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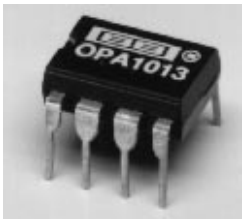


OPA1013

Precision, Single-Supply DUAL OPERATIONAL AMPLIFIER

FEATURES

- SINGLE POWER SUPPLY OPERATION
- INPUT VOLTAGE RANGE TO GROUND
- OUTPUT SWINGS NEAR GROUND
- LOW QUIESCENT CURRENT: 550μA max
- LOW V_{os}: 300μV max
- LOW DRIFT: 2.5μV/°C max
- LOW I_{os}: 1.5nA max
- LOW NOISE: 0.55μVp-p, 0.1Hz to 10Hz

APPLICATIONS

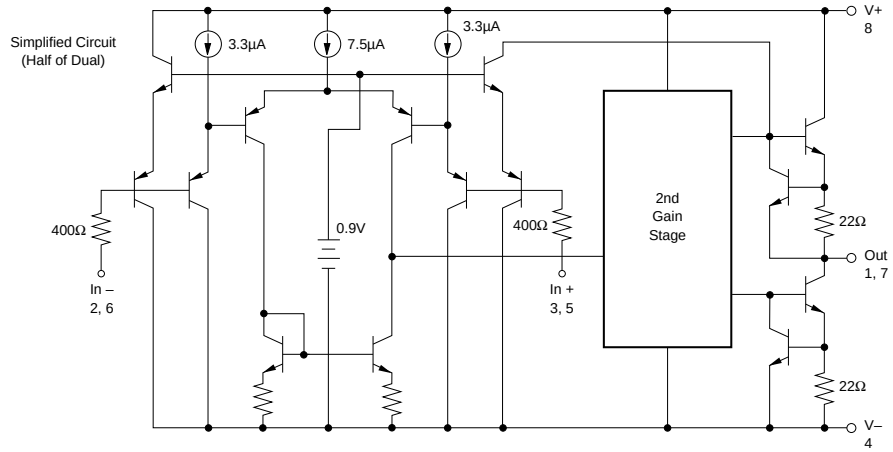
- PRECISION INSTRUMENTATION
- BATTERY-POWERED EQUIPMENT
- BRIDGE AMPLIFIERS
- 4-20mA CURRENT TRANSMITTERS
- VOLTAGE COMPARATOR

DESCRIPTION

The OPA1013 dual operational amplifier provides precision performance in single power supply and low power applications. It is laser trimmed for low offset voltage and drift, greatly reducing the large errors common with LM324-type op amps. Input offset current is also trimmed to reduce errors in high impedance applications.

The OPA1013 is characterized for operation at both +5V (single supply) and ±15V power supplies. When operated from a single supply, the input common-mode range includes ground and the output can swing to within 15mV of ground. Completely independent biasing networks eliminate interaction between the two amplifiers—even when one is used as a comparator.

The OPA1013 is available in an 8-pin plastic DIP specified for the 0°C to +70°C temperature range.



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SBOS005

SPECIFICATIONS

ELECTRICAL

V_S = ±15V, V_{CM} = 0V, T_A = +25°C unless otherwise noted.

PARAMETER	CONDITION	OPA1013CN8			OPA1013DN8			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage			±50	±300		±200	±800	µV
Time Stability			0.5			*		µV/Mo
Input Offset Current			±0.08	±1.5		*	*	nA
Input Bias Current			7	30		*	*	nA
Voltage Noise, BW = 0.1 to 10Hz			0.55			*		µVp-p
Noise Density, f = 10Hz			28			*		nV/√Hz
f = 1kHz			25			*		nV/√Hz
Current Noise Density, f = 10Hz			0.12			*		pA/√Hz
Input Resistance: Differential		70	300		*	*		MΩ
Input Resistance: Common-Mode			4			*		GΩ
Open-Loop Voltage Gain	V_O = ±10V, R_L = 2kΩ	1.2	2.9		*	*		V/µV
	V_O = ±10V, R_L = 600Ω	0.5	1.9		*	*		V/µV
Common-Mode Input Range		+13.5	+13.8		*	*		V
		–15	–15.3		*	*		V
Common-Mode Rejection	V_{CM} = +13.5 to –15V	97	114		*	*		dB
Power Supply Rejection	V_S = ±2 to ±18V	100	117		*	*		dB
Channel Separation	V_O = ±10V, R_L = 2kΩ	120	137		*	*		dB
Voltage Output	R_L = 2kΩ	±12.5	±14		*	*		V
Slew Rate		0.2	0.35		*	*		V/µs
Quiescent Current (per amplifier)			±0.35	±0.55		*	*	mA

*Specification same as OPA1013CN8.

V_S = +5V/0V, V_{CM} = 0V, V_O = +1.4V, T_A = +25°C unless otherwise noted.

PARAMETER	CONDITION	OPA1013CN8			OPA1013DN8			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage			±90	±450		±250	±950	µV
Input Offset Current			±3.0	±2.0		*	*	nA
Input Bias Current			10	50		*	*	nA
Open-Loop Voltage Gain	V_O = 5mV to 4V R_L = 500Ω		0.1			*		V/µV
Common-Mode Input Range		+3.5	+3.8		*	*		V
		0	–0.3		*	*		V
Voltage Output Low	No Load		15	25		*	*	mV
Low	R_L = 600Ω to Ground		5	10		*	*	mV
Low	I_{SINK} = 1mA		200	350		*	*	mV
High	No Load	4	4.4		*	*		V
High	R_L = 600Ω to Ground	3.4	4		*	*		V
Quiescent Current (per amplifier)			0.33	0.5		*	*	mA

*Specification same as OPA1013CN8.

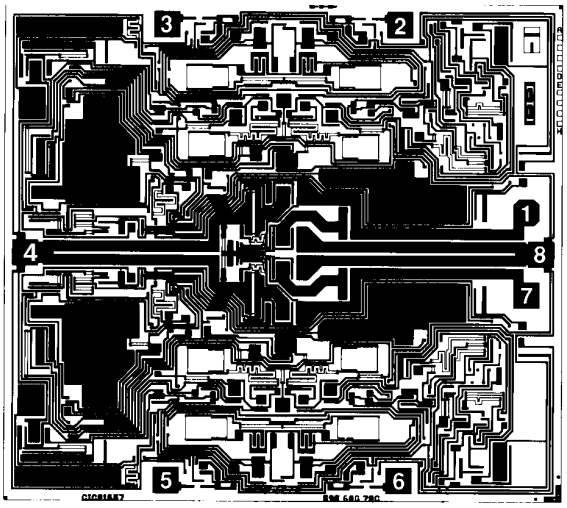
T_A = 0°C to +70°C, V_S = ±15V, V_{CM} = 0V unless otherwise noted.

PARAMETER	CONDITION	OPA1013CN8			OPA1013DN8			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage			±80	±400		±230	±1000	µV
	V_S = +5/0V, V_O = +1.4V		±110	±570		±280	±1200	µV
Input Offset Voltage Drift[1]			0.4	2.5		0.7	5	µV/°C
Input Offset Current			±0.3	±2.8		*	*	nA
	V_S = +5/0V, V_O = +1.4V		±0.5	±6		*	*	nA
Input Bias Current			9	38		*	*	nA
	V_S = +5/0V, V_O = +1.4V		13	90		*	*	nA
Open-Loop Voltage Gain	V_O = ±10V, R_L = 2kΩ	0.7	2.2		*	*		V/µV
Common-Mode Rejection	V_{CM} = +13 to –15V	94	113		*	*		dB
Power Supply Rejection	V_S = ±2 to ±18V	97	116		*	*		dB
Voltage Output	R_L = 2kΩ	±12.0	±13.9		*	*		V
V_O Low	V_S = +5/0V, R_L = 600Ω		6	13		*	*	mV
V_O High	V_S = +5/0V, R_L = 600Ω	3.2	3.9		*	*		V
Quiescent Current (per amplifier)			±0.37	±0.6		*	*	mA
	V_S = +5/0V, V_O = +1.4V		0.34	0.55		*	*	mA

*Specification same as OPA1013CN8.

NOTE: (1) Guaranteed by design. This specification is established to a 98% confidence level.

DICE INFORMATION



OPA1013 DIE TOPOGRAPHY

PAD	FUNCTION
1	Output A
2	–In A
3	+In A
4	V–
5	+In B
6	–In B
7	Output B
8	V+

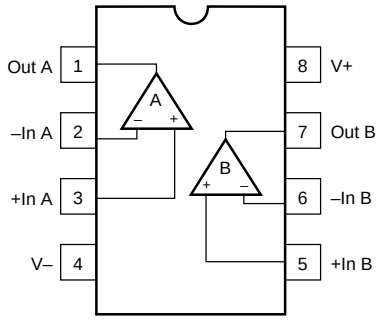
Substrate Bias: $-V_S$

MECHANICAL INFORMATION

	MILS (0.001")	MILLIMETERS
Die Size	112 x 100 ±5	2.84 x 2.54 ±0.13
Die Thickness	20 ±3	0.51 ±0.08
Min. Pad Size	4 x 4	0.10 x 0.10
Transistor Count		92
Backing		Gold

CONNECTION DIAGRAM

N8 — Plastic Package — Top View



ABSOLUTE MAXIMUM RATINGS

Power Supply Voltage	±22V
Differential Input Voltage	±30V
Input Voltage	V+ to (V–) –5V
Output Short Circuit (T_A = 25°C)	Continuous
Operating Temperature:	0°C to +70°C
Storage Temperature	–65 to +150°C
Lead Temperature (soldering, 10s)	+300°C

ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
OPA1013CN8	Plastic DIP	0°C to +70°C
OPA1013DN8	Plastic DIP	0°C to +70°C

PACKAGE INFORMATION

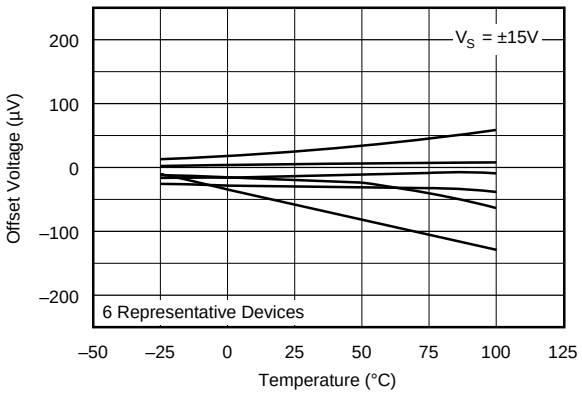
MODEL	PACKAGE	PACKAGE DRAWING NUMBER[1]
OPA1013CN8	Plastic DIP	006
OPA1013DN8	Plastic DIP	006

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

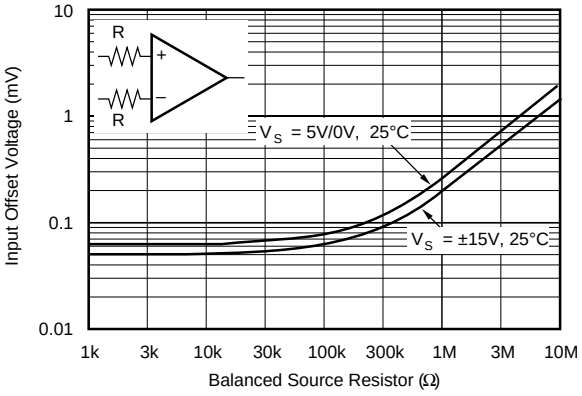
TYPICAL PERFORMANCE CURVES

T_A = +25°C unless otherwise noted.

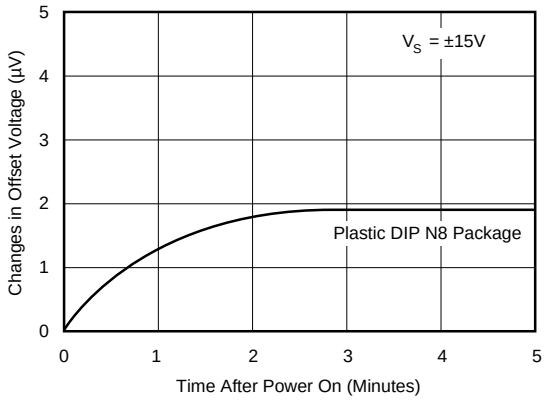
OFFSET VOLTAGE vs TEMPERATURE



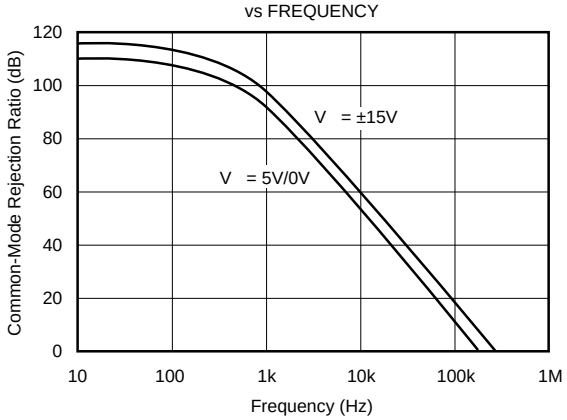
OFFSET VOLTAGE
vs BALANCED SOURCE RESISTANCE



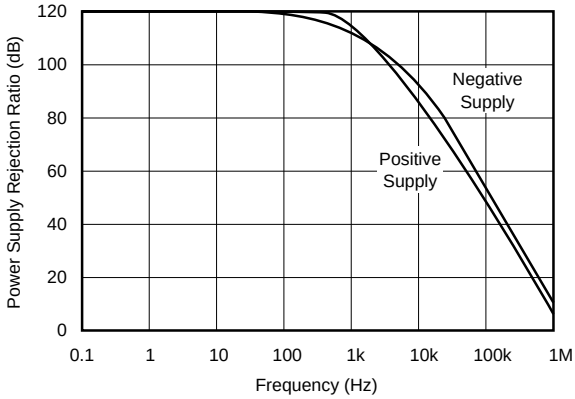
OFFSET VOLTAGE vs TIME



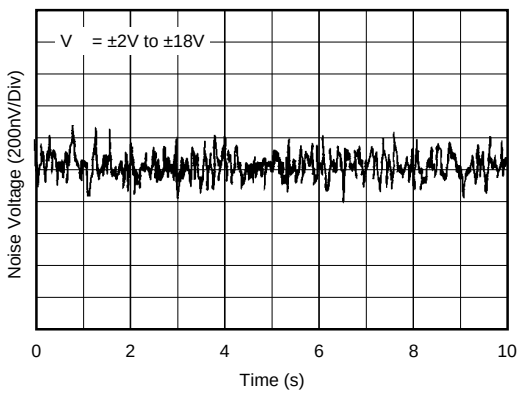
COMMON-MODE REJECTION RATIO
vs FREQUENCY



POWER SUPPLY REJECTION RATIO
vs FREQUENCY



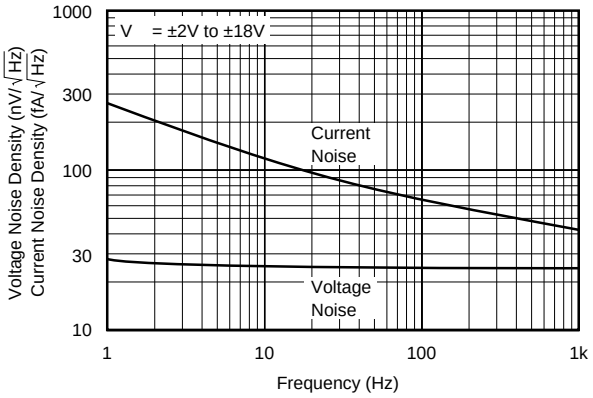
0.1Hz TO 10Hz NOISE



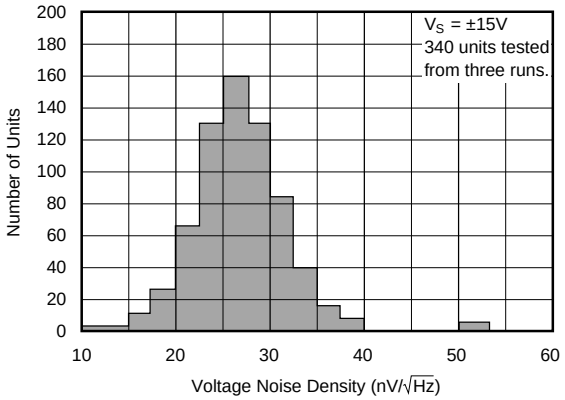
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C unless otherwise noted.

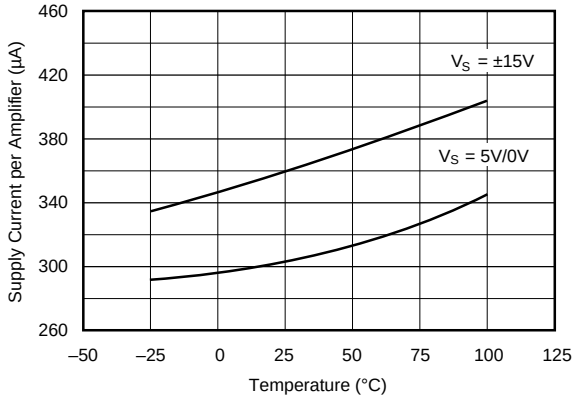
NOISE DENSITY vs FREQUENCY



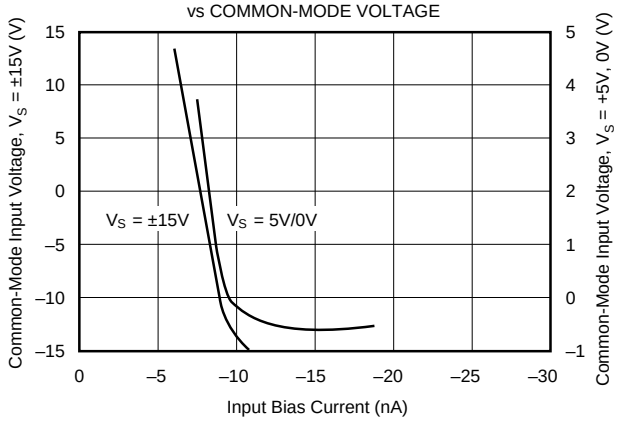
10Hz VOLTAGE NOISE DISTRIBUTION



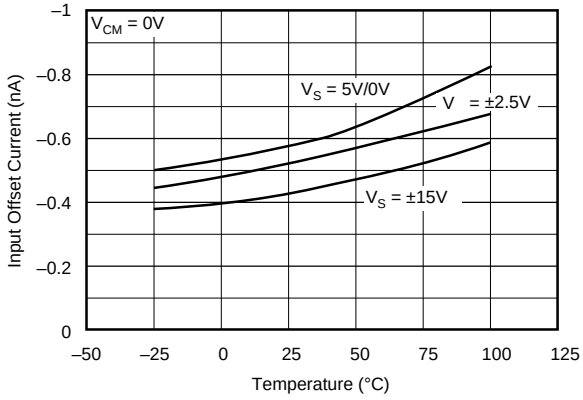
SUPPLY CURRENT vs TEMPERATURE



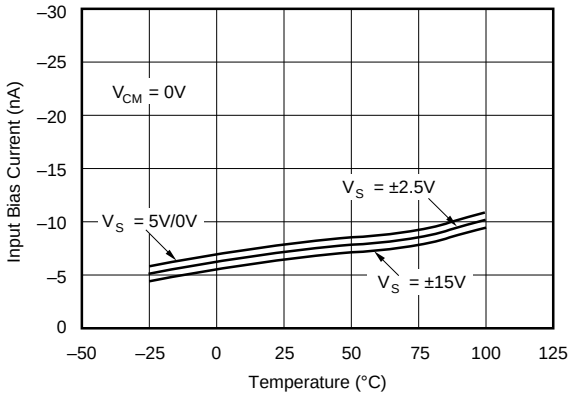
INPUT BIAS CURRENT
vs COMMON-MODE VOLTAGE



INPUT OFFSET CURRENT
vs TEMPERATURE



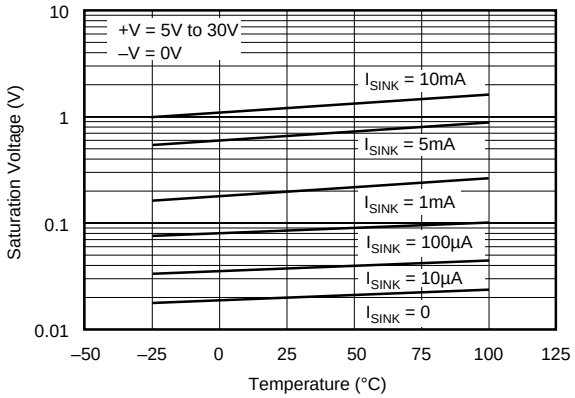
INPUT BIAS CURRENT
vs TEMPERATURE



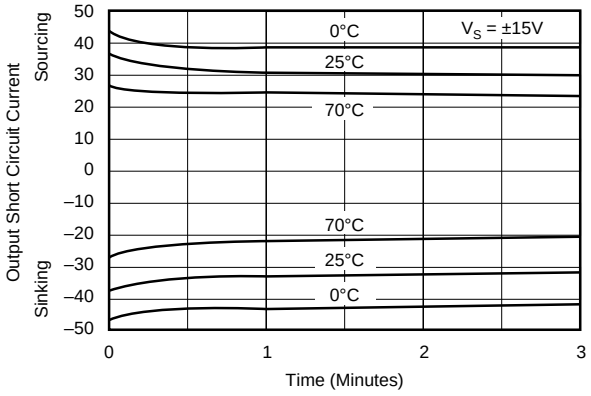
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C unless otherwise noted.

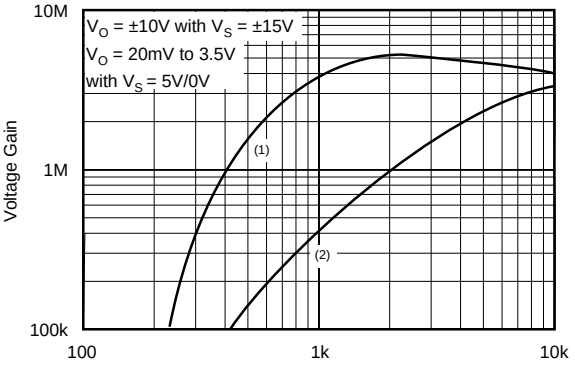
OUTPUT SATURATION AND SINK CURRENT vs TEMPERATURE



OUTPUT SHORT CIRCUIT CURRENT vs TIME

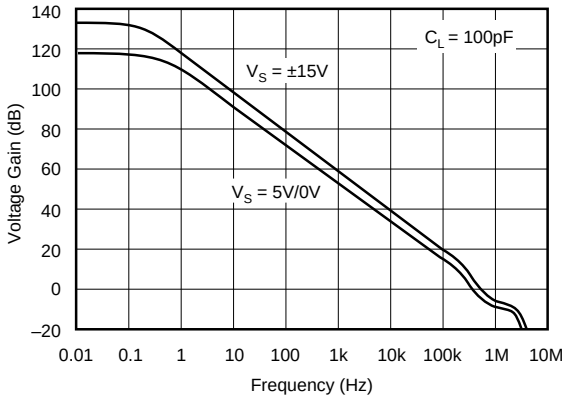


VOLTAGE GAIN vs LOAD RESISTANCE

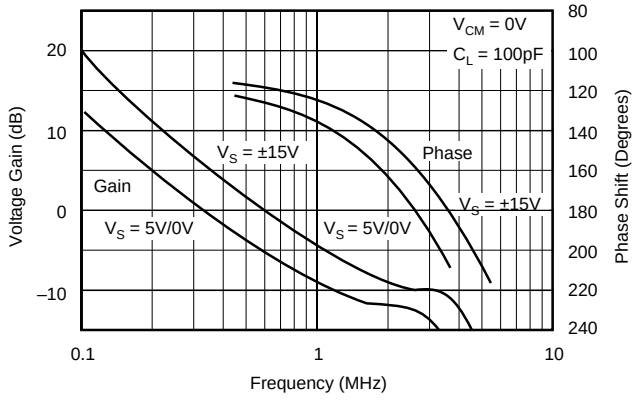


NOTES: (1) T_A = +25°C, V_S = ±15V. (2) T_A = +25°C, V_S = 5V/0V.

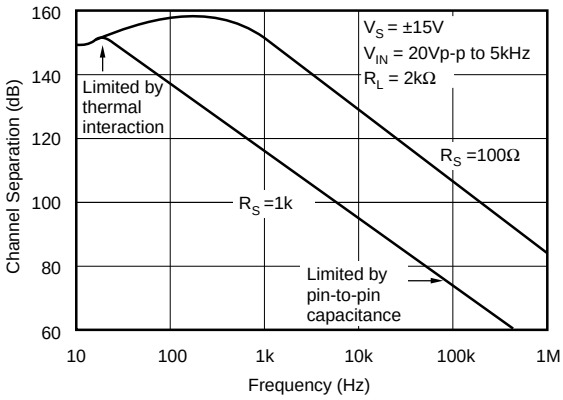
VOLTAGE GAIN vs FREQUENCY



GAIN AND PHASE vs FREQUENCY

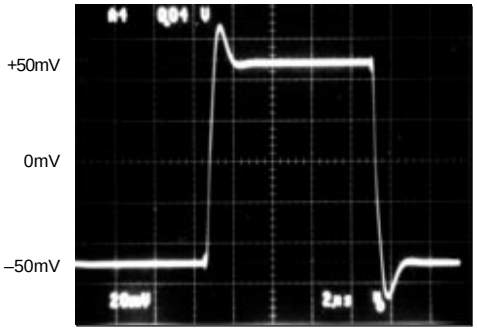


CHANNEL SEPARATION vs FREQUENCY



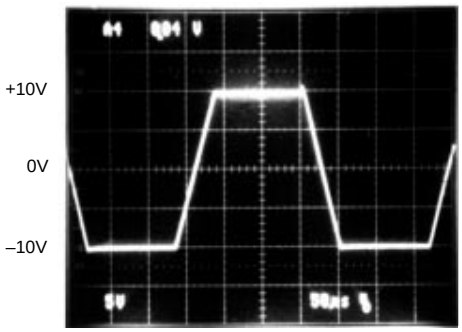
TYPICAL PERFORMANCE CURVES (CONT)

SMALL SIGNAL TRANSIENT RESPONSE
V_S = ±15V, G = +1

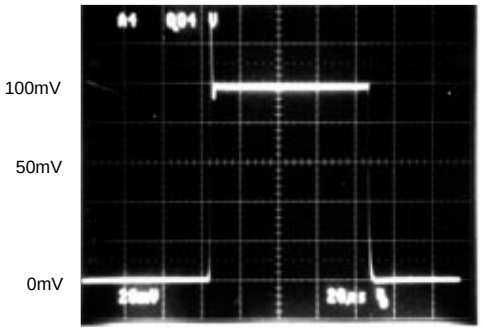


V_S = 5V/0V

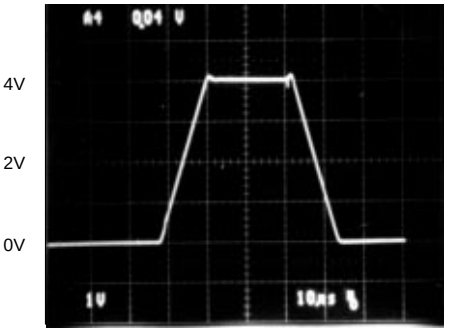
LARGE SIGNAL TRANSIENT RESPONSE
V_S = ±15V, G = +1



SMALL SIGNAL TRANSIENT RESPONSE
V_S = 5V/0V, G = +1, R_L = 600Ω to Ground

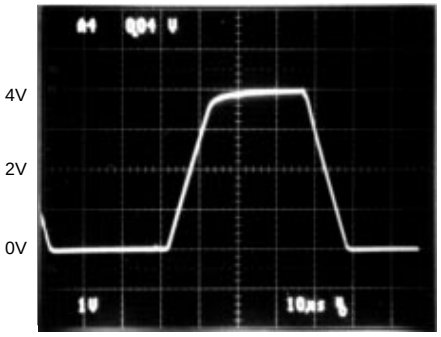


LARGE SIGNAL TRANSIENT RESPONSE
V_S = 5V/0V, G = +1, R_L = 4.7kV to 5V



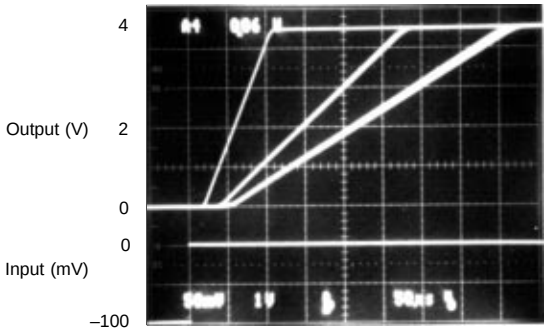
Input = 0V to 4V Pulse

LARGE SIGNAL TRANSIENT RESPONSE
V_S = 5V/0V, G = +1, No Load



Input = 0V to 4V Pulse

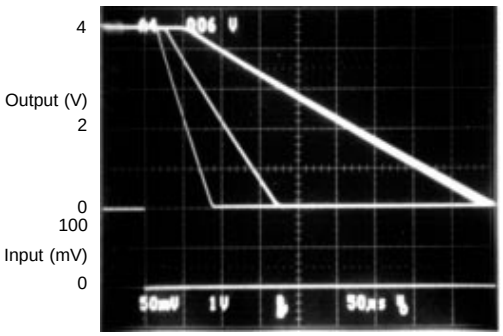
COMPARATOR RISE RESPONSE TIME
10mV, 5mV, 2mV Overdrives



V_S = 5V/0V

TYPICAL PERFORMANCE CURVES (CONT)

COMPARATOR FALL RESPONSE TIME
10mV, 5mV, 2mV Overdrives



V_S = 5V/0V

APPLICATIONS INFORMATION

The OPA1013 is unity-gain stable, making it easy to use and free from oscillations in the widest range of circuitry. Follow good design practice by bypassing the power supplies close to the op amp pins. In most cases 0.1µF ceramic capacitors are adequate.

SINGLE POWER SUPPLY OPERATION

The OPA1013 is specified for operation from a single power supply. This means that linear operation continues with the input terminals at (or even somewhat below) ground potential. When used in a non-inverting amplifier, 0V input must produce 0V output. In practice, the output swing is limited to approximately 15mV above ground with no load. Output swing near ground can be optimized when the output load is connected to ground. If the output must sink current, the ability to swing near ground will be diminished. The output swings to within approximately 200mV of ground when sinking 1mA.

INPUT PROTECTION

The circuitry of the OPA1013 is protected against overload for input voltages ranging from the positive supply voltage to 5V below the negative supply voltage (below ground in single supply operation). No external protection circuitry is required, as it is with other common single-supply op amps.

Furthermore, the OPA1013 is free from phase-reversal problems common with other single-supply op amps. When the inputs are driven below ground (or below the negative power supply), the output polarity remains correct.

COMPARATOR OPERATION

The OPA1013 functions well as a comparator, where high speed is not required. Sometimes, in fact, the low offset and docile characteristics of the OPA1013 may simplify the design of comparator circuitry. The two op amps in the OPA1013 use completely independent bias circuitry to avoid interaction when the inputs are over-driven. Driving one op amp into saturation will not affect the characteristics of the other amplifier. The outputs of the OPA1013 can drive one TTL load. Quiescent current remains stable when the inputs are overdriven.

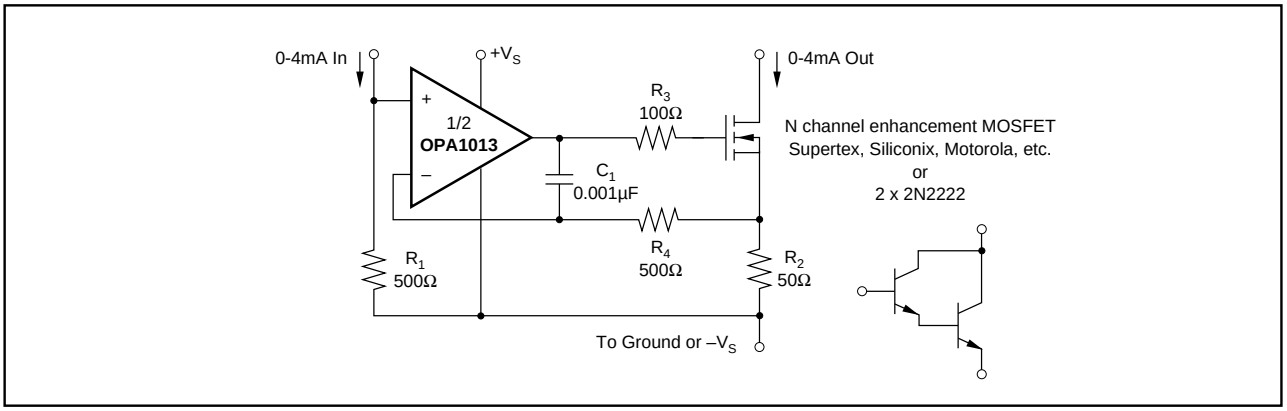


FIGURE 1. Precision Current Mirror.

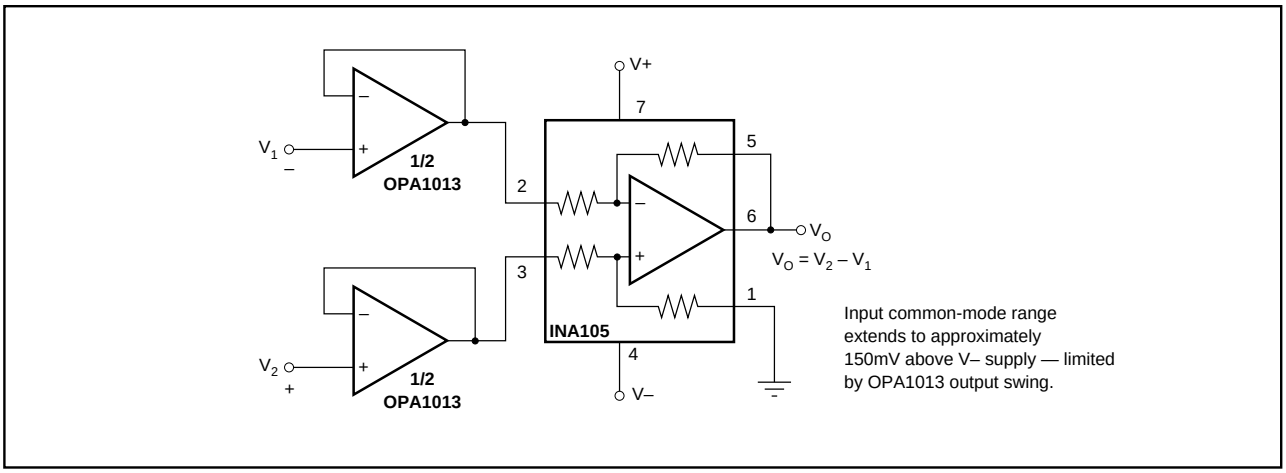


FIGURE 2. Instrumentation Amplifier.

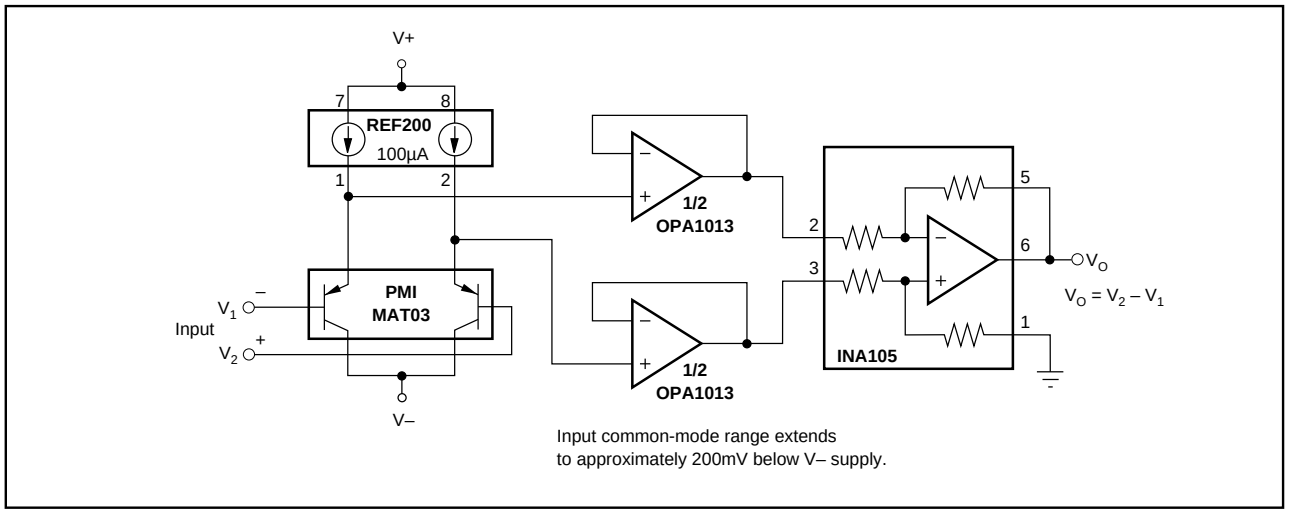


FIGURE 3. Instrumentation Amplifier.

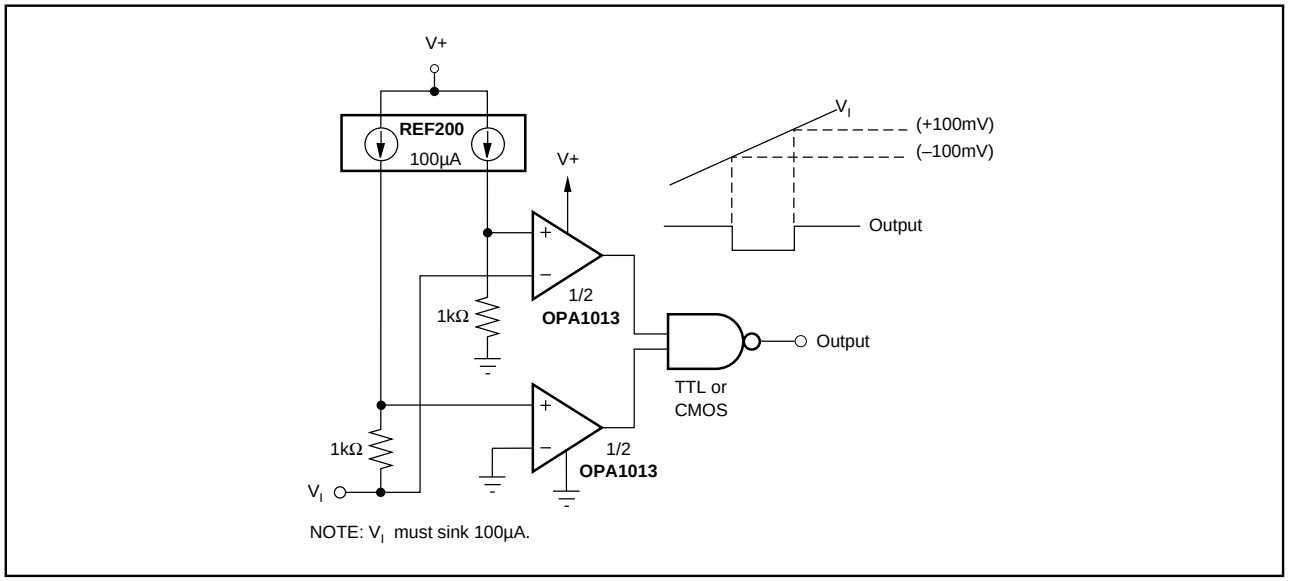


FIGURE 4. Window Comparator.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
OPA1013CN8	ACTIVE	PDIP	P	8	50	RoHS & Green	Call TI	N / A for Pkg Type	0 to 70	OPA1013C	Samples
OPA1013CN8G4	ACTIVE	PDIP	P	8	50	RoHS & Green	Call TI	N / A for Pkg Type	0 to 70	OPA1013C	Samples
OPA1013DN8	ACTIVE	PDIP	P	8	50	RoHS & Green	Call TI	N / A for Pkg Type	0 to 70	OPA1013D	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

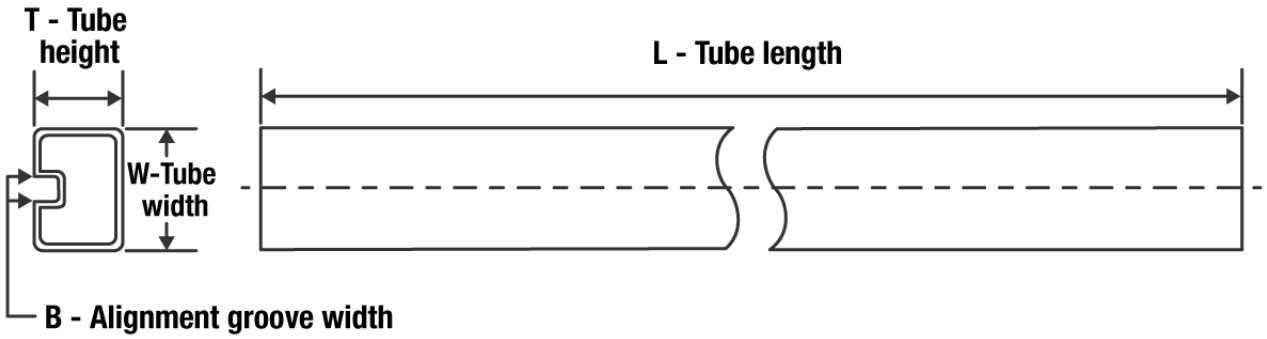
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
OPA1013CN8	P	PDIP	8	50	506	13.97	11230	4.32
OPA1013CN8G4	P	PDIP	8	50	506	13.97	11230	4.32
OPA1013DN8	P	PDIP	8	50	506	13.97	11230	4.32

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