# HIGH-TEMPERATURE, 1.5A LOW-DROPOUT VOLTAGE REGULATOR

## FEATURES

- ▲ Operational beyond the -60℃ to +230℃ temperature range.
- ▲ High output current with low dropout:
  - 1.5A @ 230℃ with 1.7V dropout
  - 0.9A @ 230℃ with 1V dropout
- ▲ Input voltages from 2.8V to 5.5V.
- ▲ Up to 32 possible discrete output voltages from same part:
  - From 0.5v to 3.6V by step of 100mV.
- ▲ Possible Vout selection based on an external resistive divider.
- ▲ No minimum dropout imposed (current limited).
- ▲ Low current consumption in full-power (1.1mA) and low-power modes (390µA).
- ▲ Output Overshoot Remover system.
- ▲ Over current protection (hiccup mode).
- ▲ Customer selectable Thermal Shutdown protection.
- ▲ Customer selectable Thermal Shutdown threshold.
- ▲ UVLO protection.
- ▲ Power supply protection for insufficiently decoupled networks.
- ▲ Accurate Bandgap reference (+/-4%).
- ▲ Low noise (300uV @25℃ typ).
- ▲ Soft startup and soft shutdown.
- ▲ Stable over a wide range of load capacitance (10nF to 33µF).
- ▲ Low temperature dependence (50 ppm/℃).
- ▲ Excellent line regulation (0.7mV/V @ 230℃).
- ▲ Excellent load regulation (-65mV/A @ 230℃).
- ▲ Monolithic design for high-reliability.
- ▲ Latch-up free.
- ▲ Ruggedized SMT and thru-hole packages.
- ▲ Also available as bare die.

## DESCRIPTION

XTR70010 is a family of low-power voltage regulators/references designed for extreme reliability and high temperature applications. Being able to operate with input voltages from 3V to 5.5V, XTR70010 parts can source a current of 1.5A at +230℃ while providing excellent regulation characteristics with a dropout as low as 0.5V (resp. 1V). Moreover, it can supply a large range of output voltages from 0.5V to 3.6V thanks to an accurate current mode bandgap reference.

Six protection systems are implemented to ensure a good operation and reliability of the circuit: UVLO, Short-circuit hiccup mode, thermal shutdown, fast output overshoot killer, soft turn-off and power supply supervision in case of bad input decoupling.

XTR70010 parts can be used on a wide range of applications such as high fan-out and low dropout regulators/references, adjustable power supply, current sources, as well as precision bridge excitation.

Especial design techniques were used allowing XTR70010 parts to offer a precise, robust and reliable operation in critical applications. Full functionality is guaranteed from -60℃ to +230℃, though operation well below and above this temperature range is achieved.

XTR70010 parts have been designed to reduce system cost and ease adoption by reducing the learning curve and providing smart and easy to use features.

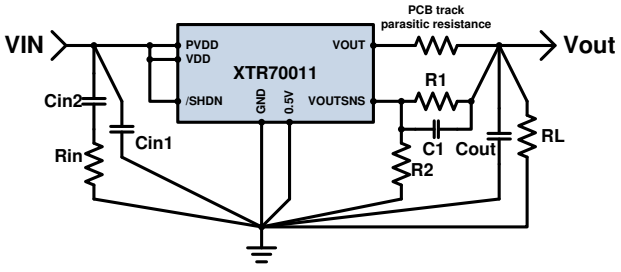
Parts from the XTR70010 family are available in ruggedized SMT and thru-hole packages. Parts are also available as bare dies.

## APPLICATIONS.

- ▲ Reliability-critical, Automotive, Aeronautics & Aerospace, Down-hole.
- ▲ High-efficiency regulated power supplies, bridge excitation, cable- or battery-powered applications.

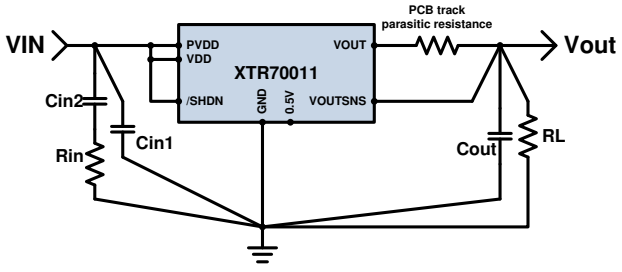
## PRODUCT HIGHLIGHT

**VOUT selected using internal reference and resistor divider**




$V_{REF}$=0.5V
$V_{OUT}=V_{REF}x\ (1 + R1/R2) < VIN$
$0 \le R1 \le 10k\Omega$

**VOUT selected using internal reference only**




$V_{REF}$=1.3V
$V_{OUT}$=1.3V

**Typical applications with Kelvin connections on load and GND.**

## ORDERING INFORMATION

| X | TR | 70 | 010 |
|---|---|---|---|
| Source: X = X-REL Semi | Process: TR = HiTemp, HiRel | Part family | Part number |

| Product Reference | Temperature Range | Package | Pin Count | Marking |
|---|---|---|---|---|
| **XTR70010-BD** | -60℃ to +230℃ | Bare die | | XTR70010 |
| **XTR70010-TD** | -60℃ to +230℃ | Tested bare die | | XTR70010 |
| **XTR70011-FE** | -60℃ to +230℃ | Gull-wing flat pack with ePad | 10 | XTR70011 |

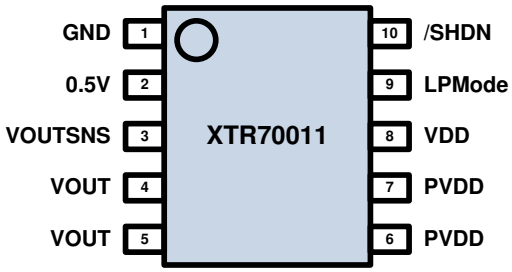
**Other packages and packaging configurations possible upon request.**

## ABSOLUTE MAXIMUM RATINGS

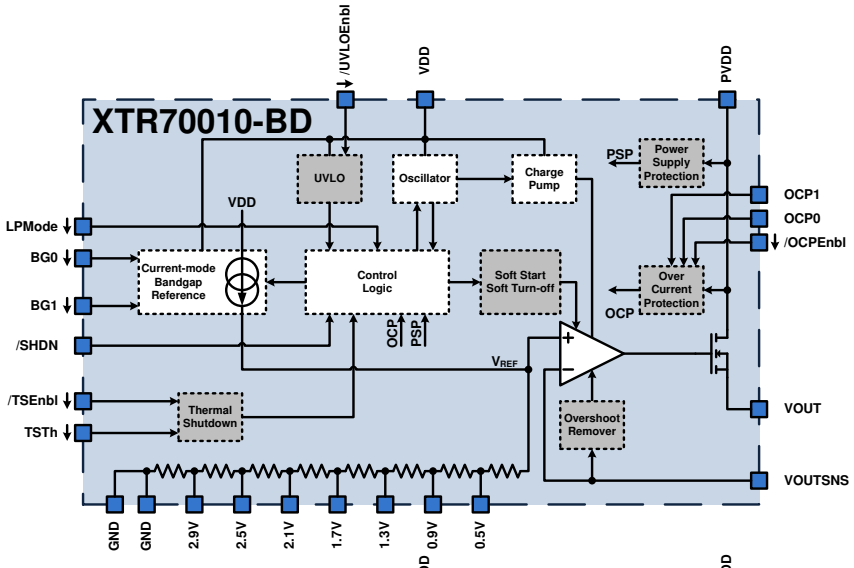
| | |
|---|---|
| Voltage on VDD, PVDD, to GND | -0.5V to 6V |
| Voltage on any pin to GND | -0.5V to 6V |
| Storage Temperature Range | -60℃ to +230℃ |
| Operating Junction Temperature Range | -60℃ to +300℃ |
| ESD Classification | 1kV HBM MIL-STD-883 |

***Caution:*** Stresses beyond *those listed in "*ABSOLUTE MAXIMUM RATINGS*" may cause permanent damage to the device. These* are stress ratings only and functionality of the device at these or any other condition beyond those indicated in the operational sections of *the specifications is not implied. Exposure to "*ABSOLUTE MAXIMUM RATINGS*" conditions for extended periods may per*manently affect device reliability.

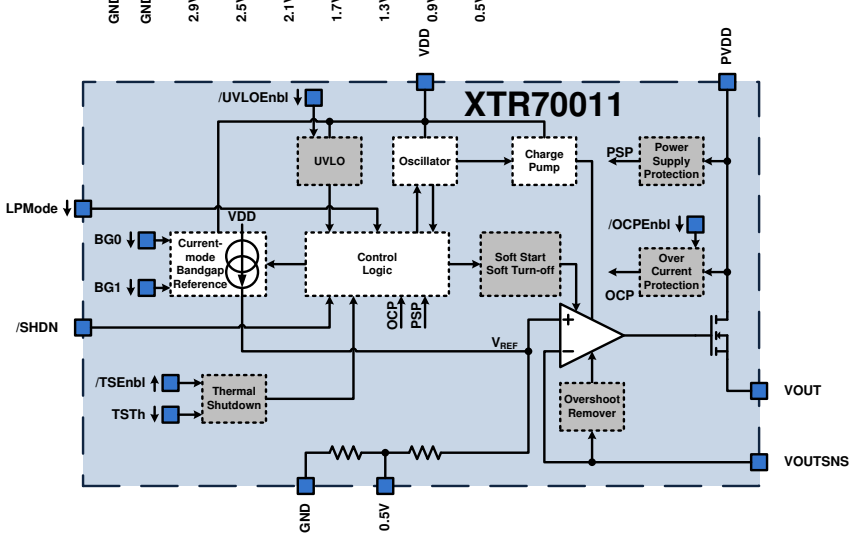
## PINOUT




## BLOCK DIAGRAM




**Die-level block diagram showing all available functionalities and bond-pads. Arrows aside pad names indicate the input is internally pulled down. Other internal pads are shown in the Die and Assembly Specifications document.**




**Block diagram of the packaged XTR70011 version showing available functionalities and internal settings. Arrows aside pad names indicate whether the input is internally pulled up or down.**

## PAD DESCRIPTION

| Pad Name | Description |
|---|---|
| **2.9V** | Connect to GND to set $V_{REF}$=2.9V. |
| **2.5V** | Connect to GND to set $V_{REF}$=2.5V. |
| **2.1V** | Connect to GND to set $V_{REF}$=2.1V. |
| **1.7V** | Connect to GND to set $V_{REF}$=1.7V. |
| **1.3V** | Connect to GND to set $V_{REF}$=1.3V. |
| **0.9V** | Connect to GND to set $V_{REF}$=0.9V. |
| **0.5V** | Connect to GND to set $V_{REF}$=0.5V. |
| **GND** | Circuit ground. Connect both bond pads. If no "x.xV" pad connected, default $V_{REF}$ is 3.3V. |
| **BG1** | Adds 200mV to $V_{REF}$ if connected to VDD. Cumulative effect with BG0. Internally pulled down. See $V_{REF}$ Settings section for details. |
| **BG0** | Adds 100mV to $V_{REF}$ if connected to VDD. Cumulative effect with BG1. Internally pulled down. See $V_{REF}$ Settings section for details. |
| **/SHDN** | Active-low shutdown functionality. Connect to VDD to enable the circuit or to GND to disable it. Do not leave floating (no internal pull). |
| **LPMode** | Active-high low-power mode. Internally pulled down (full-power mode by default). |
| **VOUTSNS** | Output voltage sense (Kelvin connection). It can be directly connected to VOUT ($V_{OUT}$=$V_{REF}$) or used to set the output voltage by means of an external resistive divider. |
| **VOUT** | Output voltage terminal. Decouple to GND with a capacitor of at least 10nF. |
| **PVDD** | Supply voltage of power transistor. |
| **VDD** | Supply voltage of the analog blocks of the device. Connect in star-like mode to PVDD or after a 10-100Ω / 10-100nF low pass filter. |
| **/TSEnbl** | Active-low thermal shut-down enable. Internally pulled down. |
| **TSTh** | Thermal shut-down threshold selector: 310°C if LOW, 225°C if HIGH. Internally pulled down. |
| **OCP0** | LSB of Over Current Protection trimming feature. See table on OCP0/OCP1 usage in the Die and Assembly Specifications document. |
| **OCP1** | MSB of Over Current Protection trimming feature. See table on OCP0/OCP1 usage in the Die and Assembly Specifications document. |
| **/OCPEnbl** | Active-low over current protection enable. Internally pulled down. |
| **/UVLOEnbl** | Active-low UVLO enable. Internally pulled down. |

## $V_{REF}$ SETTINGS

| XTR70010-BD | | | |
|---|---|---|---|
| **Pads Connected to Ground** | **BG1** | **BG0** | **Reference Voltage** |
| GND + 0.5V | 0 | 0 | 0.5V |
| GND + 0.5V | 0 | 1 | 0.6V |
| GND + 0.5V | 1 | 0 | 0.7V |
| GND + 0.5V | 1 | 1 | 0.8V |
| GND + 0.9V | 0 | 0 | 0.9V |
| GND + 0.9V | 0 | 1 | 1.0V |
| GND + 0.9V | 1 | 0 | 1.1V |
| GND + 0.9V | 1 | 1 | 1.2V |
| GND + 1.3V | 0 | 0 | 1.3V |
| GND + 1.3V | 0 | 1 | 1.4V |
| GND + 1.3V | 1 | 0 | 1.5V |
| GND + 1.3V | 1 | 1 | 1.6V |
| GND + 1.7V | 0 | 0 | 1.7V |
| GND + 1.7V | 0 | 1 | 1.8V |
| GND + 1.7V | 1 | 0 | 1.9V |
| GND + 1.7V | 1 | 1 | 2.0V |
| GND + 2.1V | 0 | 0 | 2.1V |
| GND + 2.1V | 0 | 1 | 2.2V |
| GND + 2.1V | 1 | 0 | 2.3V |
| GND + 2.1V | 1 | 1 | 2.4V |
| GND + 2.5V | 0 | 0 | 2.5V |
| GND + 2.5V | 0 | 1 | 2.6V |
| GND + 2.5V | 1 | 0 | 2.7V |
| GND + 2.5V | 1 | 1 | 2.8V |
| GND + 2.9V | 0 | 0 | 2.9V |
| GND + 2.9V | 0 | 1 | 3.0V |
| GND + 2.9V | 1 | 0 | 3.1V |
| GND + 2.9V | 1 | 1 | 3.2V |
| GND | 0 | 0 | 3.3V |
| GND | 0 | 1 | 3.4V |
| GND | 1 | 0 | 3.5V |
| GND | 1 | 1 | 3.6V |

## PIN DESCRIPTION

| XTR70011 | | |
|---|---|---|
| **Pin Number** | **Name** | **Description** |
| **1** | **GND** | Circuit ground. |
| **2** | **0.5V** | Connect to GND to set $V_{REF}$=0.5V. |
| **3** | **VOUTSNS** | Output voltage sense. Must be connected close to the load. |
| **4** | **VOUT** | Output voltage terminal. Decouple to GND with a capacitor of at least 10nF. |
| **5** | | |
| **6** | **PVDD** | Supply voltage terminal of power pass transistor. |
| **7** | | |
| **8** | **VDD** | Supply voltage terminal. |
| **9** | **LPMode** | Active-high low-power mode. Internally pulled down (full-power mode by default). |
| **10** | **/SHDN** | Active-low shut-down terminal. Connect to VDD when not used. |

The default reference voltage ($V_{REF}$) of XTR70011 is 1.3V. To change the reference voltage $V_{REF}$ to 0.5V, connect pin "0.5V" to GND. See the "*Basic Operation*" section in page 8 for details on how to obtain any output voltage from the XTR70010 based on the internal settings and external components.

| XTR70011 | | |
|---|---|---|
| **Internal Pad** | **Internal Setting** | **Description** |
| **BG1** | **GND** | Default voltage determined by "x.xV" pins connected to GND |
| **BG0** | **GND** | |
| **1.3V** | **GND** | Default voltage set to 1.3V. To set VREF to 0.5V externally connect pin 0.5V to GND. All other "x.xV" pads left floating. |
| **/TSEnbl** | **VDD** | Thermal shut-down disabled. |
| **OCP0** | **VDD** | Over-current (short-circuit) protection threshold set to 2.1Amp. |
| **OCP1** | **GND** | |
| **/OCPEnbl** | **GND** | Over-current (short-circuit) protection enabled. |
| **/UVLOEnbl** | **GND** | Under-voltage lockout (UVLO) enabled. |

## THERMAL CHARACTERISTICS

| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| **XTR70011-FE** | | | | | |
| Thermal Resistance: J-C<br>**$R_{Th\_J-C}$** | Thermal resistance to exposed pad of package. | | 15 | | ℃/W |
| Thermal Resistance: J-A<br>**$R_{Th\_J-A}$** | | | TBD | | ℃/W |

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Min | Typ | Max | Units |
|---|---|---|---|---|
| Supply voltage<br>**$V_{DD}$** | 2.8 | | 5.5 | V |
| Load capacitance<br>**$C_{Load}$** | 0.01 | 1 | 33 | µF |
| Load current<br>**$I_{Load}$** | 100µ | | 1.5 | A |
| Junction Temperature<br>**$T_j$** | -60 | | 230 | ℃ |
| Recommended input decoupling capacitor[1]<br>**$C_{IN1}$** | | 1 | | µF |

[1] In systems with inductive input connections, keep input inductance below 1µH and add bypass capacitor $C_{IN2}$=2$C_{IN1}$ with added series resistor of 1-2Ω.

## ELECTRICAL SPECIFICATIONS

Unless otherwise stated, specification applies for $V_{DD}$=$PV_{DD}$=5V, -60℃<$T_C$<230℃.

| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| **Output Characteristics** | | | | | |
| Preset reference voltages<br>**$V_{REF}$** | 2.8V≤$V_{DD}$≤5.5V, $V_{DD}$-$V_{REF}$>0.9V. | 0.5V to 3.6V in steps of 0.1V | | | |
| **Output Characteristics** | | | | | |
| Maximum output current<br>**$I_{OUT\_Max}$** | | 1.5 | 1.8 | | A |
| Output voltage range<br>**$V_{OUT}$** | 2.8V≤$V_{DD}$≤5.5V. | 0.5 | | $V_{DD}$ | V |
| Output voltage accuracy<br>**$\Delta V_{OUT}/V_{OUT}$** | | -2 | | +2 | % |
| Minimum reference voltage overhead<br>**$V_{DD}$-$V_{REF}$** | 2.8V≤$V_{DD}$≤5.5V, -60℃<$T_C$<230℃ | | 0.9 | 1.1 | V |
| Dropout voltage<br>**$V_{DD}$-$V_{OUT}$** | $I_{OUT}$=1A, $T_C$=230℃ | | 1.1 | 1.3 | V |
| Drift with temperature<br>**$1/V_{OUT}.(\Delta V_{OUT}/\Delta T)$** | | -40 | | 40 | ppm/℃ |
| Line regulation<br>**$\Delta V_{OUT}/\Delta V_{DD}$** | $V_{DD}$≤5.5V; $V_{OUT}$=3.6V (worst case configuration)<br>$I_{LOAD}$=100mA<br>$T_C$= -60℃<br>$T_C$=85℃<br>$T_C$=230℃ | | <br><br>0.3<br>0.5<br>0.7 | | mV/V |
| Load regulation<br>**$\Delta V_{OUT}/\Delta I_{LOAD}$** | $V_{DD}$≤5.5V; $V_{OUT}$=3.3V (worst case configuration)<br>$I_{LOAD}$ from 1mA to 1.5A<br>$T_C$=-60℃<br>$T_C$=85℃<br>$T_C$=230℃ | | <br><br>-25<br>-45<br>-65 | | mV/A |
| Over current protection threshold<br>**$I_{SC}$** | | 1.9 | 2.1 | 2.6 | A |
| **Current Consumption** | | | | | |
| Quiescent current<br>**$I_{DD}$** | LPMode=LOW @ $T_C$=230℃; $V_{DD}$=5.5V<br>LPMode=HIGH @ $T_C$=230℃; $V_{DD}$=5.5V | | 1.45<br>0.540 | | mA |
| Standby current<br>**$I_{Std-By}$** | /SHDN=0V, $V_{DD}$=5.5V<br>$T_C$=-60℃<br>$T_C$=85℃<br>$T_C$=230℃ | | <br>1.6<br>1.9<br>15 | <br>4<br>6<br>25 | µA |
| **Enable Functionality** | | | | | |
| Enable Voltage<br>**$V_{ENON}$** | ENABLE going up | | 1.85 | 2.1 | V |
| Disable Voltage<br>**$V_{ENOFF}$** | ENABLE going down | 0.7 | 0.95 | | V |
| **Under Voltage Lockout** | | | | | |
| $V_{DD}$ Start Voltage<br>**$V_{UVLOR}$** | $V_{DD}$ going up. LPMode=LOW. | | 2.65 | 2.85 | V |
| $V_{DD}$ Stop Voltage<br>**$V_{UVLOF}$** | $V_{DD}$ going down. LPMode=LOW. | 2.30 | 2.50 | | V |
| $V_{DD}$ Start-stop Hysteresis Erreur ! Signet non défini.<br>**$V_{UVLOH}$** | $V_{DD}$ going up then down. LPMode=LOW. | | 150 | | mV |
| **Thermal shut-down** | | | | | |
| Thermal shutdown[1] | TSTh=LOW or floating<br>Shutdown<br>Restart<br><br>TSTh =HIGH<br>Shutdown<br>Restart | <br>295<br>265<br><br><br>210<br>185 | <br>310<br>280<br><br><br>225<br>200 | <br>325<br>295<br><br><br>240<br>210 | ℃ |
| **Dynamic Response** | | | | | |
| Startup delay | | | 6.4 | | ms |
| Shutdown delay | | | 0.1 | | ms |

[1] Thermal shut-down is disabled in packaged version XTR70011. It can be activated when using bare dies by setting /TSEnbl to GND (or left floating). TSth is an internal pad.

## TYPICAL PERFORMANCE

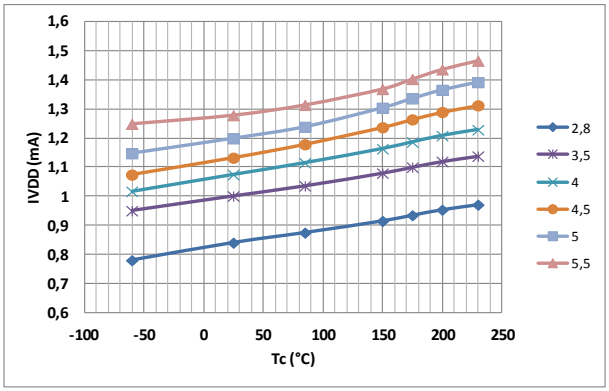



Figure 1. Supply current in full power mode vs. case temperature for different supply voltages.

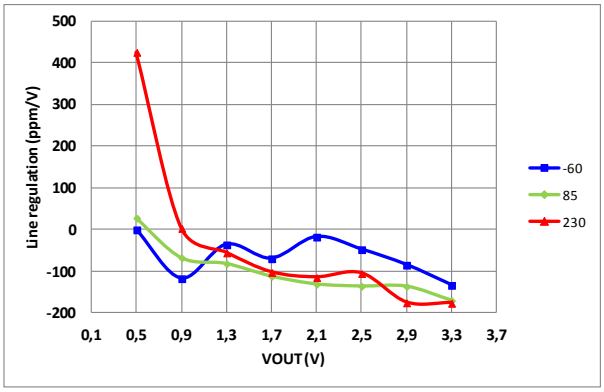



Figure 2. Line regulation vs. output voltage for Vin from4.5V to 5.5V and different temperatures.

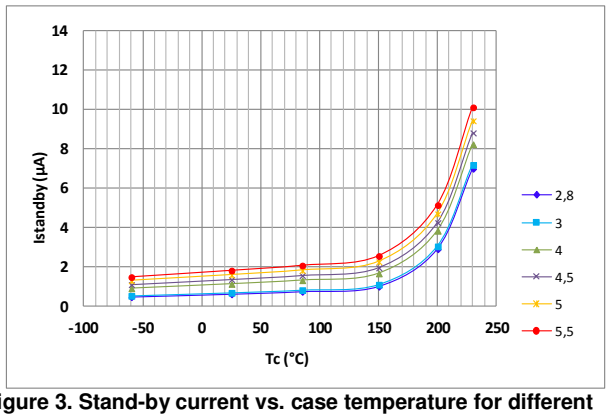



Figure 3. Stand-by current vs. case temperature for different supply voltages.

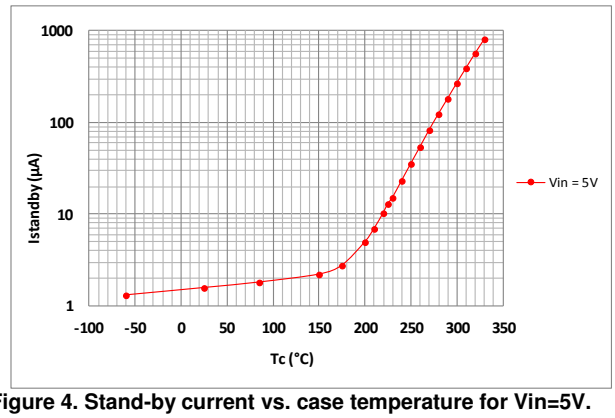



Figure 4. Stand-by current vs. case temperature for Vin=5V. (/SHDN=LOW).

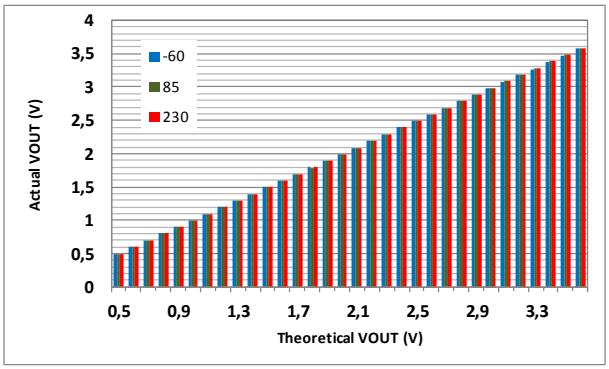



Figure 5. Actual measured output voltage vs. theoretical output voltage for VDD=5.0V and different case temperatures.

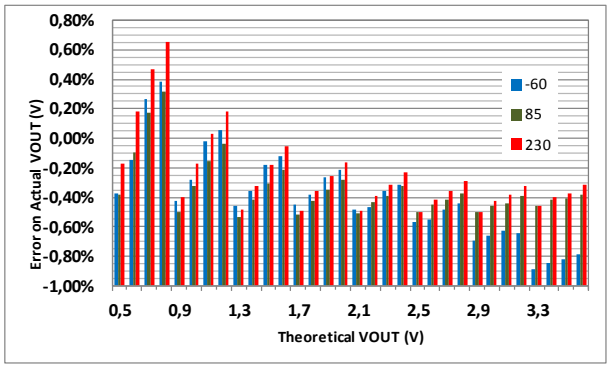



Figure 6. Accuracy of the actual measured output voltage vs. theoretical output voltage for VDD=5.0V and different case temperatures.

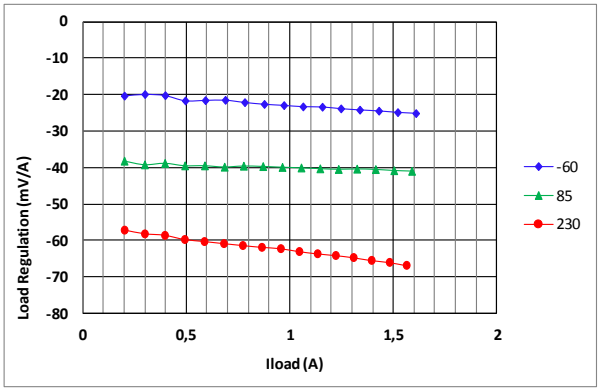



Figure 7. Load regulation vs. output current for Vout=3.3V, VDD=5.5V and different case temperatures.

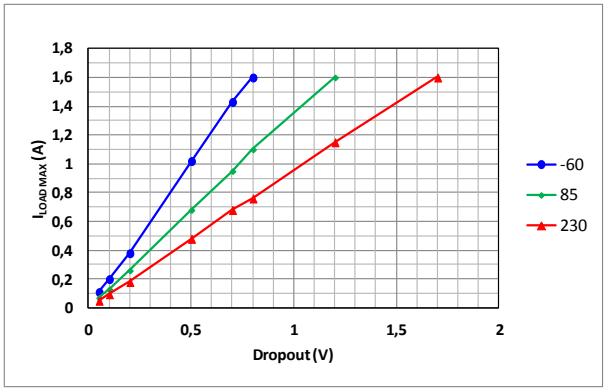



Figure 8. Maximum load current vs. dropout for Vout=3.3V, Vref=1.2V and different case temperatures.

## THEORY OF OPERATION

### Introduction

The XTR70010 is a family of high-current, low-dropout (high-efficiency), low-voltage linear regulator. Due to the high current level (>1.5A) that can be handled by this LDO regulator, several protections have been implemented in order to avoid possible damage resulting from badly bypassed input networks, fast load transients, output short circuits, excessive self heating or insufficient supply voltage.

In order to optimize the LDO dropout as well as the die size, the XTR70010 is based on an NMOS pass transistor, driven by a fully integrated charge pump.

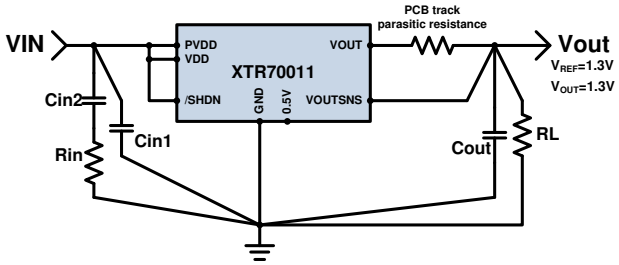
The internal feedback loop has been optimized for stable operation on any capacitive load type ranging from 10nF up to 33µF. However, if the regulator is used for high current applications or in applications where the output current may present large steps (positives or negatives), a load capacitance of 1µF or more is recommended for softer output voltage transients. Also, at low load capacitances, the residue of the internal charge pump clock could be more visible on Vout.

Once VDD goes above the UVLO upper threshold and provided that the /SHDN input is HIGH, the LDO is activated. An internal soft start ramp is generated to ensure a smooth turn on. Thanks to this ramp, the output voltage will rise-up progressively, preventing possible inrush currents as well as any output overshoot.

A separate VOUTSNS pad is available for a precise sensing of the output voltage close to the load. This is particularly important at high current level for ensuring a good load regulation. This sensing (Kelvin) pad can also be used for a fine tuning of the output voltage, using a resistive divider between VOUT, VOUTSNS and GND.

### Basic Operation

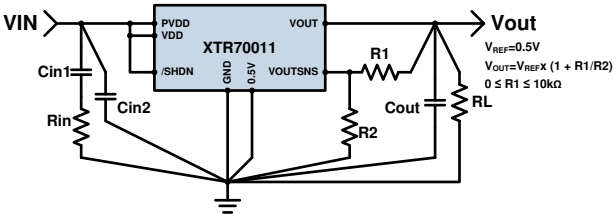
In XTR70010 products, a given output voltage can be obtained using two different possible architectures. In the minimum footprint architecture, the output voltage is directly determined by setting the internal reference to the desired output voltage. Using only input and output decoupling networks, no resistive divider is needed to set the output voltage. This architecture is shown in the following image.



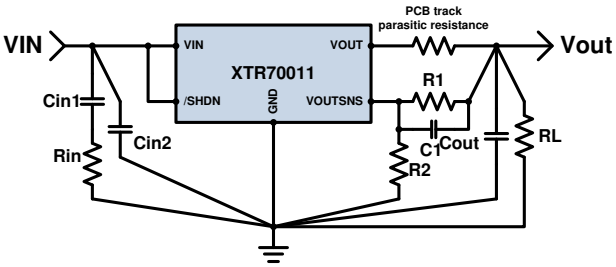

In the previous image, based on the packaged version XTR70011-FE, the internal reference is set to 1.3V. By connecting the VOUTSNS terminal (Kelvin feedback connection) to the output terminal, Vout will also be 1.3V. This architecture needs, in all cases, an overhead ($V_{DD}$ - $V_{REF}$) of 0.9V (typ).

Another way to obtain a given output voltage is to set a given reference voltage $V_{REF}<V_{OUT}$ and use a resistive divider between VOUT and VOUTSNS to set the necessary gain: $V_{OUT}=V_{REF}(1+R_1/R_2)$. The image below shows the typical application based on the XTR70011 and a resistive divider.

When setting the output voltage by means of a given $V_{REF}$ and a resistive divider, the supply voltage $V_{DD}$ must satisfy condition ($V_{DD}$ - $V_{REF}$)>0.9V, as well as the minimum dropout ($V_{DD}$ - $V_{REF}$), to be determined based on the maximum output current in the application.




When VOUSNS is connected directly on the load, to reduce the effects of PCB or substrate tracks parasitic resistance, an AC bypass capacitor may be needed in parallel with $R_1$.




If fine tuning of $V_{OUT}$ is required, it is recommended to adjust the internal $V_{REF}$ level (with x.xV pads and BG0 / BG1 pads) a little bit bellow the expected $V_{OUT}$. Then, the $R_1/R_2$ ratio is adjusted to obtain the requested $V_{OUT}=V_{REF}(1+R_1/R_2)$. If $R_1$ is not zero, it is recommended to use a parallel capacitance $C_1$ between 1nF and 10nF. This will compensate for the parasitic capacitance between VOUTSNS and GND, keeping a nice loop gain at high frequency for improved transient performance.

### Operation Modes

***Full-power mode***

Full-power mode is obtained by setting LPMode to a LOW level. This can be done by leaving LPMode pad floating or by connecting it to the GND potential.

When LPMode is at LOW state, the internal charge pump is active and the pass transistor can be operated to provide output currents in excess of 1.5Amp with a dropout voltage of 1.7V (typ).

***Low-power mode***

On request, it is possible to turn-off the internal charge pump by connecting LPMode to $V_{DD}$. By doing so, the intrinsic current consumption of the XTR70010 part becomes significantly smaller than during full-power operation mode. However, in this state, the regulator cannot provide as much current as in the full-power mode described above. The minimum dropout in low-power mode will be comprised between 2V at -60°C and 1.3V at 230°C.

This low-power mode is mainly interesting if VDD is high (>4V), VOUT is low (<2V) and $I_{Load}$ does not exceed few hundreds of mA.

Notice however that the LPMode terminal can be driven “on-the-fly” during operation. This feature may result very useful when supplying a circuit that present two distinct current consumption states, such as a microcontroller. Indeed, during normal operation, a microcontroller may present a current consumption close to 1A. However, in stand-by mode, the current consumption could be significantly decreased. In this case, the LPMode terminal of the XTR70010 part can be driven so that the regulator is in full-power or low-power modes according to the needs of the microcontroller.

## Functional Features and Protections

***Input impedance quality factor***

In applications with non-negligible parasitic inductance on the input supply line VDD, it is recommended to use two decoupling capacitors of 1µF in parallel, one of them with a small serial resistor (1 Ω to 5Ω). Its purpose is to reduce the quality factor of the input parasitic LC circuit formed by the input wire inductor and $C_{IN1}$.

***Power supply protection***

In case of an overshoot of about 0.6V on the input supply VDD due to high parasitic inductance or low value input decoupling capacitors, the LDO will consider that there is an abnormal condition. In order to protect itself against any possible large swing oscillation of the input network, the LDO will turn off for 40ms before a new startup trial.

***Under voltage lockout (UVLO)***

To prevent the regulator to start-up with insufficient supply voltages, UVLO functionality with a small hysteresis is implemented (see the Electrical Specification table). Below the threshold, the internal oscillator and the LDO pass device are kept off. However the part is not in stand-by mode.

Under voltage lockout functionality is active by default in the packaged version XTR70011 (/UVLOEnbl internally pulled down). When using bare dies of the XTR70010, UVLO functionality can be deactivated by setting /UVLOEnbl to HIGH ($V_{DD}$).

***Over-current / short circuit protection (OCP)***

XTR70010 devices have "hiccup" mode over current / short circuit protection.

When the short circuit protection threshold is reached, the LDO's pass device is turned off progressively (soft shut-down) in order to avoid fast current variations in parasitic inductors. Once off, the regulator remains in this state for about 40ms before a new soft-start cycle occurs. If the short circuit condition is still present, the circuit will go again off and would try to soft restart, remaining in hiccup mode and presenting a low average DC current level until the short-circuit condition is no longer present.

Short-circuit protection functionality is active by default in the packaged version XTR70011 (/OCPEnbl internally pulled down). When using bare dies of the XTR70010, OCP functionality can be deactivated by setting /OCPEnbl to HIGH ($V_{DD}$).

If the OCP functionality is enabled (/TSEnbl = LOW), short-circuit threshold at which this protection triggers can be selected among four possible values by setting pads OCP0 and OCP1 to HIGH or LOW.

| OCP1 | OCP0 | OCP Threshold |
|---|---|---|
| **LOW** | **LOW** | 1.9 Amp |
| **LOW** | **HIGH** | 2.1 Amp |
| **HIGH** | **LOW** | 1.7 Amp |
| **HIGH** | **HIGH** | 1.5 Amp |

***Overshoot remover***

Overshoots on the output voltage may arise when a sudden decrease of the output current occurs due to a load being disconnected or going into stand-by mode (e.g. a microcontroller).

An internal block performs a continuous monitoring of the output sensing pin VOUTSNS. In case an out overshoot reaches 60mV, the overshoot remover will promptly reduce the control voltage of the pass device in order to prevent the output voltage keeps increasing. The purpose is to protect the load against an abnormally high output voltage caused by the fast current transient.

Whenever the overshoot remover protection is activated, some ringing could be observed in the output terminal before coming back to the steady state (this depends on the load capacitance and on the di/dt that created the initial overshoot).

***Thermal shut-down***

XTR70010 devices have customer selectable thermal shutdown functionality. An internal circuitry is responsible for turning off the internal oscillator and the pass device when the junction temperature pass a predefined limit (see the Electrical Specification table). The system will automatically restart as soon as the junction temperature comes back below the lower hysteresis threshold of the thermal shutdown protection. This functionality is adjusted by bonding and can be disabled if required.

Thermal shutdown functionality is disabled by default in the packaged version XTR70011 (/TSEnbl internally pulled up). When using bare dies of the XTR70010, the thermal shutdown functionality can be activated by setting /TSEnbl to LOW (GND) or by leaving this pad floating.

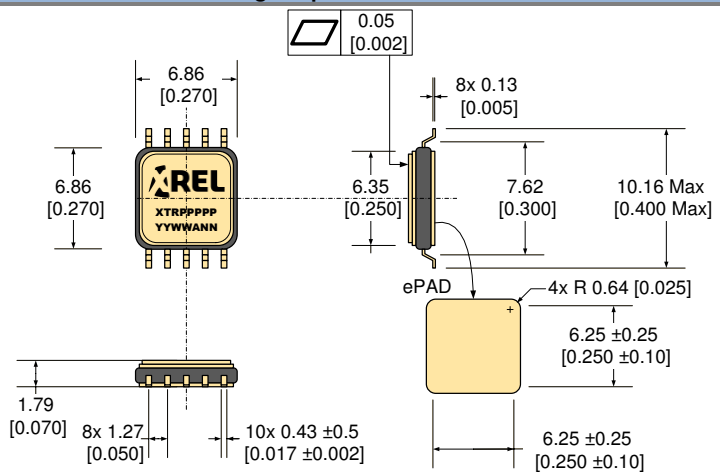
If the thermal shutdown is enabled (/TSEnbl = LOW), the temperature threshold at which this protection triggers can be chosen between two possible values by setting pad TSTh to HIGH or LOW.

| TSTh | Thermal Shutdown Threshold |
|---|---|
| **LOW** | 225℃ |
| **HIGH** | 310℃ |

## PACKAGE OUTLINES

Dimensions shown in mm [inches].

**Gull-wing flat pack with ePad CDFP10**




| Part Marking Convention | |
|---|---|
| **Part Reference: XTRPPPPPP** | |
| **XTR** | X-REL Semiconductor, high-temperature, high-reliability product (XTRM Series). |
| **PPPPP** | Part number (0-9, A-Z). |
| **Unique Lot Assembly Code: YYWWANN** | |
| **YY** | Two last digits of assembly year (e.g. 11 = 2011). |
| **WW** | Assembly week (01 to 52). |
| **A** | Assembly location code. |
| **NN** | Assembly lot code (01 to 99). |

## IMPORTANT NOTICE & DISCLAIMER



## CONTACT US

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