TLV62080, 1.2-A, High-Efficiency, Step-Down Converter in 2-mm × 2-mm SON Package

This user's guide describes the TLV62080 evaluation module (EVM) and explains how to perform a stand-alone evaluation or interface with a host or system. The converter is designed to deliver up to 1200 mA of continuous current to the output. The TLV62084 shares the same EVM by swapping the IC. The TLV62084 delivers up to 2-A continuous output current.

Contents

1 Introduction 1
2 Considerations for Evaluating the TLV62080 1
3 Test Summary 1
4 Schematic, Physical Layout and Bill of Materials 7

1 Introduction

The TLV62080 focuses on high-efficiency, step-down conversion over a wide output current range. At medium-to-heavy loads, the converter operates in PWM mode and automatically enters the PFM or power-save mode of operation at light-load currents to maintain high efficiency over the entire load current range. To address the requirements of powering supply rails, the internal compensation circuit allows a large selection of external output capacitor values, ranging from 10 µF up to 100 µF. The TLV62080 operates at a nominal frequency of 3 MHz. With its DCS-Control™ architecture, excellent load transient performance, and output voltage regulation, accuracy is achieved. The robust architecture and safety features allow perfect system integration. The device is available in a 2-mm × 2-mm package with thermal pad.

2 Considerations for Evaluating the TLV62080

This integrated circuit (IC) has two modes of operation. The PWM/PFM mode is selected when the load current is greater than half the ripple current (in continuous conduction mode). At light loads, when the inductor current is discontinuous, the IC automatically goes into PFM mode and delivers fewer pulses, trying to keep a tight regulation with low ripple.

3 Test Summary

The TLV62080EVM-641 board requires an adjustable dc power supply with up to a 6-V output and ≥ 600 mA for powering the input to the EVM, and a resistive output load between 825 Ω and 5 Ω. Choose the proper power rating for the load resistor, $P = V^2/R$. Use at least 2× the calculated power dissipation. The test setup connections and jumper settings selections are configured for a stand-alone evaluation, but can be changed to interface with external hardware such as a system load and microcontroller.

3.1 Equipment

- Adjustable dc power supply between 2.7 V and 6 V with adjustable current limit set to ~550 mA
- Load: System load or load resistors 5 Ω, 3 W; 100 Ω, 0.25 W; and 825 Ω, 0.25 W
- Three Fluke 77 digital multimeters (DMM) (equivalent or better)
- Oscilloscope, Tektronix model TDS222 (equivalent or better)

3.2 Equipment and EVM Setup

Table 1 shows the setup input/output connections and configuration of the TLV62080 evaluation module. The silk screen labels are shown in parentheses.

Table 1. Setup I/O Connections and Configuration for TLV62080EVM Evaluation

Jack/Component (Silk Screen)	Connect or Adjustment to:
J1-1/2 (Vin)	P/S positive lead, preset to 4 Vdc; 550-mA current limit
J2-1 (+ SNS); input	Positive lead of DMM #1
J2-2 (– SNS); input	Negative lead of DMM #1
J3-1/2 (GND)	P/S negative lead.
J5-1/2 (Vout)	Positive lead to system load or load resistance
J6-1 (+ SNS); output	Positive lead of DMM #2
J6-2 (– SNS); output	Negative lead of DMM #2
J7-1/2 (GND)	Negative lead to system load or load resistance
J4-1 (PG)	Positive lead of DMM #3
J4-2 (GND)	Negative lead of DMM #3
JP1-1/2 (ON)	Apply shunt to *ON* for converter operation

Connect the meters, scope probes, output load, shunt, and input power supply as listed in Table 1; set the oscilloscope to 200 ns/div, positive trigger, dc-coupled on CH2, CH1; ac-coupled and 20 mV/div on CH3; and ac-coupled and 10 mV/div on CH4. Users may want to replace the load resistors with a system load or decade load box to vary load (1-kΩ to 5-Ω load).

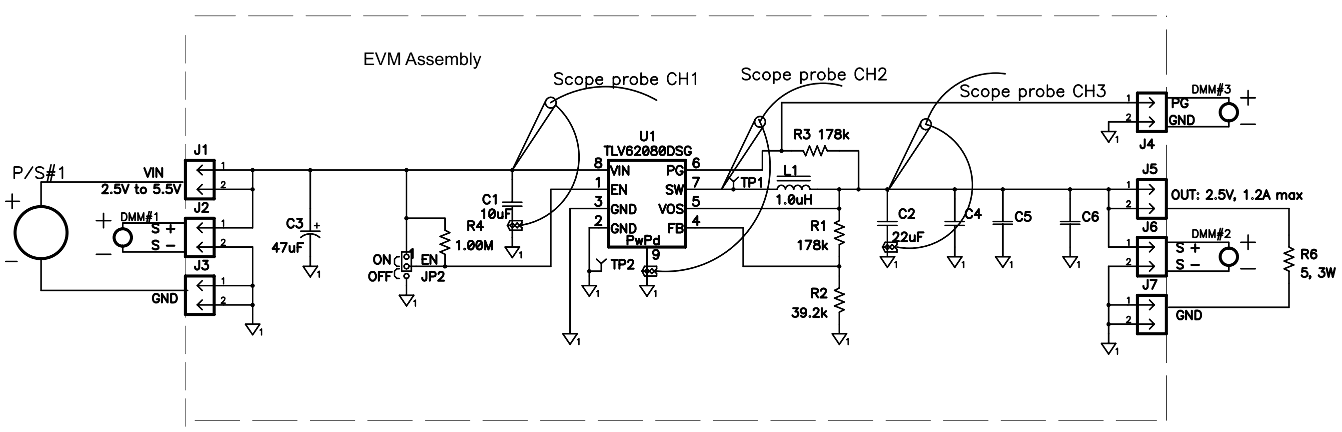

Figure 1. EVM Schematic and Evaluation Setup

3.3 Test Procedure

1. Ensure that the EVM is set up according to Table 1 and Figure 1, and that the power supply is preset to 4 Vdc at ~550-mA current limit.
2. Turn on input supply, and verify that the input voltage is ~4 Vdc (DMM#1) and the output voltage is at ~2.5 Vdc (DMM#2).
3. Look at CH2 and CH3, and verify that the duty cycle is near 67% and the output ripple is less than 10 mV; see Figure 2 for typical waveforms. Note that the output inductance used on the test board used to take the photographs is a 2.2-µH inductor and the one on the factory EVM is a 1-µH inductor; therefore, the output ripple is approximately twice the amplitude shown. These waveforms were taken with high-frequency probes (meaning that the ground lead was very short (~1 cm). This greatly reduces the high-frequency spikes that the ground loop on the probe picks up.
4. Change the load to from 5 Ω to 100 Ω, 0.25 W. Observe the change in the switching waveforms. As the load is reduced, the inductor current becomes discontinuous, and the control automatically switches to PFM mode. Users may need to change the time scale on the oscilloscope to 1 µs/div for light loads (see Figure 3). Set the load back to approximately 5 Ω.
5. Vary input voltage between 2.5 V and 5 V, and observe the change in duty cycle and ripple waveforms.
6. Disconnect positive lead of input supply. Set CH1 to 2 Vdc/div, CH3 to 1 Vdc/div, and time to 50 µs/div. Set trigger to CH1, trigger level to 2 V, and arm single-sequence trigger. Hot-plug input supply. See Figure 4 for a typical power up. Figure 5 shows the timing of the PG pin applying the input hot plug.
7. Set the single-sequence trigger for negative slope and time for 100 µs/div; arm scope and unplug power supply. See Figure 6 for an example of power down by removing input supply.
8. Remove the enable shunt, JP2, and connect CH1 to JP2-2 (EN) and plug in the input supply. Arm the oscilloscope, and short between JP2-2 and JP2-1 (OFF). The captured waveform shows output power down by pulling EN low (Figure 7).
9. Set scope to positive trigger, arm scope and remove short between JP2-1/2. The captured waveform shows output power up by pulling EN high (Figure 8)
10. With an understanding of the basic functions of the EVM, users may want to connect the EVM into their system using short, twisted wires to minimize impedance.

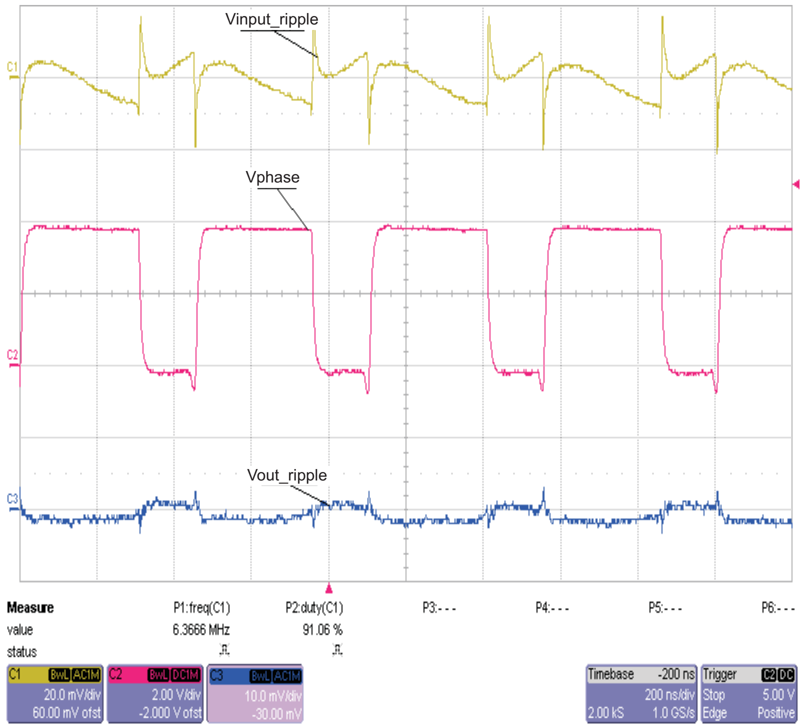

Figure 2. PWM Mode. Vin = 4 V, Vout = 2.5 V, Iout = 0.5 A. CCM Operation, Therefore PWM Mode CH1 = Input Ripple; CH2 = Phase; CH3 = Output Ripple

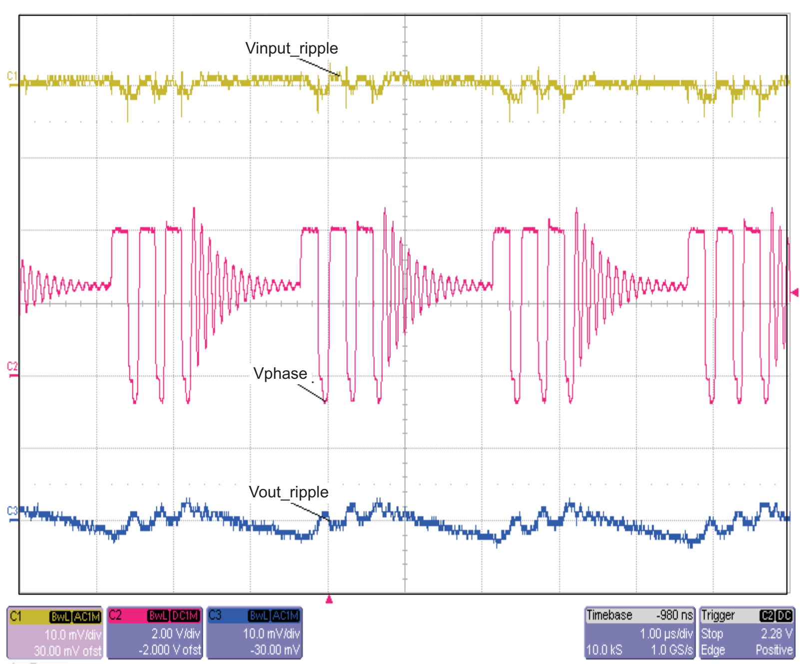

Figure 3. PFM Mode. Vin = 4 V, Vout = 2.5 V, Iout = 25 mA. DCM Operation, Therefore PFM Mode CH1 = Input Ripple; CH2 = Phase; CH3 = Output Ripple

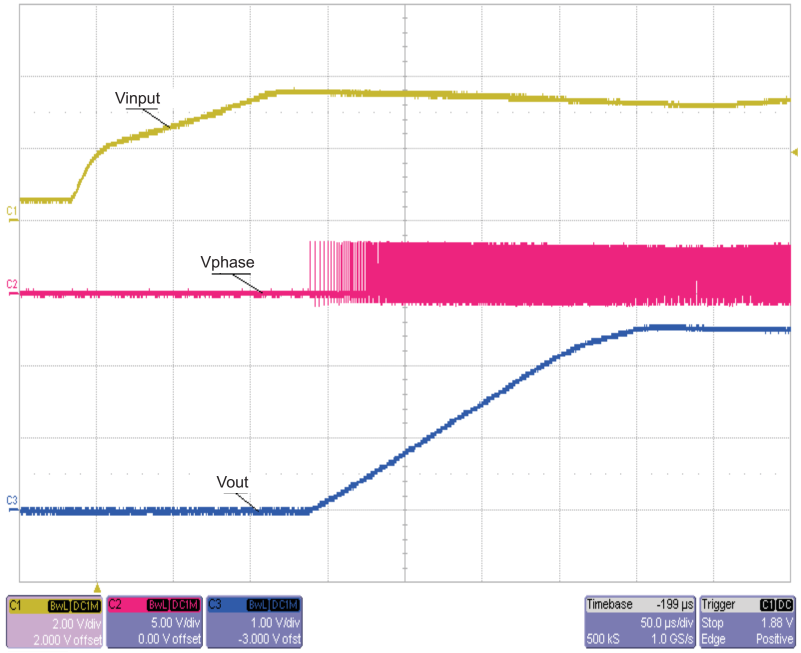

Figure 4. Start-Up in PWM/PFM Mode. Vin = 4 V, Vout = 2.5 V, Iout = 0.5 A; CH1 = Input Voltage; CH2 = Phase; CH3 = Output Voltage

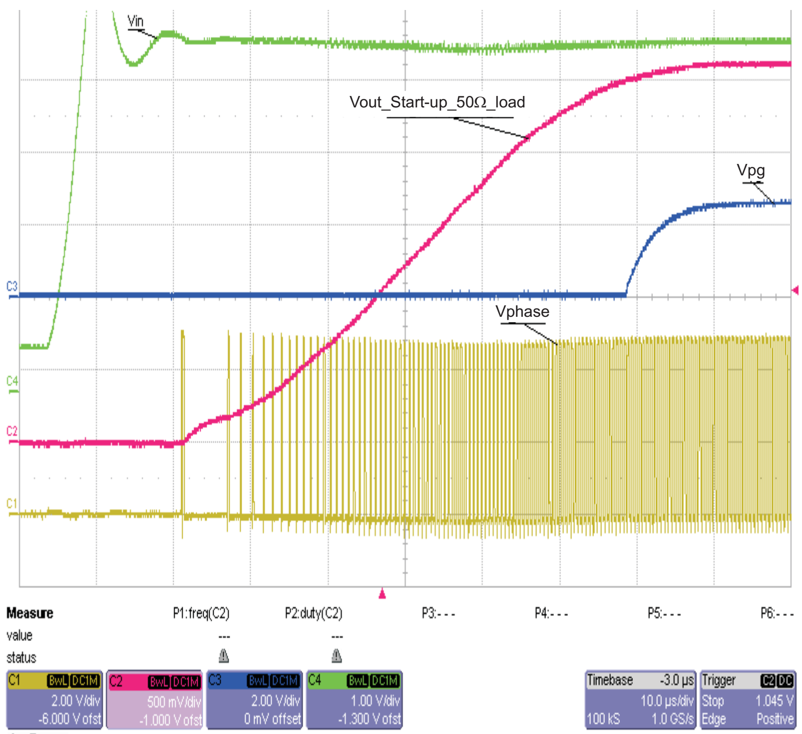

Figure 5. Start-Up in PWM/PFM Mode. Vin = 5 V, Vout = 2.5 V, Iout = 0.5 A; CH4 = Input Voltage; CH1 = Phase; CH2 = Output Voltage; CH3 = PG

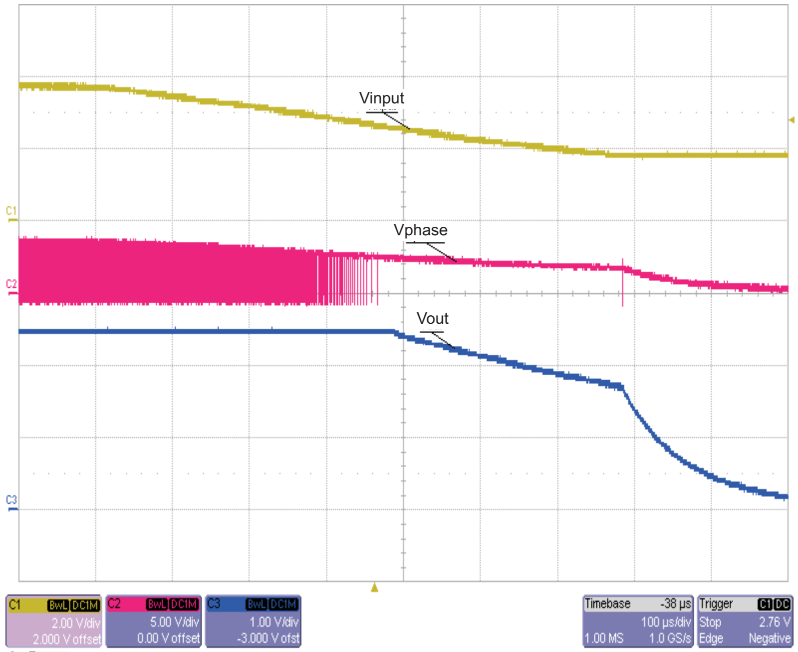

Figure 6. Power Down in PWM/PFM Mode, Vin = 4 V, Vout = 2.5 V, Iout = 0.5 A; CH1 = Input Voltage; CH2 = Phase; CH3 = Output Voltage

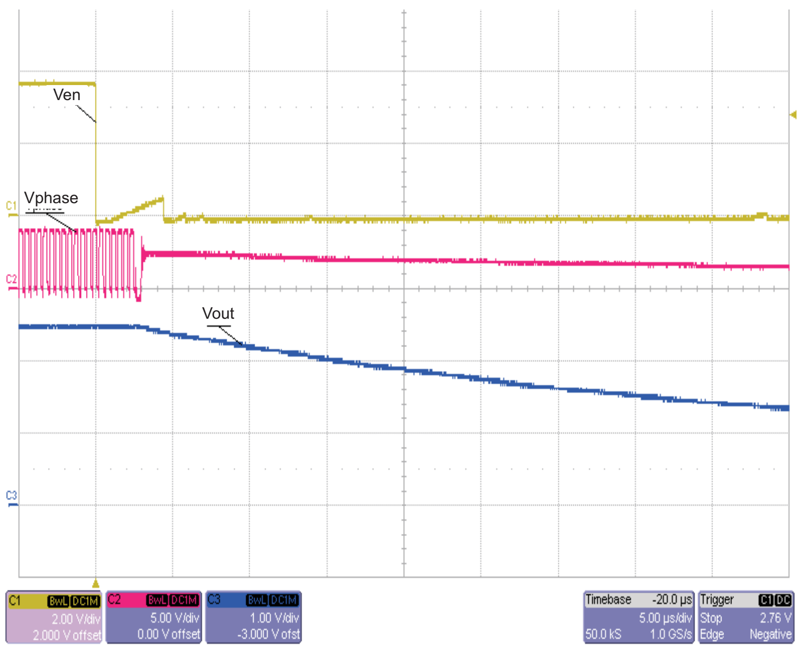

Figure 7. Shutdown Output With EN Pin. Vin = 4 V, Vout = 2.5 V, Iout = 0.5 A; CH1 = Input Voltage; CH2 = Phase; CH3 = Output Voltage

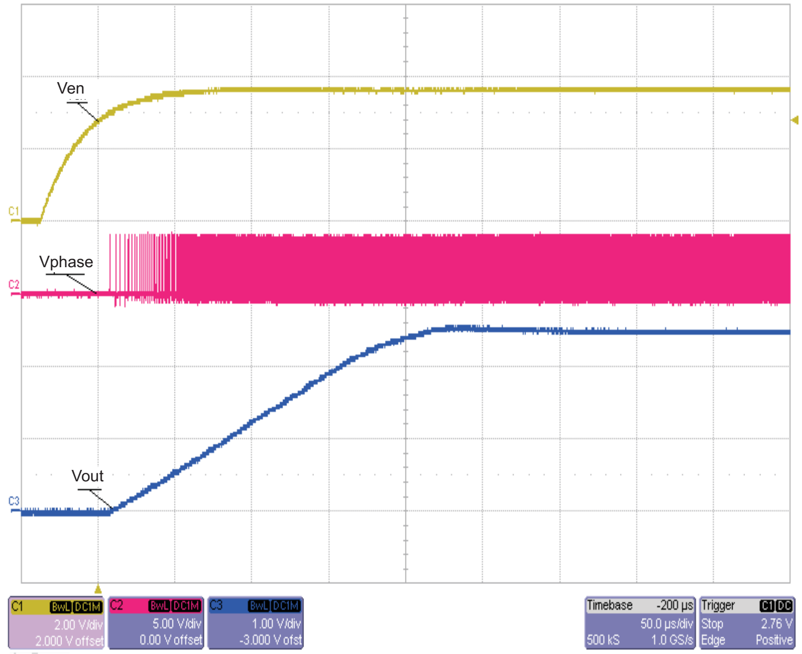

Figure 8. Power-Up Output With EN pin. Vin = 4 V, Vout = 2.5 V, Iout = 0.5 A; CH1 = Input Voltage; CH2 = Phase; CH3 = Output Voltage

4 Schematic, Physical Layout and Bill of Materials

Schematic

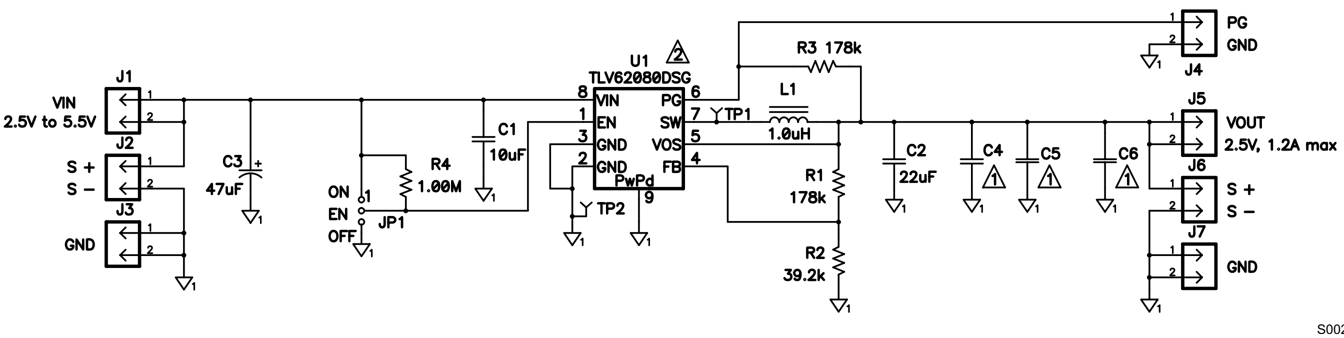

Figure 9. Schematic

Physical Layouts

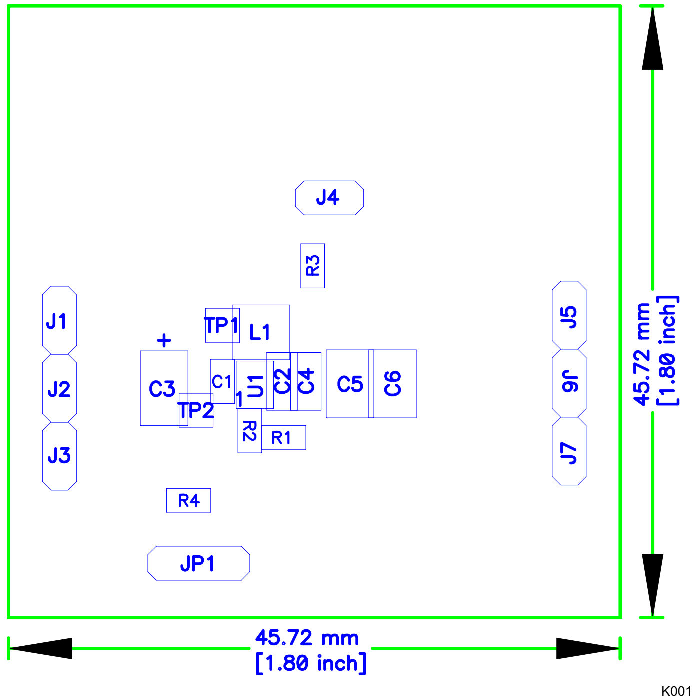

Figure 10. Assembly Layer

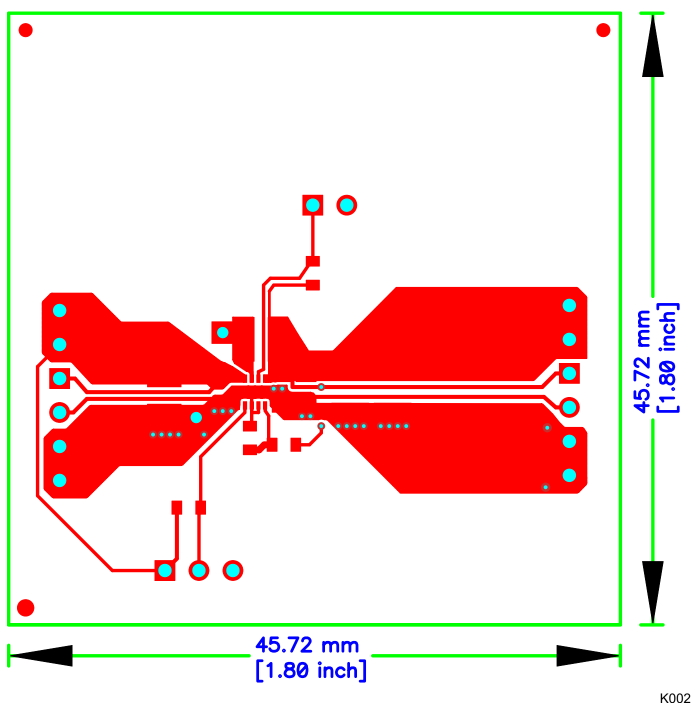

Figure 11. Top Layer

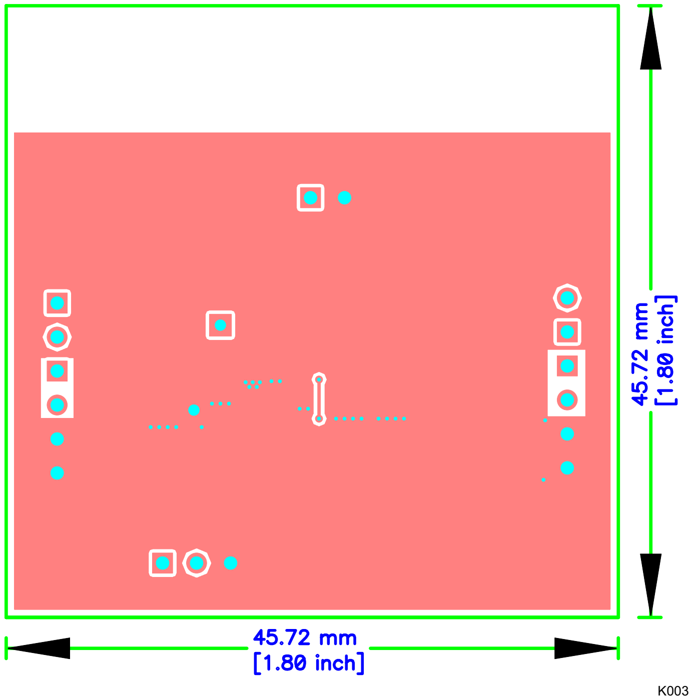

Figure 12. Bottom Layer

4.1 Bill of Materials

Table 2. Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
1	C1	10 µF	Capacitor, ceramic, 6.3-V, X5R, 20%	0603	Std	Std
1	C2	22 µF	Capacitor, ceramic, 6.3-V, X5R, 20%	0805	GRM21BR60J226ME39L	Murata
1	C3	47 µF	Capacitor, tantalum, 8-V, 35-mΩ, 20%	3528(B)	T520B476M008ATE035	Kemet
0	C4	Open	Capacitor, ceramic	0805	Std	Std
0	C5, C6	Open	Capacitor, ceramic	1210	Std	Std
7	J1, J2, J3, J4, J5, J6, J7	PEC02SAAN	Header, male 2-pin, 100-mil (2,54-mm) spacing	0.100 inch (2,54 mm) spacing	PEC02SAAN	Sullins
1	JP1	PEC03SAAN	Header, 3 pin, 100-mil (2,54-mm) spacing	0.100 inch (2,54 mm) spacing	PEC03SAAN	Sullins
1	L1	1 µH	Inductor, power, 2.2-A, ±20%	0.120 inch (3.05 mm) × 0.120 inch (3.05 mm)	XFL3012-102MEB	Coilcraft
2	R1, R3	178 kΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	R2	39.2 kΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	R4	1 MΩ	Resistor, chip, 1/16W, 1%	0603	Std	Std
1	U1	TLV62080DSG	IC, 1.2-A sync. step-down converter	SON-8	TLV62080DSG	TI
1	—		Shunt, 100-mil (2,54-mm), black	0.1	929950-00	3M
1	—		Label (see note 5)	1.25 inch (31,8 mm) × 0.25 inch (6,35 mm)	THT-13-457-10	Brady
1	—		PCB, 1.8-inch (4,57-cm) × 1.8-inch (4,57-cm) × 0.031-inch (0.787-mm)		HPA641	Any

Notes:
1. These assemblies are ESD sensitive; ESD precautions must 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. Place shunt on JP1-1/2 (ON)
5. Install label after final wash. Text shall be 8 pt font. Text shall be per Table 1.

Table 1

Assembly Number	Text
HPA756-001	TLV62080EVM-756

Revision History

Changes from Original (December 2011) to A Revision	Page
• Added the TLV62084 IC to the abstract.	1

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

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General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l’autorité de l'utilisateur pour actionner l'équipement.

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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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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.

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This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

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