TL081, TL081A, TL081B, TL082, TL082A, TL082B, TL082Y, TL084, TL084A, TL084B, TL084Y JFET-INPUT OPERATIONAL AMPLIFIERS

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**
- **Latch-Up-Free Operation**
- **High Slew Rate . . . 13 V/μs Typ**
- **Common-Mode Input Voltage Range Includes V_{CC+}**

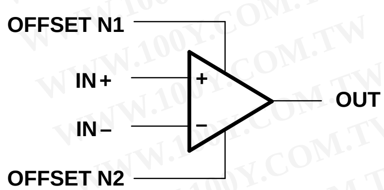
description

The TL08x 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 TL08x family.

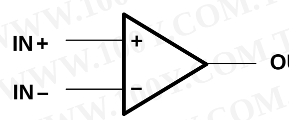
The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

symbols

TL081

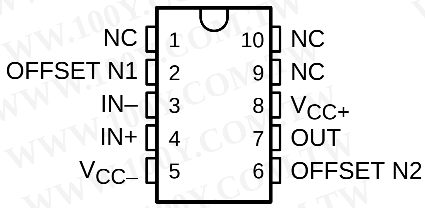


TL082 (EACH AMPLIFIER)
TL084 (EACH AMPLIFIER)

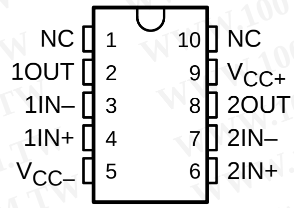


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

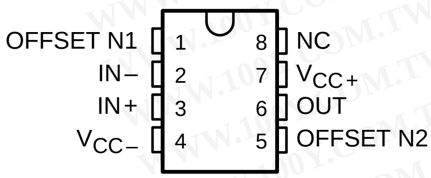
TL081, TL081A, TL081B
U PACKAGE
(TOP VIEW)



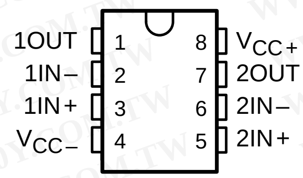
TL082, TL082A, TL082B
U PACKAGE
(TOP VIEW)



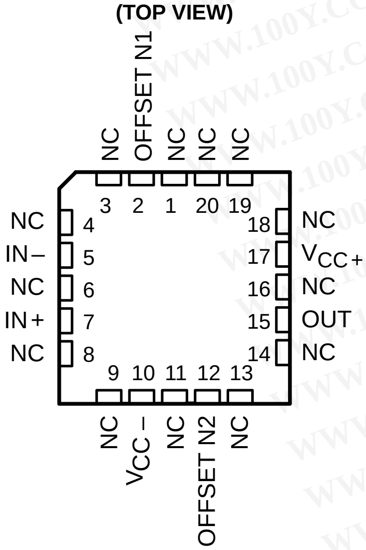
TL081, TL081A, TL081B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



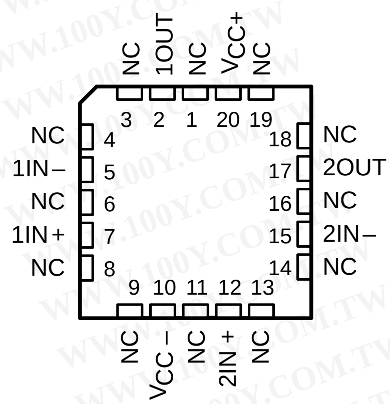
TL082, TL082A, TL082B
D, JG, P, OR PW PACKAGE
(TOP VIEW)



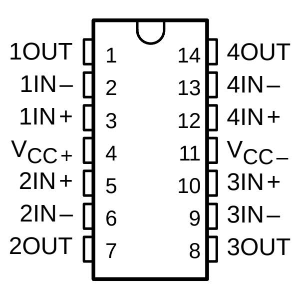
TL081M . . . FK PACKAGE
(TOP VIEW)



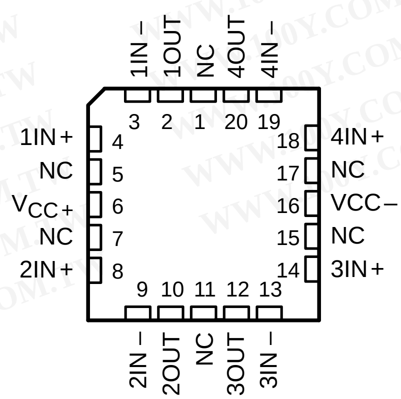
TL082M . . . FK PACKAGE
(TOP VIEW)



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



TL084M . . . FK PACKAGE
(TOP VIEW)



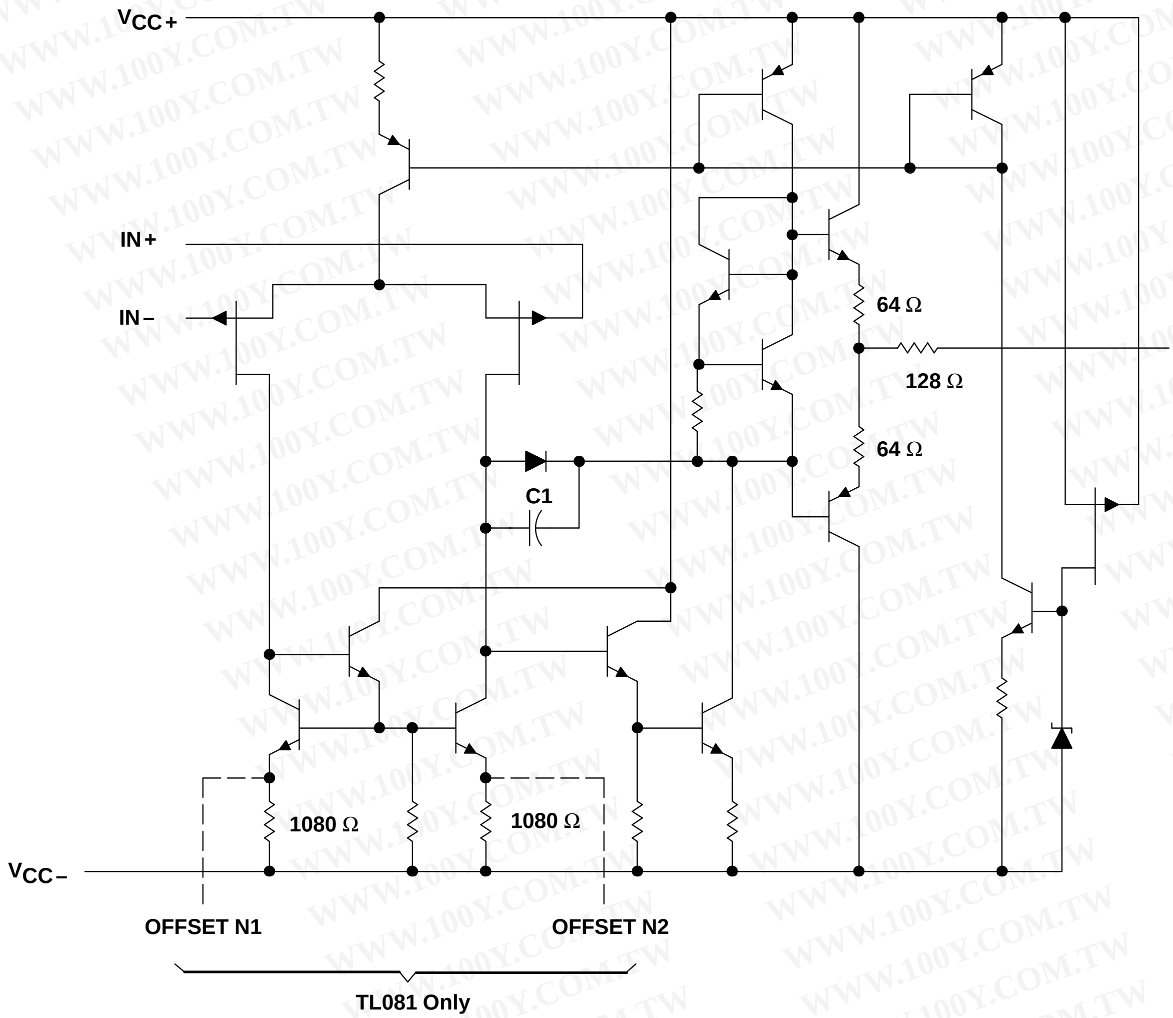
NC – No internal connection

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES										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)	FLAT PACK (U)	FLAT PACK (W)	
0°C to 70°C	15 mV 6 mV 3 mV	TL081CD TL081ACD TL081BCD	—	—	—	—	—	TL081CP TL081ACP TL081BCP	TL081CPW	—	—	—
	15 mV 6 mV 3 mV	TL082CD TL082ACD TL082BCD	—	—	—	—	—	TL082CP TL082ACP TL082BCP	TL082CPW	—	—	TL082Y
	15 mV 6 mV 3 mV	—	TL084CD TL084ACD TL084BCD	—	—	—	TL084CN TL084ACN TL084BCN	—	TL084CPW	—	—	TL084Y
–40°C to 85°C	6 mV 6 mV 6 mV	TL081ID TL082ID TL084ID	TL084ID	—	—	—	TL084IN	TL081IP TL082IP	—	—	—	—
–55°C to 125°C	6 mV 6 mV 9 mV	—	—	TL081MFK TL082MFK TL084MFK	TL084MJ	TL081MJG TL082MJG	—	—	—	TL081MU TL082MU	TL084MW	—

The D package is available taped and reeled. Add R suffix to the device type (e.g., TL081CDR).

schematic (each amplifier)

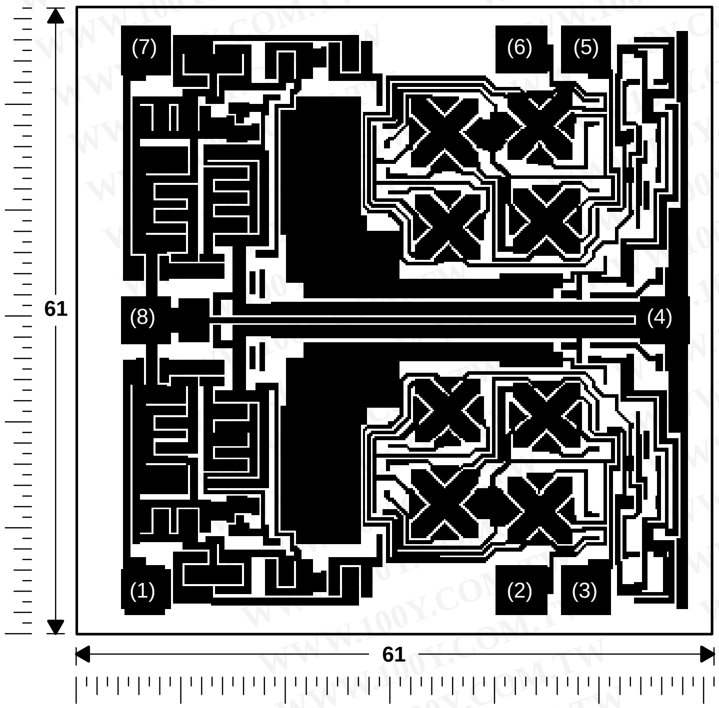


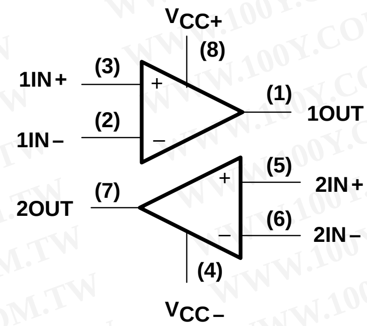
Component values shown are nominal.

TL082Y 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%.

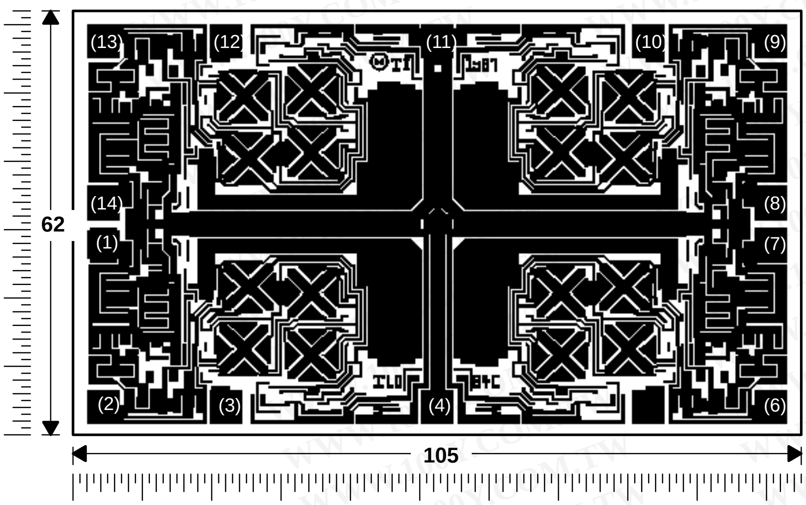
ALL DIMENSIONS ARE IN MILS.

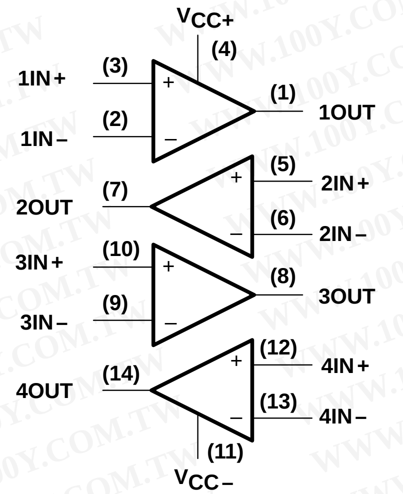
PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

TL084Y 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) IS 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, V_{ID} (see Note 2)		± 30	± 30	± 30	V
Input voltage, V_I (see Notes 1 and 3)		±15	±15	±15	V
Duration of output short circuit (see Note 4)		unlimited	unlimited	unlimited	
Continuous total power dissipation		See Dissipation Rating Table			
Operating free-air temperature range, T_A		0 to 70	– 40 to 85	– 55 to 125	°C
Storage temperature range, T_{stg}		– 65 to 150	– 65 to 150	– 65 to 150	°C
Case temperature for 60 seconds, T_C	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

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

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 IN+ with respect to IN–.
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	460 mW	373 mW	N/A
D (14 pin)	680 mW	7.6 mW/°C	60°C	604 mW	490 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	273 mW
J	680 mW	11.0 mW/° C	88°C	680 mW	680 mW	273 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	597 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
U	675 mW	5.4 mW/°C	25°C	432 mW	351 mW	135 mW
W	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	200 mW

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

	PARAMETER	TEST CONDITIONS	T_A†	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	25°C		3	15		3	6		2	3		3	6	mV
			Full range			20			7.5			5			9	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω	Full range		18			18			18			18		µV/°C
I_{IO}	Input offset current‡	V_O = 0	25°C		5	200		5	100		5	100		5	100	pA
			Full range			2			2			2			10	nA
I_{IB}	Input bias current‡	V_O = 0	25°C		30	400		30	200		30	200		30	200	pA
			Full range			10			7			7			20	nA
V_{ICR}	Common-mode input voltage range		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	R_L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		±12	±13.5		±12	±13.5		V
		R_L ≥ 10 kΩ	Full range	±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	25°C	25	200		50	200		50	200		50	200		V/mV
		V_O = ±10 V, R_L ≥ 2 kΩ	Full range	15			25			25			25			
B_1	Unity-gain bandwidth		25°C		3			3			3			3		MHz
r_i	Input resistance		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	25°C	70	86		75	86		75	86		75	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	25°C	70	86		80	86		80	86		80	86		dB
I_{CC}	Supply current (per amplifier)	V_O = 0, No load	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	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 17. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

electrical characteristics, $V_{CC\pm} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	T_A	TL081M, TL082M MIN	TL081M, TL082M TYP	TL081M, TL082M MAX	TL084M MIN	TL084M TYP	TL084M MAX	UNIT
V_{IO}	Input offset voltage	$V_O = 0$, $R_S = 50\ \Omega$	25°C		3	6		3	9	mV
			−55°C to 125°C			9			15	
α_{VIO}	Temperature coefficient of input offset voltage	$V_O = 0$, $R_S = 50\ \Omega$	−55°C to 125°C		18			18		μV/°C
I_{IO}	Input offset current‡	$V_O = 0$	25°C		5	100		5	100	pA
			125°C			20			20	nA
I_{IB}	Input bias current‡	$V_O = 0$	25°C		30	200		30	200	pA
			125°C			50			50	nA
V_{ICR}	Common-mode input voltage range		25°C	±11	±12 to 15		±11	± 12 to 15		V
V_{OM}	Maximum peak output voltage swing	$R_L = 10\ k\Omega$	25°C	±12	±13.5		±12	±13.5		V
		$R_L \geq 10\ k\Omega$	−55°C to 125°C	±12			±12			
		$R_L \geq 2\ k\Omega$		±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V, $R_L \geq 2\ k\Omega$	25°C	25	200		25	200		V/mV
		$V_O = \pm10$ V, $R_L \geq 2\ k\Omega$	−55°C to 125°C	15			15			
B_1	Unity-gain bandwidth		25°C		3			3		MHz
r_i	Input resistance		25°C		10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min$, $V_O = 0$, $R_S = 50\ \Omega$	25°C	80	86		80	86		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC} = \pm15$ V to ±9 V, $V_O = 0$, $R_S = 50\ \Omega$	25°C	80	86		80	86		dB
I_{CC}	Supply current (per amplifier)	$V_O = 0$, No load	25°C		1.4	2.8		1.4	2.8	mA
V_{O1}/V_{O2}	Crosstalk attenuation	$A_{VD} = 100$	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 17. Pulse techniques must be used that maintain the junction temperatures as close to the ambient temperature as is possible.

operating characteristics, $V_{CC\pm} = \pm15$ 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, $R_L = 2\ k\Omega$, $C_L = 100$ pF, See Figure 1	8*	13		V/μs
		$V_I = 10$ V, $R_L = 2\ k\Omega$, $C_L = 100$ pF, $T_A = -55°C$ to 125°C, See Figure 1	5*			
t_r	Rise time	$V_I = 20$ mV, $R_L = 2\ k\Omega$, $C_L = 100$ pF, See Figure 1		0.05		μs
	Overshoot factor			20%		
V_n	Equivalent input noise voltage	$R_S = 20\ \Omega$, f = 1 kHz		18		nV/√Hz
		$R_S = 20\ \Omega$, f = 10 Hz to 10 kHz		4		μV
I_n	Equivalent input noise current	$R_S = 20\ \Omega$, f = 1 kHz		0.01		pA/√Hz
THD	Total harmonic distortion	$V_{O(rms)} = 10$ V, $R_S \leq 1\ k\Omega$, $R_L \geq 2\ k\Omega$, f = 1 kHz		0.003%		

*On products compliant to MIL-PRF-38535, this parameter is not production tested.

electrical characteristics, $V_{CC\pm} = \pm15$ V, $T_A = 25°C$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		TL082Y, TL084Y			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_O = 0$,	$R_S = 50\ \Omega$,		3	15	mV
α_{VIO}	Temperature coefficient of input offset voltage	$V_O = 0$,	$R_S = 50\ \Omega$,		18		μV/°C
I_{IO}	Input offset current‡	$V_O = 0$,			5	200	pA
I_{IB}	Input bias current‡	$V_O = 0$,			30	400	pA
V_{ICR}	Common-mode input voltage range			±11	–12 to 15		V
V_{OM}	Maximum peak output voltage swing	$R_L = 10\ k\Omega$,		±12	±13.5		V
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V,	$R_L \geq 2\ k\Omega$	25	200		V/mV
B_1	Unity-gain bandwidth				3		MHz
r_i	Input resistance				10^{12}		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min$, $R_S = 50\ \Omega$	$V_O = 0$,	70 70	86 86		dB dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC} = \pm15$ V to ±9 V, $V_O = 0$,	$R_S = 50\ \Omega$	70 70	86 86		dB dB
I_{CC}	Supply current (per amplifier)	$V_O = 0$,	No load		1.4	2.8	mA
V_{O1}/V_{O2}	Crosstalk attenuation	$A_{VD} = 100$			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 17. Pulse techniques must be used that maintain the junction temperature as close to the ambient temperature as possible.

operating characteristics, $V_{CC\pm} = \pm15$ V, $T_A = 25°C$

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/μs
t_r	Rise time	$V_I = 20$ mV,	$R_L = 2\ k\Omega$, $C_L = 100$ pF, See Figure 1		0.05		μs
	Overshoot factor				20%		
V_n	Equivalent input noise voltage	$R_S = 20\ \Omega$	f = 1 kHz		18		nV/√Hz
			f = 10 Hz to 10 kHz		4		μV
I_n	Equivalent input noise current	$R_S = 20\ \Omega$,	f = 1 kHz		0.01		pA/√Hz
THD	Total harmonic distortion	$V_{O(rms)} = 10$ V,	$R_S \leq 1\ k\Omega$, $R_L \geq 2\ k\Omega$, f = 1 kHz		0.003%		

PARAMETER MEASUREMENT INFORMATION

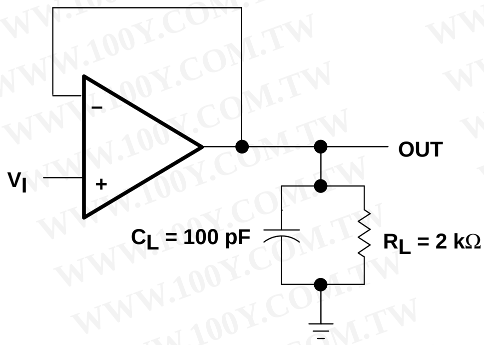


Figure 1

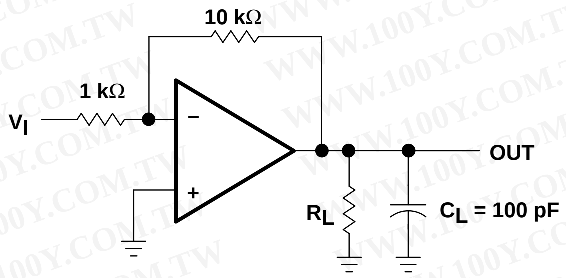


Figure 2

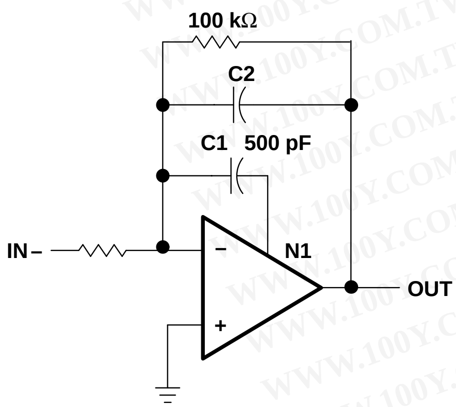


Figure 3

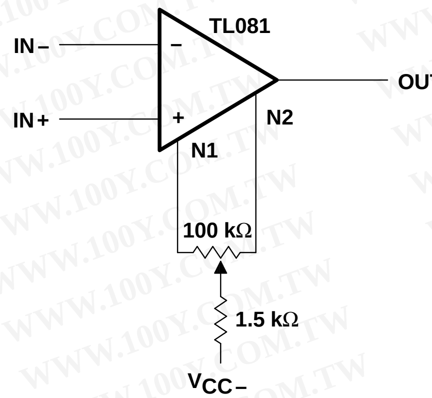


Figure 4

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{OM}	Maximum peak output voltage	vs Frequency vs Free-air temperature vs Load resistance vs Supply voltage	5, 6, 7 8 9 10
A_{VD}	Large-signal differential voltage amplification	vs Free-air temperature vs Frequency	11 12
	Differential voltage amplification	vs Frequency with feed-forward compensation	13
P_D	Total power dissipation	vs Free-air temperature	14
I_{CC}	Supply current	vs Free-air temperature vs Supply voltage	15 16
I_{IB}	Input bias current	vs Free-air temperature	17
	Large-signal pulse response	vs Time	18
V_O	Output voltage	vs Elapsed time	19
CMRR	Common-mode rejection ratio	vs Free-air temperature	20
V_n	Equivalent input noise voltage	vs Frequency	21
THD	Total harmonic distortion	vs Frequency	22

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

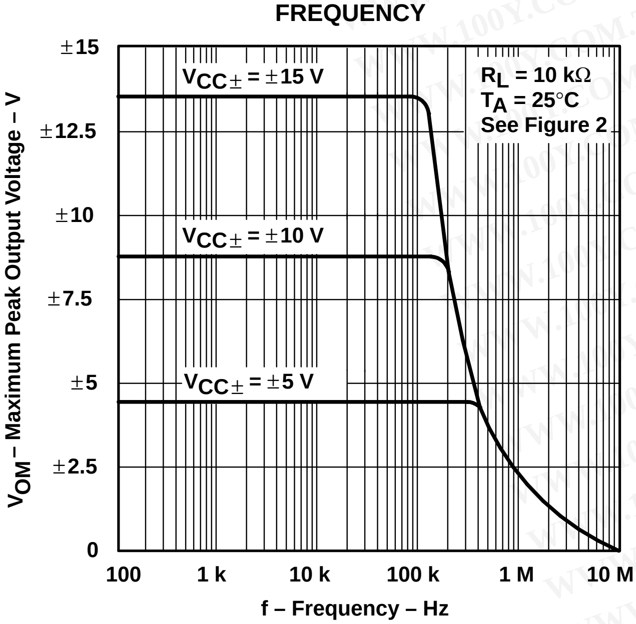


Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

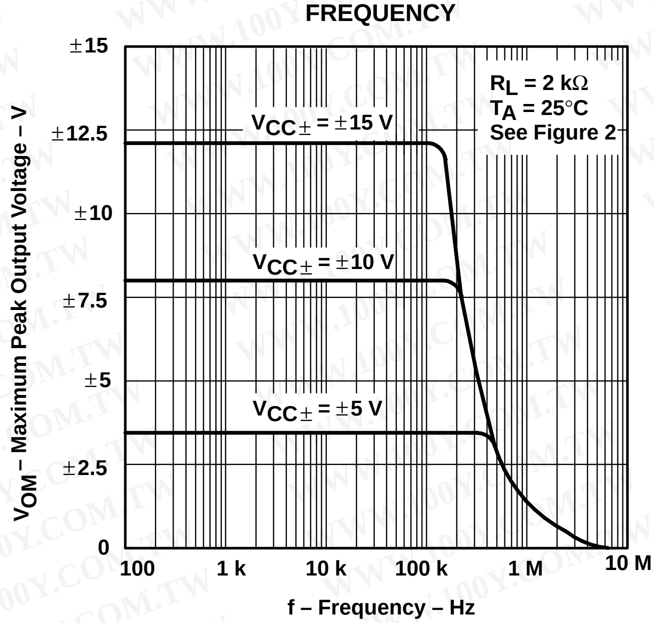


Figure 6

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

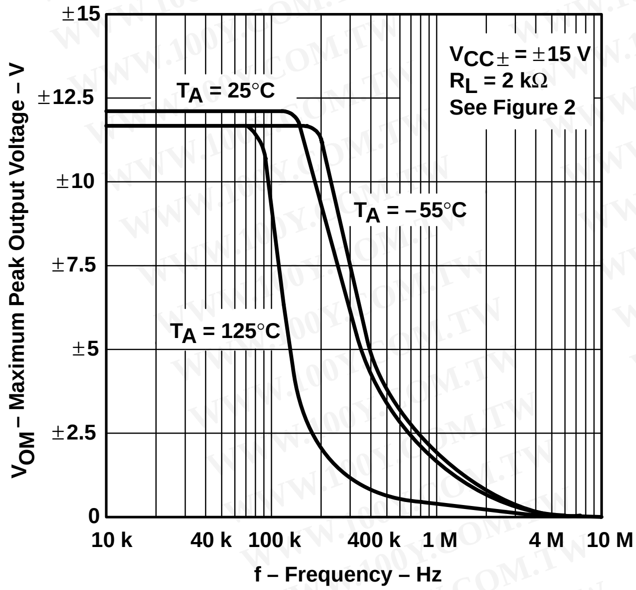


Figure 7

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

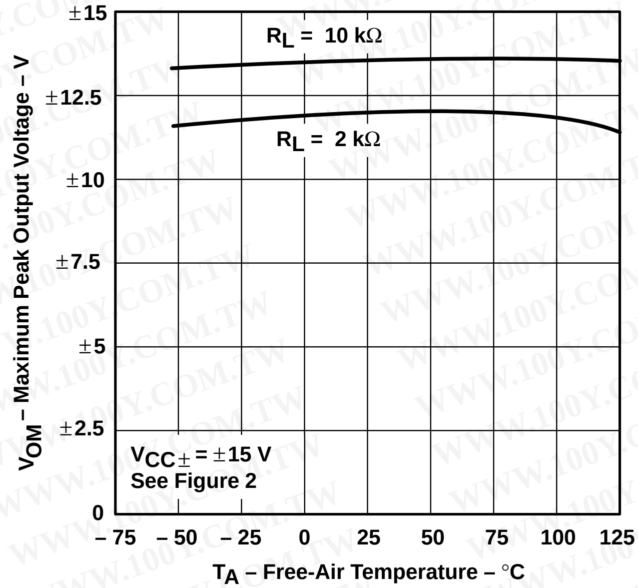


Figure 8

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

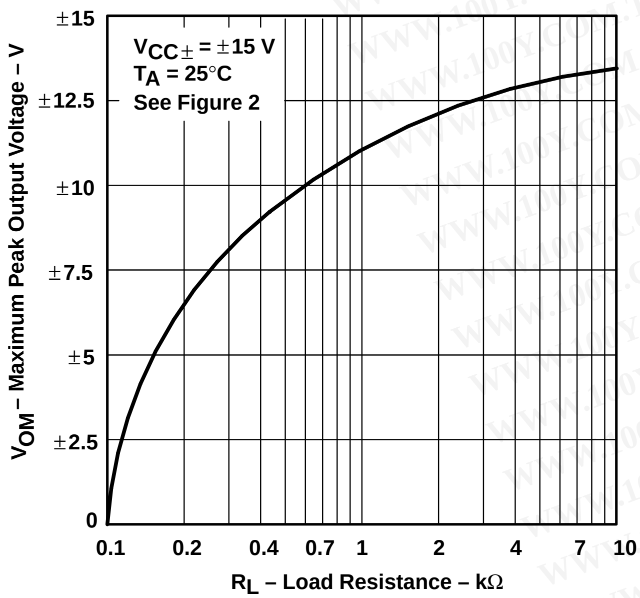


Figure 9

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

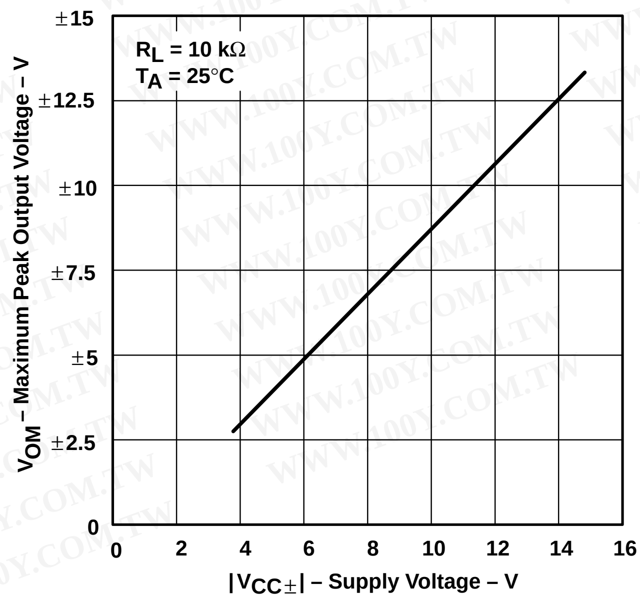


Figure 10

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

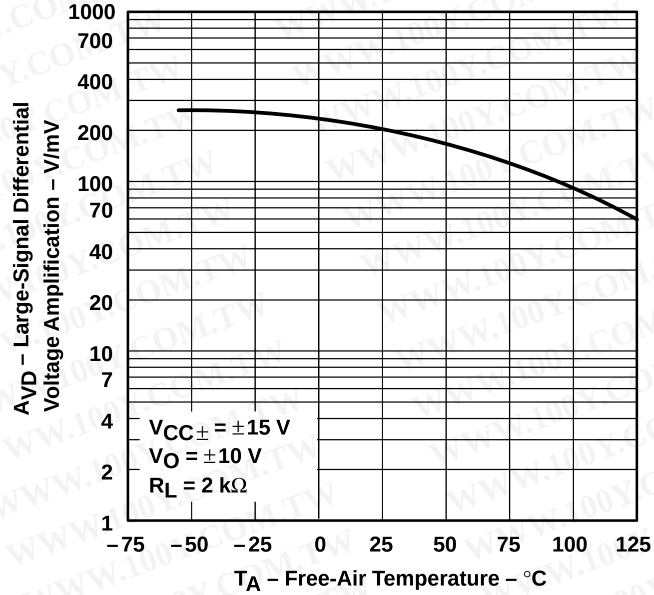


Figure 11

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY

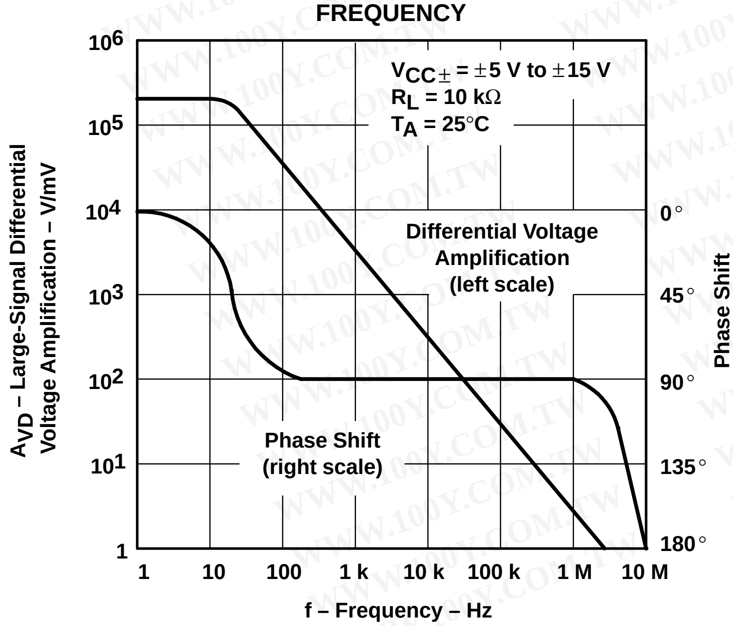


Figure 12

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREQUENCY WITH FEED-FORWARD COMPENSATION

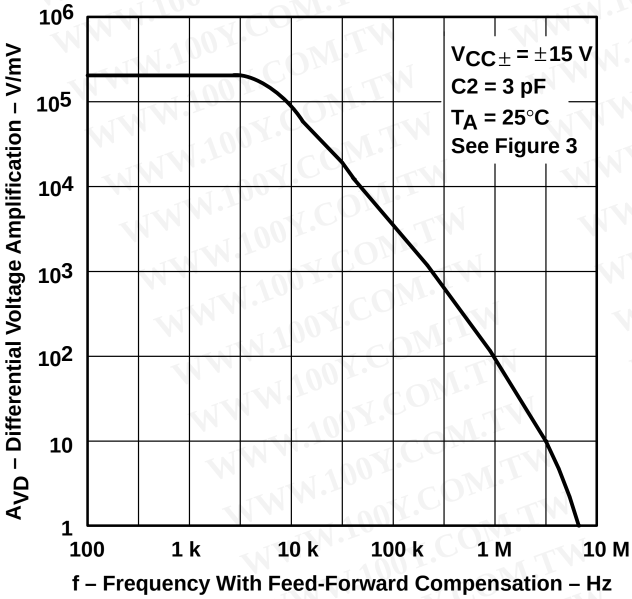


Figure 13

TOTAL POWER DISSIPATION
vs
FREE-AIR TEMPERATURE

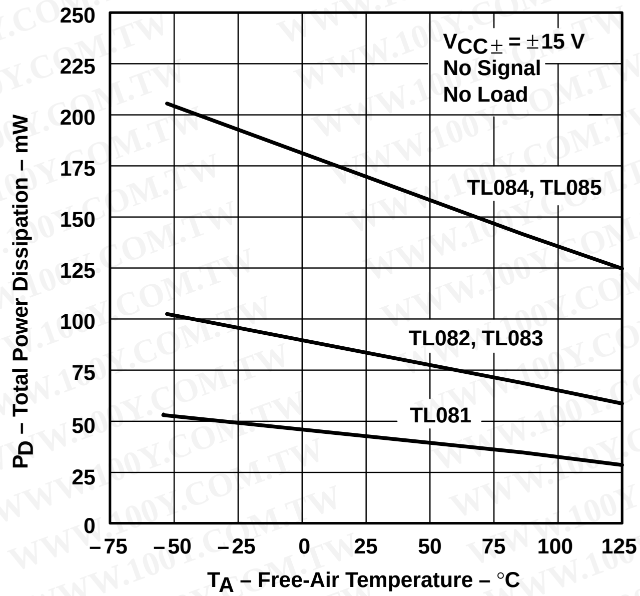


Figure 14

SUPPLY CURRENT PER AMPLIFIER
vs
FREE-AIR TEMPERATURE

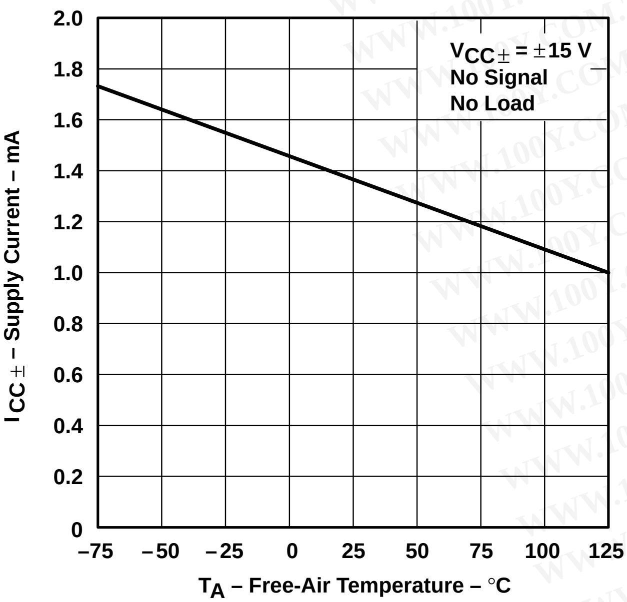


Figure 15

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

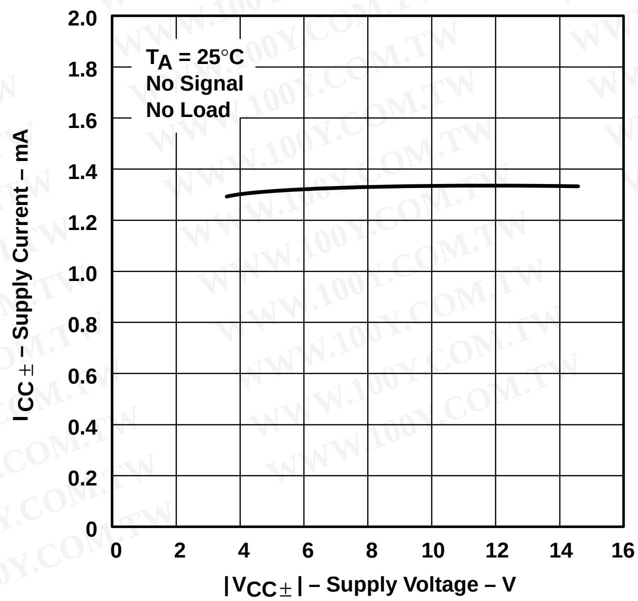


Figure 16

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

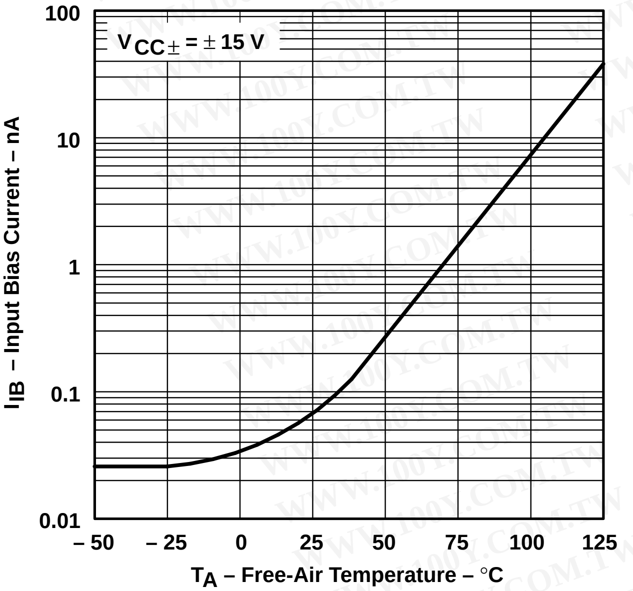


Figure 17

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

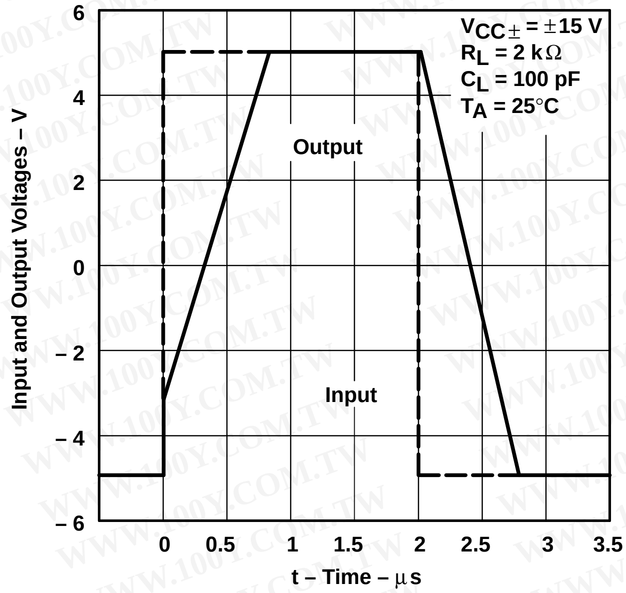


Figure 18

OUTPUT VOLTAGE vs ELAPSED TIME

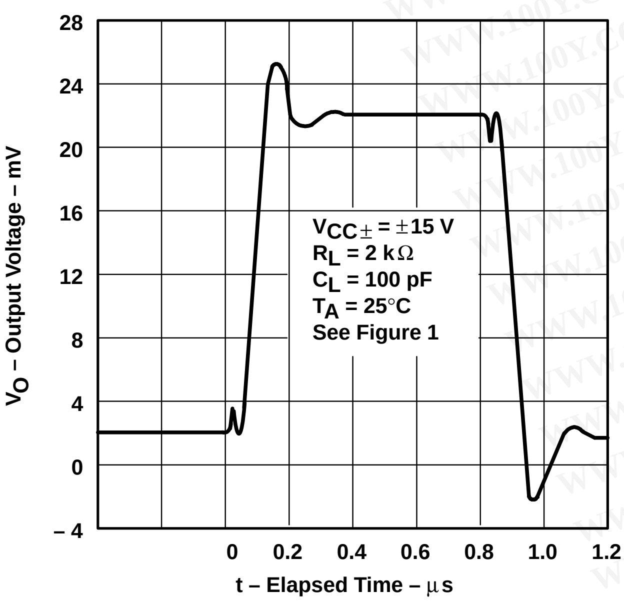


Figure 19

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

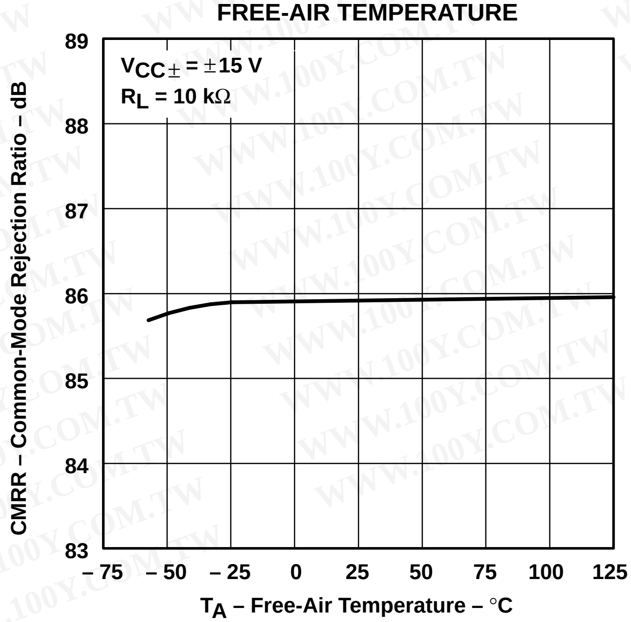


Figure 20

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

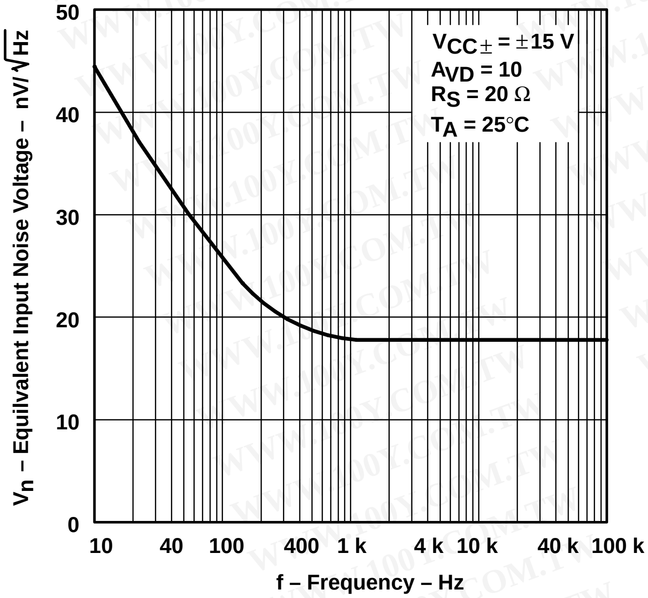


Figure 21

TOTAL HARMONIC DISTORTION vs FREQUENCY

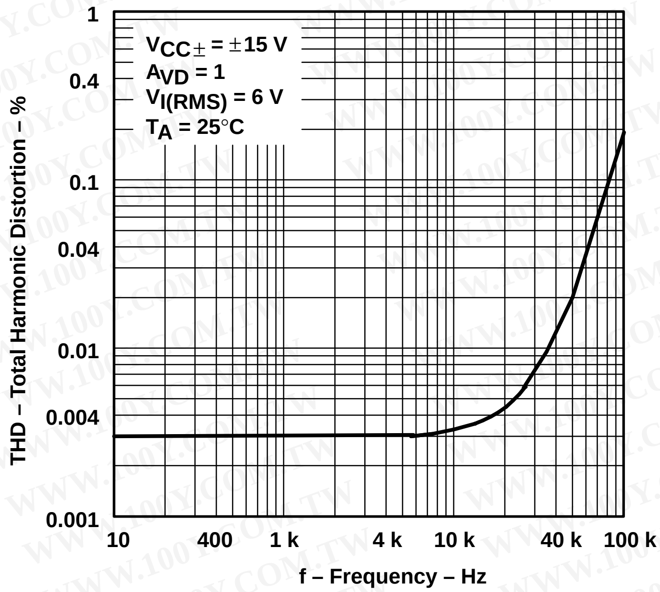


Figure 22

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

APPLICATION INFORMATION

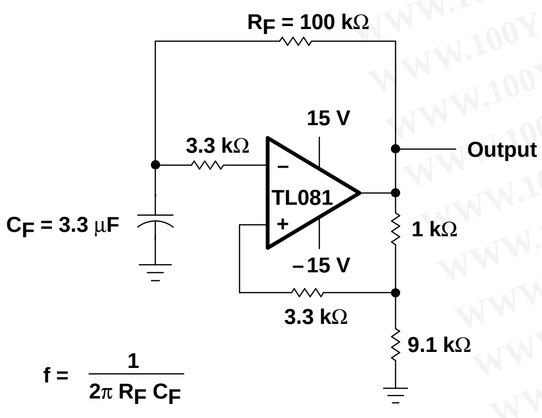


Figure 23

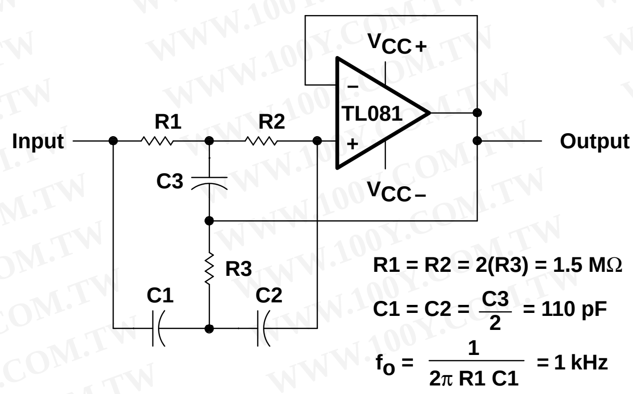


Figure 24

APPLICATION INFORMATION

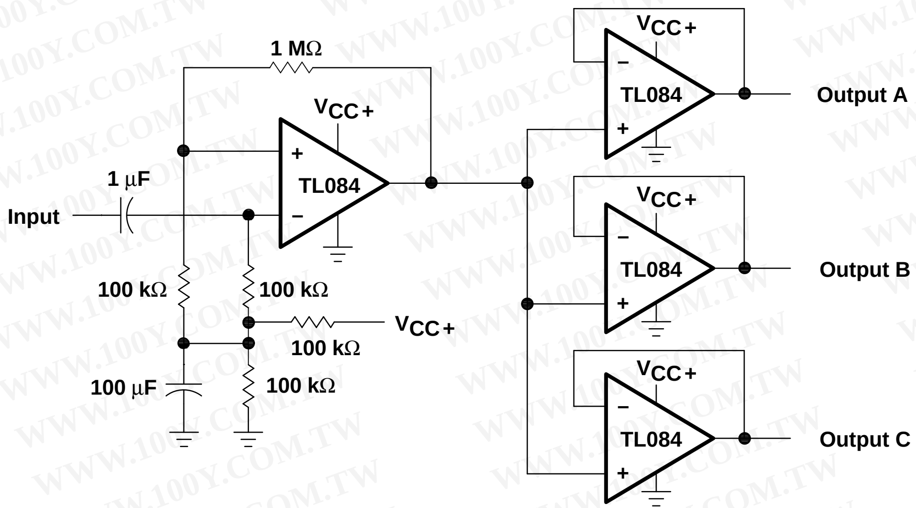
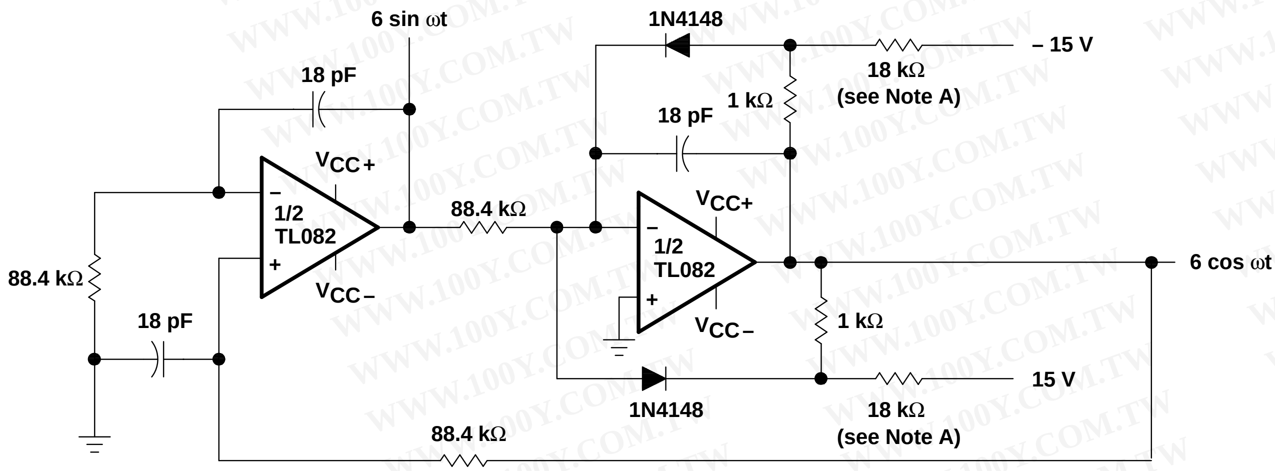


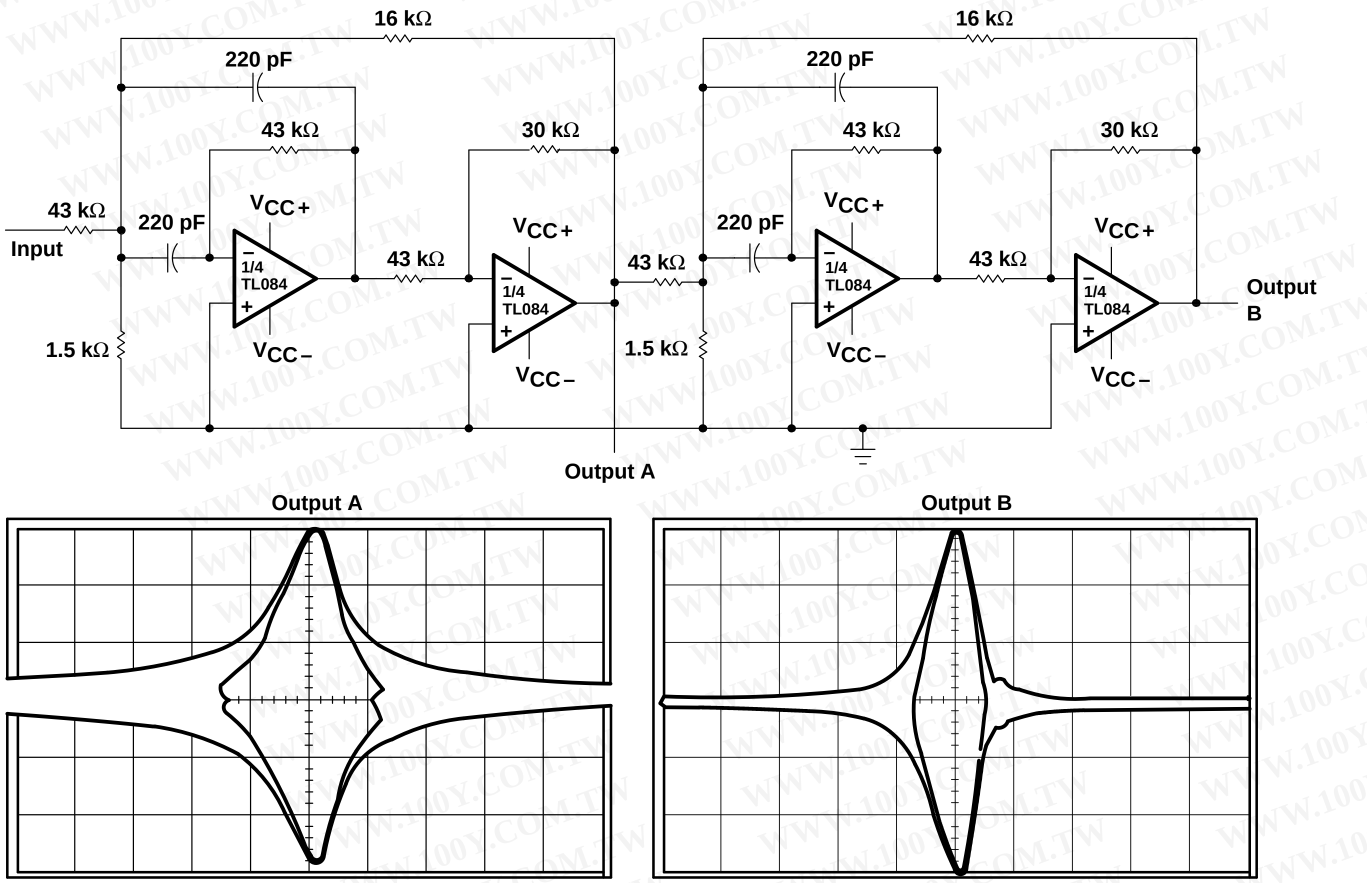
Figure 25. Audio-Distribution Amplifier



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

Figure 26. 100-KHz Quadrature Oscillator

APPLICATION INFORMATION



2 kHz/div
Second-Order Bandpass Filter
f_O = 100 kHz, Q = 30, GAIN = 4

2 kHz/div
Cascaded Bandpass Filter
f_O = 100 kHz, Q = 69, GAIN = 16

Figure 27. Positive-Feedback Bandpass Filter

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