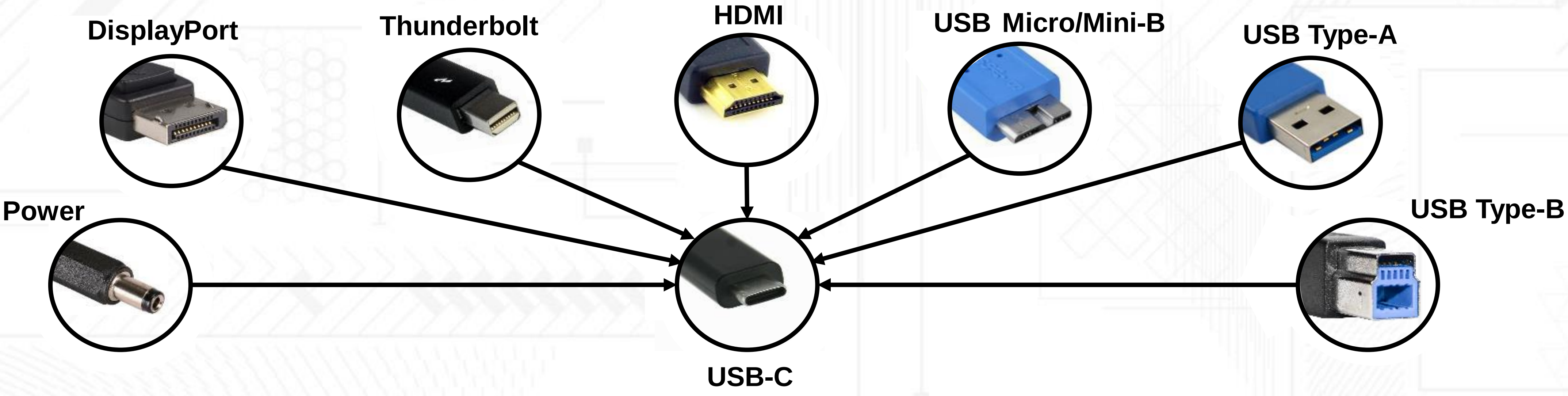
EZ-PD™ Barrel Connector Replacement (BCR) Solution

Power Your Products With Any USB-C Power Adapter

USB-C: The One Connector That Rules Them All

USB-C is the new USB standard that facilitates:

- Slim industrial design with a 2.4-mm plug height
- Reversible plug orientation and cable direction
- Transport of USB data along with DisplayPort, HDMI, or Thunderbolt signals on the same connector
- Easy implementation of low-cost USB Power Delivery up to 100 Watts



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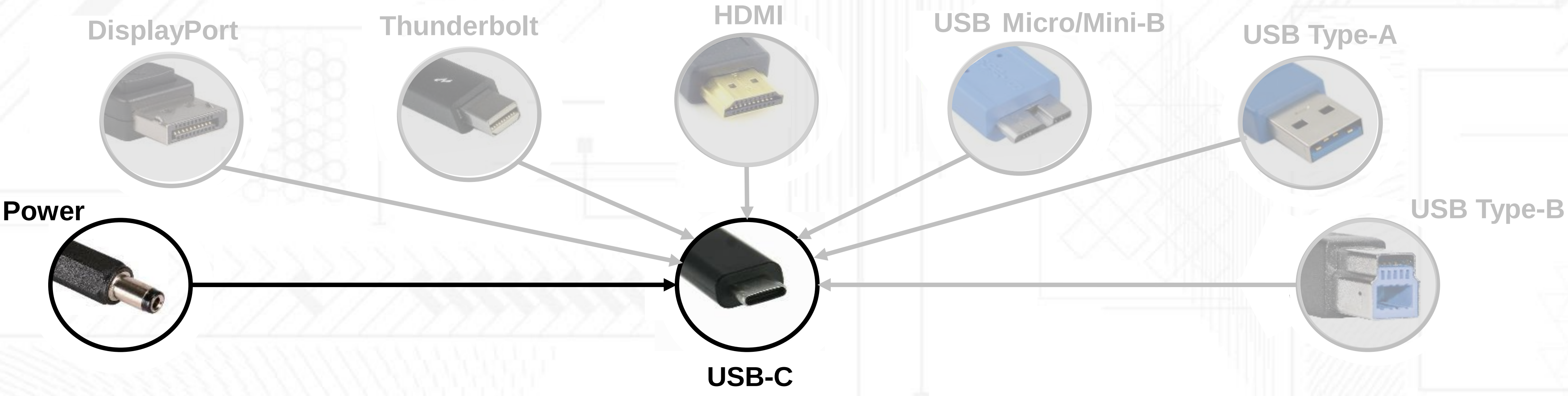


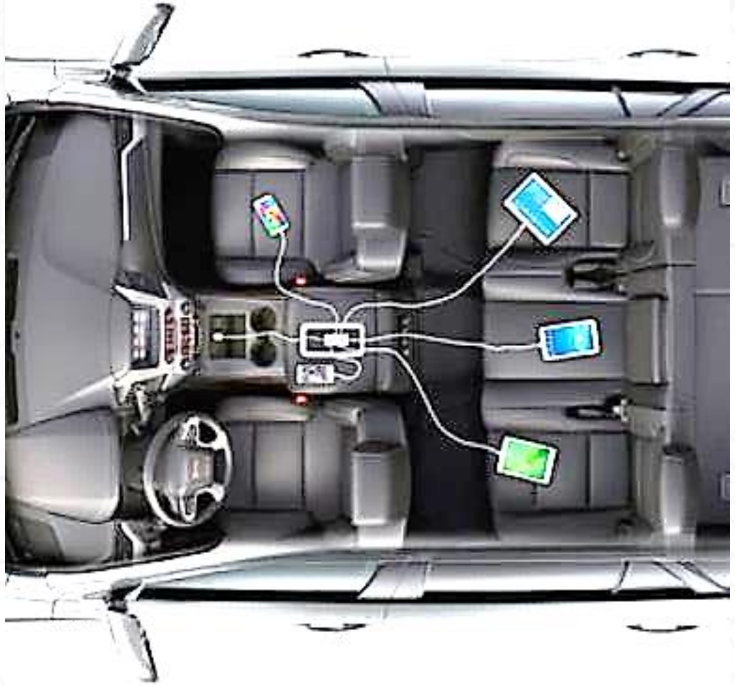
USB-C: Past, Present and Future

2015 to Today

Data, Video, Power Over USB-C

USB-C enables one-cable docking to ultra-sleek, ultra-mobile notebook and smart phones

Next 5 Years



USB-C In Every Car

Abundance of USB-C ports in a car to fast-charge everyone’s smart phone, tablet or notebook PC

Next 10 Years

USB-C Powers Everything

USB-C chargers and power outlets replace all conventional power adapters

Do You Have A Box Like This In Your House?

USB-C: The Universal Power Connector

Conventional Power Adapters

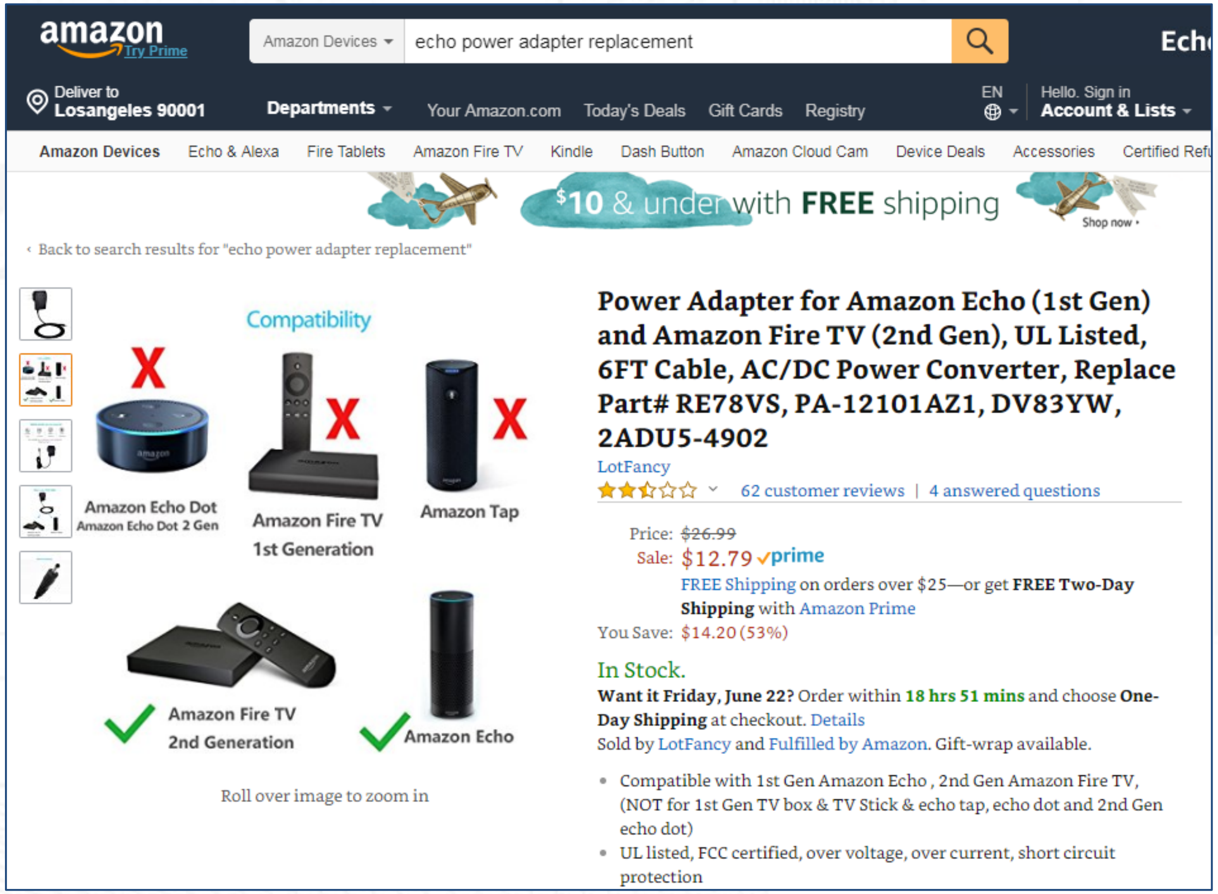
- ❌ Incompatible Connectors
- ❌ Fixed Voltage & Current
- ❌ Not made for sharing or re-use

USB-C Power Adapters

- ✅ Universal Connector
- ✅ Negotiable Voltage & Current up to 100W
- ✅ Standardized for sharing and re-use

USB-C Standardizes Power Adapters to a Common Connector

Eliminate Confusion



Carry Only One Charger With You

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e-Waste On The Rise

More Power Adapters Than Ever

- 1,000,000 tons of power adapters are shipped annually[1]
- The shipment is rising as the average life cycle of consumer electronics is shrinking

Efforts Curbing e-Waste

- Digital Europe & USB-IF memorandum on USB-C charger for mobile phones

USB-C Reduces e-Waste

- All electronic devices consuming less than 100W should be powered by a common USB-C power adapter

[1] The Global e-Waste Monitor 2017

Design Problems Engineers Face

- **Converting a barrel connector to USB-C requires in-depth USB-C knowledge**
  - Requires expert knowledge of the USB PD specification and hands-on experience in USB PD system design
  - Must meet USB-IF certification requirements to ensure spec compliance and interoperability
- **Designing a product that can be powered by any USB-C power adapter is difficult**
  - Different products require different voltage levels and current ratings in power supplies
  - Requires an MCU and firmware development to implement a full USB PD stack
- **USB-C solutions are costly in comparison to legacy barrel connectors**
  - The cost of a USB-C controller plus connector is greater than a legacy barrel connector
  - Additional power-related protection circuitry and components further increase overall BOM cost

Solution: Cypress' Barrel Connector Replacement (BCR) Controller

- **USB-IF certified with market-proven USB PD stack, ensuring spec compliance and interoperability**
- **Supports all USB PD profiles commonly used in USB-C power adapters and requires no firmware development**
- **A highly-integrated solution that minimizes incremental BOM costs**

EZ-PD BCR

USB Type-C Power-Sink Port Controller

Applications

Portable electronics – cameras, camcorders, smart speakers, toys, gaming, shavers, powered tools, wireless charging pads, and any battery-powered device

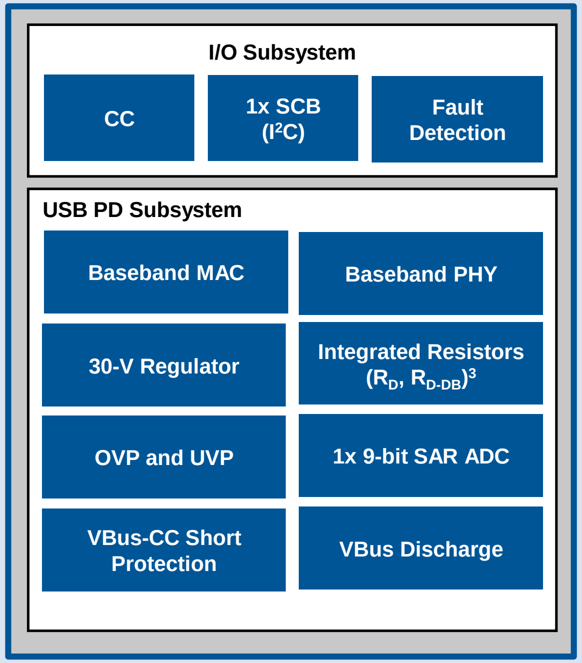
Industrial – LED lighting, scanner, printer, drones, and IoT

Any electronics device consuming less than 100W

Features

- **Integrated Type-C and Power Delivery (PD) Transceiver**
  - Integrated high-voltage 30-V–tolerant LDO to power the BCR controller
  - One serial communication blocks (SCB) for slave I^2C
- **Integrated Analog**
  - V_{BUS} overvoltage (OVP) and undervoltage (UVP) protection
  - Fault detection for PDO mismatch
  - Slew rate-controlled PMOS FET gate driver
  - Minimum 25-V–tolerant CC pins and FET control pins
- **Low-Power Operation**
  - High-voltage (5–30 V, 30 V maximum) V_{BUS} voltage inputs
  - Sleep: ~3.5 mA; Deep Sleep: 50 µA with wake-on-I^2C or CC
- **System-Level ESD on CC, and V_{BUS}**
  - ±8-kV contact, ±15-kV Air Gap IEC61000-4-2 Level 4C
- **Package**
  - 24-QFN (16 mm^2), supporting extended Industrial temp (-40 °C to 105 °C)

EZ-PD BCR: USB Type-C Power-Sink Port Controller



Collateral

Datasheet: CY3177 Datasheet
Evaluation Kit: CY4533 Kit
Product Brochure: EZ-PD Barrel Connector Replacement Product Overview

Availability

Production: Now

[1] Analog feedback voltage control circuit to control V_{BUS}
[2] Circuit to measure the current flowing on the V_{BUS}
[3] Termination resistors: R_D as a UFP, R_{D-DB} as a UFP supporting dead battery

EZ-PD BCR Product Selector Guide

Part Number	Application	Termination Resistor	Role	VBUS-CC Short Protection	OVC	30V-Tolerant LDO	Package
CYPD3177-24LQXQ	BCR	R_d[1], $R_{d\text{-}db}$[2]	UFP	Yes	Yes	Yes	24-QFN

Part Numbering Decoder

CY PD X X XX – XX XX X X X

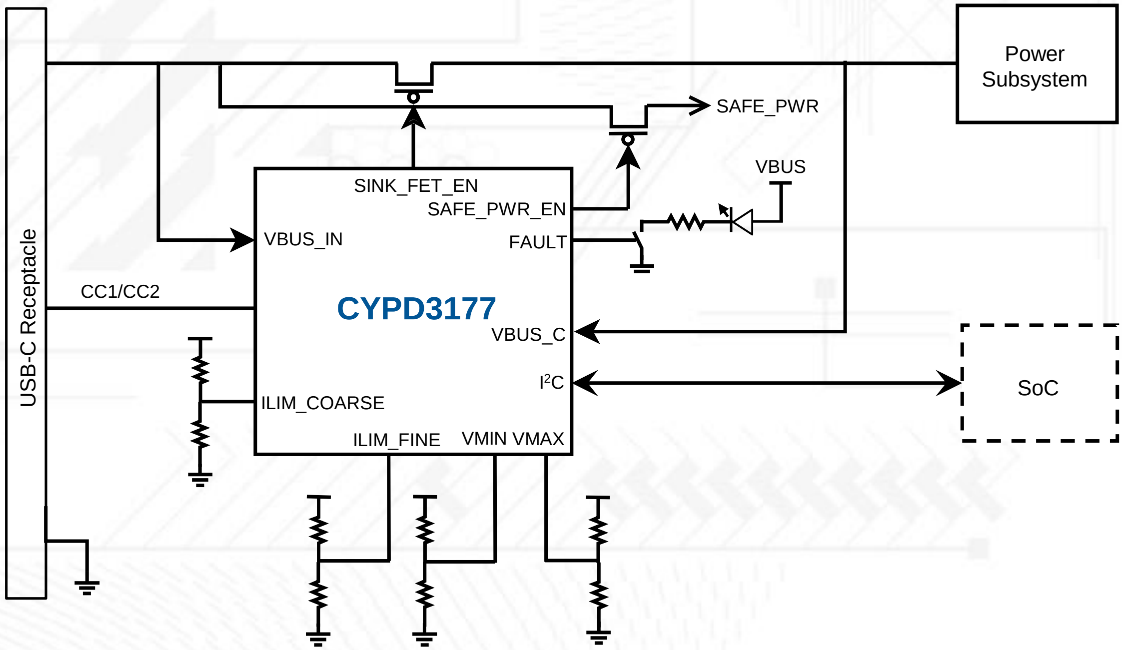
- T = Tape and Reel
- Temperature Range: Q = Extended Industrial (-40 °C to 105 °C)
- Lead: X = Lead-Free
- Package Type: LQ = QFN
- Number of Pins in the Package
- Application and Feature Combination Designation
- Number of Type-C Ports: 1 = 1 Port
- Product Type: 2 = Second Generation, 3 = Third Generation
- Marketing Code: PD = Power Delivery Product Family
- Company ID: CY = Cypress

[1] Termination resistor denoting an upstream facing port (UFP)
[2] Termination resistor denoting a UFP supporting Dead Battery

EZ-PD BCR Solution Converts Your Product to USB-C

CYPD3177 Barrel Connector Replacement (BCR) Controller is a compelling solution that

- Requires only 8 external passive components to implement a USB-C power sink
- Supports 5 USB PD PDOs (5V/9V/12V/15V/20V, up to 5A) commonly found in USB-C power adapters
- Is easily configurable using external resistors and requires no firmware development
- Integrates all protection circuitry (VBus-to-CC short, undervoltage/overvoltage, ESD) on chip



Use VMIN and VMAX to set the VBus voltage range from a USB-C power adapter

VBus	5V	9V	12V	15V	20V
Pull-up	None	5.1KΩ	5.1KΩ	5.1KΩ	0KΩ
Pull-down	0KΩ	1KΩ	2.4KΩ	5.1KΩ	None

Use ILIM_COARSE and ILIM_FINE to set maximum current from a USB-C power adapter
Maximum current = ILIM_COARSE + ILIM_FINE

ILIM_COARSE	0A	1A	2A	3A	4A	5A
Pull-up	None	5.1KΩ	5.1KΩ	5.1KΩ	5.1KΩ	0KΩ
Pull-down	0KΩ	1KΩ	2.4KΩ	5.1KΩ	10KΩ	None

ILIM_FINE	0mA	250mA	500mA	750mA	900mA
Pull-up	None	5.1KΩ	5.1KΩ	5.1KΩ	0KΩ
Pull-down	0KΩ	1KΩ	2.4KΩ	5.1KΩ	None

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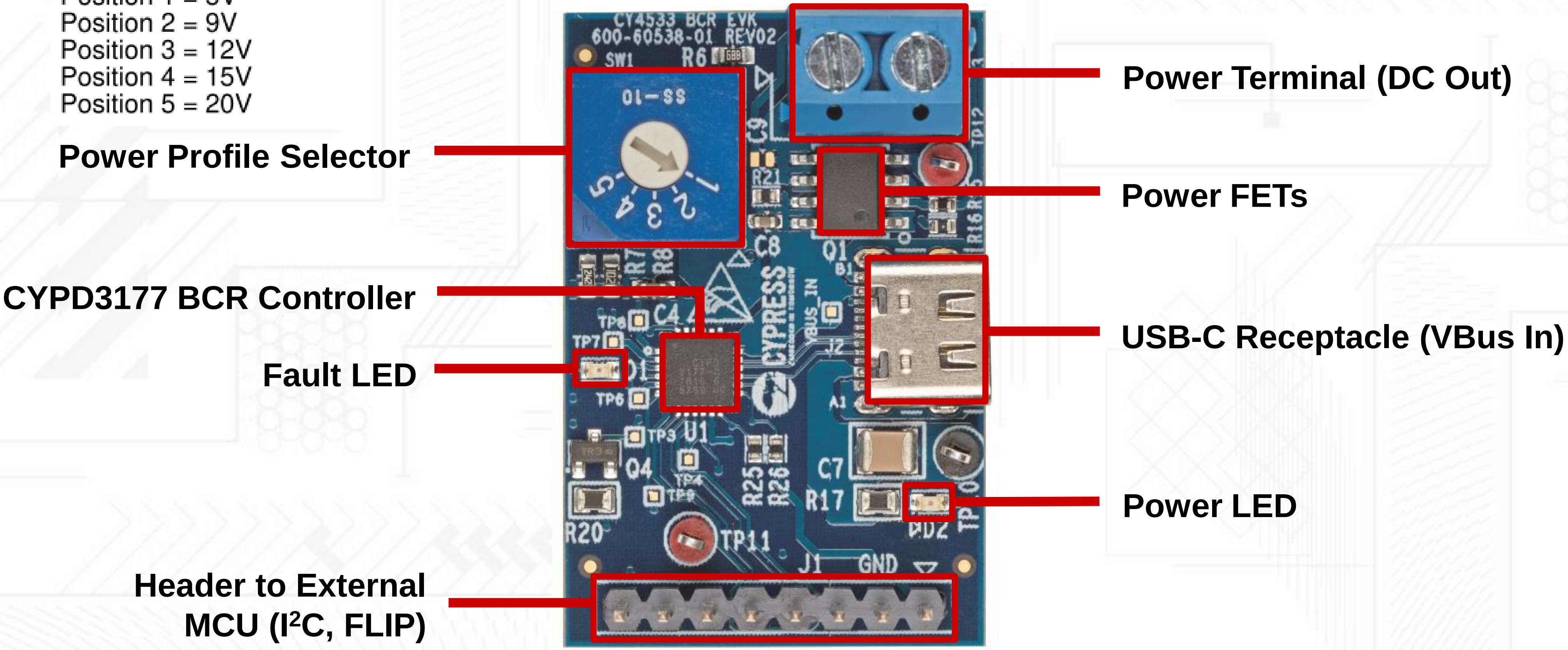
Use EZ-PD BCR Kit to Quickly Prototype a USB-C Power Sink

VBUS_MAX
Rotary Switch Options
Position 1 = 5V
Position 2 = 9V
Position 3 = 12V
Position 4 = 15V
Position 5 = 20V

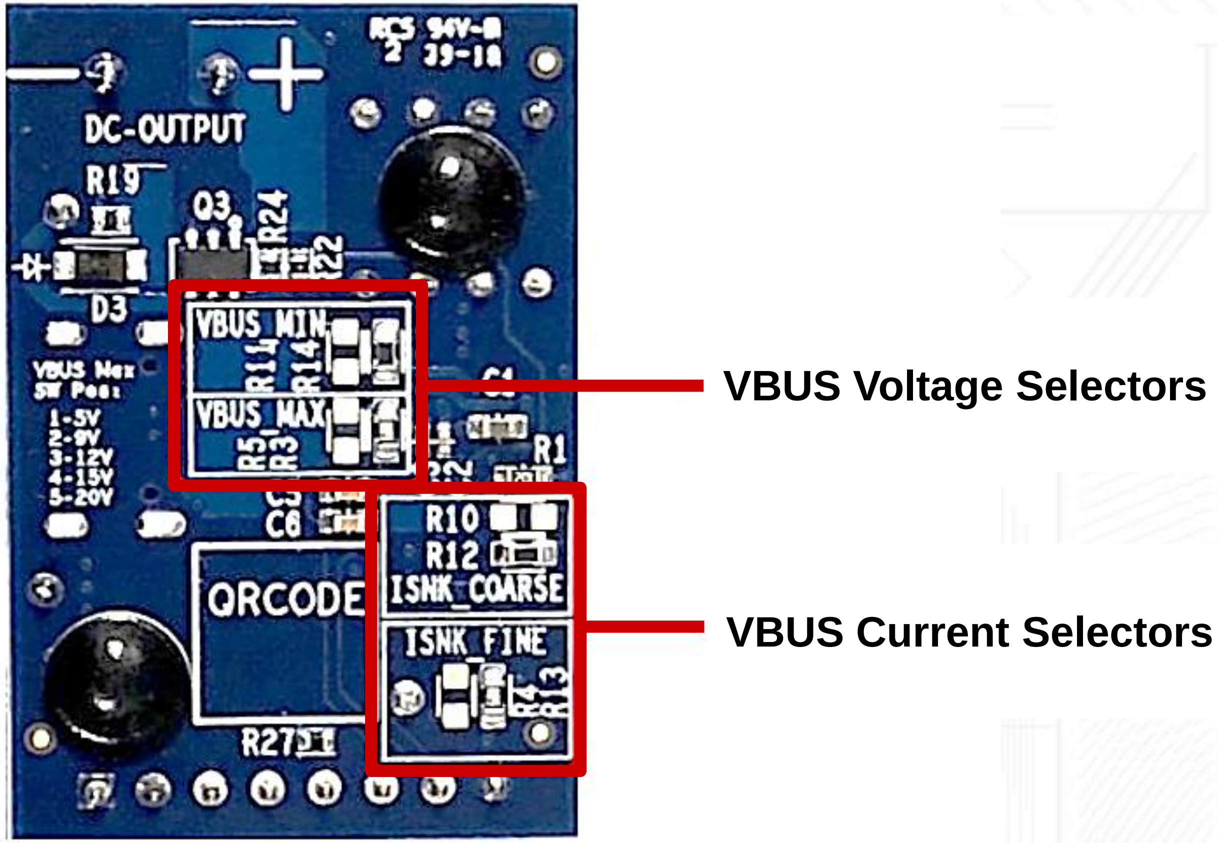
CY4533
EZ-PD BCR Kit (Top)



3.7 cm x 2.5 cm

Use EZ-PD BCR Kit to Quickly Prototype a USB-C Power Sink

CY4533
EZ-PD BCR Kit (Bottom)



3.7 cm x 2.5 cm

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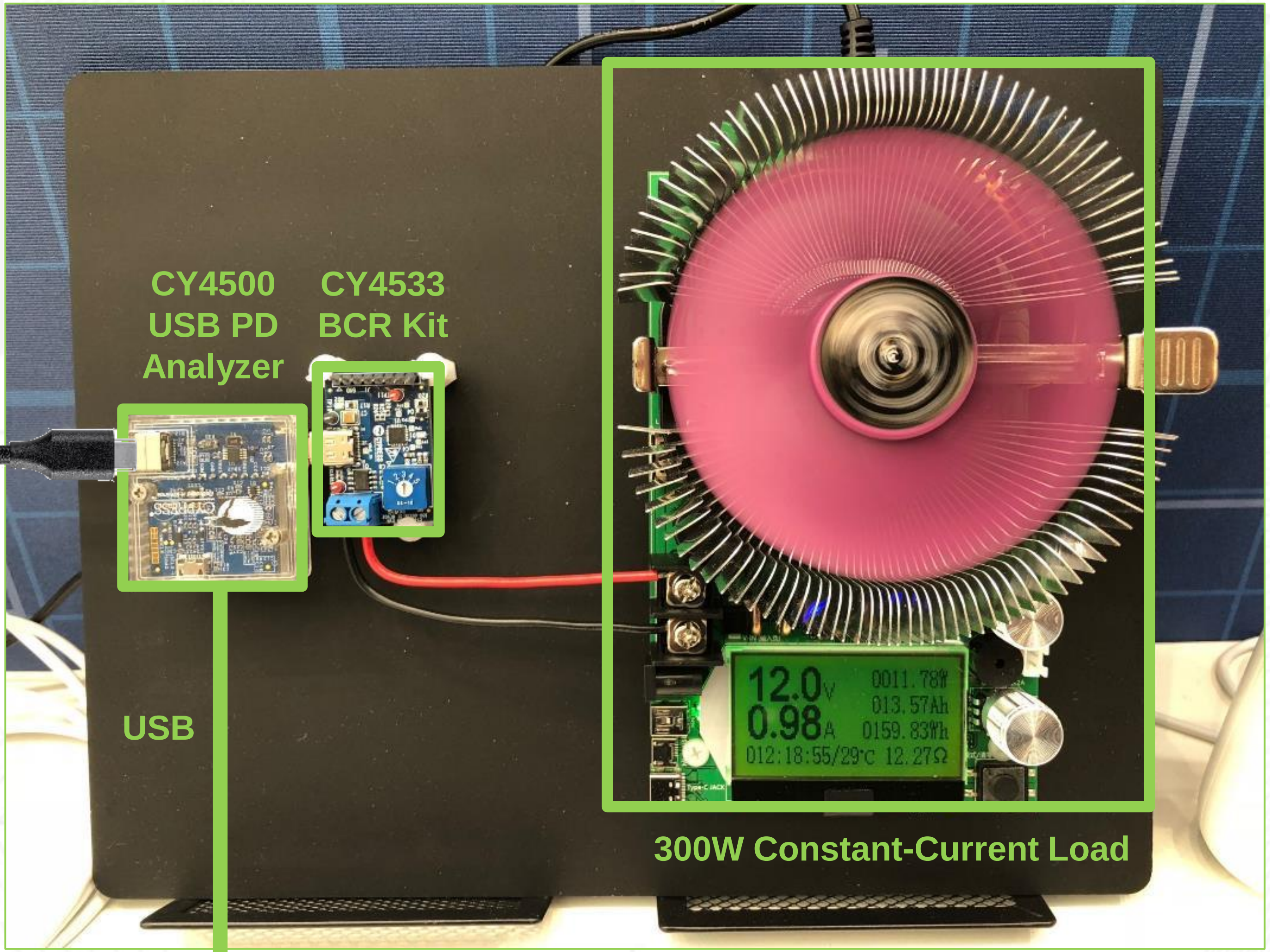
DEMO

Use EZ-PD BCR Kit to Implement a USB-C Power Sink

1. Using on-board rotary dial

USB PD Power Adapter



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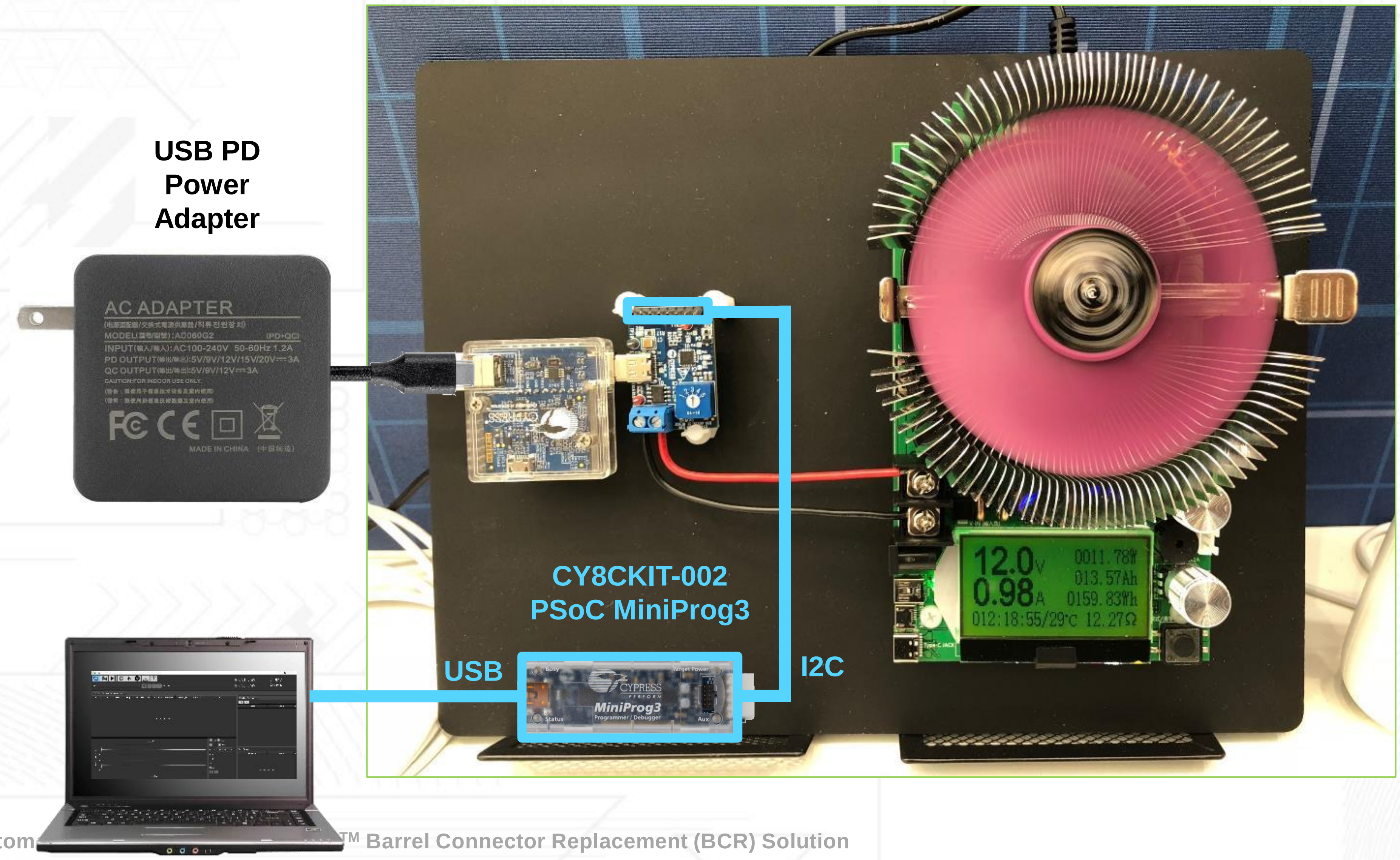
Use EZ-PD BCR Kit to Implement a USB-C Power Sink

2. Using external MCU via I²C

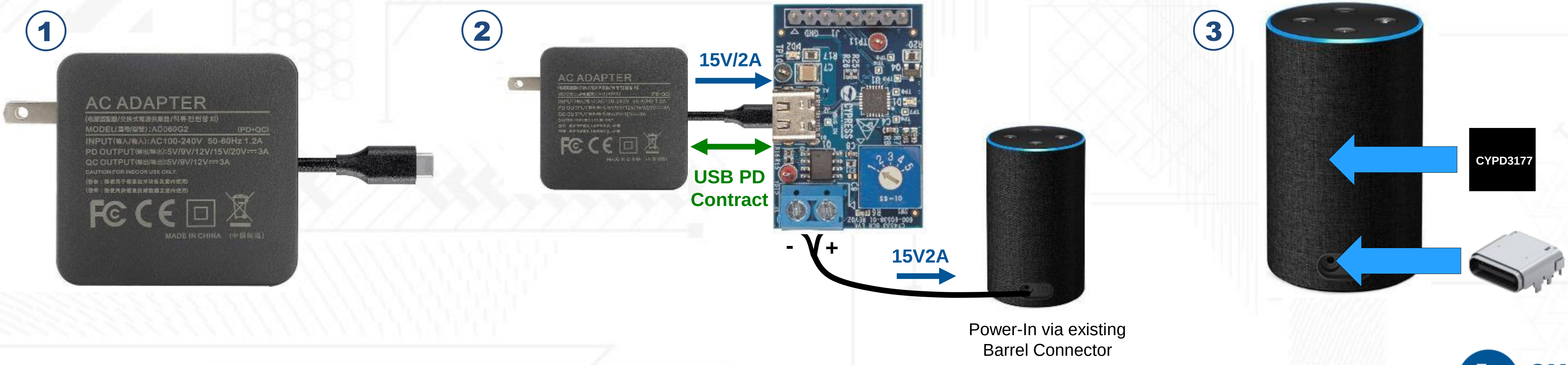


3 Easy Steps to Jumpstart Your USB-C Conversion

1. Select a commercially available USB-C power adapter that supports the desired USB PD power profile

2. Set up the desired USB PD power profile with EZ-PD BCR Kit and quickly prototype by converting the USB-C power input to a barrel connector output to the product. No firmware development required

3. Embed **CYPD3177** BCR Controller into your product and replace the barrel receptacle with a USB-C receptacle. Your product can now be powered by any USB-C power adapter supporting the required power profile. The USB-C power adapter can be shipped in-box with the product, sold separately or be left to the users to use their own



DEMO

The World Has Started Moving to a USB-C Power Source

250+ Personal Computers

60+ Smartphones

700+ 3rd-party Chargers, Power Banks

Nintendo

GoPro

Cisco

Google

Anker

LG

… And
Many More
to Come

Many Products Are Already Powered By USB-C

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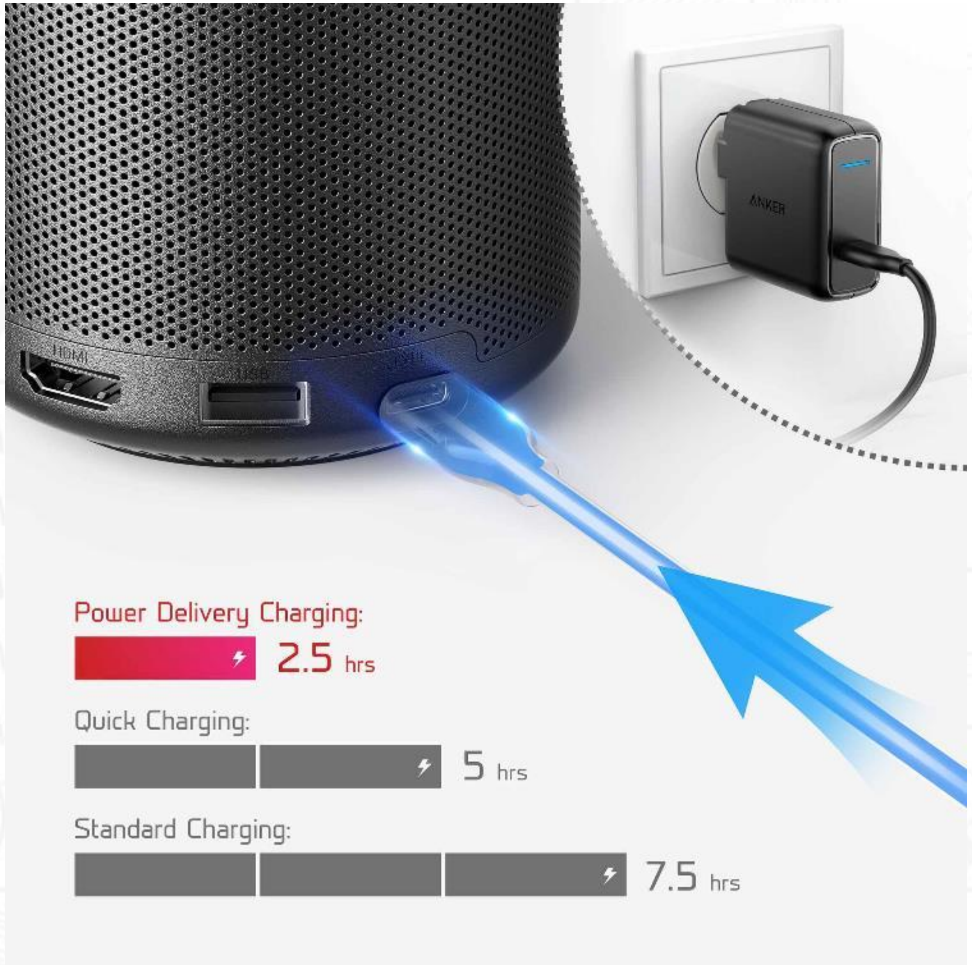
Top OEMs Are Actively Promoting USB-C Benefits



Convert Your Barrel-Powered Design To USB-C Now

Get Started By Ordering Your EZ-PD Kits

CY4533 – EZ-PD BCR Kit

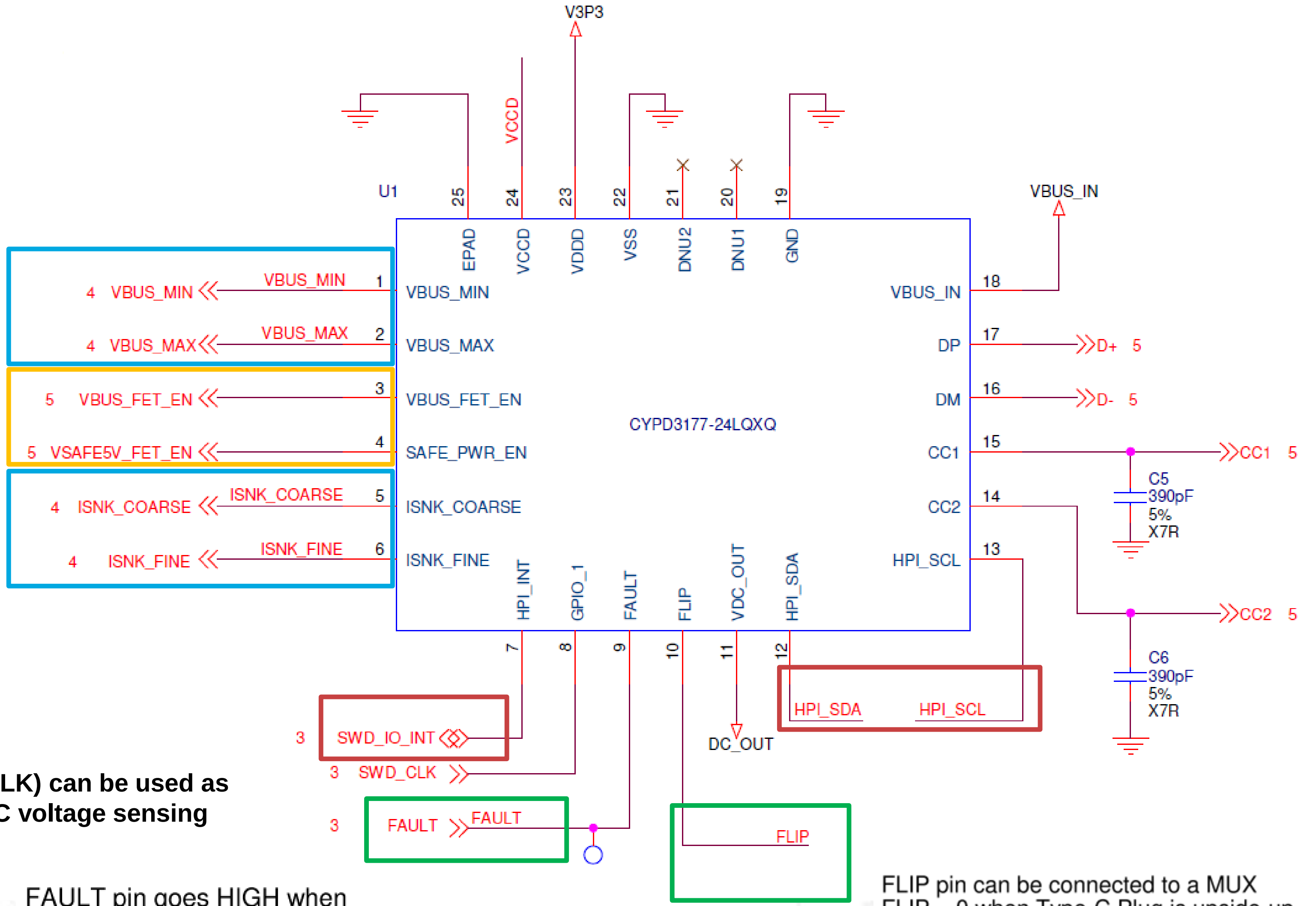
Cypress.com/cy4533

CY4500 – EZ-PD Protocol Analyzer

Cypress.com/cy4500

Workshop

Schematic Overview (1/3)

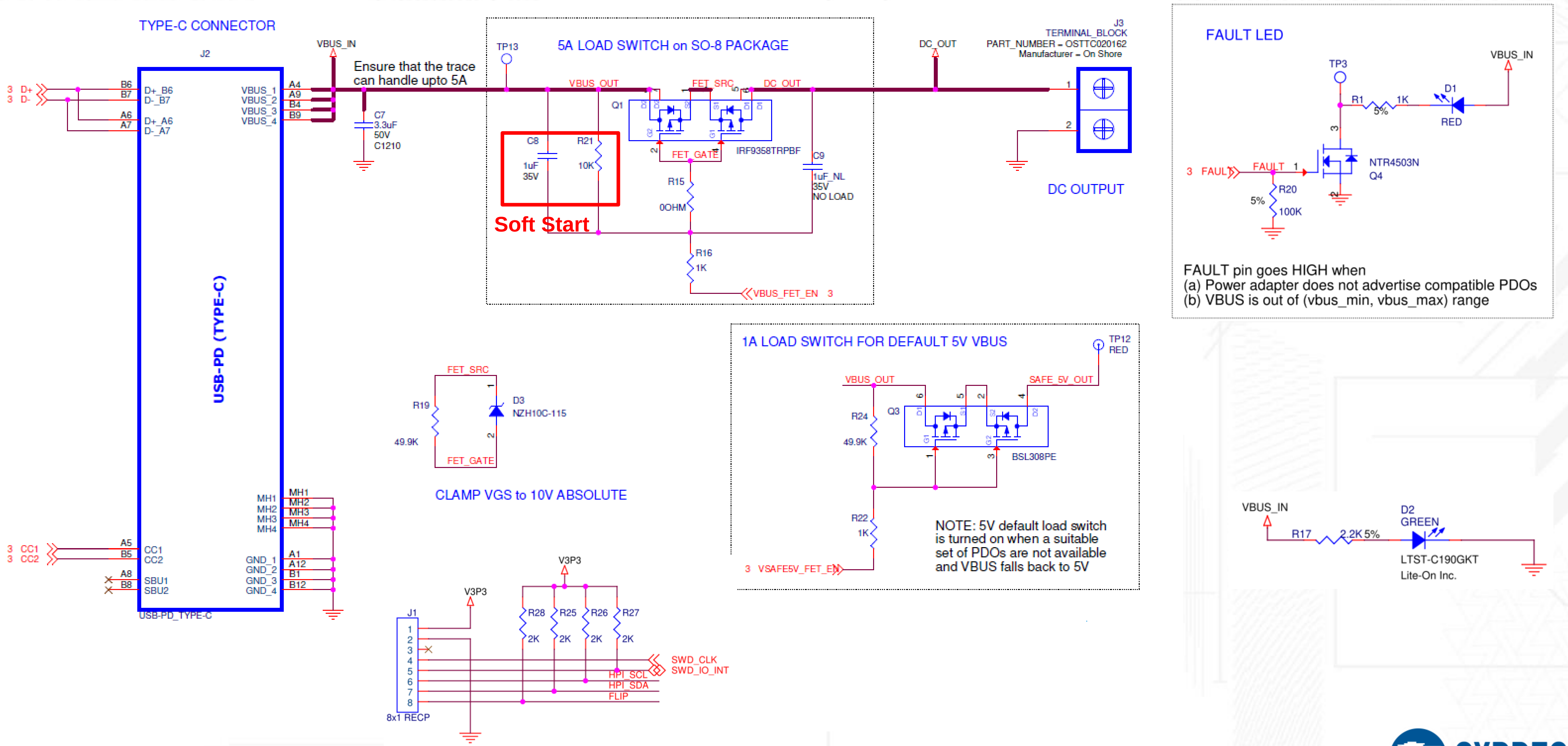


GPIO_1 (SWD_CLK) can be used as input/output/ADC voltage sensing

- FAULT pin goes HIGH when
  (a) Power adapter does not advertise compatible PDOs
  (b) VBUS is out of (vbus_min, vbus_max) range

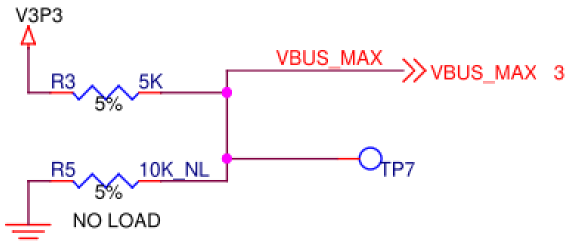
FLIP pin can be connected to a MUX
FLIP = 0 when Type-C Plug is upside-up
FLIP = 1 when Type-C Plug is upside-down
(Output is open drain: 0 or High-Z)

Schematic Overview (2/3)

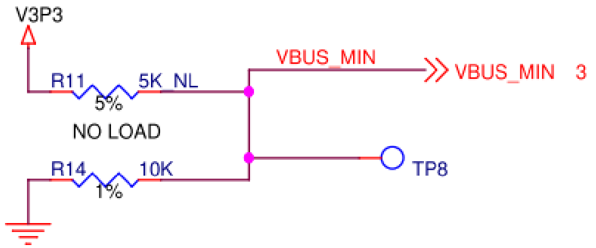


Schematic Overview (3/3)

VBUS_MIN ≦ Requested Voltage ≦ VBUS_MAX

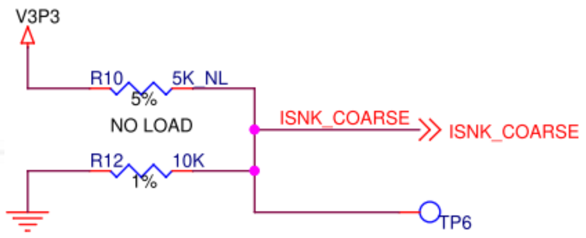


VBUS_MAX is decided by the rotary switch

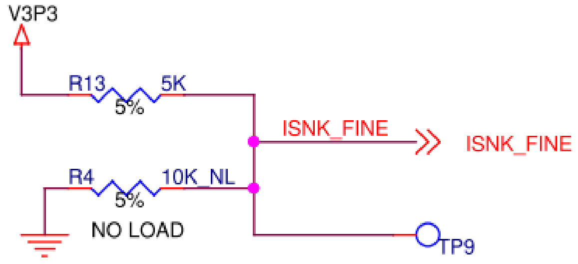


VBUS_MIN is set to 5V

Requested (RDO) current = ISNK_COARSE + ISNK_FINE



ISNK_COARSE is set to 0A



ISNK_FINE is set to +900mA

VBUS_MIN and VBUS_MAX Resistor Options Table

VBUS_MAX, VBUS_MIN	5 V	9 V	12 V	15 V	19 V	20 V
PULLUP (R3, R11)	None	5 kΩ	5 kΩ	5.kΩ	5 kΩ	0 kΩ
PULLDOWN (R5, R14)	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	10 kΩ	None

ISNK_COARSE and ISNK_FINE Resistor Options Table

ILIM_COARSE	0 A	1 A	2 A	3 A	4 A	5 A
ILIM_FINE	0 mA	250 mA	500 mA	750 mA	900 mA	
PULLUP (R10, R13)	None	5 kΩ	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN (R12, 4)	0 kΩ	1 kΩ	2.4 kΩ	5. kΩ	10 kΩ	None

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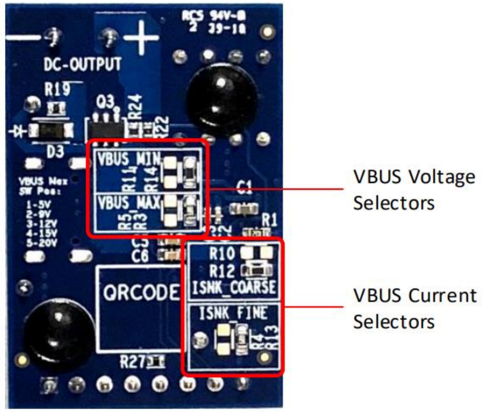
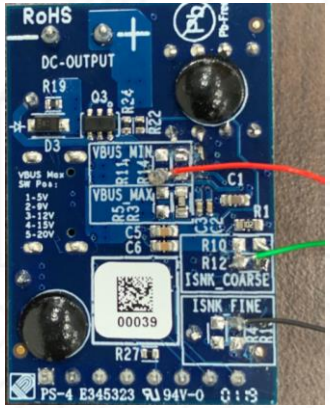
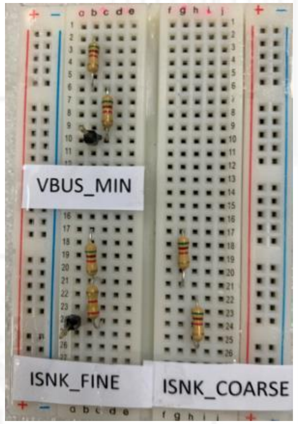
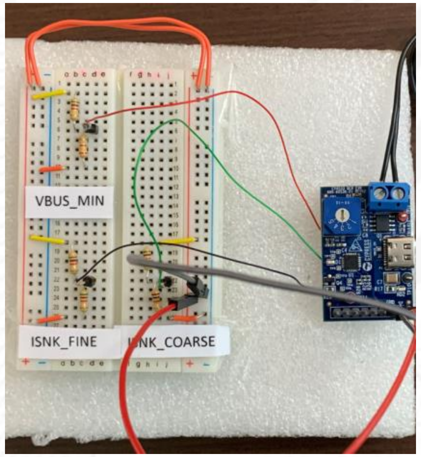
Preliminary System Setup

1. Remove R14, R12, and R13 resistors on CY4533
2. Solder three wires on VBUS_MIN, ISNK_COARSE, and ISNK_FINE pad
3. Prepare the resistors and bread board for resistor divider for VBUS_MIN, ISNK_COARSE, and ISNK_FINE
4. Prepare a Type-C power adapter supporting your device's power profile
5. Prepare Dupont cables for CY4533 and bread board connection









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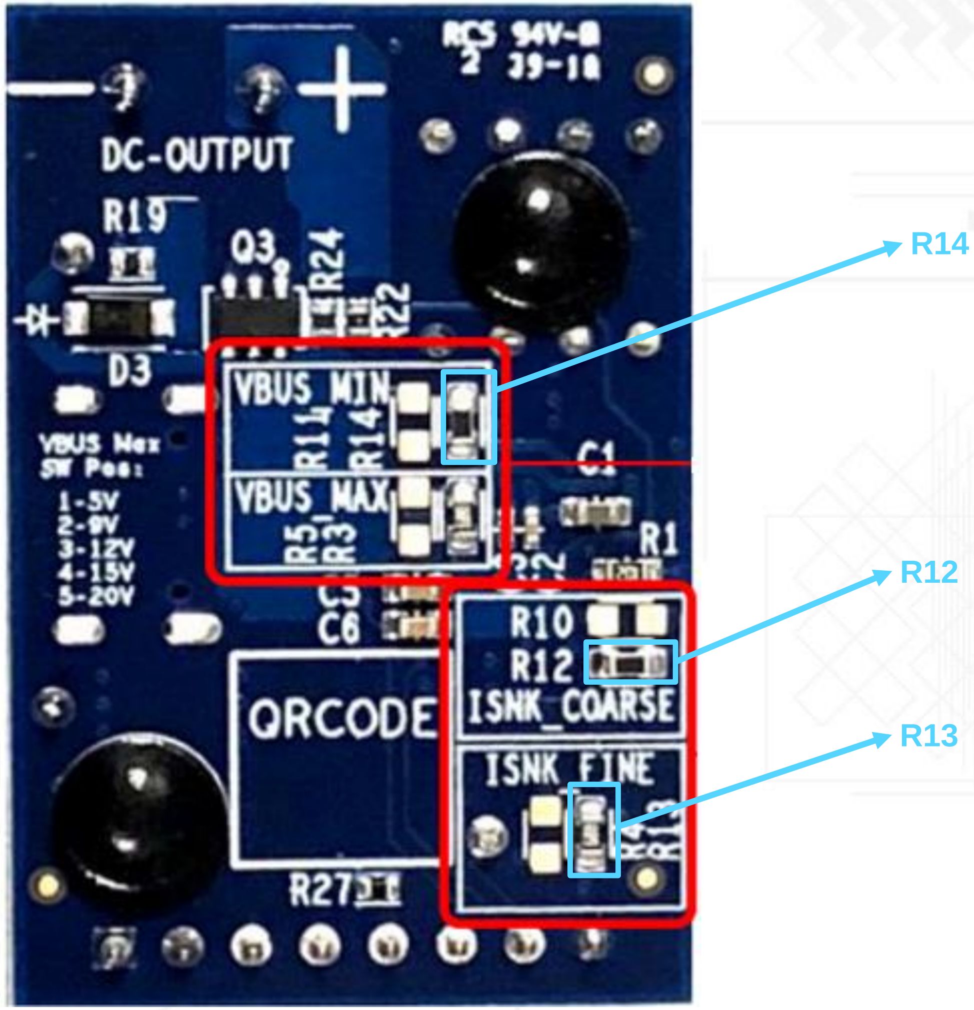
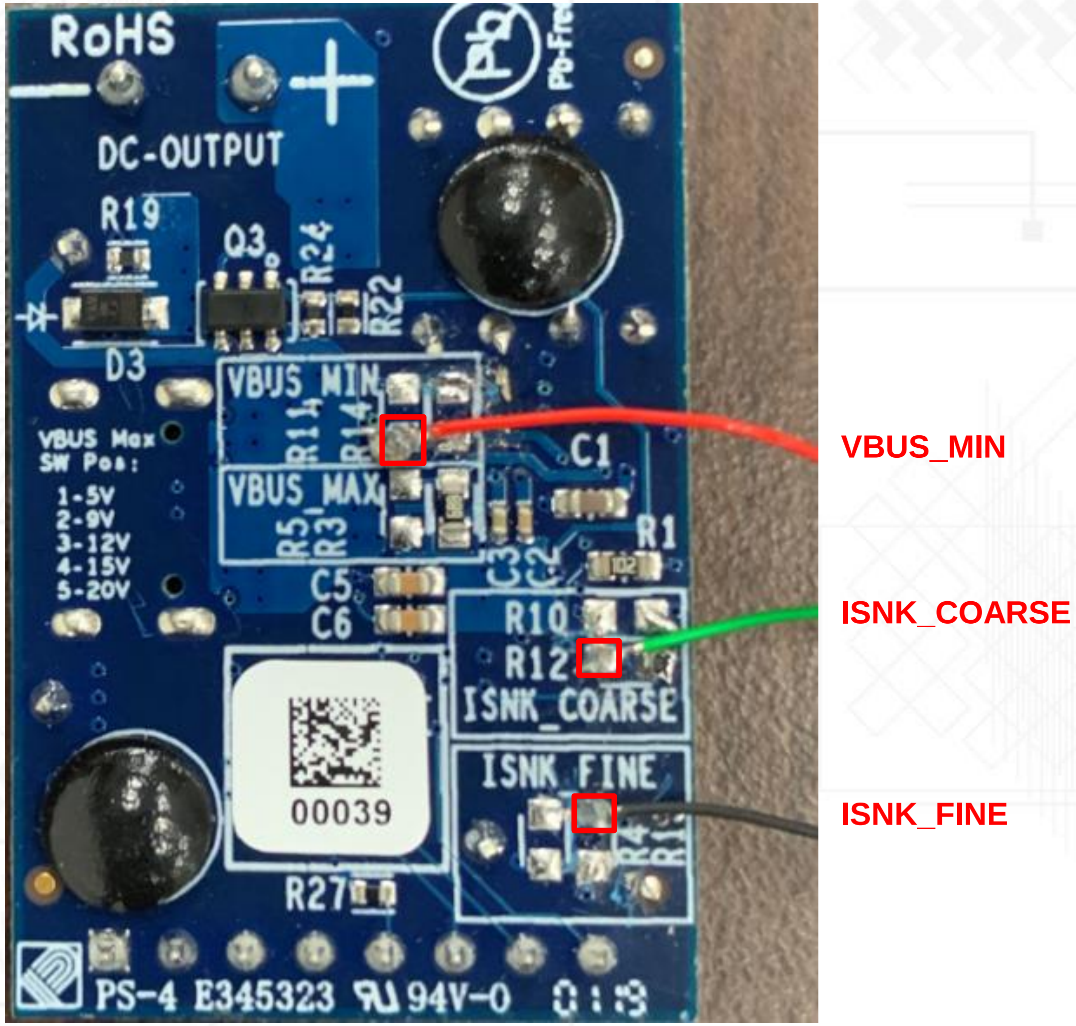
Preliminary System Setup (1/5)

Step 1: Remove R14, R12, and R13 resistors on CY4533



Preliminary System Setup (2/5)

Step 2: Solder three wires on VBUS_MIN, ISNK_COARSE, and ISNK_FINE pad



Preliminary System Setup (3/5)

Step 3: Prepare resistors and bread board for resistor divider for VBUS_MIN, ISNK_COARSE, and ISNK_FINE

VBUS_MIN

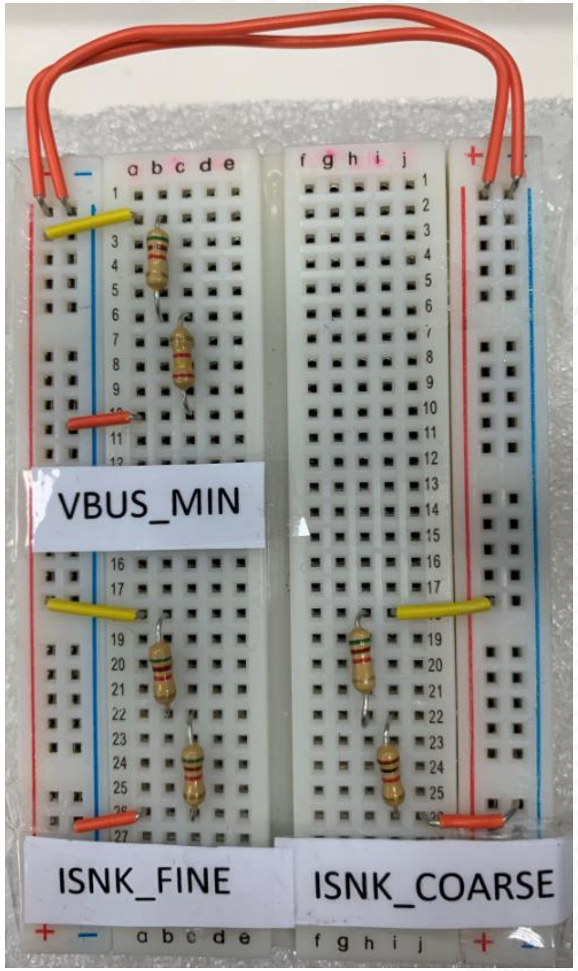
VBUS_MIN	5 V	9 V	12 V	15 V	19 V	20 V
PULLUP	None	5 kΩ	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	10 kΩ	None

ISNK_COARSE

ILIM_COARSE	0A	1 A	2 A	3 A	4 A	5 A
PULLUP	None	5 kΩ	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	10 kΩ	None

ISNK_FINE

ILIM_FINE	0 mA	250 mA	500 mA	750 mA	900 mA
PULLUP	None	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	None



Preliminary System Setup (4/5)

Step 4: Prepare a Type-C power adapter supporting your device's power profile

Profile 1: 5 V/3 A

Profile 2: 9 V/3 A

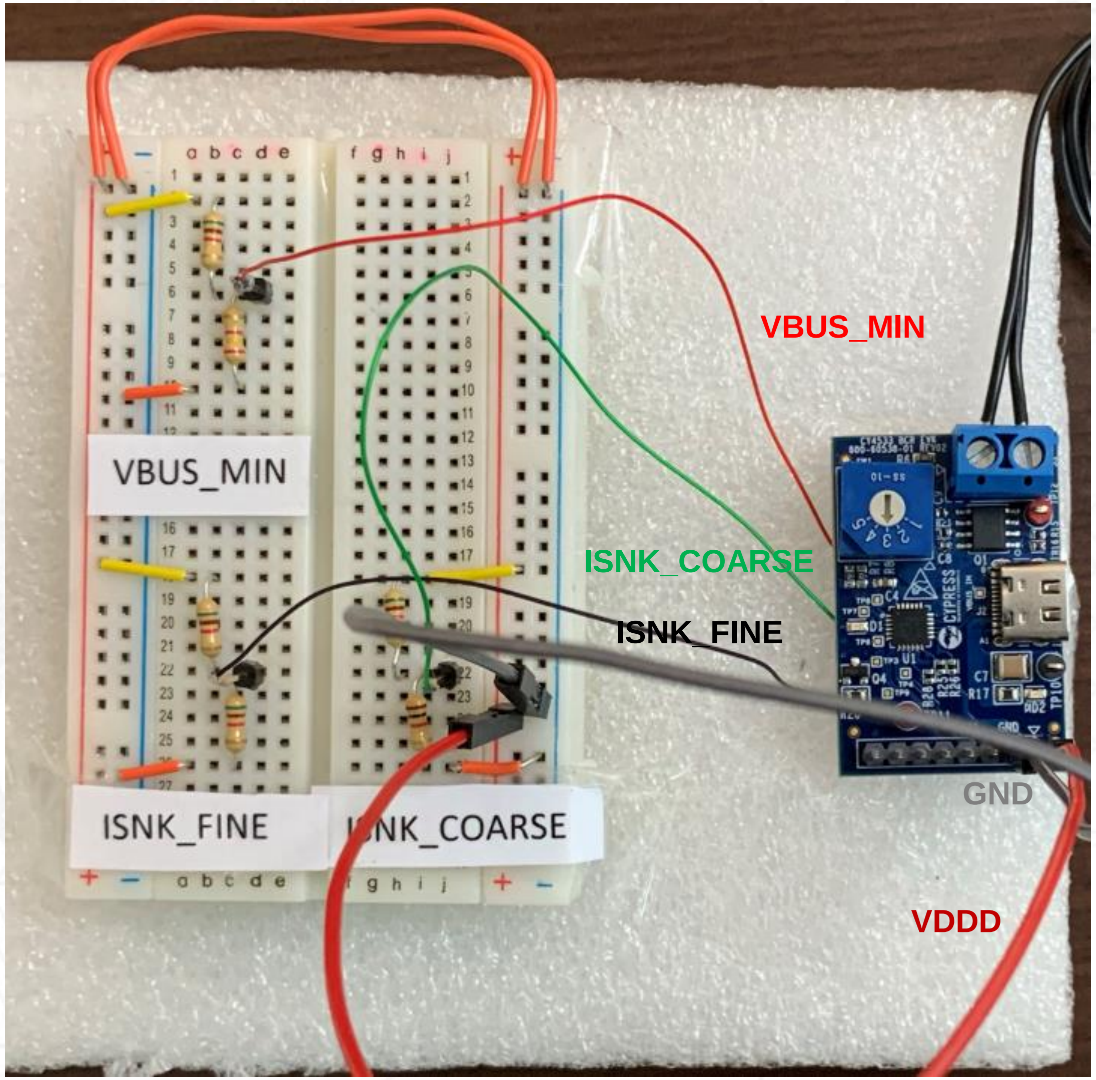
Profile 3: 12 V/3 A

Profile 4: 15 V/3 A

Profile 5: 20 V/2.25 A

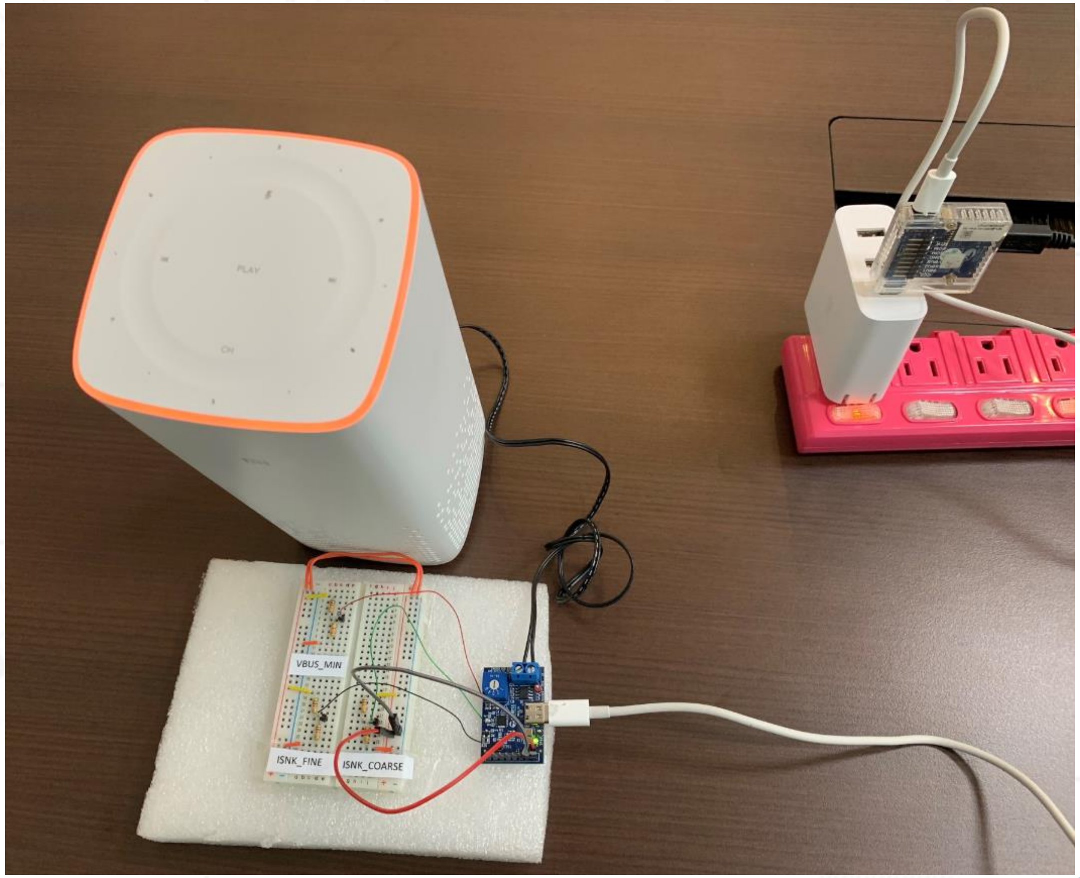
Preliminary System Setup (5/5)

Step 5: Prepare Dupont cables for CY4533 and bread board connection



Lab 1: Power up Xiaomi Smart Speaker through BCR

- **Objectives**
  - Learn how to design the right voltage and current spec to match the device spec
  - Capture and analyze traffic over a Type-C interface using a CY4500 EZ-PD Protocol Analyzer kit
- **Hardware tools**
  - EZ-PD BCR Evaluation Kit (CY4533)
  - EZ-PD Protocol Analyzer (CY4500)
  - Type-C Power Adapter
  - Multimeter
  - Barrel Connectors Cable
  - Dupont Cables, Resistors, and Bread Board
  - Smart Speaker
- **Software tools**
  - EZ-PD Analyzer Utility



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Power up Xiaomi Smart Speaker through BCR (1/8)

Step 1:

Confirm the device's input voltage and current specification

Xiaomi Mi AI Speaker
Frequency Range: 60Hz-15000Hz (-60dB)
Bluetooth version: Bluetooth 4.1
Speaker Sensitivity: 82dB/m/W
Microphone: 6pcs
Horn Impedance: 4Ω
CPU: 64-bit Cortex A53 quad-core 1.2GHz
Working Distance: 10m
Memory: 256MB
Flash: 256M BDual Wi-Fi
Bluetooth: 4.1
Support: A2DP music player
Rated Output Power: >5W
Power Supply Specification: DC 12V 1.75A

Power up Xiaomi Smart Speaker through BCR (2/8)

Step 2:

Select a barrel connector to match your device

Power up Xiaomi Smart Speaker through BCR (3/8)

Step 3:

Check the look-up table to find the right pull-up and pull-down resistors to meet up the device's voltage and current spec

VBUS_MIN and VBUS_MAX Resistor Options Table

VBUS_MAX, VBUS_MIN	5 V	9 V	12 V	15 V	19 V	20 V
PULLUP (R3, R11)	None	5 kΩ	5 kΩ	5.kΩ	5 kΩ	0 kΩ
PULLDOWN (R5, R14)	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	10 kΩ	None

ISNK_COARSE and ISNK_FINE Resistor Options Table

ILIM_COARSE	0 A	1A	2 A	3 A	4 A	5 A
ILIM_FINE	0 mA	250 mA	500 mA	750 mA	900 mA	
PULLUP (R10, R13)	None	5 kΩ	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN (R12, 4)	0 kΩ	1 kΩ	2.4 kΩ	5. kΩ	10 kΩ	None

VBUS_MIN = 12 V (R11,R14) = (5k, 2.4k)

VBUS_MAX = 12 V (R3,R5) = (5k, 2.4k)

ISNK_COARSE = 1A (R10, R12) = (5k, 1k)

ISNK_FINE = 750mA (R13, R4) = (5k, 5k)

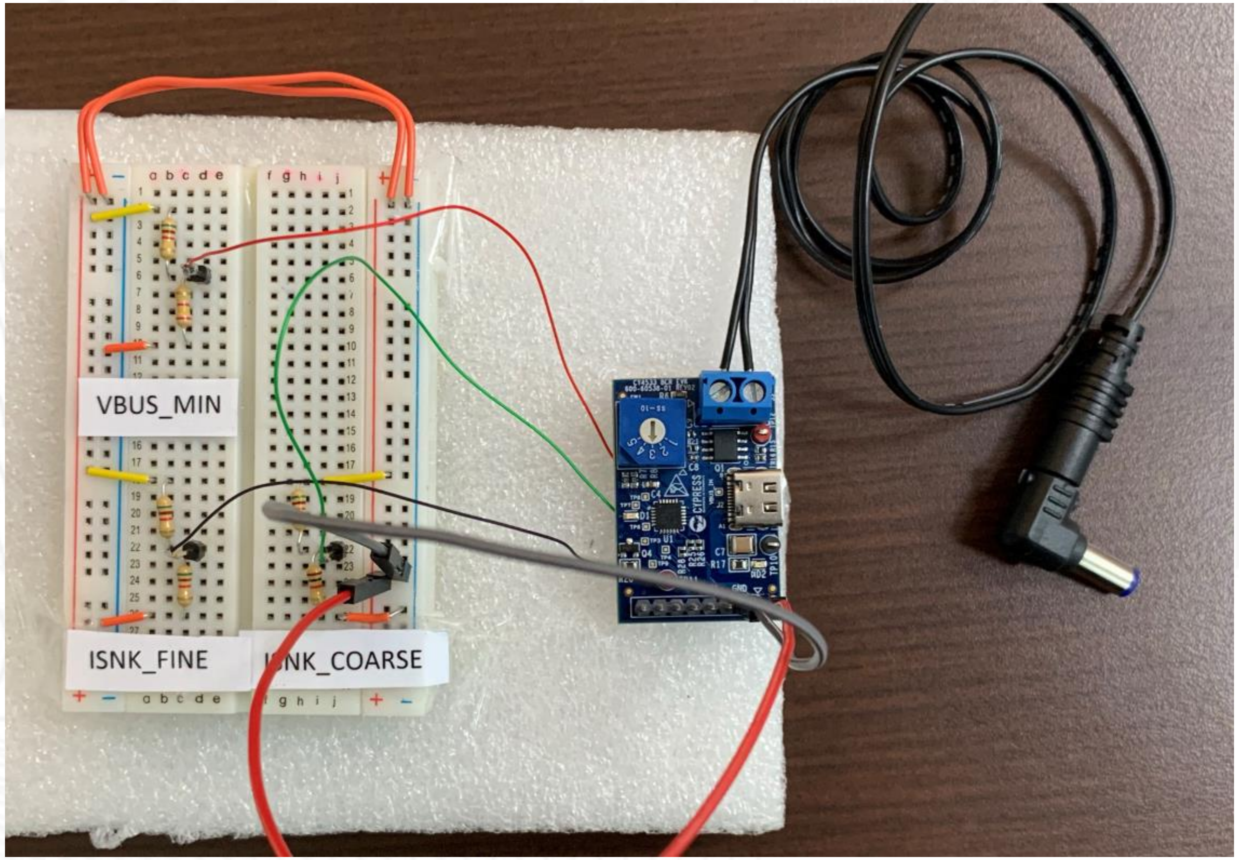
VBUS_MAX
Rotary Switch Options

Position 1 = 5V
Position 2 = 9V
Position 3 = 12V
Position 4 = 15V
Position 5 = 20V

Power up Xiaomi Smart Speaker through BCR (4/8)

Step 4:

Set up the CY4533 Kit and bread board

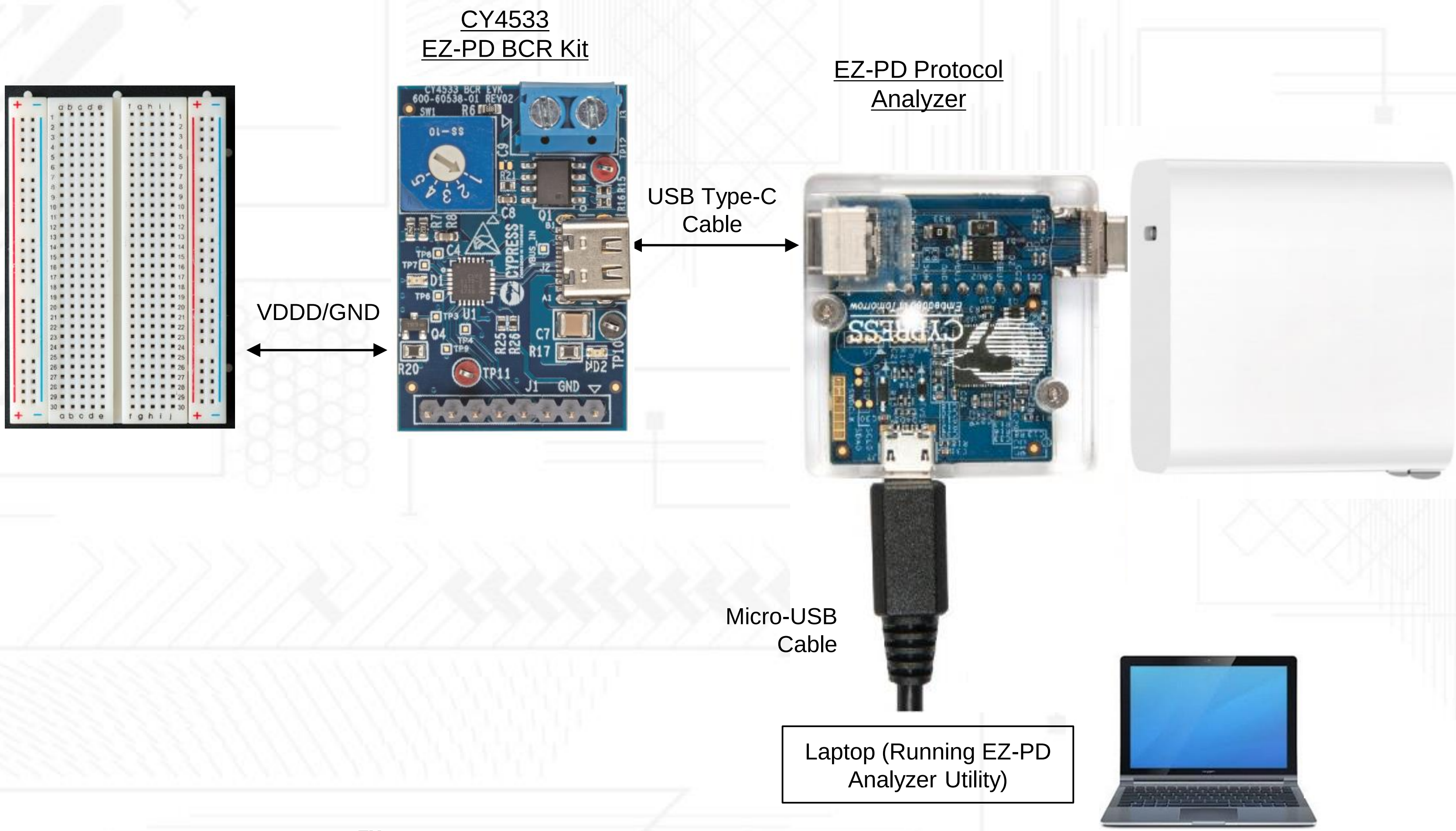


a. Connect the VDDD to the pull-up resistor high side
b. Connect the GND to pull-down resistor low side
c. Select the VBUS_MAX through the rotary switch
d. Connect the VBUS_MIN pin to the corresponding resistor divider
e. Connect the ISNK_COARSE pin to the corresponding resistor divider
f. Connect the ISNK_FINE pin to the corresponding resistor divider
g. Connect barrel connector cable to the VBUS terminal
   Make sure the barrel connector cable positive and negative pins are connected to the right polarity of the VBUS terminal

Power up Xiaomi Smart Speaker through BCR (5/8)

Step 5:

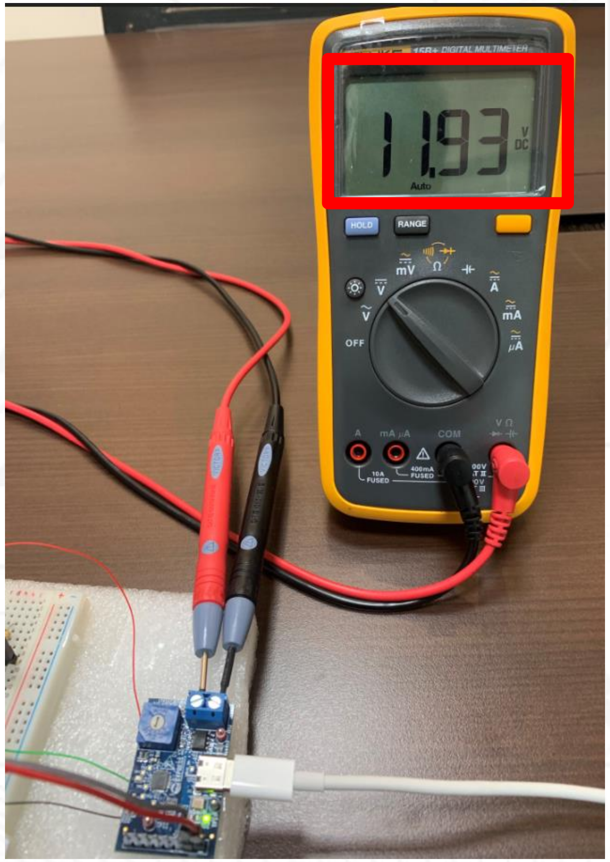
Connect CY4533 and Type-C Power Adapter with Type-C to Type-C Cable and CY4500



Power up Xiaomi Smart Speaker through BCR (6/8)

Step 6:

Connect the external Type-C adapter to your CY4533 setup



a. Make sure the voltage on the VBUS terminal is what you expect
b. Make sure there is no blinking LED on CY4533
c. Make sure there is no FAULT LED lit on CY4533

Make sure you do not connect the barrel connector to the device at this stage

Power up Xiaomi Smart Speaker through BCR (7/8)

Step 7:

Check the request VBUS voltage and current is correct through CY4500

EZ-PD™ Analyzer Utility

File Actions Help

VBUS Voltage: 11.95 V VBUS Current: -0.01 A

Status: None SOP: None Message: Msg ID: Obj Count: Data Role: Power Role:

SL#	Status	SOP	Message	Msg Id	Data Role	Power Role	Obj Count	Data	Start Time (us)	Duration (us)	Delta (us)	VBUS Voltage(V)	VBUS Current(
1	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12C ...	30,314...	1,422	0	5,054	0
2	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12C ...	30,316...	1,422	1,050	5,054	0.01
3	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12C ...	30,319...	1,422	1,049	5,054	0.01
4	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12C ...	30,497...	1,421	177,137	5,060	0
5	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12C ...	30,500...	1,422	1,050	5,060	0
6	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12C ...	30,502...	1,422	1,049	5,060	0
7	OK	SOP	Source_...	2	DFP	Source	7	0x75A1 0xB01912C 0x2D12C 0x3C12C ...	30,681...	1,422	177,038	5,060	0.01
8	OK	SOP	GoodCRC	2	UFP	Sink	0	0x441	30,682...	498	146	5,054	0
9	OK	SOP	Request	0	UFP	Sink	1	0x1082 0x3082BCAF	30,685...	631	1,962	5,060	0.01
10	OK	SOP	GoodCRC	0	DFP	Source	0	0x161	30,685...	496	146	5,060	0.01
11	OK	SOP	Accept	3	DFP	Source	0	0x7A3	30,695...	496	8,843	5,060	0.01
12	OK	SOP	GoodCRC	3	UFP	Sink	0	0x641	30,695...	498	148	5,060	0.01
13	OK	SOP	PS_RDY	4	DFP	Source	0	0x9A6	30,810...	496	114,479	11,506	0
14	OK	SOP	GoodCRC	4	UFP	Sink	0	0x841	30,811...	498	149	11,528	0

Detailed View Trigger

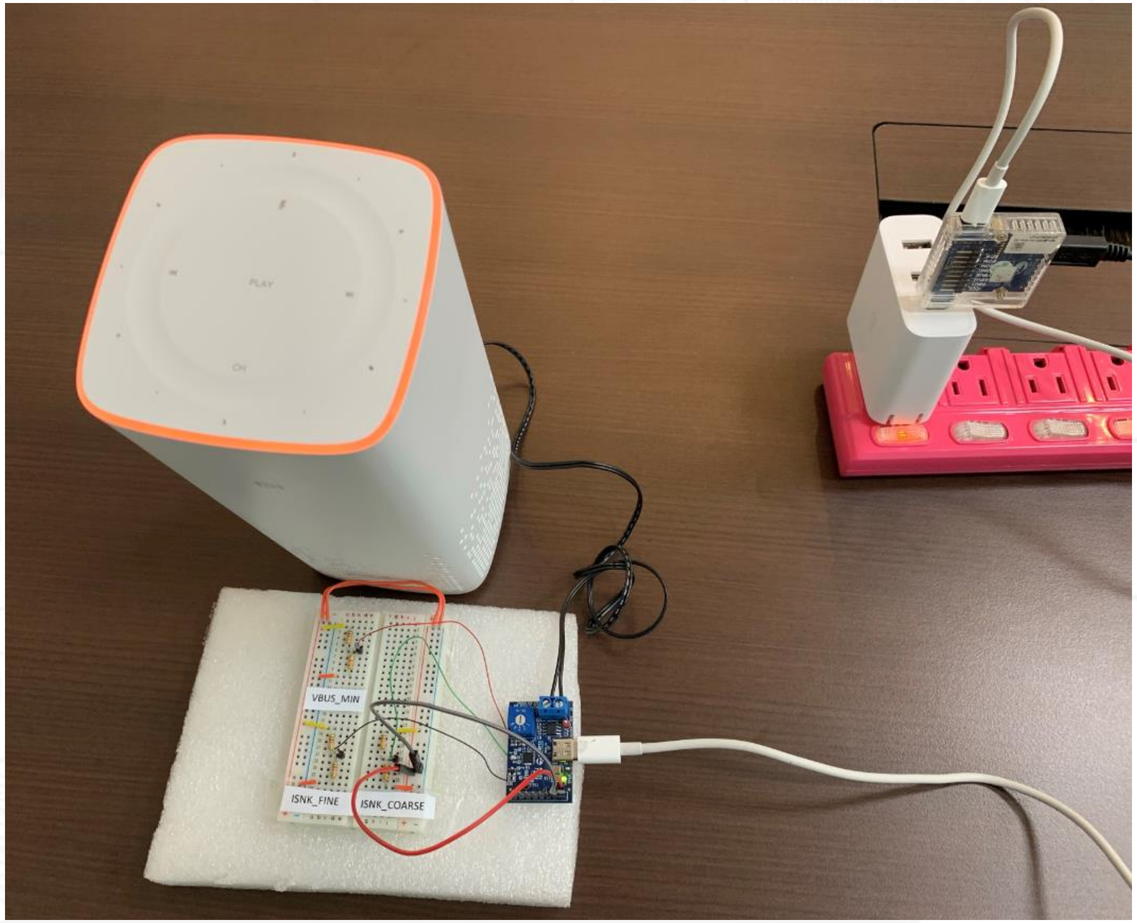
Description	Value
SOP Type	SOP
Header	0x1082
Reserved (15)	0
Data Objs (14..12)	1
Message Id (11..9)	0
Port Power Role (8)	SINK (0)
Spec Rev (7..6)	Reserved(2)
Port Data Role (5)	UFP (0)
Reserved (4)	0
Msg Type (3..0)	Request
Request Data Obj 1	0x3082BCAF
Reserved(31)	0
Object Position (30...28)	3
GiveBack flag (27)	No (0)
Capability Mismatch (26)	No (0)
USB Communication Capable (25)	No (0)
No USB Suspend	No (0)
Reserved (23...20)	0
Operating Current in 10mA (19...10)	175(1.75A)
Max Operating Current in 10mA (9...0)	175(1.75A)

See the Appendix for details on how to use EZ-PD Analyzer

Power up Xiaomi Smart Speaker through BCR (8/8)

Step 8:

Connect DC Barrel Connector to your device



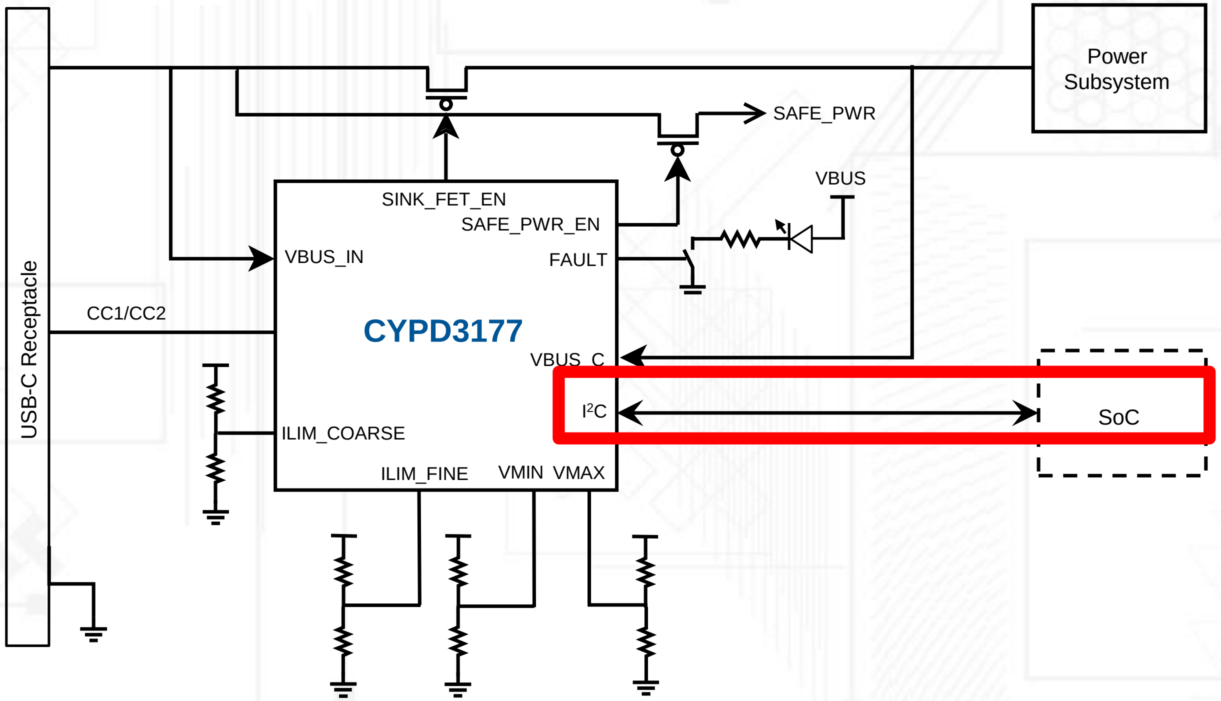
a. Make sure your device is powered up normally

b. Done and enjoy!

CYPRESS EMBEDDED IN TOMORROW™

Lab 2: Control BCR through I²C by external MCU/SOC

- **Objectives**
  - Learn how design and control BCR with external MCU/SOC
  - Use the MiniProg3 as I²C Master to control BCR through Bridge Control Panel
  - Capture and analyze traffic over a Type-C interface using a CY4500 EZ-PD Protocol Analyzer Kit
- **Hardware tools**
  - EZ-PD BCR Evaluation Kit (CY4533)
  - EZ-PD Protocol Analyzer (CY4500)
  - MiniProg3 (CY8CKIT-002)
  - Type-C Power Adapter (5V/9V/12V/15V/20V)
  - Dupont Cables, Resistors, and Bread Board
- **Software tools**
  - EZ-PD Analyzer Utility
  - Bridge Control Panel



Control BCR through I^{2}C by external MCU/SOC (1/5)

Step 1:

Set up your bread board to support 5 V/0.9 A on CY4533

VBUS_MIN and VBUS_MAX Resistor Options Table

VBUS_MAX, VBUS_MIN	5 V	9 V	12 V	15 V	19 V	20 V
PULLUP (R3, R11)	None	5 kΩ	5 kΩ	5.kΩ	5 kΩ	0 kΩ
PULLDOWN (R5, R14)	0 kΩ	1 kΩ	2.4 kΩ	5 kΩ	10 kΩ	None

ISNK_COARSE and ISNK_FINE Resistor Options Table

ILIM_COARSE	0 A	1A	2 A	3 A	4 A	5 A
ILIM_FINE	0 mA	250 mA	500 mA	750 mA	900 mA	
PULLUP (R10, R13)	None	5 kΩ	5 kΩ	5 kΩ	5 kΩ	0 kΩ
PULLDOWN (R12, 4)	0 kΩ	1 kΩ	2.4 kΩ	5. kΩ	10 kΩ	None

VBUS_MIN = 5 V (R11, R14) = (None, 0)

VBUS_MAX = 5 V (R3, R5) = (None, 0)

ISNK_COARSE = 0 A (R10, R12) = (None, 0)

ISNK_FINE = 900 mA (R13, R4) = (0, None)

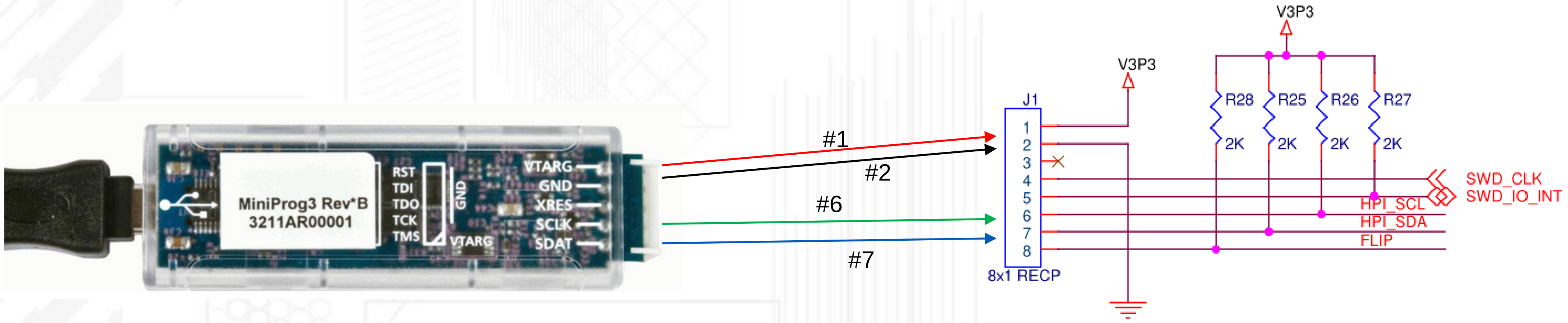
VBUS_MAX
Rotary Switch Options

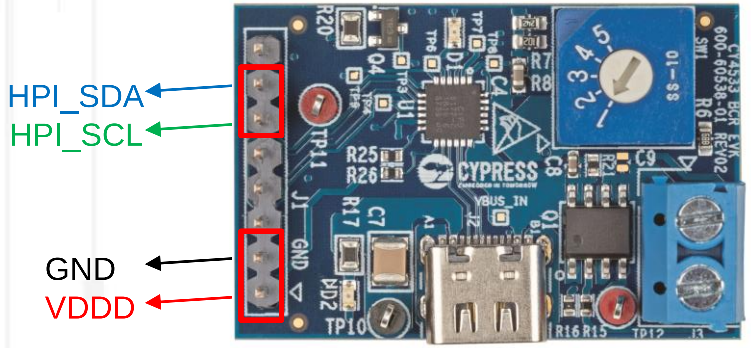
Position 1 = 5V
Position 2 = 9V
Position 3 = 12V
Position 4 = 15V
Position 5 = 20V

Control BCR through I²C by external MCU/SOC (2/5)

Step 2:

Connect your MiniProg3 SCLK and SDAT to your CY4533 HPI_SCL and HPI_SDA on J1 connector

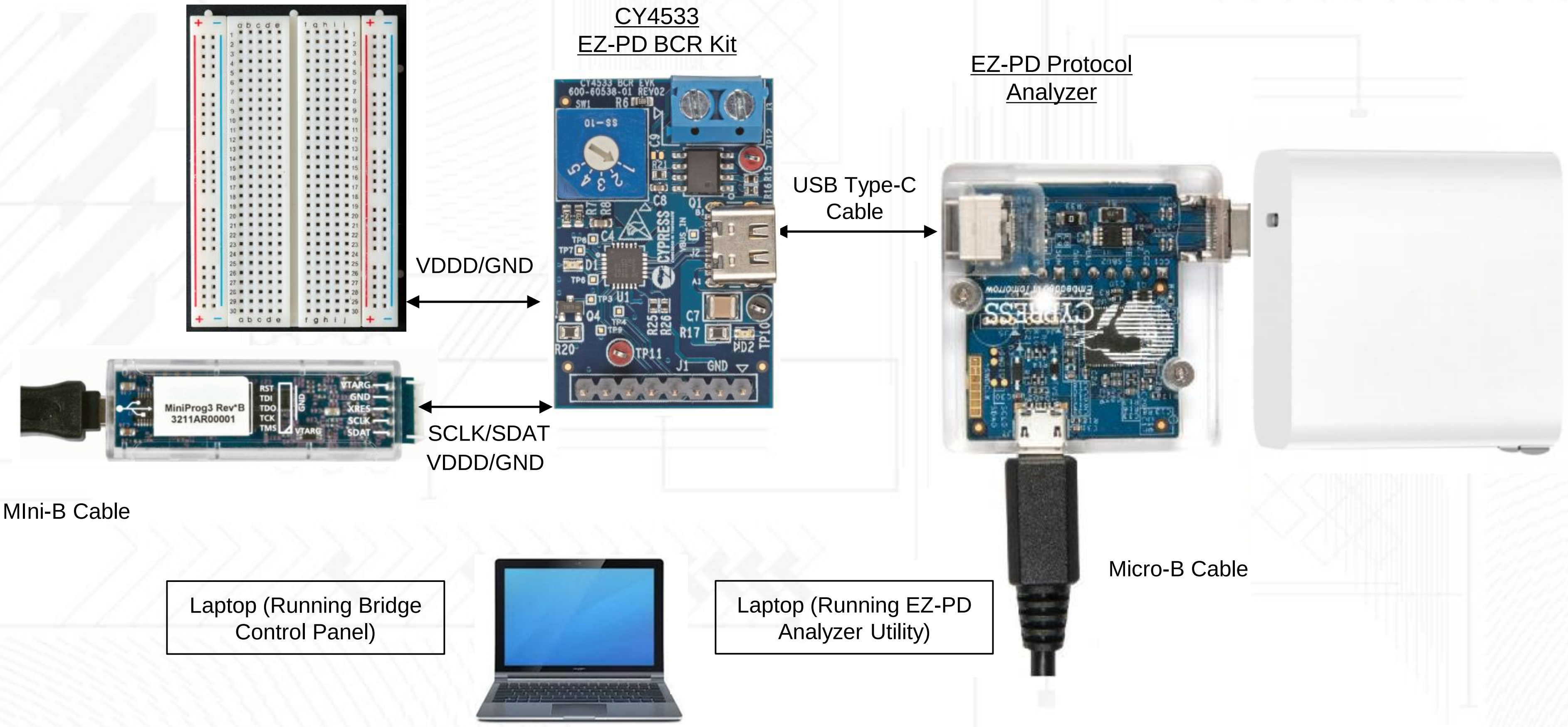




Control BCR through I^{2}C by external MCU/SOC (3/5)

Step 3:

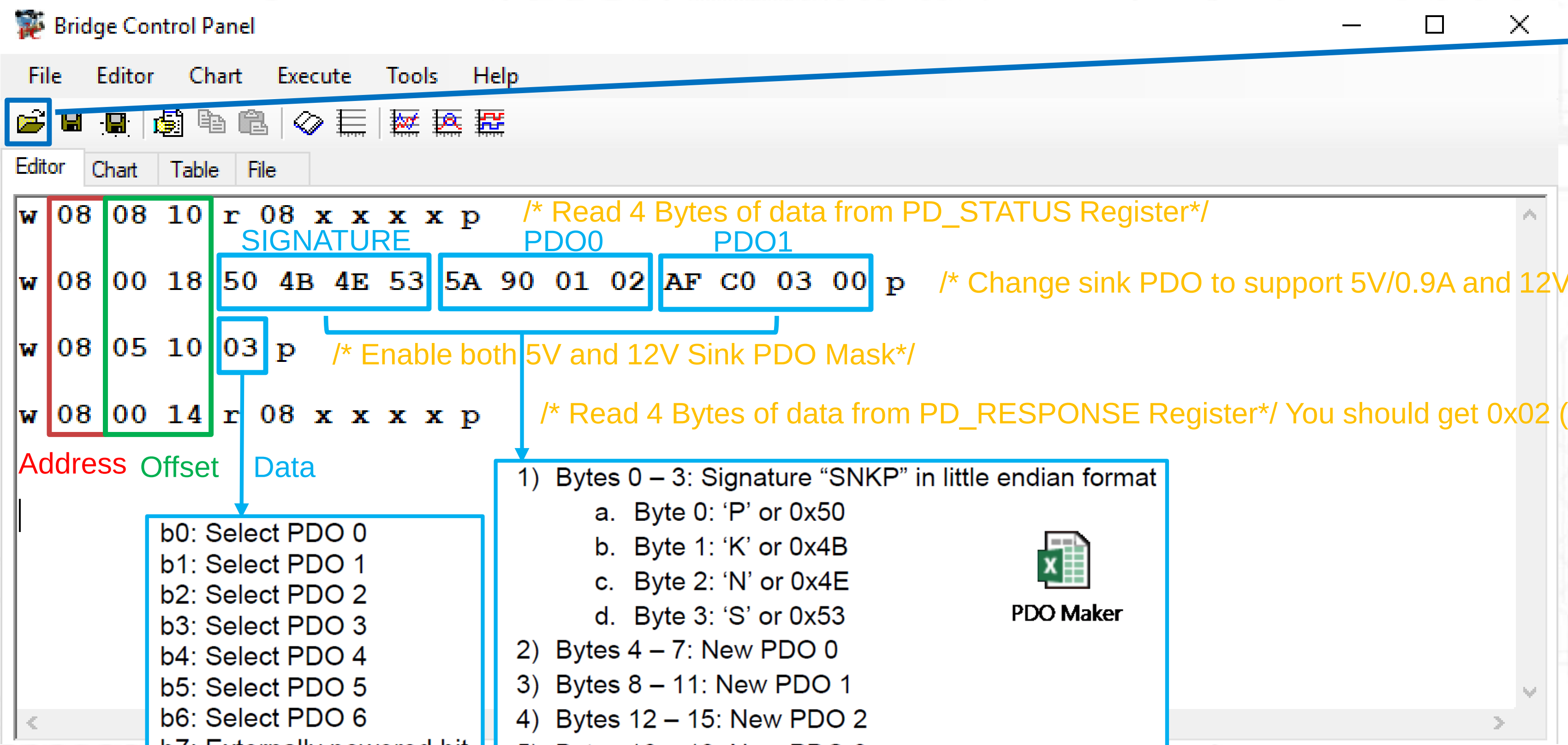
Follow the system setup shown below

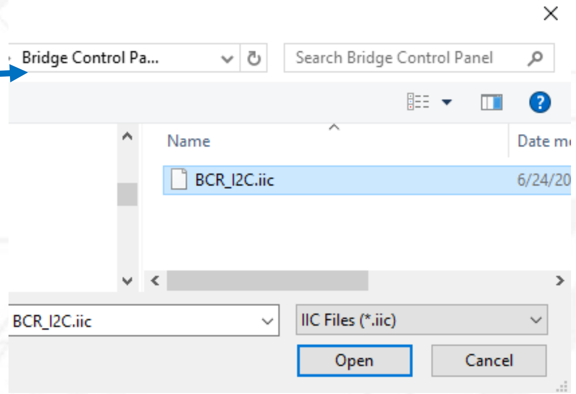


Control BCR through I²C by external MCU/SOC (4/5)

Step 4:

Open the example I²C Read and Write Command in Bridge Control Panel to control BCR





- b0: Select PDO 0
- b1: Select PDO 1
- b2: Select PDO 2
- b3: Select PDO 3
- b4: Select PDO 4
- b5: Select PDO 5
- b6: Select PDO 6
- b7: Externally powered bit

1) Bytes 0 – 3: Signature “SNKP” in little endian format
   a. Byte 0: ‘P’ or 0x50
   b. Byte 1: ‘K’ or 0x4B
   c. Byte 2: ‘N’ or 0x4E
   d. Byte 3: ‘S’ or 0x53
2) Bytes 4 – 7: New PDO 0
3) Bytes 8 – 11: New PDO 1
4) Bytes 12 – 15: New PDO 2
5) Bytes 16 – 19: New PDO 3
6) Bytes 20 – 23: New PDO 4
7) Bytes 24 – 27: New PDO 5
8) Bytes 28 – 31: New PDO 6

PDO Maker

BCR I²C Address:

0x08 (7 Bit)

BCR I²C Registers Offset:

0x1008: PD_STATUS

0x1800: Write Data Memory

0x1400: PD_RESPONSE register

0x1005: SINK_PDO_MASK

Control BCR through I²C by external MCU/SOC (5/5)

Step 5:

Check the request VBUS voltage and current is correct through CY4500

EZ-PD™ Analyzer Utility

File Actions Help

Get 5 V only with initial setup

VBUS Voltage: 11.96 V VBUS Current: 0 A

Status: None SOP: None Message: Msg ID: Obj Count: Data Role: Power Role:

SL#	Status	SOP	Message	Msg Id	Data Role	Power Role	Obj Count	Data	Start Time (us)	Duration (us)	Delta (us)	VBUS Voltage(V)	VBUS Current(A
1	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,144...	1,422	0	5,054	0.01
2	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,146...	1,422	1,050	5,060	0
3	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,149...	1,422	1,050	5,060	0
4	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,330...	1,422	179,560	5,060	0.01
5	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,332...	1,421	1,049	5,065	0
6	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,334...	1,422	1,049	5,060	0.01
7	OK	SOP	Source_...	2	DFP	Source	7	0x75A1 0xB01912C 0x2D12C 0x3C12...	32,516...	1,420	179,788	5,060	0
8	OK	SOP	GoodCRC	2	UFP	Sink	0	0x441	32,517...	498	148	5,060	0
9	OK	SOP	Request	0	UFP	Sink	1	0x1082 0x1081685A	32,520...	630	1,976	5,060	0
10	OK	SOP	GoodCRC	0	DFP	Source	0	0x161	32,521...	497	146	5,060	0
11	OK	SOP	Accept	3	DFP	Source	0	0x7A3	32,530...	497	8,727	5,065	0
12	OK	SOP	GoodCRC	3	UFP	Sink	0	0x641	32,530...	498	145	5,060	0
13	OK	SOP	PS_RDY	4	DFP	Source	0	0x9A6	32,580...	497	49,420	5,060	0
14	OK	SOP	GoodCRC	4	UFP	Sink	0	0x841	32,581...	498	146	5,060	0
15	OK	SOP	Get_Sou...	1	UFP	Sink	0	0x287	37,704...	498	5,122,...	5,060	0
16	OK	SOP	GoodCRC	1	DFP	Source	0	0x361	37,704...	497	145	5,060	0
17	OK	SOP	Source_...	5	DFP	Source	7	0x7BA1 0xB01912C 0x2D12C 0x3C12...	37,711...	1,421	5,851	5,065	0
18	OK	SOP	GoodCRC	5	UFP	Sink	0	0xA41	37,712...	499	146	5,060	0
19	OK	SOP	Request	2	UFP	Sink	1	0x1482 0x3082BCAF	37,714...	630	1,700	5,060	0
20	OK	SOP	GoodCRC	2	DFP	Source	0	0x561	37,715...	496	146	5,060	0
21	OK	SOP	Accept	6	DFP	Source	0	0xDA3	37,725...	496	9,079	5,065	0

Detailed View Trigger

Description	Value
SOP Type	SOP
Header	0x1482
Reserved (15)	0
Data Objs (14..12)	1
Message Id (11..9)	2
Port Power Role (8)	SINK (0)
Spec Rev (7..6)	Reserved(2)
Port Data Role (5)	UFP (0)
Reserved (4)	0
Msg Type (3..0)	Request
Request Data Obj 1	0x3082BCAF
Reserved(31)	0
Object Position (30...28)	3
GiveBack flag (27)	No (0)
Capability Mismatch (26)	No (0)
USB Communication Capable (25)	No (0)
No USB Suspend	No (0)
Reserved (23...20)	0
Operating Current in 10mA (19...10)	175(1.75A)
Max Operating Current in 10mA (9...0)	175(1.75A)

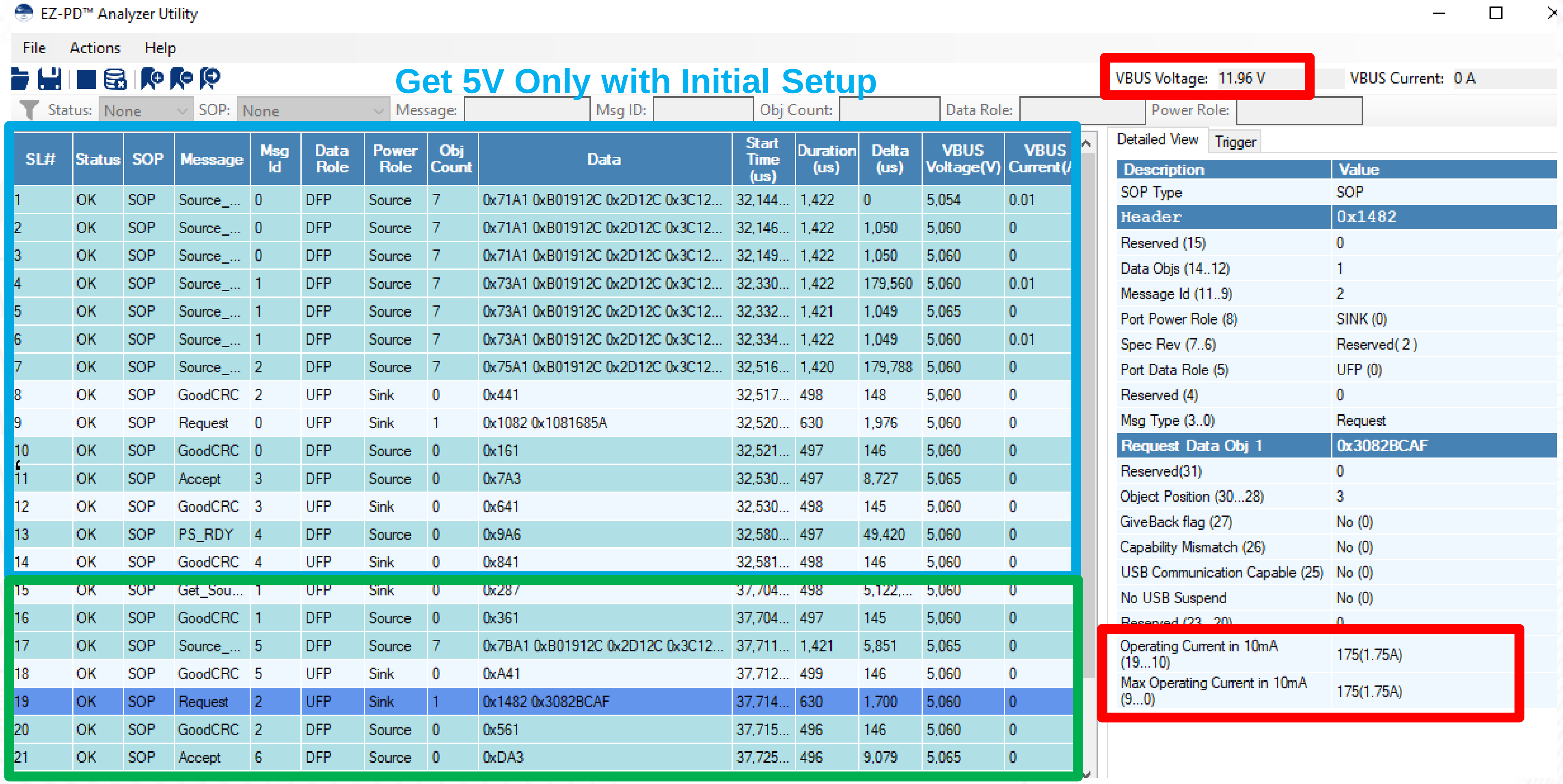
Get 12 V after I²C setup from MCU/SOC

See the Appendix for details on how to use EZ-PD Analyzer

Control BCR through I²C by external MCU/SOC (5/5)

Step 5:

Check the request VBUS voltage and current is correct through CY4500



SL#	Status	SOP	Message	Msg Id	Data Role	Power Role	Obj Count	Data	Start Time (us)	Duration (us)	Delta (us)	VBUS Voltage(V)	VBUS Current(/
1	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,144...	1,422	0	5,054	0.01
2	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,146...	1,422	1,050	5,060	0
3	OK	SOP	Source_...	0	DFP	Source	7	0x71A1 0xB01912C 0x2D12C 0x3C12...	32,149...	1,422	1,050	5,060	0
4	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,330...	1,422	179,560	5,060	0.01
5	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,332...	1,421	1,049	5,065	0
6	OK	SOP	Source_...	1	DFP	Source	7	0x73A1 0xB01912C 0x2D12C 0x3C12...	32,334...	1,422	1,049	5,060	0.01
7	OK	SOP	Source_...	2	DFP	Source	7	0x75A1 0xB01912C 0x2D12C 0x3C12...	32,516...	1,420	179,788	5,060	0
8	OK	SOP	GoodCRC	2	UFP	Sink	0	0x441	32,517...	498	148	5,060	0
9	OK	SOP	Request	0	UFP	Sink	1	0x1082 0x1081685A	32,520...	630	1,976	5,060	0
10	OK	SOP	GoodCRC	0	DFP	Source	0	0x161	32,521...	497	146	5,060	0
11	OK	SOP	Accept	3	DFP	Source	0	0x7A3	32,530...	497	8,727	5,065	0
12	OK	SOP	GoodCRC	3	UFP	Sink	0	0x641	32,530...	498	145	5,060	0
13	OK	SOP	PS_RDY	4	DFP	Source	0	0x9A6	32,580...	497	49,420	5,060	0
14	OK	SOP	GoodCRC	4	UFP	Sink	0	0x841	32,581...	498	146	5,060	0
15	OK	SOP	Get_Sou...	1	UFP	Sink	0	0x287	37,704...	498	5,122,...	5,060	0
16	OK	SOP	GoodCRC	1	DFP	Source	0	0x361	37,704...	497	145	5,060	0
17	OK	SOP	Source_...	5	DFP	Source	7	0x7BA1 0xB01912C 0x2D12C 0x3C12...	37,711...	1,421	5,851	5,065	0
18	OK	SOP	GoodCRC	5	UFP	Sink	0	0xA41	37,712...	499	146	5,060	0
19	OK	SOP	Request	2	UFP	Sink	1	0x1482 0x3082BCAF	37,714...	630	1,700	5,060	0
20	OK	SOP	GoodCRC	2	DFP	Source	0	0x561	37,715...	496	146	5,060	0
21	OK	SOP	Accept	6	DFP	Source	0	0xDA3	37,725...	496	9,079	5,065	0

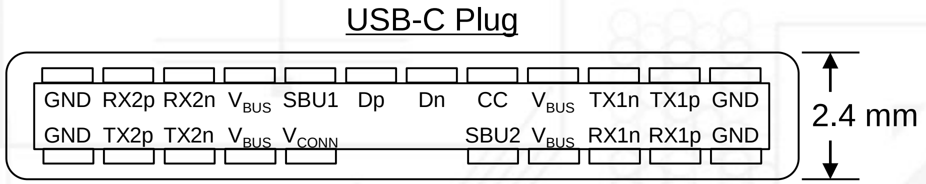
Description	Value
SOP Type	SOP
Header	0x1482
Reserved (15)	0
Data Objs (14..12)	1
Message Id (11..9)	2
Port Power Role (8)	SINK (0)
Spec Rev (7..6)	Reserved(2)
Port Data Role (5)	UFP (0)
Reserved (4)	0
Msg Type (3..0)	Request
Request Data Obj 1	0x3082BCAF
Reserved(31)	0
Object Position (30...28)	3
GiveBack flag (27)	No (0)
Capability Mismatch (26)	No (0)
USB Communication Capable (25)	No (0)
No USB Suspend	No (0)
Reserved (23...20)	0
Operating Current in 10mA (19...10)	175(1.75A)
Max Operating Current in 10mA (9...0)	175(1.75A)

See the Appendix for details on how to use EZ-PD Analyzer

APPENDIX

Glossary

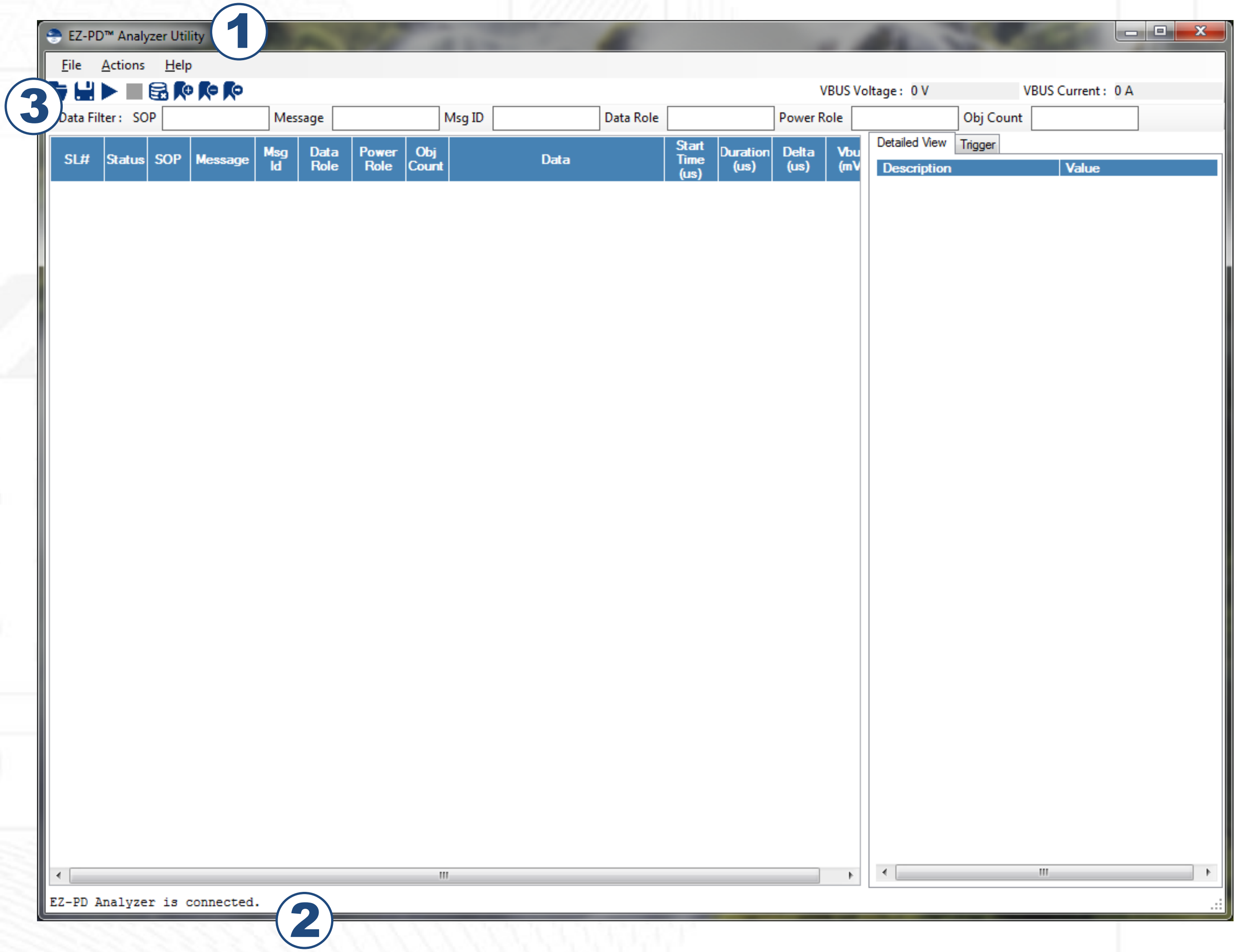
- **USB Power Delivery (USB-PD, Power Delivery, PD, PD 3.0)**
  - A new USB standard that increases power delivery over V_{BUS} from 7.5 W to 100 W
  - Both USB hosts (e.g., PCs) and USB devices (e.g., hard disk drives) can act as either a provider[1] (DFP – Downstream Facing Port) or a consumer[2] (UFP – Upstream Facing Port) of power
- **USB-C (USB Type-C, Type-C)**
  - A new standard with a slimmer and reversible USB plug, a reversible cable, multiple protocol support, and 100-W PD



[1] Provider: A Type-C port that sources power over V_{BUS}

[2] Consumer: A Type-C port that sinks power from V_{BUS}

How to Use EZ-PD Analyzer Utility (1/2)



Steps

1. Start EZ-PD Analyzer Utility:

   Windows Start Menu >

   All Programs >

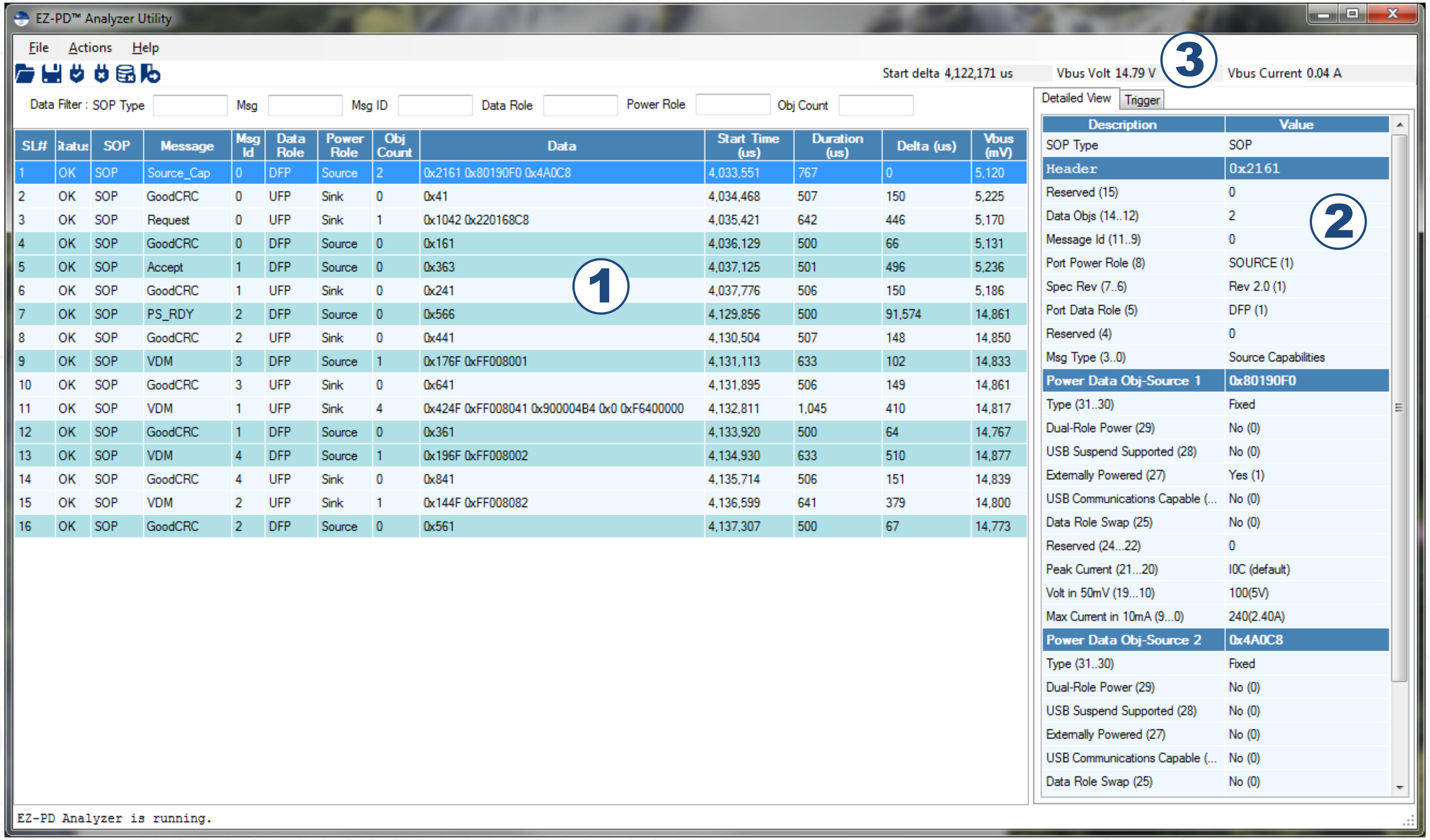
   Cypress Folder >

   EZ-PD Analyzer Utility

2. Make sure the bottom left of program window says **EZ-PD Analyzer is Connected**

3. Click the **Start Capturing** button on the button bar

How to Use EZ-PD Analyzer Utility (2/2)



Steps

1. The capture window shows a list of all the PD messages seen on the Type-C connection
2. The description window shows a detailed, "decoded" view of a specific PD message
3. The live VBUS voltage and current measurements are also captured. Positive current flows from receptacle to plug

How VBUS Voltage is Determined by BCR

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)

How VBUS Current is Determined by BCR

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

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

BCR HPI – PD_STATUS Register

Default Config	Bit0-5	0x00
Current Config	Bit0-5	0x00
	Bit6: Current Port Data Role	0: UFP/1:DFP
	Bit7: Reserve	0
	Bit8: Current Port Role	0: Sink
	Bit9: Reserve	0
	Bit10: Contract State	0: No Explicit Contract 1: Explicit Contract
	Bit11-13: Reserve	0
	Bit14: Sink Tx Ready	0: In Tx Ready 1: Not in Tx Ready
	Bit15: Policy Engine State	0: Not in PE_SNK_Ready 1: In PE_SNK_Ready
	Bit16-17: PD Spec Revision	0: PD2.0 1: PD3.0
	Bit18: Partner PD Spec Revision	0: PD2.0 1: PD3.0
	Bit19: Partner Unchunked Extended Message Support	0: Don’t Support 1: Support
	Bit20-31: Reserve	0

BCR HPI – PD_RESPONSE Register

Response Code	Byte0/Bit7: Type of Response	0: Response to Command 1: Async Event
Bit0-5	Byte0/Bit0-6: Response Code	See the response code below
Bit6: Current Port Data Role	Byte1	Length of the response if length < 256
Bit7: Reserve	Byte2-3	Length of the response if length > 256

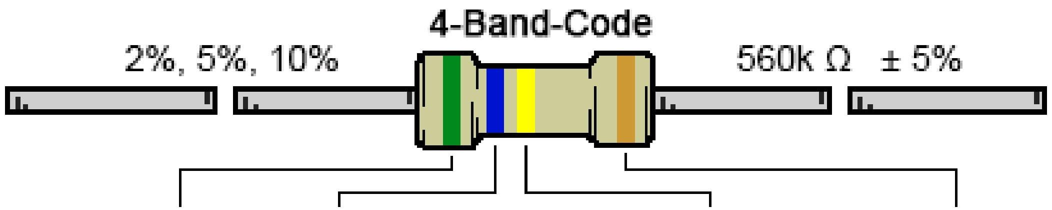
TYPE	Responses to Commands	
RESPONSE NAME	**CODE**	**DESCRIPTION**
No Response	0x00	**No Response** No outstanding command or event in BCR. Or BCR is processing a command that will take a long time to complete.
Success	0x02	**Success** Command was handled successfully. Refer to the specific Command Register definition to understand what a successful handling of command means.
Invalid Command or Argument	0x05, 0x09	**Invalid Command or Argument** Partial register writes, reserved bits set, unexpected command code or unexpected command sizes.
Not Supported	0x0A	**Command Not Supported in mode** Command is not supported in the current mode
Transaction Failed	0x0C	**Transaction Failed** The PD message was not sent successfully 1. GoodCRC was not received in response to BCR sending the command.

BCR HPI – SELECT_SINK_PDO

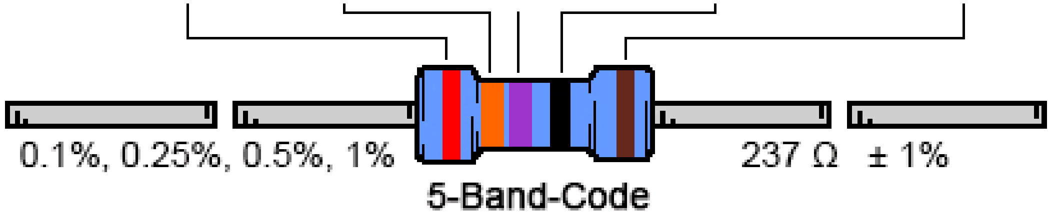
NAME	SELECT_SINK_PDO
ADDRESS	0x1005
SIZE	1-byte

FIELD NAME	R/W	FIELD OFFSET	DESCRIPTION
Sink PDO Mask	WO	Byte 0	**Bit 0: Enable PDO 1** **Bit 1: Enable PDO 2** **Bit 2: Enable PDO 3** **Bit 3: Enable PDO 4** **Bit 4: Enable PDO 5** **Bit 5: Enable PDO 6** **Bit 6: Enable PDO 7** **Bit 7: Set the “Unconstrained Power” bit in PDO 1** Once this register is written to, BCR will check if the first 4 bytes of Data Memory has the “SNKP” signature. If signature is present, it updates the Sink PDO list and uses the mask as specified in Bits 0..6. If signature is not present, it enables PDOs selected by the mask in Bits 0..6. If all bits are 0x00 then BCR will fall back to the default Sink PDOs as determined by the 4 configuration pins.

Resistor Color Decode Table



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)



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