

AS1747

Low-Voltage, Dual SPDT, Audio Clickless Switch with Negative Rail Capability

1 General Description

The SPDT (single-pole/double-throw) switch AS1747 allows signals below ground to pass through without distortion. This analog switch is ideal for switching audio signals, due to the supply voltage from +1.8V to +5.5V and the low 0.4Ω on-resistance.

This SPDT switch is available in space-saving 10-pin TDFN 3x3 packages and operate over the -40°C to +85°C extended temperature range.

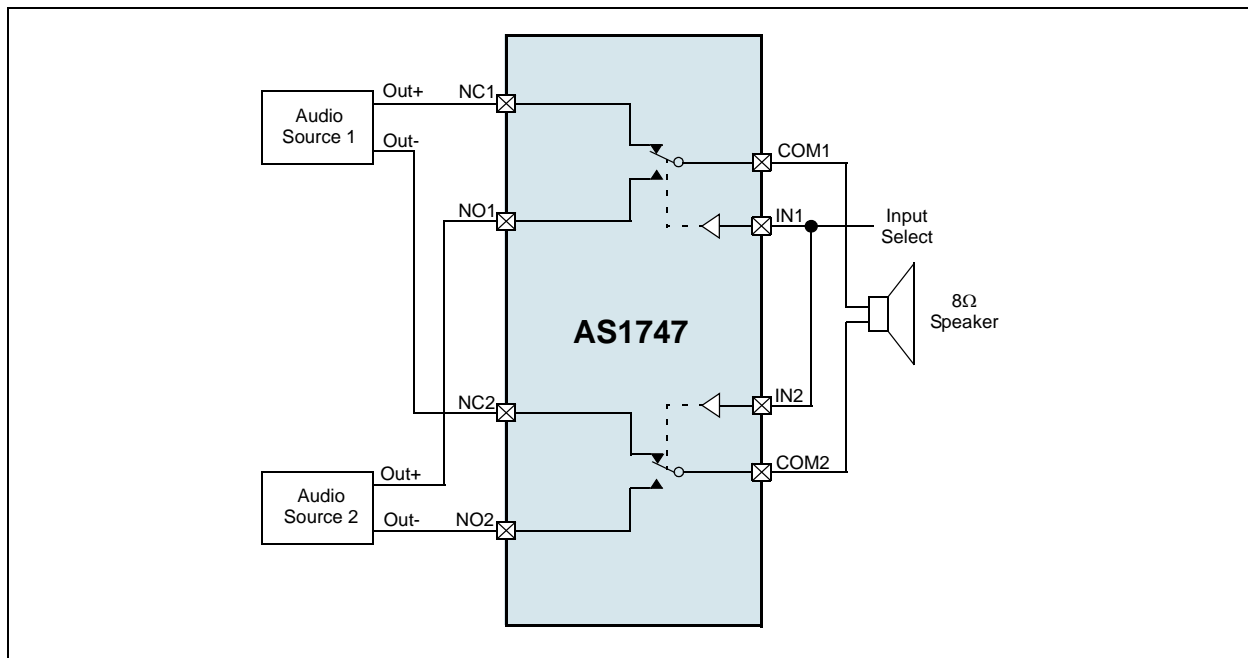
2 Key Features

- Distortion -Free Negative Signal Throughput Down to VCC - 5.5V
- Low On-Resistance (R_{ON})
0.4Ω at +2.7V Supply
- 0.25Ω On-Resistance Flatness
- 0.03Ω On-Resistance Matching
- +1.8V to 5.5V Supply Voltage
- -90dB Crosstalk (100kHz)
- -65dB Off-Isolation (100kHz)
- Available in 10-pin TDFN 3x3 Packages

3 Applications

The device is ideal for cell phones, PDAs and hand-held devices, notebook computers and MP3 players.

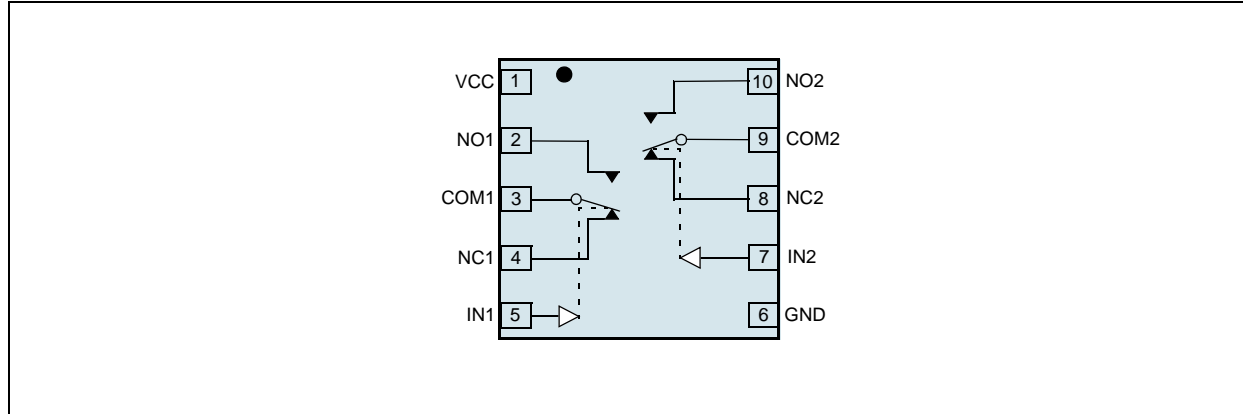
Figure 1. AS1747 - Typical Operating Circuit



4 Pinout

Pin Assignment

Figure 2. Pin Assignments (Top View)



Pin Description

Table 1. Pin Description

Pin Name	TDFN	Description
VCC	1	Positive-Supply Voltage Input
NO1	2	Analog Switch 1 - Normally Open Terminal
COM1	3	Analog Switch 1 - Common Terminal
NC1	4	Analog Switch 1 - Normally Closed Terminal
IN1	5	Digital Control Input for Analog Switch 1. A logic LOW on IN1 connects COM1 to NC1 and a logic HIGH connects COM1 to NO1.
GND	6	Ground
IN2	7	Digital Control Input for Analog Switch 2. A logic LOW on IN2 connects COM2 to NC2 and a logic HIGH connects COM2 to NO2.
NC2	8	Analog Switch 2 - Normally Closed Terminal
COM2	9	Analog Switch 2 - Common Terminal
NO2	10	Analog Switch 2 - Normally Open Terminal

5 Absolute Maximum Ratings

Stresses beyond those listed in [Table 2](#) 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 in [Electrical Characteristics on page 4](#) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
V _{CC} , I _N _	-0.3	+6.0	V	
COM_, NO_, NC_	V _{CC} - 6	V _{CC} + 0.3	V	
Closed-Switch Continuous Current COM_, NO_, NC_		±150	mA	
Open-Switch Continuous Current NO_, NC_		±30	mA	
Peak Current COM_, NO_, NC_ (pulsed at 1ms, 10% duty cycle)		±400	mA	
Continuous Power Dissipation (T_A = +70°C)				
10-Pin TDFN (derate 24.4mW/°C above +70°C)		1951	mW	
ESD	2		kV	HBM MIL-Std. 883E 3015.7 methods
Latchup Immunity	-200	+200	mA	@25°C, JEDEC 78
Operating Temperature Range	-40	+85	°C	
Junction Temperature		+150	°C	
Storage Temperature Range	-65	+150	°C	
Package Body Temperature		+260	°C	The reflow peak soldering temperature (body temperature) specified is in accordance with IPC/JEDEC J-STD-020D "Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices". The lead finish for Pb-free leaded packages is matte tin (100% Sn).

6 Electrical Characteristics

$V_{CC} = +2.7V$ to $+5.5V$, $T_A = -40^\circ C$ to $+85^\circ C$, unless otherwise specified. Typical values are at $V_{CC} = +3.0V$, $T_A = +25^\circ C$, unless otherwise specified.

Table 3. Electrical Characteristics

Symbol	Parameter	Condition		Min	Typ	Max	Unit
Analog Switch							
$V_{NO_}$ $V_{NC_}$ $V_{COM_}$	Analog Signal Range			$V_{CC} - 5.5$		V_{CC}	V
$R_{ON(NC)}$ $R_{ON(NO)}$	On-Resistance	$V_{CC} = 2.7V$; $V_{NC_}$ or $V_{NO_} = V_{CC} - 5.5V, -1V, 0V, 1V, 2V, V_{CC}$; $I_{COM_} = 100mA$	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}		0.4	0.85 0.95	Ω
ΔR_{ON}	On-Resistance Match Between Channels	$V_{CC} = 2.7V$, $V_{NC_}$ or $V_{NO_} = 0V$, $I_{COM} = 100mA$	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}		0.03	0.1 0.15	Ω
$R_{FLAT(NC)}$	On-Resistance Flatness	$V_{CC} = 2.7V$; $V_{NC_}$ or $V_{NC} = -1V, 0V, 1V, 2V, V_{CC}$; $I_{COM_} = 100mA$	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}		0.25	0.4 0.45	Ω
$I_{NO_ (OFF)}$ $I_{NC_ (OFF)}$	$NO_$, $NC_$ Off-Leakage Current	$V_{CC} = 2.7V$, switch open; $V_{NC_}$ or $V_{NO_} = -2.5V, +2.5V$; $V_{COM_} = +2.5V, -2.5V$	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}	-10 -200		+10 +200	nA
$I_{COM_ (ON)}$	$COM_$ On-Leakage Current	$V_{CC} = 2.7V$, switch closed; $V_{NC_}$ or $V_{NO_} = -2.5V, +2.5V$; or floating; $V_{COM_} = -2.5V, +2.5V$, or floating	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}	-10 -200		+10 +200	nA
Dynamic Characteristics							
t_{ON}	Turn-On Time ¹	$V_{NO} = 2.5V$; for $NO_$, $V_{IN_} = 0V$ to V_{CC} ; for $NC_$, $V_{IN_} = V_{CC}$ to $0V$; $R_L = 300\Omega$, $C_L = 35pF$, Figure 15	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}		200	400 400	ns
t_{OFF}	Turn-Off Time ¹	$V_{NC} = 2.5V$; for $NO_$, $V_{IN_} = V_{CC}$ to $0V$; for $NC_$, $V_{IN_} = 0V$ to V_{CC} ; $R_L = 300\Omega$, $C_L = 35pF$, Figure 15	$T_A = +25^{\circ}C$ $T_A = T_{MIN}$ to T_{MAX}		100	200 200	ns
t_D	Break-Before-Make Time Delay	$V_{N_} = 2.5V$, for $NO_$, $V_{IN_} = V_{CC}$ to $0V$; for $NC_$, $V_{IN_} = 0V$ to V_{CC} ; $R_L = 300\Omega$, $C_L = 35pF$, Figure 16			200		ns
Q	Charge Injection	$V_{COM_} = 0V$, $R_S = 0\Omega$, $C_L = 1.0nF$, Figure 17			2		pC
V_{ISO}	Off-Isolation	$V_{CC} = 5V$, $f = 100kHz$, $V_{COM_} = 1V_{RMS}$, $R_L = 50\Omega$, $C_L = 5pF$, Figure 18			-65		dB
V_{CT}	Crosstalk	$V_{CC} = 5V$, $f = 100kHz$, $V_{COM_} = 1V_{RMS}$, $R_L = 50\Omega$, $C_L = 5pF$, Figure 18			-90		dB
PSRR	Power-Supply Rejection Ratio	$f = 10kHz$, $V_{COM_} = 1V_{RMS}$, $R_L = 50\Omega$, $C_L = 5pF$			70		dB
BW	On-Channel-3dB Bandwidth	$V_{CC} = 5V$, Signal = $0dBm$, $R_L = 50\Omega$, $C_L = 5pF$, Figure 18			31		MHz
THD	Total Harmonic Distortion	$f = 20Hz$ to $20kHz$, $V_{COM_} = 0.5V_{P-P}$, DC Bias = 0, $R_L = 32\Omega$			0.01		%
$C_{NO_ (Off)}$ $C_{NC_ (Off)}$	$NO_$, $NC_$ Off-Capacitance	$f = 1MHz$, $V_{COM_} = 0.5V_{P-P}$, DC Bias = 0			63		pF

Table 3. Electrical Characteristics (Continued)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
C _{COM_(ON)}	COM On-Capacitance	f = 1MHz, V _{COM_} = 0.5V _{P-P} , DC Bias = 0		196		pF
Digital I/O (IN_)						
V _{IH}	Input Logic High Voltage	V _{CC} = 2.7V to 3.6V	1.4			V
		V _{CC} = 4.2V to 5.5V	2.0			
V _{IL}	Input Logic Low Voltage	V _{CC} = 2.7V to 3.6V			0.5	V
		V _{CC} = 4.2V to 5.5V			0.8	
I _{IN}	Input Leakage Current	V _{IN_} = 0V to V _{CC} , V _{CC} = 5.5V	-1		+1	μA
Power Supply						
V _{CC}	Power-Supply Range		1.8		5.5	V
I _{CC}	Supply Current	V _{CC} = 5.5V, V _{IN_} = 0V or V _{CC}		0.01	1	μA

1. Guaranteed by design

7 Typical Operating Characteristics

$V_{CC} = 3.0V$, $T_A = +25^\circ C$ (unless otherwise specified).

Figure 3. ON-Resistance vs. V_{COM}

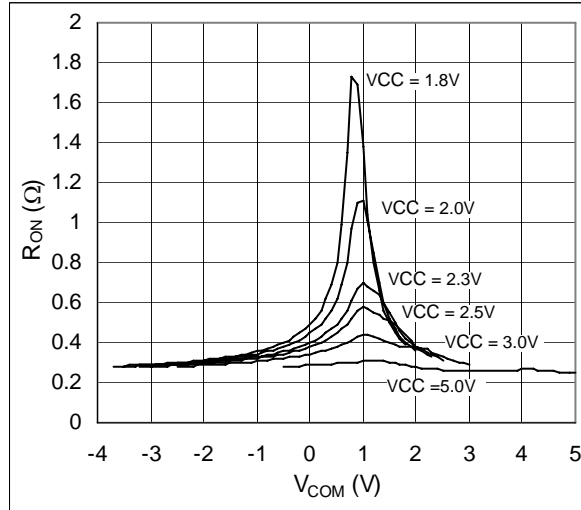


Figure 4. ON Resistance vs. V_{COM} ; $V_{CC}=3.0V$

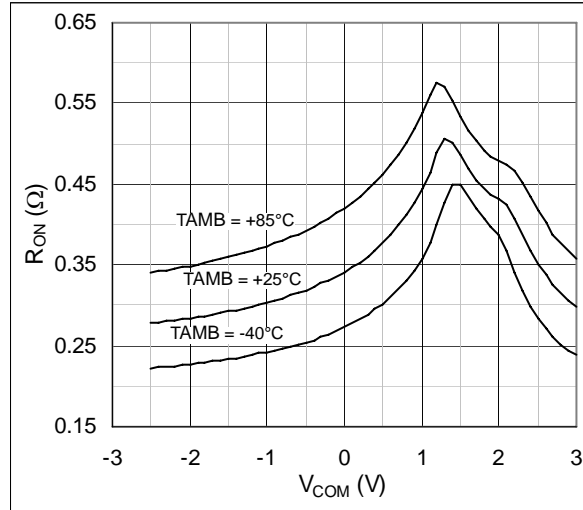


Figure 5. ON Resistance vs. V_{COM} ; $V_{CC}=5.0V$

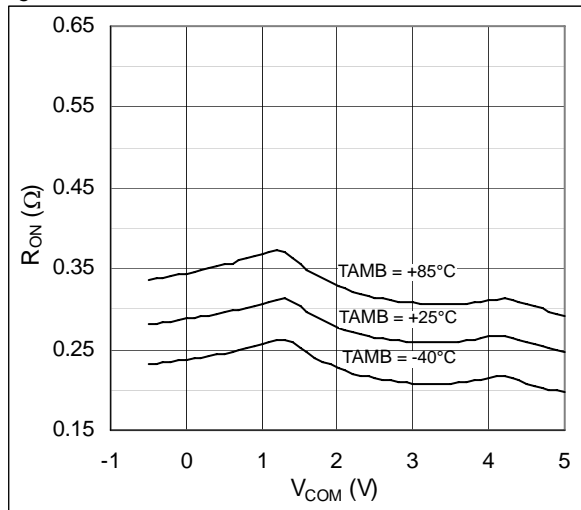


Figure 6. Charge Injection vs. V_{COM} ; $C_{LOAD} = 1nF$

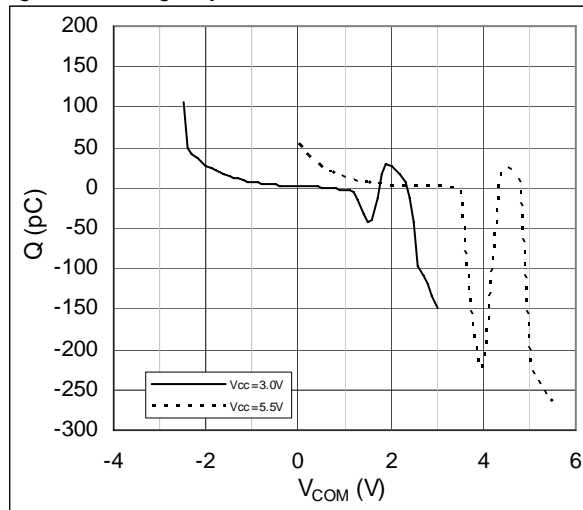


Figure 7. Frequency Response

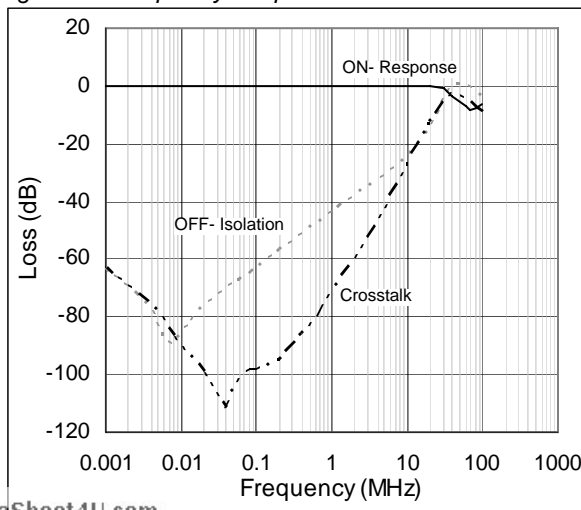


Figure 8. Logic Threshold Voltage vs. V_{CC}

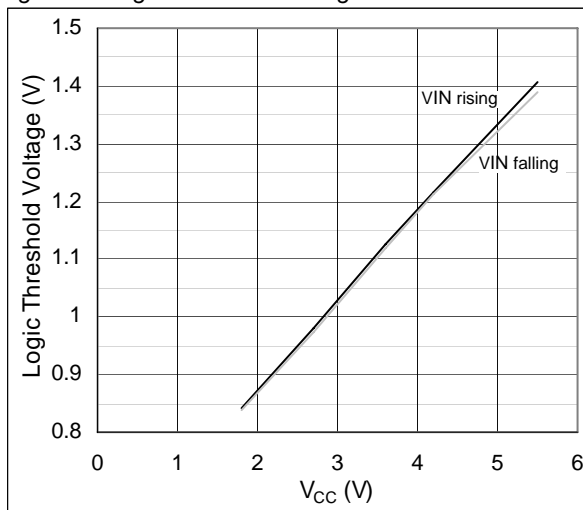


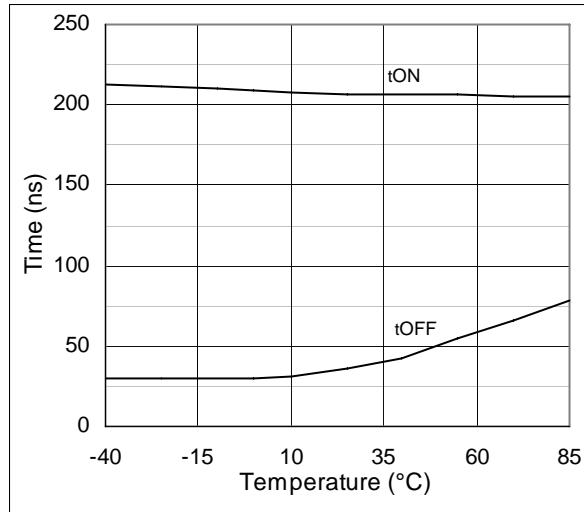
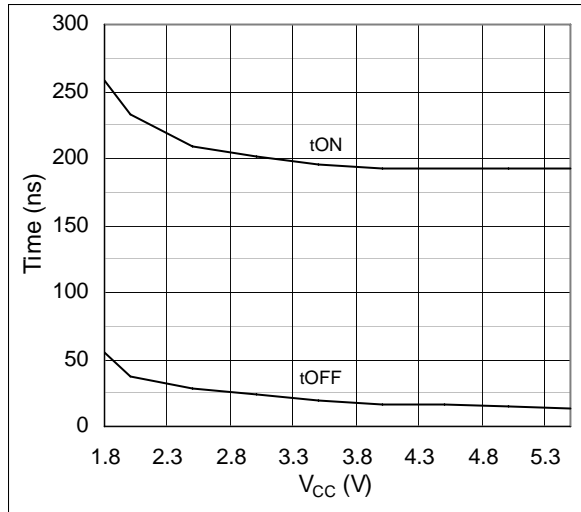
Figure 9. Turn-ON/OFF vs. Temperature; $V_{CC} = 3V$ Figure 10. Turn-ON/OFF Times vs. V_{CC} 

Figure 11. Leakage Current vs. Temperature

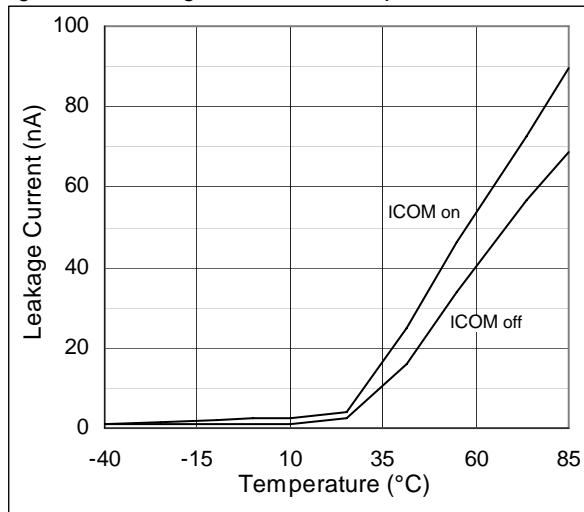
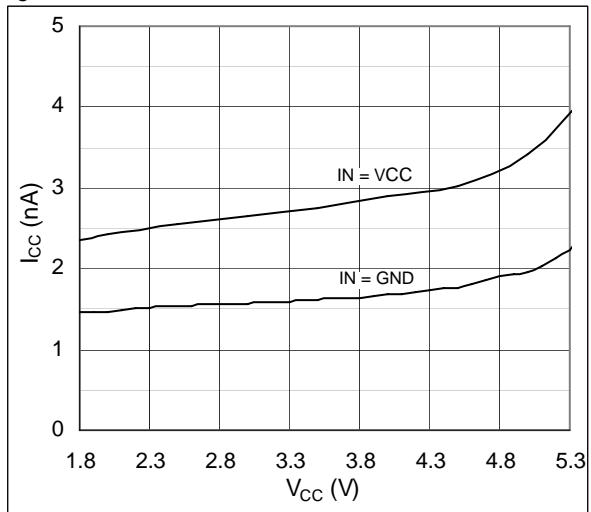
Figure 12. I_{CC} vs. V_{CC} 

Figure 13. Total Harmonic Distortion vs. Frequency

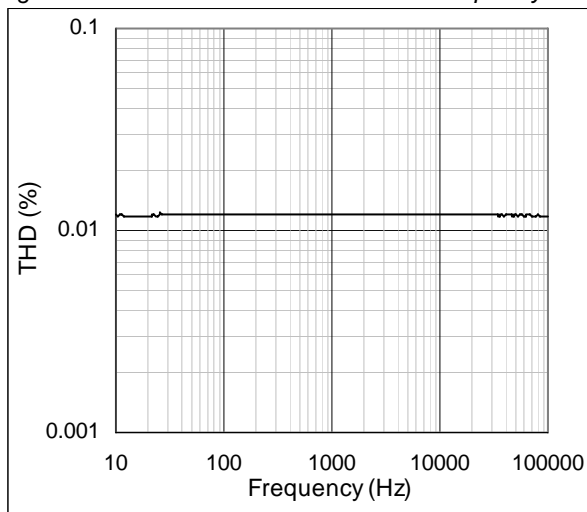
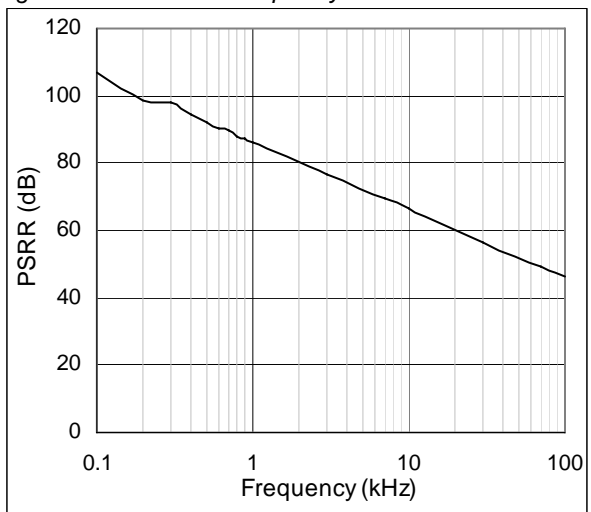


Figure 14. PSRR vs. Frequency



8 Detailed Description

The AS1747 operates from a +1.8V to +5.5V supply and features a negative signal capability that allows signals below ground to pass through without distortion. A break-before-make switching and a low on-resistance is also included in this analog dual SPDT switch. The device is fully specified for a 3.0V application.

9 Application Information

Digital Control Inputs

The logic inputs of the AS1747 accept up to +5.5V independent of the supply voltage. Due to this a mixing of the logic levels in a system is possible. For example, with a +3.3V supply, IN_ can be driven low to GND and high to +5.5V. For a +1.8V supply voltage, the logic levels are 0.5V (low) and 1.4V (high); for a +5V supply voltage, the logic levels are 0.8V (low) and 2.0V (high).

Analog Signal Levels

The change of the on-resistance of the AS1747 is very little for analog input signals over the whole supply voltage range. The switches are bi-directional, so the NO_, NC_, and COM_ pins can be either inputs or outputs.

The AS1747 pass signals as low as $V_{CC} - 5.5V$, including signals below ground with minimal distortion.

Power-Supply Sequencing and Overvoltage Protection

Caution: Do not exceed the absolute maximum ratings since stresses beyond the listed ratings may cause permanent damage to the device.

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V_{CC} before applying analog signals, especially if the analog signal is not current-limited.

10 Timing Diagrams

Figure 15. Switching Time

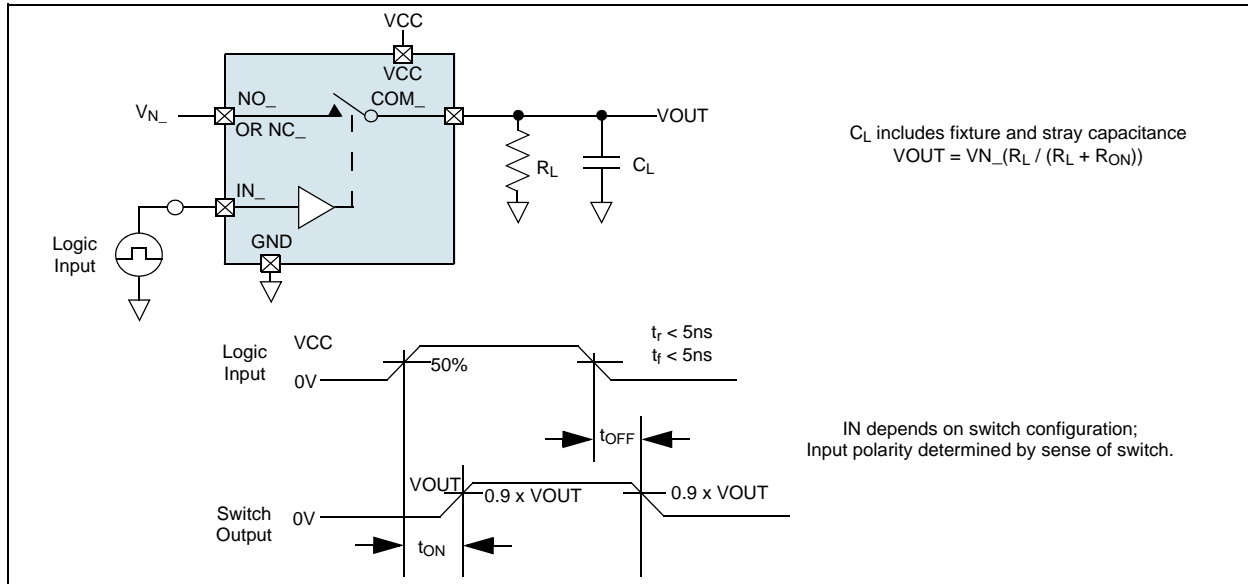


Figure 16. Break-Before-Make Interval

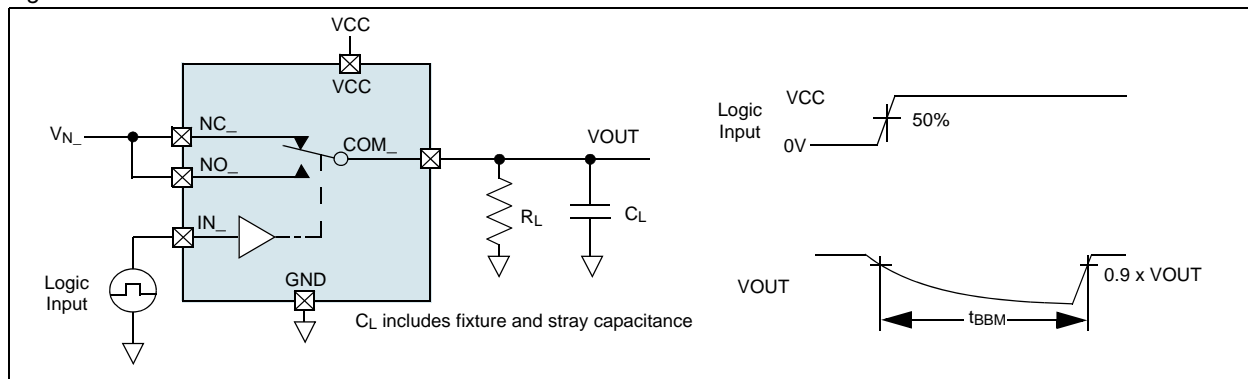


Figure 17. Charge Injection

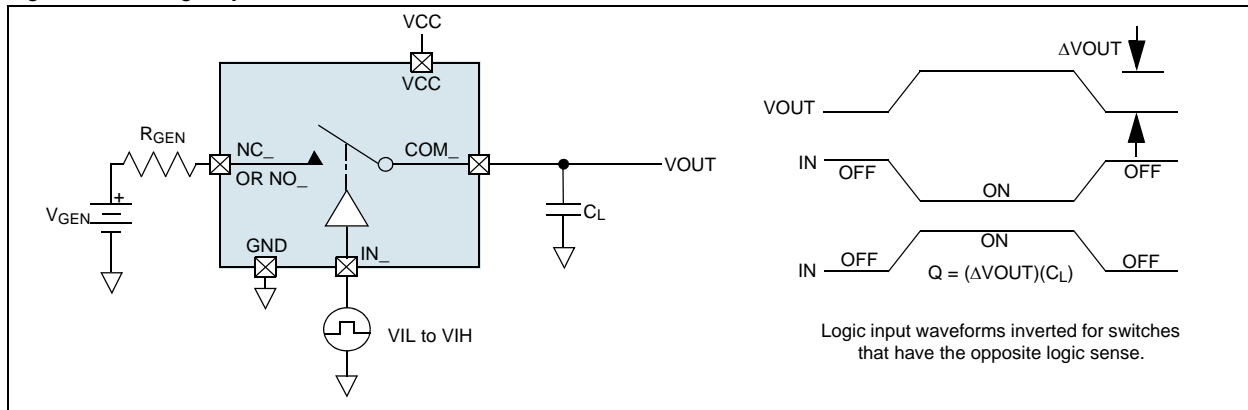
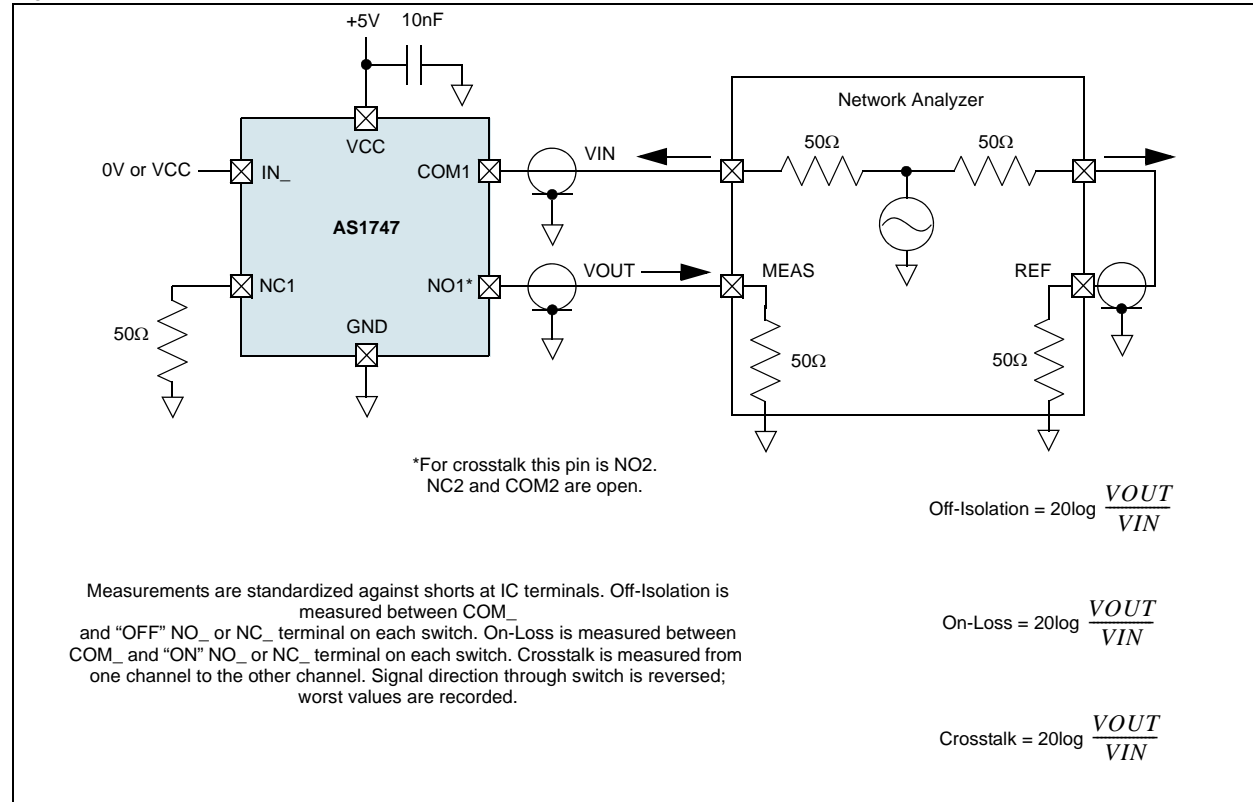


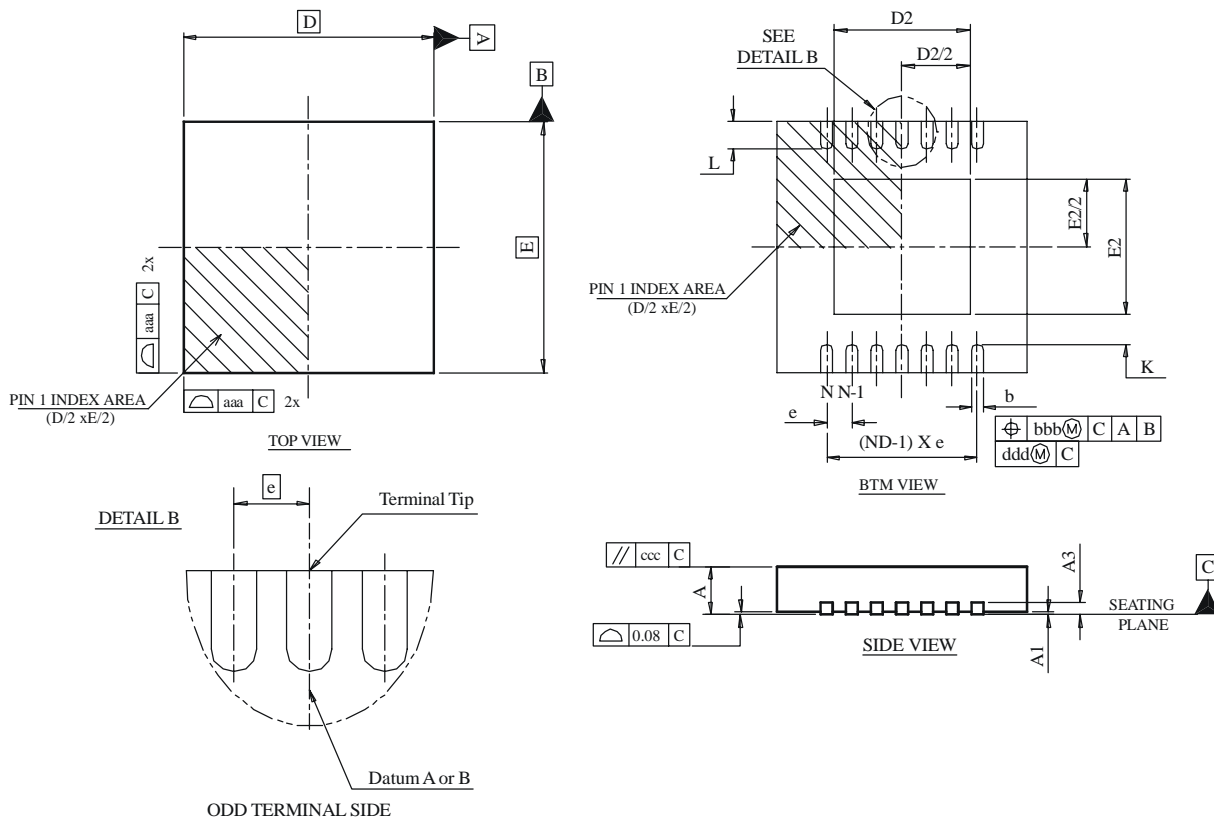
Figure 18. On-Loss, Off-Isolation, and Crosstalk



11 Package Drawings and Markings

The devices are available in 10-pin TDFN 3x3 package.

Figure 19. 10-pin TDFN 3x3 Package Dimensions



Symbol	Min	Nom	Max
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.20 REF		
θ	0°	---	14°
aaa	0.15		
bbb	0.10		
ccc	0.10		
ddd	0.05		
eee	0.08		
ggg	0.10		

Symbol	Min	Nom	Max
D BSC	3.00		
E BSC	3.00		
D2	2.20	---	2.70
E2	1.40	---	1.75
L	0.30	0.40	0.50
K	0.20	---	---
b	0.18	0.25	0.30
e	0.50		
N	10		
ND	5		

Notes:

- Figure 19 is shown for illustration only.
- Dimensioning and tolerancing conform to ASME Y14.5M-1994.
- All dimensions are in millimeters, angle is in degrees.
- N is the total number of terminals.
- ND refers to the maximum number of terminals on D side.

12 Ordering Information

The devices are available as the standard products shown in [Table 4](#).

Table 4. Ordering Information

Model	Description	Delivery Form	Package
AS1747-BTDT	Dual 0.6Ohm SPDT, Audio Clickless Switch with Negative Rail Capability	Tape & Reel	10-pin TDFN (3.0mm x 3.0mm)

Note: All products are RoHS compliant and Pb-free.

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