

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 I²C 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 PC's 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%	

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

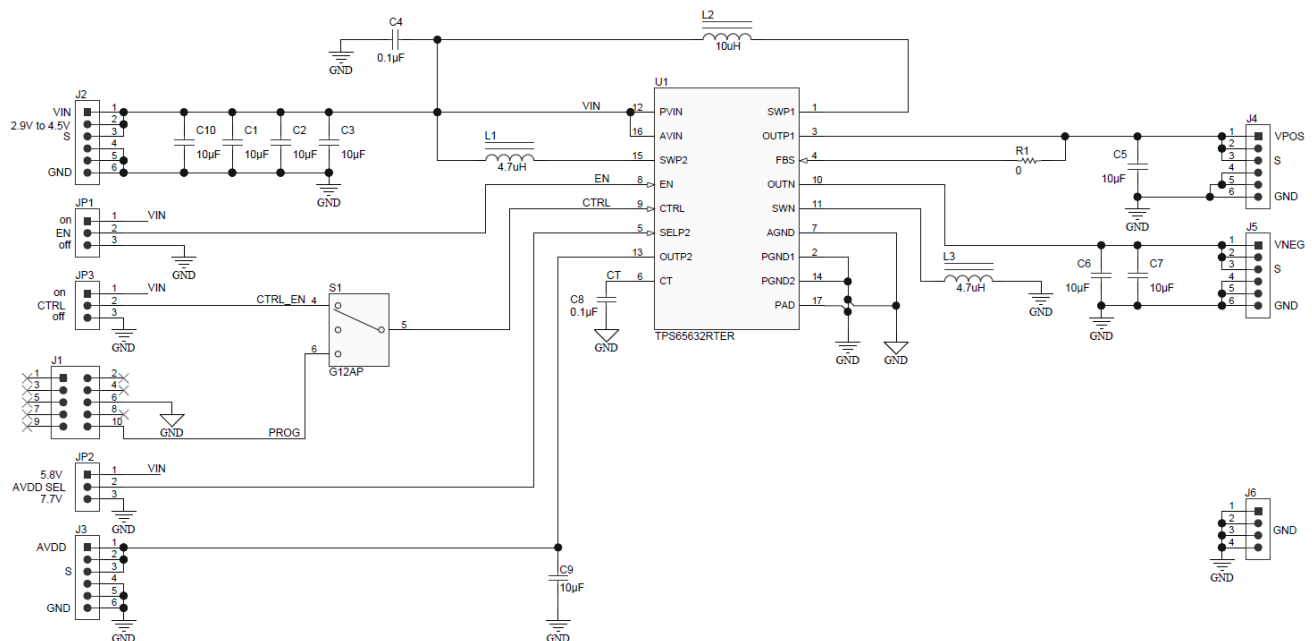


Figure 1. TPS65632 EVM Schematic

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.

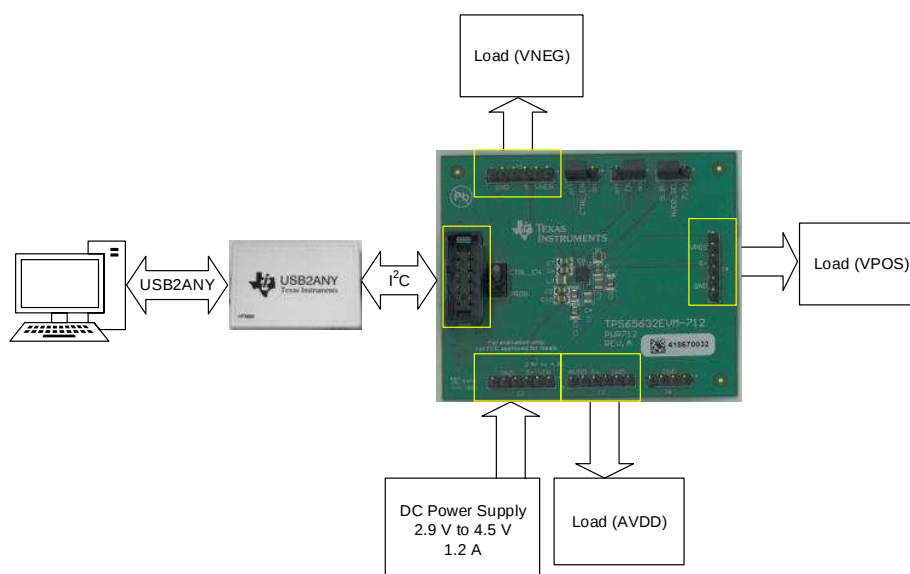


Figure 2. Hardware Setup – Full Functionality

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

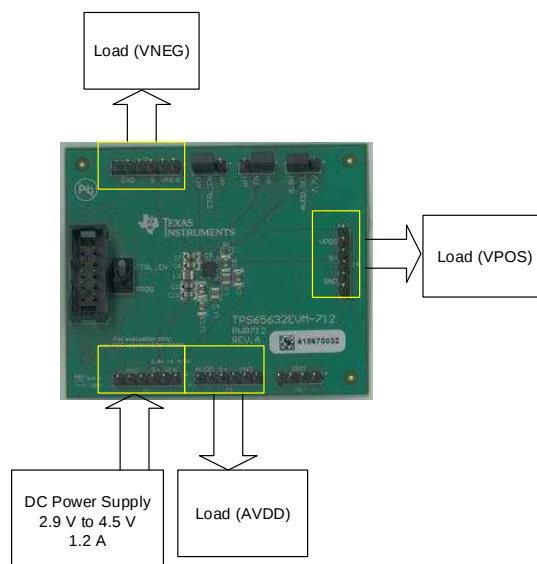


Figure 3. Hardware Setup – Simplified

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.

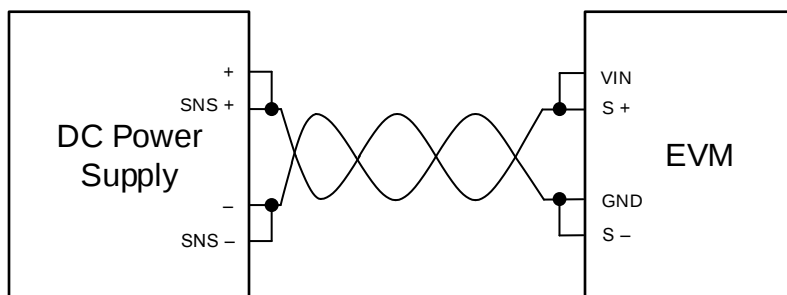


Figure 4. Two-Terminal Power Supply Connection

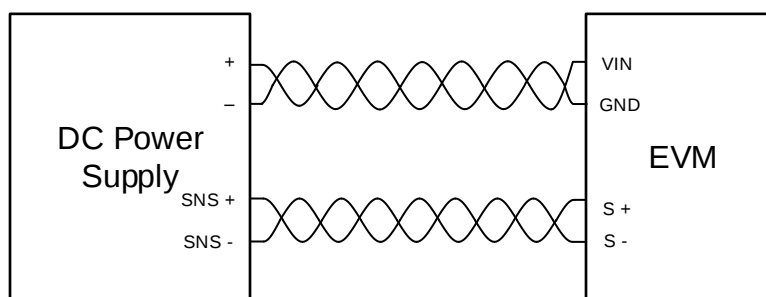


Figure 5. Four-Terminal Power Supply Connection

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.

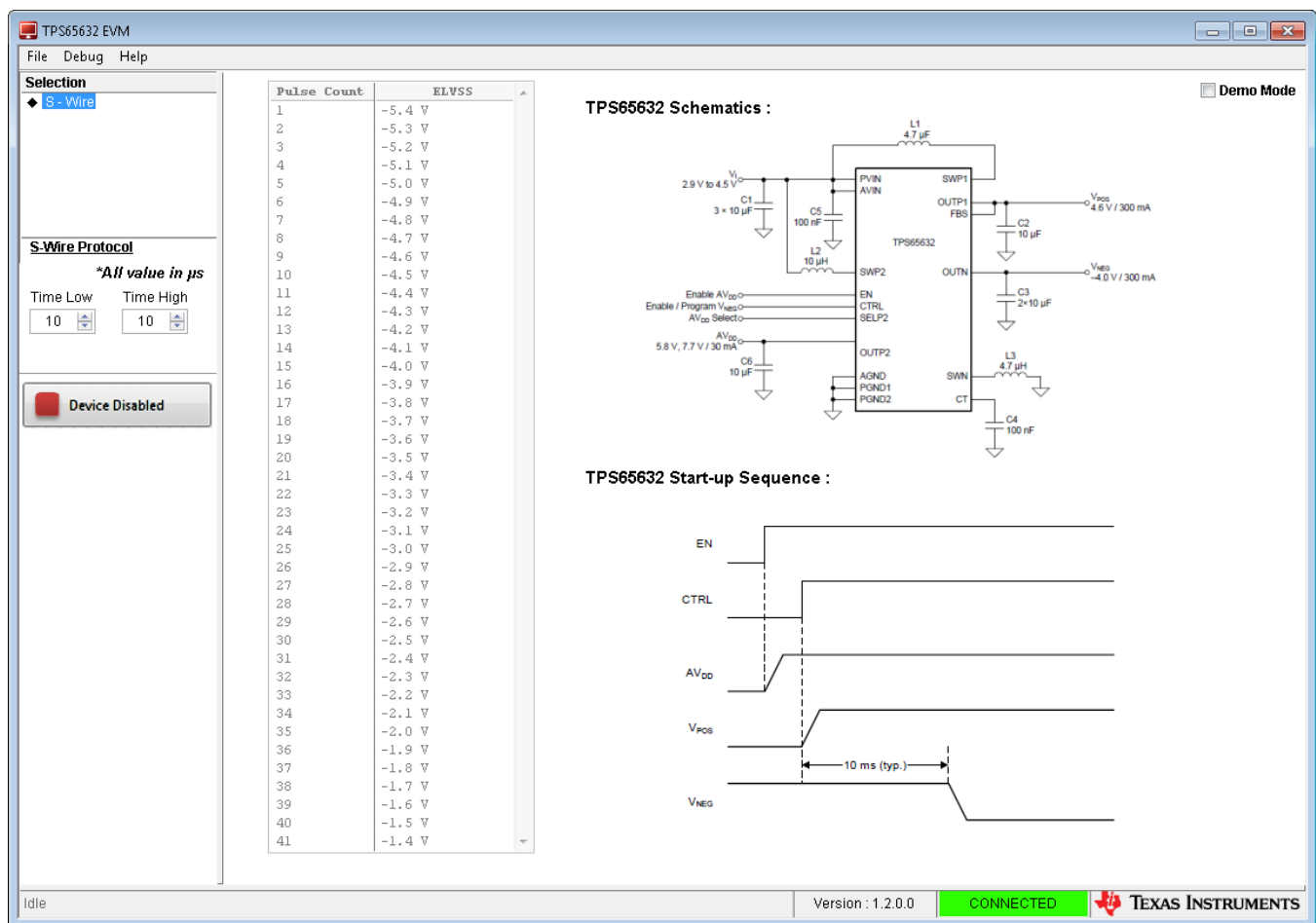


Figure 7. TPS65632 Software Window

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 μ s and the maximum is 25 μ s.

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.

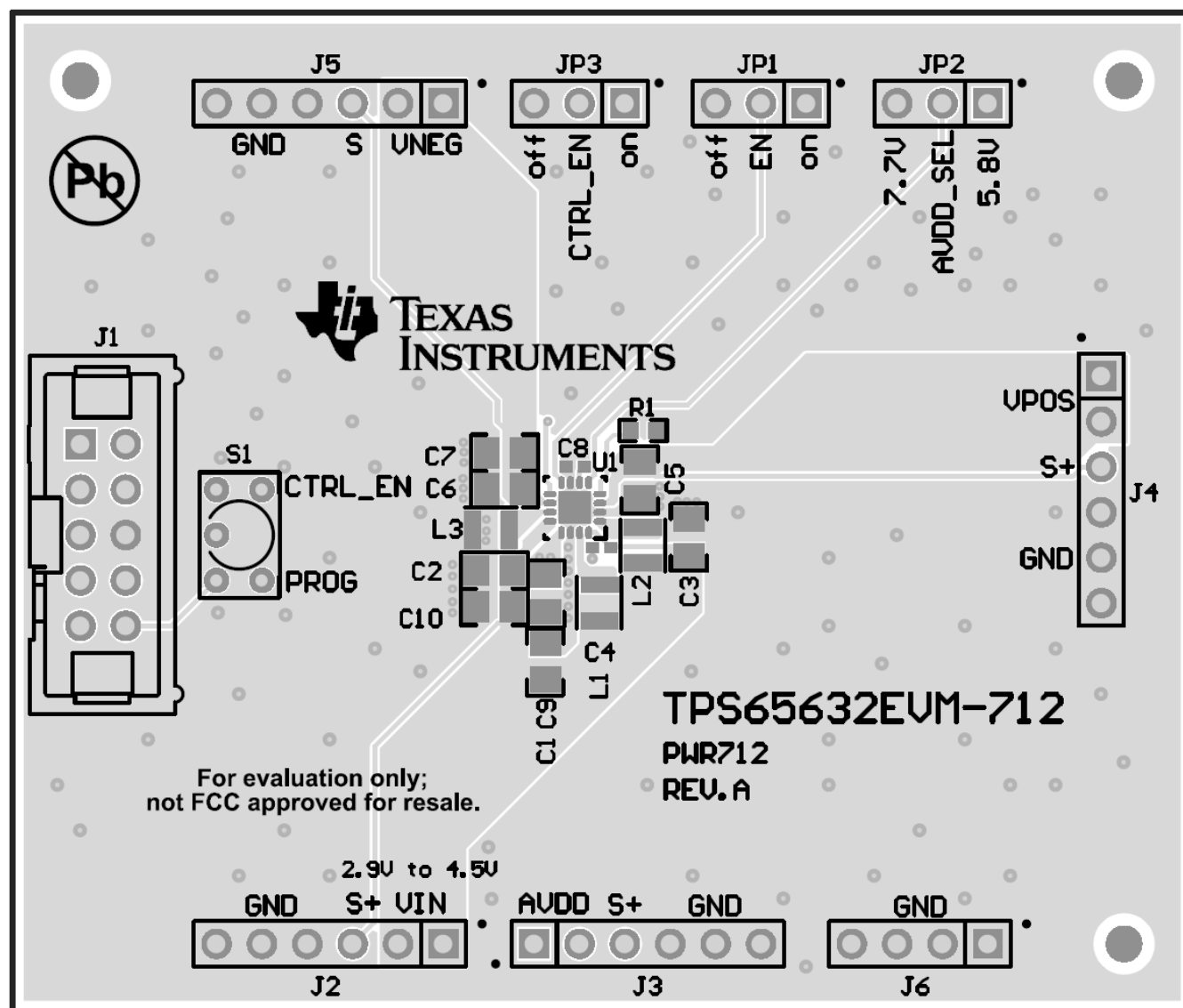


Figure 8. TPS65632 EVM Component Placement, Viewed from Top

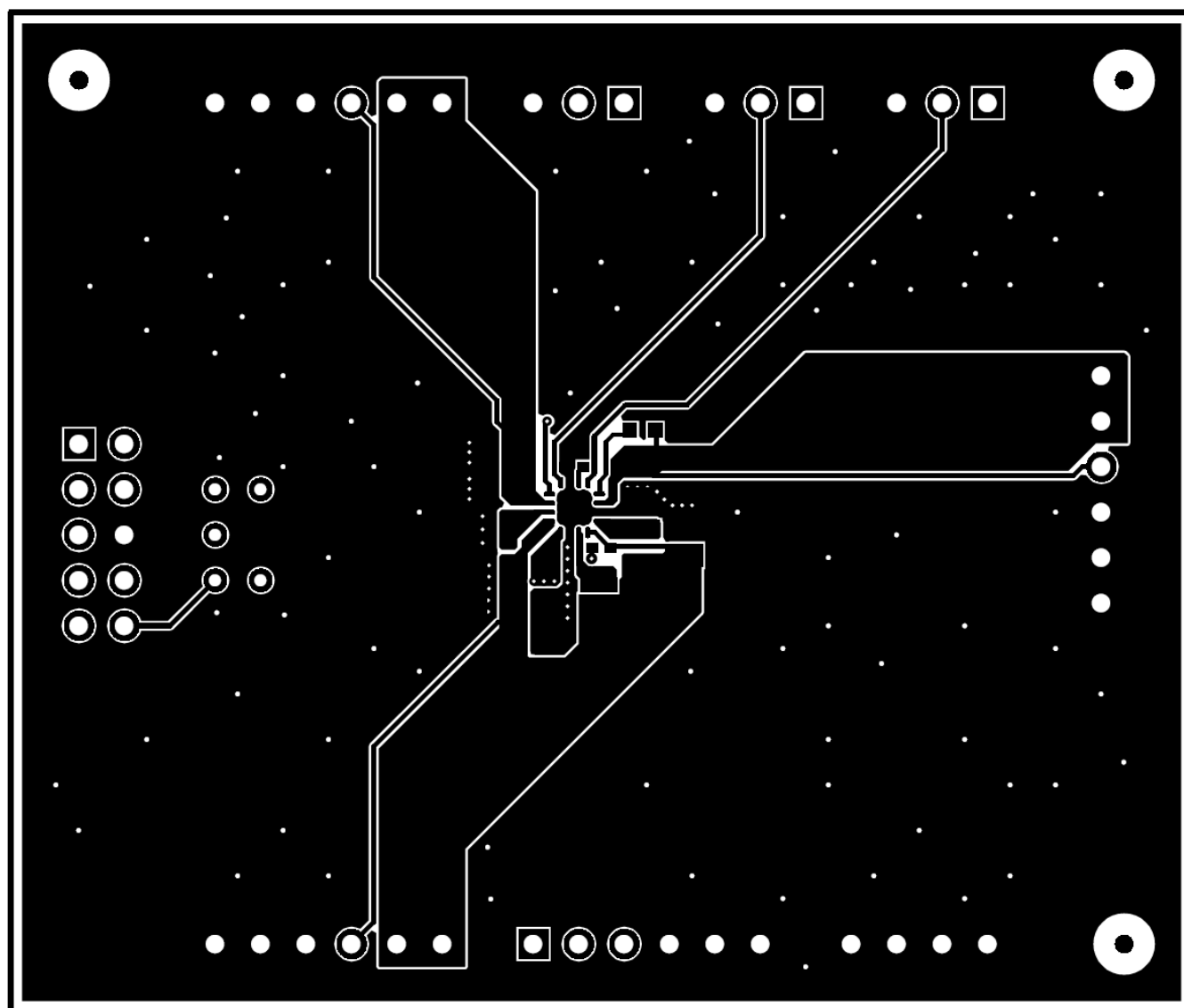


Figure 9. TPS65632 EVM Top Copper, Viewed from Top

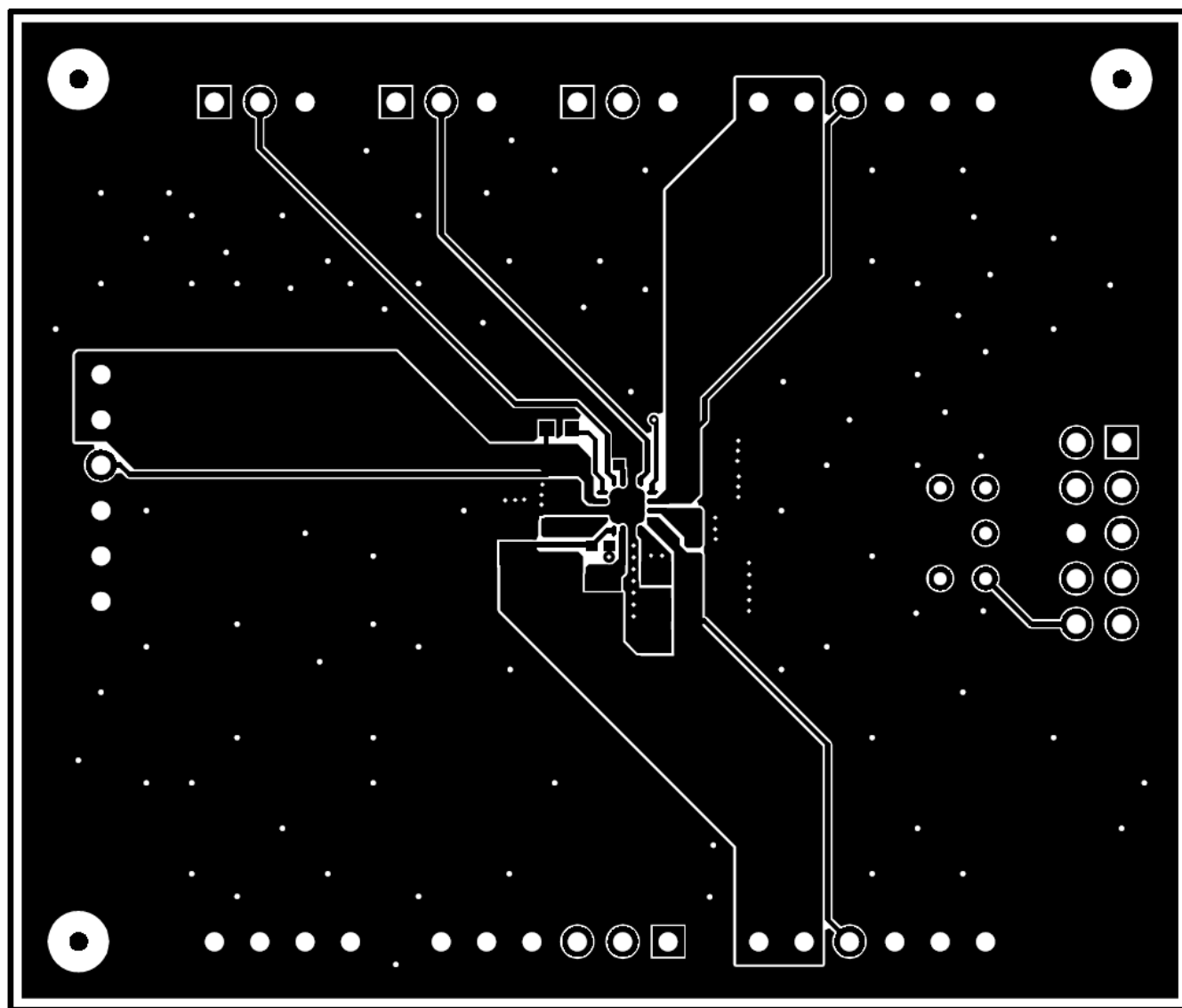


Figure 10. TPS65632 EVM Bottom Copper, Viewed from Bottom

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 μ F, 10 V, +/- 10%, X7R, 0805	MuRata	GRM21BR71A106KE51	8
C4, C8	CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X7R, 0405	MuRata	GRM155R71A104KA01	2
H1	USB2ANY	ANY	HPA665-001	1
L1, L3	Inductor, Shielded, Ferrite, 4.7 μ F, 1.3 A, 0.2 Ω , SMD	Toko	1239AS-H-4R7M	2
L2	Inductor, Shielded, Ferrite, 10 μ F, 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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- 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
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- 3 *Regulatory Notices:*

- 3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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.

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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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