

EVM User's Guide: XTR200EVM

XTR200 Evaluation Module



Description

The XTR200 evaluation module (EVM) is a development platform for evaluating the XTR200, which is a high-voltage, precision output driver for 3-wire current or voltage systems. The device is designed for standard industrial signal levels of 0mA to 20mA, 4mA to 20mA, 0mA to 25mA, and 0V to 10V.

Features

- Supports both voltage output and current output modes
- Supply voltage range of 8V to 60V
- Integrated output transistor
- Footprint for optional external output transistor
- Footprint for optional protection circuitry

Applications

- Position sensor
- Pressure transmitter
- Temperature transmitter
- Flow transmitter
- Analog output module
- AC drive control module
- CPU (PLC controller)
- HVAC valve and actuator control
- Constant-current sensor biasing
- Resistance Temperature Detector (RTD) biasing
- High-side current source

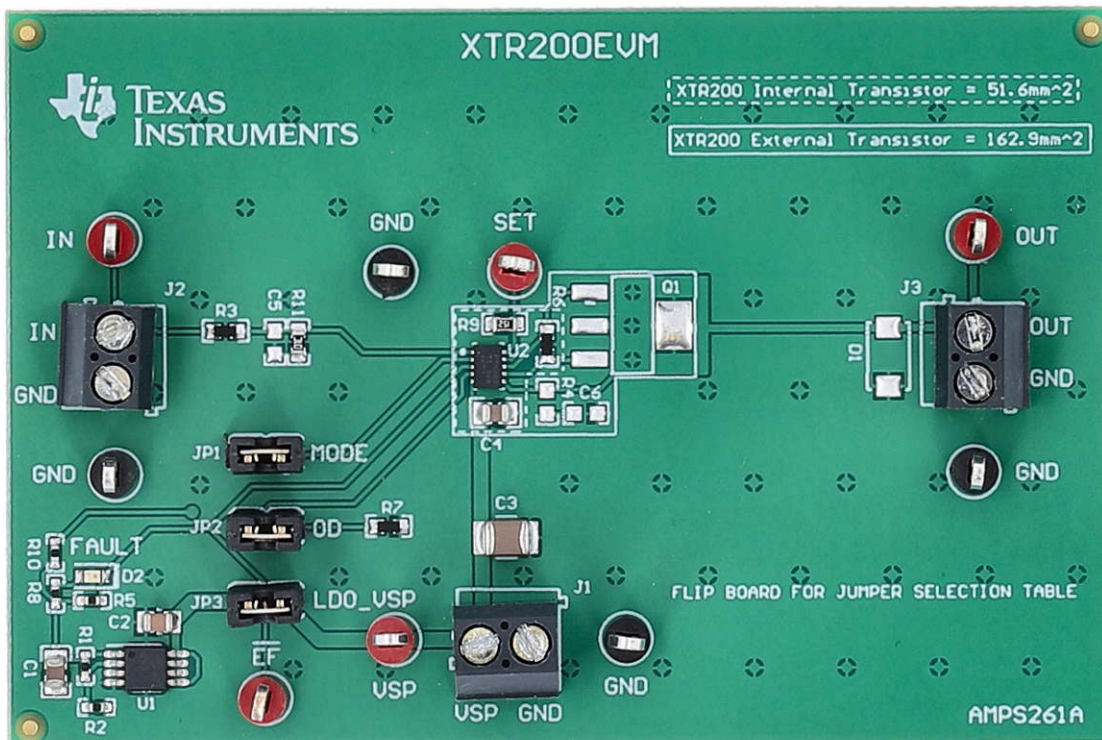


Figure 1-1. XTR200EVM Hardware Board

1 Evaluation Module Overview

1.1 Introduction

The XTR200EVM is the evaluation module (EVM) for the XTR200 high-voltage, 3-wire current-loop transmitter. The XTR200 supports both output current and output voltage configurations by setting the mode pin high or low. The device features an integrated low-leakage PMOS output transistor and short-circuit current protection.

The XTR200EVM operates over an 8V to 60V unipolar supply range. See [Section 2.6](#) for more details.

1.2 Kit Contents

| Item | Description | Quantity |
|-----------|-------------|----------|
| XTR200EVM | PCB | 1 |

1.3 Specification

The XTR200EVM offers the following features:

- Selectable output mode
- Enable or disable output
- Optional external transistor
- Optional external protection circuitry
- Easy visual of error fault detection through LED
- Visual of total solution size in actual applications

1.4 Device Information

The EVM is built with the XTR200 device in the 10-pin VSON package with a thermal pad.

2 Hardware

2.1 Evaluation Setup

To setup the XTR200EVM:

1. Set jumpers JP1, JP2 and JP3 in the desired configuration. See [Section 2.2](#) for more information.
2. Connect the power supply to J1 or test points labeled VSP and GND.
3. Connect the output load to J3 or test points labeled OUT and GND.
4. Connect the input signal to J2 or test points labeled IN and GND.
5. Turn on the power supply.

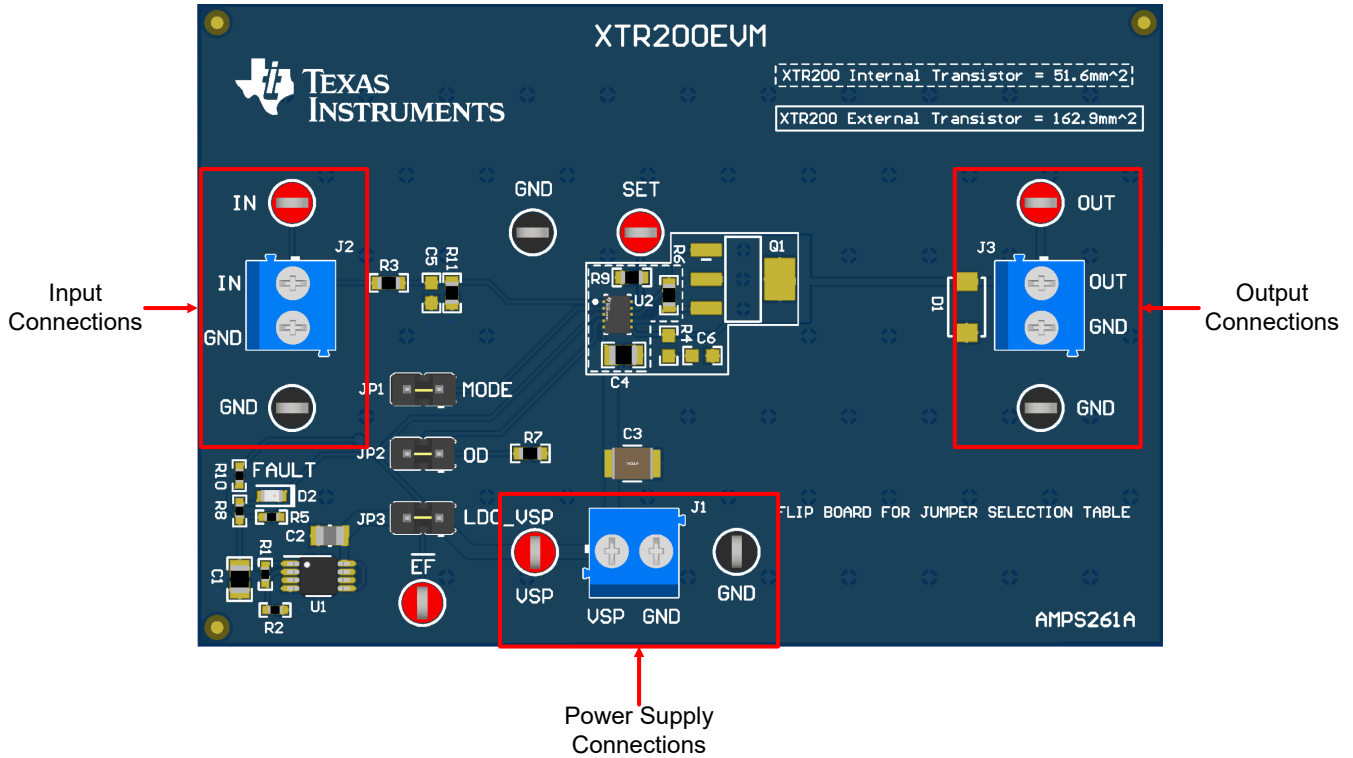


Figure 2-1. Locations of the Power Supply, Input, and Output Connections

2.2 Jumper Information

Table 2-1 shows the configuration for the jumper settings.

Table 2-1. Jumper Settings

| Jumper | Function | Default Position | Description |
|--------|----------------|------------------|--|
| JP1 | Mode Selection | Closed | Closed: Voltage Mode Open: Current Mode |
| JP2 | Output Control | Closed | Closed: Output enabled Open: Output disabled |
| JP3 | LDO_VSP | Closed | Closed: VSP does power the 3.3V LDO (U1) Open: VSP does not power the 3.3V LDO (U1) |

2.3 Output Mode Configuration

This section describes the different output mode configurations of the XTR200.

2.3.1 Current Mode Configuration

For current mode, use [Equation 1](#) to calculate the output current. The default value for the R_{SET} resistor (R9) is 1.5k Ω , optimized for input voltage ranges of 0V to 3V, to achieve an output signal of 0mA to 20mA.

$$I_{OUT} = 10 \times \frac{V_{IN}}{R_{SET}} \quad (1)$$

[Table 2-2](#) shows a list of R_{SET} resistor values for common input voltage ranges and output current ranges.

Table 2-2. Common R_{SET} Values Table

| Input Voltage Range (V) | Output Current Range (mA) | RSET Resistor Value (Ω) |
|-------------------------|---------------------------|----------------------------------|
| 0-1.8 | 0-20 | 900 |
| | 0-25 | 720 |
| 0-2.5 | 0-20 | 1.25k |
| | 0-25 | 1k |
| 0-3 | 0-20 | 1.5k |
| | 0-25 | 1.2k |
| 0-5 | 0-20 | 2.5k |
| | 0-25 | 2k |

To enable current mode in the XTR200EVM, set the jumpers in the configuration as shown in [Table 2-3](#).

Table 2-3. Current Mode Jumper Configuration Settings

| Jumper | Setting |
|--------|---------|
| JP1 | Open |
| JP2 | Closed |

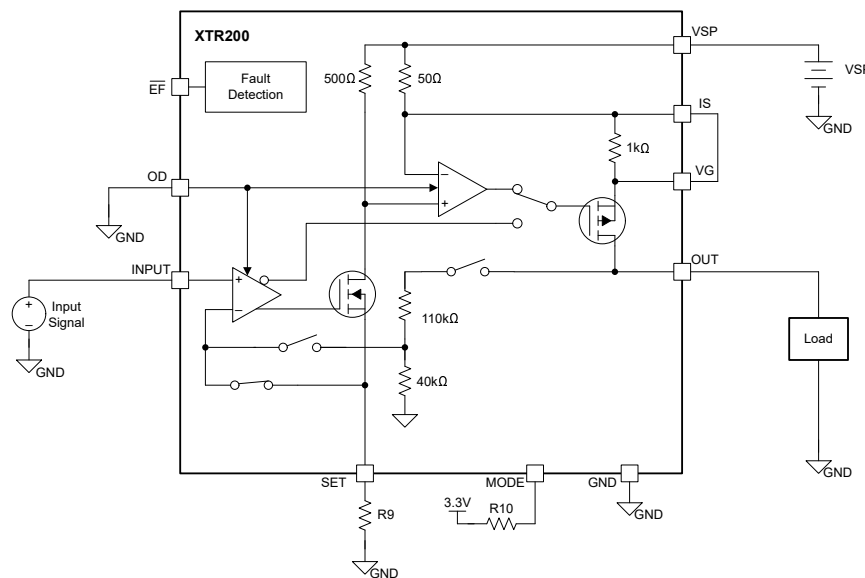


Figure 2-2. XTR200 Current Output Configuration Circuit Drawing

2.3.2 Voltage Mode Configuration

For voltage mode, use Equation 2 to calculate the output voltage. Unlike in current output mode, the R_{SET} resistor has no effect on the input or output voltage ranges.

$$V_{OUT} = V_{IN} \times 3.75 \quad (2)$$

To enable voltage mode in the XTR200EVM set the jumpers in the configuration as shown in Table 2-4.

Table 2-4. Jumper Mode Jumper Configuration Settings

| Jumper | Setting |
|--------|---------|
| JP1 | Closed |
| JP2 | Closed |

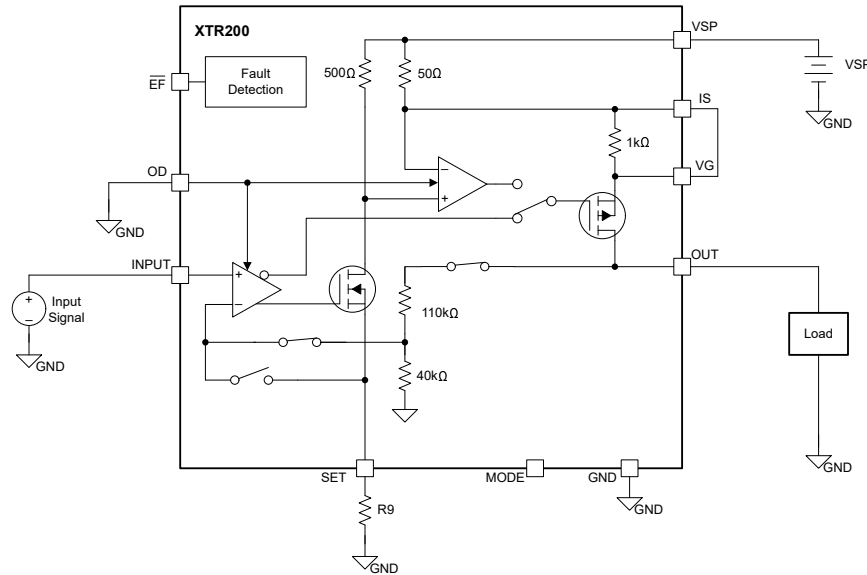


Figure 2-3. XTR200 Voltage Output Configuration Circuit Drawing

2.4 SET Pin

The SET test point can be used to monitor the voltage at the SET pin when in current mode. Do not apply a voltage onto this pin.

2.5 Error Flag

The error flag pin (\overline{EF}) indicates a number of different fault conditions as shown in Table 2-5. When an error is detected, \overline{EF} pulls low.

Table 2-5. Error States Indicated by Error Flag

| Error State | Description |
|---------------------------|---|
| Output short | Short-circuit current limit reached in voltage output mode. |
| Output open | Unable to reach correct output current in current output mode. Input voltage must be >350mV and supply voltage must be >10V to detect this fault condition. |
| SET pin short | SET pin current exceeding 1/10th of the output short circuit current limit. |
| Power supply undervoltage | Power supply voltage under 6V. |
| High die temperature | Die temperature exceeding 130°C. |

The LED (D2) turns on when the XTR200 experiences one of the fault conditions listed in [Table 2-5](#). Alternatively, users can monitor the \overline{EF} by looking at the voltage at the \overline{EF} test point.

The onboard LDO requires at least 7V to operate. Due to this limitation, the LED may not get the voltage required to work during a power supply undervoltage event. If the customer wants to use the LED to detect power supply undervoltage events, the LDO must be powered from a separate supply voltage other than the VSP supply. See [Section 2.6](#) for more details.

2.6 Power Requirements

The XTR200EVM only accepts unipolar supplies within the voltage range of 8V to 60V.

The power supply connections for the XTR200EVM are provided through terminal block connector J1 or through the test points VSP and GND.

The 3.3V LDO is not necessary for the XTR200 to operate. The XTR200 has a built-in weak internal pullup resistors to 3.3V in the OD, MODE, and \overline{EF} pins. The primary function of the onboard 3.3V LDO is to power the LED for visible fault detection from the \overline{EF} pin.

To test the quiescent current of the XTR200, or see the LED light up during a power supply undervoltage event, TI recommends to separate the VSP from the 3.3V LDO by removing the housing receptacle on JP3 and powering up the 3.3V circuitry with a separate power supply. To use a separate power supply, connect the external power supply to pin 2 of JP3.

2.7 Optional External Transistor

The XTR200EVM PCB board layout includes a transistor footprint (Q1) for either a PNP or PMOS transistor. This transistor is not necessary for the XTR200 to operate as the XTR200 has an internal transistor. An external transistor can be used in applications that want to minimize the power dissipated in the device.

To properly choose an external transistor, the transistor must be rated for the maximum supply voltage and must be capable of dissipating the power generated by the load current and voltage across the transistor.

If Q1 is installed, R6 must be removed for the external transistor to operate properly.

2.8 Optional External Protection Circuitry

The XTR200EVM comes with optional protection circuitry for the output of the device. Included is space for both a TVS diode (D1) and a snubber network (R4 and R6).

The values of R4 and R6 were arbitrarily chosen in the schematic. The recommended component values depend on the system requirements. To learn more about how to select the snubber network component values, see the [Power Tips: Calculate an R-C Snubber in Seven Steps](#) technical article.

D1 was also arbitrarily chosen and is shown as a unidirectional TVS diode in this example, but a bidirectional TVS diode can be used, as well. The best TVS diode option depends on the system requirements. To learn more about how to select the correct TVS diode, see the [How to select a Surge Diode](#) application note.

3 Hardware Design Files

3.1 Schematics

Figure 3-1 shows the EVM schematic

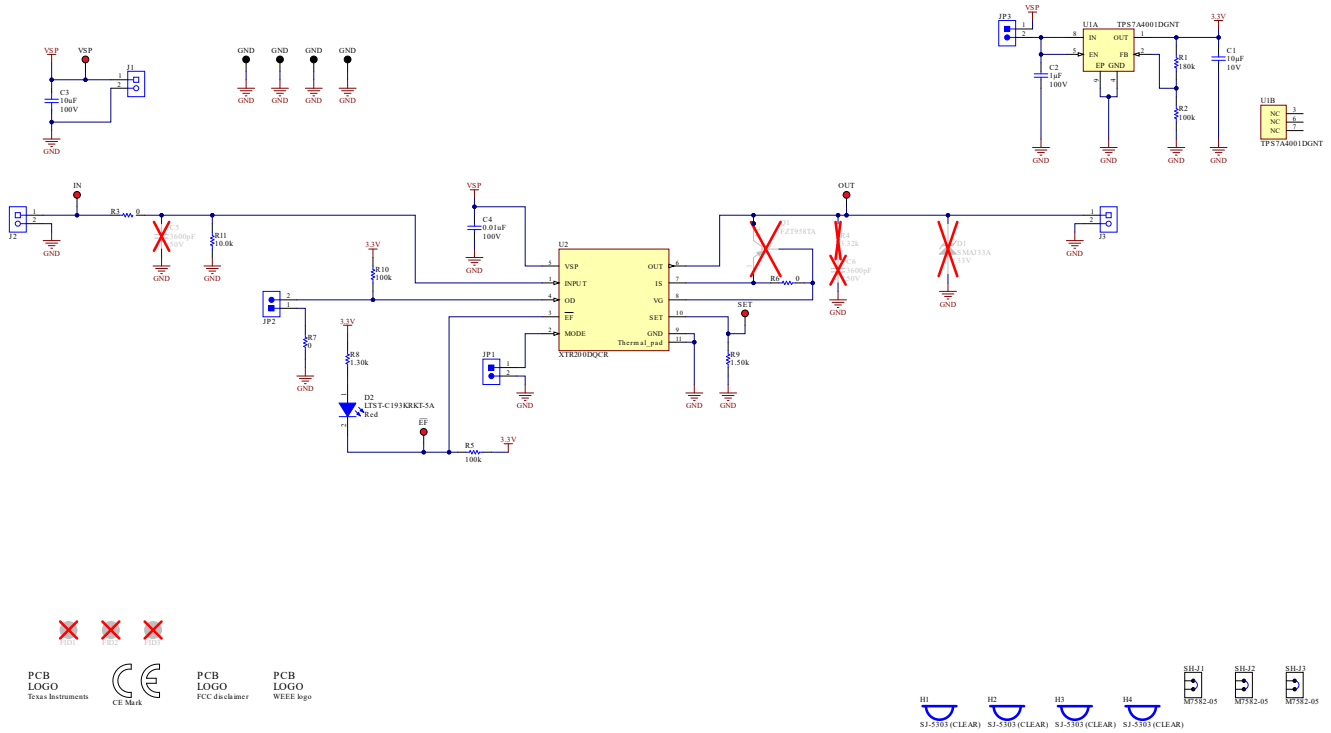


Figure 3-1. XTR200EVM Schematic

3.2 PCB Layouts

Figure 3-2 and Figure 3-3 show the PCB layouts.

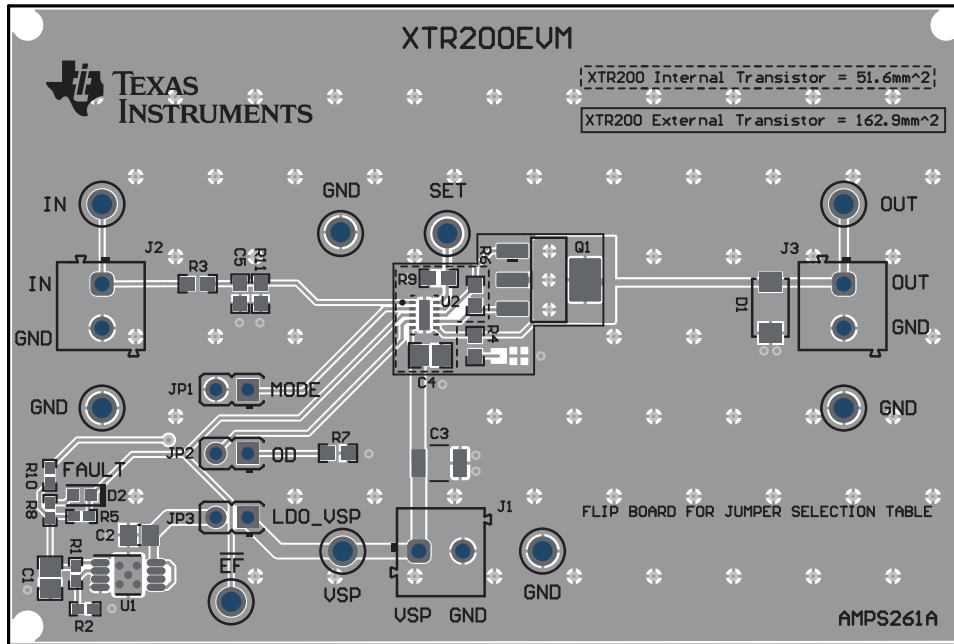


Figure 3-2. XTR200EVM Top Composite Overlay

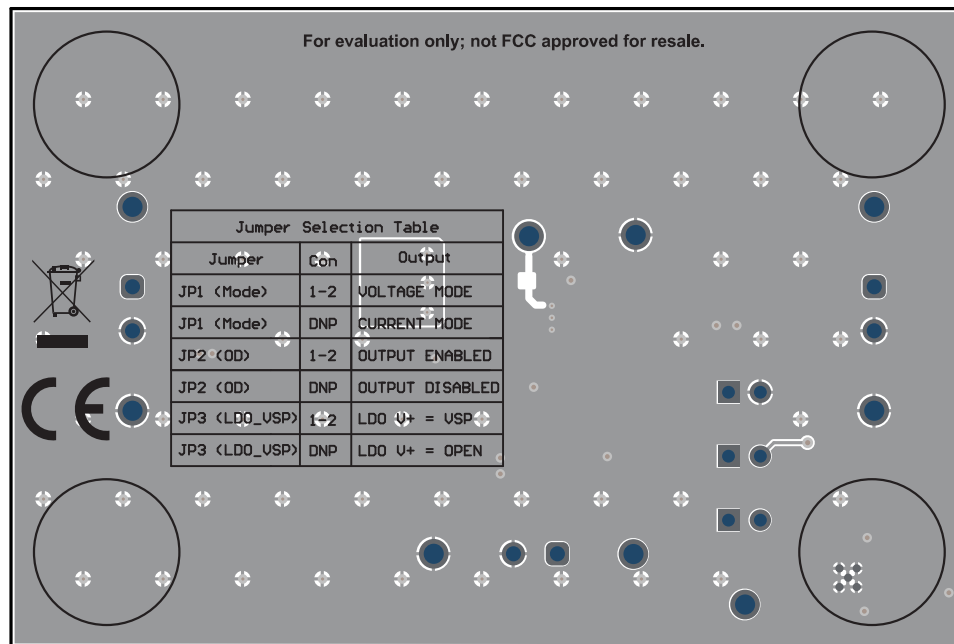


Figure 3-3. XTR200EVM Bottom Composite Overlay

3.3 Bill of Materials (BOM)

Table 3-1. XTR200EVM Bill of Materials

| Designator | Qty | Value | Description | Package Reference | Part Number | Manufacturer |
|-----------------------|-----|--------------|---|--|---------------------|----------------------|
| !PCB1 | 1 | | Printed Circuit Board | | AMPS261A | Any |
| C1 | 1 | 10 μ F | CAP, CERM, 10 μ F, 10 V, +/- 10%, X7R, 0805 | 0805 | GCM21BR71A106KE22L | MuRata |
| C2 | 1 | 1 μ F | CAP, CERM, 1 μ F, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0805 | 0805 | KAF21KR72A105KU | AVX |
| C3 | 1 | 10 μ F | 10 μ F \pm 10% 100V Ceramic Capacitor X7R 1210 (3225 Metric) | 1210 | C3225X7R2A106K250AC | TDK |
| C4 | 1 | 0.01 μ F | CAP, CERM, 0.01 μ F, 100 V, +/- 1%, COG/NP0, 0805 | 0805 | C0805C103F1GACTU | Kemet |
| D2 | 1 | Red | LED, Red, SMD | 1.6x0.8mm | LTST-C193KRKT-5A | Lite-On |
| EF, IN, OUT, SET, VSP | 5 | | Test Point, Compact, Red, TH | Red Compact Testpoint | 5005 | Keystone Electronics |
| H1, H2, H3, H4 | 4 | | Bumpon, Hemisphere, 0.44 X 0.20, Clear | Transparent Bumpon | SJ-5303 (CLEAR) | 3M |
| J1, J2, J3 | 3 | | Terminal Block, 3.5mm, 2x1, Tin, TH | Terminal Block, 3.5mm, 2x1, TH | 1776275-2 | TE Connectivity |
| JP1, JP2, JP3 | 3 | | Header, 2.54mm, 2x1, Tin, TH | Header, 2.54mm, 2x1, TH | 22284023 | Molex |
| R1 | 1 | 180k | RES, 180 k, 1%, 0.063 W, 0402 | 0402 | RC0402FR-07180KL | Yageo America |
| R2, R5, R10 | 3 | 100k | RES, 100 k, 1%, 0.0625 W, 0402 | 0402 | RC0402FR-07100KL | Yageo America |
| R3, R6, R7 | 3 | 0 | RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603 | 0603 | PMR03EZPJ000 | Rohm |
| R8 | 1 | 1.30k | RES, 1.30 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402 | 0402 | CRCW04021K30FKED | Vishay-Dale |
| R9 | 1 | 1.50k | RES, 1.50 k, 0.1%, 0.1 W, 0603 | 0603 | RT0603BRD071K5L | Yageo America |
| R11 | 1 | 10.0k | RES, 10.0 k, 1%, 0.1 W, 0603 | 0603 | M55342K12B10E0T | TT Electronics/IRC |
| SH-J1, SH-J2, SH-J3 | 3 | | Single Operation 2.54mm Pitch Open Top Jumper Socket | Single Operation 2.54mm Pitch Open Top Jumper Socket | M7582-05 | Harwin |
| TP1, TP2, TP3, TP4 | 4 | | Test Point, Compact, Black, TH | Black Compact Testpoint | 5006 | Keystone Electronics |
| U1 | 1 | | Single Output LDO, 50 mA, Adjustable 1.175 to 90 V Output, 7 to 100 V Input, 8-pin MSOP (DGN), -40 to 125 degC, Green (RoHS & no Sb/Br) | DGN0008B | TPS7A4001DGNT | Texas Instruments |
| U2 | 1 | | XTR200DQCR | WSO10 | XTR200DQCR | Texas Instruments |

Table 3-1. XTR200EVM Bill of Materials (continued)

| Designator | Qty | Value | Description | Package Reference | Part Number | Manufacturer |
|------------|-----|--------|--|-------------------|--------------------|--------------|
| C5, C6 | DNP | 3600pF | CAP, CERM, 3600 pF, 50 V, +/- 5%, C0G/NP0, 0603 | 0603 | GRM1885C1H362JA01D | MuRata |
| D1 | DNP | 33V | 'Diode, TVS, Uni, 33 V, 53.3 Vc, 400 W, 7.5 A, SMA | SMA | SMAJ33A | Littlefuse |
| Q1 | DNP | 400V | Transistor, PNP, 400 V, 0.5 A, SOT-223 | SOT-223 | FZT958TA | Diodes Inc. |
| R4 | DNP | 3.32k | RES, 3.32 k, 1%, 0.1 W, 0603 | 0603 | RC0603FR-073K32L | Yageo |

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 Related Documentation

5.1 Supplemental Content

For related documentation, see the following:

- Texas Instruments, [Power Tips: Calculate an R-C Snubber in Seven Steps](#) technical article
- Texas Instruments, [How to select a Surge Diode](#) application note

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
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 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 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

NOTE: 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

NOTE: 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.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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.

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.

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.

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.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs 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 EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

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3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

-
- 4 *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
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