UM11055

NXP USB PD shield board user manual

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Document information

Information	Content
Keywords	OM13588, USB Type-C, PD (power delivery), Alt-mode-DP, Host, Dock
Abstract	This user manual presents demonstration / application kit capability of power, data delivery through single USB Type-C cable between a shield board used in conjunction with a Kinetis KL27Z FRDM Board and a USB-PD capable device or Power source.

Revision history

Revision history

Rev	Date	Description
v.1.0	20180209	Added note to section 3.1
v.0.3	20170619	Minor corrections to text
v.0.2	20170608	Updated document information keywords
v.0.1	20170501	Initial version

1 Introduction

The main purpose of this user's manual is to illustrate USB-PD operation for a Type C port using PTN5110 PD PHY and KL27 PD controller.

PTN5110 is a 1-port TCPC compliant USB Power Delivery (PD) PHY IC that implements Type-C Configuration channel interface and USB PD Physical layer functions to a Type-C Port Manager that handles PD Policy management. It complies with USB PD, Type-C and TCPC specifications and relevant ECNs/ECRs. This IC is targeted primarily for use in system platforms.

PTN5110 is a USB PD TCPC PHY IC, in HX2QFN16 2.6 mm x 2.6 mm x 0.35 mm, 0.4 mm pitch package.

The demo kit is intended to demonstrate the power, USB data delivery through single USB Type-C cable between a shield board mounted on a KL27Z FRDM Board and any USB PD capable device or power adaptor. It also has the power swap, high/low power request capability between the shield board and connected PD Source or Sink.

This document describes the user manual of NXP USB PD Shield board,

- Overall PCB connectors, jumpers, and power supplies.
- Setup Information for USB-PD operation
- Setup Information for USB TypeC operation using simple CC Logic

1.1 Purposes

- For customers to evaluate NXP USB Type-C Power Delivery PHY and protocol IC PTN5110 and DP Alternate Mode features through single USB Type-C connection.
  - Power swap between the shield board and any connected SRC/SNK.
  - Power delivery between the Shield and any connected SRC.
  - Power delivery selection between 5V or 9V.
  - CC logic and PD control through Kinetis KL27Z residing on the Freedom board.
  - Transfer power, data through USB Type-C cable between the shield board and any connected device or power adaptor.

2 General description

2.1 Block diagram

2.1.1 USB-PD shield board schematic block diagram

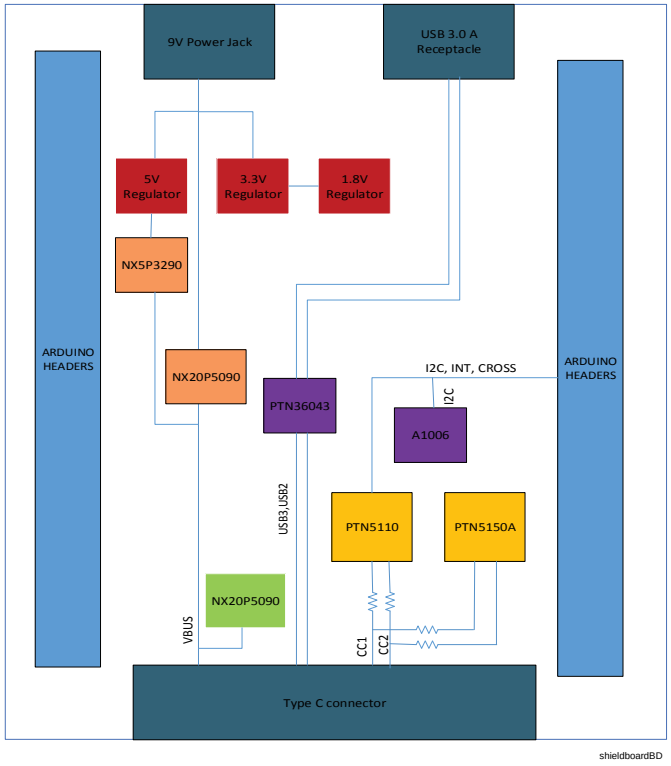

Figure 1. USB PD shield board block diagram

2.1.2 USB PD shield board

Figure 2. USB PD shield board

2.2 Shield board description

Please refer to Figure 1 and Figure 2 above for the actual shield board block diagram and image. It consists of 4 Arduino headers, 2 on either side of the board. J403, J404 on the left and J405, J9 on the right side. These Arduino headers mate with the Kinetis KL27Z Freedom board. The shield board is powered by a 9V Power Adaptor. The board has the below power regulators.

1. 5V switching regulator.
2. A 3.3V switching regulator to power up the PD PHY and circuitry on the board.
3. A 1.8V LDO to power up circuitry on the board.

The board supports both USB-PD PHY PTN5110 and a CCLogic chip, PTN5150A. The CC lines from Type C connector are connected to one of these chips depending on the jumper options we select. There is a secure Authentication chip A1006 which can be used for authenticating the devices/ Chargers plugged into the TypeC Connector. Currently the Kinetis USB-PD SDK does not support Authentication. But the hardware can be used to test out any authentication SW implemented by end user.

3 Hardware setup

3.1 Hardware setup for USB-PD

In order to set up the board for USB-PD operation please follow the below jumper settings on the board.

1. Install shunt at J4
2. Install shunt at J5
3. Install shunt at J11 – Pin 1 to 2
4. Install shunt at J12 – Pin 1 to 2
5. Install shunt at J13 – Pin 1 to 2
6. Install shunt at J14 – Pin 1 to 2

Once shunts are installed the shield board can be plugged to the Kinetis Freedom board. The signal mapping from the shield board to the Freedom board is provided below. The boards can mate only in one direction.

Note: *Before power up, please verify the USB Type-C shield is pushed all the way into the Arduino header with good contact. Make sure there are no unintentional shorts (e.g. jumper, blue wires) between the USB Type-C Shield board and the main development board.*

1. I2C – SCL to J404 Pin 10
2. SDA to J404 Pin 9
3. ALERT to J404 Pin 1

Once the boards are mated, please use the 9V Power Adaptor provided with the board to power up the shield board. The PD PHY communicates with the PD controller through the I^2C interface. The I^2C interface has the the SDA, SCL signals along with an alert signal used by the PD PHY to Interrupt the PD controller. The PD-PHY implements TCPC 1.1 spec. Please refer to PTN5110 Application programming guide for more details on the PD-PHY programming. The PD controller KL27 MCU has the Type C Port Manager (TCPM) FW stack implemented in the SDK. Please refer to the MCUXpresso USB PD quick start guide for the FW stack info. The shield board with the PD PHY can be configured for the below Type C roles.

1. DFP
2. DRP with Start as Sink. (Live Battery)

In the DFP role, the TCPC is configured by the TCPM to always source power. There are two source PDOs available. PDO1 is 5V at 2.7A and PDO2 is 9V at 1.5A. There are two source paths in the Hardware. Please check the USB PD shield board schematics for detailed block diagram and schematics. There is a 5V source path and a 9V source path implemented in the hardware. Based on the PD contract one of this path is enabled when the Shield board is used as a Power source.

In the DRP configuration the TCPC is configured to start as a sink. So if you connect a DFP to the Type C port the system will sink power. In Live battery mode, the TCPC will sink 5V initially and then once PD contract is in place it will sink Higher voltage. The Voltage can be measured at TP12. The hardware implements a Sink path with capability to Sink up to 20V. The sink path is enabled by the PD PHY when the shield board is acting as a Sink.

There is a USB Type A port on the shield board to demonstrate high speed USB operation. The Type A port is connected to the Type C port through PTN36043, USB3.1 Gen 1 redriver. It is intended to demonstrate the USB operation in a Host system. If the Host system FW is installed in the KL27 Freedom board then the user can connect the USB port on the KL27 to the shield board using a miniB to A cable from J10 on the Freedom board to J2 on the shield board. Now if a USB device is plugged into the Type C connector the user should be able to see the flash drive enumerate in the Host system.

3.2 Hardware setup for CC Logic operation

The Shield board also supports simple CC logic implementation over USB Type-C. Users need to disable the PTN5110 and to enable PTN5150 connection to CC1/CC2 by modifying J13 and J14. Disconnect the 9V AC/DC power adaptor input to the shield board, because PTN5150A only supports 5V. The PTN5150A has hardware input strapping pin#3 (TP11) to configure its power up default mode: DRP, DFP or UFP. Since PTN5150A does not support power delivery, the KL27 can disable TCPM firmware from the stack. KL27 can access PTN5150A I2C register for additional information. When PTN5150A is configured as DRP or UFP, it supports dead battery mode startup. When a power source is plugged into a shield board, PTN5150A will present 5.1Kohm pull down on CC1/CC2. The shield board receives 5V from the USB Type-C connector. PTN5150A sends a signal (TP9) to turn on the Sink Path load switch.

The jumper settings for setting the board for CC logic operation is given below. Please remove all the other shunts on the board.

1. Install shunt at J6
2. Install shunt at J13 – Pin 3 to 2
3. Install shunt at J14 – Pin 3 to 2

When operating in this mode the shield board does not need to plug in to the KL27 Freedom board. Power up the Shield board using the 9V Power Adaptor. Please refer to PTN5150 product datasheet for more details.

3.3 Authentication

The shield board also has a Secure Authentication IC, A1006 on the I2C line. The Authentication IC can be used to implement Authentication through Type C. Please check with your NXP Account Manager for details on A1006.

3.4 Dead battery operation

The shield board can be used to demonstrate dead battery operation using PTN5110 or PTN5150A. Notebook and smartphone applications will need TCPC to enable the Sink path when a charger is plugged into the Type C port even when the PD controller (TCPM) is not enabled. PTN5110 can automatically detect dead battery situation and enable the sink FET during dead battery boot up. Please contact your NXP representative if you need more info on dead battery operation.

4 USB-PD shield boards - errata list

4.1 Errata list

Table 1. Errata list

	Errata list	Demo system impact	Solution
None			

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