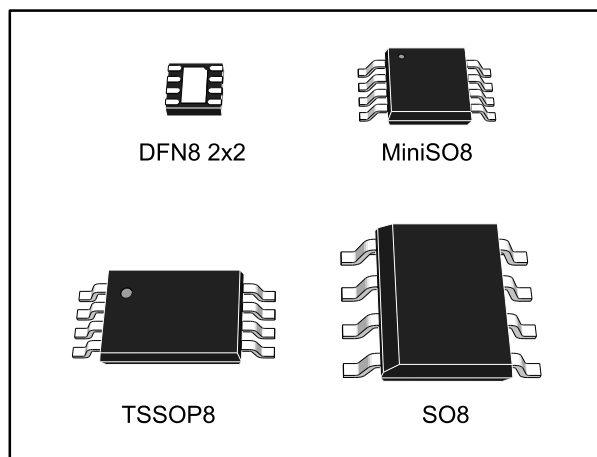


Low-power dual operational amplifiers

Datasheet - production data

**Features**

- Frequency compensation implemented internally
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)
- Very low supply current per channel 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 negative rails
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to ($V_{CC^+} - 1.5$ V)

Related products

- See LM158W for enhanced ESD ratings

Description

These circuits consist of two independent, high-gain, internally frequency-compensated op amps, specifically designed 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 can now 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 with no additional power supply.

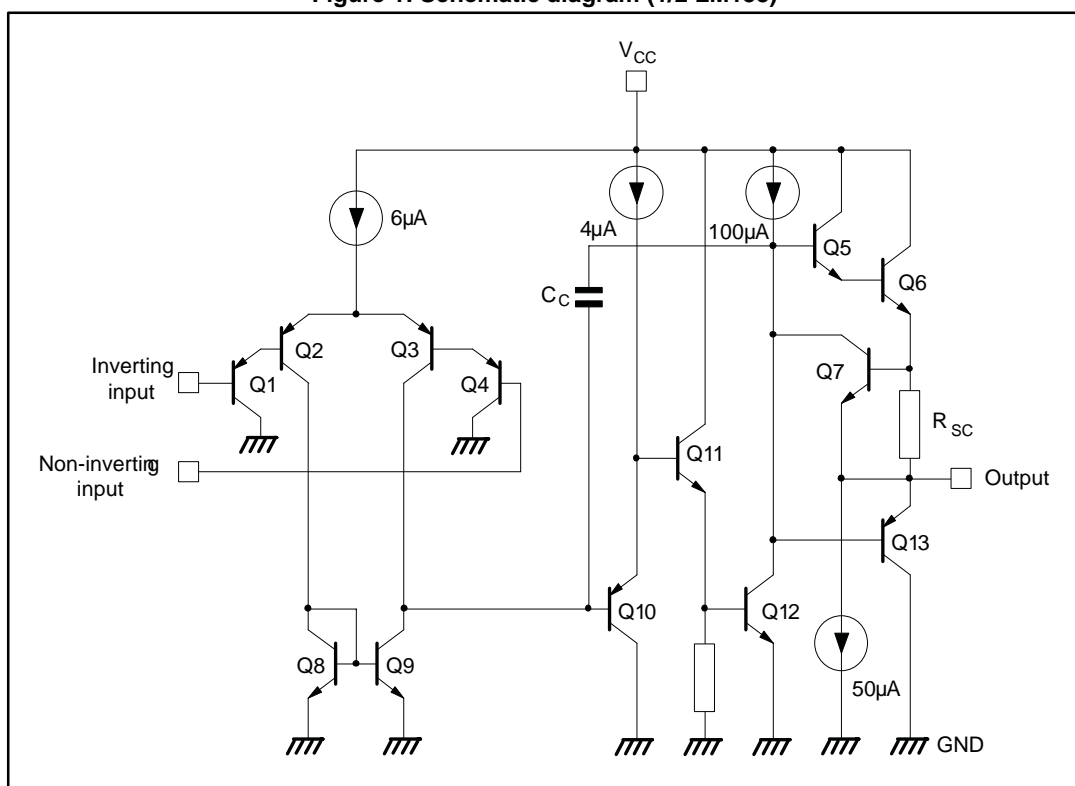
In linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

Contents

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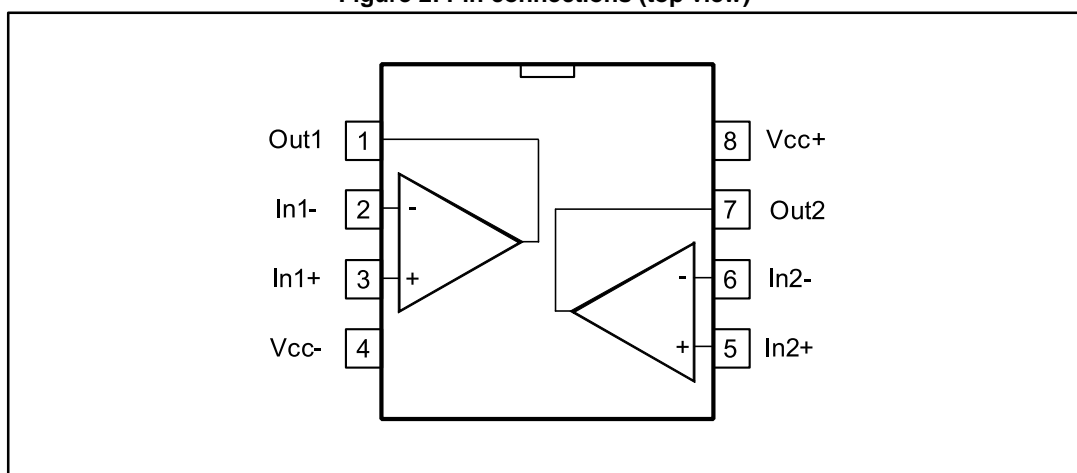
1 Schematic diagram

Figure 1: Schematic diagram (1/2 LM158)



2 Package pin connections

Figure 2: Pin connections (top view)



1. The exposed pad of the DFN8 2x2 can be left floating or connected to ground

3 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 _{id} | Differential input voltage | | 32 | | | |
| | Output short-circuit duration ⁽¹⁾ | | Infinite | | | |
| I _{in} | Input current ⁽²⁾ | | 5 mA in DC or 50 mA in AC (duty cycle = 10 %, T = 1 s) | | | 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 | | | |
| T _j | Maximum junction temperature | | 150 | | | |
| R _{thja} | Thermal resistance junction to ambient ⁽³⁾ | SO8 | 125 | | | °C/W |
| | | MiniSO8 | 190 | | | |
| | | DFN8 2x2 | 57 | | | |
| | | TSSOP8 | 120 | | | |
| R _{thjc} | Thermal resistance junction to case ⁽³⁾ | SO8 | 40 | | | |
| | | MiniSO8 | 39 | | | |
| | | TSSOP8 | 37 | | | |
| ESD | HBM: human body model ⁽⁴⁾ | | 300 | | | V |
| | MM: machine model ⁽⁵⁾ | | 200 | | | |
| | CDM: charged device model ⁽⁶⁾ | | 1.5 | | | kV |

Notes:

⁽¹⁾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.

⁽²⁾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 clamp. In addition to this diode action, there is 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.

⁽³⁾Short-circuits can cause excessive heating and destructive dissipation. R_{th} are typical values.

⁽⁴⁾Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

⁽⁵⁾Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.

⁽⁶⁾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.

Table 2: Operating conditions

| Symbol | Parameter | | Value | Unit |
|------------|--|-------|--|------|
| V_{CC} | Supply voltage | | 3 to 30 | V |
| V_{icm} | Common mode input voltage range ⁽¹⁾ | | $(V_{CC^-}) - 0.3$ to $(V_{CC^+}) - 1.5$ | |
| T_{oper} | Operating free air temperature range | LM158 | -55 to 125 | °C |
| | | LM258 | -40 to 105 | |
| | | LM358 | 0 to 70 | |

Notes:

⁽¹⁾When used in comparator, the functionality is guaranteed as long as at least one input remains within the operating common mode voltage range.

4 Electrical characteristics

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

| Symbol | Parameter | | Min. | Typ. | Max. | Unit |
|----------------------|--|--|------|------|---------------------------------------|-------|
| V _{io} | Input offset voltage ⁽¹⁾ | LM158A | | | 2 | mV |
| | | LM258A, LM358A | | 1 | 3 | |
| | | LM158, LM258 | | | 5 | |
| | | LM358 | | 2 | 7 | |
| | T _{min} ≤ T _{amb} ≤ T _{max} | LM158A, LM258A, LM358A | | | 4 | |
| | | LM158, LM258 | | | 7 | |
| | | LM358 | | | 9 | |
| ΔV _{io} /ΔT | Input offset voltage drift | LM158A, LM258A, LM358A | | 7 | 15 | μV/°C |
| | | LM158, LM258, LM358 | | 7 | 30 | |
| I _{io} | Input offset current | LM158A, LM258A, LM358A | | 2 | 10 | nA |
| | | LM158, LM258, LM358 | | 2 | 30 | |
| | T _{min} ≤ T _{amb} ≤ T _{max} | LM158A, LM258A, LM358A | | | 30 | |
| | | LM158, LM258, LM358 | | | 40 | |
| ΔI _{io} /ΔT | Input offset current drift | LM158A, LM258A, LM358A | | 10 | 200 | pA/°C |
| | | LM158, LM258, LM358 | | 10 | 300 | |
| I _{ib} | Input bias current ⁽²⁾ | LM158A, LM258A, LM358A | | 20 | 50 | nA |
| | | LM158, LM258, LM358 | | 20 | 150 | |
| | T _{min} ≤ T _{amb} ≤ T _{max} | LM158A, LM258A, LM358A | | | 100 | |
| | | LM158, LM258, LM358 | | | 200 | |
| A _{vd} | Large signal voltage gain | V _{CC} ⁺ = 15 V, R _L = 2 kΩ, V _o = 1.4 V to 11.4 V | 50 | 100 | | V/mV |
| | | T _{min} ≤ T _{amb} ≤ T _{max} | 25 | | | |
| SVR | Supply voltage rejection ratio | V _{CC} ⁺ = 5 V to 30 V, R _s ≤ 10 kΩ | 65 | 100 | | dB |
| | | T _{min} ≤ T _{amb} ≤ T _{max} | 65 | | | |
| I _{CC} | Supply current, all amp, no load | T _{min} ≤ T _{amb} ≤ T _{max} V _{CC} ⁺ = 5 V | | 0.7 | 1.2 | mA |
| | | T _{min} ≤ T _{amb} ≤ T _{max} V _{CC} ⁺ = 30 V | | | 2 | |
| V _{icm} | Input common mode voltage range | V _{CC} ⁺ = 30 V ⁽³⁾ | 0 | | (V _{CC} ⁺) - 1.5 | V |
| | | T _{min} ≤ T _{amb} ≤ T _{max} | 0 | | (V _{CC} ⁺) - 2 | |
| CMR | Common mode rejection ratio | R _s ≤ 10 kΩ | 70 | 85 | | dB |
| | | T _{min} ≤ T _{amb} ≤ T _{max} | 60 | | | |
| I _{source} | Output current source | V _{CC} ⁺ = 15 V, V _o = 2 V, V _{id} = 1 V | 20 | 40 | 60 | mA |
| I _{sink} | Output sink current | V _{CC} ⁺ = 15 V, V _o = 2 V, V _{id} = -1 V | 10 | 20 | | mA |
| | | V _{CC} ⁺ = 15 V, V _o = 0.2 V, V _{id} = -1 V | 12 | 50 | | μA |

Electrical characteristics

LM158, LM258, LM358

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|-----------------------------------|--|------|------|------------------------|
| V_{OH} | High level output voltage | $R_L = 2\text{ k}\Omega$, $V_{CC^+} = 30\text{ V}$ | 26 | 27 | V |
| | | $T_{min} \leq T_{amb} \leq T_{max}$ | 26 | | |
| | | $R_L = 10\text{ k}\Omega$, $V_{CC^+} = 30\text{ V}$ | 27 | 28 | |
| | | $T_{min} \leq T_{amb} \leq T_{max}$ | 27 | | |
| V_{OL} | Low level output voltage | $R_L = 10\text{ k}\Omega$ | 5 | 20 | mV |
| | | $T_{min} \leq T_{amb} \leq T_{max}$ | | 20 | |
| SR | Slew rate | $V_{CC^+} = 15\text{ V}$, $V_i = 0.5\text{ to }3\text{ V}$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, unity gain | 0.3 | 0.6 | V/ μ s |
| 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 | 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 | % |
| e_n | Equivalent input noise voltage | $f = 1\text{ kHz}$, $R_s = 100\text{ }\Omega$, $V_{CC^+} = 30\text{ V}$ | | 55 | $\frac{nV}{\sqrt{Hz}}$ |
| V_{o1}/V_{o2} | Channel separation ⁽⁴⁾ | $1\text{ kHz} \leq f \leq 20\text{ kHz}$ | | 120 | dB |

Notes:

⁽¹⁾ $V_o = 1.4\text{ V}$, $R_s = 0\text{ }\Omega$, $5\text{ V} < V_{CC^+} < 30\text{ V}$, $0 < V_{ic} < V_{CC^+} - 1.5\text{ V}$

⁽²⁾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.

⁽³⁾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.

⁽⁴⁾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.

5 Electrical characteristic curves

Figure 3: Open-loop frequency response

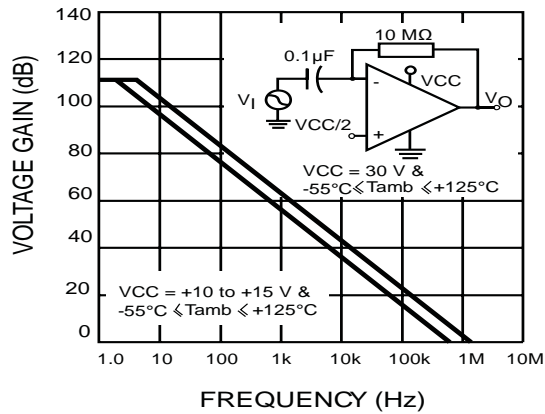


Figure 4: Large signal frequency response

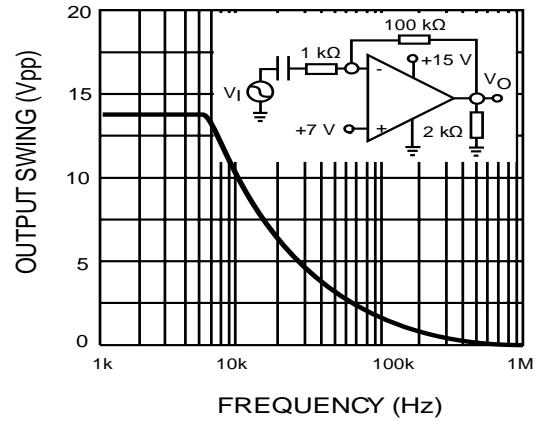
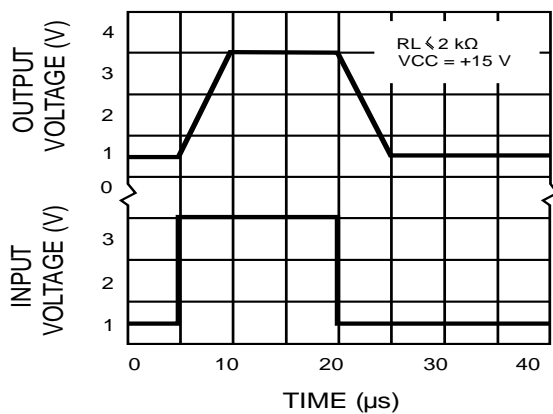
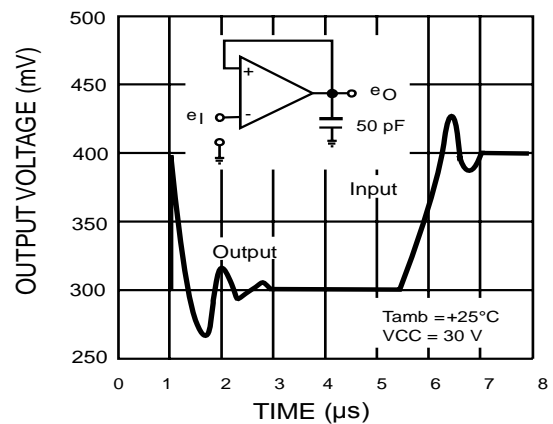
Figure 5: Voltage follower pulse response with $V_{CC} = 15\text{ V}$ Figure 6: Voltage follower pulse response with $V_{CC} = 30\text{ V}$ 

Figure 7: Input current

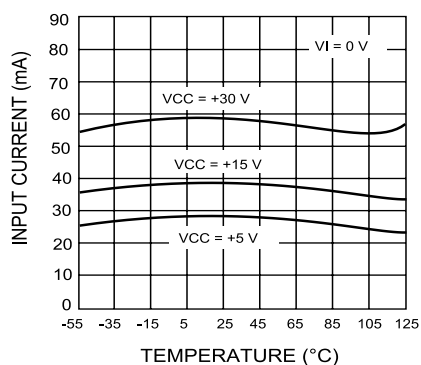


Figure 8: Output voltage vs sink current

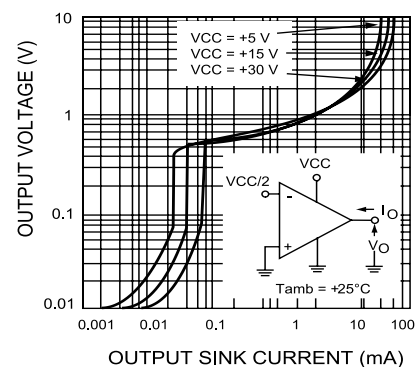


Figure 9: Output voltage vs source current

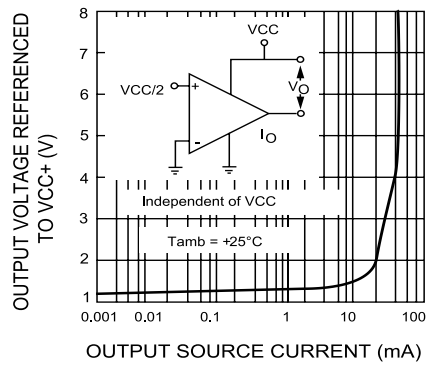


Figure 10: Current limiting

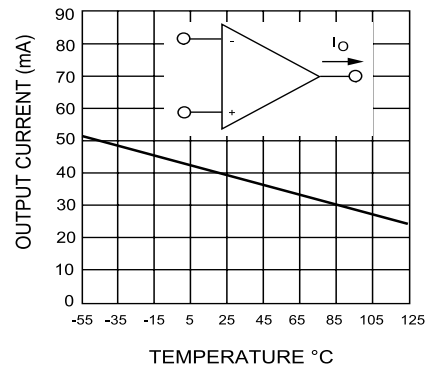


Figure 11: Input voltage range

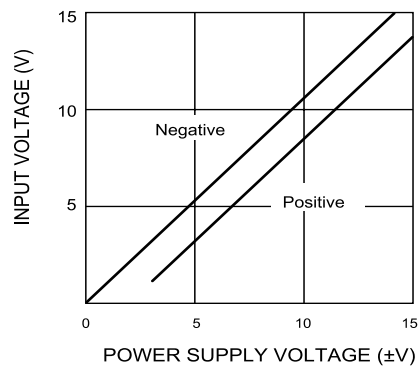


Figure 12: Open-loop gain

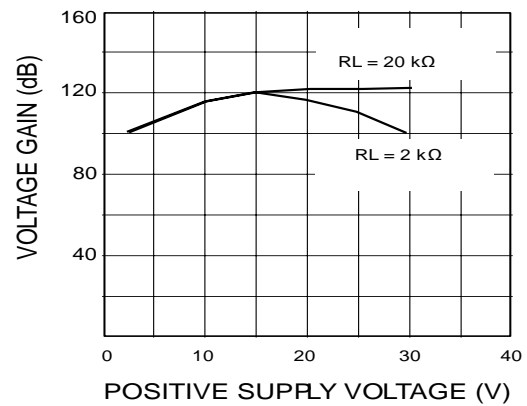


Figure 13: Supply current

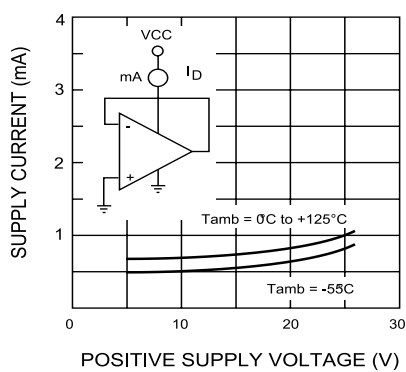


Figure 14: Input current

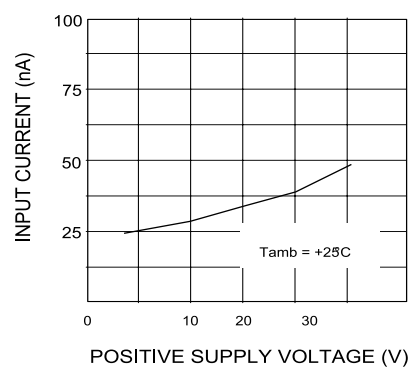


Figure 15: Gain bandwidth product

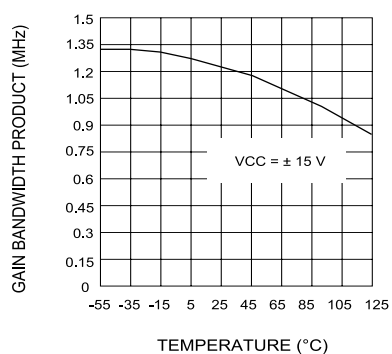


Figure 16: Power supply rejection ratio

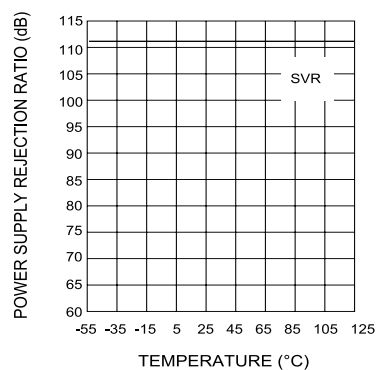


Figure 17: Common-mode rejection ratio

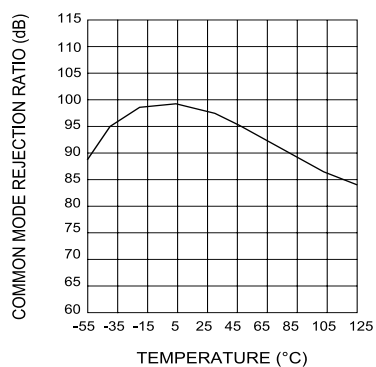
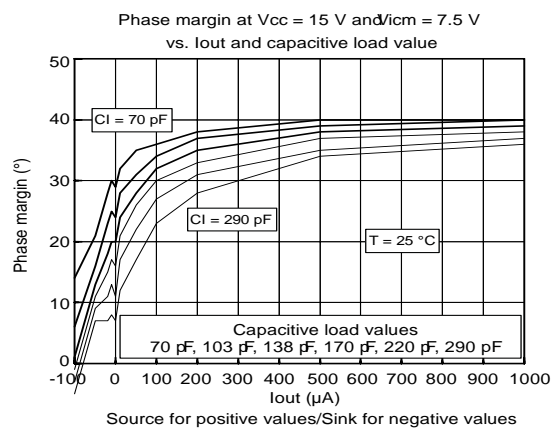


Figure 18: Phase margin vs. capacitive load



6 Typical applications

Single supply voltage $V_{CC} = 5\text{ V}_{DC}$.

Figure 19: AC-coupled inverting amplifier

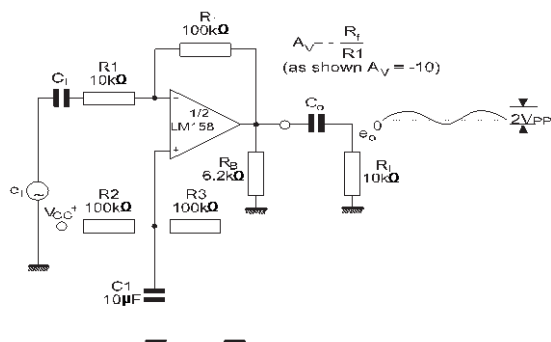


Figure 20: Non-inverting DC amplifier

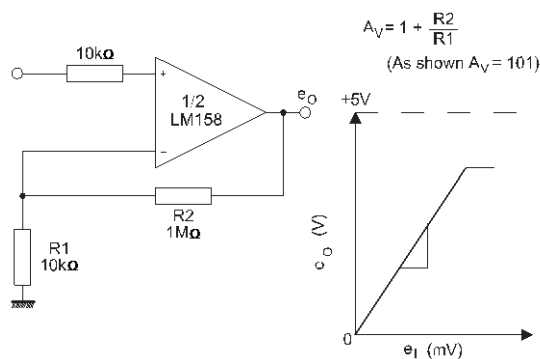


Figure 21: AC-coupled non-inverting amplifier

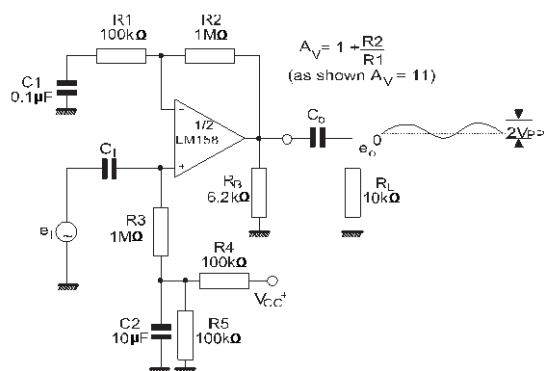


Figure 22: DC summing amplifier

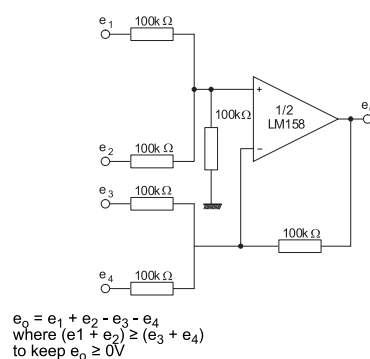


Figure 23: High input Z, DC differential amplifier

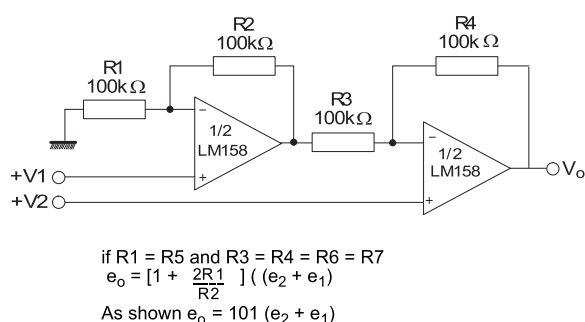


Figure 24: High input Z adjustable gain DC instrumentation amplifier

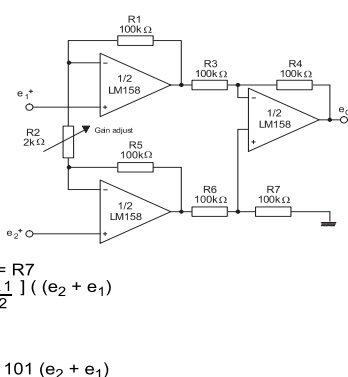


Figure 25: Using symmetrical amplifiers to reduce input current

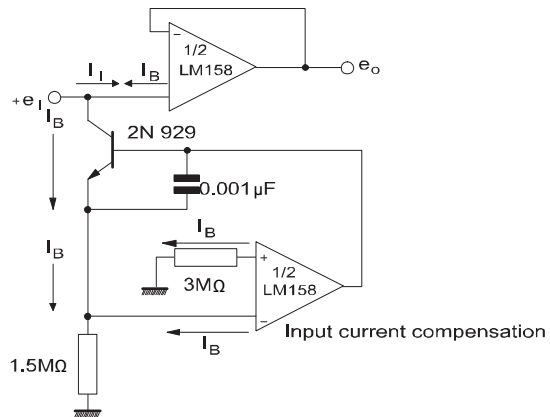


Figure 26: Low drift peak detector

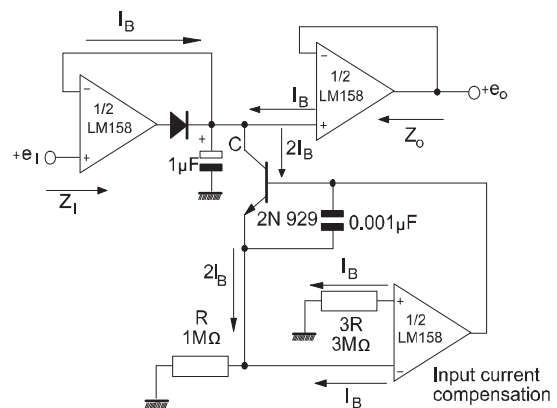
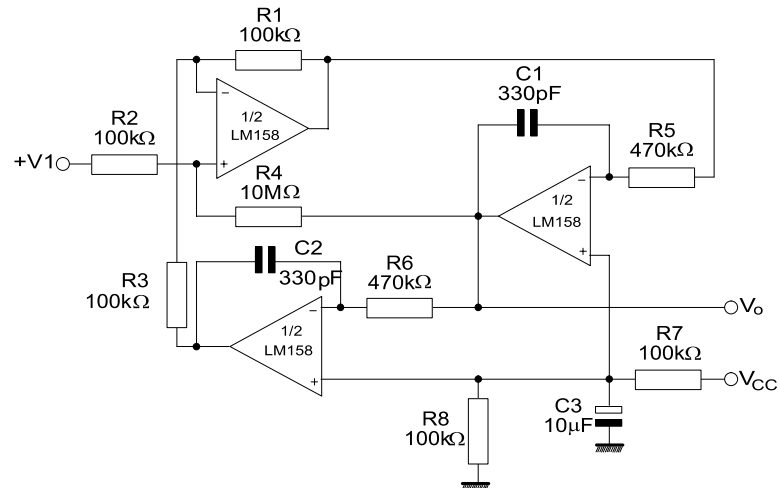


Figure 27: Active band-pass filter



7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

7.1 SO8 package information

Figure 28: SO8 package outline

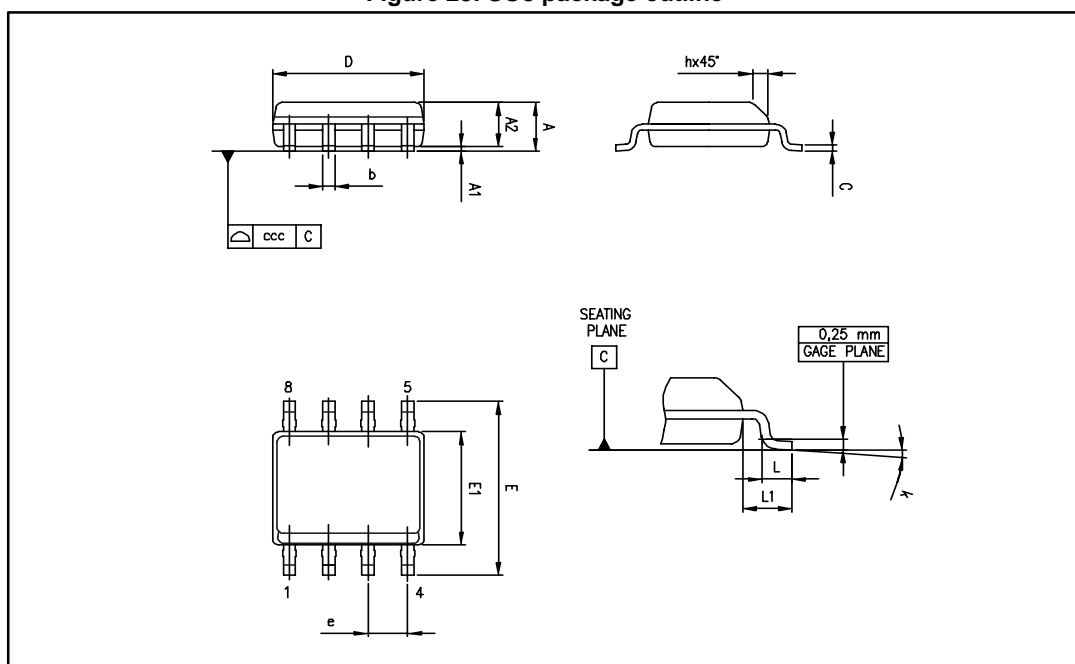


Table 4: SO8 mechanical data

| 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 |

7.2 MiniSO8 package information

Figure 29: MiniSO8 package outline

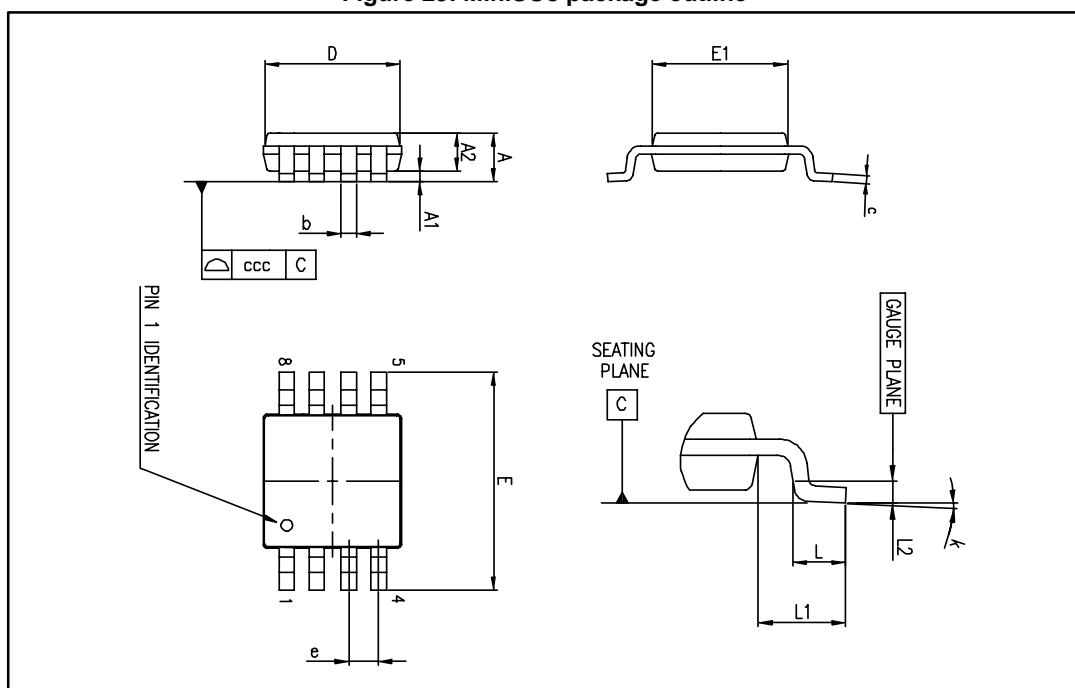


Table 5: MiniSO8 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.1 | | | 0.043 |
| A1 | 0 | | 0.15 | 0 | | 0.006 |
| A2 | 0.75 | 0.85 | 0.95 | 0.030 | 0.033 | 0.037 |
| b | 0.22 | | 0.40 | 0.009 | | 0.016 |
| c | 0.08 | | 0.23 | 0.003 | | 0.009 |
| D | 2.80 | 3.00 | 3.20 | 0.11 | 0.118 | 0.126 |
| E | 4.65 | 4.90 | 5.15 | 0.183 | 0.193 | 0.203 |
| E1 | 2.80 | 3.00 | 3.10 | 0.11 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| L | 0.40 | 0.60 | 0.80 | 0.016 | 0.024 | 0.031 |
| L1 | | 0.95 | | | 0.037 | |
| L2 | | 0.25 | | | 0.010 | |
| k | 0° | | 8° | 0° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

7.3 DFN8 2x2 package information

Figure 30: DFN8 2x2 package outline

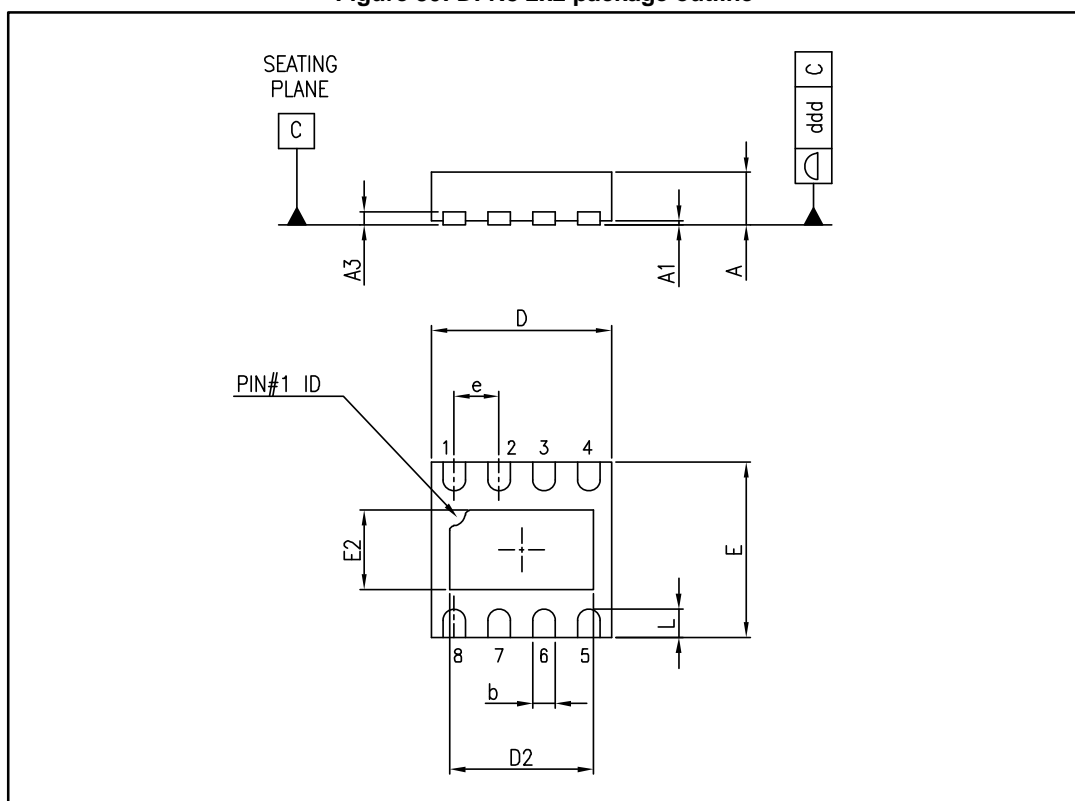
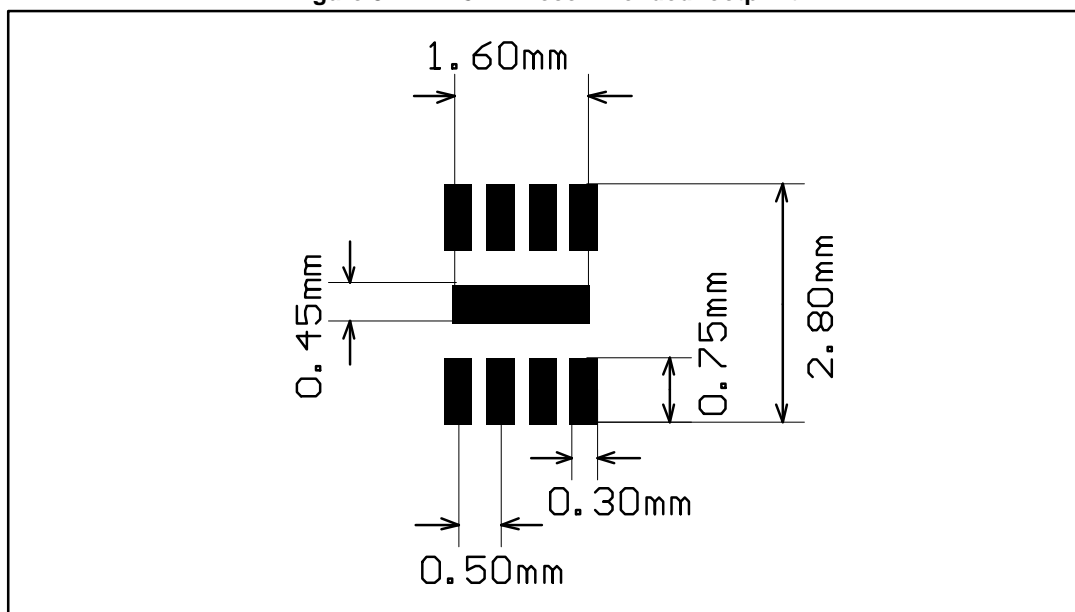


Table 6: DFN8 2x2 mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|-------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.51 | 0.55 | 0.60 | 0.020 | 0.022 | 0.024 |
| A1 | | | 0.05 | | | 0.002 |
| A3 | | 0.15 | | | 0.006 | |
| b | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| D2 | 1.45 | 1.60 | 1.70 | 0.057 | 0.063 | 0.067 |
| E | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| E2 | 0.75 | 0.90 | 1.00 | 0.030 | 0.035 | 0.039 |
| e | | 0.50 | | | 0.020 | |
| L | | 0.3 | 0.425 | | 0.012 | 0.017 |
| ddd | | | 0.08 | | | 0.003 |

Figure 31: DFN8 2x2 recommended footprint



7.4 TSSOP8 package information

Figure 32: TSSOP8 package outline

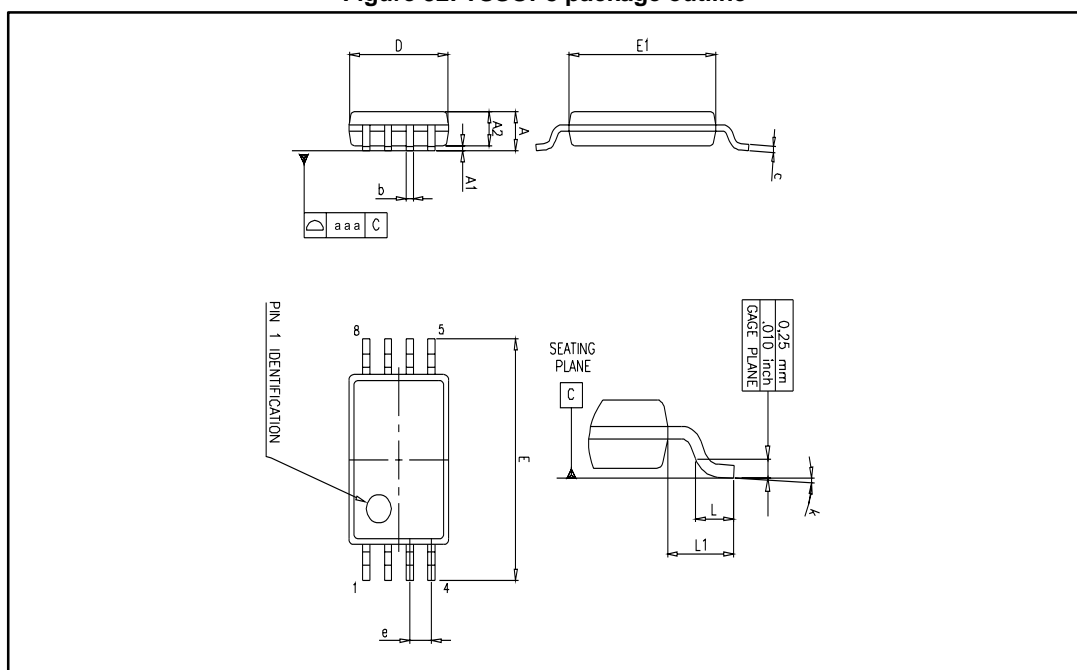


Table 7: TSSOP8 mechanical data

| 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 | |

8 Ordering information

Table 8: Order codes

| Order code | Temperature range | Package | Packaging | Marking |
|--------------------------|-----------------------|-----------------------|---------------|---------|
| LM158QT | -55 °C to 125 °C | DFN8 2x2 | Tape and reel | K4A |
| LM158DT | | SO8 | | 158 |
| LM258ADT | -40 °C to 105 °C | SO8 | | 258A |
| LM258AYDT ⁽¹⁾ | | SO8, automotive grade | | 258AY |
| LM258DT | | SO8 | | 258 |
| LM258APT | | TSSOP8 | | 258A |
| LM258AST | | MiniSO8 | | K408 |
| LM258QT | | DFN8 2x2 | | K4C |
| LM358DT | | 0 °C to 70 °C | | SO8 |
| LM358YDT ⁽¹⁾ | SO8, automotive grade | | | 358Y |
| LM358ADT | SO8 | | | 358A |
| LM358PT | TSSOP8 | | | 358 |
| LM358APT | | | | 358A |
| LM358ST | MiniSO8 | | | K405 |
| LM358AST | | | | K404 |
| LM358QT | DFN8 2x2 | K4E | | |

Notes:

⁽¹⁾Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent.

9 Revision history

Table 9: Document revision history

| Date | Revision | Changes |
|--------------|----------|--|
| 01-Jul- 2003 | 1 | First release. |
| 02-Jan-2005 | 2 | R_{thja} and T_j parameters added in AMR Table 1: "Absolute maximum ratings". |
| 01-Jul-2005 | 3 | ESD protection inserted in Table 1: "Absolute maximum ratings". |
| 05-Oct-2006 | 4 | Added Figure 17: 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 MiniSO-8 package data. L1 is 0.004 inch. Added automotive grade order codes in Section 7: "Ordering information". |
| 12-Feb-2008 | 7 | Corrected V_{CC} max (30 V instead of 32 V) in operating conditions. Changed presentation of electrical characteristics table. Deleted V_{opp} parameter in electrical characteristics table. Corrected miniSO-8 package information. Corrected temperature range for automotive grade order codes. Updated automotive grade footnotes in order codes table. |
| 26-Aug-2008 | 8 | Added limitations on input current in Table 1: "Absolute maximum ratings". Corrected title for Figure 11. Added E and L1 parameters in Table 4: "SO8 package mechanical data". Changed Figure 31: "TSSOP8 package mechanical drawing". |
| 02-Sep-2011 | 9 | In Section 6: "Package information", added: <ul style="list-style-type: none"> • DFN8 2 x 2 mm package mechanical drawing • DFN8 2 x 2 mm recommended footprint • DFN8 2 x 2 mm order codes. |
| 06-Apr-2012 | 10 | Removed order codes LM158YD, LM258AYD, LM258YD and LM358YD from Table 8: "Order codes". |
| 11-Jun-2013 | 11 | Table 8: "Order codes": removed order codes LM158D, LM158YDT, LM258YDT, and LM258AD; added automotive grade qualification to order codes LM258ATDT and LM358YDT; updated marking for order codes LM158DT and LM258D/LM258DT; updated temperature range, packages, and packaging for several order codes. |
| 20-Jun-2014 | 12 | Removed DIP8 package Corrected typos (W replaced with Ω , £ replaced with \leq) Updated Features Added Related products Table 3: replaced DV_{io} with $\Delta V_{io}/\Delta T$ and DI_{io} with $\Delta I_{io}/\Delta T$. Updated Table 7 for exposed pad dimensions Table 8: "Order codes": removed order codes LM258YPT and LM258AYPT; removed all order codes for devices with tube packing; added package code (NB) to DFN8 2x2 package. |

| Date | Revision | Changes |
|-------------|----------|--|
| 13-Nov-2015 | 13 | Updated document layout Updated name of the "DFN8 2x2 (NB) mm" package to "DFN8 2x2" everywhere in datasheet. Section 2: "Package pin connections": placed the package's pinout in this section and added note about exposed pad. Table 8: "Order codes": removed order codes LM258ST, LM358YPT, and LM358AYPT. |
| 24-Aug-2016 | 14 | <i>Table 6: "DFN8 2x2 mechanical data"</i> : added typ. value for "L" dimension. |

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