PSF FRS Demo Read Me

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REV	DATE	DESCRIPTION OF CHANGE
1.09	04-Jan-21	Initial version from DRP Demo Read Me document. Updated various sections of the document to include FRS support
1.11	06-Mar-21	Document that complies with separate FRS demo
1.13	01-Apr-22	Updated document version to align with v1.13 release

Table of Contents

1 Software License Agreement

2 Terms and Abbreviations

Term	Definition
PSF	Universal Serial Bus Power Delivery Software Framework
EVB	Evaluation Board
PD	Power Delivery
IDE	Integrated Development Environment
PDO	Power Data Object
PM-PD	Power Module-USB Power Delivery
LED	Light Emitting Diode
GPIO	General Purpose Input Output
DRP	Dual Role Power
FRS	Fast Role Swap

3 Introduction

Microchip's USB Power Delivery Software Framework (PSF) is a configurable USB PD solution that is compliant to USB-PD 3.0 specification.

PSF FRS application includes the support for PD 3.0 Fast Role Swap in addition to the features supported by PSF DRP application. This document is intended to guide a user on setting up the PSF-EVB to work properly with PSF FRS application along with a demonstration of an FRS sequence.

4 Prerequisites

Hardware:

1) Microchip PSF Evaluation Board (PSF-EVB) Rev B

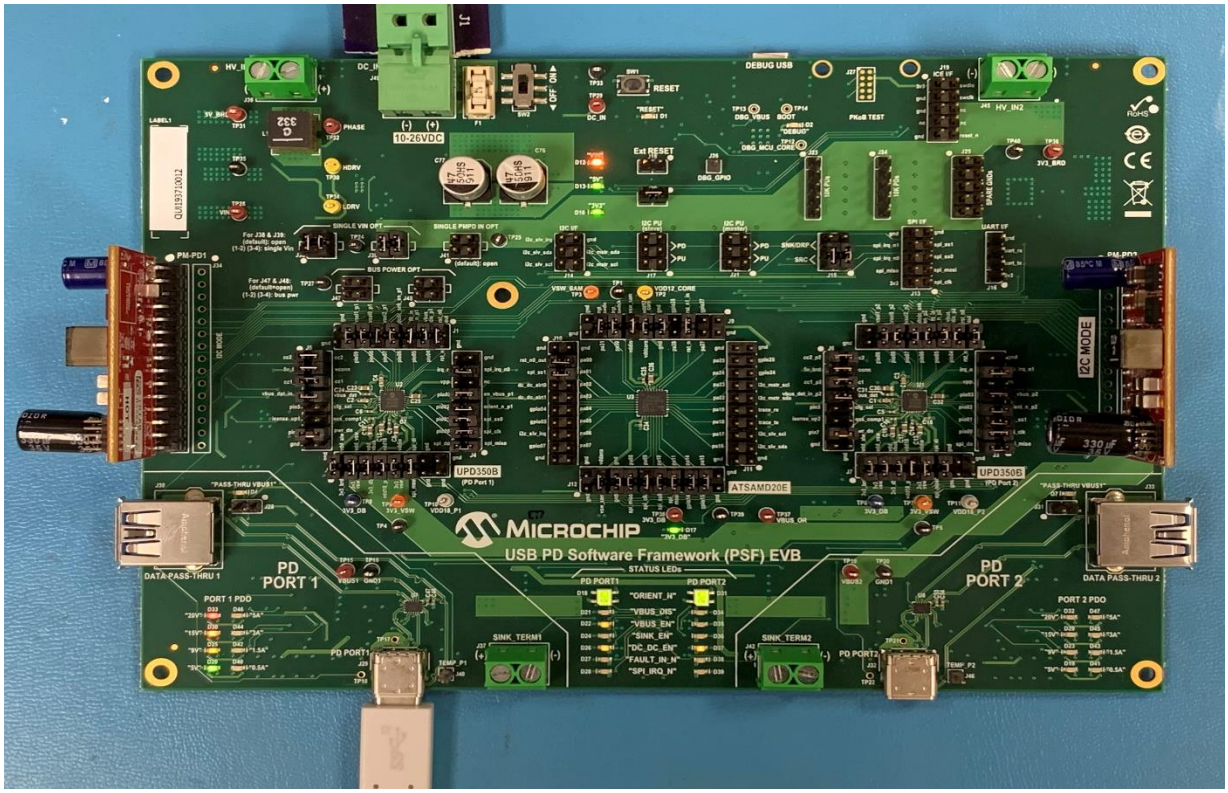

Figure 4.1 Microchip PSF Evaluation Board

2) 2 Microchip UNG 8122 Rev D PM-PD Cards – 1 per port

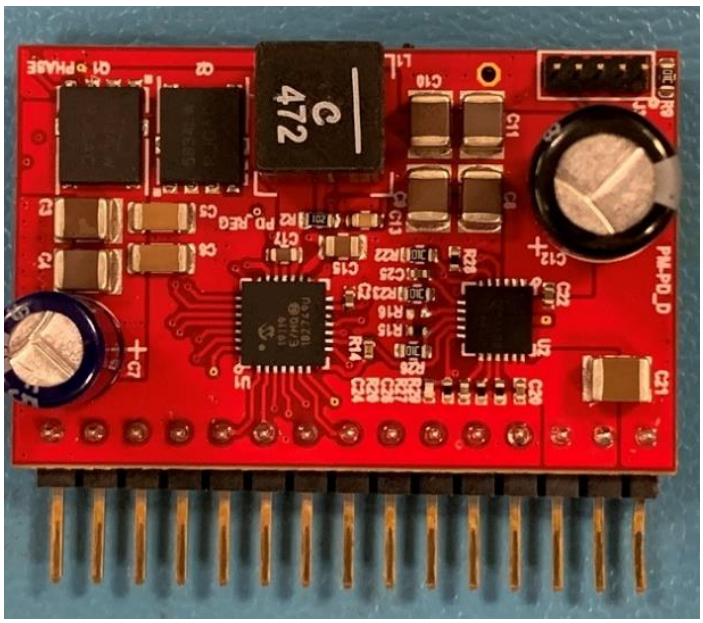

Figure 4.2 Microchip UNG 8122 Rev D PM-PD Card

3) 150W Power Adapter with 24V, 6.25A output

Figure 4.3 Power Adapter with 24V, 6.25A output capacity

4) USB-C to USB-C cable

5) Atmel ICE Debugger kit

Figure 4.4 Atmel-ICE Debugger Kit

6) USB Power Delivery capable Dock with Power adapter

Figure 4.5 Plugable Dock

5 Setting up the PSF-EVB board for “PSF_EVB_FRS”

1. Connect PM-PD cards to J35 and J44 of the PSF-EVB in correct orientation as shown in Figure 5.1

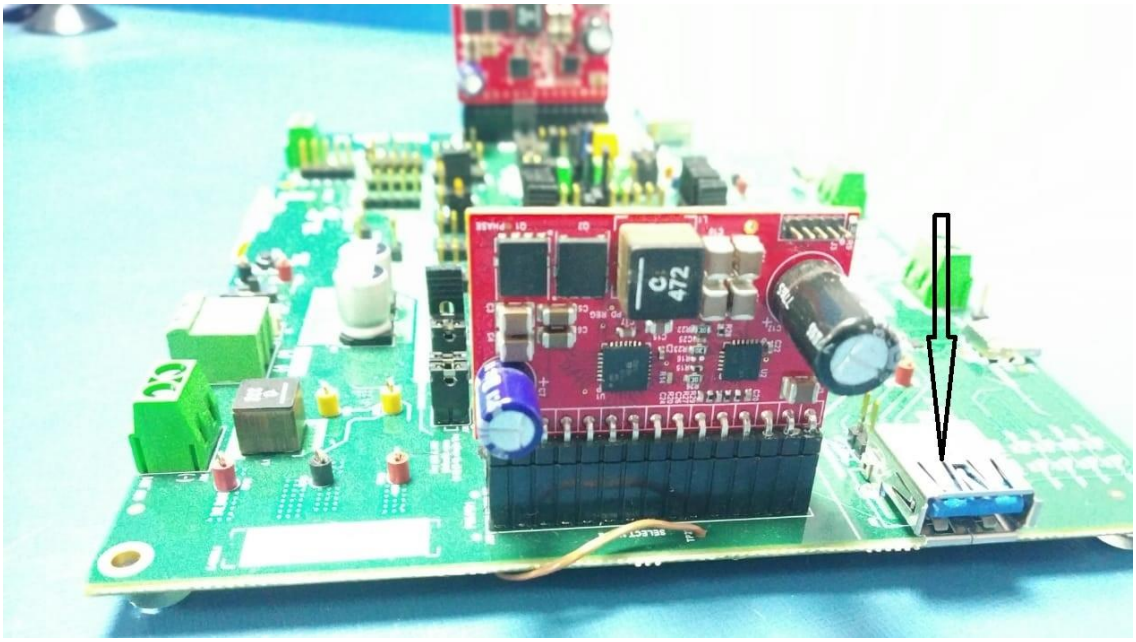

Figure 5.1 PM-PD Orientation

2. Ensure the following jumpers are connected in PSF-EVB before proceeding to next step.

Jumper	**Pins**
J38	1-2, 3-4
J39	1-2, 3-4
J17	3-5, 4-6
J21	3-5, 4-6
J15	3-5, 5-6
J1	1-2 3-4 5-6 9-10 11-12 13-14
J4	1-2 3-4 5-6 9-10 13-14
J5	1-2 3-4 5-6 7-8 9-10

	13-14
J8	1-2 3-4 5-6 7-8 9-10 11-12
J9	5-6 9-10 11-12 13-14 15-16 17-18
J10	3-4 5-6
J11	11-12 13-14
J12	3-4 5-6 7-8 9-10 11-12 13-14 15-16 17-18
J2	1-2 3-4 5-6 9-10 11-12 13-14
J3	1-2 3-4 5-6 9-10 13-14
J6	1-2 3-4 5-6 7-8 9-10 13-14
J7	1-2 3-4 5-6 7-8 9-10 11-12

Table 5.1 PSF-EVB Jumper Connections

3. Connect J1.7 to J10.14 and J9.8 to J2.7 to enable DC_DC_EN_0 and DC_DC_EN_1 function respectively

4. Connect 150W power adapter to J49 of the PSF-EVB

5. Connect J4.7 to J9.4 and J3.7 to J11.6 to enable ORIENTATION_0 and ORIENTATION_1 function respectively

6. Connect TP23 to J4.8 to enable EN_FRS function for Port 1 and connect J3.8 to J21.1 to enable EN_FRS function for Port 2

7. Connect one end of Atmel ICE to PC using USB Micro-B cable and the other end to J19 of PSF-EVB. A dot (encircled in image) will be present in Atmel ICE Adapter board which gives an indication that this pin should be connected to 3v3 of J19. The right way to connect is,

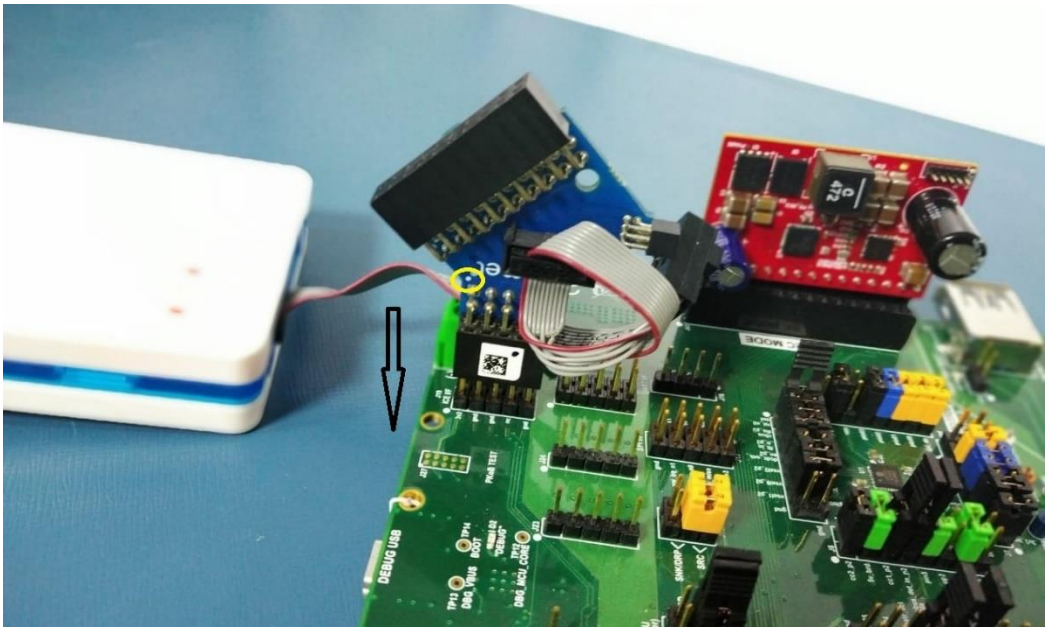

Figure 5.2 Connecting Atmel-ICE Debugger to J19

8. The whole connection looks like,

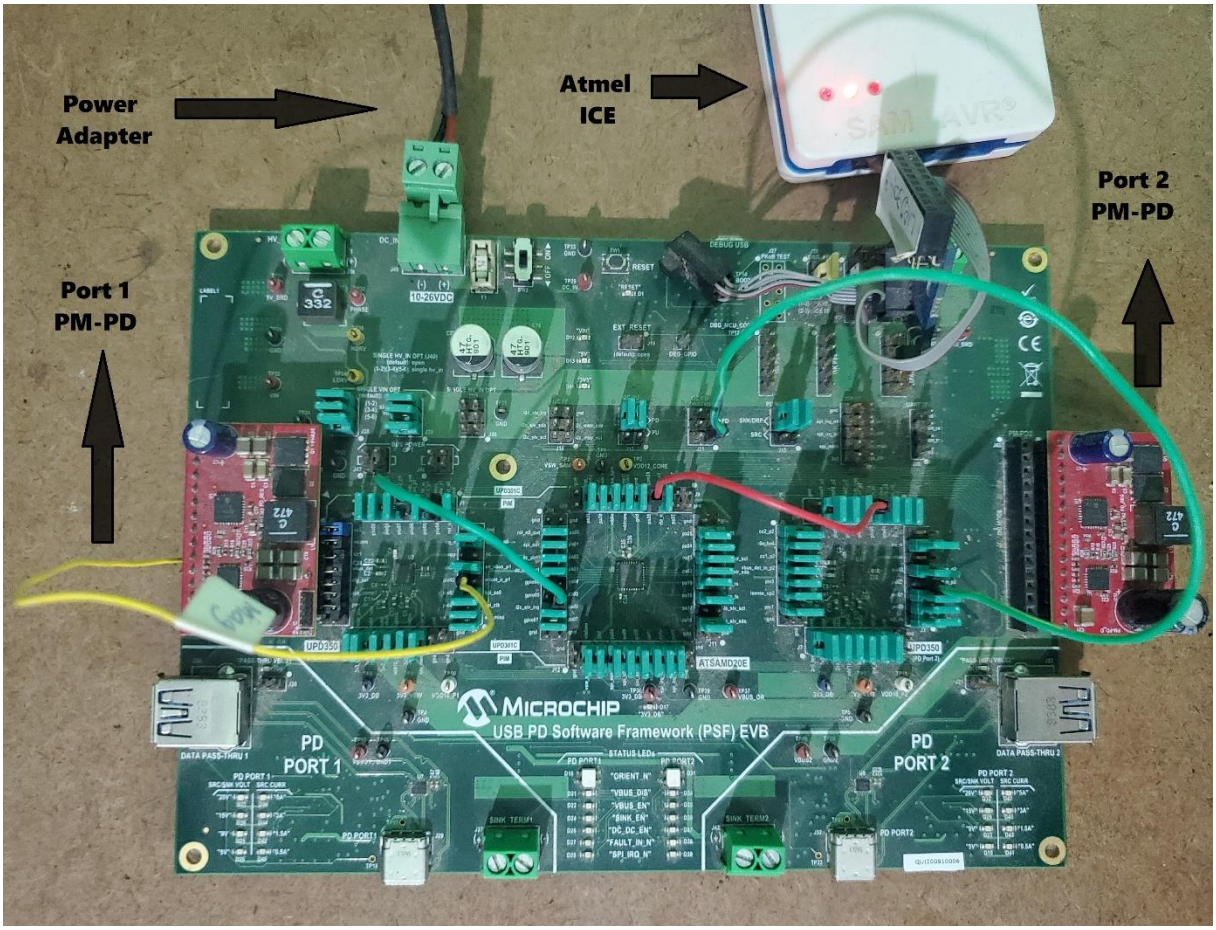

Figure 5.3 PSF-EVB Full Setup

6 Running the demo

Refer Getting Started with PSF document for the detailed steps on setting up the build environment, building the DRP project and programming the hex file in the PSF-EVB.

Refer Appendix 8.2 of Getting Started with PSF to change any SAMD20 Harmony configuration. Refer 'Boot time Configuration' section of PSF User Guide to change any configuration parameters.

1. Ensure all the jumpers are in place and Power on the PSF-EVB

2. Program the PSF_EVB_FRS.X.production.hex file by following the steps mentioned in section 8 of Getting Started with PSF

NOTE: Port 1 is configured to act as initial Sink. So, Sink to Source FRS can be demonstrated using Port 1. Port 2 is configured to act as initial Source. So, Source to Sink FRS can be demonstrated using Port 2.

6.1 Initiating a Sink to Source FRS

Complete the following steps when setting up the PSF and dock to achieve a Fast Role Swap:

1. Connect 20V PD adapter to Plugable dock
2. Connect Plugable dock partner to Port 1 of PSF-EVB through the tethered USB Type-C cable.
3. After these steps have been completed, the PSF-EVB and the dock should be setup in the same method as shown in Figure 6.1 PSF acts as power sink and dock acts as power source before an FRS.

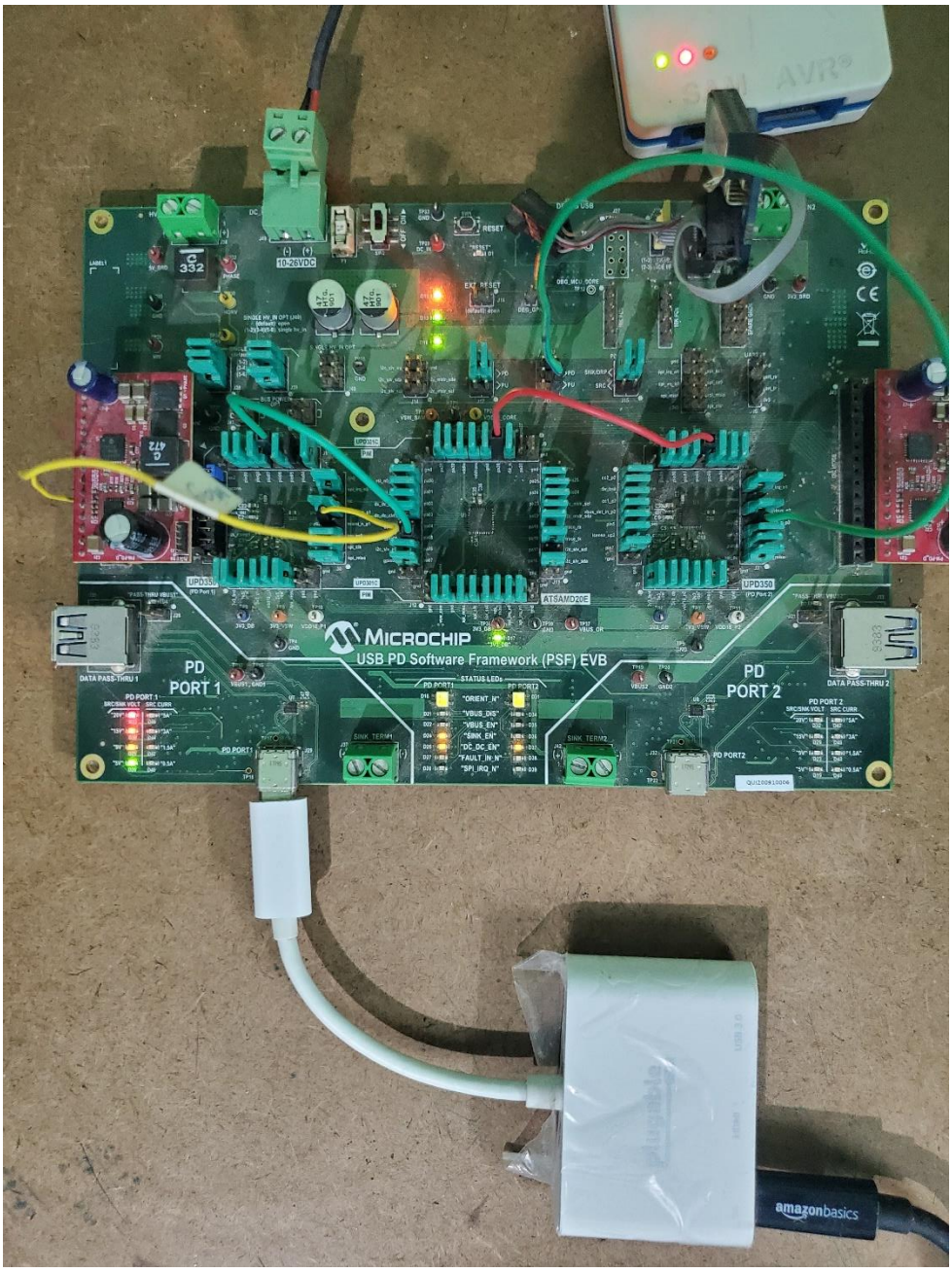

Figure 6.1 PSF and Dock before an FRS

4. To initiate the Fast Role Swap, remove the PD adapter from the Plugable dock.

5. Figure 6.2 highlights what the PSF and Plugable Dock looks like after the FRS has successfully completed. Now, PSF becomes the power source and the dock becomes the power sink.

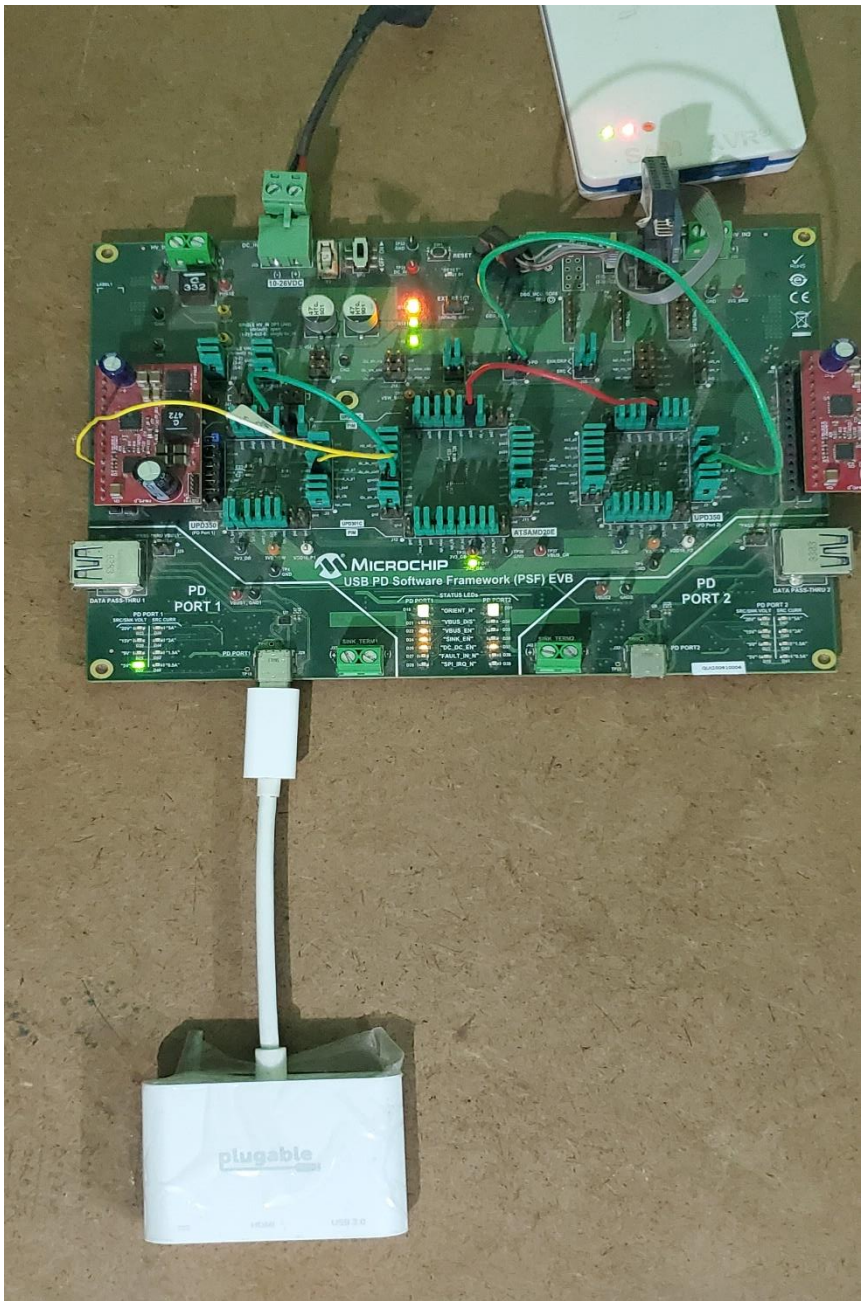

Figure 6.2 PSF and Dock after an FRS

6.2 Initiating a Source to Sink FRS

Complete the following steps when setting up the PSF to complete a Fast Role Swap:

1. Connect Port 1 of PSF-EVB to Port 2 using a USB C-C cable. After this step, the PSF-EVB should be setup in the same method as shown in Figure 6.3 Port 1 acts as power sink and Port 2 acts as power source before an FRS.

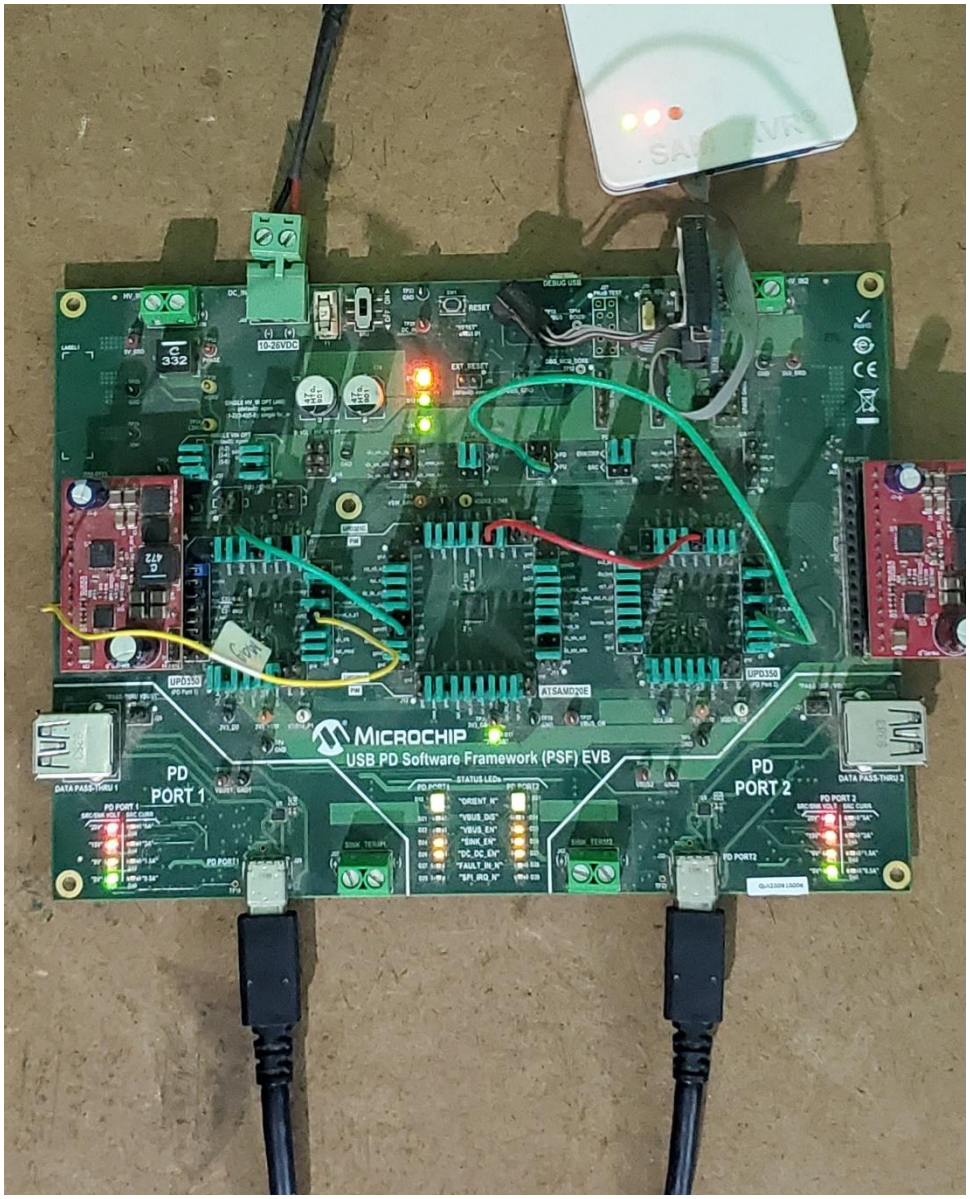

Figure 6.3 Port 1 and Port 2 of PSF before an FRS

2. To initiate the Fast Role Swap, disconnect J3.8 from J21.1 and connect it to J21.5

3. After an FRS, Port 1 becomes the power source and Port 2 becomes the power sink.

7 Expected Results

1. Once the hex file is programmed, the SPI_IRQ_N LEDs in both the ports flash and then turn off. None of the other LEDs will be ON when the ports are in unattached state.

2. The behaviour of both the DRP ports before and after an FRS is described below.

   Sink to Source FRS with Plugable dock:

   A Sink to Source Fast Role Swap Sequence between the PSF and dock will take place as follows.

   1. If PSF is attached as Source,

      - EN_VBUS and DC_DC_EN LEDs of the port will turn on.
      - Source capabilities will be advertised by the PSF, followed by a request message from the dock
      - PSF checks if the PDO requested by the dock is within the range of its capabilities. If so, it accepts the request and starts driving the requested voltage in the VBUS.
      - Once an explicit power contract is negotiated, the dock starts charging. PDO status LEDs will turn on indicating the negotiated voltage as shown in Figure 6.1
      - Followed by the initial PD negotiation, a Power Role Swap will take place between the PSF and dock so that Sink/DFP/VCONN Source will be the PSF's power data state
      - Sink Caps of the dock will be queried by PSF and FRS detection will be enabled for the port

   2. If PSF is attached as Sink,

      - Once the dock is attached to the PSF port, the dock gives out 5V followed by Source capabilities.
      - PSF requests for suitable PDO from source capability based on the configuration. PD negotiations take place if the source accepts the request and sources the requested power.
      - Once an explicit power contract negotiation is in place, the PSF gets enough power for charging. PDO status LEDs will turn ON indicating the negotiated voltage as shown in Figure 6.1
      - Followed by the initial PD negotiation, a VCONN Swap and Data Role Swap will take place between the PSF and dock so that Sink/DFP/VCONN Source will be the PSF's power data state

- Sink Caps of the dock will be queried by PSF and FRS detection will be enabled for the port

- DC_DC_EN LED of the port will turn on

3. The disconnection of power supply from dock causes the dock to trigger the FRS signal to the PSF as the dock is no longer able to source power.

4. The PSF then monitors the voltage on VBUS and turns on the load switch to enable vSafe5V in VBUS when it determines that VBUS has reached below the maximum threshold of vSafe5V as defined in USB PD Specification.

5. A successful FRS can be easily observed by monitoring the VBUS LEDs. The VBUS LEDs never turn off when VBUS transitions from 20 V to 5 V. FRS prevents VBUS from dropping to 0 V thereby maintaining the data connection.

6. PSF now becomes the power source and starts supplying power to the dock which is achieved by a PD negotiation after an FRS sequence.

Source to Sink FRS with Port Loopback:

The behaviour of Port 2 during a Source to Sink FRS is explained below.

1. If Port 2 is attached as Source,

    - EN_VBUS and DC_DC_EN LEDs of the port will turn on.

    - Source capabilities will be advertised by the Port 2, followed by a request message from the Port 1

    - Port 2 checks if the PDO requested by the Port 1 is within the range of its capabilities. If so, it accepts the request and starts driving the requested voltage in the VBUS.

    - Once an explicit power contract is negotiated, Port 2 starts charging. PDO status LEDs will turn on indicating the negotiated voltage as shown in Figure 6.3

    - Followed by the initial PD negotiation, a VCONN Swap and Data Role Swap will take place between Port 1 and Port 2 so that Source/UFP/Not VCONN Source will be the Port 2's power data state

    - Sink Caps of the dock will be queried by Port 2 and FRS transmission will be enabled for the port

2. If Port 2 is attached as Sink,

    - Once Port 2 is attached to the Port 1, Port 1 gives out 5V followed by Source capabilities.

- Port 2 requests for suitable PDO from source capability based on the configuration. PD negotiations takes place if the source accepts the request and sources the requested power.

- Once an explicit power contract negotiation is in place, Port 2 gets enough power for charging. PDO status LEDs will turn ON indicating the negotiated voltage as shown in Figure 6.3

- Followed by the initial PD negotiation, a Power Role Swap will take place between the Port 1 and Port 2 so that Source/UFP/Not VCONN Source will be the Port 2's power data state

- Sink Caps of the dock will be queried by Port 2 and FRS transmission will be enabled for the port

3. The disconnection of J3.8 from J21.1 causes the Port 2 to trigger the FRS signal

4. A successful FRS can be easily observed by monitoring the VBUS LEDs. The LEDs never turn off when VBUS transitions from 20 V to 5 V. FRS prevents VBUS from dropping to 0 V thereby maintaining the data connection.

5. Port 2 now becomes the power sink and starts consuming power from Port 1 which is achieved by a PD negotiation between the ports after an FRS sequence.

6. Port 2 continues to operate as power sink even after a detach until it regains its power supply. If system power is not available i.e J3.8 is disconnected from J2.1, Port 2 will attach as Sink and will not initiate a Power Role Swap too.

7. Once system power is available i.e J3.8 is connected to J2.1, Port 2 will transition to DRP. If a partner is attached, it will initiate a Power Role Swap to become the Power Source.

PDO Status LEDs:

Example with Port 1: If 5V is negotiated by the device, LED in the D20 of Port 1 PDO will glow. If 9V is negotiated, then LEDs in D20 and D25 will glow. In case of 15V, LEDs in D20, D25 and D30 will glow. If 20V is negotiated, all the LEDs will glow.

PDO	Status LED
5V	Port 1 – D20, Port 2 – D19
9V	Port 1 – D25, Port 2 – D23
15V	Port 1 – D30, Port 2 – D29
20V	Port 1 – D33, Port 2 – D32

Table 7.1 PDO Status LEDs