Application Note

How to Connect the BQ25756 EVM to the TPS26750 EVM and Initiate USB Type C PD EPR Contract

Christian Moyer and Aya Khedr

ABSTRACT

This application note outlines a method for connecting the BQ25756 EVM to the TPS26750 EVM in order to negotiate a 48V/ 5A USB-C PD EPR contract. It also covers the test procedures and results of this method.

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1 Introduction

The USB Power Delivery (PD) 3.1 Extended Power Range (EPR) allows up to 240W of power delivery through USB-C. This is achieved through the EPR contracts that extend beyond the Standard Power Range (SPR) of USB PD 3.0, with options such as 28V/5A, 36V/5A, and 48V/5A.

The TPS26750EVM is an evaluation module for the TPS26750 IC. The TPS26750 IC is a highly integrated stand-alone USB Type-C and PD controller optimized for USB-C PD EPR applications. The TPS26750EVM supports sourcing and sinking up to 48V at 5A, in accordance with the USB-PD specification, as well as supporting battery charging applications when paired with the BQ25756EVM.

The BQ25756EVM is an evaluation module for the BQ25756 IC. The BQ25756 IC is a buck-boost battery charge controller with a wide input range of 4.2 V - 70 V, a wide output voltage range of up to 70 V, and bi-directional capabilities. The BQ25756EVM has a maximum input and output voltage of 55V, a maximum charge current of 10A, so it can be evaluated for the full 240 W range of USB Extended Power Range (EPR).

2 Equipment

To fully test the functionality of USB-C 240 Watt EPR using this method, the following equipment is required:

- **TI EVMs:**
  - Two BQ25756EVMs and Two TPS26750 EVMs
- **Connectors:**
  - A USB-IF compliant EPR cable, Two 4x2 IDC Ribbon cables, Two TPS26750EVM to BQ25756EVM Interposer Boards or similar connector for power transfer.
- **Power Supply:**
  - A power supply capable of supplying 30V at 9A
- **Load:**
  - There are two ways to simulate a battery, the first and preferred way is to use a four-quadrant power supply. The second is to use a electronic load in constant voltage mode.
  - If load is a four-quadrant or two-quadrant power supply. Kepco: BOP 50-20MG, DC Voltage from 0 to ±50 V, DC current from 0 to ±20 A (or higher), or equivalent is recommended.
  - If load is an electronic load in constant voltage mode, Kikusui PLZ164WA 0-150V, 0-33A, or equivalent is recommended.
  - When testing without a real battery, connect 2000µF of capacitance across the input of the electronic load/four-quadrant power supply.
- **Optional Additional Equipment:**
  - To perform a power role swap test with battery charging, two Bi-Directional Power supply such as a Kepco: BOP 50-20MG DC Voltage from 0 to ±50 V, DC current from 0 to ±20 A (or higher), or equivalent is required.

2.1 Equipment Setup

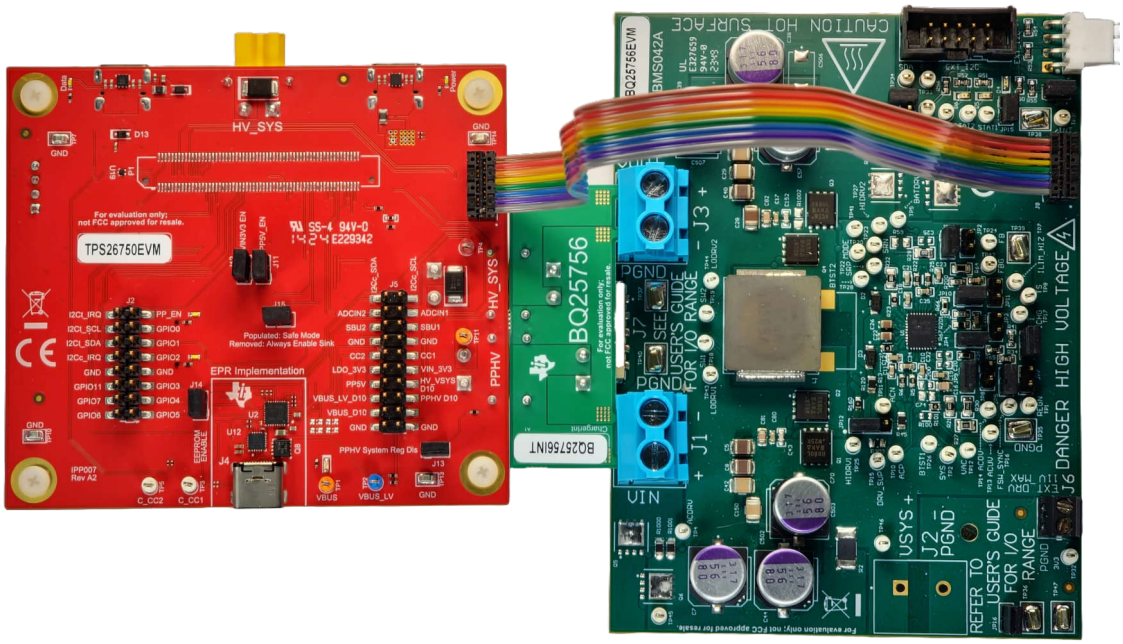


Figure 2-1. TPS26750EVM and BQ25756EVM Hardware Setup

Use the following guidelines to set up the EVMs:

1. Follow the TPS26750EVM User Guide and TPS26750 Web Application to configure one of the TPS26750 EVM as a sink device and the other TPS26750EVM as a source device.

> **Note**
>
> The BQ25756EVM has a default charge voltage of 29.4V. In order to see the full EPR range, the voltage divider on the BQ25756 FB pin needs to be changed to support a higher charger voltage or the charge current needs to be increased to 8A. The power supply on the source side is fed from the J8 connector of TPS26750 into the battery terminal of BQ25756. The voltage on the power supply needs to be proportional to the charge voltage programmed using the voltage divider on the BQ25756 FB pin. The load voltage should be set slightly lower than the targeted charge voltage (to simulate a battery that is not fully charged yet). Since the default charge voltage is 29.4V, the recommend power supply should be 29.4V with a current limit of 9A, and the load voltage should be 28V with a current limit of 9A.

2. Connect the J1 and J7 mating connectors of the TPS26750EVM to the reciprocal connectors on the provided BQ25756 interposer board.
3. Insert the other side of the BQ25756 interposer board to headers J1 and J3 on the BQ25756EVM. Make sure the prongs are inserted all the way into the headers.
4. Attach one end of the ribbon cable to header J9 on the TPS26750EVM, attach the other end of the ribbon cable to header J8 of the BQ25756EVM.
5. Install the jumpers as indicated in IO and Jumper Descriptions of the *BQ25756EVM User Guide*.
6. Repeat steps 1-5 for the other set of EVMs

7. There should be two combination of EVMs, one should be configured as the sink device and the other should be configured as a source device.
   a. On the source side, connect the power supply to port J8 of the TPS26750EVM. and set the power supply voltage to 29.4V with a current limit of 9A
   b. On the sink side, connect the load to port J8 of the TPS26750EVM and set the load voltage to 28V with a current limit of 9A

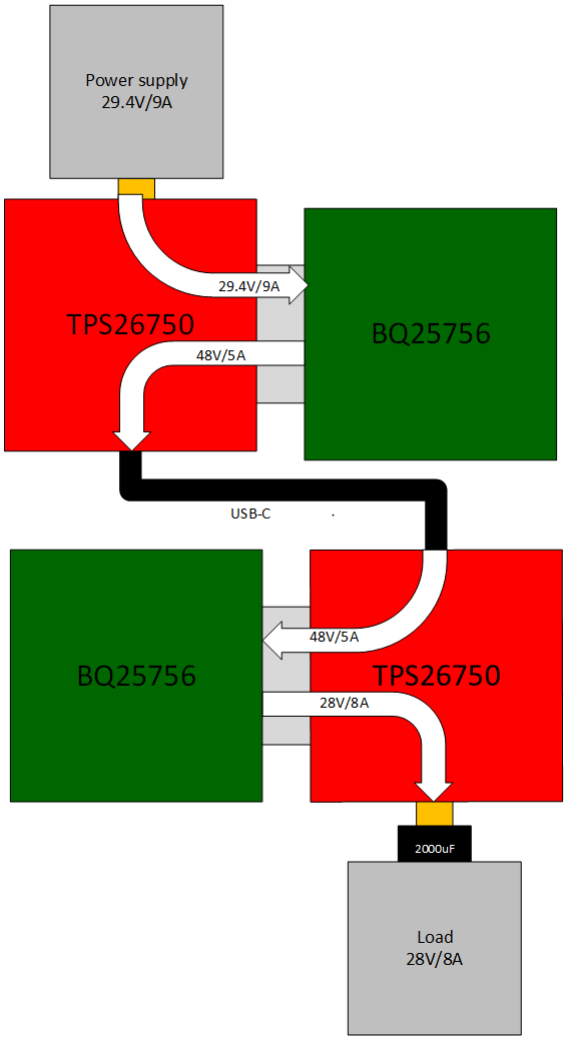


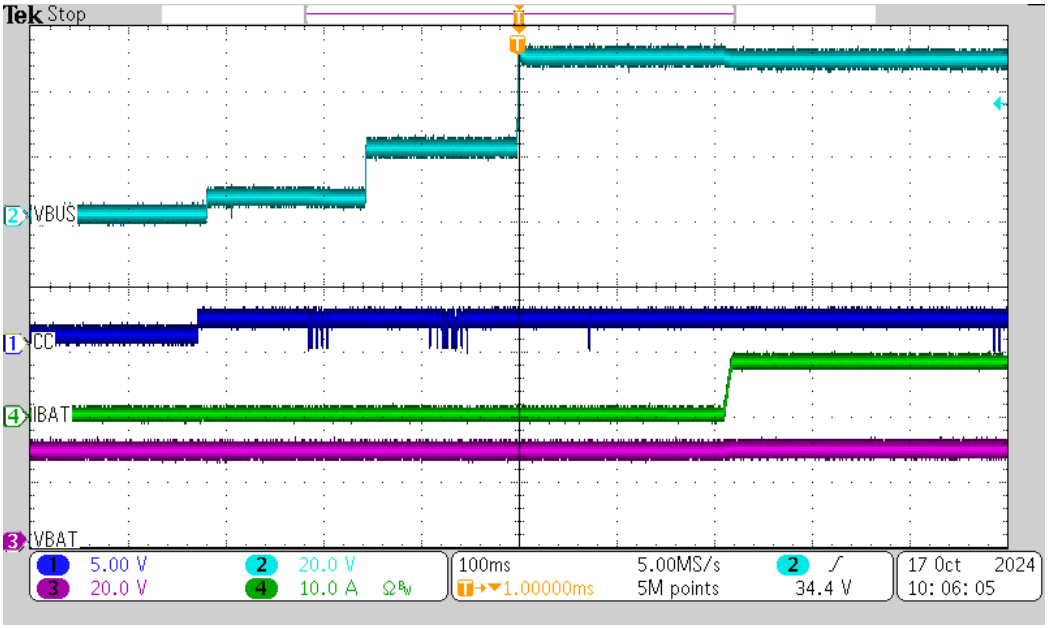
Figure 2-2. Block Diagram of the Source side connected to the Sink side

On the source side, the power supply is connected to port J8 of the TPS26750EVM. The power supply voltage is set to 29.4V with a current limit of 9A. On the sink side, the load is connected to port J8 of the TPS26750EVM. The load voltage is set to 28V with a current limit of 9A. The white arrows shows how the power from the power supply is transferred to the load supply.

2.2 Evaluation and Results

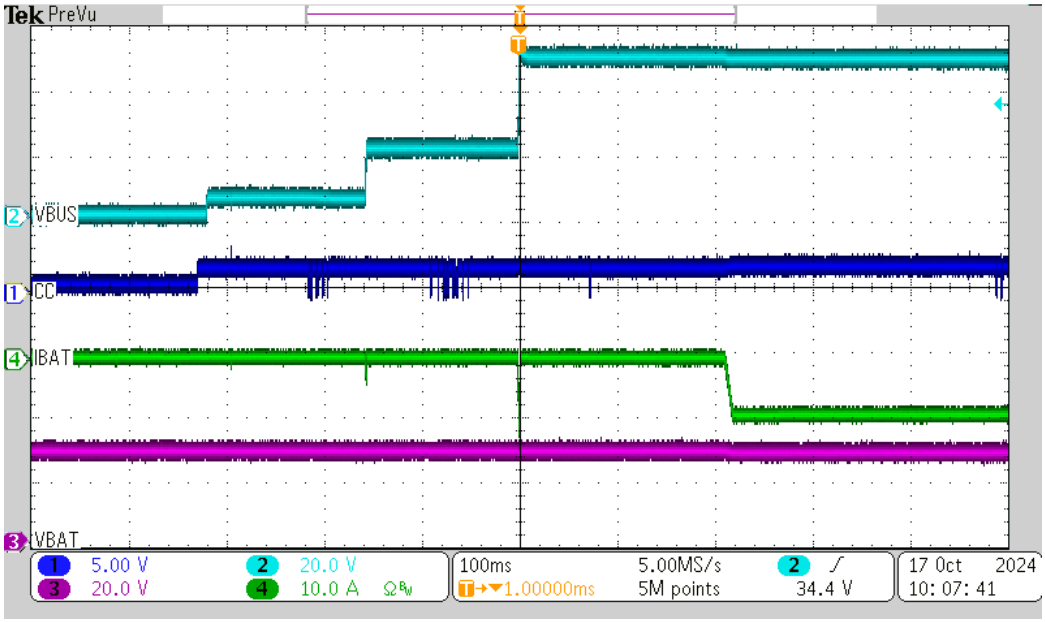
Use the following guidelines to evaluate the full 240W range of USB Extended Power Range (EPR):

1. Turn the power supply and load on.
2. Use a USB-C cable, capable of EPR, to connect the USB-C terminal J4 of the source board to the USB-C terminal J4 of the sink board
3. The two TPS26750 will begin negotiating to establish a PD contract. If the power supply, load, and USB-C cable are capable of EPR. The VBUS of the USB-C cable will go to 5V, then 20V, then 48V.



The VBUS of the USB-C cable ramps up from 0V to 5V, then 5V to 20V, and then 20V to 48V. The CC lines show that the PD controllers are communicating with each other. IBAT/VBAT shows the device is sinking 8A of current to charge the battery that is attached to the sink side

Figure 2-3. 48V/5A 240W EPR Sink PDO



The VBUS of the USB-C cable ramps up from 0V to 5V, then 5V to 20V, and then 20V to 48V. The CC lines show that the PD controllers are communicating with each other. IBAT/VBAT shows the input power supply is sourcing around 8A of current at 29.4V to the sink device to charge the attached battery.

Figure 2-4. 48V/5A 240W EPR Source PDO

2.3 Optional Power Role Swap Test

The TPS26750EVM is capable of functioning as a source, sink, or Dual Role Power (DRP) device, adapting to either power role based on the connection. When configured as a DRP device, it can initiate connections in either role (source or sink) but typically has a preferred role set. If the preferred role is set as “source,” yet it initially connects as a sink to a port partner, the TPS26750EVM actively requests a power role swap to attempt to assume the source role. To perform this test, the power supply and load needs to be switched out for two bi-directional power supplies.

Use the following guidelines to set up the EVMs for Power Role Swap test:

1. Follow the *TPS26750EVM User's Guide* and TPS26750 Web Application to configure the two TPS26750 EVM's as DRP with no preferred role set.

Note

The BQ25756EVM has a default charge voltage of 29.4V. In order to see the full EPR range, the voltage divider on the BQ25756 FB pin needs to be changed to support a higher charger voltage or the charge current needs to be increased to 8A. On the source side the power supply on the source side is fed from the J8 connector of TPS26750 into the battery terminal of BQ25756. The voltage on the power supply needs to be proportional to the charge voltage programmed using the voltage divider on the BQ25756 FB pin.

2. Connect the J1 and J7 mating connectors of the TPS26750EVM to the reciprocal connectors on the provided BQ25756 interposer board.
3. Insert the other side of the BQ25756 interposer board to headers J1 and J3 on the BQ25756EVM. Make sure the prongs are inserted all the way into the headers.
4. Attach one end of the ribbon cable to header J9 on the TPS26750EVM, attach the other end of the ribbon cable to header J8 of the BQ25756EVM.
5. Repeat steps 1-4 for the other set of EVMs
6. There should be two combination of EVMs, both configured as DRP.
7. Connect the bi-directional power supplies to the J8 ports of the TPS26750 EVM's.
8. Turn the bi-directional power supplies on.
9. Use a USB-C cable, capable of EPR, to connect the USB-C terminal J4 of the source board to the USB-C terminal J4 of the sink board
10. The two TPS26750 begins negotiating to establish a PD contract. If the power supply, load, and USB-C cable are capable of EPR. The VBUS of the PD controller goes to 5V, then 20V, then 48V.
11. After the two set's of EVM's establish a power role connection, a 4CC command can be sent to either of the TPS26750EVM's to perform a power role swap.

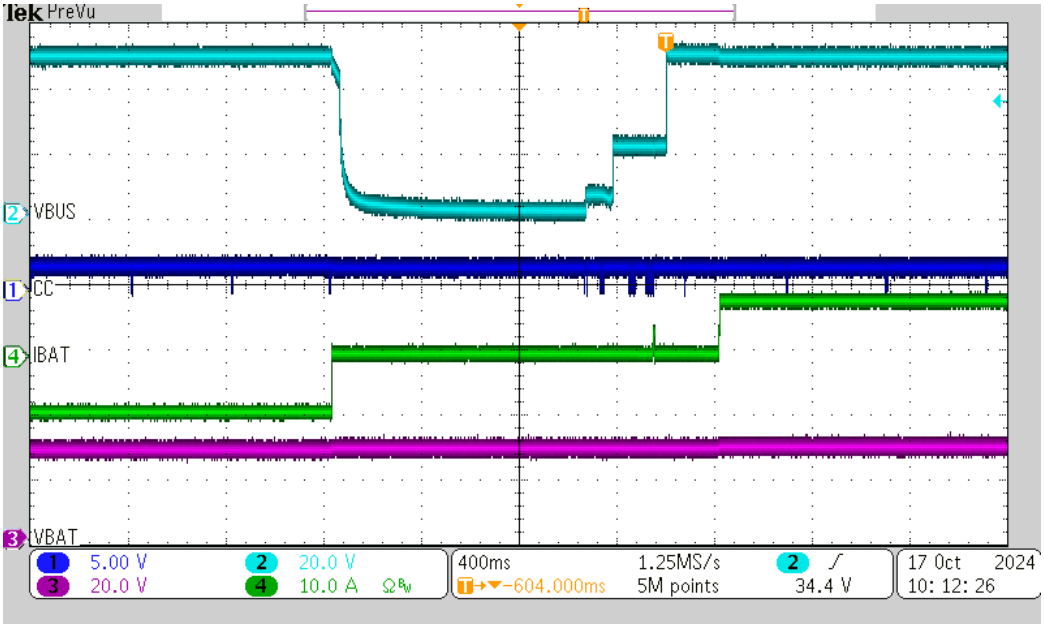


Figure 2-5. 48V/5A 240W EPR PRS Swap From Source to Sink

The device starts as a source, the host then request a PRS to sink, using 4CC command. The VBUS drops from 48V to 0V and then ramps up from 0V to 5V, then 5V to 20V, and then 20V to 48V. The CC lines show that the PD controllers are communicating with each other. IBAT/VBAT shows the device sourcing at 8A in the beginning, dropping to 0A during the PRS, and then sinking at 8A.

3 Summary

The TPS26750EVM and BQ25756 EVM can be used to evaluate the full range of both Standard Power Range (SPR) and Extended Power Range (EPR). This allows for thorough testing and assessment of the TPS26750 and BQ25756 IC across various power levels to provide a comprehensive evaluation of their performance capabilities.

4 References

- Texas Instruments: *BQ25756: Standalone/I2C Controlled, 1- to 14-Cell Bidirectional Buck-Boost Battery Charge Controller Data Sheet*
- Texas Instruments: *BQ25756EVM User's Guide*
- Texas Instruments: *TPS26750 USB Type-C® and USB PD Controller With Integrated Power Switches Optimized for Power Applications Data Sheet*
- Texas Instruments: *TPS26750EVM User's Guide*
- TPS26750 Web Application

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