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

<table>
<thead>
<tr>
<th>Document</th>
<th>Literature Number</th>
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<tr>
<td>XTR111 Product Data Sheet</td>
<td>SBOS375</td>
</tr>
<tr>
<td>QFN / SON PCB Attachment Application Note</td>
<td>SLUA271</td>
</tr>
<tr>
<td>Quad Flatpack No-Lead Logic Packages Application Note</td>
<td>SCBA017</td>
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</table>

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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 (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.

PowerPAD is a trademark of Texas Instruments.

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XTR111 Demonstration Fixture User's Guide  
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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 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, 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, \( R_{\text{SET}} \), 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
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 supply 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 IOOUT 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 additional 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.
• EF is connected to the error flag pin of the XTR111. The EF pin is active low. When there is an error, 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

<table>
<thead>
<tr>
<th>Jumper</th>
<th>Function</th>
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<tbody>
<tr>
<td>J1</td>
<td>Connects OD to the onboard 5-V supply, disabling the output.</td>
</tr>
<tr>
<td>J2</td>
<td>Configures the current output to a voltage output.</td>
</tr>
<tr>
<td>J3</td>
<td>Applies a 4-mA input signal shift.</td>
</tr>
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</table>
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
Figure 3. Voltage Output Setup
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
4.2 PCB Layout

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

Figure 5. PCB Layout
### 4.3 Bill of Materials

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

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## Revision History

### Changes from B Revision (May 2009) to C Revision

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<td>• Changed entire user guide to new version document</td>
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NOTE: Page numbers for previous revisions may differ from page numbers in the current version.
EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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REGULATORY COMPLIANCE INFORMATION

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 isotope 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.
【Important Notice for Users of this Product in Japan】
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.

Texas Instruments Japan Limited
(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan

http://www.tij.co.jp
EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.

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. 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.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. 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 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User’s Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

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.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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