XTR75030

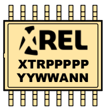
High Temperature Negative Voltage Regulator

Rev 2 – August 2021 (DS-01016-20)

Data Sheet

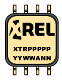
PROTOTYPE

DIP16
XTR75031



SOIC16
XTR75031

DIP8
XTR75034
XTR75035



CDFP8
XTR75034
XTR75035

FEATURES

- Up to 10 possible output voltages from same part: -1.2V / -1.8V / -2.5V / -3.3V / -5V / -5.5V / -9V / -10V / -12V / -15V.
- Input voltage from -35V to -3.2V.
- Drop-in replacement of commercial voltage references.
- Trimming capabilities.
- Operational beyond the -60°C to +230°C temperature range.
- Output current up to 50mA @ 230°C.
- Soft-start.
- Compatible with low and high dropout voltages.
- Stable over a wide range of load capacitance (0.1µF to 10µF).
- Low intrinsic current consumption (380µA @ 230°C).
- Low temperature dependence (40ppm/°C).
- Excellent line regulation (0.04%/V @ 230°C).
- Active-low shutdown control.
- Monolithic design for high-reliability.
- Latch-up free SOI process.
- Ruggedized SMT and thru-hole packages.

APPLICATIONS

- Reliability-critical, Automotive, Aeronautics & Aerospace, Down-hole.
- Positive and negative precision regulators/references, A/D and D/A converters, current sources, bridge excitation.

DESCRIPTION

XTR75030 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 -35V to -3.2V, XTR75030 parts can supply up to 50mA at +230°C while providing excellent regulation characteristics. Parts from this product family operate as a 3-terminal series regulator/reference with a temperature coefficient (TC) as low as 40ppm/°C. Up to ten possible output voltages (-15V to -1.2V) can be obtained from the same part.

Functionality features include shut-down mode and soft-start.

XTR75030 parts can be used in a wide range of applications such as positive and negative regulators/references, adjustable power supply, current sources, as well as precision bridge excitation.

Special design techniques were used allowing XTR75030 parts to offer a precise, robust and reliable operation in critical applications. Full functionality is guaranteed from -60°C to +230°C, though operation well below and above this temperature range is achieved.

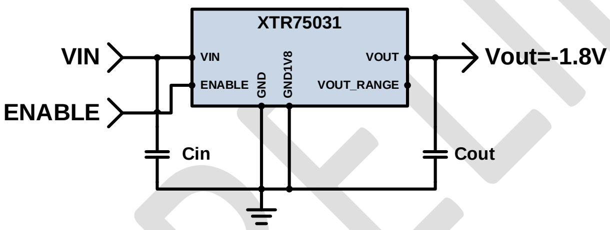
XTR75030 parts have been designed to reduce system cost and ease adoption by reducing the learning curve and providing smart and easy to use features.

Parts from the XTR75030 family are available in ruggedized SMT and thru-hole packages.

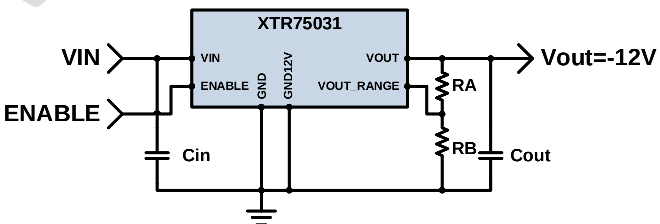
See also the Application Notes in the XTR75030 webpage

PRODUCT HIGHLIGHT

-1.8V Voltage Regulator/Reference



-12V Voltage Regultor with External Gain/or TRIM



$$V_{OUT} = \frac{(R_{A//B} + 10k\Omega) \cdot V_{OUT\_NOM} + 100k\Omega \cdot V_{REF\_ACTUAL}}{(R_{A//B} + 10k\Omega) \cdot \left(1 + \frac{100k\Omega}{R_A}\right)}$$

ORDERING INFORMATION

X	TR	75	03x
Source: X = X-REL Semi	Process: TR = HiTemp, HiRel	Part family	Part number

Product Reference	Temperature Range	Package	Pin Count	Marking
XTR75030-TD	-60°C to +230°C	Tested bare die		
XTR75031-D	-60°C to +230°C	Ceramic side brazed DIP	16	XTR75031
XTR75031-S	-60°C to +230°C	Ceramic SOIC	16	XTR75031
XTR75034-D	-60°C to +230°C	Ceramic side brazed DIP	8	XTR75034
XTR75034-FE	-60°C to +230°C	Gull-wing flat pack with ePad	8	XTR75034
XTR75035-D	-60°C to +230°C	Ceramic side brazed DIP	8	XTR75035
XTR75035-FE	-60°C to +230°C	Gull-wing flat pack with ePad	8	XTR75035

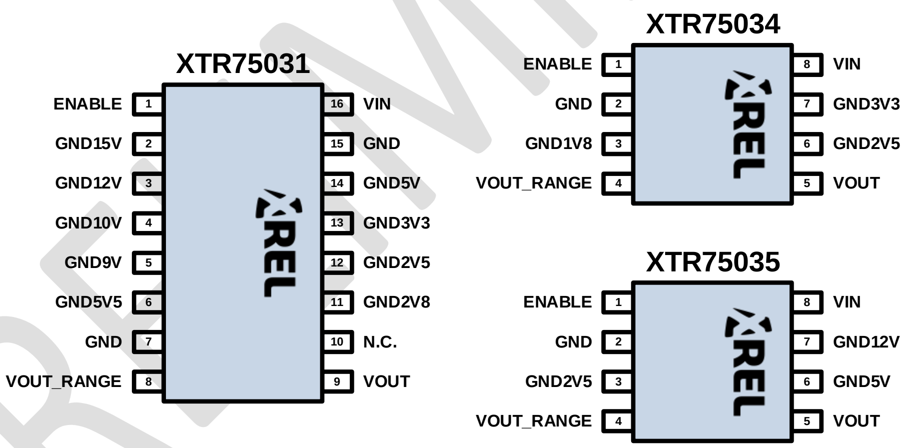
Other packages and packaging configurations possible upon request. For some packages or packaging configurations, MOQ may apply.

ABSOLUTE MAXIMUM RATINGS

Voltage on GND to VIN	-40 to 0.5V
Voltage on GND to VOUT	-17 to 0.5V
Voltage on GND to ENABLE	VIN-0.5 to 0.5V
Voltage on any other pin to GND	Max[-6V, VOUT] to 0.5V
Storage Temperature Range	-70°C to +230°C
Operating Junction Temperature Range	-70°C to +300°C
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 permanently affect device reliability.*

PACKAGING

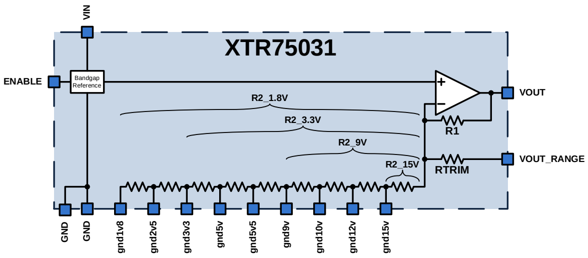


For devices with "FE" package options (CDFP8), ePAD connected to VIN.

INTERNAL BLOCK DIAGRAM

Possible output voltages depending on packaging options.

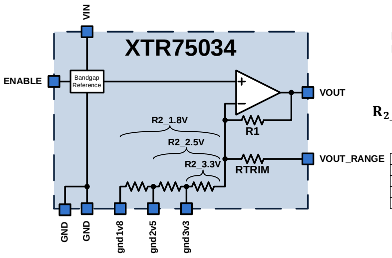
	-1.2V	-1.8V	-2.5V	-3.3V	-5V	-5.5V	-9V	-10V	-12V	-15V
XTR75030 (bare die)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
XTR75031	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
XTR75034	✓	✓	✓	✓						
XTR75035	✓		✓		✓				✓	



R1=100k
RTRIM=10k

$$VOUT = -1.2V\left(1 + \frac{R_1}{R_{2\_VOUT}}\right)$$

Possible Output Voltages
-1.2V
-1.8V
-2.5V
-3.3V
-5V
-5.5V
-9V
-10V
-12V
-15V

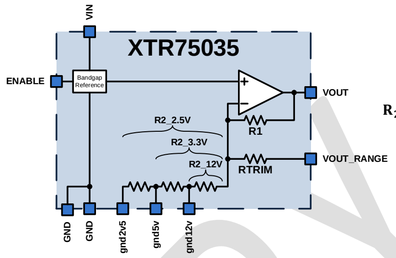


R1=100k
RTRIM=10k

$$VOUT = -1.2V\left(1 + \frac{R_1}{R_{2\_VOUT}}\right)$$

$$R_{2\_VOUT} = -\frac{1.2R_1}{VOUT + 1.2}$$

Possible Output Voltages
-1.2V
-1.8V
-2.5V
-3.3V



R1=100k
RTRIM=10k

$$VOUT = -1.2V\left(1 + \frac{R_1}{R_{2\_VOUT}}\right)$$

$$R_{2\_VOUT} = -\frac{1.2R_1}{VOUT + 1.2}$$

Possible Output Voltages
-1.2V
-2.5V
-5V
-12V

PIN DESCRIPTION

XTR75031		
Pin Number	Name	Description
1	ENABLE	Active-low shut-down terminal. Connect to GND when not used.
2	GND15V	Connect to GND to set V_{OUT}=-15V.
3	GND12V	Connect to GND to set V_{OUT}=-12V.
4	GND10V	Connect to GND to set V_{OUT}=-10V.
5	GND9V	Connect to GND to set V_{OUT}=-9.0V.
6	GND5V5	Connect to GND to set V_{OUT}=-5.5V.
7	GND	Circuit ground.
8	VOUT_RANGE	For external gain and trimming.
9	VOUT	Output voltage terminal. Decouple to GND with a capacitor of at least 100nF.
10	N.C.	No internal connection.
11	GND1V8	Connect to GND to set V_{OUT}=-1.8V.
12	GND2V5	Connect to GND to set V_{OUT}=-2.5V.
13	GND3V3	Connect to GND to set V_{OUT}=-3.3V.
14	GND5V	Connect to GND to set V_{OUT}=-5.0V.
15	GND	Circuit ground.
16	VIN	Input voltage terminal.

XTR75034		
Pin Number	Name	Description
1	ENABLE	Active-low shut-down terminal. Connect to GND when not used.
2	GND	Circuit ground.
3	GND1V8	Connect to GND to set V_{OUT}=-1.8V.
4	VOUT_RANGE	For external gain and trimming.
5	VOUT	Output voltage terminal. Decouple to GND with a capacitor of at least 100nF.
6	GND2V5	Connect to GND to set V_{OUT}=-2.5V.
7	GND3V3	Connect to GND to set V_{OUT}=-3.3V.
8	VIN	Input voltage terminal.

XTR75035		
Pin Number	Name	Description
1	ENABLE	Active-low shut-down terminal. Connect to GND when not used.
2	GND	Circuit ground.
3	GND2V5	Connect to GND to set V_{OUT}=-2.5V.
4	VOUT_RANGE	For external gain and trimming.
5	VOUT	Output voltage terminal. Decouple to GND with a capacitor of at least 100nF.
6	GND5V	Connect to GND to set V_{OUT}=-5.0V.
7	GND12V	Connect to GND to set V_{OUT}=-12V.
8	VIN	Input voltage terminal.

THERMAL CHARACTERISTICS

Parameter	Condition	Min	Typ	Max	Units
XTR75031-S (SOIC16)					
Thermal Resistance: J-C R_{Th_J-C}			22		°C/W
Thermal Resistance: J-A R_{Th_J-A}			120		°C/W
XTR75031-D (DIL16)					
Thermal Resistance: J-C R_{Th_J-C}			22		°C/W
Thermal Resistance: J-A R_{Th_J-A}			95		°C/W
XTR7503x-D (DIL8)					
Thermal Resistance: J-C R_{Th_J-C}			25		°C/W
Thermal Resistance: J-A R_{Th_J-A}			100		°C/W
XTR7503x-FE (DFP8 with exposed pad)					
Thermal Resistance: J-C R_{Th_J-C}	Measured on ePAD.		7		°C/W
Thermal Resistance: J-A R_{Th_J-A}	ePAD thermally connected to 3cm² PCB copper		70		°C/W

RECOMMENDED OPERATING CONDITIONS

Parameter	Min	Typ	Max	Units
Supply voltage V_{IN}	-35		-3.2	V
Output voltage V_{OUT}	-1.2		-15	V
Voltage on ENABLE to GND	V_{IN}		0	V
Voltage on VOUT_RANGE to GND	V_{OUT}		0	V
Output current	100µA[1]		$I_{LOADMax}$	
Case Temperature[2] T_C	-60		230	°C

[1] *A minimum output current of 100µA is recommended for stability reasons under any output voltage and temperature.*
[2] *Operation beyond the specified temperature range is achieved. The -60°C to +230°C range for the case temperature is considered for the case where no current is externally drawn from pin VDD, other than to supply the XTR75030 part.*

ELECTRICAL SPECIFICATIONS

Unless otherwise stated, specification applies for (VIN-VOUT)=-10V, ILOAD=10mA, -60°C<TC<230°C.

Parameter	Name	Condition	Min	Typ	Max	Units
Output Characteristics						
Nominal Output Voltages	V_{OUT}			-1.2 -1.8 -2.5 -3.3 -5.0 -5.5 -9.0 -10 -12 -15		V
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	T_C=85°C	-5		+5	%
Dropout Voltage	$(V_{IN}-V_{OUT})$ [1]	I_{LOAD}=10mA T_C=-60°C T_C=85°C T_C=230°C		200 280 410	270 350 540	mV
		I_{LOAD}=50mA T_C=-60°C T_C=85°C T_C=230°C		1.0 1.4 2.7	1.3 1.8 3.0	V
Drift with Temperature[2]	$(\Delta V_{OUT}/\Delta V_{OUT})/\Delta T$	Measured for worst case V_{IN} conditions. 100µA≤I_{LOAD}≤50mA	15	45	75	ppm/°C
Line Regulation[2]	$\Delta V_{OUT}/V_{OUT}$	I_{LOAD}=10mA V_{OUT}≥-1.8V; V_{IN}=-2.8V to -35V V_{OUT}≤-2.5V; V_{IN}=V_{OUT}-0.5V to -35V T_C=-60°C T_C=85°C T_C=230°C		0.005 0.02 0.04		%/V
Maximum Load Current	$I_{LOADMax}$	Any V_{OUT} for (V_{IN}-V_{OUT})≤-5V, T_C=230°C (worst case) Any V_{OUT} for (V_{IN}-V_{OUT})≤-2V, T_C=230°C (worst case) V_{IN}=-2.8V, T_C=230°C (worst case) V_{OUT}=-1.2V V_{OUT}=-1.8V V_{OUT}=-2.5V	50 30 20 15 5	70 40 30 20 7		mA
Load Regulation[2]	$\Delta V_{OUT}/\Delta I_{LOAD}$	I_{LOAD}=1mA to 30mA, (V_{IN}-V_{OUT})=-2V. See Figure 15 V_{OUT}=-1.2V (TRIM connected to VOUT) V_{OUT}=-15V		0.18 2.25	0.25 3.10	mV/mA
		I_{LOAD}=1mA to 50mA, (V_{IN}-V_{OUT})=-5V. See Figure 16 V_{OUT}=-1.2V (TRIM connected to VOUT) V_{OUT}=-15V		0.15 1.90	0.22 2.60	

[1] *ΔVOUT is defined as |VOUT_Max – VOUT_min| within the indicated range of temperature, input voltage or load current.*

[2] *Difference between the input and output voltages that makes VOUT to deviate by 1% from its nominal value at the same load current.*

[3] *The drift is defined as the following equation:* $temperature\_drift = 1e6 \times \frac{V_{OUT}(T_{MAX}) - V_{OUT}(T_{MIN})}{V_{OUT\_NOMINAL}} \times \frac{1}{T_{MAX} - T_{MIN}}$

[4] *The line regulation is defined as the following equation* $Line\_reg = 100 \times \frac{V_{OUT}(V_{IN\_MAX}) - V_{OUT}(V_{IN\_MIN})}{V_{OUT\_NOMINAL}} \frac{1}{V_{IN\_MAX} - V_{IN\_MIN}}$

[5] *Worst case: TC=230°C*

[6] *The load regulation is defined as the following equation:* $Load\_reg = \frac{V_{OUT}(I_{LOAD\_MIN}) - V_{OUT}(I_{LOAD\_MAX})}{I_{LOAD\_MIN} - I_{LOAD\_MAX}}$

ELECTRICAL SPECIFICATIONS (CONTINUED)

Unless otherwise stated, specification applies for (V_{IN}-V_{OUT})=-10V, I_{LOAD}=10mA, -60°C<T_C<230°C.

Parameter	Name	Condition	Min	Typ	Max	Units
Supply Current						
Quiescent Ground Current	I_{GND}	V_{OUT}=-5.0V T_C=-60°C T_C=85°C T_C=230°C		200 300 380	250 360 480	µA
Shut-down Mode Current	$I_{Std\text{-}by}$	V_{IN}=-35V T_C=85°C T_C=230°C		25 38	40 60	µA
Shut-down Mode						
Enable Voltage	V_{ON}	V_{IN} from -2.8V to -35V /SHDN going up. Worst case for T_C=-60°C.		1.8	2.3	V
Shut-down Voltage	V_{OFF}	V_{IN} from -2.8V to -35V /SHDN going down. Worst case for T_C=230°C.	0.6	0.9		V
Shut-down Hysteresis	V_{SDH}	/SHDN going up then down.	0.2	0.4		V
/SHDN Current	$I_{/SHDN}$	$V_{/SHDN}$=0V $V_{/SHDN}$=-5V	-6 -5		0 1	µA
Dynamic Characteristics						
Turn-ON Time vs. VIN	$t_{ON\text{-}VIN}$	V_{IN} steps up from 0V to -10V. See Figure 27 /SHDN connected to VIN, C_{LOAD}=1µF, T_C=-60°C (worst case) V_{OUT}=-1.2V V_{OUT}=-5V		10 500		µs
Turn-ON Time vs. /SHDN	$t_{ON\text{-}SHDN}$	/SHDN steps up from -0.6V to -2.3V. See Figure 28 V_{IN}=-10V, C_{LOAD}=1µF T_C=-60°C (worst case) V_{OUT}=-1.2V V_{OUT}=-5V		35 550		µs
Input Voltage Rejection	PSRR	Freq=1kHz		-50		dB
Input Capacitance[1]	C_{IN}			1		µF
Load Capacitance[1]	C_{OUT}		0.1	1	10	µF
Noise Characteristics						
Integrated Voltage Noise	V_n	V_{IN}=-10V, V_{OUT}=-5.0V, C_{IN}=C_{OUT}=1µF, I_{LOAD}=≤ 50mA BW=0.1Hz to 10Hz. T_C=-60°C T_C=85°C T_C=230°C		93 56 35		µV_{rms}
		BW=10Hz to 100kHz. T_C=-60°C T_C=85°C T_C=230°C		181 144 134		µV_{rms}
Spectral Density		V_{IN}=-10V, V_{OUT}=-5.0V, C_{IN}=1µF, C_{OUT}=1µF. I_{LOAD}=0 to 50mA, 100Hz. T_C=-60°C T_C=85°C T_C=230°C		6.7 3.6 2.8		µV/√Hz

[1] *For stability reasons, input and load capacitances must be of ceramic type with low ESR (≤1Ω) and connected as close as possible to the part, from the input and output nodes to ground.*

TYPICAL PERFORMANCE

Figure 1. Ground Current (I_{GND}) vs Case Temperature in active mode.

Figure 2. Stand-by current ($I_{Std\text{-}by}$) vs Case Temperature (/SHDN=LOW).

Figure 3. Output Voltage (V_{OUT}) vs Case Temperature. I_{LOAD}=10mA, normalized to V_{OUT}=1,2V.

Figure 4. Output Voltage (V_{OUT}) vs Case Temperature. I_{LOAD}=10mA, normalized to V_{OUT}=5,0V.

Figure 5. Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=0.1mA, normalized to V_{OUT}=1,2V.

Figure 6. Zoom on the start-up showing Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=0.1mA, normalized to V_{OUT}=1,2V.

TYPICAL PERFORMANCE (CONTINUED)

Figure 7. Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=10mA, normalized to V_{OUT}=1,2V.

Figure 8. Zoom on the start-up showing Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=10mA, normalized to V_{OUT}=1,2V.

Figure 9. Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=0.1mA, normalized to V_{OUT}=5V.

Figure 10. Zoom on the start-up showing Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=0.1mA, normalized to V_{OUT}=5V.

Figure 11. Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=10mA, normalized to V_{OUT}=5V.

Figure 12. Zoom on the start-up showing Output Voltage (V_{OUT}) vs Input Voltage for different case temperatures. I_{LOAD}=10mA, normalized to V_{OUT}=5V.

TYPICAL PERFORMANCE (CONTINUED)

Figure 13. Line Regulation vs Output Voltage for different case temperatures. I_{LOAD}=10mA, V_{IN} swept from Max[2.8V; V_{OUT}+0.5V] to 40V.

Figure 14. Line Regulation vs Case Temperature for different output voltages. I_{LOAD}=10mA, V_{IN} swept from Max[2.8V; V_{OUT}+0.5V] to 40V.

Figure 15. Load Regulation vs Nominal Output Voltage for different case temperatures. Load current sept from 1mA to 30mA, (V_{IN}-V_{OUT})=2V.

Figure 16. Load Regulation vs Nominal Output Voltage for different case temperatures. Load current sept from 1mA to 50mA, (V_{IN}-V_{OUT})=5V.

Figure 17. Output Voltage (V_{OUT}) vs Load Current for different case temperatures. V_{OUT}=1.2V, (V_{IN}-V_{OUT})=2V.

Figure 18. Output Voltage (V_{OUT}) vs Load Current for different case temperatures. V_{OUT}=1.2V, (V_{IN}-V_{OUT})=5V.

TYPICAL PERFORMANCE (CONTINUED)

Figure 19. Output Voltage (V_{OUT}) vs Load Current for different case temperatures. V_{OUT}=5V, (V_{IN}-V_{OUT})=2V.

Figure 20. Output Voltage (V_{OUT}) vs Load Current for different case temperatures. V_{OUT}=5V, (V_{IN}-V_{OUT})=5V.

Figure 21. Minimum dropout (V_{IN}-V_{OUT}) vs Case Temperature for different load currents. V_{OUT}=5V.

Figure 22. Spread of normalized initial output voltage accuracy (V_{OUT}-V_{OUT_Nom})/V_{OUT_Nom} over ten typical samples vs nominal output voltage. T_C=85°C, I_{LOAD}=1mA and (V_{IN}-V_{OUT})=2V.

Figure 23. Start-up at V_{OUT}=1.2V for several case temperatures when /SHDN swept from 0.5V to 2.3V. V_{IN}=10V, C_{OUT}=1µF, I_{LOAD}=10mA. Overlap of curves from 10 different devices.

Figure 24. Start-up at V_{OUT}=15V for several case temperatures when /SHDN swept from 0.5V to 2.3V. V_{IN}=20V, C_{OUT}=1µF, I_{LOAD}=10mA. Overlap of curves from 10 different devices.

TYPICAL PERFORMANCE (CONTINUED)

Figure 25. Start-up at V_{OUT}=1.2V for several case temperatures when V_{IN} swept from 0V to 10V. /SHDN connected to VIN, C_{OUT}=1µF, I_{LOAD}=10mA. Overlap of curves from 10 different devices.

Figure 26. Start-up at V_{OUT}=15V for several case temperatures. V_{IN} swept from 0V to 20V. /SHDN connected to VIN, C_{OUT}=1µF, I_{LOAD}=10mA. Overlap of curves from 10 different devices.

Figure 27. Start-up time vs nominal output voltage for several case temperatures when V_{IN} is swept from 0V to 10V. /SHDN connected to VIN, C_{OUT}=1µF, I_{LOAD}=10mA.

Figure 28. Start-up time vs nominal output voltage for several case temperatures when /SHDN is swept from V_{OFF}=0.6V to V_{ON}=2.3V with V_{IN} constant. C_{OUT}=1µF, I_{LOAD}=10mA.

THEORY OF OPERATION

Introduction

Product description

The XTR75030 is a full CMOS series voltage regulator able to operate from -60°C to +230°C, with input voltages from -2.8V to -35V. Depending on packaging options, up to ten different output voltages from the same part (XTR75031) or pin-to-pin compatibility with other commercial voltage references can be obtained.
An active LOW shut-down functionality feature is provided, helping reduce power consumption in power-critical applications. A trimming input allows a fine tuning of the output voltage to the desired value.

Using the XTR75031 and XTR75032

The XTR75031 is the full-featured version in the family. All voltages are available from the same 16-pin package, so there is no need to order a XTR75031 with given output voltage.
The XTR75032 has a preselected output voltage and must be ordered with the variant code corresponding to the desired output voltage (see the Ordering Information section).
To select an output voltage in the XTR75031, just connect to GND the terminal corresponding to the desired output voltage.
The following two figures show how to use the XTR75031 (in DIP16 or SOIC16 packages) in order to provide output voltages of -3.3V and -10V. In each case, the terminal corresponding to the desired output voltage is connected to GND. By doing this, the appropriate resistor tap (see internal diagram of XTR75031 in the Internal Block Diagram section) is grounded, thus providing the appropriate division factor in the feedback.

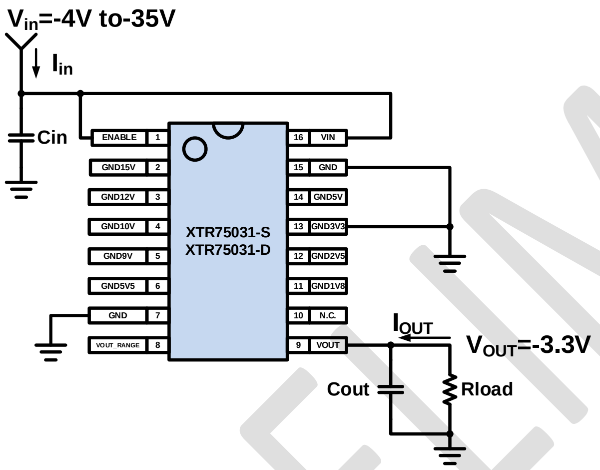


Figure 29. Application of XTR75031 providing 3.3V.

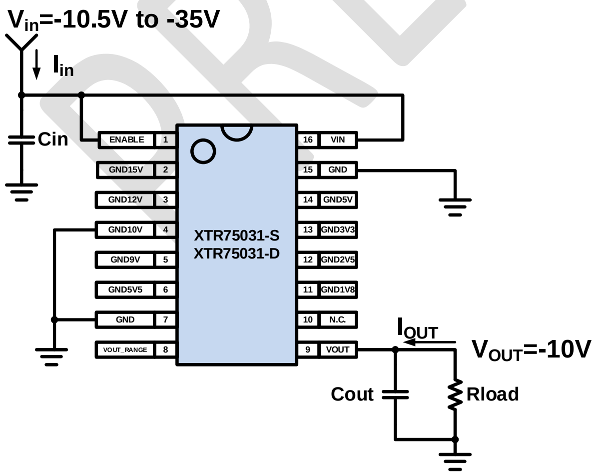


Figure 30. Application of XTR75031 providing 10V.

The usage of the XTR75032 is straightforward as no setting is needed from the user in order to obtain the desired output voltage (preset at assembly phase).

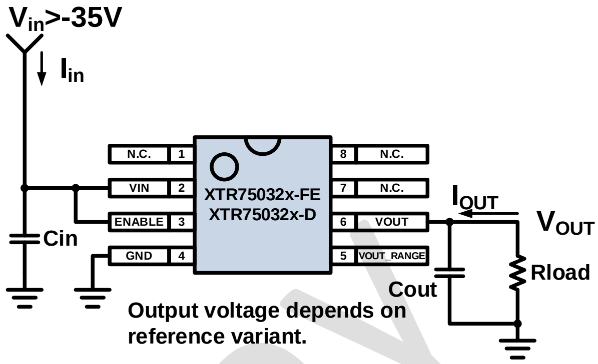


Figure 31. Application of XTR75032.

Input and output bypassing

Appropriate input bypassing is mandatory with the use of every linear regulator as the XTR75031 and XTR75032. This bypassing is needed in order to filter out input noise and provide a low AC impedance power supply to ensure stability.
In the final application, in general, the power supply is well decoupled and the parasitic inductance between the power supply and the regulator's input is low.
However, during the first evaluations of a product in the laboratory, it may happen that the part is just placed on a breadboard connected to a power supply by means of relatively long cables. In this case, the equivalent circuit would be as shown in Figure 32.

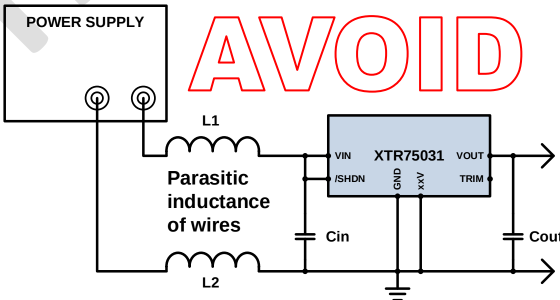


Figure 32. Non-optimum breadboard connection with voltage regulator.

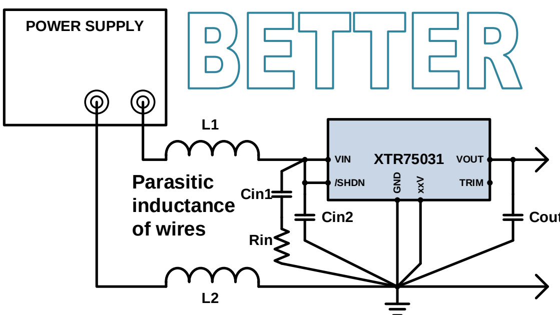


Figure 33. Better breadboard connection with voltage regulator.

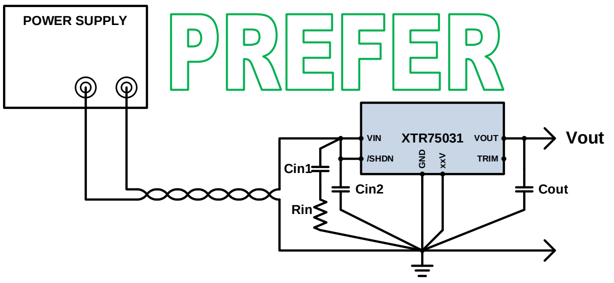


Figure 34. Preferred breadboard connection with voltage regulator.

The role of R_{IN} in Figure 33 and Figure 34 is to reduce the quality factor of the LC input circuit and provide a damping factor.
Use values for C_{IN} starting from 50-100nF and C_{OUT} values between 0.1µF to 10µF.

$$C_{IN} > 50\text{-}100nF$$

$$100nF < C_{OUT} < 10\mu F$$

These capacitors are required with low ESR-ESL and as close as possible from the XTR75030 parts. Then other capacitors with larger ESR-ESL can be used in parallel to the main input and output bypassing capacitors.

General Considerations

Thermal considerations

The XTR75030 has no internal thermal shutdown feature, allowing it to operate even above the -60°C to +230°C range. The user must ensure that the junction temperature does not exceed the temperature indicated in the Absolute Maximum Ratings and remain within the recommended temperature range whenever possible. Functionality can be achieved up to nearly 250°C at the expenses of reducing product lifetime.
Notice that there is no short circuit current limitation. The maximum short circuit current depends on input and output voltages, as well as on initial ambient temperature, being able to exceed 150mA in certain cases.

Ground connection

The XTR75030 ground pin should always be connected to the supply ground prior applying any input voltage. Accidental disconnecting of the ground terminal under operation could damage the part and its load.

Regulator input shorting

For a nominal output voltage $V_{OUT} \leq -2.5V$, connecting the input voltage to ground while the output capacitance is fully charged can create a large reverse current through the regulator pass element. If the load capacitance is large enough, the reverse current duration can be such that the regulator gets damaged.

Current sinking capabilities

XTR75030 parts are not able to source any current. Doing so would pull the output voltage above its nominal value and could damage the regulator and its load.

Minimum input voltage

The minimum input voltage required for a correct operation of the internal circuitry is -2.8V. In other words, to be within specifications, V_{IN} should be larger than Min[V_{OUT}-dropout,-2.8V] where the dropout value depends on the required output current.

Dropout

The minimum dropout of the regulator is a function of the load current, temperature and the minimum desired line regulation.
The architecture of the regulator is such that the line regulation remains at very low values even for the maximum allowed input voltage. However, thermal aspects must be considered as to not overheating the parts.

Functional Features

Start-up and transient behavior

The start-up of the regulator is guaranteed over the whole operating temperature range. Once in operation, the input voltage should not present large and fast negative voltage steps (5V with slopes higher than 100V/ms). Large and fast negative steps on VIN could briefly turn off the regulator.
As most linear voltage regulators, the line rejection decreases at higher frequencies so that a large and fast VIN step could generate a large transient on the regulator output and damage its load.
At start-up, the regulator needs to charge the output capacitance to V_{OUT}. Internal provisions are made to have the regulator to present a soft-start phase. This gives a soft ramp-up of the output voltage. However, at start-up, some output overshoot (350mV) can be observed for V_{OUT}=-1.2V when using a low-value load capacitance (100nF) and a large and fast positive step on VIN (5V with slopes higher than 100V/ms). The overshoot duration is observed to last for about 10-20µsec. However, for a load capacitance of 1µF or higher, there is no observable overshoot on the output, even for the -1.2V mode.

Shut-down functionality

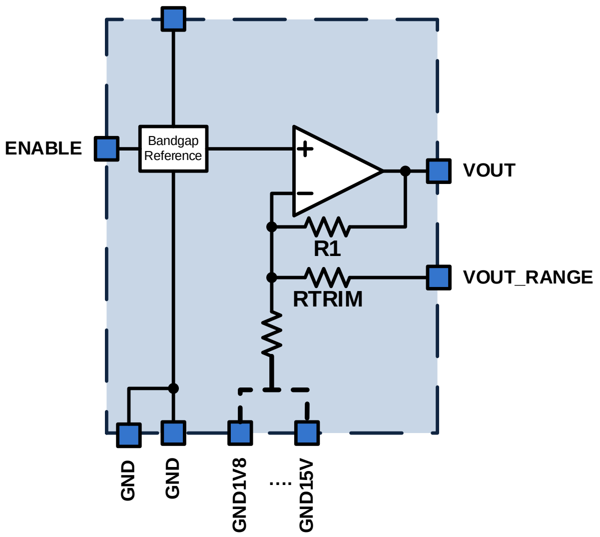
Shut-down feature allows to securely turn off the regulator when a voltage higher than -0.6V is applied on /SHDN terminal (a current up to 8µA can go out of this lead in this condition). In such condition, the regulator output goes to high impedance and the residual current consumption of the regulator is below 10% of the nominal operation current consumption.
In order to turn the regulator on, the /SHDN input must see a voltage of at least -2.3V (with a possible input current of up to 1µA). The /SHDN input must be directly connected to VIN if not used.
Considerations concerning possible output overshoot when /SHDN is pulled-up are the same than the one mentioned earlier at VIN start-up.
Start-up times when using the /SHDN input control are quite similar to those obtained by applying a VIN ramp-up.

Stability

The regulator is stable as long as it sees the minimum required input and load capacitance with an ESR ≤1Ω placed as close as possible from the VIN and VOUT nodes to GND. Other capacitors with any ESR can further be added in parallel at some distance from the regulator.
To ensure the part is stable for any output voltage and under any input voltage and temperature conditions, a minimum load current of 100µA is recommended.
When selecting V_{OUT}=-1.2V, it is recommended to connect terminal TRIM to terminal VOUT. This not only improves the stability region, also it greatly improves the load regulation.

Output voltage trimming

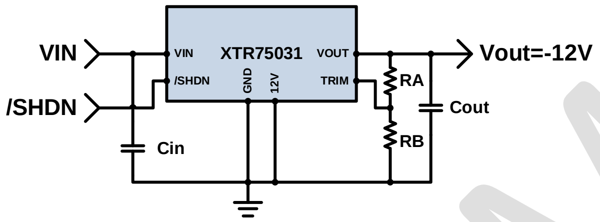
XTR75030 parts can be used as voltage regulators or as references due to their intrinsic very good stability against input voltage, load current and temperature variations.
When a highly accurate output voltage is needed, parts in the XTR75030 family have a terminal which allows the final user to fine trim the output voltage: the TRIM terminal.
The TRIM terminal has an input impedance of 10kΩ which allows modifying the feedback ratio, hence changing the output voltage.



From the block diagram it can be seen that, if the TRIM feature is not used (left floating), the nominal output voltage is given by

$$V_{OUT\_NOM} = -1.2V \cdot \left(1 + \frac{R_1}{R_2}\right)$$

The following figure shows a regulator with fine trimming feature used.



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Terminal "XX" represents any terminal from "-1.8V" to "-15V". In this case the exact output voltage is given by

$$V_{OUT} = \frac{\left(R_{A//B} + 10k\Omega\right) \cdot \frac{V_{OUT\_NOM}}{-1.2V} + 100k\Omega}{10k\Omega + R_{A//B} \cdot \left(1 + \frac{100k\Omega}{R_A}\right)} \cdot V_{REF\_ACTUAL}$$

V_{OUT_NOM} is the nominal output voltage, V_{REF_ACTUAL} is the actual (untrimmed) internal reference voltage (-1.2V±2%) and $R_{A//B}$ is the parallel reduction of R_A and R_B. The following table shows the value of R_B for R_A=100k, supposing a spread of ±2% on nominal value of the reference voltage.

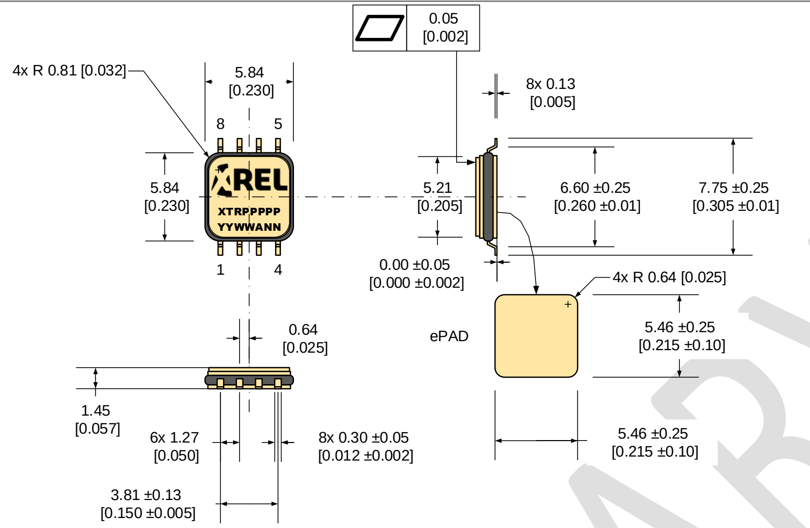
V_{OUT_NOM}	R_B (k)	
	V_{REF_NOM}-2%	V_{REF_NOM}+2%
-1.8V	176.67	228.86
-2.5V	84.92	100.66
-3.3V	53.24	61.43
-5.0V	29.64	33.66
-5.5V	26.21	29.72
-9.0V	14.44	16.39
-10V	12.78	14.54
-12V	10.39	11.87
-15V	8.10	9.33

See also product webpage for Application Notes on how to trim and get different output voltages from the XTR75030.

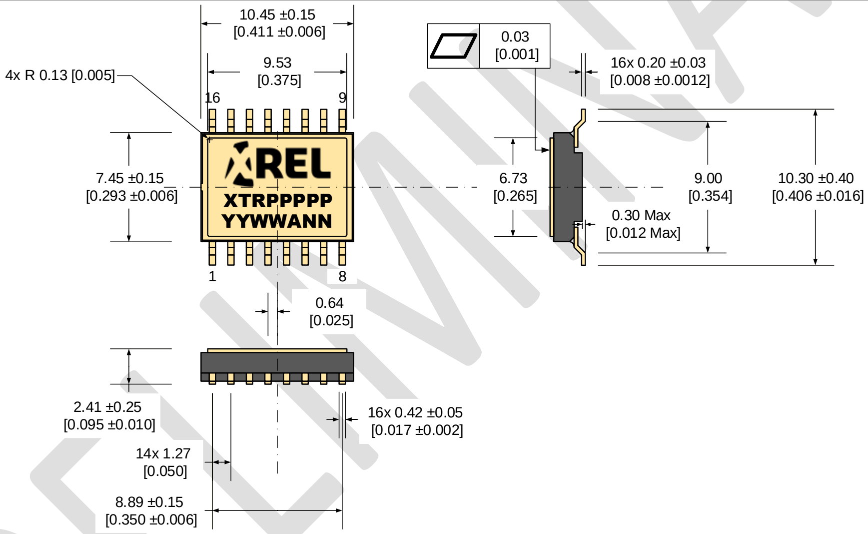
PACKAGE OUTLINES

Dimensions shown in mm [inches]. Tolerances ±0.13 mm [±0.005 in] unless otherwise stated.

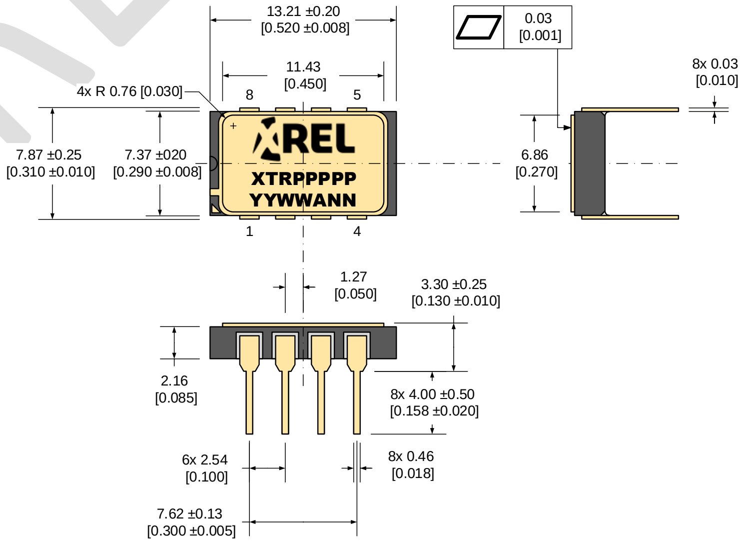
Ceramic Gull-wing Flat pack with ePad DFP8



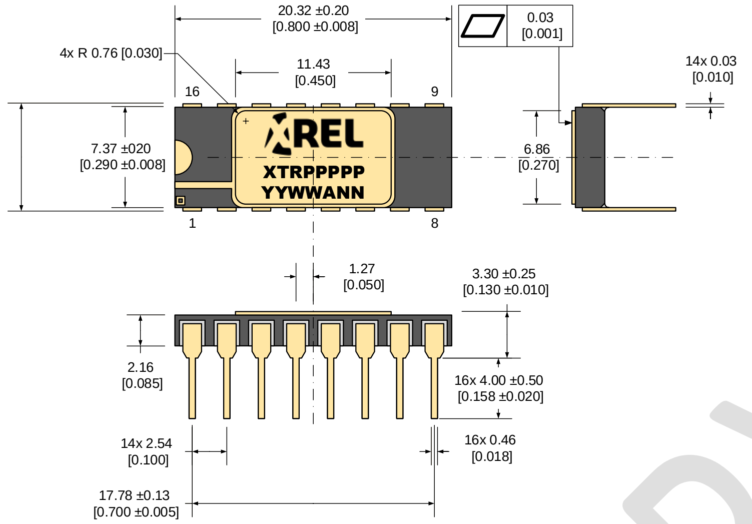
Ceramic Small Outline IC SOIC16



Ceramic Side Brazed Dual In-line DIP8



Ceramic Side Brazed Dual In-line DIP16



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).

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