TI Designs
USB Type-C™ Power Path Protection With Audio Accessory Support Reference Design

Description

The TIDA-03030 reference design provides a robust protection solution for the power path in USB Type-C applications. The design prevents damage to the system from overvoltage, overcurrent, hot-plug, and reverse current events. By leveraging the TPS25923 (eFuse) and CSD17571Q2 (reverse-blocking field-effect transistor (FET)), the solution protects the power path, increasing system reliability. The system solution emulates a downstream facing port (DFP) and is able to detect the connection of an upstream-facing port (UFP) device. The design also supports USB Type-C audio accessories, providing a flexible solution of either power or analog audio over a single port. This flexible V_{BUS} protection with audio accessory functionality is achievable within a 20×20-mm, four-layer, single-sided solution to reduce system size for space constrained applications.

Resources

TIDA-03030	Design Folder
TPS25923	Product Folder
CSD17571Q2	Product Folder
TLV733P	Product Folder
TUSB320LAI	Product Folder
TS5USBA224	Product Folder
TS3A226AE	Product Folder
TPD6E05U06	Product Folder
SN74LVC1G04	Product Folder

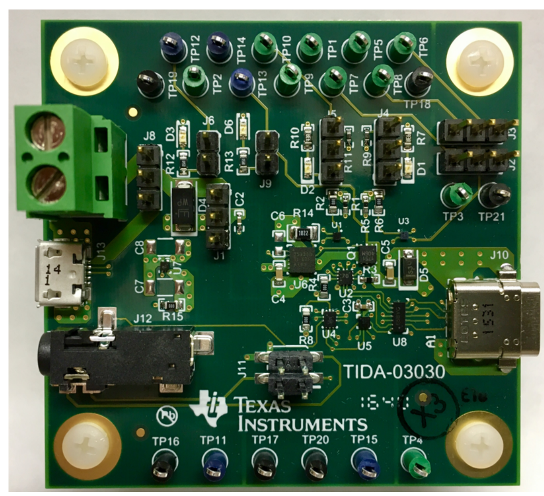
ASK Our E2E Experts

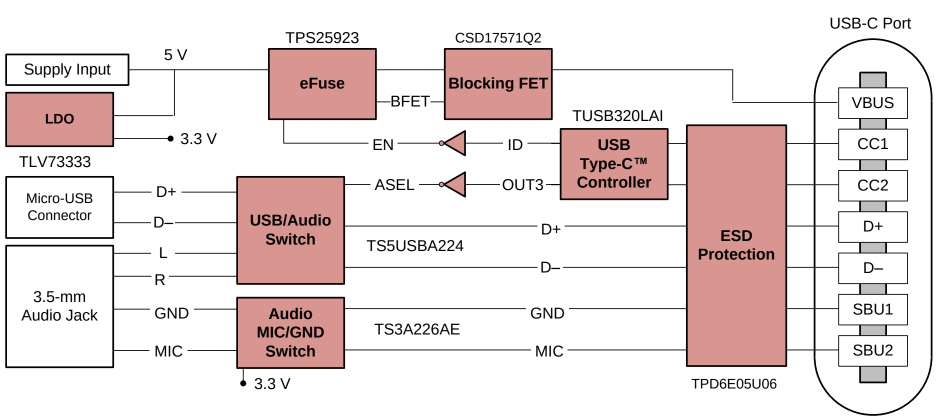
Features

- Reverse Current Blocking and Overvoltage Protection up to 30 V
- Overcurrent Events and Short Circuit Protection
- Determines UFP Connection, Audio Accessory, Port Attachment, and Cable Orientation
- Automatically Switches Between Analog Audio and USB Data Lines
- Routes MIC and GND Signals Automatically

Applications

- Notebook
- Ultrabook™
- Desktop PC
- Tablet





Copyright © 2016, Texas Instruments Incorporated

An IMPORTANT NOTICE at the end of this TI reference design addresses authorized use, intellectual property matters and other important disclaimers and information.

1 System Overview

1.1 System Description

Non-compliant or malfunctioning adapters have the capability to immediately output a high voltage and hot-plug onto a USB Type-C™ port, while short-circuit events can be generated from unwanted debris or moisture on the USB Type-C port. The central feature set of the TIDA-03030 reference design involves overvoltage protection (OVP), reverse current blocking (RCB), and current limiting. By using the TPS25923 (eFuse) to drive the CSD17571Q2s (reverse-blocking FET) gate, current flow from the load to the source is preventable. USB Type-C devices operate around small form factor (SFF) connectors and cables that have flip-ability and reversibility. Because of these requirements, a scheme is required to determine the connector orientation, when a USB Type-C device has been attached, and what the acting role of the USB port (DFP, UFP, or DRP) is. The TIDA-03030 design meets these requirements by implementing the USB Type-C configuration channel and port controller, TUSB320LAI. Analog audio accessories are also supported on the USB Type-C connector when in the audio adapter accessory mode. When in this mode, the TIDA-03030 design is able to multiplex analog audio from the audio codec instead of USB data through the TS5USBA224 (USB and audio switch). Additionally when the connectors have been reversed or flipped, the TS3A226AE device can switch the MIC and GND lines (when applicable). The 3.5-mm jack and micro-USB interfaces are used as substitutes for demonstration and emulation purposes.

1.2 Key System Specifications

Table 1. Key System Specifications

PARAMETER	SPECIFICATIONS
System input voltage	5 V to 5.25 V
Maximum overvoltage protection	30 V
Typical current limit	1 A
Maximum V_{OUT} rise time	3.5 ms
USB Type-C™ port role	Downstream-facing port (DFP)
USB Type-C™ solution – form factor	Less than 20 × 20 mm Four layers, single-sided
Audio support	Analog audio

Copyright © 2016, Texas Instruments Incorporated

1.3 Block Diagram

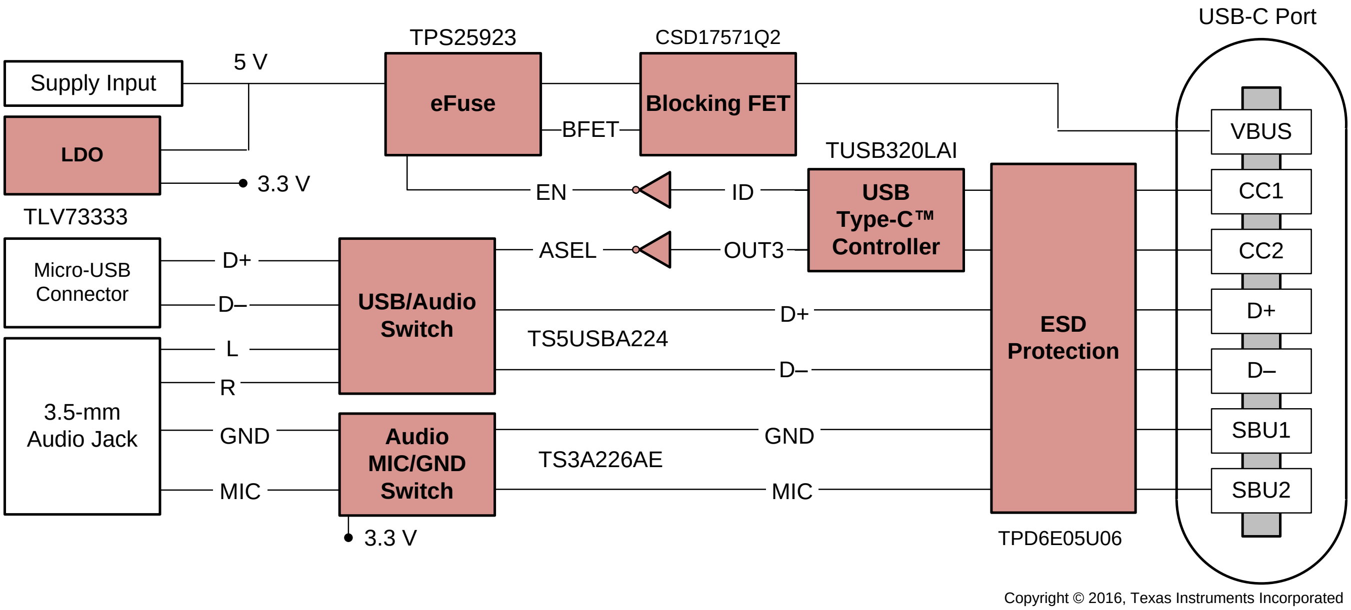


Figure 1. TIDA-03030 Block Diagram

1.4 Highlighted Products

1.4.1 TUSB320LAI

The TUSB320LAI is Texas Instrument's third-generation Type-C configuration channel logic and port controller. The TUSB320LAI devices use the CC pins to determine port attach and detach, cable orientation, role detection, and port control for Type-C current mode. The device can be configured as a downstream-facing port (DFP), upstream-facing port (UFP), or a dual-role port (DRP), which makes it ideal for any application. The CC logic block monitors the CC1 and CC2 pins for pullup or pulldown resistances to determine when a USB port has been attached, the orientation of the cable, and the role detected. When a UFP device has been plugged into the TIDA-03030's USB Type-C receptacle, a low signal (0 V) is asserted on the ID pin. The ID signal enables eFuse operation. Note that the USB Type-C controller has been set as general purpose input/output (GPIO) mode by default for simpler operation to avoid processor overhead.

For audio accessory support, the USB Type-C Controller also detects the resistance to GND of less than Ra on both CC pins of the connector, as Figure 2 shows. When an audio device has been connected, the controller outputs a low signal on OUT3 (AUDIO_EN signal), which enables the USB and audio switch and the MIC and GND switch.

Copyright © 2016, Texas Instruments Incorporated

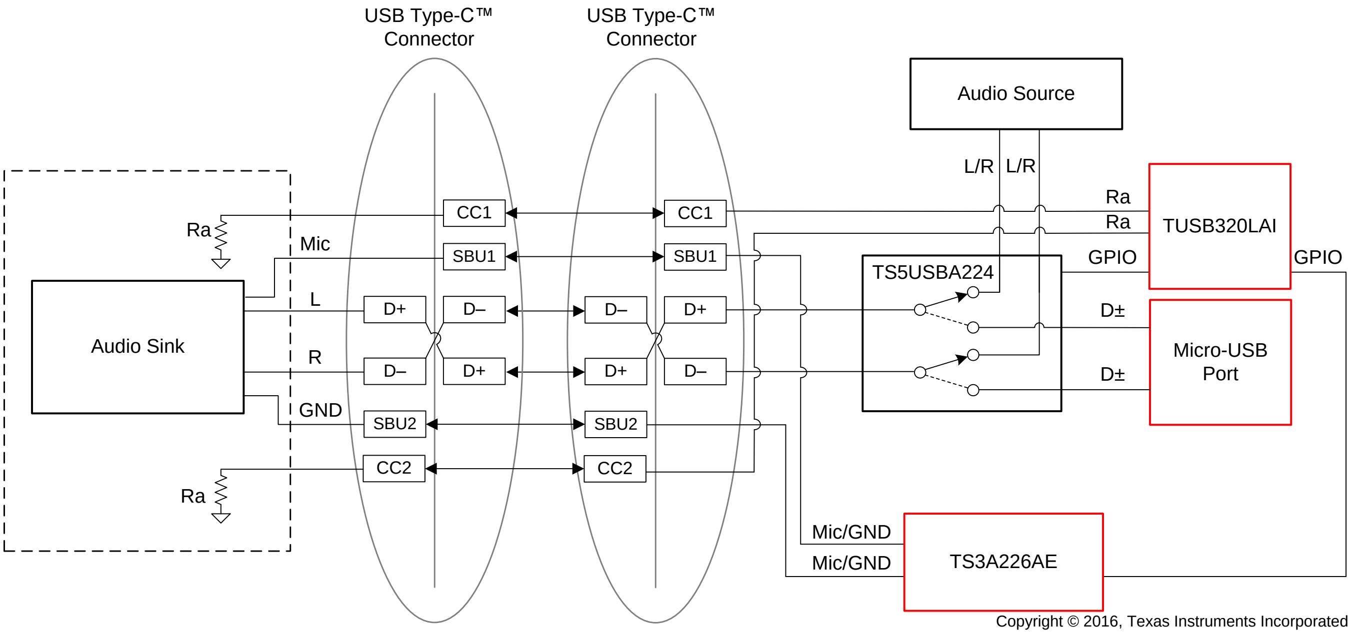


Figure 2. Audio Adapter Accessory Mode – Ra

1.4.2 TPS25923

The TPS25923 is a highly-integrated circuit protection and power management solution in a 3×3-mm package. The device uses a few external components and has robust protection against overloads, shorts circuits, voltage surges, excessive inrush current, and reverse current. When a UFP device has been plugged into the TIDA-03030 USB Type-C port, the USB Type-C controller outputs a low signal on the ID pin (0 V). The inverted ID signal then enables the eFuse. When V_{IN} rises, the internal MOSFET of the eFuse starts conducting and allows the current to flow from V_{IN} to V_{BUS}. After a successful start-up sequence, the device then actively monitors its load current and input voltage, ensuring that the adjustable overload current limit I_{OL} does not exceed at the output. This monitoring keeps any USB Type-C DFP devices safe from harmful voltage and current transients.

1.4.3 CSD17571Q2

The CSD17571Q2 is a 30-V, 20-mΩ, SON 2 × 2 NexFET™ power MOSFET. The device has been designed to minimize losses in power conversion and load management applications, while offering excellent thermal performance for the size of the package. The CSD17571Q2 is optimized for load switch applications and protects the TIDA-03030 system from 30-V hot-plug events.

1.4.4 TS5USBA224

The TS5USBA224 is a double-pole double-throw (DPDT) multiplexer that includes a low-distortion audio switch and a USB 2.0 high-speed (480-Mbps) switch in the same package. This configuration allows the system designer to use a common connector for audio and USB data. The audio switch has been designed to allow audio signals to swing below ground, which makes this common connector configuration possible. The audio and USB switch features shunt resistors on the audio path to reduce clicks and pops that may be heard after selecting the audio switches. When an audio accessory has been detected, the audio and USB switch multiplex from the USB data to the analog audio from the audio codec.

Copyright © 2016, Texas Instruments Incorporated

1.4.5 TS3A226AE

The TS3A226AE is an audio switch that detects the MIC location and routes the microphone and ground signals automatically. The ground signal is routed through a pair of low-impedance ground FETs (60 mΩ typical), which results in minimal impact on audio crosstalk performance. The autonomous detection feature allows end users to plug in accessories with different audio pole configurations into the mobile device and have them operate properly without added software control and complexity. When a USB Type-C audio device has been detected, the TIDA-03030 system switches the MIC and GND lines depending on the orientation of the USB Type-C input. This switch occurs when the user reverses or flips the input on the USB Type-C receptacle.

1.4.6 TLV733P

The TLV733P is a 1.0×1.0-mm, low quiescent current, low-dropout linear regulator (LDO) that can source 300 mA with good line and load transient performance. This device provides a typical accuracy of 1% and has been designed with a modern capacitor-free architecture to ensure stability without an input or output capacitor. The removal of the output capacitor allows for a very small solution size and can eliminate inrush current at start-up.

1.4.7 SN74LVC1G04

The SN74LVC1G04 is a single inverter gate designed for 1.65-V to 5.5 V V_{CC} operation, which performs the Boolean function $Y = \overline{A}$. The CMOS device has high output drive while maintaining low static-power dissipation over a broad V_{CC} operating range. This device is used to invert the ID and OUT3 signals for the TIDA-03030 system. The signals are asserted high (5 V) when a UFP or audio accessory has been detected at the USB Type-C port.

1.4.8 TPD6E05U06

The TPD6E05U06 is a unidirectional transient voltage suppressor (TVS) based electrostatic discharge (ESD) protection diode with ultra-low capacitance. Each device can dissipate ESD strikes above the maximum level specified by the IEC 61000-4-2 international standard. The TPD6E05U06s ultra-low loading capacitance makes it ideal for protecting any high-speed signal pins, including TIDA-03030s USB data lines on the USB Type-C port.

Copyright © 2016, Texas Instruments Incorporated

2 Getting Started Hardware

2.1 System Setup

The TIDA-03030 reference design is powered by one of two inputs: an external bench power supply or through the micro-USB V_{BUS} line. If powering through an external supply, apply 5 V on the positive terminal and connect the negative terminal to GND. The power supply cables and shunts used for connection must be rated for a minimum of 1 A. Figure 3 shows the 20×20-mm, four-layer, single-sided solution.

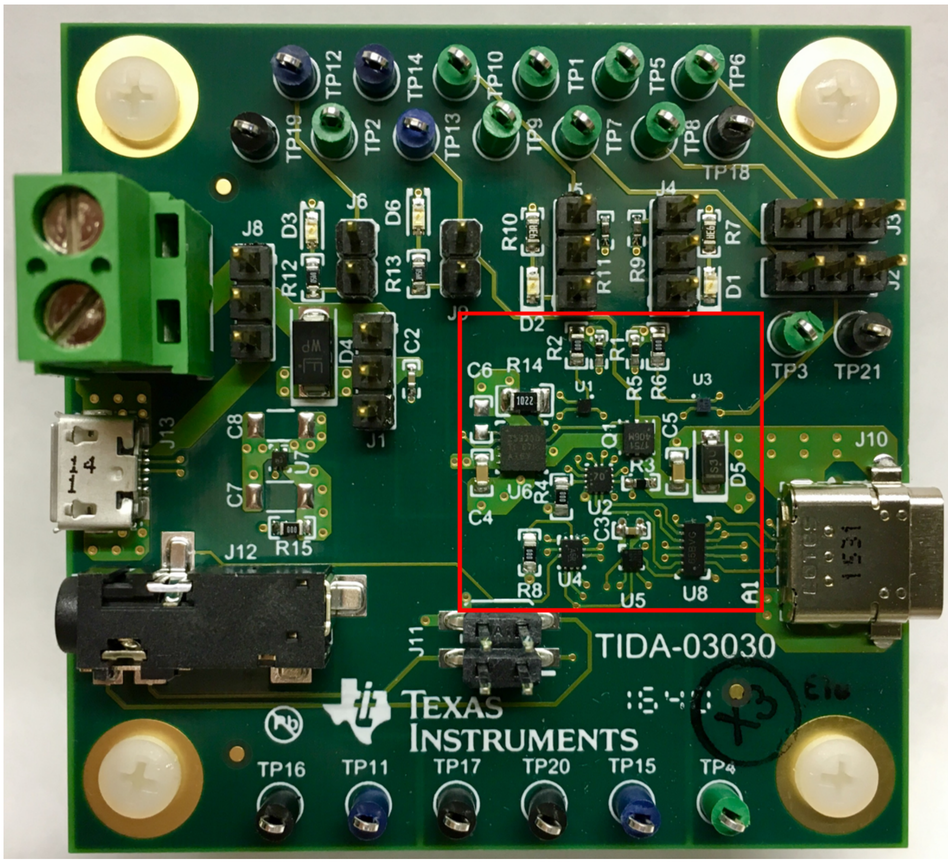


Figure 3. System Solution

Copyright © 2016, Texas Instruments Incorporated

Table 2 shows the jumper settings necessary for operation.

Table 2. System Setup—Jumper Settings

SYSTEM FUNCTIONALITY	JUMPER NAME	SHUNT CONNECTION	RESULT	DEFAULT
V_{DD} system power	J1	Pin 1 to 2	5-V net is supplied to V_{DD} net	Yes
		Pin 2 to 3	3.3-V net is supplied to V_{DD} net	No
5 V net system power	J8	Pin 1 to 2	External power source is supplied to the systems 5-V net	Yes
		Pin 2 to 3	USB power source is supplied to the systems 5-V net	No
UFP status LED (D1)	J4	Pin 1 to 2	LED ON = default current LED OFF = medium or high current	Yes
UFP status LED (D2)	J5		LED ON = default or medium current LED OFF = high current	Yes
V_{BUS} power status LED (D3)	J6		Indicates power present at V_{BUS}	Yes
eFuse enable status LED (D6)	J9		Indicates power supplied by eFuse to V_{BUS}	Yes
DFP mode	J3	Pin 1 to 2	Sets device to DFP	Yes
UFP mode		Pin 2 to 3	Sets device to UFP	No
DRP mode		Floating	Sets device to DRP	No
GPIO mode	J2	Floating	Enables GPIO mode for the TUSB320LAI	Yes
Audio accessory configuration	J11	Pin 1 to 2	Allows MIC connection to the 3.5-mm jack	Yes
		Pin 3 to 4	Allows GND connection to the 3.5-mm jack	

Copyright © 2016, Texas Instruments Incorporated

3 Testing and Results

3.1 Overview

The TIDA-03030 reference design is characterized as having the following functionality:

- Power path protection
- Audio accessory support
- UFP detection

Table 3 shows the test points used for power up and system testing.

Table 3. Test Point Descriptions

TEST POINT	NET AND SIGNAL NAMES	DESCRIPTION
TP1	ID	Used for testing UFP detection
TP2	PWR_EN	Used to verify that eFuse is enabled
TP3	VBUS_DET	Used to verify V_{BUS} voltage for UFP attachment
TP4	V_{DD}	Monitors V_{DD}
TP5	OUT3	Used to verify audio accessory support
TP6	AUDIO_EN	Used to verify the inverted "OUT3" signal that enables both the MIC/GND and USB/audio switches
TP7	ADDR	Tri-level input pin to indicate I^2C address or GPIO mode; default mode is GPIO mode (NC)
TP8	PORT	Used to verify port modes: High - DFP (pull up to VDD if DFP mode is desired) NC - DRP (leave unconnected if DRP mode is desired) Low - UFP (pull down or tie to GND if UFP mode is desired)
TP9	SDA/OUT1	Used to determine USB Type-C current mode.
TP10	SCL/OUT2	Used to determine USB Type-C current mode.
TP11	5 V Net	Used to verify external supply into the system
TP12	V_{OUT}	Monitors the output voltage from eFuse into BFET
TP13	V_{BUS}	Monitors the V_{BUS} line
TP14	BFET	eFuse enable signal into the gate of the BFET
TP15	3.3 V Net	Used to verify LDO operation from 5 V to 3.3 V

The following subsections detail the procedures, results, and test setup for the TIDA-03030 reference design.

3.2 UFP Device Detection

Device detection plays a very important role in the USB Type-C ecosystem, especially because the TIDA-03030 has a defined USB port role. As such, the TIDA-03030 board supports *UFP device detection* on the USB Type-C port as a DFP device. Detection can be accomplished through the USB Type-C configuration channel logic and port controller, TUSB320LAI.

Refer to Section 3.2.1 through Section 3.2.2 for discussion and test results.

3.2.1 Test Setup

This test applies probes on the following test points:

- TP1 - ID
- TP2 - PWR_EN
- TP11 - 5 V Net (V_{IN})
- TP13 - V_{BUS}

As per the System Setup section, apply 5 V across the input of the system. Ensure that jumpers J8 and J1 are connected to ensure power is distributed to both 5 V and V_{DD} nets.

Copyright © 2016, Texas Instruments Incorporated

See Figure 4 for test setup and device attachment.

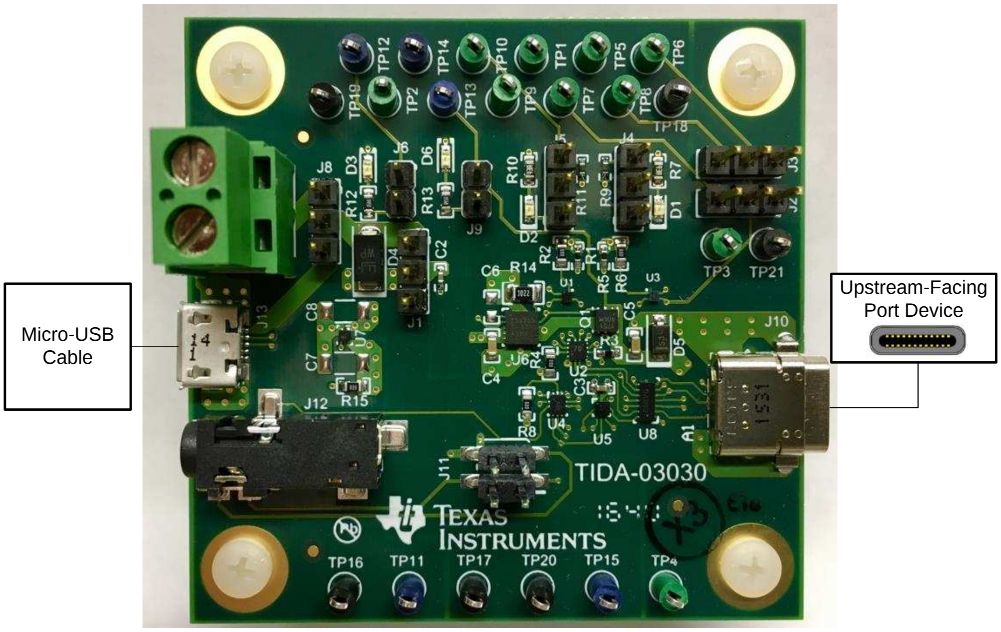


Figure 4. UFP Device Detection Test Setup

After the board was powered, a UFP device was attached to the TIDA-03030s USB Type-C receptacle. All control signals were observed on an oscilloscope.

3.2.2 Results

When a UFP device has been plugged into the TIDA-03030 board, the CC pins detect the attachment of a device and enable the eFuse. When the eFuse has been enabled, the BFET enables and allows V_{OUT} onto V_{BUS}, as Figure 5 shows. Note that flipping the USB Type-C cable does not affect the operation of the CC pin detection. The eFuse turns on during both cases of plugging in the UFP device.

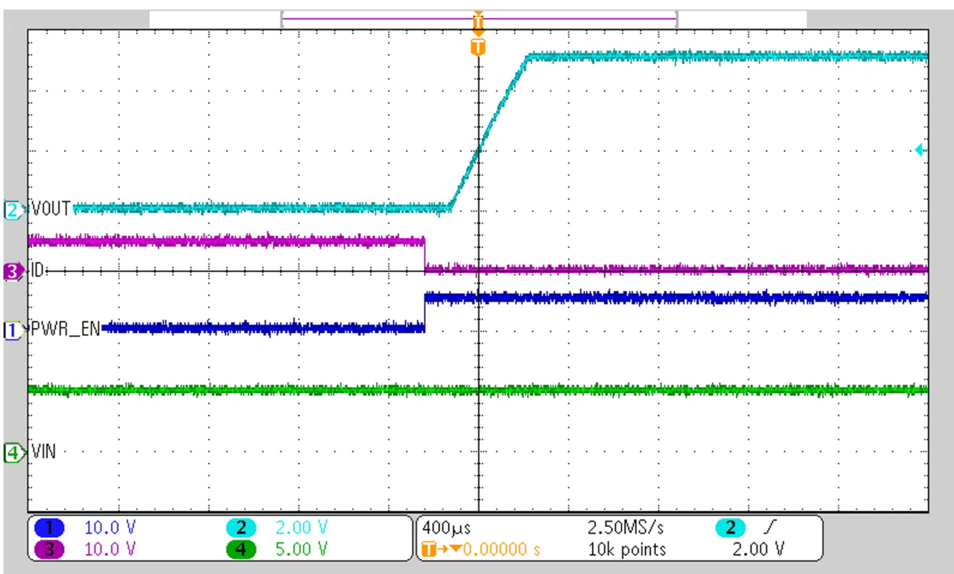


Figure 5. UFP Device Detection

Copyright © 2016, Texas Instruments Incorporated

3.3 Power Path Protection

The TIDA-03030 solution protects the V_{BUS} line from any unwanted transients caused by hot-plug, non-compliant or malfunctioning adapters, and from debris or moisture on the USB Type-C port. This test addresses overvoltage and reverse current blocking in regards to hot-plug events.

Refer to Section 3.3.1 through Section 3.3.2 for details and test results.

3.3.1 Test Setup

This test applies probes on the following test points:

- TP11 - 5 V Net
- TP13 - V_{BUS}

As per System Setup, apply 5 V across the input of the system. Ensure that jumpers J8 and J1 are connected to ensure power distributes to both 5 V and V_{DD} nets.

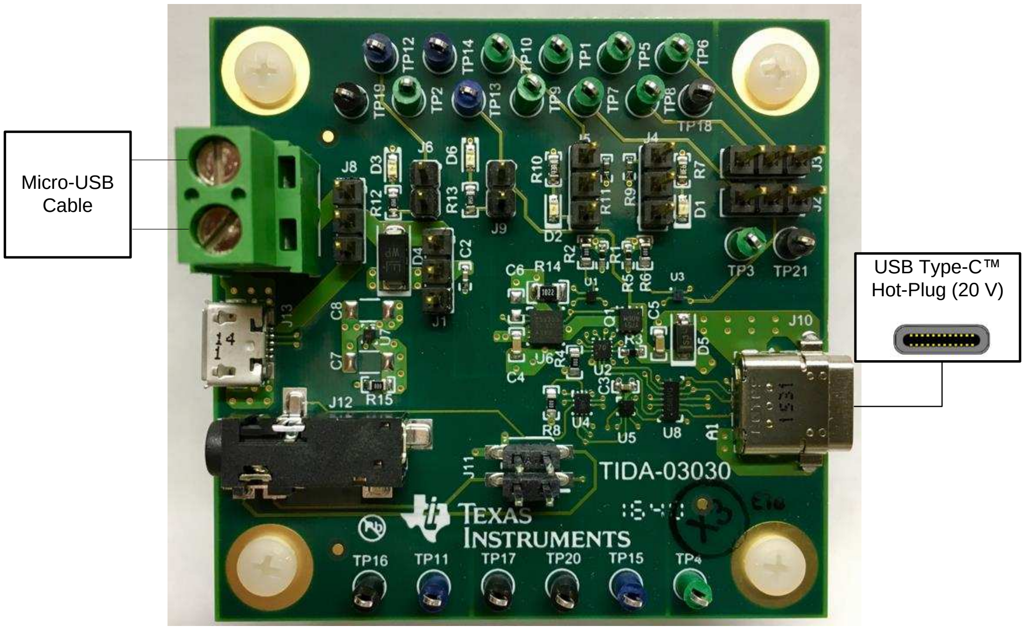


Figure 6. Power Path Protection Test Setup

After all connections have been made, 20 V is applied to the USB Type-C cable. The cable is then plugged into the TIDA-03030s USB Type-C receptacle and transients are observed through an oscilloscope.

Copyright © 2016, Texas Instruments Incorporated

3.3.2 Test Results

When a single MOSFET is in an OFF state, the body diode allows current flow when the voltage on the source is larger than the voltage on the drain. This unwanted behavior can be bypassed by utilizing the reverse blocking FET (back-to-back MOSFET configuration) to protect against overvoltage spikes, reverse current events, and hot-plug events.

During the testing of hot-plug events, the USB Type-C cable is initially disconnected from the receptacle and the eFuse is disabled, as Figure 7 shows. The TIDA-03030 solution was tested using 20 V on the V_{BUS} line, in which the voltage spiked up to nearly 30 V, eventually settling back to 20 V. During the hot-plug event, no significant voltage spikes occurred on the 5 V line of the TIDA-03030 system.

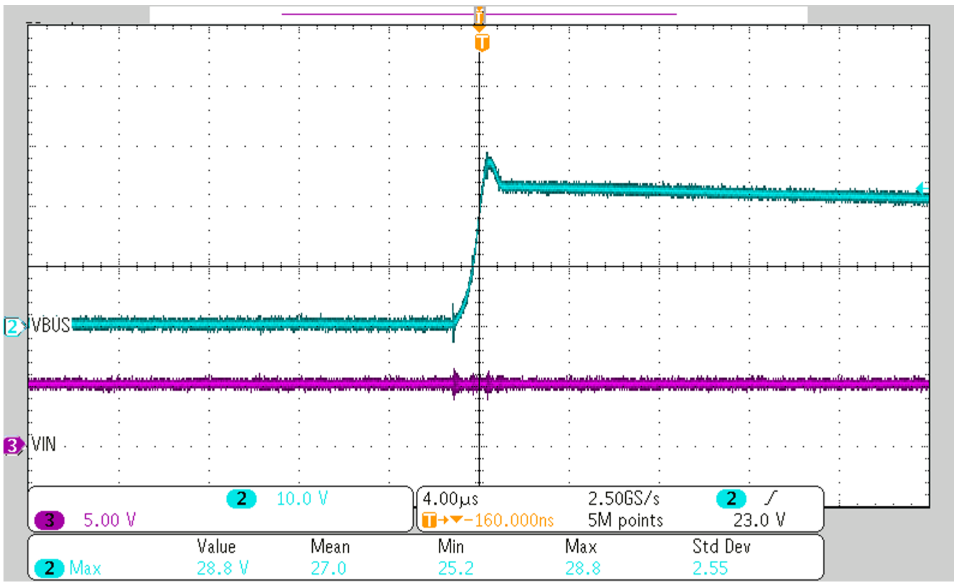


Figure 7. 20-V Hot-Plug Event

3.4 *Audio Accessory Support*

The USB Type-C environment provides the user with high levels of flexibility, convenience, and functionality. One functionality includes *audio accessory support*. The TIDA-03030 solution supports audio accessory support through the TUSB320LAI device and is able to reroute the MIC and GND lines when flipping the USB Type-C connector.

Refer to Section 3.4.1 through Section 3.4.2 for details and test results.

3.4.1 Test Setup

This test applies probes on the following test points:

- TP5 - OUT3
- TP6 - AUDIO_EN

As per Section 2.1, apply 5 V across the input of the system. Ensure that jumpers J8 and J1 are connected to ensure power distributes to both 5 V and V_{DD} nets.

Copyright © 2016, Texas Instruments Incorporated

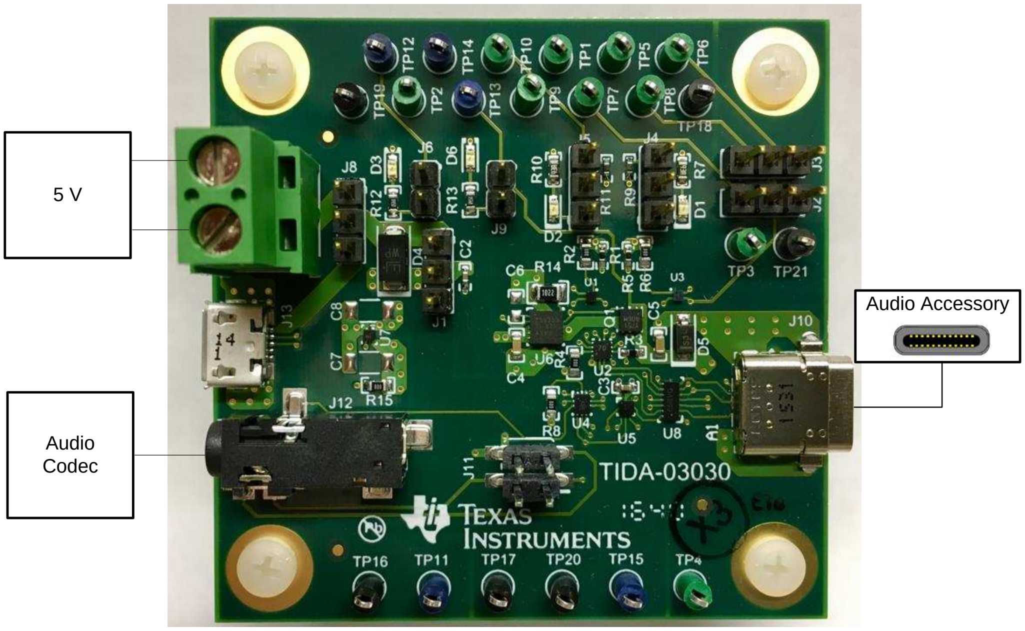


Figure 8. Audio Accessory Support Test Setup

After the board was powered, the devices were attached to the 3.5-mm audio jack connector and the USB Type-C receptacle. The signals were observed on an oscilloscope. Additionally, an audio file was played on the computer to determine whether analog audio is supported through the TIDA-03030 board, with both three- and four-pole connectors.

3.4.2 Results

When plugging in a device into the USB Type-C receptacle, the TUSB320LAIs OUT3 outputs low (0 V), as Figure 9 shows. The OUT3 is normally high when there is no detection of an audio device and low when an audio device is detected. The TS5USBA224 switches from the USB data lines of the micro-USB port to the audio lines of the 3.5-mm jack, which allows analog audio. The TS3A226AE device detects the MIC and GND lines of the connected device. When the USB Type-C connector has been flipped, analog audio is still supported for the TIDA-03030 solution.

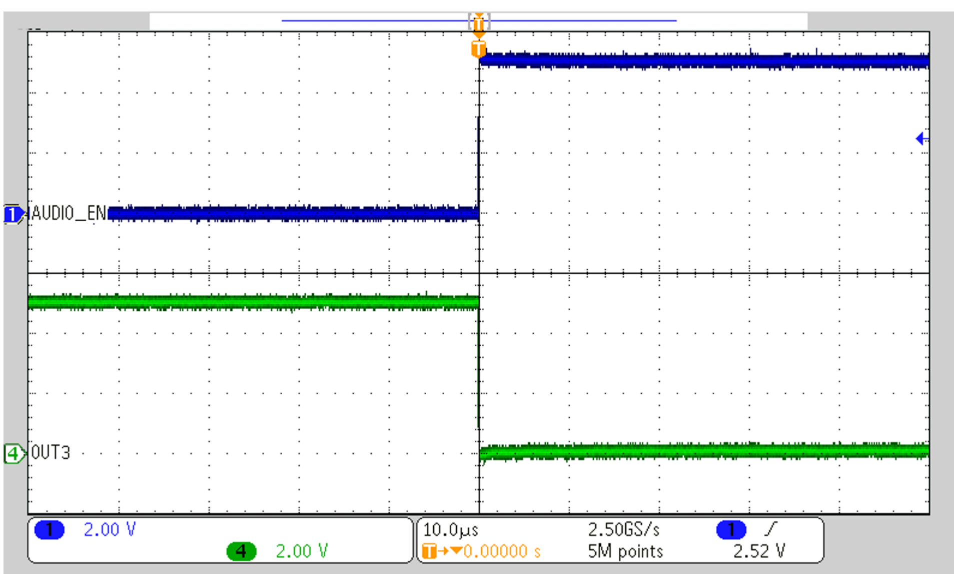


Figure 9. Audio Accessory Support

Copyright © 2016, Texas Instruments Incorporated

4 Design Files

4.1 Schematics

To download the schematics, see the design files at TIDA-03030.

4.2 Bill of Materials

To download the bill of materials (BOM), see the design files at TIDA-03030.

4.3 PCB Layout Recommendations

For each device, the layout recommendations in the datasheet were followed. All power traces were made thick enough to handle the maximum current for each power rail and all differential audio signals were routed to be the same length. All bypass capacitors were placed as close to each device as possible.

4.3.1 Layout Prints

To download the layer plots, see the design files at TIDA-03030.

4.4 Altium Project

To download the Altium project files, see the design files at TIDA-03030.

4.5 Gerber Files

To download the Gerber files, see the design files at TIDA-03030.

4.6 Assembly Drawings

To download the assembly drawings, see the design files at TIDA-03030.

5 Software Files

To download the software files, see the design files at TIDA-03030.

6 Related Documentation

1. USB 3.0 Promoter Group, *Universal Serial Bus Type-C Cable and Connector Specification*, Specification Document (Revision 1.2)
2. Texas Instruments, *TPS259230-41 EVM: Evaluation Module for TPS259230/41*, User's Guide (SLUUBA0)
3. Texas Instruments, *Low-Cost Implementation of USB Type-C*, Application Note (SLLY016)
4. Texas Instruments, *"USB Type-C audio: Do I need to buy a new pair of headphones?"*, Blog
5. Texas Instruments, *Detecting Selfie Sticks Using TI Audio Jack Switches, TS3A227E and TS3A225E*, Application Note (SCDA014)
6. Texas Instruments, *ESD by Interface*, Selection Guide (SLLT213)
7. Texas Instruments, *TUSB320 Evaluation Module*, User's Guide (SLLU222)

6.1 Trademarks

Ultrabook is a trademark of Intel.
USB Type-C is a trademark of others.

Copyright © 2016, Texas Instruments Incorporated

7 Terminology

Audio accessory mode— The accessory mode defined by the presence of Ra/Ra on CC1/CC2, respectively.

CC— Configuration channel (CC) used in the discovery, configuration, and management of connections across a USB Type-C Cable.

DFP— Downstream-facing port, specifically associated with the flow of data in a USB connection. Typically the ports on a host or the ports on a hub to which devices are connected. In its initial state, the DFP sources V_{BUS}, V_{CONN}, and supports data. A charge-only DFP port only sources V_{BUS}.

DRP— Dual-role port, referring to a USB port that can operate as either a source or a sink. The role that the port offers may be fixed to either a source or a sink, or may alternate between the two states.

eFuse— Electronic Fuse, also known as hot-swaps, load switches, or circuit breakers that provide protection against overvoltage, overcurrent, and short-circuit events. Unlike a discrete fuse, eFuses do not require to be replaced after a fault, thus reducing system downtime and maintenance.

Sink— Port asserting Rd on CC and when attached consumes power from V_{BUS}; most commonly a device.

Source— Port asserting Rp on CC and when attached provides power over V_{BUS}; most commonly a host or HUB DFP.

UFP— Upstream-facing port, specifically associated with the flow of data in a USB connection. The port on a device or hub that connects to a DFP of a hub. In its initial state, the UFP sinks V_{BUS} and supports data.

8 About the Authors

DANIEL FONCANNON is an Applications Engineer at TI, where he focuses on driving new products and TI designs. He joined TI as part of the Applications Rotation Program (ARP), and received a Bachelor of Science in Electronic Systems Engineering Technology (BSESET) from Texas A&M University in College Station, TX.

ALEK KAKNEVICIUS is an Applications Engineer at TI, where he answers technical questions about load switches from the TPS229xx family. He received his Bachelor of Science in Electrical Engineering (BSEE) and Master of Science in Electrical Engineering (MSEE) at the University of Florida in Gainesville, FL.

ALEXANDER GRONBACH is a Product Marketing Engineer from the Drivers & Load Switches product line at TI, specializing in load switches and eFuses for power management, protection, and distribution. He joined TI as part of the Technical Sales Associate (TSA) Rotation Program, and received a Bachelor of Science in Computer Engineering (BSCPE) from California Polytechnic State University in San Luis Obispo, CA.

ADAM HOOVER is a Systems Engineer at TI, where he is responsible for developing Power MUXing and USB Type-C power solutions. He received his Bachelor of Science in Electronics Engineering Technology (BSEET) from Texas A&M University in College Station, TX.

Copyright © 2016, Texas Instruments Incorporated

IMPORTANT NOTICE FOR TI REFERENCE DESIGNS

Texas Instruments Incorporated ('TI") reference designs are solely intended to assist designers ("Designer(s)") who are developing systems that incorporate TI products. TI has not conducted any testing other than that specifically described in the published documentation for a particular reference design.

TI's provision of reference designs and any other technical, applications or design advice, quality characterization, reliability data or other information or services does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such reference designs or other items.

TI reserves the right to make corrections, enhancements, improvements and other changes to its reference designs and other items.

Designer understands and agrees that Designer remains responsible for using its independent analysis, evaluation and judgment in designing Designer's systems and products, and has full and exclusive responsibility to assure the safety of its products and compliance of its products (and of all TI products used in or for such Designer's products) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to its applications, it has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any systems that include TI products, Designer will thoroughly test such systems and the functionality of such TI products as used in such systems. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

Designers are authorized to use, copy and modify any individual TI reference design only in connection with the development of end products that include the TI product(s) identified in that reference design. HOWEVER, NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of the reference design or other items described above may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI REFERENCE DESIGNS AND OTHER ITEMS DESCRIBED ABOVE ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING THE REFERENCE DESIGNS OR USE OF THE REFERENCE DESIGNS, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNERS AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS AS DESCRIBED IN A TI REFERENCE DESIGN OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THE REFERENCE DESIGNS OR USE OF THE REFERENCE DESIGNS, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

TI's standard terms of sale for semiconductor products (http://www.ti.com/sc/docs/stdterms.htm) apply to the sale of packaged integrated circuit products. Additional terms may apply to the use or sale of other types of TI products and services.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2016, Texas Instruments Incorporated