

TPS65170 Evaluation Module

This user's guide describes the characteristics, operation, and use of the TPS65170 evaluation module (EVM). This EVM contains the Texas Instruments LCD bias supply TPS65170 with a minimum 2.8 A switch current on the boost converter. The part also includes a 3.3 V, 1.5 A buck converter and a positive as well as a negative charge pump controller with 50 mA output current. The user's guide includes EVM specifications, recommended test setup, the schematic diagram, bill of materials, and the board layout.

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1 Introduction

The TPS65170 provides a simple and economic power supply solution for a wide variety of LCD bias applications. In typical display panel applications, the boost converter generates the display panel's source voltage V_S , the buck converter generates the system's logic supply V_{LOGIC} , and the two charge pump controllers regulate the external charge pumps generating the display transistors' on and off supplies V_{GH} and V_{GL} . By using external transistors to regulate the charge pump output voltage, power dissipation in the integrated circuit (IC) is significantly reduced, simplifying printed-circuit board (PCB) thermal design and improving reliability. The TPS65170 also provides a reset circuit that monitors the buck converter output (V_{LOGIC}) and generates a reset signal for the timing controller during power up.

1.1 Description

The TPS65170EVM is designed to operate over the full input voltage range and produces an output voltage of 15.6 V on the boost converter, 3.3 V on the buck converter, 26 V on the positive charge pump, and -7 V on the negative charge pump. The output voltages on the boost converter and the charge pumps can be adjusted by changing the feedback resistor divider networks. The external compensation is optimized for maximum stability for the used inductor and capacitor combinations. If another inductor and capacitor combination is used on the boost converter, the compensation must be adjusted according to the data sheet..

1.2 Applications

- LCD televisions and monitors

1.3 Features

- 8.6 V to 14.7 V input voltage range
- 2.8 A boost converter switch current limit
- Boost converter output voltages up to 18.5 V
- Boost and buck converter short-circuit protection
- 1.5 A buck converter switch current limit
- Fixed 750-kHz switching frequency for buck and boost converters
- Fixed buck converter soft start
- Programmable boost converter soft start
- Two charge pump controllers to regulate V_{GH} and V_{GL}
- Control signal for external high-side MOSFET isolation switch
- Reset signal with programmable reset pulse duration
- Thermal shutdown
- Double-sided, two-active-layer PCB with all components on top side

2 TPS65170EVM Electrical and Performance Specifications

Table 1. TPS65170EVM Electrical and Performance Specifications

| Parameter | | Notes and Conditions | Min | Typ | Max | Unit |
|-------------------------------|---|---|------|------|------|------------------|
| Input Characteristics | | | | | | |
| V_{IN} | Input Voltage | | 8 | 14.7 | | V |
| I_{IN} | Input Current | $V_{IN} = 12\text{ V}$, $I_S = I_{LOGIC} = 1\text{ A}$, $I_{VGH} = 50\text{ mA}$, $I_{VGL} = 50\text{ mA}$ | | 10 | | mA |
| | No Load Input Current | $V_{IN} = 12\text{ V}$, $I_S = I_{LOGIC} = I_{VGH} = I_{VGL} = 0\text{ A}$ | | 7 | 10 | mA |
| Output Characteristics | | | | | | |
| V_S | Boost Converter Output Voltage | $V_{IN} = 12\text{ V}$, $I_S = 1\text{ A}$ | 15.4 | 15.6 | 15.8 | V |
| | Line Regulation on V_S | $V_{IN} = 9.6\text{ V to }14.4\text{ V}$, $I_{OUT} = 750\text{ mA}$ | | 15 | | mV |
| | Load Regulation on V_S | $I_{OUT} = 100\text{ mA to }1.5\text{ A}$, PWM; $V_{IN} = 12\text{ V}$ | | 25 | | mV |
| V_{LOGIC} | Buck Converter Output Voltage | $V_{IN} = 12\text{ V}$, $I_{LOGIC} = 1\text{ A}$ | 3.2 | 3.3 | 3.4 | V |
| | Line Regulation on V_{LOGIC} | $V_{IN} = 9.6\text{ V to }14.4\text{ V}$, $I_{OUT} = 500\text{ mA}$ | | 15 | | mV |
| | Load Regulation on V_{LOGIC} | $I_{OUT} = 100\text{ mA to }1\text{ A}$, PWM; $V_{IN} = 12\text{ V}$ | | 10 | | mV |
| V_{GH} | Positive Charge Pump Output Logic Voltage | $V_{IN} = 12\text{ V}$, $I_{GH} = 50\text{ mA}$, | 25 | 26 | 27 | V |
| V_{GL} | Negative Charge Pump Output Logic Voltage | $V_{IN} = 12\text{ V}$, $I_{GL} = 50\text{ mA}$ | 6.5 | 7 | 7.5 | V |
| $V_{OUT(PP)}$ | Output Voltage Ripple, Boost Converter | $V_{IN} = 12\text{ V}$, $I_{OUT} = 1\text{ A}$ | | 20 | | mV _{PP} |
| System Characteristics | | | | | | |
| f_{SW} | Switching Frequency | | 600 | 750 | 900 | kHz |
| η_{pk} | Peak Efficiency Boost Converter | $V_{IN} = 12\text{ V}$ | | 93% | | |

3 TPS65170EVM Schematic

Figure 1 is for reference only; see Table 2 for specific values.

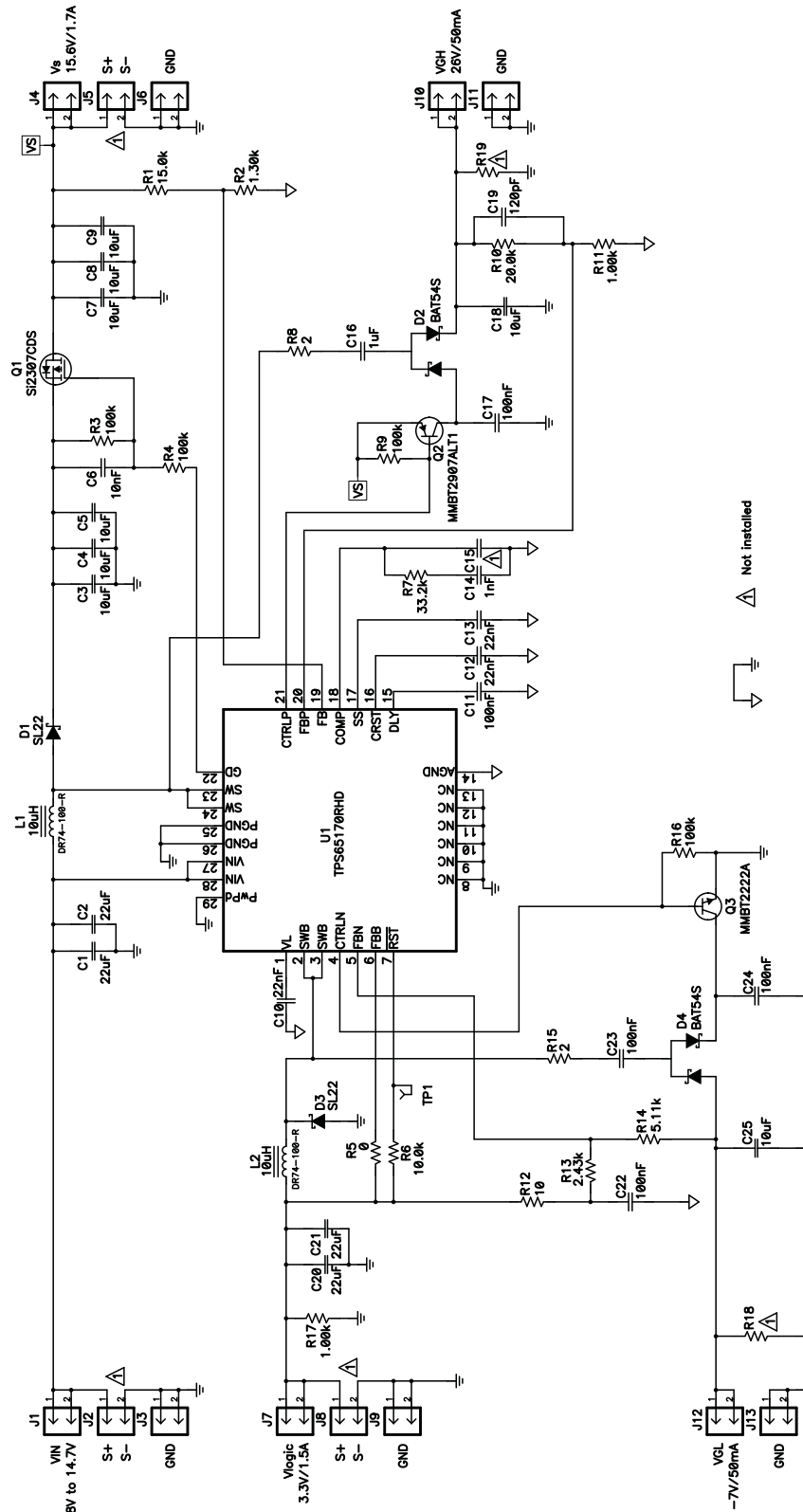


Figure 1. TPS65170EVM Schematic

4 Connector and Test Point Descriptions

4.1 Input Connectors

4.1.1 J1 – VIN

This header is the positive connection to the input power supply. The power supply must be connected between J1 and J3 (GND). Twist the leads to the input supply and keep them as short as possible. The input voltage has to be between 8 V and 14.7 V.

4.1.2 J2 – Input Sense Connector

This header is unpopulated, but is reserved for future use to measure the input voltage directly on the input capacitor. Therefore, a 4-wire power and sense supply can be connected. Twist the leads to the sensing connector.

4.1.3 J3 – GND

This header is the return connection to the input power supply. Connect the power supply between these pins and J1 (VIN). Twist the leads to the input supply and keep them as short as possible. The input voltage must be between 8 V and 14.7 V.

4.2 Output Connectors

4.2.1 J4 – V_s

This header is the positive connection of the output voltage of the boost converter. Connect the boost converter's load between J4 and J6 (GND).

4.2.2 J5 – V_s Output Sense Connector

This header is unpopulated, but is reserved for future use to measure the output voltage of the boost converter directly on the output capacitors.

4.2.3 J6 – GND

This header is the return connection of the output voltage of the boost converter. Connect the boost converter's load between these pins and J4 (VOUT).

5 Test Setup

5.1 EVM Operation

The user must connect an input power supply set between 8 V and 14.7 V between headers J1 and J3 in order for the EVM to operate. The absolute maximum input voltage is 20 V.

The user can connect a load resistance between J4 and J6, J7 and J9, J10 and J11, and J12 and J13.

5.2 Compensation – COMP

The regulator loop can be compensated by adjusting the external components connected to the COMP pin. The COMP pin is the output of the internal transconductance error amplifier.

Standard values of $R_{COMP} = R7 = 33 \text{ k}\Omega$ and $C_{COMP} = C14 = 1 \text{ nF}$ work for the majority of the applications.

6 TPS65170EVM Assembly Drawings and Layout

Figure 2 through Figure 4 show the design of the TPS65170EVM printed-circuit board (PCB). The EVM has been designed using a two-layer, 35- μm (1 oz), copper-clad circuit board. All components are on the top side, and all active traces on the top and bottom layers allow the user to easily view, probe, and evaluate the TPS65170 control IC in a practical, double-sided application. Moving components to both sides of the PCB or using additional internal layers can offer additional size reduction for space-constrained systems.

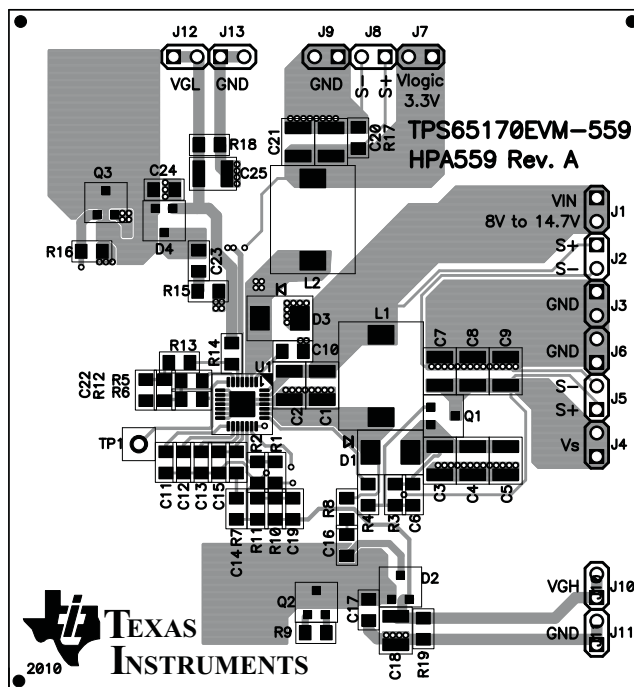


Figure 2. TPS65170EVM Component Placement, Viewed From Top

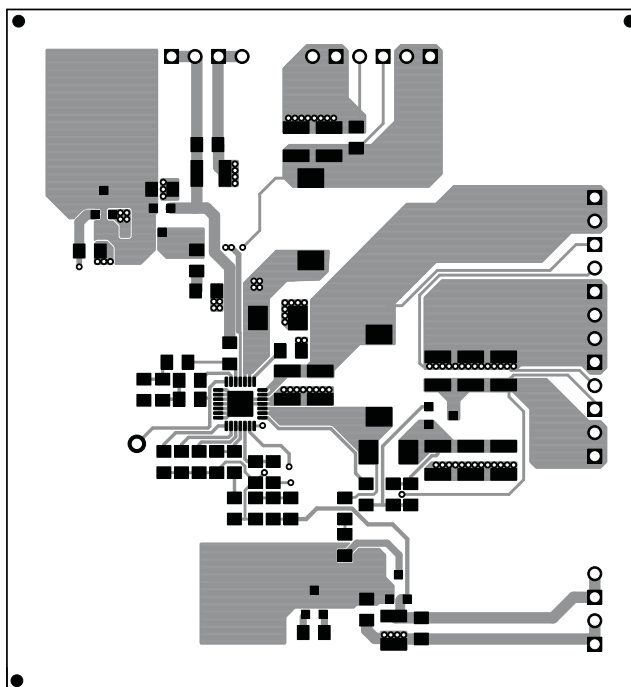


Figure 3. TPS65170EVM Top Copper, Viewed From Top

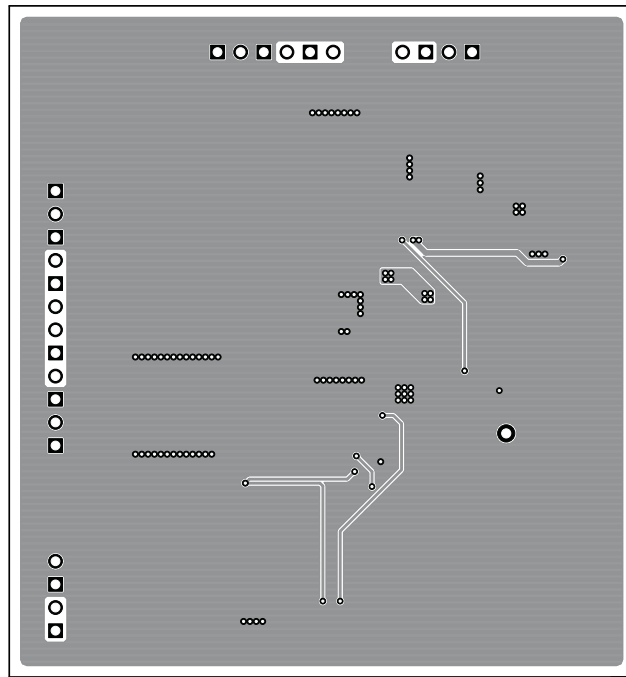


Figure 4. TPS65170EVM Bottom Copper, Viewed From Bottom

7 List of Materials

Table 2 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 2. TPS65170EVM Bill of Materials

| RefDes | Value | Description | Size | Part Number | MFR |
|-------------------------|--------------|---|--------------------|------------------|-------------------|
| C1, C2, C20, C21 | 22 μ F | Capacitor, Ceramic, 16V, X5R, 20% | 1210 | EMK325BJ226MM | Taiyo Yuden |
| C10, C12, C13 | 22 nF | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| C11, C17, C22, C23, C24 | 100 nF | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| C14 | 1 nF | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| C15 | Open | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| C16 | 1 μ F | Capacitor, Ceramic, 35V, X7R, 10% | 0805 | GMK212B7105KG | Taiyo Yuden |
| C18, C25 | 10 μ F | Capacitor, Ceramic, 50V, X5R, 20% | 1210 | UMK325BJ106MM | Taiyo Yuden |
| C19 | 120 pF | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| C3, C4, C5, C7, C8, C9 | 10 μ F | Capacitor, Ceramic, 25V, X5R, 20% | 1210 | TMK325BJ106MM | Taiyo Yuden |
| C6 | 10 μ F | Capacitor, Ceramic, 50V, X7R, 10% | 0805 | Std | Std |
| D1, D3 | SL22 | Diode, Schottky Rectifier, 2A, 20V | DO-214AA | SL22-E3/52T | Vishay |
| D2, D4 | BAT54S | Diode, Dual Schottky, 200-mA, 30-V | SOT23 | BAT54S-7-F | Diodes Inc. |
| L1, L2 | 10 μ H | Inductor, SMT, 2.4A, 49 m Ω | 0.327 X 0.327 inch | DR74-100-R | Coiltronics |
| Q1 | Si2307CDS | MOSFET, P-ch, -20V, -2.3A, 130 m Ω | SOT23 | Si2307CDS-T1-GE3 | Vishay |
| Q2 | MMBT2907ALT1 | Transistor, PNP, -60V, -600mA, 225-W | SOT23 | MMBT2907ALT1 | On Semi |
| Q3 | MMBT2222A | Transistor, NPN, High Performance, 500mA | SOT23 | MMBT2222A | Fairchild |
| R1 | 15.0k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R10 | 20.0k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R11, R17 | 1.00k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R12 | 10 | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R13 | 2.43k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R14 | 5.11k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R18, R19 | Open | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R2 | 1.30k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R3, R4, R9, R16 | 100k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R5 | 0 | Resistor, Chip, 1/10W, 10% | 0805 | Std | Std |
| R6 | 10.0k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R7 | 33.2k | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| R8, R15 | 2 | Resistor, Chip, 1/10W, 1% | 0805 | Std | Std |
| U1 | TPS65170RHD | IC, LCD Bias Supply | QFN-28 | TPS65170RHD | Texas Instruments |

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 8 V to 14.7 V and various output voltages between 3.3 V and 26 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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