ON Semiconductor®

FSUSB104 — Low-Power, Two-Port, Hi-Speed, USB2.0 (480 Mbps) Switch

Features

- Low On Capacitance: 3.7 pF Typical
- Low On Resistance: 3.9 Ω Typical
- Low Power Consumption: 1 µA Maximum
  - 15 µA Maximum I_{CCT} over an Expanded Voltage Range (V_{IN}=1.8 V, V_{CC}=4.3 V)
- Wide -3 db Bandwidth: > 720 MHz
- Packaged in Pb-free 10-Lead UMLP (1.4 x 1.8 mm)
- 8 kV ESD Rating, >16 kV Power/GND ESD Rating
- Power-Off Protection on All Ports When V_{CC}=0 V
  - D+/D- Pins Tolerate up to 5.25 V

Applications

- Cell phone, PDA, Digital Camera, and Notebook
- LCD Monitor, TV, and Set-Top Box

Description

The FSUSB104 is a bi-directional, low-power, two-port, Hi-Speed, USB2.0 switch. Configured as a double-pole, double-throw switch (DPDT) switch, it is optimized for switching between two Hi-Speed (480 Mbps) sources or a Hi-Speed and Full-Speed (12 Mbps) source.

The FSUSB104 is compatible with the requirements of USB2.0 and features an extremely low on capacitance (C_{ON}) of 3.7 pF. The wide bandwidth of this device (720 MHz) exceeds the bandwidth needed to pass the third harmonic, resulting in signals with minimum edge and phase distortion. Superior channel-to-channel crosstalk also minimizes interference.

The FSUSB104 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.

Ordering Information

Part Number	Top Mark	Operating Temperature Range	Package
FSUSB104UMX	JF	-40 to +85°C	10-Lead, Quad, Ultrathin Molded Leadless Package (UMLP), 1.4 x 1.8 mm

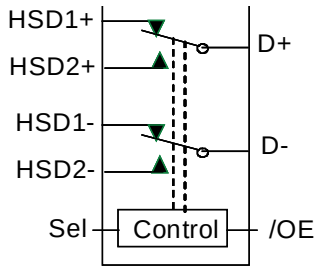


Figure 1. Analog Symbol

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Publication Order Number:
FSUSB104/D

Pin Assignments

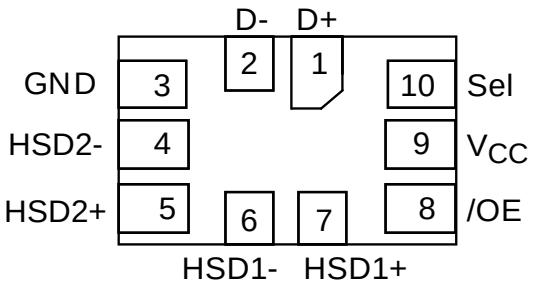


Figure 2. Pin Assignment (Top Through View)

Pin Definitions

Pin #	Name	Description
1	D+	USB Data Bus
2	D-	USB Data Bus
3	GND	Ground
4	HSD2-	Multiplexed Source Inputs
5	HSD2+	Multiplexed Source Inputs
6	HSD1-	Multiplexed Source Inputs
7	HSD1+	Multiplexed Source Inputs
8	/OE	Switch Enable
9	V_{CC}	Supply Voltage
10	Sel	Switch Select

Truth Table

Sel	/OE	Function
X	HIGH	Disconnect
LOW	LOW	D+, D-=HSD1+, HSD1-
HIGH	LOW	D+, D-=HSD2+, HSD2-

Absolute Maximum Ratings

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.

Symbol	Parameter		Min.	Max.	Unit
V_{CC}	Supply Voltage		-0.5	5.6	V
V_{CNTRL}	DC Input Voltage (S, /OE)[1]		-0.5	V_{CC}	V
V_{SW}	DC Switch I/O Voltage[1]		-0.5	5.25	V
I_{IK}	DC Input Diode Current		-50		mA
I_{OUT}	DC Output Current			50	mA
T_{STG}	Storage Temperature		-65	+150	°C
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins		7	kV
		I/O to GND		8	
		Power to GND		16	
	Charged Device Model, JEDEC: JESD22-C101			2	

Note:
1. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. ON Semiconductor does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
V_{CC}	Supply Voltage	3.0	4.4	V
V_{CNTRL}	Control Input Voltage (S, /OE)[2]	0	V_{CC}	V
V_{SW}	Switch I/O Voltage	-0.5	4.5	V
T_A	Operating Temperature	-40	+85	°C

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

DC Electrical Characteristics

All typical values are at 25°C unless otherwise specified.

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			-1.2	V
V_{IH}	Input Voltage High		3.0 to 3.6	1.3			V
			4.3	1.7			V
V_{IL}	Input Voltage Low		3.0 to 3.6			0.5	V
			4.3			0.7	V
I_{IN}	Control Input Leakage	V_{SW}=0 to V_{CC}	4.3	-1		1	µA
I_{OZ}	Off State Leakage	0 ≤ Dn, HSD1n, HSD2n ≤ 3.6V	4.3	-2		2	µA
I_{OFF}	Power-Off Leakage Current (All I/O Ports)	V_{SW}=0 V to 4.3 V, V_{CC}=0 V Figure 4	0	-2		2	µA
R_{ON}	HS Switch On Resistance(3)	V_{SW}=0.4 V, I_{ON}=-8 mA Figure 3,	3.0		3.9	6.5	Ω
ΔR_{ON}	HS Delta Ron(4)	V_{SW}=0.4 V, I_{ON}=-8 mA	3.0		0.65		Ω
I_{CC}	Quiescent Supply Current	V_{CNTRL}=0 or V_{CC}, I_{OUT}=0	4.3			1.0	µA
I_{CCT}	Increase in I_{CC} Current per Control Voltage and V_{CC}	V_{CNTRL}=2.6 V, V_{CC}=4.3 V	4.3			10.0	µA
		V_{CNTRL}=1.8 V, V_{CC}=4.3 V	4.3			15.0	µA

Notes:

3. Measured by the voltage drop between HSDn and Dn pins at the indicated current through the switch. On resistance is determined by the lower of the voltage on the two (HSDn or Dn ports).
4. Guaranteed by characterization. Not tested in production.

AC Electrical Characteristics

All typical value are for V_{CC}=3.3 V at 25°C unless otherwise specified.

Symbol	Parameter	Conditions	V_{CC} (V)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
t_{ON}	Turn-On Time S, /OE to Output	R_L=50 Ω, C_L=5 pF V_{SW}=0.8 V Figure 5, Figure 6	3.0 to 3.6		13	30	ns
t_{OFF}	Turn-Off Time S, /OE to Output	R_L=50 Ω, C_L=5 pF V_{SW}=0.8 V Figure 5, Figure 6	3.0 to 3.6		12	25	ns
t_{PD}	Propagation Delay(5)	C_L=5 pF, R_L=50 Ω Figure 5, Figure 7	3.3		0.25		ns
t_{BBM}	Break-Before-Make	R_L=50 Ω, C_L=5 pF V_{SW1}=V_{SW2}=0.8 V Figure 9	3.0 to 3.6	2.0		6.5	ns
O_{IRR}	Off Isolation	R_L=50 Ω, f=240 MHz Figure 11	3.0 to 3.6		-30		dB
Xtalk	Non-Adjacent Channel Crosstalk	R_L=50 Ω, f=240 MHz Figure 12	3.0 to 3.6		-45		dB
BW	-3db Bandwidth	R_L=50 Ω, C_L=0 pF Figure 10	3.0 to 3.6		720		MHz
		R_L=50 Ω, C_L=5 pF Figure 10			550		MHz

Note:
5. Guaranteed by characterization. Not tested in production.

USB Hi-Speed-Related AC Electrical Characteristics

Symbol	Parameter	Conditions	Vcc (V)	T_A=- 40ºC to +85ºC			Units
				Min.	Typ.	Max.	
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output(6)	C_L=5 pF, R_L=50 Ω Figure 8	3.0 to 3.6		20		ps
t_J	Total Jitter(6)	R_L=50 Ω, C_L=5 pf, t_R=t_F=500ps (10-90%) at 480 Mbps (PRBS=2^{15} – 1)	3.0 to 3.6		200		ps

Note:
6. Guaranteed by characterization. Not tested in production.

Capacitance

Symbol	Parameter	Conditions	T_A=- 40ºC to +85ºC			Units
			Min.	Typ.	Max.	
C_{IN}	Control Pin Input Capacitance	V_{CC}=0 V		1.5		pF
C_{ON}	D+/D- On Capacitance	V_{CC}=3.3 V, /OE=0 V, f=240 MHz Figure 14		3.7		
C_{OFF}	D1n, D2n Off Capacitance	V_{CC} and /OE=3.3 V See Figure 13		2.0		

Test Diagrams

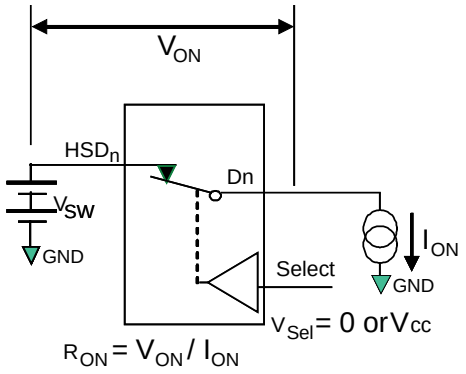
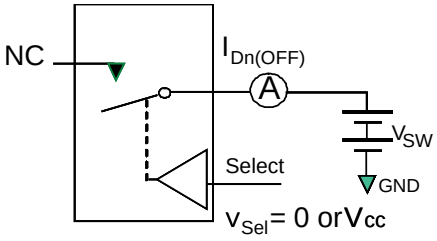
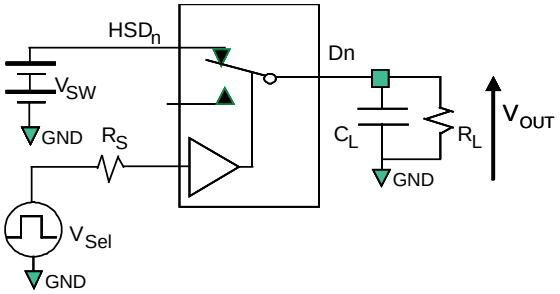


Figure 3. On Resistance



**Each switch port is tested separately

Figure 4. Off Leakage



R_L, R_S, and C_L are functions of the application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance.

Figure 5. AC Test Circuit Load

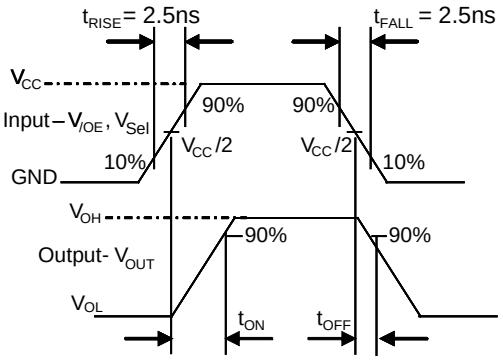


Figure 6. Turn-On / Turn-Off Waveforms

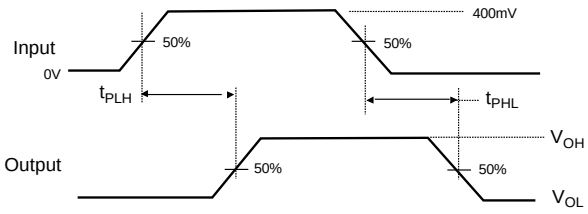


Figure 7. Propagation Delay ($t_R t_F$ – 500 ps)

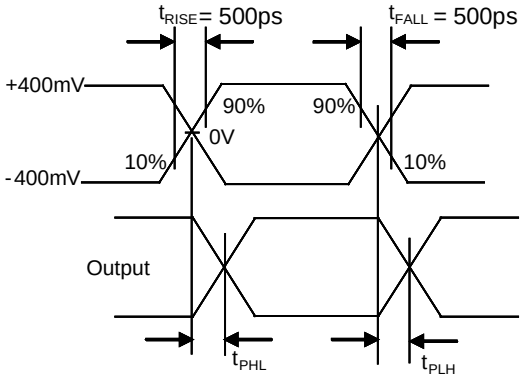
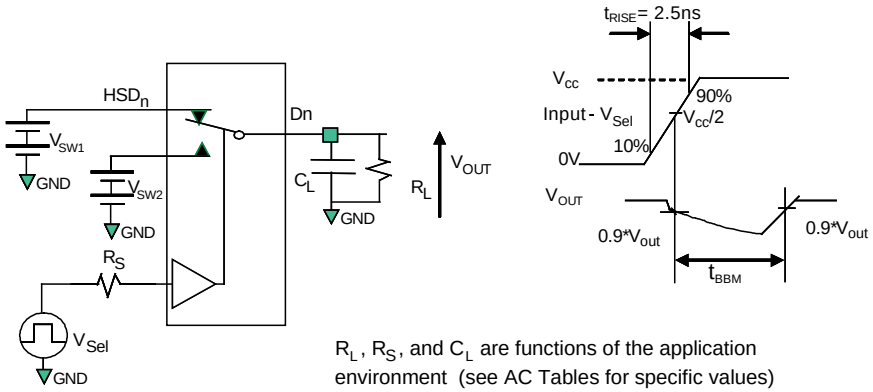


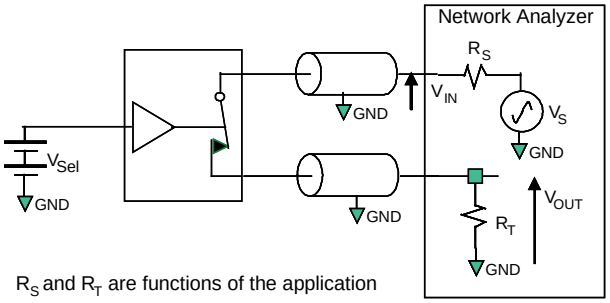
Figure 8. Intra-Pair Skew Test $t_{SK(P)}$

Test Diagrams (Continued)



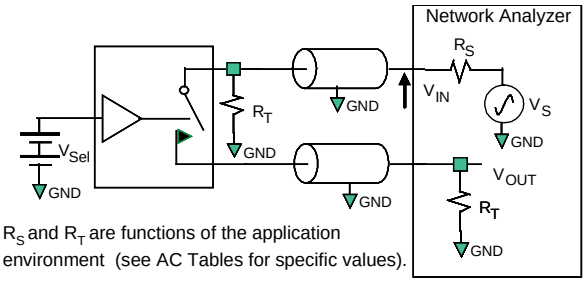
R_L, R_S, and C_L are functions of the application environment (see AC Tables for specific values)
C_L includes test fixture and stray capacitance.

Figure 9. Break-Before-Make Interval Timing



R_S and R_T are functions of the application environment (see AC Tables for specific values).

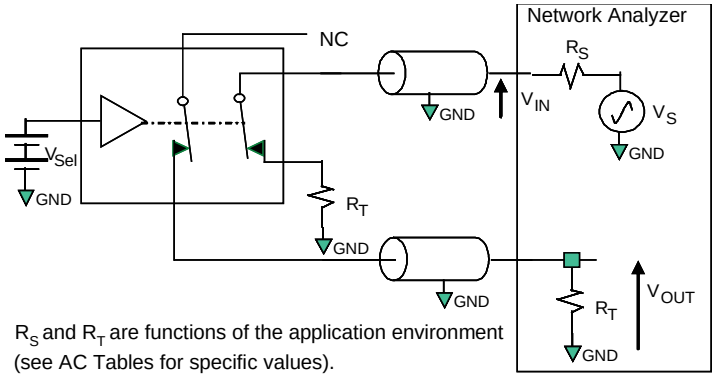
Figure 10. Bandwidth



R_S and R_T are functions of the application environment (see AC Tables for specific values).

Off isolation = 20 Log (V_{OUT} / V_{IN})

Figure 11. Channel Off Isolation



R_S and R_T are functions of the application environment (see AC Tables for specific values).

Crosstalk = 20 Log (V_{OUT} / V_{IN})

Figure 12. Non-Adjacent Channel-to-Channel Crosstalk

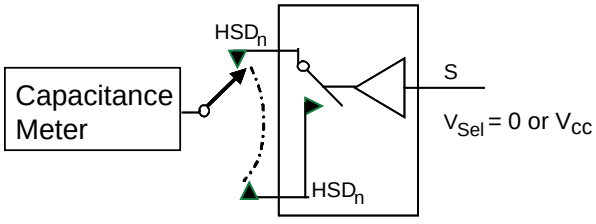


Figure 13. Channel Off Capacitance

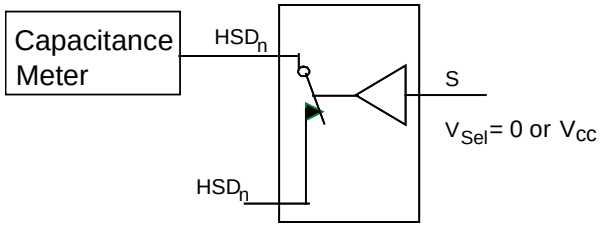
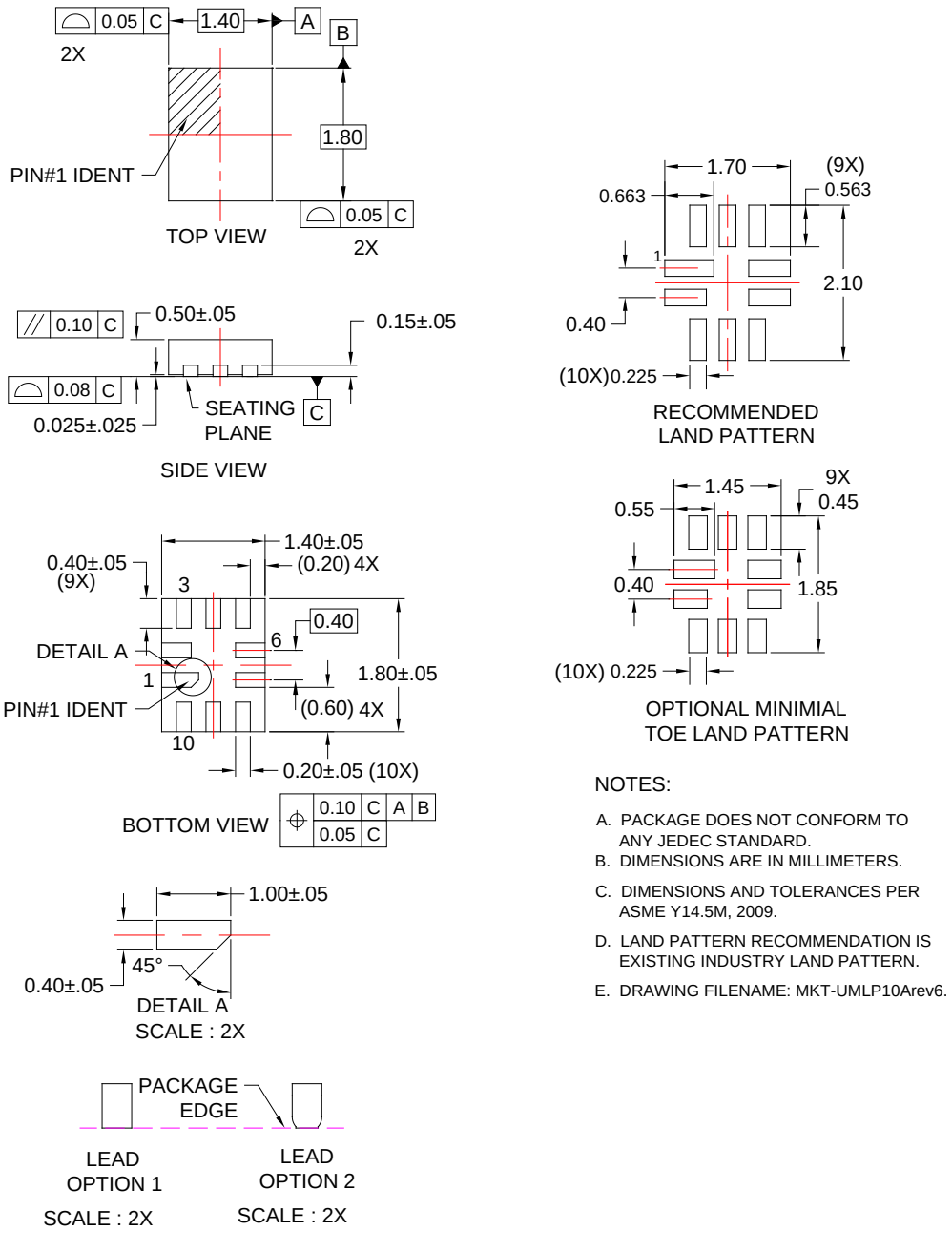


Figure 14. Channel On Capacitance

Physical Dimensions



NOTES:

A. PACKAGE DOES NOT CONFORM TO ANY JEDEC STANDARD.
B. DIMENSIONS ARE IN MILLIMETERS.
C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 2009.
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Figure 15. 10-Lead, Ultrathin Molded Leadless Package (UMLP)

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