# LOW POWER DUAL SPST HI-SPEED USB 2.0 (480MBPS) SWITCH     IDTUS8032
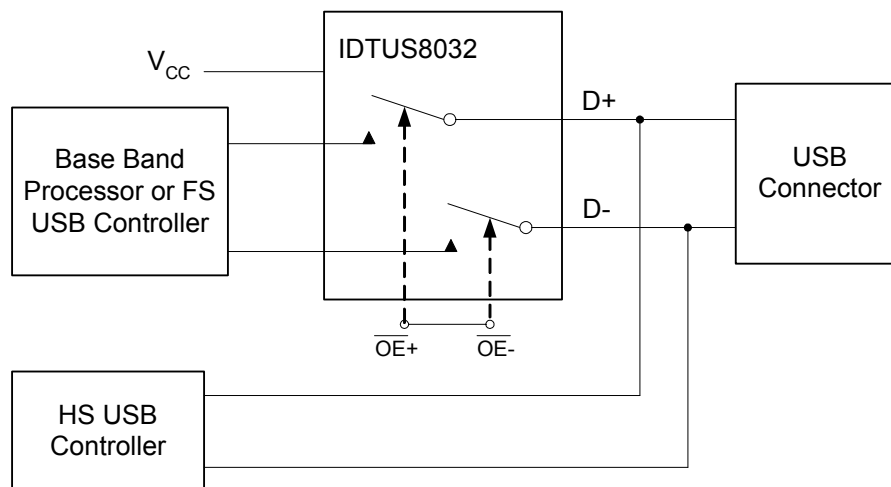
## Description

The IDTUS8032 is a low power, dual SPST 2-port hi-speed USB 2.0 switch. This part is configured as a single pole, single throw switch and is optimized for switching or isolating a hi-speed (480 Mbps) source or a hi-speed and full-speed (12 Mbps) source. The IDTUS8032 is compatible with the requirements of USB2.0 and features an extremely low ON capacitance ($C_{ON}$) of 6.0 pF. The wide bandwidth of this device (>500 MHz) exceeds the bandwidth needed to pass the 3rd harmonic, resulting in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk also minimizes interference.

The IDTUS8032 contains circuitry on the D+/D- pins which allows the device to withstand an overvoltage condition. This device is also designed to minimize current consumption even when the control voltage applied to the $\overline{OE}$ pin is lower than the supply voltage ($V_{CC}$). This feature is especially valuable to portable applications such as cell phones, allowing for direct interface with the general purpose I/Os of the baseband processor.

## Applications

- Notebooks, PDAs
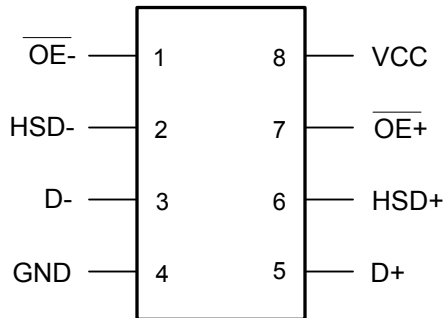- Cellular phones, Digital cameras
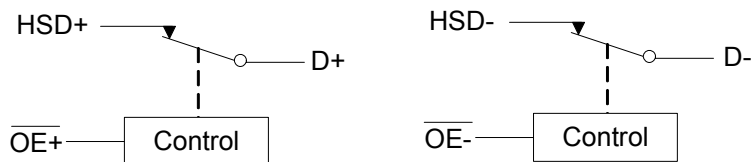- LCD monitors, TVs, Set-top Boxes

## Features

- Low On capacitance, 4.5 pF (typical)
- Low On resistance, 3.5Ω (typical)
- Low power consumption (3 mA maximum)
  - 1 mA typical ICCT over and expanded control voltage range (VIN=2.6 V, $V_{CC}$=3.6 V)
- Wide -3dB bandwidth, > 500 MHz
- 8K I/O to GND ESD protection
- Power OFF protection when $V_{CC}$= 0V, D+/D- pins can tolerate up to 3.6 V
- Packaged in RoHS compliant 8-pin SOIC or 8-pin MSOP

## Application Block Diagram

## Pin Assignment (8-pin SOIC and 8-pin MSOP)

```
    $\overline{OE}$-  ─── 1      8 ─── VCC

    HSD-  ─── 2      7 ─── $\overline{OE}$+

    D-    ─── 3      6 ─── HSD+

    GND   ─── 4      5 ─── D+
```

## Analog Symbol

```
HSD+ ───▼
         ○─── D+
         ┊
$\overline{OE}$+ ───[ Control ]
```

```
HSD- ───▼
         ○─── D-
         ┊
$\overline{OE}$- ───[ Control ]
```

## Truth Table

| $\overline{OE}$+, $\overline{OE}$- | Function |
|---|---|
| H | Disconnect |
| L | D+, D- = HSD |

## Pin Descriptions

| Pin Name | Pin Description |
|---|---|
| $\overline{OE}$+, $\overline{OE}$- | Bus switch enable. |
| D+, D-, HSD+, HSD- | Data ports. |
| NC | No connect. |

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the IDTUS8032. These ratings, which are standard values for IDT commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range. All voltages referenced to ground.

| Symbol | Parameter | Rating |
|--------|-----------|--------|
| $V_{CC}$ | Supply Voltage | -0.5 V to 5.5 V |
| $V_S$ | DC Input Voltage [1] | -0.5 V to 5.5 V |
| $V_{IN}$ | DC Switch Voltage [1] <br> HSD <br> D+, D- | -0.5 V to $V_{CC}$ to 0.3 V <br> -0.5 V to 4.6 V |
|  | DC Input Diode Current | -50 mA |
|  | DC Output Current | 50 mA |
|  | Storage Temperature | -65°C to 150°C |
|  | ESD (Human Body Mode) <br> All Pins <br> I/O to GND | <br> 7.5 kV <br> 8 kV |

## Recommended Operating Conditions [2]

| Symbol | Parameter | Rating |
|--------|-----------|--------|
| $V_{CC}$ | Supply Voltage | 3.0 V to 3.6 V |
| $V_{IN}$ | DC Switch Voltage | 0V to $V_{CC}$ |
|  | DC Input Diode Current | 0V to $V_{CC}$ |
|  | Storage Temperature | -40°C to +85°C |

Note 1: The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed. DC switch voltage may never exceed 3.6 V.

Note 2: Control input must be held HIGH or LOW and it must not float.

## DC Electrical Characteristics

Unless stated otherwise, typical values are at 25°C

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = -40°C to +85°C | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $V_{IK}$ | Clamp Diode Voltage | $I_{IN}$ = -18 mA | 3.0 | 0 | | -1.2 | V |
| $V_{IH}$ | Input Voltage HIGH | | 3.0 to 3.6 | 1.3 | | | V |
| | | | 3.6 | 1.7 | | | |
| $V_{IL}$ | Input Voltage LOW | | 3.0 to 3.6 | | | 0.5 | V |
| | | | 3.6 | | | 0.7 | |
| $I_{IN}$ | Control Input Leakage | $V_{IN}$ = 0V to $V_{CC}$ | 3.6 | -1.0 | | 1.0 | µA |
| $I_{OZ}$ | OFF State Leakage | 0 ≤ HSD ≤ $V_{CC}$ | 3.6 | -2.0 | | 2.0 | µA |
| $I_{OFF}$ | Power OFF Leakage Current (D+, D-) | $V_{IN}$ = 0V to 3.6 V $V_{CC}$ = 0V | 0 | -2.0 | | 2.0 | µA |
| $R_{ON}$ | Switch On Resistance [1] | $V_{IN}$ = 0.4 V, $I_{ON}$ = -8 mA | 3.0 | | 3.5 | 10.0 | Ω |
| $\triangle R_{ON}$ | Delta $R_{ON}$ [2] | $V_{IN}$ = 0.4 V, $I_{ON}$ = -8 mA | 3.0 | | 0.35 | | Ω |
| $R_{ON}$ Flatness | $R_{ON}$ Flatness [1] | $V_{IN}$ = 0V to 1.0 V, $I_{ON}$ = -8 mA | 3.0 | | 2.0 | | Ω |
| $I_{CC}$ | Quiescent Supply Current | $V_{IN}$ = 0V or $V_{CC}$, $I_{OUT}$ = 0 | 3.3 | | 300 | | µA |
| $I_{CCT}$ | Increase in $I_{CC}$ Current per Control voltage and $V_{CC}$ levels | $V_{IN}$ = 2.6 V, $V_{CC}$ = 3.6 V | 3.6 | | 1 | 3 | mA |

**Notes:**

1. Measured by the voltage drop between Dn, HSD, Dn pins at the indicated current through the switch. On Resistance is determined by the lower of the voltage on the two ports.
2. Guaranteed by design.

## AC Electrical Characteristics

Unless stated otherwise, typical values are for $V_{CC}$ = 3.3 V at 25°C

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = -40°C to +85°C | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $t_{ON}$ | Turn ON Time, $\overline{OE}$ to output | $V_{IN}$ = 0.8 V, $R_L$ = 50Ω, $C_L$ = 5 pF | 3.0 to 3.6 | | 15.0 | 30.0 | ns |
| $t_{OFF}$ | Turn OFF Time, $\overline{OE}$ to output | $V_{IN}$ = 0.8 V, $R_L$ = 50Ω, $C_L$ = 5 pF | 3.0 to 3.6 | | 12.0 | 30.0 | ns |
| $t_{PD}$ | Propagation Delay [1] | $R_L$ = 50Ω, $C_L$ = 5 pF | 3.3 | | 0.25 | | ns |
| $O_{IRR}$ | OFF Isolation (non-adjacent) | $R_T$ = 50Ω, f = 240 MHz | 3.0 to 3.6 | | -35.0 | | dB |
| Xtalk | Non-adjacent Channel Crosstalk | $R_T$ = 50Ω, f = 240 MHz | 3.0 to 3.6 | | -55.0 | | dB |
| BW | -3dB Bandwidth | $R_T$ = 50Ω, $C_L$ = 0 pF | 3.0 to 3.6 | | 500 | | MHz |
| | | $R_T$ = 50Ω, $C_L$ = 5 pF | | | 450 | | |

**Note 1:** Guaranteed by design.

## USB Hi-Speed Related AC Electrical Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = -40°C to +85°C | | | Units |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $t_{SK(O)}$ | Channnel-to-channel Skew [1] | $C_L$ = 5 pF | 3.0 to 3.6 | | 50.0 | | ps |
| $t_{SK(P)}$ | Skew of the Opposite Transitions of the Same Output [1] | $C_L$ = 5 pF | 3.0 to 3.6 | | 20.0 | | ps |
| $t_J$ | Total Jitter [1] | $R_L$ = 50Ω, $C_L$ = 5 pF, tR = tF = 500 ps at 480 Mbps (PRBS = $2^{15}$ - 1) | 3.0 to 3.6 | | 200 | | ps |

**Note 1:** Guaranteed by design.

## Capacitance

| Symbol | Parameter | Conditions | $T_A$ = -40°C to +85°C | | | Units |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $C_{IN}$ | Control Pin Input Capacitance | $V_{CC}$ = 0V | | 1.0 | | pF |
| $C_{ON}$ | $D1_n$, $D2_n$, Dn ON Capacitance | $V_{CC}$ = 3.3, $\overline{OE}$ = 0V | | 4.5 | | pF |
| $C_{OFF}$ | $D1_n$, $D2_n$, OFF Capacitance | $V_{CC}$ and $\overline{OE}$ = 3.3 | | 1.7 | | pF |

## Thermal Characteristics

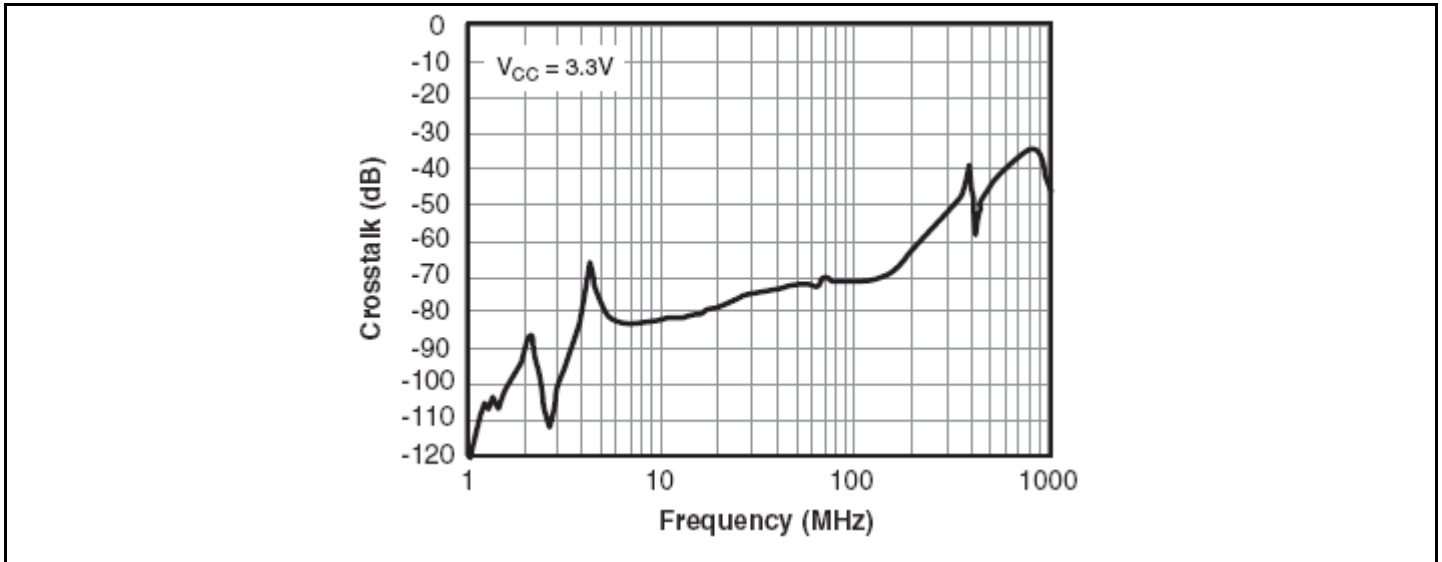| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air | | 150 | | °C/W |
| | $\theta_{JA}$ | 1 m/s air flow | | 140 | | °C/W |
| | $\theta_{JA}$ | 3 m/s air flow | | 120 | | °C/W |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | | 40 | | °C/W |
| Thermal Resistance Junction to Top of Case | $\Psi_{JT}$ | Still air | | 20 | | °C/W |

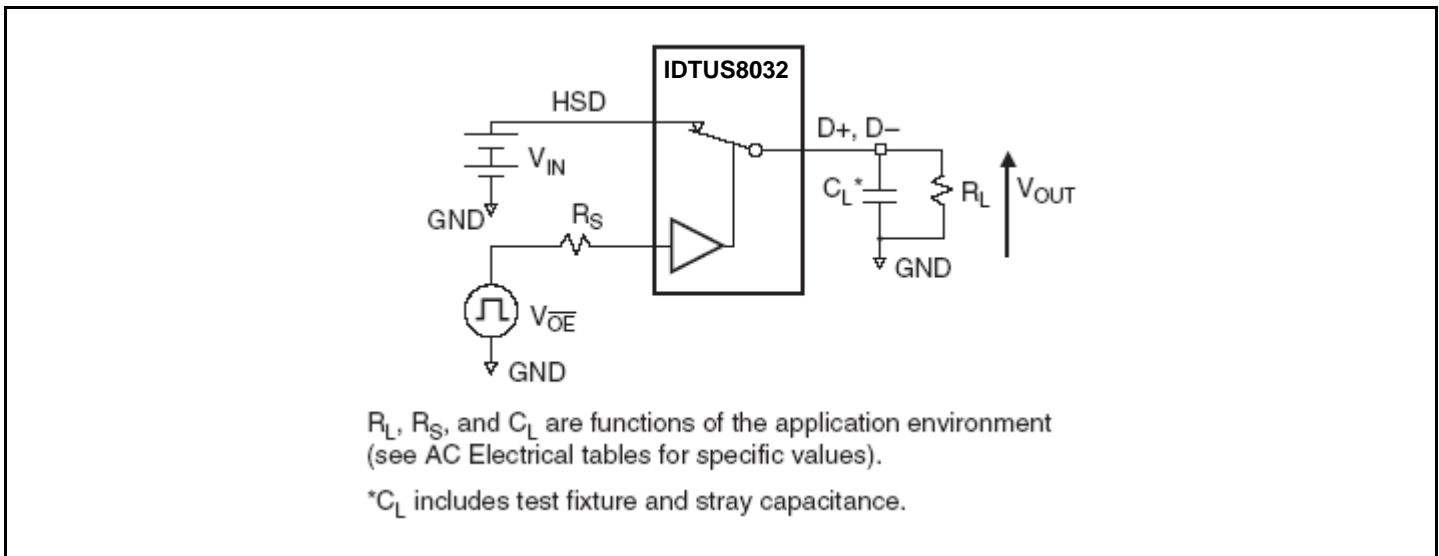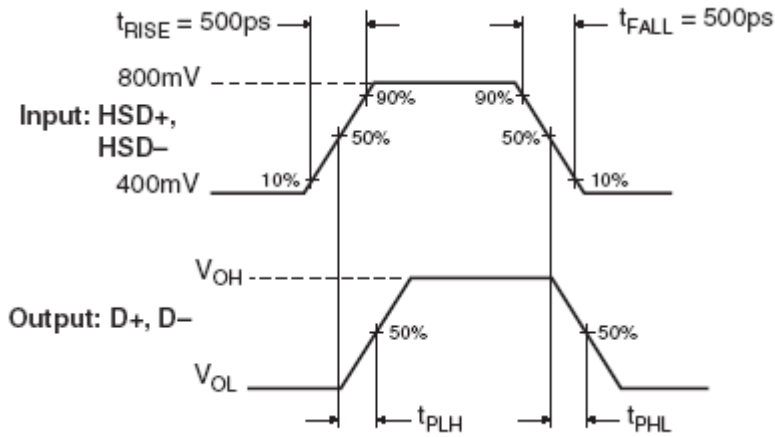## Test Circuits and Timing Diagrams
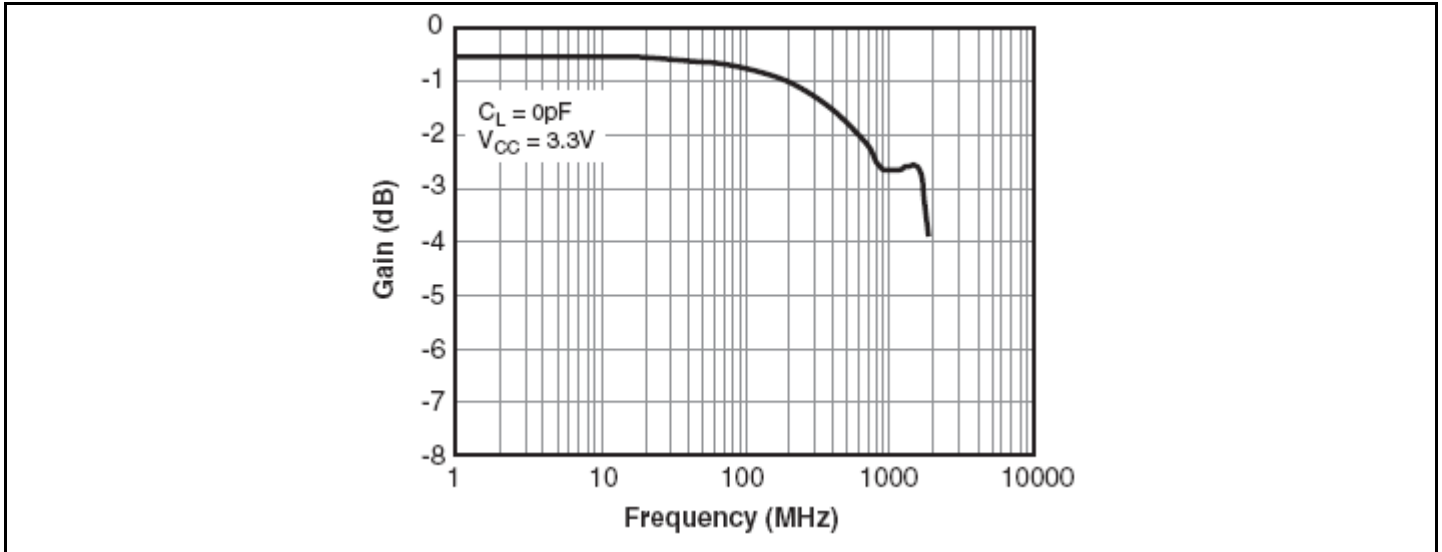


**Gain vs. Frequency**
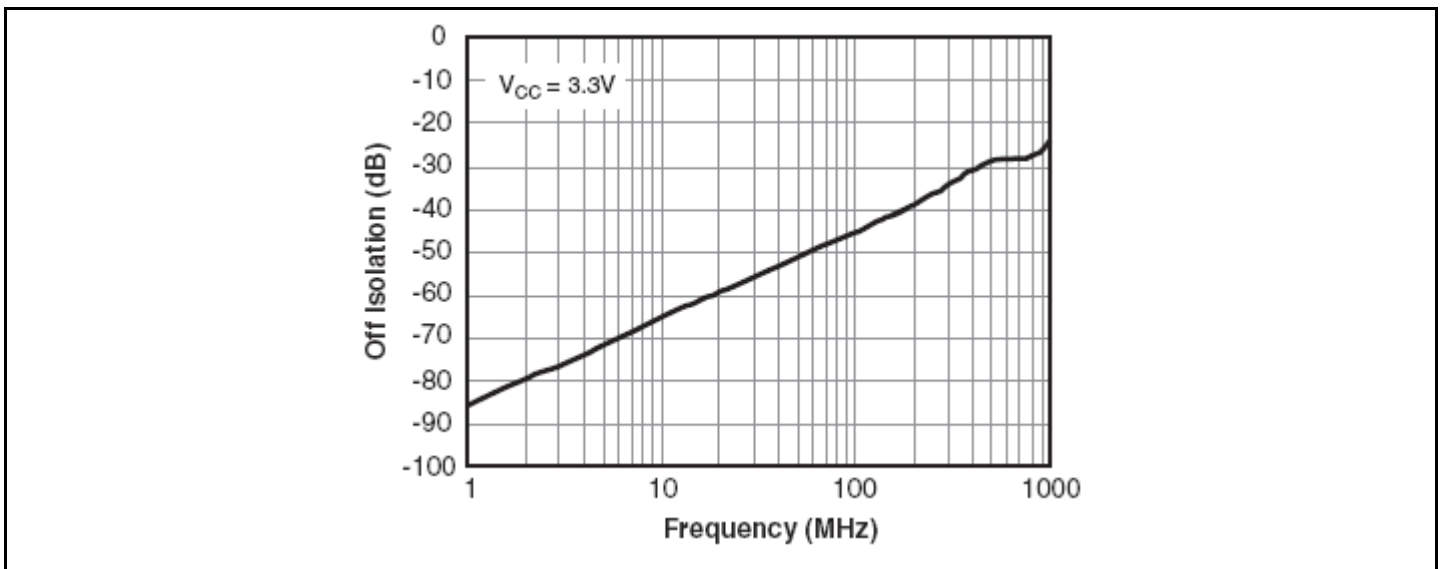


**OFF Isolation**

**Crosstalk**
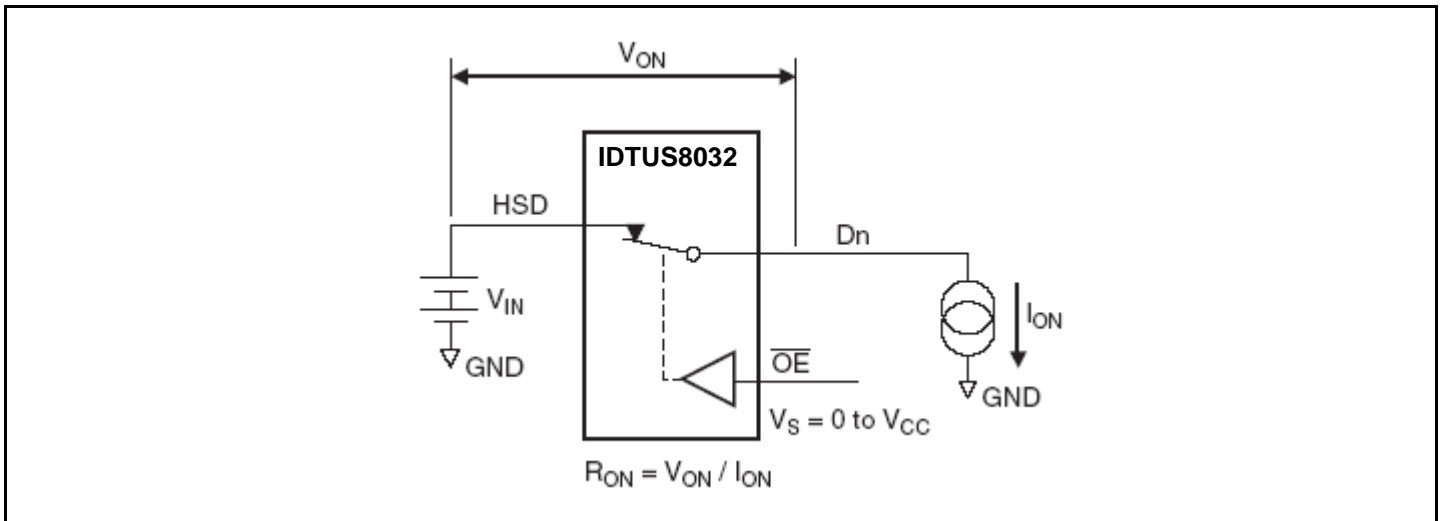


**On Resistance**
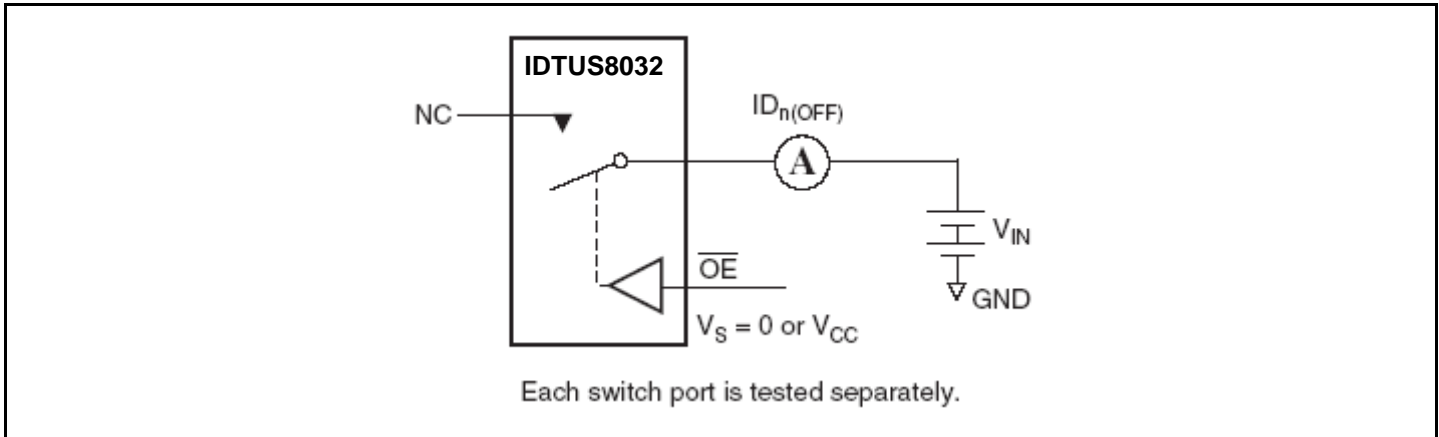
**OFF Leakage**

**AC Test Circuit Load**

$R_L$, $R_S$, and $C_L$ are functions of the application environment (see AC Electrical tables for specific values).
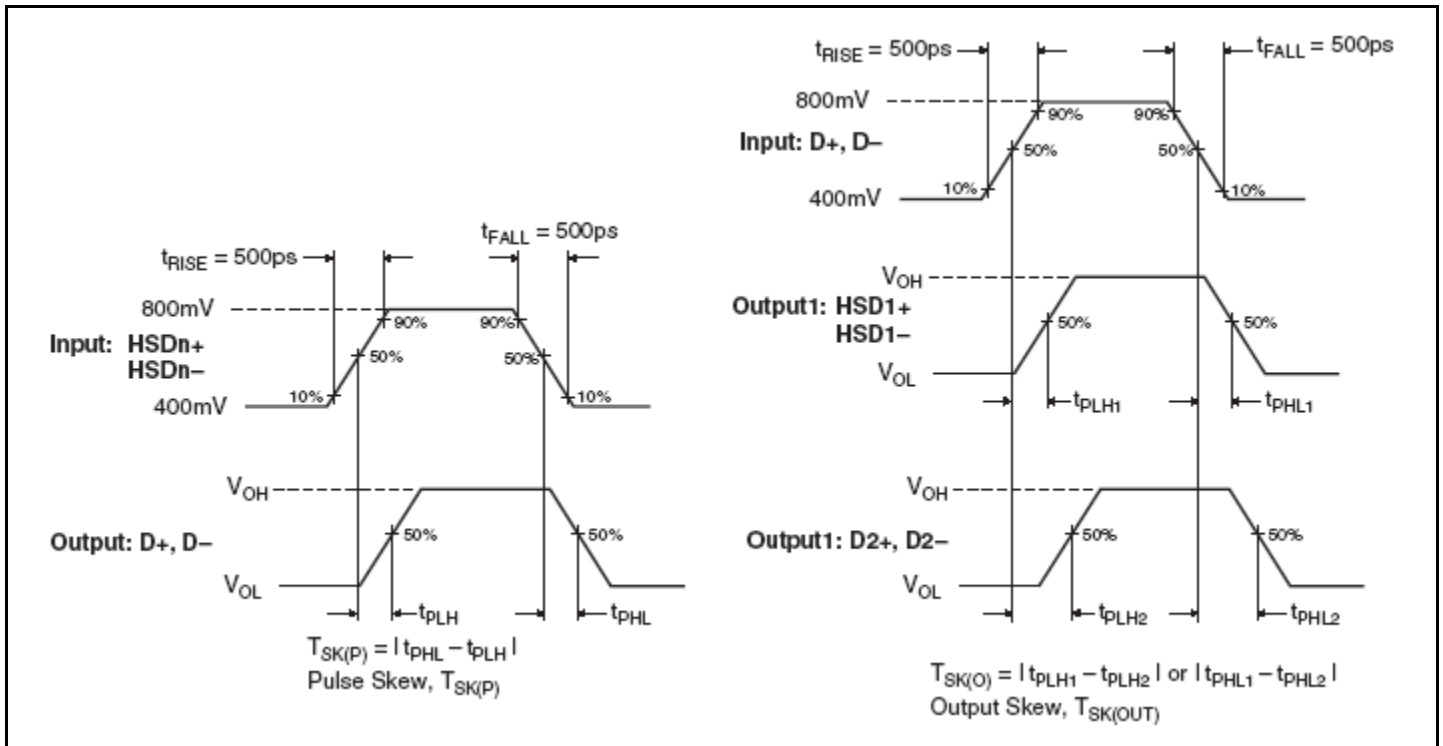
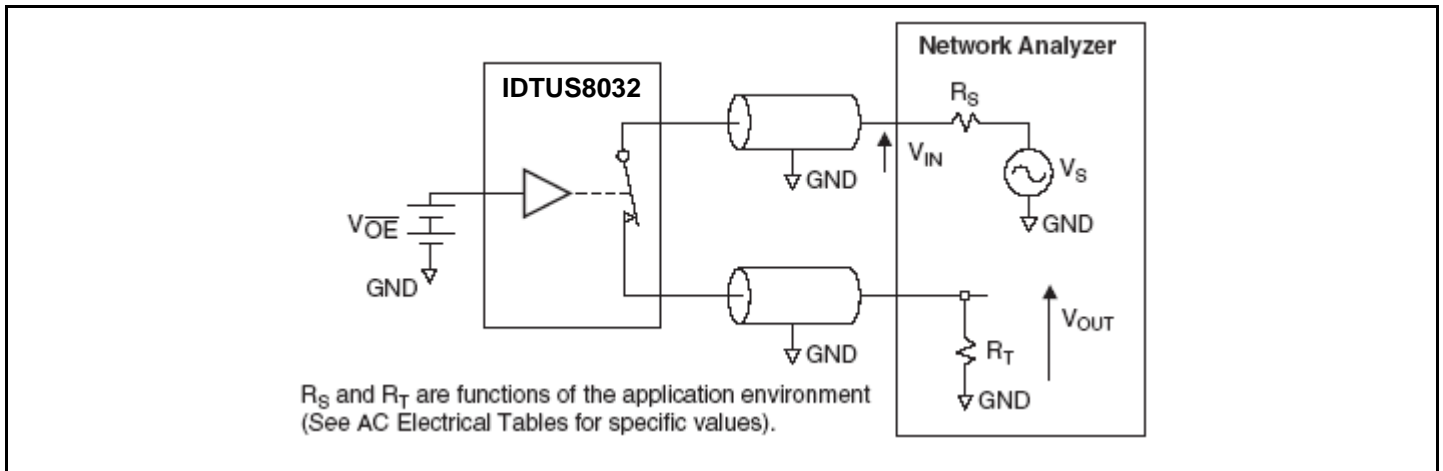*$C_L$ includes test fixture and stray capacitance.
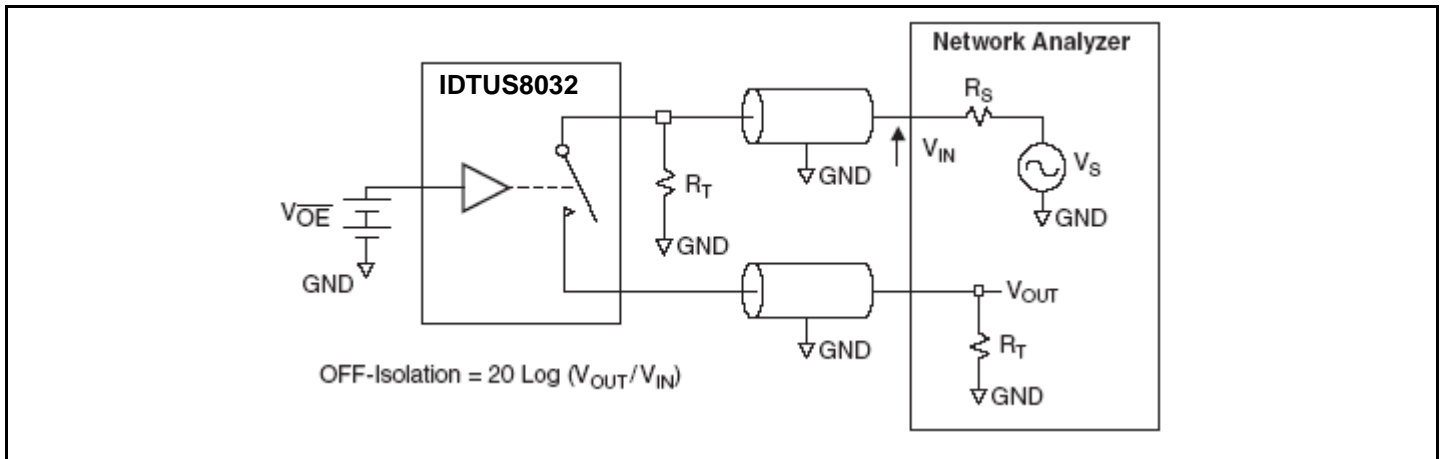
**Switch Propagation Delay Waveforms (T$_{PD}$)**
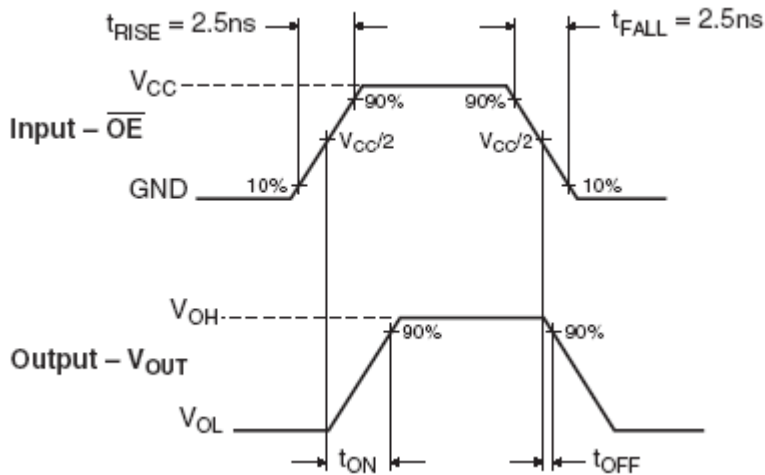


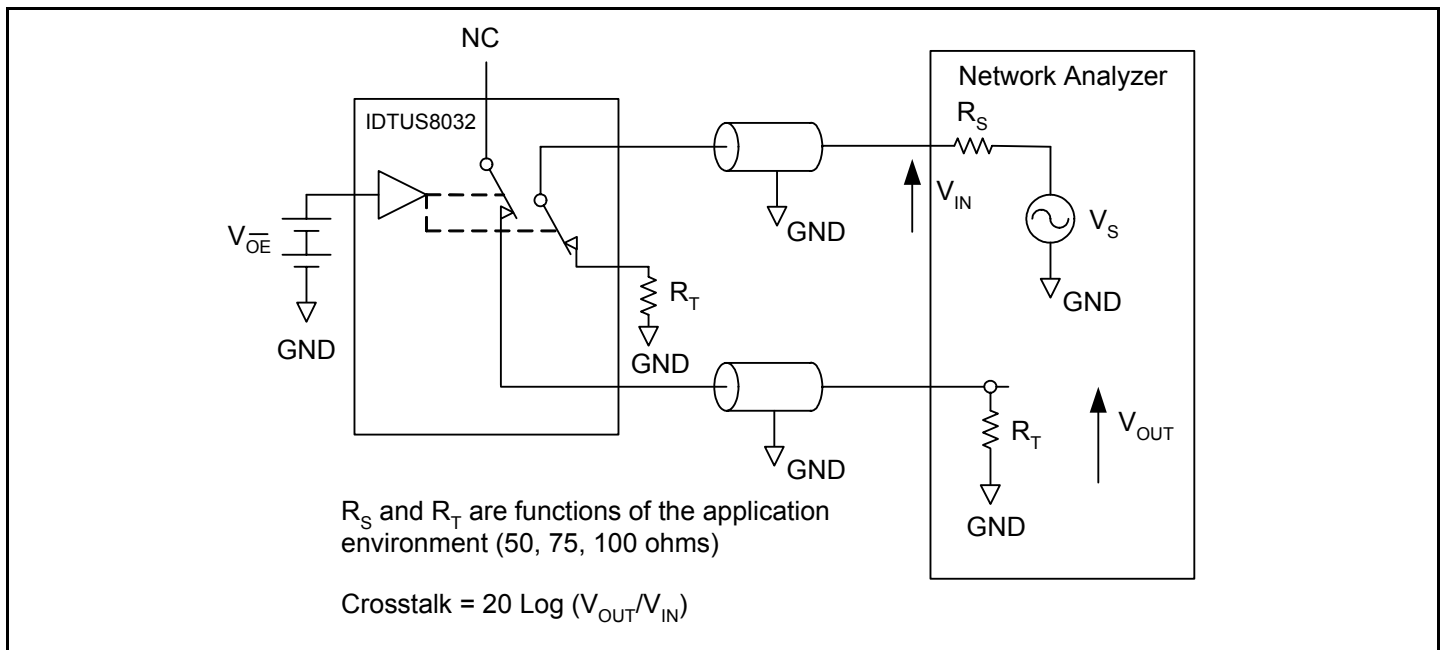**Turn ON / Turn OFF Waveform (T$_{ON}$ / T$_{OFF}$)**

**Switch Skew Tests**
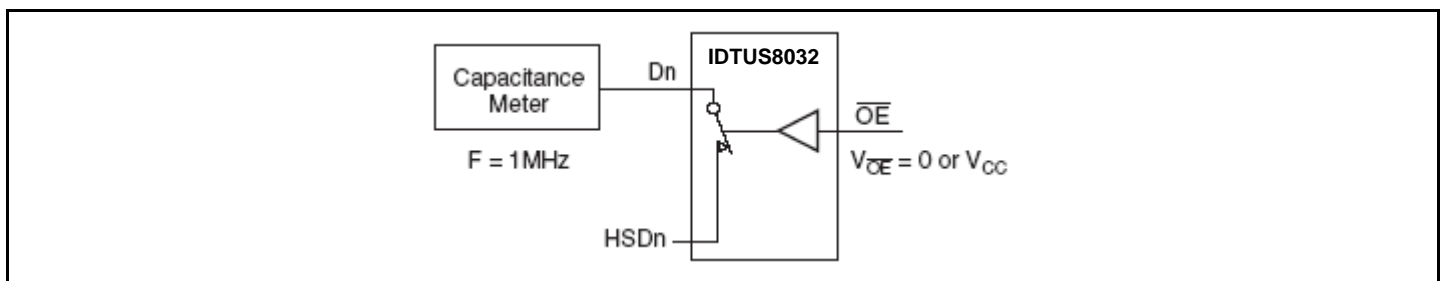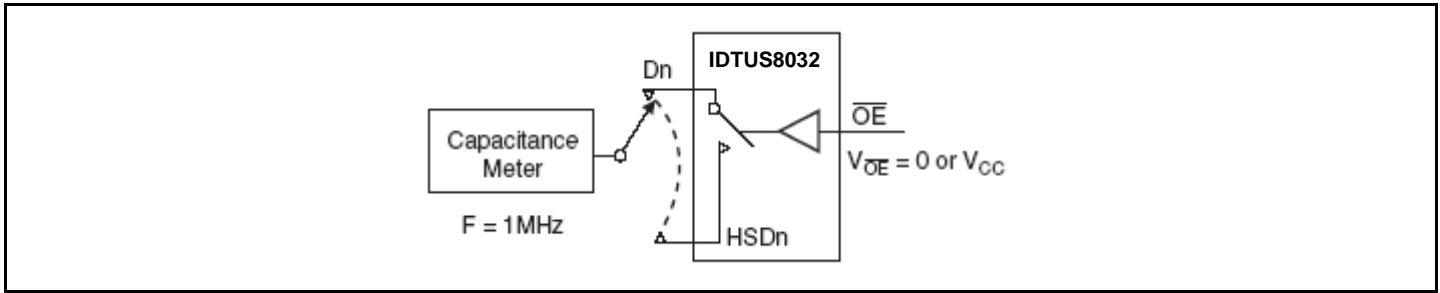


**Bandwidth**

**Channel OFF Isolation**



**Non-Adjacent Channel-to-Channel Crosstalk**



**Channel ON Capacitance**

**Channel OFF Capacitance**

## Marking Diagrams
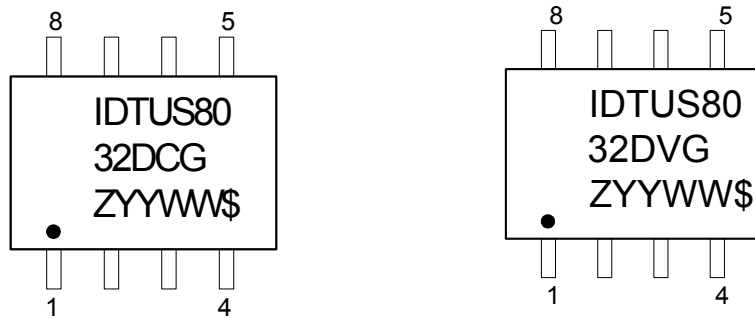


Notes:

1. "Z" is the device step (1 to 2 characters).

2. YYWW is the last two digits of the year and week that the part was assembled.

3. "$" is the assembly mark code.

4. "G" after the two-letter package code designates RoHS compliant package.

5. "I" at the end of part number indicates industrial temperature range (if applicable).

6. Bottom marking: country of origin if not USA.

## Thermal Characteristics for 8MSOP

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air | | 95 | | $^\circ$C/W |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | | 48 | | $^\circ$C/W |

## Thermal Characteristics for 8SOIC

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | Still air | | 150 | | $^\circ$C/W |
| | $\theta_{JA}$ | 1 m/s air flow | | 140 | | $^\circ$C/W |
| | $\theta_{JA}$ | 3 m/s air flow | | 120 | | $^\circ$C/W |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | | 40 | | $^\circ$C/W |
| Thermal Resistance Junction to Top of Case | $\Psi_{JT}$ | Still air | | 20 | | $^\circ$C/W |

## Package Outline and Package Dimensions (8-pin MSOP, 3.00 mm Body)

Package dimensions are kept current with JEDEC Publication No. 95
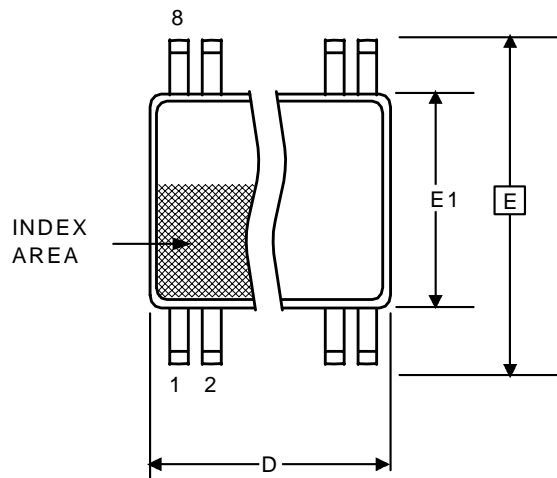
| Symbol | Millimeters | | Inches* | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | -- | 1.10 | -- | 0.043 |
| A1 | 0 | 0.15 | 0 | 0.006 |
| A2 | 0.79 | 0.97 | 0.031 | 0.038 |
| b | 0.22 | 0.38 | 0.008 | 0.015 |
| C | 0.08 | 0.23 | 0.003 | 0.009 |
| D | 3.00 BASIC | | 0.118 BASIC | |
| E | 4.90 BASIC | | 0.193 BASIC | |
| E1 | 3.00 BASIC | | 0.118 BASIC | |
| e | 0.65 Basic | | 0.0256 Basic | |
| L | 0.40 | 0.80 | 0.016 | 0.032 |
| α | 0° | 8° | 0° | 8° |
| aaa | - | 0.10 | - | 0.004 |

*For reference only. Controlling dimensions in mm.
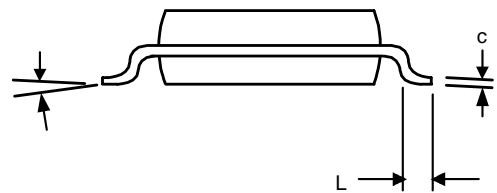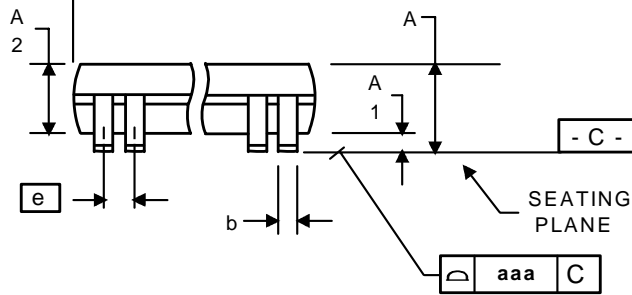
## Package Outline and Package Dimensions (8-pin SOIC, 150 Mil. Body)

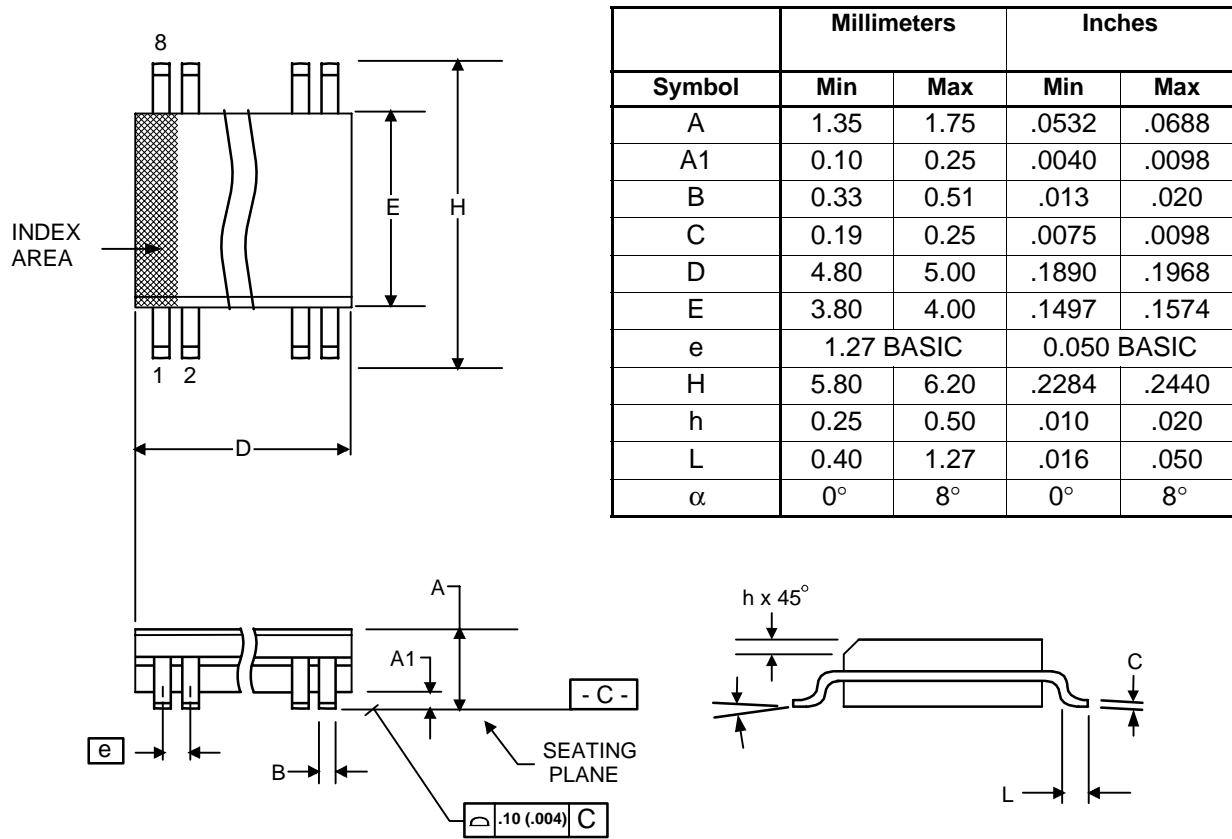Package dimensions are kept current with JEDEC Publication No. 95



|  | Millimeters | | Inches | |
|---|---|---|---|---|
| **Symbol** | **Min** | **Max** | **Min** | **Max** |
| A | 1.35 | 1.75 | .0532 | .0688 |
| A1 | 0.10 | 0.25 | .0040 | .0098 |
| B | 0.33 | 0.51 | .013 | .020 |
| C | 0.19 | 0.25 | .0075 | .0098 |
| D | 4.80 | 5.00 | .1890 | .1968 |
| E | 3.80 | 4.00 | .1497 | .1574 |
| e | 1.27 BASIC | | 0.050 BASIC | |
| H | 5.80 | 6.20 | .2284 | .2440 |
| h | 0.25 | 0.50 | .010 | .020 |
| L | 0.40 | 1.27 | .016 | .050 |
| α | 0° | 8° | 0° | 8° |

## Ordering Information

| Part / Order Number | Marking | Shipping Packaging | Package | Temperature |
|---|---|---|---|---|
| US8032DCG | see page 12 | Tubes | 8-pin SOIC | 0 to +70° C |
| US8032DCG8 | | Tape and Reel | 8-pin SOIC | 0 to +70° C |
| US8032DVG | | Tubes | 8-pin MSOP | 0 to +70° C |
| US8032DVG8 | | Tape and Reel | 8-pin MSOP | 0 to +70° C |

**Parts that are ordered with a "G" after the two-letter package code are the Pb-Free configuration and are RoHS compliant.**

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