ALPHA SEMICONDUCTOR
Excellence in Analog Power Products

AS OP-37

Ultra Low Noise Precision, High-Speed Operational Amplifier

FEATURES

- Low offset Vos .... 10µV Max.
- Low drift vs. temperature: .... 0.2µV/°C
- High CMMR................................ 126dB @ V_{CM} of ±11V
- Low noise...3nV/√Hz @ 1kHz..
  ....80 nVpp(0.1Hz to 10Hz) ..
- High open loop gain ....1.8 Million
- Slew rate 17V/µS
- Gain bandwidth ....63 MHz
- Direct replacement for 725, OP05, OP06, OP07, AD510, AD517 SE5534 in gains > 5

APPLICATIONS

- Precision Instrumentation
- Data Acquisition
- Test Equipment
- Professional Audio Equipment
- Transducer Amplifier

PRODUCT DESCRIPTION

The AS OP-37 offers the same high performance as the OP27 but the design is optimized for circuits with gains greater than five. This design change increases slew rate to 17V/µSec and gain bandwidth product to 63MHZ. The OP37 provides low noise combined with low offset and high speed operation. OP37 is ideal for precision instrumentation applications through offering low offset down to 25 µV and drift of 0.6µV/°C maximum. The low bias current of ±10nA and offset current of 7nA are achieved by using a bias-current cancellation circuit. Over the military temperature range, this circuitry typically holds I_B and I_{OS} to ±20nA and 15nA respectively.

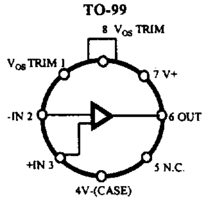
The output stage has good load driving capability. A guaranteed swing of ±10V into 600Ω and low output distortion make the OP37 an excellent choice for professional audio applications. PSRR and CMRR exceed 120dB. These characteristics, coupled with long-term drift of 0.2µV/month, allow the circuit designer to achieve performance levels previously attained only by discrete designs.

ORDERING INFORMATION

TO-99 8-PIN	PLASTIC DIP 8-PIN	PLASTIC SOIC 8-PIN	TA=25°C V_{OS} Max (mv)	Oper. Temp. Range
OP37AJ			25	MIL.
OP37EJ	OP37EP	OP37ES	25	IND/COM
OP37BJ			60	MIL.
OP37FJ	OP37FP	OP37FS	60	IND/COM
OP37CJ			100	MIL.
OP37GJ	OP37GP	OP37GS	100	IND/COM

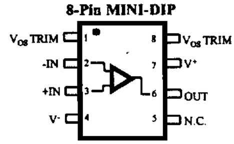
PIN CONNECTIONS

TO-99



Bottom View

8-Pin Surface Mount
8-Pin MINI-DIP



Top View

ABSOLUTE MAXIMUM RATINGS

Input 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 Voltage (Note 2) .... ±25mA
Storage Temperature Range .... -65 to +150°
Operating Temperature Range
  OP37A, OP37B, OP37C (J) .... -55 to +125°C
  OP37E, OP37F, OP37G (J) .... -25 to +85°C
  OP37E, OP37F, OP37G(P,S) .... 0 to +70°C
Dice Junction Temperature(Tj) .... -65 to +150°C
Lead Temperature (Soldering, 60 Sec.) .... 300°C

NOTES:
1. See Table for maximum ambient temperature rating and derating factor.
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 voltage less than ±22V, the absolute maximum input voltage is equal to the supply voltage.

PACKAGE TYPE	MAXIMUM AMBIENT TEMPERATURE FOR RATING	DERATE ABOVE MAXIMUM AMBIENT TEMPERATURE
TO-99(J)	80°C	7.1 mW/°C
8-Pin Plastic SOIC (S)	62°C	5.6mW/°C
9-Pin Plastic DIP (P)	62°C	5.7mW/°C

ELECTRICAL CHARACTERISTICS at V_S=±15V, Ta=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	OP-37A/E Min.	OP-37A/E Typ.	OP-37A/E Max.	OP-37B/F Min.	OP-37B/F Typ.	OP-37B/F Max.	OP-37C/G Min.	OP-37C/G Typ.	OP-37C/G Max.	Units
Input Offset Voltage	V_{OS}	(Note 1)		10	25		20	60		30	100	mV
Long-Term V_{OS} Stability	V_{OS}/Time	(Note 2,3)		0.2	1.0		0.3	1.5		0.4	2.0	μV/M_o
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_{npp}	0.1Hz to10Hz(Note 3,5)		0.08	0.18		0.08	0.18		0.09	0.25	μV_{p-p}
Input Noise Voltage Density	e_n	f_o=10Hz(Note 3)		3.5	5.5		3.5	5.5		3.8	8.0	nV/√Hz
Input Noise Voltage Density	e_n	f_o=30Hz (Note 3)		3.1	4.5		3.1	4.5		3.3	5.6	nV/√Hz
Input Noise Voltage Density	e_n	f_o=1000Hz(Note 3)		3.0	3.8		3.0	3.8		3.0	3.8	nV/√Hz
Input Noise Current Density	i_n	f_o=10Hz(Note 3,6)		1.7	4.0		1.7	4.0		1.7		pV/√Hz
Input Noise Current Density	i_n	f_o=30Hz(Note 3,6)		1.0	2.3		1.0	2.3		1.0		pV/√Hz
Input Noise Current Density	i_n	f_o=1000Hz(Note 3,6)		0.4	0.6		0.4	0.6		0.4	0.6	pV/√Hz
Input Resistance-Differential-Mode	R_{in}	(Note 3)	1.3	6		0.94	5		0.7	4		MΩ
Input Resistance-Common-Mode	R_{inCM}			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}=±11.0	114	126		106	123		100	120		dB
Power Supply Rejection Ratio	PSRR	V_S=±4 to ±18		1	10		1	10		2	20	μV/V
Large-Signal Voltage Gain	AV_O	R_l ≥2kΩ V_o=±10V	1000	1800		1000	1800		700	1500		V/mV
Large-Signal Voltage Gain	AV_O	R_l ≥1kΩ V_o=±10V	800	1500		800	1500		400	1500		V/mV
Large-Signal Voltage Gain	AV_O	R_l ≥600kΩV_o=± 10V	250	700		250	700		250	700		V/mV
Output Voltage Swing	V_o	Rl ≥ 2kΩ	±12.0	±13.8		±12.0	±13.8		±11.5	±13.5		V
Output Voltage Swing	V_o	Rl ≥600kΩ	±10.0	±11.5		±10.0	±11.5		±10.0	±11.5		V
Slew Rate	SR	Rl ≥2kΩ (Note 4)	111	17		11	17		11	17		V/μs
Gain Bandwidth Prod.	GBW	(Note 4)	45	63		45	63		45	63		MHz
Open-Loop Output Resistance	R_o	V_o=0, Io=0		70			70			70		Ω
Power Consumption	P_d	V_o		90	140		90	140		1001 70		mW
Offset Adjustment Range		R_p=21kΩ		±4.0			±4.0			±4.0		mV

1. Input Offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. A F grades guaranteed fully warmed up.
2. Long term input offset voltage stability refers to the average trend line of Vos vs. Time over extended periods after the first 30 days of operation, changes in Vos during the first 30 days are typically 2.5mV.
3. Sample tested
4. Guaranteed by Design
5. See test circuit and frequency response curve for 0.1 Hz tester
6. See test circuit for current noise measurement
7. Guaranteed by input bias current.

ELECTRICAL CHARACTERISTICS at V_S=±15V, -55°C£Ta£+125°C, unless otherwise specified.

Parameter	Symbol	Conditions	OP-37A Min.	OP-37A Typ.	OP-37A Max.	OP-37B Min.	OP-37B Typ.	OP-37B Max.	OP-37C Min.	OP-37C Typ.	OP-37C Max.	Units
Input Offset Voltage	V_{OS}	(Note 1)		30	60		50	200		70	300	µV
Average Input Offset Drift	TCV_{OS}	(Note 2)		0.2	0.6		0.3	1.3		0.4	1.8	µV/°C
Average Input Offset Drift	TCV_{OS}	(Note 3)		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_{OS}			±20	±60		±28	±95		±35	±150	nA
Input Voltage Range	IVR		±10.3	±11.5		±10.3	±11.5		±10	±11.5		V
Common-Mode Rejection Ratio	CMRR	VCM=±10V	108	122		100	119		94	116		dB
Power Supply Rejection Ratio	PSSR	V_S ±4.5V to ±18V		2	16		2	20		4	51	µV/V
Large-Signal Voltage Gain	A_{VO}	Rl ≥2kΩ, V_O=± 10V	600	1200		500	1000		300	800		V/mV
Output Voltage Swing	V_O	Rl ≥2kΩ	±11.5	±13.5		±11.0	±13.2		±1.5	±13.0		V

ELECTRICAL CHARACTERISTICS at V_S=±15V, -25°C£Ta£+85°C, for OP37Jand OP37Z, 0°C£Ta£+70°C for OP37P and OP37 unless otherwise specified.

Parameter	Symbol	Conditions	OP-37E Min.	OP-37E Typ.	OP-37E Max.	OP-37F Min.	OP-37F Typ.	OP-37F Max.	OP-37G Min.	OP-37G Typ.	OP-37G Max.	Units
Input Offset Voltage	V_{OS}	(Note 1)		20	50		40	140		55	220	µV
Average Input Offset Drift	TCV_{OS}	(Note 2)		0.2	0.6		0.3	1.3		0.4	1.8	µV/°C
Average Input Offset Drift	TCV_{OS}	(Note 3)		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_{OS}			±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	VCM=±10V	110	124		102	121		96	118		dB
Power Supply Rejection Ratio	PSSR	V_S ±4.5V to ±18V		2	15		2	16		2	32	µV/V
Large-Signal Voltage Gain	A_{VO}	Rl ≥2kΩ,V_O=±10V	750	1500		700	1300		450	1000		V/mV
Output Voltage Swing	V_O	Rl≥ 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 A F Grades guaranteed fully warmed up.
2. The TCVos performance is within the specifications unnulled or when nulled with Rp=8kΩ.TCVos is 100% tested for A/E grades. Sample tested for B C F G grades
3. Guaranteed by Design.

ELECTRICAL CHARACTERISTICS at V_S=±15V, Ta=25°C, unless otherwise specified.

Parameter	Symbol	Conditions	OP-37N/NT Typical	OP-37G/GT Typical	OP-37GR Typical	Units
Average Input Offset Voltage Drift	TCV_{OS}	Nulled or Unnulled	0.2	0.3	0.4	μV/°C
Average Input Offset Voltage Drift	TCV_{OS}	Rp =8kW to 20kW	0.2	0.3	0.4	μV/°C
Average Input Offset Current Drift	TCI_{OS}		80	130	180	pA/°C
Average Input Offset Current Drift	TCI_B		100	160	200	pA/°C
Average Input Bias Current Drift	TCI_B		160	160	200	pA/°C
Input Noise Voltage Density	e_n	f_o=10Hz	3.5	3.5	3.8	nV/√Hz
Input Noise Voltage Density	e_n	f_o=30Hz	3.1	3.1	3.3	nV/√Hz
Input Noise Voltage Density	e_n	f_o=1000Hz	3.0	3.0	3.2	nV/√Hz
Input Noise Current Density	i_n	f_o=10Hz	1.7	1.7	1.7	pA/√Hz
Input Noise Current Density	i_n	f_o=30Hz	1.0	1.0	1.0	pA/√Hz
Input Noise Current Density	i_n	f_o=1000Hz	0.4	0.4	0.4	pA/√Hz
Input Noise Voltage	e_{npp}	0.1Hz to10Hz	0.08	0.08	0.09	μV_{P-P}
Slew Rate	SR	R ³ 2kW	17	17	17	V/μs
Gain Bandwidth Product	GBW		63	63	63	MHz

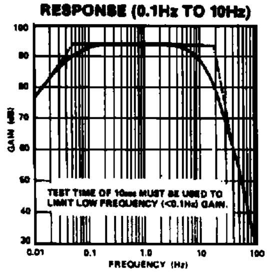
Note:

1. Input offset voltage measurements are performed by automated test equipment approximately 0.5 second after application of power.

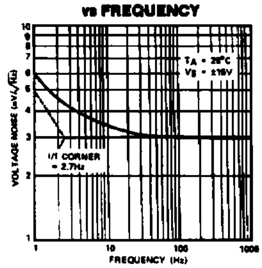
TYPICAL CHARACTERISTICS

TYPICAL CHARACTERISTICS (continued)

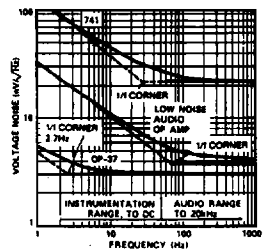
NOISE-TESTER FREQUENCY RESPONSE (0.1Hz TO 10Hz)



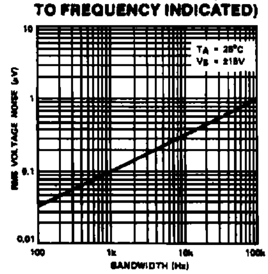
VOLTAGE NOISE DENSITY vs FREQUENCY



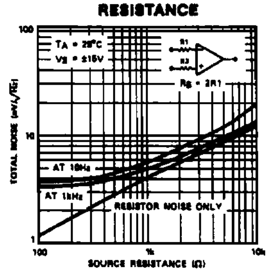
A COMPARISON OF OP AMP VOLTAGE NOISE SPECTRA



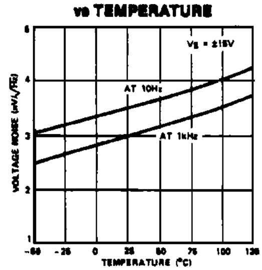
INPUT WIDEBAND VOLTAGE NOISE vs BANDWIDTH (0.1Hz TO FREQUENCY INDICATED)



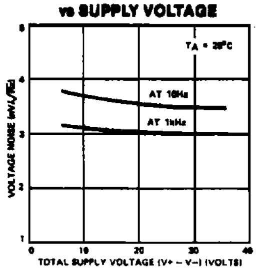
TOTAL NOISE vs SOURCE RESISTANCE



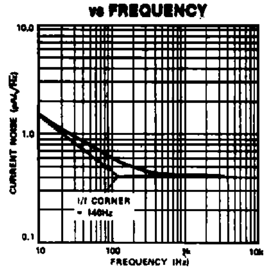
VOLTAGE NOISE DENSITY vs TEMPERATURE



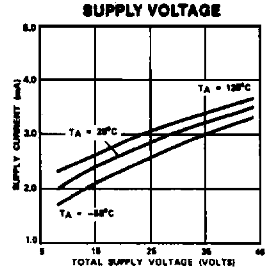
VOLTAGE NOISE DENSITY vs SUPPLY VOLTAGE



CURRENT NOISE DENSITY vs FREQUENCY

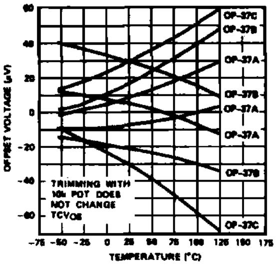


SUPPLY CURRENT vs SUPPLY VOLTAGE

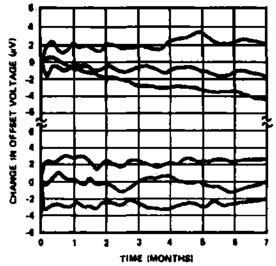


TYPICAL CHARACTERISTICS (continued)

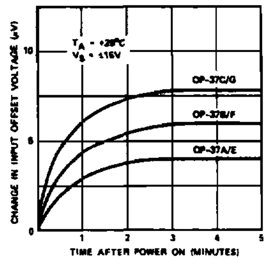
OFFSET VOLTAGE DRIFT OF EIGHT REPRESENTATIVE UNITS vs TEMPERATURE



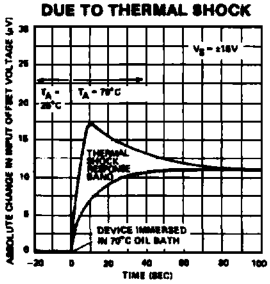
LONG-TERM OFFSET VOLTAGE DRIFT OF SIX REPRESENTATIVE UNITS



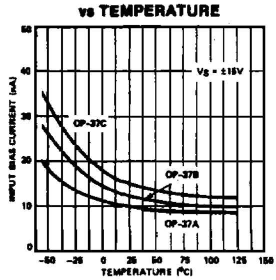
WARM-UP OFFSET VOLTAGE DRIFT



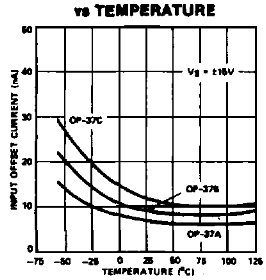
OFFSET VOLTAGE CHANGE DUE TO THERMAL SHOCK



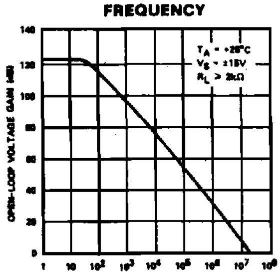
INPUT BIAS CURRENT vs TEMPERATURE



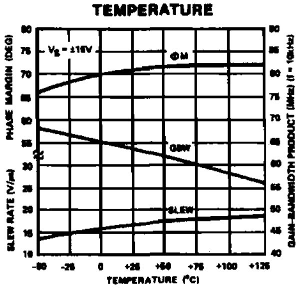
INPUT OFFSET CURRENT vs TEMPERATURE



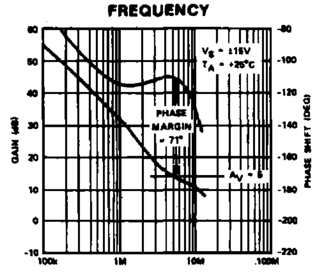
OPEN-LOOP GAIN vs FREQUENCY



SLEW RATE, GAIN BANDWIDTH PRODUCT, PHASE MARGIN vs TEMPERATURE

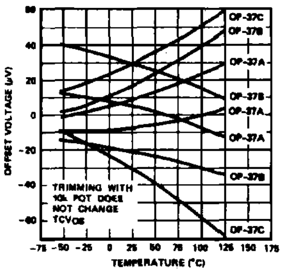


GAIN, PHASE SHIFT vs FREQUENCY

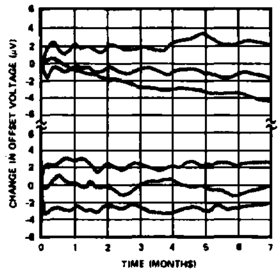


TYPICAL CHARACTERISTICS (continued)

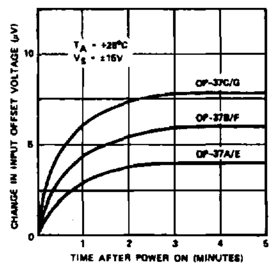
OFFSET VOLTAGE DRIFT OF EIGHT REPRESENTATIVE UNITS vs TEMPERATURE



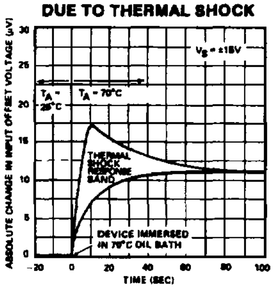
LONG-TERM OFFSET VOLTAGE DRIFT OF SIX REPRESENTATIVE UNITS



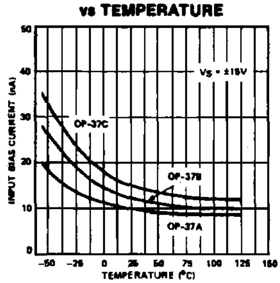
WARM-UP OFFSET VOLTAGE DRIFT



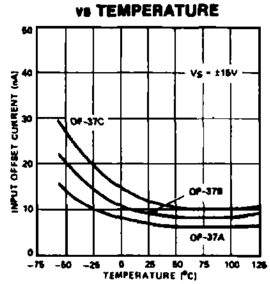
OFFSET VOLTAGE CHANGE DUE TO THERMAL SHOCK



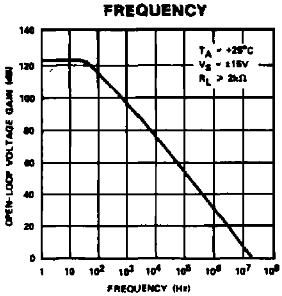
INPUT BIAS CURRENT vs TEMPERATURE



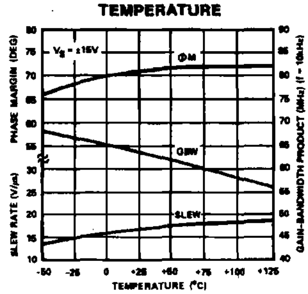
INPUT OFFSET CURRENT vs TEMPERATURE



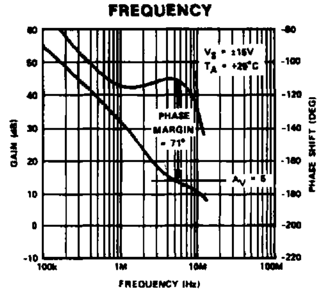
OPEN-LOOP GAIN vs FREQUENCY



SLEW RATE, GAIN BANDWIDTH PRODUCT, PHASE MARGIN vs TEMPERATURE

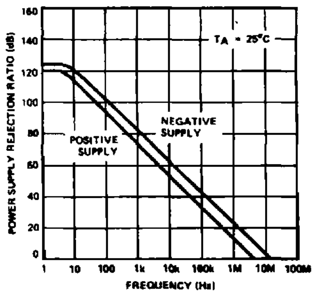


GAIN, PHASE SHIFT vs FREQUENCY

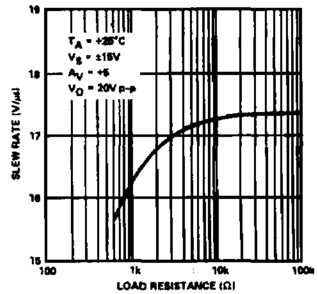


TYPICAL CHARACTERISTICS (continued)

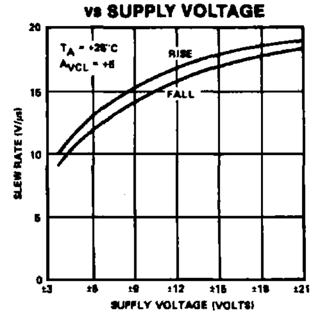
PSRR vs FREQUENCY



SLEW RATE vs LOAD



SLEW RATE vs SUPPLY VOLTAGE



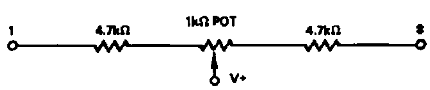
APPLICATION HINTS

OP-37 series devices can be fitted directly to 725 and OP-06, OP-07 & OP-05 Series sockets with or without removal of external compensation components. Additionally, the OP-37 may be fitted to unnulled 741 series. However, if conventional 741 nulling circuitry is in use, it should be modified or removed to enable proper OP-37 operation. The OP-37 provides stable operation with load capacitance of up to 500pF and ±10V swings; larger capacitances should be decoupled with a 50Ω resistor.

Offset stability can be degraded by stray thermoelectric voltages arising from dissimilar metals at the contacts to the input terminals. Best operation will be obtained when both input contacts are maintained at the same temperature, preferably close to the temperature of the device's package.

OP-37 OFFSET VOLTAGE ADJUSTMENT

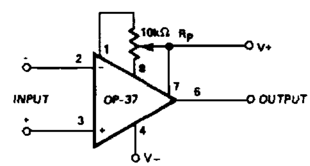
The OP-37 offset voltage is trimmed at wafer level. However if further adjustment of V_{OS} is necessary, a 10kΩ trim potentiometer may be used. Other potentiometer values from 1kΩ to 1MΩ can be used with a slight degradation. Trimming to a value other than zero creates a drift of approx. $V_{OS}/300\ \mu V\ /\ °C$.



OP-37 COMPENSATION

The OP-37 is internally compensated for unity-gain. However, it may still require a small value capacitor in parallel with the feedback resistor. The capacitor can compensate for the pole generated by R_f and input capacitance and eliminate oscillation.

OFFSET NULLING CIRCUIT



INPUT PROTECTION OF OP-37

For input protection of the OP-37, back to back diodes can be used. Over a few hundred mV differential input signals will make current flow and without external current limiting resistors at the input, it will be destroyed.

The amplifier can be damaged by any static discharge as well as high current input. The OP-37 can still be functional but for any precision amplifier such as OP-37 the input offset, drift, and noise can be permanently damaged.