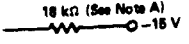
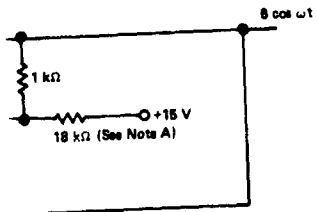


DATA



1 kΩ



a symmetrical output.

OSCILLATOR

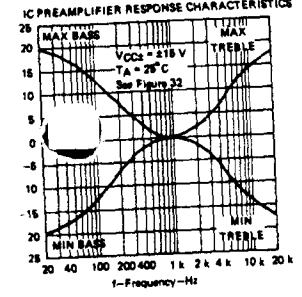
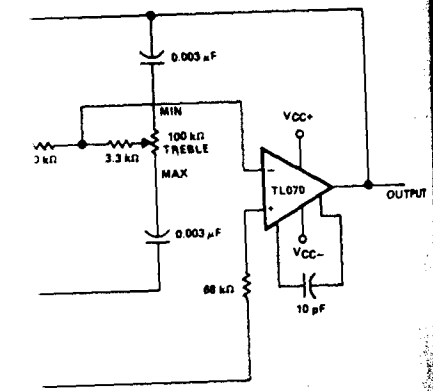


FIGURE 31



ER

LINEAR INTEGRATED CIRCUITS

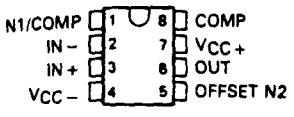
TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

02297, FEBRUARY 1977—REVISED SEPTEMBER 1983

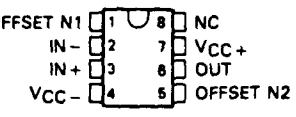
24 DEVICES COVER MILITARY, INDUSTRIAL AND COMMERCIAL TEMPERATURE RANGES

- 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

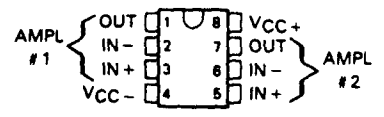
TL080, TL080A JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



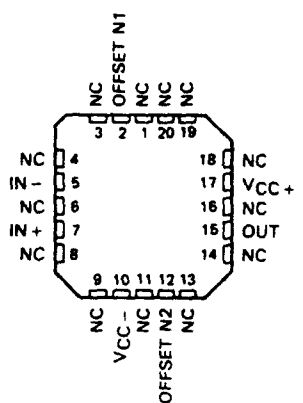
TL081, TL081A, TL081B JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



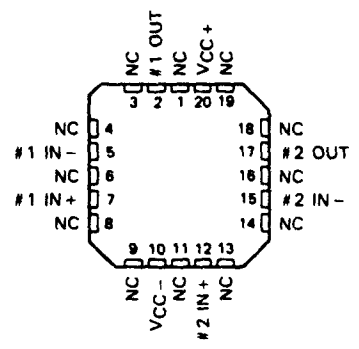
TL082, TL082A, TL082B JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



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.

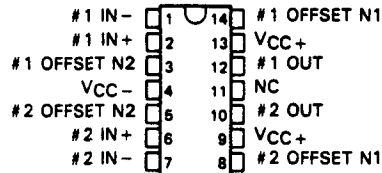
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TEXAS INSTRUMENTS

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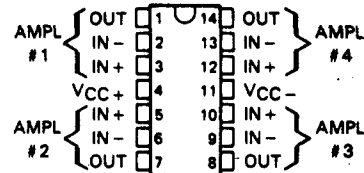
**TYPES TL080 THRU TL085, TL080A THRU TL084A  
TL081B, TL082B, TL084B  
JFET-INPUT OPERATIONAL AMPLIFIERS**

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

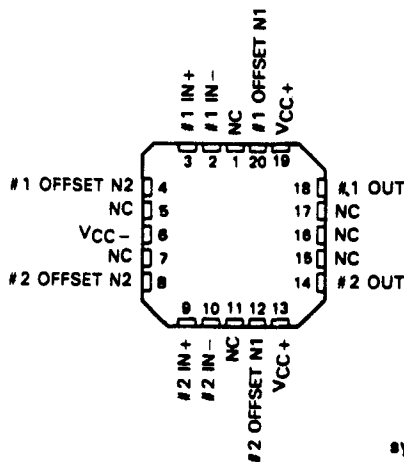


Pins 9 and 13 are internally interconnected

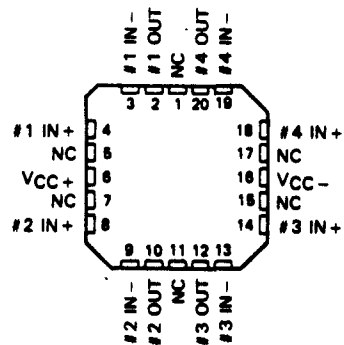
**TL084, TL084A, TL084B**  
J OR N DUAL-IN-LINE PACKAGE  
(TOP VIEW)



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

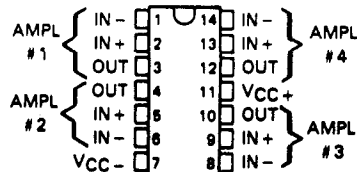


**TL084M . . . FH OR FK**  
CHIP CARRIER PACKAGE  
(TOP VIEW)



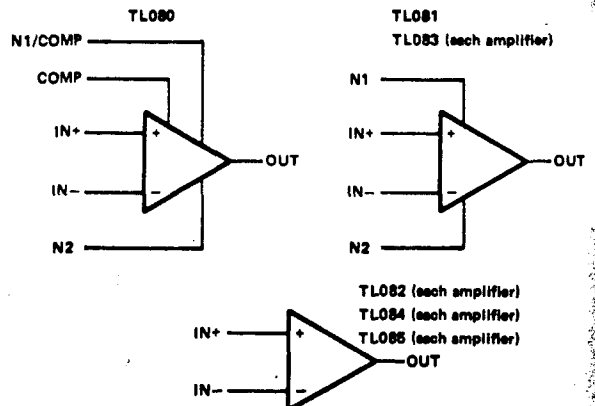
**3**  
Operational Amplifiers

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



NC—No internal connection

**symbols**



00000  
schen  
absok  
Suppl  
Suppl  
Differ  
Input  
Durati  
Contir  
Opera  
Stora  
Lead t  
from c  
Lead t  
from c  
NOTES:

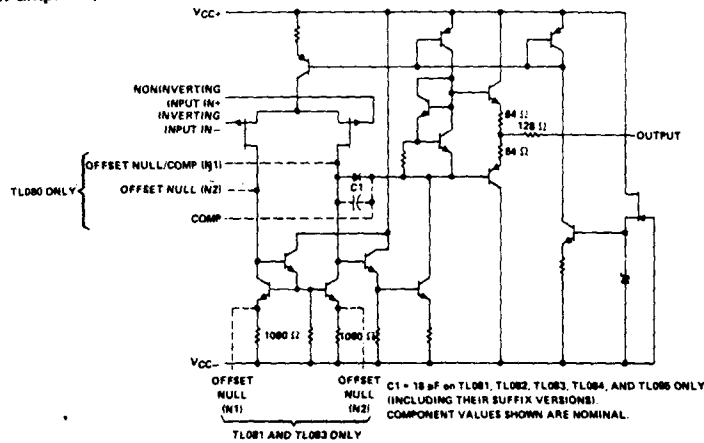
## TYPES TL080 THRU TL085, TL080A THRU TL084A TL081B, TL082B, TL084B JFET-INPUT OPERATIONAL AMPLIFIERS

### 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°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)	$\pm 30$	$\pm 30$	$\pm 30$	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°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**

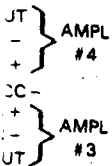
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3-137

3

Operational Amplifiers

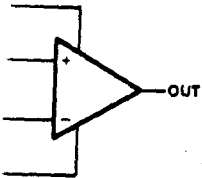
18  
KAGE



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 <sup>1</sup>		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
$\alpha_{VIO}$ 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 <sup>2</sup>	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	5 100		5 100		20		$\mu\text{A}$ nA
$I_{IB}$ Input bias current <sup>2</sup>	$V_O = 0$	$T_A = 25^\circ\text{C}$ $T_A = -55^\circ\text{C to } 125^\circ\text{C}$	30 200		30 200		20		$\mu\text{A}$ nA
$V_{ICR}$ Common-mode input voltage range	$T_A = 25^\circ\text{C}$		$\pm 11$	$\pm 12$	$\pm 11$	$\pm 12$			V
$V_{OM}$ Maximum peak output voltage swing	$T_A = 25^\circ\text{C},$	$R_L = 10 \text{ k}\Omega$	$\pm 12$	$\pm 13.5$	$\pm 12$	$\pm 13.5$			V
	$T_A = -55^\circ\text{C to } 125^\circ\text{C}$	$R_L \geq 10 \text{ k}\Omega$ $R_L \geq 2 \text{ k}\Omega$	$\pm 10$	$\pm 12$	$\pm 10$	$\pm 12$			
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V},$ $T_A = 25^\circ\text{C}$	$R_L \geq 2 \text{ k}\Omega,$	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	$T_A = 25^\circ\text{C}$		$10^{12}$		$10^{12}$				$\Omega$
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

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

<sup>2</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.

3  
Operational Amplifiers

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

081M	TL084M			
083M	MAX	MIN	TYP	MAX
	6		3	8
	9			15
			10	
100		5		100
20				20
200		30		200
50				20
	±11		±12	
		±12		±13.5
			±12	
		±10		±12
	25		200	
		15		
		3		
		10 <sup>12</sup>		
80		86		
80		86		
2.8		1.4		2.8
		120		

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

PARAMETER	TEST CONDITIONS <sup>1</sup>		TL0801		TL080C		TL080AC		TL081B		TL081C		TL082B		TL082C		TL084B		TL084C		TL084A		TL084M		UNIT	
	MIN	MAX	TYP	MAX	MIN	MAX	TYP	MAX	MIN	MAX	TYP	MAX	MIN	MAX	TYP	MAX	MIN	MAX	TYP	MAX	MIN	MAX	TYP	MAX		
$V_{IO}$	$V_O = 0$	$R_S = 50 \Omega$	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	3	6	mV	
$\alpha_{VIO}$	$V_O = 0$	$T_A = 25^\circ\text{C}$	$R_S = 50 \Omega$		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	$\mu\text{V}/^\circ\text{C}$	
			$T_A = \text{full range}$		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
$I_{IO}$	$V_O = 0$	$T_A = 25^\circ\text{C}$	5	100	5	100	5	100	5	100	5	100	5	100	5	100	5	100	5	100	5	100	5	100	pA	
$I_{IB}$	$V_O = 0$	$T_A = 25^\circ\text{C}$	$R_L = 10 \text{ k}\Omega$		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	nA	
			$R_L = 2 \text{ k}\Omega$		30	200	30	400	30	200	30	400	30	200	30	400	30	200	30	400	30	200	30	400	30	200
$V_{ICR}$	$T_A = 25^\circ\text{C}$	$R_L = 10 \text{ k}\Omega$		±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	±11	±12	V		
		$R_L = 2 \text{ k}\Omega$		±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	±12	±13.5	
$V_{OM}$	$T_A = 25^\circ\text{C}$	$R_L = 10 \text{ k}\Omega$		±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	±12	V	
		$R_L = 2 \text{ k}\Omega$		±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	±10	±12	
$A_{VD}$	$V_O = 10 \text{ V}$	$T_A = 25^\circ\text{C}$	$R_L = 2 \text{ k}\Omega$		50	200	50	200	50	200	50	200	50	200	50	200	50	200	50	200	50	200	50	200	V/mV	
			$R_L = 10 \text{ V}$		25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	15	25	
$B_1$	$T_A = 25^\circ\text{C}$	$R_L = 2 \text{ k}\Omega$		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	MHz		
$f_1$	$T_A = 25^\circ\text{C}$	$R_L = 2 \text{ k}\Omega$		10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	10 <sup>12</sup>	g	
CMRR	$V_{IC} = V_{ICR \text{ min}}$	$V_O = 0$	$R_S = 50 \Omega$	80	86	70	86	80	86	70	86	80	86	80	86	70	86	80	86	70	86	80	86	80	86	dB
$\pm\text{SVR}$	$V_{CC} = \pm 15 \text{ V}$	$V_O = \pm 9 \text{ V}$	$V_O = 0$	80	86	70	86	80	86	70	86	80	86	70	86	80	86	80	86	70	86	80	86	80	86	dB
$I_{CC}$	No load	$V_O = 0$	$T_A = 25^\circ\text{C}$	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	1.4	2.8	mA
$V_{O1}/V_{O2}$	Crosstalk attenuation	$V_O = 100$	$T_A = 25^\circ\text{C}$	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	dB	

<sup>1</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 TL081 and  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TL080, TL080A, TL080B, TL080C, TL080D, TL080E, TL080F, TL080G, TL080H, TL080I, TL080J, TL080K, TL080L, TL080M, TL080N, TL080P, TL080Q, TL080R, TL080S, TL080T, TL080U, TL080V, TL080W, TL080X, TL080Y, TL080Z, TL080AA, TL080AB, TL080AC, TL080AD, TL080AE, TL080AF, TL080AG, TL080AH, TL080AI, TL080AJ, TL080AK, TL080AL, TL080AM, TL080AN, TL080AO, TL080AP, TL080AQ, TL080AR, TL080AS, TL080AT, TL080AU, TL080AV, TL080AW, TL080AX, TL080AY, TL080AZ, TL080BA, TL080BB, TL080BC, TL080BD, TL080BE, TL080BF, TL080BG, TL080BH, TL080BI, TL080BJ, TL080BK, TL080BL, TL080BM, TL080BN, TL080BO, TL080BP, TL080BQ, TL080BR, TL080BS, TL080BT, TL080BU, TL080BV, TL080BW, TL080BX, TL080BY, TL080BZ, TL080CA, TL080CB, TL080CC, TL080CD, TL080CE, TL080CF, TL080CG, TL080CH, TL080CI, TL080CJ, TL080CK, TL080CL, TL080CM, TL080CN, TL080CO, TL080CP, TL080CQ, TL080CR, TL080CS, TL080CT, TL080CU, 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**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 $\Omega$ , $C_L = 100$ pF, See Figure 1	8	13		V/ $\mu$ s
$t_r$ Rise time	$V_I = 20$ mV, $R_L = 2$ k $\Omega$ ,		0.1		$\mu$ s
Overshoot factor	$C_L = 100$ pF, See Figure 1		10%		
$V_n$ Equivalent input noise voltage	$R_S = 100$ $\Omega$ , $f = 1$ kHz to 10 kHz		18		nV/ $\sqrt{\text{Hz}}$
$i_n$ Equivalent input noise current	$R_S = 100$ $\Omega$ , $f = 1$ kHz		0.01		pA/ $\sqrt{\text{Hz}}$
THD Total harmonic distortion	$V_{O(\text{rms})} = 10$ V, $R_S \leq 1$ k $\Omega$ , $R_L \geq 2$ k $\Omega$ , $f = 1$ kHz		0.003%		

**PARAMETER MEASUREMENT INFORMATION**

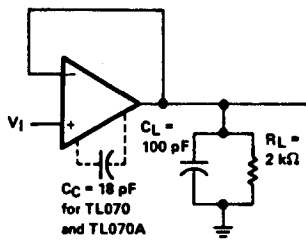


FIGURE 1—UNITY-GAIN AMPLIFIER

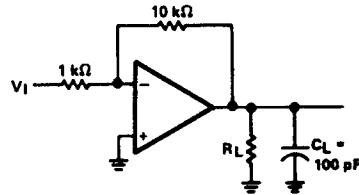


FIGURE 2—GAIN-OF-10 INVERTING AMPLIFIER

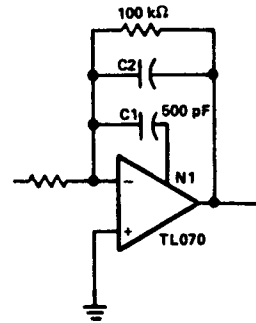


FIGURE 3—FEED-FORWARD COMPENSATION

**INPUT OFFSET VOLTAGE NULL CIRCUITS**

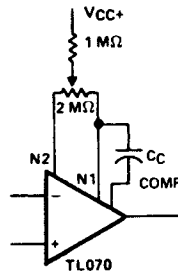


FIGURE 4

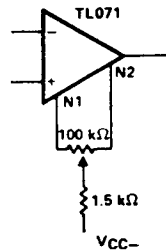
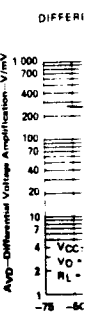
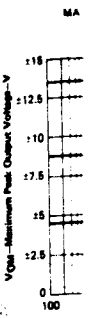


FIGURE 5

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

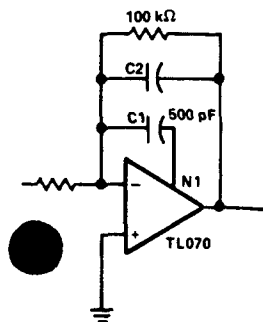


FIGURE 3—FEED-FORWARD COMPENSATION

S

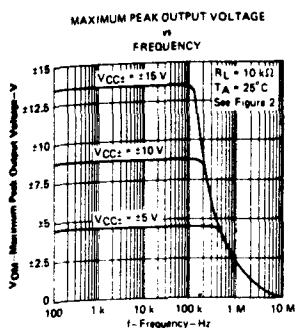


FIGURE 6

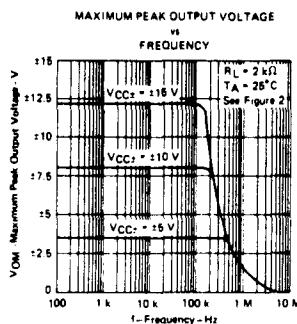


FIGURE 7

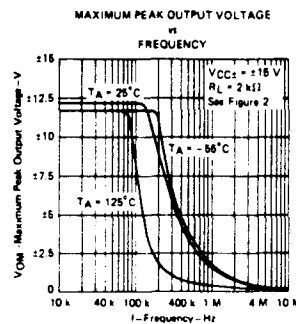


FIGURE 8

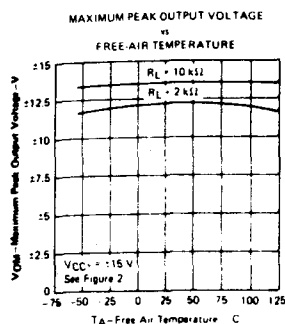


FIGURE 9

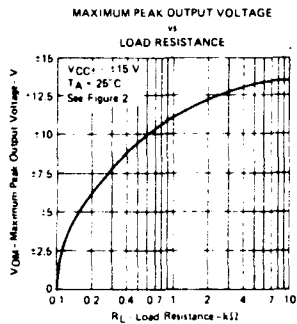


FIGURE 10

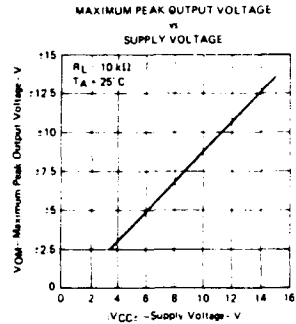


FIGURE 11

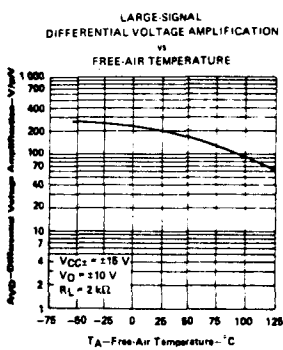


FIGURE 12

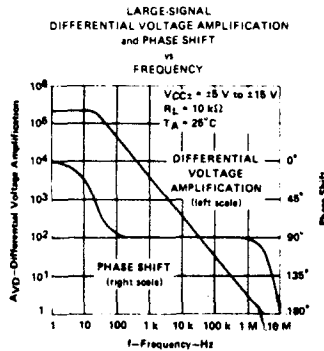


FIGURE 13

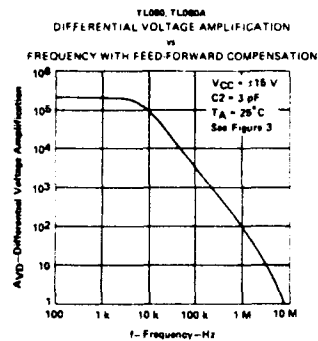


FIGURE 14

†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†**

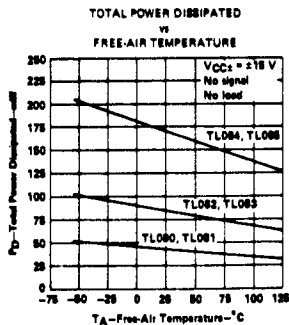


FIGURE 15

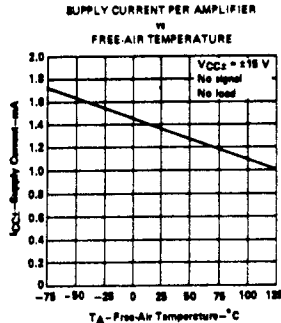


FIGURE 16

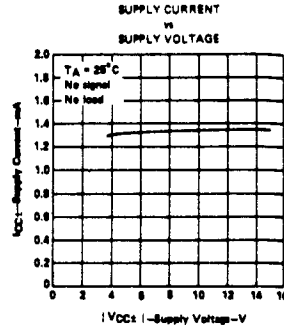


FIGURE 17

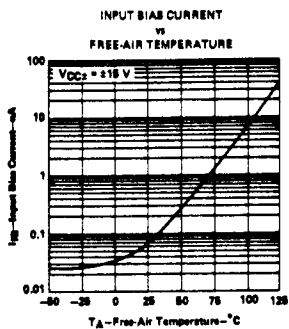


FIGURE 18

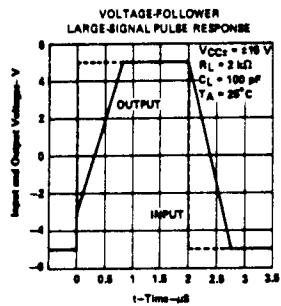


FIGURE 19

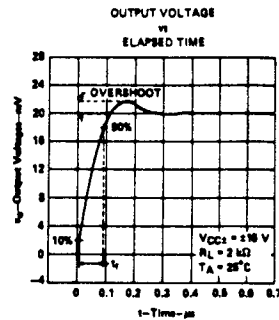


FIGURE 20

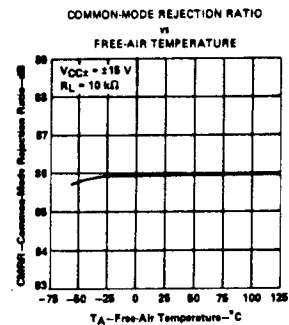


FIGURE 21

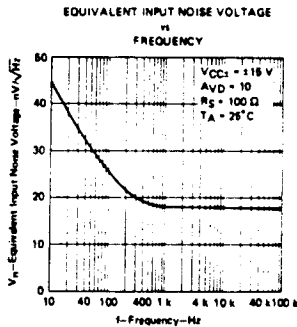


FIGURE 22

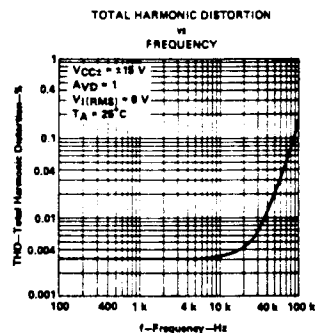


FIGURE 23

†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

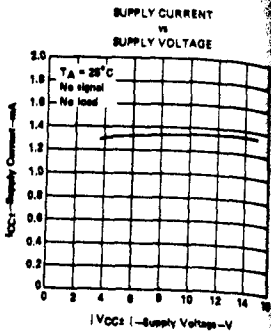


FIGURE 17

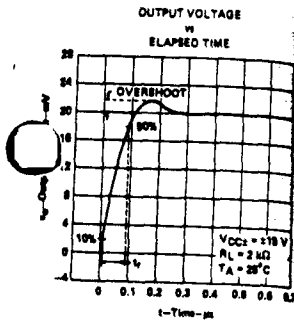


FIGURE 20

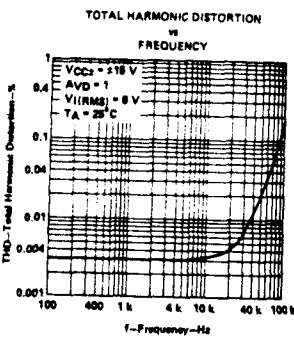


FIGURE 23

of the various devices. A 12-pF compensation

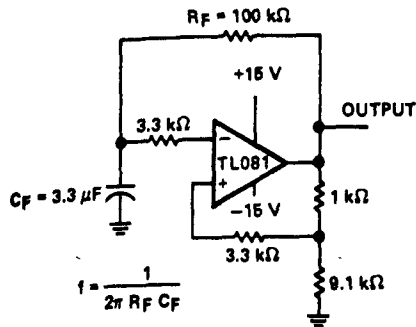


FIGURE 24—0.5-Hz SQUARE-WAVE OSCILLATOR

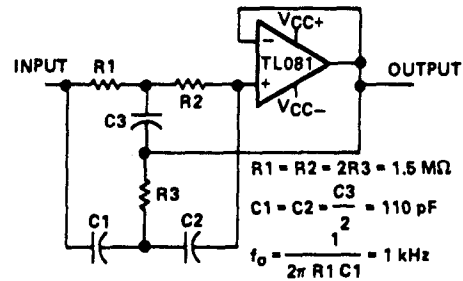


FIGURE 25—HIGH-Q NOTCH FILTER

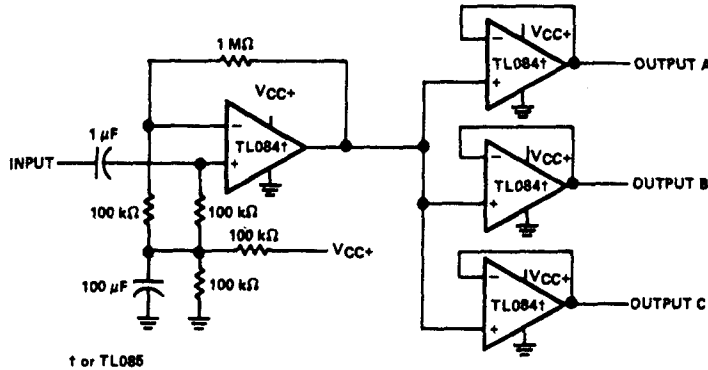
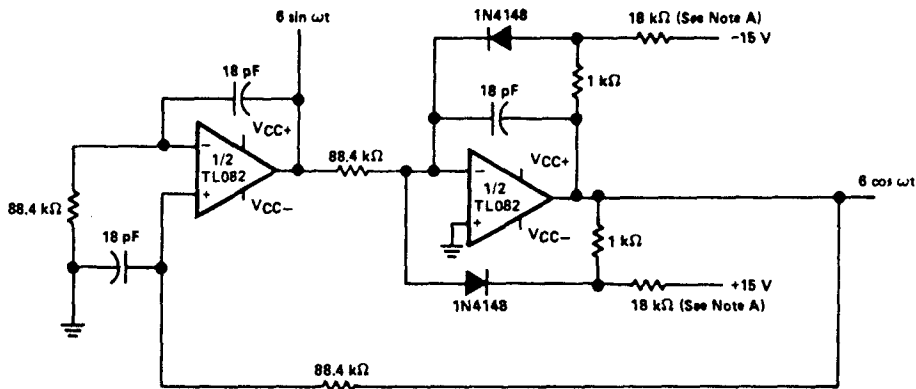


FIGURE 26—AUDIO DISTRIBUTION AMPLIFIER

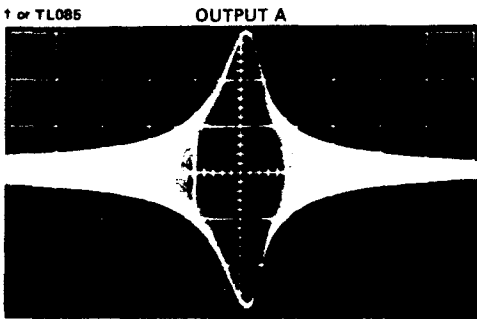
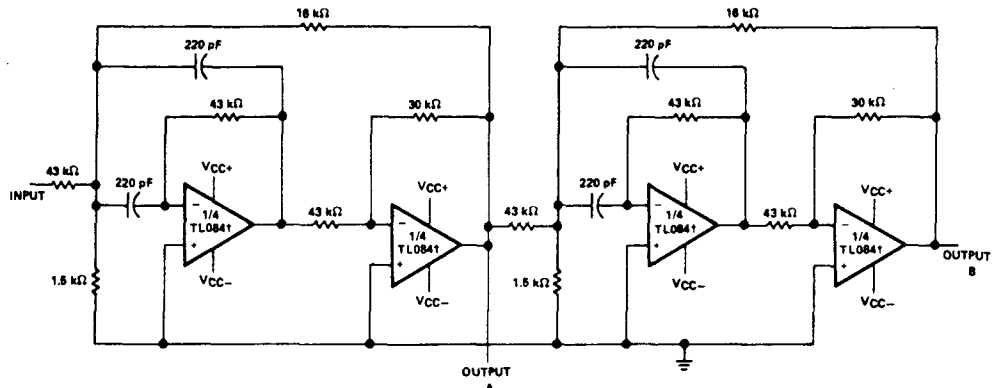


NOTE A: These resistor values may be adjusted for a symmetrical output.

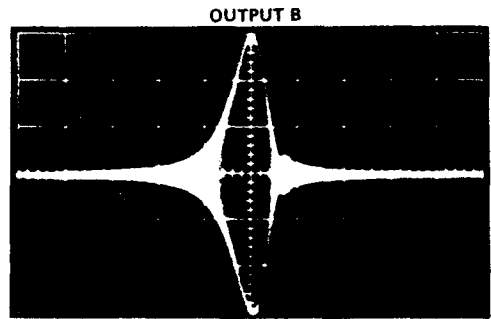
FIGURE 27—100-kHz QUADRATURE OSCILLATOR

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

TYPICAL APPLICATION DATA



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



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

FIGURE 28—POSITIVE-FEEDBACK BANDPASS FILTER

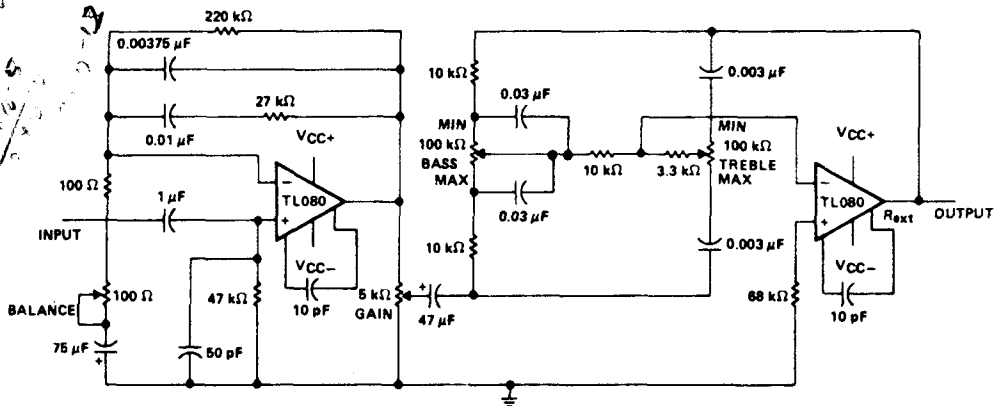


FIGURE 29—IC PREAMPLIFIER

3 Operational Amplifiers

*Handwritten notes:*  
2-20-71  
10-1-71  
2410 P.D.  
10-5-51

LINE INTI CIRI

- L
- L
- V
- L
- C

descrip

Th  
me  
an  
De  
to  
ar

symbc

NONIN  
INPUT  
INVER  
INPUT