OP27A, OP27C, OP27E, OP27G OP37A, OP37C, OP37E, OP37G LOW-NOISE, HIGH-SPEED, PRECISION OPERATIONAL AMPLIFIERS

D3176, FEBRUARY 1989—REVISED AUGUST 1991

T-79-06-10

- **Direct Replacements for PMI and LTC OP27 and OP37 Series**

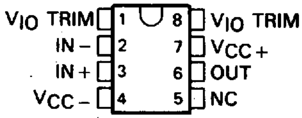
Features of OP27A, OP27C, OP37A, and OP37C:

- **Maximum Equivalent Input Noise Voltage:**
  3.8 nV/√Hz at 1 kHz
  5.5 nV/√Hz at 10 Hz
- **Very Low Peak-to-Peak Noise Voltage at 0.1 Hz to 10 Hz . . . 80 nV Typ**
- **Low Input Offset Voltage . . . 25 μV Max**
- **High Voltage Amplification . . . 1 V/μV Min**

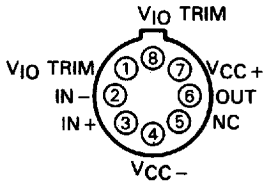
Feature of OP37 Series:

- **Minimum Slew Rate . . . 11 V/μs**

JG OR P PACKAGE (TOP VIEW)



L PACKAGE (TOP VIEW)



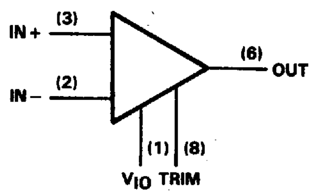
NC—No internal connection

description

The OP27 and OP37 operational amplifiers combine outstanding noise performance with excellent precision and high-speed specifications. The wideband noise is only 3 nV/√Hz, and with the 1/f noise corner at 2.7 Hz, low noise is maintained for all low-frequency applications.

The outstanding characteristics of the OP27 and OP37 make these devices excellent choices for low-noise amplifier applications requiring precision performance and reliability. Additionally, the OP37 is free of latch-up in high-gain, large-capacitive-feedback configurations.

symbol



The OP27 series is compensated for unity gain. The OP37 series is decompensated for increased bandwidth and slew rate and is stable down to a gain of 5.

The OP27A, OP27C, OP37A, and OP37C are characterized for operation over the full military temperature range of −55°C to 125°C. The OP27E, OP27G, OP37E, and OP37G are characterized for operation from −25°C to 85°C.

AVAILABLE OPTIONS

T_A	V_{IO} MAX AT 25°C	STABLE GAIN	PACKAGE		
			CERAMIC DIP (JG)	METAL CAN (L)	PLASTIC DIP (P)
−25°C to 85°C	25 μV	1	—	—	OP27EP
		5	—	—	OP37EP
	100 μV	1	—	—	OP27GP
		5	—	—	OP37GP
−55°C to 125°C	25 μV	1	OP27AJG	OP27AL	—
		5	OP37AJG	OP37AL	—
	100 μV	1	OP27CJG	—	—
		5	OP37CJG	—	—

TEXAS INSTRUMENTS

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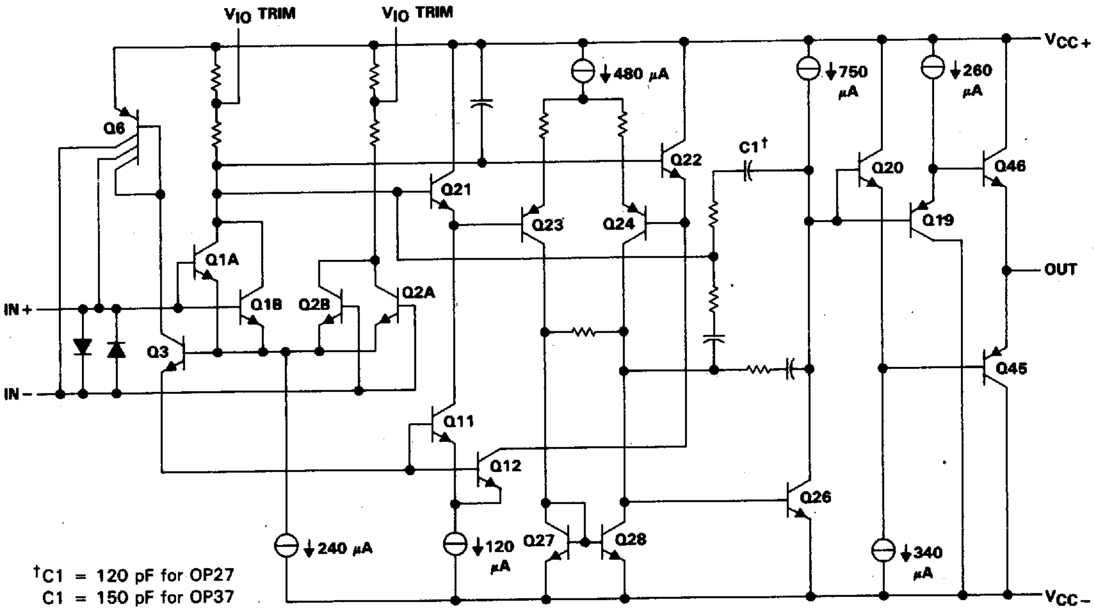
schematic



†C1 = 120 pF for OP27
C1 = 150 pF for OP37

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply voltage, V_{CC+} (see Note 1)	22 V
Supply voltage, V_{CC-} (see Note 1)	−22 V
Input voltage	$V_{CC\pm}$
Duration of output short circuit	unlimited
Differential input current (see Note 2)	±25 mA
Continuous power dissipation	See Dissipation Rating Table
Operating free-air temperature range: OP27A, OP27C, OP37A, OP37C	−55°C to 125°C
OP27E, OP27G, OP37E, OP37G	−25°C to 85°C
Storage temperature range	−65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG or L package	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: P package	260°C

NOTES: 1. All voltage values are with respect to the midpoint between V_{CC+} and V_{CC-} unless otherwise noted.
2. The inputs are protected by back-to-back diodes. Current-limiting resistors are not used in order to achieve low noise. Excessive input current will flow if a differential input voltage in excess of approximately ±0.7 V is applied between the inputs unless some limiting resistance is used.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
JG	1050 mW	8.4 mW/°C	546 mW	210 mW
L	825 mW	6.6 mW/°C	429 mW	165 mW
P	1000 mW	8.0 mW/°C	520 mW	N/A

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recommended operating conditions

		OP27A, OP37A			OP27C, OP37C			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC+}		4	15	22	4	15	22	V
Supply voltage, V_{CC-}		−4	−15	−22	−4	−15	−22	V
Common-mode input voltage, V_{ICR}	$V_{CC\pm} = \pm 15$ V, $T_A = 25°C$			±11			±11	V
	$V_{CC\pm} = \pm 15$ V, $T_A = -55°C$ to 125°C			±10.3			±10.2	V
Operating free-air temperature, T_A		−55		125	−55		125	°C

electrical characteristics, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	OP27A, OP37A MIN	TYP	MAX	OP27C, OP37C MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_O = 0$, $V_{IC} = 0$	25°C		10	25		30	100	µV
		$R_S = 50\ \Omega$, See Note 3	−55°C to 125°C			60			300	
αV_{IO}	Average temperature coefficient of input offset voltage		−55°C to 125°C		0.2	0.6		0.4	1.8	µV/°C
	Long-term drift of input offset voltage	See Note 4			0.2	1		0.4	2	µV/mo
I_{IO}	Input offset current	$V_O = 0$, $V_{IC} = 0$	25°C		7	35		12	75	nA
			−55°C to 125°C			50			135	
I_{IB}	Input bias current	$V_O = 0$, $V_{IC} = 0$	25°C		±10	±40		±15	±80	nA
			−55°C to 125°C			±60			±150	
V_{ICR}	Common-mode input voltage range		25°C	±11			±11			V
			−55°C to 125°C	±10.3			±10.2			
V_{OM}	Peak output voltage swing	$R_L \geq 2\ k\Omega$	25°C	±12	±13.8		±11.5	±13.5		V
		$R_L \geq 0.6\ k\Omega$	25°C	±10	±11.5		±10	±11.5		
		$R_L \geq 2\ k\Omega$	−55°C to 125°C	±11.5			±10.5			
A_{VD}	Large-signal differential voltage amplification	$R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V	25°C	1000	1800		700	1500		V/mV
		$R_L \geq 1\ k\Omega$, $V_O = \pm 10$ V	25°C	800	1500			1500		
		$R_L \geq 0.6\ k\Omega$, $V_O = \pm 1$ V, $V_{CC} = \pm 4$ V	25°C	250	700		200	500		
		$R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V	−55°C to 125°C	600			300			
$r_{i(CM)}$	Common-mode input resistance				3			2		GΩ
r_o	Output resistance	$V_O = 0$, $I_O = 0$	25°C		70			70		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = \pm 11$ V	25°C	114	126		100	120		dB
		$V_{IC} = \pm 10$ V	−55°C to 125°C	108			94			
k_{SVR}	Supply voltage rejection ratio	$V_{CC\pm} = \pm 4$ V to ± 18 V	25°C	100	120		94	118		dB
		$V_{CC\pm} = \pm 4.5$ V to ± 18 V	−55°C to 125°C	96			86			

NOTES: 3. Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after applying power.

4. Long-term drift of input offset voltage refers to the average trend line of offset voltage versus time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{IO} during the first 30 days are typically 2.5 µV. See Figure 3.

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC+}		4	15	22	V
Supply voltage, V_{CC-}		−4	−15	−22	V
Common-mode input voltage, V_{ICR}	$V_{CC\pm} = \pm 15$ V, $T_A = 25°C$			±11	V
	$V_{CC\pm} = \pm 15$ V, $T_A = -55°C$ to 125°C			±10.5	
Operating free-air temperature, T_A		−25		85	°C

electrical characteristics, $V_{CC\pm} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A	OP27E, OP37E			OP27G, OP37G			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_O = 0$, $V_{IC} = 0$	25°C		10	25		30	100	μV
		$R_S = 50\ \Omega$, See Note 3	−25°C to 85°C			50			220	
αV_{IO}	Average temperature coefficient of input offset voltage		−25°C to 85°C		0.2	0.6		0.4	1.8	μV/°C
	Long-term drift of input offset voltage	See Note 4			0.2	1		0.4	2	μV/mo
I_{IO}	Input offset current	$V_O = 0$, $V_{IC} = 0$	25°C		7	35		12	75	nA
			−25°C to 85°C			50			135	
I_{IB}	Input bias current	$V_O = 0$, $V_{IC} = 0$	25°C		±10	±40		±15	±80	nA
			−25°C to 85°C			±60			±150	
V_{ICR}	Common-mode input voltage range		25°C	±11			±11			V
			−25°C to 85°C	±10.5			±10.5			
V_{OM}	Peak output voltage swing	$R_L \geq 2$ kΩ	25°C	±12	±13.8		±11.5	±13.5		V
		$R_L \geq 0.6$ kΩ	25°C	±10	±11.5		±10	±11.5		
		$R_L \geq 2$ kΩ	−25°C to 85°C	±11.7			±11			
A_{VD}	Large-signal differential voltage amplification	$R_L \geq 2$ kΩ, $V_O = \pm 10$ V	25°C	1000	1800		700	1500		V/mV
		$R_L \geq 1$ kΩ, $V_O = \pm 10$ V	25°C	800	1500			1500		
		$R_L \geq 0.6$ kΩ, $V_O = \pm 1$ V, $V_{CC} = \pm 4$ V	25°C	250	700		200	500		
		$R_L \geq 2$ kΩ, $V_O = \pm 10$ V	−25°C to 85°C	750			450			
$r_{i(CM)}$	Common-mode input resistance				3			2		GΩ
r_o	Output resistance	$V_O = 0$, $I_O = 0$	25°C		70			70		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = \pm 11$ V	25°C	114	126		100	120		dB
		$V_{IC} = \pm 10$ V	−25°C to 85°C	110			96			
k_{SVR}	Supply voltage rejection ratio	$V_{CC\pm} = \pm 4$ V to ±18 V	25°C	100	120		94	118		dB
		$V_{CC\pm} = \pm 4.5$ V to ±18 V	−25°C to 85°C	97			90			

NOTES: 3. Input offset voltage measurements are performed by automatic test equipment approximately 0.5 seconds after applying power.
4. Long-term drift of input offset voltage refers to the average trend line of offset voltage versus time over extended periods after the first 30 days of operation. Excluding the initial hour of operation, changes in V_{IO} during the first 30 days are typically 2.5 μV. See Figure 3.

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OP27 operating characteristics over operating free-air temperature range, $V_{CC\pm} = \pm 15$ V

PARAMETER		TEST CONDITIONS	OP27A, OP27E			OP27C, OP27G			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$A_{VD} \geq 1$, $R_L \geq 2$ kΩ	1.7	2.8		1.7	2.8		V/μs
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 10 Hz, RS = 100 Ω, See Figure 34		0.08	0.18		0.09	0.25	μV
V_n	Equivalent input noise voltage	f = 10 Hz, R_S = 100 Ω,		3.5	5.5		3.8	8	nV/√Hz
		f = 30 Hz, R_S = 100 Ω		3.1	4.5		3.3	5.6	
		f = 1 kHz, R_S = 100 Ω		3.0	3.8		3.2	4.5	
I_n	Equivalent input noise current	f = 10 Hz, See Figure 35		1.5	4		1.5		pA/√Hz
		f = 30 Hz, See Figure 35		1.0	2.3		1.0		
		f = 1 kHz, See Figure 35		0.4	0.6		0.4	0.6	
GBW	Gain bandwidth product	f = 100 kHz	5	8		5	8		MHz

OP37 operating characteristics over operating free-air temperature range, $V_{CC\pm} = \pm 15$ V

PARAMETER		TEST CONDITIONS	OP37A, OP37E			OP37C, OP37G			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	$A_{VD} \geq 5$, $R_L \geq 2$ kΩ	11	17		11	17		V/μs
V_{NPP}	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 10 Hz, R_S = 100 Ω, See Figure 34		0.08	0.18		0.09	0.25	μV
V_n	Equivalent input noise voltage	f = 10 Hz, R_S = 100 Ω		3.5	5.5		3.8	8	nV/√Hz
		f = 30 Hz, R_S = 100 Ω		3.1	4.5		3.3	5.6	
		f = 1 kHz, R_S = 100 Ω		3.0	3.8		3.2	4.5	
I_n	Equivalent input noise current	f = 10 Hz, See Figure 35		1.5	4		1.5		pA/√Hz
		f = 30 Hz, See Figure 35		1.0	2.3		1.0		
		f = 1 kHz, See Figure 35		0.4	0.6		0.4	0.6	
GBW	Gain bandwidth product	f = 10 kHz	45	63		45	63		MHz
		$A_V \geq 5$, f = 1 MHz		40			40		

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TYPICAL CHARACTERISTICS

table of graphs

			FIGURE
V_{IO}	Input offset voltage	vs Temperature	1
ΔV_{IO}	Change in input offset voltage	vs Time after power-on	2
		vs Time (long-term drift)	3
I_{IO}	Input offset current	vs Temperature	4
I_{IB}	Input bias current	vs Temperature	5
V_{ICR}	Common-mode input voltage range	vs Supply voltage	6
V_{OM}	Maximum peak output voltage	vs Load resistance	7
V_{OPP}	Maximum peak-to-peak output voltage	vs Frequency	8, 9
A_{VD}	Differential voltage amplification	vs Supply voltage	10
		vs Load resistance	11
		vs Frequency	12, 13, 14
CMRR	Common-mode rejection ratio	vs Frequency	15
k_{SVR}	Supply voltage rejection ratio	vs Frequency	16
SR	Slew rate	vs Temperature	17
		vs Supply voltage	18
		vs Load resistance	19
ϕ_m	Phase margin	vs Temperature	20, 21
ϕ	Phase shift	vs Frequency	12, 13
V_n	Equivalent input noise voltage	vs Bandwidth	22
		vs Source resistance	23
		vs Supply voltage	24
		vs Temperature	25
		vs Frequency	26
I_n	Equivalent input noise current	vs Frequency	27
GBW	Gain bandwidth product	vs Temperature	20, 21
I_{OS}	Short-circuit output current	vs Time	28
I_{CC}	Supply current	vs Supply voltage	29
	Pulse response	Small-signal	30, 32
		Large-signal	31, 33

TYPICAL CHARACTERISTICS†

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INPUT OFFSET VOLTAGE OF REPRESENTATIVE UNITS vs FREE-AIR TEMPERATURE

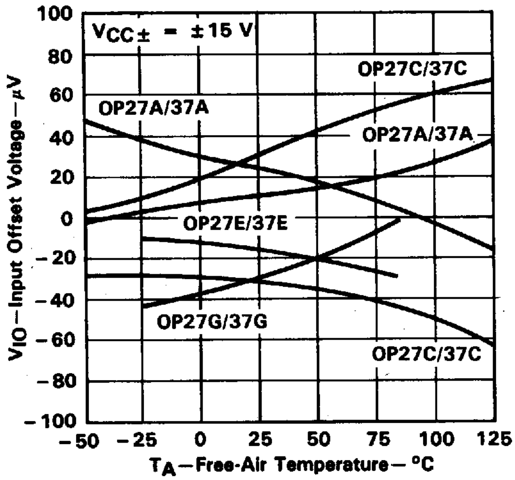

Figure 1

WARM-UP CHANGE IN INPUT OFFSET VOLTAGE vs ELAPSED TIME

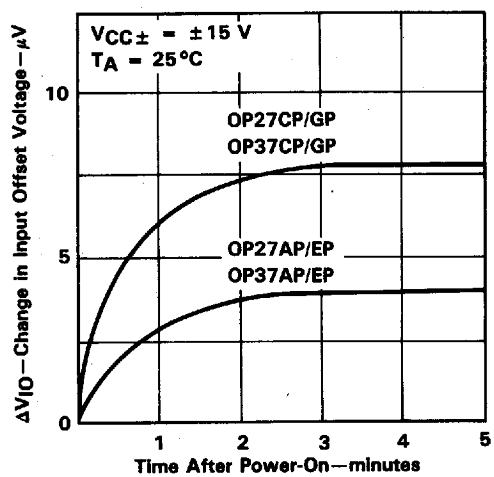

Figure 2

LONG-TERM DRIFT OF INPUT OFFSET VOLTAGE OF REPRESENTATIVE UNITS

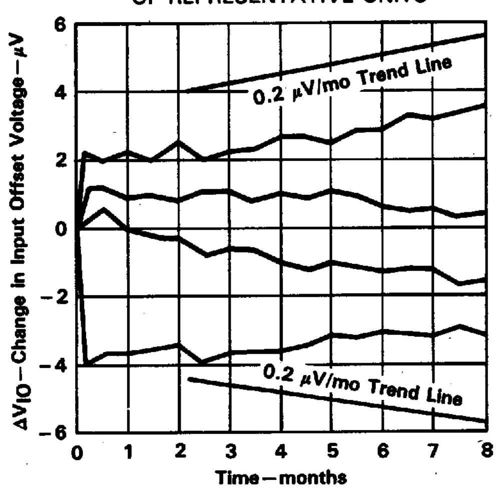

Figure 3

†Data for temperatures below −25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.

TYPICAL CHARACTERISTICS†

INPUT OFFSET CURRENT
vs
FREE-AIR TEMPERATURE

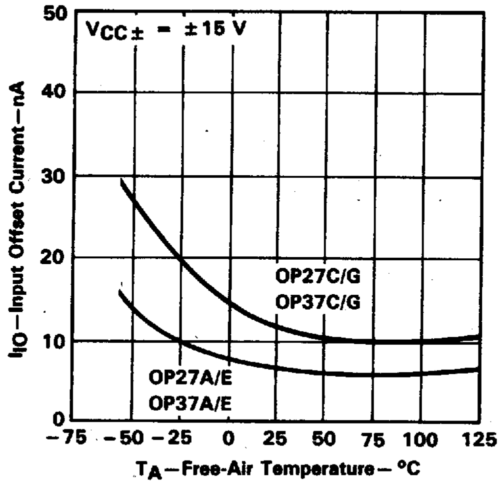

Figure 4

INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE

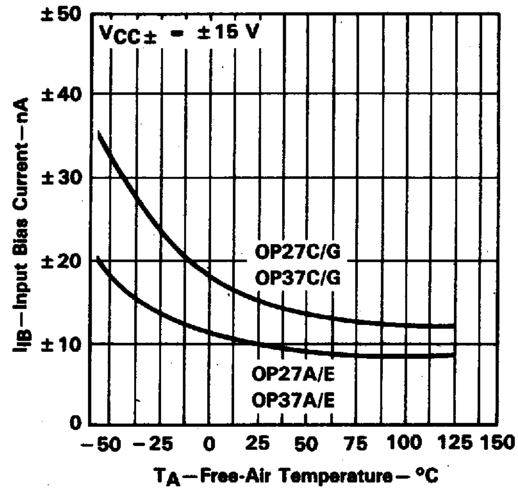

Figure 5

COMMON-MODE INPUT VOLTAGE RANGE LIMITS
vs
SUPPLY VOLTAGE

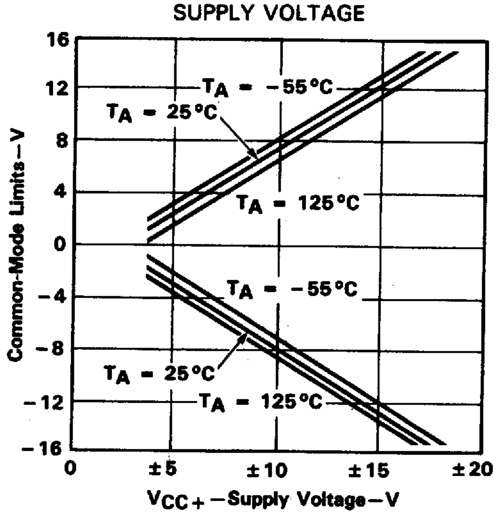

Figure 6

MAXIMUM PEAK OUTPUT VOLTAGE
vs
LOAD RESISTANCE

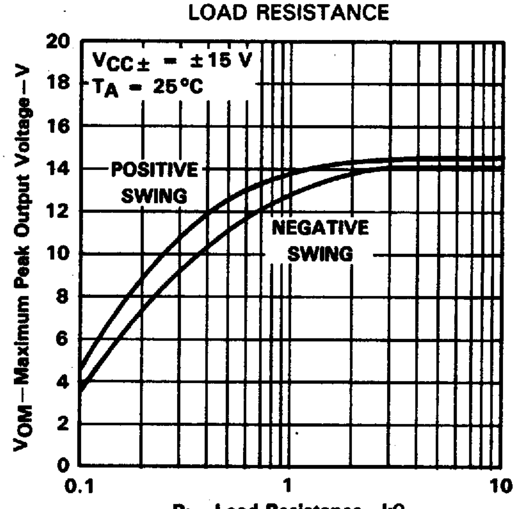

Figure 7

†Data for temperatures below −25°C and above 85°C are applicable to the OP27A, OP27C, OP37A, and OP37C only.

TYPICAL CHARACTERISTICS

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OP27
MAXIMUM PEAK-TO-PEAK
OUTPUT VOLTAGE
vs
FREQUENCY

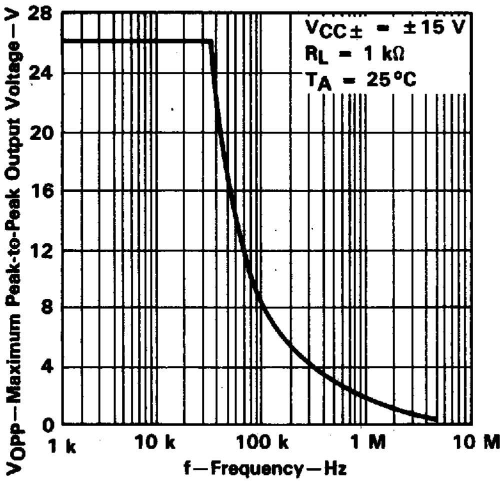

Figure 8

OP37
MAXIMUM PEAK-TO-PEAK
OUTPUT VOLTAGE
vs
FREQUENCY

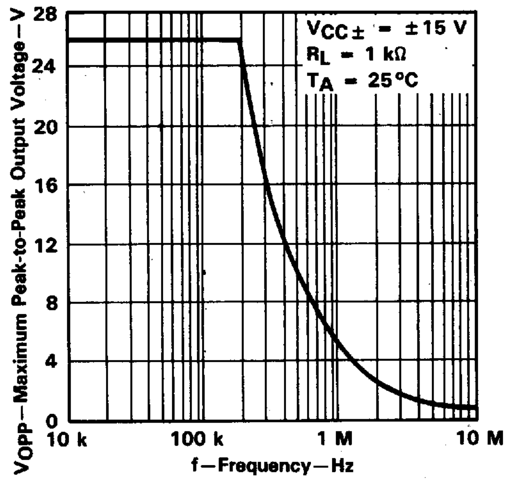

Figure 9

OP27A, OP27E, OP37A, OP37E
LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
TOTAL SUPPLY VOLTAGE

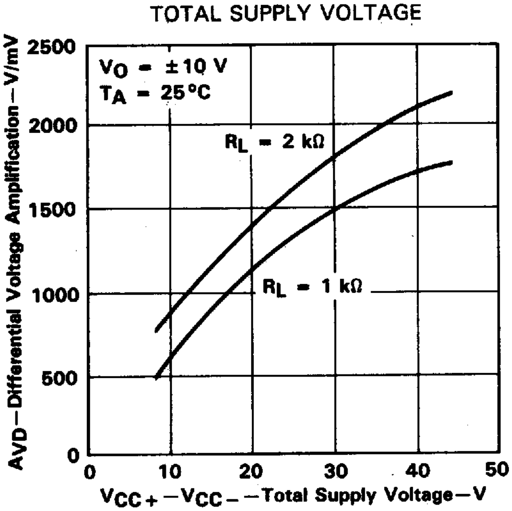

Figure 10

OP27A, OP27E, OP-37A, OP-37E
LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
LOAD RESISTANCE

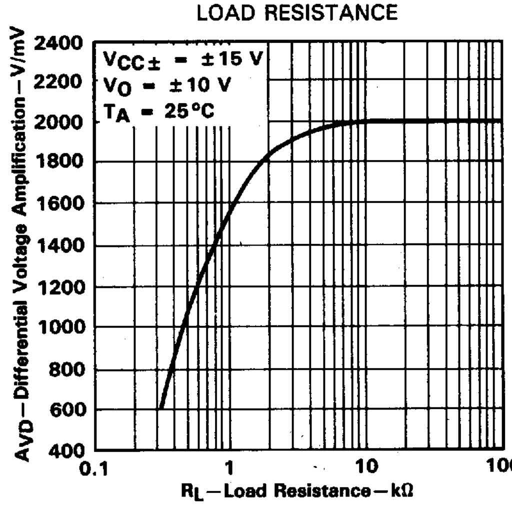

Figure 11