User's Guide
SLVUA83A–May 2014–Revised May 2019

# TPS65263EVM-645 PMIC with I²C Controlled DVS Evaluation Module

This document presents the information required to operate the TPS65263 power-management integrated circuit (PMIC) as well as the support documentation including schematic, layout, hardware setup, and bill of materials.

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## 1 Background

The TPS65263 PMIC is a triple 3-A, 2-A, 2-A output current, synchronous step-down (buck) converter with an operational range of 4.5 V to 18 V.


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The TPS65263 is equipped with I²C-compatible bus for communication with system on-chip (SoC) to control buck converters. The output voltage of each buck can be dynamically scaled from 0.68 V to 1.95 V in 10-mV step with I²C controlled 7 bits VID. The VID voltage transition slew rate is programmable with 3-bits control through I²C bus to optimize overshoot or undershoot during VID voltage transition. I²C also controls enabling and disabling output voltage, setting the pulse skipping mode (PSM) or force continuous current mode (FCC) at light load condition, and reading the power good status, overcurrent warning, and die temperature warning.

As there are many possible options to set the converters, Table 1 presents the performance specification summary for the EVM.

**Table 1. Summary of Performance**

| Test Conditions | Performance |
|---|---|
| VIN = 4.5 V to 18 V<br>fsw = 600 kHz (25°C ambient) | Buck1, 1.5 V, up to 3 A<br>Buck2, 1.2 V, up to 2 A<br>Buck3, 2.5 V, up to 2 A |

The evaluation module is designed to provide access to the features of the TPS65263. Some modifications can be made to this module to test performance at different input and output voltages for bucks. Contact the TI Field Applications Group for assistance.



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## 2 TPS65263EVM Schematic

Figure 1 illustrates the EVM schematic.

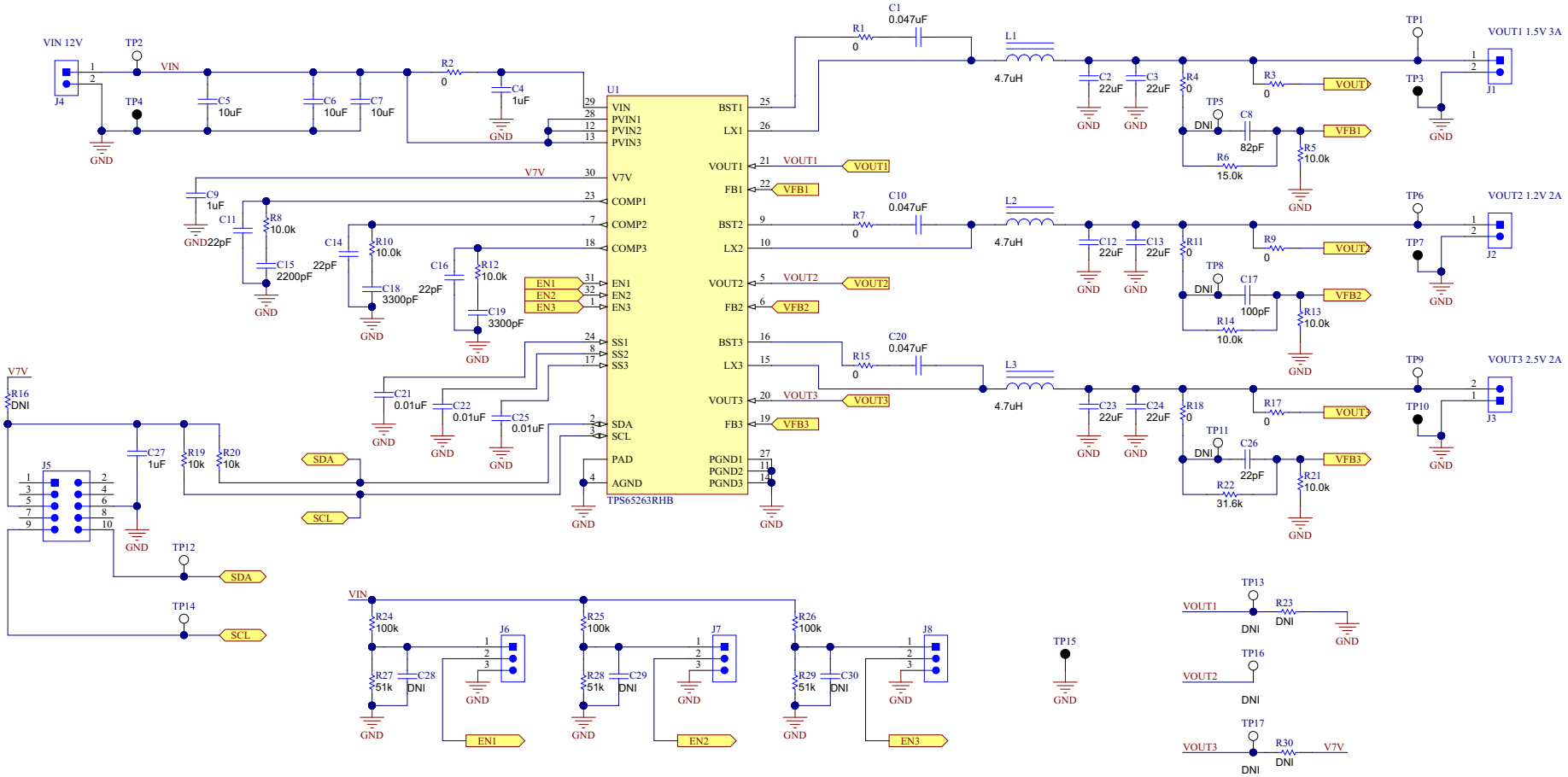



**Figure 1. TPS65263 Schematic**



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## 3 Board Layout

Figure 2 through Figure 6 show the PCB board layouts.

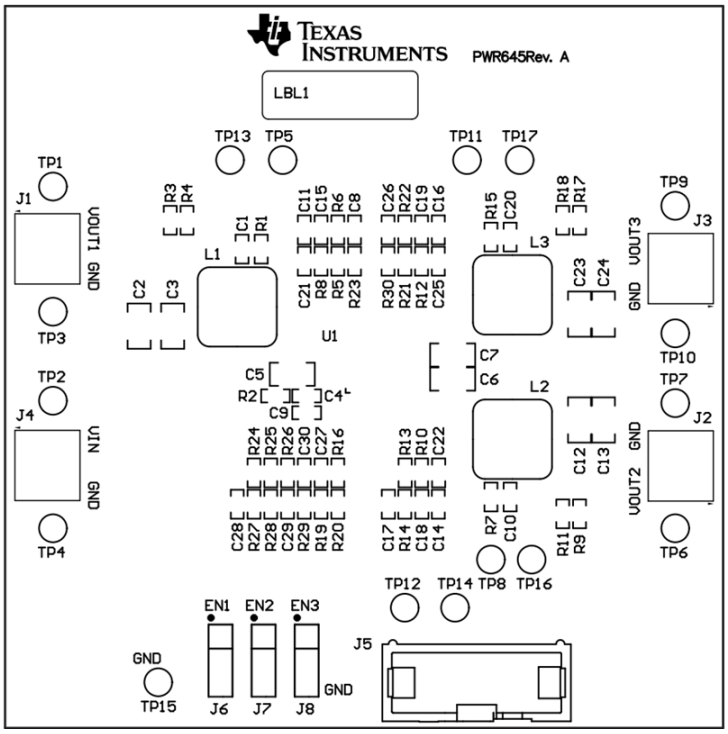



**Figure 2. Component Placement (Top Layer)**

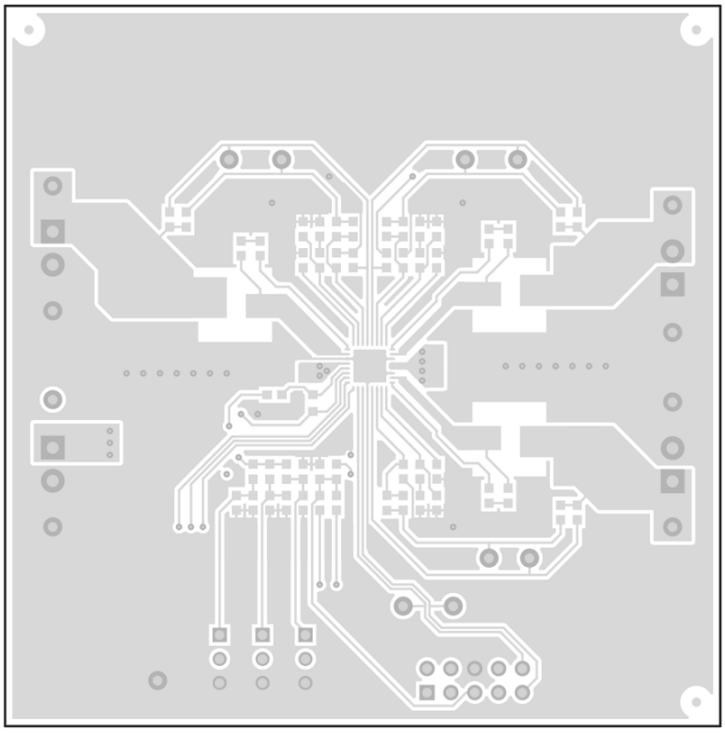


**Figure 3. Board Layout (Top Layer)**



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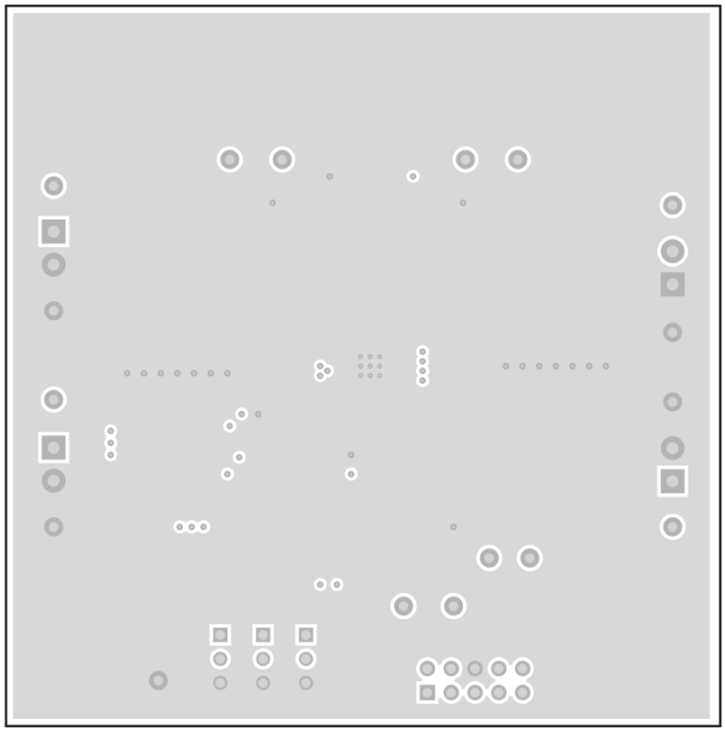


**Figure 4. Board Layout (Second Layer)**

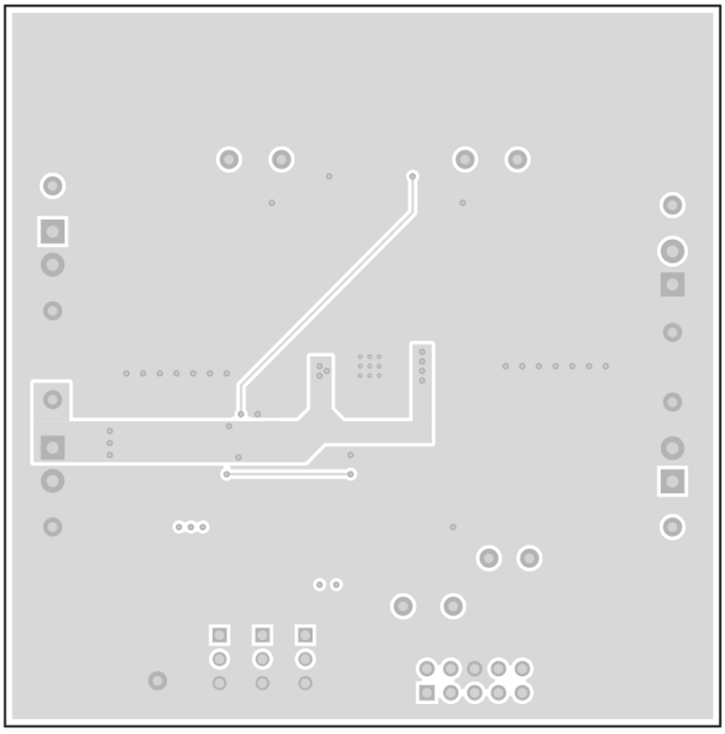


**Figure 5. Board Layout (Third Layer)**


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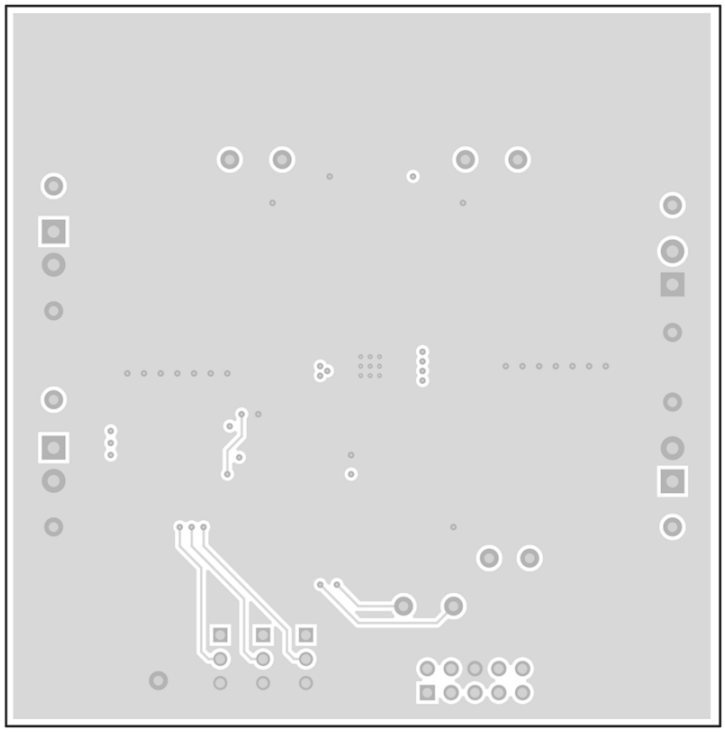


**Figure 6. Board Layout (Bottom Layer)**



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# 4 Bench Test Setup Conditions

## 4.1 Headers Description and Jumper Placement

Figure 7 illustrates header and jumper placement on the EVM.

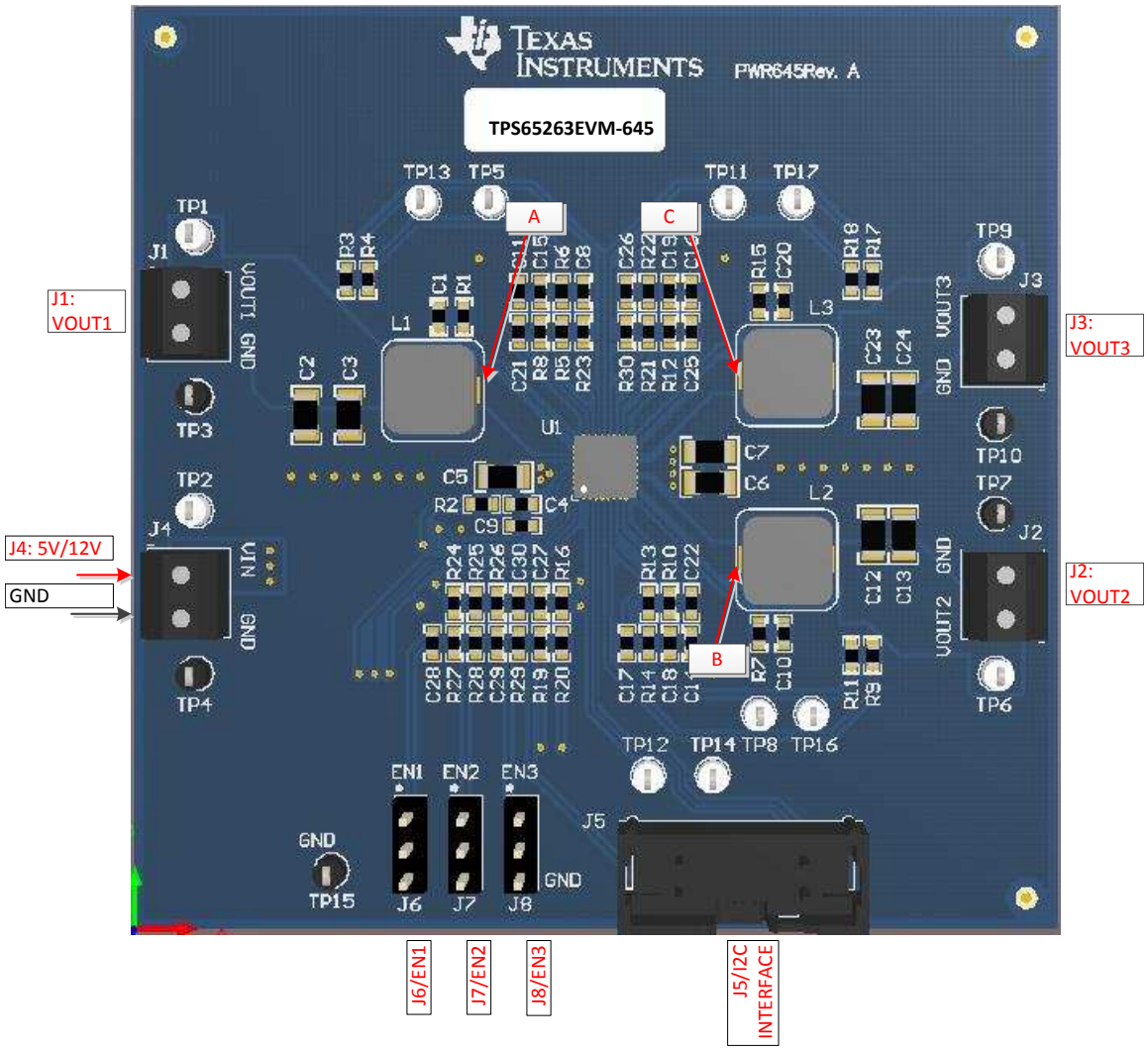



**Figure 7. Headers Description and Jumper Placement**

Test points:

A: LX of VOUT1
B: LX of VOUT2
C: LX of VOUT3

VOUT1, VOUT2, VOUT3, VIN, SDA, SCL



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**Table 2. Input/Output Connection**

| No. | Function | Description |
|---|---|---|
| J1 | Buck1 Connector | Output of Buck1 |
| J2 | Buck2 Connector | Output of Buck2 |
| J3 | Buck3 Connector | Output of Buck3 |
| J4 | Buck1, Buck2, Buck3 VIN Connector | Apply power supply to this connector |
| J5 | $I^2C$ Interface connector | Communication via $I^2C$ Interface |

**Table 3. Jumpers**

| No. | Function | Placement | Comment |
|---|---|---|---|
| J6 | Buck1 enable (EN1) | Connect EN1 to GND to disable VOUT1, connect EN1 to VIN through a 100-kΩ resistor to enable VOUT1; leave open to enable VOUT1 | |
| J7 | Buck2 enable (EN2) | Connect EN2 to GND to disable VOUT2, connect EN2 to VIN through a 100-kΩ resistor to enable VOUT2; leave open to enable VOUT2 | |
| J8 | Buck3 enable (EN3) | Connect EN3 to GND to disable VOUT3, connect EN3 to VIN through a 100-kΩ resistor to enable VOUT3; leave open to enable VOUT3 | |

## 4.2 Hardware Requirement

This EVM requires an external power supply capable of providing 4.5 V to 18 V at 6 A.

The EVM kit needs a USB-TO-GPIO interface box which, when installed on a PC and connected to the EVM, allows communication with the EVM via a GUI interface. The USB-TO-GPIO interface box can be ordered in the TI store.

The minimum PC requirements are:

- Microsoft® Windows® 2000 or Windows XP operating system
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

## 4.3 Hardware Setup

After connecting the power supply to J4, turn on the power supply, and connect J6, J7, and J8 to high or leave open, the EVM regulates the output voltages to the value per Table 1. Additional input capacitance may be required in order to mitigate the inductive voltage droop that may occur during a load-transient event.

In order to change the output voltage by sending the digital control signal via a PC running the TPS65263 controller software and USB-TO-GPIO interface box, perform the following steps:

Step 1. Connect one end of the USB-TO-GPIO box to the PC using the USB cable and the other end to J5 of the TPS65263 using the supplied 10-pin ribbon cable per Figure 8. The connectors on the ribbon cable are keyed to prevent incorrect installation.

Step 2. Connect the power supply on J4 and turn on the power supply.

Step 3. Run the software as explained in Section 4.4.



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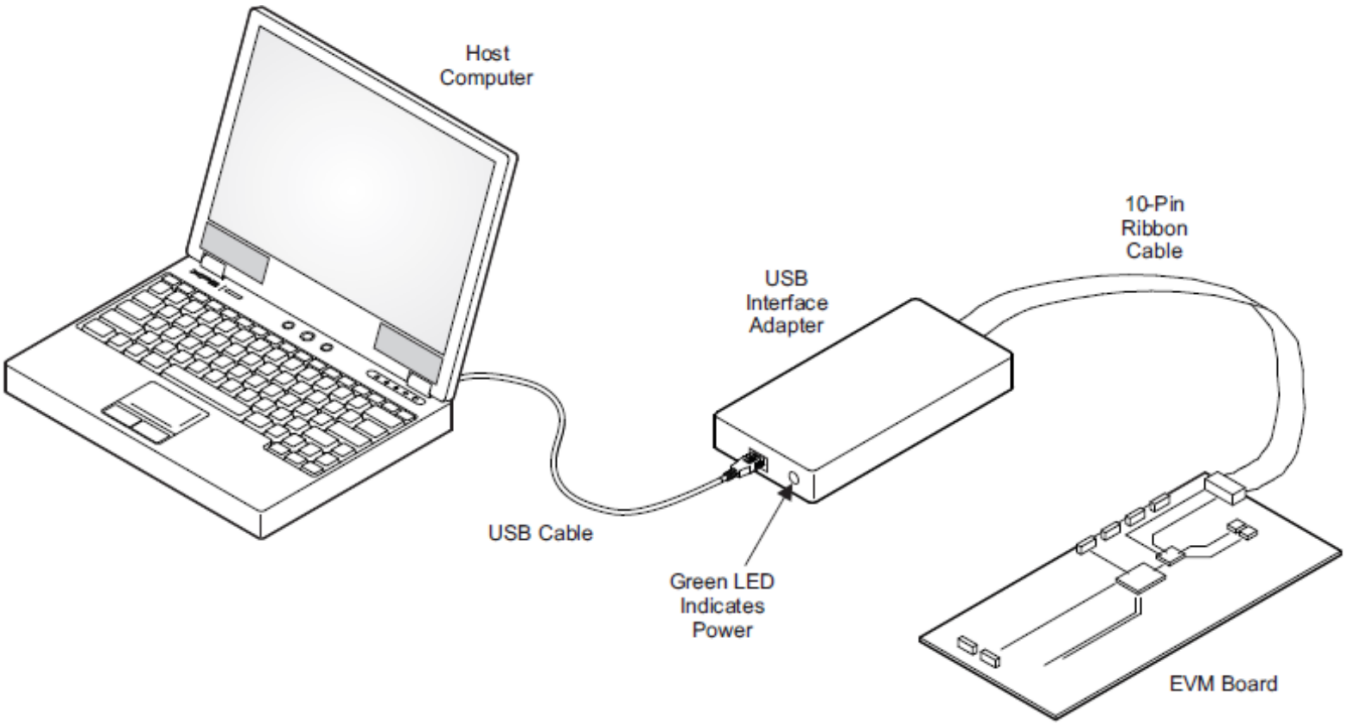



**Figure 8. USB Interface Adapter Quick Connection Diagram**

## 4.4 Software Install

If you are installing from the TI Web site, go to www.ti.com.

**NOTE:** This installation page is best viewed with Microsoft Internet Explorer® browser (the web page may not work correctly with other browsers).

Click on the *Install* button. Your PC should give you a security warning asking if you want to install this application. Select *Install* to proceed. If a pre-release or Beta version is currently installed on your PC, you must uninstall this version of the software before installing the final version.

The software attempts to install the Microsoft .NET Framework 2.0 (if it is not already installed). This framework is required for the software to run.

To run the software after installation, go to Start → All programs → Texas Instruments → TPS65263 EVM Software.

At start-up, the software first checks the firmware version of the USB-TO-GPIO adapter box. If an incorrect firmware version is installed, the software automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies of the update, downloads, and installs the software. Note that after the firmware is updated, the USB cable must be disconnected and then reconnected between the adapter and PC, as instructed during the install process. The host PC software also automatically searches on the Internet (if connected) for updates. If a new update is available, the software notifies the user of the update and downloads and installs it. During future software uses, you may be prompted to install a new version if one becomes available on the Web.

**NOTE:** VERISIGN® Code Signing is used to prevent any malicious code from changing this application. If at any time in the future the binaries are modified, the code no longer attempts to run.


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## 4.5 Software Operation

This section provides descriptions of the EVM software.

The supplied software is used to communicate with the TPS65263 EVM. Click on the icon on the host computer to start the software. The software displays the main control panel for the user interface.

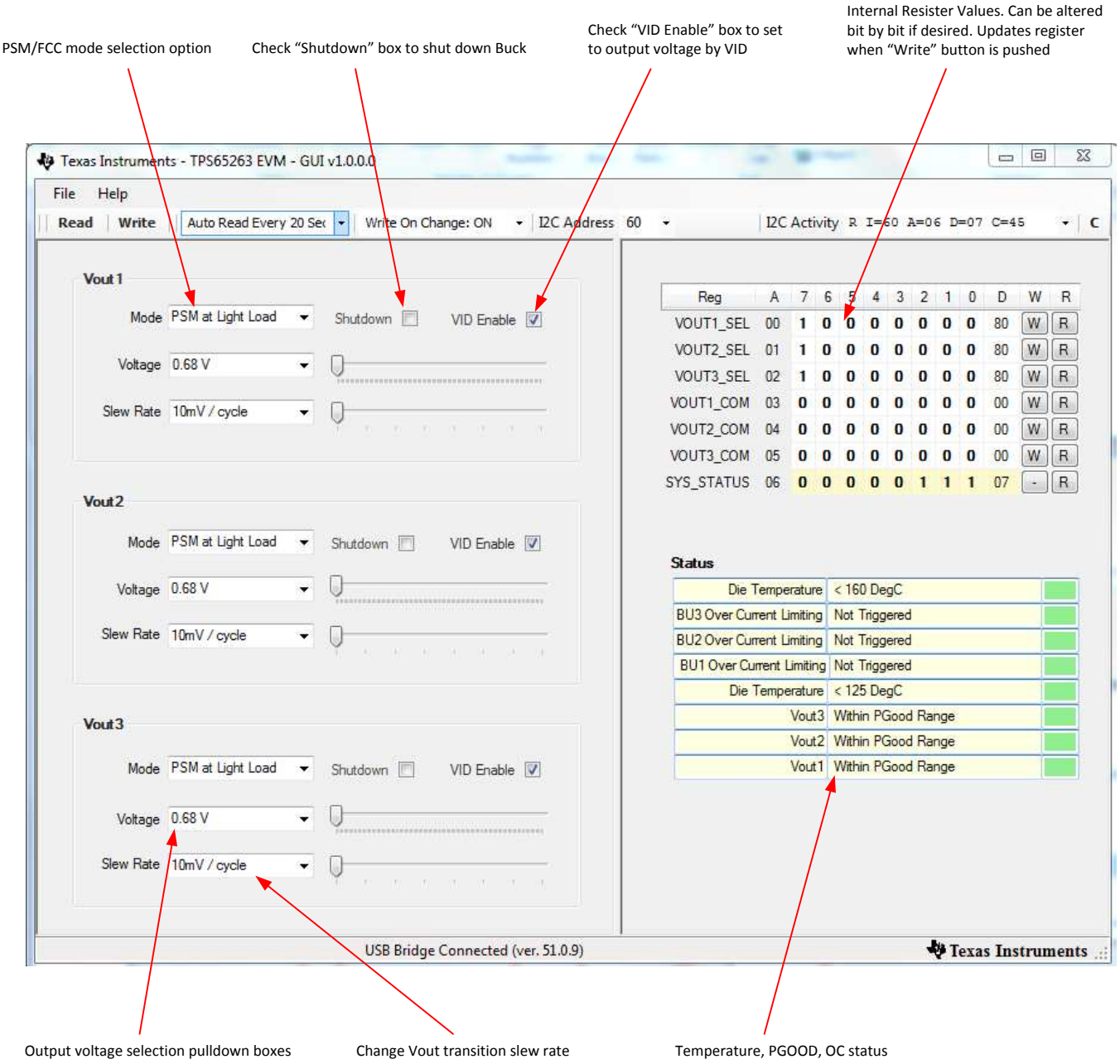



**Figure 9. Screen Capture of TPS65263 Software GUI Interface**

Figure 9 shows the control GUI interface. There are seven 8-bit registers embedded in TPS65263, three to select the output voltage, three to configure the slew rate of the buck converter, and one for status feedback. Changes can be made by selecting and checking the components in the GUI on the left hand side or by directly clicking the bits of each register. The $I^2C$ address is set to 0x60H by default.

An option is to "write on change". If this option is set to ON, any change is sent to the EVM immediately. If this option is set to OFF, "Write" button or "W" button for each register must be clicked to send the control signal.



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Register values can be read back from the EVM by clicking “Read” or “R” for each register.

## 5 Power-Up Procedure

Use the following steps to power-up the EVM:

1. Connect $I^2C$ adapter to J5.
2. Apply 12 V to J4.
3. Toggle J6, J7, or J8 to enable VOUT1, VOUT2, and VOUT3, respectively.
4. Apply loads to the output connectors.


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# 6 Bill of Materials

Table 4 lists the BOM for this EVM.

**Table 4. Bill of Materials**

| Qty | Designator | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| 1 | PCB1 | | Printed Circuit Board | | PWR645 | Any |
| 3 | C1, C10, C20 | 0.047µF | CAP, CERM, 0.047 µF, 50 V, ±10%, X7R, 0603 | 0603 | C1608X7R1H473K | TDK |
| 6 | C2, C3, C12, C13, C23, C24 | 22µF | CAP, CERM, 22 µF, 16 V, ±20%, X5R, 1206 | 1206 | 1206YD226MAT2A | AVX |
| 3 | C4, C9, C27 | 1µF | CAP, CERM, 1 µF, 25 V, ±10%, X7R, 0603 | 0603 | C1608X7R1E105K080AB | TDK |
| 3 | C5, C6, C7 | 10µF | CAP, CERM, 10 µF, 25 V, ±10%, X5R, 1206 | 1206 | GRM31CR61E106KA12L | Murata |
| 1 | C8 | 82pF | CAP, CERM, 82 pF, 50 V, ±5%, C0G/NP0, 0603 | 0603 | 06035A820JAT2A | AVX |
| 4 | C11, C14, C16, C26 | 22pF | CAP, CERM, 22 pF, 50 V, ±5%, C0G/NP0, 0603 | 0603 | 06035A220JAT2A | AVX |
| 1 | C15 | 2200pF | CAP, CERM, 2200 pF, 50 V, ±10%, X7R, 0603 | 0603 | C0603C222K5RACTU | Kemet |
| 1 | C17 | 100pF | CAP, CERM, 100 pF, 25 V, ±10%, X7R, 0603 | 0603 | 06033C101KAT2A | AVX |
| 2 | C18, C19 | 3300pF | CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603 | 0603 | C0603C332K5RACTU | Kemet |
| 3 | C21, C22, C25 | 0.01µF | CAP, CERM, 0.01 µF, 50 V, ±5%, X7R, 0603 | 0603 | C0603C103J5RACTU | Kemet |
| 4 | H1, H2, H3, H4 | | Bumpon, Hemisphere, 0.44 × 0.20, Clear | Transparent Bumpon | SJ-5303 (CLEAR) | 3M |
| 4 | J1, J2, J3, J4 | | Terminal Block, 6 A, 3.5 mm Pitch, 2-Pos, TH | 7.0x8.2x6.5mm | ED555/2DS | On-Shore Technology |
| 1 | J5 | | Header (shrouded), 100 mil, 5×2, High-Temperature, Gold, TH | 5x2 Shrouded header | N2510-6002-RB | 3M |
| 3 | J6, J7, J8 | | Header, 100mil, 3×1, Tin plated, TH | Header, 3 PIN, 100mil, Tin | PEC03SAAN | Sullins Connector Solutions |
| 3 | L1, L2, L3 | 4.7µH | Inductor, Shielded Drum Core, Superflux, 4.7 µH, 6 A, 0.02 Ω, SMD | WE-HC4 | 744311470 | Wurth Elektronik eiSos |
| 1 | LBL1 | | Thermal Transfer Printable Labels, 0.650" W × 0.200" H - 10,000 per roll | PCB Label 0.650"H x 0.200"W | THT-14-423-10 | Brady |
| 10 | R1–R4, R7, R9, R11, R15, R17, R18 | 0 | RES, 0 Ω, 5%, 0.1 W, 0603 | 0603 | CRCW06030000Z0EA | Vishay-Dale |
| 7 | R5, R8, R10, R12–R14, R21 | 10.0k | RES, 10.0 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW060310K0FKEA | Vishay-Dale |
| 1 | R6 | 15.0k | RES, 15.0 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW060315K0FKEA | Vishay-Dale |
| 2 | R19, R20 | 10k | RES, 10 kΩ, 5%, 0.1 W, 0603 | 0603 | CRCW060310K0JNEA | Vishay-Dale |
| 1 | R22 | 31.6k | RES, 31.6 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW060331K6FKEA | Vishay-Dale |
| 3 | R24, R25, R26 | 100k | RES, 100 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW0603100KFKEA | Vishay-Dale |
| 3 | R27, R28, R29 | 51k | RES, 51 kΩ, 5%, 0.1 W, 0603 | 0603 | CRCW060351K0JNEA | Vishay-Dale |
| 6 | TP1, TP2, TP6, TP9, TP12, TP14 | White | Test Point, Miniature, White, TH | White Miniature Testpoint | 5002 | Keystone |
| 5 | TP3, TP4, TP7, TP10, TP15 | Black | Test Point, Miniature, Black, TH | Black Miniature Testpoint | 5001 | Keystone |
| 1 | U1 | | 4.5 V to 18 V Input Voltage, 3 A/2 A/2 A Output Current Triple Synchronous Step-Down Converter with $I^2C$ Controlled Dynamic Voltage Scaling, RHB0032E | RHB0032E | TPS65263RHB | Texas Instruments |
| 0 | C28, C29, C30 | DNI | CAP, CERM, 0.01 µF, 50 V, ±5%, X7R, 0603 | 0603 | C0603C103J5RACTU | Kemet |
| 0 | FID1, FID2, FID3 | | Fiducial mark. There is nothing to buy or mount. | Fiducial | N/A | N/A |



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**Table 4. Bill of Materials (continued)**

| Qty | Designator | Value | Description | Package Reference | Part Number | Manufacturer |
|---|---|---|---|---|---|---|
| 0 | R16 | DNI | RES, 0 Ω, 5%, 0.1 W, 0603 | 0603 | CRCW06030000Z0EA | Vishay-Dale |
| 0 | R23 | DNI | RES, 73.2 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW060373K2FKEA | Vishay-Dale |
| 0 | R30 | DNI | RES, 100 kΩ, 1%, 0.1 W, 0603 | 0603 | CRCW0603100KFKEA | Vishay-Dale |
| 0 | TP5, TP8, TP11, TP13, TP16, TP17 | DNI | Test Point, Miniature, White, TH | White Miniature Testpoint | 5002 | Keystone |
| Note: Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents. | | | | | | |



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## Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (May 2018) to A Revision | Page |
|---|---|
| • Edited user's guide for clarity. | 1 |
| • Changed the Hardware Requirement | 8 |



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