

# LM193, LM293, LM293A LM393, LM393A, LM2903, LM2903V DUAL DIFFERENTIAL COMPARATORS

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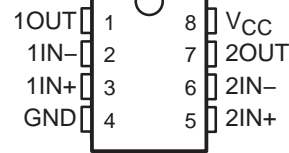
- Single Supply or Dual Supplies
- Wide Range of Supply Voltage
  - Max Rating . . . 2 V to 36 V
  - Tested to 30 V . . . Non-V Devices
  - Tested to 32 V . . . V-Suffix Devices
- Low Supply-Current Drain Independent of Supply Voltage . . . 0.4 mA Typ Per Comparator
- Low Input Bias Current . . . 25 nA Typ
- Low Input Offset Current . . . 3 nA Typ (LM193)
- Low Input Offset Voltage . . . 2 mV Typ
- 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

## description/ordering information

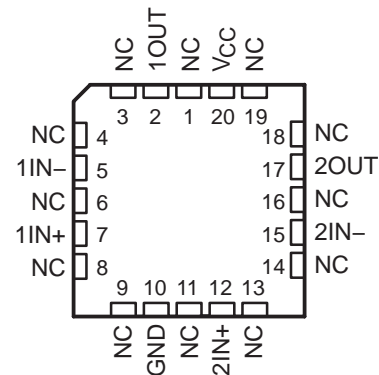
These devices consist of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible as long as the difference between the two supplies is 2 V to 36 V, and  $V_{CC}$  is at least 1.5 V more positive 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 is characterized for operation from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The LM293 and LM293A are characterized for operation from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The LM393 and LM393A are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The LM2903 is characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

LM193 . . . D OR JG PACKAGE  
LM293 . . . D, DGK, OR P PACKAGE  
LM293A . . . D OR DGK PACKAGE  
LM393, LM393A . . . D, DGK, P, PS, OR PW PACKAGE  
LM2903 . . . D, DGK, P, PS, OR PW PACKAGE  
(TOP VIEW)



LM193 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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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.

**LM193, LM293, LM293A**  
**LM393, LM393A, LM2903, LM2903V**  
**DUAL DIFFERENTIAL COMPARATORS**

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**description/ordering information (continued)**

**ORDERING INFORMATION**

| TA             | V <sub>IO</sub> max<br>AT 25°C | MAX V <sub>CC</sub> | PACKAGE†         |              | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|--------------------------------|---------------------|------------------|--------------|--------------------------|---------------------|
| 0°C to 70°C    | 5 mV                           | 30 V                | PDIP (P)         | Tube of 50   | LM393P                   | LM393P              |
|                |                                |                     | SOIC (D)         | Tube of 75   | LM393D                   | LM393               |
|                |                                |                     |                  | Reel of 2500 | LM393DR                  |                     |
|                |                                |                     | SOP (PS)         | Reel of 2000 | LM393PSR                 | L393                |
|                |                                |                     | TSSOP (PW)       | Tube of 150  | LM393PW                  | L393                |
|                |                                |                     |                  | Reel of 2000 | LM393PWR                 |                     |
|                |                                |                     | MSOP/VSSOP (DGK) | Reel of 2500 | LM393DGKR                | M9_‡                |
|                | 2 mV                           | 30 V                | PDIP (P)         | Tube of 50   | LM393AP                  | LM393AP             |
|                |                                |                     | SOIC (D)         | Tube of 75   | LM393AD                  | LM393A              |
|                |                                |                     |                  | Reel of 2500 | LM393ADR                 |                     |
|                |                                |                     | SOP (PS)         | Reel of 2000 | LM393APSR                | L393A               |
|                |                                |                     | TSSOP (PW)       | Reel of 2000 | LM393APWR                | L393A               |
|                |                                |                     | MSOP/VSSOP (DGK) | Reel of 2500 | LM393ADGKR               | M8_‡                |
| –25°C to 85°C  | 5 mV                           | 30 V                | PDIP (P)         | Tube of 50   | LM293P                   | LM293P              |
|                |                                |                     | SOIC (D)         | Tube of 75   | LM293D                   | LM293               |
|                |                                |                     |                  | Reel of 2500 | LM293DR                  |                     |
|                |                                |                     | MSOP/VSSOP (DGK) | Reel of 2500 | LM293DGKR                | MC_‡                |
|                | 2 mV                           | 30 V                | SOIC (D)         | Tube of 75   | LM293AD                  | LM293A              |
|                |                                |                     |                  | Reel of 2500 | LM293ADR                 |                     |
|                |                                |                     | MSOP/VSSOP (DGK) | Reel of 2500 | LM293ADGKR               | MD_‡                |
| –40°C to 125°C | 7 mV                           | 30 V                | PDIP (P)         | Tube of 50   | LM2903P                  | LM2903P             |
|                |                                |                     | SOIC (D)         | Tube of 75   | LM2903D                  | LM2903              |
|                |                                |                     |                  | Reel of 2500 | LM2903DR                 |                     |
|                |                                |                     | SOP (PS)         | Reel of 2000 | LM2903PSR                | L2903               |
|                |                                |                     | TSSOP (PW)       | Reel of 2000 | LM2903PWR                | L2903               |
|                |                                |                     | MSOP/VSSOP (DGK) | Reel of 2500 | LM2903DGKR               | MA_‡                |
|                | 7 mV                           | 32 V                | SOIC (D)         | Reel of 2500 | LM2903VQDR               | L2903V              |
|                |                                |                     | TSSOP (PW)       | Reel of 2000 | LM2903VQPWR              | L2903V              |
|                | 2 mV                           | 32 V                | SOIC (D)         | Reel of 2500 | LM2903AVQDR              | L2903AV             |
|                |                                |                     | TSSOP (PW)       | Reel of 2000 | LM2903AVQPWR             | L2903AV             |
| –55°C to 125°C | 5 mV                           | 30 V                | CDIP (JG)        | Tube of 50   | LM193JG                  | LM193JG             |
|                |                                |                     | LCCC (FK)        | Tube of 55   | LM193FK                  | LM193FK             |
|                |                                |                     | SOIC (D)         | Reel of 2500 | LM193DR                  | LM193               |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

‡ The actual top-side marking has one additional character that designates the assembly/test site.

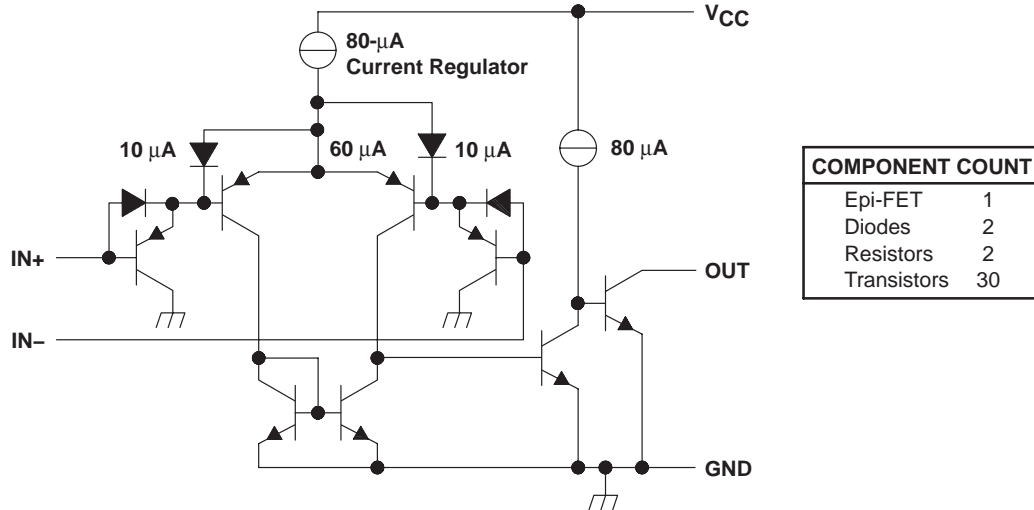


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**symbol (each comparator)**



**schematic (each comparator)**



Current values shown are nominal.

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†**

|  |                |
|--|----------------|
| Supply voltage, $V_{CC}$ (see Note 1)                                    | 36 V           |
| Differential input voltage, $V_{ID}$ (see Note 2)                        | $\pm 36$ V     |
| Input voltage range, $V_I$ (either input)                                | -0.3 V to 36 V |
| Output voltage, $V_O$  | 36 V           |
| Output current, $I_O$  | 20 mA          |
| Duration of output short-circuit to ground (see Note 3)                  | Unlimited      |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5):            |                |
| D package  | 97°C/W         |
| DGK package  | 172°C/W        |
| P package  | 85°C/W         |
| PS package   | 95°C/W         |
| PW package   | 149°C/W        |
| Package thermal impedance, $\theta_{JC}$ (see Notes 6 and 7):            |                |
| FK package   | 5.61°C/W       |
| JG package   | 14.5°C/W       |
| Operating virtual junction temperature, $T_J$                            | 150°C          |
| Case temperature for 60 seconds: FK package                              | 260°C          |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package | 300°C          |
| Storage temperature range, $T_{stg}$                                     | -65°C to 150°C |

† 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.

- NOTES:
1. All voltage values, except differential voltages, are with respect to GND.
  2. Differential voltages are at  $IN+$ , with respect to  $IN-$ .
  3. Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.
  4. Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51-7.
  6. Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JC}$ , and  $T_C$ . The maximum allowable power dissipation at any allowable case temperature is  $P_D = (T_J(\max) - T_C)/\theta_{JC}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  7. The package thermal impedance is calculated in accordance with MIL-STD-883.

**LM193, LM293, LM293A**  
**LM393, LM393A, LM2903, LM2903V**  
**DUAL DIFFERENTIAL COMPARATORS**

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

| PARAMETER        |   | TEST CONDITIONS   |                        | T <sub>A</sub> <sup>†</sup> | LM193                      |      |     | LM293<br>LM393             |      |      | UNIT |
|------------------|---|---|------------------------|-----------------------------|----------------------------|------|-----|----------------------------|------|------|------|
|                  |   |   |                        |                             | MIN                        | TYP  | MAX | MIN                        | TYP  | MAX  |      |
| V <sub>IO</sub>  | Input offset voltage                            | V <sub>CC</sub> = 5 V to 30 V,<br>V <sub>O</sub> = 1.4 V,<br>V <sub>IC</sub> = V <sub>IC(min)</sub>       |                        | 25°C                        | 2                          | 5    |     | 2                          | 5    | mV   |      |
|                  |   |   |                        | Full range                  |                            | 9    |     | 9                          |      |      |      |
| I <sub>IO</sub>  | Input offset current                            | V <sub>O</sub> = 1.4 V  |                        | 25°C                        | 3                          | 25   |     | 5                          | 50   | nA   |      |
|                  |   |   |                        | Full range                  |                            | 100  |     | 250                        |      |      |      |
| I <sub>IB</sub>  | Input bias current                              | V <sub>O</sub> = 1.4 V  |                        | 25°C                        | −25                        | −100 |     | −25                        | −250 | nA   |      |
|                  |   |   |                        | Full range                  |                            | −300 |     | −400                       |      |      |      |
| V <sub>ICR</sub> | Common-mode input voltage range‡                |   |                        | 25°C                        | 0 to V <sub>CC</sub> − 1.5 |      |     | 0 to V <sub>CC</sub> − 1.5 |      | V    |      |
|                  |   |   |                        | Full range                  | 0 to V <sub>CC</sub> − 2   |      |     | 0 to V <sub>CC</sub> − 2   |      |      |      |
| A <sub>VD</sub>  | Large-signal differential-voltage amplification | V <sub>CC</sub> = 15 V,<br>V <sub>O</sub> = 1.4 V to 11.4 V,<br>R <sub>L</sub> ≥ 15 kΩ to V <sub>CC</sub> |                        | 25°C                        | 50                         | 200  |     | 50                         | 200  | V/mV |      |
| I <sub>OH</sub>  | High-level output current                       | V <sub>OH</sub> = 5 V,    V <sub>ID</sub> = 1 V   |                        | 25°C                        | 0.1                        |      |     | 0.1                        |      | 50   | nA   |
|                  |   | V <sub>OH</sub> = 30 V,    V <sub>ID</sub> = 1 V  |                        | Full range                  | 1                          |      |     | 1                          |      | μA   |      |
| V <sub>OL</sub>  | Low-level output voltage                        | I <sub>OL</sub> = 4 mA,    V <sub>ID</sub> = −1 V   |                        | 25°C                        | 150                        | 400  |     | 150                        | 400  | mV   |      |
|                  |   |   |                        | Full range                  | 700                        |      |     | 700                        |      |      |      |
| I <sub>OL</sub>  | Low-level output current                        | V <sub>OL</sub> = 1.5 V,    V <sub>ID</sub> = −1 V  |                        | 25°C                        | 6                          |      |     | 6                          |      | mA   |      |
| I <sub>CC</sub>  | Supply current                                  | R <sub>L</sub> = ∞  | V <sub>CC</sub> = 5 V  | 25°C                        | 0.8                        |      | 1   | 0.8                        |      | 1    | mA   |
|                  |   |   | V <sub>CC</sub> = 30 V | Full range                  | 2.5                        |      |     | 2.5                        |      |      |      |

† Full range (MIN or MAX) for LM193 is -55°C to 125°C, for LM293 is 25°C to 85°C, and for LM393 is 0°C to 70°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

‡ 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.

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

| PARAMETER        |   | TEST CONDITIONS  | T <sub>A</sub> <sup>†</sup> | LM293A<br>LM393A              |     |      | UNIT |    |
|------------------|---|--|-----------------------------|-------------------------------|-----|------|------|----|
|                  |   |  |                             | MIN                           | TYP | MAX  |      |    |
| V <sub>IO</sub>  | Input offset voltage                            | V <sub>CC</sub> = 5 V to 30 V, V <sub>O</sub> = 1.4 V,<br>V <sub>IC</sub> = V <sub>IC(min)</sub>       | 25°C                        | 1                             |     | 2    | mV   |    |
|                  |   |  | Full range                  |                               |     | 4    |      |    |
| I <sub>IO</sub>  | Input offset current                            | V <sub>O</sub> = 1.4 V   | 25°C                        | 5                             |     | 50   | nA   |    |
|                  |   |  | Full range                  |                               |     | 150  |      |    |
| I <sub>IB</sub>  | Input bias current                              | V <sub>O</sub> = 1.4 V   | 25°C                        | –25                           |     | –250 | nA   |    |
|                  |   |  | Full range                  |                               |     | –400 |      |    |
| V <sub>ICR</sub> | Common-mode input voltage range§                |  | 25°C                        | 0 to<br>V <sub>CC</sub> – 1.5 |     | V    |      |    |
|                  |   |  | Full range                  | 0 to<br>V <sub>CC</sub> – 2   |     |      |      |    |
| A <sub>VD</sub>  | Large-signal differential-voltage amplification | V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1.4 V to 11.4 V,<br>R <sub>L</sub> ≥ 15 kΩ to V <sub>CC</sub> | 25°C                        | 50                            | 200 | V/mV |      |    |
| I <sub>OH</sub>  | High-level output current                       | V <sub>OH</sub> = 5 V, V <sub>ID</sub> = 1 V   | 25°C                        | 0.1                           |     | 50   | nA   |    |
|                  |   | V <sub>OH</sub> = 30 V, V <sub>ID</sub> = 1 V  | Full range                  |                               |     | 1    | μA   |    |
| V <sub>OL</sub>  | Low-level output voltage                        | I <sub>OL</sub> = 4 mA, V <sub>ID</sub> = –1 V   | 25°C                        | 150                           |     | 400  | mV   |    |
|                  |   |  | Full range                  |                               |     | 700  |      |    |
| I <sub>OL</sub>  | Low-level output current                        | V <sub>OL</sub> = 1.5 V, V <sub>ID</sub> = –1 V  | 25°C                        | 6                             |     | mA   |      |    |
| I <sub>CC</sub>  | Supply current                                  | R <sub>L</sub> = ∞   | V <sub>CC</sub> = 5 V       | 25°C                          | 0.8 |      | 1    | mA |
|                  |   |  | V <sub>CC</sub> = 30 V      | Full range                    |     |      | 2.5  |    |

† Full range (MIN or MAX) 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.

§ 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.

**LM193, LM293, LM293A**  
**LM393, LM393A, LM2903, LM2903V**  
**DUAL DIFFERENTIAL COMPARATORS**

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

| PARAMETER        |   | TEST CONDITIONS   |                       | T <sub>A</sub> † | LM2903                     |     |      | LM2903A                    |     |      | UNIT |
|------------------|---|---|-----------------------|------------------|----------------------------|-----|------|----------------------------|-----|------|------|
|                  |   |   |                       |                  | MIN                        | TYP | MAX  | MIN                        | TYP | MAX  |      |
| V <sub>IO</sub>  | Input offset voltage                            | V <sub>CC</sub> = 5 V to MAX‡, V <sub>O</sub> = 1.4 V, V <sub>IC</sub> = V <sub>IC</sub> (min)      |                       | 25°C             | 2                          |     | 7    | 1                          |     | 2    | mV   |
|                  |   |   |                       | Full range       |                            |     | 15   |                            |     | 4    |      |
| I <sub>IO</sub>  | Input offset current                            | V <sub>O</sub> = 1.4 V  |                       | 25°C             | 5                          |     | 50   | 5                          |     | 50   | nA   |
|                  |   |   |                       | Full range       |                            |     | 200  |                            |     | 200  |      |
| I <sub>IB</sub>  | Input bias current                              | V <sub>O</sub> = 1.4 V  |                       | 25°C             | –25                        |     | –250 | –25                        |     | –250 | nA   |
|                  |   |   |                       | Full range       |                            |     | –500 |                            |     | –500 |      |
| V <sub>ICR</sub> | Common-mode input voltage range§                |   |                       | 25°C             | 0 to V <sub>CC</sub> – 1.5 |     |      | 0 to V <sub>CC</sub> – 1.5 |     |      | V    |
|                  |   |   |                       | Full range       | 0 to V <sub>CC</sub> – 2   |     |      | 0 to V <sub>CC</sub> – 2   |     |      |      |
| A <sub>VD</sub>  | Large-signal differential-voltage amplification | V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1.4 V to 11.4 V, R <sub>L</sub> ≥ 15 kΩ to V <sub>CC</sub> |                       | 25°C             | 25                         |     | 100  | 25                         |     | 100  | V/mV |
| I <sub>OH</sub>  | High-level output current                       | V <sub>OH</sub> = 5 V, V <sub>ID</sub> = 1 V  |                       | 25°C             | 0.1                        |     | 50   | 0.1                        |     | 50   | nA   |
|                  |   | V <sub>OH</sub> = V <sub>CC</sub> MAX, V <sub>ID</sub> = 1 V  |                       | Full range       |                            |     | 1    |                            |     | 1    | μA   |
| V <sub>OL</sub>  | Low-level output voltage                        | I <sub>OL</sub> = 4 mA, V <sub>ID</sub> = –1 V  |                       | 25°C             | 150                        |     | 400  | 150                        |     | 400  | mV   |
|                  |   |   |                       | Full range       |                            |     | 700  |                            |     | 700  |      |
| I <sub>OL</sub>  | Low-level output current                        | V <sub>OL</sub> = 1.5 V, V <sub>ID</sub> = –1 V   |                       | 25°C             | 6                          |     |      | 6                          |     |      | mA   |
| I <sub>CC</sub>  | Supply current                                  | R <sub>L</sub> = ∞  | V <sub>CC</sub> = 5 V | 25°C             | 0.8                        |     | 1    | 0.8                        |     | 1    | mA   |
|                  |   |   | V <sub>CC</sub> = MAX | Full range       |                            |     | 2.5  |                            |     | 2.5  |      |

† Full range (MIN or MAX) for LM2903 is –40°C to 125°C. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.

‡  $V_{CC}\text{ MAX} = 30\text{ V}$  for non-V devices and 32 V for V-suffix devices.

§ 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 (32 V for V-suffix devices) without damage.

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

| PARAMETER     | TEST CONDITIONS   |                                       | LM193<br>LM293, LM293A<br>LM393, LM393A<br>LM2903 | UNIT          |
|---------------|---|---------------------------------------|---|---------------|
|               |   |                                       | TYP   |               |
| Response time | $R_L$ connected to 5 V through 5.1 k $\Omega$ ,<br>$C_L = 15\text{ pF}$ ¶, See Note 8 | 100-mV input step with 5-mV overdrive | 1.3   | $\mu\text{s}$ |
|               |   | TTL-level input step                  | 0.3   |               |

¶  $C_L$  includes probe and jig capacitance.

NOTE 8: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup>               |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|--|
| 5962-9452601Q2A  | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type                         |
| 5962-9452601QPA  | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type                         |
| JM38510/11202BPA | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type                         |
| LM193DR          | ACTIVE                | SOIC         | D               | 8    | 2500        | TBD                     | CU NIPDAU        | Level-1-220C-UNLIM                         |
| LM193FKB         | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                     | POST-PLATE       | N / A for Pkg Type                         |
| LM193JG          | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type                         |
| LM193JGB         | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                     | A42 SNPB         | N / A for Pkg Type                         |
| LM2903AVQDR      | ACTIVE                | SOIC         | D               | 8    | 2500        | Pb-Free (RoHS)          | CU NIPDAU        | Level-2-250C-1 YEAR/<br>Level-1-235C-UNLIM |
| LM2903AVQPWR     | ACTIVE                | TSSOP        | PW              | 8    | 2000        | TBD                     | CU NIPDAU        | Level-1-250C-UNLIM                         |
| LM2903D          | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DE4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DG4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DGKR       | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DGKRG4     | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DR         | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DRE4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903DRG4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903P          | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type                         |
| LM2903PE4        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type                         |
| LM2903PSR        | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903PSRG4      | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903PWLE       | OBSOLETE              | TSSOP        | PW              | 8    |             | TBD                     | Call TI          | Call TI                                    |
| LM2903PWR        | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903PWRE4      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903PWRG4      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM                         |
| LM2903QD         | NRND                  | SOIC         | D               | 8    | 75          | TBD                     | CU NIPDAU        | Level-1-220C-UNLIM                         |
| LM2903QDR        | NRND                  | SOIC         | D               | 8    | 2500        | TBD                     | CU NIPDAU        | Level-1-220C-UNLIM                         |
| LM2903QP         | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                                    |
| LM2903VQDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Pb-Free (RoHS)          | CU NIPDAU        | Level-2-250C-1 YEAR/<br>Level-1-235C-UNLIM |
| LM2903VQPWR      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | TBD                     | CU NIPDAU        | Level-1-250C-UNLIM                         |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LM293AD          | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADE4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADG4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADGKR       | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADGKRG4     | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADR         | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADRE4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293ADRG4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293D           | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DE4         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DG4         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DGKR        | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DGKRG4      | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DR          | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DRE4        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293DRG4        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM293P           | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM293PE4         | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM393AD          | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADE4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADG4        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADGKR       | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADGKRG4     | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADR         | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADRE4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393ADRG4       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |



| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LM393AP          | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM393APE4        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM393APSR        | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393APSRE4      | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393APWLE       | OBSOLETE              | TSSOP        | PW              | 8    |             | TBD                     | Call TI          | Call TI                      |
| LM393APWR        | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393APWRE4      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393D           | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DE4         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DG4         | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DGKR        | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DGKRG4      | ACTIVE                | MSOP         | DGK             | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DR          | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DRE4        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393DRG4        | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393P           | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM393PE4         | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)          | CU NIPDAU        | N / A for Pkg Type           |
| LM393PSLE        | OBSOLETE              | SO           | PS              | 8    |             | TBD                     | Call TI          | Call TI                      |
| LM393PSR         | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PSRG4       | ACTIVE                | SO           | PS              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PW          | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PWE4        | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PWG4        | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PWLE        | OBSOLETE              | TSSOP        | PW              | 8    |             | TBD                     | Call TI          | Call TI                      |
| LM393PWR         | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PWRE4       | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| LM393PWRG4       | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

(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)

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

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## JG (R-GDIP-T8)

## CERAMIC DUAL-IN-LINE

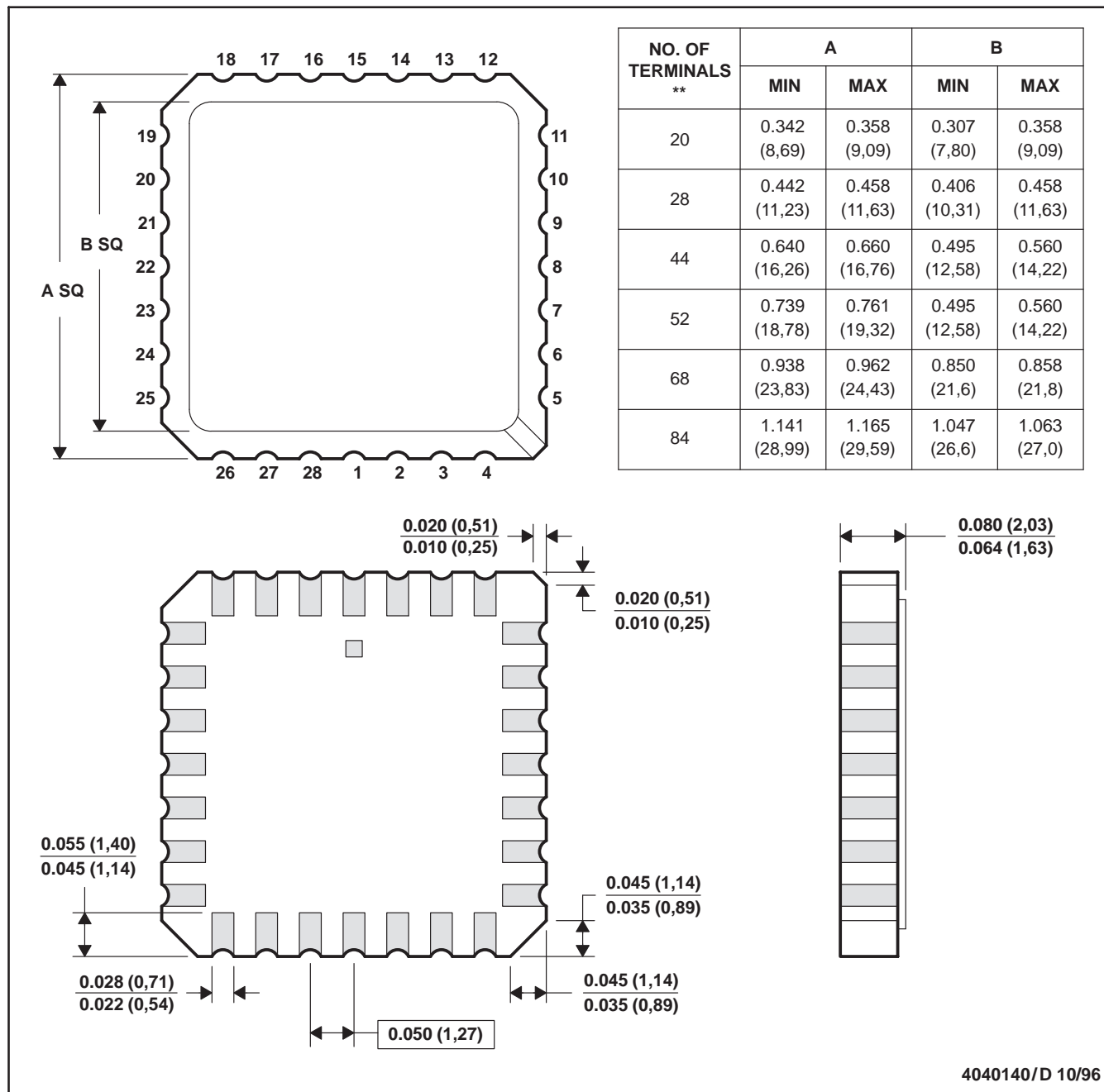


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification.
  - E. Falls within MIL STD 1835 GDIP1-T8

## FK (S-CQCC-N\*\*)

## LEADLESS CERAMIC CHIP CARRIER

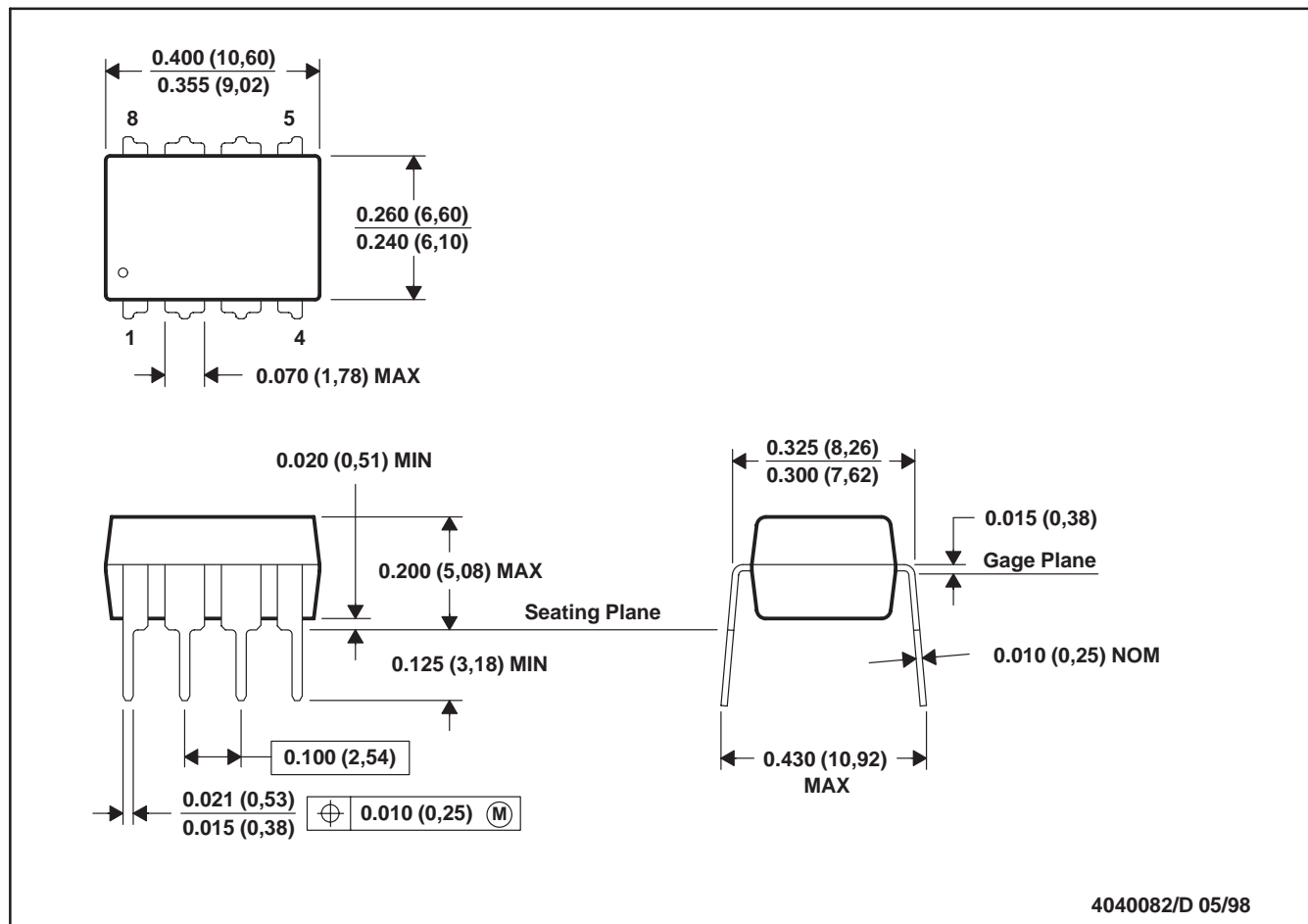
28 TERMINAL SHOWN



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - The terminals are gold plated.
  - Falls within JEDEC MS-004

## P (R-PDIP-T8)

## PLASTIC DUAL-IN-LINE



NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)



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DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

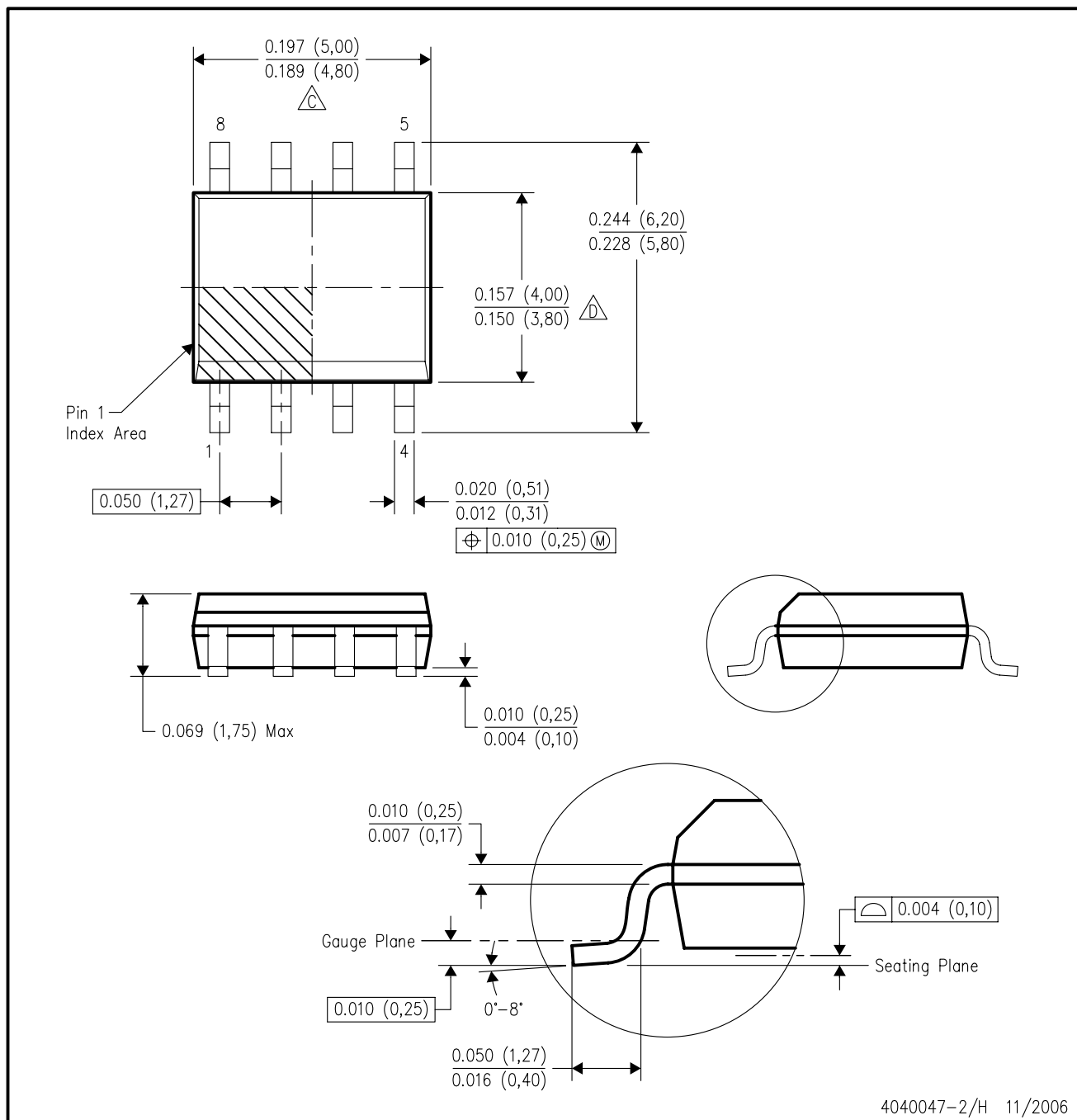


## NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
- D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
- E. Falls within JEDEC MO-187 variation AA, except interlead flash.



## D (R-PDSO-G8)

## PLASTIC SMALL-OUTLINE PACKAGE



4040047-2/H 11/2006

## NOTES:

- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
-  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
-  D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
- E. Reference JEDEC MS-012 variation AA.

# MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



4040063/C 03/03

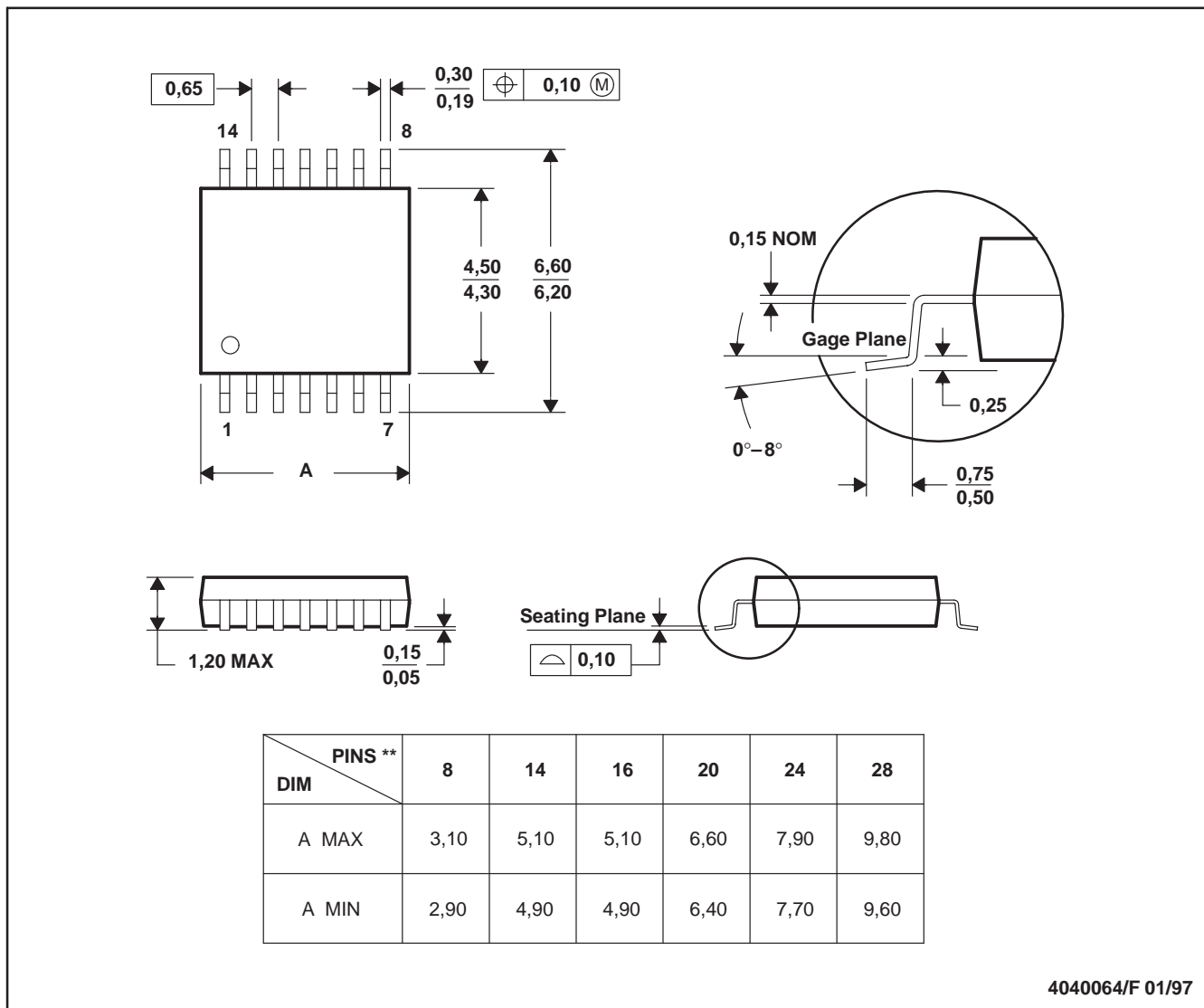
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.



## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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