具有负信号传输能力和 1.8V 逻辑兼容性的USB 2.0 高速 (480 Mbps) 和音频开关

查询样品：TS5USBA224

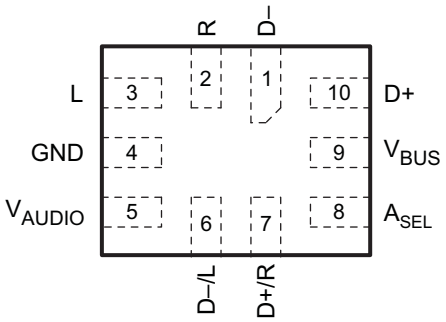
特性

- 高速 **USB** 开关：
  - **4Ω R_{DSON}** （典型值）
  - **12.5pF C_{ON}** （典型值）
  - **650MHz** 带宽 **(—3 dB)**
- 音频开关：
  - **3Ω R_{DSON}** （典型值）
  - 负轨能力
  - 低 **THD：< 0.05%**
  - 用于开关机噪声 （喀哒声和噼啪声） 抑制的内部并联电阻器
  - 从**V_{AUDIO}** （**2.7V** 至 **5.5V**） 来供电
- 可兼容 **1.8V** 的控制输入（**A_{SEL}** 和 **V_{BUS}**）门限
- **I_{OFF}** 支持部分断电模式
- 依据 **JESD 22** 标准对 **ESD** 性能进行了测试
  - **2000V** 人体模型 （**A114B，Class II**）
  - **1000V** 充电器件模型 **(C101)**
  - **200V** 机器模型 **(A115-A)**

应用

- 手机
- 个人数字助理 **(PDA)**
- 便携式仪表
- 数码相机
- 便携式导航设备

RSW 封装
(顶视图**)**



说明

TS5USBA224 是一款双刀双掷 (DPDT) 多路复用器，该器件在同一个封装中集成了一个低失真音频开关和一个 USB 2.0 高速 (480Mbps) 开关。 这种配置使得系统设计人员能够采用一个用于音频和 USB 数据的公共连接器。音频开关专为允许音频信号摆动至地电位以下而设计，从而实现了这种公共连接器配置。

TS5USBA224 采用 V_{AUDIO} 来上电。 当 A_{SEL} = 高电平时，将选择音频通路 （而不管 V_{BUS} 上的逻辑电平是多少）。 如果 A_{SEL} = 低电平且 V_{BUS} = 高电平，则选择 USB 通路。 否则，假如 A_{SEL} = 低电平且 V_{BUS} = 低电平，那么将选择音频通路。

另外，TS5USBA224 在音频通路上还布设了并联电阻器，用于抑制选择音频开关时有可能听到的喀哒声和噼啪声。

订购信息

T_A	封装(1) (2)		可订购部件号	正面标记
−40°C 至 85°C	QFN 0.4mm 间距 – RSW（无铅型）	卷带	TS5USBA224RSWR	A5R

(1) 封装图样、热数据和符号可登录 www.ti.com.cn/packaging 获取。
(2) 如需了解最新的封装及订购信息，请参见本文件结尾处的 “Package Option Addendum （封装选项附录）”，或登录 TI 的网站 www.ti.com 进行查询。

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

SUMMARY OF TYPICAL CHARACTERISTICS

	USB PATH	AUDIO PATH
Number of switches	2	2
ON-state resistance (r_{on})	4 Ω	3 Ω
ON-state resistance match (Δr_{on})	< 0.3 Ω	< 0.3 Ω
ON-state resistance flatness ($r_{on(flat)}$)	N/A	1.5 Ω
Turn-on/turn-off time (t_{ON}/t_{OFF})	< 2 µs	< 4 µs
Bandwidth (BW)	650 MHz	N/A
OFF isolation (O_{ISO})	–22 dB	–83 dB
Crosstalk (X_{TALK})	–31 dB	–83 dB
Total harmonic distortion (THD)	N/A	0.05%

PIN DESCRIPTION TABLE

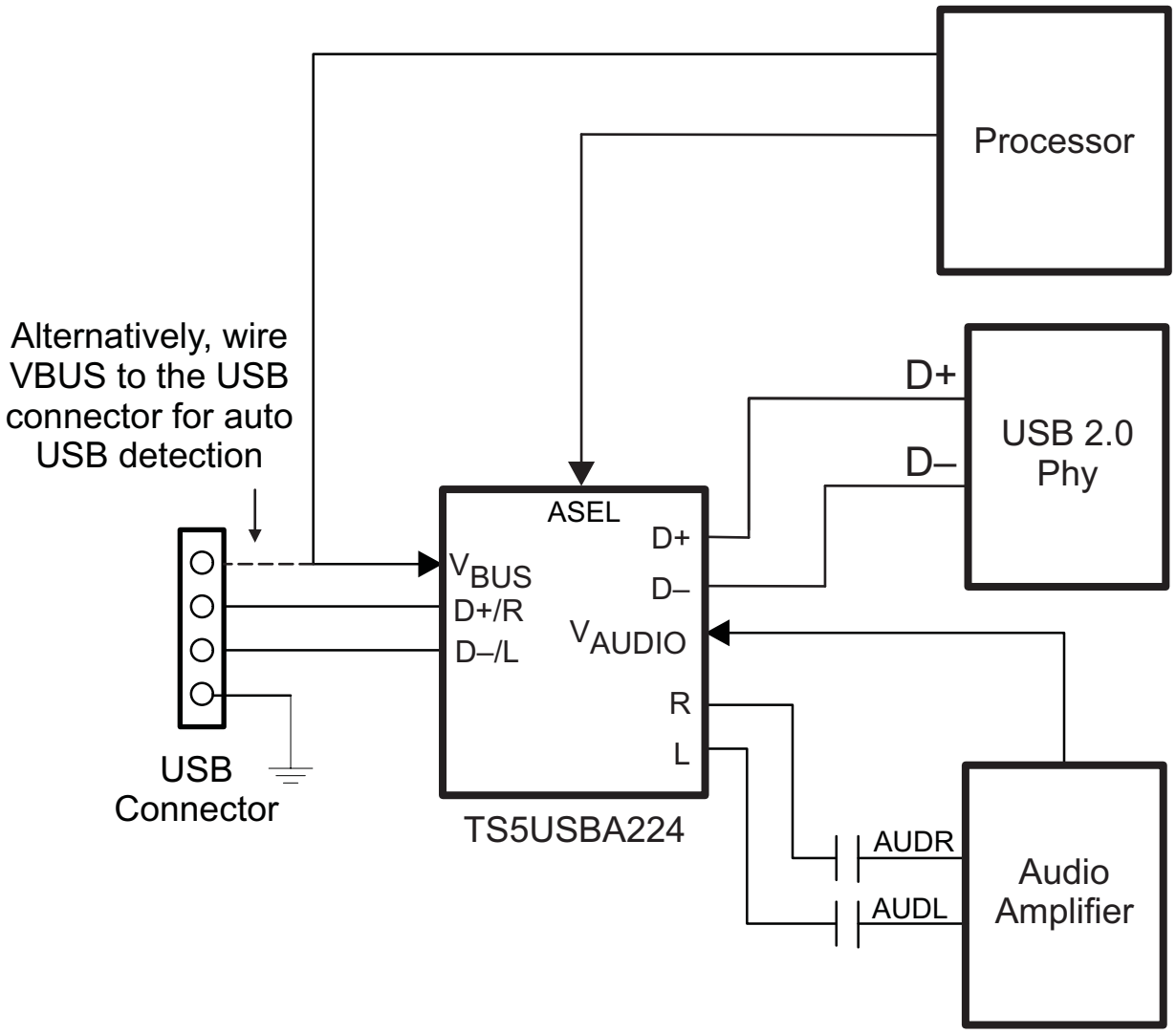
PIN			DESCRIPTION
NO.	NAME	TYPE	
1	D–	I/O	USB Data (Differential –)
2	R	I/O	Right Channel Audio
3	L	I/O	Left Channel Audio
4	GND	Ground	Ground
5	V_{AUDIO}	Power	Supply Voltage
6	D–/L	I/O	USB/Audio Common Connector
7	D+/R	I/O	USB/Audio Common Connector
8	A_{SEL}	Input	Control Input for Audio Path
9	V_{BUS}	Input	Control Input for USB Path
10	D+	I/O	USB Data (Differential +)

FUNCTION TABLE

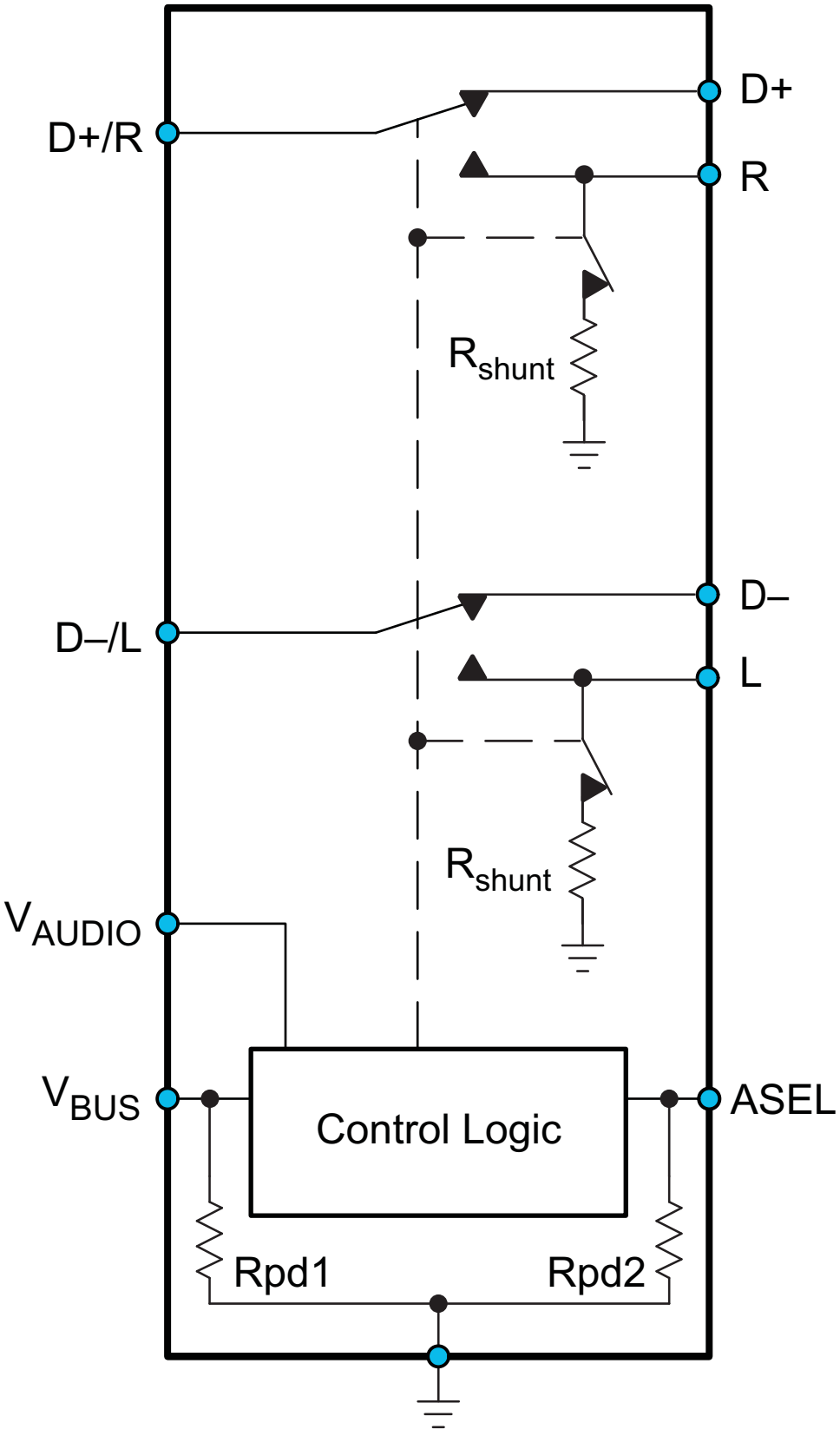
A_{SEL}	V_{AUDIO}	V_{BUS}	L,R	D+, D–
L	L	L	OFF	OFF
L	L	H	OFF	OFF
L	H	L	ON	OFF
L	H	H	OFF(1)	ON
H	L	L	OFF	OFF
H	L	H	OFF	OFF
H	H	L	ON	OFF
H	H	H	ON	OFF

(1) 100Ω shunt resistors are enabled in this state.

TYPICAL APPLICATION BLOCK DIAGRAM



SWITCH BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS(1)(2)

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{AUDIO}	Supply voltage range(3)		–0.5	6.5	V
V_{D+} $V_{D–}$	Analog voltage Range(3)		–0.5	6.5	V
V_R V_L			V_{AUDIO} – 6.5	V_{AUDIO} + 0.5	V
I_K	Analog port diode current	V_{D+}, $V_{D–}$ < 0	–50		mA
I_{D+}, $I_{D–}$ I_R, I_L	ON-state switch current	V_{D+}, $V_{D–}$ = 0 to V_{AUDIO}, V_R, V_L $V_{D+/R}$, $V_{D–/L}$ = V_{AUDIO} – 5.5 V to V_{AUDIO}	–100	100	mA
$I_{D+/R}$ $I_{D–/L}$	ON-state peak switch current(4)		–200	200	
V_I	Digital input voltage range		–0.5	6.5	V
I_{IK}	Digital logic input clamp current(3)	V_I < 0		–50	mA
I_{AUDIO}	Continuous current through V_{AUDIO}			100	mA
I_{GND}	Continuous current through GND		–100		mA
T_{stg}	Storage temperature range		–65	150	°C

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum.
(3) All voltages are with respect to ground, unless otherwise specified.
(4) Pulse at 1-ms duration <10% duty cycle.

PACKAGE THERMAL IMPEDANCE(1)

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TYP	UNIT
θ_{JA}	Package thermal impedance	RSW package	175	°C/W

(1) The package thermal impedance is calculated in accordance with JESD 51-7.

ELECTRICAL CHARACTERISTICS

T_A = –40°C to 85°C, typical values are at V_{AUDIO} = 3.3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
USB SWITCH							
V_{D+},$V_{D–}$	Analog voltage range			0		5.5	V
r_{on}	ON-state resistance	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, $V_{D+/D–}$ = 0 V, 0.4 V, I_{ON} = –8 mA	Switch ON		4	7	Ω
Δr_{on}	ON-state resistance match between channels	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, $V_{D+/D–}$ = 0 V, 0.4 V, I_{ON} = –8 mA	Switch ON			0.3	Ω
$I_{D+(OFF)}$ $I_{D–(OFF)}$	D+ ,D- OFF leakage current	V_{AUDIO} = 3.6 V, V_{BUS} = 0 V, V_{ASEL} = 3.6 V, V_{D+} ,$V_{D–}$ = 0.3 V, $V_{D+/R}$,$V_{D–/L}$ = 0.3 V	Switch OFF			±50	nA
$I_{D+(ON)}$ $I_{D–(ON)}$	D+ ,D– ON leakage current	V_{AUDIO} = 3.6 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, V_{D+} ,$V_{D–}$ = 0.3 V, $V_{D+/R}$ = Open	Switch ON			±50	nA
AUDIO SWITCH							
V_R,V_L	Analog voltage range			V_{AUDIO} – 5.5		V_{AUDIO}	V
r_{on}	ON-state resistance	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, $V_{L/R}$ = –2 V, 0 V, 0.7 V, I_{ON} = –26 mA	Switch ON		3	5	Ω
Δr_{on}	ON-state resistance match between channels	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, $V_{L/R}$ = 0.7 V, I_{ON} = –26 mA	Switch ON			0.3	Ω

ELECTRICAL CHARACTERISTICS (接下页)

T_A = –40°C to 85°C, typical values are at V_{AUDIO} = 3.3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$r_{on\ (flat)}$	ON-state resistance flatness	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, $V_{L/R}$ = –2 V, 0 V, 0.7 V, I_{ON} = –26 mA	Switch ON		1.5	2.5	Ω
r_{SHUNT}	Shunt resistance	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, $V_{L/R}$ = 0.7 V, I_{OSHUNT} = 10 mA	Switch OFF		100	200	Ω
$I_{L(OFF)}$ $I_{R(OFF)}$	L , R OFF leakage current	V_{AUDIO} = 3.6 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, V_R, V_L = 0.3 V, V_{AUDIO}–0.3 V, $V_{D+/R}$, $V_{D–/L}$ = 0.3 V, V_{AUDIO}–0.3V	Switch OFF			±50	nA
$I_{L(ON)}$ $I_{R(ON)}$	L , R ON leakage current	V_{AUDIO} = 3.6 V, V_{BUS} = 0 V, V_{ASEL} = 3.6 V,D+/R, D–L = 0.3 V, V_R, V_L = 0.3 V, V_{AUDIO}–0.3 V, V_{AUDIO}–0.3V $V_{D+/R}$, $V_{D–/L}$ =Open	Switch ON			±50	nA
DIGITAL CONTROL INPUTS (A_{SEL}, V_{BUS})							
V_{IH}	Input logic high	V_{AUDIO} = 2.7V to 5.5V		1.2			V
V_{IL}	Input logic low	V_{AUDIO} = 2.7V to 5.5V				0.5	V
I_{IN}	Input leakage current	V_{AUDIO} = 3.6V	VIN = 3.6V			±10	μA
			VIN = 0V			±1	
r_{PD1}	Internal pulldown resistance				3		MΩ
r_{PD2}	Internal pulldown resistance				5		MΩ

DYNAMIC CHARACTERISTICS

T_A = –40°C to 85°C, typical values are at V_{AUDIO} = 3.3 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
USB SWITCH							
t_{ON}	Turn-on time	V_{AUDIO} = 3 V, V_{BUS} = 0 V to 5 V, V_{ASEL} = 0 V, $V_{D+/R,\ D-/L}$ = 1 V, 图 10			2		µs
t_{OFF}	Turn-off time	V_{AUDIO} = 3 V, V_{BUS} = 5 V to 0 V, V_{ASEL} = 0 V, $V_{D+/R,\ D-/L}$ = 1 V, 图 10			1		µs
$t_{SK(O)}$	Channel-to-channel skew	f = 240 MHz, 图 11			35		ps
$t_{SK(P)}$	Skew of opposite transitions of same output	f = t 240 MHz, 图 11			25		ps
$C_{D+(OFF)}$ $C_{D-(OFF)}$	D+, D-OFF capacitance	V_{AUDIO} = 3 V, V_{BUS} = 0 V, A_{SEL} = 3 V, f = 240 MHz	Switch OFF		2.8		pF
$C_{D+(ON)}$ $C_{D-(ON)}$	D+, D– ON capacitance	V_{AUDIO} = 3 V, V_{BUS} = 5 V, A_{SEL} = 0 V, f = 240 MHz	Switch ON		12.5		pF
C_I	Digital input capacitance	V_{AUDIO} = 3 V, V_{BUS} = 0 V, A_{SEL} = 0 V, f = 1 MHz			2.2		pF
BW	Bandwidth	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, 图 12	Switch ON		650		MHz
O_{ISO}	OFF Isolation	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, R_L = 50 Ω, f = 240 MHz, 图 14	Switch OFF		–22		dB
X_{TALK}	Crosstalk	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, R_L = 50 Ω, f = 240 MHz, 图 13	Switch ON		–31		dB
AUDIO SWITCH							
t_{ON}	Turn-on time	V_{AUDIO} = 3 V, V_{BUS} = 0 V or 5 V, V_{ASEL} = 0 V to 3 V, $V_{D+/R,D-/L}$ = 1 V, 图 10			4		µs
t_{OFF}	Turn-off time	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V to 0 V, $V_{D+/R,D-/L}$ = 1 V, 图 10			1		µs
$C_{L(OFF)}$ $C_{R(OFF)}$	L , R OFF capacitance	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, f = 20 kHz	Switch OFF		4.5		pF
$C_{L(ON)}$ $C_{R(ON)}$	L, R ON capacitance	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, f = 20 kHz	Switch ON		15		pF
O_{ISO}	OFF Isolation	V_{AUDIO} = 3 V, V_{BUS} = 5 V, V_{ASEL} = 0 V, R_L = 50 Ω, f = 20 kHz, 图 14	Switch OFF		–83		dB
X_{TALK}	Crosstalk	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, R_L = 50 Ω, f = 20 kHz, 图 13	Switch ON		–83		dB
THD	Total harmonic distortion	V_{AUDIO} = 3 V, V_{BUS} = 0 V, V_{ASEL} = 3 V, f = 20 Hz to 20 kHz, R_L = 600 Ω, V_{IN} = 2 Vpp			0.05		%
SUPPLY							
V_{AUDIO}	Power supply voltage			2.7		5.5	V
I_{AUDIO}	Positive supply current	V_{AUDIO} = 3.6 V, V_{BUS} = 0 or 5 V, V_{ASEL} = 0 to 3.6 V, I_{OUT} = 0			6	10	µA
I_{OFF}	Power off leakage current	V_{AUDIO} = 0 V, $V_{D+/R,\ D-/L,\ D+,\ D-,\ L,\ R}$ = 0 to 5.5 V				±10	µA

TYPICAL CHARACTERISTICS

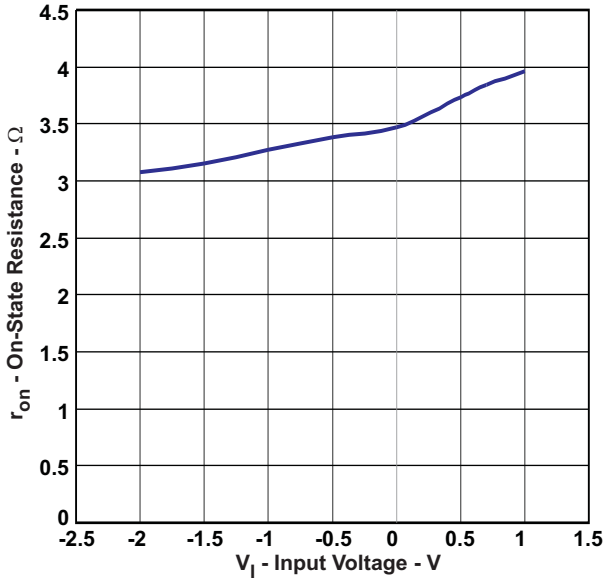


图 1. ON Resistance vs V_I for Audio Switch

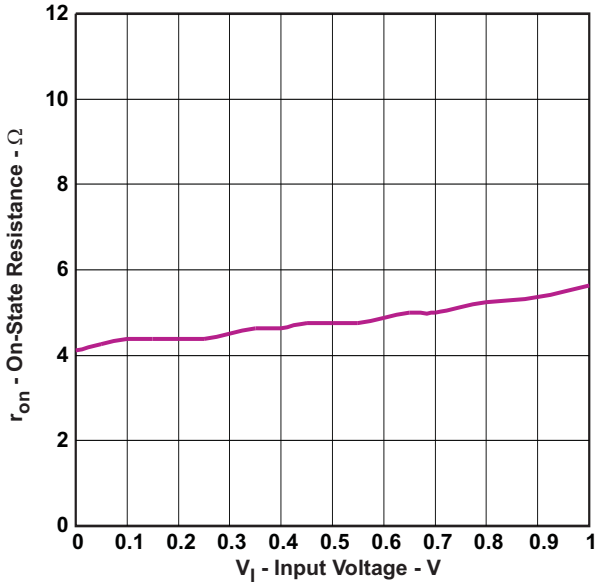


图 2. ON Resistance vs V_I for USB Switch

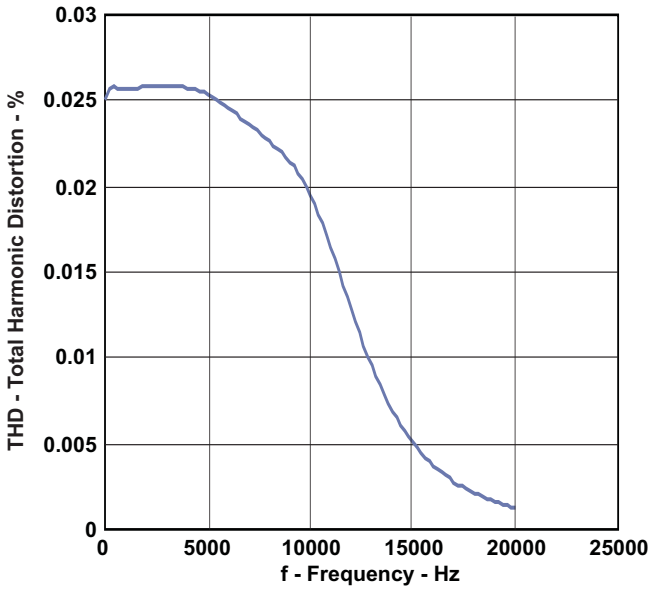


图 3. THD vs Frequency for Audio Switch

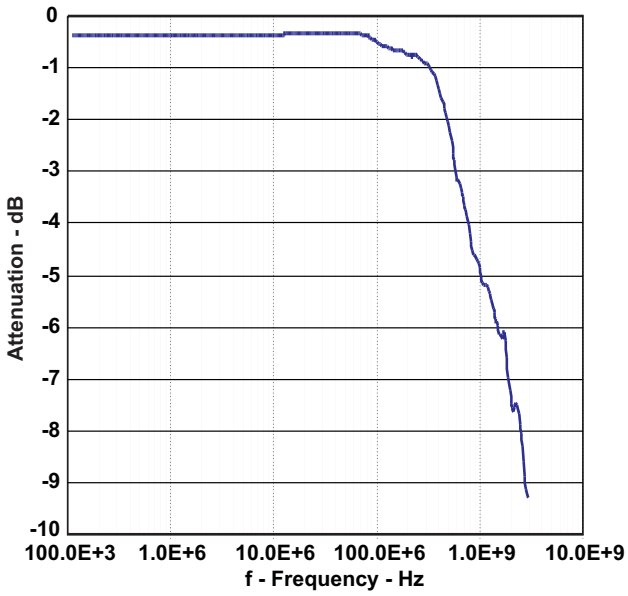


图 4. Gain vs Frequency for USB Switch

TYPICAL CHARACTERISTICS (接下页)

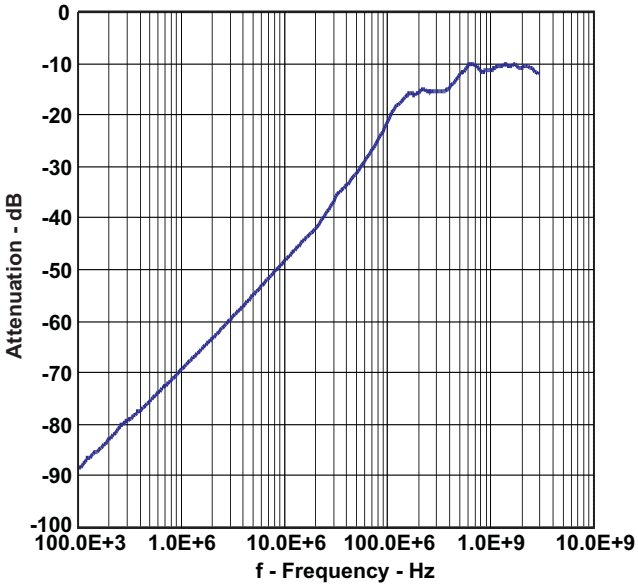


图 5. Off Isolation vs Frequency for Audio Switch

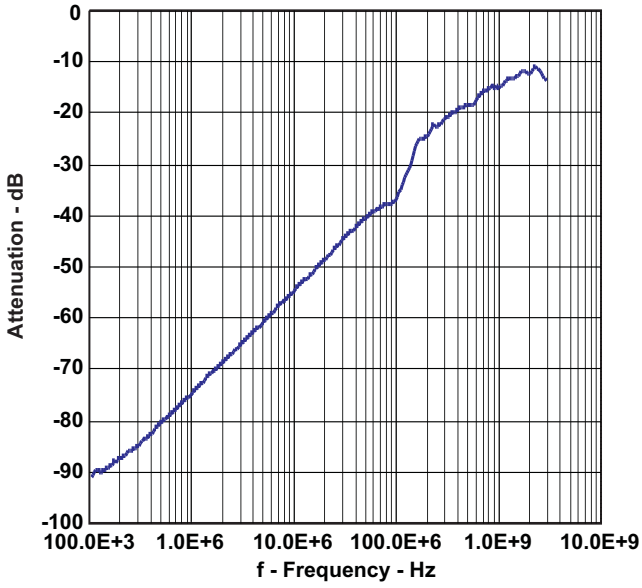


图 6. Off Isolation vs Frequency for USB Switch

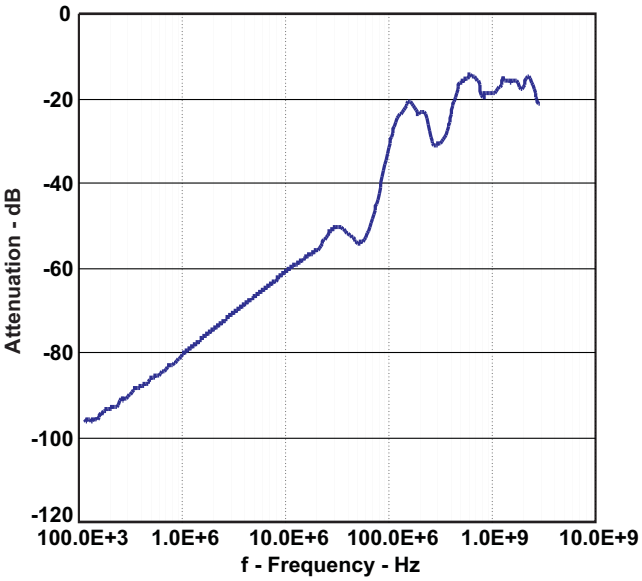


图 7. Cross Talk vs Frequency for Audio Switch

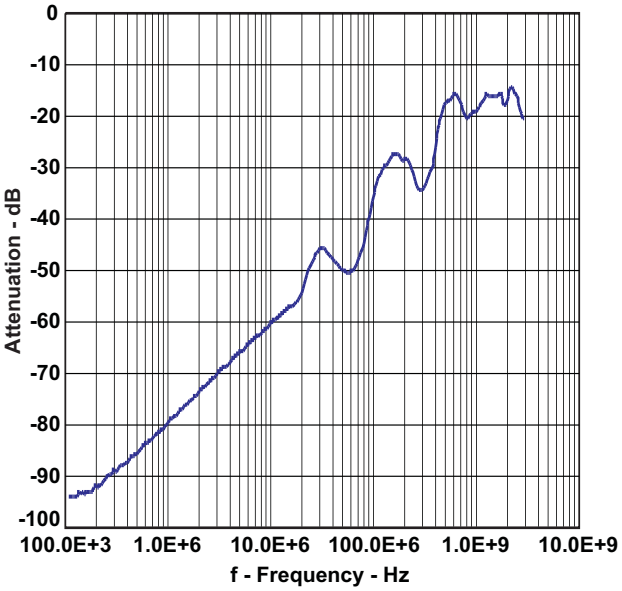


图 8. Cross Talk vs Frequency for USB Switch

TYPICAL CHARACTERISTICS (接下页)

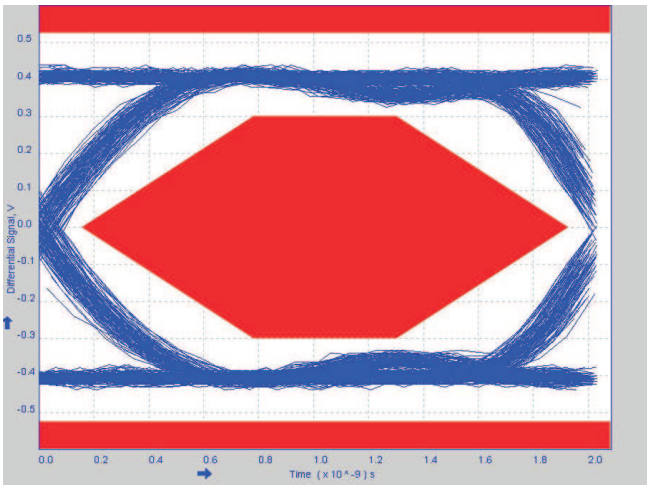
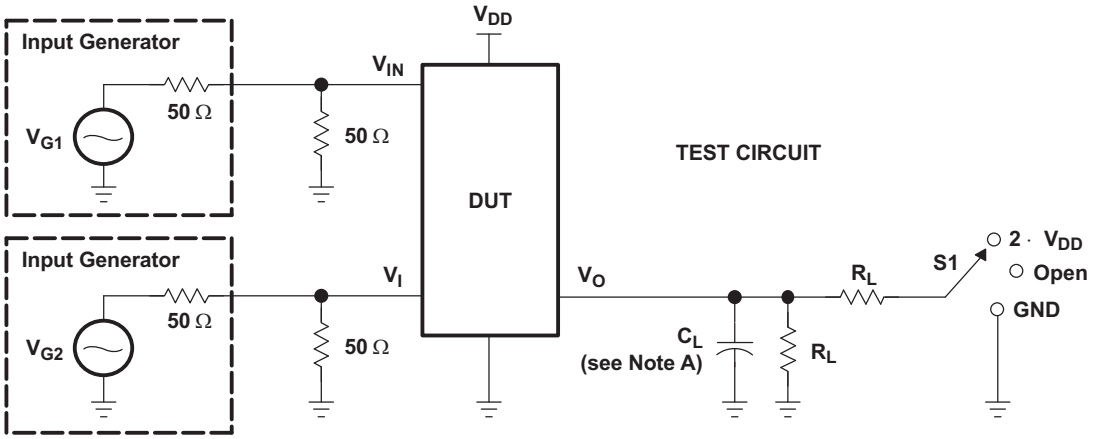
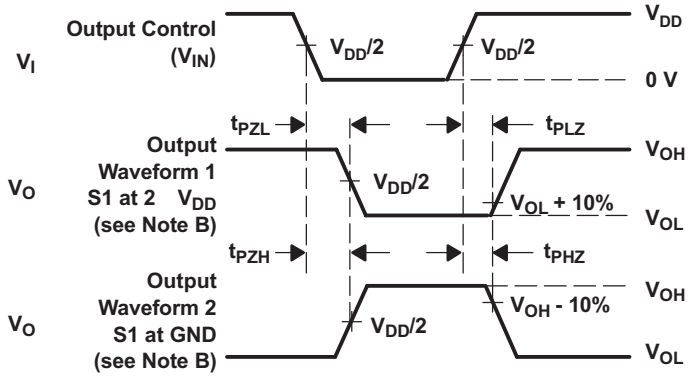


图 9. USB 2.0 Eye Pattern for USB Switch

PARAMETER MEASUREMENT INFORMATION
(Enable and Disable Times)



TEST	V_{AUDIO} (V_{DD})	S1	R_L	V_{in}	C_L	V_Δ
t_{PLZ}/t_{PZL}	3.3 V	2 · V_{DD}	200 Ω	GND	10 pF	0.3 V
t_{PHZ}/t_{PZH}	3.3 V	GND	200 Ω	V_{DD}	10 pF	0.3 V

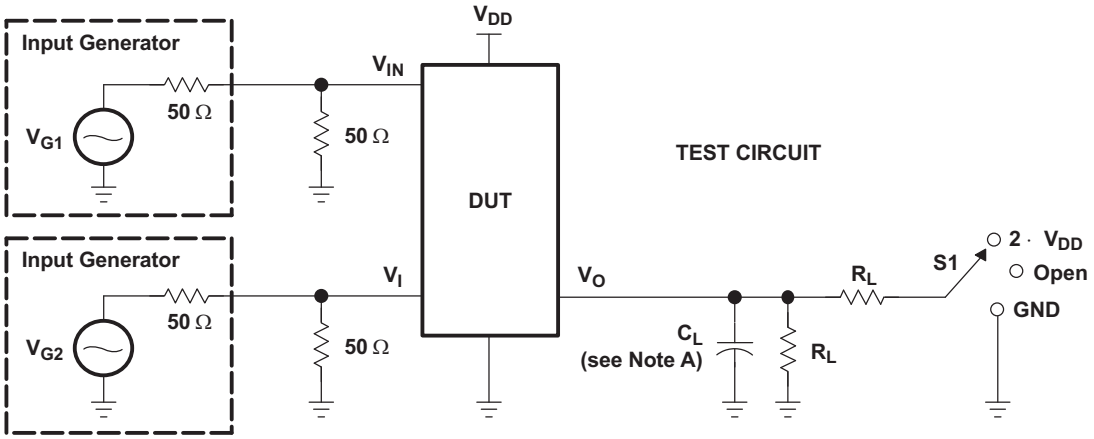


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

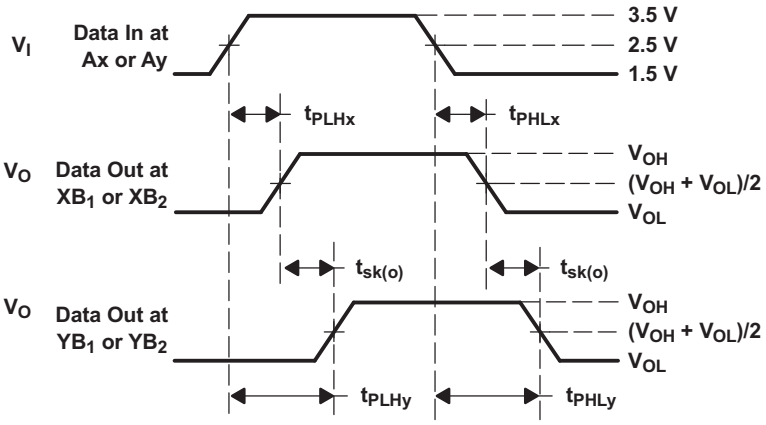
NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis} or t_{OFF}.
F. t_{PZL} and t_{PZH} are the same as t_{en} or t_{ON}.

图 10. Test Circuit and Voltage Waveforms

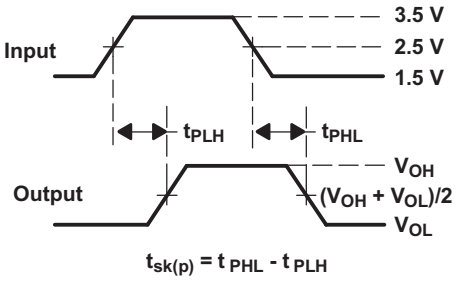
PARAMETER MEASUREMENT INFORMATION (Skew)



TEST	V_{AUDIO} (V_{DD})	S1	R_L	V_{in}	C_L
$t_{sk(o)}$	3.3 V ± 0.3 V	Open	200 Ω	V_{DD} or GND	10 pF
$t_{sk(p)}$	3.3 V ± 0.3 V	Open	200 Ω	V_{DD} or GND	10 pF



VOLTAGE WAVEFORMS
OUTPUT SKEW ($t_{sk(o)}$)

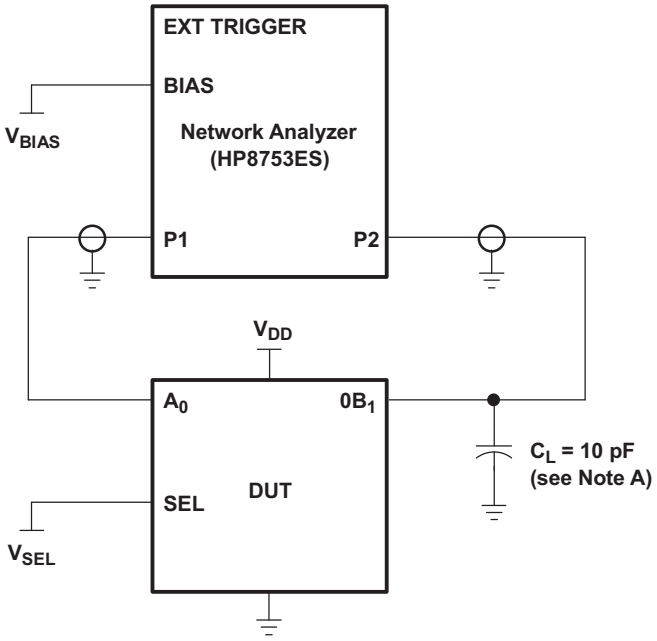


VOLTAGE WAVEFORMS
PULSE SKEW [$t_{sk(p)}$]

NOTES: A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time, with one transition per measurement.

图 11. Test Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



A. C_L includes probe and jig capacitance.

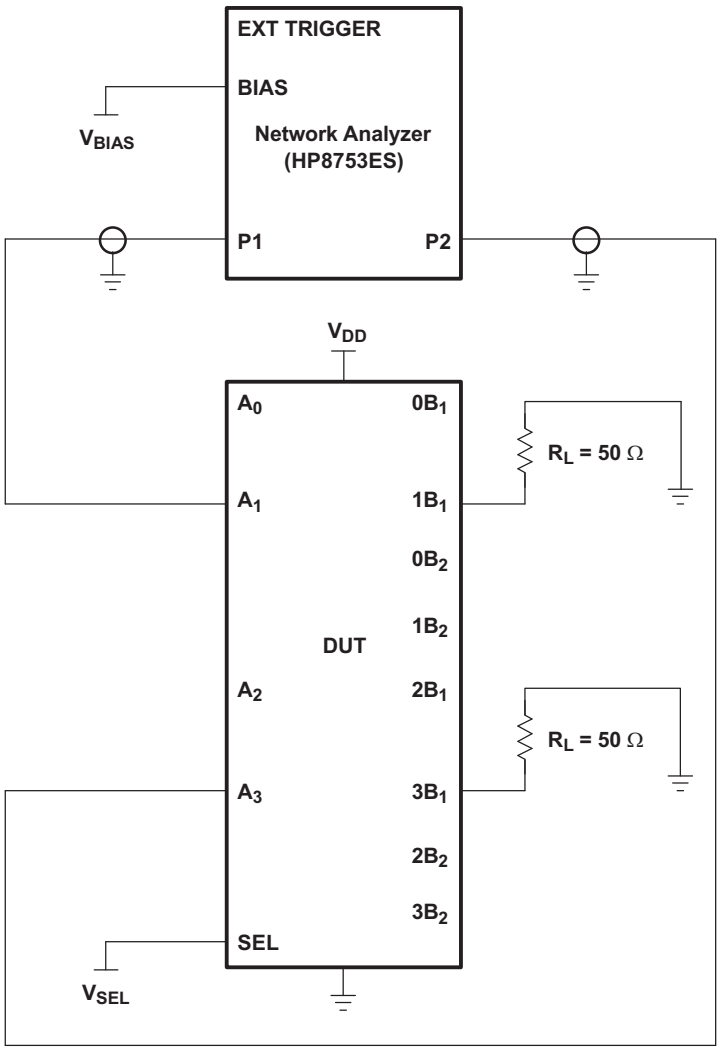
图 12. Test Circuit for Frequency Response (BW)

Frequency response is measured at the output of the ON channel. For example, when V_{SEL} = 0 and A_0 is the input, the output is measured at $0B_1$. All unused analog I/O ports are left open.

HP8753ES Setup

Average = 4
RBW = 3 kHz
V_{BIAS} = 0.35 V
ST = 2 s
P1 = 0 dBM

PARAMETER MEASUREMENT INFORMATION (continued)



A. C_L includes probe and jig capacitance.

B. A 50-Ω termination resistor is needed to match the loading of the network analyzer.

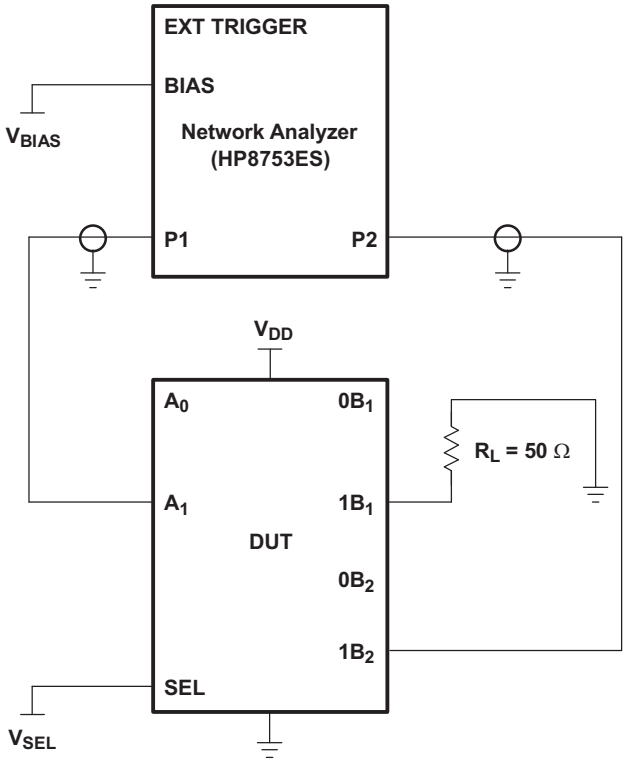
图 13. Test Circuit for Crosstalk (X_{TALK})

Crosstalk is measured at the output of the nonadjacent ON channel. For example, when V_{SEL} = 0 and A_1 is the input, the output is measured at A_3. All unused analog input (A) ports are connected to GND, and output (B) ports are left open.

HP8753ES Setup

Average = 4
RBW = 3 kHz
V_{BIAS} = 0.35 V
ST = 2 s
P1 = 0 dBM

PARAMETER MEASUREMENT INFORMATION (continued)



A. C_L includes probe and jig capacitance.

B. A 50-Ω termination resistor is needed to match the loading of the network analyzer.

图 14. Test Circuit for OFF Isolation (O_{ISO})

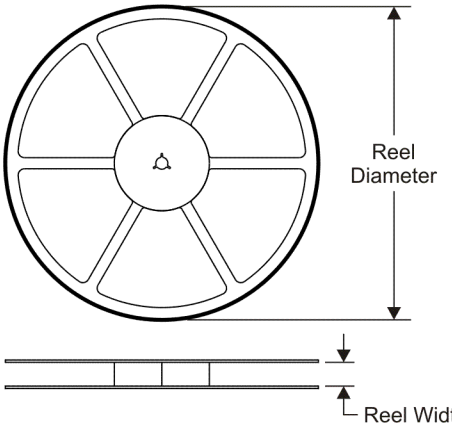
OFF isolation is measured at the output of the OFF channel. For example, when V_{SEL} = GND and A_1 is the input, the output is measured at $1B_2$. All unused analog input (A) ports are connected to ground, and output (B) ports are left open.

HP8753ES Setup

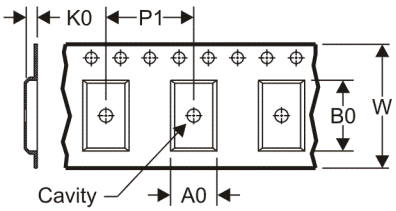
Average = 4
RBW = 3 kHz
V_{BIAS} = 0.35 V
ST = 2 s
P1 = 0 dBM

TAPE AND REEL INFORMATION

REEL DIMENSIONS

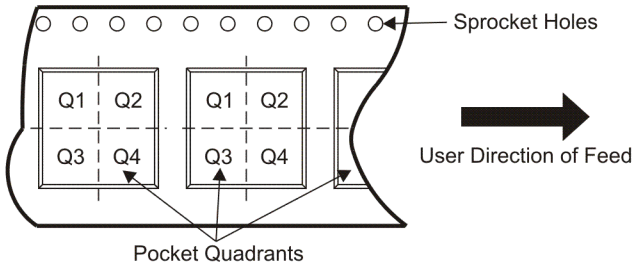


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

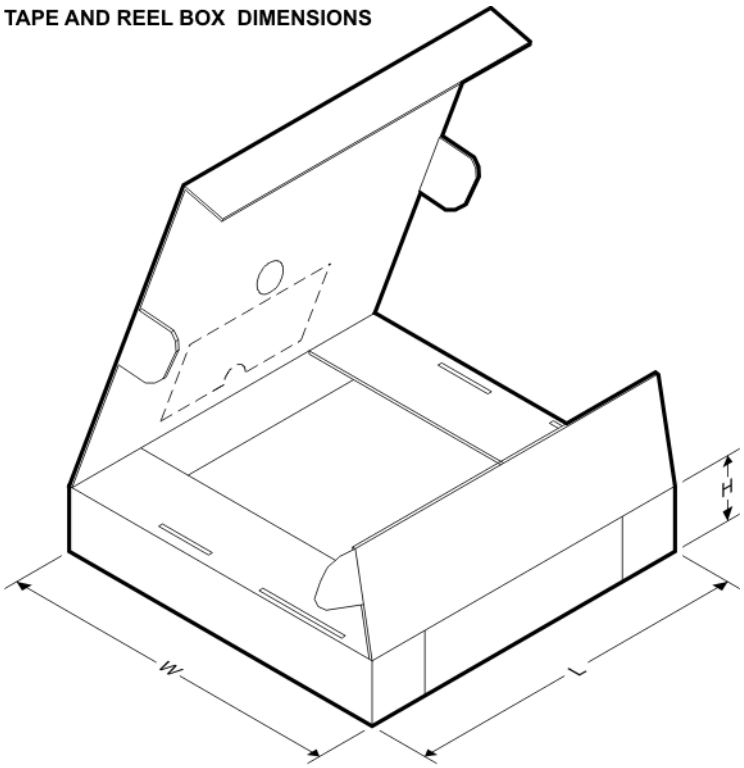
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS5USBA224RSWR	UQFN	RSW	10	3000	180.0	8.4	1.59	2.09	0.72	4.0	8.0	Q1

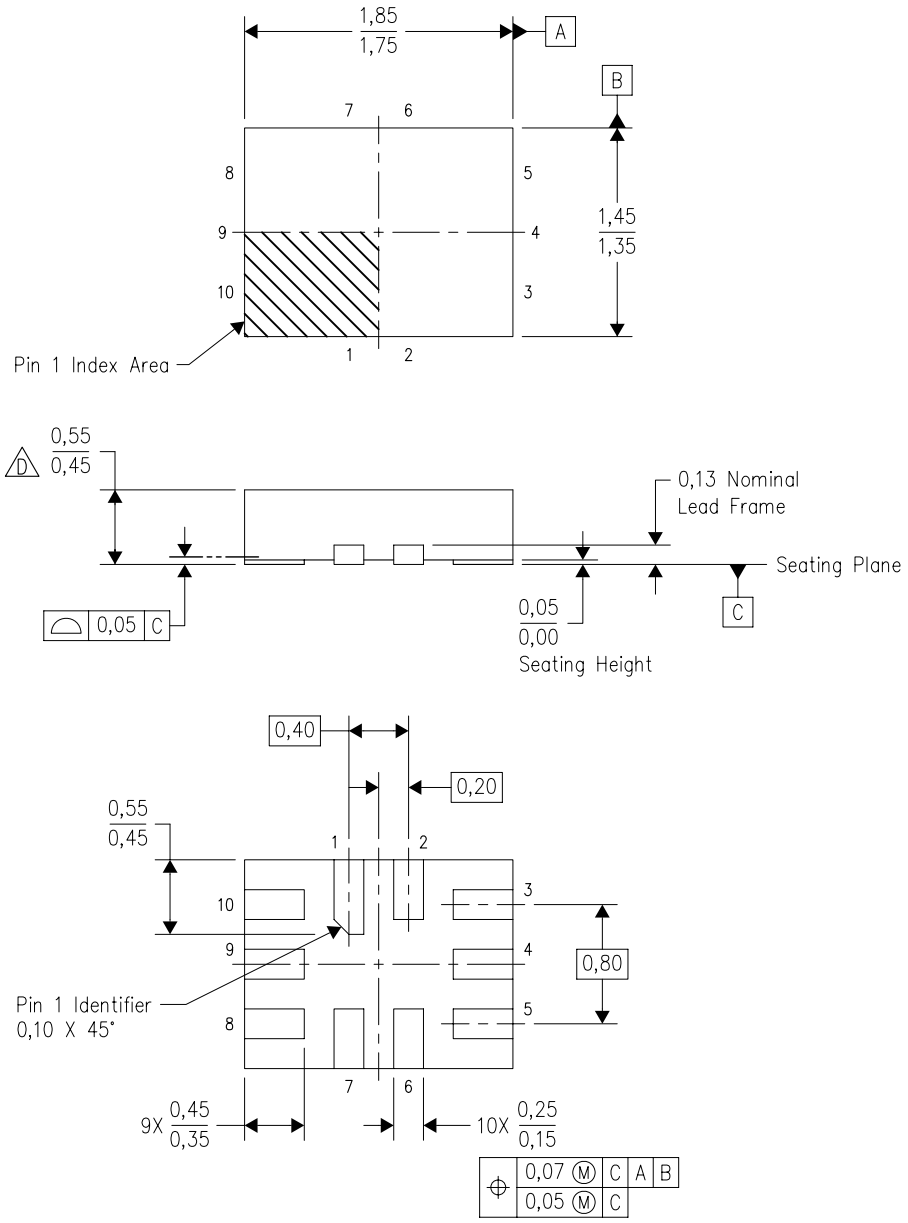
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS5USBA224RSWR	UQFN	RSW	10	3000	202.0	201.0	28.0

RSW (R–PUQFN–N10) PLASTIC QUAD FLATPACK NO–LEAD



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NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–lead) package configuration.
D. This package complies to JEDEC MO–288 variation UDEE, except minimum package height.

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