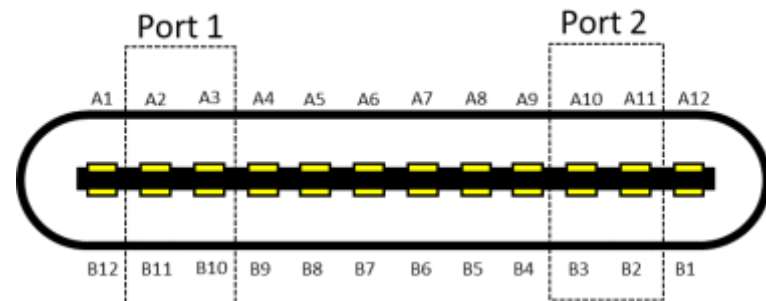
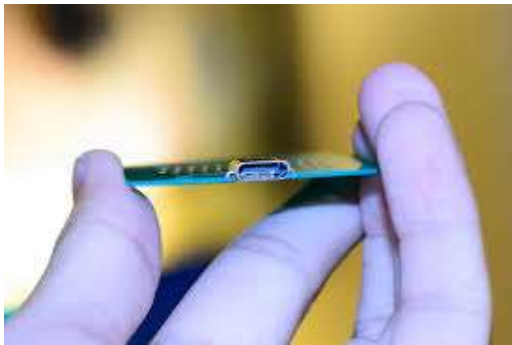


# Type-C Solutions from Keysight Technologies: Physical Layer Testing of the Type-C connector

October, 2017



# Topics

Introduction

Your problem

Considerations in Product Validation

Examination of Type-C environment

Keys to automation

Keysight automation elements

Summary



TX Compliance SW



Oscilloscopes



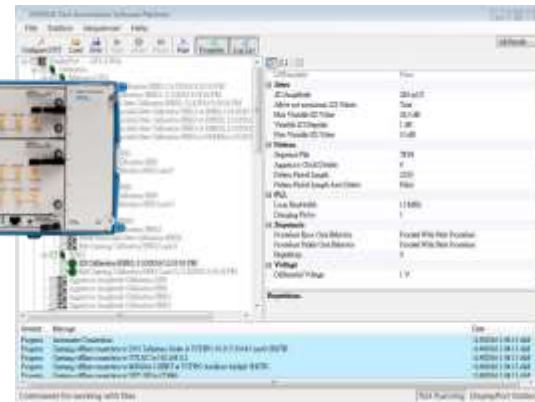
Test Fixtures



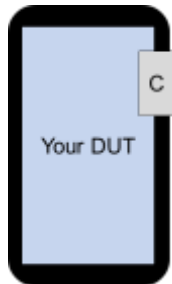
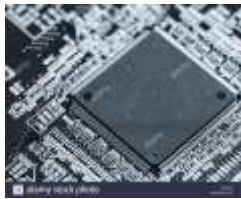
Rx Compliance SW



J-BERT  
Bit Error Ratio Tester



# Your Product



# Your Problem

You must support delivery schedules for products that may go to millions of people.

- You want NO surprises...
- You want to stay on schedule.

There's excellence, and there's else.

You test for compliance... but also for design characterization, corner case testing, environmental variation, etc.

You don't want customers to discover something about your product that you neglected to examine.

# Considerations

**Design Validation Plan**

**Bring up/Debug**

**Characterization**

**Corner Case Testing**

**Sample Plan**

**Environmental Testing**

***Compliance Plan***

***USB3.1***

***Compliance Certification***

***TBT3***

***Compliance Certification***

***DPoC***

***Compliance Certification***

**Interoperability Testing**

**Type-C Plan**

**Orientation**

**PDOs**

**Alt Modes**

With Type-C, it is no exaggeration to say that the validation/testing burden has vastly increased.

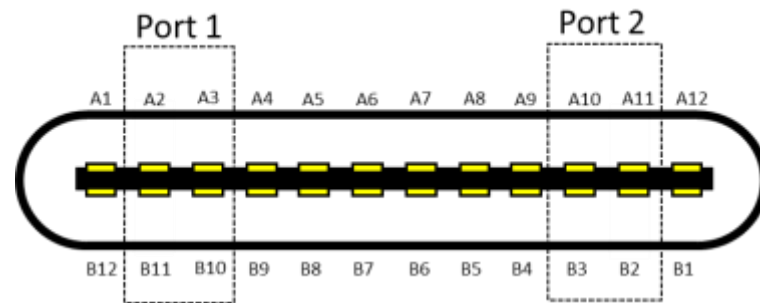
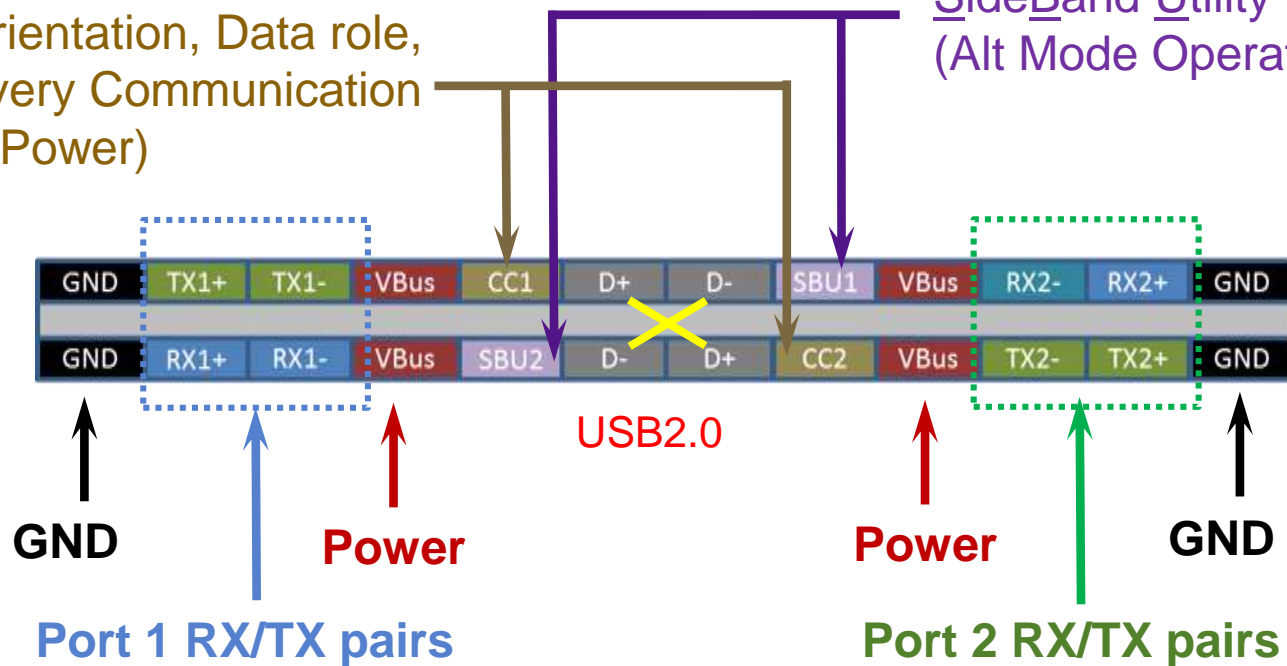
# Closer Look at the Type-C Environment



## USB Type C-Signal Plan

CC pins (Orientation, Data role, Power Delivery Communication and Cable Power)

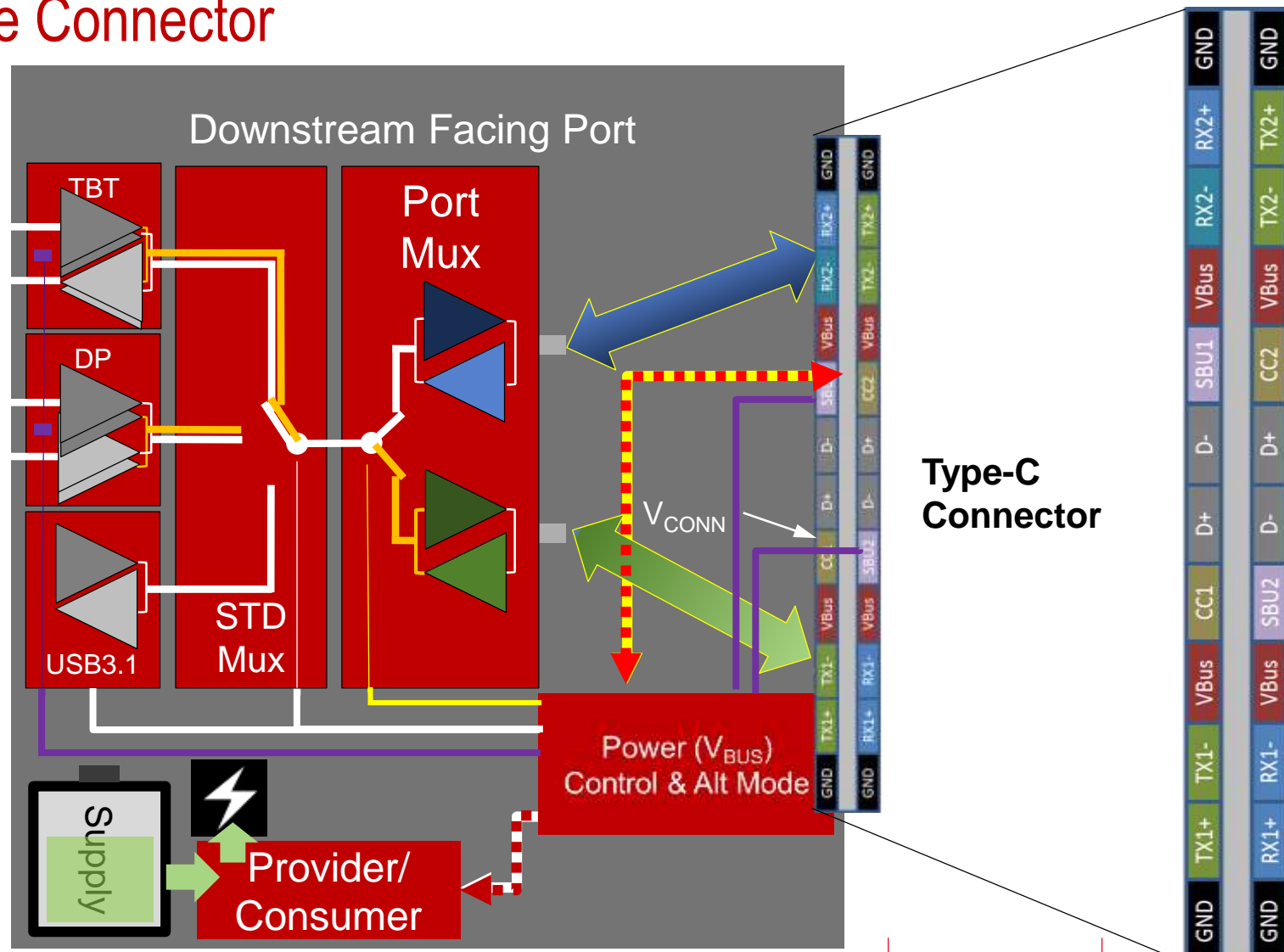
SideBand Utility pins (Alt Mode Operation)



# Closer Look at the Type-C Environment



## Behind the Connector



# Closer Look at the Type-C Environment Attributes

- There are 2 pairs of high speed ports (2 differential lanes):
  - USB3.1 use one port as an Rx/TX pair
  - TBT3 (& soon USB3.2) uses two ports as Rx/TX pairs
  - DP can be either :
    - a. 1 port dedicated to DP(two DP lanes, either Rx or TX) and the other port is dedicated to USB3.1, or,
    - b. 2 ports used as 4 DP lanes (either Rx or TX).
- $V_{BUS}$  power up to 100 Watts consuming or providing:
  - $V_{BUS}$ : 5 to 20 volts  $I_{BUS}$ : up to 5 amps
  - each device will accept several pre-defined PDOs

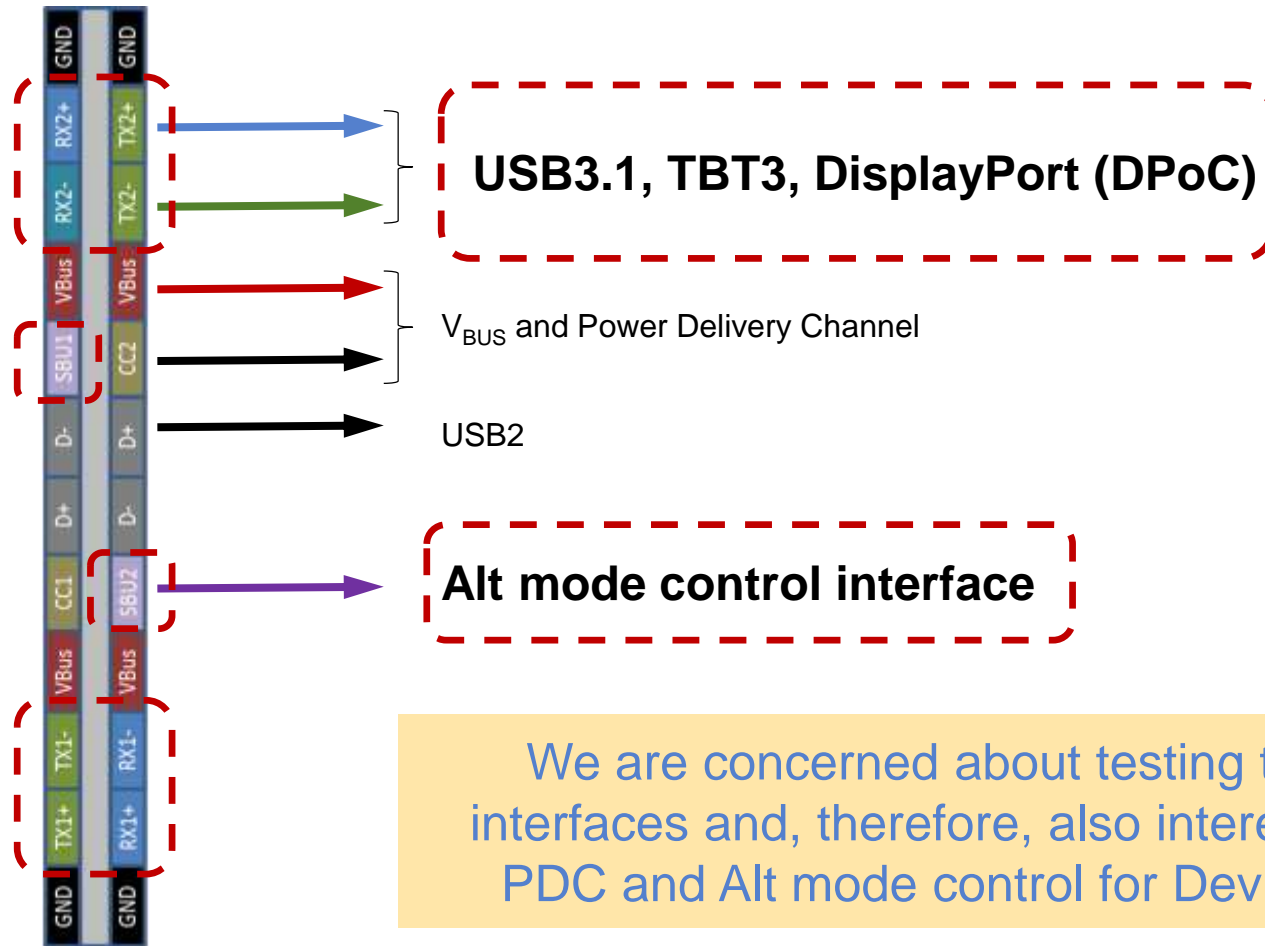


# Closer Look at the Type-C Environment Attributes

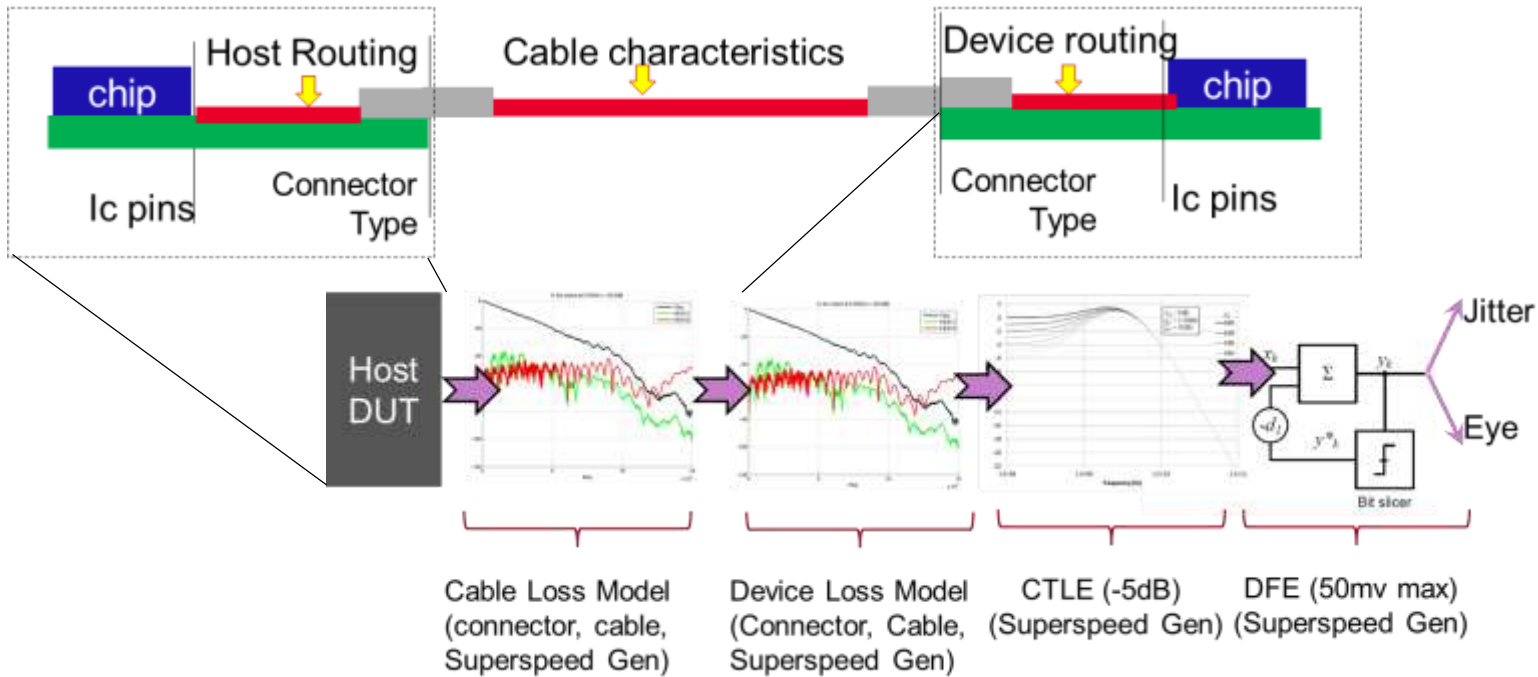
- SBU lines for **controlling devices** when in alt mode.
- Multiple uses for CC lines
  - Determine **orientation** in selecting port muxes and determines **data role**
  - Used for **alt mode setup** and **power delivery contracts**.
- Multiple standards implies signal **routing complexity**

# Focus on the High speed interfaces

## Performance AND Control



# Phy Layer Compliance testing



USB compliance patterns

Compliance Pattern	Data	Details	Bit Rate
CP0	D0.0 scrambled		5G
CP1	D10.2	Nyquist Frequency	5G
CP2	D24.3	Nyquist/2	5G
CP3	K28.5	COM pattern	5G
CP4	LFP5	Low Freq Periodic signaling	5G
CP5	K28.7	With de-emphasis (DE)	5G
CP6	K28.7	Without DE	5G
CP7	50-250 1's and 0's	With DE	5G
CP8	50-250 1's and 0's	Without DE	5G
CP9		Pseudo random data pattern	10G
CP10	AAh	Nyquist pattern	10G
CP11	CCh	Nyquist Pattern/2	10G
CP12	LFSR15	Uncoded LFSR15	10G
CP13	64 1's and 0's	With preshoot (PS)	10G
CP14	64 1's and 0's	With DE	10G
CP15	64 1's and 0's	w/ PS and DE	10G
CP16	64 1's and 0's	No PS or DE	10G

Test	RBR	HBR	HBR2	HBR3
3-1 Eye Diagram	PRBS7	PRBS7/ HBR2CPAT	HBR2CPAT TP3EQ	TPS4 TP3EQ
3-2 Non PreEmphasis Level	PRBS7	PRBS7	PRBS7	PLTPAT
3-3 Pre-Emphasis Level	PRBS7	PRBS7	PLTPAT	PLTPAT
3-4 Inter Pair Skew	D10.2	D10.2	D10.2	D10.2
3-11 Non ISI Jitter	PRBS7	PRBS7	NA	NA
3-11 Deterministic Jitter	NA	NA/ HBR2CPAT	HBR2CPAT TP3EQ	TPS4 TP3EQ
3-12 Total Jitter	PRBS7	PRBS7/ HBR2CPAT/D10.2	CP2520/D10.2 TP3EQ	TPS4 TP3EQ
3-14 Main Link Frequency	D10.2	D10.2	D10.2	D10.2
3-15 Spread Spectrum Modulation Frequency	D10.2	D10.2	D10.2	D10.2
3-16 Spread Spectrum Deviation Accuracy	D10.2	D10.2	D10.2	D10.2

DP Tests and Patterns

# Testing possibilities for Type-C devices

## USB3.1

Set orientation/role

-Set Port

-Set PDO

↻ Compliance suite

-Next PDO

-Next Port

## DPoC

Set orientation/role

-Set Port

-Set Alt mode

-Set PDO

↻ Compliance suite

-Next PDO

-Next Alt mode

-Next Port

## TBT3

Set orientation/role

Set Alt mode

-Set PDO

↻ Compliance suite

-Next PDO

This can all be covered automatically...



Standard specific control

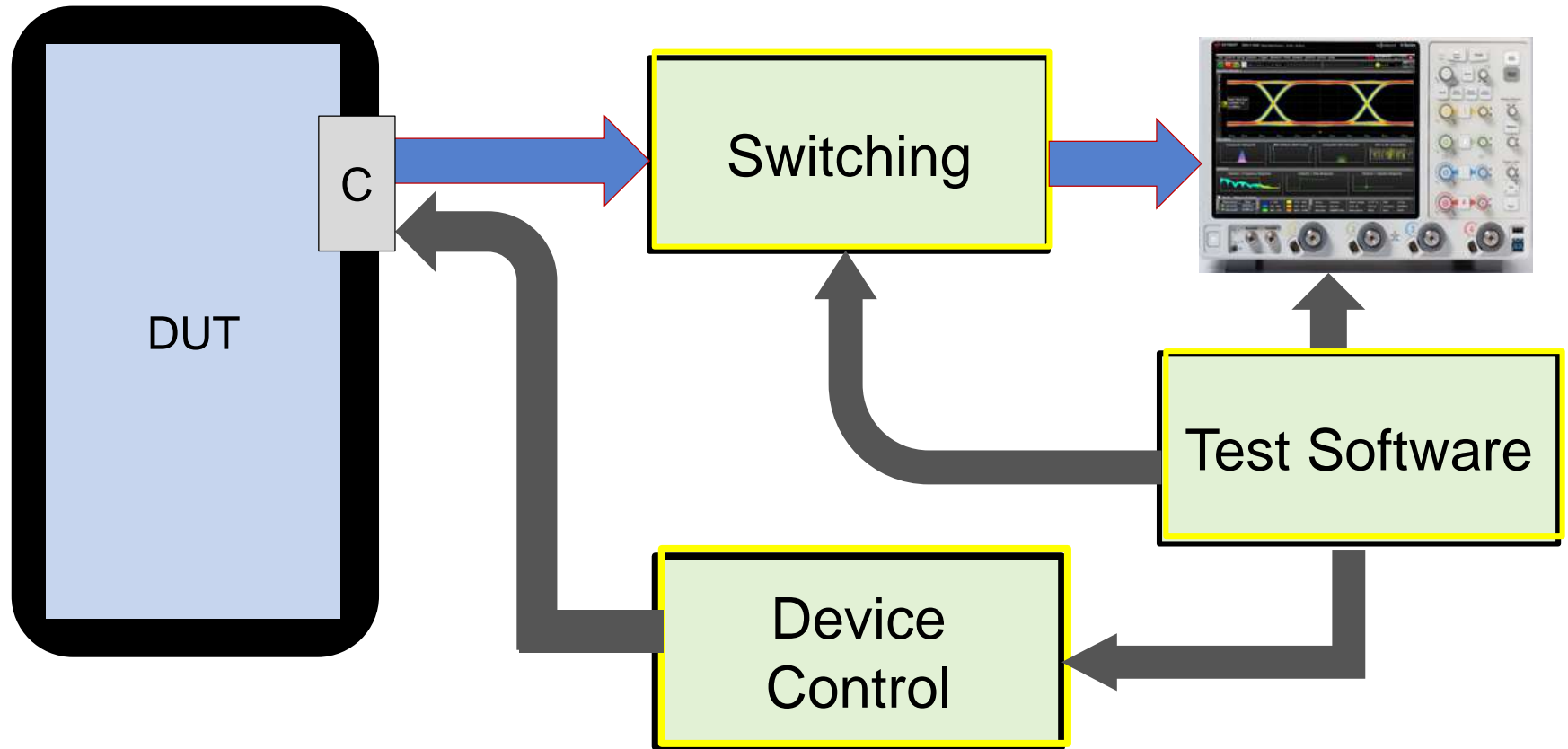


Type-C environment control



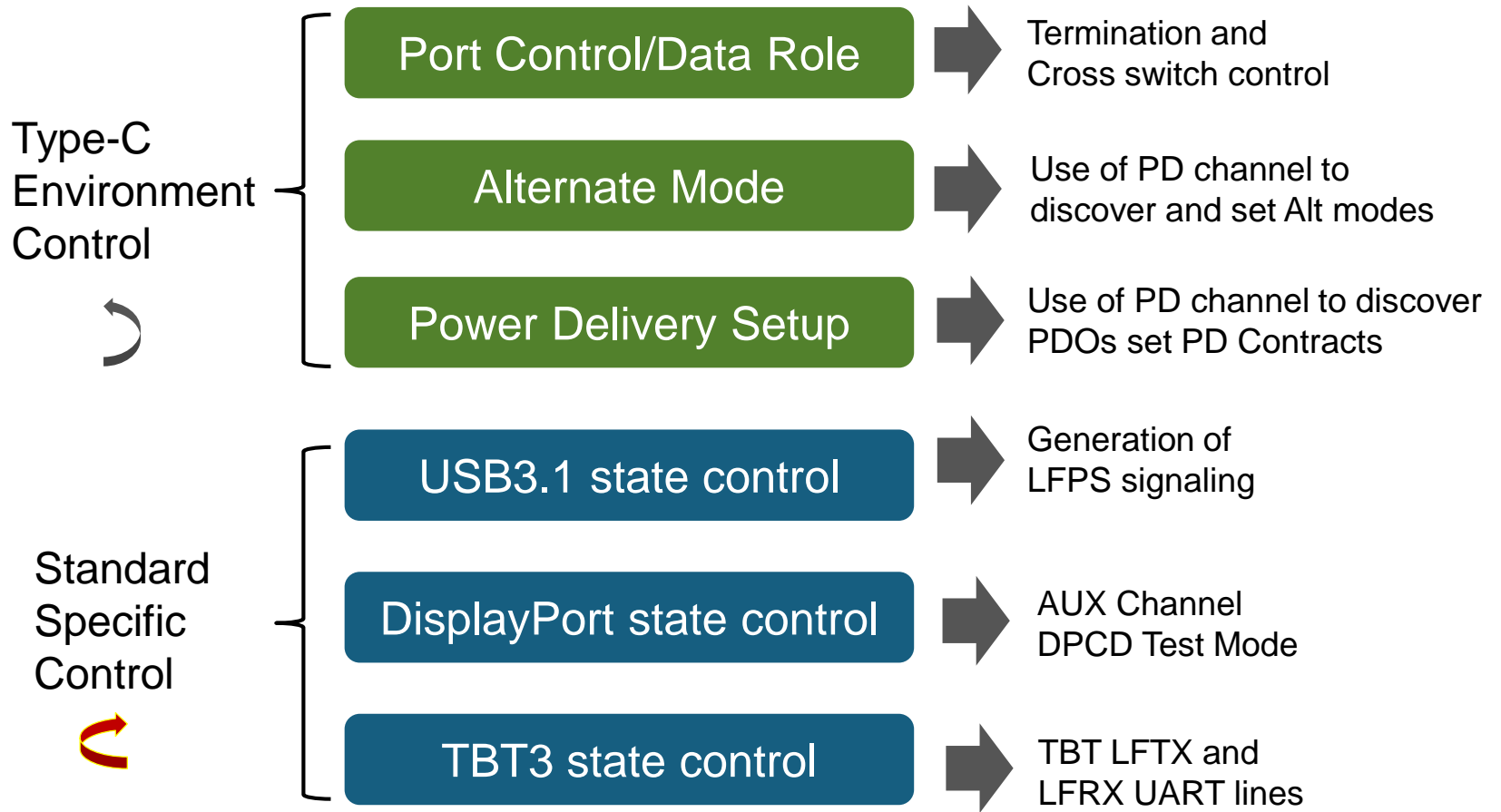
Test application control

# Keys to Automation



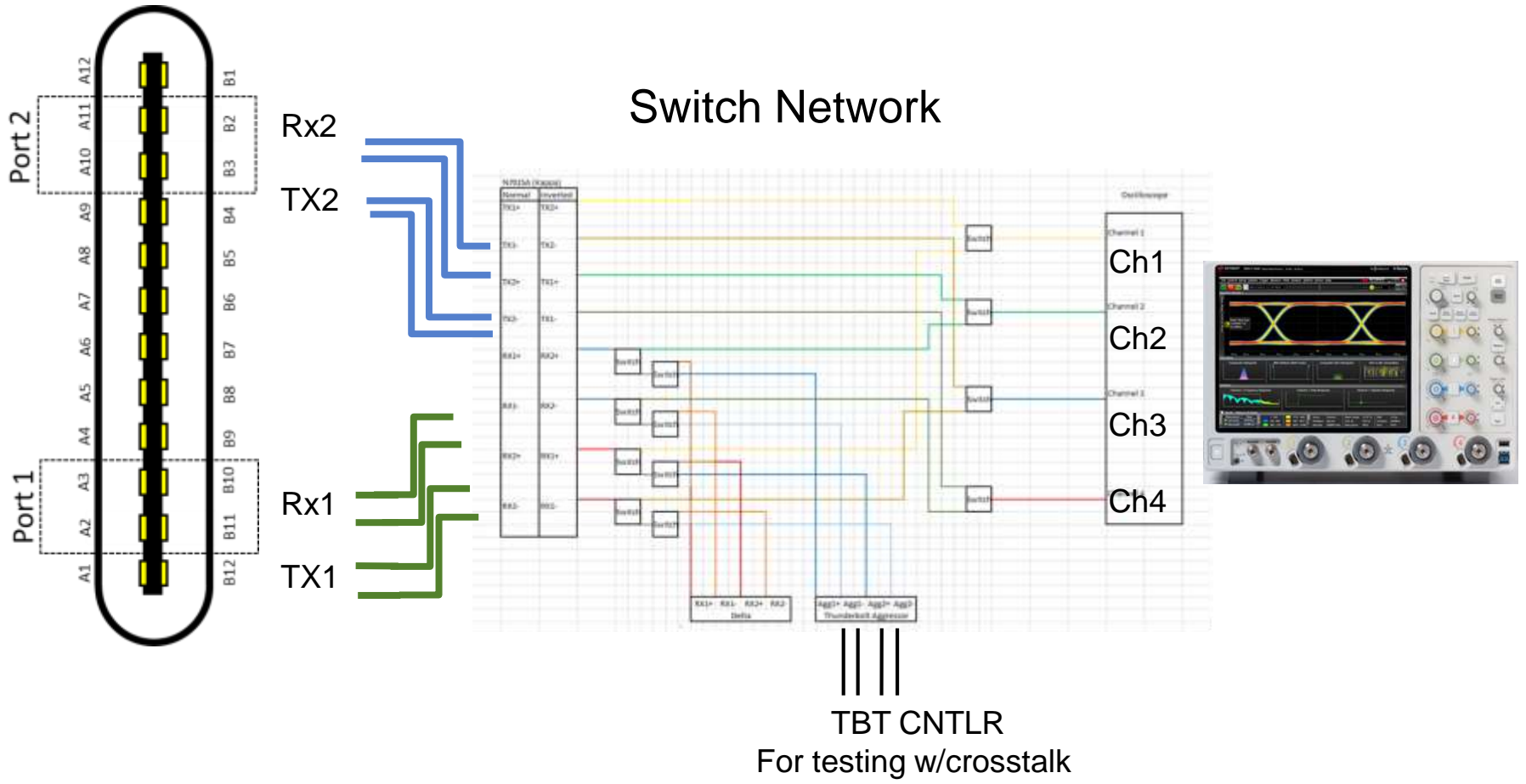
3 keys to automation: Device Control, Switching, Test Software

# Device control



# Switching

Switching



# Test Software: Integration Requirements

- Use standard-approved compliance tests.
- Must control the device for all type-C functions and standard control functions.
- Must control  $V_{BUS}$  power supply whether consuming or providing.
- Must know the orientation.
- Must be able to sequence through multiple standards
- Must be able to sweep parameters in the test plan.
- User must have flexibility to run procedures desired.



# Device control implemented

Device Control

Type-C Environment Control



Port Control/Data Role

Termination and Cross switch control

Alternate Mode

Use of PD channel to discover and set Alt modes

Power Delivery Setup

Use of PD channel to discover PDOs set PD Contracts

USB3.1 State control

Generation of LFPS signaling

DisplayPort State control

AUX Channel DPCD Test Mode

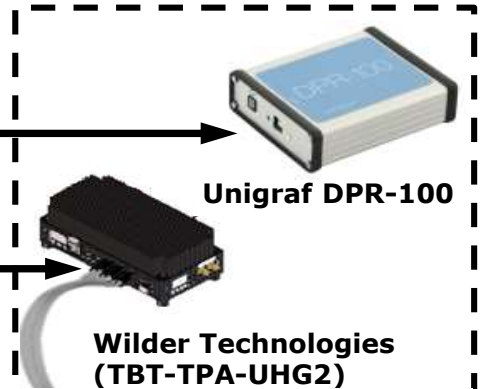
TBT3 State control

TBT LFTX and LFRX UART lines



Keysight N7018A Type-C Test Controller

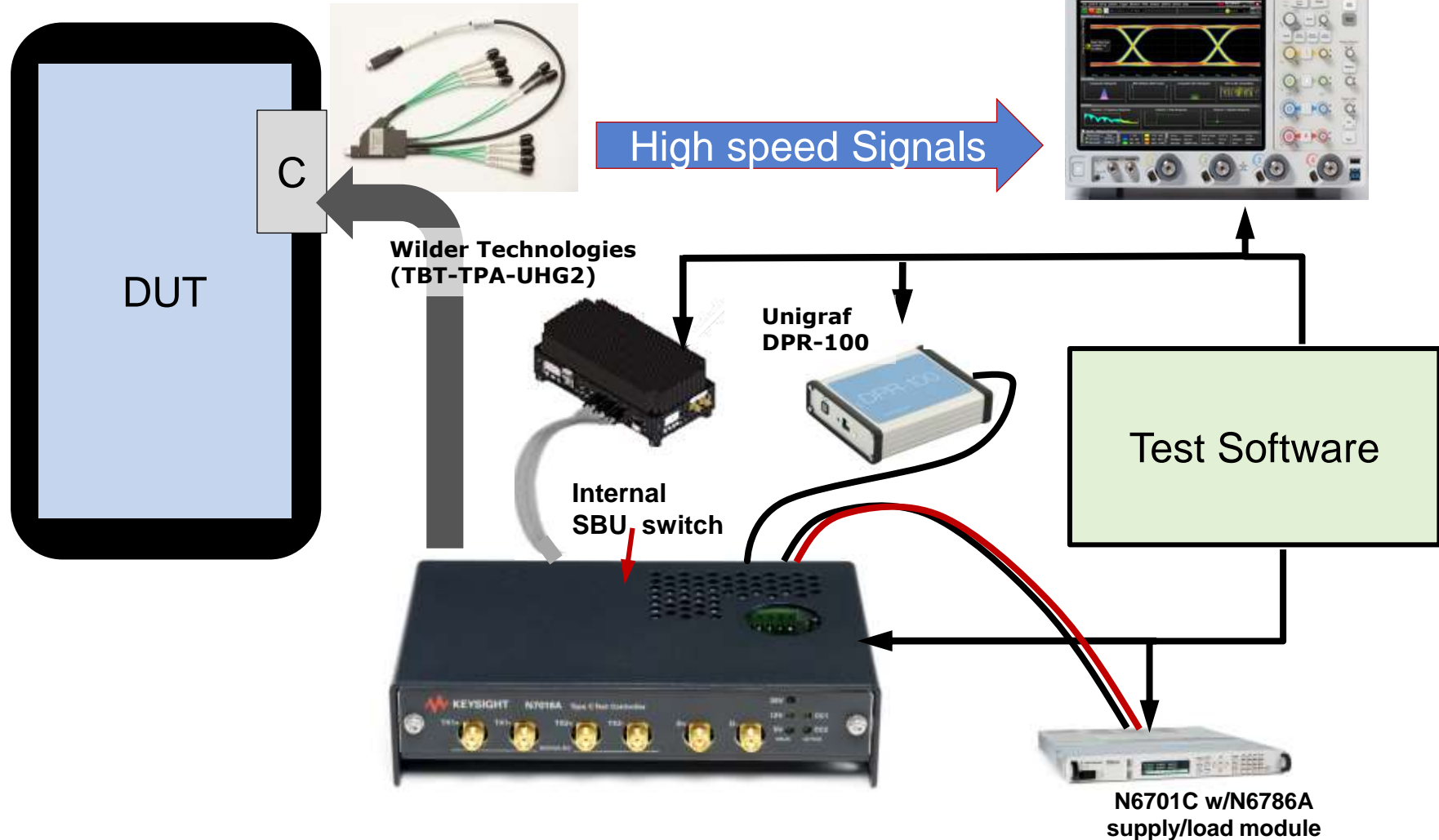
Standard Specific Control



Industry Standard Controllers

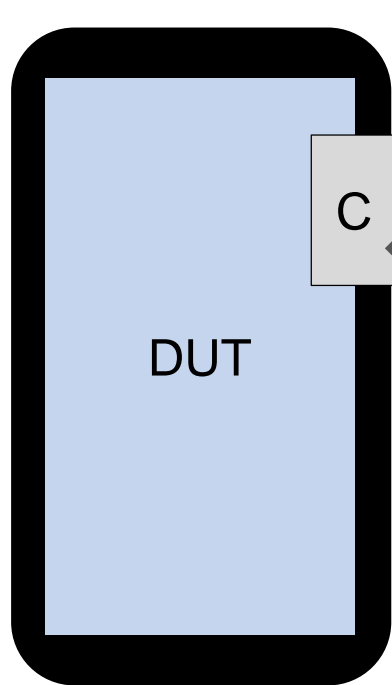
# Device control implemented

Device Control

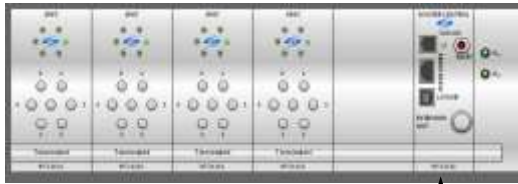


# Switching Implemented

Switching



BitifEye 2100



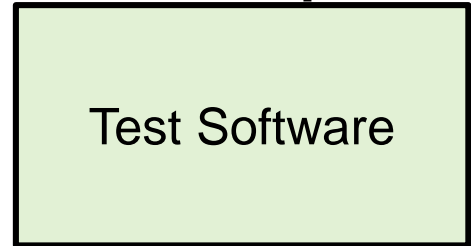
Wilder Technologies (TBT-TPA-UHG2)



Unigraf DPR-100



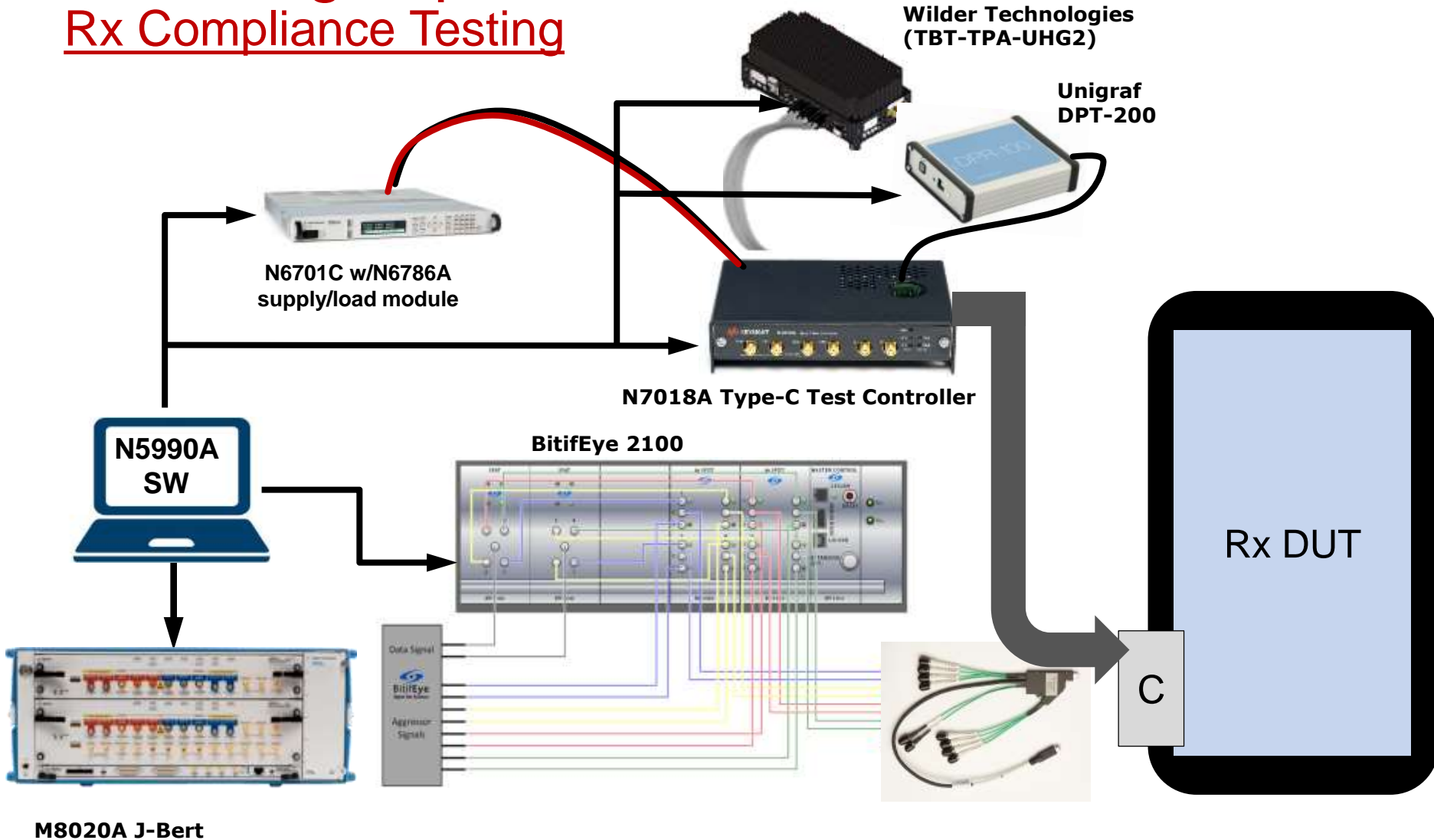
Internal SBU switch



N6701C w/N6786A supply/load module

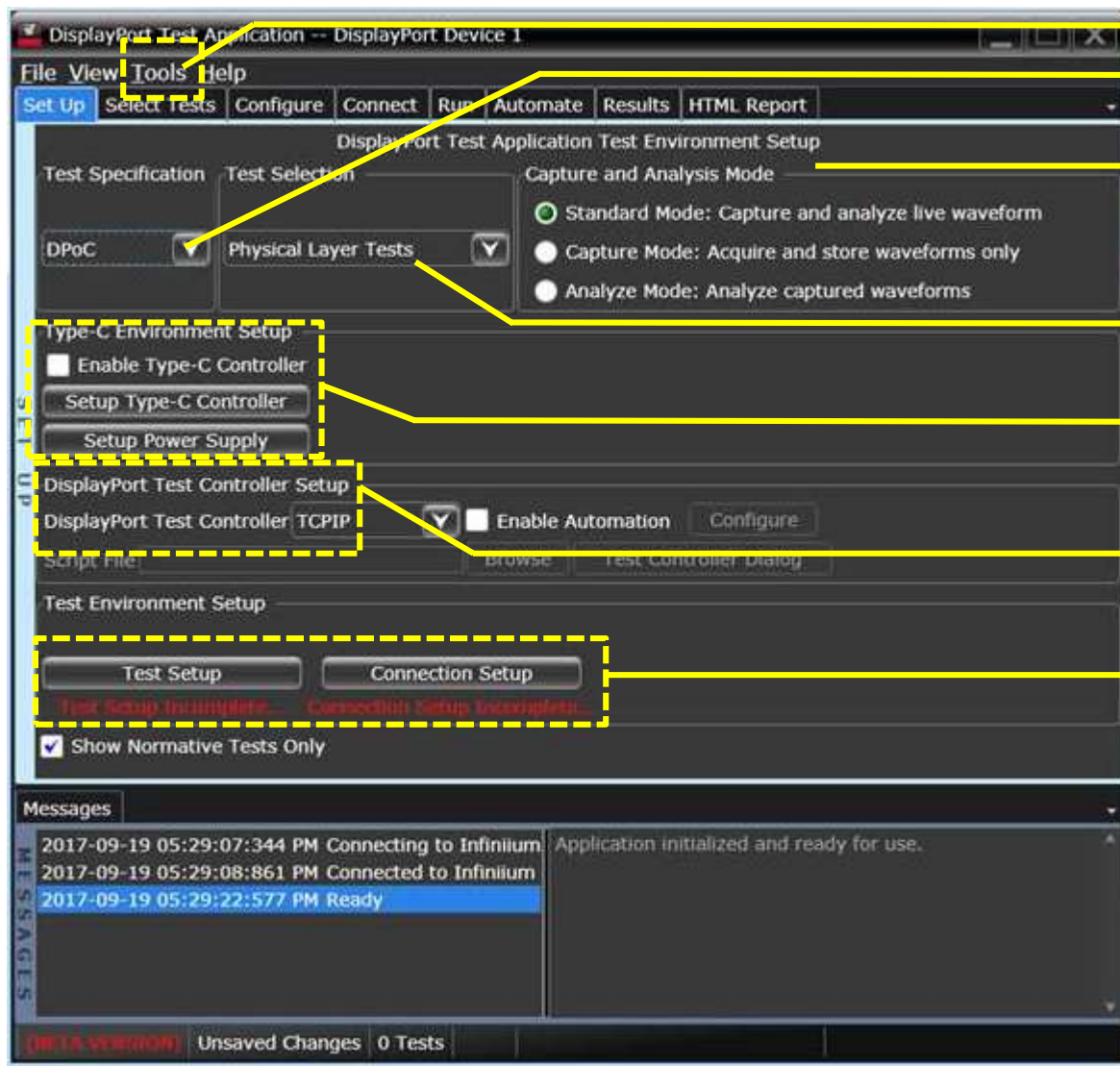


# Switching Implemented: Rx Compliance Testing



# Test Software: Integration Implemented

Test Software



Switch assignment and calibration  
Standard Selection

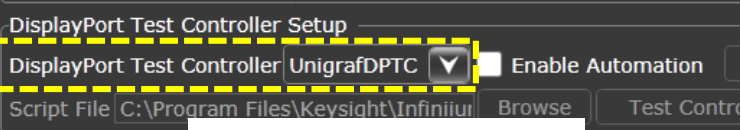
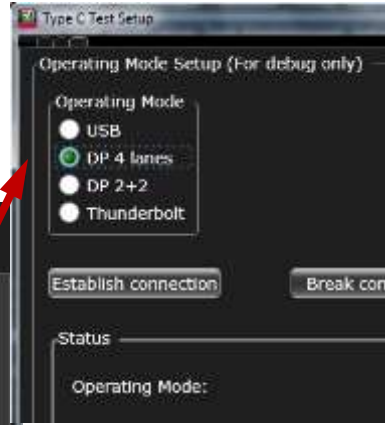
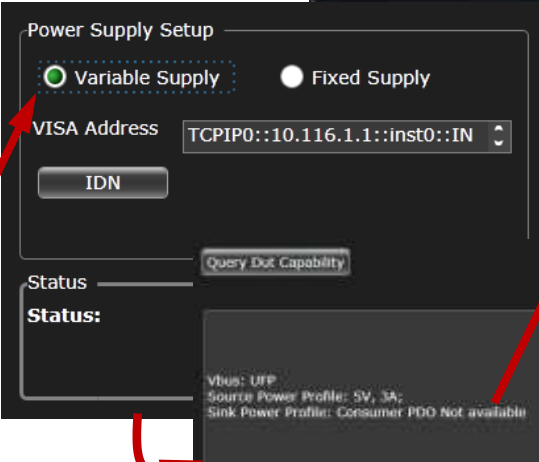
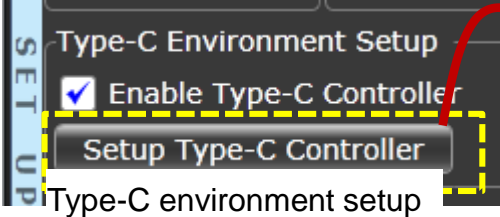
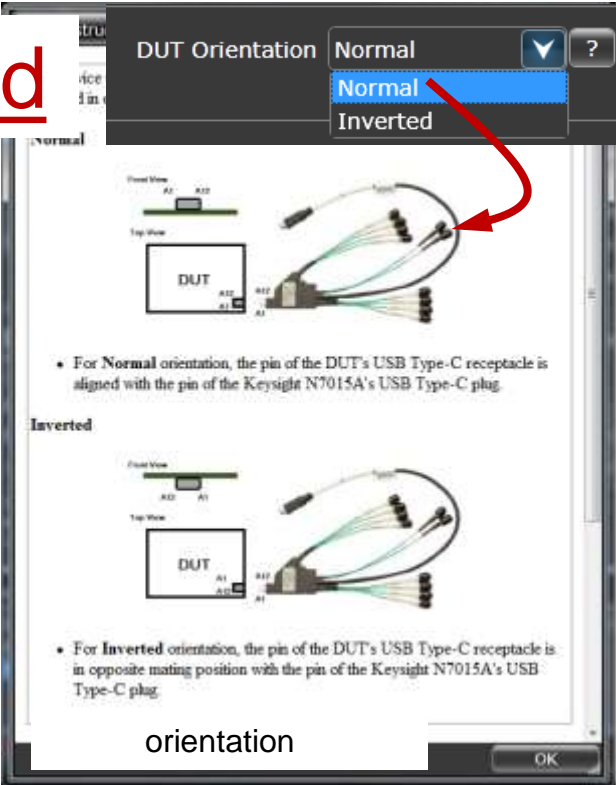
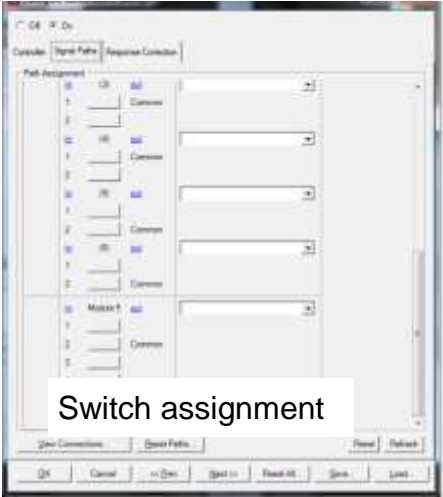
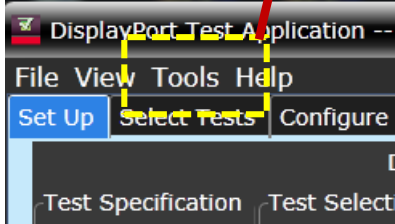
DP1.4, DPoC  
Mode of Operation  
*can store waveforms away to process offline, or later on scope*

Test Suite  
*Phy Layer Testing, Test Tools*  
Type C setup  
*Enabled, Controller, Power supply*

DisplayPort Automation  
*Enabled, Controller, Config*

DisplayPort Test setup  
*Tests and Connection*

# Software: Integration Implemented

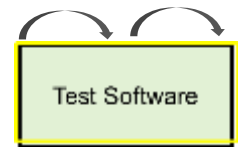


DisplayPort test control

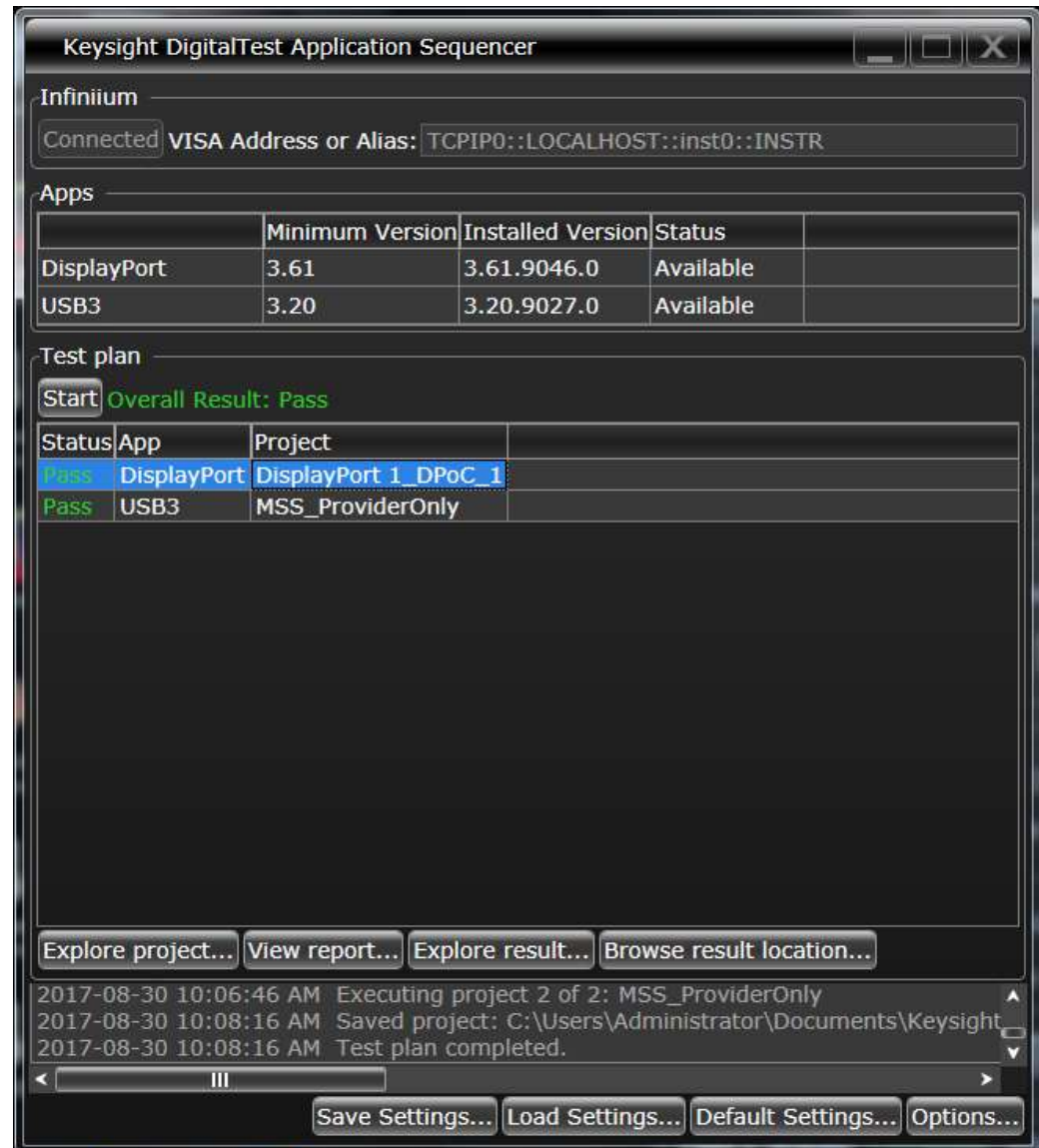




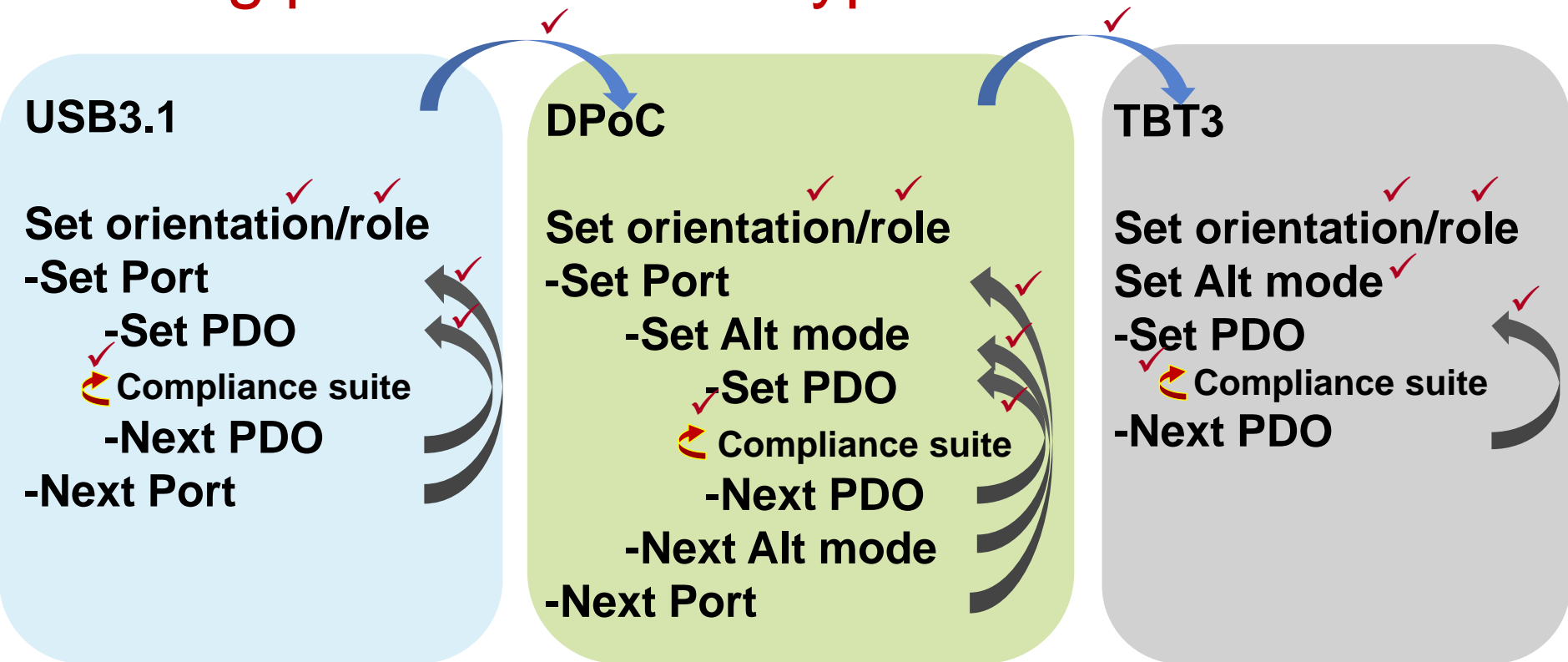
# Test Software: Standard Sequencing Implemented



- **User creates and selects projects in each standard**
- **Selects in menu**
- **Start**
  - Loads first application
  - Loads first project, runs
  - Loads second if exists
  - Loads next app
  - Loads project, runs
  - etc.
- **No user interaction required after started**
- **Shows status, reports, etc**



# Testing possibilities for Type-C devices



Keysight vision in Type-C: Total Automation

↻ Standard specific control

↻ Type-C environment control

↻ Test application control



# New Type-C products from Keysight...

## N7018A Type-C Test Controller



## DigitalTest Application Sequencer

Downloadable in  
N5452A Remote User  
interface sw



**TX compliance Applications**  
Integrates the N7018A

**Rx compliance software (N5990A)**  
Integrates the N7018A

USB3.1: **U7243C**  
DP: **U7232E**  
TBT3: **N6470B**

Type-C control: **Option 006**  
Thunderbolt TX enabled: **Option 204**



# Summary

The attractiveness of the Type-C connector is its:

- Low profile,
- Orientation independence,
- Power delivery networking ability,
- Support of multiple standards,
- High data rates supported.

This interface **deserves** a lot of attention and validation.

The compliance regimens for the interfaces supported (USB, TBT and DP) do not change, however, there are a great number of variations in setup that are possible that conscientious effort will consider for complete validation.

**Keysight** enables unlimited control and automation to help you cover the validation space you need to develop and release your quality product.

