LINEAR SYSTEMS

Low-Noise Precision Operational Amplifier

Linear Integrated Systems

LS OP-27

FEATURES:

- Replaces AD-510, 517, 725
  ..... PMI-Op27, Op37, Op07, Op05
  ..... Linear Tech. Op27, Op37, Op07
- Low Noise ..... 3nV/√Hz @ 1kHz
  ..... 80nVpp (0.1Hz to 10Hz)
- Low Drift ..... 0.2μV/°C
- Low Vos 10μV
- Slew Rate 2.8V/μS
- High Open Loop Gain ..... 1.8 Meg.
- Gain Bandwidth ..... 8 Meg Hz
- Superior CMRR ..... 126dB @ Vcm of ±11V

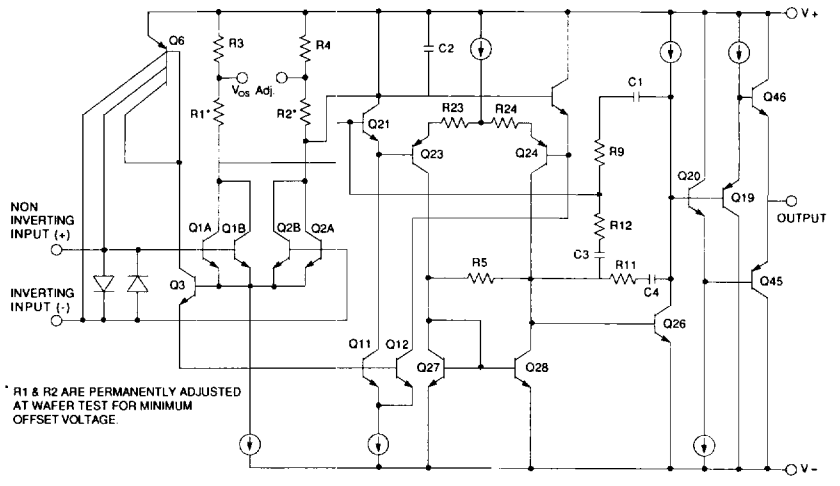
DESCRIPTION:

The Op-27 operational amplifier combines outstanding low noise performance with precision D.C. characteristics and high speed operation. Wideband noise is 3nV/√Hz, at 10Hz., with a low 1/f noise corner frequency of 2.7Hz. The Op-27's exceptionally low noise process allows for accurate high-gain amplification of low level signals. A gain-bandwidth product of 8MHz and a 2.8V/μsec slew rate provides excellent dynamic accuracy in high-speed data-acquisition. Linear Integrated Systems' advanced low noise process and design techniques make the LS Op-27 an excellent choice for reliable, precision amplifier applications. The low input bias current of 10nA and offset current of 7nA are achieved by using a bias-current-cancellation circuit. Over the military temperature range this typically holds I_B and I_{OS} to ±20nA and ±15nA respectively. PSRR and CMRR exceed 120db.

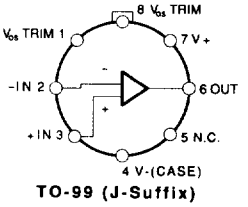
PRODUCT HIGHLIGHTS:

1. Precision amplification of very low level, low frequency voltage inputs is enhanced by ultra-low input voltage noise.
2. The Op-27 maintains high dc accuracy due to ultra-low offset voltage, offset voltage drift and input bias current.
3. Internal frequency compensation, factory adjusted offset voltage (zener-zapped) and full device protection eliminate the need for additional components.
4. Long-term stability and accuracy is assured with low offset voltage drift over time.
5. Input errors are greatly reduced by superior common mode and power supply rejection.
6. Radiation hardenable; contact factory.

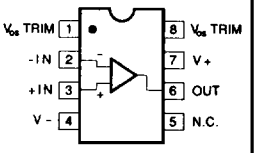
SIMPLIFIED SCHEMATIC



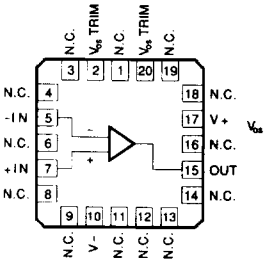
PIN CONNECTIONS



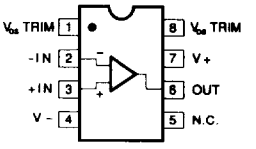
TO-99 (J-Suffix)



8-PIN HERMETIC DIP
(Z-Suffix)
EPOXY MINI-DIP
(P-Suffix)



OP-27BRC
LCC Package
(RC-Suffix)



8-PIN PLASTIC SOIC
(S-Suffix)

LSIS002

ABSOLUTE MAXIMUM RATINGS (Note 4)

Supply Voltage ..... ±22
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
Op-27A, Op-27B, Op-27C (J, Z, RC) ..... −55°C to +125°C
Op-27E, Op-27F, Op-27G (J, Z) ..... −25°C to +85°C
Op-27E, Op-27F, Op-27G (P, S) ..... 0°C to +70°C
Lead Temperature Range (Soldering, 60 sec) ..... 300°C
DICE Junction Temperature ..... −65°C to +150°C

NOTES:

1. See table for maximum ambient temperature rating and derating factor.

PACKAGE TYPE	MAXIMUM AMBIENT TEMPERATURE FOR RATING	DERATE ABOVE MAXIMUM AMBIENT TEMPERATURE
T0-99 (J)	80°C	7.1mW/°C
8-Pin Hermetic DIP (Z)	75°C	6.7mW/°C
8-Pin Plastic SOIC (S)	62°C	5.6mW/°C
8-Pin Plastic DIP (P)	62°C	5.7mW/°C
LCC	80°C	7.8mW/°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.
4. Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
5. If Military/Aerospace specified devices are required, contact the Linear Systems Sales Office for availability and specifications.

ELECTRICAL CHARACTERISTICS at $V_S = \pm 15V$, $T_A = 25°C$, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-27A/E MIN	OP-27A/E TYP	OP-27A/E MAX	OP-27B/F MIN	OP-27B/F TYP	OP-27B/F MAX	OP-27C/G MIN	OP-27C/G TYP	OP-27C/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	(Notes 2, 3)	—	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}	0.1Hz to 10Hz (Notes 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	$nV/\sqrt{Hz}$
		F_O = 30Hz (Note 3)	—	3.1	4.5	—	3.1	4.5	—	3.3	5.6	
		F_O = 1000Hz (Note 3)	—	3.0	3.8	—	3.0	3.8	—	3.2	4.5	
Input Nosie Current Density	i_n	f_O = 10Hz (Notes 3, 6)	—	1.7	4.0	—	1.7	4.0	—	1.7	—	$pA/\sqrt{Hz}$
		f_O = 30Hz (Notes 3, 6)	—	1.0	2.3	—	1.0	2.3	—	1.0	—	
		f_O = 1000Hz (Notes 3, 6)	—	0.4	0.6	—	0.4	0.6	—	0.4	0.6	
Input Resistance — Differential-Mode	R_{IN}	(Note 7)	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} = ±11V	114	126	—	106	123	—	100	120	—	dB
Power Supply Rejection Ratio	PSSR	V_S ±4V to ±18V	—	1	10	—	1	10	—	2	20	μV/V
Large-Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, V_O = ±10V	1000	1800	—	1000	1800	—	700	1500	—	V/mV
		$R_L \geq 600\Omega$, V_O = ±10V	800	1500	—	800	1500	—	400	1500		
Output Voltage Swing	V_O	$R_L \geq 2k\Omega$	±12.0	±13.8	—	±12.0	±13.8	—	±11.5	±13.5	—	V
		$R_L \geq 600\Omega$	±10.0	±11.5	—	±10.0	±11.5	—	±10.0	±11.5	—	
Slew Rate	SR	$R_L \geq 2k\Omega$ (Note 4)	1.7	2.8	—	1.7	2.8	—	1.7	2.8	—	V/μs
Gain Bandwidth Prod.	GBW	(Note 4)	5.0	8.0	—	5.0	8.0	—	5.0	8.0	—	MHz
Open-Loop Output Resistance	R_O	V_O = 0, I_O = 0	—	70	—	—	70	—	—	70	—	Ω
Power Consumption	P_d	V_O	—	90	140	—	90	140	—	100	170	mW
Offset Adjustment Range		R_p = 10kΩ	—	±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 $V_O$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 2.5μV — refer to typical performance curve.
3. Sample tested.
4. Guaranteed by design.
5. See test circuit and frequency response curve for 0.1Hz tester.
6. See test circuit for current noise measurement.
7. Guaranteed by input bias current.

ELECTRICAL CHARACTERISTICS for $V_S = \pm 15V$, $-55°C \leq T_A \leq +125°C$, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-27A MIN	OP-27A TYP	OP-27A MAX	OP-27B MIN	OP-27B TYP	OP-27B MAX	OP-27C MIN	OP-27C TYP	OP-27C 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) (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_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	$V_{CM} = \pm 10V$	108	122	—	100	119	—	94	116	—	dB
Power Supply Rejection Ratio	PSRR	$V_S = \pm 4.5V$ to $\pm 18V$	—	2	16	—	2	20	—	4	51	μV/V
Large-Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, $V_O = \pm 10V$	600	1200	—	500	1000	—	300	800	—	V/mV
Output Voltage Swing	V_O	$R_L \geq 2k\Omega$	±11.5	±13.5	—	±11.0	±13.2	—	±10.5	±13.0	—	V

ELECTRICAL CHARACTERISTICS for $V_S = \pm 15V$, $-25°C \leq T_A \leq +85°C$ for OP-27J and OP-27Z, $0°C \leq T_A \leq +70°C$ for OP-27P, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-27E MIN	OP-27E TYP	OP-27E MAX	OP-27F MIN	OP-27F TYP	OP-27F MAX	O-27G MIN	O-27G TYP	O-27G MAX	UNITS
Input Offset Voltage	V_{OS}		—	20	50	—	40	140	—	55	220	μV
Average Input Offset Drift	TCV_{OS} TCV_{OSn}	(Note 2) (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_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	$V_{CM} = \pm 10V$	110	124	—	102	121	—	96	118	—	dB
Power Supply Rejection Ration	PSRR	$V_S = \pm 4.5V$ to $\pm 18V$	—	2	15	—	2	16	—	2	32	μV/V
Large-Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, $V_O = \pm 10V$	750	1500	—	700	1300	—	450	1000	—	V/mV
Output Voltage Swing	V_O	$R_L \geq 2k\Omega$	±11.7	±13.6	—	±11.4	±13.5	—	±11.0	±13.3	—	V

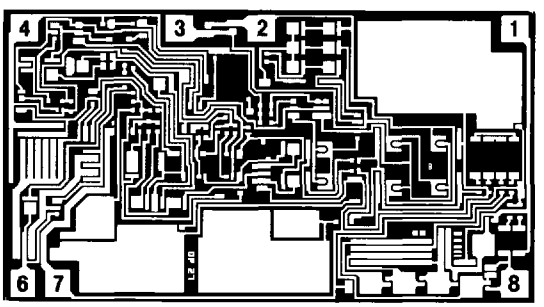
NOTES:

1. Input offset voltage measurements are performed by automated test equipment approximately 0.5 seconds after application of power. A/E grades guaranteed fully warmed up.
2. The TCV_{OS} performance is within the specifications unnulled or when nulled with $R_P = 8k\Omega$ to $20k\Omega$. TCV_{OS} is 100% tested for A/E grades, sample tested for B/C/F/G grades.
3. Guaranteed by design.

DICE CHARACTERISTICS

DIE SIZE 0.057×0.099 inch, 5643 sq. mils
(1.44×2.57mm, 3.62 sq. mm)

For additional DICE information contact factory.



1. NULL
2. (–) INPUT
3. (+) INPUT
4. V–
6. OUTPUT
7. V+
8. NULL

WAFER TEST LIMITS at $V_S = \pm 15V$, $T_A = 25°C$ for OP-27N, OP-27G and OP-27GR devices; $T_A = 125°C$ for OP-27NT and OP-27GT devices, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-27NT LIMIT	OP-27N LIMIT	OP-27GT LIMIT	OP-27G LMIT	OP-27GR LIMIT	UNITS
Input Offset Voltage	V_{OS}	(Note 1)	60	35	200	60	100	μV MAX
Input Offset Current	I_{OS}		50	35	85	50	75	nA MAX
Input Bias Current	I_B		±60	±40	±95	±55	±80	nA MAX
Input Voltage Range	IVR		±10.3	±11	±10.3	±11	±11	V MIN
Common-Mode Rejection Ratio	CMRR	$V_{CM} = \pm 11V$	108	114	100	106	100	dB MIN
Power Supply Rejection Ratio	PSRR	$T_A = 25°C$, $V_S \pm 4V$ to $\pm 18V$ $T_A = 125°C$, $V_S = \pm 4V$ to $\pm 18V$	10 16	10 —	10 20	10 —	20 —	μV/V MAX
Large-Signal Voltage Gain	A_{VO}	$R_L \geq 2k\Omega$, $V/O = \pm 10V$ $R_L \geq 1k\Omega$, $V_O = \pm 10V$	600 —	1000 800	500 —	1000 800	700 —	V/mV MIN
Output Voltage Swing	V_O	$R_L \geq 2k\Omega$ $R_L \geq 600\Omega$	±11.5 —	±12.0 ±10.0	±11.0 —	±12.0 ±10.0	±11.5 ±10.0	V MIN
Power Consumption	P_d	$V_O = 0$	—	140	—	140	170	mW MAX

NOTE:

1. Electrical tests are performed at wafer probe to the limits shown. Due to variations in asembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

TYPICAL ELECTRICAL CHARACTERISTICS at $V_S = \pm 15V$, $T_A = 25°C$, unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	OP-27N TYPICAL	OP-27G TYPICAL	OP-27GR TYPICAL	UNITS
Average Input Offset Voltage Drift	TCV_{OS} or TCV_{OSn}	Nulled or Unnulled $R_p = 8k\Omega$ to $20k\Omega$	0.2	0.3	0.4	μV/°C
Average Input Offset Current Drift	TCI_{OS}		80	130	180	pA/°C
Average Input Bias Current Drift	TCI_B		100	160	200	pA/°C
Input Noise Voltge Density	e_n	$f_O = 10Hz$ $f_O = 30Hz$ $f_O = 1000Hz$	3.5 3.1 3.0	3.5 3.1 3.0	3.8 3.3 3.2	$nV\sqrt{Hz}$
Input Noise Current Density	i_n	$f_O = 10Hz$ $f_O = 30Hz$ $f_O = 1000Hz$	1.7 1.0 0.4	1.7 1.0 0.4	1.7 1.0 0.4	$pA\sqrt{Hz}$
Input Noise Voltage	e_{np-p}	0.1Hz to 10Hz	0.08	0.08	0.09	μV_{p-p}
Slew Rate	SR	$R_L \geq 2k\Omega$	2.8	2.8	2.8	V/μs
Gain Bandwidth Product	GBW	$f_O = 10Khz$	8	8	8	MHz

NOTES:

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

ORDERING INFORMATION

	PACKAGE					
$T_A = 25°C$ $V_{OS}MAX$ (μV)	HERMETIC TO-99 8-PIN	HERMETIC DIP 8-PIN	PLASTIC DIP 8-PIN	PLASTIC SO-JEDEC 8-PIN	LCC	OPERATING TEMP RANGE
25	OP27AJ	OP27AZ				MIL
25	OP27EJ	OP27EZ	OP27EP	OP27ES		IND./COM.
60	OP27BJ	OP27BZ			OP27BRC/88	MIL
60	OP27FJ	OP27FZ	OP27FP	OP27FS		IND./COM.
100	OP27CJ	OP27CZ				MIL
100	OP27GJ	OP27GZ	OP27GP	OP27GS		IND./COM.

Linear Integrated Systems
47853 Warm Springs Blvd.
Fremont, Calif. 94539
Tel: 415 659-1015
Fax: 415 659-1365