

UM11055

NXP USB PD shield board user manual

Rev. 0.3 — 19 June 2017

User manual
COMPANY PUBLIC

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.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

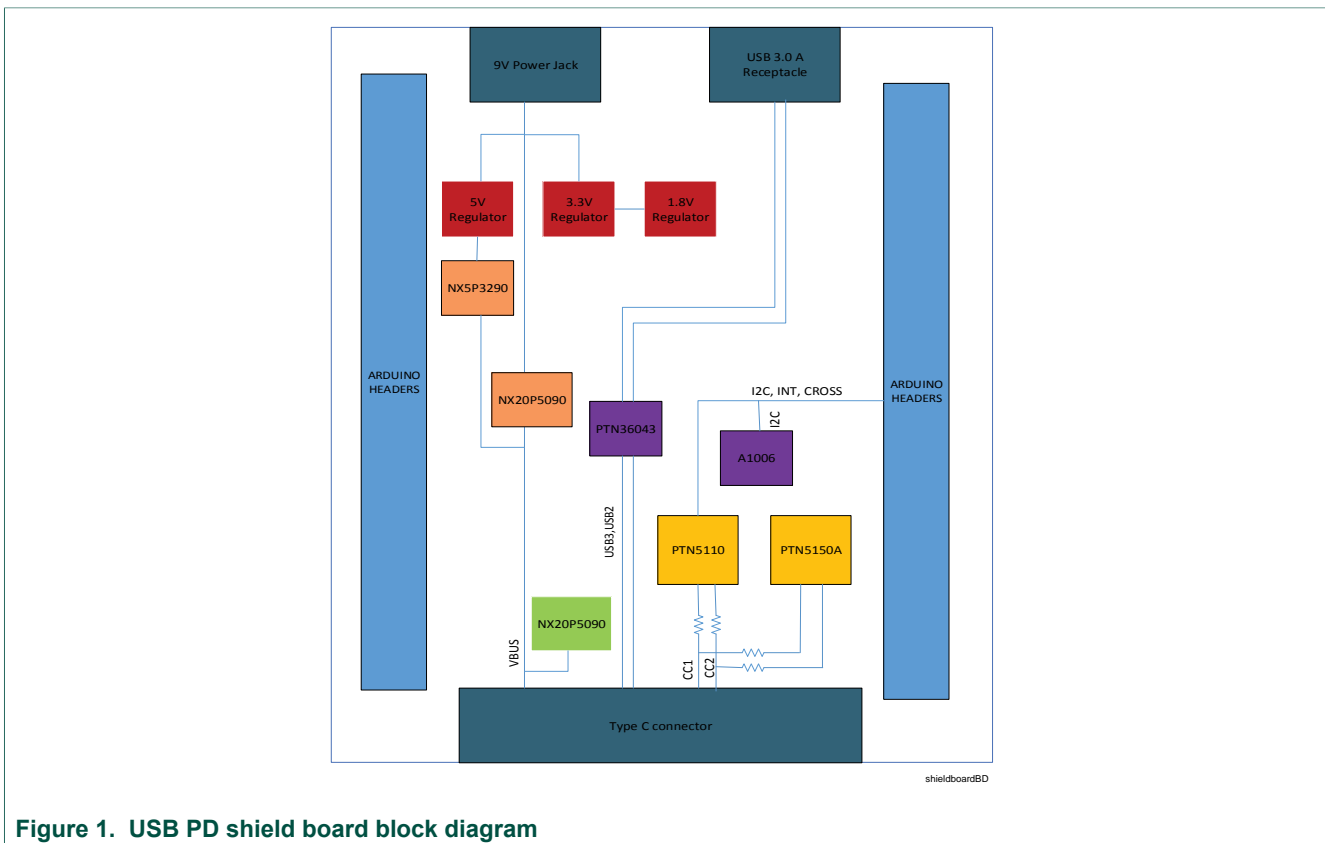


Figure 1. USB PD shield board block diagram

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.

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 I2C interface. The I2C interface has 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 [1] 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 [6] 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 2 Source PDOs available. PDO1 is 5V at 2.7A and PDO2 is 9V at 1.5A. There are 2 source paths in the Hardware. Please check the USB PD shield board schematics [3] 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 upto 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 support 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 configure as DRP or UFP, it will support dead battery mode startup. When a power source plug into shield board, PTN5150A will present 5.1Kohm pull down on CC1/CC2. The shield board will receive 5V from the USB Type-C connector. PTN5150A will send 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. You will need to power up the Shield board using the 9V Power Adaptor. Please refer to PTN5150 product datasheet [5] for more details on the product.

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			

5 Legal information

5.1 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

5.2 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors. In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms and conditions of commercial sale of NXP Semiconductors.

Right to make changes — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors

accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products. NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Evaluation products — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer. In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages. Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

5.3 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

Tables

Tab. 1. Errata list 8

Figures

Fig. 1. USB PD shield board block diagram4 Fig. 2. USB PD shield board5

Contents

1	Introduction	3
1.1	Purposes	3
2	General description	4
2.1	Block diagram	4
2.1.1	USB-PD shield board schematic block diagram	4
2.1.2	USB PD shield board	5
2.2	Shield board description	5
3	Hardware setup	6
3.1	Hardware setup for USB-PD	6
3.2	Hardware setup for CC Logic operation	7
3.3	Authentication	7
3.4	Dead battery operation	7
4	USB-PD shield boards - errata list	8
4.1	Errata list	8
5	Legal information	9

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2017.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 19 June 2017
Document identifier: UM11055