

### Low noise J-FET dual operational amplifiers

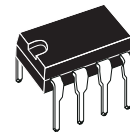
#### Features

- 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 J-FET input stage
- Low harmonic distortion: 0.01% (typ)
- 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 J-FET input dual operational amplifiers incorporating well matched, high voltage J-FET 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.

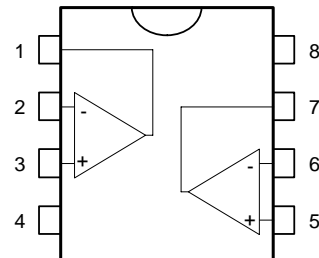


**N**  
**DIP8**  
**(Plastic package)**



**D**  
**SO8**  
**(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 -  $V_{CC}^+$

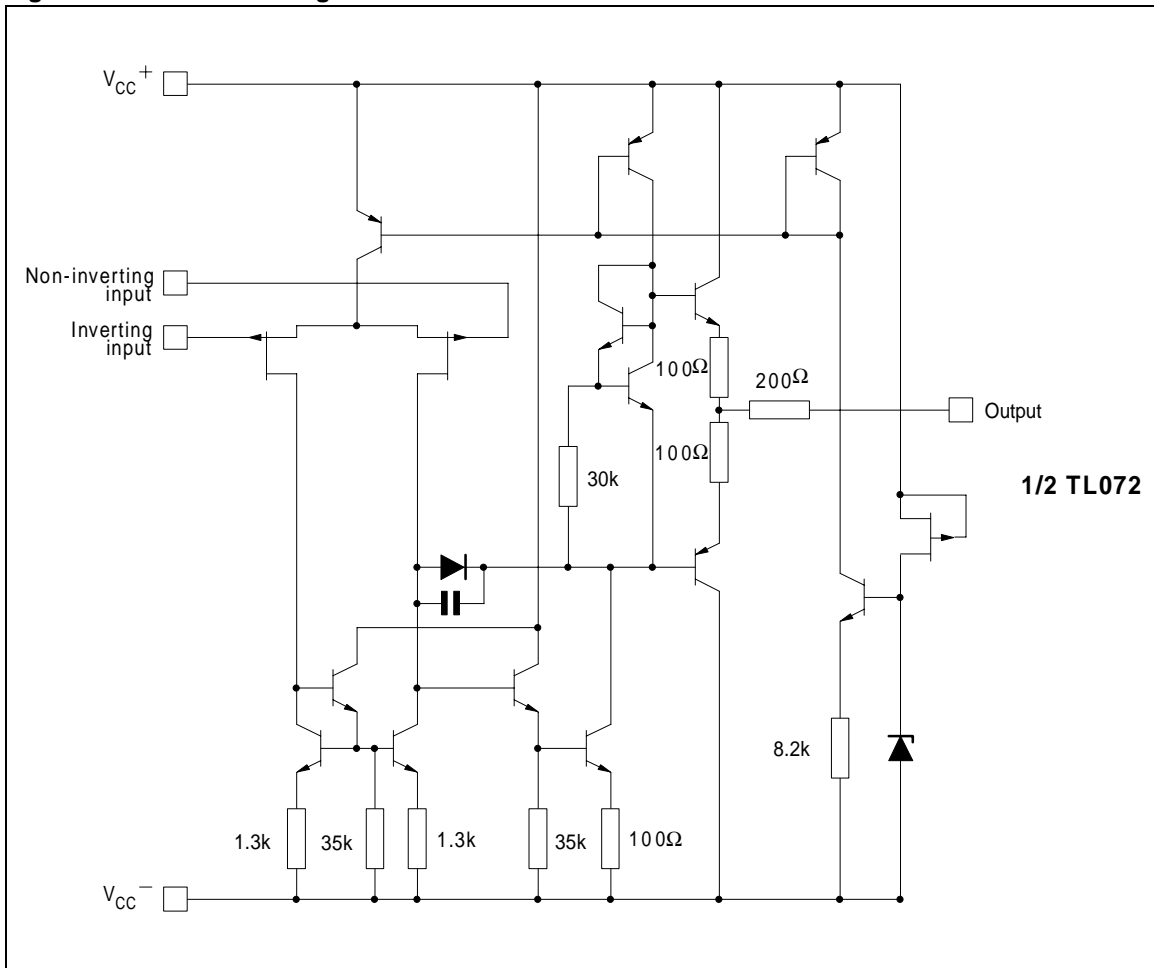
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# 1 Schematic diagram

Figure 1. Schematic diagram



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

Symbol	Parameter	TL072M, AM, BM	TL072I, AI, BI	TL072C, AC, BC	Unit
$V_{CC}$	Supply voltage <sup>(1)</sup>	±18			V
$V_i$	Input voltage <sup>(2)</sup>	±15			V
$V_{id}$	Differential input voltage <sup>(3)</sup>	±30			V
$P_{tot}$	Power dissipation	680			mW
$R_{thja}$	Thermal resistance junction to ambient <sup>(4)</sup> SO-8 DIP8	125			°C/W
		85			
$R_{thjc}$	Thermal resistance junction to case SO-8 DIP8	40			°C/W
		41			
	Output short-circuit duration <sup>(5)</sup>	Infinite			
$T_{stg}$	Storage temperature range	-65 to +150			°C
ESD	HBM: human body model <sup>(6)</sup>	1			kV
	MM: machine model <sup>(7)</sup>	200			V
	CDM: charged device model <sup>(8)</sup>	1500			V

- 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-circuit 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: 100pF discharged through a 1.5kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
- Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω), 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	TL072M, AM, BM	TL072I, AI, BI	TL072C, AC, BC	Unit
$V_{CC}$	Supply voltage	6 to 36			V
$T_{oper}$	Operating free-air temperature range	-55 to +125	-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)

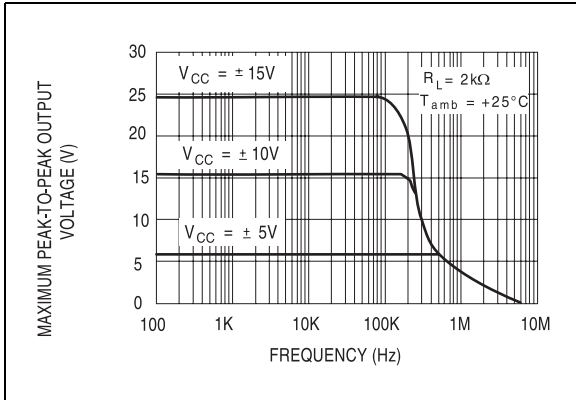
Symbol	Parameter	TL072I,M,AC,AI,AM BC,BI,BM			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{io}$	Input offset voltage ( $R_S = 50\Omega$ ) $T_{amb} = +25^{\circ}C$ TL072 TL072A TL072B		3 3 1	10 6 3		3	10	mV
	$T_{min} \leq T_{amb} \leq T_{max}$ TL072 TL072A TL072B			13 7 5			13	
$DV_{io}$	Input offset voltage drift		10			10		$\mu V/^{\circ}C$
$I_{io}$	Input offset current <sup>(1)</sup> $T_{amb} = +25^{\circ}C$		5	100		5	100	pA
	$T_{min} \leq T_{amb} \leq T_{max}$			4			10	nA
$I_{ib}$	Input bias current <sup>(1)</sup> $T_{amb} = +25^{\circ}C$		20	200		20	200	pA
	$T_{min} \leq T_{amb} \leq T_{max}$			20			20	nA
$A_{vd}$	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	$\pm 11$	+15 -12		$\pm 11$	+15 -12		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)**

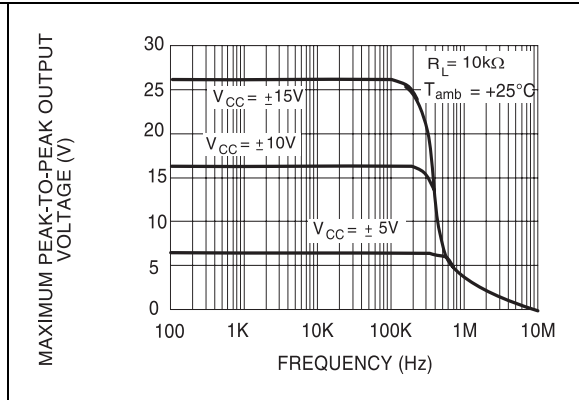
Symbol	Parameter	TL072I,M,AC,AI,AM BC,BI,BM			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$\pm V_{opp}$	Output voltage swing $T_{amb} = +25^{\circ}C$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12	12 13.5		10 12	12 13.5		V
	$T_{min} \leq T_{amb} \leq T_{max}$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12			10 12			
SR	Slew rate ( $T_{amb} = +25^{\circ}C$ ) $V_{in} = 10V$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain	8	16		8	16		V/ $\mu s$
$t_r$	Rise time ( $T_{amb} = +25^{\circ}C$ ) $V_{in} = 20mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain		0.1			0.1		$\mu s$
$K_{ov}$	Overshoot ( $T_{amb} = +25^{\circ}C$ ) $V_{in} = 20mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain		10			10		%
GBP	Gain bandwidth product ( $T_{amb} = +25^{\circ}C$ ) $V_{in} = 10mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , $f = 100kHz$	2.5	4		2.5	4		MHz
$R_i$	Input resistance		$10^{12}$			$10^{12}$		$\Omega$
THD	Total harmonic distortion ( $T_{amb} = +25^{\circ}C$ ) $f = 1kHz$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , $A_v = 20dB$ , $V_o = 2V_{pp}$		0.01			0.01		%
$e_n$	Equivalent input noise voltage $R_S = 100\Omega$ , $f = 1KHz$		15			15		$\frac{nV}{\sqrt{Hz}}$
$\phi_m$	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  $10^{\circ}C$  increase in the junction temperature.

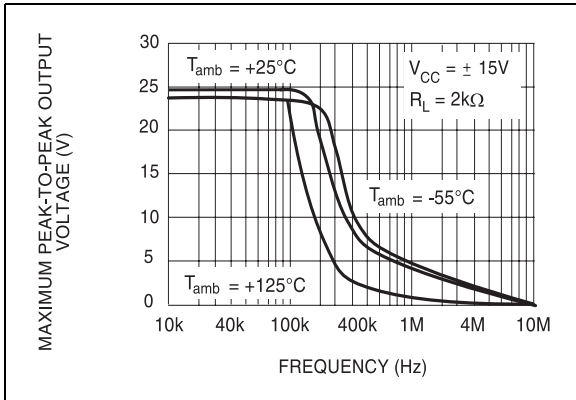
**Figure 2. Maximum peak-to-peak output voltage versus frequency**



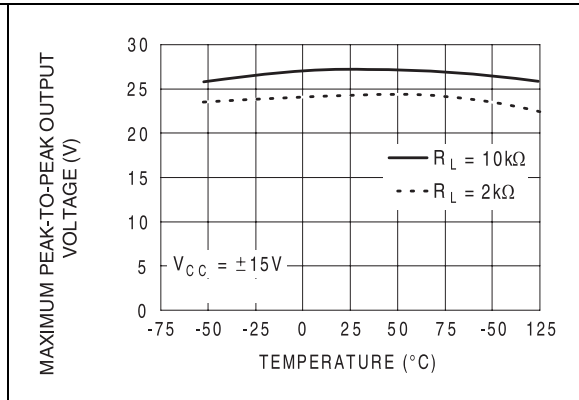
**Figure 3. Maximum peak-to-peak output voltage versus frequency**



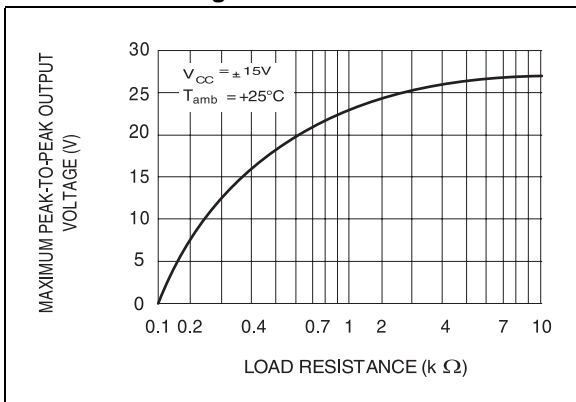
**Figure 4. Maximum peak-to-peak output voltage versus frequency**



**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**

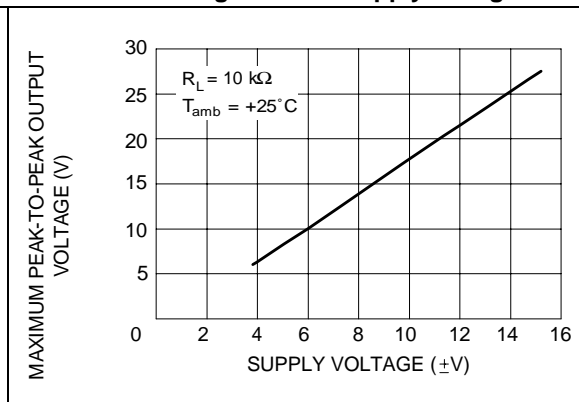


Figure 8. Input bias current versus free air temperature

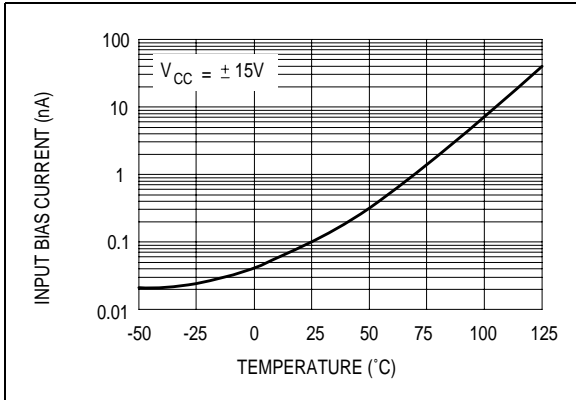


Figure 9. Large signal differential voltage amplification versus free air temp

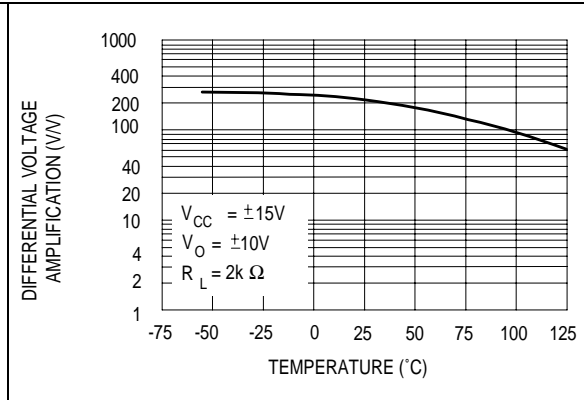


Figure 10. Large signal differential voltage amplification and phase shift versus frequency

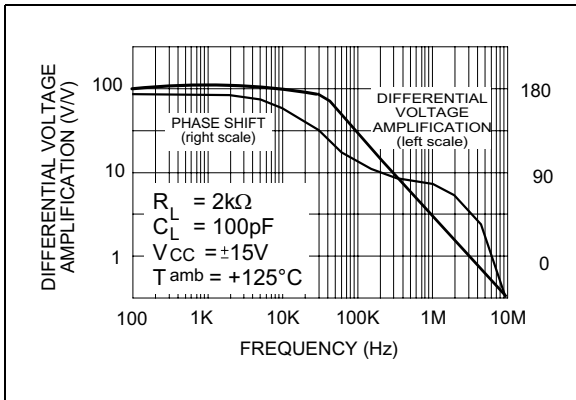


Figure 11. Total power dissipation versus free air temperature

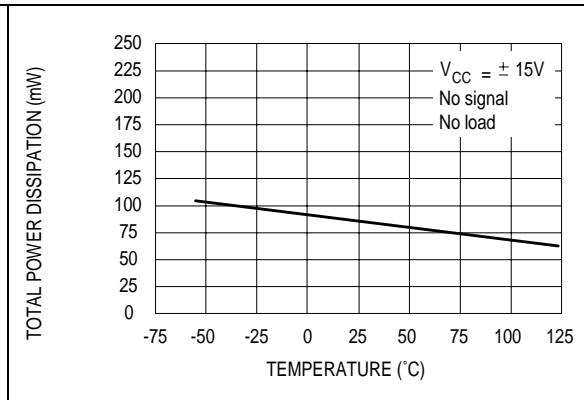


Figure 12. Supply current per amplifier versus free air temperature

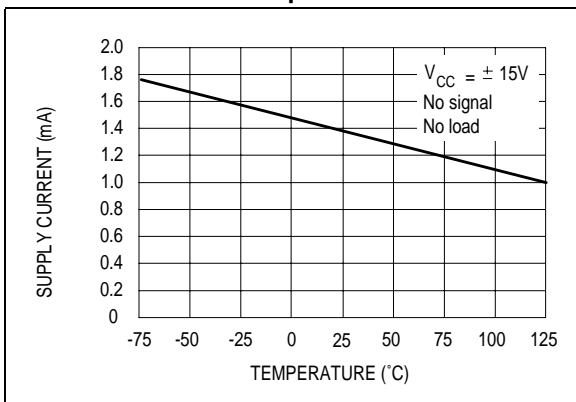


Figure 13. Common mode rejection ratio versus free air temperature

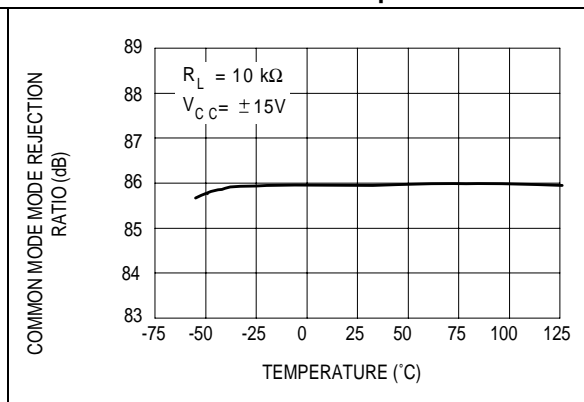




Figure 14. Voltage follower large signal pulse response

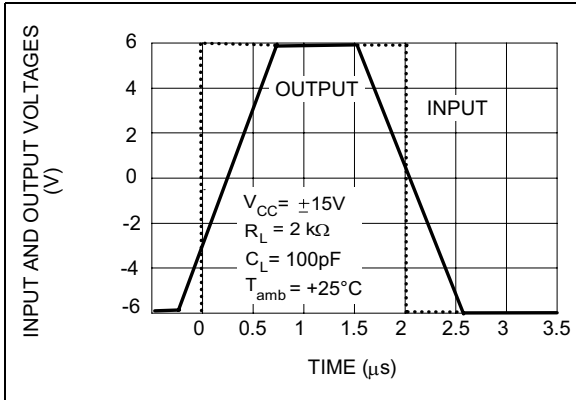


Figure 15. Output voltage versus elapsed time

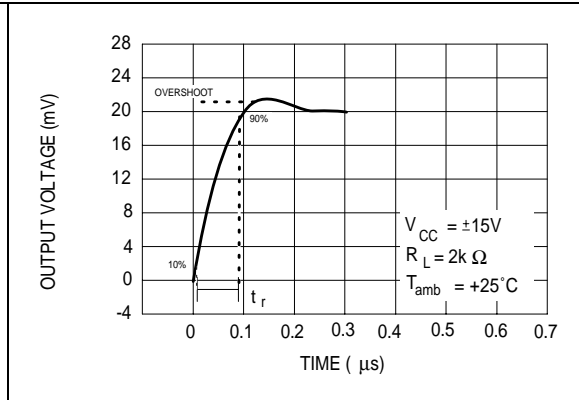


Figure 16. Equivalent input noise voltage versus frequency

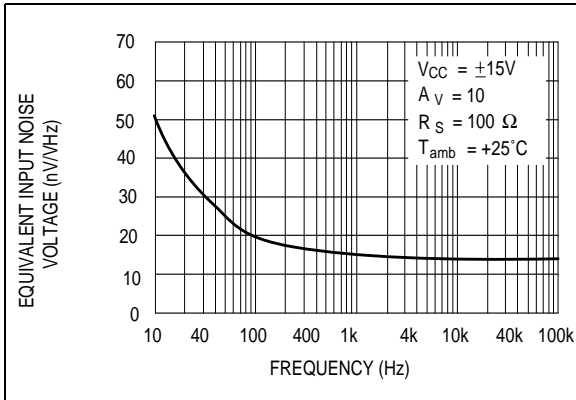
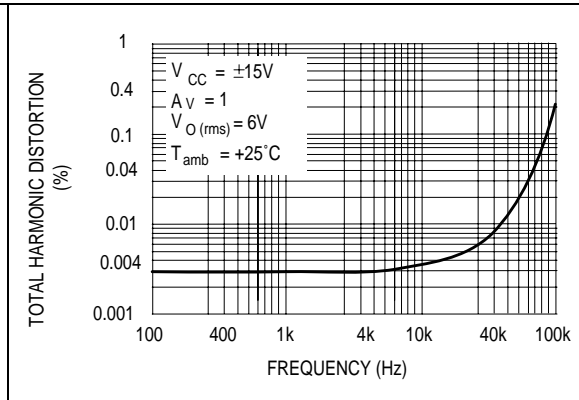


Figure 17. Total harmonic distortion versus frequency



## 4 Parameter measurement information

Figure 18. Voltage follower

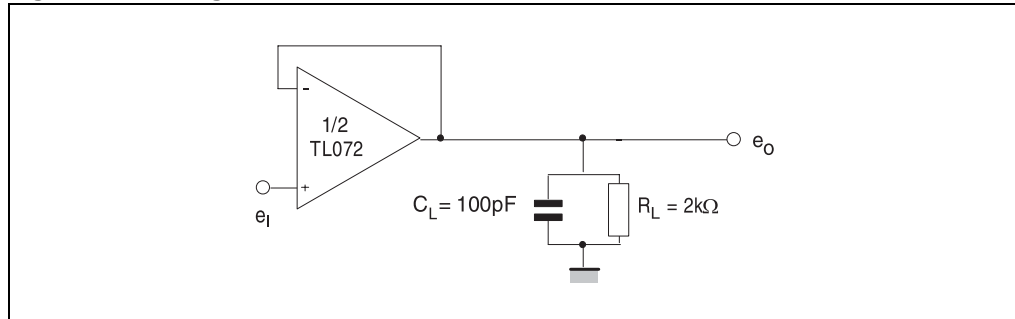
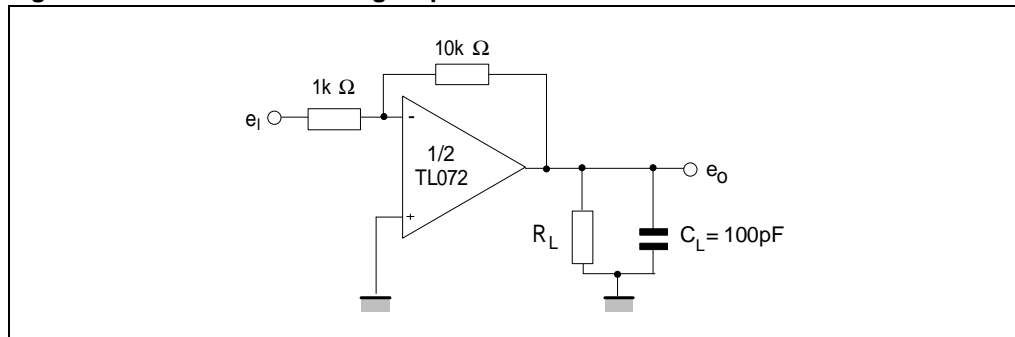
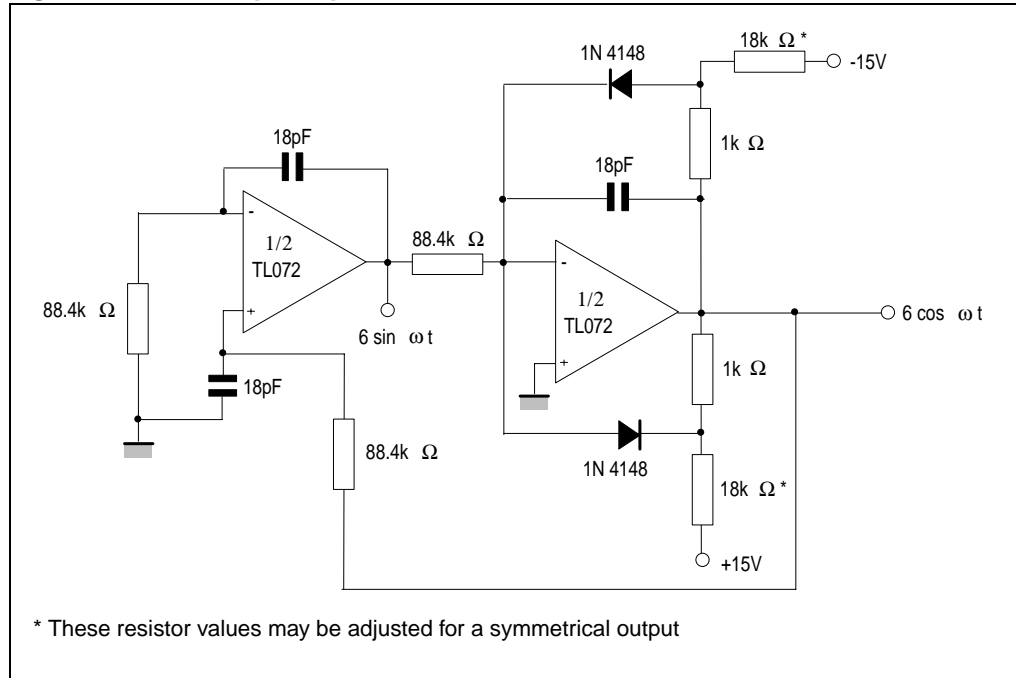


Figure 19. Gain-of-10 inverting amplifier



## 5 Typical application

Figure 20. 100kHz quadruple oscillator

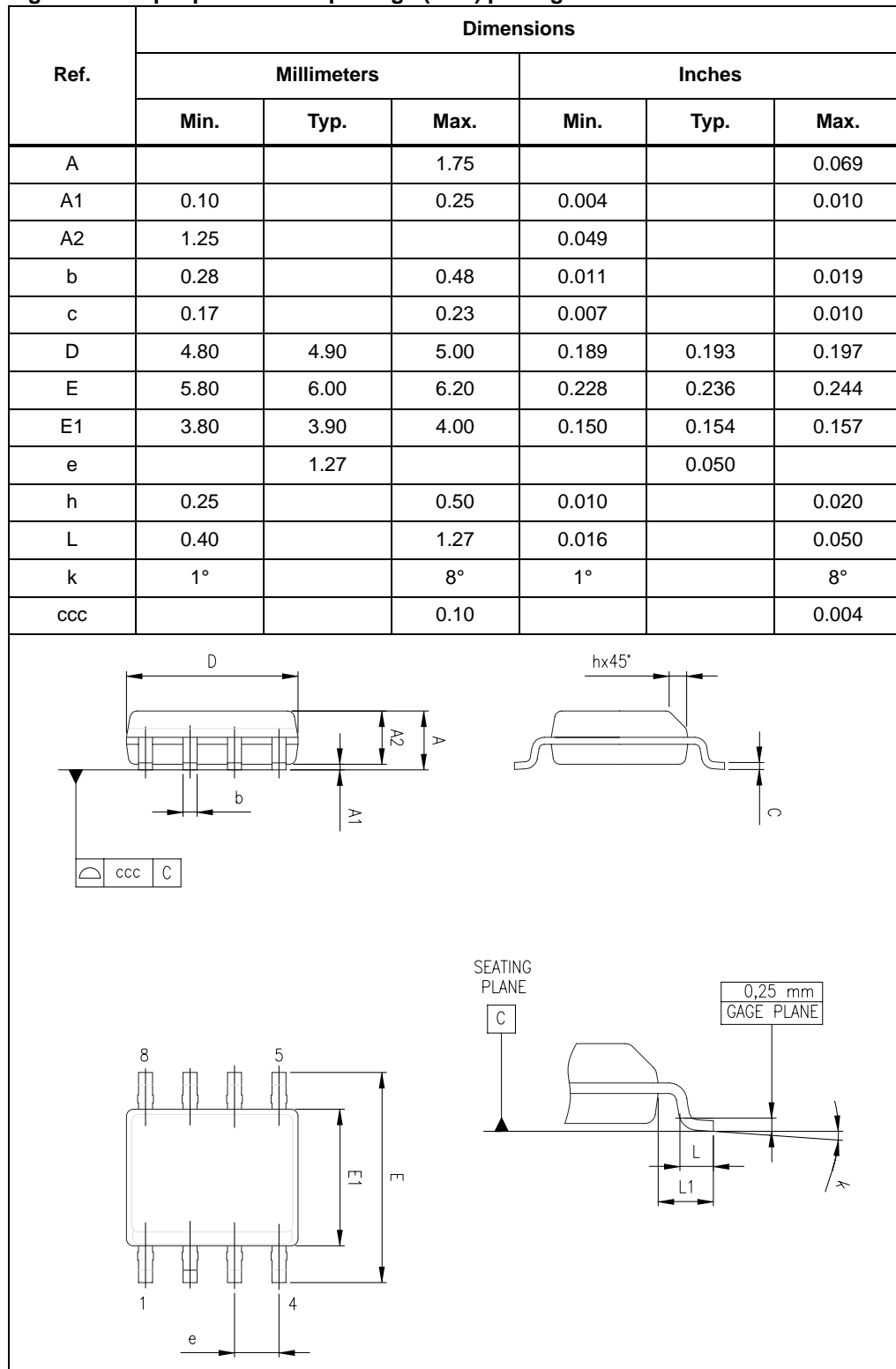


## 6 Package information

Figure 21. 8-pin plastic DIP 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

Figure 22. 8-pin plastic micropackage (SO8) package mechanical data



## 7 Ordering information

**Table 4. Order codes**

Part number	Temperature range	Package	Packing	Marking
TL072MN	-55°C, + 125°C	DIP8	Tube	TL072MN
TL072MD/MDT		SO8	Tube or tape & reel	072M
TL072AMN		DIP8	Tube	TL072AMN
TL072AMD/AMDT		SO8	Tube or tape & reel	072AM
TL072BMN		DIP8	Tube	TL072BMN
TL072BMD/BMDT		SO8	Tube or tape & reel	072BM
TL072IN	-40°C, +105°C	DIP8	Tube	TL072IN
TL072ID/IDT		SO8	Tube or tape & reel	072I
TL072AIN		DIP8	Tube	TL072AIN
TL072AID/AIDT		SO8	Tube or tape & reel	072AI
TL072BIN		DIP8	Tube	TL072BIN
TL072BID/BIDT		SO8	Tube or tape & reel	072BI
TL072CN	0°C, +70°C	DIP8	Tube	TL072CN
TL072CD/CDT		SO8	Tube or tape & reel	072C
TL072ACN		DIP8	Tube	TL072ACN
TL072ACD/ACDT		SO8	Tube or tape & reel	072AC
TL072BCN		DIP8	Tube	TL072BCN
TL072BCD/BCDT		SO8	Tube or tape & reel	072BC
TL072IYDT <sup>(1)</sup>	-40°C, +105°C	SO8 (automotive grade level)	Tube or tape & reel	072IY
TL072AIYDT <sup>(1)</sup>				72AIY
TL072BIYDT <sup>(1)</sup>				72BIY

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

## 8 Revision history

Date	Revision	Changes
28-Mar-2001	1	Initial release.
2-Apr-2004	2	Correction to pin connection diagram on cover page. Unpublished.
4-Dec-2006	3	Modified graphics in package mechanical data.
6-Mar-2007	4	Expanded order codes table and added automotive grade order codes. See <a href="#">Table 4 on page 14</a> . Added thermal resistance and ESD tolerance in <a href="#">Table 1 on page 4</a> . Added <a href="#">Table 2: Operating conditions on page 4</a> . Updated package mechanical data to make it compliant with the latest JEDEC standards.

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