



# TS461-TS462-TS464

## Output Rail-to-Rail Operational Amplifiers

- High dynamic features
- Large output swing ( $\pm 2.4V$  @  $V_{CC} = \pm 2.5V$ )
- Low noise level:  $4nV/\sqrt{Hz}$
- Low distortion: 0.003%
- Operating range: 2.7V to 10V
- Available in SOT23-5 micropackage

### Description

The TS46x are a family of operational amplifiers able to operate with voltages as low as  $\pm 1.35V$  and to reach a minimum of  $\pm 2V_{pp}$  of output swing when supplied with  $\pm 2.5V$ .

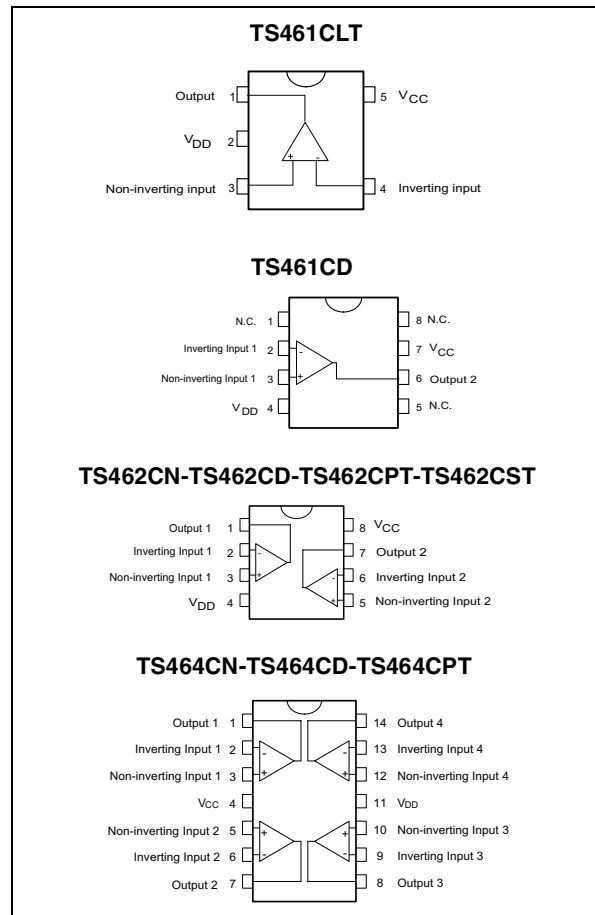
This device is well-suited for all kinds of portable and battery-supplied equipment, where low noise and low distortion are key requirements.

The TS461/2/4 offer excellent output rail-to-rail performance at an attractive cost.

### Applications

- Sound cards
- PDA
- CD players
- Recording equipment
- Multimedia
- Microphone preamplifiers

### Pin Connections (top view)



### Order Codes

| Part Number | Temperature Range | Package                                   | Packaging           | Marking |
|-------------|-------------------|---|---------------------|---------|
| TS461CLT    | -20°C, +70°C      | SOT23-5L                                  | Tape & Reel         | K105    |
| TS461CD/CDT |                   | SO-8                                      | Tube or Tape & Reel |         |
| TS462CST    |                   | mini SO-8                                 | Tape & Reel         |         |
| TS462CPT    |                   | TSSOP-8<br>(Thin Shrink Outline Package)  | Tape & Reel         |         |
| TS462CN     |                   | DIP8                                      | Tube                |         |
| TS462CD/CDT |                   | SO-8                                      | Tube or Tape & Reel |         |
| TS464CPT    |                   | TSSOP-14<br>(Thin Shrink Outline Package) | Tape & Reel         |         |
| TS464CN     |                   | DIP14                                     | Tube                |         |
| TS464CD/CDT |                   | SO-14                                     | Tube or Tape & Reel |         |

## 1 Absolute Maximum Ratings

**Table 1: Key parameters and their absolute maximum ratings**

| Symbol            | Parameter  | Value  | Unit |
|-------------------|--|--|------|
| VCC               | Supply voltage <sup>1</sup>                      | 12   | V    |
| V <sub>id</sub>   | Differential Input Voltage <sup>2</sup>          | ±VCC   | V    |
| V <sub>in</sub>   | Input Voltage Range                              | V <sub>dd</sub> -0.3 to V <sub>cc</sub> +0.3 | V    |
| T <sub>oper</sub> | Operating Free Air Temperature Range             | -20 to +70                                   | °C   |
| T <sub>std</sub>  | Storage Temperature Range                        | -65 to +150                                  | °C   |
| T <sub>j</sub>    | Maximum Junction Temperature                     | 150  | °C   |
| R <sub>thja</sub> | Thermal Resistance Junction to Case <sup>3</sup> |  | °C/W |
|                   | SOT23-5  | 250  |      |
|                   | SO8  | 125  |      |
|                   | SO14   | 103  |      |
|                   | TSSOP8   | 120  |      |
|                   | TSSOP14  | 100  |      |
| ESD               | HBM: Human Body Model <sup>4</sup>               | 2  | kV   |
|                   | MM: Machine Model <sup>5</sup>                   | 200  | V    |
|                   | CDM: Charged Device Model                        | 1.5  | kV   |
|                   | Lead Temperature (soldering, 10sec)              | 250  | °C   |

1) All voltages values, except differential voltage are with respect to network group terminal.

2) Differential voltages are non-inverting input terminal with respect to the inverting input terminal.

3) Short-circuits can cause excessive heating and destructive dissipation.

4) Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.

5) Machine model ESD, a 200pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin to pin of device.

**Table 2: Operating conditions**

| Symbol            | Parameter                            | Value   | Unit |
|-------------------|--------------------------------------|---|------|
| VCC               | Supply Voltage                       | 2.7 to 10                                       | V    |
| V <sub>icm</sub>  | Common Mode Input Voltage Range      | V <sub>DD</sub> +1.15 to V <sub>CC</sub> - 1.15 | V    |
| T <sub>oper</sub> | Operating Free Air Temperature Range | -20 to +70                                      | °C   |

## 2 Electrical Characteristics

Table 3:  $V_{CC} = 2.5V$ ,  $V_{DD} = -2.5V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

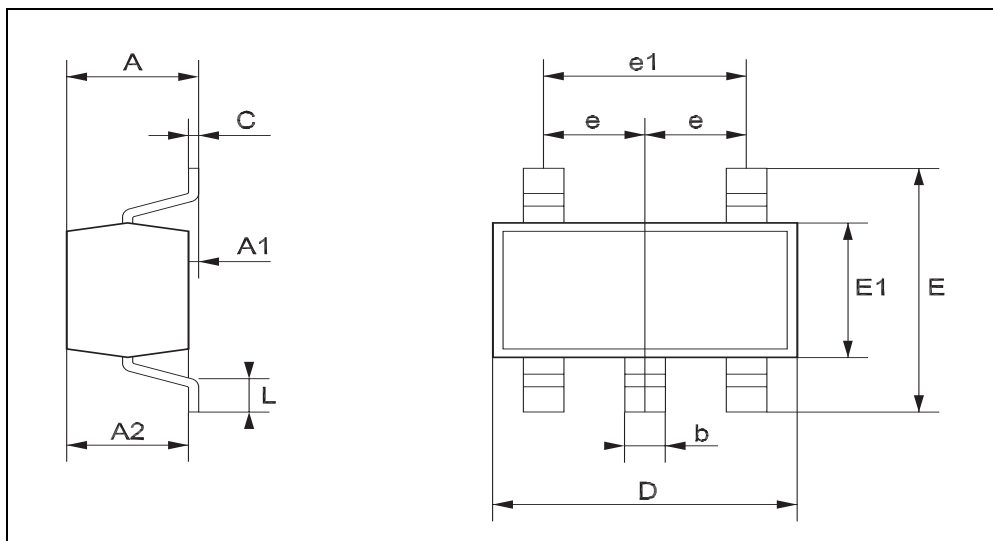
| Symbol          | Parameter   | Min.  | Typ.       | Max.        | Unit                   |
|-----------------|---|-------|------------|-------------|------------------------|
| $V_{io}$        | Input Offset Voltage<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                             |       | 1          | 5<br>7      | mV                     |
| $\Delta V_{io}$ | Input Offset Voltage Drift<br>$V_{icm} = 0V, V_o = 0V$                                    |       | 5          |             | $\mu V/^{\circ}C$      |
| $I_{io}$        | Input Offset Current<br>$V_{icm} = 0V, V_o = 0V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ |       | 10         | 150<br>200  | nA                     |
| $I_{ib}$        | Input Bias Current<br>$V_{icm} = 0V, V_o = 0V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   |       | 200<br>200 | 750<br>1000 | nA                     |
| $V_{icm}$       | Common Mode Input Voltage Range   | -1.35 |            | 1.35        | V                      |
| CMR             | Common Mode Rejection Ratio<br>$V_{icm} = \pm 1.35V$                                      | 60    | 85         |             | dB                     |
| SVR             | Supply Voltage Rejection Ratio<br>$V_{cc} = \pm 2V$ to $\pm 3V$                           | 60    | 70         |             | dB                     |
| $A_{vd}$        | Large Signal Voltage Gain<br>$R_L = 2k\Omega$   | 70    | 80         |             | dB                     |
| $V_{OH}$        | High Level Output Voltage<br>$R_L = 2k\Omega$   | 2     | 2.4        |             | V                      |
| $V_{OL}$        | Low Level Output Voltage<br>$R_L = 2k\Omega$  |       | -2.4       | -2          | V                      |
| $I_{CC}$        | Supply Current, per amplifier<br>Unity gain - no load                                     |       | 2          | 2.8         | mA                     |
| GBP             | Gain Bandwidth Product<br>$f = 100kHz$<br>$R_L = 2k\Omega, C_L = 100pF$                   | 8.5   | 12         |             | MHz                    |
| SR              | Slew Rate<br>$A_V = 1, V_{in} = \pm 1V$   | 2.8   | 4          |             | V/ $\mu s$             |
| $e_n$           | Equivalent Input Noise Voltage<br>$f = 100kHz$  |       | 4          |             | $\frac{nV}{\sqrt{Hz}}$ |
| THD             | Total Harmonic Distortion<br>$f = 1kHz, A_V = -1$<br>$R_L = 10k\Omega$                    |       | 0.003      |             | %                      |

3 Package Mechanical Data

3.1 SOT23-5L package

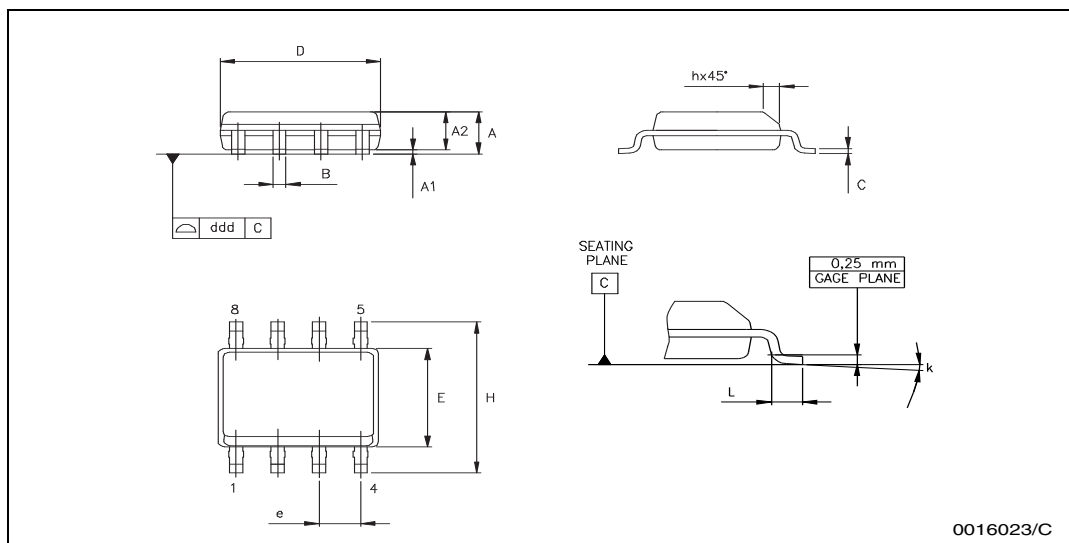
SOT23-5L MECHANICAL DATA

| DIM. | mm.  |      |      | mils  |      |       |
|------|------|------|------|-------|------|-------|
|      | MIN. | TYP. | MAX. | MIN.  | TYP. | MAX.  |
| A    | 0.90 |      | 1.45 | 35.4  |      | 57.1  |
| A1   | 0.00 |      | 0.15 | 0.0   |      | 5.9   |
| A2   | 0.90 |      | 1.30 | 35.4  |      | 51.2  |
| b    | 0.35 |      | 0.50 | 13.7  |      | 19.7  |
| C    | 0.09 |      | 0.20 | 3.5   |      | 7.8   |
| D    | 2.80 |      | 3.00 | 110.2 |      | 118.1 |
| E    | 2.60 |      | 3.00 | 102.3 |      | 118.1 |
| E1   | 1.50 |      | 1.75 | 59.0  |      | 68.8  |
| e    |      | 0.95 |      |       | 37.4 |       |
| e1   |      | 1.9  |      |       | 74.8 |       |
| L    | 0.35 |      | 0.55 | 13.7  |      | 21.6  |



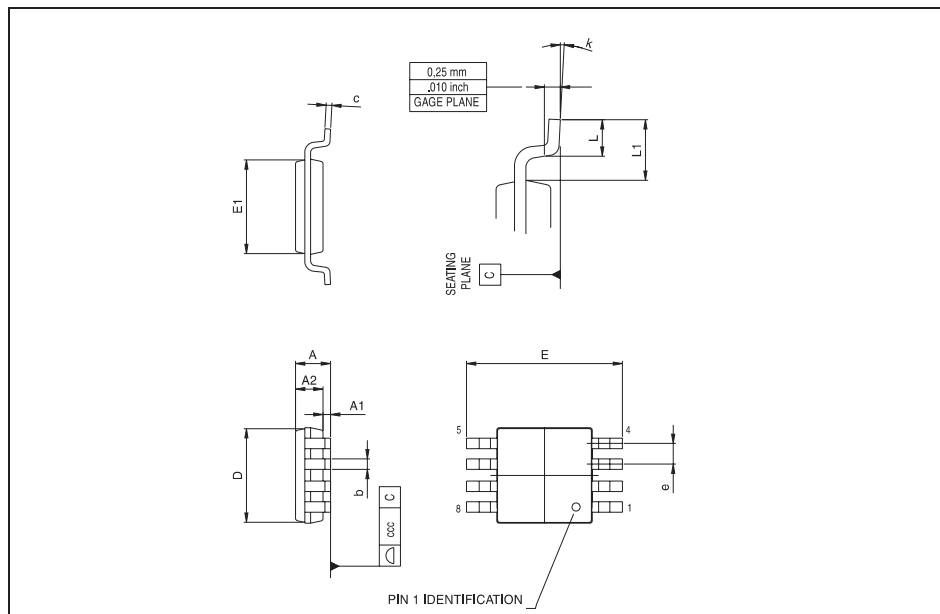
3.2 SO-8 package

| SO-8 MECHANICAL DATA |           |      |      |       |       |       |
|----------------------|-----------|------|------|-------|-------|-------|
| DIM.                 | mm.       |      |      | inch  |       |       |
|                      | MIN.      | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A                    | 1.35      |      | 1.75 | 0.053 |       | 0.069 |
| A1                   | 0.10      |      | 0.25 | 0.04  |       | 0.010 |
| A2                   | 1.10      |      | 1.65 | 0.043 |       | 0.065 |
| B                    | 0.33      |      | 0.51 | 0.013 |       | 0.020 |
| C                    | 0.19      |      | 0.25 | 0.007 |       | 0.010 |
| D                    | 4.80      |      | 5.00 | 0.189 |       | 0.197 |
| E                    | 3.80      |      | 4.00 | 0.150 |       | 0.157 |
| e                    |           | 1.27 |      |       | 0.050 |       |
| H                    | 5.80      |      | 6.20 | 0.228 |       | 0.244 |
| h                    | 0.25      |      | 0.50 | 0.010 |       | 0.020 |
| L                    | 0.40      |      | 1.27 | 0.016 |       | 0.050 |
| k                    | 8° (max.) |      |      |       |       |       |
| ddd                  |           |      | 0.1  |       |       | 0.04  |



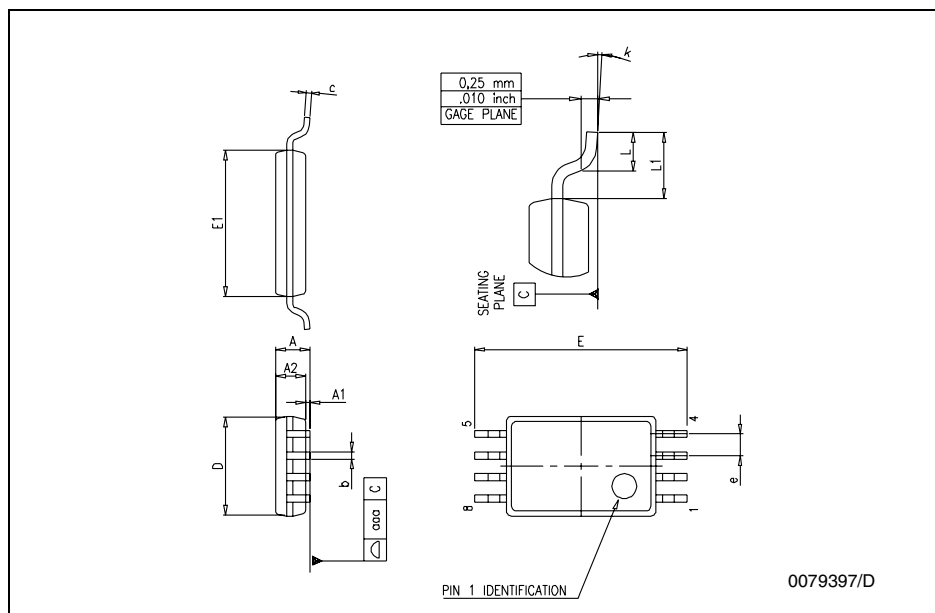
3.3 Mini SO-8 package

| miniSO-8 MECHANICAL DATA |      |      |      |       |       |       |
|--------------------------|------|------|------|-------|-------|-------|
| DIM.                     | mm.  |      |      | inch  |       |       |
|                          | 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 | 0.031 | 0.037 |
| b                        | 0.25 | 0.33 | 0.40 | 0.010 | 0.13  | 0.013 |
| 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 | .0114 | 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 |



3.4 TSSOP8 package

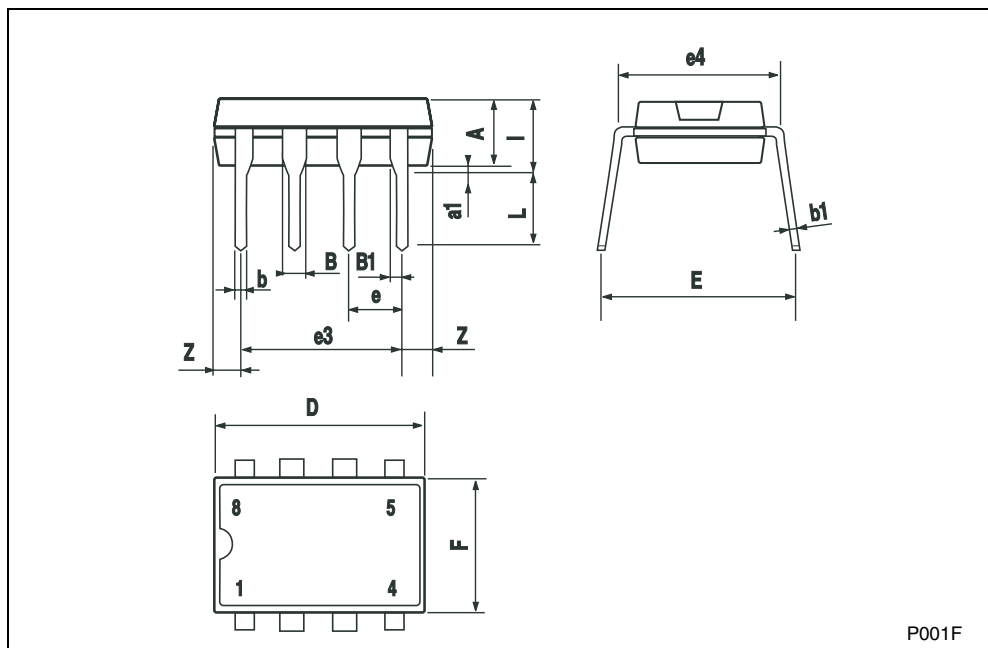
| TSSOP8 MECHANICAL DATA |      |      |      |       |        |       |
|------------------------|------|------|------|-------|--------|-------|
| DIM.                   | mm.  |      |      | inch  |        |       |
|                        | MIN. | TYP  | MAX. | MIN.  | TYP.   | MAX.  |
| A                      |      |      | 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  |       |



3.5 DIP8 package

**Plastic DIP-8 MECHANICAL DATA**

| DIM. | mm.  |      |      | inch  |       |       |
|------|------|------|------|-------|-------|-------|
|      | MIN. | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |      | 3.3  |      |       | 0.130 |       |
| a1   | 0.7  |      |      | 0.028 |       |       |
| B    | 1.39 |      | 1.65 | 0.055 |       | 0.065 |
| B1   | 0.91 |      | 1.04 | 0.036 |       | 0.041 |
| b    |      | 0.5  |      |       | 0.020 |       |
| b1   | 0.38 |      | 0.5  | 0.015 |       | 0.020 |
| D    |      |      | 9.8  |       |       | 0.386 |
| E    |      | 8.8  |      |       | 0.346 |       |
| e    |      | 2.54 |      |       | 0.100 |       |
| e3   |      | 7.62 |      |       | 0.300 |       |
| e4   |      | 7.62 |      |       | 0.300 |       |
| F    |      |      | 7.1  |       |       | 0.280 |
| l    |      |      | 4.8  |       |       | 0.189 |
| L    |      | 3.3  |      |       | 0.130 |       |
| Z    | 0.44 |      | 1.6  | 0.017 |       | 0.063 |

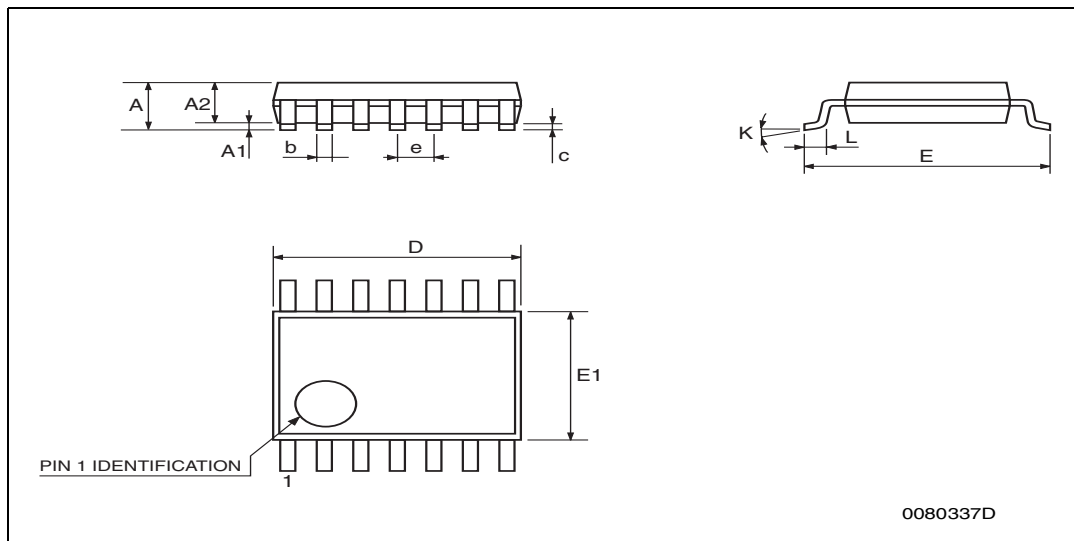




3.6 TSSOP14 package

**TSSOP14 MECHANICAL DATA**

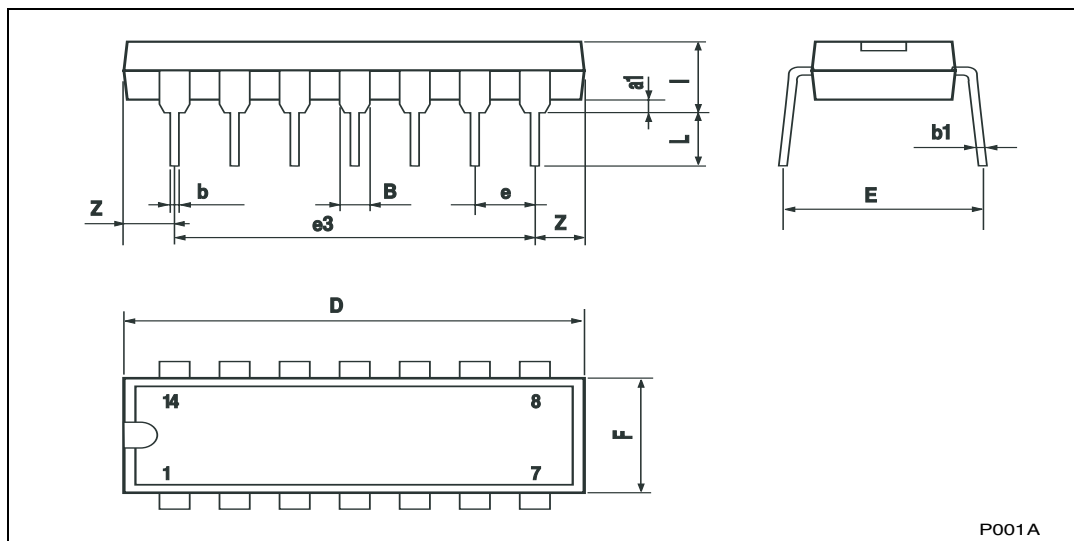
| DIM. | mm.  |          |      | inch  |            |        |
|------|------|----------|------|-------|------------|--------|
|      | MIN. | TYP      | MAX. | MIN.  | TYP.       | MAX.   |
| A    |      |          | 1.2  |       |            | 0.047  |
| A1   | 0.05 |          | 0.15 | 0.002 | 0.004      | 0.006  |
| A2   | 0.8  | 1        | 1.05 | 0.031 | 0.039      | 0.041  |
| b    | 0.19 |          | 0.30 | 0.007 |            | 0.012  |
| c    | 0.09 |          | 0.20 | 0.004 |            | 0.0089 |
| D    | 4.9  | 5        | 5.1  | 0.193 | 0.197      | 0.201  |
| E    | 6.2  | 6.4      | 6.6  | 0.244 | 0.252      | 0.260  |
| E1   | 4.3  | 4.4      | 4.48 | 0.169 | 0.173      | 0.176  |
| e    |      | 0.65 BSC |      |       | 0.0256 BSC |        |
| K    | 0°   |          | 8°   | 0°    |            | 8°     |
| L    | 0.45 | 0.60     | 0.75 | 0.018 | 0.024      | 0.030  |



3.7 DIP14 package

**Plastic DIP-14 MECHANICAL DATA**

| DIM. | mm.  |       |      | inch  |       |       |
|------|------|-------|------|-------|-------|-------|
|      | MIN. | TYP.  | MAX. | MIN.  | TYP.  | MAX.  |
| a1   | 0.51 |       |      | 0.020 |       |       |
| B    | 1.39 |       | 1.65 | 0.055 |       | 0.065 |
| b    |      | 0.5   |      |       | 0.020 |       |
| b1   |      | 0.25  |      |       | 0.010 |       |
| D    |      |       | 20   |       |       | 0.787 |
| E    |      | 8.5   |      |       | 0.335 |       |
| e    |      | 2.54  |      |       | 0.100 |       |
| e3   |      | 15.24 |      |       | 0.600 |       |
| F    |      |       | 7.1  |       |       | 0.280 |
| l    |      |       | 5.1  |       |       | 0.201 |
| L    |      | 3.3   |      |       | 0.130 |       |
| Z    | 1.27 |       | 2.54 | 0.050 |       | 0.100 |

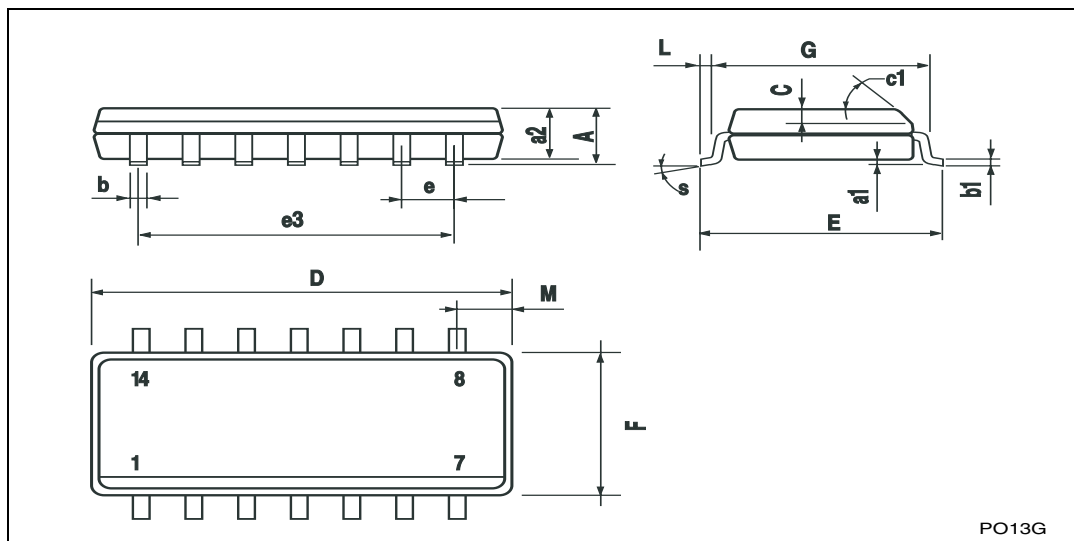


P001A

3.8 SO-14 package

**SO-14 MECHANICAL DATA**

| DIM. | mm.        |      |      | inch  |       |       |
|------|------------|------|------|-------|-------|-------|
|      | MIN.       | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    |            |      | 1.75 |       |       | 0.068 |
| a1   | 0.1        |      | 0.2  | 0.003 |       | 0.007 |
| a2   |            |      | 1.65 |       |       | 0.064 |
| b    | 0.35       |      | 0.46 | 0.013 |       | 0.018 |
| b1   | 0.19       |      | 0.25 | 0.007 |       | 0.010 |
| C    |            | 0.5  |      |       | 0.019 |       |
| c1   | 45° (typ.) |      |      |       |       |       |
| D    | 8.55       |      | 8.75 | 0.336 |       | 0.344 |
| E    | 5.8        |      | 6.2  | 0.228 |       | 0.244 |
| e    |            | 1.27 |      |       | 0.050 |       |
| e3   |            | 7.62 |      |       | 0.300 |       |
| F    | 3.8        |      | 4.0  | 0.149 |       | 0.157 |
| G    | 4.6        |      | 5.3  | 0.181 |       | 0.208 |
| L    | 0.5        |      | 1.27 | 0.019 |       | 0.050 |
| M    |            |      | 0.68 |       |       | 0.026 |
| S    | B° (max.)  |      |      |       |       |       |



#### 4 Revision History

| Date         | Revision | Description of Changes  |
|--------------|----------|---|
| January 2002 | 1        | First Release   |
| March 2005   | 2        | Modifications on AMR <a href="#">Table 1 on page 2</a> (explanation of Vid and Vi limits) |

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