TL071

Low noise JFET single operational amplifier

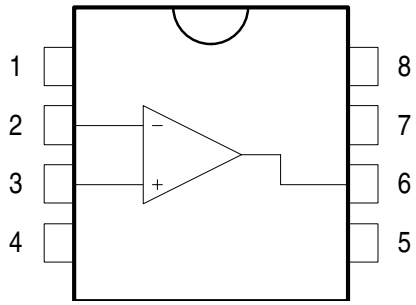
Features

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

N
DIP8
(Plastic package)

D
SO-8
(Plastic micropackage)

Pin connections
(Top view)



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

Description

The TL071 is a high-speed JFET input single operational amplifier. This JFET input operational amplifier incorporates well matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

The device features high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

1 Schematic diagram

Figure 1. Circuit schematics

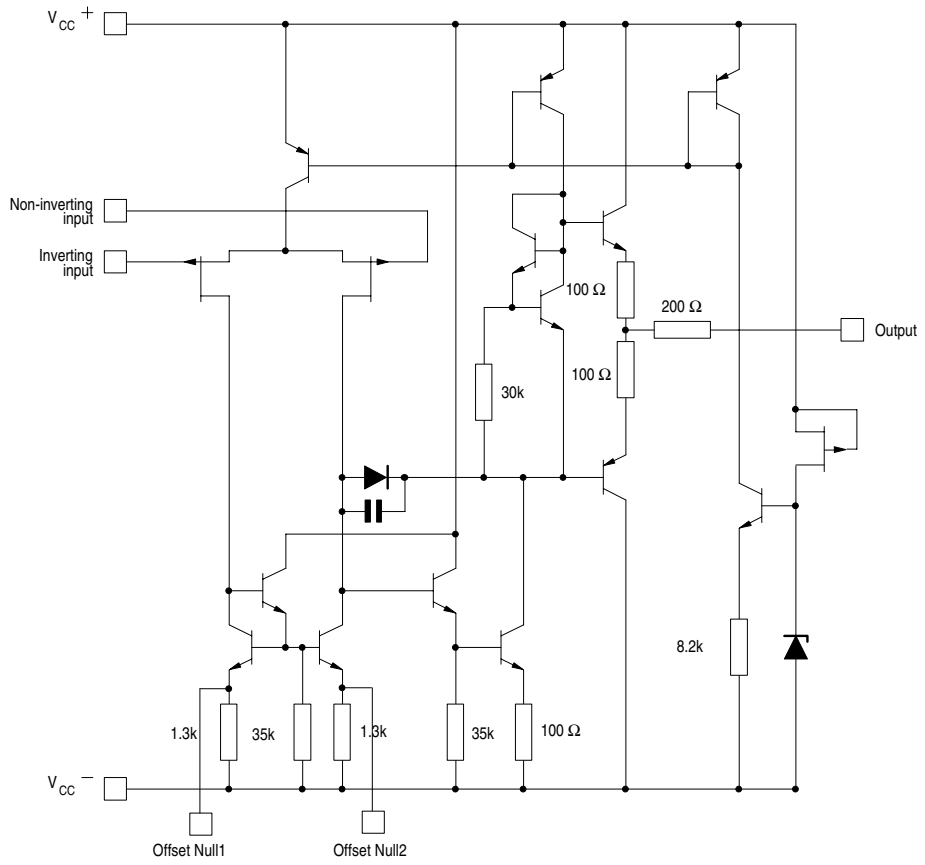
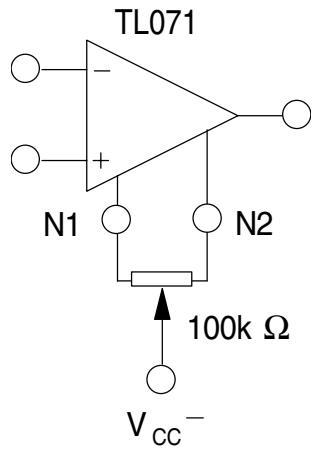


Figure 2. Input offset voltage null circuit



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TL071M, AM, BM	TL071I, AI, BI	TL071C, AC, BC	
V_{CC}	Supply voltage (1)	±18			V
V_i	Input voltage (2)	±15			V
V_{id}	Differential input voltage (3)	±30			V
R_{thja}	Thermal resistance junction to ambient(4) (5) SO-8 DIP8	125 85			°C/W
R_{thjc}	Thermal resistance junction to case(4) (5) SO-8 DIP8	40 41			°C/W
	Output short-circuit duration (6)	Infinite			
T_{oper}	Operating free-air temperature range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage temperature range	-65 to +150			°C
ESD	HBM: human body model(7)	500			V
	MM: machine model(8)	200			V
	CDM: charged device model(9)	1500			V

1. 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}^-.
2. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
3. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
5. Rth are typical values.
6. 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.
7. 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.
8. 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), done for all couples of pin combinations with other pins floating.
9. 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	TL071I, AI, BI	TL071C, 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. V_{CC} = ±15V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	TL071I,M,AC,AI,AM, BC,BI,BM			TL071C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input offset voltage (R_s = 50Ω) T_{amb} = +25°C TL071 TL071A TL071B $T_{min} \le T_{amb} \le T_{max}$ TL071 TL071A TL071B		 3 3 1	 10 6 3 13 7 5		 3	 10 13	 mV
DV_{io}	Input offset voltage drift		10			10		µV/°C
I_{io}	Input offset current T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		5	100 4		5	100 10	pA nA
I_{ib}	Input bias current (1) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		20	200 20		20	200 20	pA nA
A_{vd}	Large signal voltage gain (R_L= 2kΩ, V_o= ±10V) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	50 25	200		25 15	200		V/mV
SVR	Supply voltage rejection ratio (R_S = 50Ω) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	80 80	86		70 70	86		dB
I_{CC}	Supply current, no load T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		1.4	2.5 2.5		1.4	2.5 2.5	mA
V_{icm}	Input common mode voltage range	±11	+15 -12		±11	+15 -12		V
CMR	Common mode rejection ratio (R_S = 50Ω) T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	80 80	86		70 70	86		dB
I_{os}	Output short-circuit current T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	10 10	40	60 60	10 10	40	60 60	mA
$\pm V_{opp}$	Output voltage swing T_{amb} = +25°C R_L = 2kΩ R_L = 10kΩ $T_{min} \le T_{amb} \le T_{max}$ R_L = 2kΩ R_L = 10kΩ	10 12 10 12	12 13.5		10 12 10 12	12 13.5		V
SR	Slew rate V_{in} = 10V, R_L = 2kΩ, C_L = 100pF, unity gain	8	16		8	16		V/µs

Table 3. V_{CC} = ±15V, T_{amb} = +25°C (unless otherwise specified) (continued)

Symbol	Parameter	TL071I,M,AC,AI,AM, BC,BI,BM			TL071C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
t_r	Rise time V_{in} = 20mV, R_L = 2kΩ, C_L = 100pF, unity gain		0.1			0.1		µs
K_{ov}	Overshoot V_{in} = 20mV, R_L = 2kΩ, C_L = 100pF, unity gain		10			10		%
GBP	Gain bandwidth product V_{in} = 10mV, R_L = 2kΩ, C_L = 100pF, f= 100kHz	2.5	4		2.5	4		MHz
R_i	Input resistance		10^{12}			10^{12}		W
THD	Total harmonic distortion, f= 1kHz, R_L= 2kΩ,C_L = 100pF, A_v = 20dB, V_o = $2V_{pp}$)		0.01			0.01		%
e_n	Equivalent input noise voltage R_S = 100Ω, f = 1KHz		15			15		$\frac{nV}{\sqrt{Hz}}$
∅m	Phase margin		45			45		degrees

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

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

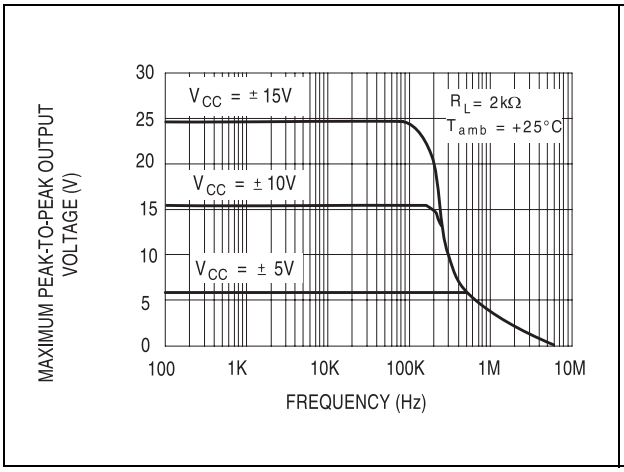


Figure 4. Maximum peak-to-peak output voltage versus frequency

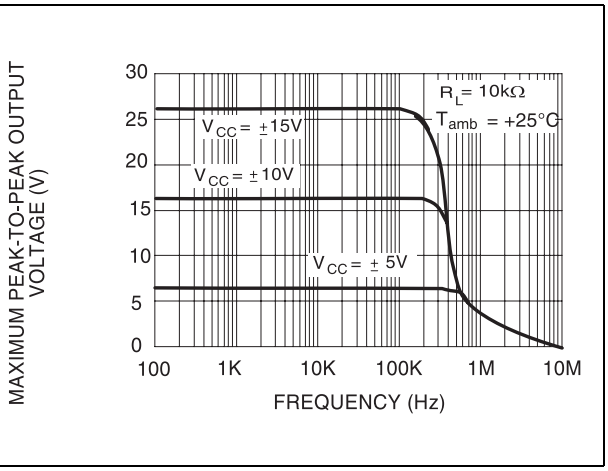


Figure 5. Maximum peak-to-peak output voltage versus frequency

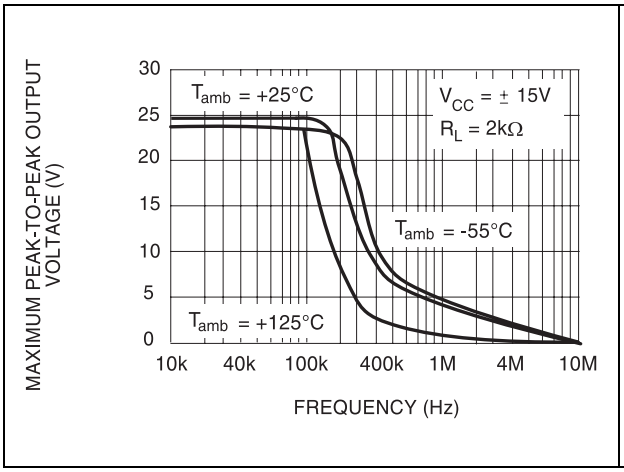


Figure 6. Maximum peak-to-peak output voltage versus free air temp.

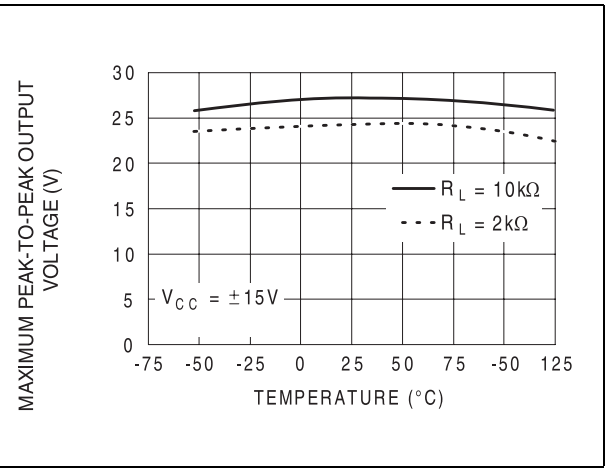


Figure 7. Maximum peak-to-peak output voltage versus load resistance

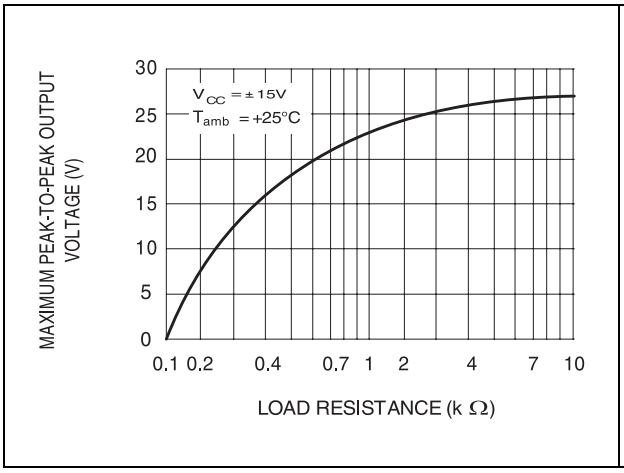


Figure 8. Maximum peak-to-peak output voltage versus supply voltage

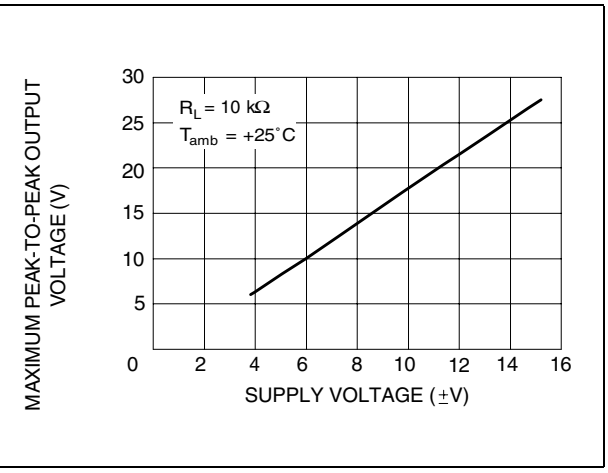


Figure 9. Input bias current versus free air temperature

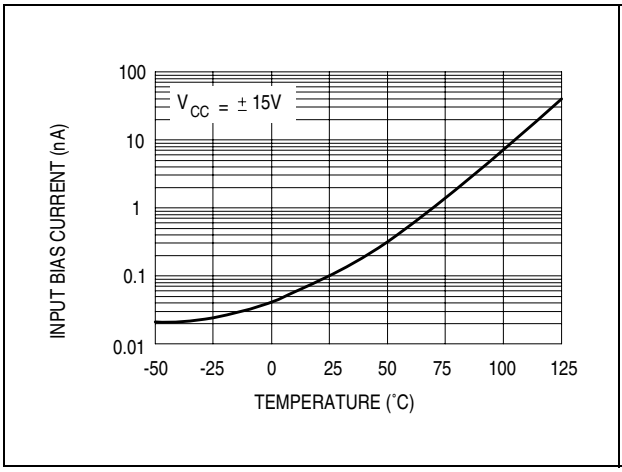


Figure 10. Large signal differential voltage amplification versus free air temp.

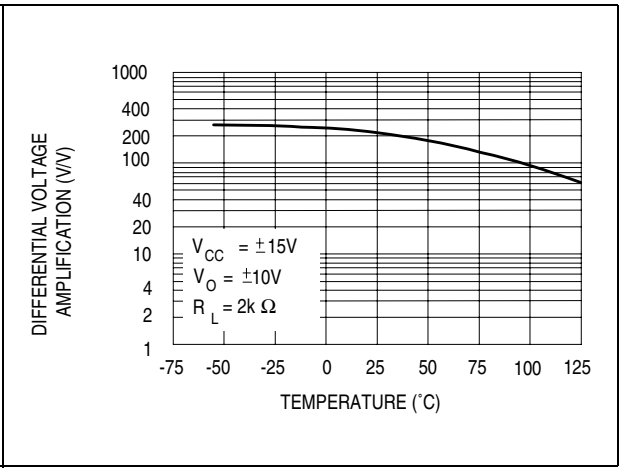


Figure 11. Large signal differential voltage amplification and phase shift versus frequency

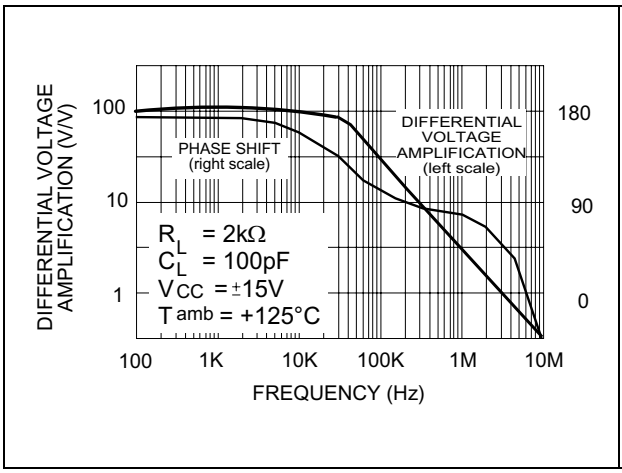


Figure 12. Total power dissipation versus free air temperature

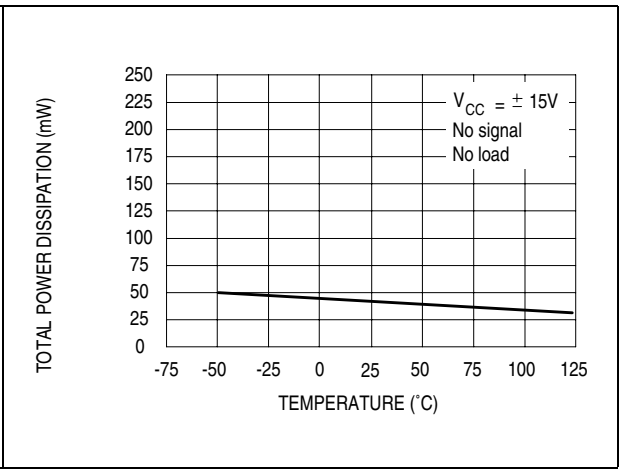


Figure 13. Supply current per amplifier versus free air temperature

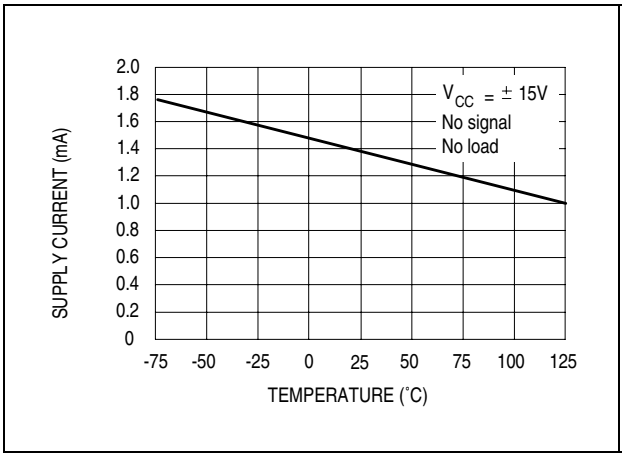


Figure 14. Common mode rejection ratio versus free air temperature

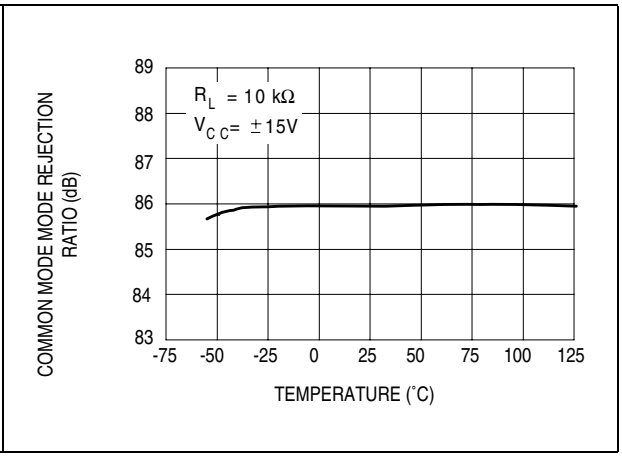


Figure 15. Voltage follower large signal pulse response

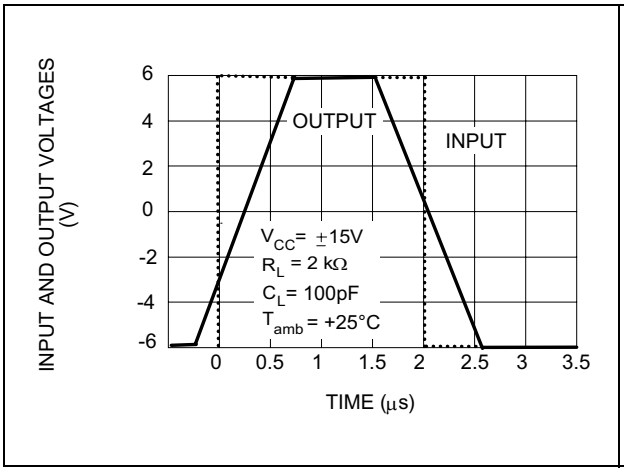


Figure 16. Output voltage versus elapsed time

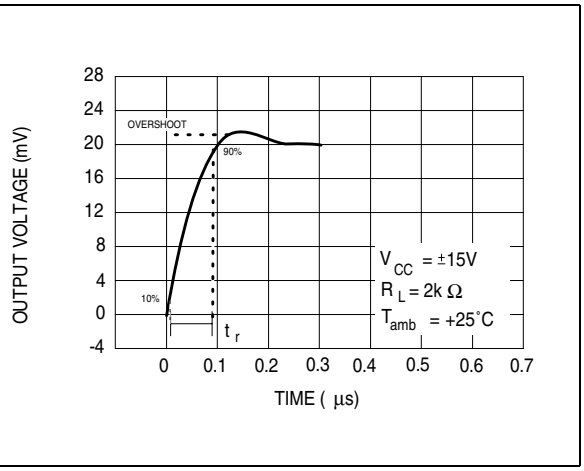


Figure 17. Equivalent input noise voltage versus frequency

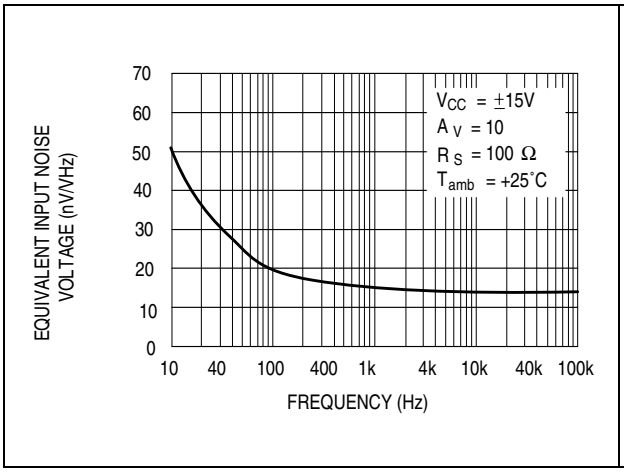
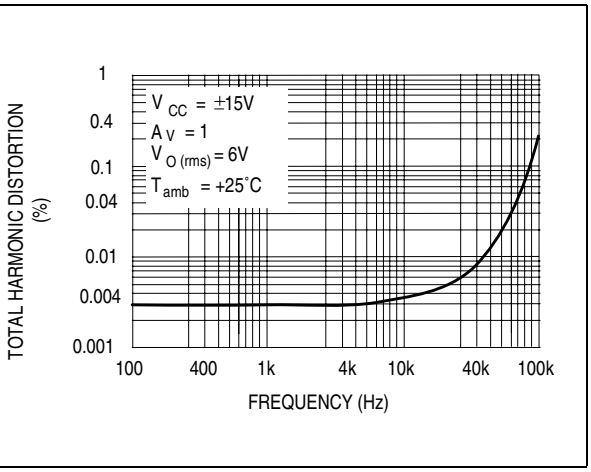


Figure 18. Total harmonic distortion versus frequency



Parameter measurement information

Figure 19. Voltage follower

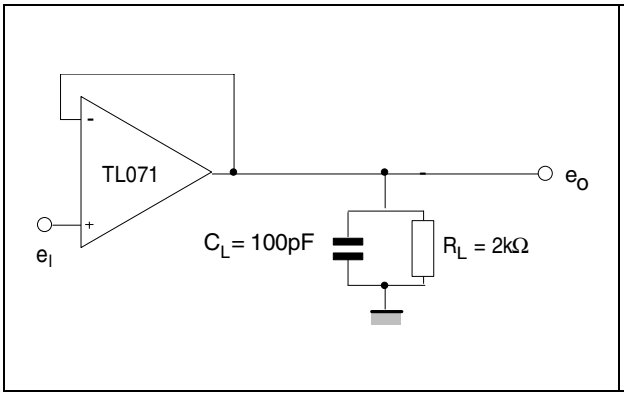
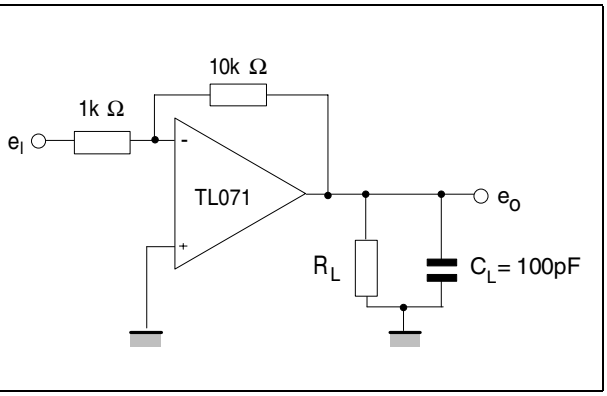


Figure 20. Gain-of-10 inverting amplifier



4 Typical applications

Figure 21. (0.5 Hz) Square wave oscillator

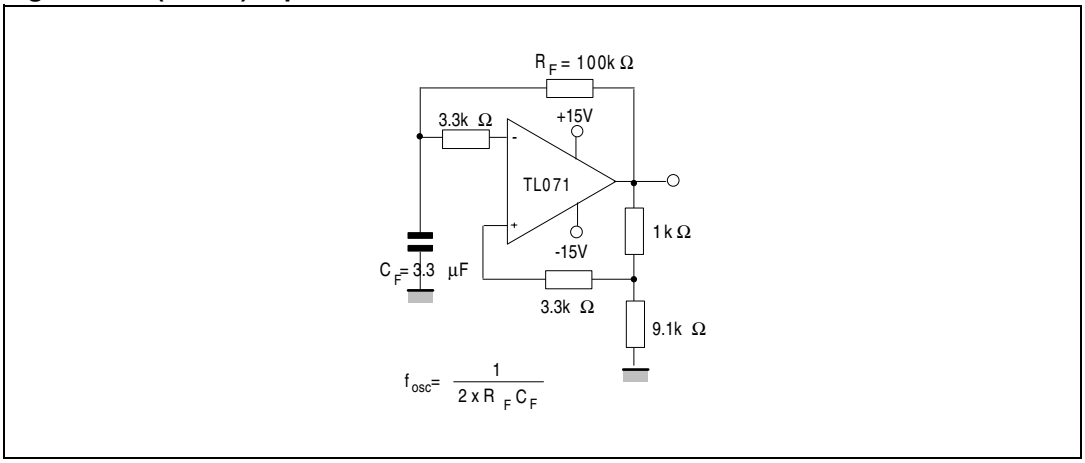
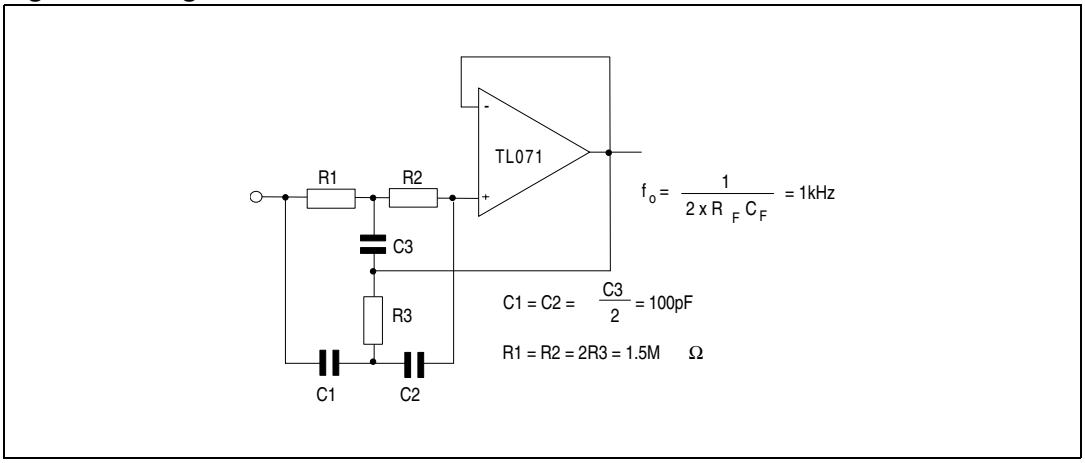


Figure 22. High Q notch filter



5 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.

5.1 DIP8 package information

Figure 23. DIP8 package mechanical drawing

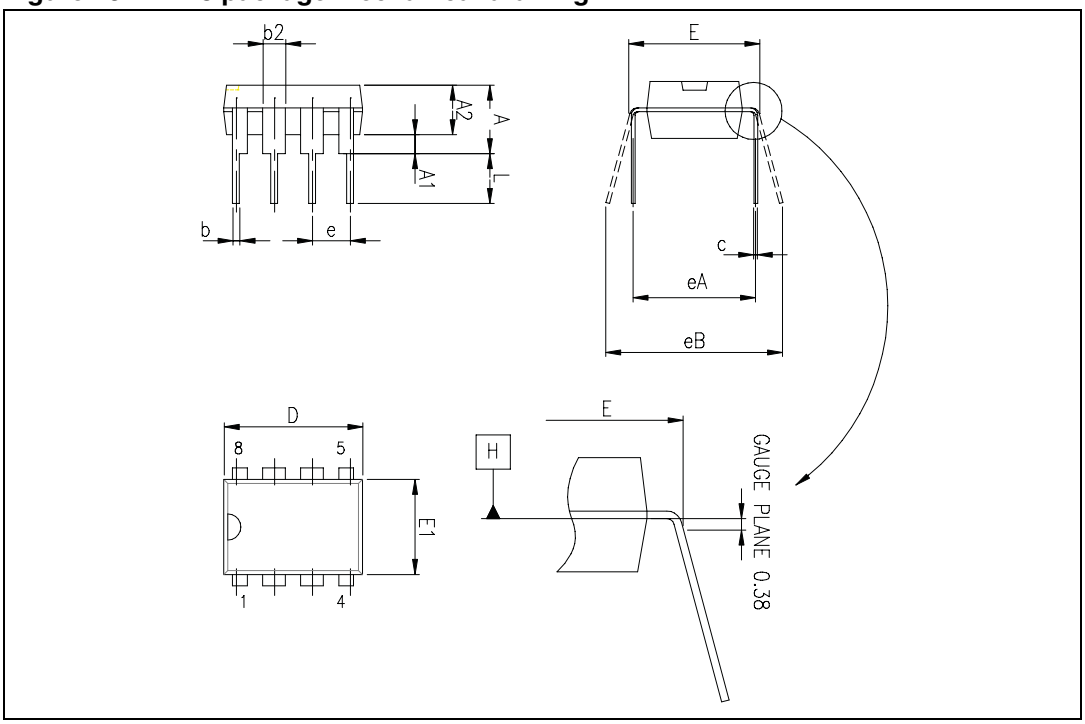


Table 4. DIP8 package mechanical data

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

5.2 SO-8 package information

Figure 24. SO-8 package mechanical drawing

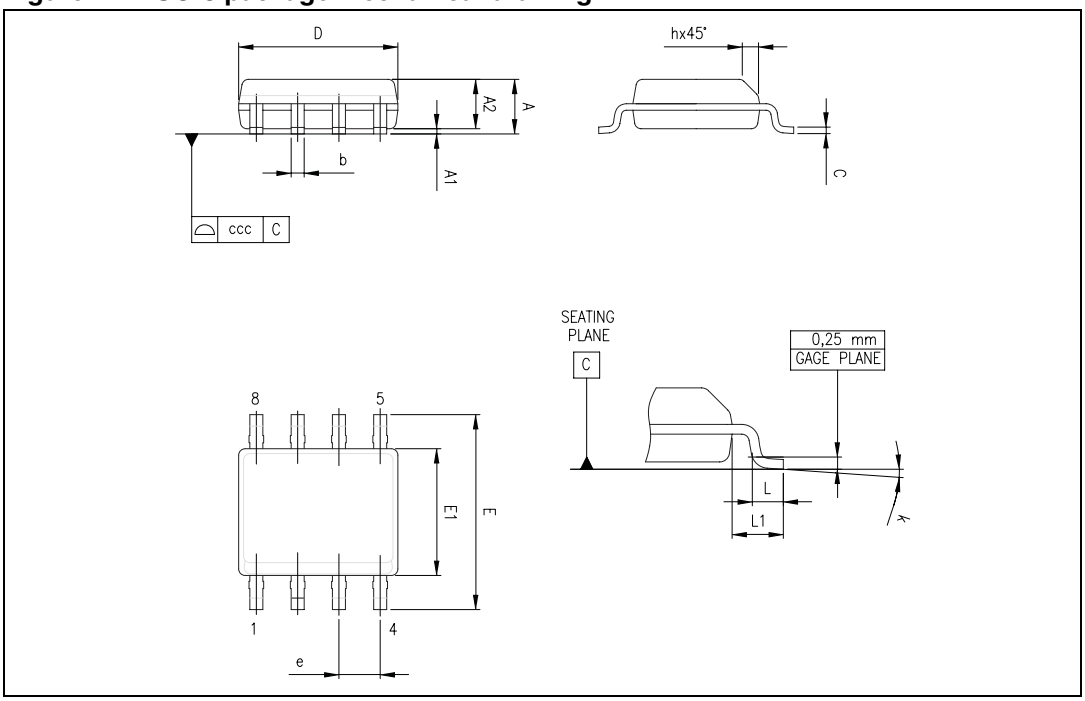


Table 5. SO-8 package mechanical data

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
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

6 Ordering information

Table 6. Order codes

Part number	Temperature range	Package	Packing	Marking
TL071IN TL071AIN TL071BIN	-40°C, +105°C	DIP8	Tube	TL071IN TL071AIN TL071BIN
TL071ID/IDT TL071AID/AIDT TL071BID/BIDT		SO-8	Tube or tape & reel	071I 071AI 071BI
TL071CN TL071ACN TL071BCN	0°C, +70°C	DIP8	Tube	TL071CN TL071ACN TL071BCN
TL071CD/CDT TL071ACD/ACDT TL071BCD/BCDT		SO-8	Tube or tape & reel	071C 071AC 071BC
TL071IYD/DT(1) TL071AIYD/DT(1) TL071BIYD/DT(1)	-40°C, +105°C	SO-8 (Automotive grade)	Tube or tape & reel	071IY 071AIY 071BIY

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

7 Revision history

Table 7. Document revision history

Date	Revision	Changes
29-Mar-2001	1	Initial release.
30-Jul-2007	2	Added values for R_{thja}, R_{thjc} and ESD in *Table 1: Absolute maximum ratings*. Added *Table 2: Operating conditions*. Expanded *Table 6: Order codes*. Format update.
19-Sep-2008	3	Corrected ESD HBM value in *Table 1: Absolute maximum ratings*. Added L1 parameter in *Table 5: SO-8 package mechanical data*. Added missing order codes for automotive grade products in *Table 6: Order codes*. Removed information concerning military temperature ranges (TL071Mx, TL071AMx, TL071BMx) in *Table 6*.

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