

Micropower dual CMOS voltage comparators

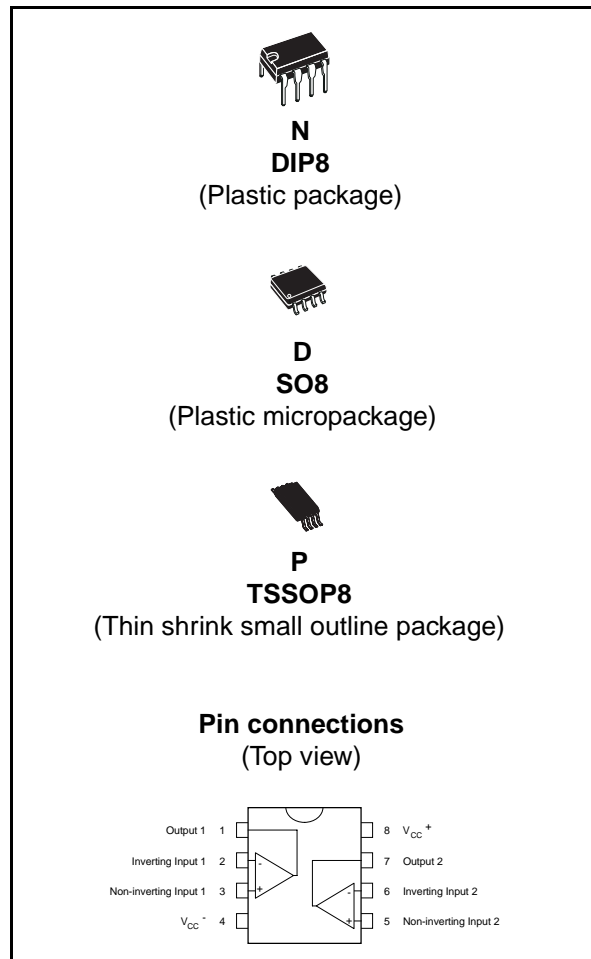
Features

- Push-pull CMOS output (no external pull-up resistor required)
- Extremely low supply current: 9 μ A typ / comparator
- Wide single supply range: 2.7V to 16V or dual supplies (± 1.35 V to ± 8 V)
- Extremely low input bias current: 1pA typ
- Extremely low input offset currents: 1pA typ
- Input common-mode voltage range includes GND
- High input impedance: 10¹² Ω typ
- Fast response time: 2 μ s typ for 5mV overdrive
- Pin-to-pin and functionally compatible with bipolar LM393

Description

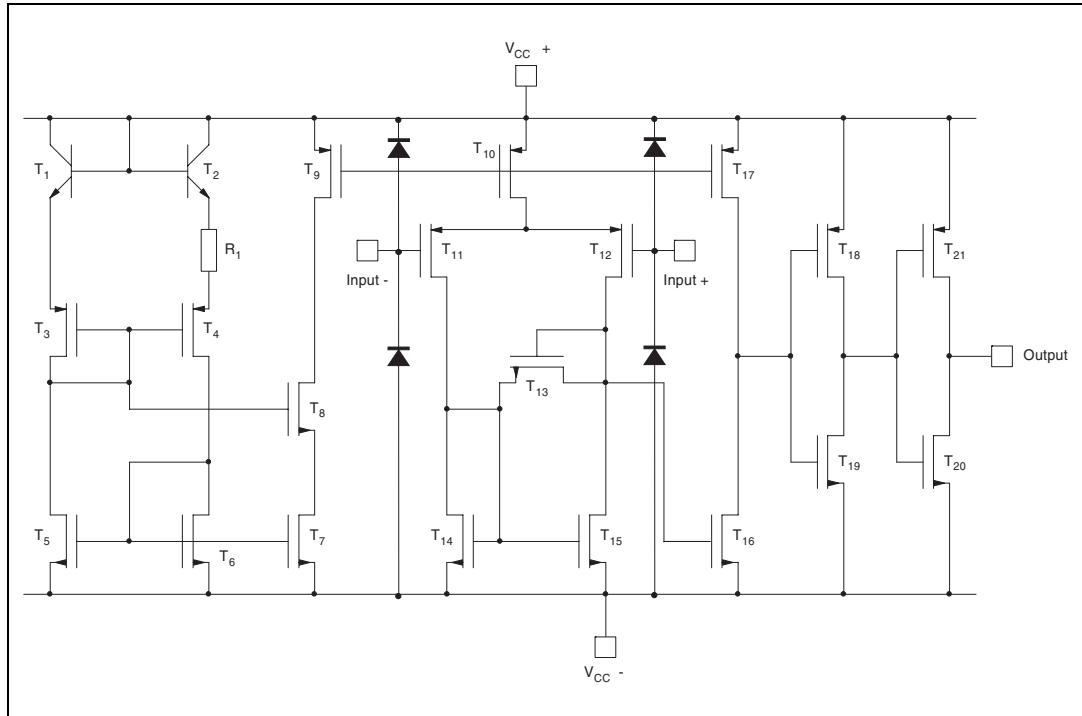
The TS3702 is a micropower CMOS dual voltage comparator with extremely low consumption of 9 μ A typ / comparator (20 times less than bipolar LM393). The push-pull CMOS output stage allows power and space saving by eliminating the external pull-up resistor required by usual open-collector output comparators.

Thus response times remain similar to the LM393.



1 Schematic diagram

Figure 1. Schematic diagram (for 1/2 TS3702)



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|--|-------------|------|
| V_{CC}^+ | Supply voltage ⁽¹⁾ | 18 | V |
| V_{id} | Differential input voltage ⁽²⁾ | ±18 | V |
| V_i | 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 input ⁽⁴⁾ | 50 | mA |
| P_d | Power dissipation ⁽⁵⁾ | | |
| | DIP8 | 1250 | mW |
| | SO8 | 710 | |
| TSSOP8 | 625 | | |
| T_{stg} | Storage temperature range | -65 to +150 | °C |
| ESD | HBM: human body model ⁽⁶⁾ | 400 | V |
| | MM: machine model ⁽⁷⁾ | 50 | V |
| | CDM: charged device model ⁽⁸⁾ | 1.5 | kV |

- All voltage values, except differential voltage, are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- The magnitude of the input and the output voltages must never exceed the magnitude of the positive and negative supply voltages.
- Guaranteed by design.
- P_d is calculated with $T_{amb} = +25^\circ\text{C}$, $T_j = +150^\circ\text{C}$ and
 $R_{thja} = 100^\circ\text{C/W}$ for DIP8 package
 $R_{thja} = 175^\circ\text{C/W}$ for SO8 package
 $R_{thja} = 200^\circ\text{C/W}$ for TSSOP8 package
- Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.
- 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 | | |
| | TS3702C, TS3702I TS3702M | 2.7 to 16 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 | | |
| | TS3702C | 0 to +70 | °C |
| | TS3702I | -40 to +125 | |
| TS3702M | -55 to +125 | | |

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 ⁽¹⁾ $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ | | | 5 6.5 | mV |
| I_{io} | Input offset current ⁽²⁾ $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 | pA |
| I_{ib} | Input bias current ⁽²⁾ $V_{ic} = 1.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 600 | pA |
| V_{icm} | Input common mode voltage range $T_{min} \leq T_{amb} \leq T_{max}$ | 0 0 | | $V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$ | V |
| CMR | Common-mode rejection ratio $V_{ic} = V_{icm\ min}$ | | 80 | | dB |
| SVR | Supply voltage rejection ratio $V_{CC}^+ = 3V$ to $5V$ | | 75 | | dB |
| V_{OH} | High level output voltage $V_{id} = 1V$, $I_{OH} = -4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ | 2 1.8 | 2.4 | | V |
| V_{OL} | Low level output voltage $V_{id} = -1V$, $I_{OL} = 4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 300 | 400 575 | mV |
| I_{CC} | Supply current (each comparator) No load - Outputs low $T_{min} \leq T_{amb} \leq T_{max}$ | | 7 | 20 25 | μA |
| t_{PLH} | Response time low to high $V_{ic} = 0V$, $f = 10kHz$, $C_L = 50pF$, overdrive = 5mV TTL input | | 1.5 0.7 | | μs |
| t_{PHL} | Response time high to low $V_{ic} = 0V$, $f = 10kHz$, $C_L = 50pF$, overdrive = 5mV TTL input | | 2.2 0.15 | | μs |

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 include unavoidable inaccuracies of the industrial tests.

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 $V_{ic} = V_{icm\ min}$, $V_{CC}^+ = 5V$ to $10V$ (1) $T_{min} \leq T_{amb} \leq T_{max}$ | | 1.2 | 5 6.5 | mV |
| I_{io} | Input offset current (2) $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 300 | pA |
| I_{ib} | Input bias current (2) $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 600 | pA |
| V_{icm} | Input common mode voltage range $T_{min} \leq T_{amb} \leq T_{max}$ | 0 0 | | $V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$ | V |
| CMR | Common-mode rejection ratio $V_{ic} = V_{icm\ min}$ | | 82 | | dB |
| SVR | Supply voltage rejection ratio $V_{CC}^+ = +5V$ to $+10V$ | | 90 | | dB |
| V_{OH} | High level output voltage $V_{id} = 1V$, $I_{OH} = -4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ | 4.5 4.3 | 4.7 | | V |
| V_{OL} | Low level output voltage $V_{id} = -1V$, $I_{OL} = 4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 200 | 300 375 | mV |
| I_{CC} | Supply current (each comparator) No load - Outputs low $T_{min} \leq T_{amb} \leq T_{max}$ | | 9 | 20 25 | μA |
| t_{PLH} | Response time low to high $V_{ic} = 0V$, $f = 10kHz$, $C_L = 50pF$, overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL input | | 1.5 1.1 0.9 0.7 0.6 | | μs |
| t_{PHL} | Response time high to low $V_{ic} = 0V$, $f = 10kHz$, $C_L = 50pF$, overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL input | | 2.2 1.6 1.1 0.75 0.17 | | μs |
| t_f | Fall time $f = 10kHz$, $C_L = 50pF$, overdrive 50mV | | 30 | | ns |

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 include unavoidable inaccuracies of the industrial tests.

4 Package information

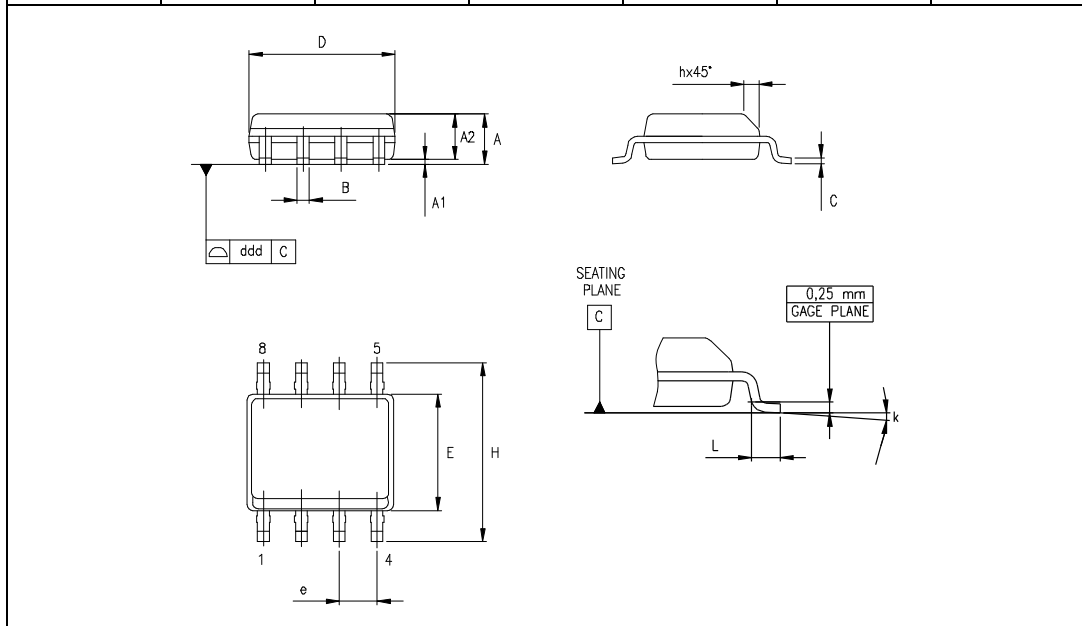
In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK[®] packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97.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

4.1 DIP8 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | 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 |
| I | | | 4.8 | | | 0.189 |
| L | | 3.3 | | | 0.130 | |
| Z | 0.44 | | 1.6 | 0.017 | | 0.063 |

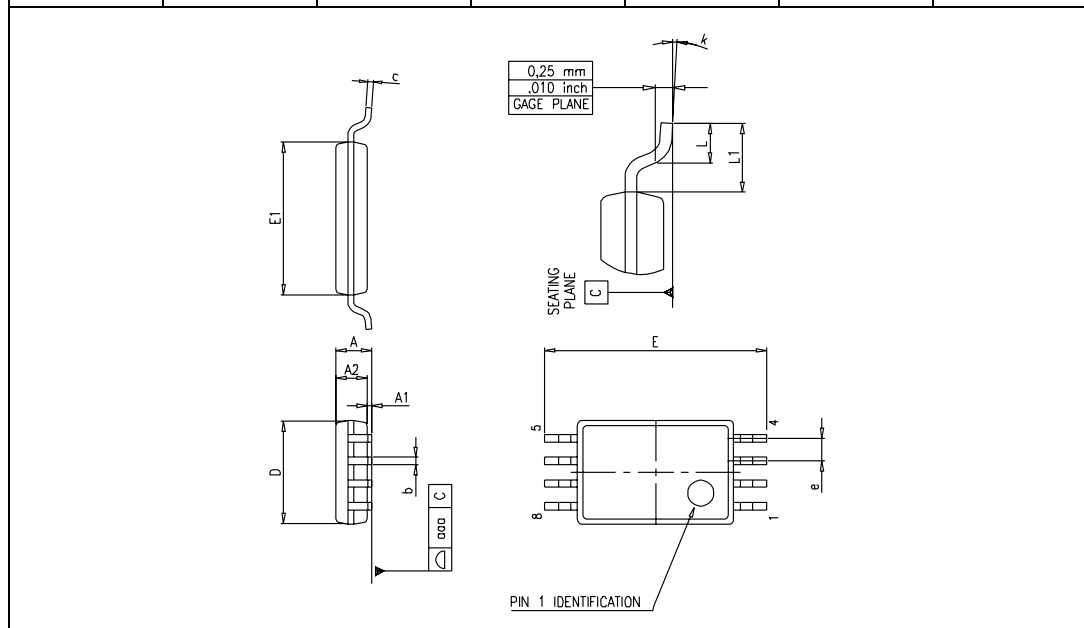
4.2 SO8 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | 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 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 | |



5 Ordering information

Table 5. Order codes

| Part number | Temperature range | Package | Packaging | Marking |
|--------------|-------------------|---------|---------------------|----------|
| TS3702CN | 0°C, +70°C | DIP8 | Tube | TS3702CN |
| TS3702CD/CDT | | SO8 | Tube or tape & reel | 3702C |
| TS3702IN | -40°C, +125°C | DIP8 | Tube | TS3702IN |
| TS3702ID/IDT | | SO8 | Tube or tape & reel | 3702I |
| TS3702IPT | | TSSOP8 | Tape & reel | 3702I |
| TS3702MN | -55°C, +125°C | DIP8 | Tube | TS3702MN |
| TS3702MD/MDT | | SO8 | Tube or tape & reel | 3702M |
| TS3702MPT | | TSSOP8 | Tape & reel | 3702M |

6 Revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 2-Jan-2003 | 1 | First release. |
| 2-May-2005 | 2 | PPAP references inserted in the datasheet, see Section 5: Ordering information on page 10 . |
| 26-Feb-2007 | 3 | PPAP references removed. ESD data added to Table 1 on page 3 . Order codes added to Table 5 on page 10 . |

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