HARRIS

HA-OP27

PRELIMINARY

Ultra-Low Noise, Precision Operational Amplifier

Features

- High Slew Rate ..... 10 V/μs
- Low Noise ..... 3nV/$\sqrt{Hz}$
- Low Drift ..... 0.2 μV/^{o}C
- Low V_{OS} ..... 10 μV
- High Gain ..... 1800 V/mV
- High CMRR ..... 126 dB
- Wideband ..... 8.5 MHz

Applications

- Low Level Transducer Amplifiers
- Precision Summing Amplifiers
- Audio Preamplifiers
- Integrators
- Precision Threshold Detectors

Description

The HA-OP27 is a low noise operational amplifier offering a remarkable blend of AC and DC parameters. Through advanced processing techniques, this design offers 3nV/$\sqrt{Hz}$ of noise at 1kHz while combining the characteristics of precision and wideband amplifiers.

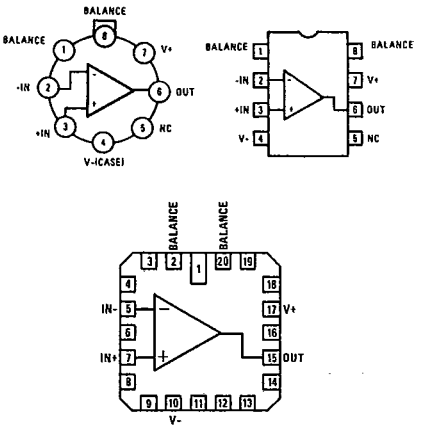
Laser trimming results in a typical input offset voltage of 10μV while stabilizing TCV_{OS} to 0.2μV/^{o}C without affecting the 8.5 MHz bandwidth or the 10V/μs slew rate. Precision performance is further enhanced by A_{VO} of 1800V/mV, PSRR of 1 μV/V, and CMRR exceeding 120 dB. A modest power consumption of 90 mW and on-chip compensation for unity gain stability increase the potential uses of this device.

These features make the HA-OP27 an excellent choice for low level signal transducer applications. Additionally, the HA-OP27 is ideally suited for precision summers, audio preamplifiers, stable integrators, and precision threshold detectors.

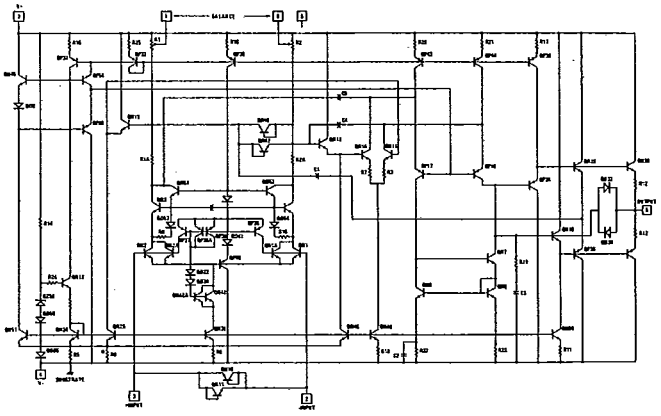
The HA-OP27 can also be used as a design enhancement by directly replacing the 725, OP05, OP06 and OP07. The HA-OP27 is available in TO-99 Metal Can, both Epoxy and Ceramic 8 pin Mini-DIPs, as well as 20 pin LCC packages.

Pinouts

TOP VIEWS



Schematic



Specifications

Absolute Maximum Ratings

Supply Voltage ..... ±22V
Internal Power Dissipation (Note 1) 500mW
Input Voltage (Note 3) ..... ±22V
Output Short Circuit Duration ..... Indefinite
Differential Input Voltage (Note 2) ..... ±0.7V
Differential Input Current (Note 2) ..... ±25mA
Storage Temperature Range ..... -65°C to +150°C
Operating Temperature Range
HA-OP27A, OP27B, OP27C (J,Z) ..... -55°C to +125°C
HA-OP27E, OP27F, OP27G (J,Z) ..... -25°C to +85°C
HA-OP27E, OP27F, OP27G (P) ..... 0°C to +70°C

NOTES:
1. Maximum Package Power Dissipation vs. ambient temperature.

Package Type	Maximum Ambient Temperature for Rating	Derate Above Maximum Ambient Temperature
TO-99 (J)	80°C	7.1mW/°C
8-Pin Hermetic DIP (Z)	75°C	6.7mW/°C
8-Pin Plastic DIP (P)	62°C	5.6mW/°C

2. The OP 27's inputs are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise. If differential input voltage exceeds ±0.7V, the input current should be limited to 25mA.
3. For supply voltages less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

Electrical Characteristics at V_S = ±15 V, T_A = 25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	HA-OP27A/E MIN	HA-OP27A/E TYP	HA-OP27A/E MAX	HA-OP27B/F MIN	HA-OP27B/F TYP	HA-OP27B/F MAX	HA-OP27C/G MIN	HA-OP27C/G TYP	HA-OP27C/G MAX	UNITS
Input Offset Voltage	V_{OS}	(Note 1)	-	10	25	-	20	60	-	30	100	µV
Long-Term V_{OS} Stability	V_{OS}/Time	(Note 2)	-	0.2	1.0	-	0.3	1.5	-	0.4	2.0	µV/Mo
Input offset Current	I_{OS}	-	-	7	35	-	9	50	-	12	75	nA
Input Bias Current	I_B	-	-	±10	±40	-	±12	±55	-	±15	±80	nA
Input Noise Voltage	e_{np-p}	0.1 Hz to 10 Hz (Note 3, 5)	-	0.08	0.18	-	0.08	0.18	-	0.09	0.25	µVp-p
Input Noise Voltage Density	e_n	f_o = 10 Hz (Note 3) f_o = 30 Hz (Note 3) f_o = 1000 Hz (Note 3)	- - -	3.5 3.1 3.0	5.5 4.5 3.8	- - -	3.5 3.1 3.0	5.5 4.5 3.8	- - -	3.8 3.3 3.2	8.0 5.6 4.5	nV/√Hz
Input Noise Current Density	I_n	f_o = 10 Hz (Note 3) f_o = 30 Hz (Note 3) f_o = 1000 Hz (Note 3)	- - -	1.7 1.0 0.4	4.0 2.3 0.6	- - -	1.7 1.0 0.4	4.0 2.3 0.6	- - -	1.7 1.0 0.4	- - 0.6	pA/√Hz
Input Resistance—Differential-Mode	R_{IN}	(Note 4)	1.5	6	-	1.2	5	-	0.8	4	-	MΩ
Input Resistance—Common-Mode	R_{INCM}	(Note 4)	-	3	-	-	2.5	-	-	2	-	GΩ
Input Voltage Range	IVR		±11.0	±12.3	-	±11.0	±12.3	-	±11.0	±12.3	-	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = ±11 V	114	126	-	106	123	-	100	120	-	dB
Power Supply Rejection Ratio	PSSR	V_S = ±4 V to ±18 V	-	1	10	-	1	10	-	2	20	µV/V
Large-Signal Voltage Gain	A_{VO}	R_L ≥ 2kΩ, V_O = ±10 V R_L ≥ 1kΩ, V_O = ±10 V R_L = 600Ω, V_O = ±1V, V_S = ±4V, (Note 4)	1000 800 250	1800 1500 700	- - -	1000 800 250	1800 1500 700	- - -	700 600 200	1500 1500 500	- - -	V/mV
Output Voltage Swing	V_O	R_L ≥ 2kΩ R_L ≥ 600Ω	±12.0 ±10.0	±13.8 ±11.5	- -	±12.0 ±10.0	±13.8 ±11.5	- -	±11.5 ±10.0	±13.5 ±11.5	- -	V
Slew Rate	SR	R_L ≥ 2kΩ (Note 4)	7.0	10	-	7.0	10	-	7.0	10	-	V/µs
Gain Bandwidth Prod.	GBW	(Note 4)	5.0	8.5	-	5.0	8.5	-	5.0	8.5	-	MHz
Open Loop Output Resistance	R_O	V_O = 0, I_O = 0 (Note 4)	-	70	-	-	70	-	-	70	-	Ω
Power Consumption	P_d	V_O = 0	-	90	140	-	90	140	-	100	170	mW
Offset Adjustment Range		R_P = 10 kΩ	-	±4.0	-	-	±4.0	-	-	±4.0	-	mV

NOTES:
1. Input Offset Voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. A/E Grades Guaranteed Fully Warmed up.
2. Long Term Input Offset Voltage Stability refers to the average trend line of V_{OS} vs. Time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{OS} during the first 30 days are typically 2.5 µV.
3. Sample tested.
4. Guaranteed by design.
5. See test circuit and typical 0.1 Hz to 10 Hz noise photograph.

Electrical Characteristics for $V_S = \pm 15$ V, $-55^oC \leq T_A \leq +125^oC$, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	HA-OP27A			HA-OP27B			HA-OP27C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	(Note 1)	-	30	60	-	50	200	-	70	300	μV
Average Input Offset Drift	TCV_{OS} TCV_{OSN}	(Note 2)	-	0.2	0.6	-	0.3	1.3	-	0.4	1.8	μV/°C
Input Offset Current	I_{OS}		-	15	50	-	22	85	-	30	135	nA
Input Bias Current	I_S		-	±20	±60	-	±28	±95	-	±35	±150	nA
Input Voltage Range	IVR		±10.3	±11.5	-	±10.3	±11.5	-	±10.2	±11.5	-	V
Common Mode Rejection Ratio	CMRR	$V_{CM} = \pm 10$ V	108	122	-	100	119	-	94	116	-	dB
Power Supply Rejection Ratio	PSRR	$V_S = \pm 4.5$ V to ±18 V	-	2	16	-	2	20	-	4	51	μV/V
Large Signal Voltage Gain	A_{VO}	$R_L \geq 2K\Omega$, $V_O = \pm 10$ V	600	1200	-	500	1000	-	300	800	-	V/mV
Output Voltage Swing	V_{OM}	$R_L \geq 2k\Omega$	±11.5	±13.5	-	±11.0	±13.2	-	±10.5	±13.0	-	V

Electrical Characteristics for $V_S = \pm 15$ V, $-25^oC \leq T_A \leq +85^oC$, $0^oC \leq T_A \leq +70^oC$, unless otherwise noted.

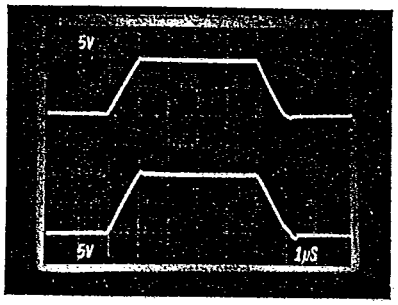
PARAMETER	SYMBOL	CONDITIONS	HA-OP27E			HA-OP27F			HA-OP27G			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}		-	20	50	-	40	140	-	55	220	μV
Average Input Offset Drift	TCV_{OS} TCV_{OSN}	(Note 2)	-	0.2	0.6	-	0.3	1.3	-	0.4	1.8	μV/°C
Input Offset Current	I_{OS}		-	10	50	-	14	85	-	20	135	nA
Input Bias Current	I_S		-	±14	±60	-	±18	±95	-	±25	±150	nA
Input Voltage Range	IVR		±10.5	±11.8	-	±10.5	±11.8	-	±10.5	±11.8	-	V
Common Mode Rejection Ratio	CMRR	$V_{CM} = \pm 10$ V	110	124	-	102	121	-	96	118	-	dB
Power Supply Rejection Ratio	PSRR	$V_S = \pm 4.5$ V to ±18V	-	2	15	-	2	16	-	2	32	μV/V
Large Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, $V_O = \pm 10$ V	750	1500	-	700	1300	-	450	1000	-	V/mV
Output Voltage Swing	V_{OM}	$R_L \geq 2k\Omega$	±11.7	±13.6	-	±11.4	±13.5	-	±11.0	±13.3	-	V

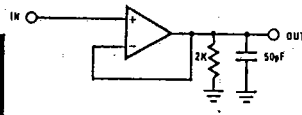
NOTES:
1. Input Offset Voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power.
2. The TCV_{OS} performance is within the specifications unnulled or when nulled with R_P = 8kΩ to 20kΩ.

Test Circuits

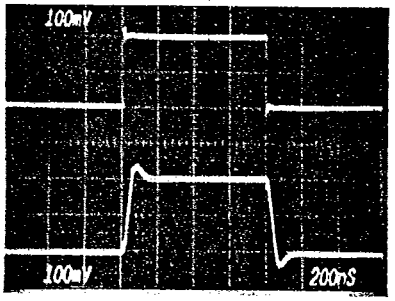
LARGE AND SMALL SIGNAL RESPONSE TEST CIRCUIT

LARGE SIGNAL RESPONSE



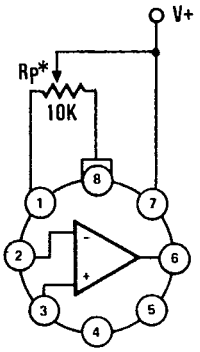


SMALL SIGNAL RESPONSE



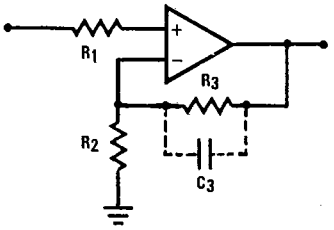
Test Circuits (continued)

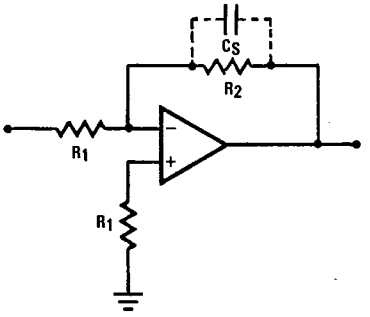
SUGGESTED OFFSET VOLTAGE ADJUSTMENT



* Offset adjustment range is approximately ±4mV

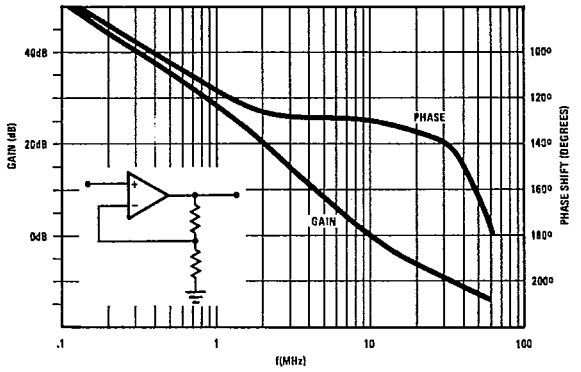
SUGGESTED STABILITY CIRCUITS





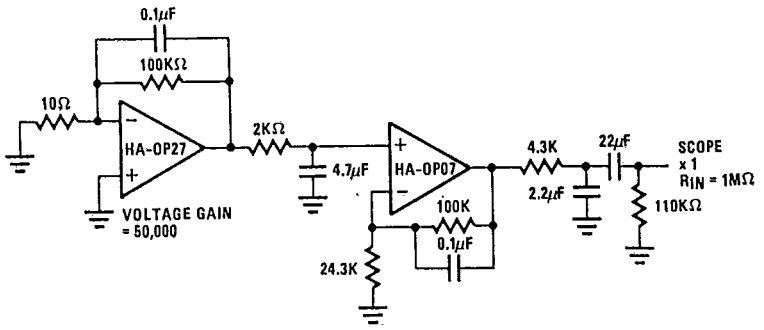
Low resistances are preferred for low noise applications as a 1KΩ resistor has 4nV$\sqrt{Hz}$ of thermal noise. Total resistances of greather than 10KΩ on either input can reduce stability. In most high resistance applications, a few picofarads of capacitance across the feedback resistor will improve stability.

GAIN, PHASE SHIFT FREQUENCY



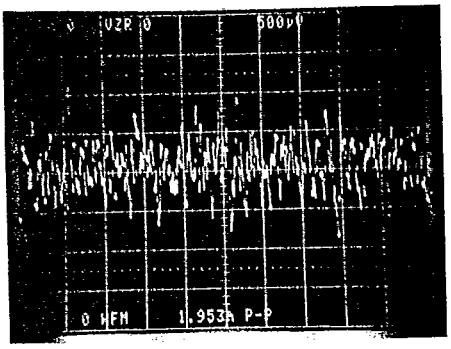
Typical Performance

0.1Hz to 10Hz NOISE TEST CIRCUIT



NOTE: ALL CAPACITOR VALUES ARE FOR NON-POLARIZED CAPACITORS ONLY

LOW FREQUENCY NOISE



VOLTAGE NOISE FREQUENCY