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FSA3341 — 高速 4:1 USB2.0 / MHL™ 开关

产品特性

- 低导通电容：4.2 pF / 5 pF MHL / USB（典型值）
- 低功耗：30 μ A（最大值）
- 支持 MHL 版本 2.0
- 3 个 USB2.0 路径
- MHL 数据速率：4.0 Gbps
- 16-引脚 UMLP 封装（1.8 x 2.6 mm）
- 所有 USB 端口上的过压容差（OVT）：达到 5.25 V，无外部组件

应用

- 手机和数码相机

说明

FSA3341 是一款双向、低功率、高速、4:1、USB2.0 和 MHL™ 开关。配置为双刀四掷（DP4T）开关，专门针对高速或全速 USB 端口与移动高清链路源（MHL 修订版 2.0 规范）之间的切换进行了优化。另外，USB2.0 路径可用作通用异步接收/发送装置（UART）的路径。

FSA3341 的开关 I/O 引脚上有电路，使得器件能够在 V_{cc} 电源断开（ $V_{cc} = 0$ V）的应用中承受过压状况。

此开关设计用于将电流消耗降低至最低，即使应用于控制引脚上的控制电压低于电源电压（ V_{cc} ）时也是如此。该特性特别适合手机等移动应用，可直接连接基带处理器的通用 I/O。

其他应用包括便携手机、数码相机和笔记本电脑中实现开关和连接器共用功能。

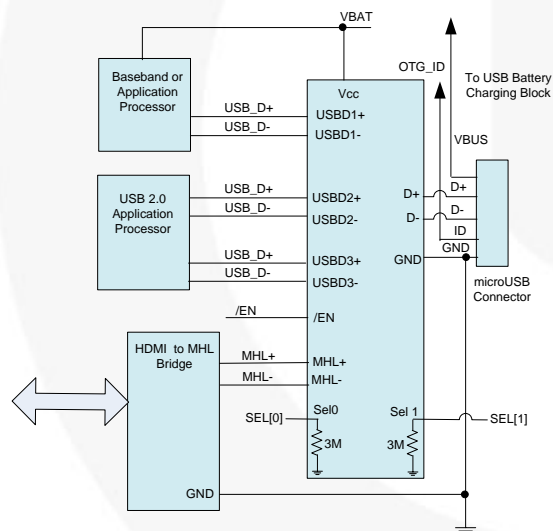


图 1. 典型应用

订购信息

器件型号	顶标	工作温度范围	封装
FSA3341UMX	LY	-40 至 +85° C	16-引脚，超薄膜塑无铅封装（UMLP），1.8 mm x 2.6 mm

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引脚布局

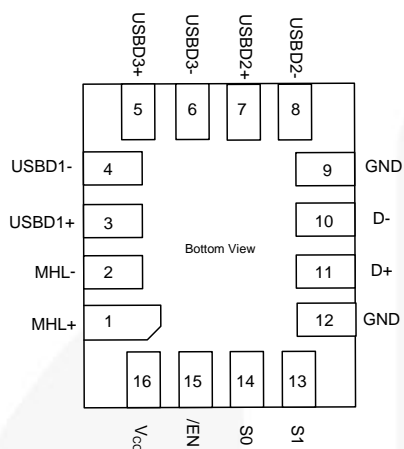


图 2. 引脚配置

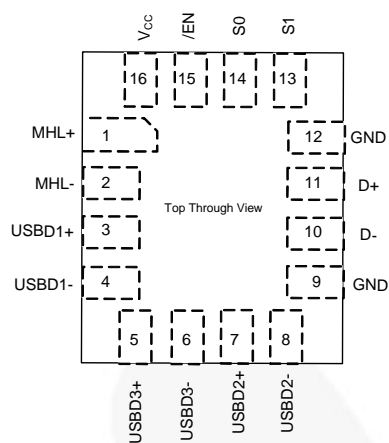


图 3. 顶视图

引脚说明

引脚号	名称	说明
1	MHL+	MHL 差分数据 (正)
2	MHL-	MHL 差分数据 (负)
3	USB1+	USB 差分数据 (正)；也可用作附加 UART
4	USB1-	USB 差分数据 (负)；也可用作附加 UART
5	USB3+	USB 差分数据 (正)；也可用作附加 UART
6	USB3-	USB 差分数据 (负)；也可用作附加 UART
7	USB2+	USB 差分数据 (正)；可用作附加 UART 端口 (见图 1)
8	USB2-	USB 差分数据 (负)；可用作附加 UART 端口 (见图 1)
9	GND	接地
10	D-	USB 差分数据 (负)，公共端口
11	D+	USB 差分数据 (正)，公共端口
12	GND	接地
13	S1	数据开关选择 (见表格 1)
14	S0	数据开关选择 (见表格 1)
15	/EN	启用引脚 - 有效低电平
16	V _{CC}	来自系统的设备电源 (通常是 V _{BAT})

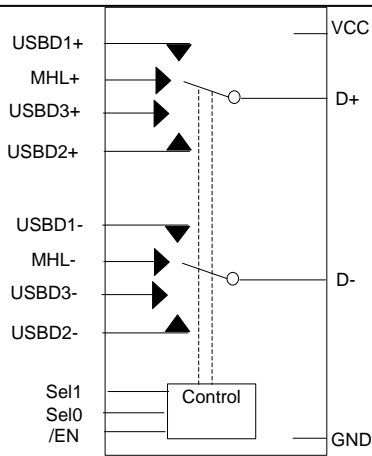


图 4. 模拟符号

表格 1. 数据开关选择真值表

SEL1 ⁽¹⁾	SEL0 ⁽¹⁾	/EN ⁽¹⁾	功能
0	0	0	D+/D- 连接到 USB1+/USB1- (或 UART) 路径
0	1	0	D+/D- 连接到 USB2+/USB2- (或 UART) 路径
1	0	0	D+/D- 连接到 MHL+/MHL- 路径
1	1	0	D+/D- 连接到 USB3+/USB3- (或 UART) 路径
X	X	1	D+/D- 高阻态

注意:

1. 严禁悬空或断连控制输入。
为了保证默认开关在 USB 位置闭合，需使用内部弱下拉电阻 (3 MΩ) 把 SEL[0:1] 引脚连接到 GND 接地，以将静态电流消耗降至最低。

绝对最大额定值

应力超过绝对最大额定值，可能会损坏设备。

在超出推荐的工作条件的情况下，该器件可能无法正常运行或操作，且不建议让器件在这些条件下长期工作。此外，过度暴露在高于推荐的工作条件下，会影响器件的可靠性。绝对最大额定值仅是额定应力值。

符号	参数	最小值	最大值	单位	
V_{CC}	电源电压	-0.5	5.5	V	
V_{CTRL}	直流输入电压 (/EN, SEL[1:0]) ⁽²⁾	-0.5	V_{CC}	V	
$V_{SW}^{(3)}$	直流开关 I/O 电压 ⁽²⁾	USB, MHL	-0.5	V_{CC}	V
I_{IK}	直流输入二极管电流	-50		mA	
I_{OUT}	开关直流输出电流 (连续)	USB, MHL	60	mA	
$I_{OUTPEAK}$	开关直流输出峰值电流 (脉冲时间为 1 ms, 占空比 <10%)	USB, MHL	150	mA	
T_{STG}	存储温度	-65	+150	°C	
MSL	潮湿敏感度 JEDEC J-STD-020A		1		
ESD	人体模型, JEDEC: JESD22-A114	全部引脚	4	kV	
	IEC 61000-4-2, 4 级, 用于 D+/D- 和 V_{CC} 引脚 ⁽⁴⁾	接触式	8		
	IEC 61000-4-2, 4 级, 用于 D+/D- 和 V_{CC} 引脚 ⁽⁴⁾	空气放电	15		
	充电器件模式, JESD22-C101		2		

说明:

2. 当测量输入与输出二极管电流额定值时，该输入与输出可能超出负额定值。
3. V_{SW} 指模拟数据开关路径 (USB、MHL 和音频)。
4. 在使用 TVS 二极管的系统环境中进行测试。

推荐工作条件

推荐的操作条件表定义了器件的真实工作条件。 指定推荐的工作条件，以确保设备的最佳性能达到数据表中的规格。 飞兆半导体建议不要超过推荐工作条件，也不能按照绝对最大额定值进行设计。

符号	参数	最小值	最大值	单位
V_{CC}	电源电压	2.5	4.5	V
$t_{RAMP(VCC)}$	电源转换速率	100	1000	$\mu\text{S}/\text{V}$
V_{CNTRL}	控制输入电压 (/EN, SEL[1:0]) ⁽⁵⁾	0	4.5	V
$V_{SW(USB)}$	开关输入/输出电压 (USB 开关路径)	-0.5	3.6	V
Θ_{JA}	热阻		273	$^{\circ}\text{C}/\text{W}$
$V_{SW(MHL)}$	开关输入/输出电压 (MHL 开关路径)	1.65	3.45	V
T_A	工作温度	-40	+85	$^{\circ}\text{C}$

注意：

- 控制输入必须保持高电平或低电平，不允许悬空。

直流电气特性

若无其他说明, 所有典型值都在 $T_A = 25^\circ\text{C}$ 下测得。

符号	参数	条件	V _{CC} (V)	T _A =-40° C 至 +85° C			单位
				最小值	典型值	最大值	
V _{IK}	箝位二极管电压	I _{IN} =-18 mA	2.5			-1.2	V
V _{IH}	控制输入高电平	SEL[1:0]	2.5	1.3			V
			3.6	1.4			V
			4.5	1.5			V
V _{IL}	控制输入低电平	SEL[1:0]	2.5			0.4	V
			3.6			0.4	V
			4.5			0.4	V
I _{IN}	控制输入漏电 SEL[1:0]	V _{SW} (MHL & USB)=0 至 3.6 V, V _{CTRL} =0 至 V _{CC}	4.5	-2.5		2.5	μA
I _{OZ} (MHL)	开放 MHL 数据路径关断状态漏电	V _{SW} =1.65 ≤ MHL ≤ 3.45 V, /EN=V _{CC} , 图 6	4.5	-0.5		0.5	μA
I _{OZ} (USB)	开放 USB 数据路径关断状态漏电	V _{SW} =0 ≤ USB ≤ 3.6 V, /EN=V _{CC} , 图 6	4.5	-0.5		0.5	μA
I _{CL} (MHL)	封闭 MHL 数据路径导通状态漏电 (6)	V _{SW} =1.65 ≤ MHL ≤ 3.45 V, /EN=GND, SEL0=GND, SEL1=V _{CC}	4.5	-0.5		0.5	μA
I _{CL} (USB)	封闭 USB 数据路径导通状态漏电 (6)	V _{SW} =0 ≤ USB ≤ 3.6 V, /EN=GND, SEL[1:0]=GND, SEL1=GND, SEL0=V _{CC}	4.5	-0.5		0.5	μA
I _{OFF}	关闭电源漏电 (USB 和 MHL 路径)	V _{SW} =0 V 或 3.6 V, 见图 6	0	-0.5		0.5	μA
R _{ON} (USB)	HS 开关导通电阻 (USB _{Dn} 至 D _n 路径)	V _{SW} =0.4 V, I _{ON} =-8 mA, SEL[1:0]=GND, SEL1=GND, SEL0=V _{CC} , 图 5	2.5 至 4.5		8		Ω
R _{ON} (MHL)	HS 开关导通电阻 (MHL 至 D 路径)	V _{SW} =V _{CC} -1050 mV, SEL0=GND, SEL1=V _{CC} , I _{ON} =-8 mA, 图 5	2.5 至 4.5		5		Ω
ΔR _{ON} (MHL)	R _{ON} 在 MHL 正负极之间的差异	V _{SW} =V _{CC} -1050 mV, SEL0=GND, SEL1=V _{CC} , I _{ON} =-8 mA, 图 5,	2.5 至 4.5		0.03		Ω
ΔR _{ON} (USB)	R _{ON} 在 USB 正负极之间的差异	V _{SW} =0.4V, I _{ON} =-8 mA, SEL[1:0]=GND, SEL1=GND, SEL0=V _{CC} , 图 5	2.5 至 4.5		0.18		Ω
R _{ONF} (MHL)	R _{ON} MHL 路径平坦度	V _{SW} =1.65 V 至 3.45 V, SEL0=GND, SEL1=V _{CC} , I _{ON} =-8 mA	2.5 至 4.5		1		Ω
R _{ONFD} (USB)	R _{ON} USB 路径平坦度	V _{SW} =0 V 至 3.6 V, SEL[1:0]=GND, SEL1=GND, SEL0=V _{CC} , I _{ON} =-8 mA, 图 5	2.5 至 4.5		2.1		Ω
R _{PD}	SEL0 和 SEL1 内部下拉电阻		2.5		3		MΩ

直流电气特性

若无其他说明，所有典型值都在 $T_A = 25^\circ\text{C}$ 下测得。

符号	参数	条件	V_{CC} (V)	$T_A = -40^\circ\text{C}$ 至 $+85^\circ\text{C}$			单位
				最小值	典型值	最大值	
			至 4.5				
I_{CC}	静态电流	$V_{CTRL}=0$ 或 4.5 V , $I_{OUT}=0$	4.5			30	μA
I_{COZ}	静态电流—高阻抗	$V_{/EN}=4.5\text{ V}$, $I_{OUT}=0$	4.5			1	μA
I_{CCT}	每个控制引脚静态电流 Δ 增量	$V_{CTRL}=1.65\text{ V}$, $I_{OUT}=0$	4.5			10	μA
		$V_{CTRL}=2.5\text{ V}$, $I_{OUT}=0$	4.5			5	

注意:

6. 对于该项测试，使用相应的悬空开关引脚将数据开关闭合。

交流电气特性

若无其他说明，所有典型值都在 $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$ 下测得。

符号	参数	条件	V_{CC} (V)	$T_A = -40^\circ\text{C}$ 至 $+85^\circ\text{C}$			单位
				最小值	典型值	最大值	
t_{ONUSB}	USB 导通时间, SEL[1:0] 至输出	$R_L=50\ \Omega$, $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, $V_{SW(MHL)}=3.3\text{ V}$, 图 7, 图 8	2.5 至 4.5		445	700	ns
t_{OFFUSB}	USB 关断时间, SEL[1:0] 至输出	$R_L=50\ \Omega$, $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, $V_{SW(MHL)}=3.3\text{ V}$, 图 7, 图 8	2.5 至 4.5		445	600	ns
t_{ONMHL}	MHL 导通时间, SEL[1:0] 至输出	$R_L=50\ \Omega$ 至 3.3 V , $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, V_S $W(MHL)}=3.3\text{ V}$	2.5 至 4.5		445	600	ns
t_{OFFMHL}	MHL 关断时间, SEL[1:0] 至输出	$R_L=50\ \Omega$ 至 3.3 V , $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, V_S $W(MHL)}=3.3\text{ V}$	2.5 至 4.5		445	600	ns
t_{ENABLE}	启用导通时间, /EN 至输出	$R_L=50\ \Omega$, $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, $V_{SW(MHL)}=3.3\text{ V}$, 图 7, 图 8	2.5 至 4.5		80		μs
$t_{DISABLE}$	禁用导通时间, /EN 至输出	$R_L=50\ \Omega$, $C_L=5\text{ pF}$, $V_{SW(USB)}=0.8\text{ V}$, $V_{SW(MHL)}=3.3\text{ V}$, 图 7, 图 8	2.5 至 4.5		35		ns
t_{PD}	传输延迟 ⁽⁷⁾	$C_L=5\text{ pF}$, $R_L=50\ \Omega$, 图 7	2.5 至 4.5		0.25		ns
t_{BBM}	先开后合 ⁽⁷⁾	$R_L=50\ \Omega$, $C_L=50\text{ pF}$, $V_{MHL}=3.3\text{ V}$, $V_{USB}=0.8\text{ V}$, 图 11	2.5 至 4.5	50	120	600	ns
$O_{IRR(MHL)}$	关断隔离 ⁽⁷⁾	$V_S=1\text{ V}_{pk-}$ pk , $R_L=50\ \Omega$, $f=24\text{ MHz}$, 图 13	2.5 至 4.5		-36		dB
$O_{IRR(USB)}$		$V_S=400\text{ mV}_{pk-}$ pk , $R_L=50\ \Omega$, $f=240\text{ MHz}$, 图 13	2.5 至 4.5		-38		dB
$O_{IRR(UART)}$		$V_S=40\text{ mV}_{pk-}$ pk , $R_L=50\ \Omega$, $f=10\text{ MHz}$, 图 13	2.5 至 4.5		-40		dB

交流电气特性

若无其他说明, 所有典型值都在 $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{ C}$ 下测得。

符号	参数	条件	V_{CC} (V)	$T_A = -40^\circ\text{ C 至 } +85^\circ\text{ C}$			单位
				最小值	典型值	最大值	
Xtalk _{MHL}	非相邻通道串扰 ⁽⁷⁾	$V_S = 1\text{ V}_{pk-pk}$, $R_L = 50\ \Omega$, $f = 240\text{ MHz}$, 图 14	2.5 至 4.5		-44		dB
Xtalk _{USB}		$V_S = 400\text{ mV}_{pk-pk}$, $R_L = 50\ \Omega$, $f = 240\text{ MHz}$, 图 14	2.5 至 4.5		-36		dB
Xtalk _{UART}		$V_S = 400\text{ mV}_{pk-pk}$, $R_L = 50\ \Omega$, $f = 10\text{ MHz}$, 图 14	2.5 至 4.5		-36		dB
THD	总谐波失真度 - LINOUT ⁽⁷⁾	$R_T = 600\ \Omega$, $V_{SW} = 2\text{ V}_{pk-pk}$, $f = 20\text{ Hz}$ 至 20 kHz , $V_{BIAS} = 0\text{ V}$	2.5 至 4.5		0.01		%
BW	S _{DD21} 差分 -3db 带宽 ⁽⁷⁾	$V_{IN} = 1\text{ V}_{pk-pk}$, 共模电压 = $V_{CC} - 1.1\text{ V}$, MHL 路径, $R_L = 50\ \Omega$, $C_L = 0\text{ pF}$, 图 12	2.5 至 4.5		2.0		GHz
		$V_{IN} = 400\text{ mV}_{pk-pk}$, 共模电压 = 0.2 V , USB 路径, $R_L = 50\ \Omega$, $C_L = 0\text{ pF}$, 图 12			650 ⁽⁸⁾		MHz

注意:

- 由产品特性保证。
- 650 MHz USB 带宽, 通过 USB2.0 标准的测试。

USB 高速交流电气特性

典型值测量条件为 $T_A=25^\circ\text{C}$ 且 $V_{CC}=3.0$ 至 3.6V 。

符号	参数	条件	典型值	单位
$t_{SK(P)}$	在相同输出下, 反向转换的时滞 ⁽⁹⁾	$C_L=5\text{ pF}$, $R_L=50\ \Omega$, 图 10	3	ps
t_J	总抖动 ⁽⁹⁾	$R_L=50\ \Omega$, $C_L=5\text{ pF}$, $t_R=t_F=500\text{ ps}$ (10-90%) (480 Mbps, PN7 时)	20	ps

注意:

9. 由产品特性保证。

MHL™ 交流特性

典型值测量条件为 $T_A=25^\circ\text{C}$ 且 $V_{CC}=3.0$ 至 3.6V 。

符号	参数	条件	典型值	单位
$t_{SK(P)}$	在相同输出下, 反向转换的时滞 ⁽¹⁰⁾	$R_{PU}=50\ \Omega$ 至 V_{CC} , $C_L=0\text{ pF}$	2	ps
t_J	总抖动 ⁽¹⁰⁾	$f=2.25\text{ Gbps}$, PN7, $R_{PU}=50\ \Omega$ 至 V_{CC} , $C_L=0\text{ pF}$	15	ps

注意:

10. 由产品特性保证。

电容值

所有典型值均针对 $T_A = 25^\circ\text{C}$ 。

符号	参数	条件	典型值	单位
C_{IN}	控制引脚输入电容 ⁽¹¹⁾	$V_{CC}=0\text{V}$, $f=1\text{ MHz}$	2.5	pF
$C_{ON(USB)}$	USB 路径导通电容 ⁽¹¹⁾	$V_{CC}=3.3\text{ V}$, $f=240\text{ MHz}$, 图 16	5.0	
$C_{OFF(USB)}$	USB 路径关断电容 ⁽¹¹⁾	$V_{CC}=3.3\text{ V}$, $f=240\text{ MHz}$, 图 15	2.5	
$C_{ON(MHL)}$	MHL 路径导通电容 ⁽¹¹⁾	$V_{CC}=3.3\text{ V}$, $f=240\text{ MHz}$, 图 16	4.2	
$C_{OFF(MHL)}$	MHL 路径关断电容 ⁽¹¹⁾	$V_{CC}=3.3\text{ V}$, $f=240\text{ MHz}$, 图 15	2.5	

注意:

11. 由产品特性保证。

测试框图

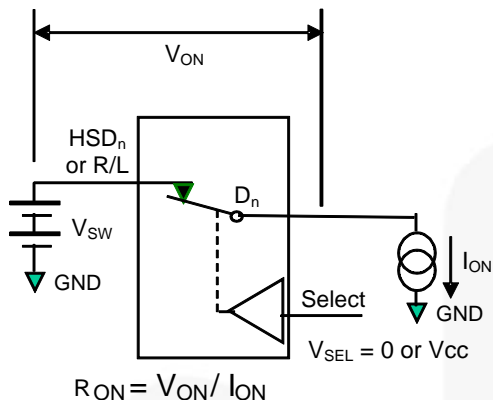
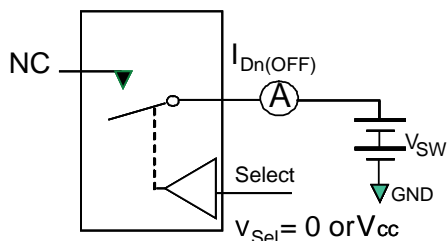
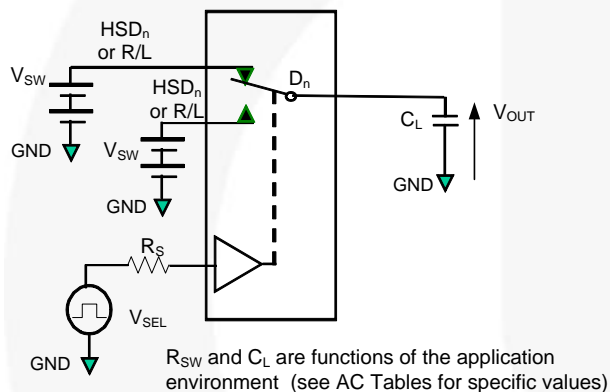


图 5. 导通电阻



**Each switch port is tested separately

图 6. 关断漏电



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

图 7. 交流测试电路负载

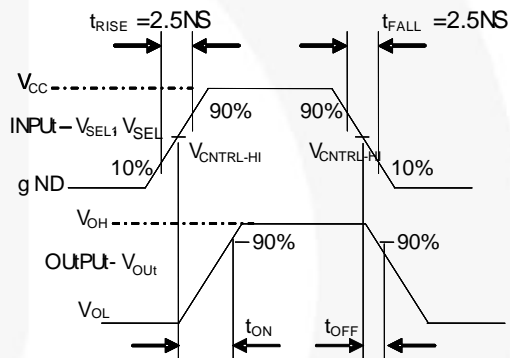


图 8. 开通/关断波形

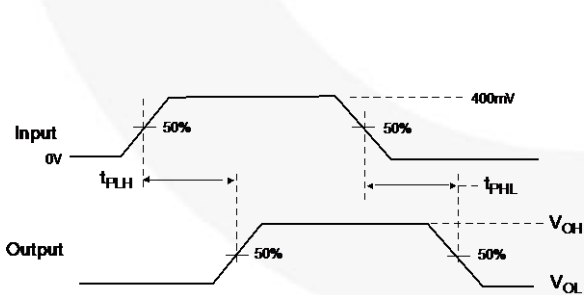


图 9. 传输延迟 ($t_{r}t_{f}$ - 500 ps)

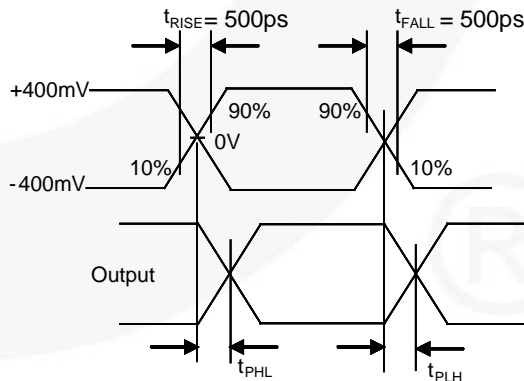
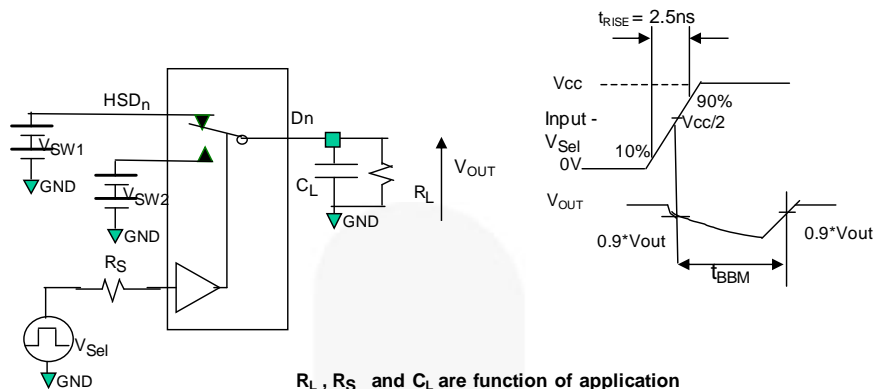


图 10. 内部成对时滞测试 $t_{sk(p)}$

注意:

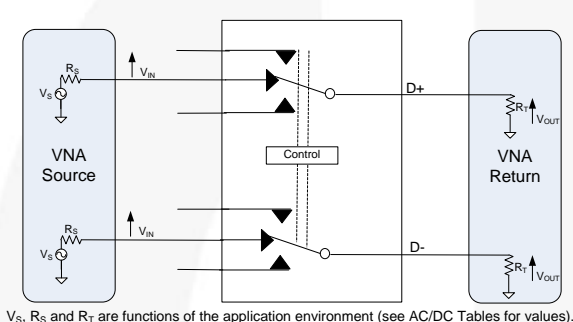
12. HSD_n 指高速数据 USB 或 MHL 路径。

测试框图 (续)



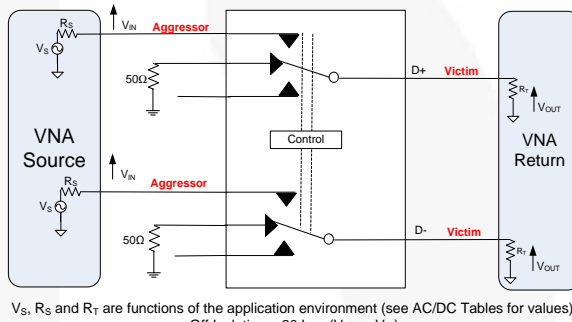
R_L , R_S and C_L are function of application environment (see AC Tables for specific values)
 C_L includes test fixture and stray capacitance

图 11. 先开后关间隔时序



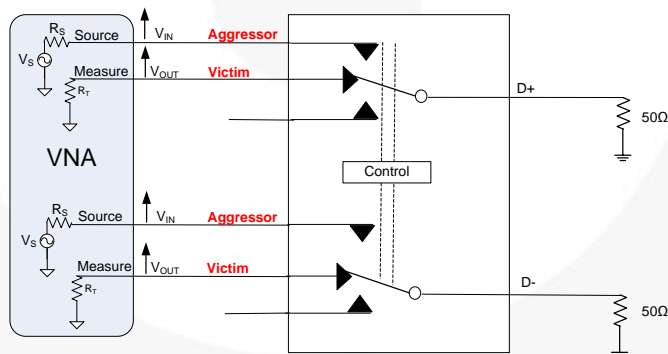
V_S , R_S and R_T are functions of the application environment (see AC/DC Tables for values).

图 12. 插入损耗 (SDD21)



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

图 13. 沟道关断隔离 (SDD21)



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

图 14. 非相邻通道间串扰 (SDD21)

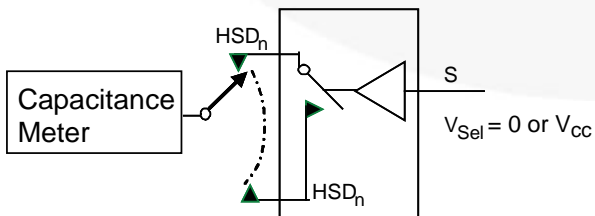


图 15. 通道关断电容

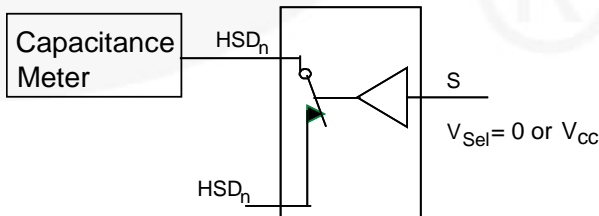


图 16. 通道导通电容

功能说明

插入损耗

在移动数字视频应用中使用 FSA3341 的主要优点之一是接收信号的插入损耗低，因为该插入损耗通过了开关。

这就使收到的眼图信号劣化程度降至最低。

测量高数据速率信道质量的方法之一是，使用平衡端口和四端口差分

S 参数分析法，尤其是 SDD21。

带宽测量使用 S 参数 SDD21 方法。

典型应用

图 19 显示利用 V_{BAT} 连接的 FSA3341。通过微型 USB 连接器进行制造测试时，阻值为 3 MΩ 的电阻器确保 FSA3341 配置连接到基带或应用处理器。

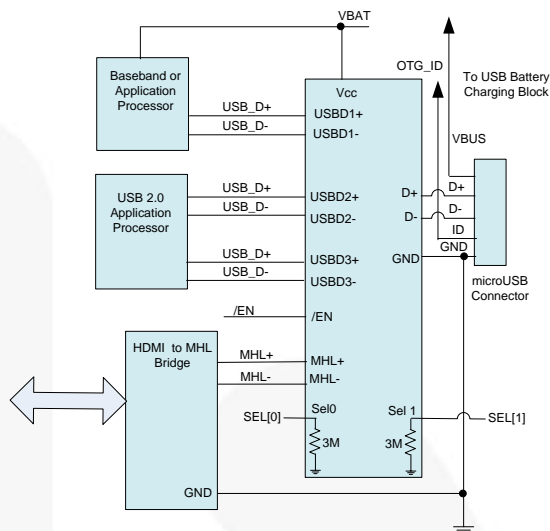


图 19. 典型应用



图 17. MHL 路径 SDD21 插入损耗曲线

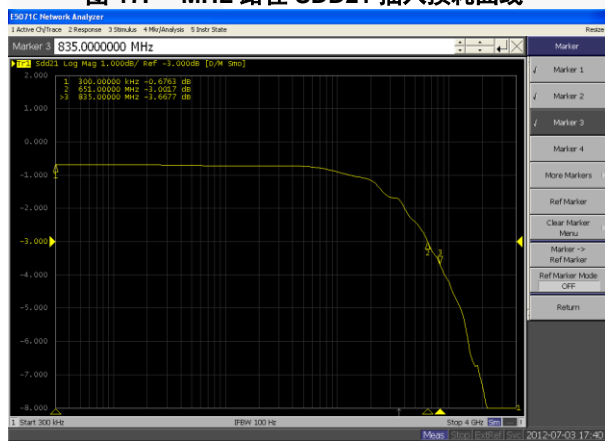
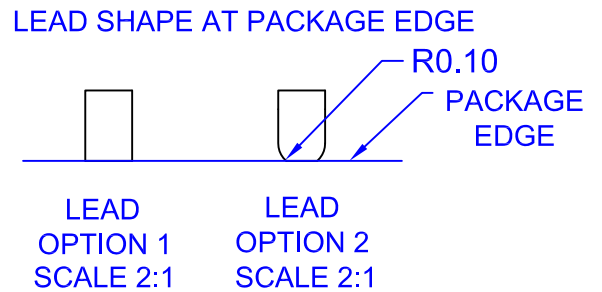
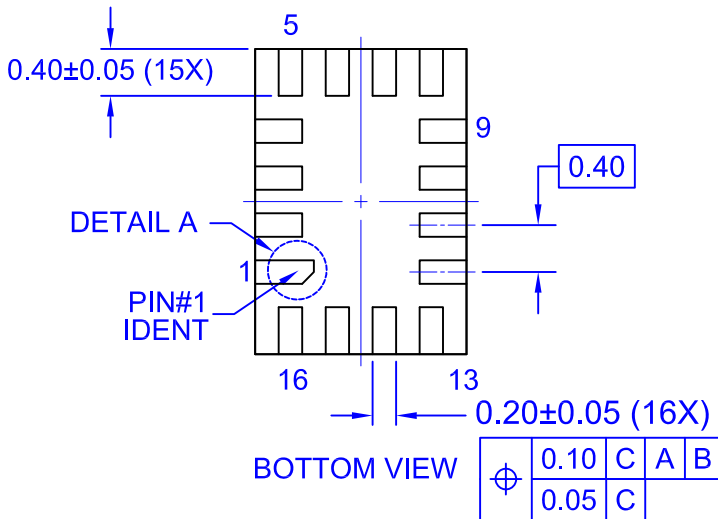
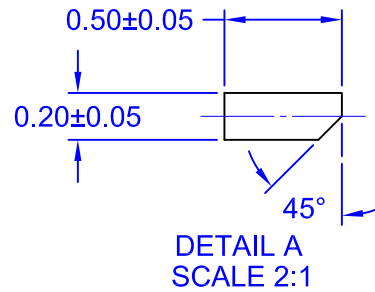
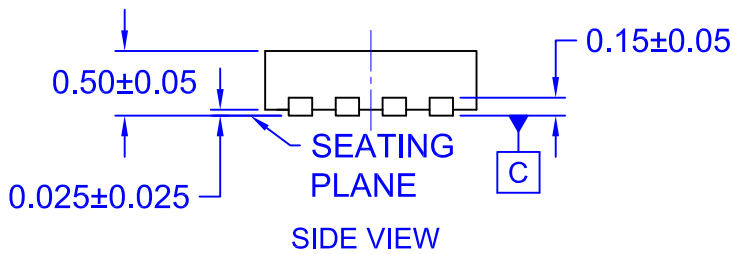
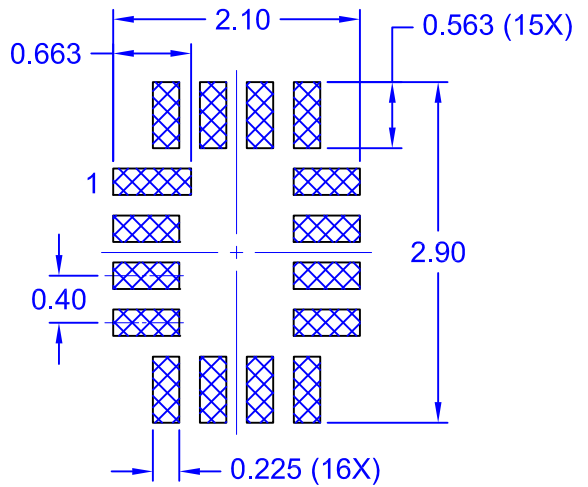
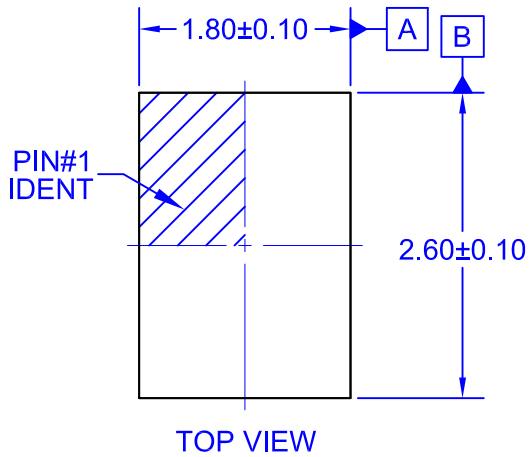


图 18. USB 路径 SDD21 插入损耗曲线



NOTES:

- A. PACKAGE DOES NOT FULLY CONFORM TO JEDEC STANDARD.
- B. DIMENSIONS ARE IN MILLIMETERS.
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