

## R9A02G011

R19AN0054EJ0100

Rev.1.0

### RTK-251-1PowerBank3 Instruction Manual

Nov 9, 2018

## Introduction

The RTK-251-1PowerBank3 is a 3cell (series connected) Li-ion battery power bank reference board having one USB Type-C™ port. The USB Type-C port supports the Dual Role Power (DRP) Feature. When the power bank is in Sink mode, the power bank requests 5, 9, 15, 20V which is supported by a USB Power Delivery (USB PD) provider such as a USB PD AC adapter. When the power bank is in Source mode, as long as an installed battery has enough power budget, it will supply 5, 9, 12, 15, 20V which is requested by a USB PD consumer product such as a Tablet, PC, or smartphone.

The RTK-251-1PowerBank3 works as DRP device and automatically detects Power provider such as a USB PD AC adapter and Power consumer such as a Tablet, PC, and smartphone that is connected to this board. Also, it changes own power role depending on the remaining battery capacities. The battery remaining capacities are always displayed on LEDs.

The RTK-251-1PowerBank3 board is USB-IF PD3.0 certified and the functions and capabilities are fixed in the setting at that time.

## Target Device

USB Power Delivery Controller (PDC): R9A02G011

Buck-Boost Battery Charger (BB-Charger): ISL95538B

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## 1. Features

The RTK-251-1PowerBank3 supports the following features.

- USB Power Delivery and USB Type-C
  - Having one USB Type-C port
  - Power Role: Dual Role (Supports Try.SRC mode)
    - Power Source voltage (no PPS): 5, 9, 12, 15, 20V
    - Power Sink: 5, 9, 15, 20V
- Battery Charger
  - Battery type: Li-ion battery.
  - Number of cells: 3series cells
  - Trickle Charging
- 5 LED indicators
  - USB Type-C port status indicator (1 LED)
  - Battery remaining capacity indicator (4 LEDs)
- Protections
  - Over Temperature Protection (USB Type-C Receptacle)
  - Over Voltage Protection (VBUS voltage)
  - Over Current Protection (VBUS current)

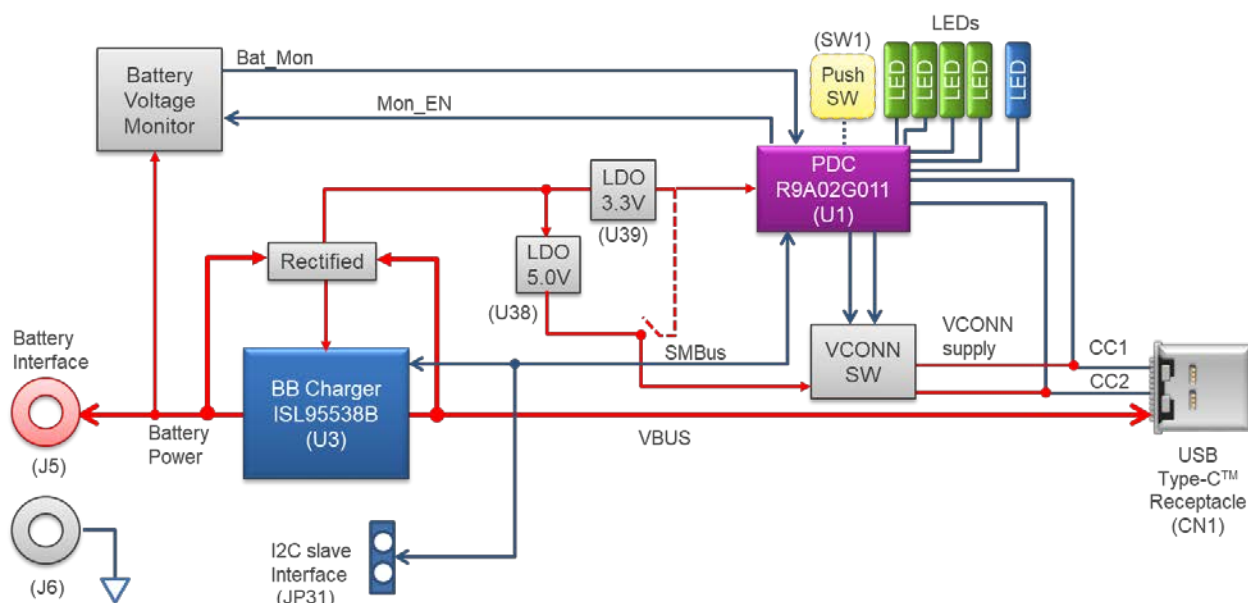


Figure 1-1 RTK-251-1PowerBank3 Block Diagram

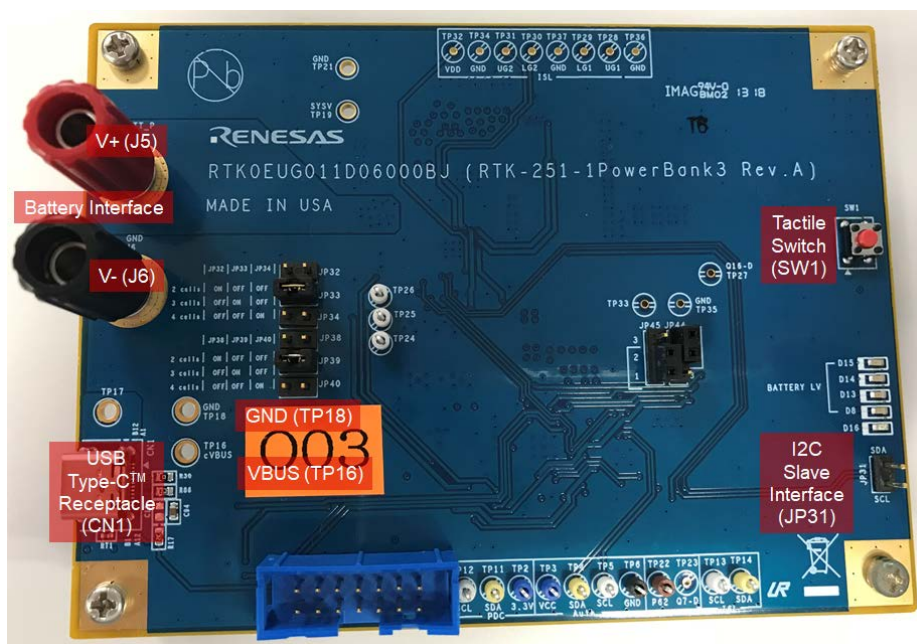


Figure 1-2 RTK-251-1PowerBank3 Board picture (Top View)

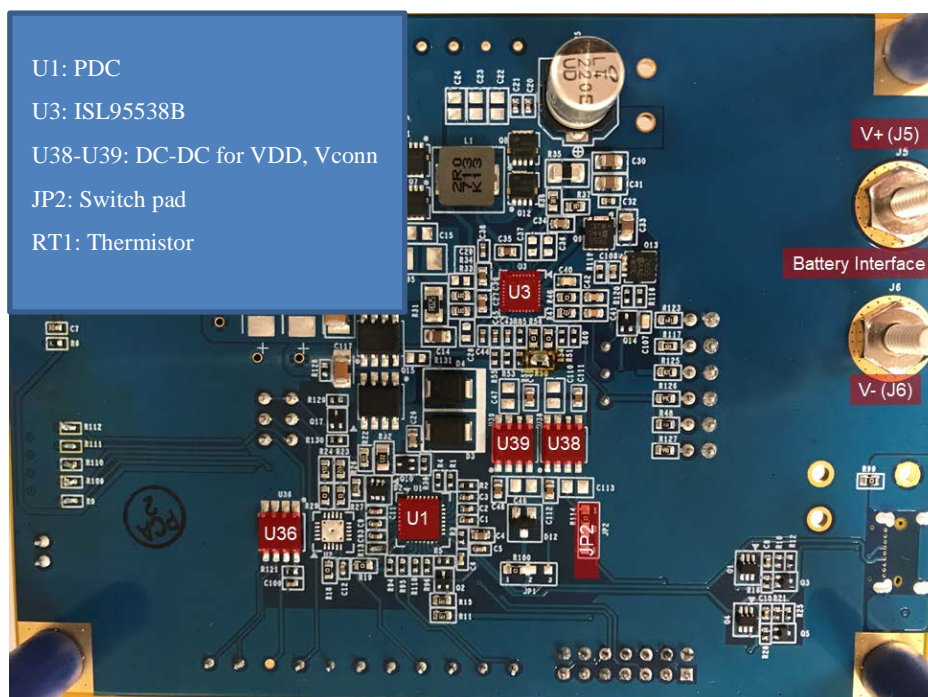


Figure 1-3 RTK-251-1PowerBank3 Board picture (Bottom View)

## 1.1 USB-IF PD3.0 certified configurations

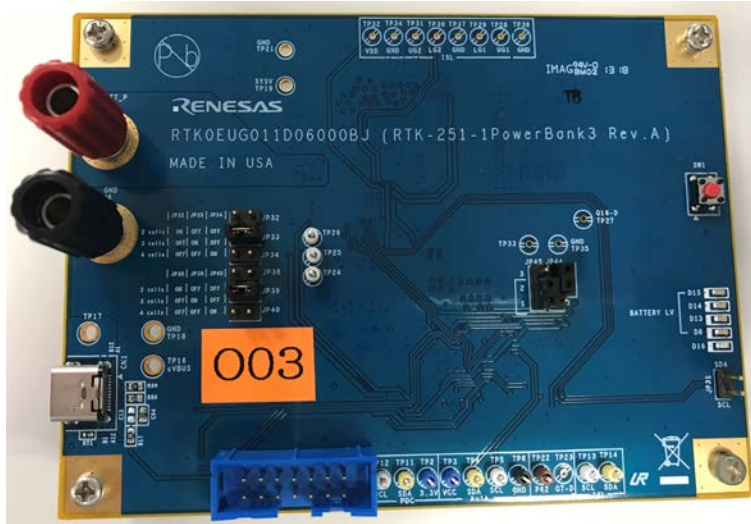
The RTK-251-1PowerBank3 board is USB-IF PD3.0 certified under the following configurations.

Category: Power Brick (no PPS)

Product Name: RTK-251-1PowerBank3

TID: 1090007

- Power Role: Dual Role (Supports Try.SRC)
  - 45W Power Source: 5, 9, 12, 15, 20V
  - 60W Power Sink: 5, 9, 15, 20V
- Supports BC1.2 DCP



## 2. Functions

The RTK-251-1PowerBank3 board functions are described in this section.

### 2.1 Battery charging

The RTK-251-1PowerBank3 manages Battery Charging. it starts to charge the battery with charging current and stops charging when the battery charging current is less than 200mA for 200ms in CV loop. The RTK-251-1PowerBank3 restarts charging when the battery voltage is decreased below “Max Voltage”. The RTK-251-1PowerBank3 also supports trickle charging to an overly discharged battery. It can activate the trickle charging function when the battery voltage is lower than “Min Voltage”. “Max Voltage” and “Min Voltage” are pre-programmed in PDC firmware.

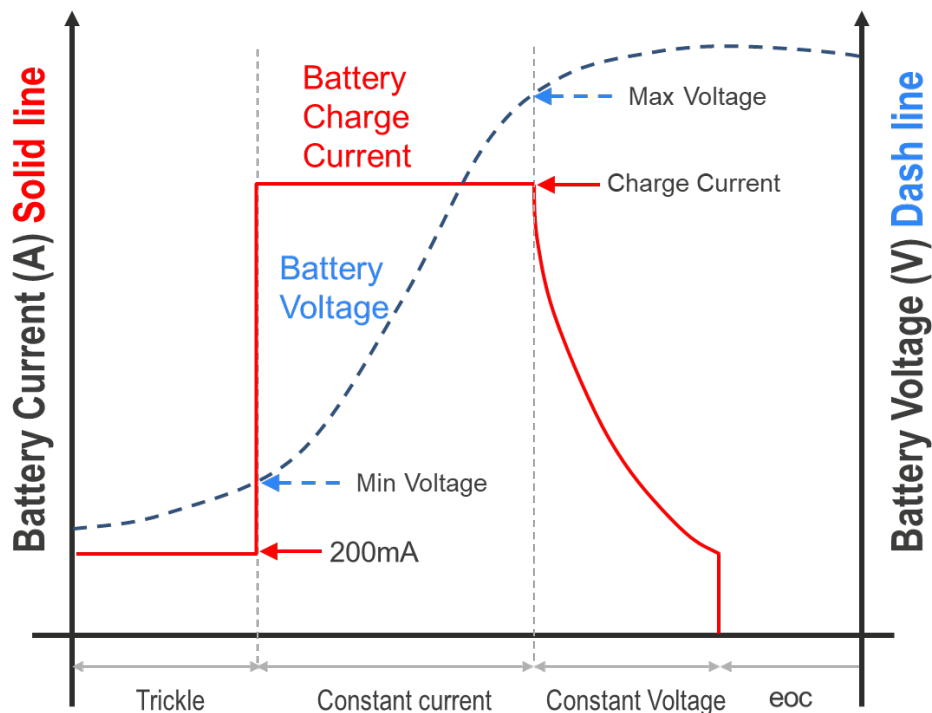


Figure 2-1 Battery Charging Image.

2.2 LED function

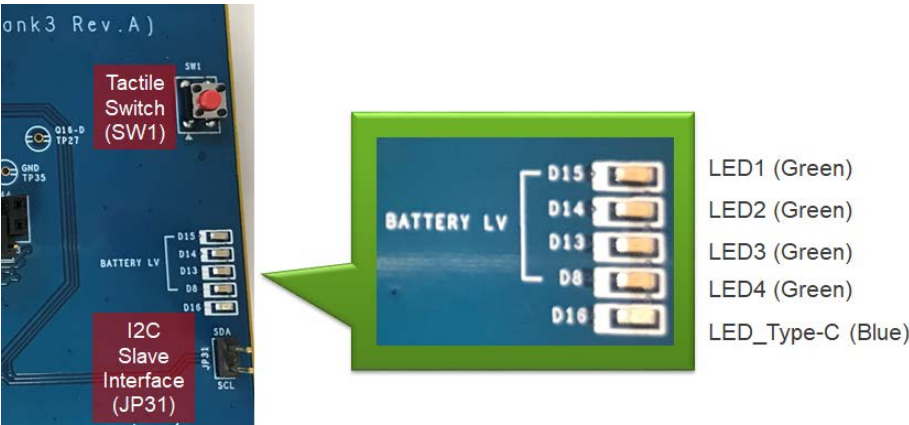


Figure 2-2 LEDs on RTK-251-1PowerBank3.

USB Type-C port role	LED_Type-C behavior
Unplugged	OFF
Sink mode	Blinking (0.5 sec interval as default)
Sink mode (Fully-charged)	OFF
Source mode	Lighted
Source mode (Low Battery)	OFF

Table 2-1 USB Type-C Port role indicator (Blue LED: D16)

Under charging RTK-251-1PowerBank3 from USB PD source device				
Battery power	LED1	LED2	LED3	LED4
Low Battery - 0 %	OFF	OFF	OFF	OFF
0 % - 30 %	OFF	OFF	OFF	OFF
30 % - 45 %	Lighted	OFF	OFF	OFF
45 % - 60 %	Lighted	Lighted	OFF	OFF
60 % -	Lighted	Lighted	Lighted	OFF
Fully-charged	Lighted	Lighted	Lighted	Lighted

Table 2-2 Battery remaining capacity indicator (Green LED: D15, D14, D13, D8)

Under discharging RTK-251-1PowerBank3 to other battery device or Unplugged				
Battery power	LED1	LED2	LED3	LED4
Low Battery - 0 %	OFF	OFF	OFF	OFF
0 % - 30 %	Lighted	OFF	OFF	OFF
30 % - 45 %	Lighted	Lighted	OFF	OFF
45 % - 60 %	Lighted	Lighted	Lighted	OFF
60 % -	Lighted	Lighted	Lighted	Lighted
Fully-charged	Lighted	Lighted	Lighted	Lighted

Table 2-3 Battery remaining capacity indicator (Green LED: D15, D14, D13, D8)

## 2.3 Protection functions

The RTK-251-1PowerBank3 supports the protection functions.

Parameter	Description	Threshold value
OCP	When VBUS current is over 3.2A, ISL95538B will stop VBUS. Then PDC detect VBUS drop as OCP.	Fixed
OVP	Over voltage protection value. Send Hard Reset command to source when VBUS voltage is reaching the OVP value.	25V
OTP	Over temperature protection value. For details, please refer to R9A02G011 User Manual.	Safe: 40 degrees C Warning: 60 degrees C Danger: 80 degrees C



### 3. Board Setup and how to use

Prior to start using the board, please make sure if the jumpers settings are the same as the following instructions. Also, please don't try other settings, which all are reserved.

#### 3.1 Required materials to use this board.

- 3 cells Li-ion battery pack **having a battery protection function**, the battery emulator or the two/four-quadrant DC power supply: 1 unit
- USB Type-C Cable: 1pcs

#### **Caution:**

Please use this board when you understand and agree that Renesas DOES NOT have any responsibility, indemnification, or liability for use of this board. Especially, Li-ion batteries may cause fire, injury, explosion, etc. if they are handled incorrectly. Please use the charge / discharge of the battery at your own risk.

Item	Condition / Note	Specification
Nominal Voltage	Average	10.8V
Standard Charge	Constant current	Greater than 2000mA
Maximum Charge Voltage		12.6V
Standard Discharge	Cut off voltage	Lower than 8.25V
	Constant current	Greater than 6000mA
Operating Temperature	Charge	0 ~ 45 degrees C at least.
	Discharge	-20 ~ 60 degrees C at least.

**Table 3-1 Requirements for 3 cells battery pack to be used.**

3.2 Board settings

The Jumper settings of RTK-251-1PowerBank3 board is described in this section. Other settings are reserved and please DO NOT change them.

**Caution:**

Make sure the HW setting matches the battery pack configuration. Li-ion batteries may cause fire, injury, explosion, etc. if this HW setting is different from an actual battery configuration.



Figure 3-1 JP32/JP33/JP34/JP38/JP39/JP40 jumpers on RTK-251-1PowerBank3.

	JP32	JP33	JP34	JP38	JP39	JP40
3 cells	OFF	ON	OFF	OFF	ON	OFF

Table 3-2 JP32/33/34/38/39/40 settings.

JP2 (Switch Pad)	R114 mounted on 1-2 side
------------------	--------------------------

Table 3-3 JP2 setting.

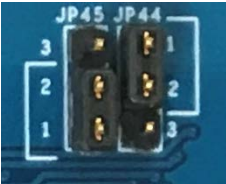


Figure 3-2 JP44/JP45 jumpers on RTK-251-1PowerBank3.

JP44	JP45
Connected 1 and 2	Connected 1 and 2

Table 3-4 JP44/JP45 setting

### 3.3 Battery power connection

Figure 3-3 shows the battery power connection to RTK-251-1PowerBank3 board.

- Battery V+ should be connected to J5 (Red Banana Jack)
- Battery V- should be connected to J6 (Black Banana Jack)

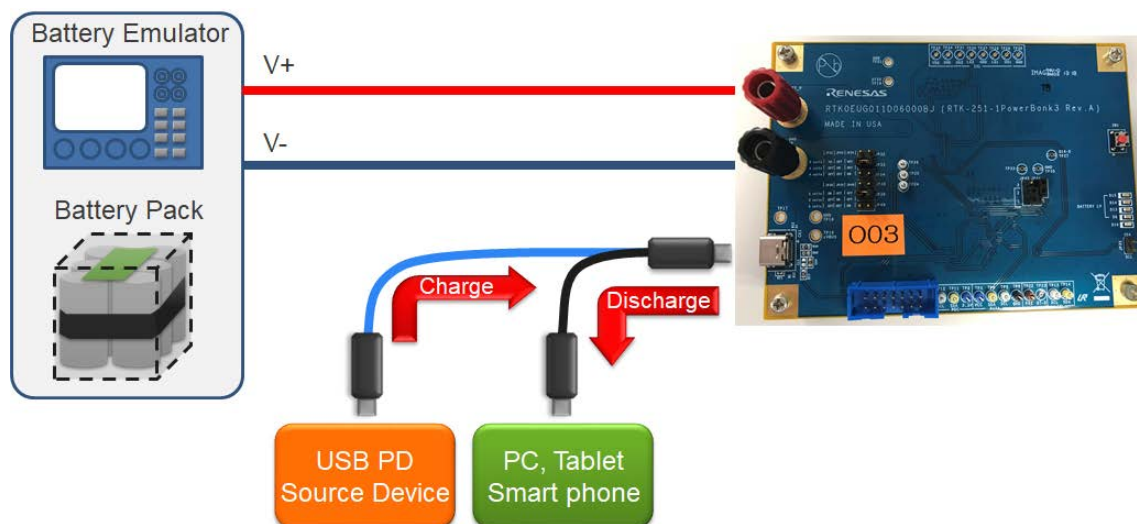


Figure 3-3 Battery power and USB device connection.

After installing the battery power, RTK-251-1PowerBank3 is ready to use.

#### 3.3.1 Operation example of Source mode.

Figure 3-4 shows the connection example of charging device using RTK-251-1PowerBank3 board.

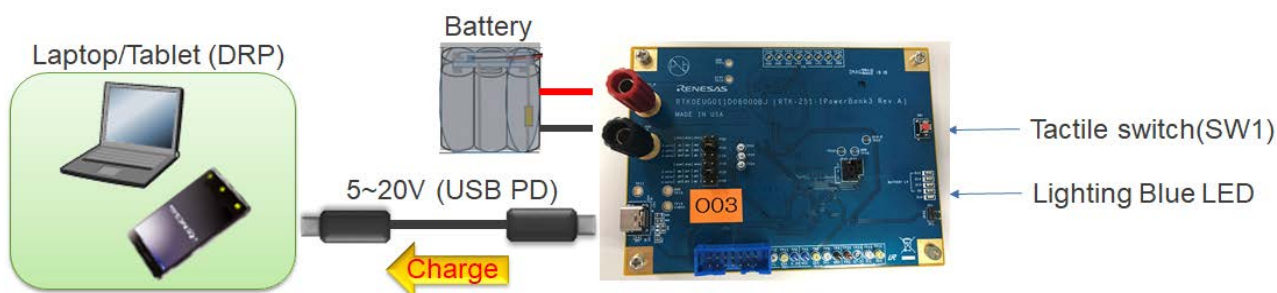


Figure 3-4 connection configuration of source mode.

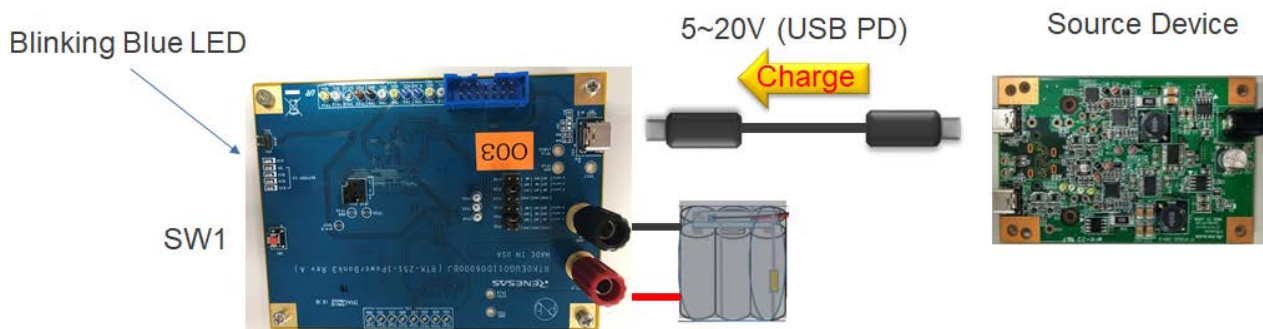
When connecting a PD device to RTK-251-1PowerBank3 board via Type-C cable, RTK-251-1PowerBank3 detects it and tries to be in Source mode so that power can be charged to an attached device as much as possible. If the RTK-251-1PowerBank3 is in source mode, Lighting blue LED on RTK-251-1PowerBank3 and charging VBUS to an attached device.

The RTK-251-1PowerBank3 does not operate as Source device when the power role of connected device is Source only or RTK-251-1PowerBank3 is in the low battery status.

The RTK-251-1PowerBank3 operates only as Sink device when the Battery Level falls below the Low Battery Detection Threshold. And Source operations resumes when the Battery Level exceeds the Low Battery Detection Threshold.

### 3.3.2 Operation example of Sink mode.

Figure 3-5 shows the connection example of charging RTK-251-1PowerBank3 using PD source device.



**Figure 3-5 connection configuration of sink mode.**

When the RTK-251-1PowerBank3 is connected to Source only device such as USB PD AC adapter via USB Type-C cable, it automatically detects the device and always becomes Sink mode. If the RTK-251-1PowerBank3 is connected to the Legacy USB downstream port using USB A to C cable, RTK-251-1PowerBank3 also becomes Sink mode automatically by detecting VBUS power.

When DRP device is connected, the RTK-251-1PowerBank3 tries to become Source mode as much as possible. If RTK-251-1PowerBank3 detects the low battery status, RTK-251-1PowerBank3 is fixed to Sink mode until battery is charged enough. When RTK-251-1PowerBank3 is in Sink mode, LED (Blue) is blinking.

## 4. Optional functions

The RTK-251-1PowerBank3 board is not possible to change parameters by using the Renesas ROM Image Generator. The RTK-251-1PowerBank3 supports any other optional functions as following. They are disabled in this kit. For changes in these functions, please contact Renesas local sales offices.

- Customize USB Type-C output power (Up to 60W PDP<sup>Note</sup>, supported optional capabilities such as 12V or 14.8V, supported PPS)
- Customize Battery power (Number of cells, Battery capabilities)
- Customize LED behavior
- Switch function
- Deep Sleep mode

Note: Maximum PDP is depended on Battery power.

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**Revision History**

Rev.	Date	Description	
		Page	Summary
1.0	Nov 9, 2018	—	Initial Release

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### 1. Handling of Unused Pins

Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, and an associated shoot-through current flows internally; malfunctions can occur due to the false recognition of the pin state as an input signal. Unused pins should be handled as described under Handling of Unused Pins in the manual.

### 2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.  
In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.  
In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

### 3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

### 4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

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Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

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(Rev.4.0-1 November 2017)



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