User's Guide
SLVU421–December 2010

TPS61199EVM-598 Evaluation Module for TPS61199 White LED Driver for LCD Monitor Backlighting

This user's guide describes the characteristics, operation, and use of the TPS61199 evaluation module (EVM). This EVM contains the Texas Instruments TPS61199, 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, bill of materials, and a schematic diagram.

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1 Applications

The TPS61199 is an excellent solution for computer notebook and monitor LCD display backlighting.

2 TPS61199EVM-598 Electrical Performance Specifications

Table 1 provides a summary of the TPS61199EVM-598 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. TPS61199EVM-598 Electrical Performance Specifications

Parameter		Notes and Conditions [1]	Min	Typ	Max	Unit
Input Characteristics						
V_{IN}	Input voltage		8		30	V
EN, PWM	Logic high		2		20	V
EN, PWM	Logic low				0.8	V
I_{q_VIN}	Input quiescent current	EN=high, PWM=low, no switching, V_{IN} = 30 V, No load			1.5	mA
V_{IN_UVLO}	Input UVLO	V_{IN} ramp down		6.5	7	V
		V_{IN} hysteresis		0.3		
Output Characteristics						
V_{OUT}	V(TP1)	J6 connected to 8 strings of 17 WLEDs, JP1 shorted, JP4-11 pins 1-2 shorted, EN/PWM = VDD	50		53	V
		J6 connected to 8 strings of 17 WLED, JP1 open, JP4-11 pins 1-2 shorted, EN/PWM = VDD, OVP active			60	V
I_{OUT}	I(JP1) = 8 X IFBx	V_{IN} = 12 V, R_{ISET} = 40.6 kΩ, PWM = VDD		480		mA
System Characteristics						
f_S	Oscillator frequency	R_{FSW} = 160 kΩ	0.4	0.5	0.6	MHz

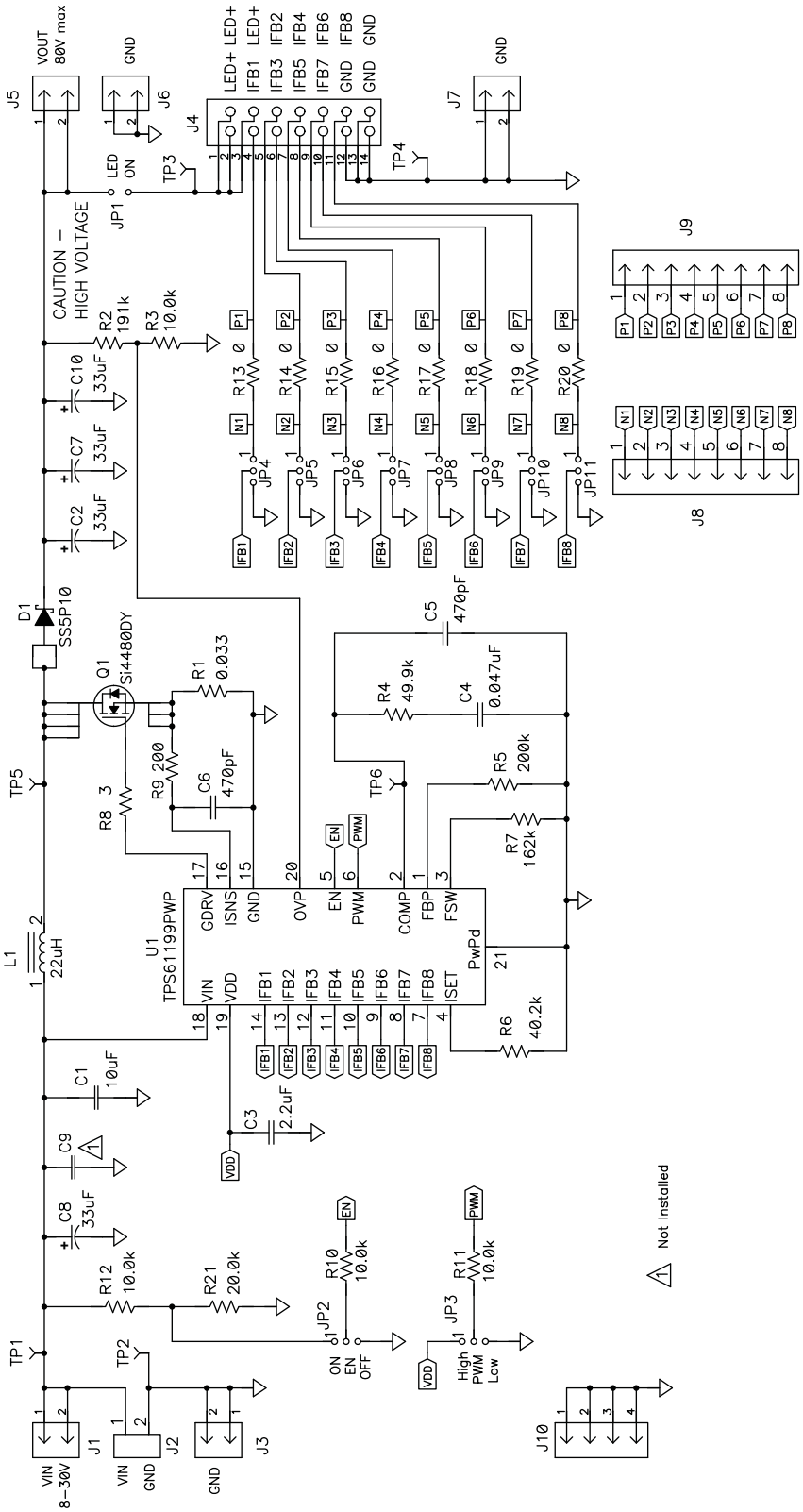
(1) The user can estimate the input current by solving the power balance equation, eff = P_{OUT}/P_{IN} = (V_O × I_O)/(V_{IN} × I_{IN}), for I_{IN} and estimating the efficiency to be a conservative 85%. For example, for V_O = 51 V, V_{IN} = 8 V and I_O = 8 × 60 mA = 480 mA, I_{IN} = (51 V × 480 mA)/(8 V × 0.85) = 3.6 A

3 Modifications

See the data sheet (SLVSAN3) when changing components such as R6 to set the LED current or R2 and R3 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 saturation current rating allows the use of lower input voltages.

4 Schematic and Bill of Materials



NOTE: For Reference Only, See Table 2 specific Values

Figure 1. HPA598EVM Schematic

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	10 µF	Capacitor, Ceramic, 50V, X7R, 10%	1210	Std	Std
4	C2, C7, C8, C10	33 µF	Capacitor, Electrolytic, 100VDC, 20%	8 x 11.5 mm	UPW2A330MPD6	Nichicon
1	C3	2.2 µF	Capacitor, Ceramic, 10V, X7R, 10%	0805	Std	Std
1	C4	0.047 µF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
2	C5, C6	470 pF	Capacitor, Ceramic, 25V, X7R, 10%	0603	Std	Std
0	C9	Open	Capacitor, Ceramic	1210	Std	Vishay
1	D1	SS5P10 Alt. PDS5100H	Diode, High Current, Schottky Barrier, 5A, 100V	TO-277	SS5P10-M3/86A Alt. PDS5100H	Vishay Alt. Diodes Inc
5	J1, J3, J5-J7	PEC02SAAN	Header, Male 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
1	J2	ED555/2DS	Terminal Block, 2-pin, 6-A, 3.5mm	0.27 x 0.25 inch	ED555/2DS	OST
1	J4	N2514-6002-RB	Connector, Male Straight 2x7 pin, 100mil spacing, 4 Wall	0.100 inch x 2x7	N2514-6002-RB	3M
2	J8, J9	PEC08SAAN	Header, Male 8-pin, 100mil spacing	0.100 inch x 8	PEC08SAAN	Sullins
1	J10	PEC04SAAN	Header, Male 4-pin, 100mil spacing,	0.100 inch x 4	PEC04SAAN	Sullins
1	JP1	PEC02SAAN	Header, 2-pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
10	JP2-JP11	PEC03SAAN	Header, 3-pin, 100mil spacing	0.100 inch x 3	PEC03SAAN	Sullins
1	L1	22 µH	Inductor, SMT, 3.6A, 43.2 mΩ	0.485 sq inch	CDRH127NP-220MC Alt. MSS1278-223ML	Sumida Alt. Coilcraft
1	Q1	SI4480DY Alt. FDS3590	MOSFET, N-ch, 80V, 6A, 35 mΩ	SO8	SI4480DY-T1-E3 Alt. FDS3590	Vishay Alt. Fairchild
1	R1	0.033	Resistor, Chip, 1/2W, 1%	1812	Std	Std
1	R2	191k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	R3, R10-R12	10k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	49.9K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	200K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	40.2k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R7	162k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R8	3	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R9	200	Resistor, Chip, 1/16W, 1%	0603	Std	Std
8	R13-R20	0	Resistor, Chip, 1/10W, 1%	0805	Std	Std
1	R21	20k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
4	TP1, TP3, TP5, TP6	5000	Test Point, Red, Thru Hole Color Keyed	0.100 x 0.100 inch	5000	Keystone
2	TP2, TP4	5001	Test Point, Black, Thru Hole Color Keyed	0.100 x 0.100 inch	5001	Keystone
1	U1	TPS61199PWP	IC, WLED Driver for LCD Monitors Backlighting	HTSSOP	TPS61199PWP	TI
11	–		Shunt, 100-mil, Black	0.100	929950-00	3M
1			PCB, 2.05 x 3.675 x 0.062 inch		HPA598	Any

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 – VIN/GND

This header provides a high current positive and return connection to the input power supply. Twist the input supply leads and keep them as short as possible.

5.1.3 J3 – GND

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

5.1.4 J4 – 14-Pin Connector

This header facilitates connecting the TPS61199EVM-598 to the load using a 14-pin ribbon cable. The load must be created by the user with WLEDs or properly sized resistors.

5.1.5 J5 – VOUT

This header connects to the board's VOUT plane.

5.1.6 J6, J7, and J10 – GND

These headers connect to the board's GND plane.

5.1.7 J8 and J9

By changing R13-R20 from 0 ohms to a small resistor, these headers allow the user to measure the voltage across each resistor and therefore the current into each IFBx pin individually. They also provide the user easy connection to the IFBx pins if a ribbon cable into J4 is not used.

5.1.8 JP1 – LED ON

The user can remove the shunt on this jumper and connect the high side of the load to J5. Installing the shunt on this jumper connects the output of the boost converter to J4. Removing the jumper removes the load connected to J4 from the boost converter feedback path and causes the integrated circuit's (IC) overvoltage 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).

5.1.9 JP2 – EN

Installing the shunt on this jumper to ON sets the ENABLE pin voltage to VIN scaled down with a resistor divider, thereby enabling the IC's boost converter. Connecting it to OFF pulls EN to ground, which disables the IC's boost converter.

5.1.10 JP3 – PWM

Installing the shunt on this jumper to VDD 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 JP3 to take PWM to a logic high (above 2 V but no higher than 20 V) in order to enable the current sinks.

5.1.11 JP4 – JP11

The user can use the shunt to tie the IFBx pin to JPx and then connect J8 or J9 to the low side of the external resistors or WLEDs. Alternatively, the user can connect J4 to the load. For strings that are not used, the user should tie the applicable IFBx pin to GND using these jumpers.

6 Test Requirements and Setup

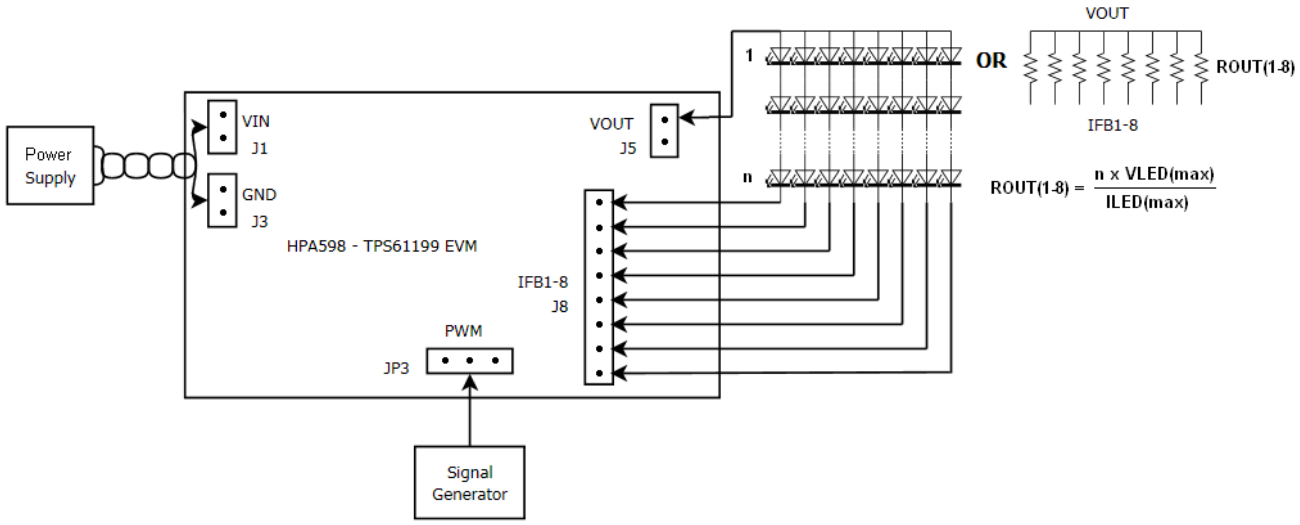


Figure 2. TPS61199EVM Test Setup

6.1 Hardware Requirements

1. This EVM requires an external power supply capable of providing up to 30 V at 4 A.
2. If dimming via an external PWM signal is desired, then a function generator capable of providing at least a 2-V amplitude PWM signal between 100 Hz to 22 kHz is required to avoid screen flickering and maintain dimming linearity.
3. A load using resistors or WLEDs is required. The resistance required in each string is chosen using the output voltage and desired current in each string. The output voltage is determined by the sum of the maximum forward voltage drop of all "n" WLEDs in one string. $R_{OUT} = (n \times V_{LED(MAX)})/I_{LED(MAX)}$. For example, if there are n=14 LEDs with $V_{LED(MAX)}$ = 3.6 V, $I_{LED(MAX)}$ = 60 mA, then R_{OUT} = (14 × 3.6 V)/60 mA = 840 Ω → 845 Ω next highest standard value.
4. Digital multimeters capable of measuring voltages and currents are recommended.
5. An oscilloscope is also recommended.

6.2 Hardware Setup

- Connect a power supply capable of supplying up to 30 V at 4 A between VIN and GND (J2 or J1 and J3). Do not turn on the power supply.
- Either set JP2 ON or connect a second logic signal or power supply capable of providing at least 2-V voltage to the high-impedance EN pin of JP2.
- J5 must be connected directly or through an ammeter to the high side of the load. The low side of each string in the load must then be connected to IFBx using J8 or J9. Alternatively, JP1 must be connected directly or through an ammeter. Alternatively, a load can be connected to J4 using a 14-pin ribbon cable.
- Properly configure JP4-JP11 so that each IFB line either connects directly to the J8 connector or to GND. Unused IFBx lines must have the appropriate JP4-JP11 jumpers shunted to ground.
- To turn on the LEDs at full LED current and brightness, install JP3's shunt to VDD.
- To dim the LEDs by PWM dimming, connect the function generator to the PWM pin of JP3.

7 TPS61199EVM-598 Assembly Drawings and Layout

The following figures (Figure 3 through Figure 5) show the design of the TPS61199EVM-598

printed-circuit board (PCB). The EVM has been designed using a two-layer, 2-oz, copper-clad circuit board, 52.070 mm × 93.345 mm, with all components 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 TPS61199 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.

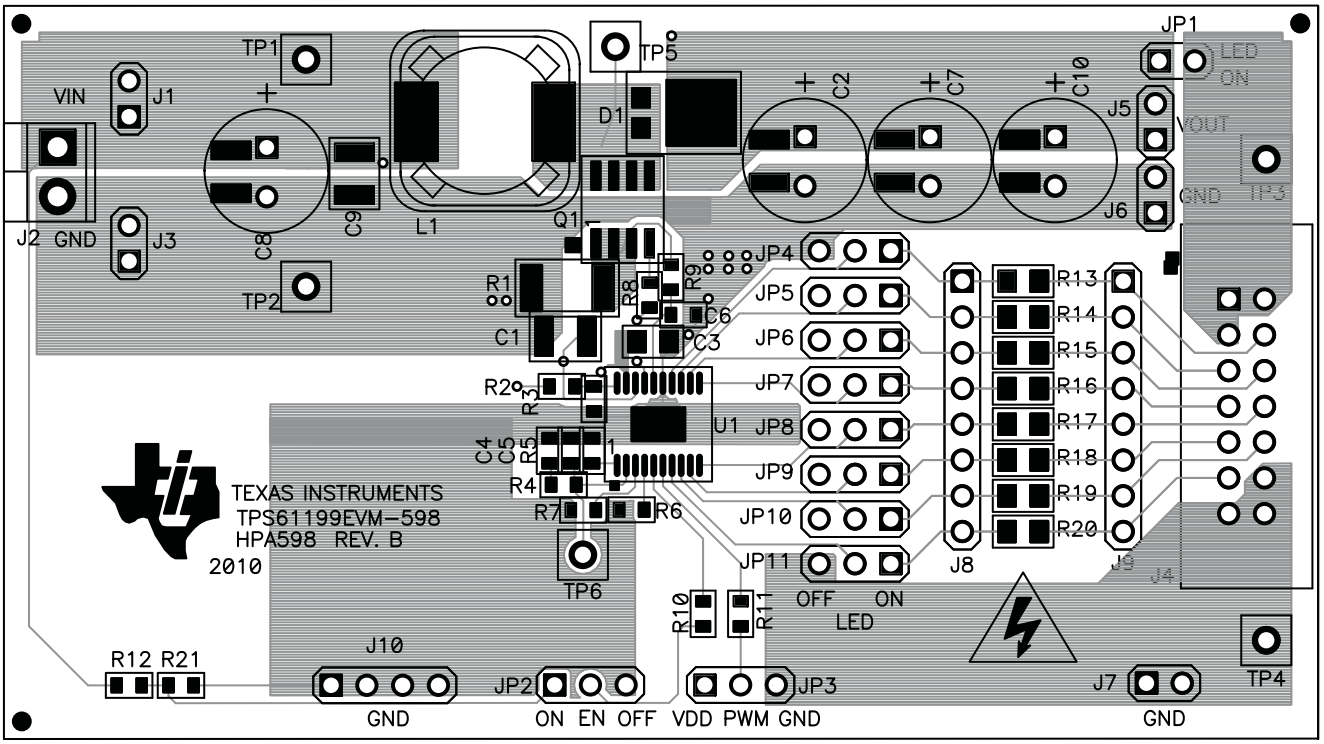


Figure 3. TPS61199EVM-598 Component Placement, Viewed From Top

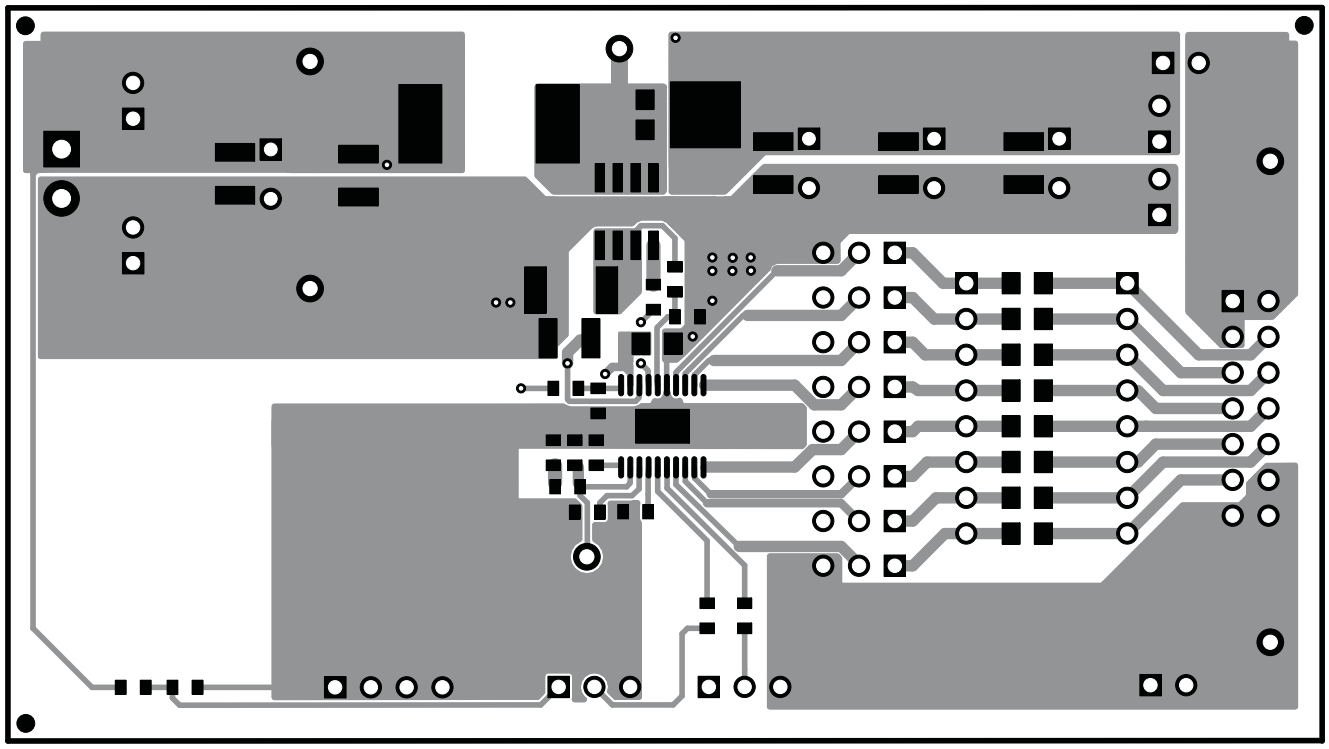


Figure 4. TPS61199EVM-598 Top Copper, Viewed From Top

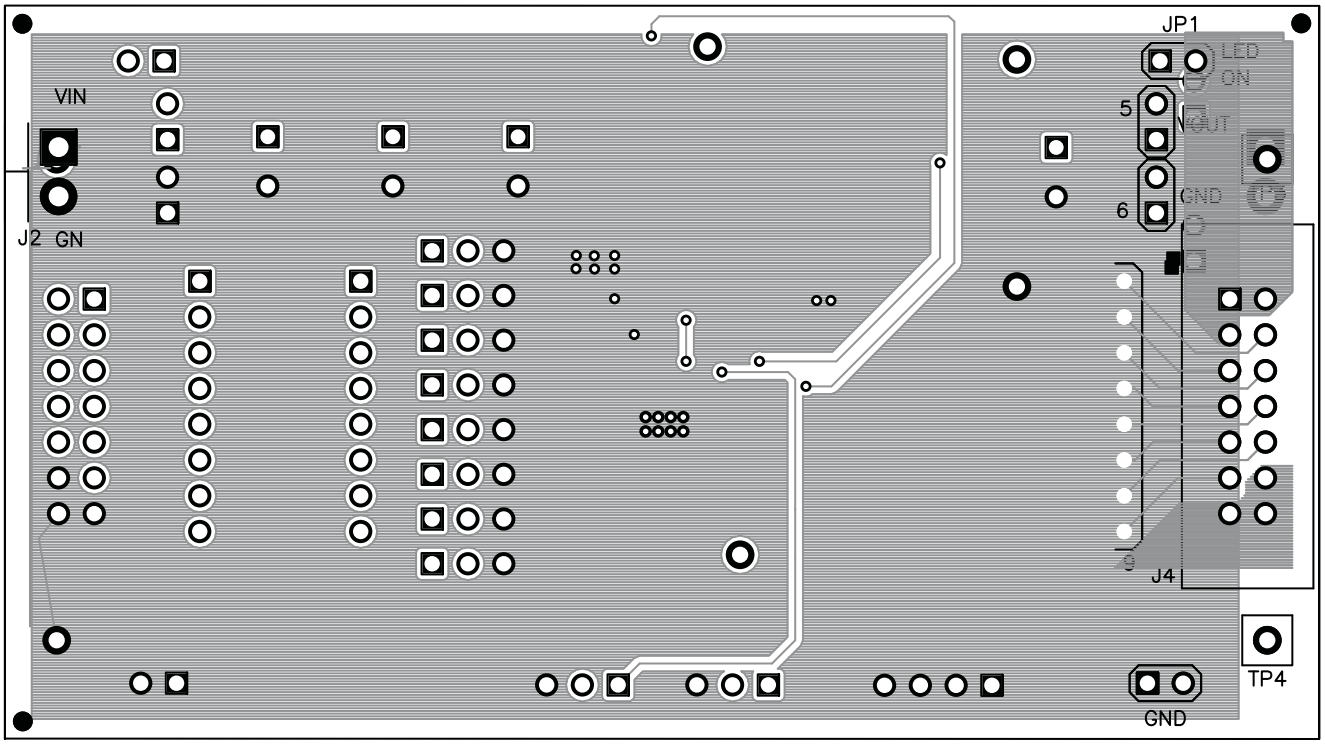


Figure 5. TPS61199EVM-598 Bottom Copper, Viewed From Bottom

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 8 V to 30 V and the output voltage range of 0 V to 100 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 150° C. The EVM is designed to operate properly with certain components above 150° 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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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   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.

WARNING

Evaluation Kits 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 shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

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