User's Guide

TPS6213xEVM Buck Converter Evaluation Module User's Guide

ABSTRACT

This user's guide describes the characteristics, operation, and use of TI's TPS62135 and TPS62136 evaluation modules (EVM). These EVMs are designed to help the user easily evaluate and test the operation and functionality of the TPS62135 and TPS62136 4-A buck converters. The EVMs convert a 3-V to 17-V input voltage to a regulated 3.3-V or 5-V output voltage that delivers up to 4 A. This user's guide includes setup instructions for the hardware, a printed-circuit board (PCB) layout, a schematic diagram, a bill of materials (BOM), and test results of the EVMs. Throughout this document, TPS6213xEVM-698 is used as an abbreviation representing the TPS62135EVM-698 (001) and TPS62136EVM-698 (002) EVMs.

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Trademarks

1 Introduction

The TPS62135 and TPS62136 are 4-A, synchronous, step-down converters in 3 mm × 2 mm, 11-pin QFN packages. The TPS62135EVM-698 (PWR698-001) uses the TPS62135 integrated circuit (IC) which operates with a nominal switching frequency of 2.5 MHz. The TPS62136EVM-698 (PWR698-002) uses the TPS62136 IC which operates with a nominal switching frequency of 1 MHz.

1.1 Performance Specification

Table 1-1 provides a summary of the TPS6213xEVM-698 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1-1. Performance Specification Summary

Specification		Test Conditions	MIN	TYP	MAX	Unit
Input voltage			3		17	V
Output voltage setpoint	VSEL = High			5		V
	VSEL = Low			3.3		V
Output current			0		4	A

1.2 Modifications

The printed-circuit board (PCB) for this EVM is designed to accommodate the adjustable voltage version of this integrated circuit (IC). On the EVM, additional input and output capacitors can be added, the soft-start time can be changed, the tracking voltage and the input voltage at which the IC turns on can be adjusted. Finally, the loop response of the IC can be measured.

1.2.1 Input and Output Capacitors

C5 is provided for an additional input capacitor. This capacitor is not required for proper operation but can be used to reduce the input voltage ripple.

C7, C8, and C9 are provided for additional output capacitors. These capacitors are not required for proper operation but can be used to reduce the output voltage ripple and to improve the load transient response. For output voltages higher than 5 V, more output capacitance is necessary. The total output capacitance must remain within the recommended range in the TPS62135 (SLVSBH3) and TPS62136 (SLVSDV2) data sheet for proper operation.

1.2.2 Soft-Start Time

C3 controls the soft-start time of the output voltage on the TPS6213xEVM-698. It can be changed for a shorter or slower ramp up of Vout. Note that as the value of C3 is decreased, the inrush current increases.

1.2.3 Configurable Tracking Voltage

R5 and R6 can be installed to set a user-selectable tracking voltage. See the equations in the data sheet for details of calculating the resistor values.

1.2.4 Configurable Enable Threshold Voltage

With JP1 removed, R7 and R8 can be installed to set a user-selectable input voltage at which the IC turns on. See the equations in the data sheet for details of calculating the resistor values.

1.2.5 Loop Response Measurement

The loop response of the TPS6213xEVM-698 can be measured with two simple changes to the circuitry. First, install a 10-Ω resistor across the pads in the middle of the back of the PCB. The pads are spaced to allow installation of 0603-sized resistors. Second, cut the trace between the via on the VOS pin on the top layer and output capacitor. These changes are shown in Figure 1-1. With these changes, an ac signal (10-mV, peak-to-peak amplitude recommended) can be injected into the control loop across the added resistor.

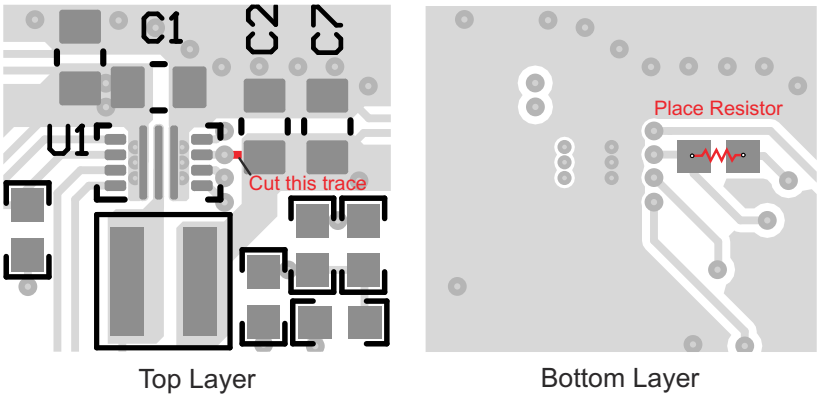

Figure 1-1. Loop Response Measurement Modification

2 Setup

This section describes how to properly use the TPS6213xEVM-698.

2.1 Connector Descriptions

J1, Pin 1 and 2 – VIN	Positive input voltage connection from the input supply for the EVM.
J1, Pin 3 and 4 – S+/S–	Input voltage sense connections. Measure the input voltage at this point.
J1, Pin 5 and 6 – GND	Input return connection from the input supply for the EVM.
J2, Pin 1 and 2 – VOUT	Positive output voltage connection.
J2, Pin 3 and 4 – S+/S–	Output voltage sense connections. Measure the output voltage at this point.
J2, Pin 5 and 6 – GND	Output return connection.
J3 – SS/TR/GND	The SS/TR pin voltage appears on pin 1 of this header with a convenient ground on pin 3.
J3 – TRACK-IN	The TRACK-IN pin can be used to scale down a tracking-voltage.
J4 – PG/GND	The PG output appears on pin 1 of this header with a convenient ground on pin 2.
JP1 – EN	EN pin jumper. Place the supplied jumper across ON and EN to turn on the IC. Place the jumper across OFF and EN to turn off the IC.
JP2 – MODE	Mode pin jumper. Place the supplied jumper across PWM and MODE to operate the converter in a forced PWM mode. Placed the jumper across MODE and PFM to operate the converter in power-saving mode.
JP3 – VSEL	VSEL pin jumper. Place the supplied jumper across LOW and VSEL for 3.3-V output. Place the jumper across HIGH and VSEL for 5-V output.
JP4 – PG Pullup Voltage	PG pin pullup voltage jumper. Place the supplied jumper on JP4 to connect the PG pin pullup resistor to the output voltage. Alternatively, the jumper can be removed and a different voltage can be supplied on pin 1 to pull up the PG pin to a different level. This externally applied voltage must remain below 6 V.

2.2 Hardware Setup

To operate the EVM, set jumpers JP1 through JP4 to the desired positions per Section 2.1. Connect the input supply to J1, and connect the load to J2.

3 TPS6213xEVM-698 Test Results

The TPS6213xEVM-698 was used to take the data in the TPS62135 (SLVSBH3) and TPS62136 (SLVSDV2) data sheet. See the device data sheet for the performance of this EVM.

4 Board Layout

This section provides the TPS6213xEVM-698 board layout and illustrations. The Gerbers are available on the EVM product pages: TPS62135EVM-698 and TPS62136EVM-698.

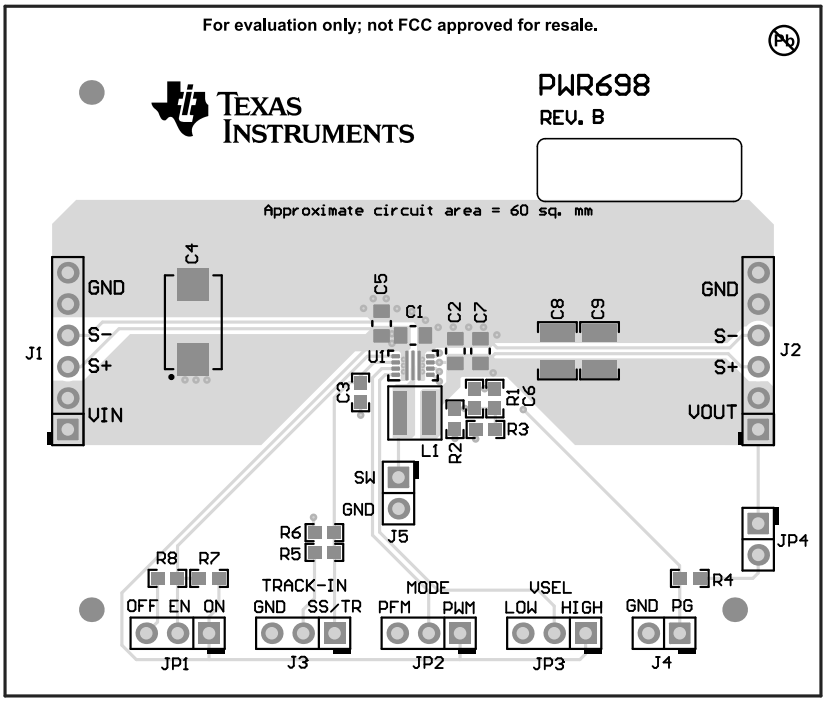

Figure 4-1. Top Assembly

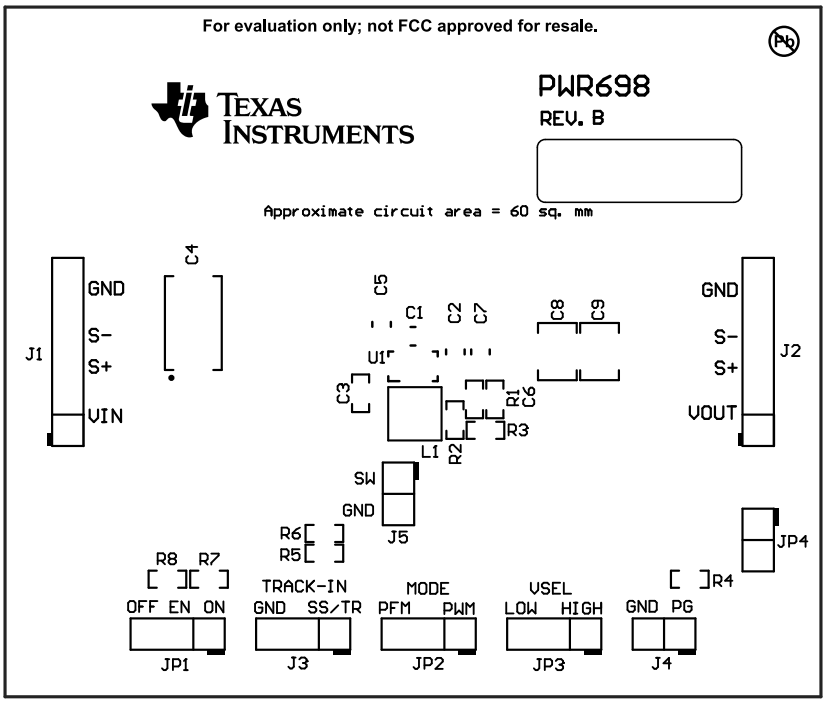

Figure 4-2. Top Overlay

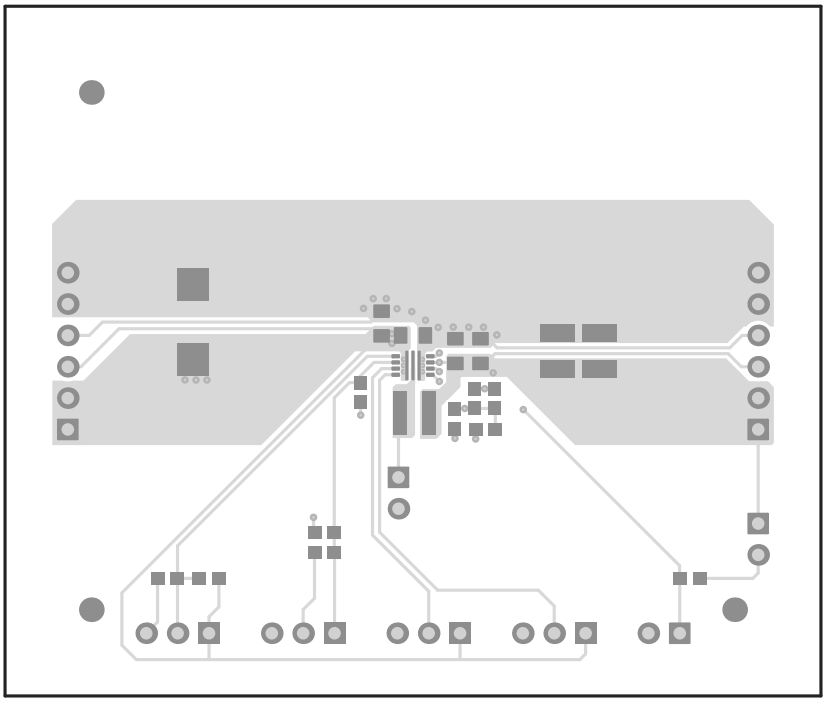

Figure 4-3. Top Layer

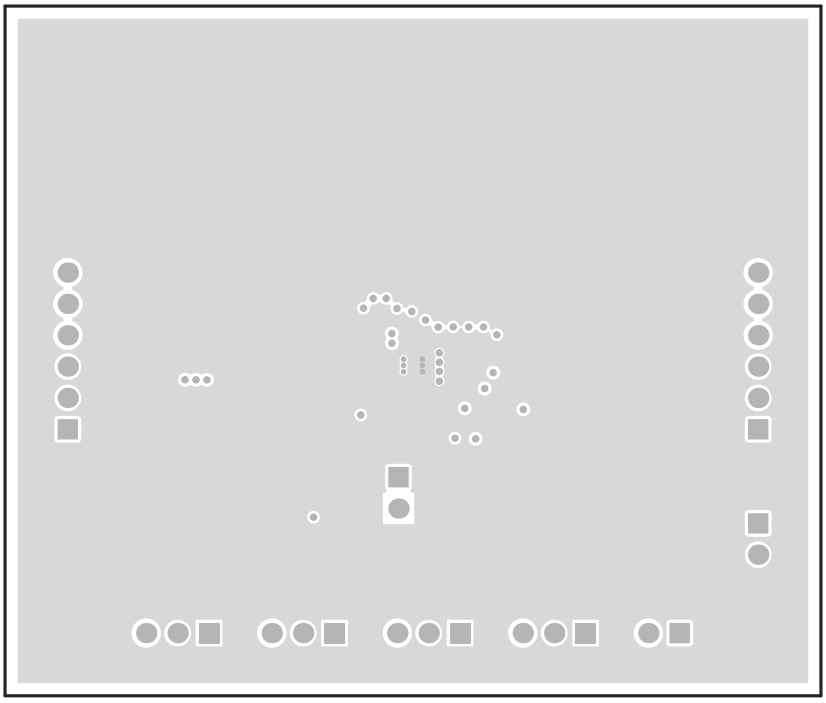

Figure 4-4. Internal Layer 1

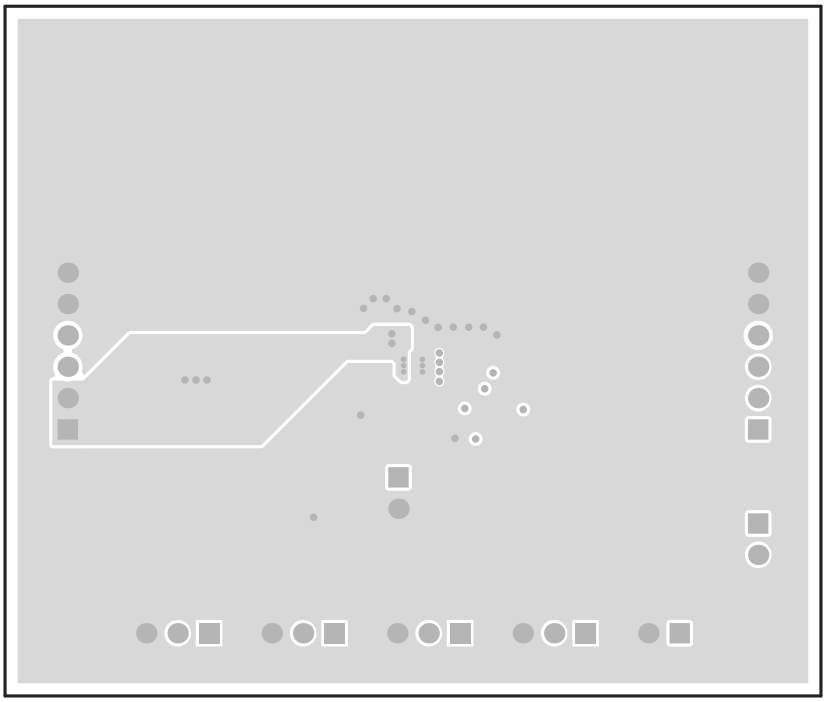

Figure 4-5. Internal Layer 2

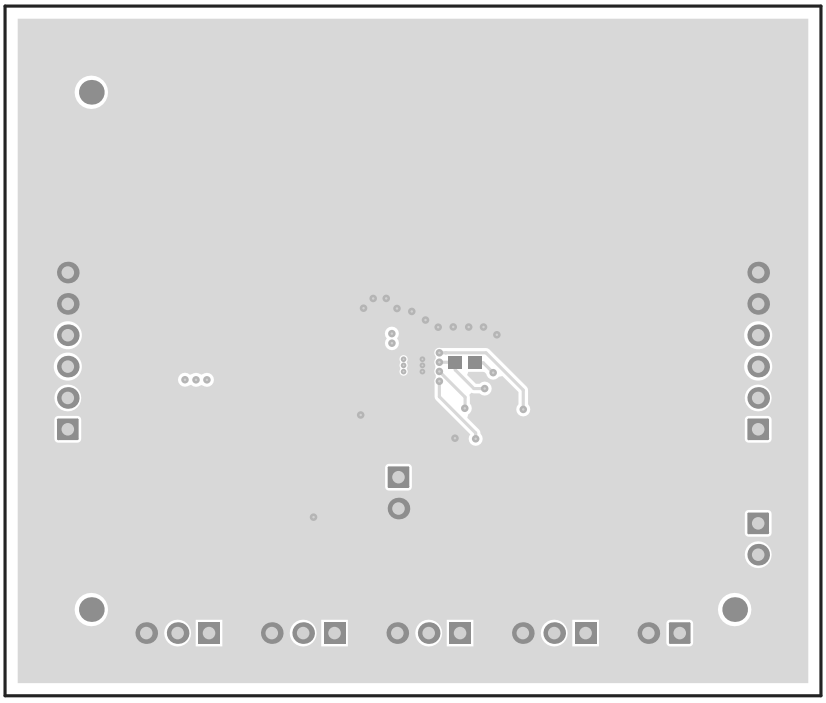

Figure 4-6. Bottom Layer

5 Schematic and Bill of Materials

This section provides the TPS6213xEVM-698 schematic and bill of materials.

5.1 Schematic

Figure 5-1 and Figure 5-2 illustrate the TPS6213xEVM-698 schematics.

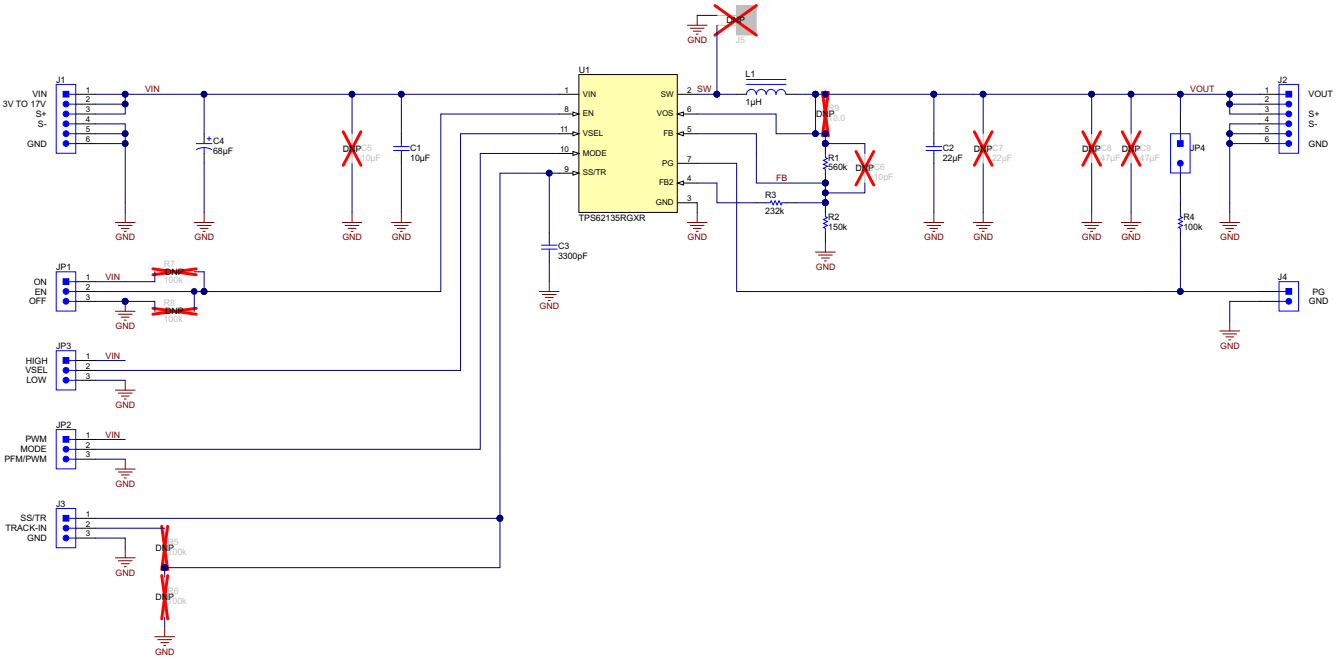

Figure 5-1. TPS62135EVM-698 Schematic

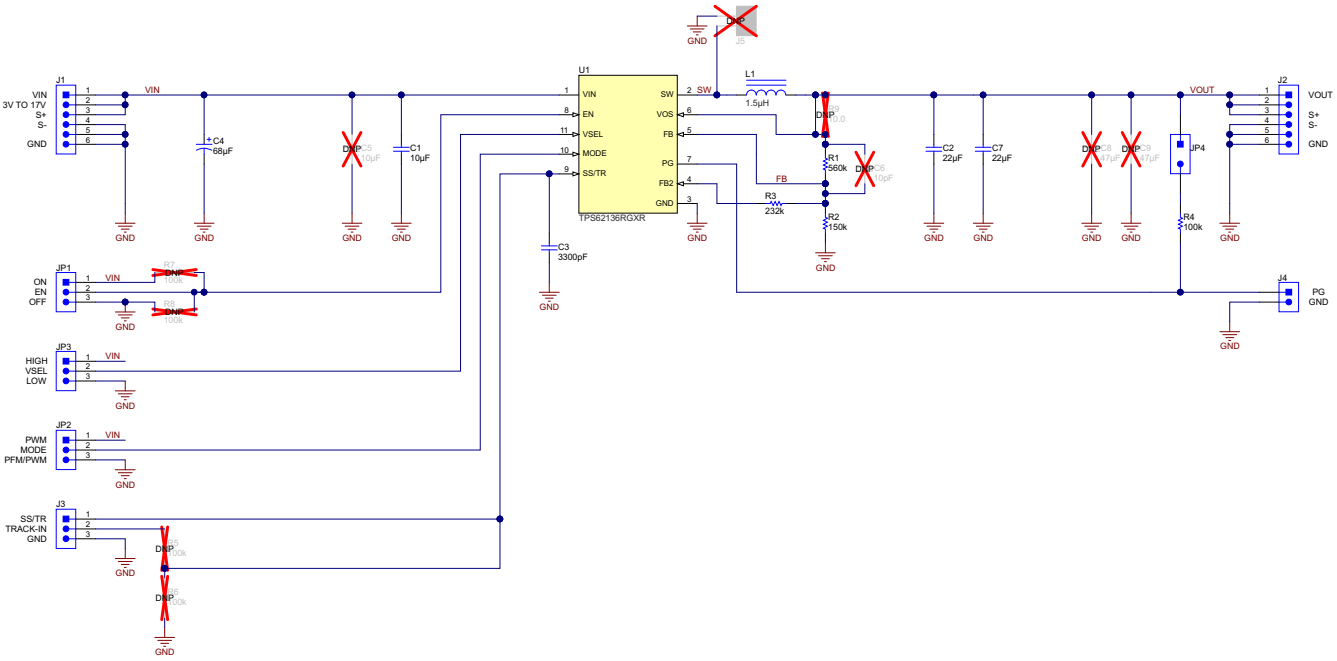

Figure 5-2. TPS62136EVM-698 Schematic

5.2 Bill of Materials

Table 5-1 lists the BOM for the TPS6213xEVM-698.

Table 5-1. TPS6213xEVM-698 Bill of Materials

Qty		Ref Des	Value	Description	Size	Part Number	Manufacturer
TPS62135EVM-698	TPS62136EVM-698						
1	1	C1	10 µF	Capacitor, Ceramic, 25V, X5R, ±10%	0805	TMK212BBJ106KG-T	Taiyo Yuden
1	1	C2	22 µF	Capacitor, Ceramic, 16V, X5R, ±20%	0805	EMK212BBJ226MG-T	Taiyo Yuden
1	1	C3	3300 pF	Capacitor, Ceramic, 50V, C0G/NP0, ±5%	0603	Std	Std
1	1	C4	68 µF	Capacitor, Tantalum, 35V, 68uF, ±20%	7343-43	TPSE686M025R0125	AVX
1	0	L1	1.0 µH	Inductor, Shielded, 5.4A, 0.011 Ω, ±20%	4x4x2mm	XFL4020-102MEB	Coilcraft
0	1	L1	1.5 µH	Inductor, Shielded, 7.4A, 0.021 Ω, ±20%	4x4x2mm	XEL4020-152MEB	Coilcraft
1	1	R1	560k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R2	150k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R3	232k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	R4	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	0	U1	TPS62135	IC, 17V 4-A, Step-Down Converter	2x3 mm	TPS62135RGX	TI
0	1	U1	TPS62136	IC, 17V 4-A, Step-Down Converter	2x3 mm	TPS62136RGX	TI

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (March 2017) to Revision B (June 2021) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document. 2
- Updated user's guide title..... 2

Changes from Revision * (August 2016) to Revision A (March 2017) **Page**

- Added TPS62136EVM-698 support to document globally..... 1
- Changed output voltage from 3.5 V to 4.0 V globally..... 1
- Deleted soft-start time from *Performance Specification Summary* table..... 2
- Changed *Setup* section to *Hardware Setup*..... 4

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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.*

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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.

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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.

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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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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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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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.

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