

USB Power Delivery - Compliance Tests

ABSTRACT

The USB Power-Delivery Certification process requires all USB Power Delivery (PD) end-products using TI's TPS659xx PD Controllers to comply with the deterministic and communication-engine MOI of the USB-IF, in addition to various other load and signaling tests. This application report explains the setup of four extensively used USB-PD testers, and configuration of the PD Vendor Information File (VIF) as per the PD features or capabilities of the product.

Contents

1	Introduction	2
2	Compliance Test Program Overview	2
3	Getting Started - Ellisys [®]	5
4	Getting Started – Granite River Labs GRL-USB-PD-C2	28
5	Getting Started – MQP Packet-Master	29
6	Getting Started – LeCroy M310P	31
7	Compliance Test Notes	32

List of Figures

1	Ellisys Consistency Check Failure Example 3
2	VIF Generation Dialog 4
3	USB VIF Generator 5
4	Port Configuration - Port Configuration (0x28) Register
5	USB Communication Capability - Autonegotiate Sink (0x37) Register 7
6	Data Role Swap Capability - Port Control (0x29) Register 7
7	Externally Powered - Port Control (0x29) Register
8	VCONN Swap Capability - Port Control (0x29) Register
9	Transmit Identity Data Object (0x47) Register
10	PD Power - Transmit Source Capabilities (0x32) Register 10
11	USB Suspend Support - Transmit Source Capabilities (0x32) Register 11
12	Total Source PDOs - Transmit Source Capabilities (0x32) Register 12
13	Supply Type - Transmit Source Capabilities (0x32) Register 12
14	Peak Current - Transmit Source Capabilities (0x32) Register 13
15	PDO Voltage - Transmit Source Capabilities (0x32) Register 13
16	Maximum PDO Current - Transmit Source Capabilities (0x32) Register
17	Minimum and Maximum Voltage - Transmit Source Capabilities (0x32) Register 14
18	Maximum PDO Current - Transmit Source Capabilities (0x32) Register 15
19	PD Power - Transmit Sink Capabilities (0x33) Register 16
20	No USB Suspend - Autonegotiate Sink (0x37) Register 17
21	Giveback Flag - Autonegotiate Sink (0x37) Register 17
22	Total Sink PDOs - Transmit Sink Capabilities (0x33) Register
23	Supply Type - Transmit Sink Capabilities (0x33) Register
24	Operating Current and Voltage - Transmit Sink Capabilities (0x33) Register



25	Minimum and Maximum Voltage - Transmit Sink Capabilities (0x33) Register	20
26	Power Swap Capabilities - Port Control (0x29) Register	20
27	Power Swap Capabilities - Control Configuration (0x29) Register	21
28	Transmit Identity Data Object (0x47) Register	22
29	Type-C Current - System Configuration (0x28) Register	23
30	Type-C Supported Options - System Configuration (0x28) Register	23
31	Accessory Support - Port Configuration (0x28) Register	23
32	VCONN Support - Port Configuration (0x28) Register	24
33	BC1.2 Support - Port Control (0x29) Register	24
34	Transmit Identity Data Object	24
35	Data Capability as USB Device and Host - Port Configuration (0x28) Register	25
36	Ellisys® Examiner and UUT - Connection Diagram	25
37	Test Selection - Ellisys [®] Examiner	26
38	Vendor Information File - Ellisys [®] Examiner	27
39	Test Results - Ellisys [®] Examiner	28
40	GRL Connection Setup	29
41	GRL VIF Entry	29
42	MQP VIF Entry	30
43	MQP Test Selection	31
44	LeCroy Test Selection	32
45	LeCroy VIF Entry	32
46	Undervoltage Protection Options	33

List of Tables

Trademarks

Ellisys Explorer 350 is a registered trademark of Ellisys. Microsoft Windows is a registered trademark of Microsoft Corporation. Aardvark I2C/SPI is a trademark of Total Phase, Inc.. Type-C is a trademark of USB Implementers Forum, Inc.. All other trademarks are the property of their respective owners.

1 Introduction

The TPS65988 device is a standalone, USB Type-C[™], power-delivery controller that provides cable-plug and orientation detection at the USB Type-C connector. Upon cable detection, the TPS65988 device communicates on the CC wire using the USB-PD protocol. After successfully completing USB-PD negotiation, the TPS65988 enables the appropriate power paths, and configures alternate mode settings for internal and external (optional) multiplexers.

The device must comply with the PD specifications and test plans of the USB-IF and the various USB-PD testers or examiners that test the compliance of the device. This document describes the setup of four extensively used USB-PD testers and the execution of their various compliance test suites with the TPS65988EVM.

2 Compliance Test Program Overview

The USB-IF Compliance Program uses multiple test specifications to qualify each product. This application note covers three test specifications, due to their wide applicability to products based on the TPS65988. These are: the USB Type-C Functional Test Specification, the USB PD 3.0 Compliance Plan, and the USB PD 2.0 Compliance Plan. Each document contains a series of test plans designed to verify a portion of the corresponding standard specification. These specifications can be obtained from the Document Library at www.usb.org.



Note that in each USB PD Compliance Test Specification there are a series of tests designed to verify consistency between the VIF and product-reported results. Mismatches between VIF and the product are a common source of Compliance failures. These failures do not indicate an issue with device behavior. Rather, they require a reexamination of VIF settings against the Application Configuration Tool project settings to ensure the desired configuration is set and reflected in the VIF. In the following example, there are two mismatches between the VIF and UUT.

TD.PD.VNDI.E5 Source Capabilities - Testing Downstream Port				
PASSED	Checking Rp	Source must advertise Rp for 3A @ 5V (actual CC voltage is 1.69 V)		
FAILED	Checking Source PDOs	Number of Source PDOs declared as 1, actual is 4		
PASSED	Checking Source PDO 1	Supply Type declared as Fixed		
PASSED	Checking Source PDO 1	Data Role Swap bit must be 1		
FAILED	Checking Source PDO 1	USB Communication Capable declared as No, actual is Yes		
PASSED	Checking Source PDO 1	Unconstrained Power declared as Yes		
PASSED	Checking Source PDO 1	Dual Power Role bit must be 1		
PASSED	Checking Source PDO 1	Voltage declared as 5 V		
PASSED	Checking Source PDO 1	Peak Current declared as 100% IOC		
PASSED	Checking Source PDO 1	Max Current declared as 3 A		
PASSED	Sending DR_Swap	PUT must respond with Accept or Wait		
PASSED	Sending PR_Swap	PUT must respond with Accept or Wait		

Figure 1. Ellisys Consistency Check Failure Example

2.1 Vendor Information File Generation

The Vendor Information File (VIF) defines the capabilities of the UUT, and is a medium for the all test solutions to detect the UUT and the associated properties. The testers use this information to assign certain tests and interpret the results. For example, if the UUT is configured to *not* accept any *DR Swap to DFP* requests, the tester fails the corresponding test cases if the UUT accepts such a request. Also, the tester selectively includes or excludes the tests depending on the capabilities of the UUT.

There are two methods to generating the VIF: Automatic and User Defined VIF Generation

2.2 Automatic VIF Generation

Certain versions of the TPS6598x Configuration Tool support Automatic VIF Generation. This feature enables the tool to create a VIF based on current project settings. During Automatic VIF Generation, project settings are extracted and converted into corresponding lines in the VIF. The result is a complete VIF ready for use in a compliance test. Access Automatic VIF Generation from the Application Configuration Tool menu Binary and select menu item Save Binary. If the current tool supports Automatic VIF Generation, then there is an option to Save a VIF of the Current Project.

Save Binary ? ×						
Do you want to extend BillBoard binary ? Yes -						
Do you also want to save VIF of current project ? Yes 🔻						
BB Firmware Image						
Change 82BB Binary File 82bb_default.bin						
Firmware Version: f401.37.00						
Binary Save File Type:						
Low Region (To merge with Thunderbolt NVM)						
Binary Save File Format: binary (.bin)						
OK Cancel						

Figure 2. VIF Generation Dialog

2.3 User Defined VIF Generation

User Defined VIF Generation is the process of creating a VIF based on settings selected in the TPS6598x Configuration Tool. The USB-IF supports this process with the USB VIF Generator tool.

To start this process, launch the *USB VIF Generator* tool to create a VIF for the tests. The format of the VIF and information about the various fields are detailed in the VIF user guide (VIF-UG), which is part of the installer. The following sections briefly explains these fields, and relates them to configurations and features of the TPS65988. Transfer the TPS65988 application configuration project settings to the VIF as described.



Getting Started - Ellisys®

	USP, JE Vandar Info Eila Editor 2.0.0.1	Towar Instruments	TDC65000	DI (000000*1
VIE	USD-IF vendor into File Editor 2.0.0.1 -	[rexas-instruments_	_1K207800		000000

VIF USB-IF Vendor Info File Editor 2.0.	0.1 - [Texas-Instruments_TPS65988_DJ_000000*]		- 🗆 X
Vendor Info File: Texas-Instr	uments_TPS65988_DJ_000000* Product Type: Port P	roduct Specification: Version 2.01 Application	on: USB-IF Vendor Info File Editor 2.0.0.1
Vendor Name	VIF Product General PD USB Type-C [™] Product Power USB	Host Battery Charging 1.2 PD Source PD Sink Du	al Role SOP Discover ID SOP Modes
Texas Instruments			
Model Part Number	PD_Specification_Revision 2 : Revision 3.0		
TPS65988	SOP*	USB Comms Capable	YES
Product Revision	SOP_Capable YES		
DJ	SOP_P_Capable NO	DR_Swap_To_DFP_Supported	YES *
TID	SOP PP Canable NO	DR_Swap_To_UFP_Supported	YES -
000000			
Ports	SOP_P_Debug_Capable NO	Unconstrained_Power	NO
Port: 0	SOP_PP_Debug_Capable NO	VCONN_Swap_To_On_Supported	YES
		VCONN_Swap_To_Off_Supported	YES
	Security_Msgs_Supported_SOP NO		
	Manufacturer_Info_Supported_Port YES	Responds_Io_Discov_SOP_UFP (YES •
Move Up Move Down	Manufacturer Info VID Port 0000	Responds_To_Discov_SOP_DFP	YES
Add Delete	Manufacturer Info PID Port 0000	Attempts_Discov_SOP	YES 👻
Make Copy			
make copy	Num_Fixed_Batteries 1	Chunking_Implemented_SOP	YES
	Num_Swappable_Battery_Slots 0	Unchunked_Extended_Messages_Supported(YES -
Palazza Natar	Clay		
Nelease Notes	Clear	Load Save As	

Figure 3. USB VIF Generator

3 **Getting Started - Ellisys®**

This section lists the instructions for setting up the Ellisys Explorer 350[®] tester, the unit under test (UUT), and the host and control system for executing the compliance tests using the Ellisys compliance test solution. Instructions to configure the UUT using the TPS598x Configuration Tool and USB VIF Tool are common for all compliance test solutions.

Prerequisites 3.1

- Ellisys USB Explorer 350 protocol test and analysis system •
- **USB VIF Generator** •
- **TPS65988 EVM** •
- Aardvark I2C/SPI™ adapter, or Micro USB Cable
- PC running Microsoft Windows® 7 or greater ٠



Getting Started - Ellisys®

3.2 Installation

Download and install the following drivers and tools (if not yet installed on the Windows PC):

- Ellisys USB Explorer 350 Examiner
- Ellisys USB Explorer 350 Analyzer
 - The Analyzer software is optional, and only required for the collection of PD logs.
- TPS6598x Configuration Tool

NOTE: This guide assumes that all TI tools are installed at location *C:\Program Files\Texas Instruments.*

3.3 Test Setup

3.3.1 Preparing the UUT for the Tests

If the customized application binaries are already programmed on the TPS6598x EVM or customer platform, proceed to Section 3.3.2.

Launch the latest version of the *TPS6598x Configuration* tool and generate a test binary to be programmed on the UUT. See *TPS6598x Application-Customization Tool User Guide* for detailed instructions on generating the binaries and programming the same on the UUT.

3.3.2 VIF Item Entry

Intro Fields

• *UUT_Device_Type*: This field defines the type of UUT, and a suitable (or valid) option must be set for the same depending on the configuration of the device. For example, if the *Port Configuration* field of the *Port Configuration* register is set as Figure 4, the field in VIF must be set to 4 : *DRP*.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Configuration (0x28)	
Global System Configuration	Field	Value
Port Configuration	Port Configuration	DRP 👻
Port Control Transmit Source Capabilities	Receptacle Type	
Transmit Sink Capabilities	Audio Accessory Support	DRP
Autonegotiate Sink	Debug Accessory Support	Disabled
Alternate Mode Entry Queue PD3 Configuration Register	Type-C Supported Options	No Options
Event Delay	VConn Supported	VCONN supported as DFP/UFP (accept VC -
Transmit Identity Data Object	USB3.0/3.1 Rate	USB3 Gen2 signaling rate supported
Display Port Capabilities	Set UVP to 4.5 V	
Intel VID Config Register	Under-voltage Protection Trip Point, PP_5V	20% _
MIPI VID Configuration	Under-voltage Protection Usage, PP_HV	20%
I/O Contig Retimer Debug Register	Over Voltage Protection Trip Point	24 V 🔹
App Config Binary Data Indices	Over Voltage Protection Usage	Disconnect VBUS if voltage exceeds 5% of 💌

Figure 4. Port Configuration - Port Configuration (0x28) Register

 Other fields in this tab define the vendor and product name or ID of the UUT. Refer to the VIF-UG for details, and fill these fields appropriately.



General PD Fields

- *PD_Specification_Revision*: This field defines the version of the PD specification supported by the UUT. For example, TPS65988 is PDd-compliant, so this field must be set to 2 *Revision 3.0*.
- USB_Comms_Capable: This field is used by the tester to determine if the UUT is capable of USB communication. The field must be set to either YES or NO depending on the setting of USB Communication Capable bit of Autonegotiate Sink register.
 If this field is configured as YES, then one of the companion fields, Type_C_Can_Act_As_Device or Type_C_Can_Act_As_Host, in the USB Type-C tab of the VIF Generator tool is set to YES.

Customer Use	Autonegotiate Sink (0x37)	
nterrupt Mask for I2C2	General Settings	
System Power State	Field	
Control Configuration	Autonegotiate Sink Enable	
Transmit Source Capabilities	Autonegotiate Variable Sink Enable	
Transmit Sink Capabilities	Autonegotiate Battery Sink Enable	
Alternate Mode Entry Queue	USB Communication Capable	
Transmit Identity Data Object	Offer Priority	Choose Highest Voltage
Jser Alternate Mode Config	No USB Suspend	
ntel VID Config Register	Giveback Flag	
Texas Instruments VID Config		

Figure 5. USB Communication Capability - Autonegotiate Sink (0x37) Register

• DR_Swap_To_DFP_Supported and DR_Swap_To_UFP_Supported: These fields define the data-role swap capability of the UUT, and must be set in accordance with the properties of the device defined in the Port Control Configuration register in Figure 6.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Control (0x29)	^
Global System Configuration	Field	Value
Port Configuration	Type-C Current	3 A (strongest pullup)
Port Control Transmit Source Canabilities	PD Mode	Normal PD Behavior
Transmit Sink Capabilities	Process Swap To Sink	
Autonegotiate Sink	Initiate Swap To Sink	
Alternate Mode Entry Queue PD3 Configuration Register	Process Swap To Source	
Event Delay	Initiate Swap To Source	
Transmit Identity Data Object	Process VCONN Swap	
User Alternate Mode Config Display Port Capabilities	Process Swap to UFP	
Intel VID Config Register	Initiate Swap to UFP	
MIPI VID Configuration	Process Swap to DFP	
Retimer Debug Register	Initiate Swap to DFP	
App Config Binary Data Indices	Automatic ID Request	
I2C Master Configuration	Force USB Generation 1	
Sleep Control Register	Externally Powered	
Tx Manufacturer Info SOP	Automatic Sink Cap	

Figure 6. Data Role Swap Capability - Port Control (0x29) Register



Unconstrained_Power. This field indicates to the tester that the UUT is powered by a source other than
the VBus. It must be set to either YES or NO depending on the properties of the device. As shown in
Figure 7, this is defined in the Port Control register, where it is called Externally Powered.

Port Control (0x29)		,
Field	Value	
Type-C Current	3 A (strongest pullup)	_
PD Mode	Normal PD Behavior	•
Process Swap To Sink		
Initiate Swap To Sink		
Process Swap To Source		
Initiate Swap To Source		
Process VCONN Swap		
Process Swap to UFP		
Initiate Swap to UFP		
Process Swap to DFP		
Initiate Swap to DFP		
Automatic ID Request		
Force USB Generation 1		
Externally Powered		
Automatic Sink Cap		
	Port Control (0x29) Field Type-C Current PD Mode Process Swap To Sink Initiate Swap To Source Initiate Swap To Source Initiate Swap To Source Process VCONN Swap Process Swap to UFP Initiate Swap to UFP Process Swap to DFP Initiate Swap to DFP	Fort Control (0x29) Field Value Type-C Current 3 A (strongest pullup) PD Mode Normal PD Behavior Process Swap To Sink Initiate Swap To Sink Initiate Swap To Source Initiate Swap To Source Process Swap To Source Initiate Swap To Source Process VCONN Swap Image: Comparison of the system

Figure 7. Externally Powered - Port Control (0x29) Register

 VCONN_Swap_To_On_Supported and VCONN_Swap_To_Off_Supported: These fields define the VCONN swap capability of the device. Both must be set to either YES' or NO depending on the setting of the device, as defined in the Port Control register in Figure 8.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Control (0x29)		^
Global System Configuration	Field	Value	
Port Configuration	Type-C Current	3 A (strongest pullup)	ſ
Port Control Transmit Source Canabilities	PD Mode	Normal PD Behavior	Í
Transmit Sink Capabilities	Process Swap To Sink		
Autonegotiate Sink	Initiate Swap To Sink		
PD3 Configuration Register	Process Swap To Source		
Event Delay	Initiate Swap To Source		
Transmit Identity Data Object	Process VCONN Swap		
User Alternate Mode Config Display Port Capabilities	Process Swap to UFP		
Intel VID Config Register	Initiate Swap to UFP		
MIPI VID Configuration	Process Swap to DFP		
Retimer Debug Register	Initiate Swap to DFP		
App Config Binary Data Indices	Automatic ID Request	\checkmark	
I2C Master Configuration	Force USB Generation 1		
Sleep Control Register	Externally Powered		
Tx Manufacturer Info SOP	Automatic Sink Cap		

Figure 8. VCONN Swap Capability - Port Control (0x29) Register

Responds_To_Discov_SOP and Attempts_Discov_SOP: These fields define the ability of the device to respond or initiate a Discover Identity message respectively. As shown in Figure 9, Responds_To_Discov_SOP must be set to YES if the Transmit Identity Object register is set to a non-zero value. Attempts_Discov_SOP must be set to YES if the device supports any Alternate Modes, or NO otherwise.

Customer Use	Transmit Identity Data Object (0x47)	
Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration	- Record Counts		
Port Configuration			
Port Control	Field		value
Transmit Source Capabilities	Number of UFP Identity Objects	3	* *
Autonegotiate Sink Alternate Mode Entry Queue PD3 Configuration Register Event Delay	UFP Discover Identity Response		
Transmit Identity Data Object	Field	Val	lue
User Alternate Mode Config	USB Vendor ID	0x451	
Intel VID Config Register	Modal Operation Supported		
MIPI VID Configuration	Product Type	Undefined	-
I/O Config Retimer Debug Register App Config Binary Data Indices	Data Capable as USB Device		
	Data Capable as USB Host		
I2C Master Configuration			

Figure 9. Transmit Identity Data Object (0x47) Register

• SOP*: This section defines the capabilities of the device to handle the SOP* protocol, and must be set in accordance to the properties of the device. For the TPS6598x, SOP_Capable must be set to YES.

Source Fields

 PD_Power_as_Source: This field defines the maximum PDP level in mW supported by the sourcecapable device, and must be set per the settings in the *Transmit Source Capabilities* register. For example, as shown in Figure 10 this field is set to (3 A × 12 V) = 36000 mW if the device has two source PDOs.

Customer Use Interrupt Mask for I2C1	Transmit Source Capabilities (0x32	2)	
Interrupt Mask for I2C2 Global System Configuration Port Configuration	Tx Source PDO Config		
Port Control	Field	Value	
Transmit Source Capabilities	Active PDO Bank	Use Bank 0	-
Transmit Sink Capabilities Autonegotiate Sink	Active PDO Bank Follows EP		
Alternate Mode Entry Queue PD3 Configuration Register	Bank 0 Settings		
Event Delay Transmit Identity Data Object	Number of Bank 0 Source PDOs		
User Alternate Mode Config	1		-
Intel VID Config Register MIPI VID Configuration	Source PDO 1		
I/O Config	Field	Value	
Retimer Debug Register	Switch Source	PP1 sources this PDO	-
App Config Binary Data Indices I2C Master Configuration	Maximum Current	3 A	-
App configuration Register	Voltage	5 V	
Sleep Control Register	Peak Current	100%	•
Tx Manufacturer into SOP Tx Source Capabilities Extended Data Block	Unchunked Extended Msg Supported		
Tx Battery Capabilities	USB Capable		
Tx Manufacturer Info SOP Prime	USB Suspend Supported		
Raw view	Supply Type	Fixed Source	

Figure 10. PD Power - Transmit Source Capabilities (0x32) Register

• USB_Suspend_May_Be_Cleared: This field indicates to the connected sink whether it must obey USB Suspend. It must be set depending on the settings in Figure 11 in the Transmit Source Capabilities register. If the UUT (as a source) has USB Suspend Supported set to 0, then the VIF must set this field to YES, or NO otherwise.

Texas Instruments

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Transmit Source Capabilities (0x32	2)		
Global System Configuration	Tx Source PDO Config			
Port Configuration			_	
Port Control	Field	Value		
Transmit Source Capabilities	Active PDO Bank	Use Bank 0	-	
Transmit Sink Capabilities Autonegotiate Sink	Active PDO Bank Follows EP	, 		
Alternate Mode Entry Queue PD3 Configuration Register	Bank 0 Settings			
Transmit Identity Data Object	Number of Bank 0 Source PDOs			
User Alternate Mode Config Display Port Capabilities	1			
Intel VID Config Register MIPI VID Configuration	Source PDO 1			
I/O Config	Field	Value		
Retimer Debug Register	Switch Source	PP1 sources this PDO 🔹		
I2C Master Configuration	Maximum Current	3 A 🗧		
App configuration Register	Voltage	5 V		
Sleep Control Register	Peak Current	100% 💌		
Tx Source Capabilities Extended Data Block	Unchunked Extended Msg Supported	\square		
Tx Battery Capabilities	USB Capable			
Tx Manufacturer Info SOP Prime	USB Suspend Supported			
	Supply Type	Fixed Source		

Figure 11. USB Suspend Support - Transmit Source Capabilities (0x32) Register



 Num_Src_PDOs: This field defines the number of source PDOs supported by the UUT. It must be set in accordance to the device properties defined in the *Transmit Source Capabilities* register in Figure 12.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration Port Configuration	Transmit Source Capabilities (0x32)
Port Control	Field	Value
Transmit Source Capabilities	Active PDO Bank	Use Bank 0 👻
Transmit Sink Capabilities Autonegotiate Sink Alternate Mode Entry Queue	Active PDO Bank Follows EP	
PD3 Configuration Register	Dank o Settings	
Transmit Identity Data Object	Number of Bank 0 Source PDOs	
Display Port Capabilities	1	
Intel VID Config Register	Source PDO 1	

Figure 12. Total Source PDOs - Transmit Source Capabilities (0x32) Register

- Source PDOs: The following fields represent the parameters for a single Source PDO where <X> is an
 integer between 1 and 7:
 - Src_PDO_Supply_Type <X>: This field defines the type of the source PDO, and, depending on the settings in Figure 13 in the *Transmit Source Capabilities* register, must be set to either 1 : Fixed, 2 : Battery, or 3 : Variable.

Customer Use	Maximum Current		3 A	-	Ī
Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration	Voltage	Voltage			
	Peak Current		100%	-	
Port Configuration	Unchunked Extended	Msg Supported			
Port Control	USB Capable				
Transmit Source Capabilities Transmit Sink Capabilities	USB Suspend Support	ted			
Autonegotiate Sink	Supply Type		Fixed Source		
Alternate Mode Entry Queue PD3 Configuration Register Event Delay Transmit Identity Data Object	Source PDO 2				
	Field		Value		
User Alternate Mode Config	Advertised Mask	Advertise only	if Externally Powered	•	
Display Port Capabilities Intel VID Config Register	Switch Source	PP1 sources	this PDO	•	
MIPI VID Configuration	Maximum Current	0 A		-	
I/O Config	Voltage	0 V		-	
Retimer Debug Register App Config Binary Data Indices	Peak Current	100%		•	
I2C Master Configuration	Supply Type	Fixed Source		-	
App configuration Register		Fixed Source			
Sleep Control Register Tx Manufacturer Info SOP	Bank 1 Settings	Battery Sourc Variable Sour	e ce		
Ty Source Canabilities Extended Data Block					

Figure 13. Supply Type - Transmit Source Capabilities (0x32) Register



www.ti.com

Src_PDO_Peak_Current <X>: This field defines the peak currents supported by the UUT for short periods, and is indicated as a percent of the operating current. Depending on the settings in Figure 14 in the Transmit Source Capabilities register, it must be set to one of the available options

Customer Use	Field		Value	
Interrupt Mask for I2C1	Number of Source PDOs		2	÷
Interrupt Mask for I2C2				
System Power State	Source PDO 1			
System Configuration				
Control Configuration	Field		Value	
Transmit Source Capabilities	Switch Source	Internal 5 volt Po	ower Path (PP_5V)(00b)	-
Autonegotiate Sink	Maximum Current	3A		*
Alternate Mode Entry Queue	Voltage	5 V		
Transmit Identity Data Object	Peak Current	100%		-
Display Port Capabilities	USB Capable	100%		
Intel VID Config Register	USB Suspend Supported	130%		I
Texas Instruments VID Config GPIO Event Man	Supply Type	200%		
Miscellaneous Configuration	Source DDO 2			

Figure 14. Peak Current - Transmit Source Capabilities (0x32) Register

Src_PDO_Voltage <X>: This field defines the output voltage of a source PDO in the units of 50 mV, and must be set per the Figure 15 configuration in the Transmit Source Capabilities register. For example, for the Figure 15 settings of PDO-1, this field must be set to 5000 mV / 50 mV = 100. The VIF Generator tool takes care of this conversion when generating the vendor information file.

Customer Use / Interrupt Mask for I2C1	Source PDO 1	
Interrupt Mask for I2C2	Field	
System Power State	Switch Source	Internal 5
Control Configuration	Maximum Current	3 A
Transmit Source Capabilities	Voltage	5 V
Transmit Sink Capabilities	Peak Current	100%
	USB Canable	

Figure 15. PDO Voltage - Transmit Source Capabilities (0x32) Register

Src PDO Max Current. This field defines the maximum operating current of a source PDO in units of 10 mA, and must be set per the Figure 16 configuration in the Transmit Source Capabilities register. For example, for the Figure 16 settings of PDO-1, this field must be set to 3000 mA / 10 mA = 300. The VIF Generator tool takes care of this conversion when generating the vendor information file.

Customer Use	Field		\
Interrupt Mask for I2C1 Interrupt Mask for I2C2	Number of Source PDOs		2
System Power State System Configuration	Source PDO 1		
Control Configuration	Field		Value
Transmit Source Capabilities	Switch Source	Internal 5 volt	Power Path (PP_5V)(00b)
Autonegotiate Sink	Maximum Current	3 A	
Alternate Mode Entry Queue Transmit Identity Data Object	Voltage	5 V	
	Peak Current	100%	

Figure 16. Maximum PDO Current - Transmit Source Capabilities (0x32) Register



www.ti.com

Src_PDO_Min_Voltage <X> and Src_PDO_Max_Voltage <X>: These fields define the minimum and maximum output voltage of a source PDO in units of 50 mV, and must be set per the Figure 17 configuration in the *Transmit Source Capabilities* register. For example, for the 5V and 12V settings of PDO-2, these fields must be set to (5000 mV / 50 mV) = 100 and (12000 mV / 50 mV) = 240, respectively. The *VIF Generator* tool takes care of this conversion when generating the vendor information file.

Customer Use		Number of Bank 0 Sou	rce PDOs		
Interrupt Mask for I2C1 Interrupt Mask for I2C2		2			•
Global System Configuration Port Configuration		Source PDO 1			
Port Control		Fiel	d	Value	
Transmit Source Capabilities		Switch Source		PP1 sources this PDO	-
Autonegotiate Sink Alternate Mode Entry Queue		Maximum Current		3A	
		Voltage		5 V	
PD3 Configuration Register		Peak Current		100%	•
Transmit Identity Data Object User Alternate Mode Config		Unchunked Extended	Msg Supported	, 	
		USB Capable USB Suspend Supported			
Intel VID Config Register					
MIPI VID Configuration		Supply Type		Fixed Source	
I/O Config					
App Config Binary Data Indices		Source PDO 2			
I2C Master Configuration		Field		Value	
App configuration Register		Advertised Mask	Always Advert	lise	<u> </u>
Tx Manufacturer Info SOP		Switch Source	PP1 sources	this PDO	<u> </u>
Tx Source Capabilities Extended Data Block		Maximum Current	0 A		-
Tx Battery Capabilities		Minimum Voltage	0 V		÷
Raw View		Maximum Voltage	0 V		÷
		Supply Type	Variable Sour	ce	•

Figure 17. Minimum and Maximum Voltage - Transmit Source Capabilities (0x32) Register



Src_PDO_Max_Power <X>: This field defines the maximum operating power of a source PDO in units of 250 mW. It must be set based on the Figure 18 configuration in the *Transmit Source Capabilities* register. For example, for 15V and 5A settings of PDO-2, this field must be set to 75000 mW / 250 mW = 300. The *VIF Generator* tool takes care of this conversion when generating the vendor information file.

Customer Use	Number of Bank 0 Sour	ce PDOs		
Interrupt Mask for I2C1	0			
Interrupt Mask for I2C2	2			•
Global System Configuration	Source PDO 1			
Port Configuration	Source FDO T			
Port Control	 Field	t	Value	
Transmit Source Capabilities	Switch Source		PP1 sources this PDO	_
Autonogotisto Sink	Maximum Oursent			
Alternate Mode Entry Queue	maximum Current		3A	-
PD3 Configuration Pegister	Voltage		5 V	
Event Delay	Peak Current		100%	-
Transmit Identity Data Object	Unchunked Extended N	Isg Supported	\checkmark	
User Alternate Mode Config	USB Capable			
Intel VID Config Register	USB Suspend Supporte	ed		
MIPI VID Configuration	Supply Type		Fixed Source	
I/O Config				
Retimer Debug Register	Source PDO 2			
App Config Binary Data Indices				
I2C Master Configuration	Field		Value	
App configuration Register	Advertised Mask	Always Adver	tise	-
Tx Manufacturer Info SOP	Switch Source	PP1 sources	this PDO	•
Tx Source Capabilities Extended Data Block	Maximum Current	0 A		Ē
Tx Battery Capabilities	Minimum Voltage	0.V		
Tx Manufacturer Info SOP Prime	Maximum Voltage	0.1		•
Raw View	waximum voitage	UV		
	Supply Type	Variable Sour	ce	<u> </u>

Figure 18. Maximum PDO Current - Transmit Source Capabilities (0x32) Register

Sink Fields

PD_Power_as_Sink: This field defines the maximum PDP level in mW supported by the sink-capable device. It must be set per the Figure 19 settings in the *Transmit Sink Capabilities* register. For example, if the device has two sink PDOs, as shown in Figure 19, this field must be set to (3 A × 5 V) = 15000 mW.



Getting Started - Ellisys®

Customer Use	Transmit Sink Capabilities (0x33)	Transmit Sink Capabilities (0x33)		
Interrupt Mask for I2C1				
Interrupt Mask for I2C2				
Global System Configuration	Sink PDO Count			
Port Configuration				
Port Control	Field	Value		
Transmit Source Capabilities	Number of Sink PDOs	2	-	
Transmit Sink Capabilities		1		
Autonegotiate Sink	Sink PDO 1			
Alternate Mode Entry Queue				
PD3 Configuration Register	Field	Value		
Event Delay	Operating Current	0.9 A	+	
I ransmit Identity Data Object	Voltage	5 V		
User Alternate Mode Config	voltage	5 V		
Display Port Capabilities	Peak Current	100%	<u> </u>	
Intel VID Config Register	Fast Role Swap required USB Type-C Current	Fast Swap not Supported	-	
I/O Config	Supply Type	Fixed Sink		
Retimer Debug Register	Maximum Operating Current	3A	-	
App Config Binary Data Indices	Minimum Operating Current	0.9 A	÷	
I2C Master Configuration App configuration Register	Ask For Max			
Sleep Control Register		1		

Figure 19. PD Power - Transmit Sink Capabilities (0x33) Register



No_USB_Suspend_May_Be_Set: This field indicates the intent of the sink device to not obey USB Suspend. It must be set depending on the Figure 20 settings in the Autonegotiate Sink register. If the UUT (as a sink) has No USB Suspend set to 1, then the VIF must set this field to YES, or NO otherwise.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration Port Configuration	Autonegotiate Sink (0x37) General Settings	
Port Control	Field	Value
Transmit Source Capabilities Transmit Sink Capabilities	Autonegotiate Sink Enable	
	Autonegotiate Variable Sink Enable	\checkmark
Alternate Mode Entry Queue	Autonegotiate Battery Sink Enable	
PD3 Configuration Register	USB Communication Capable	
Event Delay	Offer Priority	Choose Highest Power
User Alternate Mode Config	No USB Suspend	
Display Port Capabilities	Giveback Flag	
MIPI VID Configuration	Power Settings	

Figure 20. No USB Suspend - Autonegotiate Sink (0x37) Register

 GiveBack_May_Be_Set. This field indicates if a sink is prepared to lower the operating current to the minimum-supported operating current, on demand. It must be set depending on the Figure 21 settings in the Autonegotiate Sink register. If the UUT (as a sink) has Giveback Flag set to 1, then the VIF must set this field to YES, or NO otherwise.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration	Autonegotiate Sink (0x37)		
Port Configuration Port Control Transmit Source Capabilities Transmit Sink Capabilities	Field Autonegotiate Sink Enable	Value	
Autonegotiate Sink Alternate Mode Entry Queue PD3 Configuration Register	Autonegotiate Variable Sink Enable Autonegotiate Battery Sink Enable USB Communication Capable		
Event Delay Transmit Identity Data Object User Alternate Mode Config	Offer Priority No USB Suspend	Choose Highest Power _	
Intel VID Config Register MIPI VID Configuration	Giveback Flag		

Figure 21. Giveback Flag - Autonegotiate Sink (0x37) Register

• *Higher_Capability_Set.* This field indicates that the sink requires more than vSafe5V to provide full functionality, and must be set to YES if the UUT has more than one sink PDO.

• *Num_Snk_PDOs*: This field defines the number of sink PDOs supported by the UUT. It must be set in accordance to the device properties defined in the *Transmit Sink Capabilities* register in Figure 22.

Customer Use	Fransmit Sink Capabilities (0x33)	
Interrupt Mask for I2C1		
Interrupt Mask for I2C2	Sink PDO Count	
System Power State	Field	
System Configuration	Field	
Control Configuration	Number of Sink PDOs	2
Transmit Source Capabilities	L	
Transmit Sink Capabilities	Sink PDO 1	
Autoperotiste Sink		

Figure 22. Total Sink PDOs - Transmit Sink Capabilities (0x33) Register

- Sink PDO: The below fields represent the parameters for a single-sink PDO where <X> is an integer between 1 and 7:
 - Snk_PDO_Supply_Type <X>: The field defines the sink-PDO type, and must be set to either 1 : Fixed, 2 : Battery, or 3 : Variable. This depends on the Figure 23 settings in Transmit Sink Capabilities register.

Customer Use	Number of Sink PDOs	2	-
Interrupt Mask for I2C1			
Interrupt Mask for I2C2	Sink PDO 1		
Global System Configuration	Field	Value	
Port Configuration	Operating Current	0.9.4	
Transmit Source Capabilities	Voltage	5 V	
Transmit Sink Capabilities	Peak Ourrent	400%	
Autonegotiate Sink	Peak Current	100%	<u> </u>
Alternate Mode Entry Queue	Fast Role Swap required USB Type-C Curre	nt Fast Swap not Supported	<u> </u>
PD3 Configuration Register	Supply Type	Fixed Sink	
Transmit Identity Data Object	Maximum Operating Current	3A	-
User Alternate Mode Config	Minimum Operating Current	0.9 A	•
Display Port Capabilities	Ask For Max		
Intel VID Config Register			
MPI VID Configuration	Sink PDO 2		
Retimer Debug Register	Field	Value	
App Config Binary Data Indices	Operating Current		
I2C Master Configuration		0.9 A	
App configuration Register	Minimum Voltage	5 V	<u> </u>
Sleep Control Register	Maximum Voltage	20 V	-
Tx Source Capabilities Extended Data Block	Supply Type	Variable Sink	•
Tx Battery Capabilities	Maximum Operating Current	Fixed Sink	
Tx Manufacturer Info SOP Prime	Minimum Operating Current	Variable Sink	
Raw view	Ask For Max		

Figure 23. Supply Type - Transmit Sink Capabilities (0x33) Register



- Snk_PDO_Voltage <X>: This field defines the output voltage of a sink PDO in the units of 50 mV, and must be set per the Figure 24 configuration in the *Transmit Sink Capabilities* register. For example, for theFigure 24 settings of PDO-1, this field must be set to 5000 mV / 50 mV = 100. The VIF Generator tool takes care of this conversion when generating the vendor information file.
- Snk_PDO_Op_Current <X>: This field defines the operating current of a sink PDO in units of 10 mA, and must be set per the Figure 24 configuration in *Transmit Sink Capabilities* register. For example, for the Figure 24 settings of PDO-1, this field must be set to 900 mA / 10 mA = 90. The VIF Generator tool takes care of this conversion when generating the vendor information file.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2 Global System Configuration Port Configuration	Transmit Sink Capabilities (0x33) Sink PDO Count		
Port Control	Field	Value	
Transmit Source Capabilities	Number of Sink PDOs	2	-
Autonegotiate Sink Alternate Mode Entry Queue	Sink PDO 1		
PD3 Configuration Register	Field	Value	
Event Delay Transmit Identity Data Object	Operating Current	0.9 A	-
User Alternate Mode Config	Voltage	5 V	
Display Port Capabilities	Peak Current	100%	<u> </u>
Intel VID Config Register	Fast Role Swap required USB Type-C Current	Fast Swap not Supported	•
I/O Config	Supply Type	Fixed Sink	
Retimer Debug Register	Maximum Operating Current	3 A	-
App Config Binary Data Indices	Minimum Operating Current	0.9 A	-
App configuration Register Sleen Control Register	Ask For Max		

Figure 24. Operating Current and Voltage - Transmit Sink Capabilities (0x33) Register



www.ti.com

Snk_PDO_Min_Voltage <X> and Snk_PDO_Max_Voltage <X>: These fields define the minimum and maximum voltage of a sink PDO in units of 50 mV. They must be set per the Figure 25 configuration in the *Transmit Sink Capabilities* register. For example, for the Figure 25 settings of PDO-2, these fields must be set to (12000 mV / 50 mV) = 240 and (20000 mV / 50 mV) = 400, respectively. The *VIF Generator* tool takes care of this conversion when generating the vendor information file.

Customer Use	Sink PDO 1	
Interrupt Mask for I2C2	Field	Value
Global System Configuration	Operating Current	0.9 A
Port Configuration	Voltage	5 V
Transmit Source Canabilities	Peak Current	100%
Transmit Sink Capabilities	Fact Data Owen as avies d UOD Tures O Overset	
Autonegotiate Sink	Fast Role Swap required USB Type-C Current	Fast Swap not Supported
Alternate Mode Entry Queue	Supply Type	Fixed Sink
SRCPolicyMaster Auto Negotiate Source	Maximum Operating Current	3A 🗧
PD3 Configuration Register	Minimum Operating Current	0.9 A
Event Delay	Ask For Max	
I ransmit identity Data Object		
Display Port Capabilities	Sink PDO 2	
Intel VID Config Register		
MIPI VID Configuration	Field	Value
I/O Config	Operating Current	0.9A
Retimer Debug Register	Minimum Voltage	5 V 🗧
App Config Binary Data Indices	Maximum Voltage	20 V 🗧
External Billboard Configuration	Supply Type	Variable Sink
App configuration Register	Maximum Operating Current	3A 🗧
Sleep Control Register	Minimum Operating Current	0.9 A
Transmit Sink Capabilities Extended Data Block (SCEDB) Re	Ask For Max	3

Figure 25. Minimum and Maximum Voltage - Transmit Sink Capabilities (0x33) Register

Dual Role Fields

• Accepts_PR_Swap_As_Src and Accepts_PR_Swap_As_Snk: These fields define the power-role swap capability of the device, and must be set in accordance to the device properties defined in the *Port Control* register in Figure 26.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Control (0x29)	
Global System Configuration Port Configuration	Field Type-C Current	Value 3 A (strongest pullup)
Port Control Transmit Source Canabilities	PD Mode	Normal PD Behavior
Transmit Sink Capabilities	Process Swap To Sink	
Autonegotiate Sink	Initiate Swap To Sink	
PD3 Configuration Register	Process Swap To Source	
Event Delay	Initiate Swap To Source	
Transmit Identity Data Object User Alternate Mode Config	Process VCONN Swap	
Display Port Capabilities	Process Swap to UFP	

Figure 26. Power Swap Capabilities - Port Control (0x29) Register

 Requests_PR_Swap_As_Src and Requests_PR_Swap_As_Snk: These fields define the ability of the device to request for power-role swaps. They must be set in accordance to the device properties as defined in the Control Configuration register in Figure 27.



Customer Use Interrupt Mask for I2C1	Port Control (0x29)	Port Control (0x29)	
Interrupt Mask for I2C2			
Global System Configuration	Field	Value	
Port Configuration	Type-C Current	3 A (strongest pullup)	
Port Control	PD Mode	Normal PD Rehavior	
Transmit Source Capabilities	PD Mode		
Transmit Sink Capabilities	Process Swap To Sink		
Autonegotiate Sink	Initiate Swap To Sink		
Alternate Mode Entry Queue	Process Swap To Source		
Event Delay	Initiate Swap To Source		
Transmit Identity Data Object	Process VCONN Swap		
User Alternate Mode Config	· · · · ·		

Figure 27. Power Swap Capabilities - Control Configuration (0x29) Register



SOP Discovery Fields

 The fields in the Part One tab define the identity of the UUT, and must be set in accordance with the Figure 28 configuration defined in the Transmit Identity Data Object register. Data_Capable_as_USB_Host_SOP and Data_Capable_as_USB_Device_SOP: These fields are automatically set by the tool, and depend on the corresponding settings in USB Type-C fields.

Customer Use Interrupt Mask for I2C1	Transmit Identity Dat	a Object (0x47)	
Global System Configuration	Record Counts		
Port Control		Field	Value
Transmit Source Capabilities	Number of UFP Identity	Objects 3	-
Transmit Sink Capabilities Autonegotiate Sink Alternate Mode Entry Queue PD3 Configuration Register Event Delay	UFP Discover Identity R	lesponse	
Transmit Identity Data Object	Field	d Value	
User Alternate Mode Config	USB Vendor ID	0x451	
Display Port Capabilities	Modal Operation Su	pported	
MIPI VID Configuration	Product Type	Undefined	
I/O Config	Data Capable as US	B Device	
Retimer Debug Register App Config Binary Data Indices	Data Capable as US	iB Host	
I2C Master Configuration App configuration Register Sleep Control Register	Certification Test ID		
Tx Manufacturer Into SOP Tx Source Capabilities Extended Data Block Tx Battery Capabilities	Product Vendor Defi	ined Object	
Tx Manufacturer Info SOP Prime	Field	Value	
Raw View	BCD Device	0x700	
	USB Product ID	0x0	

Figure 28. Transmit Identity Data Object (0x47) Register



USB Type-C Fields

- *Type_C_State_Machine*: This field indicates the type of Type-C state machine implemented on the UUT. For some of the configurations of UUT_Device_Type, this field is set automatically by the tool.
- *Rp_Value*: This field defines the Rp value that the UUT (as a source) presents upon a connection. It must be set depending on the Figure 29 configuration in the *System Configuration* register.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Control (0x29)	
Global System Configuration	Field	Value
Port Configuration	Type-C Current	3 A (strongest pullup)
Port Control	PD Mode	Default Current (weakest pullup)
Transmit Source Capabilities	1 D Mode	1.5 A (medium pullup)
Transmit Sink Capabilities	Process Swap To Sink	3 A (strongest pullup)
Autonegotiate Sink	Initiate Swap To Sink	

Figure 29. Type-C Current - System Configuration (0x28) Register

• *Type_C_Implements_Try_SRC* and *Type_C_Implements_Try_SNK*: These fields define the ability of the UUT to support *Try.SRC* and *Try.SNK* states when transitioning out of *AttachWait.SNK* and *AttacheWait.SRC* respectively. These fields must be set in accordance with the Figure 30 configuration in the *Port Configuration* register.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Configuration (0x28)		
Global System Configuration	Field	Value	
Port Configuration	Port Configuration	DRP	
Port Control Transmit Source Capabilities Transmit Sink Capabilities Autonegotiate Sink	Receptacle Type	Standard fully-featured USB-C receptacle 🔹	
	Audio Accessory Support		
	Debug Accessory Support		
Alternate Mode Entry Queue PD3 Configuration Register	Type-C Supported Options	No Options 🗾	
Event Delay	VConn Supported	No Options	
Transmit Identity Data Object	USB3.0/3.1 Rate	Try.Snk	
User Alternate Mode Config Display Port Capabilities	Set UVP to 4.5 V	Powered Accessory	

Figure 30. Type-C Supported Options - System Configuration (0x28) Register

• Type_C_Is_Debug_Target_SRC, Type_C_Is_Debug_Target_SNK, and Type_C_Supports_Audio_Accessory: These fields define the ability of the device to support Debug Accessory Mode and Audio Accessory Mode respectively, and must be set per the Figure 31 configuration in the Port Configuration register.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	Port Configuration (0x28)	
Global System Configuration	Field	Value
Port Configuration	Port Configuration	DRP
Port Control Transmit Source Capabilities	Receptacle Type	Standard fully-featured USB-C receptacle 🚽
Transmit Sink Capabilities	Audio Accessory Support	
Autonegotiate Sink	Debug Accessory Support	
PD3 Configuration Register	Type-C Supported Options	No Options 👤

Figure 31. Accessory Support - Port Configuration (0x28) Register

- **NOTE:** Some device variants do not have support for the accessory modes. Contact your TI representative for more details.
- *Type_C_Sources_VCONN* and *Type_C_Supports_VCONN_Powered_Accessory*: These fields indicate whether the UUT source VCONN supports communication with a VCONN-powered accessory. They



www.ti.com

must be set per the configuration in the *Port Configuration* register. These fields are automatically set by the tool if *VCONN_Swap_To_XXX* is set as *YES* in the *General PD Settings* tab.

Customer Use Interrupt Mask for I2C1	Port Configuration (0x28)	Port Configuration (0x28)	
Interrupt Mask for I2C2 Global System Configuration Port Configuration	Field Port Configuration	Value DRP _	
Transmit Source Capabilities Transmit Sink Capabilities	Receptacle Type Audio Accessory Support	Standard fully-featured USB-C receptacle 👤	
Autonegotiate Sink Alternate Mode Entry Queue	Debug Accessory Support	── ✓ No Options	
Event Delay	VConn Supported	VCONN supported as DFP/UFP (accept VC	
Transmit Identity Data Object User Alternate Mode Config Display Port Canabilities	USB3.0/3.1 Rate Set UVP to 4.5 V	VCONN not supported (disabled) Reserved VCONN supported asONN Swap requests)	
Intel VID Config Register	Under-voltage Protection Trip Point, PP_5	V VCONN supported asONN_Swap requests)	

Figure 32. VCONN Support - Port Configuration (0x28) Register

• *Type_C_BC_1_2_Support*. This field indicates whether the UUT supports *USB Battery Charging v1.2* and must be set per the Figure 33 configuration in the *Port Control* register.

Customer Use	Force USB Generation 1		^
Interrupt Mask for I2C1	Externally Powered		
Global System Configuration	Automatic Sink Cap		
Port Configuration	Sink Control Bit		
Port Control Transmit Source Canabilities	15 kOhm Resistor Present		
Transmit Sink Capabilities	Data Contact Detection Enable		
Autonegotiate Sink	Charger Advertise Enable	Charger Advertise Disabled	ſ
Alternate Mode Entry Queue	USB Disable		
Event Delay	Charger Detect Enable	Charger Detect Disabled	Π.
			1

Figure 33. BC1.2 Support - Port Control (0x29) Register

Type_C_Can_Act_As_Host and Type_C_Can_Act_As_Device: These fields indicate whether the UUT can communicate with USB 2.0 or USB 3.1 (as a host or device) respectively. They must be set per the Figure 34 configuration in the Transmit Identity Data Object register.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2	^	Transmit Identity Data Object(0x47)		
Global System Configuration Port Configuration		Record Counts		1	
Port Control		Field		Value	
Transmit Source Capabilities	- 11	Number of UFP Identity Objects 3			
Autonegotiate Sink Alternate Mode Entry Queue PD3 Configuration Register Event Delay		UFP Discover Identity Response			
Transmit Identity Data Object	- 1	Field		Value	
User Alternate Mode Config		USB Vendor ID	0x451		
Intel VID Config Register		Modal Operation Supported			
MIPI VID Configuration		Product Type	Undefined		-
I/O Config Detimer Debug Degister		Data Capable as USB Device			
App Config Binary Data Indices		Data Capable as USB Host			
100 Mactor Configuration					

Figure 34. Transmit Identity Data Object



٠

Type_C_Host_Speed and *Type_C_Device_Speed*: These fields indicate which USB speed is supported when communicating as a host or a device respectively.

Customer Use Interrupt Mask for I2C1 Interrupt Mask for I2C2		Port Configuration (0x28)	
Global System Configuration Port Configuration		Field Port Configuration	Value
Transmit Source Capabilities		Receptacle Type	Standard fully-featured USB-C receptack
Transmit Sink Capabilities Autonegotiate Sink		Audio Accessory Support Debug Accessory Support	<u> </u>
Alternate Mode Entry Queue PD3 Configuration Register		Type-C Supported Options	No Options 🔽
Event Delay		VConn Supported	VCONN supported as DFP/UFP (accept '
Transmit Identity Data Object		USB3.0/3.1 Rate	USB3 Gen2 signaling rate supported 🔄
Display Port Capabilities		Set UVP to 4.5 V	USB3 not supported USB3 Gen1 signaling rate supported
Intel VID Config Register		Under-voltage Protection Trip Point, PP_5V	USB3 Gen2 signaling rate supported

Figure 35. Data Capability as USB Device and Host - Port Configuration (0x28) Register

• *Type_C_Is_Alt_Mode_Controller* and *Type_C_Is_Alt_Mode_Device*: These fields indicate whether the UUT is capable of acting as an *Alternate Mode Controller* or *Alternate Mode Device* respectively. They must be set to YES if the device supports alternate modes.

3.3.3 Connection and Test Execution

Connect the test-equipment and UUT to the PC as shown in Figure 36.



Figure 36. Ellisys[®] Examiner and UUT - Connection Diagram

- 1. Connect the test equipment to the Windows PC.
- 2. Launch the tester GUI, and select the tests to execute.



Fests selection: No tests			▼ Ready	8
No tests			Test lefernation	
All tests All stable tests			l est information	
USB Type All RC/stable tests			Text ID:	
TD.PLUSB-IF certification tests - PD and Type-0			Test ID.	
TD.P. Custom				
	Stable	0/1//2010	Operator:	
	Stable	4/20/2010		
	Stable	6/17/2016	Comments:	
TD 4 2 1 Source Connect Sink	Stable	2/10/2017		
TD 4.2.2 Source Connect Sink Accessory	Stable	2/10/2017		
TD.4.2.3 Source Connect DRP	Stable	4/3/2017		
TD.4.2.4 Source Connect Try.SRC DRP	Beta	4/3/2017		
TD.4.2.5 Source Connect Try.SNK DRP	Beta	4/3/2017		
TD.4.2.6 Source Connect Audio Accessory	Stable	3/6/2017		
TD.4.2.8 Source Connect Powered Accessory	Stable	9/9/2015		
TD.4.3.1 Sink Connect Source	Stable	2/10/2017		
TD.4.3.2 Sink Connect DRP	Stable	8/12/2016		
TD.4.3.4 Sink Connect Try.SNK DRP	Beta	3/13/2017		
TD.4.3.5 Sink Connect SNKAS	RC	7/1/2016		
TD.4.3.6 Sink Connect Accessories	RC	10/27/2016		
TD.4.4.1 SNKAS Connect Source	Stable	2/7/2017		
TD.4.4.2 SNKAS Connect DRP	Stable	8/10/2015		
TD.4.4.3 SNKAS Connect Try.SRC DRP	Beta	4/3/2017	-	
oad selection from file Save selection			USB 3.0 Physical Settings	
unning Tests				
De Clatel				
Ready				

Figure 37. Test Selection - Ellisys[®] Examiner

3. Upload the VIF that was created previously, and run the selected tests.



	Texas Instruments	Product Name	TPS65982 EVM		
Test ID (TID)	0	Port Label			
Version Info	1.3	VIF Revision	Revision 1.11, Version 1.0		
General					
🧼 UU	Т Туре	Due	I-role Port		
USB Type	÷C				
Typ	e-C State Machine	DR	þ		
🧼 Ca;	otive Cable	No			
🧼 Rp	Value	3A.	@ 5V		
🧼 lmp	lements Try.SRC	No			
🥥 lmp	lements Try.SNK	No	No		
🧼 Su;	oports Audio Accessories	No	No		
🥥 ls \	conn-Powered Accessory	No			
🥥 ls /	Vt-Mode Controller	No			
🥥 ls /	Nt-Mode Device	No			
🥥 is L	Jebug Target as Source	No			
🥥 is L	Jebug Target as Sink	No			
9 Sol	Jrces Vconn	No			
⊘ Car	t act as USB Host	Tes	2.0		
	s opeeu	Va	52.0		
	i act as USD Device	165	20		
oad from file	Save	031	2.0		

Figure 38. Vendor Information File - Ellisys® Examiner

4. After the tests are completed, the results can be found under the Results tab.



Ellisys USB Explorer 3	50 Examiner	
Tests Results Settin	as Vendor Info	
	a Tasta	
TD PD SE	C F1 Source Canabilities sent timely	- All All All All All All All All All Al
TD PD SE	C E2 Source Capabilities Belds Checks	
E TD PD SF	C.E3 SourceCapabilityTimer Timeout	
🗉 🧳 TD.PD.SF	RC.E4 SenderResponseTimer Deadline - Request	
🕀 🧹 TD.PD.SF	RC.E5 SenderResponseTimer Timeout - Request	
🗉 🧹 TD.PD.SF	RC.E6 PSHardResetTimer Timeout	E
🖲 🧹 TD.PD.SF	RC.E7 Accept sent timely	
🕀 🧹 TD.PD.SF	RC.E8 Accept Fields Checks	
🗉 🧹 TD.PD.SF	RC.E9 PS_RDY sent timely	
🗉 🗸 TD.PD.SF	C.E10 PS_RDY Fields Checks	
🖲 🗸 TD.PD.SF	RC.E11 Accept Requests can be met	
🗷 🗸 TD.PD.SF	RC.E12 Reject Requests can't be met	
🖲 🗸 TD.PD.SF	C.E13 Reject Request - Invalid Object Position	_
🗈 🗸 TD.PD.SF	RC.E14 Atomic Message Sequence	_
🗈 🗸 TD.PD.SF	RC.E15 Give_Source_Cap	_
🕒 🧹 TD.PD.SF	C.E16 PDO Transition	
USB PD Sink	Tests	-
Tests Summary		
Tests ran:	26	
Tests failed:	0	
Tests not completed:	0	
🗸 All tests comp	eleted successfully but some warnings need to be checked.	Show Report
lunning Tests		
Run Selected 👻		
All tests completed		
rsion 3.1.6304		Quit
		sion

Figure 39. Test Results - Ellisys® Examiner

4 Getting Started – Granite River Labs GRL-USB-PD-C2

4.1 Installation

Download and install the following tool on the Windows PC from Granite River Labs

• GRL USB PD/Type-C Compliance Test Software/Firmware for USB Power Delivery and Type-C[™] Tester and Analyzer (GRL-USB-PD-C2)

4.2 Setup and Test Execution

- 1. Connect the test equipment to the Windows PC. The C2 device connects using Ethernet.
- 2. Launch "GRL-USB-PD-C2" Software
- 3. Select Connection Setup. Click on Connect/Refresh and verify the Tester Status turns green.

	🍯 🏹 🚺 🗰 🌞 -	+ <u> </u>
	Connection Setup	
	GRL-USB-PD-C2 Controller Status	
Connection Type:	Ethernet	
IP Address Configuration:	Oefault IP O Tester Dynamic IP	Connect / Refresh
IP Address :	192.168.255.1	Connect/ Kenesh
Tester Status:	Not Connected 🔕	
Firmware Version:	Not Available	Update C2 Firmware
Eload Version:	Not Available	
Serial No:	Not Available	Update Eload Firmware

Figure 40. GRL Connection Setup

4. Select Product Capability. Click on VIF1, locate the VIF created and click Open.

		🌍 .	🖸 💽 🗿 🗿	j 🔟 🗕 🕨	→ 📄		
			Product	Capability			
	Select Test Cable:	○ Select UUT Type (OR)	Load VIF	Read Capabilities:	Reset Capabilities:	File Name:	
Port 1:	GRL-SPL Cable $ \smallsetminus $	DRP ~	VIF 1	Port1	Reset Port 1	-	
Port 2:	GRL-SPL Cable $ \smallsetminus $	DRP ~	VIF 2	Port2	Reset Port 2	-	
Port1 Ca	apabilities Port2 Cap	abilities					

Figure 41. GRL VIF Entry

- 5. Select Test Configuration. Review settings and change if needed.
- 6. Review Test Setup Connection and connect UUT to the GRL C2 as shown.
- 7. Select Test Selection. Click to select the desired compliance tests.
- 8. Select Run/Start to execute selected tests. The GRL Advanced Plot window opens to show current operations.
- 9. Select Report Generation. Leave default options checked and select Generate Report. Launch "GRL-USB-PD-C2 Software"

5 Getting Started – MQP Packet-Master

5.1 Installation

Download and install the following tool onto the Windows PC from MQP Electronics

GraphicUSB Software

5.2 Setup and Test Execution

- 1. Connect the test equipment to the Windows PC. The MQP Packet-Master device connects using USB.
- 2. Launch the "Graphics USB" software.
- 3. Select menu items Operations, PD, and PD Compliance
- 4. Under the Gen tab, select Load an Existing Vendor Info File



Getting Started – MQP Packet-Master

www.ti.com

PD Compliance Tests using USB-PDT

	Gen Gen (cont) Source Sink E Path to Vendor Information File	Ext Mess ID (SOP) SVIDs (SOP) Type-C	Test Parameters	Rev 2 Rev 2 'Det' Rev 3 Strict Compliance 🔽
Status Capturing Rp Rd CC1 CC2	Import Vendor Info File (e.g. from Memory Stick) Save and Close all Open PD Compliance Results Files	Save To Vendor Info File Save Current Vendor Compliance Results (e.g. to Memory Stick)	Renam Save	d An Existing Vendor Info File All Compliance Result Folders (e.g. to Memory Stick)
VBUS VCONN Active Connected Activity Contract	Version 1.7 Version 1.7 Component TID 1 1 App VIF Vers: Revision 1.37, Version 1.	Port Port Type Port V DRP	PD_Supp Conned	tor Extract Info From UUT Make TID List
Source PR Swapped DR Swapped VC Swapped Mismatch	File VIF Vers : Revision 1.37, Version 1. VIF Producer: - GraphicUSB V6.05.00 VIF Status VIF Status VIF Inconsistent VIF - No Duplicates Found - No Unneeded Parameters Found File Validated) Fresults in FAIL	Auto	Create NotesText File
Diagnostic Plug-in VBUS Gen Curr Sink				Ŷ
00:00:00	Run Selected Run All Stop	Test: -not running- No PDT detected	1	Timeout -

Figure 42. MQP VIF Entry

5. Select one of the tabs Rev 2, Rev 2 Det, or Rev 3 to select the desired Compliance Tests





Figure 43. MQP Test Selection

6. Select Run Selected or Run All to execute desired tests

6 Getting Started – LeCroy M310P

6.1 Installation

TEXAS

www.ti.com

STRUMENTS

Download and install the following tool on the Windows PC from Teledyne LeCroy Protocol Analyzers

- USB Analysis Software: USB Compliance Suite
- USB Analysis Software: USB Protocol Suite
 - Note: This item is optional and only required for collecting PD logs

6.2 Setup and Test Execution

- 1. Connect the test equipment to the Windows PC. The LeCroy M310P device connects using USB.
- 2. Launch USB Compliance Suite.
- 3. Use the left Workspace area to select desired compliance tests.

Workspace	x
🖶 🛃 ಿ 🗒 🐗 🋄 Repeat: 1 📑	
USB 3.1 - USBIF	
🗄 🗔 USB Type C - USBIF	
Power Delivery 2.0 Communication MOI - USBIF	
Power Delivery 2.0 Deterministic MOI - USBIF	
DTS Physical Layer Tests	
Figure 44. LeCroy Test Selection	

- 4. Select the green plus sign to add selected tests to the test queue
- 5. Select the VIF icon. Select the Load File icon and enter the previously created VIF file

S	ettings							
	Genera	il	Analyzer / Exercsier	Test Specific	Hub	VIF		
		2	2					
		Na	ame			Value		Comment
		Int	ro					
			\$VIF_Specification			"Revision	1.40, Ver	
			\$VIF_Producer			"Teledyne	e LeCroy	

Figure 45. LeCroy VIF Entry

6. Select the blue forward arrow icon (or enter shortcut F5) to execute selected tests

7 Compliance Test Notes

- Some tests like TD.PD.VNDI.E4 SOP* might fail if SOP_P_Capable is set to YES in VIF because the
 tester wrongly marks the test case as failed if the tester does not detect a Good-CRC from the UUT.
 Instead, the tester must check if the device sent any VDM response against the set configuration for
 this particular test-case. Though the TPS65988 supports SOP' and SOP" handling, the device
 monitors SOP* messages from the plug only when expecting a response.
- Certain tests under the PD2 and Type-C Functional Test Specification (Ex: TD.4.10.2, TD.PD.VNDI.E10, etc.) might fail with 'Init Swap to DFP/UFP' set in the configuration of the UUT. The tester will incorrectly responds to the role swap requests of the UUT, which results in a test failure.
- Some Type-C Functional Tests are sensitive to the UUT Under Voltage Protection (UVP) threshold when set to 20% or less of the negotiated contract. The testers expect the UUT to maintain a stable contract when VBUS is reduced to 3.7 V for a 5-V contract, and the UUT may trigger a disconnect if the UVP threshold is not set low enough.

TEXAS INSTRUMENTS

www.ti.com

Customer Use	^	Port Configuration (0x28)	
Interrupt Mask for I2C1		,	
Interrupt Mask for I2C2			
Global System Configuration		Field	Value
Port Configuration		Port Configuration	DRP 🔹
Port Control Transmit Source Capabilities		Receptacle Type	Standard fully-featured USB-C receptact
Transmit Sink Capabilities		Audio Accessory Support	
Autonegotiate Sink		Debug Accessory Support	
Alternate Mode Entry Queue SRCPolicyMaster Auto Negotiate Source		Type-C Supported Options	Try.Src 💌
PD3 Configuration Register		VConn Supported	VCONN supported as DFP/UFP (accept
Event Delay		USB3.0/3.1 Rate	USB3 Gen1 signaling rate supported 🔄
User Alternate Mode Config		AMD I2C Mux Enable	
Display Port Capabilities	- I	Set UVP to 4.5 V	
Intel VID Config Register		Under-voltage Protection Trip Point, PP_5V	20%
MIPI VID Configuration		Under-voltage Protection Usage, PP_HV	20%
Retimer Debug Register		Over Voltage Protection Trip Point	24 V 👻
App Config Binary Data Indices		Over Voltage Protection Usage	Disconnect VBUS if voltage exceeds 5% 💌

Figure 46. Undervoltage Protection Options



Revision History

www.ti.com

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Cł	Changes from Original (May 2017) to A Revision F	
•	Updated app report for increased clarity	1
•	Added Compliance Test Program Overview section	2
•	Added Compliance Test Notes section	32

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2019, Texas Instruments Incorporated