

## FAMILY OF NANOPOWER PUSH-PULL OUTPUT COMPARATORS

### FEATURES

- Low Supply Current . . . 560 nA/Per Channel
- Input Common-Mode Range Exceeds the Rails . . .  $-0.1\text{ V}$  to  $V_{CC} + 5\text{ V}$
- Supply Voltage Range . . . 2.5 V to 16 V
- Reverse Battery Protection Up to 18 V
- Push-Pull CMOS Output Stage
- Specified Temperature Range
  - $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  – Commercial Grade
  - $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  – Industrial Grade
- Ultrasmall Packaging
  - 5-Pin SOT-23 (TLV3701)
  - 8-Pin MSOP (TLV3702)
- Universal Op-Amp EVM (Reference SLOU060 for more information)

### APPLICATIONS

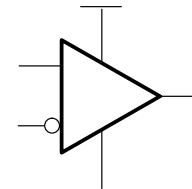
- Portable Battery Monitoring
- Consumer Medical Electronics
- Security Detection Systems

### DESCRIPTION

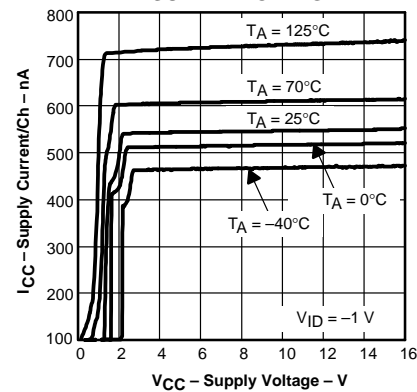
The TLV370x is Texas Instruments' first family of nanopower comparators with only 560 nA per channel supply current, which make this device ideal for battery power and wireless handset applications.

The TLV370x has a minimum operating supply voltage of 2.7 V over the extended industrial temperature range ( $T_A = -40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ), while having an input common-mode range of  $-0.1$  to  $V_{CC} + 5\text{ V}$ . The low supply current makes it an ideal choice for battery powered portable applications where quiescent current is the primary concern. Reverse battery protection guards the amplifier from an over-current condition due to improper battery installation. For harsh environments, the inputs can be taken 5 V above the positive supply rail without damage to the device.

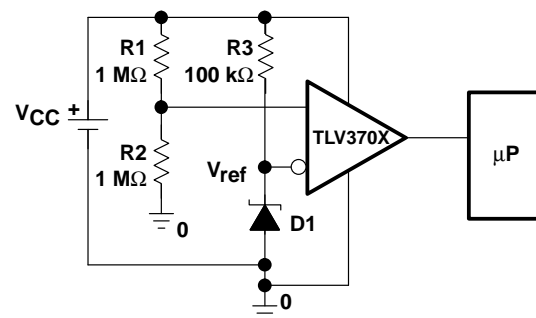
All members are available in PDIP and SOIC with the singles in the small SOT-23 package, duals in the MSOP, and quads in the TSSOP package.



SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE



### high side voltage sense circuit



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.

**A SELECTION OF OUTPUT COMPARATORST**

| DEVICE     | V <sub>CC</sub> (V) | V <sub>IO</sub> (μV) | I <sub>CC/Ch</sub> (μA) | I <sub>B</sub> (pA) | t <sub>PLH</sub> (μs) | t <sub>PHL</sub> (μs) | t <sub>f</sub> (μs) | t <sub>r</sub> (μs) | RAIL-TO-RAIL | OUTPUT STAGE |
|------------|---------------------|----------------------|-------------------------|---------------------|-----------------------|-----------------------|---------------------|---------------------|--------------|--------------|
| TLV370x    | 2.5 – 16            | 250                  | 0.56                    | 80                  | 56                    | 83                    | 22                  | 8                   | I            | PP           |
| TLV340x    | 2.5 – 16            | 250                  | 0.47                    | 80                  | 55                    | 30                    | 5                   | –                   | I            | OD           |
| TLC3702/4  | 3 – 16              | 1200                 | 9                       | 5                   | 1.1                   | 0.65                  | 0.5                 | 0.125               | –            | PP           |
| TLC393/339 | 3 – 16              | 1400                 | 11                      | 5                   | 1.1                   | 0.55                  | 0.22                | –                   | –            | OD           |
| TLC372/4   | 3 – 16              | 1000                 | 75                      | 5                   | 0.65                  | 0.65                  | –                   | –                   | –            | OD           |

† All specifications are typical values measured at 5 V.

**TLV3701 AVAILABLE OPTIONS**

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C | PACKAGED DEVICES   |               |        |                 |
|----------------|-----------------------------|--------------------|---------------|--------|-----------------|
|                |                             | SMALL OUTLINE (D)† | SOT-23 (DBV)‡ | SYMBOL | PLASTIC DIP (P) |
| 0°C to 70°C    | 5000 μV                     | TLV3701CD          | TLV3701CDBV   | VBCC   | —               |
| –40°C to 125°C |                             | TLV3701ID          | TLV3701IDBV   | VBCI   | TLV3701IP       |

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3701CDR).

‡ This package is only available taped and reeled. For standard quantities (3000 pieces per reel), add an R suffix (i.e., TLV3701CDBVR). For small quantities (250 pieces per mini-reel), add a T suffix to the part number (e.g., TLV3701CDBVT).

**TLV3702 AVAILABLE OPTIONS**

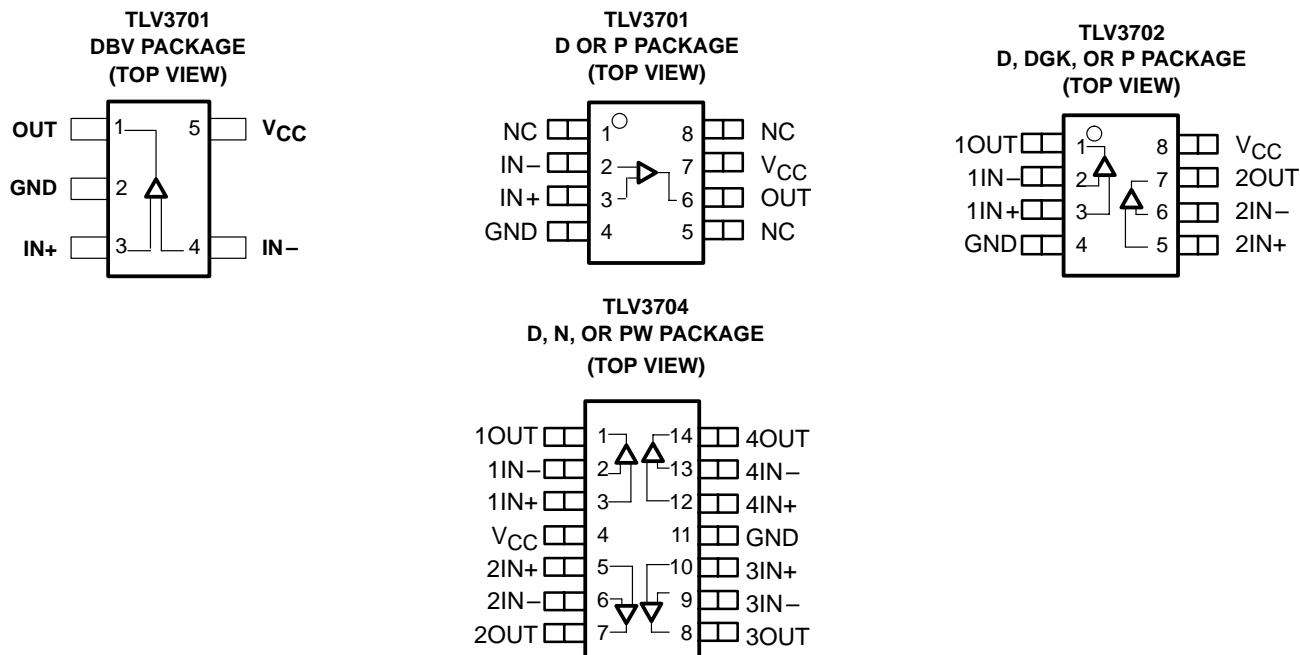
| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C | PACKAGED DEVICES   |             |         |                 |
|----------------|-----------------------------|--------------------|-------------|---------|-----------------|
|                |                             | SMALL OUTLINE (D)† | MSOP (DGK)† | SYMBOL  | PLASTIC DIP (P) |
| 0°C to 70°C    | 5000 μV                     | TLV3702CD          | TLV3702CDGK | xxTIAKC | —               |
| –40°C to 125°C |                             | TLV3702ID          | TLV3702IDGK | xxTIAKD | TLV3702IP       |

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3702CDR).

**TLV3704 AVAILABLE OPTIONS**

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C | PACKAGED DEVICES   |                 |            |
|----------------|-----------------------------|--------------------|-----------------|------------|
|                |                             | SMALL OUTLINE (D)† | PLASTIC DIP (N) | TSSOP (PW) |
| 0°C to 70°C    | 5000 μV                     | TLV3704CD          | —               | TLV3704CPW |
| –40°C to 125°C |                             | TLV3704ID          | TLV3704IN       | TLV3704IPW |

† This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV3704CDR).



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

|   |                              |
|---|------------------------------|
| Supply voltage, V <sub>CC</sub> (see Note 1)                    | 17 V                         |
| Differential input voltage, V <sub>ID</sub>                     | ±20 V                        |
| Input voltage range, V <sub>I</sub> (see Notes 1 and 2)         | 0 to V <sub>CC</sub> + 5 V   |
| Input current range, I <sub>I</sub>                             | ±10 mA                       |
| Output current range, I <sub>O</sub>                            | ±10 mA                       |
| Continuous total power dissipation                              | See Dissipation Rating Table |
| Operating free-air temperature range, T <sub>A</sub> : C suffix | 0°C to 70°C                  |
| I suffix  | -40°C to 125°C               |
| Maximum junction temperature, T <sub>J</sub>                    | 150°C                        |
| Storage temperature range, T <sub>stg</sub>                     | -65°C to 150°C               |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds    | 260°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. Input voltage range is limited to 20 V max or V<sub>CC</sub> + 5 V, whichever is smaller.

DISSIPATION RATING TABLE

| PACKAGE | $\theta_{JC}$<br>(°C/W) | $\theta_{JA}$<br>(°C/W) | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|---------|-------------------------|-------------------------|---|---|
| D (8)   | 38.3                    | 176                     | 710 mW                                      | 142 mW                                    |
| D (14)  | 26.9                    | 122.6                   | 1022 mW                                     | 204.4 mW                                  |
| DBV (5) | 55                      | 324.1                   | 385 mW                                      | 77.1 mW                                   |
| DGK (8) | 54.2                    | 259.9                   | 481 mW                                      | 96.2 mW                                   |
| N (14)  | 32                      | 78                      | 1600 mW                                     | 320.5 mW                                  |
| P (8)   | 41                      | 104                     | 1200 mW                                     | 240.4 mW                                  |
| PW (14) | 29.3                    | 173.6                   | 720 mW                                      | 144 mW                                    |

recommended operating conditions

|  |               | MIN      | MAX        | UNIT    |   |
|--|---------------|----------|------------|---------|---|
| Supply voltage, $V_{CC}$                   | Single supply | C-suffix | 2.5        | 16      | V |
|  |               | I-suffix | 2.7        | 16      |   |
|  | Split supply  | C-suffix | $\pm 1.25$ | $\pm 8$ |   |
|  |               | I-suffix | $\pm 1.35$ | $\pm 8$ |   |
| Common-mode input voltage range, $V_{ICR}$ |               | -0.1     | $V_{CC}+5$ | V       |   |
| Operating free-air temperature, $T_A$      | C-suffix      | 0        | 70         | °C      |   |
|  | I-suffix      | -40      | 125        |         |   |

electrical characteristics at specified operating free-air temperature,  $V_{CC} = 2.7\text{ V}, 5\text{ V}, 15\text{ V}$  (unless otherwise noted)

dc performance

| PARAMETER      |   | TEST CONDITIONS                                       | $T_A$ †    | MIN | TYP  | MAX  | UNIT                         |
|----------------|---|---|------------|-----|------|------|------------------------------|
| $V_{IO}$       | Input offset voltage                            | $V_{IC} = V_{CC}/2, R_S = 50\ \Omega$                 | 25°C       |     | 250  | 5000 | $\mu\text{V}$                |
|                |   |   | Full range |     |      | 7000 |                              |
| $\alpha_{VIO}$ | Offset voltage drift                            |   | 25°C       |     | 3    |      | $\mu\text{V}/^\circ\text{C}$ |
| CMRR           | Common-mode rejection ratio                     | $V_{IC} = 0\text{ to }2.7\text{ V}, R_S = 50\ \Omega$ | 25°C       | 55  | 72   | dB   |                              |
|                |   |   | Full range | 50  |      |      |                              |
|                |   | $V_{IC} = 0\text{ to }5\text{ V}, R_S = 50\ \Omega$   | 25°C       | 60  | 76   |      |                              |
|                |   |   | Full range | 55  |      |      |                              |
|                |   | $V_{IC} = 0\text{ to }15\text{ V}, R_S = 50\ \Omega$  | 25°C       | 65  | 88   |      |                              |
|                |   |   | Full range | 60  |      |      |                              |
| $A_{VD}$       | Large-signal differential voltage amplification |   | 25°C       |     | 1000 | V/mV |                              |

† Full range is 0°C to 70°C for C suffix and -40°C to 125°C for I suffix. If not specified, full range is -40°C to 125°C.

input/output characteristics

| PARAMETER  |                               | TEST CONDITIONS  | $T_A$ †        | MIN            | TYP             | MAX  | UNIT       |
|------------|-------------------------------|--|----------------|----------------|-----------------|------|------------|
| $I_{IO}$   | Input offset current          | $V_{IC} = V_{CC}/2, R_S = 50\ \Omega$                              | 25°C           |                | 20              | 100  | pA         |
|            |                               |  | Full range     |                |                 | 1000 |            |
| $I_{IB}$   | Input bias current            |  | 25°C           |                | 80              | 250  | pA         |
|            |                               |  | Full range     |                |                 | 1500 |            |
| $r_{i(d)}$ | Differential input resistance |  | 25°C           |                | 300             |      | M $\Omega$ |
| $V_{OH}$   | High-level output voltage     | $V_{IC} = V_{CC}/2, I_{OH} = 2\ \mu\text{A}, V_{ID} = 1\text{ V}$  | 25°C           |                | $V_{CC} - 0.08$ | mV   |            |
|            |                               |  | 25°C           | $V_{CC} - 320$ |                 |      |            |
|            |                               | Full range   | $V_{CC} - 450$ |                |                 |      |            |
| $V_{OL}$   | Low-level output voltage      | $V_{IC} = V_{CC}/2, I_{OH} = 2\ \mu\text{A}, V_{ID} = -1\text{ V}$ | 25°C           |                | 8               | mV   |            |
|            |                               |  | 25°C           |                | 80              |      | 200        |
|            |                               | Full range   |                |                | 300             |      |            |

† Full range is 0°C to 70°C for C suffix and -40°C to 125°C for I suffix. If not specified, full range is -40°C to 125°C.

power supply

| PARAMETER |                              | TEST CONDITIONS                          | $T_A$ †                               | MIN        | TYP | MAX  | UNIT |
|-----------|------------------------------|--|---------------------------------------|------------|-----|------|------|
| $I_{CC}$  | Supply current (per channel) | Output state high                        | 25°C                                  |            | 560 | 800  | nA   |
|           |                              |  | Full range                            |            |     | 1000 |      |
| PSRR      | Power supply rejection ratio | $V_{IC} = V_{CC}/2\text{ V},$<br>No load | $V_{CC} = 2.7\text{ V to }5\text{ V}$ | 25°C       | 75  | 100  | dB   |
|           |                              |  |                                       | Full range | 70  |      |      |
|           |                              |  | $V_{CC} = 5\text{ V to }15\text{ V}$  | 25°C       | 85  | 105  |      |
|           |                              |  |                                       | Full range | 80  |      |      |

† Full range is 0°C to 70°C for C suffix and -40°C to 125°C for I suffix. If not specified, full range is -40°C to 125°C.

switching characteristics at recommended operating conditions,  $V_{CC} = 2.7\text{ V}, 5\text{ V}, 15\text{ V}, T_A = 25^\circ\text{C}$  (unless otherwise noted)

| PARAMETER   |  | TEST CONDITIONS  | MIN               | TYP | MAX | UNIT          |
|-------------|--|--|-------------------|-----|-----|---------------|
| $t_{(PLH)}$ | Propagation response time, low-to-high-level output (see Note 3) | f = 10 kHz,<br>VSTEP = 100 mV,<br>C <sub>L</sub> = 10 pF,<br>V <sub>CC</sub> = 2.7 V | Overdrive = 2 mV  | 240 |     | $\mu\text{s}$ |
|             |  |  | Overdrive = 10 mV | 64  |     |               |
|             |  |  | Overdrive = 50 mV | 36  |     |               |
| $t_{(PHL)}$ | Propagation response time, high-to-low-level output (see Note 3) |  | Overdrive = 2 mV  | 167 |     |               |
|             |  |  | Overdrive = 10 mV | 67  |     |               |
|             |  |  | Overdrive = 50 mV | 37  |     |               |
| $t_r$       | Rise time  | C <sub>L</sub> = 10 pF, V <sub>CC</sub> = 2.7 V                                      |                   | 7   |     | $\mu\text{s}$ |
| $t_f$       | Fall time  | C <sub>L</sub> = 10 pF, V <sub>CC</sub> = 2.7 V                                      |                   | 9   |     | $\mu\text{s}$ |

NOTE 3: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V. Propagation responses are longer at higher supply voltages, refer to Figures 12–17 for further details.

### TYPICAL CHARACTERISTICS

#### Table of Graphs

|                                |  |                              | FIGURE     |
|--------------------------------|--|------------------------------|------------|
| Input bias/offset current      |  | vs Free-air temperature      | 1          |
| Open collector leakage current |  | vs Free-air temperature      | 2          |
| V <sub>OL</sub>                | Low-level output voltage                                       | vs Low-level output current  | 3, 5, 7    |
| V <sub>OH</sub>                | High-level output voltage                                      | vs High-level output current | 4, 6, 8    |
| I <sub>CC</sub>                | Supply current   | vs Supply voltage            | 9          |
|                                |  | vs Free-air temperature      | 10         |
|                                | Output fall time/rise time                                     | vs Supply voltage            | 11         |
|                                | Low-to-high level output response for various input overdrives |                              | 12, 14, 16 |
|                                | High-to-low level output response for various input overdrives |                              | 13, 15, 17 |

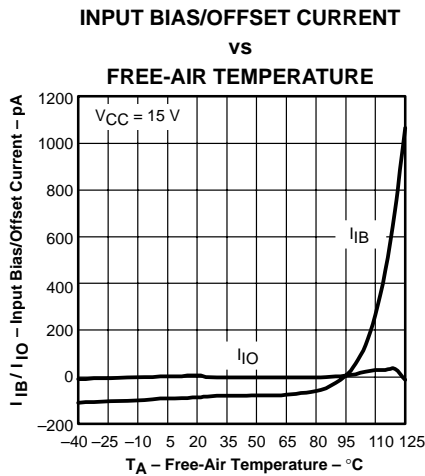


Figure 1

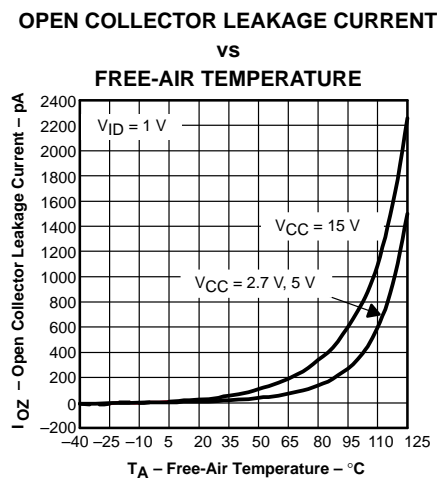


Figure 2

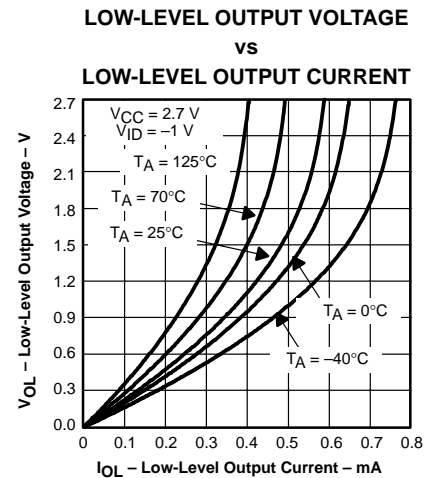


Figure 3

TYPICAL CHARACTERISTICS

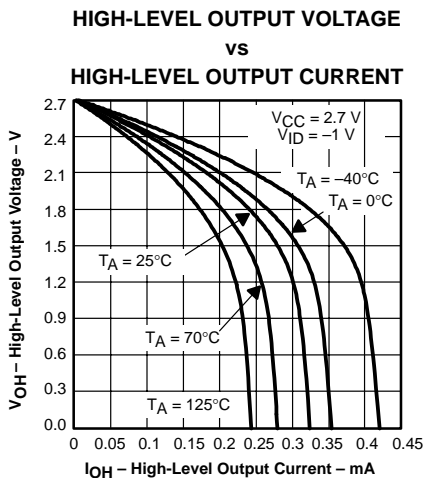


Figure 4

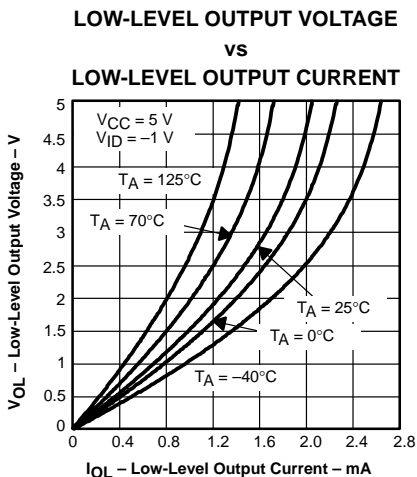


Figure 5

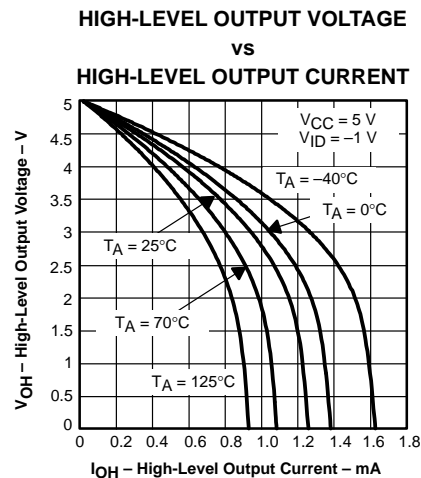


Figure 6

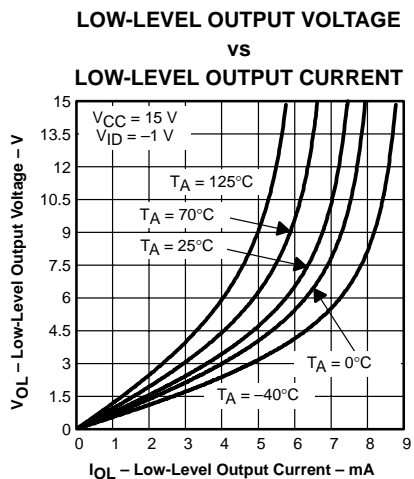


Figure 7

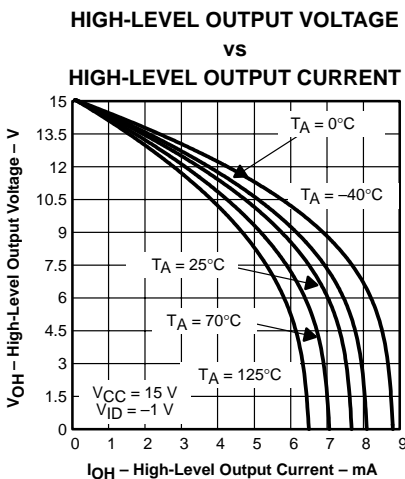


Figure 8

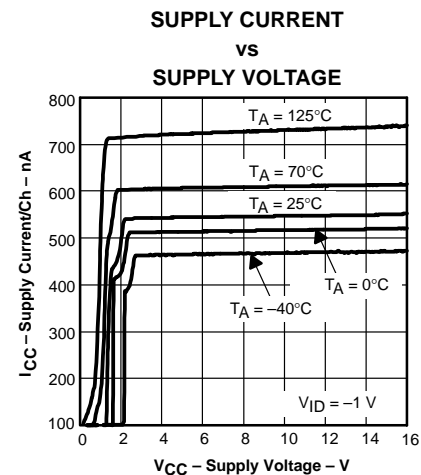


Figure 9

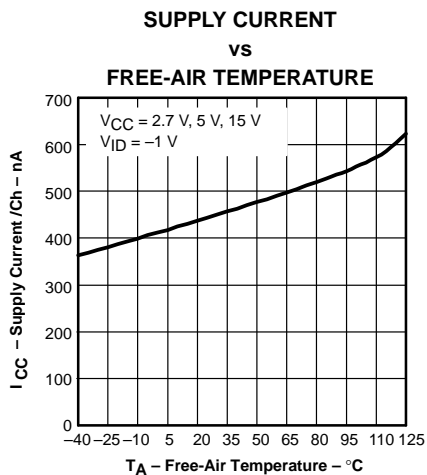


Figure 10

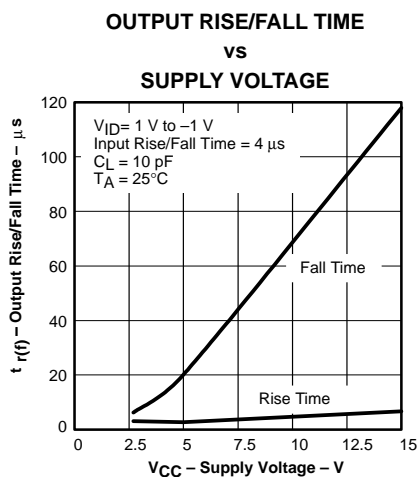


Figure 11

TYPICAL CHARACTERISTICS

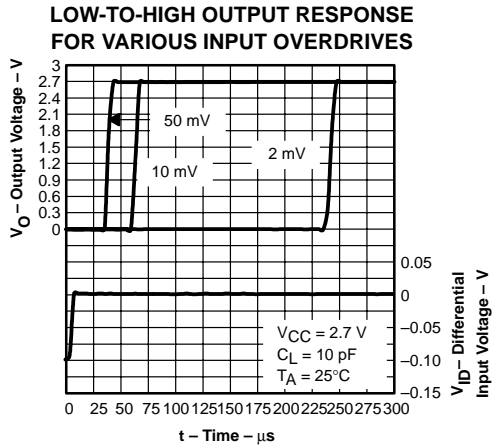


Figure 12

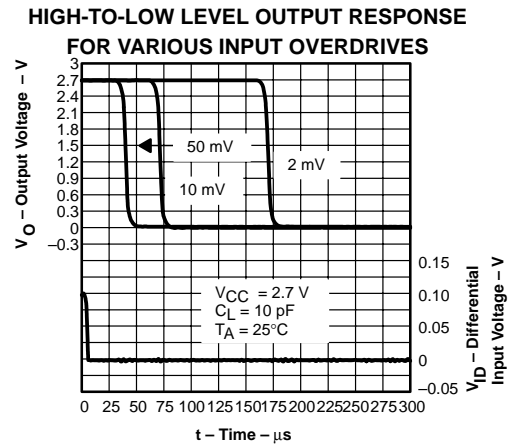


Figure 13

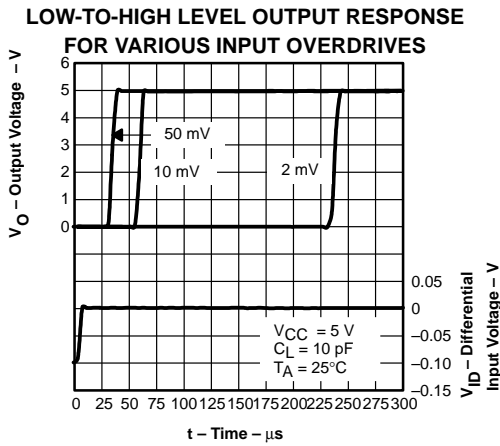


Figure 14

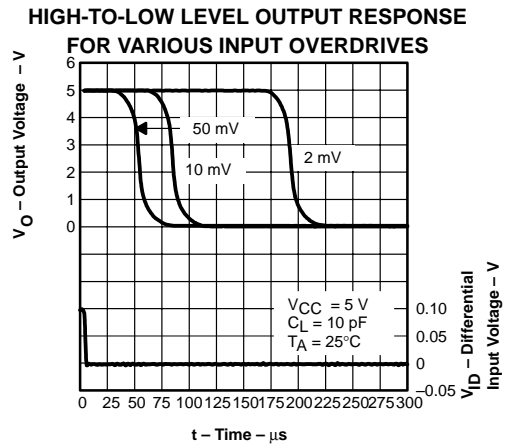


Figure 15

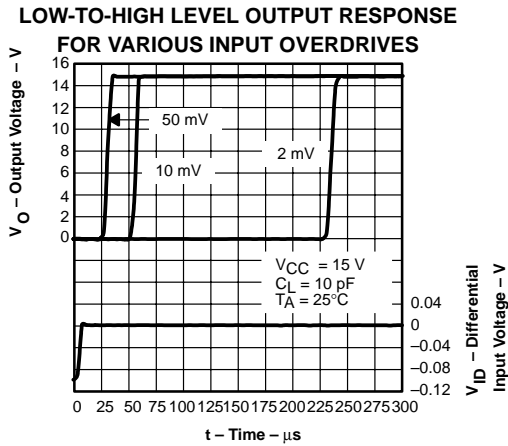


Figure 16

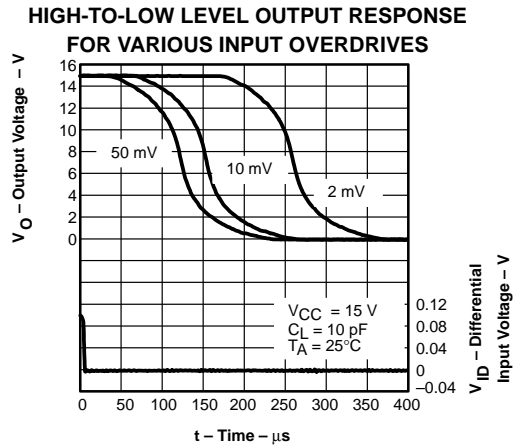


Figure 17

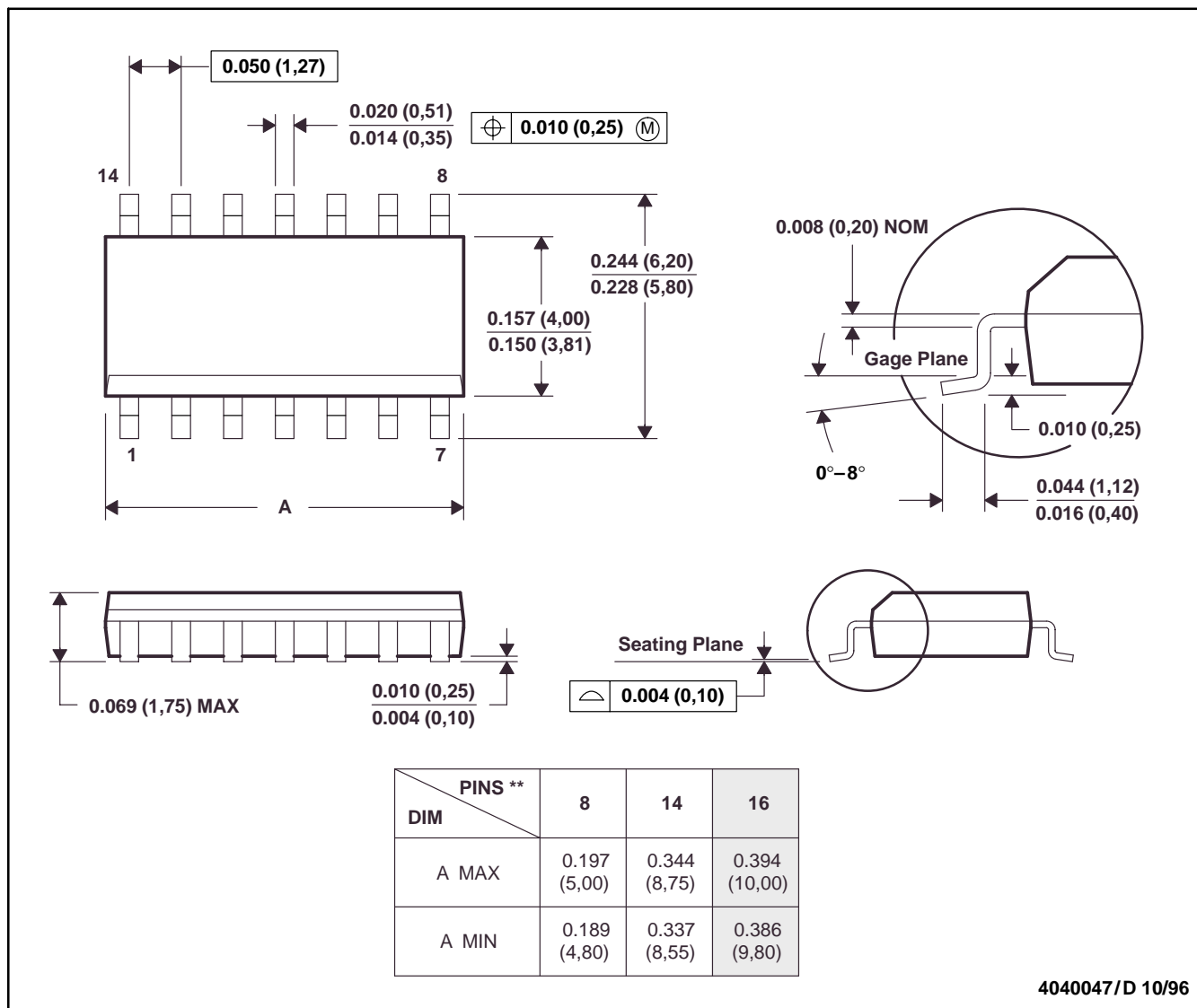


MECHANICAL DATA

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



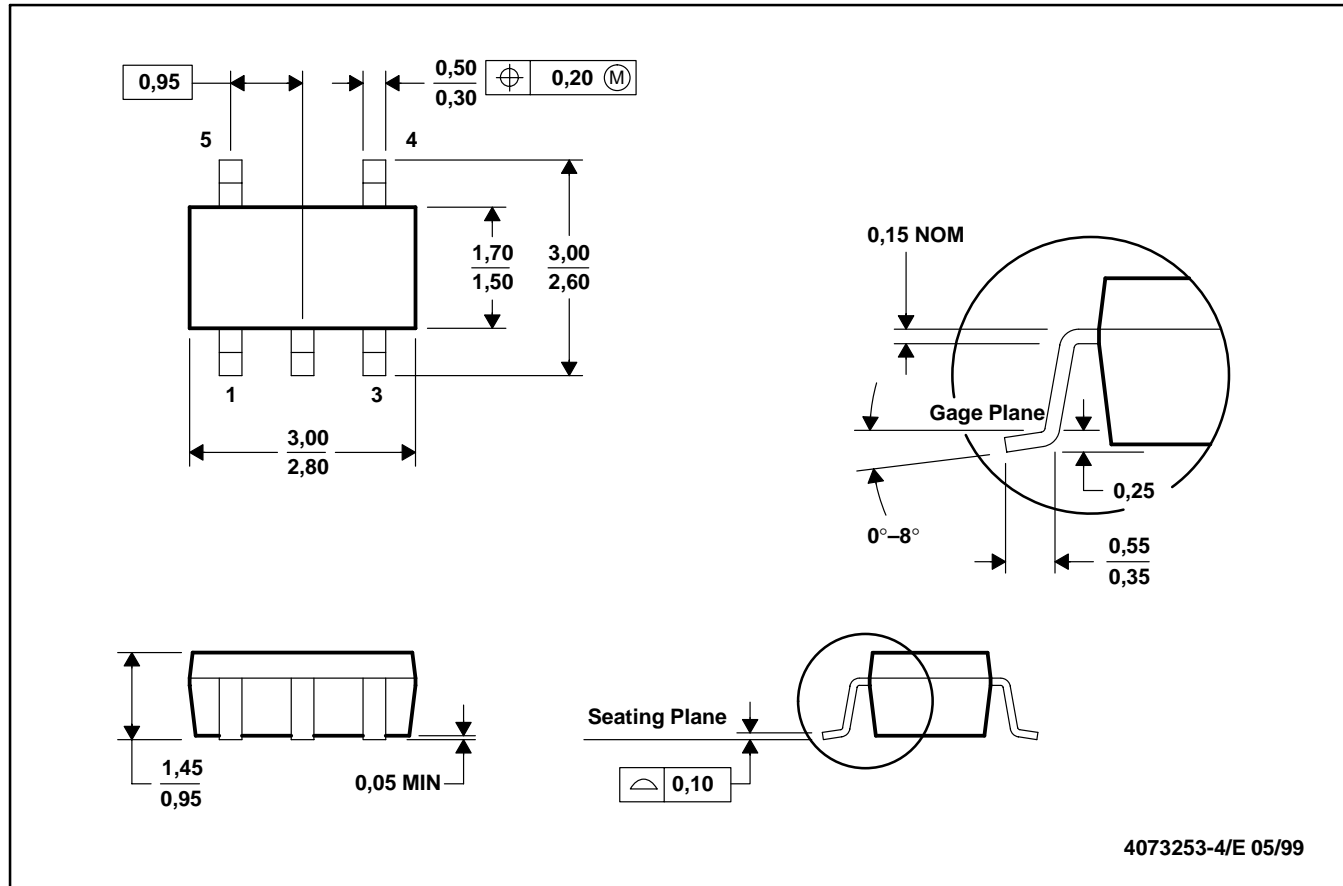
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MS-012

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)

MECHANICAL DATA

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE



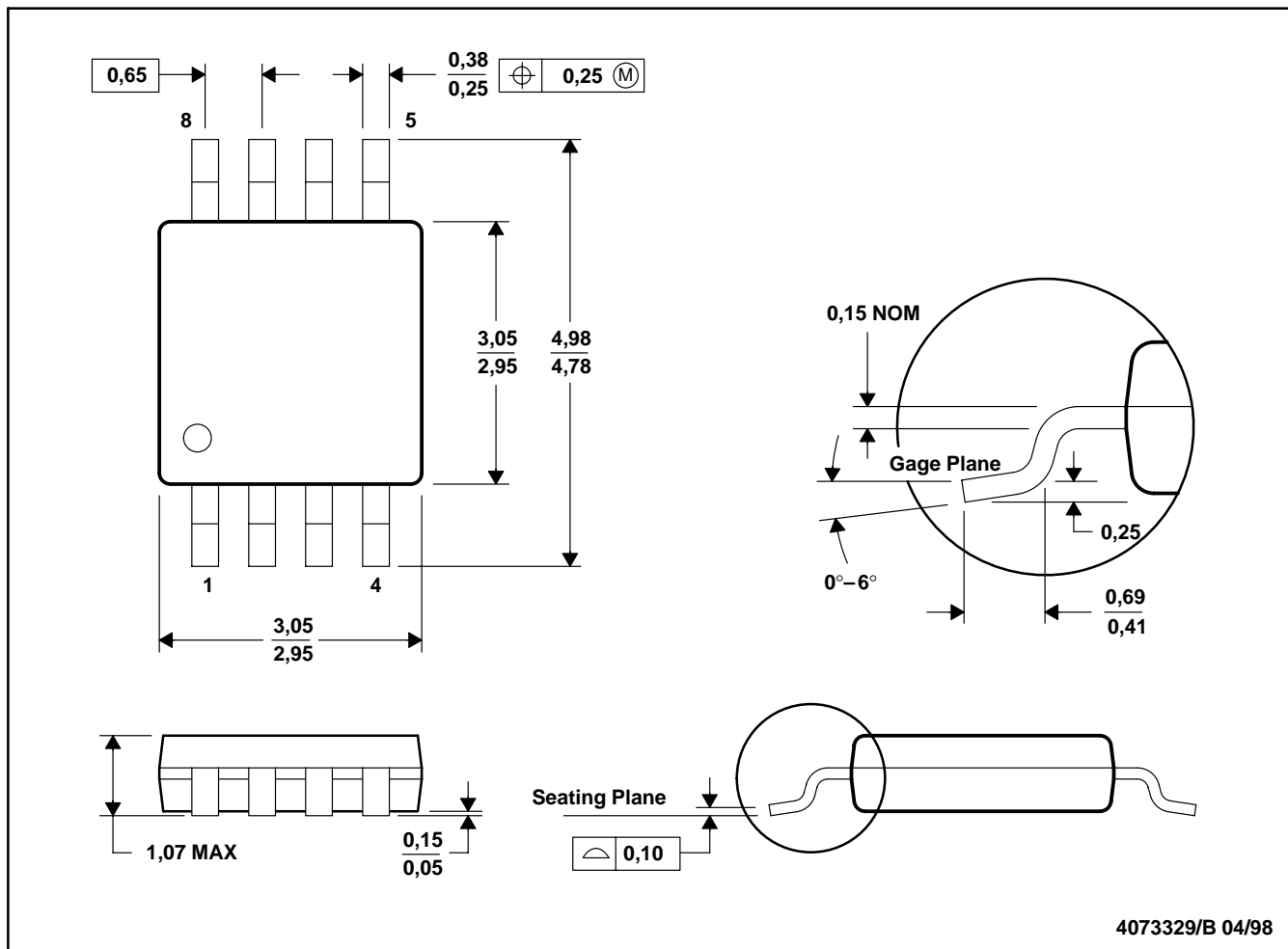
- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion.  
 D. Falls within JEDEC MO-178

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)

MECHANICAL DATA

DGK (R-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 dimensions do not include mold flash or protrusion.  
 D. Falls within JEDEC MO-187

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)

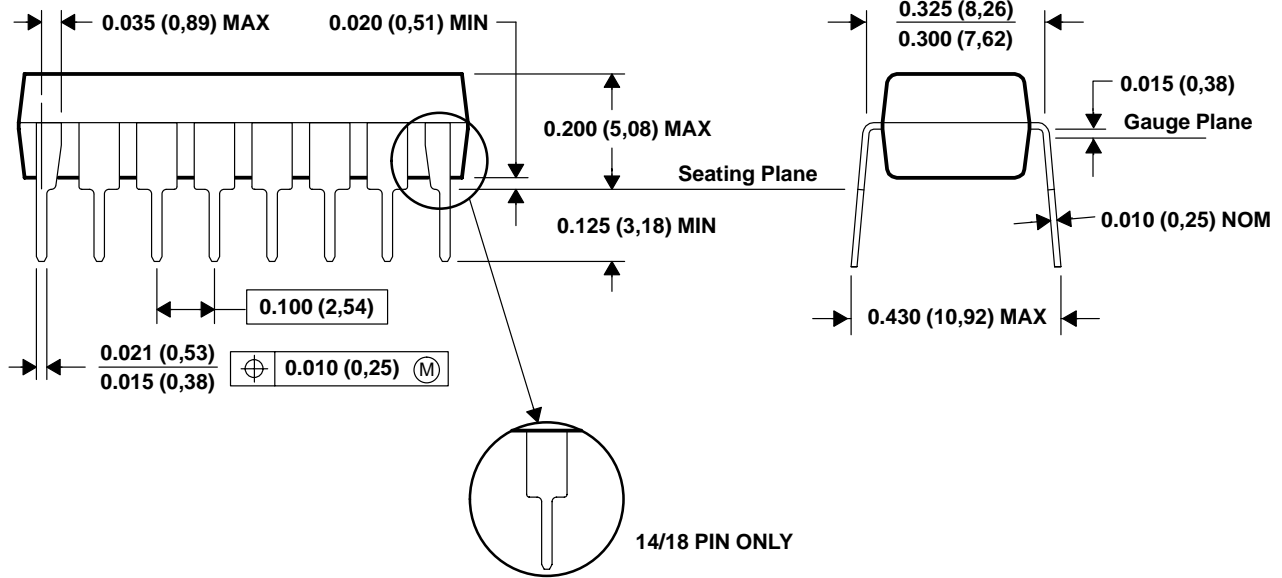
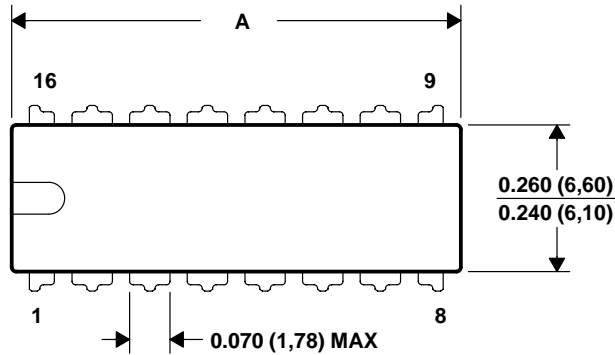
MECHANICAL DATA

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

| DIM \ PINS ** | 14               | 16               | 18               | 20               |
|---------------|------------------|------------------|------------------|------------------|
| A MAX         | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 0.975<br>(24,77) |
| A MIN         | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |



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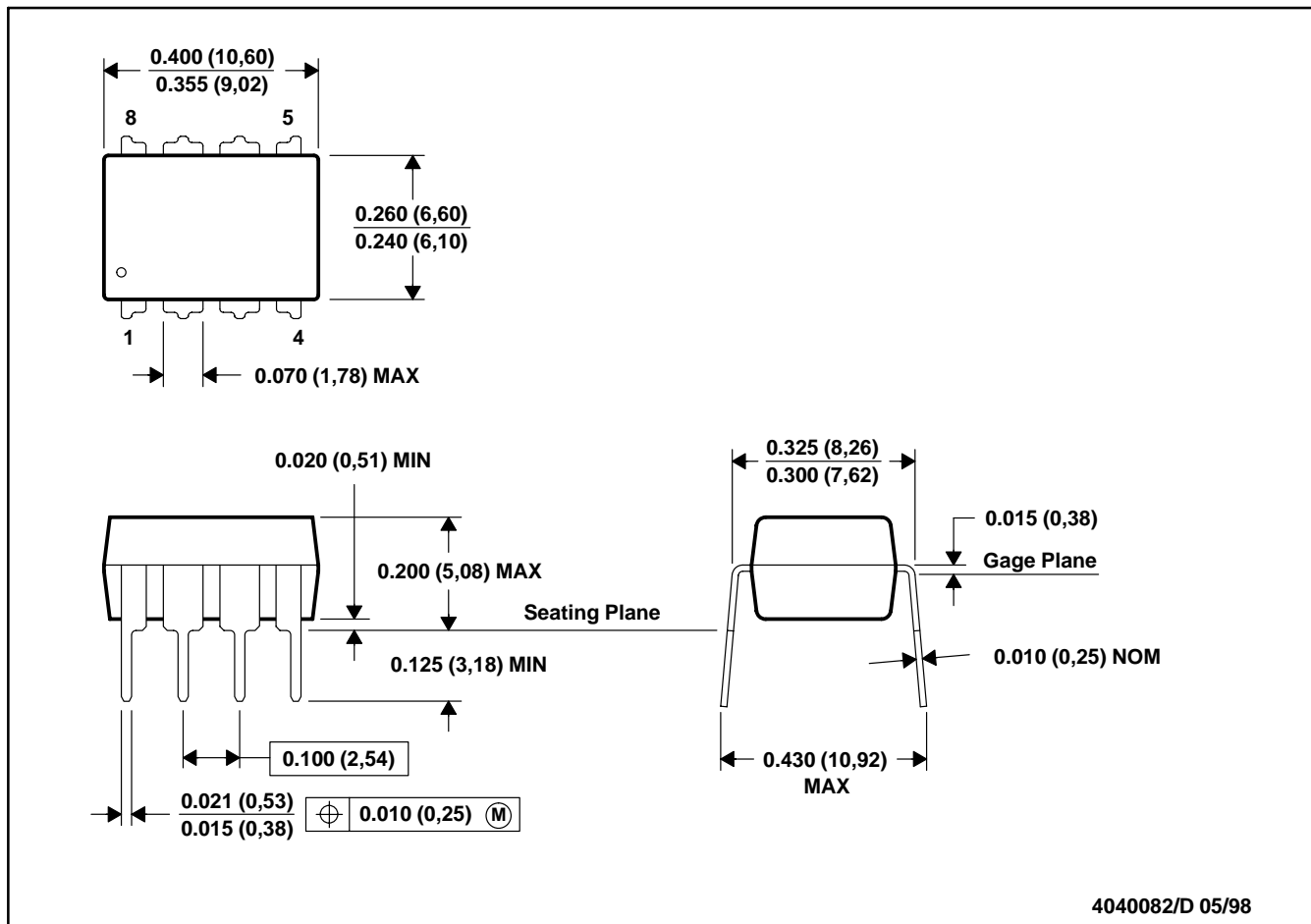
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (20-pin package is shorter than MS-001).

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)

MECHANICAL DATA

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

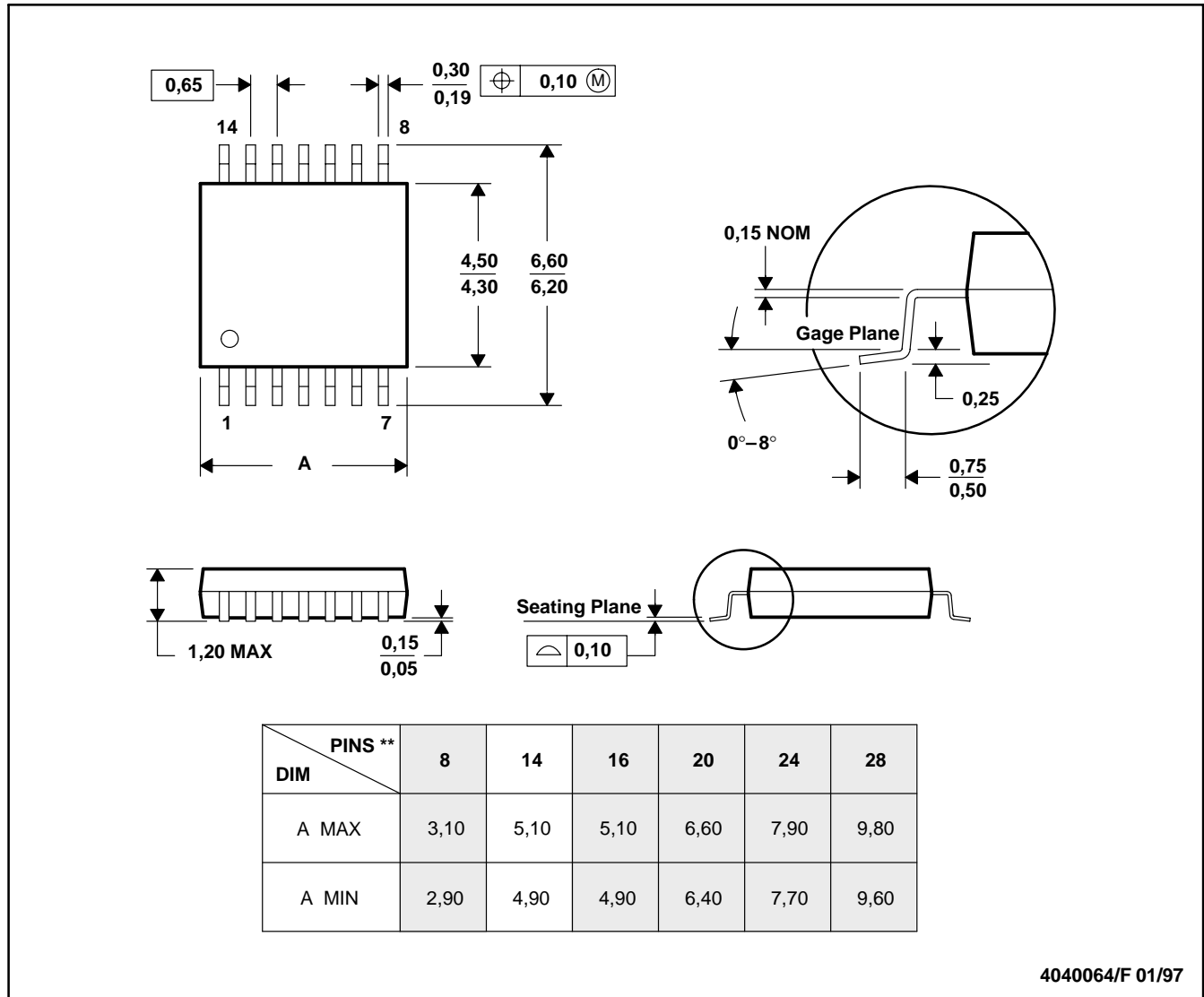
For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)

MECHANICAL DATA

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

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- 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

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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