HARRIS

HA-OP37

PRELIMINARY

Ultra-Low Noise, Precision, High-Speed Operational Amplifier

Features

- **Low Noise** .... $3nV/\sqrt{Hz}$ at 1 kHz
- **Low Drift** .... 0.2 $\mu V/^{o}C$
- **Low V_{OS}** .... 10 μV
- **High Gain** .... 1800 V/mV
- **High CMRR** .... 126 dB
- **High Slew Rate** 20V/μs

Applications

- **Low Level Transducer Amplifiers**
- **Instrumentation Amplifiers**
- **Audio Preamplifiers**
- **Precision Threshold Detectors**
- **Signal Conditioners**

Description

The HA-OP37 operational amplifier is a connection between precision and high speed performance. The low device noise, 3 $nV/\sqrt{Hz}$ at 1 KHz, allows accurate high speed amplification of extremely low level signals. Precision is attained by a low V_{OS} of typically 10 μV, a high gain of 1800 V/mV, a differential input resistance of 6MΩ and an average input offset drift of just 0.2 $\mu V/^{o}C$. High speed is guaranteed by a slew rate of 17V/μs and a gain bandwidth product of 63 MHz. Also the HA-OP37 has a CMRR above 120 dB and a PSRR of typically 1 $\mu V/V$.

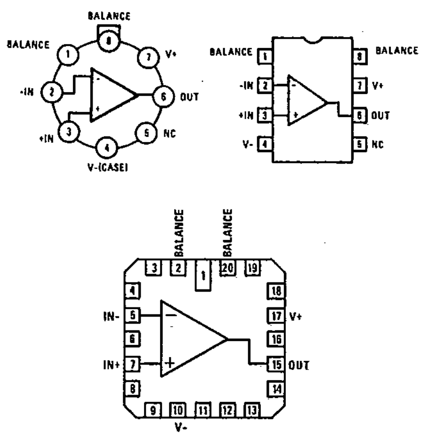
This combination of characteristics makes the HA-OP37 an outstanding choice for all low noise, precision and high speed applications where gains are greater than five. The HA-OP37 can be used for precision threshold detectors, instrumentation amplifiers, many audio circuits such as RIAA phone preamplifiers, and in signal conditioning circuits for data acquisition systems.

The HA-OP37 can also be used as an enhancement for existing designs by directly replacing the 725, OP05, OP06, OP07 and OP27 where gains are greater than five.

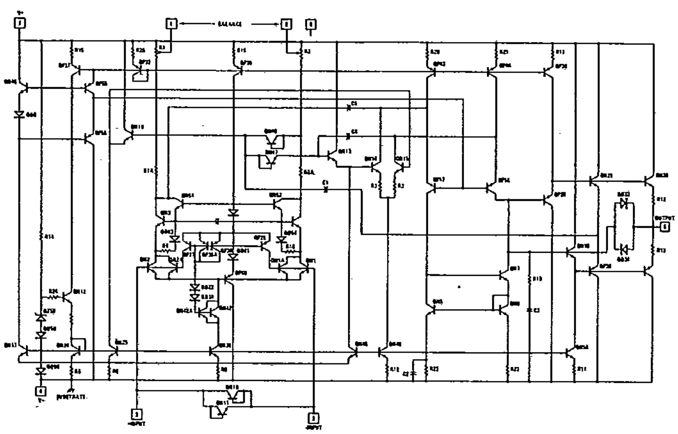
The HA-OP37 is available in TO-99 metal can, both epoxy and ceramic 8 pin mini-DIPs, as well as 20 pin LCC packages.

Pinouts

TOP VIEWS



Schematic



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-OP37A, OP37B, OP37C (J,Z) .... -55°C to +125°C
HA-OP37E, OP37F, OP37G (J,Z) .... -25°C to +85°C
HA-OP37E, OP37F, OP37G (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 OP37'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-OP37A/E MIN	HA-OP37A/E TYP	HA-OP37A/E MAX	HA-OP37B/F MIN	HA-OP37B/F TYP	HA-OP37B/F MAX	HA-OP37C/G MIN	HA-OP37C/G TYP	HA-OP37C/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	-	0.08	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/$\sqrt{Hz}$
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/$\sqrt{Hz}$
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 = ±10V R_L ≥1KΩ, V_O = ±10V R_L = 600Ω, V_O = ±1V, V_S = ± 4V, (Note 4)	1000 800 250	1800 1500 700	- - -	1000 800 250	1800 1500 700	- - -	700 400 200	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)	14	20	-	14	20	-	14	20	-	V/μS
Gain Bandwidth Prod	GBW	f_O = 10 kHz (Note 4) f_O = 1 MHz (Note 4)	60 -	80 63	- -	60 -	80 63	- -	60 -	80 63	- -	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 = ±15 V, -55°C ≤ T_A ≤ 125°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	HA-OP37A MIN	HA-OP37A TYP	HA-OP37A MAX	HA-OP37B MIN	HA-OP37B TYP	HA-OP37B MAX	HA-OP37C MIN	HA-OP37C TYP	HA-OP37C MAX	UNITS
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_B		-	±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} = ±10 V	108	122	-	100	119	-	94	116	-	dB
Power Supply Rejection Ratio	PSSR	V_S = ±4.5 V to ±18 V	-	2	16	-	2	20	-	4	51	μV/V
Large Signal Voltage Gain	A_{VO}	R_L ≥ 2kΩ, V_O = ±10 V	600	1200	-	500	1000	-	300	800	-	V/mV
Output Voltage Swing	V_{OM}	R_L ≥ 2kΩ	±11.5	±13.5	-	±11.0	±13.2	-	±10.5	±13.0	-	V

Electrical Characteristics for V_S = ±15 V, -25°C ≤ T_A ≤ 85°C, 0°C ≤ T_A ≤ + 70°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	HA-OP37E MIN	HA-OP37E TYP	HA-OP37E MAX	HA-OP37F MIN	HA-OP37F TYP	HA-OP37F MAX	HA-OP37G MIN	HA-OP37G TYP	HA-OP37G MAX	UNITS
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_B		-	±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} = ±10 V	110	124	-	102	121	-	96	118	-	dB
Power Supply Rejection Ratio	PSSR	V_S = ±4.5 V to ±18V	-	2	15	-	2	16	-	2	32	μV/V
Large Signal Voltage Gain	A_{VO}	R_L ≥ 2kΩ, V_O = ±10 V	750	1500	-	700	1300	-	450	1000	-	V/mV
Output Voltage Swing	V_{OM}	R_L ≥ 2kΩ	±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 R_P = 8kΩ to 20kΩ.

Test Circuits

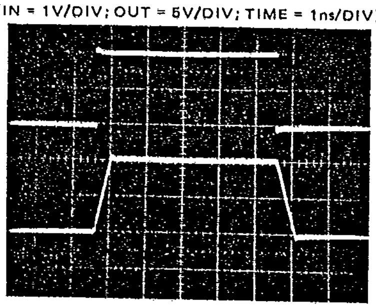
LARGE AND SMALL SIGNAL RESPONSE TEST CIRCUIT

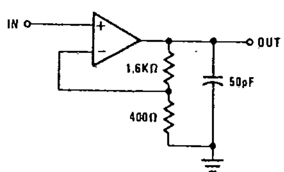
LARGE SIGNAL RESPONSE

(IN = 1V/DIV; OUT = 5V/DIV; TIME = 1ns/DIV)

IN

OUT



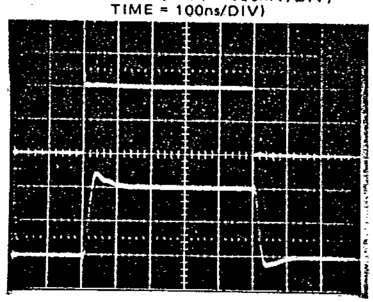


SMALL SIGNAL RESPONSE

(IN = 20mV/DIV; OUT = 100mV/DIV; TIME = 100ns/DIV)

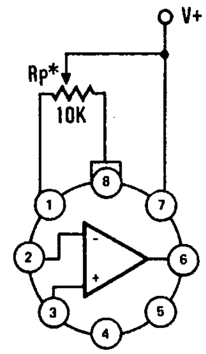
IN

OUT



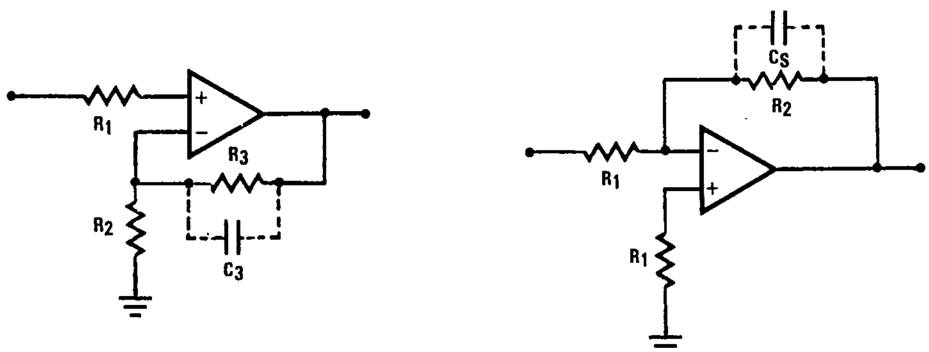
Test Circuits (continued)

SUGGESTED OFFSET VOLTAGE ADJUSTMENT



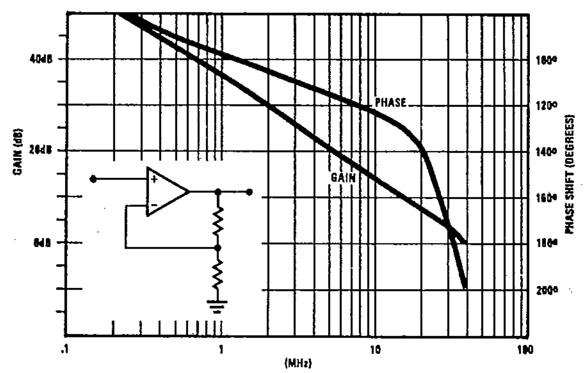
* Offset adjustment range is approximately ±4mV

SUGGESTED STABILITY CIRCUITS



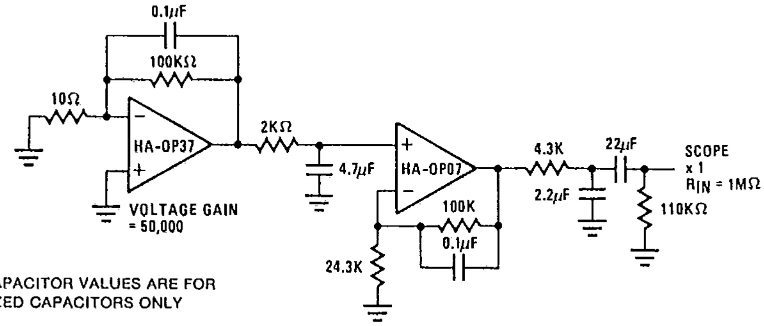
Low resistances are preferred for low noise applications as a 1KΩ resistor has $4nV/\sqrt{Hz}$ of thermal noise. Total resistances of greather than 10KΩ on either input can reduce stability. In most high resistance applications, a few picofarads of capacitance across the feedback resistor will improve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

GAIN, PHASE SHIFT VERSUS FREQUENCY



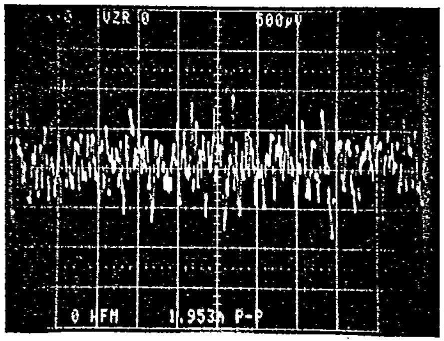
Typical Performance

0.1Hz to 10Hz NOISE TEST CIRCUIT



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

LOW FREQUENCY NOISE



VOLTAGE NOISE VERSUS FREQUENCY