



# Low Noise XFET Voltage References with Current Sink and Source Capability

## ADR431-EP/ADR434-EP/ADR435-EP

### FEATURES

Low noise (0.1 Hz to 10.0 Hz): 3.5  $\mu\text{V p-p}$  @ 2.5  $V_{\text{OUT}}$  (ADR431-EP)

No external capacitor required

Low temperature coefficient

T Grade: 3 ppm/ $^{\circ}\text{C}$  maximum (ADR434-EP/ADR435-EP)

T Grade: 5 ppm/ $^{\circ}\text{C}$  maximum (ADR431-EP)

Load regulation: 15 ppm/mA

Line regulation: 20 ppm/V

Wide operating range: 4.5 V to 18 V (ADR431-EP)

High output source and sink current: +10 mA and -10 mA

### ENHANCED PRODUCT FEATURES

Supports defense and aerospace applications (AQEC standard)

Military temperature range (-55 $^{\circ}\text{C}$  to +125 $^{\circ}\text{C}$ )

Controlled manufacturing baseline

One assembly/test site

One fabrication site

Enhanced product change notification

Qualification data available on request

### APPLICATIONS

Precision data acquisition systems

High resolution data converters

Optical control circuits

Precision instruments

### GENERAL DESCRIPTION

The ADR431-EP/ADR434-EP/ADR435-EP are XFET<sup>®</sup> voltage references featuring low noise, high accuracy, and low temperature drift performance. Using Analog Devices, Inc., patented temperature drift curvature correction and XFET (eXtra implanted junction FET) technology, voltage change vs. temperature nonlinearity in the ADR431-EP/ADR434-EP/ADR435-EP is minimized.

The XFET references operate at lower current (800  $\mu\text{A}$ ) and lower supply voltage headroom (2 V) than buried Zener references. Buried Zener references require more than 5 V headroom for operation. The ADR431-EP/ADR434-EP/ADR435-EP XFET references are optimal low noise solutions for 5 V systems.

### PIN CONFIGURATION



#### NOTES

- 1. NC = NO CONNECT.
- 2. TP = TEST PIN (DO NOT CONNECT).

Figure 1. 8-Lead SOIC\_N (R-8)

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The ADR431-EP/ADR434-EP/ADR435-EP have the capability to source up to 10 mA of output current and sink up to -10 mA. They also come with a trim terminal to adjust the output voltage over a 0.5% range without compromising performance.

The ADR431-EP/ADR434-EP/ADR435-EP are available in an 8-lead narrow SOIC package and are specified over the military temperature range of -55 $^{\circ}\text{C}$  to +125 $^{\circ}\text{C}$ .

Additional application and technical information can be found in the [ADR430/ADR431/ADR433/ADR434/ADR435/ADR439](#) data sheet.

Table 1. Selection Guide

Model	Output Voltage (V)	Accuracy (mV)	Temperature Coefficient (ppm/ $^{\circ}\text{C}$ )
ADR431T-EP	2.500	$\pm 1.0$	5
ADR434T-EP	4.096	$\pm 1.5$	3
ADR435T-EP	5.000	$\pm 2.0$	3

#### Rev. A

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# ADR431-EP/ADR434-EP/ADR435-EP

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## REVISION HISTORY

### 8/10—Rev. 0 to Rev. A

Added ADR431-EP .....	Throughout
Added ADR435-EP .....	Throughout
Changes to Ordering Guide .....	8

### 7/10—Revision 0: Initial Version

## SPECIFICATIONS

### ADR431-EP ELECTRICAL CHARACTERISTICS

$V_{IN} = 4.5\text{ V to }18\text{ V}$ ,  $I_L = 0\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 2.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
OUTPUT VOLTAGE T Grade	$V_O$		2.499	2.500	2.501	V
INITIAL ACCURACY T Grade	$V_{OERR}$				$\pm 1.0$ $\pm 0.04$	mV %
TEMPERATURE COEFFICIENT T Grade	$TCV_O$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		1.5	5	ppm/ $^\circ\text{C}$
LINE REGULATION	$\Delta V_O / \Delta V_{IN}$	$V_{IN} = 4.5\text{ V to }18\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		5	20	ppm/V
LOAD REGULATION	$\Delta V_O / \Delta I_L$	$I_L = 0\text{ mA to }10\text{ mA}$ , $V_{IN} = 5\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
		$I_L = -10\text{ mA to }0\text{ mA}$ , $V_{IN} = 5\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
QUIESCENT CURRENT	$I_{IN}$	No load, $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		580	800	$\mu\text{A}$
VOLTAGE NOISE	$e_N$ p-p	0.1 Hz to 10.0 Hz		3.5		$\mu\text{V p-p}$
VOLTAGE NOISE DENSITY	$e_N$	1 kHz		80		nV/ $\sqrt{\text{Hz}}$
TURN-ON SETTLING TIME	$t_R$	$C_L = 0\ \mu\text{F}$		10		$\mu\text{s}$
LONG-TERM STABILITY <sup>1</sup>	$\Delta V_O$	1000 hours		40		ppm
OUTPUT VOLTAGE HYSTERESIS	$V_{O\_HYS}$			20		ppm
RIPPLE REJECTION RATIO	RRR	$f_{IN} = 1\text{ kHz}$		-70		dB
SHORT CIRCUIT TO GND	$I_{SC}$			40		mA
SUPPLY VOLTAGE OPERATING RANGE	$V_{IN}$		4.5		18	V
SUPPLY VOLTAGE HEADROOM	$V_{IN} - V_O$		2			V

<sup>1</sup> The long-term stability specification is noncumulative. The drift in subsequent 1000 hour periods is significantly lower than in the first 1000 hour period.

# ADR431-EP/ADR434-EP/ADR435-EP

## ADR434-EP ELECTRICAL CHARACTERISTICS

$V_{IN} = 6.1\text{ V to }18\text{ V}$ ,  $I_L = 0\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 3.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
OUTPUT VOLTAGE T Grade	$V_O$		4.0945	4.096	4.0975	V
INITIAL ACCURACY T Grade	$V_{OERR}$				$\pm 1.5$ $\pm 0.04$	mV %
TEMPERATURE COEFFICIENT T Grade	$TCV_O$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		1	3	ppm/ $^\circ\text{C}$
LINE REGULATION	$\Delta V_O / \Delta V_{IN}$	$V_{IN} = 6.1\text{ V to }18\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		5	20	ppm/V
LOAD REGULATION	$\Delta V_O / \Delta I_L$	$I_L = 0\text{ mA to }10\text{ mA}$ , $V_{IN} = 7\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
		$I_L = -10\text{ mA to }0\text{ mA}$ , $V_{IN} = 7\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
QUIESCENT CURRENT	$I_{IN}$	No load, $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		595	800	$\mu\text{A}$
VOLTAGE NOISE	$e_n$ p-p	0.1 Hz to 10.0 Hz		6.25		$\mu\text{V p-p}$
VOLTAGE NOISE DENSITY	$e_n$	1 kHz		100		nV/ $\sqrt{\text{Hz}}$
TURN-ON SETTLING TIME	$t_R$	$C_L = 0\ \mu\text{F}$		10		$\mu\text{s}$
LONG-TERM STABILITY <sup>1</sup>	$\Delta V_O$	1000 hours		40		ppm
OUTPUT VOLTAGE HYSTERESIS	$V_{O\_HYS}$			20		ppm
RIPPLE REJECTION RATIO	RRR	$f_{IN} = 1\text{ kHz}$		-70		dB
SHORT CIRCUIT TO GND	$I_{SC}$			40		mA
SUPPLY VOLTAGE OPERATING RANGE	$V_{IN}$		6.1		18	V
SUPPLY VOLTAGE HEADROOM	$V_{IN} - V_O$		2			V

<sup>1</sup> The long-term stability specification is noncumulative. The drift in subsequent 1000 hour periods is significantly lower than in the first 1000 hour period.

**ADR435-EP ELECTRICAL CHARACTERISTICS**

$V_{IN} = 7.0\text{ V to }18\text{ V}$ ,  $I_L = 0\text{ mA}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

**Table 4.**

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
OUTPUT VOLTAGE T Grade	$V_O$		4.998	5.000	5.002	V
INITIAL ACCURACY T Grade	$V_{OERR}$				$\pm 2.0$ $\pm 0.04$	mV %
TEMPERATURE COEFFICIENT T Grade	$TCV_O$	$-55^\circ\text{C} < T_A < +125^\circ\text{C}$		1	3	ppm/ $^\circ\text{C}$
LINE REGULATION	$\Delta V_O/\Delta V_{IN}$	$V_{IN} = 7.0\text{ V to }18\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		5	20	ppm/V
LOAD REGULATION	$\Delta V_O/\Delta I_L$	$I_L = 0\text{ mA to }10\text{ mA}$ , $V_{IN} = 8\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
		$I_L = -10\text{ mA to }0\text{ mA}$ , $V_{IN} = 8\text{ V}$ , $-55^\circ\text{C} < T_A < +125^\circ\text{C}$			15	ppm/mA
QUIESCENT CURRENT	$I_{IN}$	No load, $-55^\circ\text{C} < T_A < +125^\circ\text{C}$		620	800	$\mu\text{A}$
VOLTAGE NOISE	$e_N$ p-p	0.1 Hz to 10.0 Hz		8		$\mu\text{V p-p}$
VOLTAGE NOISE DENSITY	$e_N$	1 kHz		115		nV/ $\sqrt{\text{Hz}}$
TURN-ON SETTLING TIME	$t_R$	$C_L = 0\ \mu\text{F}$		10		$\mu\text{s}$
LONG-TERM STABILITY <sup>1</sup>	$\Delta V_O$	1000 hours		40		ppm
OUTPUT VOLTAGE HYSTERESIS	$V_{O\_HYS}$			20		ppm
RIPPLE REJECTION RATIO	RRR	$f_{IN} = 1\text{ kHz}$		-70		dB
SHORT CIRCUIT TO GND	$I_{SC}$			40		mA
SUPPLY VOLTAGE OPERATING RANGE	$V_{IN}$		7.0		18	V
SUPPLY VOLTAGE HEADROOM	$V_{IN} - V_O$		2			V

<sup>1</sup> The long-term stability specification is noncumulative. The drift in subsequent 1000 hour periods is significantly lower than in the first 1000 hour period.

# ADR431-EP/ADR434-EP/ADR435-EP

## ABSOLUTE MAXIMUM RATINGS

$T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 5.

Parameter	Rating
Supply Voltage	20 V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	$-65^\circ\text{C}$ to $+125^\circ\text{C}$
Operating Temperature Range	$-55^\circ\text{C}$ to $+125^\circ\text{C}$
Junction Temperature Range	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature, Soldering (60 sec)	$300^\circ\text{C}$

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## THERMAL RESISTANCE

$\theta_{JA}$  is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 6. Thermal Resistance

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
8-Lead SOIC_N (R)	130	43	$^\circ\text{C}/\text{W}$

## ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## TYPICAL PERFORMANCE CHARACTERISTICS

$\pm 5$  V,  $C_L = 5$  pF,  $G = 2$ ,  $R_G = R_F = 1$  k $\Omega$ ,  $R_L = 2$  k $\Omega$ ,  $V_o = 2$  V p-p,  $f = 1$  MHz,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

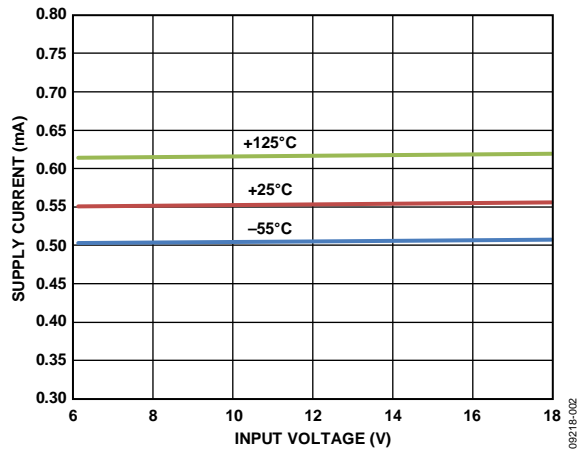
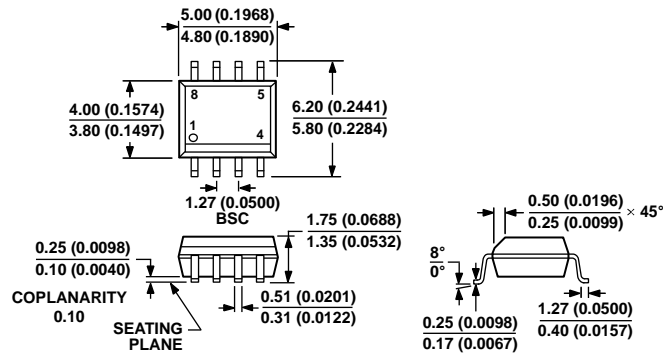


Figure 2. Supply Current vs. Temperature

# ADR431-EP/ADR434-EP/ADR435-EP

## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-012-AA  
 CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS  
 (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR  
 REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

012407-A

Figure 3. 8-Lead Standard Small Outline Package [SOIC\_N]  
 Narrow Body  
 (R-8)

Dimensions shown in millimeters and (inches)

## ORDERING GUIDE

Model <sup>1</sup>	Output Voltage (V)	Initial Accuracy, ±		Temperature Coefficient Package (ppm/°C)	Temperature Range	Package Description	Package Option	Ordering Quantity
		(mV)	(%)					
ADR431TRZ-EP	2.500	1.0	0.04	5	-55°C to +125°C	8-Lead SOIC_N	R-8	98
ADR431TRZ-EP-R7	2.500	1.0	0.04	5	-55°C to +125°C	8-Lead SOIC_N	R-8	1,000
ADR434TRZ-EP	4.096	1.5	0.04	3	-55°C to +125°C	8-Lead SOIC_N	R-8	98
ADR434TRZ-EP-R7	4.096	1.5	0.04	3	-55°C to +125°C	8-Lead SOIC_N	R-8	1,000
ADR435TRZ-EP	5.000	2.0	0.04	3	-55°C to +125°C	8-Lead SOIC_N	R-8	98
ADR435TRZ-EP-R7	5.000	2.0	0.04	3	-55°C to +125°C	8-Lead SOIC_N	R-8	1,000

<sup>1</sup> Z = RoHS Compliant Part.