



## LOW POWER DUAL OPERATIONAL AMPLIFIERS

- INTERNALLY FREQUENCY COMPENSATED
- LARGE DC VOLTAGE GAIN: 100dB
- WIDE BANDWIDTH (unity gain): 1.1MHz (temperature compensated)
- VERY LOW SUPPLY CURRENT/OP (500µA) ESSENTIALLY INDEPENDENT OF SUPPLY VOLTAGE
- LOW INPUT BIAS CURRENT: 20nA (temperature compensated)
- LOW INPUT OFFSET VOLTAGE: 2mV
- LOW INPUT OFFSET CURRENT: 2nA
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- DIFFERENTIAL INPUT VOLTAGE RANGE EQUAL TO THE POWER SUPPLY VOLTAGE
- LARGE OUTPUT VOLTAGE SWING 0V TO (V<sub>cc</sub> - 1.5V)

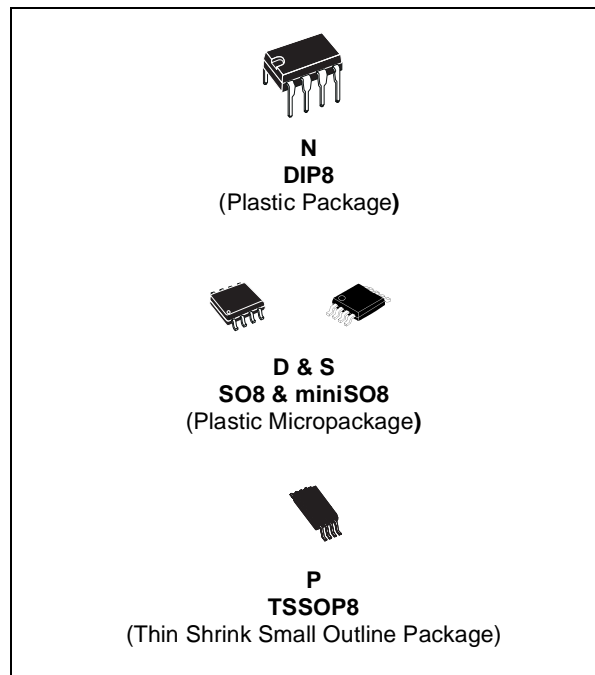
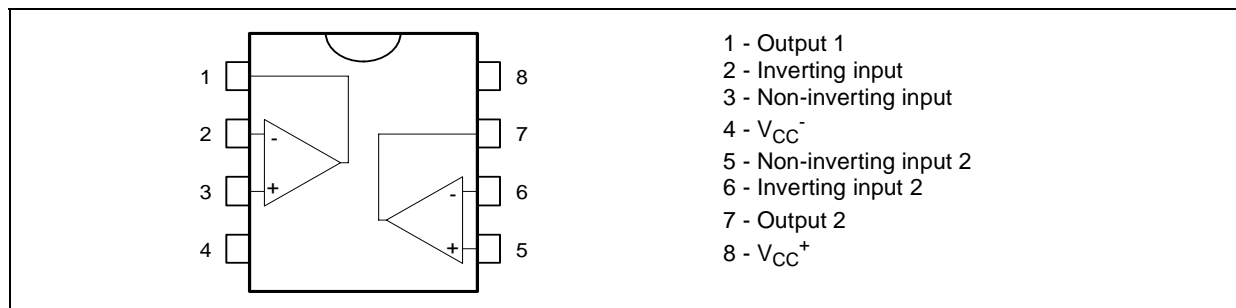
### DESCRIPTION

These circuits consist of two independent, high gain, internally frequency compensated which were 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 +5V which is used in logic systems and will easily provide the required interface electronics without requiring any additional power supply.

In the 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.

### PIN CONNECTIONS (top view)



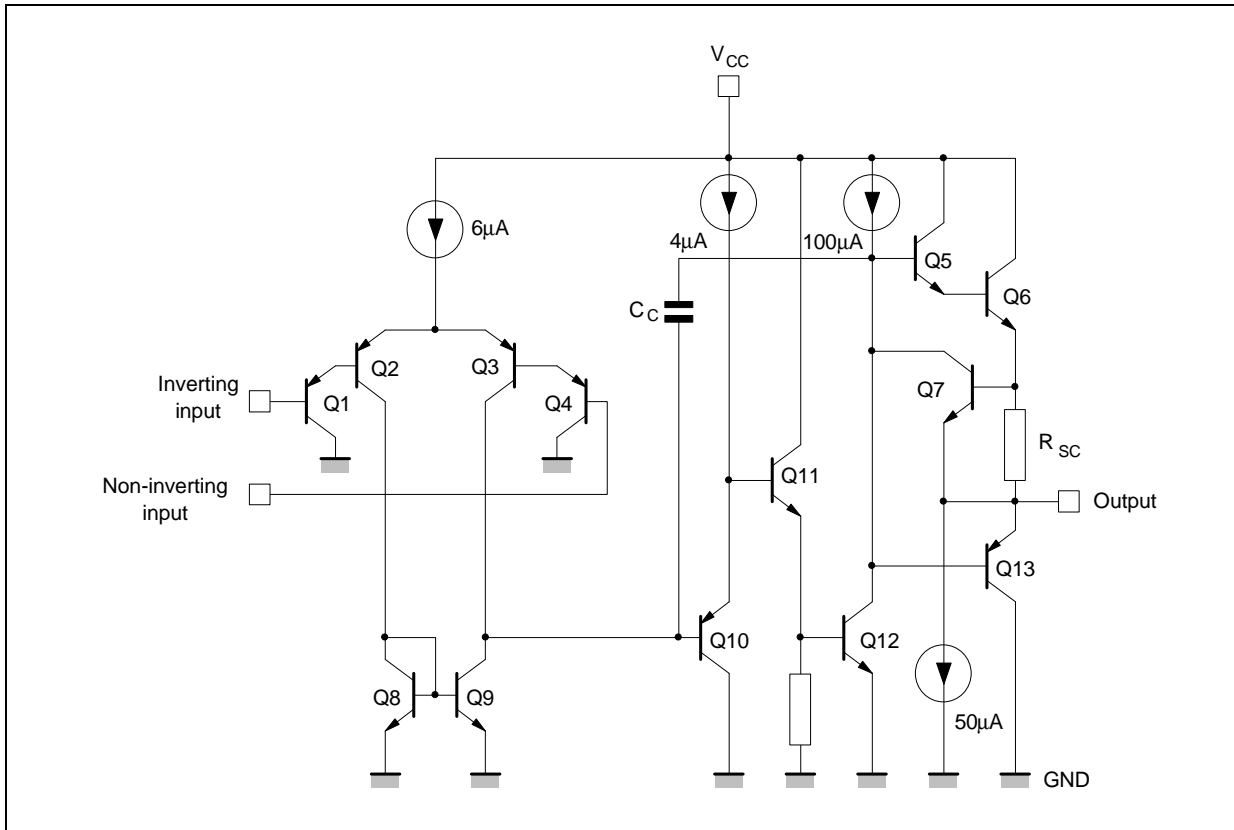
### ORDER CODE

| Part Number | Temperature Range | Package |   |   |   |
|-------------|-------------------|---------|---|---|---|
|             |                   | N       | S | D | P |
| LM158,A     | -55°C, +125°C     | •       |   | • | • |
| LM258,A     | -40°C, +105°C     | •       |   | • | • |
| LM358,A     | 0°C, +70°C        | •       | • | • | • |

**Example : LM258N**

**N** = Dual in Line Package (DIP)  
**D** = Small Outline Package (SO) - also available in Tape & Reel (DT)  
**S** = Small Outline Package (miniSO) only available in Tape & Reel (DT)  
**P** = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)

**SCHEMATIC DIAGRAM (1/2 LM158)**



**ABSOLUTE MAXIMUM RATINGS**

| Symbol     | Parameter                                   | LM158,A     | LM258,A     | LM358,A  | Unit |
|------------|---|-------------|-------------|----------|------|
| $V_{CC}$   | Supply voltage                              | +/-16 or 32 |             |          | V    |
| $V_i$      | Input Voltage                               | -0.3 to +32 |             |          | V    |
| $V_{id}$   | Differential Input Voltage                  | +32         |             |          | V    |
| $P_{tot}$  | Power Dissipation <sup>1)</sup>             | 500         |             |          | mW   |
|            | Output Short-circuit Duration <sup>2)</sup> | Infinite    |             |          |      |
| $I_{in}$   | Input Current <sup>3)</sup>                 | 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   |

1. Power dissipation must be considered to ensure maximum junction temperature ( $T_j$ ) is not exceeded.
2. Short-circuits from the output to  $V_{CC}$  can cause excessive heating if  $V_{CC} > 15V$ . The maximum output current is approximately 40mA independent of the magnitude of  $V_{CC}$ . Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
3. 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 diodes 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 duration than an input is driven negative.  
This is not destructive and normal output will set up again for input voltage higher than -0.3V.

**ELECTRICAL CHARACTERISTICS**

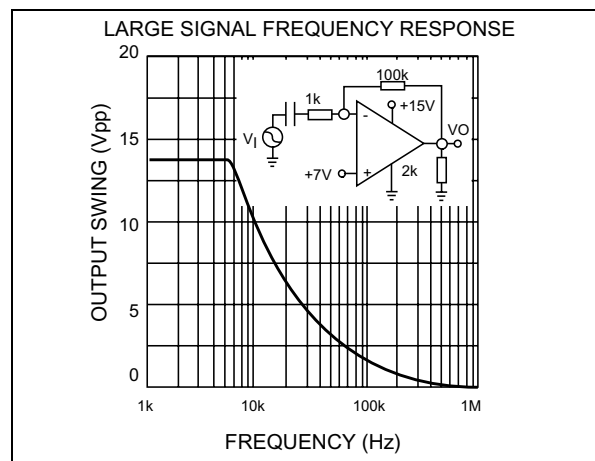
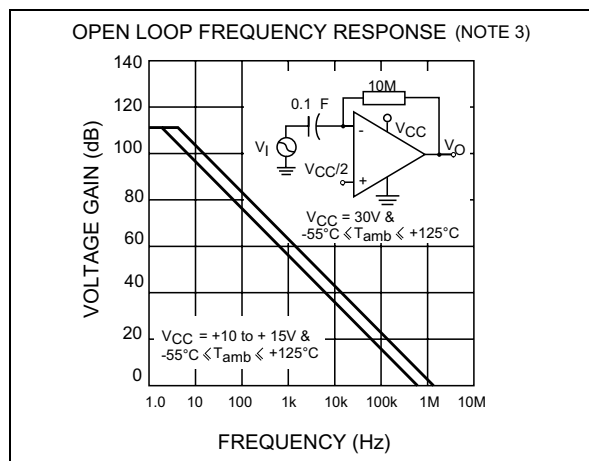
$V_{CC^+} = +5V$ ,  $V_{CC^-} = \text{Ground}$ ,  $V_o = 1.4V$ ,  $T_{amb} = +25^\circ C$  (unless otherwise specified)

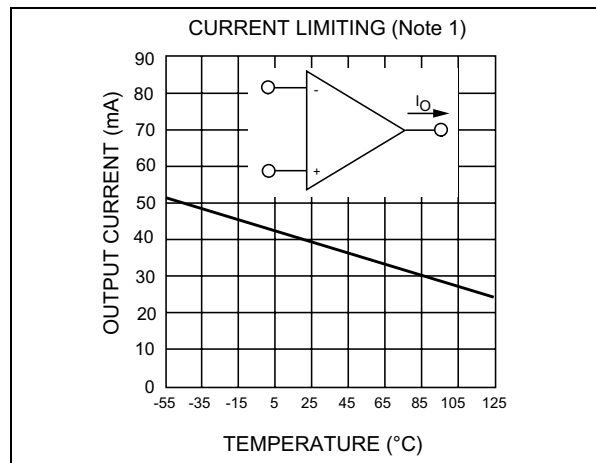
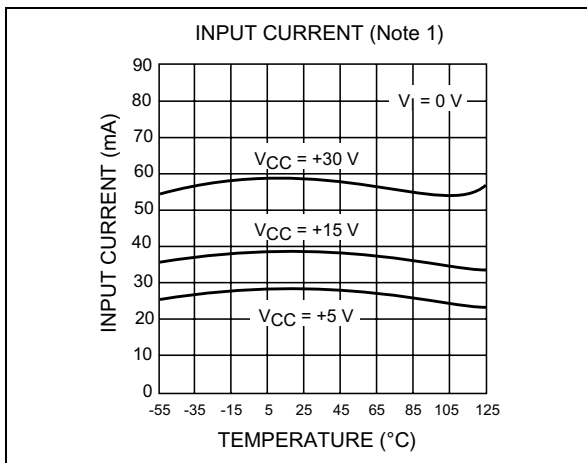
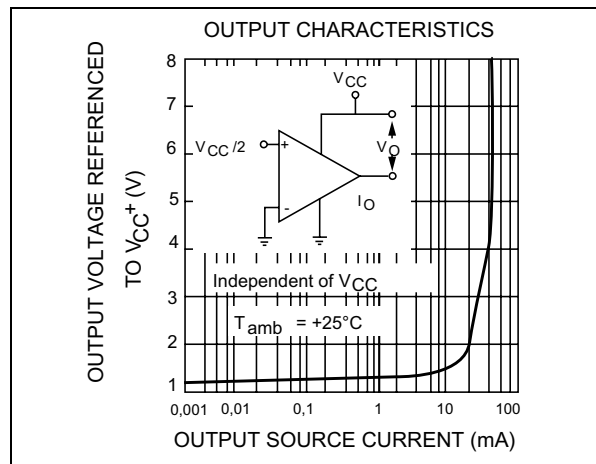
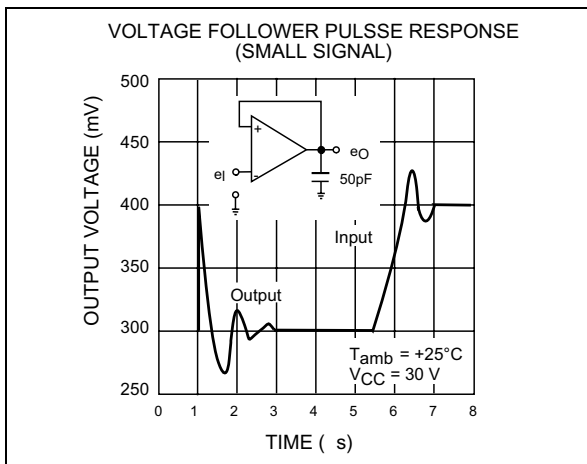
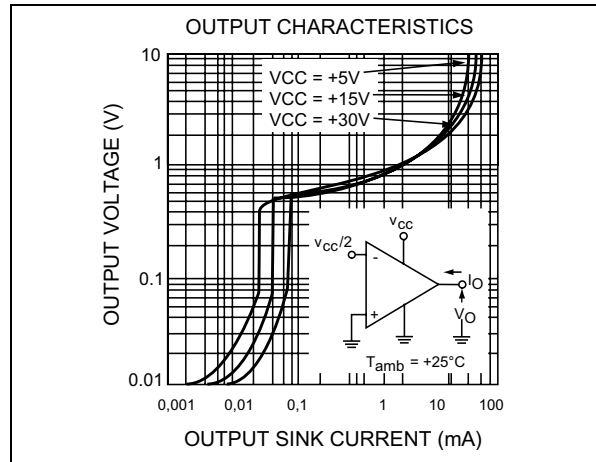
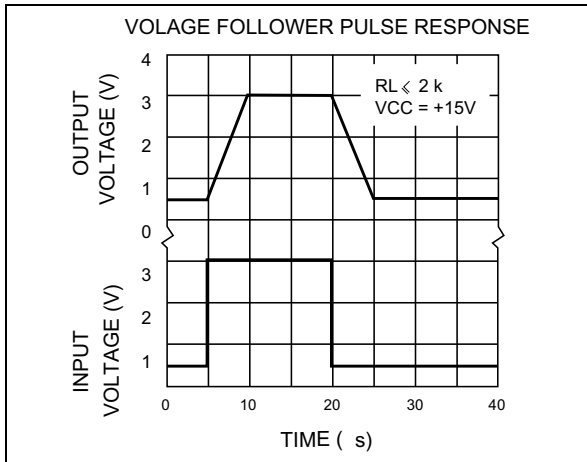
| Symbol       | Parameter   | LM158A-LM258A<br>LM358A |          |                                    | LM158-LM258<br>LM358 |          |                                    | Unit          |
|--------------|---|-------------------------|----------|------------------------------------|----------------------|----------|------------------------------------|---------------|
|              |   | Min.                    | Typ.     | Max.                               | Min.                 | Typ.     | Max.                               |               |
| $V_{io}$     | Input Offset Voltage - note <sup>1)</sup><br>$T_{amb} = +25^\circ C$<br><br>LM158, LM258<br>LM158A<br><br>$T_{min} \leq T_{amb} \leq T_{max}$<br><br>LM158, LM258 |                         | 1        | 3<br><br>2<br>4                    |                      | 2        | 7<br>5<br><br>9<br>7               | mV            |
| $I_{io}$     | Input Offset Current<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$  |                         | 2        | 10<br>30                           |                      | 2        | 30<br>40                           | nA            |
| $I_{ib}$     | Input Bias Current - note <sup>2)</sup><br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$   |                         | 20       | 50<br>100                          |                      | 20       | 150<br>200                         | nA            |
| $A_{vd}$     | Large Signal Voltage Gain<br>$V_{CC} = +15V$ , $R_L = 2k\Omega$ , $V_o = 1.4V$ to $11.4V$<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$       | 50<br>25                | 100      |                                    | 50<br>25             | 100      |                                    | V/mV          |
| SVR          | Supply Voltage Rejection Ratio ( $R_s \leq 10k\Omega$ )<br>$V_{CC^+} = 5V$ to $30V$<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$             | 65<br>65                | 100      |                                    | 65<br>65             | 100      |                                    | dB            |
| $I_{CC}$     | Supply Current, all Amp, no load<br>$T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +5V$<br>$T_{min} \leq T_{amb} \leq T_{max}$ $V_{CC} = +30V$                     |                         | 0.7      | 1.2<br>1                           |                      | 0.7      | 1.2<br>2                           | mA            |
| $V_{icm}$    | Input Common Mode Voltage Range<br>$V_{CC} = +30V$ - note <sup>3)</sup><br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$                         | 0<br>0                  |          | $V_{CC^+} - 1.5$<br>$V_{CC^+} - 2$ | 0<br>0               |          | $V_{CC^+} - 1.5$<br>$V_{CC^+} - 2$ | V             |
| CMR          | Common Mode Rejection Ratio ( $R_s \leq 10k\Omega$ )<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$  | 70<br>60                | 85       |                                    | 70<br>60             | 85       |                                    | dB            |
| $I_{source}$ | Output Current Source<br>$V_{CC} = +15V$ , $V_o = +2V$ , $V_{id} = +1V$   | 20                      | 40       | 60                                 | 20                   | 40       | 60                                 | mA            |
| $I_{sink}$   | Output Sink Current ( $V_{id} = -1V$ )<br>$V_{CC} = +15V$ , $V_o = +2V$<br>$V_{CC} = +15V$ , $V_o = +0.2V$  | 10<br>12                | 20<br>50 |                                    | 10<br>12             | 20<br>50 |                                    | mA<br>$\mu A$ |
| $V_{OPP}$    | Output Voltage Swing ( $R_L = 2k\Omega$ )<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$   | 0<br>0                  |          | $V_{CC^+} - 1.5$<br>$V_{CC^+} - 2$ | 0<br>0               |          | $V_{CC^+} - 1.5$<br>$V_{CC^+} - 2$ |               |

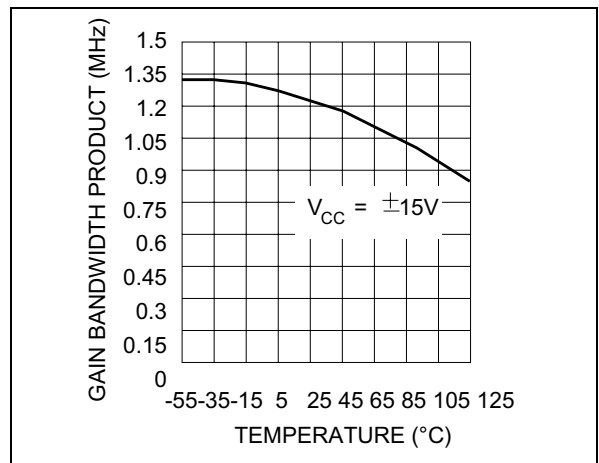
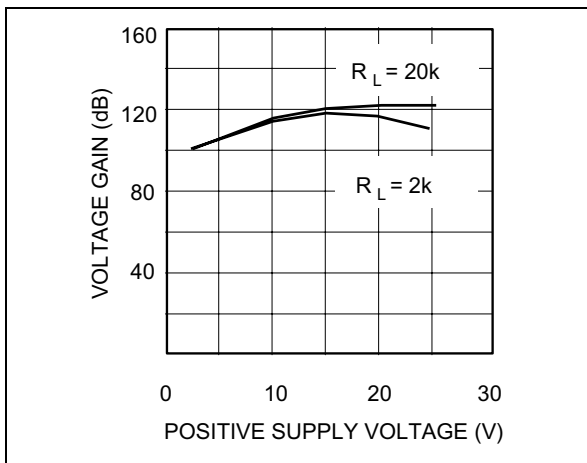
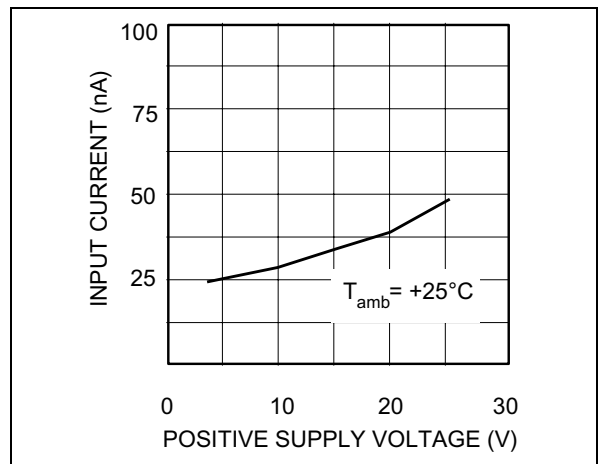
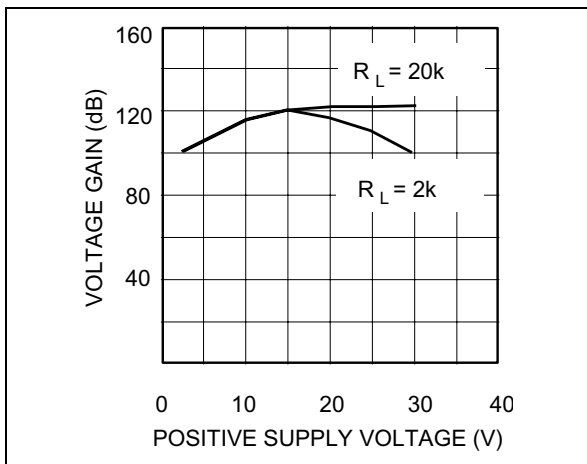
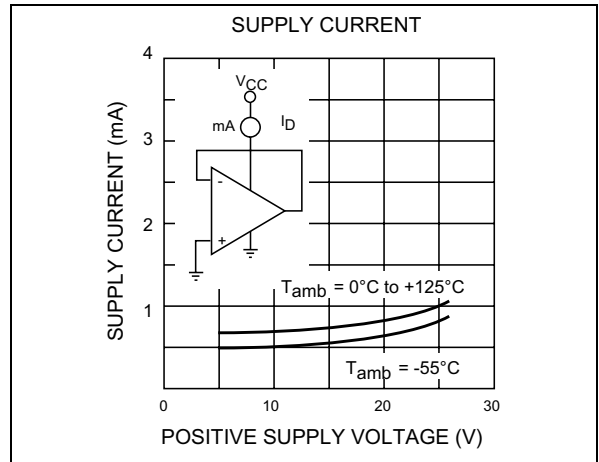
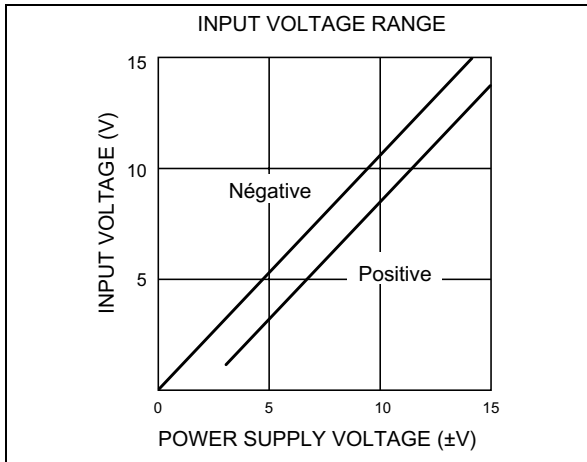
# LM158,A-LM258,A-LM358,A

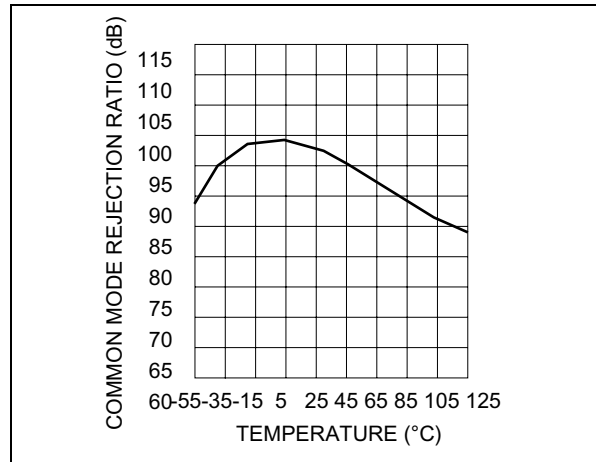
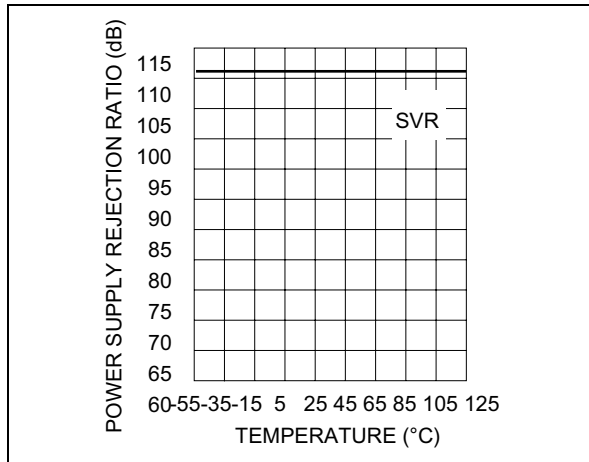
| Symbol          | Parameter   | LM158A-LM258A<br>LM358A |                   |      | LM158-LM258<br>LM358 |                   |      | Unit                   |
|-----------------|---|-------------------------|-------------------|------|----------------------|-------------------|------|------------------------|
|                 |   | Min.                    | Typ.              | Max. | Min.                 | Typ.              | Max. |                        |
| $V_{OH}$        | High Level Output Voltage ( $V_{CC}^+ = 30V$ )<br>$T_{amb} = +25^\circ C$ $R_L = 2k\Omega$<br>$T_{min} \leq T_{amb} \leq T_{max}$<br>$T_{amb} = +25^\circ C$ $R_L = 10k\Omega$<br>$T_{min} \leq T_{amb} \leq T_{max}$ | 26<br>26<br>27<br>27    | 27<br><br>28      |      | 26<br>26<br>27<br>27 | 27<br><br>28      |      | V                      |
| $V_{OL}$        | Low Level Output Voltage ( $R_L = 10k\Omega$ )<br>$T_{amb} = +25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$  |                         | 5<br><br>20<br>20 |      |                      | 5<br><br>20<br>20 |      | mV                     |
| SR              | Slew Rate<br>$V_{CC} = 15V, V_i = 0.5$ to $3V, R_L = 2k\Omega,$<br>$C_L = 100pF,$ unity Gain  | 0.3                     | 0.6               |      | 0.3                  | 0.6               |      | V/ $\mu s$             |
| GBP             | Gain Bandwidth Product<br>$V_{CC} = 30V, f = 100kHz, V_{in} = 10mV, R_L = 2k\Omega,$<br>$C_L = 100pF$   | 0.7                     | 1.1               |      | 0.7                  | 1.1               |      | MHz                    |
| THD             | Total Harmonic Distortion<br>$f = 1kHz, A_v = 20dB, R_L = 2k\Omega, V_o = 2V_{pp},$<br>$C_L = 100pF, V_o = 2V_{pp}$   |                         | 0.02              |      |                      | 0.02              |      | %                      |
| $e_n$           | Equivalent Input Noise Voltage<br>$f = 1kHz, R_s = 100\Omega, V_{CC} = 30V$   |                         | 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 - note 4)<br>$1kHz \leq f \leq 20kHz$  |                         | 120               |      |                      | 120               |      | dB                     |

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



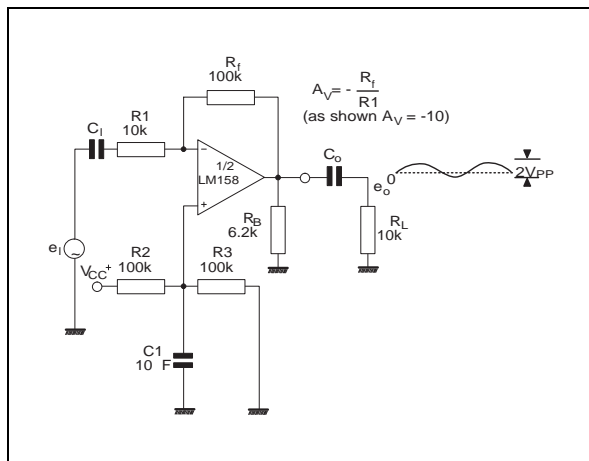




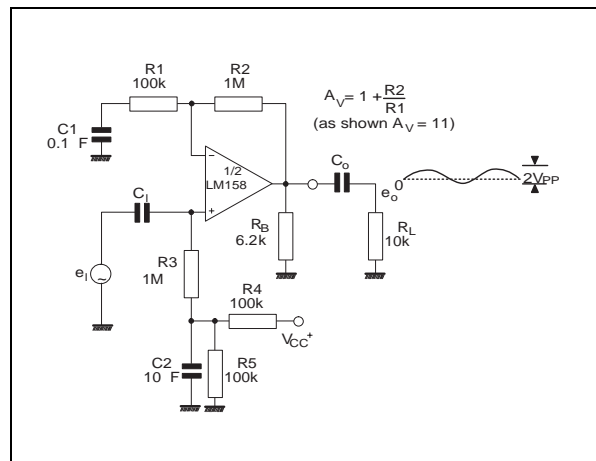


**TYPICAL APPLICATIONS** (single supply voltage)  $V_{CC} = +5V_{dc}$

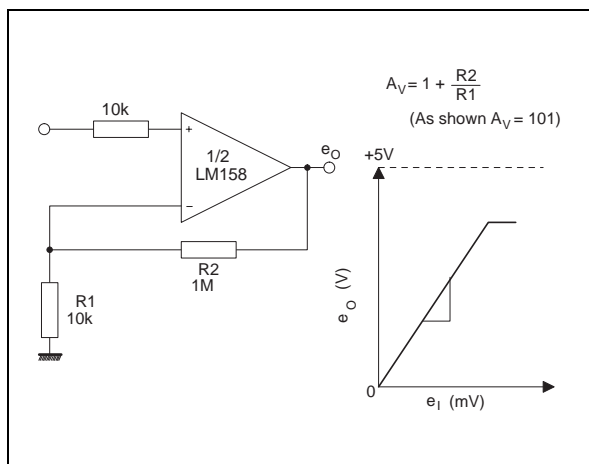
**AC COUPLED INVERTING AMPLIFIER**



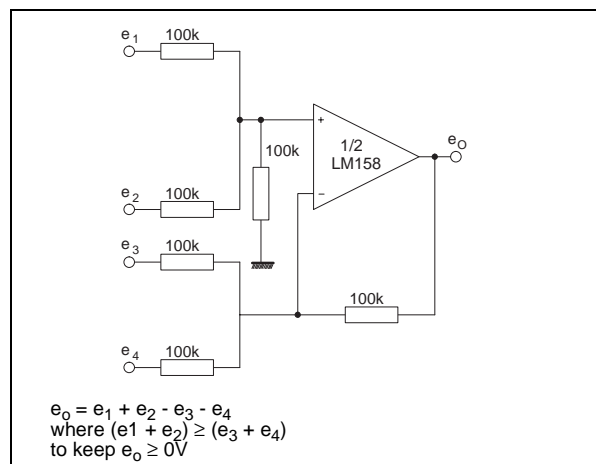
**AC COUPLED NON-INVERTING AMPLIFIER**



**NON-INVERTING DC AMPLIFIER**

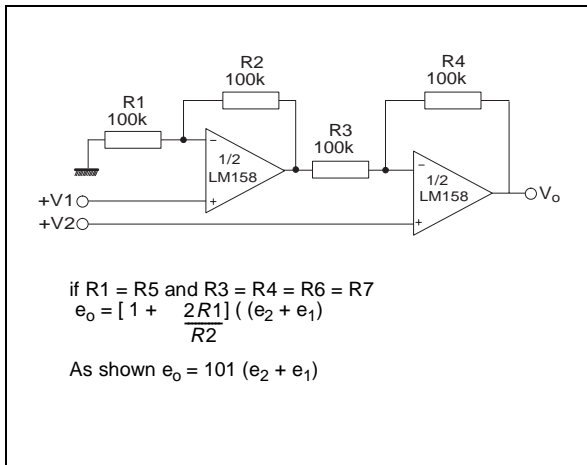


**DC SUMMING AMPLIFIER**

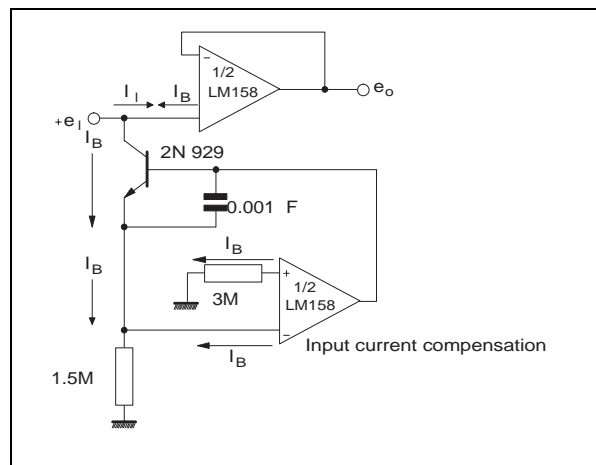


# LM158,A-LM258,A-LM358,A

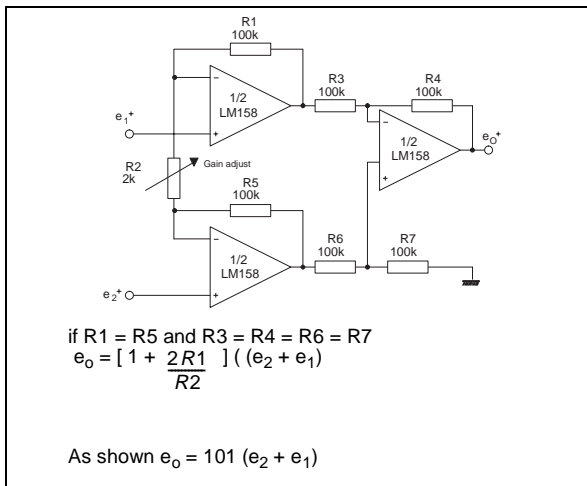
## HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER



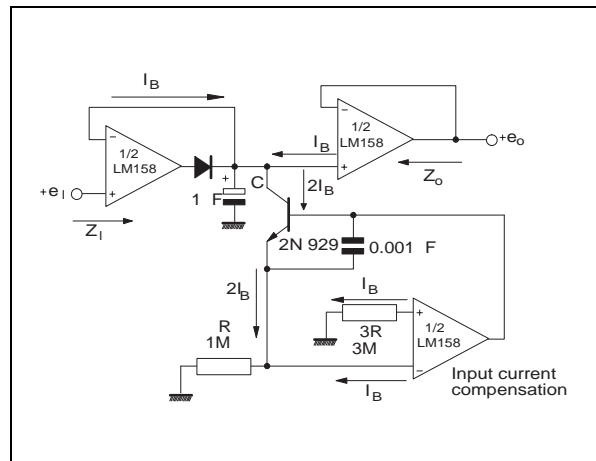
## USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT



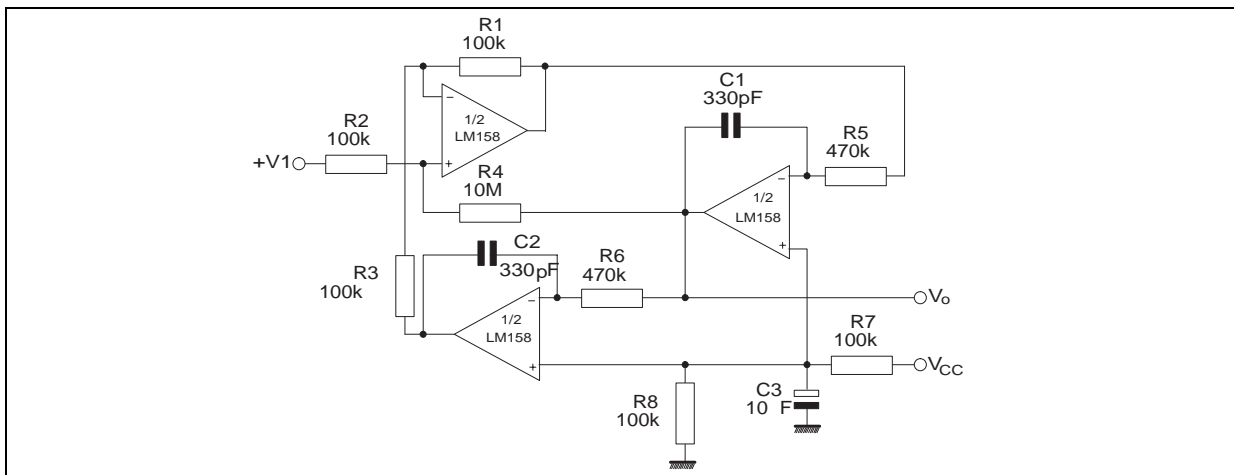
## HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER



## LOW DRIFT PEAK DETECTOR



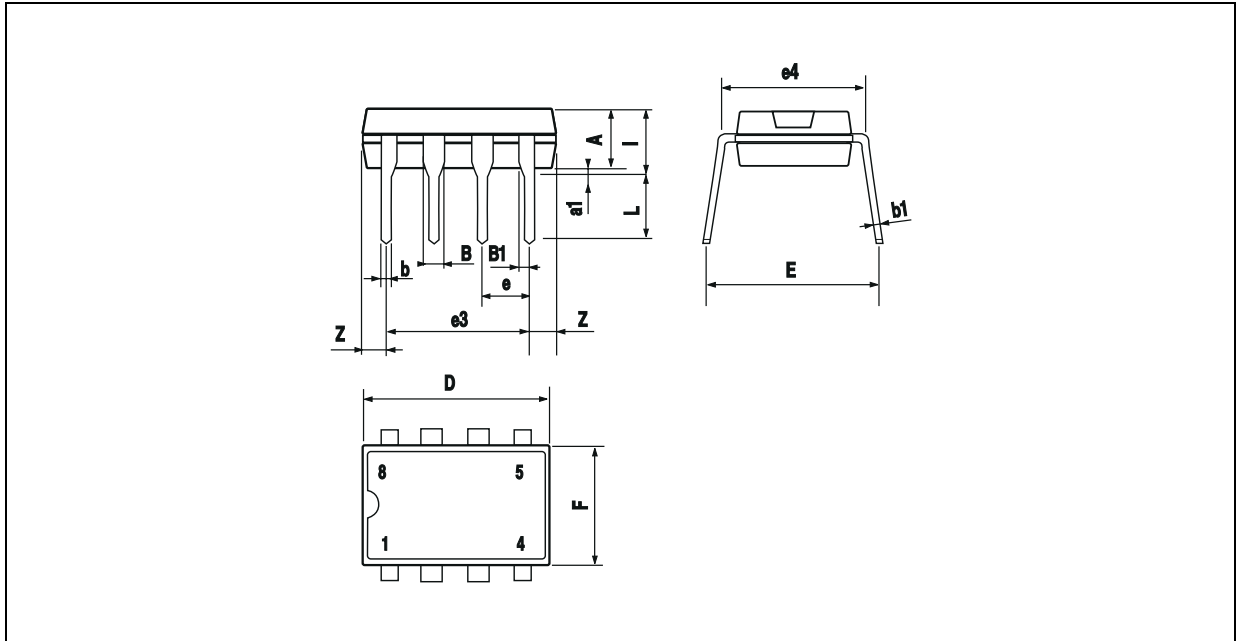
## ACTIVE BAND-PASS FILTER





**PACKAGE MECHANICAL DATA**

8 PINS - PLASTIC DIP

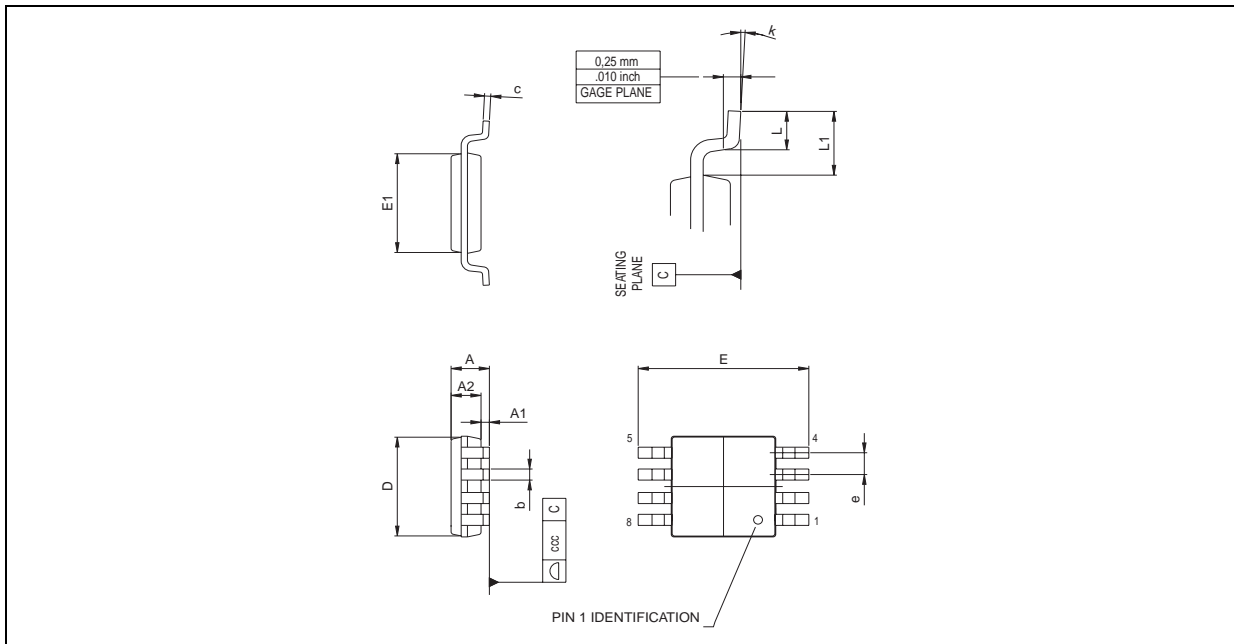


| Dim. | Millimeters |      |       | Inches |       |       |
|------|-------------|------|-------|--------|-------|-------|
|      | Min.        | Typ. | Max.  | Min.   | Typ.  | Max.  |
| A    |             | 3.32 |       |        | 0.131 |       |
| a1   | 0.51        |      |       | 0.020  |       |       |
| B    | 1.15        |      | 1.65  | 0.045  |       | 0.065 |
| b    | 0.356       |      | 0.55  | 0.014  |       | 0.022 |
| b1   | 0.204       |      | 0.304 | 0.008  |       | 0.012 |
| D    |             |      | 10.92 |        |       | 0.430 |
| E    | 7.95        |      | 9.75  | 0.313  |       | 0.384 |
| e    |             | 2.54 |       |        | 0.100 |       |
| e3   |             | 7.62 |       |        | 0.300 |       |
| e4   |             | 7.62 |       |        | 0.300 |       |
| F    |             |      | 6.6   |        |       | 0.260 |
| i    |             |      | 5.08  |        |       | 0.200 |
| L    | 3.18        |      | 3.81  | 0.125  |       | 0.150 |
| Z    |             |      | 1.52  |        |       | 0.060 |

# LM158,A-LM258,A-LM358,A

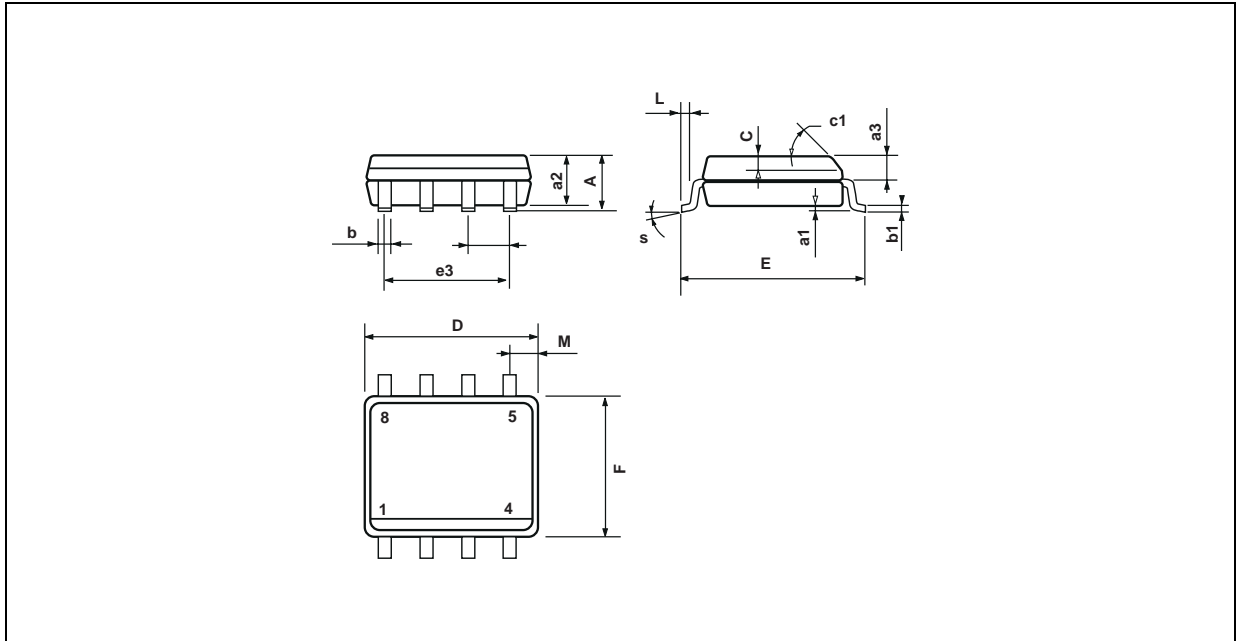
## PACKAGE MECHANICAL DATA

8 PINS - PLASTIC MICROPACKAGE ( miniSO )



| Dim. | Millimeters |       |       | Inches |       |       |
|------|-------------|-------|-------|--------|-------|-------|
|      | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| A    |             |       | 1.100 |        |       | 0.043 |
| A1   | 0.050       | 0.100 | 0.150 | 0.002  | 0.004 | 0.006 |
| A2   | 0.780       | 0.860 | 0.940 | 0.031  | 0.034 | 0.037 |
| b    | 0.250       | 0.330 | 0.400 | 0.010  | 0.013 | 0.016 |
| c    | 0.130       | 0.180 | 0.230 | 0.005  | 0.007 | 0.009 |
| D    | 2.900       | 3.000 | 3.100 | 0.114  | 0.118 | 0.122 |
| E    | 4.750       | 4.900 | 5.050 | 0.187  | 0.193 | 0.199 |
| E1   | 2.900       | 3.000 | 3.100 | 0.114  | 0.118 | 0.122 |
| e    |             | 0.650 |       |        | 0.026 |       |
| L    | 0.400       | 0.550 | 0.700 | 0.016  | 0.022 | 0.028 |
| L1   |             | 0.950 |       |        | 0.037 |       |
| k    | 0d          | 3d    | 6d    | 0d     | 3d    | 6d    |
| ccc  |             |       | 0.100 |        |       | 0.004 |

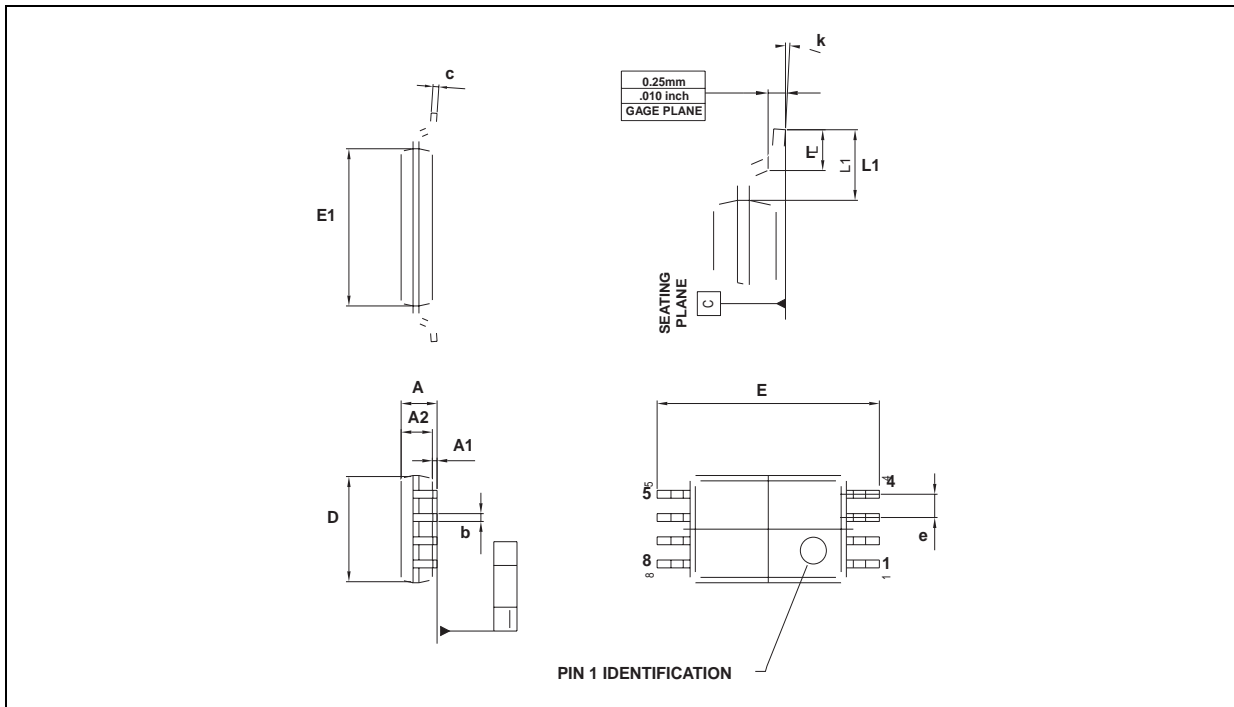
**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC MICROPACKAGE (SO)



| Dim. | Millimeters |      |      | Inches |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             |      | 1.75 |        |       | 0.069 |
| a1   | 0.1         |      | 0.25 | 0.004  |       | 0.010 |
| a2   |             |      | 1.65 |        |       | 0.065 |
| a3   | 0.65        |      | 0.85 | 0.026  |       | 0.033 |
| b    | 0.35        |      | 0.48 | 0.014  |       | 0.019 |
| b1   | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| C    | 0.25        |      | 0.5  | 0.010  |       | 0.020 |
| c1   | 45° (typ.)  |      |      |        |       |       |
| D    | 4.8         |      | 5.0  | 0.189  |       | 0.197 |
| E    | 5.8         |      | 6.2  | 0.228  |       | 0.244 |
| e    |             | 1.27 |      |        | 0.050 |       |
| e3   |             | 3.81 |      |        | 0.150 |       |
| F    | 3.8         |      | 4.0  | 0.150  |       | 0.157 |
| L    | 0.4         |      | 1.27 | 0.016  |       | 0.050 |
| M    |             |      | 0.6  |        |       | 0.024 |
| S    | 8° (max.)   |      |      |        |       |       |

**PACKAGE MECHANICAL DATA**

8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



| Dim. | Millimeters |       |      | Inches |        |       |
|------|-------------|-------|------|--------|--------|-------|
|      | Min.        | Typ.  | Max. | Min.   | Typ.   | Max.  |
| A    |             |       | 1.20 |        |        | 0.05  |
| A1   | 0.05        |       | 0.15 | 0.01   |        | 0.006 |
| A2   | 0.80        | 1.00  | 1.05 | 0.031  | 0.039  | 0.041 |
| b    | 0.19        |       | 0.30 | 0.007  |        | 0.15  |
| c    | 0.09        |       | 0.20 | 0.003  |        | 0.012 |
| D    | 2.90        | 3.00  | 3.10 | 0.114  | 0.118  | 0.122 |
| E    |             | 6.40  |      |        | 0.252  |       |
| E1   | 4.30        | 4.40  | 4.50 | 0.169  | 0.173  | 0.177 |
| e    |             | 0.65  |      |        | 0.025  |       |
| k    | 0°          |       | 8°   | 0°     |        | 8°    |
| L    | 0.50        | 0.60  | 0.75 | 0.09   | 0.0236 | 0.030 |
| L1   | 0.45        | 0.600 | 0.75 | 0.018  | 0.024  | 0.030 |
| L1   |             | 1.000 |      |        | 0.039  |       |

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