

## Description

The 74LVC245A is an octal transceiver designed for asynchronous communication between data buses. The device transmits data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ( $\overline{OE}$ ) pin can be used to disable the device so the buses effectively are isolated.

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.

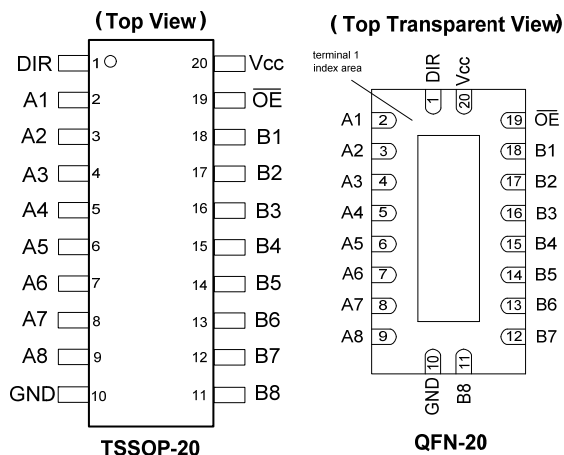
## Features

- 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.

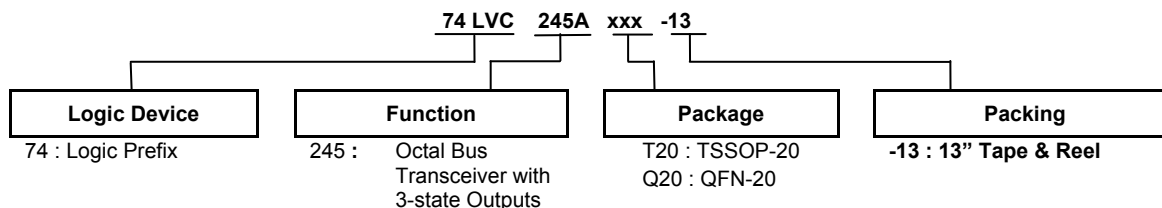
## Pin Assignments



## 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 |
| 74LVC245AT20-13 | T20          | TSSOP-20             | 6.4mm X 6.5mm X 1.2mm<br>0.65 mm lead pitch  | 2500/Tape & Reel  | -13                |
| 74LVC245AQ20-13 | Q20          | V-QFN4525-20         | 2.5mm X 4.5mm X 0.95mm<br>0.50 mm lead pitch | 2500/Tape & Reel  | -13                |

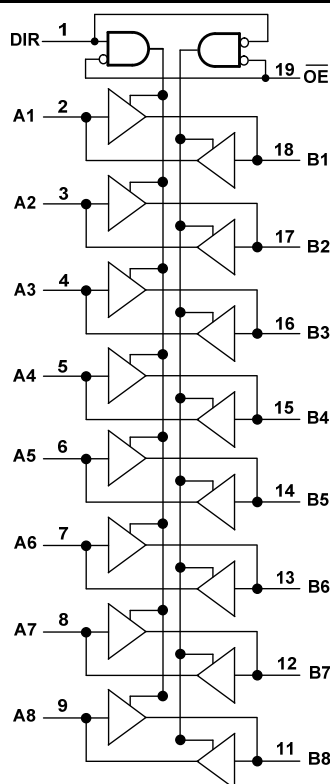
Notes:

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          | DIR      | 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         | 2OE      | Output Enable 2 |
| 20         | Vcc      | Supply Voltage  |

## Logic Diagram



## Function Table

| INPUTS |     | Operation       |
|--------|-----|-----------------|
| OE     | DIR |                 |
| L      | L   | B Data to A Bus |
| L      | H   | A Data to B Bus |
| H      | X   | Bus Isolation   |

**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    |
| $V_{CC}$  | Supply Voltage Range                                    | -0.5 to +7.0 | V    |
| $V_I$     | Input Voltage Range note 3                              | -0.5 to +7.0 | V    |
| $I_{IK}$  | Input Clamp Current $V_I < 0V$                          | -20          | mA   |
| $I_{OK}$  | Output Clamp Current $V_O < 0V$                         | -50          | mA   |
| $I_O$     | Continuous Output Current $-0.5V < V_O < V_{CC} + 0.5V$ | $\pm 50$     | mA   |
| $I_{CC}$  | Continuous Current Through $V_{CC}$                     | 100          | mA   |
| $I_{GND}$ | Continuous Current Through GND                          | -100         | mA   |
| $T_J$     | Operating Junction Temperature                          | -40 to +150  | °C   |
| $T_{STG}$ | Storage Temperature                                     | -65 to +150  | °C   |
| $P_{TOT}$ | 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 |
|---------------------|------------------------------------|---------------------|------|----------|------|
| $V_{CC}$            | Supply Voltage                     | Operating           | 1.65 | 3.6      | V    |
|                     |                                    | Data Retention Only | 1.5  | —        | V    |
| $V_I$               | Input Voltage                      | —                   | 0    | 5.5      | V    |
| $V_O$               | Output Voltage                     | —                   | 0    | $V_{CC}$ | V    |
| $I_{OH}$            | High-Level Output Current          | $V_{CC} = 1.65V$    | —    | -4       | mA   |
|                     |                                    | $V_{CC} = 2.3V$     | —    | -8       |      |
|                     |                                    | $V_{CC} = 2.7V$     | —    | -12      |      |
|                     |                                    | $V_{CC} = 3.0V$     | —    | -24      |      |
| $I_{OL}$            | Low-Level Output Current           | $V_{CC} = 1.65V$    | —    | 4        | mA   |
|                     |                                    | $V_{CC} = 2.3V$     | —    | 8        |      |
|                     |                                    | $V_{CC} = 2.7V$     | —    | 12       |      |
|                     |                                    | $V_{CC} = 3.0V$     | —    | 24       |      |
| $\Delta t/\Delta V$ | Input Transition Rise or Fall Rate | —                   | —    | 10       | ns/V |
| $T_A$               | Operating Free-Air Temperature     | —                   | -40  | +125     | °C   |

- Note:
- Unused inputs should be held at  $V_{CC}$  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°C 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<br>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                      |     |      |

## Switching Characteristics

| Symbol             | Parameter                                                                                         | Test Conditions | V <sub>CC</sub> | T <sub>A</sub> = +25°C |     |      | T <sub>A</sub> = -40°C to +85°C |      | T <sub>A</sub> = -40°C to +125°C |      | Unit |
|--------------------|---------------------------------------------------------------------------------------------------|-----------------|-----------------|------------------------|-----|------|---------------------------------|------|----------------------------------|------|------|
|                    |                                                                                                   |                 |                 | Min                    | Ty  | Max  | Min                             | Max  | Min                              | Max  |      |
| t <sub>PD</sub>    | Propagation Delay A <sub>N</sub> to B <sub>N</sub> or B <sub>N</sub> to A <sub>N</sub>            | Figure 1        | 1.8V ± 0.15V    | 1                      | 6.0 | 12.2 | 1                               | 12.7 | 1                                | 16.9 | ns   |
|                    |                                                                                                   |                 | 2.5V ± 0.2V     | 1                      | 3.9 | 8.1  | 1                               | 8.5  | 1                                | 9.1  |      |
|                    |                                                                                                   |                 | 2.7V            | 1                      | 4.2 | 8.7  | 1                               | 9.6  | 1                                | 9.9  |      |
|                    |                                                                                                   |                 | 3.3V ± 0.3      | 1.5                    | 3.8 | 8.1  | 1.5                             | 8.7  | 1.5                              | 9.2  |      |
| t <sub>EN</sub>    | Enable Time $\overline{\text{OE}}$ to A <sub>N</sub> or $\overline{\text{OE}}$ to B <sub>N</sub>  | Figure 1        | 1.8V ± 0.15V    | 1                      | 7   | 14.8 | 1                               | 15.3 | 1                                | 22.5 | ns   |
|                    |                                                                                                   |                 | 2.5V ± 0.2V     | 1                      | 4.5 | 10   | 1                               | 10.5 | 1                                | 12.4 |      |
|                    |                                                                                                   |                 | 2.7V            | 1                      | 5.4 | 9.3  | 1                               | 9.5  | 1                                | 12.0 |      |
|                    |                                                                                                   |                 | 3.3V ± 0.3      | 1.5                    | 4.4 | 8.3  | 1.5                             | 8.5  | 1.5                              | 11.0 |      |
| t <sub>DIS</sub>   | Disable Time $\overline{\text{OE}}$ to A <sub>N</sub> or $\overline{\text{OE}}$ to B <sub>N</sub> | Figure 1        | 1.8V ± 0.15V    | 1                      | 7.8 | 16.5 | 1                               | 17   | 1                                | 14.2 | ns   |
|                    |                                                                                                   |                 | 2.5V ± 0.2V     | 1                      | 4   | 9    | 1                               | 9.5  | 1                                | 8.2  |      |
|                    |                                                                                                   |                 | 2.7V            | 1                      | 4.4 | 8.3  | 1                               | 8.5  | 1                                | 10.0 |      |
|                    |                                                                                                   |                 | 3.3V ± 0.3      | 1.7                    | 4.1 | 7.3  | 1.7                             | 7.5  | 1.7                              | 9.0  |      |
| 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

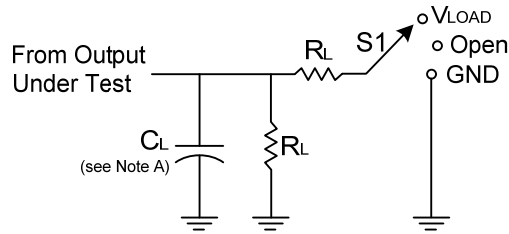
| Symbol          | Parameter                              | Test Conditions              | V <sub>CC</sub> | Typ  | Unit |
|-----------------|----------------------------------------|------------------------------|-----------------|------|------|
| C <sub>pd</sub> | Power dissipation capacitance per gate | F = 10MHz<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 |

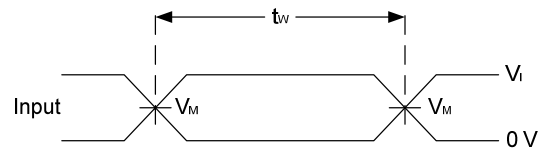
Note: 9. Test conditions for TSSOP-20 and V-QFN4525-20: Devices mounted on 4 layer FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout per JESD 51-7.

## Parameter Measurement Information

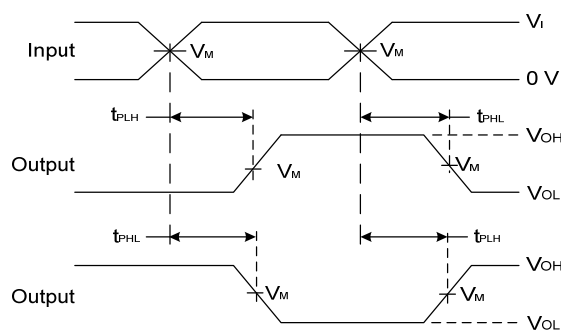


| TEST              | S1         |
|-------------------|------------|
| $t_{PLH}/t_{PHL}$ | Open       |
| $t_{PLZ}/t_{PZL}$ | $V_{LOAD}$ |
| $t_{PHZ}/t_{PZH}$ | GND        |

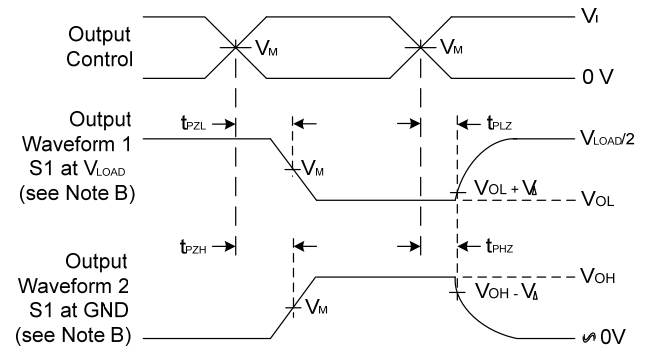
| $V_{CC}$         | Inputs   |              | $V_M$      | $V_{LOAD}$        | $C_L$ | $R_L$        | $V_{\Delta}$ |
|------------------|----------|--------------|------------|-------------------|-------|--------------|--------------|
|                  | $V_I$    | $t_r/t_f$    |            |                   |       |              |              |
| $1.8V \pm 0.15V$ | $V_{CC}$ | $\leq 2ns$   | $V_{CC}/2$ | $2 \times V_{CC}$ | 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



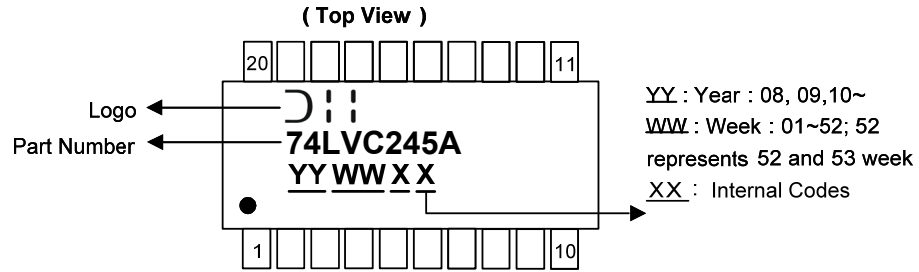
Voltage Waveform Enable and Disable Times  
Low and High Level Enabling

- 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

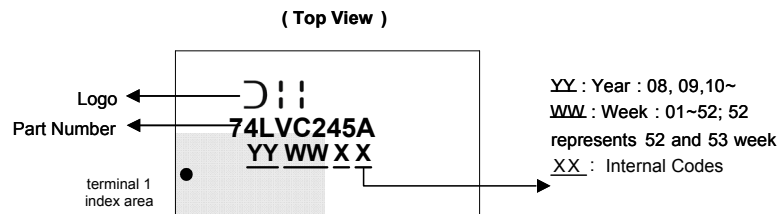
## Marking Information

### (1) TSSOP20



| Part Number  | Package  |
|--------------|----------|
| 74LVC245AT20 | TSSOP-20 |

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

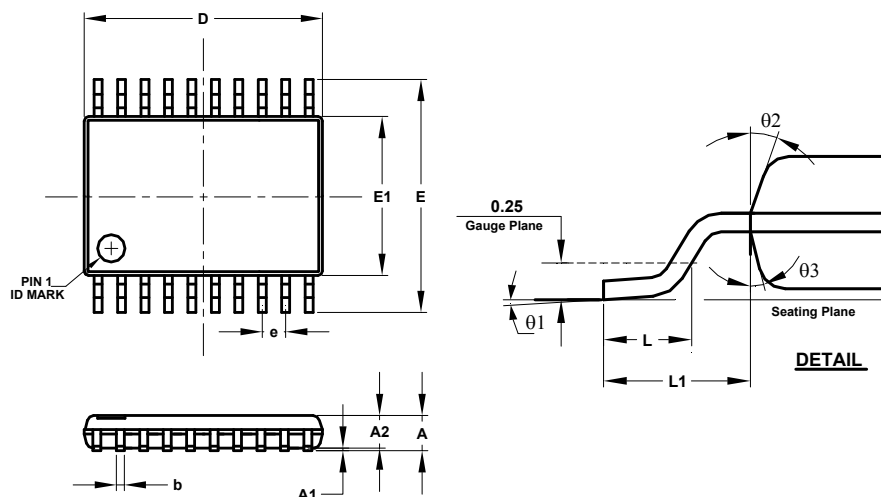


| Part Number  | Package      |
|--------------|--------------|
| 74LVC245AQ20 | V-QFN4525-20 |

## Package Outline Dimensions (All Dimensions in mm)

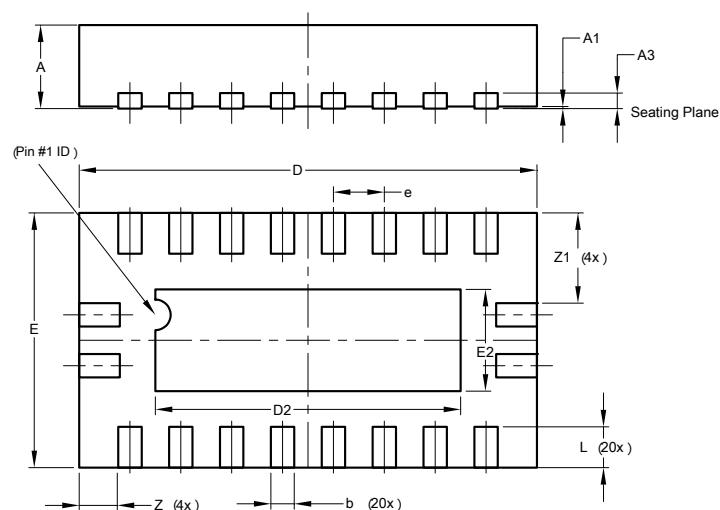
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

### (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  |      |      |
| θ1                   | 0°       | 8°   | -    |
| θ2                   | 10°      | 14°  | 12°  |
| θ3                   | 10°      | 14°  | 12°  |
| All Dimensions in mm |          |      |      |

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

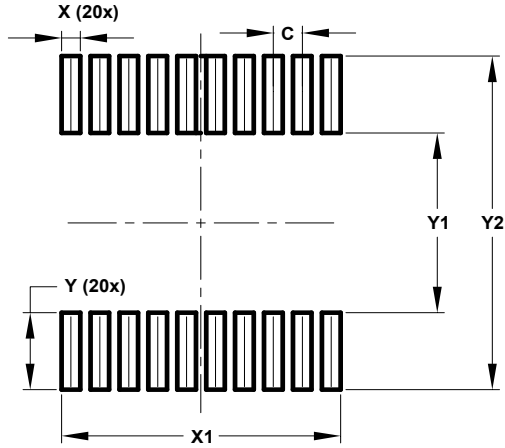


| V-QFN4525-20         |         |      |       |
|----------------------|---------|------|-------|
| Dim                  | Min     | Max  | Typ   |
| A                    | 0.75    | 0.85 | 0.80  |
| A1                   | 0.00    | 0.05 | 0.02  |
| A3                   | -       | -    | 0.15  |
| 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 |         |      |       |

## Suggested Pad Layout

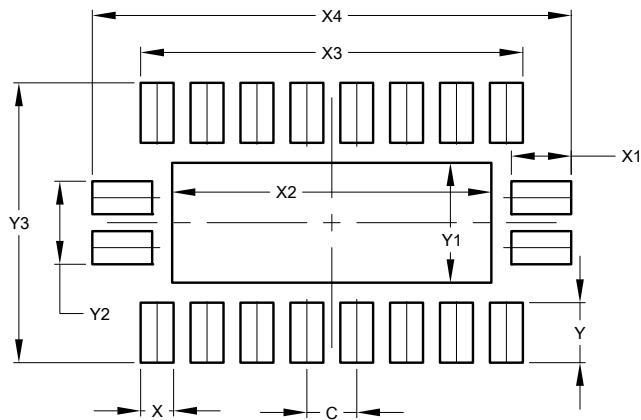
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

### (1) TSSOP-20



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 0.650         |
| X          | 0.420         |
| X1         | 6.270         |
| Y          | 1.789         |
| Y1         | 4.160         |
| Y2         | 7.720         |

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



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 0.500         |
| X          | 0.330         |
| X1         | 0.600         |
| X2         | 3.200         |
| X3         | 3.830         |
| X4         | 4.800         |
| Y          | 0.600         |
| Y1         | 1.200         |
| Y2         | 0.830         |
| Y3         | 2.800         |

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