PSF Source Pro Demo Read Me

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REV	DATE	DESCRIPTION OF CHANGE
1.01	16-Mar-20	Initial version from Source Lite Demo Read Me document. Updated the images to show MPQ I2C DC/DC Controllers.
1.04	26-May-20	Updated section 3 Updated document version to align with v1.04 release
1.05	24-Jul-20	Updated document version to align with v1.05 release
1.06	12-Aug-20	Updated document version to align with v1.06 release
1.07	08-Sep-20	Updated document version to align with v1.07 release
1.12	22-Sep-20	Updated document version to align with v1.12 release
1.13	01-Apr-22	Updated document version to align with v1.13 release
1.14	24-May-22	Updated document version to align with v1.14 release

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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
I2C	Inter Integrated Circuit
PPS	Programmable Power Supply

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 Source Pro application includes PD Source functionality with the support for Power Balancing, Power Throttling, Source only PPS, Boot time configuration parameters and I2C based DC-DC controller for port power control. This document is intended to guide a user on setting up the [USB Power Delivery Software Framework Evaluation kit with part number EV65D44A] to work properly with PSF Source Pro application.

EV65D44A consists of the following:

1 x USB Power Delivery Software Framework EVB (EVB-PSF)
2 x One-Hot Vertical Mount PM-PDs (PMPD-VM-HOT)

For evaluating PPS, we use Microchip's I2C mode PM-PD modules. For more information regarding this module, contact Microchip Support.

Power Delivery Port Balancing is a feature which makes a best effort to distribute a limited amount of power between the PD ports.

- Power Balancing Algorithm "A": First Come First Serve - The first port which completes PD contract negotiation will be offered power PDOs which can source up to PORT1_MAX_PWR or PORT2_MAX_PWR (depending on whichever port the device is connected to). The second device to complete negotiation will be offered power based on the remaining amount of power within the power budget.

- Power Balancing Algorithm "B": Last Plugged Gets Priority: Whenever a new device is attached, the device will be offered power PDOs which can source up to PORT1_MAX_PWR or PORT2_MAX_PWR (depending on whichever port the device is connected to). If the device requests more power than is remaining in the budget, the device which was already attached will be renegotiated and forced to select a reduced amount of power which is within the remaining power budget.

Power Throttling is a Power Delivery capability banking system which allows the system to actively switch between up to three different power capability banks. The PSF never initiates a switch between the banks; the switching between banks must always be initiated by an external stimulus.

Power Throttling is configured through 3 complete banks of PD power capability settings.

- Bank A Total System Power
- Bank A Guaranteed Minimum Power
- Bank A Port X Max Power
- Bank B Total System Power
- Bank B Guaranteed Minimum Power
- Bank B Port X Max Power
- Bank C Total System Power
- Bank C Guaranteed Minimum Power
- Bank C Port X Max Power

Programmable Power Supply (PPS) provides PD Sink devices a method to specify discrete voltage and current limit values, dynamically throughout their explicit contract as their batteries become charged. PPS is only available between Source and Sink devices operating under the USB PD 3.0 protocol specification.

For information on how to configure the above listed features, please refer PSF User Guide.

4 Prerequisites

Hardware:

1) USB Power Delivery Software Framework Evaluation kit with part number EV65D44A (EVB-PSF)

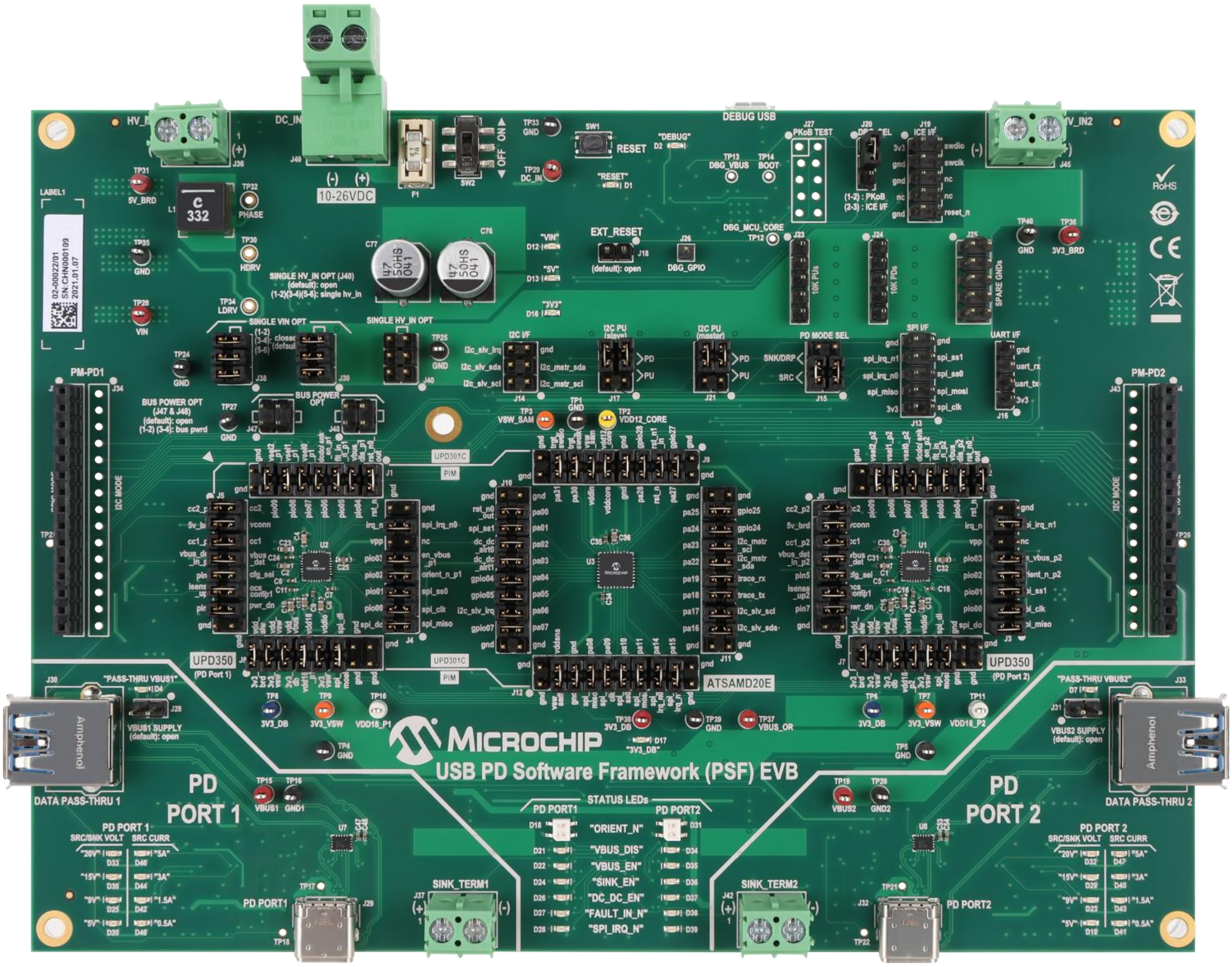

Figure 4.1 USB Power Delivery Software Framework EVB (EVB-PSF)

2) Two I2C based PPS capable PM-PD modules (UNG8198).

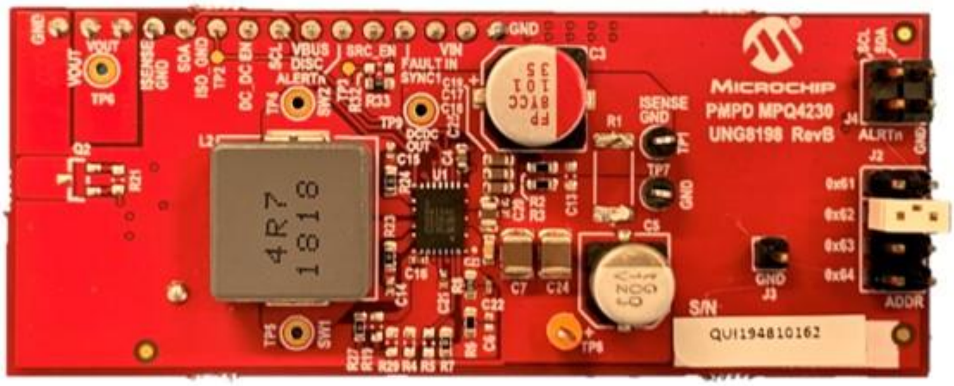

Figure 4.2 Microchip UNG 8198 PM-PD Card

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

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

4) USB-C to USB-C cable

5) [Atmel ICE Debugger kit](Optional).

Figure 4.4 Atmel-ICE Debugger Kit

6) USB Power Delivery capable Phones or Laptops

5 Setting up the EVB-PSF board for "EVB_PSF_Source_Pro"

1. Connect PM-PD cards to J34 and J43 of the EVB-PSF in correct orientation as shown in Figure 5.1
   I2C Slave address for Port 1's PM-PD should be selected as 0x61 by connecting the jumper in 0x61 of J2 and slave address for Port 2's PM-PD should be selected as 0x62 by connecting the jumper in 0x62 of J2. J2 can be found on top left corner of the PM-PDs.

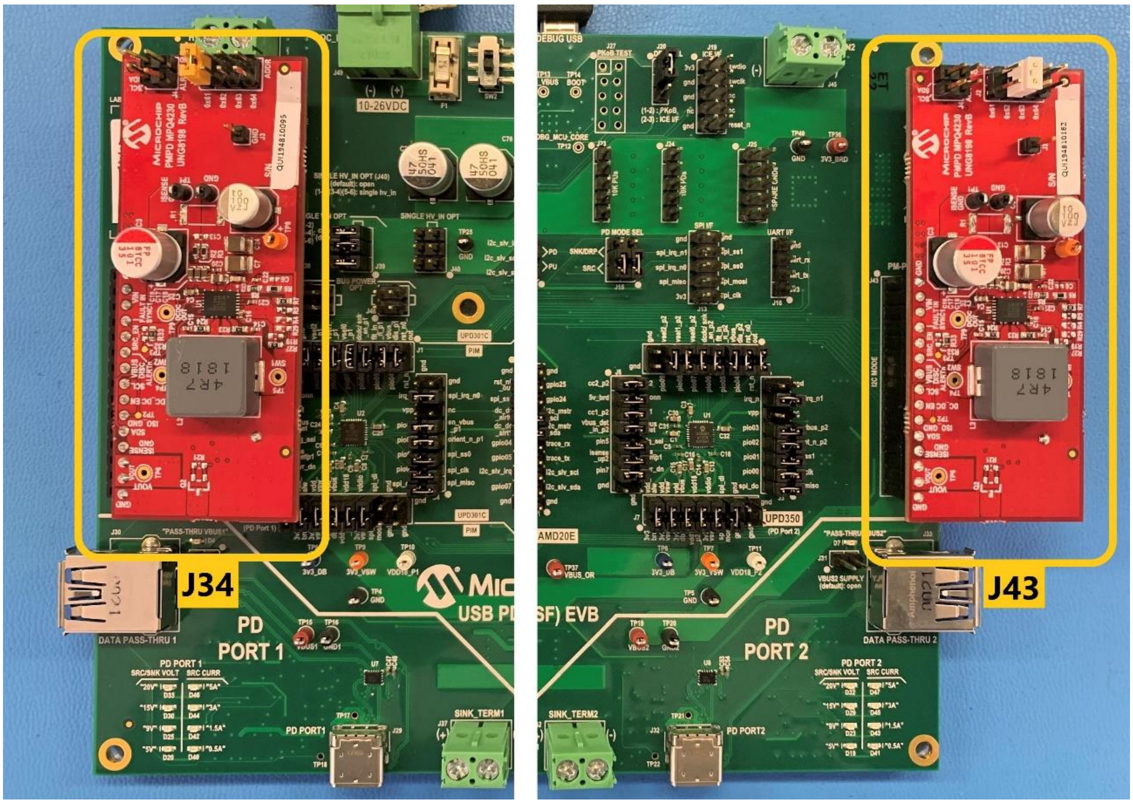

Figure 5.1 PM-PD Installation

2. Ensure the following jumpers are connected in EVB-PSF before proceeding to next step. An image of EVB-PSF with all the required jumper connections highlighted is shown in Figure 5.2

Jumper	**Pins**
J38	1-2, 3-4, 5-6
J39	1-2, 3-4, 5-6
J21	1-3, 2-4
J15	1-3, 2-4
J17	3-5, 4-6
J1	1-2 3-4 5-6 7-8 9-10 11-12 13-14
J4	1-2 3-4 5-6 7-8 9-10 13-14
J5	1-2 3-4 5-6 7-8 9-10 11-12 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 7-8 9-10
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 7-8 9-10 11-12 13-14
J3	1-2 3-4 5-6 7-8 9-10 13-14
J6	1-2 3-4 5-6 7-8 9-10 11-12 13-14
J7	1-2 3-4 5-6 7-8 9-10 11-12

Table 5.1 EVB-PSF Jumper Connections

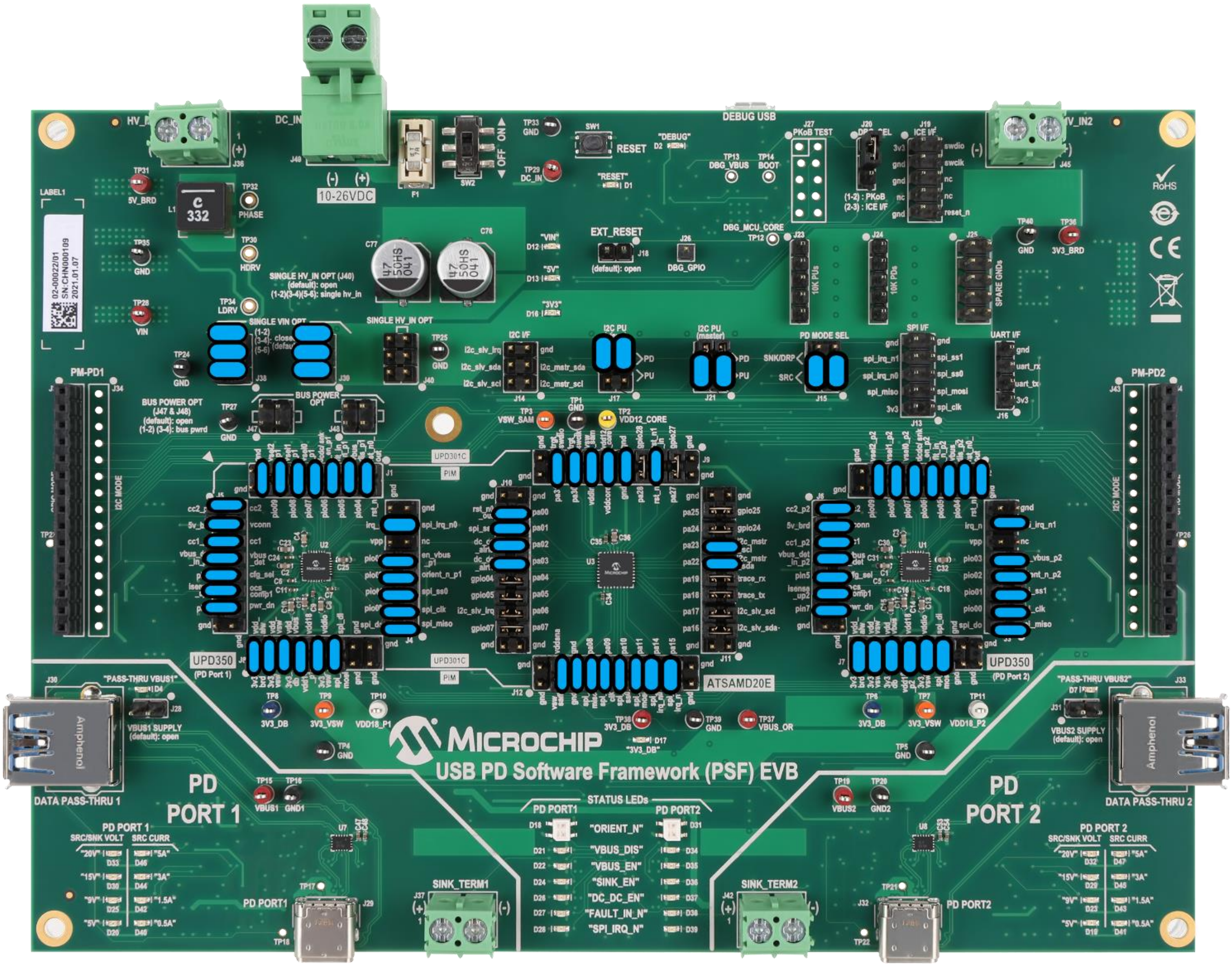

Figure 5.2 EVB-PSF with jumper connections highlighted

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

4. Connect one end of Atmel ICE to PC using USB Micro-B cable and the other end to J19 of EVB-PSF. 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. Refer Fig 5.3,

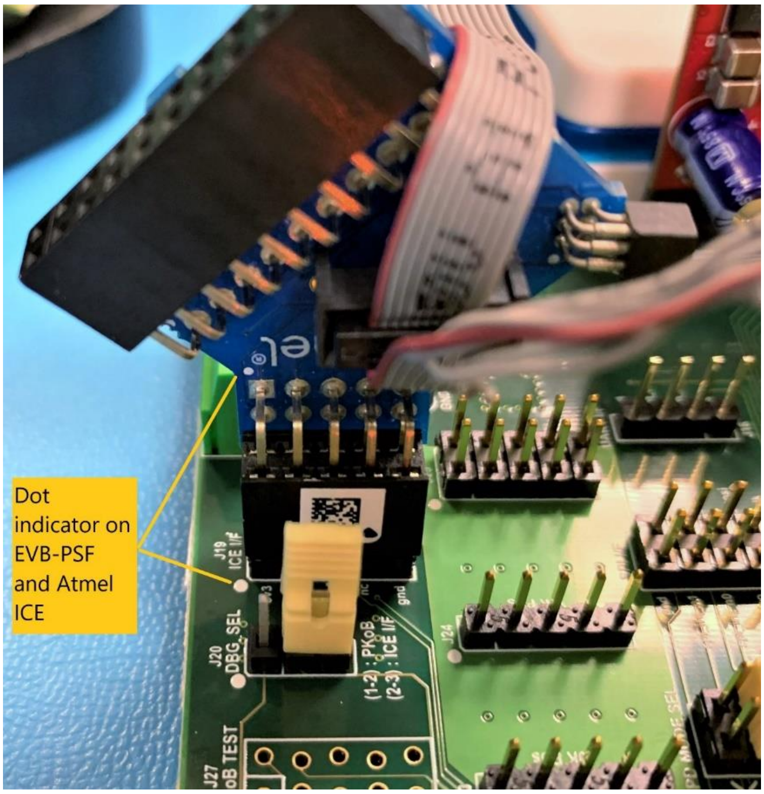

Figure 5.3 Connecting Atmel-ICE Debugger to J19

5. In Case if you are using Onboard Debugger ,Connect a USB Micro-B cable to “DEBUG USB” which on the top of the board and connect the other end USB Type-A to the laptop as shown in the below image

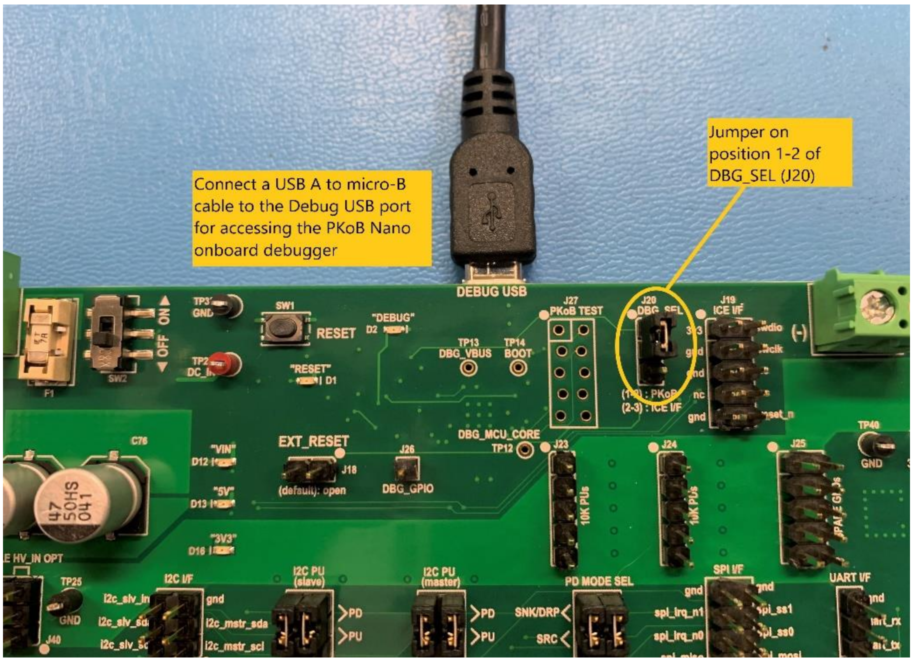

Fig 5.4 On Board Debugger

6. The whole connection is shown in Figure 5.5,

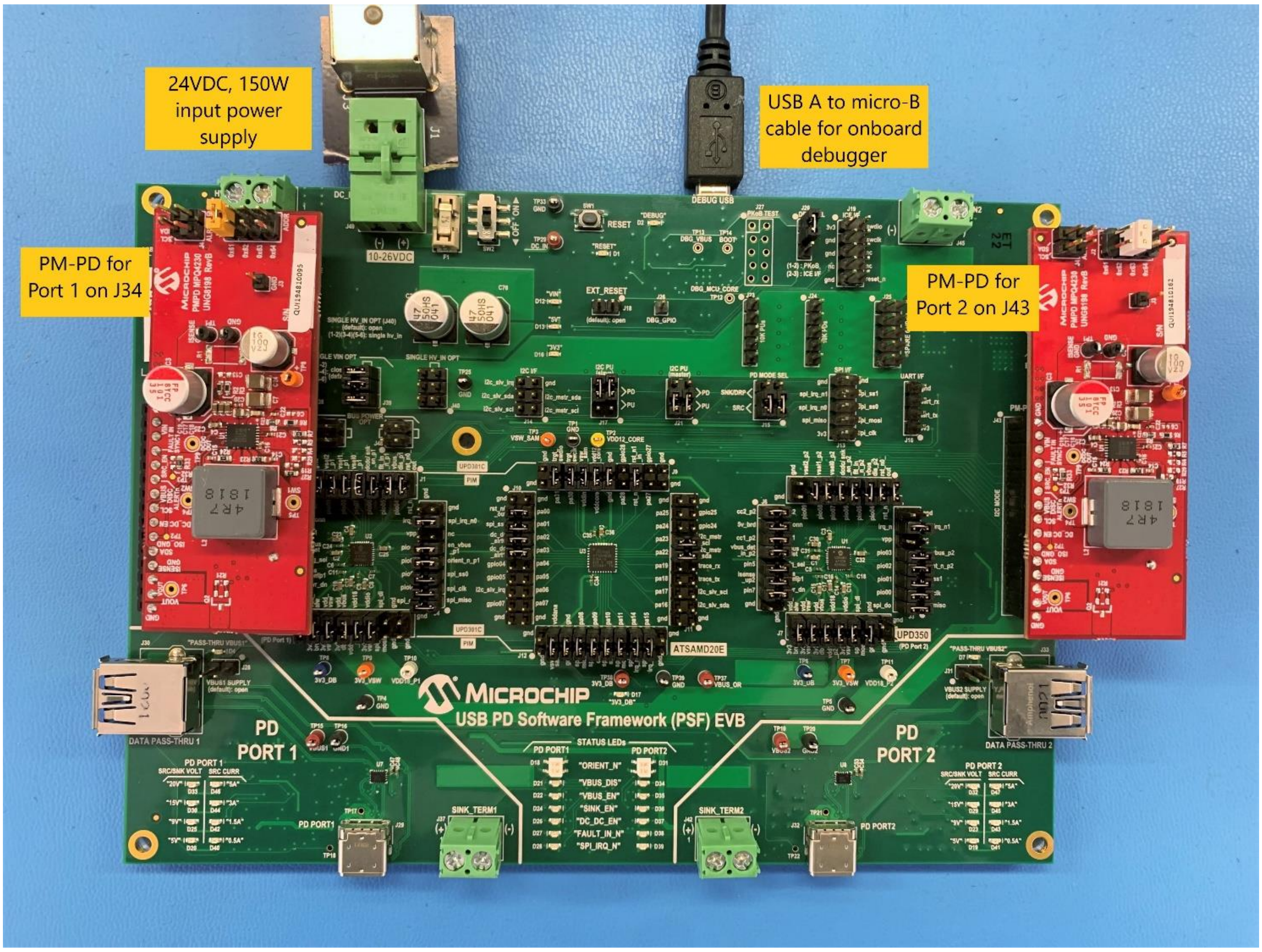

Figure 5.5 EVB-PSF Full Setup

6 Running the demo

Refer Getting Started with PSF document for the detailed steps on setting up the build environment, building the Source Pro PSF project and programming the EVB-PSF.

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 EVB-PSF.

2. Program the EVB-PSF by following the steps mentioned in section 7 of Getting Started with PSF

3. Connect a PD device to Port 1 of EVB-PSF using a USB-C to USB-C cable.

4. Connect another PD device to Port 2 of EVB-PSF using a USB-C to USB-C cable.

5. The Figure 6.1 demonstrates a scenario where a PD Capable phone has been connected to Port 1 and PD Capable phone has been connected to Port 2

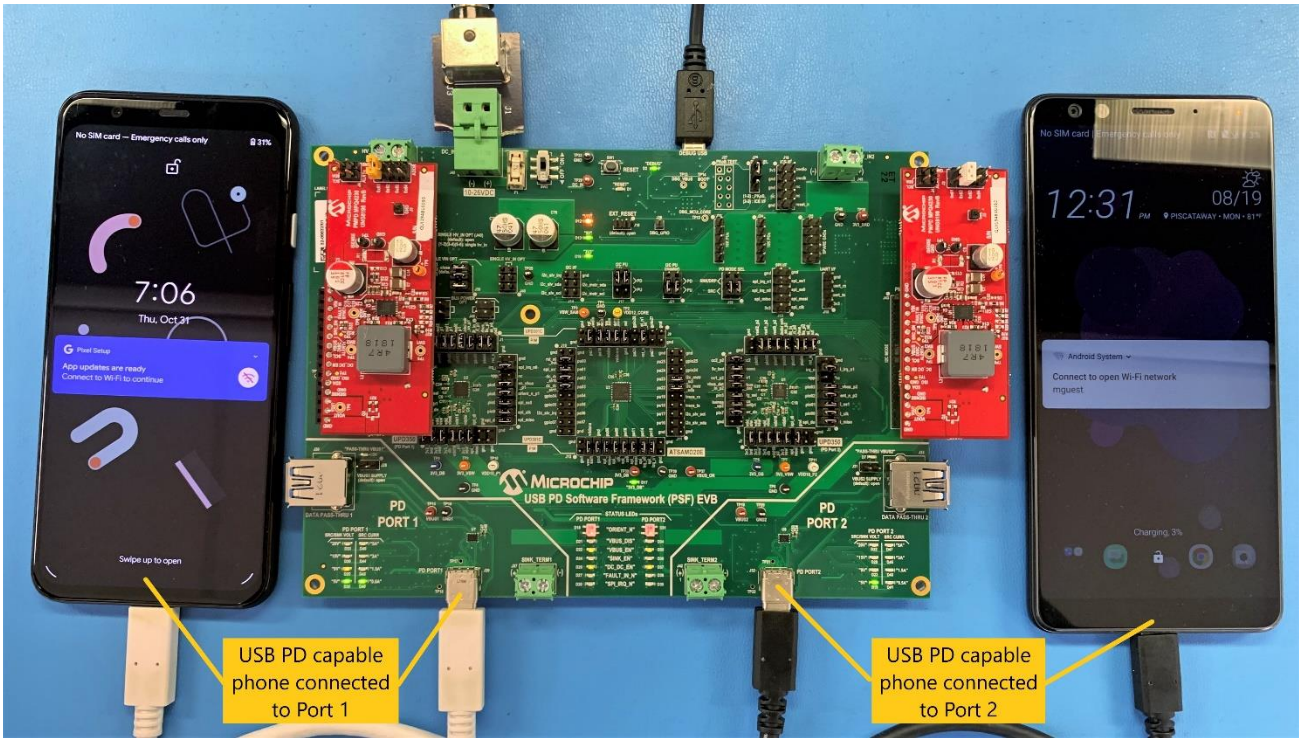

Figure 6.1 Two PD Capable Phones connected to each PD ports

6. The Figure 6.2 demonstrates a scenario where a PD Capable phone has been connected to Port 1 and PD Capable laptop has been connected to Port 2

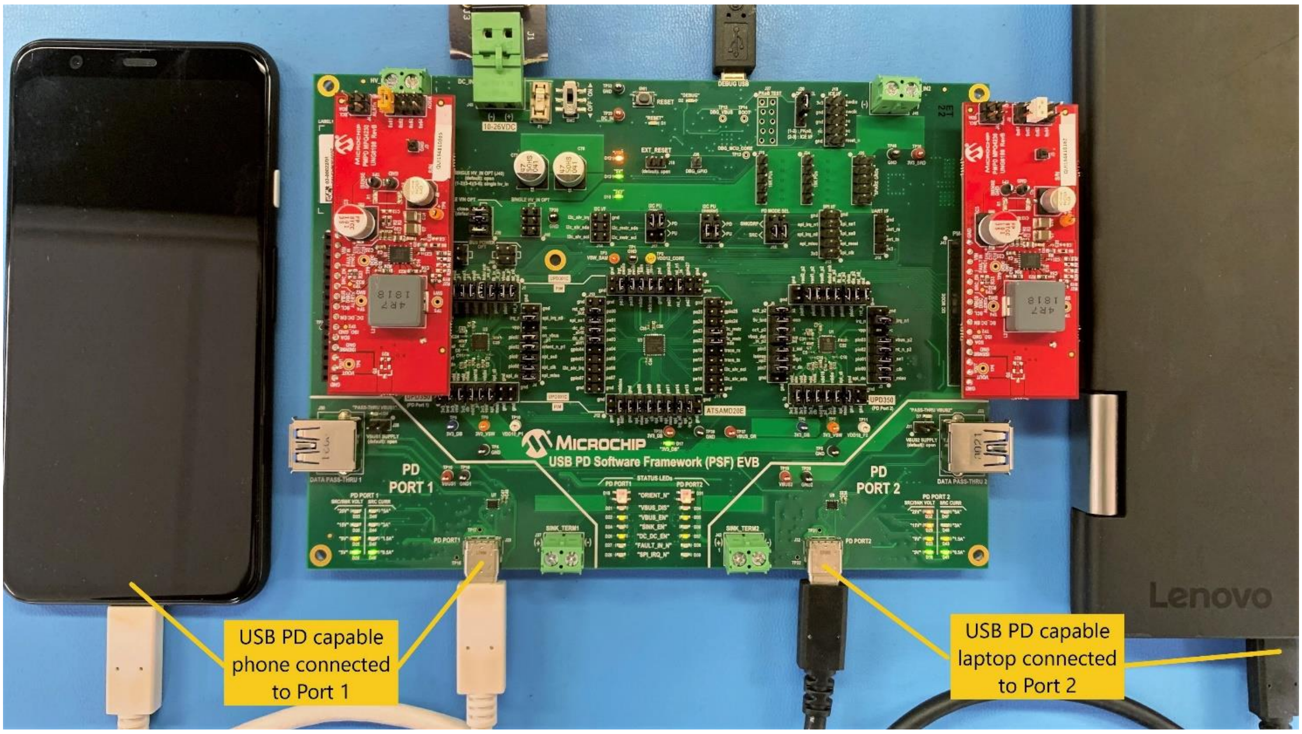

Figure 6.2 PD Capable phone connected to Port 1 and PD Capable Laptop connected to Port 2

7 Expected Results

1. Once the hex file is programmed, the SPI_IRQ_N LEDs in both the ports flash and then turn off. DC_DC_EN and VBUS_EN LEDs will turn on.

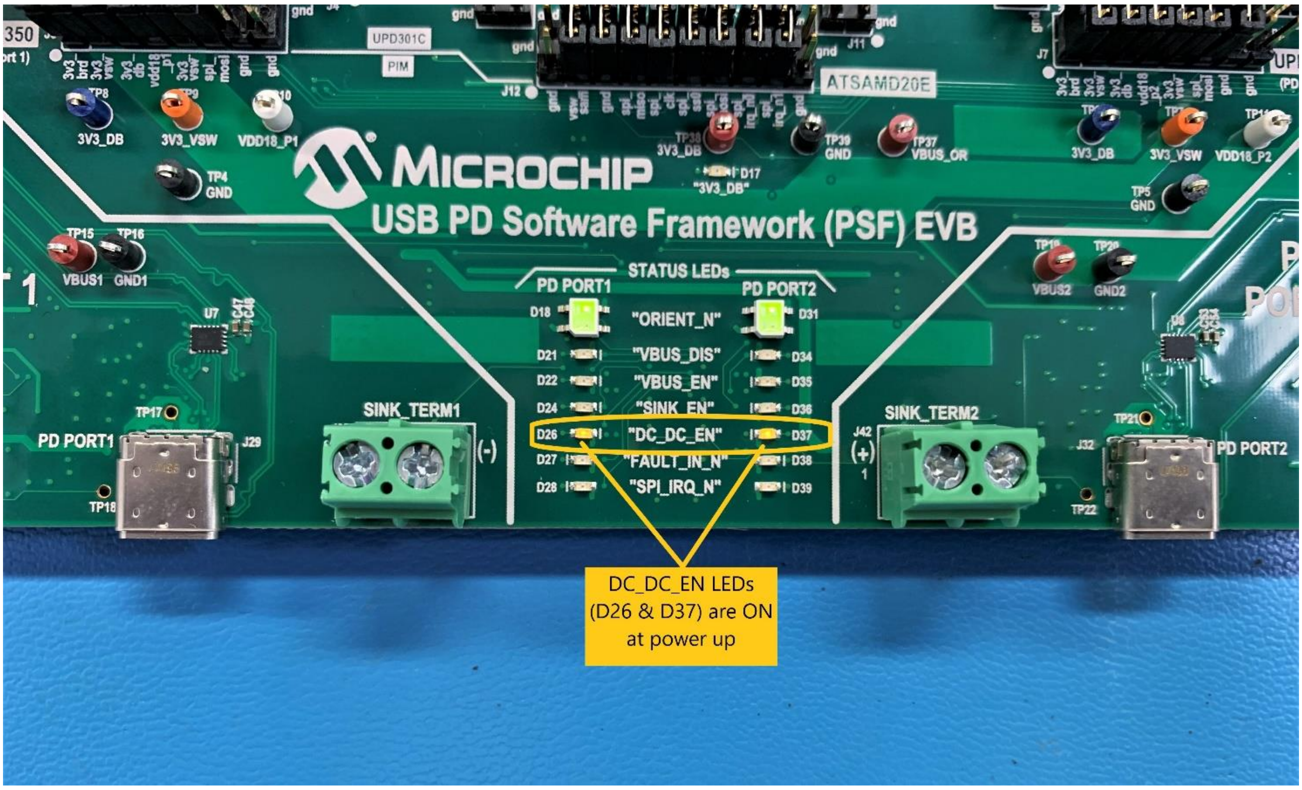

Figure 7.1 Status of DC_DC_EN LEDs after power on

2. Once a PD Device is attached to a PD port, Source capabilities will be advertised by the PSF, followed by a PDO request from the device.

3. PSF checks if the PDO requested by the device is within the range of its capabilities. If so, it accepts the request and starts driving the requested voltage in the VBUS.

4. Once an explicit power contract negotiation is in place, the device starts charging. PDO status LEDs will turn ON indicating the negotiated voltage as shown in Figure 7.2

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

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.

5. In our case, PD Capable Phone connected in Port 1 has requested 9V and PD Capable Phone connected in Port 2 has requested 5V. The status of ORIENT_N, VBUS_EN LED after device attach are shown in Figure 7.2

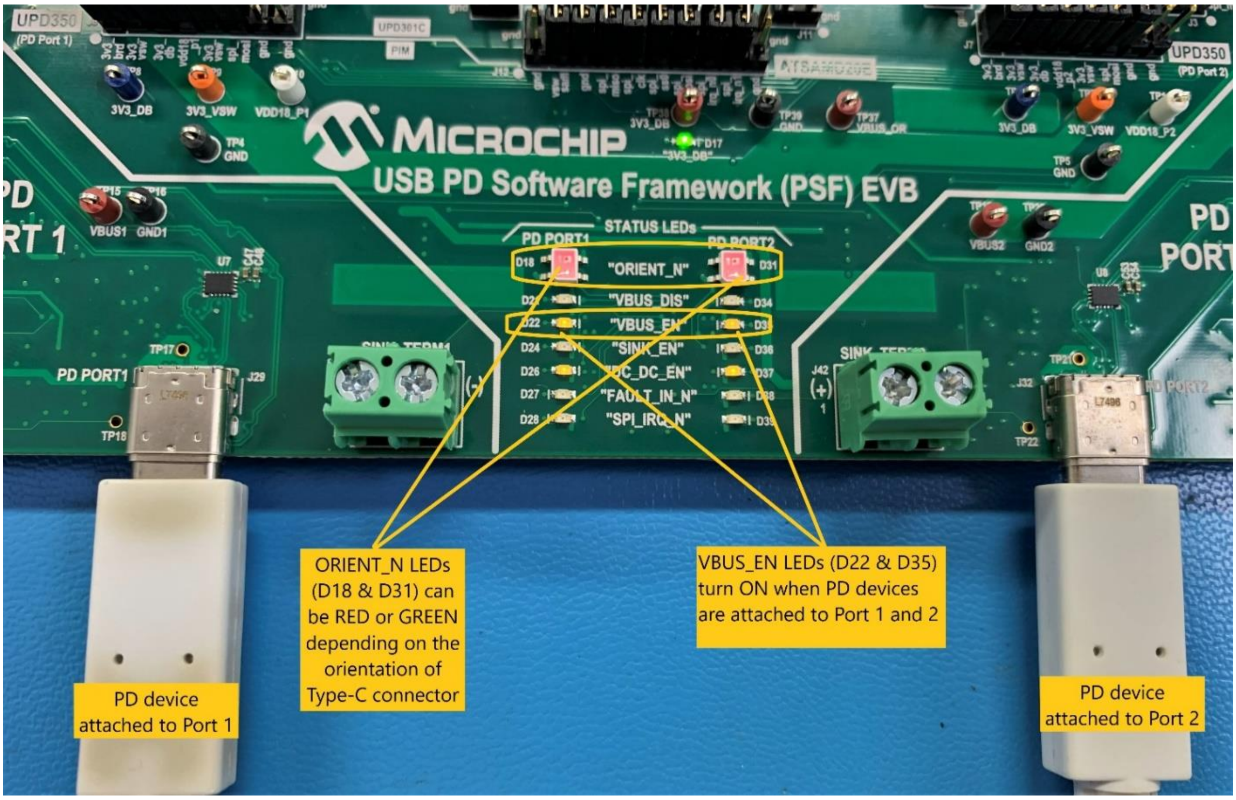

Figure 7.2 Status of ORIENT_N,VBUS_EN LED after device attach

6. One more scenario is shown where a PD Capable Phone connected to Port1 has requested for 5V and PD Capable Laptop connected to PD port 2 has requested for 20V. After PD negotiation, the laptop starts charging. All the PDO status LEDs glow which indicates that 20V is negotiated as shown in Figure 7.3.

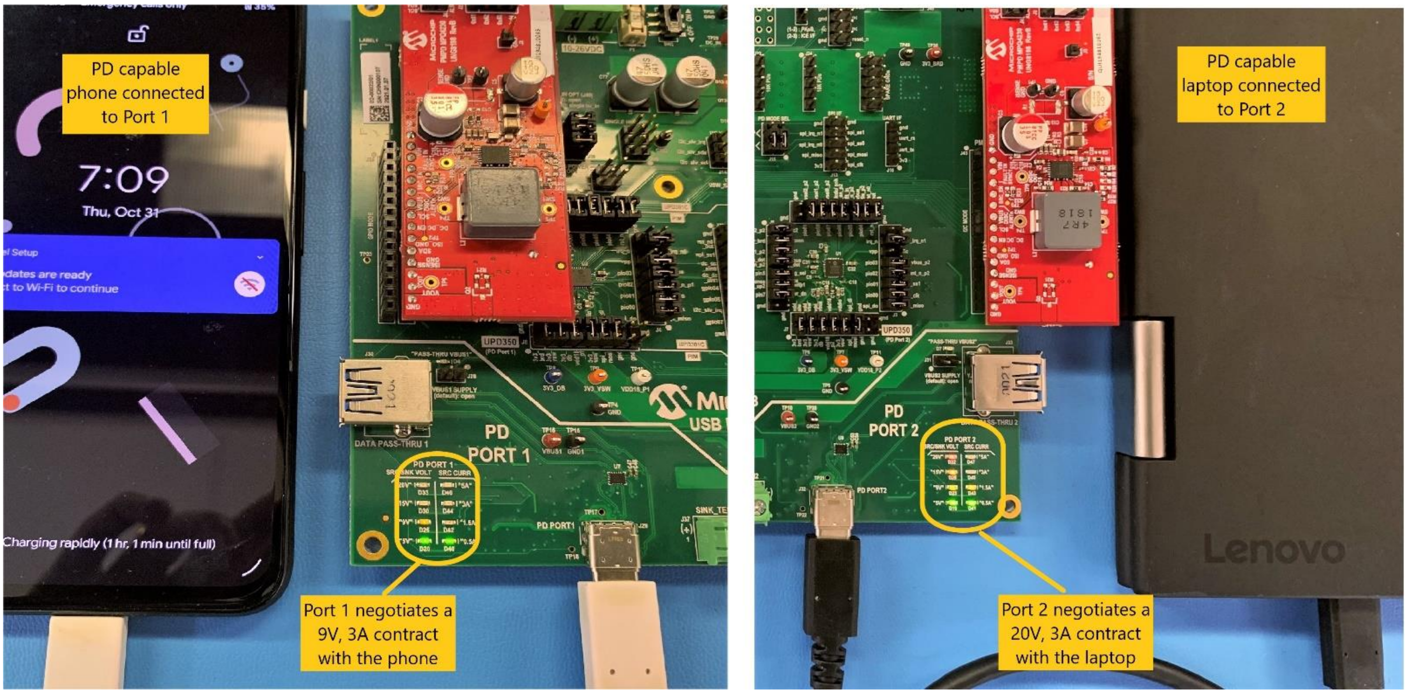

Figure 7.3 20V negotiation with PD Capable Laptop connected to PD Port 2