

Low noise JFET dual operational amplifiers

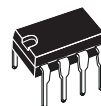
Features

- Wide common-mode (up to V_{CC^+}) and differential voltage range
- Low input bias and offset current
- Low noise $e_n = 15 \text{ nV}/\sqrt{\text{Hz}}$ (typ)
- Output short-circuit protection
- High input impedance JFET input stage
- Low harmonic distortion: 0.01% (typical)
- Internal frequency compensation
- Latch-up free operation
- High slew rate: $16 \text{ V}/\mu\text{s}$ (typ)

Description

The TL072, TL072A and TL072B are high speed JFET input dual operational amplifiers incorporating well matched, high voltage JFET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset current, and low offset voltage temperature coefficient.

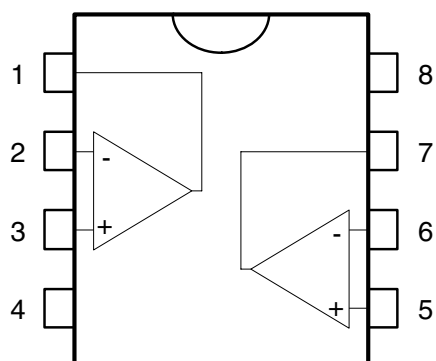


N
DIP8
(Plastic package)



D
SO-8
(Plastic micropackage)

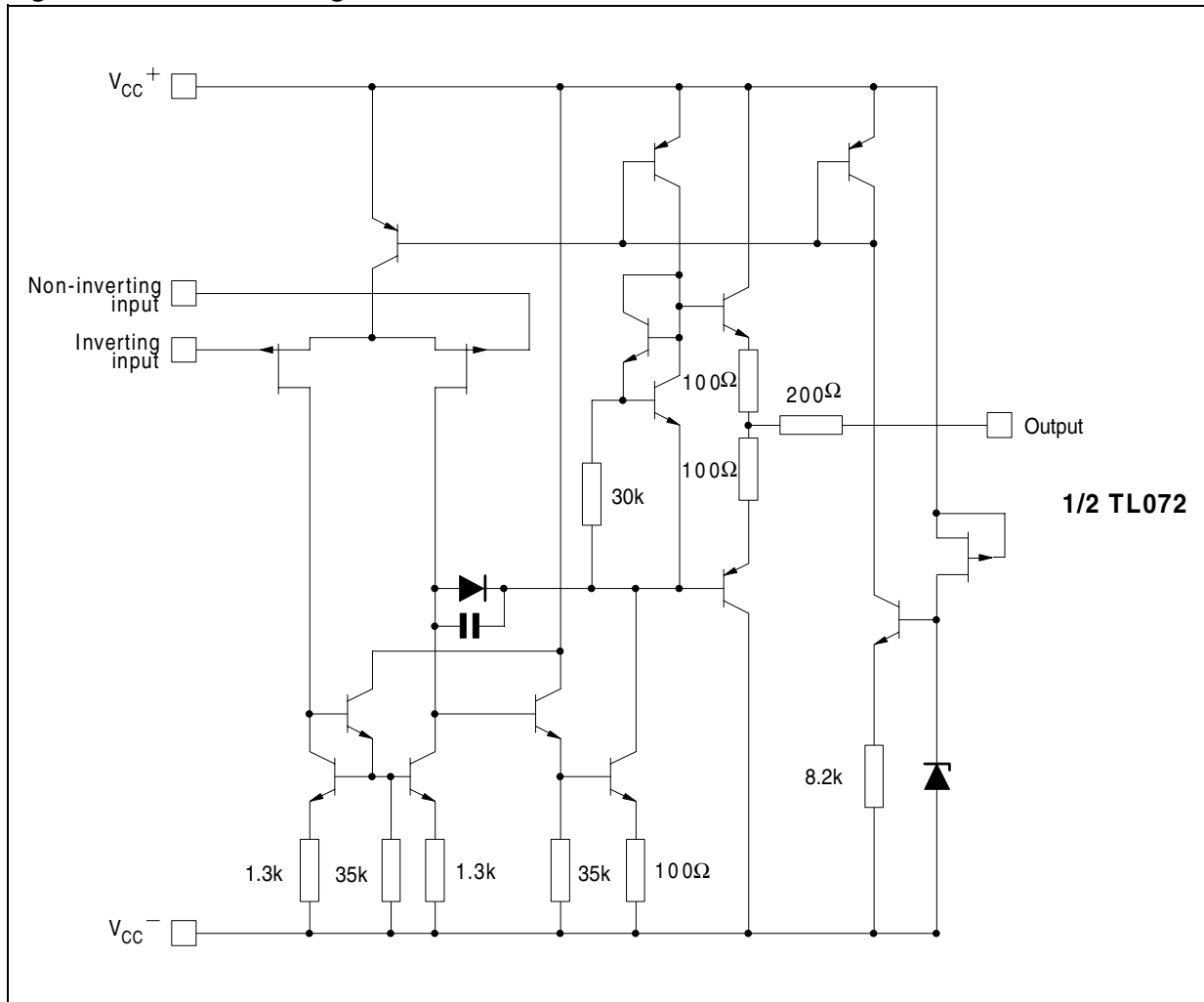
Pin connections (top view)



- 1 - Output 1
- 2 - Inverting input 1
- 3 - Non-inverting input 1
- 4 - V_{CC^-}
- 5 - Non-inverting input 2
- 6 - Inverting input 2
- 7 - Output 2
- 8 - V_{CC^+}

1 Schematic diagram

Figure 1. Schematic diagram



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	TL072I, AI, BI	TL072C, AC, BC	Unit
V_{CC}	Supply voltage ⁽¹⁾	±18		V
V_{in}	Input voltage ⁽²⁾	±15		V
V_{id}	Differential input voltage ⁽³⁾	±30		V
R_{thja}	Thermal resistance junction to ambient ⁽⁴⁾ SO-8 DIP8	125		°C/W
		85		
R_{thjc}	Thermal resistance junction to case ⁽⁴⁾ SO-8 DIP8	40		°C/W
		41		
	Output short-circuit duration ⁽⁵⁾	Infinite		
T_{stg}	Storage temperature range	-65 to +150		°C
ESD	HBM: human body model ⁽⁶⁾	1		kV
	MM: machine model ⁽⁷⁾	200		V
	CDM: charged device model ⁽⁸⁾	1.5		kV

- All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between V_{CC}^+ and V_{CC}^- .
- The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
- 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.
- Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
- Machine model: a 200 pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of pin combinations with other pins floating.
- Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

Table 2. Operating conditions

Symbol	Parameter	TL072I, AI, BI	TL072C, AC, BC	Unit
V_{CC}	Supply voltage	6 to 36		V
T_{oper}	Operating free-air temperature range	-40 to +105	0 to +70	°C

3 Electrical characteristics

Table 3. Electrical characteristics at $V_{CC} = \pm 15V$, $T_{amb} = +25^{\circ}C$ (unless otherwise specified)

Symbol	Parameter	TL072I,AC,AI BC,BI			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input offset voltage ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$ TL072 TL072A TL072B		3	10		3	10	mV
	$T_{min} \leq T_{amb} \leq T_{max}$ TL072 TL072A TL072B		1	3			13	
DV_{io}	Input offset voltage drift		10			10		$\mu V/^{\circ}C$
I_{io}	Input offset current ⁽¹⁾ $T_{amb} = +25^{\circ}C$		5	100		5	100	pA nA
	$T_{min} \leq T_{amb} \leq T_{max}$			4			10	
I_{ib}	Input bias current ⁽¹⁾ $T_{amb} = +25^{\circ}C$		20	200		20	200	pA nA
	$T_{min} \leq T_{amb} \leq T_{max}$			20			20	
A_{vd}	Large signal voltage gain ($R_L = 2k\Omega$, $V_O = \pm 10V$) $T_{amb} = +25^{\circ}C$	50	200		25	200		V/mV
	$T_{min} \leq T_{amb} \leq T_{max}$	25			15			
SVR	Supply voltage rejection ratio ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$	80	86		70	86		dB
	$T_{min} \leq T_{amb} \leq T_{max}$	80			70			
I_{CC}	Supply current, no load $T_{amb} = +25^{\circ}C$		1.4	2.5		1.4	2.5	mA
	$T_{min} \leq T_{amb} \leq T_{max}$			2.5			2.5	
V_{icm}	Input common mode voltage range	± 11	-12 to +15		± 11	-12 to +15		V
CMR	Common mode rejection ratio ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$	80	86		70	86		dB
	$T_{min} \leq T_{amb} \leq T_{max}$	80			70			
I_{os}	Output short-circuit current $T_{amb} = +25^{\circ}C$	10	40	60	10	40	60	mA
	$T_{min} \leq T_{amb} \leq T_{max}$	10		60	10		60	

Table 3. Electrical characteristics at $V_{CC} = \pm 15V$, $T_{amb} = +25^{\circ}C$ (unless otherwise specified) (continued)

Symbol	Parameter	TL072I,AC,AI BC,BI			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$\pm V_{opp}$	Output voltage swing							V
	$T_{amb} = +25^{\circ}C$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12	12 13.5		10 12	12 13.5		
	$T_{min} \leq T_{amb} \leq T_{max}$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12			10 12			
SR	Slew rate $V_{in} = 10V$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain	8	16		8	16		V/ μs
t_r	Rise time $V_{in} = 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain		0.1			0.1		μs
K_{ov}	Overshoot $V_{in} = 20mV$, $R_L = 2k\Omega$, $C_L = 100pF$, unity gain		10			10		%
GBP	Gain bandwidth product $V_{in} = 10mV$, $R_L = 2k\Omega$, $C_L = 100pF$, $F = 100kHz$	2.5	4		2.5	4		MHz
R_i	Input resistance		10^{12}			10^{12}		Ω
THD	Total harmonic distortion $F = 1kHz$, $R_L = 2k\Omega$, $C_L = 100pF$, $A_v = 20dB$, $V_o = 2V_{pp}$		0.01			0.01		%
e_n	Equivalent input noise voltage $R_S = 100\Omega$, $F = 1kHz$		15			15		$\frac{nV}{\sqrt{Hz}}$
ϕ_m	Phase margin		45			45		degrees
V_{o1}/V_{o2}	Channel separation $A_v = 100$		120			120		dB

1. The input bias currents are junction leakage currents which approximately double for every 10° C increase in the junction temperature.

Figure 2. Maximum peak-to-peak output voltage versus frequency

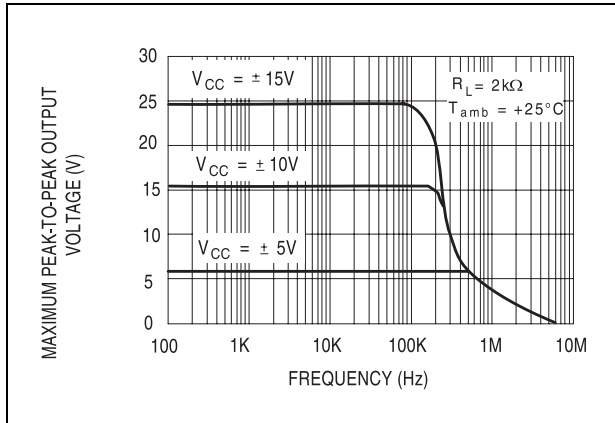


Figure 3. Maximum peak-to-peak output voltage versus frequency

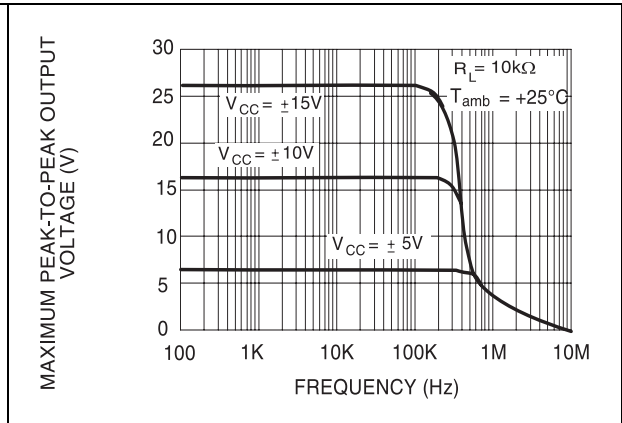


Figure 4. Maximum peak-to-peak output voltage versus frequency

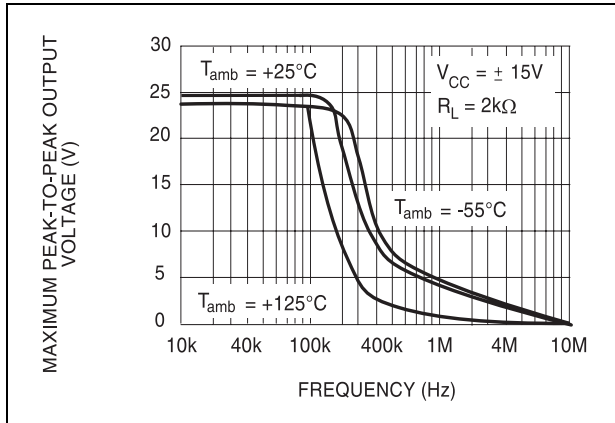


Figure 5. Maximum peak-to-peak output voltage versus free air temperature

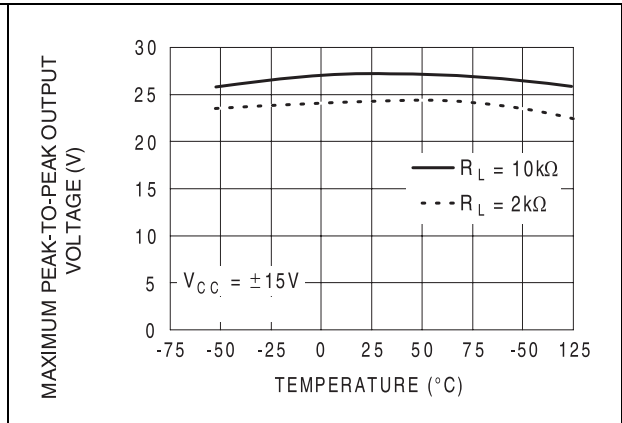


Figure 6. Maximum peak-to-peak output voltage versus load resistance

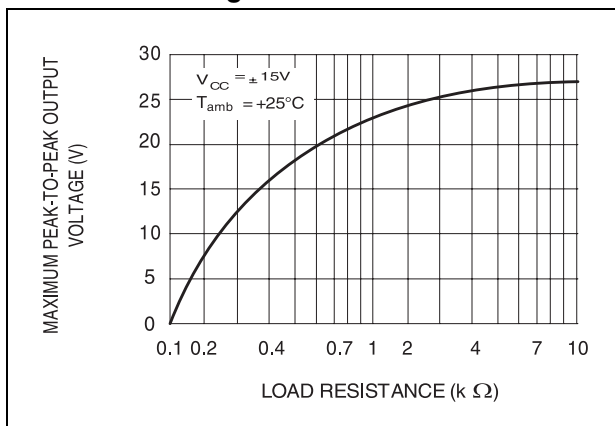


Figure 7. Maximum peak-to-peak output voltage versus supply voltage

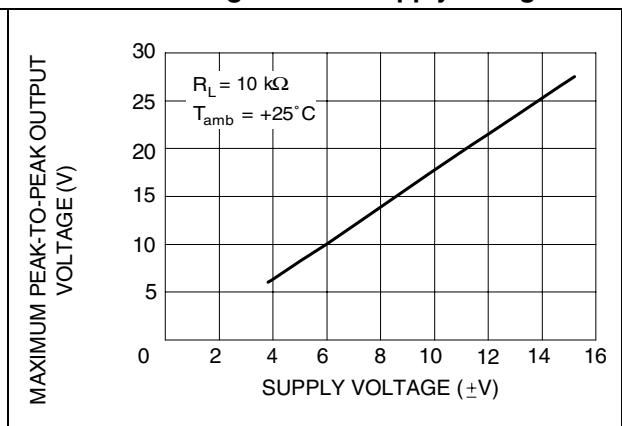


Figure 8. Input bias current versus free air temperature

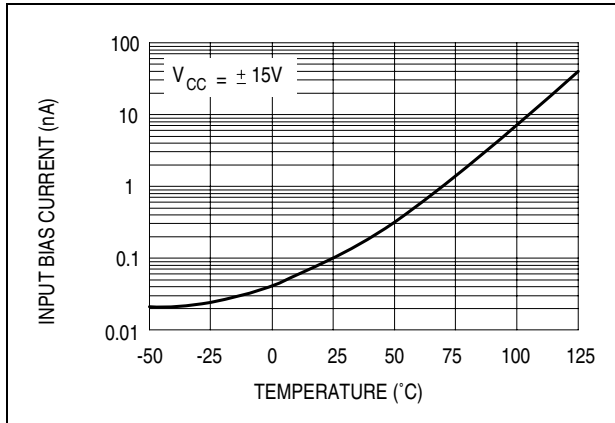


Figure 9. Large signal differential voltage amplification versus free air temp

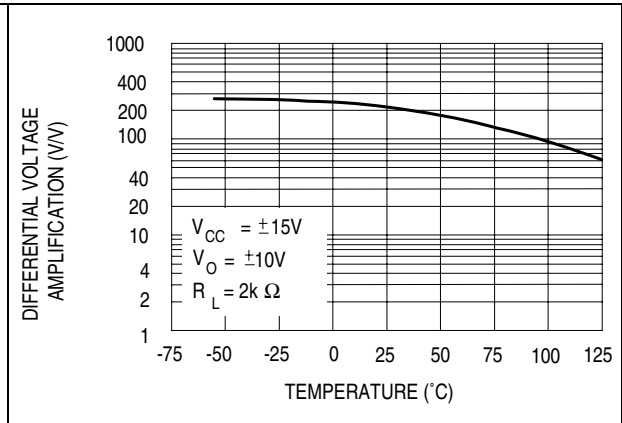


Figure 10. Large signal differential voltage amplification and phase shift versus frequency

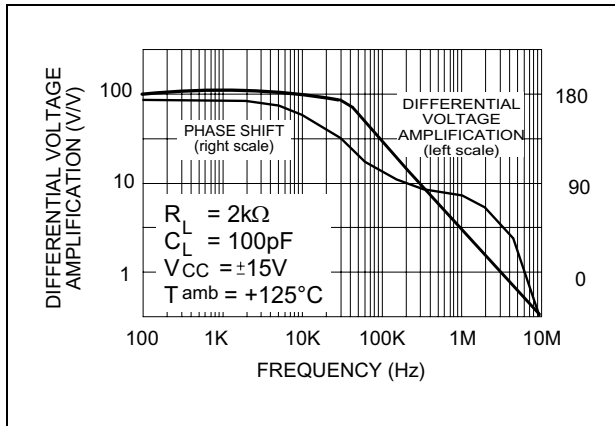


Figure 11. Total power dissipation versus free air temperature

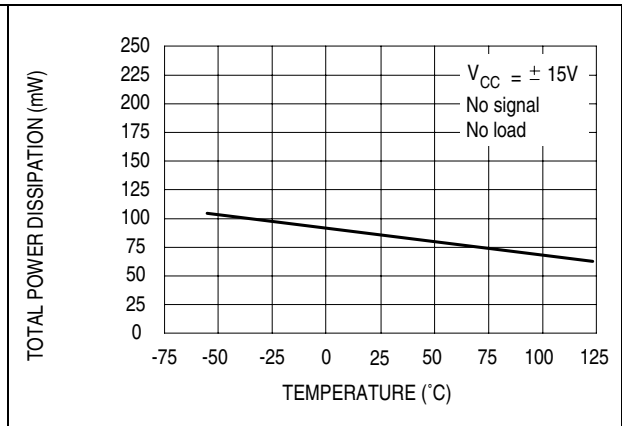


Figure 12. Supply current per amplifier versus free air temperature

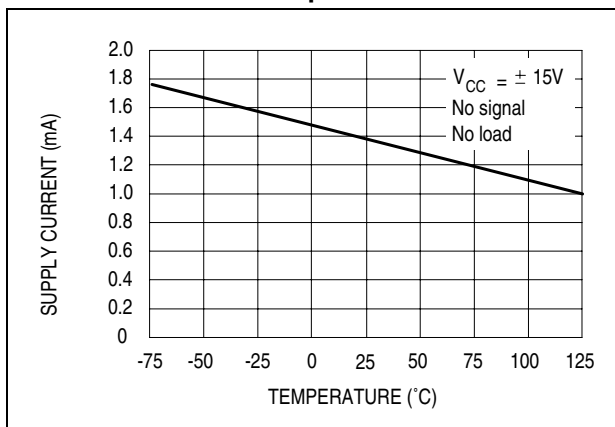


Figure 13. Common mode rejection ratio versus free air temperature

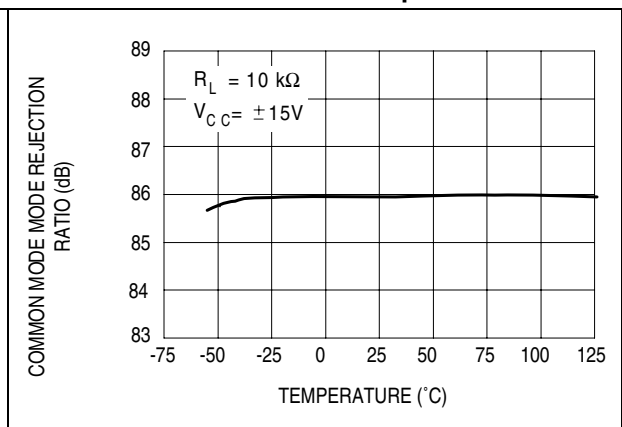


Figure 14. Voltage follower large signal pulse response

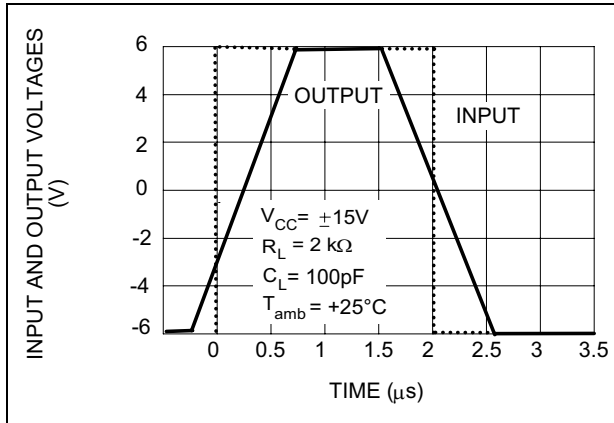


Figure 15. Output voltage versus elapsed time

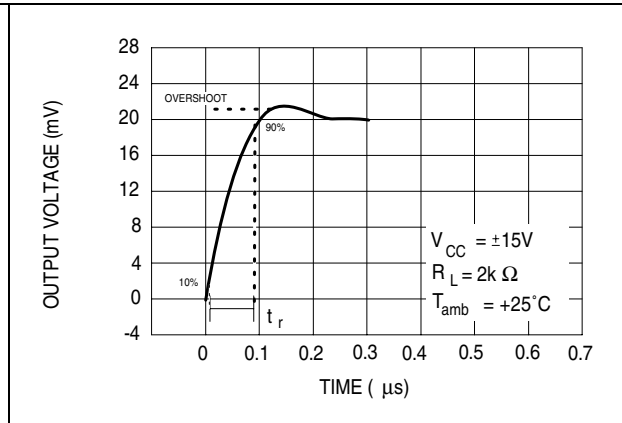


Figure 16. Equivalent input noise voltage versus frequency

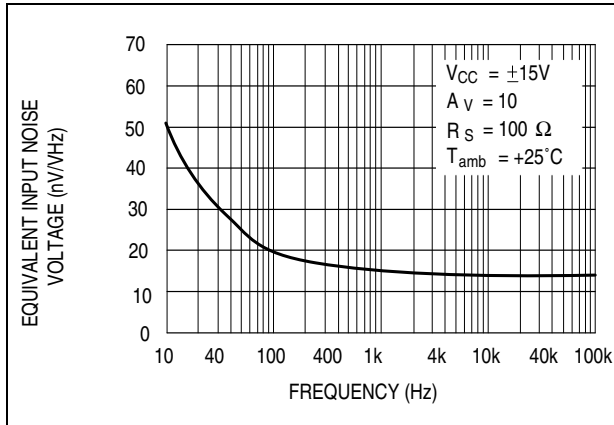
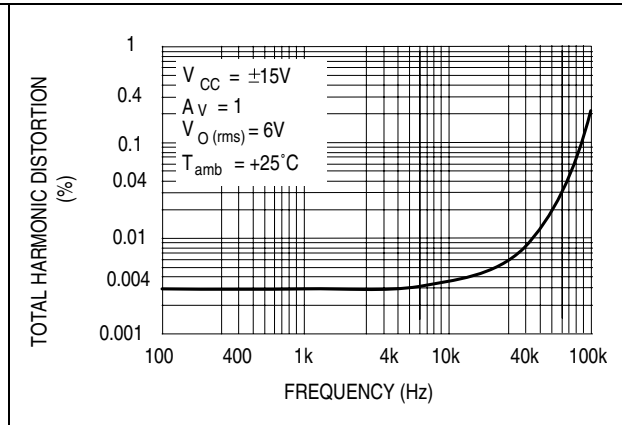


Figure 17. Total harmonic distortion versus frequency



4 Parameter measurement information

Figure 18. Voltage follower

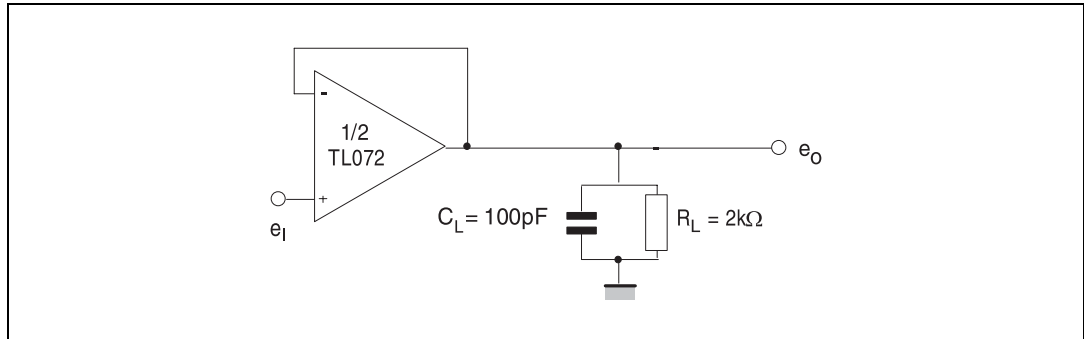
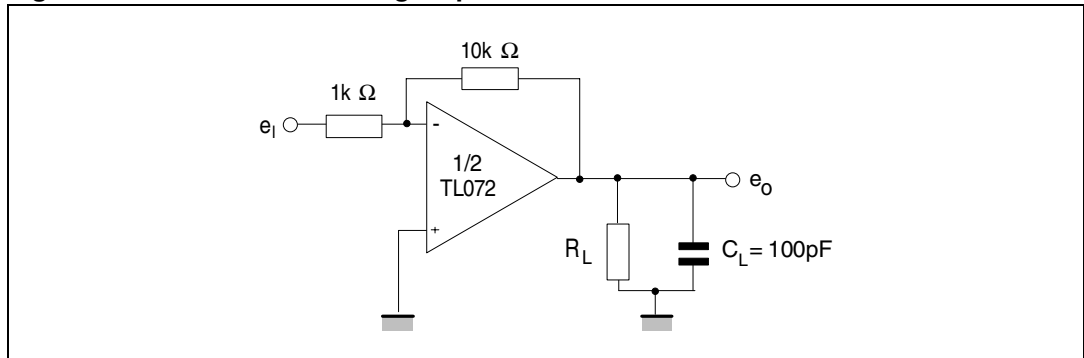
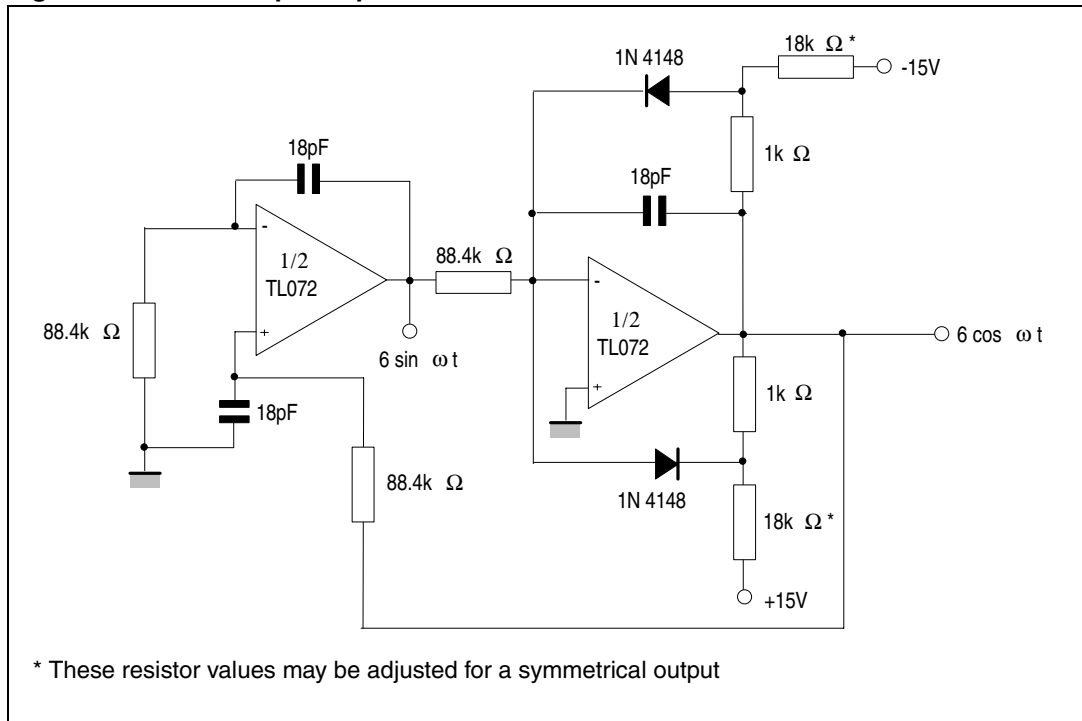


Figure 19. Gain-of-10 inverting amplifier



5 Typical application

Figure 20. 100 kHz quadruple oscillator



6 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

6.1 DIP8 package information

Figure 21. DIP8 package mechanical drawing

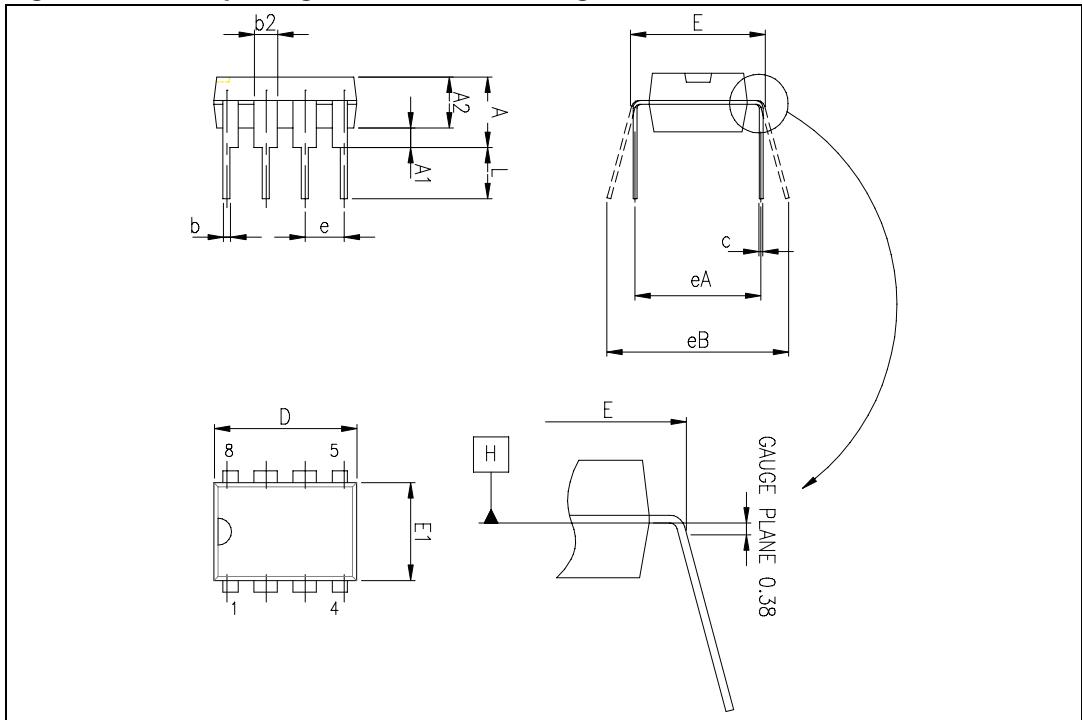


Table 4. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

6.2 SO-8 package information

Figure 22. SO-8 package mechanical drawing

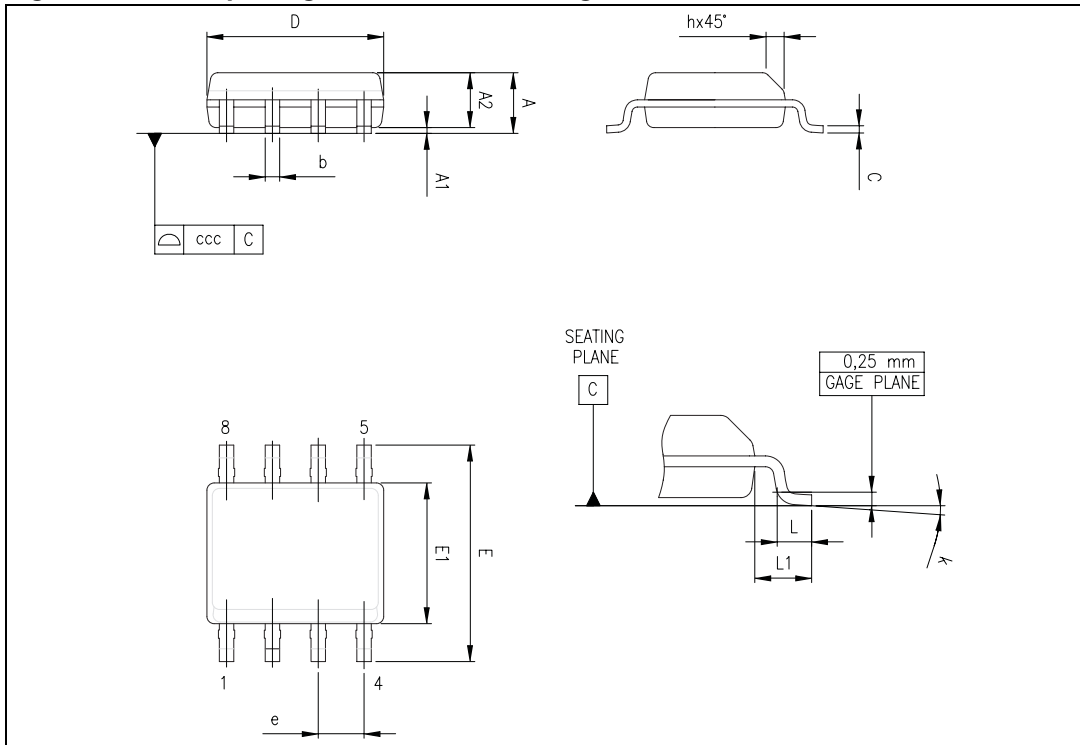


Table 5. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004

7 Ordering information

Table 6. Order codes

Order code	Temperature range	Package	Packing	Marking
TL072IN	-40°C, +105°C	DIP8	Tube	TL072IN
TL072AIN				TL072AIN
TL072BIN				TL072BIN
TL072ID TL072IDT		SO-8	Tube or tape & reel	072I
TL072AID TL072AIDT				072AI
TL072BID TL072BIDT				072BI
TL072CN	0°C, +70°C	DIP8	Tube	TL072CN
TL072ACN				TL072ACN
TL072BCN				TL072BCN
TL072CD TL072CDT		SO-8	Tube or tape & reel	072C
TL072ACD TL072ACDT				072AC
TL072BCD TL072BCDT				072BC
TL072IYD/DT ⁽¹⁾ TL072AIYD/DT ⁽¹⁾ TL072BIYD/DT ⁽¹⁾	-40°C, +105°C	SO-8 (Automotive grade)	Tube or tape & reel	072IY 072AIY 072BIY

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

8 Revision history

Table 7. Document revision history

Date	Revision	Changes
28-Mar-2001	1	Initial release.
02-Apr-2004	2	Correction to pin connection diagram on cover page. Unpublished.
04-Dec-2006	3	Modified graphics in package mechanical data.
06-Mar-2007	4	Expanded order codes table and added automotive grade order codes. See Table 6 on page 14 . Added thermal resistance and ESD tolerance in Table 1 on page 3 . Added Table 2: Operating conditions on page 3 . Updated package mechanical data to make it compliant with the latest JEDEC standards.
13-Mar-2008	5	ESD HBM value modified in AMR table. Re-ordered order codes table. Removed TL072BIY and TL072AIY order codes from order code table. Corrected footnote for automotive grade order codes in order codes table.
15-Jul-2008	6	Removed information concerning military temperature range (TL072Mx, TL072AMx, TL072BMx). Added order codes for automotive grade products in Table 6: Order codes .

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