

### FEATURES

#### Ultralow noise (0.1 Hz to 10 Hz)

- ADR440: 1  $\mu\text{V}$  p-p
- ADR441: 1.2  $\mu\text{V}$  p-p
- ADR443: 1.4  $\mu\text{V}$  p-p
- ADR444: 1.8  $\mu\text{V}$  p-p
- ADR445: 2.25  $\mu\text{V}$  p-p

#### Superb temperature coefficient

- A grade: 10 ppm/ $^{\circ}\text{C}$
- B grade: 3 ppm/ $^{\circ}\text{C}$

#### Low dropout operation: 500 mV

#### Input range: ( $V_{\text{OUT}} + 500 \text{ mV}$ ) to 18 V

#### High output source and sink current

- +10 mA and -5 mA, respectively

#### Wide temperature range: $-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$

### APPLICATIONS

Precision data acquisition systems

High resolution data converters

Battery-powered instrumentation

Portable medical instruments

Industrial process control systems

Precision instruments

Optical control circuits

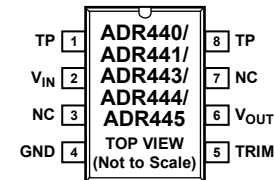
### GENERAL DESCRIPTION

The ADR44x series is a family of XFET<sup>®</sup> voltage references featuring ultralow 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 ADR44x is greatly minimized.

The XFET references offer better noise performance than buried Zener references, and XFET references operate off low supply voltage headroom (0.5 V). This combination of features makes the ADR44x family ideally suited for precision signal conversion applications in high-end data acquisition systems, optical networks, and medical applications.

The ADR44x family has the capability to source up to 10 mA of output current and sink up to -5 mA. It also comes with a trim terminal to adjust the output voltage over a 0.5% range without compromising performance.

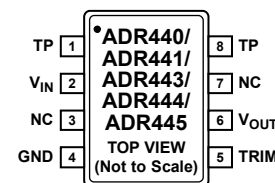
### PIN CONFIGURATIONS



#### NOTES

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

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



#### NOTES

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

Figure 2. 8-Lead MSOP (RM-Suffix)

Offered in two electrical grades, the ADR44x family is available in 8-lead MSOP and narrow SOIC packages. All versions are specified over the extended industrial temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

Table 1. Selection Guide

Model	Output Voltage (V)	Initial Accuracy (mV)	Temperature Coefficient (ppm/ $^{\circ}\text{C}$ )
ADR440A	2.048	$\pm 3$	10
ADR440B	2.048	$\pm 1$	3
ADR441A	2.500	$\pm 3$	10
ADR441B	2.500	$\pm 1$	3
ADR443A	3.000	$\pm 4$	10
ADR443B	3.000	$\pm 1.2$	3
ADR444A	4.096	$\pm 5$	10
ADR444B	4.096	$\pm 1.6$	3
ADR445A	5.000	$\pm 6$	10
ADR445B	5.000	$\pm 2$	3

**ADR443 ELECTRICAL CHARACTERISTICS**

$V_{IN} = 3.5\text{ V to }18\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $C_{IN} = C_{OUT} = 0.1\ \mu\text{F}$ , unless otherwise noted.

**Table 4.**

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
OUTPUT VOLTAGE	$V_O$					
A Grade			2.996	3.000	3.004	V
B Grade			2.9988	3.000	3.0012	V
INITIAL ACCURACY	$V_{OERR}$					
A Grade					4	mV
					0.13	%
B Grade					1.2	mV
					0.04	%
TEMPERATURE DRIFT	$TCV_O$					
A Grade		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		2	10	ppm/ $^\circ\text{C}$
B Grade		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		1	3	ppm/ $^\circ\text{C}$
LINE REGULATION	$\Delta V_O/\Delta V_{IN}$	$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		10	20	ppm/V
LOAD REGULATION	$\Delta V_O/\Delta I_{LOAD}$	$I_{LOAD} = 0\text{ mA to }10\text{ mA}$ , $V_{IN} = 5\text{ V}$ , $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	-50		+50	ppm/mA
	$\Delta V_O/\Delta I_{LOAD}$	$I_{LOAD} = 0\text{ mA to }-5\text{ mA}$ , $V_{IN} = 5\text{ V}$ , $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	-50		+50	ppm/mA
QUIESCENT CURRENT	$I_{IN}$	No load, $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		3	3.75	mA
VOLTAGE NOISE	$e_N\text{ p-p}$	0.1 Hz to 10 Hz		1.4		$\mu\text{V p-p}$
VOLTAGE NOISE DENSITY	$e_N$	1 kHz		57.6		nV/ $\sqrt{\text{Hz}}$
TURN-ON SETTLING TIME	$t_R$			10		$\mu\text{s}$
LONG-TERM STABILITY <sup>1</sup>	$V_O$	1000 hours		50		ppm
OUTPUT VOLTAGE HYSTERESIS	$V_{O\_HYS}$			70		ppm
RIPPLE REJECTION RATIO	RRR	$f_{IN} = 1\text{ kHz}$		-80		dB
SHORT CIRCUIT TO GND	$I_{SC}$			27		mA
SUPPLY VOLTAGE OPERATING RANGE	$V_{IN}$		3.5		18	V
SUPPLY VOLTAGE HEADROOM	$V_{IN} - V_O$		500			mV

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

# ADR440/ADR441/ADR443/ADR444/ADR445

## ADR444 ELECTRICAL CHARACTERISTICS

$V_{IN} = 4.6 \text{ V to } 18 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$ , unless otherwise noted.

Table 5.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
OUTPUT VOLTAGE	$V_O$					
A Grade			4.091	4.096	4.101	V
B Grade			4.0944	4.096	4.0976	V
INITIAL ACCURACY	$V_{OERR}$					
A Grade					5	mV
					0.13	%
B Grade					1.6	mV
					0.04	%
TEMPERATURE DRIFT	$TCV_O$					
A Grade		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		2	10	ppm/ $^\circ\text{C}$
B Grade		$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		1	3	ppm/ $^\circ\text{C}$
LINE REGULATION	$\Delta V_O / \Delta V_{IN}$	$-40^\circ\text{C} < T_A < +125^\circ\text{C}$		10	20	ppm/V
LOAD REGULATION	$\Delta V_O / \Delta I_{LOAD}$	$I_{LOAD} = 0 \text{ mA to } 10 \text{ mA}$ , $V_{IN} = 5.5 \text{ V}$ , $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	-50		+50	ppm/mA
	$\Delta V_O / \Delta I_{LOAD}$	$I_{LOAD} = 0 \text{ mA to } -5 \text{ mA}$ , $V_{IN} = 5.5 \text{ V}$ , $-40^\circ\text{C} < T_A < +125^\circ\text{C}$	-50		+50	ppm/mA
QUIESCENT CURRENT	$I_{IN}$	No load, $-40^\circ\text{C} < T_A < +125^\circ\text{C}$		3	3.75	mA
VOLTAGE NOISE	$e_N$ p-p	0.1 Hz to 10 Hz		1.8		$\mu\text{V}$ p-p
VOLTAGE NOISE DENSITY	$e_N$	1 kHz		78.6		nV/ $\sqrt{\text{Hz}}$
TURN-ON SETTLING TIME	$t_R$			10		$\mu\text{s}$
LONG-TERM STABILITY <sup>1</sup>	$V_O$	1000 hours		50		ppm
OUTPUT VOLTAGE HYSTERESIS	$V_{O\_HYS}$			70		ppm
RIPPLE REJECTION RATIO	RRR	$f_{IN} = 1 \text{ kHz}$		-80		dB
SHORT CIRCUIT TO GND	$I_{SC}$			27		mA
SUPPLY VOLTAGE OPERATING RANGE	$V_{IN}$		4.6		18	V
SUPPLY VOLTAGE HEADROOM	$V_{IN} - V_O$		500			mV

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

# ADR440/ADR441/ADR443/ADR444/ADR445

## ABSOLUTE MAXIMUM RATINGS

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

Table 7.

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	$-40^\circ\text{C}$ 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 8. Thermal Resistance

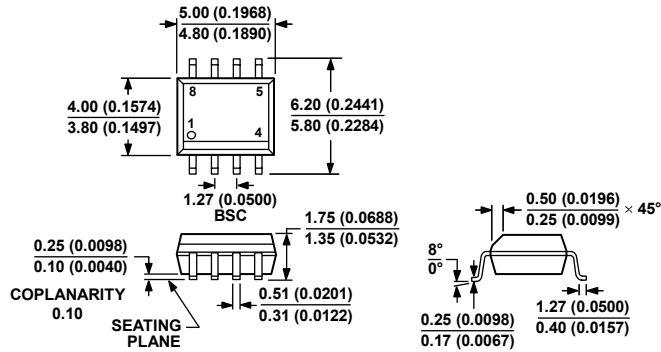
Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
8-Lead SOIC (R-Suffix)	130	43	$^\circ\text{C}/\text{W}$
8-Lead MSOP (RM-Suffix)	132.5	43.9	$^\circ\text{C}/\text{W}$

## 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.

OUTLINE DIMENSIONS

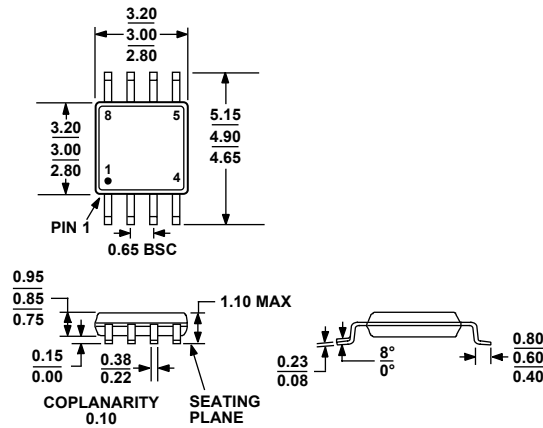


COMPLIANT TO JEDEC STANDARDS MS-012-AA  
 CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS  
 (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR  
 REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

012407-A

Figure 42. 8-Lead Standard Small Outline Package [SOIC\_N]  
 Narrow Body  
 (R-8)

Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-187-AA

Figure 43. 8-Lead Mini Small Outline Package [MSOP]  
 (RM-8)

Dimensions show in millimeters

# ADR440/ADR441/ADR443/ADR444/ADR445

## ORDERING GUIDE

Model	Output Voltage (V)	Initial Accuracy		Temperature Coefficient Package (ppm/°C)	Package Description	Branding	Temperature Range	Package Option
		±mV	%					
ADR440ARZ <sup>1</sup>	2.048	3	0.15	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR440ARZ-REEL7 <sup>1</sup>	2.048	3	0.15	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR440ARMZ <sup>1</sup>	2.048	3	0.15	10	8-Lead MSOP	R01	-40°C to +125°C	RM-8
ADR440ARMZ-REEL7 <sup>1</sup>	2.048	3	0.15	10	8-Lead MSOP	R01	-40°C to +125°C	RM-8
ADR440BRZ <sup>1</sup>	2.048	1	0.05	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR440BRZ-REEL7 <sup>1</sup>	2.048	1	0.05	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR441ARZ <sup>1</sup>	2.500	3	0.12	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR441ARZ-REEL7 <sup>1</sup>	2.500	3	0.12	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR441ARMZ <sup>1</sup>	2.500	3	0.12	10	8-Lead MSOP	R02	-40°C to +125°C	RM-8
ADR441ARMZ-REEL7 <sup>1</sup>	2.500	3	0.12	10	8-Lead MSOP	R02	-40°C to +125°C	RM-8
ADR441BRZ <sup>1</sup>	2.500	1	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR441BRZ-REEL7 <sup>1</sup>	2.500	1	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR443ARZ <sup>1</sup>	3.000	4	0.13	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR443ARZ-REEL7 <sup>1</sup>	3.000	4	0.13	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR443ARMZ <sup>1</sup>	3.000	4	0.13	10	8-Lead MSOP	R03	-40°C to +125°C	RM-8
ADR443ARMZ-REEL7 <sup>1</sup>	3.000	4	0.13	10	8-Lead MSOP	R03	-40°C to +125°C	RM-8
ADR443BRZ <sup>1</sup>	3.000	1.2	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR443BRZ-REEL7 <sup>1</sup>	3.000	1.2	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR444ARZ <sup>1</sup>	4.096	5	0.13	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR444ARZ-REEL7 <sup>1</sup>	4.096	5	0.13	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR444ARMZ <sup>1</sup>	4.096	5	0.13	10	8-Lead MSOP	R04	-40°C to +125°C	RM-8
ADR444ARMZ-REEL7 <sup>1</sup>	4.096	5	0.13	10	8-Lead MSOP	R04	-40°C to +125°C	RM-8
ADR444BRZ <sup>1</sup>	4.096	1.6	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR444BRZ-REEL7 <sup>1</sup>	4.096	1.6	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR445ARZ <sup>1</sup>	5.000	6	0.12	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR445ARZ-REEL7 <sup>1</sup>	5.000	6	0.12	10	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR445ARMZ <sup>1</sup>	5.000	6	0.12	10	8-Lead MSOP	R05	-40°C to +125°C	RM-8
ADR445ARMZ-REEL7 <sup>1</sup>	5.000	6	0.12	10	8-Lead MSOP	R05	-40°C to +125°C	RM-8
ADR445BRZ <sup>1</sup>	5.000	2	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8
ADR445BRZ-REEL7 <sup>1</sup>	5.000	2	0.04	3	8-Lead SOIC_N		-40°C to +125°C	R-8

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