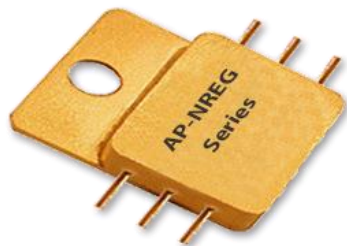


Rad-Hard Temperature Stable Negative Voltage Regulators/References

Adjustable and Fixed Temperature Stable Regulators and References Manufactured in a Certified Class-K Facility



Features

- Rad-Hard to 300 krad TID (note 1)
- Single Event Latch-up (SEL) immune (LET>87 MeV/mg/cm²)
- Wide Input/Output Voltage Differential: 40V
- K-level screening
- Excellent Temperature Stability

The APNREG Series are space qualified, wide-input range negative linear voltage regulators designed for military and space flight applications. Packaged in a hermetic TO-257 package, the regulators provide up to 1.5A of output current over their full input voltage range as per specification (see table 1). The device also features internal thermal shutdown and output current-limiting circuitry. This series is an excellent choice for applications requiring high radiation tolerance, low noise and high power supply rejection ratios.

These voltage regulators are provided in both adjustable and fixed output voltage configurations. The adjustable version requires only one external resistor to program the output.

Absolute Maximum Ratings

(Exceeding maximum ratings may damage the device.)

Symbol	Parameter	Value	Unit
Vin- Vo	DC input- Output Differential	40	V
Io	Output Current	1.5	A
Pd	Power Dissipation Tcase=25°C	50	W
Rthjc	Thermal Resistance, Junction to Case	3	°C/W
Tstg	Storage Temperature	-65 to +150	°C
Top	Operating Temperature Range	-55 to +125	°C
Tj	Maximum Junction Temperature	175	°C
W	Package weight	5	G
Tsold	Maximum Soldering Temperature, 10sec	265	°C

Radiation Ratings

Symbol	Parameter	Value	Unit
TID	Minimum in Spec Total Dose Performance (Dose Rate: 50-300 rad(Si)/s)	> 300	krads (Si)
ELDRS	Minimum in Spec Low Dose Rate Performance (Dose Rate ≤ 10 mRad (Si)/s)	> 50	krads (Si)
SET	Linear Energy Threshold, Single Event Transients < 100mV, (note 5)	> 15	MeV/mg/cm ²
SEL/SEB	Single-Event Latch-up Free linear Energy Transfer Threshold	> 87	MeV/mg/cm ²

Electrical Characteristics (@ Ta= -55°C to +125°C Unless Otherwise Specified)

Pre-Radiation

Symbol	Parameter	Test Conditions	Min	Typical	Max	Units
V _{REF}	Reference Voltage Accuracy ⁽⁷⁾	V _{diff} = 3.25 to 35V, I _L = 10mA		⁽⁹⁾		V
V _{LINE}	Line Regulation ^{(2) (7)}	V _{out} = V _{ref} , I _L = 10mA, 3.0V ≤ V _{diff} ≤ 40V			+/-0.02	%/V
V _{load}	Load Regulation ^{(2) (8)}	V _{diff} = 6.75V, 10mA ≤ I _L ≤ 1.25 A			+/-1.5	%
I _{ADJ}	Adjust-Pin Current V _{load} ⁽⁷⁾	V _{diff} = 3.0V – 39V, I _{Load} = 10mA			100	μA
ΔI _{ADJ}	Adjust-Pin Current Change ⁽⁸⁾	V _{diff} = 3.0V – 40V, I _L = 10mA, 25°C	-5		5	μA
ΔI _{ADJ}	Adjust-Pin Current Change ⁽⁸⁾	V _{diff} = 3.0V – 40V, I _L = 10mA	-6		6	μA
I _{OUT}	Output Current ⁽⁷⁾		1.25			A
V _{in} (Min)	Minimum I/O Differential ^{(4) (8)}	I _o ≤ 1.25 A	3.0			V

Post-Radiation (Ta= 25 °C) Notes ^{(1) (3)}

Symbol	Parameter	Test Conditions	Min	Typical	Max	Units
V _{REF}	Reference Voltage Change	V _{diff} = 40V, I _L = 10mA			+/- 50	mV
I _{ADJ}	Adjust-Pin Current Change	V _{diff} = 3-35V, I _{Load} = 10mA			+/- 5	μA

Notes:

- At the time of publication of this datasheet, API Technologies/Marlborough did not have a DLA certified radiation hardness assurance program.
- Load & Line regulation are measured at constant (T_j) junction temperature using a low duty cycle pulse. Changes in output voltage due to heating effects must be evaluated separately.
- TID radiation testing is performed per MIL-STD-883, method 1019.
- Internal SOA protection limits output current with high input voltage.
- Minimum exposure where parameters are guaranteed to stay within spec.
- V_{in} ≤ -9V and C_{OUT} ≥ 44 uF
- V_{DIFF} ≥ 39V @ 125°C
- At 125°C, a 1.5A output requires an I/O differential of ≥ 6.75 V.
- Please see Table 1 for values and limits of the various versions.

Screening Options

Tests	Screening Levels			Mil-Std-883-Method
	EM	H	K	
	Engineering Models	Compliant- MIL-PRF-38534		
100 % Non-Destruct Wire-Pull	N/A	Sample	100%	2023
Pre-Cap Visual	N/A	N/A	100%	2017
Temperature Cycle	N/A	100%	100%	1010
Constant Acceleration	N/A	100%	100%	2001
PIND	N/A	N/A	100%	2020
Pre-Burn-In Electrical (Ta= 25C)	N/A	100%	100%	
Burn-In	N/A	100% (240 Hours)	100% (320 Hours)	1015
Final Electrical	100% (25C)	100%	100%	
Hermeticity (Fine & Gross Leak)	N/A	100%	100%	1014
X-Ray	N/A	N/A	100%	2012
External Visual	Sample	100%	100%	2009

Table 1 – Product Functionality

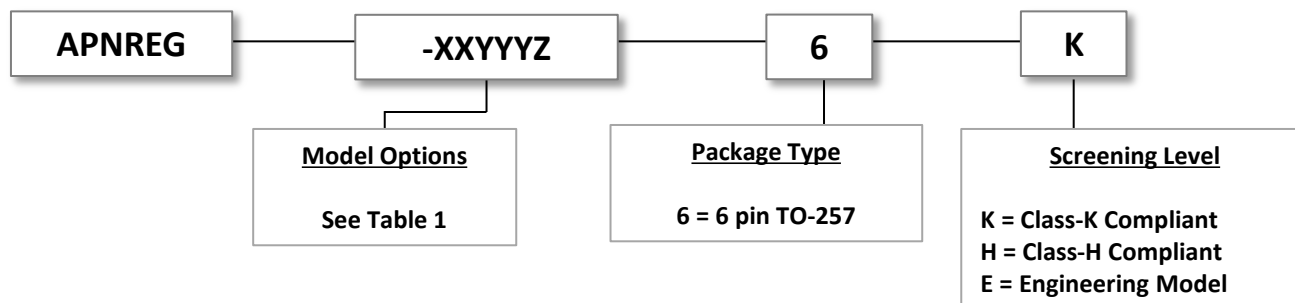
($-55^{\circ}\text{C} = T_a \leq 125^{\circ}\text{C}$, $V_{IN} - V_O = -5\text{V}$, $I_O = 0.5\text{ A UOS}$)

APNREG Series Model Options	Protection Resistor ⁽¹⁾	Vout	Fixed/ Variable Output	Remote Sense	Ref/output Voltages @ 25° C	Ref/output Tolerance @ 25° C ⁽²⁾	Output Change -55-125°C	Operating Input Voltage (Vin-Vout must be 5 V or higher)
-RSNONN	No	-1.25 to -37	Variable	Yes	Ref = -1.25 V (See figure 2 & 6)	+/- 12 mV ⁽³⁾	+/- 25 mV ⁽³⁾ @ V _O = 6.25 V	-4.25 to -40 V
-RSRESR	Yes							
-TCADJN	No	-7.5 to -37	Variable	Yes	Ref = -7.45 V (See figure 3 & 6)	+/- 330 mV	+/- 35 mV @ V _O = 7.5 V +/- 50 mV @ V _O = 37 V	-11 to -40 V
-TCADJR	Yes							
-TC7.5N	No	-7.5 V	Fixed	Yes	Output = -7.50 V (See figure 4, 5, 6)	+/- 10 mV ⁽²⁾	+/- 35 mV @ V _O = 7.5 V	-11 to -40 V
-TC7.5R	Yes							
-TC10.N	No	-10.0 V	Fixed	Yes	Output = -10.0 V (See figure 4, 5, 6)	+/- 10 mV ⁽²⁾	+/- 40 mV @ V _O = 10 V	-13 to -40 V
-TC10.R	Yes							
-TC15.N	No	-15.0 V	Fixed	Yes	Output = -15.0 V (See figure 4, 5, 6)	+/- 10 mV ⁽²⁾	+/- 50 mV @ V _O = 15 V	-18 to -40 V
-TC15.R	Yes							

Notes:

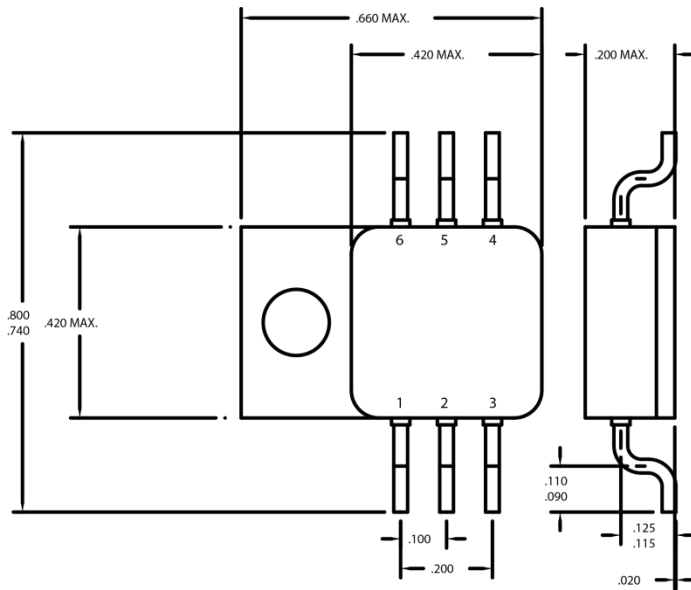
1. Protection resistor is 10 Ohms and is internally connected between the Output pin and the Sense pin to prevent a high Output Voltage excursion should the external remote sense connection be severed.
2. For fixed output versions, output tolerance is adjustable to zero with one external resistor.
3. Both Output Accuracy and Temperature Drift are specified as $\pm 25\text{ mV Max}$. However, the sum of the two will not exceed +/- 25 mV (Applies to the non-TC versions only).

Ordering Information



Example: 15 Volt Fixed Output Model with Protection Resistor, Class K:
Model # APNREG-TC15.R6K

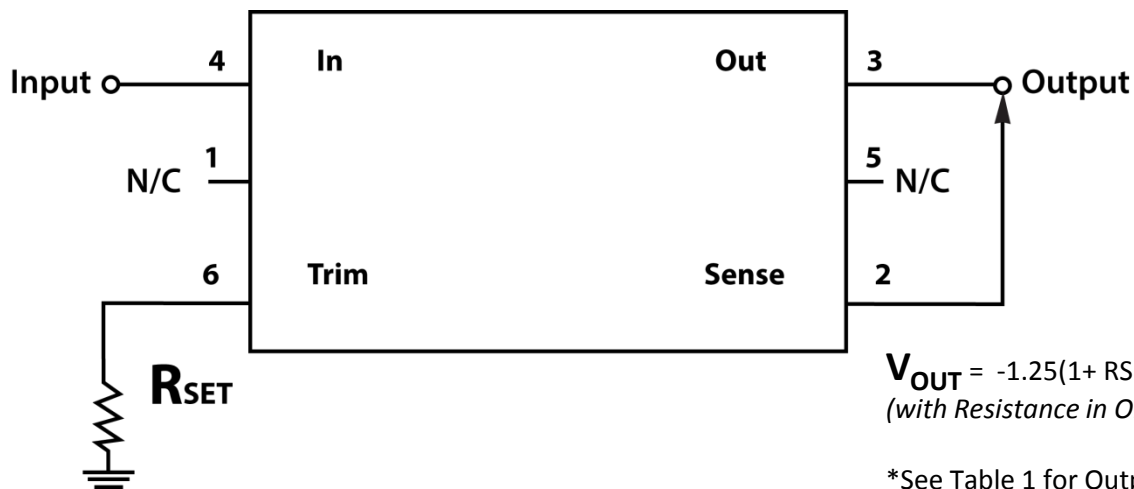
Figure 1 – APNREG Series Package Outline Drawing



Pin No	Pin Name	Pin Description
1	COMP	Comp Pin
2	SENSE	Remote Sense
3	OUT	Output Voltage
4	IN	Input Voltage
5	GND	Ground
6	TRIM	Trim Pin
	Case	No Connection-Isolated

*Consult Factory for additional lead bend options.

Figure 2 – APNREG-RS (Remote Sense) Series

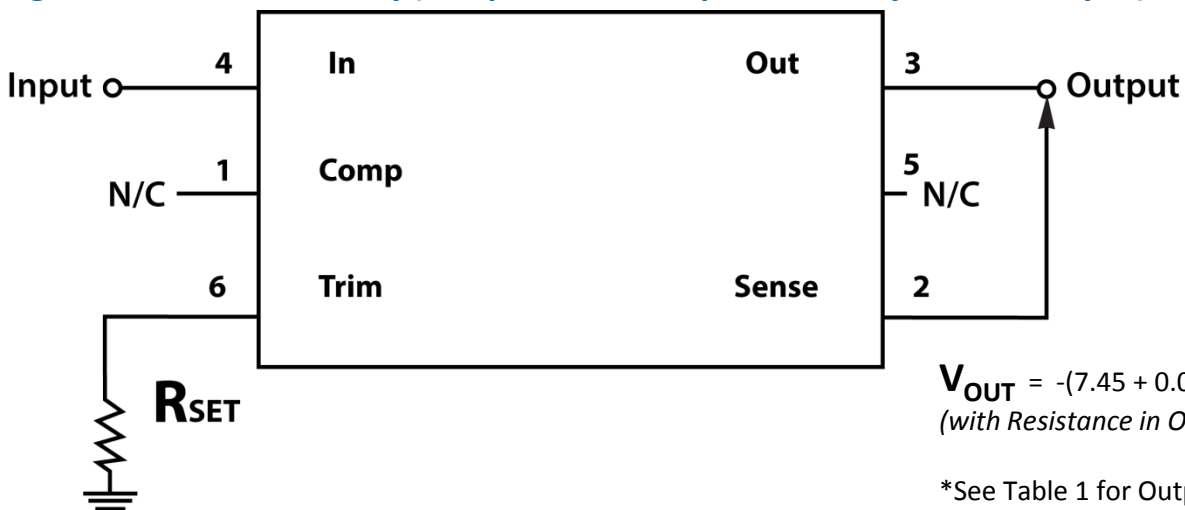


$$V_{OUT} = -1.25(1 + R_{SET}/125)$$

(with Resistance in Ohms)

*See Table 1 for Output Voltage Tolerances

Figure 3 – APNREG-TC-Adj (Temperature Compensated Adjustable Output) Series

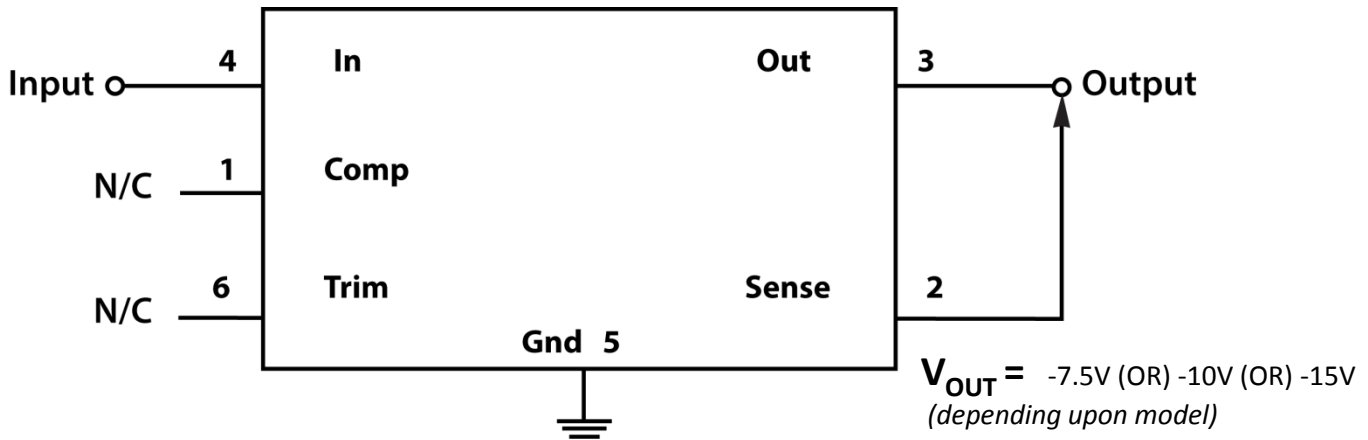


$$V_{OUT} = -(7.45 + 0.01 \times R_{SET})$$

(with Resistance in Ohms)

*See Table 1 for Output Voltage Tolerances

Figure 4 – APNREG-TC (Temperature Compensated) Fixed Output Voltage Series



*See Table 1 for Output Voltage Tolerances

Figure 5 – APNREG-TC (Temperature Compensated) Fixed Output Voltage Series with Output Trim Method

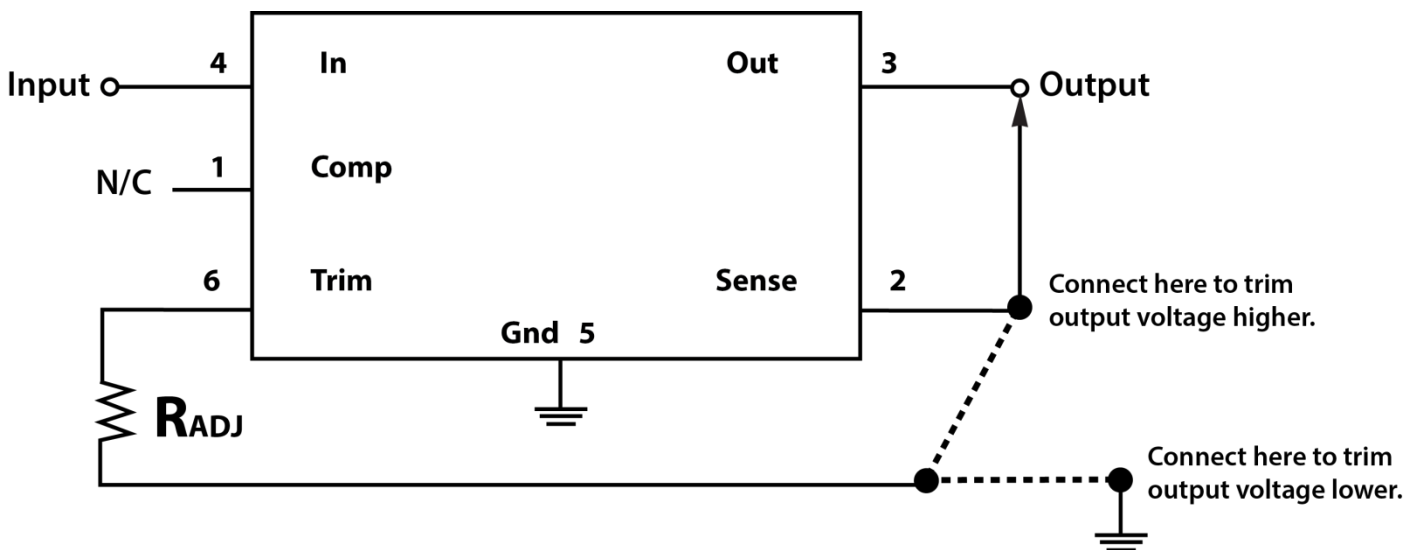


Figure 6 – APNREG Series – Recommended Application Circuit

