TYPES TL060, TL060A, TL061, TL061A, TL061B, TL062, TL062A, TL062B, TL064, TL064A, TL064B LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

BULLETIN NO. DL-S 12647, NOVEMBER 1978–REVISED OCTOBER 1979

19 DEVICES COVER COMMERCIAL, INDUSTRIAL, AND MILITARY TEMPERATURE RANGES

- Very Low Power Consumption
- Typical Supply Current . . . 200 μA
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Output Short-Circuit Protection
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate . . . 3.5 V/μs Typ

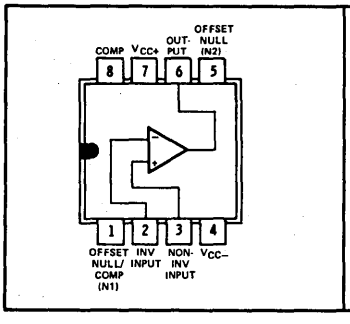
description

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.

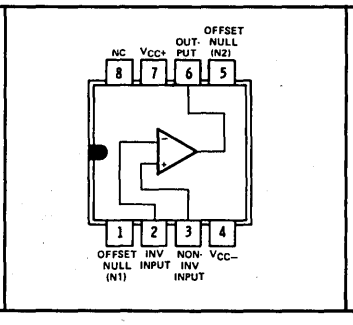
Device types with an "M" suffix are characterized for operation over the full military temperature range of –55°C to 125°C, those with an "I" suffix are characterized for operation from –25°C to 85°C, and those with a "C" suffix are characterized for operation from 0°C to 70°C.

4

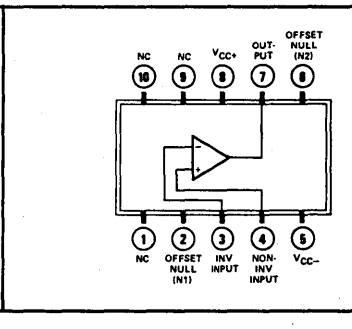
TL060, TL060A
JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



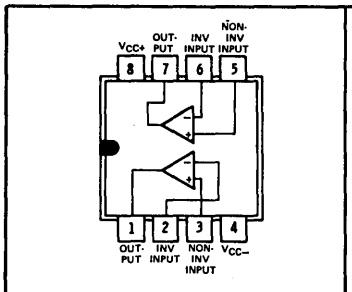
TL061, TL061A, TL061B
JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



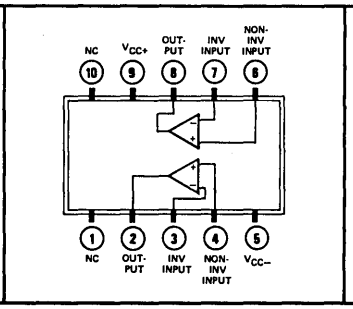
TL061
U FLAT PACKAGE (TOP VIEW)



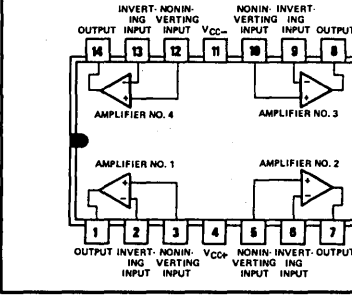
TL062, TL062A, TL062B
JG OR P DUAL-IN-LINE PACKAGE (TOP VIEW)



TL062
U FLAT PACKAGE (TOP VIEW)



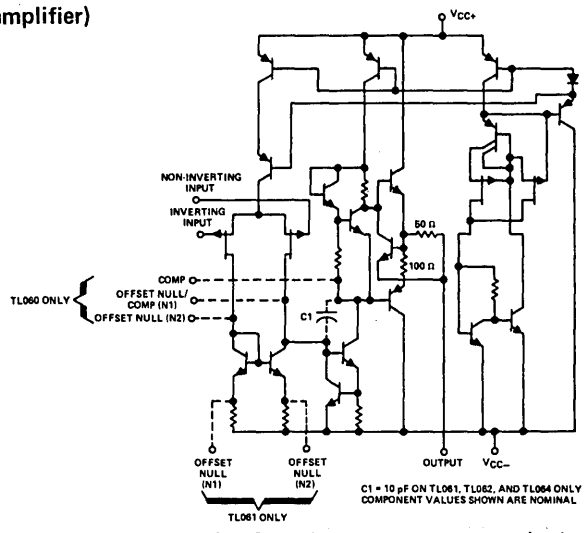
TL064 . . . J, N, OR W PACKAGE
TL064A, TL064B . . . J OR N PACKAGE
(TOP VIEW)



NC—No internal connection

TYPES TL060, TL060A, TL061, TL061A, TL061B, TL062, TL062A, TL062B, TL064, TL064A, TL064B
LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

schematic (each amplifier)



absolute maximum ratings over operating free-air temperature range (unless other wise 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
Duration of output short circuit (see Note 4)		Unlimited	Unlimited	Unlimited	
Continuous total dissipation at (or below) 25°C free-air temperature (see Note 5)	J, JG, N, P, or W package	680	680	680	mW
	U package	675			
Operating free-air temperature range		–55 to 125	–25 to 85	0 to 70	°C
Storage temperature range		–65 to 150	–65 to 150	–65 to 150	°C
Lead temperature 1/16 inch (1,6 mm) from case for 60 seconds	J, JG, U, or W package	300	300	300	°C
Lead temperature 1/16 inch (1,6 mm) from case for 10 seconds	N or P 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 volts, whichever is less.
4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.
5. For operation above 25°C, free-air temperature, refer to Dissipation Derating Table. In the J and JG packages, TL06_M chips are alloy-mounted; TL06_I, TL06_C, TL06_AC, and TL06_BC chips are glass-mounted.

DISSIPATION DERATING TABLE

PACKAGE	POWER RATING	DERATING FACTOR	ABOVE T_A
J (Alloy-Mounted Chip)	680 mW	11.0 mW/°C	88°C
J (Glass-Mounted Chip)	680 mW	8.2 mW/°C	67°C
JG (Alloy-Mounted Chip)	680 mW	8.4 mW/°C	69°C
JG (Glass-Mounted Chip)	680 mW	6.6 mW/°C	47°C
N	680 mW	9.2 mW/°C	76°C
P	680 mW	8.0 mW/°C	65°C
U	675 mW	5.4 mW/°C	25°C
W	680 mW	8.0 mW/°C	65°C

DEVICE TYPES, SUFFIX VERSIONS, AND PACKAGES

	TL060	TL061	TL062	TL064
TL06_M	JG	JG, U	JG, U	J, W
TL06_I	JG, P	JG, P	JG, P	J, N
TL06_C	JG, P	JG, P	JG, P	J, N
TL06_AC	JG, P	JG, P	JG, P	J, N
TL06_BC		JG, P	JG, P	J, N

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 225012 • DALLAS, TEXAS 75265

electrical characteristics, $V_{CC+} = \pm 15$ V

PARAMETER		TEST CONDITIONS†		TL06_M			TL06_I			TL06_C TL06_AC TL06_BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$R_S = 50\ \Omega$, $T_A = 25°C$	'60, '61, '62		3	6		3	6		3	15	mV
			'64		3	9		3	6		3	15	
			'60A, '61A, '62A, '64A								3	6	
			'61B, '62B, '64B								2	3	
		$R_S = 50\ \Omega$, T_A = full range	'60, '61, '62			9			9			20	
			'64			15			9			20	
			'60A, '61A, '62A, '64A									7.5	
			'61B, '62B, '64B									5	
α_{VIO}	Temperature coefficient of input offset voltage	$R_S = 50\ \Omega$,	T_A = full range		10			10			10		μV/°C
I_{IO}	Input offset current‡	$T_A = 25°C$	'60, '61, '62, '64		5	100		5	100		5	200	pA
			'60A, '61A, '62A, '64A								5	100	
			'61B, '62B, '64B								5	100	
		T_A = full range	'60, '61, '62, '64			20			10			5	nA
			'60A, '61A, '62A, '64A									3	
			'61B, '62B, '64B									3	
I_{IB}	Input bias current‡	$T_A = 25°C$	'60, '61, '62, '64		30	200		30	200		30	400	pA
			'60A, '61A, '62A, '64A								30	200	
			'61B, '62B, '64B								30	200	
		T_A = full range	'60, '61, '62, '64			50			20			10	nA
			'60A, '61A, '62A, '64A									7	
			'61B, '62B, '64B									7	
V_{ICR}	Common-mode input voltage range	$T_A = 25°C$	'60, '61, '62, '64	±11	±12		±11.5	±12		±10	±11		V
			'60A, '61A, '62A, '64A							±11.5	±12		
			'61B, '62B, '64B							±11.5	±12		
V_{OPP}	Maximum peak-to-peak output voltage swing	$T_A = 25°C$,	$R_L = 10\ k\Omega$	20	27		20	27		20	27		V
		T_A = full range,	$R_L \geq 10\ k\Omega$	20			20			20			
A_{VD}	Large-signal differential voltage amplification	$R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V, $T_A = 25°C$	'60, '61, '62, '64	4	6		4	6		3	6		V/mV
			'60A, '61A, '62A, '64A							4	6		
			'61B, '62B, '64B							4	6		
		$R_L \geq 10\ k\Omega$, $V_O = \pm 10$ V, T_A = full range	'60, '61, '62, '64	4			4			3			
			'60A, '61A, '62A, '64A							4			
			'61B, '62B, '64B							4			
B_1	Unity-gain bandwidth	$T_A = 25°C$,	$R_L = 10\ k\Omega$		1			1			1		MHz
r_i	Input resistance	$T_A = 25°C$			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	$R_S \leq 10\ k\Omega$, $T_A = 25°C$	'60, '61, '62, '64	80	86		80	86		70	76		dB
			'60A, '61A, '62A, '64A							80	86		
			'61B, '62B, '64B							80	86		
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$R_S \leq 10\ k\Omega$, $T_A = 25°C$	'60, '61, '62, '64	80	95		80	95		70	95		dB
			'60A, '61A, '62A, '64A							80	95		
			'61B, '62B, '64B							80	95		
P_D	Total power dissipation (each amplifier)	No load, $T_A = 25°C$	No signal,		6	7.5		6	7.5		6	7.5	mW
I_{CC}	Supply current (each amplifier)	No load, $T_A = 25°C$	No signal,		200	250		200	250		200	250	μA
V_{o1}/V_{o2}	Channel separation	$A_{VD} = 100$,	$T_A = 25°C$		120			120			120		dB

†All characteristics are specified under open-loop conditions unless otherwise noted. Full range for T_A is −55°C to 125°C for TL06_M; −25°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. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as is possible.

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

PARAMETER		TEST CONDITIONS		TL06_M			ALL OTHERS			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_I = 10 V, C_L = 100 pF,	R_L = 10 kΩ, See Figure 1	2	3.5			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			0.2		μs
	Overshoot factor				10%			10%		
V_n	Equivalent input noise voltage	R_S = 100 Ω,	f = 1 kHz		42			42		nV/√Hz

PARAMETER MEASUREMENT INFORMATION

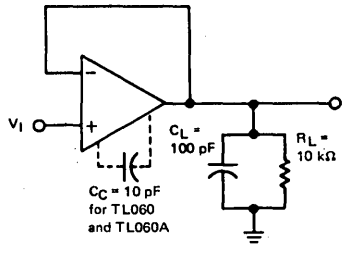


FIGURE 1–UNITY-GAIN AMPLIFIER

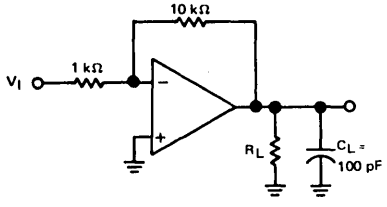


FIGURE 2–GAIN-OF-10 INVERTING AMPLIFIER

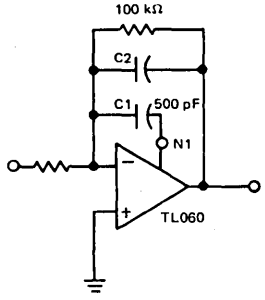
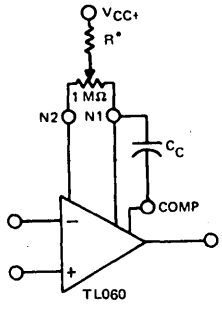


FIGURE 3–FEED-FORWARD COMPENSATION

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

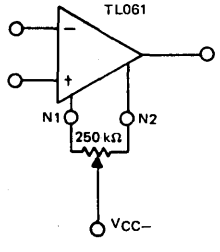


FIGURE 5

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 225012 • DALLAS, TEXAS 75265

TYPICAL CHARACTERISTICS†

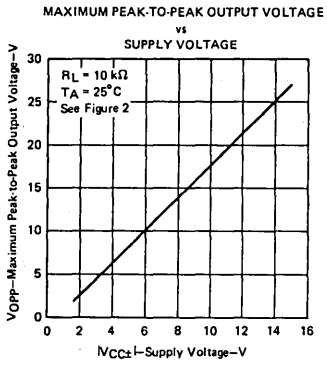


FIGURE 6

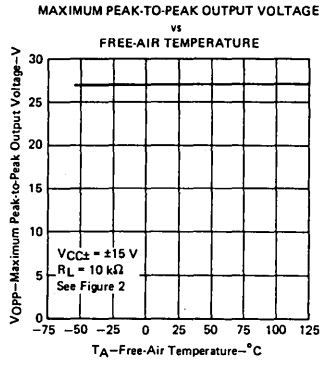


FIGURE 7

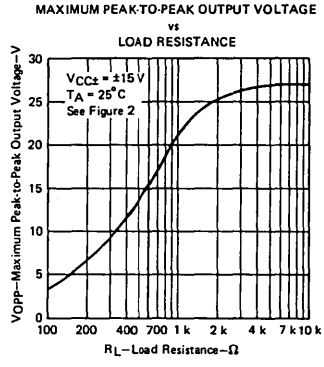


FIGURE 8

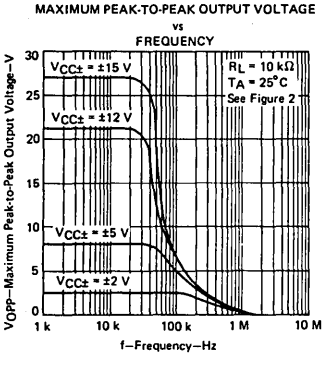


FIGURE 9

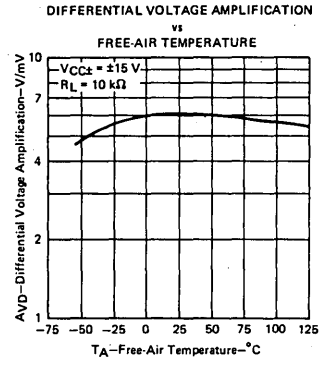


FIGURE 10

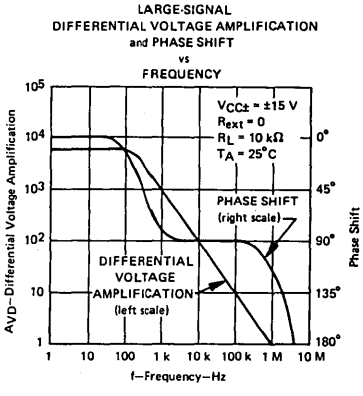


FIGURE 11

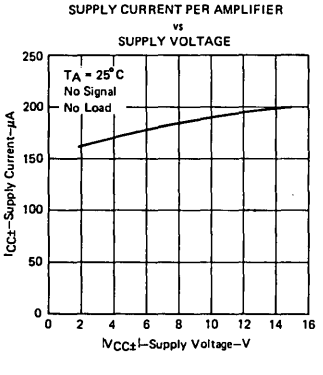


FIGURE 12

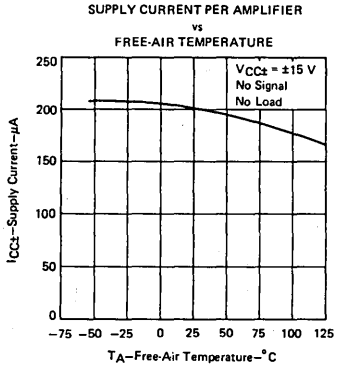


FIGURE 13

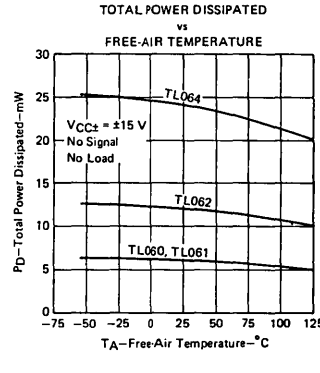


FIGURE 14

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

TYPICAL CHARACTERISTICS†

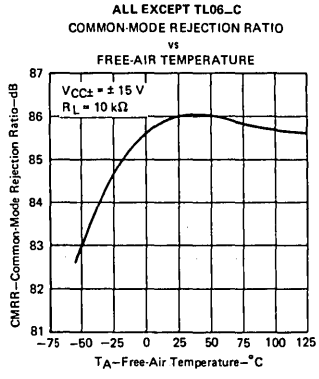


FIGURE 15

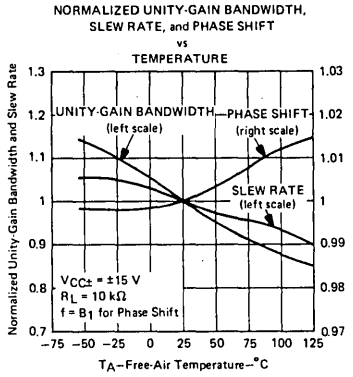


FIGURE 16

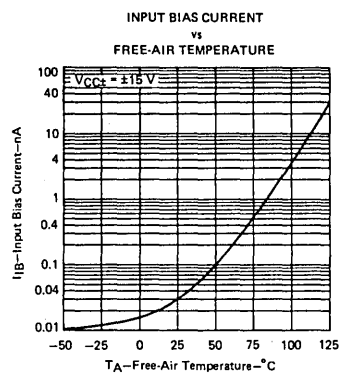


FIGURE 17

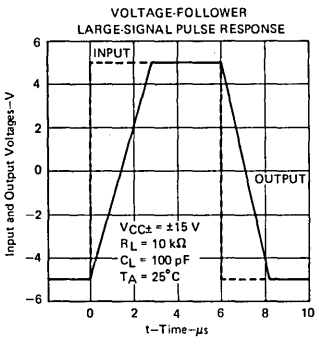


FIGURE 18

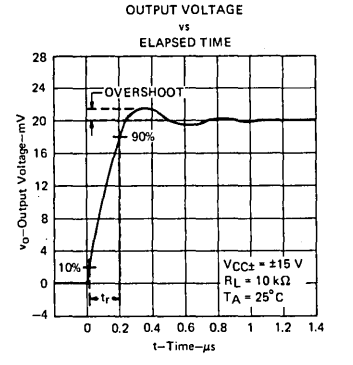


FIGURE 19

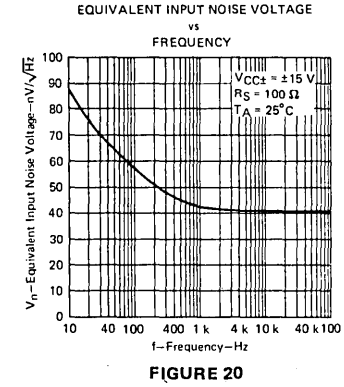


FIGURE 20

†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

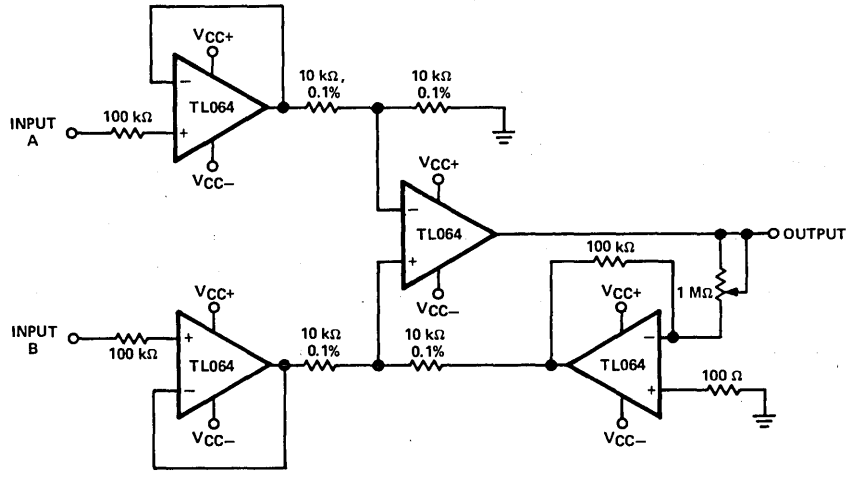


FIGURE 21–INSTRUMENTATION AMPLIFIER

TEXAS INSTRUMENTS
INCORPORATED
POST OFFICE BOX 225012 • DALLAS, TEXAS 75265