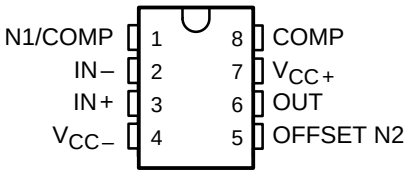
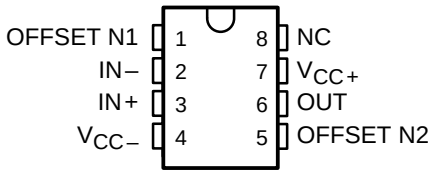
24 DEVICES COVER COMMERCIAL, INDUSTRIAL, AND MILITARY TEMPERATURE RANGES

- **Low-Power Consumption**
- **Wide Common-Mode and Differential Voltage Ranges**
- **Low Input Bias and Offset Currents**
- **Output Short-Circuit Protection**
- **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/μs Typ**
- **Common-Mode Input Voltage Range Includes V_{CC+}**

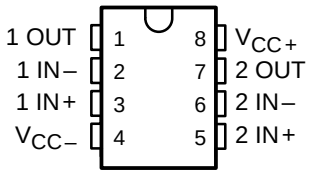
TL080
D, P, OR PW PACKAGE
(TOP VIEW)



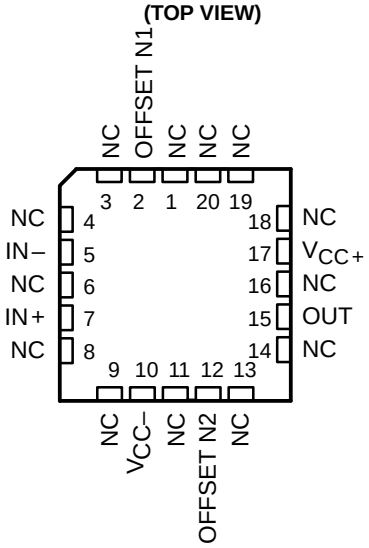
TL081, TL081A, TL081B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



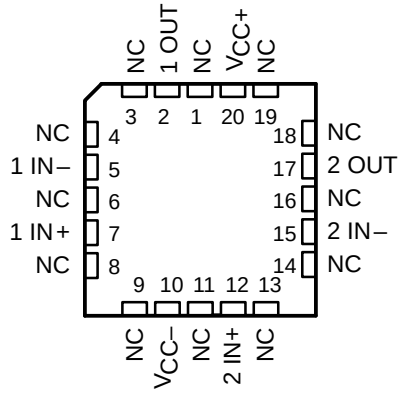
TL082, TL082A, TL082B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



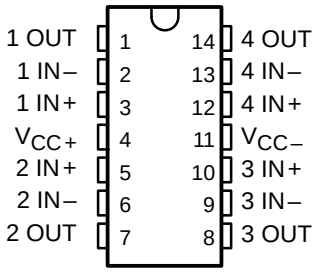
TL081M . . . FK PACKAGE
(TOP VIEW)



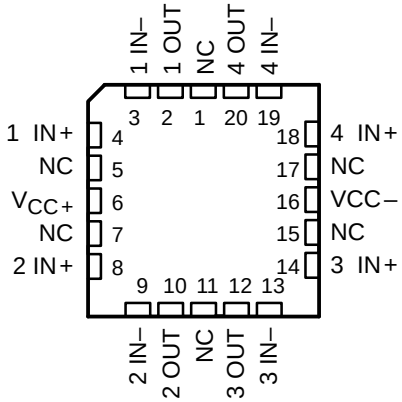
TL082M . . . FK PACKAGE
(TOP VIEW)



TL084, TL084A, TL084B
D, J, N, OR PW PACKAGE
(TOP VIEW)



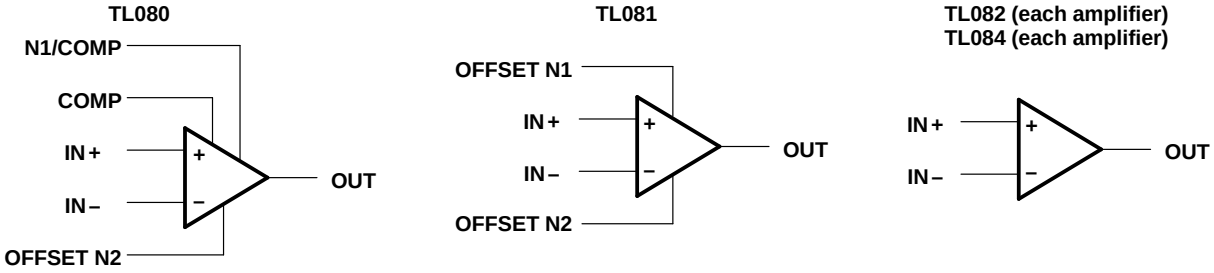
TL084M . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS
77251–1443

symbols



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.

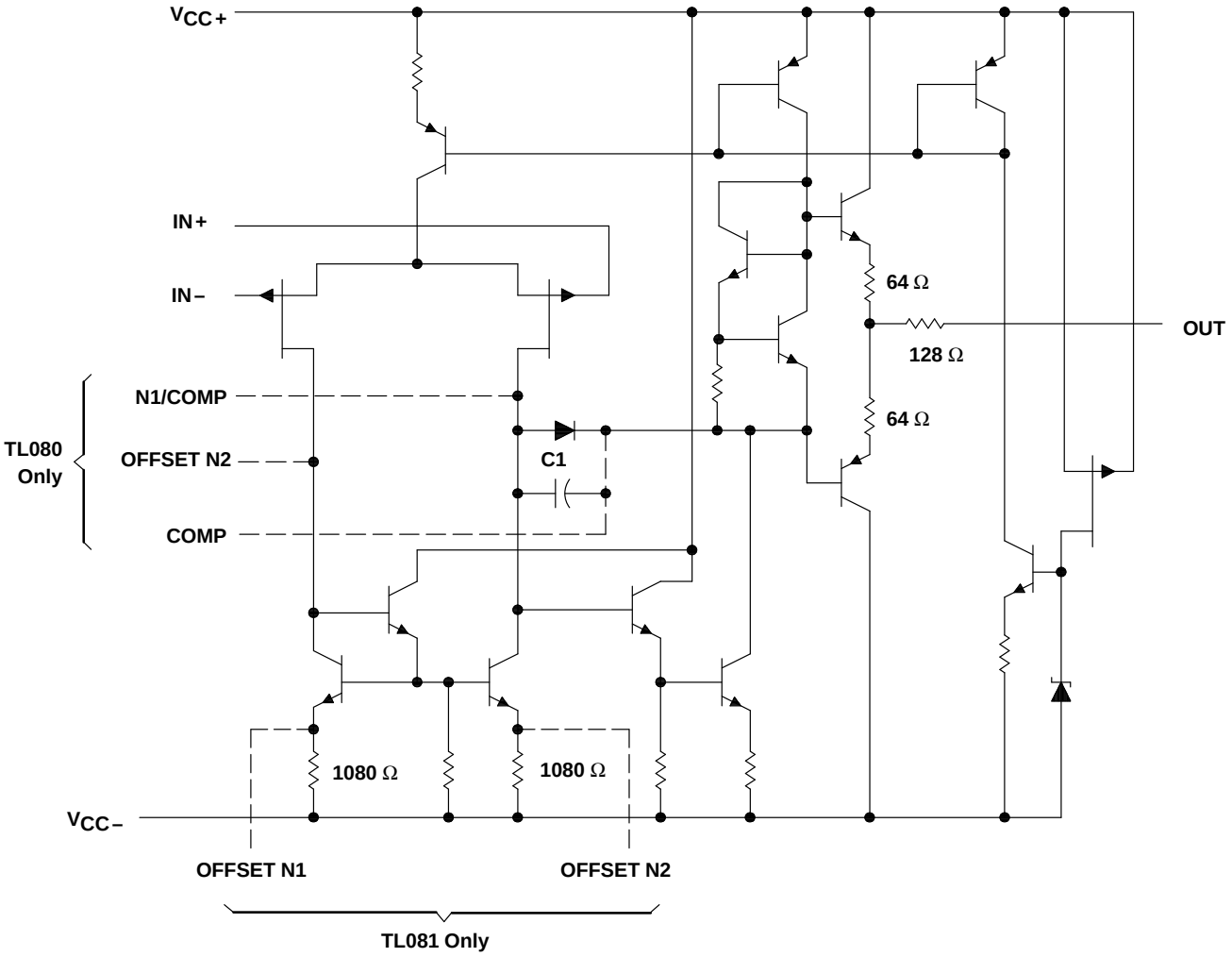
Device types with a C suffix are characterized for operation from 0°C to 70°C, those with an I suffix are characterized for operation from –40°C to 85°C, and those with an M suffix are characterized for operation over the full military temperature range of –55°C to 125°C.

AVAILABLE OPTIONS

T_A	V_{IO} MAX at 25°C	PACKAGE								CHIP FORM (Y)
		SMALL OUTLINE (D008)	SMALL OUTLINE (D014)	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLASTIC DIP (N)	PLASTIC DIP (P)	TSSOP (PW)	
0°C to 70°C	15 mV	TL080CD	—	—	—	—	—	TL080CP	TL080CPW	—
	15 mV	TL081CD						TL081CP	TL081CPW	
	6 mV	TL081ACD						TL081ACP		
	3 mV	TL081BCD						TL081BCP		
	15 mV	TL082CD	—	—	—	—	—	TL082CP	TL082CPW	TL082Y
	6 mV	TL082ACD						TL082ACP		
	3 mV	TL082BCD						TL082BCP		
	15 mV	—	TL084CD	—	—	—	TL084CN	—	TL084CPW	TL084Y
	6 mV		TL084ACD				TL084ACN			
	3 mV		TL084BCD				TL084BCN			
–40°C to 85°C	6 mV	TL081ID		—	—	—		TL081IP	—	—
	6 mV	TL082ID						TL082IP		
	6 mV	TL084ID	TL084ID				TL084IN			
–55°C to 125°C	6 mV	—	—	TL081MFK		TL081MJG	—	—	—	—
	6 mV			TL082MFK		TL082MJG				
	9 mV			TL084MFK	TL084MJ					

The D package is available taped and reeled. Add R suffix to device type, (e.g., TL080CDR).

schematic (each amplifier)

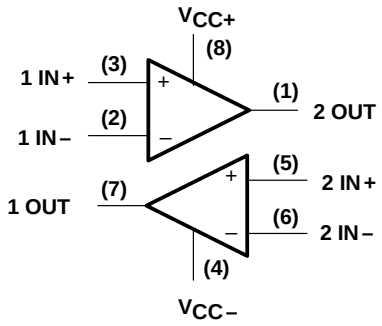


C1 = 18 pF on TL081, TL082, and TL084 only (including their suffix versions).
Component values shown are nominal.

chip information

These chips, when properly assembled, display characteristics similar to the TL082. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS



CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%

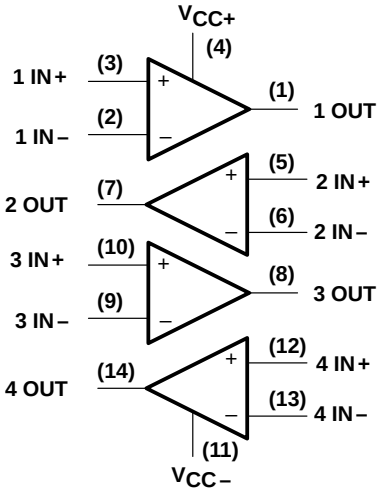
ALL DIMENSIONS ARE IN MILS

PIN (4) INTERNALLY CONNECTED TO BACKSIDE OF CHIP

chip information

These chips, when properly assembled, display characteristics similar to the TL084. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS



CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%

ALL DIMENSIONS ARE IN MILS

PIN (11) INTERNALLY CONNECTED TO BACKSIDE OF CHIP

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

		TL08_C TL08_AC TL08_BC	TL08_I	TL08_M	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		See Dissipation Rating Table			
Operating free-air temperature range		0 to 70	– 40 to 85	– 55 to 125	°C
Storage temperature range		– 65 to 150	– 65 to 150	– 65 to 150	°C
Case temperature for 60 seconds	FK package			260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J or JG package			300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D, N, P, or PW 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 V, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D (8 Pin)	680 mW	5.8 mW/°C	32°C	464 mW	377 mW	N/A
D (14 Pin)	680 mW	7.6 mW/ °C	60°C	608 mW	494 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
J	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
JG	680 mW	8.4 mW/°C	69°C	672 mW	546 mW	210 mW
N	680 mW	9.2 mW/°C	76°C	680 mW	598 mW	N/A
P	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	N/A
PW (8 Pin)	525 mW	4.2 mW/°C	25°C	336 mW	N/A	N/A
PW (14 Pin)	700 mW	5.6 mW/°C	25°C	448 mW	N/A	N/A

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

PARAMETER		TEST CONDITIONS†		TL080C TL081C TL082C TL084C			TL081AC TL082AC TL084AC			TLO81BC TL082BC TL084BC			TL081I TL082I TL084I			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	T_A = 25°C		3	15		3	6		2	3		3	6	mV
			T_A = full range			20			7.5			5			9	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω, T_A = full range			18			18			18			18		μV/°C
I_{IO}	Input offset current‡	V_O = 0	T_A = 25°C		5	200		5	100		5	100		5	100	pA
			T_A = full range			2			2			2			10	nA
I_{IB}	Input bias current‡	V_O = 0	T_A = 25°C		30	400		30	200		30	200		30	200	pA
			T_A = full range			10			7			7			20	nA
V_{ICR}	Common-mode input voltage range	T_A = 25°C		±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		±11	−12 to 15		V
V_{OM}	Maximum peak output voltage swing	T_A = 25°C	R_L = 10 kΩ	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
		T_A = full range	R_L ≥ 10 kΩ	±12			±12			±12			±12			
			R_L ≥ 2 kΩ	±10	±12		±10	±12		±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L ≥ 2 kΩ, T_A = 25°C		25	200		50	200		50	200		50	200		V/mV
		V_O = ±10 V, R_L ≥ 2 kΩ, T_A = full range		15			25			25			25			
B_1	Unity-gain bandwidth	T_A = 25°C			3			3			3			3		MHz
r_i	Input resistance	T_A = 25°C			10^{12}			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, V_O = 0, R_S = 50 Ω, T_A = 25°C		70	86		80	86		80	86		80	86		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	V_{CC} = ±15 V to ±9 V, V_O = 0, R_S = 50 Ω, T_A = 25°C		70	86		80	86		80	86		80	86		dB
I_{CC}	Supply current (per amplifier)	No load, V_O = 0, T_A = 25°C			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°C			120			120			120			120		dB

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for T_A is 0°C to 70°C for TL08_C, TL08_AC, TL08_BC and −40°C to 85°C for TL08_I.

‡ 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 possible.

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

PARAMETER		TEST CONDITIONS†		TL081M, TL082M			TL084M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	T_A = 25°C		3	6		3	9	mV
			T_A = –55°C to 125°C			9			15	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, T_A = –55°C to 125°C	R_S = 50 Ω,		18			18		μV/°C
I_{IO}	Input offset current‡	V_O = 0	T_A = 25°C		5	100		5	100	pA
			T_A = 125°C			20			20	nA
I_{IB}	Input bias current‡	V_O = 0	T_A = 25°C		30	200		30	200	pA
			T_A = 125°C			50			50	nA
V_{ICR}	Common-mode input voltage range	T_A = 25°C		±11	±12 to 15		±11	±12 to 15		V
V_{OM}	Maximum peak output voltage swing	T_A = 25°C,	R_L = 10 kΩ	±12	±13.5		±12	±13.5		V
		T_A = –55°C to 125°C	R_L ≥ 10 kΩ	±12			±12			
			R_L ≥ 2 kΩ	±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, T_A = 25°C	R_L ≥ 2 kΩ,	25	200		25	200		V/mV
		V_O = ±10 V, T_A = –55°C to 125°C	R_L ≥ 2 kΩ,	15			15			
B_1	Unity-gain bandwidth	T_A = 25°C			3			3		MHz
r_i	Input resistance	T_A = 25°C			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, R_S = 50 Ω,	V_O = 0, T_A = 25°C	80	86		80	86		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±15 V to ±9 V, R_S = 50 Ω,	V_O = 0, T_A = 25°C	80	86		80	86		dB
I_{CC}	Supply current (per amplifier)	No load,	V_O = 0, T_A = 25°C		1.4	2.8		1.4	2.8	mA
V_{01}/V_{02}	Crosstalk attenuation	A_{VD} = 100,	T_A = 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.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1		8*	13		V/μs
		V_I = 10 V, T_A = – 55°C to 125°C,	R_L = 2 kΩ,	C_L = 100 pF, See Figure 1	5*			
t_r	Rise time	V_I = 20 mV, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1			0.05		μs
	Overshoot factor					20%		
V_n	Equivalent input noise voltage	R_S = 100 Ω	f = 1 kHz			18		nV/√Hz
			f = 10 Hz to 10 kHz			4		μV
I_n	Equivalent input noise current	R_S = 100 Ω,	f = 1 kHz			0.01		pA/√Hz
THD	Total harmonic distortion	$V_{O(rms)}$ = 10 V, f = 1 kHz	R_S ≤ 1 kΩ,	R_L ≥ 2 kΩ,		0.003%		

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

TL082Y, TL084Y electrical characteristics, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†			MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_O = 0,	R_S = 50 Ω,	T_A = 25°C		3	15	mV
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0,	R_S = 50 Ω,	T_A = 25°C		18		μV/°C
I_{IO}	Input offset current‡	V_O = 0,		T_A = 25°C		5	200	pA
I_{IB}	Input bias current‡	V_O = 0,		T_A = 25°C		30	400	pA
V_{ICR}	Common-mode input voltage range	T_A = 25°C			±11	−12 to 15		V
V_{OM}	Maximum peak output voltage swing	T_A = 25°C,		R_L = 10 kΩ	±12	±13.5		V
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V,	T_A = 25°C,	R_L ≥ 2 kΩ	25	200		V/mV
B_1	Unity-gain bandwidth	T_A = 25°C				3		MHz
r_i	Input resistance	T_A = 25°C				10^{12}		Ω
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min,	R_S = 50 Ω,	V_O = 0, T_A = 25°C	70	86		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}$ / ΔV_{IO})	V_{CC} = ±15 V to ± 9 V,	R_S = 50 Ω,	V_O = 0, T_A = 25°C	70	86		dB
I_{CC}	Supply current (per amplifier)	No load,	V_O = 0,	T_A = 25°C		1.4	2.8	mA
V_{01}/V_{02}	Crosstalk attenuation	A_{VD} = 100,		T_A = 25°C		120		dB

† All characteristics are measured under open-loop conditions with zero common-mode 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 temperature as close to the ambient temperature as possible.

operating characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 2 kΩ, See Figure 1	8	13		V/μs
t_r	Rise time	V_I = 20 mV,	R_L = 2 kΩ,		0.05		μs
	Overshoot factor	C_L = 100 pF,	See Figure 1		20%		
V_n	Equivalent input noise voltage	R_S = 100 Ω	f = 1 kHz		18		nV/√Hz
			f = 10 Hz to 10 kHz		4		μV
I_n	Equivalent input noise current	R_S = 100 Ω,	f = 1 kHz		0.01		pA/√Hz
THD	Total harmonic distortion	$V_{O(rms)}$ = 10 V, f = 1 kHz	R_S ≤ 1 kΩ, R_L ≥ 2 kΩ,		0.003%		

PARAMETER MEASUREMENT INFORMATION

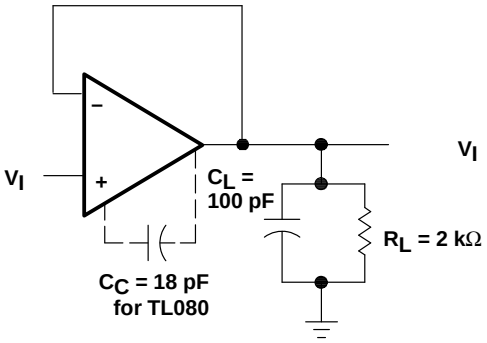


Figure 1. Unity-Gain Amplifier

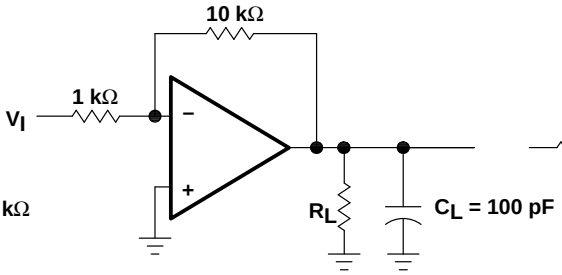


Figure 2. Gain-of-10 Inverting Amplifier

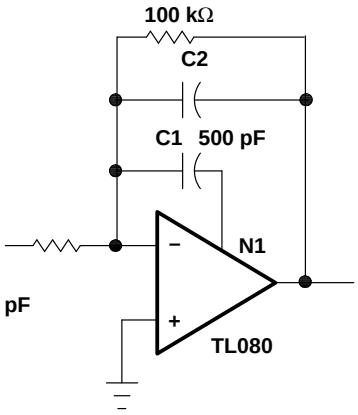


Figure 3. Feed-Forward Compensation

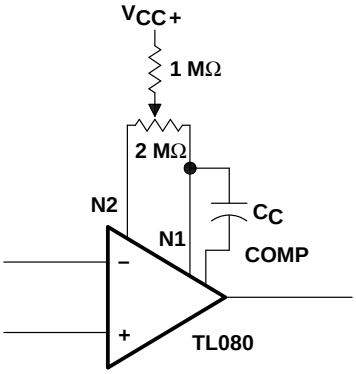


Figure 4. TL080 Input Offset Voltage Null Circuit

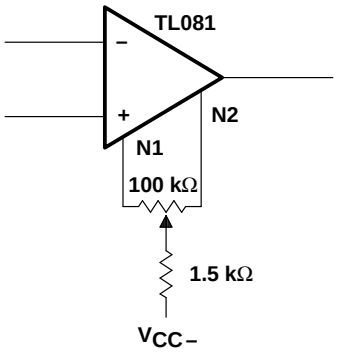


Figure 5. TL081 Input Offset Voltage Null Circuit

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77001

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

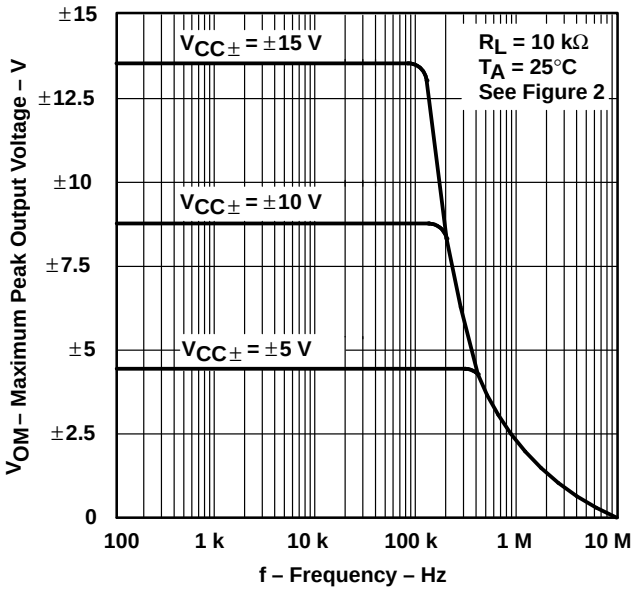


Figure 6

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

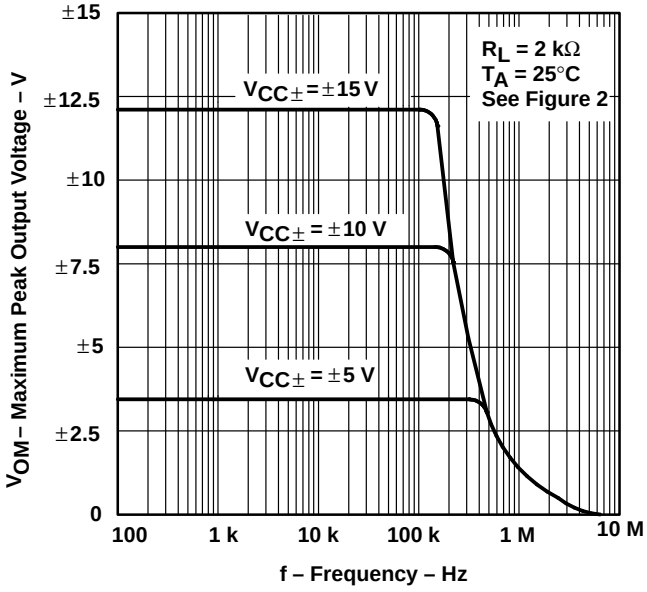


Figure 7

MAXIMUM PEAK OUTPUT VOLTAGE‡ vs FREQUENCY

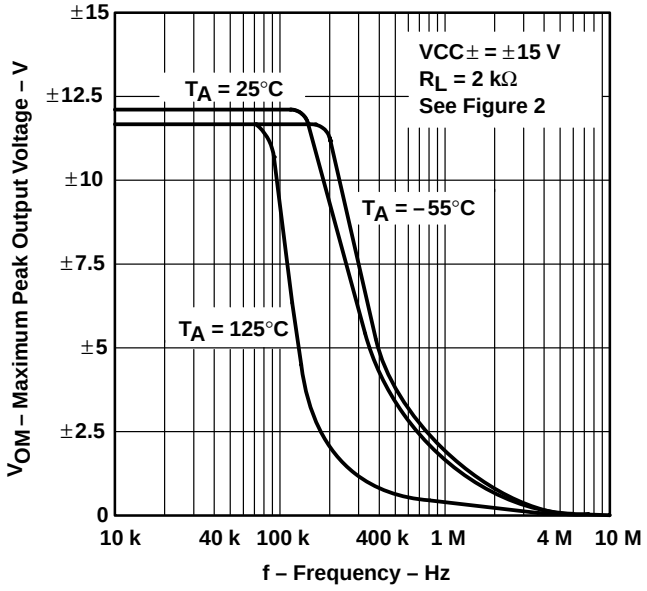


Figure 8

MAXIMUM PEAK OUTPUT VOLTAGE§ vs FREE-AIR TEMPERATURE

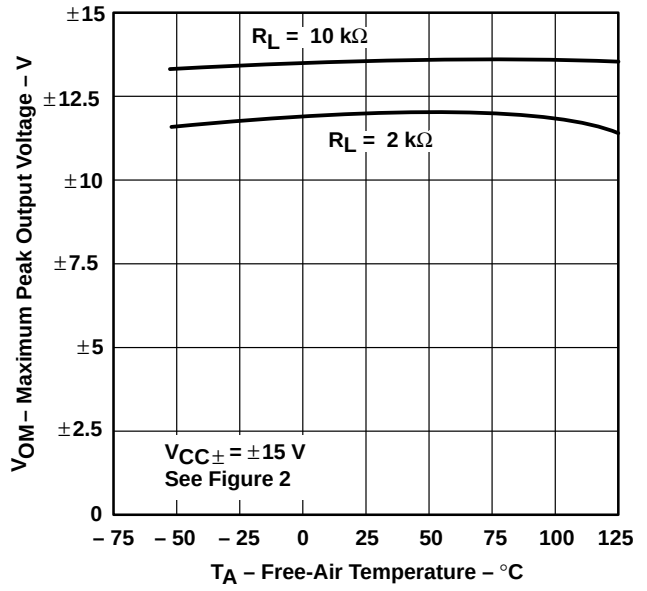


Figure 9

† 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.
‡ The –55°C curve and the 125°C curve apply only to the M version.
§ The temperature range of the C version is 0°C to 75°C, the I version is –40°C to 85°C, and the M version is –55°C to 125°C.

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

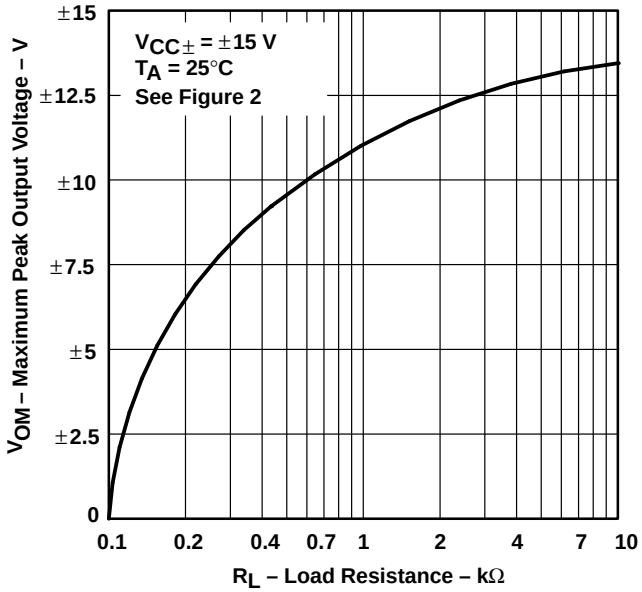


Figure 10

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

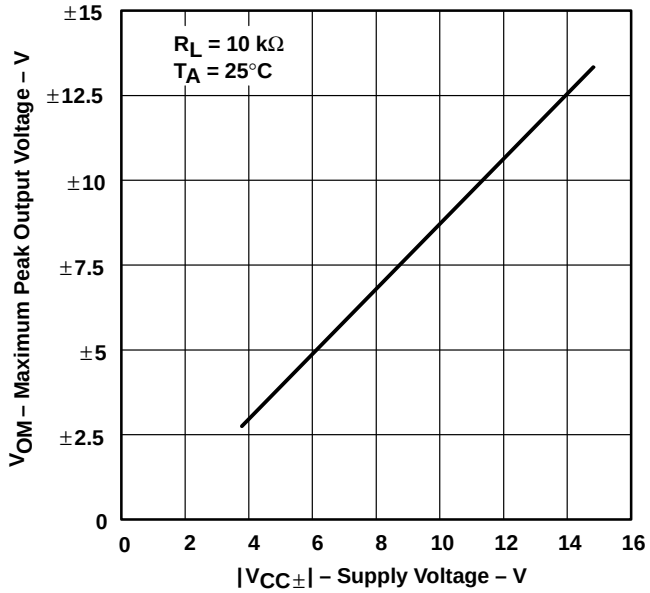


Figure 11

LARGE-SIGNAL‡ DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

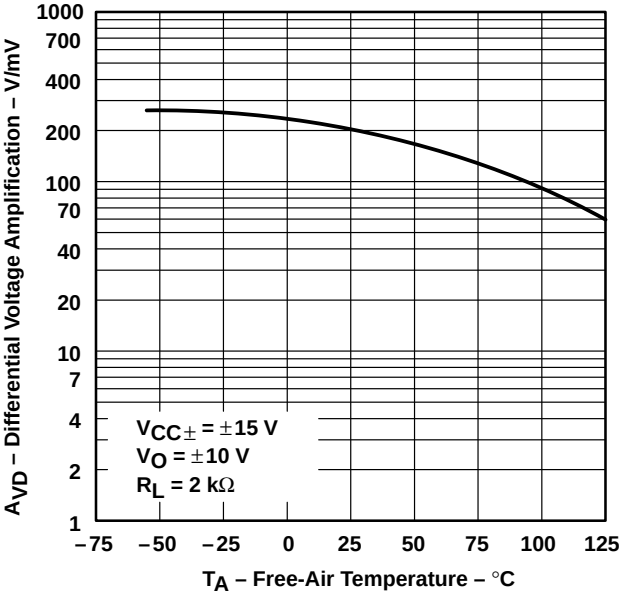


Figure 12

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY

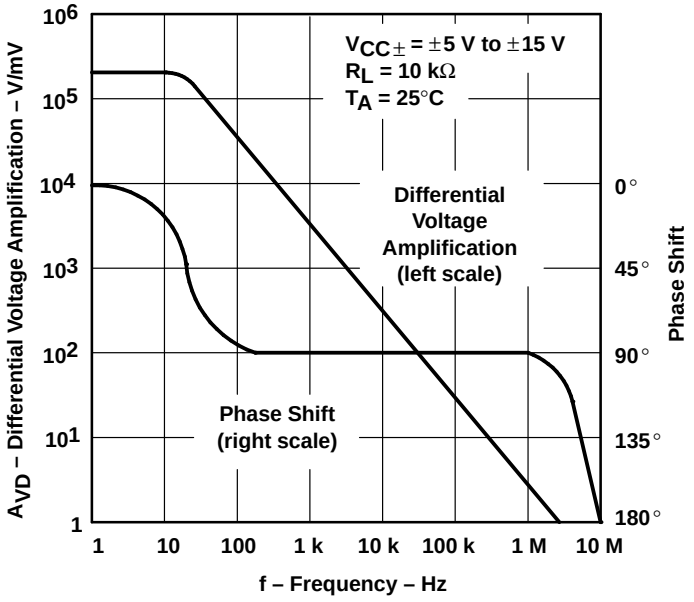


Figure 13

† 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.

‡ The temperature range of the C version is 0°C to 75°C, the I version is –40°C to 85°C, and the M version is –55°C to 125°C.

TYPICAL CHARACTERISTICS†

TL080
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREQUENCY WITH FEED-FORWARD COMPENSATION

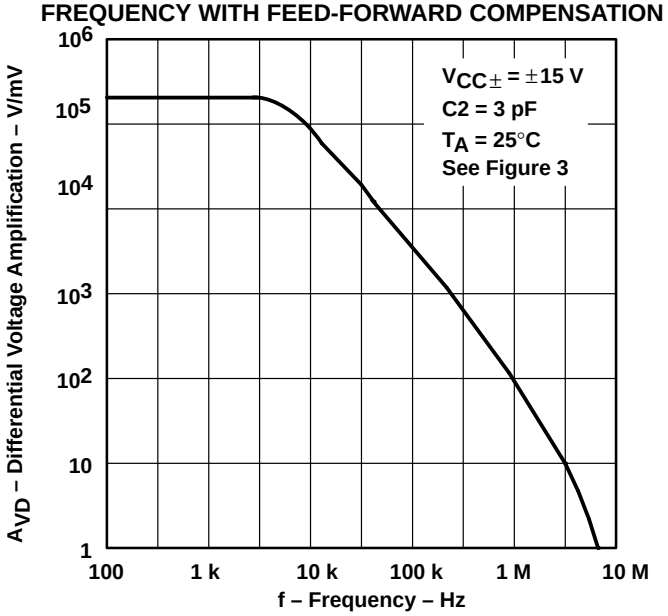


Figure 14

TOTAL POWER DISSIPATED‡
vs
FREE-AIR TEMPERATURE

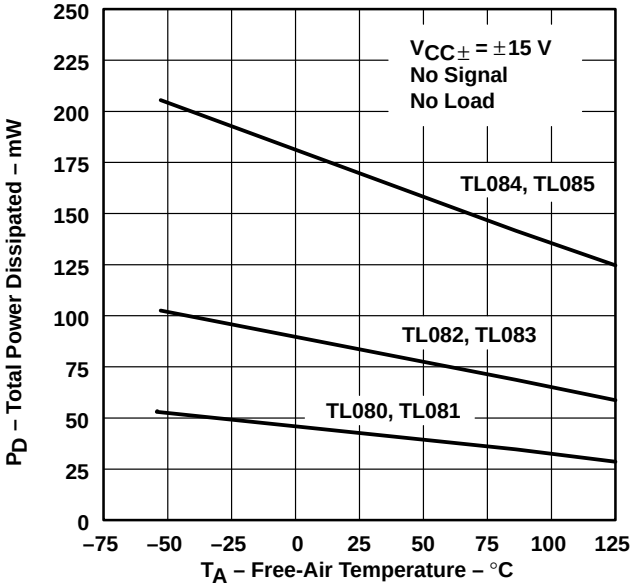


Figure 15

SUPPLY CURRENT PER AMPLIFIER‡
vs
FREE-AIR TEMPERATURE

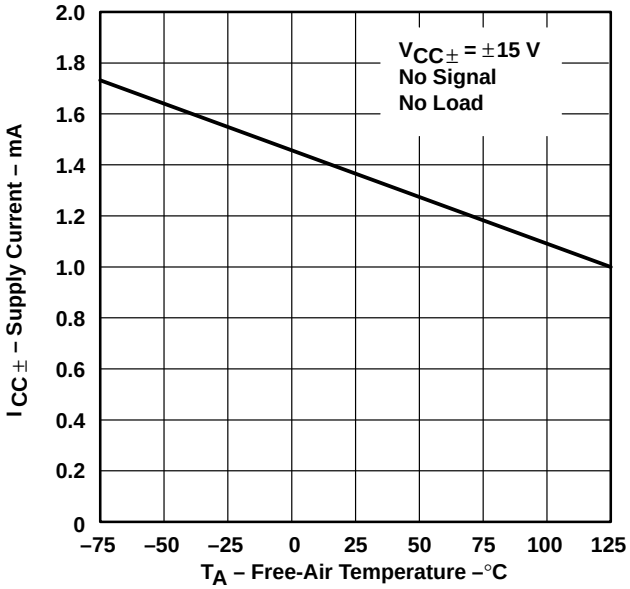


Figure 16

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

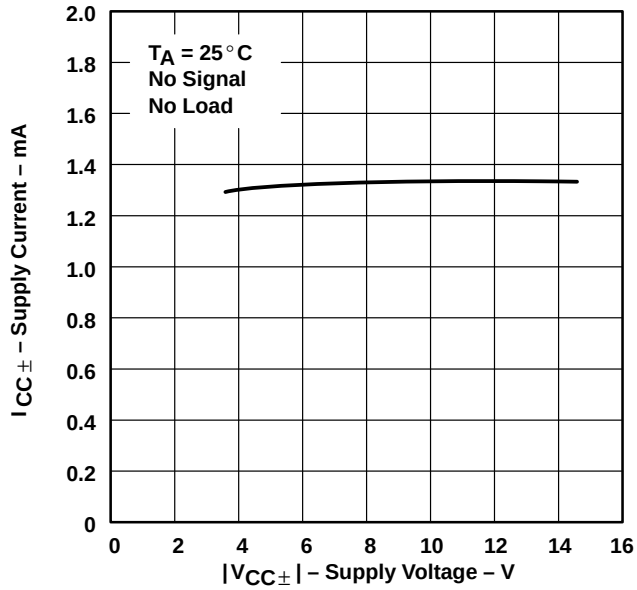


Figure 17

† 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.
‡ The temperature range of the C version is 0°C to 75°C, the I version is –40°C to 85°C, and the M version is –55°C to 125°C.

TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT‡ vs FREE-AIR TEMPERATURE

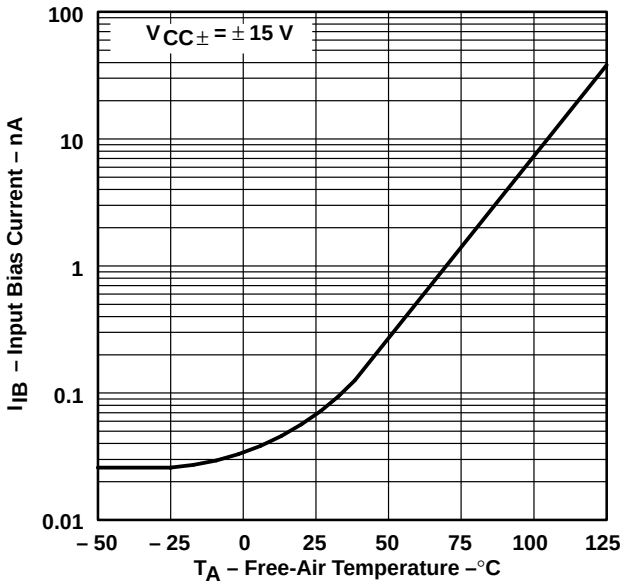


Figure 18

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

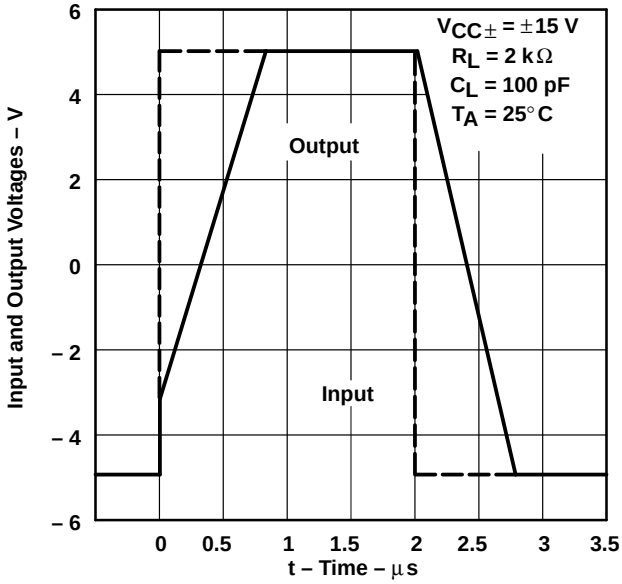


Figure 19

OUTPUT VOLTAGE vs ELAPSED TIME

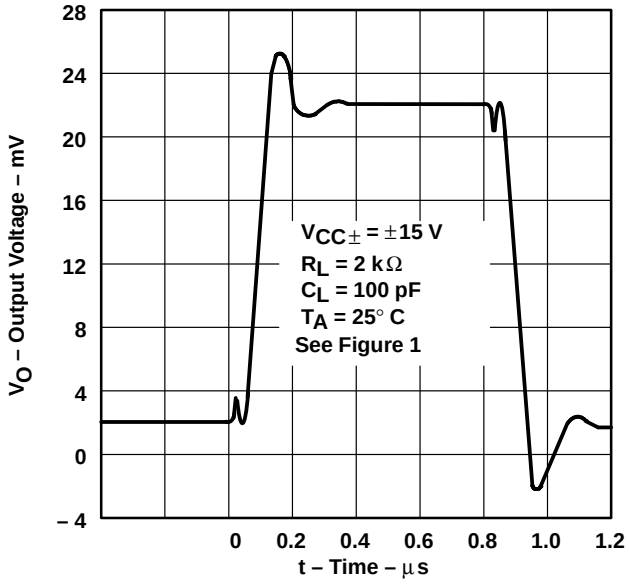


Figure 20

† 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.

‡ The temperature range of the C version is 0°C to 75°C, the I version is –40°C to 85°C, and the M version is –55°C to 125°C.

TYPICAL CHARACTERISTICS†

COMMON-MODE REJECTION RATIO‡ vs FREE-AIR TEMPERATURE

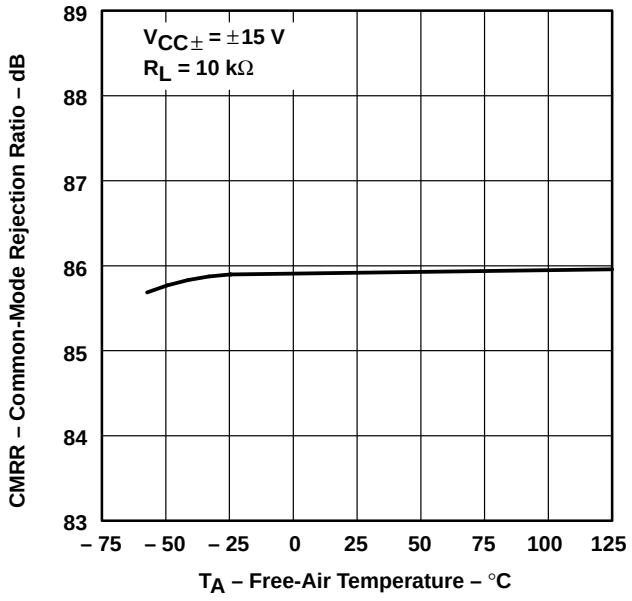


Figure 21

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

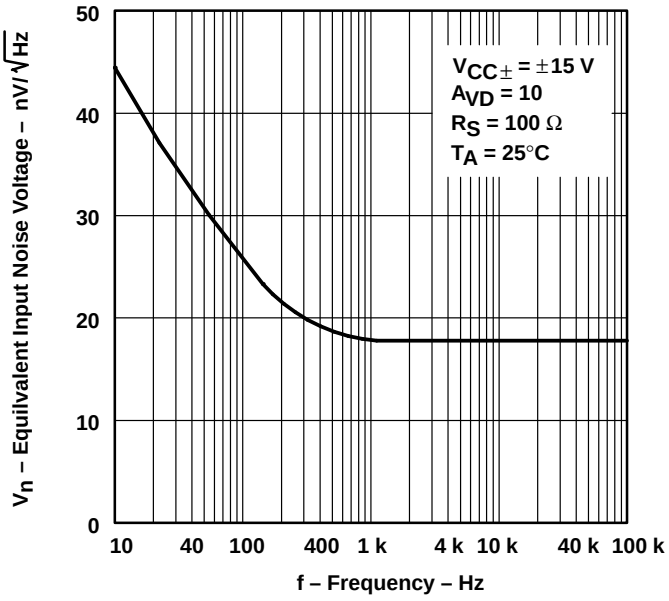


Figure 22

TOTAL HARMONIC DISTORTION vs FREQUENCY

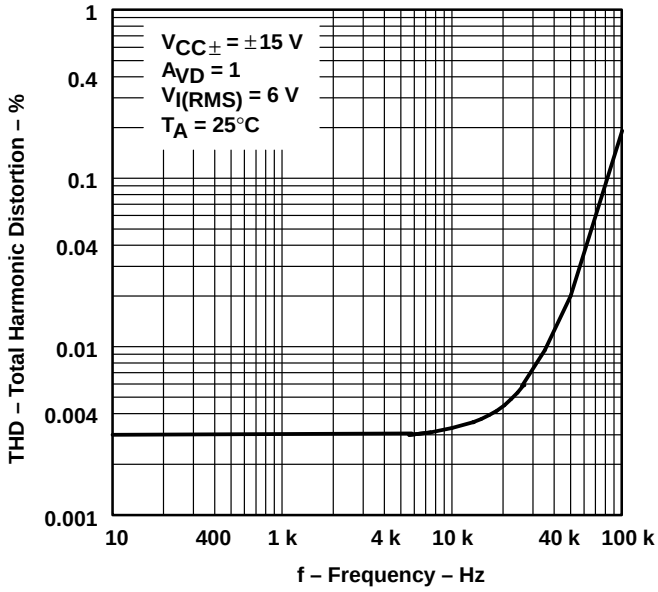


Figure 23

† 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.

‡ The temperature range of the C version is 0°C to 75°C, the I version is –40°C to 85°C, and the M version is –55°C to 125°C.

TYPICAL APPLICATION DATA

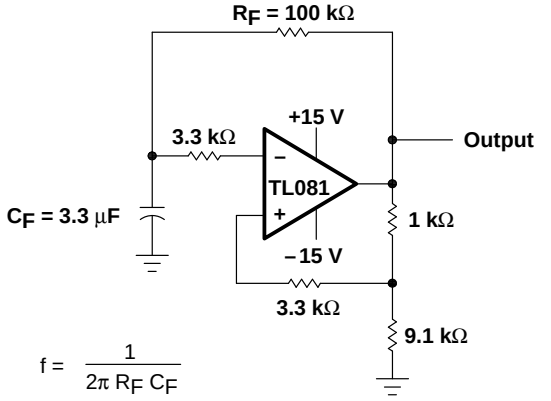


Figure 24. 0.5-Hz Square-Wave Oscillator

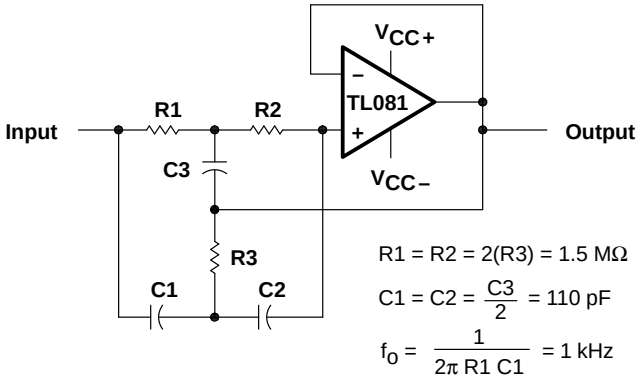


Figure 25. High-Q Notch Filter

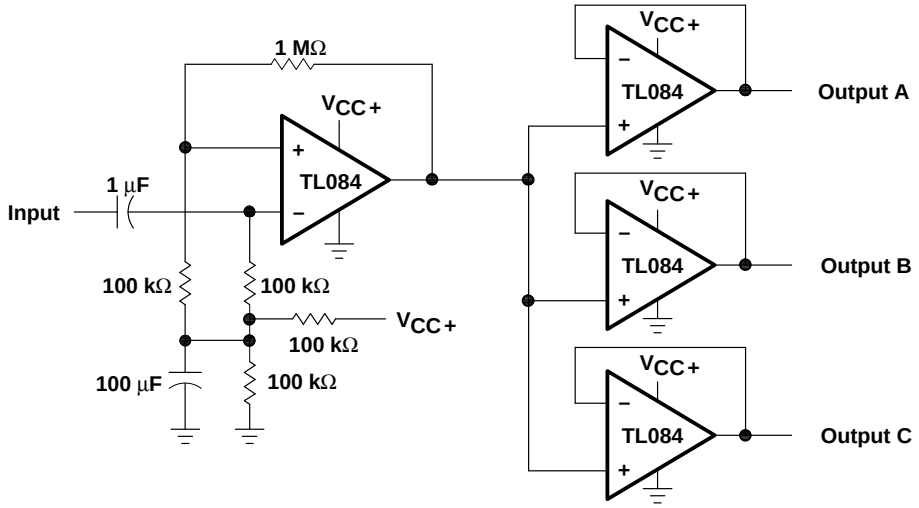
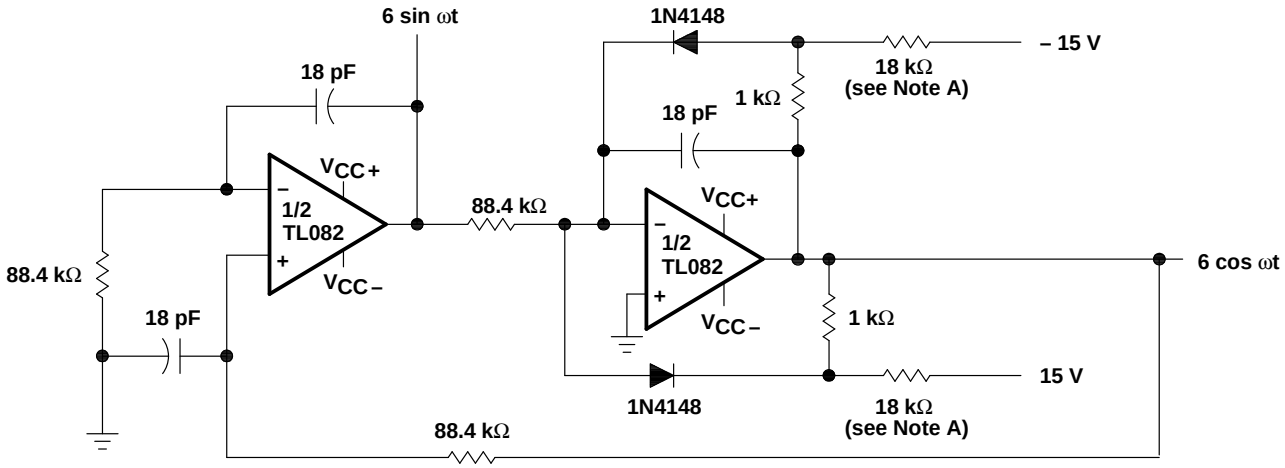


Figure 26. Audio Distribution Amplifier



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

Figure 27. 100-KHz Quadrature Oscillator

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265
POST OFFICE BOX 1443 • HOUSTON, TEXAS 77001

TYPICAL APPLICATION DATA

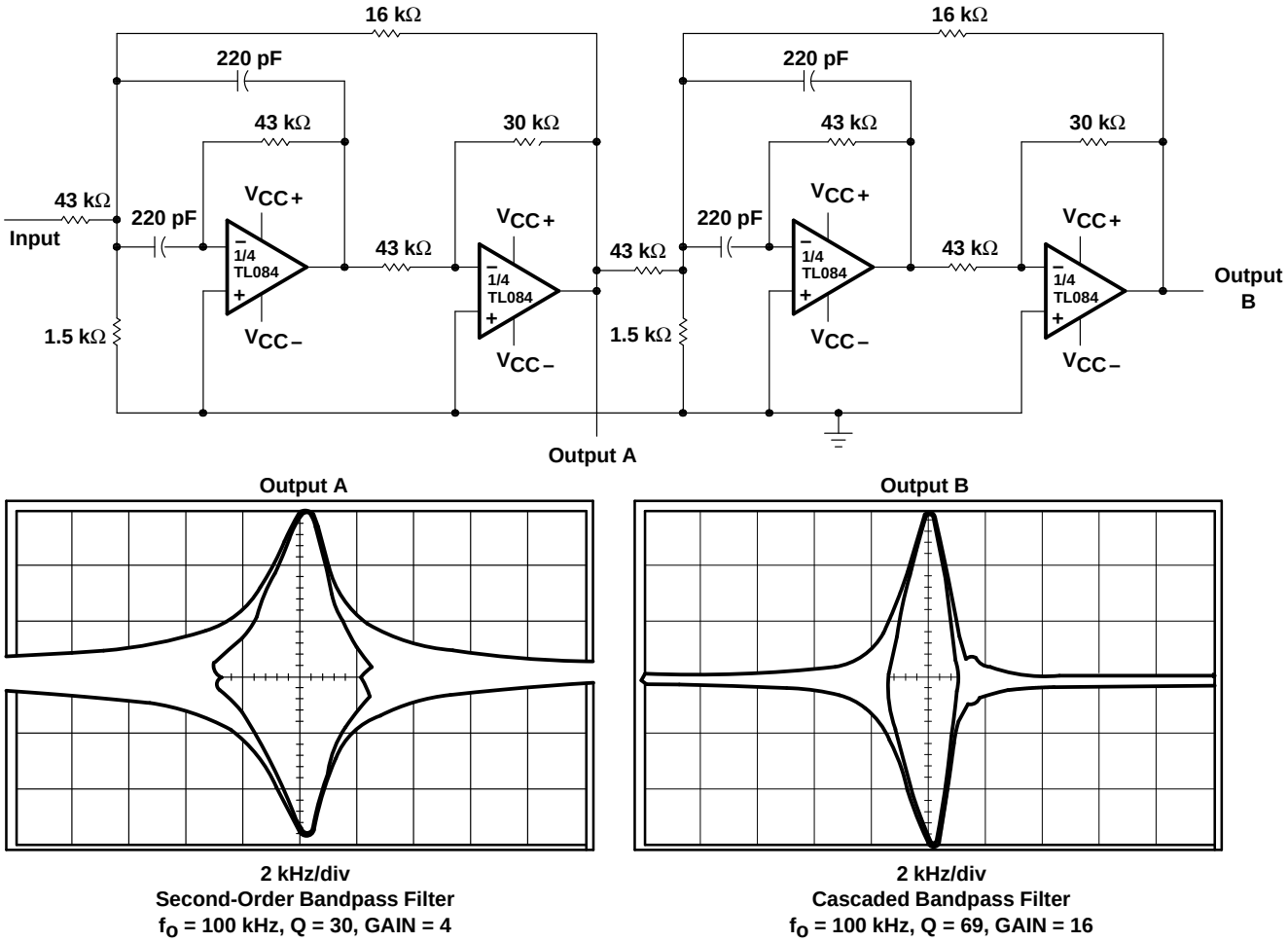


Figure 28. Positive-Feedback Bandpass Filter

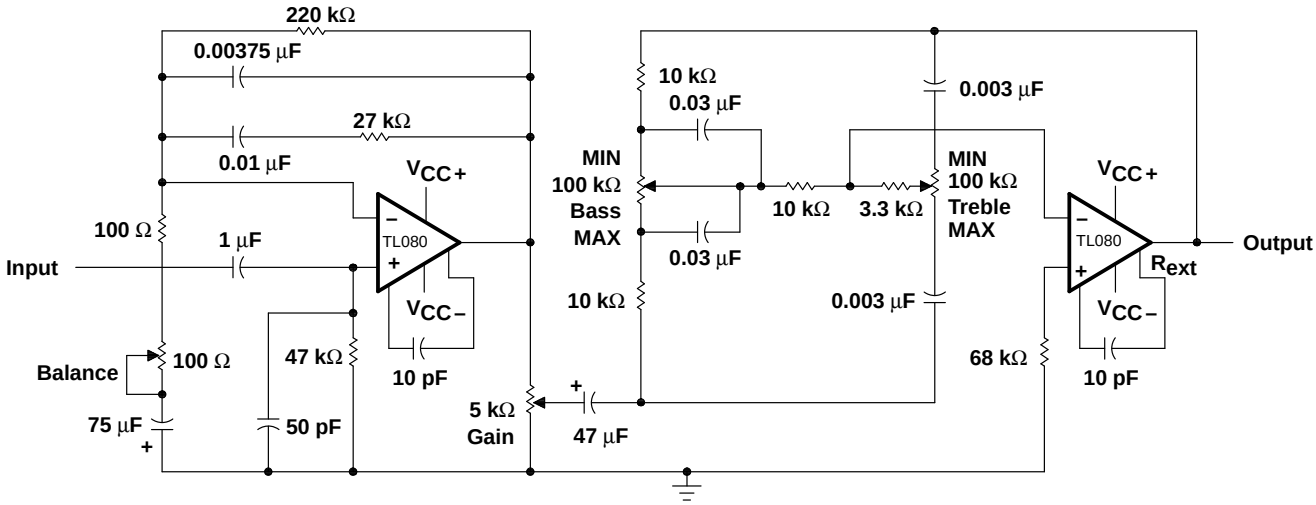


Figure 29. IC Preamplifier