

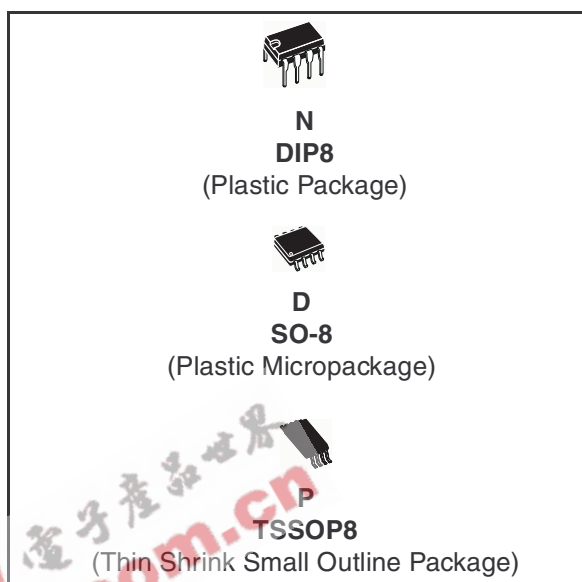
## Micropower Dual CMOS Voltage Comparators

- Extremely low supply current: **9µA typ/comp.**
- Wide single supply range **2.7V to 16V** or dual supplies ( $\pm 1.35V$  to  $\pm 8V$ )
- Extremely low input bias current: **1pA typ.**
- Extremely low input offset current: **1pA typ.**
- Input common-mode voltage range includes GND
- High input impedance:  $10^{12}\Omega$  typ
- Fast response time: 2.5µs typ. for 5mV overdrive
- Pin-to-pin and functionally compatible with bipolar LM393

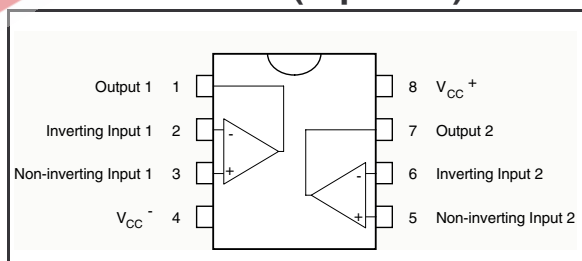
### Description

The TS393 is a micropower CMOS dual voltage comparator with extremely low consumption of 9µA typ / comparator (20 times less than bipolar LM339). Similar performances are offered by the quad micropower comparator TS3702 with a push-pull CMOS output.

Thus response times remain similar to the LM393.



### Pin Connection (top view)



### Order Codes

| Part Number   | Temperature Range | Package                                 | Packaging           | Marking |
|---------------|-------------------|---|---------------------|---------|
| TS393CN       | 0°C, +70°C        | DIP84                                   | Tube                | TS393CN |
| TS393CD/CDT   |                   | SO-8                                    | Tube or Tape & Reel | S399C   |
| TS393MD/MDT   | -55°C, +125°C     | SO-8                                    | Tube or Tape & Reel | S393M   |
| TS393IN       | -40°C, +125°C     | DIP8                                    | Tube                | TS393IN |
| TS393ID/IDT   |                   | SO-8                                    | Tube or Tape & Reel | S393I   |
| TS393IPT      |                   | TSSOP8<br>(Thin Shrink Outline Package) | Tape & Reel         | S393I   |
| TS393IYD/IYDT | -40°C, +125°C     | SO-8 (automotive grade level)           | Tube or Tape & Reel | S393IY  |

# 1 Absolute Maximum Ratings

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

| Symbol     | Parameter   | Value       | Unit |
|------------|---|-------------|------|
| $V_{CC}^+$ | Supply Voltage <sup>(1)</sup>                                     | 18          | V    |
| $V_{id}$   | Differential Input Voltage <sup>(2)</sup>                         | ±18         | V    |
| $V_i$      | Input Voltage <sup>(3)</sup>                                      | 18          | V    |
| $V_o$      | Output Voltage  | 18          | V    |
| $I_o$      | Output Current  | 20          | mA   |
| $I_F$      | Forward Current in ESD Protection Diodes on Inputs <sup>(4)</sup> | 50          | mA   |
| $P_d$      | Power Dissipation <sup>(5)</sup> DIP8                             | 1250        | mW   |
|            | SO8   | 710         |      |
|            | TSSOP8  | 625         |      |
| $T_{stg}$  | Storage Temperature Range   | -65 to +150 | °C   |
| ESD        | HBM: Human Body Model <sup>(6)</sup>                              | 50          | V    |
|            | MM: Machine Model <sup>(7)</sup>                                  | 40          | V    |
|            | CDM: Charged Device Model   | 1           | kV   |

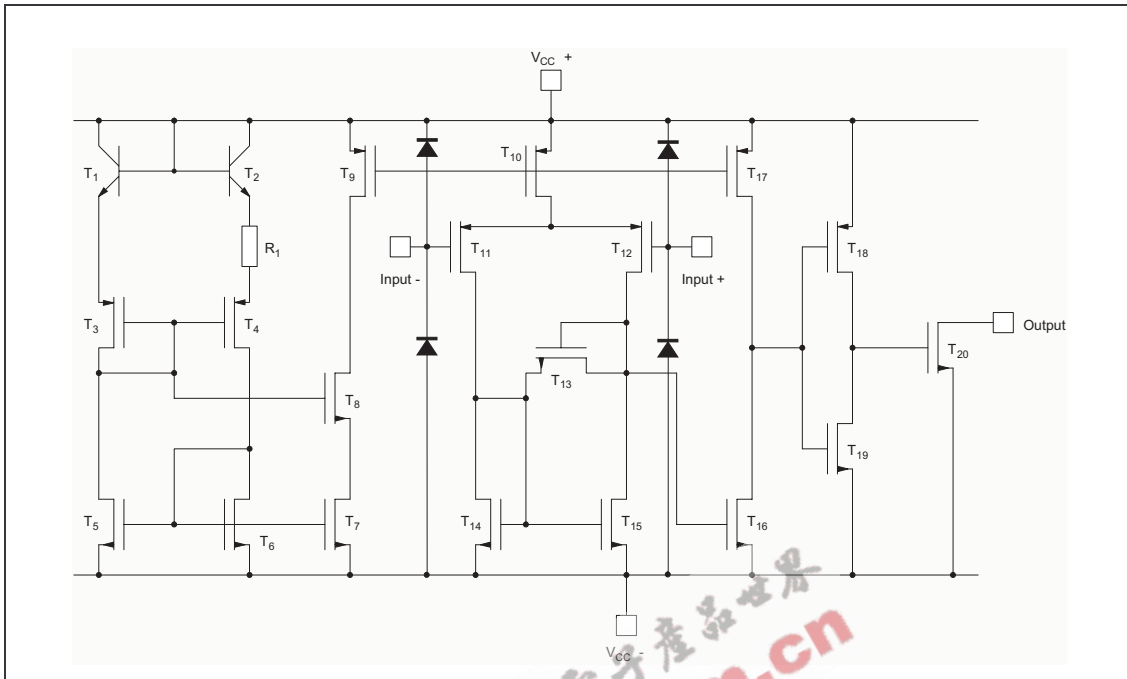
1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage [ $V_{icm}=(V_{in}^+ + V_{in}^-)/2$ ] remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes (IF) of the input stage must strictly be observed.
4. Guaranteed by design.
5.  $P_d$  is calculated with  $T_{amb} = +25^{\circ}C$ ,  $T_j = +150^{\circ}C$  and  $R_{thja} = 80^{\circ}C/W$  for DIP14 package =  $150^{\circ}C/W$  for SO14 package =  $175^{\circ}C/W$  for TSSOP14 package
6. Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.
7. 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 |
|------------|--|--|------|
| $V_{CC}^+$ | Supply Voltage<br>TS393C,I<br>TS393M                               | 2.7 to 16<br>4 to 16                   | V    |
| $V_{icm}$  | Common Mode Input Voltage Range                                    | 0 to $V_{CC}^+ - 1.5$                  | V    |
| $T_{oper}$ | Operating Free-Air Temperature range<br>TS393C<br>TS393I<br>TS393M | 0 to +70<br>-40 to +125<br>-55 to +125 | °C   |

## 2 Typical Application Schematics

Figure 1. Schematic diagram (for 1/2 TS393)



### 3 Electrical Characteristics

Table 3.  $V_{CC}^+ = 3V$ ,  $V_{CC}^- = 0V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

| Symbol    | Parameter   | Min.   | Typ.        | Max.                                 | Unit    |
|-----------|---|--------|-------------|--------------------------------------|---------|
| $V_{io}$  | Input Offset Voltage <sup>(1)</sup><br>$V_{ic} = 1.5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                             |        |             | 5<br>6.5                             | mV      |
| $I_{io}$  | Input Offset Current <sup>(2)</sup><br>$V_{ic} = 1.5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                             |        | 1           | 300                                  | pA      |
| $I_{ib}$  | Input Bias Current <sup>(2)</sup><br>$V_{ic} = 1.5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                               |        | 1           | 600                                  | pA      |
| $V_{icm}$ | Input Common Mode Voltage Range<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  | 0<br>0 |             | $V_{CC}^+ - 1.2$<br>$V_{CC}^+ - 1.5$ | V       |
| CMR       | Common-mode Rejection Ratio<br>$V_{ic} = V_{icm \text{ min.}}$  |        | 70          |                                      | dB      |
| SVR       | Supply Voltage Rejection Ratio<br>$V_{CC}^+ = 3V \text{ to } 5V$  |        | 70          |                                      | dB      |
| $I_{OH}$  | High Level Output Current<br>$V_{id} = +1V$ , $V_{OH} = 3V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                        |        | 2           | 40<br>1000                           | nA      |
| $V_{OL}$  | Low Level Output Voltage<br>$V_{id} = -1V$ , $I_{OL} = +6mA$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                       |        | 400         | 550<br>800                           | mV      |
| $I_{CC}$  | Supply Current (each comparator)<br>No load - Outputs low<br>$T_{min.} \leq T_{amb} \leq T_{max.}$                          |        | 9           | 20<br>25                             | $\mu A$ |
| $t_{PLH}$ | Response Time Low to High<br>$V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ , Overdrive = 5mV<br>TTL Input |        | 1.5<br>0.7  |                                      | $\mu s$ |
| $t_{PHL}$ | Response Time High to Low<br>$V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ , Overdrive = 5mV<br>TTL Input |        | 2.5<br>0.08 |                                      | $\mu s$ |

1. The specified offset voltage is the maximum value required to drive the output up to 2.5V or down to 0.3V.
2. Maximum values including unavoidable inaccuracies of the industrial test.

Table 4.  $V_{CC}^+ = 5V$ ,  $V_{CC}^- = 0V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

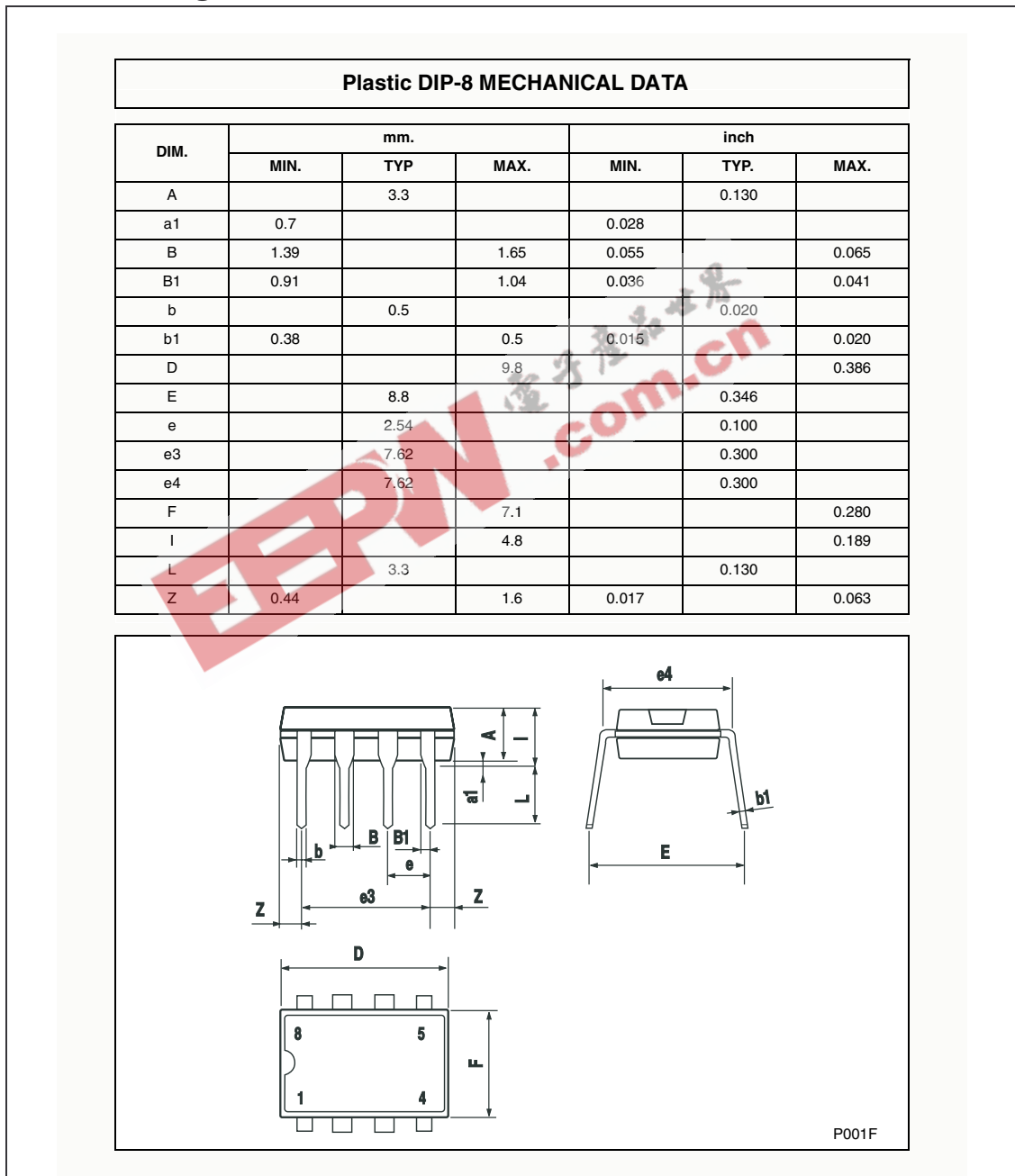
| Symbol    | Parameter  | Min.   | Typ.                             | Max.                                 | Unit    |
|-----------|--|--------|----------------------------------|--------------------------------------|---------|
| $V_{io}$  | Input Offset Voltage <sup>(1)</sup><br>$V_{ic} = 2.5V$ , $V_{CC}^+ = 5V$ to $10V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   |        | 1.4                              | 5<br>6.5                             | mV      |
| $I_{io}$  | Input Offset Current <sup>(2)</sup><br>$V_{ic} = 2.5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  |        | 1                                | 300                                  | pA      |
| $I_{ib}$  | Input Bias Current <sup>(2)</sup><br>$V_{ic} = 2.5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  |        | 1                                | 600                                  | pA      |
| $V_{icm}$ | Input Common Mode Voltage Range<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   | 0<br>0 |                                  | $V_{CC}^+ - 1.2$<br>$V_{CC}^+ - 1.5$ | V       |
| CMR       | Common-mode Rejection Ratio<br>$V_{ic} = 0V$   |        | 71                               |                                      | dB      |
| SVR       | Supply Voltage Rejection Ratio<br>$V_{CC}^+ = +5V$ to $+10V$   |        | 80                               |                                      | dB      |
| $I_{OH}$  | High Level Output Voltage<br>$V_{id} = 1V$ , $V_{OH} = +5V$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   |        | 2                                | 40<br>1000                           | nA      |
| $V_{OL}$  | Low Level Output Voltage<br>$V_{id} = -1V$ , $I_{OL} = 6mA$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   |        | 260                              | 400<br>650                           | mV      |
| $I_{CC}$  | Supply Current (each comparator)<br>No load - Outputs low<br>$T_{min.} \leq T_{amb} \leq T_{max.}$   |        | 10                               | 20<br>25                             | $\mu A$ |
| $t_{PLH}$ | Response Time Low to High<br>$V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ ,<br>Overdrive = 5mV<br>Overdrive = 10mV<br>Overdrive = 20mV<br>Overdrive = 40mV<br>TTL Input |        | 1.5<br>1.2<br>1.0<br>0.8<br>0.7  |                                      | $\mu s$ |
| $t_{PHL}$ | Response Time High to Low<br>$V_{ic} = 0V$ , $f = 10kHz$ , $R_L = 5.1k\Omega$ , $C_L = 50pF$ ,<br>Overdrive = 5mV<br>Overdrive = 10mV<br>Overdrive = 20mV<br>Overdrive = 40mV<br>TTL Input |        | 2.5<br>1.9<br>1.2<br>0.8<br>0.08 |                                      | $\mu s$ |
| $t_f$     | Fall time<br>$f = 10kHz$ , $C_L = 50pF$ , $R_L = 5.1k\Omega$ , Overdrive 50mV  |        | 25                               |                                      | as      |

1. The specified offset voltage is the maximum value required to drive the output up to 4.5V or down to 0.3V.
2. Maximum values including unavoidable inaccuracies of the industrial test.

## 4 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

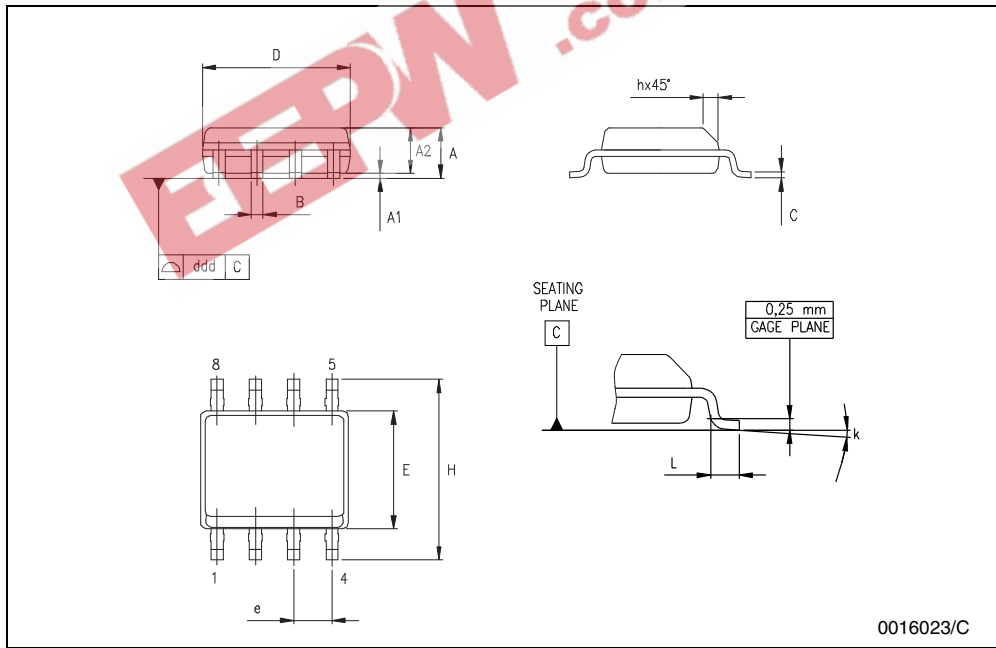
### 4.1 DIP8 Package



4.2 SO-8 Package

**SO-8 MECHANICAL DATA**

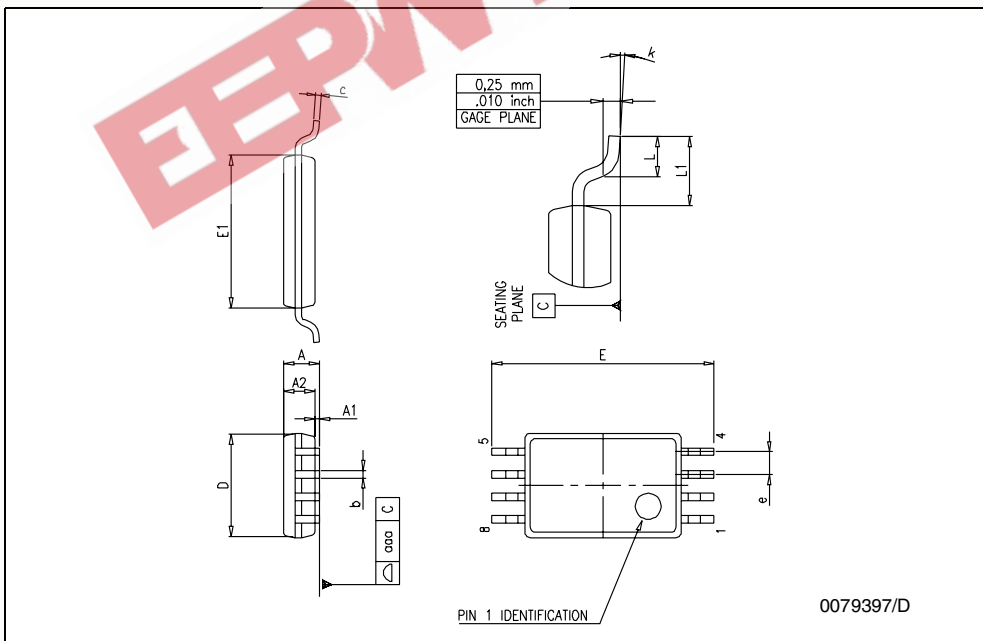
| DIM. | mm.       |      |      | inch  |       |       |
|------|-----------|------|------|-------|-------|-------|
|      | MIN.      | TYP  | MAX. | MIN.  | TYP.  | MAX.  |
| A    | 1.35      |      | 1.75 | 0.053 |       | 0.069 |
| A1   | 0.10      |      | 0.25 | 0.04  |       | 0.010 |
| A2   | 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  |



### 4.3 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  |       |





## 5 Revision History

| Date      | Revision | Changes  |
|-----------|----------|--|
| Jan. 2003 | 1        | Initial release.   |
| July 2005 | 2        | 1 - PPAP references inserted in the datasheet see <i>Table : Order Codes on page 1</i> .<br>2 - ESD protection inserted in <i>Table 1: Key parameters and their absolute maximum ratings on page 2</i> . |

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