FSA1153

DP3T USB Type C Audio and UART Analog Switch with OVP

Description

The FSA1153 is a bi−directional, low power, high speed USB2.0 Type−C, Audio and UART analog switch with overvoltage protection. It is configured as a Double−Pole, Triple Throw (DP3T) switch. The FSA1153s protection function prevents damage to Type−C USB 2.0 port pins caused by high voltage. It provides a receptacle side OVP function on the USB 2.0 data pins and will turn off the relative switch once the voltage level on DN_L or DP_R exceed the OV threshold. It can withstand up to 20.5 V DC.

Features

- DP3T USB Type C Audio and UART Analog Switch
- V_{DD}: 2.7 V to 5.5 V
- I_{CC}: 35 μA Typical
- USB Switch
  - −3 dB Bandwidth (Sdd21): 850 MHz
- Audio Switch:
  - Negative Rail Capability: −3 V to +3 V
  - Audio Path R_{ON} = 1 Ω (Typ.) at 3.3 V
  - THD + N = −110 dB; 1 V_{RMS}, 32 Ω Load; f = 20 Hz ~ 20 kHz with A−Weighted Filter
- UART Switch:
  - RON: 5 Ω (Typ.) at 3.3 V
  - Signal Range: 0 – 4.4 V
- High Power Supply Ripple Rejection
- 20.5 V Overvoltage Protection on DN_L/DP_R
- 20.5 V Surge Protection on DN_L/DP_R

Applications

- Mobile Phones
- Tablets
- Notebook PC
- Media Player

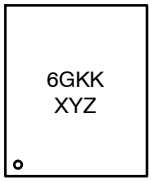
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WLCSP12
CASE 567WM

MARKING DIAGRAM



6G	= Device Number
KK	= Assembly Lot
X	= Year
Y	= Work Week
Z	= Assembly Location

ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

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Typical Application

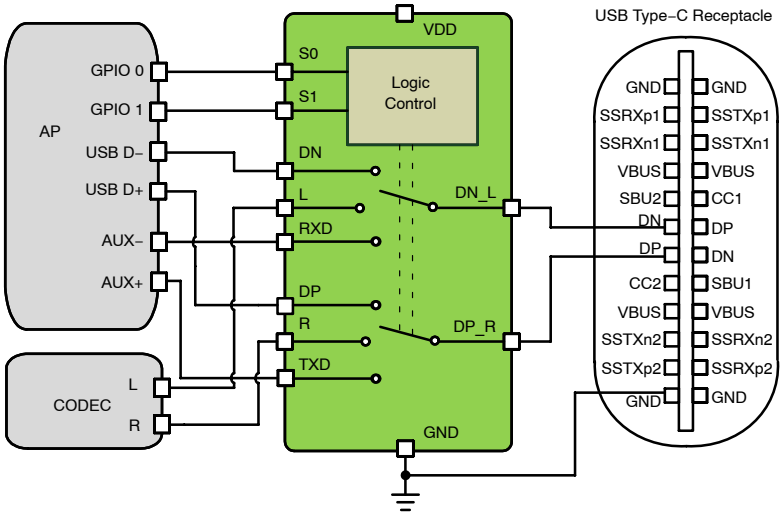


Figure 1. Typical Application

Pin Definitions

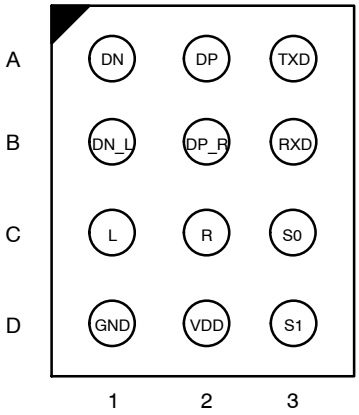


Figure 2. Top Through View

PIN DESCRIPTION

Pin	Name	Description
A1	DN	USB Data (Differential –)
A2	DP	USB Data (Differential +)
A3	TXD	UART Transmit Data
B1	DN_L	USB/Audio/UART Common Connector
B2	DP_R	USB/Audio/UART Common Connector
B3	RXD	UART Receive Data
C1	L	Audio – Left Channel
C2	R	Audio – Right Channel
C3	S0	Data Switch Select
D1	GND	Chip Ground
D2	VDD	Power Supply (2.7 to 5.5 V)
D3	S1	Data Switch Select

Table 1. CONTROL LOGIC STATUS

S1	S0	USB Switch	Audio Switch	UART Switch
0	0	ON	OFF	OFF
0	1	OFF	ON	OFF
1	0	OFF	OFF	ON
1	1	Disable	Disable	Disable

ORDERING INFORMATION

Part Number	Operating Temperature Range	Package	Top Mark
FSA1153UCX	−40 to +85°C	12−Ball WLCSP, Non−JEDEC 1.45 mm x 1.615 mm, 0.4 mm Pitch	6G

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Min.	Max.	Unit
VDD	Supply Voltage from VDD		−0.5	6.5	V
V_{SW_C}	V_{DP_R} to GND, V_{DN_L} to GND (Note 1)		−3.6	20.5	V
V_{SW_USB}	V_{DP} to GND, V_{DN} to GND (Note 1)		−0.5	6.5	V
V_{SW_Audio}	V_L to GND, V_R to GND (Note 1)		−3.6	6.5	V
V_{SW_UART}	V_{TXD} to GND, V_{RXD} to GND (Note 1)		−0.5	6.5	V
V_{SW}	Control Input Voltage: S1, S0 (Note 2)		−0.5	6.5	V
I_{SW_Audio}	Switch I/O Current, Audio path: R, L, DP_R, DN_L		−250	250	mA
I_{SW_USB}	Switch I/O Current, USB path; DP to DP_R, DN to DN_L		−	100	mA
I_{SW_UART}	Switch I/O Current, UART path; TXD to DP_R, RXD to DN_L		−	50	mA
I_{IK}	DC Input Diode Current		−50	−	mA
ESD	Human Body Model, ANSI / ESDA / JEDEC JS−001−2012	Connector side and power pins: VDD, DP_R, DN_L	4	−	kV
		Host side pins: The rest pins	2	−	
	Charged Device Model, JEDEC: JESD22−C101		1	−	
Surge	IEC 61000−4−5 System	Connector side pins: DP_R, DN_L	−20.5	+20.5	V
T_A	Absolute Maximum Operating Temperature		−40	+85	°C
T_{STG}	Storage Temperature		−65	+150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The input and output negative ratings may be exceeded if the input and output diode current ratings are observed.
2. V_{SW} refers to analog data switch paths.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
POWER					
VDD	Supply Voltage	2.7	–	5.5	V
USB SWITCH					
V_{SW_USB}	V_{DP} to GND, V_{DN} to GND, V_{DP_R} to GND, V_{DN_L} to GND	0	–	4.5	V
AUDIO SWITCH					
V_{SW_Audio}	V_{DP_R} to GND, V_{DN_L} to GND, V_L to GND, V_R to GND,	−3.0	–	+3.0	V
UART SWITCH					
V_{SW_UART}	V_{TXD} to GND, V_{RXD} to GND	0	–	4.4	V
OPERATING TEMPERATURE					
T_A	Ambient Operating Temperature	−40	25	+85	°C
CONTROL VOLTAGE (S1, S0)					
V_{IH}	Input Voltage High	1.3	–	VCC	V
V_{IL}	Input Voltage Low	0	–	0.5	V

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

DC AND TRANSIENT CHARACTERISTICS

(V_{DD} = 2.7 V to 5.5 V. V_{DD}(Typ.) = 3.3 V, T_A = −40°C to 85°C, and T_A (Typ.) = 25°C, unless otherwise specified)

Symbol	Parameter	Condition	Power	T_A = −40°C to 85°C			Unit
				Min	Typ	Max	
GENERAL DEVICE PINS							
I_{CC}	Supply current	For all switches	VDD: 2.7 to 5.5	–	–	35	μA
I_{CCZ}	Quiescent current	S0, 1 = 1		–	–	3	
I_{CCT}		Vin = 1.5 V		–	10	–	μA
COMMON PINS: DP_R, DN_L							
I_{OZ}	Off leakage current of Port DP_R and DN_L	DP_R, DN_L = −3 V to 4.0 V	VDD: 2.7 to 5.5	−3.0	0.1	3.0	μA
I_{OFF}	Power−Off leakage current of Port DP_R and DN_L	DP_R, DN_L = 0 V to 4.0 V	Power off	−3.0	0.1	3.0	μA
V_{OV_TRIP}	Input OVP Lockout	Sweep from 3 V to 6 V	VDD: 2.7 to 5.5	4.7	5.0	5.3	V
V_{OV_HYS}	Input OVP Hysteresis		VDD: 2.7 to 5.5	0.2	0.3	0.4	V
AUDIO SWITCH							
I_{ON}	On leakage current of Audio switch	DN_L, DP_R = −3 V to 3.0 V, R, L = Float	VDD: 2.7 to 5.5	−2.0	0.1	2.0	μA
I_{OZ}	Off leakage current of	L / R = −3 V to 3.0 V	VDD: 2.7 to 5.5	−1	0.1	1	μA
I_{OFF}	Input Leakage Current , Power off	L, R = 0 to 3 V, DP_R, DP_L = Float, (I_{SW} = 0 mA)	Power off	−1.0	0.1	1.0	μA
R_{ON}	Switch On Resistance	I_{SW} = 100 mA, V_{SW} = −3 V to 3 V	VDD: 2.7 to 5.5	–	1	2	Ω
ΔR_{ON}	On Resistance Matching, Channel to Channel	I_{SW} = 100 mA, V_{SW} = −3 V to 3 V	VDD: 2.7 to 5.5	–	0.1	0.2	Ω
R_{FLAT}	On Resistance Flatness	I_{SW} = 100 mA, V_{SW} = −3 V to 3 V	VDD: 2.7 to 5.5	–	10	–	mΩ
USB SWITCH							
I_{ON}	On leakage current of USB switch	DN_L, DP_ R = 0 V to 3.6 V, DP = DN = Float	VDD: 2.7 to 5.5	−3.0	0.1	5	μA
		DN_L, DP_R = 3.6 V to 4.5 V, DP = DN = Float		−5	–	15	μA
I_{OZ}	Off leakage current of Port DP and DN	DN, DP = 0 V to 4.5 V	VDD: 2.7 to 5.5	−3.0	0.1	3.0	μA
I_{OFF}	Power−Off leakage current of Port DP and DN	DN, DP = 0 V to 4.5 V	Power off	−3.0	0.1	3.0	μA
R_{ON_USB}	Switch On Resistance	V_{SW} = 0.4 V, I_{ON}= −8 mA	VDD: 2.7 to 5.5	–	3	5	Ω
		Vsw = 4.0 V, I_{ON} = −8 mA		–	3	5	
UART SWITCH							
I_{ON}	On leakage current of UART switch	DN_L, DP_ R = 0 V to 4.4 V, UART = Float	VDD: 2.7 to 5.5	−3.0	0.1	15	μA
I_{OZ}	Off leakage current of Port TXD and RXD	TXD/RXD = 0 V to 4.4 V,	VDD: 2.7 to 5.5	−3.0	0.1	3.0	μA
I_{OFF}	Power−Off leakage current of Port TXD/RXD	TXD/RXD = 0 V to 4.4 V,	Power off	−3.0	0.1	3.0	μA
R_{ON_UART}	UART Switch On Resistance	V_{SW} = 0 to 4.4 V, I_{ON}= −8 mA	VDD: 2.7 to 5.5	–	5	7	Ω
S1, S0							
V_{IH}	Input Voltage High		VDD: 2.7 to 5.5	1.3	–	VDD	V
V_{IL}	Input Voltage Low		VDD: 2.7 to 5.5	–	–	0.5	V
R_{PD}	Internal Pull down resistor on S1,S0	S1, S0 = VDD	VDD: 2.7 to 5.5	–	3	–	MΩ

AC CHARACTERISTICS

(V_{DD} = 2.7 V to 5.5 V. V_{DD}(Typ.) = 3.3 V, T_A = −40°C to 85°C. T_A (Typ.) = 25°C, unless otherwise specified)

Symbol	Parameter	Condition		Power	T_A = −40°C to 85°C			Unit
					Min	Typ	Max	Unit
AUDIO PATH SWITCH								
t_{ON}	Turn On Time (Note 3)	DP/R = DN/L = 0 V → to 1 V, L, R = 32 Ω to GND			–	80	–	μs
t_{OFF}	Turn OFF Time (Note 3)	DP/R = DN/L = 1 V fall to GND, L, R = 32 Ω to GND			–	0.4	–	μs
t_{BBM}	Break Before Make (Note 3)	USB → Audio, DP/R = DN/L = 0 V → 1 V, L, R = 32 Ω to GND, DP, DN = 50 Ω to GND UART → Audio, UART = 50 Ω			–	80	–	μs
T_{EN}	Enable Time (Note 3)	DP/R = DN/L = 1 V, L, R = 32 Ω to GND, S[1, 0] from 11 to 01			–	230	–	μs
T_{Dis}	Disable Time (Note 3)	DP/R = DN/L = 1 V, L, R = 32 Ω to GND, S[1, 0] from 01 to 11			–	0.3	–	μs
t_{OVP}	Response Time	R_{LOAD} = 32 Ω, Vsw = 3 V to 6 V (slew rate >10 V/1 μs), measure OV threshold to 90% OVP trigger level of output falling			–	0.2	1	μs
O_{IRR}	Off Isolation (Note 3)	f = 1 kHz, R_L = 50 Ω, C_L = 0 pF, V_{SW} = 1 V_{RMS}			–	−100	–	dB
		f = 1 MHz, R_L = 50 Ω, C_L = 0 pF, V_{SW} = 1 V_{RMS}				−65		
X_{TALK}	Cross Talk (Adjacent) (Note 3)	f = 1 kHz, R_L = 50 Ω, V_{SW} = 1 V_{RMS}			–	−120	–	dB
	Cross Talk (USB−Audio) (Note 3)	f = 1 kHz or 20 kHz, R_L = 50 Ω, V_{SW} = 1 V_{RMS} on DP or DN			–	−108	–	
BW	−3 dB Bandwidth (Note 3)	R_L = 50 Ω			–	500	–	MHz
PSRR	Power Supply Rejection Ratio (Note 3)	V_{PSRR} = VDD + 100 mV_{RMS} R_L = 20 kΩ or 32 Ω (at DP / R,DN / L), f = 1 kHz	R_L = 32 Ω		–	−119	–	dB
			R_L = 20 kΩ		–	−105	–	
THD+N	Total Harmonic Distortion + Noise (Note 3)	R_L = 16 Ω, f = 20Hz ~ 20 kHz, V_{SW} = 0.5 V_{RMS}	With A−weighted		–	−108	–	dB
			Non A−weighted		–	−105		
		R_L= 32 Ω, f = 20Hz ~ 20 kHz, V_{SW} = 1 V_{RMS}	With A−weighted		–	−110		dB
			Non A−weighted		–	−105		
		R_L = 20 kΩ, f = 20 Hz ~ 20 kHz, V_{SW} = 0.3 V_{RMS}	With A−weighted		–	−110		dB
			Non A−weighted		–	−105		
USB SWITCH								
t_{ON}	Turn−on time (Note 3)	DP/R = DN/L = 1.0 V, DP, DN = 50 Ω to GND			–	40	–	μs
t_{OFF}	Turn−off time (Note 3)	DP/R = DN/L = 1.0 V, DP, DN = 50 Ω to GND			–	0.35	–	μs
T_{BBM}	Break−Before−Make (Note 3)	Audio → USB; DP/R = DN/L = 1.5 V, L, R = 50 Ω to GND, DP, DN = 50 Ω to GND UART → USB: UART = 50 Ω			–	40	–	μs
T_{EN}	Enable Time (Note 3)	DP/R = DN/L = 1 V, DP/DN = 50 Ω to GND, S[1, 0] from 11 to 00			–	200	–	μs
T_{Dis}	Disable Time (Note 3)	DP / R = DN / L = 1 V, DP / DN = 50 Ω to GND, S[1, 0] from 00 to 11			–	0.25	–	μs
BW	−3dB Bandwidth (Note 3)	RL = 50 Ω, Switch ON			–	0.85	–	GHz
X_{TALK}	Cross Talk (Adjacent) (Note 3)	RL = 50 Ω, Switch ON, f = 240 MHz			–	−40	–	dB
O_{IRR}	Off Isolation (Note 3)	RL = 50 Ω, Switch OFF, f = 240 MHz			–	−24	–	dB
t_{OVP}	Response Time	R_{LOAD} = 50 Ω, Vsw = 3 V to 6 V (slew rate >10 V/1 μs), measure OV threshold to 90% OVP trigger level of output falling			–	0.2	1	μs

AC CHARACTERISTICS (continued)
(V_{DD} = 2.7 V to 5.5 V. V_{DD}(Typ.) = 3.3 V, T_A = −40°C to 85°C. T_A (Typ.) = 25°C, unless otherwise specified) (continued)

Symbol	Parameter	Condition	Power	T_A = −40°C to 85°C			Unit
				Min	Typ	Max	Unit
USB SWITCH							
$t_{Recovery}$	Recovery Debounced time (Note 3)	R_{LOAD} = 50 Ω, Vsw = 6 V to 3 V (slew rate < 10 V/1 μs), measure OV threshold to 90% output rising		–	30	–	us
t_{PD}	Propagation Delay (Note 3)	R_L = 50 Ω, C_L = 5 pF		–	100	–	ps
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output (Note 3)	R_L = 50 Ω, C_L = 5 pF		–	10	–	ps
t_J	Total Jitter (Note 3)	V_{SW} = 0.4 $Vdiff_{PP}$, R_L = 50 Ω, C_L = 5 pF, t_R = t_F = 500 ps (10 – 90%) @ 480 Mbps (PBRS = 2^{15} − 1)		–	200	–	ps
UART SWITCH							
t_{ON}	Turn−on time (Note 3)	UART = 1.8 V, Rload = 50 Ω		–	50	–	μs
t_{OFF}	Turn−off time (Note 3)	UART = 1.8 V, Rload = 50 Ω		–	0.4	–	μs
T_{BBM}	Break−Before−Make (Note 3)	USB → UART, USB = 50 Ω, UART=50 Ω Audio → UART		–	50	–	μs
T_{EN}	Enable Time (Note 3)	DP/R = DN/L = 1 V, DP/DN = 50 Ω to GND, S[1, 0] from 11 to 10		–	200	–	μs
T_{Dis}	Disable Time (Note 3)	DP/R = DN/L = 1 V, DP/DN = 50 Ω to GND, S[1, 0] from 10 to 11		–	300	–	μs
t_{OVP}	Response Time	R_{LOAD} = 50 Ω, Vsw = 3 V to 6 V (slew rate > 10 V/1 μs), measure OV threshold to 90% OVP trigger level of output falling		–	0.2	1	μs
BW	Bandwidth (Note 3)	R_L = 50 Ω		–	400	–	MHz

3. Guaranteed by characterization, not production tested.

CAPACITANCE (V_{DD} = 2.7 V to 5.5 V. V_{DD}(Typ.) = 3.3 V, T_A = −40°C to 85°C. T_A (Typ.) = 25°C, unless otherwise specified)

Symbol	Parameter	Condition		Power	T_A = −40°C to 85°C			Unit
					Min	Typ	Max	Unit
AUDIO PATH SWITCH								
$C_{ON_USB/Audio/UART}$	On Capacitance (Common Port) (Note 4)	f =1MHz, 240 MHz, 100 mV_{PK-PK}, 100 mV DC bias		3.3	–	7	–	pF
$C_{OFF_USB/Audio/UART}$	Off Capacitance (Common Port) (Note 4)	f = 1MHz, 240MHz, 100 mV_{PK-PK}, 100 mV DC bias		3.3	–	7	–	pF
C_{OFF_USB}	Off Capacitance (Non−Common Ports) (Note 4)	f = 240 MHz, 100 mV_{PK-PK}, 100 mV DC bias		3.3	–	2.5	–	pF
C_{OFF_Audio}	Off Capacitance (Non−Common Ports) (Note 4)	f = 1 MHz, 100 mV_{PK-PK}, 100 mV DC bias		3.3	–	3.5	–	pF
C_{OFF_UART}	Off Capacitance (Non−Common Ports) (Note 4)	f = 1 MHz, 100 mV_{PK-PK}, 100 mV DC bias		3.3	–	3.5	–	pF
C_{IN}	EN,SEL Pin Capacitance (Note 4)	f = 1 MHz, 100 mV_{PP}, 100 mV DC bias	S1, S0	0	–	2.5	–	pF

4. Guaranteed by characterization, not production tested.

Application Information

Over−Voltage Protection

The FSA1153 features over−voltage protection (OVP) on the receptacle side pins DN_L and DP_R which will switch off the internal signal routing path if the input voltage exceeds the OVP threshold. When an over voltage condition has occurred the switch will open immediately and remain open until the over voltage condition is removed.

Test Diagrams

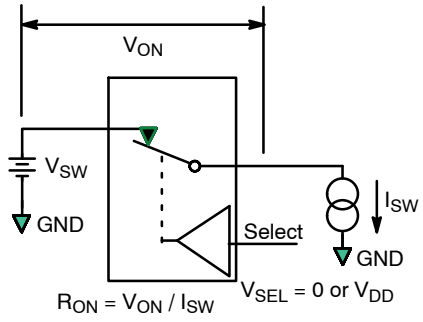
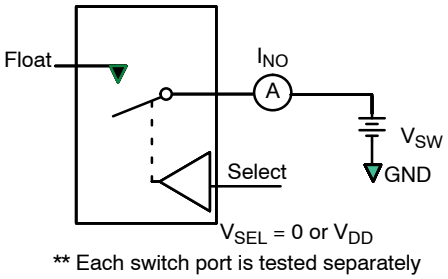


Figure 3. On Resistance



** Each switch port is tested separately

Figure 4. Off Leakage (Ioz)

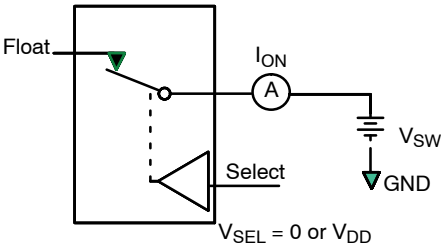
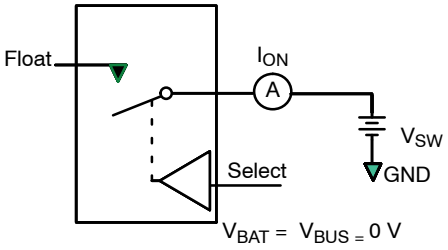
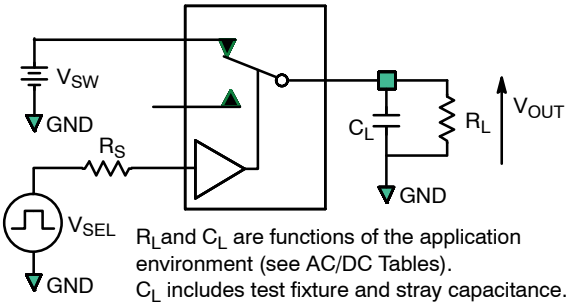


Figure 5. On Leakage



** Each switch port is tested separately

Figure 6. Power Off Leakage (Ioff)



RL and CL are functions of the application environment (see AC/DC Tables).
CL includes test fixture and stray capacitance.

Figure 7. Test Circuit Load

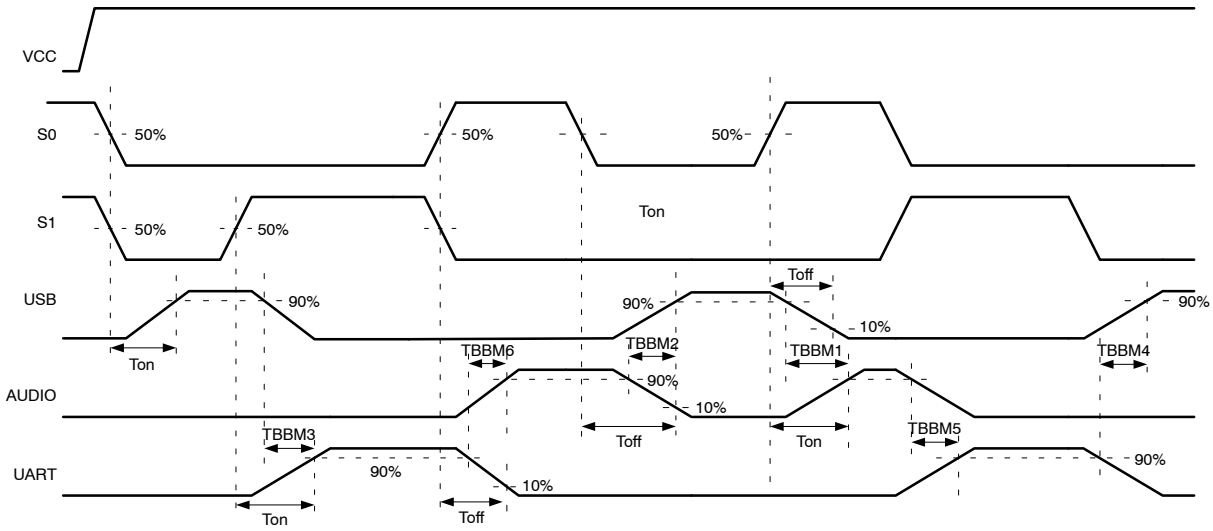


Figure 8. Timing Waveforms

Test Diagrams (continued)

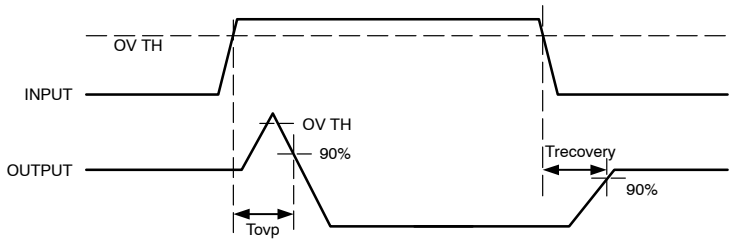


Figure 9. OVP Timing

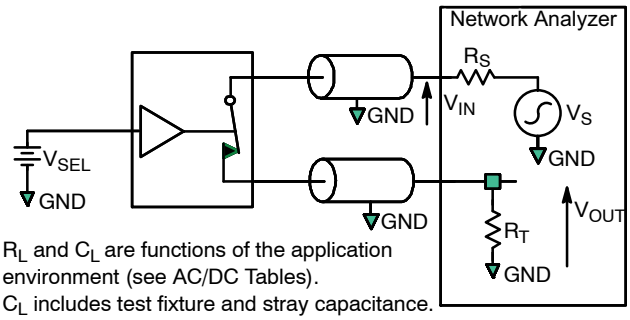


Figure 10. Bandwidth

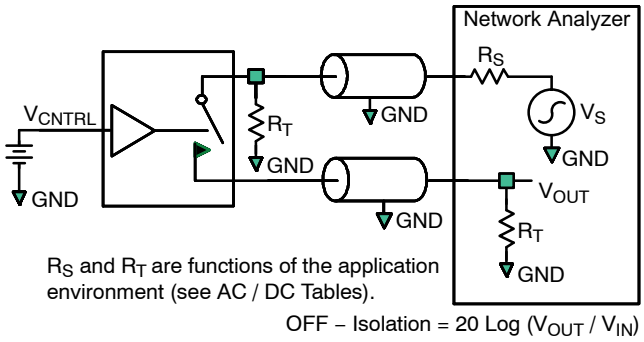


Figure 11. Channel Off Isolation

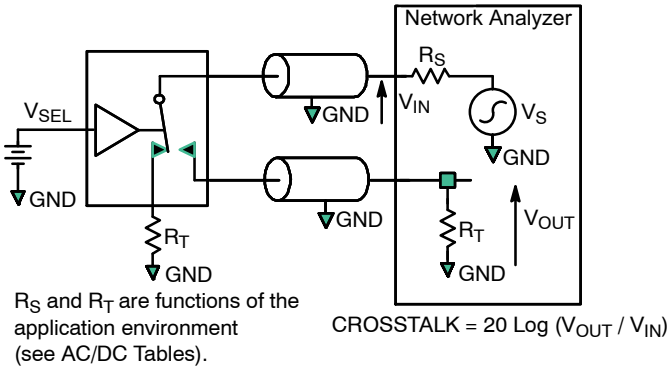


Figure 12. Adjacent Channel Crosstalk

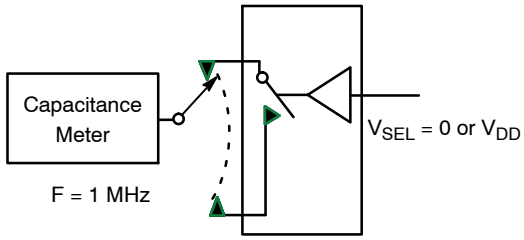


Figure 13. Channel Off Capacitance

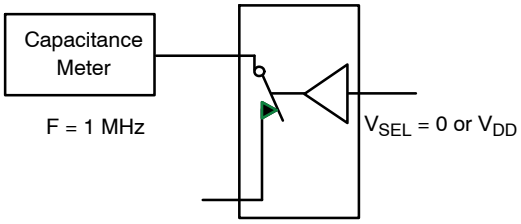


Figure 14. Channel On Capacitance

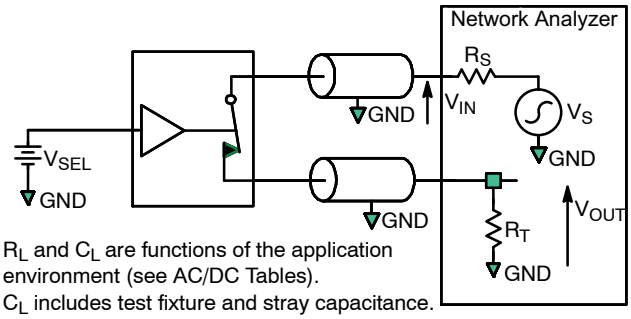
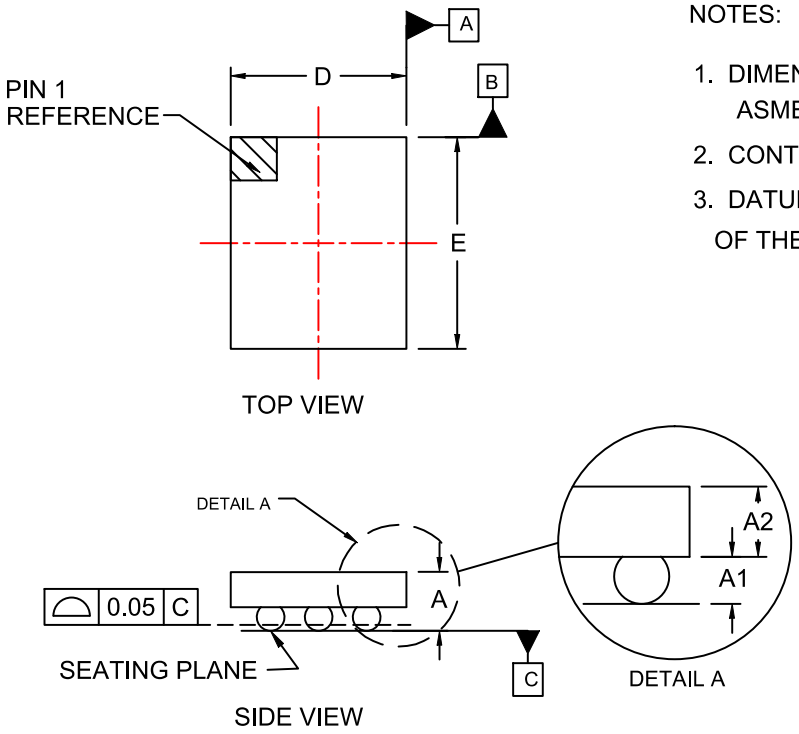


Figure 15. Total Harmonic Distortion (THD+N)

WLCSP12, 1.41x1.575x0.599
CASE 567WM
ISSUE O

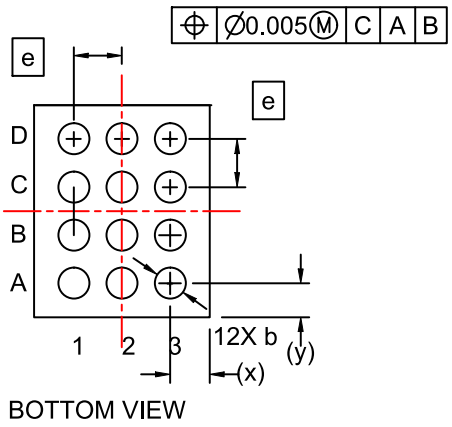
DATE 31 MAY 2018

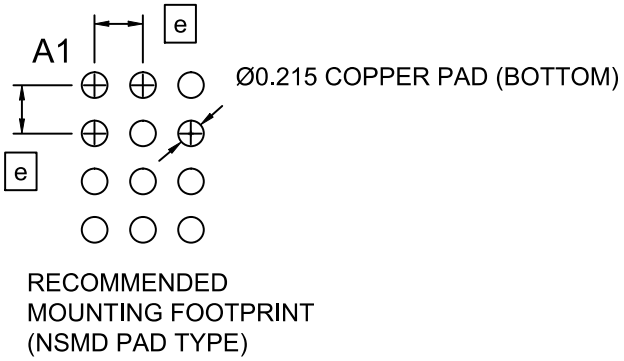


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DATUM C APPLIES TO THE SPHERICAL CROWN OF THE SOLDER BALLS

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.561	0.599	0.637
A1	0.174	0.194	0.214
A2	0.387	0.405	0.423
b	0.240	0.260	0.280
D	1.380	1.410	1.440
E	1.545	1.575	1.605
e	0.40 BSC		
x	0.290	0.305	0.320
y	0.1725	0.1875	0.2025





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