

General purpose JFET single operational amplifiers

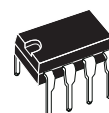
Features

- 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: 16 V/ μ s (typ)

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.

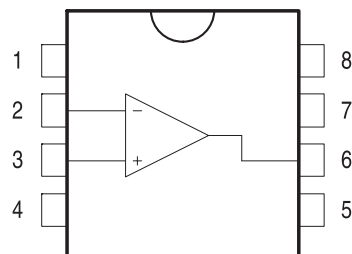


**N
DIP8**
(Plastic package)



**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.

1 Schematic diagram

Figure 1. Schematic diagram

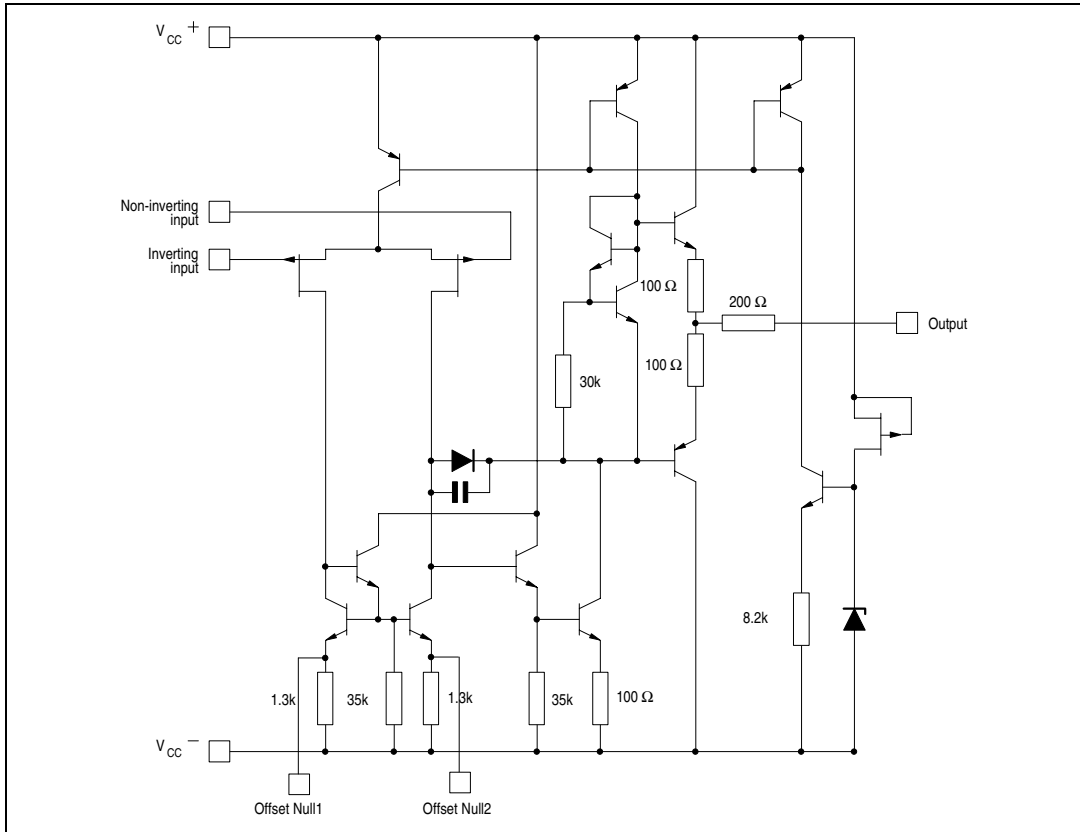
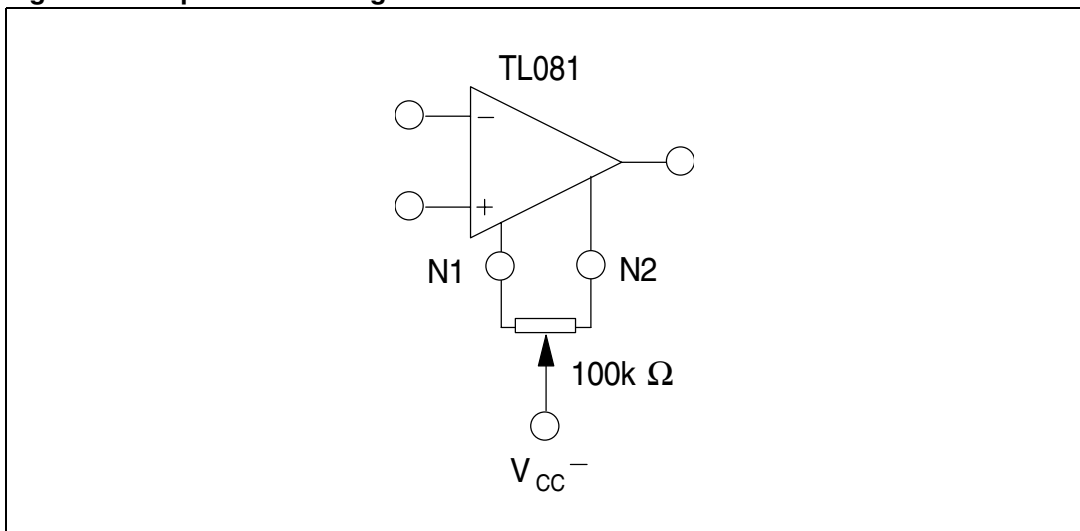


Figure 2. Input offset voltage null circuit



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | 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)} | | | °C/W |
| | SO-8 | 125 | | |
| | DIP8 | 85 | | |
| R_{thjc} | Thermal resistance junction to case ^{(5) (6)} | | | °C/W |
| | SO-8 | 40 | | |
| | DIP8 | 41 | | |
| ESD | HBM: human body model ⁽⁷⁾ | 500 | | V |
| | MM: machine model ⁽⁸⁾ | 200 | | V |
| | CDM: charged device model ⁽⁹⁾ | 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.
- 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.
- Short-circuits can cause excessive heating and destructive dissipation.
- R_{th} are typical values.
- Human body model: 100 pF 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 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.
- 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 | TL081I, AI, BI | TL081C, AC, BC | Unit |
|------------|--------------------------------------|----------------|----------------|------|
| V_{CC} | Supply voltage range | 6 to 36 | | V |
| T_{oper} | Operating free-air temperature range | -40 to +105 | 0 to +70 | °C |

3 Electrical characteristics

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

| Symbol | Parameter | TL081I, AC, AI, BC, BI | | | TL081C | | | Unit |
|---------------|--|------------------------|------------|------|----------|------------|------|-------------------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V_{io} | Input offset voltage ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$ | | 3 | 10 | | 3 | 10 | mV |
| | TL081 | | 3 | 6 | | | | |
| | TL081A | | 1 | 3 | | | | |
| | TL081B | | | 13 | | | 13 | |
| | $T_{min} \leq T_{amb} \leq T_{max}$ | | | 7 | | | 5 | |
| 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 | 400 | 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 | +15 -12 | | ± 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 | |
| $\pm V_{opp}$ | Output voltage swing $T_{amb} = +25^{\circ}C$ | 10 | 12 | | 10 | 12 | | V |
| | $R_L = 2k\Omega$ | 12 | 13.5 | | 12 | 13.5 | | |
| | $R_L = 10k\Omega$ | 10 | | | 10 | | | |
| | $T_{min} \leq T_{amb} \leq T_{max}$ | 12 | | | 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/ μs |

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

| Symbol | Parameter | TL081I, AC, AI, BC, BI | | | TL081C | | | Unit |
|----------|--|------------------------|-----------|------|--------|-----------|------|------------------------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| 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 | | μs |
| 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} | | Ω |
| 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 | | $\frac{nV}{\sqrt{Hz}}$ |
| ϕ_m | Phase margin | | 45 | | | 45 | | degrees |

1. The input bias currents are junction leakage currents which approximately double for every $10^{\circ}C$ increase in the junction temperature.

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

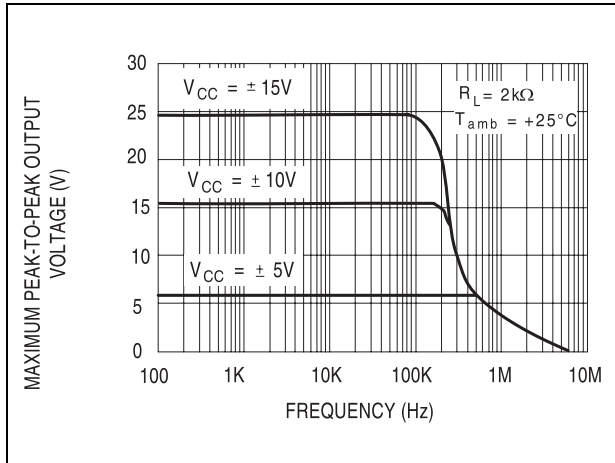


Figure 4. Maximum peak-to-peak output voltage versus frequency

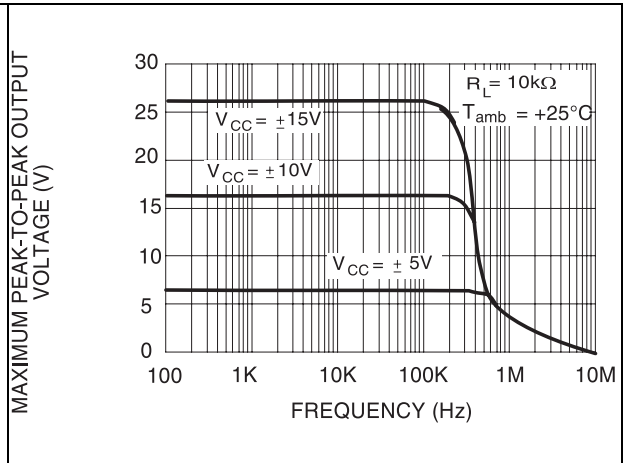


Figure 5. Maximum peak-to-peak output voltage versus frequency

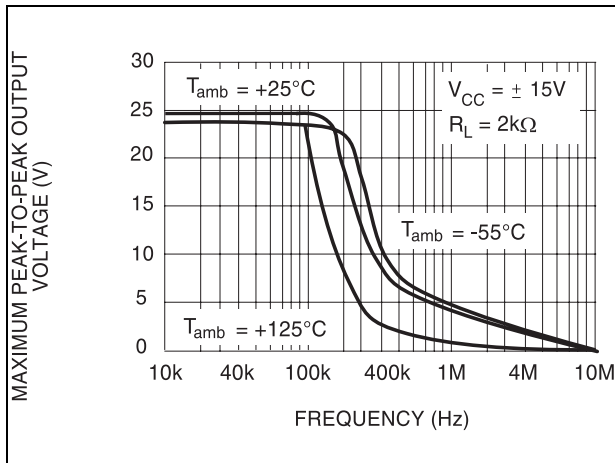


Figure 6. Maximum peak-to-peak output voltage versus free air temperature

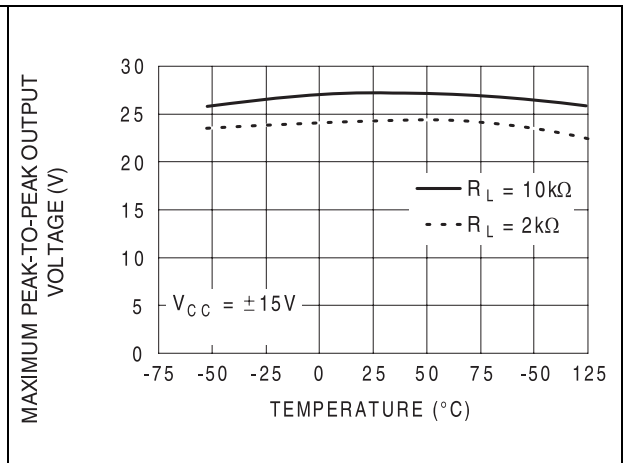


Figure 7. Maximum peak-to-peak output voltage versus load resistance

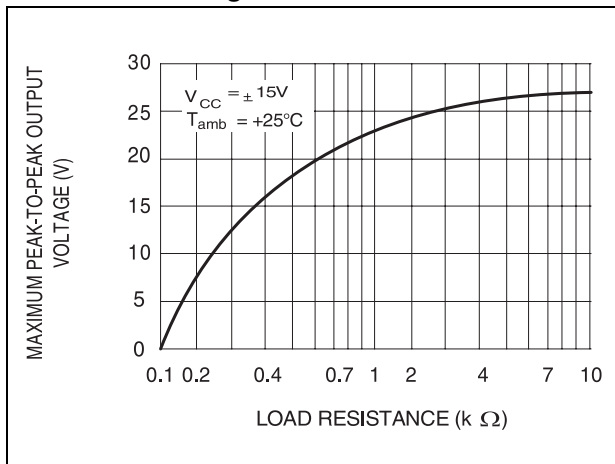


Figure 8. Maximum peak-to-peak output voltage versus supply voltage

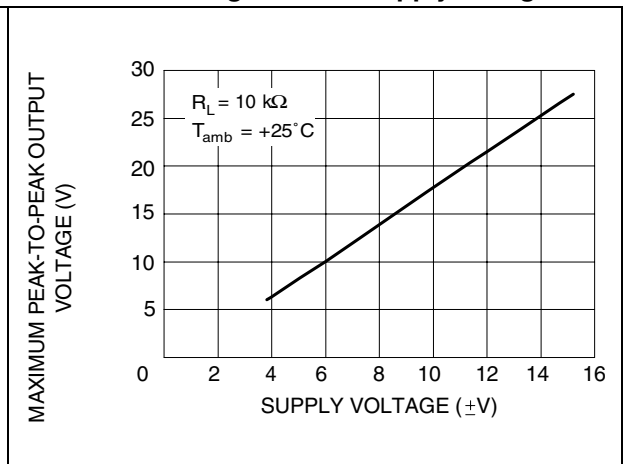


Figure 9. Input bias current versus free air temperature

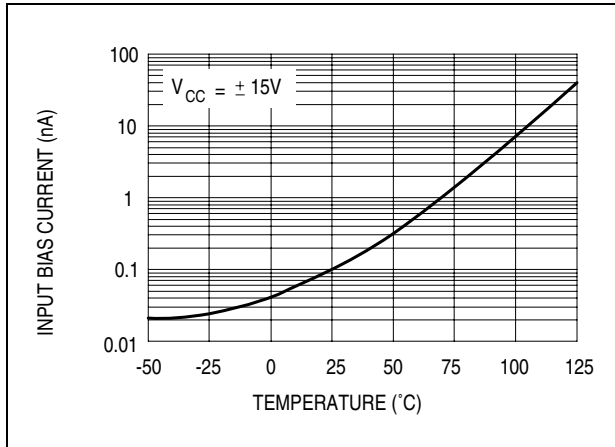


Figure 10. Large signal differential voltage amplification versus free air temp

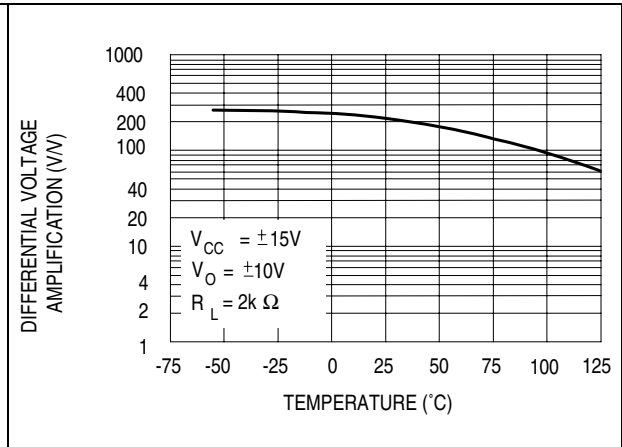


Figure 11. Large signal differential voltage amplification and phase shift versus frequency

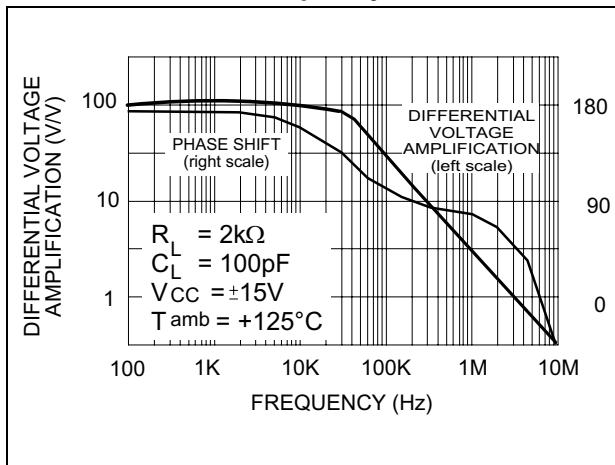


Figure 12. Total power dissipation versus free air temperature

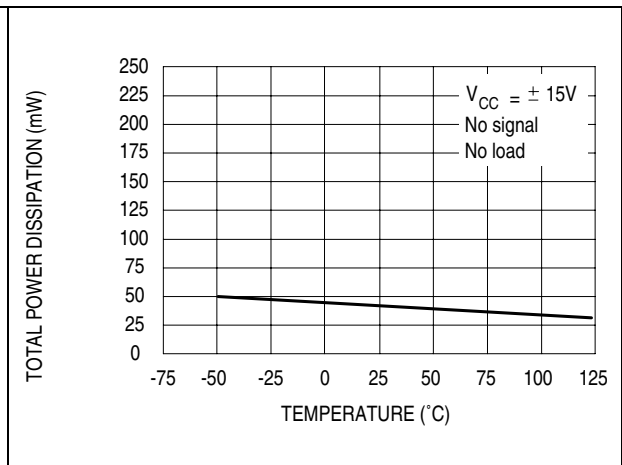


Figure 13. Supply current per amplifier versus free air temperature

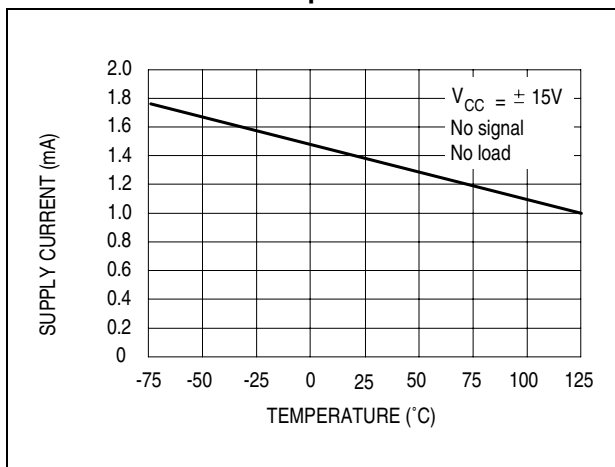


Figure 14. Supply current per amplifier versus supply voltage

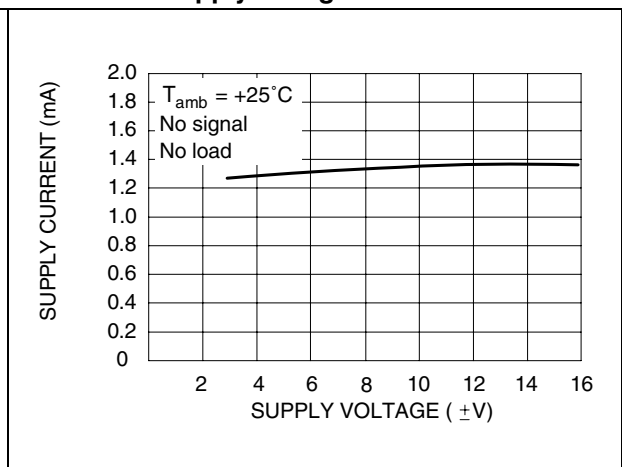


Figure 15. Common mode rejection ratio versus free air temperature

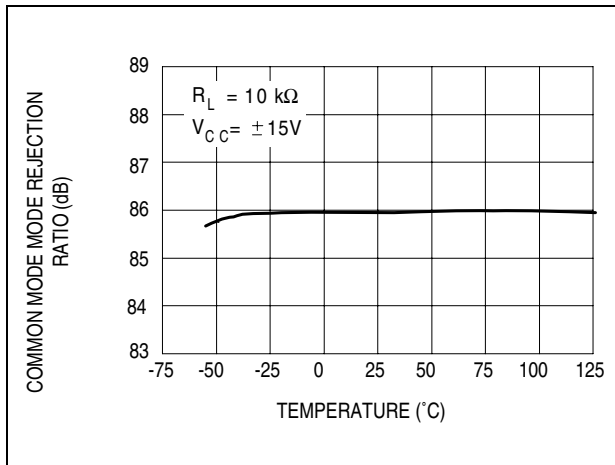


Figure 16. Equivalent input noise voltage versus frequency

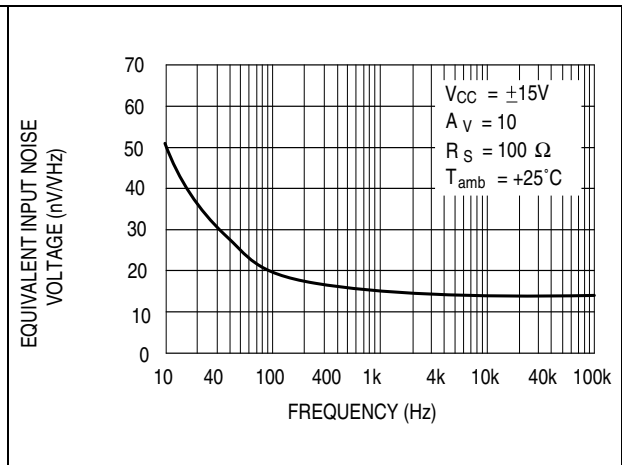


Figure 17. Output voltage versus elapsed time **Figure 18. Total harmonic distortion versus frequency**

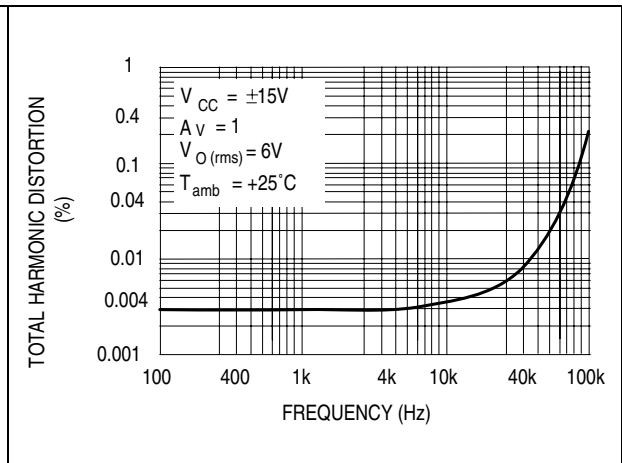
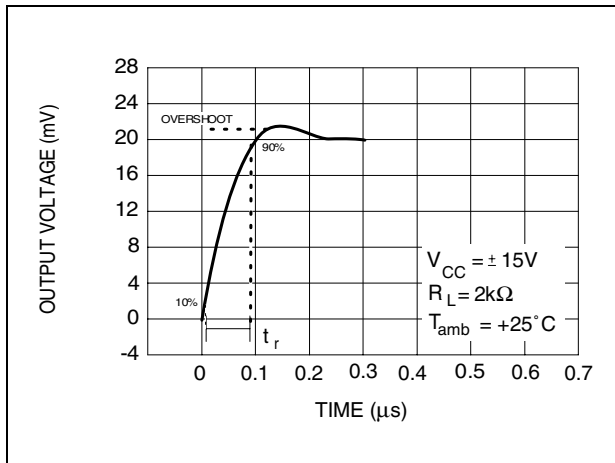
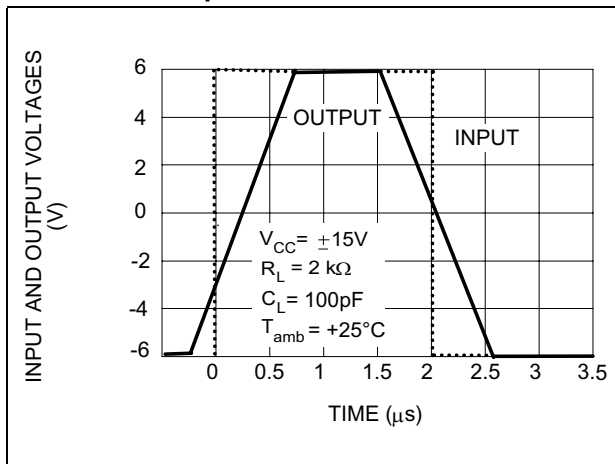


Figure 19. Voltage follower large signal pulse response



4 Parameter measurement information

Figure 20. Voltage follower

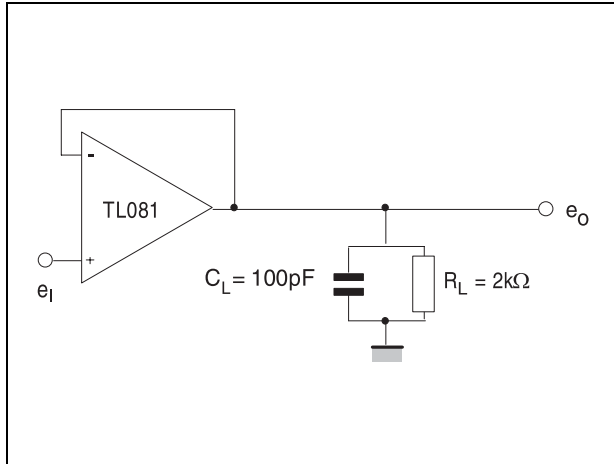
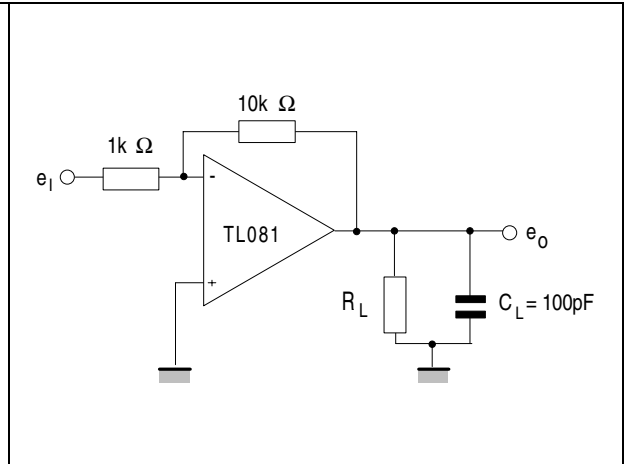


Figure 21. Gain-of-10 inverting amplifier



5 Typical applications

Figure 22. 0.5 Hz square wave oscillator

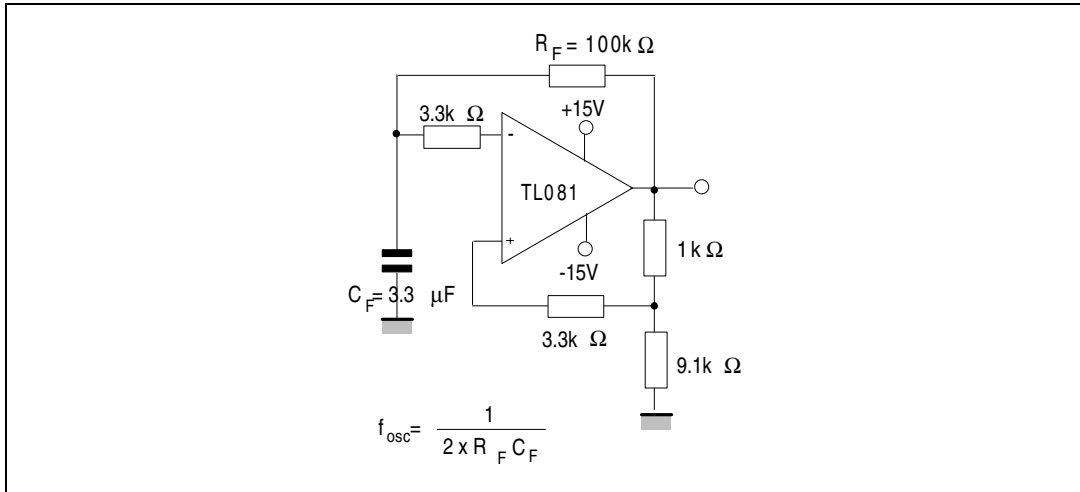
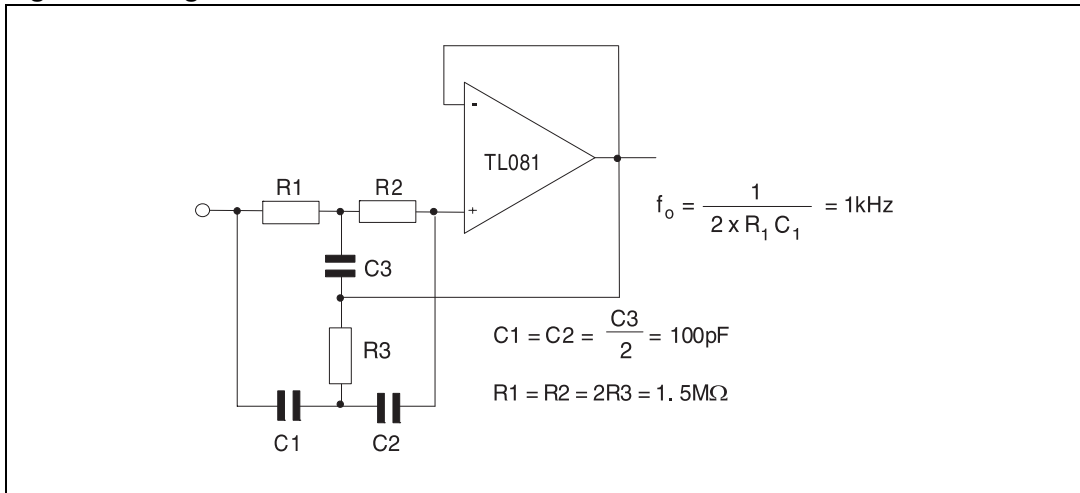


Figure 23. High Q notch filter



6 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.

6.1 DIP 8 package information

Figure 24. DIP8 package mechanical drawing

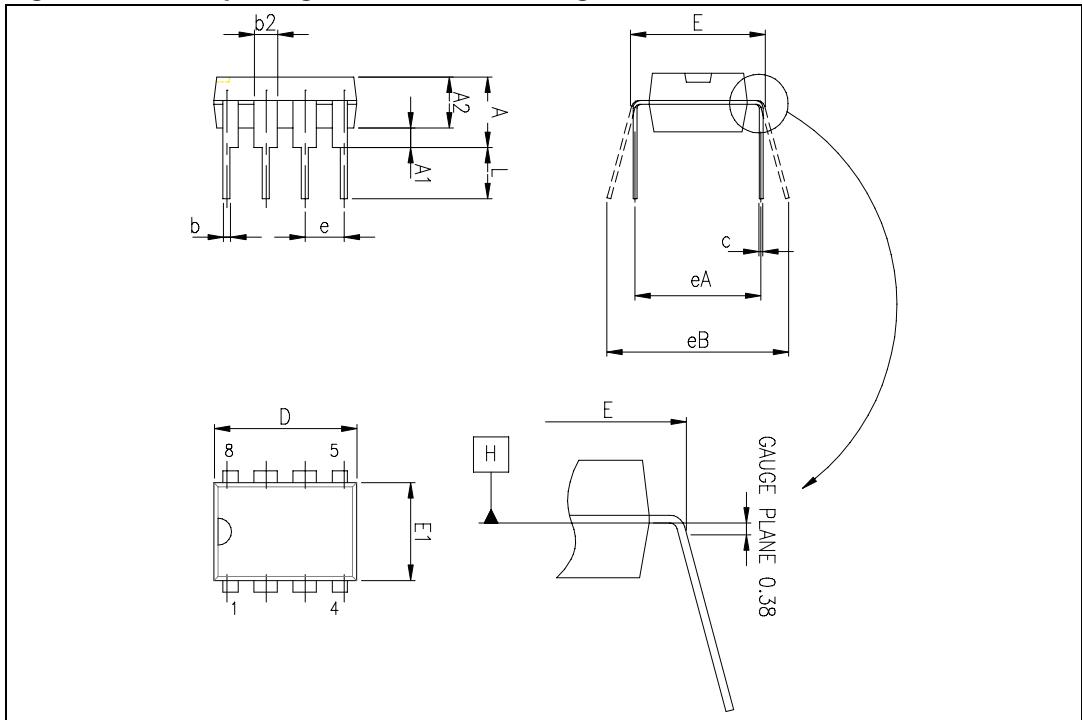


Table 4. DIP8 package mechanical data

| 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 25. SO-8 package mechanical drawing

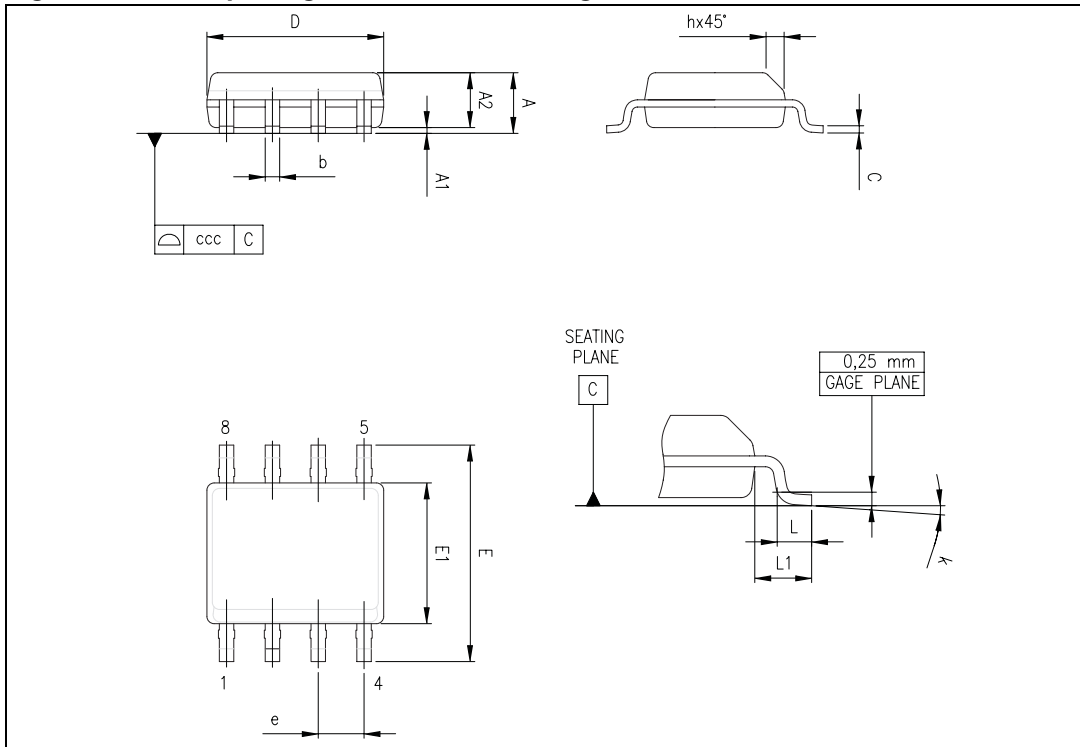


Table 5. SO-8 package mechanical data

| 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 |
|--|-------------------|----------------------------|------------------------|---------------------------------|
| 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/DT ⁽¹⁾ TL081AIYD/DT ⁽¹⁾ TL081BIYD/DT ⁽¹⁾ | | SO-8 (Automotive grade) | Tube or tape & reel | 081IY 081AIY 081BIY |
| 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. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

8 Revision history

Table 7. 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 6: Order codes . Format update. |
| 27-Jun-2008 | 3 | Removed information concerning military temperature range (TL081Mx, TL081AMx, TL081BMx). Added missing order codes for automotive grade products and updated footnote in Table 6: Order codes . |

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