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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 -40ºC to +85ºC extended temperature range.

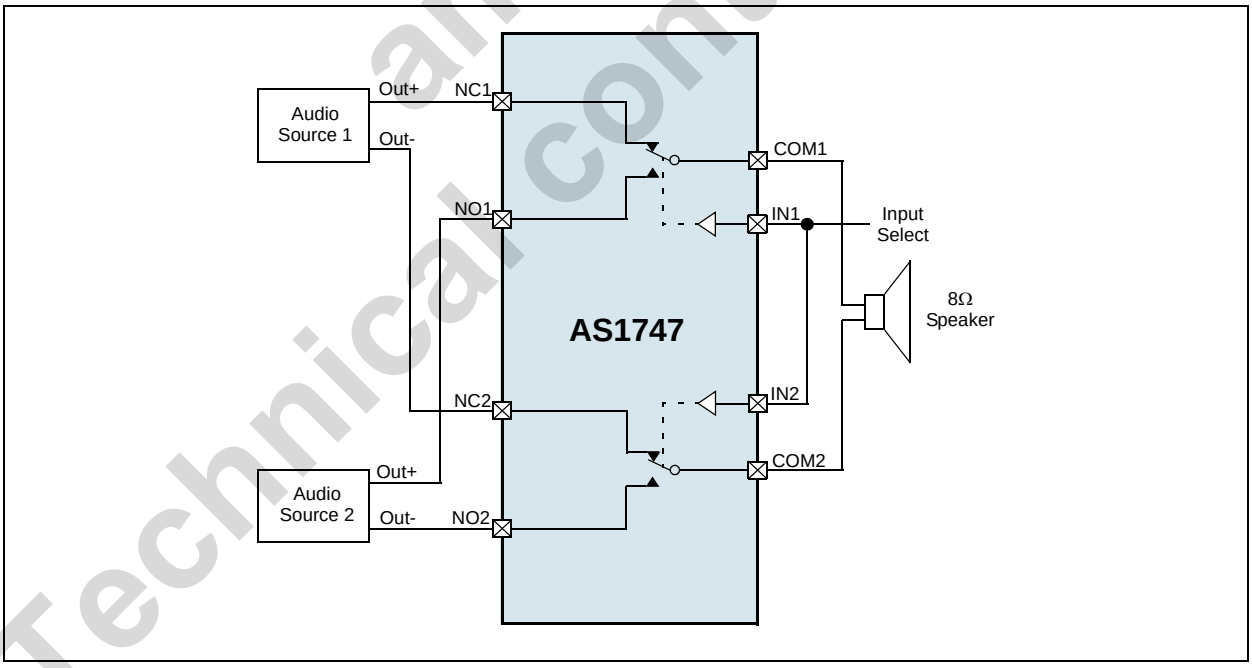
2 Key Features

- Distortion -Free Negative Signal Throughput Down to V_{CC} - 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.

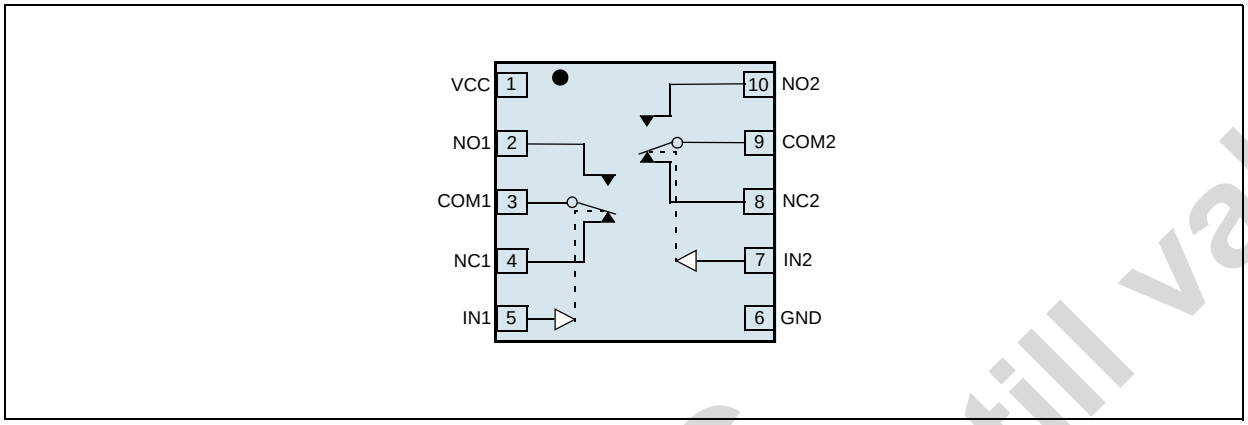
Figure 1. AS1747 - Typical Operating Circuit



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 N02.
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
Vcc, IN_	-0.3	+6.0	V	
COM_, NO_, NC_	Vcc - 6	Vcc + 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 = +70ºC)				
10-Pin TDFN (derate 24.4mW/ºC above +70ºC)		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	ºC	
Junction Temperature		+150	ºC	
Storage Temperature Range	-65	+150	ºC	
Package Body Temperature		+260	ºC	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 = -40ºC to +85ºC, unless otherwise specified. Typical values are at V_{CC} = +3.0V, T_A = +25ºC, 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 = +25ºC		0.4	0.85	Ω
			T_A = T_{MIN} to T_{MAX}			0.95	
ΔR_{ON}	On-Resistance Match Between Channels	V_{CC} = 2.7V, $V_{NC\_}$ or $V_{NO\_}$ = 0V, I_{COM} = 100mA	T_A = +25ºC		0.03	0.1	Ω
			T_A = T_{MIN} to T_{MAX}			0.15	
$R_{FLAT(NC)}$	On-Resistance Flatness	V_{CC} = 2.7V; $V_{NC\_}$ or V_{NC} = -1V, 0V, 1V, 2V, V_{CC}; $I_{COM\_}$ = 100mA	T_A = +25ºC		0.25	0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.45	
$I_{NO\_(OFF)}$ $I_{NC\_(OFF)}$	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 = +25ºC	-10		+10	nA
			T_A = T_{MIN} to T_{MAX}	-200		+200	
$I_{COM\_(ON)}$	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 = +25ºC	-10		+10	nA
			T_A = T_{MIN} to T_{MAX}	-200		+200	
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 = 300Ω, C_L = 35pF, Figure 15	T_A = +25ºC		200	400	ns
			T_A = T_{MIN} to T_{MAX}			400	
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 = 300Ω, C_L = 35pF, Figure 15	T_A = +25ºC		100	200	ns
			T_A = T_{MIN} to T_{MAX}			200	
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 = 300Ω, C_L = 35pF, Figure 16			200		ns
Q	Charge Injection	$V_{COM\_}$ = 0V, R_S = 0Ω, C_L = 1.0nF, Figure 17			2		pC
V_{ISO}	Off-Isolation	V_{CC} = 5V, f = 100kHz, $V_{COM\_}$ = $1V_{RMS}$, R_L = 50Ω, C_L = 5pF, Figure 18			-65		dB
V_{CT}	Crosstalk	V_{CC} = 5V, f = 100kHz, $V_{COM\_}$ = $1V_{RMS}$, R_L = 50Ω, C_L = 5pF, Figure 18			-90		dB
PSRR	Power-Supply Rejection Ratio	f = 10kHz, $V_{COM\_}$ = $1V_{RMS}$, R_L = 50Ω, C_L = 5pF			70		dB
BW	On-Channel-3dB Bandwidth	V_{CC} = 5V, Signal = 0dBm, R_L = 50Ω, 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 = 32Ω			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 = +25ºC (unless otherwise specified).

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

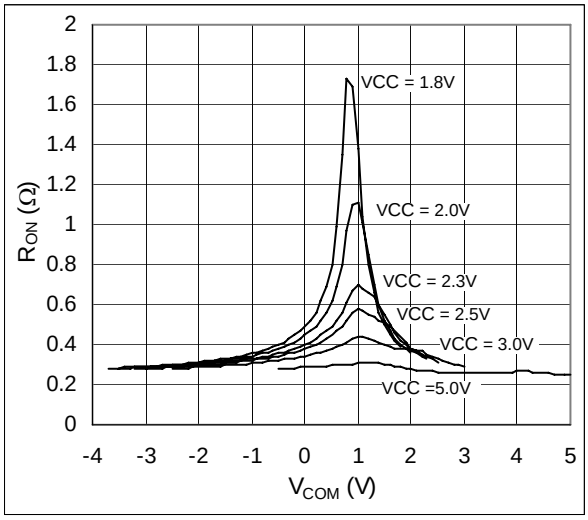


Figure 4. ON Resistance vs. V_{COM}; V_{CC}=3.0V

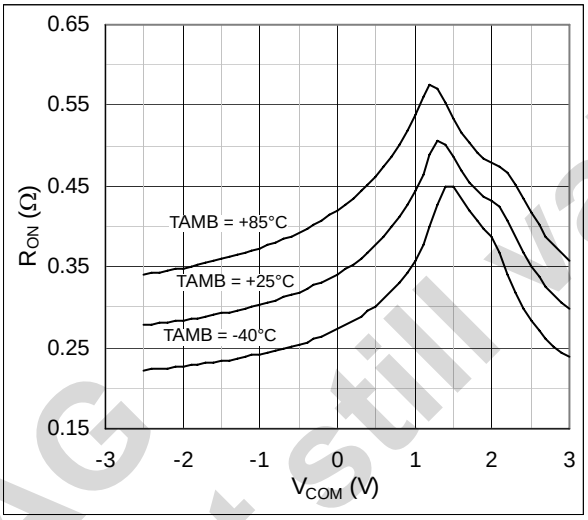


Figure 5. ON Resistance vs. V_{COM}; V_{CC}=5.0V

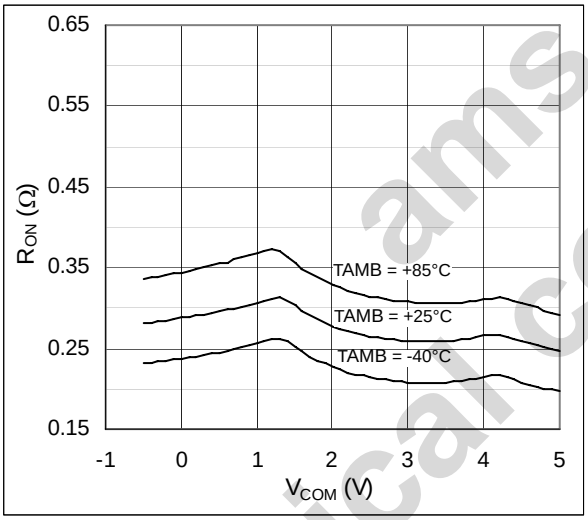


Figure 6. Charge Injection vs. V_{COM}; C_{LOAD} = 1nF

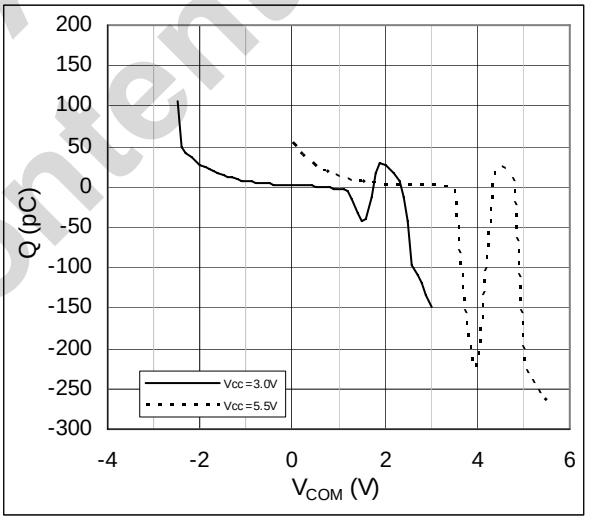


Figure 7. Frequency Response

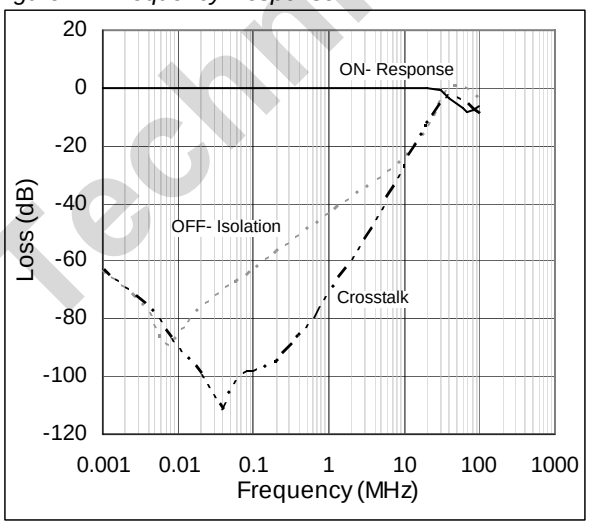


Figure 8. Logic Threshold Voltage vs. V_{CC}

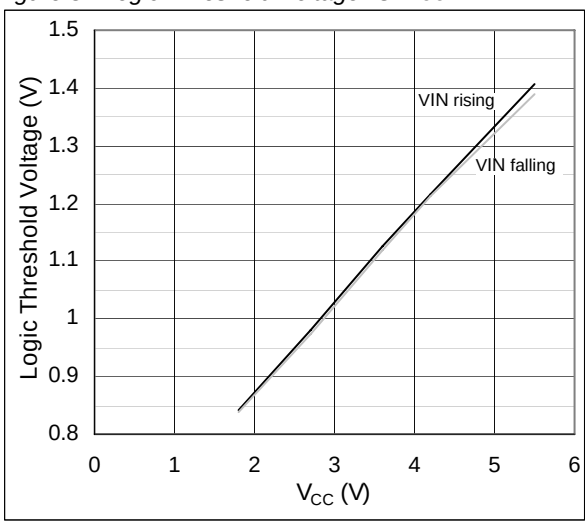


Figure 9. Turn-ON/OFF vs. Temperature; VCC = 3V

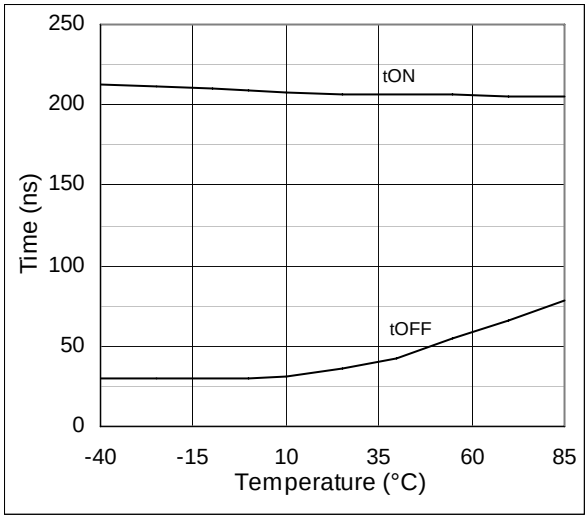


Figure 10. Turn-ON/OFF Times vs. VCC

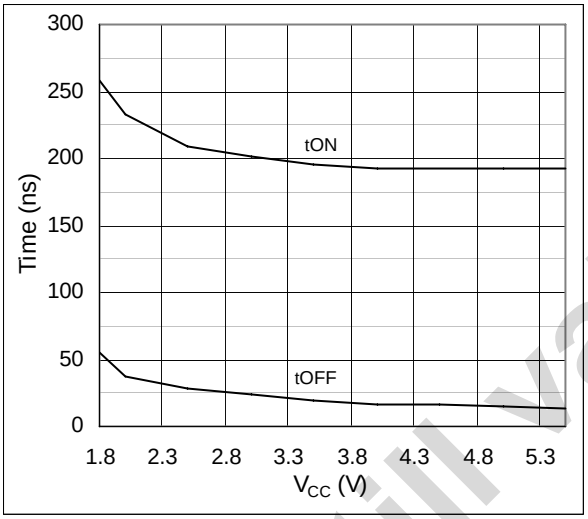


Figure 11. Leakage Current vs. Temperature

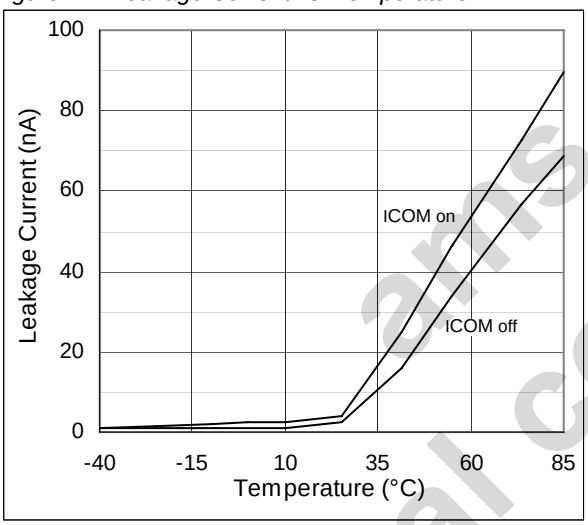


Figure 12. ICC vs. VCC

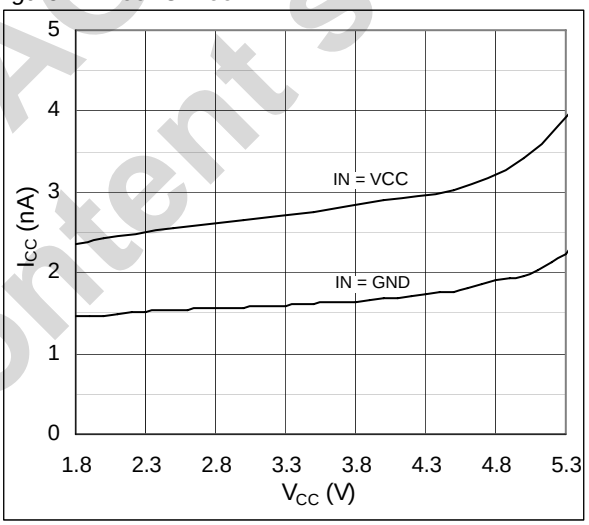


Figure 13. Total Harmonic Distortion vs. Frequency

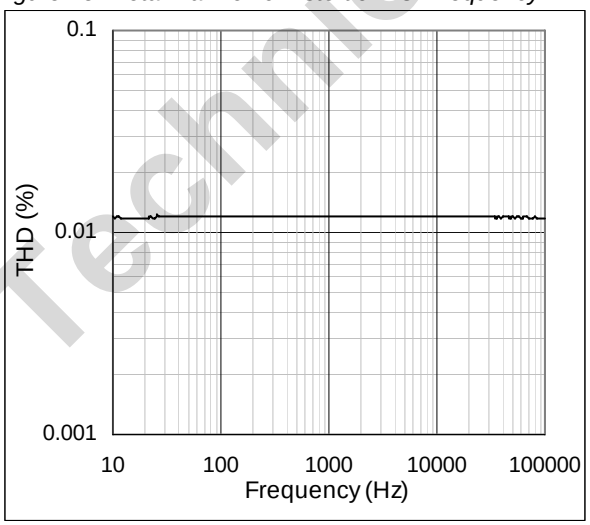
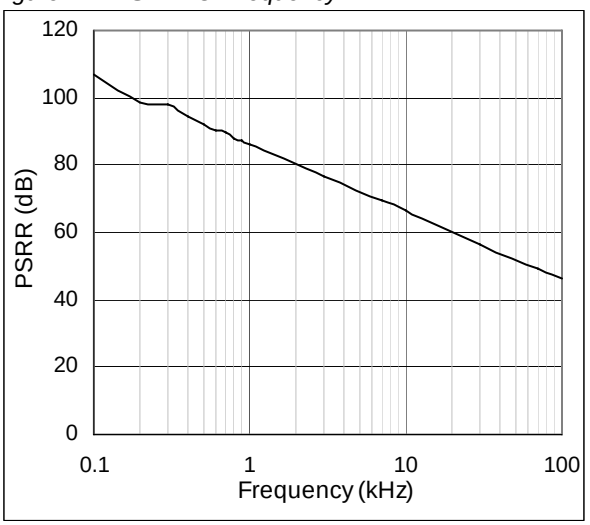


Figure 14. PSRR vs. Frequency



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

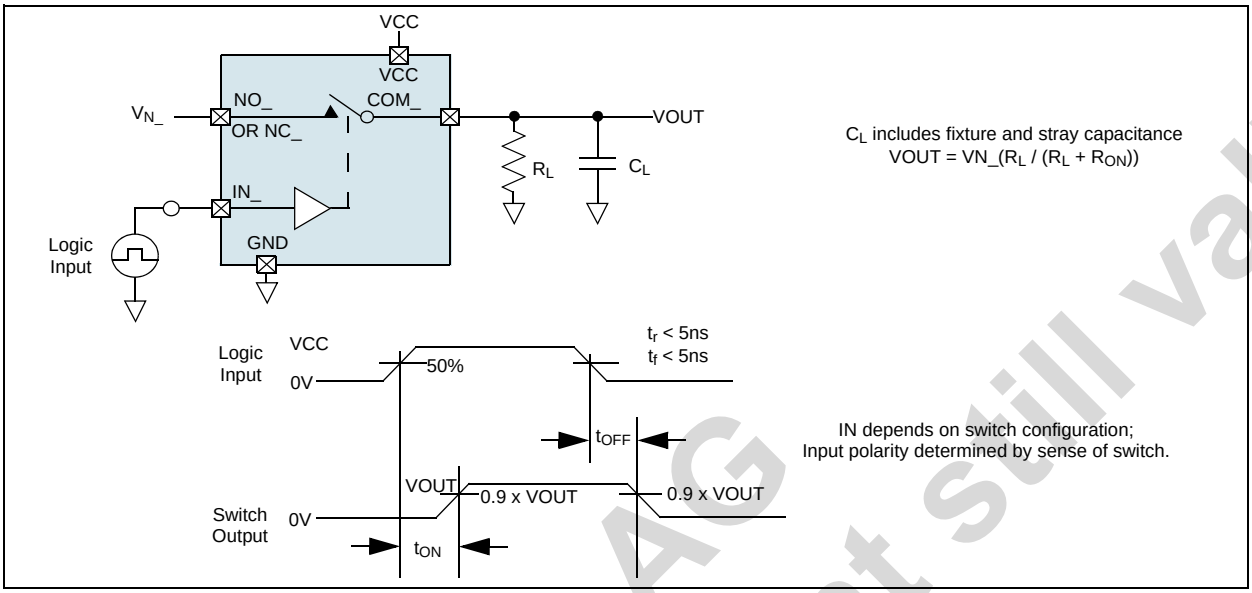


Figure 16. Break-Before-Make Interval

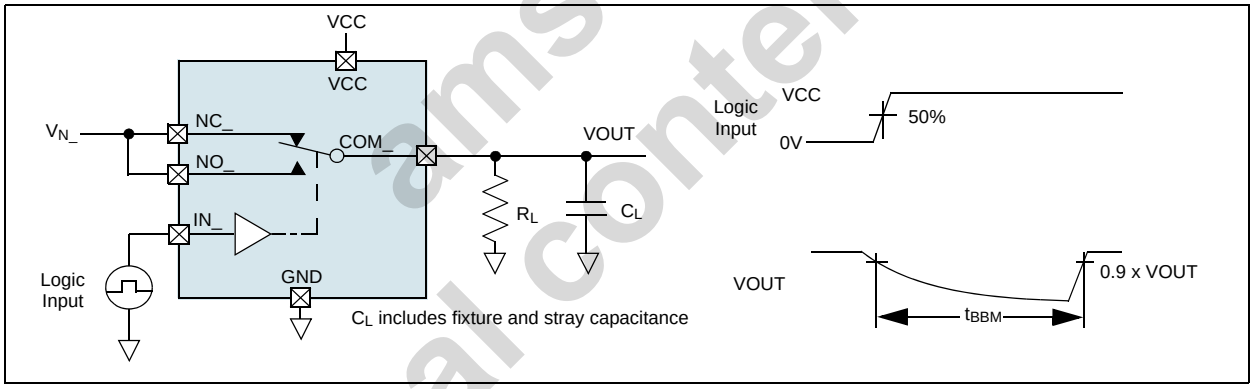


Figure 17. Charge Injection

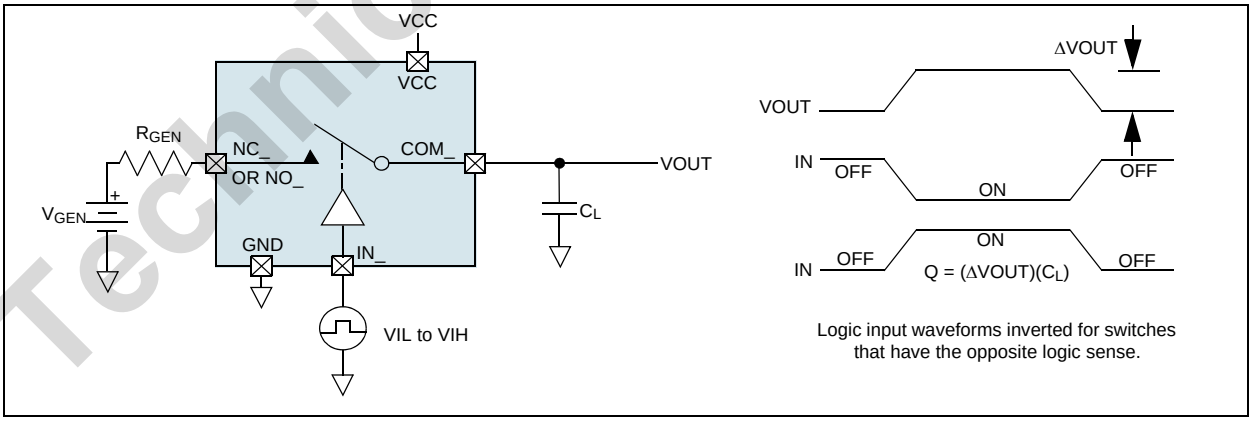
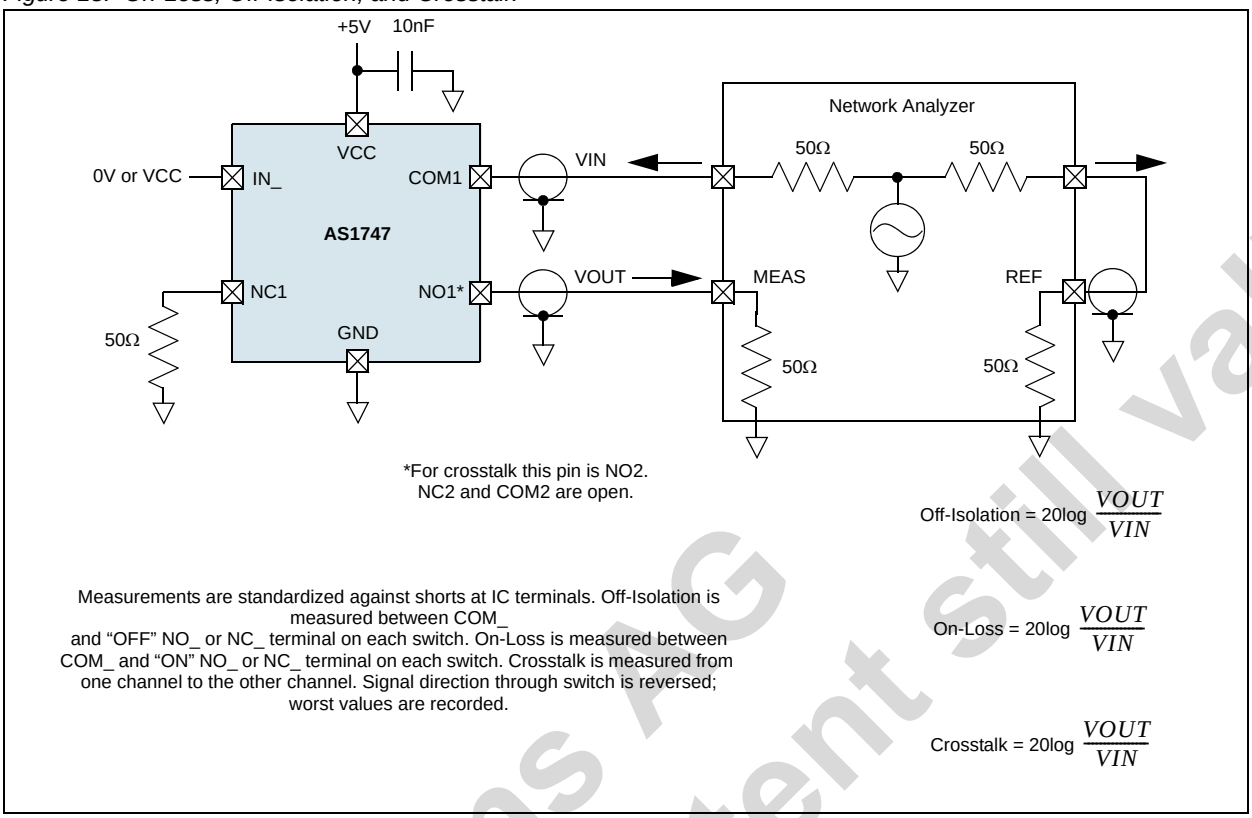


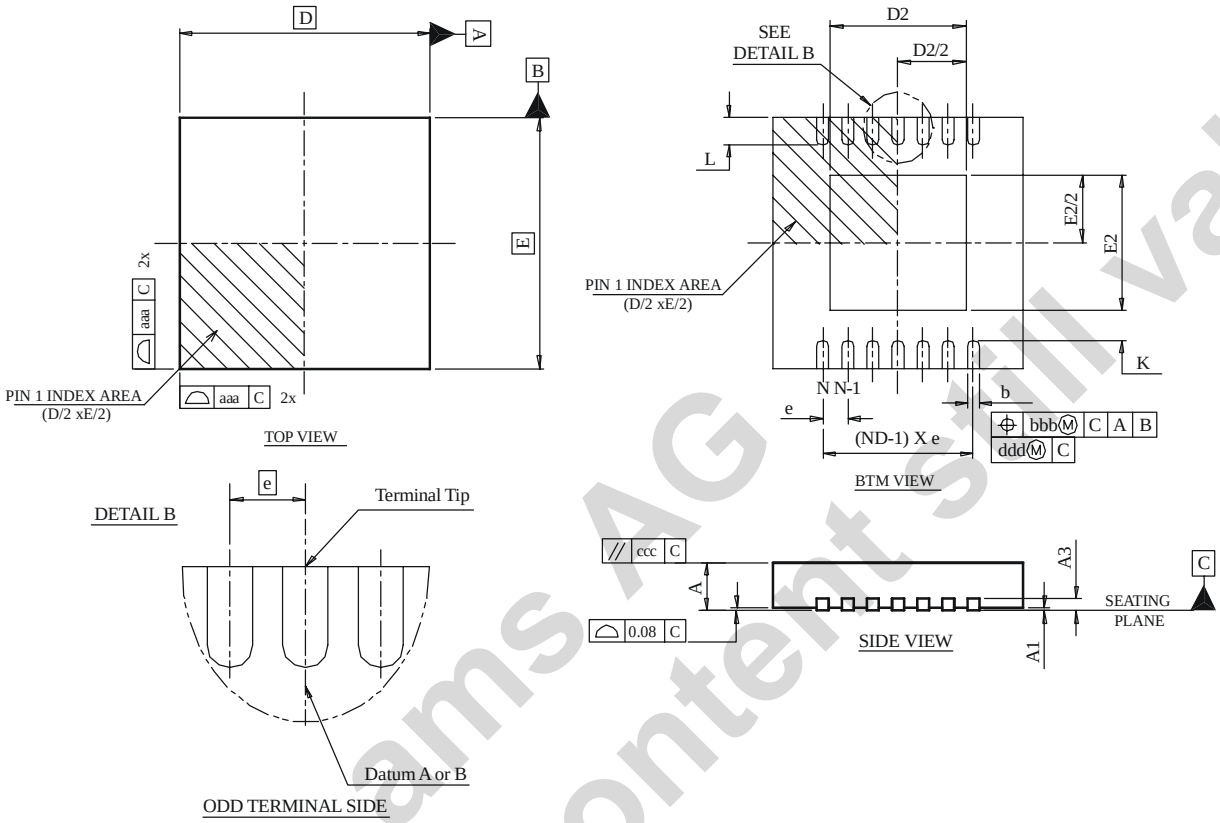
Figure 18. On-Loss, Off-Isolation, and Crosstalk



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	0º	---	14º
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:

1. Figure 19 is shown for illustration only.
2. Dimensioning and tolerancing conform to *ASME Y14.5M-1994*.
3. All dimensions are in millimeters, angle is in degrees.
4. N is the total number of terminals.
5. 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.
Buy our products or get free samples online at ICdirect: http://www.austriamicrosystems.com/ICdirect

For further information and requests, please contact us mailto:sales@austriamicrosystems.com or find your local distributor at http://www.austriamicrosystems.com/distributor

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