您必须了解的 USB3.1 与 Type C

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2016年3月
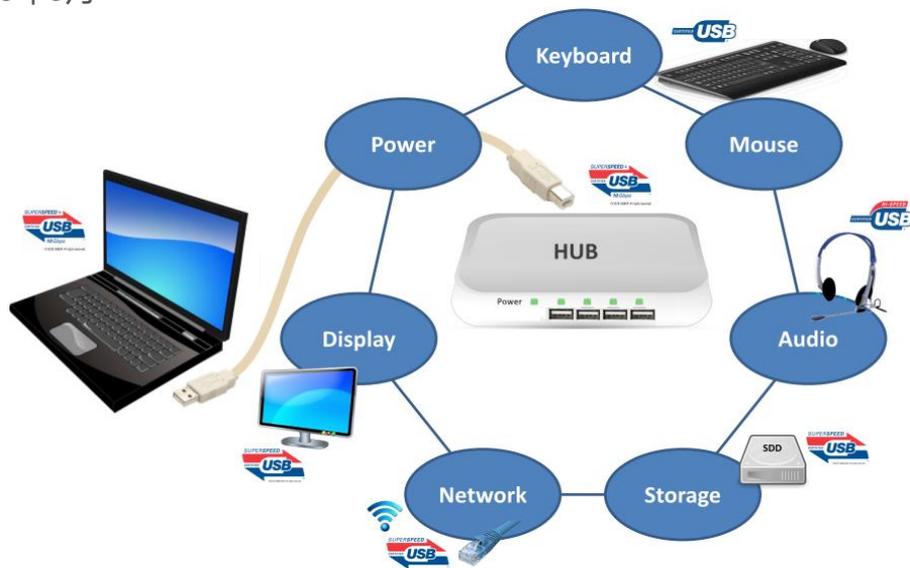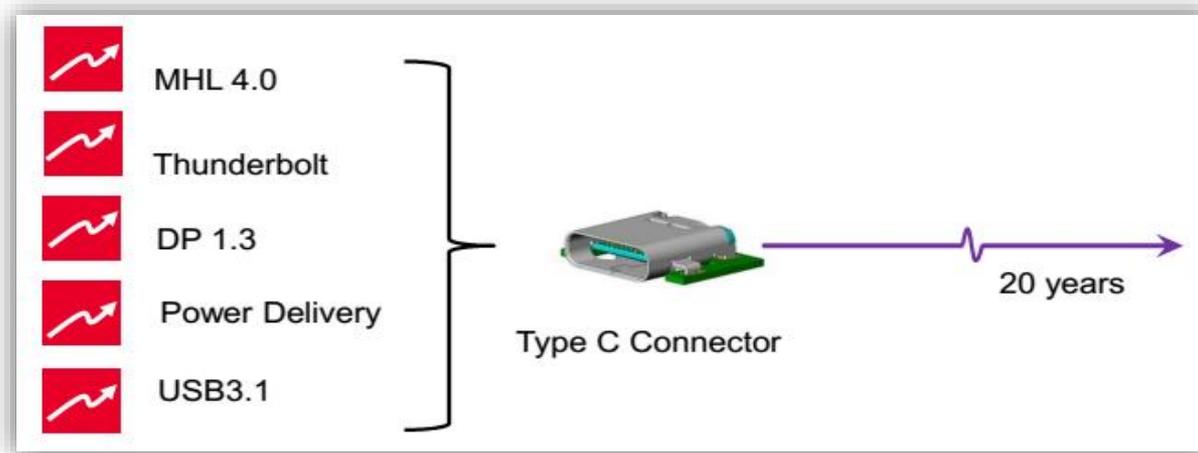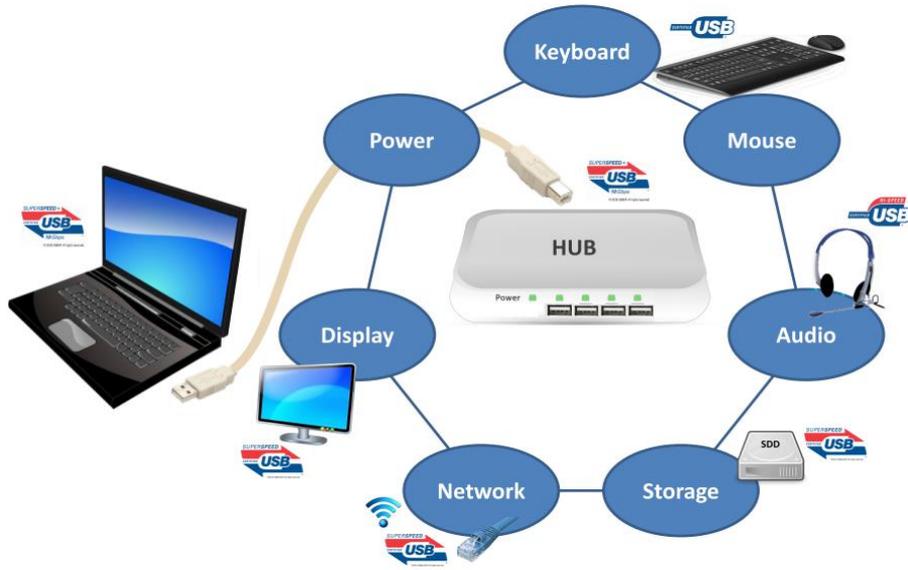
KEYSIGHT
TECHNOLOGIES

USB接口应用

KEYSIGHT
TECHNOLOGIES

HARDWARE + SOFTWARE + PEOPLE = INSIGHTS

Topics Today

- **TYPE-C 接口技术**
  - ➢ **TYPE-C 接口**
  - ➢ **TYPE-C 技术**
  - ➢ **Power Delivery 技术**
  - ➢ **问题和挑战**

- **TYPE-C 测试方案**
  - ➢ **发送端测试**
  - ➢ **接收端测试**
  - ➢ **Cable/连接器测试**
  - ➢ **Power Delivery测试**

KEYSIGHT TECHNOLOGIES

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Keysight 数字总线标准专家组

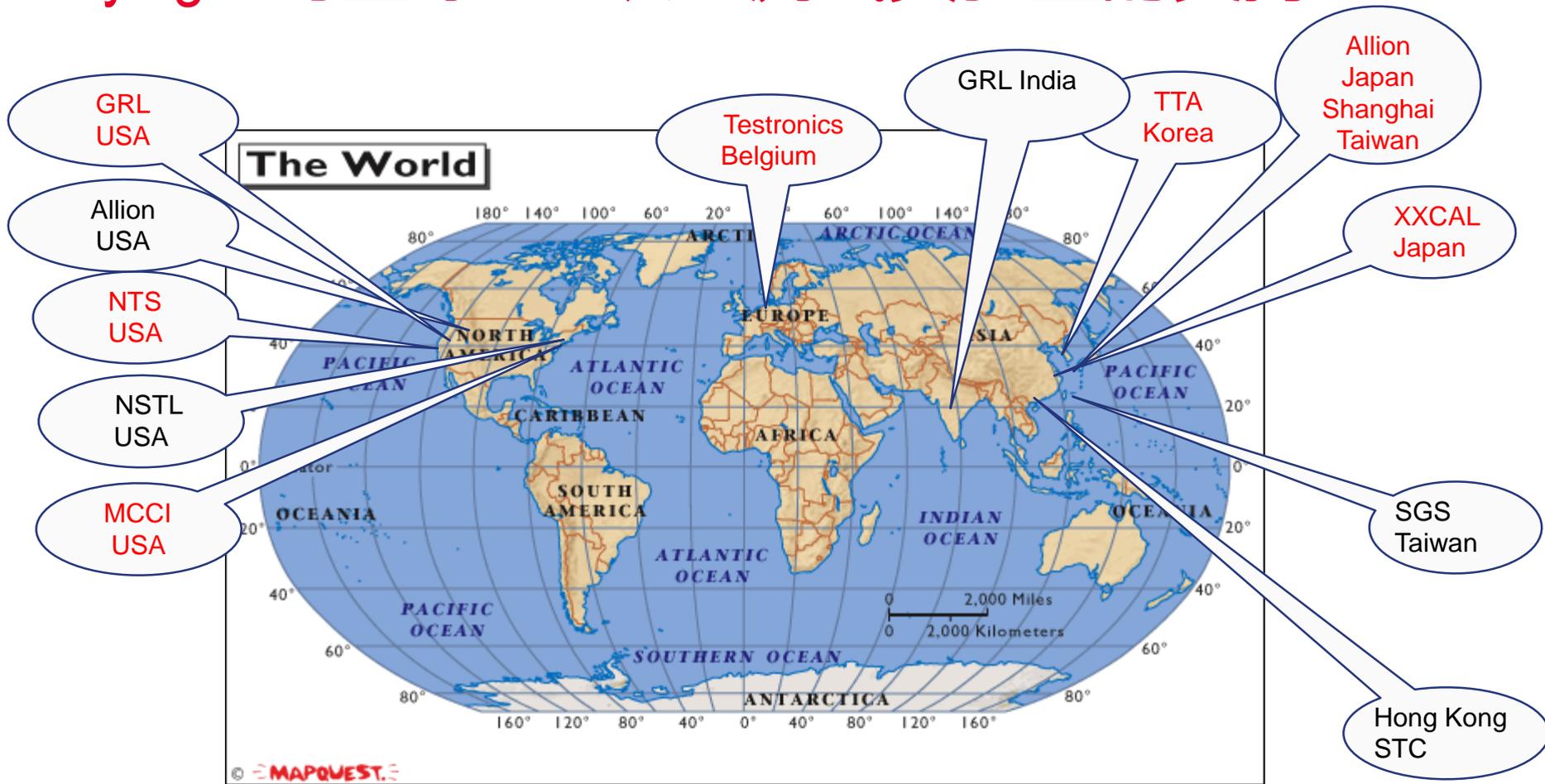## Industry's most comprehensive application-specific measurements

Keysight experts helping define next generation standards, and solutions

Memory Perry Keller	DisplayPort Brian Fetz	USB Jit Lim	Computer Rick Eads	Optical Greg LeCheminant	HDMI Stefan Friebe	Storage Matthew Woerner	MIPI Roland Scherzinger
Board of Directors JEDEC **Compliance Chair** UFSA	**Board of Directors** VESA **Contributor** VESA Phy Sub Group USB-IF Compliance	**Contributor** USB-IF Thunderbolt	**Contributor, Board Member Alumni** PCI-SIG	**Contributor** IEEE, OIF-CEI, T11 FC	**Contributor** HDMI BoD (Thomas Dippon)	**Contributor** SATA-IO, T10 SAS	**TSG Member UniPro Vice Chair** MIPI Alliance
LPDDR4, UFS	DP 1.3 Type-C	USB 1/2/3.x Type-C	PCIe G3, G4, PAM4 (RT)	PAM-4, CEI 3.1	HDMI 2.0	SATA, SAS-3	D/M/C–PHY, UniPro

JEDEC · UFSA · VESA · SUPERSPEED+ CERTIFIED USB 10Gbps · PCI SIG · IEEE · OIF OPTICAL INTERNETWORKING FORUM · HDMI HIGH DEFINITION MULTIMEDIA INTERFACE · SERIAL ATA · 12Gb/s Serial Attached SCSI · mipi alliance

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Keysight 对全球USB认证测试实验室的支持

GRL USA

Allion USA

NTS USA

NSTL USA

MCCI USA

The World

Testronics Belgium

GRL India

TTA Korea

Allion Japan Shanghai Taiwan

XXCAL Japan

SGS Taiwan

Hong Kong STC

*Test Labs Currently Qualified for USB 3.0 Certification
Approved labs are listed at http://www.usb.org/developers/compliance/labs

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KEYSIGHT TECHNOLOGIES

Topics Today

TYPE-C 接口技术

➢ TYPE-C 接口
➢ TYPE-C 技术
➢ Power Delivery 技术
➢ 问题和挑战

TYPE-C 测试方案

➢ 发送端测试
➢ 接收端测试
➢ Cable/连接器测试
➢ Power Delivery测试

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Type C Connector

Big Discontinuity
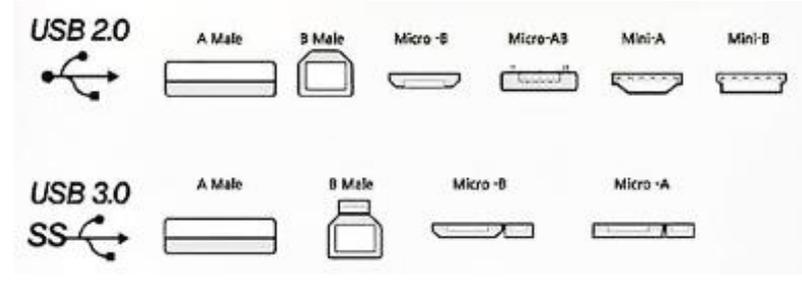
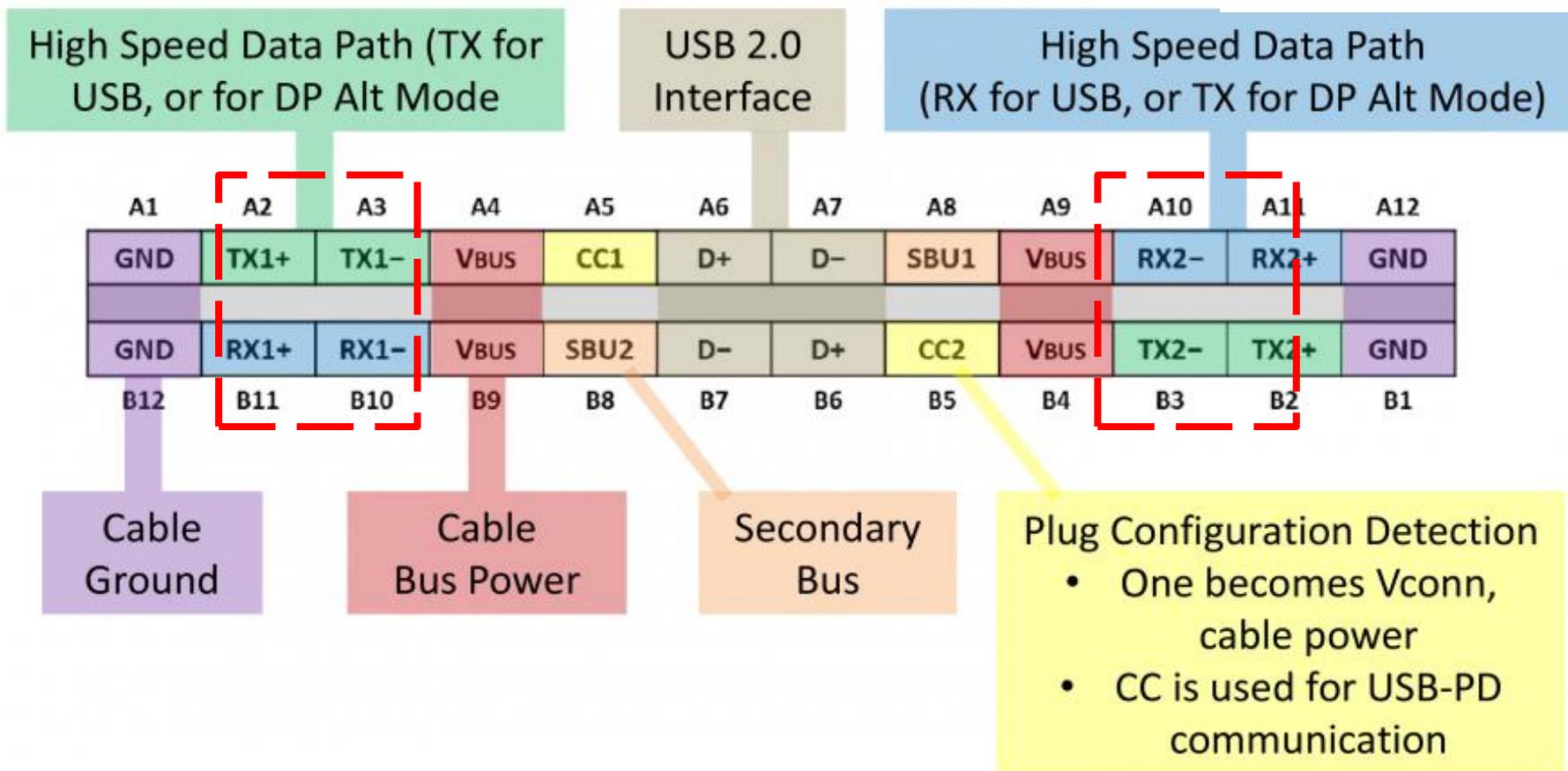| Type A	Type B	Type C
12mmx4.6mm	13.35mmx2.4mm	8.3mmx2.5mm

Industry Drivers for Type C

★ ***Eliminate form factor orientation dependency***

★ ***Enables infrastructure for adoption by other standards (i.e. video)***

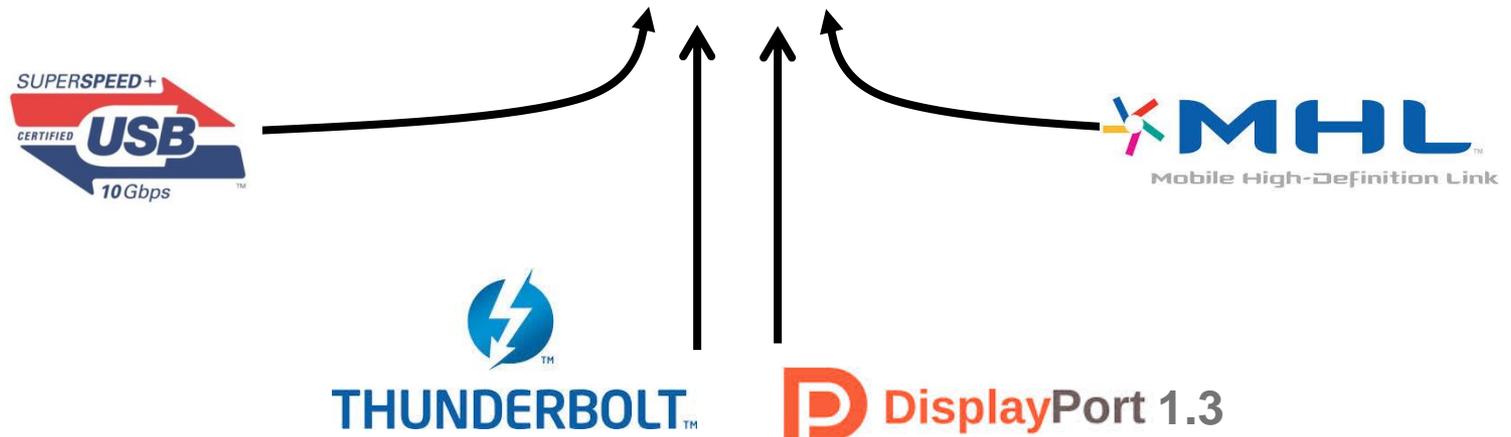★ ***Establishes power delivery and charging infrastructure***

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USB Type C-Signal Pins

High Speed Data Path (TX for USB, or for DP Alt Mode

USB 2.0 Interface

High Speed Data Path (RX for USB, or TX for DP Alt Mode)

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1−	VBUS	CC1	D+	D−	SBU1	VBUS	RX2−	RX2+	GND
GND	RX1+	RX1−	VBUS	SBU2	D−	D+	CC2	VBUS	TX2−	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Cable Ground

Cable Bus Power

Secondary Bus

Plug Configuration Detection
- One becomes Vconn, cable power
- CC is used for USB-PD communication

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USB Type C Test Implications

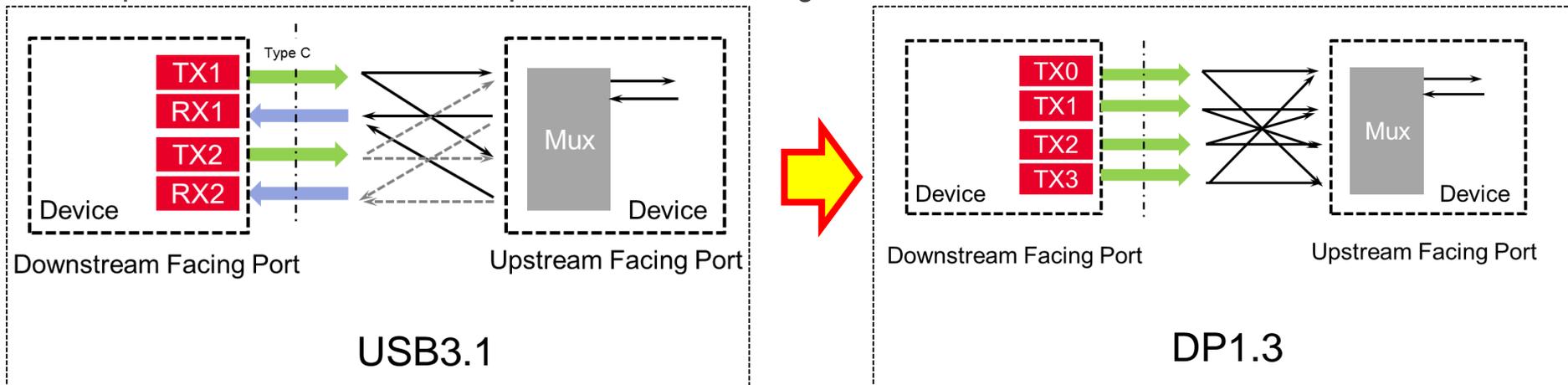| Type C Pin	Feature	Test Implication Comment
USB2 pins D+, D-	USB2 is assumed to be active in type C designs.	USB2 Host/Device testing required.
Config pins CC1, CC2	Three functions: -Termination/Orientation detection -Vconn Supply -Power Delivery Channel	PD channel testing (protocol, PD channel phy) V_{Conn} loading. Must be terminated properly depending on DUT type. Must be controlled to test both ports (TX/RX 1&2) of the interface during USB3.x testing). Channel used to set up alternate modes.
SBU1, SBU2	Control of alt standards. (TBT, DP, MHL)	Used to control devices in alternate modes
Power V_{Bus}, Ground	Voltage Range: 5 to 20 volt Current Range: 0 to 5 amp Direction: provider or consumer, or both.	Wide range of operation possible on any given device. Verification of V/I profile. Test system be designed for setting up arbitrary Vbus state, or, several, or only one Vbus state.
TX1, TX2, RX1, RX2	High Speed differential lanes	USB3.1 uses only 1 port (TX/RX set) at a time and will require testing the flipped condition. TBT devices will use both ports. DP may have all four lanes as either TX or RX lanes depending on the device.

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Alternate Mode

A port could wake up as USB 3.1, then get configured to DisplayPort 1.3

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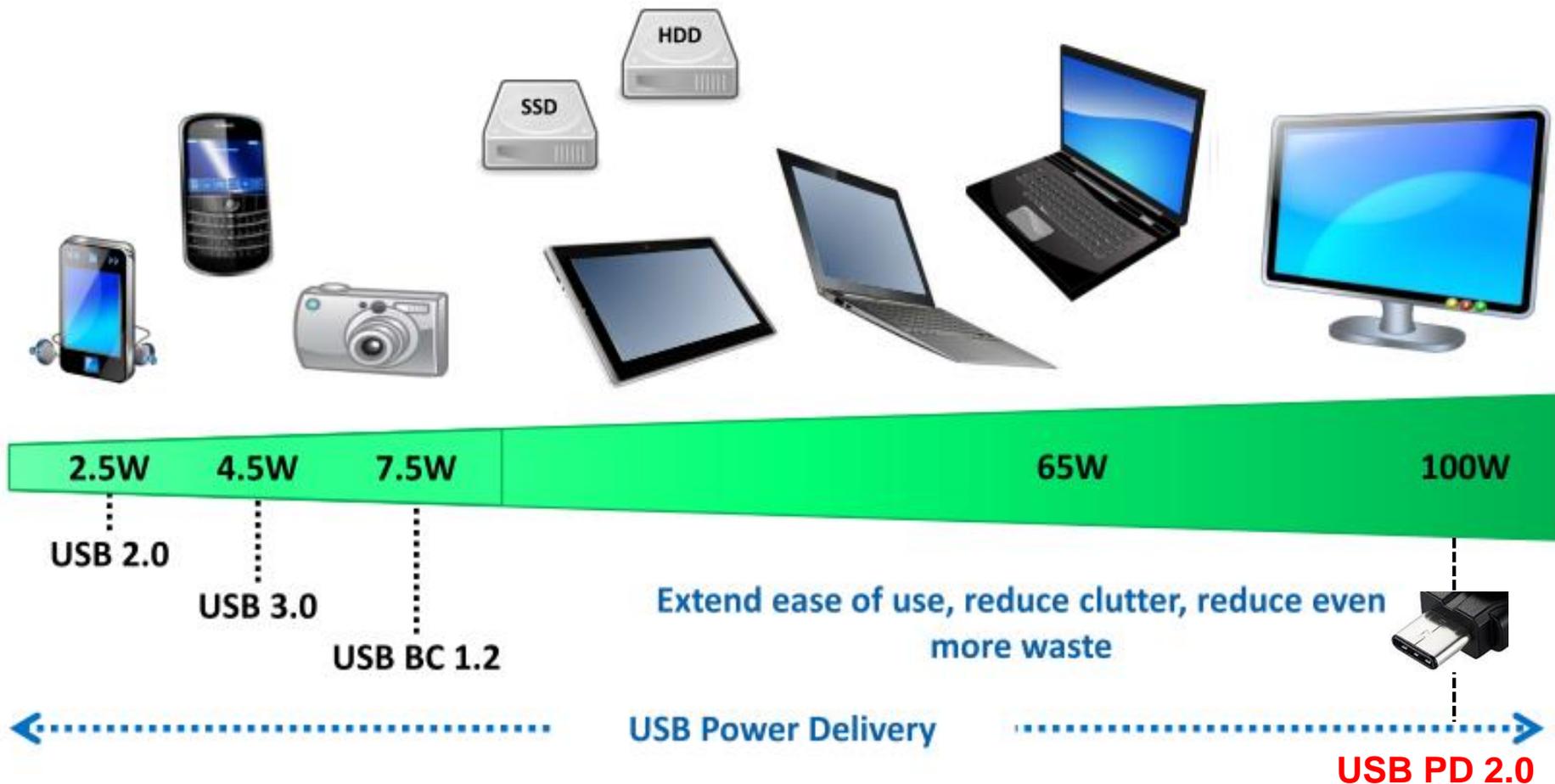
KEYSIGHT
TECHNOLOGIES

Alternate Mode

– An operational mode of devices on a link that dynamically reassigns USB Type-C pin functionality by communication via the Power Delivery channel to change the character of the link.

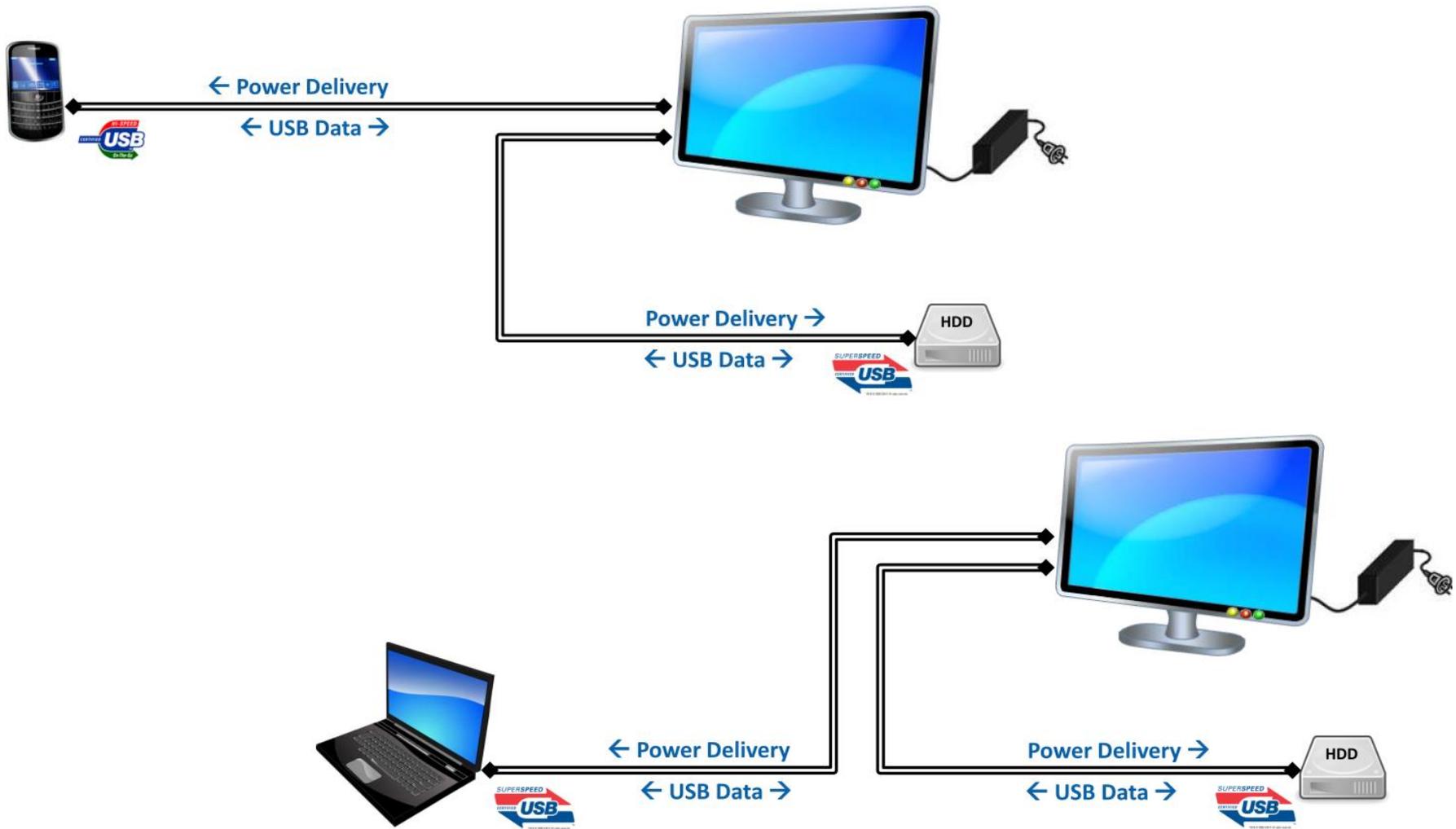Example: a 'device' can wake up USB3.1 and change to DP1.3


USB3.1

DP1.3

DisplayPort 1.3, & MHL, & Thunderbolt

Power Delivery 2.0

2.5W	4.5W	7.5W		65W	100W

USB 2.0

USB 3.0

USB BC 1.2

Extend ease of use, reduce clutter, reduce even more waste

USB Power Delivery

USB PD 2.0

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Power Delivery 2.0 Application

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USB Power Delivery Technologies

- Management of a <u>power network</u> and device modes through a one line interface. The interface can set up the network to quickly charge devices with up to 5 amps, supply power to active cables, discover cable functionality, enable guest protocols (Alternate Modes), facilitate device role and power direction swaps.

- Power Management

Downstream Facing Port   Upstream Facing Port
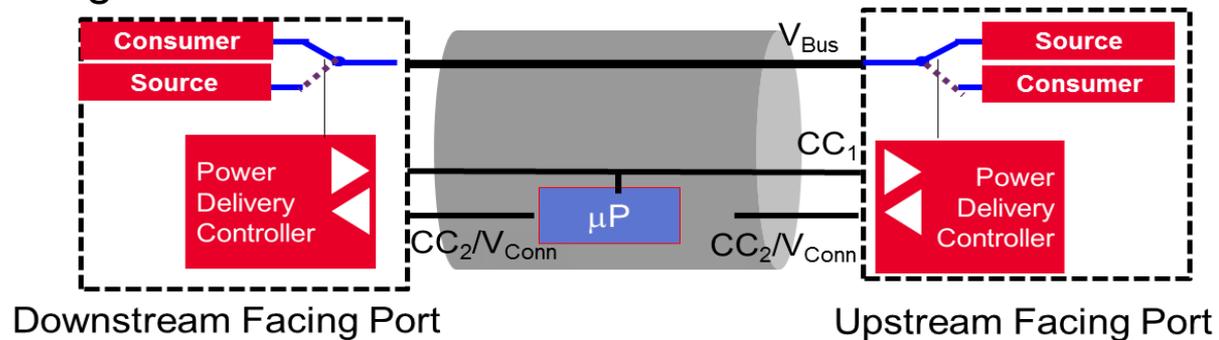
- V_{Conn} Power Management

Downstream Facing Port
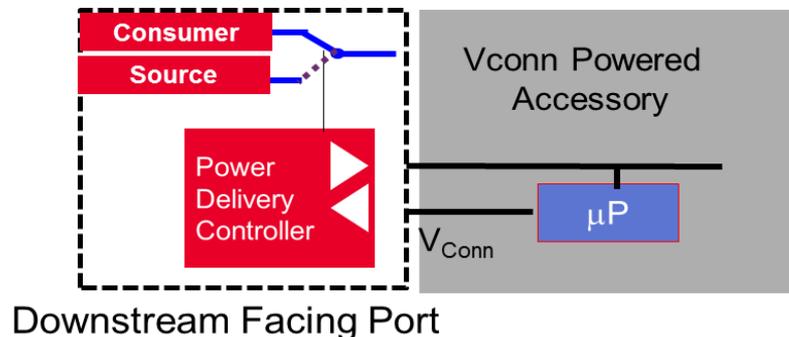
USB Type C Power Options

Precedence	Mode of Operation		Nominal Voltage	Maximum Current
Highest	USB PD		Configurable	5 A
↓	USB Type-C Current @ 3.0 A		5 V	3.0 A
	USB Type-C Current @ 1.5 A		5 V	1.5 A
	USB BC 1.2		5 V	Up to 1.5 A
	Default USB Power	USB 3.1	5 V	900 mA
Lowest		USB 2.0	5 V	500 mA

PROFILE 1 5V @ 2A	10W Default	
PROFILE 2 5V @ 2A, 12V @ 1.5A	18W	
PROFILE 3 5V @ 2A, 12V @ 3A	36W	
PROFILE 4 5V @ 2A, 12V, 20V @ 3A	60W Limit for	
PROFILE 5 5V @ 2A, 12V, 20V @ 5A	100W Limit for	

Sink/source can be swapped, power direction no longer fixed

HDD
SSD

2.5W   4.5W   7.5W   65W   100W

USB 2.0
USB 3.0
USB BC 1.2

Extend ease of use, reduce clutter, reduce even more waste

USB Power Delivery

AC/Battery → Provider
P/C   P/C

Consumer/ Provider
P/C   P/C   P/C

Charger (Consumer/ Provider)   Consumer   Consumer   Consumer/ Provider ← AC/Battery

Power + PD Communications
USB Communications
P/C Provider/Consumer
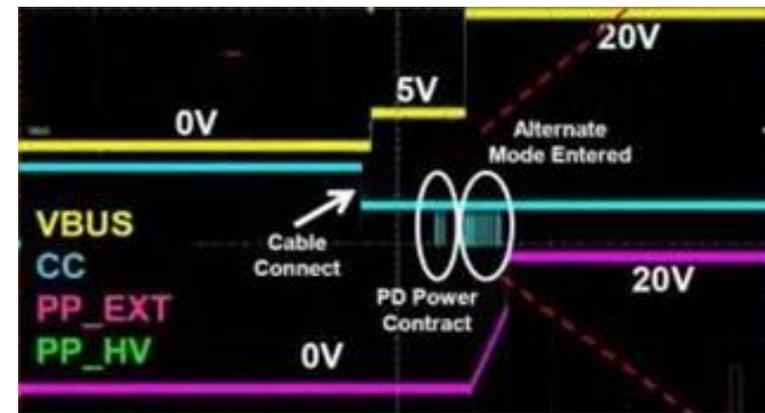
KEYSIGHT TECHNOLOGIES
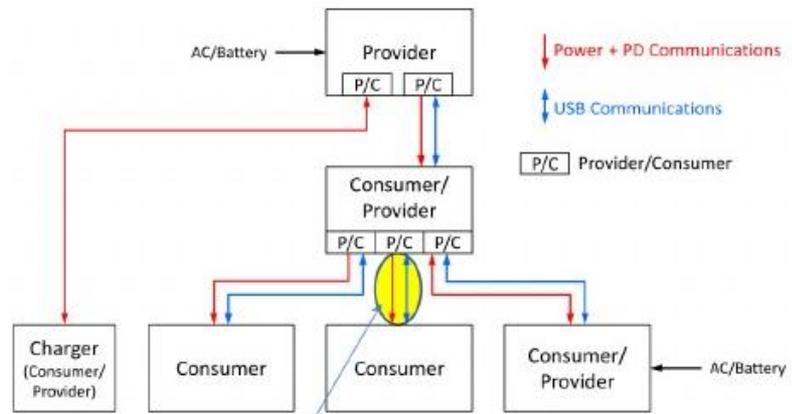
The Key to the Type C

USB Type-C Configuration Channel (CC)

1. Detect attach of USB ports
2. Resolve cable orientation and twist connections to establish USB data bus routing
3. Establish "host" and "device" roles between two attached ports
4. Discover and configure Vbus: USB Type-C Current modes or USB Power Delivery
5. Configure Vconn
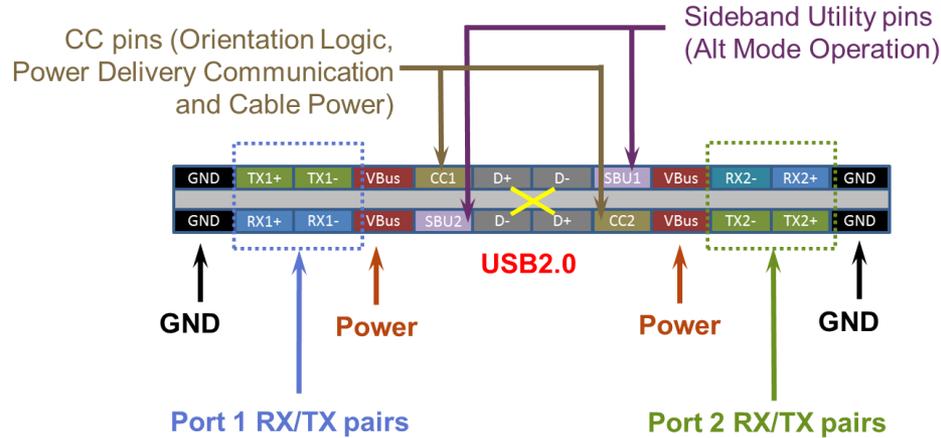6. Discover and configure optional Alternate and Accessory modes

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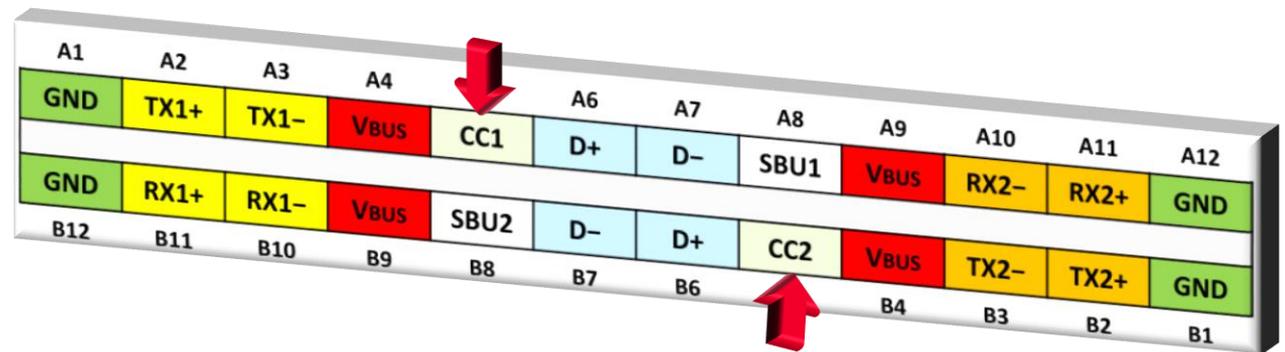
Type C Interconnection

DFP to UFP Functional model
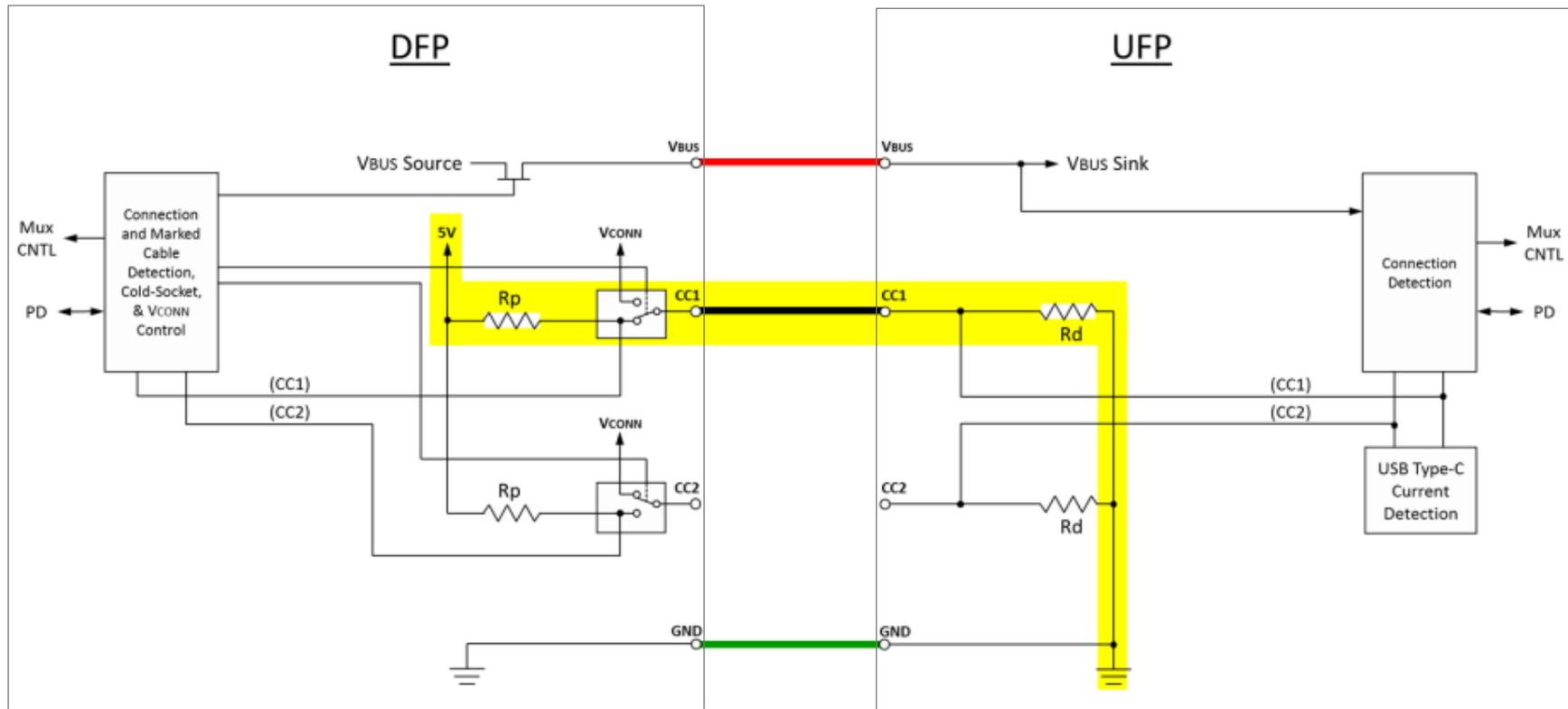
New Forces Present

Type C

CC pins (Orientation Logic, Power Delivery Communication and Cable Power)

Sideband Utility pins (Alt Mode Operation)

| GND | TX1+ | TX1- | VBus | CC1 | D+ | D- | SBU1 | VBus | RX2- | RX2+ | GND |
| GND | RX1+ | RX1- | VBus | SBU2 | D- | D+ | CC2 | VBus | TX2- | TX2+ | GND |

USB2.0

GND — Power — Power — GND

Port 1 RX/TX pairs — Port 2 RX/TX pairs

A Low Profile, orientation independent, high data rate connection (40Gbs).

PD

Downstream Facing Port — Upstream Facing Port

V_{Bus} — CC_1 — CC_2/V_{Conn} — μP

Management of a <u>power network</u> and device modes through a one line communication channel

USB3.1

TX: Pre Shoot, De-Emp, Loss
RX: Loss, EQ (Device)
RX: EQ, Loss (Host)
TX: Loss, Pre Shoot, De-Emp
Cable Model
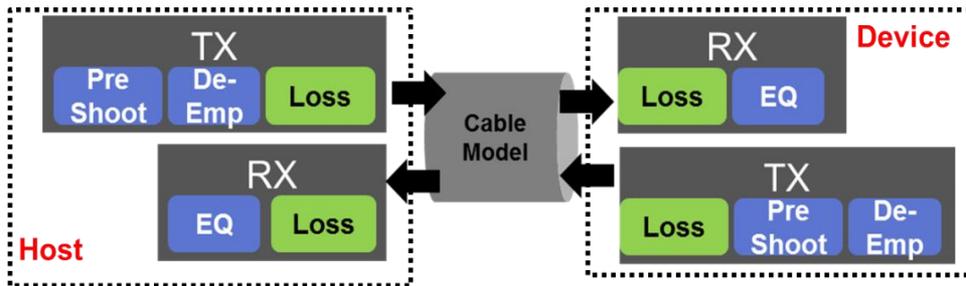
Universally accepted interface going to 10Gbs and beyond.

Alt Mode

Example: a 'device' can wake up USB3.1 and change to DP1.3

USB3.1 — DP1.3
Downstream Facing Port — Upstream Facing Port
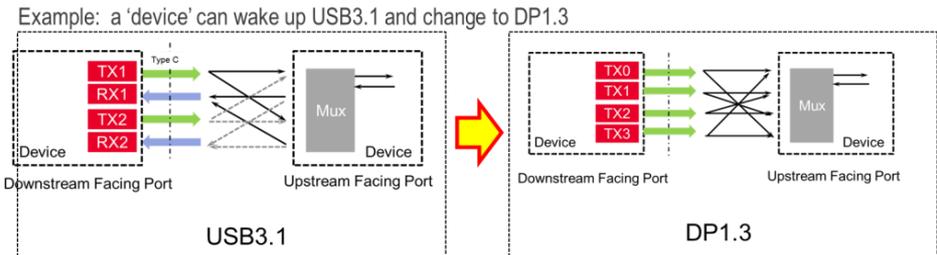
Devices in a link can dynamically re-assign USB Type C pin functionality.

Type C Testing Challenge

Orientation Independence

Type C

TX1
RX1
TX2
RX2

Device

Mux

Device

Downstream Facing Port

Upstream Facing Port
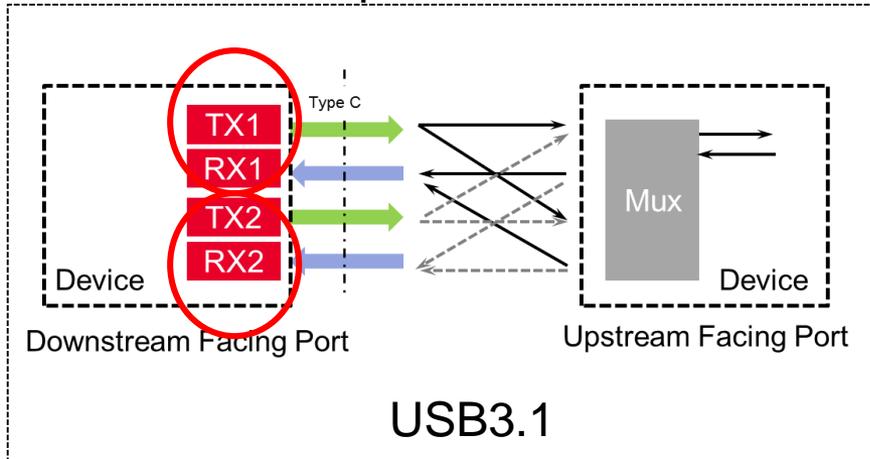
USB3.1

Test time DOUBLES

Test Twice for USB3.1 /2.0

Alternate Mode

TX0
TX1
TX2
TX3

Device
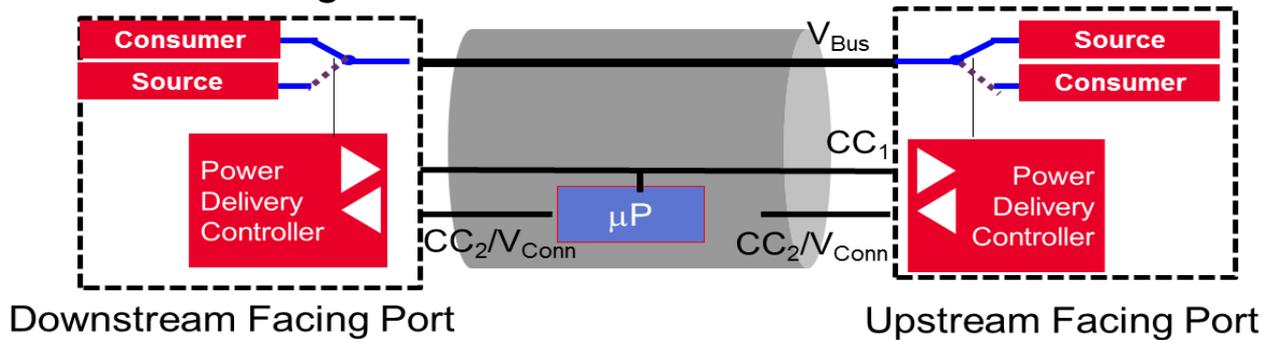
Mux

Device

Downstream Facing Port

Upstream Facing Port

DP1.3
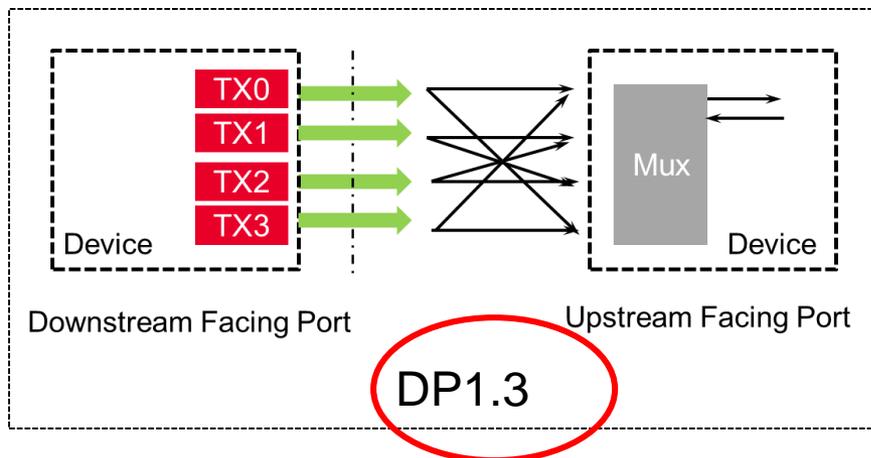
Test DisplayPort!

Type C Testing Challenge

- Power Management

Precedence	Mode of Operation		Nominal Voltage	Maximum Current
Highest	USB PD		Configurable	5 A
↓	USB Type-C Current @ 3.0 A		5 V	3.0 A
	USB Type-C Current @ 1.5 A		5 V	1.5 A
	USB BC 1.2		5 V	Up to 1.5 A
	Default USB Power	USB 3.1	5 V	900 mA
Lowest		USB 2.0	5 V	500 mA

PROFILE 1
5V @ 2A — 10W Default

PROFILE 2
5V @ 2A, 12V @ 1.5A — 18W

PROFILE 3
5V @ 2A, 12V @ 3A — 36W

PROFILE 4
5V @ 2A, 12V, 20V @ 3A — 60W Limit for

PROFILE 5
5V @ 2A, 12V, 20V @ 5A — 100W Limit for

CC1 /CC2

Vconn

Power

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Topics Today

■ **TYPE-C 接口技术**
  - ➤ TYPE-C 接口
  - ➤ TYPE-C 技术
  - ➤ Power Delivery 技术
  - ➤ 问题和挑战

■ **TYPE-C 测试方案**
  - ➤ 发送端测试
  - ➤ 接收端测试
  - ➤ Cable/连接器测试
  - ➤ Power Delivery测试

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Keysight Type C Test Fixture

N7015A: High Speed Fixture

Vbus and CC lines to N7016A fixture via USB Type C (plug style) cable

High speed coax cables, Matched pairs for TX2+, TX2-, RX2+, RX2-

SBU1 and SBU2 lines

2 pin header for USB2 D+ and D- probe points

Type C connection to device under test

High speed coax cables, Matched pairs for TX1+, TX1-, RX1+, RX1-
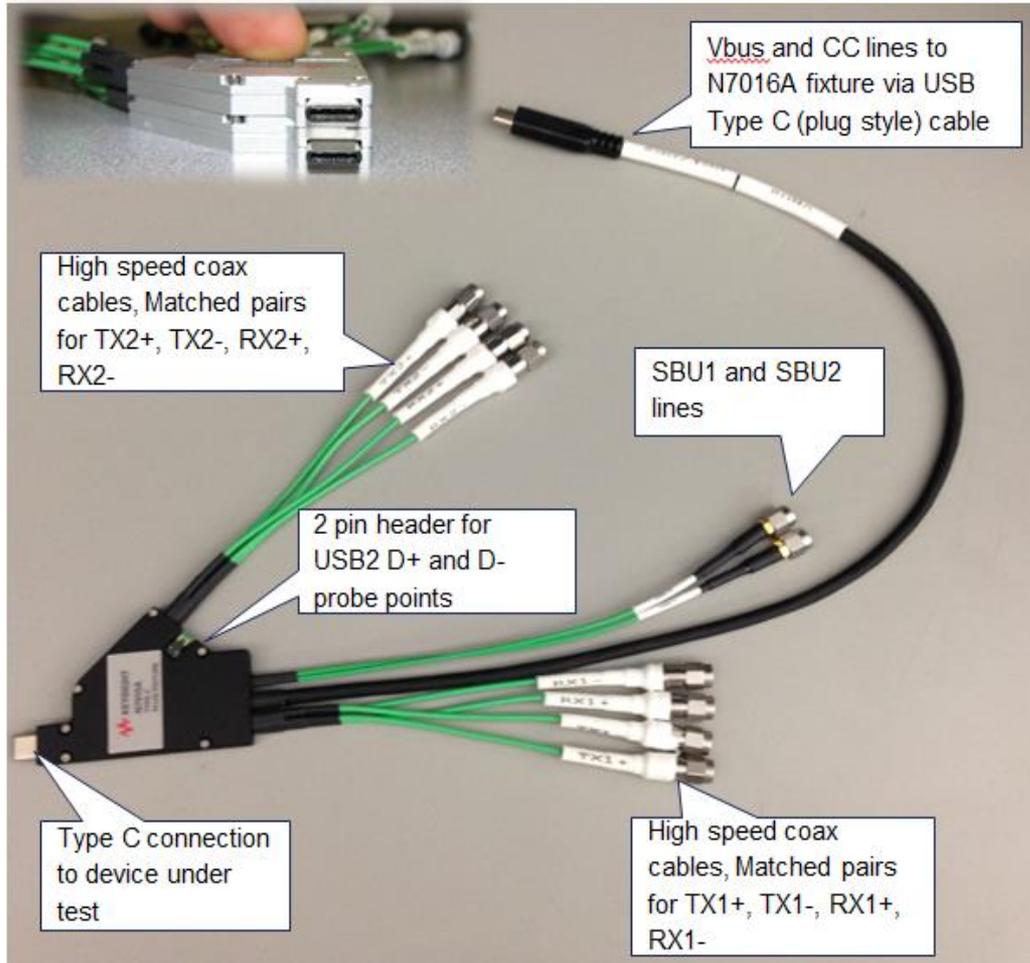
N7016A: Low Speed Fixture

ADS

>20GHz @-3dB

~30GHz @-5dB

db(Sdd21_N7015A)

freq, GHz
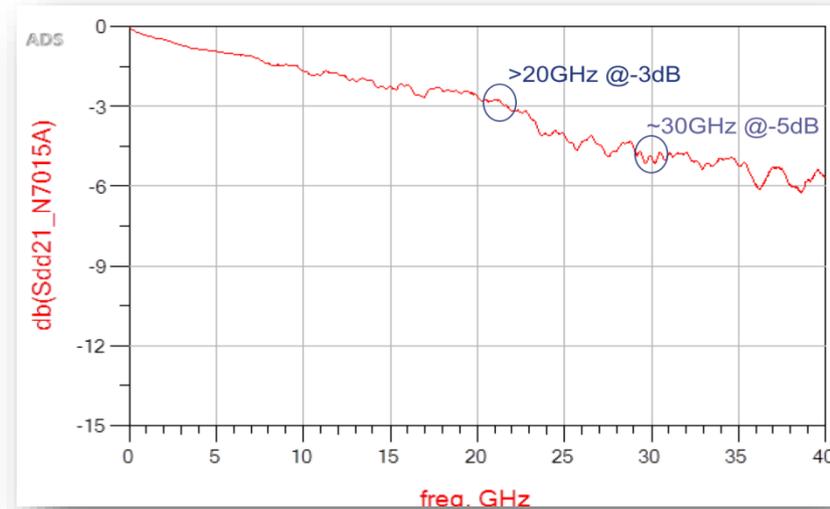
Type C-USB3.1 Transmitter Test Solution

Scope: DSAV254A

High Speed Signals

DUT — N7015A

SBU1
SBU2

USB 2.0

CC1
CC2
GND
VBUS

GND VBUS | SBU1 SBU2 RX1+ RX1- TX1+ TX1-

N7016A

USB connection — Power Delivery Controller

CC1
CC2
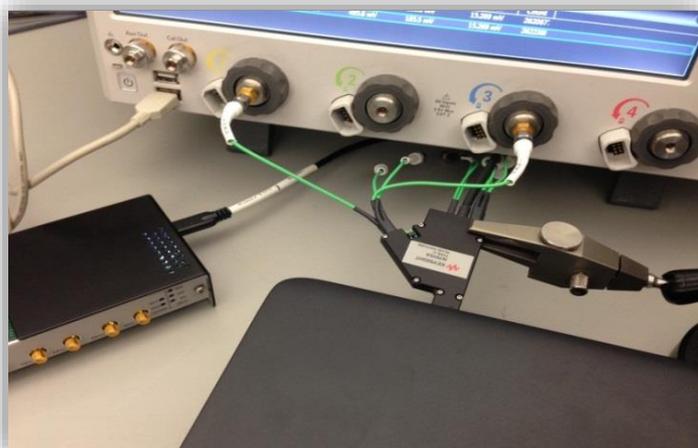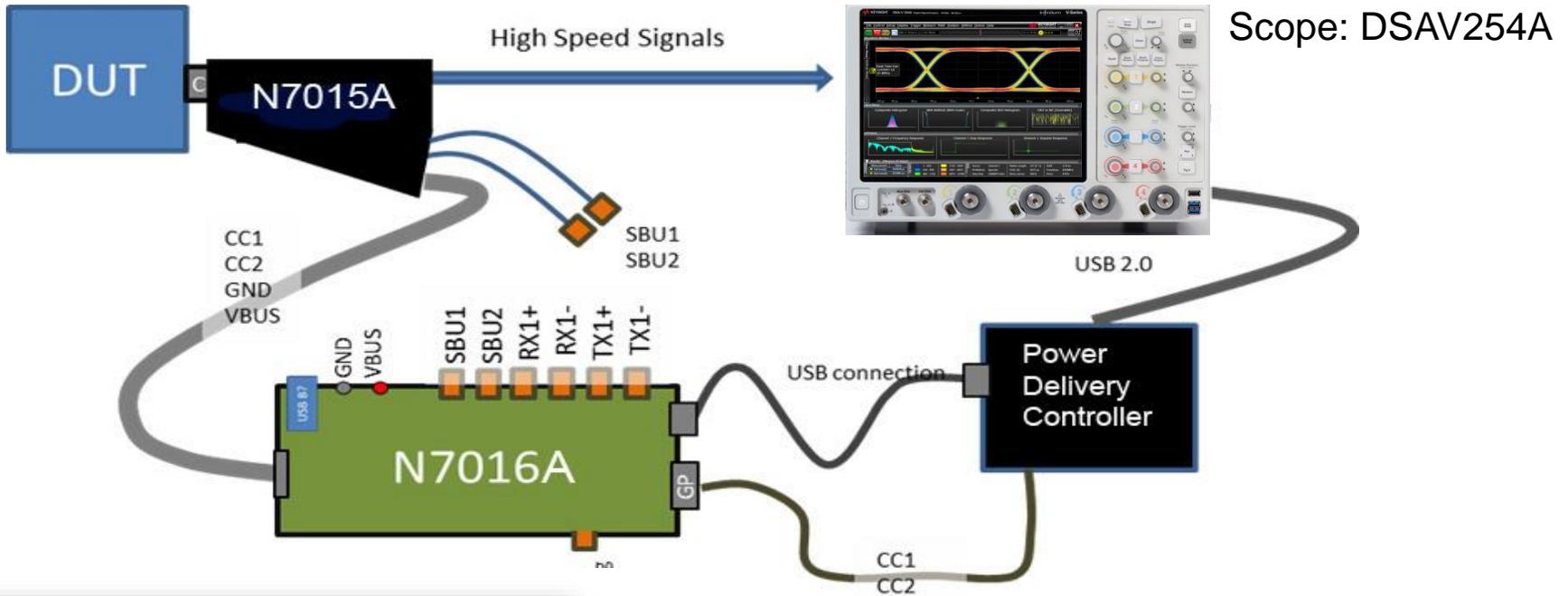
USB3.1 Test Report

Overall Result: PASS

Test Configuration Details	
Device Description	
10GTransFunc	C:\Users\Public\Documents\Infiniium\Apps\USB3Test\TransferFunctions\USB3Gen2ReferenceChannel.tf4
5GTransFunc	C:\Users\Public\Documents\Infiniium\Apps\USB3Test\TransferFunctions\USB3_TX_Device_Channel.tf4
Input File Path	Device 1
Input Signal Type	Saved signal
AdcMode	AUTO
DC Gain	0
Reference Clock	SSC
De-emphasis Mode	-3.5 dB
Device	Device
Device ID:	Device 1
Test Session Detail	
Infiniium SW Version	05.50.0005
Infiniium Model Number	DSAV334A

Trial 1: Transition Eye Diagram

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Type C-DisplayPort Transmitter Test Solution

Plug Fixture

Port 1

TX
TX
TX
TX

Port 2

Direct
Or
Diff Probe

V series Oscilloscope

Product Under Test

C-DP cable

Signal Access
And Control Fixture

DPR100

Power Supply/Load

PDC

alt mode control

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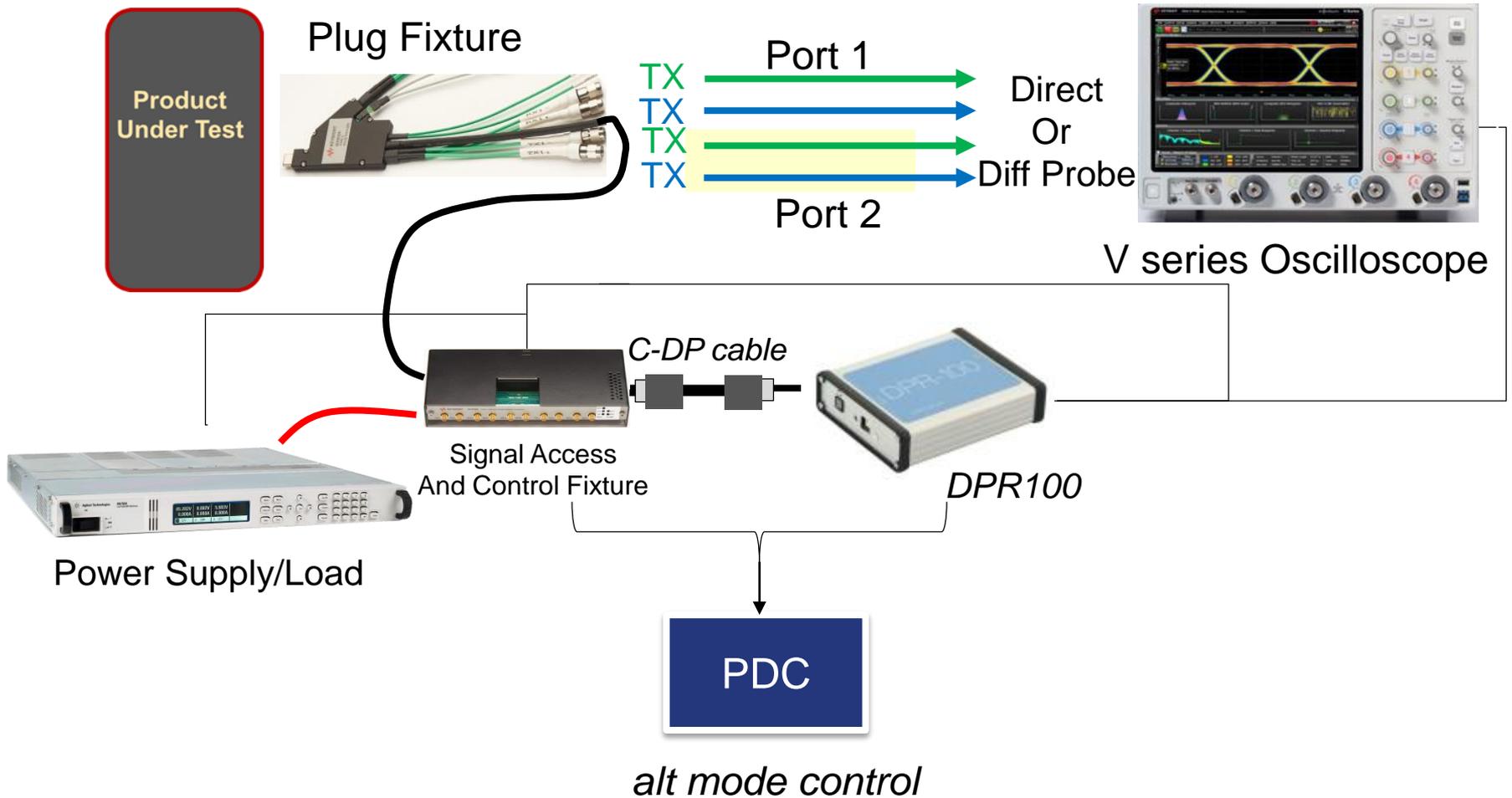
Type C-USB3.1 Receiver Test Solution

Plug Fixture
Mating Fixture
RX
TX
RX
TX
Port 1
Port 2
ISI
CLE1000

V series Oscilloscope

Calibration Setup

Product Under Test
Plug Fixture
RX
TX
RX
TX
Port 1
Port 2
ISI
CLE1000

Signal Access and Control Fixture

Power Supply/Load

PDC

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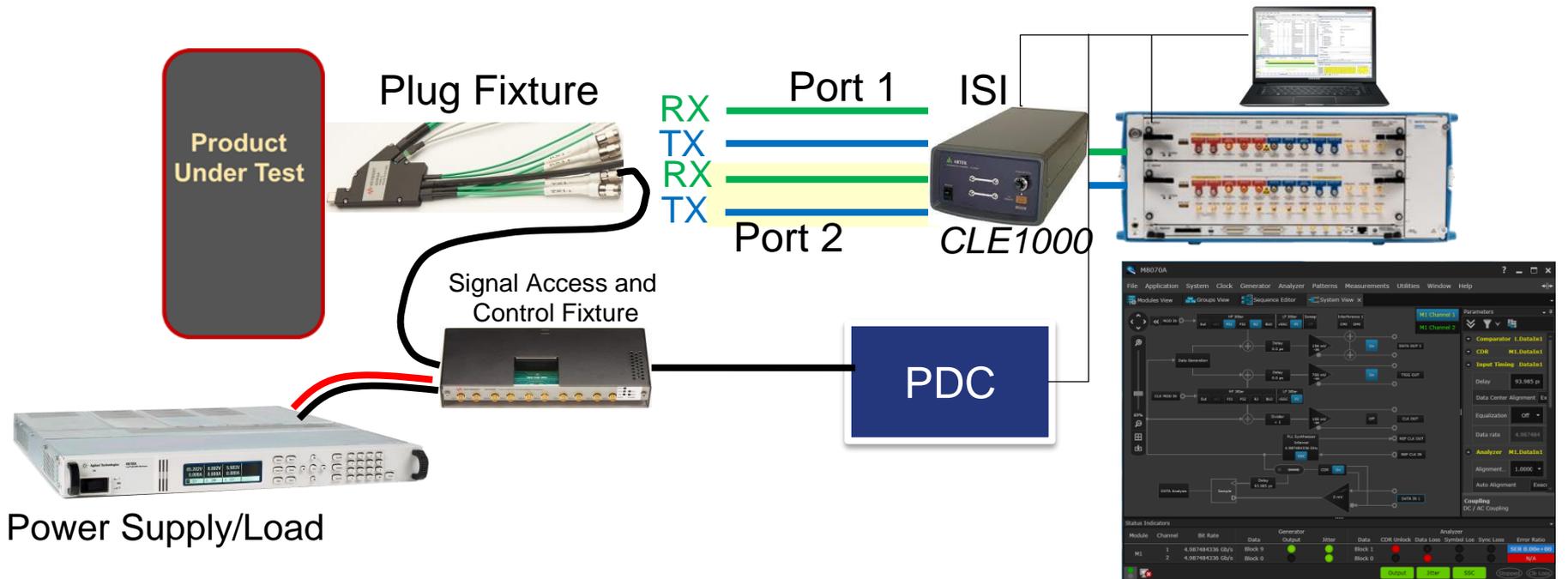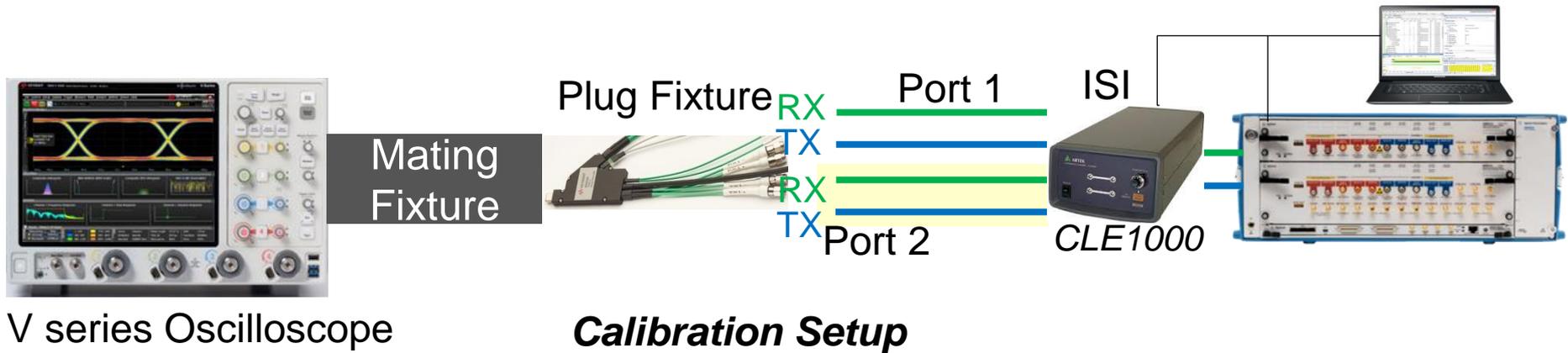
Type C-Cable/Connector Compliance Test

New Solution

•**ALL** parameters can be measured with **ENA Option TDR**

One-box Solution !!
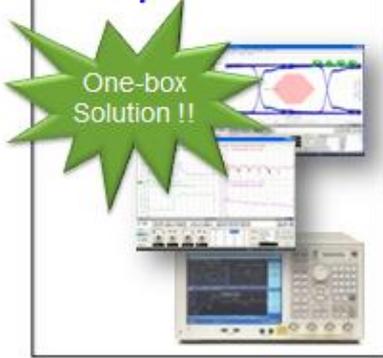
• ENA Mainframe
  • E5071C-4D5: 4-port, 300 kHz to 14 GHz
  • E5071C-4K5: 4-port, 300 kHz to 20 GHz
• Enhanced Time Domain Analysis Option (E5071C-TDR)
• ECal Module (N4433A)

(*) The list above includes the major equipment required. Please contact our local sales representative for configuration details.

MOI
(Method of Implementation)
Step-by-step procedure on how to measure the specified parameters in the specification document using ENA Option TDR.
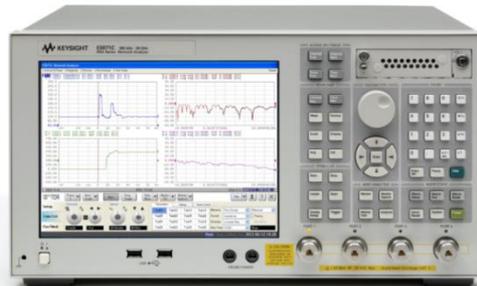
Test Fixtures
Fixtures are available for purchase through Luxshare-ICT.
http://web.luxshare-ict.com/en/

ENA Option TDR is a authorized test tool for Cable PHY.
http://www.vesa.org/displayport-developer/certified-components/

Type C-Cable/Connector Compliance Test
Measurement Parameters (**Normative** & **Informative**)
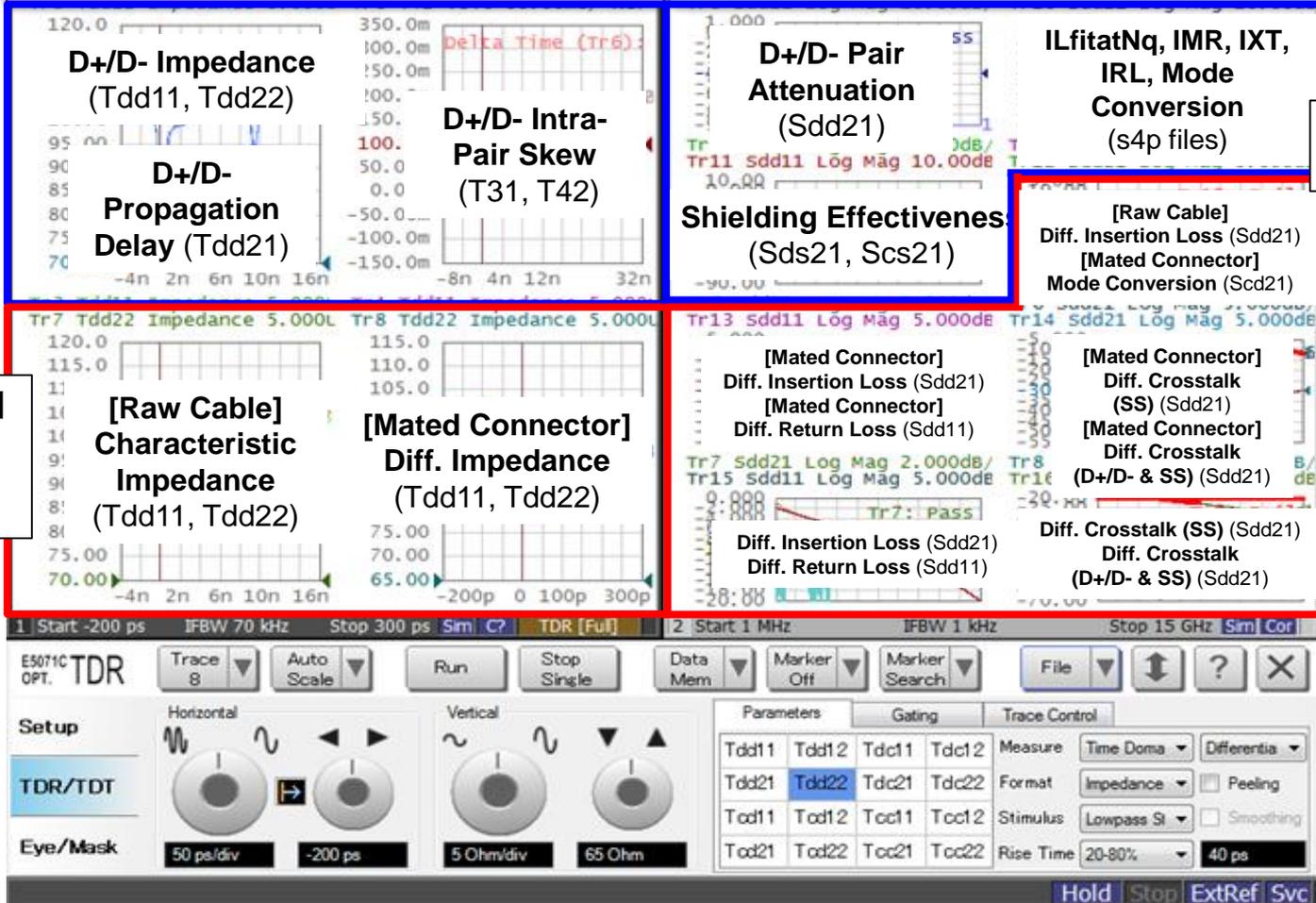
Type C-Power Delivery Test Solutions

Power Delivery

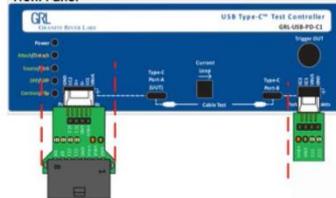S series Oscilloscope

GRL-USB-PD Power Delivery SW

N2873A passive probes

1147B current probe
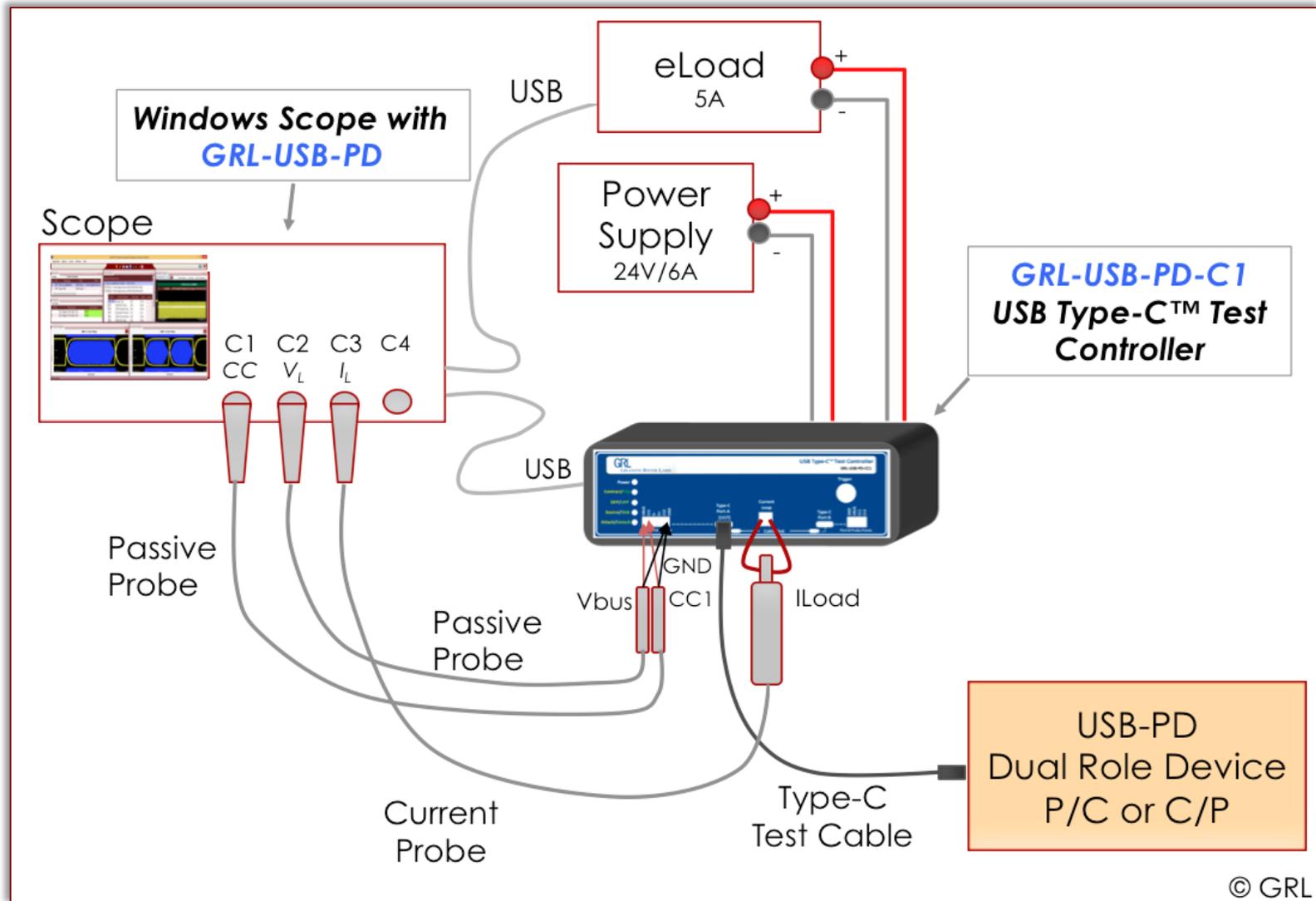
GRL-USB-PD-C1

N3301A /N3303A Electronic Load

N6700 Modular Power System

USB Type-C Device PD Test Setup

© GRL

PD Test Contents

Test Name	Test Description	Required Tests by Device Type			
		Provider Only	Consumer Only	Dual Role Device	
				P/C	C/P
	Primary Power Delivery Device Tests				
	BMC PHYSICAL LAYER TESTS-TRANSMIT				
BMC-PHY-TX-EYE	BMC Transmitter Eye Diagram Test	✓	✓	✓	✓
BMC-PHY-TX-BIT	BMC Transmit Bit Rate and Bit Rate Drift	✓	✓	✓	✓
	BMC PHYSICAL LAYER TESTS-RECEIVE				
BMC-PHY-RX-BUSIDL	BMC Bus Idle Detection Test	✓	✓	✓	✓
BMC-PHY-RX-INT-REJ	BMC Receive Interference Rejection Test	✓	✓	✓	✓
	BMC PHYSICAL LAYER TESTS-MISCELLANEOUS				
BMC-PHY-TERM	BMC Termination Impedance Test	✓	✓	✓	✓
BMC-PHY-MSG	BMC PHY Level Message Test	✓	✓	✓	✓
	PROTOCOL SPECIFIC-Message Checks				
BMC-PROT-SEQ-GETCAPS	Get_Source_Cap and Get_Sink_Cap Test	✓	✓	✓	✓
BMC-PROT-SEQ-CHKCAB-P-PC	Check Cable Capabilities (3A Marked) Test	✓	✓	✓	✓
BMC-PROT-SEQ-CHKCAB-NOMRK-P-PC	Check Cable Capabilities (UnMarked) Test	✓	✓	✓	✓
BMC-PROT-SEQ-CHKCAB-CP-ACC	Check Cable Capabilities (3A Marked) Test-After PR Swap	✓	✓	✓	✓
BMC-PROT-SEQ-CHKCAB-NOMRK-CP-ACC	Check Cable Capabilities (UnMarked) Test-After PR Swap	✓	✓	✓	✓
BMC-PROT-SEQ-DRSWAP	Dual Role Swap Test	✓	✓	✓	✓
BMC-PROT-SEQ-VCSWAP	VCONN Swap Test	✓	✓	✓	✓
BMC-PROT-DISCOV	ID Checks	✓		✓	✓
BMC-PROT-SEQ-SWAP-REJ	Reject Swap Test - Provider/Consumer			✓	
BMC-PROT-BIST-NOT-5V-SRC	BIST Functionality at Above 5V Test	>5V DUT Only		>5V DUT Only	
BMC-PROT-REV-NUM	Revision Number Test	✓	✓	✓	✓
	Power Source/Sink Tests				
BMC-POW-SRC-LOAD-P-PC	Source Dynamic Load Test,Provider or Provider/Consumer	✓		✓	
BMC-POW-SRC-LOAD-CP-ACC	Source Dynamic Load Test,Consumer/Provider Accepting Swap				✓
BMC-POW-SRC-TRANS-P-PC	PDO Transition Test - Source,Provider or Provider/consumer	✓		✓	
BMC-POW-SRC-TRANS-CP-ACC	PDO Transition Test - Source,Consumer/Provider Accepting Swap				✓
BMC-POW-SNK-TRANS-C-CP	PDO Transition,Current Draw and Suspend Test-Sink,Consumer or Consumer/Provider		✓		✓
BMC-POW-SNK-TRANS-PC	PDO Transition, Current Draw, and Suspend Test, Sink, Provider/Consumer			✓	

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Physical Layer Results

– BMC Eye & Measurements

Pass/Fail BMC 'One'


Select Packet From List

When Checked, All Results Update On Selected Packet

Packets Info

Packets: ☑ Update Test details on packet select

Index	Port ...	Message	SOP	PDO	Message Type	M...	Header (MSB t...	Payload (MSB ...	CRC
0	DFP	Source Capabilities	SOP-Sync1 S...	Fixed Supply;Fixed Supply;Fixed ...	Data	0	0x31 0x61	0x6412C 0x...	0xC704DD7B
1	DFP	Source Capabilities	SOP-Sync1 S...	Fixed Supply;Fixed Supply;Fixed ...	Data	0	0x31 0x61	0x6412C 0x...	0xC704DD7B
2	DFP	Source Capabilities	SOP-Sync1 S...	Fixed Supply;Fixed Supply;Fixed ...	Data	0	0x31 0x61	0x6412C 0x...	0xC704DD7B
3	DFP	Source Capabilities	SOP-Sync1 S...	Fixed Supply;Fixed Supply;Fixed ...	Data	0	0x31 0x61	0x6412C 0x...	0xC704DD7B
4	UFP	Good CRC	SOP-Sync1 S...		Control	0	0x00 0x41		0xC704DD7B
5	UFP	Request	SOP-Sync1 S...	Request;	Data	0	0x10 0x42	0x3804B12C	0xC704DD7B
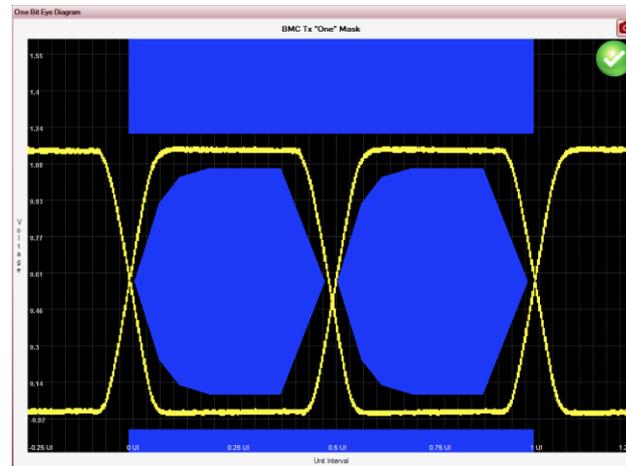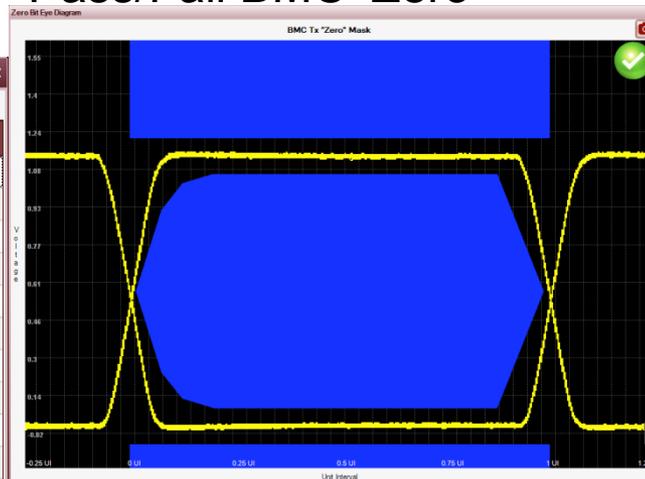
Pass/Fail Measurements

Pass/Fail BMC 'Zero'

**Test Results**

Selected Packet Test Result:

Index	Test Name	Test Result	Test Limit	Average Value	Minimum Value	Maximum Value
1	Eye Diagram One Mask Test	PASS	-	-	-	-
2	Eye Diagram Zero Mask Test	PASS	-	-	-	-
3	CRC Test	PASS	-	-	-	-
4	Rise Time Test	PASS	X > 300 ns	577.898248 nS	306.714286 nS	50.0666786 µS
5	Fall Time Test	PASS	X > 300 ns	326.930994 nS	320.798611 nS	340.279018 nS
6	Symbol Encoding Test	PASS	-	-	-	-
7	Packet Format Test	PASS	-	-	-	-
8	Bit Rate Test	PASS	(270 < X < 330) Kbps	295.931 Kbps	292.997 Kbps	304.435 Kbps
9	Inter-Frame Gap Test	PASS	X > 25µs	102.639847 mS	102.639847 mS	102.639847 mS
10	Unit Interval Test	PASS	(3.03 < X < 3.70) µs	3.37928346 µS	3.28477273 µS	3.41300000 µS
11	Voltage Swing Test	FAIL	(1.05 < X < 1.20) V	0.589 V	0 V	1.14 V
12	pBitRate Test	PASS	X < 0.25 %	0.026 %	0.026 %	0.026 %

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INSIGHTS

Keysight USB Type C Solutions
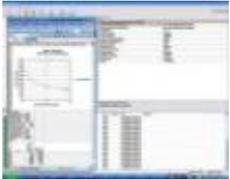
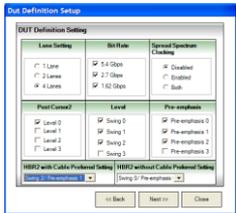|	TX SW	RX SW	TX HW	RX HW
USB3.1	**U7243B** USB Compliance Test Software	**N5990A-102** USB Compliance Test Software -302 Link training tools	**DSAV254A** Infiniium Scope	M8020A JBERT
DisplayPort Test	**U7232D** DP Compliance Test Software	**N5990A-155** DP Compliance Test Software	**DSAV164A** Infiniium Scope	M8020A JBERT
Thunderbolt Test	**N6463B** Thunderbolt Compliance Test Software	**N5990A-104** Thunderbolt Compliance Test Software	**DSAV334A** Infiniium Scope	M8020A JBERT
MHL Test	**N6460B** MHL Compliance Test Software	**N5990A-153** DP Compliance Test Software	**DSAV164A** Infiniium Scope	M8190A ARB

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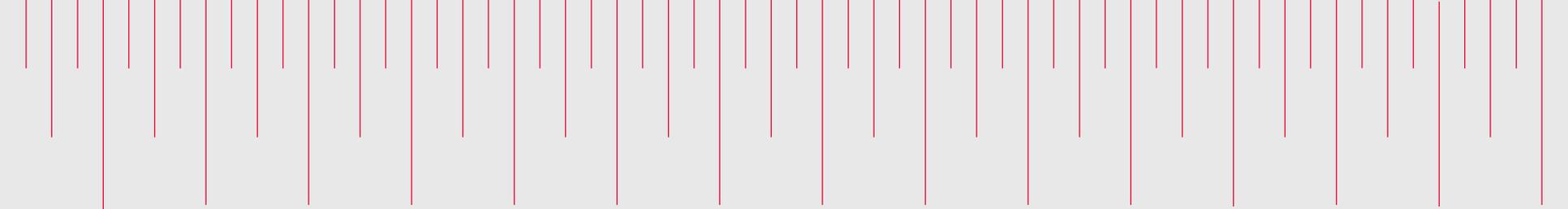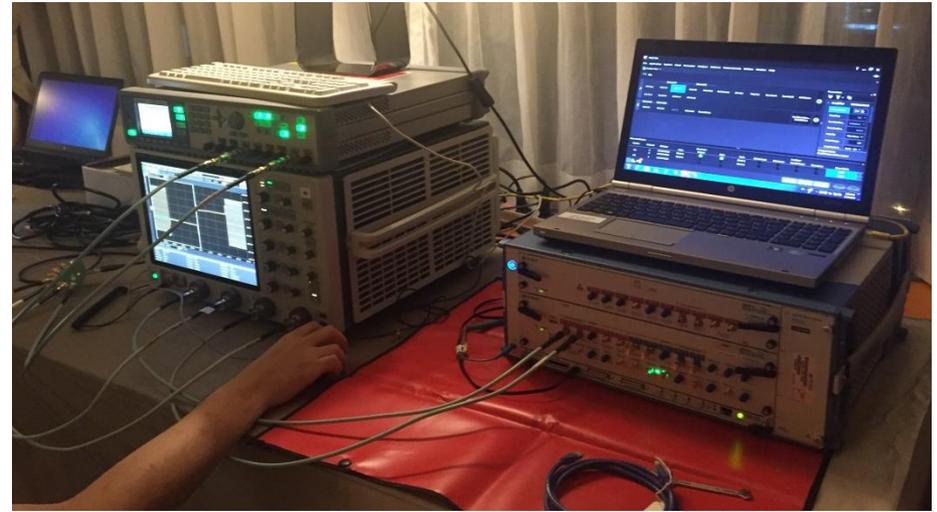
2015 Nov. USB-IF Workshop Update

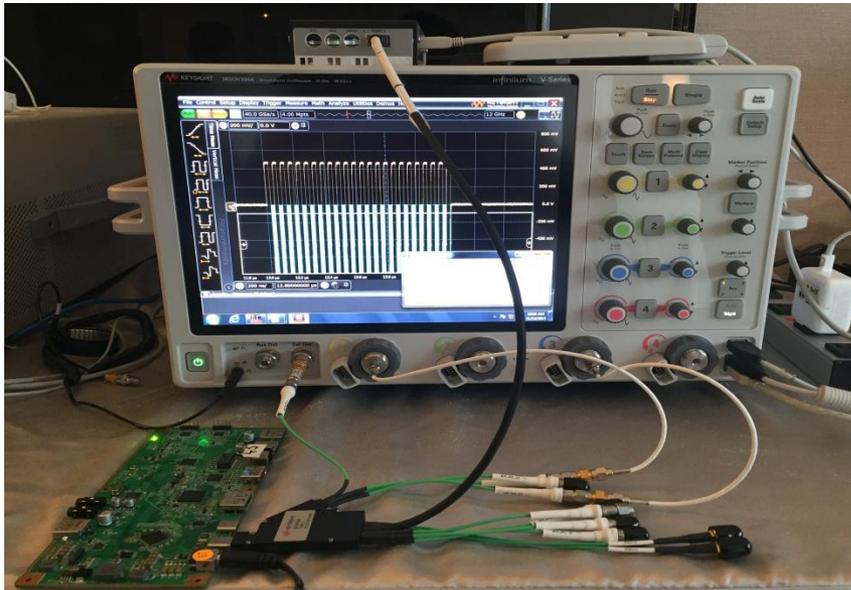# 2015 USB-IF WORKSHOP EVENT
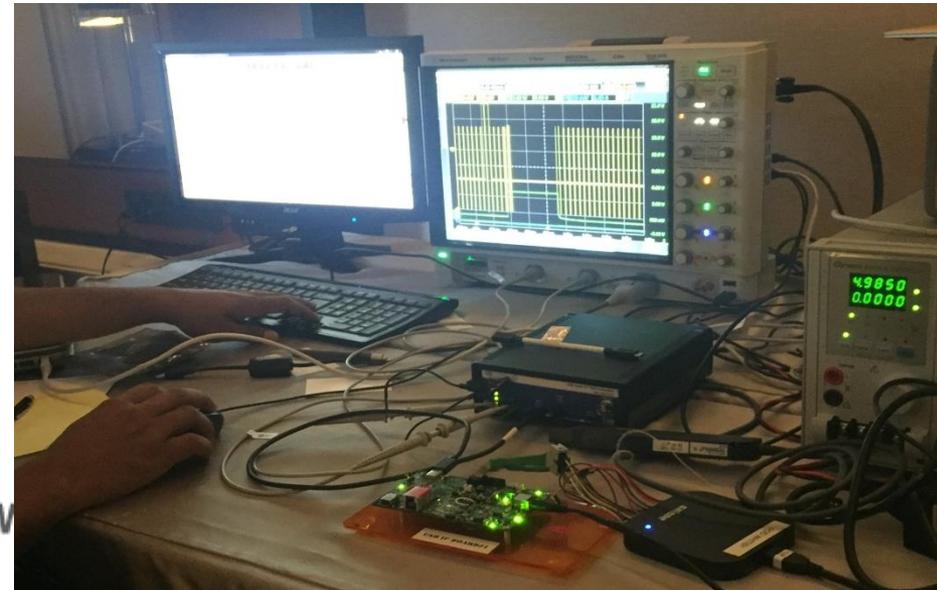
➢ *USB 2.0 Test*
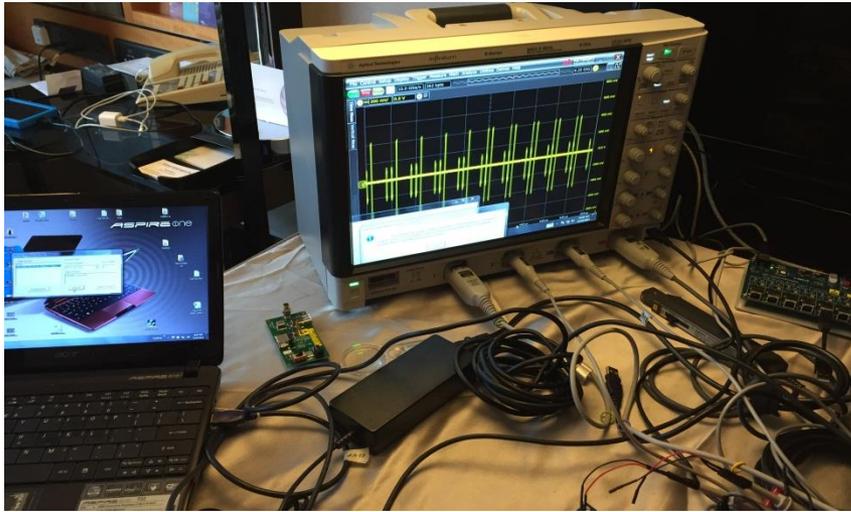
➢ *USB 3.1 Gen2 Test*

➢ *USB 3.1 TYPE -C Test*

➢ *USB Power Deliver Test*

Thank You!

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