



# TL072 TL072A - TL072B

## Low noise J-FET dual operational amplifiers

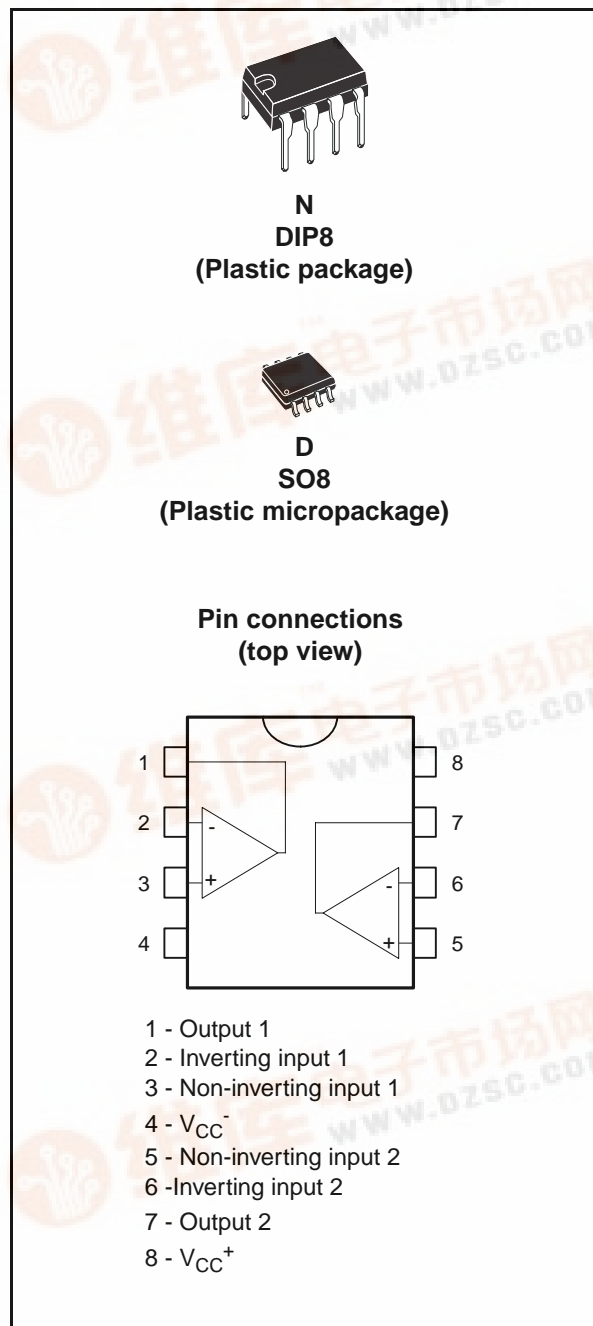
### Features

- 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.



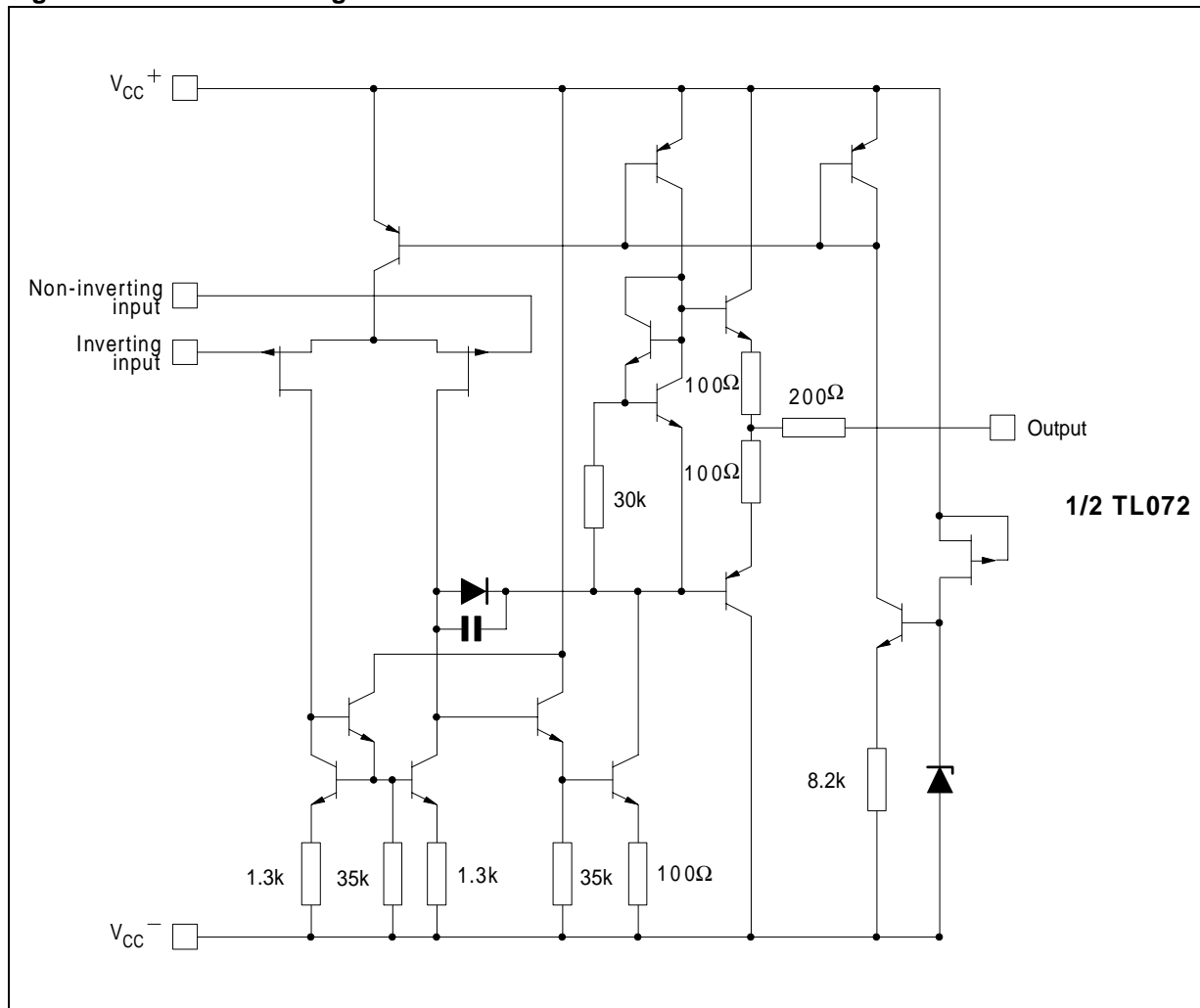
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# 1 Schematic diagram

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>				°C/W
	SO-8	125			
	DIP8	85			
$R_{thjc}$	Thermal resistance junction to case				°C/W
	SO-8	40			
	DIP8	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)

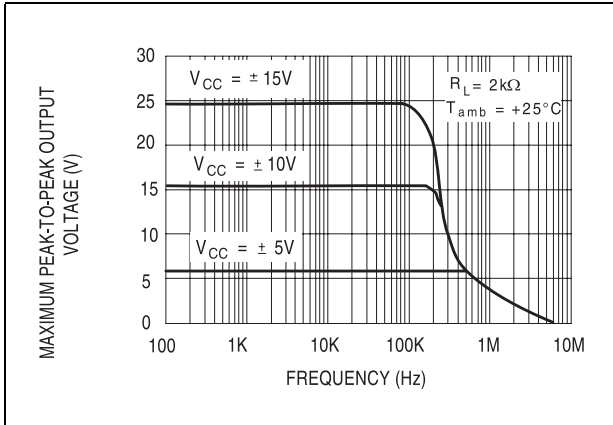
Symbol	Parameter	TL072I,M,AC,AI,AM BC,BI,BM			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{io}$	Input offset voltage ( $R_S = 50\Omega$ ) $T_{amb} = +25^{\circ}C$ TL072 TL072A TL072B		3 3 1	10 6 3		3 10		mV
	$T_{min} \leq T_{amb} \leq T_{max}$ TL072 TL072A TL072B			13 7 5		13		
$DV_{io}$	Input 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)**

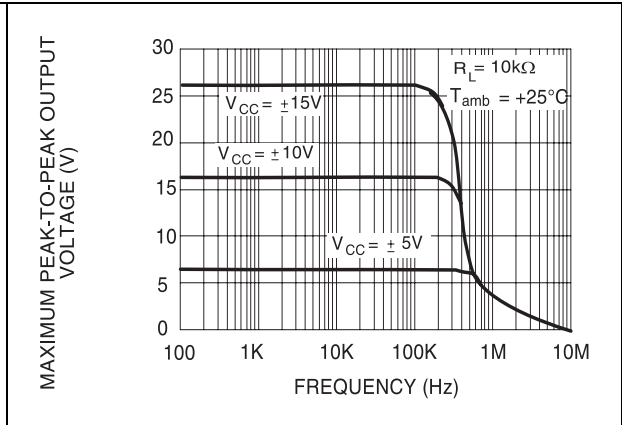
Symbol	Parameter	TL072I,M,AC,AI,AM BC,BI,BM			TL072C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$\pm V_{opp}$	Output voltage swing $T_{amb} = +25^{\circ}C$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12	12 13.5		10 12	12 13.5		V
	$T_{min} \leq T_{amb} \leq T_{max}$ $R_L = 2k\Omega$ $R_L = 10k\Omega$	10 12			10 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.

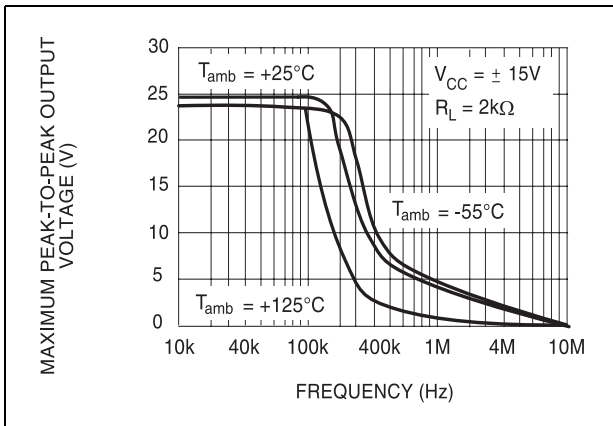
**Figure 2. Maximum peak-to-peak output voltage versus frequency**



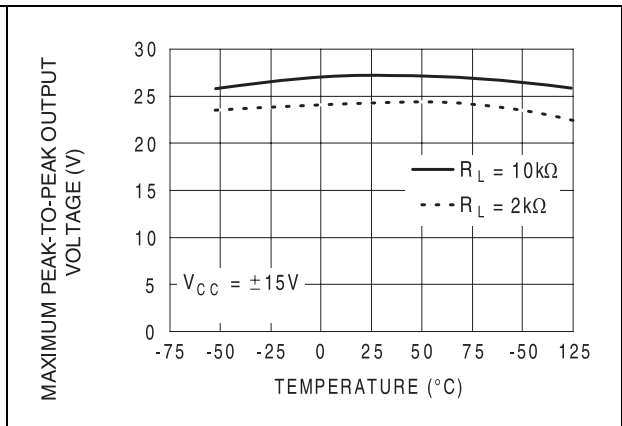
**Figure 3. Maximum peak-to-peak output voltage versus frequency**



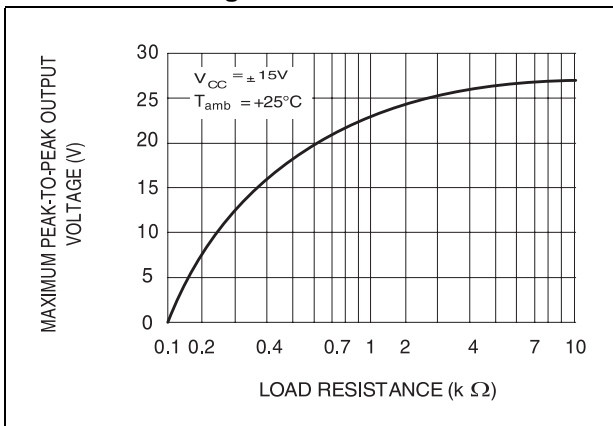
**Figure 4. Maximum peak-to-peak output voltage versus frequency**



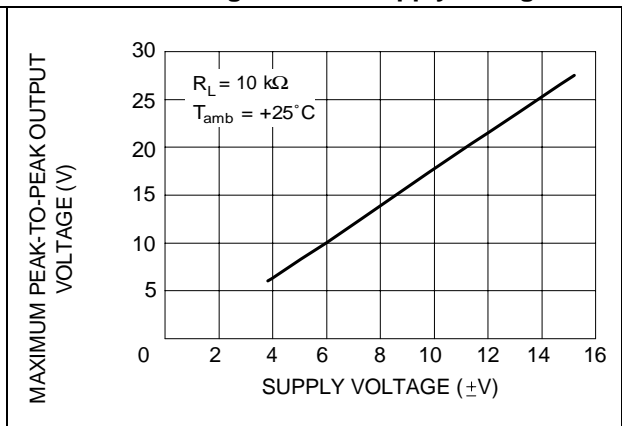
**Figure 5. Maximum peak-to-peak output voltage versus free air temperature**



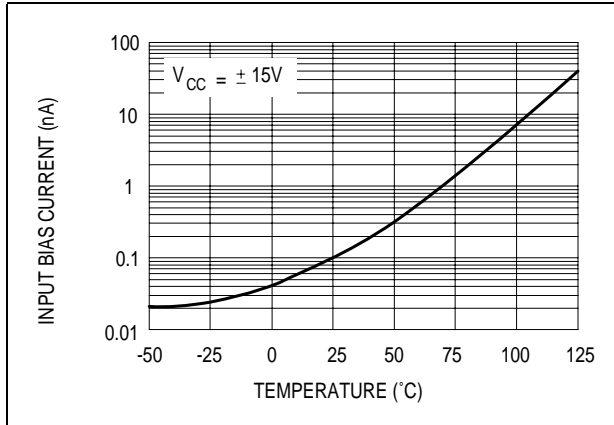
**Figure 6. Maximum peak-to-peak output voltage versus load resistance**



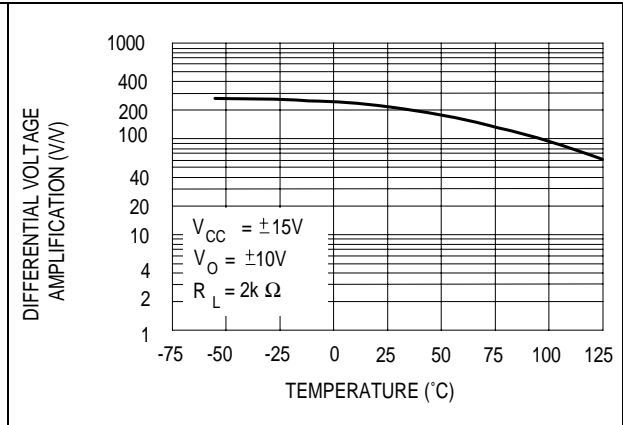
**Figure 7. Maximum peak-to-peak output voltage versus supply voltage**



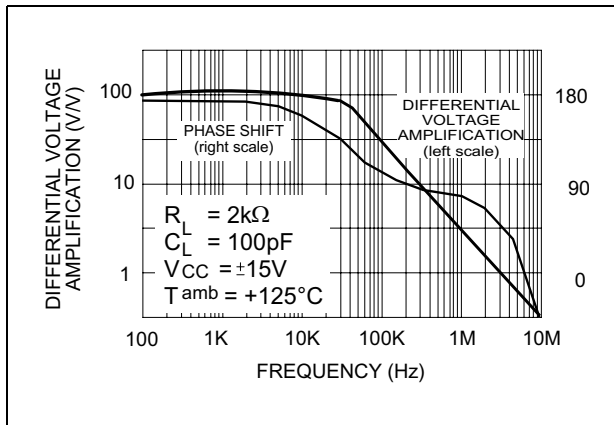
**Figure 8. Input bias current versus free air temperature**



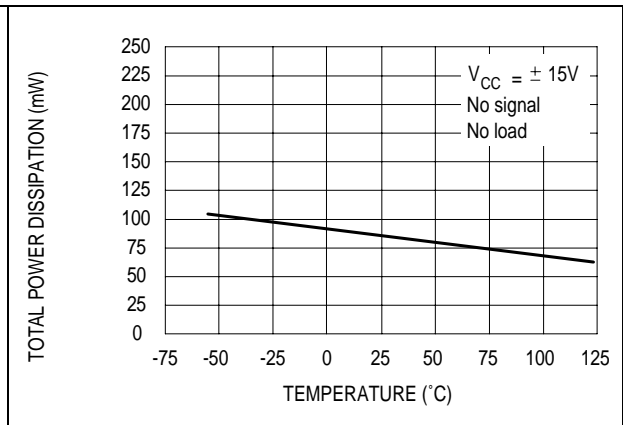
**Figure 9. Large signal differential voltage amplification versus free air temp**



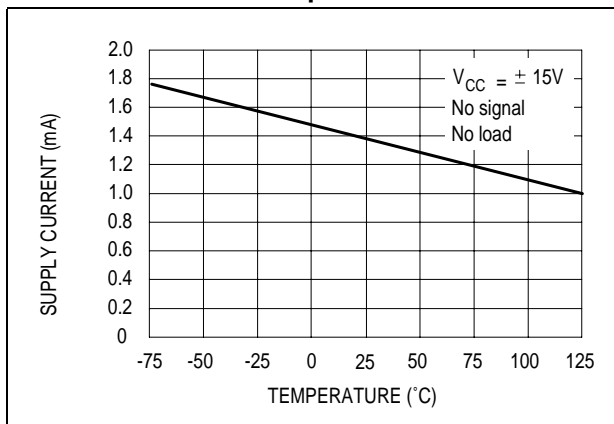
**Figure 10. Large signal differential voltage amplification and phase shift versus frequency**



**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**

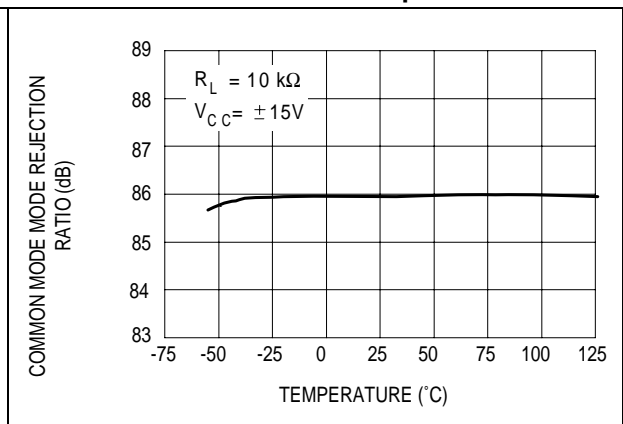




Figure 14. Voltage follower large signal pulse response

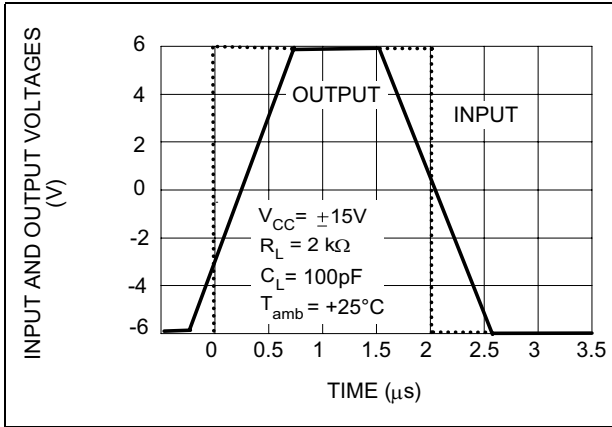


Figure 15. Output voltage versus elapsed time

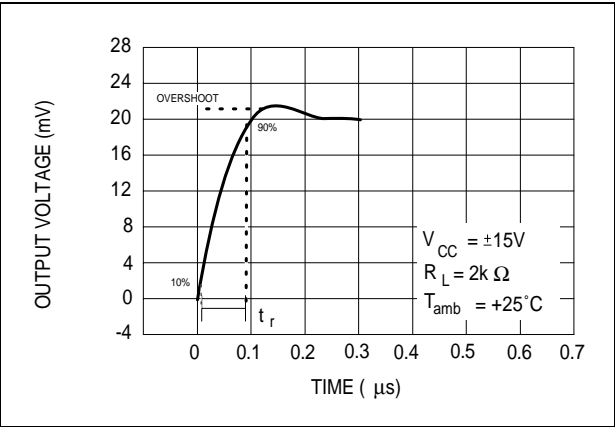


Figure 16. Equivalent input noise voltage versus frequency

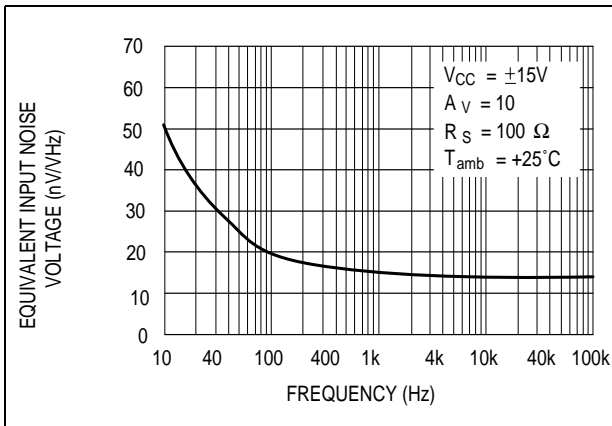
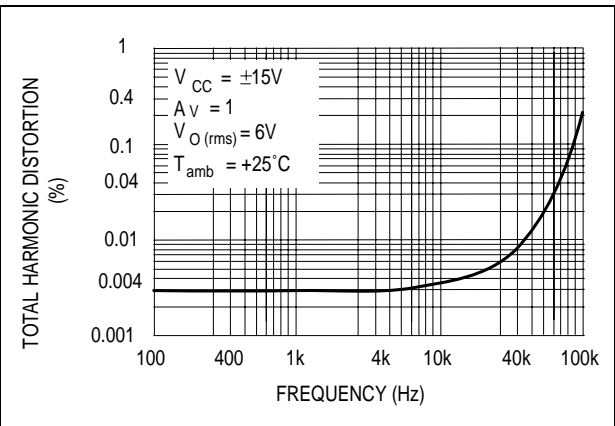


Figure 17. Total harmonic distortion versus frequency



## 4 Parameter measurement information

Figure 18. Voltage follower

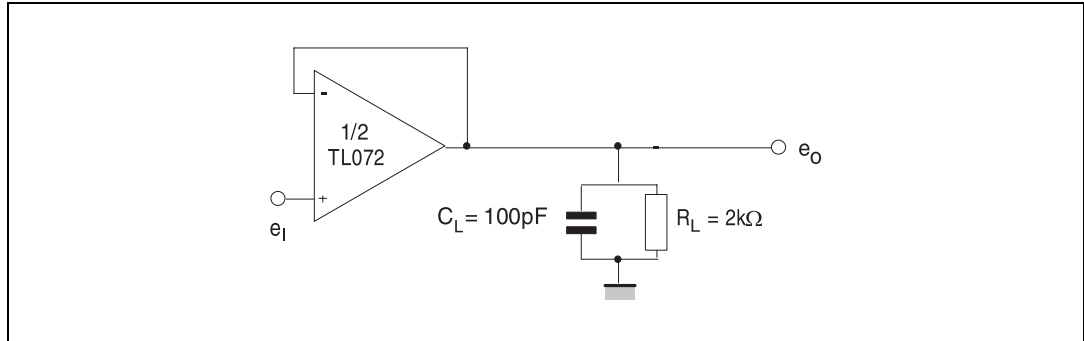
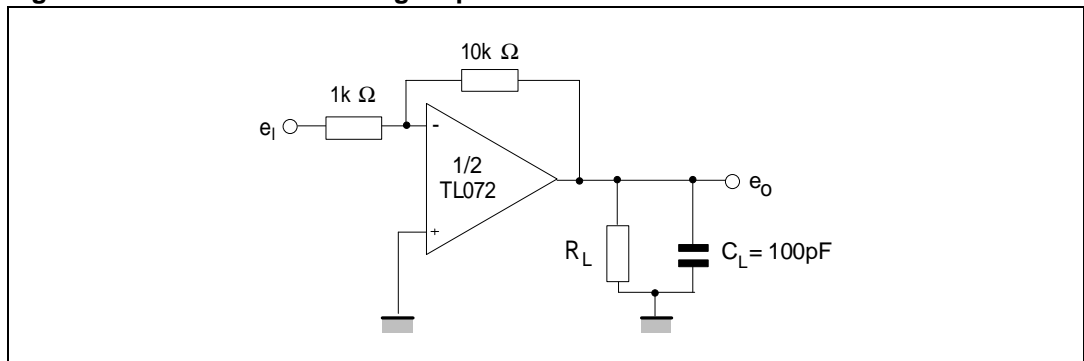
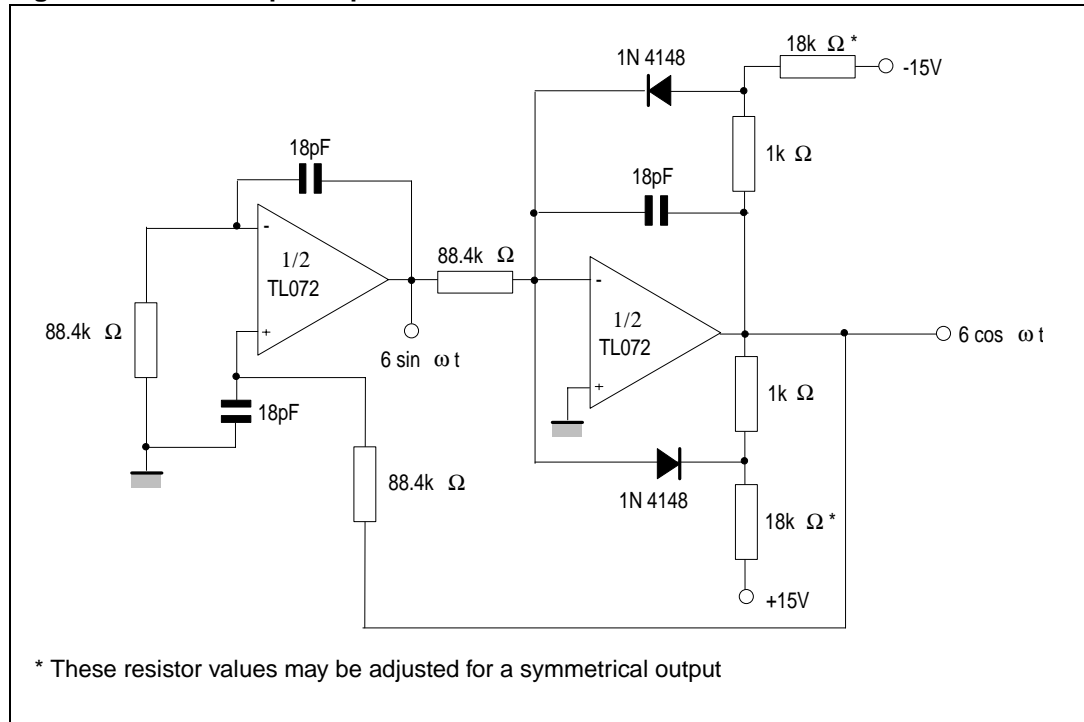


Figure 19. Gain-of-10 inverting amplifier



## 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

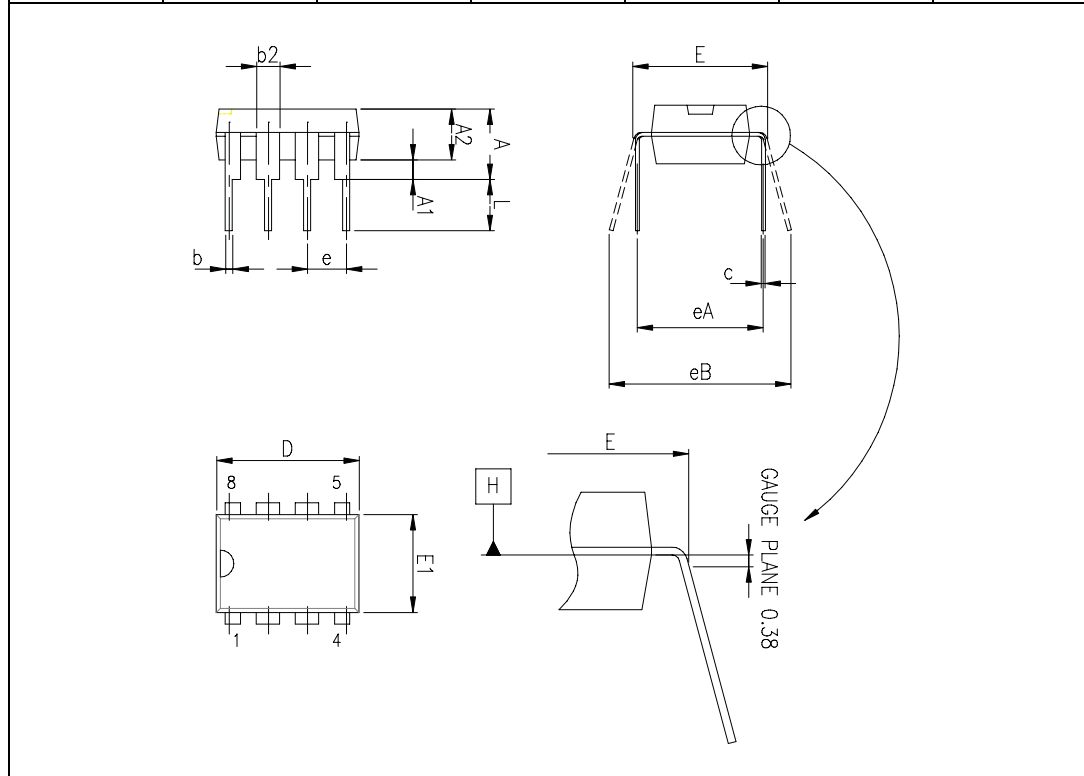
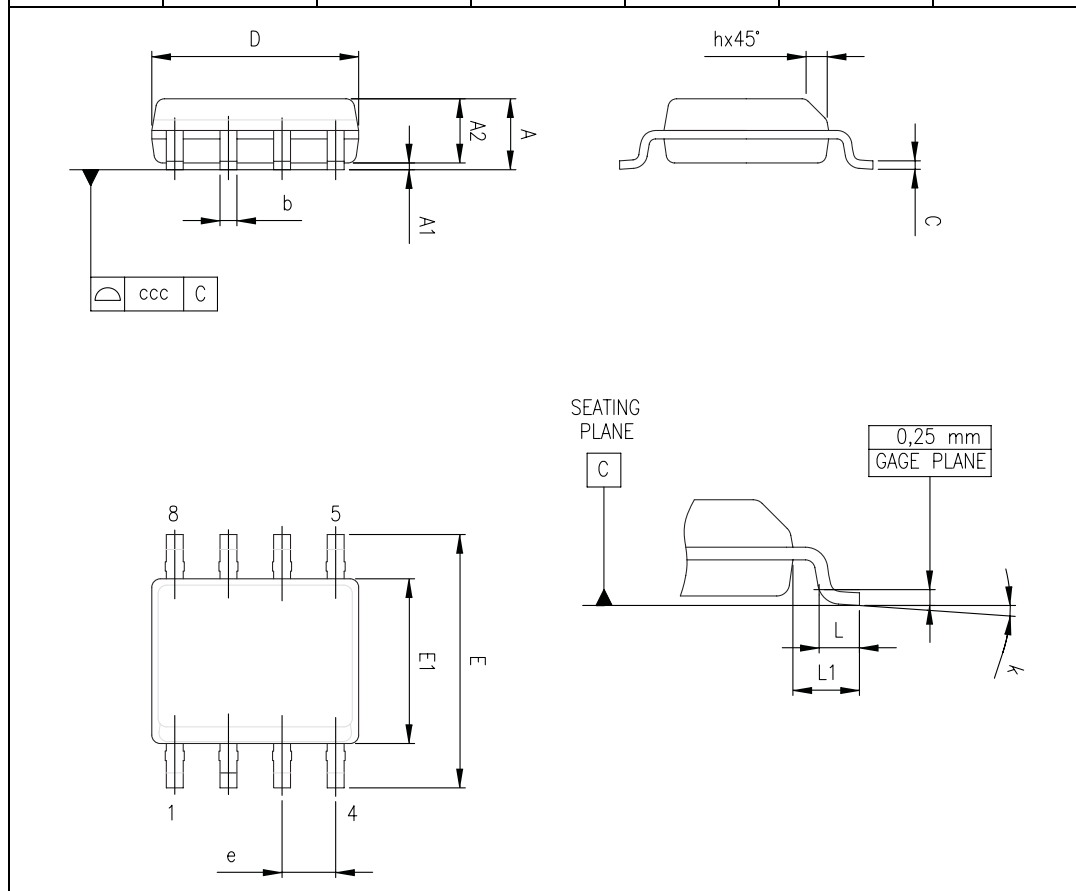


Figure 22. 8-pin plastic micropackage (SO8) package mechanical data

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 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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