Using the TPS22946EVM-499 Single Channel Load Switch IC

This user's guide describes the functionality of the TPS22946 evaluation module (EVM). The guide will show how to make the connections to the EVM and demonstrate the features of the TPS22946 load switch. It contains the following; schematic and layout drawings, bill of materials, setup and testing instructions.

Table 1. TPS22946 Feature List

EVM	Ron at 5.5V Typical	Current Limit	Integrated Inrush Current Timeout	Current Limit Blanking Time	Auto restart Time	Over Current Timeout	Enable
HPA499	300 mW	30 mA, 70 mA or 155 mA	Yes	10mS	70mS	6S	Active High

Contents

List of Figures

List of Tables

1 Description

The device contains a 300-mΩ current-limited P-channel MOSFET that can operate over an input voltage range of 1.62 V to 5.5 V. The switch is controlled by an on/off input (ON), which is capable of interfacing directly with low-voltage control signals. The TPS22946 includes thermal shutdown protection that prevents damage to the device when a continuous over-current condition causes excessive heating by turning off the switch.

When the switch current reaches the maximum limit, the TPS22946 operates in a constant-current mode to prohibit excessive currents from causing damage. The current limit can be selected using the CL input: a high CL input sets the current limit to 155 mA, a low CL input sets the current limit to 70 mA, and a floating CL input sets the current limit to 30 mA. If the constant current condition still persists after 10ms, the switch is turned off and the fault signal pin (OC) is pulled low. The TPS22946 has an auto-restart feature which turns the switch on again after 70 ms if the ON pin is still active. If the TPS22946 remains in an over-current condition for 5 seconds, the device shuts off until it is turned back on by setting the ON control signal off and then on again. If the device is used to protect an LDO, the inrush current required by the LDO at startup can, in some cases, exceed the current limit and initiate a blanking (current limiting) condition. TPS22946 provides allowance for this scenario during startup of the LDO by temporarily increasing the current limit to 435-mA 8-ms after the load switch is enabled.

1.1 Typical Applications

- Portable Consumer Electronics
- Mobile Phones
- Portable Media Players
- Smart Phones / Tablets
- GPS Devices

2 Electrical Performance

Refer to the Datasheet document SLVS984 for a detailed listing of the electrical performance specifications.

3 Operation

3.1 Equipment

- **Voltage sources:**
  - DC supply will be used.
    - DC Supply capable of minimum of 10V, 5A.
- **Multi Meter:**
  - Multi Meter for measuring switch voltage drop and VOUT voltage.
- **Output Load:**
  - Variable load connected to VOUT, observe power rating.
- **Oscilloscope:**
  - 4 channel 100MHz
- **Recommended Wire Gauge:** 18 AWG

3.2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the EVM.

3.2.1 J1/J3 – Input Connections

This is the connection for the leads from the input source. Connect the positive lead to VIN J1, and the negative lead connection to GND J3.

3.2.2 J4/J6 – Output Connections

This is the connection for the output of the EVM. Connect the positive connection of the load to VOUT J4, and the negative connection to GND J6.

3.2.3 JP3 - ON

This is the enable input for the device. A shorting jumper must be installed on JP3 in either the High or Low Position. The TPS22946 is active High. ON must not be left floating. An external enable source can be applied to the EVM by removing the shunt and connecting a signal to the center pin of J3. Refer to the datasheet for proper ON and OFF voltage level settings. A switching signal may also be used and connected at this point.

3.2.4 JP4 – CL

This is the current limit select pin for the device. A high CL input sets the current limit to 155mA, a low CL input sets the current limit to 70 mA, and a floating CL input sets the current limit to 30 mA.

3.2.5 J2/J5 - VIN Sense and VOUT Sense

These two connections are used when very accurate measurements of the input or output voltage are required. rON measurements should be made using these sense connections when measuring the voltage drop from VIN to VOUT and then calculating the resistance.

3.2.6 JP1/JP2 – Input Capacitors

During normal operation a shorting jumper is placed on JP2 and connects C2 capacitor from the input of the device to ground. JP1 and C1 may be used to connect a user selected capacitor value from the input of the device to ground.

3.2.7 JP5/JP6 – Output Capacitors

During normal operation a shorting jumper is placed on JP6 and connects C4 capacitor from the output of the device to ground. JP5 and C3 may be used to connect a user selected capacitor value from the output of the device to ground.

3.2.8 JP7 – Output Resistor

During normal operation no shorting jumper is placed on JP7. A shorting jumper may be used on JP7 to connect R1 load resistor from the output of the device to ground. R1 is sized for 2010 3/4W power rated resistor.

4 Operation

Connect the positive input of the power supply to VIN at J1 and the negative lead of the power supply to GND at J3. The input voltage range of the TPS22946EVM-499 is 1.62V to 5.5V.

Output loads can be applied by connecting between J4 VOUT and J6 GND. The TPS22946EVM-499 is rated for a maximum continuous current of 200mA. Configure JP3 as required. JP3 must be installed for proper operation. When the ON pin is asserted the TPS22946 device will control the slew rate of VOUT. The slew rate of the device is internally controlled to avoid inrush current.

5 Test Configurations

5.1 On State Resistance (rON) Test Setup

Figure 1 shows a typical setup for measuring On State Resistance. The voltage drop across the switch is measured using the sense connections then divided by the current into the load yielding the r_{ON} resistance.

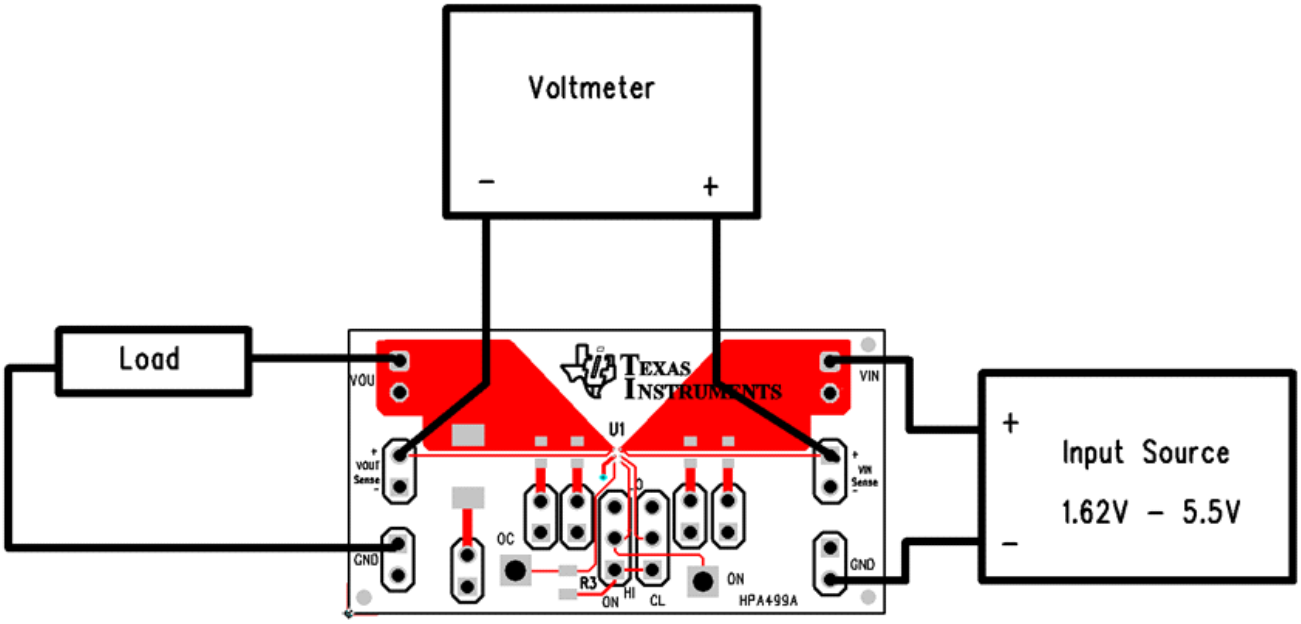


Figure 1. r_{ON} Setup

5.2 Slew Rate Test Setup

Figure 2 shows a test setup for measuring the Slew Rate of the Load Switch. Controlling the ON pin of the switch with a signal source and then measuring the output with a scope shows the switches ability to avoid inrush current.

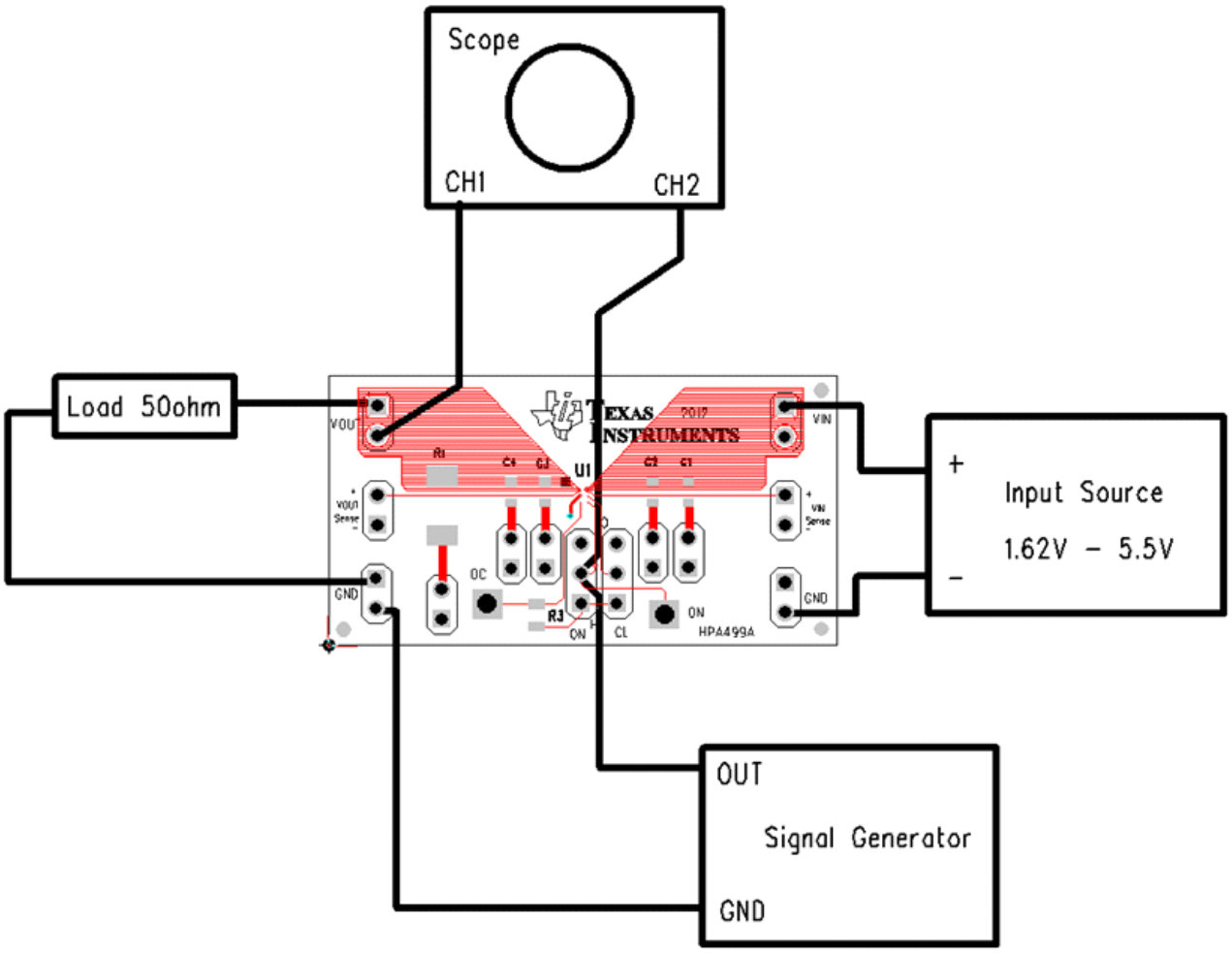


Figure 2. Slew Rate Setup

5.3 VOUT Slew Rate Example

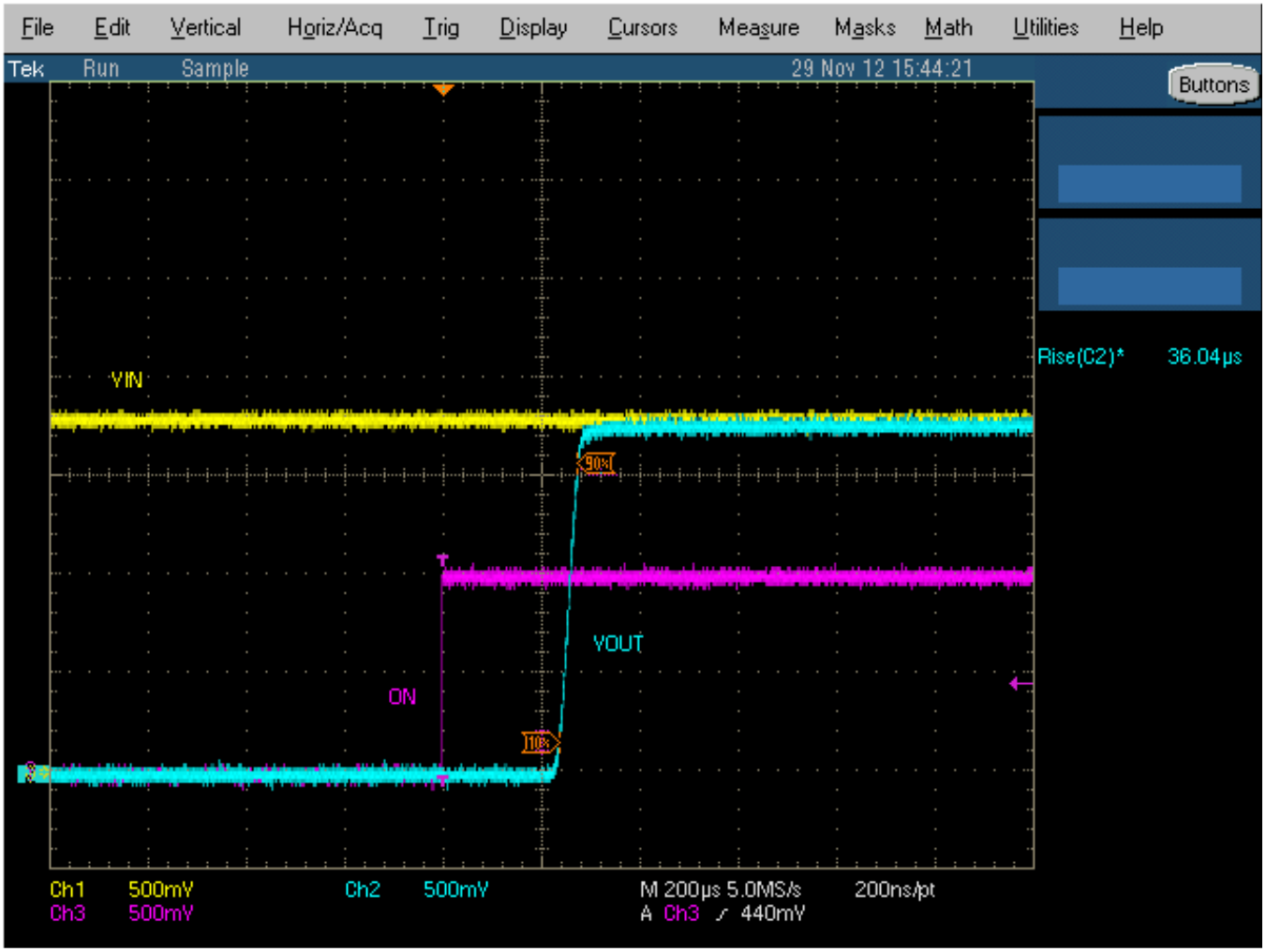


Figure 3. TPS22946 TRISE Example

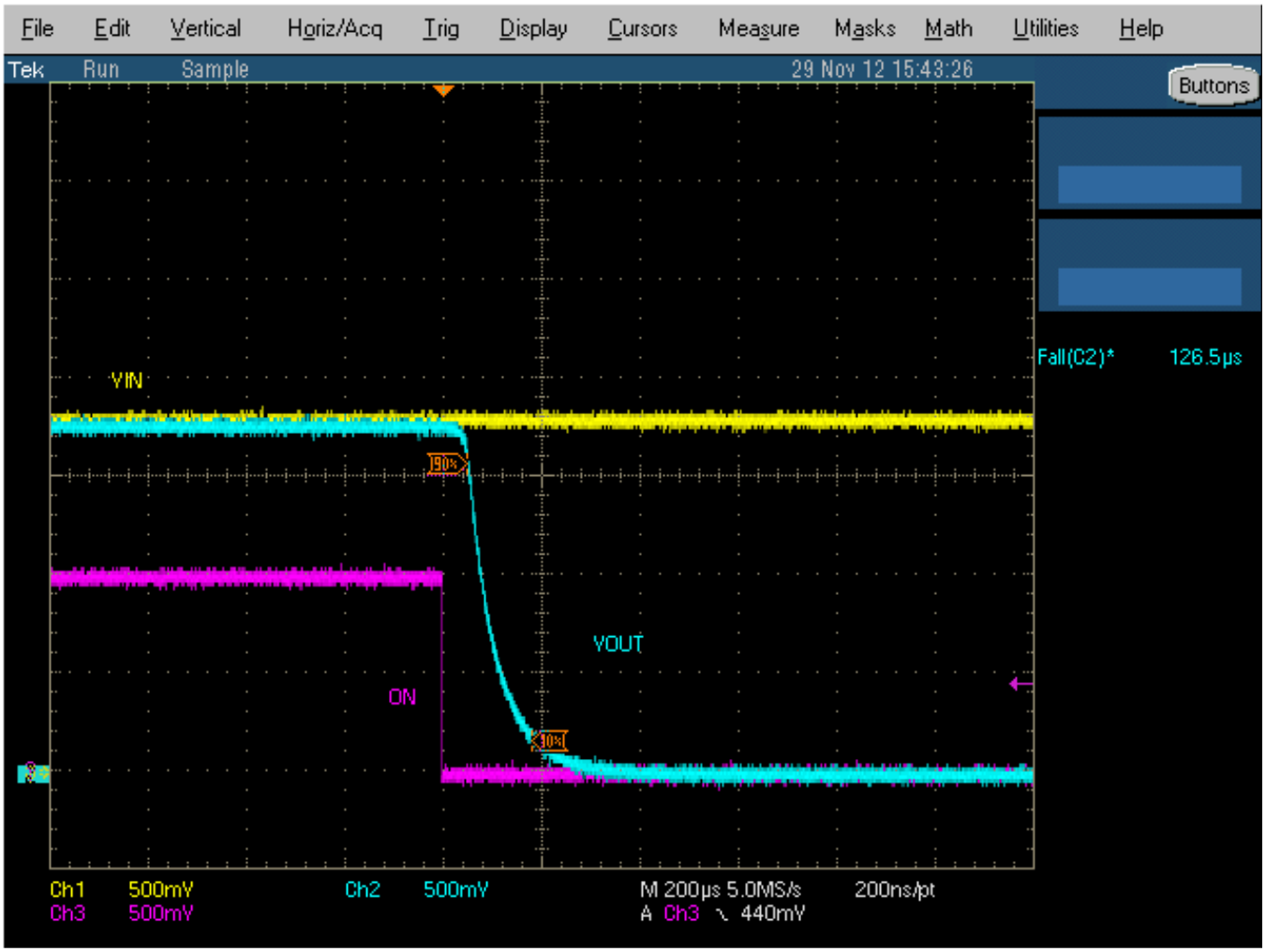


Figure 4. TPS22946 TFALL Example

6 Layout

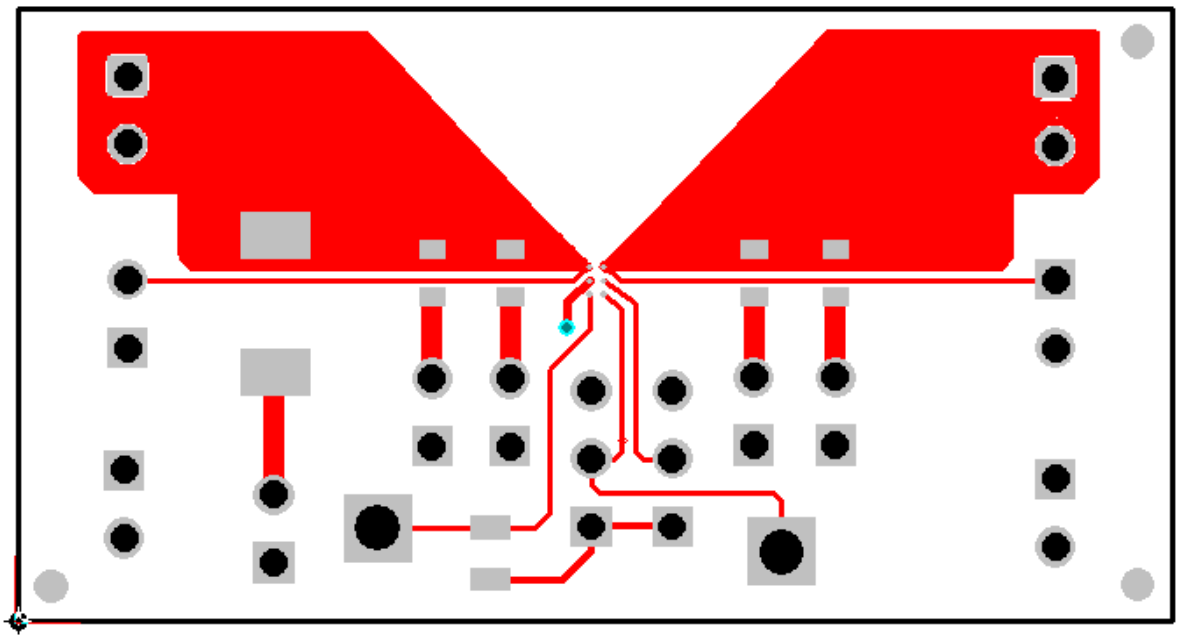


Figure 5. Top Side

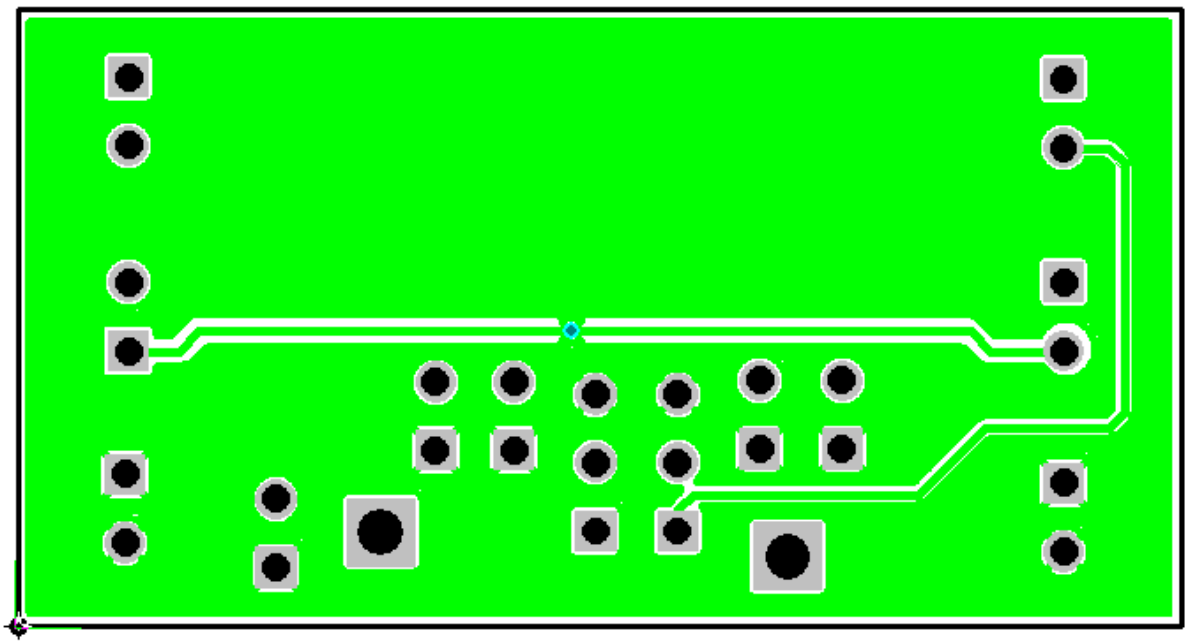
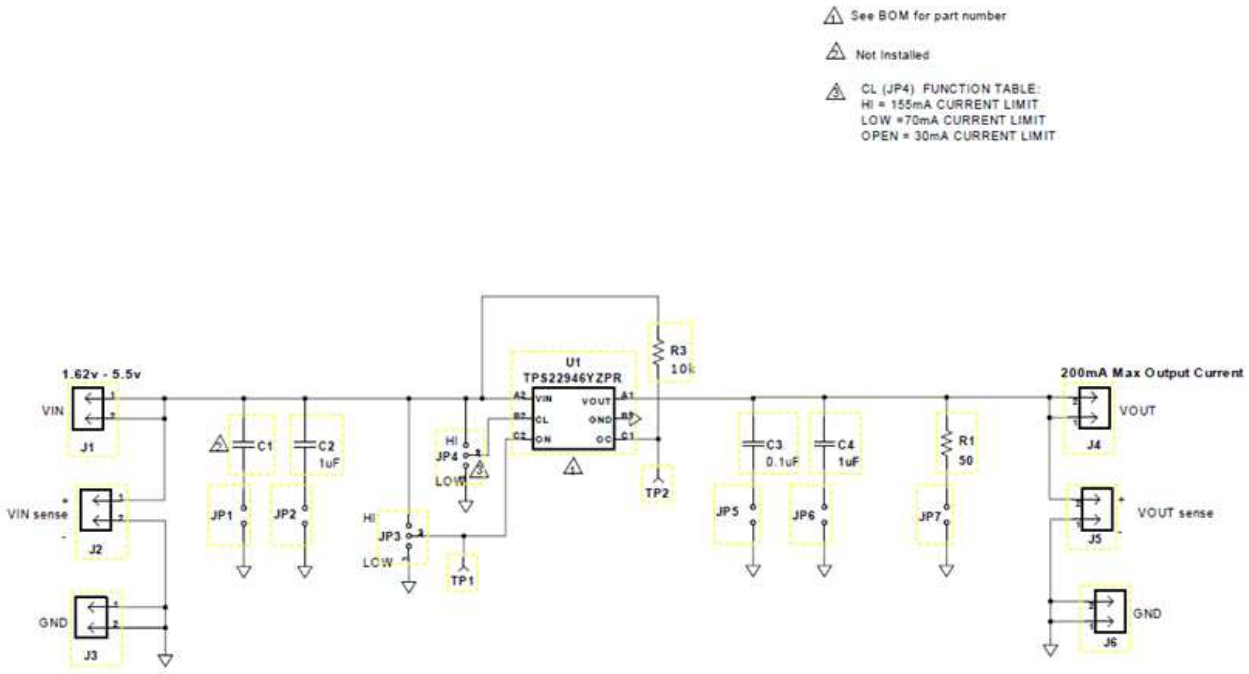


Figure 6. Bottom Side

7 Schematic



8 Bill of Materials

Table 2. Bill of Materials[(1)(2)(3)(4)]

COUNT	RefDes	Value	Description	SIZE	Part Number	MFR
1	--		PCB, 0.9 In x 1.7 In x 0.062 In		HPA499	Any
0	C1	OPEN	Capacitor, Ceramic	603	Std	Std
2	C2, C4	1uF	Capacitor, Ceramic, 10-V, X5R,20%	603	Std	Std
1	C3	0.1uF	Capacitor, Ceramic, 16-V, X7R,10%	603	Std	Std
1	R2	49.9	Resistor, Chip 3/4W 5%	2010	Std	Std
1	R1	10K	Resistor, Chip 1/8W 5%	805	Std	Std
11	J1-J6,JP1-2,JP5-7	PEC02SAAN	Header,2pin, 100mil spacing	0.100 inch x 2	PEC02SAAN	Sullins
2	JP3, JP4	PEC03SAAN	Header,3pin, 100mil spacing	0.100 inch x 3	PEC03SAAN	Sullins
2	TP2, TP3	5012	Test Point, White, Thru Hole Compact Style	0.125 x 0.125 inch	5012	Keystone
1	U1	TPS22946YZP	IC, Single Chip,Current-Limited Load Switch with Controlled Turn On	YZP	TPS22946YZP	TI
4	NA	NA	Shunt, 100-mil, Black	0.100	929950-00	3M

(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.

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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.

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.

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 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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3. 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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