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

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15 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

- Low Noise $V_n = 18 \text{ nV}/\sqrt{\text{Hz}}$ Typ at f = 1 kHz
- High Input Impedance . . . JFET Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate . . . 13 V/μs Typ
- Common-Mode Input Voltage Range Includes V_{CC+}

description

The JFET-input operational amplifiers in the TL07_ series are designed as low-noise versions of the TL08_ series amplifiers with low input bias and offset currents and fast slew rate. The low harmonic distortion and low noise make the TL07_ series ideally suited for high-fidelity and audio preamplifier applications. Each amplifier features JFET inputs (for high input impedance) coupled with bipolar output stages integrated on a single monolithic chip.

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.

AVAILABLE OPTIONS

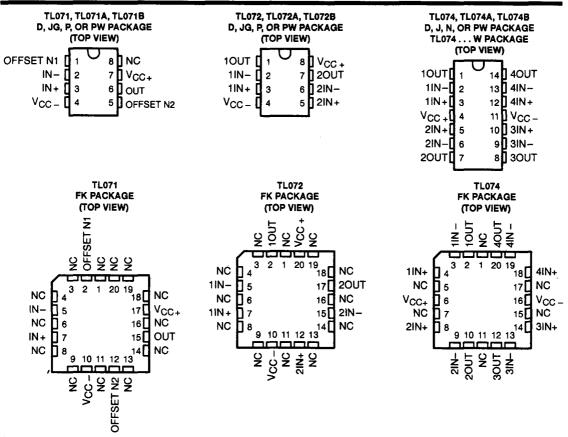
					PA	CKAGE			
TA	V _{IO} max AT 25°C	SMALL OUTLINE (D)†	CHIP CARRIER (FK)	CERAMIC DIP (J)	CERAMIC DIP (JG)	PLASTIC DIP (N)	PLASTIC DIP (P)	TSSOP PACKAGE (PW)	FLAT PACKAGE (W)
	10 mV 6 mV 3 mV	TL071CD TL071ACD TL071BCD	_	_		_	TL071CP TL071ACP TL071BCP	TL071CPWLE	
0°C to 70°C	10 mV 6 mV 3 mV	TL072CD TL072ACD TL072BCD	-	_	_	_	TL072CP TL072ACP TL072BCP	TL072CPWLE — —	_
	10 mV 6 mV 3 mV	TL074CD TL074ACD TL074BCD	_	_	_	TL074CN TL074ACN TL074BCN	_	TL074CPWLE — —	_
-40°C to 85°C	6 mV	TL071ID TL072ID TL074ID	_	_		 TL074IN	TL071IP TL072P	_	_
-55°C to 125°C	6 mV 6 mV 9 mV	_	TL071MFK TL072MFK TL074MFK	— — TL074MJ	TL071MJG TL072MJG —		_	_	— — TL074MW

[†] The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL071CDR). The PW package is only available left-ended taped and reeled (e.g., TL072CPWLE).



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

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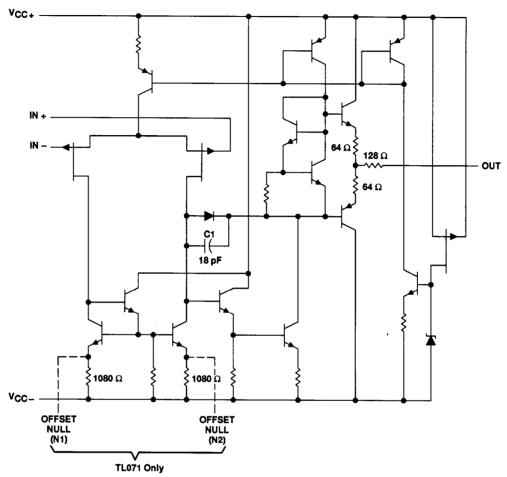


NC - No internal connection

symbols



schematic (each amplifier)



All component values shown are nominal.

СОМ	PONENT C	OUNT	
COMPONENT TYPE	TL071	TL072	TL074
Resistors	11	22	44
Transistors	14	28	56
JFET	2	4	6
Diodes	1	2	4
Capacitors	1	2	4
epi-FET	1	2	4

[†] Includes bias and trim circuitry



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

Supply voltage, V _{CC+} (see Note 1)	18 V
Supply voltage, V _{CC} (see Note 1)	–18 V
Differential input voltage, V _{ID} (see Note 2)	
Input voltage, V _I (see Notes 1 and 3)	
Duration of output short-circuit (see Note 4)	
Continuous total dissipation See Di	
Operating free-air temperature range, TA: C suffix	
I suffix	
M suffix	55°C to 125°C
Storage temperature range	65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J, JG, or W package	
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P, or PW packa	ge 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.
 - 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 ≤ 25°C POWER RATING	DERATING FACTOR	DERATE ABOVE TA	TA = 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	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	275 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	598 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	70°C	525 mW	N/A	N/A
PW (14 pin)	700 mW	5.6 mW/°C	70°C	700 mW	N/A	N/A
W	680 mW	8.0 mW/°C	65°C	640 mW	520 mW	200 mW

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				14	TL071C		TLO	TL071AC		TL071BC	ပ္က		TL0711		
	PARAMETER	TEST CONDITIONST	τĄ‡	##	TL072C TL074C		55	TL072AC TL074AC		TL072BC TL074BC	ပ္ကပ္က		TL0721 TL0741		TINO
				NIN	TYP	MAX	MIN	TYP MAX	WIN	N TYP	MAX	N N	TYP	MAX	
<u> </u>		, ا	25°C		ဗ	10		3	9	,,	2 3		3	9	Ě
, O _A	Input offset voltage	VO = 0, HS = 50.12	Full range			13		7.	2.5		5			8	
αVIO	Temperature coefficient of input offset voltage	V _O = 0, R _S = 50 Ω	Full range		18			18		18			82		μV/°C
			25°C		S.	100		5 100	0		5 100		5	100	Ą
<u>Q</u>	Input offset current	0 = 0 _A	Full range			10			2		2			2	Æ
	4		25°C		89	200		65 200	0	65	200		65	200	Ą
<u>9</u>	Input bias currents	0 = 0v	Full range			7			7		7			50	υĄ
V GG	Common-mode input		25°C	±11	-12 12		±±	-12 to	뷰	1		#11	-12 to		>
<u>.</u>	vortage range				15			15	4	15		_	5		
		R _L = 10 kΩ	25°C	± 21∓	±13.5		±12 ±1	±13.5	±12	2 ±13.5		±12	±13.5		
NO _N	Maximum peak output	R _L ≥ 10 kΩ	1. T	∓12			±12		±12	2		±12			>
1	Noting a will be	R _L ≥ 2 kΩ	Low range	∓10			±10		±10	0		±10			
	Large-signal differential	V _O = ±10 V,	25°C	22	500	_	20 2	200	12)	50 200		20	200		//m//
₽	voltage amplification	R[≥2kΩ	Full range	15			25		2	25		25			*/
9	Unity-gain bandwidth		25°C		က			3	_	·	3		3		MHz
5	Input resistance		25°C	,	1012		10	1012		1012			1012		a
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min, $V_{O} = 0$, $R_{S} = 50 \Omega$	25°C	02	100		75	90		75 100		75	<u>5</u>		æ
ksvR	Supply-voltage rejection ratio	$V_{CC} = \pm 9 \text{ V to } \pm 15 \text{ V,}$ $V_{O} = 0$, $R_{S} = 50 \Omega$	26°C	70	100		8	<u>8</u>		80 100		8	901		8
<u>8</u>	Supply current (each amplifier)	V _O = 0, No load	25°C		1.4	2.5		1.4 2.	2.5	1.4	1 2.5		4.	2.5	Ψ
V01/V02	VO1/VO2 Crosstalk attenuation	AvD = 100	25°C		120		•	120		120			120		8
+ 4 11 4	bon bon soom one or inches	regional and services with zero common mode of a long services of the service solutions and services are serv	the coro	000	oction of	solui a	e otherwi	so coorific	5						

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

‡ Full range is T_A = 0°C to 70°C for TL07_C, TL07_AC, TL07_BC and is T_A = -40°C to 85°C for TL07_I.

§ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 4. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

INSTRUMENTS

TL071, TL071A, TL071B, TL072 TL072A, TL072B, TL074, TL074A, TL074B LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS SLOS080C - SEPTEMBER 1978 - REVISED AUGUST 1994

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

PARAMETER		TEST CONDITIONST	TA‡			TL071M TL072M		TL074 M		UNIT
		<u> </u>		MIN	TYP	MAX	MIN	TYP	MAX	
VIO	Input offset voltage	V _O = 0, R _S = 50 Ω	25°C		3	6		3	9	mV
VIO	input onset voltage	VO = 0, 11S = 30 12	Full range			9			15	HIV
αVIO	Temperature coefficient of input offset voltage	$V_{O} = 0$, $R_{S} = 50 \Omega$	Full range		18			18		μV/°C
lio	Input offset current	V _O = 0	25°C		5	100		5	100	рΑ
U	input onset current	VO = 0	Full range			20			20	nΑ
lв	Input bias current‡	V _O = 0	25°C		65	200		65	200	pА
אוי –	mput bias current+					50			50	nA
VICR	Common-mode input voltage range		25°C	±11	-12 to 15		±11	-12 to 15		v
	Maria	R _L = 10 kΩ	25°C	±12	±13.5		±12	±13.5		
VOM	Maximum peak output voltage swing	R _L ≥ 10 kΩ	Full range	±12			±12			٧
		R _L ≥2kΩ	ruii range	±10			±10	10		
AvD	Large-signal differential	$V_{O} = \pm 10 \text{ V},$	25°C	35	200		35	200		V/mV
	voltage amplification	R _L ≥2kΩ		15			15		-	V/IIIV
B ₁	Unity-gain bandwidth	T _A = 25°C			3			3		MHz
rj	Input resistance	T _A = 25°C			1012			1012		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
ksvr	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC} = \pm 9 \text{ V to } \pm 15 \text{ V},$ $V_{O} = 0, R_{S} = 50 \Omega$	25°C	80	86		80	86		dB
loc	Supply current (each amplifier)	V _O = 0, No load	25°C		1.4	2.5		1.4	2.5	mA
V _{O1} /V _{O2}	Crosstalk attenuation	A _{VD} = 100	25°C		120			120		dB

[†] Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 4. Pulse techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

[‡] All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range is $T_A = -55$ °C to 125°C.

operating characteristics, $V_{CC\pm} = \pm 15 \text{ V}$, $T_A = 25^{\circ}\text{C}$

	DADAMETED	TEST CONDITIONS		TL07xM			ALI	OTHER	s	UNIT
	PARAMETER	125100	DADITIONS	MIN	TYP	MAX	MIN	TYP	MAX	UNII
SR	Slew rate at unity gain	V _I = 10 V, C _L = 100 pF,	R _L = 2 kΩ, See Figure 1	5	13		8	13		V/µs
	Rise time overshoot	V _I = 20 mV,	$R_L = 2 k\Omega$,		0.1			0.1		μs
4	factor	C _L = 100 pF,	See Figure 1		20%			20%		
V.	Equivalent input noise	D= 00.0	f = 1 kHz		18			18		nV/√Hz
٧n	voltage	R _S = 20 Ω	f = 10 Hz to 10 kHz		4			4		μV
^l n	Equivalent input noise current	R _S = 20 Ω,	f = 1 kHz		0.01			0.01		pA/√Hz
THD	Total harmonic distortion	VO(RMS) = 10 V, R _L ≥ 2 kΩ,	Rs≤1kΩ, f=1kHz		0.003%			0.003%		

PARAMETER MEASUREMENT INFORMATION

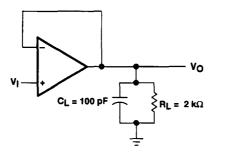


Figure 1. Unity-Gain Amplifier

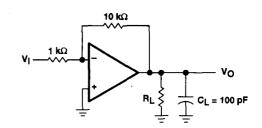


Figure 2. Gain-of-10 Inverting Amplifier

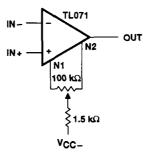


Figure 3. input Offset Voltage Null Circuit

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
l _{IB}	Input bias current	vs Free-air temperature	4
Vом	Maximum output voltage	vs Frequency vs Free-air temperature vs Load resistance vs Supply voltage	5, 6, 7 8 9 10
AVD	Large-signal differential voltage amplification	vs Free-air temperature vs Frequency	11 12
	Phase shift	vs Frequency	12
	Normalized unity-gain bandwidth	vs Free-air temperature	13
	Normalized phase shift	vs Free-air temperature	13
CMRR	Common-mode rejection ratio	vs Free-air temperature	14
Icc	Supply current	vs Supply voltage vs Free-air temperature	15 16
PD	Total power dissipation	vs Free-air temperature	17
	Normalized slew rate	vs Free-air temperature	18
V _n	Equivalent input noise voltage	vs Frequency	19
THD	Total harmonic distortion	vs Frequency	20
	Large-signal pulse response	vs Time	21
V _O	Output voltage	vs Time	22

TYPICAL CHARACTERISTICST

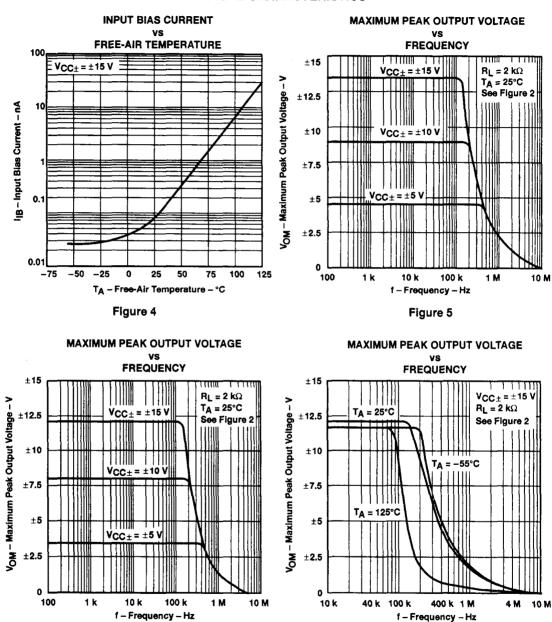


Figure 6



Figure 7

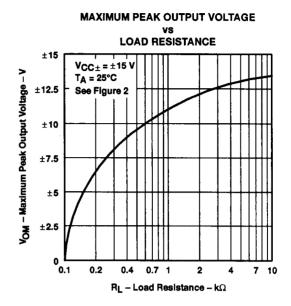
[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS[†]

MAXIMUM PEAK OUTPUT VOLTAGE FREE-AIR TEMPERATURE ±15 $R_L = 10 \text{ k}\Omega$ VOM - Maximum Peak Output Voltage ±12.5 $R_1 = 2 k\Omega$ ±10 ±7.5 ±5 ±2.5 VCC±=±15 V See Figure 2 _75 -50 50 100 75 125 TA - Free-Air Temperature - °C

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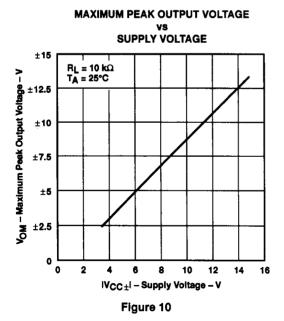
Figure 8



Flaure 9

LARGE-SIGNAL

DIFFERENTIAL VOLTAGE AMPLIFICATION



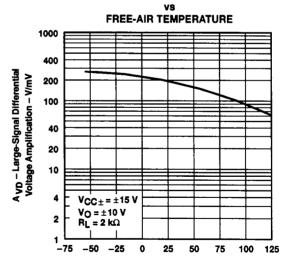


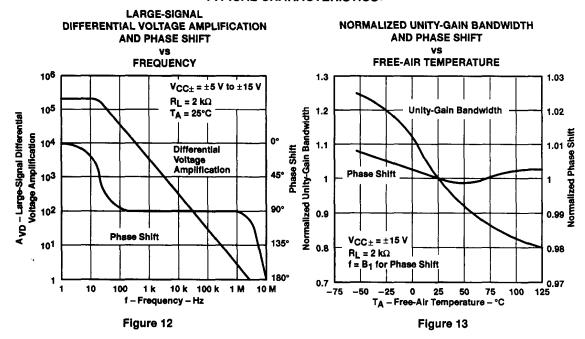
Figure 11

TA - Free-Air Temperature - °C

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



TYPICAL CHARACTERISTICS!



COMMON-MODE REJECTION RATIO

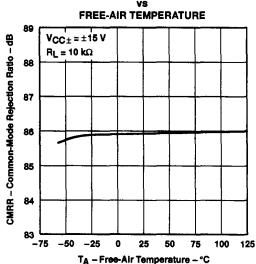


Figure 14

SUPPLY CURRENT PER AMPLIFIER

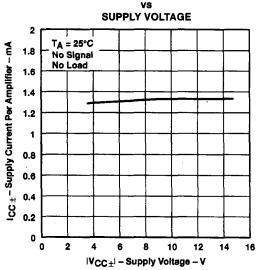


Figure 15

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



TYPICAL CHARACTERISTICS[†]

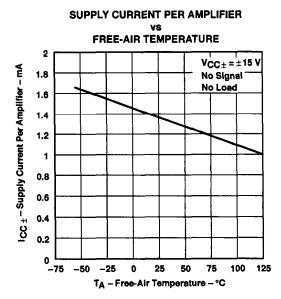


Figure 16

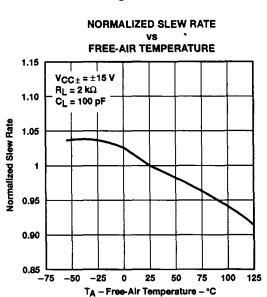


Figure 18

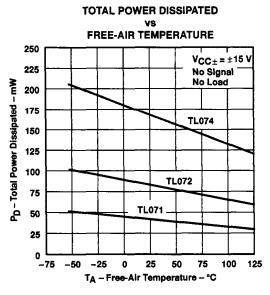


Figure 17

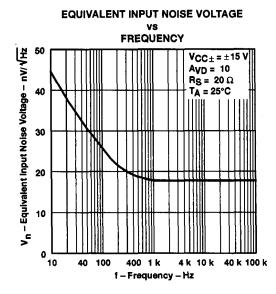


Figure 19

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



TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION VS **FREQUENCY** VCC± = ±15 V Avp = 1 THD - Total Harmonic Distortion - % 0.4 VI(RMS) = 6 V TA = 25°C 0.1 0.04 | | | | | | | 0.01 0.004 Ш Ш 0.001 100 400 1 k 4 k 10 k 40 k 100 k f - Frequency - Hz

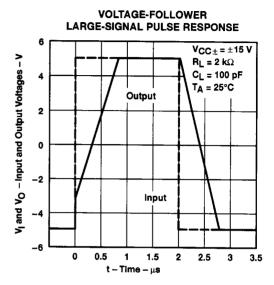


Figure 20

Figure 21

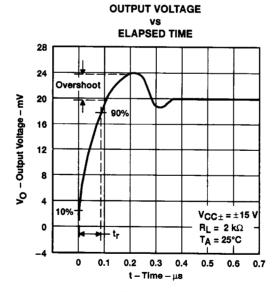


Figure 22

APPLICATION INFORMATION

Table of Application Diagrams

APPLICATION DIAGRAM	PART NUMBER	FIGURE
0.5-Hz square-wave oscillator	TL071	23
High-Q notch filter	TL071	24
Audio-distribution amplifier	TL074	25
100-kHz quadrature oscillator	TL072	26
AC amplifier	TL071	27

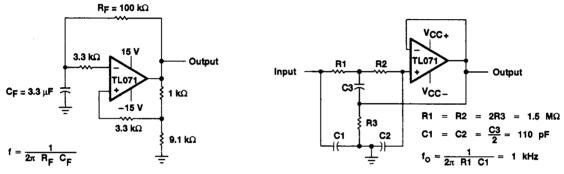


Figure 23. 0.5-Hz Square-Wave Oscillator

Figure 24. High-Q Notch Filter

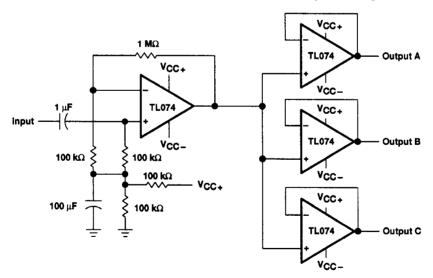
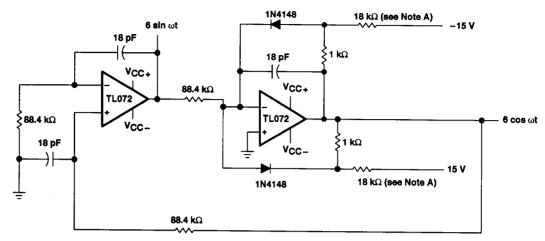


Figure 25. Audio-Distribution Amplifier

APPLICATION INFORMATION



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

Figure 26. 100-kHz Quadrature Oscillator

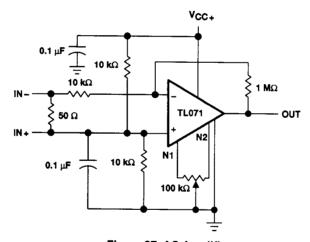


Figure 27. AC Amplifier