

## LMx93, LM2903 Dual Differential Comparators

### 1 Features

- Single-Supply or Dual Supplies
- Wide Range of Supply Voltage
  - Maximum Rating: 2 V to 36 V
  - Tested to 30 V: Non-V Devices
  - Tested to 32 V: V-Suffix Devices
- Low Supply-Current Drain Independent of Supply Voltage: 0.4 mA (Typical) Per Comparator
- Low Input Bias Current: 25 nA (Typical)
- Low Input Offset Current: 3 nA (Typical) (LM139)
- Low Input Offset Voltage: 2 mV (Typical)
- Common-Mode Input Voltage Range Includes Ground
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:  $\pm 36$  V
- Low Output Saturation Voltage
- Output Compatible With TTL, MOS, and CMOS
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

### 2 Applications

- Chemical or Gas Sensor
- Desktop PC
- Motor Control: AC Induction
- Weigh Scale

### 3 Description

These devices consist of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible as long as the difference between the two supplies is 2 V to 36 V, and  $V_{CC}$  is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

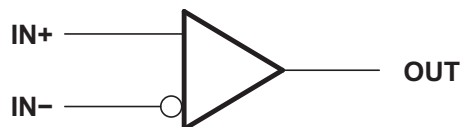
The LM193 device is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The LM293 and LM293A devices are characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LM393 and LM393A devices are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LM2903 device is characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

#### Device Information<sup>(1)</sup>

| PART NUMBER   | PACKAGE   | BODY SIZE (NOM)    |
|---|-----------|--------------------|
| LM193D, LM293D, LM293AD, LM393D, LM393AD, LM2903D   | SOIC (8)  | 4.90 mm x 6.00 mm  |
| LM293DGK, LM293ADGK, LM393DGK, LM393ADGK, LM2903DGK | VSSOP (8) | 3.00 mm x 5.00 mm  |
| LM293P, LM393P, LM393AP, LM2903P                    | PDIP (8)  | 9.50 mm x 6.30 mm  |
| LM393PS, LM393APS, LM2903PS                         | SO (8)    | 6.20 mm x 7.90 mm  |
| LM393PW, LM393APW, LM2903PW                         | TSSOP (8) | 6.40 mm x 3.00 mm  |
| LM193JG   | GDIP (8)  | 10.00 mm x 7.00 mm |
| LM193FK   | CQCC (8)  | 9.00 mm x 9.00 mm  |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

#### Simplified Schematic



## Table of Contents

|   |          |  |           |
|---|----------|--|-----------|
| <b>1 Features</b> .....                                     | <b>1</b> | 7.2 Functional Block Diagram .....                               | <b>9</b>  |
| <b>2 Applications</b> .....                                 | <b>1</b> | 7.3 Feature Description .....                                    | <b>9</b>  |
| <b>3 Description</b> .....                                  | <b>1</b> | 7.4 Device Functional Modes .....                                | <b>9</b>  |
| <b>4 Revision History</b> .....                             | <b>2</b> | <b>8 Application and Implementation</b> .....                    | <b>10</b> |
| <b>5 Pin Configuration and Functions</b> .....              | <b>3</b> | 8.1 Application Information .....                                | <b>10</b> |
| <b>6 Specifications</b> .....                               | <b>4</b> | 8.2 Typical Application .....                                    | <b>10</b> |
| 6.1 Absolute Maximum Ratings .....                          | <b>4</b> | <b>9 Power Supply Recommendations</b> .....                      | <b>12</b> |
| 6.2 ESD Ratings .....                                       | <b>4</b> | <b>10 Layout</b> .....   | <b>12</b> |
| 6.3 Recommended Operating Conditions .....                  | <b>4</b> | 10.1 Layout Guidelines .....                                     | <b>12</b> |
| 6.4 Thermal Information .....                               | <b>4</b> | 10.2 Layout Example .....  | <b>12</b> |
| 6.5 Electrical Characteristics for LMx93 .....              | <b>5</b> | <b>11 Device and Documentation Support</b> .....                 | <b>13</b> |
| 6.6 Electrical Characteristics for LMx93A .....             | <b>6</b> | 11.1 Related Links .....   | <b>13</b> |
| 6.7 Electrical Characteristics for LM2903 and LM2903A ..... | <b>7</b> | 11.2 Community Resources .....                                   | <b>13</b> |
| 6.8 Switching Characteristics .....                         | <b>7</b> | 11.3 Trademarks .....  | <b>13</b> |
| 6.9 Typical Characteristics .....                           | <b>8</b> | 11.4 Electrostatic Discharge Caution .....                       | <b>13</b> |
| <b>7 Detailed Description</b> .....                         | <b>9</b> | 11.5 Glossary .....  | <b>13</b> |
| 7.1 Overview .....  | <b>9</b> | <b>12 Mechanical, Packaging, and Orderable Information</b> ..... | <b>13</b> |

## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

### Changes from Revision X (January 2014) to Revision Y

Page

- Added *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section. .... **1**

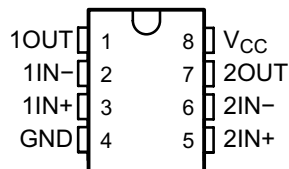
### Changes from Revision W (July 2010) to Revision X

Page

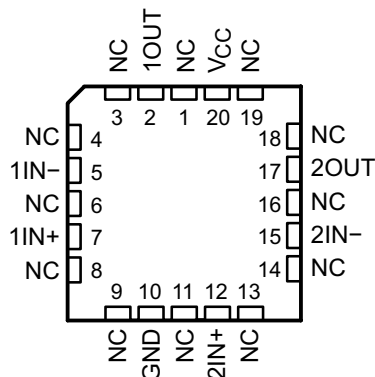
- Updated document to new TI data sheet format - no specification changes. .... **1**
- Updated *Features* .....
- Removed *Ordering Information* table .....
- Added ESD warning. .... **13**

## 5 Pin Configuration and Functions

D, DGK, JG, P, PS, or PW  
8-Pin SOIC, VSSOP, GDIP, PDIP, SO, or TSSOP  
Top View



FK Package  
20-Pin CQCC  
Top View



NC – No internal connection

### Pin Functions

| NAME            | PIN                                   |      | I/O    | DESCRIPTION                         |
|-----------------|---------------------------------------|------|--------|-------------------------------------|
|                 | SOIC, VSSOP, GDIP, PDIP, SO, or TSSOP | LCCC |        |                                     |
| 1OUT            | 1                                     | 2    | Output | Output pin of comparator 1          |
| 1IN-            | 2                                     | 5    | Input  | Negative input pin of comparator 1  |
| 1IN+            | 3                                     | 7    | Input  | Positive input pin of comparator 1  |
| GND             | 4                                     | 10   | Input  | Ground                              |
| 2IN+            | 5                                     | 12   | Input  | Positive input pin of comparator 2  |
| 2IN-            | 6                                     | 15   | Input  | Negative input pin of comparator 2  |
| 2OUT            | 7                                     | 17   | Output | Output pin of comparator 2          |
| V <sub>CC</sub> | 8                                     | 20   | Input  | Supply Pin                          |
| NC              | —                                     | 1    | N/A    | No Connect (No Internal Connection) |
|                 |                                       | 3    |        |                                     |
|                 |                                       | 4    |        |                                     |
|                 |                                       | 6    |        |                                     |
|                 |                                       | 8    |        |                                     |
|                 |                                       | 9    |        |                                     |
|                 |                                       | 11   |        |                                     |
|                 |                                       | 13   |        |                                     |
|                 |                                       | 14   |        |                                     |
|                 |                                       | 16   |        |                                     |
| 18              |                                       |      |        |                                     |
| 19              |                                       |      |        |                                     |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

 over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                  |   | MIN        | MAX       | UNIT |
|------------------|---|------------|-----------|------|
| V <sub>CC</sub>  | Supply voltage <sup>(2)</sup>                             |            | 36        | V    |
| V <sub>ID</sub>  | Differential input voltage <sup>(3)</sup>                 |            | ±36       | V    |
| V <sub>I</sub>   | Input voltage (either input)                              | -0.3       | 36        | V    |
| V <sub>O</sub>   | Output voltage  |            | 36        | V    |
| I <sub>O</sub>   | Output current  |            | 20        | mA   |
|                  | Duration of output short circuit to ground <sup>(4)</sup> |            | Unlimited |      |
| T <sub>J</sub>   | Operating virtual-junction temperature                    |            | 150       | °C   |
|                  | Case temperature for 60 s                                 | FK package | 260       | °C   |
|                  | Lead temperature 1,6 mm (1/16 in) from case for 60 s      | J package  | 300       | °C   |
| T <sub>stg</sub> | Storage temperature                                       | -65        | 150       | °C   |

- (1) Stresses beyond 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-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to network ground.
- (3) Differential voltages are at IN+ with respect to IN-.
- (4) Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.

### 6.2 ESD Ratings

|                    |                         | VALUE  | UNIT |
|--------------------|-------------------------|--|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | 1000 |
|                    |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | 750  |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                                 | MIN                  | MAX | UNIT |    |
|---------------------------------|----------------------|-----|------|----|
| V <sub>CC</sub> (non-V devices) | 2                    | 30  | V    |    |
| V <sub>CC</sub> (V devices)     | 2                    | 32  | V    |    |
| T <sub>J</sub>                  | Junction Temperature | -40 | 125  | °C |

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> | LMx93, LM2903                             |             |          |         |            |           |           | UNIT |      |
|-------------------------------|---|-------------|----------|---------|------------|-----------|-----------|------|------|
|                               | D (SOIC)                                  | DGK (VSSOP) | P (PDIP) | PS (SO) | PW (TSSOP) | JG (GDIP) | FK (LCCC) |      |      |
|                               | 8 PINS                                    | 8 PINS      | 8 PINS   | 8 PINS  | 8 PINS     | 8 PINS    | 20 PINS   |      |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance    | 97          | 172      | 85      | 95         | 149       | —         | —    | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance | —           | —        | —       | —          | —         | 14.5      | 5.61 | °C/W |

- (1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.5 Electrical Characteristics for LMx93

 at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS  | $T_A^{(1)}$            | LM193      |                        |      | LM293<br>LM393 |                        |      | UNIT          |    |
|--|--|------------------------|------------|------------------------|------|----------------|------------------------|------|---------------|----|
|  |  |                        | MIN        | TYP                    | MAX  | MIN            | TYP                    | MAX  |               |    |
| $V_{IO}$ Input offset voltage                            | $V_{CC} = 5\text{ V to }30\text{ V}$ ,<br>$V_{IC} = V_{ICR\text{ min}}$ ,<br>$V_O = 1.4\text{ V}$                    | 25°C                   |            | 2                      | 5    |                | 2                      | 5    | mV            |    |
|  |  | Full range             |            |                        | 9    |                | 9                      |      |               |    |
| $I_{IO}$ Input offset current                            | $V_O = 1.4\text{ V}$   | 25°C                   |            | 3                      | 25   |                | 5                      | 50   | nA            |    |
|  |  | Full range             |            |                        | 100  |                | 250                    |      |               |    |
| $I_{IB}$ Input bias current                              | $V_O = 1.4\text{ V}$   | 25°C                   |            | -25                    | -100 |                | -25                    | -250 | nA            |    |
|  |  | Full range             |            |                        | -300 |                | -400                   |      |               |    |
| $V_{ICR}$ Common-mode input-voltage range <sup>(2)</sup> |  | 25°C                   |            | 0 to<br>$V_{CC} - 1.5$ |      |                | 0 to<br>$V_{CC} - 1.5$ |      | V             |    |
|  |  | Full range             |            | 0 to<br>$V_{CC} - 2$   |      |                | 0 to<br>$V_{CC} - 2$   |      |               |    |
| $A_{VD}$ Large-signal differential-voltage amplification | $V_{CC} = 15\text{ V}$ ,<br>$V_O = 1.4\text{ V to }11.4\text{ V}$ ,<br>$R_L \geq 15\text{ k}\Omega\text{ to }V_{CC}$ | 25°C                   |            | 50                     | 200  |                | 50                     | 200  | V/mV          |    |
| $I_{OH}$ High-level output current                       | $V_{OH} = 5\text{ V}$  | $V_{ID} = 1\text{ V}$  | 25°C       |                        | 0.1  |                | 0.1                    | 50   | nA            |    |
|  | $V_{OH} = 30\text{ V}$   | $V_{ID} = 1\text{ V}$  | Full range |                        |      | 1              |                        | 1    | $\mu\text{A}$ |    |
| $V_{OL}$ Low-level output voltage                        | $I_{OL} = 4\text{ mA}$ ,<br>$V_{ID} = -1\text{ V}$   | 25°C                   |            | 150                    | 400  |                | 150                    | 400  | mV            |    |
|  |  | Full range             |            |                        | 700  |                | 700                    |      |               |    |
| $I_{OL}$ Low-level output current                        | $V_{OL} = 1.5\text{ V}$ ,<br>$V_{ID} = -1\text{ V}$  | 25°C                   |            | 6                      |      |                | 6                      |      | mA            |    |
| $I_{CC}$ Supply current                                  | $R_L = \infty$   | $V_{CC} = 5\text{ V}$  | 25°C       |                        | 0.8  | 1              |                        | 0.8  | 1             | mA |
|  |  | $V_{CC} = 30\text{ V}$ | Full range |                        |      | 2.5            |                        | 2.5  |               |    |

- (1) Full range (minimum or maximum) for LM193 is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ , for LM293 is  $25^\circ\text{C}$  to  $85^\circ\text{C}$ , and for LM393 is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ . All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (2) The voltage at either input or common-mode should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is  $V_{CC+} - 1.5\text{ V}$  for the inverting input ( $-$ ), and the non-inverting input ( $+$ ) can exceed the  $V_{CC}$  level; the comparator provides a proper output state. Either or both inputs can go to 30 V without damage.

## 6.6 Electrical Characteristics for LMx93A

 at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS  | $T_A$ <sup>(1)</sup> | LM293A<br>LM393A |                     |      | UNIT          |
|--|--|----------------------|------------------|---------------------|------|---------------|
|  |  |                      | MIN              | TYP                 | MAX  |               |
| $V_{IO}$ Input offset voltage                            | $V_{CC} = 5\text{ V to }30\text{ V}$ , $V_O = 1.4\text{ V}$<br>$V_{IC} = V_{ICR(min)}$                       | 25°C                 |                  | 1                   | 2    | mV            |
|  |  | Full range           |                  |                     | 4    |               |
| $I_{IO}$ Input offset current                            | $V_O = 1.4\text{ V}$   | 25°C                 |                  | 5                   | 50   | nA            |
|  |  | Full range           |                  |                     | 150  |               |
| $I_{IB}$ Input bias current                              | $V_O = 1.4\text{ V}$   | 25°C                 |                  | -25                 | -250 | nA            |
|  |  | Full range           |                  |                     | -400 |               |
| $V_{ICR}$ Common-mode input-voltage range <sup>(2)</sup> |  | 25°C                 |                  | 0 to $V_{CC} - 1.5$ |      | V             |
|  |  | Full range           |                  | 0 to $V_{CC} - 2$   |      |               |
| $A_{VD}$ Large-signal differential-voltage amplification | $V_{CC} = 15\text{ V}$ , $V_O = 1.4\text{ V to }11.4\text{ V}$ ,<br>$R_L \geq 15\text{ k}\Omega$ to $V_{CC}$ | 25°C                 |                  | 50                  | 200  | V/mV          |
| $I_{OH}$ High-level output current                       | $V_{OH} = 5\text{ V}$ , $V_{ID} = 1\text{ V}$  | 25°C                 |                  | 0.1                 | 50   | nA            |
|  | $V_{OH} = 30\text{ V}$ , $V_{ID} = 1\text{ V}$   | Full range           |                  |                     | 1    | $\mu\text{A}$ |
| $V_{OL}$ Low-level output voltage                        | $I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$  | 25°C                 |                  | 150                 | 400  | mV            |
|  |  | Full range           |                  |                     | 700  |               |
| $I_{OL}$ Low-level output current                        | $V_{OL} = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$ ,   | 25°C                 |                  | 6                   |      | mA            |
| $I_{CC}$ Supply current<br>(four comparators)            | $R_L = \infty$   | 25°C                 |                  | 0.8                 | 1    | mA            |
|  |  | Full range           |                  |                     | 2.5  |               |

(1) Full range (minimum or maximum) for LM293A is 25°C to 85°C, and for LM393A is 0°C to 70°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

(2) The voltage at either input or common-mode should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is  $V_{CC+} - 1.5\text{ V}$ , but either or both inputs can go to 30 V without damage.

## 6.7 Electrical Characteristics for LM2903 and LM2903A

 at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER  | TEST CONDITIONS   | $T_A$ <sup>(1)</sup>  | LM2903                 |     |      | LM2903A                |     |      | UNIT          |
|--|---|-----------------------|------------------------|-----|------|------------------------|-----|------|---------------|
|  |   |                       | MIN                    | TYP | MAX  | MIN                    | TYP | MAX  |               |
| $V_{IO}$ Input offset voltage                            | $V_{CC} = 5\text{ V to MAX}^{(2)}$ ,<br>$V_O = 1.4\text{ V}$ ,<br>$V_{IC} = V_{ICR(min)}$ ,                   | 25°C                  |                        | 2   | 7    |                        | 1   | 2    | mV            |
|  |   | Full range            |                        |     | 15   |                        |     | 4    |               |
| $I_{IO}$ Input offset current                            | $V_O = 1.4\text{ V}$  | 25°C                  |                        | 5   | 50   |                        | 5   | 50   | nA            |
|  |   | Full range            |                        |     | 200  |                        |     | 200  |               |
| $I_{IB}$ Input bias current                              | $V_O = 1.4\text{ V}$  | 25°C                  |                        | -25 | -250 |                        | -25 | -250 | nA            |
|  |   | Full range            |                        |     | -500 |                        |     | -500 |               |
| $V_{ICR}$ Common-mode input-voltage range <sup>(3)</sup> |   | 25°C                  | 0 to<br>$V_{CC} - 1.5$ |     |      | 0 to<br>$V_{CC} - 1.5$ |     |      | V             |
|  |   | Full range            | 0 to<br>$V_{CC} - 2$   |     |      | 0 to<br>$V_{CC} - 2$   |     |      |               |
| $A_{VD}$ Large-signal differential-voltage amplification | $V_{CC} = 15\text{ V}$ , $V_O = 1.4\text{ V to } 11.4\text{ V}$ ,<br>$R_L \geq 15\text{ k}\Omega$ to $V_{CC}$ | 25°C                  | 25                     | 100 |      | 25                     | 100 | V/mV |               |
| $I_{OH}$ High-level output current                       | $V_{OH} = 5\text{ V}$ , $V_{ID} = 1\text{ V}$<br>$V_{OH} = V_{CC} \text{ MAX}^{(2)}$ , $V_{ID} = 1\text{ V}$  | 25°C                  |                        | 0.1 | 50   |                        | 0.1 | 50   | nA            |
|  |   | Full range            |                        |     | 1    |                        |     | 1    | $\mu\text{A}$ |
| $V_{OL}$ Low-level output voltage                        | $I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$ ,   | 25°C                  |                        | 150 | 400  |                        | 150 | 400  | mV            |
|  |   | Full range            |                        |     | 700  |                        |     | 700  |               |
| $I_{OL}$ Low-level output current                        | $V_{OL} = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$  | 25°C                  | 6                      |     |      | 6                      |     | mA   |               |
| $I_{CC}$ Supply current                                  | $R_L = \infty$  | $V_{CC} = 5\text{ V}$ |                        | 0.8 | 1    |                        | 0.8 | 1    | mA            |
|  |   | Full range            |                        |     | 2.5  |                        |     | 2.5  |               |

- (1) Full range (minimum or maximum) for LM2903 is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ . All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (2)  $V_{CC} \text{ MAX} = 30\text{ V}$  for non-V devices and  $32\text{ V}$  for V-suffix devices.
- (3) The voltage at either input or common-mode should not be allowed to go negative by more than  $0.3\text{ V}$ . The upper end of the common-mode voltage range is  $V_{CC+} - 1.5\text{ V}$ , but either or both inputs can go to  $30\text{ V}$  ( $32\text{ V}$  for V-suffix devices) without damage.

## 6.8 Switching Characteristics

 $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ 

| PARAMETER     | TEST CONDITIONS   | LM2901, LM293, LM293A<br>LM393, LM393A LM2903 | UNIT |               |
|---------------|---|---|------|---------------|
|               |   | TYP   |      |               |
| Response time | $R_L$ connected to $5\text{ V}$ through $5.1\text{ k}\Omega$ ,<br>$C_L = 15\text{ pF}^{(1)(2)}$ | 100-mV input step with 5-mV overdrive         | 1.3  | $\mu\text{s}$ |
|               |   | TTL-level input step                          | 0.3  |               |

- (1)  $C_L$  includes probe and jig capacitance.
- (2) The response time specified is the interval between the input step function and the instant when the output crosses  $1.4\text{ V}$ .

## 6.9 Typical Characteristics

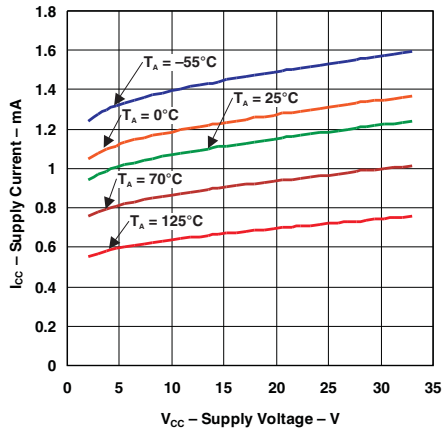


Figure 1. Supply Current vs Supply Voltage

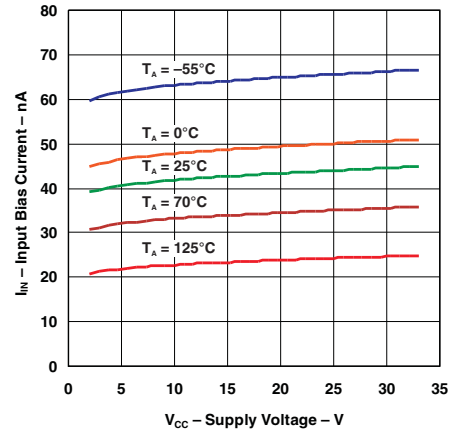


Figure 2. Input Bias Current vs Supply Voltage

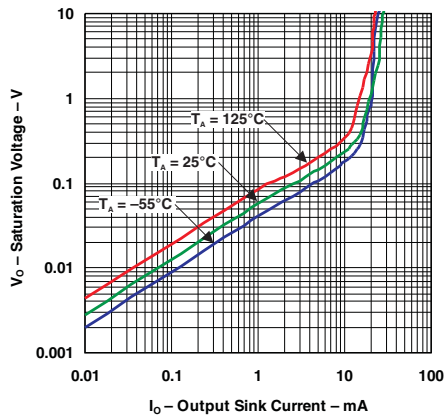


Figure 3. Output Saturation Voltage

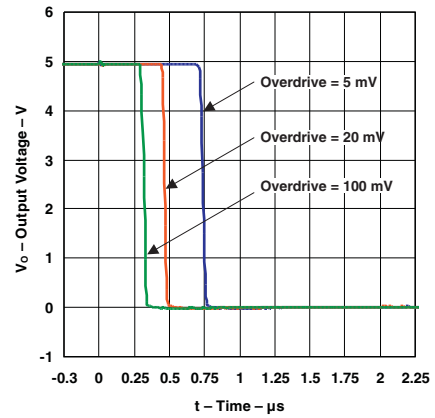


Figure 4. Response Time for Various Overdrives Negative Transition

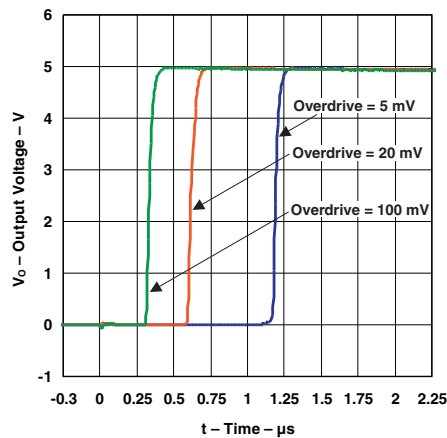


Figure 5. Response Time for Various Overdrives Positive Transition



## 7 Detailed Description

### 7.1 Overview

The LM2903 is a dual comparator with the ability to operate up to 36 V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to very wide supply voltages range (2 V to 36 V), low  $I_q$  and fast response of the devices.

The open-drain output allows the user to configure the output's logic low voltage ( $V_{OL}$ ) and can be used to enable the comparator to be used in AND functionality.

### 7.2 Functional Block Diagram

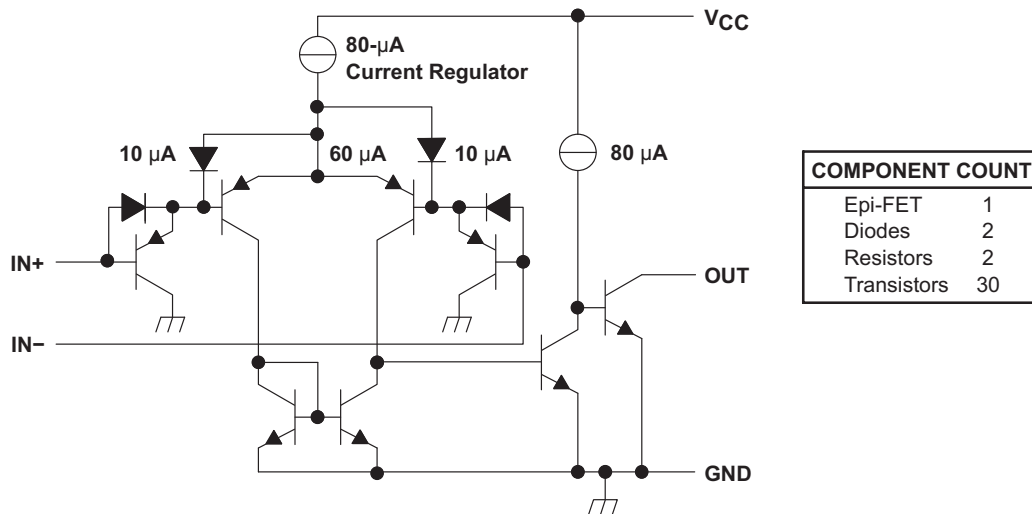


Figure 6. Schematic (Each Comparator)

### 7.3 Feature Description

LM2903 consists of a PNP darlington pair input, allowing the device to operate with very high gain and fast response with minimal input bias current. The input Darlington pair creates a limit on the input common mode voltage capability, allowing LM2903 to accurately function from ground to  $V_{CC}-1.5V$  differential input. This enables much head room for modern day supplies of 3.3 V and 5 V.

The output consists of an open drain NPN (pull-down or low side) transistor. The output NPN will sink current when the positive input voltage is higher than the negative input voltage and the offset voltage. The  $V_{OL}$  is resistive and will scale with the output current. See Figure 3 for  $V_{OL}$  values with respect to the output current.

### 7.4 Device Functional Modes

#### 7.4.1 Voltage Comparison

The LM2903 operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pullup) based on the input differential polarity.

## 8 Application and Implementation

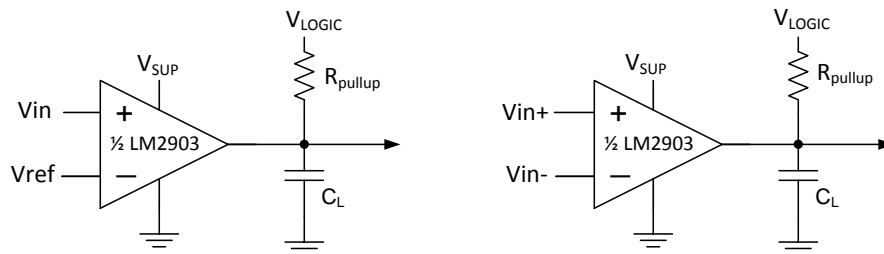
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

LM2903 will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes LM2903 optimal for level shifting to a higher or lower voltage.

### 8.2 Typical Application



**Figure 7. Single-Ended and Differential Comparator Configurations**

#### 8.2.1 Design Requirements

For this design example, use the parameters listed in [Table 1](#) as the input parameters.

**Table 1. Design Parameters**

| DESIGN PARAMETER                | EXAMPLE VALUE          |
|---------------------------------|------------------------|
| Input Voltage Range             | 0 V to $V_{sup}-1.5$ V |
| Supply Voltage                  | 2 V to 36 V            |
| Logic Supply Voltage            | 2 V to 36 V            |
| Output Current ( $R_{PULLUP}$ ) | 1 $\mu$ A to 20 mA     |
| Input Overdrive Voltage         | 100 mV                 |
| Reference Voltage               | 2.5 V                  |
| Load Capacitance ( $C_L$ )      | 15 pF                  |

#### 8.2.2 Detailed Design Procedure

When using LM2903 in a general comparator application, determine the following:

- Input Voltage Range
- Minimum Overdrive Voltage
- Output and Drive Current
- Response Time

##### 8.2.2.1 Input Voltage Range

When choosing the input voltage range, the input common mode voltage range ( $V_{ICR}$ ) must be taken in to account. If temperature operation is above or below 25°C the  $V_{ICR}$  can range from 0 V to  $V_{CC}-2.0$  V. This limits the input voltage range to as high as  $V_{CC}-2.0$  V and as low as 0 V. Operation outside of this range can yield incorrect comparisons.

Below is a list of input voltage situation and their outcomes:

1. When both IN- and IN+ are both within the common-mode range:
  - (a) If IN- is higher than IN+ and the offset voltage, the output is low and the output transistor is sinking current
  - (b) If IN- is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
2. When IN- is higher than common-mode and IN+ is within common-mode, the output is low and the output transistor is sinking current
3. When IN+ is higher than common-mode and IN- is within common-mode, the output is high impedance and the output transistor is not conducting
4. When IN- and IN+ are both higher than common-mode, the output is low and the output transistor is sinking current

### 8.2.2.2 Minimum Overdrive Voltage

Overdrive Voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage ( $V_{IO}$ ). In order to make an accurate comparison the Overdrive Voltage ( $V_{OD}$ ) should be higher than the input offset voltage ( $V_{IO}$ ). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive. [Figure 8](#) and [Figure 9](#) show positive and negative response times with respect to overdrive voltage.

### 8.2.2.3 Output and Drive Current

Output current is determined by the load/pull-up resistance and logic/pullup voltage. The output current will produce a output low voltage ( $V_{OL}$ ) from the comparator. In which  $V_{OL}$  is proportional to the output current. Use [Typical Characteristics](#) to determine  $V_{OL}$  based on the output current.

The output current can also effect the transient response. See [Response Time](#) for more information.

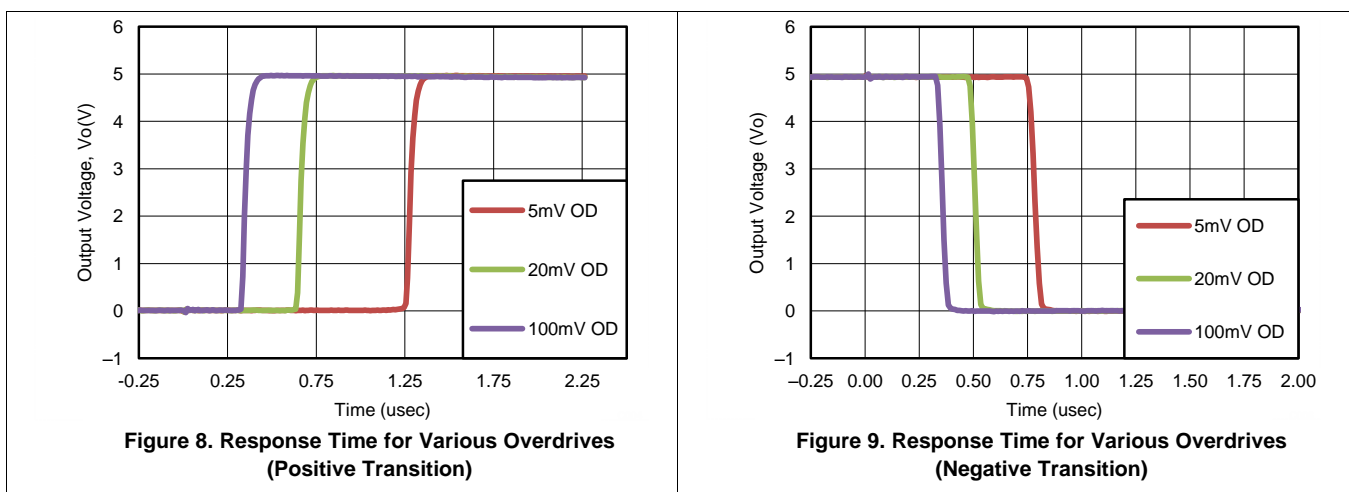
### 8.2.2.4 Response Time

The transient response can be determined by the load capacitance ( $C_L$ ), load/pullup resistance ( $R_{PULLUP}$ ) and equivalent collector-emitter resistance ( $R_{CE}$ ).

- The positive response time ( $\tau_P$ ) is approximately  $\tau_P \sim R_{PULLUP} \times C_L$
- The negative response time ( $\tau_N$ ) is approximately  $\tau_N \sim R_{CE} \times C_L$ 
  - $R_{CE}$  can be determine by taking the slope of [Typical Characteristics](#) in it's linear region at the desired temperature, or by dividing the  $V_{OL}$  by  $I_{out}$

### 8.2.3 Application Curves

The following curves were generated with 5 V on  $V_{CC}$  and  $V_{Logic}$ ,  $R_{PULLUP} = 5.1 \text{ k}\Omega$ , and 50 pF scope probe.



## 9 Power Supply Recommendations

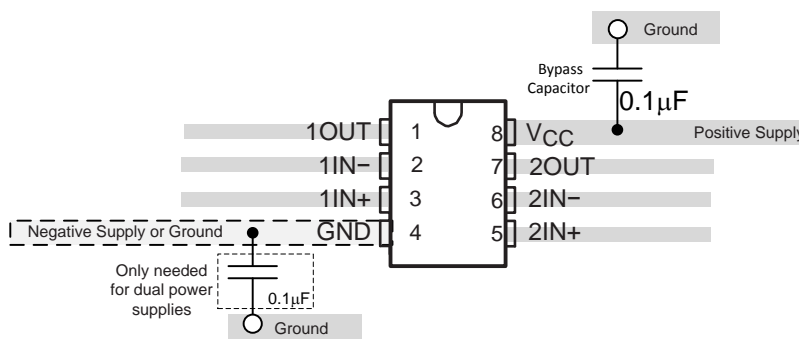
For fast response and comparison applications with noisy or AC inputs, TI recommends to use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation can eat into the input common-mode range of the comparator and create an inaccurate comparison.

## 10 Layout

### 10.1 Layout Guidelines

For accurate comparator applications without hysteresis it is important maintain a stable power supply with minimized noise and glitches, which can affect the high level input common-mode voltage range. In order to achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC's GND pin and system ground.

### 10.2 Layout Example



**Figure 10. LM2903 Layout Example**

## 11 Device and Documentation Support

### 11.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 2. Related Links**

| PARTS   | PRODUCT FOLDER             | SAMPLE & BUY               | TECHNICAL DOCUMENTS        | TOOLS & SOFTWARE           | SUPPORT & COMMUNITY        |
|---------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| LM193   | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM293   | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM293A  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM393   | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM393A  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM2903  | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |
| LM2903V | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> | <a href="#">Click here</a> |

### 11.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 11.3 Trademarks

E2E is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 11.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 11.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)         | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|---------------------------------|-------------------------|
| 5962-9452601Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9452601Q2A<br>LM193FKB | <a href="#">Samples</a> |
| 5962-9452601QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9452601QPA<br>LM193             | <a href="#">Samples</a> |
| 5962R9452602V9A  | ACTIVE        | DIESALE      | Y                  | 0    | 40             | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| 5962R9452603V9A  | ACTIVE        | DIESALE      | Y                  | 0    | 40             | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| JM38510/11202BPA | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | JM38510<br>/11202BPA            | <a href="#">Samples</a> |
| LM193 MD8        | ACTIVE        | DIESALE      | Y                  | 0    | 400            | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| LM193 MDE        | ACTIVE        | DIESALE      | Y                  | 0    | 40             | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| LM193 MDR        | ACTIVE        | DIESALE      | Y                  | 0    | 40             | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| LM193 MW8        | ACTIVE        | WAFERSALE    | YS                 | 0    | 1              | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     |              |                                 | <a href="#">Samples</a> |
| LM193DR          | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | LM193                           | <a href="#">Samples</a> |
| LM193DRG4        | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | LM193                           | <a href="#">Samples</a> |
| LM193FKB         | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9452601Q2A<br>LM193FKB | <a href="#">Samples</a> |
| LM193JG          | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | LM193JG                         | <a href="#">Samples</a> |
| LM193JGB         | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9452601QPA<br>LM193             | <a href="#">Samples</a> |
| LM2903AVQDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | L2903AV                         | <a href="#">Samples</a> |
| LM2903AVQDRG4    | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | L2903AV                         | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6)    | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|----------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM2903AVQPWR     | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903AV                 | <a href="#">Samples</a> |
| LM2903AVQPWRG4   | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903AV                 | <a href="#">Samples</a> |
| LM2903D          | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DE4        | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DG4        | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DGKR       | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU  <br>CU NIPDAUAG | Level-1-260C-UNLIM   | -40 to 125   | (MAP ~ MAS ~ MAU)       | <a href="#">Samples</a> |
| LM2903DGKRG4     | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | (MAP ~ MAS ~ MAU)       | <a href="#">Samples</a> |
| LM2903DR         | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN          | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DRE4       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DRG3       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN                      | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903DRG4       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | LM2903                  | <a href="#">Samples</a> |
| LM2903P          | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU                  | N / A for Pkg Type   | -40 to 125   | LM2903P                 | <a href="#">Samples</a> |
| LM2903PE4        | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU                  | N / A for Pkg Type   | -40 to 125   | LM2903P                 | <a href="#">Samples</a> |
| LM2903PSR        | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |
| LM2903PSRG4      | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |
| LM2903PWLE       | OBSOLETE      | TSSOP        | PW              | 8    |             | TBD                     | Call TI                    | Call TI              | -40 to 125   |                         |                         |
| LM2903PWR        | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN          | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |
| LM2903PWRE4      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6)    | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|----------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM2903PWRG3      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU SN                      | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |
| LM2903PWRG4      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903                   | <a href="#">Samples</a> |
| LM2903QD         | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | 2903Q                   | <a href="#">Samples</a> |
| LM2903QDG4       | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | 2903Q                   | <a href="#">Samples</a> |
| LM2903QDRG4      | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | 2903Q                   | <a href="#">Samples</a> |
| LM2903QP         | OBSOLETE      | PDIP         | P               | 8    |             | TBD                     | Call TI                    | Call TI              | -40 to 125   |                         |                         |
| LM2903VQDR       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903V                  | <a href="#">Samples</a> |
| LM2903VQDRG4     | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903V                  | <a href="#">Samples</a> |
| LM2903VQPWR      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903V                  | <a href="#">Samples</a> |
| LM2903VQPWRG4    | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -40 to 125   | L2903V                  | <a href="#">Samples</a> |
| LM293AD          | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293A                  | <a href="#">Samples</a> |
| LM293ADE4        | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293A                  | <a href="#">Samples</a> |
| LM293ADG4        | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293A                  | <a href="#">Samples</a> |
| LM293ADGKR       | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU  <br>CU NIPDAUAG | Level-1-260C-UNLIM   | -25 to 85    | (MDP ~ MDS ~ MDU)       | <a href="#">Samples</a> |
| LM293ADGKRG4     | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | (MDP ~ MDS ~ MDU)       | <a href="#">Samples</a> |
| LM293ADR         | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN          | Level-1-260C-UNLIM   | -25 to 85    | LM293A                  | <a href="#">Samples</a> |
| LM293ADRG4       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293A                  | <a href="#">Samples</a> |
| LM293D           | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |



| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6)    | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|----------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM293DE4         | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293DG4         | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293DGKR        | ACTIVE        | VSSOP        | DGK                | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU  <br>CU NIPDAUAG | Level-1-260C-UNLIM   | -25 to 85    | (MCP ~ MCS ~ MCU)       | <a href="#">Samples</a> |
| LM293DGKRG4      | ACTIVE        | VSSOP        | DGK                | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | (MCP ~ MCS ~ MCU)       | <a href="#">Samples</a> |
| LM293DR          | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU   CU SN          | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293DRE4        | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293DRG3        | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN                      | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293DRG4        | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | -25 to 85    | LM293                   | <a href="#">Samples</a> |
| LM293P           | ACTIVE        | PDIP         | P                  | 8    | 50             | Pb-Free<br>(RoHS)          | CU NIPDAU   CU SN          | N / A for Pkg Type   | -25 to 85    | LM293P                  | <a href="#">Samples</a> |
| LM293PE4         | ACTIVE        | PDIP         | P                  | 8    | 50             | Pb-Free<br>(RoHS)          | CU NIPDAU                  | N / A for Pkg Type   | -25 to 85    | LM293P                  | <a href="#">Samples</a> |
| LM393 MDC        | ACTIVE        | DIESALE      | Y                  | 0    | 400            | Green (RoHS<br>& no Sb/Br) | Call TI                    | Level-1-NA-UNLIM     |              |                         | <a href="#">Samples</a> |
| LM393AD          | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |
| LM393ADE4        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |
| LM393ADG4        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |
| LM393ADGKR       | ACTIVE        | VSSOP        | DGK                | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU  <br>CU NIPDAUAG | Level-1-260C-UNLIM   | 0 to 70      | (M8P ~ M8S ~ M8U)       | <a href="#">Samples</a> |
| LM393ADGKRG4     | ACTIVE        | VSSOP        | DGK                | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | 0 to 70      | (M8P ~ M8S ~ M8U)       | <a href="#">Samples</a> |
| LM393ADR         | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU   CU SN          | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |
| LM393ADRE4       | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU                  | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM393ADRG4       | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393A                  | <a href="#">Samples</a> |
| LM393AP          | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU   CU SN       | N / A for Pkg Type   | 0 to 70      | LM393AP                 | <a href="#">Samples</a> |
| LM393APE4        | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | LM393AP                 | <a href="#">Samples</a> |
| LM393APSR        | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393APSRE4      | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393APSRG4      | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393APWLE       | OBSOLETE      | TSSOP        | PW              | 8    |             | TBD                     | Call TI                 | Call TI              | 0 to 70      |                         |                         |
| LM393APWR        | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN       | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393APWRE4      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393APWRG4      | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393A                   | <a href="#">Samples</a> |
| LM393D           | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393DE4         | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393DG4         | ACTIVE        | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393DGKR        | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU NIPDAUAG | Level-1-260C-UNLIM   | 0 to 70      | (M9P ~ M9S ~ M9U)       | <a href="#">Samples</a> |
| LM393DGKRG4      | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | (M9P ~ M9S ~ M9U)       | <a href="#">Samples</a> |
| LM393DR          | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN       | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393DRE4        | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393DRG3        | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM393DRG4        | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | LM393                   | <a href="#">Samples</a> |
| LM393P           | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU   CU SN       | N / A for Pkg Type   | 0 to 70      | LM393P                  | <a href="#">Samples</a> |
| LM393PE3         | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU SN                   | N / A for Pkg Type   | 0 to 70      | LM393P                  | <a href="#">Samples</a> |
| LM393PE4         | ACTIVE        | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | LM393P                  | <a href="#">Samples</a> |
| LM393PSLE        | OBSOLETE      | SO           | PS              | 8    |             | TBD                     | Call TI                 | Call TI              | 0 to 70      |                         |                         |
| LM393PSR         | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PSRG4       | ACTIVE        | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PW          | ACTIVE        | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PWG4        | ACTIVE        | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PWLE        | OBSOLETE      | TSSOP        | PW              | 8    |             | TBD                     | Call TI                 | Call TI              | 0 to 70      |                         |                         |
| LM393PWR         | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU   CU SN       | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PWRG3       | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| LM393PWRG4       | ACTIVE        | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | L393                    | <a href="#">Samples</a> |
| M38510/11202BPA  | ACTIVE        | CDIP         | JG              | 8    | 1           | TBD                     | A42                     | N / A for Pkg Type   | -55 to 125   | JM38510 /11202BPA       | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

---

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM2903, LM293 :**

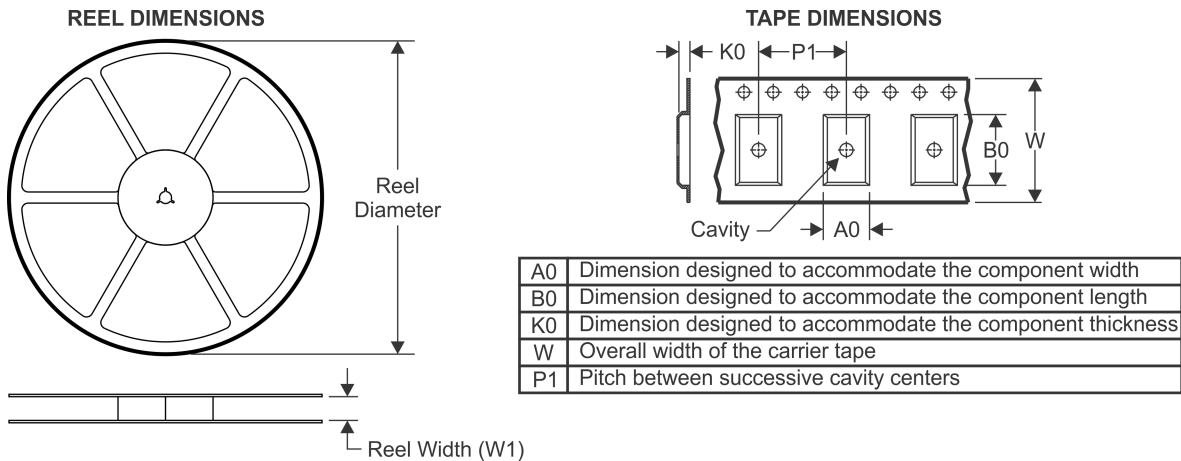
● Automotive: [LM2903-Q1](#)

● Enhanced Product: [LM293-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM193DR        | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903AVQPWR   | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903AVQPWRG4 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903DGKR     | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903DRG3     | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903DRG4     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903DRG4     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903PSR      | SO           | PS              | 8    | 2000 | 330.0              | 16.4               | 8.2     | 6.6     | 2.5     | 12.0    | 16.0   | Q1            |
| LM2903PWR      | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903PWR      | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903PWRG3    | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903PWRG4    | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903QDRG4    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM2903VQPWR    | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM2903VQPWRG4  | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |

| Device      | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM293ADGKR  | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| LM293ADR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293ADR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293ADRG4  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293ADRG4  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DGKR   | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| LM293DR     | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DR     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DR     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DRG3   | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DRG4   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM293DRG4   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393ADGKR  | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393ADRG4  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393ADRG4  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393APSR   | SO           | PS              | 8    | 2000 | 330.0              | 16.4               | 8.2     | 6.6     | 2.5     | 12.0    | 16.0   | Q1            |
| LM393APWR   | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM393APWR   | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM393APWRG4 | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM393DGKR   | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| LM393DR     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393DR     | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393DRG3   | SOIC         | D               | 8    | 2500 | 330.0              | 12.8               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393DRG4   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393DRG4   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| LM393PSR    | SO           | PS              | 8    | 2000 | 330.0              | 16.4               | 8.2     | 6.6     | 2.5     | 12.0    | 16.0   | Q1            |
| LM393PWR    | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM393PWRG3  | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| LM393PWRG4  | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM193DR        | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 38.0        |
| LM2903AVQPWR   | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM2903AVQPWRG4 | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM2903DGKR     | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM2903DR       | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM2903DRG3     | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM2903DRG4     | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM2903DRG4     | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM2903PSR      | SO           | PS              | 8    | 2000 | 367.0       | 367.0      | 38.0        |
| LM2903PWR      | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM2903PWR      | TSSOP        | PW              | 8    | 2000 | 364.0       | 364.0      | 27.0        |
| LM2903PWRG3    | TSSOP        | PW              | 8    | 2000 | 364.0       | 364.0      | 27.0        |
| LM2903PWRG4    | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM2903QDRG4    | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 38.0        |
| LM2903VQPWR    | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM2903VQPWRG4  | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM293ADGKR     | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM293ADR       | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM293ADR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM293ADRG4  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM293ADRG4  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM293DGKR   | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM293DR     | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM293DR     | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM293DR     | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM293DRG3   | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM293DRG4   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM293DRG4   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM393ADGKR  | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM393ADR    | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM393ADRG4  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM393ADRG4  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM393APSR   | SO           | PS              | 8    | 2000 | 367.0       | 367.0      | 38.0        |
| LM393APWR   | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM393APWR   | TSSOP        | PW              | 8    | 2000 | 364.0       | 364.0      | 27.0        |
| LM393APWRG4 | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| LM393DGKR   | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM393DR     | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM393DR     | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM393DRG3   | SOIC         | D               | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| LM393DRG4   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| LM393DRG4   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM393PSR    | SO           | PS              | 8    | 2000 | 367.0       | 367.0      | 38.0        |
| LM393PWR    | TSSOP        | PW              | 8    | 2000 | 364.0       | 364.0      | 27.0        |
| LM393PWRG3  | TSSOP        | PW              | 8    | 2000 | 364.0       | 364.0      | 27.0        |
| LM393PWRG4  | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |  |
|------------------------------|--|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>   |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>   |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |  |
|-------------------------------|--|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)