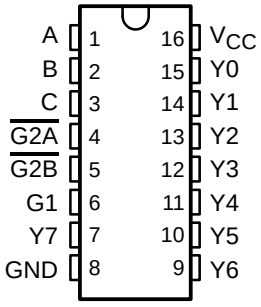
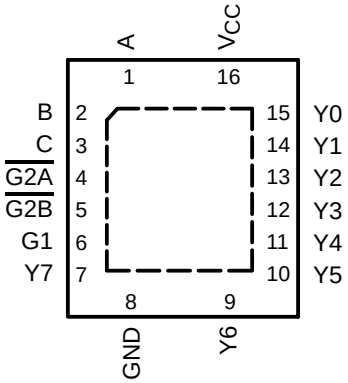
- 2-V to 5.5-V $V_{CC}$ Operation
- Max $t_{pd}$ of 9.5 ns at 5 V
- Typical $V_{OLP}$ (Output Ground Bounce) <0.8 V at $V_{CC}$ = 3.3 V, $T_A$ = 25°C
- Typical $V_{OHV}$ (Output $V_{OH}$ Undershoot) >2.3 V at $V_{CC}$ = 3.3 V, $T_A$ = 25°C
- Support Mixed-Mode Voltage Operation on All Ports
- $I_{off}$ Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)
  - 1000-V Charged-Device Model (C101)

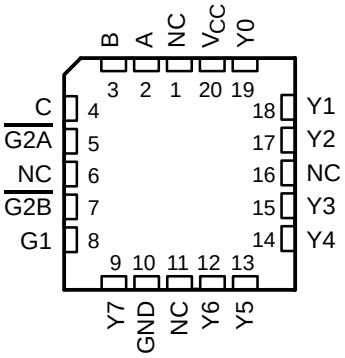
**SN54LV138A . . . J OR W PACKAGE**
**SN74LV138A . . . D, DB, DGV, NS OR PW PACKAGE**
**(TOP VIEW)**




**SN74LV138A . . . RGY PACKAGE**
**(TOP VIEW)**




**SN54LV138A . . . FK PACKAGE**
**(TOP VIEW)**




NC – No internal connection

## description/ordering information

The ’LV138A devices are 3-line to 8-line decoders/demultiplexers designed for 2-V to 5.5-V $V_{CC}$ operation.

**ORDERING INFORMATION**

| $T_A$ | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| –40°C to 85°C | QFN – RGY | Reel of 1000 | SN74LV138ARGYR | LV138A |
| | SOIC – D | Tube of 40 | SN74LV138AD | LV138A |
| | | Reel of 2500 | SN74LV138ADR | |
| | SOP – NS | Reel of 2000 | SN74LV138ANSR | 74LV138A |
| | SSOP – DB | Reel of 2000 | SN74LV138ADBR | LV138A |
| | TSSOP – PW | Tube of 90 | SN74LV138APW | LV138A |
| | | Reel of 2000 | SN74LV138APWR | |
| | | Reel of 250 | SN74LV138APWT | |
| | TVSOP – DGV | Reel of 2000 | SN74LV138ADGVR | LV138A |
| –55°C to 125°C | CDIP – J | Tube of 25 | SNJ54LV138AJ | SNJ54LV138AJ |
| | CFP – W | Tube of 150 | SNJ54LV138AW | SNJ54LV138AW |
| | LCCC – FK | Tube of 55 | SNJ54LV138AFK | SNJ54LV138AFK |

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

## description/ordering information (continued)

These devices are designed for high-performance memory-decoding or data-routing applications requiring very short propagation delay times. In high-performance memory systems, these decoders can be used to minimize the effects of system decoding. When employed with high-speed memories utilizing a fast enable circuit, the delay times of these decoders and the enable time of the memory usually are less than the typical access time of the memory. This means that the effective system delay introduced by the decoder is negligible.

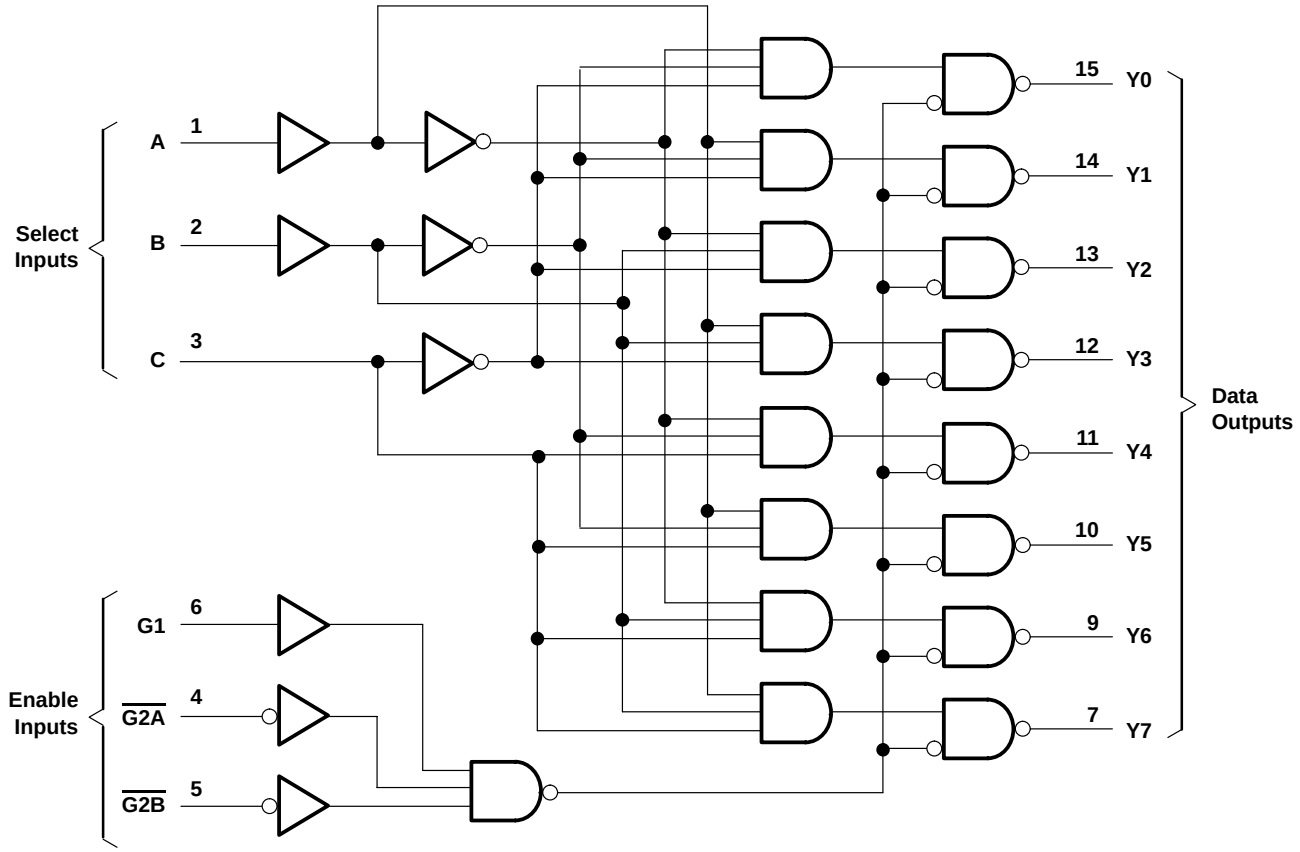
The conditions at the binary-select inputs (A, B, C) and the three enable inputs (G1, $\overline{G2A}$, $\overline{G2B}$) select one of eight output lines. The two active-low ($\overline{G2A}$, $\overline{G2B}$) and one active-high (G1) enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

These devices are fully specified for partial-power-down applications using $I_{off}$. The $I_{off}$ circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down.

**FUNCTION TABLE**

| ENABLE INPUTS | | | SELECT INPUTS | | | OUTPUTS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G1 | $\overline{G2A}$ | $\overline{G2B}$ | C | B | A | Y0 | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y7 |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| X | X | H | X | X | X | H | H | H | H | H | H | H | H |
| L | X | X | X | X | X | H | H | H | H | H | H | H | H |
| H | L | L | L | L | L | L | H | H | H | H | H | H | H |
| H | L | L | L | L | H | H | L | H | H | H | H | H | H |
| H | L | L | L | H | L | H | H | L | H | H | H | H | H |
| H | L | L | L | H | H | H | H | H | L | H | H | H | H |
| H | L | L | H | L | L | H | H | H | H | L | H | H | H |
| H | L | L | H | L | H | H | H | H | H | H | L | H | H |
| H | L | L | H | H | L | H | H | H | H | H | H | L | H |
| H | L | L | H | H | H | H | H | H | H | H | H | H | L |

## logic diagram (positive logic)




Pin numbers shown are for the D, DB, DGV, J, NS, PW, RGY, and W packages.

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

Supply voltage range, $V_{CC}$ . . . . . –0.5 V to 7 V
Input voltage range, $V_I$ (see Note 1) . . . . . –0.5 V to 7 V
Voltage range applied to any output in the high-impedance
or power-off state, $V_O$ (see Note 1) . . . . . –0.5 V to 7 V
Output voltage range, $V_O$ (see Notes 1 and 2) . . . . . –0.5 V to $V_{CC}$ + 0.5 V
Input clamp current, $I_{IK}$ ($V_I$ < 0) . . . . . –20 mA
Output clamp current, $I_{OK}$ ($V_O$ < 0 or $V_O$ > $V_{CC}$) . . . . . ±50 mA
Continuous output current, $I_O$ ($V_O$ = 0 to $V_{CC}$) . . . . . ±25 mA
Continuous current through $V_{CC}$ or GND . . . . . ±50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): D package . . . . . 73°C/W
(see Note 3): DB package . . . . . 82°C/W
(see Note 3): DGV package . . . . . 120°C/W
(see Note 3): NS package . . . . . 64°C/W
(see Note 3): PW package . . . . . 108°C/W
(see Note 4): RGY package . . . . . 39°C/W
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. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 5.5 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51-7.
4. The package thermal impedance is calculated in accordance with JESD 51-5.

## recommended operating conditions (see Note 5)

| | | | SN54LV138A | | SN74LV138A | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX | |
| $V_{CC}$ | Supply voltage | | 2 | 5.5 | 2 | 5.5 | V |
| $V_{IH}$ | High-level input voltage | $V_{CC}$ = 2 V | 1.5 | | 1.5 | | V |
| | | $V_{CC}$ = 2.3 V to 2.7 V | $V_{CC} \times 0.7$ | | $V_{CC} \times 0.7$ | | |
| | | $V_{CC}$ = 3 V to 3.6 V | $V_{CC} \times 0.7$ | | $V_{CC} \times 0.7$ | | |
| | | $V_{CC}$ = 4.5 V to 5.5 V | $V_{CC} \times 0.7$ | | $V_{CC} \times 0.7$ | | |
| $V_{IL}$ | Low-level input voltage | $V_{CC}$ = 2 V | | 0.5 | | 0.5 | V |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | $V_{CC} \times 0.3$ | | $V_{CC} \times 0.3$ | |
| | | $V_{CC}$ = 3 V to 3.6 V | | $V_{CC} \times 0.3$ | | $V_{CC} \times 0.3$ | |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | $V_{CC} \times 0.3$ | | $V_{CC} \times 0.3$ | |
| $V_I$ | Input voltage | | 0 | 5.5 | 0 | 5.5 | V |
| $V_O$ | Output voltage | | 0 | $V_{CC}$ | 0 | $V_{CC}$ | V |
| $I_{OH}$ | High-level output current | $V_{CC}$ = 2 V | | –50 | | –50 | μA |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | –2 | | –2 | mA |
| | | $V_{CC}$ = 3 V to 3.6 V | | –6 | | –6 | |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | –12 | | –12 | |
| $I_{OL}$ | Low-level output current | $V_{CC}$ = 2 V | | 50 | | 50 | μA |
| | | $V_{CC}$ = 2.3 V to 2.7 V | | 2 | | 2 | mA |
| | | $V_{CC}$ = 3 V to 3.6 V | | 6 | | 6 | |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | 12 | | 12 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | $V_{CC}$ = 2.3 V to 2.7 V | | 200 | | 200 | ns/V |
| | | $V_{CC}$ = 3 V to 3.6 V | | 100 | | 100 | |
| | | $V_{CC}$ = 4.5 V to 5.5 V | | 20 | | 20 | |
| $T_A$ | Operating free-air temperature | | –55 | 125 | –40 | 85 | °C |

NOTE 5: All unused inputs of the device must be held at $V_{CC}$ or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $V_{CC}$ | SN54LV138A | | | SN74LV138A | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{OH}$ | $I_{OH}$ = –50 μA | 2 V to 5.5 V | $V_{CC}$–0.1 | | | $V_{CC}$–0.1 | | | V |
| | $I_{OH}$ = –2 mA | 2.3 V | 2 | | | 2 | | | |
| | $I_{OH}$ = –6 mA | 3 V | 2.48 | | | 2.48 | | | |
| | $I_{OH}$ = –12 mA | 4.5 V | 3.8 | | | 3.8 | | | |
| $V_{OL}$ | $I_{OL}$ = 50 μA | 2 V to 5.5 V | | | 0.1 | | | 0.1 | V |
| | $I_{OL}$ = 2 mA | 2.3 V | | | 0.4 | | | 0.4 | |
| | $I_{OL}$ = 6 mA | 3 V | | | 0.44 | | | 0.44 | |
| | $I_{OL}$ = 12 mA | 4.5 V | | | 0.55 | | | 0.55 | |
| $I_I$ | $V_I$ = 5.5 V or GND | 0 to 5.5 V | | | ±1 | | | ±1 | μA |
| $I_{CC}$ | $V_I = V_{CC}$ or GND, $I_O$ = 0 | 5.5 V | | | 20 | | | 20 | μA |
| $I_{off}$ | $V_I$ or $V_O$ = 0 to 5.5 V | 0 | | | 5 | | | 5 | μA |
| $C_i$ | $V_I = V_{CC}$ or GND | 3.3 V | | 2.1 | | | 2.1 | | pF |

### switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | $T_A$ = 25°C | | | SN54LV138A | | SN74LV138A | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 15 pF | | 11.7* | 17.6* | 1* | 21* | 1 | 21 | ns |
| | G1 | | | | 12.3* | 19.2* | 1* | 22* | 1 | 22 | |
| | $\overline{G2A}$ or $\overline{G2B}$ | | | | 11.4* | 18.2* | 1* | 21* | 1 | 21 | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 50 pF | | 14.9 | 21.4 | 1 | 25 | 1 | 25 | ns |
| | G1 | | | | 15.7 | 22.6 | 1 | 26 | 1 | 26 | |
| | G2A or G2B | | | | 14.8 | 22 | 1 | 25 | 1 | 25 | |



* On products compliant to MIL-PRF-38535, this parameter is not production tested.

### switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | $T_A$ = 25°C | | | SN54LV138A | | SN74LV138A | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 15 pF | | 8.1* | 11.4* | 1* | 13.5* | 1 | 13.5 | ns |
| | G1 | | | | 8.4* | 12.8* | 1* | 15* | 1 | 15 | |
| | $\overline{G2A}$ or $\overline{G2B}$ | | | | 7.8* | 11.4* | 1* | 13.5* | 1 | 13.5 | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 50 pF | | 10.3 | 15.8 | 1 | 18 | 1 | 18 | ns |
| | G1 | | | | 10.6 | 16.3 | 1 | 18.5 | 1 | 18.5 | |
| | G2A or G2B | | | | 10 | 14.9 | 1 | 17 | 1 | 17 | |



* On products compliant to MIL-PRF-38535, this parameter is not production tested.

### switching characteristics over recommended operating free-air temperature range, $V_{CC}$ = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD CAPACITANCE | $T_A$ = 25°C | | | SN54LV138A | | SN74LV138A | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 15 pF | | 5.6* | 8.1* | 1* | 9.5* | 1 | 9.5 | ns |
| | G1 | | | | 5.7* | 8.1* | 1* | 9.5* | 1 | 9.5 | |
| | $\overline{G2A}$ or $\overline{G2B}$ | | | | 5.4* | 8.1* | 1* | 9.5* | 1 | 9.5 | |
| $t_{pd}$ | A, B, or C | Y | $C_L$ = 50 pF | | 7 | 10.1 | 1 | 11.5 | 1 | 11.5 | ns |
| | G1 | | | | 7.1 | 10.1 | 1 | 11.5 | 1 | 11.5 | |
| | G2A or G2B | | | | 6.8 | 10.1 | 1 | 11.5 | 1 | 11.5 | |

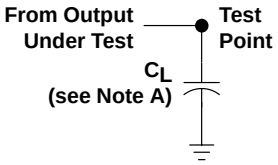


* On products compliant to MIL-PRF-38535, this parameter is not production tested.

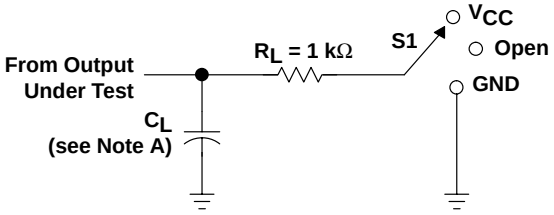
### operating characteristics, $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | | $V_{CC}$ | TYP | UNIT |
|---|---|---|---|---|---|---|
| $C_{pd}$ | Power dissipation capacitance | $C_L$ = 50 pF, | f = 10 MHz | 3.3 V | 16.8 | pF |
| | | | | 5 V | 19.1 | |

## PARAMETER MEASUREMENT INFORMATION

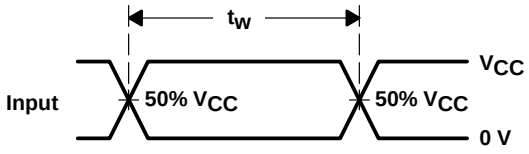



LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

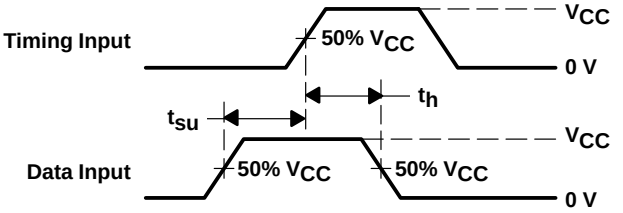



| TEST | S1 |
|---|---|
| $t_{PLH}/t_{PHL}$ | Open |
| $t_{PLZ}/t_{PZL}$ | $V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND |
| Open Drain | $V_{CC}$ |

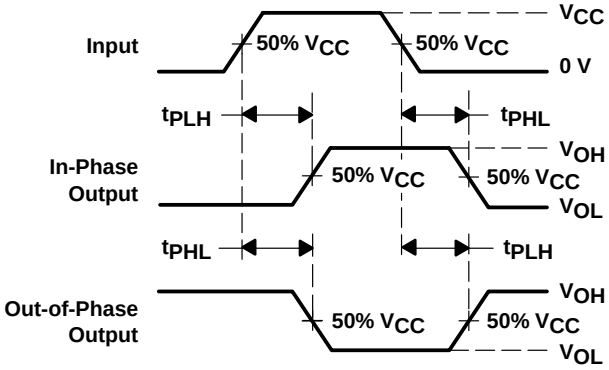
LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS



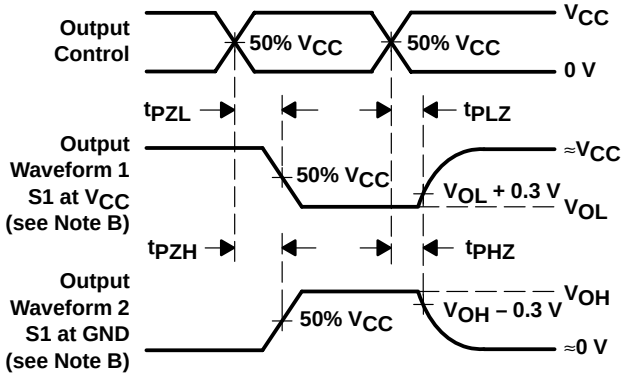

VOLTAGE WAVEFORMS
PULSE DURATION




VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES




VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



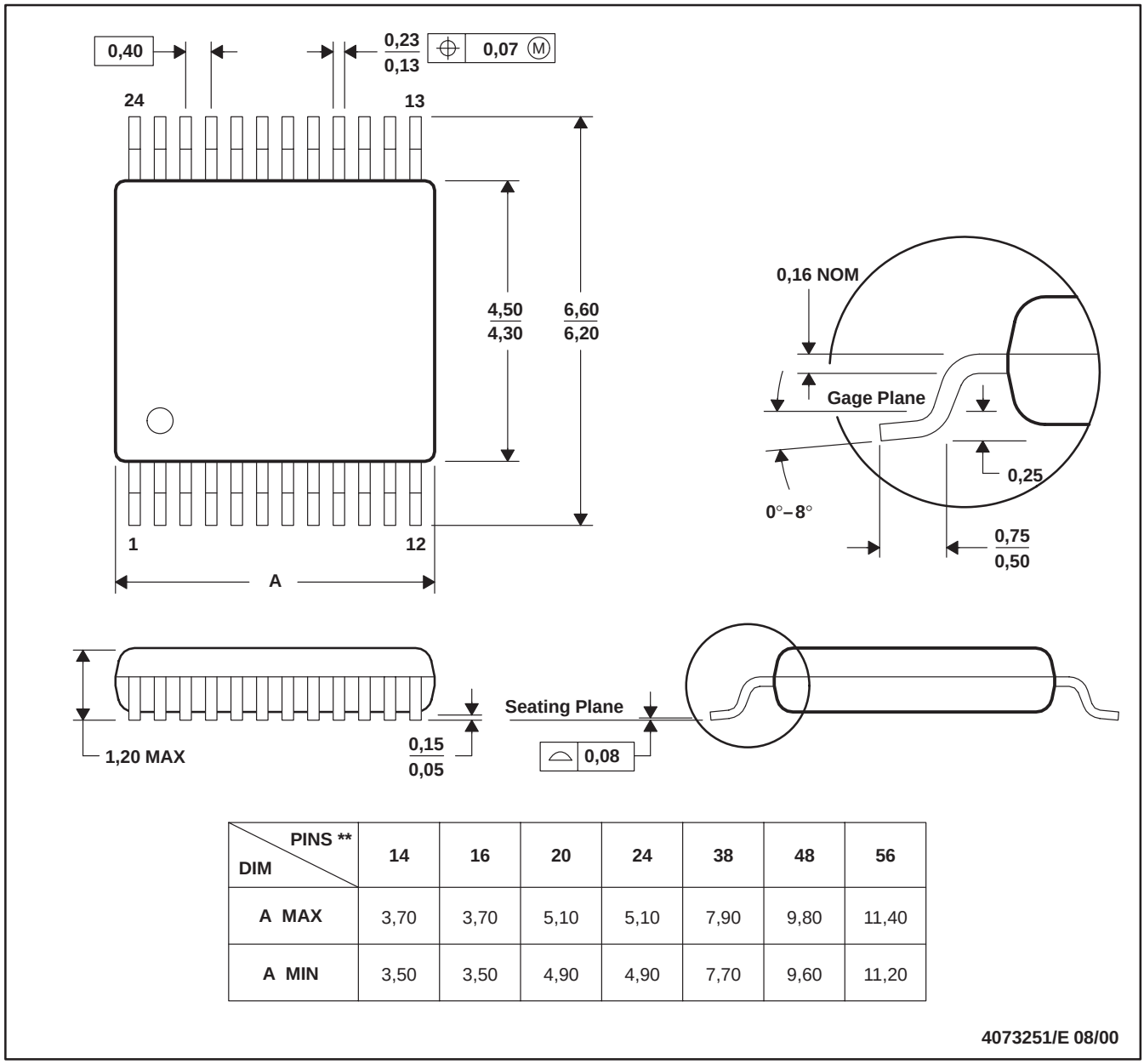

VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

NOTES: A. $C_L$ includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 3 ns, $t_f$ ≤ 3 ns.
D. The outputs are measured one at a time with one input transition per measurement.
E. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.
F. $t_{PZL}$ and $t_{PZH}$ are the same as $t_{en}$.
G. $t_{PHL}$ and $t_{PLH}$ are the same as $t_{pd}$.
H. All parameters and waveforms are not applicable to all devices.

**Figure 1. Load Circuit and Voltage Waveforms**

**DGV (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

**24 PINS SHOWN**

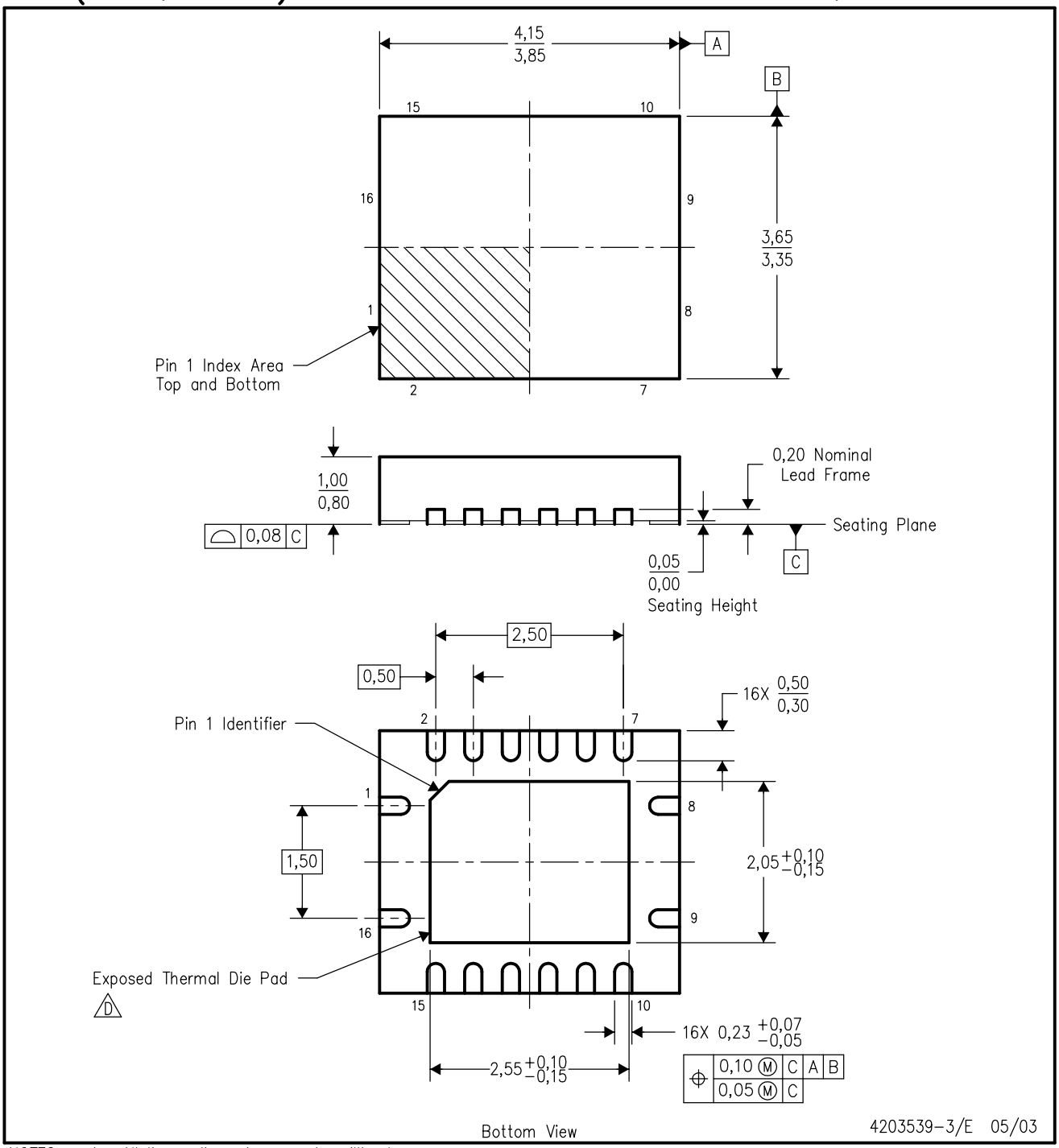



| DIM \ PINS ** | 14 | 16 | 20 | 24 | 38 | 48 | 56 |
|---|---|---|---|---|---|---|---|
| A MAX | 3,70 | 3,70 | 5,10 | 5,10 | 7,90 | 9,80 | 11,40 |
| A MIN | 3,50 | 3,50 | 4,90 | 4,90 | 7,70 | 9,60 | 11,20 |

**4073251/E 08/00**

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 per side.
D. Falls within JEDEC: 24/48 Pins – MO-153
14/16/20/56 Pins – MO-194

RGY (R–PQFP–N16) PLASTIC QUAD FLATPACK



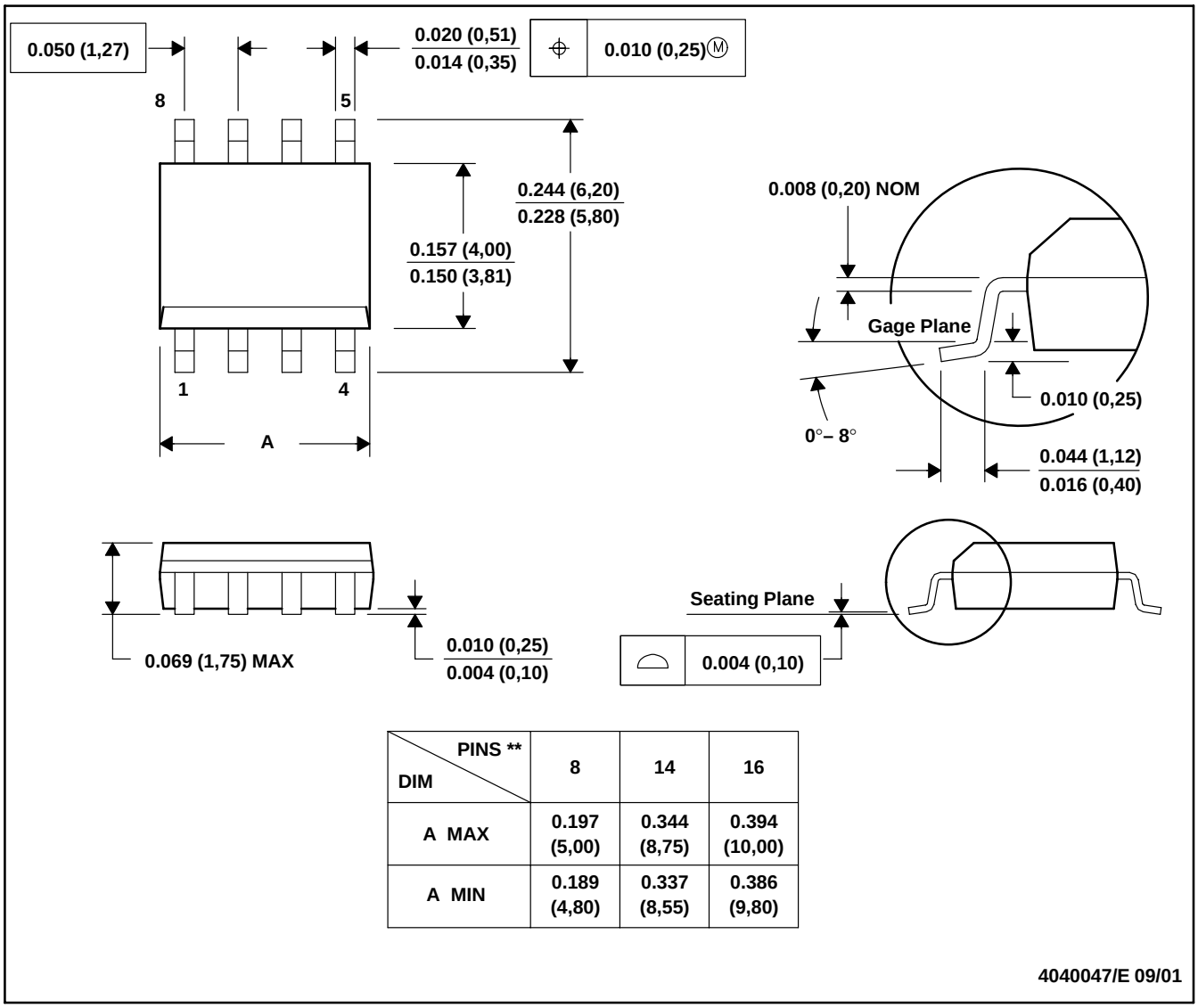

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–Lead) package configuration.
D. The package thermal performance may be enhanced by bonding the thermal die pad to an external thermal plane. This pad is electrically and thermally connected to the backside of the die and possibly selected ground leads.
E. Package complies to JEDEC MO–241 variation BB.

MSOI002B – JANUARY 1995 – REVISED SEPTEMBER 2001

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

## PLASTIC SMALL-OUTLINE PACKAGE

**8 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 |
|---|---|---|---|
| A MAX | 0.197 (5,00) | 0.344 (8,75) | 0.394 (10,00) |
| A MIN | 0.189 (4,80) | 0.337 (8,55) | 0.386 (9,80) |

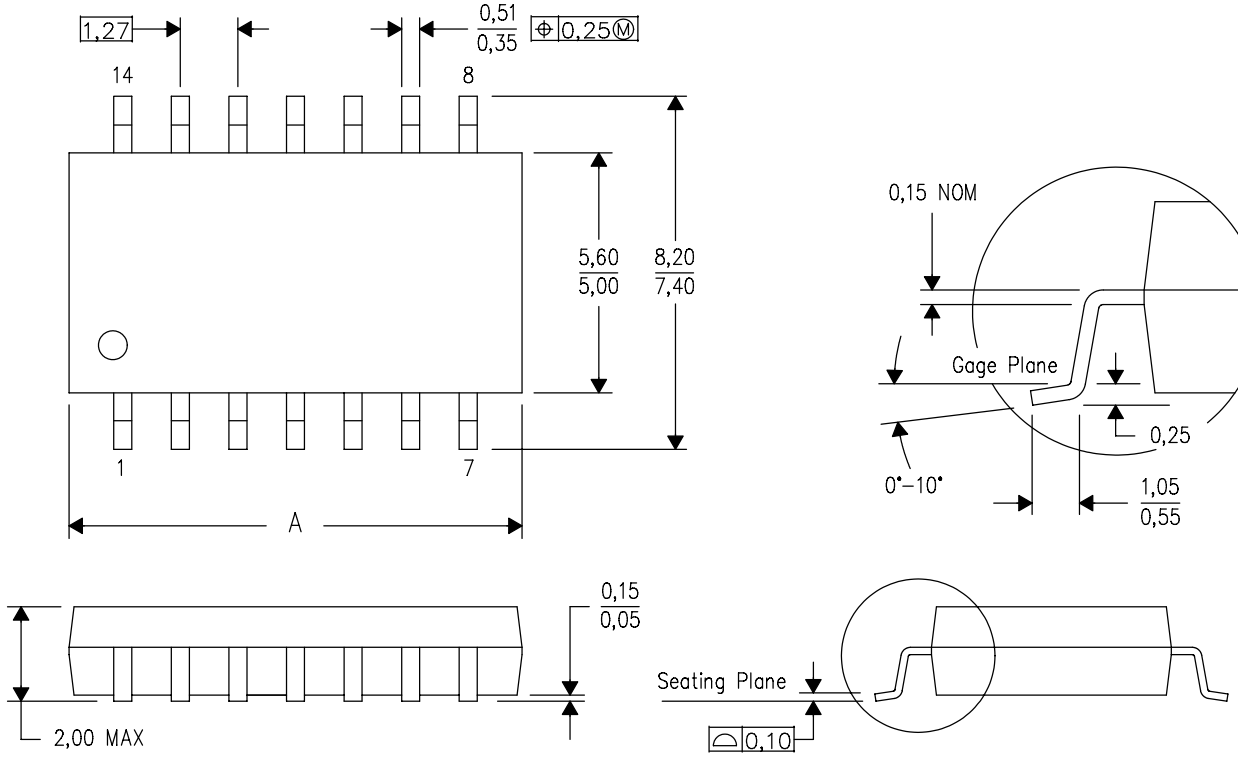
4040047/E 09/01

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

## MECHANICAL DATA

**NS (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14-PINS SHOWN**




| DIM \ PINS ** | 14 | 16 | 20 | 24 |
|---|---|---|---|---|
| A MAX | 10,50 | 10,50 | 12,90 | 15,30 |
| A MIN | 9,90 | 9,90 | 12,30 | 14,70 |

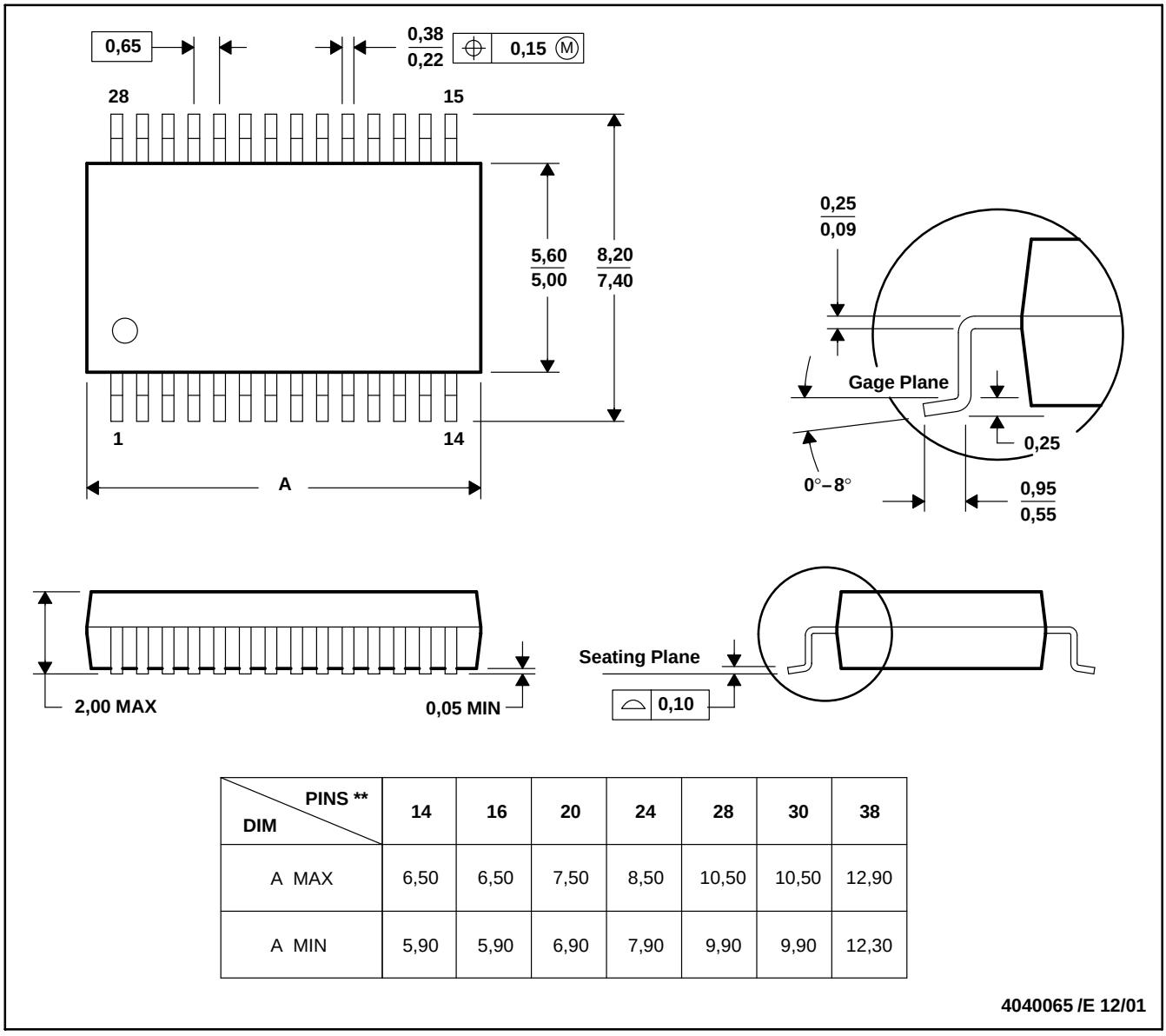
4040062/C 03/03

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.

MSSO002E – JANUARY 1995 – REVISED DECEMBER 2001

**DB (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE**

**28 PINS SHOWN**



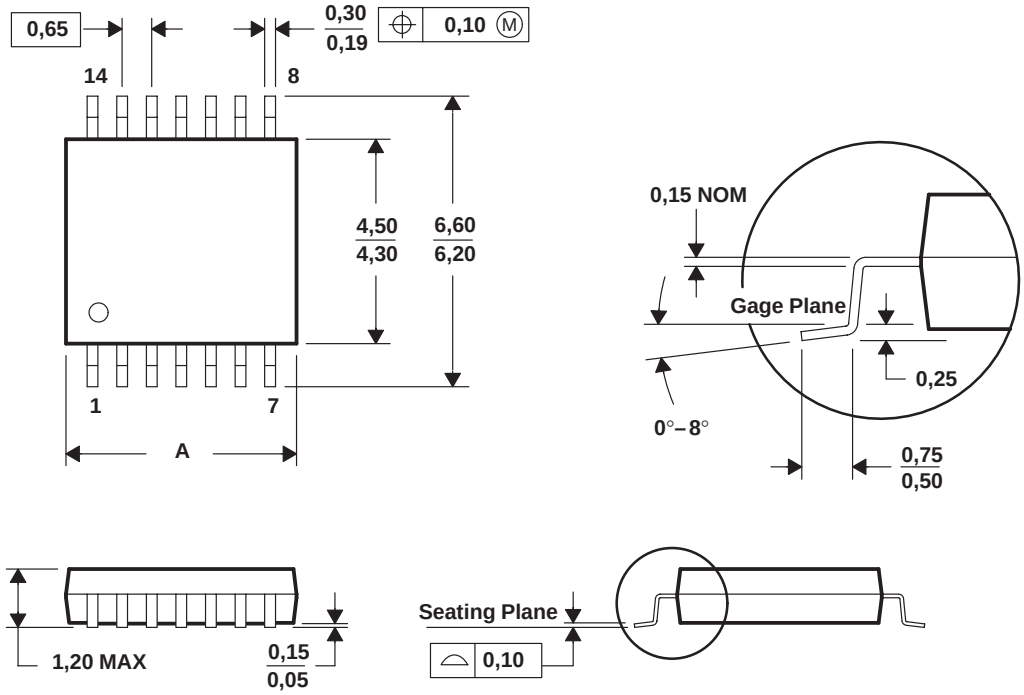

| DIM \ PINS ** | 14 | 16 | 20 | 24 | 28 | 30 | 38 |
|---|---|---|---|---|---|---|---|
| A MAX | 6,50 | 6,50 | 7,50 | 8,50 | 10,50 | 10,50 | 12,90 |
| A MIN | 5,90 | 5,90 | 6,90 | 7,90 | 9,90 | 9,90 | 12,30 |

**4040065 /E 12/01**

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-150

**PW (R-PDSO-G**)** **PLASTIC SMALL-OUTLINE PACKAGE**

**14 PINS SHOWN**




| DIM \ PINS ** | 8 | 14 | 16 | 20 | 24 | 28 |
|---|---|---|---|---|---|---|
| A MAX | 3,10 | 5,10 | 5,10 | 6,60 | 7,90 | 9,80 |
| A MIN | 2,90 | 4,90 | 4,90 | 6,40 | 7,70 | 9,60 |

**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

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