# TPS61195EVM-460

This user's guide describes the characteristics, operation, and use of the TPS61195 evaluation module (EVM). This EVM contains the Texas Instruments TPS61195, a WLED power solution providing up to eight independently regulated current outputs using a single inductor step-up (boost) converter. The current outputs are ideal for driving a WLED backlight in notebook/laptop computers. This user's guide includes EVM specifications, recommended test setup, test results, bill of materials, and a schematic diagram.

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# 1 Applications

Notebook and Monitor LCD display backlight

# 2 TPS61195EVM-460 Electrical Performance Specifications

Table 1 provides a summary of the TPS61195EVM-460 performance specifications. All specifications are given for an ambient temperature of 25°C.

**Table 1. TPS61195EVM-460 Electrical and Performance Specifications**

| Parameter | | Notes and Conditions [1] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **INPUT CHARACTERISTICS** | | | | | | |
| $V_{IN}$ | Input Voltage | | 7 | | 21 | V |
| En | EN Logic high | | 1.2 | | 6 | V |
| PWM | PWM Logic high | | 1.2 | | 6 | V |
| $I_{q\_VIN}$ | Input quiescent Current | Device enable, switching 600 KHz and no load, $V_{IN}$ = 21 V | | | 3 | mA |
| $V_{IN\_UVLO}$ | Input UVLO | $V_{IN}$ ramp down | | | 3.55 | V |
| | | V ramp up | | | 3.80 | |
| **OUTPUT CHARACTERISTICS** | | | | | | |
| $V_{OUT}$ | V(TP3) | J6 connected to 10 WLED configured WLEDEVM-260, JP4 shorted, JP5-12 shorted, EN/PWM =VDDIO, SEL1=SEL2=GND | | 32 | 35 | V |
| | | J6 connected to 10 WLED configured WLEDEVM-260, JP4 open, JP5-12 shorted, EN/PWM=VDDIO, SEL1=SEL2=GND, OVP active | 44 | 45 | 46 | V |
| $I_{OUT1}$ | I(JP4) = 8 X IFBx | $V_{IN}$ = Min to Max, R1 = 64.9k | 156 | 160 | 164 | mA |
| **SYSTEMS CHARACTERISTICS** | | | | | | |
| $F_{SW}$ | Switching Frequency | $R_{FSLCT}$ = 523K | 0.8 | 1 | 1.2 | MHz |

[1] The user can estimate the input current by solving the power balance equation, eff = $P_{OUT}/P_{IN}$ = $(V_O \times I_O)/(V_{IN} \times I_{IN})$, for $I_{IN}$ and estimating the efficiency to be a conservative 85%. For example, for $V_O$ = 30V, $V_{IN}$ = 7V and $I_O$ = 8 × 20mA = 160mA, $I_{IN}$ = (30V × 160mA)/(7V × 0.85) = 0.81A

# 3 Modifications

See the datasheet (SLVSA07) when changing components such as R1 to set the LED current or R5 and R6 to set the OVP threshold. To aid in such customization of the EVM, the board was designed with devices having 0603 or larger footprints. A real implementation likely occupies less total board space.

Note that changing components can improve or degrade EVM performance. For example, using inductors with larger dc resistances lowers the dc/dc conveter's efficiency.

## 4    Schematic
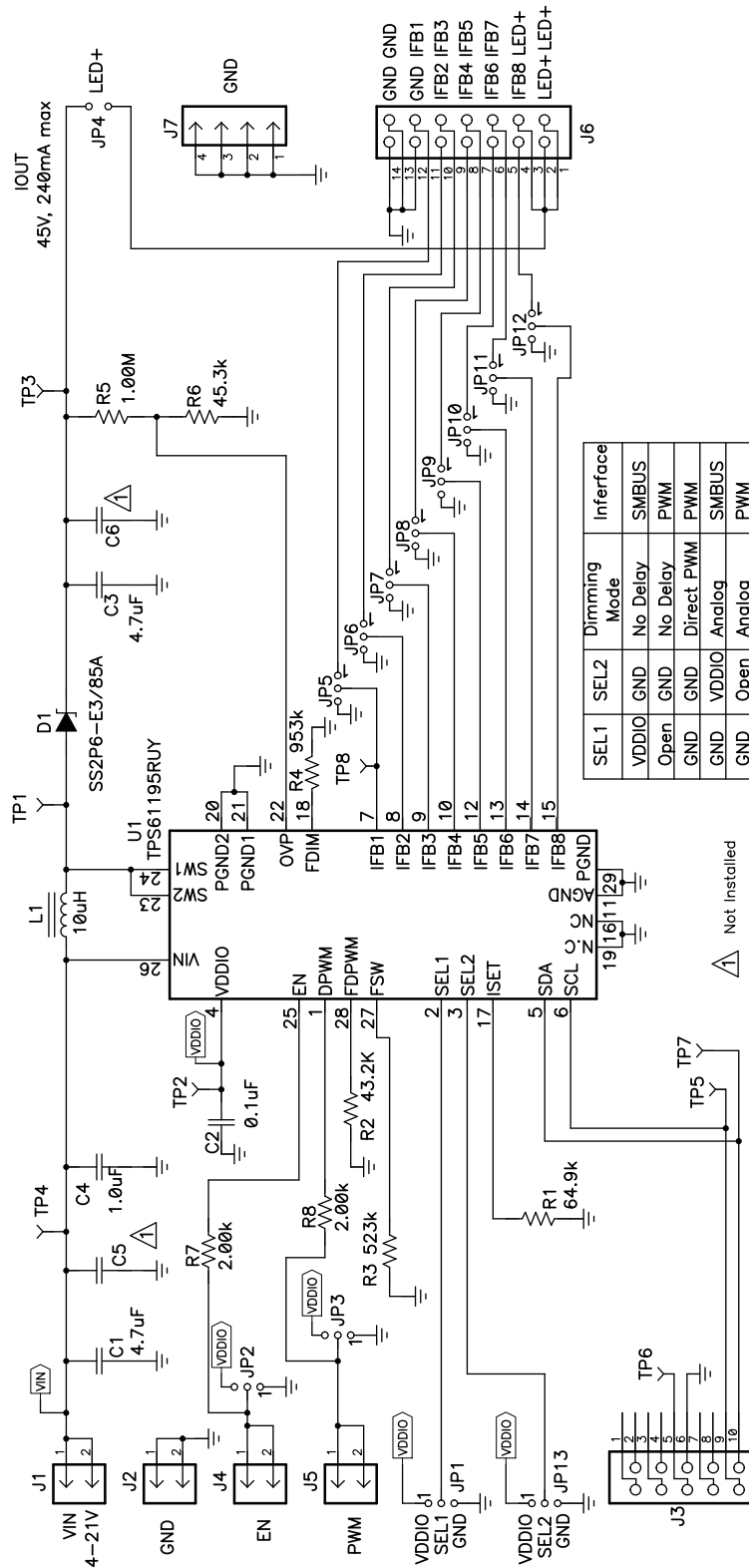


NOTE:  For Reference Only, See Table 3. Bill of Materials for Specific Values

**Figure 1. HPA460EVM Schematic**

## 5 Connector and Test Point Descriptions

### 5.1 Input/Output Connections

The connections points are described in the following paragraphs.

#### 5.1.1 J1 – VIN

This header is the positive connection to the input power supply. Twist the input supply and GND leads to the input supply and keep them as short as possible.

#### 5.1.2 J2 – GND

This header is the return connection to the input power supply.

#### 5.1.3 J3 – USB-to-GPIO Connector

This connector is for the 10-pin ribbon cable that connects the EVM to the USB-TO-GPIO interface box. It is only used when the SMBus software is used to control the IC.

#### 5.1.4 J4 – EN

This header connects to the IC's EN pin. The user must connect an external signal or use JP3 to take EN to a logic high (above 1.2 V but no higher than 6V) in order to enable the boost converter. Removing the logic high signal allows the internal pulldown resistor to pull EN to ground, which disables the IC.

#### 5.1.5 J5 – PWM

This header is the connection for an external PWM signal. The user must connect an external PWM signal or use JP4 to take PWM to a logic high (above 1.2 V but no higher than 6V) in order to enable the current sinks.

#### 5.1.6 J6 – 14-Pin Connector

This header facilitates connecting the TPS61195EVM-460 to the WLEDEVM-260 LED EVM boards. This board must be ordered separately from the TPS61195EVM.

#### 5.1.7 J7 – GND

This header connects to the board's ground plane.

#### 5.1.8 JP1 – SEL1 and JP13 - SEL2

Table 2 shows the IC's different modes of operation as determined by the voltage or current on the SEL1 and SEL2 pins.

**Table 2. Modes of Operation**

| SEL1 | SEL2 | MODE | INTERFACE |
|------|------|------|-----------|
| VDDIO | GND | No Delay | SMBUS |
| Open | GND | No Delay | PWM |
| GND | GND | Direct PWM | PWM |
| GND | VDDIO | Analog | SMBUS |
| GND | Open | Analog | PWM |

#### 5.1.9 JP2 – EN-VDDIO

Installing the shunt on this jumper sets the ENABLE pin voltage to VDDIO, thereby enabling the IC's boost converter. Removing the logic high signal allows the internal pulldown resistor to pull EN to ground, which disables the IC's boost converter.

### 5.1.10    JP3 – PWM-VDDIO

Installing the shunt on this jumper sets the PWM pin voltage to VDDIO, which sets the current sinks to 100% current and therefore any attached LEDs to full brightness. The user must connect an external PWM signal or use JP4 to take PWM to a logic high (above 1.2 V but no higher than 6V) in order to enable the current sinks.

### 5.1.11    JP4 – Open LED

The user can remove the shunt on this jumper and connect the high side of external LED strings. When using the WLEDEVM-260 LED EVM, installing the shunt on this jumper connects the output of the boost converter to J6. Removing the jumper removes the WLEDs from the boost converter feedback path and causes the IC's over-voltage protection circuitry to activate. Instead of the shunt, the user can place an ammeter across the jumper to measure the total output current (i.e., 8×IFBx).

### 5.1.12    JP5 – JP12

The user can remove the shunt and tie the middle pin of this jumper to an external string of LEDs. Alternatively, the user can use the shunt to tie the IFBx pin to JP6 and then connect JP6 to the WLEDEVM-260 EVM. For strings that are not used, the user can either use the shunt to tie the unused IFBx to GND or remove the shunt entirely and leave the unused IFBx pin floating.

## 6        Test Requirements and Setup

### 6.1    Hardware Requirements

This EVM requires an external power supply capable of providing up to 24V at 3A.

If dimming via an external PWM signal is desired, then a function generator capable of providing 1.2-V to 6-V maximum amplitude PWM signal between 200 Hz to 20 kHz is required to avoid screen flickering and maintain dimming linearity.

If dimming and status reporting through the SMBus interface is desired, the minimum PC requirements for the are:

*  Windows™ 2000 or Windows™ XP or Vista or Windows™ 7 operating system
*  USB port
*  Minimum of 30 MB of free hard disk space (100 MB recommended)
*  Minimum of 256 MB of RAM

### 6.2    Hardware Setup

*  Connect a power supply capable of supplying up to 24 V at 3 A between the VIN pin and GND (J1 and J2). Do not turn on the power supply.
*  Either use JP3 or connect a second logic signal or power supply capable of providing 1.2 V–6 V to the high impedance EN pin (J4) referenced to the same ground on J2.
*  JP5 should be connected directly or through an ammeter to the high side of external LED strings. Or, the shunt installed or replace with an ammeter and the WLEDEVM-260 or WLEDEVM-461 connected to J6.
*  Properly configure JP6-JP13 so that each IFB line either connects directly to an LED string, to the J6 connector or to GND. Unused IFBx lines should have the appropriate JP6-JP13 jumpers shunted to ground.

### 6.2.1    PWM Dimming via an External PWM Signal

*  Properly configure JP1 and JP2 so that SEL is not connected to VDDIO
*  Connect the function generator to J5.
*  Turn on the power supply. The LEDs should turn on.

### 6.2.2 PWM Dimming via SMBus Interface

- Use JP1 to connect SEL to VDDIO.
- Connect one end of the USB-TO-GPIO box to the PC using the USB cable and the other end to J3 of the TPS61195EVM-460 using the supplied 10-pin ribbon cable per Figure 2. The connectors on the ribbon cable are keyed and/or labeled to prevent incorrect installation.
- Install and operate the software as explained in the following section.
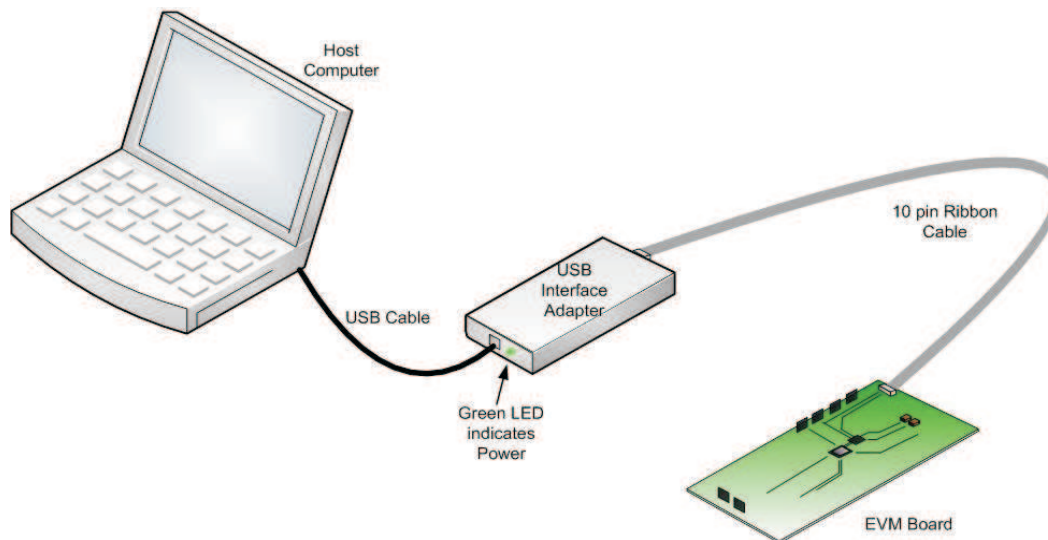


**Figure 2. USB Interface Adapter Quick Connection Diagram**

### 6.2.3 Software Installation and Operation

- If installing from a CD, insert the CD and run Setup.exe; follow all the prompts to install the software.
- If installing from the TI Web site, go to the URL,

    http://focus.ti.com/docs/toolsw/folders/print/tps61195evm-sw.html

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

- Click on the install button; your PC gives you a security warning and asks if you want to install this application. Select Install to proceed.

    **NOTE:** 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 from either the CD or the TI Web site.

- Immediately following installation, the software automatically runs.
- To run the software after installation, go to

    Start → all programs → Texas Instruments, Incorporated → TPS6119x Controller 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 the user of the update, downloads and installs the software. Note that after the firmware is updated, the user must disconnect and then reconnect the USB cable 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, downloads, and installs it.

    **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.

- Turn on the power supply.
- Figure 3 shows the software interface screen.
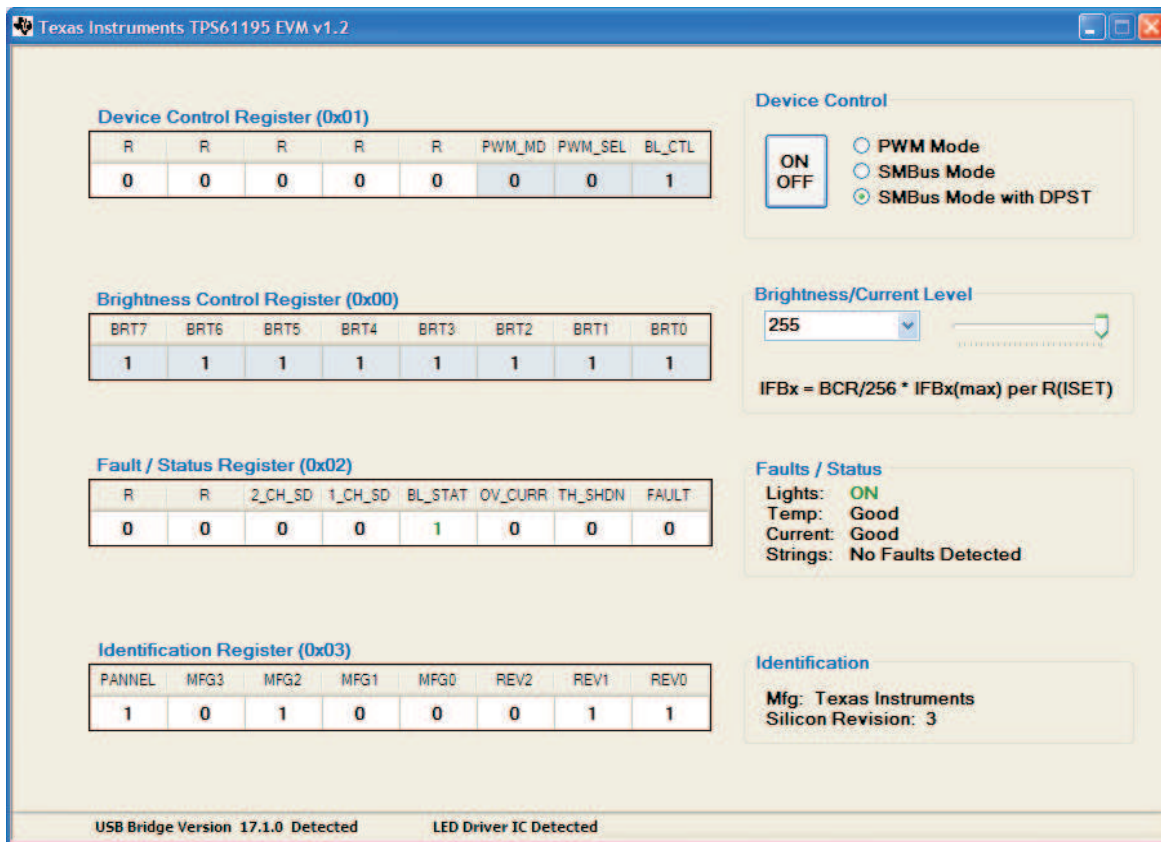
**Figure 3. Screen Capture of TPS61195 Controller Software GUI Interface**

- Assuming the SEL1 and SEL2 pins are properly configured for SMBus interface per Table 2 and the EN pin is pulled high to VDDIO or other logic high signal, the user must press the ON/OFF button in the upper right corner of the software screen to turn on the IC. The TPS61195 IC has four registers which are more fully explained in the datasheet. The writable bits are shown in blue. While it is possible for the user to write to each bit directly the bit register maps shown on the left, it is recommended that the user use the buttons, drop down menus and slide bar on the right to control the IC. The Device Control Register has three writable bits. These bits determine which of the three dimming methods the IC uses. The Brightness Control Register sets the LED brightness/current level. The register can be changed either by using the drop down box or the slide control. At startup and/or re-enable, the default dimming method is SMBus Mode with DPST and the default brightness level is 255. Note that in DPST mode, LED dimming is controlled by both the register value and the input PWM signal. The remaining two registers, Fault/Status and Identification, are output only. The meaning of the register values is displayed in the boxes to the left of each register.

## 7   TPS61195EVM-460 Assembly Drawings and Layout

The following figures (Figure 4 through Figure 6) show the design of the TPS61195EVM-460 printed circuit board. The EVM has been designed using a 2-Layer, 2oz copper-clad circuit board 6.58 cm × 5.44 cm with all components in a 1.9cm × 2.2cm active area on the top side and all active traces to the top and bottom layers to allow the user to easily view, probe and evaluate the TPS61195 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.
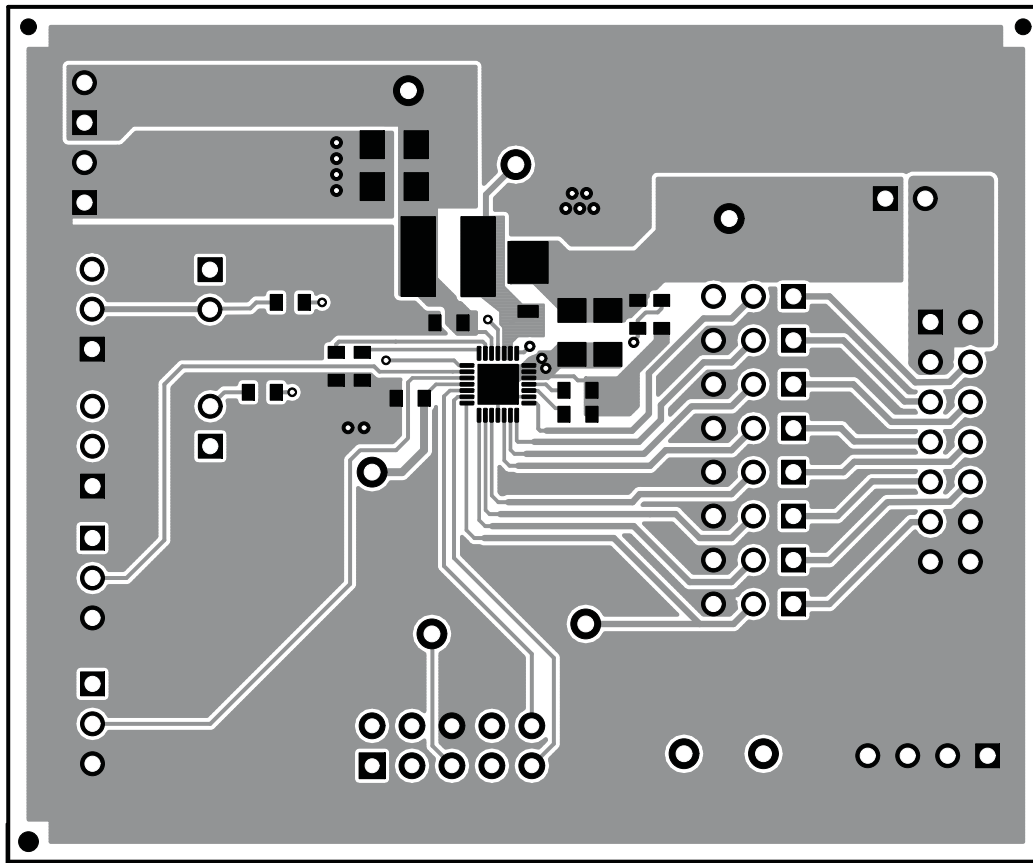
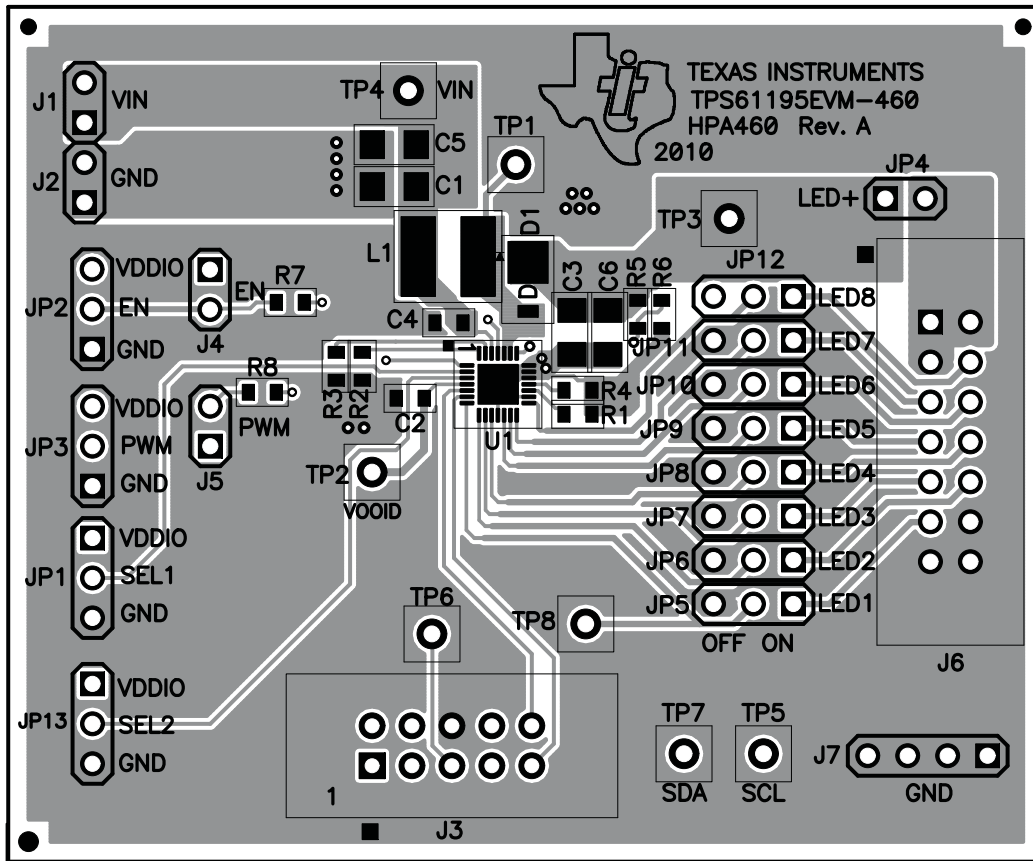**Figure 4. TPS61195EVM-460 Component Placement (Viewed from Top)**
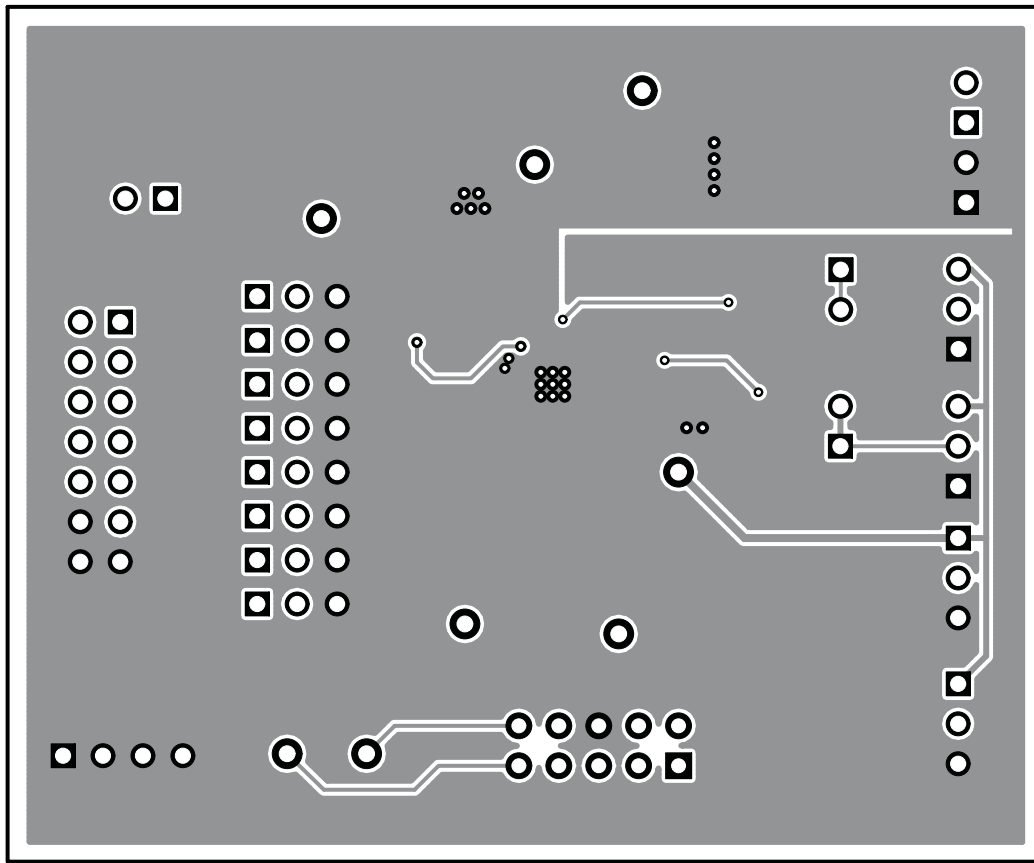
**Figure 5. TPS61195EVM-460 Top Copper (Viewed from Top)**

**Figure 6. TPS61195EVM-460 Bottom Copper (Viewed from Bottom)**

# 8    Bill of Materials

## Table 3. Bill of Materials

| COUNT | RefDes | Value | Description | Size | Part Number | MFR |
|---|---|---|---|---|---|---|
| 1 | C1 | 4.7uF | Capacitor, Ceramic, 25V, X5R, 10% | 1206 | Std | muRata |
| 1 | C2 | 0.1uF | Capacitor, Ceramic, 50V, X7R, 10% | 0603 | Std | TDK |
| 1 | C3 | 4.7uF | Capacitor, Ceramic, 50V, X5R, 10% | 1206 | Std | Std |
| 1 | C4 | 1.0uF | Capacitor, Ceramic, 25V, X5R, 10% | 0603 | Std | Std |
| 0 | C5 | Open | Capacitor, Ceramic, 25V, X5R, 10% | 1206 | Std | Std |
| 0 | C6 | Open | Capacitor, Ceramic, 50V, X5R, 10% | 1206 | Std | Std |
| 1 | D1 | SS2P6-E3/8xA, SS2P6-M3/8xA | Diode, High Current SMD Schottky Rectifier, 2A, 60VDC | DO-220AA | SS2P6-E3/8xA, SS2P6-M3/8xA | Vishay |
| 4 | J1, J2, J4, J5 | PEC02SAAN | Header, Male 2-pin, 100mil spacing | 0.100 inch x 2 | PEC02SAAN | Sullins |
| 1 | J3 | N2510-6002-RB | Header, 2x5-pin, 100mil spacing, 4 Wall | 0.330 x 0.800 inch | N2510-6002-RB | 3M |
| 1 | J6 | N2514-6002-RB | Connector, Male Straight 2x7 pin, 100mil spacing, 4 Wall | 0.100 inch x 2X7 | N2514-6002-RB | 3M |
| 1 | J7 | PEC04SAAN | Header, Male 4-pin, 100mil spacing | 0.100 inch x 4 | PEC04SAAN | Sullins |
| 12 | JP1 - JP3, JP5 - JP13 | PEC03SAAN | Header, 3-pin, 100mil spacing | 0.100 inch x 3 | PEC03SAAN | Sullins |
| 1 | JP4 | PEC02SAAN | Header, 2-pin, 100mil spacing | 0.100 inch x 2 | PEC02SAAN | Sullins |
| 1 | L1 | 10uH | Inductor, SMT, 1.49A, 90milliohm | 0.157 x 0.157 inch | A915AY-100M | Toko |
| 1 | R1 | 64.9k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R2 | 43.2K | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R3 | 523k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R4 | 953k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R5 | 1.00M | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 1 | R6 | 45.3k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 2 | R7, R8 | 2.00k | Resistor, Chip, 1/16W, 1% | 0603 | Std | Std |
| 8 | TP1 - TP8 | 5000 | Test Point, Red, Thru Hole Color Keyed | 0.100 x 0.100 inch | 5000 | Keystone |
| 1 | U1 | TPS61195RUY | IC, LCD Monitors Backlighting with PWM Control Interface | QFN-28 | TPS61195RUY | |
| 13 | -- | | Shunt, 100-mil, Black | 0.100 | 929950-00 | 3M |
| 1 | | | PCB, 2.14" x 2.59" x 0.062" | | HPA460 | Any |

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## EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 4 V to 24 V and the output voltage range of 32 V to 46 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 85°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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