Precision, Micropower LDO Voltage References in TSOT-23

Preliminary Technical Data

ADR121/ADR125/ADR127

FEATURES

Initial Accuracy:
- **A-Grade: ±0.24%**
- **B-Grade: ±0.12%**

Max. Tempco.
- **A-Grade: 25ppm/°C**
- **B-Grade: 9ppm/°C**

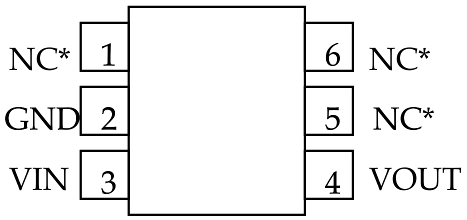
Low Dropout: 300mV
High Output Current: +5mA/-2mA
Low Operating Current: 85μA
Input Range: 2.7V to 18V
Temperature Range: -40°C to +125 °C
Tiny TSOT-23-6 Package

APPLICATIONS

Battery-Powered Instrumentation
Portable Medical Equipment
Data Acquisition Systems
Automotive

PIN CONFIGURATION

6-Lead TSOT-23
(UJ Suffix)



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GENERAL DESCRIPTION

The ADR12x is a family of micropower high precision, series mode bandgap reference with sink and source capability. It features high accuracy, and low-power consumption in a tiny package. The ADR12x design includes a patented temperature drift curvature correction techniques minimizes the non-linearities in the output voltage vs. temperature characteristics.

The ADR12x is a low-dropout voltage reference, requiring only 300mV above the nominal output voltage on the input to provide a stable output voltage. This low dropout performance coupled with the low 85uA operating current makes the ADR12x ideal for battery-powered applications.

Available in industrial temperature range of –40°C to +125°C, the ADR12x is housed in the tiny TSOT-23-6 package.

ORDERING GUIDE

Model	Vout	Initial Accuracy	Max. Tempco	Package
ADR127AUJZ	1.25V	±3mV	25ppm/°C	TSOT-23-6 (lead-free)
ADR127BUJZ	1.25V	±1.5mV	9ppm/°C	TSOT-23-6 (lead-free)
ADR121AUJZ	2.5V	±6mV	25ppm/°C	TSOT-23-6 (lead-free)
ADR121BUJZ	2.5V	±3mV	9ppm/°C	TSOT-23-6 (lead-free)
ADR125AUJZ	5.0V	±12mV	25ppm/°C	TSOT-23-6 (lead-free)
ADR125BUJZ	5.0V	±6mV	9ppm/°C	TSOT-23-6 (lead-free)

REV. PrA

Last Edited: August 31, 2005

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ADR127 ELECTRICAL CHARACTERISTICS (@ T_A = 25°C, 2.7V to 18V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITION	Min	Typ	Max	UNITS
Output Voltage	V_O	@ 25°C				
B-Grade			1.2485	1.25	1.2515	V
A-Grade			1.2470	1.25	1.2530	V
Initial Accuracy Error						
B-Grade	V_{OERR}	@ 25°C	-0.12		+0.12	%
A-Grade			-0.24		+0.24	%
Temperature Coefficient	TCV_O	-40°C < T_A < +125°C				
B-Grade				3	9	ppm/°C
A-Grade				15	25	ppm/°C
Load Regulation		-40°C < T_A < +125°C; V_{IN} = 3.0V 0mA < I_{OUT} < 5mA			0.5	mV/mA
		40°C < T_A < +125°C; V_{IN} = 3.0V -2mA < I_{OUT} < 0mA			0.5	mV/mA
Line Regulation		2.7V to 18V I_{OUT} = 0mA			90	ppm/V
Ripple Rejection	$\Delta V_{OUT}/\Delta V_{IN}$	f= 60Hz		60		dB
Quiescent Current	I_Q	-40°C < T_A < +125°C, No Load				
		V_{IN} = 18V		95	125	µA
		V_{IN} = 2.7V		85		µA
Short Circuit Current to Ground		V_{IN} = 5.0V		25		mA
Noise Voltage		@ 25°C 0.1Hz to 10Hz		10		µVp-p
Turn-on Settling Time		To 0.1%, C_L = 0.2 µF		200		µs
Long-Term Stability		1,000 Hours @ 25°C		TBD		ppm/1000 hrs.
Output Voltage Hysteresis				TBD		ppm

ADR121 ELECTRICAL CHARACTERISTICS (@ T_A = 25°C, V_{IN} = 2.8V to 18V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITION	Min	Typ	Max	UNITS
Output Voltage	V_O	@ 25°C				
B-Grade			2.497	2.5	2.503	V
A-Grade			2.494	2.5	2.506	V
Initial Accuracy Error	V_{OERR}	@ 25°C				
B-Grade			-0.12		+0.12	%
A-Grade			-0.24		+0.24	%
Temperature Coefficient	TCV_O	-40°C < T_A < +125°C				
B-Grade				3	9	ppm/°C
A-Grade				15	25	ppm/°C
Dropout (V_{IN} – V_{OUT})	V_{DO}	I_{OUT} = 5mA	300			mV
Load Regulation		-40°C < T_A < +125°C; V_{IN} = 3.0V 0mA < I_{OUT} < 5mA			0.5	mV/mA
		-40°C < T_A < +125°C; V_{IN} = 3.0V -2mA < I_{OUT} < 0mA			0.5	mV/mA
Line Regulation		2.8V < V_{IN} < 18V I_{OUT} = 0mA			90	ppm/V
Ripple Rejection	$\Delta V_{OUT}/\Delta V_{IN}$	f= 60Hz		60		dB
Quiescent Current	I_Q	-40°C < T_A < +125°C, No Load				
		V_{IN} = 18V		95	125	µA
		V_{IN} = 3.0V		85		µA
Short Circuit Current to Ground				25		mA
Noise Voltage		@ 25°C 0.1Hz to 10Hz		20		µVp-p
Turn-on Settling Time		To 0.1%, C_L = 0.2 µF		200		µs
Long-Term Stability		1,000 Hours @ 25°C		TBD		ppm/1000 hrs.
Output Voltage Hysteresis				TBD		ppm

ADR125 ELECTRICAL CHARACTERISTICS (@ $T_A = 25^oC$, $V_{IN} = 5.3V$ to 18V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITION	Min	Typ	Max	UNITS
Output Voltage	V_O	@ 25^oC				
B-Grade			4.994	5.0	5.006	V
A-Grade			4.988	5.0	5.012	V
Initial Accuracy Error	V_{OERR}					
B-Grade		@ 25^oC	-0.12		+0.12	%
A-Grade			-0.24		+0.24	
Temperature Coefficient	TCV_O	$-40^oC < T_A < +125^oC$				
B-Grade				3	9	ppm/ ^oC
A-Grade				15	25	ppm/ ^oC
Dropout ($V_{IN} – V_{OUT}$)	V_{DO}	$I_{OUT} = 5mA$	300			mV
Load Regulation		$-40^oC < T_A < +125^oC$; $V_{IN} = 5.5V$ $0mA < I_{OUT} < 5mA$			0.5	mV/mA
		$-40^oC < T_A < +125^oC$; $V_{IN} = 5.5V$ $-2mA < I_{OUT} < 0mA$			0.5	mV/mA
Line Regulation		$5.3V < V_{IN} < 18V$ $I_{OUT} = 0mA$			30	ppm/V
Ripple Rejection	$\Delta V_{OUT}/\Delta V_{IN}$	f = 60Hz		60		dB
Quiescent Current	I_Q	$-40^oC < T_A < +125^oC$, No Load				
		$V_{IN} = 18V$		95	125	µA
		$V_{IN} = 5.3V$		85		µA
Short Circuit Current to Ground				25		mA
Noise Voltage		@ 25^oC 0.1Hz to 10Hz		40		µVp-p
Turn-on Settling Time		To 0.1%, $C_L = 0.2$ µF		200		µs
Long-Term Stability		1,000 Hours @ 25^oC		TBD		ppm/1000 hrs.
Output Voltage Hysteresis				TBD		ppm

ABSOLUTE MAXIMUM RATINGS[1]

V_{IN} to GND... 20V
Internal Power Dissipation[2]
SOT-23 (RT) 400mW
Storage Temperature Range .... –65°C to +150°C
Specified Temperature Range........................... –40°C to +120°C
Lead Temperature, Soldering
Vapor Phase (60 sec) .... +215°C
Infrared (15 secs)... +220°C

TERMINILOGY

Temperature Coefficient

The change of output voltage with respect to operating temperature change normalized by the output voltage at 25°C. This parameter is expressed in ppm/°C and can be determined by

$$TCV_O[ppm/^oC] = \frac{V_o(T_2) - V_o(T_1)}{V_o(25^oC) \times (T_2 - T_1)} \times 10^6$$

where;

V_o (25°C) = V_o at 25°C.
V_o (T_1) = V_o at Temperature 1.
V_o (T_2) = V_o at Temperature 2.

Line Regulation

The change in the output due to a specified change in input voltage. This parameter accounts for the effects of self-heating. Line regulation is expressed in either percent per volt, parts-per-million per volt, or microvolts per voltage changes in input voltage.

Load Regulation

The change in output voltage due to a specified change in load current. This parameter accounts for the effects of self-heating. Load regulation is expressed in either microvolts per milliampere, parts-per-million per milliampere, or ohms of dc output resistance.

Long-Term Stability

Typical shift of output voltage at 25°C on a sample of parts subjected to a test of 1,000 hours at 25°C.

$$\Delta V_o = V_o(t_o) - V_o(t_1)$$

$$\Delta V_o[ppm] = \frac{V_o(t_o) - V_o(t_1)}{V_o(t_o)} \times 10^6$$

where:

$V_o(t_0)$ = V_o at 25°C at Time 0.
$V_o(t_1)$ = V_o at 25°C after 1,000 hours operating at 25°C.

Thermal Hysteresis

The change of output voltage after the device is cycled through temperature from +25°C C to -40°C to +125°C and back to +25°C. This is a typical value from a sample of parts put through such a cycle.

$$V_{O\_HYS} = V_O(25^oC) - V_{O\_TC}$$

$$V_{O\_HYS}[ppm] = \frac{V_O(25^oC) - V_{O\_TC}}{V_O(25^oC)} \times 10^6$$

where:

V_o (25°C) = V_o at 25°C.
V_{o_TC} = V_o at 25°C after temperature cycle at +25°C to -40°C to +125°C and back to +25°C.

NOTES

Input Capacitor

Input capacitors are not required on the ADR12x. There is no limit for the value fo the capacitor used on trhe input, but a 1μF to 10μF capacitor on the input improved transient response in the applications where there is a sudden supply change. An additional 0.1μF capacitor in parallel also helps reduce noise from the supply.

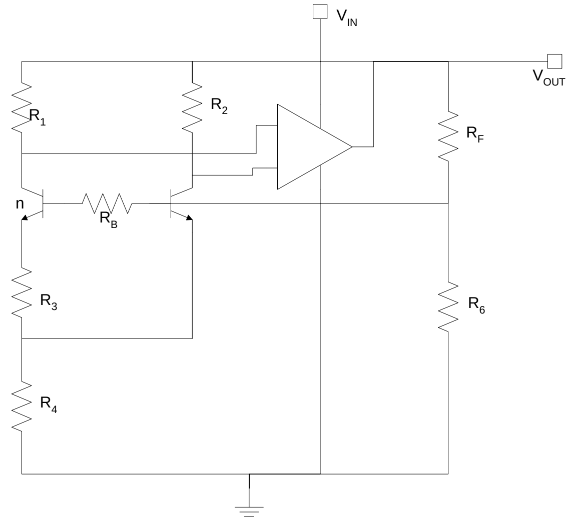
Output Capacitor

The ADR12x requires a small 0.1μF for stability. Additional 0.1μF to 10μF capacitance in parallel can improve load transient response. This acts as a source of stored energy for a sudden increase in load current. The only parameter affected with the additional capacitance is turn-on time.

TYPICAL PERFORMANCE CHARACTERISTICS

THEORY OF OPERATION

The ADR12x band gap references are the high performance solution for low supply voltage and low power applications. This family of precision references uses the underlying temperature characteristics of a silicon transistor's base emitter voltage in the forward-biased operating region. Under this condition, all such transisitors have a -2mV/^{o}C temperature coeffient (TC) and a V_{BE} that, when exptrapolated to absolute zero, 0^{o}K (with collector current proportional to absolute temperature), approximates the silicon band gap voltage by summing a voltage that has equal and opposite temperature coefficient of 2mV/^{o}C with the V_{BE} of a forward-biased transistor, an almost zero TC reference can be developed. In the ADR12x simplified circuit diagram shown in Figure xx, such a compensating voltage, V_{R4}, is derived by driving two transistors at different current densities and amplying the resultant V_{R3} or V_{BE} (ΔVBE, which has a positive TC). The sum of V_{BE} and V_{R4} is then buffered and amplified to produce stable reference voltage outputs of 1.25V, 2.5V, and 5.0V.



Devices Power Dissipation Considerations

The ADR12x family is capable of delivering load currents to 5mA with and input range from 3.0V to 18V. When this device is used in applications with large input voltages, care should be take to avoid exceeding the specified maximum power dissipation or junction temperature because it could result in premature device failure. Use the following formula to calculate a device's maximum junction temperature or dissipation:

$$P_D = \frac{T_J - T_A}{\Theta_{JA}}$$

In this equation, T_J and T_A are respectively, the junction and the ambient temperatures, P_D is the device power dissipation, and Θ_{JA} is the device package thermal resistance.

APPLICATIONS

Basic Voltage Reference Connection

The circuit in Figure a illustrustates the basic confirguration for the ADR12x family voltage reference.

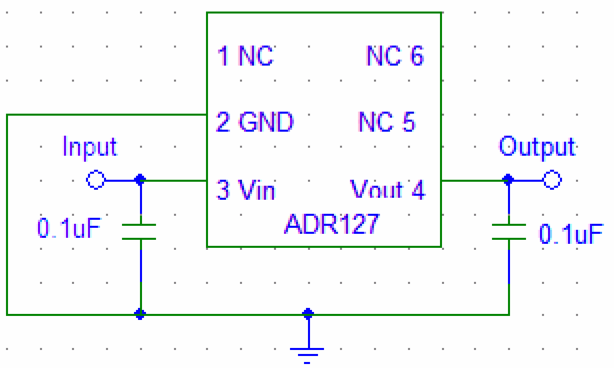


Figure xx. Basic Configuration for the ADR12x Familiy

Stacking Reference ICs for Arbitrary Outputs

Some applications may require two reference votlage sources, which are a combined sum of the standard outputs. Figure xx shows how this stacked output reference can be implemented.

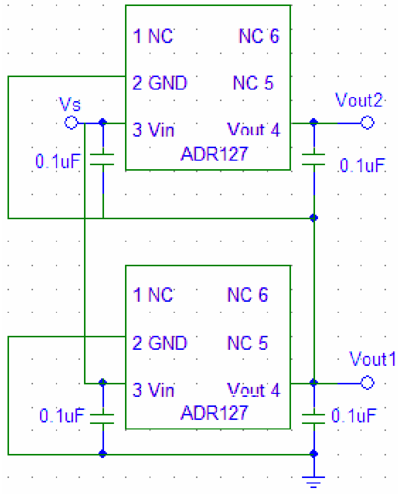


Figure xx. Stacking References with ADR12x

Two reference ICs are used, and fed from an unregulated input, V_{IN}. The outputs of the individual ICs are connected in series, which provides tow output voltages, V_{OUT1} and V_{OUT2}. V_{OUT1} is the terminal voltage of U1, while V_{OUT2} is the sum of this voltage and the terminal of U2. U1 and U2 are chosen for the two votlages that supply the required outputs (see Table xx). For example, if U1 and U2 are ADR127, V_{OUT1} is 1.25V and V_{OUT2} is 2.5V.

Table xx Output

U1/U2	**V_{OUT1}**	**V_{OUT2}**
ADR127/ADR121	1.25V	3.75V
ADR127/ADR125	1.25V	6.25V
ADR121/ADR125	2.5V	7.5V

A Negative Precision Reference Without Precision Resistors

A negative reference I easily generated by adding an op amp, A1, and is configured in Figure xx. V_{OUT1} is at virtual ground and, therefore, the negative reference can be taken directly form the output of the op amp. The op amp must be dual-supply, low offset, and rail-to-rail if the negative supply voltage is close to the reference output.

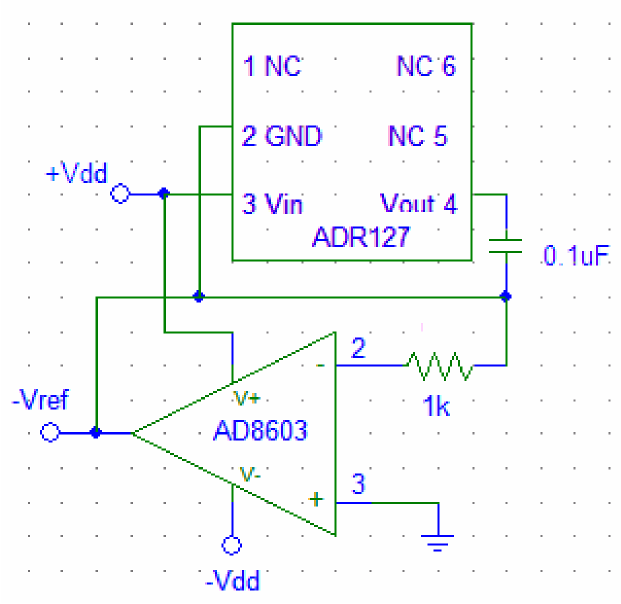
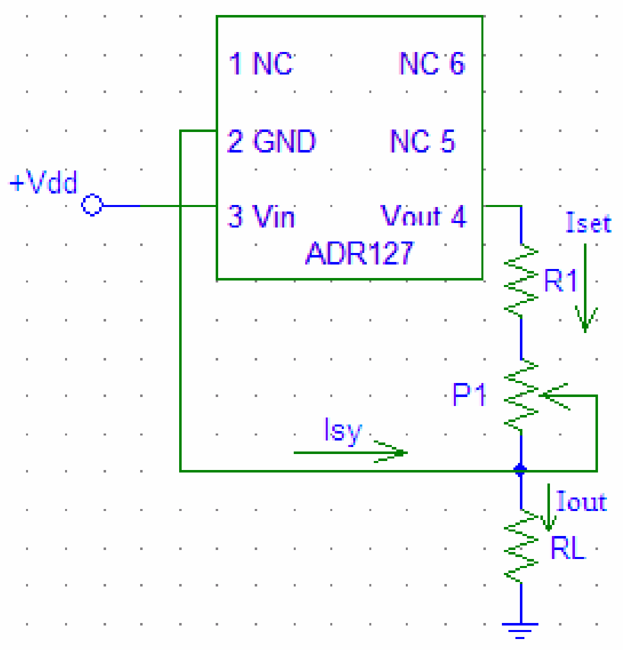


Figure xx. Negative Reference

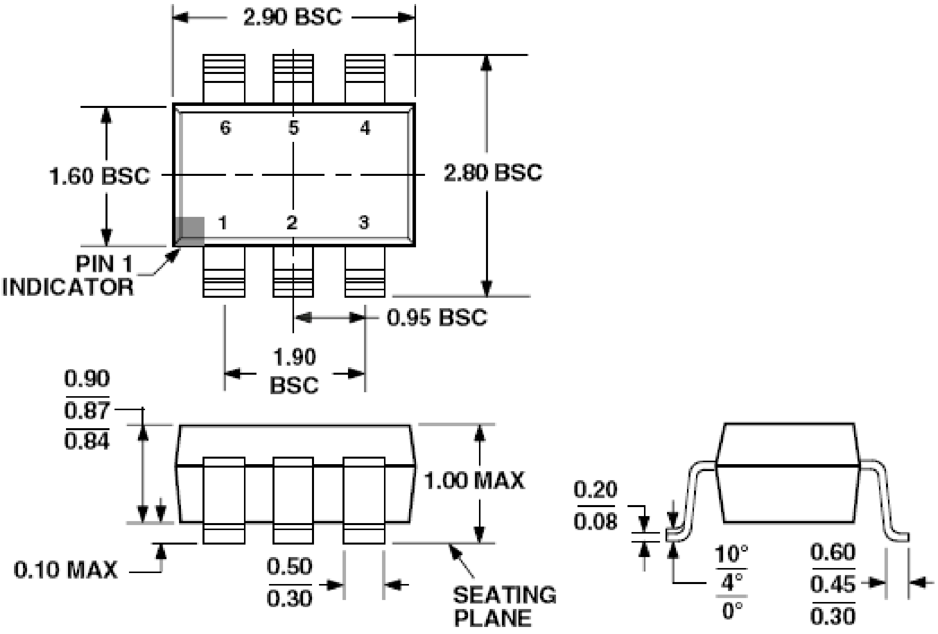
General Purpose Current Source

Many times in low power applications, the need arises for a precision current source that can operate on low supply voltages. The ADR12x can be configured as a precision current source (see Figure xx). The circuit configuration illustrated is a floating current source with a grounded load. The reference's output voltage is bootstrapped acrossed R_{SET}, which sets the output current into the load. With this configuration, circuit precision is maintained for load currents ranging form the reference's supply current, typically 95µA, to approximately 5mA.



OUTLINE DIMENSIONS

6-Lead Thin Small Outline Transistor Package [TSOT]
(UJ-6)
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-193AA

PR05725-0-8/05(PrA)

ORDERING GUIDE

Models*	Output Voltage (V_O)	Initial Accuracy		Temperature Coefficient (ppm/°C)	Package Description	Package Option	Temperature Range (°C)	Branding
ADR127AUJZ-REEL7	1.25V	3mV	0.24%	25	TSOT	UJ-6	-40 to +125	R0S
ADR127BUJZ-REEL7	1.25V	1.5mV	0.12%	9	TSOT	UJ-6	-40 to +125	R0T
ADR121AUJZ-REEL7	2.5V	6mV	0.24%	25	TSOT	UJ-6	-40 to +125	R0N
ADR121BUJZ-REEL7	2.5V	3mV	0.12%	9	TSOT	UJ-6	-40 to +125	R0P
ADR125AUJZ-REEL7	5.0V	12mV	0.24%	25	TSOT	UJ-6	-40 to +125	R0Q
ADR125BUJZ-REEL7	5.0V	6mV	0.12%	9	TSOT	UJ-6	-40 to +125	R0R

*3,000 pieces per reel