TYPES TL070, TL070A, TL071, TL071A, TL071B, TL072, TL072A, TL072B, TL074, TL074A, TL074B, TL075 LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS

BULLETIN NO. DL-S 12640, SEPTEMBER 1978—REVISED OCTOBER 1979

20 DEVICES COVER COMMERCIAL, INDUSTRIAL, AND MILITARY TEMPERATURE RANGES

- Low Noise . . . $V_n = 18\ nV/\sqrt{Hz}$ Typ
- Low Harmonic Distortion . . . 0.01% Typ
- 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
- Low Power Consumption
- Latch-Up-Free Operation
- High Slew Rate . . . 13 V/μs Typ

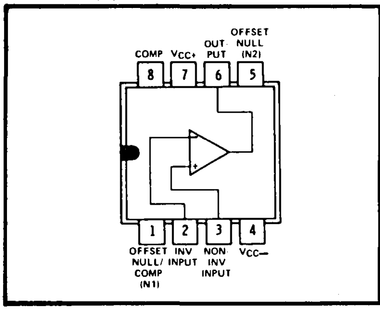
description

The JFET-input operational amplifiers of the TL071 series are designed as low-noise versions of the TL081 series amplifiers with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL071 series ideally suited as amplifiers for high-fidelity and audio preamplifier applications. Each amplifier features JFET-inputs (for high input impedance) coupled with bipolar output stages all integrated on a single monolithic chip.

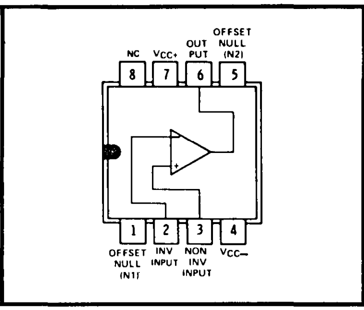
Device types with an "M" suffix are characterized for operation over the full military temperature range of −55°C to 125°C, those with an "I" suffix are characterized for operation from −25°C to 85°C, and those with a "C" suffix are characterized for operation from 0°C to 70°C.

4

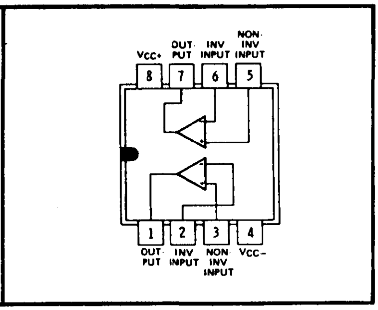
TL070, TL070A
JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



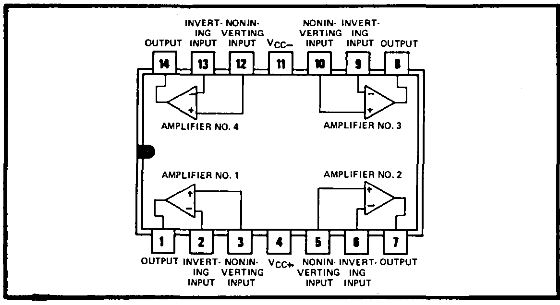
TL071, TL071A, TL071B
JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



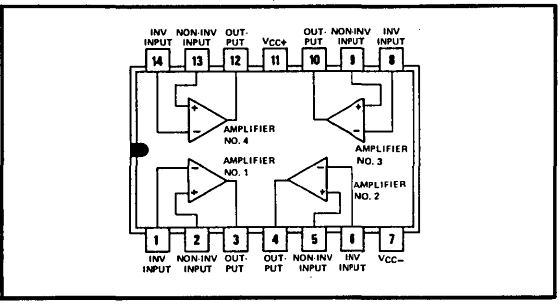
TL072, TL072A, TL072B
JG OR P DUAL-IN-LINE
PACKAGE (TOP VIEW)



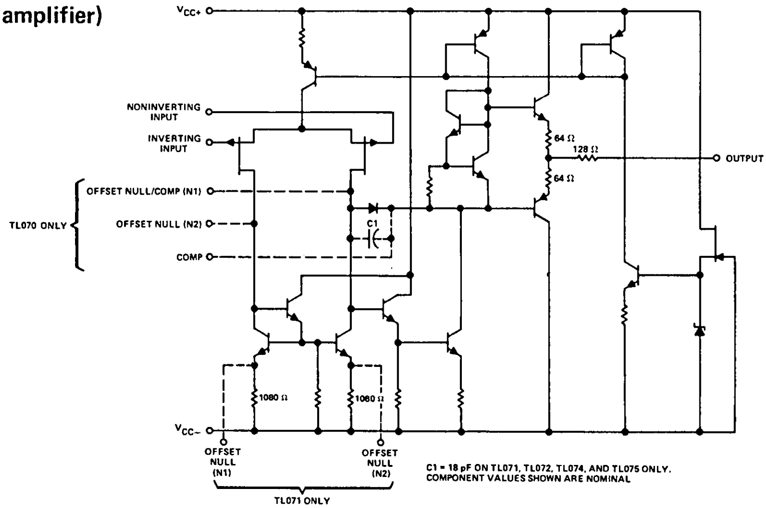
TL074, TL074A, TL074B
J OR N DUAL-IN-LINE
OR W PACKAGE (TOP VIEW)



TL075
N DUAL-IN-LINE
PACKAGE (TOP VIEW)



schematic (each amplifier)



C1 = 18 pF ON TL071, TL072, TL074, AND TL075 ONLY.
COMPONENT VALUES SHOWN ARE NOMINAL

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

		TL07_C	TL07_I	TL07_C TL07_AC TL07_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)		680	680	680	mW
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 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, TL07_M chips are alloy-mounted; TL07_I, TL07_C, TL07_AC, and TL07_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
W	680 mW	8.0 mW/°C	65°C

Also see Dissipation Derating Curves, Section 2.

DEVICE TYPES, SUFFIX VERSIONS, AND PACKAGES

	TL070	TL071	TL072	TL074	TL075
TL07_M	JG,	JG,	JG,	J, W	*
TL07_I	JG, P	JG, P	JG, P	J, N	*
TL07_C	JG, P	JG, P	JG, P	J, N	N
TL07_AC	JG, P	JG, P	JG, P	J, N	*
TL07_BC	*	JG, P	JG, P	J, N	*

*These combinations are not defined by this data sheet.

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

PARAMETER		TEST CONDITIONS†		TL07_M			TL07_I			TL07_C / TL07_AC / TL07_BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$R_S = 50\ \Omega$, $T_A = 25°C$	'70, '71, '72, '75‡		3	6		3	6		3	10	mV
			'74		3	9		3	6		3	10	
			'70A, '71A, '72A, '74A								3	6	
			'71B, '72B, '74B								2	3	
		$R_S = 50\ \Omega$, T_A = full range	'70, '71, '72, '75‡			9			9			13	
			'74			15			9			13	
			'70A, '71A, '72A, '74A									7.5	
			'71B, '72B, '74B									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§	$T_A = 25°C$	'70, '71, '72, '74, '75‡		5	50		5	50		5	50	pA
			'70A, '71A, '72A, '74A								5	50	
			'71B, '72B, '74B								5	50	
		T_A = full range	'70, '71, '72, '74, '75‡			20			10			2	nA
			'70A, '71A, '72A, '74A									2	
			'71B, '72B, '74B									2	
I_{IB}	Input bias current§	$T_A = 25°C$	'70, '71, '72, '74, '75‡		30	200		30	200		30	200	pA
			'70A, '71A, '72A, '74A								30	200	
			'71B, '72B, '74B								30	200	
		T_A = full range	'70, '71, '72, '74, '75‡			50			20			7	nA
			'70A, '71A, '72A, '74A									7	
			'71B, '72B, '74B									7	
V_{ICR}	Common-mode input voltage range	$T_A = 25°C$	'70, '71, '72, '74, '75‡	±11	±12		±11	±12		±10	±11		V
			'70A, '71A, '72A, '74A							±11	±12		
			'71B, '72B, '74B							±11	±12		
V_{OPP}	Maximum peak-to-peak output voltage swing	$T_A = 25°C$,	$R_L = 10\ k\Omega$	24	27		24	27		24	27		V
		T_A = full range	$R_L \geq 10\ k\Omega$	24			24			24			
			$R_L \geq 2\ k\Omega$	20	24		20	24		20	24		
A_{VD}	Large-signal differential voltage amplification	$R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V, $T_A = 25°C$	'70, '71, '72, '74, '75‡	35	200		50	200		25	200		V/mV
			'70A, '71A, '72A, '74A							50	200		
			'71B, '72B, '74B							50	200		
		$R_L \geq 2\ k\Omega$, $V_O = \pm 10$ V, T_A = full range	'70, '71, '72, '74, '75‡	20			25			15			
			'70A, '71A, '72A, '74A							25			
			'71B, '72B, '74B							25			
B_1	Unity-gain bandwidth	$T_A = 25°C$,	$R_L = 10\ k\Omega$		3			3			3		MHz
r_i	Input resistance	$T_A = 25°C$			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common-mode rejection ratio	$R_S \leq 10\ k\Omega$, $T_A = 25°C$	'70, '71, '72, '74, '75‡	80	86		80	86		70	76		dB
			'70A, '71A, '72A, '74A							80	86		
			'71B, '72B, '74B							80	86		
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$R_S \leq 10\ k\Omega$, $T_A = 25°C$	'70, '71, '72, '74, '75‡	80	86		80	86		70	76		dB
			'70A, '71A, '72A, '74A							80	86		
			'71B, '72B, '74B							80	86		
I_{CC}	Supply current (per amplifier)	No load, $T_A = 25°C$	No signal,		1.4	2.5		1.4	2.5		1.4	2.5	mA
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 TL07_M; −25°C to 85°C for TL07_I; and 0°C to 70°C for TL07_C, TL07_AC, and TL07_BC.

‡Types TL075I and TL075M are not defined by this data sheet.

§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, $V_{CC\pm} = \pm 15$ V, $T_A = 25°C$

PARAMETER		TEST CONDITIONS		TL07_M MIN	TL07_M TYP	TL07_M MAX	ALL OTHERS MIN	ALL OTHERS TYP	ALL OTHERS MAX	UNIT
SR	Slew rate at unit gain	$V_I = 10$ V, $C_L = 100$ pF,	$R_L = 2$ kΩ, See Figure 1	10	13			13		V/μs
t_r	Rise time	$V_I = 20$ mV,	$R_L = 2$ kΩ,		0.1			0.1		μs
	Overshoot factor	$C_L = 100$ pF,	See Figure 1		10			10		%
V_n	Equivalent input noise voltage	$R_S = 100$ Ω	f = 1 kHz		18			18		nV/√Hz
			f = 10 Hz to 10 kHz		4			4		μV
I_n	Equivalent input noise current	$R_S = 100$ Ω,	f = 1 kHz		0.01			0.01		pA/√Hz
THD	Total harmonic distortion	$V_{O(rms)} = 10$ V, $R_L \geq 2$ kΩ,	$R_S \leq 1$ kΩ, f = 1 kHz		0.01			0.01		%

PARAMETER MEASUREMENT INFORMATION

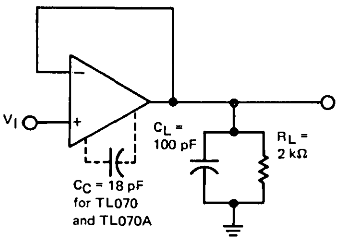

FIGURE 1—UNITY-GAIN AMPLIFIER

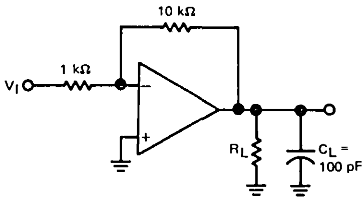

FIGURE 2—GAIN-OF-10 INVERTING AMPLIFIER

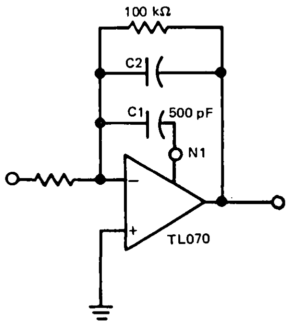

FIGURE 3—FEED-FORWARD COMPENSATION

INPUT OFFSET VOLTAGE NULL CIRCUITS

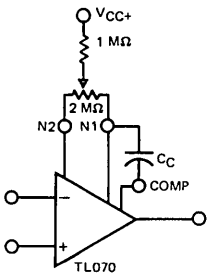

FIGURE 4

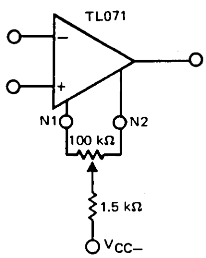

FIGURE 5

TYPICAL CHARACTERISTICS†

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

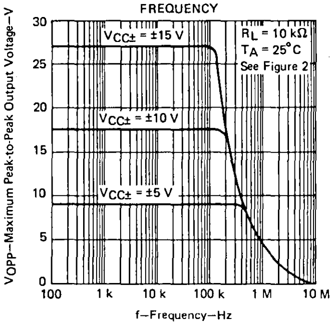

FIGURE 6

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

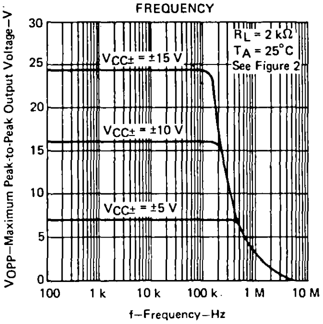

FIGURE 7

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

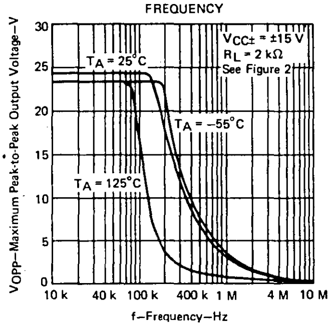

FIGURE 8

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREE-AIR TEMPERATURE

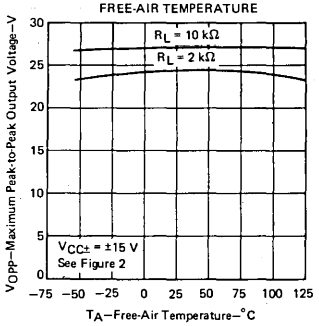

FIGURE 9

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
LOAD RESISTANCE

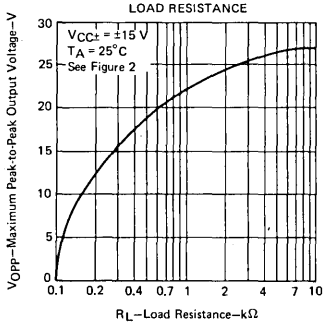

FIGURE 10

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
SUPPLY VOLTAGE

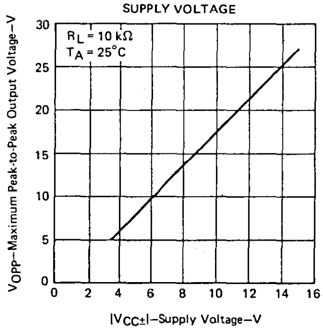

FIGURE 11

TOTAL POWER DISSIPATED
vs
FREE-AIR TEMPERATURE

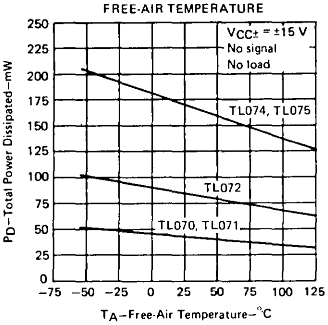

FIGURE 12

SUPPLY CURRENT PER AMPLIFIER
vs
FREE-AIR TEMPERATURE

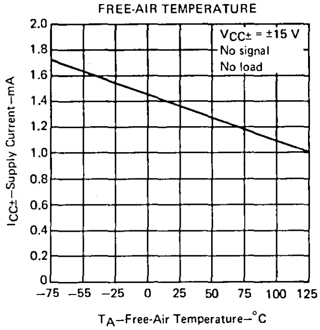

FIGURE 13

SUPPLY CURRENT
vs
SUPPLY VOLTAGE

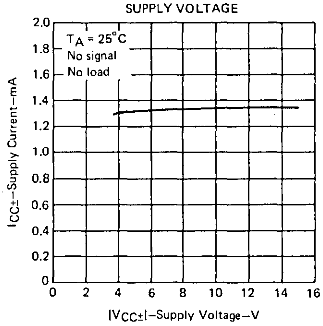

FIGURE 14

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 18-pF compensation capacitor is used with TL070 and TL070A.

TYPICAL CHARACTERISTICS†

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREE-AIR TEMPERATURE

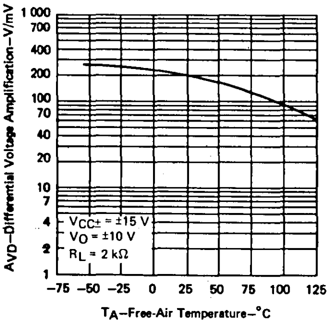

FIGURE 15

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION and PHASE SHIFT vs FREQUENCY

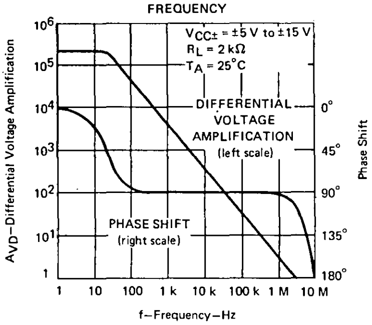

FIGURE 16

TL070 DIFFERENTIAL VOLTAGE AMPLIFICATION vs FREQUENCY WITH FEED-FORWARD COMPENSATION

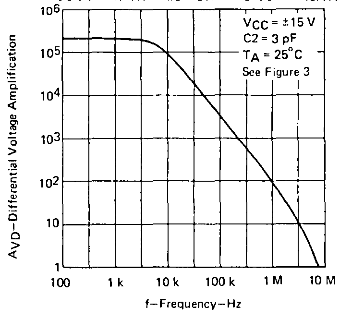

FIGURE 17

INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

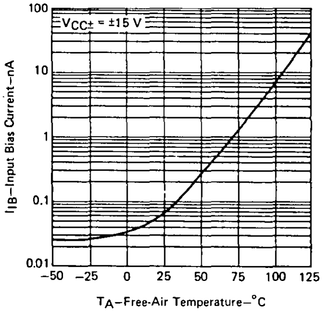

FIGURE 18

NORMALIZED UNITY-GAIN BANDWIDTH and PHASE SHIFT vs TEMPERATURE

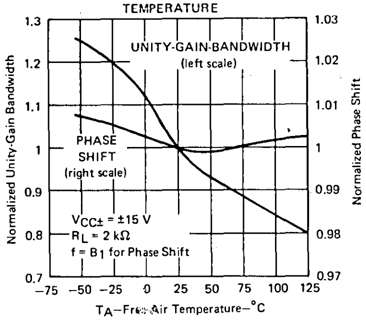

FIGURE 19

NORMALIZED SLEW RATE vs TEMPERATURE

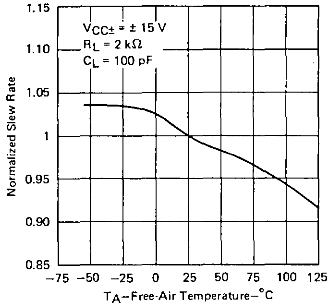

FIGURE 20

ALL EXCEPT TL07–C COMMON-MODE REJECTION RATIO vs FREE-AIR TEMPERATURE

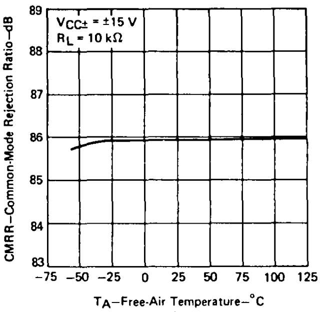

FIGURE 21

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

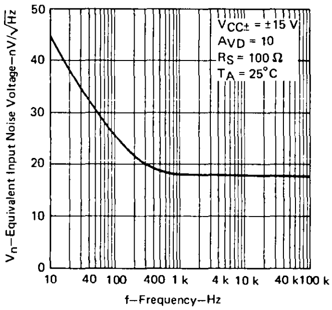

FIGURE 22

TOTAL HARMONIC DISTORTION vs FREQUENCY

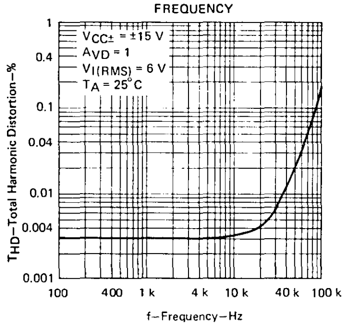

FIGURE 23

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 18-pF compensation capacitor is used with TL070 and TL070A.

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TYPICAL CHARACTERISTICS†

VOLTAGE-FOLLOWER
LARGE-SIGNAL PULSE RESPONSE

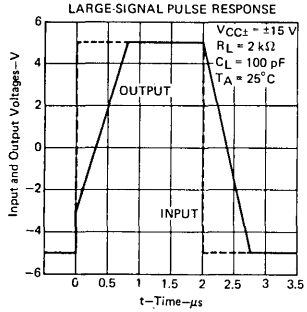


FIGURE 24

OUTPUT VOLTAGE
vs
ELAPSED TIME

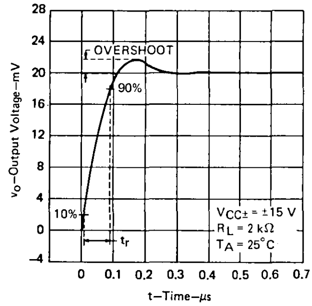


FIGURE 25

†Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices. A 18-pF compensation capacitor is used with TL070 and TL070A.

TYPICAL APPLICATION DATA

0.5-Hz SQUARE-WAVE OSCILLATOR

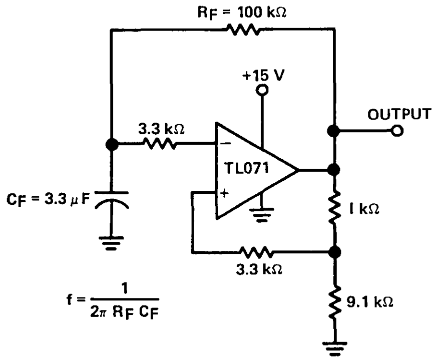


FIGURE 26–0.5-Hz SQUARE-WAVE OSCILLATOR

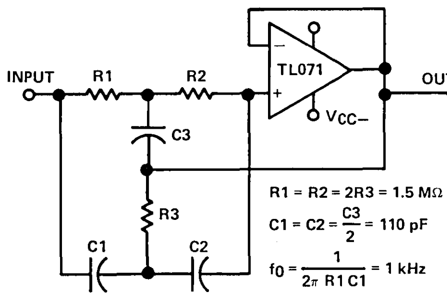
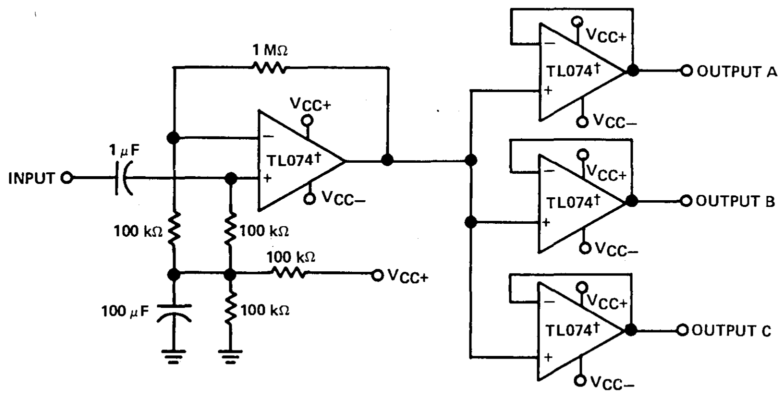


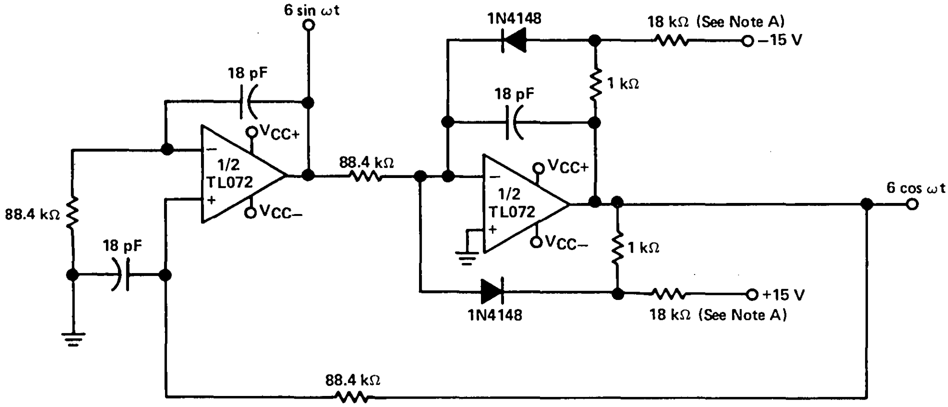
FIGURE 27–HIGH-Q NOTCH FILTER



† or TL075

FIGURE 28–AUDIO DISTRIBUTION AMPLIFIER

TYPICAL APPLICATION DATA



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

FIGURE 29—100-KHz QUADRATURE OSCILLATOR

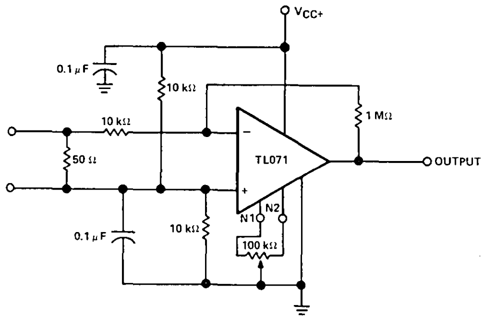


FIGURE 30—AC AMPLIFIER

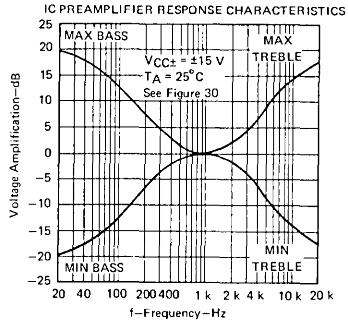


FIGURE 31

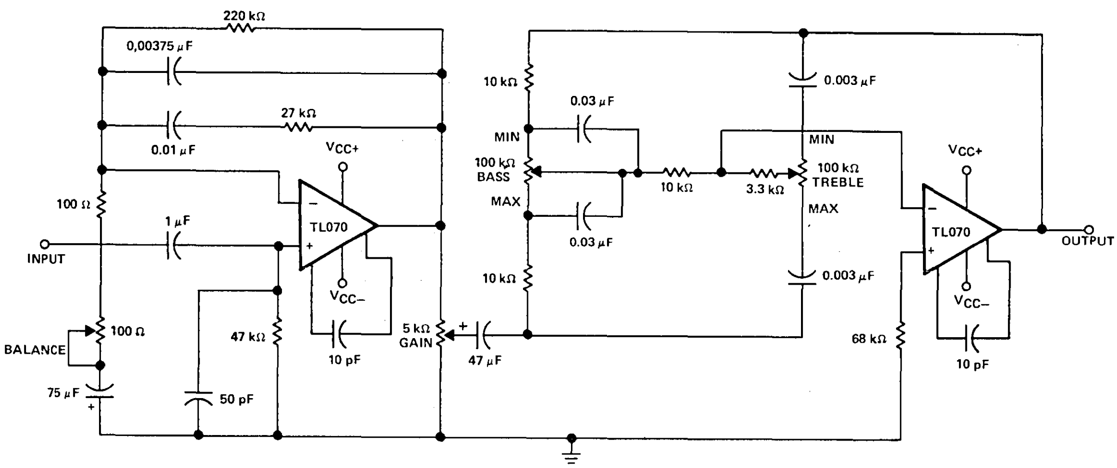


FIGURE 32—IC PREAMPLIFIER

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