

Low power dual operational amplifiers

Features

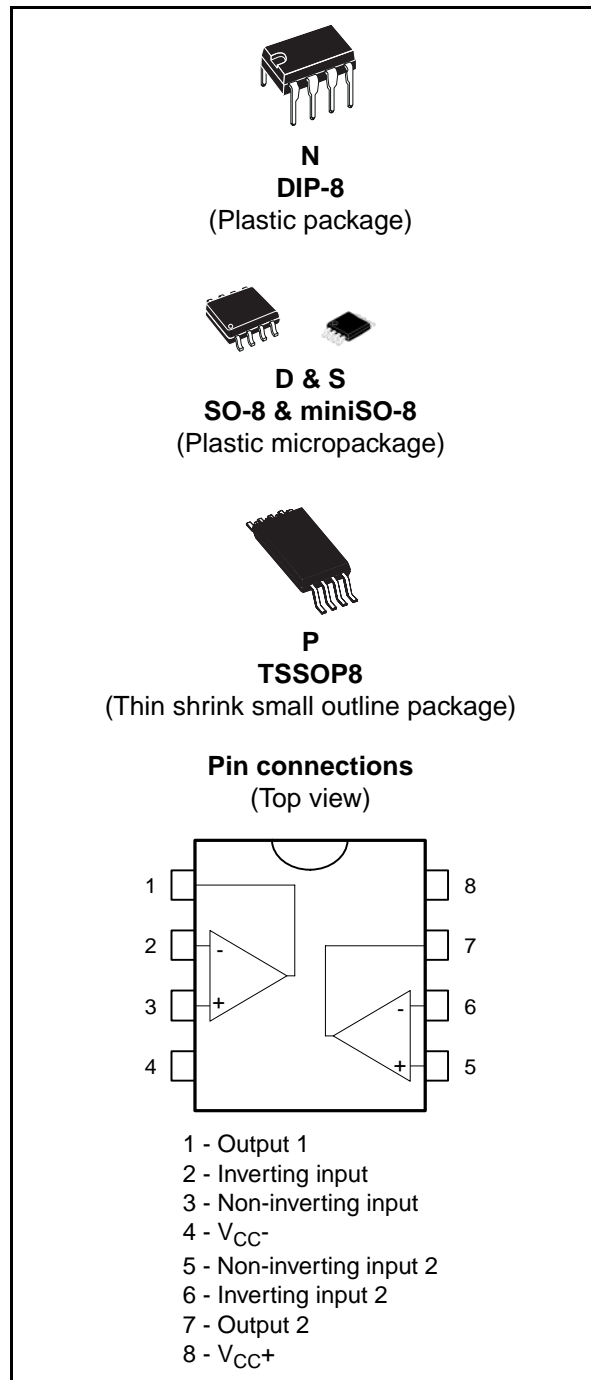
- Internally frequency compensated
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)
- Very low supply current per operator essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)
- Low input offset voltage: 2 mV
- Low input offset current: 2 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to ($V_{CC} - 1.5$ V)

Description

These circuits consist of two independent, high-gain, internally frequency-compensated op-amps which are designed specifically to operate from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, these circuits can be directly supplied with the standard +5 V which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

In linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

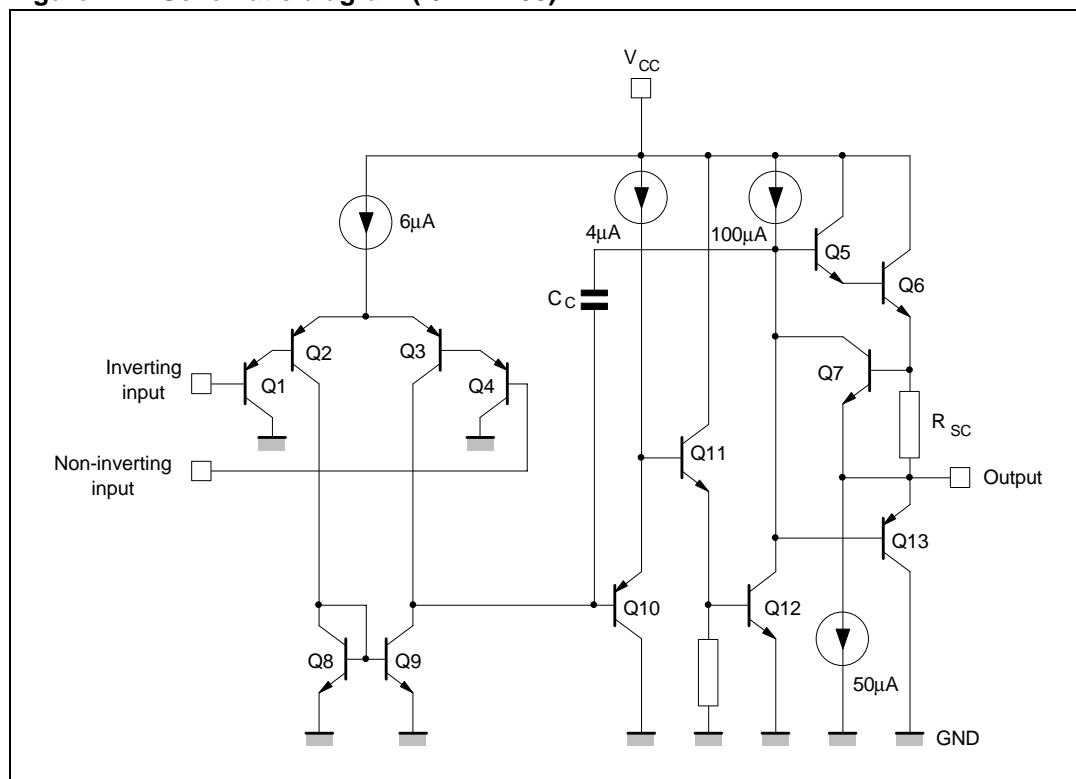


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1 Schematic diagram

Figure 1. Schematic diagram (1/2 LM158)



2 Absolute maximum ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | LM158,A | LM258,A | LM358,A | Unit |
|------------|---|-------------|-------------|----------|------|
| V_{CC} | Supply voltage | +/-16 or 32 | | | V |
| V_i | Input voltage | 32 | | | V |
| V_{id} | Differential input voltage | 32 | | | V |
| P_{tot} | Power dissipation ⁽¹⁾ | 500 | | | mW |
| | Output short-circuit duation ⁽²⁾ | Infinite | | | |
| I_{in} | Input current ⁽³⁾ | 50 | | | mA |
| 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 |
| T_j | Maximum junction temperature | 150 | | | °C |
| R_{thja} | Thermal resistance junction to ambient ^{(4) (5)} | | | | °C/W |
| | SO-8 | 125 | | | |
| | MiniSO-8 | 190 | | | |
| | TSSOP8 | 120 | | | |
| R_{thjc} | Thermal resistance junction to case | | | | °C/W |
| | SO-8 | 40 | | | |
| | MiniSO-8 | 39 | | | |
| | TSSOP8 | 37 | | | |
| ESD | HBM: human body model ⁽⁶⁾ | 300 | | | V |
| | MM: machine model ⁽⁷⁾ | 200 | | | V |
| | CDM: charged device model ⁽⁸⁾ | 1.5 | | | kV |

- Power dissipation must be considered to ensure that the maximum junction temperature (T_j) is not exceeded.
- Short-circuits from the output to V_{CC} can cause excessive heating if $V_{CC} > 15$ V. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC} . Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
- This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative. This is not destructive and normal output is restored for input voltages above -0.3 V.
- Short-circuits can cause excessive heating and destructive dissipation.
- R_{th} are typical values.
- Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

3 Operating conditions

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|------------|--|---|-------------|
| V_{CC} | Supply voltage | 3 to 32 | V |
| V_{icm} | Common mode input voltage range $T_{amb} = +25^{\circ}C$ | $V_{DD} - 0.3$ to $V_{CC} - 1.5$ | V |
| T_{oper} | Operating free air temperature range LM158 LM258 LM358 LM258Y-LM358Y | -55 - +125 -40 - +105 0 - +70 -40 - +125 | $^{\circ}C$ |

4 Electrical characteristics

Table 3. Electrical characteristics for $V_{CC^+} = +5V$, $V_{CC^-} = \text{Ground}$, $V_O = 1.4V$, $T_{amb} = +25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | LM158A-LM258A LM358A | | | LM158-LM258 LM358 | | | Unit |
|--------------|---|-------------------------|------|------------------------------------|----------------------|------|------------------------------------|---------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V_{io} | Input offset voltage ⁽¹⁾ $T_{amb} = +25^\circ C$ LM158, LM258 LM158A | | 1 | 3 | | 2 | 7 5 | mV |
| | $T_{min} \leq T_{amb} \leq T_{max}$ LM158, LM258 | | | 4 | | | 9 7 | |
| I_{io} | Input offset current $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 2 | 10 30 | | 2 | 30 40 | nA |
| I_{ib} | Input bias current ⁽²⁾ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 20 | 50 100 | | 20 | 150 200 | nA |
| A_{vd} | Large signal voltage gain $V_{CC} = +15 V$, $R_L = 2 k\Omega$, $V_O = 1.4 V$ to $11.4 V$ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | 50 25 | 100 | | 50 25 | 100 | | V/mV |
| SVR | Supply voltage rejection ratio ($R_s \leq 10 k\Omega$) $V_{CC^+} = 5 V$ to $30 V$ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | 65 65 | 100 | | 65 65 | 100 | | dB |
| I_{CC} | Supply current, all amp, no load $T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +5 V$ $T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +30 V$ | | 0.7 | 1.2 2 | | 0.7 | 1.2 2 | mA |
| V_{icm} | Input common mode voltage range $V_{CC} = +30 V$ ⁽³⁾ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | 0 0 | | $V_{CC^+} - 1.5$ $V_{CC^+} - 2$ | 0 0 | | $V_{CC^+} - 1.5$ $V_{CC^+} - 2$ | V |
| CMR | Common mode rejection ratio ($R_s \leq 10 k\Omega$) $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | 70 60 | 85 | | 70 60 | 85 | | dB |
| I_{source} | Output current source $V_{CC} = +15 V$, $V_O = +2 V$, $V_{id} = +1 V$ | 20 | 40 | 60 | 20 | 40 | 60 | mA |
| I_{sink} | Output sink current ($V_{id} = -1V$) $V_{CC} = +15V$, $V_O = +2V$ | 10 | 20 | | 10 | 20 | | mA |
| | $V_{CC} = +15V$, $V_O = +0.2V$ | 12 | 50 | | 12 | 50 | | μA |

Table 3. Electrical characteristics for $V_{CC}^+ = +5V$, $V_{CC}^- = \text{Ground}$, $V_O = 1.4V$, $T_{amb} = +25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | LM158A-LM258A LM358A | | | LM158-LM258 LM358 | | | Unit |
|-----------------|---|-------------------------|----------|------------------------------------|----------------------|----------|------------------------------------|------------------------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V_{OPP} | Output voltage swing ($R_L = 2\text{ k}\Omega$) $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | 0 0 | | $V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$ | 0 0 | | $V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$ | |
| V_{OH} | High level output voltage ($V_{CC}^+ = 30\text{ V}$) $T_{amb} = +25^\circ C$, $R_L = 2\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$ $T_{amb} = +25^\circ C$, $R_L = 10\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$ | 26 26 27 27 | 27 28 | | 26 26 27 27 | 27 28 | | V |
| V_{OL} | Low level output voltage ($R_L = 10\text{ k}\Omega$) $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 5 | 20 20 | | 5 20 | | mV |
| SR | Slew rate $V_{CC} = 15V$, $V_i = 0.5\text{ to }3V$, $R_L = 2\text{ k}\Omega$ $C_L = 100\text{ pF}$, unity Gain | 0.3 | 0.6 | | 0.3 | 0.6 | | V/ μs |
| GBP | Gain bandwidth product $V_{CC} = 30\text{ V}$, $f = 100\text{ kHz}$, $V_{in} = 10\text{ mV}$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 0.7 | 1.1 | | 0.7 | 1.1 | | MHz |
| THD | Total harmonic distortion $f = 1\text{ kHz}$, $A_v = 20\text{ dB}$, $R_L = 2\text{ k}\Omega$, $V_O = 2\text{ V}_{pp}$, $C_L = 100\text{ pF}$, $V_O = 2\text{ V}_{pp}$ | | 0.02 | | | 0.02 | | % |
| e_n | Equivalent input noise voltage $f = 1\text{ kHz}$, $R_s = 100\ \Omega$, $V_{CC} = 30\text{ V}$ | | 55 | | | 55 | | $\frac{nV}{\sqrt{Hz}}$ |
| DV_{io} | Input offset voltage drift | | 7 | 15 | | 7 | 30 | $\mu V/^\circ C$ |
| DI_{io} | Input offset current drift | | 10 | 200 | | 10 | 300 | pA/ $^\circ C$ |
| V_{o1}/V_{o2} | Channel separation ⁽⁴⁾ $1\text{ kHz} \leq f \leq 20\text{ kHz}$ | | 120 | | | 120 | | dB |

- $V_O = 1.4\text{ V}$, $R_s = 0\ \Omega$, $5\text{ V} < V_{CC}^+ < 30\text{ V}$, $0 < V_{ic} < V_{CC}^+ - 1.5\text{ V}$
- The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so there is no change in the load on the input lines.
- The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC}^+ - 1.5\text{ V}$, but either or both inputs can go to +32 V without damage.
- Due to the proximity of external components, ensure that stray capacitance between these external parts does not cause coupling. Typically, this can be detected because this type of capacitance increases at higher frequencies.

Figure 2. Open loop frequency response

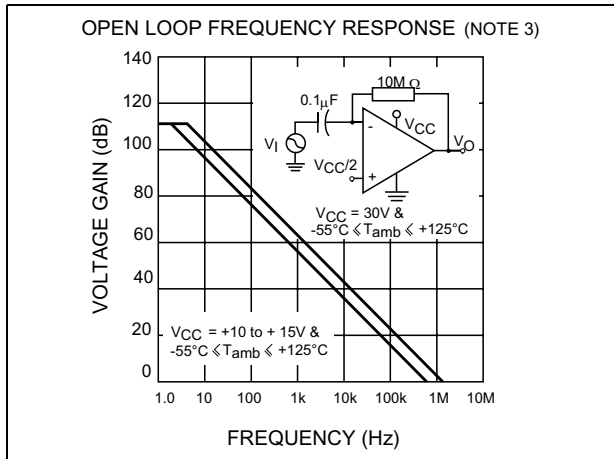


Figure 3. Large signal frequency response

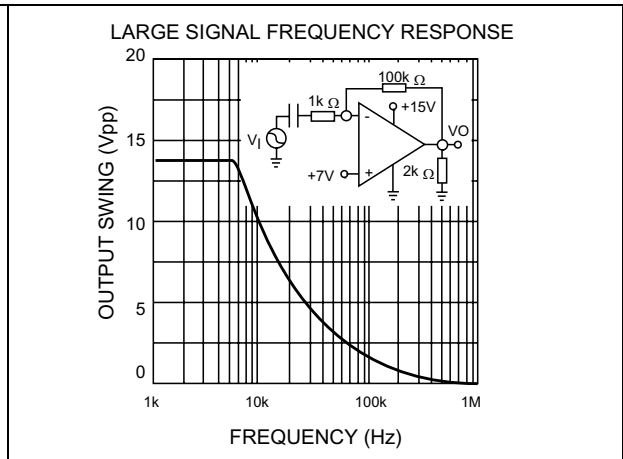


Figure 4. Voltage follower pulse response

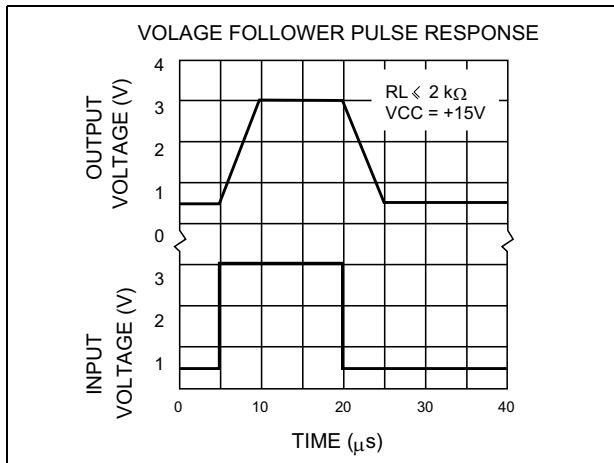


Figure 5. Voltage follower pulse response (small signal)

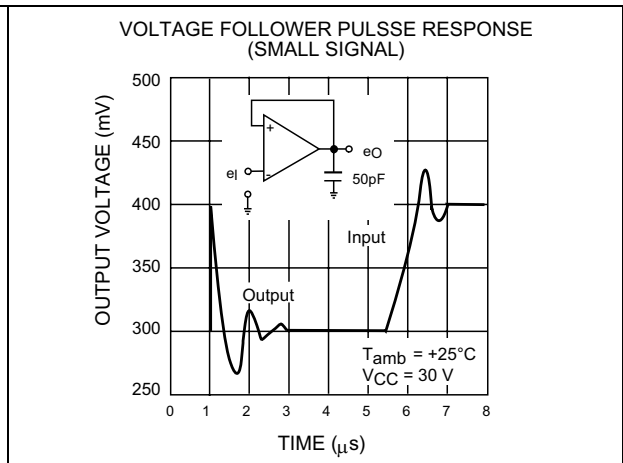


Figure 6. Input current

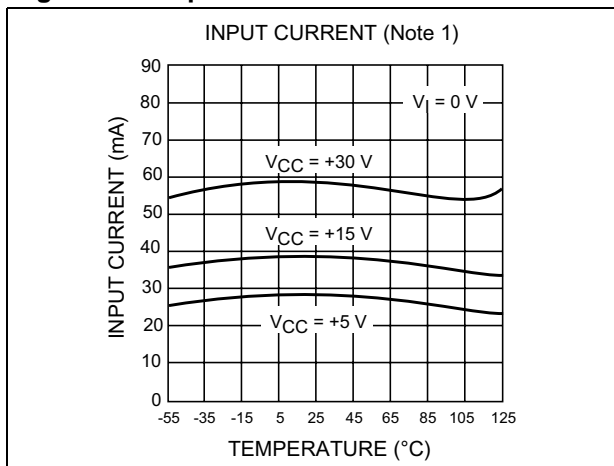


Figure 7. Output characteristics

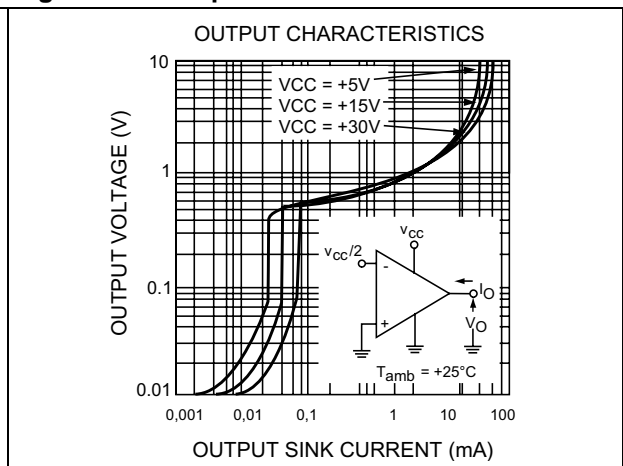


Figure 8. Output characteristics

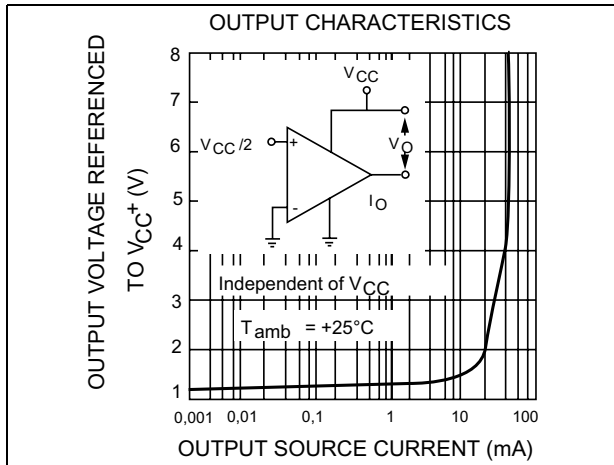


Figure 9. Current limiting

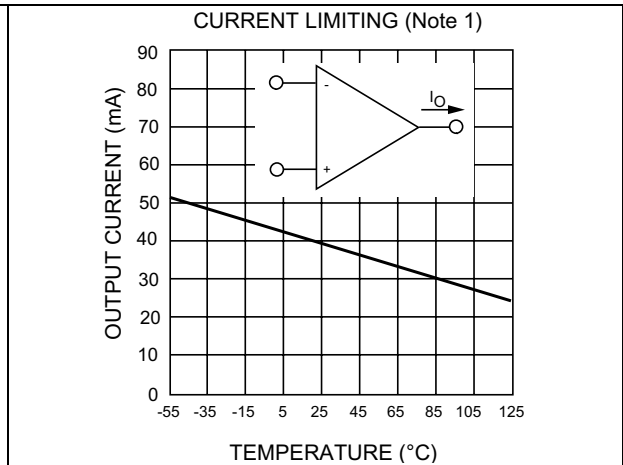


Figure 10. Input voltage range

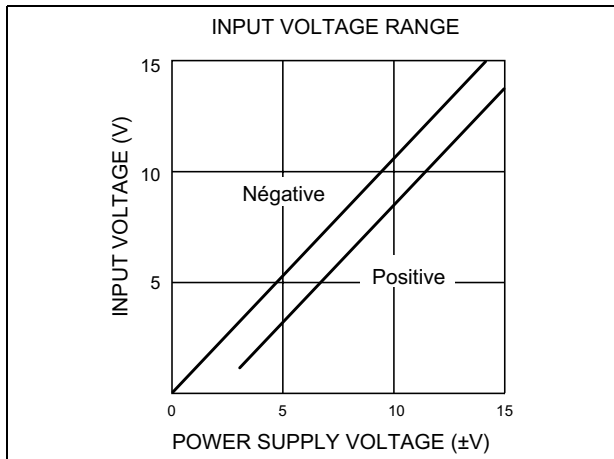


Figure 11. Positive supply voltage

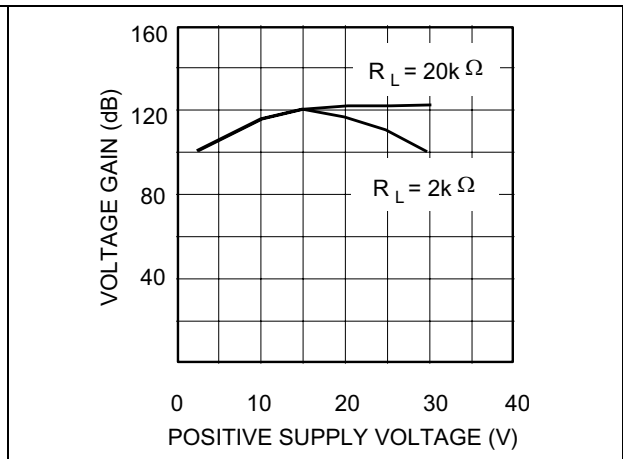


Figure 12. Input voltage range

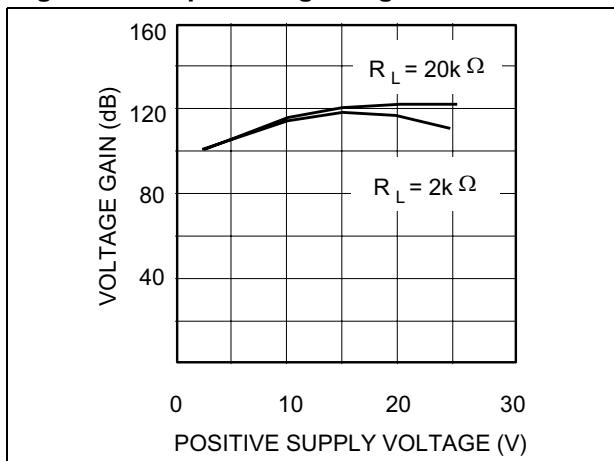


Figure 13. Supply current

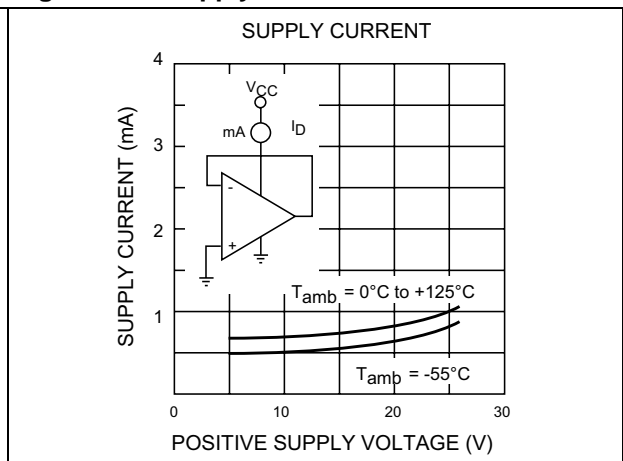


Figure 14. Input current

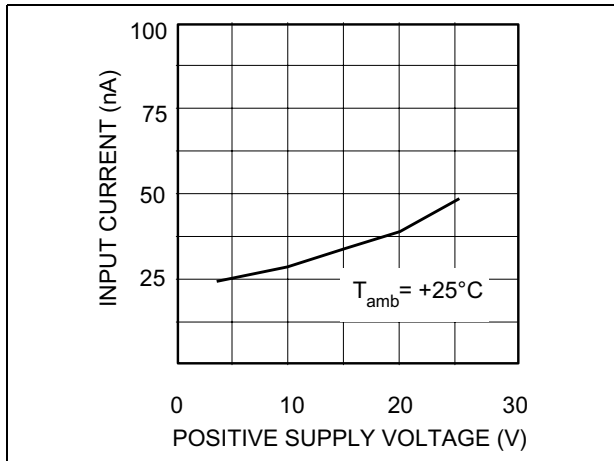


Figure 15. Gain bandwidth product

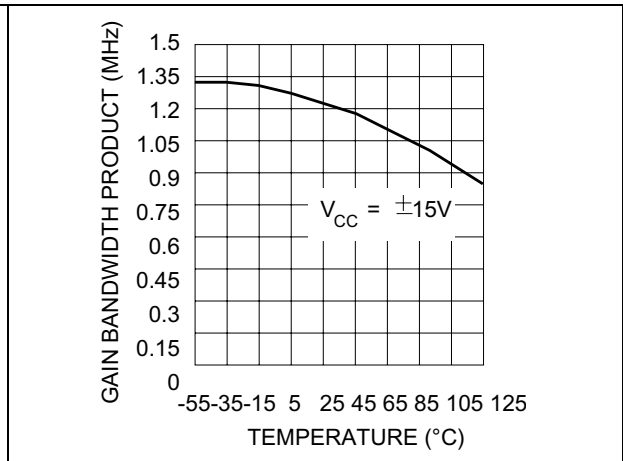


Figure 16. Power supply rejection ratio

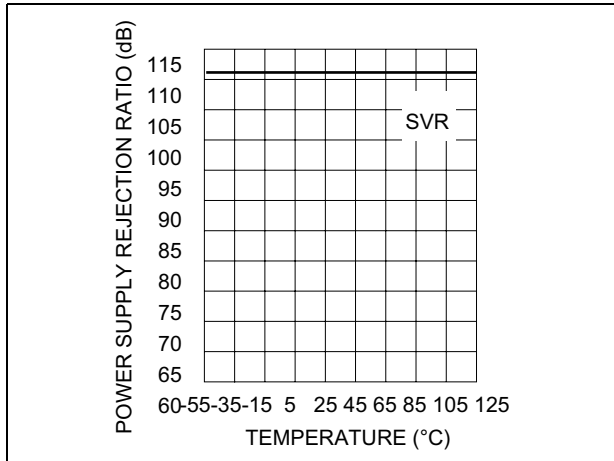


Figure 17. Common mode rejection ratio

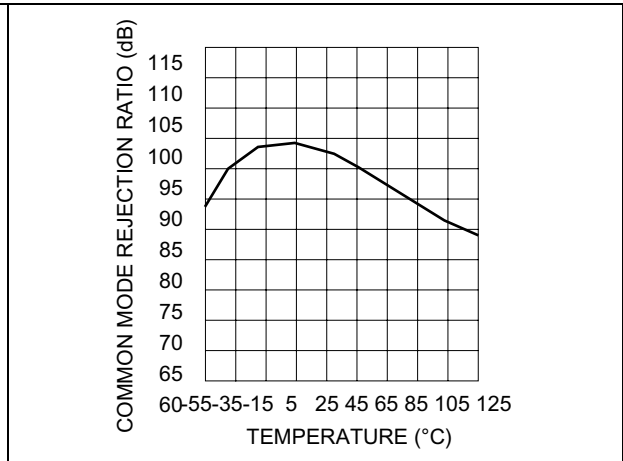
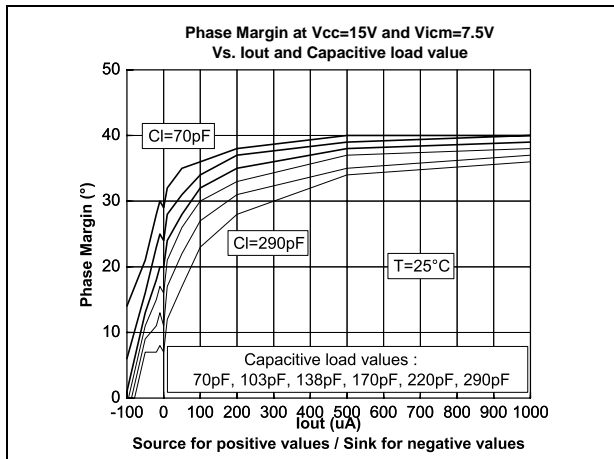


Figure 18. Phase margin vs capacitive load



5 Typical applications

Single supply voltage $V_{CC} = +5V_{dc}$.

Figure 19. AC coupled inverting amplifier

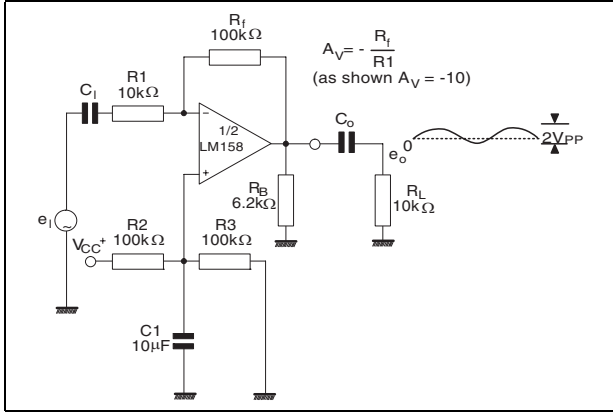


Figure 20. Non-inverting DC amplifier

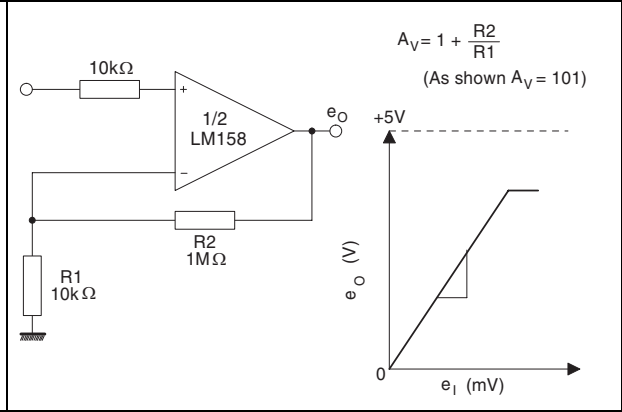


Figure 21. AC coupled non-inverting amplifier

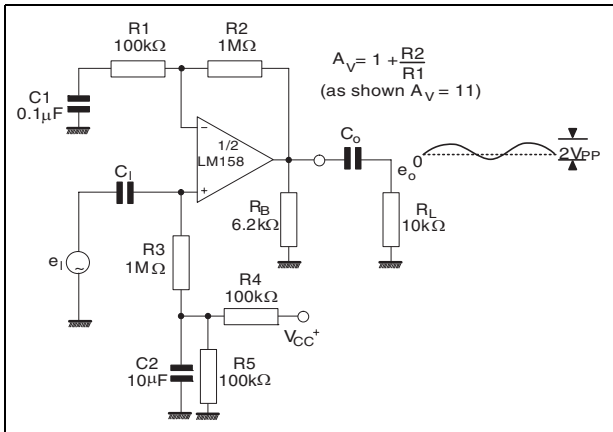


Figure 22. DC summing amplifier

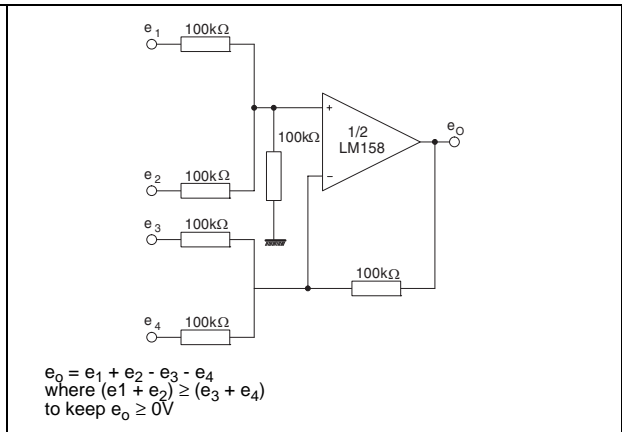


Figure 23. High input Z, DC differential amplifier

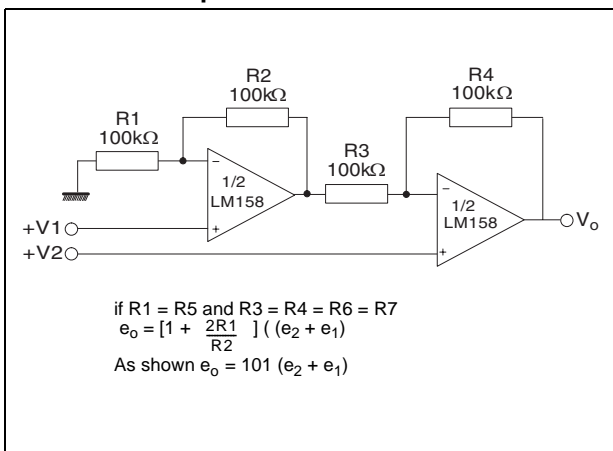


Figure 24. High input Z adjustable gain DC instrumentation amplifier

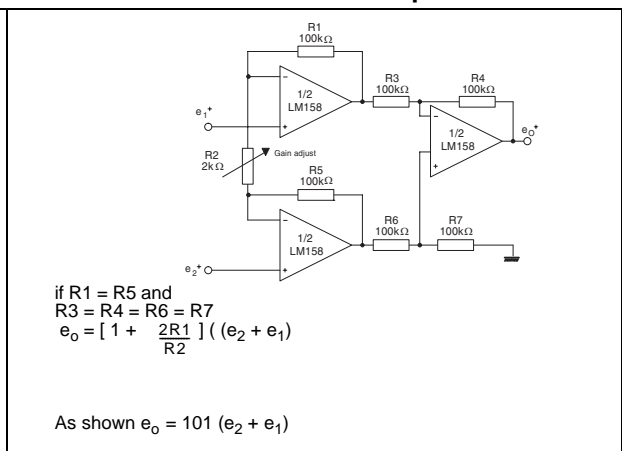


Figure 25. Using symmetrical amplifiers to reduce input current

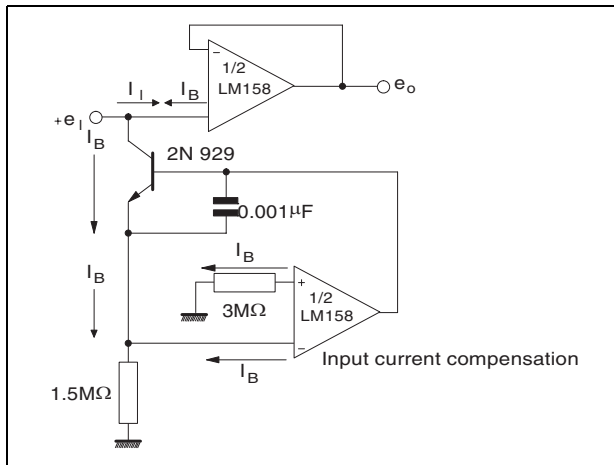


Figure 26. Low drift peak detector

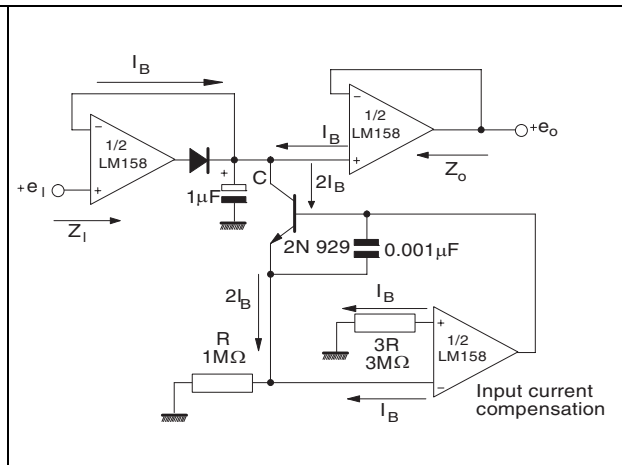
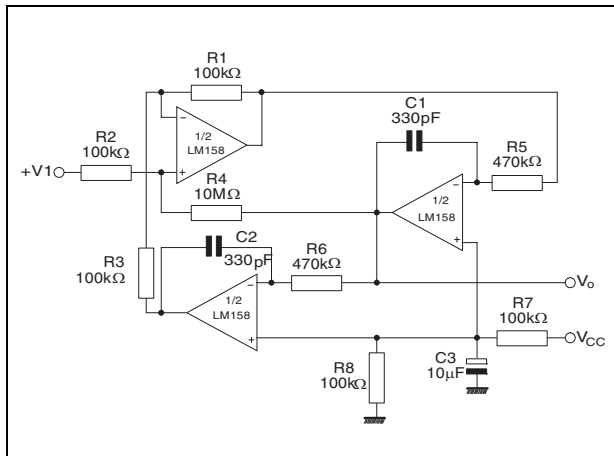


Figure 27. Active band-pass filter

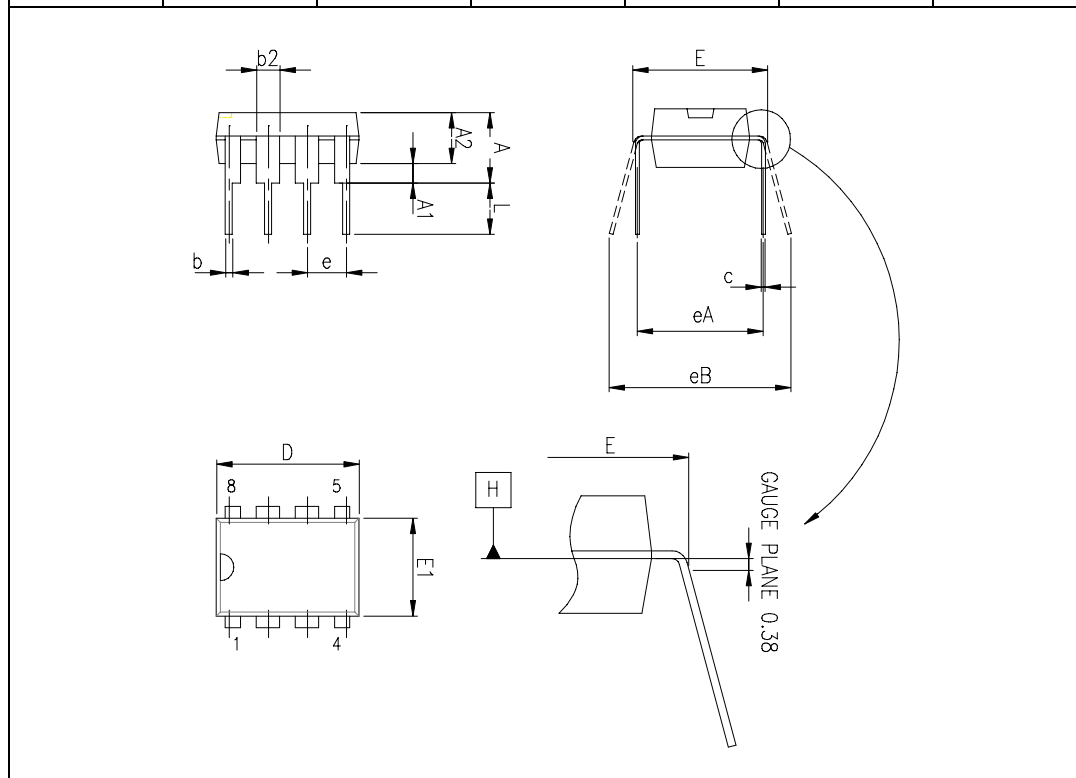


6 Package information

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.

6.1 DIP8 package

| 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 |



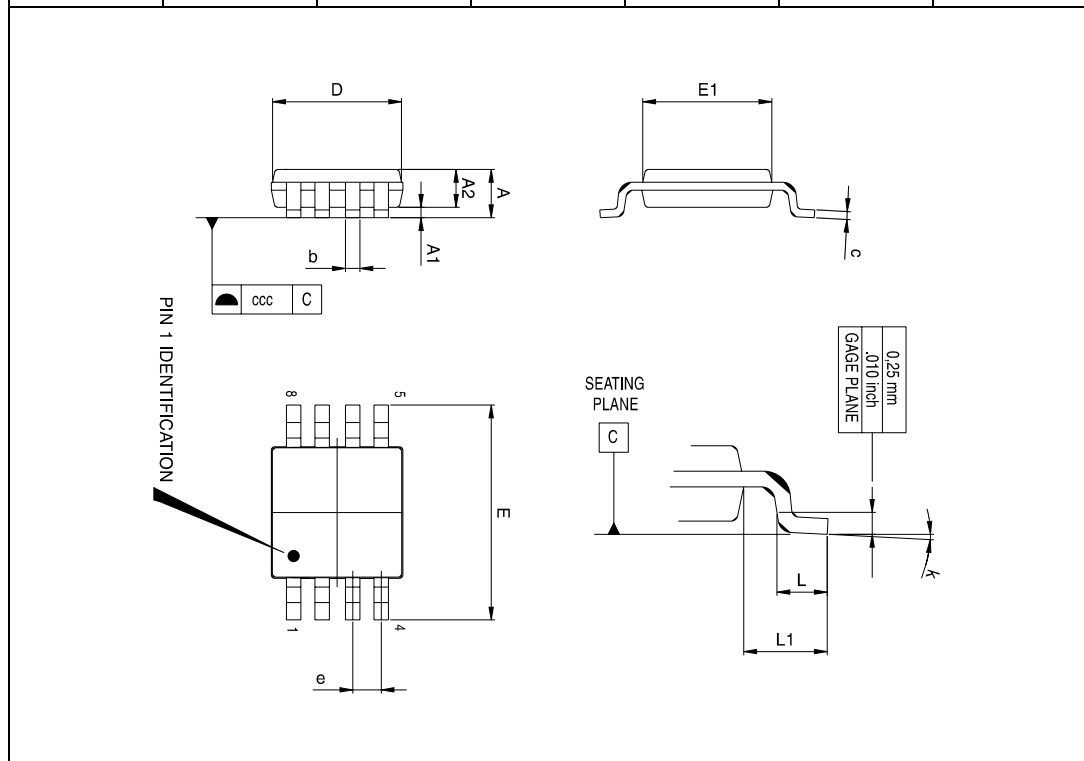
6.2 SO-8 package

| 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 |

The technical drawings illustrate the SO-8 package geometry. The top view shows dimensions D (total width), A (total height), A1 (lead height), A2 (lead thickness), and b (lead width). The side view shows the lead height A, lead thickness A2, and lead width b. The perspective view shows the package with pins numbered 1 through 8, and dimensions E (total length), E1 (lead length), e (lead pitch), L (lead length), L1 (lead length), and k (lead angle). The package is shown with a seating plane (C) and a gage plane (0.25 mm) for the lead length. The lead angle is labeled as hx45°.

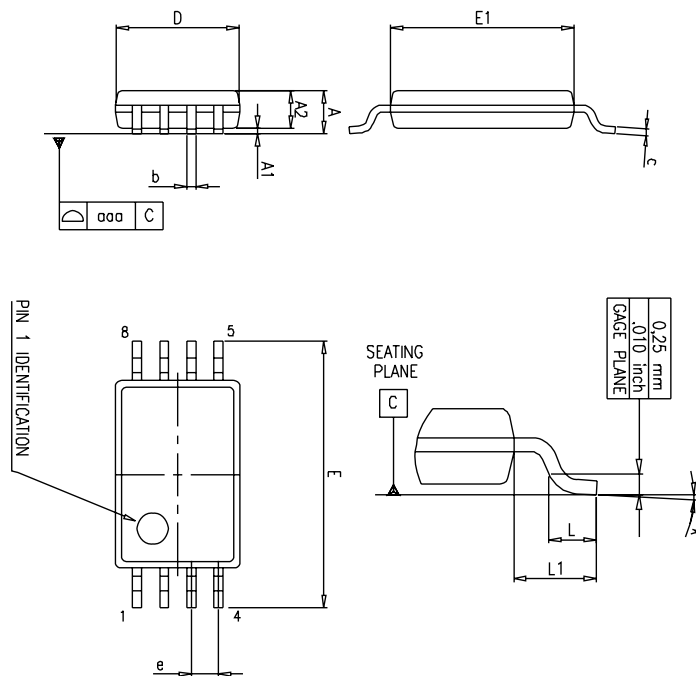
6.3 MiniSO-8 package

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.1 | | | 0.043 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.78 | 0.86 | 0.94 | 0.031 | 0.034 | 0.037 |
| b | 0.25 | 0.33 | 0.40 | 0.010 | 0.013 | 0.016 |
| c | 0.13 | 0.18 | 0.23 | 0.005 | 0.007 | 0.009 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 4.75 | 4.90 | 5.05 | 0.187 | 0.193 | 0.199 |
| E1 | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| K | 0° | | 6° | 0° | | 6° |
| L | 0.40 | 0.55 | 0.70 | 0.016 | 0.022 | 0.028 |
| L1 | | | 0.10 | | | 0.004 |



6.4 TSSOP8 package

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|--------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.2 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.008 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 6.20 | 6.40 | 6.60 | 0.244 | 0.252 | 0.260 |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | | 0.65 | | | 0.0256 | |
| k | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1 | | | 0.039 | |
| aaa | | 0.1 | | | 0.004 | |



7 Ordering information

| Part number | Temperature range | Package | Packaging | Marking |
|--------------------------------------|-------------------|--|---------------------|---------|
| LM158N | -55°C, +125°C | DIP-8 | Tube | LM158N |
| LM158D LM158DT | | SO-8 | Tube or tape & reel | 158 |
| LM158YD LM158YDT ⁽¹⁾ | | SO-8 Automotive grade | | 158Y |
| LM258AN | -40°C, +105°C | DIP-8 | Tube | LM258A |
| LM258AD LM258ADT | | SO-8 | Tube or tape & reel | 258A |
| LM258AYD LM258AYDT ⁽¹⁾ | | SO-8 Automotive grade | | 258AY |
| LM258PT | | TSSOP-8 (Thin shrink outline package) | Tape & reel | 258 |
| LM258APT | | | | 258A |
| LM258YPT ⁽¹⁾ | | TSSOP-8 Automotive grade | 258Y | |
| LM258AYPT | | | 258AY | |
| LM258AST | | miniSO-8 | Tape & reel | K408 |
| LM258N | | DIP-8 | Tube | LM258N |
| LM258D LM258DT | | SO-8 | Tube or tape & reel | 258 |
| LM258YD LM258YDT ⁽¹⁾ | | SO-8 Automotive grade | | 258Y |
| LM358N | 0°C, +70°C | DIP-8 | Tube | LM358N |
| LM358AN | | | | LM358AN |
| LM358D LM358DT | | SO-8 | Tube or tape & reel | 358 |
| LM358YD LM358YDT ⁽¹⁾ | | SO-8 Automotive grade | | 358Y |
| LM358AD LM358ADT | | SO-8 | | 358A |
| LM358PT | | TSSOP-8 (Thin shrink outline package) | Tape & reel | 358 |
| LM358APT | | | | 358A |
| LM358YPT ⁽¹⁾ | | TSSOP-8 Automotive grade | 358Y | |
| LM358AYPT ⁽¹⁾ | | | 358AY | |
| LM358ST | | miniSO-8 | Tape & reel | K405 |
| LM358AST | | | | K404 |

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 |
|-------------|----------|--|
| 1-Jul-2003 | 1 | First release. |
| 2-Jan-2005 | 2 | R_{thja} and T_j parameters added in AMR Table 1 on page 4 . |
| 1-Jul-2005 | 3 | ESD protection inserted in Table 1 on page 4 . |
| 5-Oct-2006 | 4 | Added Figure 18: Phase margin vs capacitive load . |
| 30-Nov-2006 | 5 | Added missing ordering information. |
| 25-Apr-2007 | 6 | Removed LM158A, LM258A and LM358A from document title. Corrected error in miniSO8 package data. L1 is 0.004 inch. Added automotive grade order codes in Section 7 on page 18 . |

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