Application Note

TPSM8D6C24 Module Stackability Using the TPSM8D6C24EVM-2V0 Evaluation Module

ABSTRACT

The TPSM8D6C24 dual synchronous BUCK module with PMBus™ interface offers a two-output 35A converter with two synchronous BUCK converters integrated with their common passives in a small, open frame module platform. To increase the flexibility of the TPSM8D6C24 module, the two synchronous BUCK converters outputs can be combined to provide 70-A, or two modules can be combined to provide a 4-phase solution delivering up to 140-A from a common high-current building block. This stackability is easily demonstrated using the TPSM8D6C24EVM-2V0 evaluation module.

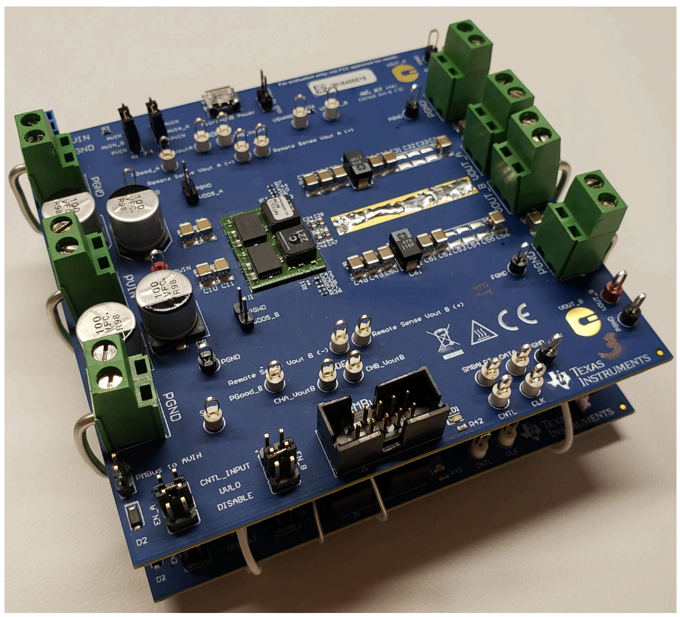

Figure 1-1. 4-Phase Converter Using Two TPSM8D6C24EVM-2V0

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Trademarks

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1 Configuring One TPSM8D6C24EVM-2V0 as a Two-Phase Single Output Evaluation Module

In a two-phase configuration with Channel A set as the primary, the TPSM8D6C24 needs the following connections, along with their TPSM8D6C24EVM-2V0 reference designators:

1. GOSNS/FLWR_B pulled up to BP1V5_B (R11)
2. VSHARE_B connected to VSHARE_A (R26)
3. BCX_CLK_B connected to BCX_CLK_A (R19, already installed)
4. BCX_DAT_B connected to BCX_DAT_A (R20, already installed)
5. SYNC is already connected internally between the two converters.

To convert the TPSM8D6C24EVM-2V0 evaluation module from a dual output configuration to a dual phase configuration mimicking the TPSM8D6C24EVM-2PH make the following changes listed below. See Figure 1-1 and Figure 1-2 for visual reference.

1. Remove R39 (Bottom) to disconnect GOSNS/FLWR_B from the output ground
2. Install a 10-kΩ resistor in the R11 (Top) position (GOSNS/FLWR_B to BP1V5) to pull GOSNS/FLWR up to 1.5 V and configure Converter B as a Follower.
3. Remove R21 (Bottom - MSEL2_A to GND) to float the MSEL2 pin and configure Converter A as the primary converter of a 2-phase stack.
4. Install a 0-Ω resistor (you can reuse R21 if you did not damage it) in the R26 (Top) location (VSHAREA to VSHAREB) location to connect the output of the Channel A voltage error amplifier to Channel B.
5. Short VOUT_A and VOUT_B on the top and bottom of the PCB together by soldering the exposed copper area on the top and bottom of the PCB.
6. BCX_CLK_A is already connected to BCX_CLK_B through R19 and BCX_DAT_A is already connected to BCX_DAT_B through R20 since these pins are not used in a dual output configuration, and a common SYNC signal is used for both channel A and B.

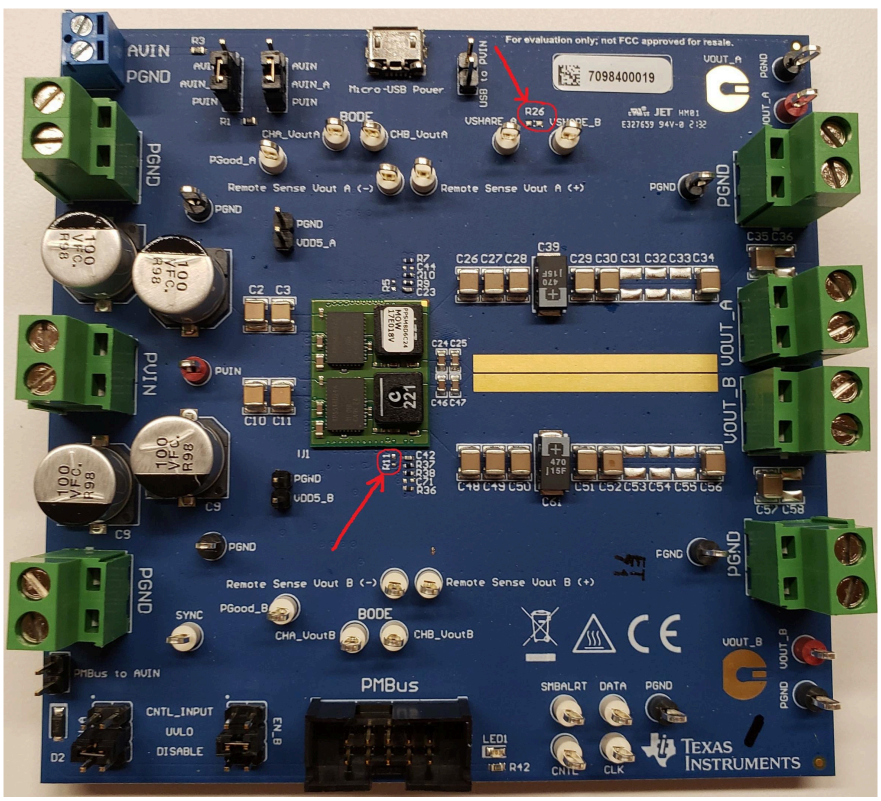

Figure 1-1. Top View of TPSM8DC24EVM-2V0 Highlighting R11 and R26

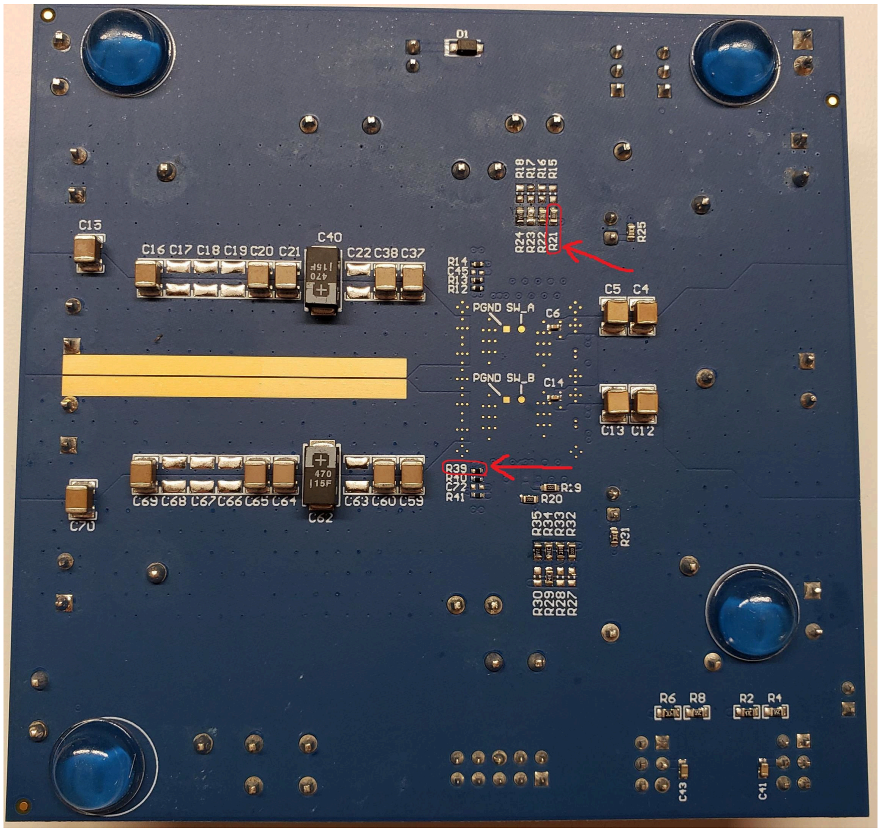

Figure 1-2. Bottom View of TPSM8DC24EVM-2V0 Highlighting R21 and R39

On power up, Converter A will program Converter B's switching frequency, compensation, and output voltage, and serve as Converter B's connection to PMBus so R29, R33, R34, R35 are not required and can be removed. PMB_CLK_B, PMB_DAT_B, and PGOOD_B also do not need to be connected.

2 Configuring Two TPSM8D6C24EVM-2V0 as a Four-Phase Single Output Evaluation Module

In addition, two TPSM8D6C24EVM-2V0 evaluation modules can be combined with a four board to board interconnects, in addition to common VIN and VOUT, to demonstrate a two module, four-phase design.

First, update both boards as if converting them from a dual-output to a two-phase following the steps mentioned in Section 1. See Figure 1-1, Figure 1-2 and Figure 2-1 for visual reference.

Now, update board number one with the following changes:

1. Remove R32 (bottom) to make space for programming MSEL2_B for phase 02 of a 4-phase.
2. Install a 8.25-kΩ resistor in the R21 (bottom) location to configure Channel A as the leader (Phase 00) of a 4-phase stack.
3. Install a 68.1-kΩ resistor in the R32 (bottom) location to configure Channel B as a phase 02 of a 4-phase stack. Note: Channel B of board 1 is configured as Phase 02 rather than Phase 01 so that phases within a single module operate 180 degrees out of phase with each other.
4. Add a small signal wire to the SYNC test point (TP15)
5. Add a small signal wire to the VSHAREA test point (TP12)
6. Add a small signal wire to one side of R19 (BCX_CLK)
7. Add a small signal wire to one side of R20 (BCX_DAT)

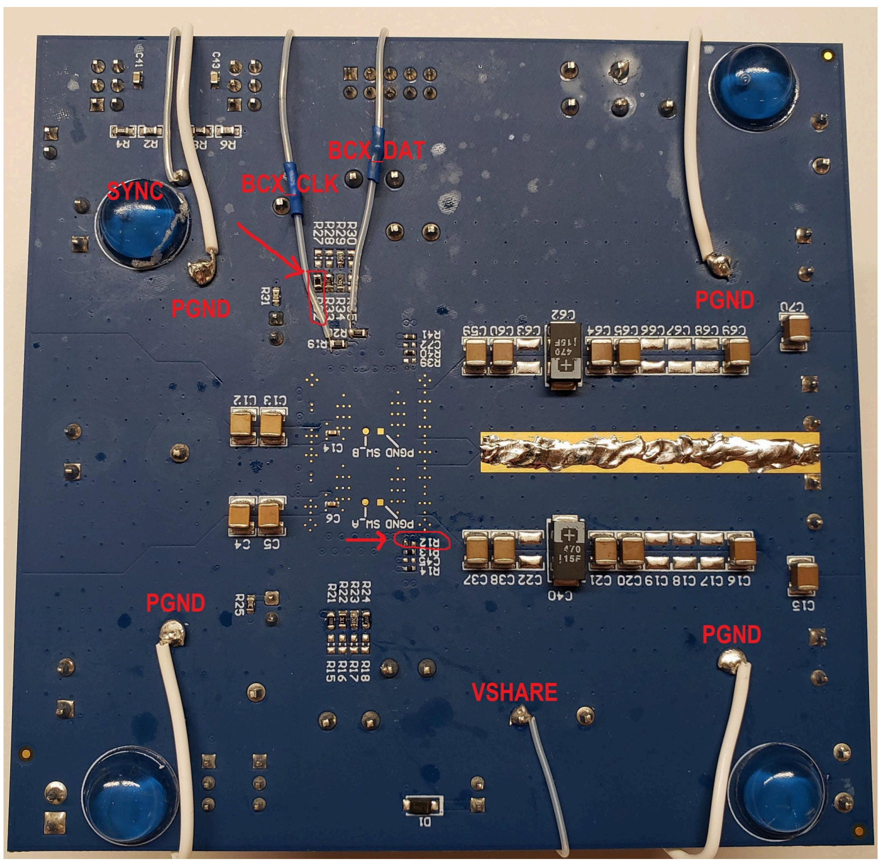

Figure 2-1. Bottom View of Four-Phase Configuration

Update board number-two with the following changes:

1. Remove R12 (Bottom) to disconnect GOSNS/FLWR_A from the output ground
2. Remove R32 (Bottom) to make space for programming MSEL2_B for phase 03 of a 4-phase
3. Install a 10-kΩ resistor in the R5 (top) location to pull GOSNS/FLWR_A to BP1V5_A to configure channel A as a stack follower.
4. Install a 6.81-kΩ resistor in the R21 (Bottom) location to configure Channel A as a Phase 01 follower of a 4-pahse stack.

5. Install a 31.6-kΩ resistor in the R32 (Bottom) location to configure Channel A as a Phase 03 follower of a 4-phase stack

Finally, connect the two boards together.

1. Add Short, Heavy Gauge wires (solid preferred) to PVIN_A, PVIN_B, VOUT_A, and VOUT_B and GND terminals on both input and output sides of board two.
   - Tighten the terminal blocks.
2. Stack Board number 1 directly on top of board number two, and connect the wires to the matching terminal blocks on board number one.
   - Tighten the terminal blocks on board number one
3. Solder the 4 small signal wires from board number one to the matching location on board number two.
   - VSHARE_A to VSHARE_A (TP12)
   - SYNC to SYNC (TP15)
   - BCX_CLK (R19) to BCX_CLK (R19)
   - BCX_DAT (R20) to BCX_CLK (R20)

The two EVMs are now configured as a single output 4-phase converter (Figure 1-1). Thanks to the BCX_CLK and BCX_DAT connections between the four devices, the PMBus only needs to connect to EVM board one, which is placed on top to allow access to the 10-pin connector for the USB-to-GPIO adapter.

3 Configuring Two TPSM8D6C24EVM-2PH as a Four-Phase Single Output Evaluation Module

Two TPSM8D6C24EVM-2PH evaluation modules can also be converted into a four-phase single output evaluation module following a similar process as outlined in Section 2 of this application note. The TPSM8D6C24EVM-2V0 and the TPSM8D6C24EVM-2PH have the same reference designators in the same PCB locations. Components are just populated differently and both channels outputs are shorted together on the TPSM8D6C24EVM-2PH. See Figure 1-1, Figure 1-2 and Figure 2-1 for visual reference.

Update board number one with the following changes:

1. Remove R32 (bottom) to make space for programming MSEL2_B for phase 02 of a 4-phase.
2. Install a 8.25-kΩ resistor in the R21 (bottom) location to configure Channel A as the leader (Phase 00) of a 4-phase stack.
3. Install a 68.1-kΩ resistor in the R32 (bottom) location to configure Channel B as a phase 02 of a 4-phase stack. Note: Channel B of board 1 is configured as Phase 02 rather than Phase 01 so that phases within a single module operate 180 degrees out of phase with each other.
4. Add a small signal wire to the SYNC test point (TP15)
5. Add a small signal wire to the VSHAREA test point (TP12)
6. Add a small signal wire to one side of R19 (BCX_CLK)
7. Add a small signal wire to one side of R20 (BCX_DAT)

Update board number-two with the following changes:

1. Remove R12 (Bottom) to disconnect GOSNS/FLWR_A from the output ground
2. Remove R32 (Bottom) to make space for programming MSEL2_B for phase 03 of a 4-phase
3. Install a 10-kΩ resistor in the R5 (top) location to pull GOSNS/FLWR_A to BP1V5_A to configure channel A as a stack follower.
4. Install a 6.81-kΩ resistor in the R21 (Bottom) location to configure Channel A as a Phase 01 follower of a 4-pahse stack.
5. Install a 31.6-kΩ resistor in the R32 (Bottom) location to configure Channel A as a Phase 03 follower of a 4-phase stack

Connect the two boards together.

1. Add Short, Heavy Gauge wires (solid preferred) to PVIN_A, PVIN_B, VOUT_A, and VOUT_B and GND terminals on both input and output sides of board two.
   - Tighten the terminal blocks.
2. Stack Board number 1 directly on top of board number two, and connect the wires to the matching terminal blocks on board number one.
   - Tighten the terminal blocks on board number one
3. Solder the 4 small signal wires from board number one to the matching location on board number two.
   - VSHARE_A to VSHARE_A (TP12)
   - SYNC to SYNC (TP15)
   - BCX_CLK (R19) to BCX_CLK (R19)
   - BCX_DAT (R20) to BCX_CLK (R20)

The two EVMs are now configured as a single output 4-phase converter (Figure 1-1). Thanks to the BCX_CLK and BCX_DAT connections between the 4 devices, the PMBus only needs to connect to EVM board one, which is placed on top to allow access to the 10-pin connector for the USB-to-GPIO adapter.

4 References

- Texas Instruments, *TPSM8D6C24 2.95-V to 16-V, Dual 35-A, 2x Stackable, PMBus® Buck Power Module* data sheet.
- Texas Instruments, *Product Details*
- Texas Instruments, *Fusion Digital Power™ Graphical User Interface*

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