



GRL USB-PD Test Solution

Jun 2019

USB:PD 様々なデバイス・仕様の組み合わせ



Apple



Samsung



Xiaomi



Lenovo/Moto



Google



Huawei



Phone Charging Only

Tablet and Phone
Charging

PC, Tablet and Phone
Charging

Workstation, PC, Tablet,
Phone Charging

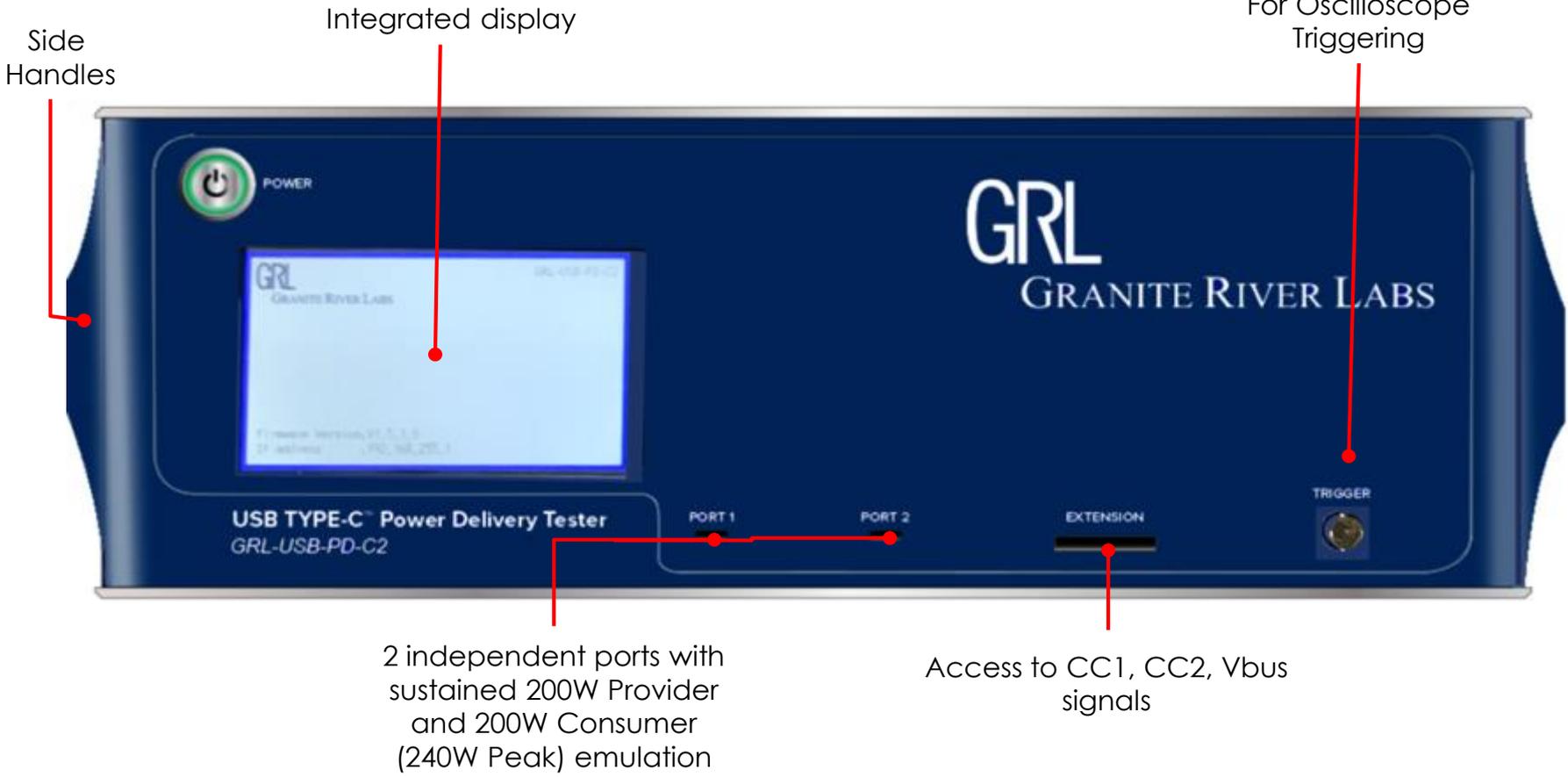
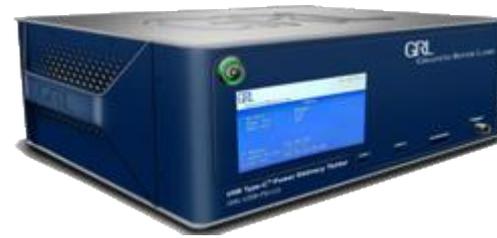
Powering USB PD 3.0 and Quick Charge 4



GRL-USB-PD-C2

*The Complete USB Type-C™ Power Delivery Compliance Tester
& Analyzer*

C2 Tour (Front Panel)



Powerテストに必要な機材を一筐体に



USB PD ソース/シンク機能をエミュレート

- ・ USB PD3.0/QC2.0/3.0/4.0/DP ALT mode/TBT AITMode
プロトコルに対応
- ・ 2 Port独立に設定・制御



PD 電源 100W x2
Peak 240W

PD E-Load 100W x2

電圧・電流測定機能
マルチチャンネル
VBUS, CC, D+, D-
時系列メモリ

GRL-USB-PD-C2

2ポートの信号・プロトコルを同時に取り込み
PD Protocol, CC/VBUS/D+/D-



GRL-USB-PD-C2



- 一台で、広範囲な規格をカバーするテスター

USB Type-C : Power Delivery, Qualcomm Quick Charge, Thunderbolt 3
DisplayPort Alt Mode

- 2ポート独立に制御・計測

ポートごとの電源/eロード、データ取り込み、プロトコル制御

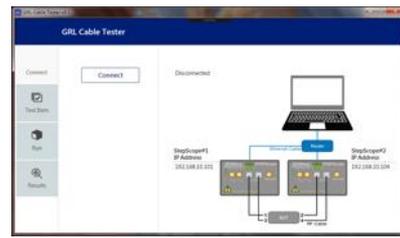
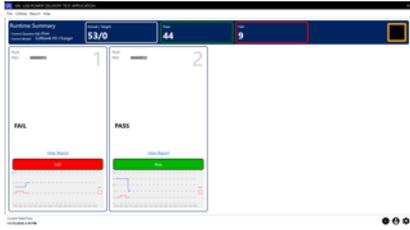
- VBUS, D+/D-, CC ラインの解析、USB PDや以前のパワーネゴシエーション解析

- USBType-Cパワー全機能テスト

- カスタマイズ可能なプログラマブル機能

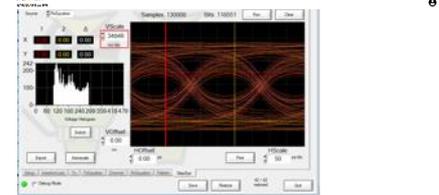
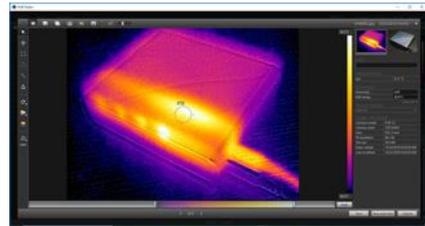
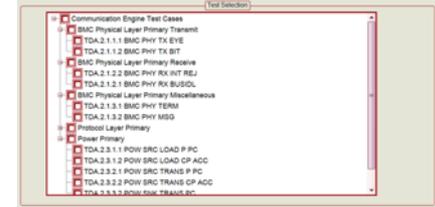
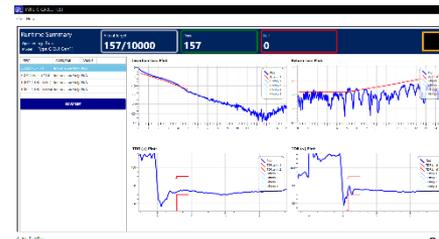
Python/C#でカスタムプログラムで利用可能なAPIを公開

広範囲なアプリケーションに最適なソフトウェアで対応



GRL USB Power Test App

PDO	Port1 (V)	Port2 (V)	%	Port1 (A)	Port2 (A)	%	IR drop (mohm)
PDO#1	Fixed: 5.08	4.75	93.4%	2.99	2.97	99.5%	112
5V 3A							
PDO#2	Fixed: 9.04	8.75	96.8%	3.01	2.97	98.6%	96
9V 3A							
PDO#3	Fixed: 15.04	14.73	98%	3.04	2.99	98.1%	100
15V 3A							
PDO#4	Fixed: 14.5	14.16	97.7%	3.24	3.16	97.7%	104
20V 3A							



ケーブル製造ライン向け
GO/NG判定

USB Power Suite Pro
解析・デバッグ/エミュレーション

Open Python/C# API's
カスタムプログラムを構築

Compliance Test App
Type-C コンプライアンステストを

Volume Production
& Reliability Testing

Performance Benchmarking
& Sample Testing

Passive Cable Signal
Quality Testing

Fully Analysis and
Compliance Testing



V Series



F1



DI



C2

Powering USB PD 3.0 and Quick Charge 4



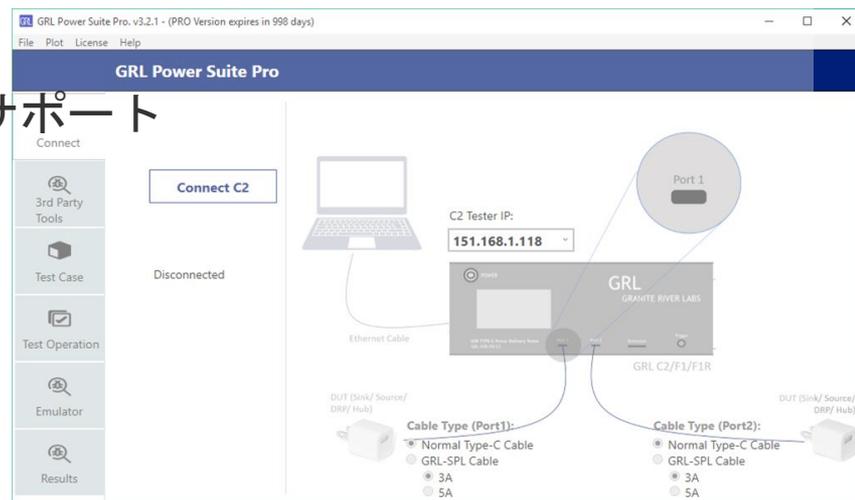
GRL-Power –Suite-Pro (GRL-PSP)

Software to emulate and analyze power unit performance

GRL Power Suite Pro(GRL-SPS)

USB電源デバイスエミュレーション、機能/性能テストソフトウェア

- USB-PDデバイスの様々なテストを行うソフトウェア
 - GRL-USB-PD-C2を使用し広範囲のテストを最小限の機材で実行
- ソース・シンクのエミュレーション
- Type-C 電源アダプタ、PC、Phone、タブレット、モニター、パワーバンク、ハブ、マルチポートデバイス、ドックなどの電源試験
- 機能検証、トラブルの原因究明
- USB-Power Delivery、Quick Chargeをサポート
- 自動テスト機能とレポート機能



PSP Applications and Test Features



マルチポート DUT

Multiport
Chargers



ソースデバイス

- Create Custom Sink
- Capture & Save Source DUT Capabilities
- Emulate Sink to functionally test with Source DUT
- Source DUT IV-Curves & OCP Behavior
- Source DUT Power Efficiency

シンクデバイス

- Create Custom Source
- Load & Emulate Source DUT Capabilities
- Characterize Sink Power Capabilities

ソース/シンク デバイス

Battery Cycler



ハブ/ケーブル

- Passthrough Hub Testing
- Cable Testing

Power Suite Pro <PSP> アプリケーション機能



GRL Power Suite Pro

DUT Type	Port	Test Case
Sink	Single	1) Manual Control - Port as Source
Source	Single	2) Manual Control - Port as Sink
Source	Single	3) OCP & IV Curves
Source	Single	4) Power Efficiency
Sink	Single	5) USB PD Sink Capabilities Characterization
DRP	Single	6) Battery Charge/Drain Cycler
Source	Dual	7) Multi-port Loading
Hub	Dual	8) USB PD Hub Power Passthrough Characterization
Cable	Dual	9) Cables E-Marker and Power Capabilities Characterization

ソース/シンクエミュレート
(マニュアル操作)

オーバーカレント/I-Vカーブ
測定

効率測定

シンク機能チェック

バッテリー・サイクルテスト

マルチポート負荷テスト

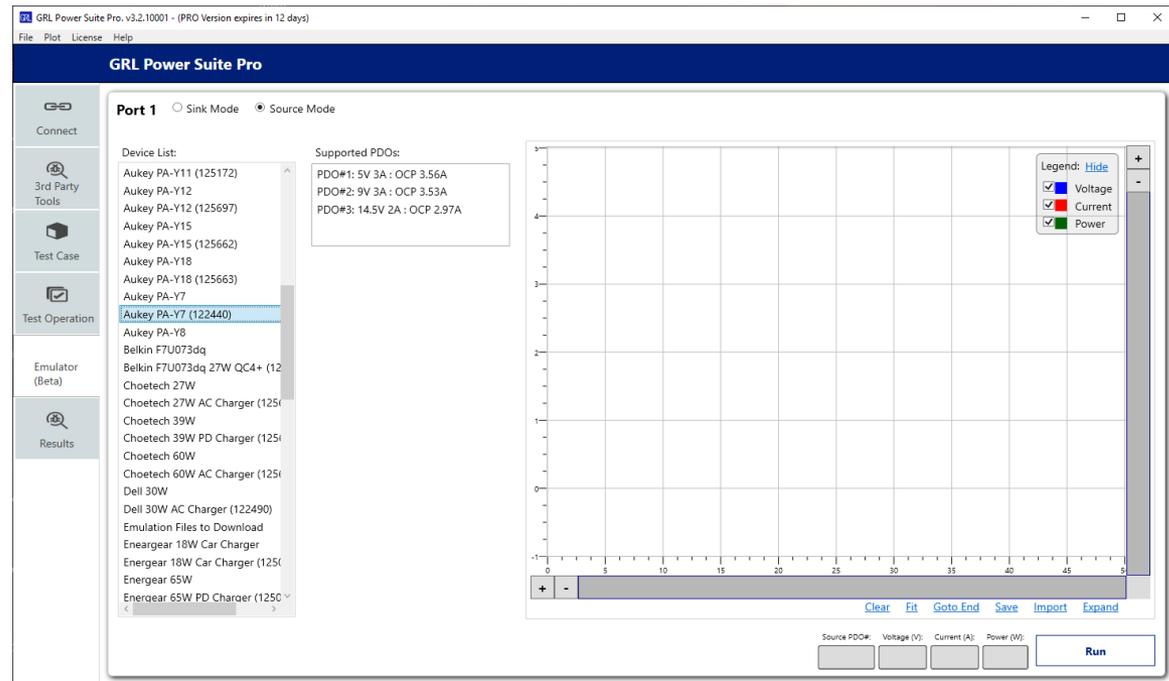
ハブ・パススルー・テスト

ケーブル・テスト

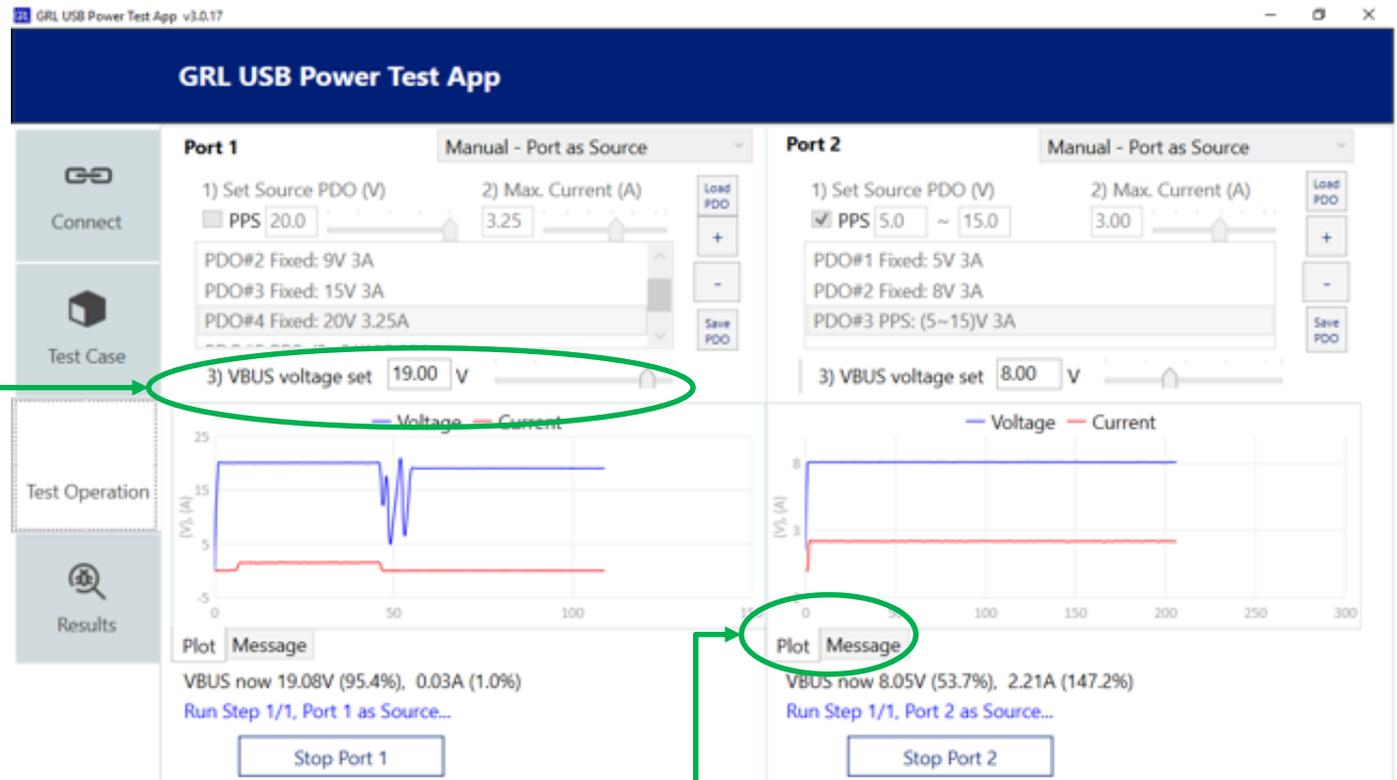
Device Emulation



- 市場のデバイスの動作をエミュレート
- 簡単にIOPテスト
- 実際の市場デバイスへのF/W対応
- 要求ベースで、カスタムデバイスの作成も可能



PDソース・エミュレーション

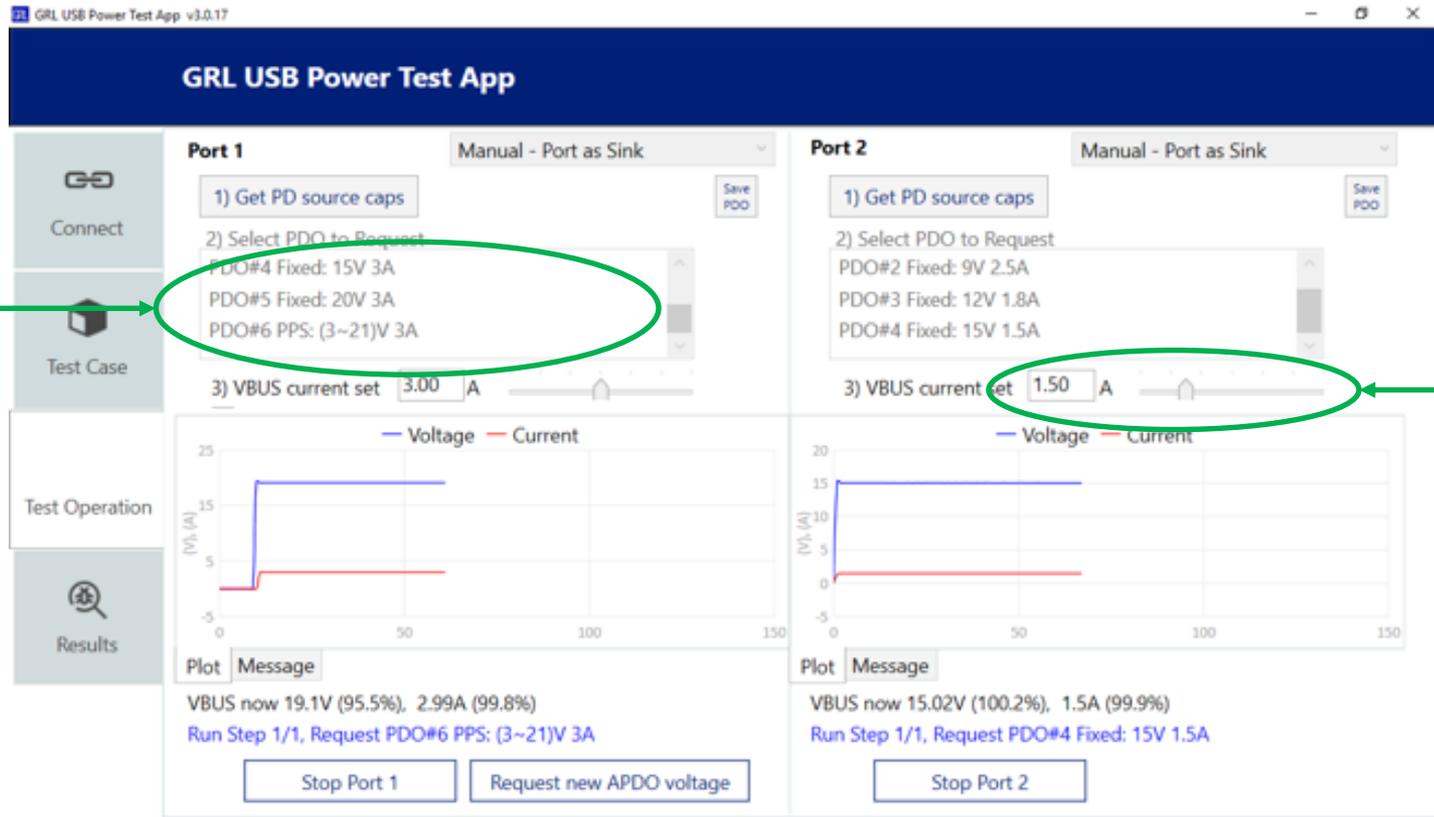


C2 Portをソースとして設定
PPSを含む任意のPDOを設定可能

マニュアルでVbus電圧を変更

グラフとプロトコルメッセージを
簡単に切り替え

PDシンク・エミュレート

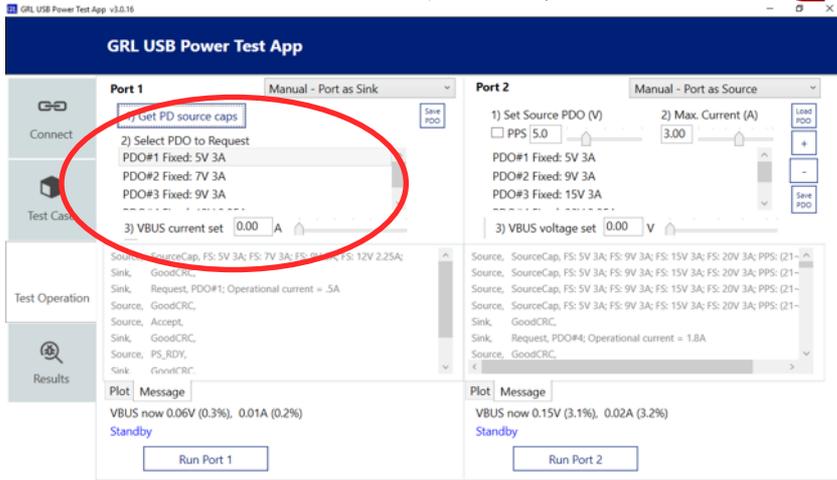


C2 Portをシンクに設定
デバイスがアダプタイズしたPDOを自動読み込みしリスト化
試験対象のPDOを選択するだけ

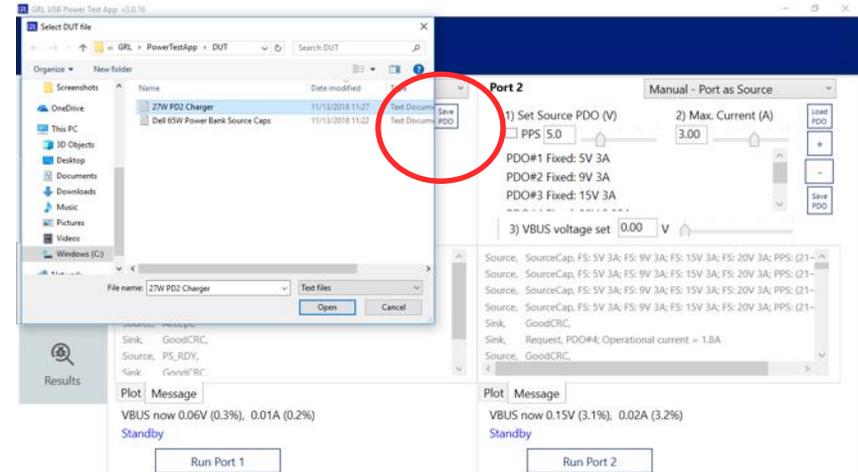
Vbus 電流(負荷電流) を任意に設定

Port1、Port2をソース/シンク自由に割り当て可能

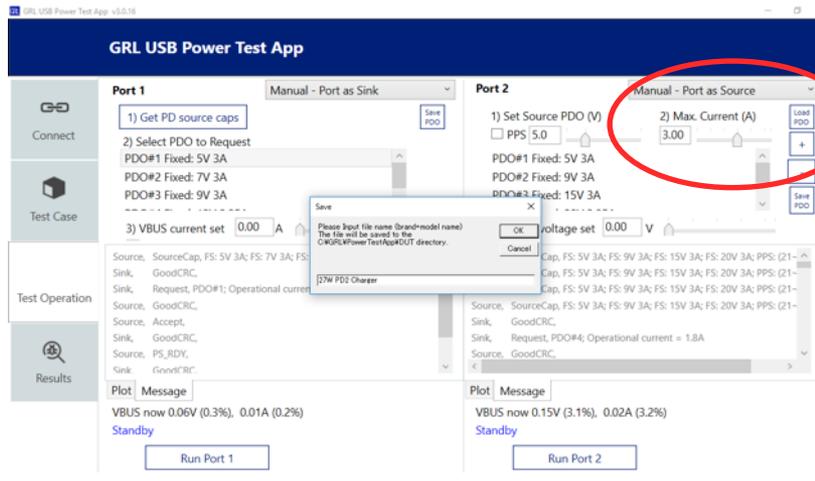
実際のソース機器をエミュレート GRLデータベースを利用可能



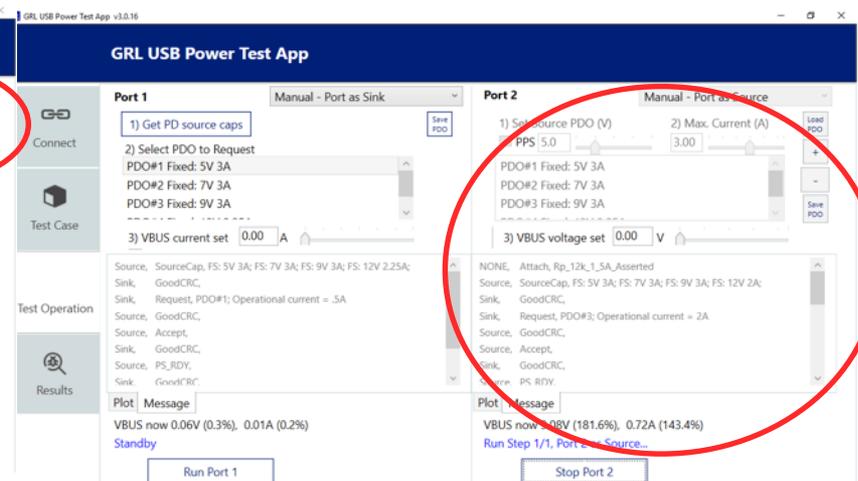
1) 接続したソースデバイスからPDOを読み取る



2) 読み取ったPDOをファイルにセーブ

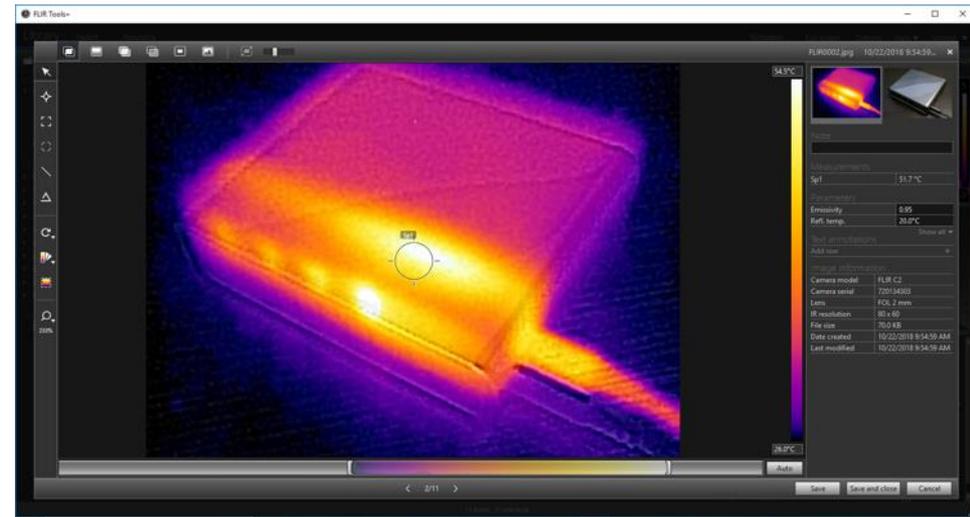
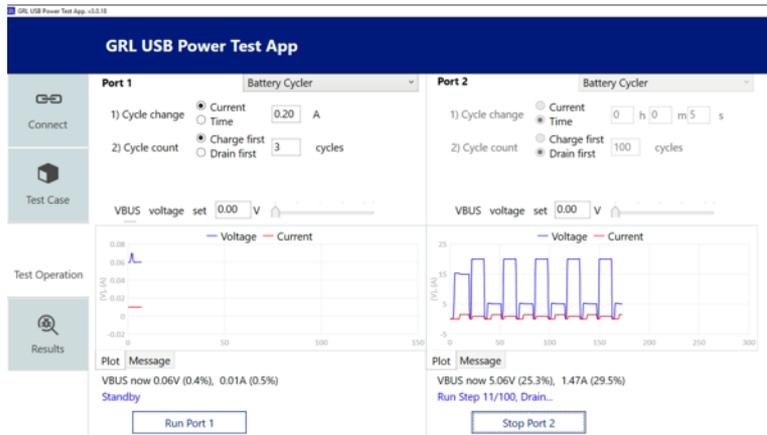


3) ポートをソースに設定し、セーブしてあるファイルからPDOをロード



4) デバイスをエミュレートしたポートに、テストするシンク機器を接続

バッテリーのサイクル充放電テスト



- 1) バッテリー・サイクル・テストでは、充放電の切り替えタイミングを時間または電流閾値で設定可能
- 2) バッテリテストポート（DRPポート）にバッテリーデバイスを接続しテストをスタート

- 3) 異常なプロトコルや電源のふるまいを監視。また、サーマル・イメージ・センサーを接続しホットスポットのチェック

Type-Cケーブル : E-markerとPower Capabilities テスト



GRL USB Power Test App

PDO	Port1 (V)	Port2 (V)	%	Port1 (A)	Port2 (A)	%	IR drop (mohm)
PDO#1 Fixed: 5V 3A	5.08	4.75	93.4%	2.99	2.97	99.5%	112
PDO#2 Fixed: 9V 3A	9.04	8.75	96.8%	3.01	2.97	98.6%	96
PDO#3 Fixed: 15V 3A	15.04	14.73	98%	3.04	2.99	98.1%	100
PDO#4 Fixed: 20V 3A	14.5	14.16	97.7%	3.24	3.16	97.7%	104

GRL USB Power Test App

PDO	Port1 (V)	Port2 (V)	%	Port1 (A)	Port2 (A)	%	IR drop (mohm)
PDO#1 Fixed: 5V 3A	4.35	3.94	90.5%	5.04	5.01	99.5%	82
PDO#2 Fixed: 9V 3A	8.04	7.63	94.9%	5.03	4.95	98.5%	81
PDO#3 Fixed: 15V 3A	13.79	13.34	96.7%	5.08	4.98	98.2%	88
PDO#4 Fixed: 20V 3A	18.65	18.26	97.9%	5.13	5.06	98.6%	76

1) Type-Cケーブルの両端をそれぞれPort1, Port2に繋ぎE-Markerのテスト、実際に電流を流してケーブルのPower Capabilityを測定

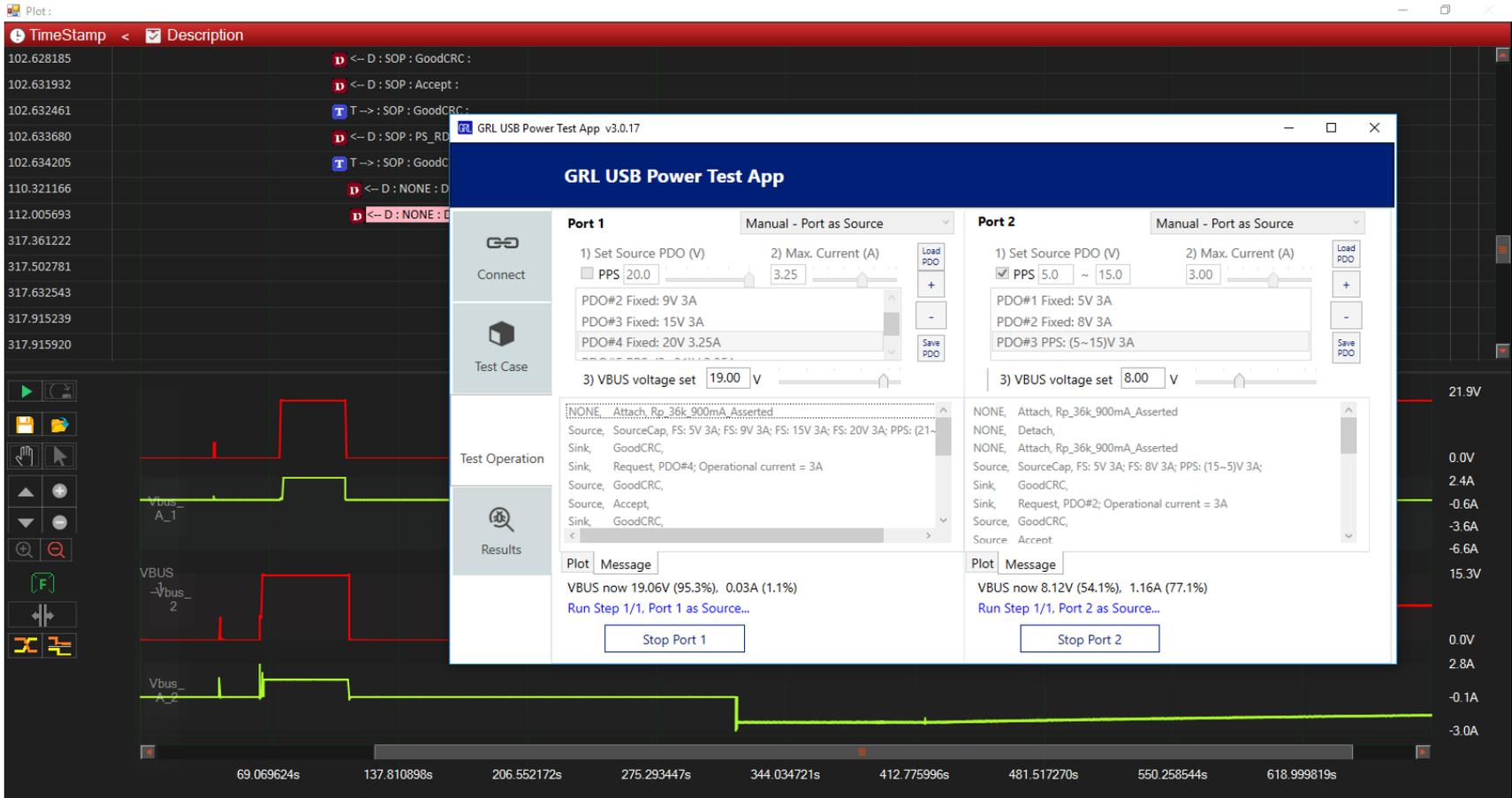
2) Power Capability結果表示

3) E-Markerの検証
 3A <-> 5A
 USB 2.0 <-> USB 3.1

Vendor Defined Messaging		Vendor Defined Messaging		Vendor Defined Messaging	
Key	Value	Key	Value	Key	Value
Vendor_ID	65280	Vendor_ID	65280	Vendor_ID	65280
VDM_Type	Structured VDM	VDM_Type	Structured VDM	VDM_Type	Structured VDM
VDM_Version	Version 1.0	VDM_Version	Version 1.0	VDM_Version	Version 1.0
Reserved[12:11]	0	Reserved[12:11]	0	Reserved[12:11]	0
Object_Position	0	Object_Position	0	Object_Position	0
Command_Type	ACK	Command_Type	ACK	Command_Type	ACK
Command	Discover ID	Command	Discover ID	Command	Discover ID
USB_Vendor_ID	Apple	USB_Vendor_ID	Granite River Labs	USB_Vendor_ID	Apple
USB_Product_ID	0x1781	USB_Product_ID	0x0003	USB_Product_ID	0x0003
USB_Superspeed_Signalling_Support	USB 2.0 only	USB_Superspeed_Signalling_Support	USB 3.1 Gen 2	USB_Superspeed_Signalling_Support	USB 3.1 Gen 2
SOP_PP_Controller_present	[2:0]	SOP_PP_Controller_present	[2:0]	SOP_PP_Controller_present	[2:0]
VBUS_through_cable	[4]	VBUS_through_cable	[4]	VBUS_through_cable	[4]
VBUS_Current_Handling_Capability	5A	VBUS_Current_Handling_Capability	5A	VBUS_Current_Handling_Capability	3A
SSRX2_Directionality_Support	0	SSRX2_Directionality_Support	0	SSRX2_Directionality_Support	0
SSRX1_Directionality_Support	0	SSRX1_Directionality_Support	0	SSRX1_Directionality_Support	0
SSTX2_Directionality_Support	0	SSTX2_Directionality_Support	0	SSTX2_Directionality_Support	0
SSTX1_Directionality_Support	0	SSTX1_Directionality_Support	0	SSTX1_Directionality_Support	0
Cable_Termination_Type	Both ends passive, VCONN not req	Cable_Termination_Type	Both ends passive, VCONN not req	Cable_Termination_Type	Both ends passive, VCONN not req
Cable_Latency	10ns - 20ns	Cable_Latency	10ns	Cable_Latency	Reserved
TypeC_Plug_To_PlugOrReceptacle	Plug	TypeC_Plug_To_PlugOrReceptacle	Plug	TypeC_Plug_To_PlugOrReceptacle	Plug
TypeC_Plug_To_TypeA_B_C_Captive	TYPE-C	TypeC_Plug_To_TypeA_B_C_Captive	TYPE-C	TypeC_Plug_To_TypeA_B_C_Captive	TYPE-C
Reserved[23:20]	[23:20]	Reserved[23:20]	[23:20]	Reserved[23:20]	[23:20]
FW_Version	1	FW_Version	0	FW_Version	1
HW_Version	10	HW_Version	0	HW_Version	1

4) ベンダー名、モデル名のチェック

コンプライアンステストで使用している 強力なプロトコル解析を利用



カスタムテストをC#/Pythonで構築 APIを利用可能



GRL GRANITE RIVER LABS **GRL-USB-PD-C2 API** 0.8.5
GRL-USB-PD-C2 / GRL-USB-PD-F1 API Documentation

Main Page Packages Classes

- GetPdStatus
- GetPresentMeasurementVi
- GetSerialNumber
- Initialize
- SendControlMessage
- SendPdoRequestMessage
- SendVendorDefinedMessa
- SetBatteryStatusMessage
- SetControllerMode
- SetEloadCurrent
- SetEloadState
- SetNotToSendRequestMes
- SetPdSpecificationRevision
- SetSinkCapability
- SetSinkCapabilityExtenc
- SetSinkRequestMessage
- SetSourceCapability**
- SetSourceCapabilityExtenc
- SetTesterVbusCapacitance
- SetVbusSwitch
- SetVbusVoltage
- ShowPlot
- StartCapture
- StartDataStream
- StopCapture
- StopDataStream
- UseTesterCable
- UseTypeCCable
- IpAddress

▶ GrlPdLib
Class Index
Class Hierarchy

◆ SetSourceCapability()

```
int GrlPdApiLib.GrlC2Controller.SetSourceCapability ( SourceCapability objSourceCapability,  
                                                    ControllerPort port = ControllerPort.ONE  
                                                    )
```

Sets the source capability of the GRL-USB-PD-C2/F1 controller. This is only applicable when the controller mode is set as Source or DRP.

Python Example:

```
# Refer Python environment setup section to set up Python environment and how to import the packages before following this example  
#import the packages  
import GrlPdLib  
import GrlPdApiLib  
  
#Create instance of the object  
objController = GrlPdApiLib.GrlC2Controller()  
retVal = objController.Initialize("192.168.255.1")  
#set the controller mode as Source  
objController.SetControllerMode(GrlPdLib.ControllerMode.Source);  
  
# Configure Source Capability  
srcCap = GrlPdLib.SourceCapability()  
  
# Configure PDO1 as 5V 3A  
srcCap.AddFixedSupply(5000/50, 3000/10)  
  
# Configure PDO2 as 9V 3A  
srcCap.AddFixedSupply(9000/50, 3000/10)  
  
# Configure PDO3 as 12V 3A  
srcCap.AddFixedSupply(12000/50, 3000/10)  
  
# Configure Source Capability for Port 1 of the controller  
objController.SetSourceCapability(srcCap, ControllerPort.ONE)  
  
#Attach the conroller  
objController.Attach()
```

C# Example:

```
// Refer visual studio environment setup section to set up the development environment  
//import the packages  
import GrlPdLib  
import GrlPdApiLib
```

Powering USB PD 3.0 and Quick Charge 4



USB Type-C PD Compliance Test *The Complete USB Type-C™ Power Delivery Compliance Tester*

C2 Is Your All-In-One Compliance Tester



	Test Item	GRL C1	GRL C2	MQP	Ellisys	LeCroy
1.	PD 3.0 Tests	✗	✓✓	✓	✓	✓
2.	PD 2.0/3.0 Communication Engine Compliance Tests	✓	✓✓	✓	✗	✓
3.	PD 2.0/3.0 Deterministic Tests	✗	✓✓	✗	✓	✗
4.	PD 3.0 PPS Tests Source Power Tests (SPT) 'Quadramax'	✗	✓	✗	✗	✗
5.	Type-C Functional Tests	✗	✓✓ (In Approval Process)	✗	✓	✓
6.	All E-Marker Cable Tests (Comm Engine, Deterministic, IR Drop)	✗	✓	✗	✗	✗
7.	QC 2.0/3.0 Tests	✗	✓	✗	✗	✗
8.	QC 4/4+ Tests	✗	✓	✗	✗	✗
9.	Thunderbolt 3 Tests	✓	✓ (In Approval Process)	✗	✗	✗



C2 Clearly Organizes and Automated Compliance Tests by Spec Documents



The screenshot displays the 'GRL-USB-PD-C2 Compliance Test Solution (Version: 1.3.6.4)' interface. The main window is titled 'Test Configuration' and features a menu bar with 'Options', 'Windows', and 'Help'. A toolbar at the top includes icons for file operations and a 'Remote mode: OFF' indicator.

The interface is divided into several sections:

- Test Configuration:** A central area with three columns of radio button options:
 - Column 1: Power Delivery 3.0 Tests, **PD Communication Engine Tests** (selected), PD Deterministic Compliance Tests, USB-C Source Power Tests, USB-C Functional Tests.
 - Column 2: Displayport Alternate Mode Tests, Quick Charge 4 Tests, Quick Charge Legacy Tests, Thunderbolt Power Tests.
 - Column 3: Offline Analysis.
- Offline File Selection:** A sub-section within the Offline Analysis area containing input fields for 'CCLine:', 'Signal1:', and 'Signal2:', along with 'Add Signal' and 'Remove Signal' buttons.
- Test Selection:** A large tree view at the bottom showing a hierarchical list of test cases, each with a checkbox:
 - Communication Engine Test Cases
 - BMC Physical Layer Primary Transmit
 - TDA.2.1.1.1 BMC PHY TX EYE
 - TDA.2.1.1.2 BMC PHY TX BIT
 - BMC Physical Layer Primary Receive
 - TDA.2.1.2.2 BMC PHY RX INT REJ
 - TDA.2.1.2.1 BMC PHY RX BUSIDL
 - BMC Physical Layer Primary Miscellaneous
 - TDA.2.1.3.1 BMC PHY TERM
 - TDA.2.1.3.2 BMC PHY MSG
 - Protocol Layer Primary
 - Power Primary
 - TDA.2.3.1.1 POW SRC LOAD P PC
 - TDA.2.3.1.2 POW SRC LOAD CP ACC
 - TDA.2.3.2.1 POW SRC TRANS P PC
 - TDA.2.3.2.2 POW SRC TRANS CP ACC
 - TDA.2.3.3.2 POW SNK TRANS PC

Read Device Capabilities and Use Them to Generate or Identify Errors in VIF's

GRL-USB-PD-C2 Compliance Test Solution (Version: 1.3.6.4)

Options Windows Help

Product Capability Remote mode: OFF

Product Capability

Select Test Cable: Select UUT Type (OR) Load VIF

Read Capabilities: Reset Capabilities: File Name:

Port 1: GRL-SPL Cable | DRP | VIF 1 | Port1 | Reset Port 1 | -

Port 2: GRL-SPL Cable | DRP | VIF 2 | Port2 | Reset Port 2 | -

Port1 Capabilities Port2 Capabilities

General Device Info:		Parameter	Vendor File Info	Device Info
		VENDOR NAME	-	-
		VIF_PRODUCT_TYPE	-	PORT
		MODEL_PART_NUMBER	-	Your Product Information
		PRODUCT_REVISION	-	Your Product Information
		TID	-	-
		PORT_LABEL	-	1
		CONNECTOR_TYPE	-	USB TYPE-C
		USB_PD_SUPPORT	-	YES
		PD_PORT_TYPE	-	DRP
		MANUFACTURER INFO PID PORT	-	-
		STRUCTURED VDM VERSION	-	-

*Supporting Vendor Info File Generator v1.2.1.1 and Later Versions

Generate Port1 VIF Generate Port2 VIF

Easily Generate Reports in Multiple Formats and Various Layers of Details

GRL-USB-PD-C2 Compliance Test Solution (Version: 1.3.6.4)

Options Windows Help

Report Generation

Remote mode: OFF

Select Report Content

- Configuration
- Packet List
- Test Results
- Eye Diagrams
- Saved Images

Saved Screenshots

DUT Information

Manufacturer:

Model number:

Serial Number:

Report Generation

Choose Report Format:

- CSV (.csv) HTML (.html)
- PDF (.pdf)

Report Folder Location:

Copy waveform captures into report folder

Test Information

Test Lab:

Test Engineer:

Remarks:

USB-IF High Level Mapping Summary

ID No	Test Category	Test Group Description	Test Result
1	PHY_PRIMARY_TX	BMC Physical Layer Transmitter	PASS
2	PHY_PRIMARY_RX	BMC Physical Layer Receiver	PASS
3	PHY_PRIMARY_MISC	BMC Physical Layer Miscellaneous	PASS
4	PROT_PRIMARY	Protocol Specific Primary	FAIL
5	POWER_PRIMARY	Power Source/Sink Primary	PASS

Result Summary

ID No	Test ID	Test Name	Test Result
1	FDA.2.1.1.1	FDA.2.1.1.1.BMC.PHY.TX.EYE	PASS
2	FDA.2.1.1.2	FDA.2.1.1.2.BMC.PHY.TX.BIT	PASS
3	FDA.2.1.2.2	FDA.2.1.2.2.BMC.PHY.RX.INT.REJ	PASS
4	FDA.2.1.2.1	FDA.2.1.2.1.BMC.PHY.RX.SUSIDL	PASS
5	FDA.2.1.3.1	FDA.2.1.3.1.BMC.PHY.TDRH	PASS
6	FDA.2.1.3.2	FDA.2.1.3.2.BMC.PHY.HSG	NA
7	FDA.2.2.1	FDA.2.2.1.BMC.PROT.SEO.SETCAPS	PASS
8	FDA.2.2.3	FDA.2.2.3.BMC.PROT.SEO.DRSWAP	FAIL
9	FDA.2.2.4	FDA.2.2.4.BMC.PROT.SEO.VCSWAP.SEP	FAIL
10	FDA.2.2.5	FDA.2.2.5.BMC.PROT.DISCOV	WARNING
11	FDA.2.2.6	FDA.2.2.6.BMC.PROT.SEO.PRSWAP	FAIL
12	FDA.2.2.7	FDA.2.2.7.BMC.PROT.BEST.NOT.VK.SRC	PASS
13	FDA.2.2.8	FDA.2.2.8.BMC.PROT.BK.V.NUM	PASS
14	FDA.2.2.9	FDA.2.2.9.BMC.PROT.SNC.REC	PASS
15	FDA.2.2.10	FDA.2.2.10.BMC.PROT.IGN.FPS	PASS
16	FDA.2.3.1.1	FDA.2.3.1.1.POW.SRC.LOAD.P.PC	PASS
17	FDA.2.3.1.2	FDA.2.3.1.2.POW.SRC.LOAD.CP.ACC	PASS
18	FDA.2.3.2.1	FDA.2.3.2.1.POW.SRC.TRANS.P.PC	NA
19	FDA.2.3.2.2	FDA.2.3.2.2.POW.SRC.TRANS.CP.ACC	PASS
20	FDA.2.3.2.3	FDA.2.3.2.3.POW.SNK.TRANS.PC	PASS

BMC Eye Diagram

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