TPS63010EVM-235

This user's guide describes the characteristics, operation, and use of the TPS63010EVM evaluation module (EVM). This EVM is designed to help the user easily evaluate and test the operation and functionality of the TPS63010 single-inductor, buck-boost converter. This document includes setup instructions for the hardware, a schematic diagram, a bill of materials, and printed-circuit board (PCB) layout drawings for the EVM.

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1 Introduction

The Texas Instruments TPS63010 is a high-efficiency, single-inductor, buck-boost converter in a 20-pin, WCSP package. Both fixed and adjustable output voltage units are available.

1.1 Background

The TPS63010EVM-235 uses the TPS63010 adjustable version and is set to 3.3-V output. The EVM operates with full-rated performance with an input voltage between 2 V and 5.5 V. However, the input voltage at start up must be at least 2.2 V. Once the TPS63010 has started switching, the input voltage can be reduced to 2 V.

1.2 Performance Specification

Table 1 provides a summary of the TPS63010EVM-235 performance specifications. All specifications are given for an ambient temperature of 25°C.

Table 1. Performance Specification Summary

Specification	Test Conditions	Min	Typ	Max	Unit
Input voltage	Iout = 500 mA	2	3.6	5.5	V
Output voltage	Iout = 0 mA to 500 mA	3.25	3.3	3.40	V
Output current	3.6 V in	0	500	1200	mA
Operating frequency			2400		kHz
Maximum efficiency	4.2 V in at 300-mA load		94.2%		
Output ripple	3.6 V in at 500-mA load		25		mV

1.3 Modifications

The PCB for this EVM is designed to accommodate both the fixed and adjustable versions of this integrated circuit (IC). If the fixed version is installed, R1 is replaced with a 0-Ω resistor and R2 is open.

1.3.1 Adjustable Output IC U1 Operation

U1 is configured for evaluation of the adjustable output version. This unit is configured for 3.3 V. Resistors R1 and R2 are used to set the output voltage between 1.2 V and 5.5 V. See the data sheet (SLVS653) for recommended values.

1.3.2 Fixed Output Operation

U1 can be replaced with the fixed version for evaluation. If U1 is replaced, R1 needs to be replaced with a 0-Ω resistor, and the R2 position needs to be open.

2 Setup and Results

This section describes how to properly use the TPS63010EVM-235.

2.1 Input/Output Connector and Header Descriptions

2.1.1 J1 – VIN

J1-1 is the positive sense (+S) for the positive input connection from the input supply for U1. J1-2 is the positive voltage connection (VIN) from the input supply to U1. J1-1 and J1-2 are electrically common.

2.1.2 J2 – GND

J1-1 is the return voltage connection (GND) from the input supply to U1. J2-2 is the negative sense (-S) for the return voltage connection from the input supply for U1. J2-1, J2-2, J4-1 and J4-2 are electrically common.

2.1.3 J3 – VOUT

J3-1 is the positive sense (+S) for the positive output connection to the load. J1-2 is the positive output connection (VOUT). J3-1 and J3-2 are electrically common.

2.1.4 J4 – GND

J4-1 is the return output connection (GND). J4-2 is the positive sense (-S) for the return output connection to the load. J2-1, J2-2, J4-1 and J4-2 are electrically common.

2.1.5 JP1 – EN

Enable function control jumper. JP1-1 (EN) is connected to Vin. JP1-2 (EN) is connected to U1-A4. J1-3 (DIS) is connected to ground. Shorting jumper JP1 between the JP1-1 (EN) and center pin JP1-2 (EN) turns on the unit. Shorting the jumper JP1 between the JP1-3 (DIS) and center pin JP1-2 (EN) turns on the unit off.

2.1.6 JP2 –PS

Power Save mode control jumper. JP2-1 (DIS) is connected to Vin. JP2-2 (PS) is connected to U1-C4. J2-3 (EN) is connected to ground. Shorting jumper JP2 between the JP2-1 (DIS) and center pin JP2-2 (PS) turns Power Save mode off. Shorting the jumper JP1 between the JP2-3 (EN) and center pin JP2-2 (PS) turns Power Save mode on.

2.1.7 JP3–VSEL

Voltage Select mode control jumper. Used to set high or low voltage option when the EVM is configured for use with the TPS63011 or the TPS63012. JP3-1 (HI V) is connected to Vin. JP3-2 (VSEL) is connected to U1-D4. J3-3 (LO V) is connected to ground. Shorting jumper JP3 between the JP3-1 (HI V) and center pin JP3-2 (VSEL) selects the higher voltage option. Shorting the jumper JP3 between the JP3-3 (LO V) and center pin JP3-2 (VSEL) selects the lower voltage option. JP3 must be set to either position for operation with the TPS63010.

2.1.8 JP4 –SYNC

SYNC mode control and input jumper. JP4-1 (N/A) is connected to Vin. JP4-2 (SYNC) is connected to U1-B4. J4-3 (DIS) is connected to ground. Shorting jumper JP4 between the JP4-3 (DIS) and center pin JP4-2 (SYNC) disables external synchronization. Leave JP4 open to enable SYNC function control. JP4-2 center pin is SYNC input and is used to synchronize the unit with an external clock.

2.2 Setup

To operate the EVM, simply connect an input supply to the appropriate pins, connect a load to the appropriate pins. Maximum recommended load is dependent on input supply voltage. Typically, the TPS63010 is capable of 800 mA in boost mode (Vin > 2.4 V) and 1.2 A in buck mode (Vin ≥3.6). Input supply voltage of 2 V to 5.5 V is recommended. The TPS63010 requires a minimum input voltage of 2.2 V at power up. After the device is switching the input voltage can be lowered to 2 V.

2.3 Power Up

After being enabled, the device starts operating. The average current limit ramps up from an initial 400 mA following the output voltage increasing. At an output voltage of about 1.2 V, the current limit is at its nominal value. Output voltage is monitored during this time and must increase for switch current to increase. In the start-up waveform pictured, CH1 is EN, CH2 is Vout and CH3 is Iin.

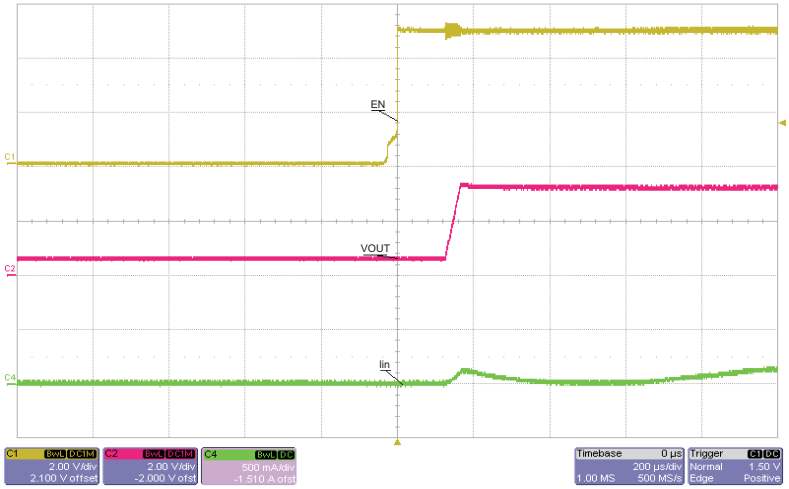


Figure 1. Turn ON Into Electronic Load

2.4 Output Ripple

Output ripple occurs at the switching frequency of 2.4 MHz, and with the recommended L and output C, is low. Amplitude of the ripple varies, depending on load current and input voltage. Ensure that the oscilloscope probe is connected as close as possible to the output capacitor, with a short ground lead, for accurate measurements. Resistance in trace and leads adds to output ripple, and ground lead length increases the amplitude of switching spikes. In the voltage ripple waveforms pictured, CH1 is L1 (U1-B1 and U1-B2), CH2 is Vout and CH3 is L2 (U1-D1 and U1-D2).

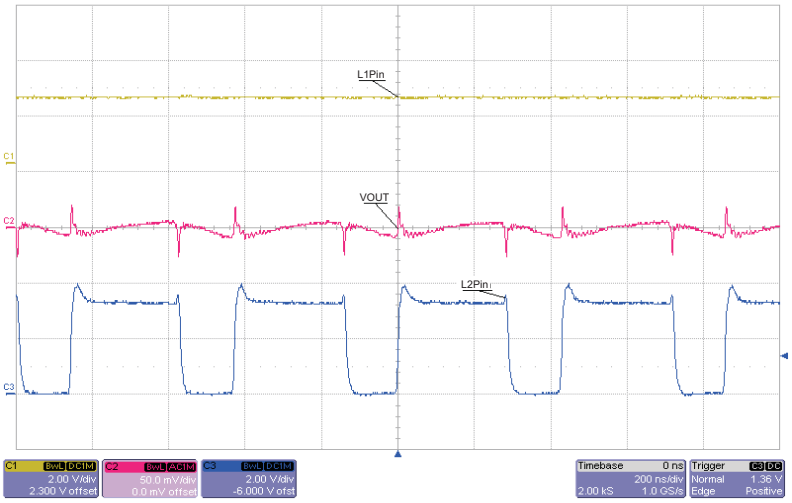


Figure 2. Output Ripple Vin 3 V

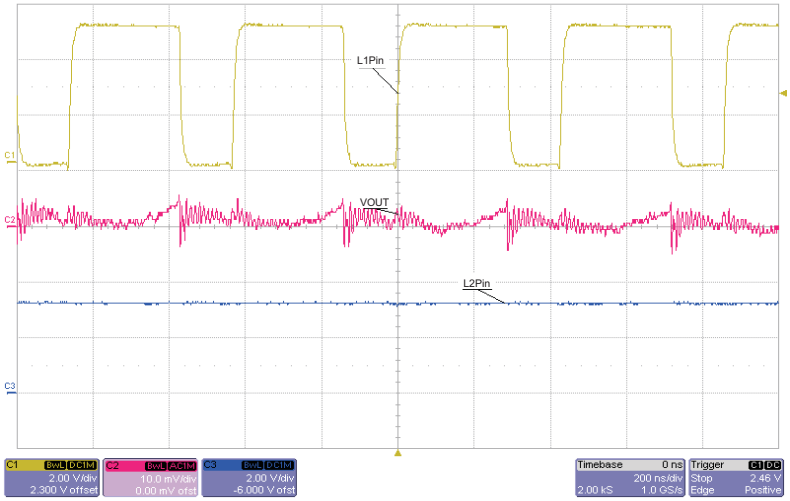


Figure 3. Output Ripple Vin 5 V

2.5 Efficiency

Efficiency is shown in the following graph. Peak efficiency occurs between 300- and 400-mA load currents.

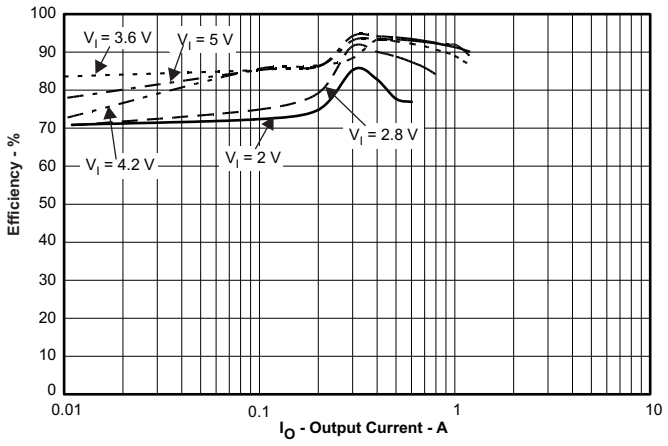


Figure 4. Efficiency Over Li-Ion Cell Range

2.6 Load Transients

Load transient response is well regulated. Additional output capacitance reduces voltage over- and undershoot.

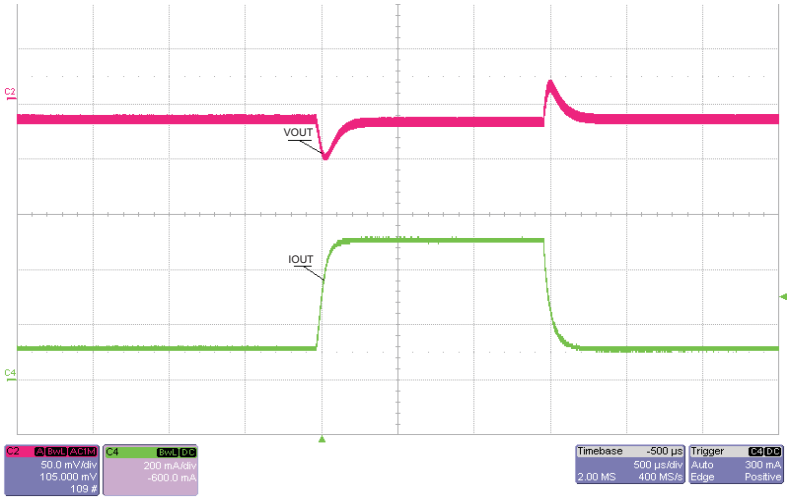


Figure 5. Load Step 100 mA to 500 mA

2.7 Closed Loop Response

The closed loop response for the TPS63010 EVM is shown for Vin = 5 V and Iout = 500 mA.

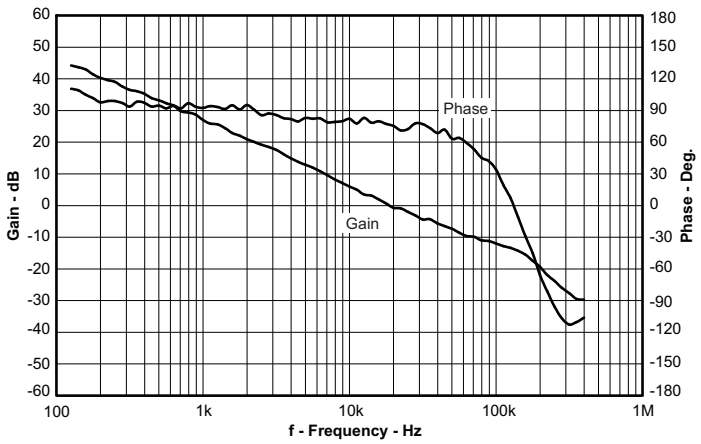


Figure 6. Closed Loop Response

3 Board Layout

This section provides the TPS63010EVM-235 board layout and illustrations.

3.1 Layout

Figure 7 through Figure 9 show the board layout for the TPS63010EVM-235 PCB.

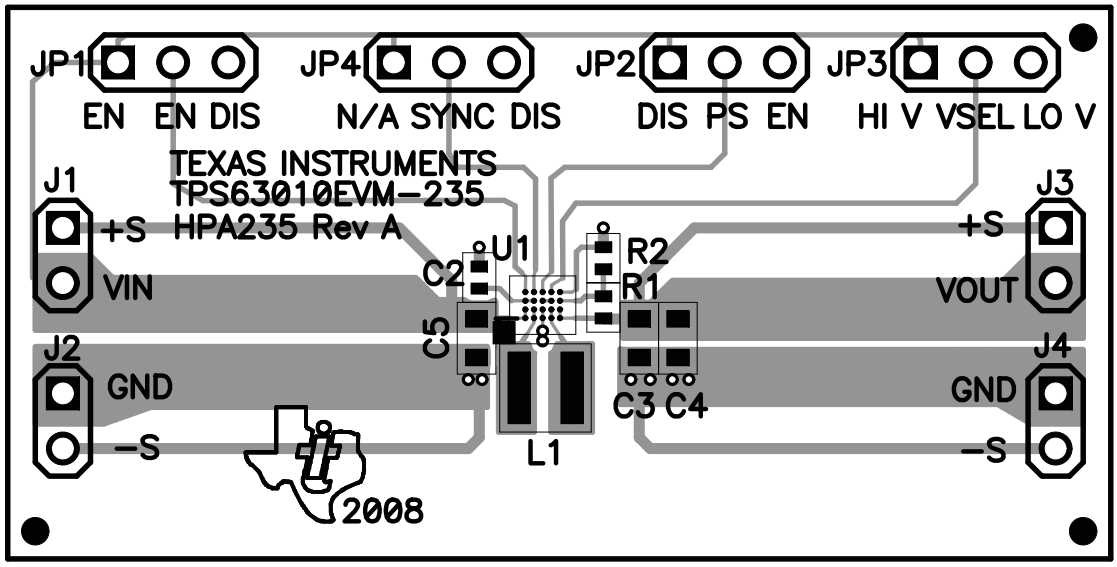


Figure 7. Assembly Layer

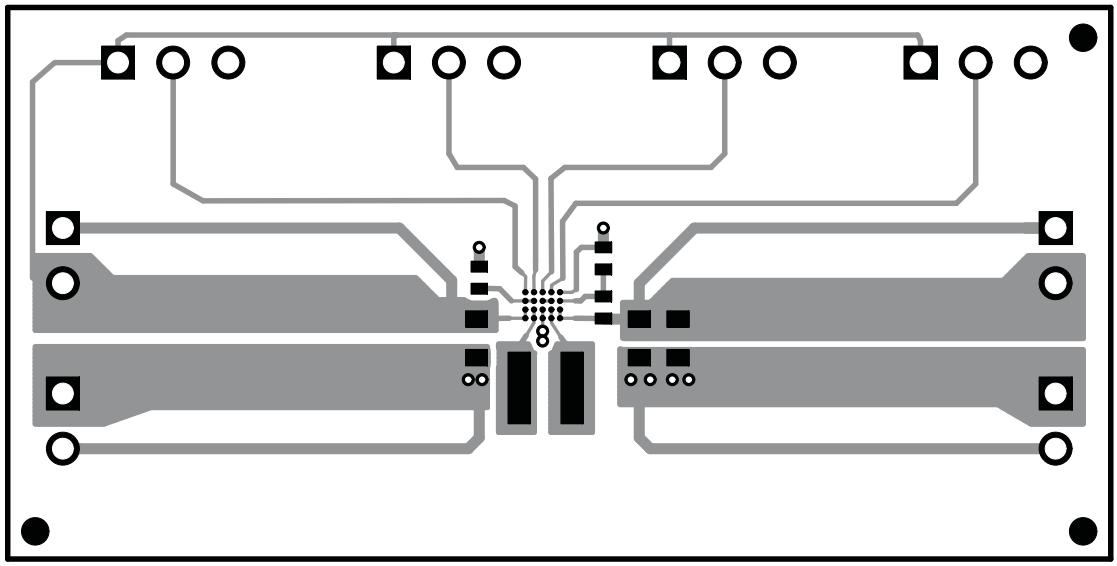


Figure 8. Top Layer Routing

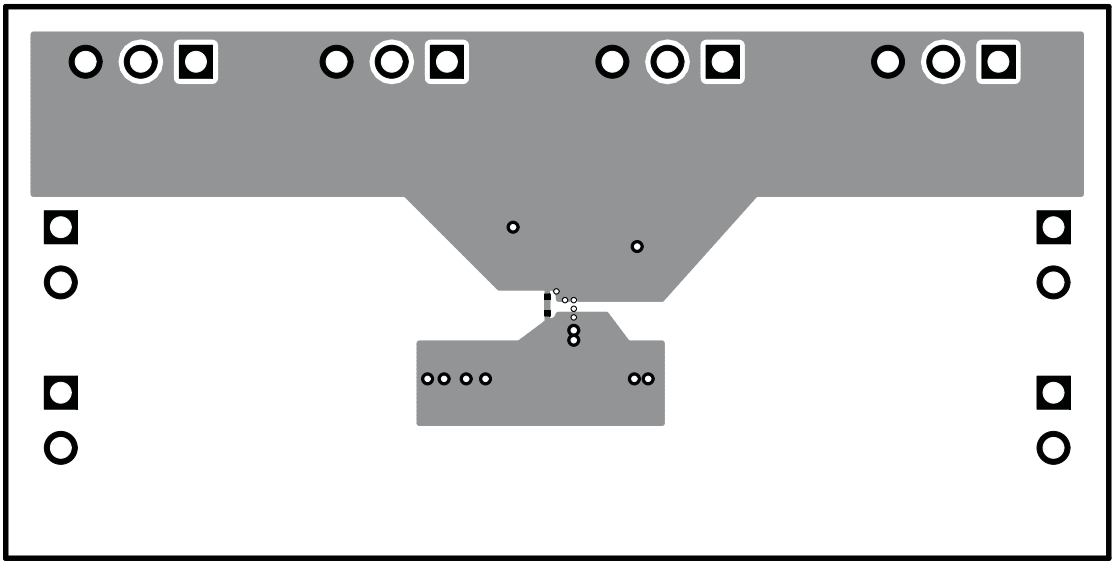


Figure 9. Bottom Layer Routing

4 Schematic and Bill of Materials

This section provides the TPS63010EVM-235 schematic and bill of materials.

4.1 Schematic

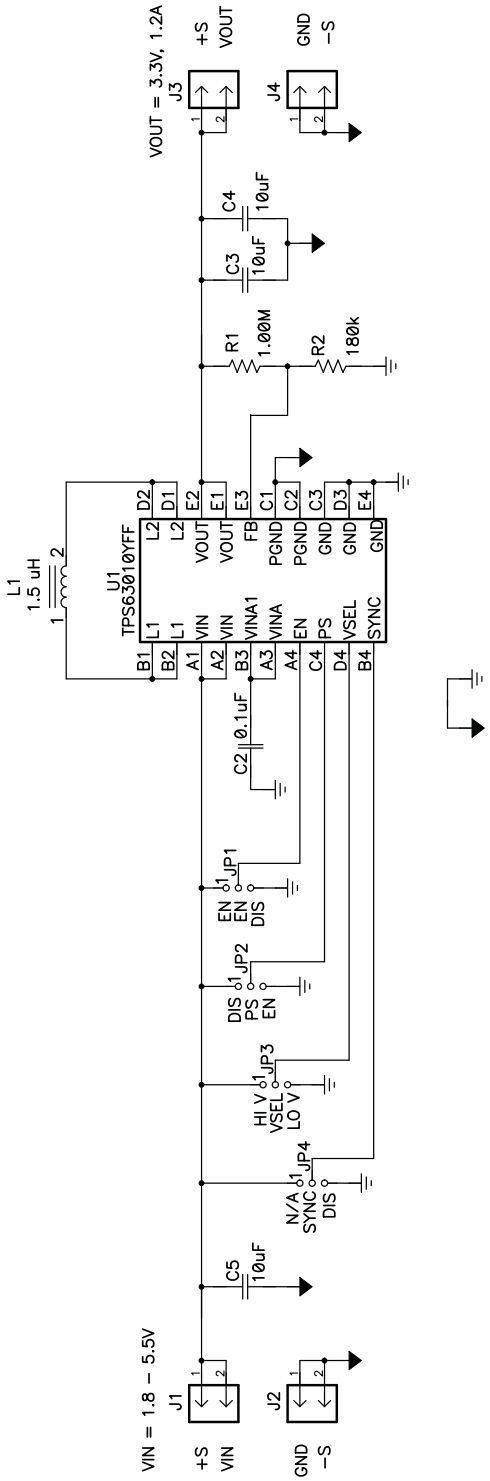


Figure 10. TPS63010EVM-235 Schematic

4.2 Bill of Materials

Table 2. TPS63010EVM-235 Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C2	0.1 µF	Capacitor, Ceramic, 16V, X7R, 10%	0402	GRM155R71C104KA88D	Murata
3	C3–C5	10 µF	Capacitor, Ceramic, 6.3V, X5R, 20%	0603	ECJ-1VB0J106M	Panasonic
4	J1–J4	PTC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PTC36SAAN	Sullins
4	JP1–JP4	PTC36SAAN	Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 inch x 3	PTC36SAAN	Sullins
1	L1	1.5 µH	Inductor, SMT, 2.1A, 100milliohm	0.118 x 0.118 inch	LPS3015-152ML	Coilcraft
1	R1	1.00 M	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	R2	180k	Resistor, Chip, 1/16W, 1%	0402	Std	Std
1	U1	TPS63010YFF	IC, High Efficient Single Inductor Buck-Boost Converter	WCSP	TPS63010YFF	TI
1	—		PCB, 2 In x 1 In x 0.062 In		HPA235A	Any
4	—		Shunt, 100-mil, Black	0.1	929950-00	3m

Notes: 1. These assemblies are ESD sensitive, ESD precautions shall be observed.
2. These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.
3. These assemblies must comply with workmanship standards IPC-A-610 Class 2.
4. Ref designators marked with an asterisk ('**') cannot be substituted.
All other components can be substituted with equivalent MFG's components.
5. **Maximum 30 grams placement pressure on WCSP parts.**

4.3 Related Documentation From Texas Instruments

TPS63010 data sheet (SLVS653)

4.4 If You Need Assistance

Contact your local TI sales representative.

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 3.6 V to 5.5 V and the output voltage range of 1000 mA.

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 50 C. The EVM is designed to operate properly with certain components above 50 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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