

Table of Contents

Chapter 1. CLA-PD Summary2

1.1 GENERAL DESCRIPTION2

1.2 KEY FEATURES.....2

1.2.1 AP43776Q - 2-Channel Type-C PD Decoder 2

1.2.2 PI3USB31532Q – 3.3V, 10Gb/s Type-C USB 3.2 Gen 2/DP 2.1 (UHBR10) 6:4/4:6
Crossbar Switch 2

1.2.3 PI3DPX1207Q – DP-Alt DP1.4/USB3.1 10Gbps Re-Driver 2

1.2.4 PI3USB221EQ – High-Speed USB2.0 1:2 Mux/DeMux Switch with Signal Enable..... 2

1.3 APPLICATIONS.....2

1.4 MAIN POWER SPECIFICATIONS2

1.5 CLA-PD EVB PICTURE.....2

Chapter 2. Function Description, Schematic and BOM.....3

2.1 APPLICATION SCENARIO3

2.2 FUNCTIONAL DESCRIPTION4

2.3 EVALUATION BOARD SCHEMATIC5

2.4 BILL OF MATERIAL (BOM).....6

2.5 PCB LAYOUT10

**Chapter 3. Down-Facing Port (DFP) Charging Test Set Up and
Testing Summary.....11**

3.1 DFP TYPE-C PD CHARGING TEST SETUP..... 11

3.2 CHARGING EFFICIENCY TESTING 12

**Chapter 4. Up-Facing Port (UFP) Video/Data Setup and
Testing Summary.....14**

4.1 UFP VIDEO/DATA SET UP 14

4.2 SIGNAL INTEGRITY (EYE DIAGRAM) TEST.....20

Chapter 5. USB-C PD Protocol Compliance Test23

5.1 ELLYSIS -23

5.2 LECORY23

5.3 QUADRAMAX26

Chapter 6. Reference Documents27

6.1 AP43776Q DATASHEET -27

6.2 PI3DPX1207Q DATASHEET -27

6.3 PI3USB31532Q DATASHEET -.....27

6.4 PI3USB221EQ DATASHEET -.....27

Chapter 7. Revision History28

Chapter 1. CLA-PD Summary

1.1 General Description

Standardization of USB Type-C® Power Delivery (PD) spurs pervasive use of USB-C PD compliance chargers to power various USB-C Devices (TCDs) such as smartphones, notebook PCs and other mobile or non-mobile devices. Inclusion support of various video and data interfaces in the PD protocol, such as DisplayPort™ (DP) under USB-C Alternate (Alt) mode and USB3.1 data transfer, further stimulates the emergence of new breeds of USB-C PD In-Vehicle-Infotainment (IVI) systems, which serve as the power sourcing sources and video display platform.

The USB-C-Link-to-Automotive Evaluation Board (CLA EVB) is designed to provide USB-C PD Downstream Facing Port (DFP) charging as well as Upstream Facing Port (UFP) video DP Alt Mode and data (USB3.1 Gen 1/ Gen 2 interface) for new generation of USB-C PD IVI applications. It also supports legacy BC 1.2 Charging Downstream Port (CDP) mode to enable D+/D- data communication for legacy mobile devices through Micro-USB to USB-C cable.

1.2 Key Features

1.2.1 AP43776Q - 2-Channel Type-C PD Decoder

- USB-C PD 3.1 SPR Compliance Protocol Controller
- Embedded MCU with hardwired PD protocol supports CC1/2 detection, traffic identification and routing requirements for PD compliance charging and data flow control
- Support DFP charging up to 100W (20V @ 5A)
- Support UFP USB-C PD DP Alt mode and USB3.1 Gen 1 / Gen 2
- Support BC1.2 CDP mode
- Configure I2C Slave devices to support PD charging, video and data routing through configuration of I2C registers
- OVP, OCP, UVP Protection

1.2.2 PI3USB31532Q – 3.3V, 10Gb/s Type-C USB 3.2 Gen 2/DP 2.1 (UHBR10) 6:4/4:6 Crossbar Switch

- Six Differential Channels to 2/4 Differential Channel Switch
- Support Pin Assignment C, D, E for Sink
- USB 2.1 Gen I 10Gbps/s (-3db) for Super Speed and (-3.7db) Switching to USB-C Connector
- Multiplexes one of the following to USB-C
- One Lane of USB 3.1 Gen1/Gen2 Signal and Channels of DP1.2 / DP1.4 Channels of Signal

1.2.3 PI3DPX1207Q – DP-Alt DP1.4/USB3.1 10Gbps Re-Driver

- DP-Alt 4-channel ReDriver™ and DeMux (DP 2-ch and USB 2-ch)
- DP1.4 (8.1Gbps) and USB3.1 Gen 2 (10 Gbps) standard compliance
- USB-C DP/USB mode selection: DP only, USB only, DP/USB split modes
- USB-C Plug and Aux Flipping control through I2C slave pins

1.2.4 PI3USB221EQ – High-Speed USB2.0 1:2 Mux/DeMux Switch with Signal Enable

- Ron = 6Ω(max), ΔRon = 0.2Ω (typ), Cio (on)=0.4pF (typ)
- Low-Power Mode when OE is disabled (2μA)
- High-Bandwidth – 1.6Gbps

1.3 Applications

- Car Navigation / IVI Panel

1.4 Main Power Specifications

Parameter	Value
Panel Interface	USB-C, DP
Applicable USB-C Devices (TCDs), or USB-A Devices	USB-C PD equipped Notebook, Smartphones, PADs, USB-A Smartphones, Notebooks
Input / Operating Voltage	12Vdc Car Battery
Output Charging Power	USB-C PD 100W maximum output power (20V @ 5A)
Charging Efficiency	93.65% (5V@5A), 95.02% (20V@5A)
Video/Data Support	USB-C PD Alt Mode–2-lane/4-lane DP, USB 3.1 Gen 1 /Gen 2
Standby Power	<20mWatt
Dimension	75mm * 75mm * 14mm

1.5 CLA-PD EVB Picture

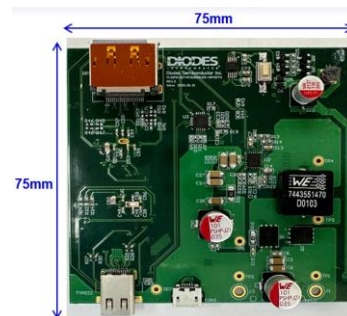


Figure 1. CLA-PD Board

Chapter 2. Function Description, Schematic and BOM

2.1 Application Scenario

With emerging USB-C connectors and PD capability available, a new generation of USB-C PD automotive monitors can be used as both a power source and a data hub for personal and professional smartphone work environments. While a USB-C PD monitor is the only device-powered in-car-battery for DC power inputs, it plays as data UFP to the connected to TCDs (e.g. notebook, tablet, smartphone) as well as DC power DFP for the required power in the monitor. Once the DFP DC power is delivered, the monitor and the TCD swap data roles. Playing as the DFP role, the TCD requests the UFP monitor to support the DP Alt mode so that the DP video signal can go to the DP monitor properly. Figure 2 illustrates usage set up for a smartphone and automotive monitors in typical smartphone scenarios.

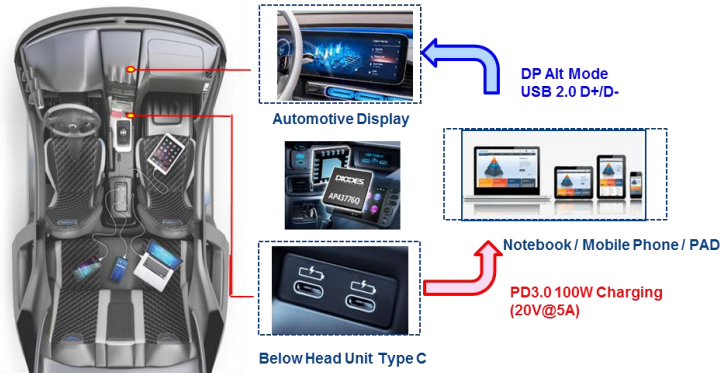


Figure 2. The Application Scenario of a USB-C PD Charging and Video Data Streaming

The USB-C PD IVI system block can be divided into four main functions:

1. Power Unit (conversion of Car Battery Power, 12V, into Desired DC Power)
2. Major Image Processing and Display SoC (Image formatting and scaling)
3. USB hub controller (support various USB devices)
4. USB-C PD Interface (dealing with PD charging and data/video signaling and routing)

The CLA EVB, Figure 3, is designed to implement the USB-C PD Interface for IVI Panels.

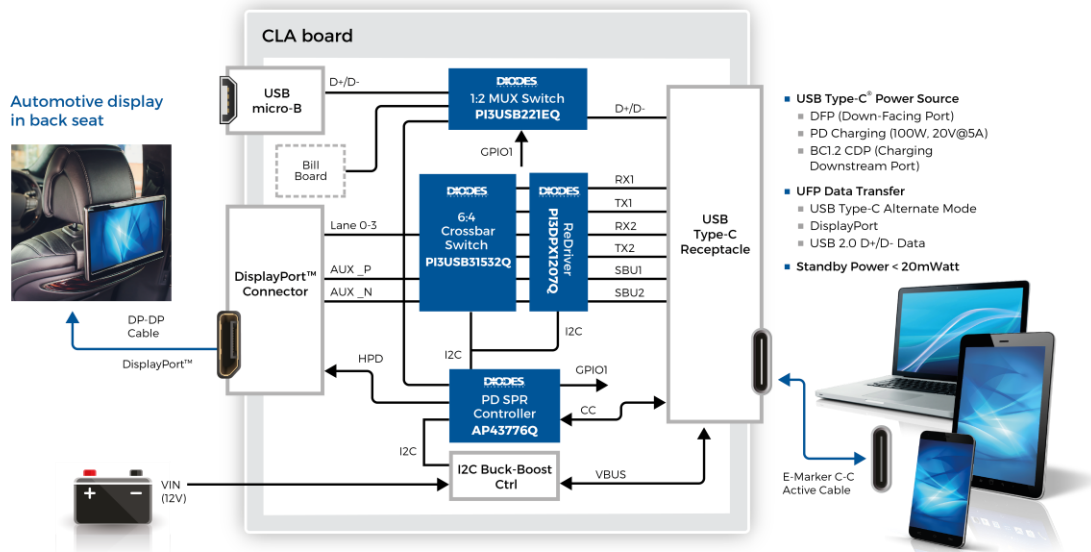


Figure 3. An AP43776Q-based EVB for USB-C PD DFP Charging and UFP Video Data Streaming

2.2 Functional Description

The input power for the CLA-PD EVB is powered by a typical battery power (typical 12V) available in a car. This application operates in the following modes:

- 100W DFP charging port with UFP supported for DP Alt mode for mobile TCDs (e.g. USB-C smartphones)
When the USB-C port is connected to a notebook or a smartphone by a USB Type-C cable, CLA EVB sources up to 100W power for charging the notebook or smartphone. Then, the CLA EVB swaps to be a UFP to support the monitor with DP Alt mode output to the DP connector.
- Legacy BC1.2 CDP Mode (Charging + USB2.0 Data Transfer) for legacy devices with Micro-USB connectors.
When the IVI panel is connected to a legacy BC1.2 CDP compliance device through a Micro-USB-to-USB-C Cable, the CLA EVB supports legacy BC1.2 charging under CDP model to allow USB2.0 data transfer.

To support the desired PD3.1 charging and data/video signaling and routing for DP Alt mode, the CLA EVB adopts the following key components:

- 1) DP-Over-USB-C Capable PD Controller ([AP43776Q](#) - USB PD controller supporting DP Alt mode, U3)
- 2) I2C Buck-Boost Controller (capable to support up to 100W PD charging, 20V@5A)
- 3) I2C USB-C ReDriver ([PI3DPX1207Q](#) - DP-Alt DP1.4/USB3.1 10Gbps linear re-driver with non-blocking, latency-free and built-in aux switch, U5)
- 4) I2C 6:4 crossbar switch ([PI3USB31532Q](#) - 3.3V, 10Gb/s USB-C USB 3.2 Gen 2/DP 2.1 (UHBR10) 6:4/4:6 crossbar switch, U6)
- 5) USB2.0 High-Speed Switch ([PI3USB221EQ](#) - High-Speed USB2.0 1:2 Multiplexer/DeMultiplexer Switch with Signal Enable, U7)

When the USB-C attachment is completed between an active CLA EVB and the notebook or smartphone (host device), the power profile negotiation begins with a series of channel configuration (CC) commands and response exchanges. Upon successful negotiation, the power profile selection is concluded. The AP43776Q enables the attached I2C buck-boost controller to output the matched PDO (Power Data Object) to charge the notebook/smartphone host.

Once the charging is conducted, the AP43776Q sends the data role swap request to the NB host. If the request is accepted, the NB host plays as DFP, and starts to request the UFP AP43776Q to support the DP Alt mode. Upon successful decoding the Vendor-Defined Message (VDM) commands on the CC line driven by NB host, the AP43776Q enters the DP Alt mode. The decoded information is then sent to the high-speed switches and retimer/ReDriver signaling chips through the AP43776Q I2C interface, so that the data stream can be delivered from the host side to the DP in the right routing path and in the correct signaling.

During the video and data inquiry process, the AP43776Q identifies proper Pin Assignment (C, D, E, 2-lane/4-lane DP, 1-lane USB 3.1, 2-lane DP+1-Lane USB) to match various attached output devices (e.g. Monitor, or SSD), where it includes the routing information for the crossbar switches (e.g. PI3USB31532Q) and the signaling parameters for signal conditioning chip (e.g. PI3DPX1207Q). In addition to its default value, the crucial parameters of PI3DPX1207Q (register values) can be set up according to PCB trace lengths (USB-C Connector to redriver/ReDriver to DP/USB port), types of incoming data/video and cable loss characteristic by the AP43776Q through the I2C interface.

Considering the power requirements to support various USB-C active cables, the CLA EVB has an extra power circuitry based on synchronous buck regulation (AP63205) to support more than 2.0W power. If adequate power source in the main monitor board is available to support up to 2.0W power (5V), this power circuitry could be saved.

When a legacy smartphone with a Micro-USB connector is connected to the IVI panel through a Micro-USB-to-USB-C cable, the AP43776Q enters the BC1.2 CDP model through D+/D- communication. Upon completion of power negotiation to start charging through the VBus power line, the AP43776Q disengages D+/D- from power negotiation to start data negotiation and continues to precede USB (USB2.0) data transmission.

The [CH552E \(U8\)](#), an 8-bit MCU device with embedded flash, is used in an optional circuitry device to implement Billboard Device Class required to support USB-C Alt Mode for DP over USB-C applications. Billboard Class and CDP data communication is switched through a high-speed USB2.0 multiplexer (e.g. PI3USB221EQ), which is controlled by AP43776Q GPIO (GPIO1).

Furthermore, the AP43776Q also minimizes the use of standby power consumption (<20mWatt) of the overall CLA EVB to meet Energy Star requirements on IVI applications.

2.3 Evaluation Board Schematic

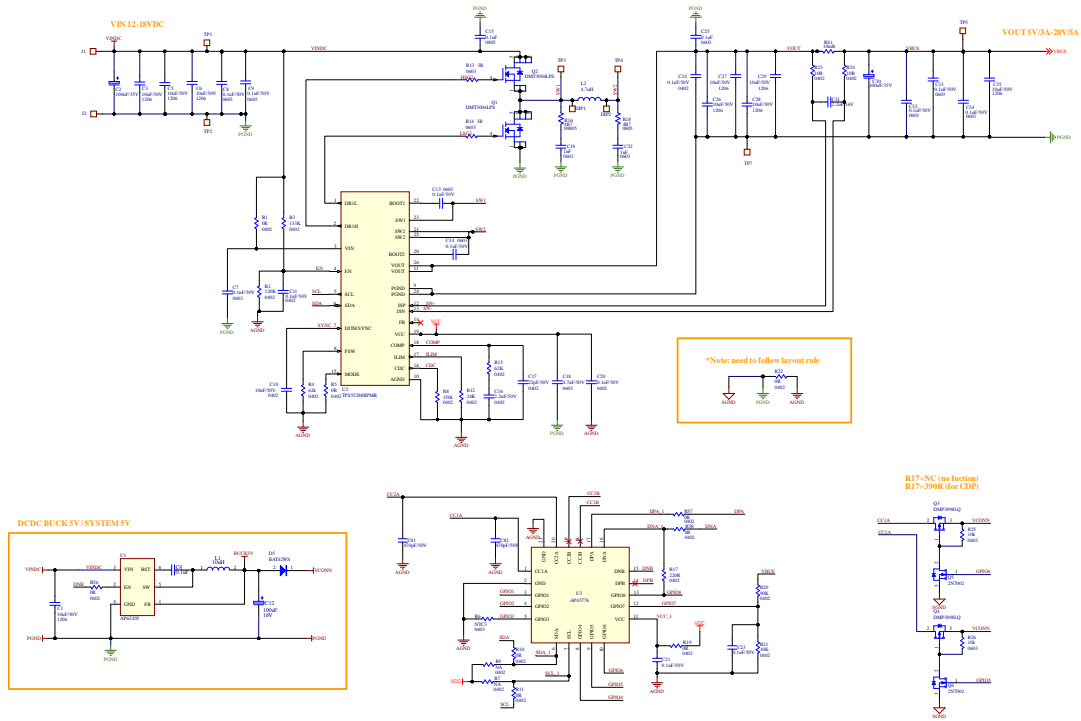


Figure 4. Charging Related Circuitry

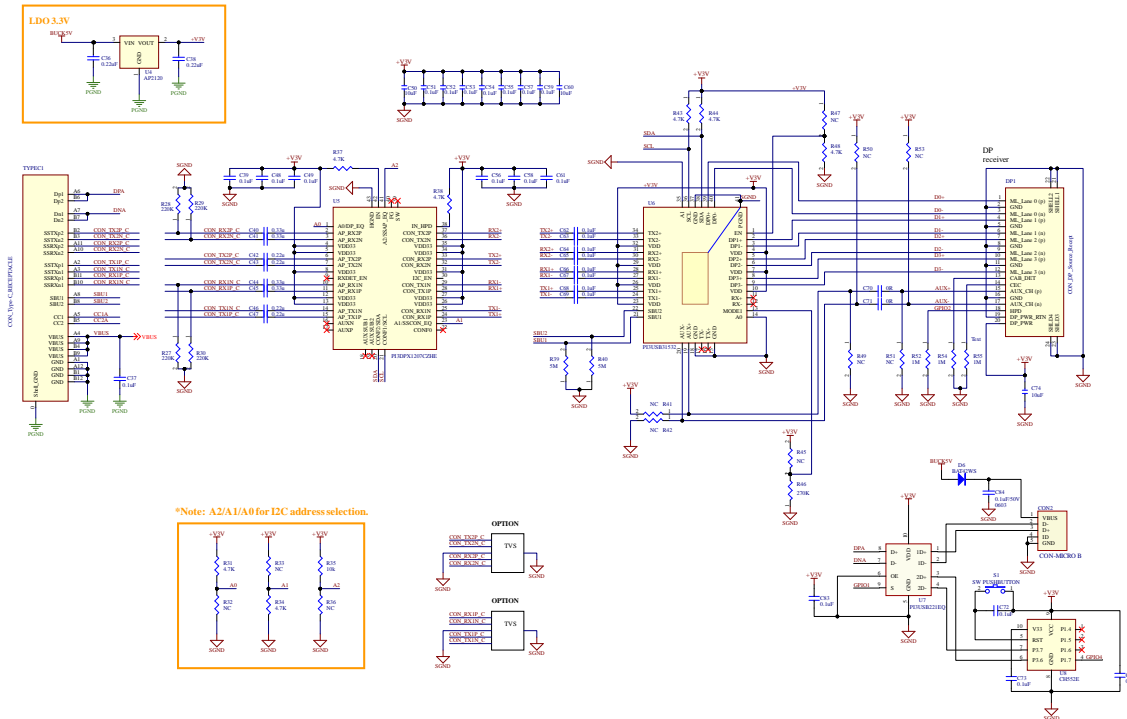


Figure 5. Video Conditioning and Routing Related Circuitry

2.4 Bill of Material (BOM)

Item	Quantity	Designator	Description	Footprint	Manufacturer
1	1	U1	AP63205QWU-7	SMD IC-TSOT26	Diodes Incorporated (Diodes)
2	1	U2	TPS55288RPMR	SMD IC-VQFN-HR	TI
3	1	U3	AP43776Q	SMD IC-QFN 4X4 20-1	Diodes
4	1	U4	AP2120N-3.3TRG1	SMD IC SOT23 N	Diodes
5	1	U5	PI3DPX1207Q3ZHEX	SMD IC-42 TQFN42	Diodes
6	1	U6	PI3USB31532Q2ZLCEX	SMD IC-40 W-QFN3060-40	Diodes
7	1	U7	PI3USB221EQ	SMD IC-10 UQFN, 1.5X2.0	Diodes
8	1	U8	CH552E	SOP10_050P500X500	WCH
9	2	Q1, Q2	DMT36M1LPS-13	DFN5x6	Diodes
10	2	Q3, Q4	DMP3098LQ	QSOT23	Diodes
11	2	Q5, Q6	2N7002	QSOT23	Diodes
12	2	D5, D6	BAT42WS SOD323	A-SOD323	Diodes
13	9	C1, C3, C5, C6, C26, C27, C28, C29, C35	MLCC 10µF 50V 1206 X7R	C-1206	MURATA
14	2	C2, C30	EC 100µF 35V 8X12 POLYMER	EC-SMD_875-115-655-003	WURTH
15	2	C4, C15	MLCC 0.1µF 50V 0805 X7R	C-0805	YAGEO
16	1	C7	MLCC 1µF 50V 0603 X7R	C-0603	YAGEO
17	12	C8, C9, C13, C14, C32, C33, C34, C84, C25, C72, C73, C75	MLCC 0.1µF 50V 0603 X7R	C-0603	YAGEO
18	1	C10	MLCC 10nF 50V 0402 X7R	C-0402	YAGEO
19	5	C11, C20, C21, C23, C24	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
20	1	C12	EC 100µF 35V 6.3X5.4 POLYMER	EC-SMD_865-080-545-012	WURTH
21	1	C16	MLCC 2.2nF 50V 0402 X7R	C-0402	YAGEO
22	1	C17	MLCC 22pF 50V 0402 X7R	C-0402	YAGEO
23	1	C18	MLCC 4.7µF 50V 0603 X7R	C-0603	YAGEO
24	2	C19, C22	MLCC 1nF 50V 0603 X7R	C-0603	YAGEO
25	1	C31	MLCC 2.2µF 16V 0402 X5R	C-0603	YAGEO
26	2	C37, C83	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
27	2	C36, C38	MLCC 1µF 50V 0402 X7R	C-0402	YAGEO
28	21	C39, C48, C49, C51, C52, C53, C54, C55, C56, C57, C58, C59, C61, C62, C63, C64, C65, C66, C67, C68, C69	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
29	4	C40, C41, C44, C45	MLCC 0.33µF 50V 0402 X7R	C-0402	YAGEO

30	4	C42, C43, C46, C47	MLCC 0.22µF 50V 0402 X7R	C-0402	YAGEO
31	3	C50, C60, C74	MLCC 10µF 25V 0805 X7R	C-0805	YAGEO
32	2	C70, C71	RES 0R 0402 1%	C-0402	YAGEO
33	2	C81, C82	MLCC 470pF 50V 0402 X7R	C-0402	YAGEO
34	3	R1, R5, R56	RES 0R 0402 1%	R-0402	YAGEO
35	1	R2,	RES 120k 0402 1%	R-0402	YAGEO
36	1	R3	RES 133K 0402 1%	R-0402	YAGEO
37	2	R4, R15	RES 62K 0402 1%	R-0402	YAGEO
38	1	R6	RES NTC 0603 1%	R-0603	YAGEO
39	2	R7, R9	RES NA 0402 1%	R-0402	YAGEO
40	1	R8	RES 150K 0402 1%	R-0402	YAGEO
41	6	R10, R11, R19, R22, R57, R58	RES 0R 0402 1%	R-0402	YAGEO
42	1	R12	RES 24K 0402 1%	R-0402	YAGEO
43	2	R13, R14	RES 3R 0603 1%	R-0603	YAGEO
44	2	R16, R18	RES 4.7R 0805 1%	R-0805	YAGEO
45	1	R17	RES 220R 0402 1%	R-0402	YAGEO
46	1	R20	RES 120K 0402 1%	R-0402	YAGEO
47	1	R21	RES 13.3K 0402 1%	R-0402	YAGEO
48	2	R23, R24	RES 10R 0402 1%	R-0402	YAGEO
49	2	R25, R26	RES 10K 0603 1%	R-0603	YAGEO
50	4	R27, R28, R29, R30	RES 220K 0402 1%	R-0402	YAGEO
51	2	R31, R34	RES 4.7K 0603 1%	R-0603	YAGEO
52	3	R32, R33, R36	RES NC 0603 1%	R-0603	YAGEO
53	1	R35	RES 10K 0603 1%	R-0603	YAGEO
54	3	R37, R38, R48	RES 4.7K 0402 1%	R-0402	YAGEO
55	2	R39, R40	RES 5M 0402 1%	R-0402	YAGEO
56	7	R41, R42, R45, R47, R49, R50, R53	RES NC 0402 1%	R-0402	YAGEO
57	2	R43, R44	RES 4.7K 0402 1%	R-0402	YAGEO
58	1	R46	RES 270K 0402 1%	R-0402	YAGEO
59	1	R51	RES NC 0402 1%	R-0402	YAGEO
60	3	R52, R54, R55	RES 1M 0402 1%	R-0402	YAGEO
61	1	RS1	RES 10mR 1206 1%	R-1206	YAGEO
62	1	L1	10µH_4.5*5.5mm	SMD_744-355-1470	WURTH
63	1	L2	4.7µH_12*12mm	SMD_784-773-115	WURTH
64	1	CON2	UMMBF-051MGCB9-CF1066	MOLEX_105017-0001	Cherng Weei
65	1	DP1	C6990020-X29-H	CON DP Receiver	Cherng Weei
66	1	S1			

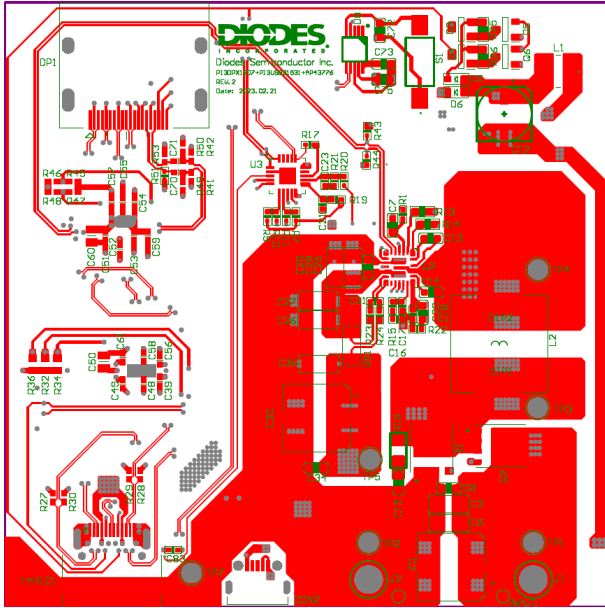
C-Link Automotive PD Charging & Video Evaluation Board (CLA EVB)

67	1	TYPEC1	MUSB12-30-216	SMD TYPEC	MATRIX
Item	Quantity	Designator	Description	Footprint	Manufacturer
1	1	U1	AP63205QWU-7	SMD IC-TSOT26	Diodes
2	1	U2	TPS55288RPMR	SMD IC-VQFN-HR	TI
3	1	U3	AP43776Q	SMD IC-QFN 4X4 20-1	Diodes
4	1	U4	AP2120N-3.3TRG1	SMD IC SOT23 N	Diodes
5	1	U5	PI3DPX1207Q3ZHEX	SMD IC-42 TQFN42	Diodes
6	1	U6	PI3USB31532Q2ZLCEX	SMD IC-40 W-QFN3060-40	Diodes
7	1	U7	PI3USB221EQ	SMD IC-10 UQFN, 1.5X2.0	Diodes
8	1	U8	CH552E	SOP10_050P500X500	WCH
9	2	Q1, Q2	DMT36M1LPS-13	DFN5x6	Diodes
10	2	Q3, Q4	DMP3098LQ	QSOT23	Diodes
11	2	Q5, Q6	2N7002	QSOT23	Diodes
12	2	D5, D6	BAT42WS SOD323	A-SOD323	Diodes
13	9	C1, C3, C5, C6, C26, C27, C28, C29, C35	MLCC 10µF 50V 1206 X7R	C-1206	MURATA
14	2	C2, C30	EC 100µF 35V 8X12 POLYMER	EC-SMD_875-115-655-003	WURTH
15	2	C4, C15	MLCC 0.1µF 50V 0805 X7R	C-0805	YAGEO
16	1	C7	MLCC 1µF 50V 0603 X7R	C-0603	YAGEO
17	12	C8, C9, C13, C14, C32, C33, C34, C84, C25, C72, C73, C75	MLCC 0.1µF 50V 0603 X7R	C-0603	YAGEO
18	1	C10	MLCC 10nF 50V 0402 X7R	C-0402	YAGEO
19	5	C11, C20, C21, C23, C24	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
20	1	C12	EC 100µF 35V 6.3X5.4 POLYMER	EC-SMD_865-080-545-012	WURTH
21	1	C16	MLCC 2.2nF 50V 0402 X7R	C-0402	YAGEO
22	1	C17	MLCC 22pF 50V 0402 X7R	C-0402	YAGEO
23	1	C18	MLCC 4.7µF 50V 0603 X7R	C-0603	YAGEO
24	2	C19, C22	MLCC 1nF 50V 0603 X7R	C-0603	YAGEO
25	1	C31	MLCC 2.2µF 16V 0402 X5R	C-0603	YAGEO
26	2	C37, C83	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
27	2	C36, C38	MLCC 1µF 50V 0402 X7R	C-0402	YAGEO
28	21	C39, C48, C49, C51, C52, C53, C54, C55, C56, C57, C58, C59, C61, C62, C63, C64, C65, C66, C67, C68, C69	MLCC 0.1µF 50V 0402 X7R	C-0402	YAGEO
29	4	C40, C41, C44, C45	MLCC 0.33µF 50V 0402 X7R	C-0402	YAGEO
30	4	C42, C43, C46, C47	MLCC 0.22µF 50V 0402 X7R	C-0402	YAGEO
31	3	C50, C60, C74	MLCC 10µF 25V 0805 X7R	C-0805	YAGEO

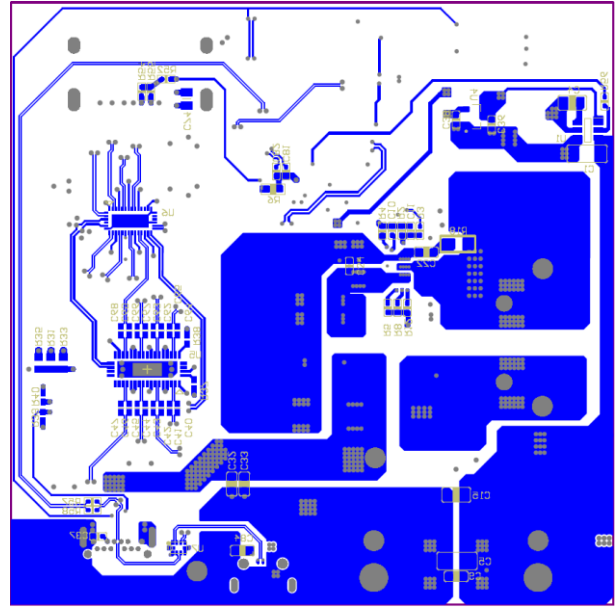
32	2	C70, C71	RES 0R 0402 1%	C-0402	YAGEO
33	2	C81, C82	MLCC 470pF 50V 0402 X7R	C-0402	YAGEO
34	3	R1, R5, R56	RES 0R 0402 1%	R-0402	YAGEO
35	1	R2,	RES 120k 0402 1%	R-0402	YAGEO
36	1	R3	RES 133K 0402 1%	R-0402	YAGEO
37	2	R4, R15	RES 62K 0402 1%	R-0402	YAGEO
38	1	R6	RES NTC 0603 1%	R-0603	YAGEO
39	2	R7, R9	RES NA 0402 1%	R-0402	YAGEO
40	1	R8	RES 150K 0402 1%	R-0402	YAGEO
41	6	R10, R11, R19, R22, R57, R58	RES 0R 0402 1%	R-0402	YAGEO
42	1	R12	RES 24K 0402 1%	R-0402	YAGEO
43	2	R13, R14	RES 3R 0603 1%	R-0603	YAGEO
44	2	R16, R18	RES 4.7R 0805 1%	R-0805	YAGEO
45	1	R17	RES 220R 0402 1%	R-0402	YAGEO
46	1	R20	RES 120K 0402 1%	R-0402	YAGEO
47	1	R21	RES 13.3K 0402 1%	R-0402	YAGEO
48	2	R23, R24	RES 10R 0402 1%	R-0402	YAGEO
49	2	R25, R26	RES 10K 0603 1%	R-0603	YAGEO
50	4	R27, R28, R29, R30	RES 220K 0402 1%	R-0402	YAGEO
51	2	R31, R34	RES 4.7K 0603 1%	R-0603	YAGEO
52	3	R32, R33, R36	RES NC 0603 1%	R-0603	YAGEO
53	1	R35	RES 10K 0603 1%	R-0603	YAGEO
54	3	R37, R38, R48	RES 4.7K 0402 1%	R-0402	YAGEO
55	2	R39, R40	RES 5M 0402 1%	R-0402	YAGEO
56	7	R41, R42, R45, R47, R49, R50, R53	RES NC 0402 1%	R-0402	YAGEO
57	2	R43, R44	RES 4.7K 0402 1%	R-0402	YAGEO
58	1	R46	RES 270K 0402 1%	R-0402	YAGEO
59	1	R51	RES NC 0402 1%	R-0402	YAGEO
60	3	R52, R54, R55	RES 1M 0402 1%	R-0402	YAGEO
61	1	RS1	RES 10mR 1206 1%	R-1206	YAGEO
62	1	L1	10µH_4.5*5.5mm	SMD_744-355-1470	WURTH
63	1	L2	4.7µH_12*12mm	SMD_784-773-115	WURTH
64	1	CON2	UMMBF-051MGCB9- CF1066	MOLEX_105017-0001	Cherng Weei
65	1	DP1	C6990020-X29-H	CON DP Receiver	Cherng Weei
66	1	S1			
67	1	TYPEC1	MUSB12-30-216	SMD TYPEC	MATRIX

Table 1. BOM List

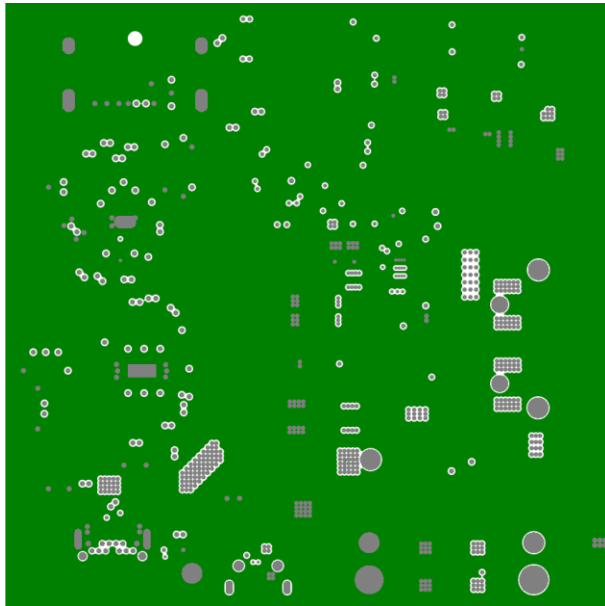
2.5 PCB Layout



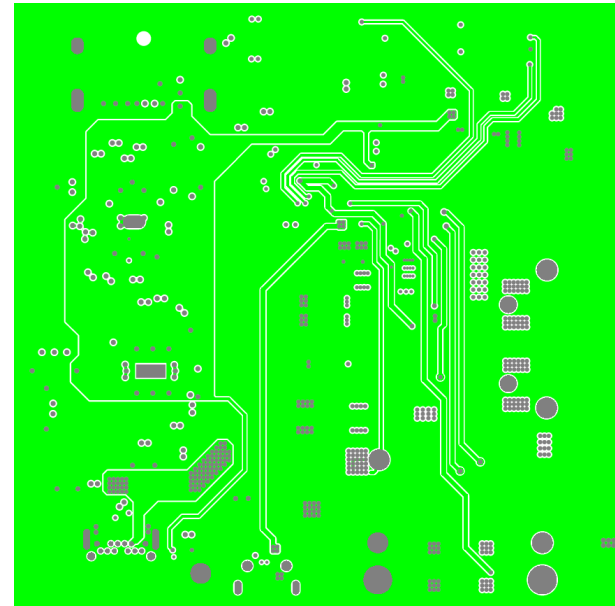
Top Layer



Bottom Layer



Single Layer1



Single Layer2

Chapter 3. Down-Facing Port (DFP) Charging Test Set Up and Testing Summary

3.1 DFP Type-C PD Charging Test Setup

A Power-Z Voltage Tester, along with a USB-C pin out board, to emulate power request for 100W (20V@5A0, is shown in Figure 6. Figure 7 shows successful voltage switching stepping various fixed PDO (5V, 9V, 15V, 20V).

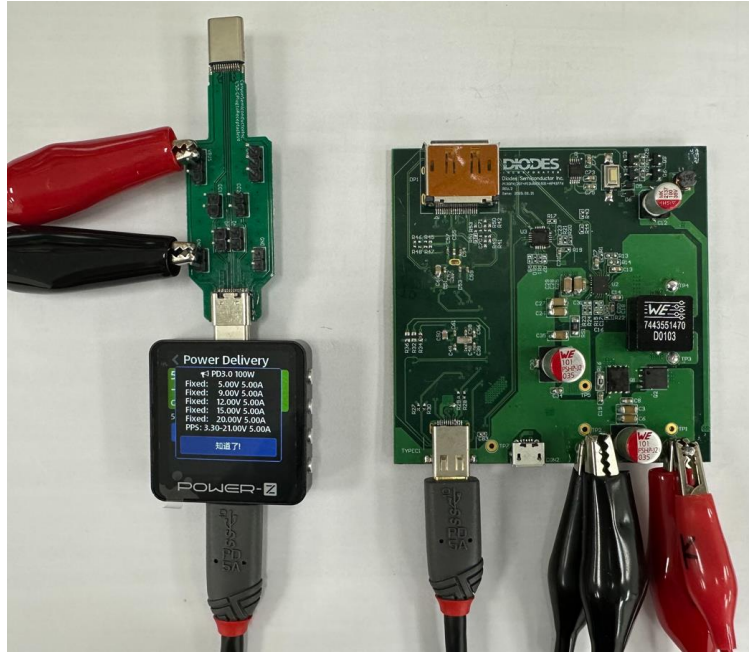


Figure 6. 100W DFP PD Charging Set-Up

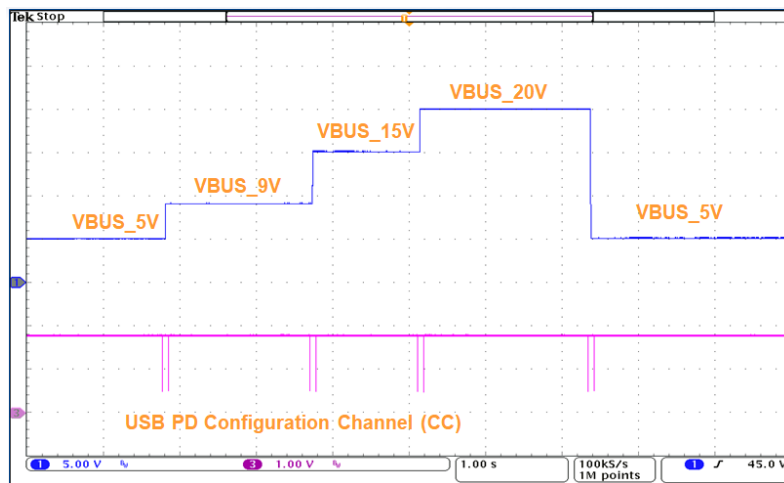


Figure 7. 100W PD Voltage Switching

3.2 Charging Efficiency Testing

Vin (V)	Iin (A)	Pi (W)	Vout (V)	Iout (A)	Po (W)	Eff (%)	U2 (°C)	Q1 (°C)	Q2 (°C)	L2 (°C)
10	2.676	26.76	5.044	5.00	25.22	94.25	43.2	40.4	41	39.8
10	4.666	46.66	9.039	5.00	45.20	96.86	42	38.3	40.5	38.1
10	6.253	62.53	12.049	5.00	60.24	96.34	63.7	41.4	44.6	46.4
10	7.893	78.93	15.046	5.00	75.23	95.31	87.5	51.4	56.5	60.8
10	10.746	107.46	20.047	5.00	100.24	93.28	138.3	59.9	71.1	72.2
12	2.245	26.94	5.046	5.00	25.23	93.65	42.8	39.5	40.6	39.6
12	3.903	46.84	9.040	5.00	45.20	96.51	41.6	38.3	40.1	38.1
12	5.165	61.98	12.047	5.00	60.24	97.18	48.5	37.5	40	39
12	6.496	77.95	15.044	5.00	75.22	96.50	71.5	43.7	46.9	49.5
12	8.786	105.43	20.036	5.00	100.18	95.02	116.4	58.4	65.2	71.8
14	1.932	27.05	5.045	5.00	25.23	93.26	43.8	40.2	41.3	40.9
14	3.355	46.97	9.040	5.00	45.20	96.23	42.6	39.8	42.3	40.2
14	4.423	61.92	12.046	5.00	60.23	97.27	42.9	38.5	42	38.5
14	5.528	77.39	15.042	5.00	75.21	97.18	62.7	38.1	40.2	41.9
14	7.445	104.23	20.033	5.00	100.17	96.10	96	50.1	55.2	60.5

Table 2. Efficiency and Thermal Test for PD Output

Vin (V)	Vo (V)	Io (A)	Ripple ΔV (mV)	Ripple (%)
10	5	5	22	0.44
10	9	5	22	0.24
10	12	5	64	0.53
10	15	5	96	0.64
10	20	5	128	0.64
12	5	5	24	0.48
12	9	5	24	0.27
12	12	5	60	0.50
12	15	5	76	0.51
12	20	5	116	0.58
14	5	5	26	0.52
14	9	5	28	0.31
14	12	5	26	0.22
14	15	5	60	0.40
14	20	5	104	0.52

Table 3. Output Ripple during PD Voltage Switching

Vin (V)	Iin (mA)	Standby Power (mW)
10	0.89	8.90
12	0.9	10.80
14	0.91	12.74

Table 4. Standby Power Consumption

Vin (V)	PDO (V)	Vout (V)	Iout (A)	VBUS			
				Overshoot(V)	Tolerance (%)	Undershoot(V)	Tolerance (%)
10	5	5.07	0.5<-->4.5	5.25	3.55	4.86	-4.14
10	9	9.08	0.5<-->4.5	9.26	1.98	8.8	-3.08
10	12	12.1	0.5<-->4.5	12.4	2.48	11.8	-2.48
10	15	15.1	0.5<-->4.5	15.4	1.99	14.7	-2.65
10	20	20.1	0.5<-->4.5	20.5	1.99	19.6	-2.49
12	5	5.07	0.5<-->4.5	5.24	3.35	4.88	-3.75
12	9	9.08	0.5<-->4.5	9.27	2.09	8.88	-2.20
12	12	12.1	0.5<-->4.5	12.4	2.48	11.8	-2.48
12	15	15.1	0.5<-->4.5	15.4	1.99	14.8	-1.99
12	20	20.1	0.5<-->4.5	20.5	1.99	19.7	-1.99
14	5	5.07	0.5<-->4.5	5.25	3.55	4.86	-4.14
14	9	9.08	0.5<-->4.5	9.27	2.09	8.88	-2.20
14	12	12.1	0.5<-->4.5	12.3	1.65	11.8	-2.48
14	15	15.1	0.5<-->4.5	15.4	1.99	14.8	-1.99
14	20	20.1	0.5<-->4.5	20.4	1.49	19.7	-1.99

Table 5. Dynamic Loading for Various Fixed PDO Output

Vin (V)	Vo (V)	Io (A)	Rising (ms)	Overshoot (V)	Overshoot (%)	Vin (V)	Vo (V)	Io (A)	Falling (ms)	Undershoot (V)	Undershoot (%)
10	5-->9	5	1.37	9.27	3.0%	10	9-->5	5	1.38	5.07	1.3%
10	9-->12	5	0.98	12.22	1.8%	10	12-->9	5	0.98	9.11	1.3%
10	12-->15	5	0.96	15.26	1.7%	10	15-->12	5	0.96	12.01	0.1%
10	15-->20	5	1.64	20.33	1.7%	10	20-->15	5	1.651	15	0.0%
12	5-->9	5	1.34	9.19	2.1%	12	9-->5	5	1.33	4.94	-1.2%
12	9-->12	5	0.98	12.13	1.1%	12	12-->9	5	0.97	8.99	-0.1%
12	12-->15	5	1.00	15.16	1.1%	12	15-->12	5	1.01	12.02	0.2%
12	15-->20	5	1.67	20.23	1.2%	12	20-->15	5	1.637	14.91	-0.6%
14	5-->9	5	1.37	9.27	2.9%	14	9-->5	5	1.37	5.07	1.3%
14	9-->12	5	0.98	12.22	1.8%	14	12-->9	5	0.95	9.11	1.2%
14	12-->15	5	0.98	15.24	1.6%	14	15-->12	5	0.99	12.04	0.3%
14	15-->20	5	1.70	20.28	1.4%	14	20-->15	5	1.705	15.03	0.2%

Table 6. Dynamic Performance of Voltage Switching

Chapter 4. Up-Facing Port (UFP) Video/Data Setup and Testing Summary

4.1 UFP Video/Data Set Up

Figure 8 shows the connection setup to validate the UFP video path from a notebook (MacBook in this example) to DP Monitor (Model No of the Monitor) through the CLA-PD EVB. A USB-C-to-USB-C cable connects between USB-C Port of MacBook (Receptor) and USB-C port of the CLA-PD EVB (Plug).

This video test confirms support of Pin Assignment C/D.

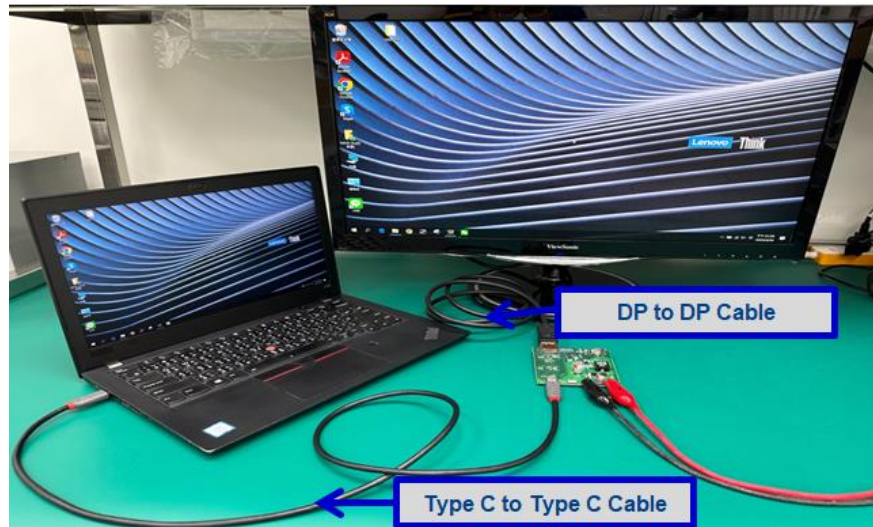


Figure 8. Notebook to DP Monitor UFP Test Set Up

Figure 9 shows the connection setup to validate the UFP video path from a smartphone (Galaxy S20 in this example) to DP Monitor (Model No of the Monitor) through the CLA-PD EVB. A USB-C-to-USB-C cable connects between a USB-C Port smartphone (Receptor) and USB-C port of the CLA-PD EVB (Plug).

This video test confirms support of **Pin Assignment C**.

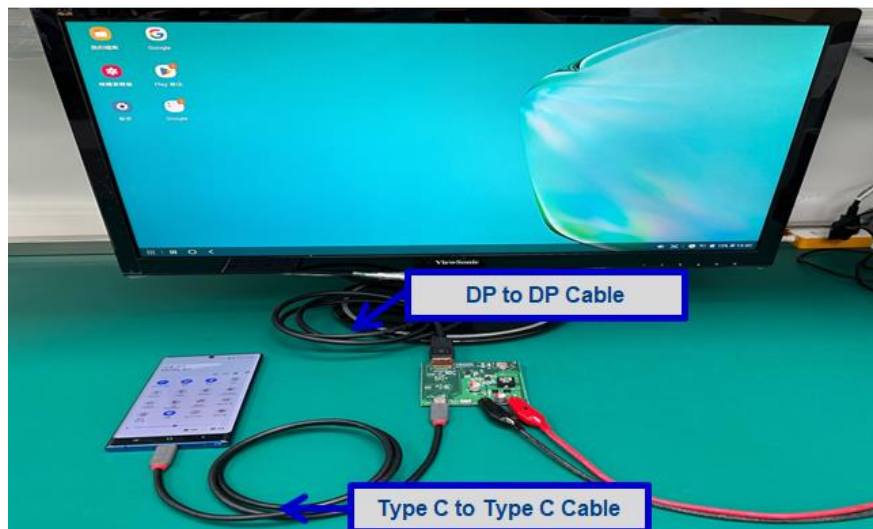


Figure 9. Smartphone to DP Monitor UFP Test Set Up

Figure 10 shows the connection setup to validate the UFP video path from a Desktop PC to a DP Monitor (Model No of the Monitor) through the CLA-PD EVB. A DP-to-DP cable connects between DP output (Receptor) of the Desktop PC and the DP port of the CLA-PD EVB (Plug).

This video test confirms support of **Pin Assignment E**.

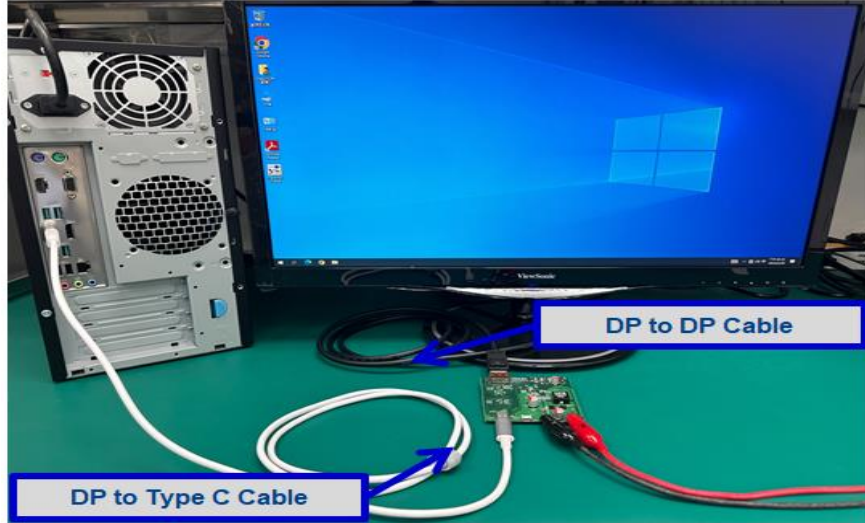


Figure 10. Desktop to DP Monitor UFP Test Set Up

C-Link Automotive PD Charging & Video Evaluation Board (CLA EVB)

Device	USB-C flip / non-flip	Pin assignment request	Data Role swap	Power request
MacBook Air (2019) + USB-C Cable	OK	C / D	OK	20V/5A
MacBook (2016) + USB-C Cable	OK	Depending on MacBook Selection (C or D)	OK	20/5A
MacBook Pro (2017 A1707) + USB-C Cable	OK	D	OK	20V/5A
MacBookAir (2022 A2337) + USB-C Cable	OK		OK	20V/5A
MacBookAir (2020 A2179) + USB-C Cable	OK		OK	20V/5A
MacBookPro (2021 A2442) + USB-C Cable	OK		OK	20V/5A
MacBookPro (2023 A2779) + USB-C Cable	OK		OK	20V/5A
MacBookPro (inter2020 A2289) + USB-C Cable	OK		OK	20V/3A
MakBookPro (2021 A2485) + USB-C Cable	OK		OK	20/5A
Lenovo ThinkPad E14 Gen2 (2020) + USB-C Cable	OK		OK	20V/3.25A
Lenovo ThinkPad X1 Carbon Gen 8 (2020) + USB-C Cable	OK		OK	20V/3.25A
Lenovo Legion Y540-15IRH-PG0 (2020) + USB-C Cable	OK		OK	5V/3A
Lenovo Yoga Slim 7i Pro (2021) + USB-C Cable	OK		OK	20V/5A
DELL Inspiron 16 5625-R1508STW (2022) + USB-C Cable	OK		OK	20V/3A
DELL XPS13-9310-P3708STW (2020) + USB-C Cable	OK		OK	20V/2.25A
DELL G15-5525 (2021) + USB-C Cable	OK		OK	5V/3A
ASUS ZenBook 13 OLED UX325UA (2020) + USB-C Cable	OK		OK	20V/3A
ASUS ROG Zephyrus G14 (2022) + USB-C Cable	OK		OK	20V/5A
HP ProBook (2021 AX201NGW)	OK		OK	20V/5A
HP EliteBook 640 14 inch G9 Notebook PC (2022) + USB-C Cable	OK	OK	20V/5A	
iPad Pro (III A2377)	OK	D	OK	20V/4.4A
iPad pro III (12.9 inch)	OK	D	OK	
iPhone 15 / Plus	OK	D	OK	
Samsung Galaxy S20 + USB-C Cable	OK	C	OK	5V/3A
Samsung Galaxy S21 / S22 + USB-C Cable	OK	D	OK	9V/3A
Samsung NOTE 10 / Plus+ USB-C Cable	OK	C / D	OK	5V/3A
HUAWEI P60	OK	C	OK	9V/5A
HUAWEI P30 Pro / Mate 20	OK	C	OK	5V/2A
Microsoft Surface GO 3 (Mode I 1901, Win 11 version 21H2)	OK	D	OK	20V/2.25A
Desktop PC + CableCreation CD0738-G (DP-to-USB-C Cable)	OK	C (Non-Standard-Compliance Cable)	OK	5V/3A (no E-mark)
Desktop PC + Moshi 5K (DP-to-USB-C Cable)	OK	E (Standard-Compliance Cable)	OK	5V/3A (no E-mark)
Nintendo Switch 2019/2021	OK	C	OK	15V/3A

Table 7. Pin Assignment Compliance Test Summary

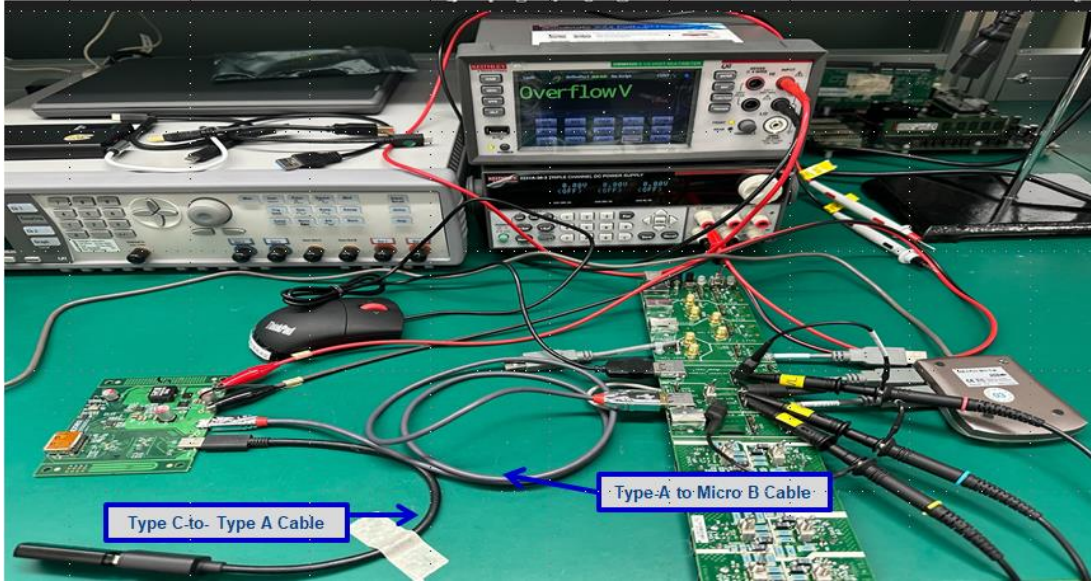


Figure 11. USB2.0 full-speed Test Setup

TekExpress USB2 Report

Report for Device

Setup Information			
DUT ID	3776_Micro-USB_to_USB-C	Suite	Device
Date/Time	2023-04-07 12:32:20	TekExpress USB2	1.2.7.2
Acquisition Mode	Live	FrameWork Version	4.18.0.2
Test Point	Near End	Scope Model	MSO56
Probing	Single Ended only	Scope Firmware	1.44.3.433
Over All Test Result	Pass		
Total Execution Time	1 Minute 6 Seconds		
DUT COMMENT:	General Comment - USB2-Device		

Test Name Summary Table	
Eye Diagram	Pass
EOP Width	Pass
Signal Rate	Pass
Edge Monotonicity	Pass
Cross Over	Pass
Consecutive Jitter	Pass
Paired JK Jitter	Pass
Paired KJ Jitter	Pass
Rising Edge Rate	Pass
Falling Edge Rate	Pass
Edge Rate Match	Pass
Rise Time	Pass
Fall Time	Pass

C-Link Automotive PD Charging & Video Evaluation Board (CLA EVB)

Eye Diagram							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Mask Hits	Full Speed	0.000	Pass	0.000 & 0.000	0.000	0.000	N.A
ERROR MESSAGE	N.A						

EOP Width							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
EOP Width	Full Speed	162.200 ns	Pass	2.200 ns & 12.800 ns	160.000 ns	175.000 ns	N.A
ERROR MESSAGE	N.A						

Signal Rate							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Signal Rate	Full Speed	12.002 Mbps	Pass	0.032 Mbps & 0.028 Mbps	11.970 Mbps	12.030 Mbps	N.A
ERROR MESSAGE	N.A						

Edge Monotonicity							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Edge Monotonicity	Full Speed	200.000 mV	Pass	300.000 mV	N.A	500.000 mV	N.A
ERROR MESSAGE	N.A						

Cross Over							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Max Crossover Voltage	Full Speed	1.740 V	Pass	0.440 V & 0.260 V	1.300 V	2.000 V	N.A
Min Crossover Voltage	Full Speed	1.520 V	Pass	0.220 V & 0.480 V	1.300 V	2.000 V	N.A
Mean Crossover Voltage	Full Speed	1.630 V	Pass	0.330 V & 0.370 V	1.300 V	2.000 V	N.A
ERROR MESSAGE	N.A						

Consecutive Jitter							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Max Consecutive Jitter	Full Speed	3748.273 ps	Pass	36251.727 ps	N.A	40000.000 ps	Passed on waiver limits.
Min Consecutive Jitter	Full Speed	-3500.060 ps	Pass	5500.060 ps	N.A	2000.000 ps	N.A
RMS Consecutive Jitter	Full Speed	3016.437 ps	Pass	36983.563 ps	N.A	40000.000 ps	Passed on waiver limits.
ERROR MESSAGE	N.A						

Paired JK Jitter							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Max JK Jitter	Full Speed	723.333 ps	Pass	276.667 ps	N.A	1000.000 ps	N.A
Min JK Jitter	Full Speed	-791.667 ps	Pass	1791.667 ps	N.A	1000.000 ps	N.A
RMS JK Jitter	Full Speed	485.545 ps	Pass	514.455 ps	N.A	1000.000 ps	N.A
ERROR MESSAGE	N.A						

Paired KJ Jitter							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Max KJ Jitter	Full Speed	366.667 ps	Pass	633.333 ps	N.A	1000.000 ps	N.A
Min KJ Jitter	Full Speed	-496.667 ps	Pass	1496.667 ps	N.A	1000.000 ps	N.A
RMS KJ Jitter	Full Speed	286.389 ps	Pass	713.611 ps	N.A	1000.000 ps	N.A
ERROR MESSAGE	N.A						

Rising Edge Rate							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Rising Edge Rate	Full Speed	84.720 V/μs	Informative	-47.280 V/μs & 575.280 V/μs	132.000 V/μs	660.000 V/μs	N.A
ERROR MESSAGE	N.A						

Falling Edge Rate							
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C-Link Automotive PD Charging & Video Evaluation Board (CLA EVB)

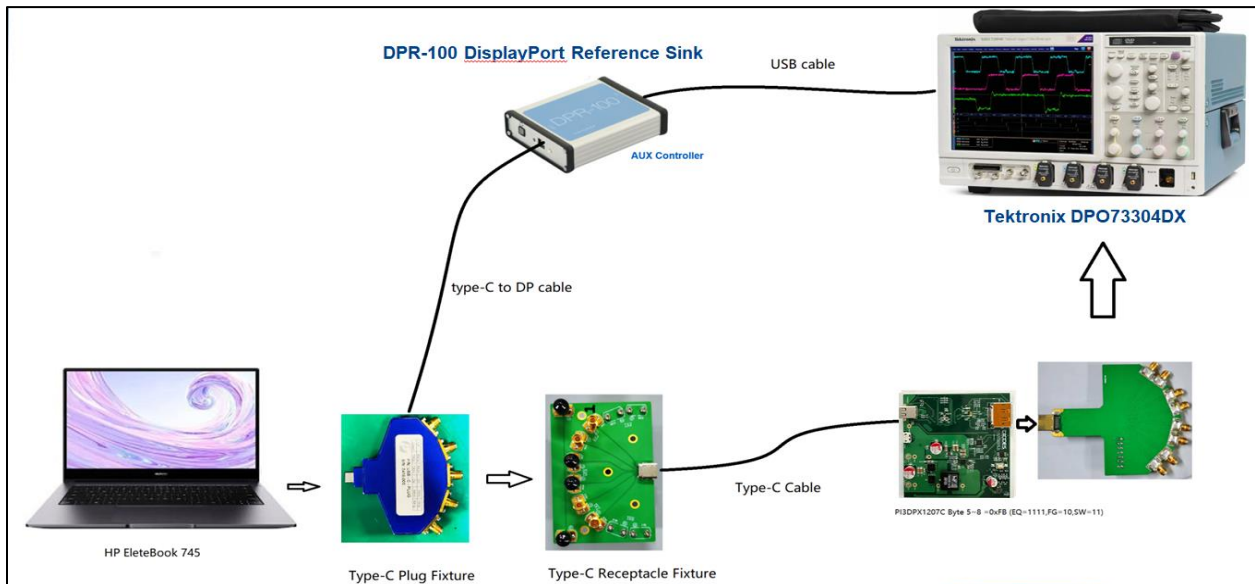
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Falling Edge Rate	Full Speed	83.110 V/ μ s	Informative	-48.890 V/ μ s & 576.890 V/ μ s	132.000 V/ μ s	660.000 V/ μ s	N.A
ERROR MESSAGE	N.A						

Edge Rate Match							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Edge Rate Match	Full Speed	1.910 %	Informative	21.910 % & 18.090 %	-20.000 %	20.000 %	N.A
ERROR MESSAGE	N.A						

Rise Time							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Rise Time	Full Speed	31.160 ns	Informative	27.160 ns & -11.160 ns	4.000 ns	20.000 ns	N.A
ERROR MESSAGE	N.A						

Fall Time							
Measurement Details	Speed	Measured Value	Test Result	Margin	Low Limit	High Limit	Comments
Fall Time	Full Speed	31.760 ns	Informative	27.760 ns & -11.760 ns	4.000 ns	20.000 ns	N.A
ERROR MESSAGE	N.A						

4.2 Signal Integrity (Eye Diagram) Test



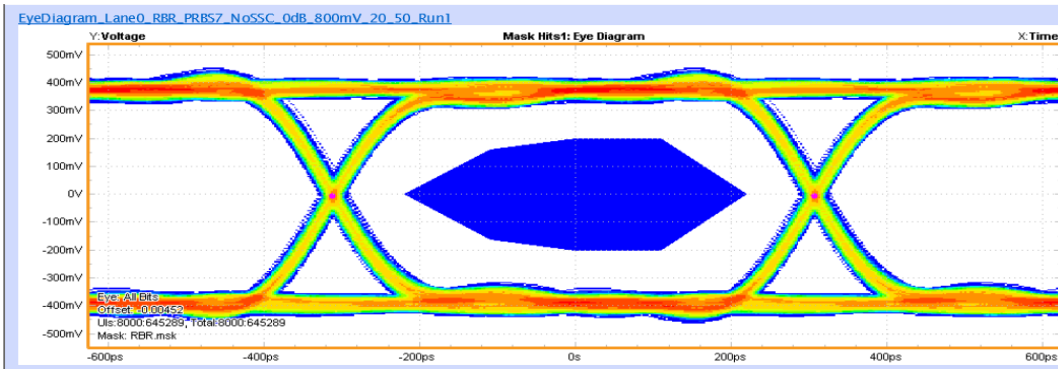
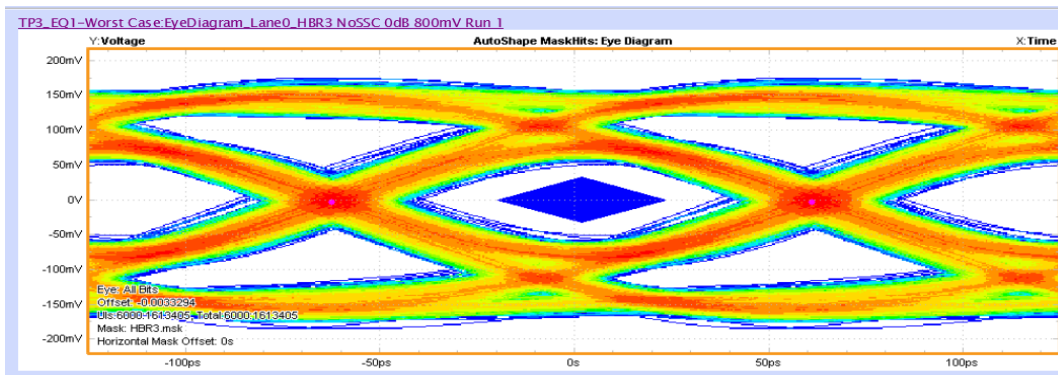
TekExpress Automated Test Solution TekExpress DisplayPort™

Setup Information			
DUT ID	Diodes_CLM_Lane1_2	Scope Model	DPO73304DX
Date/Time	2023-04-11 18:46:24	Scope Serial Number	B280031
Device Type	DisplayPort	SPC, FactoryCalibration	PASS;PASS
App Version	Display Port:10.3.5.4	Scope F/W Version	10.8.7 Build 29
TekExpress Version	Framework:4.9.0.5	DPOJET Version	10.3.0.5
Execution Mode	Live	ProbeCH1 Model	P7313SMA
Overall Compliance Mode	Yes	ProbeCH1 Serial Number	B022534
OverallResult	Pass	ProbeCH2 Model	P7313SMA
Overall Execution Time	0:17:36	ProbeCH2 Serial Number	B021949
DUT Automation Method	DPR-100	ProbeCH3 Model	P7313SMA
Connector	Standard	ProbeCH3 Serial Number	B020655
CTS Version	CTS 1.4	ProbeCH4 Model	P7313SMA
DPR100 Version	DP Rev 1.2	ProbeCH4 Serial Number	B021953
DUT COMMENT:	General Comment - DisplayPort		

Test Name Summary Table	
Test 3.1_Eye diagram testing	Pass
Total Measurements Executed: 36: Pass = 36: Fail = 0: Skipped = 0: Error = 0	

Test 3.1_Eye diagram testing							
Lane	Measurement Details	Measured Value	Units	Test Result	Margin	Low Limit	High Limit
Lane0	MaskHits TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane0	Width TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	0.6571	UI	Pass	0.2371	0.42	N.A
Lane0	Height TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	355.6190	mV	Pass	290.6190	65	N.A
Lane0	MaskHits TP3_EQ1-Worst Case-CTLE -7dB:HBR3 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane0	Width TP3_EQ1-Worst Case-CTLE -7dB:HBR3 NoSSC 0dB 800mV Run 1	0.5602	UI	Pass	0.1402	0.42	N.A
Lane0	Height TP3_EQ1-Worst Case-CTLE -7dB:HBR3 NoSSC 0dB 800mV Run 1	99.5669	mV	Pass	34.5669	65	N.A
Lane1	MaskHits TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane1	Width TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	0.5843	UI	Pass	0.1643	0.42	N.A
Lane1	Height TP3_EQ1-Zero Length-CTLE 0dB:HBR3 NoSSC 0dB 800mV Run 1	390.7208	mV	Pass	325.7208	65	N.A
Lane1	MaskHits TP3_EQ1-Worst Case-CTLE -6dB:HBR3 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane1	Width TP3_EQ1-Worst Case-CTLE -6dB:HBR3 NoSSC 0dB 800mV Run 1	0.5409	UI	Pass	0.1209	0.42	N.A
Lane1	Height TP3_EQ1-Worst Case-CTLE -6dB:HBR3 NoSSC 0dB 800mV Run 1	106.4804	mV	Pass	41.4804	65	N.A
Lane0	MaskHits TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane0	Width TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0.6465	UI	Pass	0.2265	0.42	N.A
Lane0	Height TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	532.8713	mV	Pass	428.8713	104	N.A
Lane0	MaskHits TP3_EQ1-Worst Case-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane0	Width TP3_EQ1-Worst Case-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0.7176	UI	Pass	0.2976	0.42	N.A
Lane0	Height TP3_EQ1-Worst Case-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	368.0946	mV	Pass	264.0946	104	N.A
Lane1	MaskHits TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane1	Width TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0.6805	UI	Pass	0.2605	0.42	N.A
Lane1	Height TP3_EQ1-Zero Length-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	438.3891	mV	Pass	334.3891	104	N.A
Lane1	MaskHits TP3_EQ1-Worst Case-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0	Hits	Pass	0.0000	N.A	0
Lane1	Width TP3_EQ1-Worst Case-sdlactle:HBR2 NoSSC 0dB 800mV Run 1	0.7118	UI	Pass	0.2918	0.42	N.A

Lane1	Height TP3_EQ1-Worst Case-sdlectle:HBR2 NoSSC 0dB 800mV Run 1	373.6053	mV	Pass	269.6053	104	N.A
Lane0	MaskHits:RBR NoSSC 0dB 800mV Run1	0	Hits	Pass	0.0000	N.A	0
Lane0	Eye Width:RBR NoSSC 0dB 800mV Run1	0.9315	UI	Pass	0.1855	0.746	N.A
Lane0	Eye Height:RBR NoSSC 0dB 800mV Run1	666.3655	mV	Pass	266.3655	400	N.A
Lane0	MaskHits:HBR NoSSC 0dB 800mV Run1	0	Hits	Pass	0.0000	N.A	0
Lane0	Eye Width:HBR NoSSC 0dB 800mV Run1	0.9156	UI	Pass	0.3356	0.58	N.A
Lane0	Eye Height:HBR NoSSC 0dB 800mV Run1	614.1387	mV	Pass	264.1387	350	N.A
Lane1	MaskHits:RBR NoSSC 0dB 800mV Run1	0	Hits	Pass	0.0000	N.A	0
Lane1	Eye Width:RBR NoSSC 0dB 800mV Run1	0.9377	UI	Pass	0.1917	0.746	N.A
Lane1	Eye Height:RBR NoSSC 0dB 800mV Run1	656.7731	mV	Pass	256.7731	400	N.A
Lane1	MaskHits:HBR NoSSC 0dB 800mV Run1	0	Hits	Pass	0.0000	N.A	0
Lane1	Eye Width:HBR NoSSC 0dB 800mV Run1	0.9245	UI	Pass	0.3445	0.58	N.A
Lane1	Eye Height:HBR NoSSC 0dB 800mV Run1	610.9469	mV	Pass	260.9469	350	N.A
COMMENTS		DFE Taps:1, Amplitude:0.05V, Threshold:0					



Chapter 5. USB-C PD Protocol Compliance Test

5.1 Ellysis

Ellisys USB Compliance Report	
Date and time	Wednesday, 26 April 2023 18:51:49 GMT+8
Vendor	CLA_100W
Product	AP43776
Product revision	1
Test ID	0000
Component Under Test	1
Port Label	1
Generator used	Ellisys USB Explorer 350 (EX350-62138)
Analyzer used	Ellisys USB Explorer 350 (EX350-62136)
Software version	Report generated with version 3.1.8502
Overall result	Passed
Summary	

5.2 LeCroy

Teledyne LeCroy USB Compliance Suite Overview Result

Device Under Test
 Vendor_Name CLA_100W
 Model_Part_Number AP43776
 Product_Revision 1
 UUT Alias CLA_100W-AP43776-0000

Friday, May 12, 2023 - 13:58

JSB Power Delivery - USBIF
 CTS implemented: r1.4 V6 RC4 (full), Q3 2023 CR1 (partial)

Compliance Test	Result	Description
TEST.PREP.PR.01 Preparation for Bring-up Source UUT	Pass	
Rev3ChkdSrc	Pass	
TEST.PREP.PR.1#1	Pass	
TEST.PD.PHY.ALL.01 Transmit Bit Rate and the Drift	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.PHY.ALL.1#1	Pass	
TEST.PD.PHY.ALL.1#2	Pass	
TEST.PD.PHY.ALL.1#3	Pass	
TEST.PD.PHY.ALL.02 Transmitter Eye Diagram	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.PHY.ALL.2#1	Pass	
TEST.PD.PHY.ALL.2#2	Pass	
TEST.PD.PHY.ALL.03 Collision Avoidance	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.PHY.ALL.3#1	Pass	
TEST.PD.PHY.ALL.3#2	Pass	

TEST.PD.PHY.ALL.04 Bus Idle Detection	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.PHY.ALL.4#1	Pass	
TEST.PD.PHY.ALL.05 Receiver Interference Rejection (AWG method)	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.PHY.ALL.5#1	Pass	
TEST.PD.PHY.ALL.5#2	N/A	This is not applicable for the current selected 'PD_Port_Type'.
TEST.PD.PHY.ALL.5#3	Pass	
TEST.PD.PHY.ALL.5#4	N/A	This is not applicable for the current selected 'VIF_Product_Type'.
TEST.PD.PHY.ALL.05 Receiver Interference Rejection (2-Tone method)	Pass	
Rev3ChkdSrc	Pass	
COMMON.PROC.BU.1#1	Pass	
COMMON.PROC.BU.1#2	Pass	
COMMON.PROC.BU.1#3	Pass	
COMMON.PROC.BU.1#4	Pass	
TEST.PD.USB4.CBL.01 Enter_USB command response of cable UUT-Valid Mode	N/A	This test is only applicable for any device with 'Captive_Cable' is 'YES' and 'Captive_Cable_Is_Emarked' = 'YES'
TEST.PD.USB4.CBL.02 Enter_USB command response of Cable UUT-Invalid Mode	N/A	This test is only applicable for any device with 'Captive_Cable' is 'YES' and 'Captive_Cable_Is_Emarked' = 'YES'

Total Tests 116
Passed Tests 57
Failed Tests 0
N/A Tests 59
Indeterminate Tests 0

Common Checks

Common Checks	Result	Occurance
COMMON.CHECK.PD.1 Check Preamble	Pass	
COMMON.CHECK.PD.2 Check Message Header	Pass	
COMMON.CHECK.PD.3 Check GoodCRC	Pass	
COMMON.CHECK.PD.4 Check Atomic Message Sequence	Pass	
COMMON.CHECK.PD.5 Check Unexpected Messages and Signals	Pass	
COMMON.CHECK.PD.6 Check Control Message	Pass	
COMMON.CHECK.PD.7 Check Source Capabilities Message	Pass	
COMMON.CHECK.PD.8 Check Request Message	Pass	
COMMON.CHECK.PD.9 Check Structured VDM Message	Pass	
COMMON.CHECK.PD.10 Check Extended Message Header	Pass	
COMMON.CHECK.PD.11 Check Source Capabilities Extended Message	Pass	
COMMON.CHECK.PD.12 Check Sink Capabilities Message	Pass	
COMMON.CHECK.PD.13 Check Correct Use of Rp	Pass	
COMMON.CHECK.PD3.1 Check EPR_Request Message	Pass	
COMMON.CHECK.PD3.2 Check EPR_Mode Message	Pass	
COMMON.CHECK.PD3.3 Check EPR_Source_Capabilities Message	Pass	
COMMON.CHECK.PD3.4 Check EPR_Sink_Capabilities Message	Pass	
COMMON.PROC.PD.2 UUT Sent Get_Source_Cap	Pass	
COMMON.PROC.PD.3 UUT Sent Get_Sink_Cap	Pass	
COMMON.PROC.PD.4 UUT Sent Ping	Pass	
COMMON.PROC.PD.5 UUT Sent PR_Swap	Pass	
COMMON.PROC.PD.6 UUT Sent VCONN_Swap	Pass	
COMMON.PROC.PD.7 UUT Sent Discover Identity Request	Pass	
COMMON.PROC.PD.8 UUT Sent Discover SVIDs Request	Pass	
COMMON.PROC.PD.9 UUT Sent Attention	Pass	
COMMON.PROC.PD.10 UUT Sent Request	Pass	
COMMON.PROC.PD.11 UUT Sent Source Capabilities	Pass	
COMMON.PROC.PD.12 UUT Sent DR_Swap	Pass	
COMMON.PROC.PD.17 Tester Sent Vconn_swap message	Pass	
COMMON.PROC.PD3.1 Sink Start an AMS	Pass	
COMMON.PROC.PD3.2 UUT Sent EPR_Source_Cap message	Pass	
COMMON.PROC.PD3.3 UUT Sent EPR_Get_Source_Cap	Pass	
COMMON.PROC.PD3.4 UUT Sent EPR_Request	Pass	
COMMON.PROC.PD3.5 Tester Sent EPR_Mode (Enter)	Pass	
COMMON.PROC.PD3.6 UUT Sent EPR_Mode (Enter)	Pass	
COMMON.PROC.PD3.7 Tester Sends EPR_KeepAlive Message	Pass	

Total Tests 36
Passed Tests 36
Failed Tests 0
N/A Tests 0
Indeterminate Tests 0

Report 1 Teledyne LeCroy USB Compliance Suite Overview Result -AP43776Q



Adobe Acrobat
文档

5.3 QuadraMAX

QuadraMAX is a USB-C source power and load test.

PDO1 5V/5A
PDO2 9V/5A
PDO3 15V/5A
PDO4 20V/5A
APDO 3.3V~21V/5A

Select Tests:

Cable **Source** Sink

Select All

- Load Test
- Capabilities Test
- Hard Reset Test
- GiveBack Test
- Over Current Test
- PPS Voltage Step Test
- PPS Current Limit Test

DUT Power Capability
 Watts

Testing Initialized
 2023/4/24 下午 03:30:40
 QuadDraw Version: 0.8.8111
 QM#16 HWRv:1.4.4 FWST:0.0.1376 FWCCG1:0.10

TD SPT.1 Load Test

Test Result:
PASS

TD SPT.2 Capabilities Test

Test Result:
PASS

TD SPT.3 Hard Reset Test

Test Result:
PASS

TD SPT.5 Over Current Test

Voltage: 5 Current: 5
 Result Graph #3551
 Port 1 triggered OC condition at 5.5 A load
 Last Voltage: 4.58 V, Last Current: 5.38 A

Test Result:
PASS

PDO1 5V/5A
PDO2 9V/5A
PDO3 15V/5A
PDO4 20V/5A
APDO 3.3V~21V/5A

Select Tests:

Cable **Source** Sink

Select All

- Load Test
- Capabilities Test
- Hard Reset Test
- GiveBack Test
- Over Current Test
- PPS Voltage Step Test
- PPS Current Limit Test

DUT Power Capability
 Watts

Testing Initialized
 2023/4/25 下午 01:36:09
 QuadDraw Version: 0.8.8111
 QM#16 HWRv:1.4.4 FWST:0.0.1376 FWCCG1:0.10

TD SPT.6 PPS Voltage Step Test

APDO Capabilities:
 Source Capability Object #: 4 Max Voltage: 21 V Min Voltage: 3.3 V Max Current: 5 A Power Limited: False
 Cable Resistance: 77 mΩ

Test Result:
PASS

Testing Initialized
 2023/4/25 上午 11:03:52
 QuadDraw Version: 0.8.8111
 QM#16 HWRv:1.4.4 FWST:0.0.1376 FWCCG1:0.10

TD SPT.7 PPS Current Limit Test

APDO Capabilities:
 Source Capability Object #: 4 Max Voltage: 21 V Min Voltage: 3.3 V Max Current: 5 A Power Limited: False
 Cable Resistance: 77 mΩ

Result Graph #2488 Step 5.j, Port 1 Under APDO Voltage triggered for RDO Voltage: 3.3 V, RDO Current: 1 A, Current Step: 0.5 A Last Voltage: 3.24 V, Last Current: 0.65 A Last Resistance: 4.98 Ω

Test Result:
PASS

Chapter 6. Reference Documents

6.1 AP43776Q Datasheet -

Please refer to: <https://www.diodes.com/assets/Datasheets/AP43776Q.pdf>

6.2 PI3DPX1207Q Datasheet -

Please refer to: <https://www.diodes.com/assets/Databriefs/PI3DPX1207Q-Product-Brief.pdf>

6.3 PI3USB31532Q Datasheet -

Please refer to: <https://www.diodes.com/assets/Datasheets/PI3USB31532Q.pdf>

6.4 PI3USB221EQ Datasheet -

Please refer to: <https://www.diodes.com/assets/Datasheets/PI3USB221EQ.pdf>

Chapter 7. Revision History

Item NO	Hardware Version	Firmware Version	Change Description	Date
1	1.0	1.0	1st Release	12/21/2023

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