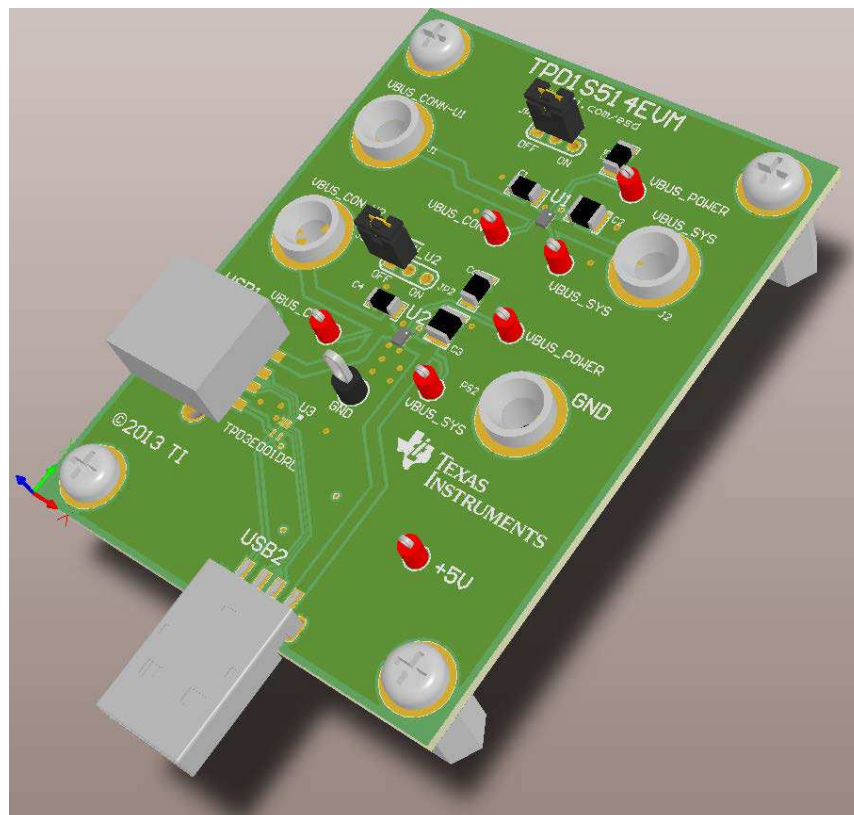


## **TPD1S514-2EVM**

This user's guide describes the characteristics, operation, and use of the TPD1S514-2EVM evaluation module (EVM). This EVM includes 4 TPD1S514-2's in various configurations for testing. One TPD1S514-2 is configured with pin-outs and one TPD1S514-2 is configured with USB 2.0 Type A connectors for throughput analysis. This user's guide includes setup instructions, schematic diagrams, a bill of materials, and printed-circuit board layout drawings for the EVM.



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## 1 Introduction

Texas Instrument's TPD1S514-2 evaluation module helps designers evaluate the operation and performance of the TPD1S514-2 device. The TPD1S514-2 is a single-chip solution for USB connector's VBUS line protection. The bi-directional nFET switch ensures safe current flow in both charging and host mode while protecting the internal system circuits from any over-voltage conditions at the  $V_{BUS\_CON}$  pin. On the  $V_{BUS\_CON}$  pin, this device can handle over-voltage protection up to 30 V. After the  $\overline{EN}$  pin toggles low, the TPD1S514-2 waits 21 ms before turning ON the nFET through a startup delay.  $V_{BUS\_POWER}$  pin indicates the nFET is completely turned ON.

**Table 1. EVM Configuration**

| Reference Designator | TI Part Number          | Configuration |
|----------------------|-------------------------|---------------|
| U1                   | TPD1S514-2              | Surge         |
| U2 and U3            | TPD1S514-2 and TPD3E001 | Surge and ESD |

## 2 Board Setup

This section describes the intended use of the TPD1S514-2EVM. A generalized outline of the procedure given in IEC-61000-4-5 is described here. IEC-61000-4-5 should be referred to for a more specific testing outline. Connect +5V and GND during any tests.

### 2.1 U1

TPD1S514-2 (U1) is pinned out to allow evaluating device performance during normal operating conditions as well as during surge events.  $V_{BUS\_CON}$  is J1 and  $V_{BUS\_SYS}$  is J2. A 3-pin header (JP2) allows shunting the  $\overline{EN}$  pin on or off. Test points allow monitoring of  $V_{BUS\_CON}$ ,  $V_{BUS\_SYS}$ , and  $V_{BUS\_POWER}$ . TPD1S514-2 can pass up to 3.5 A continuous current from  $V_{BUS\_CON}$  to  $V_{BUS\_SYS}$ .  $R_{DYN}$  can be measured under these conditions using the test points  $V_{BUS\_CON}$  and  $V_{BUS\_SYS}$ , where  $R_{DYN} = (V_{V_{BUS\_CON}} - V_{V_{BUS\_SYS}}) / I_{V_{BUS}}$ .

Surge can be injected onto  $V_{BUS\_CON}$  using J1. Over Voltage Protection (OVP) and Under Voltage Lockout (UVLO) can be measured by sweeping 0 V - 30 V on  $V_{BUS\_CONN}$  and measuring at the three test points.  $V_{BUS\_SYS}$  should have a load typical to the expected operational condition.

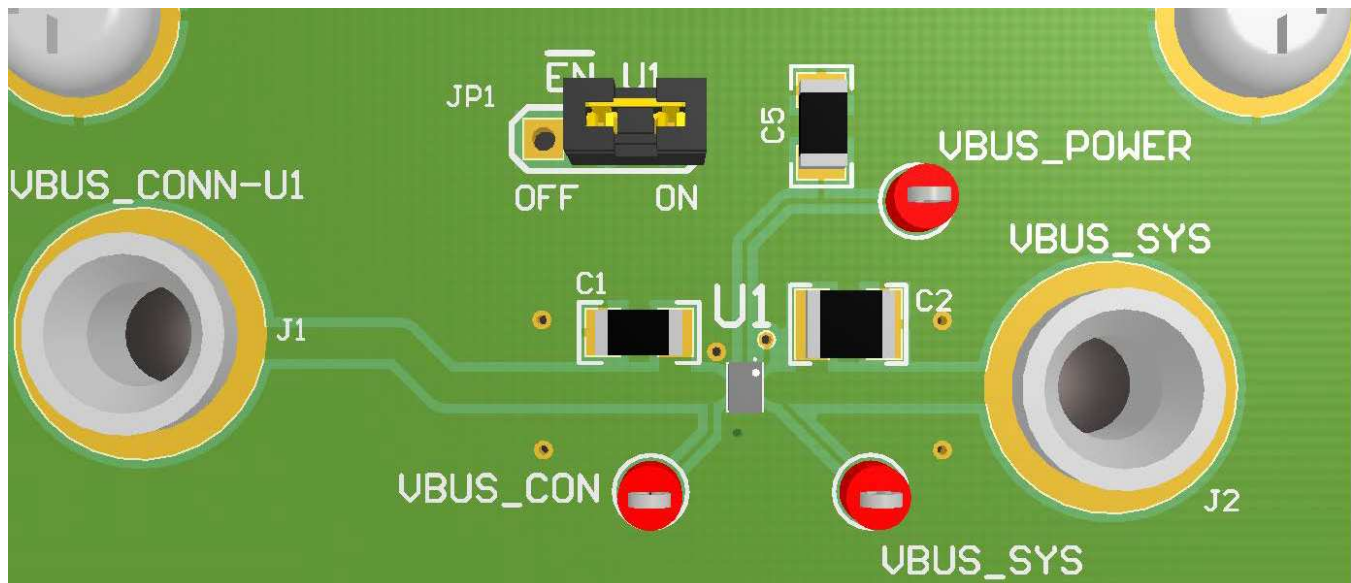


Figure 1. TPD1S514-2 Board Configuration for U1

Timing measurements should be performed after removal of C1, C2, and C3.

2.2 U2

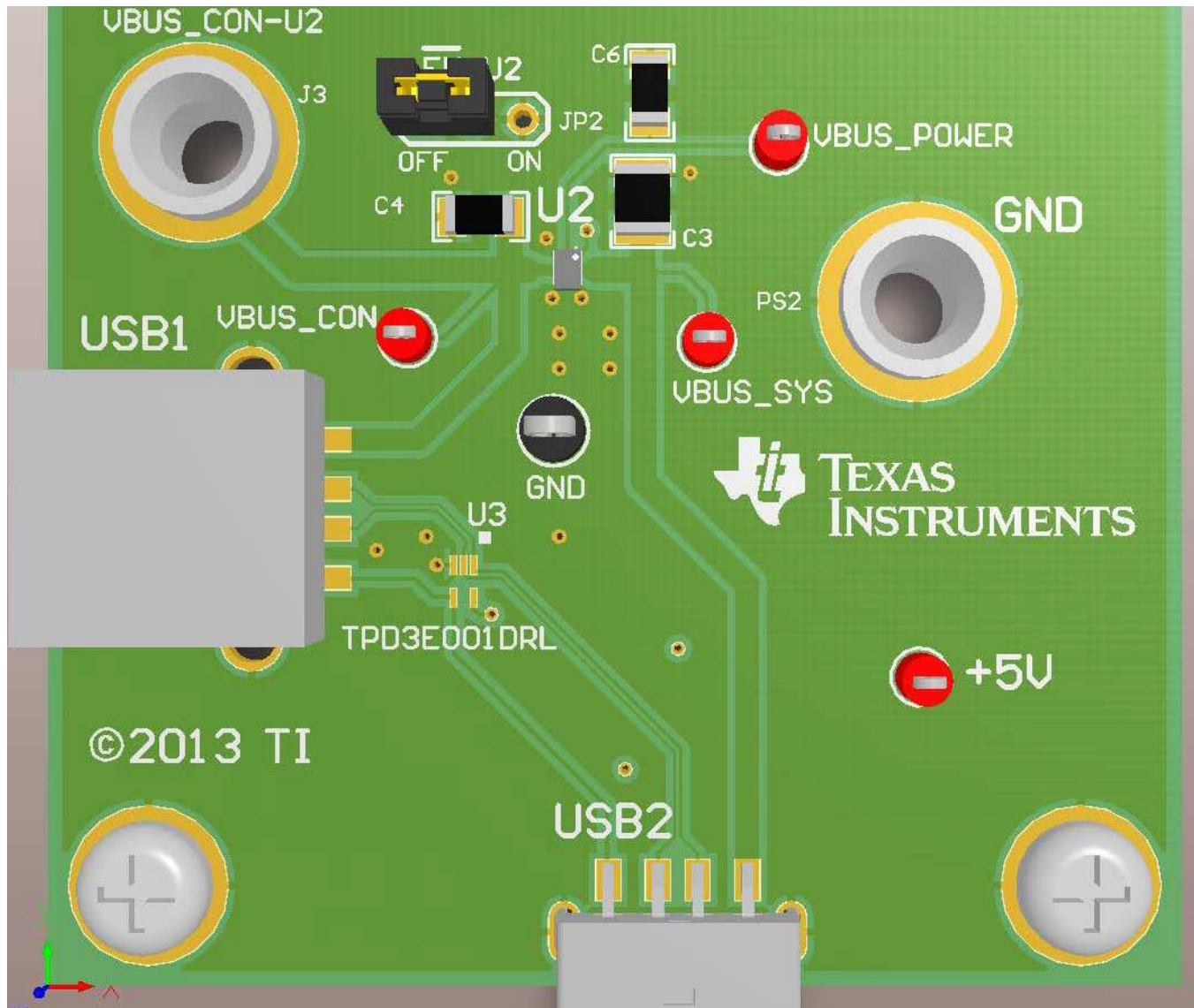


Figure 2. TPD1S514 Board Configuration for U2

A pass through USB2.0 port is included for system level testing. The female USB connector (USB1) is the “Connector” side of TPD1S514-2 and a male USB connector (USB2) is the “System” side. ESD protection has been added to the Hi-Speed data lines and ID pin in the form of TPD3E001DRL to complete the port protection example scheme.

Surge can be injected into V<sub>BUS\_CON</sub> using J3.

A 3-pin header (JP2) allows shunting the EN pin on or off. Test points allow monitoring of V<sub>BUS\_CON</sub>, V<sub>BUS\_SYS</sub>, and V<sub>BUS\_POWER</sub>.

### 3 Schematics

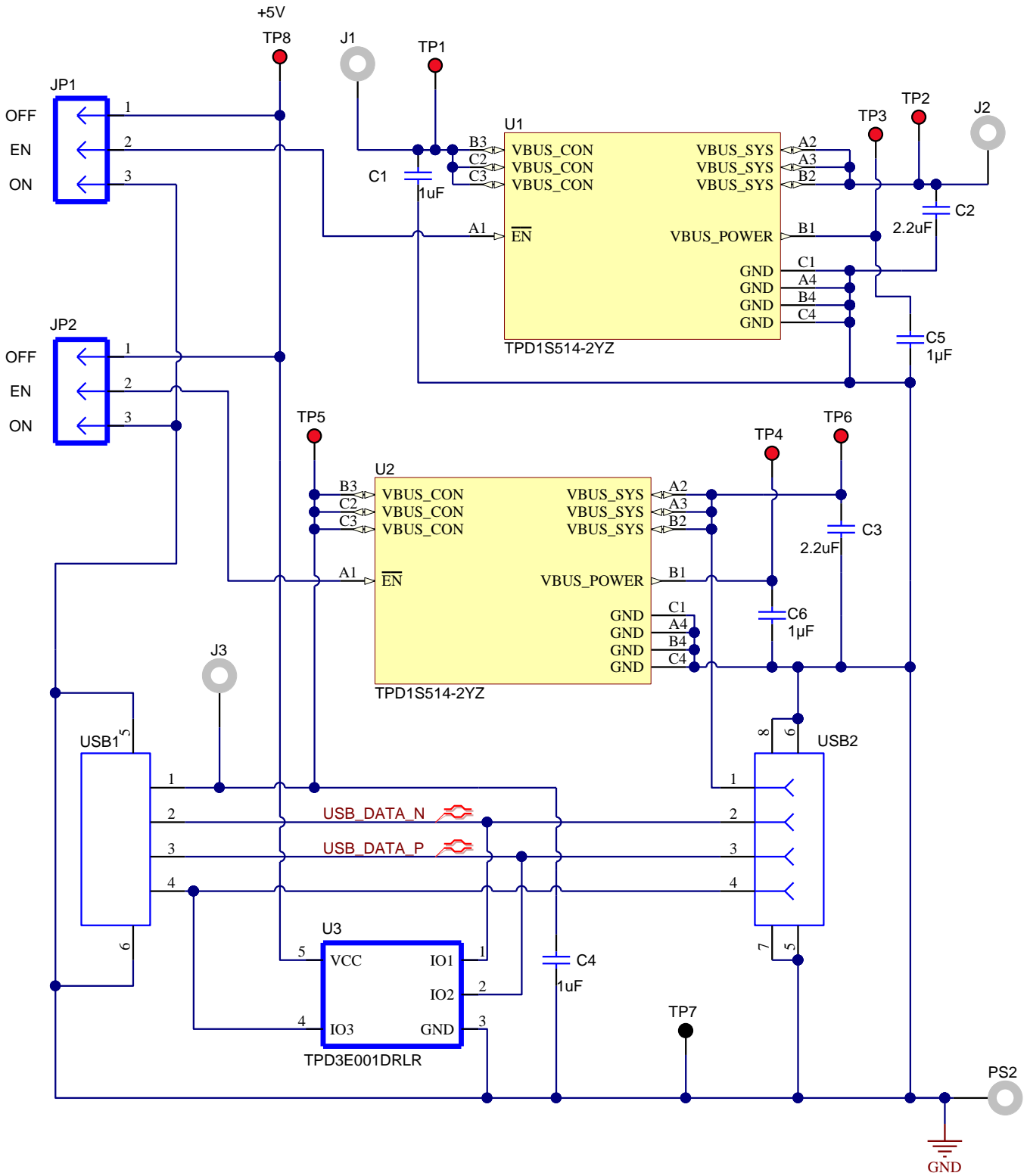


Figure 3. TPD1S514-2EVM Schematic

#### 4 Board Layout

This section provides the TPD1S514-2EVM board layout. TPD1S514-2EVM is a 4-layer board of FR-4 at 0.062" thickness, with ½ oz. copper outer layers and 1 oz. copper inner layers.

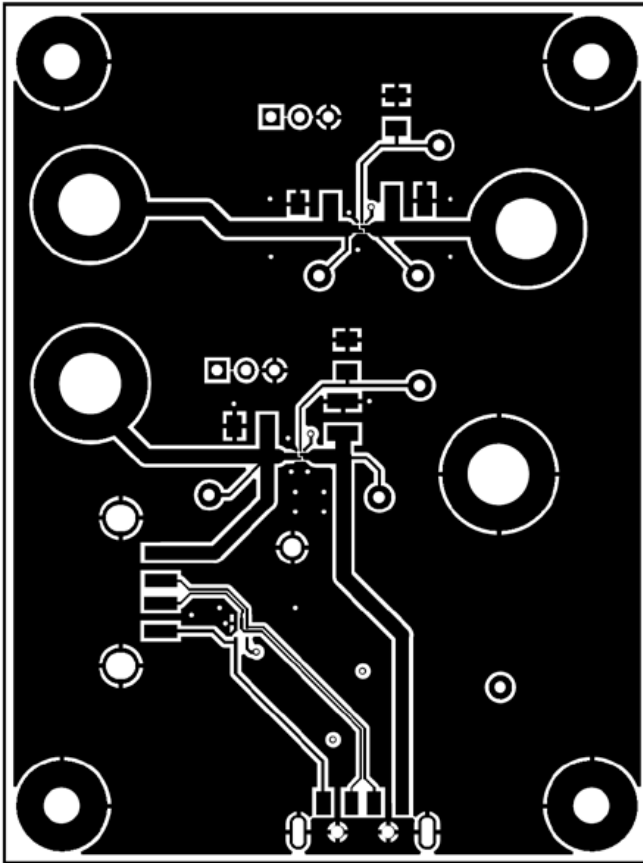


Figure 4. Top Layer Copper

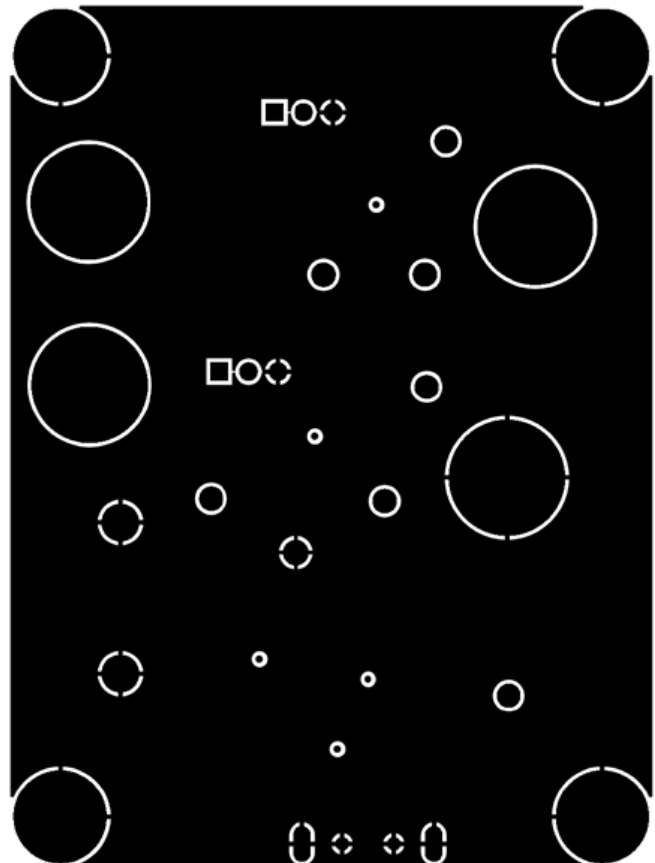


Figure 5. Second Layer Copper

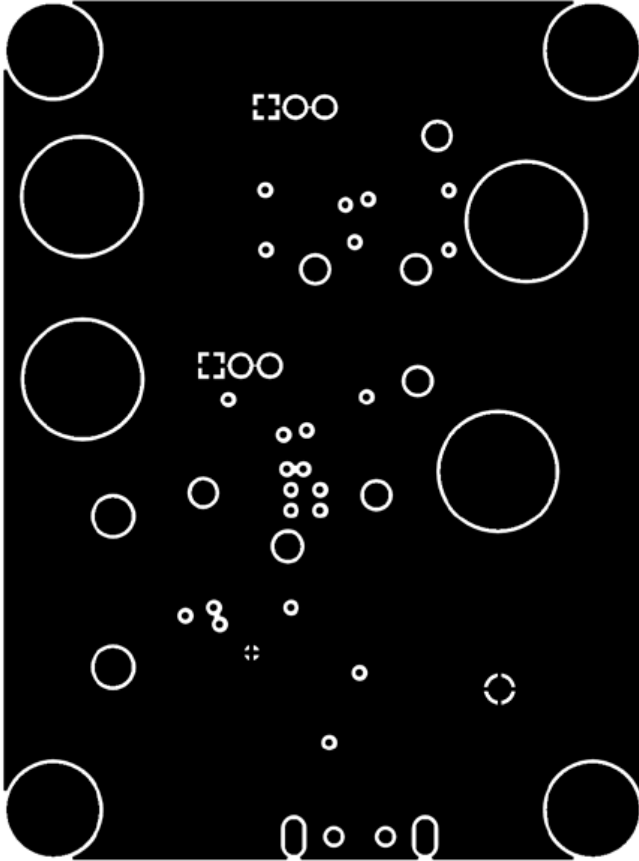


Figure 6. Layer 3 Copper

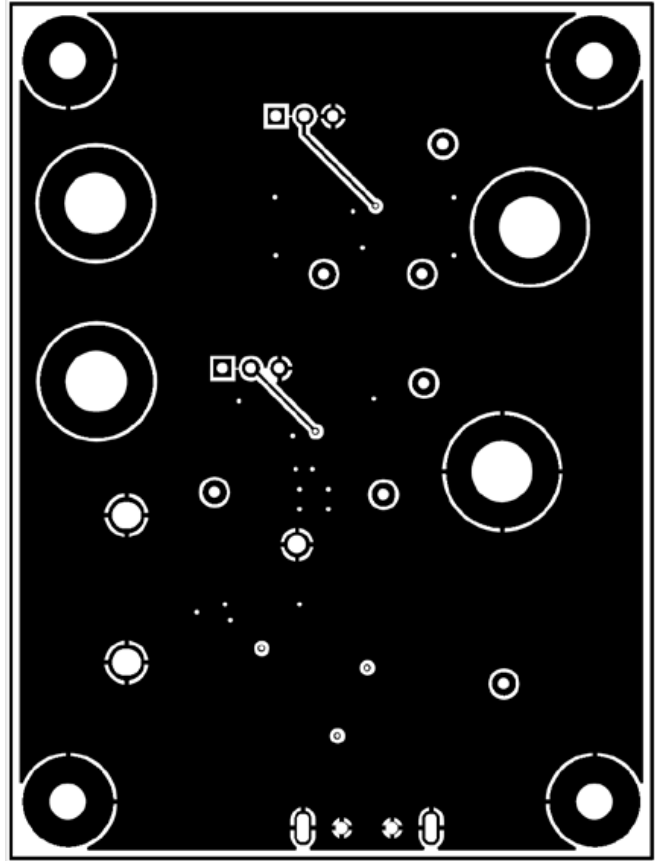


Figure 7. Bottom Layer Copper

## 5 Bill of Materials

**Table 2. Bill of Materials**

| Designator                        | Quantity | Value        | Description   | Package Reference                        | Part Number          | Manufacturer        |
|-----------------------------------|----------|--------------|---|--|----------------------|---------------------|
| C1, C4, C5, C6                    | 4        | 1 $\mu$ F    | CAP, CERM, 1 $\mu$ F, 25V, $\pm$ 10%, X7R, 1206   | 1206                                     | 12063C105KAT2A       | AVX                 |
| C2, C3                            | 2        | 2.2 $\mu$ F  | CAP, CERM, 2.2 $\mu$ F, 100V, $\pm$ 10%, X7R, 1210  | 1210                                     | GRM32ER72A225KA35L   | MuRata              |
| H1, H2, H3, H4                    | 4        |              | Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead                                     | Screw                                    | NY PMS 440 0025 PH   | B&F Fastener Supply |
| H5, H6, H7, H8                    | 4        |              | Standoff, Hex, 0.5"L #4-40 Nylon  | Standoff                                 | 1902C                | Keystone            |
| J1, J2, J3, PS2                   | 4        |              | Standard Banana Jack, Uninsulated, 5.5mm  | Keystone_575-4                           | 575-4                | Keystone            |
| JP1, JP2                          | 2        | PEC03SAAN    | Header, Male 3-pin, 100mil spacing,   | 0.100 inch x 3                           | PEC03SAAN            | Sullins             |
| SH-J1A, SH-J2A                    | 2        | 1x2          | Shunt, 100mil, Gold plated, Black   | Shunt                                    | 969102-0000-DA       | 3M                  |
| TP1, TP2, TP3, TP4, TP5, TP6, TP8 | 7        | Red          | Test Point, Miniature, Red, TH  | Red Miniature Testpoint                  | 5000                 | Keystone            |
| TP7                               | 1        | Black        | Test Point, Multipurpose, Black, TH   | Black Multipurpose Testpoint             | 5011                 | Keystone            |
| U1, U2                            | 2        |              | USB Charger Over Voltage, Surge and ESD Protection for VBUS_CON Pin, YZ0012AFV                | YZ0012AFV                                | TPD1S514-2YZ         | Texas Instruments   |
| U3                                | 1        | TPD3E001DRLR | IC, LOW-CAPACITANCE 3-CHANNEL $\pm$ 15-kV ESD-PROTECTION ARRAY FOR HIGH-SPEED DATA INTERFACES | SOP-5 (DRL)                              | TPD3E001DRL          | Texas Instruments   |
| USB1                              | 1        |              | Connector, Receptacle, USB TYPE A, 4POS SMD   | USB TYPE A CONNECTOR RECEPTACLE 4POS SMD | 896-43-004-00-000000 | Mill-Max            |
| USB2                              | 1        |              | Connector, USB Type A, 4POS R/A, SMD  | USB Type A right angle                   | 48037-1000           | Molex               |



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