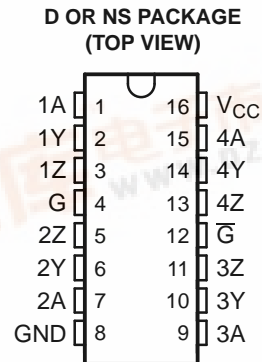


## FEATURES

- Switching Rates up to 32 MHz
- Operate From a Single 3.3-V Supply
- Propagation Delay Time . . . 8 ns Typ
- Pulse Skew Time . . . 500 ps Typ
- High Output-Drive Current . . .  $\pm 30$  mA
- Controlled Rise and Fall Times . . . 3 ns Typ
- Differential Output Voltage With 100- $\Omega$  Load . . . 1.5 V Typ
- Ultra-Low Power Dissipation
  - dc, 0.3 mW Max
  - 32 MHz All Channels (No Load), 385 mW Typ
- Accept 5-V Logic Inputs With 3.3-V Supply
- Low-Voltage Pin-to-Pin Compatible Replacement for AM26C31, AM26LS31, MB571
- High Output Impedance in Power-Off Condition
- Driver Output Short-Protection Circuit
- Package Options Include Plastic Small-Outline (D, NS) Packages



## DESCRIPTION/ORDERING INFORMATION

The AM26LV31C and AM26LV31I are BiCMOS quadruple differential line drivers with 3-state outputs. They are designed to be similar to TIA/EIA-422-B and ITU Recommendation V.11 drivers with reduced supply-voltage range.

The devices are optimized for balanced-bus transmission at switching rates up to 32 MHz. The outputs have very high current capability for driving balanced lines such as twisted-pair transmission lines and provide a high impedance in the power-off condition. The enable function is common to all four drivers and offers the choice of active-high or active-low enable inputs. The AM26LV31C and AM26LV31I are designed using Texas Instruments proprietary LinIMPACT-C60™ technology, facilitating ultra-low power consumption without sacrificing speed. These devices offer optimum performance when used with the AM26LV32 quadruple line receivers.

The AM26LV31C is characterized for operation from 0°C to 70°C. The AM26LV31I is characterized for operation from –45°C to 85°C

## ORDERING INFORMATION

| T <sub>A</sub> | PACKAGE <sup>(1)</sup> |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------------------|---------------|-----------------------|------------------|
| 0°C to 70°C    | SOIC – D               | Tape and reel | AM26LV31CD            | AM26LV31C        |
|                |                        |               | AM26LV31CDR           |                  |
|                | SOIC – NS              | Tape and reel | AM26LV31CNS           | 26LV31           |
|                |                        |               | AM26LV31CNSR          |                  |
| –45°C to 85°C  | SOIC – D               | Tape and reel | AM26LV31ID            | AM26LV31I        |
|                |                        |               | AM26LV31IDR           |                  |
|                | SOIC – NS              | Tape and reel | AM26LV31INS           | 26LV31I          |
|                |                        |               | AM26LV31INSR          |                  |

(1) 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).

# AM26LV31C, AM26LV31I LOW-VOLTAGE HIGH-SPEED QUADRUPLE DIFFERENTIAL LINE DRIVERS

SLLS201G—MAY 1995—REVISED MAY 2005

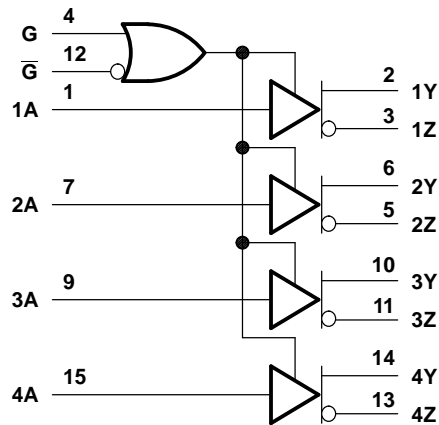


FUNCTION TABLE<sup>(1)</sup>

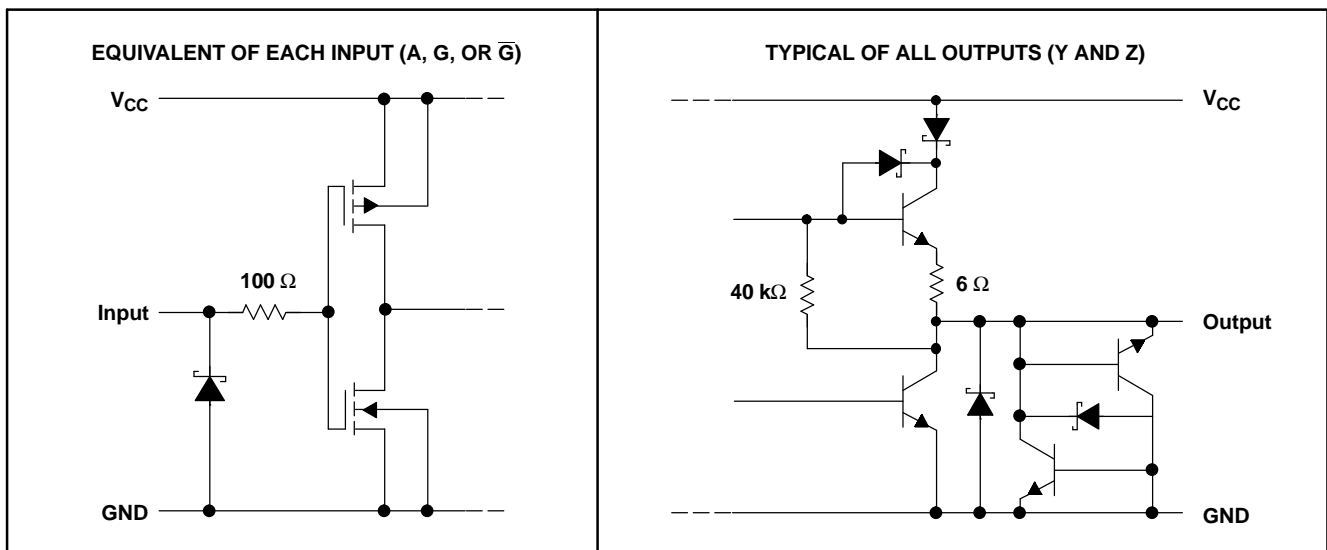
| INPUT<br>A | ENABLES |           | OUTPUTS |   |
|------------|---------|-----------|---------|---|
|            | G       | $\bar{G}$ | Y       | Z |
| H          | H       | X         | H       | L |
| L          | H       | X         | L       | H |
| H          | X       | L         | H       | L |
| L          | X       | L         | L       | H |
| X          | L       | H         | Z       | Z |

(1) H = high level, L = low level, X = irrelevant,  
Z = high impedance (off)

LOGIC DIAGRAM (POSITIVE LOGIC)



SCHEMATIC (EACH DRIVER)



All resistor values are nominal.

### Absolute Maximum Ratings<sup>(1)</sup>

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

|                  |  | MIN                                 | MAX | UNIT |    |
|------------------|--|-------------------------------------|-----|------|----|
| V <sub>CC</sub>  | Supply voltage range <sup>(2)</sup>      | -0.3                                | 6   | V    |    |
| V <sub>I</sub>   | Input voltage range                      | -0.3                                | 6   | V    |    |
| V <sub>O</sub>   | Output voltage range                     | -0.3                                | 6   | V    |    |
| θ <sub>JA</sub>  | Package thermal impedance <sup>(3)</sup> | D package                           |     | °C/W |    |
|                  |  | NS package                          |     |      |    |
|                  | Lead temperature                         | 1,6 mm (1/16 in) from case for 10 s |     | 260  | °C |
| T <sub>stg</sub> | Storage temperature range                | -65                                 | 150 | °C   |    |

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to GND.

(3) The package thermal impedance is calculated in accordance with JESD 51-7.

### Recommended Operating Conditions

|                 |                                | MIN       | NOM | MAX | UNIT |    |
|-----------------|--------------------------------|-----------|-----|-----|------|----|
| V <sub>CC</sub> | Supply voltage                 | 3         | 3.3 | 3.6 | V    |    |
| V <sub>IH</sub> | High-level input voltage       | 2         |     |     | V    |    |
| V <sub>IL</sub> | Low-level input voltage        |           |     | 0.8 | V    |    |
| I <sub>OH</sub> | High-level output current      |           |     | -30 | mA   |    |
| I <sub>OL</sub> | Low-level output current       |           |     | 30  | mA   |    |
| T <sub>A</sub>  | Operating free-air temperature | AM26LV31C |     | 0   | 70   | °C |
|                 |                                | AM26LV31I |     | -45 | 85   |    |

### Electrical Characteristics

over recommended operating supply-voltage and free-air temperature ranges (unless otherwise noted)

| PARAMETER          | TEST CONDITIONS  | MIN  | TYP <sup>(1)</sup> | MAX  | UNIT |
|--------------------|--|------|--------------------|------|------|
| V <sub>IK</sub>    | Input clamp voltage<br>I <sub>I</sub> = 18 mA  |      |                    | -1.5 | V    |
| V <sub>OH</sub>    | High-level output voltage<br>V <sub>IH</sub> = 2 V, I <sub>OH</sub> = -12 mA                                     | 1.85 | 2.3                |      | V    |
| V <sub>OL</sub>    | Low-level output voltage<br>V <sub>IL</sub> = 0.8 V, I <sub>OH</sub> = 12 mA                                     |      | 0.8                | 1.05 | V    |
| V <sub>OD</sub>    | Differential output voltage <sup>(2)</sup>   | 0.95 | 1.5                |      | V    |
| V <sub>OC</sub>    | Common-mode output voltage<br>R <sub>L</sub> = 100 Ω   | 1.3  | 1.55               | 1.8  | V    |
| Δ V <sub>Ocl</sub> | Change in magnitude of common-mode output voltage <sup>(2)</sup>   |      |                    | ±0.2 | V    |
| I <sub>O</sub>     | Output current with power off<br>V <sub>O</sub> = -0.25 V or 6 V, V <sub>CC</sub> = 0                            |      |                    | ±100 | μA   |
| I <sub>OZ</sub>    | Off-state (high-impedance state) output current<br>V <sub>O</sub> = -0.25 V or 6 V, G = 0.8 V or $\bar{G}$ = 2 V |      |                    | ±100 | μA   |
| I <sub>H</sub>     | High-level input current<br>V <sub>CC</sub> = 0 or 3 V, V <sub>I</sub> = 5.5 V                                   |      |                    | 10   | μA   |
| I <sub>L</sub>     | Low-level input current<br>V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = 0   |      |                    | -10  | μA   |
| I <sub>OS</sub>    | Short-circuit output current<br>V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0                                      |      |                    | -200 | mA   |
| I <sub>CC</sub>    | Supply current (all drivers)<br>V <sub>I</sub> = V <sub>CC</sub> or GND, No load                                 |      |                    | 100  | μA   |
| C <sub>pd</sub>    | Power-dissipation capacitance (all drivers) <sup>(3)</sup><br>No load  |      | 160                |      | pF   |

(1) All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

(2) Δ|V<sub>OD</sub>| and Δ|V<sub>OC</sub>| are the changes in magnitude of V<sub>OD</sub> and V<sub>OC</sub>, respectively, that occur when the input is changed from a high level to a low level.

(3) C<sub>pd</sub> determines the no-load dynamic current consumption. I<sub>S</sub> = C<sub>pd</sub> × V<sub>CC</sub> × f + I<sub>CC</sub>

# AM26LV31C, AM26LV31I LOW-VOLTAGE HIGH-SPEED QUADRUPLE DIFFERENTIAL LINE DRIVERS

SLLS201G–MAY 1995–REVISED MAY 2005



## Switching Characteristics

$V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER     |   | TEST CONDITIONS                               | MIN | TYP <sup>(1)</sup> | MAX | UNIT |
|---------------|---|---|-----|--------------------|-----|------|
| $t_{PLH}$     | Propagation delay time, low- to high-level output | See Figure 2                                  | 4   | 8                  | 12  | ns   |
| $t_{PHL}$     | Propagation delay time, high- to low-level output |   | 4   | 8                  | 12  | ns   |
| $t_t$         | Transition time ( $t_r$ or $t_f$ )                |   |     | 3                  |     | ns   |
| SR            | Slew rate, single-ended output voltage            | See Note <sup>(2)</sup> and Figure 2          |     | 0.3                | 1   | V/ns |
| $t_{PZH}$     | Output-enable time to high level                  | See Figure 3                                  |     | 10                 | 20  | ns   |
| $t_{PZL}$     | Output-enable time to low level                   | See Figure 4                                  |     | 10                 | 20  | ns   |
| $t_{PHZ}$     | Output-disable time from high level               | See Figure 3                                  |     | 10                 | 20  | ns   |
| $t_{PLZ}$     | Output-disable time from low level                | See Figure 4                                  |     | 10                 | 20  | ns   |
| $t_{sk(p)}$   | Pulse skew  | $f = 32\text{ MHz}$ , See Note <sup>(3)</sup> |     | 0.5                | 1.5 | ns   |
| $t_{sk(o)}$   | Skew limit  | $f = 32\text{ MHz}$                           |     |                    | 1.5 | ns   |
| $t_{sk(lim)}$ | Skew limit (device to device)                     | $f = 32\text{ MHz}$ , See Note <sup>(4)</sup> |     |                    | 3   | ns   |

(1) All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

(2) Slew rate is defined by:

$$SR = \frac{90\%(V_{OH} - V_{OL}) - 10\%(V_{OH} - V_{OL})}{t_r}, \text{ the differential slew rate of } V_{OD} \text{ is } 2 \times SR.$$

(3) Pulse skew is defined as the  $|t_{PLH} - t_{PHL}|$  of each channel of the same device.

(4) Skew limit (device to device) is the maximum difference in propagation delay times between any two channels of any two devices.

PARAMETER MEASUREMENT INFORMATION

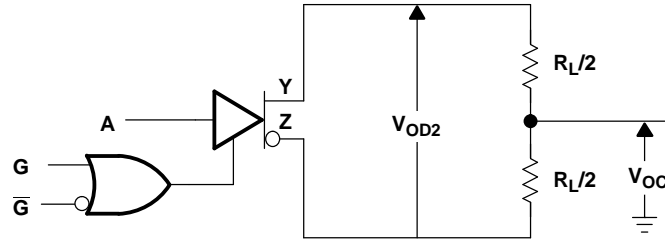
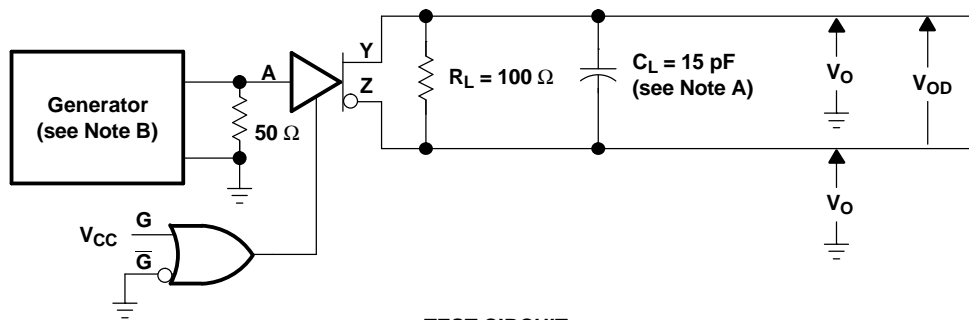
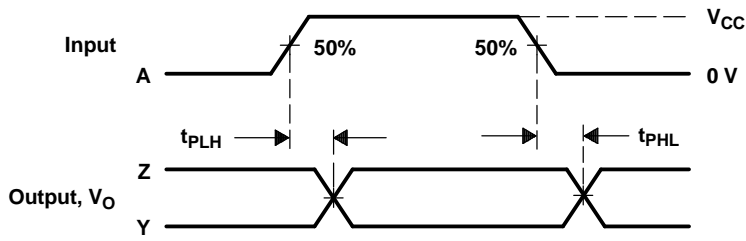


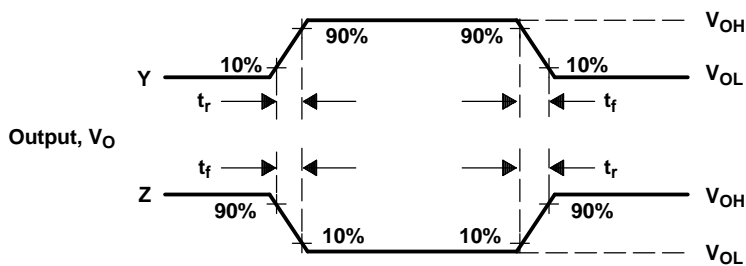
Figure 1. Differential and Common-Mode Output Voltages



TEST CIRCUIT



PROPAGATION DELAY TIMES



RISE AND FALL TIMES

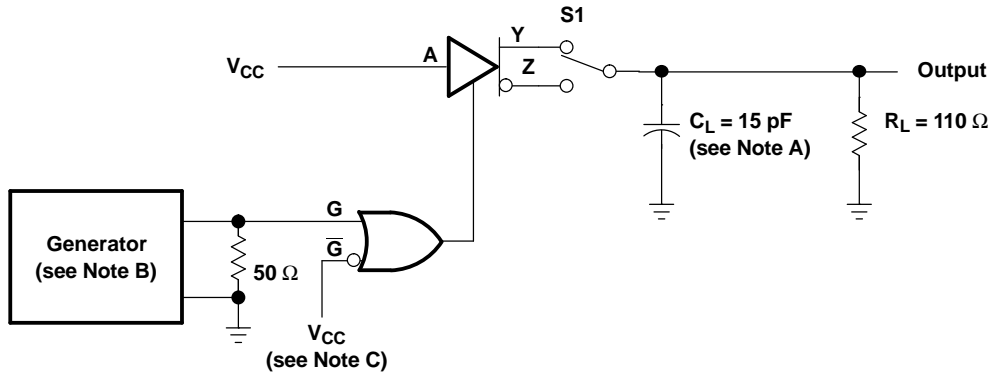
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. The input pulse is supplied by a generator having the following characteristics: PRR = 32 MHz,  $Z_O \approx 50 \Omega$ , 50% duty cycle,  $t_r$  and  $t_f \leq 2$  ns.

Figure 2. Test Circuit and Voltage Waveforms,  $t_{PHL}$  and  $t_{PLH}$

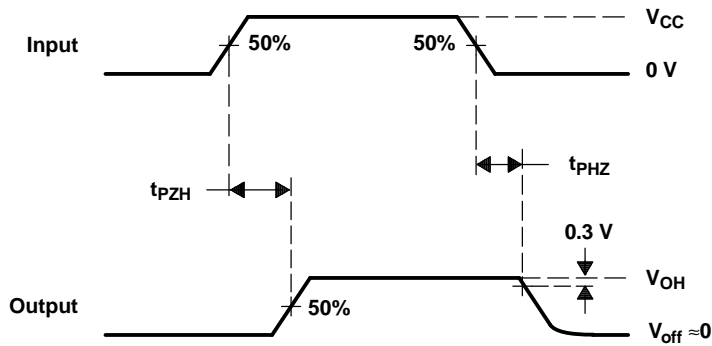
**AM26LV31C, AM26LV31I**  
**LOW-VOLTAGE HIGH-SPEED QUADRUPLE DIFFERENTIAL LINE DRIVERS**

SLLS201G—MAY 1995—REVISED MAY 2005

**PARAMETER MEASUREMENT INFORMATION**



**TEST CIRCUIT**

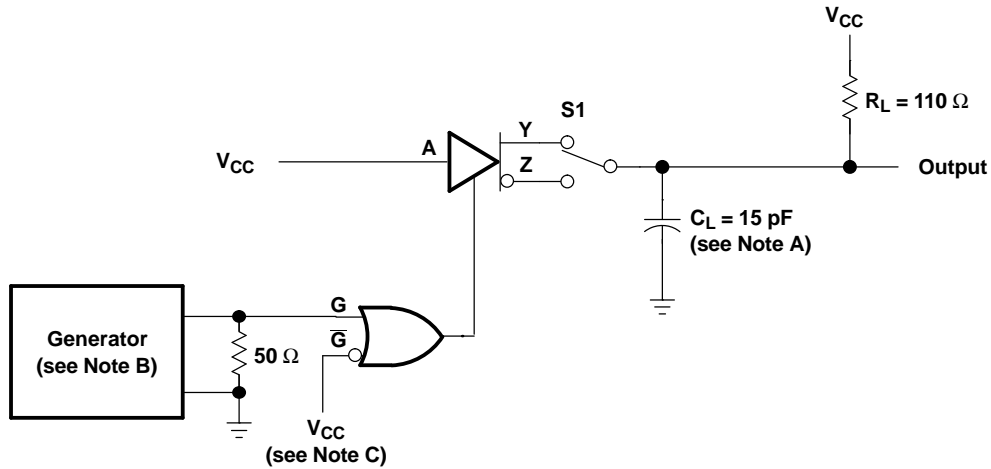


**VOLTAGE WAVEFORMS**

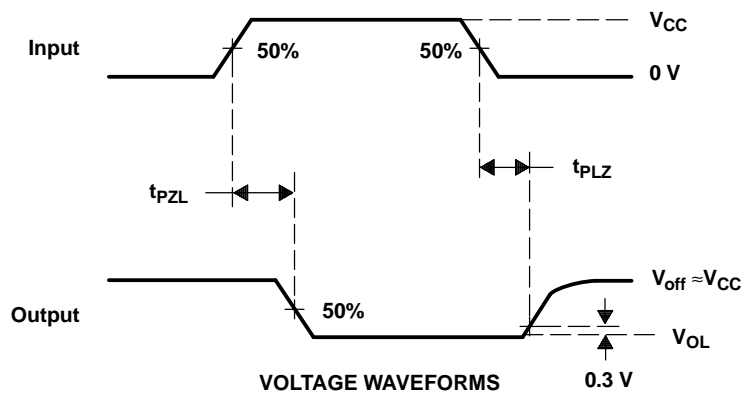
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r$  and  $t_f$  (10% to 90%)  $\leq 2$  ns.  
 C. To test the active-low enable  $\bar{G}$ , ground G and apply an inverted waveform to  $\bar{G}$ .

**Figure 3. Test Circuit and Voltage Waveforms,  $t_{pZH}$  and  $t_{pHL}$**

**PARAMETER MEASUREMENT INFORMATION**



**TEST CIRCUIT**



**VOLTAGE WAVEFORMS**

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. The input pulse is supplied by a generator having the following characteristics: PRR = 1 MHz,  $Z_O = 50 \Omega$ , 50% duty cycle,  $t_r$  and  $t_f$  (10% to 90%)  $\leq 2$  ns.  
 C. To test the active-low enable  $\overline{G}$ , ground G and apply an inverted waveform to  $\overline{G}$ .

**Figure 4. Test Circuit and Voltage Waveforms,  $t_{PZL}$  and  $t_{PLZ}$**

## 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> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| AM26LV31CD       | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CDE4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CDG4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CDR      | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CDRE4    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CDRG4    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CNSLE    | OBSOLETE              | SO           | NS              | 16   |             | TBD                     | Call TI          | Call TI                      |
| AM26LV31CNSR     | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CNSRE4   | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31CNSRG4   | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31ID       | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31IDE4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31IDG4     | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31IDR      | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31IDRE4    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31IDRG4    | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31INSR     | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31INSRE4   | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| AM26LV31INSRG4   | ACTIVE                | SO           | NS              | 16   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> 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.

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

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

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



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

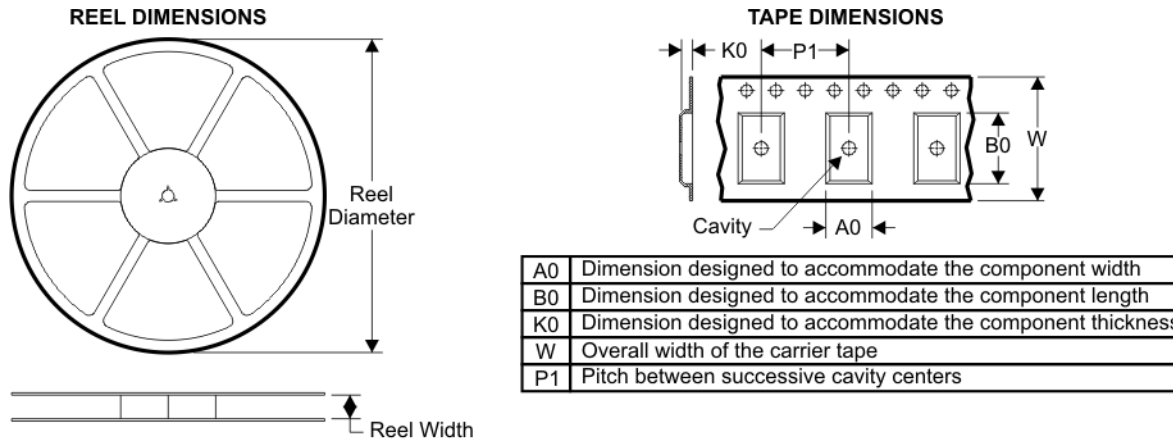
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

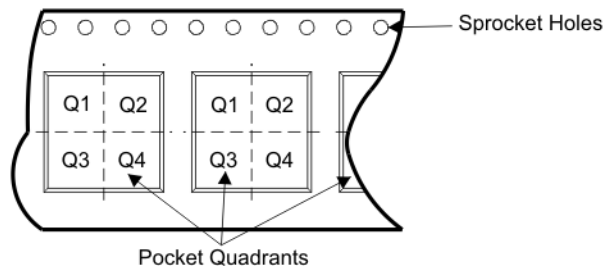
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**TAPE AND REEL BOX INFORMATION**

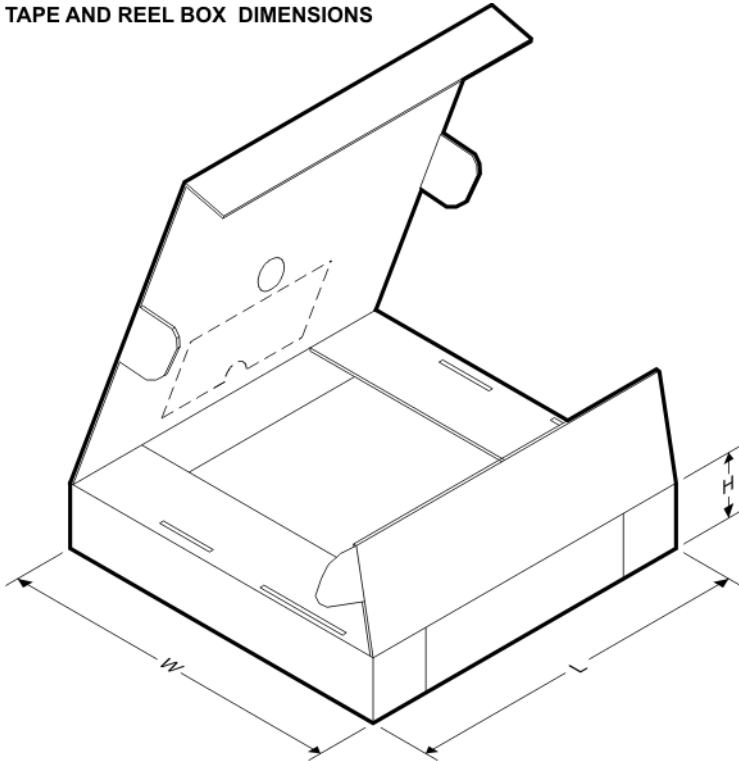


**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



| Device       | Package | Pins | Site    | Reel Diameter (mm) | Reel Width (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|---------|------|---------|--------------------|-----------------|---------|---------|---------|---------|--------|---------------|
| AM26LV31CDR  | D       | 16   | SITE 27 | 330                | 16              | 6.5     | 10.3    | 2.1     | 8       | 16     | Q1            |
| AM26LV31CNSR | NS      | 16   | SITE 41 | 330                | 16              | 8.2     | 10.5    | 2.5     | 12      | 16     | Q1            |
| AM26LV31IDR  | D       | 16   | SITE 27 | 330                | 16              | 6.5     | 10.3    | 2.1     | 8       | 16     | Q1            |
| AM26LV31INSR | NS      | 16   | SITE 41 | 330                | 16              | 8.2     | 10.5    | 2.5     | 12      | 16     | Q1            |

## TAPE AND REEL BOX DIMENSIONS

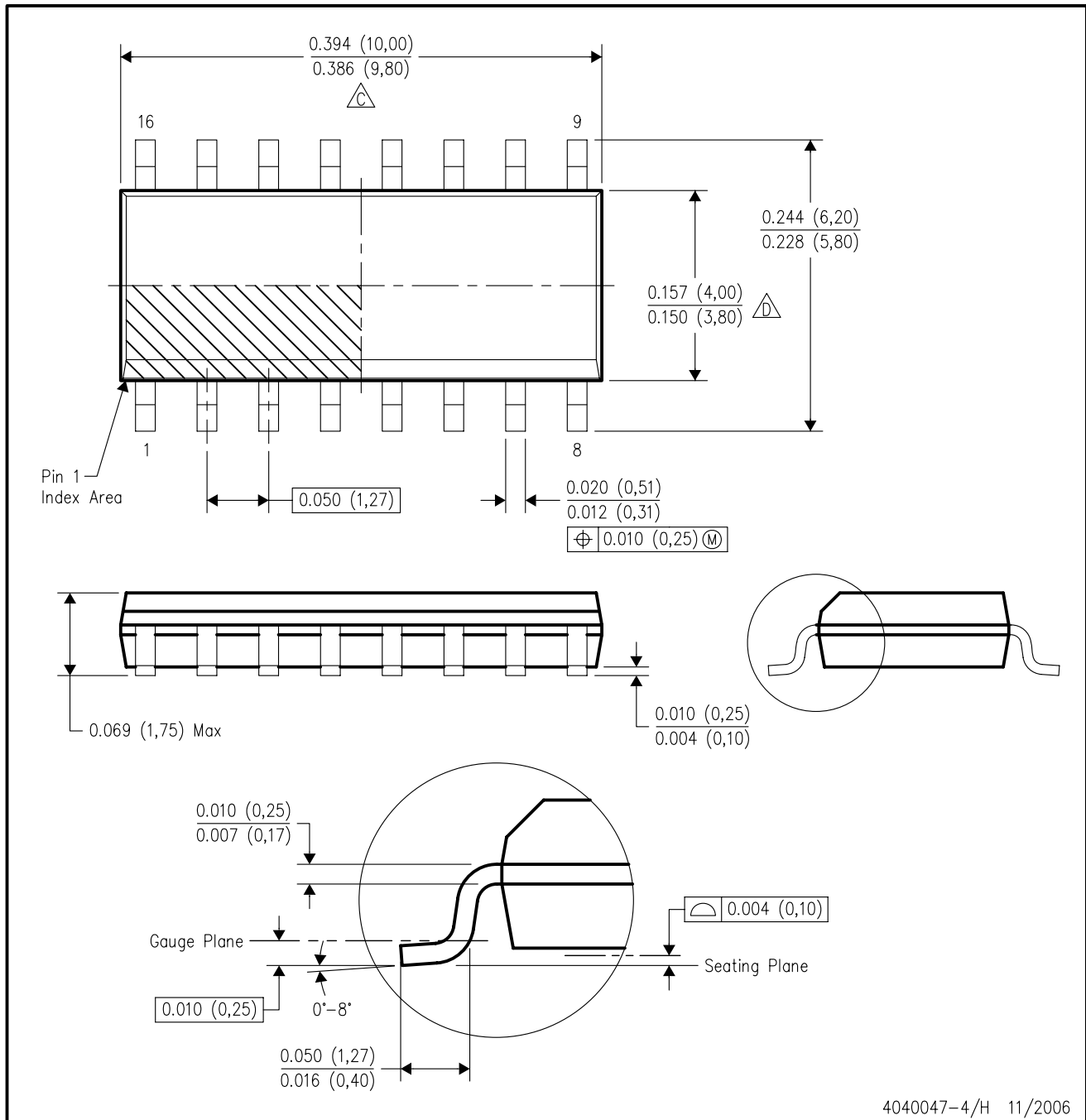


| Device       | Package | Pins | Site    | Length (mm) | Width (mm) | Height (mm) |
|--------------|---------|------|---------|-------------|------------|-------------|
| AM26LV31CDR  | D       | 16   | SITE 27 | 342.9       | 336.6      | 28.58       |
| AM26LV31CNSR | NS      | 16   | SITE 41 | 346.0       | 346.0      | 33.0        |
| AM26LV31IDR  | D       | 16   | SITE 27 | 342.9       | 336.6      | 28.58       |
| AM26LV31INSR | NS      | 16   | SITE 41 | 346.0       | 346.0      | 33.0        |

# MECHANICAL DATA

## D (R-PDSO-G16)

## PLASTIC SMALL-OUTLINE PACKAGE



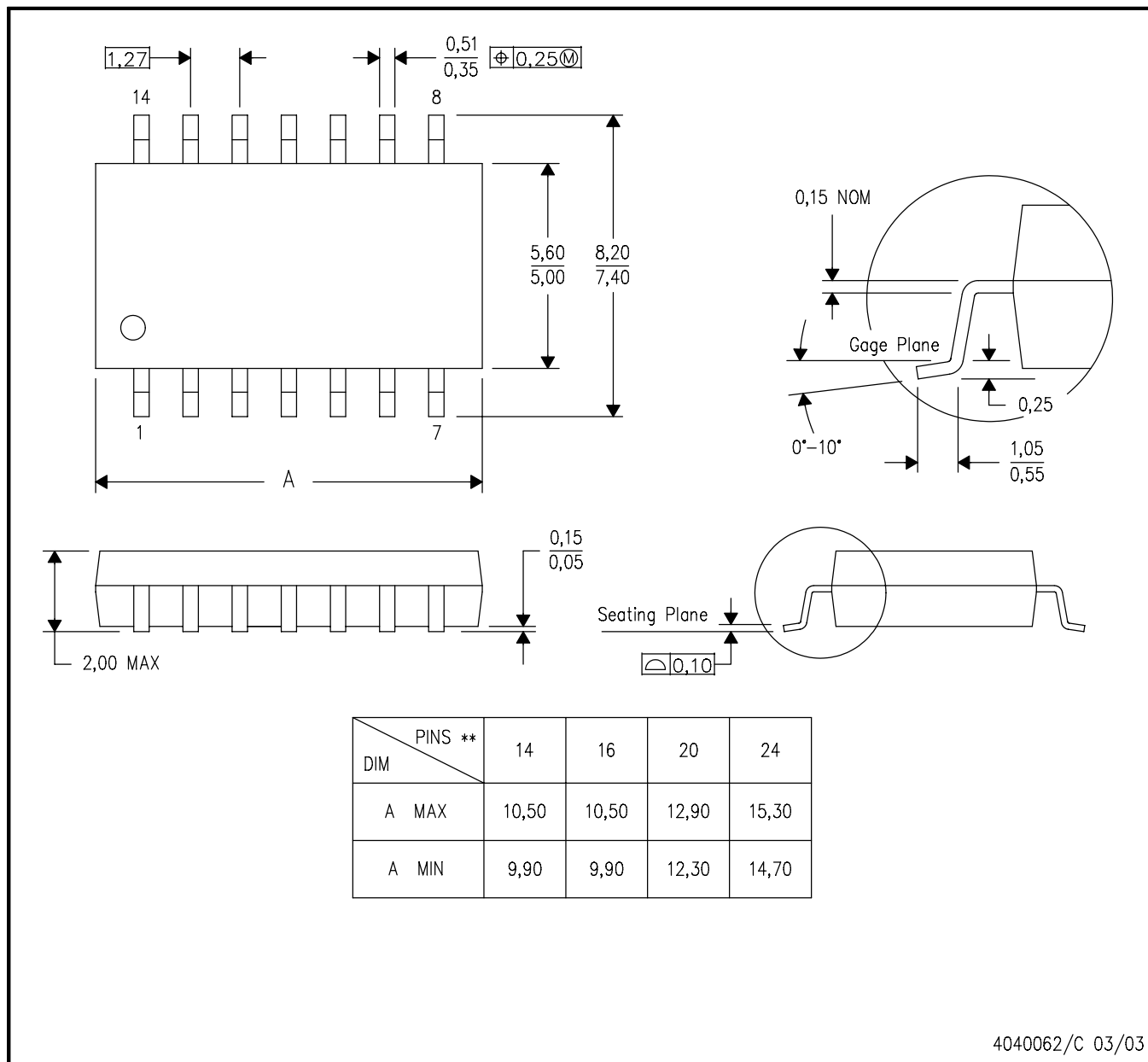
- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
  - $\triangle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

## MECHANICAL DATA

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

**PLASTIC SMALL-OUTLINE PACKAGE**

**14-PINS SHOWN**



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.

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