

## DS26LV31T

### 3V Enhanced CMOS Quad Differential Line Driver

#### General Description

The DS26LV31T is a high-speed quad differential CMOS driver that meets the requirements of both TIA/EIA-422-B and ITU-T V.11. The CMOS DS26LV31T features low static  $I_{CC}$  of 100  $\mu$ A MAX which makes it ideal for battery powered and power conscious applications.

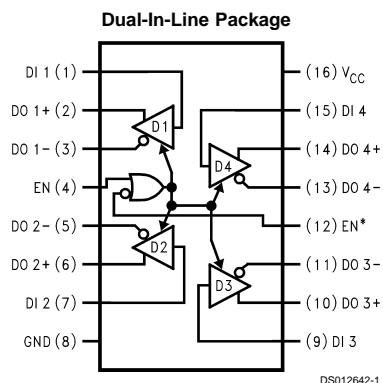
Differential outputs have the same  $V_{OD}$  guarantee ( $\geq 2V$ ) as the 5V version.

The EN and EN\* inputs allow active Low or active High control of the TRI-STATE® outputs. The enables are common to all four drivers. Protection diodes protect all the driver inputs against electrostatic discharge. Outputs have enhanced ESD protection providing greater than 7 kV tolerance. The driver and enable inputs (DI, EN, EN\*) are compatible with low voltage LVTTTL and LVC MOS devices.

#### Features

- Industrial product meets TIA/EIA-422-B (RS-422) and ITU-T V.11 recommendation
- Military product conforms to TIA/EIA-422-B (RS-422)
- Interoperable with existing 5V RS-422 networks
- Industrial and Military temperature range
- Guaranteed  $V_{OD}$  of 2V min over operating conditions
- Balanced output crossover for low EMI (typical within 40 mV of 50% voltage level)
- Low power design (330  $\mu$ W 3.3V static)
- ESD  $\geq 7$  kV on cable I/O pins (HBM)
- Guaranteed AC parameter:
  - Maximum driver skew: 2 ns
  - Maximum transition time: 10 ns
- Pin compatible with DS26C31
- Available in SOIC and Cerpack packaging
- Standard Microcircuit Drawing (SMD) 5962-98584

#### Connection Diagram



Top View

Order Number DS26LV31TM or DS26LV31W  
See NS Package Number M16A or W16A

#### Truth Table

| Enables                                 |     | Input | Outputs |     |
|---|-----|-------|---------|-----|
| EN                                      | EN* | DI    | DO+     | DO- |
| L                                       | H   | X     | Z       | Z   |
| All other combinations of enable inputs |     | L     | L       | H   |
|   |     | H     | H       | L   |

L = Low logic state  
X = Irrelevant  
H = High logic state  
Z = TRI-STATE

## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|   |                          |
|---|--------------------------|
| Supply Voltage ( $V_{CC}$ )             | -0.5V to +7V             |
| Enable Input Voltage (EN, EN*)          | -0.5V to $V_{CC} + 0.5V$ |
| Driver Input Voltage (DI)               | -0.5V to $V_{CC} + 0.5V$ |
| Clamp Diode Current                     | $\pm 20$ mA              |
| DC Output Current, per pin              | $\pm 150$ mA             |
| Driver Output Voltage                   |                          |
| (Power Off: DO+, DO-)                   | -0.5V to +7V             |
| Maximum Package Power Dissipation +25°C |                          |
| M Package                               | 1226 mW                  |
| W Package                               | 1119 mW                  |
| Derate M Package 9.8 mW/°C above +25°C  |                          |
| Derate W Package 7.5 mW/°C above +25°C  |                          |
| Storage Temperature Range               | -65°C to +150°C          |

Lead Temperature Range  
Soldering

(4 sec.)

+260°C

ESD Ratings (HBM, 1.5 k $\Omega$ , 100 pF)

Driver Outputs

$\geq 7$  kV

Other Pins

$\geq 2.5$  kV

## Recommended Operating Conditions

|  | Min | Typ | Max  | Units |
|--|-----|-----|------|-------|
| Supply Voltage ( $V_{CC}$ )                    | 3.0 | 3.3 | 3.6  | V     |
| Operating Free Air Temperature Range ( $T_A$ ) |     |     |      |       |
| DS26LV31T                                      | -40 | +25 | +85  | °C    |
| DS26LV31W                                      | -55 | +25 | +125 | °C    |
| Input Rise and Fall Time                       |     |     | 500  | ns    |

## Electrical Characteristics (Note 2) (Note 3)

Over supply voltage and operating temperature ranges, unless otherwise specified

| Symbol           | Parameter  | Conditions  | Pin      | Min  | Typ       | Max      | Units   |
|------------------|--|---|----------|------|-----------|----------|---------|
| $V_{OD1}$        | Output Differential Voltage                        | $R_L = \infty$ (No Load)                            | DO+,     |      | 3.3       | 4        | V       |
| $V_{OD2}$        | Output Differential Voltage                        | $R_L = 100\Omega$ (Figure 1)                        | DO-      | 2    | 2.6       |          | V       |
| $\Delta V_{OD2}$ | Change in Magnitude of Output Differential Voltage | $I_O \geq 20$ mA                                    |          | -400 | 7         | 400      | mV      |
| $V_{OD3}$        | Output Differential Voltage                        | $R_L = 3900\Omega$ (V.11)<br>Figure 1 (Note 7)      |          |      | 3.2       | 3.6      | V       |
| $V_{OC}$         | Common Mode Voltage                                | $R_L = 100\Omega$ (Figure 1)                        |          |      | 1.5       | 2        | V       |
| $\Delta V_{OC}$  | Change in Magnitude of Common Mode Voltage         |   |          | -400 | 6         | 400      | mV      |
| $I_{OZ}$         | TRI-STATE Leakage Current                          | $V_{OUT} = V_{CC}$ or GND<br>Drivers Disabled       |          |      | $\pm 0.5$ | $\pm 20$ | $\mu$ A |
| $I_{SC}$         | Output Short Circuit Current                       | $V_{OUT} = 0V$<br>$V_{IN} = V_{CC}$ or GND (Note 4) |          | -40  | -70       | -150     | mA      |
|                  |  | $T_A = -40^\circ\text{C}$ to +85°C                  |          |      |           |          |         |
|                  |  | $T_A = -55^\circ\text{C}$ to +125°C (Note 10)       |          | -30  |           | -160     | mA      |
| $I_{OFF}$        | Output Leakage Current                             | $V_{CC} = 0V$ , $V_{OUT} = 3V$ or 6V                |          |      | 0.03      | 100      | $\mu$ A |
|                  |  | $V_{CC} = 0V$ , $V_{OUT} = -0.25V$                  |          |      | -0.08     | -100     | $\mu$ A |
|                  |  | $T_A = -40^\circ\text{C}$ to +85°C                  |          |      |           |          |         |
|                  |  | $T_A = -55^\circ\text{C}$ to +125°C                 |          |      |           | -200     | $\mu$ A |
| $V_{IH}$         | High Level Input Voltage                           |   | DI,      | 2.0  |           | $V_{CC}$ | V       |
| $V_{IL}$         | Low Level Input Voltage                            |   | EN,      | GND  |           | 0.8      | V       |
| $I_{IH}$         | High Level Input Current                           | $V_{IN} = V_{CC}$                                   | EN*      |      |           | 10       | $\mu$ A |
| $I_{IL}$         | Low Level Input Current                            | $V_{IN} = \text{GND}$                               |          | -10  |           |          | $\mu$ A |
| $V_{CL}$         | Input Clamp Voltage                                | $I_{IN} = -18$ mA                                   |          |      |           | -1.5     | V       |
| $I_{CC}$         | Power Supply Current                               | No Load, $V_{IN}$ (all) = $V_{CC}$ or GND           | $V_{CC}$ |      |           | 100      | $\mu$ A |
|                  |  | $T_A = -40^\circ\text{C}$ to +85°C                  |          |      |           |          |         |
|                  |  | $T_A = -55^\circ\text{C}$ to +125°C                 |          |      |           | 125      | $\mu$ A |

## Switching Characteristics - Industrial (Note 5) (Note 6)

Over supply voltage and -40°C to +85°C operating temperature range, unless otherwise specified

| Sym               | Parameter  | Conditions  | Min | Typ  | Max | Units |
|-------------------|--|---|-----|------|-----|-------|
| t <sub>PHLD</sub> | Differential Propagation Delay<br>High to Low                              | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 50 pF<br>(Figures 2, 3) | 6   | 10.5 | 16  | ns    |
| t <sub>PLHD</sub> | Differential Propagation Delay<br>Low to High                              |   | 6   | 11   | 16  | ns    |
| t <sub>SKD</sub>  | Differential Skew (same<br>channel)  t <sub>PHLD</sub> - t <sub>PLHD</sub> |   |     | 0.5  | 2.0 | ns    |
| t <sub>SK1</sub>  | Skew, Pin to Pin<br>(same device)  |   |     | 1.0  | 2.0 | ns    |
| t <sub>SK2</sub>  | Skew, Part to Part (Note 8)  |   |     | 3.0  | 5.0 | ns    |
| t <sub>TLH</sub>  | Differential Transition Time<br>Low to High (20% to 80%)                   |   |     | 4.2  | 10  | ns    |
| t <sub>THL</sub>  | Differential Transition Time<br>High to Low (80% to 20%)                   |   |     | 4.7  | 10  | ns    |
| t <sub>PHZ</sub>  | Disable Time High to Z   | (Figures 4, 5)  |     | 12   | 20  | ns    |
| t <sub>PLZ</sub>  | Disable Time Low to Z  |   |     | 9    | 20  | ns    |
| t <sub>PZH</sub>  | Enable Time Z to High  |   |     | 22   | 32  | ns    |
| t <sub>PZL</sub>  | Enable Time Z to Low   |   |     | 22   | 32  | ns    |
| f <sub>max</sub>  | Maximum Operating<br>Frequency (Note 9)                                    |   | 32  |      |     | MHz   |

## Switching Characteristics - Military (Note 5) (Note 6)

Over supply voltage and -55°C to +125°C operating temperature range, unless otherwise specified

| Sym               | Parameter  | Conditions  | Min | Max | Units |
|-------------------|--|---|-----|-----|-------|
| t <sub>PHLD</sub> | Differential Propagation Delay<br>High to Low                              | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 50 pF<br>(Figures 2, 3) | 5   | 25  | ns    |
| t <sub>PLHD</sub> | Differential Propagation Delay<br>Low to High                              |   | 5   | 25  | ns    |
| t <sub>SKD</sub>  | Differential Skew (same<br>channel)  t <sub>PHLD</sub> - t <sub>PLHD</sub> |   |     | 5.0 | ns    |
| t <sub>SK1</sub>  | Skew, Pin to Pin<br>(same device)  |   |     | 5.0 | ns    |
| t <sub>PHZ</sub>  | Disable Time High to Z   |   |     | 35  | ns    |
| t <sub>PLZ</sub>  | Disable Time Low to Z  | (Figures 4, 5)  |     | 35  | ns    |
| t <sub>PZH</sub>  | Enable Time Z to High  |   |     | 40  | ns    |
| t <sub>PZL</sub>  | Enable Time Z to Low   |   |     | 40  | ns    |

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" specifies conditions of device operation.

**Note 2:** Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except differential voltages V<sub>OD1</sub>, V<sub>OD2</sub>, V<sub>OD3</sub>.

**Note 3:** All typicals are given for V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C.

**Note 4:** Only one output shorted at a time. The output (true or complement) is configured High.

**Note 5:** f = 1 MHz, t<sub>r</sub> and t<sub>f</sub> ≤ 6 ns, 10% to 90%.

**Note 6:** See TIA/EIA-422-B specifications for exact test conditions.

**Note 7:** This specification limit is for compliance with TIA/EIA-422-B and ITU-T V.11.

**Note 8:** Devices are at the same V<sub>CC</sub> and within 5°C within the operating temperature range

**Note 9:** All channels switching, output duty cycle criteria is 40%/60% measured at 50%. This parameter is guaranteed by design and characterization.

**Note 10:** This parameter does not meet the TIA/EIA-422-B specification.

## Parameter Measurement Information

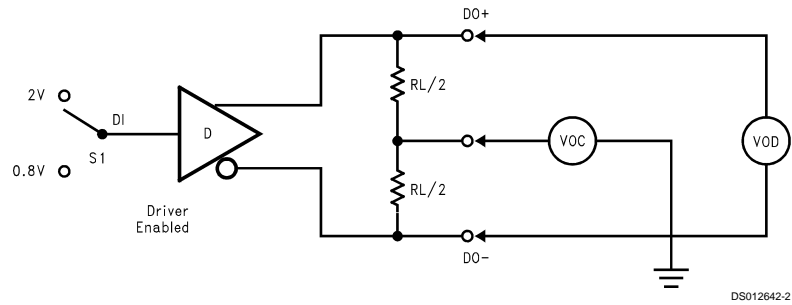


FIGURE 1. Differential Driver DC Test Circuit

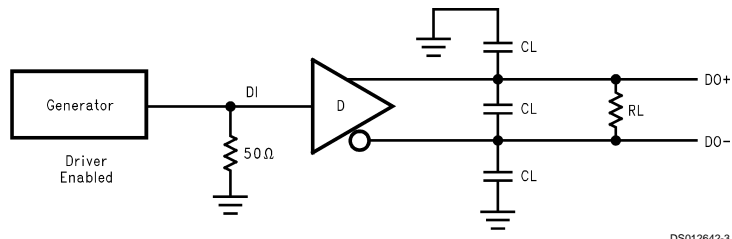


FIGURE 2. Differential Driver Propagation Delay and Transition Time Test Circuit

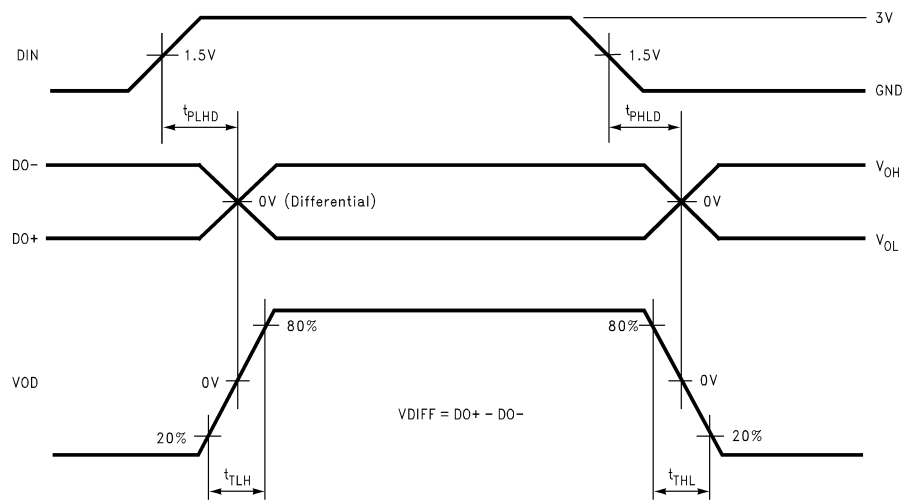
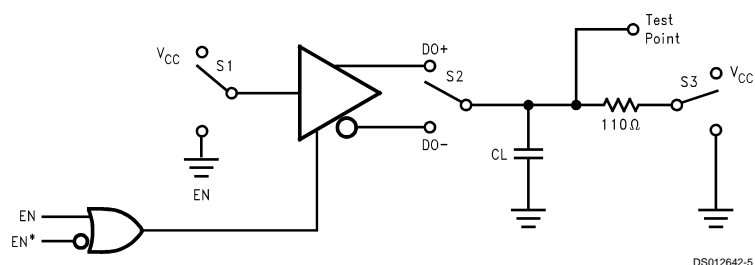


FIGURE 3. Differential Driver Propagation Delay and Transition Time Waveforms

**Note 11:** Generator waveform for all tests unless otherwise specified:  $f = 1 \text{ MHz}$ , Duty Cycle = 50%  $Z_0 = 50\Omega$ ,  $t_r \leq 10 \text{ ns}$ ,  $t_f \leq 10$ .

**Note 12:**  $C_L$  includes probe and fixture capacitance.

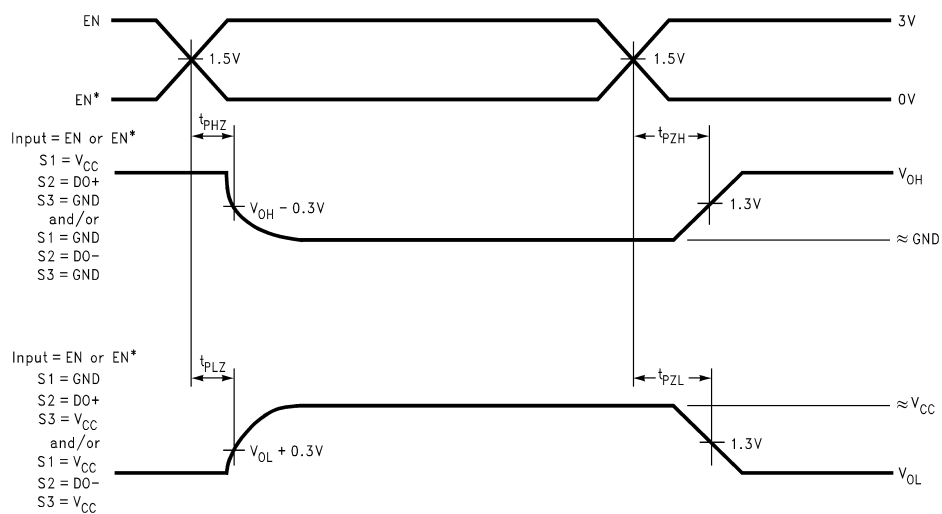
## Parameter Measurement Information (Continued)



DS012642-5

If EN is the input, then EN\* = High  
If EN\* is the input, then EN = Low

**FIGURE 4. Driver Single-Ended TRI-STATE Test Circuit**



DS012642-6

**FIGURE 5. Driver Single-Ended TRI-STATE Waveforms**

## Typical Application Information

General application guidelines and hints for differential drivers and receivers may be found in the following application notes:

AN-214, AN-457, AN-805, AN-847, AN-903, AN-912, AN-916.

### Power Decoupling Recommendations:

Bypass caps must be used on power pins. High frequency ceramic (surface mount is recommended) 0.1  $\mu\text{F}$  in parallel with 0.01  $\mu\text{F}$  at the power supply pin. A 10  $\mu\text{F}$  or greater solid tantalum or electrolytic should be connected at the power entry point on the printed circuit board.

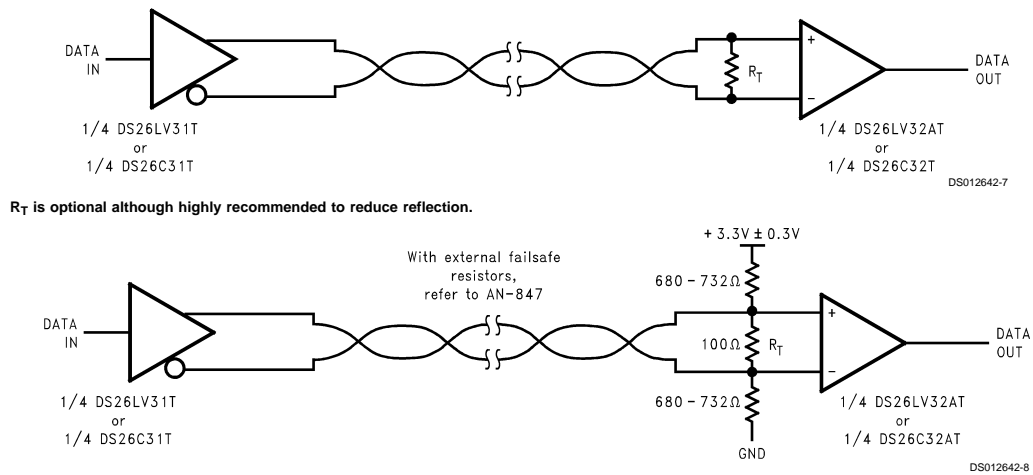


FIGURE 6. Typical Driver Connection

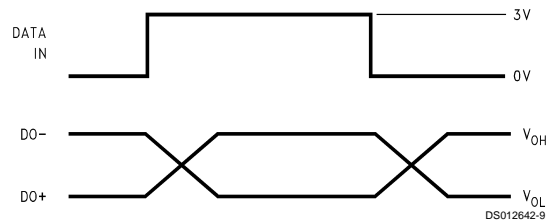
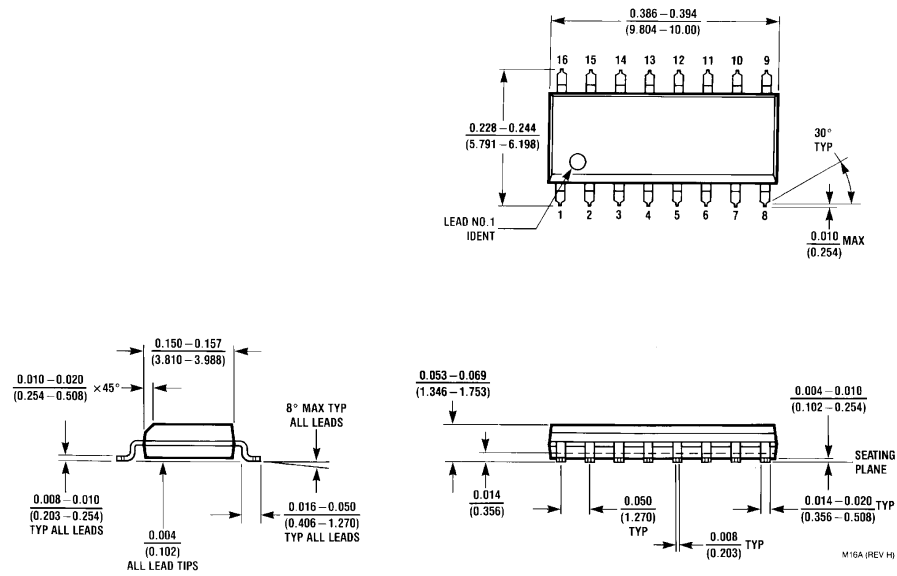


FIGURE 7. Typical Driver Output Waveforms

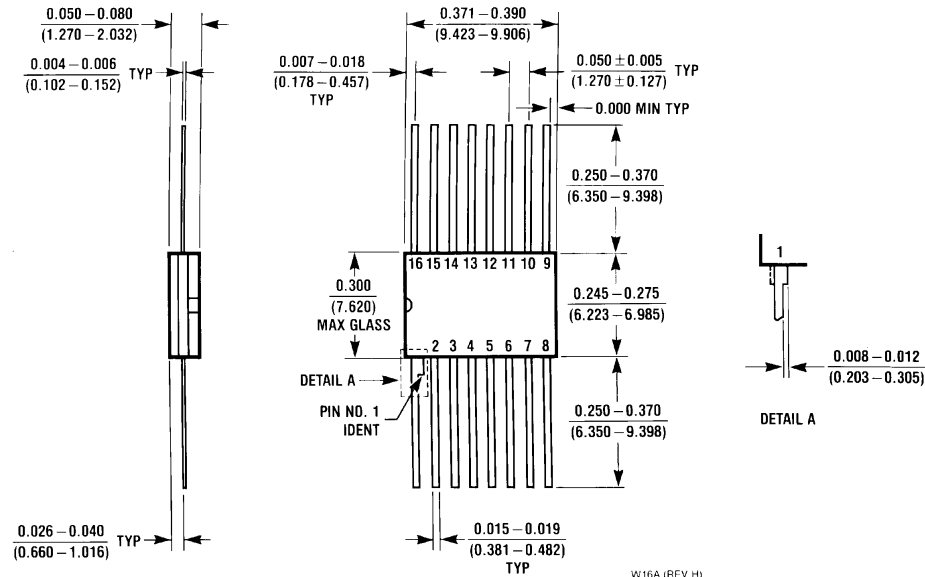
**Physical Dimensions** inches (millimeters) unless otherwise noted



**16-Lead Molded Small Outline Package (M)**  
**Order Number DS26LV31TM**  
**NS Package Number M16A**

M16A (REV H)

# Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**16-Lead Ceramic Flatpack (W)**  
**Order Number DS26LV31W**  
**NS Package Number W16A**

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