

# LM2903/LM2903I, LM393/LM393A, LM293/LM293A

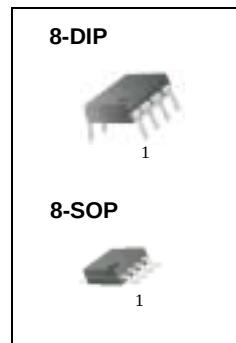
## Dual Differential Comparator

### Features

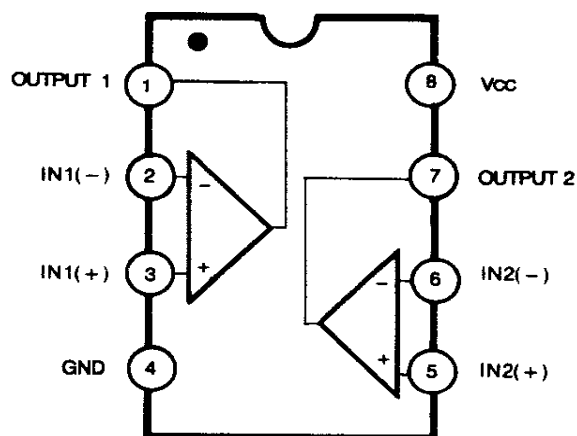
- Single Supply Operation: 2V to 36V
- Dual Supply Operation:  $\pm 1\text{V}$  to  $\pm 18\text{V}$
- Allow Comparison of Voltages Near Ground Potential
- Low Current Drain  $800\mu\text{A}$  Typ.
- Compatible with all Forms of Logic
- Low Input Bias Current  $25\text{nA}$  Typ.
- Low Input Offset Current  $\pm 5\text{nA}$  Typ.
- Low Offset Voltage  $\pm 1\text{mV}$  Typ.

### Description

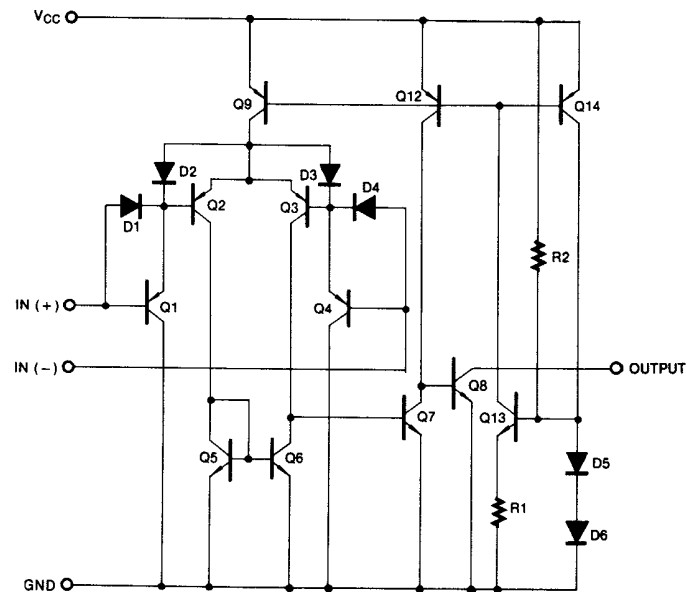
The LM2903/LM2903I, LM393/LM393A, LM293/LM293A consist of two independent voltage comparators designed to operate from a single power supply over a wide voltage range.



### Internal Block Diagram



Schematic Diagram



Absolute Maximum Ratings

| Parameter                                                                  | Symbol               | Value                                            | Unit |
|----------------------------------------------------------------------------|----------------------|--------------------------------------------------|------|
| Power Supply Voltage                                                       | V <sub>CC</sub>      | ±18 or 36                                        | V    |
| Differential Input Voltage                                                 | V <sub>I(DIFF)</sub> | 36                                               | V    |
| Input Voltage                                                              | V <sub>I</sub>       | - 0.3 to +36                                     | V    |
| Output Short Circuit to GND                                                | -                    | Continuous                                       | -    |
| Power Dissipation, T <sub>a</sub> = 25 °C<br>8-DIP<br>8-SOP                | P <sub>D</sub>       | 1040<br>480                                      | mW   |
| Operating Temperature<br>LM393/LM393A<br>LM2903<br>LM2903I<br>LM293/LM293A | T <sub>OPR</sub>     | 0 ~ +70<br>- 40 ~ +85<br>-40 ~ +105<br>-25 ~ +85 | °C   |
| Storage Temperature                                                        | T <sub>STG</sub>     | - 65 ~ +150                                      | °C   |

Thermal Data

| Parameter                                                  | Symbol           | Value      | Unit |
|------------------------------------------------------------|------------------|------------|------|
| Thermal Resistance Junction-Ambient Max.<br>8-DIP<br>8-SOP | R <sub>θja</sub> | 120<br>260 | °C/W |

## Electrical Characteristics

(V<sub>CC</sub> = 5V, T<sub>A</sub> = 25°C, unless otherwise specified)

| Parameter                       | Symbol              | Conditions                                                                                                   | LM293A/LM393A |      |                       | LM293/LM393 |      |                       | Unit |
|---------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------|---------------|------|-----------------------|-------------|------|-----------------------|------|
|                                 |                     |                                                                                                              | Min.          | Typ. | Max.                  | Min.        | Typ. | Max.                  |      |
| Input Offset Voltage            | V <sub>IO</sub>     | V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω                                                                | -             | ±1   | ±2                    | -           | ±1   | ±5                    | mV   |
|                                 |                     | V <sub>CM</sub> = 0 to 1.5V   Note 1                                                                         | -             | -    | ±4.0                  | -           | -    | ±9.0                  |      |
| Input Offset Current            | I <sub>IO</sub>     |                                                                                                              | -             | ±5   | ±50                   | -           | ±5   | ±50                   | nA   |
|                                 |                     | Note 1                                                                                                       | -             | -    | ±150                  | -           | -    | ±150                  |      |
| Input Bias Current              | I <sub>BIAS</sub>   |                                                                                                              | -             | 65   | 250                   | -           | 65   | 250                   | nA   |
|                                 |                     | Note 1                                                                                                       | -             | -    | 400                   | -           | -    | 400                   |      |
| Input Common Mode Voltage Range | V <sub>I(R)</sub>   |                                                                                                              | 0             | -    | V <sub>CC</sub> - 1.5 | 0           | -    | V <sub>CC</sub> - 1.5 | V    |
|                                 |                     | Note 1                                                                                                       | 0             | -    | V <sub>CC</sub> - 2   | 0           | -    | V <sub>CC</sub> - 2   |      |
| Supply Current                  | I <sub>CC</sub>     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 5V                                                                     | -             | 0.6  | 1                     | -           | 0.6  | 1                     | mA   |
|                                 |                     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 30V                                                                    | -             | 0.8  | 2.5                   | -           | 0.8  | 2.5                   |      |
| Voltage Gain                    | G <sub>V</sub>      | V <sub>CC</sub> = 15V, R <sub>L</sub> ≥ 15KΩ<br>(for large V <sub>O(P-P)</sub> swing)                        | 50            | 200  | -                     | 50          | 200  | -                     | V/mV |
| Large Signal Response Time      | T <sub>LRES</sub>   | V <sub>I</sub> = TTL Logic Swing<br>V <sub>REF</sub> = 1.4V, V <sub>RL</sub> = 5V,<br>R <sub>L</sub> = 5.1KΩ | -             | 350  | -                     | -           | 350  | -                     | nS   |
| Response Time                   | T <sub>RES</sub>    | V <sub>RL</sub> = 5V, R <sub>L</sub> = 5.1KΩ                                                                 | -             | 1.4  | -                     | -           | 1.4  | -                     | μS   |
| Output Sink Current             | I <sub>SINK</sub>   | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V,<br>V <sub>O(P)</sub> ≤ 1.5V                                  | 6             | 18   | -                     | 6           | 18   | -                     | mA   |
| Output Saturation Voltage       | V <sub>SAT</sub>    | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V                                                               | -             | 160  | 400                   | -           | 160  | 400                   | mV   |
|                                 |                     | I <sub>SINK</sub> = 4mA   Note 1                                                                             | -             | -    | 700                   | -           | -    | 700                   |      |
| Output Leakage Current          | I <sub>O(LKG)</sub> | V <sub>I(-)</sub> = 0V,<br>V <sub>I(+)</sub> = 1V   V <sub>O(P)</sub> = 5V                                   | -             | 0.1  | -                     | -           | 0.1  | -                     | nA   |
|                                 |                     | V <sub>O(P)</sub> = 30V                                                                                      | -             | -    | 1.0                   | -           | -    | 1.0                   | μA   |

### NOTE 1

LM393/LM393A: 0 ≤ T<sub>A</sub> ≤ +70°C

LM2903: -40 ≤ T<sub>A</sub> ≤ +85°C

LM2903I: -40 ≤ T<sub>A</sub> ≤ +105°C

LM293/LM293A: -25 ≤ T<sub>A</sub> ≤ +85°C

**Electrical Characteristics** (Continued)

(VCC = 5V, TA = 25°C, unless otherwise specified)

| Parameter                       | Symbol              | Conditions                                                                                               |                         | LM2903/LM2903I |      |                      | Unit |
|---------------------------------|---------------------|----------------------------------------------------------------------------------------------------------|-------------------------|----------------|------|----------------------|------|
|                                 |                     |                                                                                                          |                         | Min.           | Typ. | Max.                 |      |
| Input Offset Voltage            | V <sub>IO</sub>     | V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω                                                            |                         | -              | ±1   | ±7                   | mV   |
|                                 |                     | V <sub>CM</sub> = 0 to 1.5V                                                                              | Note 1                  | -              | ±9   | ±15                  |      |
| Input Offset Current            | I <sub>IO</sub>     |                                                                                                          |                         | -              | ±5   | ±50                  | nA   |
|                                 |                     |                                                                                                          | Note 1                  | -              | ±50  | ±200                 |      |
| Input Bias Current              | I <sub>BIAS</sub>   |                                                                                                          |                         | -              | 65   | 250                  | nA   |
|                                 |                     |                                                                                                          | Note 1                  | -              | -    | 500                  |      |
| Input Common Mode Voltage Range | V <sub>I(R)</sub>   |                                                                                                          |                         | 0              | -    | V <sub>CC</sub> -1.5 | V    |
|                                 |                     |                                                                                                          | Note 1                  | 0              | -    | V <sub>CC</sub> -2   |      |
| Supply Current                  | I <sub>CC</sub>     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 5V                                                                 |                         | -              | 0.6  | 1                    | mA   |
|                                 |                     | R <sub>L</sub> = ∞, V <sub>CC</sub> = 30V                                                                |                         | -              | 1    | 2.5                  |      |
| Voltage Gain                    | G <sub>V</sub>      | V <sub>CC</sub> = 15V, R <sub>L</sub> ≥ 15KΩ<br>(for large V <sub>O(P-P)</sub> swing)                    |                         | 25             | 100  | -                    | V/mV |
| Large Signal Response Time      | T <sub>LRES</sub>   | V <sub>I</sub> = TTL Logic Swing<br>V <sub>REF</sub> = 1.4V, V <sub>R</sub> = 5V, R <sub>L</sub> = 5.1KΩ |                         | -              | 350  | -                    | nS   |
| Response Time                   | T <sub>RES</sub>    | V <sub>R</sub> = 5V, R <sub>L</sub> = 5.1KΩ                                                              |                         | -              | 1.5  | -                    | μS   |
| Output Sink Current             | I <sub>SINK</sub>   | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V, V <sub>O(P)</sub> ≤ 1.5V                                 |                         | 6              | 16   | -                    | mA   |
| Output Saturation Voltage       | V <sub>SAT</sub>    | V <sub>I(-)</sub> ≥ 1V, V <sub>I(+)</sub> = 0V                                                           |                         | -              | 160  | 400                  | mV   |
|                                 |                     | I <sub>SINK</sub> = 4mA                                                                                  | Note 1                  | -              | -    | 700                  |      |
| Output Leakage Current          | I <sub>O(LKG)</sub> | V <sub>I(-)</sub> = 0V,                                                                                  | V <sub>O(P)</sub> = 5V  | -              | 0.1  | -                    | nA   |
|                                 |                     | V <sub>I(+)</sub> = 1V                                                                                   | V <sub>O(P)</sub> = 30V | -              | -    | 1.0                  | μA   |

**Note 1**

LM393/LM393A: 0 ≤ TA ≤ +70°C

LM2903: -40 ≤ TA ≤ +85°C

LM2903I: -40 ≤ TA ≤ +105°C

LM293/LM293A: -25 ≤ TA ≤ +85°C

## Typical Performance Characteristics

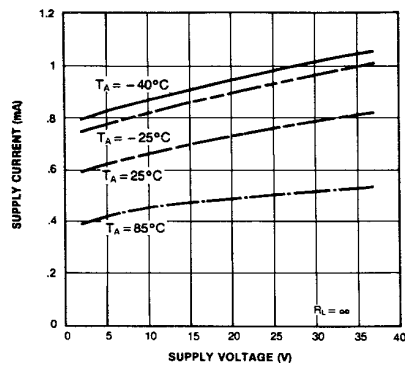


Figure 1. Supply Current vs Supply Voltage

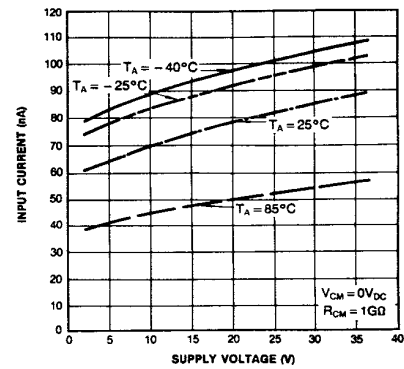


Figure 2. Input Current vs Supply Voltage

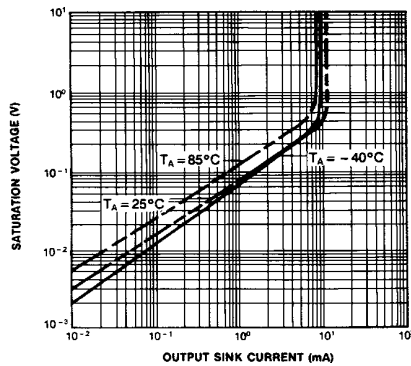


Figure 3. Output Saturation Voltage vs Sink Current

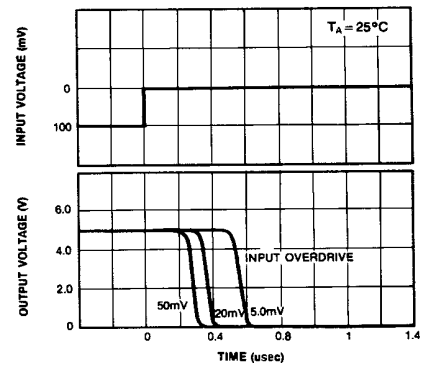


Figure 4. Response Time for Various Input Overdrive-Negative Transition

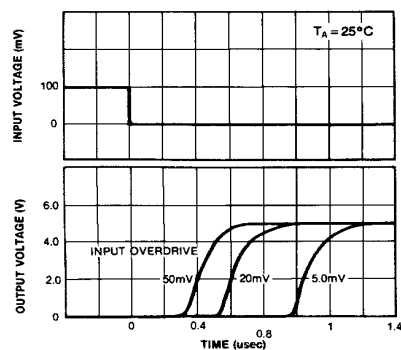


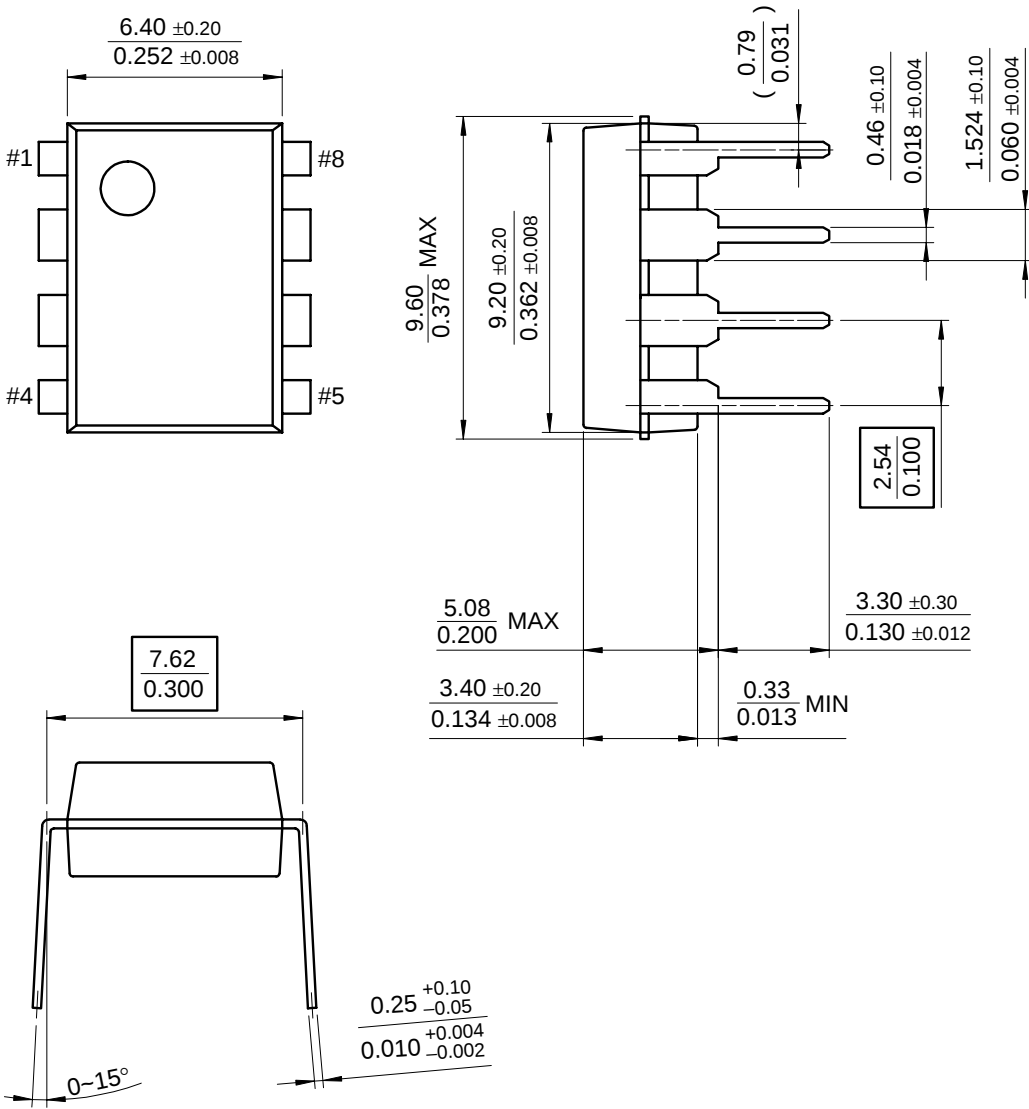
Figure 5. Response Time for Various Input Overdrive-Positive Transition

Mechanical Dimensions

Package

Dimensions in millimeters

8-DIP





## Ordering Information

| Product Number | Package | Operating Temperature |
|----------------|---------|-----------------------|
| LM393N         | 8-DIP   | 0 ~ + 70°C            |
| LM393AN        |         |                       |
| LM393M         | 8-SOP   |                       |
| LM393AM        |         |                       |
| LM2903N        | 8-DIP   | -40 ~ + 85°C          |
| LM2903M        | 8-SOP   |                       |
| LM2903IN       | 8-DIP   | -40 ~ + 105°C         |
| LM2903IM       | 8-SOP   |                       |
| LM293N         | 8-DIP   | -25 ~ + 85°C          |
| LM293AN        |         |                       |
| LM293M         | 8-SOP   |                       |
| LM293AM        |         |                       |

### DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

### LIFE SUPPORT POLICY

FAIRCHILD' S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.