

## General Description

The TP3USB31 is a Low-Power, Two-Port, High-Speed, USB2.0 (480Mbps) double-pole double-throw (DPDT) Analog Switch featuring an On-Resistance of  $4.5\Omega$  at  $V_{CC}=3V$  and a Low On Capacitance 3.7pF Typical.

The TP3USB31 is compatible with the requirements of USB2.0 and the wide bandwidth needed to pass the third harmonic, resulting in signals with minimum edge and phase distortion. Superior channel-to channel crosstalk also minimizes interference. Break-before-make function for both parts eliminates signal disruption during switching from preventing both switches being enabled simultaneously.

The TP3USB31 contains special circuitry on the switch I/O pins for applications where the  $V_{CC}$  supply is powered-off ( $V_{CC}=0$ ), which allows the device to withstand an over-voltage condition. This device is designed to minimize current consumption even when the control voltage applied to the Sel pin is lower than the supply voltage ( $V_{CC}$ ). This feature is especially valuable to ultra-portable applications, such as cell phones, allowing for direct interface with the general purpose I/Os of the baseband processor. Other applications include switching and connector sharing in portable cell phones, PDAs, digital cameras, printers, and notebook computers.

The TP3USB31 is available in TQFN10 (1.8x1.4) and MSOP10 packages.

## Applications

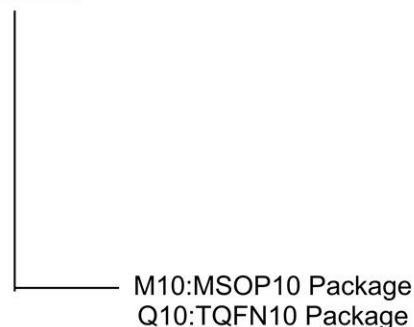
- Wide Power Supply Range: 2.3V to 5V
- Low On Capacitance 3.7pF Typical
- Low On Resistance  $4.5\Omega$  (typ.) at 3V  $V_{DD}$  when  $V_{SW}=0.4V$
- High Bandwidth (-3db):  $>720MHz$  without  $C_L$  and  $>550MHz$  with  $C_L=5pF$
- Low Power Consumption: 1uA Maximum
- ESD: pass 8kV HBM test
- Over voltage tolerance (OVT) on all USB ports up to 5.25V without external components
- TTL/CMOS Compatible
- Break-Before-Make Switching
- Operation Temperature Range:  $-40^{\circ}C$  to  $85^{\circ}C$
- Available in TQFN10 (1.8x1.4) and MSOP10 Packages

## Features

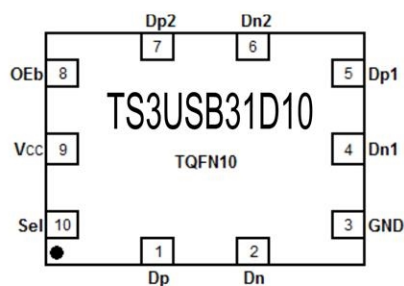
- Cell phone, PDAs, Digital camera, Notebook, LCD Monitor, TV, SET-TOP BOX

## Ordering Information

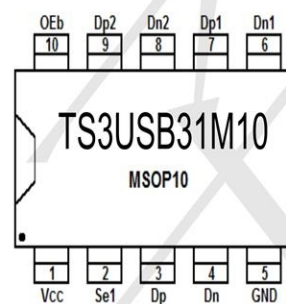
### TP3USB31D10



## PIN CONFIGURATION



Top View



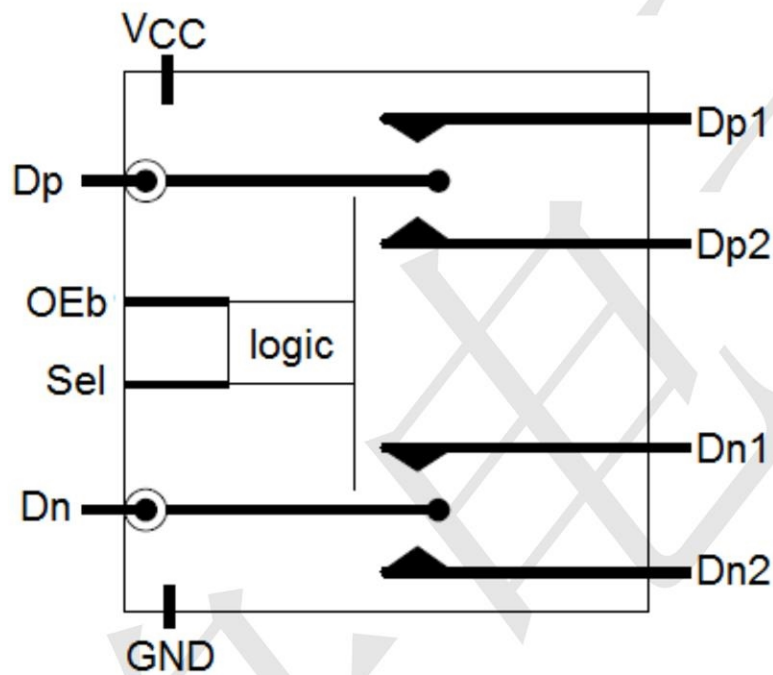
Top View

Pin #		Symbol	Type	Function
TQFN10	MSOP10			
5	7	Dp1	Input / Output	Data Port
7	9	Dp2	Input / Output	Data Port
1	3	Dp	Input / Output	USD Data BUS
3	5	GND	Ground	Ground
2	4	Dn	Input / Output	USD Data BUS
6	8	Dn2	Input / Output	Data Port
4	6	Dn1	Input / Output	Data Port
8	10	OEB	Input	Switch enable
9	1	Vcc	PWR	Power Supply
10	2	Sel	Input	Switch select

## FUNCTION TABLE

OEB	Sel	Function
1	X	Disconnect
0	0	Dp , Dn=Dp1, Dn1
0	1	Dp , Dn=Dp2, Dn2

## BLOCK DIAGRAM



## Absolute Maximum Ratings

$V_{CC}$ , DC Supply Voltage	-0.5V~5.5V
Dpn / Dnn / Dp / Dn, DC Switch Voltage	-0.5V~ $V_{CC}+0.3V$
$V_{Oeb}$ / $V_{Sel}$ , DC Input Voltage	-0.5V~ $V_{CC}$
$I_{(Dpn/Dnn/Dp/Dn)}$ , Continuous Current	-50mA~+50mA
$I_{PEAK(Dpn/Dnn/Dp/Dn)}$ , Peak Current <sup>NOTE1</sup>	-100mA ~+100mA
$T_A$ , Operating Temperature Range	-40°C~85°C

Stress beyond above listed "Absolute Maximum Ratings" may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE1: Pulsed at 1ms, 50% duty circle

## Electrical Characteristics

Typical characteristics are at +25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>Analog Switch</b>						
Analog Signal Range	$V_{Pn}/V_{Nn}/V_p/V_n$		0		$V_{CC}$	V
On-Resistance <sup>NOTE2</sup>	$R_{ON}$	$V_{CC} = 3V, V_{SW}=0.4V,$ $I_{ON}=-8mA$		4.5		$\Omega$
On-Resistance Match Between Channels <sup>NOTE3</sup>	$\Delta R_{ON}$	$V_{CC} = 3V, V_{SW}=0.4V,$ $I_{ON}=-8mA$		0.1		$\Omega$
<b>Current</b>						
Source Off Leakage Current	$I_{Pn} / Nn (OFF)$	$V_{CC}=3.6V, V_p/V_n= 3.6/0.3V,$ $V_{Pn}/V_{Nn}=0.3/3.6V$	-1		1	$\mu A$
Channel on Leakage Current	$I_{Pn} / Nn (ON)$	$V_{CC}=3.6V, V_p/V_n= 3.6/0.3V,$ $V_{Pn}/V_{Nn}=3.6/0.3V$	-1		1	$\mu A$
POWER OFF leakage current	$I_{OFF}$	$V_{CC} = 0V, V_{SW}=0V$ to 3.6V, $V_{control}=0$ or $V_{CC}$	-1		1	$\mu A$
Quiescent supply current	$I_{CC}$	$V_{CC}=3V,$ $V_{control}=0$ or $V_{CC}, I_{OUT}=0$			1	$\mu A$
Increase in ICC current per control voltage and $V_{CC}$	$I_{CC\Delta}$	$V_{CC}=3.6V, V_{control}=2.6V$			4	$\mu A$
Input Leakage Current	$I_{OEb} / Sel$	$V_{OEb} / Sel = 0$ or $V_{CC}$			1	$\mu A$
<b>Digital I/O</b>						
Input Voltage High	$V_{IH}$	$V_{CC} = 3.0$ to 3.6V	1.6			V
Input Voltage Low	$V_{IL}$	$V_{CC} = 3.0$ to 3.6V			0.5	V

NOTE2: Measured by the voltage drop between Dpn/Dnn and Dp/Dn pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two (Dpn/Dnn and Dp/Dn ports).

NOTE3:  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ , between Dp and Dn .

## DYNAMIC CHARACTERISTICS

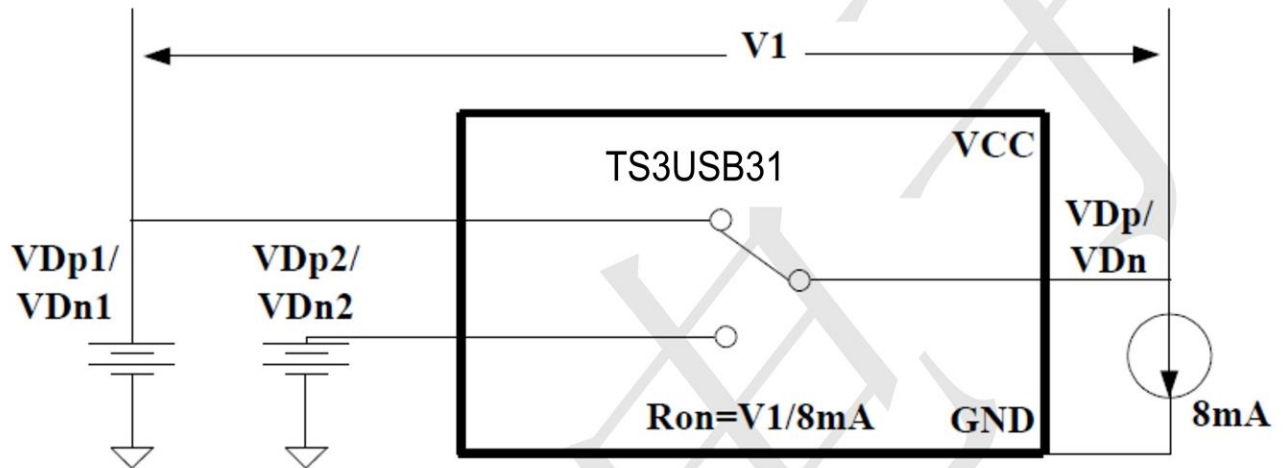
Typical characteristics are at 25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>DRIVER CHARACTERISTICS</b>						
Turn-On Time	$t_{ON}$	$V_{CC}=3.3V, R_L=50\Omega, C_L=5pF, V_{SW}=0.8V$		10	30	ns
Turn-Off Time	$t_{OFF}$	$V_{CC}=3.3V, R_L=50\Omega, C_L=5pF, V_{SW}=0.8V$		20	25	ns
Break-Before-Make Time	$t_{BBM}$	$V_{CC}=3.3V, R_L=50\Omega, C_L=5pF, V_{SW1,2}=0.8V$	2.0	3	6.5	ns
Propagation Delay	$t_{PD}$	$V_{CC}=3.3V, R_L=50\Omega, C_L=5pF$		0.2		ns
<b>CAPACITANCE</b>						
Control Capacitance	$C_{IN}$	$V_{CC}=0V$		1.5		pF
ON Capacitance	$C_{ON}$	$V_{CC}=3.3V, OE=0V, f=240MHz$		3.7		pF
OFF Capacitance	$C_{OFF}$	$V_{CC}=3.3V, OE=3.3V, f=240MHz$		2.0		pF
<b>APPLICATION CHARACTERISTICS</b>						
3dB Bandwidth	$f_{3dB}$	$V_{CC}=3.3V, R_L=50\Omega, C_L=0pF$		720		MHz
		$V_{CC}=3.3V, R_L=50\Omega, C_L=5pF$		550		MHz
Off Isolation <sup>NOTE4</sup>	$V_{ISO}$	$V_{CC}=3.3V, R_L=50\Omega, f=250MHz$		-30		dB
Channel crosstalk	XTALK	$V_{CC}=3.3V, R_L=50\Omega, f=250MHz$		-35		dB

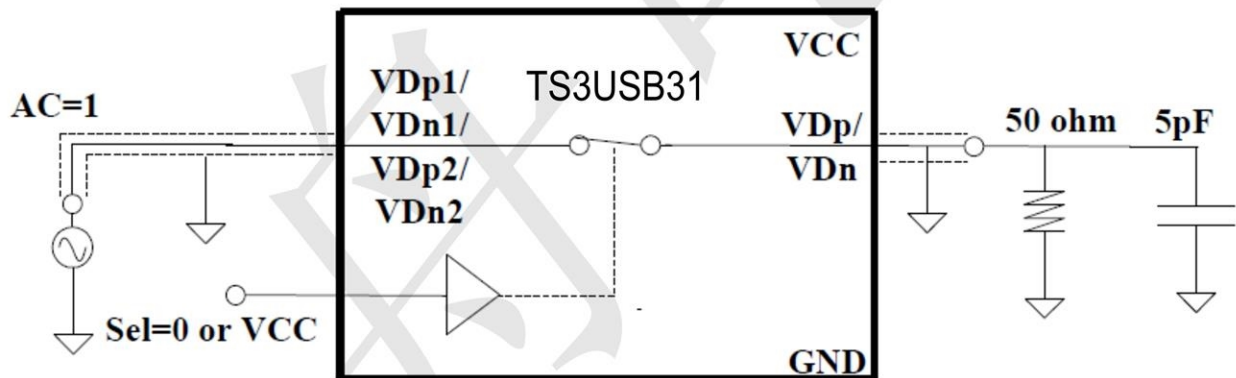
NOTE3: Off Channel Isolation =  $20\log_{10} [(V_{P1P2})/V_P]$  or  $20\log_{10} [(V_{N1N2})/V_N]$

**TEST CIRCUIT**

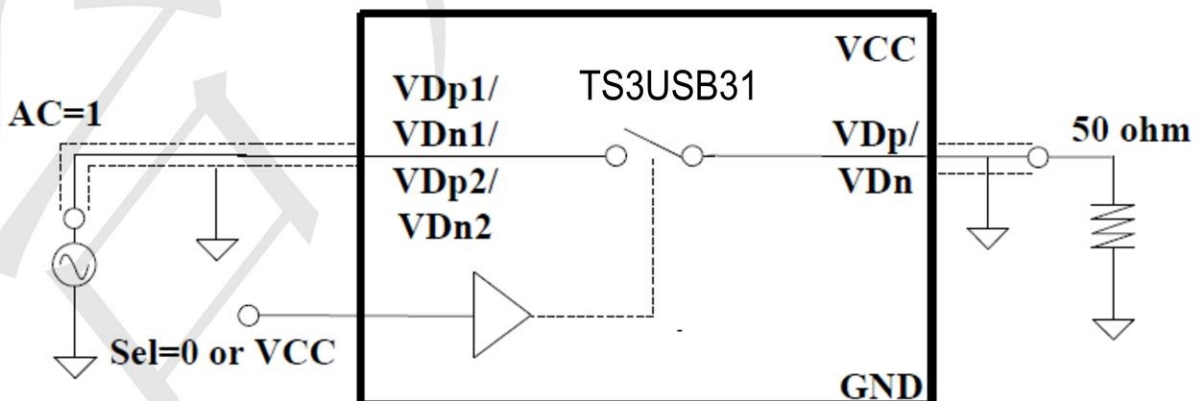
1. Test Circuit for On Resistor



2. Test Circuit for Bandwidth

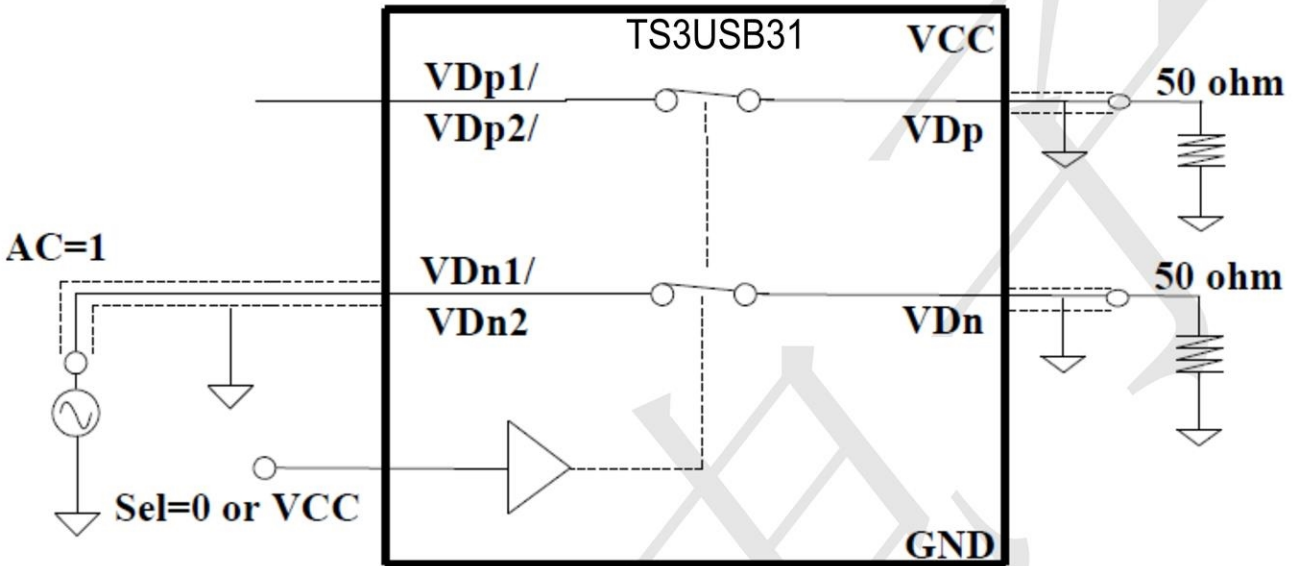


3. Test Circuit for Off Isolation

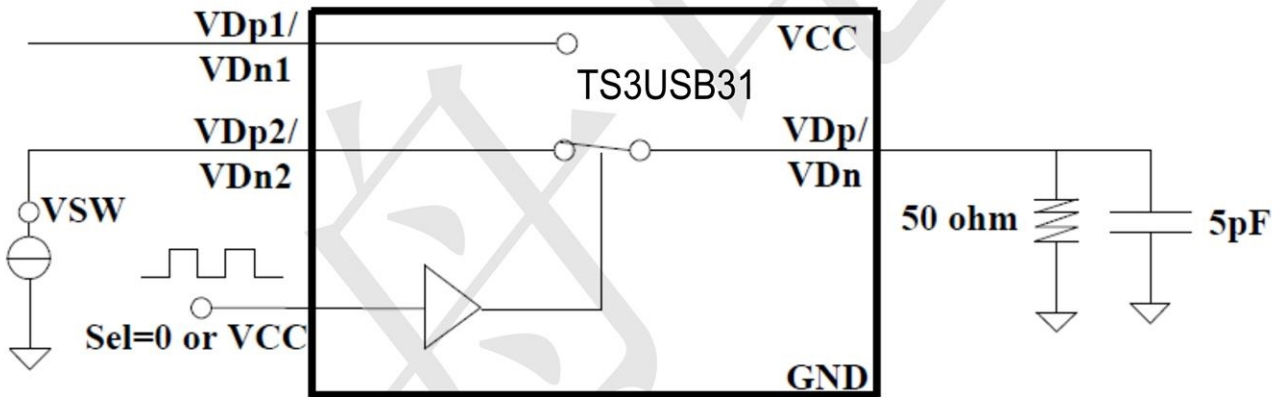




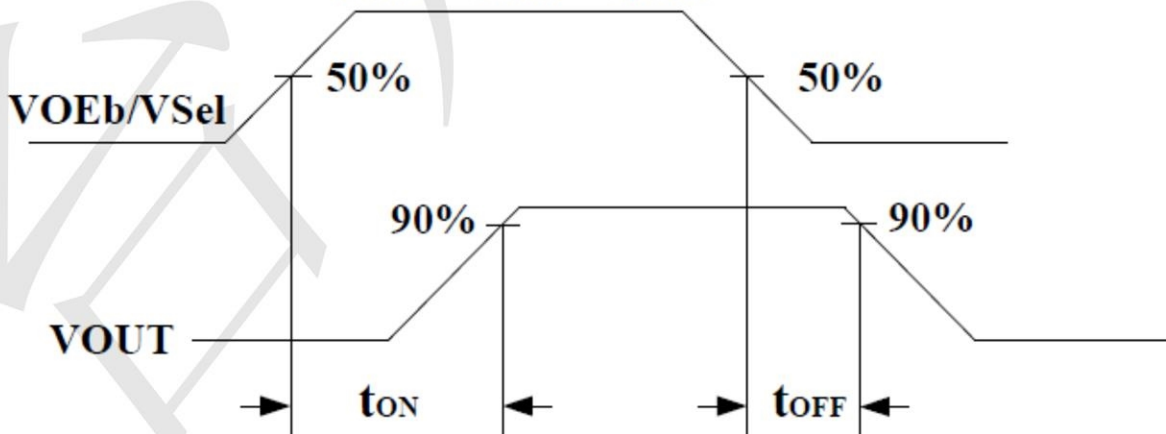
4. Test Circuit for Crosstalk



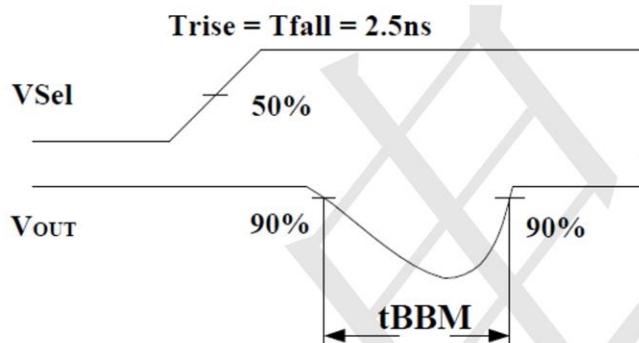
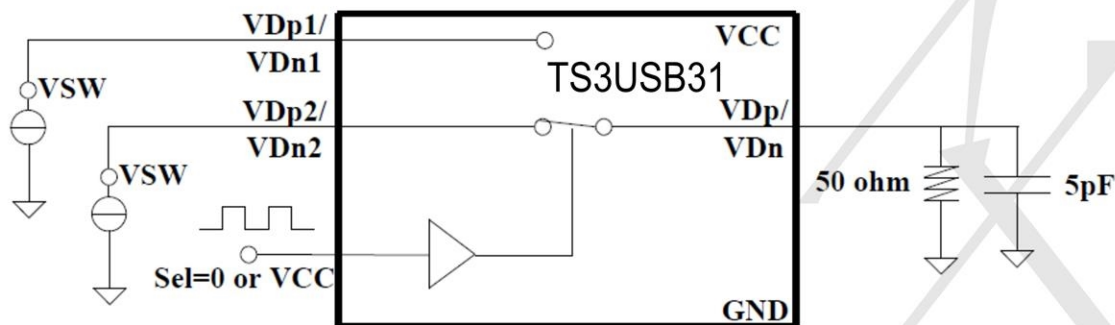
5. Test Circuit for Switch Times



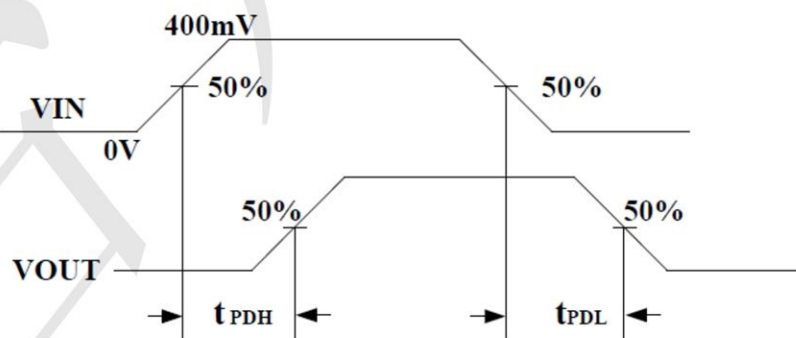
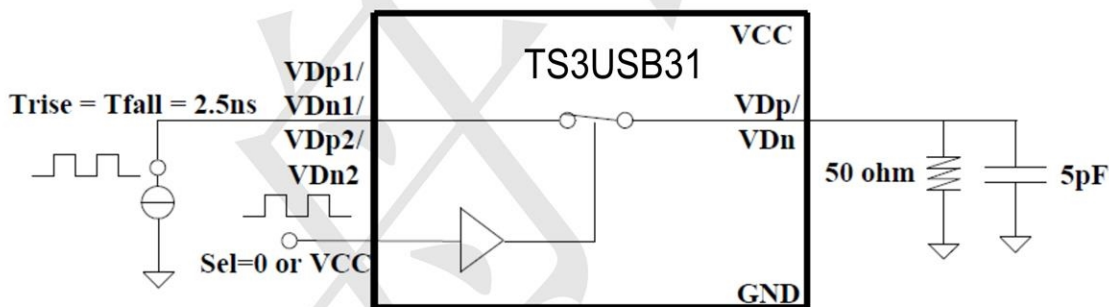
$Trise = Tfall = 2.5ns$



6. Test Circuit for Break-Before-Make Time Delay,  $t_{BBM}$

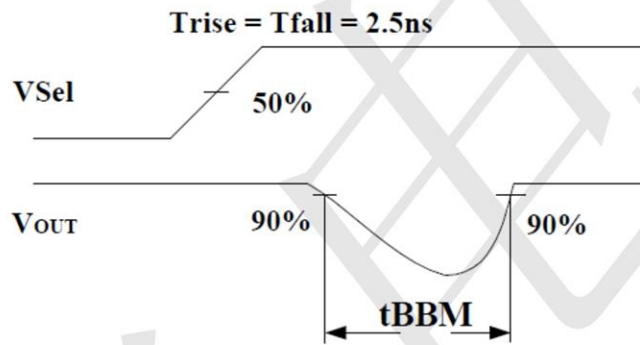
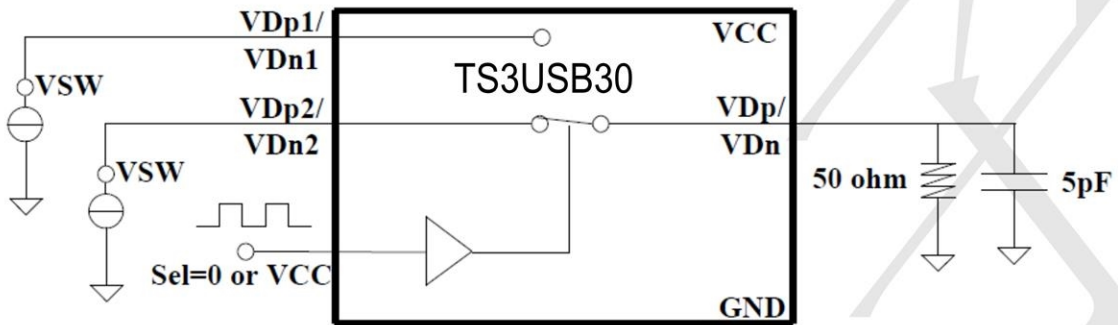


7. Test Circuit for Propagation Delay,  $T_{PD}$

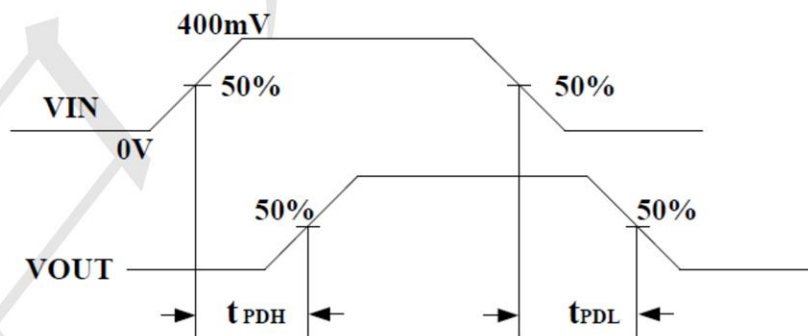
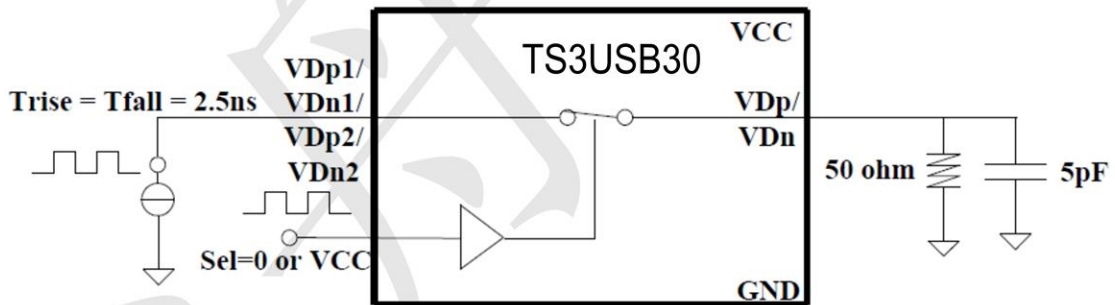




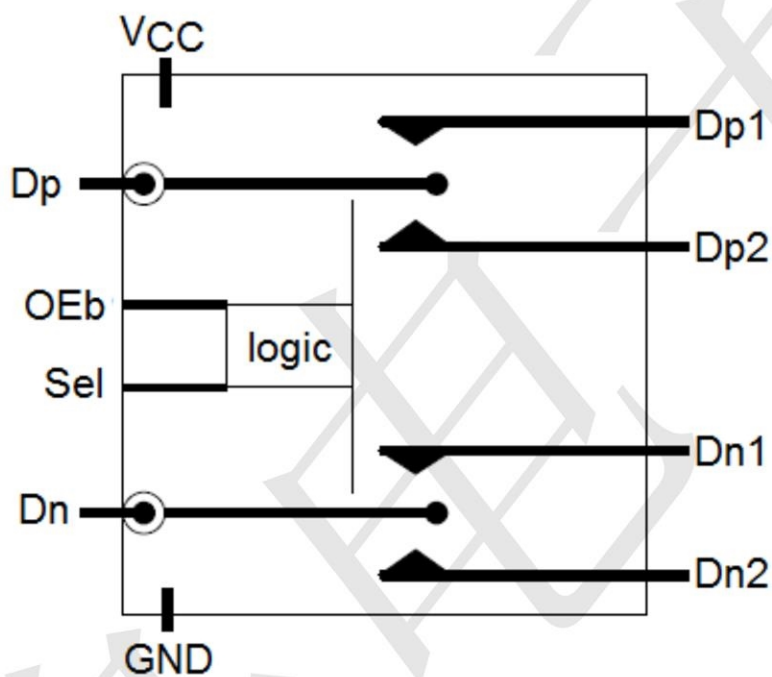
6. Test Circuit for Break-Before-Make Time Delay,  $t_{BBM}$



7. Test Circuit for Propagation Delay,  $T_{PD}$



**BLOCK DIAGRAM**



## DETAILED INFORMATION

### APPLICATION NOTE

#### Meeting USB 2.0 $V_{BUS}$ Short Requirements

#### Power-Off Protection

For a  $V_{BUS}$  short circuit the switch is expected to withstand such a condition for at least 24 hours. The TS3USB30 has the specially designed circuit which prevents unintended signal bleed through as well as guaranteed system reliability during a power-down, over-voltage condition. The protection has been added to the common pins (Dp, Dn).

#### Power-On Protection

The USB 2.0 specification also notes that the USB device should be capable of withstanding a  $V_{BUS}$  short during transmission of data. This modification works by limiting current flow back into the  $V_{CC}$  rail during the over-voltage event so current remains within the safe operating range.

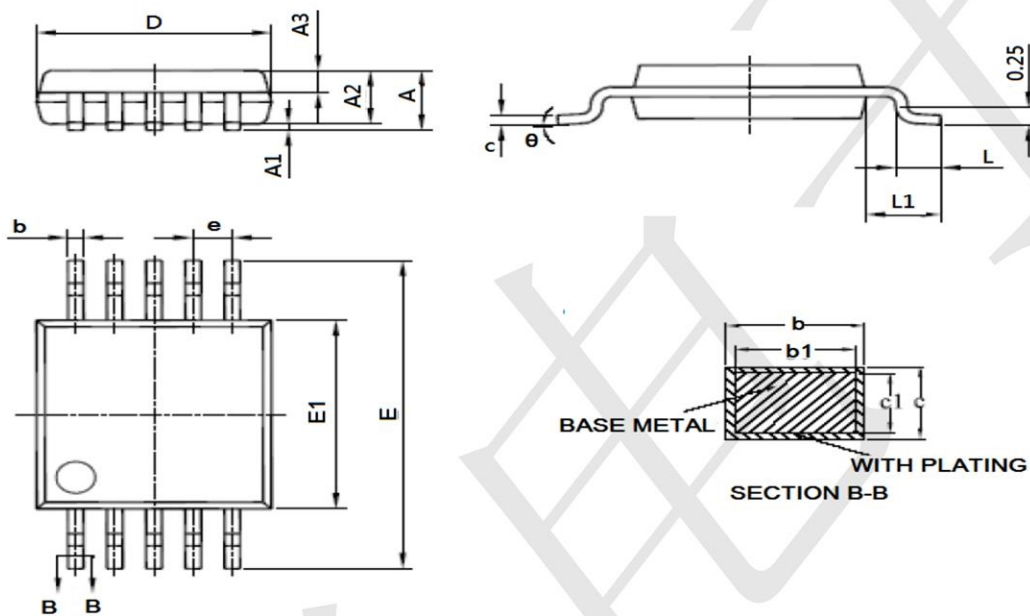
11

Time (250 $\mu$ s/Div)

Time (10 $\mu$ s/Div)

### Package information

Dimension in MSOP10 (1.8x1.4) (Unit: mm)



Symbol	Min	Max
A	-	1.100
A1	0.050	0.150
A2	0.750	0.950
A3	0.300	0.400
b	0.190	0.280
b1	0.180	0.230
c	0.150	0.200
c1	0.140	0.160
D	2.900	3.100
E	4.700	5.100
E1	2.900	3.100
e	0.500(BSC)	
L	0.400	0.700
L1	0.950(BSC)	
θ	0°	8°



### Package information

Dimension in TQFN10 (Unit: mm)

