

## FUSB302 Type-C™ Interface Detection Solution Evaluation Board User's Manual



ON Semiconductor®

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This user guide supports the evaluation kit for the FUSB302. It should be used in conjunction with the FUSB302 data sheets as well as ON Semiconductor's application notes and technical support team. Please visit ON Semiconductor's website at [www.onsemi.com](http://www.onsemi.com).

### INTRODUCTION

The FUSB302 evaluation board (EVB) and included software allows customers a complete platform to evaluate the Type-C interface detection solution the FUSB302 provides. The EVB is designed for both stand-alone operation and connection to test equipment for specific testing requirements. The FUSB302 software provides both fully automatic control and manual control of the FUSB302 functions. With a single connection to a PC and a couple configurations in the GUI, the EVB can function as a source, sink or dual-role port.

### Description

The FUSB302 targets system designers looking to implement a DRP/DFP/UFP USB Type-C connector with low amount of programmability.

The FUSB302 does the USB Type-C detection including attach, and orientation. The FUSB302 integrates the physical layer of the USB BMC Power Delivery (PD) protocol to allow up to 100 W of power and role swap. The BMC PD block enables full support for alternative interfaces of the Type-C specification.

### Features

- Dual-Role functionality:
  - ♦ Autonomous DRP toggle
  - ♦ Ability to automatically connect as either a source or a sink based on what has been attached
  - ♦ Software configurable as a dedicated source, dedicated sink, or dual-role
  - ♦ Dedicated devices can operate both on a Type-C receptacle or a Type-C plug with a fixed CC and VCONN channel
- Full Type-C 1.3 support. Integrates the following functionality of the CC pin:
  - ♦ Attach/detach detection as source
  - ♦ Current capability indication as source
  - ♦ Current capability detection as sink
  - ♦ Audio adapter accessory mode
  - ♦ Debug accessory mode

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- ♦ Active cable detection
- Integrates CCx to VCONN switch with over-current limiting for powering USB3.1 full featured cables
- USB PD 3.0 support
  - ♦ Automatic GoodCRC packet response
  - ♦ Automatic retries of sending a packet if a GoodCRC is not received
  - ♦ Automatic soft reset packet sent with retries if needed
  - ♦ Automatic hard reset ordered set sent
  - ♦ Support for extended/chunked messages
  - ♦ Programmable Power Supply (PPS) support
  - ♦ Basic source-side collision avoidance
- Package 9-ball WLCSP (1.215 × 1.260 mm)

### POWER CONFIGURATION

The FUSB302 EVB is designed to be able to be powered from a PC connection or powered externally based on the testing requirements.

### Power Supplied from Board

The FUSB302 can fully operate from the VBUS input of the micro-B USB receptacle J2. To operate the EVB, the USB power should be provided to the board over the micro-B USB. Then, the on board regulator generates VDD, which is 3.3V for device supply. Once valid USB power is provided, the indicator LED, 3.3V, will be turned on.

### I²C Communication

Communication with the FUSB302 is done through I²C accesses. The EVB allows different ways of connecting I²C masters to the FUSB302.

### Direct I²C Connection

Customers that want to directly connect their I²C masters to the EVB can connect the I²C master signals to the SCL, SDA and INT\_N test points.

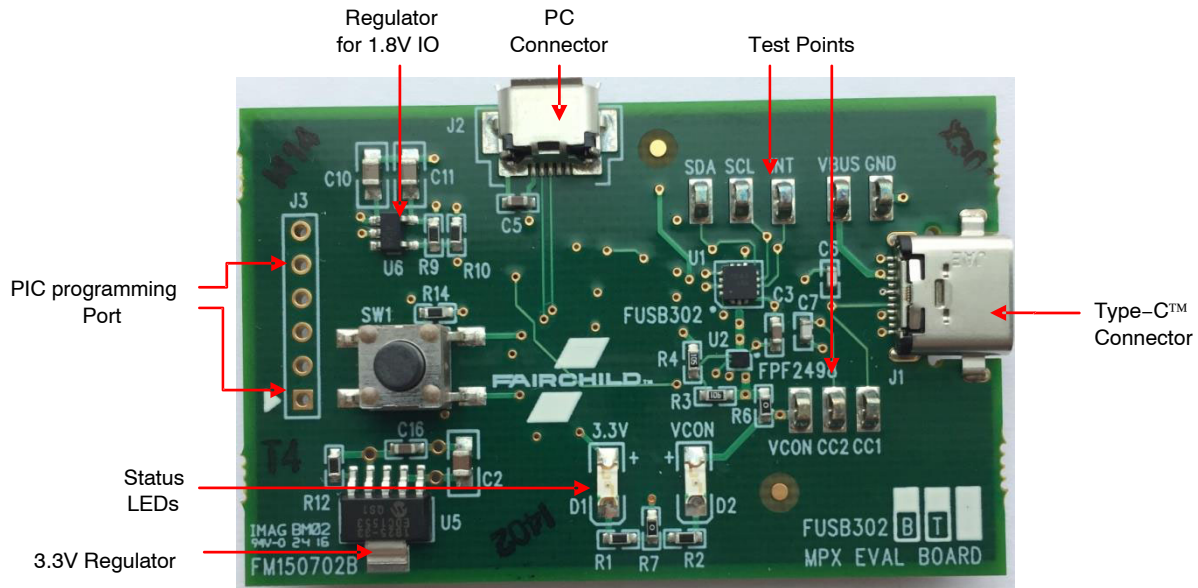
### PC I²C Connection

The EVB uses a PIC32MX250F128 micro-controller as an I²C master to control the FUSB302. This is the communication method used by the FUSB302 GUI. By connecting the PC to the micro-B USB receptacle J2, the EVB automatically powers the microcontroller and

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connects the I<sup>2</sup>C master to the FUSB302. The EVB automatically generates a regulated 1.8 V supply, U6, which

is used by an external I<sup>2</sup>C translator to set the I<sup>2</sup>C levels used with the FUSB302.



### Figure 1. EVB Layout

## TYPE-C SIGNAL CONNECTIONS

The FUSB302 EVB 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 CCC1 and CC2 pins are directly connected to the Type-C receptacle J1 on the board. There is also a test point for each pin that can be used to connect the CC pins externally. Note that the FUSB302 EVB contains the minimum cReceiver capacitance specified in the USB PD specification for the CC pins which is 200pF. This capacitance is C6 and C7 in the schematic.

## VBUS

VBUS is used differently based on the Type-C port type. As a sink port, VBUS is directly connected to the Type-C receptacle J1 and the VBUS test point located near J1. As a source port, VBUS can be supplied to the receptacle J1 and controlled by the FUSB302 GUI. When controlled by the FUSB302 software, VBUS is supplied from the PC micro-B USB connection. The FUSB302 software uses an on board

load switch to control the enabling of VBUS to the Type-C receptacle.

## VCONN

VCONN is supplied to the FUSB302 from the VBUS pin of the PC connection. To supply VCONN externally, remove R6 and apply the external VCONN to the VCON test point. Note that the EVB has 10°F on VCONN input of the FUSB302 which is the minimum bulk capacitance specified in the Type-C specification. This capacitance is C4.

## USB2.0 and SBU

They are left open in the Type-C connector and no connections in the board.

## STATUS LEDs

The following status LEDs are provided on the EVB.

### Table 1. STATUS LEDs

LED	Status
D1	VDD is Supplied to FUSB302
D2	VCONN is Supplied to FUSB302

## SCHEMATIC



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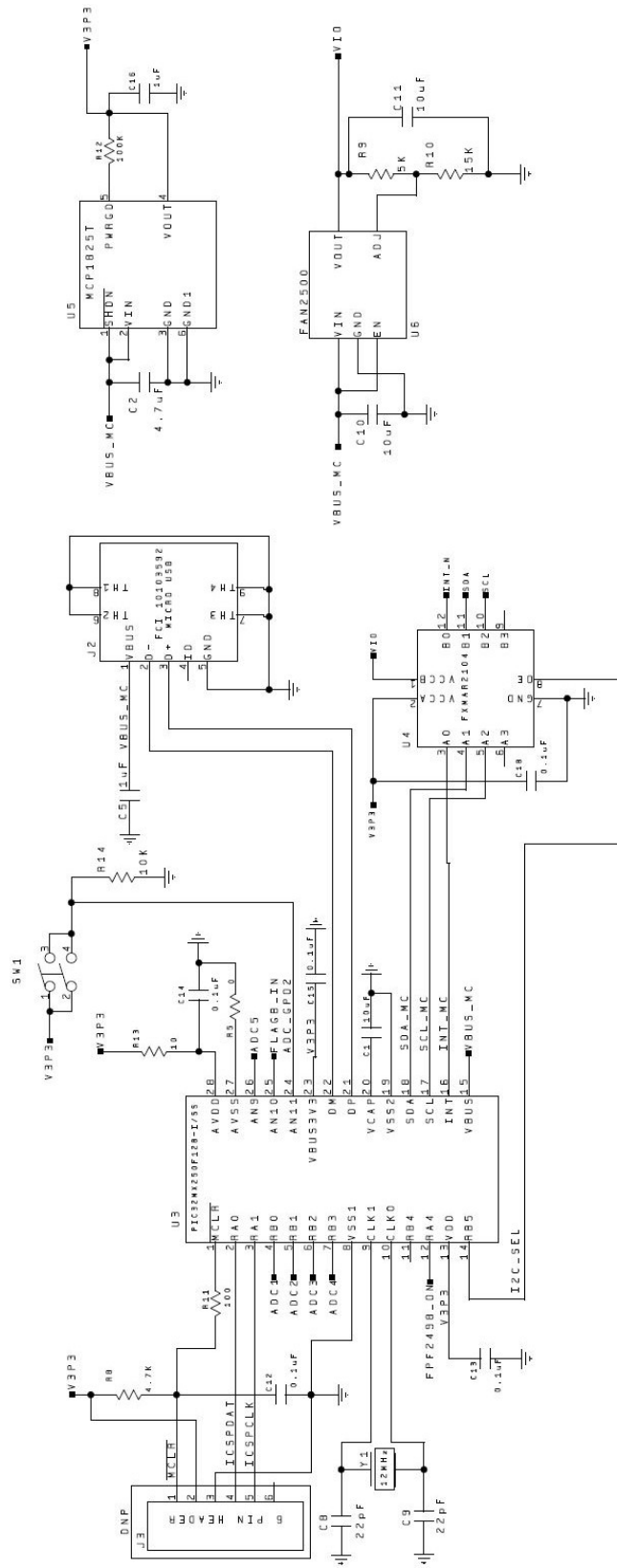


Figure 3. FUSB302 EVB FM150702B Schematic (2/2)

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## FUSB302 EVALUATION PLATFORM GUI CONFIGURATION

### GUI Installation

Instructions for installing ON Semiconductor FUSB302 Control Software

1. Locate and extract the file “fusb302\_gui\_1\_0\_0\_Customer.exe” (versions of the file will include the release number) from the archive file “fusb302\_gui\_1\_0\_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. Plug the STD-B 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 (J2 at the top board edge) on the EVB (3.3V 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:0x0779 PID:0x1118”. 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 FUSB302 Evaluation Platform, perform the following steps:

1. Install the FUSB302 GUI software as described in the previous section.
2. Connect the FUSB302 board to your computer with a micro-USB cable.
3. Start the GUI software by clicking the .exe file from the location you saved it to.
4. The base operation GUI will appear as shown in Figure 4 below.
5. The lower right part of the screen will now indicate “Device Connected v4.0.0” (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 FUSB302 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 FUSB302. Accessories can be plugged in and used.

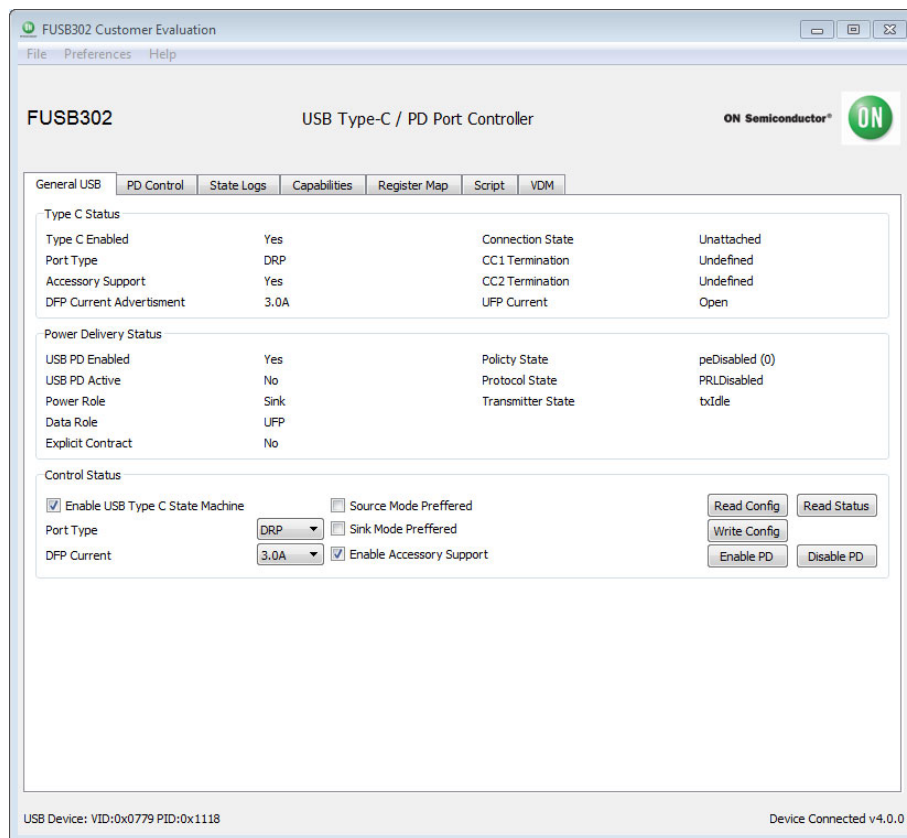


Figure 4. Initial Page of FUSB302GUI

## USING THE GUI

There are two basic modes of operation using the FUSB302 GUI:

- Autonomous operation which uses the “Enable USB Type C State Machine” option on the “General USB” tab
- Manual operation which disables the “Enable USB Type C State Machine” option and requires manually configuring the device using all the tabs

These two modes should not be used together, as it will interfere with the autonomous mode state machine. Type-C Status and Power Delivery Status information is shown in the “General USB” tab as well as in the “State Logs” tab. Scripts can also be entered 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.

### Application Menu Bar

- “File”
  - ♦ Click “Exit” to exit the FUSB302 GUI program

- “Preferences”
  - ♦ Select “Auto Poll” for the GUI to continuously poll the FUSB302 for register and log updates
- “Help”
  - ♦ “About” provides GUI version information

### Device Control Tabs

Tabs provide detailed control and monitoring of the FUSB302. The sections below describe how to use these controls.

#### General USB

The “General USB” tab implements functional Type-C state machines to configure the FUSB302 EVB as a Dual-Role Port (DRP), Sink Port, or Source Port interface. When first attaching the EVB, the options in the “Control Status” section are automatically updated. To configure the device to the desired state, select either “DRP”, “Sink”, or “Source” in the “Port Type” drop down box, then click the “Write Config” button to update the FUSB302.

General USB			
Type C Status		Power Delivery Status	
Type C Enabled	Yes	USB PD Enabled	Yes
Port Type	DRP	USB PD Active	No
Accessory Support	Yes	Power Role	Sink
DFP Current Advertisement	3.0A	Data Role	UFP
		Explicit Contract	No

Control Status	
<input checked="" type="checkbox"/> Enable USB Type C State Machine	<input type="checkbox"/> Source Mode Preferred
Port Type: <span>DRP</span>	<input type="checkbox"/> Sink Mode Preferred
DFP Current: <span>3.0A</span>	<input checked="" type="checkbox"/> Enable Accessory Support

Buttons: Read Config, Read Status, Write Config, Enable PD, Disable PD

**Figure 5. General USB Tab**

The autonomous Type-C State Machine control is enabled and disabled by selecting the checkbox and then clicking the “Write Config” button. Connect any desired Type-C port to the FUSB302, and the status change will be seen in the Status sections.

The PD state machines are enabled by default when the Type-C state machine is enabled. You can enable or disable

PD by clicking the appropriate button in the Control Status section. When the PD state machine is running, it will automatically negotiate a power contract based on what was detected on attach and the configuration in the “Capabilities” tab.

## PD Control

The “PD Control” tab logs any PD activity in the USB PD Message History window. 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.

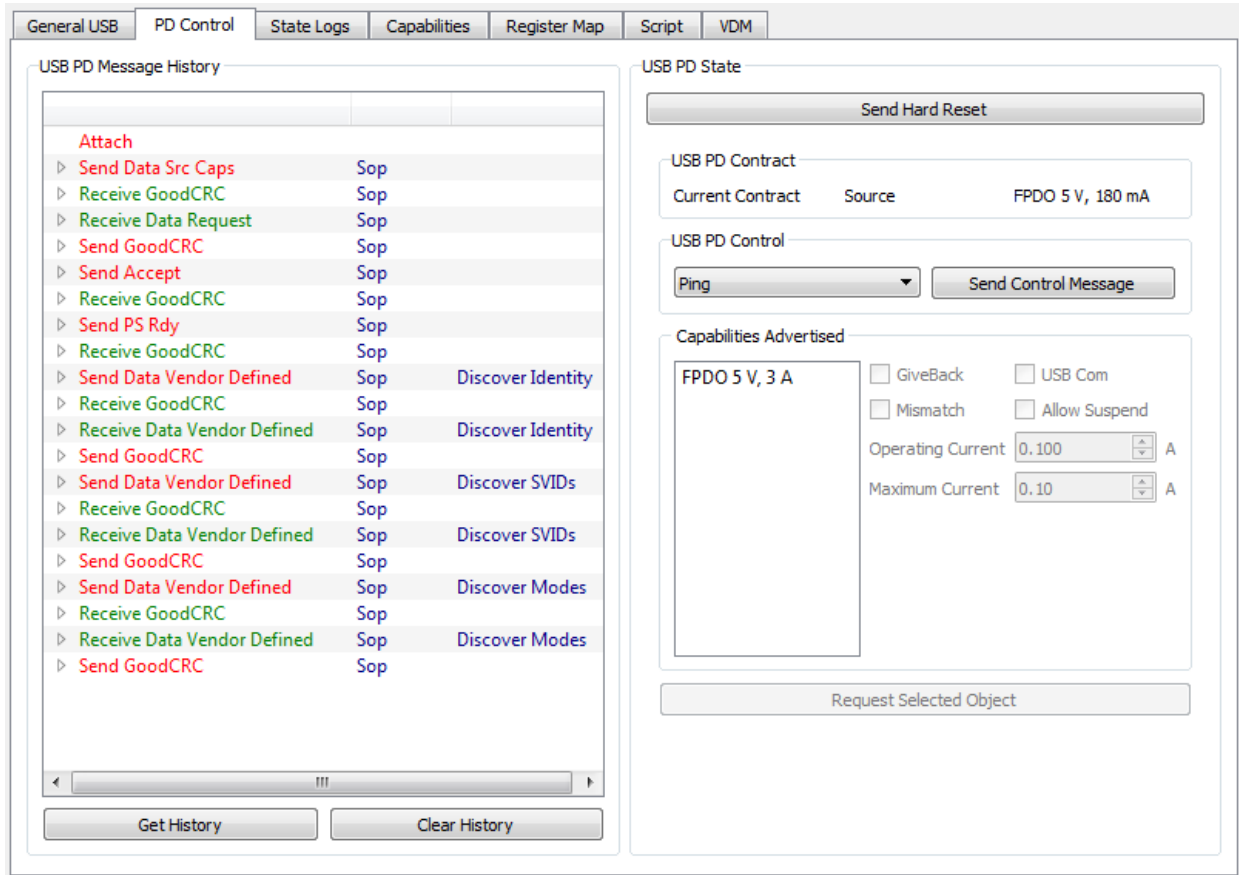


Figure 6. PD Control Tab



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.

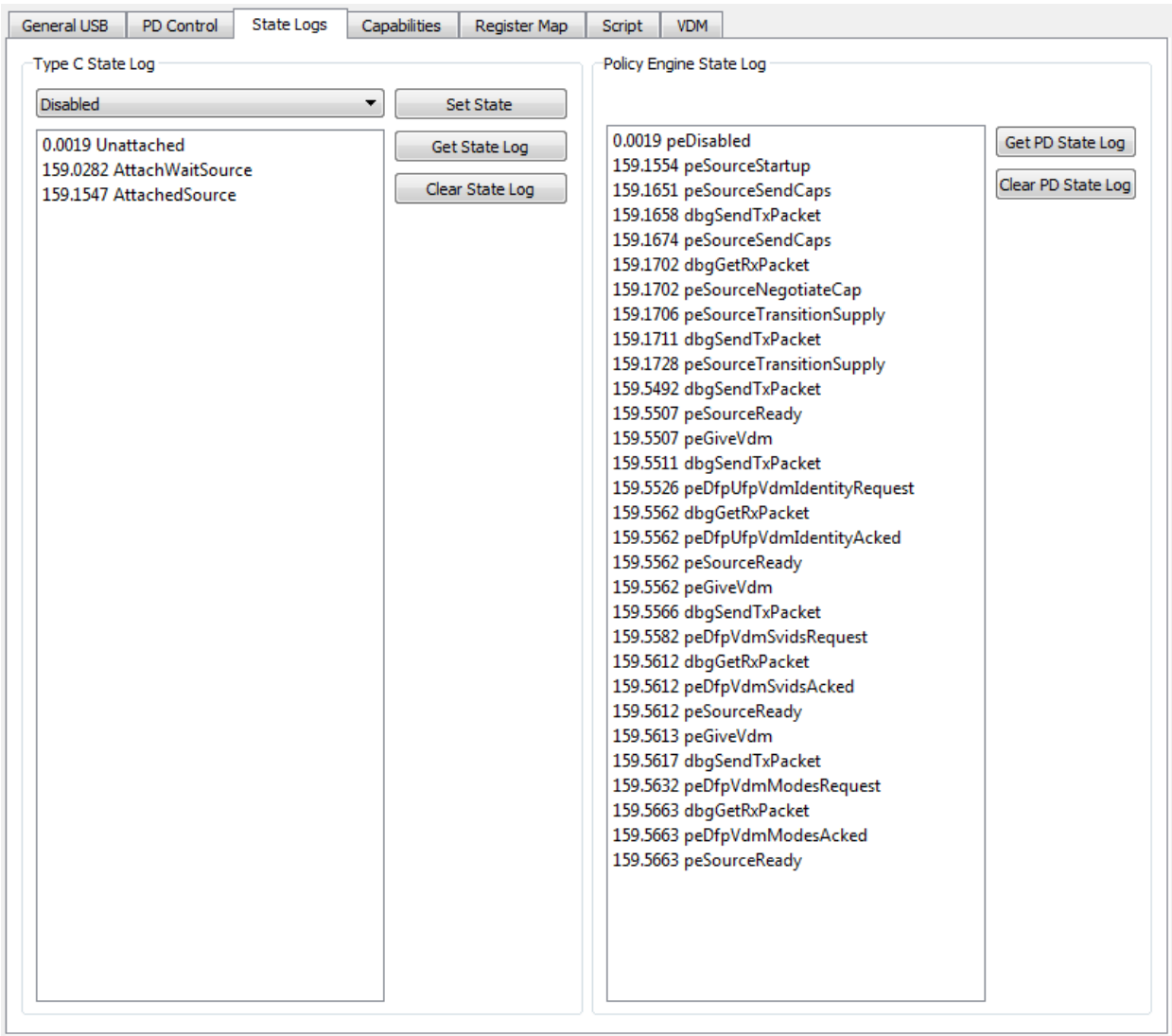


Figure 7. State Logs Tab



## 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.

The screenshot shows the 'Capabilities' tab of the FUSB302GEVB software. The interface is divided into three main sections:

- Programmed Source Capabilities:**
  - Number of Capabilities: 1
  - Cap 1:
    - Supply Type: Fixed
    - Voltage: 5.000
    - Max Current: 3.000
    - Peak Current: 150%/1ms, 125%/2ms, 110%/10ms
  - Buttons: Read Src Caps, Default Src Caps, Write Src Caps
- Programmed Sink Capabilities:**
  - Number of Capabilities: 1
  - Cap 1:
    - Supply Type: Fixed
    - Voltage: 5.000
    - Op. Current: 0.100
  - Buttons: Read Sink Caps, Default Sink Caps, Write Sink Caps
  - Force Cap Mismatch: ☐
- Default Sink Request Settings:**
  - Max Voltage: 0.00 V
  - Operating Power: 18.00 W
  - Min/Max Power: 18.00 W
  - Buttons: Read Settings, Write Settings
  - Options:
    - GotoMin Compatible: ☐
    - USB Suspend Operation: ☐
    - USB Comm Capable: ☐

Figure 8. Capabilities Tab

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## Register Map

The “Register Map” tab enables reading and writing any value to any register in the FUSB302. When performing a register write, the selected register/register(s) 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 I2C address selected in the “Addr” pull down box and display the “Device

Connected ...” or “No Device” message in the lower left corner of the GUI.

The “Register Poll” option tells the GUI to constantly poll the FUSB302 registers and update the register values. This should be used only for debugging since it can disrupt the timing operations of the firmware and also can clear interrupts that occur because the FUSB302 interrupt registers are “Read to Clear”.

General USB PD Control State Logs Capabilities Register Map Script VDM										
Addr	Name	Data(Hex)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0x01	DEVICE_ID	A0	VerID				RevID			
			1010				0000			
0x02	SWITCHES0	03	PU_EN2	PU_EN1	VCONN_...	VCONN_...	MEAS_CC2	MEAS_CC1	PDWN	
			0	0	0	0	0	0	11	
0x03	SWITCHES1	20	POWERR...	SPECREV		DATAROLE	RESERVED	AUTOCRC	TXCC2	TXCC1
			0	01		0	0	0	0	0
0x04	MEASURE	31	RESERVED	MEAS_V...	MDAC					
			0	0	110001					
0x05	SLICE	60	SDAC_HYS			SDAC				
			01			100000				
0x06	CONTROL0	24	RESERVED	TX_FLUSH	INT_MASK	LOOPBACK	HOST_CUR		AUTO_PRE	TX_START
			0	0	1	0	01		0	0
0x07	CONTROL1	00	RESERVED	ENSOPDB		BISTMO...	RESERVED	RX_FLUSH	ENSOP	
			0	00		0	0	0	00	
0x08	CONTROL2	02	TOLG_SAVE_PWR		TOG_RD...	WAKE_S...	WAKE_EN	MODE		TOGGLE
			00		0	0	0	01		0
0x09	CONTROL3	06	RESERVED	SEND_H...	RESERVED	AUTO_H...	AUTO_S...	N_RETRIES		AUTO_R...
			0	0	0	0	0	11		0
0x0A	MASK	00	M_VBUSOK	M_ACTIV...	M_COMP...	M_CRC_C...	M_ALERT	M_WAKE	M_COLLI...	M_BC_LVL

Addr: 0x44 ☒ Device Poll ☐ Register Poll
 Read All Registers
Write All Registers
Read Register
Write Register

Figure 9. Register Map Tab

## Script

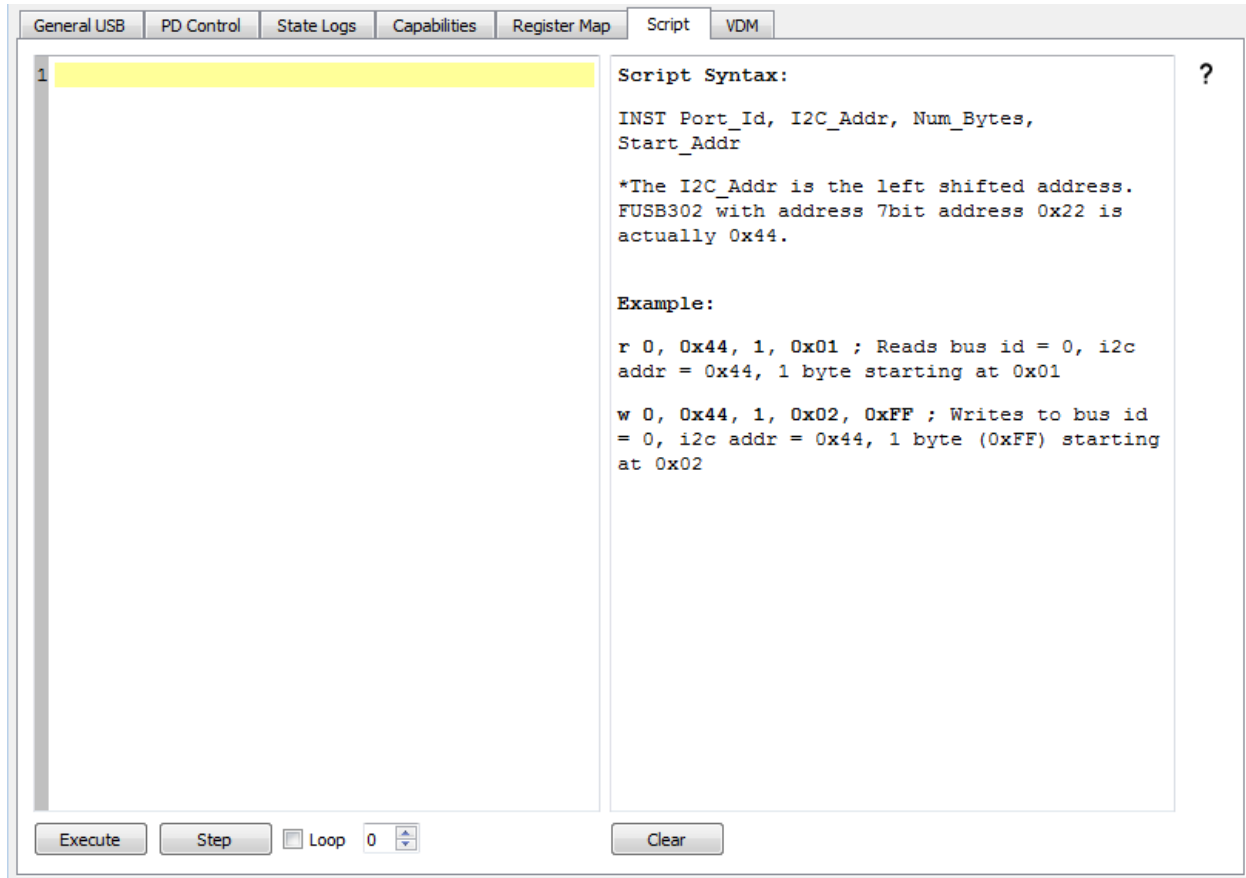


Figure 10. Script Tab

The “Script” tab enables the use of scripts to configure the FUSB302. Scripts can be added through the GUI using the editing window on the left of the tab. This edit window allows for normal copying and pasting to or from any text file if you want to save or copy your scripts from external files. Each line of the script should be formatted as follows:

**Command, port, I<sup>2</sup>C addr, # bytes, register addr, data1, ..., dataN, optional comment**

- The **Command** is: “r” or “w”
  - The **port** is always 0
  - The **I<sup>2</sup>C addr** is either 0x44, 0x46, 0x48, or 0x4A
  - 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 (“;”).

An example of reading from 3 consecutive registers:

**r 0 0x42 3 0x04 ; read 3 bytes starting at MEASURE (register address 0x04)**

An example of writing to 2 consecutive registers:

**w 0 0x42 2 0x0E 0x22 0x55 ; write 2 bytes starting at MASKA (register address 0x0E)**

The Execute button will run 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.

Results of the executed script are shown in the box on the right side of the tab. These results can be copied and pasted to an external file.

An example of the power delivery loopback test is given below:

```
w,0,0x44,1,0x02,0x44; Switches0(PU_EN1, MEAS_CC1)
w,0,0x44,1,0x03,0x01; Switches1(TXCC1)
w,0,0x44,1,0x04,0x31; MDAC
w,0,0x44,1,0x05,0x20; SDAC
w,0,0x44,1,0x0B,0x0F; Configure Power
w,0,0x44,1,0x06,0x10; Control0(Loopback, clear int mask)
w,0,0x44,1,0x43,0x12; SOP1
w,0,0x44,1,0x43,0x12; SOP1
w,0,0x44,1,0x43,0x12; SOP1
w,0,0x44,1,0x43,0x13; SOP2
w,0,0x44,1,0x43,0x82; PACKSYM with 2 bytes
w,0,0x44,1,0x43,0x01; Data1
```

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w,0,0x44,1,0x43,0x02; Data2  
w,0,0x44,1,0x43,0xFF; Jam CRC  
w,0,0x44,1,0x43,0x14; EOP  
w,0,0x44,1,0x43,0xFE; TXOFF  
w,0,0x44,1,0x43,0xA1; TXON

### VDM

The VDM tab supports Vendor Defined Messages (VDM). The “Configuration” section is used for configuring the FUSB302. The upper left “FUSB302” 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.

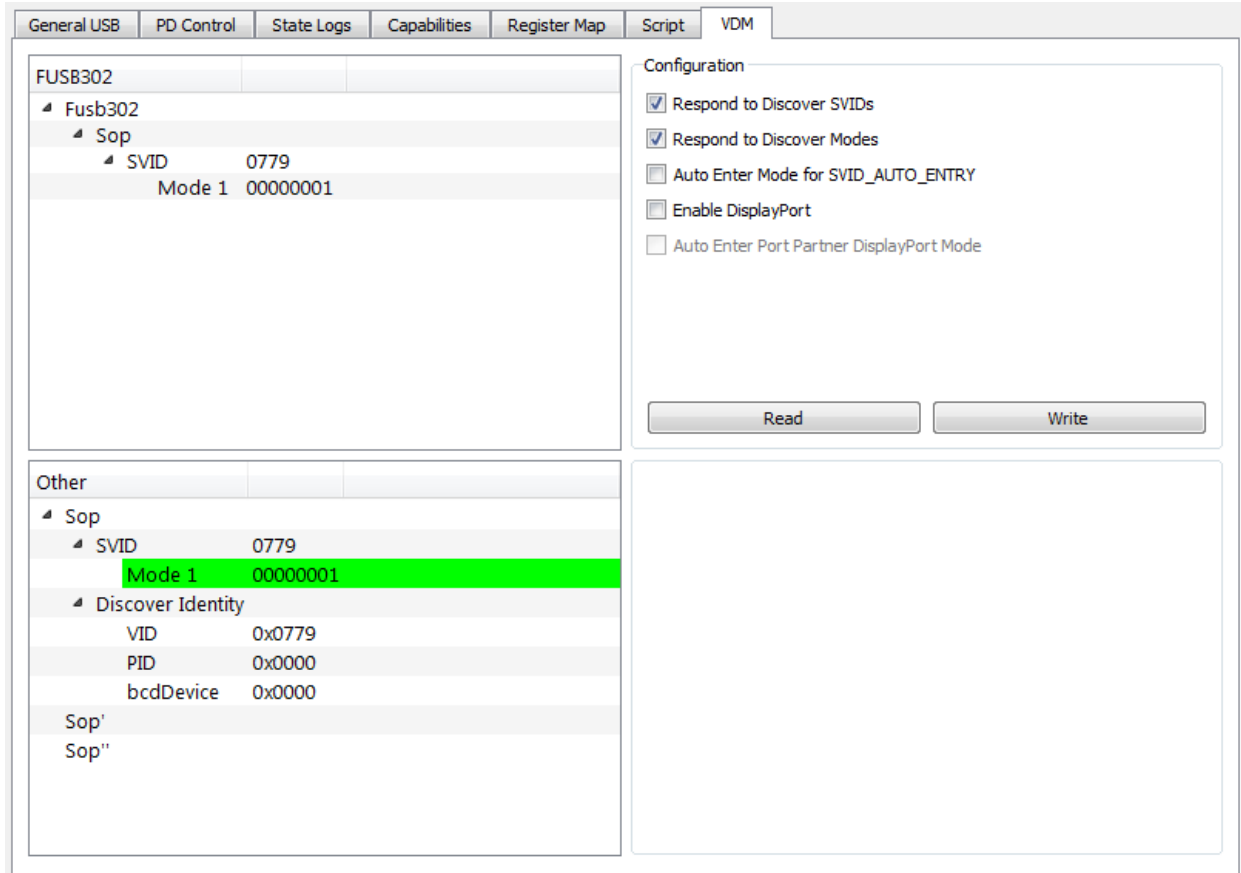


Figure 11. VDM Tab

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