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**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**General Description**

The AS393/393A consist of two independent precision voltage comparators with a typical offset voltage of 1.0mV and high gain. They are specifically designed to operate from a single power supply over wide range of voltages. Operation from split power supply is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

The AS393/393A series are compatible with industry standard 393. AS393A has more stringent input offset voltage than AS393.

The AS393 is available in standard DIP-8, TDIP-8, SOIC-8, TSSOP-8 and MSOP-8 packages, AS393A is available in standard DIP-8 and SOIC-8 packages.

**Features**

- Wide Supply Voltage Range
  - Single Supply: 2.0V to 36V
  - Dual Supplies:  $\pm 1.0V$  to  $\pm 18V$
- Low Supply Current Drain: 0.6mA
- Low Input Bias Current: 25nA (Typical)
- Low Input Offset Current:  $\pm 5.0nA$  (Typical)
- Low Input Offset Voltage: 1.0mV (Typical)
- Input Common Mode Voltage Range Includes Ground
- Differential Input Voltage Range Equals to the Power Supply Voltage
- Low Output Saturation Voltage: 200mV at 4mA
- Open Collector Output

**Applications**

- Battery Charger
- Cordless Telephone
- Switching Power Supply
- DC-DC Module
- PC Motherboard
- Communication Equipment

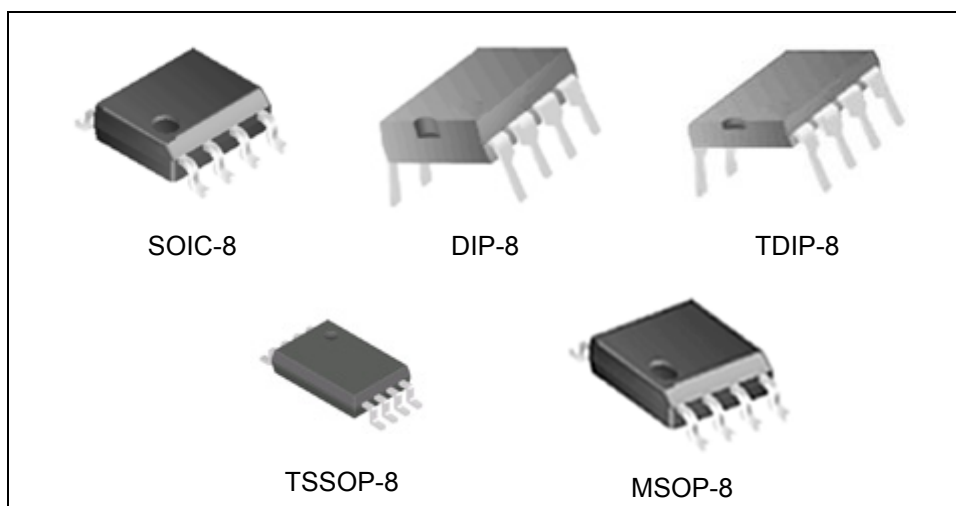


Figure 1. Package Types of AS393/393A

**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Pin Configuration**

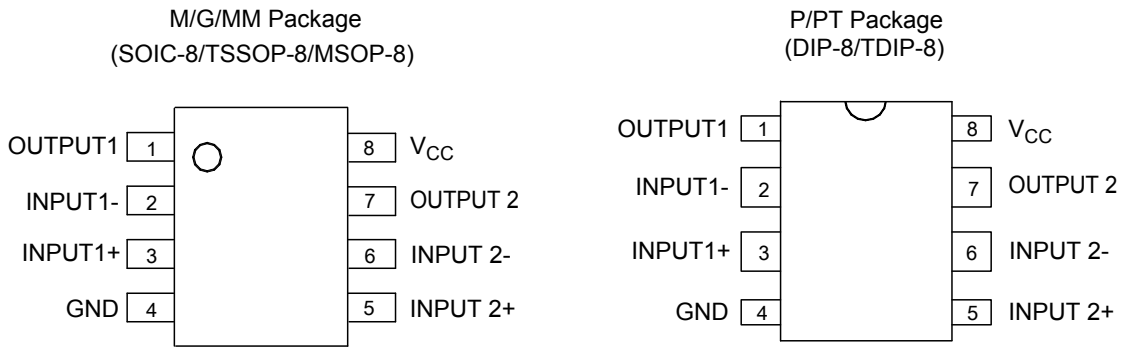


Figure 2. Pin Configuration of AS393/393A (Top View)

**Functional Block Diagram**

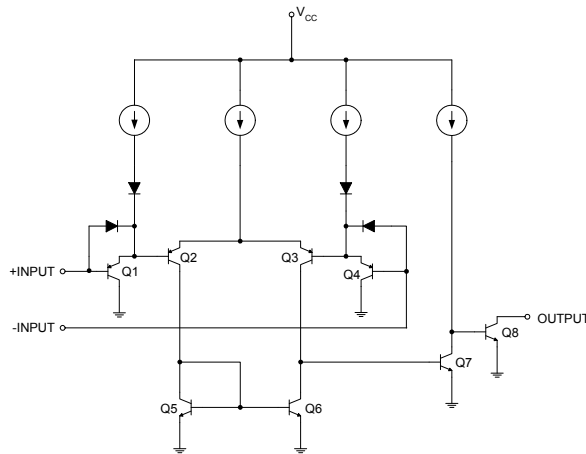
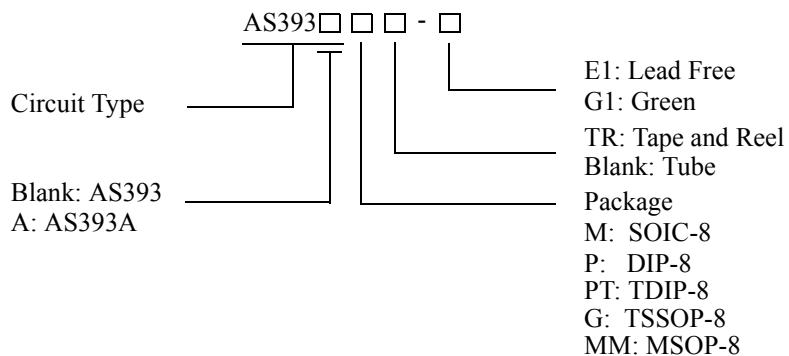


Figure 3. Functional Block Diagram of AS393/393A (Each comparator)



**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Ordering Information**



| Package | Temperature Range | Part Number  |              | Marking ID |            | Packing Type |
|---------|-------------------|--------------|--------------|------------|------------|--------------|
|         |                   | Lead Free    | Green        | Lead Free  | Green      |              |
| SOIC-8  | -40 to 85°C       | AS393M-E1    | AS393M-G1    | AS393M-E1  | AS393M-G1  | Tube         |
|         |                   | AS393MTR-E1  | AS393MTR-G1  | AS393M-E1  | AS393M-G1  | Tape & Reel  |
|         |                   | AS393AM-E1   | AS393AM-G1   | AS393AM-E1 | AS393AM-G1 | Tube         |
|         |                   | AS393AMTR-E1 | AS393AMTR-G1 | AS393AM-E1 | AS393AM-G1 | Tape & Reel  |
| DIP-8   | -40 to 85°C       | AS393P-E1    | AS393P-G1    | AS393P-E1  | AS393P-G1  | Tube         |
|         |                   | AS393AP-E1   | AS393AP-G1   | AS393AP-E1 | AS393AP-G1 | Tube         |
| TDIP-8  | -40 to 85°C       |              | AS393PT-G1   |            | AS393PT-G1 | Tube         |
| TSSOP-8 | -40 to 85°C       | AS393GTR-E1  | AS393GTR-G1  | EG3C       | GG3C       | Tape & Reel  |
| MSOP-8  | -40 to 85°C       |              | AS393MMTR-G1 |            | AS393MM-G1 | Tape & Reel  |

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.



**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS****AS393/393A****Absolute Maximum Ratings (Note 1)**

| Parameter                                   | Symbol     | Value      | Unit       |    |
|---|------------|------------|------------|----|
| Supply Voltage                              | $V_{CC}$   | 40         | V          |    |
| Differential Input Voltage                  | $V_{ID}$   | 40         | V          |    |
| Input Voltage                               | $V_{IN}$   | -0.3 to 40 | V          |    |
| Input Current ( $V_{IN} < -0.3V$ ) (Note 2) | $I_{IN}$   | 50         | mA         |    |
| Output Short-Circuit Current to Ground      |            | Continuous |            |    |
| Power Dissipation ( $T_A=25^\circ C$ )      | $P_D$      | DIP-8      | 780        | mW |
|   |            | SOIC-8     | 660        |    |
|   |            | TSSOP-8    | 570        |    |
|   |            | MSOP-8     | 450        |    |
| Operating Junction Temperature              | $T_J$      | 150        | $^\circ C$ |    |
| Storage Temperature                         | $T_{STG}$  | -65 to 150 | $^\circ C$ |    |
| Lead Temperature (Soldering, 10 sec)        | $T_{LEAD}$ | 260        | $^\circ C$ |    |

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Note 2: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the  $V+$  voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than  $-0.3 V_{DC}$  (at  $25^\circ C$ ).

**Recommended Operating Conditions**

| Parameter                   | Symbol   | Min | Max | Unit       |
|-----------------------------|----------|-----|-----|------------|
| Supply Voltage              | $V_{CC}$ | 2   | 36  | V          |
| Operating Temperature Range | $T_A$    | -40 | 85  | $^\circ C$ |



**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Electrical Characteristics**

Limits in standard typeface are for  $T_A=25^{\circ}\text{C}$ , **bold** typeface applies over  $T_A=-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  (Note 3),  $V_{CC}=5\text{V}$ ,  $\text{GND}=0\text{V}$ , unless otherwise specified.

| Parameter                                | Conditions  |                     | Min | Typ | Max          | Unit                        |
|--|---|---------------------|-----|-----|--------------|-----------------------------|
| Input Offset Voltage                     | $V_O=1.4\text{V}$ , $R_S=0\Omega$<br>$V_{CC}=5\text{V}$ to $30\text{V}$                             | AS393               |     | 1.0 | 5.0          | mV                          |
|  |   |                     |     |     | <b>7</b>     |                             |
|  |   | AS393A              |     | 1.0 | 3.0          |                             |
|  |   |                     |     |     | <b>5</b>     |                             |
| Input Bias Current                       | $I_{IN+}$ or $I_{IN-}$ with output in Linear Range,<br>$V_{CM}=0\text{V}$                           |                     |     | 25  | 250          | nA                          |
|  |   |                     |     |     | <b>400</b>   |                             |
| Input Offset Current                     | $I_{IN+}-I_{IN-}$ , $V_{CM}=0\text{V}$  |                     |     | 5.0 | 50           | nA                          |
|  |   |                     |     |     | <b>200</b>   |                             |
| Input Common Mode Voltage Range (Note 4) | $V_{CC}=30\text{V}$   |                     | 0   |     | $V_{CC}-1.5$ | V                           |
| Supply Current                           | $R_L=\infty$  | $V_{CC}=5\text{V}$  |     | 0.6 | 1.0          | mA                          |
|  |   |                     |     |     | <b>2</b>     |                             |
|  |   | $V_{CC}=30\text{V}$ |     | 0.7 | 1.7          |                             |
|  |   |                     |     |     | <b>3</b>     |                             |
| Voltage Gain                             | $V_{CC}=15\text{V}$ , $R_L \geq 15\text{k}\Omega$ , $V_O=1\text{V}$ to $11\text{V}$                 |                     | 50  | 200 |              | V/mV                        |
| Large Signal Response Time               | $V_{IN}=\text{TTL Logic Swing}$ , $V_{REF}=1.4\text{V}$ ,<br>$V_{RL}=5\text{V}$ , $R_L=5.1\text{k}$ |                     |     | 200 |              | ns                          |
| Response Time                            | $V_{RL}=5\text{V}$ , $R_L=5.1\text{k}$  |                     |     | 1.3 |              | $\mu\text{s}$               |
| Output Sink Current                      | $V_{IN-}=1\text{V}$ , $V_{IN+}=0$ , $V_O=1.5\text{V}$   |                     | 6.0 | 16  |              | mA                          |
| Output Leakage Current                   | $V_{IN-}=0\text{V}$ , $V_{IN+}=1\text{V}$ , $V_O=5\text{V}$   |                     |     | 0.1 |              | nA                          |
|  | $V_{IN-}=0\text{V}$ , $V_{IN+}=1\text{V}$ , $V_O=30\text{V}$  |                     |     |     | <b>1</b>     | $\mu\text{A}$               |
| Saturation Voltage                       | $V_{IN-}=1\text{V}$ , $V_{IN+}=0$ , $I_{SINK} \leq 4\text{mA}$                                      |                     |     | 200 | 400          | mV                          |
|  |   |                     |     |     | <b>500</b>   |                             |
| Thermal Resistance (Junction to Case)    | DIP-8   |                     |     | 93  |              | $^{\circ}\text{C}/\text{W}$ |
|  | SOIC-8  |                     |     | 138 |              |                             |

Note 3: These specifications are limited to  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ . Limits over temperature are guaranteed by design, but not tested in production.

Note 4: The input common-mode voltage of either input signal voltage should not be allowed to go negatively by more than 0.3V (at  $25^{\circ}\text{C}$ ). The upper end of the common-mode voltage range is  $V_{CC}-1.5\text{V}$  (at  $25^{\circ}\text{C}$ ), but either or both inputs can go to +36V without damages, independent of the magnitude of the  $V_{CC}$ .



**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Typical Performance Characteristics**

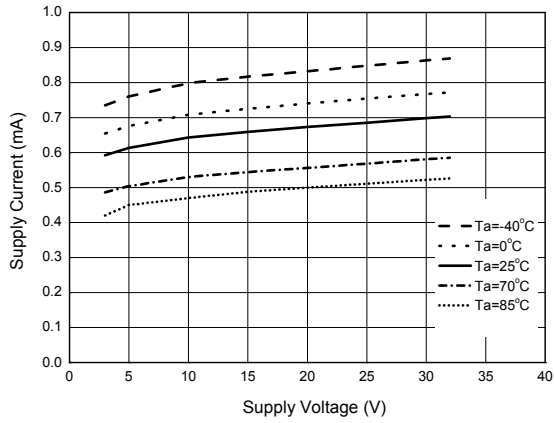


Figure 4. Supply Voltage vs. Supply Current

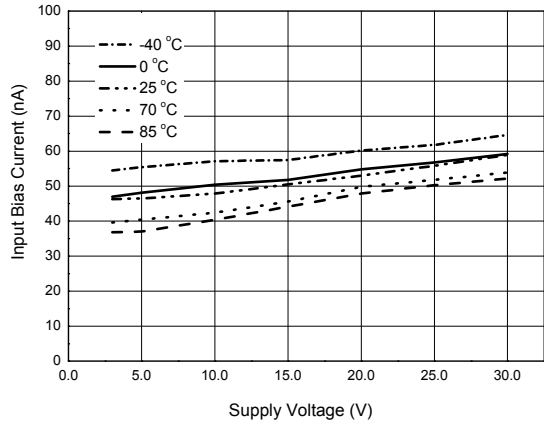


Figure 5. Supply Voltage vs. Input Bias Current

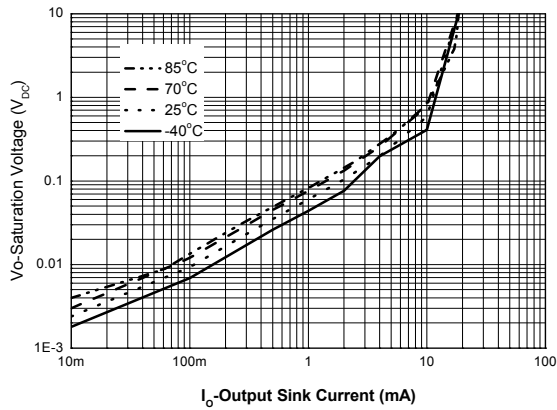


Figure 6. Output Sink Current vs. Saturation Voltage

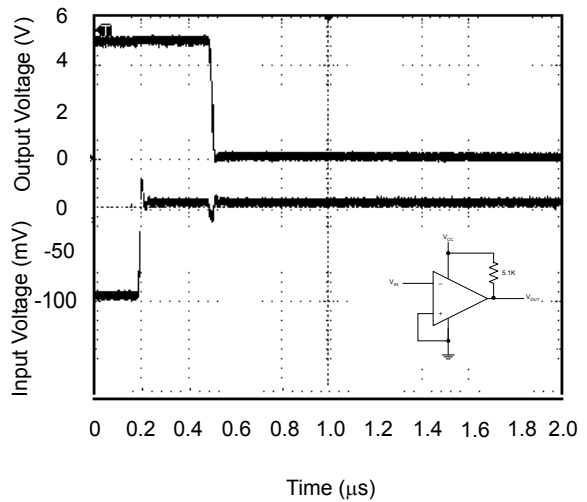


Figure 7. Response Time for 5mV Input Overdrive - Negative Transition

**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Typical Performance Characteristics (Continued)**

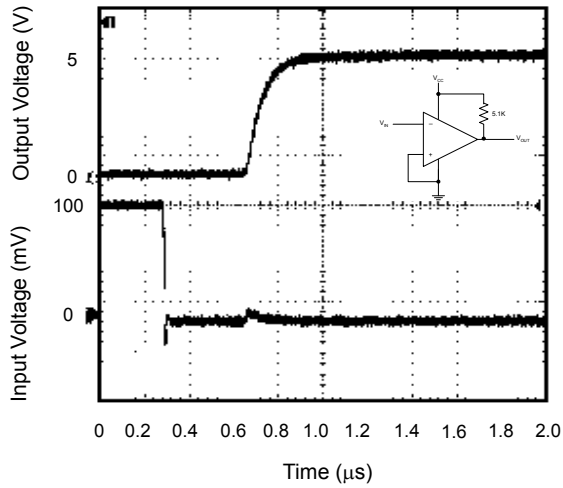


Figure 8. Response Time for 5mV Input Overdrive - Positive Transition

**Typical Applications**

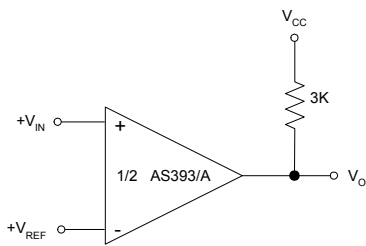


Figure 9. Basic Comparator

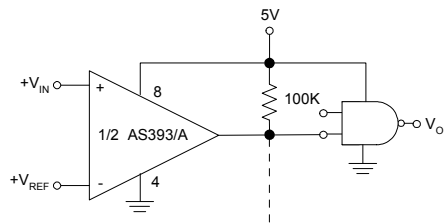


Figure 10. Driving CMOS



**Typical Applications (Continued)**

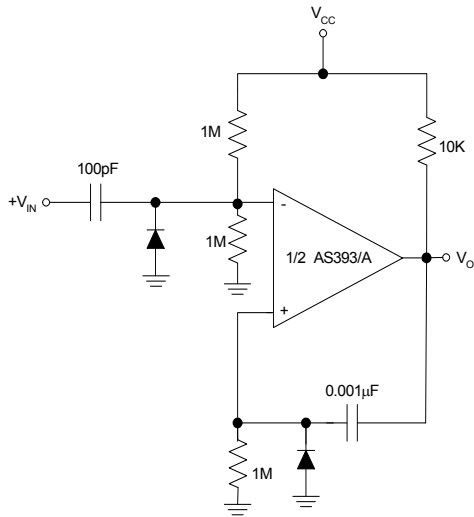


Figure 11. One Shot Multivibrator

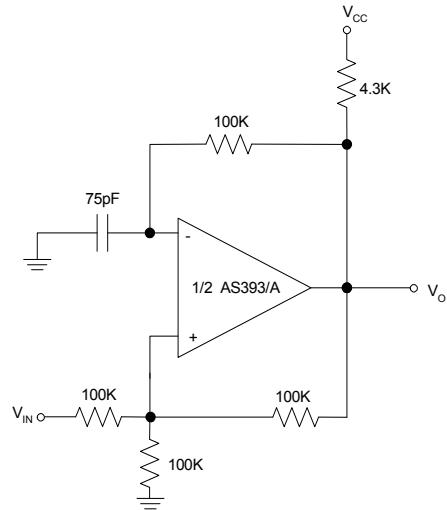


Figure 12. Squarewave Oscillator

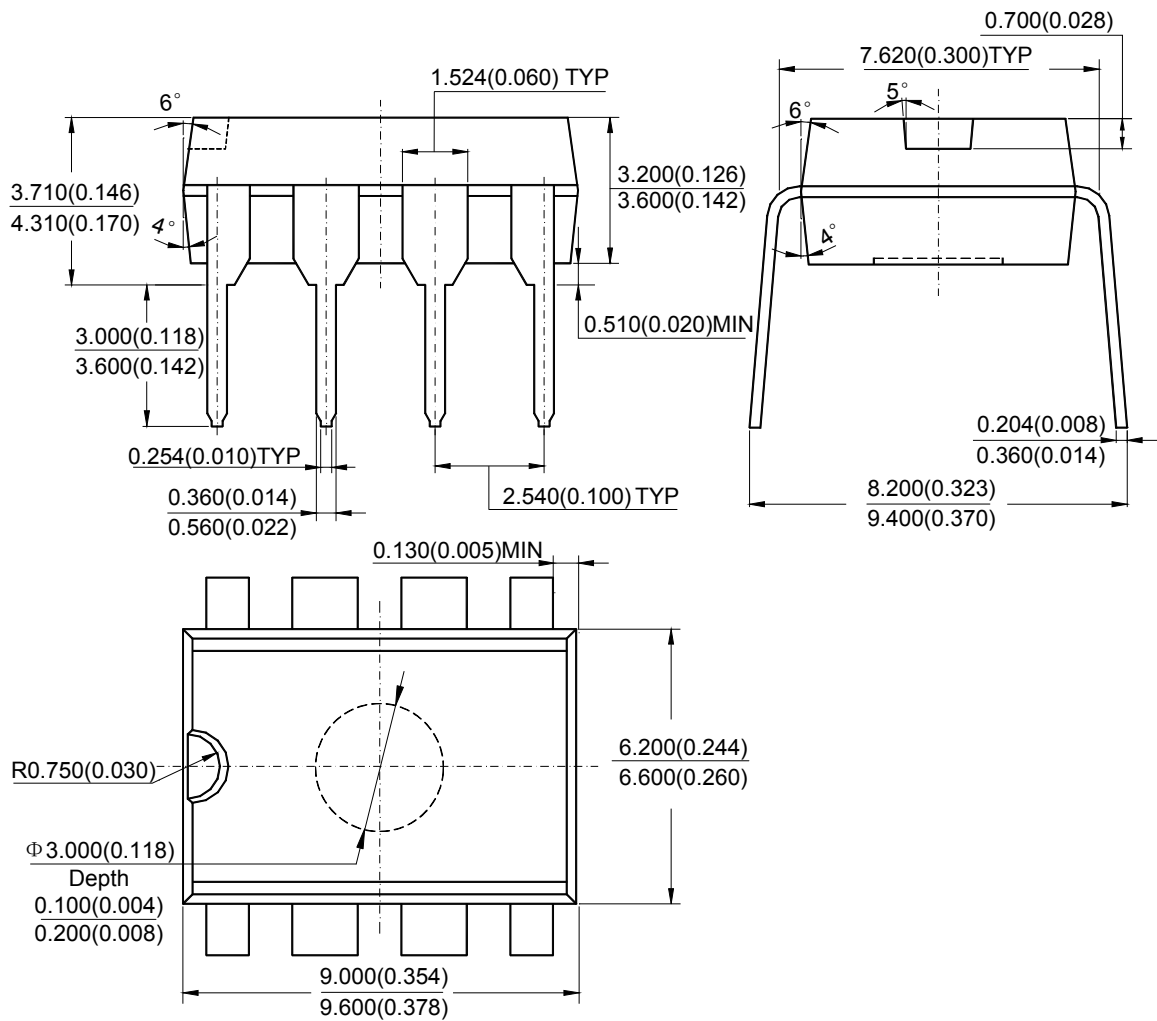


**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Mechanical Dimensions**

**DIP-8**

**Unit: mm(inch)**



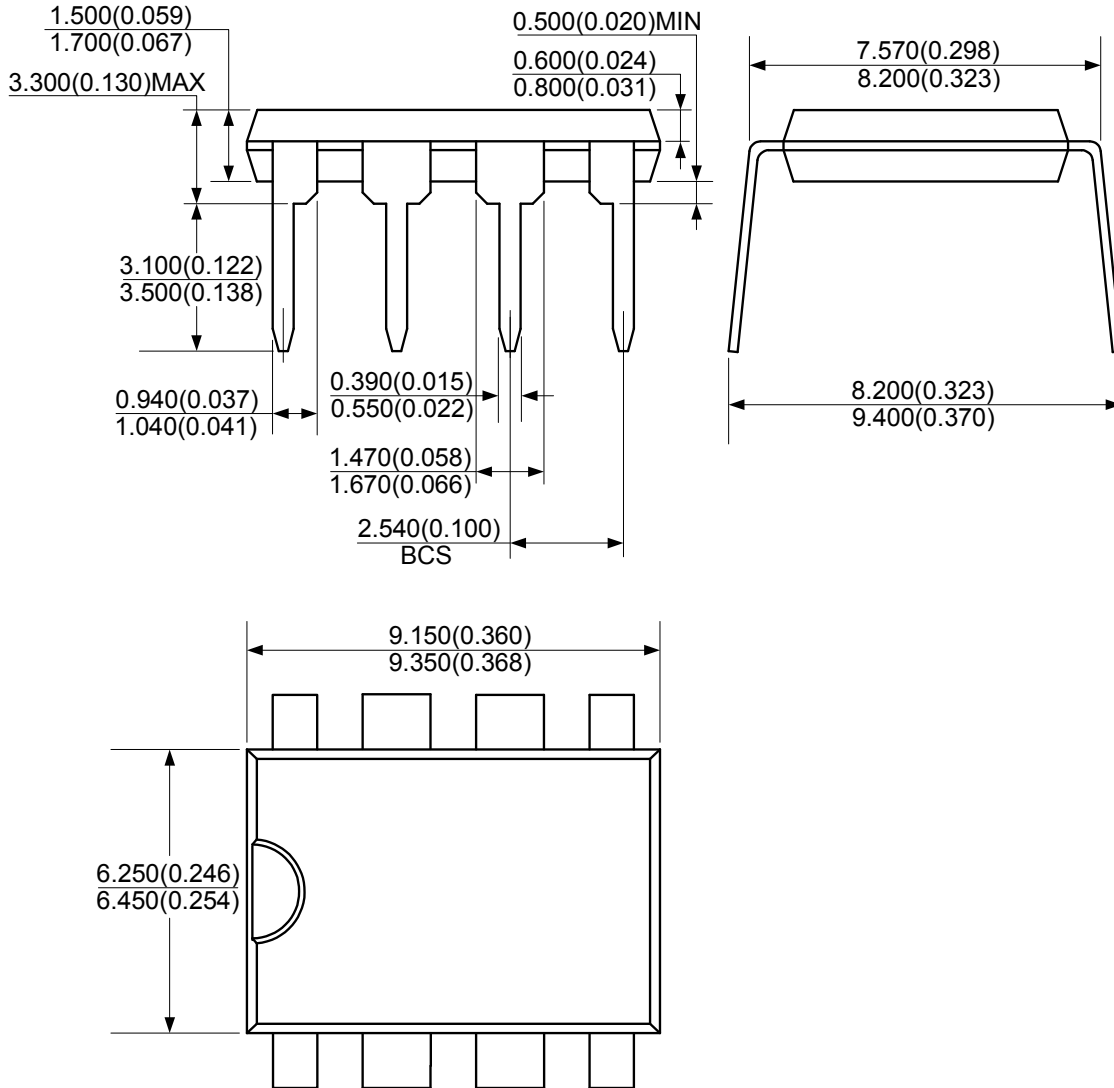
Note: Eject hole, oriented hole and mold mark is optional.

**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Mechanical Dimensions (Continued)**

**TDIP-8**

**Unit: mm(inch)**



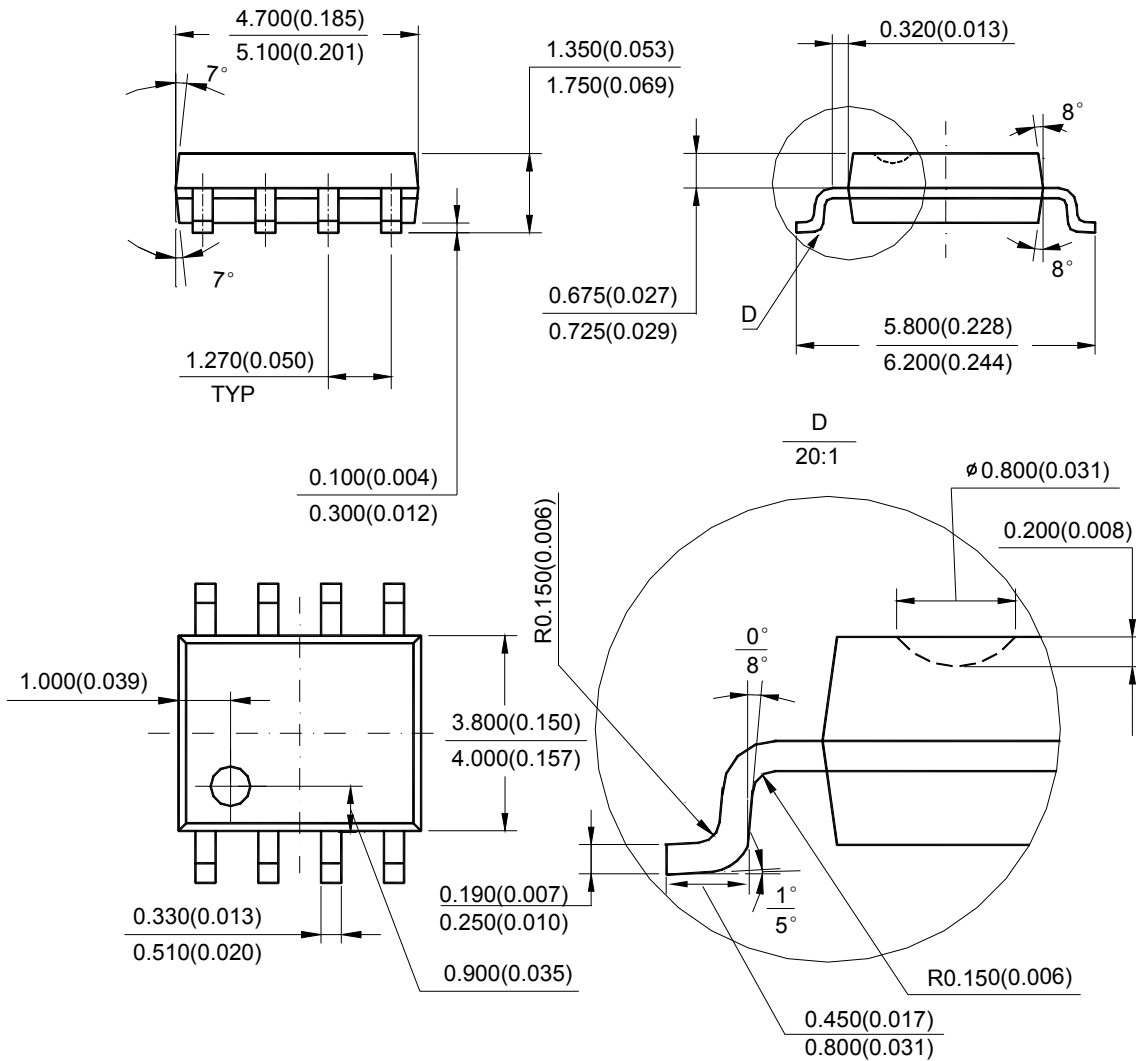
Note: Eject hole, oriented hole and mold mark is optional.



Mechanical Dimensions (Continued)

SOIC-8

Unit: mm(inch)



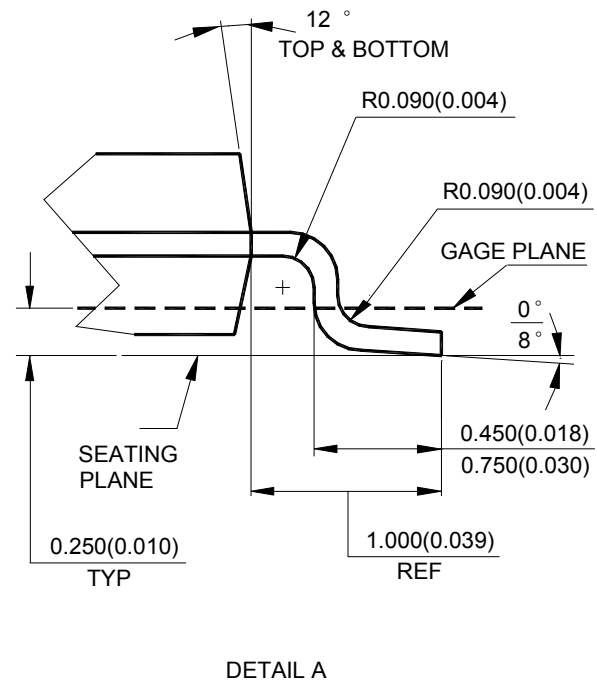
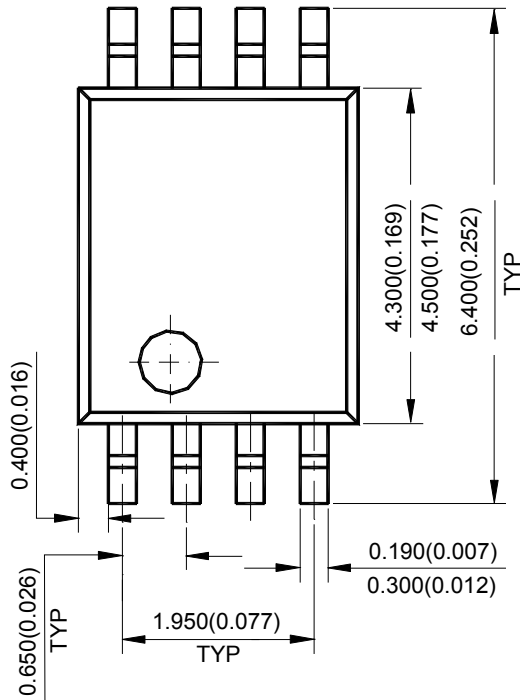
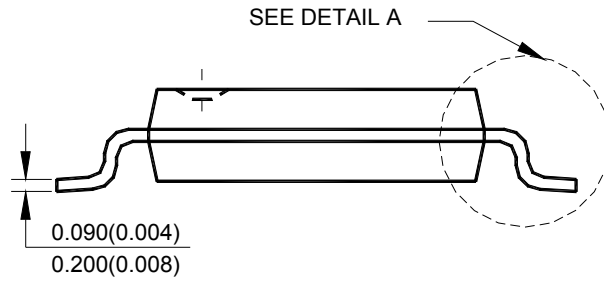
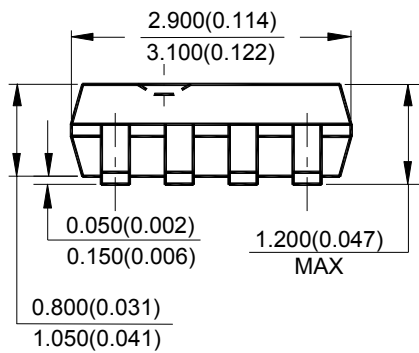
Note: Eject hole, oriented hole and mold mark is optional.



Mechanical Dimensions (Continued)

TSSOP-8

Unit: mm(inch)



Note: Eject hole, oriented hole and mold mark is optional.

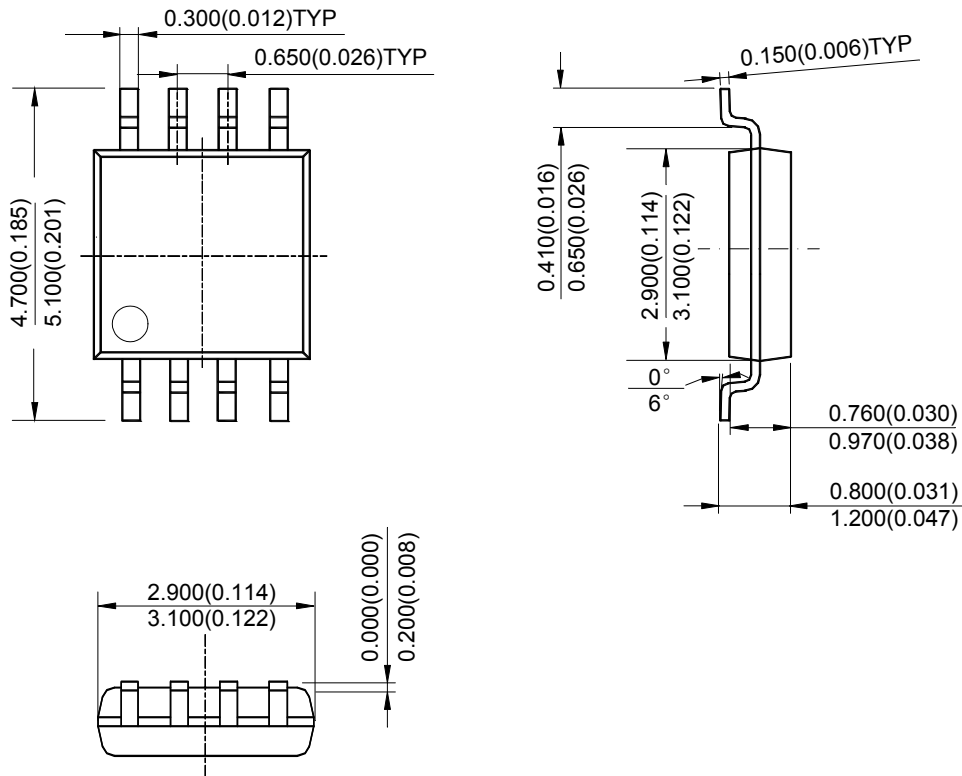


**LOW POWER LOW OFFSET VOLTAGE DUAL COMPARATORS AS393/393A**

**Mechanical Dimensions (Continued)**

**MSOP-8**

**Unit: mm(inch)**



Note: Eject hole, oriented hole and mold mark is optional.





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