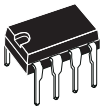
TL081

General purpose JFET single operational amplifiers

Features

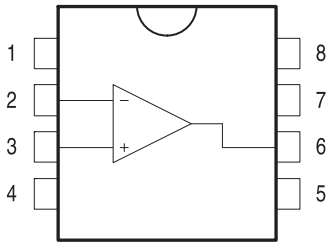
- Wide common-mode (up to V_{CC}^+) and differential voltage range
- Low input bias and offset current
- Output short-circuit protection
- High input impedance JFET input stage
- Internal frequency compensation
- Latch-up free operation
- High slew rate: 16V/µs (typ)



N
DIP8
(Plastic package)

D
SO8
(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 TL081, TL081A and TL081B are high-speed JFET input single 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 currents, and low offset voltage temperature coefficient.

1 Schematic diagram

Figure 1. Schematic diagram

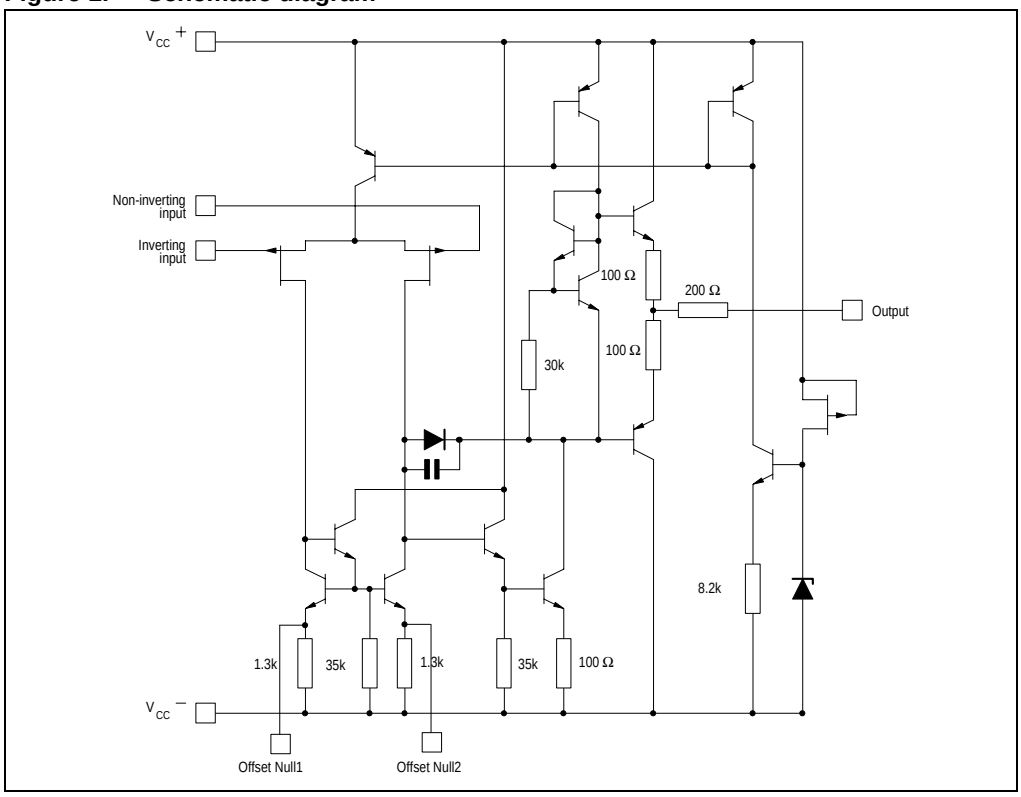
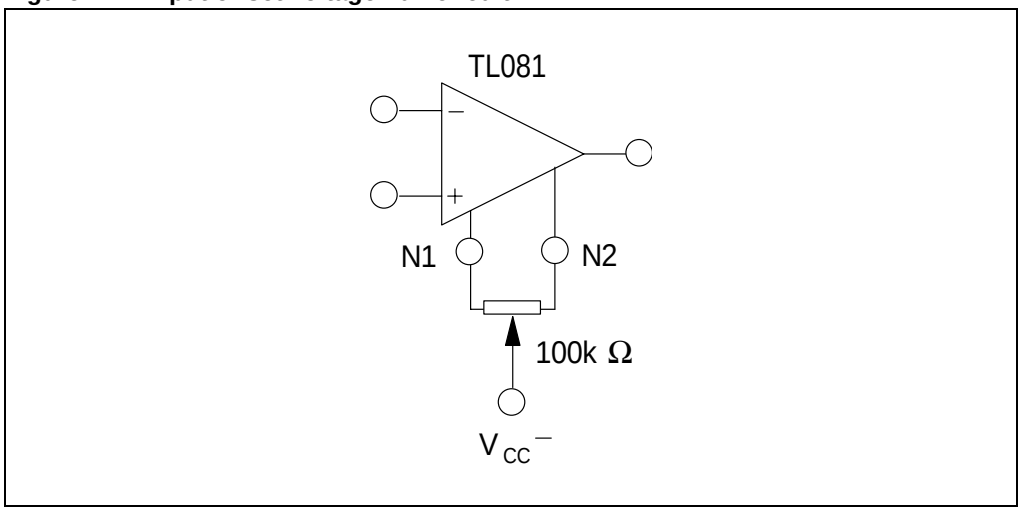


Figure 2. Input offset voltage null circuit



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	TL081M, AM, BM	TL081I, AI, BI	TL081C, 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
P_{tot}	Power dissipation	680			mW
	Output short-circuit duration (4)	Infinite			
T_{stg}	Storage temperature range	-65 to +150			°C
R_{thja}	Thermal resistance junction to ambient(5) (6) SO-8 DIP8	 125 85			°C/W
R_{thjc}	Thermal resistance junction to case(5) (6) SO-8 DIP8	 40 41			°C/W
ESD	HBM: human body model(7)	500			V
	MM: machine model(8)	200			V
	CDM: charged device model(9)	1.5			kV

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. 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.
5. Short-circuits can cause excessive heating and destructive dissipation.
6. Rth are typical values.
7. 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.
8. 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.
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	TL081M, AM, BM	TL081I, AI, BI	TL081C, AC, BC	Unit
V_{CC}	Supply voltage range	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. V_{CC} = ±15V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	TL081I,M,AC,AI,AMBC,BI,BM			TL081C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input offset voltage (R_s = 50Ω) T_{amb} = +25°C TL081 TL081A TL081B $T_{min} \le T_{amb} \le T_{max}$ TL081 TL081A TL081B		 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 (1) 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	 400 20	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 (T_{amb} = +25°C) 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	TL081I,M,AC,AI,AM BC,BI,BM			TL081C			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
t_r	Rise time (T_{amb} = +25°C) V_{in} = 20mV, R_L = 2kΩ, C_L = 100pF, unity gain		0.1			0.1		µs
K_{ov}	Overshoot (T_{amb} = +25°C) V_{in} = 20mV, R_L = 2kΩ, C_L = 100pF, unity gain		10			10		%
GBP	Gain bandwidth product (T_{amb} = +25°C) 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}		Ω
THD	Total harmonic distortion (T_{amb} = +25°C), 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

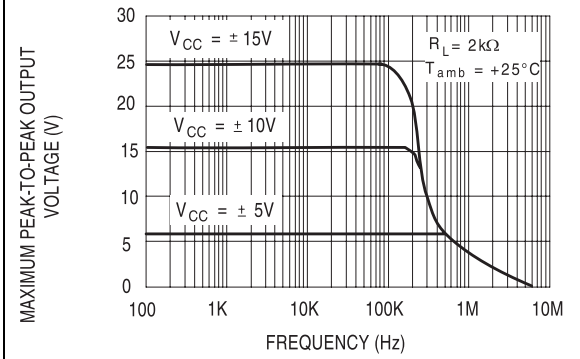


Figure 4. Maximum peak-to-peak output voltage versus frequency

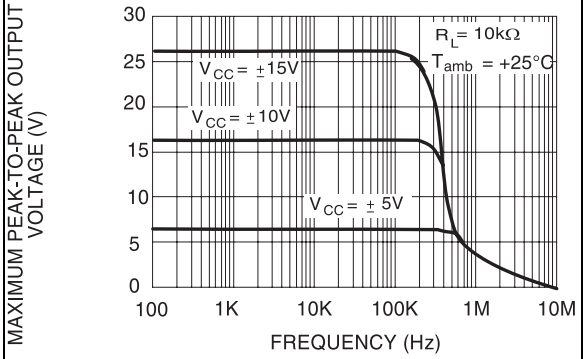


Figure 5. Maximum peak-to-peak output voltage versus frequency

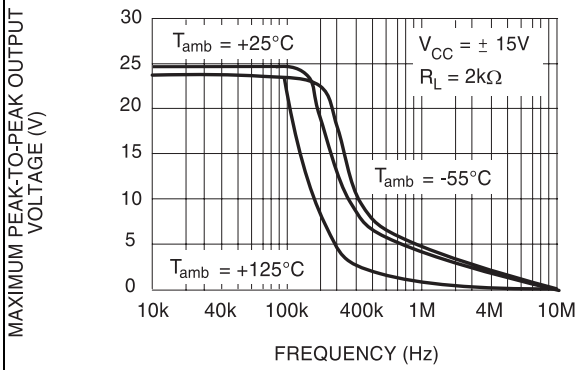


Figure 6. Maximum peak-to-peak output voltage versus free air temperature

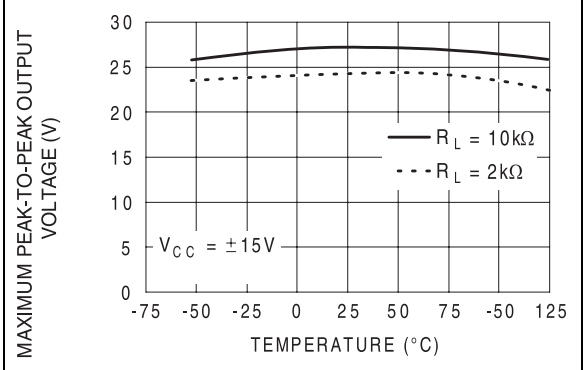


Figure 7. Maximum peak-to-peak output voltage versus load resistance

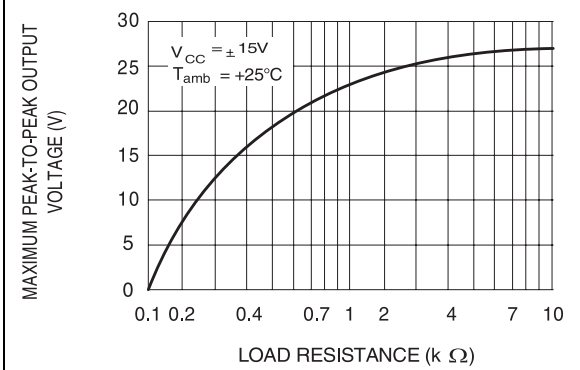


Figure 8. Maximum peak-to-peak output voltage versus supply voltage

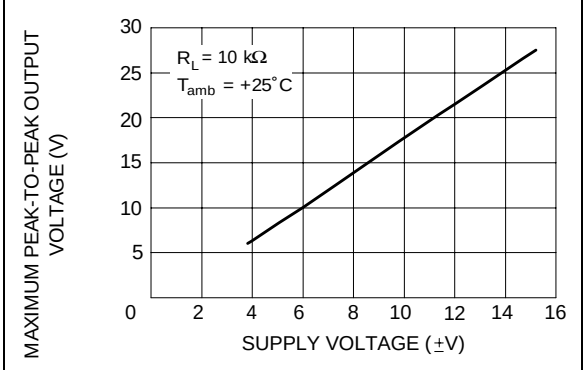


Figure 9. Input bias current versus free air temperature

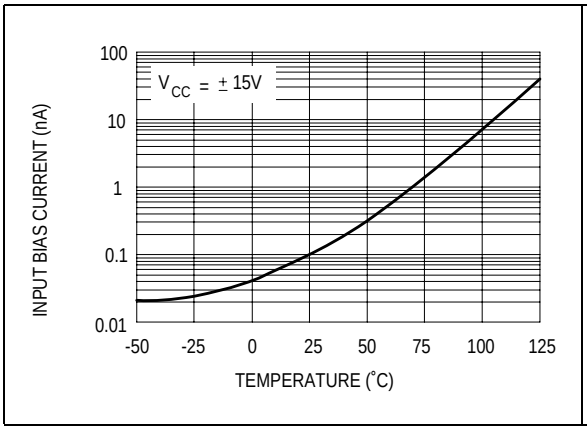


Figure 10. Large signal differential voltage amplification versus free air temp

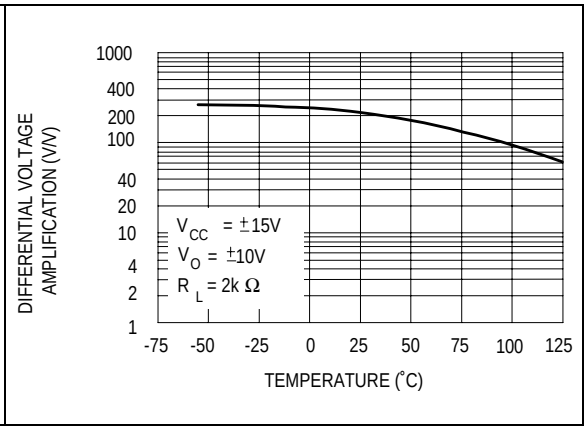


Figure 11. Large signal differential voltage amplification and phase shift versus frequency

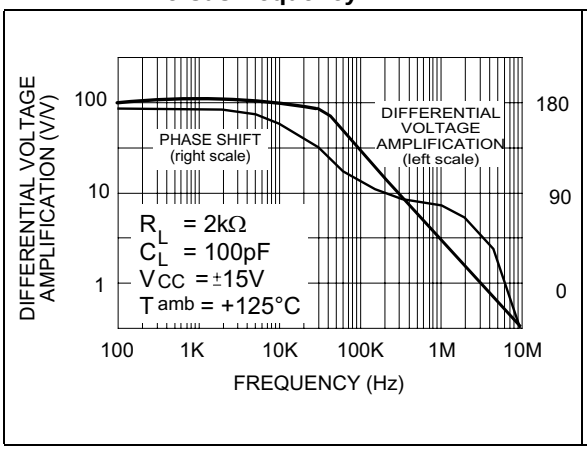


Figure 12. Total power dissipation versus free air temperature

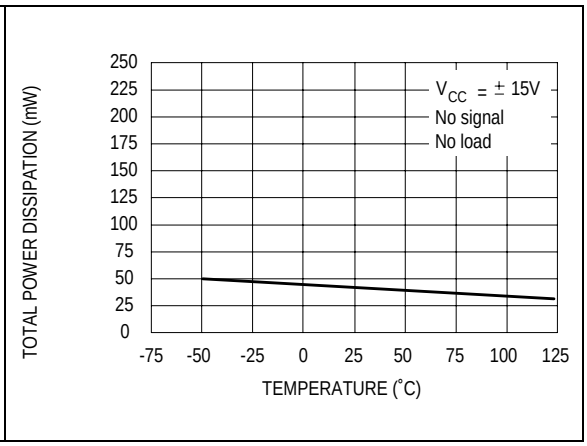


Figure 13. Supply current per amplifier versus free air temperature

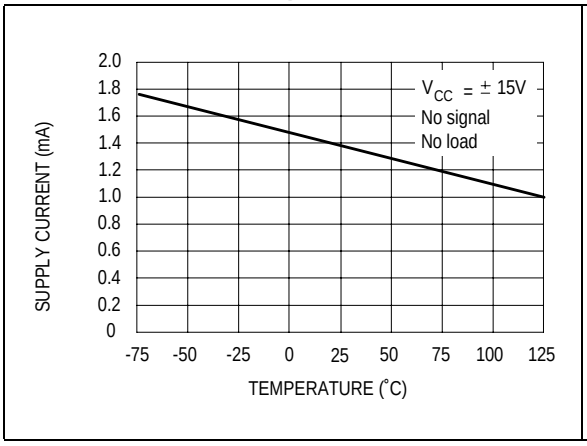


Figure 14. Supply current per amplifier versus supply voltage

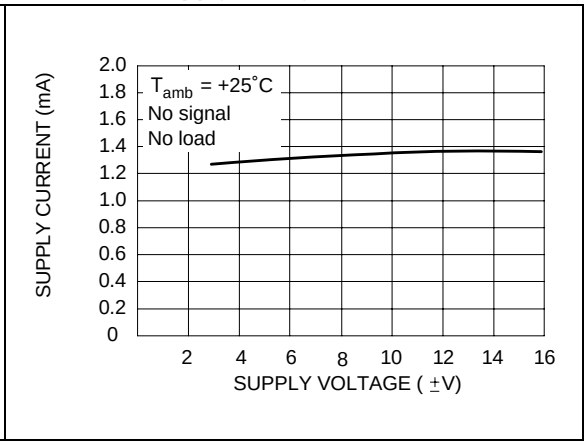


Figure 15. Common mode rejection ratio versus free air temperature

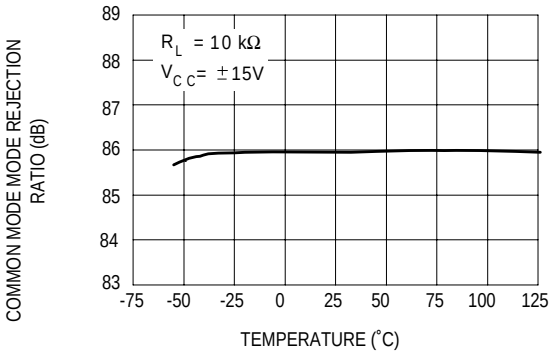


Figure 16. Equivalent input noise voltage versus frequency

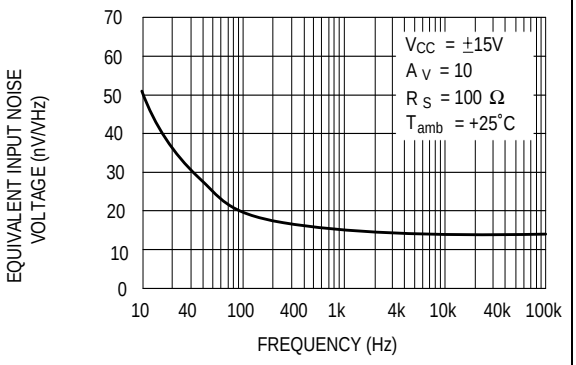


Figure 17. Output voltage versus elapsed time

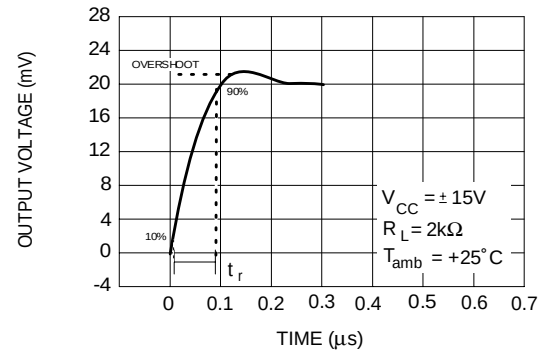


Figure 18. Total harmonic distortion versus frequency

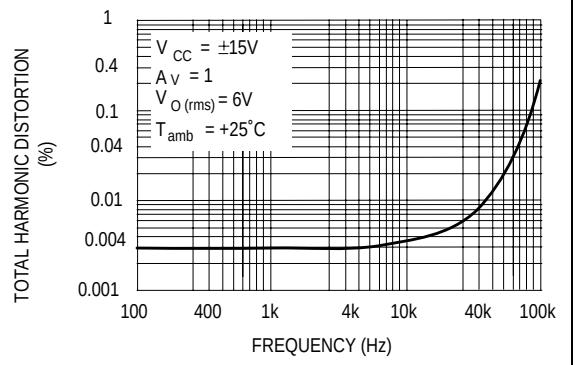
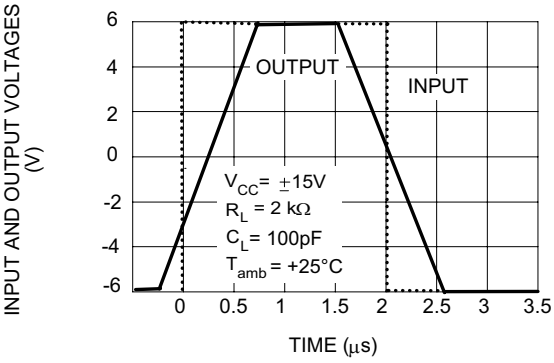


Figure 19. Voltage follower large signal pulse response



Parameter measurement information

Figure 20. Voltage follower

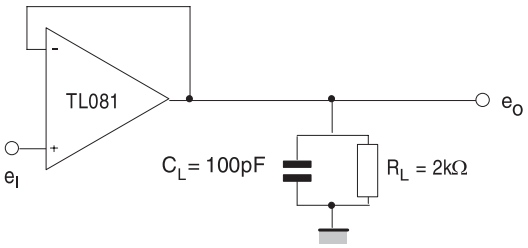
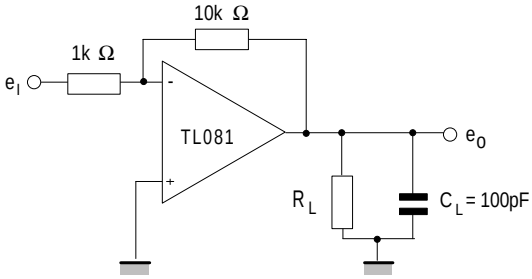


Figure 21. Gain-of-10 inverting amplifier



4 Typical applications

Figure 22. 0.5Hz square wave oscillator

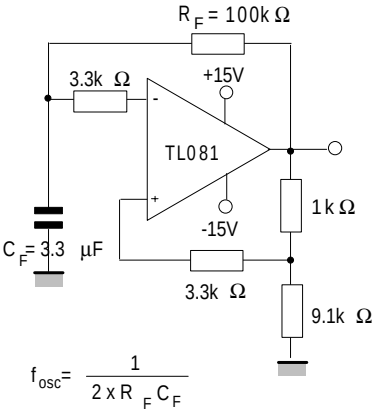
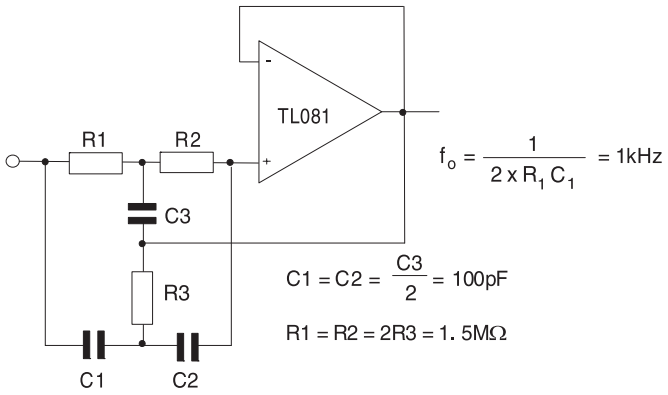


Figure 23. High Q notch filter



5 Package information

In order to meet environmental requirements, ST 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 ST trademark. ECOPACK specifications are available at: www.st.com.

Figure 24. 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

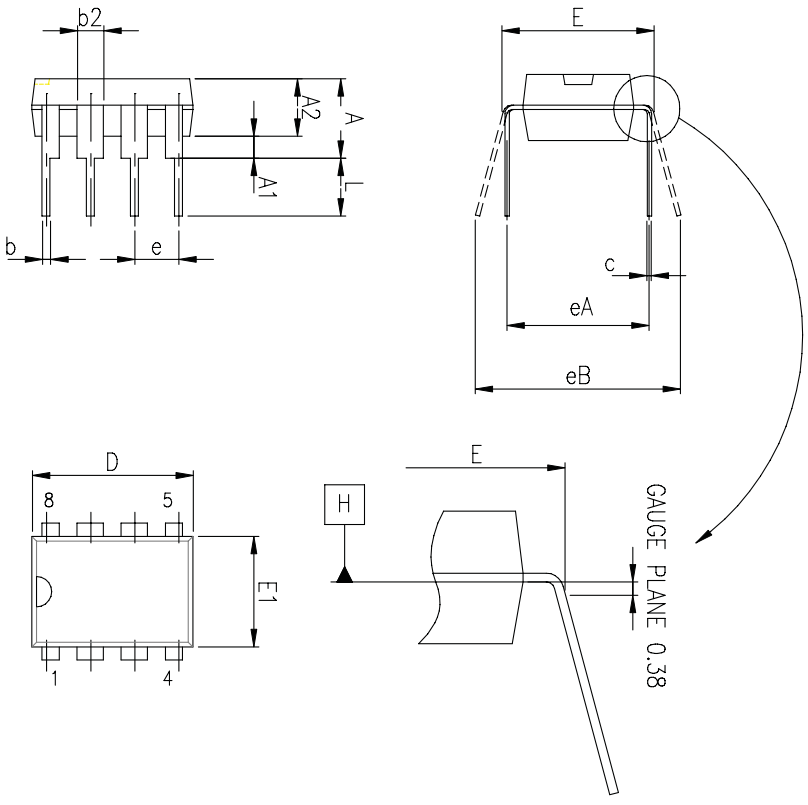
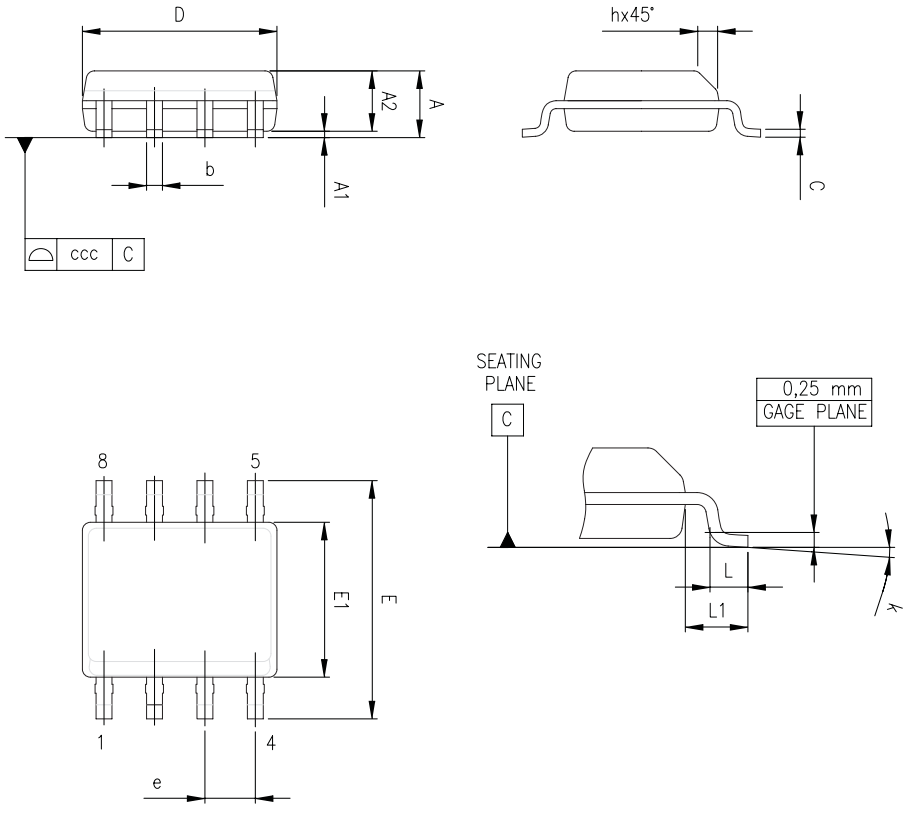


Figure 25. SO-8 package mechanical data

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
H	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



6 Ordering information

Table 4. Order codes

Part number	Temperature range	Package	Packing	Marking
TL081MN TL081AMN TL081BMN	-55°C, +125°C	DIP8	Tube	TL081MN TL081AMN TL081BMN
TL081MD/MDT TL081AMD/AMDT TL081BMD/BMDT		SO-8	Tube or tape & reel	081M 081AM 081BM
TL081IN TL081AIN TL081BIN	-40°C, +105°C	DIP8	Tube	TL081IN TL081AIN TL081BIN
TL081ID/IDT TL081AID/AIDT TL081BID/BIDT		SO-8	Tube or tape & reel	081I 081AI 081BI
TL081IYD/IYDT(1)		SO-8 (Automotive grade)	Tube or tape & reel	081IY
TL081CN TL081ACN TL081BCN	0°C, +70°C	DIP8	Tube	TL081CN TL081ACN TL081BCN
TL081CD/CDT TL081ACD/ACDT TL081BCD/BCDT		SO-8	Tube or tape & reel	081C 081AC 081BC

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

7 Revision history

Table 5. Document revision history

Date	Revision	Changes
30-Apr-2001	1	Initial release.
27-Jul-2007	2	Added values for R_{thja} and R_{thjc} in *Table 1: Absolute maximum ratings*. Added *Table 2: Operating conditions*. Added automotive grade part numbers in *Table 4: Order codes*. Format update.

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