XTR300EVM

This user's guide describes the characteristics, operation, and use of the XTR300 evaluation module (EVM) board. It also describes how to set up and configure the hardware and reviews various aspects of the parts operation. Throughout this document, the terms *evaluation board, evaluation module*, and *EVM* are synonymous with the XTR300EVM. 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.

Contents

1 Overview

The XTR300 is a universal output driver for industrial and process-control applications. This device can be configured as a current or voltage output device without requiring an external shunt resistor. The XTR300 requires minimal external circuitry, including a few gain-setting resistors and a loop compensation capacitor. The XTR300 offers separate driver and receiver channels for improved flexibility. The internal instrumentation amplifier is normally connected for remote voltage sensing in voltage output mode. Alternatively, it can be used as a high-voltage, high-impedance measurement channel. In voltage output mode, a copy of the output current is provided to allow for easy testing of the load condition and eventual calculation of the load resistance. In current output mode, the load voltage can be monitored.

The XTR300 device provides configuration and notification functionality by using the error flag and digital control pins. The digital output selection capability, together with the error flags and monitor pins, make remote configuration and troubleshooting possible. Fault conditions on the output and the instrumentation amplifier (IA) input, as well as overtemperature conditions are indicated by the error flags. The monitoring pins, IMON and IAOUT, provide continuous feedback regarding load power or impedance. For additional protection, the maximum output current is internally limited and thermal protection is provided.

The XTR300EVM highlights and demonstrates various configurations of the XTR300. The EVM allows the user to modify the inputs, configuration pins, and support circuitry to test and evaluate desired behavior.

1.1 XTR300EVM Kit Contents

Table 1 details the contents of the XTR300EVM kit. Contact the Texas Instruments Product Information Center nearest to you if any component is missing.

Table 1. Contents of XTR300EVM Kit

Item	Quantity
XTR300EVM PCB Evaluation Board	1

1.2 Related Documentation from Texas Instruments

The following document provides information regarding Texas Instruments integrated circuits used in the assembly of the XTR300EVM. This user's guide is available from the TI web site under literature number SBOU034 . Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site at http://www.ti.com/, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number

Table 2. Related Documentation

Document	Literature Number
XTR300 Product Data Sheet	SBOS336

2   XTR300EVM Features

The XTR300EVM is intended to provide basic functional evaluation of the XTR300. The XTR300EVM is shown in Figure 1 and provides the following features:

- Easy handling of the small QFN package with the recommended land pattern to which the QFN device is soldered. A mechanical drawing of the recommended land pattern is found at the end of the XTR300 datasheet. The solder connection includes heat sinking through the exposed thermal die pad of the QFN package.
- Easy access to all pins of the device.
- Easily-configured mode-select pins to switch between voltage output and current output modes.
- LEDs indicators for the error flags.
- Optional use of a +5-V regulated voltage.
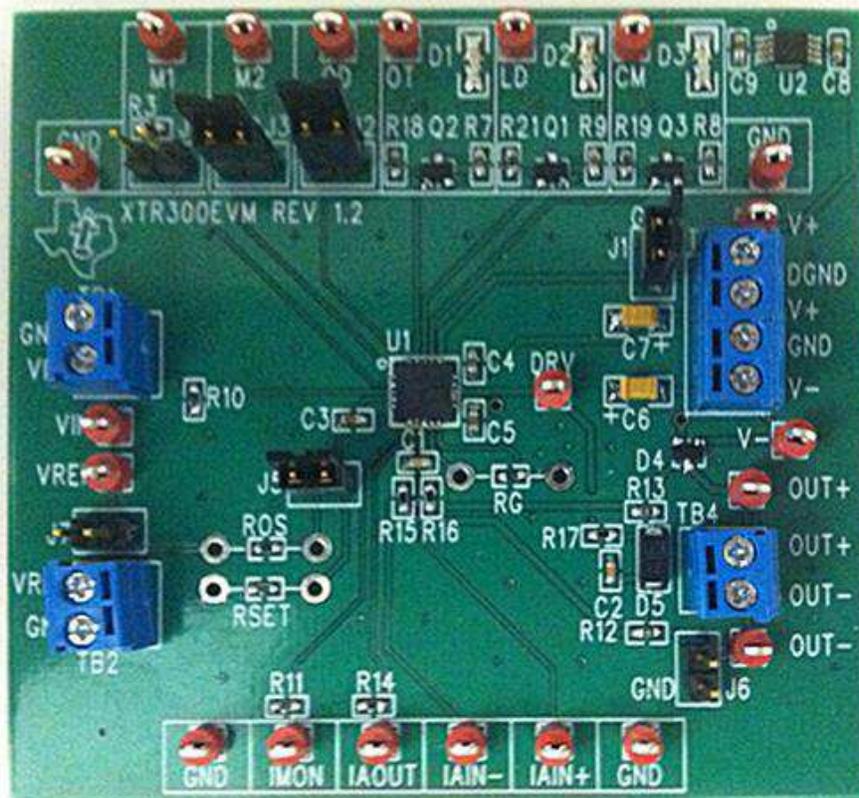- Output protection and filtering circuitry.

Figure 1. XTR300EVM

2.1 External Connections

Make external connections to the XTR300EVM using either the installed test-points or by installing wires into the terminal block connectors. The main connections that must be made to the XTR300EVM are the analog supply voltage, analog input signal, and output load and monitoring equipment.

2.1.1 Powering the XTR300EVM

Terminal block TB3 contains the positive and negative power-supply connections, V+ and V−, as well as the analog ground (GND) and digital ground (DGND) connections. The valid range for the analog supply voltages is ±10 V to ±20 V. The supplies are decoupled with a 10-µF tantalum capacitor as well as a 1-µF ceramic capacitor near the device. The XTR300EVM also contains test points for the positive and negative supply and GND connections located next to TB3.

2.1.2 Single Input

Terminal block TB1 is used for the noninverting input signal, V_{IN}. Its valid range is from −10 V to +10 V. However, the EVM is configured for a 0-V to 5-V or a ±5-V input signal. A test point connected to V_{IN} is located next to TB1.

2.1.3 Reference Voltage

Terminal block TB2 allows the user to connect a reference voltage. This reference voltage is used to produce a bidirectional output from a single-ended source. Shunt J7 to apply an onboard reference voltage of 5 V. However, never connect an external source to TB2 while the J7 shunt is applied.

2.1.4 XTR300EVM Output

The output for the XTR300EVM is located at terminal block TB4. The output stage of the XTR300 consists of an IA (IAIN− and IAIN+) and a unique op amp (DRV) that combine to form an analog output that can be digitally configured to provide either current or voltage output to TB4. OUT+ and OUT− are also connected to test points near TB4.

2.1.5 Other Test Points

- M1 and M2 are connected to the M1 and M2 mode select pins of the XTR300.
- OD is connected to the output disable (OD) pin of the XTR300.
- OT, LD, and EF are connected to the error flags of the XTR300. These flags are active low.
- IMON is a 1:10 copy of the output current from the OPA in voltage mode. IMON can be used to monitor the XTR300 output, as well as calculate load resistance or load power.
- IAOUT is a 1:10 copy of the current mode output. A 750-Ω resistor converts this current into a voltage.
- IAIN− is the inverting input of the IA.
- IAIN+ is the noninverting input of the IA.

2.2 Jumper Configuration Settings

There are seven jumpers located on the XTR300EVM. Their functions are described in Table 3.

Table 3. Jumper Settings

Jumper	Function
J1	Connects the digital ground pin (DGND) to GND
J2	Pulls the output disable pin (OD) high, enabling the output
J3	Pulls the mode select pin (M2) high
J4	Pulls the mode select pin (M1) high
J5	Applies an offset to the V_{IN} signal. Is used with V_{REF} to create a bidirectional output with a single-ended input
J6	Connects OUT− to ground
J7	Connects an onboard 5-V reference to V_{REF}

3 Basic EVM Configuration

This section describes four configurations for the XTR300EVM that enable evaluation of the basic XTR300 functions.

3.1 Voltage Mode Configurations
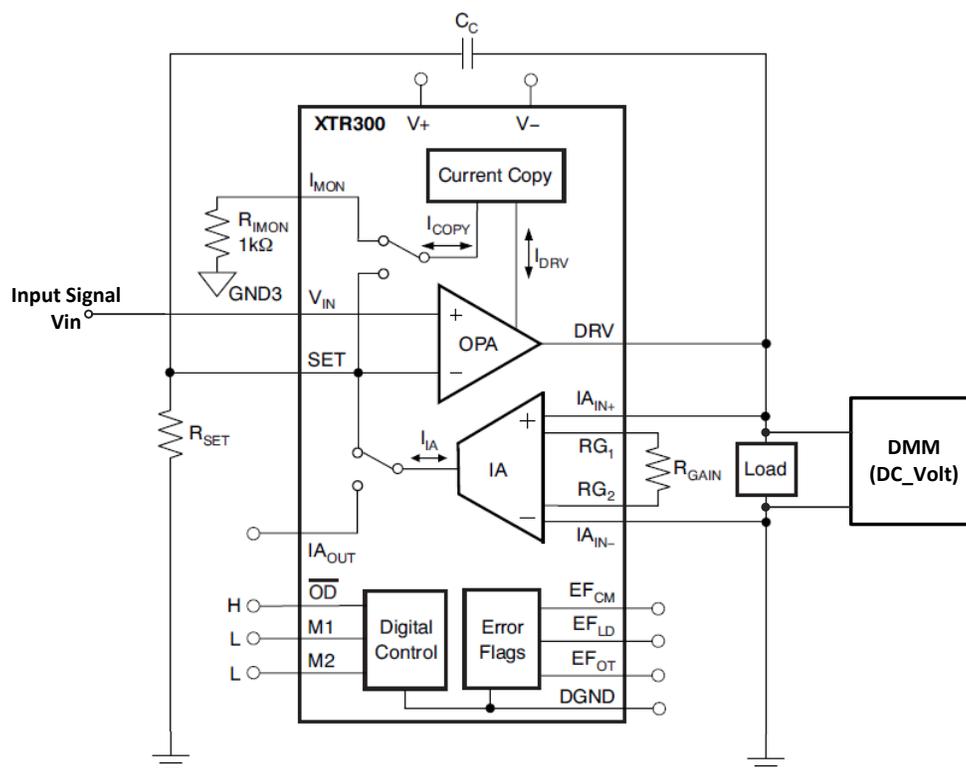
3.1.1 Single-Ended Output

The first voltage mode configuration creates a single-ended output from a single ended input. The jumper settings for this configuration are listed in Table 4. Connect your load to TB4 between OUT+ and OUT−. Apply ±15 V to V+ and V−. Apply a 5-V signal to V_{IN}. The voltage across TB4 should be 10 V. The voltage output is calculated by the transfer function shown in Equation 1:

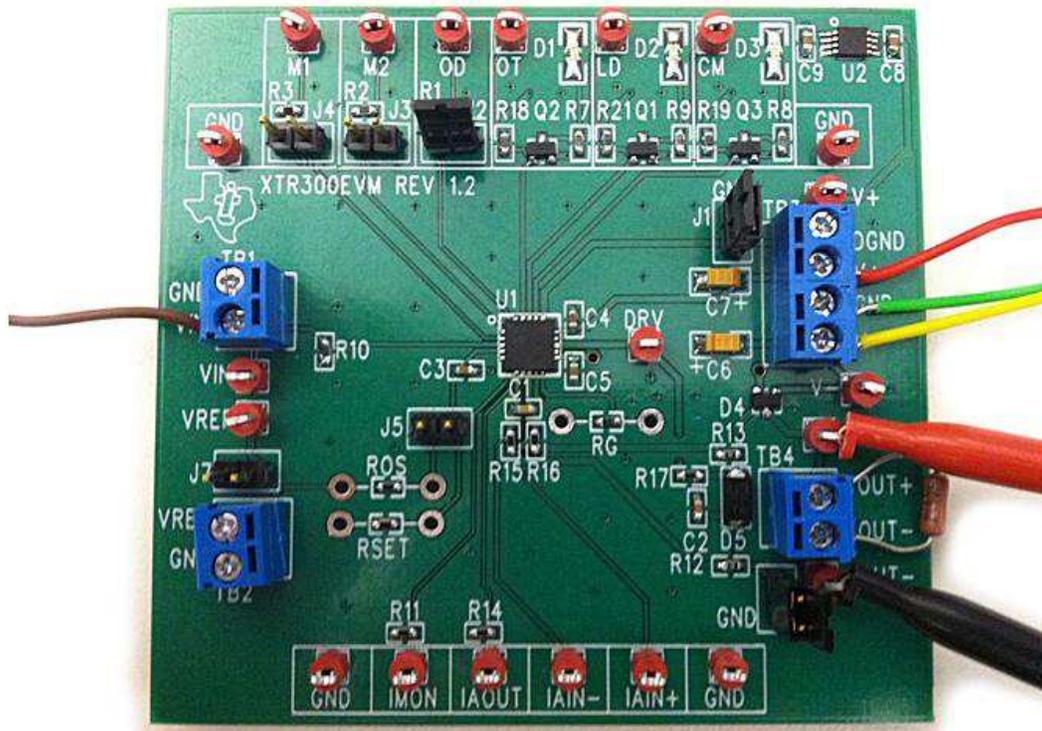$$V_{OUT} = \frac{R_{GAIN}}{2R_{SET}} V_{IN}$$

(1)

The default EVM configurations set R_{GAIN} to 10 kΩ and R_{SET} to 2.5 kΩ.

Table 4. Single Ended Voltage Output Jumper Settings

Jumper	Function
J1	On
J2	On
J3	Off
J4	Off
J5	Off
J6	On
J7	Off

Figure 2. XTR300 Single-Ended Voltage Output Configuration Circuit Drawing

Figure 3. XTR300EVM Single-Ended Voltage Output Configuration Screenshot

3.1.2 Bidirectional Output

The second voltage-mode configuration creates a bidirectional output from a single-ended input. The jumper settings for this configuration are listed in Table 5. Connect your load to TB4 between OUT+ and OUT–. Connect ±15 V to V+ and V–. Apply a 5-V signal to V_{IN}. Connect a 5-V reference voltage to V_{REF}. If an external reference voltage is not required, a shunt can be placed on J7 to apply an onboard reference voltage of 5 V. In this configuration, the voltage across TB4 is 10 V. If you apply a 0-V signal to V_{IN}, the voltage across TB4 is approximately –10 V. The voltage output is calculated by the transfer function in Equation 2:

$$V_{OUT} = \frac{R_{GAIN}}{2}\left(\frac{V_{IN}}{R_{SET}} + \frac{V_{IN} - V_{REF}}{R_{OS}}\right)$$

(2)

The default EVM configuration sets R_{GAIN} to 10 kΩ, R_{SET} to 2.5 kΩ, and R_{OS} to 2.5 kΩ.

Table 5. Bidirectional Voltage Output Jumper Settings

Jumper	Function
J1	On
J2	On
J3	Off
J4	Off
J5	On
J6	On
J7	On[1]

[1] J7 should be off if an external reference is used and on if the internal reference is to be used.

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Figure 4. XTR300 Bidirectional Voltage Output Configuration Circuit Drawing

Figure 5. XTR300EVM Bidirectional Voltage Output Configuration Screenshot

3.2 Current Mode Configurations
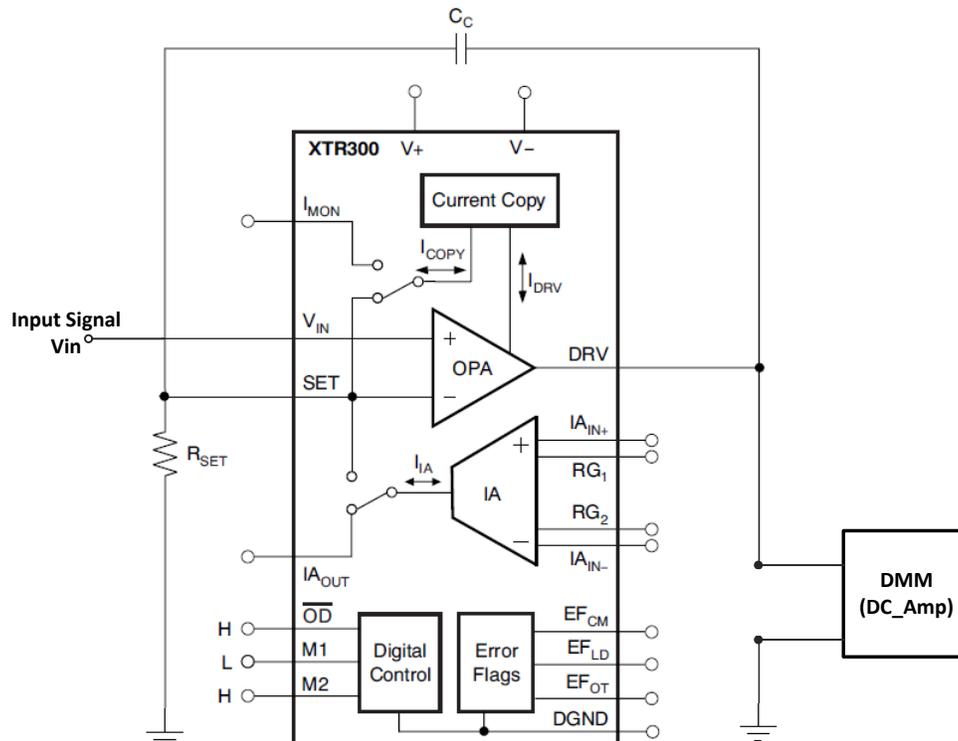
3.2.1 Single-Ended Output

The first current-mode configuration creates a single-ended output from a single-ended input. The jumper settings for this configuration are listed in Table 6. Connect your load to TB4 between OUT+ and OUT−. Apply ±15 V to V+ and V−. Connect a 5-V signal to V_{IN}. Measure the current through the load by attaching your digital multimeter (DMM) between OUT− and GND. The current though the load is approximately 20 mA. The current output is calculated by the transfer function in Equation 3:

$$I_{OUT} = \frac{10}{R_{SET}} V_{IN}$$

(3)

The default EVM value for R_{SET} is 2.5 kΩ.

Table 6. Single Ended Current Output Jumper Settings

Jumper	Function
J1	On
J2	On
J3	On
J4	Off
J5	Off
J6	Off
J7	Off

Figure 6. XTR300 Single-Ended Current Output Configuration Circuit Drawing
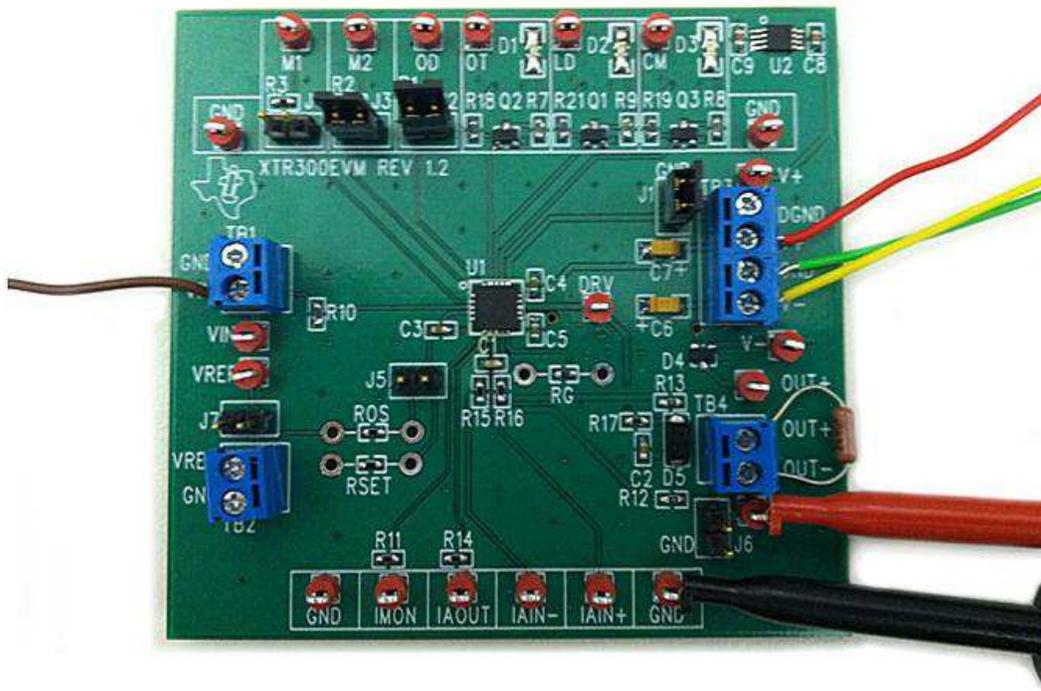
Figure 7. XTR300EVM Single-Ended Current Output Configuration Screenshot

3.2.2   Bidirectional Output

The second current output configuration creates a bidirectional output from a single-ended input. The jumper settings for this configuration are listed in Table 7. Connect your load to TB4 between OUT+ and OUT–. Apply ±15 V to V+ and V–. Connect a 5-V signal to V_{IN}. Connect a 5-V reference to V_{REF}. If there is no reference voltage, connect J7 to apply an onboard reference voltage of 5 V. Measure the current though the load by attaching your DMM between OUT– and GND. The current though the load is approximately 20 mA. Apply a 0-V signal to V_{IN} and measure the current though the load; it is approximately –20 mA. The output current is calculated by the transfer function in Equation 4:

$$I_{OUT} = 10\left(\frac{V_{IN}}{R_{SET}} + \frac{V_{IN} - V_{REF}}{R_{OS}} \right)$$

(4)

The default EVM configuration sets R_{SET} to 2.5 kΩ and R_{OS} to 2.5 kΩ.

Table 7. Bidirectional Current Output Jumper Settings

Jumper	Function
J1	On
J2	On
J3	On
J4	Off
J5	On
J6	On
J7	Off or on[1]

[1]   J7 should be off if an external reference is used and on if the internal reference is to be used.
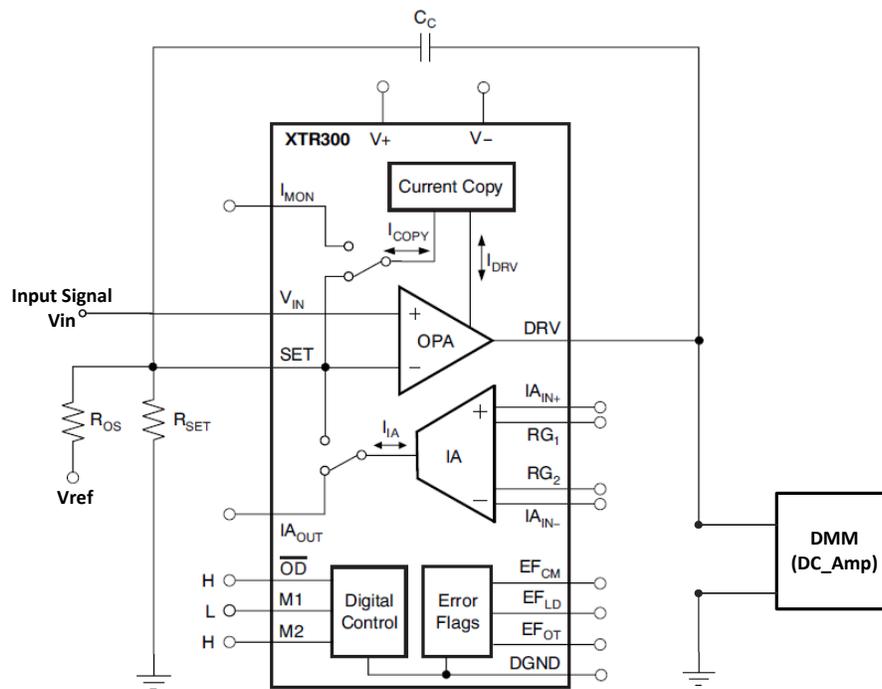
Figure 8. XTR300 Bidirectional Current Output Configuration Circuit Drawing
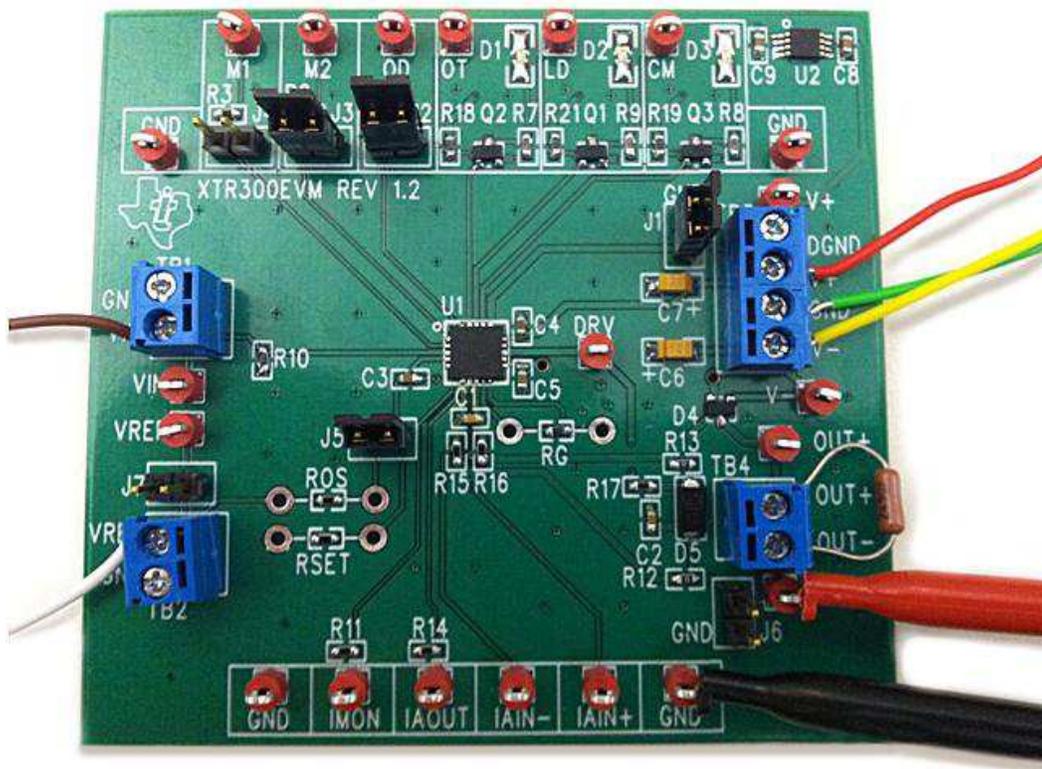

Figure 9. XTR300EVM Bidirectional Current Output Configuration Screenshot

4   4 Layout, Schematic, and Bill of Materials

4.1   XTR300EVM Layout

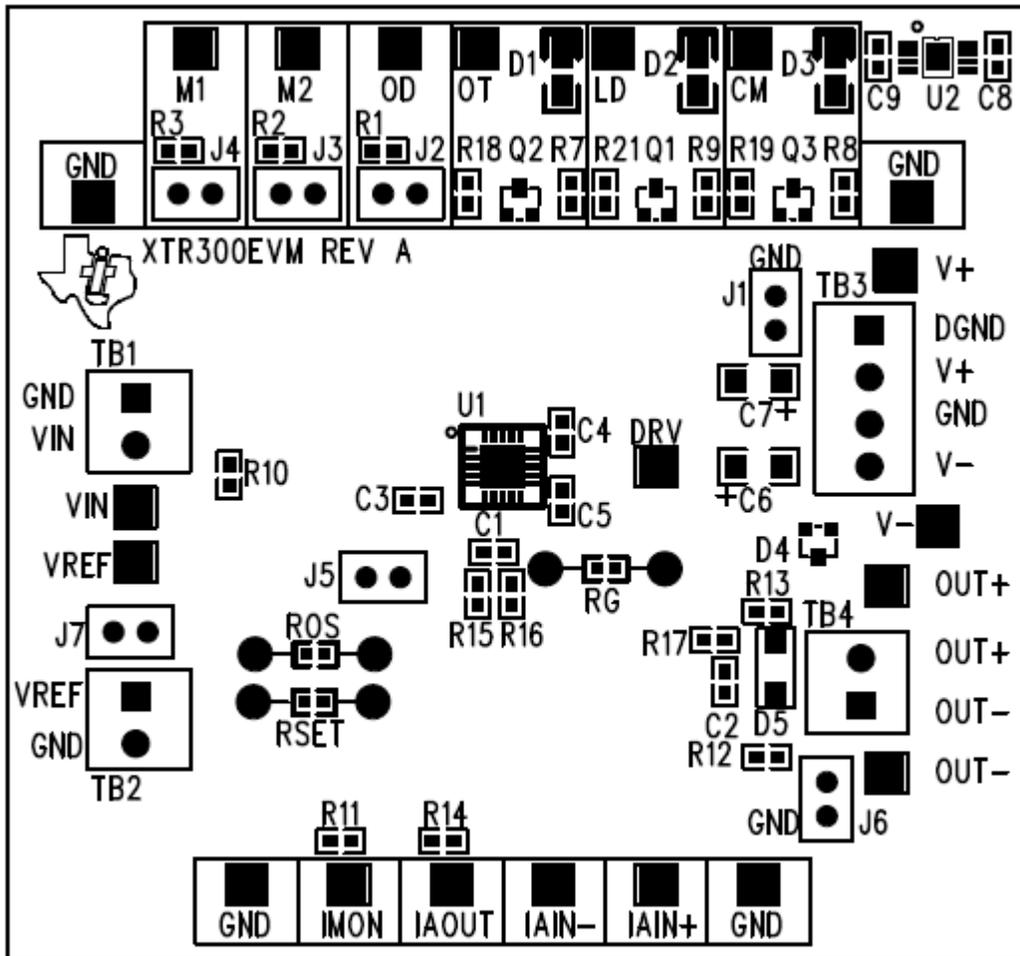Figure 10 displays the top layer silkscreen and solder for the XTR300EVM.

Figure 10. XTR300EVM Layout

4.2   Complete Schematic

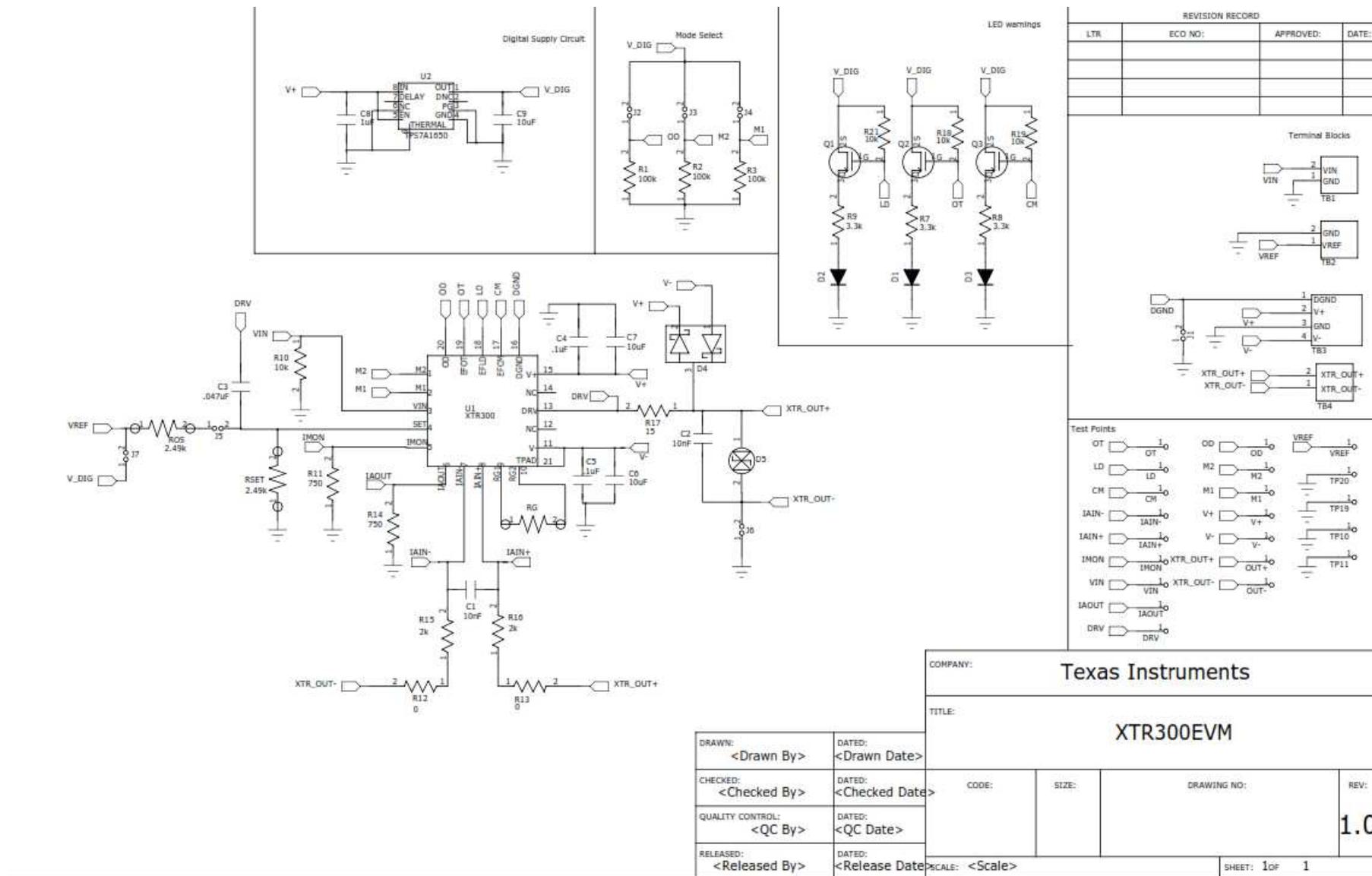Figure 11 shows the schematic of the XTR300EVM board.

Figure 11. XTR300EVM Schematic

4.3   Bill of Materials

Table 8 lists the materials for the XTR300EVM board.

Table 8. XTR300EVM Bill of Materials

Qty	Value	Designator	Description	Manufacturer
21	NA	OT, LD, CM, IAIN-, IAIN+, IAOUT, IMON, VIN, DRV, OD, VREF, M1, M2, OUT+, OUT-, V+, V-, GND,	TEST POINT PC COMPACT .063"D RED	Keystone electronics
3	NA	Q1, Q2, Q3	MOSFET P-CH 60 V 900MA SOT23-3	Diodes Inc
3	NA	D1, D2, D3	LED RED HIGH BRIGHT ESS SMD	Panasonic Electronic Components
1	NA	D5	DIODE TVS 40V 400W BIDIR 5% SMA	Littelfuse Inc
1	NA	D4	DIODE SCHOTKY SS 40V 200MA SOT23	Vishay Semiconductors
2	10uf	C7, C6	CAP TANT 10UF 50V 10% 2917	Kemet
2	.1uf	C4, C5	CAP CER 0.1UF 50V 10% X7R 0603	Murata Electronics North America
2	10nf	C1,C2	CAP CER 10000PF 50V 10% X7R 0603	Murata Electronics North America
1	1uf	C8	CAP CER 1UF 50V 10% X5R 0603	TDK Corporation
1	10uF	C9	CAP CER 10UF 10V 10% X5R 0603	TDK Corporation
1	.047uf	C3	CAP CER 0.047UF 50V 10% X7R 0603	Murata Electronics North America
2	2.49k ohm	ROS, RSET	RES 2.49K OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
2	750 ohm	R11,R14	RES 750 OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
2	2k ohm	R15, R16	RES 2.00K OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
2	0 ohm	R12, R13	RES 0.0 OHM 1/10W 0603 SMD	Panasonic Electronic Components
1	15 ohm	R17	RES 15.0 OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
3	100k ohm	R1, R2, R3	RES 100K OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
3	3.3k ohm	R9, R8, R7	RES 3.3K OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
4	10k ohm	R21, R19, R18, RG	RES 10.0K OHM 1/10W 1% 0603 SMD	Panasonic Electronic Components
3	NA	TB1, TB2, TB4	TERM BLOCK 2 POS SIDE ENT 3.5MM	TE Connectivity
1	NA	TB3	TERM BLOCK 2POS SIDE ENT 3.5MM	TE Connectivity
7	NA	NA	SHUNT LP W/HANDLE 2 POS 30AU	TE Connectivity
1	NA	J1, J2, J3, J4, J5, J6, J7	CONN HEADER 50POS .100" SGL GOLD	Samtec Inc
1	NA	U1	IC ANLG CURR/VOLT OUT DVR 20VQFN	Texas Instruments
1	NA	U2	IC REG LDO 5V .1A 8MSOP	Texas Instruments

Revision History

Changes from Original (February 2006) to A Revision **Page**

• Changed entire user guide to new version 1

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

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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.

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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.

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