TL060, TL060A, TL060B, TL061, TL061A, TL061B, TL062, TL062A, TL062B, TL064, TL064A, TL064B

Low-Power JFET-Input Operational Amplifiers

The JFET-input operational amplifiers of the TL061 series are designed as low-power versions of the TL081 series amplifiers. They feature high input impedance, wide bandwidth, high slew rate, and low input offset and bias currents. The TL061 series features the same terminal assignments as the TL071 and TL081 series. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

Rochester Electronics Manufactured Components

Rochester branded components are manufactured using either die/wafers purchased from the original suppliers or Rochester wafers recreated from the original IP. All recreations are done with the approval of the OCM.

Parts are tested using original factory test programs or Rochester developed test solutions to guarantee product meets or exceeds the OCM data sheet.

Quality Overview

- ISO-9001
- AS9120 certification
- Qualified Manufacturers List (QML) MIL-PRF-38535
  - Class Q Military
  - Class V Space Level
- Qualified Suppliers List of Distributors (QSLD)
  - Rochester is a critical supplier to DLA and meets all industry and DLA standards.

Rochester Electronics, LLC is committed to supplying products that satisfy customer expectations for quality and are equal to those originally supplied by industry manufacturers.

The original manufacturer's datasheet accompanying this document reflects the performance and specifications of the Rochester manufactured version of this device. Rochester Electronics guarantees the performance of its semiconductor products to the original OEM specifications. 'Typical' values are for reference purposes only. Certain minimum or maximum ratings may be based on product characterization, design, simulation, or sample testing.

D2392, NOVEMBER 1978—REVISED NOVEMBER 1988

20 DEVICES COVER MILITARY, INDUSTRIAL, AND COMMERCIAL TEMPERATURE RANGES

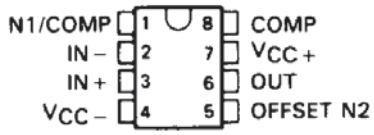
- Very Low Power Consumption
- Typical Supply Current . . . 200 μA (per Amplifier)
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Common-Mode Input Voltage Range Includes V_{CC+}
- Output Short-Circuit Protection
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation (Except TL060)
- Latch-Up-Free Operation
- High Slew Rate . . . 3.5 V/μs Typ

description

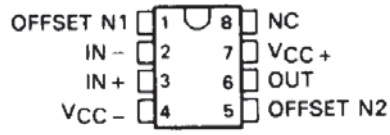
The JFET-input operational amplifiers of the TL061 series are designed as low-power versions of the TL081 series amplifiers. They feature high input impedance, wide bandwidth, high slew rate, and low input offset and bias currents. The TL061 series features the same terminal assignments as the TL071 and TL081 series. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

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

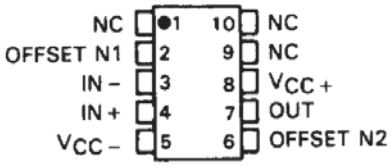
TL060, TL060A, TL060B
D, JG, OR P PACKAGE
(TOP VIEW)



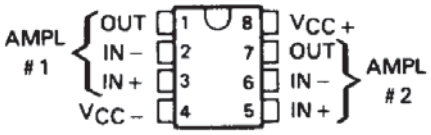
TL061, TL061A, TI061B
D, JG, OR P PACKAGE
(TOP VIEW)



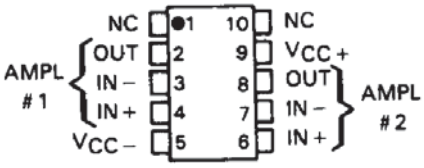
TL061 . . . U PACKAGE
(TOP VIEW)



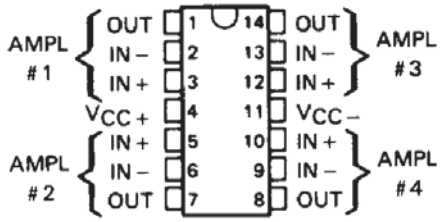
TL062, TL062A, TL062B
D, JG, OR P PACKAGE
(TOP VIEW)



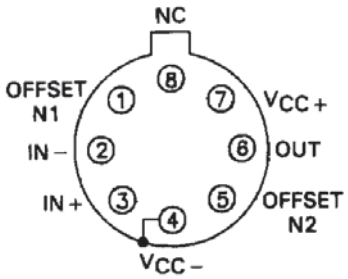
TL062 . . . U PACKAGE
(TOP VIEW)



TL064 . . . D, J, N, OR W PACKAGE
TL064A, TL064B . . . D, J, OR N PACKAGE
(TOP VIEW)

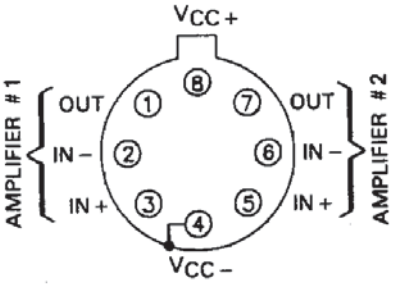


TL061 . . . L PACKAGE
(TOP VIEW)



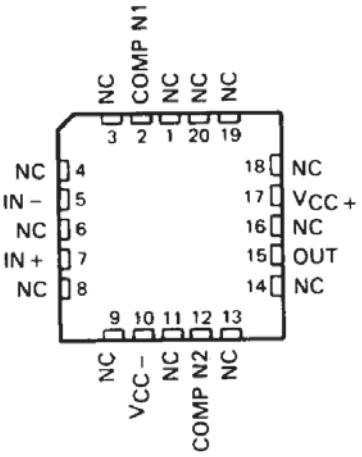
PIN 4 IS IN ELECTRICAL CONTACT WITH THE CASE

TL062 . . . L PACKAGE
(TOP VIEW)

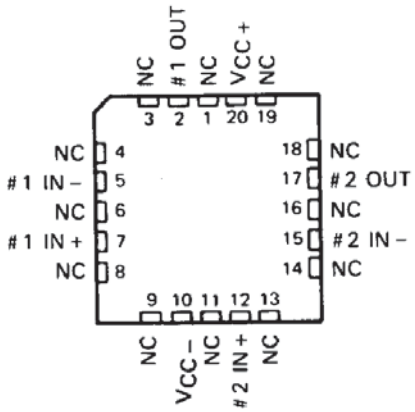


PIN 4 IS IN ELECTRICAL CONTACT WITH THE CASE

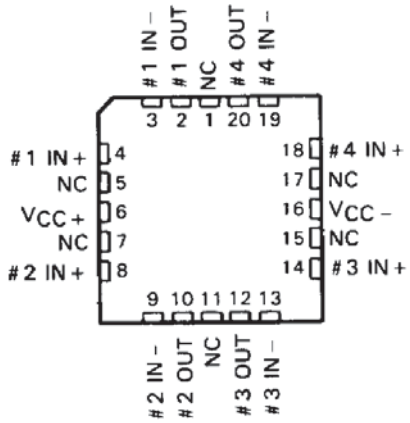
TL061 . . . FK PACKAGE
(TOP VIEW)



TL062 . . . FK PACKAGE
(TOP VIEW)



TL064 . . . FK PACKAGE
(TOP VIEW)



NC—No internal connection

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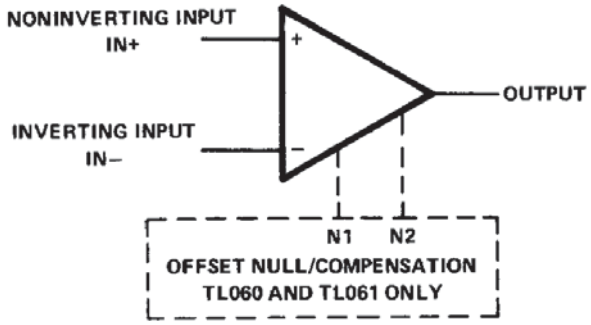
AVAILABLE OPTIONS

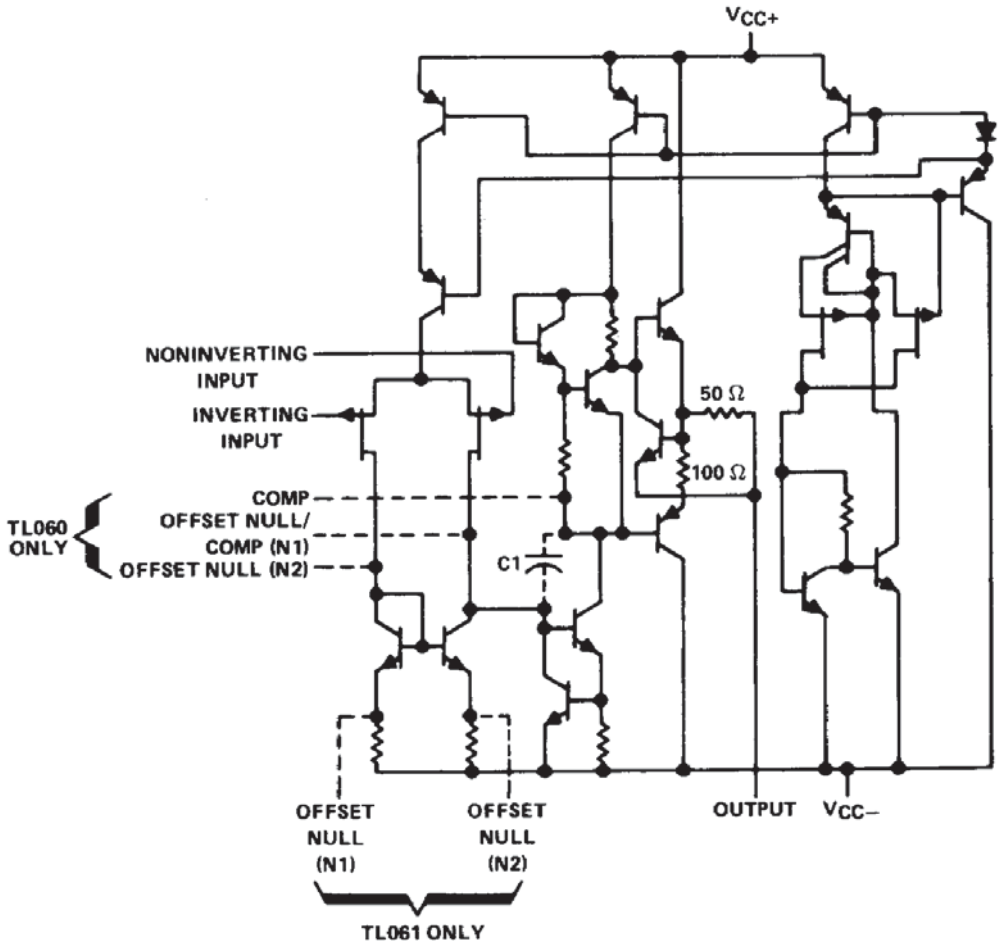
T_A	V_{IO} MAX at 25°C	PACKAGE								
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLUG-IN (L)	PLASTIC DIP (N)	PLASTIC DIP (P)	FLAT PACK (U)	FLAT PACK (W)
0°C to 70°C	15 mV	TL060CD			TL060CJG			TL060CP		
	6 mV	TL060ACD			TL060ACJG			TL060ACP		
	3 mV	TL060BCD			TL060BCJG			TL060BCP		
	15 mV	TL061CD			TL061CJG			TL061CP		
	6 mV	TL061ACD			TL061ACJG			TL061ACP		
	3 mV	TL061BCD			TL061BCJG			TL061BCP		
	15 mV	TL062CD			TL062CJG			TL062CP		
	6 mV	TL062ACD			TL062ACJG			TL062ACP		
	3 mV	TL062BCD			TL062BCJG			TL062BCP		
	15 mV	TL064CD		TL064CJ			TL064CN			
	6 mV	TL064ACD		TL064ACJ			TL064ACN			
	3 mV	TL064BCD		TL064BCJ			TL064BCN			
−40°C to 85°C	6 mV	TL060ID			TL060IJG			TL060IP		
	6 mV	TL061ID			TL061IJG			TL061IP		
	6 mV	TL062ID			TL062IJG			TL062IP		
	6 mV	TL064ID		TL064IJ			TL064IN			
−55°C to 125°C	6 mV		TL061MFK		TL061MJG	TL061ML			TL061MU	
	6 mV		TL062MFK		TL062MJG	TL062ML			TL062MU	
	9 mV		TL064MFK	TL064MJ						TL064MW

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL061CDR).

symbol (each amplifier)



schematic (each amplifier)



C1 = 10 pF ON TL061, TL062, AND TL064 ONLY
COMPONENT VALUES SHOWN ARE NOMINAL

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

		TL06_M	TL06_I	TL06_C, TL06_AC, TL06_BC	UNIT
Supply voltage, V_{CC+} (see Note 1)		18	18	18	V
Supply voltage, V_{CC-} (see Note 1)		−18	−18	−18	V
Differential input voltage (see Note 2)		±30	±30	±30	V
Input voltage (see Notes 1 and 3)		±15	±15	±15	V
Voltage between power-control terminal and V_{CC-}		±0.5	±0.5	±0.5	V
Duration of output short circuit (see Note 4)		unlimited	unlimited	unlimited	
Continuous total dissipation		See Dissipation Rating Table			
Operating free-air temperature range		−55 to 125	−40 to 85	0 to 70	°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, JG, U or W package	300	300	300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D, N or P package		260	260	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	L package	300			°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	$T_A \leq 25°C$ 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	33°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 (TL06_M)	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 mW
J (all others)	680 mW	8.2 mW/°C	67°C	656 mW	533 mW	N/A
JG (TL06_M)	680 mW	8.4 mW/°C	69°C	672 mW	546 mW	210 mW
JG (all others)	680 mW	6.6 mW/°C	47°C	528 mW	429 mW	N/A
L	680 mW	6.6 mW/°C	47°C	528 mW	429 mW	165 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
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†		TL061M TL062M			TL064M			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, R_S = 50 Ω, T_A = −55°C to 125°C			10			10		μV/°C
I_{IO}	Input offset current‡	V_O = 0	T_A = 25°C		5	100		5	100	pA
			T_A = −55°C to 125°C			20			20	nA
I_{IB}	Input bias current	V_O = 0	T_A = 25°C		30	200		30	200	pA
			T_A = −55°C to 125°C			50			50	nA
V_{ICR}	Common-mode input voltage range	T_A = 25°C		±11.5	−12 to +15		±11.5	−12 to +15		V
V_{OM}	Maximum peak output voltage swing	R_L = 10 kΩ,	T_A = 25°C	±10	±13.5		±10	±13.5		V
		R_L ≥ 10 kΩ,	T_A = −55°C to 125°C	±10			±10			
A_{VD}	Large-signal differential voltage amplification	V_O = ± 10 V, R_L ≥ 10 kΩ	T_A = 25°C	4	6		4	6		V/mV
			T_A = −55°C to 125°C	4			4			
B_1	Unity-gain bandwidth	R_L = 10 kΩ, T_A = 25°C								MHz
r_i	Input resistance	T_A = 25°C			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		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		80	95		80	95		dB
P_D	Total power dissipation (each amplifier)	No load, V_O = 0, T_A = 25°C			6	7.5		6	7.5	mW
I_{CC}	Supply current (each amplifier)	No load, V_O = 0, T_A = 25°C			200	250		200	250	μA
V_{o1}/V_{o2}	Crosstalk attenuation	A_{VD} = 100, T_A = 25°C			120			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 will 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†		TL060I TL061I TL062I TL064I			TL060C TL061C TL062C TL064C			TL060AC TL061AC TL062AC TL064AC			TL060BC TL061BC TL062BC TL064BC			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	6		3	15		3	6		2	3	mV
			T_A = full range			9			20			7.5			5	
α_{VIO}	Temperature coefficient of input offset voltage	V_O = 0, R_S = 50 Ω, T_A = full range			10			10			10			10		μV/°C
I_{IO}	Input offset current‡	V_O = 0	T_A = 25°C		5	100		5	200		5	100		5	100	pA
			T_A = full range			10			5			3			3	nA
I_{IB}	Input bias current‡	V_O = 0	T_A = 25°C		30	200		30	400		30	200		30	200	pA
			T_A = full range			20			10			7			7	nA
V_{ICR}	Common-mode input voltage range	T_A = 25°C		±11.5	−12 to +15		±11	−12 to +15		±11.5	−12 to +15		±11.5	−12 to +15		V
V_{OM}	Maximum peak output voltage swing	R_L = 10 kΩ,	T_A = 25°C	±10	±13.5		±10	±13.5		±10	±13.5		±10	±13.5		V
		R_L ≥ 10 kΩ,	T_A = full range	±10			±10			±10			±10			
A_{VD}	Large-signal differential voltage amplification	V_O = ± 10 V,	T_A = 25°C	4	6		3	6		4	6		4	6		V/mV
		R_L ≥ 10 kΩ	T_A = full range	4			3			4			4			
B_1	Unity-gain bandwidth	R_L = 10 kΩ,	T_A = 25°C		1			1			1			1		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	80	86		70	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	80	95		70	95		80	95		80	95		dB
P_D	Total power dissipation (each amplifier)	No load, V_O = 0,	T_A = 25°C		6	7.5		6	7.5		6	7.5		6	7.5	mW
I_{CC}	Supply current (each amplifier)	No load, V_O = 0,	T_A = 25°C		200	250		200	250		200	250		200	250	μA
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 −40°C to 85°C for TL06_I and 0°C to 70°C for TL06_C, TL06_AC, and TL06_BC.

‡ 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 will maintain the junction temperature as close to the ambient temperature as possible.

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 10 kΩ, See Figure 1	1.5	3.5		V/μs
t_r	Rise time	V_I = 20 mV, C_L = 100 pF,	R_L = 10 kΩ, See Figure 1		0.2		μs
	Overshoot factor				10%		
V_n	Equivalent input noise voltage	R_S = 100 Ω,	f = 1 kHz		42		nV/√Hz

PARAMETER MEASUREMENT INFORMATION

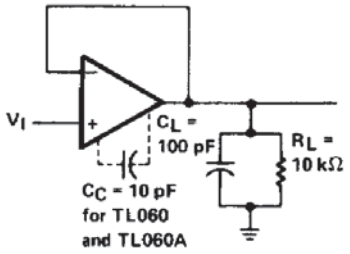


FIGURE 1. UNITY-GAIN AMPLIFIER

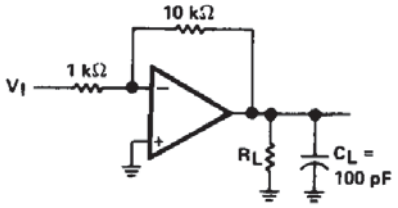


FIGURE 2. GAIN-OF-10 INVERTING AMPLIFIER

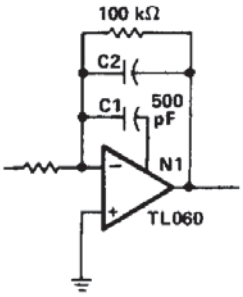
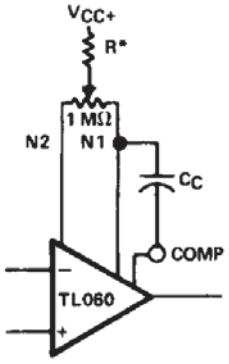


FIGURE 3. FEED-FORWARD COMPENSATION

INPUT OFFSET VOLTAGE NULL CIRCUITS



*For best results use R = 20 MΩ for $V_{CC\pm}$ = ±15 V to R = 5 MΩ for $V_{CC\pm}$ = ±3 V.

FIGURE 4

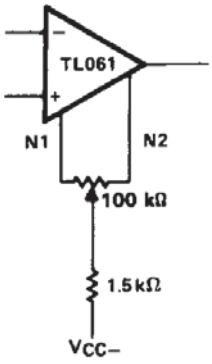


FIGURE 5

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TYPICAL CHARACTERISTICS†

MAXIMUM PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

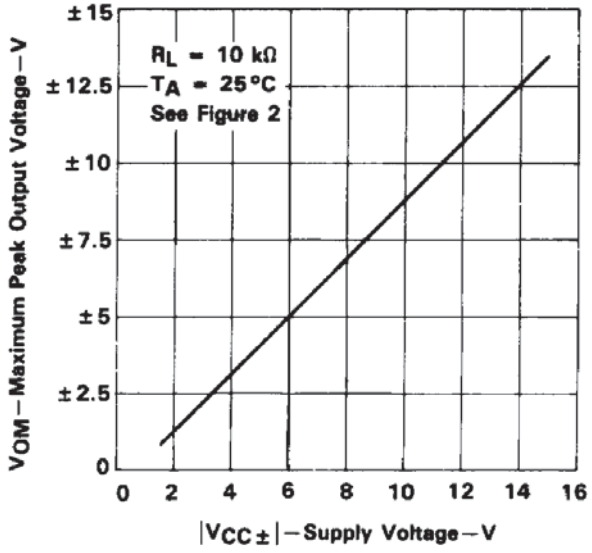

FIGURE 6

MAXIMUM PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

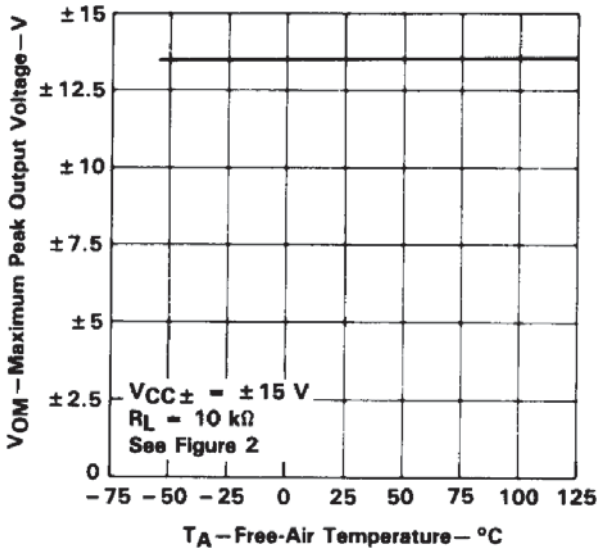

FIGURE 7

MAXIMUM PEAK OUTPUT VOLTAGE
vs
LOAD RESISTANCE

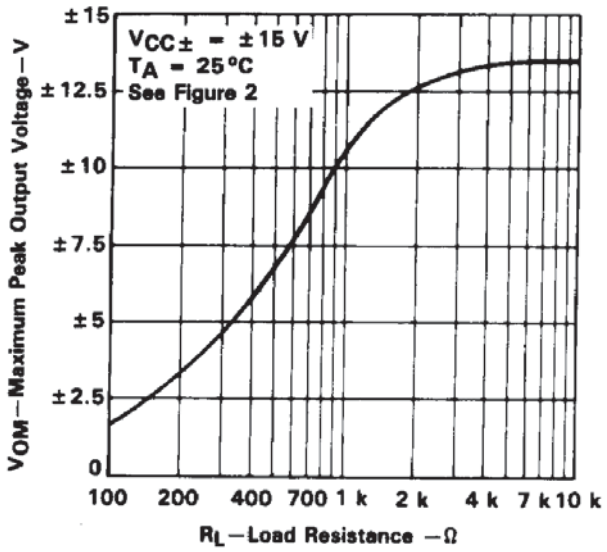

FIGURE 8

MAXIMUM PEAK OUTPUT VOLTAGE
vs
FREQUENCY

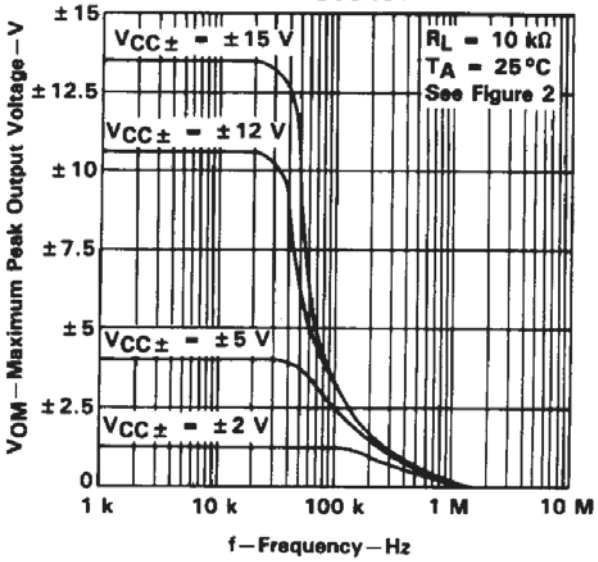

FIGURE 9

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 10-pF compensation capacitor is used with TL060 and TL060A.

TYPICAL CHARACTERISTICS†

DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREE-AIR TEMPERATURE

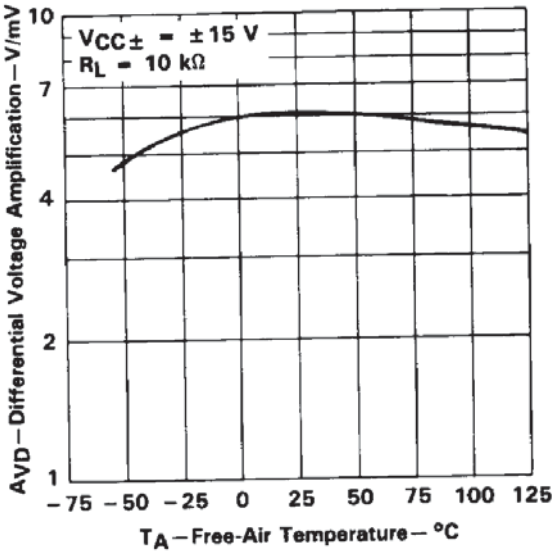

FIGURE 10

LARGE-SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
AND PHASE SHIFT
vs
FREQUENCY

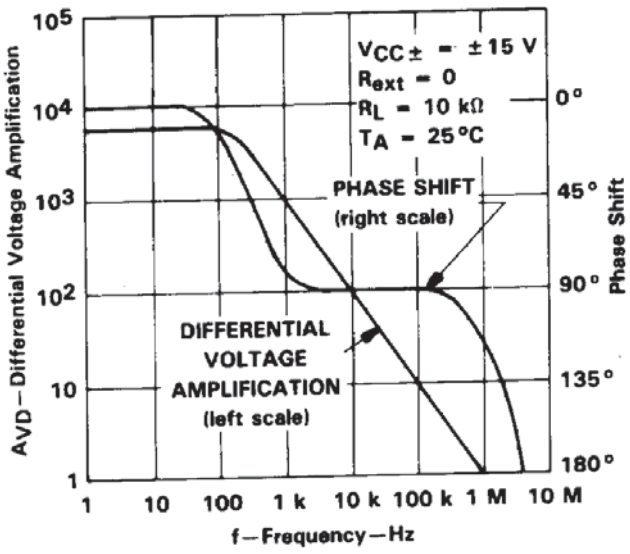

FIGURE 11

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

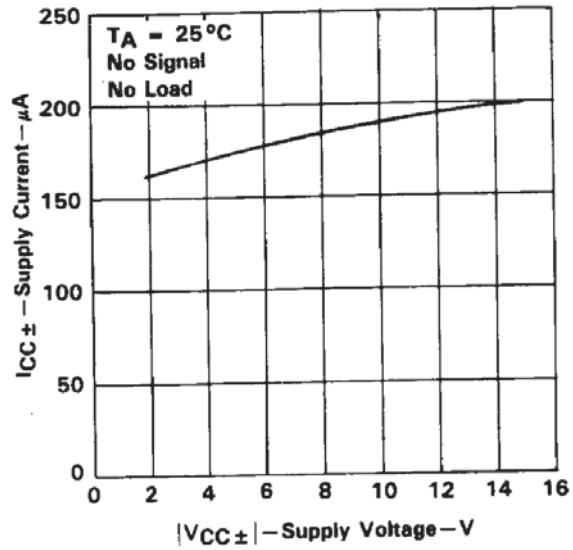

FIGURE 12

SUPPLY CURRENT
vs
FREE-AIR TEMPERATURE

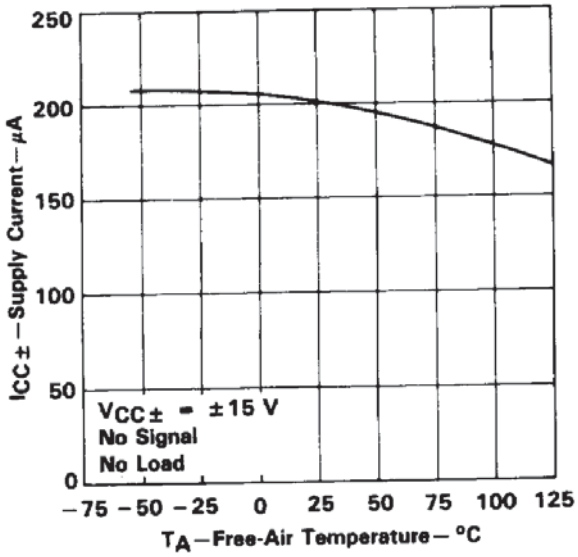

FIGURE 13

†A 10-pF compensation capacitor is used with TL060 and TL060A.

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TYPICAL CHARACTERISTICS†

TOTAL POWER DISSIPATED
vs
FREE-AIR TEMPERATURE

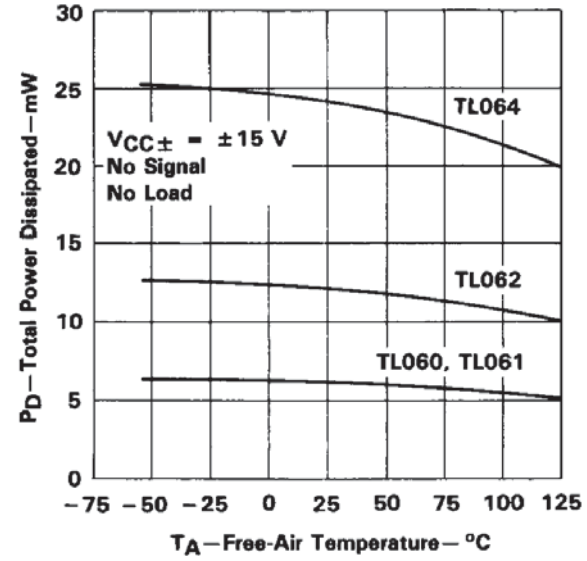

FIGURE 14

ALL EXCEPT TL06_C
COMMON-MODE REJECTION RATIO
vs
FREE-AIR TEMPERATURE

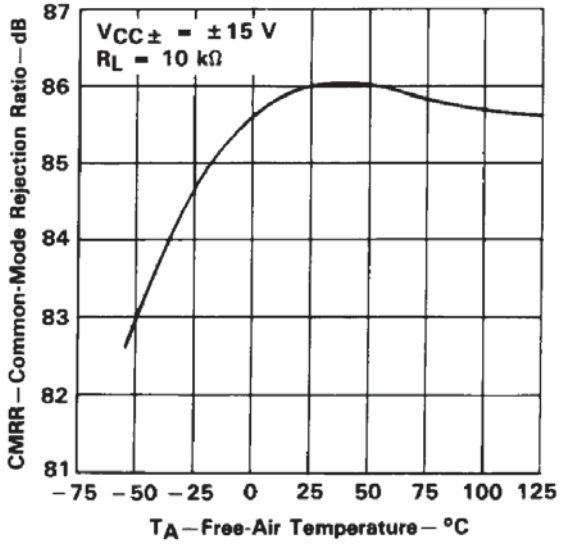

FIGURE 15

NORMALIZED UNITY GAIN BANDWIDTH
SLEW RATE, AND PHASE SHIFT
vs
FREE-AIR TEMPERATURE

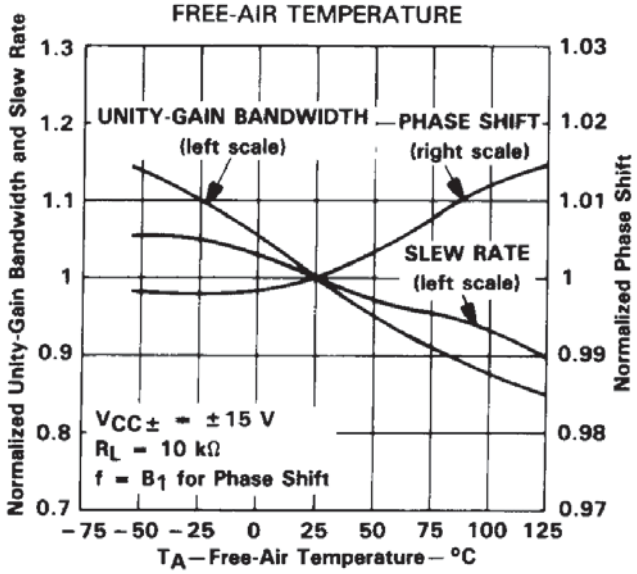

FIGURE 16

INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE

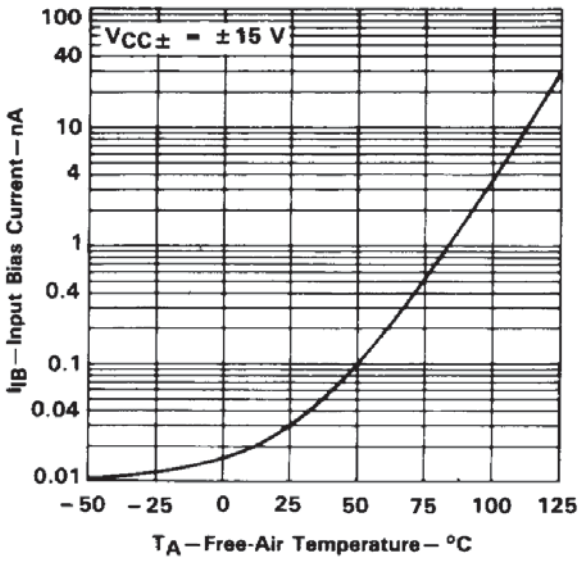

FIGURE 17

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 10-pF compensation capacitor is used with TL060 and TL060A.

TYPICAL CHARACTERISTICS†

VOLTAGE FOLLOWER
LARGE SIGNAL PULSE RESPONSE

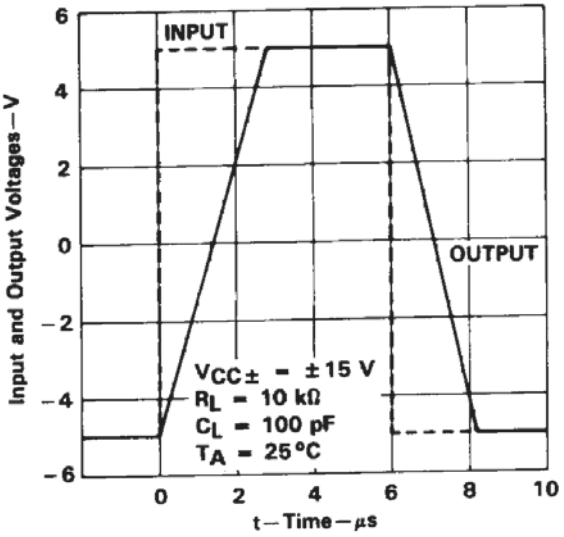

FIGURE 18

OUTPUT VOLTAGE
vs
ELAPSED TIME

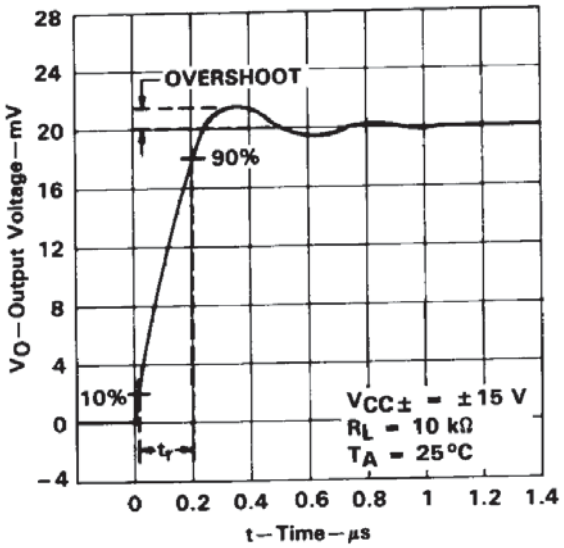

FIGURE 19

EQUIVALENT INPUT NOISE VOLTAGE
vs
FREQUENCY

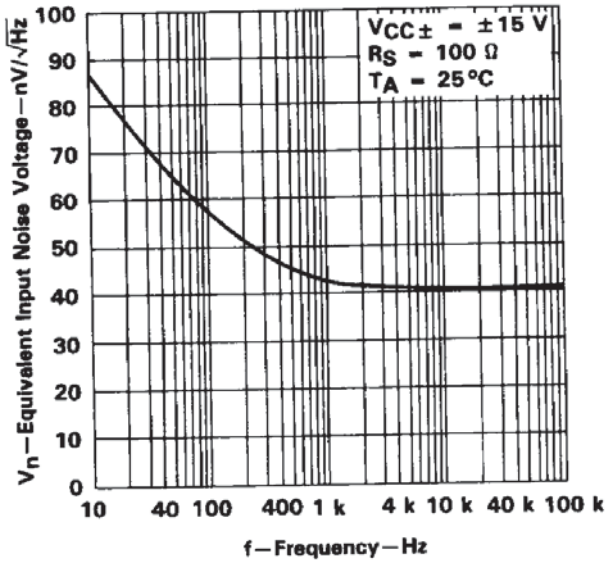

FIGURE 20

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 10-pF compensation capacitor is used with TL060 and TL060A.

TYPICAL APPLICATION DATA

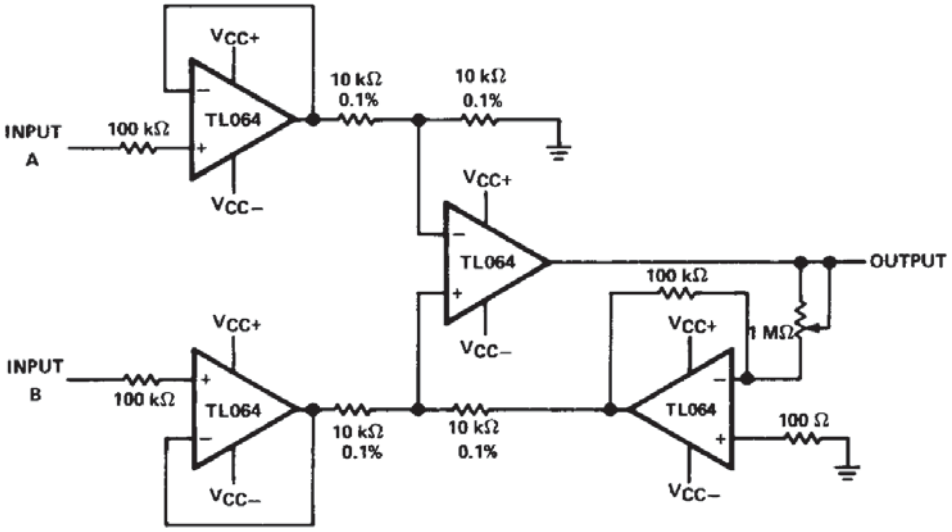

FIGURE 21. INSTRUMENTATION AMPLIFIER

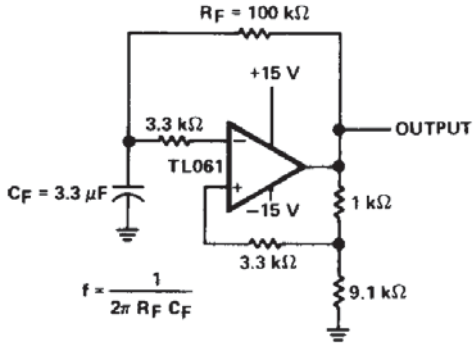

FIGURE 22. 0.5-Hz SQUARE-WAVE OSCILLATOR

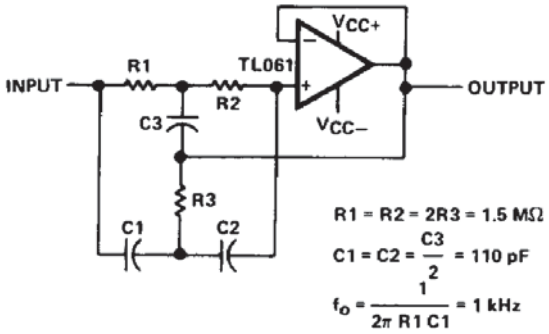

FIGURE 23. HIGH-Q NOTCH FILTER

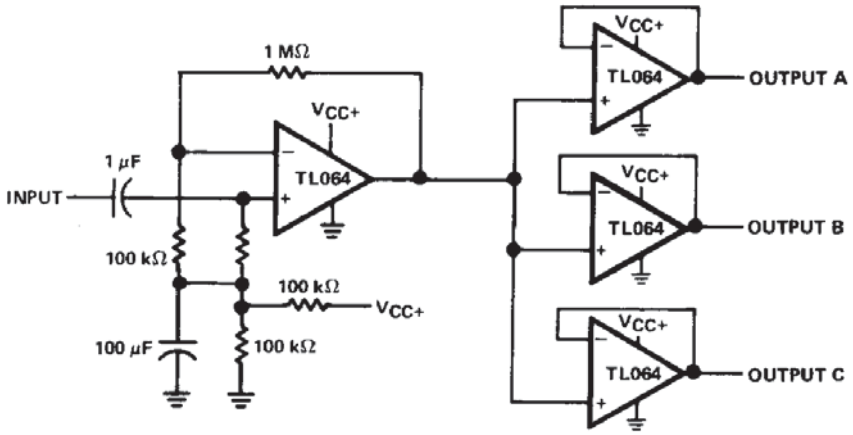

FIGURE 24. AUDIO DISTRIBUTION AMPLIFIER

TYPICAL APPLICATION DATA

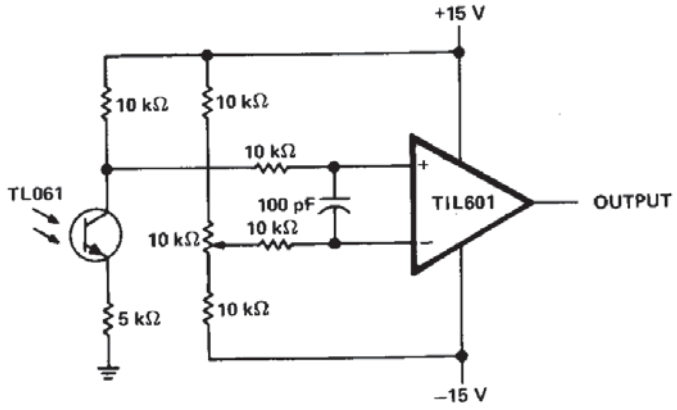

FIGURE 25. LOW-LEVEL LIGHT DETECTOR PREAMPLIFIER

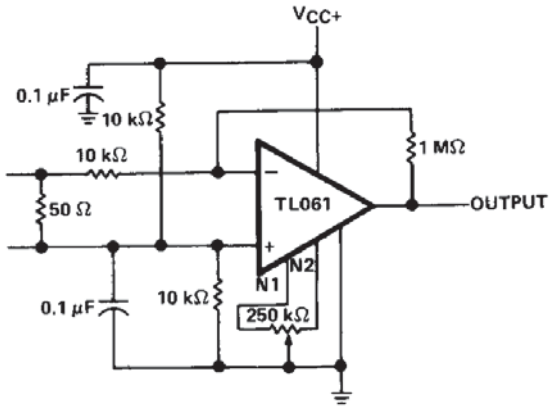

FIGURE 26. AC AMPLIFIER

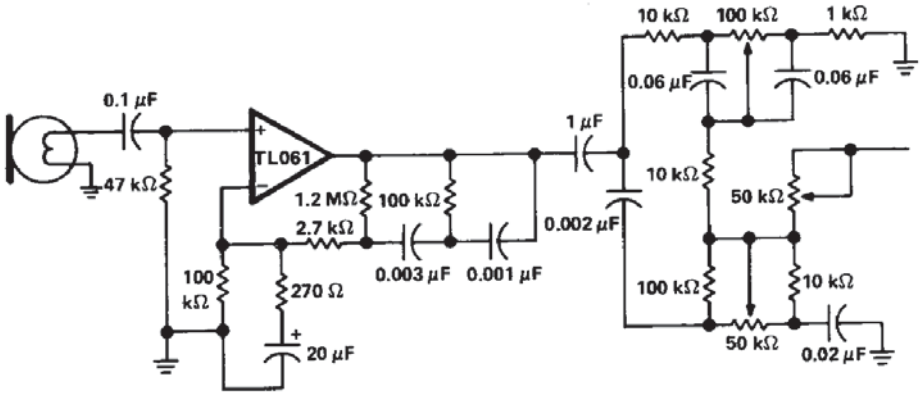

FIGURE 27. MICROPHONE PREAMPLIFIER WITH TONE CONTROL

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TYPICAL APPLICATION DATA

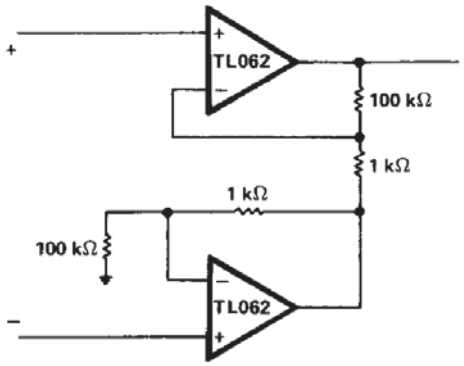

FIGURE 28. INSTRUMENTATION AMPLIFIER

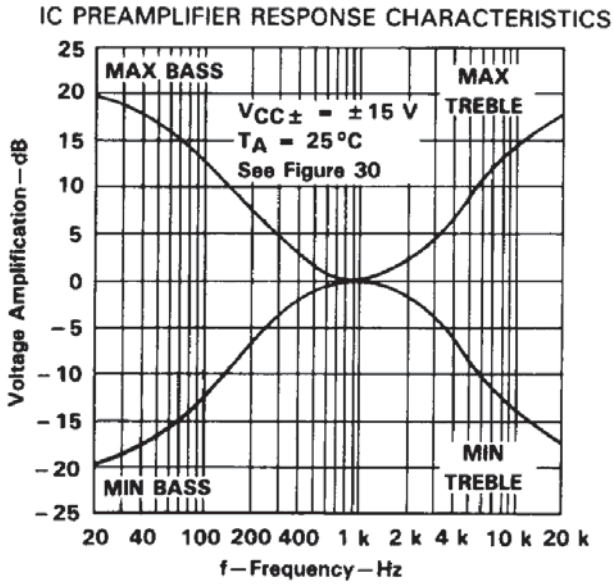

FIGURE 29

TYPICAL APPLICATION DATA

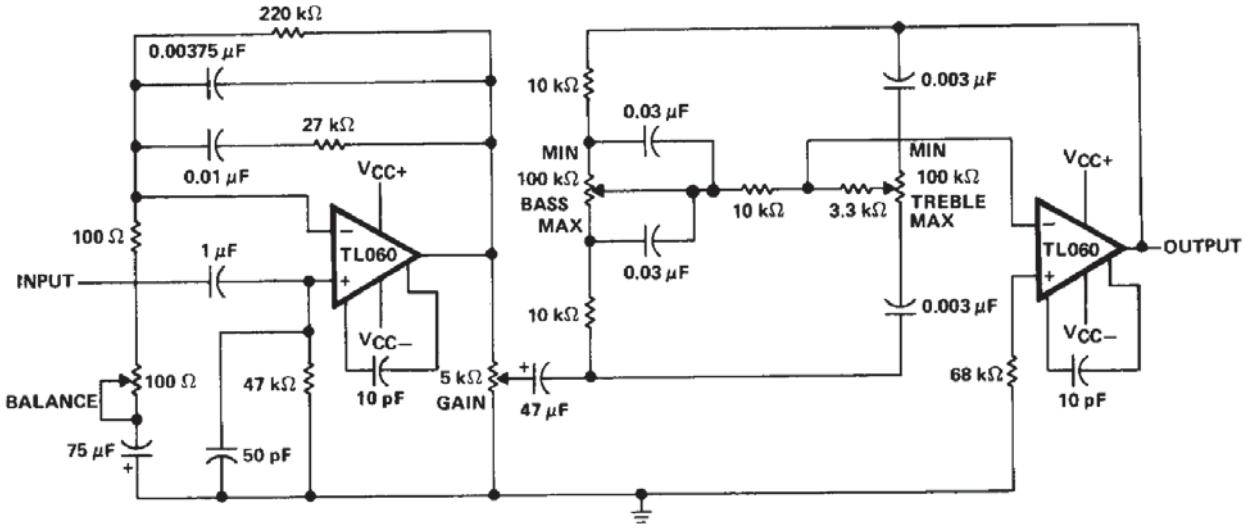

FIGURE 30. IC PREAMPLIFIER

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