TL08xx JFET-Input Operational Amplifiers

Check for Samples: TL081, TL081A, TL081B, TL082, TL082A, TL082B, TL084, TL084A, TL084B

FEATURES

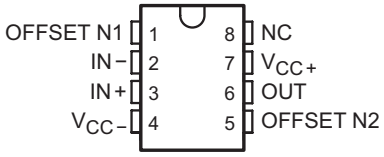
- Low Power Consumption: 1.4 mA/ch Typ
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias Current: 30 pA Typ
- Low Input Offset Current: 5 pA Typ
- Output Short-Circuit Protection
- Low Total Harmonic Distortion: 0.003% Typ
- High Input Impedance: JFET Input Stage
- Latch-Up-Free Operation
- High Slew Rate: 13 V/μs Typ
- Common-Mode Input Voltage Range Includes V_{CC+}

DESCRIPTION

The TL08xx 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.

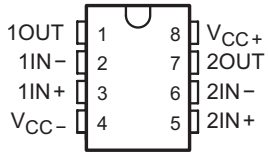
The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from −40°C to 85°C. The Q-suffix devices are characterized for operation from −40°C to 125°C. The M-suffix devices are characterized for operation over the full military temperature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

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

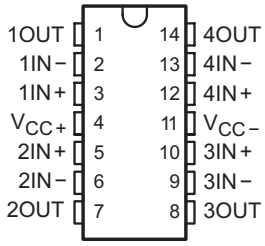


NC − No internal connection

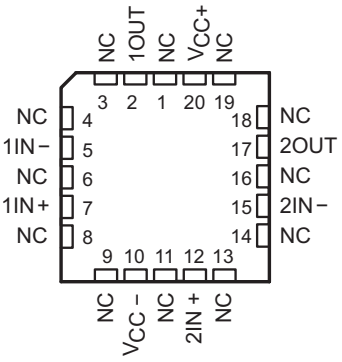
TL082, TL082A, TL082B
D, JG, P, PS, OR PW PACKAGE
(TOP VIEW)



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

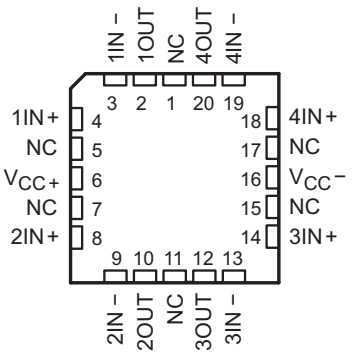


TL082M . . . FK PACKAGE
(TOP VIEW)



NC − No internal connection

TL084M . . . FK PACKAGE
(TOP VIEW)



NC − No internal connection

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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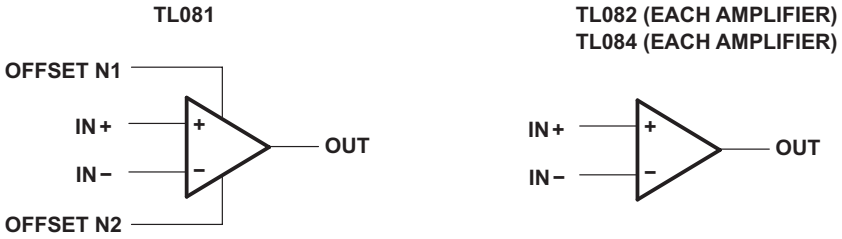
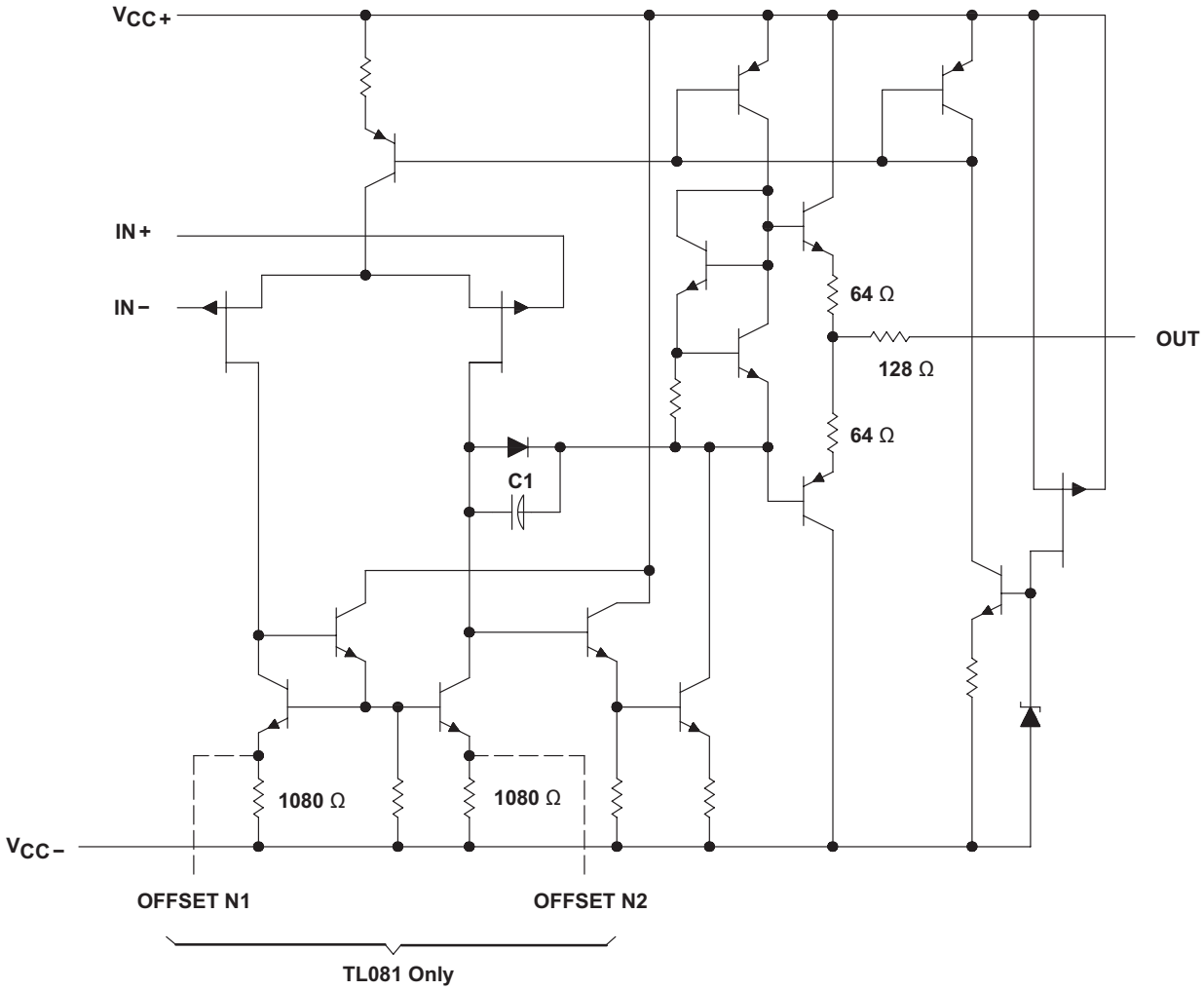
This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

Symbols



Schematic (Each Amplifier)



Component values shown are nominal.

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Absolute Maximum Ratings(1)

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

			TL08_C TL08_AC TL08_BC	TL08_I	TL084Q	TL08_M	UNIT
V_{CC+}	Supply voltage(2)		18	18	18	18	V
V_{CC-}			–18	–18	–18	–18	
V_{ID}	Differential input voltage(3)		±30	±30	±30	±30	V
V_I	Input voltage(2)(4)		±15	±15	±15	±15	V
	Duration of output short circuit(5)		Unlimited	Unlimited	Unlimited	Unlimited	
	Continuous total power dissipation		See Dissipation Rating Table				
T_A	Operating free-air temperature range		0 to 70	–40 to 85	–40 to 125	–55 to 125	°C
θ_{JA}	Package thermal impedance(6)(7)	D package (8-pin)	97	97		97	°C/W
		D package (14-pin)	86	86		86	
		N package (14-pin)	76	76		80	
		NS package (14-pin)	80			76	
		P package	85	85		85	
		PS package	95	95		95	
		PW package (8 pin)	149			149	
		PW package (14 pin)	113	113		113	
	Operating virtual junction temperature		150	150	150	150	°C
T_C	Case temperature for 60 seconds	FK package				260	°C
	Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	J or JG package				300	°C
T_{stg}	Storage temperature range		–65 to 150	–65 to 150	–65 to 150	–65 to 150	°C

(1) 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.
(2) All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+} and V_{CC-}.
(3) Differential voltages are at IN+, with respect to IN−.
(4) The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
(5) 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.
(6) Maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(7) The package thermal impedance is calculated in accordance with JESD 51-7.

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 (14 pin)	680 mW	7.6 mW/°C	60°C	604 m/W	490 mW	186 mW
FK	680 mW	11.0 mW/°C	88°C	680 m/W	680 mW	273 mW
J	680 mW	11.0 mW/°C	88°C	680 m/W	680 mW	273 mW
JG	680 mW	8.4 mW/°C	69°C	672 m/W	546 mW	210 mW

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Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	T_A (1)	TL081C TL082C TL084C			TL081AC TL082AC TL084AC			TL081BC 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 (2)	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 (2)	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
			Full range	15			15			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 (each 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

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

(2) Input bias currents of an 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.

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Electrical Characteristics

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

PARAMETER		TEST CONDITIONS[1]	T_A	TL081M, TL082M			TL084Q, TL084M			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_O = 0, R_S = 50 Ω	25°C		3	6		3	9	mV
			Full range			9			15	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω	Full range		18			18		μV/°C
I_{IO}	Input offset current[2]	V_O = 0	25°C		5	100		5	100	pA
			125°C			20			20	nA
I_{IB}	Input bias current[2]	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 kΩ	25°C	±12	±13.5		±12	±13.5		V
		R_L ≥ 10 kΩ	Full range	±12			±12			
		R_L ≥ 2 kΩ		±10	±12		±10	±12		
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L ≥ 2 kΩ	25°C	25	200		25	200		V/mV
			Full range	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 Ω	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, V_O = 0, R_S = 50 Ω	25°C	80	86		80	86		dB
I_{CC}	Supply current (each 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

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
(2) 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 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, R_L = 2 kΩ, C_L = 100 pF, See Figure 1		8[1]	13		V/μs
		V_I = 10 V, R_L = 2 kΩ, C_L = 100 pF, T_A = − 55°C to 125°C, See Figure 1		5[1]			
t_r	Rise-time	V_I = 20 V, R_L = 2 kΩ, C_L = 100 pF, See Figure 1			0.05		μs
	overshoot factor				20		%
V_n	Equivalent input noise voltage	R_S = 20 Ω	f = 1 kHz		18		nV/√Hz
			f = 10 Hz to 10 kHz		4		μV
I_n	Equivalent input noise current	R_S = 20 Ω,	f = 1 kHz		0.01		pA/√Hz
THD	Total harmonic distortion	$V_I$rms = 6 V, A_{VD} = 1, R_S ≤ 1 kΩ, R_L ≥ 2 kΩ, f = 1 kHz,			0.003		%

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

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Parameter Measurement Information

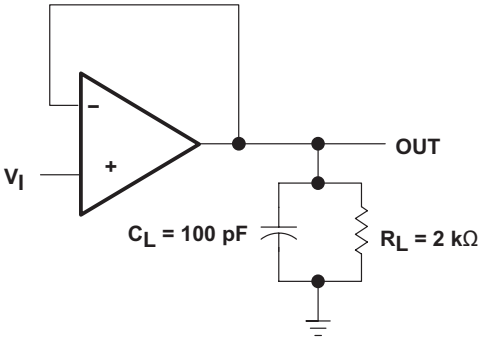

Figure 1.

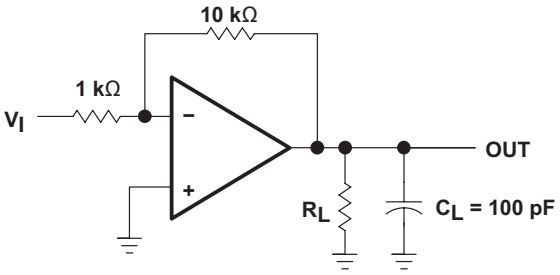

Figure 2.

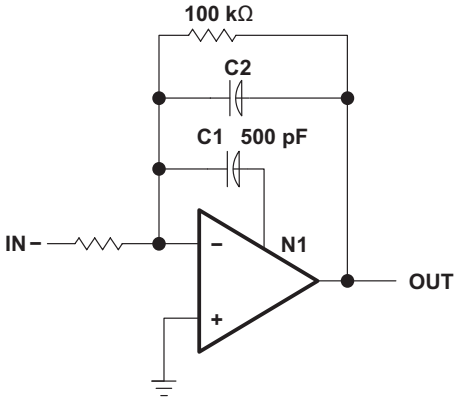

Figure 3.

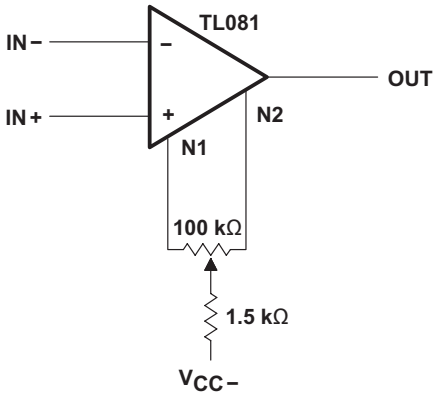

Figure 4.

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Typical Characteristics

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

Table of Graphs

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

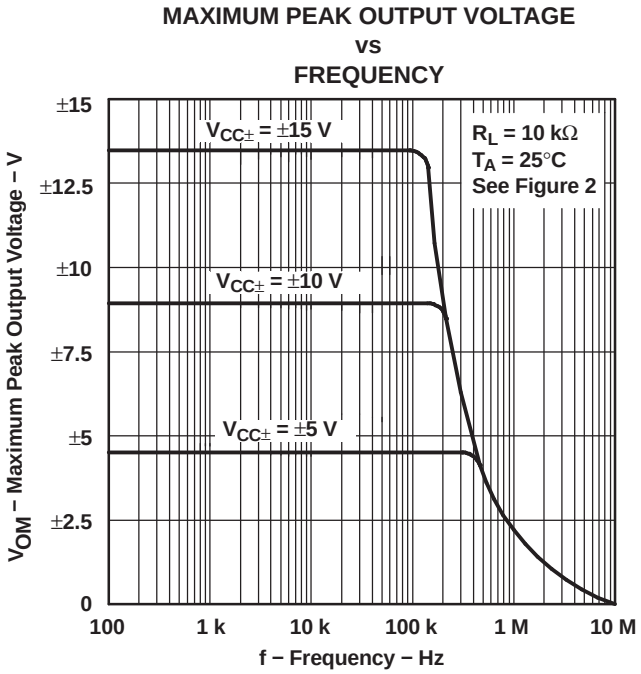

Figure 5.

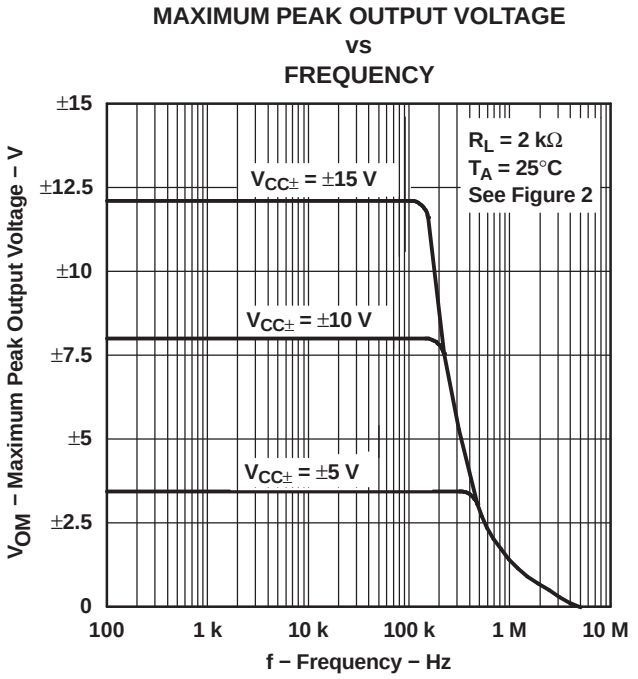

Figure 6.

MAXIMUM PEAK OUTPUT VOLTAGE vs FREQUENCY

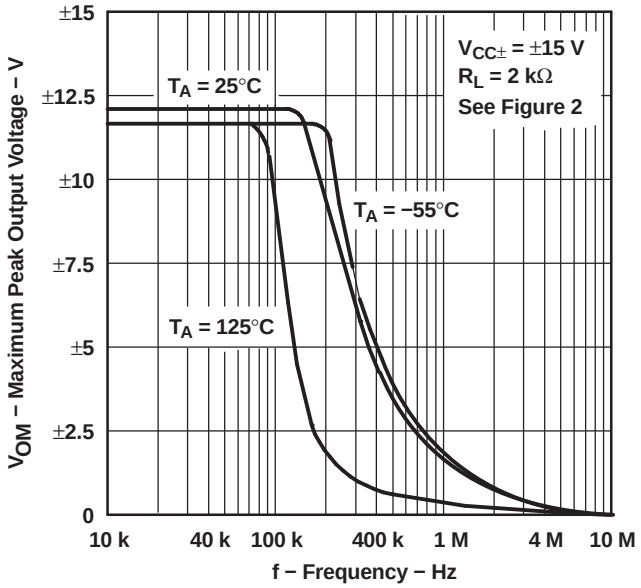

Figure 7.

MAXIMUM PEAK OUTPUT VOLTAGE vs FREE-AIR TEMPERATURE

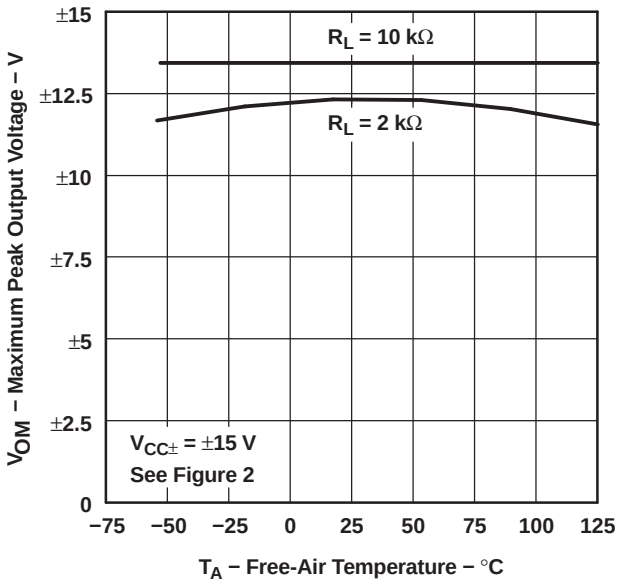

Figure 8.

MAXIMUM PEAK OUTPUT VOLTAGE vs LOAD RESISTANCE

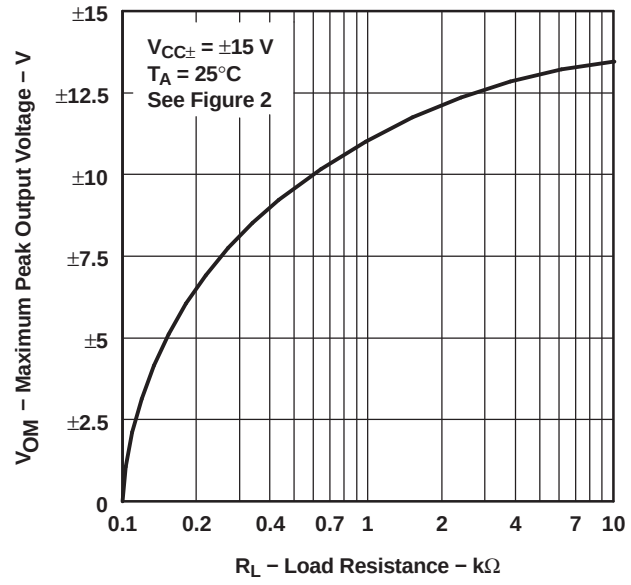

Figure 9.

MAXIMUM PEAK OUTPUT VOLTAGE vs SUPPLY VOLTAGE

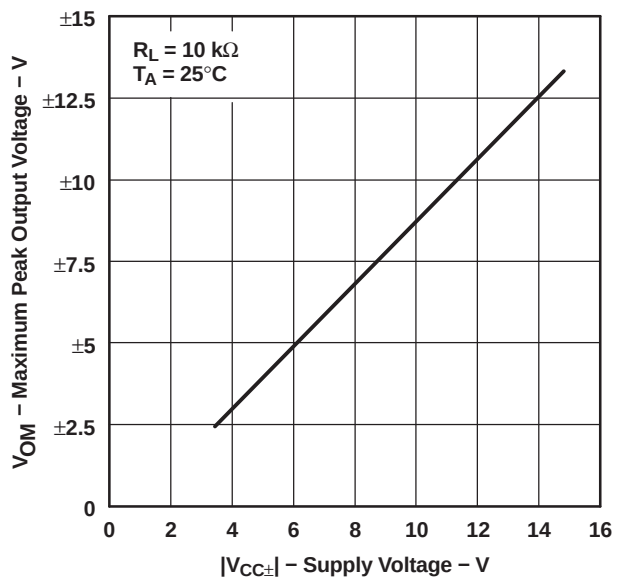

Figure 10.

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LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

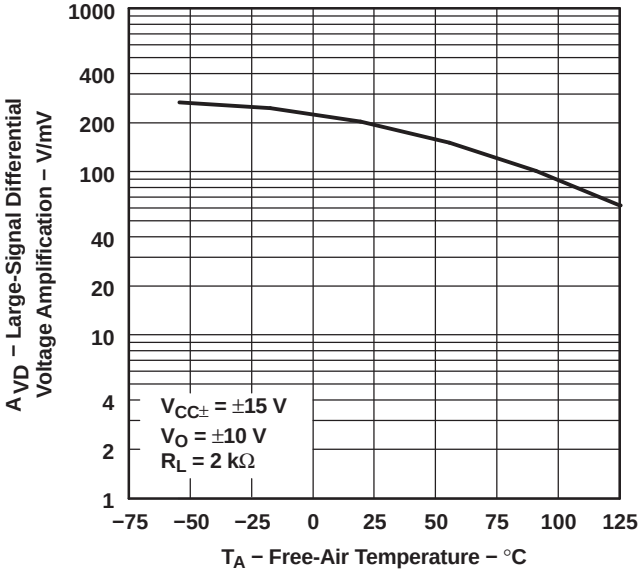

Figure 11.

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT vs FREQUENCY

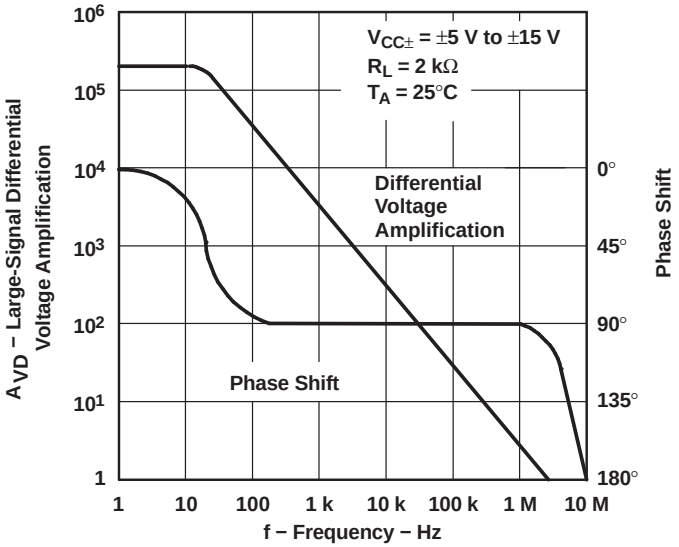

Figure 12.

DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY WITH FEED-FORWARD COMPENSATION

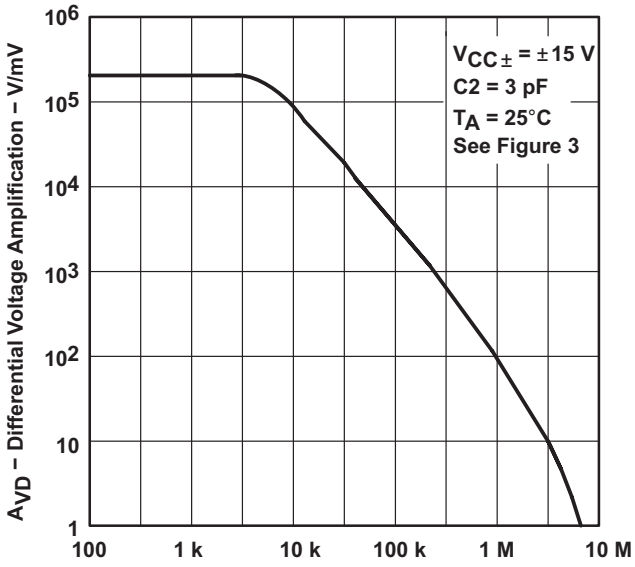

Figure 13.

TOTAL POWER DISSIPATION vs FREE-AIR TEMPERATURE

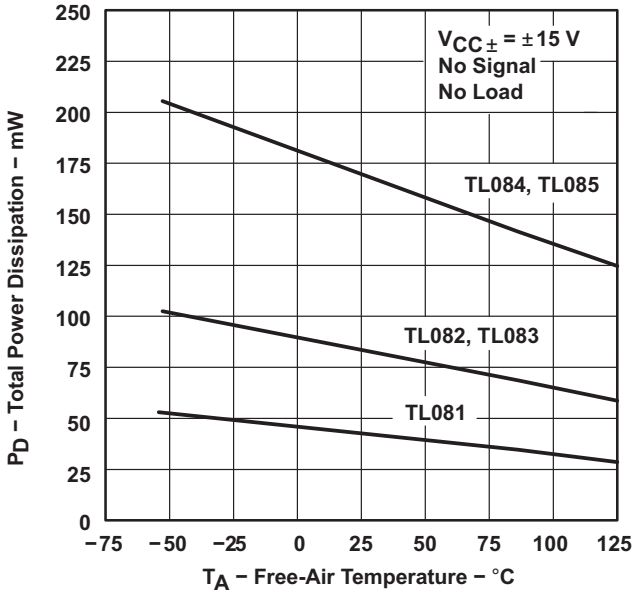

Figure 14.

SUPPLY CURRENT PER AMPLIFIER vs FREE-AIR TEMPERATURE

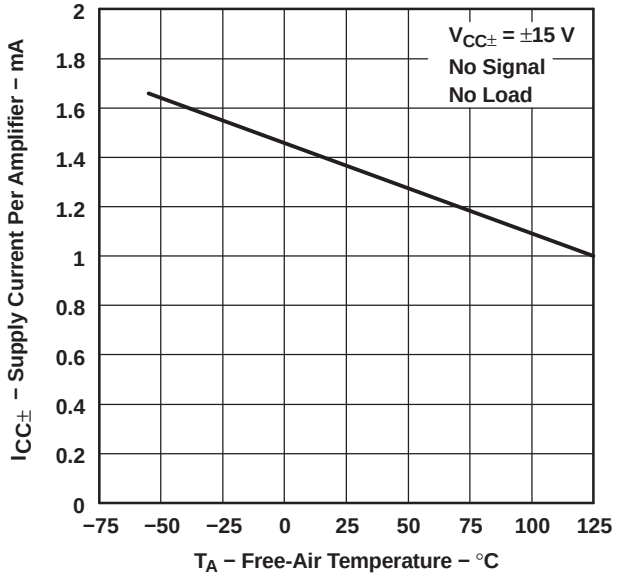

Figure 15.

SUPPLY CURRENT PER AMPLIFIER vs SUPPLY VOLTAGE

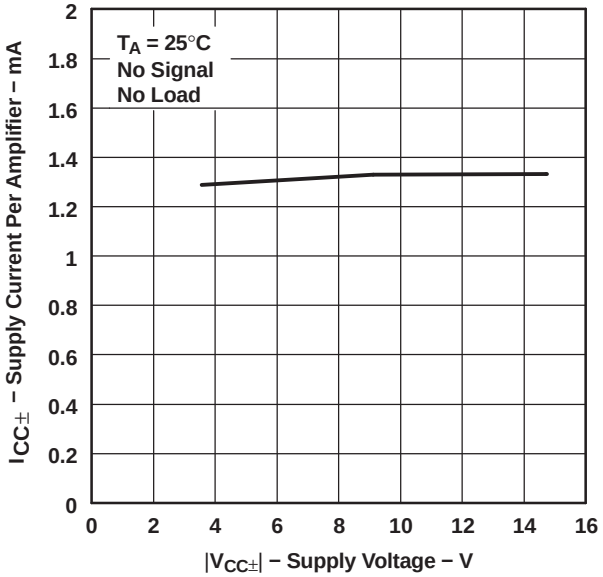

Figure 16.

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

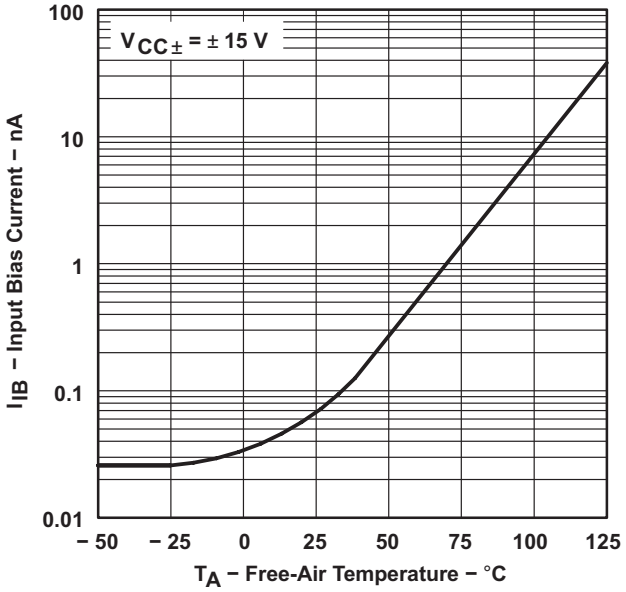

Figure 17.

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

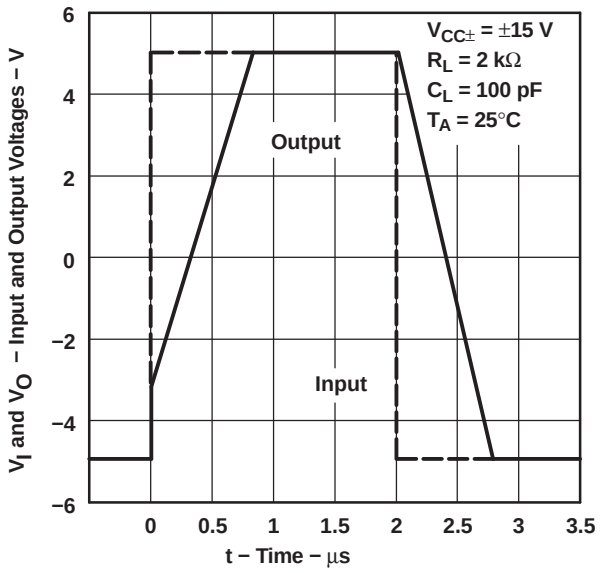

Figure 18.

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OUTPUT VOLTAGE vs ELAPSED TIME

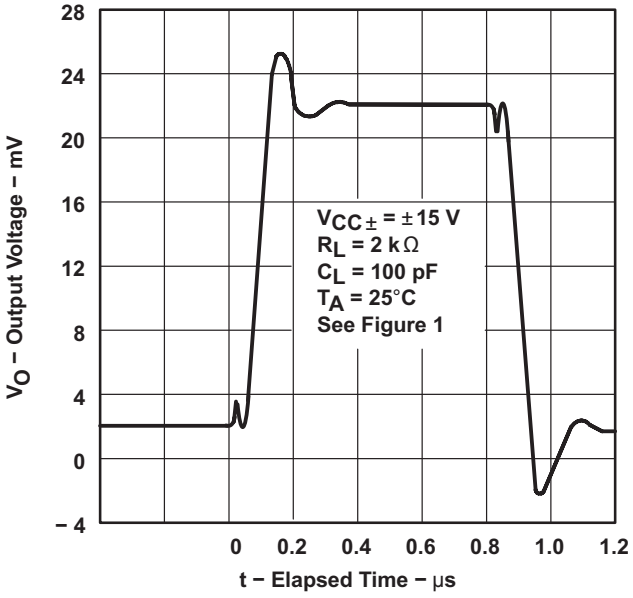

Figure 19.

COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

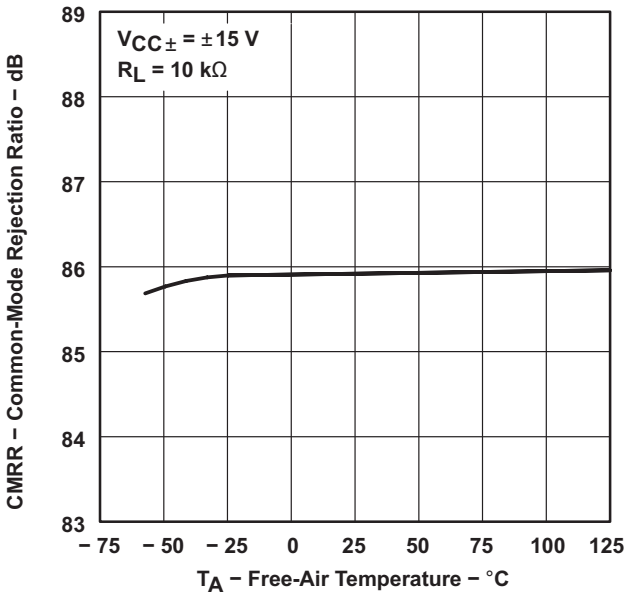

Figure 20.

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

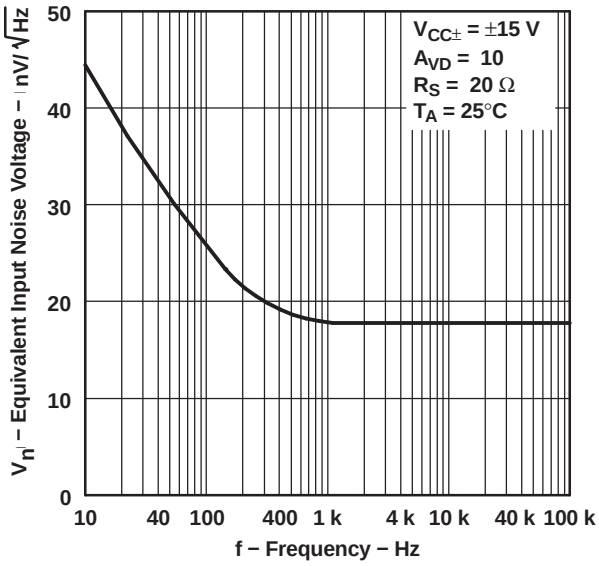

Figure 21.

TOTAL HARMONIC DISTORTION vs FREQUENCY

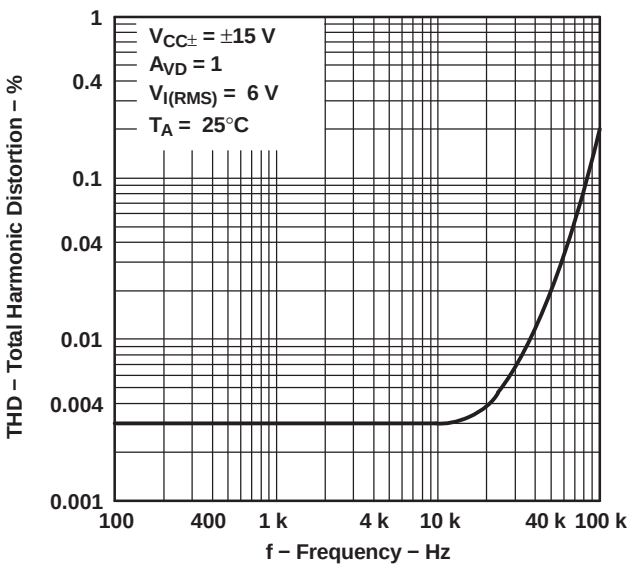

Figure 22.

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APPLICATION INFORMATION

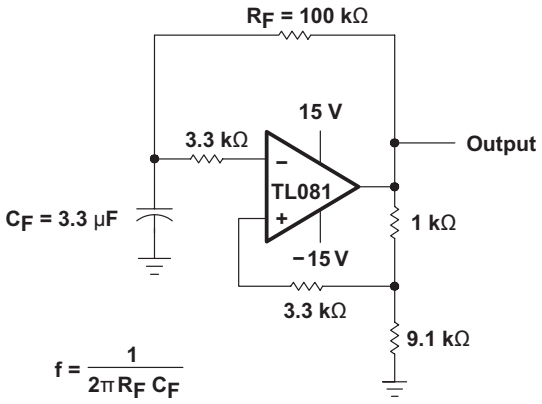

Figure 23.

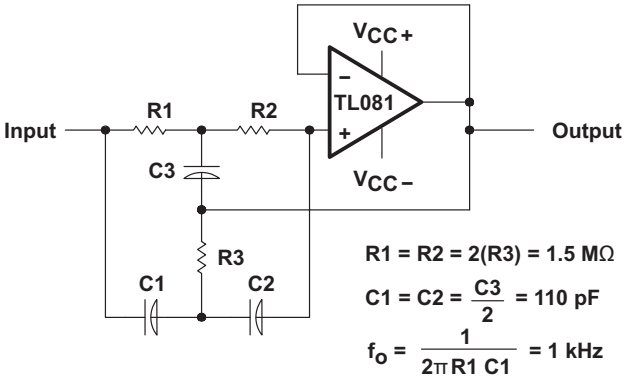

Figure 24.

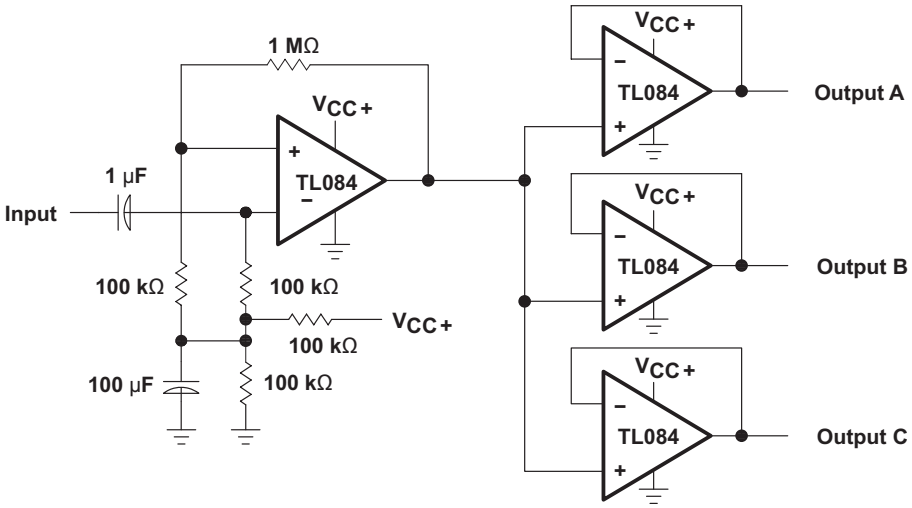

Figure 25. Audio-Distribution Amplifier

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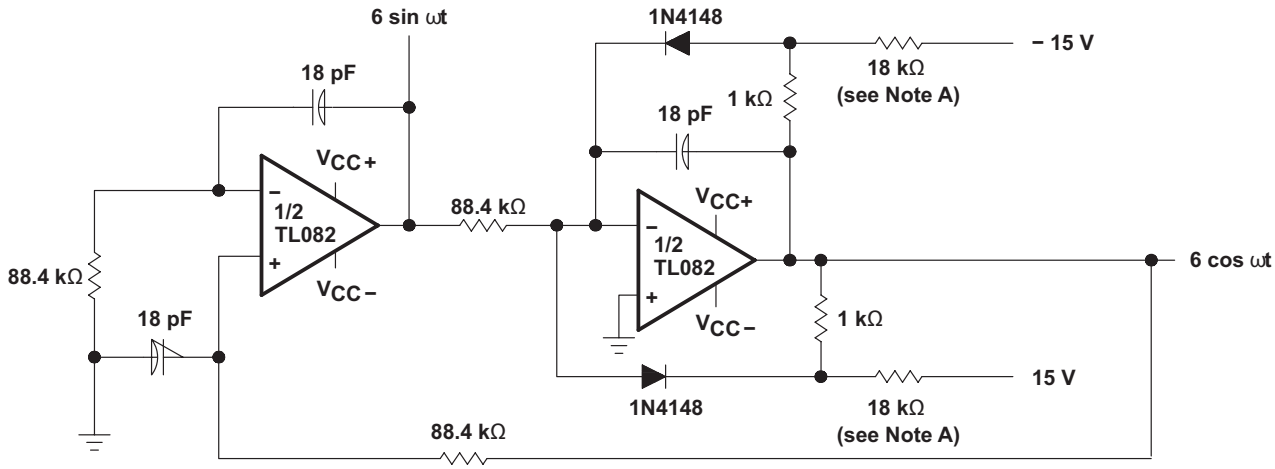

A. These resistor values may be adjusted for a symmetrical output.

Figure 26. 100-KHz Quadrature Oscillator

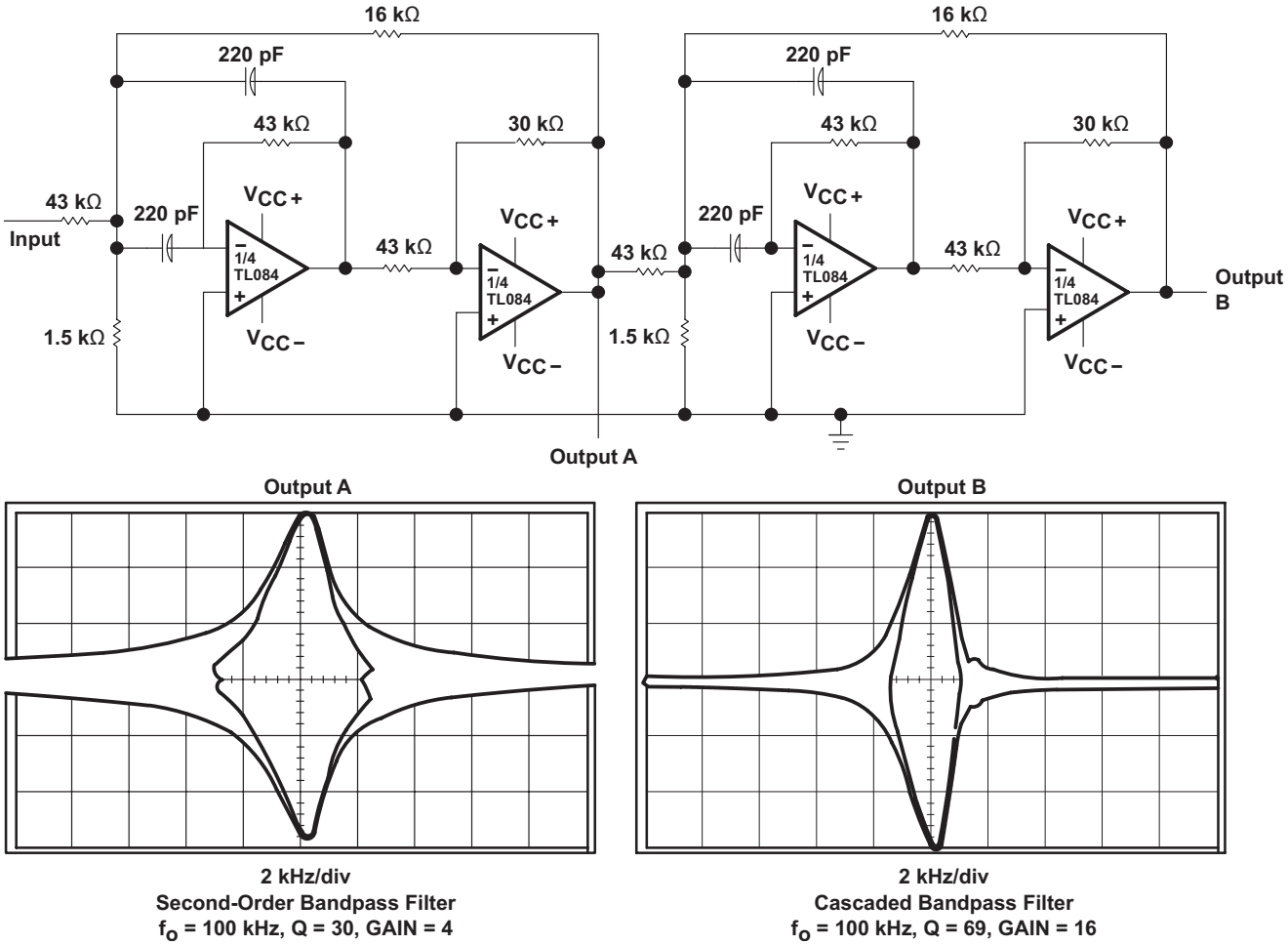

Figure 27. Positive-Feedback Bandpass Filter

REVISION HISTORY

Changes from Revision G (September 2004) to Revision H **Page**

- Updated document to new TI datasheet format - no specification changes. 1
- Added ESD warning. 2

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