TPS65632 Evaluation Module

This user's guide describes the characteristics, operation and use of the TPS65632 evaluation module (EVM) and its drive software. This EVM contains TI's TPS65632 device which generates all three output voltages of typical AMOLED displays. This user's guide includes EVM specifications, the recommended test setup (hardware and software), the schematic diagram, the bill of materials, and the board layouts.

All typical characteristics measurements in the TPS65632 datasheet (SLVSCY2) were made with this evaluation module.

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1   Introduction

The TI TPS65632 EVM uses a TPS65632 device to supply a typical AMOLED display. The goal of the EVM is to facilitate evaluation of the TPS65632. With its input voltage range of 2.9 V to 4.5 V, it is optimized for products powered by single-cell batteries.

1.1   Requirements

All components and connectors for this voltage change are supplied in the EVM box. For full functionality of this EVM you need a host computer and a DC power supply. Software must be downloaded from the TI Web site at http://www.ti.com/product/TPS65632. If the user wants to change the negative output voltage, then use the I^{2}C interface.

1.1.1   Power Supply

In order to operate this EVM it is necessary to have a DC power supply capable of delivering between 2.9 V and 4.5 V at up to 1.2 A. With just the power supply the user can fully operate the EVM, except if the user wants to change the negative output voltage.

1.1.2   Host Computer

It is recommended that a computer with a USB port be used to operate this EVM. The TPS65632 software runs on the personal computer (PC) and communicates with the EVM via the PCs USB port.

The PC must have a minimum specification of:
*   Microsoft® Windows® 7 operating system
*   One USB port
*   A minimum of 280 MB of free hard disk space (610MB recommended)
*   A minimum of 512 MB of RAM

1.1.3   Software

TI provides the software necessary to evaluate the TPS65632 EVM. Check the TPS65632 product folder on the TI Web site (http://www.ti.com/product/TPS65632) for updates to the software.

1.2   Features

*   2.9-V to 4.5-V input voltage range
*   –1.5 V to –5.4 V (0.1 V-step) negative output voltage range
*   1% output voltage accuracy
*   Excellent line transient regulation
*   Short-Circuit Protection
*   Thermal shutdown
*   Two-layer PCB with all components on top side

2   TPS65632 EVM Electrical and Performance Specifications

Table 1. TPS65632 EVM Electrical and Performance Specifications

Parameter		Notes and Conditions	Min	Typ	Max	Unit
Input Characteristics						
V_{IN}	Input voltage		2.9		4.5	V
V_{IT}	Under-voltage lockout threshold	V_{IN} falling	1.8		2.1	V
		V_{IN} rising	2.1		2.5	V
Output Characteristics						
VPOS	Positive output voltage			4.6		V
$I_{(SW1)}$	Switch current limit of boost converter	Inductor valley current	0.8	1	1.4	A
	Line regulation	I_{POS} = 200 mA		0.001		%/V
	Load regulation	1 mA ≤ I_{POS} ≤ 300 mA		0.007		%/A
VNEG	Default negative output voltage			−4		V
	Negative output voltage range		−1.4		−5.4	V
$I_{(SW2)}$	Switch current limit of inverting buck-boost converter		1.5	2.2	3	A
	Line regulation NEG	I_{NEG} = 200 mA		0.004		%/V
	Load regulation NEG			0.1		%/A
AVDD	Output voltage	SELP2 = LOW		7.7		V
		SELP2 = HIGH		5.8		V
	Output voltage accuracy	25 °C ≤ T_A ≤ 85 °C, no load	−1%		1%	
		-30 °C ≤ T_A ≤ 85 °C, no load	−1.3%		1.3%	

3   TPS65632 EVM Schematic

Figure 1 is for reference only; see the bill of materials in Table 4 for specific values.
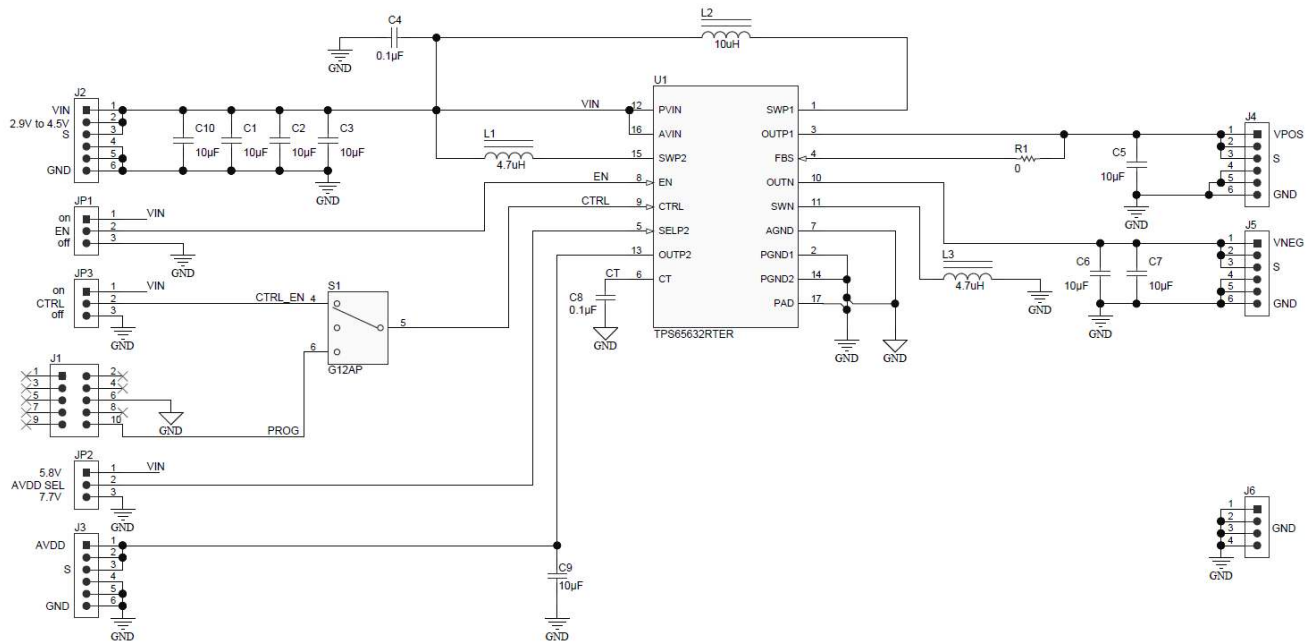

Figure 1. TPS65632 EVM Schematic

4   Connector and Jumper Descriptions

Table 2 and Table 3 give an overview of the connector and jumper of the EVM with additional remarks on how to use these.

Table 2. Connector Overview

CONNECTOR		SIGNAL	PIN	DESCRIPTION	REMARKS
J1	Positive/Negative Output Program	PROG	10	Data	Use the 10-way ribbon cable supplied with the EVM to connect J1 to the USB2ANY interface adapter (Figure 6).
		GND	6	Ground	
J2	Input Supply	VIN	1, 2	Input Supply	Connect a 2.9 V to 4.5 V dc power supply to J2. You can use two-terminal (Figure 4) or four-terminal connections (Figure 5). To minimize parasitic inductance, use a short (<20cm) cable and twist the leads.
		S+	3	Input Supply Sense	
		GND	4, 5, 6	Ground	
J3	Boost Output	AVDD	1, 2	Positive Output	You can connect a load between the positive output AVDD and ground.
		S+	3	Positive Output Sense	
		GND	4, 5, 6	Ground	
J4	Positive Output	VPOS	1, 2	Positive Output	You can connect a load between the positive output and ground or between the positive and negative outputs.
		S+	3	Positive Output Sense	
		GND	4, 5, 6	Ground	
J5	Negative Output	VNEG	1,2	Negative Output	You can connect a load between the negative output and ground or between the positive and negative outputs.
		S	3	Negative Output Sense	
		GND	4,5,6	Ground	
J6	Ground	GND	1, 2, 3, 4, 5, 6	Ground	You can use these pins when you do a measurement and need a ground connection.

Table 3. Jumper/Switch Overview

JUMPER		SIGNAL	PIN	DESCRIPTION	REMARKS
JP1	AVDD Output Enable/Disable	VIN	1	Input Supply	Connect a jumper between pins 1 and 2 to enable the AVDD output, or between pins 2 and 3 to disable it.
		ENN	2	AVDD Output Enable	
		GND	3	Ground	
JP2	AVDD Output Voltage Select	7.7 V	1	Input Supply	Connect a jumper between pins 1 and 2 to select AVDD = 7.7 V, or between pins 2 and 3 to select AVDD = 5.8 V.
		AVDD_SEL	2	Select AVDD Output Voltage	
		5.8 V	3	Ground	
JP3	Positive/Negative Output Enable/Disable	on	1	Input Supply	Connect a jumper between pins 1 and 2 to enable the positive and negative output, or between pins 2 and 3 to disable it.
		CTRL_EN	2	Positive/Negative Output Enable	
		off	3	Ground	
S1	Switch Enable/Program	CTRL_EN	4	Jumper Position of JP3	Set switch on pin 4 to either enable or disable the negative output voltage, depending on the position of JP1. Set switch on pin 6 to use the I^{2}C interface to program the negative output voltage.
		CTRL	5	Data Output of J1	
		PROG	6	Control Input	

5 Test Setup

5.1 Hardware Connections

Figure 2 details the connection of the power supply, the load, and the host computer. The host computer is just required if a voltage change on VNEG is necessary. The connection of the load is just an example. The user can also connect a load between VPOS and VNEG.
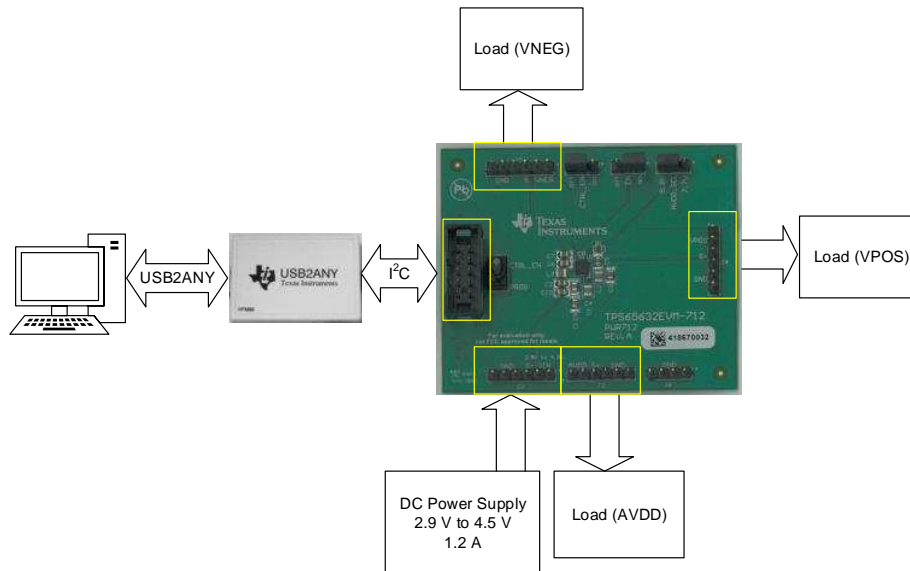

Figure 2. Hardware Setup – Full Functionality

If the user does not need to change the negative output voltage, then use the simplified set-up shown in Figure 3.
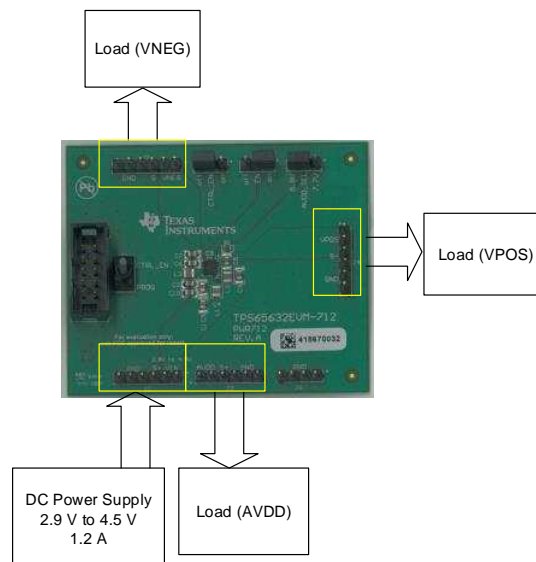

Figure 3. Hardware Setup – Simplified

The user can use two-terminal (Figure 4) or four-terminal (Figure 5) connections to connect the power supply to the EVM. Two-terminal connections are simpler, but four terminal connections are more accurate.

To minimize parasitic inductance, the recommendation is to use a short cable (<20 cm) and twist the power and return conductors together.
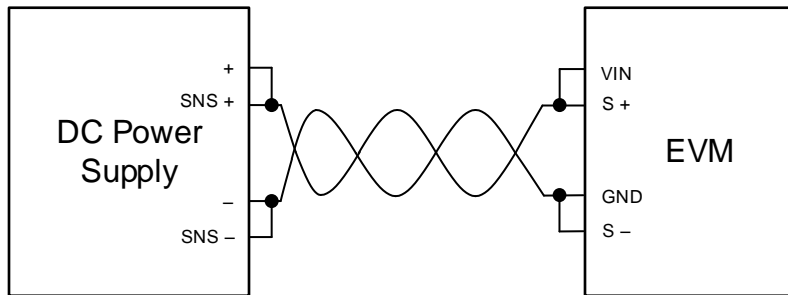

Figure 4. Two-Terminal Power Supply Connection
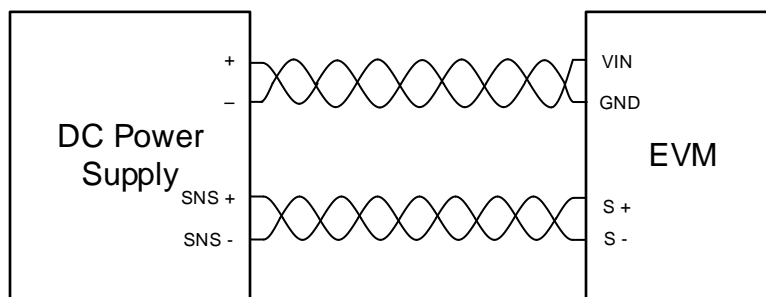

Figure 5. Four-Terminal Power Supply Connection

When connecting the USB2ANY interface adapter to the EVM, use the middle ten connections (Figure 6).

Figure 6. Ribbon Cable Connected to the Ten Middle Pins of the USB2ANY Interface Adapter

5.2 Software Operation

To change the negative output voltage, the user must install the EVM software on a host PC and use the USB2ANY interface adapter to connect the host PC to the EVM hardware.

For the newest software version, go to the TPS65632 product folder on the TI Web site (http://www.ti.com/product/TPS65632), download the software and the installation instructions (zipped file), unpack it and execute the *setup.exe* file. This installs the newest software version. It is recommended to remove older versions before installing the newest one.

After the installation of the software, an icon with the name TPS65632 appears on the desktop of the host computer. If it does not, browse the program files in the Start menu for the software. The default location is *All Programs → Texas Instruments → TPS65632*.

After connecting the USB interface adapter to the host computer, the software can be started. Most likely, at the first startup, the system asks to update the adapter's firmware (for firmware update instructions please check out the installation instructions included in the software package). After confirmation of this update, the software window shown in Figure 7 appears.

Figure 7. TPS65632 Software Window
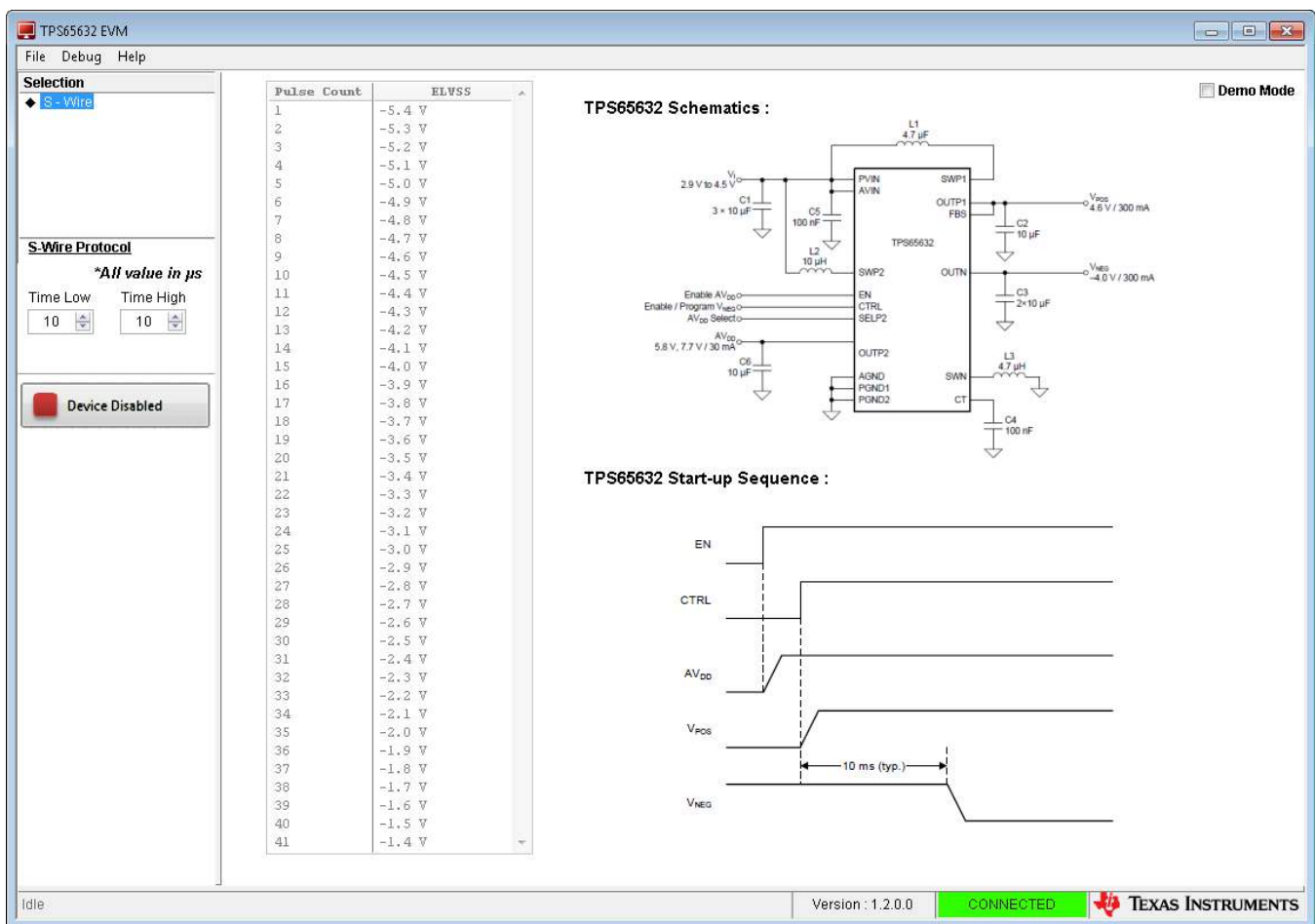
To adjust the negative output voltage enable, the device and click on the desired output voltage on the table. There is an additional box on the left side, where the user can adjust the on and off time of the program pulse. The minimum on/off time is 10 µs and the maximum is 25 µs.

> **NOTE:** Do not change the output voltages too fast (<10 seconds) as it can cause the program to crash.

6   TPS65632 EVM Assembly Drawings and Layout

Figure 8 through Figure 10 show the design of the TPS65632 EVM 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 TPS65632 control IC. Moving components to both sides of the PCB can offer additional size reduction for space-constrained systems.
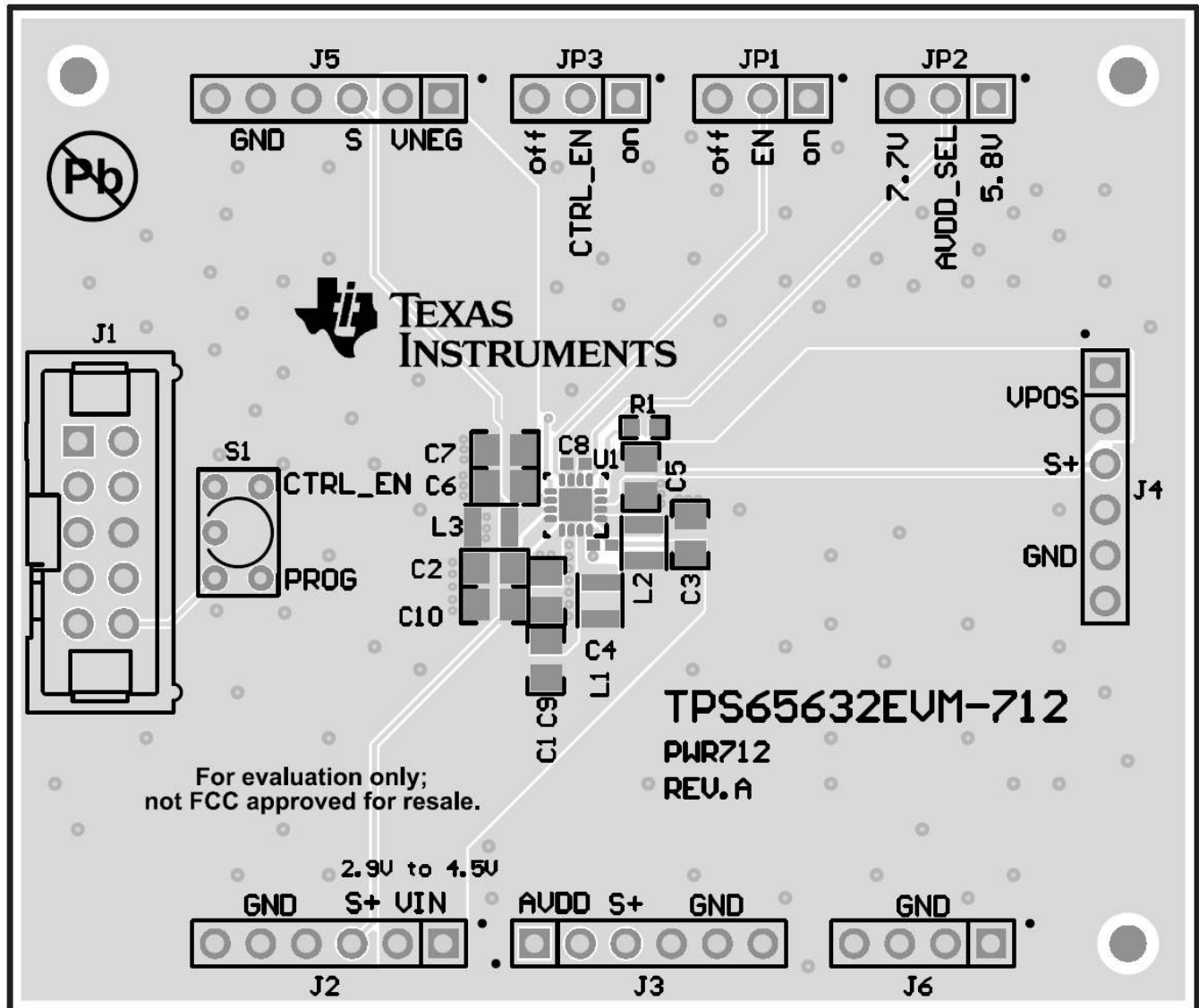

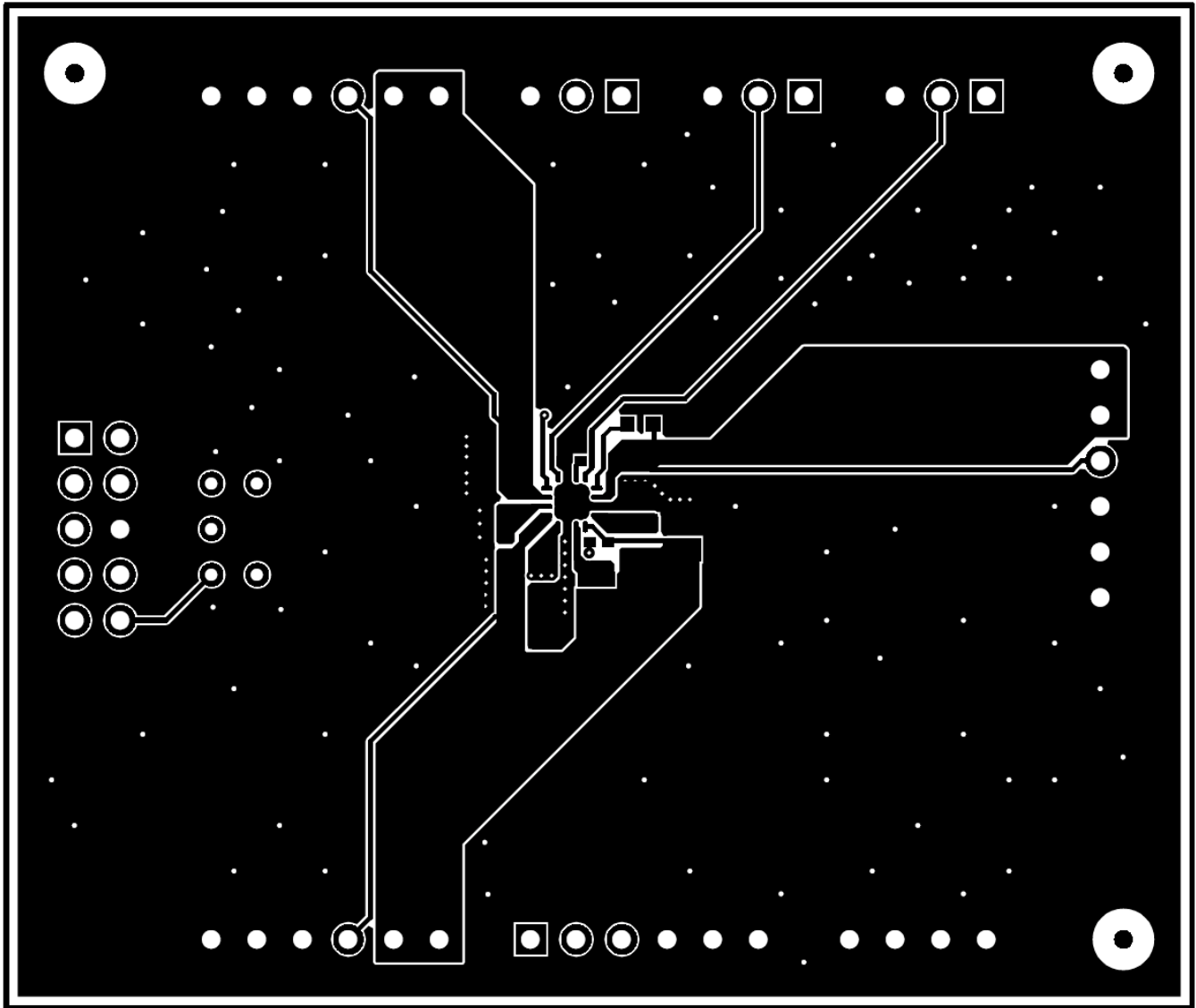**Figure 8. TPS65632 EVM Component Placement, Viewed from Top**

Figure 9. TPS65632 EVM Top Copper, Viewed from Top
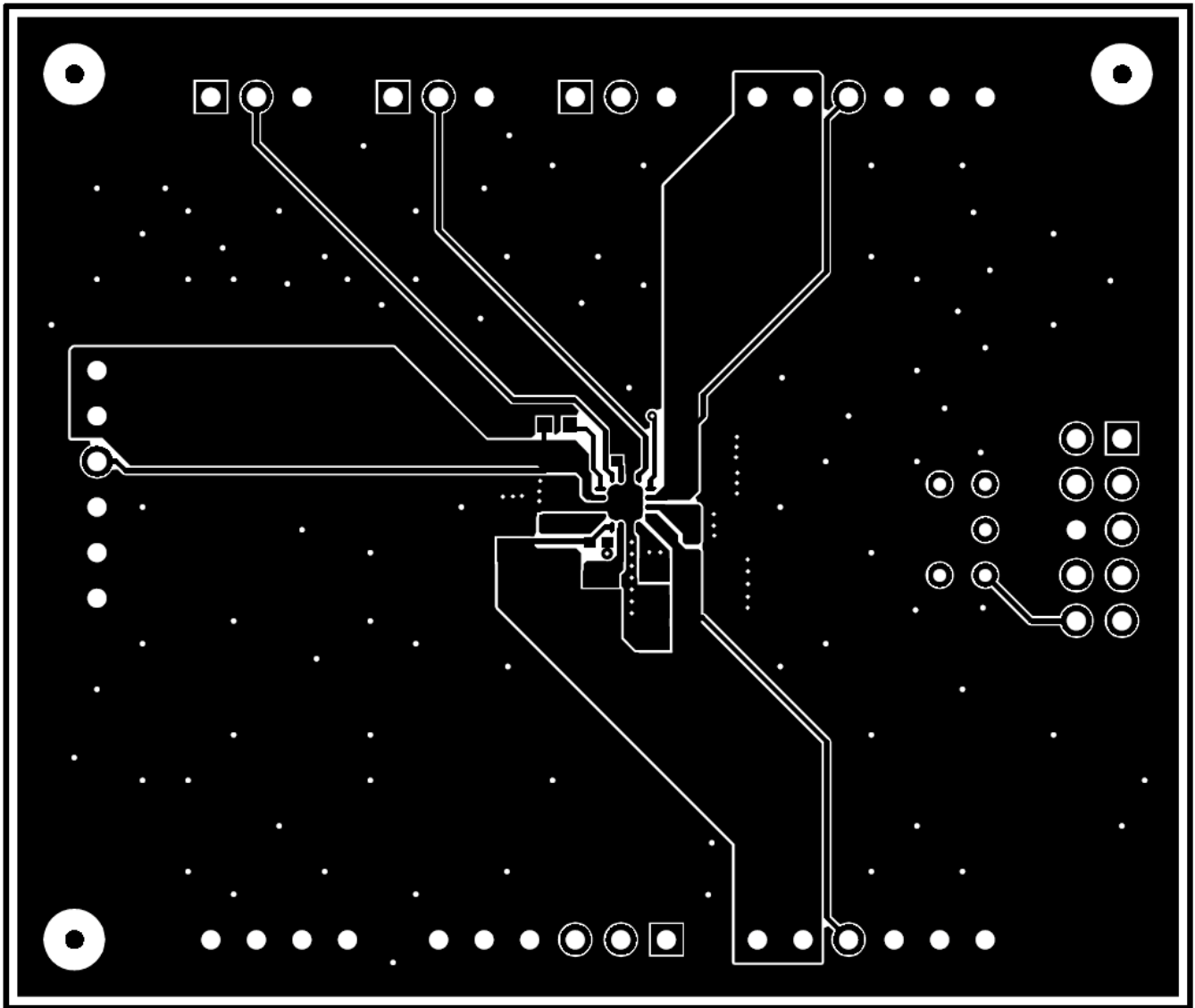
Figure 10. TPS65632 EVM Bottom Copper, Viewed from Bottom

7 List of Materials

Table 4 lists the EVM components as configured according to the schematic shown in Figure 1.

Table 4. TPS65632 EVM Bill of Materials

Designator	Description	Manufacturer	PartNumber	Quantity
C1, C2, C3, C5, C6, C7, C9, C10	CAP, CERM, 10 µF, 10 V, +/- 10%, X7R, 0805	MuRata	GRM21BR71A106KE51	8
C4, C8	CAP, CERM, 0.1 µF, 10 V, +/- 10%, X7R, 0405	MuRata	GRM155R71A104KA01	2
H1	USB2ANY	ANY	HPA665-001	1
L1, L3	Inductor, Shielded, Ferrite, 4.7 µF, 1.3 A, 0.2 Ω, SMD	Toko	1239AS-H-4R7M	2
L2	Inductor, Shielded, Ferrite, 10 µF, 0.85 A, 0.4 Ω , SMD	Toko	1239AS-H-100N=P2	1
R1	RES, 0, 0.5%, 0.1 W, 0.603	Vishay-Dale	CRCW06030000Z0EA	1
S1	Switch, Toggle, SPDT 1Pos, TH	NKK Switches	G12AP	1
U1	Triple-Output AMOLED Display Power Supply, RTE0016C	Texas Instruments	TPS65632RTER	1

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    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.

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- *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.*

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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

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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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