

USB-Redriver Evaluation Module

This is the user guide for the USB-Redriver evaluation module (EVM). The contents of this user's guide are meant to provide an overview of the USB-Redriver, which includes highlighting its key features, operating conditions, and how to setup this EVM for use in a system-level evaluation. The layout information, schematics, and bill of materials is included at the end of this manual.



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1 Introduction

The USB-REDRIVER-EVM is a fully functioning USB 2.0 and USB 3.0 Re-driver dongle.

1.1 Key Features

The key features include:

- Supports operation as a USB 2.0 or USB 3.0 extender by re-driving the high-speed signals
- Operates as a bus-powered device not requiring an external supply
- Supports all system low-power states

1.2 Featured Applications

The following applications are supported by this EVM:

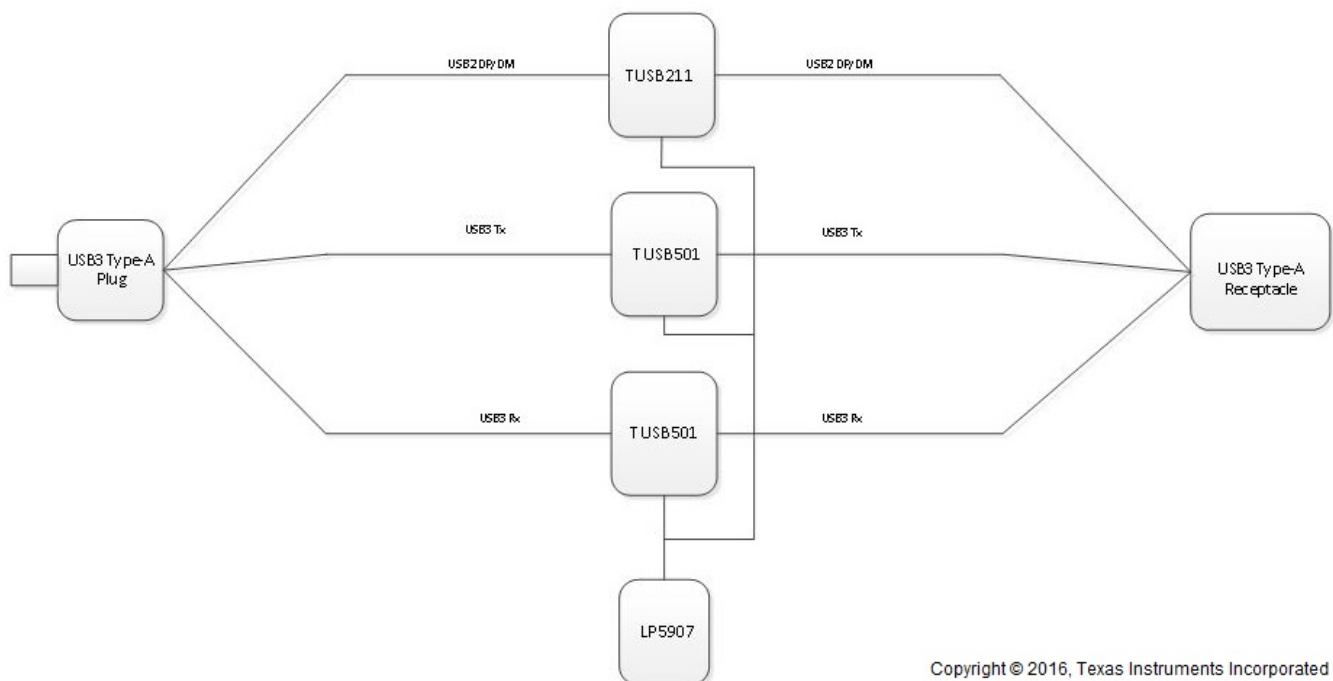
- Computer systems
- Docking stations
- Storage drives

2 Circuit Description

This USB 2.0, USB 3.0 Re-driver Dongle Design connects directly to a Host USB port and re-drives the High-Speed or SuperSpeed signals to the downstream port to enable a long cable connection to a SuperSpeed or High-Speed device. The dongle is powered from the VBUS pin provided by the Host and passes VBUS to the downstream port to power a connected device.

3 Theory of Operation

A block diagram of the design in [Figure 1](#) shows the USB 3.0 Type-A plug as the upstream port, USB 3.0 receptacle as the downstream port. The TUSB211 USB 2.0 Re-driver re-drives the DP/DM signals between upstream and downstream ports. There are two TUSB501 USB 3.0 Re-drivers, one used for the Host SuperSpeed TX differential pair and the other used for the Host SuperSpeed RX differential pair. The LP5907 is used to provide the 3.3-V supply to all three USB re-drivers.



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Figure 1. USB2 and USB3 Redriver Dongle Block Diagram

3.1 TUSB211

The TUSB211 is a USB 2.0 High-Speed signal conditioner designed to compensate for ISI signal loss in a transmission channel. It provides various EQ or Boost settings configurable via specific resistor values present on a single pin. The TUSB211 is a low-cost, low-BOM-count device to enhance the signal integrity of the High-Speed USB bi-directional channel.

3.2 TUSB501

The TUSB01 is a single-channel USB 3.0 SuperSpeed re-driver designed to recover signal loss created by loss and ISI. It provides various EQ settings to recover signal loss and adds de-emphasis and output swing to the recovered signal to drive a lossy channel.

3.3 LP5907

The LP5907 is a 3.3-V regulator capable of supplying 250-mA output. Voltage input to the LP5907 is provided from VBUS supplied by the host platform. The LP5907 provides low noise, high PSRR, low quiescent current and low line or load transient response figures.

4 Component Selection

All components contained in this design are chosen to provide a low-cost solution when purchased in large quantities, while minimizing component count and maintaining performance to satisfy the design criteria.

4.1 USB 2.0 Redriver Selection

The TUSB211 was chosen as it is the world's first USB 2.0 High-Speed re-driver. This device is also compatible with USB On The Go (OTG) and Battery Charging (BC 1.2) protocols. The footprint of the TUSB211 was created such that it does not break the continuity of the DP/DM signal path.

4.2 USB 3.0 Redriver Selection

There are two TUSB501 devices used in this reference design, each is a single-channel re-driver consuming low power while active. The TUSB501 can be configured with equalization up to 9 dB along with de-emphasis up to -8.3 dB. The EQ and de-emphasis settings available allow the dongle to recover signals from extended length cables and drive long cables to an attached device.

4.3 Regulator Selection

The LP5907 accepts VBUS (5 V) input and regulates down to 3.3 V to supply power to each re-driver. The LP5907 is available in a small (1 mm × 1 mm) footprint to be used in space-limited designs. The LP5907 was designed for mobile device applications such as cell phones, tablets, or other handsets.

5 PCB Design

The PCB stack-up design was chosen to accommodate the 90-Ω impedance of USB signal traces. All differential signal traces are routed on the top or bottom-side of the board and references a solid plane on layer 2 or 5.

5.1 PCB Layout

Figure 2 through Figure 9 illustrate the USB-Redriver PDB layouts.

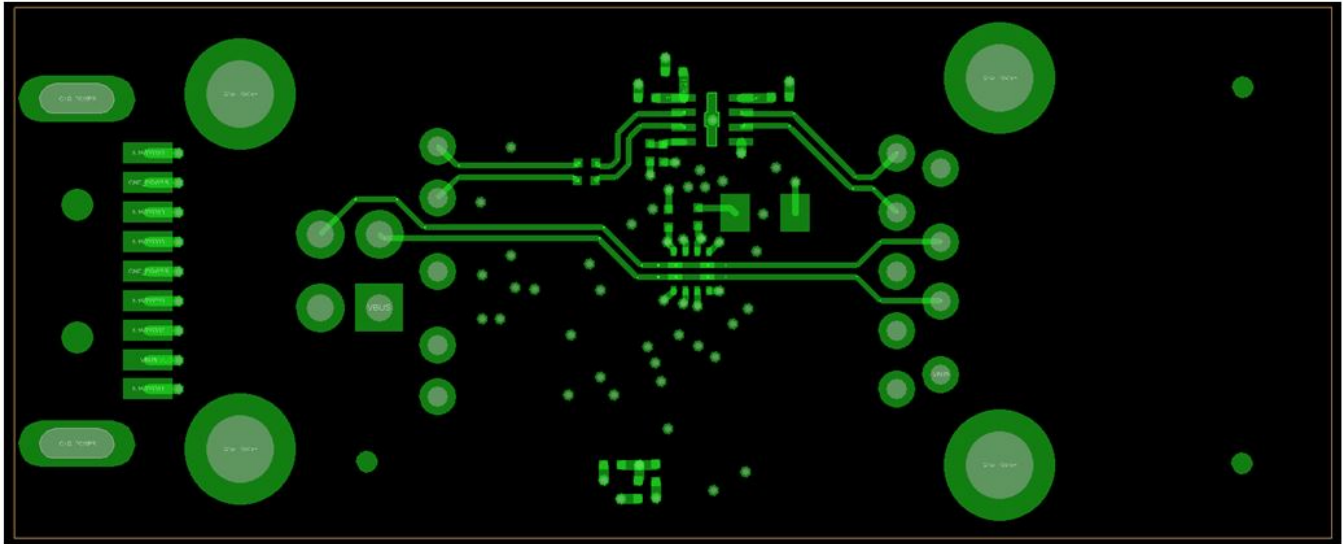


Figure 2. Top Layer

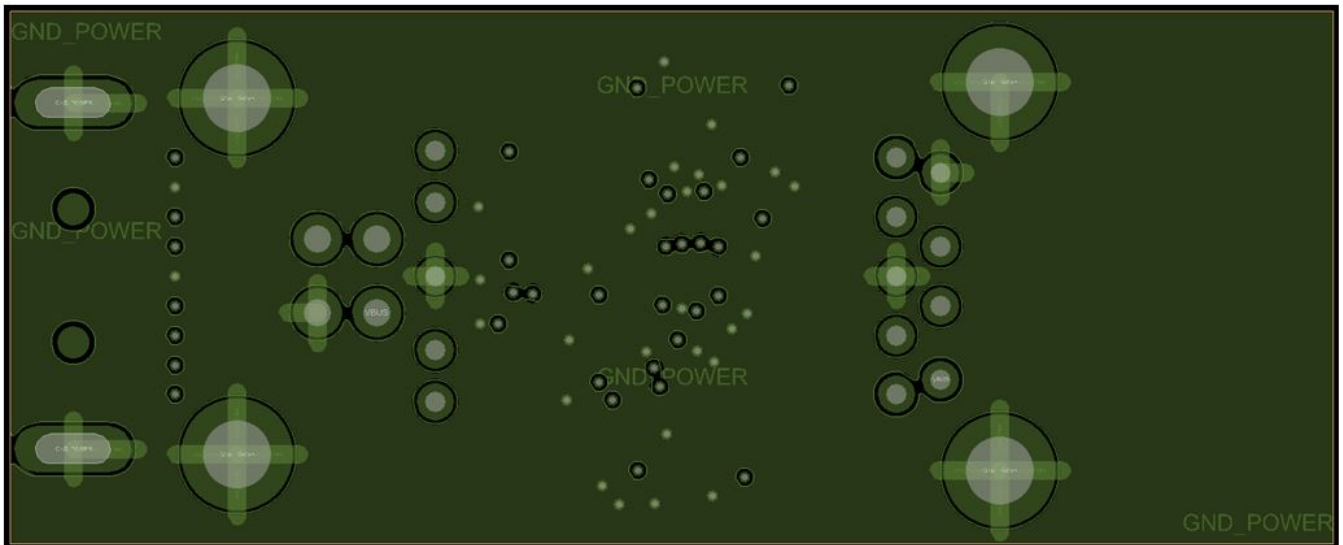


Figure 3. Layer 2 – Ground Plane

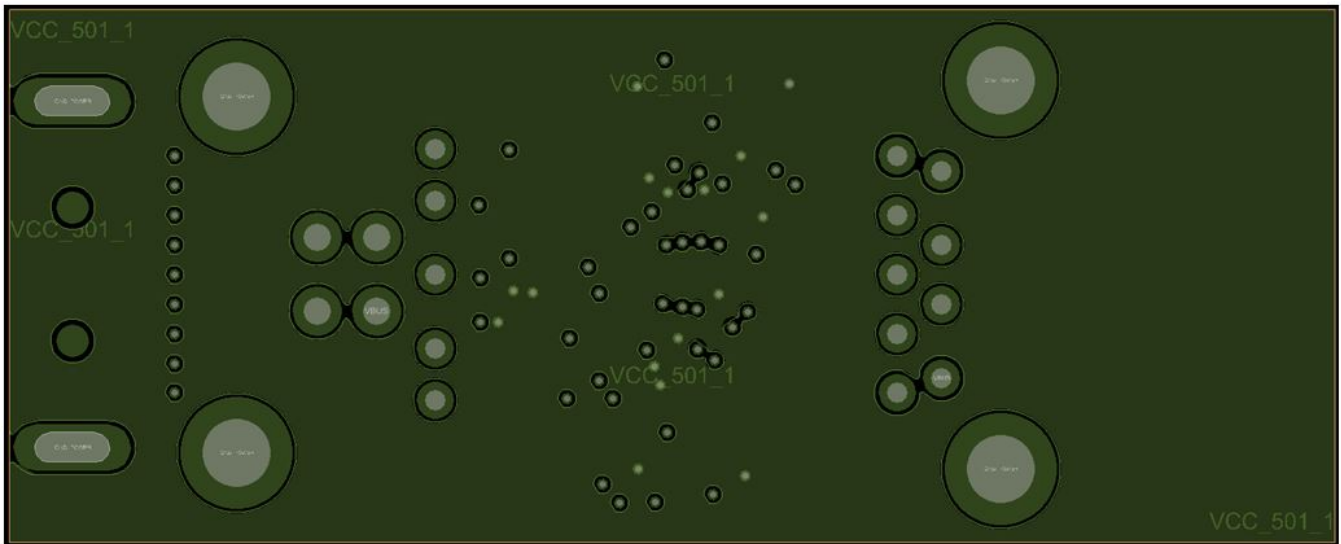


Figure 4. Layer 3 – VCC Power Plane

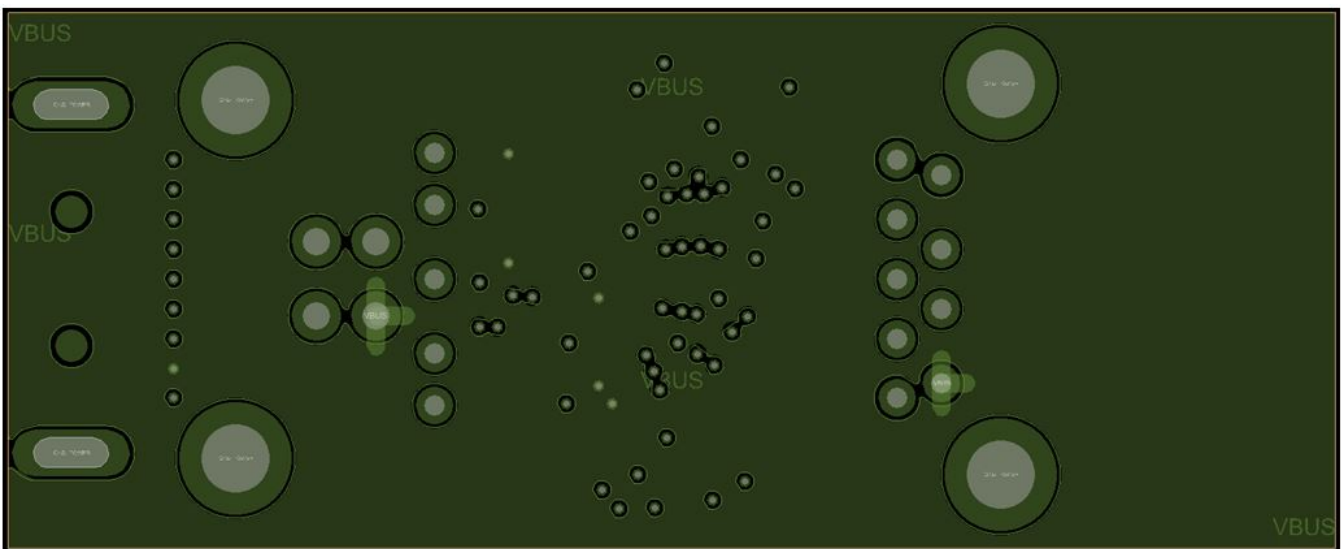


Figure 5. Layer 4 – VBUS

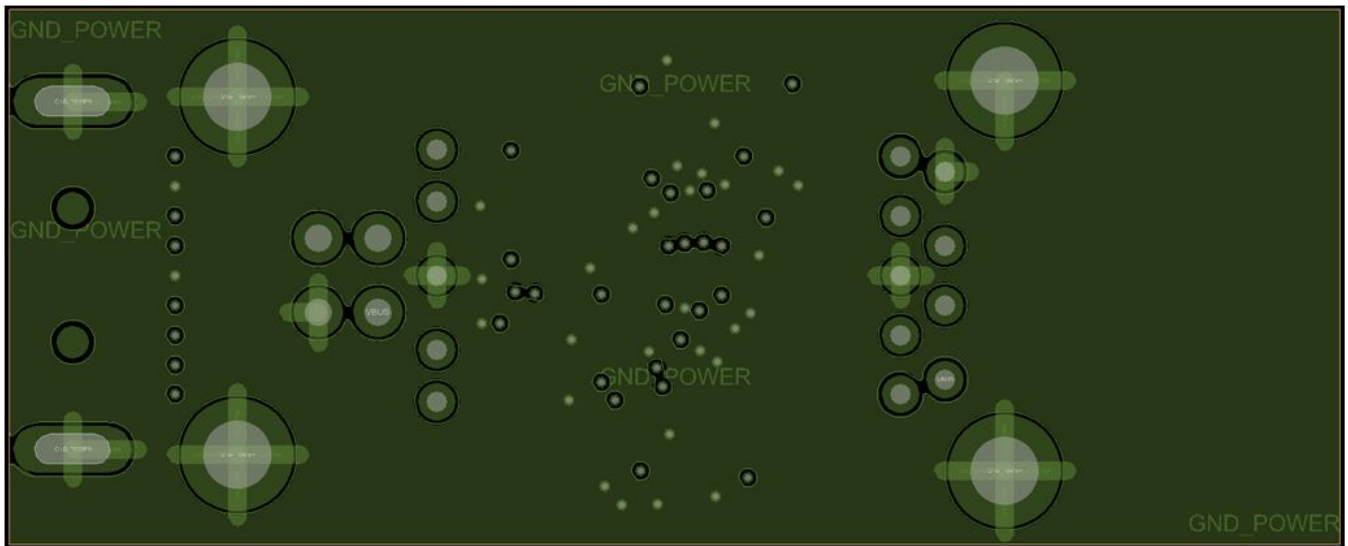


Figure 6. Layer 5 – GND

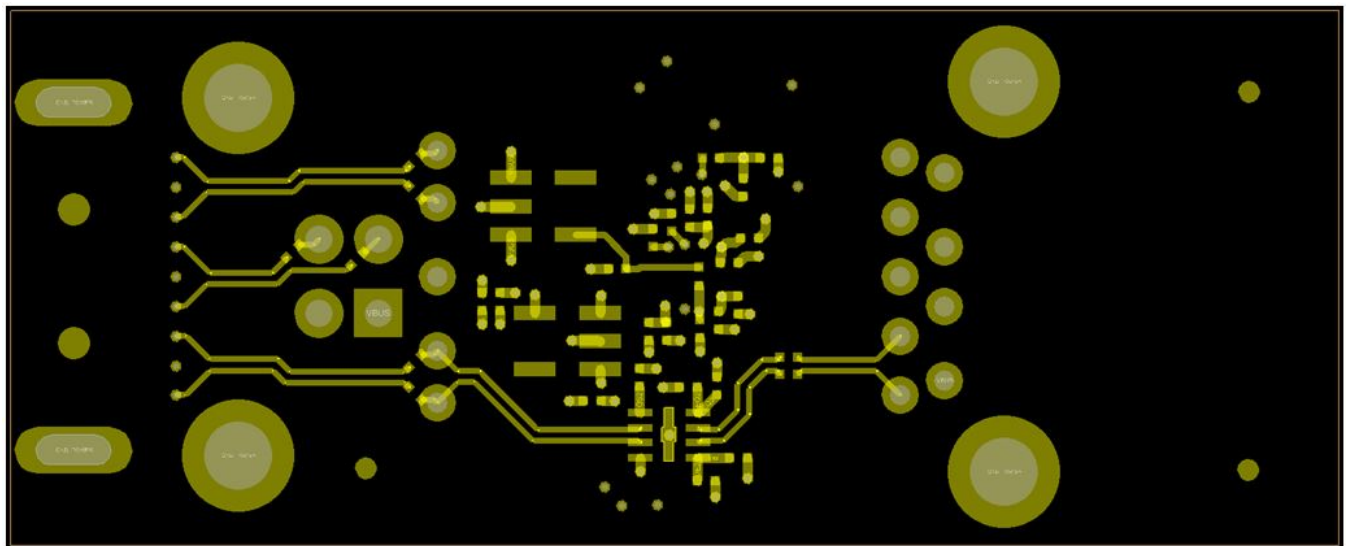


Figure 7. Layer 6 – Bottom

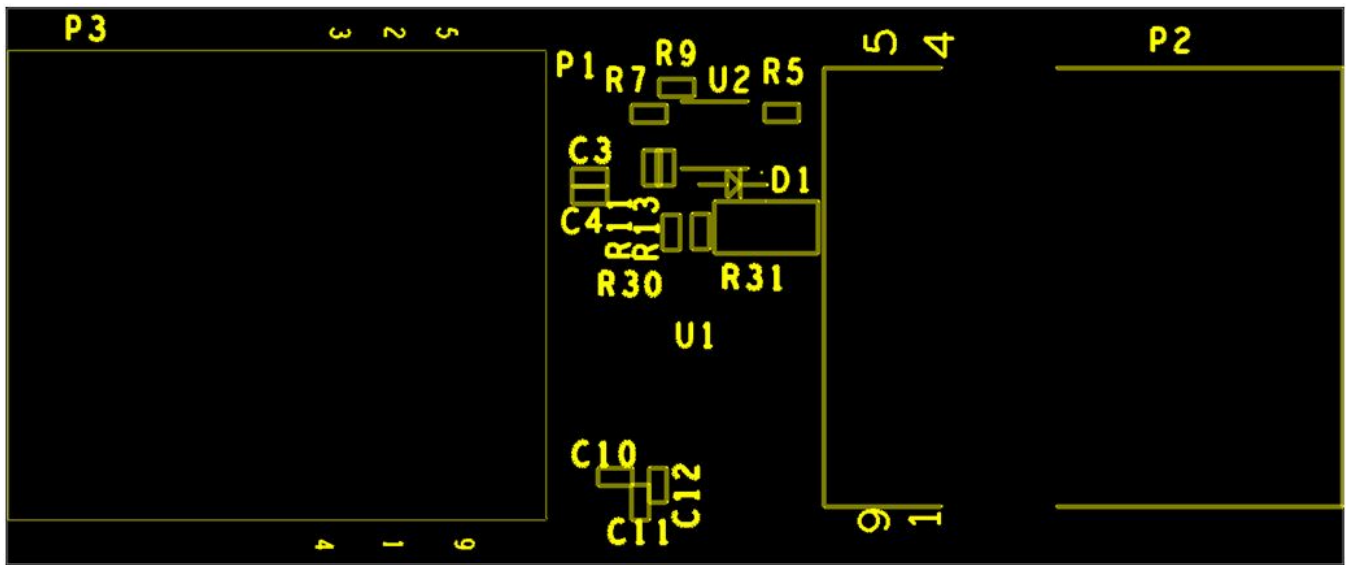


Figure 8. Top Side Silk Screen

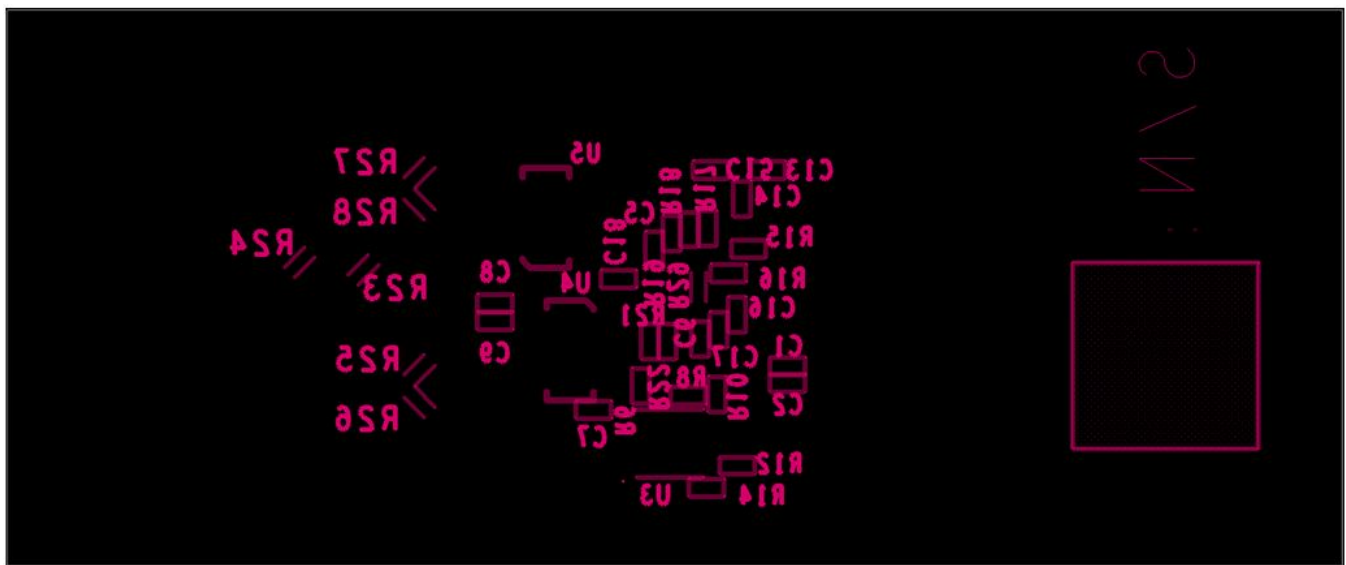


Figure 9. Bottom Side Silk Screen

5.2 Layout Guidelines

All USB3.0 and 2.0 lines must be routed as controlled impedance, high-speed differential pairs. Minimize the use of vias and 90 degree corners in the routing of the high speed lines. Assure the high-speed lines reference a solid ground plane and the plane is void of cuts and splits to prevent impedance discontinuities.

5.3 PCB Stack-Up

Figure 10, shows the PCB stack-up used for the USB-Redriver-EVM reference design.

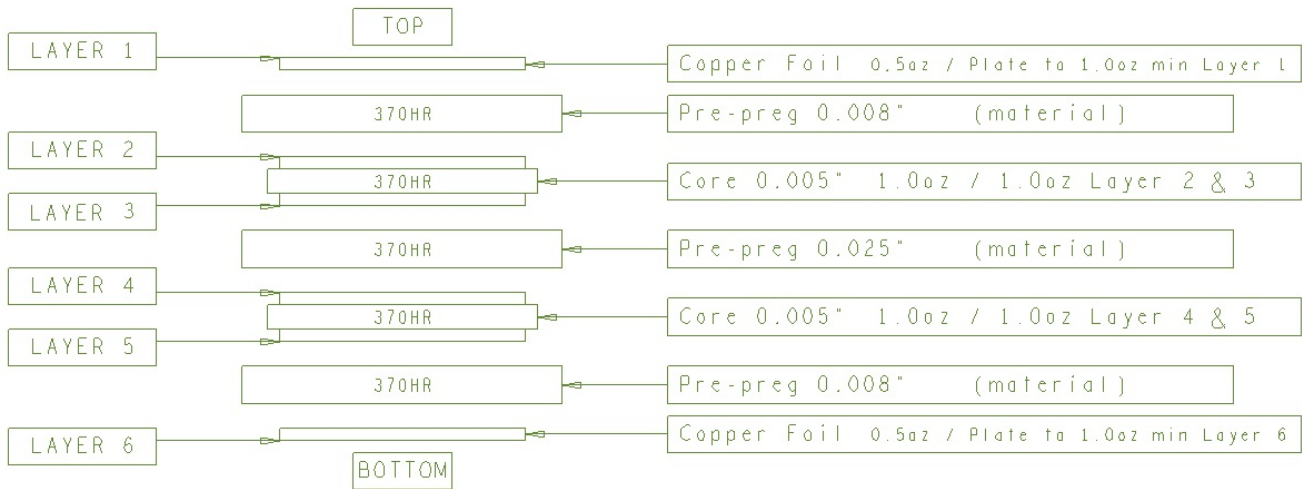


Figure 10. PCB Stack-Up

6 Design Options

This section discusses different design *options* that were evaluated for this project to give the designer flexibility to modify the design.

6.1 TUSB211

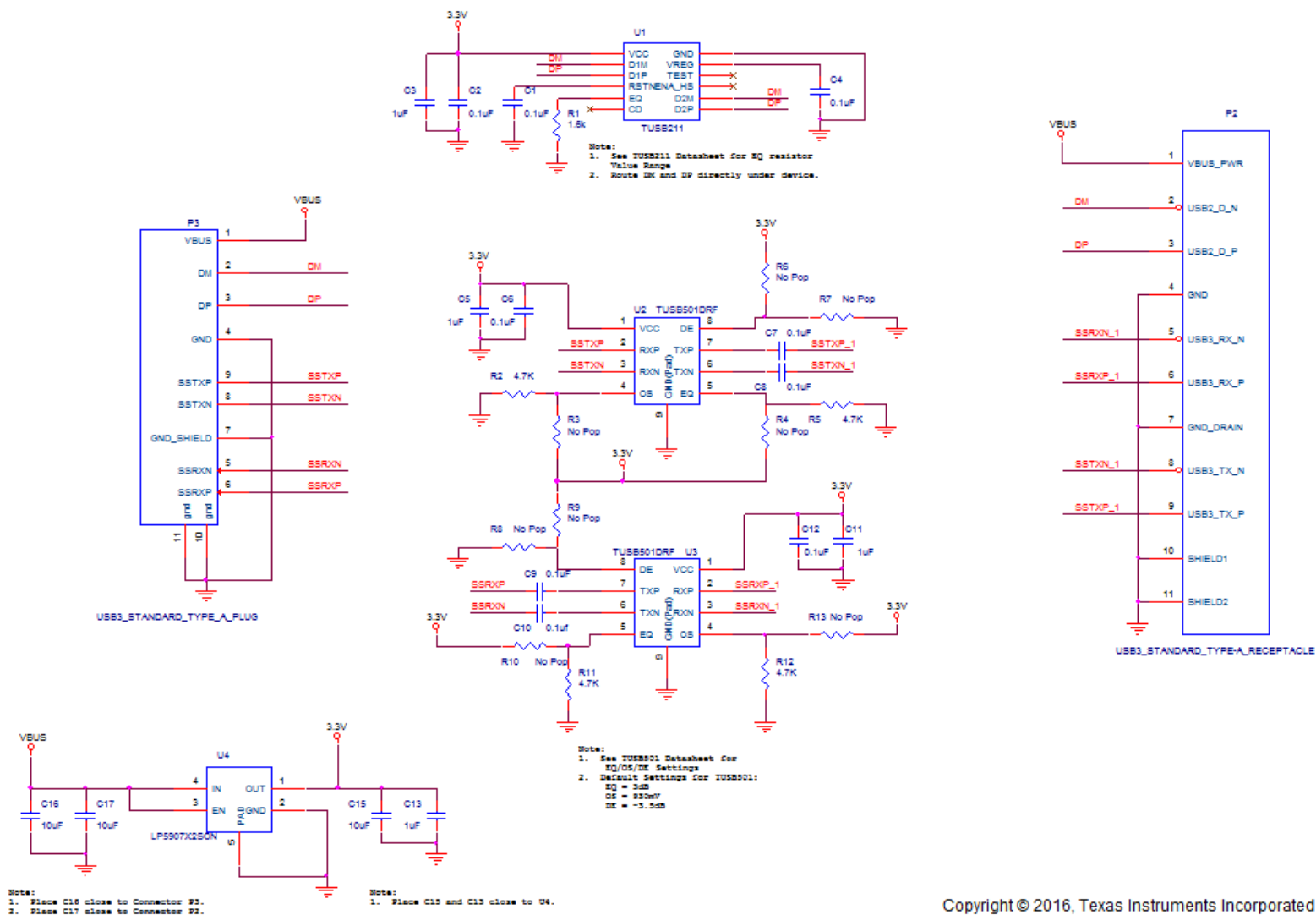
The TUSB211 has flexible EQ gain settings to compensate for different amounts of signal loss. This design uses a value that is typically used in most PC applications using a 3–5 m USB cable. See the TUSB211 data sheet ([SLLSE00](#)) for details on configuration of the EQ settings.

6.2 TUSB501

The TUSB501 has multiple settings for equalization and de-emphasis, this design uses values typically found in receiving and driving a 3–5 m USB cable and 8–10 inches of board trace. Please consult the TUSB501 data sheet ([SLLSEG5](#)) for details on configuring the device.

7 Schematic

Figure 11 illustrates the EVM schematic.



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Figure 11. USB-Redriver EVM Schematic

8 Bill of Materials

Table 1 displays the EVM bill of materials.

Table 1. USB-Redriver EVM

Item	Qty	Reference	Value	Part Description	Manufacturer	Manufacturer Part Number	PCB Footprint	Note
1	9	C1,C2,C4,C6,C7,C8,C9,C10,C12	0.1uF	Capacitor	TDK	C0603X5R0J104K030BC	0201	
2	4	C3,C5,C11,C13	1uF	Capacitor	TDK	C0603X5R0G105M030BC	0201	
3	3	C15,C16,C17	10uF	Capacitor	TDK	C1005X5R0J106M050BC	0402	
4	1	P2		USB3 Type-A Receptacle	TE Connectivity AMP	1932258-1		
5	1	P3		USB3 Type-A Plug	TE Connectivity AMP	692112030100		
6	1	R1	1.6K	Resistor	Panasonic Electronic Components	ERJ-1GEF1601C	0201	
7	4	R2,R5,R11,R12	4.7K	Resistor	Panasonic Electronic Components	ERJ-1GEF4701C	0201	
8	8	R3,R4,R6,R7,R8,R9,R10,R13	4.7K	Resistor	Panasonic Electronic Components	ERJ-1GEF4701C	0201	No Pop
9	1	U1		USB2 Redriver	Texas Instruments	TUSB211RWB	RWB	
10	2	U2,U3		USB3 Redriver	Texas Instruments	TUSB501DRF	DRF	
11	11	U4		3.3V Regulator	Texas Instruments	LP5907X2SON	X2SON	

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

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Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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