

# TL070, TL070A, TL071, TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075 LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

D2393, SEPTEMBER 1978—REVISED JANUARY 1989

## 19 DEVICES COVER COMMERCIAL, INDUSTRIAL, AND MILITARY TEMPERATURE RANGES

- Low Power Consumption
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- Low Total Harmonic Distortion . . . 0.003% Typ
- Common-Mode Input Voltage Range Includes  $V_{CC} +$
- Low Noise . . .  $V_n = 18 \text{ nV}/\sqrt{\text{Hz}}$  Typ
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation (Except TL070, TL070A)
- Latch-Up-Free Operation
- High Slew Rate . . .  $13 \text{ V}/\mu\text{s}$  Typ

### description

The JFET-input operational amplifiers in the TL07\_\_ series are designed as low-noise versions of the TL08\_\_ series amplifiers with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07\_\_ series ideally suited as amplifiers for high-fidelity and audio preamplifier applications. Each amplifier features JFET-inputs (for high input impedance) coupled with bipolar output stages all integrated on a single monolithic chip.

The M suffix devices are characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ . The I suffix devices are characterized for operation from  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ , and the C suffix devices are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

### AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> MAX AT 25°C	PACKAGE							
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	METAL CAN (L)	PLASTIC DIP (N)	PLASTIC DIP (P)	FLAT PACK (W)
0°C to 70°C	10 mV	TL070CD			TL070CJG			TL070CP	
	6 mV	TL070ACD			TL070ACJG			TL070ACP	
	10 mV	TL071CD			TL071CJG			TL071CP	
	6 mV	TL071ACD			TL071ACJG			TL071ACP	
	3 mV	TL071BCD			TL071BCJG			TL071BCP	
	10 mV	TL072CD			TL072CJG			TL072CP	
	6 mV	TL072ACD			TL072ACJG			TL072ACP	
	3 mV	TL072BCD			TL072BCJG			TL072BCP	
	10 mV	TL074CD		TL074CJ			TL074CN		
	6 mV	TL074ACD		TL074ACJ			TL074ACN		
	3 mV	TL074BCD		TL074BCJ			TL074BCN		
	10 mV						TL075CN		
-40°C to 85°C	6 mV	TL070ID			TL070IJG			TL070IP	
	6 mV	TL071ID			TL071IJG			TL071IP	
	6 mV	TL072ID			TL072IJG			TL072IP	
	6 mV	TL074ID		TL074IJ			TL074IN		
-55°C to 125°C	6 mV		TL071MFK		TL071MJG	TL071ML			
	6 mV		TL072MFK		TL072MJG	TL072ML			
	9 mV		TL074MFK	TL074MJ					TL074MW

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL071CDR).

PRODUCTION DATA documents contain information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS  
INSTRUMENTS

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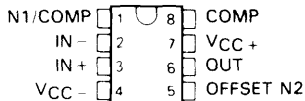
2-387

Operational Amplifiers

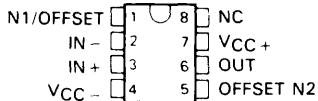
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# **TL070, TL070A, TL071, TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075** **LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

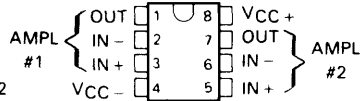
**TL070, TL070A**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



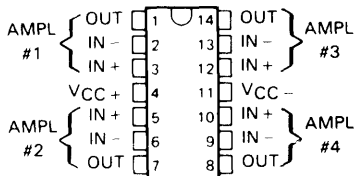
**TL071, TL071A, TL071B**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



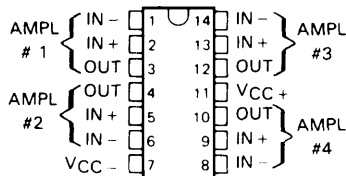
**TL072, TL072A, TL072B**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



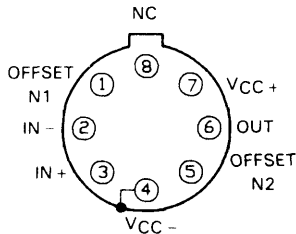
**TL074, TL074A, TL074B**  
**D, J, OR N PACKAGE**  
**TL074 . . . W PACKAGE**  
**(TOP VIEW)**



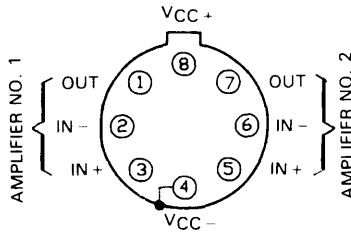
**TL075**  
**N PACKAGE**  
**(TOP VIEW)**



**TL071 . . . L PACKAGE**  
**(TOP VIEW)**



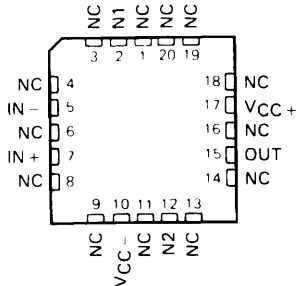
**TL072 . . . L PACKAGE**  
**(TOP VIEW)**



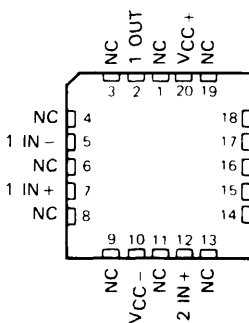
PIN 4 IS IN ELECTRICAL CONTACT  
WITH THE CASE

PIN 4 IS IN ELECTRICAL CONTACT  
WITH THE CASE

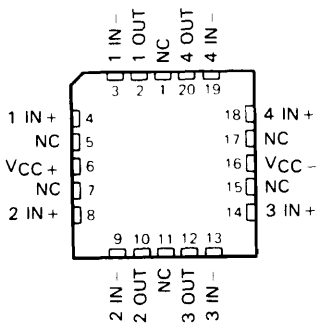
**TL071**  
**FK PACKAGE**  
**(TOP VIEW)**



**TL072**  
**FK PACKAGE**  
**(TOP VIEW)**



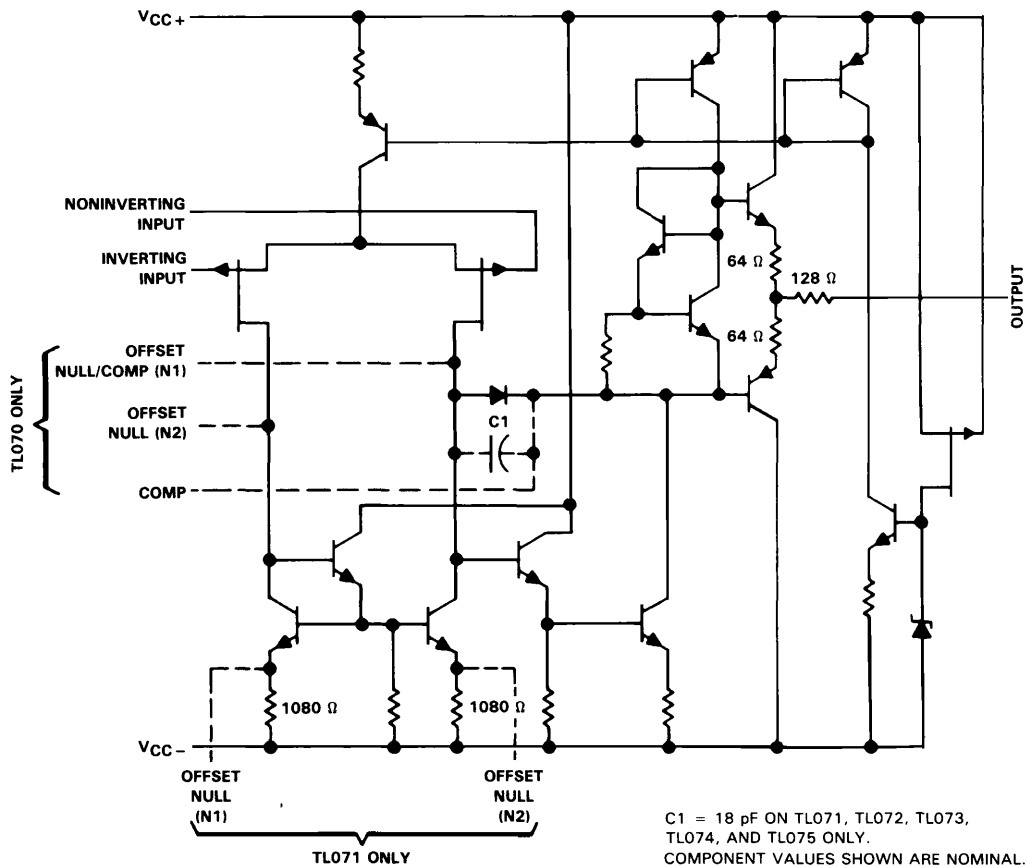
**TL074**  
**FK PACKAGE**  
**(TOP VIEW)**



NC—No internal connection.

**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

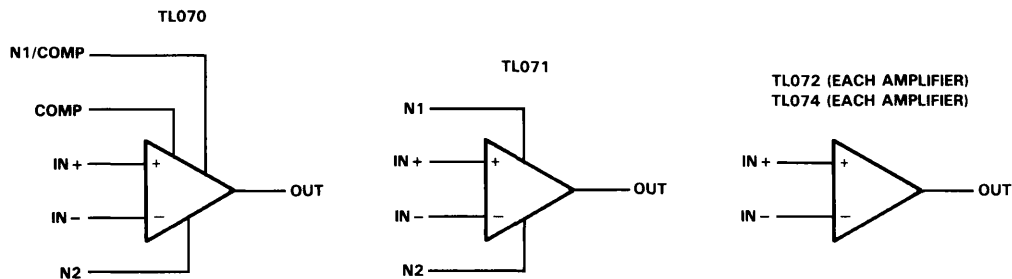
schematic (each amplifier)



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Operational Amplifiers

symbols



**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

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

	TL07__M	TL07__J	TL07__C TL07__AC TL07__BC	UNIT
Supply voltage, $V_{CC+}$ (see Note 1)	18	18	18	V
Supply voltage, $V_{CC-}$ (see Note 1)	-18	-18	-18	V
Differential input voltage (see Note 2)	$\pm 30$	$\pm 30$	$\pm 30$	V
Input voltage (see Notes 1 and 3)	$\pm 15$	$\pm 15$	$\pm 15$	V
Duration of output short circuit (see Note 4)	unlimited	unlimited	unlimited	
Continuous total dissipation	See Dissipation Rating Table			
Operating free-air temperature range	-55 to 125	-40 to 85	0 to 70	°C
Storage temperature range	-65 to 150	-65 to 150	-65 to 150	°C
Case temperature for 60 seconds	FK package	260		°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J, JG, or W package	300	300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D, N, or P package		260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	L package	300		°C

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .  
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.  
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.  
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR	DERATE ABOVE $T_A$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D (8-pin)	680 mW	5.8 mW/°C	33°C	464 mW	377 mW	N/A
D (14-pin)	680 mW	7.6 mW/°C	60°C	608 mW	494 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
J (TL07__M)	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
J (all others)	680 mW	8.2 mW/°C	67°C	656 mW	533 mW	N/A
JG (TL07__M)	680 mW	8.4 mW/°C	69°C	672 mW	546 mW	210 mW
JG (all others)	680 mW	6.6 mW/°C	47°C	528 mW	429 mW	N/A
L	680 mW	6.6 mW/°C	25°C	528 mW	429 mW	165 mW
N	680 mW	9.2 mW/°C	76°C	680 mW	598 mW	N/A
P	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	N/A
W	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	200 mW

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Operational Amplifiers

**TL071M, TL072M, TL074M**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

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

PARAMETER		TEST CONDITIONS <sup>†</sup>		TL071M TL072M			TL074M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_O = 0,$	$T_A = 25^\circ\text{C}$		3	6		3	9	mV
		$R_S = 50 \Omega,$	$T_A = -55^\circ\text{C to } 125^\circ\text{C}$			9			15	
$\alpha V_{IO}$	Temperature coefficient of input offset voltage	$V_O = 0,$	$R_S = 50 \Omega,$		18			18		$\mu\text{V}/^\circ\text{C}$
$I_{IO}$	Input offset current <sup>‡</sup>	$V_O = 0$	$T_A = 25^\circ\text{C}$		5	100		5	100	pA
			$T_A = -55^\circ\text{C to } 125^\circ\text{C}$			20			20	nA
$I_{IB}$	Input bias current	$V_O = 0$	$T_A = 25^\circ\text{C}$		65	200		65	200	pA
			$T_A = -55^\circ\text{C to } 125^\circ\text{C}$			50			50	nA
$V_{ICR}$	Common-mode input voltage range	$T_A = 25^\circ\text{C}$			-12 to +15			-12 to +15		V
$V_{OM}$	Maximum peak output voltage swing	$R_L = 10 \text{ k}\Omega$	$T_A = 25^\circ\text{C}$		$\pm 12$	$\pm 13.5$		$\pm 12$	$\pm 13.5$	V
		$R_L \geq 10 \text{ k}\Omega$	$T_A = -55^\circ\text{C to } 125^\circ\text{C}$		$\pm 12$			$\pm 12$		
		$R_L \geq 2 \text{ k}\Omega$			$\pm 10$			$\pm 10$		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V},$ $R_L \geq 2 \text{ k}\Omega$	$T_A = 25^\circ\text{C}$		35	200		35	200	V/mV
			$T_A = -55^\circ\text{C to } 125^\circ\text{C}$		15			15		
$B_1$	Unity-gain bandwidth	$T_A = 25^\circ\text{C}$			3			3		MHz
$r_i$	Input resistance	$T_A = 25^\circ\text{C}$			$10^{12}$			$10^{12}$		$\Omega$
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR} \text{ min}, V_O = 0,$ $R_S = 50 \Omega, T_A = 25^\circ\text{C}$			80	86		80	86	dB
$k_{SVR}$	Supply voltage rejection ratio ( $\Delta V_{CC} \pm / \Delta V_{IO}$ )	$V_{CC} = \pm 15 \text{ V to } \pm 9 \text{ V}, V_O = 0,$ $R_S = 50 \Omega, T_A = 25^\circ\text{C}$			80	86		80	86	dB
$I_{CC}$	Supply current (each amplifier)	No load, $V_O = 0,$ $T_A = 25^\circ\text{C}$			1.4	2.5		1.4	2.5	mA
$V_{O1}/V_{O2}$	Crosstalk attenuation	$A_{VD} = 100, T_A = 25^\circ\text{C}$			120			120		dB

<sup>†</sup>All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

<sup>‡</sup>Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 6. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

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Operational Amplifiers

## Operational Amplifiers

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### TL070, TL070A, TL071, TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075 LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

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

PARAMETER	TEST CONDITIONS†	TL070I			TL070C			TL070AC			TL070BC			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 0$ , $R_S = 50\ \Omega$	3	6		3	10		3	6		2	3	mV	
	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$			8		13			7.5		5			
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage	$V_O = 0$ , $T_A = \text{full range}$	18			18			18			18		$\mu\text{V}/^\circ\text{C}$	
$I_{IO}$ Input offset current†	$V_O = 0$	5	100		5	100		5	100		5	100	pA	
	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$		10			2			2		2		nA	
$I_{IB}$ Input bias current†	$V_O = 0$	65	200		65	200		65	200		65	200	pA	
	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$		20			7			7		7		nA	
$V_{ICR}$ Common-mode input voltage range	$T_A = 25^\circ\text{C}$	$\pm 11$ to $\pm 15$	$\pm 12$ to $\pm 13.5$		$\pm 11$ to $\pm 15$	$\pm 12$ to $\pm 13.5$		$\pm 11$ to $\pm 15$	$\pm 12$ to $\pm 13.5$		$\pm 11$ to $\pm 15$	$\pm 12$ to $\pm 13.5$	V	
$V_{OM}$ Maximum peak output voltage swing	$R_L = 10\ \text{k}\Omega$ $R_L \geq 10\ \text{k}\Omega$ $R_L \geq 2\ \text{k}\Omega$	$\pm 12$ to $\pm 13.5$	$\pm 12$ to $\pm 13.5$		$\pm 12$ to $\pm 13.5$	$\pm 12$ to $\pm 13.5$		$\pm 12$ to $\pm 13.5$	$\pm 12$ to $\pm 13.5$		$\pm 12$ to $\pm 13.5$	$\pm 12$ to $\pm 13.5$	V	
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$ $R_L \geq 2\ \text{k}\Omega$	50 to 200	25 to 200		25 to 200	25 to 200		50 to 200	50 to 200		50 to 200	50 to 200	V/mV	
$B_1$ Unity-gain bandwidth	$T_A = 25^\circ\text{C}$	3	3		3	3		3	3		3	3	MHz	
$f_i$ Input resistance	$T_A = 25^\circ\text{C}$	$10^{12}$	$10^{12}$		$10^{12}$	$10^{12}$		$10^{12}$	$10^{12}$		$10^{12}$	$10^{12}$	$\Omega$	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\ \text{min}}$ , $V_O = 0$ , $R_S = 50\ \Omega$ , $T_A = 25^\circ\text{C}$	80 to 100	70 to 100		80 to 100	80 to 100		80 to 100	80 to 100		80 to 100	80 to 100	dB	
$k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{CC} \pm / \Delta V_{IO}$ )	$V_{CC} = \pm 15\ \text{V}$ to $\pm 9\ \text{V}$ , $V_O = 0$ , $R_S = 50\ \Omega$ , $T_A = 25^\circ\text{C}$	80 to 100	70 to 100		80 to 100	80 to 100		80 to 100	80 to 100		80 to 100	80 to 100	dB	
$I_{CC}$ Supply current (each amplifier)	No load, $V_O = 0$ , $T_A = 25^\circ\text{C}$	1.4 to 2.5	1.4 to 2.5		1.4 to 2.5	1.4 to 2.5		1.4 to 2.5	1.4 to 2.5		1.4 to 2.5	1.4 to 2.5	mA	
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 100$ , $T_A = 25^\circ\text{C}$	120	120		120	120		120	120		120	120	dB	

†All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for  $T_A$  is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TL071 and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TL070, TL072, TL074, TL075.

‡Input bias currents of a JFET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 6. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

# TL070, TL070A, TL071, TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075 LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

operating characteristics,  $V_{CC\pm} = \pm 15 \text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TL07__M			ALL OTHERS			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
SR Slew rate at unity gain	$V_I = 10 \text{ V}$ , $R_L = 2 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$ , See Figure 1	8	13		8	13		$\text{V}/\mu\text{s}$
$t_r$ Rise time	$V_I = 20 \text{ mV}$ , $R_L = 2 \text{ k}\Omega$ , $C_L = 100 \text{ pF}$ , See Figure 1		0.1			0.1		$\mu\text{s}$
overshoot factor			20			20		%
$V_n$ Equivalent input noise voltage	$R_S = 100 \Omega$ , $f = 1 \text{ kHz}$		18			18		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 10 \text{ Hz to } 10 \text{ kHz}$		4			4		$\mu\text{V}$
$I_n$ Equivalent input noise current	$R_S = 100 \Omega$ , $f = 1 \text{ kHz}$		0.01			0.01		$\text{pA}/\sqrt{\text{Hz}}$
THD Total harmonic distortion	$V_{O(rms)} = 10 \text{ V}$ , $R_S \leq 1 \text{ k}\Omega$ , $R_L \geq 2 \text{ k}\Omega$ , $f = 1 \text{ kHz}$		0.003			0.003		%

## PARAMETER MEASUREMENT INFORMATION

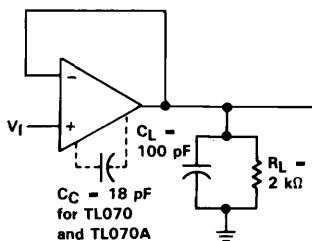


FIGURE 1. UNITY-GAIN AMPLIFIER

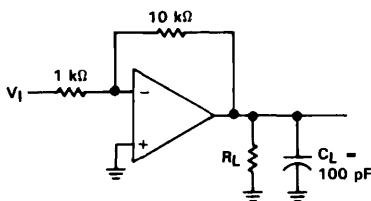


FIGURE 2. GAIN-OF-10  
INVERTING AMPLIFIER

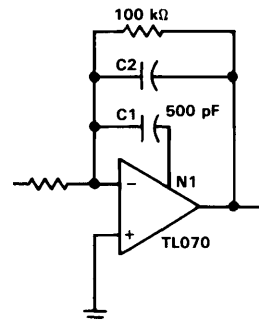


FIGURE 3. FEED-FORWARD  
COMPENSATION

## INPUT OFFSET VOLTAGE NULL CIRCUITS

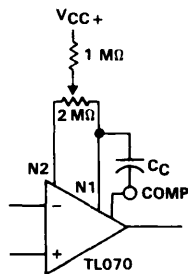


FIGURE 4

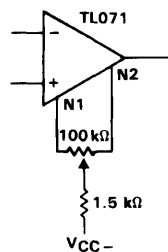


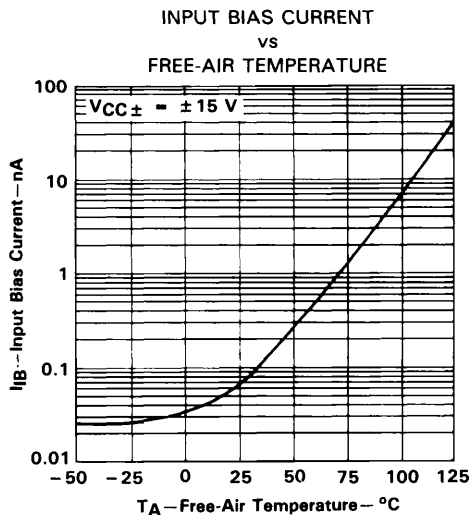
FIGURE 5

Operational Amplifiers

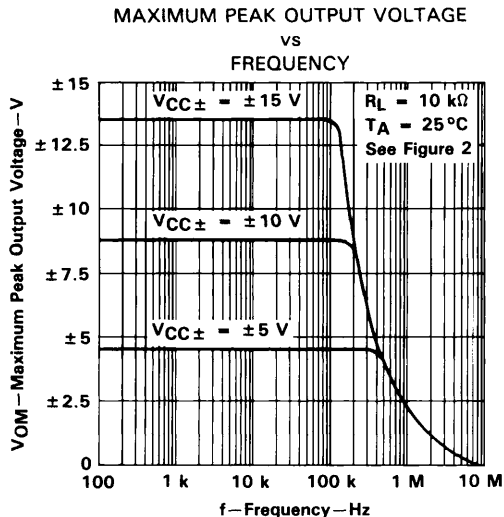
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**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

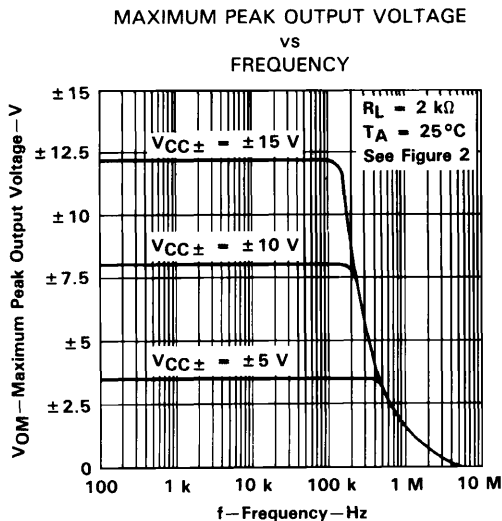
**TYPICAL CHARACTERISTICS†**



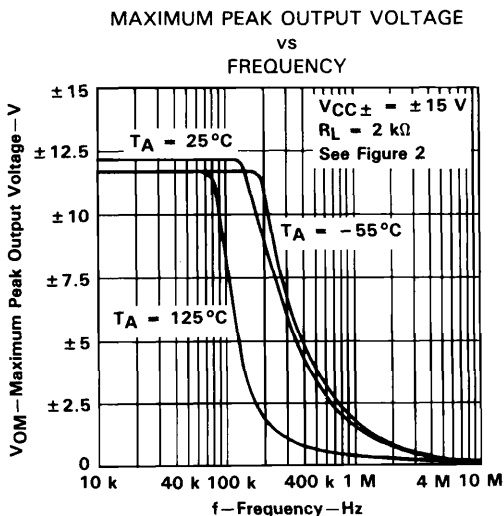
**FIGURE 6**



**FIGURE 7**



**FIGURE 8**



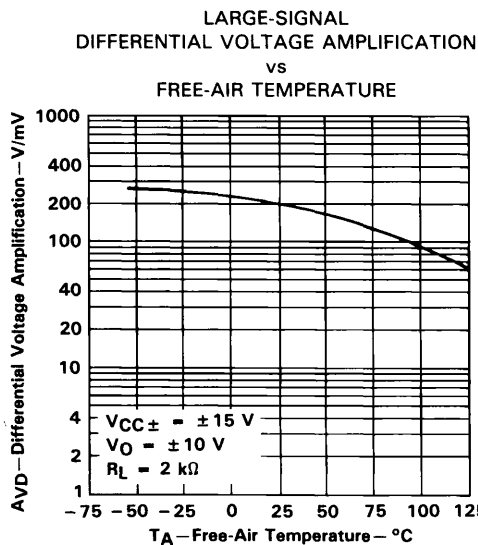
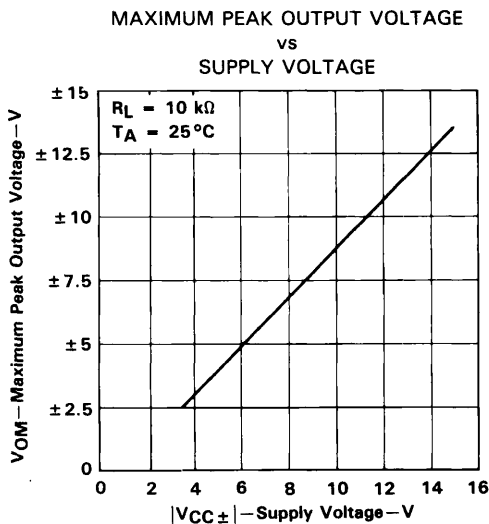
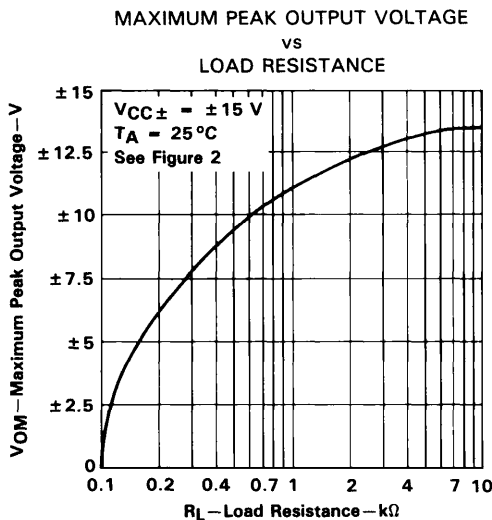
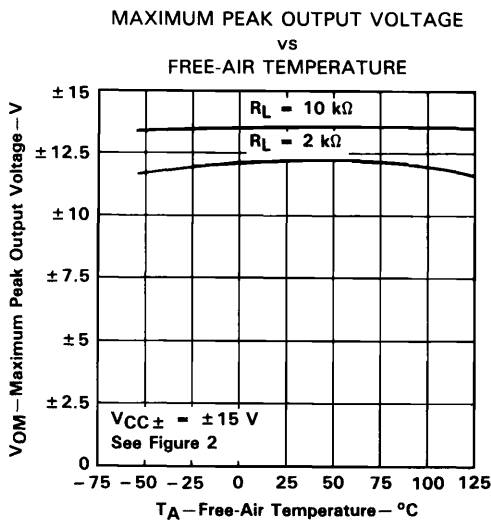
**FIGURE 9**

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. An 18-pF compensation capacitor is used with TL070 and TL070A.



**TL070, TL070A, TL071, TL071A, TL071B  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

**TYPICAL CHARACTERISTICS†**

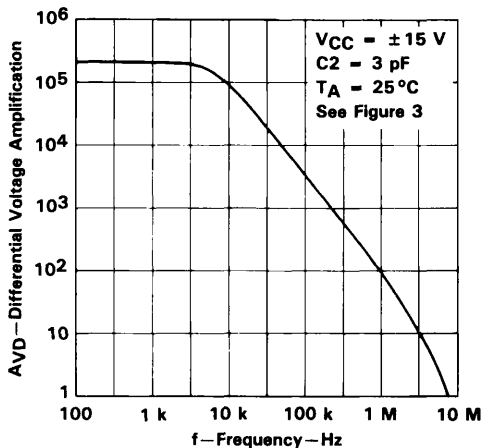


†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. An 18-pF compensation capacitor is used with TL070 and TL070A.

**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

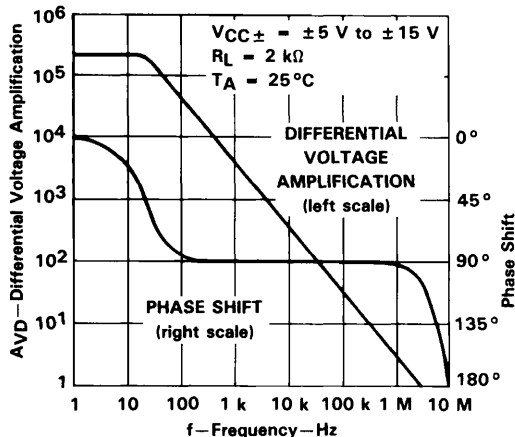
**TYPICAL CHARACTERISTICS†**

**TL070**  
**DIFFERENTIAL VOLTAGE AMPLIFICATION**  
**vs**  
**FREQUENCY WITH FEED-FORWARD**  
**COMPENSATION**



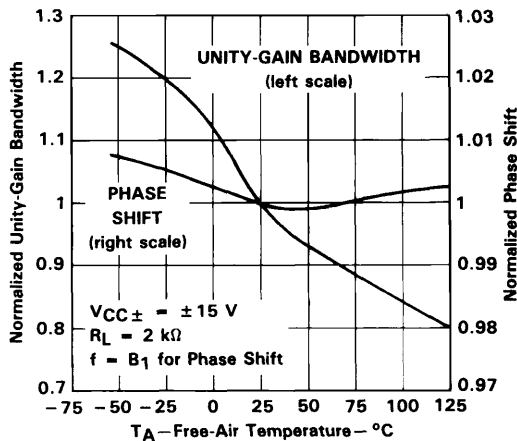
**FIGURE 14**

**LARGE-SIGNAL**  
**DIFFERENTIAL VOLTAGE AMPLIFICATION**  
**and PHASE SHIFT**  
**vs**  
**FREQUENCY**



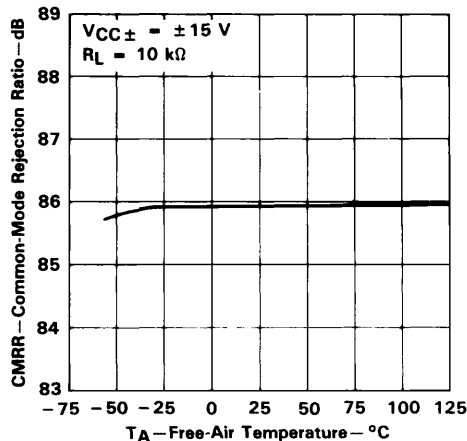
**FIGURE 15**

**NORMALIZED UNITY-GAIN BANDWIDTH**  
**and PHASE SHIFT**  
**vs**  
**FREE-AIR TEMPERATURE**



**FIGURE 16**

**COMMON-MODE REJECTION RATIO**  
**vs**  
**FREE-AIR TEMPERATURE**



**FIGURE 17**

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. An 18-pF compensation capacitor is used with TL070 and TL070A.

**TL070, TL070A, TL071, TL071A, TL071B  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

**TYPICAL CHARACTERISTICS†**

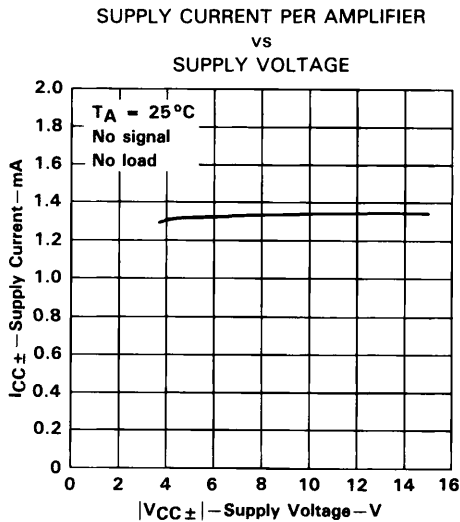


FIGURE 18

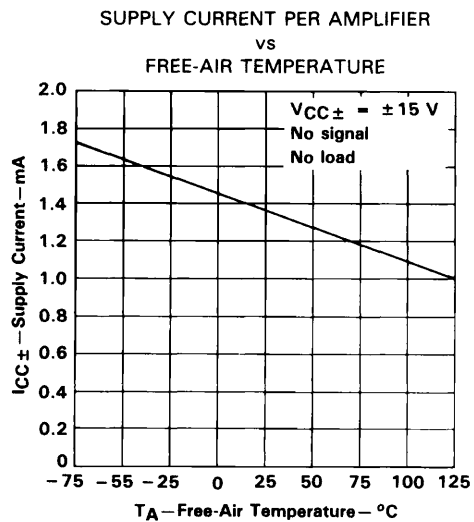


FIGURE 19

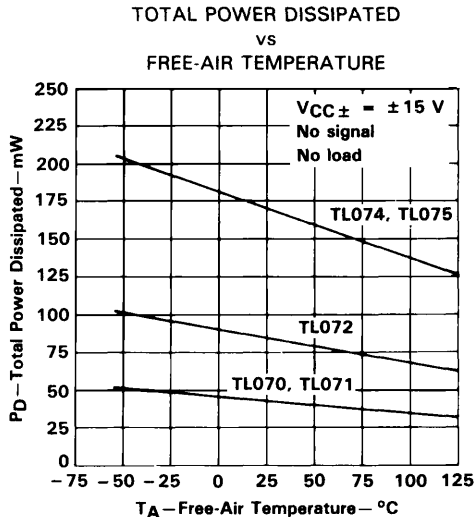


FIGURE 20

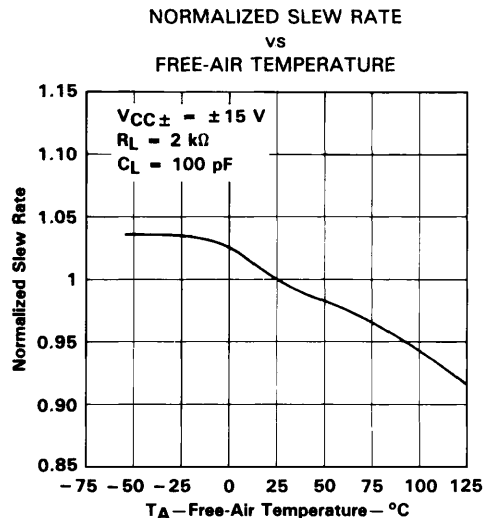


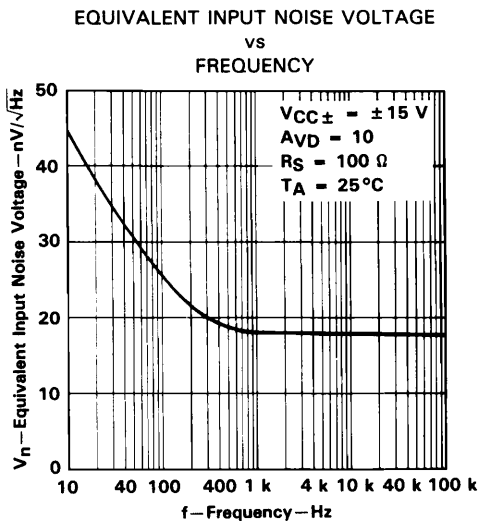
FIGURE 21

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. An 18-pF compensation capacitor is used with TL070 and TL070A.

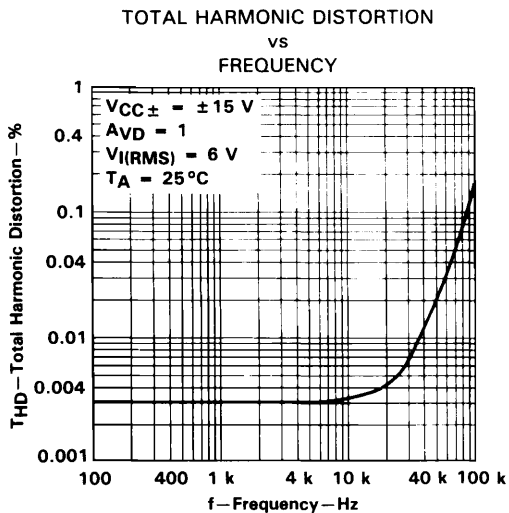
**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

**TYPICAL CHARACTERISTICS**

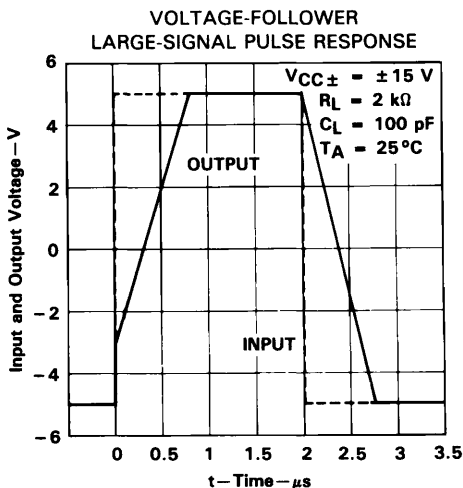
**2**  
**Operational Amplifiers**



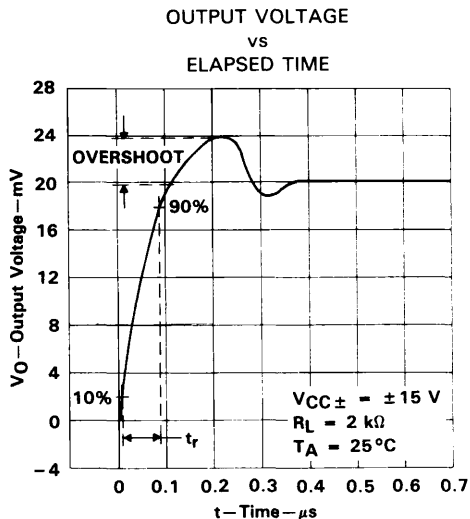
**FIGURE 22**



**FIGURE 23**



**FIGURE 24**



**FIGURE 25**

TL070, TL070A, TL071, TL071A, TL071B  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL APPLICATION DATA

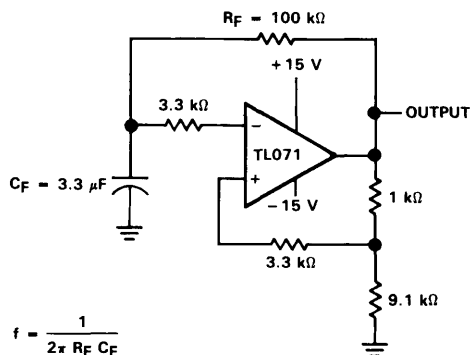


FIGURE 26. 0.5-Hz SQUARE-WAVE OSCILLATOR

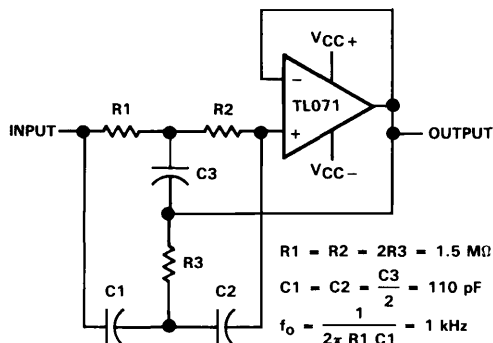
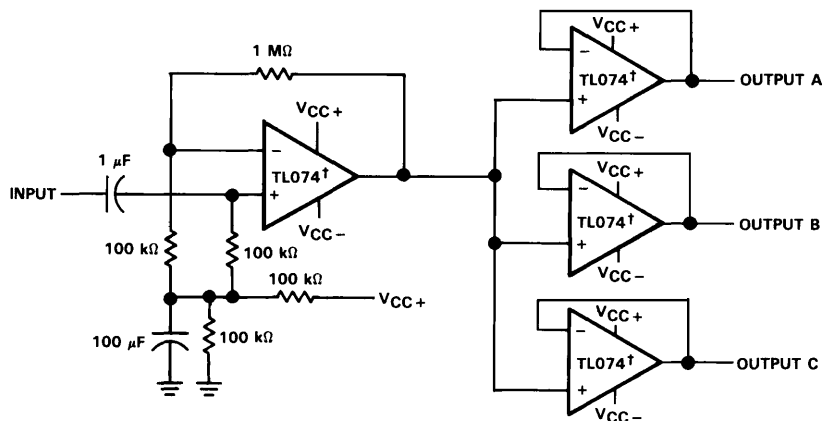


FIGURE 27. HIGH-Q NOTCH FILTER



<sup>†</sup>or TL075

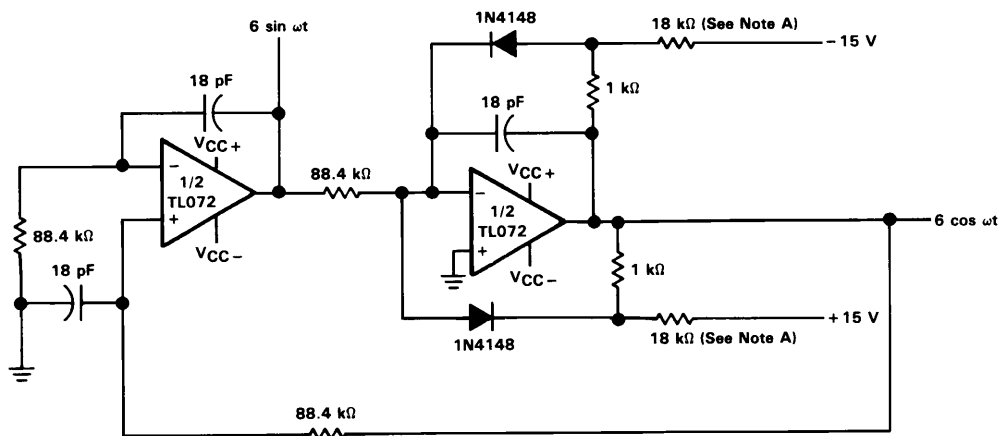
FIGURE 28. AUDIO DISTRIBUTION AMPLIFIER

**TL070, TL070A, TL071, TL071A, TL071B,  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

**TYPICAL APPLICATION DATA**

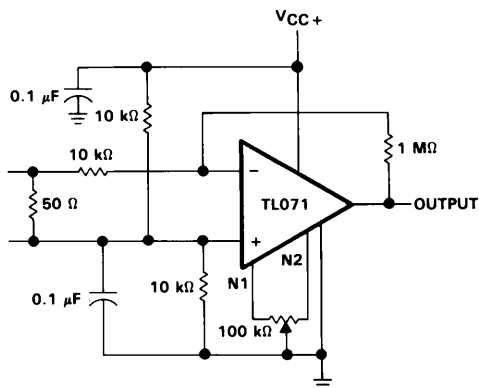
**2**

**Operational Amplifiers**



Note A: These resistor values may be adjusted for a symmetrical output.

**FIGURE 29. 100-kHz QUADRATURE OSCILLATOR**



**FIGURE 30. AC AMPLIFIER**

TL070, TL070A, TL071, TL071A, TL071B  
TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075  
LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL APPLICATION DATA

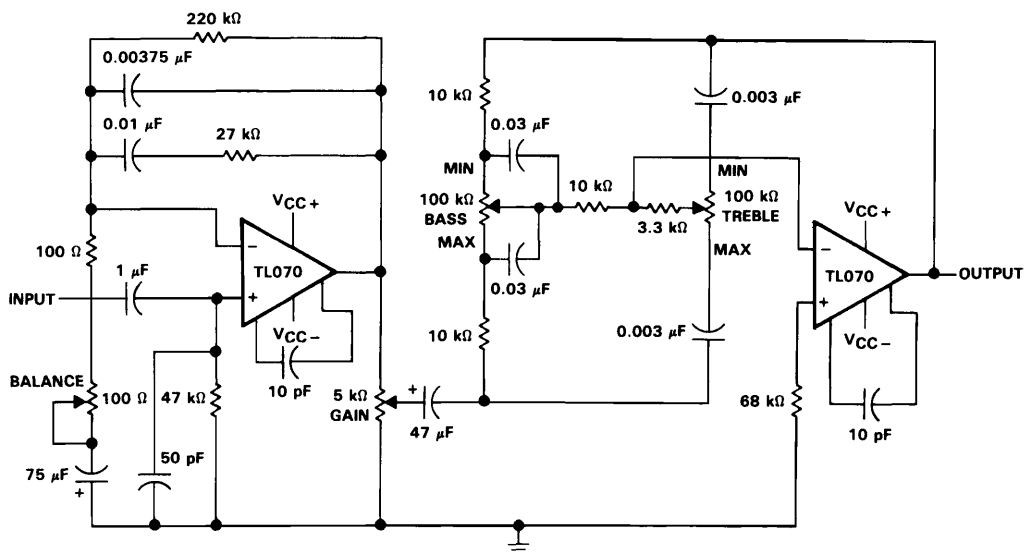


FIGURE 31. IC PREAMPLIFIER

IC PREAMPLIFIER  
RESPONSE CHARACTERISTICS

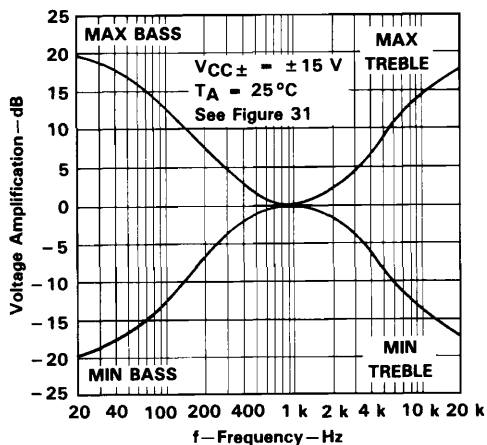


FIGURE 32

2

Operational Amplifiers