

US274-100USBPDPOCZ

100W USB Power Delivery (PD) Source

Description

The US274-100USBPDPOCZ board is a Universal Serial Bus Power Delivery (USB PD) evaluation board that supports DC input and USB PD output. It is designed with the RAA489000 – a digitally configurable buck-boost battery charger with USB-C® Port Controller (TCPC).

The US274-100USBPDPOCZ supports USB PD 2.0, USB PD 3.1, and USB Type-C® specifications, and works as a USB Type-C SPR power source capable of delivering 100W (20V, 5A) from DC power to a USB-C interface. The RAA489000 TCPC controller integrates TCPC PHY, CC-Logic, and VCONN switches and supports reverse buck, boost, or buck-boost operation. The USB-C Port Manager (TCPM) function is implemented in the RL78F14 series MCU R5F10PBE via I²C. The LIN interface allows the charger to communicate with the other modules in automobile applications.

Features

- USB Power Delivery and USB Type-C:
 - Supports USB Power Delivery Specification Revision 2.0, USB Power Delivery Specification Revision 3.1, USB Type-C Cable and Connector Specification Revision 2.2.
- Supported features:
 - Power Role: source only
 - Under Source Only mode: US274-100USBPDPOCZ can provide SPR mode 5, 9, 15, or 20 V output as USB Type-C power sourcing device
- One USB Type-C port
- Interface:
 - Renesas on-chip debugging emulator interface to write and debug firmware for R5F10PBE

Target Devices

- RAA489000 – a USB-C Port Controller (SPR TCPC) and buck-boost battery charger
- R5F10PBE – a USB-C Port Manager (TCPM: 32-pin plastic VQFN, 64kB Flash, 6kB RAM)

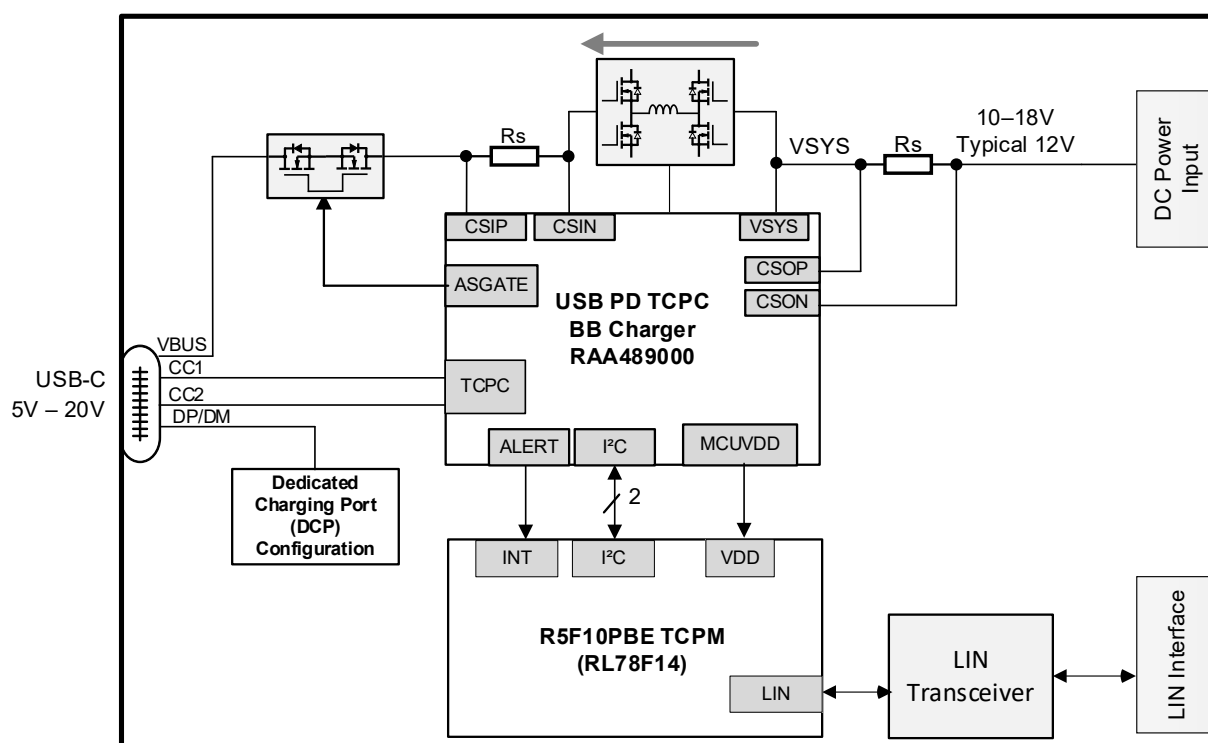


Figure 1. US274-100USBPDPOCZ Block Diagram (20V, 5A, SPR Mode)

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1. Related Documents

Use the US274-100USBPDPOCZ Evaluation Board manual in combination with the following documents:

- [RAA489000 Datasheet](#)
- [R5F10PBELNA#G5 User Manual](#)
- [E1 Emulator E20 Emulator User's Manual](#)
- [E2 Emulator Lite User's Manual](#)
- [E1/E20 Emulator, E2 Emulator Lite Additional Document for User's Manual \(Notes on Connection of RL78\)](#)
- [Renesas Flash Programmer V3.13 Flash Memory Programming Software User's Manual](#)

Note: The related documents above may include preliminary versions. However, preliminary versions are not always marked accordingly.

2. Board Design

2.1 Overview

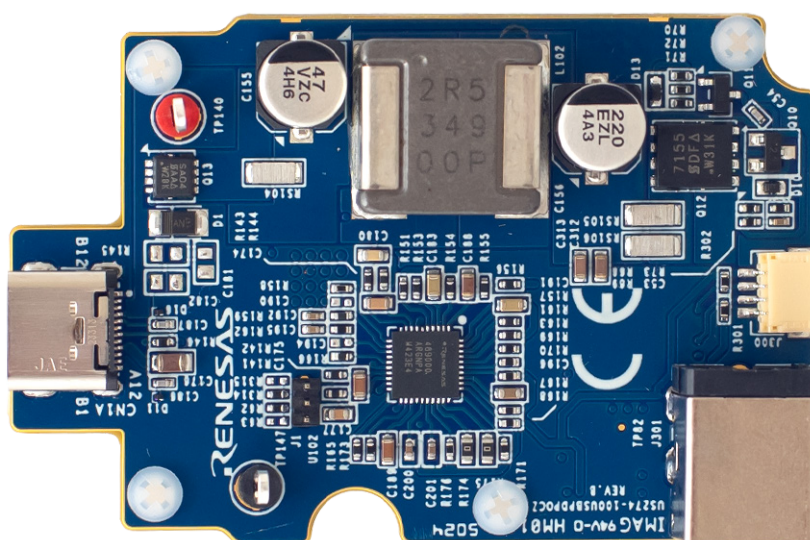


Figure 2. US274-100USBPDPOCZ USB PD Source Evaluation Board (Top)

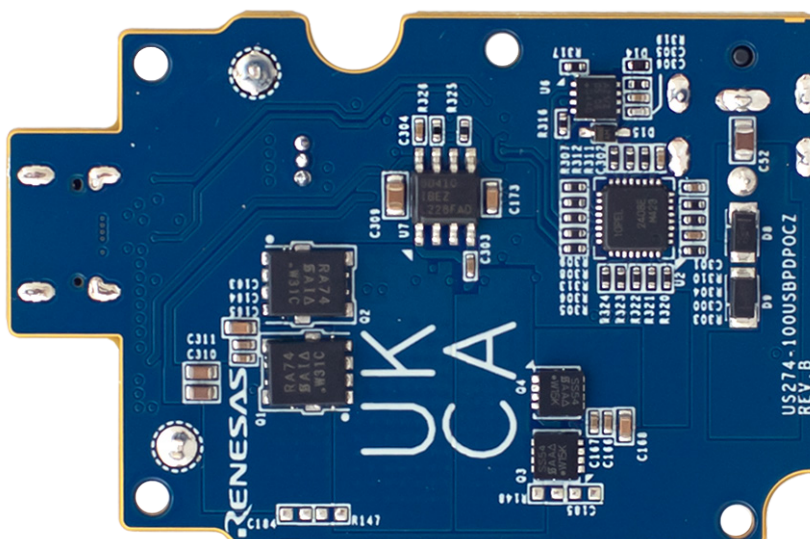


Figure 3. US274-100USBPDPOCZ USB PD Source Evaluation Board (Bottom)

2.2 Required Materials

- US274-100USBPDPOCZ: 1 unit
- USB Type-C Cable: 1pc (when the required maximum Type-C sourcing PD Power is 20V at 5A, 5A cable or EPR cable that has 5A capability is required.)

Important: Renesas does not have any responsibility, indemnification, or liability for the use of this board.

2.3 Board Components

The following is an overview of only the board's main components.

Note: there are no switches or LEDs incorporated on this board.

2.3.1 ICs

- **U102** – RAA489000 (48V USB-C Port Controller: SPR/EPR TCPC, Buck Booster charger). For more details, see section [2.3.3.1](#).
- **U2** – R5F10PBE1NA#G5 (USB-C Port Manager: TCPM). For more details, see section [2.3.3.2](#).
- **U6** – TJA1021TK/20 (ISO 17987/LIN 2.x/SAE J2602 transceiver)
- **U7** – ISL80410 (5V output LDO)

2.3.2 Connectors

- **CN1a** – USB Type-C receptacle
- **J300** – Renesas on-chip debugging emulator interface
- **J301** – DC power input
- **J1** – I²C/SMBus Target SCL, SDA, on R5F10PBE (U2: P10/P11 or P62/P63)

2.3.3 Test Points

- **TP140** – USB C VBUS
- **TP147** – GND

2.3.3.1 RAA489000 Pin Assignments and Functions

Pin Name	Function	Description
Bottom Pad	GND	Ground.
VDDP	VDD	Power supply for the gate drivers. Connected to the VDD pin through a resistor.
LGATE1	LG1	Low-side MOSFET Q2 gate drive.
PHASE1	PH1	Current return path for the high-side MOSFET Q1 gate drive.
UGATE1	UG1	High-side MOSFET Q1 gate drive.
BOOT1	BT1	High-side MOSFET Q1 gate driver supply.
BGATE	Open	-
VBAT	VAUTO	DC jack input voltage sense input.
CSN	CSN	DC jack input current sense "-" input.
CSOP	CSOP	DC jack input current sense "+" input.
NC	Open	-
PROG	PROG	With 232ohm PROG-GND resistor, I ² C Address is 1 and the default current limit is 0.476A.
COMPf	COMPf	Error amplifier output for Forward/Charging mode.
COMPp	COMPp	Error amplifier output for Reverse/OTG mode.

Pin Name	Function	Description
AMON/BMON (IMON)	Open	-
ACLIM	ACLIM	hardware-based adapter current limit.
ASRC	Gate	N-channel MOSFET source input reference for ASGATE/PD FETs.
CSIN	CSIN	Current sense “-” input from VBUS path.
CSIP	CSIP	Current sense “+” input from VBUS path.
ASGATE	Gate	Gate drive output of the N-channel system back to back MOSFETs.
VBUS	VBUS	USB-C VBUS; input to the HV selector for LDO power.
VSYS	VSYS	DC jack input voltage; input to the HV selector for LDO power.
BATGONE/NTC	BATGONE	Pull down to GND by 10kohm resistor. No battery present.
VDD	VDD	Output of the internal LDO
PROCHOT#	Open	-
MCU_VDD	VDD	Output for the 3.3V LDO to supply an external RL78 MCU.
VDD2P5	Open	-
ALERT_C	ALERT	Interrupt line for the TCPC, SDA_C and SCL_C; open-drain ;connected to RL78 MCU.
CC1	CC1	Configuration Channel 1.
CC2	CC2	Configuration Channel 2.
ALERT_B	ALERT	Open-drain output. Interrupt function output.
SCL_B	SCL_B	SMBus target clock input connected to RL78 MCU.
SDA_B	SDA_B	SMBus target data input/output (open-drain) connected to RL78 MCU.
VCONN_POWER	VCONN	Power supply (+5V) for VCONN.
SCL_C	SCL_C	SMBus target clock IO connected to RL78 MCU; for TCPC.
SDA_C	SDA_C	SMBus target data IO (open-drain) connected to RL78 MCU; for TCPC.
OTGEN/CMIN	DRP	Connected to MCU_VDD through 10k resistor.
BOOT2	BT2	High-side MOSFET Q4 gate driver supply.
UGATE2	UG2	High-side MOSFET Q4 gate drive.
PHASE2	PH2	Current return path for the high-side MOSFET Q4 gate drive.

2.3.3.2 R5F10PBE Pin Assignments and Functions

Pin Name	Function	Description
P120	Open	-
P41	Open	-
P40/TOOL	TOOL0	Connected to on-chip debugging emulator interface for flash programming.
RESET	RESET	Chip Reset Input (active low).
P137/INTPO	ALERT_B	SMBus controller ALERT_B input connected to RAA489000.
P122	Open	-
P121	Open	-
REGC	REGC	Regulator capacitance. Connecting regulator output stabilization capacitance for internal operation.
VSS	GND	Ground.
VDD	VDD	Power supply (+3.3V) connected to MCU_VDD pin of RAA489000.
P60	Open	-
P61	Open	-
P62/ SCLLA0	SCL_C	SMBus target clock input connected to SCL_C of RAA489000.
P63/SDAAA0	SDA_C	SMBus target data input/output (open-drain) connected to SDA_C of RAA489000.
P30/INTP2	ALERT_C	SMBus controller ALERT_C input connected to RAA489000.
P17/SCL00	Open	-
P16/SDA00	Open	-
P15	Open	-
P14/LRXD0	LIN_TDX	Currently not supported by firmware.
P13/LTXD0	LIN_RXD	Currently not supported by firmware.
P12	LIN_SLEEP	Currently not supported by firmware.
P11/SDA10	SDA_B	SMBus target clock input connected to SCL_B of RAA489000
P10/SCL10	SCL_B	SMBus target data input/output (open-drain) connected to SDA_B of RAA489000.
P33	Open	-
P34	Open	-
P80	Open	-
P81	Open	-
P82	Open	-
P83	Open	-
P84	Open	-
P85	Open	-
P125/INTP1	Open	-

3. Functional Operation

3.1 Sourcing Mode

The US274-100USBPDPOCZ runs under sourcing mode, meaning that the board draws the current from DC power and output to USB-C.

It supports the standard maximum sourcing PD power as shown in [Table 1](#) is based on the following formula.

The standard PD power in the FW is:

- Maximum supply current (3 or 5A) × standard supply voltage (SPR: 5, 9, 15, or 20V)
- 5, 27, 45, or 60 W (SPR and 3A cable), or 100W (SPR and 5A cable)

The maximum sourcing PD power in the FW $\leq$ available sourcing power.

The USB-PD fixed PDO list, which is used on PD negotiation, is as follows:

Table 1. PDO List

	SPR PDO1	SPR PDO2	SPR PDO3	SPR PDO4
PDP 15W	5V/3A	-	-	-
PDP 27W	5V/3A	9V/3A	-	-
PDP 45W	5V/3A	9V/3A	15V/3A	20V/2.25A
PDP 60W	5V/3A	9V/3A	15V/3A	20V/3A
PDP 100W	5V/3A	9V/3A	15V/3A	20V/5A ^[1]

1. When the connected cable does not have 5A capability, the US274-100USBPDPOCZ presents 20V/3A PDO instead of 20V/5A PDO.

Note: The range of DC input voltage is 11V–18V. If the DC input is lower than 11V, some of the PDO requests in [Table 1](#) might not be achieved.

3.2 Firmware Writing to the RL78

This section describes the method of writing the firmware (for example, Intel HEX file) to the RL78F14 MCU.

3.2.1 Firmware Generation – ROM Image File

The US274-100USBPDPOCZ board is shipped with the default firmware already flashed.

Note: The instruction tool “VIDWriter” that generates the firmware is currently under development.

3.2.2 Outline of Flash Memory Writing

The code flash memory can be rewritten through serial programming using a flash memory programmer.

The following dedicated flash memory programmers can be used to write data to the flash.

- PG-FP6
- E1, E2, E2 Lite, E20 on-chip debugging emulator

For more details, refer to the [Related Documents](#) section.

Data can be written to the flash memory on-board by using a dedicated flash memory programmer. [Table 2](#) shows the relationship between the situation of the firmware writing method and the available writing tool using this interface.

Table 2. Firmware Writing Method and Available Writing Tool

Interface	Situation	Available Writing Tool	Device
Serial Programming (TOOL0)	Customer's manufacturing	Example: PG-FP6 SF2000A made by Superfly China	On-board
	Design debug, FW update	E1, E2, E2 Lite, E20 on-chip debugging emulator	On-board

3.2.2.1 On-Board Programming

The contents of the flash memory can be rewritten after the MCU have been mounted on the target system. The connectors that the dedicated flash memory programmer uses must be mounted on the target system.

Use the Renesas Flash Programmer V3 as programming software. Refer to the following documents:

- [Renesas Flash Programmer V3.13 Flash Memory Programming Software User's Manual](#)
- [List of MCUs supported by Renesas Flash Programmer V3](#)
- [RL78 microcontrollers \(RL78 Protocol A\) Programmer Edition Application Note](#) (on the development of flash memory programmer by user)

Table 3. Wiring between RL78/F14 MCU R5F10PBE and Dedicated Flash Memory Programmer

Pin Configuration of Dedicated Flash Memory Programmer				R5F10PBE 32-pin QFN	
Signal Name		IO	Pin Function		
PG-FP6	E1, E2, E2 Lite, E20 on-chip debugging emulator			Pin Name	Pin No.
SI/RxD	TOOL0	I/O	Transmit/Receive signal	P40	3
/RESET	RESET	Output	Reset signal	RESET	4
VDD	VDD	I/O	VDD voltage	VDD	10
GND	GND	-	Ground	GND Pad	GND PAD
FLMD1	EMVDD	-	Driving power for TOOL0 pin	VDD	10

Note: Pins that are not indicated in the above table can be left open when using the flash memory programmer for flash programming.

3.2.3 Firmware Writing with Renesas On-chip Debugging Emulator

Firmware can be written (loaded) with the Renesas on-chip debugging emulator. Since the US274-100USBPDPOCZ does not have a full 14-pin connector for the emulator, the connection is made via a converter made with the bundled cable when using the Renesas on-chip debugging emulator. Follow the steps below.

1. Connect conversion connector to J300 on the board.
2. Connect the Renesas on-chip debugging emulator to the conversion connector.
3. Connect the emulator to the USB port of the PC.

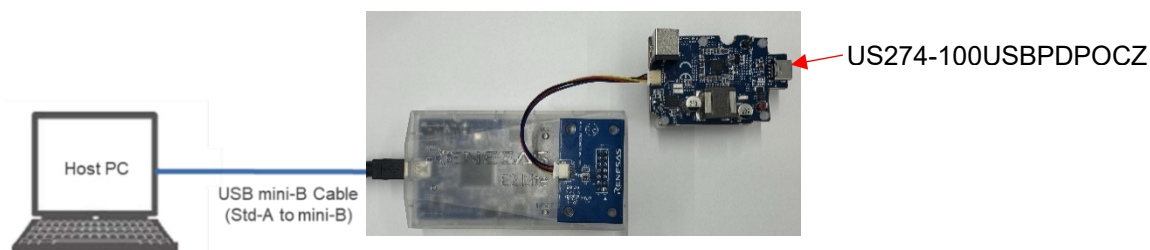


Figure 4. Board Connection for Programming by On-chip Debugging Emulator

4. Execute the Renesas Flash Programmer V3.xx.
5. Create a “New Project”. See [Figure 5](#).

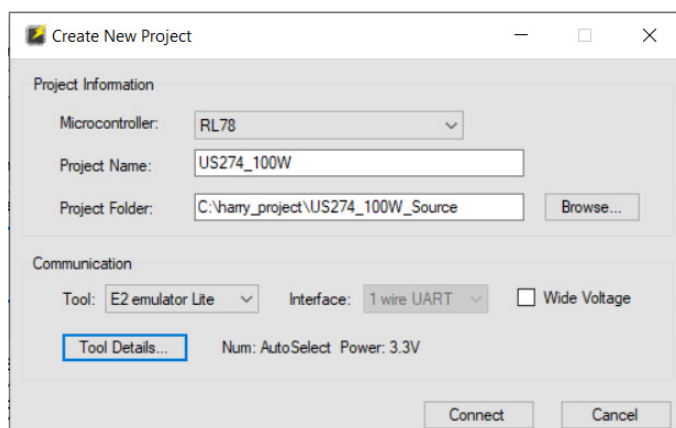


Figure 5. New Project Window

6. Select *RL78* from the “Microcontroller” pull-down list, then input an arbitrary name in the “Project Name” field.
7. Select the preferred on-chip debugging emulator product in the “Connection > Tool” pull-down list.
8. Click *Tool Details* and select “3.3V” Power Supply, then click OK. See [Figure 6](#).

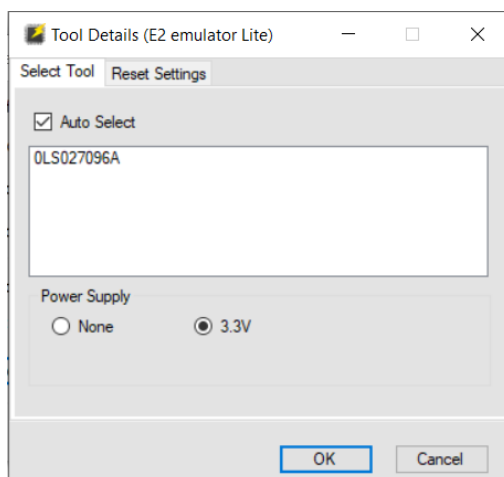


Figure 6. Power Supply Connection Window

After selecting the Power Supply, click *Connect* in the “Create new Project” window.

9. Once the project has been successfully created, the following window displays (see [Figure 7](#)).

Note: confirm that the Microcontroller detects **R5F10PBE**.

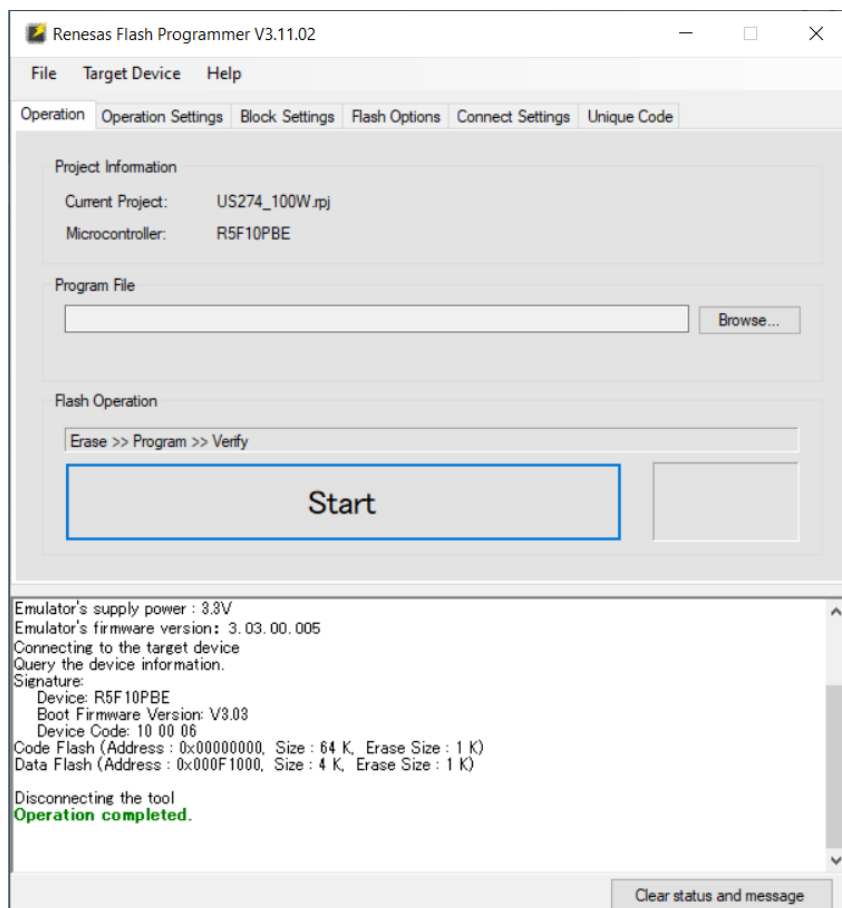


Figure 7. Renesas Flash Programmer Window – Operation Tab

10. Click on the “Operation Settings” tab (see [Figure 8](#)). Check the *Erase*, *Program* and *Verify* boxes.

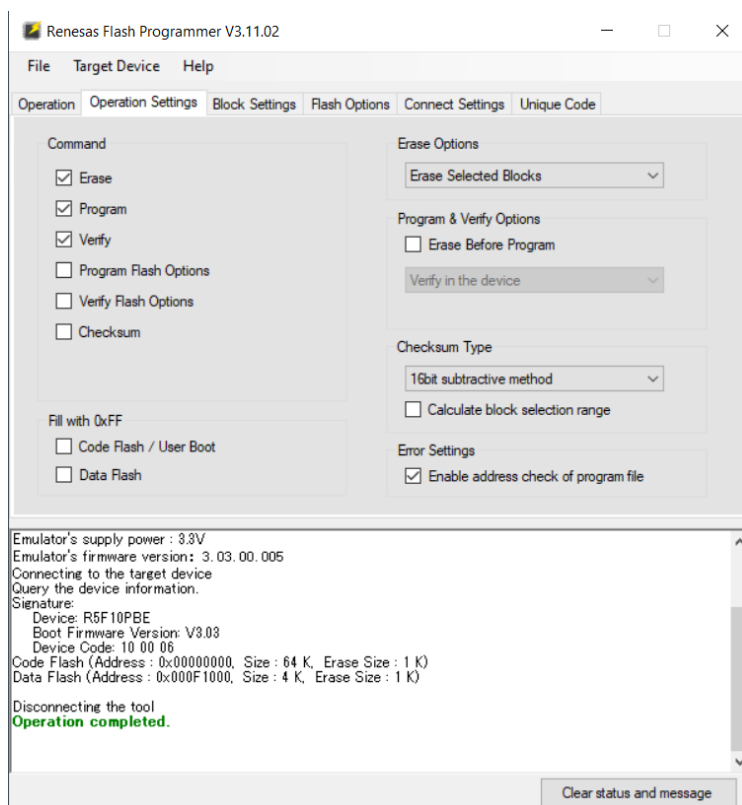


Figure 8. Operation Setting Tab

11. Select the “Operation” tab and click on *Browse* to select the HEX file (see [Figure 9](#)). Click the *Start* button to start programming the flash memory data.

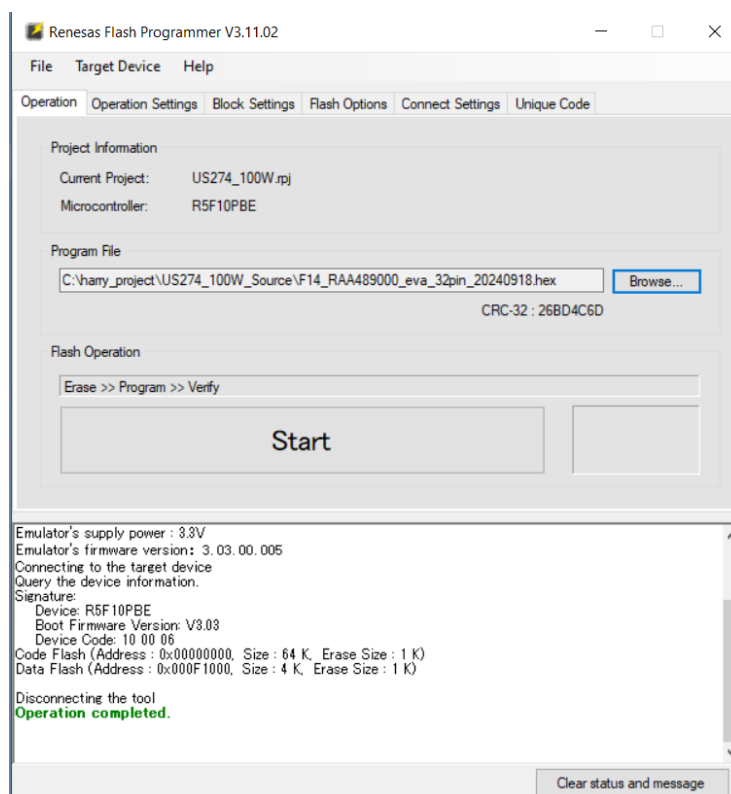


Figure 9. Select HEX File

12. If the program is successfully completed, the green OK indicator displays (see [Figure 10](#)).

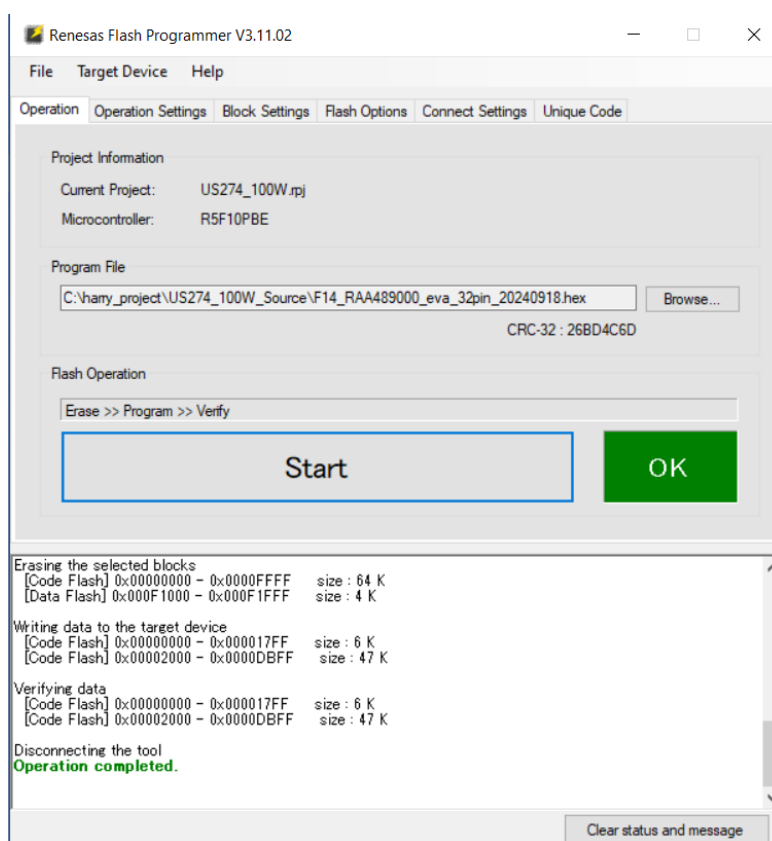


Figure 10. Program Success Window

3.3 Board Test

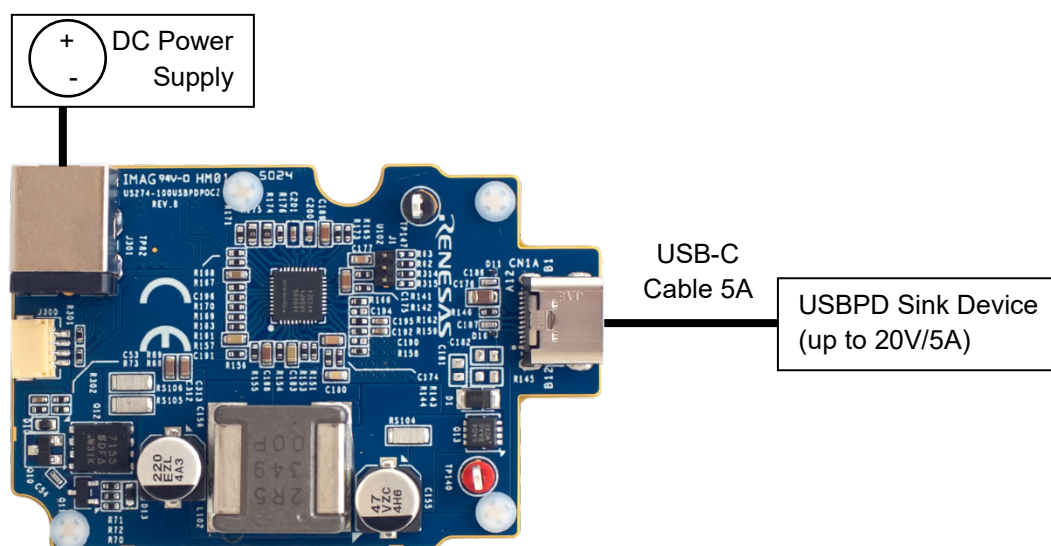


Figure 11. Board DC Power Supply Input and USBPD Output

3.3.1 DC Input

The range of DC input voltage is 11V–18V. If the DC input is lower than 11V, some of the PDO requests in [Table 1](#) might not be achieved. Typically, DC input can be set to 12V. The DC power supply should be able to provide at least 150W/up to 15A power.

A male plug is required to match the DC jack (ID:2.50mm/0.098, OD: 5.50mm/0.217, Mating Depth: 0.324"/8.23mm) on the board for the DC cable. The current rating of the DC cable is at least 10A.

3.3.2 USB PD Output

- The US274-100USBPDPOCZ works as a source device. A USB PD device requiring less than 100W can be powered by this board.
- User 5A USB C cable for test.
- The USB-C output voltage is decided by the requested PDO by the USB PD sink device (see [Table 1](#)).
- The range of output voltage on the USB Type-C receptacle is $0.95 \times \text{PDO voltage}$ to $1.05 \times \text{PDO voltage}$. For example, if it is 5V output, the actual output voltage will be in the range of 4.75V to 5.25V depending on the current load. The maximum current is 3A for 5V, 9V, 15V and the maximum current can be up to 5A for 20V PDO.
- TP140(VBUS) and TP147(GND) can be used for the voltage measurement of USB-C output.
- A USB-C meter/tester is recommended to measure the voltage and current of USB-C output.

4. Optional Features

4.1 SMBus Target Interface

The board has an SMBus target interface to communicate with other controllers outside of this board to expand the feature with the total system.

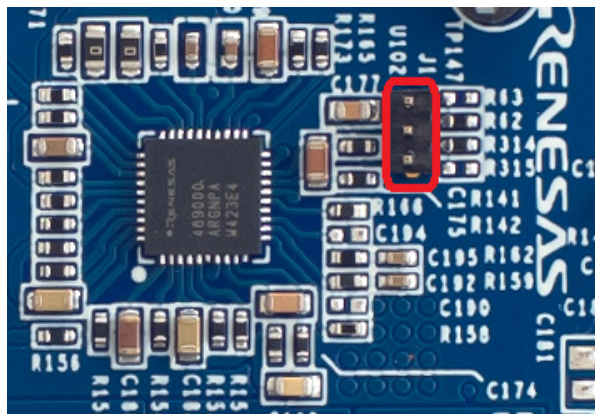


Figure 12. Connector for SMBus Target Interface

To control US274-100USBPDPOCZ by external controller via the SMBus Target Interface, the SMBus Controller signaling of the system is to be connected to J1.

Note: The shipped software does not support SMBus target interface. For more information, contact [Renesas support](#).

4.2 LIN Interface

The board has a LIN interface to communicate with other controllers outside of this board. The LIN interface is accessed via TP82.

Note: The shipped software does not support LIN interface. For more information, contact [Renesas support](#).

5. Ordering Information

Part Number	Description
US274-100USBPDPOCZ	100W USB Power Delivery Source Evaluation Board

6. Revision History

Revision	Date	Description
1.00	Mar 18, 2025	Initial release.

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