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# FSA3041 High-Speed 4:1 USB2.0 / MHL™ / Audio / UART Switch

## Features

- Low On Capacitance: 4.2 pF / 7.5 pF MHL / USB (Typical)
- Low Power Consumption: 30  $\mu$ A Maximum
- Supports MHL Rev. 2.0
- MHL Data Rate: 3.8 Gbps
- LINOUT Swing: -1.5 V to +3.0 V (Typical)
- USB 2.0 Compliant
- Packaged in 16-Lead UMLP (1.8 x 2.6 mm)
- Over-Voltage Tolerance on All USB Ports: Up to 5.25 V without External Components

## Applications

- Cell Phones
- Digital Cameras

## Description

The FSA3041 is a bi-directional, low-power, high-speed, 4:1, USB2.0, MHL™, UART, and audio switch. Configured as a Double-Pole, Four-Throw (DP4T) switch; it is optimized for switching between high- or full-speed USB, Mobile High-Definition Link sources (MHL Rev. 2.0 specification), UART, and negative-swing capable audio. In addition, either USB 2.0 path can be used as a UART path.

The FSA3041 contains circuitry on the switch I/O pins, for applications where the  $V_{CC}$  supply is powered off ( $V_{CC} = 0$  V), that allows the device to withstand an over-voltage condition. This switch is designed to minimize current consumption even when the control voltage applied to the control pins is lower than the supply voltage ( $V_{CC}$ ). This is especially valuable in mobile applications, such as cell phones, allowing direct interface with the general-purpose I/Os of the baseband processor. Other applications include switching and connector sharing in portable cell phones, digital cameras, and notebook computers.

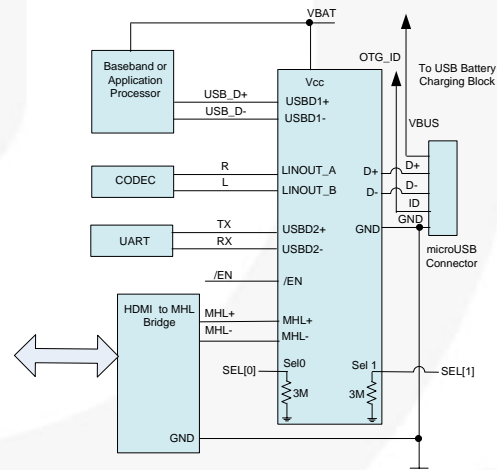


Figure 1. Typical Application

## Ordering Information

Part Number	Top Mark	Operating Temperature Range	Package
FSA3041UMX	LZ	-40 to +85°C	16-Lead, Ultrathin Molded Leadless Package (UMLP), 1.8 mm x 2.6 mm

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## Pin Configuration

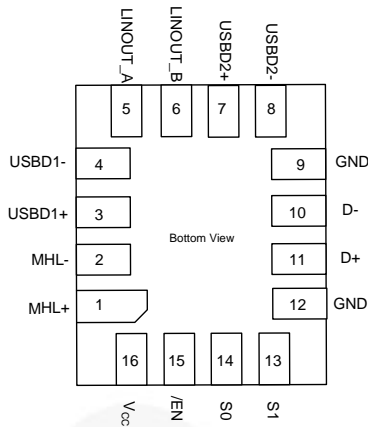


Figure 2. Pin Assignments

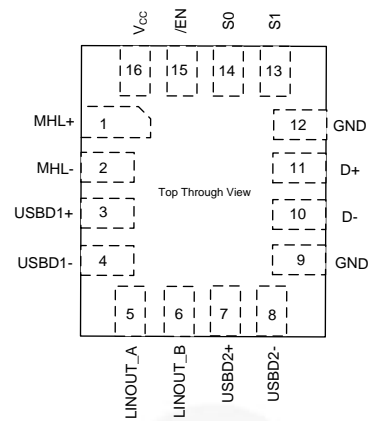


Figure 3. Top Through View

## Pin Definitions

Pin#	Name	Description
1	MHL+	MHL Differential Data (Positive)
2	MHL-	MHL Differential Data (Negative)
3	USB D1+	USB Differential Data (Positive). Can also be used as additional UART.
4	USB D1-	USB Differential Data (Negative). Can also be used as additional UART.
5	LINOUT_A	Audio
6	LINOUT_B	Audio
7	USB D2+	USB Differential Data (Positive). Can be used as a UART port (see Figure 1).
8	USB D2-	USB Differential Data (Negative). Can be used as a UART port (see Figure 1).
9	GND	Ground
10	D-	USB Differential Data (Negative), Common Port
11	D+	USB Differential Data (Positive), Common Port
12	GND	Ground
13	SEL1	Data Switch Select (see Table 1)
14	SEL0	Data Switch Select (see Table 1)
15	/EN	Enable Pin - Active LOW
16	V <sub>CC</sub>	Device Power from System (Typically V <sub>BAT</sub> )

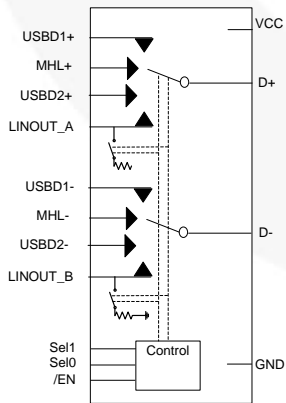


Figure 4. Analog Symbol

Table 1. Data Switch Select Truth Table

SEL1 <sup>(1)</sup>	SEL0 <sup>(1)</sup>	Shunt	/EN <sup>(1)</sup>	Function
0	0	Enabled	0	D+/D- connected to USB D1+/USB D1- (or UART) path
0	1	Enabled	0	D+/D- connected to USB D2+/USB D2- (or UART) path
1	0	Enabled	0	D+/D- connected to MHL+/MHL- path
1	1	Disabled	0	D+/D- connected to LINOUT_A/LINOUT_B audio path
X	X	Disabled	1	D+/D- high impedance

**Note:**

- Control inputs should never be left floating or unconnected. To guarantee default switch closure to the USB position, the SEL[0:1] pins are tied to GND with internal weak pull-down resistors (3MΩ) to minimize static current draw.

## 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 <sub>CC</sub>	Supply Voltage	-0.5	5.5	V	
V <sub>CNTRL</sub>	DC Input Voltage (/EN, SEL[1:0]) <sup>(2)</sup>	-0.5	V <sub>CC</sub>	V	
V <sub>SW</sub> <sup>(3)</sup>	DC Switch I/O Voltage <sup>(2)</sup>	USB, MHL, UART	-0.5	V <sub>CC</sub>	V
		Audio (Active)	-2.0	3.0	
		Audio (Inactive)	-2.0	V <sub>CC</sub>	
I <sub>IK</sub>	DC Input Diode Current	-50		mA	
I <sub>OUT</sub>	Switch DC Output Current (Continuous)	USB, MHL, UART		60	mA
		Audio		60	mA
I <sub>OUTPEAK</sub>	Switch DC Output Peak Current (Pulsed at 1ms Duration, <10% Duty Cycle)	USB, MHL, UART		150	mA
		Audio		150	mA
T <sub>STG</sub>	Storage Temperature	-65	+150	°C	
MSL	Moisture Sensitivity Level: JEDEC J-STD-020A		1		
ESD	Human Body Model, JEDEC: JESD22-A114	All Pins		4	kV
	IEC 61000-4-2, Level 4, for D+/D- and V <sub>CC</sub> Pins <sup>(4)</sup>	Contact		8	
	IEC 61000-4-2, Level 4, for D+/D- and V <sub>CC</sub> Pins <sup>(4)</sup>	Air		15	
	Charged Device Model, JESD22-C101			2	

### Notes:

- The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.
- V<sub>SW</sub> refers to analog data switch paths (USB, MHL, and audio).
- Testing performed in a system environment using TVS diodes.

## 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. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

Symbol	Parameter	Min.	Max.	Unit
V <sub>CC</sub>	Supply Voltage	2.5	4.5	V
t <sub>RAMP(VCC)</sub>	Power Supply Slew Rate	100	1000	μs/V
V <sub>CNTRL</sub>	Control Input Voltage (/EN, SEL[1:0]) <sup>(5)</sup>	0	4.5	V
V <sub>SW(USB)</sub>	Switch I/O Voltage (USB Switch Path)	-0.5	3.6	V
θ <sub>JA</sub>	Thermal Resistance		273	C°/W
V <sub>SW(MHL)</sub>	Switch I/O Voltage (MHL Switch Path)	1.65	3.45	V
V <sub>SW(AUD)</sub>	Switch I/O Voltage (Audio Switch Path)	-1.5	3.0	V
V <sub>SW(UART)</sub>	Switch I/O Voltage (UART Switch Path)	-0.5	3.6	V
T <sub>A</sub>	Operating Temperature	-40	+85	°C

### Note:

- The control inputs must be held HIGH or LOW; they must not float.

## DC Electrical Characteristics

All typical value are at  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Condition	V <sub>CC</sub> (V)	T <sub>A</sub> =-40°C to +85°C			Unit
				Min.	Typ.	Max.	
V <sub>IK</sub>	Clamp Diode Voltage	I <sub>IN</sub> =-18 mA	2.5			-1.2	V
V <sub>IH</sub>	Control Input Voltage HIGH	SEL[1:0]	2.5	1.3			V
			3.6	1.4			V
			4.5	1.5			V
V <sub>IL</sub>	Control Input Voltage LOW	SEL[1:0]	2.5			0.4	V
			3.6			0.4	V
			4.5			0.4	V
I <sub>IN</sub>	Control Input Leakage SEL[1:0]	V <sub>SW</sub> (MHL & USB)=0 to 3.6 V, V <sub>SW</sub> (AUD)=0 to 3 V, V <sub>CNTRL</sub> =0 to V <sub>CC</sub>	4.5	-2.5		2.5	μA
I <sub>OZ(MHL)</sub>	Off-State Leakage for Open MHL Data Paths	V <sub>SW</sub> =1.65 ≤ MHL ≤ 3.45 V, /EN=V <sub>CC</sub> , Figure 6	4.5	-0.5		0.5	μA
I <sub>OZ(USB, UART)</sub>	Off-State Leakage for Open USB Data Paths	V <sub>SW</sub> =0 ≤ USB, UART ≤ 3.6 V, /EN=V <sub>CC</sub> , Figure 6	4.5	-0.5		0.5	μA
I <sub>CL(MHL)</sub>	On-State Leakage for Closed MHL Data Paths <sup>(6)</sup>	V <sub>SW</sub> =1.65 ≤ MHL ≤ 3.45 V, /EN=GND, SEL0=GND, SEL1=V <sub>CC</sub>	4.5	-0.5		0.5	μA
I <sub>CL(USB, UART)</sub>	On-State Leakage for Closed USB Data Paths <sup>(6)</sup>	V <sub>SW</sub> =0 ≤ USB, UART ≤ 3.6 V, /EN=GND, SEL[1:0]=GND and SEL1=GND, SEL0=V <sub>CC</sub>	4.5	-0.5		0.5	μA
I <sub>CL(AUD)</sub>	On-State Leakage for Closed <sup>(6)</sup> Audio Data Path	V <sub>SW</sub> =0 ≤ LINOUT ≤ 3.0 V, SEL[1:0]=V <sub>CC</sub>	4.5	-1		1	μA
I <sub>OFF</sub>	Power-Off Leakage Current (USB, MHL, Audio Paths)	V <sub>SW</sub> =0V or 3.6 V, Figure 6	0	-1		1	μA
R <sub>ON(USB)</sub>	HS Switch On Resistance (USB <sub>Dn</sub> to D <sub>n</sub> Path)	V <sub>SW</sub> =0.4V, I <sub>ON</sub> =-8 mA, SEL[1:0]=GND, and SEL1=GND, SEL0=V <sub>CC</sub> Figure 5	2.5 to 4.5		7		Ω
R <sub>ON(MHL)</sub>	HS Switch On Resistance (MHL to D Path)	V <sub>SW</sub> =V <sub>CC</sub> -1050 mV, SEL0=GND, SEL1=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		5		Ω
R <sub>ON(AUD)</sub>	Audio Switch On Resistance (LINOUT Path)	V <sub>SW</sub> =-1.5V to 1.5V, SEL[1:0]=V <sub>CC</sub> , I <sub>ON</sub> =-24 mA, Figure 5	2.5 to 4.5		7		Ω
R <sub>ON(UART)</sub>	UART Switch On Resistance (UART Path)	V <sub>SW</sub> =0V to 3.6 V, SEL[1:0]=GND and SEL1=GND, SEL0=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		8.5		Ω
ΔR <sub>ON(MHL)</sub>	Difference in R <sub>ON</sub> Between MHL Positive-Negative	V <sub>SW</sub> =V <sub>CC</sub> -1050 mV, SEL0=GND, SEL1=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5,	2.5 to 4.5		0.03		Ω
ΔR <sub>ON(USB)</sub>	Difference in R <sub>ON</sub> Between USB Positive-Negative	V <sub>SW</sub> =0.4V, I <sub>ON</sub> =-8 mA, SEL[1:0]=GND and SEL1=GND, SEL0=V <sub>CC</sub> , Figure 5	2.5 to 4.5		0.18		Ω
ΔR <sub>ON(AUD)</sub>	Difference in R <sub>ON</sub> Between LINOUT	V <sub>SW</sub> =1.5 V, SEL[1:0]=V <sub>CC</sub> , I <sub>ON</sub> =-24 mA, Figure 5	2.5 to 4.5		0.1		Ω
ΔR <sub>ON(UART)</sub>	Difference in R <sub>ON</sub> Between UART	V <sub>SW</sub> =1.5 V, SEL[1:0]=GND, and SEL1=GND, SEL0=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		0.1		Ω

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## DC Electrical Characteristics

All typical value are at  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Condition	V <sub>CC</sub> (V)	T <sub>A</sub> =-40°C to +85°C			Unit
				Min.	Typ.	Max.	
R <sub>ONF(MHL)</sub>	Flatness for R <sub>ON</sub> MHL Path	V <sub>SW</sub> =1.65 to 3.45 V, SEL0=GND, SEL1=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		1		Ω
R <sub>ONFA(AUDIO)</sub>	Flatness for R <sub>ON</sub> Audio (LINUX) Path	V <sub>SW</sub> =-1.5 V to 1.5 V, SEL[1:0]=V <sub>CC</sub> , I <sub>ON</sub> =-24 mA, Figure 5	2.5 to 4.5		0.1		Ω
R <sub>ONFT(UART)</sub>	Flatness for R <sub>ON</sub> UART Path	V <sub>SW</sub> =0 V to 3.6 V, SEL[1:0]=GND and SEL1=GND, SEL0=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		1.9		Ω
R <sub>ONFD(USB)</sub>	Flatness for R <sub>ON</sub> USB Path	V <sub>SW</sub> =0V to 3.6 V, SEL[1:0]=GND and SEL1=GND, SEL0=V <sub>CC</sub> , I <sub>ON</sub> =-8 mA, Figure 5	2.5 to 4.5		1.9		Ω
R <sub>PD</sub>	Internal Pull-Down Resistors on SEL0 & SEL1		2.5 to 4.5		3		MΩ
R <sub>SH</sub>	Shunt Resistance		3.6		100	200	Ω
I <sub>CC</sub>	Quiescent Current	V <sub>CNTRL</sub> =0 or 4.5 V, I <sub>OUT</sub> =0	4.5			30	μA
I <sub>CCZ</sub>	Quiescent Current-High Impedance	V <sub>EN</sub> =4.5 V, I <sub>OUT</sub> =0	4.5			1	μA
I <sub>CCT</sub>	Delta Increase in Quiescent Current per Control Pin	V <sub>CNTRL</sub> =1.65 V, I <sub>OUT</sub> =0	4.5			10	μA
		V <sub>CNTRL</sub> =2.5 V, I <sub>OUT</sub> =0	4.5			5	

**Note:**

6. For this test, the data switch is closed with the respective switch pin floating.

## AC Electrical Characteristics

All typical values are for V<sub>CC</sub> = 3.3 V and T<sub>A</sub> = 25°C unless otherwise specified.

Symbol	Parameter	Condition	V <sub>CC</sub> (V)	T <sub>A</sub> =-40°C to +85°C			Unit
				Min.	Typ.	Max.	
t <sub>ONUSB</sub>	USB Turn-On Time, SEL[1:0] to Output	R <sub>L</sub> =50 Ω, C <sub>L</sub> =5 pF, V <sub>SW(USB)</sub> =0.8 V, V <sub>SW(MHL)</sub> =3.3 V, V <sub>SW(AUD)</sub> =1.5V, V <sub>SW(UART)</sub> =3.3 V, Figure 7, Figure 8	2.5 to 4.5		445	600	ns
t <sub>OFFUSB</sub>	USB Turn-Off Time, SEL[1:0] to Output	R <sub>L</sub> =50 Ω, C <sub>L</sub> =5 pF, V <sub>SW(USB)</sub> =0.8 V, V <sub>SW(MHL)</sub> =3.3 V, V <sub>SW(AUD)</sub> =1.5 V, V <sub>SW(UART)</sub> =3.3 V, Figure 7, Figure 8	2.5 to 4.5		445	600	ns
t <sub>ONAUD</sub>	Audio Turn-On Time, SEL[1:0] to Output	R <sub>L</sub> =50 Ω, C <sub>L</sub> =5 pF, V <sub>SW(USB)</sub> =0.8 V, V <sub>SW(MHL)</sub> =3.3 V, V <sub>SW(AUD)</sub> =1.5 V, V <sub>SW(UART)</sub> =3.3 V, Figure 7, Figure 8	2.5 to 4.5		445	600	ns
t <sub>OFFAUD</sub>	Audio Turn-Off Time, SEL[1:0] to Output	R <sub>L</sub> =50 Ω, C <sub>L</sub> =5 pF, V <sub>SW(USB)</sub> =0.8 V, V <sub>SW(MHL)</sub> =3.3 V, V <sub>SW(AUD)</sub> =1.5 V, V <sub>SW(UART)</sub> =3.3 V, Figure 7, Figure 8	2.5 to 4.5		445	600	ns
t <sub>ONMHL</sub>	MHL Turn-On Time, SEL[1:0] to Output	R <sub>L</sub> =50 Ω to 3.3 V, C <sub>L</sub> =5 pF, V <sub>SW(USB)</sub> =0.8 V, V <sub>SW(MHL)</sub> =3.3 V, V <sub>SW(AUD)</sub> =1.5 V, V <sub>SW(UART)</sub> =3.3 V, Figure 7, Figure 8	2.5 to 4.5		445	600	ns

## AC Electrical Characteristics

All typical values are for  $V_{CC} = 3.3\text{ V}$  and  $T_A = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Condition	$V_{CC}$ (V)	$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$			Unit
				Min.	Typ.	Max.	
$t_{\text{OFFMHL}}$	MHL Turn-Off Time, SEL[1:0] to Output	$R_L=50\ \Omega$ to 3.3 V, $C_L=5\ \text{pF}$ , $V_{\text{SW(USB)}}=0.8\ \text{V}$ , $V_{\text{SW(MHL)}}=3.3\ \text{V}$ , $V_{\text{SW(AUD)}}=1.5\ \text{V}$ , $V_{\text{SW(UART)}}=3.3\ \text{V}$ , Figure 7, Figure 8	2.5 to 4.5		445	600	ns
$t_{\text{ONUART}}$	UART Turn-On Time, SEL[1:0] to Output	$R_L=5\ \text{k}\Omega$ , $C_L=5\ \text{pF}$ , $V_{\text{SW(USB)}}=0.8\ \text{V}$ , $V_{\text{SW(MHL)}}=3.3\ \text{V}$ , $V_{\text{SW(AUD)}}=1.5\ \text{V}$ , $V_{\text{SW(UART)}}=3.3\ \text{V}$ , Figure 7, Figure 8	2.5 to 4.5		445	600	ns
$t_{\text{OFFUART}}$	UART Turn-Off Time, SEL[1:0] to Output	$R_L=5\ \text{k}\Omega$ , $C_L=5\ \text{pF}$ , $V_{\text{SW(USB)}}=0.8\ \text{V}$ , $V_{\text{SW(MHL)}}=3.3\ \text{V}$ , $V_{\text{SW(AUD)}}=1.5\ \text{V}$ , $V_{\text{SW(UART)}}=3.3\ \text{V}$ , Figure 7, Figure 8	2.5 to 4.5		445	600	ns
$t_{\text{ENABLE}}$	Enable Turn-On Time, /EN to Output	$R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{\text{SW(USB)}}=0.8\ \text{V}$ , $V_{\text{SW(MHL)}}=3.3\ \text{V}$ , $V_{\text{SW(AUD)}}=1.5\ \text{V}$ , $V_{\text{SW(UART)}}=3.3\ \text{V}$ , Figure 7, Figure 8	2.5 to 4.5		70		$\mu\text{s}$
$t_{\text{DISABLE}}$	Disable Turn-Off Time, /EN to Output	$R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{\text{SW(USB)}}=0.8\ \text{V}$ , $V_{\text{SW(MHL)}}=3.3\ \text{V}$ , $V_{\text{SW(AUD)}}=1.5\ \text{V}$ , $V_{\text{SW(UART)}}=3.3\ \text{V}$ , Figure 7, Figure 8	2.5 to 4.5		35		ns
$t_{\text{PD}}$	Propagation Delay <sup>(7)</sup>	$C_L=5\ \text{pF}$ , $R_L=50\ \Omega$ , Figure 7, Figure 9	2.5 to 4.5		0.25		ns
$t_{\text{BBM}}$	Break-Before-Make <sup>(7)</sup>	$R_L=50\ \Omega$ , $C_L=5\ \text{pF}$ , $V_{\text{AUD}}=1.5\ \text{V}$ , $V_{\text{MHL}}=3.3\ \text{V}$ , $V_{\text{USB}}=0.8\ \text{V}$ , $V_{\text{UART}}=3.3\ \text{V}$ , Figure 11	2.5 to 4.5	50	120	425	ns
$O_{\text{IRR(MHL)}}$	Off Isolation <sup>(7)</sup>	$V_S=1\ \text{V}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=240\ \text{MHz}$ , Figure 13	2.5 to 4.5		-36		dB
$O_{\text{IRR(USB)}}$		$V_S=400\ \text{mV}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=240\ \text{MHz}$ , Figure 13	2.5 to 4.5		-38		dB
$O_{\text{IRR(UART)}}$		$V_S=3.6\ \text{V}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=10\ \text{MHz}$ , Figure 13	2.5 to 4.5		-38		dB
$X_{\text{talkMHL}}$	Non-Adjacent Channel Crosstalk <sup>(7)</sup>	$V_S=1\ \text{V}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=240\ \text{MHz}$ , Figure 14	2.5 to 4.5		-44		dB
$X_{\text{talkUSB}}$		$V_S=400\ \text{mV}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=240\ \text{MHz}$ , Figure 14	2.5 to 4.5		-32		dB
$X_{\text{talkAUD}}$		$V_S=100\ \text{mV}_{\text{RMS}}$ , $R_L=32\ \Omega$ , $f=20\ \text{kHz}$ , Figure 14	2.5 to 4.5		-70		dB
$X_{\text{talkUART}}$		$V_S=400\ \text{mV}_{\text{pk-pk}}$ , $R_L=50\ \Omega$ , $f=10\ \text{MHz}$ , Figure 14	2.5 to 4.5		-70		dB
THD	Total Harmonic Distortion - LINOUT	$R_T=600\ \Omega$ , $V_{\text{SW}}=2\ \text{V}_{\text{pk-pk}}$ , $f=20\ \text{Hz}$ to $20\ \text{kHz}$ , $V_{\text{BIAS}}=0\ \text{V}$	2.5 to 4.5		0.01		%
BW	S <sub>DD21</sub> Differential - 3db Bandwidth <sup>(7)</sup>	$V_{\text{IN}}=1\ \text{V}_{\text{pk-pk}}$ , Common Mode Voltage= $V_{CC}-1.1\ \text{V}$ , MHL Path, $R_L=50\ \Omega$ , $C_L=0\ \text{pF}$ , Figure 12	2.5 to 4.5		1.9		GHz
		$V_{\text{IN}}=400\ \text{mV}_{\text{pk-pk}}$ , Common Mode Voltage= $0.2\ \text{V}$ , USB Path, $R_L=50\ \Omega$ , $C_L=0\ \text{pF}$ , Figure 12			640 <sup>(8)</sup>		MHz
	Single Ended	Audio Path, $R_L=50\ \Omega$ , $C_L=0\ \text{pF}$			5		

**Note:**

7. Guaranteed by characterization.
8. Passed USB 2.0 Compliant Test

## USB High-Speed AC Electrical Characteristics

Typical values are at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 3.0$  to  $3.6$  V.

Symbol	Parameter	Condition	Typ.	Unit
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output <sup>(9)</sup>	$C_L=5$ pF, $R_L=50$ $\Omega$ , Figure 10	3	ps
$t_J$	Total Jitter <sup>(9)</sup>	$R_L=50$ $\Omega$ , $C_L=5$ pf, $t_R=t_F=500$ ps (10-90%) at 480 Mbps, PN7	26	ps

**Note:**

9. Guaranteed by characterization.

## MHL™ AC Electrical Characteristics

Typical values are at  $T_A = 25^\circ\text{C}$  and  $V_{CC} = 3.0$  to  $3.6$  V.

Symbol	Parameter	Condition	Typ.	Unit
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output <sup>(10)</sup>	$R_{PU}=50$ $\Omega$ to $V_{CC}$ , $C_L=0$ pF	3	ps
$t_J$	Total Jitter <sup>(10)</sup>	$f=2.25$ Gbps, PN7, $R_{PU}=50$ $\Omega$ to $V_{CC}$ , $C_L=0$ pF	18	ps

**Note:**

10. Guaranteed by characterization.

## Capacitance

Typical values are at  $T_A = 25^\circ\text{C}$ .

Symbol	Parameter	Condition	Typ.	Unit
$C_{IN}$	Control Pin Input Capacitance <sup>(11)</sup>	$V_{CC}=0$ V, $f=1$ MHz	2.5	pF
$C_{ON(USB)}$	USB Path On Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=240$ MHz, Figure 16	7.5	
$C_{OFF(USB)}$	USB Path Off Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=240$ MHz, Figure 15	2.5	
$C_{ON(MHL)}$	MHL Path On Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=240$ MHz, Figure 16	4.2	
$C_{OFF(MHL)}$	MHL Path Off Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=240$ MHz, Figure 15	2.5	
$C_{ON(AUD)}$	Audio Path On Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=1$ MHz, Figure 16	7.0	pF
$C_{OFF(AUD)}$	Audio Path Off Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=1$ MHz, Figure 15	3.5	
$C_{ON(UART)}$	UART Path On Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=1$ MHz, Figure 16	8.0	pF
$C_{OFF(UART)}$	UART Path Off Capacitance <sup>(11)</sup>	$V_{CC}=3.3$ V, $f=1$ MHz, Figure 15	3.0	

**Note:**

11. Guaranteed by characterization.



### Test Diagrams

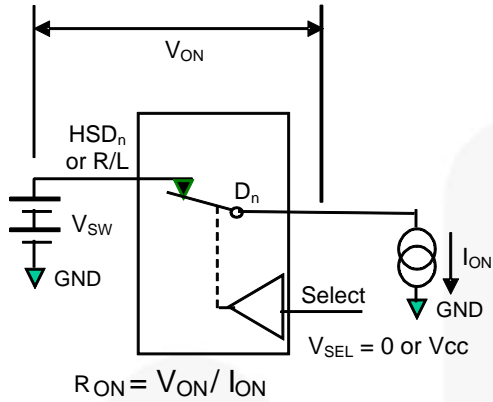
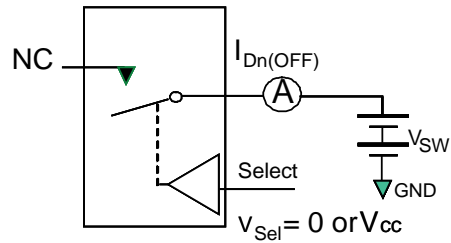
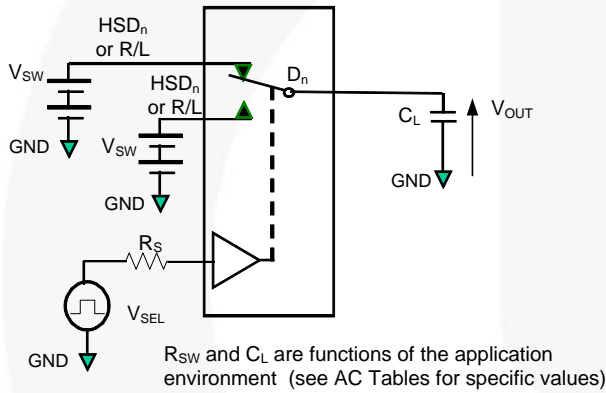


Figure 5. On Resistance



\*\*Each switch port is tested separately

Figure 6. Off Leakage



$R_{sw}$  and  $C_L$  are functions of the application environment (see AC Tables for specific values)

Figure 7. AC Test Circuit Load

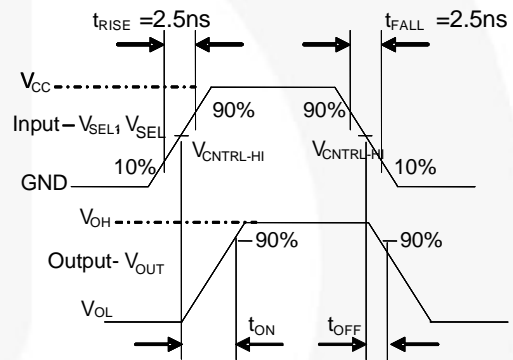


Figure 8. Turn-On / Turn-Off Waveforms

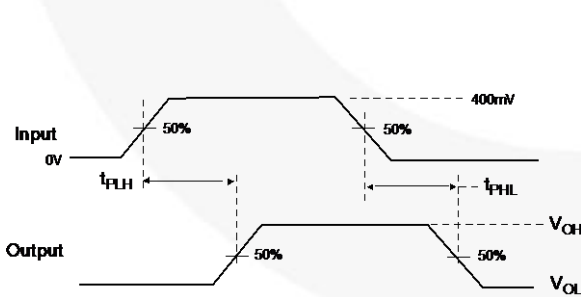


Figure 9. Propagation Delay ( $t_{rtf} = 500$  ps)

**Note:**

12.  $HSD_n$  refers to the high-speed data USB or MHL paths.

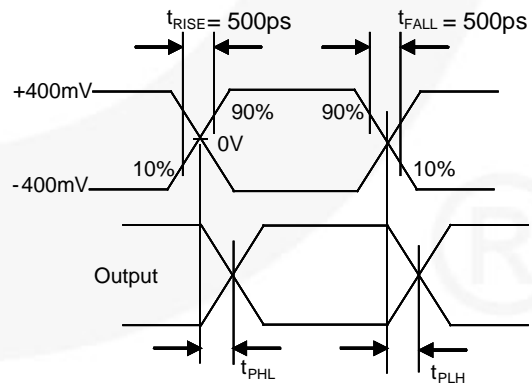
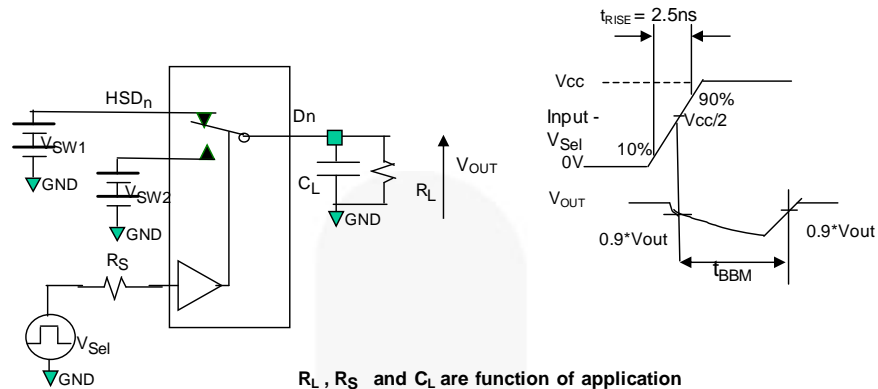


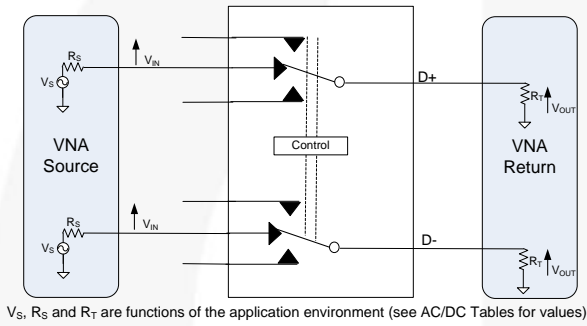
Figure 10. Intra-Pair Skew Test  $t_{SK(P)}$

**Test Diagrams (Continued)**



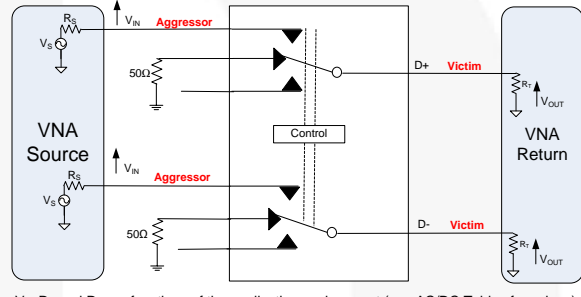
$R_L$ ,  $R_S$  and  $C_L$  are function of application environment (see AC Tables for specific values)  
 $C_L$  includes test fixture and stray capacitance

**Figure 11. Break-Before-Make Interval Timing**



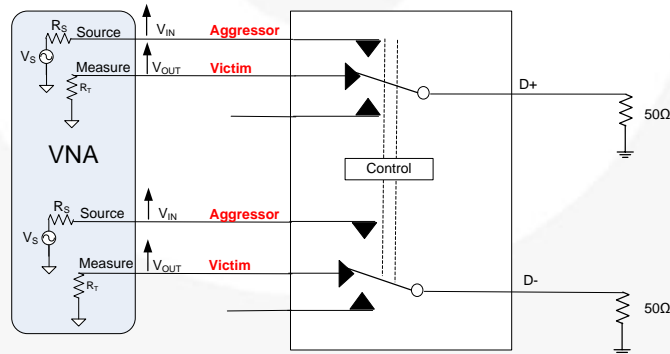
$V_S$ ,  $R_S$  and  $R_T$  are functions of the application environment (see AC/DC Tables for values).

**Figure 12. Insertion Loss (SDD21)**



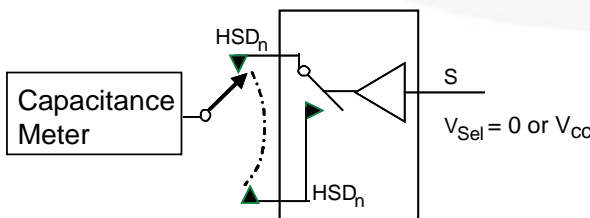
$V_S$ ,  $R_S$  and  $R_T$  are functions of the application environment (see AC/DC Tables for values).  
 Off Isolation = 20 Log ( $V_{OUT} - V_{IN}$ )

**Figure 13. Channel Off Isolation (SDD21)**

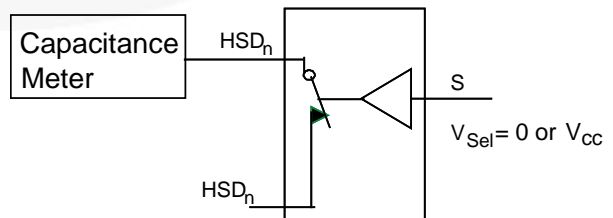


$V_S$ ,  $R_S$  and  $R_T$  are functions of the application environment (see AC/DC Tables for values).  
 Off Isolation = 20 Log ( $V_{OUT} - V_{IN}$ )

**Figure 14. Non-Adjacent Channel-to-Channel Crosstalk (SDD21)**



**Figure 15. Channel Off Capacitance**



**Figure 16. Channel On Capacitance**

## Functional Description

### Insertion Loss

One of the key advantages of using the FSA3041 in mobile digital video applications is the small amount of insertion loss experienced by the received signal as it passes through the switch. This results in minimal degradation to the received eye. One of the ways to measure the quality of the high data rate channels is using balanced ports and four-port differential S-parameter analysis, particularly SDD21.

Bandwidth is measured using the S-parameter SDD21 methodology.

### Typical Applications

Figure 19 shows the FSA3041 utilizing the  $V_{BAT}$  connection. The 3 M $\Omega$  resistors are used to ensure, for manufacturing test via the micro-USB connector, that the FSA3041 configures for connectivity to the baseband or application processor.

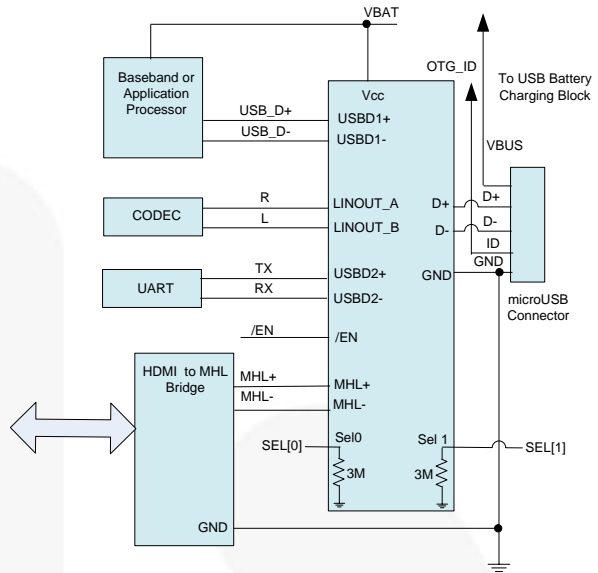


Figure 19. Typical Application



Figure 17. MHL Path SDD21 Insertion Loss Curve

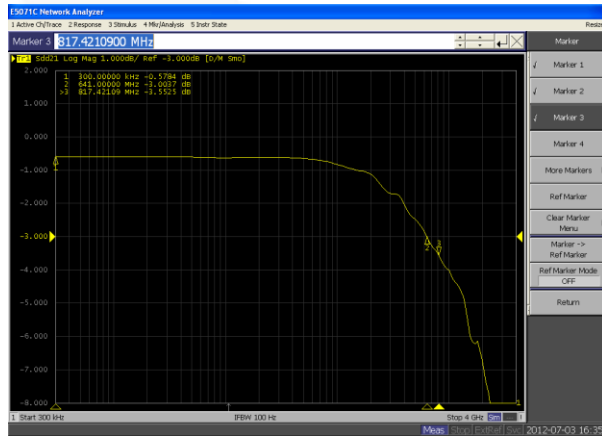
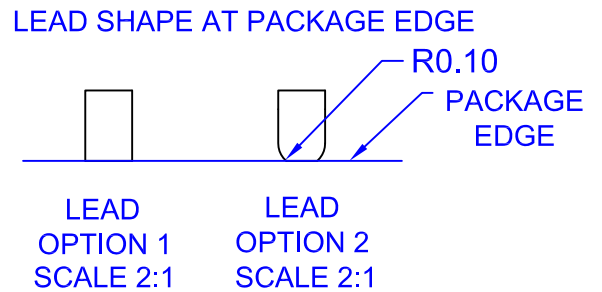
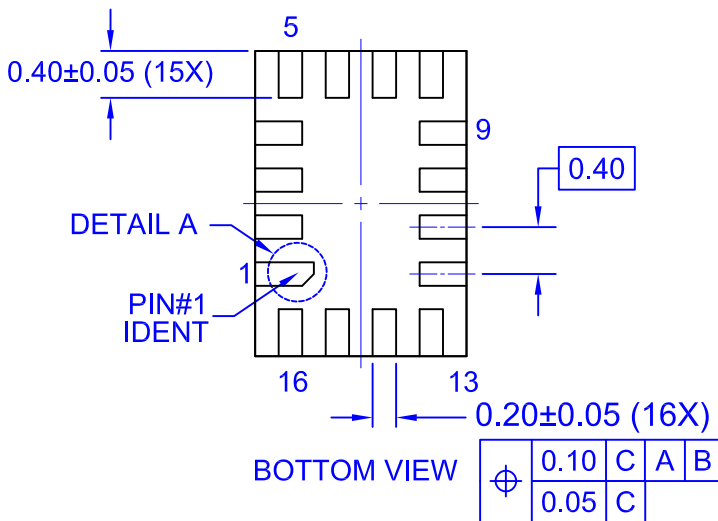
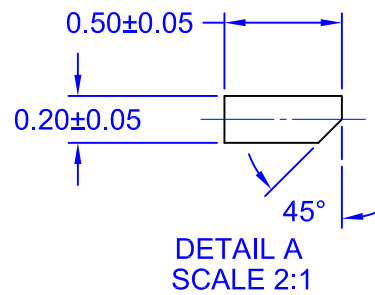
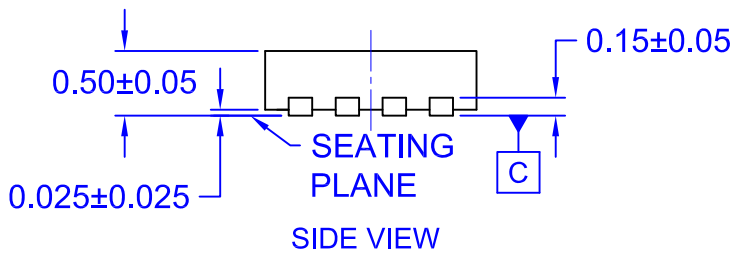
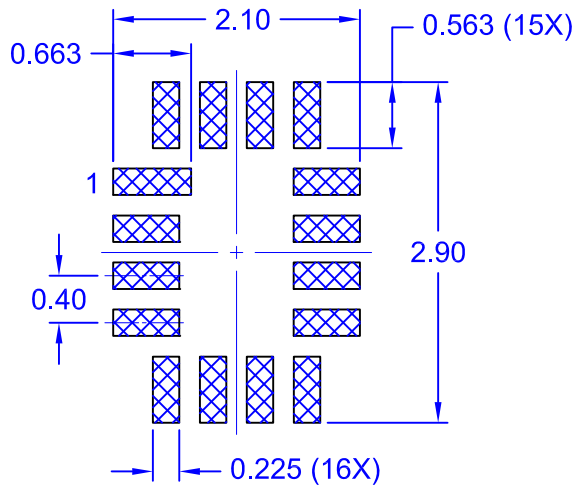
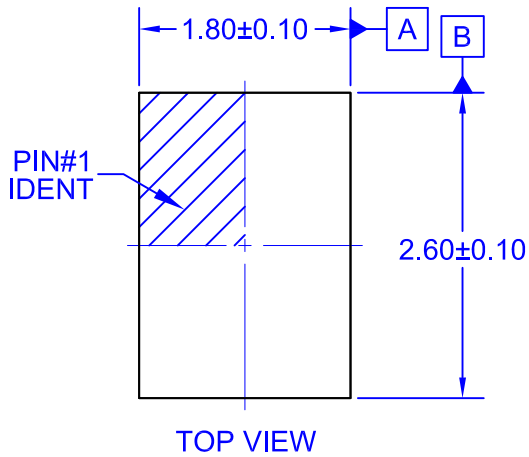


Figure 18. USB Path SDD21 Insertion Loss Curve



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