CY4535 EZ-PD™ barrel connector replacement-lite (BCR-LITE) evaluation kit guide

About this document

Scope and purpose

The CY4535 EZ-PD™ barrel connector replacement-lite (BCR-LITE) evaluation kit (EVK) is based on the BCR family product of USB Type-C and power delivery controllers. This EVK is intended to be an evaluation platform for customers who want to replace an existing barrel/power input connector with a USB-C connector. This document serves as the user guide for this CY4535 EZ-PD™ BCR-LITE EVK.

Intended audience

This is primarily intended for Infineon USB Type-C customers who want an evaluation platform to replace an existing barrel/power input connector with a USB-C connector.

Abbreviations and definitions

Table 1 Abbreviations

Abbreviation	Definition
AFC	Adaptive Fast Charging
BC	Battery 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
HPI	Host Processor Interface
IC	Integrated Circuit
I^2C	Inter-Integrated Circuit
LED	Light-Emitting Diode
NA	Not Applicable
OVP	Over Voltage Protection
PA	Power Adapter
PD	Power Delivery
PDO	Power Data Object

About this document

Abbreviation	Definition
PFET	P-channel Field Effect Transistor
PSoC™	Programmable System-on-Chip
QC®	Qualcomm Quick Charge
SDK	Software Development Kit
SoC	System-on-Chip
UFP	Upstream Facing Port
USB	Universal Serial Bus
USB-PD	Universal Serial Bus Power Delivery
UVP	Under Voltage Protection

Safety information

The CY4535 EZ-PD™ barrel connector replacement-lite (BCR-LITE) 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 CY4535 EZ-PD™ BCR-LITE 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 CY4535 EZ-PD™ BCR-LITE 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. Infineon 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 CY4535 EZ-PD™ BCR-LITE 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 5 A.

Table of contents

1 Introduction

The CY4535 EZ-PD™ barrel connector replacement lite (BCR-LITE) evaluation kit (EVK) is based on the CYPD3178 device which is a part of the BCR product family of Infineon's USB Type-C and power delivery controllers. This EVK is intended to be an evaluation vehicle for customers who want to replace an existing barrel/power input connector with a USB-C connector. Implementing this solution in an end-product allows the system to be powered by any USB-C compliant Power Adapter. The CYPD3178 device (and hence the CY4535 EZ-PD™ BCR-LITE kit) can be used for USB-C sinks or devices that are only capable of accepting power from the following:

1. USB Type-C only chargers that are capable of delivering 5 V (up to 3 A) or;
2. USB Type-A or Type-C chargers that can operate at 5 V, 9 V, 12 V, 15 V or 20 V using proprietary methods of negotiation over the D+/D- lines.

The CYPD3178 device does not support the USB-PD (Power Delivery) protocol unlike the CYPD3177 or CYPD3176 devices. Refer to the CY4533 or CY4534 EZ-PD™ BCR EVK user guides for more details if your application requires USB-PD support.

A device, such as a speaker, shaver, power tool, modem etc. that uses a barrel connector for power will benefit from using a universal power interface such as USB Type-C. To make the transition easier, the CY4535 EZ-PD™ BCR-LITE 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.

The CY4535 EZ-PD™ BCR-LITE EVK ships with pre-programmed firmware with functionality as documented in the CYPD3178 device datasheet.

1.1 Kit contents

The CY4535 EZ-PD™ BCR-LITE EVK consists of the following:

- CY4535 EZ-PD™ BCR-LITE EVK board
- Quick start guide

1.1.1 Hardware not included with the kit

The CY4535 EZ-PD™ BCR-LITE 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 connector 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)

1.2 Getting started

For instructions on how to run a quick demonstration and observe the kit functionality, see the **Kit operation** chapter.

2 Hardware

This chapter covers the hardware details of the CY4535 EZ-PD™ BCR-LITE EVK board, a complete system overview, and description of the critical circuit blocks of the EVK board schematic. For more details, refer to the schematics of the CY4535 EZ-PD™ BCR-LITE EVK board on the kit **webpage**.

2.1 Board details

Figure 1 below shows the pictures of the front and back side of the CY4535 EZ-PD™ BCR-LITE EVK board with the critical components highlighted.

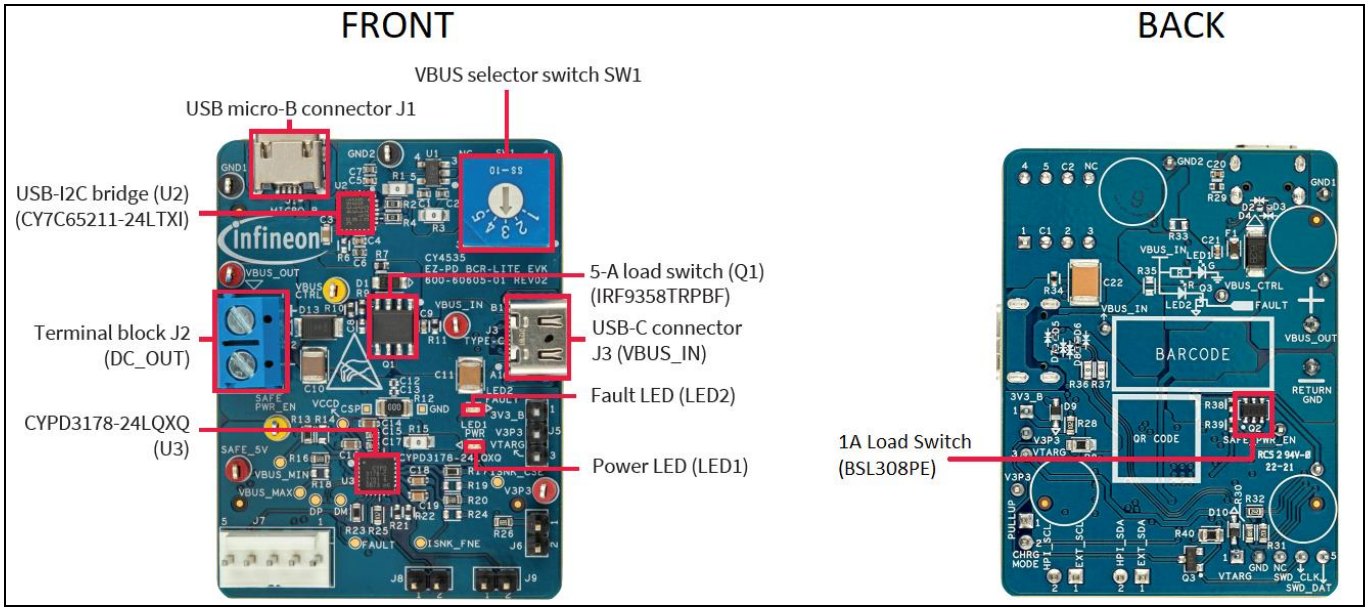


Figure 1 CY4535 EZ-PD™ BCR-LITE EVK board (front and back) details

Table 2 lists the major components of the CY4535 EZ-PD™ BCR-LITE EVK. A detailed bill-of-materials (BOM) list is available in the design files on the kit webpage.

Table 2 A brief list of components in the CY4535 EZ-PD™ BCR-LITE EVK

REFDES	Component	Description
U3	EZ-PD™ BCR-LITE controller	Barrel connector replacement controller lite i.e. CYPD3178-24LQXQ device (referred to as “BCR-LITE” through this document). This part manages the USB Type-C port and controls the load switch (PFET).
U2	USB-I2C bridge controller	Infineon USB-Serial part (CY7C65211-24LTXI) is connected to the USB Micro-B connector (J1) of the CY4535 EZ-PD™ BCR-LITE EVK. This part works as a USB-I2C bridge for downloading firmware.
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.
J1	USB Micro-B connector	A USB micro-B connector connects to the PC Host for downloading firmware or configuring the device.

REFDES	Component	Description
J2	"DC_OUT" terminal block	Terminal block to measure output voltage of CY4535 EZ-PD™ BCR-LITE EVK or to connect any external electronic load.
J3	Type-C connector	A power-only USB Type-C connector with D+/D-.
J5	Alternate power selection jumper	Power selection jumper to select the alternate power to supply the BCR-LITE device. See **Alternate power selection jumper** for details.
J6	Legacy charging mode selection header	A header to enable or disable the legacy charging protocol support feature. See **Legacy charging mode selection jumper** for details.
J7	Debug header	5-pin debug header for internal use.
J8, J9	External HPI connection header	Headers to route external HPI (HPI_SDA, HPI_SCL) connection to BCR-LITE device. See **External Host Processor Interface (HPI) connection header** for details.
LED1	VBUS powered LED	Power LED indicating system state.
LED2	Fault LED	LED indicating system faults. See **Fault LED and VBUS powered LED** for details.
Q1	PFET as a main 5 A load switch	A back-to-back PMOSFET used as a 5 A load switch isolating the system power from VBUS. See **DC power transfer system** for more details.
Q2	PFET as a safe 5 V 1A load switch	A back-to-back PMOSFET used as a safe 5V 1A load switch, enabled when the PD contract defaults to 5V due to mismatching capabilities. See section **Behavior under mismatching capabilities** for more details.
R16, R18	VBUS_MAX resistor selector	Resistor dividers that set the maximum and minimum voltage that BCR-LITE will negotiate with the USB Type-C charger. See **VBUS voltage and current selectors** for details.
R13, R14	VBUS_MIN resistor selector	
R17, R19	ISNK_COARSE resistor selector	Resistor dividers that set the coarse and fine settings for minimum current that BCR-LITE device will negotiate with the USB Type-C charger. See **VBUS voltage and current selectors** for details.
R20, R24	ISNK_FINE resistor selector	

2.2 BCR system overview

All DC-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 is an example of one such combination.

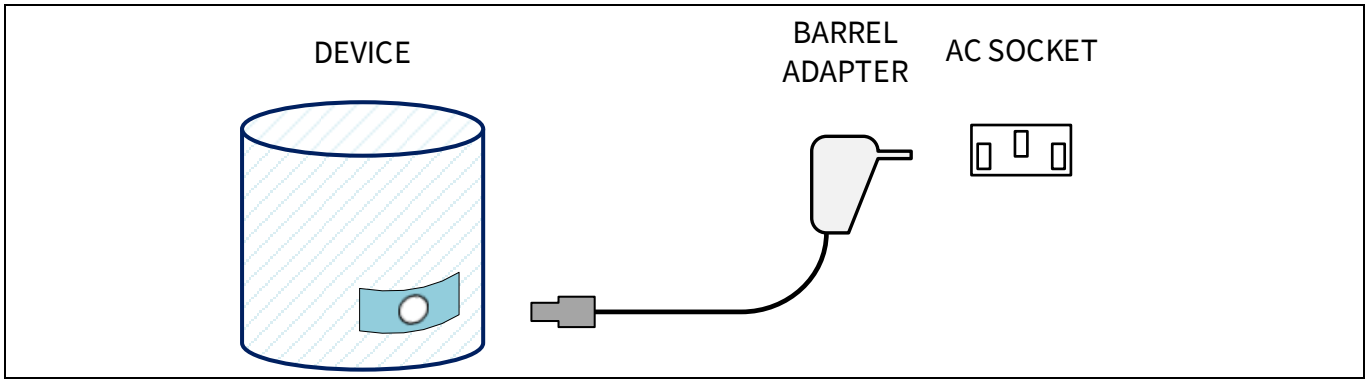


Figure 2 Typical electronic device and its DC barrel power adapter

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 7.5 W power at 5 V 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 on this device extends the approach for devices that consume up to 15 W of power. Some proprietary methods of legacy charging allow this power range to be extended from 15 W to about 45 W.

The EZ-PD™ BCR-LITE controller device makes the transition from DC barrel connector to USB Type-C connector easier by offering a plug-and-play approach to power input design, including support for proprietary methods of legacy charging for eg: BC 1.2, QC 2.0, and Apple charging.

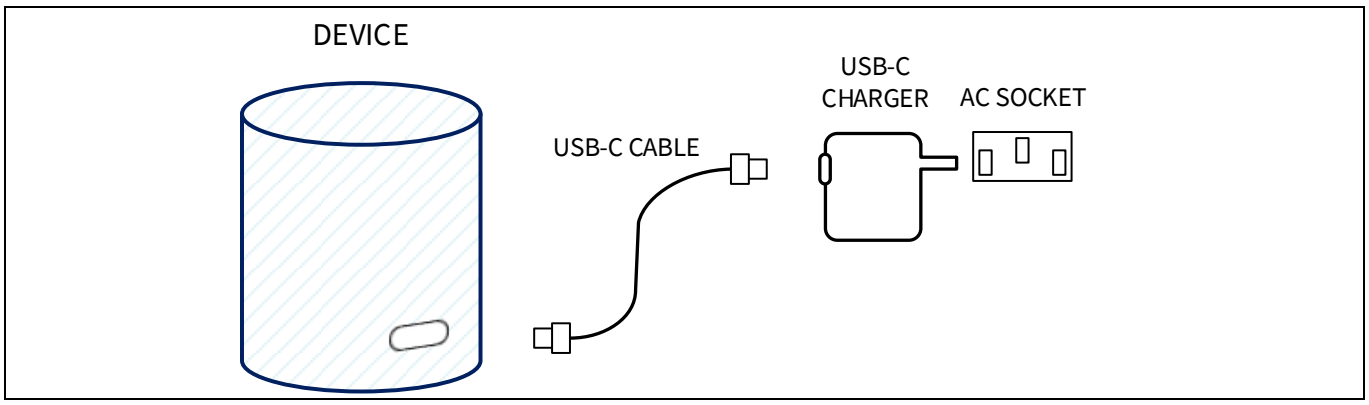


Figure 3 Newer electronic devices powered by USB Type-C power adapters

The CY4535 EZ-PD™ BCR-LITE EVK therefore has a USB Type-C connector(J3) on one end to negotiate the power with Type-C power adapters. It has a terminal block J2 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.

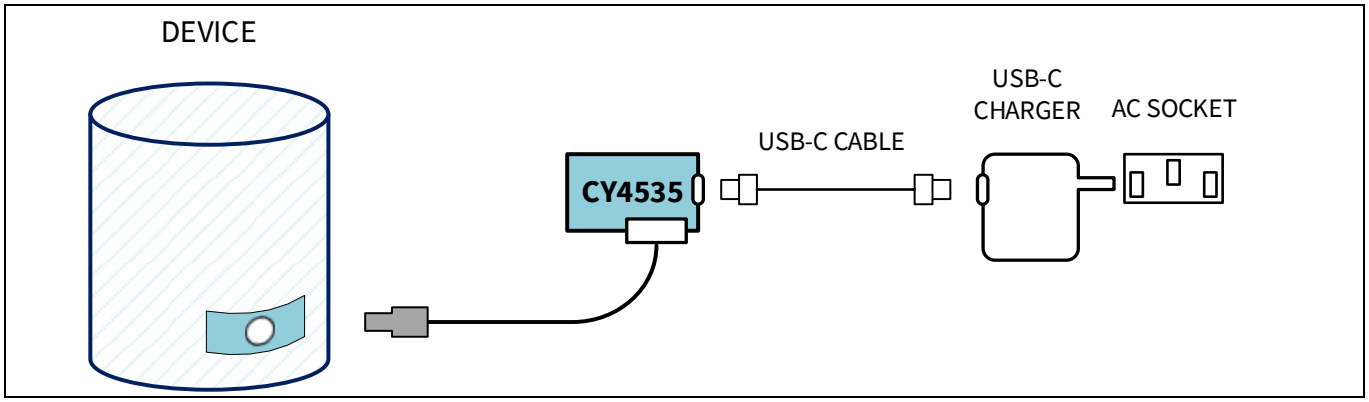


Figure 4 Using the CY4535 EZ-PD™ BCR-LITE EVK to convert USB Type-C power adapter to legacy barrel adapter

2.3 Block diagram and functional description

Figure 5 shows the block diagram of the CY4535 EZ-PD™ BCR-LITE EVK board.

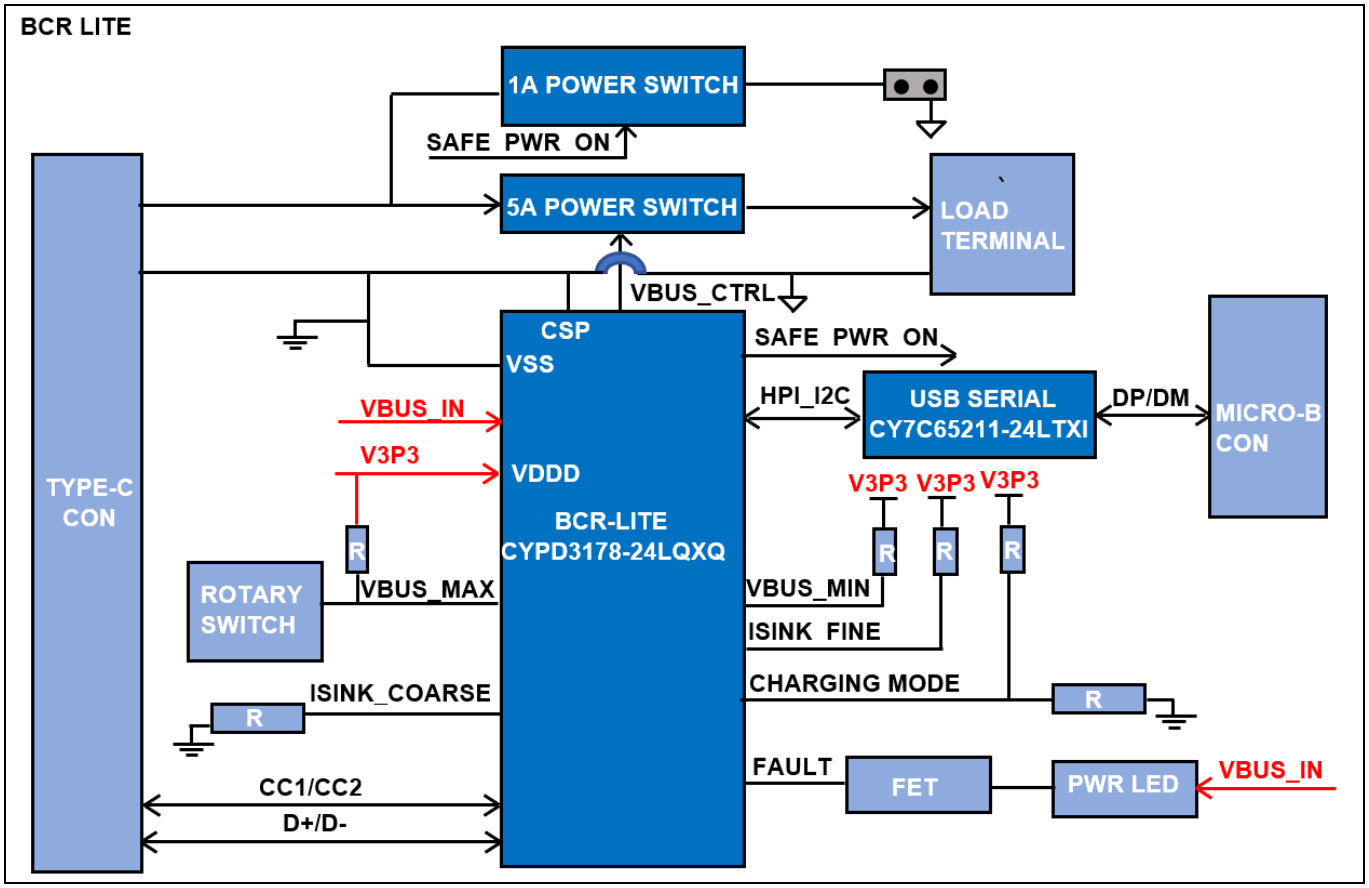


Figure 5 CY4535 EZ-PD™ BCR-LITE EVK board block diagram

The EZ-PD™ BCR-LITE controller is a new device in the USB Type-C family for barrel connector replacement (BCR) applications. This device combines a certified USB Type-C rev 1.2, high-voltage analog for protection, sink side over current protection and monitoring, legacy charging support (for BC 1.2, QC 2.0, AFC and Apple charging), and a load switch controller in an easy-to-use package. As mentioned earlier, the CYPD3178 device does not support the USB-PD (Power Delivery) protocol unlike the CYPD3177 and CYPD3176 devices. Refer to

the CY4533 EZ-PD™ BCR EVK or CY4534 EZ-PD™ BCR-PLUS EVK kit guide for further details if your application requires USB-PD support.

The CY4535 EZ-PD™ BCR-LITE EVK features an onboard BCR-LITE controller which communicates through the legacy charging protocol to negotiate for the proper voltage and current, as specified by onboard resistors.

The CY4535 EZ-PD™ BCR-LITE EVK has a green LED (LED1) to indicate the availability of VBUS and a red LED (LED2) to indicate a fault with the expected output.

2.3.1 EZ-PD™ BCR-LITE controller features

- Fixed-function USB Type-C controller supporting 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
- Supports legacy charging protocol (BC 1.2, QC 2.0, AFC and Apple charging)
- System level ESD protection on CC, VBUS, DP and DM pins. ±8 kV contact discharge and ±15 kV air gap discharge based on IED61000-4-2 level 4C.
- Available in a 24-pin QFN package

For more information, refer to the **BCR-LITE datasheet**.

2.3.2 DC power transfer system

Figure 6 shows the PFET load switch circuitry and the VBUS path of the CY4535 EZ-PD™ BCR-LITE EVK board.

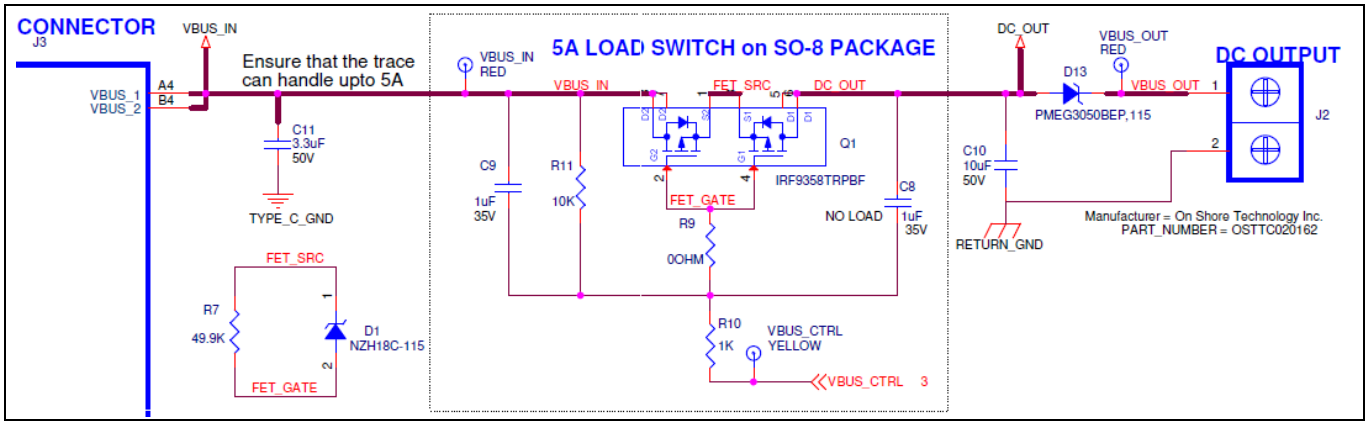


Figure 6 VBUS net and P-FET load switch

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 in-rush current due to large capacitive loads. The BCR-LITE device turns the FETs on slowly to ensure that the in-rush current is limited and controls the rise time of the DC output voltage. The RC circuit of R11 and C9 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-LITE 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-LITE device turns the FETs off.

The output of the FETs is connected to terminal block J2. The system to be evaluated can be connected and powered via this block.

2.3.3 VBUS voltage and current selectors

Figure 7 shows the voltage and current resistor divider networks of the CY4535 EZ-PD™ BCR-LITE EVK board. The voltage and current ranges that the BCR-LITE device will negotiate with the USB Type-C power adapter is determined by these set of resistor dividers.

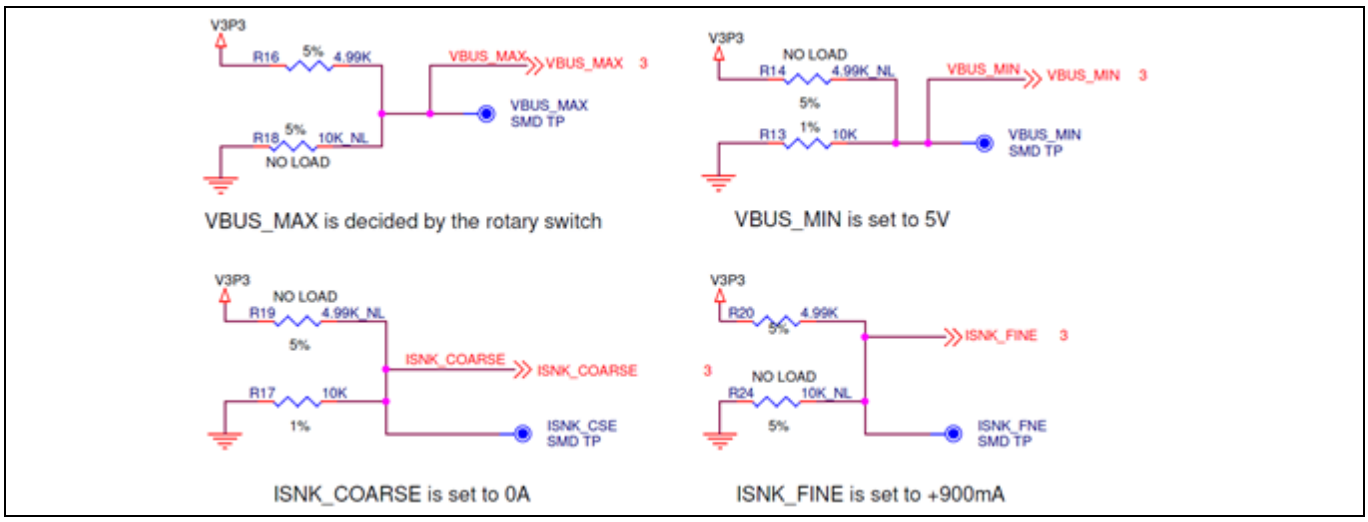


Figure 7 Four resistor dividers that select VBUS voltage and current

The dividers on the VBUS_MIN and VBUS_MAX pins of the BCR-LITE (R16 and R18 for VBUS_MAX, R14 and R13 for VBUS_MIN) determine the minimum and maximum voltages that BCR-LITE device will negotiate. By default, the VBUS_MIN is set to 5 V, and the 5-position switch is used to determine the VBUS_MAX value. However, for customers using the BCR-LITE device for their end application, the VBUS_MAX voltage can be finalized using the resistor divider network values as shown in **Table 3** instead of using the 5-position switch SW1. If the user wants 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 9 V (i.e. R14 = 5 kΩ pull-up, R13 = 1 kΩ pull-down) and VBUS_MAX is set to 12 V (R16 = 5 kΩ pull-up, R18 = 2.4 kΩ pull-down), the BCR-LITE device will request any voltage between 9 V and 12 V from the power adapter, always preferring the highest voltage. If the power adapter cannot supply power at 9 V, 12 V, or a value in between, the BCR-LITE device will turn the load switch OFF and will assert the FAULT pin. See **Table 3** as for a complete list of available pull-up and pull-down resistor values.

Table 3 Resistor divider values for achieving desired VBUS_MIN and VBUS_MAX voltages

Voltage on VBUS_MAX or VBUS_MIN pin of BCR_LITE device (V)	Correlated VBUS voltage(V)	Pull-up resistor value for R14 or R16 (kΩ)	Pull-down resistor value for R13 or R18 (kΩ)
V = 3.3 * (0/6)	5	None (DNP)	0
V = 3.3 * (1/6)	9	5	1
V = 3.3 * (2/6)	12	5	2.4

Voltage on VBUS_MAX or VBUS_MIN pin of BCR_LITE device (V)	Correlated VBUS voltage(V)	Pull-up resistor value for R14 or R16 (kΩ)	Pull-down resistor value for R13 or R18 (kΩ)
V = 3.3 * (3/6)	15	5	5
V = 3.3 * (4/6)	19	5	10
V = 3.3 * (6/6)	20	0	None (DNP)

For USB sinks that must interoperate with 5V power adapters that are USB Type-C only or USB Type-A only, VBUS_MIN must be set at 5V.

Similarly, the resistor 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 900 mA. See **Table 4** and **Table 5** for a complete list of 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 5 A (i.e. ISNK_COARSE + ISNK_FINE > 5 A), the BCR-LITE device will limit the operating current (ISNK) value to 5 A.

Table 4 Resistor divider values for achieving desired ISNK_COARSE current values

Voltage on ISNK_COARSE (V)	Pull-up resistor on ISNK_COARSE (R19) (kΩ)	Pull-down resistor on ISNK_COARSE (R17) (kΩ)	ISNK_COARSE (A)
V = 3.3 * (0/6)	None (DNP)	0	0
V = 3.3 * (1/6)	5	1	1
V = 3.3 * (2/6)	5	2.4	2
V = 3.3 * (3/6)	5	5	3
V = 3.3 * (4/6)	5	10	4
V = 3.3 * (6/6)	0	None (DNP)	5

Table 5 Resistor divider values for achieving desired ISNK_FINE current values

Voltage on ISNK_FINE (V)	Pull-up resistor on ISNK_FINE (R20) (kΩ)	Pull-down resistor on ISNK_FINE (R24) (kΩ)	ISNK_FINE (mA)
V = 3.3 * (0/6)	None	0	0
V = 3.3 * (1/6)	5	1	250
V = 3.3 * (2/6)	5	2.4	500
V = 3.3 * (3/6)	5	5	750
V > 3.3 * (3/6)	0	None (DNP)	900

2.3.4 Fault LED and VBUS powered LED

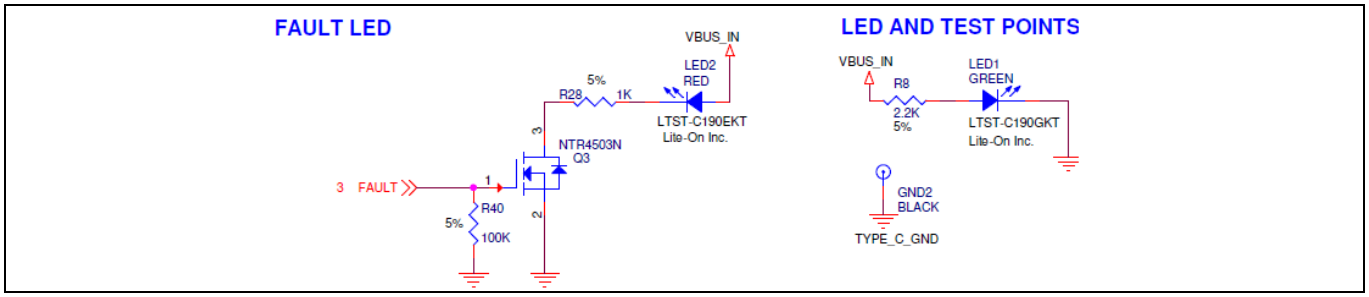


Figure 8 Red fault LED and green VBUS powered LED

The fault LED will be turned on by driving the FAULT pin high under the following conditions:

- A power negotiation contract could not be negotiated and the VBUS_MIN voltage indicated is not 5 V
- A power negotiation contract was negotiated but none of the voltages offered are within VBUS_MIN and VBUS_MAX ranges
- Voltages offered by the power adapter is within range but the current is below ILIM limit
- VBUS voltage supplied by power adapter is outside expected limits
- Load draws more current than the expected current threshold (Sink OCP)

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 Alternate power selection jumper

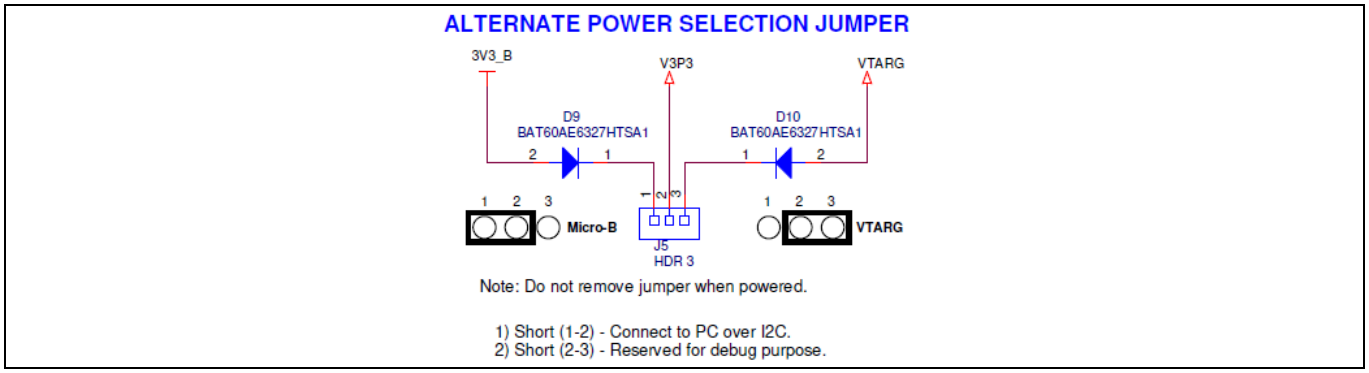


Figure 9 Alternate power selection jumper circuit

The CY4535 EZ-PD™ BCR-LITE EVK has a 3-pin jumper (J5) which is designed with a 3 position 100-mil pitch male header. The jumper header is used for selecting an alternate power supply to power the BCR-LITE device during the debug process. If no jumper is connected to J5, then the kit is powered by the USB power adapter connected to the USB-C receptacle (J3).

In order to use the HPI protocol to configure the CY4535 EZ-PD™ BCR-LITE EVK, the alternate power selection jumper(J5) should be placed at position 1-2. In addition to this, the Type-C connector (J3) should be left unconnected and the USB Micro-B connector (J1) should be connected to the PC using a USB Micro-B cable. Shorting pins 2-3 of jumper J5 is an option for internal use only and not for customer usage.

2.3.6 External Host Processor Interface (HPI) connection header

Host processor interface (HPI) is a proprietary protocol on top of I^2C that exposes control and status registers of the BCR-LITE device. See the EZ-BCR LITE HPI protocol specification for more details.

The HPI pins (HPI_SCL and HPI_SDA) of the CY4535 EZ-PD™ BCR-LITE EVK are exposed on external HPI connection headers (pin 2 of J8, pin 2 of J9) with internal 2 kΩ resistor pulled up to V3P3. An external embedded controller (EC) can connect to these pins directly and communicate to the BCR-LITE device through EZ-BCR-LITE HPI protocol. The BCR-LITE device appears as an I^2C slave with a 7-bit slave address of 0x08.

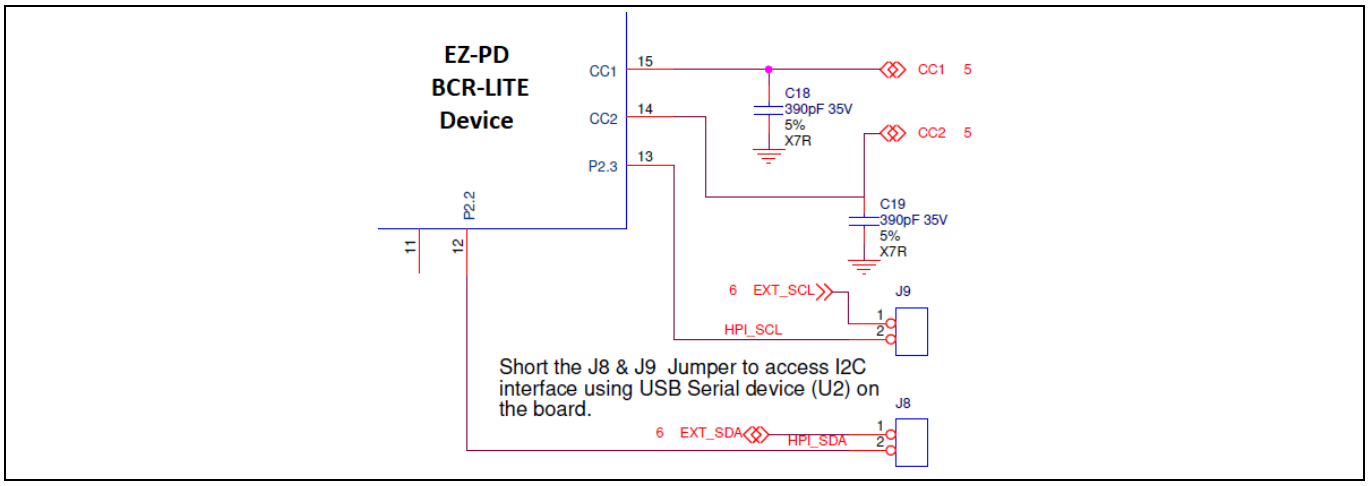


Figure 10 External HPI connection header circuit

2.3.7 Legacy charging mode selection jumper

The CHARGING_MODE pin of the BCR-LITE device on the EVK board is connected to the legacy charging mode selection jumper header (J6). Upon power-up, the BCR-LITE device will check the status of the CHARGING_MODE detection pin to determine which legacy charging protocol should be supported.

- Keep J6 open/unconnected to support all legacy charging protocols. The negotiation sequence will be as follows:
  - **Negotiation sequence:** (BC1.2 → AFC → QC2.0 (Class B) → Apple → Type-C only)
- Short J6 to ensure support for BC1.2 legacy charging protocol only.

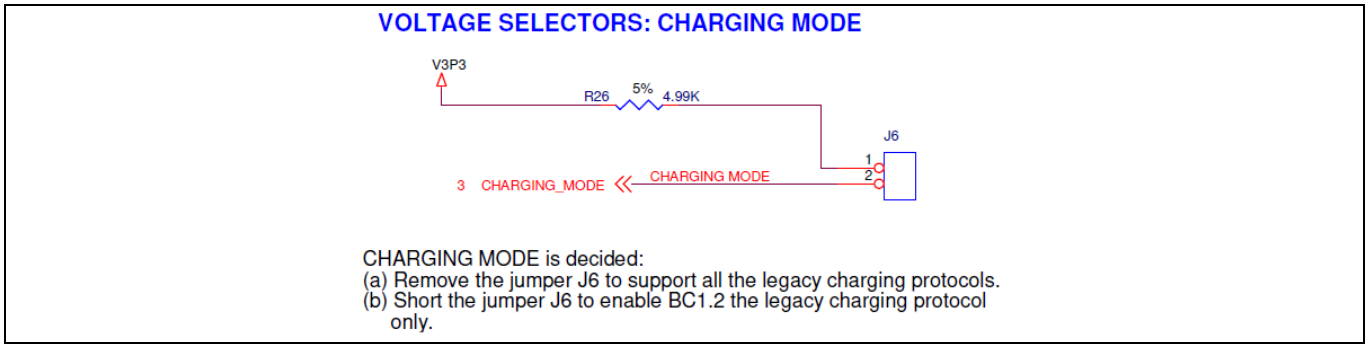


Figure 11 Legacy charging mode selection jumper circuit

3 Kit operation

This chapter describes how to configure the CY4535 EZ-PD™ BCR-LITE 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 demos

- A USB Type-C power adapter or power bank device
  - **Example power adapters: Apple 30W power adapter**, **HP 45W laptop AC power adapter**
  - **Example power banks: Anker PowerCore 13000 C**, **Anker PowerCore III 45W PD Portable Charger**
- A USB Type-A power adapter that is capable of handling legacy charging protocol like QC 2.0 (for eg: **Anker 60W PIQ 3.0 Dual Port 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 CY4535 EZ-PD™ BCR-LITE EVK board
- An electronic device that is powered by a DC barrel connector (for **Demo #1: Test with a multimeter**)
- A DC barrel power adapter for the electronic device (for **Demo #1: Test with a multimeter**)
- A 3 mm flat head screwdriver
- A wire stripper
- A USB Micro-B cable
- A multimeter to measure voltages (for **Demo #1: Test with a multimeter**)

3.2 Running the demos

3.2.1 Demo #1: Test with a multimeter

In this demo, a multimeter is connected to the CY4535 EZ-PD™ BCR-LITE EVK to test the 5V 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 the capabilities of the power adapter (or power bank) and the CY4535 EZ-PD™ BCR-LITE EVK.

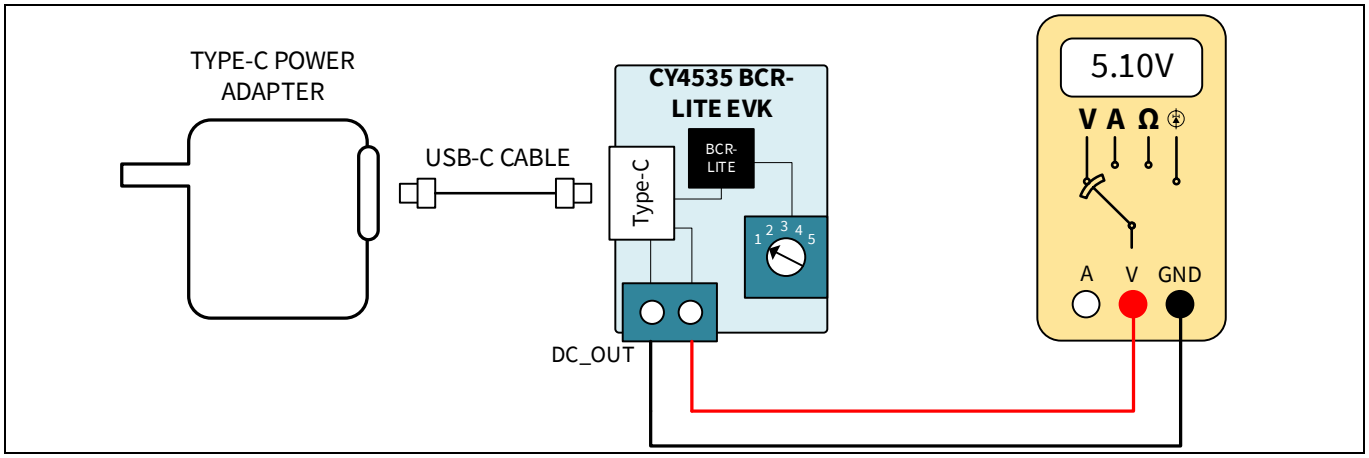


Figure 12 CY4535 EZ-PD™ BCR-LITE EVK, multimeter, and a Type-C power adapter

To set up the demo, perform the following steps:

1. Connect a multimeter to the DC_OUT terminal block J2 of the CY4535 EZ-PD™ BCR-LITE EVK. 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 a USB Type-C power adapter to the Type-C receptacle of the CY4535 EZ-PD™ BCR-LITE EVK.

Some USB Type-C power adapters will support the legacy charging protocol. The BCR-LITE device will select the preferred charging protocol based on a set of rules described in **Legacy charging mode selection jumper** section.

The VBUS_MAX rotary switch governs the highest voltage that the BCR-LITE device will try to request. If that voltage is unavailable, it looks for the next highest voltage, and so on. Note that voltages higher than 5V can be negotiated only when connected to a charger that is capable of handling proprietary charging methods using negotiation over the D+/D- lines.

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

1. Set the VBUS_MAX Rotary Switch (SW1) to position 1. Verify that the multimeter connected to the DC_OUT terminal J2 displays a voltage between 4.5 V and 5.5 V. Detach the power adapter after this observation is verified.

3.2.2 Demo #2: Test with legacy charging mode feature

The CY4535 EZ-PD™ BCR-LITE EVK ships with pre-programmed firmware supported to enable or disable the Legacy charging protocol by changing the jumper J6's setting for the CHARGING_MODE pin. For details, refer to the **Legacy charging mode selection jumper** section.

In this demo, a multimeter is connected to the CY4535 EZ-PD™ BCR-LITE EVK to test the various voltages offered by the USB Type-A power adapter (or power bank) which supports legacy charging protocol (for eg., QC 2.0). The **Anker 60W PIQ 3.0 dual port charger** is used as an example. Users can also connect an electronic load in parallel with the multimeter to test current capabilities of the power adapter (or power bank) and the CY4535 EZ-PD™ BCR-LITE EVK.

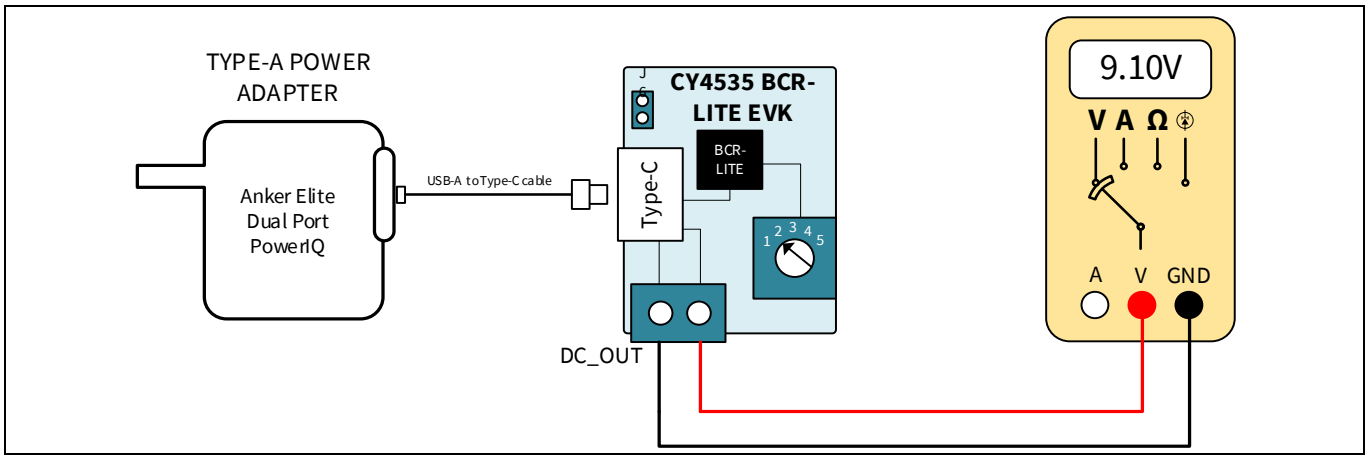


Figure 13 CY4535 EZ-PD™ BCR-LITE EVK, multimeter and Type-A power adapter (Anker 60 W dual port)

Since the Anker dual port powerIQ supports 9 V AFC legacy charging protocol, the BCR-LITE controller will select the highest voltage available from the power adapter that is within the VBUS_MIN to VBUS_MAX range as described in section **VBUS voltage and current selectors**

In other words, the VBUS_MAX rotary switch governs the highest voltage that the BCR-LITE device will try to request with legacy charging support enabled. If that voltage is unavailable, it looks for the next available highest voltage, and so on.

To test legacy charging support for all supported protocols (BC1.2, AFC, QC 2.0, Apple charging), perform the following steps on the demo setup:

1. Connect a multimeter to the DC_OUT terminal block J2. 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. Leave J6 open/unconnected on the CY4535 EZ-PD™ BCR-LITE EVK board to enable the legacy charging support for BCR-LITE device.
3. Connect the Type-A port of the charger to the CY4535 EZ-PD™ BCR-LITE EVK using a Type-A to Type-C cable.
4. Set the VBUS_MAX rotary switch (SW1) to position 1. Verify that the multimeter displays a voltage between 4.5 V and 5.5 V. Disconnect the power adapter after this is verified.
5. Set the VBUS_MAX rotary switch (SW1) to position 2. Reconnect the power adapter and verify that the multimeter displays a voltage between 8.55 V and 9.45 V.
6. Remove the USB-A to Type-C cable from the CY4535 EZ-PD™ BCR-LITE EVK's Type-C receptacle connector.

To test legacy charging support for BC1.2 protocol only, perform the following steps on the demo setup:

1. Short J6 pin 1 and pin 2 to disable the legacy charging support for all protocols other than BC1.2 for the BCR-LITE device.
2. Set the VBUS_MAX rotary switch (SW1) to position 1. Reconnect the power adapter using the USB-A to Type-C cable. Verify that the multimeter displays a voltage between 4.5 V and 5.5 V. Disconnect the power adapter after this is verified.
3. Set the VBUS_MAX rotary switch (SW1) to position 2. Reconnect the power adapter and verify that the multimeter still displays a voltage between 4.5 V and 5.5 V. This is because the BC1.2 protocol can only support a typical voltage of 5 V on VBUS.

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 CY4535 EZ-PD™ BCR-LITE EVK will turn the load switch ON to pass the voltage onto the DC_OUT terminal block (J2).

On the other hand, if the attached power adapter does not have a matching voltage/current combination, the BCR-LITE device will turn the load switch OFF. See **VBUS voltage and current selectors** for details.

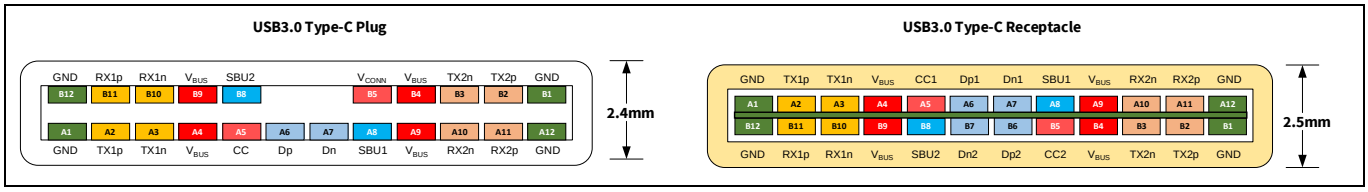
Under mismatch conditions, the red LED2 for FAULT turns ON, the main 5 A load switch is turned off, a 5 V contract is negotiated with the Type-C power adapter and the 5 V available on the VBUS power rail is routed to the SAFE_5V test point by turning on the 1 A load switch. See **Fault LED and VBUS powered LED** for details.

4 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 (VESA). 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.
- **PDO**: Power Data Object used to expose a Source Port's power capabilities or a Sink's power requirements.
- **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.

Revision history

Date	Version	Description
2021-10-26	**	Initial release

Trademarks

All referenced product or service names

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