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FUSB307B Type-C Port Controller IC Evaluation Board User's Manual

FUSB307BGEVB

This user guide supports the evaluation kit for the FUSB307B. It should be used in conjunction with the FUSB307B data sheets as well as **onsemi**'s application notes and technical support team. Please visit **onsemi**'s website at <u>www.onsemi.com</u>.

INTRODUCTION

The FUSB307B evaluation board and included software allows customers a complete platform to evaluate the Type–C interface detection solution the FUSB307B provides. The evaluation board is designed for both stand-alone operation and connection to test equipment for specific testing requirements. The FUSB307B software provides both fully automatic control and manual control of the FUSB307B functions. With a single connection to a PC and a couple configurations in the GUI, the evaluation board can function as a Source, Sink, or Dual Role port.

Description

The FUSB307B targets system designers looking to implement up to four USB Type– $C^{(B)}$ port controllers (TCPC) with USB–PD capabilities.

This solution provides integrated Type–C Rev 1.3 detection circuitry enabling manual attach/detach detection. Time critical Power Delivery functionality is handled autonomously, offloading the μ Processor or Type–C Port Manager (TCPM).

The FUSB307B complies with the USB-PD Interface Specification.



Figure 2. Block Diagram



Figure 1. FUSB307B Evaluation Board

Features

- USB–PD Interface Spec Rev 1.0 Ver. 1.2 Compatible
- USB Type-C Rev 1.3 Compatible
- USB-PD Rev 3.0 Ver. 1.1 Compatible
- Fast Role Swap
- Sink Transmit
- Extended Data Messages (Chunked)
- Dual-Role Functionality
 - ◆ Manual Type-C Detection
 - Automatic DRP Toggling
- USB-PD Interface Specification Support
 Automatic GoodCRC Packet Response
 - Automatic Retries of Sending Packet
 - All SOP* Types Supported
- VBUS Source and Sink Control
- Integrated 3 W Capable VCONN to CCx Switch
- 10-bit VBUS ADC
- Programmable GPIOs
- 4 Selectable I²C Addresses
- Dead Battery Operation
 - Powered from VBUS
 - LDO Output provides power to TCPM
- Packaging
 - ◆ 16-pin WQFN (3.0 × 3.0 mm)



External Power Inputs

Figure 3. Evaluation Board Layout

POWER CONFIGURATION

The FUSB307B evaluation board is designed to be able to be powered from just the PC connection or powered externally based on the testing requirements. To use the external VDD to the device, take the jumper off of JP1 and connect external VDD to the middle post of JP1, which is FUSB307B VDD.

Power Supplied from Board

The FUSB307B can fully operate from the VBUS input of the micro-B USB receptacle J3. To operate the evaluation board, the USB power should be provided to the board over the micro-B USB. Then, the on board regulator (LDO) generates VDD, which is 3.3 V for device supply. Once valid USB power is provided, the indicator LED, 3.3 V, is turned on.

I²C Connection

Direct I²C Connection

Customers that want to directly connect their I²C masters to the evaluation board can connect the I²C master signals to the SCL, SDA, and INT N test points.

PC I²C Connection

The evaluation board uses an STM32F072CB micro-controller-unit (mcu) as an I²C master to control the FUSB307B. This is the communication method used by the FUSB307B GUI. By connecting the PC to the micro-B USB receptacle J3, the evaluation board automatically powers the microcontroller and connects the I²C master to the FUSB307B.

TYPE-C SIGNAL CONNECTIONS

The FUSB307B evaluation board allows different ways of connecting to another Type–C device or controlling the signals of the Type–C receptacle based on the type of testing that is required.

CC Pins

The Type–C CC1 and CC2 pins are directly connected to the Type–C receptacle J1 on the board. Note that the FUSB307B evaluation board contains the minimum cReceiver capacitance specified in the USB PD specification for the CC pins which is 220 pF. This capacitance is C27 and C28 in the schematic.

VBUS 5 V

VBUS is used differently based on the Type–C port type. The FUSB307B controls an integrated load switch (FPF2895C) for Sink and Source path depending on what device is connected. In each case, an LED indicator (SNK ON and SRC ON) tells which VBUS power path is established. A test point for VBUS voltage sensing (VBUS_S on the schematic, VBUSC on the EVB) is located near J1. The EVB is designed to supply 5.0 V VBUS from PC USB power or an external supply. This option can be configurable by JP7 as shown below.



Figure 4. 5V_IN Power Selection

- Jumper on VBUS_MC: PC USB power to 5V_IN
- Jumper off: external power (V_SRC_IN test point) to 5V_IN thru JP4
- Jumper on 5 V: external power (5 V test point) to 5V_IN

VBUS Greater Than 5 V Option

The "FM160305F" version of the FUSB307BGEVB does not have the higher voltage source VBUS option installed. To offer VBUS greater than 5 V, the HV_SRC_IN test point can be used as an input for a VBUS level of 9 V, 12 V, 15 V, or 20 V. This input is controlled by the FPF2895C load switch and the SRV_HV_ON signal from the mcu. To enable this option, the following modifications need to be made to the EVB:

• Populate the empty U2 footprint with an FPF2895CUCX device

- Short both JP17 and JP18 to GND (for 23 V over voltage protection)
- Short JP8 (connecting to Type-C VBUS)
- Populate R23 with 1.3 kΩ resistor (for approx 3.4 A VBUS overcurrent limit)
- Populate C12 with a 1 µF capacitor
- Populate C25 with a 10 µF capacitor
- Provide 9 V, 12 V, 15 V, or 20 V at the HV_SRC_IN test point at the bottom right corner of the EVB

VCONN

VCONN can be supplied to the FUSB307B externally through the VCONN test point found along the External Power Inputs test points.

USB2.0 and SBU

They are left open in the Type–C connector with no connections to other circuitry on the board. Test points are near the Type–C connector J1.

STATUS LED'S

The following status LEDs are provided on the evaluation board. All of the LEDs can be disconnected by JP11 and JP12.



Figure 5. LED Indicators

Table 1.	STATUS	LED'S
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LED	Status
D1	on when GPIO2 is active (low)
D2	on when DBG_N is in active (low)
D3	on when SNK_ON is active (high)
D4	on when SRC_ON is active (high)
D5	on when SRC_HV_ON is active (high)
D6	on when V3P3_SYS is present (high)



SCHEMATIC

Figure 6. FUSB307B Evaluation Board FM160305D Schematic (1/2)



SCHEMATIC

Figure 7. FUSB307B Evaluation Board FM160305D Schematic (2/2)

FUSB307B EVALUATION PLATFORM GUI CONFIGURATION

GUI Installation

Instructions for installing **onsemi** FUSB307B Control Software

- Locate and extract the file "FUSB307B_gui_1_1_0_Customer.exe" (versions of the file will include the release number) from the archive file "FUSB307B_gui_1_1_0_Customer.7z". The .exe can be located in any location you prefer. Double-click the .exe file to start the GUI.
- 2. Plug the STD-A end of the USB Cable into the USB port of your PC.
- 3. Plug the Micro–B end of the USB Cable into the GUI Interface (J3 at the top right corner of the board) on the Evaluation Board. V3P3_SYS LED will illuminate if properly connected.
- 4. Wait for the USB Port to connect with a message in the lower left hand corner of the GUI that states "USB Device: VID:0x1057 PID:0x0133" and "Device Connected v1.1.1" in the lower right corner (or a newer version if applicable). If the message states "Disconnected", then there is a connection problem.

Upgrading the GUI Software:

- 1. Simply delete the previous version of the .exe.
- 2. Repeat the installation process above.

GUI OPERATION

Program Startup

To operate the FUSB307B Evaluation Platform, perform the following steps:

- 1. Install the FUSB307B GUI software as described in the previous section.
- 2. Connect the FUSB307B board to your computer with a micro-USB cable.
- 3. Start the GUI software by double-clicking the .exe file from the location you saved it to.
- 4. The base operation GUI will appear as shown in Figure 8 below.
- 5. The lower right part of the screen will now indicate "Device Connected v1.1.1" (the version number may be different as newer firmware is released). If this is not shown, there is a likely a power configuration issue with the FUSB307B device. If power is supplied correctly, check that the firmware was programmed correctly. The document for firmware download is posted separately. You can now read, write, and configure the FUSB307B. Accessories can be plugged in and used.

eneral USB PD Control	State Logs Capabilities Regi	ster Map Script VDM	
Type C Status			
Type C Enabled	Yes	Connection State	Unattached
Port Type	DRP	CC1 Termination	Undefined
Accessory Support	No	CC2 Termination	Undefined
DFP Current Advertisment	1.5A	UFP Current	Open
Power Delivery Status			
USB PD Enabled	Yes	Policty State	PE SRC Disabled (0)
USB PD Active	No	Protocol State	Disabled
Power Role	Source	Transmitter State	Idle
Data Role	DFP		
Explicit Contract	No		
Control Status			
Enable USB Type C State I	Machine Port Type DRP	•	Read Config Read Status
Source Mode Preffered	DFP Current 1.5A	· · · ·	Write Config
Sink Mode Preffered			
Enable Accessory Comment			Enable PD Disable PD

Figure 8. Initial Page of FUSB307B GUI

USING THE GUI

There are two basic modes to control/monitor the FUSB307B. Pre-programmed firmware on the mcu can control the FUSB307B and then the GUI can work with the firmware to control/monitor the FUSB307B. The GUI can also be used with the Register Map and Script tabs to manually control/monitor the FUSB307B.

These two modes should not be used together, as it will interfere with the autonomous mode state machine. By default, the USB Type–C state machine is enabled. The checkbox has to be de-selected to use the device manually.

Status information is shown in the top half of the window, as well as in the "PD Control" tab and the "State Logs" tab. Scripts can also be loaded in the "Script" tab for easier loading of multiple sequential steps.

More information on specific operation of each section of the GUI is provided in the following sections.

File Menu

- "File"
 - Click "Exit" to exit the FUSB307B GUI program
- "Preferences"
 - Select "Auto Poll" to automatically update the GUI with the FUSB307B status
- "Help"
 - "About" provides GUI version information

General

This tab provides the overall device status. The lower third of this tab is the "Control" section. When the FUSB307B EVB is initially connected to the PC, this section will automatically update itself. At any time after that, the "Read Config" button should be used before making any changes to this section. The port type can be set to either DRP, Sink, or Source, and other features can be enabled or disabled here. After making any changes, press "Write Config" to update the device with any changes.

General USB	PD Control	State Logs	Capabilities	Register Map	Script	VDM			
Type C Statu	s								
Type C Enabl	ed	Ye	s		Conne	ction Stat	te	Unattached	
Port Type		DR	P		CC1 Te	erminatior	n	Undefined	
Accessory Su	pport	No			CC2 Te	ermination	n l	Undefined	
DFP Current	Advertisment	1.5	5A		UFP Cu	urrent		Open	
Power Deliver	y Status								
USB PD Enabl	ed	Ye	5		Policty	State		PE SRC Disabled (0)	
USB PD Active	e	No			Protoc	ol State		Disabled	
Power Role		So	urce		Transm	hitter Stat	te	Idle	
Data Role		DF	P						
Explicit Contr	act	No							
-Control Statu	s								
Enable US Source Mi Sink Mode Enable Ac	B Type C State ode Preffered Preffered cessory Suppor	Machine Port DFP t	Type Current	DRP 1.5A	▼ ▼			Read Config F Write Config Enable PD	Read Status Disable PD

Figure 9. General Tab

PD Control

This tab logs any PD activity with PD Message History Box. The log file can be expanded or collapsed to show more or less detail of the PD packets. The other control boxes indicate the current state of the PD state machine and what contract was negotiated. When connected as a sink, it displays the source capabilities of the source that is attached. The user can select different capabilities and make the requests. The user can also manually send different PD messages through the pull-down menu and the click buttons.

General USB	PD Control	State Logs	Capabilitie	es Register	Map Script	VDM			
USB PD Mess	age History				USB PD	State			
								Send Hard Reset	
Attach At	e Data Src Caps loodCRC lata Request e GoodCRC e Accept loodCRC e DS Rdy loodCRC e Data Vendor I loodCRC e Data Vendor Def e GoodCRC e Data Vendor Def e GoodCRC lata Vendor Def e GoodCRC	Defined ined Defined ined	Sop Sop Sop Sop Sop Sop Sop Sop Sop Sop	Discover Ident Discover Ident Discover SVID: Discover SVID:	ity FI	3 PD Cont rrent Con 3 PD Cont et Src Cap pabilities PDO 5 V, PDO 5 V,	tract S tract S trol Ext. Advertised 3 A 3 A	ink Send GiveBack GiveBack Mismatch Operating Current Maximum Current	FPDO 5 V, 100 mA
							Rei	quest Selected Objec	t
•					F				
	Get History		Clear	History					

Figure 10. PD Control Tab

State Logs

Events can be logged in the software by checking the "Auto Poll" option in the Preferences menu. These logs can be useful in debugging and in checking the timing of various operations. Each log message has the timestamp (with $100 \,\mu s$ resolution). To stop logging, click the "Auto Poll" option in the Preferences menu.

An example of a Type–C attach and the PD communication flow is shown below.

To support debug efforts, the "Set State" button can be used to force a specific state machine state. The state can be selected in the pull down menu to the left of the "Set State" button.

The screens can be cleared with the "Clear State Log" and "Clear PD State Log" buttons to the right of each window.

Either Type–C State log or Policy Engine State log can be saved to a text log file using the "Save TC Log" and/or "Save PD log" buttons.

Figure 11. State Logs Tab

Capabilities

The "Capabilities" tab is to set-up PD functionality of the EVB. The settings in this tab dictate how the PD state machine will respond once a connection is made. It is the programmed source and sink capabilities of the device and

the charging algorithm that is used to automatically select a source capability when connected to a source. Note, the "Read Src Caps", "Read Sink Caps", and "Read Settings" buttons need to be clicked to reflect the default settings of the PD state machine.

General USB PD Control State Logs	Capabilities Register Map Scrip	t VDM				
Programmed Source Capabilties						
Number of Capabilities	Cap1		_			
PR_Swap Supported	Supply Type	Fixed 💌	Read Src Caps			
USB Suspend Supported	Voltage	5.000	Default Src Caps			
Externally Powered	Max Current	3.000	Write Src Caps			
USB Communications Capable	Peak Current	150%/1ms, 125%/2ms, 110%/10ms 🔻				
☑ DR_Swap Supported						
Programmed Sink Capabilties						
Number of Capabilities	Cap1		_			
PR_Swap Supported	Supply Type	Fixed •	Read Sink Caps			
Higher Capability	Voltage	5.000	Default Sink Caps			
Externally Powered	Op. Current	0.100	Write Sink Caps			
USB Communications Capable			Force Cap Mismatch			
☑ DR_Swap Supported						
Default Sink Request Settings						
Max Voltage 1.00 V 🔿 🗇 GotoMin Compatible Read Settings						
Operating Power 10.00 W 🚔 🔲 USB S	Suspend Operation		Write Settings			
Min/Max Power 10.00 W 👘 🔲 USB (Comm Capable					

Figure 12. Capacitance Tab

Register Map

The "Register Map" tab enables reading and writing any value to any register in the FUSB307B. When performing a register write, the selected register/registers is/are read back again to confirm the write action. So the write button actually performs a write and then a read operation.

The "Device Poll" option tells the GUI to automatically check the DEVICE ID register for the I^2C address selected

in the "Addr" pull down box and display the "Device Connected ..." or " No Device" message in the lower right corner of the GUI.

The "Register Poll" option tells the GUI to constantly poll the FUSB307B registers and update the register values. This should be used only for debugging since it can disrupt the timing operations of the firmware.

Addr	Name	Data(Hex)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	BitO		
0~00	VENDIDI	70		Vendor_ID_Low =								
0,000	VENDIDE	/3				0111	1001					
0x01	VENDIDH	07				Vendor_	ID_High					
0.01	121101011					0000	0111					
0x02	PRODIDI	31				Product_	_ID_Low					
UNUL	1100102					0011	0001					
0x03	PRODIDH	01				Product_	_IDHigh					
	TRODIDIT					0000	0001					
0v04	DEVIDI	02	Device_ID_Low									
	DEVIDE	02		00000010								
0v05	DEVIDH	00	Device_ID_High									
0,000	DEVIDIT		0000000									
0x06	TYPECREVI	12			U:	SB_Type-C_	Revision_Lo	w				
			00010010									
0x07	TYPECREVH	00			U:	SB_Type-C_	Revision_Hig	jh 🦷				
0,07	THE CREW		0000000									
0x08	USBPDVER	12	USB_PD_Version									
0,00	COD. DVEN	12	00010010									
0200	LISBPDREV	20				USB_PD_	Revision					

Figure 13. Register Map Tab

Scripting

This tab enables the use of scripts to configure the FUSB307B. The window in the left side of the tab controls the scripting.

Scripts can be added through the GUI using normal copy/paste methods or imported from an external file using the "Load" button. After achieving a desired setup, a script can also be exported to a file using the "Save" button.

Each line of the script should be formatted as follows:

Command, port, I²C addr, # bytes, register addr, data1, ..., dataN, optional comment

- The *Command* is: "r" or "w"
- The *port* is always 0
- The I^2C addr is any connected device I^2C address
- The # bytes is the number of bytes to read or write
- The *register addr* is the starting register address
- The *data1*, ..., *dataN* are for writing values to registers

• And optional comment is just informational

Each field can be separated with a space (" "), a comma (","), or a semicolon (";").

The Run button will execute all the lines of the script. The Step button will execute the highlighted line. The Loop feature will loop the entire script up to 99 times. Setting Loop count to 0 will loop indefinitely. Some example script commands are given below:

- r 0, 0xA0, 2, 0x04; Read DeviceID
- r 0, 0xA0, 1, 0x1A; Read RoleControl
- w 0, 0xA0, 1, 0x1A, 0x1B; Set Rp 1.5A
- w 0, 0xA0, 3, 0x51, 0x02, 0x47, 0x06; Write PD Byte Count and Header for GetSourceCaps
- w 0, 0xA0, 1, 0x50, 0x30; Write Transmit SOP command

Results of an executed script are shown in the box on the right side of the tab. These results can be exported to a file using normal copy and paste functions.

2

General USB	PD Control State Logs	Capabilities Registi	er Map Script VDM	
Load	state Logs		<pre>Supt VDM Script Syntax: INST Port_Id, I2C_Addr, Num_Bytes, Start_Addr *The I2C_Addr is the left shifted address. FUSB305 with address 7bit address 0x22 is actually 0x44. Example: r 0, 0xA0, 1, 0x01; Reads bus id = 0, i2c addr = 0xA0, 1 byte starting at 0x01 w 0, 0xA0, 1, 0x02, 0xFF; Writes to bus id = 0, i2c addr = 0xA0, 1 byte (0xFF) starting at 0x02</pre>	?
Loop 0			Clear	

Figure 14. Script Tab

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1	r 0, 0xA0, 2, 0x04; Read DeviceID r 0, 0xA0, 1, 0x1A; Read BoleControl	Read 2 bytes 0xA0[0x04-0x05]: 0x02 0x02
3	w 0, 0xA0, 1, 0x1A, 0x1B; Set Rp 1.5A	Read 1 bytes
4	w 0, 0xA0, 3, 0x51, 0x02, 0x47, 0x06; Write	0xA0[0x1A]: 0x6E
	PD Byte Count and Header for GetSourceCaps	Written 1 bytes
5	w 0, 0xA0, 1, 0x50, 0x30; Write Transmit	0xA0[0x1A]: 0x1B
	SOP command	Written 3 bytes
		0xA0[0x51-0x53]: 0x02 0x47 0x06
		Written 1 bytes
		0xA0[0x50]: 0x30

Figure 15. Example Script and Results

VDM

This tab enables supports Vendor Defined Messages (VDM). The "Configuration" section is used for configuring the FUSB307B. The upper left "FUSB305" section window is used for displaying and modifying or adding VDM information to the EVB. Right-clicking on the Sop field allows you to add SVIDs. Right-clicking on an SVID allows you to remove the SVID or add a Mode. Right-clicking on a Mode allows you to remove it.

Retrieving VDM information from a connected device can be done in the lower left "Other" section window. Right-clicking on Sop allows you to request Discover Identity or Discover SVIDs. Right-clicking on a SVID allows you to request Discover Modes. Right-clicking on a Mode allows you to request to Enter or Exit that Mode.

General USB PD Contro	State Logs Capabilities R	egister Map Script VDM	
General USB PD Control FUSB305 Fusb305	State Logs Capabilities R 1057 00000001 00000001	egister Map Script VDM Configuration Respond to Discover SVIDs Respond to Discover Modes Auto Enter Mode for SVID_AUTO_ENTRY Enable DisplayPort	
		Auto Enter Port Partner DisplayPort Mode Read	Write
Other			
▲ Sop	0770		
A SVID	0779		
A Discover Identit	0000001		
	y 0v0779		
PID	0x0000		
bcdDevice	0x0000		
Sop'			
Sop"			

Figure 16. VDM Tab

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