XTR111 Demonstration Fixture User's Guide

This EVM features the XTR111 voltage-to-current converter integrated circuit and allows for evaluation in a variety of configurations. This user's guide describes the characteristics, operation, and use of the XTR111EVM evaluation board. It discusses how to set up and configure the hardware and reviews various aspects of the parts operation. Throughout this document the terms *demonstration fixture, evaluation board, evaluation module,* and *EVM* are synonymous with the XTR111EVM. This user's guide also includes information regarding operating procedures, input/output connections, an electrical schematic, printed circuit board (PCB) layout, and a parts list for the EVM.

The following related documents are available through the Texas Instruments web site at www.ti.com.

Table 1. Related Documentation from Texas Instruments

Document	Literature Number
XTR111 Product Data Sheet	SBOS375
QFN / SON PCB Attachment Application Note	SLUA271
Quad Flatpack No-Lead Logic Packages Application Note	SCBA017

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1 Overview

The XTR111 is a precision voltage-to-current converter designed for standard 0-mA to 20-mA or 4-mA to 20-mA analog signals, but can source up to 36 mA. The ratio between input voltage and output current is set by a single resistor, R_{SET}. This reference resistor is an external device because absolute accuracy is required and performance can be selected to meet application requirements. A few features of the XTR111 include:

- An external P-MOSFET ensures high output resistance and a broad compliance voltage range extending from 2 V below the positive supply (VSP) to voltages well below the negative supply (GND).
- An adjustable 3-V to 15-V subregulator output provides the supply voltage for additional circuitry.
- An error flag ($\overline{EF}$) is provided to indicate fault conditions on the current output. This flag indicates open load or high load resistance.
- The XTR111 also provides output disable control (OD). OD must be asserted low to activate the output.

The XTR111 is available in either a DFN surface-mount package or an MSOP PowerPAD™ package.

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2 Hardware Features

This section describes the hardware features found on the XTR111EVM.

2.1 XTR111EVM

The XTR111EVM is used for the basic functional evaluation of the XTR111. The EVM provides the following features:

- Easy handling of the small DFN package. The DFN device is already soldered to the landing pattern on the PCB. A mechanical drawing of the recommended land pattern can be found at the end of the XTR111 product data sheet.
- Easy access to all device pins.
- Easily-configurable digital inputs (OD and $\overline{EF}$) to disable the output, modify the output circuit for voltage output, or apply a 4-mA signal shift.
- LED indicator for the error flag, $\overline{EF}$.
- Output protection and filtering circuitry.

The XTR111EVM is initially configured to a basic setup for 0 mA to 20 mA operation with a 0-V to 5-V input. Note that although the accuracy of the gain setting resistor, R_{SET}, used in the EVM is 0.1%, the XTR111 device has greater accuracy. The remaining resistors are standard 1%. The voltage regulator is set to 5 V.

The EVM requires one external power-supply voltage with a range of 8 V to 40 V.

Refer to the XTR111 product data sheet for comprehensive information about the XTR111 and possible device configurations. Figure 1 shows the XTR111 EVM.

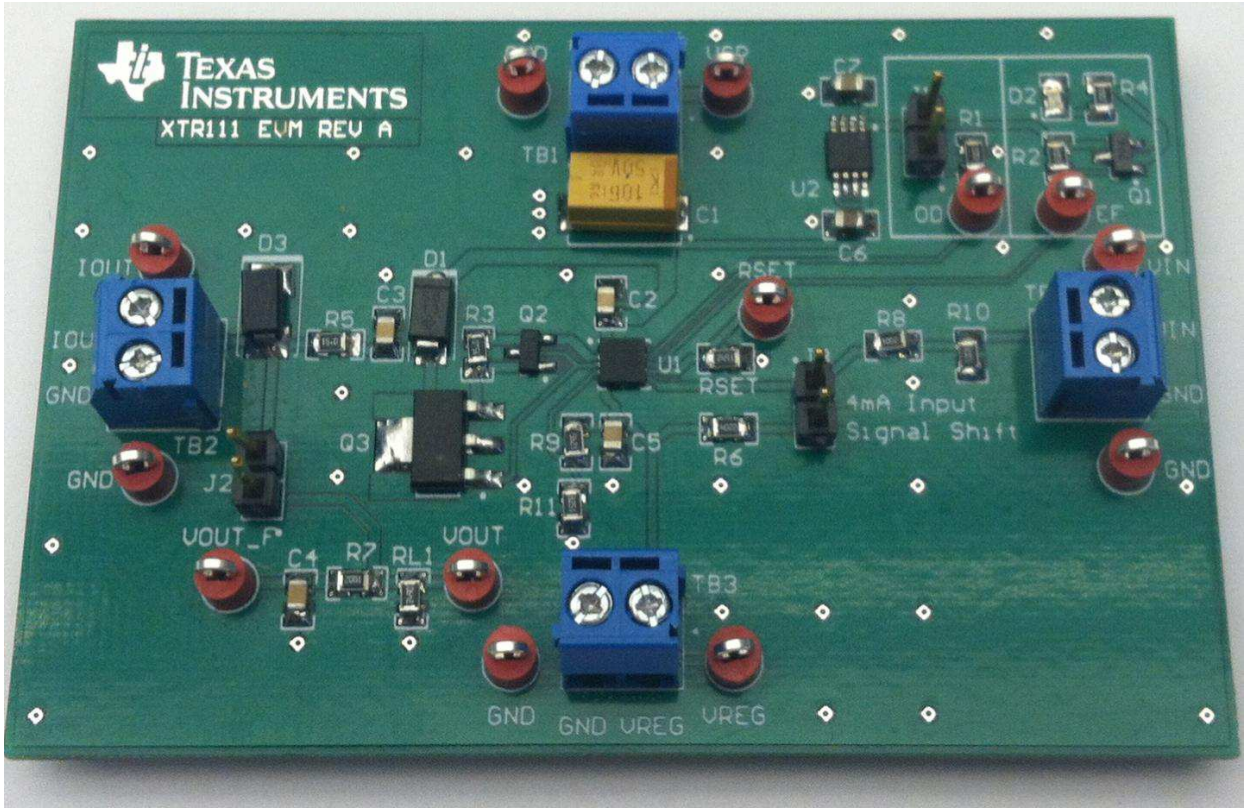


Figure 1. XTR111EVM

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2.2 External Connections

2.2.1 Power Supply

The power-supply connections for the EVM are located on the TB1 terminal block. The valid power-supply range is +7 V to +44 V. The supplie is decoupled with a 10-µF tantalum capacitor, as well as a 1-µF ceramic capacitor near the device. The XTR111EVM also contains test points for the supply voltage and ground located next to TB1.

2.2.2 Signal Input

Terminal block TB4 is used for the noninverting signal input, VIN. The valid range is from 0 V to +12 V. A test point connected to VIN is located next to TB4.

2.2.3 Voltage Regulator

The XTR111 provides an externally-adjustable voltage regulator that can provide up to 5 mA of current. The regulator has drive (REGF) and sense (REGS) inputs. Sense input REGS is referenced to 3 V, representing the lowest adjustable voltage level. An external resistor divider sets the drive input, REGF. For the XTR111EVM, REGF is set to 5 V. REGF (named VREG on the XTR111EVM), is accessible through terminal block TB3 and by a test point labeled VREG.

2.2.4 Output

The XTR111 is designed for use with a discrete p-channel MOSFET (Q3). This FET extends the voltage compliance for the controlled current to a potential well below the negative supply voltage. The current output for the XTR111EVM is located at terminal block TB2. A test point connected to IOUT is located next to TB2. The XTR111EVM can be configured for a voltage output by shunting J2. There are two test points connected to the voltage output circuit. The VOUT test point is placed directly at the node of the resistive load, and VOUT_F provides a basic filter for the output.

2.2.5 Additional Test Points

The following list shows additonal test points:

- OD is connected to the output disable pin of the XTR111. To disable the output, pull the OD pin high by shunting J1.
- $\overline{EF}$ is connected to the error flag pin of the XTR111. The $\overline{EF}$ pin is active low. When there is an error, $\overline{EF}$ is pulled low and the LED circuit is enabled.

2.3 Jumper Configuration Settings

Jumper configurations for the XTR111EVM are shown in Section 3

Table 2. XTR111EVM Jumper Settings

Jumper	Function
J1	Connects OD to the onboard 5-V supply, disabling the output.
J2	Configures the current output to a voltage output.
J3	Applies a 4-mA input signal shift.

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3 Basic EVM Configuration

3.1 EVM Setup

Follow these procedures to set up and use the XTR111EVM:

- Remove jumper J1 to enable the output.
- Connect a power supply configured for +24 V and GND to terminal block TB1.
- Enable the power supply. Expect a supply current of less than 6 mA and an output voltage near ground.
- Apply a 0-V to 5-V signal to VIN, located on terminal block TB4.
- Measure IOUT at terminal block TB2.
- Connect J2 to place a resistive load on the XTR111 output in order to measure the voltage at VOUT or VOUT_F.

The XTR111EVM configurations for current and voltage outputs are shown in Figure 2 and Figure 3, respectively.

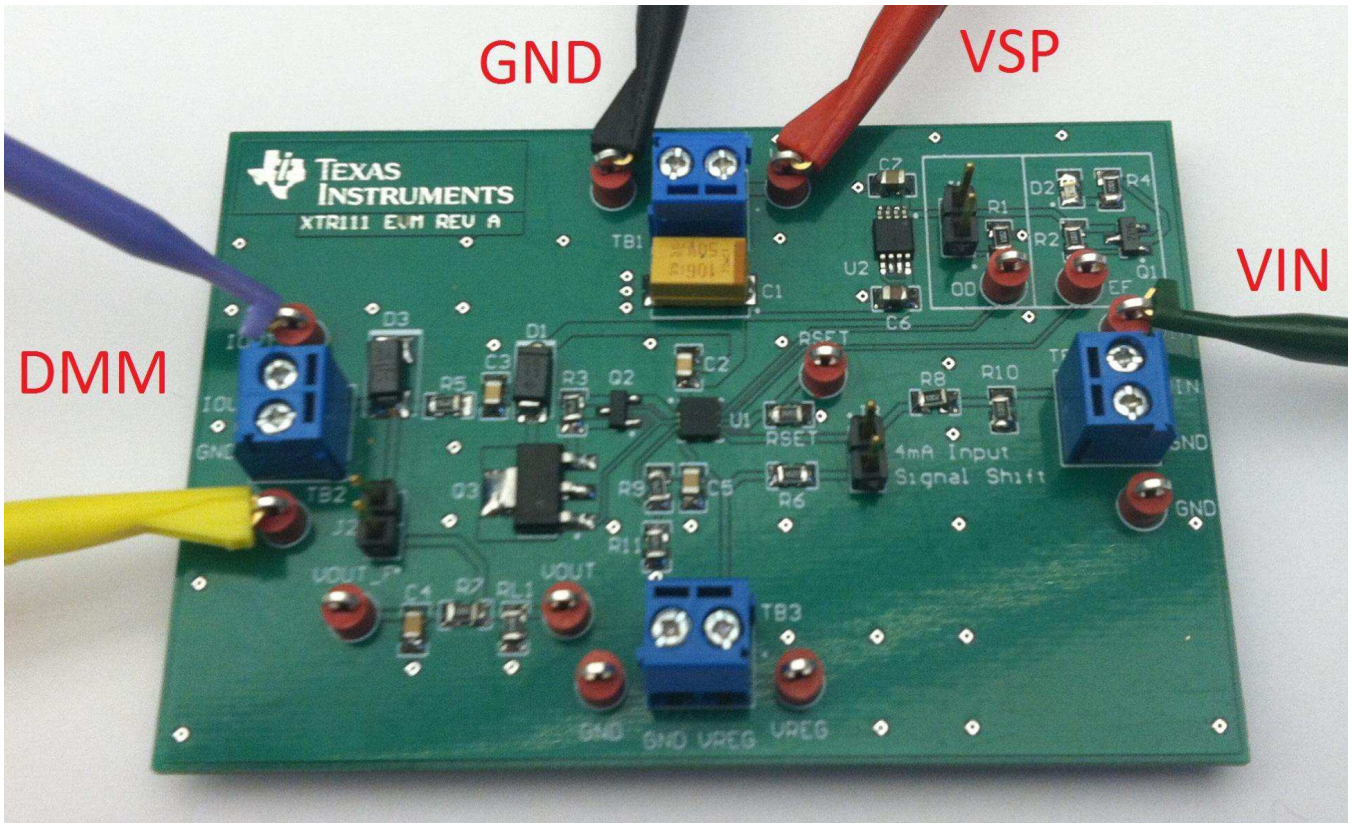


Figure 2. Current Output Setup

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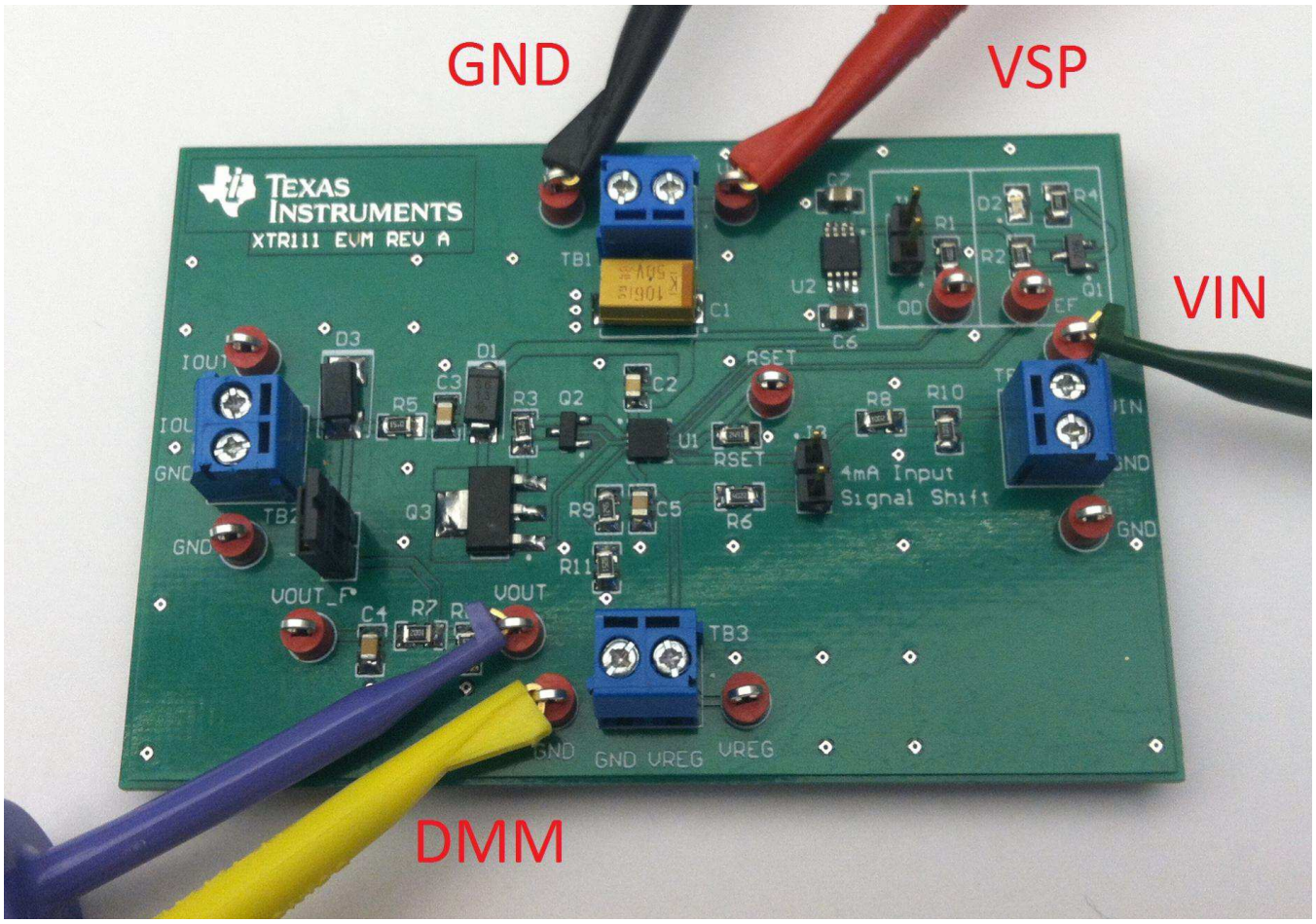


Figure 3. Voltage Output Setup

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4 Schematic, PCB Layout, and Bill of Materials

4.1 Schematic

The schematic for the XTR111EVM can be seen in Figure 4.

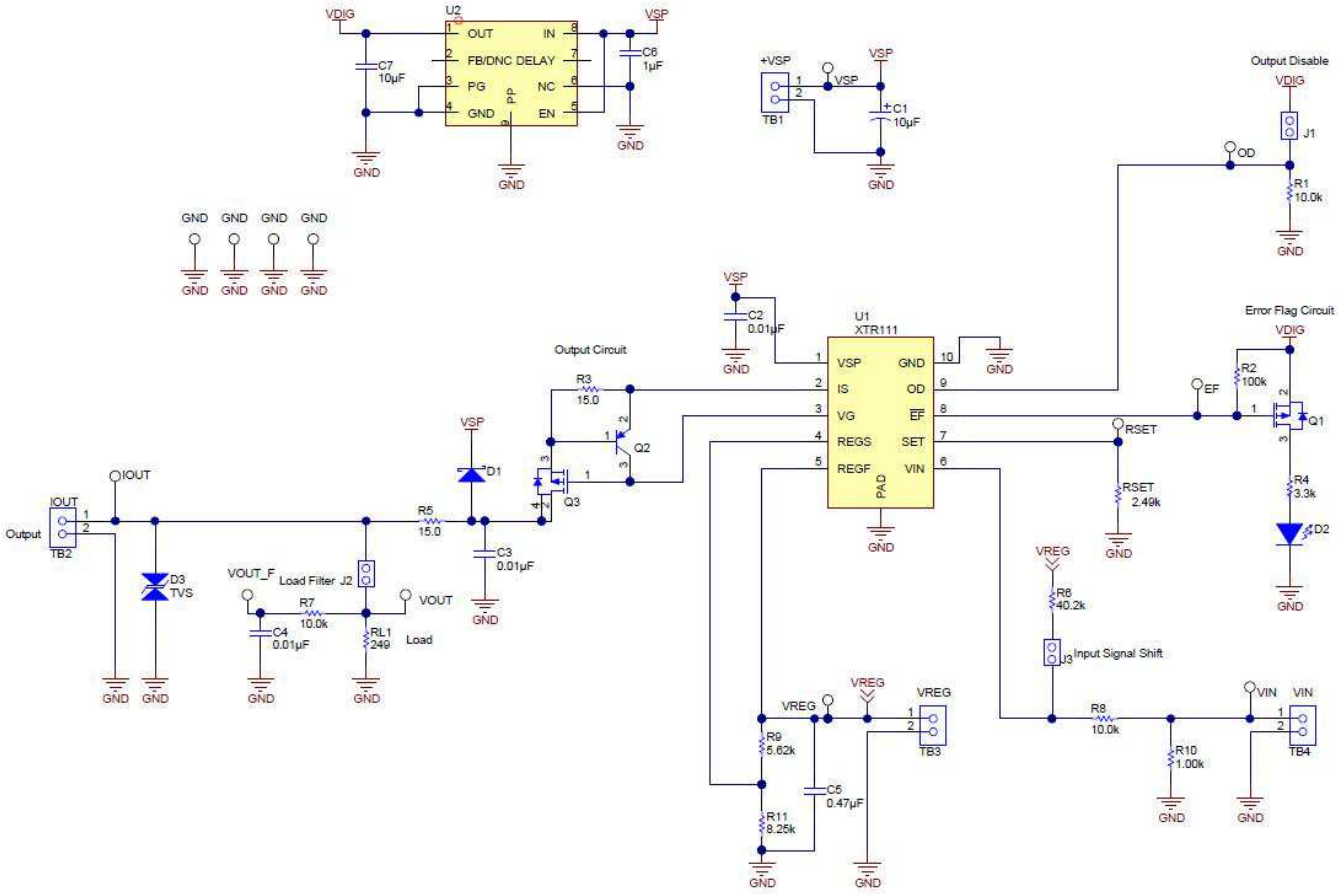


Figure 4. Schematic

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4.2 PCB Layout

The PCB layout for the XTR111EVM can be seen in Figure 5.

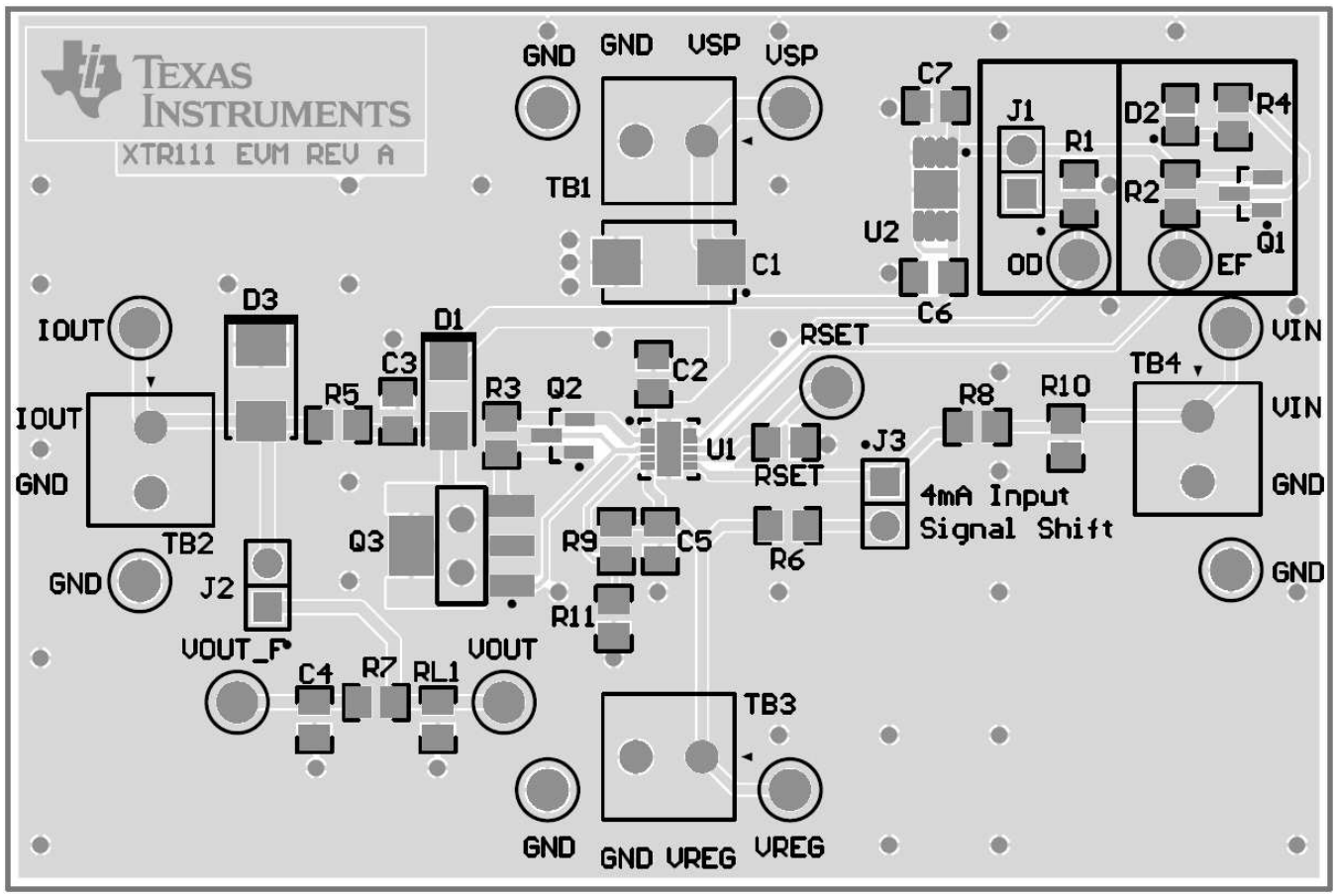


Figure 5. PCB Layout

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4.3 Bill of Materials

The bill of materials for the XTR111EVM can be seen in Table 3.

Table 3. Bill of Materials

Item No.	Qty	Ref Des	Description	Manufacturer	Manufacturer Part Number	Supplier Part Number
1	1	U1	IC CONV/TX PREC VOLT-CURR 10-SON	Texas Instruments	XTR111AIDRCT	N/A
2	1	U2	IC REG LDO 5V .1A 8MSOP	Texas Instruments	TPS7A1650DGNR	N/A
3	4	TB1, TB2, TB3, TB4	TERM BLOCK 2POS SIDE ENT 3.5MM	TE Conectivity	1776275-2	A98036-ND
4	1	Q1	MOSFET P-CH 60V 900MA SOT23-3	Diodes Inc	ZXMP6A13FTA	ZXMP6A13FCT-ND
5	1	Q2	TRANSISTOR GP PNP AMP SOT-23	Fairchild Semiconductor	MMBT5087	MMBT5087CT-ND
6	1	Q3	MOSFET P-CH 60V 1.9A SOT-223	Infineon Technologies	BSP170P L6327	BSP170PL6327INCT-ND
7	1	C1	CAP TANT 10UF 50V 20% 2917	Kermet	T491X106M050ZT	495-2288-1-ND
8	3	C2, C3, C4	CAP CER 10000PF 100V 5% X7R 0805	AVX Corporation	08051C103JAT2A	478-3745-1-ND
9	1	C5	CAP CER 0.47UF 50V 10% X7R 0805	AVX Corporation	08055C474KAT2A	478-5033-1-ND
10	1	C6	CAP CER 1UF 50V 10% X5R 0805	Taiyo Yuden	UMK212BJ105KG-T	587-2229-1-ND
11	1	C7	CAP CER 10UF 6.3V 10% X7R 0805	AVX Corporation	08056C106KAT2A	478-5322-1-ND
12	4	R1, R4, R7, R8	RES 10.0K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF1002V	P10.0KCCT-ND
13	1	R2	RES 100K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF1003V	P100KCCT-ND
14	2	R3, R5	RES 15.0 OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF15R0V	P15.0CCT-ND
15	1	R6	RES 40.2K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF4022V	P40.2KCCT-ND
16	1	R9	RES 5.62K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF5621V	P5.62KCCT-ND
17	1	R10	RES 1.00K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF1001V	P1.00KCCT-ND
18	1	R11	RES 8.25K OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF8251V	P8.25KCCT-ND
19	1	RSET	RES 2.49K OHM 1/8W .1% 0805 SMD	Panasonic Electronic Components	ERA-6AEB2491V	P2.49KDACT-ND
20	1	RL1	RES 249 OHM 1/8W 1% 0805 SMD	Panasonic Electronic Components	ERJ-6ENF2490V	P249CCT-ND
21	1	D1	DIODE SCHOTTKY 1A 60V SMA	Vishay Semiconductor Diodes Division	SS16-E3/5AT	SS16-E3/61TGICT-ND
22	1	D2	LED RED HIGH BRIGHT ESS SMD	Panasonic Electronic Components	LNJ237W82RA	LNJ237W82RACT-ND
23	1	D3	DIODE TVS 40V 400W BIDIR 5% SMA	Littlefuse Inc	SMAJ40CA	SMAJ40CALFCT-ND
24	13	EF, VIN, GND, VREG	TEST POINT PC COMPACT .063"D RED	Keystone Electronics	5005	5005K-ND
25	3	N/A	SHUNT LP W/HANDLE 2 POS 30AU	TE Connectivity	881545-2	A26242-ND
26	3	J1, J2, J3	CONN HEADER 50POS .100" SGL GOLD	Samtec Inc	TSW-150-07-G-S	SAM1029-50-ND
27	4	Bumpons	BUMPON CYLINDRICAL .50X.14 BLACK	3M	SJ-5012 (BLACK)	SJ5012-0-ND

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Revision History

Changes from B Revision (May 2009) to C Revision	Page
• Changed entire user guide to new version document	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.

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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