



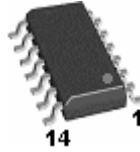
# TS339

## Quad Voltage Comparator

DIP-14



SOP-14



Pin assignment:

- |                |                 |
|----------------|-----------------|
| 1. Output 2    | 14. Output 3    |
| 2. Output 1    | 13. Output 4    |
| 3. Vcc         | 12. Input D (+) |
| 4. Input 1(-)  | 11. Input 4(+)  |
| 5. Input 1(+)  | 10. Input 4(-)  |
| 6. Input 2 (-) | 9. Input 3(+)   |
| 7. Input 2(+)  | 8. Input 3 (-)  |

**Supply Voltage Range -18 V to 18V**  
**Quad Channel Comparator**

### General Description

The TS339 is quad independent precision voltage comparators capable of single-supply or split-supply operation. The specifications as low as 2.0 mV make this device an excellent ground level with single-supply operation. Input offset-voltage selection for many applications in consumer automotive, and It is designed to permit a common mode range-to- industrial electronics.

The TS339 is offered in SOP-14 and DIP-14 package.

### Features

- ◇ Output voltage compatible with DTL, ECL, TTL, MOS and CMOS Logic Levels
- ◇ Low input bias current -25nA
- ◇ Low input offset current  $\pm 5\text{nA}$
- ◇ Low input offset voltage  $\pm 5\text{mV}(\text{max})$
- ◇ Input common mode range to ground level
- ◇ Differential input voltage range equal to power supply voltage

### Ordering Information

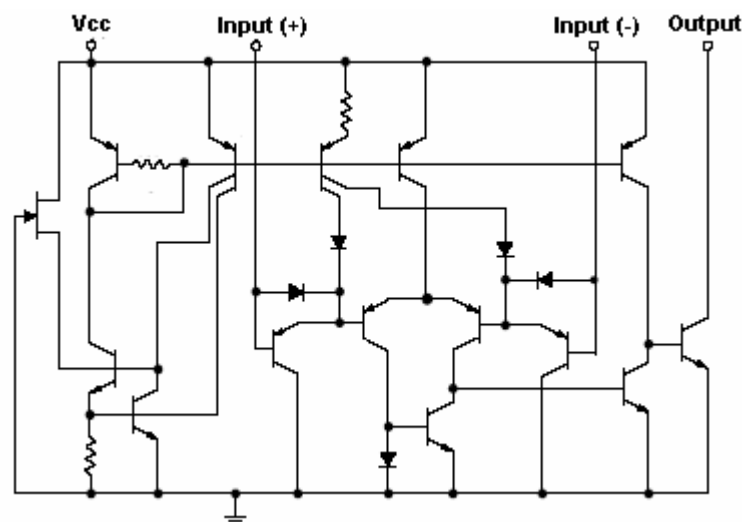
| Part No. | Operating Temp. | Package |
|----------|-----------------|---------|
| TS339CD  | 0 ~ +70 °C      | DIP-14  |
| TS339CS  |                 | SOP-14  |

### Pin Assignment



Pin 3 = Vcc Pin 12 = Gnd

### Schematic (each comparator)





| Absolute Maximum Rating                                                                   |                   |                                                                                                                    |       |      |                      |      |
|-------------------------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------|-------|------|----------------------|------|
| Supply Voltage                                                                            | V <sub>CC</sub>   | +36 or ±18                                                                                                         | V     |      |                      |      |
| Differential Input Voltage                                                                | V <sub>IDR</sub>  | 36                                                                                                                 | V     |      |                      |      |
| Input Common Mode Voltage Range                                                           | V <sub>ICR</sub>  | -0.3 to 36                                                                                                         | V     |      |                      |      |
| Input Current (note 2)                                                                    | I <sub>in</sub>   | 50                                                                                                                 | mA    |      |                      |      |
| Output Short Circuit to Ground                                                            | I <sub>sc</sub>   | Continuous                                                                                                         |       |      |                      |      |
| Output Sink Current (note 1)                                                              | I <sub>sink</sub> | 20                                                                                                                 | mA    |      |                      |      |
| Power Dissipation @ Ta=25 °C                                                              |                   | 1.0                                                                                                                | W     |      |                      |      |
| Derate above 25 °C                                                                        | 1/Rθja            | 8                                                                                                                  | mW/°C |      |                      |      |
| Operating Junction Temperature Range                                                      | T <sub>J</sub>    | 0 ~ +125                                                                                                           | °C    |      |                      |      |
| Storage Temperature Range                                                                 | T <sub>STG</sub>  | -65 ~ +150                                                                                                         | °C    |      |                      |      |
| Lead Temperature 1.6mm(1/16") from case for 10Sec.                                        | T <sub>LEAD</sub> | 260                                                                                                                | °C    |      |                      |      |
| Electrical Characteristics (V <sub>CC</sub> = 5V, Ta =25 °C; unless otherwise specified.) |                   |                                                                                                                    |       |      |                      |      |
| Characteristics                                                                           | Symbol            | Test condition                                                                                                     | Min   | Typ  | Max                  | Unit |
| Input Offset Voltage (note 3)                                                             | V <sub>io</sub>   |                                                                                                                    | --    | ±2.0 | ±5.0                 | mV   |
| Input Offset Current (note 3)                                                             | I <sub>io</sub>   |                                                                                                                    | --    | ±5.0 | ±50                  | nA   |
| Input Bias Current (note 3, 4)<br>(output in linear range)                                | I <sub>IB</sub>   |                                                                                                                    | --    | 25   | 250                  | nA   |
| Input Common Mode Voltage Range (note 6)                                                  | V <sub>ICR</sub>  |                                                                                                                    | 0     | --   | V <sub>CC</sub> -1.5 | V    |
| Voltage Gain                                                                              | A <sub>VOL</sub>  | R <sub>L</sub> ≥15K, V <sub>CC</sub> = 15Vdc.                                                                      | --    | 200  | --                   | V/mV |
| Large Signal Response Time                                                                | --                | V <sub>in</sub> = TTL Logic Swing.<br>V <sub>ref</sub> = 1.4Vdc, V <sub>RL</sub> = 5Vdc.<br>R <sub>L</sub> = 5.1KΩ | --    | 300  | --                   | nS   |
| Response Time (note 6)                                                                    | t <sub>TLH</sub>  | V <sub>RL</sub> = 5Vdc, R <sub>K</sub> = 5.1KΩ                                                                     | --    | 1.3  | --                   | uS   |
| Output Sink Current                                                                       | I <sub>SINK</sub> | V <sub>in</sub> ≥1Vdc, V <sub>in</sub> +=0Vdc,<br>V <sub>O</sub> ≤15 Vdc                                           | 6     | 16   | --                   | mA   |
| Output Saturation Voltage                                                                 | V <sub>OL</sub>   | V <sub>in</sub> ≥1Vdc, V <sub>in</sub> +=0,<br>I <sub>SINK</sub> ≤4mA,                                             | --    | 130  | 400                  | mV   |
| Output Leakage Current                                                                    | I <sub>OL</sub>   | V <sub>in</sub> =0V, V <sub>in</sub> ≥1Vdc, V <sub>O</sub> =5Vdc                                                   | --    | 0.1  | --                   | nA   |
| Input Offset Voltage (note 3)                                                             | V <sub>io</sub>   | T <sub>LOW</sub> ≤ Ta ≤T <sub>HIGH</sub>                                                                           | --    | --   | ±9.0                 | mV   |
| Input Offset Current (note 3)                                                             | I <sub>io</sub>   | T <sub>LOW</sub> ≤ Ta ≤T <sub>HIGH</sub>                                                                           | --    | --   | ±150                 | nA   |
| Input Bias Current (note 3, 4)<br>(output in linear range)                                | I <sub>IB</sub>   | T <sub>LOW</sub> ≤ Ta ≤T <sub>HIGH</sub>                                                                           | --    | --   | 400                  | nA   |
| Input Common Mode Voltage Range (note 6)                                                  | V <sub>ICR</sub>  | T <sub>LOW</sub> ≤ Ta ≤T <sub>HIGH</sub>                                                                           | 0     | --   | V <sub>CC</sub> -2.0 | V    |
| Output Saturation Voltage                                                                 | V <sub>OL</sub>   | V <sub>in</sub> ≥1Vdc, V <sub>in</sub> +=0,<br>I <sub>SINK</sub> ≤4mA, T <sub>LOW</sub> ≤Ta≤T <sub>HIGH</sub>      | --    | --   | 700                  | mV   |
| Output Leakage Current                                                                    | I <sub>OL</sub>   | V <sub>in</sub> =0V, V <sub>in</sub> ≥1Vdc, V <sub>O</sub> =30V                                                    | --    | 0.1  | --                   | nA   |
| Input Differential Voltage                                                                | V <sub>ID</sub>   | All V <sub>in</sub> ≥ 0Vdc, T <sub>LOW</sub> ≤Ta≤T <sub>HIGH</sub>                                                 | --    | --   | V <sub>CC</sub>      | V    |
| Supply Current                                                                            | I <sub>CC</sub>   | R <sub>L</sub> = ∞ (for all comparators)                                                                           | --    | 0.8  | 2.0                  | mA   |



## Electrical Characteristics (Continues)

- Note 1. The maximum output current may be as high as 20mA, independent of the magnitude of  $V_{CC}$ . Output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.
- Note 2. This magnitude of input current will only occur if the leads are driven more negative than ground or the negative supply voltage. This is due to the input PNP collector base junction become forward biased, acting as an input clamp diode. There is also a lateral PNP parasitic transistor action which can cause the output voltage of the comparators to go to the  $V_{CC}$  voltage level (or ground if overdrive is large) during the time that an input is driven negative. This will not destroy the device when limited to the max rating and normal output states will recover when the inputs become  $\geq$ ground or negative supply.
- Note 3. At the output switch point,  $V_O=1.4V_{dc}$ ,  $R_S \leq 100\Omega$ ,  $5.0V_{dc} \leq V_{CC} \leq 30V_{dc}$ , with the inputs over the full common-mode range ( $0V_{dc}$  to  $V_{CC} - 1.5V_{dc}$ ).
- Note 4. The bias current flows out of the inputs due to the PNP input stage. This current is virtually constant, independent of the output state.
- Note 5. The response time specified is for a 100mV input step with 5mV overdrive. For larger signals, 300ns is typical.
- Note 6. Positive excursions of input voltage may exceed the power supply level. As long as one of the inputs remain within the common-mode range, the comparator will provide the proper output state.
- Note 7. The comparator will inhibit proper output state if one of the inputs is become greater than  $V_{CC}$ , the other input must remain within the common mode range. The low input state must not be less than -0.3volts of ground of minus supply.

## Applications Information

This quad comparator feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitive coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions ( $V_{OL}$  to  $V_{OH}$ ). To alleviate this situation input resistors  $<10K\Omega$  should be used. The addition of positive feedback ( $<10$  mV) is also recommended.

It is good design practice to ground all unused pins. Differential input voltages may be larger than supply voltage without damaging the comparator's inputs. Voltages more negative than  $-0.3V$  should not be used.

## Electrical Characteristics Curve

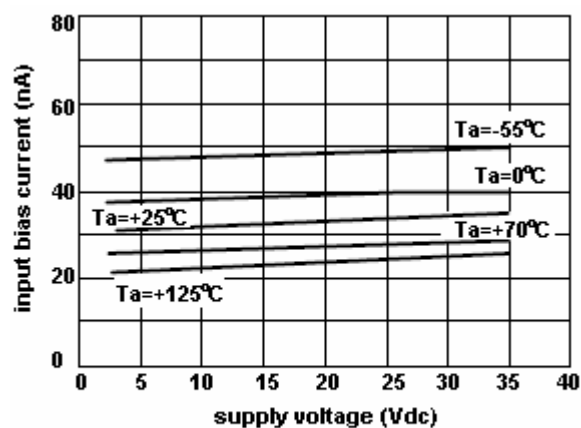


Figure 1. input bias current vs power supply voltage

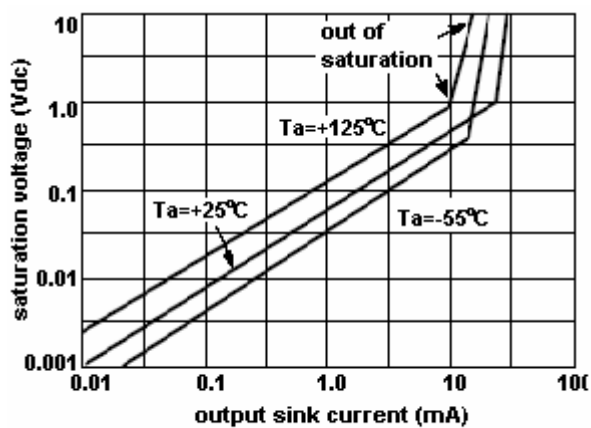


Figure 2. output saturation voltage vs output sink current

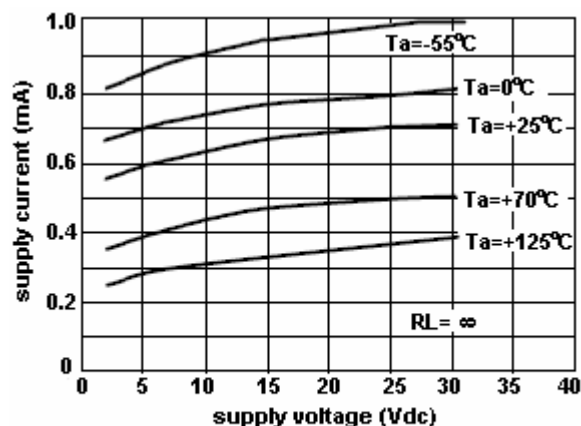
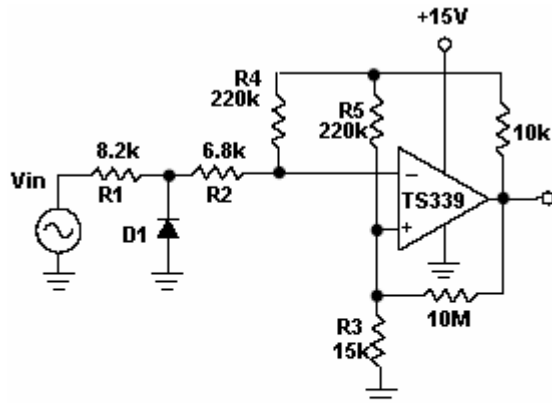


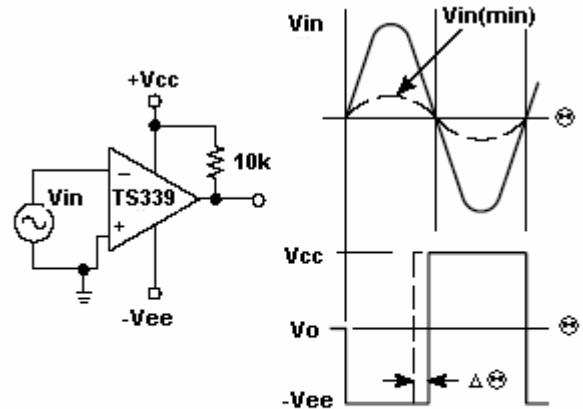
Figure 3. power supply current vs power supply voltage

## Circuit Description



D1 prevents input from going negative by more than 0.6V,  $R1 + R2 = R3$   
 $R3 \leq R5 / 10$  for small error in zero crossing

Figure 4. zero crossing detector (single supply)



$V_{in(min)} = 0.4V$  peak for 1% phase distortion ( $\Delta$ )

Figure 5. zero crossing detector (split supply)

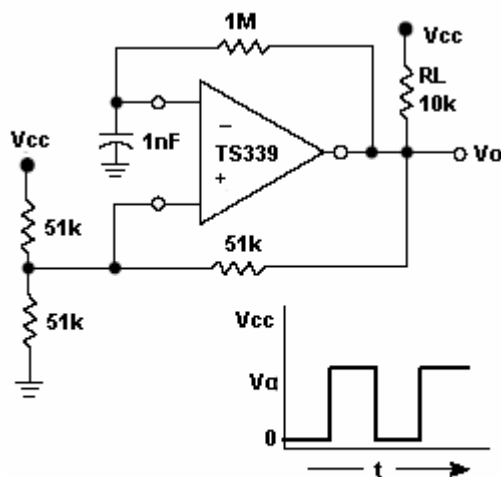
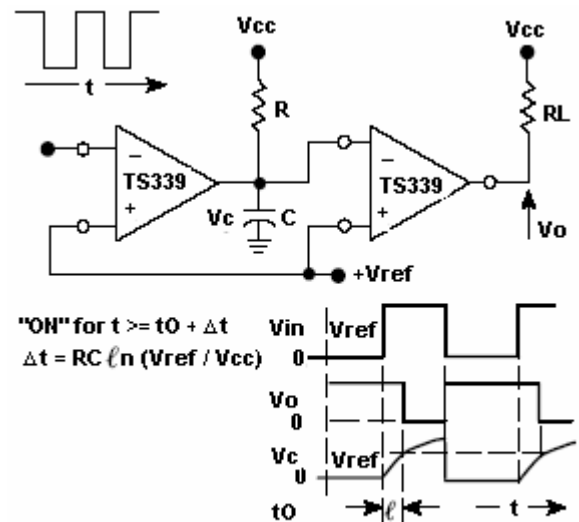
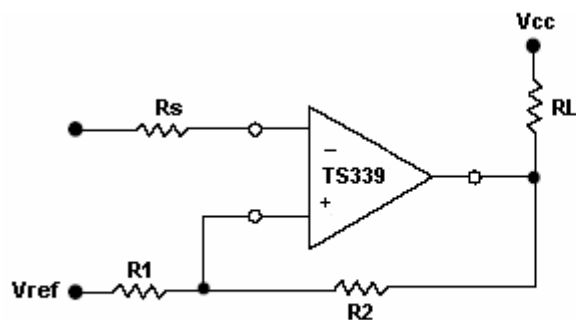


Figure 6. free-running square-wave oscillator



"ON" for  $t \geq t_0 + \Delta t$   
 $\Delta t = RC \ln(V_{ref} / V_{cc})$

Figure 7. time delay generator



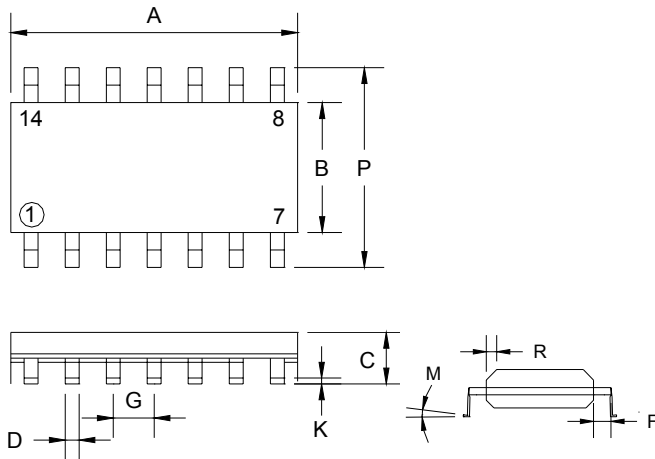
$$R_s = R_1 \parallel R_2$$

$$V_{th1} = V_{ref} + \frac{(V_{cc} - V_{ref}) \cdot R_1}{R_1 + R_2 + R_L}$$

$$V_{th2} = V_{ref} - \frac{(V_{ref} - V_{o\ low}) \cdot R_1}{R_1 + R_2}$$

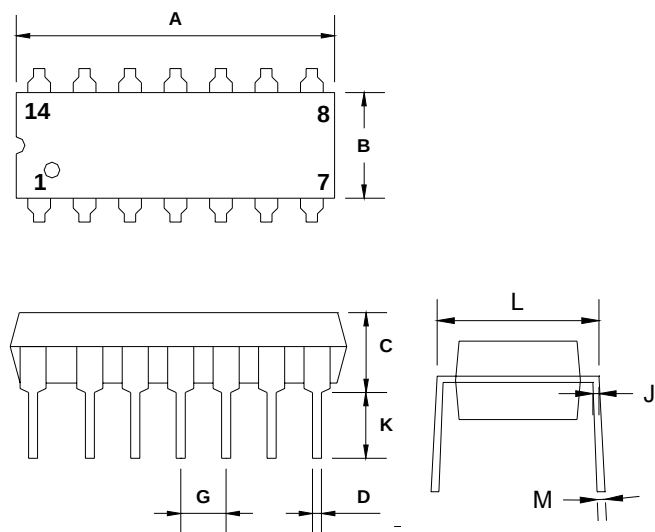
Figure 8. comparator with hysteresis

## SOP-14 Mechanical Drawing



| SOP-14 DIMENSION |             |      |            |       |
|------------------|-------------|------|------------|-------|
| DIM              | MILLIMETERS |      | INCHES     |       |
|                  | MIN         | MAX  | MIN        | MAX   |
| A                | 8.55        | 8.75 | 0.337      | 0.344 |
| B                | 3.80        | 4.00 | 0.150      | 0.157 |
| C                | 1.35        | 1.75 | 0.054      | 0.068 |
| D                | 0.35        | 0.49 | 0.014      | 0.019 |
| F                | 0.40        | 1.25 | 0.016      | 0.049 |
| G                | 1.27 (typ)  |      | 0.05 (typ) |       |
| K                | 0.10        | 0.25 | 0.004      | 0.009 |
| M                | 0°          | 7°   | 0°         | 7°    |
| P                | 5.80        | 6.20 | 0.229      | 0.244 |
| R                | 0.25        | 0.50 | 0.010      | 0.019 |

## DIP-14 Mechanical Drawing



| DIP-14 DIMENSION |             |       |            |       |
|------------------|-------------|-------|------------|-------|
| DIM              | MILLIMETERS |       | INCHES     |       |
|                  | MIN         | MAX   | MIN        | MAX   |
| A                | 18.55       | 19.56 | 0.730      | 0.770 |
| B                | 6.22        | 6.48  | 0.245      | 0.255 |
| C                | 3.18        | 4.45  | 0.125      | 0.135 |
| D                | 0.35        | 0.55  | 0.019      | 0.020 |
| G                | 2.54 (typ)  |       | 0.10 (typ) |       |
| J                | 0.29        | 0.31  | 0.011      | 0.012 |
| K                | 3.25        | 3.35  | 0.128      | 0.132 |
| L                | 7.75        | 8.00  | 0.305      | 0.315 |
| M                | -           | 10°   | -          | 10°   |