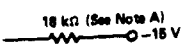
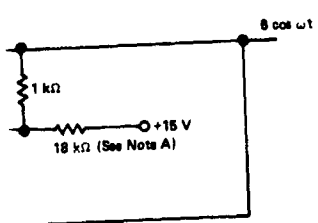


DATA



1 kΩ



a symmetrical output.

OSCILLATOR

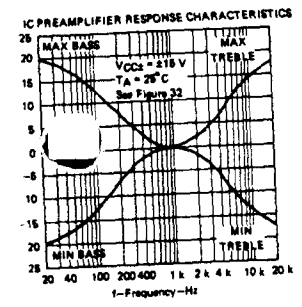
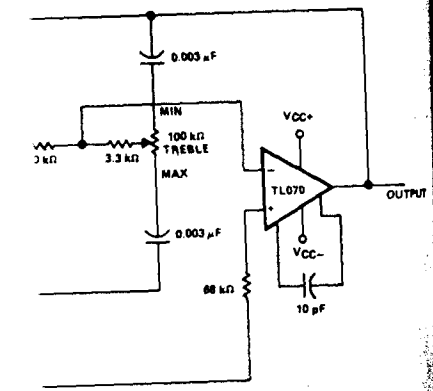


FIGURE 31



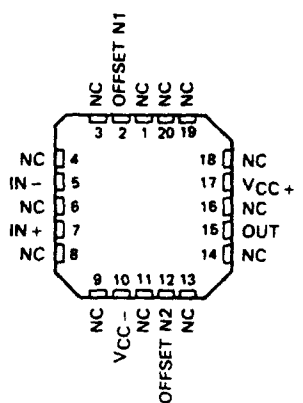
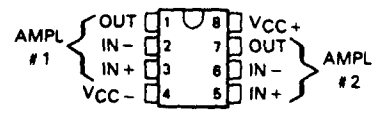
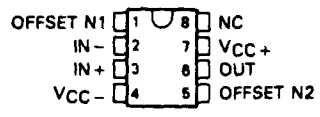
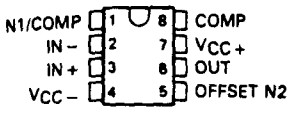
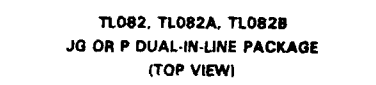
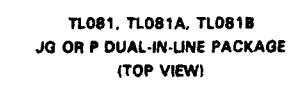
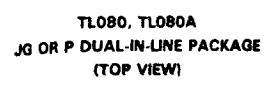
ER

LINEAR INTEGRATED CIRCUITS

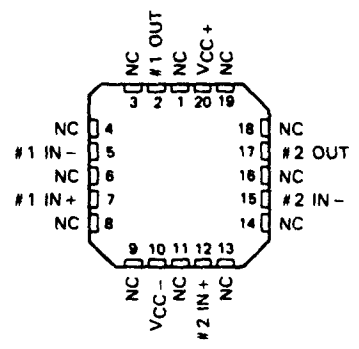
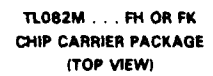
TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B
JFET-INPUT OPERATIONAL AMPLIFIERS
02297, FEBRUARY 1977—REVISED SEPTEMBER 1983

24 DEVICES COVER MILITARY, INDUSTRIAL AND COMMERCIAL TEMPERATURE RANGES

- Low-Power Consumption
- High Input Impedance . . . JFET-Input Stage
- Wide Common-Mode and Differential Voltage Ranges
- Internal Frequency Compensation (Except TL080, TL080A)
- Low Input Bias and Offset Currents
- Latch-Up-Free Operation
- Output Short-Circuit Protection
- High Slew Rate . . . 13 V/μs Typ
- Low Total Harmonic Distortion . . . 0.003% TYP



NC—No internal connection



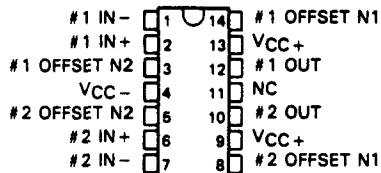
DEVICE TYPES, SUFFIX VERSIONS, AND PACKAGES

	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	*

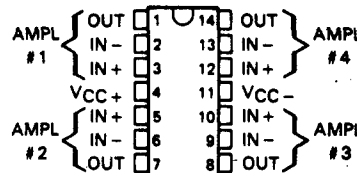
*These combinations are not defined by this data sheet.

**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)

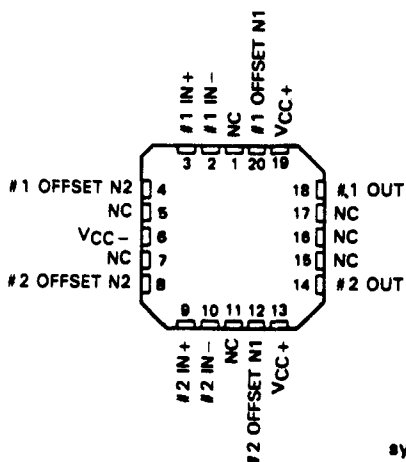


TL084, TL084A, TL084B
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)

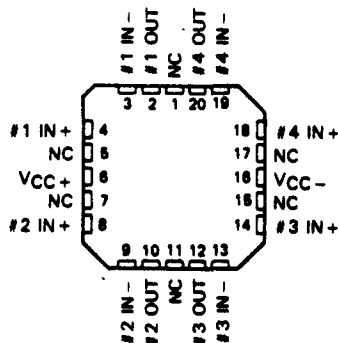


Pins 9 and 13 are internally interconnected

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

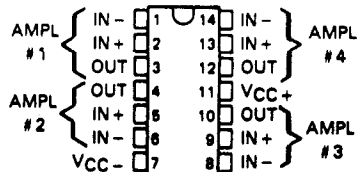


TL084M . . . FH OR FK
CHIP CARRIER PACKAGE
(TOP VIEW)

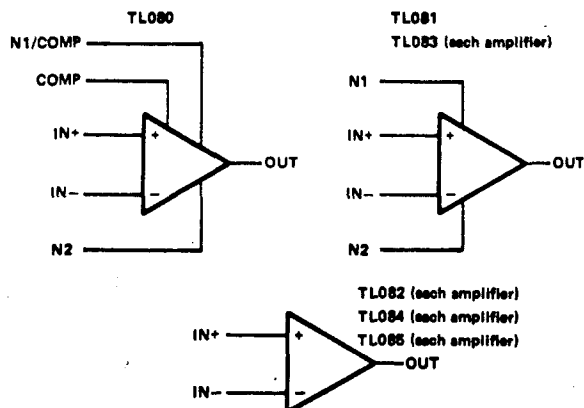


3
Operational Amplifiers

TL085
N DUAL-IN-LINE PACKAGE
(TOP VIEW)



symbols



NC—No internal connection

Suppl
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NOTES:

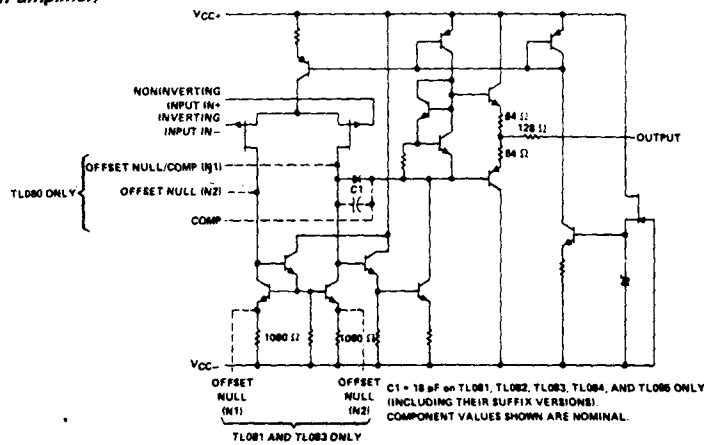
TYPES TL080 THRU TL085, TL080A THRU TL084A
TL081B, TL082B, TL084B
JFET-INPUT OPERATIONAL AMPLIFIERS

Description

The TL080 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 TL080 family.

Device types with an "M" suffix are characterized for operation over the full military temperature range of -55°C to 125°C, those with an "I" suffix are characterized for operation from -25°C to 85°C, and those with a "C" suffix are characterized for operation from 0°C to 70°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)	± 30	± 30	± 30	V
Input voltage (see Notes 1 and 3)	± 15	± 15	± 15	V
Duration of output short circuit (see Note 4)	unlimited	unlimited	unlimited	
Continuous total dissipation at (or below) 25°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	°C
Storage temperature range	-65 to 150	-65 to 150	-65 to 150	°C
Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds	FH, FK, J, JG, or W package	300	300	°C
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds	N or P package		260	°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°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.

TEXAS
INSTRUMENTS

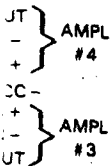
POST OFFICE BOX 225012 • DALLAS, TEXAS 75265

3-137

3

Operational Amplifiers

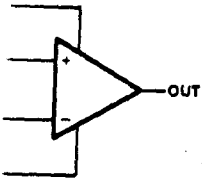
18
KAGE



FK
AGE



TL081
TL083 (each amplifier)



82 (each amplifier)
84 (each amplifier)
85 (each amplifier)
-OUT

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

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

PARAMETER	TEST CONDITIONS ¹		TL080M, TL081M TL082M, TL083M			TL084M			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_O = 0,$ $R_S = 50 \Omega$	$T_A = 25^\circ\text{C}$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	3 6		3 9		15		mV
α_{VIO} Temperature coefficient of input offset voltage	$V_O = 0,$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	$R_S = 50 \Omega,$	10		10				$\mu\text{V}/^\circ\text{C}$
I_{IO} Input offset current ²	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	5 100		5 100		20		μA nA
I_{IB} Input bias current ²	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	30 200		30 200		20		μA nA
V_{ICR} Common-mode input voltage range	$T_A = 25^\circ\text{C}$		± 11	± 12	± 11	± 12			V
V_{OM} Maximum peak output voltage swing	$T_A = 25^\circ\text{C},$	$R_L = 10 \text{ k}\Omega$	± 12	± 13.5	± 12	± 13.5			V
	$T_A = -55^\circ\text{C to } 125^\circ\text{C}$	$R_L \geq 10 \text{ k}\Omega$ $R_L \geq 2 \text{ k}\Omega$	± 12		± 12		± 10	± 12	
A_{VD} Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V},$ $T_A = 25^\circ\text{C}$	$R_L \geq 2 \text{ k}\Omega,$	25	200	25	200			V/mV
	$V_O = \pm 10 \text{ V},$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	$R_L \geq 2 \text{ k}\Omega,$	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}				Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR \text{ min}},$ $R_S = 50 \Omega,$	$V_O = 0,$ $T_A = 25^\circ\text{C}$	80	86	80	86			dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{CC} \pm / \Delta V_{IO}$)	$V_{CC} = \pm 15 \text{ V to } \pm 9 \text{ V},$ $R_S = 50 \Omega,$	$V_O = 0,$ $T_A = 25^\circ\text{C}$	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				mA
V_{O1}/V_{O2} Crosstalk attenuation	$A_{VD} = 100,$	$T_A = 25^\circ\text{C}$	120		120				dB

¹All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified.

²Input 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.

3
Operational Amplifiers

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

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

PARAMETER	TEST CONDITIONS ¹	TL0801			TL080C			TL080AC			TL081BC			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	$V_O = 0$ $R_S = 50 \Omega$	3	6	9	3	15	20	3	6	6	2	3	mV	
e_{VIO}	$V_O = 0$ $T_A = \text{full range}$				10			10					$\mu\text{V}/^\circ\text{C}$	
I_{IO}	$V_O = 0$	5	100		5	200		5	100		5	100	μA	
I_{IB}	$V_O = 0$	30	200		30	400		30	200		30	200	nA	
V_{ICR}	$T_A = 25^\circ\text{C}$	± 11	± 12		± 11	± 12		± 11	± 12		± 11	± 12	V	
V_{OM}	$T_A = 25^\circ\text{C}$ $R_L = 10 \text{ k}\Omega$ $R_L = \geq 10 \text{ k}\Omega$	± 12	± 13.5		± 12	± 13.5		± 12	± 13.5		± 12	± 13.5	V	
A_{VD}	$V_O = 10 \text{ V}$ $T_A = 25^\circ\text{C}$ $R_L = \geq 2 \text{ k}\Omega$	50	200		25	200		50	200		50	200	V/mV	
B_1	$V_O = \pm 10 \text{ V}$ $T_A = \text{full range}$	25			15			25			25		MHz	
f_1	$T_A = 25^\circ\text{C}$	3			3			3			3		dB	
CMRR	$V_{IC} = V_{ICR \text{ min}}$ $R_S = 50 \Omega$ $T_A = 25^\circ\text{C}$	80	86		70	86		80	86		80	86	dB	
$\pm\text{SVR}$	$V_{CC} = \pm 15 \text{ V}$ to $\pm 9 \text{ V}$ $R_S = 50 \Omega$ $T_A = 25^\circ\text{C}$	80	86		70	86		80	86		80	86	dB	
I_{CC}	No load $T_A = 25^\circ\text{C}$	1.4	2.8		1.4	2.8		1.4	2.8		1.4	2.8	mA	
V_{O1}/V_{O2}	Crosstalk attenuation $T_A = 25^\circ\text{C}$	120			120			120			120		dB	

¹All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for T_A is 25°C to 85°C for TL080_1 and 0°C to 70°C for TL080_C, TL080_AC, and TL080_BC.
Input bias currents of a JFET-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.

Operational Amplifiers



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

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

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

PARAMETER MEASUREMENT INFORMATION

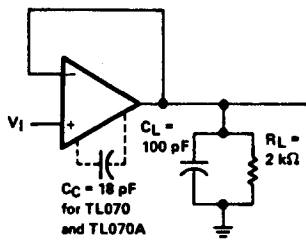


FIGURE 1—UNITY-GAIN AMPLIFIER

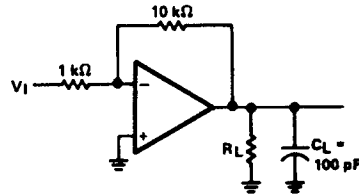


FIGURE 2—GAIN-OF-10 INVERTING AMPLIFIER

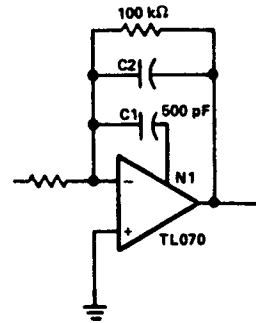


FIGURE 3—FEED-FORWARD COMPENSATION

INPUT OFFSET VOLTAGE NULL CIRCUITS

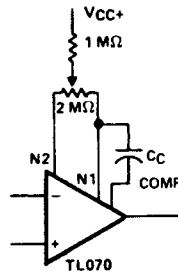


FIGURE 4

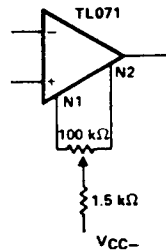
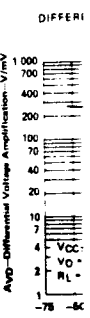
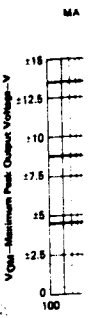


FIGURE 5

3
Operational Amplifiers



†Data at high capacitor

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

TYPICAL CHARACTERISTICS†

MIN	TYP	MAX	UNIT
8	13		V/μs
	0.1		μs
	10%		
	18		nV/√Hz
	4		μV
	0.01		pA/√Hz
	0.003%		

ION

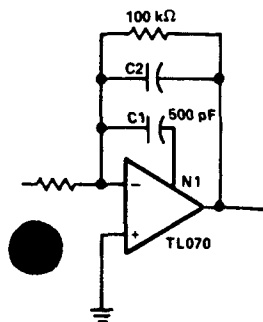


FIGURE 3—FEED-FORWARD COMPENSATION

S

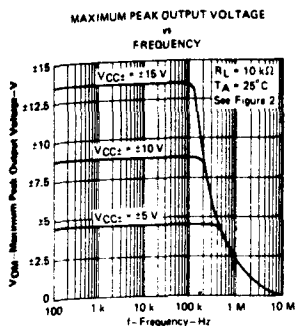


FIGURE 6

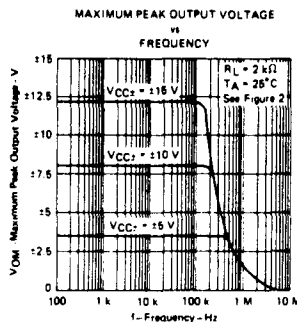


FIGURE 7

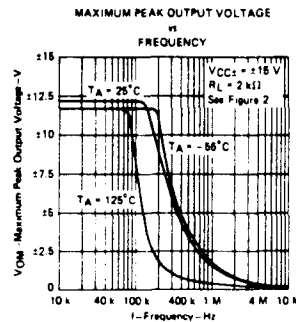


FIGURE 8

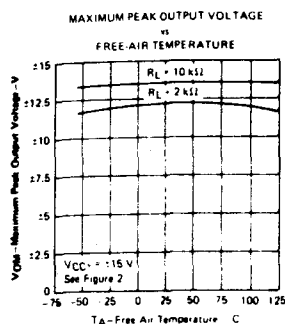


FIGURE 9

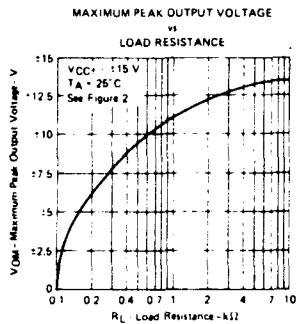


FIGURE 10

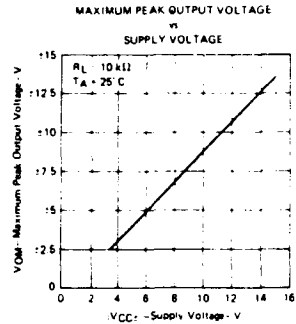


FIGURE 11

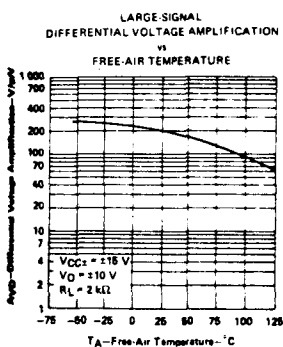


FIGURE 12

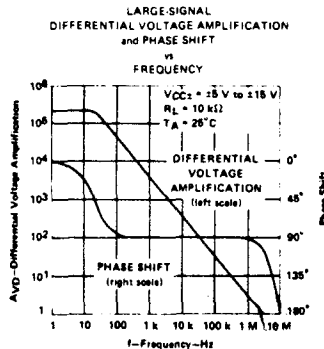


FIGURE 13

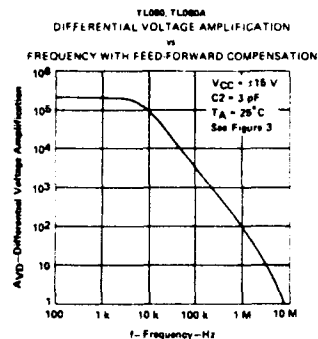


FIGURE 14

†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.

3
Operational Amplifiers

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

TYPICAL CHARACTERISTICS†

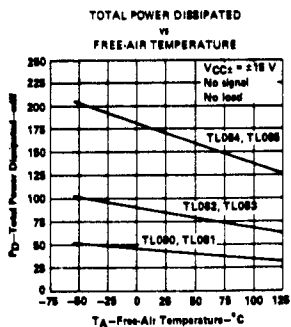


FIGURE 15

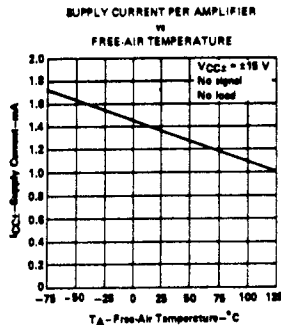


FIGURE 16

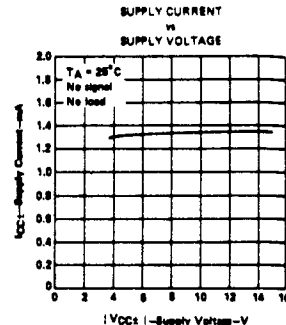


FIGURE 17

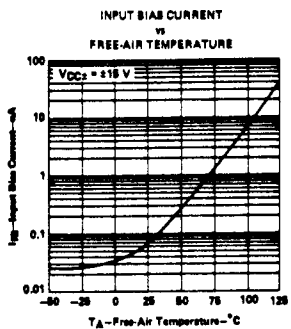


FIGURE 18

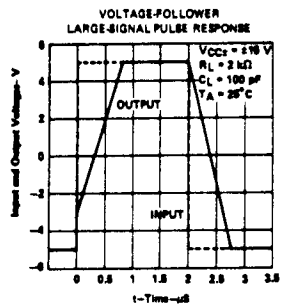


FIGURE 19

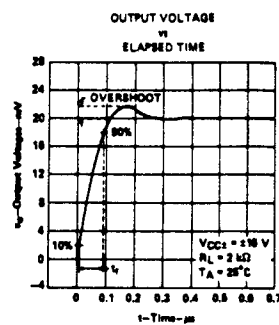


FIGURE 20

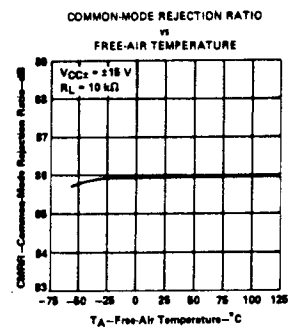


FIGURE 21

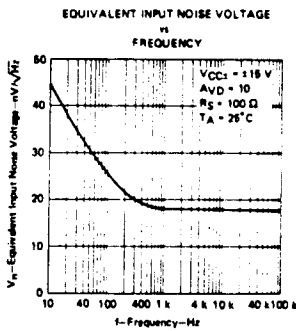


FIGURE 22

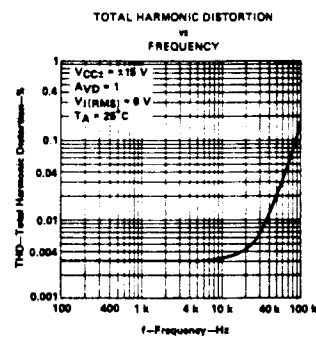


FIGURE 23

†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.

3

Operational Amplifiers

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

TYPICAL APPLICATION DATA

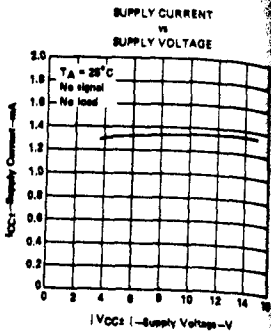


FIGURE 17

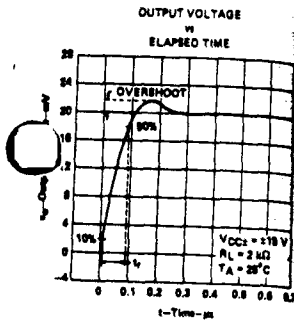


FIGURE 20

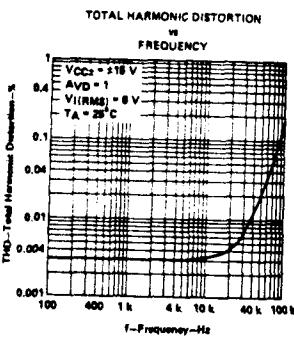


FIGURE 23

of the various devices. A 12-pF compensation

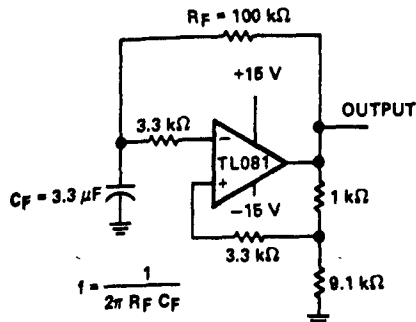


FIGURE 24—0.5-Hz SQUARE-WAVE OSCILLATOR

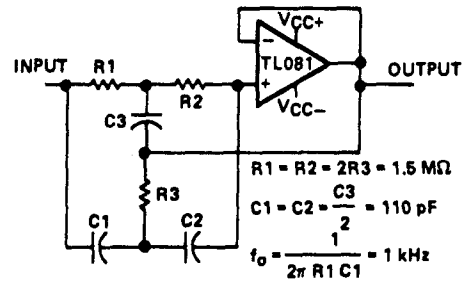


FIGURE 25—HIGH-Q NOTCH FILTER

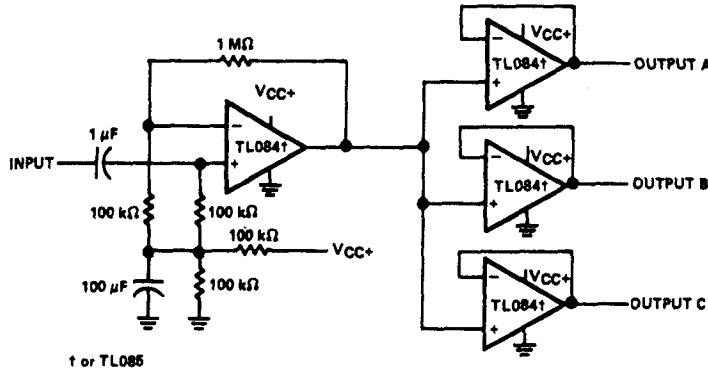
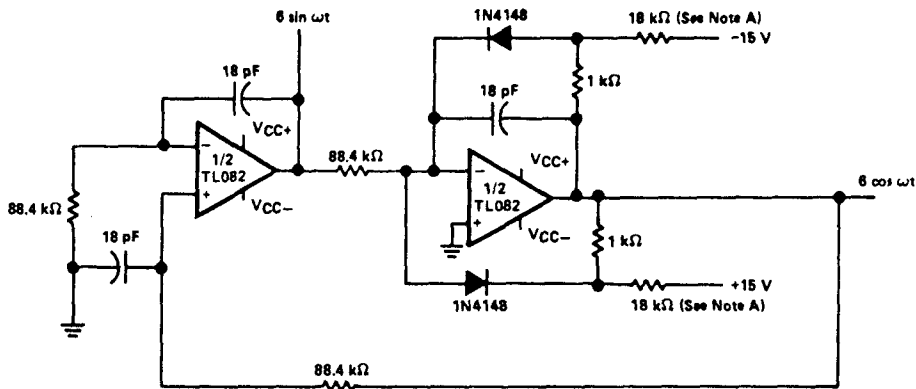


FIGURE 26—AUDIO DISTRIBUTION AMPLIFIER

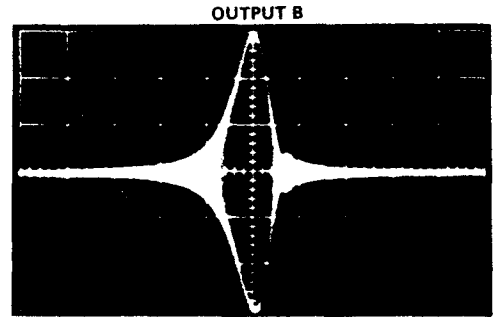
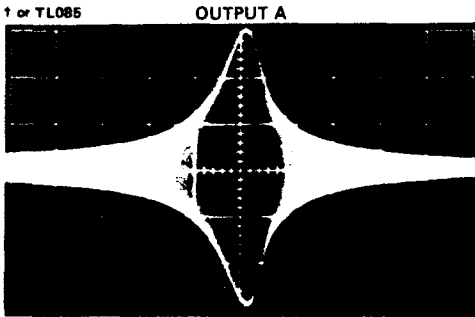
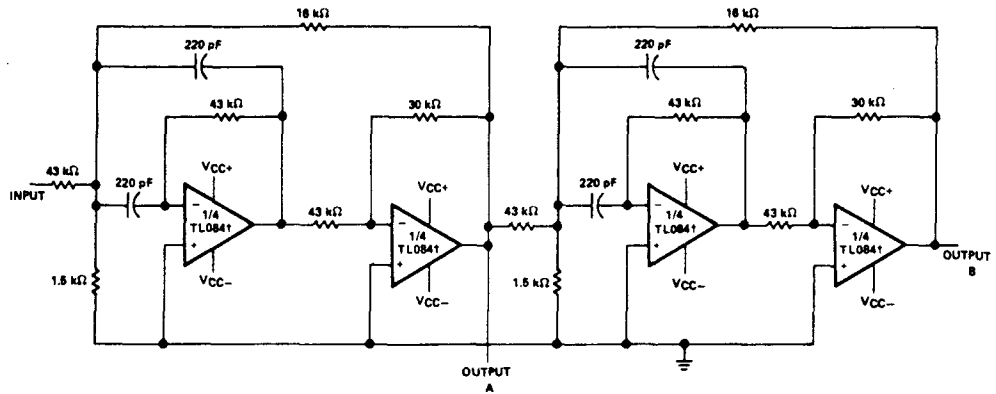


NOTE A: These resistor values may be adjusted for a symmetrical output.

FIGURE 27—100-kHz QUADRATURE OSCILLATOR

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

TYPICAL APPLICATION DATA



SECOND-ORDER BANDPASS FILTER
 $f_o = 100 \text{ kHz}, Q = 30, \text{GAIN} = 4$

CASCADED BANDPASS FILTER
 $f_o = 100 \text{ kHz}, Q = 69, \text{GAIN} = 16$

FIGURE 28—POSITIVE-FEEDBACK BANDPASS FILTER

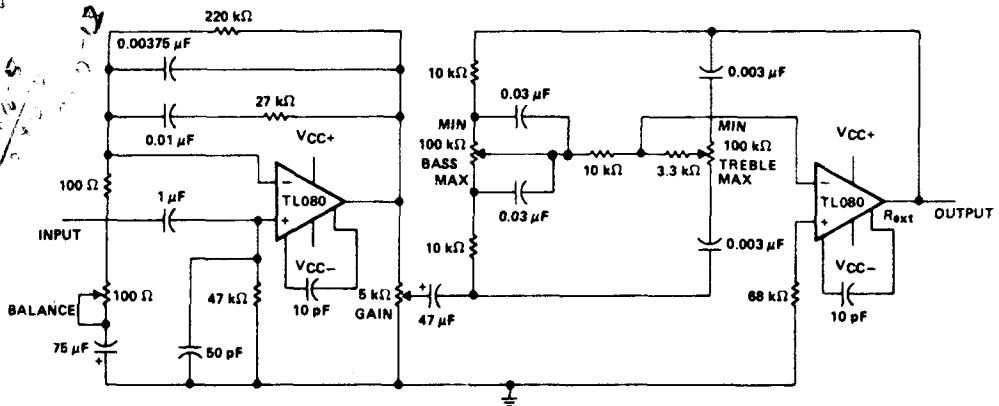


FIGURE 29—IC PREAMPLIFIER

3
Operational Amplifiers

Handwritten notes:
2-20-70
10-1-71
2410 P.D.
10-5-57

LINE INTI CIRI

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- L
- V
- L
- C

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symbc
NONIN
INPUT
INVERT
INPUT