

## High-Speed USB 2.0 (480-Mbps) 1:2 Multiplexer / Demultiplexer Switch

### Features

- 1.8V to 5.5V Single Supply Operation
- Low Power Consumption (1 $\mu$ A Max.)
- Low ON-State Resistance: 10 $\Omega$  Max.
- -3dB Bandwidth: 900 MHz Typical
- Fast Switching Speed
- Break-Before-Make Operation
- Rail-to-Rail Operation
- TTL/CMOS Logic Compatible
- Supports Analog and Digital Signals
- Small Packaging: MSOP10, UQFN10
- Extended Industrial Temperature Range: -40°C to +125°C

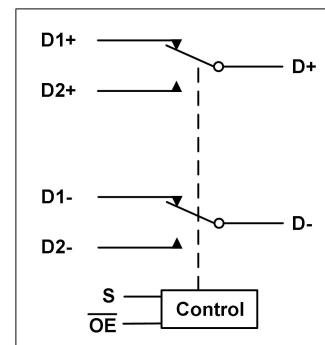
### Applications

- Multiple-Purpose Signal Switching
- Routes Signals for USB1.0/1.1/2.0
- Portable Devices
- Set-Top Box
- Signal Gating, Multiplexer/Demultiplexer
- Signal Modulation or Demodulation
- Sample and Hold Systems
- Telecom Signal Switching
- Battery Power Systems

### General Description

The COSTS3USB30E is a low voltage, high bandwidth double-pole / double-throw (DPDT) CMOS analog switch with single output enable control pin. The device can pass signals with rail-to-rail swing from a single supply 1.8V to 5.5V. The switches conduct equally well in both directions when it is on. The output enable pin place the signal paths in high impedance which isolates the bus when it is not in use and thus consume less current.

The COSTS3USB30E offers low ON-state resistance and excellent ON-state resistance matching with the break-before-make feature which prevents signal distortion during the transferring of a signal from one channel to another. The device is well suitable for the switching of high-speed USB 2.0 signals in handset and consumer applications with limited USB I/Os.

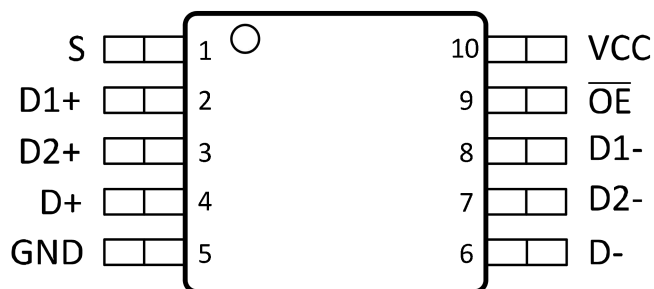


Simplified Schematic

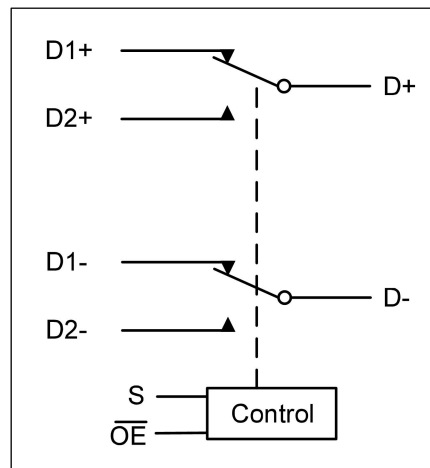
Rev1.0

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## 1. Pin Configuration and Functions



(a) Pin Diagram



(b) Simplified Schematic

Truth Table

| $\overline{OE}$ | S | D1+, D1- | D2+, D2- |
|-----------------|---|----------|----------|
| 0               | 0 | ON       | OFF      |
| 0               | 1 | OFF      | ON       |
| 1               | X | OFF      | OFF      |

X=don't care

Pin Description

| PIN |                 |     | FUNCTION               |
|-----|-----------------|-----|------------------------|
| NO. | NAME            | I/O |                        |
| 1   | S               | I   | Select input           |
| 2   | D1+             | I/O | USB signal path port 1 |
| 3   | D2+             | I/O | USB signal path port 2 |
| 4   | D+              | I/O | Common USB signal path |
| 5   | GND             | -   | Ground                 |
| 6   | D-              | I/O | Common USB signal path |
| 7   | D2-             | I/O | USB signal path port 2 |
| 8   | D1-             | I/O | USB signal path port 1 |
| 9   | $\overline{OE}$ | I   | Output enable          |
| 10  | VCC             | -   | Power supply           |

## 2. Package and Ordering Information

| Order Number   | Package | Package Option      | Marking Information |
|----------------|---------|---------------------|---------------------|
| COSTS3USB30EMR | MSOP10  | Tape and Reel, 3000 | COSTS3/USB30E       |
| COSTS3USB30EQN | UQFN10  | Tape and Reel, 3000 | COSTS3/USB30E       |

## 3. Product Specification

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

| Parameter                                | Min  | Max            | Unit |
|------------------------------------------|------|----------------|------|
| Supply voltage range ( $V_{CC}$ )        | -0.5 | 6.0            | V    |
| Analog voltage range ( $V_{IO}$ )        | -0.5 | $V_{CC} + 0.5$ | V    |
| Digital input voltage range ( $V_{IN}$ ) | -0.5 | 6.0            | V    |
| Continuous current into any terminal     | -50  | 50             | mA   |
| Peak current into any terminal           | -100 | 100            | mA   |
| Operating junction temperature           | -40  | +125           | °C   |
| Storage temperature                      | -55  | +150           | °C   |

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

### 3.2 Thermal Data

| Parameter                                                            | Rating       | Unit |
|----------------------------------------------------------------------|--------------|------|
| Package Thermal Resistance, $R_{\theta JA}$<br>(Junction-to-ambient) | 160 (MSOP10) | °C/W |

### 3.3 Recommended Operating Conditions

| Parameter                              | Min | Max      | Unit |
|----------------------------------------|-----|----------|------|
| $V_{CC}$                               | 1.8 | 5.5      | V    |
| $V_{IO}$                               | 0   | $V_{CC}$ |      |
| $V_{IN}$                               | 0   | $V_{CC}$ |      |
| $T_A$ , Operating free-air temperature | -40 | +85      | °C   |

### 3.4 Electrical Characteristics

(  $V_{CC}=1.8V$  to  $5.5V$ ,  $T_A=-40^{\circ}C$  to  $85^{\circ}C$ , Typical value are at  $V_{CC}=3.3V$ ,  $T_A=25^{\circ}C$ , unless otherwise noted)

| Parameter                                                    | Symbol           | Conditions                                                                                            | Min. | Typ. | Max.     | Unit     |
|--------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------------|------|------|----------|----------|
| <b>Analog Switch</b>                                         |                  |                                                                                                       |      |      |          |          |
| Analog signal range                                          | $V_{IS}$         |                                                                                                       | 0    |      | $V_{CC}$ | V        |
| On-state resistance                                          | $R_{on}$         | $V_{CC}=3V$ , $V_{IS}=0.4V$ ,<br>$I_D = -8mA$ ,<br>Switch On, See Figure 1                            |      | 6    | 10       | $\Omega$ |
| On-state resistance match between channels                   | $\Delta R_{on}$  |                                                                                                       |      | 0.35 |          | $\Omega$ |
| On-state resistance flatness                                 | $R_{on(flat)}$   | $V_{CC}=3V$ , $V_{IS}=0V$ to $1V$ ,<br>$I_D = -8mA$ ,<br>Switch On, See Figure 1                      |      | 2    |          | $\Omega$ |
| Power OFF leakage current                                    | $I_{OFF}$        | $V_{CC}=0V$ , $V_{IS}=0V$ to $3.6V$ ,<br>$V_S$ or $V_{OE}=0V$ or $3.6V$ ,<br>See Figure 2             |      |      | $\pm 1$  | $\mu A$  |
| OFF-state leakage current (D+, D-)                           | $I_{OZ}$         | $V_{CC}=3.6V$ , $V_D=0V$ to $3.6V$ ,<br>$V_{IS}=0V$ to $3.6V$ ,<br>Switch OFF, See Figure 2           |      |      | $\pm 1$  | $\mu A$  |
| Channel ON leakage current                                   | $I_{D(OFF)}$     | $V_{CC}=3.6V$ , $V_D=0V$ to $3.6V$ ,<br>$V_{IS}=0V$ to $3.6V$ or floating,<br>Switch ON, See Figure 3 |      |      | $\pm 1$  | $\mu A$  |
| Increase in $I_{CC}$ per Control Voltage                     | $\Delta I_{CC}$  | $V_{CC}=4.3V$ , $V_{IN}=2.6V$                                                                         |      |      | 10       | $\mu A$  |
| <b>Digital Control Input (S, <math>\overline{OE}</math>)</b> |                  |                                                                                                       |      |      |          |          |
| Input logic high                                             | $V_{IH}$         |                                                                                                       | 2.4  |      | 5.5      | V        |
| Input logic low                                              | $V_{IL}$         |                                                                                                       | 0    |      | 0.8      | V        |
| Input leakage current                                        | $I_{IH}, I_{IL}$ | $V_{IN}=0$ or $5.5$                                                                                   |      |      | $\pm 1$  | $\mu A$  |
| <b>Switch Dynamic Characteristics</b>                        |                  |                                                                                                       |      |      |          |          |
| Turn-on time                                                 | $t_{ON}$         | $V_{IS}=0.8V$ , $R_L=50\Omega$ ,<br>$C_L=5pF$ , See Figure 5                                          |      | 15   |          | ns       |
| Turn-off time                                                | $t_{OFF}$        |                                                                                                       |      | 6    |          | ns       |
| Propagation delay                                            | $t_D$            | $R_L=50\Omega$ , $C_L=5pF$                                                                            |      | 0.3  |          | ns       |
| Break-before-make delay                                      | $t_{BBM}$        | $V_{IS}=0.8V$ , $R_L=50\Omega$ ,<br>$C_L=5pF$ , See Figure 6                                          |      | 4    |          | ns       |
| Charge injection                                             | Q                | $V_{GEN}=0V$ , $R_{GEN}=0$ ,<br>$C_L=1nF$ , See Figure 10                                             |      | 10   |          | pC       |
| OFF-state capacitance                                        | $C_{I/O(OFF)}$   | $V_{CC}=3.3V$ , $V_{I/O}=V_{CC}$ or $0$ ,<br>Switch OFF, See Figure 4                                 |      | 5    |          | pF       |
| ON-state capacitance                                         | $C_{I/O(ON)}$    | $V_{CC}=3.3V$ , $V_{I/O}=V_{CC}$ or $0$ ,<br>Switch ON, See Figure 4                                  |      | 10   |          | pF       |
| Digital input capacitance                                    | $C_i$            | $V_{CC}=0V$ , $V_{IN}=V_{CC}$ or $0$ ,<br>See Figure 4                                                |      | 1    |          | pF       |

|                         |            |                                                                                            |     |     |     |         |
|-------------------------|------------|--------------------------------------------------------------------------------------------|-----|-----|-----|---------|
| OFF-isolation           | $V_{ISO}$  | $R_L = 50\Omega, C_L = 5pF,$<br>$V_{I/O} = 1V_{RMS}, f = 1MHz$<br>Switch OFF, See Figure 8 |     | -40 |     | dB      |
| Crosstalk               | $X_{TALK}$ | $R_L = 50\Omega, C_L = 5pF,$<br>$V_{I/O} = 1V_{RMS}, f = 1MHz$<br>Switch ON, See Figure 9  |     | -60 |     | dB      |
| Bandwidth               | BW         | $R_L = 50\Omega, C_L = 5pF,$<br>$V_{I/O} = 1V_{RMS}, f = 1MHz$<br>Switch ON, See Figure 7  |     | 900 |     | MHz     |
| <b>Power Supply</b>     |            |                                                                                            |     |     |     |         |
| $V_{CC}$ supply range   | $V_{CC}$   |                                                                                            | 1.8 |     | 5.5 | V       |
| $V_{CC}$ supply current | $I_{CC}$   | $V_{CC}=4.3V, I_{I/O} = 0,$<br>Switch ON or OFF                                            |     |     | 1   | $\mu A$ |

#### 4. Test Circuits and Timing Diagrams

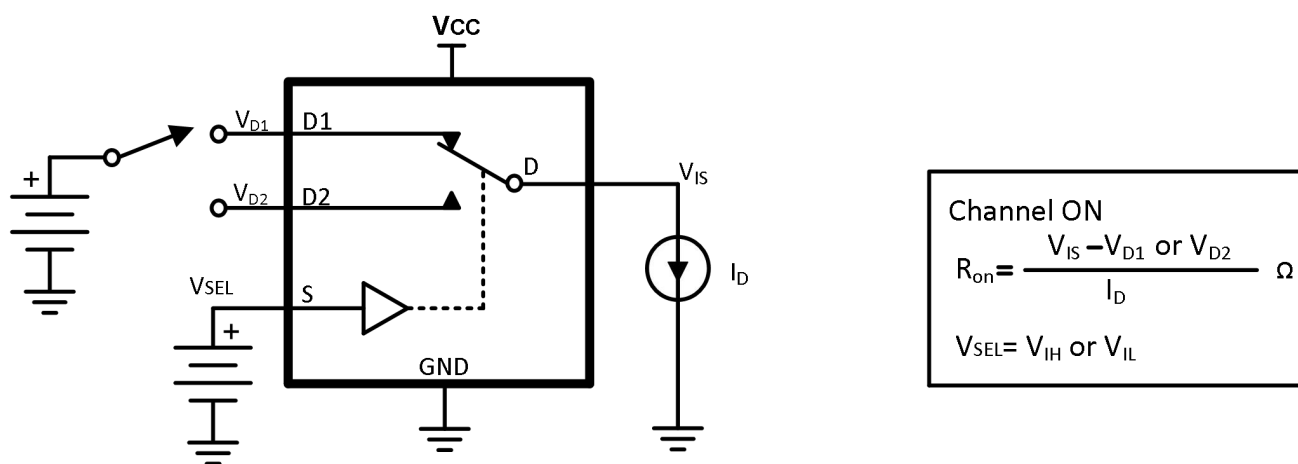


Figure 1. ON-State Resistance ( $R_{ON}$ )

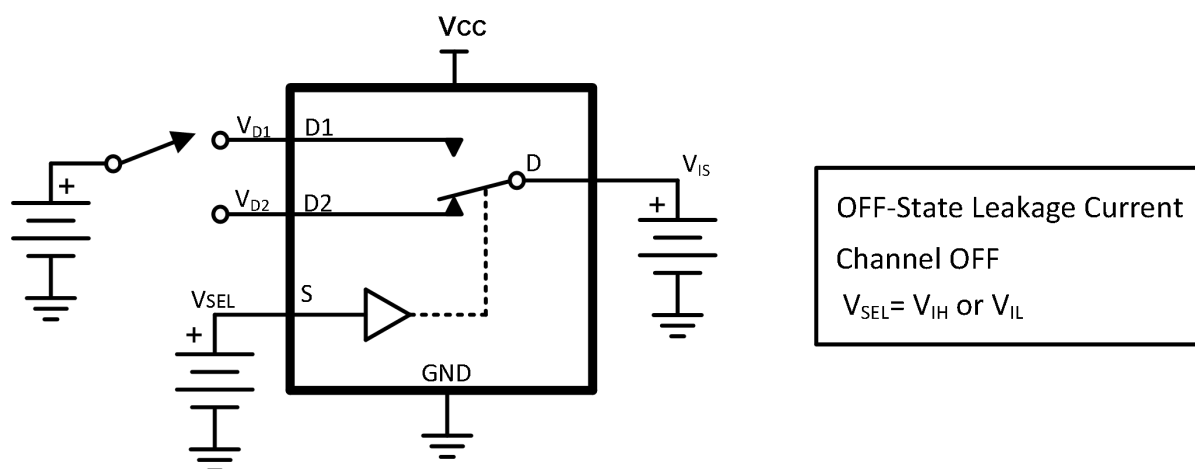
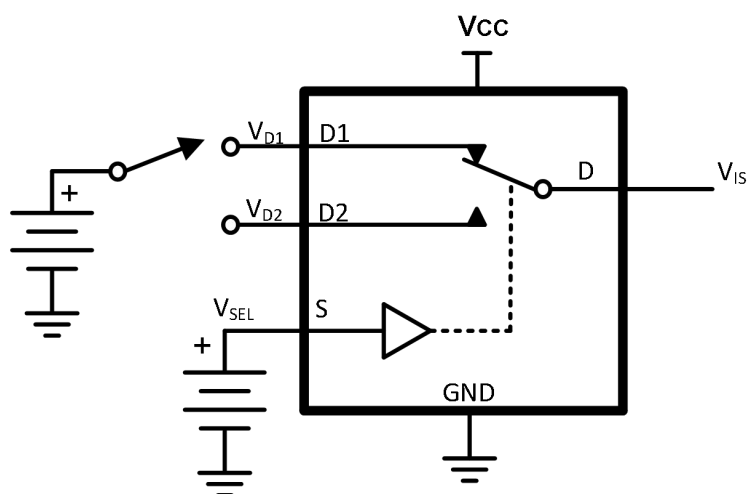
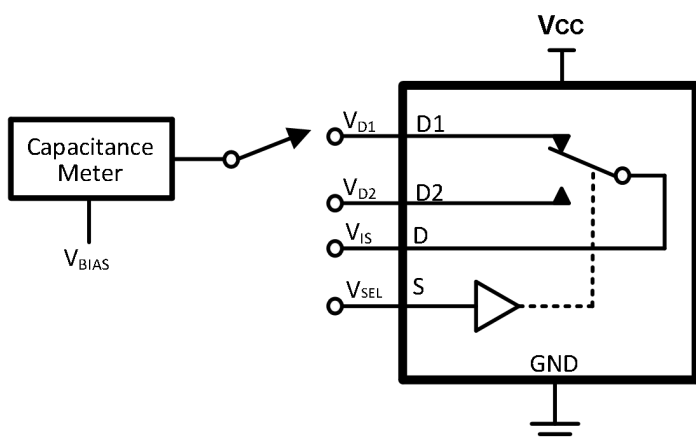


Figure 2. OFF-State Leakage Current



ON-State Leakage Current  
Channel ON  
 $V_{SEL} = V_{IH}$  or  $V_{IL}$

Figure 3. ON-State Leakage Current



$V_{BIAS} = V_{CC}$  or GND  
 $V_{SEL} = V_{CC}$  or GND  
Capacitance is measured at D1, D2, D, and S inputs during ON and OFF conditions.

Figure 4. Capacitance

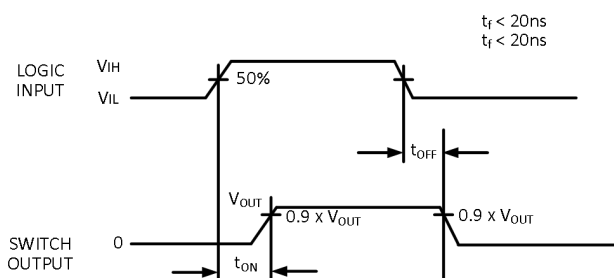
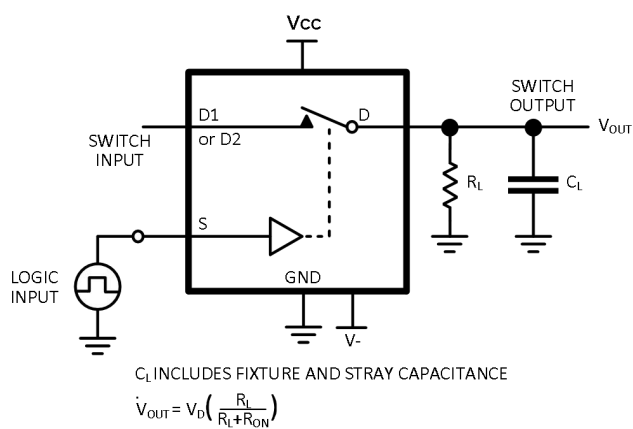


Figure 5. Turn-On ( $T_{ON}$ ) and Turn-Off Time ( $T_{OFF}$ )

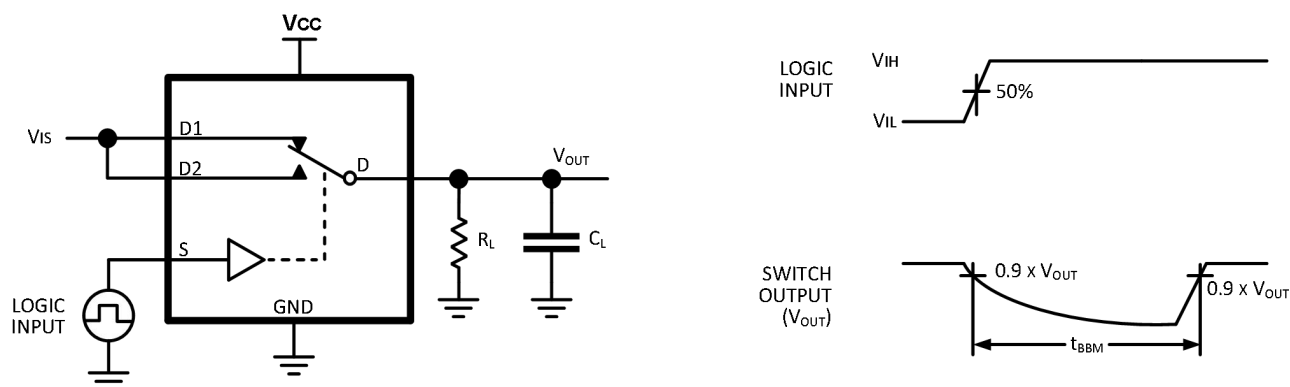


Figure 6. Break-Before-Make Time ( $T_{BBM}$ )

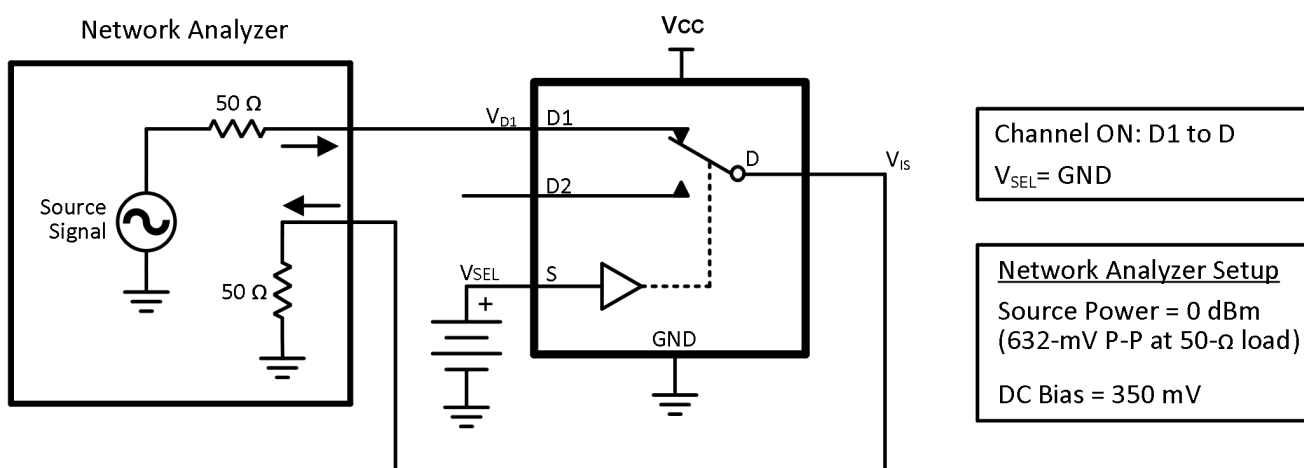


Figure 7. Bandwidth (BW)

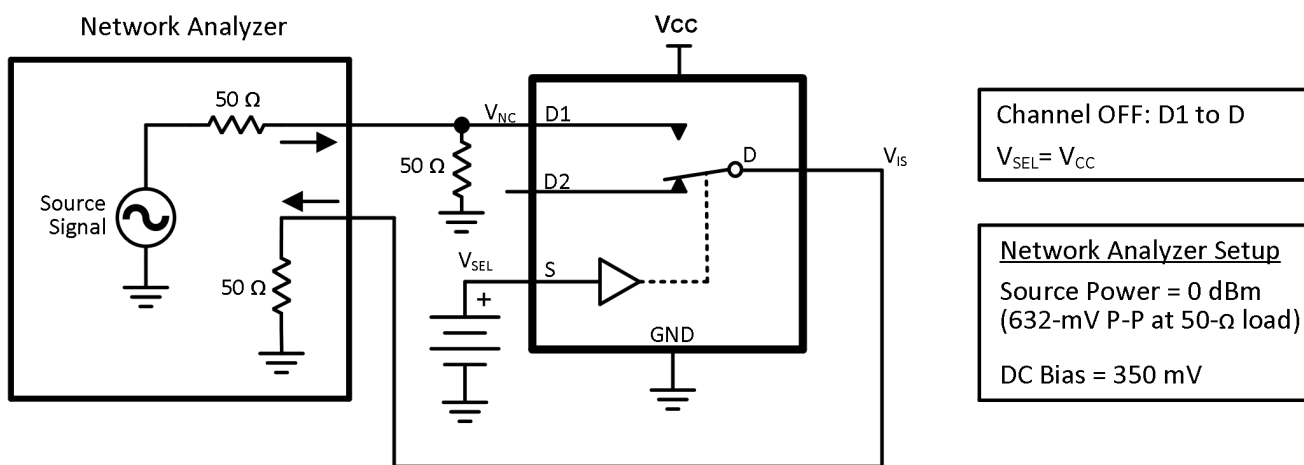


Figure 8. OFF Isolation ( $O_{ISO}$ )

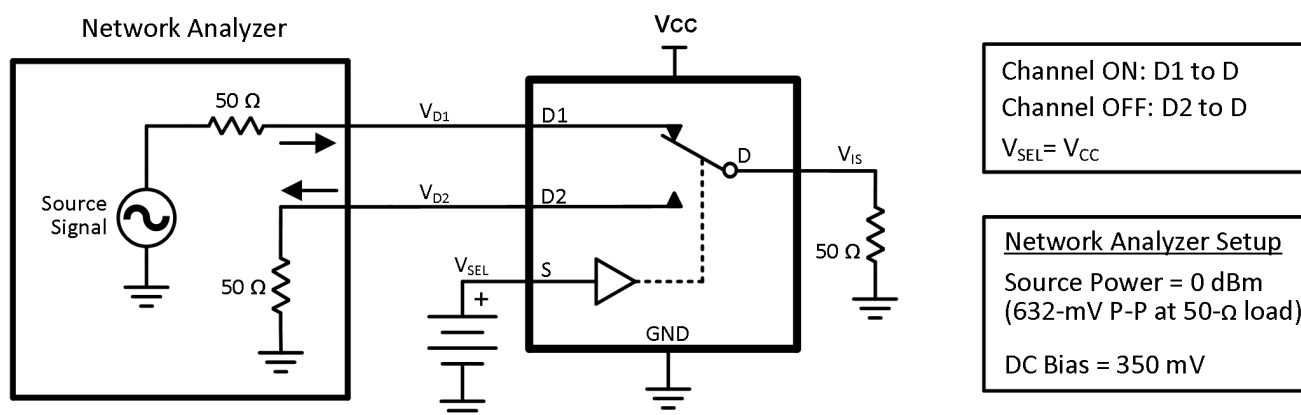


Figure 9. Crosstalk ( $X_{TALK}$ )

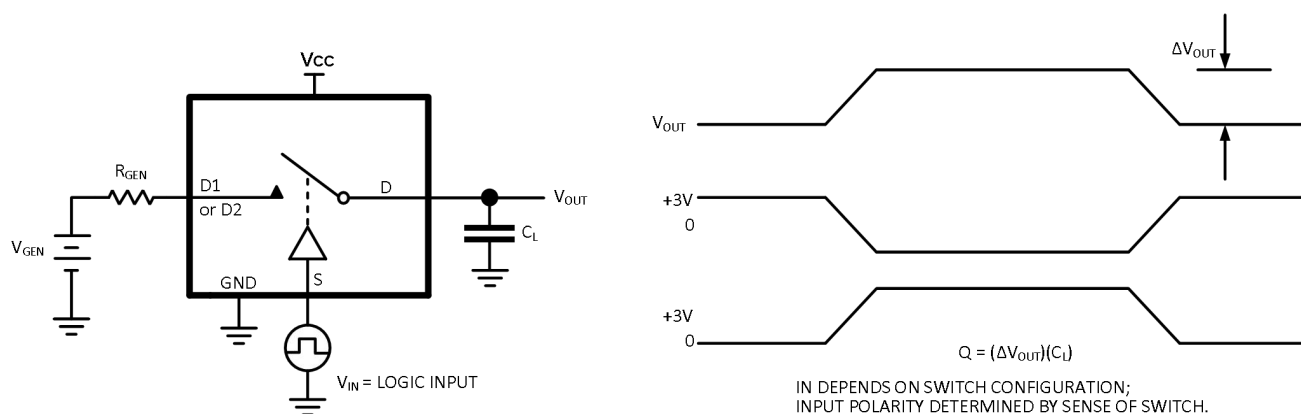


Figure 10. Charge Injection ( $Q_c$ )

## 5. Typical Application

COSTS3USB30E can be used to connect a single controller to two USB connectors or controllers as shown in Figure 11. There are many USB applications in which the USB hubs or controllers have a limited number of USB I/Os. The COSTS3USB30E can effectively expand the limited USB I/Os by switching between multiple USB buses in order to interface them to a single USB hub or controller.

The COSTS3USB30E can properly operate without any external components. However, it is recommended that unused pins be connected to ground through a 50-Ω resistor to prevent signal reflections back into the device. The digital control pins S and  $\overline{OE}$  should be pulled up to V<sub>CC</sub> or down to GND to avoid undesired switch positions that could result from the floating pin.

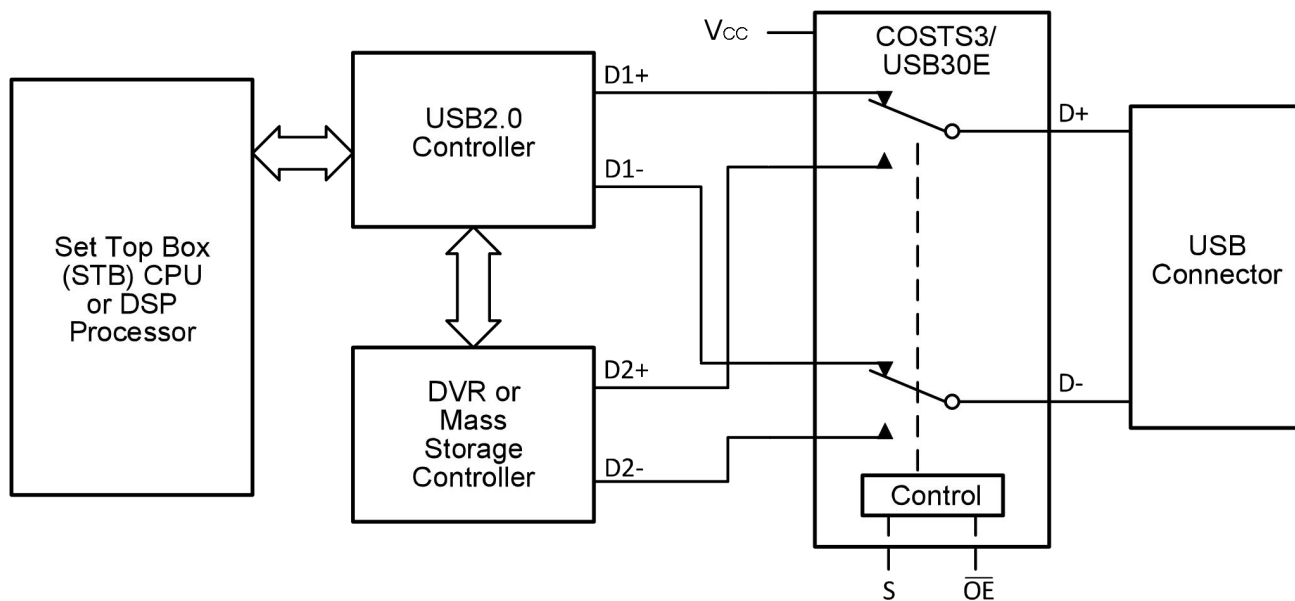
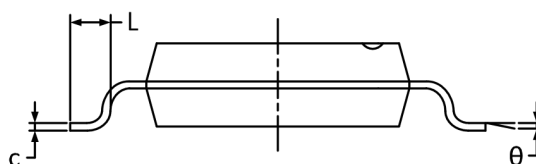
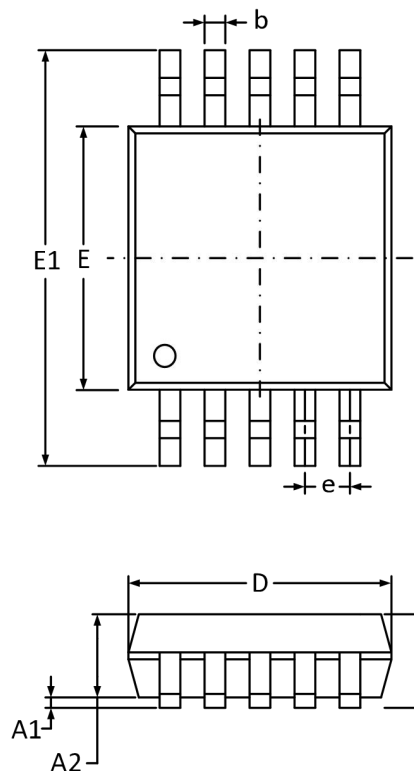


Figure 11. Typical Application Diagram

## 6. Package Information

### 6.1 MSOP10 (Package Outline Dimensions)



| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.820                        | 1.100 | 0.032                   | 0.043 |
| A1     | 0.020                        | 0.150 | 0.001                   | 0.006 |
| A2     | 0.750                        | 0.950 | 0.030                   | 0.037 |
| b      | 0.180                        | 0.280 | 0.007                   | 0.011 |
| c      | 0.090                        | 0.230 | 0.004                   | 0.009 |
| D      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E1     | 4.750                        | 5.050 | 0.187                   | 0.199 |
| e      | 0.500 BSC                    |       | 0.020 BSC               |       |
| L      | 0.400                        | 0.800 | 0.016                   | 0.031 |
| θ      | 0°                           | 6°    | 0°                      | 6°    |