

Micropower dual CMOS voltage comparators

Datasheet – production data

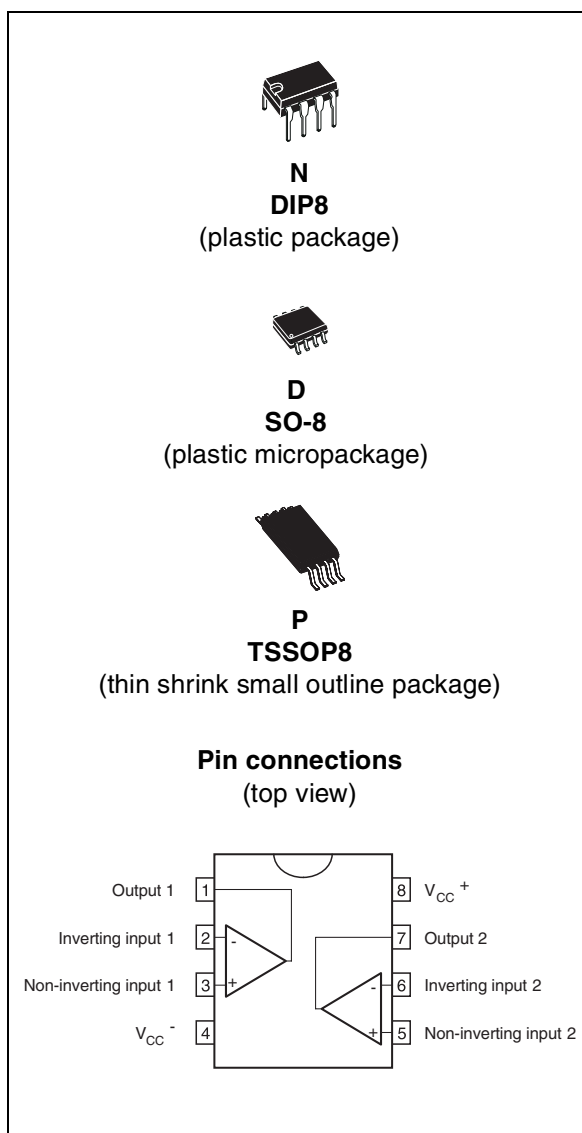
Features

- Extremely low supply current: typically 9 μA per comparator
- Wide single supply range 2.7 V to 16 V or dual supplies (± 1.35 V to ± 8 V)
- Extremely low input bias current: 1 pA typical
- Extremely low input offset current: 1 pA typical
- Input common-mode voltage range includes ground
- High input impedance: 10^{12} Ω typ.
- Fast response time: 2.5 μs typ. for 5 mV overdrive
- Pin-to-pin and functionally compatible with dual bipolar LM393

Description

The TS393 device is a micropower CMOS dual voltage comparator with extremely low consumption of 9 μA typically per comparator (20 times less than the dual bipolar LM393 device). Similar performance is offered by the dual micropower comparator TS3702 with a push-pull CMOS output.

Thus response times remain similar to the LM393 device.



1 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

| Symbol | Parameter | Value | Unit |
|------------|---|-------------|------|
| V_{CC}^+ | Supply voltage ⁽¹⁾ | 18 | V |
| V_{id} | Differential input voltage ⁽²⁾ | ±18 | V |
| V_{in} | Input voltage ⁽³⁾ | 18 | V |
| V_o | Output voltage | 18 | V |
| I_o | Output current | 20 | mA |
| I_F | Forward current in ESD protection diodes on inputs ⁽⁴⁾ | 50 | mA |
| T_j | Maximum junction temperature | 150 | °C |
| R_{thja} | Thermal resistance junction-to-ambient ⁽⁵⁾ | | °C/W |
| | DIP8 | 85 | |
| | SO-8 TSSOP8 | 125 120 | |
| R_{thjc} | Thermal resistance junction-to-case ⁽⁵⁾ | | °C/W |
| | DIP8 | 41 | |
| | SO-8 TSSOP8 | 40 37 | |
| T_{stg} | Storage temperature range | -65 to +150 | °C |
| ESD | HBM: human body model ⁽⁶⁾ | 500 | V |
| | MM: machine model ⁽⁷⁾ | 200 | V |
| | CDM: charged device model ⁽⁸⁾ | 1 | kV |

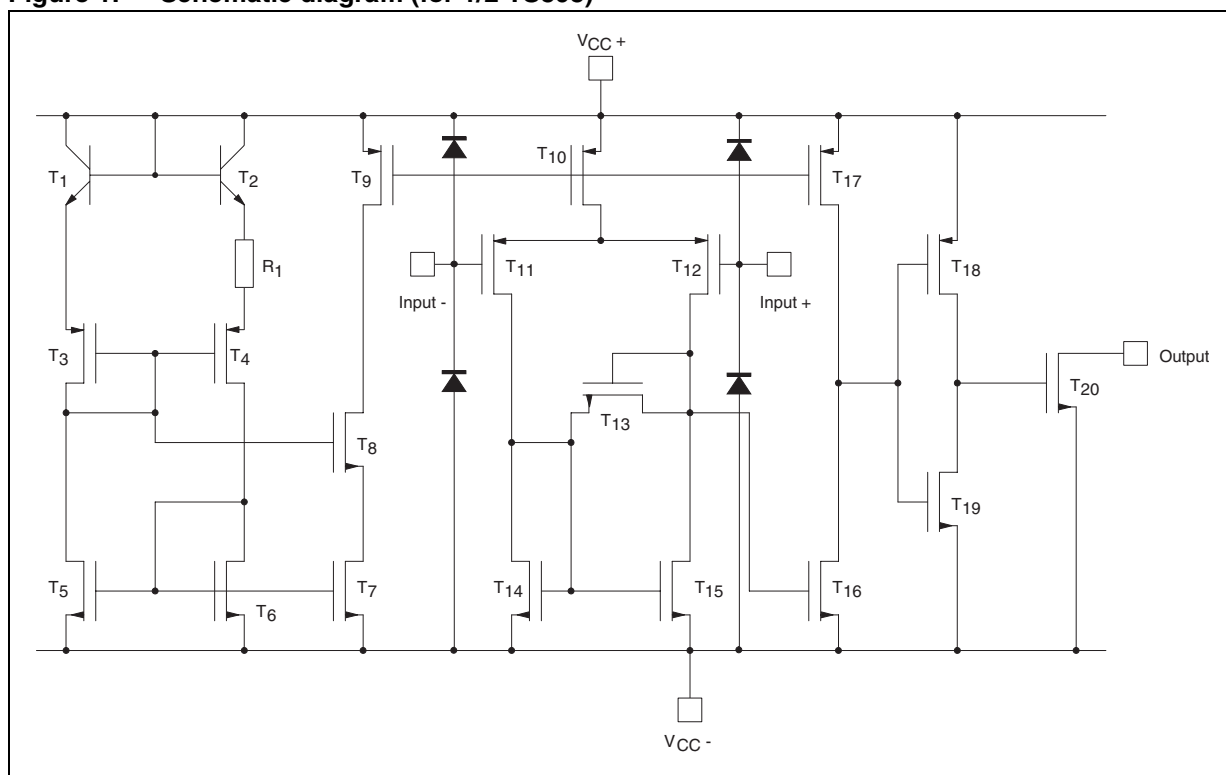
1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. Excursions of input voltages may exceed the power supply level. As long as the common mode voltage $[V_{icm} = (V_{in}^+ + V_{in}^-)/2]$ remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes (I_F) of the input stage must strictly be observed.
4. Guaranteed by design.
5. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
6. 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.
7. 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.
8. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|------------|--|--|------|
| V_{CC}^+ | Supply voltage TS393C, TS393I | 2.7 to 16 | V |
| V_{icm} | Common mode input voltage range $T_{min} \leq T_{amb} \leq T_{max}$ | 0 to $V_{CC}^+ - 1.5$ 0 to $V_{CC}^+ - 2$ | V |
| T_{oper} | Operating free air temperature range TS393C TS393I | 0 to +70 -40 to +125 | °C |

2 Schematic diagram

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



3 Electrical characteristics

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|------------------|--|------|-------------|------------|---------------|
| V_{io} | Input offset voltage ⁽¹⁾ $V_{\text{ic}} = 1.5\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | | 5 6.5 | mV |
| I_{io} | Input offset current ⁽²⁾ $V_{\text{ic}} = 1.5\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 1 | 300 | pA |
| I_{ib} | Input bias current ⁽²⁾ $V_{\text{ic}} = 1.5\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 1 | 600 | pA |
| CMR | Common-mode rejection ratio $V_{\text{ic}} = V_{\text{icm-min}}$ | | 70 | | dB |
| SVR | Supply voltage rejection ratio $V_{CC}^+ = 3\text{ V to }5\text{ V}$ | | 70 | | dB |
| I_{OH} | High level output current $V_{\text{id}} = +1\text{ V}$, $V_{\text{OH}} = 3\text{ V}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 2 | 40 1000 | nA |
| V_{OL} | Low level output voltage $V_{\text{id}} = -1\text{ V}$, $I_{\text{OL}} = +6\text{ mA}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 400 | 550 800 | mV |
| I_{CC} | Supply current (each comparator) No load - outputs low $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 9 | 20 25 | μA |
| t_{PLH} | Response time low to high $V_{\text{ic}} = 0\text{ V}$, $f = 10\text{ kHz}$, $R_{\text{L}} = 5.1\text{ k}\Omega$, $C_{\text{L}} = 50\text{ pF}$ Overdrive = 5 mV TTL input | | 1.5 0.7 | | μs |
| t_{PHL} | Response time high to low $V_{\text{ic}} = 0\text{ V}$, $f = 10\text{ kHz}$, $R_{\text{L}} = 5.1\text{ k}\Omega$, $C_{\text{L}} = 50\text{ pF}$ Overdrive = 5 mV TTL input | | 2.5 0.08 | | μs |

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

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------|--|------|----------------------------------|------------|---------------|
| V_{io} | Input offset voltage ⁽¹⁾ $V_{ic} = 2.5\text{ V}$, $V_{CC}^+ = 5\text{ V to } 10\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1.4 | 5 6.5 | mV |
| I_{io} | Input offset current ⁽²⁾ $V_{ic} = 2.5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 | pA |
| I_{ib} | Input bias current ⁽²⁾ $V_{ic} = 2.5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 600 | pA |
| CMR | Common-mode rejection ratio $V_{ic} = 0\text{ V}$ | | 71 | | dB |
| SVR | Supply voltage rejection ratio $V_{CC}^+ = +5\text{ V to } +10\text{ V}$ | | 80 | | dB |
| I_{OH} | High level output voltage $V_{id} = 1\text{ V}$, $V_{OH} = +5\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 2 | 40 1000 | nA |
| V_{OL} | Low level output voltage $V_{id} = -1\text{ V}$, $I_{OL} = 6\text{ mA}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 260 | 400 650 | mV |
| I_{CC} | Supply current (each comparator) No load - outputs low $T_{min} \leq T_{amb} \leq T_{max}$ | | 10 | 20 25 | μA |
| t_{PLH} | Response time low to high $V_{ic} = 0\text{ V}$, $f = 10\text{ kHz}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, Overdrive = 5 mV Overdrive = 10 mV Overdrive = 20 mV Overdrive = 40 mV TTL input | | 1.5 1.2 1.0 0.8 0.7 | | μs |
| t_{PHL} | Response time high to low $V_{ic} = 0\text{ V}$, $f = 10\text{ kHz}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, Overdrive = 5 mV Overdrive = 10 mV Overdrive = 20 mV Overdrive = 40 mV TTL input | | 2.5 1.9 1.2 0.8 0.08 | | μs |
| t_f | Fall time $f = 10\text{ kHz}$, $C_L = 50\text{ pF}$, $R_L = 5.1\text{ k}\Omega$ overdrive 50 mV | | 25 | | ns |

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

4 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.

4.1 DIP8 package

Figure 2. DIP8 package outline

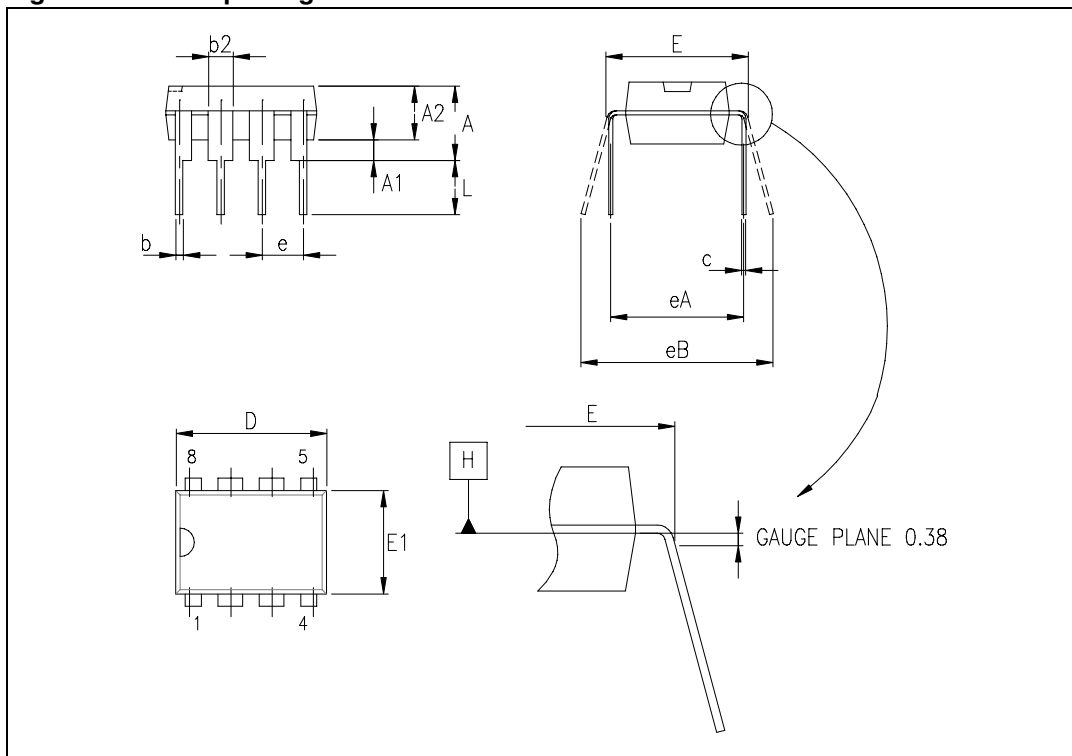


Table 5. DIP8 package mechanical data

| Symbol | 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 |

4.2 SO-8 package

Figure 3. SO-8 package outline

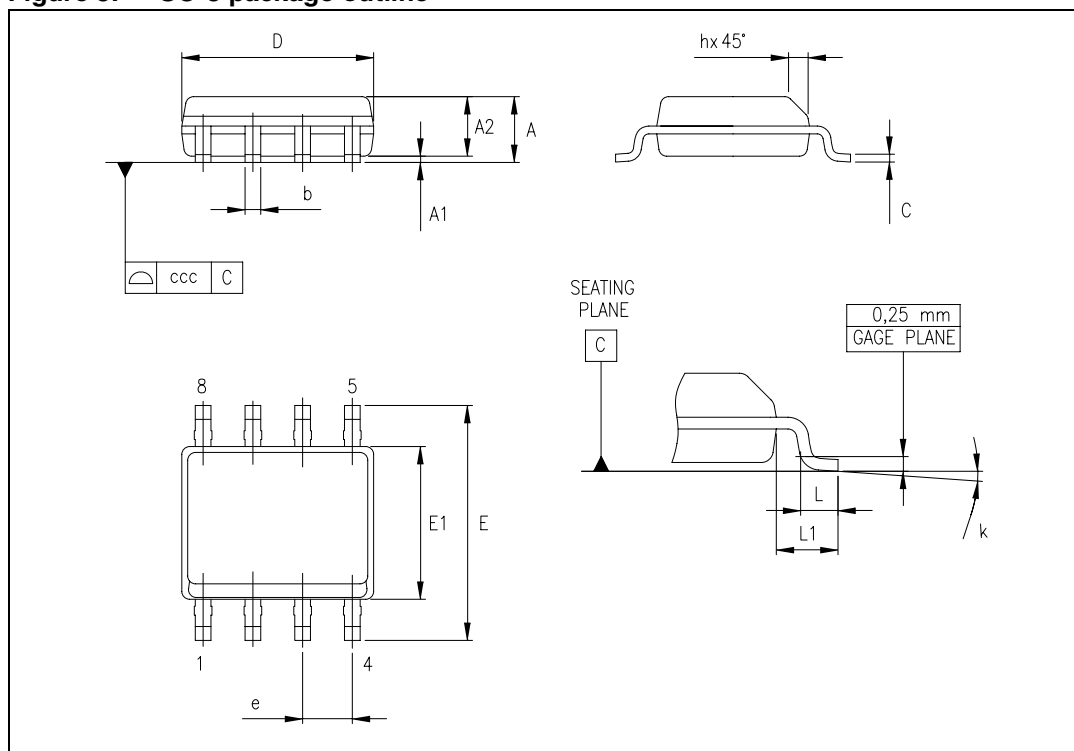


Table 6. SO-8 package mechanical data

| Symbol | 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 |

4.3 TSSOP8 package

Figure 4. TSSOP8 package outline

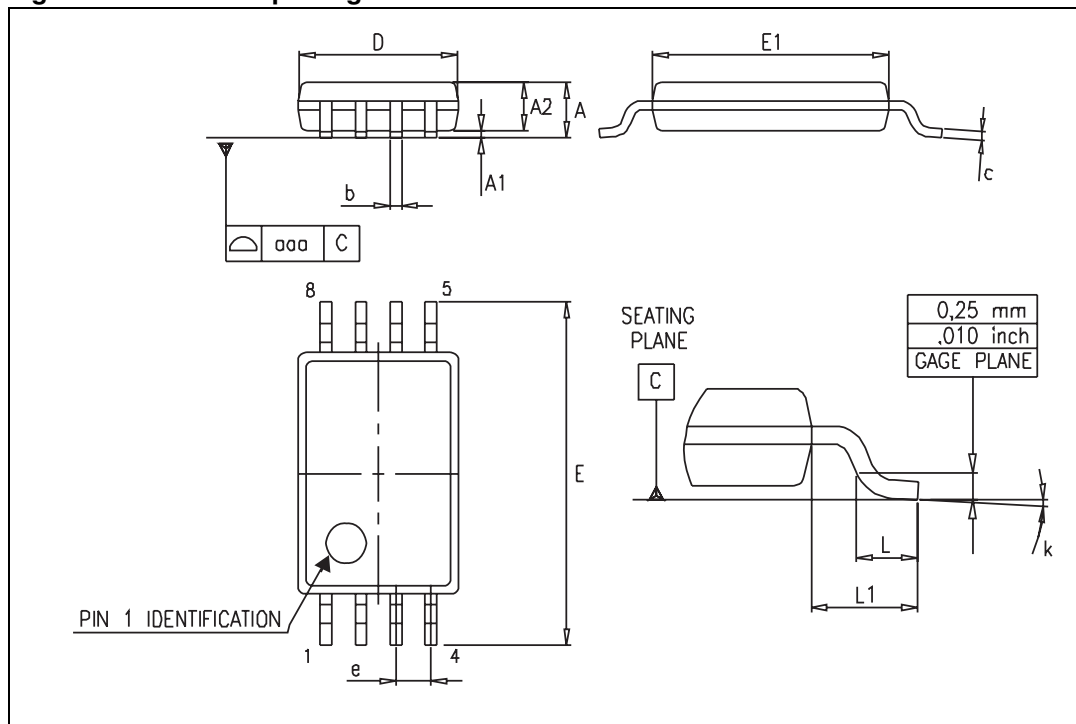


Table 7. TSSOP8 package mechanical data

| Symbol | 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 | |

5 Ordering information

Table 8. Order codes

| Order code | Temperature range | Package | Packing | Marking |
|--------------------------|-------------------|----------------------------|--------------------------|---------|
| TS393CN | 0 °C, +70 °C | DIP8 | Tube | TS393CN |
| TS393CD TS393CDT | | SO-8 | Tube or tape and reel | S393C |
| TS393IN | -40 °C, +125 °C | DIP8 | Tube | TS393IN |
| TS393ID TS393IDT | | SO-8 | Tube or tape and reel | S393I |
| TS393IPT | | TSSOP8 | Tape and reel | S393I |
| TS393IYDT ⁽¹⁾ | | SO-8 (automotive grade) | Tube or tape and reel | S393IY |

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

6 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 31-Jan-2003 | 1 | Initial release. |
| 31-Jul-2005 | 2 | PPAP references inserted in the datasheet, see order codes table. ESD protection inserted in AMR table. |
| 28-Apr-2008 | 3 | Added footnotes for automotive grade order codes in order codes table. Updated ESD values for HBM and MM. Updated document format. |
| 21-Nov-2012 | 4 | Updated ECOPACK text in Section 4: Package information . Updated Table 8 (qualified TS393IYDT and removed TS393IYD order code). Minor corrections throughout document. |

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