User's Guide
SLVUB28–June 2017

# TPS25740BEVM-741 Evaluation Module

This user's guide describes the TPS25740B evaluation module (TPS25740BEVM-741). The TPS25740BEVM-741 contains evaluation and reference circuitry for the TPS25740B, which is a dedicated USB Type-C™ Power Delivery (PD) downstream facing port (DFP) controller. The TPS25740B relies on an upstream converter to output 5 V, 9 V, 15 V, and 20 V or optionally 5 V, 9 V, 12 V, and 15 V. This EVM uses an LM5175-based buck-boost converter as the power supply for the TPS25740B. The TPS25740B portion of the circuit will be very similar in an adapter application where an AC/DC input power stage is used. Note that this EVM does support BC1.2 charging by shorting the D+ and D- pins of the receptacle. A TPS2514A can be added to DP and DM lines of the USB Type-C connector for BC1.2 charging support. In addition, this EVM features a barrel jack input to allow for easy demonstration. The recommended adapter is listed in the features section.

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## Trademarks

USB Type-C is a trademark of USB Implementers Forum, Inc.
All other trademarks are the property of their respective owners.

# 1 Introduction

The TPS25740BEVM-741 allows the user to evaluate the performance of the TPS25740B in an adapter-like application. Note that the TPS25740B is powered from the output of the DC/DC converter and does not require an external LDO. The upstream converter remains ON at all times to ensure that the TPS25740B remains powered and can detect the upstream-facing port (UFP) connection.

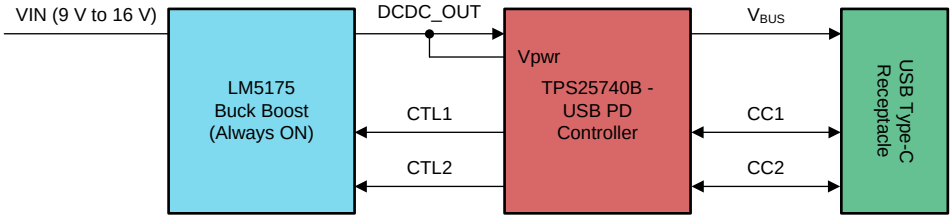


**Figure 1. Block Diagram**

## 1.1 Features

The TPS25740B features include:

- USB Type-C PD communication protocol via CC1 and CC2 pins.
- Variable output voltage combinations depending on request:
  - 5 V, 9 V, 15 V, and 20 V (default)
  - 5 V, 9 V, 12 V, and 15 V
- Up to 5-A output current for all voltage levels. Default is 3 A.
- Smooth voltage transitions per the USB PD specification.
- Barrel jack input. (The ETSA190342UDC-P5P-SZ adapter has been tested with the EVM.)

## 1.2 Applications

The TPS25740B can be used in the following applications:

- Automotive USB ports
- Power banks
- USB power delivery adaptors

### 1.3 Electrical Specifications

Table 1 lists the EVM electrical specifications.

**Table 1. TPS25740BEVM-741 Electrical and Performance Specifications at 25°C**

| Characteristic | HIPWR = H1 or H2 | HIPWR = H3 or H4 |
|---|---|---|
| Input voltage range (Recommended) | 9 V to 16 V | 9 V to 16 V |
| Input voltage range (Absolute Maximum) | 0 V to 40 V | 0 V to 40 V |
| Operating output current | Default: 3 A | Default: 3 A |
| | Configurable to 5 A | Configurable to 5 A |
| Overcurrent protection | Default: 4.2 A | Default: 4.2 A |
| | Configurable to 6.3 A | Configurable to 6.3 A |
| Output voltages | 5 V, 9 V, 15 V, 20 V | 5 V, 9 V, 12 V, 15 V |
| UVLO rising on input | 7.75 V | 7.75 V |
| UVLO falling on input | 7.25 V | 7.25 V |
| Advertised voltages | 5 V, 9 V, 15 V, 20 V | 5 V, 9 V, 12 V, 15 V |
| Advertised current | 3 A (default) or 5 A | 3 A (default) or 5 A |

**NOTE:**
- For H1 or H2 setting, R22 = 6.65 kΩ and R49 = 8.06 kΩ (default).
- For H3 or H4 setting, R22 = 13.3 kΩ and R49 = 13.3 kΩ.

## 2 Description

Referring to the schematic in Figure 2 and Figure 3, a 12-V DC input is applied at the J1, J3 terminals or J4 connector. The voltage at the DCDC_OUT node is regulated by the LM5175PWP buck-boost regulator (U1) and associated circuitry. This provides a nominal 5-V, 5-A output for the TPS25740B (U2) and associated output load.

A USB Type-C upstream facing port (UFP) is plugged in at J9. When TPS25740B detects the UFP via CC1 or CC2 then it will activate Q6, Q10 with the GDNG signal. This will apply the default VBUS voltage of 5 V at J9 to the UFP. A USB PD-capable device can now request the power delivery capabilities from the TPS25740B which are programmed by J7 and J8. Once the UFP knows the voltage capabilities of the DFP, then it can request a different VBUS voltage.

The voltage change request is processed by the TPS25740B and is relayed to the LM5175 regulator through the CTL1, CTL2, and CTL3 pins. R21 and R24 program the default 5-V output at DCDC_OUT. R22, R19, and R49 are switched in by CTL1, CTL2, and CTL3, respectively and are placed in parallel with R24 to change the feedback voltage regulation point. Capacitors C31 and C32 provide slew rate control in order to comply with the USB PD specification.

The TPS25740C can also be installed in place of TPS25740B on the TPS25740BEVM-741 without further modification. For more information as well as detailed design information, refer to the TPS25740B and TPS25740C datasheet (SLVSDR6).

## 3 Schematic

Figure 2 and Figure 3 illustrate the EVM schematic.

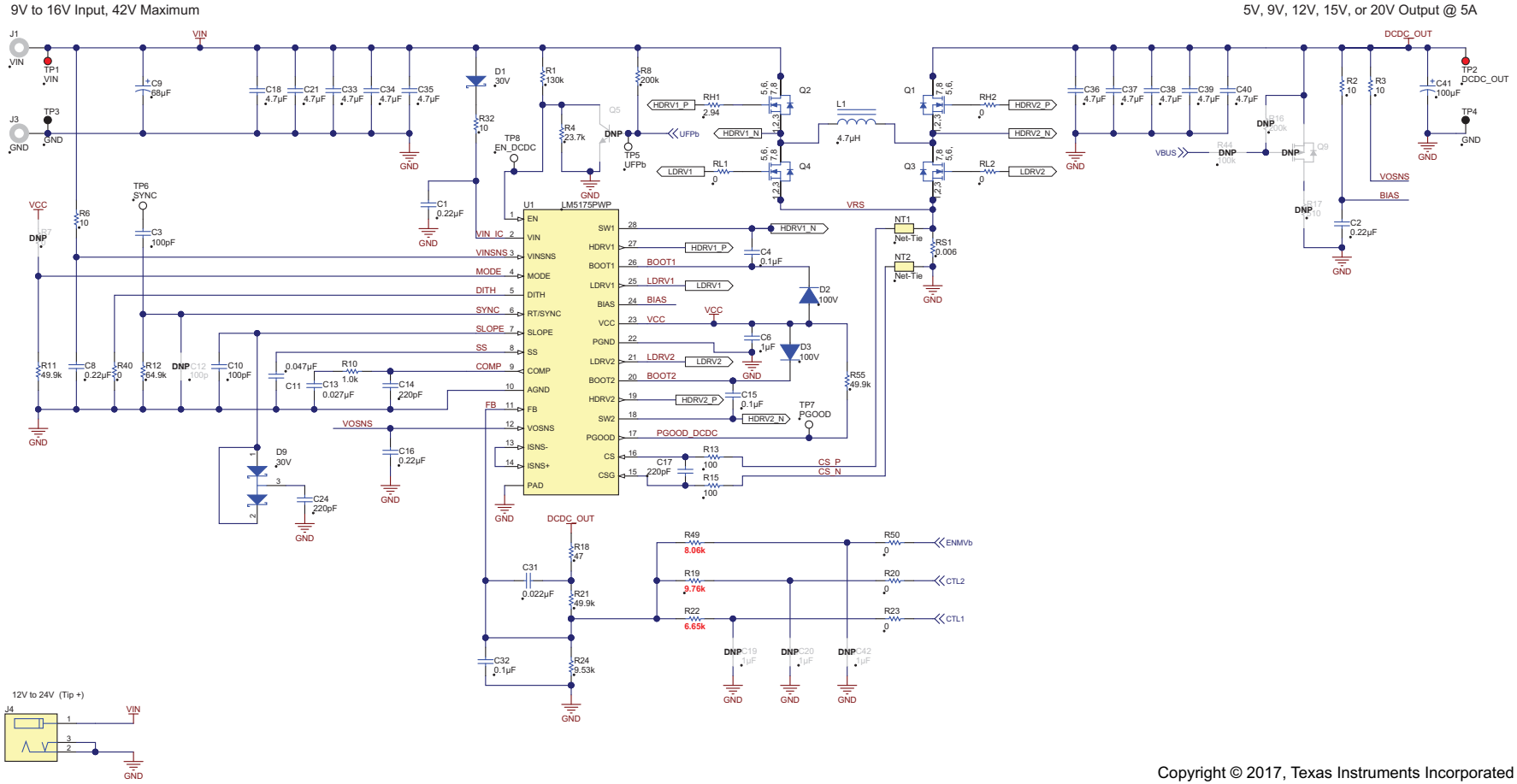




**Figure 2. LM5175 Buck-Boost Power Supply**

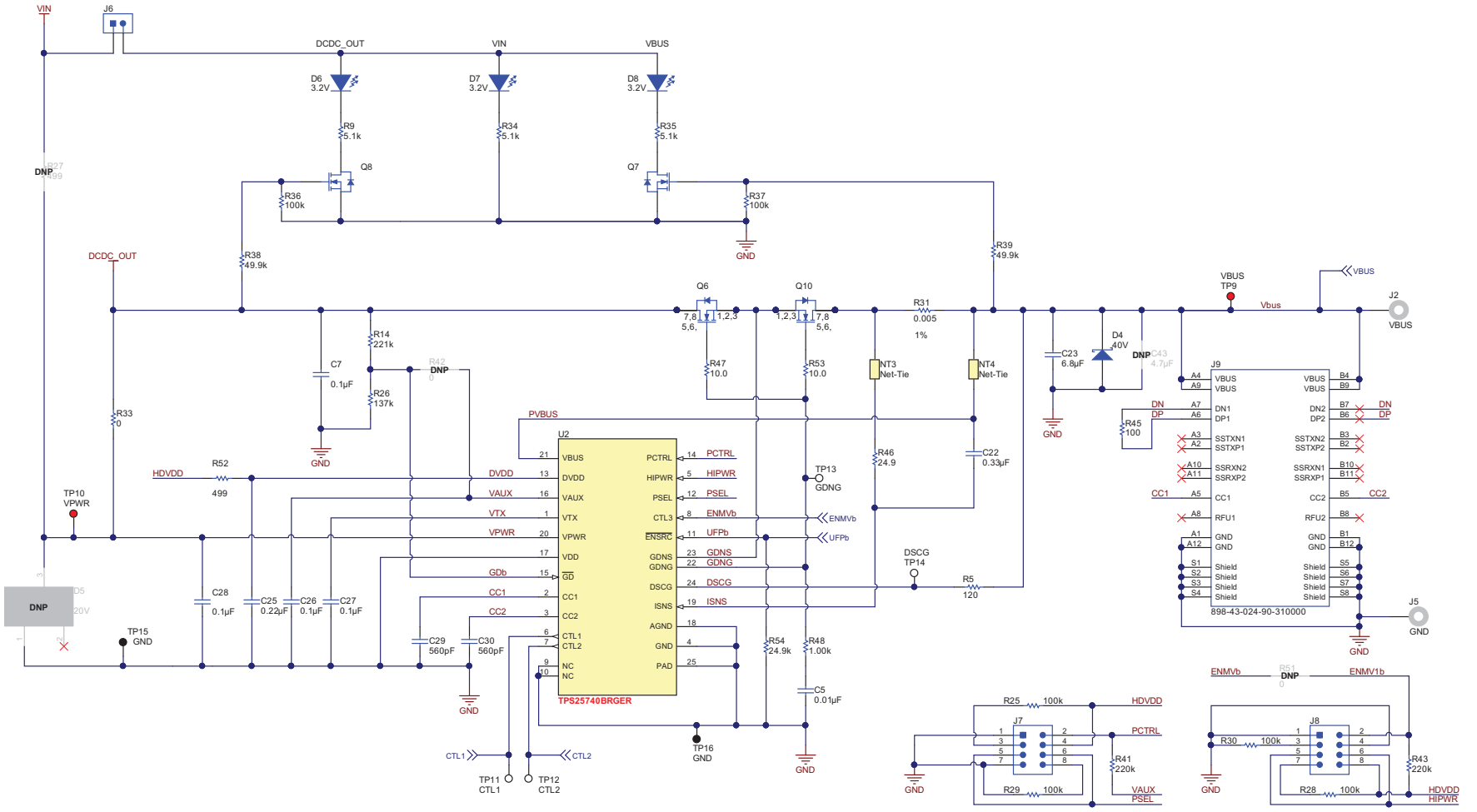




**Figure 3. TPS25740B DFP**

# 4 Configuring the EVM

## 4.1 Physical Access

Table 2 lists the TPS25740BEVM-741 connector and LED functionality, Table 3 describes jumper functionality, and Table 4 describes the test point availability.

**Table 2. Connector and LED Functionality**

| Connector | Label | Description |
|---|---|---|
| J1 | VIN | Power bus input. Apply bus input voltage between J1 and J3. |
| J2 | VBUS | Output voltage that is applied to the VBUS of the USB Type-C cable. J2 along with J5 can be used to apply an external load. |
| J3 | GND | Power bus input return connector. Apply bus input voltage between J1 and J3. |
| J4 | J4 | Barrel jack input from an AC to DC power supply. The center tip is positive. |
| J5 | GND | Switch bus output return connector. Apply the load between J2 and J5. |
| J9 | J9 | USB Type-C receptacle |
| D6 | DCDC_OUT | This Green LED indicates when the output of the DC/DC converter is above approximately 3 V |
| D7 | D7 | This Green LED indicates when an input voltage is present at J1, J3 or J4 |
| D8 | D8 | This Green LED indicates when VBUS is above approximately 3 V |

**Table 3. Jumpers Functionality**

| Jumper | Label | Description |
|---|---|---|
| J7 | PSEL/PCTRL | Used to program the PSEL and PCTRL pins of the TPS25740B. This advertises the power level to the UFP. Install a single shunt in the P1, P2, P3, or P4 position. Optionally, a second shunt can be installed in the PCTRL position. The position locations are shown in Figure 4 and also on the PCB silkscreen near J7.<br>P1 position: PSEL = 93 W<br>P2 position (default): PSEL = 65 W<br>P3 position: PSEL = 45 W<br>P4 position: PSEL = 36 W<br>PCTRL position (shunt installed): PMAX = PSEL / 2<br>PCTRL position (no shunt installed-default): PMAX = PSEL |
| J8 | HIPWR/ENMVb | Used to program the HIPWR pin of the TPS25740B. This advertises maximum voltage and maximum current to the UFP. Install a single shunt in the H1, H2, H3, or H4 position. The position locations are shown in Figure 5 and also on the PCB silkscreen near J8. V1 = 5 V, V2 = 9 V, V3 = 12 V or 15 V, V4 = 15 V or 20 V<br>H1 position: 5 V, 9 V, 15 V, 20 V and IMAX = 5 A (OCP = 6.3 A)<br>H2 position (default): 5 V, 9 V, 15 V, 20 V and IMAX = 3 A (OCP = 4.2 A)<br>H3 position: 5 V, 9 V, 12 V, 15 V and IMAX = 5 A (OCP = 6.3 A)<br>H4 position: 5 V, 9 V, 12 V, 15 V and IMAX = 3 A (OCP = 4.2 A)<br>Advertised current at Vx: Ix = min (PMAX / Vx, IMAX) |
| J6 | LED Power | Used to disconnect the LED power. This allows for more accurate measurement of the efficiency of the board, especially at light loads or when UFP is disconnected. |

**Table 4. Test Points**

| J7 | J8 | Description |
|---|---|---|
| TP1 | VIN | Input voltage |
| TP2 | DCDC_OUT | Output of the buck boost and input to the TPS25740B circuitry |
| TP3/TP4 | GND | Input ground test points |
| TP15/TP16 | GND | Output ground test points |
| TP6 | SYNC | Capacitive coupled measurement of SYNC pin |
| TP7 | PGOOD | Power good output of the DC/DC. High = power good |
| TP5 | UFPb | Active low signal which is asserted when a UFP is connected on the other side of the cable |
| TP11, TP12 | CTL1, CTL2 | Control signals coming from the TPS25740B that adjust the output voltage of the buck boost converter based on the following table: |

| Voltage Contained in PDO Requested by UFP | CTL3 State | CTL2 State | CTL1 State |
|---|---|---|---|
| 5 V | High-Z | High-Z | High-Z |
| 9 V | High-Z | Low | High-Z |
| 12 V or 15 V | High-Z | Low | Low |
| 15 V or 20 V | Low | Low | Low |

| | | |
|---|---|---|
| TP13 | GDNG | NFET gate drive signal |
| TP9 | VBUS | Voltage that is applied to the VBUS of the USB Type-C receptacle and cable |
| TP10 | VPWR | Voltage tied to VPWR, which is used to power the TPS25740B chip |
| TP14 | DSCG | The TPS25740B discharge VBUS with this pin |
| TP8 | EN_DCDC | Tied to the enable pin of the DC DC |

## 4.2 Setting Advertisement Levels With J7 and J8

The advertised power, voltages, and currents can be configured using J7 and J8 as shown in Figure 4 and Figure 5.

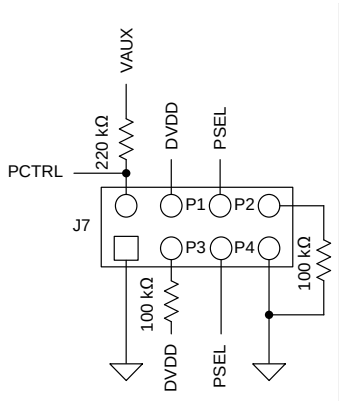


**Figure 4. Power Select Header – J7**

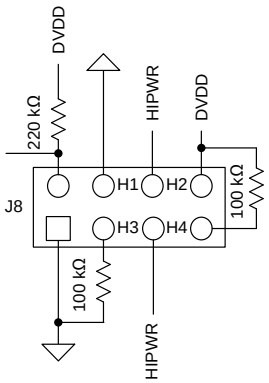


**Figure 5. Voltage and J8 Current Select Header – J8**

## 4.3 Equipment Setup

The following equipment is required to set up the EVM:

- Power supply capable of 12 V and preferably 10 A (120 W).
- Resistive or electronic load
- PD-capable UFP to negotiate voltages, in this case PMP20413 (TPS25725 + MSP430) reference design was used
- USB Type-C cable

## 5 Operation

Use the following steps for EVM operation:

1. Turn the 12-V input power supply on.
2. Connect the UFP to TPS25740BEVM-741 through a USB Type-C cable.
3. Make desired voltage requests from the UFP to the TPS25740BEVM-741.
4. Connect load between J2 and J5, as desired, to test efficiency and other performance.

## 6 Test Results

This section provides typical performance waveforms for the TPS25740BEVM-741 with $V_{IN}$ = 12 V and no load (unless otherwise specified). Actual performance data is affected by measurement techniques and environmental variables; therefore, these curves are presented for reference and may differ from actual results obtained.

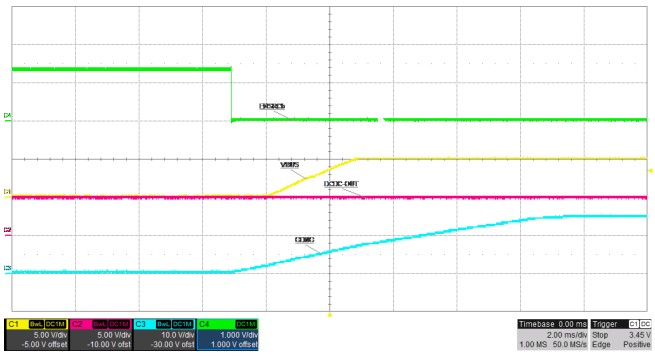

**Figure 6. UFP Plug-In (5 V)**

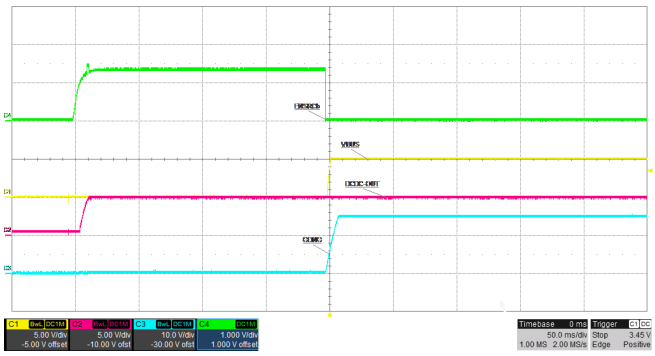

**Figure 7. Ramp VIN With UFP Connected**

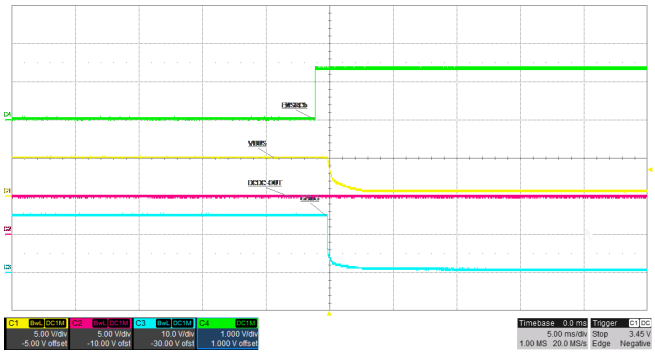

**Figure 8. UFP Unplug (5 V)**

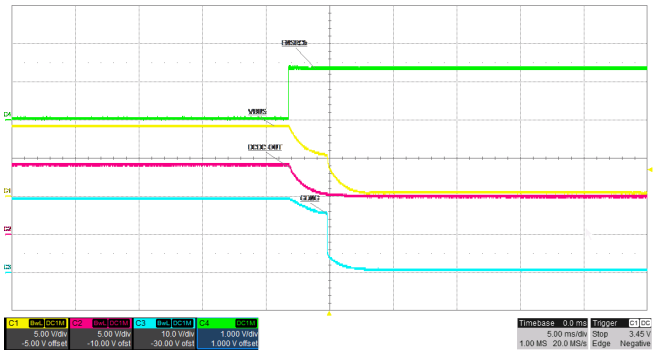

**Figure 9. UFP Unplug (9 V)**

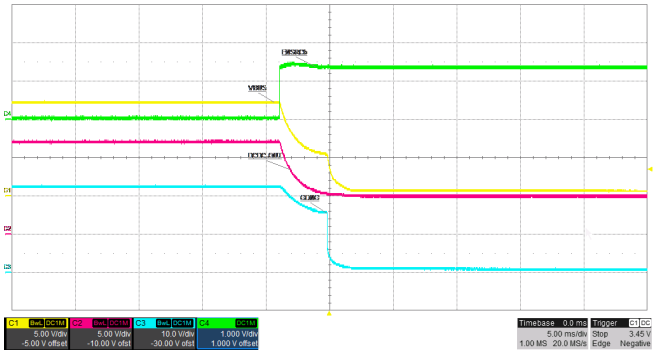

Figure 10. UFP Unplug (12 V)

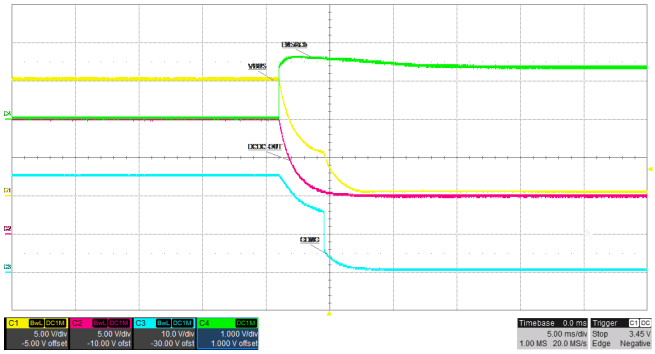

Figure 11. UFP Unplug (15 V)

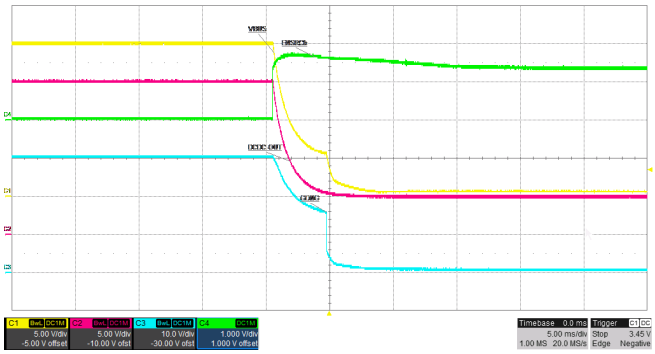

Figure 12. UFP Unplug (20 V)

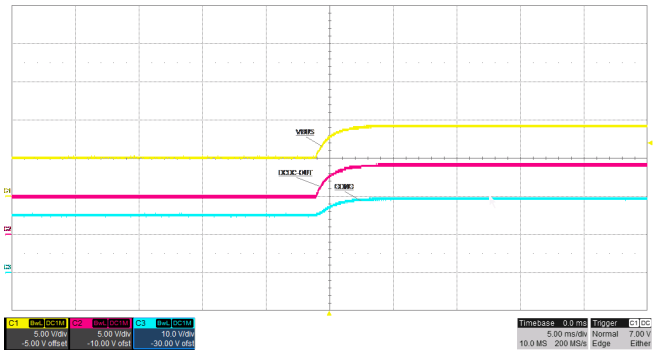

Figure 13. 5-V to 9-V Transition

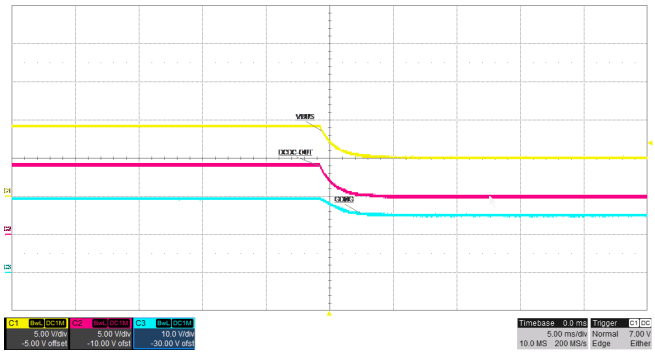

Figure 14. 9-V to 5-V Transition

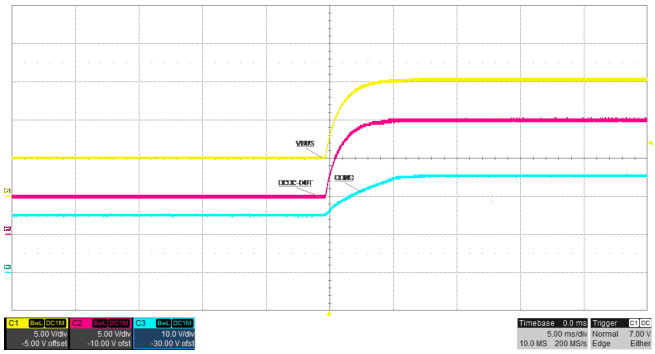

Figure 15. 5-V to 15-V Transition

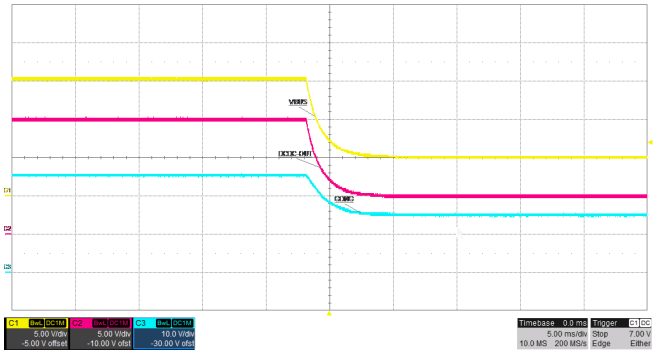

Figure 16. 15-V to 5-V Transition

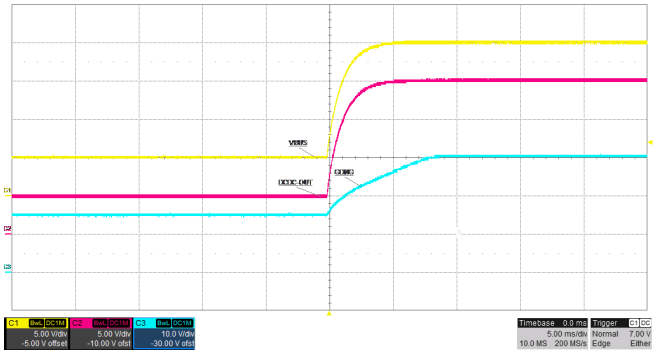

Figure 17. 5-V to 20-V Transition

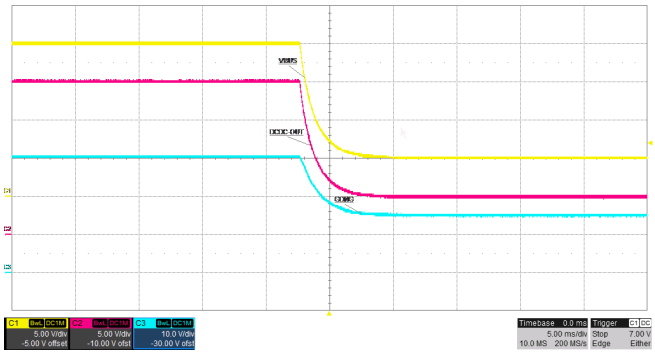

Figure 18. 20-V to 5-V Transition

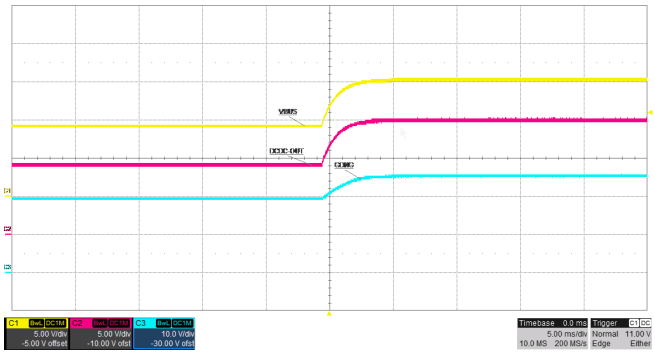

Figure 19. 9-V to 15-V Transition

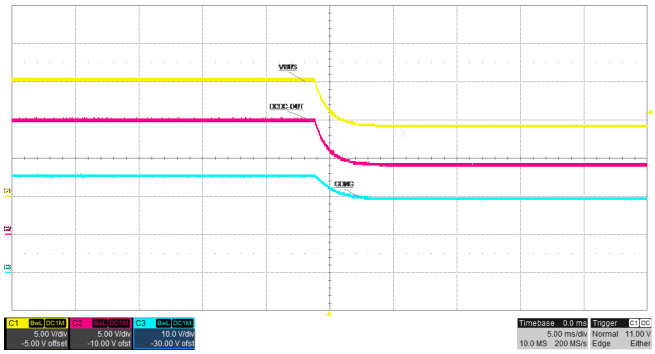

Figure 20. 15-V to 9-V Transition

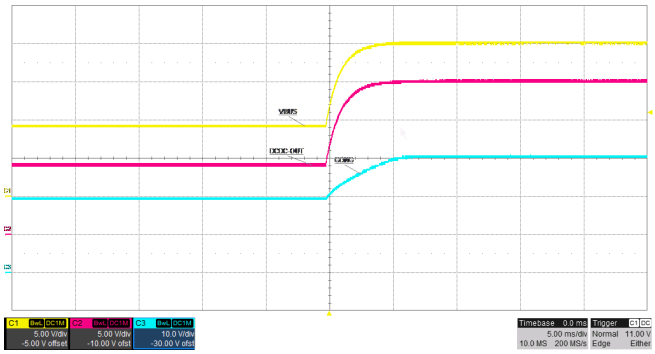

Figure 21. 9-V to 20-V Transition

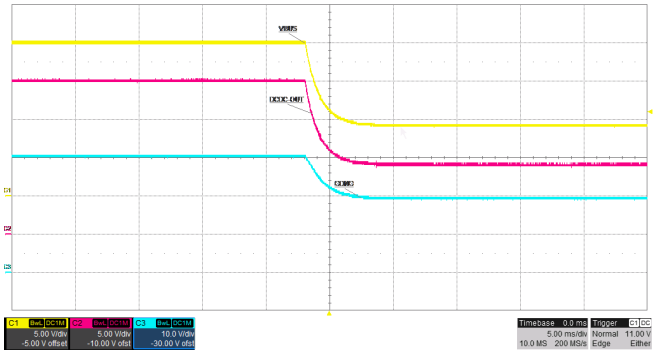

Figure 22. 20-V to 9-V Transition

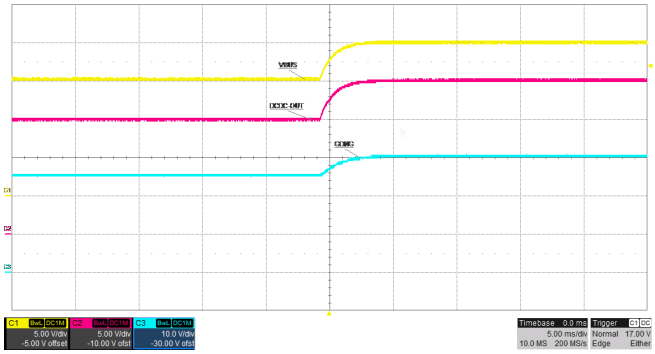

Figure 23. 15-V to 20-V Transition

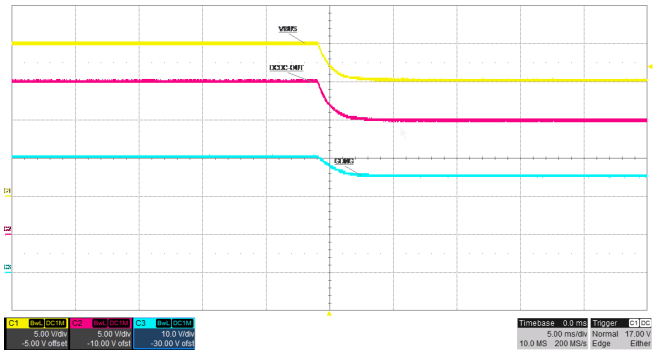

Figure 24. 20-V to 15-V Transition

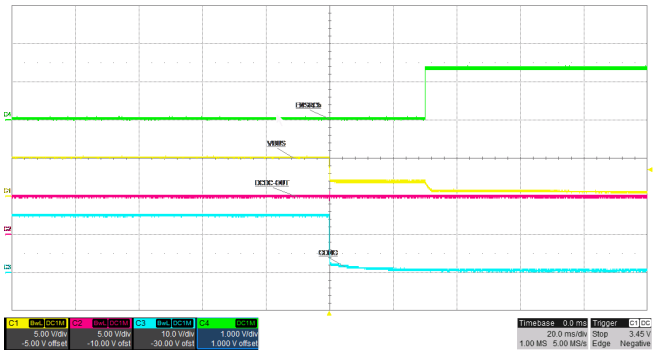

Figure 25. 5-A Transient Triggers OCP at 5 V

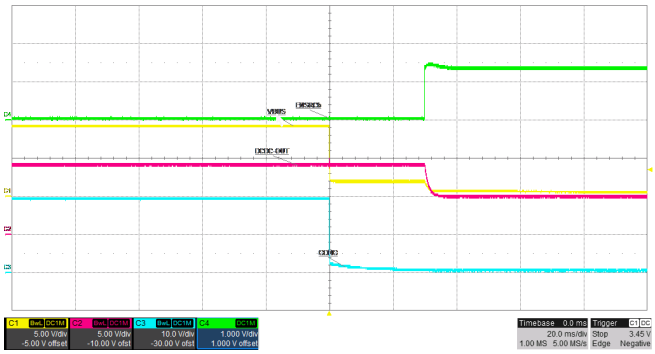

Figure 26. 5-A Transient Triggers OCP at 9 V

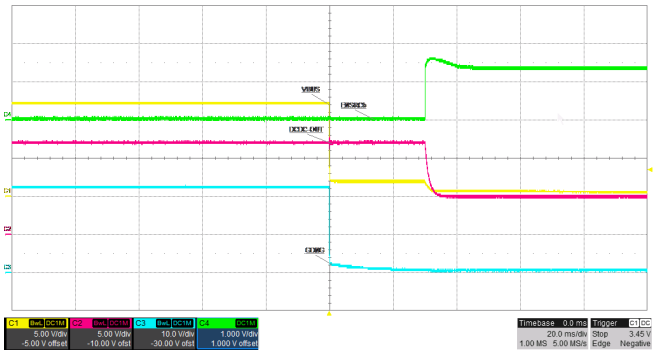

Figure 27. 5-A Transient Triggers OCP at 12 V

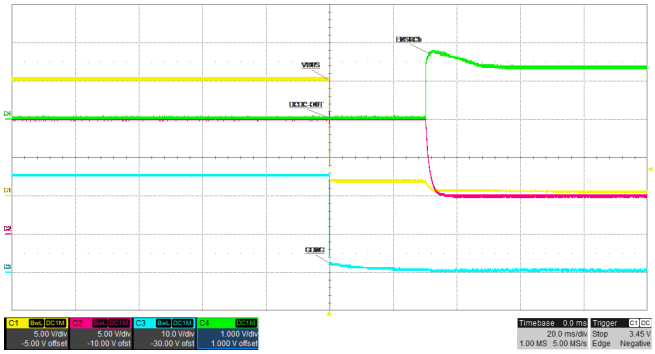

Figure 28. 5-A Transient Triggers OCP at 15 V

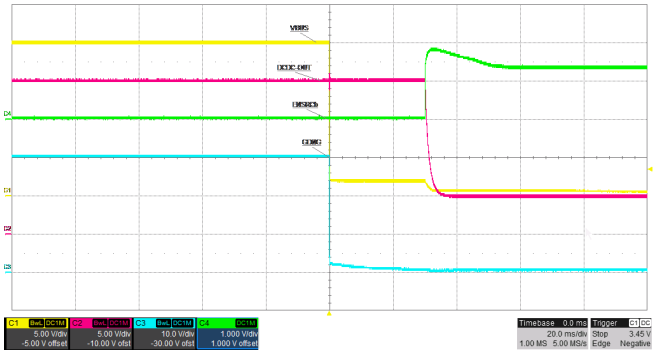

Figure 29. 5-A Transient Triggers OCP at 20 V

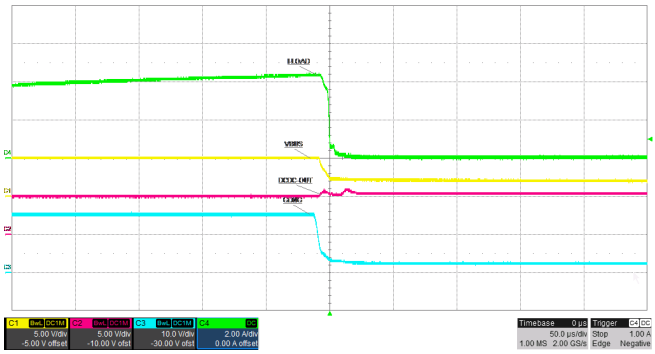

Figure 30. 5-A Soft Load Step Triggers 4.2-A OCP at 5 V

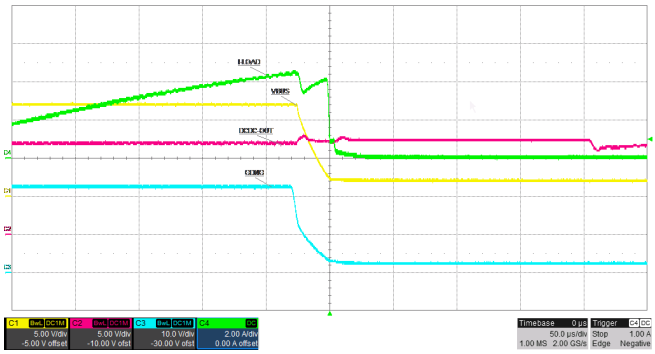

Figure 31. 5-A Soft Load Step Triggers 4.2-A OCP at 12 V

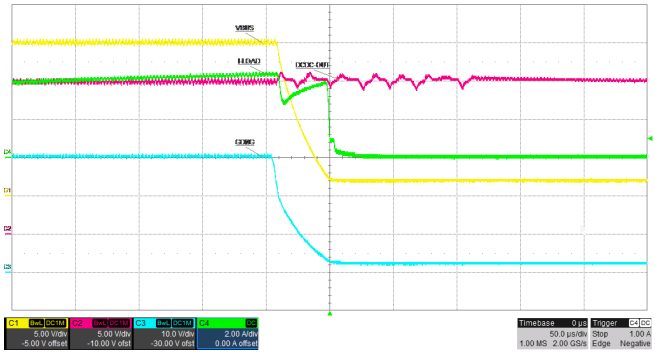

Figure 32. 5-A Soft Load Step Triggers 4.2-A OCP at 20 V

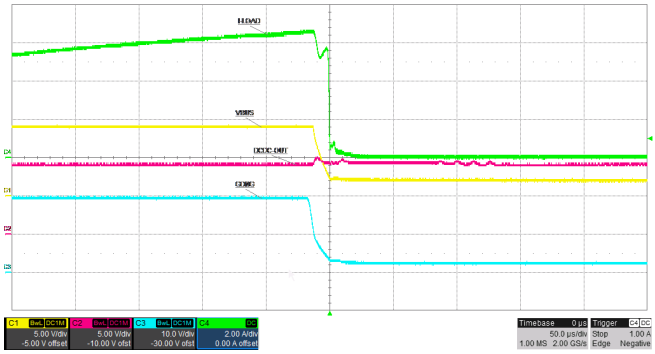

Figure 33. 8-A Soft Load Step Triggers 6.3-A OCP at 9 V

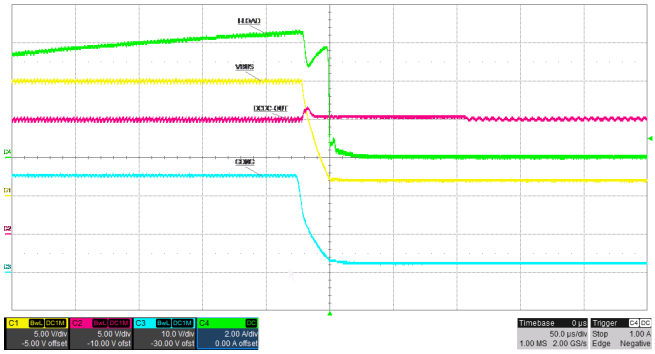

Figure 34. 8-A Soft Load Step Triggers 6.3-A OCP at 15 V

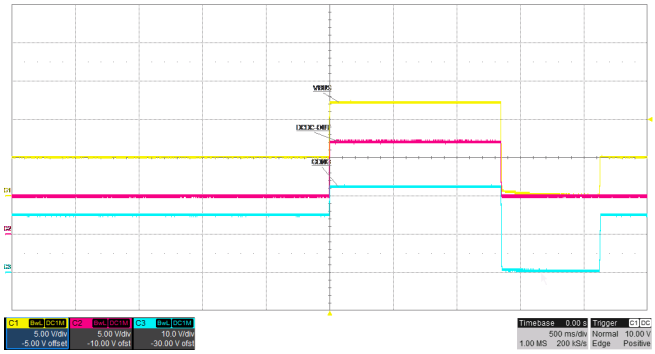

Figure 35. UVP - Requests 15 V but Provides 12 V

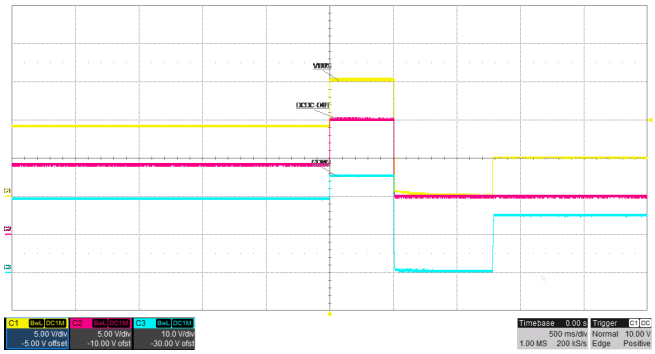

Figure 36. UVP - Requests 20 V but Provides 15 V

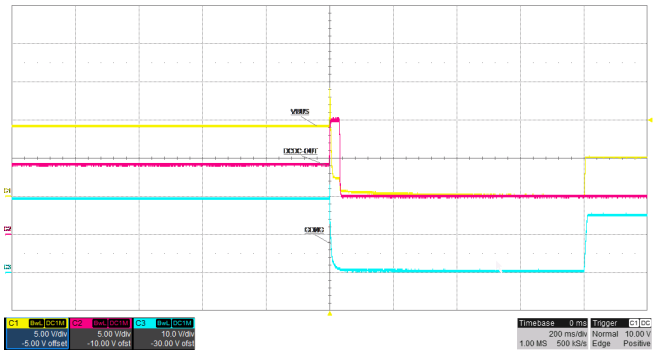

Figure 37. OVP - Requests 12 V but Provides 15 V

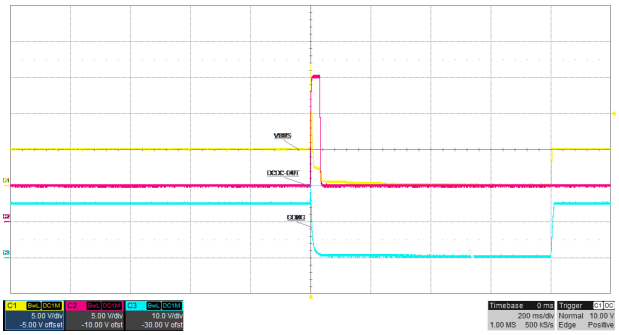

Figure 38. OVP - Requests 15 V but Provides 20 V

## 7 EVM Assembly Drawings and Layout Guidelines

Figure 39 through Figure 43 show component placement and layout of the EVM.

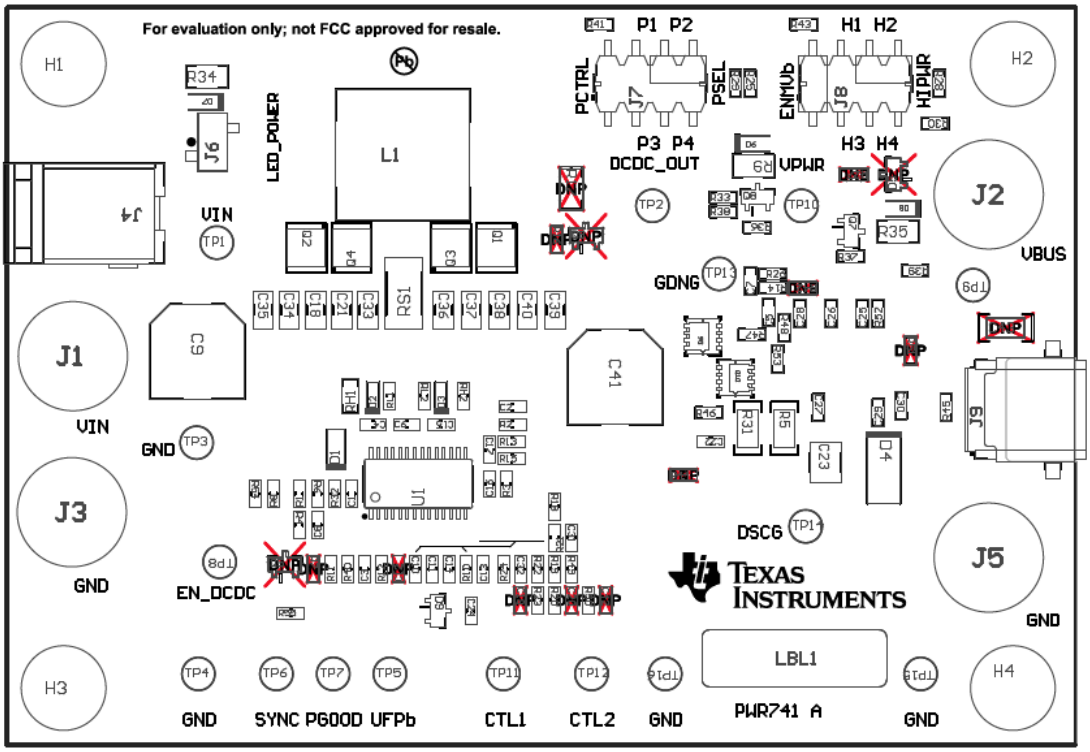


**Figure 39. Top Side Placement**

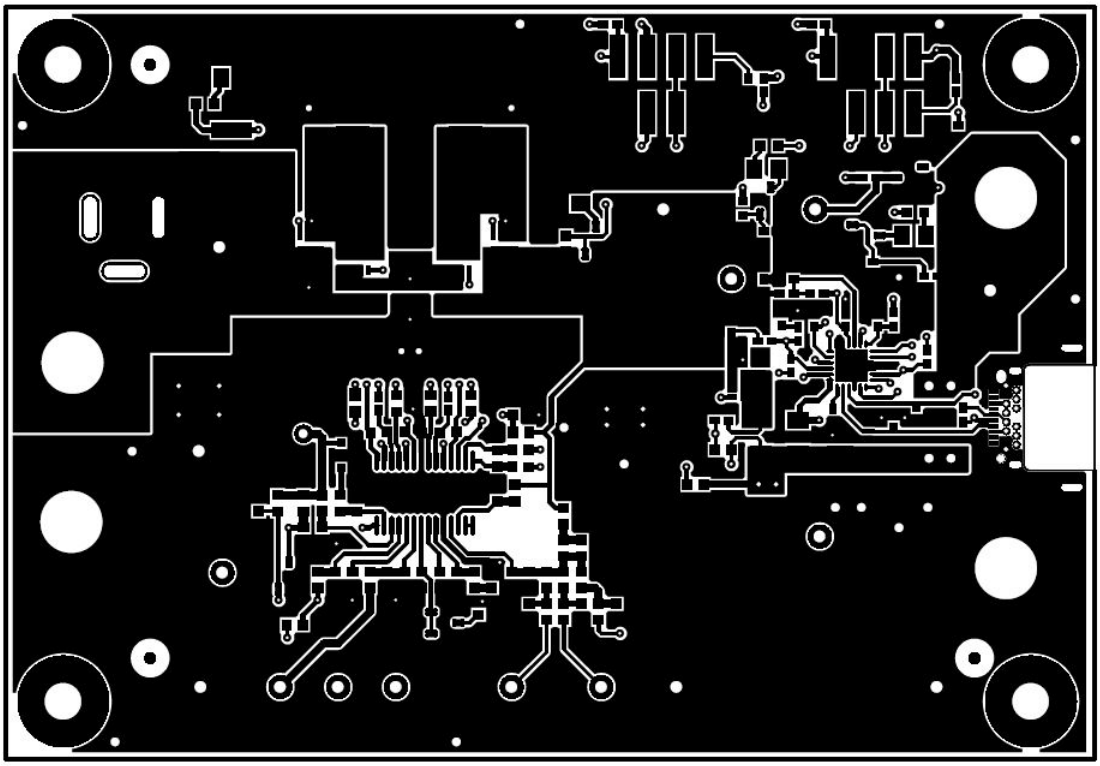

**Figure 40. Top Side Routing**

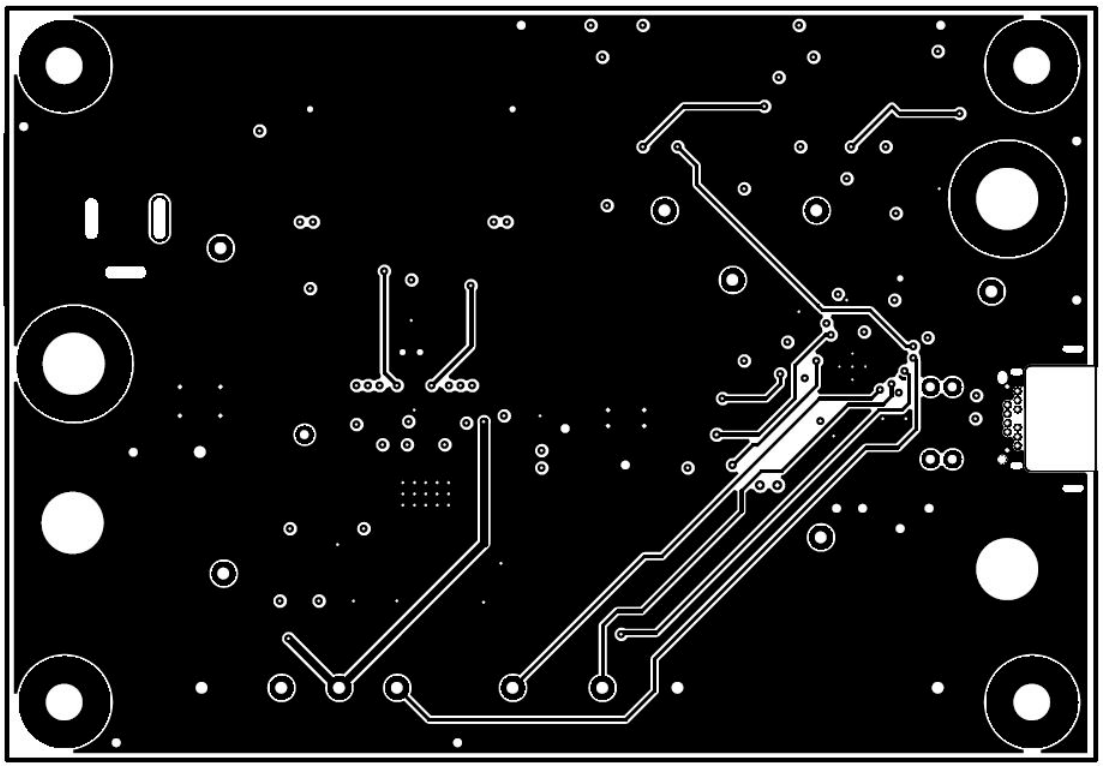

**Figure 41. Layer Two Routing**

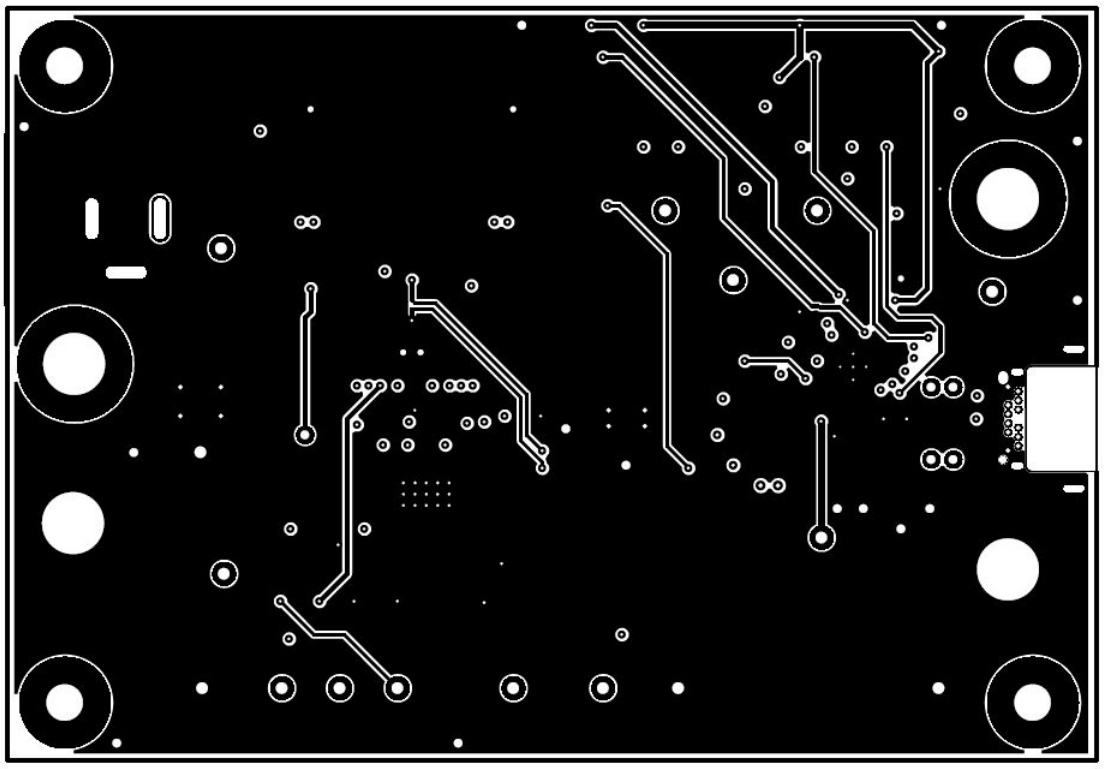

**Figure 42. Layer Three Routing**

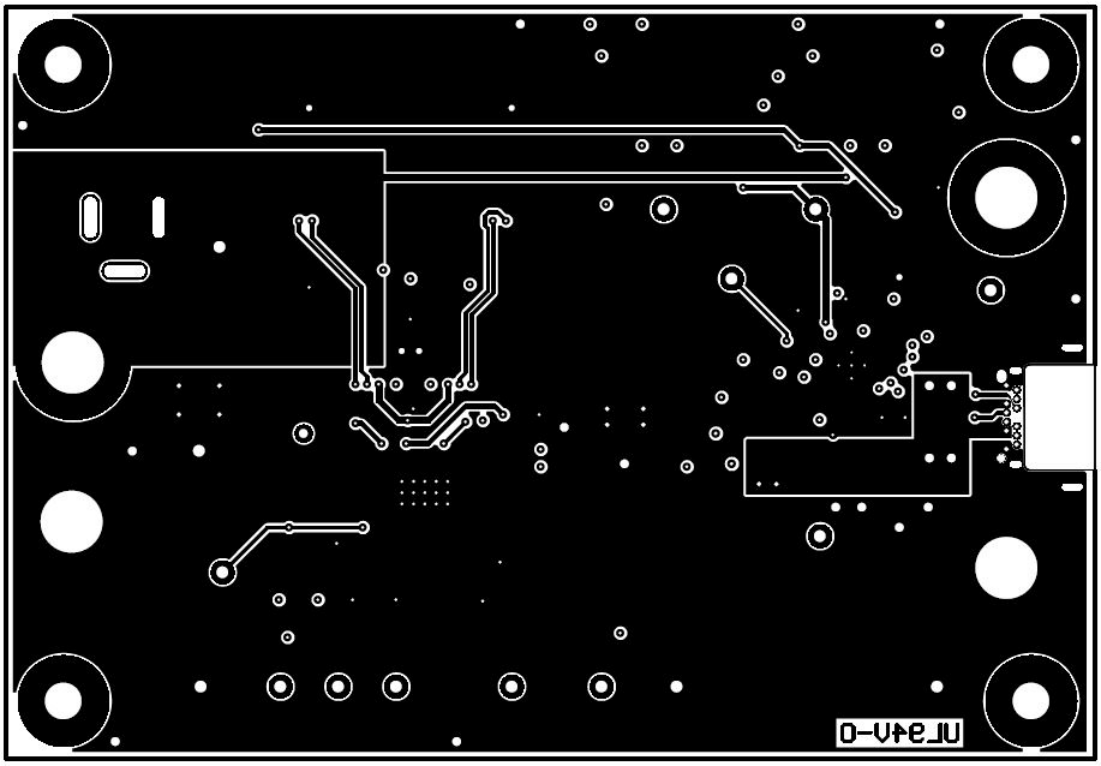

**Figure 43. Bottom Side Routing**

# 8 Component Placement and Routing Guidelines

This section contains component placement instructions and EVM layout guidelines.

## 8.1 Power Pin Bypass Capacitors

Place the power pin bypass capacitors as instructed in the following:

- **C28:** Place close to pin 20 (VPWR) and connect with low-inductance traces and vias according to Figure 39.
- **C25:** Place close to pin 13 (DVDD) and connect with low-inductance traces and vias according to Figure 39.
- **C26:** Place close to pin 16 (VAUX) and connect with low-inductance traces and vias according to Figure 39
- **C27:** Place close to pin 1 (VTX) and connect with low-inductance traces and vias according to Figure 39.

## 8.2 Supporting Components

The following list provides instructions for installing the other components:

- **CRX:** Place C29 and C30 inline with the CC1 and CC2 traces as shown in Figure 39. These should be placed within one inch from the USB Type-C connector. Minimize stubs and tees from on the trace routes.
- **Q1:** Place Q6 and Q10 in a manner such that power flows uninterrupted from the Q6 and Q10 drain to the USB Type-C connector VBUS connections. Provide adequate copper plane from the Q6 and Q10 drain and source to the interconnecting circuits.
- **RS:** Place R31, as shown in Figure 39, to facilitate uninterrupted power flow to the USB Type-C connector. Orient RS for optimal Kelvin sense connection and routing back to the TPS25740B. In high-current applications where the power dissipation is over 250 mW, provide an adequate copper feed to the pads of R31.
- **RG:** Place R47 and R53 near Q6 and Q10 as shown in Figure 39. Minimize stray leakage paths as the GDNG sourcing current could be affected.
- **RSLEW and CSLEW:** Place R48 and C5 near R47 and R53 as shown in Figure 39.
- **R5**: Place on top of the VBUS copper route and connect to the DSCG pin with a 15-mil trace.
- **RF and CF:** When required, place R46 and C22 (as shown in Figure 39) to facilitate the Kelvin sense connection back to the TPS25740B.
- **CVBUS and DVBUS:** Place C23 and D4 within one inch of the USB Type-C connector and connect them to VBUS and GND using adequate copper shapes.

# 9 Bill of Materials

Table 5 lists the EVM BOM.

**Table 5. TPS25740BEVM-741 Bill of Materials**

| Designator | Quantity (HIPWR = H3 or H4) | Quantity (HIPWR = H1 or H2) | Value | Description | Package Reference | Part Number | Manufacturer | Alternate Part Number | Alternate Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| C1, C2 | 2 | 2 | 0.22uF | CAP, CERM, 0.22uF, 50V, +/-10%, X7R, 0603 | 0603 | C1608X7R1H224K080AB | TDK | | |
| C3, C10 | 2 | 2 | 100pF | CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603 | 0603 | GRM1885C1H101JA01D | Murata | | |
| C4, C15 | 2 | 2 | 0.1uF | CAP, CERM, 0.1 µF, 25 V, +/- 5%, X7R, 0603 | 0603 | 06033C104JAT2A | AVX | | |
| C5 | 1 | 1 | 0.01uF | CAP, CERM, 0.01 µF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402 | 0402 | CGA2B3X7R1H103K050BB | TDK | | |
| C6 | 1 | 1 | 1uF | CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603 | 0603 | GRM188R71C105KA12D | Murata | | |
| C7, C26, C27, C28 | 4 | 4 | 0.1uF | CAP, CERM, 0.1 µF, 50 V, +/- 10%, X7R, 0402 | 0402 | C1005X7R1H104K | TDK | | |
| C8, C16 | 2 | 2 | 0.22uF | CAP, CERM, 0.22 µF, 50 V, +/- 10%, X7R, 0603 | 0603 | C1608X7R1H224K080AB | TDK | | |
| C9 | 1 | 1 | 68uF | CAP, AL, 68 µF, 63 V, +/- 20%, 0.65 ohm, SMD | SMT Radial F | EEE-FK1J680UP | Panasonic | | |
| C11 | 1 | 1 | 0.047uF | CAP, CERM, 0.047 µF, 25 V, +/- 10%, X7R, 0603 | 0603 | C1608X7R1E473K | TDK | | |
| C13 | 1 | 1 | 0.022uF | CAP, CERM, 0.022 µF, 50 V, +/- 10%, X7R, 0603 | 0603 | GRM188R71H223KA01D | Murata | | |
| C14, C17 | 2 | 2 | 220pF | CAP, CERM, 220 pF, 50 V, +/- 5%, C0G/NP0, 0603 | 0603 | GRM1885C1H221JA01D | Murata | | |
| C18, C21, C33, C34, C35, C36, C37, C38, C39, C40 | 10 | 10 | 4.7uF | CAP, CERM, 4.7 µF, 50 V, +/- 10%, X7R, 1206 | 1206 | GRM31CR71H475KA12L | Murata | | |
| C22 | 1 | 1 | 0.33uF | CAP, CERM, 0.33 µF, 16 V, +/- 10%, X7R, 0603 | 0603 | GRM188R71C334KA01D | Murata | | |
| C23 | 1 | 1 | 6.8uF | CAP, CERM, 6.8 µF, 25 V, +/- 10%, X7R, 1210 | 1210 | C3225X7R1E685K250AB | TDK | | |
| C24 | 1 | 1 | 220pF | CAP, CERM, 220 pF, 100 V, +/- 10%, X7R, 0603 | 0603 | 06031C221KAT2A | AVX | | |
| C25 | 1 | 1 | 0.22uF | CAP, CERM, 0.22 µF, 6.3 V, +/- 20%, X5R, 0402 | 0402 | C1005X5R0J224M | TDK | | |
| C29, C30 | 2 | 2 | 560pF | CAP, CERM, 560 pF, 50 V, +/- 5%, C0G/NP0, 0402 | 0402 | GRM1555C1H561JA01D | Murata | | |
| C31 | 1 | 1 | 0.022uF | CAP, CERM, 0.022 µF, 50 V, +/- 10%, X7R, 0603 | 0603 | C0603C223K5RACTU | Kemet | | |
| C32 | 1 | 1 | 0.1uF | CAP, CERM, 0.1 µF, 25 V, +/- 10%, X5R, 0603 | 0603 | 06033D104KAT2A | AVX | | |
| C41 | 1 | 1 | 100uF | CAP, AL, 100 µF, 50 V, +/- 20%, 0.34 ohm, SMD | SMT Radial F | EEE-FK1H101P | Panasonic | | |
| D1 | 1 | 1 | 30V | Diode, Schottky, 30V, 0.2A, SOD-323 | SOD-323 | BAT54HT1G | ON Semiconductor | | |
| D2, D3 | 2 | 2 | 100V | Diode, Switching, 100V, 0.25 A, SOD-523 | SOD-523 | BAS516,115 | NXP Semiconductor | | |
| D4 | 1 | 1 | 40V | Diode, Schottky, 40 V, 3 A, SMA | SMA | B340A-13-F | Diodes Inc. | | |
| D6 | 1 | 1 | DCDC_OUT | LED, Green, SMD | LED_0603 | 150060GS75000 | Wurth Elektronik | | |
| D7 | 1 | 1 | VIN | LED, Green, SMD | LED_0603 | 150060GS75000 | Wurth Elektronik | | |
| D8 | 1 | 1 | VBUS | LED, Green, SMD | LED_0603 | 150060GS75000 | Wurth Elektronik | | |
| D9 | 1 | 1 | 30V | Diode, Schottky, 30 V, 0.2 A, SOT-23 | SOT-23 | BAT54SLT1G | ON Semiconductor | | |
| H1, H2, H3, H4 | 4 | 4 | | Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead | Screw | NY PMS 440 0025 PH | B&F Fastener Supply | | |
| H5, H6, H7, H8 | 4 | 4 | | Standoff, Hex, 0.5"L #4-40 Nylon | Standoff | 1902C | Keystone | - | - |
| J1, J2, J3, J5 | 4 | 4 | | Standard Banana Jack, Uninsulated, 5.5mm | Keystone_575-4 | 575-4 | Keystone | | |

## Table 5. TPS25740BEVM-741 Bill of Materials (continued)

| Designator | Quantity (HIPWR = H3 or H4) | Quantity (HIPWR = H1 or H2) | Value | Description | Package Reference | Part Number | Manufacturer | Alternate Part Number | Alternate Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| J4 | 1 | 1 | | Connector, DC Jack 2.1X5.5 mm, TH | Conn, DC Jack, pin 2mm Dia. | PJ-202AH | CUI Inc. | | |
| J6 | 1 | 1 | | Header, 100mil, 2x1, Gold with Tin Tail, SMT | 2x1 Header | TSM-102-01-L-SV | Samtec | | |
| J7, J8 | 2 | 2 | | Header, 2.54mm, 4x2, Gold, SMT | Header, 2.54mm, 4x2, SMT | TSM-104-01-L-DV | Samtec | | |
| J9 | 1 | 1 | | Connector, Receptacle, USB Type-C, R/A, TH | Connector, Receptacle, USB Type-C, R/A, TH | 898-43-024-90-310000 | Mill-Max | | |
| L1 | 1 | 1 | 4.7uH | Inductor, Shielded Drum Core, Ferrite, 4.7 µH, 15.5 A, 0.0064 ohm, SMD | 12.1x9.5x11.4mm | 7443320470 | Wurth Elektronik | | |
| LBL1 | 1 | 1 | | Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll | PCB Label 0.650"H x 0.200"W | THT-14-423-10 | Brady | - | - |
| Q1, Q2, Q3, Q4 | 4 | 4 | 60V | MOSFET, N-CH, 60 V, 17 A, PG-TSDSON-8 | PG-TSDSON-8 | BSZ042N06NS | Infineon Technologies | | None |
| Q6, Q10 | 2 | 2 | 30V | MOSFET, N-CH, 30 V, 14 A, SON 3.3x3.3mm | SON 3.3x3.3mm | CSD17578Q3A | Texas Instruments | | None |
| Q7, Q8 | 2 | 2 | 60V | MOSFET, N-CH, 60 V, 0.17 A, SOT-23 | SOT-23 | 2N7002-7-F | Diodes Inc. | | None |
| R1 | 1 | 1 | 130k | RES, 130 k, 5%, 0.1 W, 0603 | 0603 | CRCW0603130KJNEA | Vishay-Dale | | |
| R2, R3, R6, R32 | 4 | 4 | 10 | RES, 10, 5%, 0.1 W, 0603 | 0603 | CRCW060310R0JNEA | Vishay-Dale | | |
| R4 | 1 | 1 | 23.7k | RES, 23.7 k, 1%, 0.1 W, 0603 | 0603 | CRCW060323K7FKEA | Vishay-Dale | | |
| R5 | 1 | 1 | 120 | RES, 120 ohm, 5%, 0.25W, 1206 | 1206 | CRCW1206120RJNEA | Vishay-Dale | | |
| R8 | 1 | 1 | 200k | RES, 200 k, 1%, 0.1 W, 0603 | 0603 | CRCW0603200KFKEA | Vishay-Dale | | |
| R9, R34, R35 | 3 | 3 | 5.1k | RES, 5.1 k, 5%, 0.125 W, 0805 | 0805 | CRCW08055K10JNEA | Vishay-Dale | | |
| R10 | 1 | 1 | 3.3k | RES, 3.3 k, 5%, 0.1 W, 0603 | 0603 | CRCW06033K30JNEA | Vishay-Dale | | |
| R11 | 1 | 1 | 49.9k | RES, 93.1 k, 1%, 0.1 W, 0603 | 0603 | CRCW060393K1FKEA | Vishay-Dale | | |
| R12 | 1 | 1 | 64.9k | RES, 64.9 k, 1%, 0.1 W, 0603 | 0603 | CRCW060364K9FKEA | Vishay-Dale | | |
| R13, R15 | 2 | 2 | 100 | RES, 100, 1%, 0.1 W, 0603 | 0603 | CRCW0603100RFKEA | Vishay-Dale | | |
| R14 | 1 | 1 | 221k | RES, 221 k, 1%, 0.063 W, 0402 | 0402 | CRCW0402221KFKED | Vishay-Dale | | |
| R18 | 1 | 1 | 47 | RES, 47, 5%, 0.1 W, 0603 | 0603 | CRCW060347R0JNEA | Vishay-Dale | | |
| R19 | 1 | 1 | 9.76k | RES, 9.76 k, 1%, 0.1 W, 0603 | 0603 | CRCW06039K76FKEA | Vishay-Dale | | |
| R20, R23, R40, R50 | 4 | 4 | 0 | RES, 0, 5%, 0.1 W, 0603 | 0603 | CRCW06030000Z0EA | Vishay-Dale | | |
| R21, R55 | 2 | 2 | 49.9k | RES, 49.9 k, 1%, 0.1 W, 0603 | 0603 | CRCW060349K9FKEA | Vishay-Dale | | |
| R22 | 1 | 0 | 13.3k | RES, 13.3 k, 1%, 0.1 W, 0603 | 0603 | CRCW060313K3FKEA | Vishay-Dale | | |
| R22 | 0 | 1 | 6.65k | RES, 6.65 k, 1%, 0.1 W, 0603 | 0603 | CRCW06036K65FKEA | Vishay-Dale | | |
| R24 | 1 | 1 | 9.53k | RES, 9.53 k, 1%, 0.1 W, 0603 | 0603 | CRCW06039K53FKEA | Vishay-Dale | | |
| R25, R28, R29, R30, R36, R37 | 6 | 6 | 100k | RES, 100 k, 5%, 0.063 W, 0402 | 0402 | CRCW0402100KJNED | Vishay-Dale | | |
| R26 | 1 | 1 | 137k | RES, 137 k, 1%, 0.063 W, 0402 | 0402 | CRCW0402137KFKED | Vishay-Dale | | |
| R31 | 1 | 1 | 0.005 | RES, 0.005, 1%, 0.5 W, 1206 | 1206 | WSL12065L000FEA18 | Vishay-Dale | | |
| R33 | 1 | 1 | 0 | RES, 0, 5%, 0.063 W, 0402 | 0402 | RC0402JR-070RL | Yageo America | | |
| R38, R39 | 2 | 2 | 49.9k | RES, 49.9 k, 1%, 0.063 W, 0402 | 0402 | CRCW040249K9FKED | Vishay-Dale | | |

**Table 5. TPS25740BEVM-741 Bill of Materials (continued)**

| Designator | Quantity (HIPWR = H3 or H4) | Quantity (HIPWR = H1 or H2) | Value | Description | Package Reference | Part Number | Manufacturer | Alternate Part Number | Alternate Manufacturer |
|---|---|---|---|---|---|---|---|---|---|
| R41, R43 | 2 | 2 | 220k | RES, 220 k, 5%, 0.063 W, 0402 | 0402 | CRCW0402220KJNED | Vishay-Dale | | |
| R45 | 1 | 1 | 100 | RES, 100, 5%, 0.063 W, 0402 | 0402 | CRCW0402100RJNED | Vishay-Dale | | |
| R46 | 1 | 1 | 24.9 | RES, 24.9, 1%, 0.063 W, 0402 | 0402 | CRCW040224R9FKED | Vishay-Dale | | |
| R47, R53 | 2 | 2 | 10.0 | RES, 10.0, 1%, 0.063 W, 0402 | 0402 | CRCW040210R0FKED | Vishay-Dale | | |
| R48 | 1 | 1 | 1.00k | RES, 1.00 k, 1%, 0.063 W, 0402 | 0402 | CRCW04021K00FKED | Vishay-Dale | | |
| R49 | 1 | 0 | 13.3k | RES, 13.3 k, 1%, 0.1 W, 0603 | 0603 | CRCW060313K3FKEA | Vishay-Dale | | |
| R49 | 0 | 1 | 8.06 k | RES, 8.06 k 1% 0.1 W, 0603 | 0603 | CRCW06038K06FKEA | Vishay-Dale | | |
| R52 | 1 | 1 | 499 | RES, 499, 1%, 0.063 W, 0402 | 0402 | CRCW0402499RFKED | Vishay-Dale | | |
| R54 | 1 | 1 | 24.9k | RES, 24.9 k, 1%, 0.1 W, 0603 | 0603 | CRCW060324K9FKEA | Vishay-Dale | | |
| RH1 | 1 | 1 | 2.94 | RES, 2.94, 1%, 0.1 W, 0603 | 0603 | CRCW06032R94FKEA | Vishay-Dale | | |
| RH2, RL1, RL2 | 3 | 3 | 0 | RES, 0 ohm, 5%, 0.1W, 0603 | 0603 | CRCW06030000Z0EA | Vishay-Dale | | |
| RS1 | 1 | 1 | 0.006 | RES, 0.006, 1%, 1 W, 2512 | 2512 | ERJ-M1WSF6M0U | Panasonic | | |
| SH-J1, SH-J2, SH-J3, SH-J4 | 4 | 4 | 1x2 | Shunt, 100mil, Gold plated, Black | Shunt | 969102-0000-DA | 3M | SNT-100-BK-G | Samtec |
| TP1, TP2, TP9, TP10 | 4 | 4 | Red | Test Point, TH, Miniature, Red | Keystone5000 | 5000 | Keystone | - | - |
| TP3, TP4, TP15, TP16 | 4 | 4 | Black | Test Point, TH, Miniature, Black | Keystone5001 | 5001 | Keystone | - | - |
| TP5, TP6, TP7, TP8, TP11, TP12, TP13, TP14 | 8 | 8 | White | Test Point, Miniature, White, TH | White Miniature Testpoint | 5002 | Keystone | | |
| U1 | 1 | 1 | | 42V Wide VIN 4-Switch Synchronous Buck-Boost Controller, PWP0028F | PWP0028F | LM5175PWP | Texas Instruments | | None |
| U2 | 1 | 1 | | USB Power Delivery (PD) Provider-Only and USB Type-C Downward Facing Port (DFP) Port Controller, RGE0024H | RGE0024H | TPS25740BRGER | Texas Instruments | TPS25740BRGET | Texas Instruments |
| C12 | 0 | 0 | 100pF | CAP, CERM, 100pF, 50V, +/-5%, C0G/NP0, 0603 | 0603 | GRM1885C1H101JA01D | Murata | | |
| C19, C20, C42 | 0 | 0 | 1uF | CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0603 | 0603 | C1608X7R1C105K | TDK | | |
| C43 | 0 | 0 | 4.7uF | CAP, CERM, 4.7 µF, 25 V, +/- 10%, X5R, 1206 | 1206 | 12063D475KAT2A | AVX | | |
| D5 | 0 | 0 | 20V | Diode, Zener, 20 V, 225 mW, SOT-23 | SOT-23 | MMBZ5250BLT1G | ON Semiconductor | | |
| FID1, FID2, FID3 | 0 | 0 | | Fiducial mark. There is nothing to buy or mount. | Fiducial | N/A | N/A | | |
| Q5 | 0 | 0 | 40 V | Transistor, NPN, 40 V, 0.2 A, SOT-23 | SOT-23 | MMBT3904-7-F | Diodes Inc. | | |
| Q9 | 0 | 0 | -50V | MOSFET, P-CH, -50 V, -0.13 A, SOT-23 | SOT-23 | BSS84-7-F | Diodes Inc. | | None |
| R7 | 0 | 0 | 0 | RES, 0, 5%, 0.1 W, 0603 | 0603 | CRCW06030000Z0EA | Vishay-Dale | | |
| R16 | 0 | 0 | 200k | RES, 200 k, 1%, 0.1 W, 0603 | 0603 | CRCW0603200KFKEA | Vishay-Dale | | |
| R17 | 0 | 0 | 510 | RES, 510, 5%, 0.125 W, 0805 | 0805 | ERJ-6GEYJ511V | Panasonic | | |
| R27 | 0 | 0 | 499 | RES, 499, 1%, 0.063 W, 0402 | 0402 | CRCW0402499RFKED | Vishay-Dale | | |
| R42 | 0 | 0 | 0 | RES, 0, 5%, 0.063 W, 0402 | 0402 | RC0402JR-070RL | Yageo America | | |
| R44 | 0 | 0 | 100k | RES, 100 k, 1%, 0.1 W, 0603 | 0603 | CRCW0603100KFKEA | Vishay-Dale | | |
| R51 | 0 | 0 | 0 | RES, 0, 5%, 0.063 W, 0402 | 0402 | RC0402JR-070RL | Yageo America | | |
| Notes: | Unless otherwise noted in the Alternate Part Number or Alternate Manufacturer columns, all parts may be substituted with equivalents. | | | | | | | | |

# STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      **FCC NOTICE:** This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      **CAUTION**

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      **FCC Interference Statement for Class A EVM devices**

      *NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

**FCC Interference Statement for Class B EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

**Concerning EVMs Including Radio Transmitters:**

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

**Concernant les EVMs avec appareils radio:**

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

**Concernant les EVMs avec antennes détachables**

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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