

## Description

The 74LVC244A provides two 4-bit line drivers with separate output-enable ( $\overline{OE}$ ) inputs. When  $\overline{OE}$  is low, the device passes data from the A inputs to the Y outputs. When  $\overline{OE}$  is high, the outputs are in the high-impedance state.

The device is designed for operation with a power supply range of 1.65V to 3.6V.

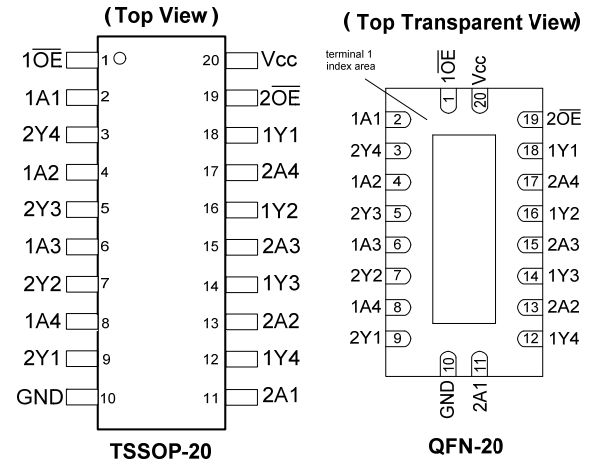
The inputs are tolerant to 5.5V allowing this device to be used in a mixed voltage environment. The device is fully specified for partial power down applications using  $I_{OFF}$ . The  $I_{OFF}$  circuitry disables the output preventing damaging current backflow when the device is powered down.

## Features

- Supply Voltage Range from 1.65V to 3.6V
- Sinks or Sources 24ma at  $V_{CC} = 3V$
- CMOS Low Power Consumption
- $I_{OFF}$  Supports Partial - Power Down Operation
- Inputs or Outputs Accept up to 5.5V
- Inputs can be Driven by 3.3V or 5V Allowing for Mixed Voltage Applications
- Schmitt Trigger Action at All Inputs
- Typical  $V_{OLP}$  (Quiet Output Ground Bounce) Less than 0.8V with  $V_{CC} = 3.3V$  and  $T_A = +25^\circ C$
- Typical  $V_{OHV}$  (Quiet Output Dynamic VOH) Greater than 2.0V with  $V_{CC} = 3.3V$  and  $T_A = +25^\circ C$
- ESD Protection Tested per JESD 22
  - Exceeds 200-V Machine Model (A115)
  - Exceeds 2000-V Human Body Model (A114)
  - Exceeds 1000-V Charged Device Model (C101)
- Latch-Up Exceeds 250mA per JESD 78, Class I
- All devices are:
  - **Totally Lead-Free & Fully RoHS compliant (Notes 1 & 2)**
  - **Halogen and Antimony Free. "Green" Device (Note 3)**

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.  
 2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen and Antimony free, "Green" and Lead-Free.  
 3. Halogen and Antimony free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

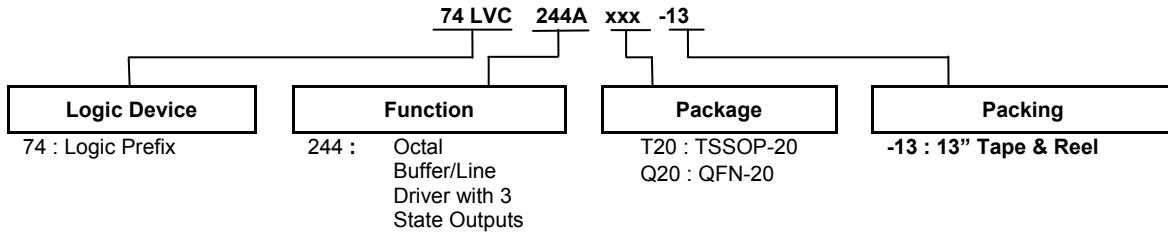
## Pin Assignments



## Applications

- General Purpose Logic
- Bus Driving
- Power Down Signal Isolation
- Wide array of products such as:
  - PCs, Notebooks, Netbooks, Ultrabooks
  - Networking Computer Peripherals, Hard Drives, CD/DVD ROM
  - TV, DVD, DVR, Set Top Box

## Ordering Information



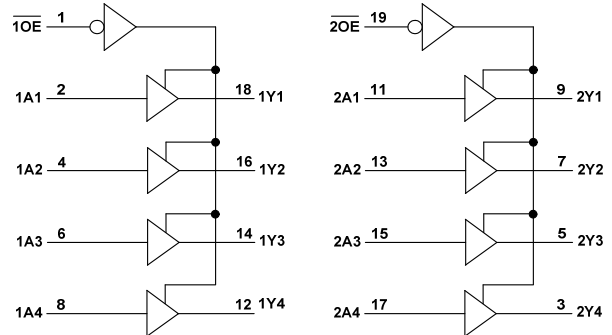
| Part Number     | Package Code | Package (Note 4 & 5) | Package Size                                 | 13" Tape and Reel |                    |
|-----------------|--------------|----------------------|--|-------------------|--------------------|
|                 |              |                      |  | Quantity          | Part Number Suffix |
| 74LVC244AT20-13 | T20          | TSSOP-20             | 6.4mm X 6.5mm X 1.2mm<br>0.65 mm lead pitch  | 2500/Tape & Reel  | -13                |
| 74LVC244AQ20-13 | Q20          | V-QFN4525-20         | 2.5mm X 4.5mm X 0.95mm<br>0.50 mm lead pitch | 2500/Tape & Reel  | -13                |

- Notes:
4. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.
  5. V-QFN4525-20 is a JEDEC recognized naming convention that specifies the package thickness category as V and the number 4525 describes the package as 4.5mm X 2.5mm.

## Pin Descriptions

| Pin Number | Pin Name         | Description     |
|------------|------------------|-----------------|
| 1          | $\overline{1OE}$ | Output Enable 1 |
| 2          | 1A1              | Data Input      |
| 3          | 2Y4              | Data Output     |
| 4          | 1A2              | Data Input      |
| 5          | 2Y3              | Data Output     |
| 6          | 1A3              | Data Input      |
| 7          | 2Y2              | Data Output     |
| 8          | 1A4              | Data Input      |
| 9          | 2Y1              | Data Output     |
| 10         | GND              | Ground          |
| 11         | 2A1              | Data Input      |
| 12         | 1Y4              | Data Output     |
| 13         | 2A2              | Data Input      |
| 14         | 1Y3              | Data Output     |
| 15         | 2A3              | Data Input      |
| 16         | 1Y2              | Data Output     |
| 17         | 2A4              | Data Input      |
| 18         | 1Y1              | Data Output     |
| 19         | $\overline{2OE}$ | Output Enable 2 |
| 20         | V <sub>CC</sub>  | Supply Voltage  |

## Logic Diagram



## Function Table

| (Each 4-Bit Buffer) |   |        |
|---------------------|---|--------|
| INPUTS              |   | OUTPUT |
| $\overline{OE}$     | A | Y      |
| L                   | H | H      |
| L                   | L | L      |
| H                   | X | Z      |

**Absolute Maximum Ratings** (Notes 6 & 7)

| Symbol           | Description  | Rating       | Unit |
|------------------|--|--------------|------|
| ESD HBM          | Human Body Model ESD Protection  | 2            | kV   |
| ESD CDM          | Charged Device Model ESD Protection                                    | 1            | kV   |
| ESD MM           | Machine Model ESD Protection   | 200          | V    |
| V <sub>CC</sub>  | Supply Voltage Range   | -0.5 to +7.0 | V    |
| V <sub>I</sub>   | Input Voltage Range  | -0.5 to +7.0 | V    |
| I <sub>IK</sub>  | Input Clamp Current V <sub>I</sub> < 0V                                | -20          | mA   |
| I <sub>OK</sub>  | Output Clamp Current V <sub>O</sub> < 0V                               | -50          | mA   |
| I <sub>O</sub>   | Continuous Output Current -0.5V < V <sub>O</sub> V <sub>CC</sub> +0.5V | ±50          | mA   |
| I <sub>CC</sub>  | Continuous Current Through V <sub>CC</sub>                             | 100          | mA   |
| I <sub>GND</sub> | Continuous Current Through GND   | -100         | mA   |
| T <sub>J</sub>   | Operating Junction Temperature   | -40 to +150  | °C   |
| T <sub>STG</sub> | Storage Temperature  | -65 to +150  | °C   |
| P <sub>TOT</sub> | Total Power Dissipation  | 500          | mW   |

- Notes:
- Stresses beyond the absolute maximum may result in immediate failure or reduced reliability. These are stress values and device operation should be within recommend values.
  - Forcing the maximum allowed voltage could cause a condition exceeding the maximum current or conversely forcing the maximum current could cause a condition exceeding the maximum voltage. The ratings of both current and voltage must be maintained within the controlled range.

**Recommended Operating Conditions** (Note 8)

| Symbol          | Parameter                          | Conditions              | Min  | Max             | Unit |
|-----------------|------------------------------------|-------------------------|------|-----------------|------|
| V <sub>CC</sub> | Supply Voltage                     | Operating               | 1.65 | 3.6             | V    |
|                 |                                    | Data Retention Only     | 1.5  | —               | V    |
| V <sub>I</sub>  | Input Voltage                      | —                       | 0    | 5.5             | V    |
| V <sub>O</sub>  | Output Voltage                     | —                       | 0    | V <sub>CC</sub> | V    |
| I <sub>OH</sub> | High-Level Output Current          | V <sub>CC</sub> = 1.65V | —    | -4              | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3V  | —    | -8              |      |
|                 |                                    | V <sub>CC</sub> = 2.7V  | —    | -12             |      |
|                 |                                    | V <sub>CC</sub> = 3.0V  | —    | -24             |      |
| I <sub>OL</sub> | Low-Level Output Current           | V <sub>CC</sub> = 1.65V | —    | 4               | mA   |
|                 |                                    | V <sub>CC</sub> = 2.3V  | —    | 8               |      |
|                 |                                    | V <sub>CC</sub> = 2.7V  | —    | 12              |      |
|                 |                                    | V <sub>CC</sub> = 3.0V  | —    | 24              |      |
| Δt/ΔV           | Input Transition Rise or Fall Rate | —                       | —    | 10              | ns/V |
| T <sub>A</sub>  | Operating Free-Air Temperature     | —                       | -40  | +125            | °C   |

- Note: 8. Unused inputs should be held at V<sub>CC</sub> or ground.

**Electrical Characteristics**

| Symbol           | Parameter  | Test Conditions  | V <sub>CC</sub>                         | T <sub>A</sub> = -40°C to +85°C |                        | T <sub>A</sub> = -40° to +125°C |                        | Unit |    |
|------------------|--|--|---|---------------------------------|------------------------|---------------------------------|------------------------|------|----|
|                  |  |  |   | Min                             | Max                    | Min                             | Max                    |      |    |
| V <sub>IH</sub>  | High-Level Input Voltage                         |  | 1.65V to 1.95V                          | V <sub>CC</sub> X 0.65          | —                      | V <sub>CC</sub> X 0.65          | —                      | V    |    |
|                  |  |  | 2.3V to 2.7V                            | 1.7                             | —                      | 1.7                             | —                      |      |    |
|                  |  |  | 3.0V to 3.6V                            | 2                               | —                      | 2                               | —                      |      |    |
| V <sub>IL</sub>  | Low-Level input Voltage                          |  | 1.65V to 1.95V                          | —                               | V <sub>CC</sub> X 0.35 | —                               | V <sub>CC</sub> X 0.35 | V    |    |
|                  |  |  | 2.3V to 2.7V                            | —                               | 0.7                    | —                               | 0.7                    |      |    |
|                  |  |  | 3.0V to 3.6V                            | —                               | 0.8                    | —                               | 0.8                    |      |    |
| V <sub>OH</sub>  | High-Level Output Voltage                        | I <sub>OH</sub> = -50μA                                      | 1.65V to 3.6V                           | V <sub>CC</sub> -0.2            | —                      | V <sub>CC</sub> -0.3            | —                      | V    |    |
|                  |  | I <sub>OH</sub> = -4mA                                       | 1.65V                                   | 1.2                             | —                      | 1.05                            | —                      |      |    |
|                  |  | I <sub>OH</sub> = -8mA                                       | 2.3V                                    | 1.7                             | —                      | 1.65                            | —                      |      |    |
|                  |  | I <sub>OH</sub> = -12mA                                      | 2.7V                                    | 2.2                             | —                      | 2.05                            | —                      |      |    |
|                  |  |  | 3.0V                                    | 2.4                             | —                      | 2.48                            | —                      |      |    |
|                  |  | I <sub>OH</sub> = -24mA                                      | 3.0V                                    | 2.3                             | —                      | 2.0                             | —                      |      |    |
| V <sub>OL</sub>  | Low-Level Output Voltage                         | I <sub>OL</sub> = 100μA                                      | 1.65V to 3.6V                           | —                               | 0.2                    | —                               | 0.3                    | V    |    |
|                  |  | I <sub>OL</sub> = 4mA  | 1.65V                                   | —                               | 0.45                   | —                               | 0.65                   |      |    |
|                  |  | I <sub>OL</sub> = 8mA  | 2.3V                                    | —                               | 0.60                   | —                               | 0.80                   |      |    |
|                  |  | I <sub>OL</sub> = 12mA                                       | 2.7V                                    | —                               | 0.40                   | —                               | 0.60                   |      |    |
|                  |  | I <sub>OL</sub> = 24mA                                       | 3.0V                                    | —                               | 0.55                   | —                               | 0.80                   |      |    |
| I <sub>OFF</sub> | Power Down Leakage Current                       | V <sub>I</sub> or V <sub>O</sub> = 0 or 5.5V                 | 0V                                      | —                               | ±10                    | —                               | 20                     | μA   |    |
| I <sub>I</sub>   | Input Current Control Pins                       | V <sub>I</sub> = GND or 5.5V                                 | 0 to 3.6V                               | —                               | ±5                     | —                               | ± 20                   | μA   |    |
| I <sub>OZ</sub>  | Z-state Current including Input Current I/O Pins | V <sub>I</sub> = GND or 5.5V<br>V <sub>O</sub> = 0 to 5.5V   | 3.6V                                    | —                               | ±5                     | —                               | ± 20                   | μA   |    |
| I <sub>CC</sub>  | Supply Current                                   | V <sub>I</sub> = GND or V <sub>CC</sub> , I <sub>O</sub> = 0 | 3.6V                                    | —                               | 10                     | —                               | 40                     | μA   |    |
| ΔI <sub>CC</sub> | Additional Supply Current                        | One input at V <sub>CC</sub> -0.6V, I <sub>O</sub> = 0A      | 2.7V to 3.6V                            | —                               | 500                    | —                               | 5000                   | μA   |    |
| C <sub>i</sub>   | Input Capacitance                                | Control Pins   | V <sub>I</sub> = GND or V <sub>CC</sub> | 0V to 3.6V                      | 4.0 typical            |                                 | 4.0 typical            |      | pF |
|                  |  | I/O Pins   |   |                                 | 5.5 typical            |                                 | 5.5 typical            |      |    |

**NEW PRODUCT**

### Switching Characteristics

| Symbol             | Parameter  | Test Conditions | V <sub>CC</sub> | T <sub>A</sub> = +25°C |      |      | T <sub>A</sub> = -40° to +85°C |      | T <sub>A</sub> = -40° to +125°C |      | Unit |
|--------------------|--|-----------------|-----------------|------------------------|------|------|--------------------------------|------|---------------------------------|------|------|
|                    |  |                 |                 | Min                    | Typ  | Max  | Min                            | Max  | Min                             | Max  |      |
| t <sub>PD</sub>    | Propagation Delay A <sub>N</sub> to Y <sub>N</sub> | Figure 1        | 1.5V            | 1                      | 7    | 16.9 | 1                              | 18.9 | 1                               | 20.4 | ns   |
|                    |  |                 | 1.8V ± 0.15V    | 1                      | 6.0  | 11.4 | 1                              | 11.3 | 1                               | 12.4 |      |
|                    |  |                 | 2.5V ± 0.2V     | 1                      | 3.9  | 7.4  | 1                              | 8.0  | 1                               | 10.0 |      |
|                    |  |                 | 2.7V            | 1                      | 4.2  | 7.7  | 1                              | 8.5  | 1                               | 8.8  |      |
|                    |  |                 | 3.3V ± 0.3      | 1.5                    | 3.8  | 7.3  | 1.5                            | 7.7  | 1.5                             | 7.9  |      |
| t <sub>EN</sub>    | Enable Time $\overline{OE}$ to Y <sub>N</sub>      | Figure 1        | 1.5V            | 1                      | 12.4 | 18.3 | 1                              | 19.8 | 1                               | 25.4 | ns   |
|                    |  |                 | 1.8V ± 0.15V    | 1                      | 6.4  | 12.1 | 1                              | 12.6 | 1                               | 14.1 |      |
|                    |  |                 | 2.5V ± 0.2V     | 1                      | 4.6  | 9.1  | 1                              | 9.6  | 1                               | 11.7 |      |
|                    |  |                 | 2.7V            | 1                      | 5    | 8.4  | 1                              | 8.6  | 1                               | 10.3 |      |
|                    |  |                 | 3.3V ± 0.3      | 1.5                    | 4.5  | 7.4  | 1.5                            | 7.6  | 1.5                             | 9.4  |      |
| t <sub>DIS</sub>   | Disable Time $\overline{OE}$ to Y <sub>N</sub>     | Figure 1        | 1.5V            | 1                      | 7.2  | 15.6 | 1                              | 16.1 | 1                               | 17.6 | ns   |
|                    |  |                 | 1.8V ± 0.15V    | 1                      | 5.8  | 11.6 | 1                              | 12.1 | 1                               | 13.6 |      |
|                    |  |                 | 2.5V ± 0.2V     | 1                      | 3.7  | 7.3  | 1                              | 7.8  | 1                               | 9.9  |      |
|                    |  |                 | 2.7V            | 1                      | 3.8  | 6.6  | 1                              | 6.8  | 1                               | 8.6  |      |
|                    |  |                 | 3.3V ± 0.3      | 1.5                    | 3.8  | 6.3  | 1.5                            | 6.5  | 1.5                             | 8    |      |
| t <sub>sk(0)</sub> | Output Skew Time                                   |                 | 3.3V ± 0.3      | —                      | —    | 1.0  | —                              | —    | —                               | 1.5  | ns   |

### Operating Characteristics

 T<sub>A</sub> = +25°C

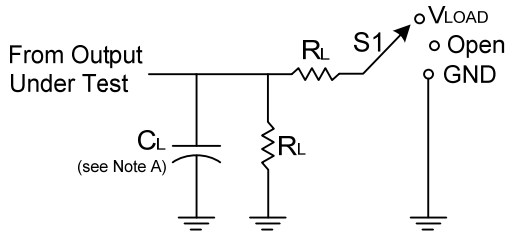
| Symbol          | Parameter                              | Test Conditions               | V <sub>CC</sub> | Typ  | Unit |
|-----------------|--|-------------------------------|-----------------|------|------|
| C <sub>pd</sub> | Power dissipation capacitance per gate | F = 10 MHz<br>Outputs Enabled | 1.8V ± 0.15V    | 9.9  | pF   |
|                 |  |                               | 2.5V ± 0.2V     | 10.2 |      |
|                 |  |                               | 3.3V ± 0.3V     | 10.6 |      |

### Package Characteristics

| Symbol          | Parameter                              | Package      | Test Conditions | Min | Typ | Max | Unit |
|-----------------|--|--------------|-----------------|-----|-----|-----|------|
| θ <sub>JA</sub> | Thermal Resistance Junction-to-Ambient | TSSOP-20     | (Note 9)        | —   | 74  | —   | °C/W |
| θ <sub>JC</sub> | Thermal Resistance Junction-to-Case    | TSSOP-20     | (Note 9)        | —   | 15  | —   | °C/W |
| θ <sub>JA</sub> | Thermal Resistance Junction-to-Ambient | V-QFN4525-20 | (Note 9)        | —   | 67  | —   | °C/W |
| θ <sub>JC</sub> | Thermal Resistance Junction-to-Case    | V-QFN4525-20 | (Note 9)        | —   | 20  | —   | °C/W |

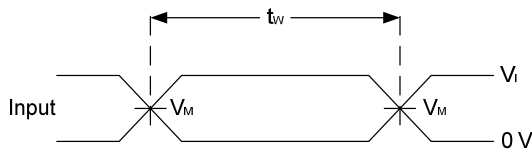
Note: 9. Test conditions for TSSOP-20 and V-QFN4525-20: Devices mounted on 4 layer FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout per JESD 51-7.

**Parameter Measurement Information**

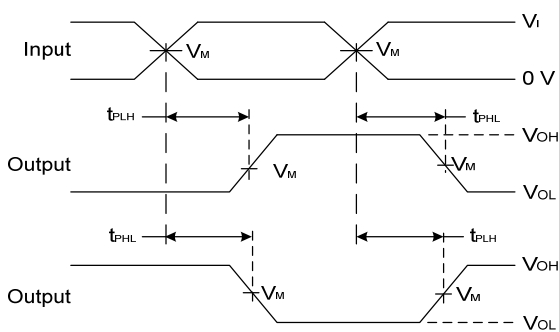


| TEST              | S1         |
|-------------------|------------|
| $t_{PLH}/t_{PHL}$ | Open       |
| $t_{PLZ}/t_{PZL}$ | $V_{LOAD}$ |
| $t_{PHZ}/t_{PZH}$ | GND        |

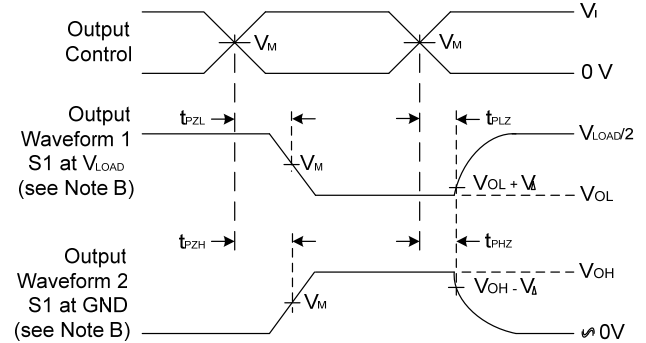
| $V_{CC}$         | Inputs   |              | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|------------------|----------|--------------|------------|-------------------|-------|--------------|--------------|
|                  | $V_I$    | $t_r/t_f$    |            |                   |       |              |              |
| $1.8V \pm 0.15V$ | $V_{CC}$ | $\leq 2ns$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30pF  | 1K $\Omega$  | 0.15V        |
| $2.5V \pm 0.2V$  | $V_{CC}$ | $\leq 2ns$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 30pF  | 500 $\Omega$ | 0.15V        |
| 2.7V             | 2.7V     | $\leq 2.5ns$ | 1.5V       | 6V                | 50pF  | 500 $\Omega$ | 0.3V         |
| $3.3V \pm 0.3V$  | 2.7V     | $\leq 2.5ns$ | 1.5V       | 6V                | 50pF  | 500 $\Omega$ | 0.3V         |



**Voltage Waveform Pulse Duration**



**Voltage Waveform Propagation Delay Times  
Inverting and Non Inverting Outputs**



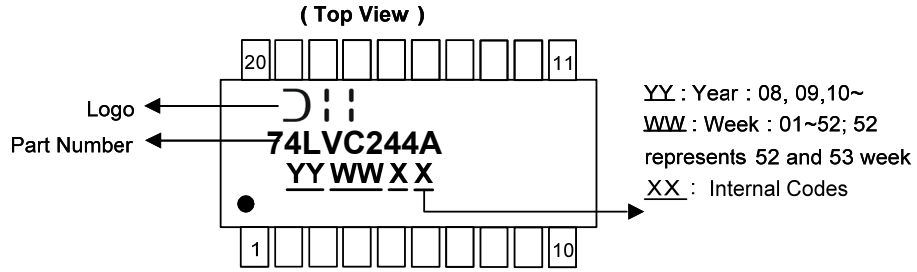
**Voltage Waveform Enable and Disable Times  
Low and High Level Enabling**

- Notes:
- A. Includes test lead and test apparatus capacitance.
  - B. All pulses are supplied at pulse repetition rate  $\leq 10$  MHz.
  - C. Inputs are measured separately one transition per measurement.
  - D.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - E.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{ENO}$ .
  - F.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{PD}$ .

**Figure 1 Load Circuit and Voltage Waveforms**

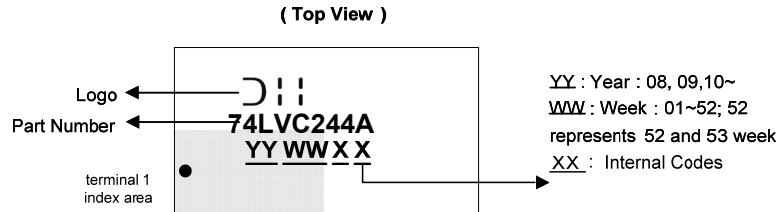
**Marking Information**

(1) TSSOP20



| Part Number  | Package  |
|--------------|----------|
| 74LVC244AT20 | TSSOP-20 |

(2) QFN-20 (V-QFN4525-20)



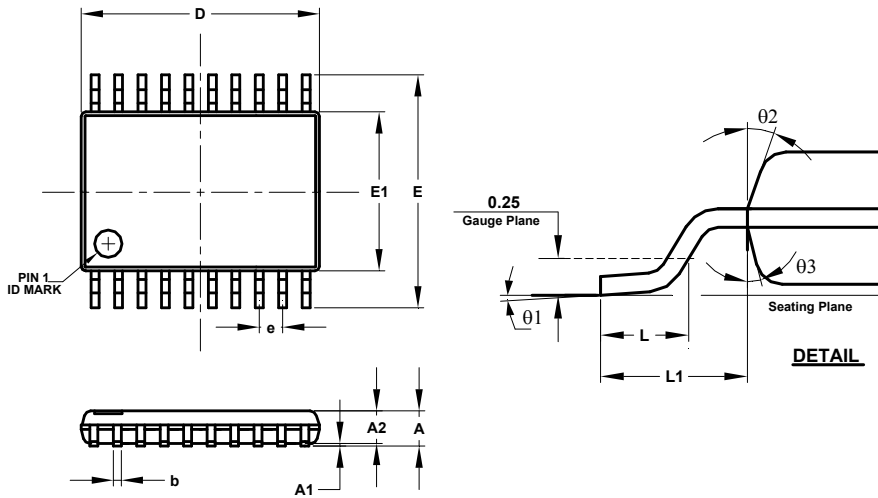
| Part Number  | Package      |
|--------------|--------------|
| 74LVC244AQ20 | V-QFN4525-20 |

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**Package Outline Dimensions (All Dimensions in mm)**

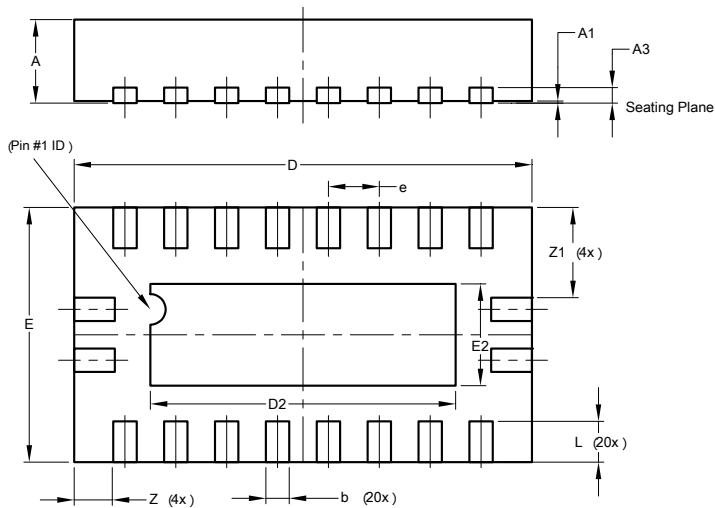
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

(1) TSSOP-20



| TSSOP-20             |          |      |      |
|----------------------|----------|------|------|
| Dim                  | Min      | Max  | Typ  |
| A                    | -        | 1.20 | -    |
| A1                   | 0.05     | 0.15 | -    |
| A2                   | 0.80     | 1.05 | -    |
| b                    | 0.19     | 0.30 | -    |
| c                    | 0.09     | 0.20 | -    |
| D                    | 6.40     | 6.60 | 6.50 |
| E                    | 6.20     | 6.60 | 6.40 |
| E1                   | 4.30     | 4.50 | 4.40 |
| e                    | 0.65 BSC |      |      |
| L                    | 0.45     | 0.75 | 0.60 |
| L1                   | 1.0 REF  |      |      |
| theta1               | 0°       | 8°   | -    |
| theta2               | 10°      | 14°  | 12°  |
| theta3               | 10°      | 14°  | 12°  |
| All Dimensions in mm |          |      |      |

(2) QFN-20 (V-QFN4525-20)



| V-QFN4525-20         |         |      |       |
|----------------------|---------|------|-------|
| Dim                  | Min     | Max  | Typ   |
| A                    | 0.75    | 0.85 | 0.80  |
| A1                   | 0.00    | 0.05 | 0.02  |
| A3                   | -       | -    | 0.15  |
| b                    | 0.18    | 0.30 | 0.23  |
| D                    | 4.45    | 4.55 | 4.50  |
| D2                   | 2.85    | 3.15 | 3.00  |
| E                    | 2.45    | 2.55 | 2.50  |
| E2                   | 0.85    | 1.15 | 1.00  |
| e                    | 0.50BSC |      |       |
| L                    | 0.30    | 0.50 | 0.40  |
| Z                    | -       | -    | 0.385 |
| Z1                   | -       | -    | 0.885 |
| All Dimensions in mm |         |      |       |





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