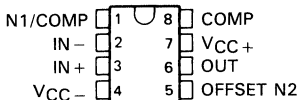


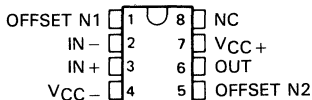
**24 DEVICES COVER MILITARY, INDUSTRIAL AND COMMERCIAL TEMPERATURE RANGES**

- 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
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation (Except TL080, TL080A)
- Latch-Up-Free Operation
- High Slew Rate . . . 13 V/ $\mu$ s Typ

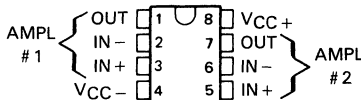
**TL080, TL080A**  
JG OR P DUAL-IN-LINE PACKAGE  
(TOP VIEW)



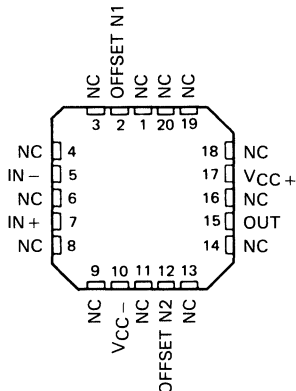
**TL081, TL081A, TL081B**  
JG OR P DUAL-IN-LINE PACKAGE  
(TOP VIEW)



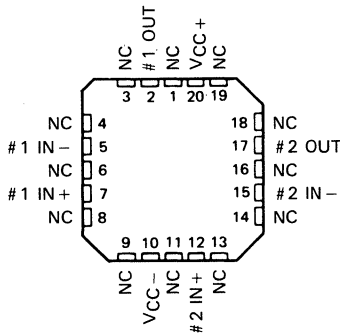
**TL082, TL082A, TL082B**  
JG OR P DUAL-IN-LINE PACKAGE  
(TOP VIEW)



**TL081M . . . FH OR FK**  
CHIP CARRIER PACKAGE  
(TOP VIEW)



**TL082M . . . FH OR FK**  
CHIP CARRIER PACKAGE  
(TOP VIEW)



NC—No internal connection

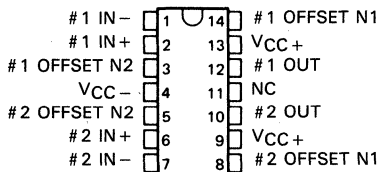
**DEVICE TYPES, SUFFIX VERSIONS, AND PACKAGES**

	TL080	TL081	TL082	TL083	TL084	TL085
TL08_M	JG	FH, FK, JG	FH, FK, JG	FH, FK, J	FH, FK, J, W	*
TL08_I	JG, P	JG, P	JG, P	J, N	J, N	*
TL08_C	JG, P	JG, P	JG, P	J, N	J, N	N
TL08_AC	JG, P	JG, P	JG, P	J, N	J, N	*
TL08_BC	*	JG, P	JG, P	*	J, N	*

\*These combinations are not defined by this data sheet.

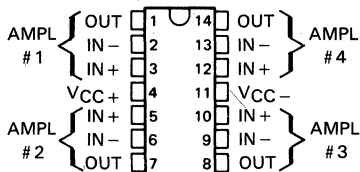
# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

TL083, TL083A  
J OR N DUAL-IN-LINE PACKAGE  
(TOP VIEW)

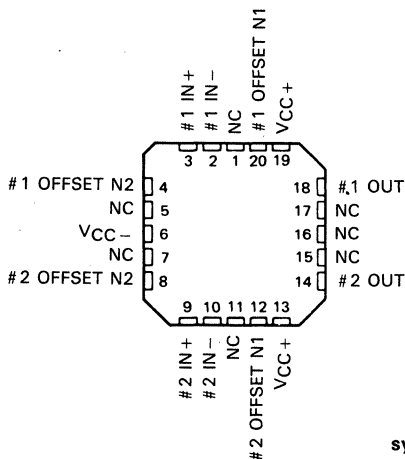


Pins 9 and 13 are internally interconnected

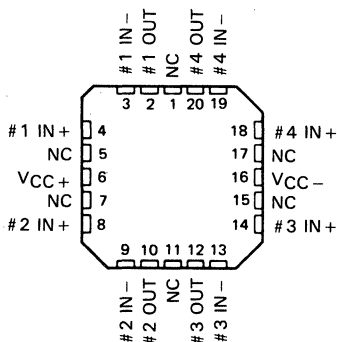
TL084, TL084A, TL084B  
J OR N DUAL-IN-LINE PACKAGE  
(TOP VIEW)



TL083M . . . FH OR FK  
CHIP CARRIER PACKAGE  
(TOP VIEW)

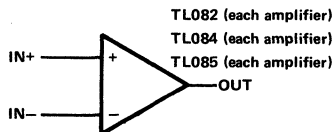
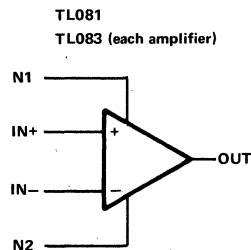
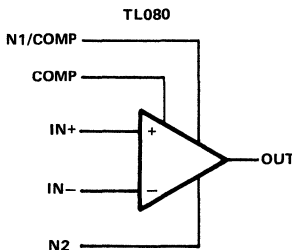


TL084M . . . FH OR FK  
CHIP CARRIER PACKAGE  
(TOP VIEW)



## 3 Operational Amplifiers

### symbols



NC—No internal connection

TEXAS  
INSTRUMENTS

POST OFFICE BOX 225012 • DALLAS, TEXAS 75265

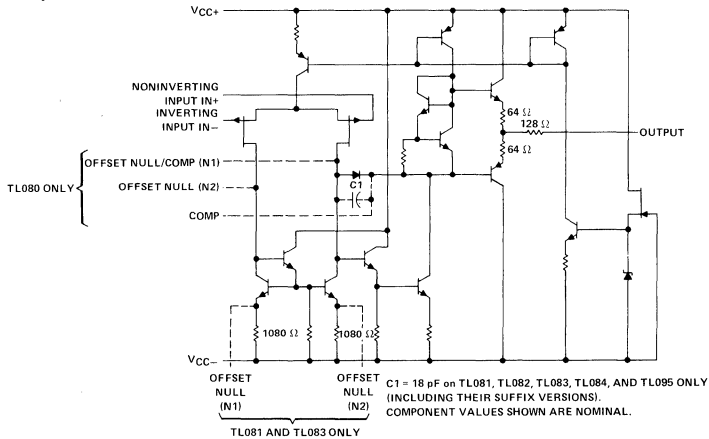
# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

## description

The TL08\_ JFET-input operational amplifier family is designed to offer a wider selection than any previously developed operational amplifier family. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit. The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient. Offset adjustment and external compensation options are available within the TL08\_ family.

Device types with an "M" suffix are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , those with an "I" suffix are characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , and those with a "C" suffix are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## schematic (each amplifier)



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

	TL08_M	TL08_I	TL08_C TL08_AC TL08_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 at (or below) $25^{\circ}\text{C}$ free-air temperature (see Note 5)	680	680	680	mW
Operating free-air temperature range	$-55$ to $125$	$-25$ to $85$	$0$ to $70$	$^{\circ}\text{C}$
Storage temperature range	$-65$ to $150$	$-65$ to $150$	$-65$ to $150$	$^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	FH, FK, J, JG, or W package		300	$^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	N or P package		260	$^{\circ}\text{C}$

- 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 volts, 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.
5. For operation above  $25^{\circ}\text{C}$  free-air temperature, refer to Dissipation Derating Curves in Section 2. In the J and JG packages, TL08\_M chips are alloy-mounted; TL08\_I, TL08\_C, TL08\_AC, and TL08\_BC chips are glass-mounted.

**TYPES TL080M, TL081M, TL082M, TL083M, TL084M**  
**LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS**

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

PARAMETER		TEST CONDITIONS†		TL080M, TL081M TL082M, TL083M			TL084M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω	T <sub>A</sub> = 25 °C T <sub>A</sub> = -55 °C to 125 °C	3      6 9			3      9 15			mV
α <sub>VIO</sub>	Temperature coefficient of input offset voltage	V <sub>O</sub> = 0, T <sub>A</sub> = -55 °C to 125 °C	R <sub>S</sub> = 50 Ω	10			10			μV/°C
I <sub>IO</sub>	Input offset current‡	V <sub>O</sub> = 0	T <sub>A</sub> = 25 °C T <sub>A</sub> = -55 °C to 125 °C	5      100 20			5      100 20			pA nA
I <sub>IB</sub>	Input bias current‡	V <sub>O</sub> = 0	T <sub>A</sub> = 25 °C T <sub>A</sub> = -55 °C to 125 °C	30      200 50			30      200 20			pA nA
V <sub>ICR</sub>	Common-mode input voltage range	T <sub>A</sub> = 25 °C		± 11	± 12		± 11	± 12		V
V <sub>OM</sub>	Maximum peak output voltage swing	T <sub>A</sub> = 25 °C,	R <sub>L</sub> = 10 kΩ	± 12	± 13.5		± 12	± 13.5		V
		T <sub>A</sub> = -55 °C to 125 °C	R <sub>L</sub> ≥ 10 kΩ	± 12			± 12			
			R <sub>L</sub> ≥ 2 kΩ	± 10    ± 12			± 10    ± 12			
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>O</sub> = ± 10 V, T <sub>A</sub> = 25 °C	R <sub>L</sub> ≥ 2 kΩ,	25	200		25	200		V/mV
		V <sub>O</sub> = ± 10 V, T <sub>A</sub> = -55 °C to 125 °C	R <sub>L</sub> ≥ 2 kΩ,	15			15			
B <sub>1</sub>	Unity-gain bandwidth	T <sub>A</sub> = 25 °C		3			3			MHz
r <sub>i</sub>	Input resistance	T <sub>A</sub> = 25 °C		10 <sup>12</sup>			10 <sup>12</sup>			Ω
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICR</sub> min, R <sub>S</sub> = 50 Ω,	V <sub>O</sub> = 0, T <sub>A</sub> = 25 °C	80	86		80	86		dB
k <sub>SVR</sub>	Supply voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> )	V <sub>CC</sub> = ± 15 V to ± 9 V, R <sub>S</sub> = 50 Ω,	V <sub>O</sub> = 0, T <sub>A</sub> = 25 °C	80	86		80	86		dB
I <sub>CC</sub>	Supply current (per amplifier)	No load, T <sub>A</sub> = 25 °C	V <sub>O</sub> = 0,	1.4    2.8			1.4    2.8			mA
V <sub>O1</sub> /V <sub>O2</sub>	Crosstalk attenuation	A <sub>VD</sub> = 100,	T <sub>A</sub> = 25 °C	120			120			dB

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 18. Pulse techniques must be used that will maintain the junction temperatures as close to the ambient temperature as is possible.

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

PARAMETER	TEST CONDITIONS <sup>†</sup>		TL080I TL081I TL082I TL083I TL084I			TL080C TL081C TL082C TL083C TL084C TL085C			TL080AC TL081AC TL082AC TL083AC TL084AC			TL081BC TL082BC  TL084BC			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_O = 0$ , $R_S = 50 \Omega$	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$	3	6		3	15		3	6		2	3		mV
$\alpha_{VIO}$ Temperature coefficient of input offset voltage	$V_O = 0$ , $T_A = \text{full range}$	$R_S = 50 \Omega$	10			10			10			10			$\mu\text{V}/^\circ\text{C}$
$I_{IO}$ Input offset current <sup>‡</sup>	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$	5	100		5	200		5	100		5	100		pA
$I_{IB}$ Input bias current <sup>‡</sup>	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = \text{full range}$	30	200		30	400		30	200		30	200		pA
				20			10			7			7		nA
$V_{ICR}$ Common-mode input voltage range	$T_A = 25^\circ\text{C}$		$\pm 11$	$\pm 12$		$\pm 11$	$\pm 12$		$\pm 11$	$\pm 12$		$\pm 11$	$\pm 12$		V
$V_{OM}$ Maximum peak output voltage swing	$T_A = 25^\circ\text{C}$ , $R_L = 10 \text{ k}\Omega$		$\pm 12$	$\pm 13.5$		$\pm 12$	$\pm 13.5$		$\pm 12$	$\pm 13.5$		$\pm 12$	$\pm 13.5$		V
	$T_A = \text{full range}$ , $R_L \geq 10 \text{ k}\Omega$		$\pm 12$			$\pm 12$			$\pm 12$			$\pm 12$			
	$T_A = \text{full range}$ , $R_L \geq 2 \text{ k}\Omega$		$\pm 10$	$\pm 12$		$\pm 10$	$\pm 12$		$\pm 10$	$\pm 12$		$\pm 10$	$\pm 12$		
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}$ , $T_A = 25^\circ\text{C}$	$R_L \geq 2 \text{ k}\Omega$	50	200		25	200		50	200		50	200		V/mV
	$V_O = \pm 10 \text{ V}$ , $T_A = \text{full range}$	$R_L \geq 2 \text{ k}\Omega$	25			15			25			25			
$B_1$ Unity-gain bandwidth	$T_A = 25^\circ\text{C}$		3			3			3			3			MHz
$r_i$ Input resistance	$T_A = 25^\circ\text{C}$		$10^{12}$			$10^{12}$			$10^{12}$			$10^{12}$			$\Omega$
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	86		70	86		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		70	86		80	86		80	86		dB
$I_{CC}$ Supply current (per amplifier)	No load, $T_A = 25^\circ\text{C}$	$V_O = 0$	1.4	2.8		1.4	2.8		1.4	2.8		1.4	2.8		mA
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 100$ , $T_A = 25^\circ\text{C}$		120			120			120			120			dB

<sup>†</sup>All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for  $T_A$  is  $25^\circ\text{C}$  to  $85^\circ\text{C}$  for TL08...I and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TL08...C, TL08...AC, and TL08...BC.

<sup>‡</sup>Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 18. Pulse techniques must be used that will maintain the junction temperatures as close to the ambient temperature as is possible.

TYPES TL080 THRU TL085, TL080A THRU TL084A  
TL081B, TL082B, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS

# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

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

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

## PARAMETER MEASUREMENT INFORMATION

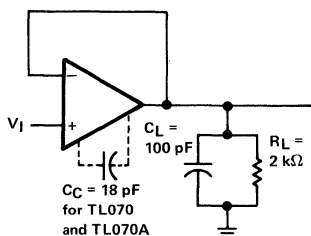


FIGURE 1—UNITY-GAIN AMPLIFIER

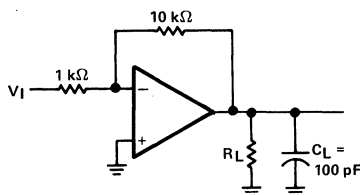


FIGURE 2—GAIN-OF-10 INVERTING AMPLIFIER

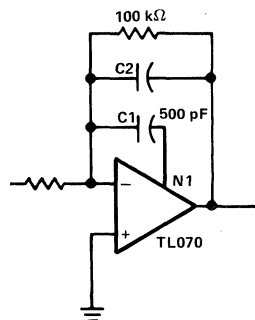


FIGURE 3—FEED-FORWARD  
COMPENSATION

## INPUT OFFSET VOLTAGE NULL CIRCUITS

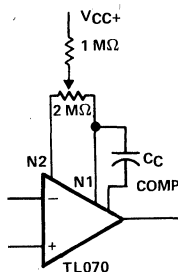


FIGURE 4

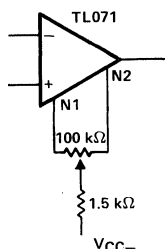


FIGURE 5

# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

## TYPICAL CHARACTERISTICS†

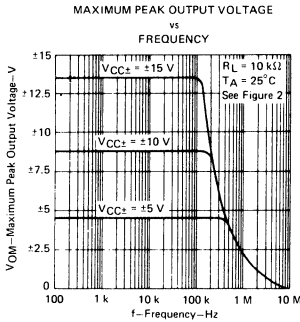


FIGURE 6

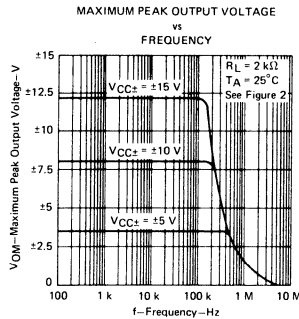


FIGURE 7

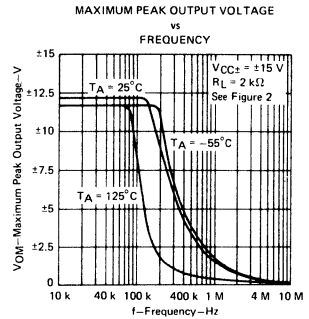


FIGURE 8

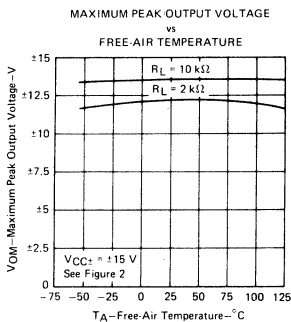


FIGURE 9

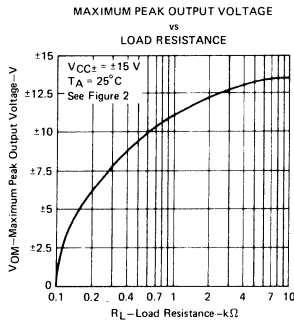


FIGURE 10

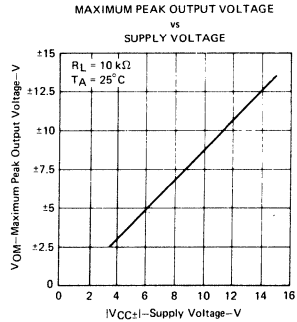


FIGURE 11

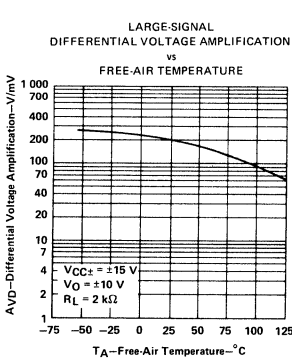


FIGURE 12

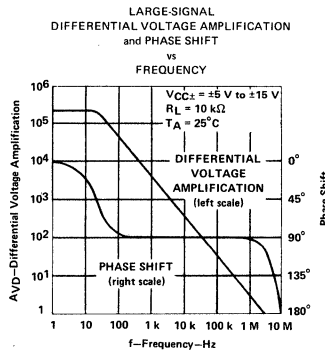


FIGURE 13

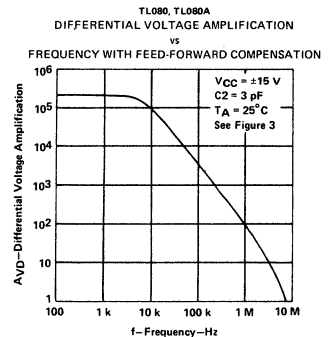


FIGURE 14

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 12-pF compensation capacitor is used with TL080 and TL080A.

# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

## TYPICAL CHARACTERISTICS†

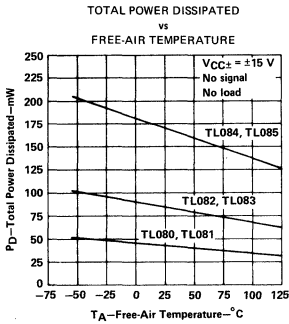


FIGURE 15

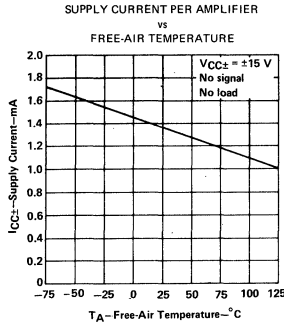


FIGURE 16

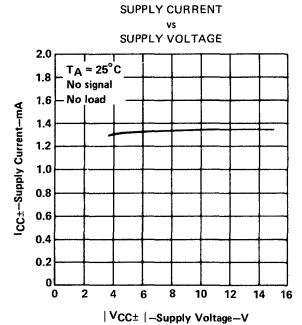


FIGURE 17

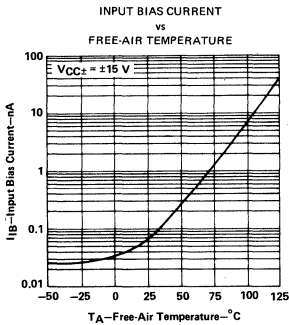


FIGURE 18

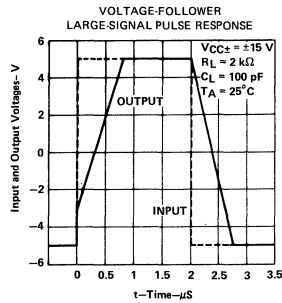


FIGURE 19

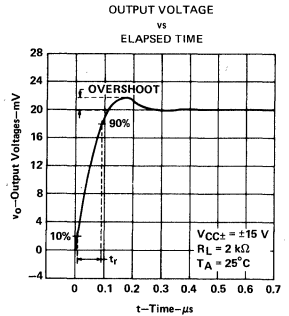


FIGURE 20

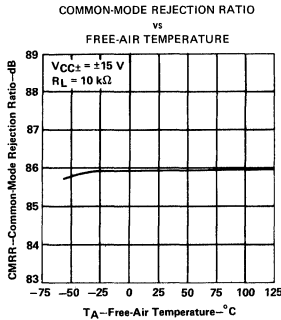


FIGURE 21

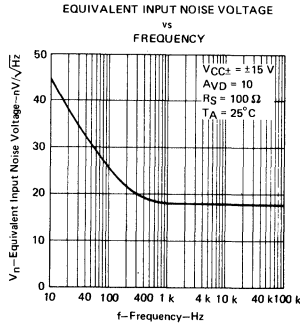


FIGURE 22

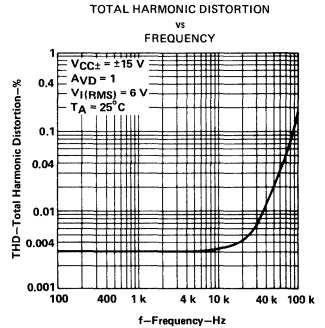


FIGURE 23

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 12-pF compensation capacitor is used with TL080 and TL080A.



# TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

## TYPICAL APPLICATION DATA

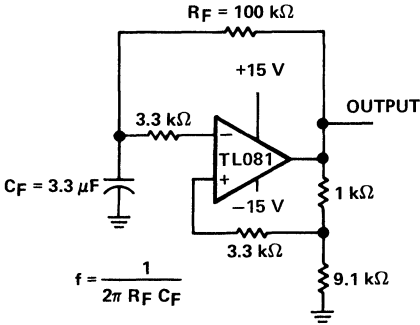


FIGURE 24—0.5-Hz SQUARE-WAVE OSCILLATOR

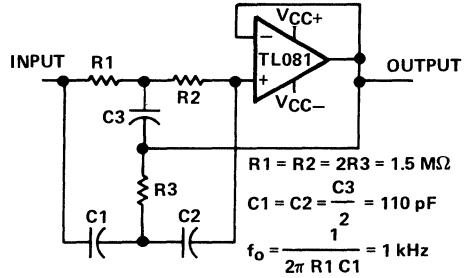


FIGURE 25—HIGH-Q NOTCH FILTER

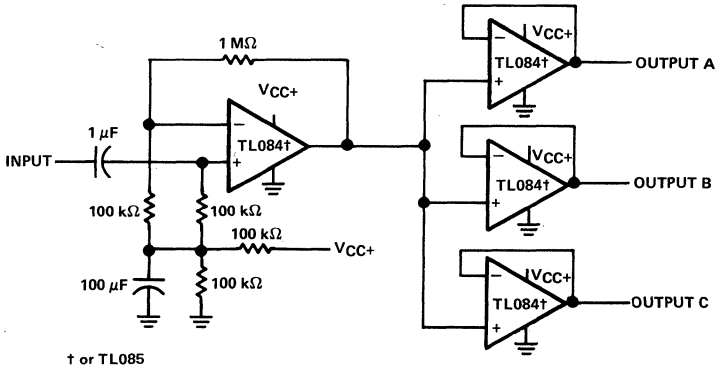


FIGURE 26—AUDIO DISTRIBUTION AMPLIFIER

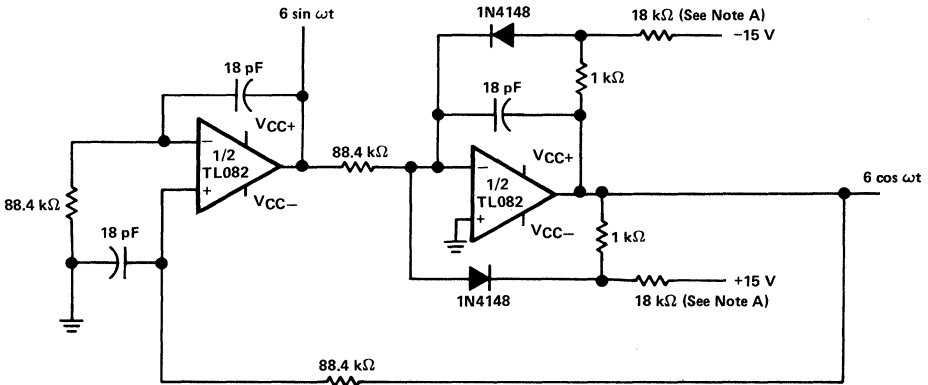
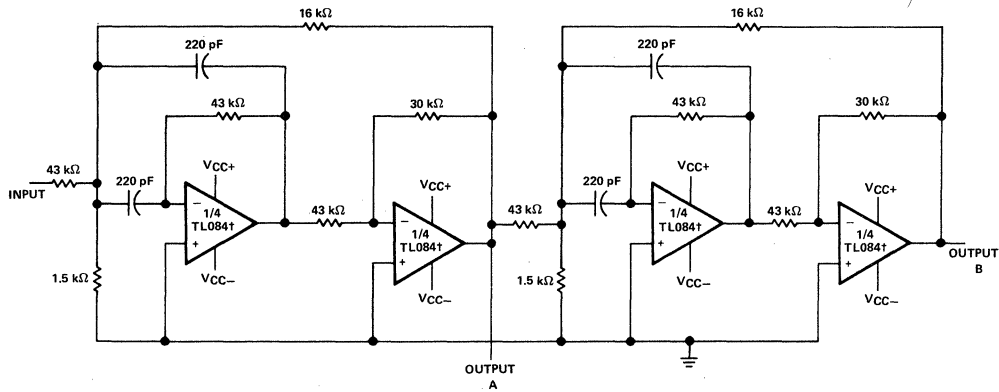


FIGURE 27—100-kHz QUADRATURE OSCILLATOR

TYPES TL080 THRU TL085, TL080A THRU TL084A  
TL081B, TL082B, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS

TYPICAL APPLICATION DATA



3  
Operational Amplifiers

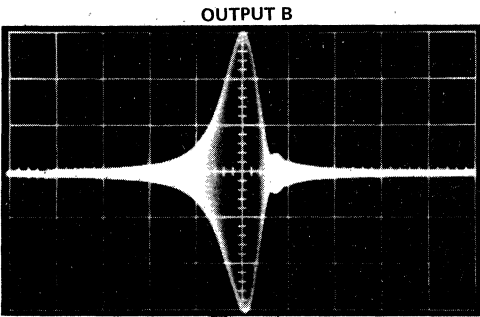
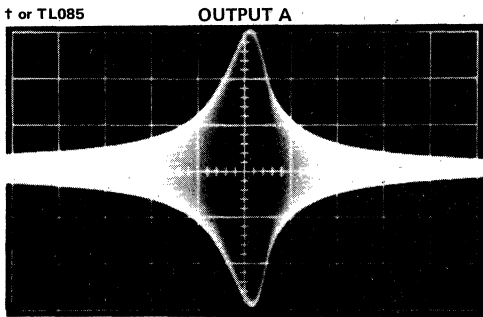


FIGURE 28—POSITIVE-FEEDBACK BANDPASS FILTER

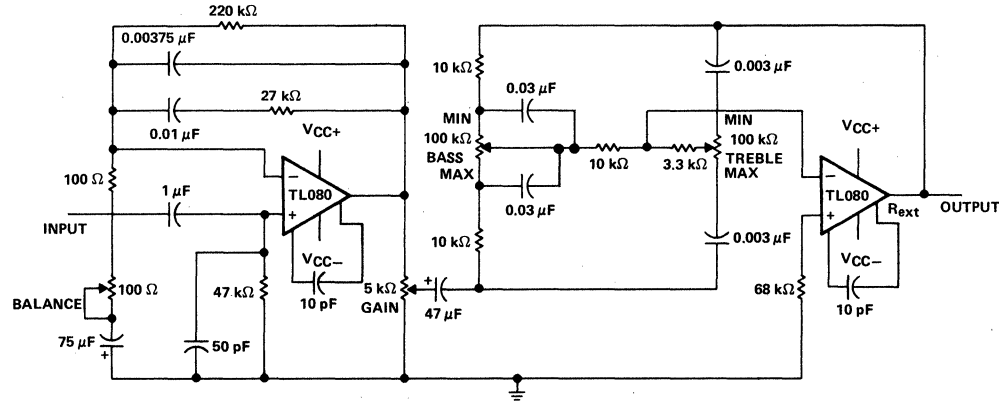


FIGURE 29—IC PREAMPLIFIER