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

BULLETIN NO. DL-S 12484, FEBRUARY 1977—REVISED OCTOBER 1979

24 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
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation (Except TL080, TL080A)
- Latch-Up-Free Operation
- High Slew Rate . . . 13 V/μs Typ

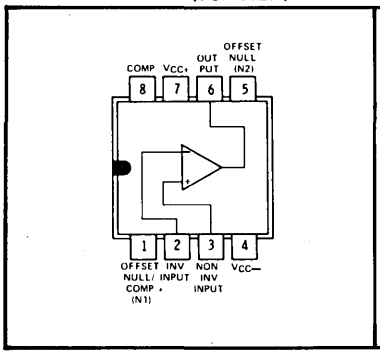
description

The TL081 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 TL081 Family.

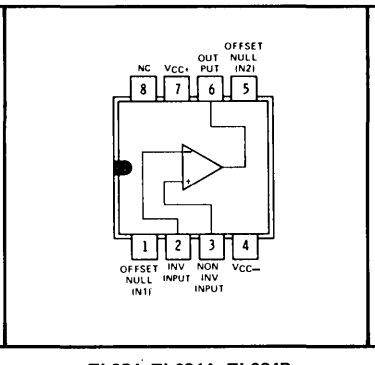
Device types with an "M" suffix are characterized for operation over the full military temperature range of −55°C to 125°C, those with an "I" suffix are characterized for operation from −25°C to 85°C, and those with a "C" suffix are characterized for operation from 0°C to 70°C.

4

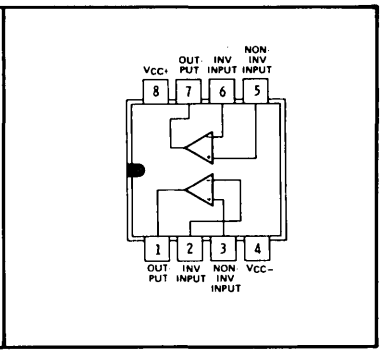
TL080, TL080A
JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



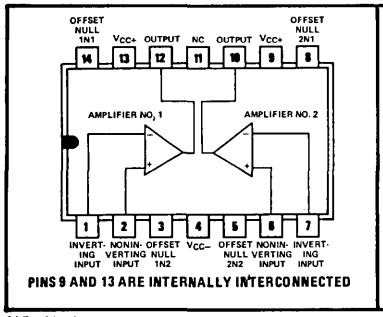
TL081, TL081A, TL081B
JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



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

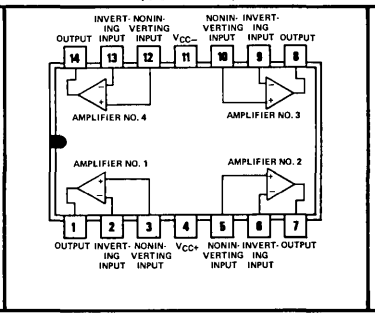


TL083, TL083A
J OR N DUAL-IN-LINE
PACKAGE (TOP VIEW)

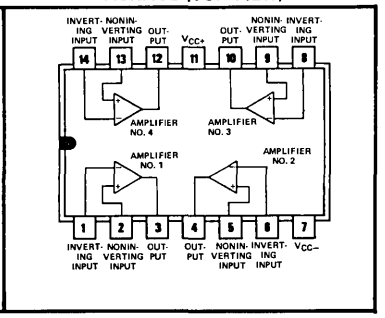


PINS 9 AND 13 ARE INTERNALLY INTERCONNECTED

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

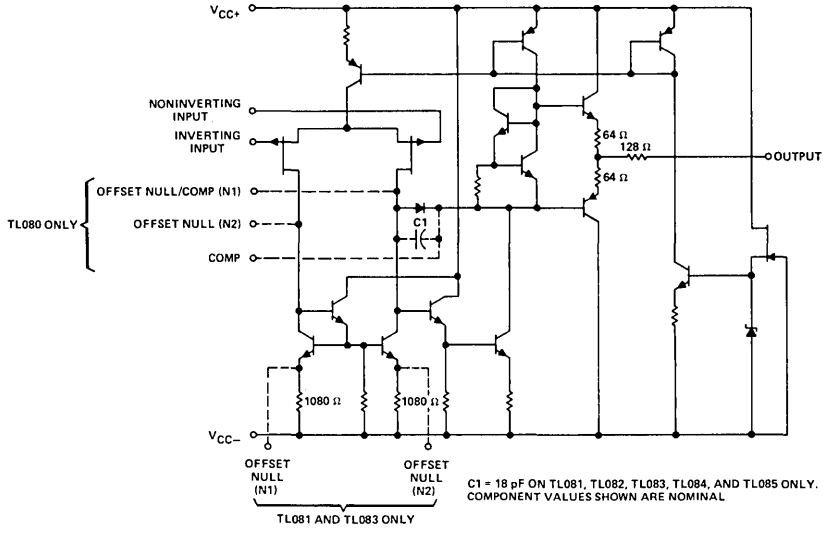


TL085
N DUAL-IN-LINE
PACKAGE (TOP VIEW)



NC—No internal connection

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 1/16 inch (1,6 mm) from case for 60 seconds	J, JG, or W package	300	300	300	°C
Lead temperature 1/16 inch (1,6 mm) from case for 10 seconds	N or P package		260	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 Table. 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.

DISSIPATION DERATING TABLE

PACKAGE	POWER RATING	DERATING FACTOR	ABOVE T_A
J (Alloy-Mounted Chip)	680 mW	11.0 mW/°C	88°C
J (Glass-Mounted Chip)	680 mW	8.2 mW/°C	67°C
JG (Alloy-Mounted Chip)	680 mW	8.4 mW/°C	69°C
JG (Glass-Mounted Chip)	680 mW	6.6 mW/°C	47°C
N	680 mW	9.2 mW/°C	76°C
P	680 mW	8.0 mW/°C	65°C
W	680 mW	8.0 mW/°C	65°C

Also see Dissipation Derating Curves, Section 2.

DEVICE TYPES, SUFFIX VERSIONS, AND PACKAGES

	TL080	TL081	TL082	TL083	TL084	TL085
TL08_M	JG	JG	JG	J	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.

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electrical characteristics, $V_{CC\pm}$ = ±15 V

PARAMETER		TEST CONDITIONS†		TL08_M			TL08_I			TL08_C, TL08_AC, TL08_BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	R_S = 50 Ω, T_A = 25°C	'80,'81,'82,'83,'85‡		3	6		3	6		5	15	mV
			TL084		3	9		3	6		5	15	
			TL08_A								3	6	
			'81B,'82B,'84B								2	3	
		R_S = 50 Ω, T_A = full range	'80,'81,'82,'83,'85‡			9			9			20	
			TL084			15			9			20	
			TL08_A									7.5	
			'81B,'82B,'84B									5	
α_{VIO}	Temperature coefficient of input offset voltage	R_S = 50 Ω,	T_A = full range		10			10			10		μV/°C
I_{IO}	Input offset current§	T_A = 25°C	TL08_‡		5	100		5	100		5	200	pA
			TL08_A								5	100	
			'81B,'82B,'84B								5	100	
		T_A = full range	TL08_‡			20			10			5	nA
			TL08_A									3	
			'81B,'82B,'84B									3	
I_{IB}	Input bias current§	T_A = 25°C	TL08_‡		30	200		30	200		30	400	pA
			TL08_A								30	200	
			'81B,'82B,'84B								30	200	
		T_A = full range	TL08_‡			50			20			10	nA
			TL08_A									7	
			'81B,'82B,'84B									7	
V_{ICR}	Common-mode input voltage range	T_A = 25°C	TL08_‡	±11	±12		±11	±12		±10	±11		V
			TL08_A							±11	±12		
			'81B,'82B,'84B							±11	±12		
V_{OPP}	Maximum peak-to-peak output voltage swing	T_A = 25°C	R_L = 10 kΩ	24	27		24	27		24	27		V
		T_A = full range	R_L ≥ 10 kΩ	24			24			24			
			R_L ≥ 2 kΩ	20	24		20	24		20	24		
A_{VD}	Large-signal differential voltage amplification	R_L ≥ 2 kΩ, V_O = ±10 V, T_A = 25°C	TL08_‡	25	200		50	200		25	200		V/mV
			TL08_A							50	200		
			'81B,'82B,'84B							50	200		
		R_L ≥ 2 kΩ, V_O = ±10 V, T_A = full range	TL08_‡	15			25			15			
			TL08_A							25			
			'81B,'82B,'84B							25			
B_1	Unity-gain bandwidth	T_A = 25°C			3			3			3		MHz
r_i	Input resistance	T_A = 25°C			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	R_S ≥ 10 kΩ, T_A = 25°C	TL08_‡	80	86		80	86		70	76		dB
			TL08_A							80	86		
			'81B,'82B,'84B							80	86		
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	R_S ≥ 10 kΩ, T_A = 25°C	TL08_‡	80	86		80	86		70	76		dB
			TL08_A							80	86		
			'81B,'82B,'84B							80	86		
I_{CC}	Supply current (per amplifier)	No load, T_A = 25°C	No signal,		1.4	2.8		1.4	2.8		1.4	2.8	mA
V_{o1}/V_{o2}	Channel separation	A_{VD} = 100,	T_A = 25°C		120			120			120		dB

† All characteristics are specified under open-loop conditions unless otherwise noted. Full range for T_A is −55°C to 125°C for TL08_M; −25°C to 85°C for TL08_I; and 0°C to 70°C for TL08_C, TL08_AC, and TL08_BC.

‡ Types TL085I and TL085M are not defined by this data sheet.

§ 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 temperature as close to the ambient temperature as is possible.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25° C

PARAMETER		TEST CONDITIONS		TL08_M			ALL OTHERS			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1	8	13			13		V/μs
t_r	Rise time	V_I = 20 mV, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1		0.1			0.1		μs
	Overshoot factor				10%			10%		
V_n	Equivalent input noise voltage	R_S = 100 Ω,	f = 1 kHz		25			25		nV/√Hz

PARAMETER MEASUREMENT INFORMATION

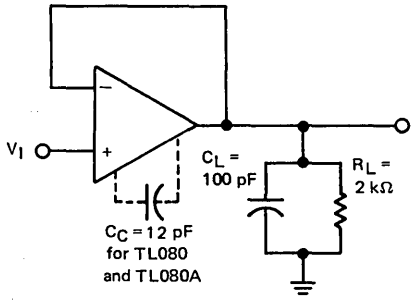


FIGURE 1–UNITY-GAIN AMPLIFIER

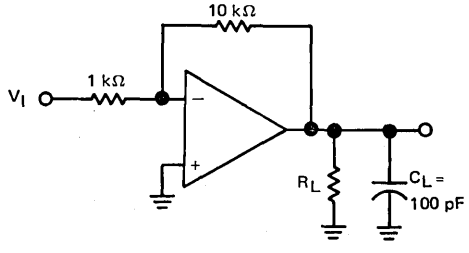


FIGURE 2–GAIN-OF-10 INVERTING AMPLIFIER

INPUT OFFSET VOLTAGE NULL CIRCUITS

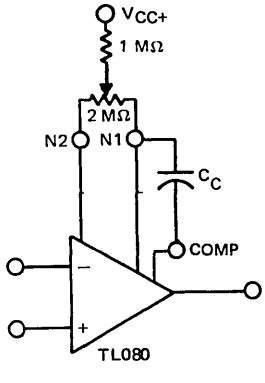


FIGURE 3

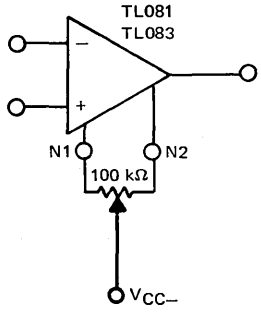
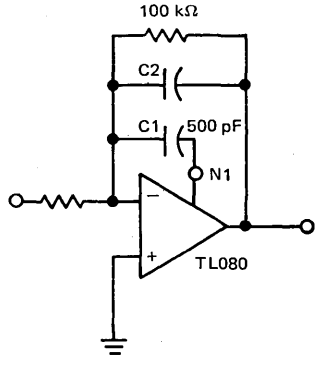


FIGURE 4



FEED-FORWARD COMPENSATION

FIGURE 5

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TYPICAL CHARACTERISTICS†

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

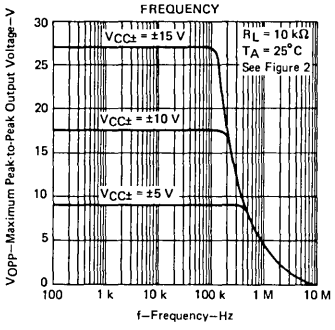


FIGURE 6

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

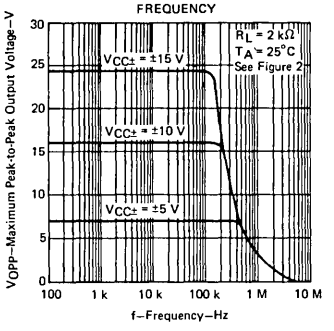


FIGURE 7

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

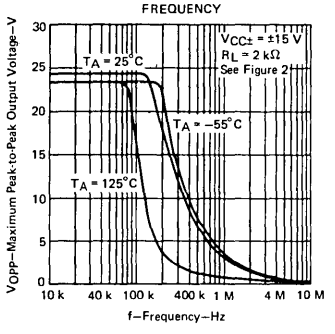


FIGURE 8

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

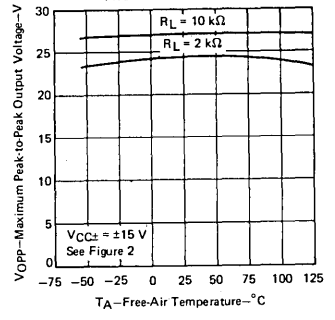


FIGURE 9

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
LOAD RESISTANCE

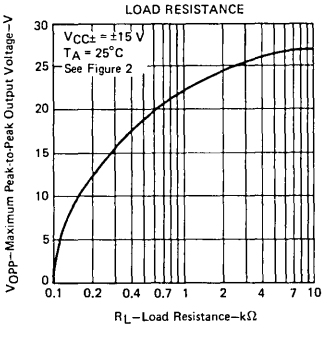


FIGURE 10

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

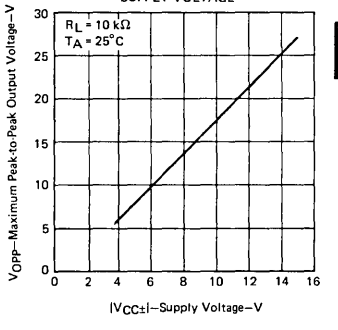


FIGURE 11

LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE

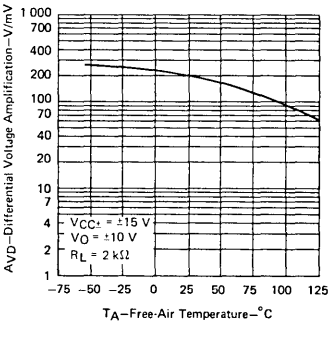


FIGURE 12

LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
and PHASE SHIFT
vs
FREQUENCY

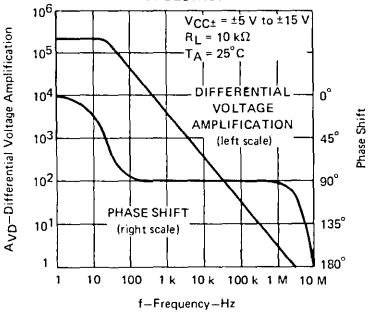


FIGURE 13

TL080, TL080A
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREQUENCY WITH FEED-FORWARD COMPENSATION

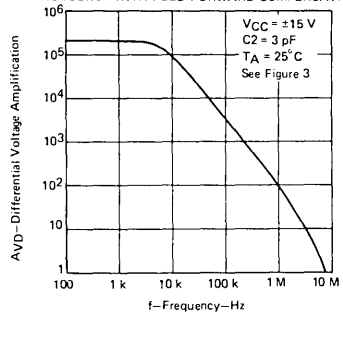


FIGURE 14

†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.

TYPICAL CHARACTERISTICS†

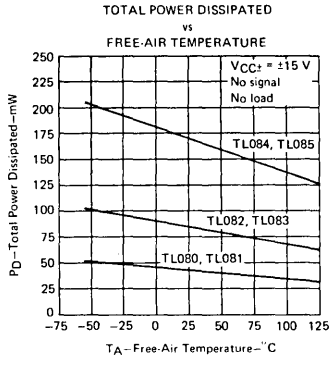


FIGURE 15

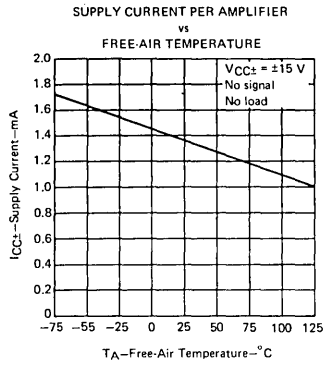


FIGURE 16

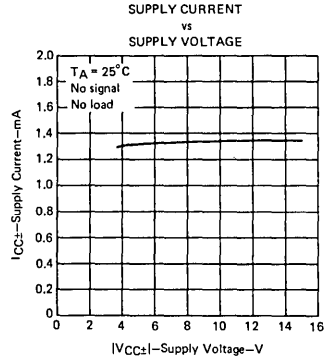


FIGURE 17

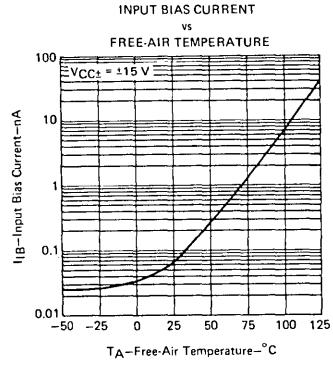


FIGURE 18

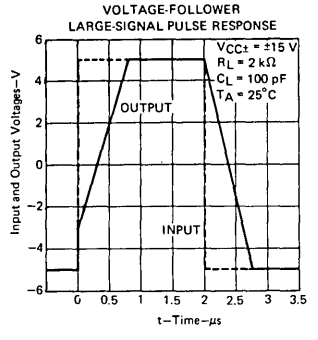


FIGURE 19

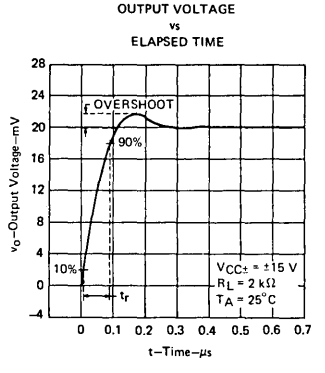


FIGURE 20

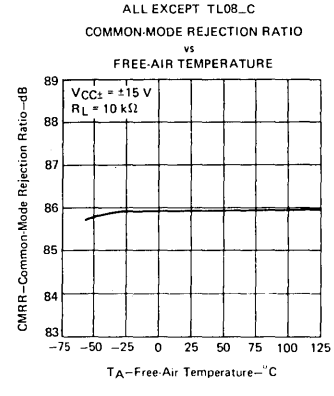


FIGURE 21

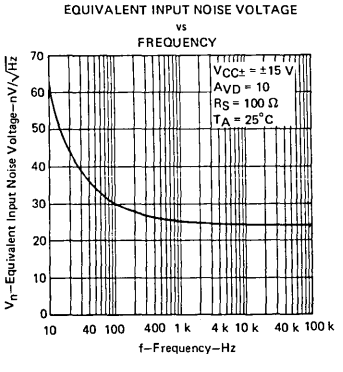


FIGURE 22

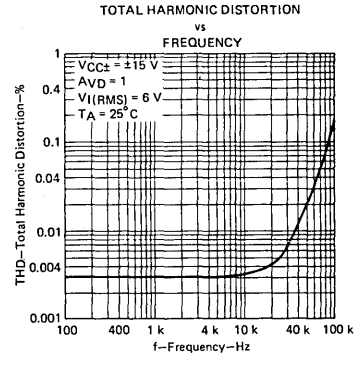


FIGURE 23

†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.

TYPICAL APPLICATION DATA

0.5-Hz SQUARE-WAVE OSCILLATOR

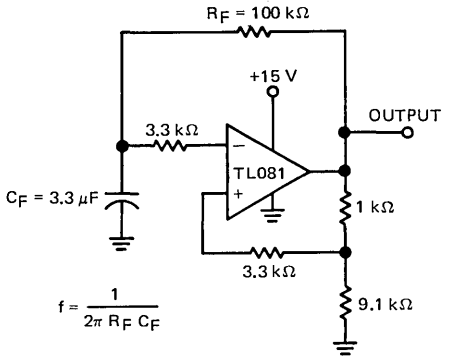


FIGURE 24—0.5-Hz SQUARE-WAVE OSCILLATOR

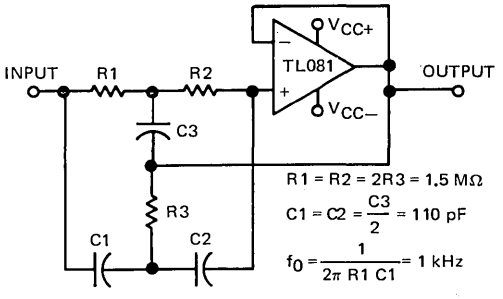
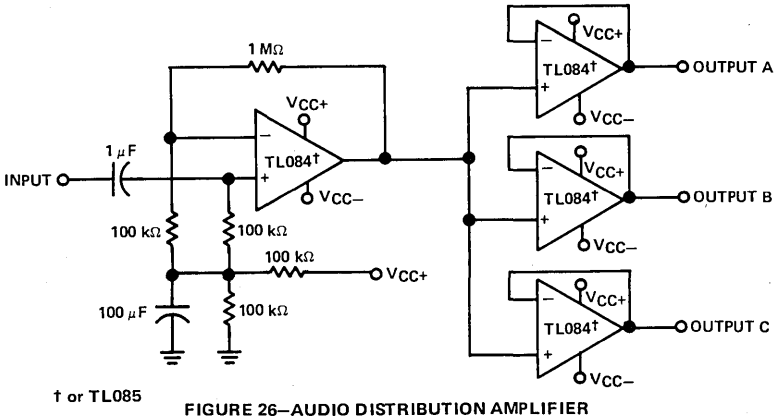
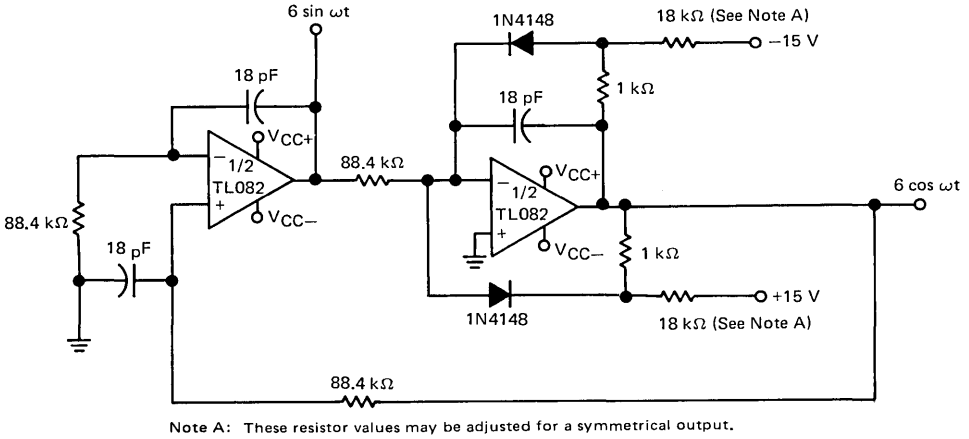


FIGURE 25—HIGH-Q NOTCH FILTER



† or TL085

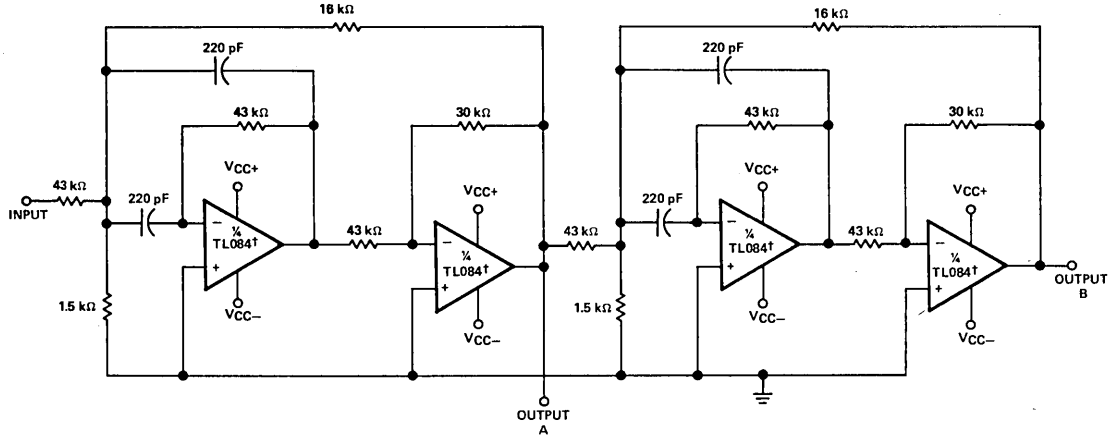
FIGURE 26—AUDIO DISTRIBUTION AMPLIFIER



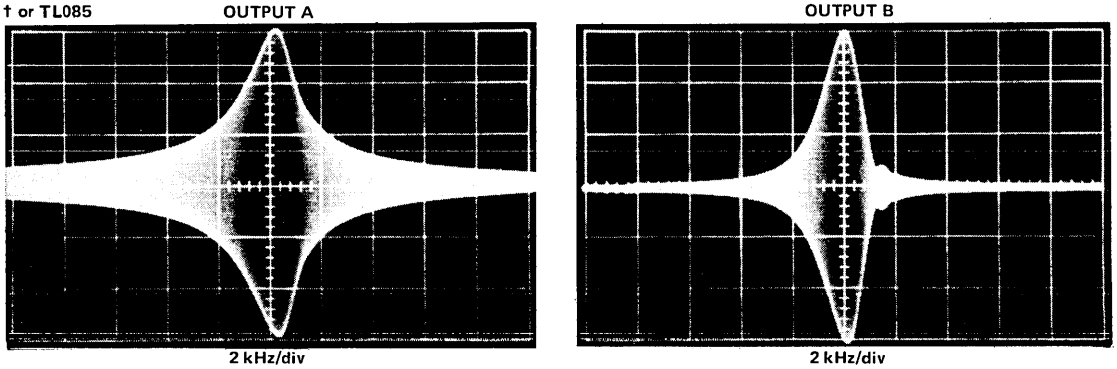
Note A: These resistor values may be adjusted for a symmetrical output.

FIGURE 27—100-kHz QUADRATURE OSCILLATOR

TYPICAL APPLICATION DATA



† or TL085



SECOND-ORDER BANDPASS FILTER
f_o = 100 kHz, Q = 30, GAIN = 4

CASCADED BANDPASS FILTER
f_o = 100 kHz, Q = 69, GAIN = 16

FIGURE 28—POSITIVE-FEEDBACK BANDPASS FILTER

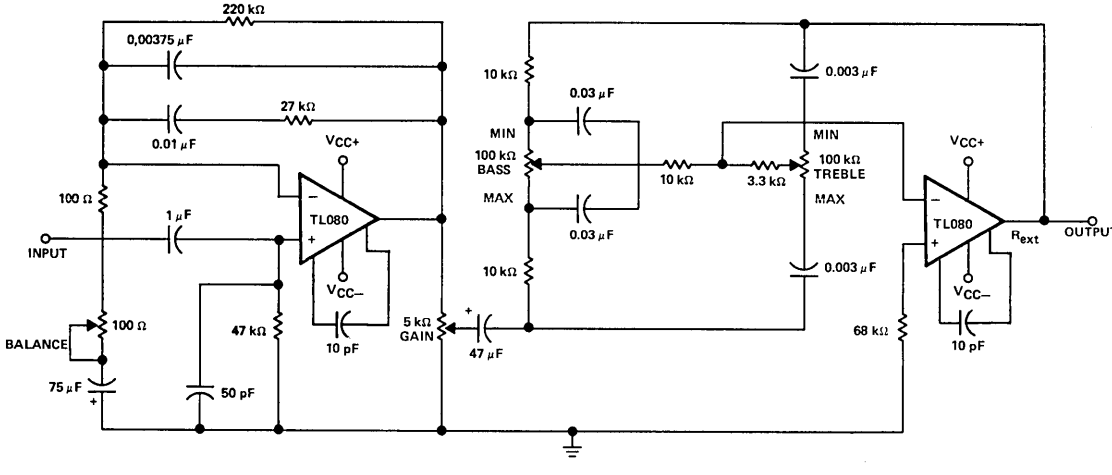


FIGURE 29—IC PREAMPLIFIER

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