



CY4533

EZ-PD™ Barrel Connector Replacement (BCR) Evaluation Kit Guide

Document Number. 002-25263 Rev. *B

Cypress Semiconductor
198 Champion Court
San Jose, CA 95134
www.cypress.com

Copyrights

© Cypress Semiconductor Corporation, 2018-2019. This document is the property of Cypress Semiconductor Corporation and its subsidiaries (“Cypress”). This document, including any software or firmware included or referenced in this document (“Software”), is owned by Cypress under the intellectual property laws and treaties of the United States and other countries worldwide. Cypress reserves all rights under such laws and treaties and does not, except as specifically stated in this paragraph, grant any license under its patents, copyrights, trademarks, or other intellectual property rights. If the Software is not accompanied by a license agreement and you do not otherwise have a written agreement with Cypress governing the use of the Software, then Cypress hereby grants you a personal, non-exclusive, nontransferable license (without the right to sublicense) (1) under its copyright rights in the Software (a) for Software provided in source code form, to modify and reproduce the Software solely for use with Cypress hardware products, only internally within your organization, and (b) to distribute the Software in binary code form externally to end users (either directly or indirectly through resellers and distributors), solely for use on Cypress hardware product units, and (2) under those claims of Cypress’s patents that are infringed by the Software (as provided by Cypress, unmodified) to make, use, distribute, and import the Software solely for use with Cypress hardware products. Any other use, reproduction, modification, translation, or compilation of the Software is prohibited.

TO THE EXTENT PERMITTED BY APPLICABLE LAW, CYPRESS MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT OR ANY SOFTWARE OR ACCOMPANYING HARDWARE, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. No computing device can be absolutely secure. Therefore, despite security measures implemented in Cypress hardware or software products, Cypress shall have no liability arising out of any security breach, such as unauthorized access to or use of a Cypress product. CYPRESS DOES NOT REPRESENT, WARRANT, OR GUARANTEE THAT CYPRESS PRODUCTS, OR SYSTEMS CREATED USING CYPRESS PRODUCTS, WILL BE FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION (collectively, “Security Breach”). Cypress disclaims any liability relating to any Security Breach, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from any Security Breach. In addition, the products described in these materials may contain design defects or errors known as errata which may cause the product to deviate from published specifications. To the extent permitted by applicable law, Cypress reserves the right to make changes to this document without further notice. Cypress does not assume any liability arising out of the application or use of any product or circuit described in this document. Any information provided in this document, including any sample design information or programming code, is provided only for reference purposes. It is the responsibility of the user of this document to properly design, program, and test the functionality and safety of any application made of this information and any resulting product. “High-Risk Device” means any device or system whose failure could cause personal injury, death, or property damage. Examples of High-Risk Devices are weapons, nuclear installations, surgical implants, and other medical devices. “Critical Component” means any component of a High-Risk Device whose failure to perform can be reasonably expected to cause, directly or indirectly, the failure of the High-Risk Device, or to affect its safety or effectiveness. Cypress is not liable, in whole or in part, and you shall and hereby do release Cypress from any claim, damage, or other liability arising from any use of a Cypress product as a Critical Component in a High-Risk Device. You shall indemnify and hold Cypress, its directors, officers, employees, agents, affiliates, distributors, and assigns harmless from and against all claims, costs, damages, and expenses, arising out of any claim, including claims for product liability, personal injury or death, or property damage arising from any use of a Cypress product as a Critical Component in a High-Risk Device. Cypress products are not intended or authorized for use as a Critical Component in any High-Risk Device except to the limited extent that (i) Cypress’s published data sheet for the product explicitly states Cypress has qualified the product for use in a specific High-Risk Device, or (ii) Cypress has given you advance written authorization to use the product as a Critical Component in the specific High-Risk Device and you have signed a separate indemnification agreement.

Cypress, the Cypress logo, Spansion, the Spansion logo, and combinations thereof, WICED, PSoC, CapSense, EZ-USB, F-RAM, and Traveo are trademarks or registered trademarks of Cypress in the United States and other countries. For a more complete list of Cypress trademarks, visit cypress.com. Other names and brands may be claimed as property of their respective owners.

Contents



Safety Information	4
1. Introduction	5
1.1 Kit Contents.....	5
1.1.1 Hardware Not Included with the Kit.....	5
1.2 Getting Started	5
1.3 Acronyms	6
2. Hardware	7
2.1 Board Details.....	7
2.2 BCR System Overview	8
2.3 Block Diagram and Functional Description.....	9
2.3.1 EZ-PD BCR Controller Features.....	10
2.3.2 DC Power Transfer System	10
2.3.3 VBUS Voltage and Current Selectors	11
2.3.4 FAULT LED and Safe 5V Load Switch	12
2.3.5 8-Pin I/O Header.....	13
2.4 Changing VBUS Voltage and Current Requested from Power Adapter	13
3. Kit Operation	15
3.1 External Hardware Required for Demo.....	15
3.2 Running the Demos.....	15
3.2.1 Demo #1: Convert an Electronic Device to Power it from USB Type-C	15
3.2.2 Demo #2: Test with a Multimeter and EZ-PD Protocol Analyzer	17
3.3 Behavior under Mismatching Capabilities.....	18
A. Terminology	19
Revision History	20

Safety Information



The CY4533 EZ-PD™ Barrel Connector Replacement (BCR) Evaluation Kit (EVK) is intended for use as an evaluation platform for hardware or software in a laboratory environment. The board is an open-system design, which does not include a shielded enclosure. Due to this reason, the board may cause interference to other electrical or electronic devices in close proximity. In such cases, take adequate preventive measures. Also, do not use this board near any medical equipment or RF devices.

Attaching additional wiring to this product or modifying the product operation from the factory default may affect its performance and cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures must be taken.



The CY4533 EZ-PD BCR EVK board contains ESD-sensitive devices. Electrostatic charges readily accumulate on the human body and any equipment, which can cause a discharge without detection. Permanent damage may occur to devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Store unused CY4533 EZ-PD BCR EVK boards in the protective shipping package.



End-of-Life/Product Recycling

The end-of-life cycle for this kit is five years from the date of manufacture mentioned on the back of the box. Contact the nearest recycler to discard the kit.



General Safety Instructions

ESD Protection

ESD can damage boards and associated components. Cypress recommends that the user perform procedures only at an ESD workstation. If an ESD workstation is not available, use appropriate ESD protection by wearing an antistatic wrist strap attached to the chassis ground (any unpainted metal surface) on the board when handling parts.

Handling Boards

The board provided with CY4533 EZ-PD BCR EVK is sensitive to ESD. Hold the board only by the edges. After removing the board from the box/casing, place it on a grounded, static-free surface. Use a conductive foam pad, if available. Do not slide the board over any surface.

Do's and Don'ts



Maximum current that can be consumed by an external load connected to the EVK board cannot exceed 5A.

1. Introduction



The CY4533 EZ-PD™ Barrel Connector Replacement (BCR) Evaluation Kit (EVK) is based on the BCR product in Cypress' USB Type-C and Power Delivery controllers. This EVK is intended to be an evaluation vehicle for applications that would want to consume power over a USB Type-C Connector.

A device, such as a speaker, shaver, power tools, modem etc. that use a barrel connector for power will benefit from using a universal power interface such as USB Type-C. To make the transition easier, the CY4533 EVK provides a USB Type-C receptacle to consume power from a charger and then supply it over a terminal block. A barrel connector can be attached to this block using wires to convert a barrel input to USB Type-C.

1.1 Kit Contents

The CY4533 EZ-PD BCR EVK consists of the following:

- CY4533 EZ-PD BCR EVK Board
- Quick Start Guide

1.1.1 Hardware Not Included with the Kit

The CY4533 EZ-PD BCR EVK does not come with all the hardware required to perform the demonstrations mentioned in Kit Operation. The following items are not included:

- A USB Type-C Power Adapter that can supply power over the Type-C port
- A two-wire cable with a barrel plug to supply power to an existing device
- A device that accepts power from a barrel input
- USB-C cable required (if not already provided with the USB-C Power Adapter) for connecting the USB Type-C power adapter to the Type-C receptacle on the EVK
- Multimeter and other measurement equipment
- A 3 mm flat head screw driver (for turning the SW1 rotary switch knob)
- A wire stripper
- CY4500 EZ-PD Protocol Analyzer

1.2 Getting Started

For instructions on how to run a quick demonstration and observe the kit functionality, see the Kit Operation section.

1.3 Acronyms

Table 1-1. Acronyms Used in this Document

Acronym	Definition
AFC	Adaptive Fast Charging
BCR	Barrel Connector Replacement
CC	Configuration Channel
CCG	Cable Controller Generation
DFP	Downstream Facing Port
DNP	Do Not Populate
EC	Embedded Controller
EMCA	Electronically Marked Cable Assembly
ESD	Electrostatic Discharge
EVK	Evaluation Kit
FET	Field-Effect Transistor
GPIO	General-Purpose Input/ Output
IC	Integrated Circuit
I ² C	Inter-Integrated Circuit
LED	Light-Emitting Diode
NA	Not Applicable
OVP	Over Voltage Protection
PA	Power Adapter
PD	Power Delivery
PDO	Power Data Object
PFET	P-channel Field Effect Transistor
PSoC [®]	Programmable System-on-Chip
QC [®]	Qualcomm Quick Charge
SoC	System-on-Chip
USB	Universal Serial Bus
USB-PD	Universal Serial Bus Power Delivery
UVP	Under Voltage Protection

2. Hardware



2.1 Board Details

Figure 2-1. CY4533 EVK Top and Bottom Details

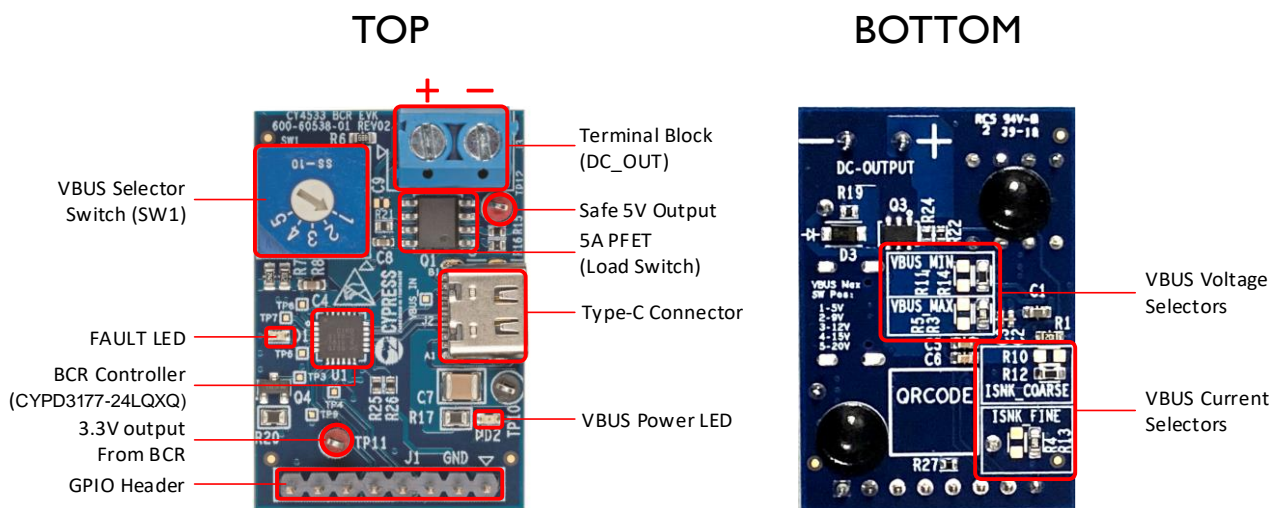


Table 2-1 lists the components of the CY4533 BCR EVK. A detailed Bill-of-Materials list is available in the design files on the kit [webpage](#).

Table 2-1. A Brief List of Components in the CY4533 EVK

REFDES	Component	Description
U1	EZ-PD BCR Controller	Barrel Connector Replacement Controller i.e. CYPD3177-24LQXQ device (referred to as “BCR” through this document). This manages the USB Type-C port and controls the load switch (PFET).
J2	Type-C Connector	A power-only USB Type-C connector.
SW1	Rotary Switch	A single-pole 5-throw switch. Set this switch to different positions to change the maximum voltage negotiated on VBUS. See VBUS Voltage and Current Selectors for details.
Q1	PFET as a Load Switch	A back-to-back PMOSFET used as a load switch isolating the system power from VBUS. See DC Power Transfer System for details.
R3, R5	VBUS_MAX Resistor Selector	Resistor dividers that set the maximum and minimum voltage that BCR will negotiate with the USB Type-C charger. See VBUS Voltage and Current Selectors for details.
R11, R14	VBUS_MIN Resistor Selector	
R10, R12	ISNK_COARSE Resistor Selector	Resistor dividers that set the coarse and fine settings for minimum current that BCR device will negotiate with the USB Type-C charger. See VBUS Voltage and Current Selectors for details.
R13, R4	ISNK_FINE Resistor Selector	

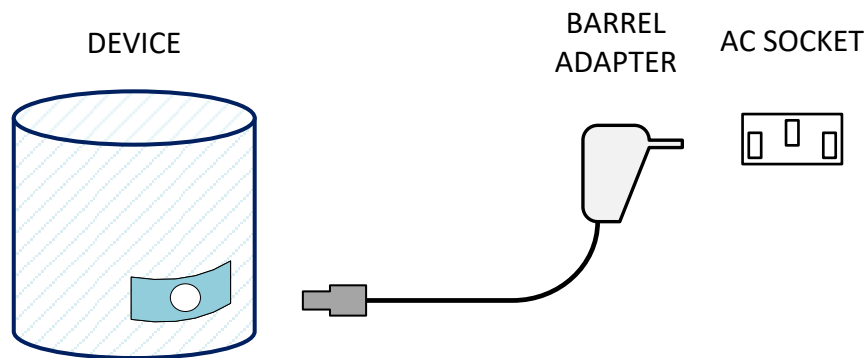
REFDES	Component	Description
J1	8-pin GPIO, I2C and FLIP Header	I/Os from BCR exposed to an external controller. See 8-Pin I/O Header for details.
D1, D2	Fault and Power LEDs	LEDs indicating system state. See FAULT LED and Safe 5V Load Switch for details.
J3	"DC_OUT" Terminal Block	Terminal block to measure output voltage of CY4533 BCR EVK or to connect any external electronic load.

2.2 BCR System Overview

All powered electronic devices need a power source to operate normally or to charge their battery. Such devices often have a barrel receptacle connector and a corresponding DC barrel power adapter to supply power.

Figure 2-2 is an example of one such combination.

Figure 2-2. Typical Electronic Device and its DC Barrel Power Adapter



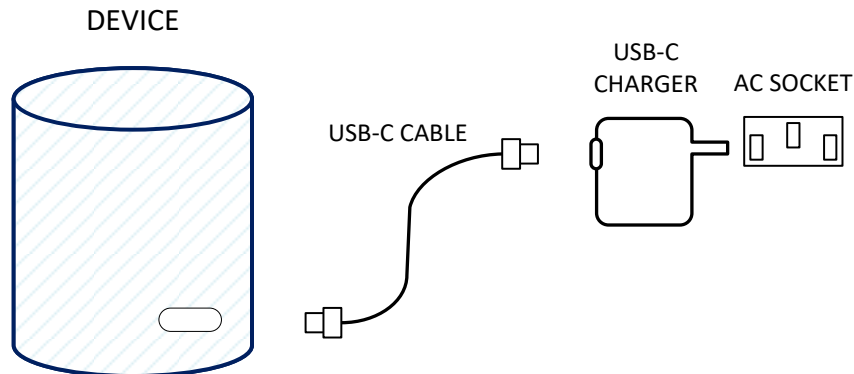
Such electronic devices usually require a specific voltage and current output from the power adapter. To satisfy this, the DC barrel adapter's plug is often custom-made for a device.

USB was the first connector to introduce a standard method of supplying 7.5W power at 5V to electronic devices. A device with a USB Micro-B connector can use a standard USB charger that can also be used with other devices with Micro-B ports.

USB Type-C extends this approach for devices that consume up to 100W of power.

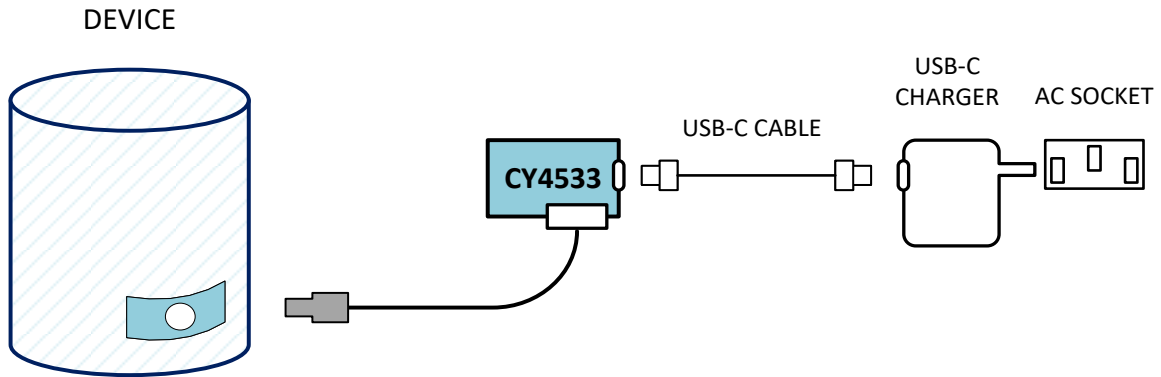
The EZ-PD BCR controller makes the transition from DC barrel to USB Type-C easier by offering a plug-and-play approach to power input design.

Figure 2-3. Newer Electronic Devices Powered by USB Type-C Power Adapters



The CY4533 EVK therefore has a USB Type-C connector on one end to negotiate power with Type-C power adapters. It has a terminal block J3 to which any cable with a DC barrel plug can be connected. The EVK is therefore a converter between USB Type-C and a DC Barrel plug.

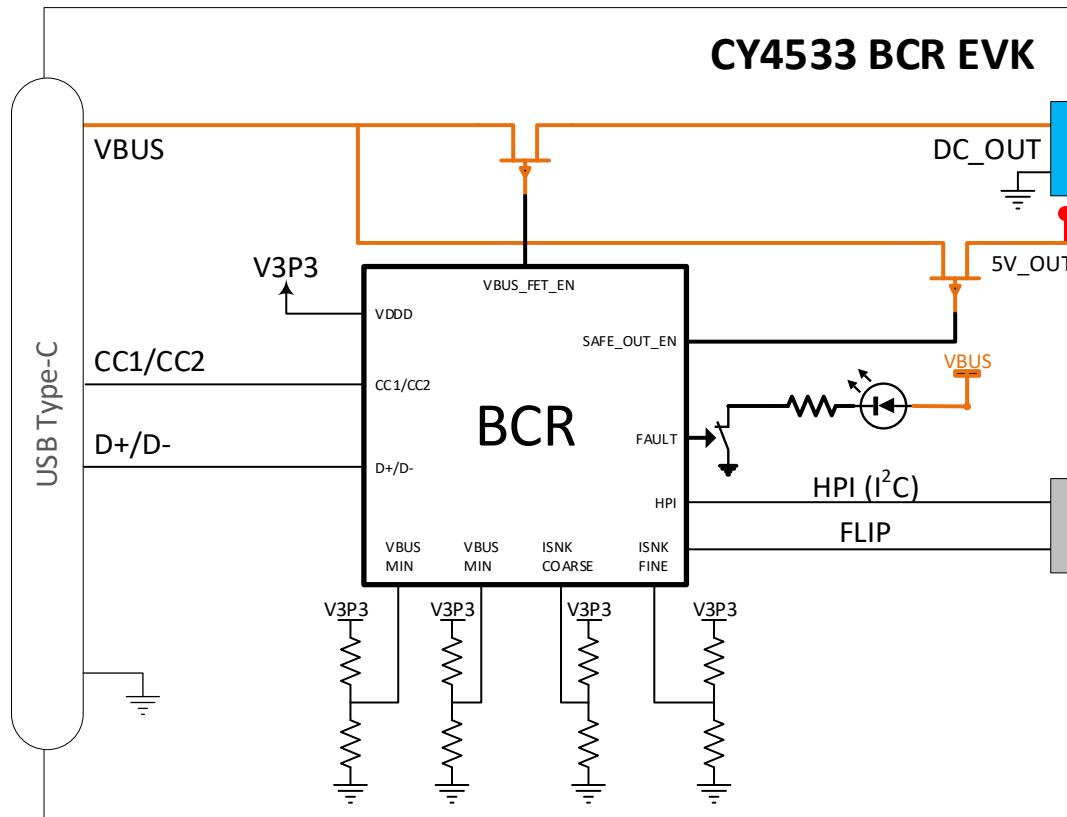
Figure 2-4. Using the CY4533 EVK to Convert USB Type-C Power Adapter to Legacy Barrel Adapter



2.3 Block Diagram and Functional Description

Figure 2-5 shows the block diagram of the CY4533 BCR EVK.

Figure 2-5. CY4533 Block Diagram



The EZ-PD BCR controller is a new device in the USB Type-C family of devices from Cypress for power sink applications. This device combines a certified USB Type-C r1.2 and Power Delivery r3.0 subsystem, high-voltage analog for protection and monitoring, and a load switch controller in an easy-to-use package.

The CY4533 EVK features an onboard BCR controller which communicates with a USB Type-C power adapter to negotiate for the proper voltage and current, as specified by onboard resistors. The DP, DM lines from the BCR controller are connected to the Type-C connector for future usage.

The CY4533 EVK has a green LED to indicate the availability of VBUS and a red LED to indicate a fault with the connection. A few I/O pins from BCR are taken out on an 8-pin header for use with an external SoC or controller.

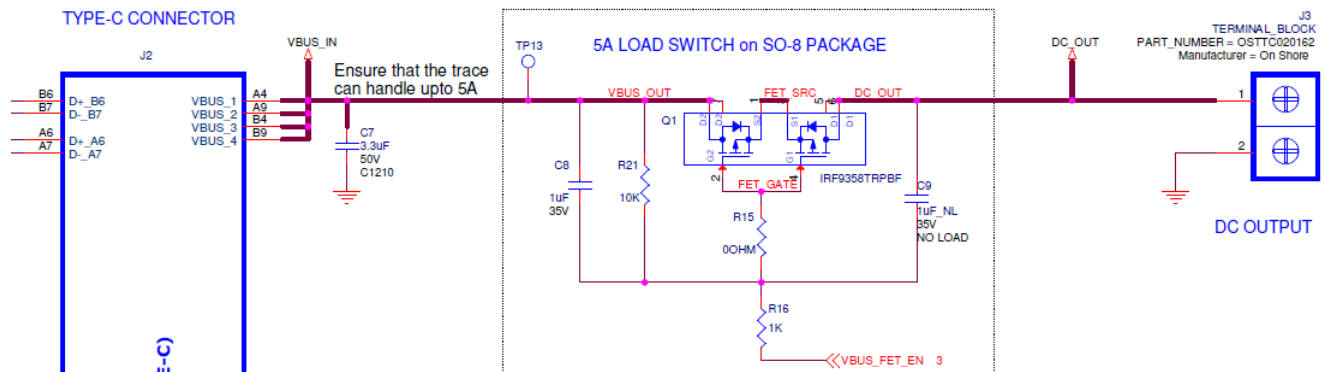
2.3.1 EZ-PD BCR Controller Features

- Fixed-function USB Type-C and Power Delivery controller supporting USB-PD Rev 3 and Type-C Rev 1.2
- Integrated precision Rd and dead-battery Rd termination resistors
- Integrated regulator to power from VBUS
- Supports a high-voltage P-MOSFET gate driver with slew-rate control
- Supports on-chip OVP and UVP to protect system from faults
- System level ESD protection on CC, VBUS, DP and DM pins. ±8kV Contact Discharge and ±15kV Air Gap Discharge based on IED61000-4-2 Level 4C
- Available in a 24-pin QFN Package

For more information, refer to the [BCR datasheet](#).

2.3.2 DC Power Transfer System

Figure 2-6. VBUS Net and P-FET Load Switch



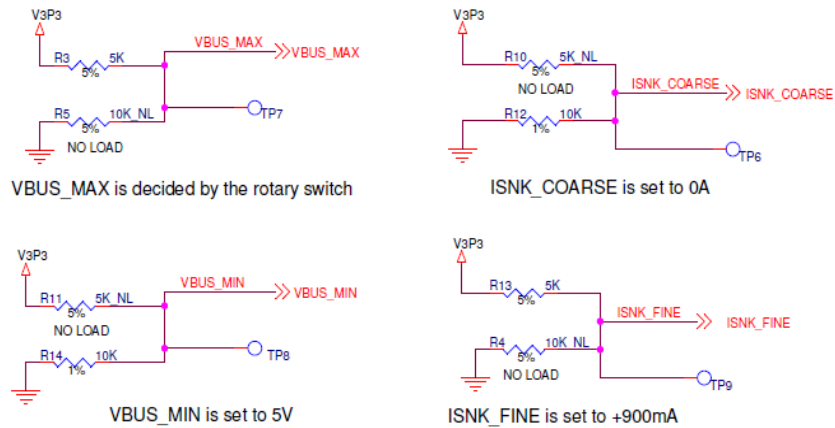
Power supplied by the USB Type-C power adapter is sent to an external device or load through a set of back-to-back Power PMOSFETs. The PMOSFETs are used for the following functions:

- Reduce inrush current due to large capacitive loads. The BCR device turns the FETs on slowly to ensure that the inrush current is limited and controls the rise time of the DC output voltage. The RC circuit of R21 and C8 also help in slowing the FET turn-on time, and its values can be modified to change the turn-on behavior for application specific needs.
- When the VBUS input on the USB Type-C connector is out of range, the BCR device turns the FETs off to protect the rest of the system.
- If the attached USB Type-C power adapter cannot supply the voltages required by the system (as indicated by the resistor divider selectors), the BCR device turns the FETs off.

The output of the FETs is connected to a two-terminal block J3. The system to be evaluated can be powered using this block.

2.3.3 VBUS Voltage and Current Selectors

Figure 2-7. Four Resistor Dividers that Select VBUS Voltage and Current



The range of voltages and currents that the BCR device will negotiate with the USB Type-C power adapter is determined by a set of resistor dividers.

The dividers on the VBUS_MIN and VBUS_MAX pins of the BCR (R3 and R5 for VBUS_MAX, R11 and R14 for VBUS_MIN) determine the minimum and maximum voltages that BCR will negotiate. By default, VBUS_MIN is set to 0V, and the 5-position switch is used to determine the VBUS_MAX value. However, for customers using the BCR device for their end application, the VBUS_MAX voltage can be finalized using the resistor divider network values as shown in Table 2-2 instead of using the 5-position switch SW1. If you want to use the resistor divider network on the kit for VBUS_MAX, then the switch SW1 must be at position 5.

For example, if the divider on VBUS_MIN is set to 9V (i.e. R11 = 5kΩ pull-up, R14 = 1kΩ pull-down) and VBUS_MAX is set to 12V (R3 = 5kΩ pull-up, R5 = 2.4kΩ pull-down), the BCR device will request any voltage between 9V and 12V from the power adapter, always preferring the highest voltage. See Table 2-2 as an example for the pull-up and pull-down resistor values.

Table 2-2. Resistor Divider Values for Achieving Desired VBUS_MIN and VBUS_MAX Voltages

Voltage on VBUS_MAX or VBUS_MIN Pin of BCR Device (V)	Correlated VBUS Voltage(V)	Pull-Up Resistor Value for R3 or R11 (kΩ)	Pull-Down Resistor Value for R5 or R14 (kΩ)
3.3 * (0/6)	5	None (DNP)	0
3.3 * (1/6)	9	5	1
3.3 * (2/6)	12	5	2.4
3.3 * (3/6)	15	5	5
3.3 * (4/6)	19	5	10
3.3 * (6/6)	20	0	None (DNP)

If the power adapter cannot supply 9V or 12V, or power in between, BCR will turn the load switch OFF and will assert FAULT.

Similarly, the dividers on ISNK_COARSE and ISNK_FINE determine the Operating Current communicated to the Type-C power adapter (in the Request Data Object; see Section 6.4.2 of the USB-PD Specification Rev 3.0 Version 1.2). The Operating Current value (ISNK) is the sum of currents indicated by ISNK_COARSE and ISNK_FINE. By default, the maximum current is set to 900mA. See Table 2-3 and Table 2-4 as examples for the pull-up and pull-down resistor values for the resistor dividers on ISNK_COARSE and ISNK_FINE respectively.

For scenarios where the operating current value ISNK is greater than 5A (i.e. ISNK_COARSE + ISNK_FINE > 5A), the BCR device will limit the Operating Current (ISNK) value to 5A.

Table 2-3. Resistor Divider Values for Achieving Desired ISNK_COARSE Current Values

Voltage on ISNK_COARSE (V)	Pull-Up Resistor on ISNK_COARSE (R10) (kΩ)	Pull-Down Resistor on ISNK_COARSE (R12) (kΩ)	ISNK_COARSE (A)
3.3 * (0/6)	None (DNP)	0	0
3.3 * (1/6)	5	1	1
3.3 * (2/6)	5	2.4	2
3.3 * (3/6)	5	5	3
3.3 * (4/6)	5	10	4
3.3 * (6/6)	0	None (DNP)	5

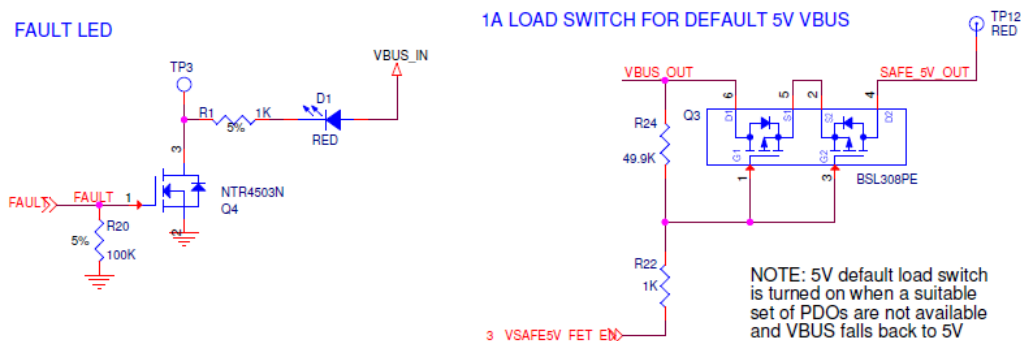
Table 2-4. Resistor Divider Values for Achieving Desired ISNK_FINE Current Values

Voltage on ISNK_FINE (V)	Pull-Up Resistor on ISNK_FINE (R13) (kΩ)	Pull-Down Resistor on ISNK_FINE (R4) (kΩ)	ISNK_FINE (mA)
3.3 * (0/6)	None	0	0
3.3 * (1/6)	5	1	250
3.3 * (2/6)	5	2.4	500
3.3 * (3/6)	5	5	750
3.3 * (6/6)	0	None (DNP)	900

See [Changing VBUS Voltage and Current Requested from Power Adapter](#) for more details on how the BCR uses these pins to select VBUS voltages and how you can change them.

2.3.4 FAULT LED and Safe 5V Load Switch

Figure 2-8. Red FAULT LED and Safe 5 V Load Switch



The FAULT LED is turned ON in the following conditions:

- The Type-C power adapter cannot provide the voltages or current required by the system.

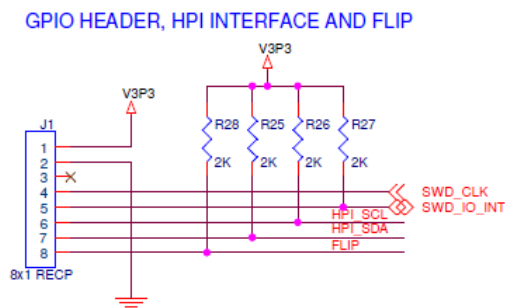
- Voltage on VBUS is 20% below the VBUS_MIN setting or 20% above the VBUS_MAX setting.

When the Type-C power adapter cannot provide the voltage or current set in the selector pins, the BCR part negotiates for 5V at 900mA and turns ON the Safe 5V Load Switch (Q2 on the EVK).

A system can use this voltage to either run in reduced feature mode or notify you that an incompatible power adapter is attached.

2.3.5 8-Pin I/O Header

Figure 2-9. 8-pin GPIO Header



The CY4533 EVK has an 8-pin header (J1) that exposes a few pins, the internal 3.3V rail generated by the BCR device, and ground pins for debug use.

The HPI pins (HPI_SCL and HPI_SDA) are connected to an I2C slave on the BCR at address 0x08 (7-bit). Host Processor Interface (HPI) is a proprietary protocol on top of I2C that exposes control and status registers of the BCR device. See the [BCR datasheet](#) for details about this interface.

The FLIP pin can be used to detect the orientation of the Type-C cable connection (right-side-up or upside-down). The FLIP pin is a simple push-pull output from the BCR that indicates if the Type-C power adapter was attached right-side-up (FLIP = 0V) or upside-down (FLIP = 3.3V). The polarity of this signal can be used to control a Multiplexer for flipping the USB signals in an application that is a Power Sink and Data Host/Device.

2.4 Changing VBUS Voltage and Current Requested from Power Adapter

The BCR controller executes a capability matching algorithm to select the best voltage and current from the attached USB Type-C power adapter.

Internally, the BCR maintains a Sink Capabilities list based on the VBUS voltage and current selector pins. See [Table 2-5](#) for the capabilities.

Table 2-5. Sink Capabilities Stored Inside the BCR Controller

Field in the PDO	Sink Capability/PDO #1	Sink Capability/PDO #2
Type of PDO (Power Delivery Object)	Fixed Supply	Variable Supply
Min Voltage	5V	VBUS_MIN Value
Max Voltage	5V	VBUS_MAX Value
Current	900mA	ISNK_COARSE + ISNK_FINE

If the VBUS_MIN value is higher than 5V, then the “Higher Capability” bit is set in the first Sink Power Delivery Object (PDO). This tells the Type-C power adapter that voltages higher than 5V are needed by the system.

The capability matching algorithm works as follows:

1. Loop through the power adapter’s source PDOs from highest voltage first to find the first PDO that satisfies the following conditions:
 - a. Source_PDO_Voltage ≥ VBUS_MIN
 - b. Source_PDO_Voltage ≤ VBUS_MAX
 - c. Source_PDO_Maximum_Current ≥ ISNK_COARSE + ISNK_FINE

2. If all three conditions are satisfied, then BCR sends a request for this PDO with Operating Current set to ISNK_COARSE + ISNK_FINE.
3. If any condition is not satisfied, the BCR device requests 5V (PDO #1) with 900mA Operating Current. The BCR device also sets the Capability Mismatch flag in the request message.
 - a. Once this mismatch of capabilities is detected, FAULT goes HIGH (3.3V strong drive) and the “Safe 5V” load switch (Q2) turns ON.

To modify the VBUS_MAX value, use the rotary switch. To modify the VBUS_MIN, ISNK_COARSE, and ISNK_FINE values, mount the correct resistor on the bottom of the board.

See the layout design files on the CY4533 EZ-PD™ BCR Evaluation Kit [webpage](#).

3. Kit Operation



This chapter describes how to configure the CY4533 EZ-PD BCR EVK to demonstrate the functionality as a USB Type-C Power Sink attached to an external device or load.

3.1 External Hardware Required for Demo

- A USB Type-C Power Adapter or Power Bank

Example Power Adapters: [Apple 30W Power Adapter](#), [Google 18W Type-C Charger](#), [HP 45W Laptop AC Power Adapter](#)

Example Power Banks: [Anker PowerCore 13000 C](#), [RAVPower 20100 Portable Charger](#)

- A cable to connect the power adapter or power bank ((if not already provided with the USB-C Power Adapter) to the Type-C receptacle on the EVK
- An electronic device that is powered by a DC barrel connector (for [Demo #1: Convert an Electronic Device to Power it from USB Type-C](#))
- A DC barrel power adapter for the electronic device (for [Demo #1: Convert an Electronic Device to Power it from USB Type-C](#))
- A 3mm flat head screw driver
- A wire stripper
- A multimeter to measure voltages (for [Demo #2: Test with a Multimeter and EZ-PD Protocol Analyzer](#))

3.2 Running the Demos

3.2.1 Demo #1: Convert an Electronic Device to Power it from USB Type-C

To set up the demo, do the following:

1. Cut the DC barrel power's cable and strip the two wires (power and ground) on the end of the cable with the barrel plug.
2. Connect the power wire to the positive terminal and connect the ground wire to the negative terminal of the terminal block J3 on the CY4533 EVK (voltage on terminal block J3 is referred to as "DC_OUT" in [Table 3-1](#)). See [Figure 2-1](#) to determine the polarity of the terminal block or look at the markings on the back of the board.

Your CY4533 EVK is now a USB Type-C to DC Barrel converter. Now set the rotary switch (SW1) to the position corresponding to the voltage you want from the Type-C power adapter. See [Table 3-1](#) for details.

Table 3-1. VBUS_MAX Values corresponding to SW1 Rotary Switch Positions

SW1 Switch Position	Max VBUS Requested (V)	DC_OUT Voltage (V)	Minimum Current Requested (mA)
1	5	5	900
2	9	9	900
3	12	12 ^[1]	900
4	15	15 ^[2]	900
5	20	20 ^[2]	900

Note 1: Newer USB Type-C power adapters may not provide 12V. In that case, you will see 9V instead at SW1 position 3.

Note 2: Use 45W or higher wattage USB Type-C power adapters to get higher voltages (15V, 20V).

To run the demo, connect the barrel plug to the device. Then, connect a USB Type-C cable to the power adapter (or Power Bank) and to the CY4533 EVK.

The device will now be powered by the USB Type-C power adapter (or Power Bank). [Figure 3-1](#) and [Figure 3-2](#) illustrate the setup.

Figure 3-1. CY4533 EVK Connected with Barrel Plug Cable

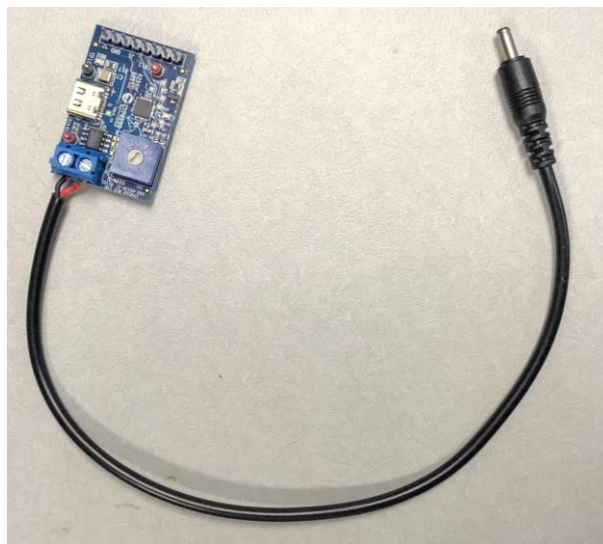
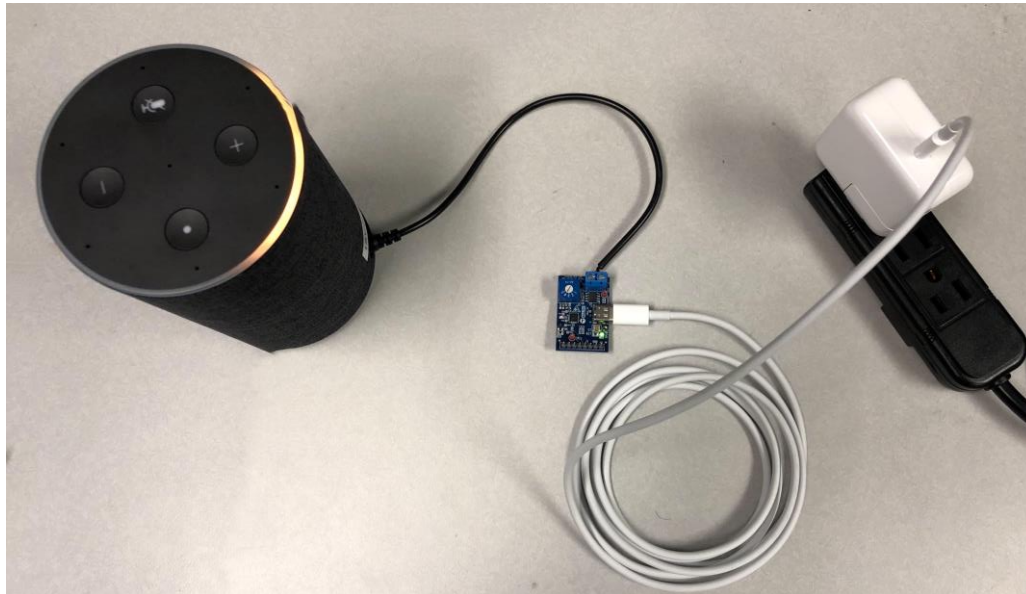


Figure 3-2. Complete Setup: Amazon Echo, CY4533 EVK with Barrel Plug Cable, and Apple 30W USB-C Power Adapter

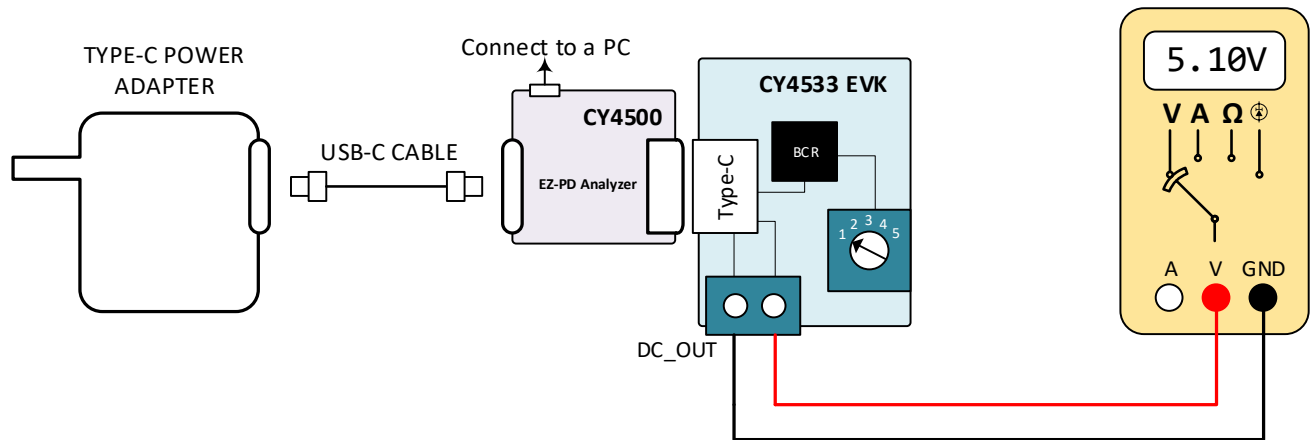


3.2.2 Demo #2: Test with a Multimeter and EZ-PD Protocol Analyzer

In this demo, a multimeter is connected to the CY4533 EVK to test the various voltages offered by the USB Type-C power adapter (or Power Bank). You can also connect an electronic load in parallel with the multimeter to test current capabilities of the power adapter (or power bank) and the CY4533 EVK.

In addition, you will use the CY4500 EZ-PD Protocol Analyzer to analyze the USB Power Delivery packets exchanged between BCR and the power adapter.

Figure 3-3. CY4533 EVK, Multimeter, and a Type-C Power Adapter (Apple 30 W USB-C Adapter)



To set up the demo, do the following:

1. Connect a multimeter to the DC_OUT terminal block J3. If desired, you may also have a load connected in parallel with the multimeter. See Board Details to determine the polarity of the terminal block or look at the markings on the back of the board.
2. Connect the CY4533 EVK to the EZ-PD Protocol Analyzer's plug. Connect the analyzer to your PC using the supplied USB Micro-B cable.
3. Ensure that the analyzer software and the necessary drivers are installed. See CY4500 EZ-PD Protocol Analyzer's [website](#) for details.

4. Open the analyzer software and start a capture.
5. Connect a USB Type-C power adapter to the Type-C receptacle of the analyzer. You will see USB Power Delivery packets on the analyzer software.

Each USB Type-C power adapter will advertise a list of voltage and current combinations (called PDOs). The BCR controller will select the best PDO based on a set of rules described in [Changing VBUS Voltage and Current Requested from Power Adapter](#).

In short, the VBUS_MAX rotary switch governs the highest voltage that the BCR device will try to request. If that voltage is unavailable, it looks for the next highest voltage, and so on.

To test this, perform the following steps on the demo setup:

1. Set the VBUS_MAX Rotary Switch (SW1) to position 1. Verify that the multimeter displays a voltage between 4.5V and 5.5V.
2. Set the VBUS_MAX rotary switch (SW1) to position 2. Verify that the multimeter displays a voltage between 8.55V and 9.45V. If the power adapter does not support this voltage, you will see ~5V.
3. Similarly loop through all voltages and verify that the multimeter reads VBUS_MAX \pm 5%, if the power adapter supports that voltage.

3.3 Behavior under Mismatching Capabilities

If the attached USB Type-C power adapter can supply a VBUS voltage within VBUS_MIN and VBUS_MAX limits, the CY4533 EVK will turn the load switch ON to pass the voltage onto the terminal block J3.

On the other hand, if the attached power adapter does not have a matching voltage/current combination, the BCR device will indicate a capability mismatch to the power adapter and will turn the load switch OFF. See [VBUS Voltage and Current Selectors](#) for details.

Under mismatch conditions, the red FAULT LED D1 turns ON and the VBUS voltage is routed to the VSAFE5V test point (TP12). See [FAULT LED and Safe 5V Load Switch](#) for details.

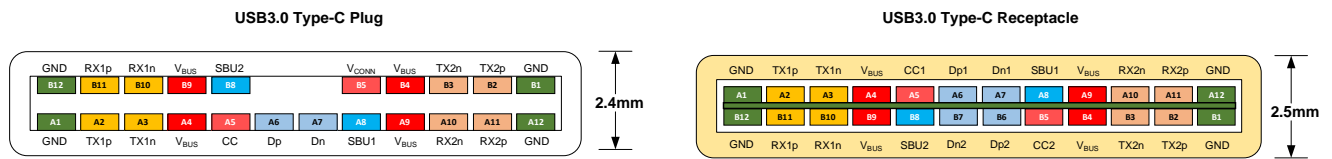
A. Terminology



Terminology

This guide assumes that you are familiar with the fundamentals of the Type-C connectivity and the USB Power Delivery protocol. A brief description of Type-C terms is provided here for reference.

- **Alternate Modes:** A feature of a USB Type-C system whereby one or both SuperSpeed lanes may be repurposed for use with a different serial protocol, such as a DisplayPort, eSATA, or Thunderbolt.
- **Client:** A USB peripheral such as a hub, docking station, or monitor.
- **Configuration channel (CC):** A USB Type-C bus wire used to transmit protocol signals. This is a half-duplex 300 kHz signal.
- **Consumer:** A Type-C port that sinks power from VBUS.
- **DisplayPort:** A digital display interface standard developed by the Video Electronics Standards Association. It is used primarily to connect a video source to a display such as a computer monitor.
- **Downstream facing port (DFP):** A USB Type-C port on a host or a hub to which devices are connected.
- **Dp, Dn:** USB Type-C bus wires used to transmit and receive USB 2.0 data.
- **Dual-role port (DRP):** A USB Type-C port that can operate as either a DFP or a UFP.
- **Electronically Marked Cable Assembly (EMCA):** A USB cable that includes an IC that reports cable characteristics (such as current rating) to the Type-C ports.



- **Host:** A USB Host system such as a PC, notebook, and laptop.
- **Provider:** A Type-C port that sources power over VBUS.
- **Sideband use (SBU):** A USB Type-C bus wire used for non-USB control signals, such as DisplayPort control signals.
- **Type-C Transceiver:** A transmitter/receiver that communicates over the CC.
- **TX1p, TX1n, RX1p, RX1n, TX2p, TX2n, RX2p, and RX2n:** USB Type-C bus wires used to transmit and receive SuperSpeed USB and PCIe or DisplayPort data.
- **Upstream facing port (UFP):** A USB Type-C port on a device or a hub that connects to a host or the DFP of a hub.
- **USB Power Delivery (USB PD, PD):** A new USB standard that increases maximum power delivery over USB from 7.5 W to 100 W.
- **USB Type-C (Type-C):** A new standard with a slimmer USB connector and a reversible cable, capable of sourcing up to 100 W of power and supporting Alternate Modes.
- **VBUS:** A USB Type-C bus wire used for power; initially 5 V, but can be increased up to 20 V on USB PD systems.
- **VCONN:** A USB Type-C bus wire used to power the IC in the EMCA.