

### FEATURES

- Single- or dual-supply operation
- Low noise: 4.7 nV/ $\sqrt{\text{Hz}}$  @ 1 kHz
- Wide bandwidth: 3.4 MHz
- Low offset voltage: 100  $\mu\text{V}$
- Very low drift: 0.2  $\mu\text{V}/^\circ\text{C}$
- Unity gain stable
- No phase reversal

### APPLICATIONS

- Digital scales
- Multimedia
- Strain gages
- Battery-powered instrumentation
- Temperature transducer amplifier

### GENERAL DESCRIPTION

The OPx13 family of single-supply operational amplifiers features both low noise and drift. It has been designed for systems with internal calibration. Often these processor-based systems are capable of calibrating corrections for offset and gain, but they cannot correct for temperature drifts and noise. Optimized for these parameters, the OPx13 family can be used to take advantage of superior analog performance combined with digital correction. Many systems using internal calibration operate from unipolar supplies, usually either 5 V or 12 V. The OPx13 family is designed to operate from single supplies from 4 V to 36 V and to maintain its low noise and precision performance.

The OPx13 family is unity gain stable and has a typical gain bandwidth product of 3.4 MHz. Slew rate is in excess of 1 V/ $\mu\text{s}$ . Noise density is a very low 4.7 nV/ $\sqrt{\text{Hz}}$ , and noise in the 0.1 Hz to 10 Hz band is 120 nV p-p. Input offset voltage is guaranteed and offset drift is guaranteed to be less than 0.8  $\mu\text{V}/^\circ\text{C}$ . Input common-mode range includes the negative supply and to within 1 V of the positive supply over the full supply range. Phase reversal protection is designed into the OPx13 family for cases where input voltage range is exceeded. Output voltage swings also include the negative supply and go to within 1 V of the positive rail. The output is capable of sinking and sourcing current throughout its range and is specified with 600  $\Omega$  loads.

### PIN CONFIGURATIONS

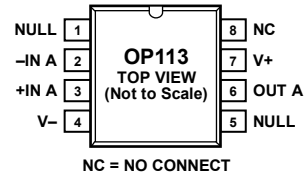


Figure 1. 8-Lead Narrow-Body SOIC\_N

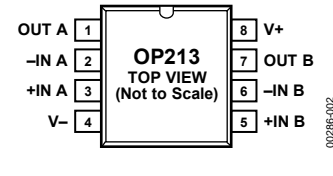


Figure 2. 8-Lead Narrow-Body SOIC\_N

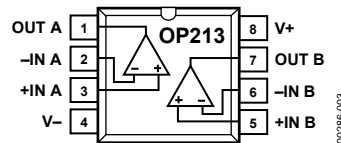


Figure 3. 8-Lead PDIP

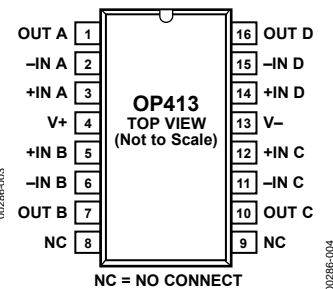


Figure 4. 16-Lead Wide-Body SOIC\_W

Digital scales and other strain gage applications benefit from the very low noise and low drift of the OPx13 family. Other applications include use as a buffer or amplifier for both analog-to-digital (ADC) and digital-to-analog (DAC) sigma-delta converters. Often these converters have high resolutions requiring the lowest noise amplifier to utilize their full potential. Many of these converters operate in either single-supply or low-supply voltage systems, and attaining the greater signal swing possible increases system performance.

The OPx13 family is specified for single 5 V and dual  $\pm 15$  V operation over the XIND—extended industrial temperature range ( $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ ). They are available in PDIP and SOIC surface-mount packages.

# SPECIFICATIONS

## ELECTRICAL CHARACTERISTICS

@  $V_S = \pm 15.0\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	E Grade			F Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
INPUT CHARACTERISTICS									
Offset Voltage	$V_{OS}$	OP113 $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			75			150	$\mu\text{V}$
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			125			225	$\mu\text{V}$
		OP213 $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			100			250	$\mu\text{V}$
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			150			325	$\mu\text{V}$
		OP413 $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			125			275	$\mu\text{V}$
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			175			350	$\mu\text{V}$
Input Bias Current	$I_B$	$V_{CM} = 0\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$		240	600			600	nA
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			700			700	nA
Input Offset Current	$I_{OS}$	$V_{CM} = 0\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			50			50	nA
Input Voltage Range	$V_{CM}$		-15		+14	-15		+14	V
Common-Mode Rejection	CMR	$-15\text{ V} \leq V_{CM} \leq +14\text{ V}$ $-15\text{ V} \leq V_{CM} \leq +14\text{ V}$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	100	116		96			dB
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	97	116		94			dB
Large-Signal Voltage Gain	$A_{VO}$	OP113, OP213, $R_L = 600\ \Omega$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	1	2.4		1			V/ $\mu\text{V}$
		OP413, $R_L = 1\text{ k}\Omega$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	1	2.4		1			V/ $\mu\text{V}$
		$R_L = 2\text{ k}\Omega$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	2	8		2			V/ $\mu\text{V}$
Long-Term Offset Voltage <sup>1</sup>	$V_{OS}$				150			300	$\mu\text{V}$
Offset Voltage Drift <sup>2</sup>	$\Delta V_{OS}/\Delta T$			0.2	0.8			1.5	$\mu\text{V}/^\circ\text{C}$
OUTPUT CHARACTERISTICS									
Output Voltage Swing High	$V_{OH}$	$R_L = 2\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	14			14			V
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	13.9			13.9			V
Output Voltage Swing Low	$V_{OL}$	$R_L = 2\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ , $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			-14.5			-14.5	V
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			-14.5			-14.5	V
Short-Circuit Limit	$I_{SC}$			$\pm 40$			$\pm 40$		mA
POWER SUPPLY									
Power Supply Rejection Ratio	PSRR	$V_S = \pm 2\text{ V to } \pm 18\text{ V}$ $V_S = \pm 2\text{ V to } \pm 18\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	103	120		100			dB
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	100	120		97			dB
Supply Current/Amplifier	$I_{SY}$	$V_{OUT} = 0\text{ V}$ , $R_L = \infty$ , $V_S = \pm 18\text{ V}$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			3			3	mA
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			3.8			3.8	mA
Supply Voltage Range	$V_S$		4		$\pm 18$	4		$\pm 18$	V

# OP113/OP213/OP413

Parameter	Symbol	Conditions	E Grade			F Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
AUDIO PERFORMANCE									
THD + Noise		$V_{IN} = 3\text{ V rms}, R_L = 2\text{ k}\Omega,$ $f = 1\text{ kHz}$		0.0009			0.0009		%
Voltage Noise Density	$e_n$	$f = 10\text{ Hz}$		9			9		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		4.7			4.7		nV/ $\sqrt{\text{Hz}}$
Voltage Noise	$e_n\text{ p-p}$	$f = 1\text{ kHz}$		0.4			0.4		pA/ $\sqrt{\text{Hz}}$
		0.1 Hz to 10 Hz		120			120		nV p-p
DYNAMIC PERFORMANCE									
Slew Rate	SR	$R_L = 2\text{ k}\Omega$	0.8	1.2		0.8	1.2		V/ $\mu\text{s}$
Gain Bandwidth Product	GBP			3.4			3.4		MHz
Channel Separation		$V_{OUT} = 10\text{ V p-p}$ $R_L = 2\text{ k}\Omega, f = 1\text{ kHz}$		105			105		dB
Settling Time	$t_s$	to 0.01%, 0V to 10V step		9			9		$\mu\text{s}$

<sup>1</sup> Long-term offset voltage is guaranteed by a 1000 hour life test performed on three independent lots at 125°C, with an LTPD of 1.3.

<sup>2</sup> Guaranteed specifications, based on characterization data.

@  $V_S = 5.0\text{ V}, T_A = 25^\circ\text{C}$ , unless otherwise noted.

**Table 2.**

Parameter	Symbol	Conditions	E Grade			F Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
INPUT CHARACTERISTICS									
Offset Voltage	$V_{OS}$	OP113			125			175	$\mu\text{V}$
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			175			250	$\mu\text{V}$
		OP213			150			300	$\mu\text{V}$
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			225			375	$\mu\text{V}$
		OP413			175			325	$\mu\text{V}$
Input Bias Current	$I_B$	$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			250			400	$\mu\text{V}$
		$V_{CM} = 0\text{ V}, V_{OUT} = 2$		300	650		650	nA	
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			750		750	nA	
Input Offset Current	$I_{OS}$	$V_{CM} = 0\text{ V}, V_{OUT} = 2$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			50		50	nA	
Input Voltage Range	$V_{CM}$		0		4		4	V	
Common-Mode Rejection	CMR	$0\text{ V} \leq V_{CM} \leq 4\text{ V}$	93	106		90			dB
		$0\text{ V} \leq V_{CM} \leq 4\text{ V},$ $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$	90			87			dB
Large-Signal Voltage Gain	$A_{VO}$	OP113, OP213, $R_L = 600\ \Omega, 2\text{ k}\Omega,$ $0.01\text{ V} \leq V_{OUT} \leq 3.9\text{ V}$	2			2			V/ $\mu\text{V}$
		OP413, $R_L = 600, 2\text{ k}\Omega,$ $0.01\text{ V} \leq V_{OUT} \leq 3.9\text{ V}$	1			1			V/ $\mu\text{V}$
Long-Term Offset Voltage <sup>1</sup>	$V_{OS}$				200		350	$\mu\text{V}$	
Offset Voltage Drift <sup>2</sup>	$\Delta V_{OS}/\Delta T$			0.2	1.0		1.5	$\mu\text{V}/^\circ\text{C}$	

Parameter	Symbol	Conditions	E Grade			F Grade			Unit
			Min	Typ	Max	Min	Typ	Max	
OUTPUT CHARACTERISTICS									
Output Voltage Swing High	$V_{OH}$	$R_L = 600\text{ k}\Omega$	4.0			4.0			V
		$R_L = 100\text{ k}\Omega$	4.1			4.1			V
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$							
Output Voltage Swing Low	$V_{OL}$	$R_L = 600\ \Omega$	3.9			3.9			V
		$R_L = 600\ \Omega$							
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			8			8	mV
		$R_L = 100\text{ k}\Omega$							mV
		$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$		8			8		mV
Short-Circuit Limit	$I_{SC}$			$\pm 30$			$\pm 30$		mA
POWER SUPPLY									
Supply Current	$I_{SY}$	$V_{OUT} = 2.0\text{ V}$ , no load		1.6	2.7			2.7	mA
	$I_{SY}$	$-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$			3.0			3.0	mA
AUDIO PERFORMANCE									
THD + Noise		$V_{OUT} = 0\text{ dBu}$ , $f = 1\text{ kHz}$		0.001			0.001		%
Voltage Noise Density	$e_n$	$f = 10\text{ Hz}$		9			9		nV/ $\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$		4.7			4.7		nV/ $\sqrt{\text{Hz}}$
Current Noise Density	$i_n$	$f = 1\text{ kHz}$		0.45			0.45		pA/ $\sqrt{\text{Hz}}$
Voltage Noise	$e_n\text{ p-p}$	0.1 Hz to 10 Hz		120			120		nV p-p
DYNAMIC PERFORMANCE									
Slew Rate	SR	$R_L = 2\text{ k}\Omega$	0.6	0.9		0.6			V/ $\mu\text{s}$
Gain Bandwidth Product	GBP			3.5			3.5		MHz
Settling Time	$t_s$	to 0.01%, 2 V step		5.8			5.8		$\mu\text{s}$

<sup>1</sup> Long-term offset voltage is guaranteed by a 1000 hour life test performed on three independent lots at 125°C, with an LTPD of 1.3.

<sup>2</sup> Guaranteed specifications, based on characterization data.

## ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	±18 V
Input Voltage	±18 V
Differential Input Voltage	±10 V
Output Short-Circuit Duration to GND	Indefinite
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +85°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature Range (Soldering, 60 sec)	300°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

Table 4. Thermal Resistance

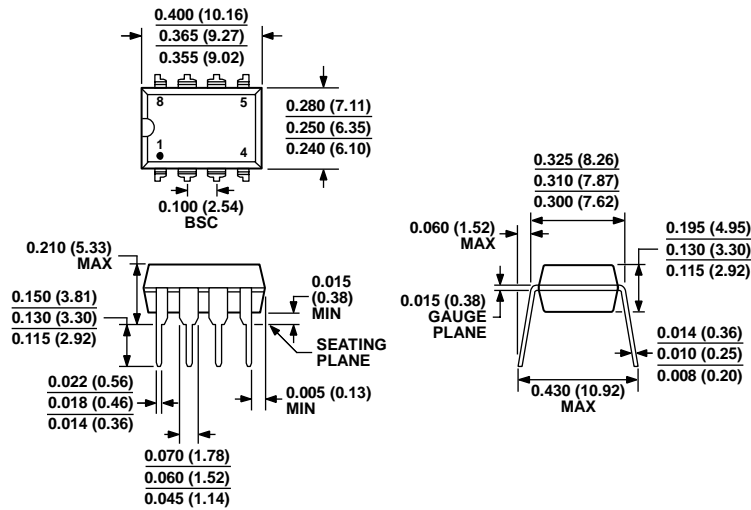
Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
8-Lead PDIP (P)	103	43	°C/W
8-Lead SOIC_N (S)	158	43	°C/W
16-Lead SOIC_W (S)	92	27	°C/W

## 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.

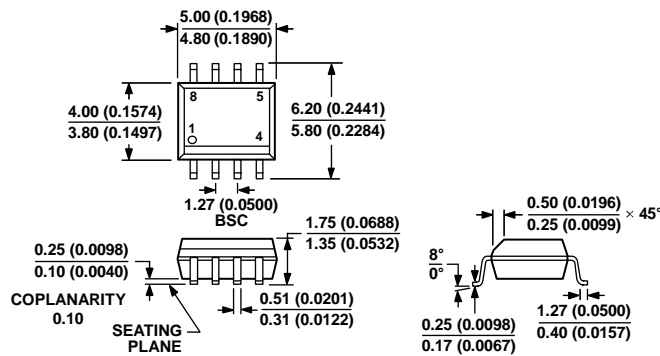
# OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-001  
 CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN. CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.

Figure 53. 8-Lead Plastic Dual In-Line Package [PDIP]  
 Narrow Body  
 P-Suffix  
 (N-8)  
 Dimensions shown in inches and (millimeters)

070606-A

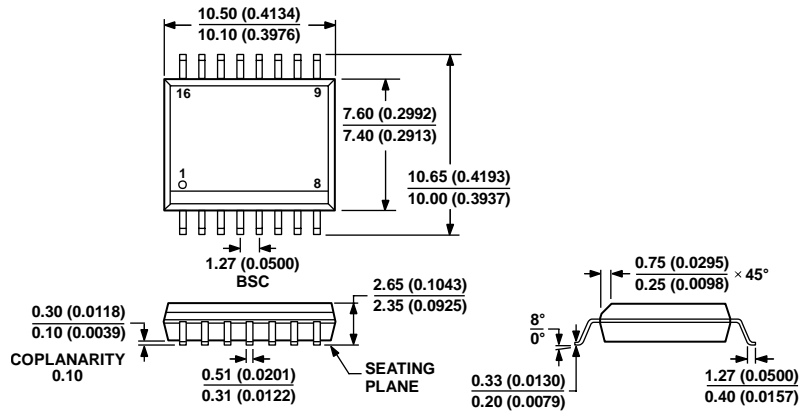


COMPLIANT TO JEDEC STANDARDS MS-012-AA  
 CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 54. 8-Lead Standard Small Outline Package [SOIC\_N]  
 Narrow Body  
 S-Suffix  
 (R-8)  
 Dimensions shown in millimeters and (inches)

012407-A

# OP113/OP213/OP413



COMPLIANT TO JEDEC STANDARDS MS-013-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.

Figure 55. 16-Lead Standard Small Outline Package [SOIC\_W]  
 Wide Body  
 S-Suffix  
 (RW-16)

Dimensions shown in millimeters and (inches)

030707-B

## ORDERING GUIDE

Model	Temperature Range	Package Description	Package Options
OP113ES	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ES-REEL	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ES-REEL7	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ESZ <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ESZ-REEL <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ESZ-REEL7 <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FS	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FS-REEL	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FS-REEL7	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FSZ <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FSZ-REEL <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FSZ-REEL7 <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ES	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ES-REEL	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ES-REEL7	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ESZ <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ESZ-REEL <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ESZ-REEL7 <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FP	-40°C to +85°C	8-Lead PDIP	N-8 (P-Suffix)
OP213FPZ <sup>1</sup>	-40°C to +85°C	8-Lead PDIP	N-8 (P-Suffix)
OP213FS	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FS-REEL	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FS-REEL7	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FSZ <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FSZ-REEL <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FSZ-REEL7 <sup>1</sup>	-40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)