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

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- 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 TL072IP —	_	_
−55°C to 125°C	6 mV 6 mV 9 mV	_	TL071MFK TL072MFK TL074MFK	— — TL074MJ	TL071MJG TL072MJG —	— — TL074MN	— TL072MP —	_	— — 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).

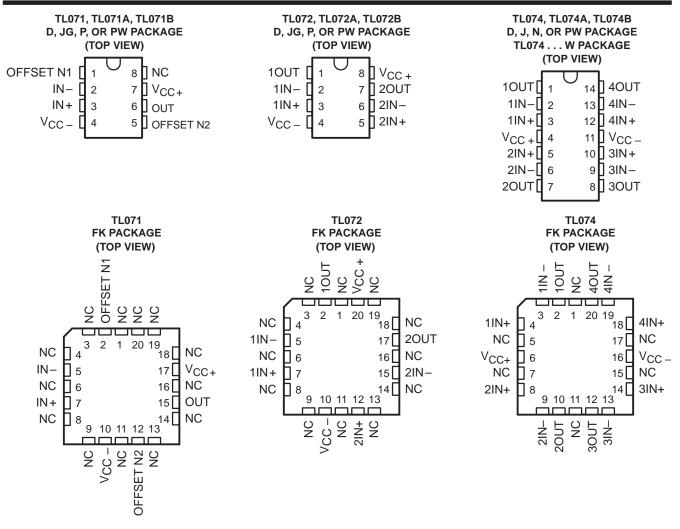


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



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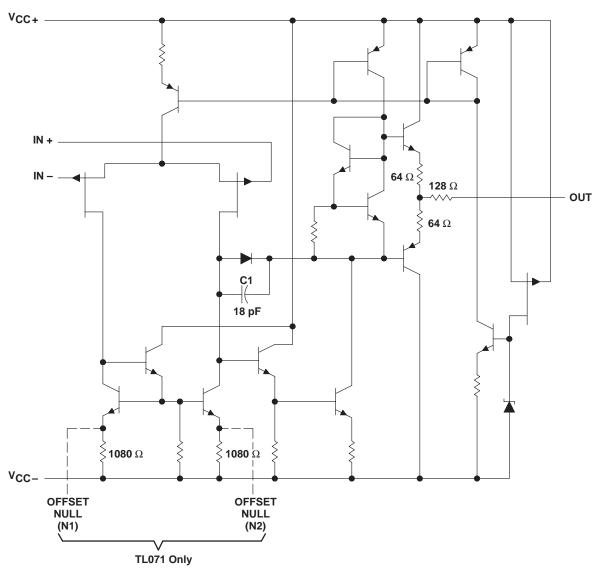


NC - No internal connection

symbols



schematic (each amplifier)



All component values shown are nominal.

COMPONENT COUNT [†]									
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



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

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

Supply voltage, V _{CC+} (see Note 1)
Supply voltage, V _{CC} (see Note 1)
Differential input voltage, V _{ID} (see Note 2)±30 V
Input voltage, V _I (see Notes 1 and 3)±15 V
Duration of output short circuit (see Note 4) unlimited
Continuous total power dissipation See Dissipation Rating Table
Operating free-air temperature range, T _A : C suffix
I suffix40°C to 85°C
M suffix−55°C to 125°C
Storage temperature range
Case temperature for 60 seconds: FK package
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J, JG, or W package 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, N, P, or PW package 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 VCC+ and VCC-.
 - 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.
 - 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	$T_{\mbox{\scriptsize A}} \le 25^{\circ}\mbox{\scriptsize C}$ 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	465 mW	378 mW	N/A
D (14 pin)	680 mW	7.6 mW/°C	60°C	604 mW	490 mW	N/A
FK	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	273 mW
J	680 mW	11.0 mW/°C	88°C	680 mW	680 mW	273 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	597 mW	N/A
Р	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



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

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	UNI	TL071I TL072I TL074I			ГL071В(ГL072В(ГL074В(7	С	TL071A0 TL072A0 TL074A0] 1		TL071C TL072C TL074C	·	T _A ‡	NDITIONS†	TEST CON	ARAMETER	P
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	MAX	TYP	MIN	MAX	TYP	MIN	MAX	TYP	MIN	MAX	TYP	MIN					
$ \frac{\text{Full range}}{\text{coefficient of input offset current}} V_{O} = 0, R_{S} = 50 \Omega $ Full range $ \frac{13}{18} \frac{7.5}{18} \frac{5}{18} $ Temperature coefficient of input offset voltage $ \frac{18}{18} \frac{18}{1$	6 mV	3			2			3			3			$R_S = 50 \Omega$	V _O = 0,	Input offset voltage	ViO
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	8			5			7.5			13			Full range		,		10
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	μV/°(18			18			18			18		Full range	R _S = 50 Ω	V _O = 0,	coefficient of input	ανιο
	100 pA	5			5			5			5		25°C		Vo = 0	Input offset current	lio
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	2 nA														VO = 0	Input onset current	10
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	200 pA	65			65			65			65				VO = 0	Input bias current§	liB
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	20 nA			7			7	-		7			Full range				
V _{OM} output voltage $R_L \ge 10 \text{ k}\Omega$ Full range ± 12 ± 12 ± 12	V	to	±11		to	±11		to	±11		to	±11	25°C				VICR
V_{OM} output voltage $R_L \ge 10 \text{ k}\Omega$ E_{UII} range ± 12 ± 12 ± 12 ± 12		±13.5	±12		±13.5	±12		±13.5	±12		±13.5	±12	25°C		R _L = 10 kΩ	Maximum peak	
swing Pull lange Han	V		±12			±12			±12			±12	Full rongs		$R_L \ge 10 \text{ k}\Omega$		VOM
TIO TIO TIO			±10			±10			±10			±10	Full range		$R_L \ge 2 k\Omega$	swing	
	V/m\	200	50		200	50		200	50		200	25	25°C	Pr > 2 kO	\/a - ±10.\/		Δ
AVD differential voltage amplification $V_0 = \pm 10 \text{ V}, R_L \ge 2 \text{ k}\Omega$ Full range 15 25 25	V/III		25			25			25			15	Full range	L	$VO = \pm 10 \text{ V},$		AVD
bandwidth	MHz	3			3			3			3		25°C				B ₁
r _i Input resistance 25°C 10 ¹² 10 ¹² 10 ¹² 10 ¹²	Ω	10 ¹²			10 ¹²			1012			1012		25°C			Input resistance	rį
CMRR Common-mode rejection ratio $V_{IC} = V_{ICR}min$, $V_{O} = 0$, $R_{S} = 50 \Omega$ 25°C 70 100 75 100 75 100	dB	100	75		100	75		100	75		100	70	25°C				CMRR
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	dB	100	80		100	80		100	80		100	70	25°C			rejection ratio	kSVR
$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	2.5 mA	1.4		2.5	1.4		2.5	1.4		2.5	1.4		25°C	No load	V _O = 0,	117	ICC
VO1/VO2 Crosstalk attenuation AVD = 100 25°C 120 120 120 120	dB	120			120			120			120		25°C		A _{VD} = 100		V _{O1} /V _{O2}

[†] 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 maintain the junction temperature as close to the ambient temperature as possible.

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

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

PARAMETER		TEST CONDITIONS† TA		T _A ‡	1	TL071M TL072M			TL074M		UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
VIO	Input offset voltage	V _O = 0,	$R_S = 50 \Omega$	25°C		3	6		3	9	mV
VIO	input onset voltage	VO = 0,	NS = 50 22	Full range			9			15	1117
αγιο	Temperature coefficient of input offset voltage	V _O = 0,	$R_S = 50 \Omega$	Full range		18			18		μV/°C
li o	Innuit officet ourrent	V _O = 0		25°C		5	100		5	100	pА
110	Input offset current	VO = 0		Full range			20			20	nA
lin	Input bias current‡	V _O = 0		25°C		65	200		65	200	pА
IB	input bias current+	ΛΩ = 0					50			50	nA
	Common-mode input					-12			-12		
VICR	voltage range			25°C	±11	to		±11	to		V
		D 4010		0500		15			15		
l.,	Maximum peak output	$R_L = 10 \text{ k}\Omega$		25°C	±12	±13.5			±13.5		1 ., l
VOM	voltage swing	R _L ≥ 10 kΩ		Full range	±12			±12			_
		$R_L \ge 2 k\Omega$			±10			±10			
AVD	Large-signal differential	$V_0 = \pm 10 \text{ V},$	$R_1 \ge 2 k\Omega$	25°C	35	200		35	200		V/mV
	voltage amplification				15			15			·
B ₁	Unity-gain bandwidth	$T_A = 25^{\circ}C$				3			3		MHz
rį	Input resistance	$T_A = 25^{\circ}C$				1012			1012		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$ $V_{O} = 0$,		25°C	80	86		80	86		dB
ksvr	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC} = \pm 9 V$ $V_{O} = 0$,	to ± 15 V, R _S = 50Ω	25°C	80	86		80	86		dB
ICC	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 $T_A = -55^{\circ}\text{C}$ to 125°C.

operating characteristics, $V_{CC\pm}\,{=}\,\pm15$ V, $T_A\,{=}\,25^{\circ}C$

PARAMETER		TEST CO	7	ΓL07xM		ALL OTHERS			UNIT	
	PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	V _I = 10 V, C _L = 100 pF,	$R_L = 2 k\Omega$, See Figure 1	5	13		8	13		V/μs
	Rise time overshoot	$V_{I} = 20 \text{ mV},$	$R_L = 2 k\Omega$,		0.1			0.1		μs
τr	factor	C _L = 100 pF,	See Figure 1		20%			20%		
V	Equivalent input noise	Rs = 20 Ω	f = 1 kHz		18			18		nV/√ Hz
Vn	voltage	KS = 20 12	f = 10 Hz to 10 kHz		4			4		μV
In	Equivalent input noise current	$R_S = 20 \Omega$,	f = 1 kHz		0.01			0.01		pA/√ Hz
THD	Total harmonic distortion	V_{l} rms = 6 V, $R_{L} \ge 2 k\Omega$, f = 1 kHz	$A_{VD} = 1,$ $R_S \le 1 \text{ k}\Omega,$		0.003%		(0.003%		

PARAMETER MEASUREMENT INFORMATION

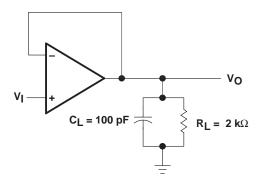


Figure 1. Unity-Gain Amplifier

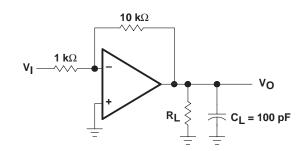


Figure 2. Gain-of-10 Inverting Amplifier

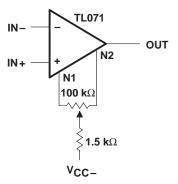


Figure 3. Input Offset Voltage Null Circuit

TL071, TL071A, TL071B, TL072 TL072A, TL072B, TL074, TL074A, TL074B LOW-NOISE JFET-INPUT OPERATIONAL AMPLIFIERS SLOS080D - SEPTEMBER 1978 - REVISED AUGUST 1996

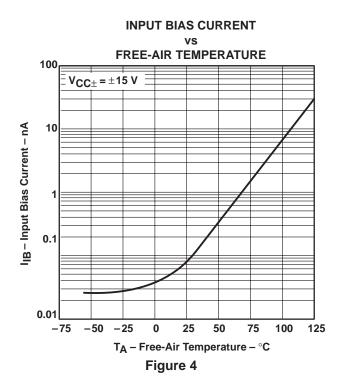
TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
I _{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
٧n	Equivalent input noise voltage	vs Frequency	19
THD	Total harmonic distortion	vs Frequency	20
	Large-signal pulse response	vs Time	21
٧o	Output voltage	vs Elapsed time	22



TYPICAL CHARACTERISTICS†



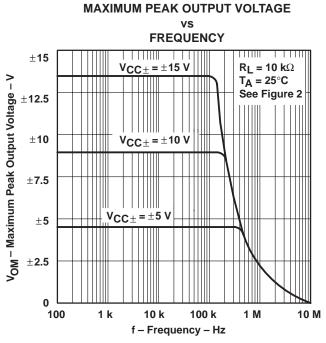
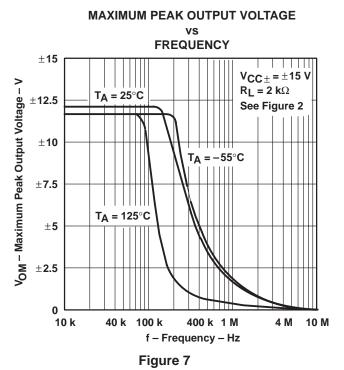


Figure 5

MAXIMUM PEAK OUTPUT VOLTAGE ٧S **FREQUENCY** ±15 $R_L = 2 k\Omega$ V_{OM} - Maximum Peak Output Voltage - V $T_A = 25^{\circ}C$ $V_{CC\pm} = \pm 15 \text{ V}$ ±12.5 See Figure 2 ± 10 $V_{CC\pm} = \pm 10 \text{ V}$ ± 7.5 $\pm \mathbf{5}$ $V_{CC\pm} = \pm 5 V$ ±2.5 0 100 1 k 10 k 100 k 10 M f - Frequency - Hz

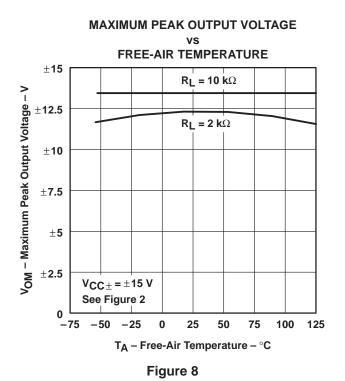
Figure 6

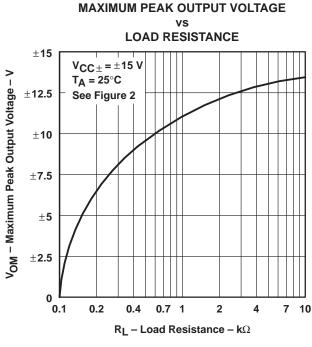


[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

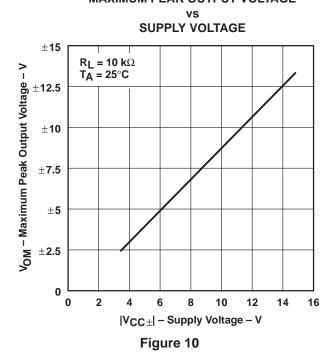


TYPICAL CHARACTERISTICS[†]



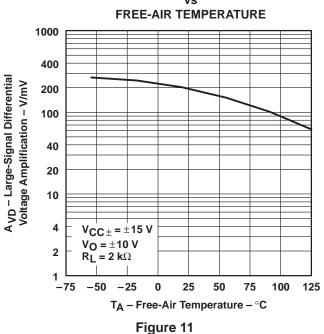


MAXIMUM PEAK OUTPUT VOLTAGE



LARGE-SIGNAL **DIFFERENTIAL VOLTAGE AMPLIFICATION**

Figure 9



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



TYPICAL CHARACTERISTICS[†]

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

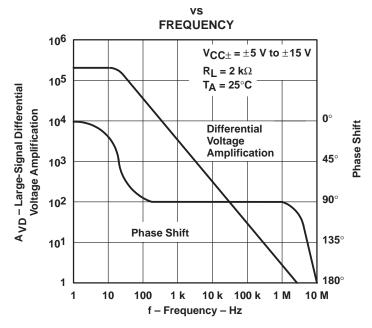


Figure 12

NORMALIZED UNITY-GAIN BANDWIDTH AND PHASE SHIFT

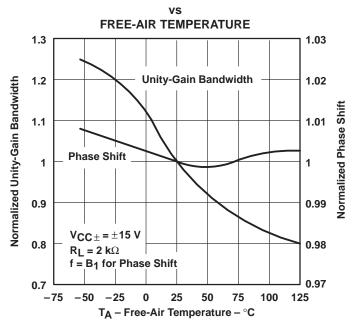


Figure 13

[†] 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 FREE-AIR TEMPERATURE 89 $V_{CC\pm} = \pm 15 V$ CMRR - Common-Mode Rejection Ratio - dB $R_L = 10 \text{ k}\Omega$ 88 87 86 85 84 83 -25 50 75 -75 -50 25 100 125 T_A - Free-Air Temperature - °C

Figure 14

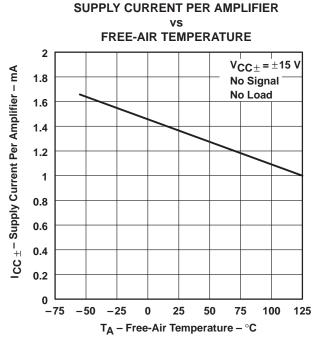


Figure 16

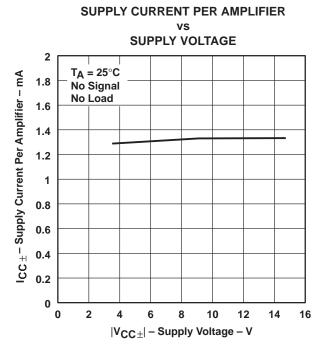
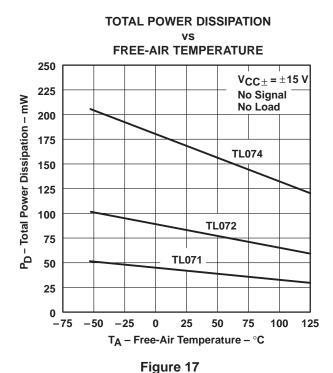


Figure 15



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



TYPICAL CHARACTERISTICS

NORMALIZED SLEW RATE FREE-AIR TEMPERATURE 1.15 $V_{CC\pm} = \pm 15 V$ $R_L = 2 k\Omega$ 1.10 $C_{L} = 100 \text{ pF}$ Normalized Slew Rate − V/µ s 1.05 1 0.95 0.90 0.85 _75 -25 50 75 125 -50 25 100

Figure 18

T_A - Free-Air Temperature - °C

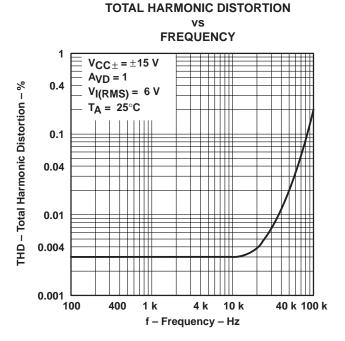


Figure 20

EQUIVALENT INPUT NOISE VOLTAGE

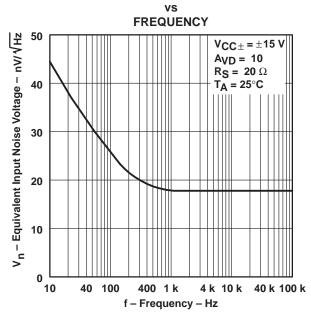


Figure 19

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

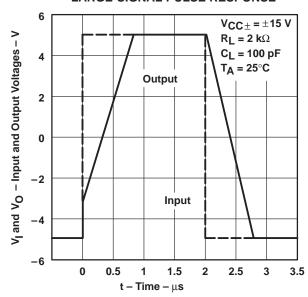


Figure 21

TYPICAL CHARACTERISTICS

OUTPUT VOLTAGE ELAPSED TIME 28 24 Overshoot V_O - Output Voltage - mV 20 90% 16 12 8 4 10% $V_{CC\pm} = \pm 15 V$ $R_L = 2 k\Omega$ 0 T_A = 25°C 0 0.2 0.3 0.4 0.5 0.6 $\textbf{t-Elapsed Time} - \mu \textbf{s}$

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

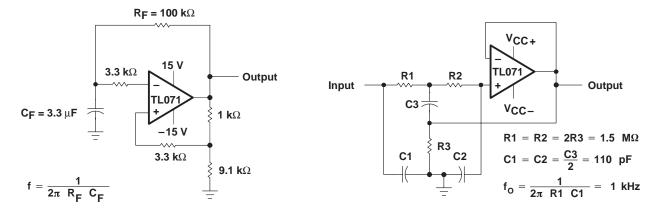


Figure 23. 0.5-Hz Square-Wave Oscillator

Figure 24. High-Q Notch Filter

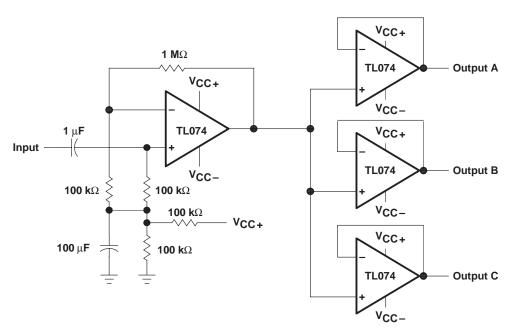
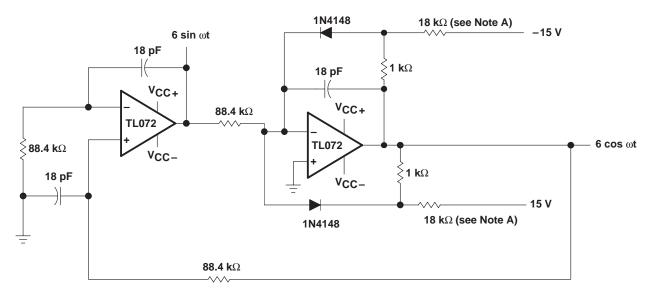


Figure 25. Audio-Distribution Amplifier

APPLICATION INFORMATION



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

Figure 26. 100-kHz Quadrature Oscillator

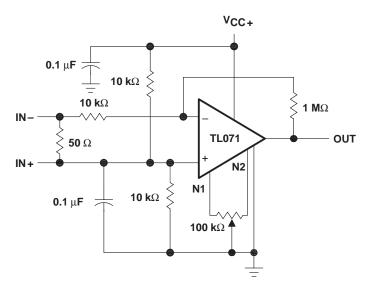


Figure 27. AC Amplifier



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