USB Type-C Power Delivery Controller

BD93F10MWV Function Description

This device is a USB Type-C controller that implements USBPD3.0 (USB Power Delivery rev.3.0 Ver1.2) for an end product that is required to sink power (referred to as a SNK / UFP (Sink / Upstream Facing Port)). These devices are intended to operate in stand-alone mode with no configuration or control required from the product's SoC. The intended application is for products that are connected to an external USB-PD power source device. These devices perform USB-PD negotiations to communicate the necessary and desired voltage and power requirements with the power source, and assures that the correct voltage and power is provided or it will not allow power into the product.

These devices can be used in products that require up to 80W (20V/4A) of delivered power. Using these devices allow the product designer to allow for powering their device over USB, whereas previously a separate power input had to be provided.

Specifications Description

The product automatically performs the operations required for USBPD3.0 due to complete FW. After power up, the product pulls down the CC (Configuration Channel) terminal and enters standby state. During this state, when a Source device is connected, the Type-C connection is determined, then it enters the Active (Type-C) state. CC terminals are then used to communicate with USBPD in the following sequence: As the "Source Capabilities" comes from the Source side, the product returns a "Request" according the initial configuration which is specified below. Next, the Source sends an "Accept" and "PS_RDY" respectively, and connects (makes a contract) as USBPD, then transitions to Active (USBPD) state which operates as SNK / UFP. In the case where the Source device does not support USBPD, it remains in the Active (Type-C) state and operates as SNK / UFP.
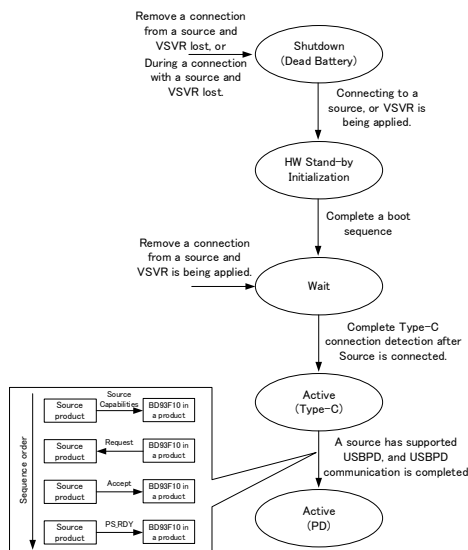
After contracting (receiving PS_RDY) to the specified power, the Nch-MOS switch on the VBUS power line is controlled, where it automatically starts receiving power. Therefore, stand-alone operation is possible even without the control from Host.

The product can support Dead Battery operation by utilizing the voltage of the VBUS power line. Therefore, it can still operate even if the internal power of the system has lost completely.

The Nch-MOS switch on the VBUS Power turns off automatically when it is disconnected to the Source device.

[Power Supply specification]
- VBUS Voltage = 3.67 to 22V
- VSVR = 3.1 to 5.5V
- VDDIO = 1.7 to 5.5V

[Type-C initial Connection specification]
- SNK / UFP

[SRC (Power Source) specification]
Disabled

[SNK (Power Sink) specification]
Dependent on VMIN / VMAX / PMIN setting of the GPIO

[Role Swap initial specification]
- Power Role Swap to SNK : Disabled
- Power Role Swap to SRC : Disabled
- Data Role Swap to DFP (Downstream Facing Port) : Disabled
- Data Role Swap to UFP : Disabled

Figure 1. Operation modes of BD93F10MWV

[Protection Function specification]

● VBUS Over Voltage Protection : Enabled (Auto Recovery)

● VBUS Short Circuit Protection : Disabled

● CC Over Voltage Protection : Enabled (Auto Recovery)

● VBUS Over Current Protection : Optional (Auto Recovery)

● Over Temperature Protection (external thermistor)

: Optional (Auto Recovery)

● Over Temperature Protection (internal temperature

of this product) : Enabled (Auto Recovery)

[Host IF Function specification]

The product is on stand-alone and does not use this function.

[GPIO Function specification]

The following functions are assigned to GPIO.

Table 1. GPIO Function

Terminal#	Name	I/O	Function
21	GPIO0/MSDA	-	(Unused : Hi-Z)
22	GPIO1/MSCL	-	(Unused : Hi-Z)
23	GPIO2	N-OD	ALERT#
24	GPIO3	I	VMAX
25	GPIO4	I	STOPENB
26	GPIO5	O	ORIENT
27	GPIO6	I	VMIN
28	GPIO7	I	PMIN
29	GPIO8/SDA1	I	ORIENT
30	GPIO9/SCL1	O	VBRDY

"O" : VDDIO Level Output

"N-OD" : Nch Open Drain Output

Unused terminal is Hi-Z. Please use Open or Pull down to GND.

Specifications Detail

Power Supply of this product

This product has two power supply terminals; VSVR and VB. A priority is set on these power supplies, where powering from VSVR has the priority. VSVR terminal is assumed to be supplied from the inside of the system and VB is supplied from the VBUS (Type-C connector).

VCCIN is sourced from an internal ORing power supply. Since VCCIN is the internal power supply of the product, consuming power from the VCCIN terminal is not recommended.
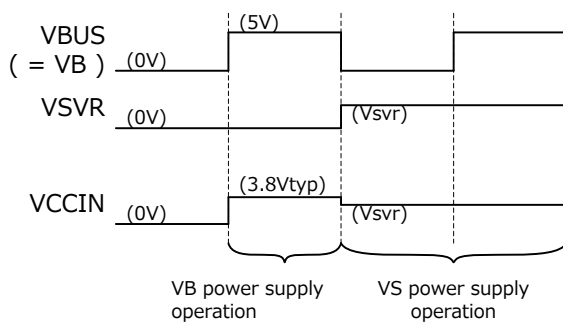

Figure 2. Power Supply Selection

(VSVR power supply operation)

In the instance where only the VB terminal (VBUS) is operated as a power source, no power supply is required for VSVR. Terminal VSVR should be open in this condition.

The VSVR terminal is a power terminal that supplies power from the system side (built-in battery, etc.) If power is applied at the VSVR terminal, it would operate as the power supply of the system regardless of whether the voltage at VB terminal is applied. If voltage is lost from the VSVR power terminal while the VB terminal is powered on, the product resets. During reset, type-C disconnects, but automatically returns to type-C connection state after startup time and Type-C/PD connection time.

(VB power supply operation)

When VSVR voltage is applied while supplying power to VB terminal, the product automatically transitions to VSVR operation and starts to consume current from the VSVR terminal. Throughout the transition, reset would not be triggered, maintaining the Type-C connection. If power is supplied to VB terminal only, the product's behavior is similar to Dead Battery operation.

The Operation modes and bootup time

The product has 2 operation modes; (1) power is supplied by the system (i.e., built-in-batteries) and (2) Dead Battery operation, where power is supplied externally through the VBUS power line. The operation mode is determined by the power condition applied at VB and VSVR. The operation mode transitions to Normal operation whenever power is applied at VSVR during the Dead Battery operation.

Table 2. Operation detection condition

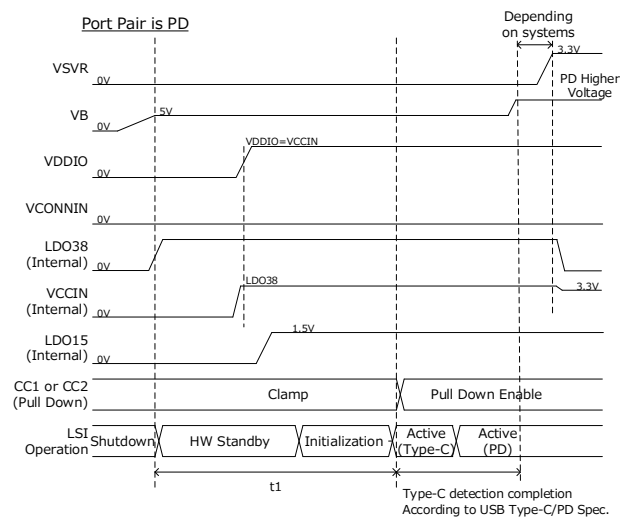| VB	VSVR	Power source for VCCIN	Operation
Applied	Not exist	Via VB	Dead battery operation
Don't care	Applied	Via VSVR	Normal operation
Not exist	Not exist	No Power	Shutdown

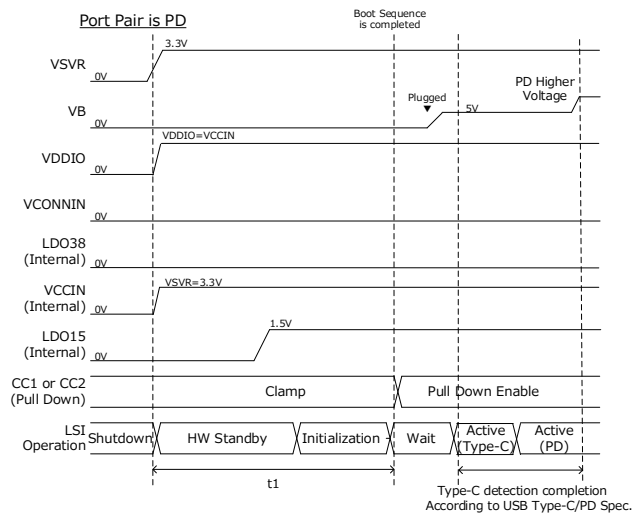Figure 3. Timing Chart for Dead Battery Operation

Figure 4. Timing Chart for Normal Operation

Table 3. Timing Characteristic for Dead Battery

Parameter	Symbol	Min	Typ	Max	Unit
PDIC Startup Time	t1	-	-	100	ms

If the device is disconnected from the Source and VSVR power is maintained, "Wait" condition is kept until a device re-connects to Source. The startup time specified above is not applicable in this case since HW Standby and Initialization was not performed.

CC Terminal Voltage Clamper Setting

The product has a built-in voltage clamper at the CC pin to allow connection detection from the Source during Dead Battery operation. It is required for the Stand-Alone device to support dead battery operation, both XCLPOFF1 and XCLPOFF2 shall open. At boot-up sequence, the voltage clampers are automatically disabled by internal control.

Output Voltage to VBUS

Since there is no path to Source in stand-alone operation, S1_DRV shall be open and S1_SRC shall be shorted to GND directly.

Consuming Voltage from VBUS

The product meets the required power specifications according to USB Type-C and USBPD standards. S2_DRV turns on Nch-MOS switch on the VBUS power line, allowing the system to receive power. The power supplied by

the product depends on the VMIN / VMAX / PMIN settings of the GPIO function (Please see VMAX / VMIN / PMIN features for more detail.)

The Nch-MOS switch on the VBUS power line only turns on when the Source device that meets the power requirements set by VMIN / VMAX / PMIN is connected. Please see Figure 11 to learn about the configurable range where Nch-MOS is turned on.

NOTE: BD93F10MWV can only support Type-C and USB PD standards and NOT support any proprietary charging methods including DCP and CDP in BC1.2. These are interpreted by the product as the SDP with Type-A to C cable if it is connected to such ports, and the Nch-MOS switch can only be turned on when the configuration is set to VMIN=5V and PMIN=0.5W.

VBUS Discharge Resistor

This product connects VB terminal and DISCHG terminal with external discharge resistor, RDSCHG. It controls an internal switch according to USB Type-C and USBPD specification for the VBUS electric discharge. Please connect VBUS terminal and DISCHG terminal via external 120Ω resistance for discharging operation. The error of the resistance value of RDSCHG shall be less than ± 5%, please select the resistance value within that range.
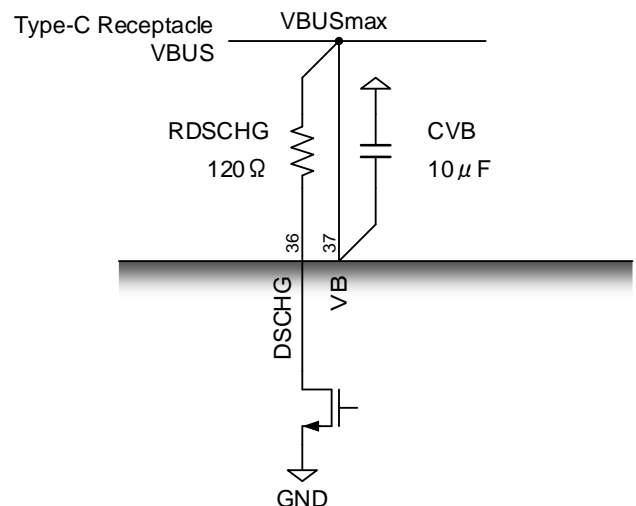

Figure 5. External Discharge Resistor (RDSCHG)

VBUS Over Voltage Protection / Short Circuit Protection Function

This product has an overvoltage protection function for the VB pin voltage (VBUS voltage). When an overvoltage is detected, the Nch-MOS switch on the VBUS power line is turned off to isolate the system from Type-C receptacle safely.

The SCP (Short Circuit Protection) can only be used on the source mode, therefore the SCP is disabled.

Please refer to Table 9 regarding the behavior after these detections, the releasing voltage, or something for more detail.

Over Current Protection Function

Please remove 10 mΩ resistor for current sensing then short CSP and CSN each other if this feature is NOT required.

By using current sensing external shunt resistor of 10 mΩ, which connected with this product GND side, load current is detected by monitoring the voltage difference between CSP and CSN. Current to detect OCP is detected through the shunt resistor. The error of ±1% can be acceptable for the RS resistance, so please select the appropriate resistor within the range.

This over current protection is being enabled during plugged condition, Active (Type-C) and Active (USBPD) state. The OCP is triggered whenever the over current condition is ongoing above the threshold for the specific mask duration (It is 200ms fixed). As well as the OVP, the Nch-MOS switch on the VBUS power line is turned off to isolate the system from Type-C receptacle safely.

Depending on the noise situation on the actual applications, the OCP cannot detect the current correctly. In case of the situation, it is recommended that the capacitor ("CS" in Figure 17) is connected between CSP /CSN terminals to stabilize the voltage (ΔV) of the voltage on both terminal.
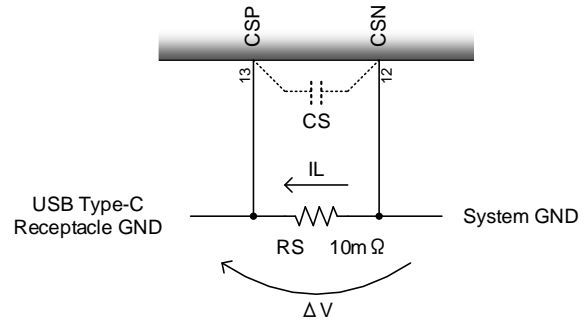

Figure 6. Current Detection Resistor

As shown in Table 4. The threshold of the OCP is depending on the connected source device.

Table 4. Source Device and its VB OCP threshold

Connected Source Device	VBUS OCP Threshold	Note
Type-C Default*/1.5A	Fixed 1.95A	
Type-C 3.0A	Fixed 3.9A	
Type-C USB PD	Contracted Current ×1.3	Contracted current is depending on the GPIO configuration, VMAX / VMIN / PMIN features.

*The current of "Type-C Default" is according to the definition in USB version.

The OCP threshold is set to 1.3 times the contracted current when the source device has supported the USB PD. The contracted current means the maximum current that can be supplied by the source and also the maximum current that the sink device can consume. Please see VMAX / VMIN / PMIN features in the GPIO clause for more detail regarding the contracted currents.

Over Temperature Protection Function using external thermistor

Please remove RTHU in Figure 7 between ADCVREF terminal and ADCIN terminal and remove RTHD from ADCIN terminal then short ADCIN terminal to GND directly if the feature is NOT required.

This product can provide the over-temperature protection function (OTP function: Over Temperature Protection) in the system by using an external thermistor RTHD (PTC Thermistor). For example, the system can monitor the thermal condition via the OTP by implementing a PTC

thermistor RTHD around the Nch-MOS FET switch on the VBUS power rail, which is controlled by the product. There shall be an external pullup resistor between ADCIN and ADCVREF. The error of ±1% can be acceptable for the RTHU resistance.

The OTP is enabled in either Active (Type-C) or Active (USB PD) state, and by comparing with the varying voltage via PTC thermistor, the OTP detects under the over-temperature condition when the voltage at ADCIN is equal or over 0.75V. The over-temperature condition is released when the voltage goes equal to or below 0.65V.

Depending on the noise situation on the actual application, the voltage may not be detected correctly by GND noise. In this case, it is recommended that the capacitor (CADIN) is implemented to stabilize the monitoring voltage of the PTC thermistor.
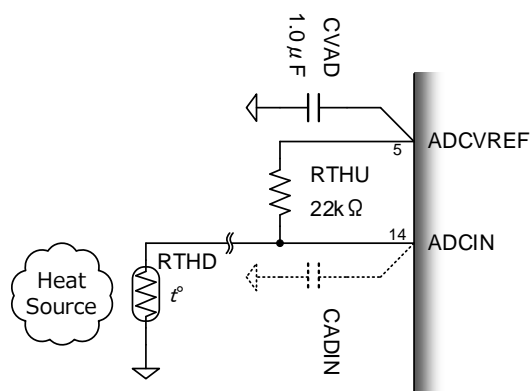

Figure 7. Over Temperature Detecting

Built-in Over Temperature Protection Function in this product

This product has the built-in over-temperature protection function for itself (TSD function : Thermal Shut Down). The product enters shutdown status forcibly when the die temperature goes over 175°C. The shutdown status is released if the die temperature is less than 135°C after detecting over temperature.

Over Voltage Protection Function for CCs.

This product provides overvoltage protection to both CC1 and CC2 terminals. When the function detects overvoltage, the Nch-MOS switch on the VBUS power line is turned off to isolate the system from Type-C receptacle safely. Please see Table 9 for more details regarding the behavior after the

detection, the release voltage, or something.

HOST IF Function

It is the premise for this product to operate in Stand-Alone mode, the function is not available. Therefore, both SCL0 and SDA0 shall short to VDDIO, and GPIO2 shall be open, and IDSEL shall short to GND.

Internal reference power LDO15 / LDO38

Both LDO15 and LDO38 are internal power reference. Therefore, no application can utilize these outputs.

Reset by the system

This product is always reset by power-on reset with either VSVR or VB terminals. Therefore, no reset is required by triggering XRST terminal in the system. The XRST terminal shall be short to GND via the capacitance, which specify in Figure 17.

Supplying the power to VCONN

In premise, this product is for Sink in Stand-Alone operation. Therefore, it is NOT required for the VCONNIN terminal to be supplied by power from the external power lanes for powering an active cable by VCONN. The VCONNIN shall be short to GND directly, which specify in Figure 17.

ATST1 / ATST2 Terminals

These terminals are utilized for the shipment tests or validations. The actual operation requires no function for these terminals, therefore these shall be implemented according to Figure 17.

Regarding EXP-PAD

EXP-PAD has no connection to internal GND. It is acceptable for the application to be connected or not connected.

GPIO Functions Description

This product requires connecting VCCIN to VDDIO to utilize these GPIO functions. And shall not apply the voltage to GPIOs over VDDIO (=VCCIN) voltage.

Unused pins are always fixed to Hi-Z. Therefore, both Open and Short to GND are acceptable. Please refer to Table 1 regarding the default condition of these GPIOs after bootup. And also refer to the BD93F10MWV Datasheet regarding the electrical characteristic of the inputs and outputs.

● **Unused (GPIO0, GPIO1)**

These terminals don't be used.

● **ALERT# Function (GPIO2)**

The ALERT# is NOT required in the Stand-Alone operation. The terminal shall be Open.

● **STOPENB Function (GPIO4)**

The STOPENB is NOT required in the Stand-Alone operation. The terminal shall be short to GND directly.

● **ORIENT Function (GPIO5)**

This ORIENT shall be open if it is NOT required for the system.

The function can detect which side of CC1 or CC2 has been connected to the port pair. The result of the detection indicates which side of the Type-C plug is connecting to the sink. The connection by CC1 maintains the voltage level of the ORIENT terminal to "L," as well as the default and the connection by CC2 goes the ORIENT terminal to "H" as the flipped connection. The ORIENT output is asserted when the state is just entering Active (Type-C).
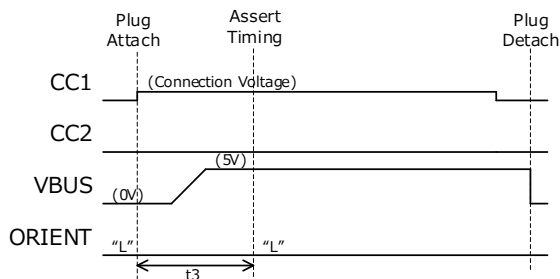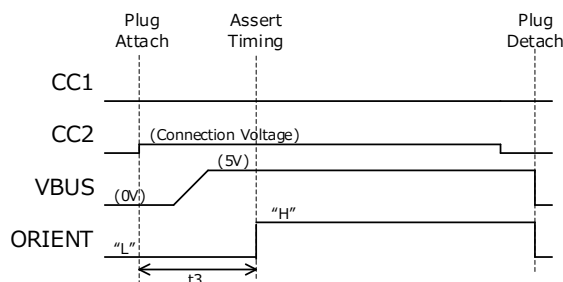

Figure 8. CC1 Connection of SNK / UFP

Figure 9. CC2 Connection of SNK / UFP

Table 5. Timing characteristic of asserting ORIENT

Parameter	Symbol	Min	Typ	Max	Unit
Asserting timing of ORIENT	t3	100	-	550	ms

● **USBCAPB Function (GPIO8 / SDA1)**

This USBCAPB informs the port pair of whether the local port has USB communication capability or not in USBPD negotiation communication. The terminal notifies the other party whether the local port is capable of USB communication. This product is connected as UFP, so the terminal shall be set to "L" if the system enables USB communication, if not, set this pin to "H" (connect to VDDIO).

The configuration of the function doesn't affect the system operation. However, it causes failures at the USB PD compliance test for the finished product. Therefore, it shall accord to the system architecture.

● **VBRDY Function (GPIO9 / SCL1)**

The VBRDY shall be open if it is NOT required for the system.

The terminal can be used to detect the start timing of the USB communication as UFP. VBRDY is asserted to "H" when a series of the sequences of USB Type-C and PD is completed. It is asserted when the status is entering Active (Type-C) if the connected source cannot support USB PD after confirming whether the source has not supported USB PD.

Table 6. Timing characteristic of VBRDY

Parameter	Symbol	Min	Typ	Max	Unit
Asserting timing of VBRDY	-	-	-	992	ms

●**VMAX / VMIN / PMIN Function (GPIO3 / GPIO6 / GPIO7)**

VMAX / VMIN / PMIN sets the required maximum voltage / required minimum voltage / required minimum power respectively by external resistors (pull-up resistor RVU1 / RVU2 / RPU and pull-down resistor RVD1 / RVD2 / RPD). These three terminals shall be pulled up to ADCVREF and pulled down to GND via these six resistors according to table Table 7. VMAX / VMIN / PMIN setting table. The tolerance of the resistance of RVU1, RVU2, RPU, RVD1, RVD2, RPD shall be within ± 1%. Therefore, please select the resistance value within the tolerance of the range.

Depending on the noise situation on the actual application, the configuration by these terminals may not be detected correctly due to the noise flow-round.
In this case, it is recommended that the bypass capacitor be implemented to suppress the noise and stabilize the configuration's detection.

The pin voltage is stored as the configuration at the initial startup then it has been maintained until the power supply of this product being lost. XRST (pin 40) can also reset the configuration for the debugging but XRST shall not be utilized on the actual application.
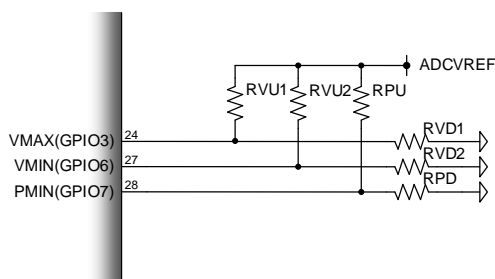

Figure 10. VMAX / VMIN / PMIN terminal setting

Table 7. VMAX / VMIN / PMIN setting table

Set	RVD1 RVD2 RPD [kΩ]	RVU1 RVU2 RPU [kΩ]	VMAX [V]	VMIN [V]	PMIN [W]
1	200	Open	5	5	0.5
2	36	160	9	9	7.5
3	68	150	12	12	15
4	82	110	15	15	27
5	110	82	16	16	36
6	150	68	18	18	45
7	160	36	19	19	60
8	open	200	20	20	80

This product requests and negotiates a PDO that does not exceed the maximum current from the required voltage /

power range. The device can connect a source that has the range coming into contact with or overlapping the "Connectable power range" in Figure 11.
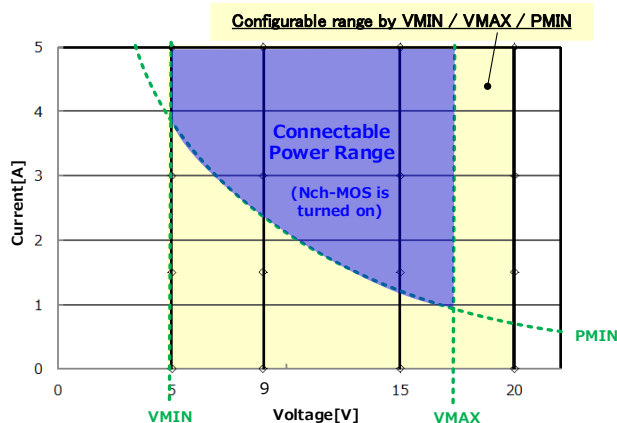

Figure 11. The connectable range by VMIN / VMAX / PMIN

●**The Example of VMIN / VMAX / PMIN configuration**

VMAX=15V(Set4), VMIN=9V(Set2), PMIN=15W(Set3)

Sink devices with the setting above have a minimum required power of 15W and contract at 9V to 15V.
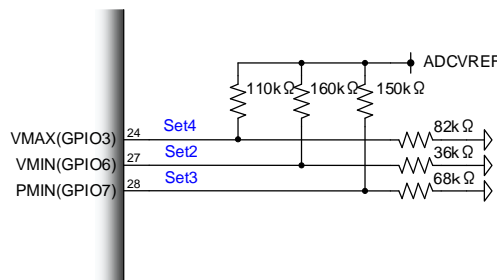

Figure 12. Example of VMIN / VMAX / PMIN configuration

In this configuration, if the connected Source device supports power of minimum 15W at 9V, a USB PD contract will be established.
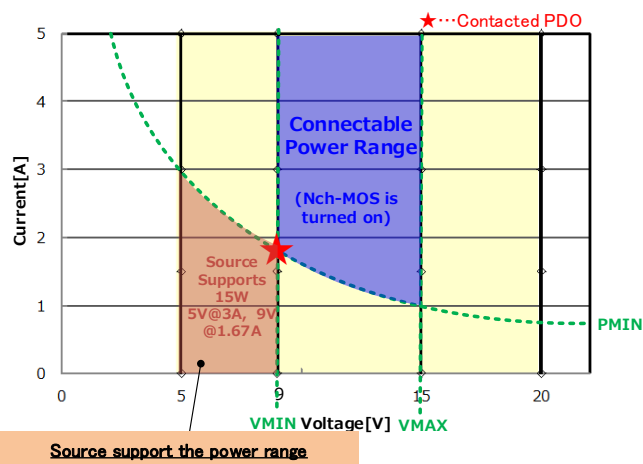

Figure 13. Example of the contract with a 15W source device.

In addition, the product can establish a contract with the maximum power supported by the Source device. Therefore, when connected to a Source device that can supply 45W (5V, 9V, 15V@max3A), a contract can establish at 15V@3A and turns on Nch-MOS to power the system.
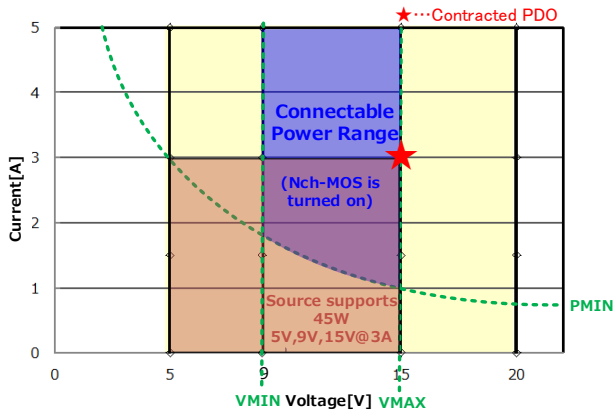
The threshold for VBUS overcurrent detection is set to 1.3 times the contracted current according to Figure 16.

Figure 16. VBUS Overcurrent detection configuration example.

Figure 14. Example of contract with 45W configuration example.

●**Regarding the limitation by the cable and the threshold of VBUS OCP.**

On cable current limit and VBUS Over-Current Detection (OCP), there is a cable current limit for USB PD standards. Since normal cables can only allow up to 3A, a contract would be established with the Source at 3A, even if the Source can allow up to 5A.
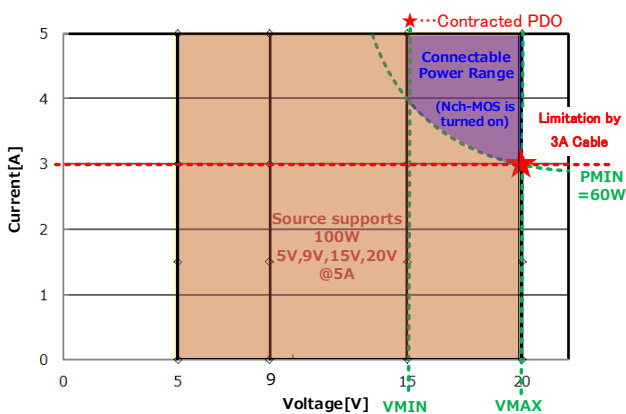

Figure 15. Contract with 100W Source device via 3A cable
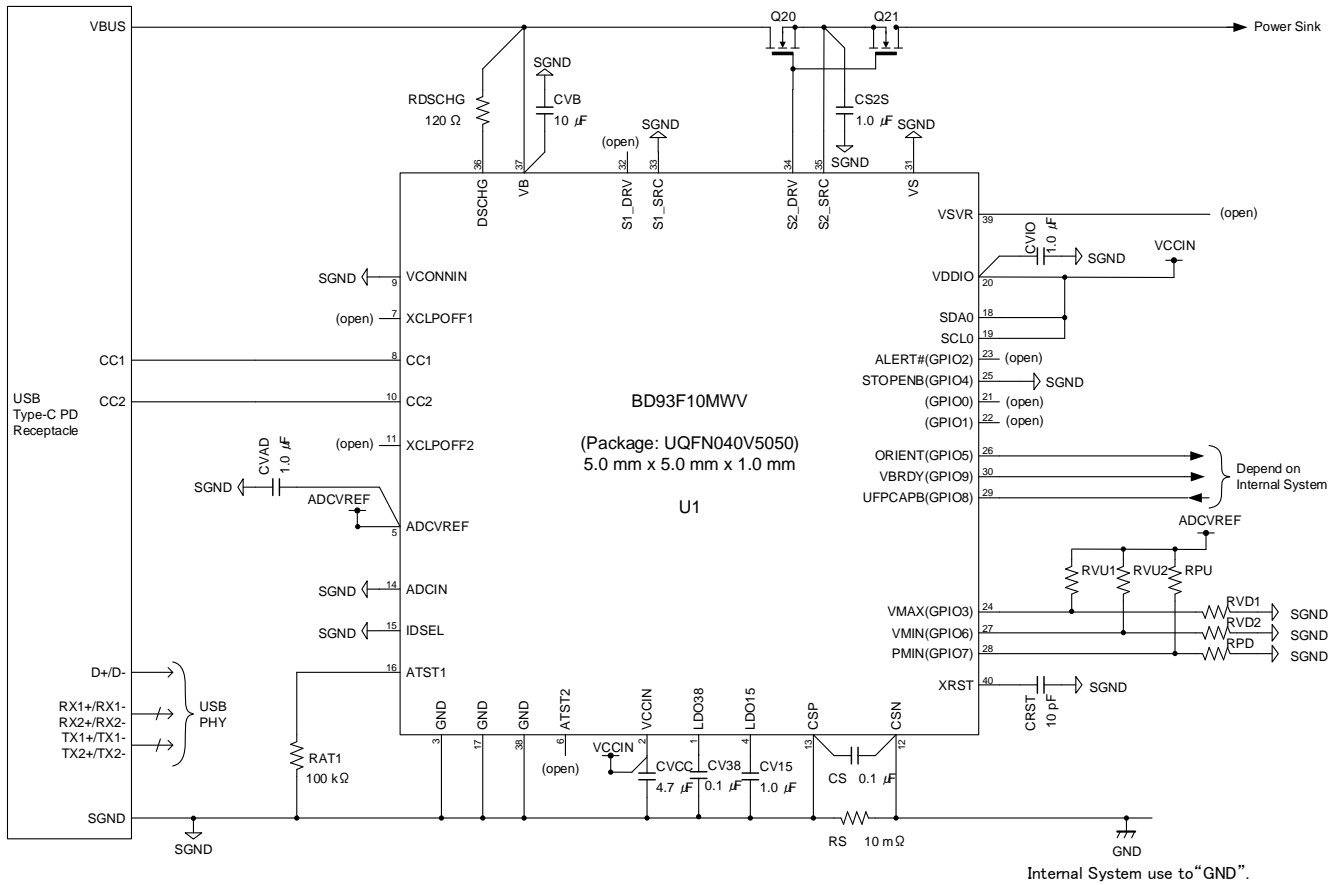
Recommended Application Example

Figure 17. The Recommended Application Example for Stand-Alone Operation (VBUS OCP: Available, OTP with PTC thermistor: Disabled)

Recommended application parts and its selection

Table 8. Recommended application parts selection

Symbol Name	Contents	Characteristic	Comment/Recommendation
U1	IC	5.0mm×5.0.mm, QFN40	BD93F10MWV
CVB	Capacitor	10µF, ≥ 50V, X5R/X7R	Please select appropriate capacitors according to the highest applied voltage.
CS2S	Capacitor	1µF, ≥ 50V, X5R/X7R	
CVIO, CV15, CVAD	Capacitor	1µF, ≥ 16V, X5R/X7R	-
CV38	Capacitor	0.1µF, ≥ 16V, X5R/X7R	-
CVS	Capacitor	0.1µF, ≥ 50V, X5R/X7R	-
CVCC	Capacitor	4.7µF, ≥ 25V, X5R/X7R	-
CRST	Capacitor	10pF, ≥ 16V, X5R/X7R	-
RAT1	Resistor	100kΩ (accuracy ≤ ±5%), ≥ 0.05W	MCR01MZPJ104
RS	Resistor	10mΩ (accuracy ≤ ±1%), ≥ 1W	LTR18EZPFU10L0
RDSCHG	Resistor	120Ω (accuracy ≤ ±5%), ≥ 0.25W	MCR18EZPJ121
RPU, RMU0, RMU2, RPD, RMD0, RMD1	Resistor	**kΩ (accuracy ≤ ±1%), ≥ 0.05W	MCR01MZPFxxxx (E24 Series)
*Q20, Q21	Nch MOSFET	Nch-MOSFET	RW4E075AJ (5A Application) RW4E045AJ (3A Application)
RTHU	Resistor	22kΩ (accuracy ≤ ±1%), ≥ 0.05W	MCR01MZPF2202 If not using OTP function, this is NOT required.
RTHD	Thermistor	PTC Thermistor	PRF15**102QB6RC If not using OTP function, this is NOT required. Please select the thermistor which can be detected with expected temperature.

*The back-to-back architecture is composed by Q20 and Q21. And these parts have been complied with the official USB PD certification.

Function configuration List

Table 9. The list of the configuration for Stand-Alone operation.

Item		Value	Behavior on Application Example [1]
Type-C Initial Connect	Port Shape	Receptacle	<-
	Port Role	SNK / UFP	<-
	Type-C Current	-（depend on facing device）	<-
	VCONN	Disable	<-
Role Swap	Power Role Swap to SRC request from own port	Disable	<-
	Power Role Swap to SRC respond to request from facing port	Not Accept	<-
	Power Role Swap to SNK request from own port	-	<-
	Power Role Swap to SNK respond to request from facing port	-	<-
	DFP への Data Role Swap to DFP request from own port	Disable	<-
	Data Role Swap to DFP respond to request from facing port	Not Accept	<-
	Data Role Swap to UFP request from own port	-	<-
	Data Role Swap to UFP respond to request from facing port	-	<-
	VCONN Swap to VCONN_SRC request from own port	Disable	<-
	VCONN Swap to VCONN_SRC respond to request from facing port	Not Accept	<-
	VCONN Swap to NOT_VCONN_SRC request from own port	-	<-
	VCONN Swap to NOT_VCONN_SRC respond to request from facing port	-	<-
SRC (Power Source)	Power Source	Disable	<-
SNK (Power Sink)	Enable Power Sink	Enable	<-
	Number of PDO, depend on VMAX/VMIN/PMIN (GPIO3/GPIO6/GPIO7)	4	depend on the external resistance
	PDO1-4, depend on VMAX/VMIN/PMIN (GPIO3/GPIO6/GPIO7)	5V/3A, 9V/3A, 15V/3A, 20V/3A	depend on the external resistance
	PDO5-7	-	<-
	Automatically USBPD negotiation start, Negotiation Voltage depend on VMAX/VMIN/PMIN (GPIO3/GPIO6/GPIO7)	Enable	<-
	Dead Battery start	Enable	<-
Protect: VBUS Over Voltage Protection	Enable VBUS OVP	Enable	<-
	After detected	Automatically recovery	<-
	When USB Type-C connect, detected Voltage	6.0V	<-
	When USBPD negotiation, detected Voltage	Negotiation voltage*1.2V	<-
	Release Voltage	5.625V	<-
Protect: CC Over Voltage Protection	Enable CC OVP	Enable	<-
	After detected	Automatically recovery	<-
	Detected Voltage	6.0V	<-
	Release Voltage	6.0V	<-
Protect: VBUS Over Voltage Protection	Enable OCP	Enable	<-
	After detected	Automatically recovery	<-
	Mask time of detected	200ms	<-
	When Type-C default/1.5A connect, detected Current	1.95A	<-
	When Type-C 3.0A connect, detected Current	3.9A	<-
	When USBPD contract, detected Current	Negotiation Current*1.3A	<-
	Release Current	-（sync）	<-
Protect: Over-temperature protection by PTC thermistor	Enable OTP	Enable	Disable
	After detected	Automatically recovery	-
	Detected threshold (ADCIN port voltage)	0.75V	-
	Release threshold (ADCIN port voltage)	0.65V	-
	Cycle time of monitoring temperature	10s	-
Protect: Short Circuit Protection	Enable SCP	Disabled	<-
	After detected	-	<-
Protect: Built-in Thermal Shutdown	Detected Temperature (Internal temperature of this device)	175℃	<-
	Release Temperature (Internal temperature of this device)	135℃	<-
Sleep Mode	Standby Mode (When Type-C plug connect, Low power mode)	Enable	<-
	Stop Mode (When Type-C plug connect, Low power mode), depend on STOPENB (GPIO4)	Enable	<-

[1] "<-" shows that it does the Behavior same as the Value

Revision History

Date	Revision Number	Description
Sep. 8. 2021	001	Initial Release
Nov. 8. 2021	002	Added Captions on PDF.

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifica-
tions :

3) Although ROHM is continuously working to improve product reliability and quality, semicon-
ductors can break down and malfunction due to various factors.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety
measures such as complying with the derating characteristics, implementing redundant and
fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no
responsibility for any damages arising out of the use of our Poducts beyond the rating specified by
ROHM.

4) Examples of application circuits, circuit constants and any other information contained herein are
provided only to illustrate the standard usage and operations of the Products. The peripheral
conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and
examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly,
any license to use or exercise intellectual property or other rights held by ROHM or any other
parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of
such technical information.

6) The Products specified in this document are not designed to be radiation tolerant.

7) For use of our Products in applications requiring a high degree of reliability (as exemplified
below), please contact and consult with a ROHM representative : transportation equipment (i.e.
cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety
equipment, medical systems, servers, solar cells, and power transmission systems.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace
equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with
the recommended usage conditions and specifications contained herein.

10) ROHM has used reasonable care to ensure the accuracy of the information contained in this
document. However, ROHM does not warrants that such information is error-free, and ROHM
shall have no responsibility for any damages arising from any inaccuracy or misprint of such
information.

11) Please use the Products in accordance with any applicable environmental laws and regulations,
such as the RoHS Directive. For more details, including RoHS compatibility, please contact a
ROHM sales office. ROHM shall have no responsibility for any damages or losses resulting
non-compliance with any applicable laws or regulations.

12) When providing our Products and technologies contained in this document to other countries,
you must abide by the procedures and provisions stipulated in all applicable export laws and
regulations, including without limitation the US Export Administration Regulations and the Foreign
Exchange and Foreign Trade Act.

13) This document, in part or in whole, may not be reprinted or reproduced without prior consent of
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