Low Noise, Low Drift Single-Supply Operational Amplifiers

OP113/OP213/OP413

FEATURES

Single- or dual-supply operation
Low noise: 4.7 nV/√Hz @ 1 kHz
Wide bandwidth: 3.4 MHz
Low offset voltage: 100 μV
Very low drift: 0.2 μV/°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/μs. Noise density is a very low 4.7 nV/√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 μV/°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 Ω loads.

PIN CONFIGURATIONS

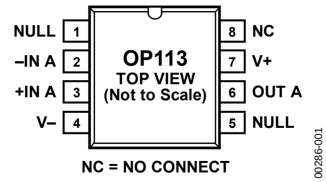

Figure 1. 8-Lead Narrow-Body SOIC_N

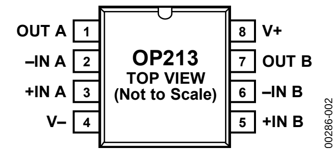

Figure 2. 8-Lead Narrow-Body SOIC_N

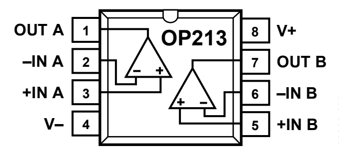

Figure 3. 8-Lead PDIP

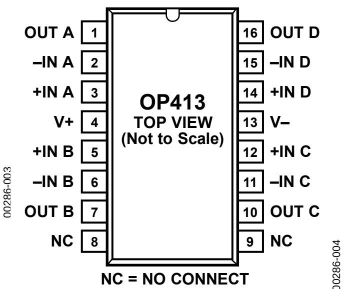

Figure 4. 16-Lead Wide-Body SOIC_W

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 ±15 V operation over the XIND—extended industrial temperature range (−40°C to +85°C). They are available in PDIP and SOIC surface-mount packages.

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS

@ V_S = ±15.0 V, T_A = 25°C, unless otherwise noted.

Table 1.

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

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

[1] 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.
[2] Guaranteed specifications, based on characterization data.

@ V_S = 5.0 V, T_A = 25°C, unless otherwise noted.

Table 2.

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

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

[1] 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.
[2] 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	θ_{JA}	θ_{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.

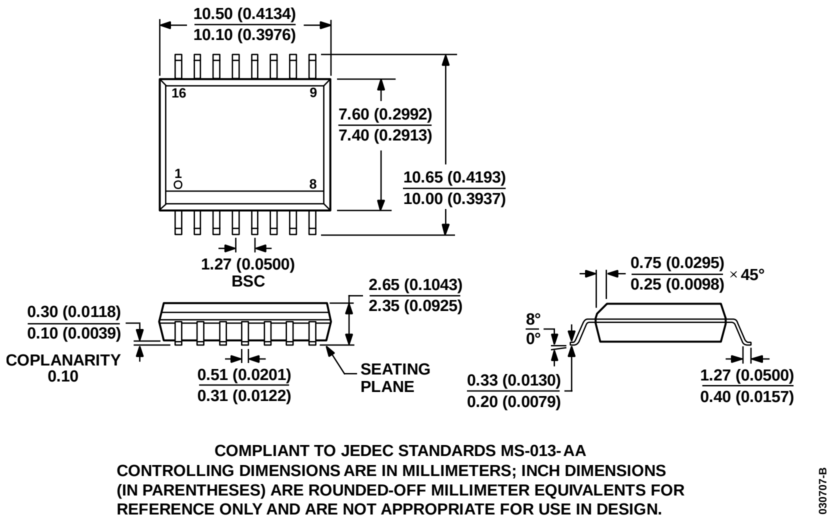

Figure 55. 16-Lead Standard Small Outline Package [SOIC_W]
Wide Body
S-Suffix
(RW-16)
Dimensions shown in millimeters and (inches)

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[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ESZ-REEL[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113ESZ-REEL7[1]	−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[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FSZ-REEL[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP113FSZ-REEL7[1]	−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[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ESZ-REEL[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213ESZ-REEL7[1]	−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[1]	−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[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FSZ-REEL[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)
OP213FSZ-REEL7[1]	−40°C to +85°C	8-Lead SOIC_N	R-8 (S-Suffix)

Model	Temperature Range	Package Description	Package Options
OP413ES	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413ES-REEL	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413ESZ[1]	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413ESZ-REEL[1]	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413FS	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413FS-REEL	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413FSZ[1]	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)
OP413FSZ-REEL[1]	−40°C to +85°C	16-Lead Wide Body SOIC_W	RW-16 (S-Suffix)

[1] Z = RoHS Compliant Part.