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A New Direction in Mixed-Signal

May 2013

**XRP1117**

## 800mA Low Dropout Positive Voltage Regulator

Rev. 1.0.0

### GENERAL DESCRIPTION

The XRP1117 is a low power positive-voltage low dropout regulator capable of providing up to 800mA of output load current. This device is available in a fixed 3.3V output voltage and an adjustable output voltage version.

The XRP1117 is optimized for low voltage operations where transient response and minimum input voltage are critical. Dropout voltage is guaranteed at a maximum of 1.3V at 800mA, decreasing at lower load currents. As the load current decreases, the quiescent current flows into the load effectively increasing the efficiency of the regulator. On chip trimming adjusts the reference/output voltage to within  $\pm 1\%$ .

Built-in over temperature and over-current protection insures safe operation under abnormal operating conditions.

The XRP1117 is available in a RoHS compliant, green/halogen free space-saving and low profile 3-pin SOT223 package.

### APPLICATIONS

- Desktop PC Server
- Graphic/Video Card
- Industrial Equipment
- Power Supplies Post Regulation

### FEATURES

- **Guaranteed 800mA Output Current**
  - 1A Peak Current
  - 1.35A Typical Current Limit
- **Adjustable and 3.3V Fixed Output Voltage Options**
  - $\pm 1\%$  Accuracy
- **1.2V Low Dropout Voltage**
- **Low Quiescent Current**
- **Over Current and Thermal Protection**
- **Lead Free, RoHS Compliant SOT223 Package**

### FUNCTIONAL DIAGRAM

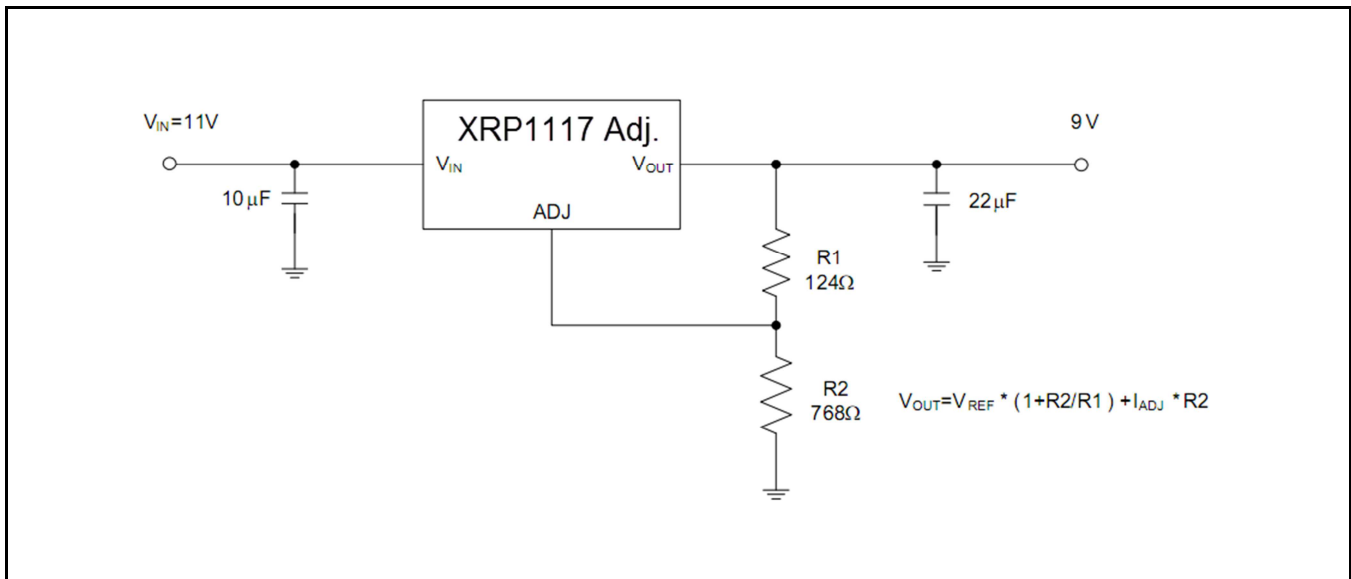


Fig. 1: XRP1117 Application Diagram



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**ABSOLUTE MAXIMUM RATINGS**

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Input Supply Voltage  $V_{IN}$  ..... 18V  
 Junction Temperature ..... 150°C  
 Lead Temperature (Soldering, 10 sec) ..... 260°C  
 Storage Temperature ..... -65°C to 150°C  
 ESD Rating (HBM - Human Body Model) ..... 2kV

**OPERATING RATINGS**

Input Voltage  $V_{IN}$  ..... 15V  
 Operating Junction Temperature ..... -40°C to 125°C  
 Maximum Output Current ..... 800mA min  
 Thermal Resistance .....  
 $\theta_{JC}$  ..... 15°C/W  
 $\theta_{JA}$  (see Thermal Characteristics in the Application Information)

**ELECTRICAL SPECIFICATIONS**

Specifications are for an Operating Ambient Temperature of  $T_A = T_J = 25^\circ\text{C}$  only; limits applying over the full Operating Junction Temperature range are denoted by a "•". Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at  $T_J = 25^\circ\text{C}$ , and are provided for reference purposes only. Unless otherwise indicated,  $V_{IN} = V_{OUT} + 2\text{V}$ ,  $I_{OUT} = 10\text{mA}$ ,  $T_A = T_J = 25^\circ\text{C}$ .

Parameter	Min.	Typ.	Max.	Units	Conditions
<b>3.3V Version</b>					
Output Voltage	3.267 3.235	3.300	3.333 3.365	V	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
Line Regulation		0.5	6 10	mV	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
Load Regulation		2	15	mV	
<b>Adjustable Voltage Version</b>					
Reference Voltage	1.238 1.225	1.250	1.262 1.270	V	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
Line Regulation		0.001	0.1 0.2	%	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
Load Regulation		0.4	1	%	
Adjust Pin Current		60	120	$\mu\text{A}$	•
Adjust Pin Current Change		0.2	5	$\mu\text{A}$	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
Minimum Load Current		1.7	5	mA	• $1.5\text{V} \leq (V_{IN} - V_{OUT}) \leq 10\text{V}$
<b>All Voltage Options</b>					
Dropout Voltage		1.2	1.3	V	$I_{OUT} = 800\text{mA}$ , $\Delta V_{REF} = 1\%^2$
Current Limit	1.0	1.35		A	
Ripple Rejection		70		dB	$f = 120\text{Hz}$ , $C_{OUT} = 22\mu\text{F}$ , $I_{OUT} = 300\text{mA}$ , $(V_{IN} - V_{OUT}) = 3\text{V}$
Output Voltage Temperature Stability		0.5		%	
RMS Output Noise		0.003		%	% of $V_{OUT}$ , $10\text{Hz} \leq f \leq 10\text{kHz}$
Thermal Shutdown		160		°C	Junction temperature
Thermal Shutdown Hysteresis		16		°C	

Note 2: Dropout voltage is the input voltage minus output voltage that produces a 1% decrease in output voltage with respect to the nominal output voltage at  $V_{IN} = V_{OUT} + 2\text{V}$



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**PIN ASSIGNMENT**

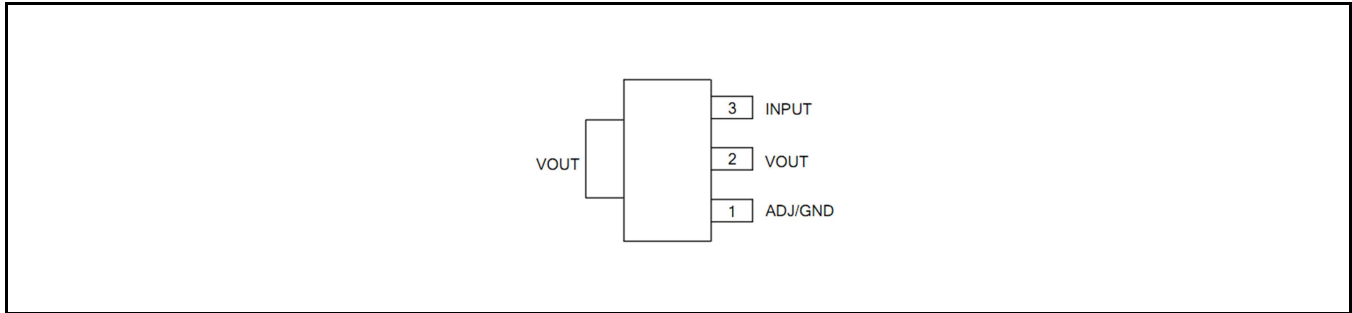


Fig. 2: XRP1117 Pin Assignment (Top View, TAB connected to  $V_{OUT}$ )

**ORDERING INFORMATION**

Part Number	Temperature Range	Marking	Package	Packing Quantity	Note 1	Note 2
XRP1117ESETR-F	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	1117ESE YYWWF	SOT223-3	2.5K/Tape & Reel	Halogen Free	Adjustable Output Voltage
XRP1117ESETR-33-F	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	1117ESE 33YYWWF	SOT223-3	2.5K/Tape & Reel	Halogen Free	3.3V Output Voltage

“YY” = Year - “WW” = Work Week - “F” = Halogen Free Indicator - “X” = Lot Number

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**TYPICAL PERFORMANCE CHARACTERISTICS**

All data taken at  $T_A = T_J = 25^\circ\text{C}$ , unless otherwise specified - Schematic and BOM from Application Information section of this datasheet.

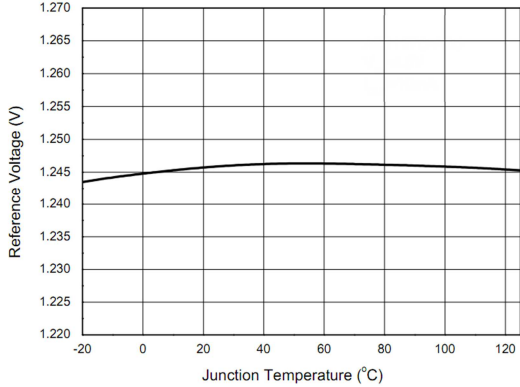


Fig. 3: Reference Voltage vs Junction Temperature  
XRP1117ESETR-F,  $V_{IN}=4.5\text{V}$ ,  $I_{OUT}=10\text{mA}$

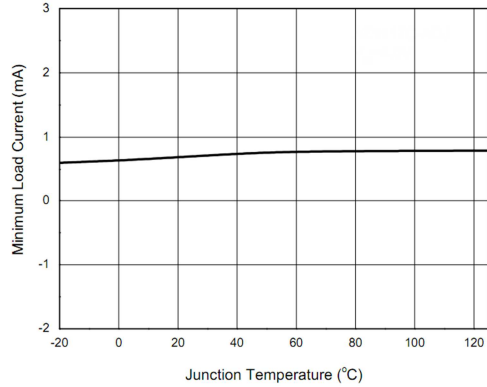


Fig. 4: Minimum Load Current vs Junction Temperature  
XRP1117ESETR-F,  $V_{IN}=4.5\text{V}$

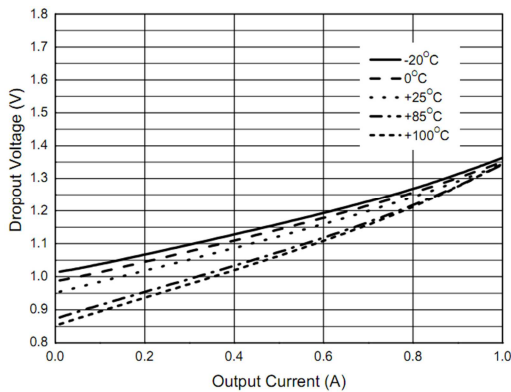


Fig. 5: Dropout Voltage vs. Output Current

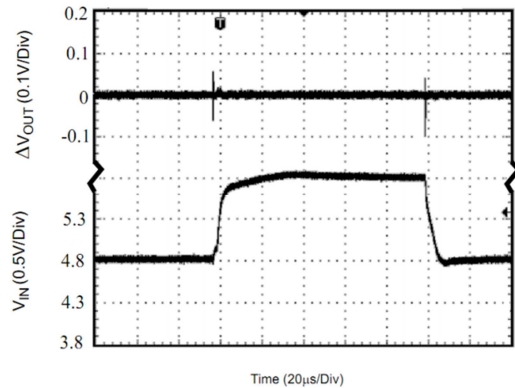


Fig. 6: Line Transient Response

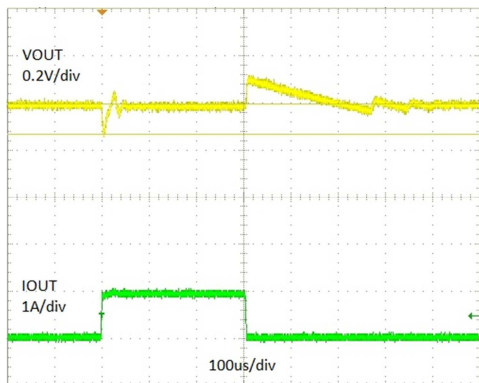


Fig. 7: Load Transient Response, 10mA-800mA

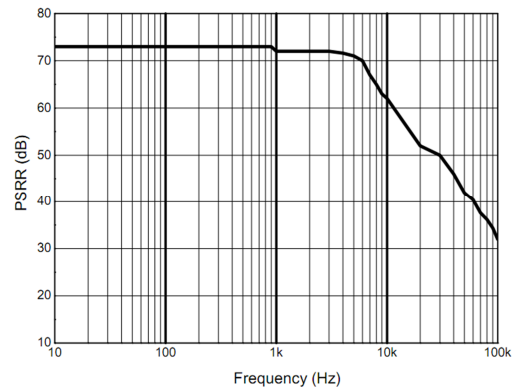


Fig. 8: PSRR vs. Frequency

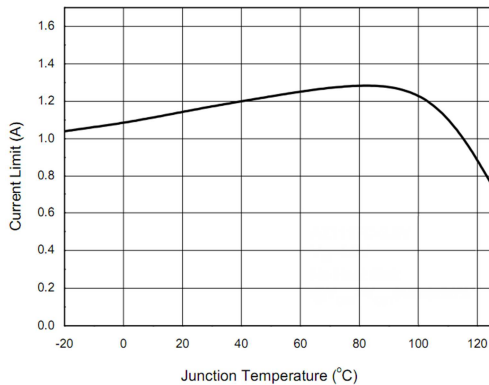


Fig. 9: Current Limit vs. Junction Temperature  
 $V_{IN}=4.5V$ , no heatsink,  $V_{OUT}=V_{OUT(nom)}\times 98\%$

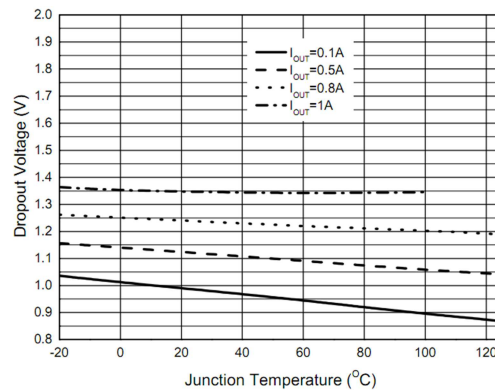


Fig. 10: Dropout Voltage vs. Junction Temperature

## APPLICATION INFORMATION

### OUTPUT VOLTAGE

The typical application circuits for the adjustable output regulator are shown below in Figures 15.

The adjustable output voltage device is a floating voltage regulator. The XRP1117 develops and maintains a nominal 1.25 V reference voltage between the output and adjust pins. The reference voltage is programmed to a constant current source by resistor R1, and this current flows through R2 to ground to set the output voltage.

The output of the adjustable regulator can be set to any voltage between 1.25V and 15V. The value of  $V_{OUT}$  can be quickly approximated using the formula

$$V_{OUT} = 1.25 \times \frac{R_1 + R_2}{R_1}$$

A small correction to this formula is required depending on the values of resistors R1 and R2, since the adjustable pin current (approx 50µA) flows through R2. When  $I_{ADJ}$  is taken into account, the formula becomes

$$V_{OUT} = V_{REF} \times \frac{R_1 + R_2}{R_1} + I_{ADJ} \times R_2$$

Where  $V_{REF}=1.25V$

The programmed current level is usually selected to be greater than the specified

5.0mA minimum that is required for regulation.

For fixed voltage option, the resistors R1 and R2 are included in the regulator.

### INPUT CAPACITOR

A XRP1117 device located more than a few inches away from the power source may require an input bypass capacitor  $C_{in}$  for regulator stability. This capacitor will reduce the circuit's sensitivity when powered from a complex source impedance and significantly enhance the output transient response. The input bypass capacitor should be mounted with the shortest possible traces as close as possible to the regulator's input and ground terminals. A 10µF ceramic or tantalum capacitor should be adequate for most applications.

### OUTPUT CAPACITOR

The XRP1117 requires an output capacitor of at least 22µF (tantalum or ceramic or Aluminum Electrolytic) to ensure stability. The value may change based on the application requirements of the output load or temperature range. The value of ESR can vary based on the type of capacitor used in the applications to guarantee stability. The recommended value for ESR is 0.5Ω or less. A larger value of output capacitance (up to 100µF) can improve the loop stability and load

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transient response as well as reducing output noise.

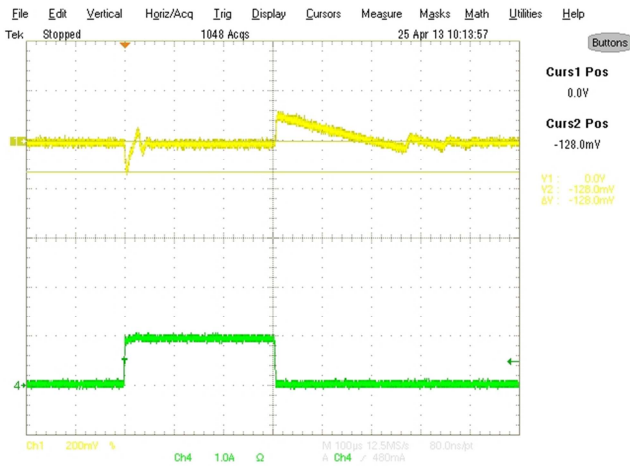


Fig. 11: Load Step Response 10mA to 800mA  
 $V_{IN}=3.3V$ ,  $V_{OUT}=1.8V$ ,  $C_{IN}=10\mu F$ ,  $C_{OUT}=22\mu F$  Ceramic  
 $ch1=V_{OUT}$ ,  $ch4=I_{LOAD}$ ,  $time=100us/div$

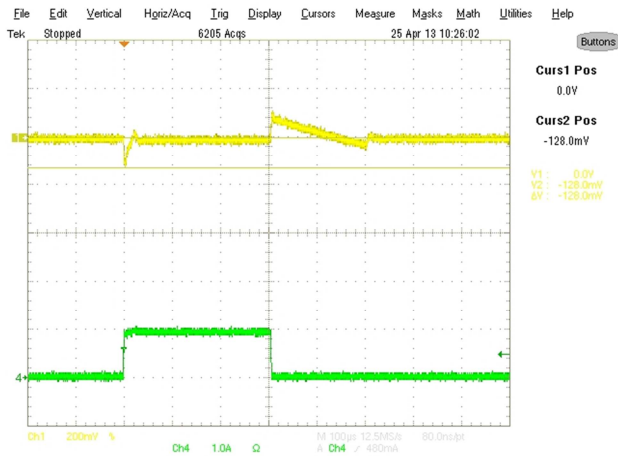


Fig. 12: Load Step Response 10mA to 800mA  
 $V_{IN}=3.3V$ ,  $V_{OUT}=1.8V$ ,  $C_{IN}=10\mu F$ ,  $C_{OUT}=22\mu F$ , OSCON  
 $ch1=V_{OUT}$ ,  $ch4=I_{LOAD}$ ,  $time=100us/div$

**PRE-BIAS OUTPUT VOLTAGE START-UP**

The SPX1117 is not intended for operations requiring start-up into a pre-biased load. Proper discharge of the output voltage is recommended prior of turning on the device through the application of the input voltage.

**PROTECTION DIODES**

The XRP1117 does not require any protection diodes for normal operations and diodes between input and output are not usually needed. The internal diode between the output

and input pins of the device can withstand microsecond surge currents. A combination of large output capacitors and an input pin instantaneously shorted to ground may cause some damage to the device; under these conditions, a diode between the output (anode) and input (cathode) pins is recommended.

**SOLDERING METHODS**

The XRP1117 SOT-223 package is designed to be compatible with infrared reflow or vapor-phase reflow soldering techniques. During soldering, the non-active or mildly active fluxes may be used. The XRP1117 die is attached to the heatsink lead which exits opposite the input, output, and ground pins.

Hand soldering and wave soldering should be avoided since these methods can cause damage to the device with excessive thermal gradients on the package. The SOT-223 recommended soldering method are as follows: vapor phase reflow and infrared reflow with the component preheated to within 65°C of the soldering temperature range.

**THERMAL CHARACTERISTICS**

The junction-to-ambient thermal resistance ( $\theta_{JA}$ ) of XRP1117 is dependent on the PCB layout. The XRP1117 features an internal thermal limiting circuitry to protect the device during overload conditions. Special care needs to be taken during continuous load conditions such that the maximum junction temperature does not exceed 125 °C. Thermal protection is activated at >160°C and deactivated at <144°C.

Taking the FR-4 printed circuit board and 1/16 thick with 1 ounce copper foil as an experiment (fig.13), the PCB material is effective at transmitting heat with the tab attached to the pad area and a ground plane layer on the backside of the substrate. Refer to table 1 for the results of the experiment.

The thermal interaction from other components in the application can affect the thermal resistance of the XRP1117. The actual thermal resistance can be determined with experimentation.

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XRP1117 power dissipation is calculated as follows:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$$

Maximum Junction Temperature

$$T_J = T_{A(MAX)} + P_D \times \text{thermal resistance (Jct to amb.)}$$

Maximum junction temperature must not exceed 125°C.

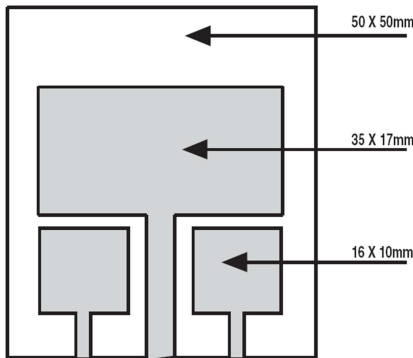


Fig. 13: Substrate Layout for SOT-223

PC Board mm <sup>2</sup>	Topside Copper mm <sup>2</sup>	Backside Copper mm <sup>2</sup>	Thermal Resistance Jct to amb. °C/W
2500	2500	2500	46
2500	1250	2500	47
2500	950	2500	49
2500	2500	0	51
2500	1800	0	53
1600	600	1600	55
2500	1250	0	58
2500	915	0	59
1600	600	0	67
900	240	900	72
900	240	0	85

Table 1

**LAYOUT CONSIDERATIONS**

Parasitic line resistance can degrade local regulation. In order to avoid this, connect R<sub>1</sub> to XRP1117 V<sub>OUT</sub> pin as illustrated in figure 17. For the same reason R<sub>2</sub> should be connected to the negative side of the load.

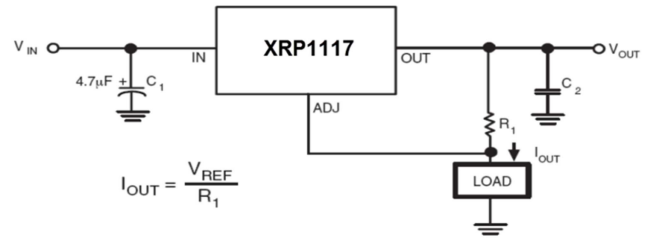


Fig. 14: Current Source

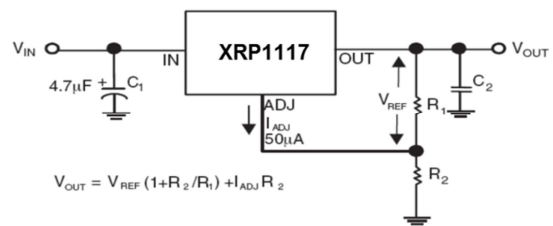
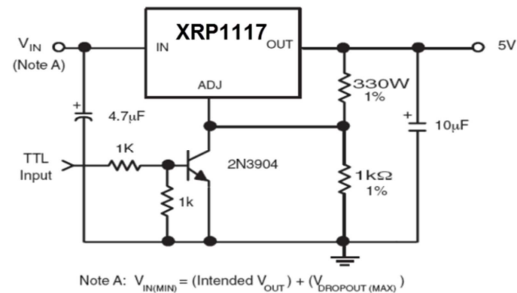


Fig. 15: Typical Adjustable Regulator



Note A:  $V_{IN(MIN)} = (\text{Intended } V_{OUT}) + (V_{DROPOUT(MAX)})$

Fig. 16: 5V Regulator with Shutdown

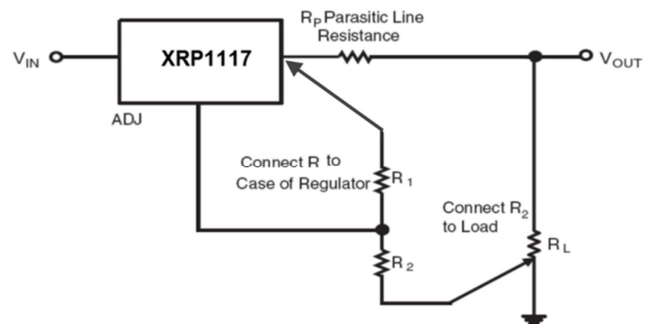


Fig. 17: Recommended Connections for Best Results





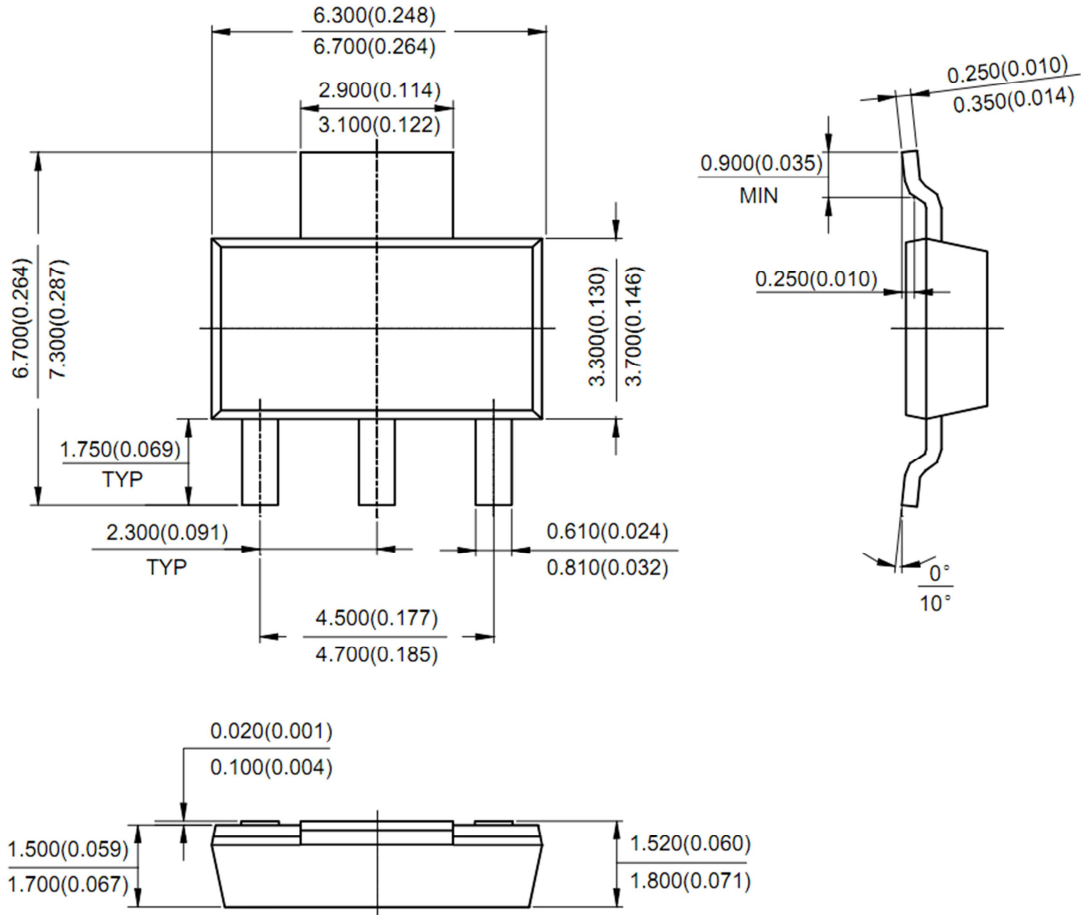
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**XRP1117**

## 800mA Low Dropout Positive Voltage Regulator

### PACKAGE SPECIFICATION

#### 3-PIN SOT-223



**REVISION HISTORY**

Revision	Date	Description
1.0.0	05/03/2013	Initial release of datasheet

**FOR FURTHER ASSISTANCE**

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