AS1744, AS1745
High-Speed, Low-Voltage, Dual, Single-Supply, 4Ω, SPDT Analog Switches

Data Sheet

1 General Description

The AS1744/AS1745 are high-speed, low-voltage, dual single-pole/double-throw (SPDT) analog switches.

Fast switching speeds, low ON-resistance, and low power-consumption make these devices ideal for single-cell battery powered applications.

These highly-reliable devices operate from a +1.8 to +5.5V supply, are differentiated by inverted logic, and support break-before-make switching.

With low ON-resistance (RON), RON matching, and RON flatness, the devices can accurately switch signals for sample and hold circuits, digital filters, and op-amp gain switching networks.

The devices are available in a 10-pin MSOP package.

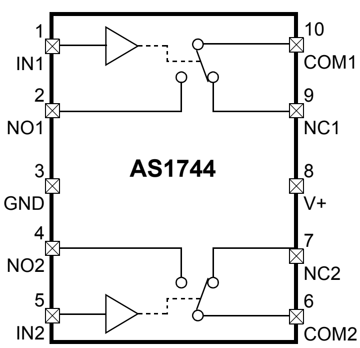
2 Key Features

- ON-Resistance:
  - 4Ω (+5V supply)
  - 5.5Ω (+3V supply)
- RON Matching: 0.2Ω (+5V supply)
- RON Flatness: 1Ω (+5V supply)
- Supply Voltage Range: +1.8 to +5.5V
- 1.8V Operation:
  - 9.5Ω ON-Resistance over Temperature
  - 38ns Turn On Time
  - 12ns Turn Off Time
- Current-Handling: 150mA continuous
- Break-Before-Make Switching
- Rail-to-Rail Signal Handling
- Crosstalk: -90dB at 1MHz
- Off-Isolation: -85dB at 1MHz
- Total Harmonic Distortion: 0.1%
- Operating Temperature Range: -40 to +85ºC
- 10-pin MSOP Package

3 Applications

The devices are ideal for use in power routing systems, cordless and mobile phones, MP3 players, CD and DVD players, PDAs, handheld computers, digital cameras, and any other application where high-speed signal switching is required.

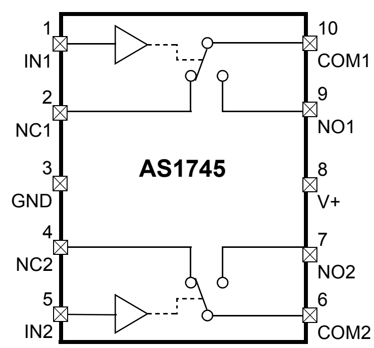
Figure 1. Block Diagrams



Truth Table

INx	NOx to COMx	NCx to COMx
Low	Off	On
High	On	Off

Switches shown for low input.



4 Absolute Maximum Ratings

Stresses beyond those listed in Table 1 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 Section 5 Electrical Characteristics on page 3 is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 1. Absolute Maximum Ratings

Parameter	Min	Max	Units	Comments
V+, IN1, IN2 to GND	-0.3	+7	V	
COM*x*, NO*x*, NC*x* to GND †	-0.3	V+ + 0.3	V	
Continuous Current (any pin)	-30	+30	mA	
COM*x*, NO*x*, NC*x* Peak Current	-100	+100	mA	Pulsed at 1ms, 10% duty cycle
Continuous Power Dissipation (T_{AMB} = +70ºC)		330	mW	Derate at 4.7mW/ºC above +70ºC
Electro-Static Discharge		1000	V	*HBM Mil-Std883E 3015.7* methods
Latch Up Immunity		100	mA	Norm: *JEDEC 17*
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-020C "Moisture/Reflow Sensitivity Classification for non-hermetic Solid State Surface Mount Devices"*

† Signals on pins COM1, COM2, NO1, NO2, NC1, or NC2 that exceed V+ or GND are clamped by internal diodes. Limit forward-diode current to the maximum current rating.

5 Electrical Characteristics

V+ = +4.5 to 5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, T_{AMB} = T_{MIN} to T_{MAX} (unless otherwise specified). Typ Values @T_{AMB} = +25ºC.

Table 2. +5V Supply Electrical Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Analog Switch							
V_{COMx}, V_{NOx}, V_{NCx}	Analog Signal Range			0		V+	V
R_{ON}	ON-Resistance	V+ = 4.5V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		2.5	4	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			4.5	
ΔR_{ON}	ON-Resistance Match Between Channels [1]	V+ = 4.5V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		0.1	0.2	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			0.4	
$R_{FLAT(ON)}$	ON-Resistance Flatness [2]	V+ = 4.5V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		0.5	1	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			1.2	
$I_{NOx(OFF)}$, $I_{NCx(OFF)}$	NOx or NCx Off-Leakage Current [3]	V+ = 5.5V, V_{COMx} = 1 or 4.5V, V_{NOx} or V_{NCx} = 4.5 or 1V	T_{AMB} = +25ºC	-0.1	±0.01	0.1	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-0.3		0.3	
$I_{COMx(OFF)}$	COMx Off-Leakage Current [3]	V+ = 5.5V, V_{COMx} = 1 or 4.5V, V_{NOx} or V_{NCx} = 4.5 or 1V	T_{AMB} = +25ºC	-0.1	±0.01	0.1	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-3		3	
$I_{COMx(ON)}$	COMx On-Leakage Current [3]	V+ = 5.5V, V_{COMx} = 4.5 or 1V, V_{NOx} or V_{NCx} = 4.5 or 1V	T_{AMB} = +25ºC	-0.4	±0.1	0.4	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-4		4	
Logic Input: INx							
V_{IH}	Input Logic High			2.4			V
V_{IL}	Input Logic Low					0.8	V
I_{IH}, I_{IL}	Input Leakage Current	V_{INx} = 0 or +5.5V		-100	5	100	nA
Switch Dynamic Characteristics							
t_{ON}	Turn On Time [3]	V_{NOx} or V_{NCx} = 3V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 11	T_{AMB} = +25ºC		14	17	ns
			T_{AMB} = T_{MIN} to T_{MAX}			18	
t_{OFF}	Turn Off Time [3]	V_{NOx} or V_{NCx} = 3V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 11	T_{AMB} = +25ºC		4	6	ns
			T_{AMB} = T_{MIN} to T_{MAX}			8	
t_{BBM}	Break-Before-Make [3]	V_{NOx} or V_{NCx} = 3V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 12	T_{AMB} = +25ºC		10		ns
			T_{AMB} = T_{MIN} to T_{MAX}	1			
Q	Charge Injection	V_{GEN} = 2V, R_{GEN} = 0, C_{LOAD} = 1.0nF, Figure 13			7		pC
$C_{NOx(OFF)}$, $C_{NCx(OFF)}$	NOx, NCx Off-Capacitance	V_{NOx} or V_{NCx} = GND, f = 1MHz, Figure 14			20		pF
$C_{COMx(ON)}$	COMx On-Capacitance	V_{COMx} = GND, f = 1MHz, Figure 14			56		pF
V_{ISO}	Off-Isolation [4]	f = 10MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-52		dB
		f = 1MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-85		
V_{CT}	Crosstalk [5]	f = 10MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-52		dB
		f = 1MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-90		
THD	Total Harmonic Distortion	f = 20Hz to 20kHz, V_{NOx} = 5Vp-p, R_{LOAD} = 600Ω			0.1		%
Power Supply							
I+	Positive Supply Current	V+ = 5.5V, V_{INx} = 0 or V+			0.01	1.0	µA

V+ = +2.7 to 3.6V, V_{IH} = +2.0V, V_{IL} = +0.4V, T_{AMB} = T_{MIN} to T_{MAX} (unless otherwise specified). Typ values @ T_{AMB} = +25ºC.

Table 3. +3V Supply Electrical Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Analog Switch							
V_{COMx}, V_{NOx}, V_{NCx}	Analog Signal Range			0		V+	V
R_{ON}	ON-Resistance	V+ = 2.7V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		5	5.5	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			8	
ΔR_{ON}	ON-Resistance Match Between Channels [1]	V+ = 2.7V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		0.1	0.2	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			0.4	
$R_{FLAT(ON)}$	ON-Resistance Flatness [2]	V+ = 2.7V, I_{COMx} = 10mA, V_{NOx} or V_{NCx} = 0 to V+	T_{AMB} = +25ºC		1.5	2	Ω
			T_{AMB} = T_{MIN} to T_{MAX}			2.5	
$I_{NOx(OFF)}$, $I_{NCx(OFF)}$	NO*x* or NC*x* Off-Leakage Current [3]	V+ = 3.3V, V_{COMx} = 1 or 3V, V_{NOx} or V_{NCx} = 3 or 1V	T_{AMB} = +25ºC	-0.1	±0.01	0.1	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-0.3		0.3	
$I_{COMx(OFF)}$	COM*x* Off-Leakage Current [3]	V+ = 3.3V, V_{COMx} = 1 or 3V, V_{NOx} or V_{NCx} = 3 or 1V	T_{AMB} = +25ºC	-0.1	±0.01	0.1	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-3		3	
$I_{COMx(ON)}$	COM*x* On-Leakage Current [3]	V+ = 3.3V, V_{COMx} = 1 or 3V, V_{NOx} or V_{NCx} = 1 or 3V	T_{AMB} = +25ºC	-0.4	±0.1	0.4	nA
			T_{AMB} = T_{MIN} to T_{MAX}	-4		4	
Logic Input: (IN*x*)							
V_{IH}	Input Logic High			2.0			V
V_{IL}	Input Logic Low					0.4	V
I_{IH},I_{IL}	Input Leakage Current	V_{INx} = 0 or +5.5V		-100	5	100	nA
Switch Dynamic Characteristics							
t_{ON}	Turn On Time [3]	V_{NOx} or V_{NCx} = 2V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 11	T_{AMB} = +25ºC		17	23	ns
			T_{AMB} = T_{MIN} to T_{MAX}			28	
t_{OFF}	Turn Off Time [3]	V_{NOx} or V_{NCx} = 2V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 11	T_{AMB} = +25ºC		6	8	ns
			T_{AMB} = T_{MIN} to T_{MAX}			10	
t_{BBM}	Break-Before-Make [3]	V_{NOx} or V_{NCx} = 2V, R_{LOAD} = 300Ω, C_{LOAD} = 35pF, Figure 12	T_{AMB} = +25ºC		11		ns
			T_{AMB} = T_{MIN} to T_{MAX}	1			
Q	Charge Injection	V_{GEN} = 1.5V, R_{GEN} = 0, C_{LOAD} = 1.0nF, Figure 13			0		pC
$C_{NOx(OFF)}$, $C_{NCx(OFF)}$	NO*x*, NC*x* Off-Capacitance	V_{NOx} or V_{NCx} = GND, f = 1MHz, Figure 14			20		pF
$C_{COMx(ON)}$	COM*x* On-Capacitance	V_{COMx} = GND, f = 1MHz, Figure 14			56		pF
V_{ISO}	Off-Isolation [4]	f = 10MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-52		dB
		f = 1MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-85		
V_{CT}	Crosstalk [5]	f = 10MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-52		dB
		f = 1MHz, R_{LOAD} = 50Ω, C_{LOAD} = 5pF, Figure 15			-90		
Power Supply							
I+	Positive Supply Current	V+ = 3.6V, V_{IN} = 0 or +3.6V			0.01	1.0	µA

1. ΔR_{ON} = $R_{ON(MAX)}$ - $R_{ON(MIN)}$.
2. Flatness is defined as the difference between the maximum and the minimum value of ON-resistance as measured over the specified analog signal ranges.
3. Guaranteed by design.
4. Off-Isolation = 20log10(V_{COMx}/V_{NOx}), V_{COMx} = output, V_{NOx} = input to off switch.
5. Between any two switches.

6 Typical Operating Characteristics

Figure 2. Frequency Response

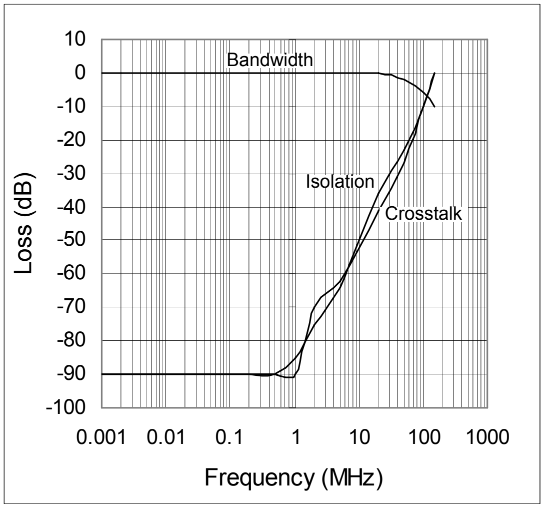


Figure 3. THD vs. Frequency

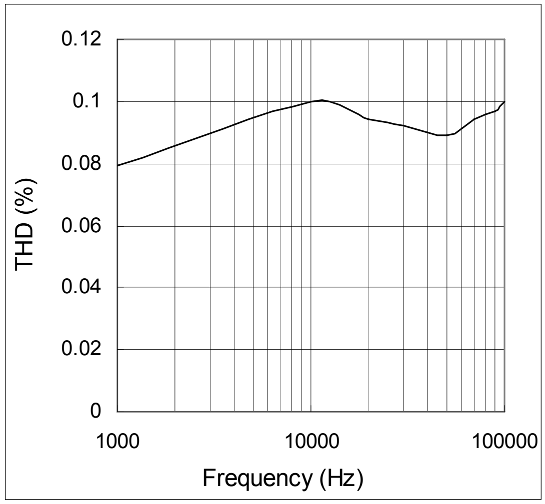


Figure 4. RON vs. VCOM and Temperature (VDD = 5V)

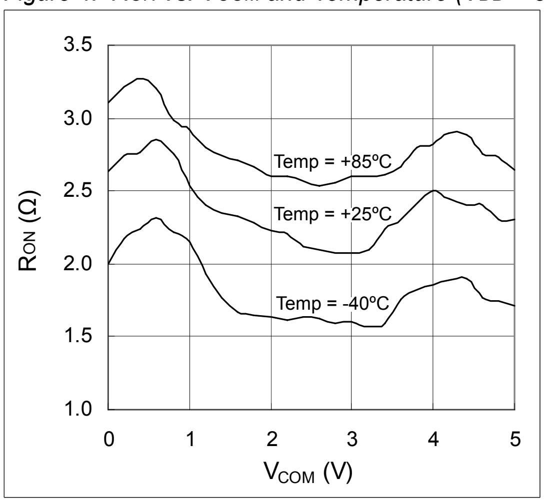


Figure 5. RON vs. VCOM and Temperature (VDD = 3V)

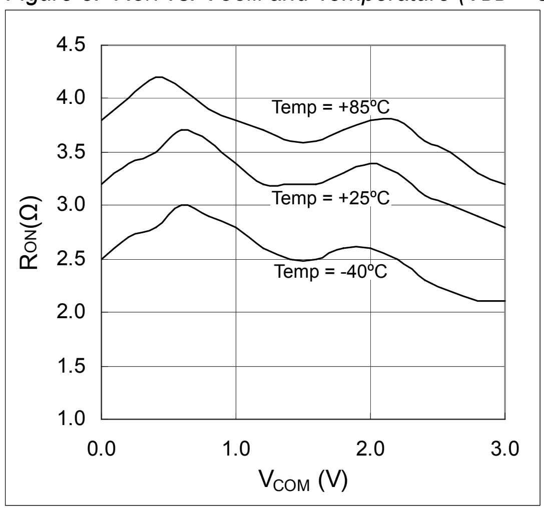


Figure 6. RON vs. VCOM

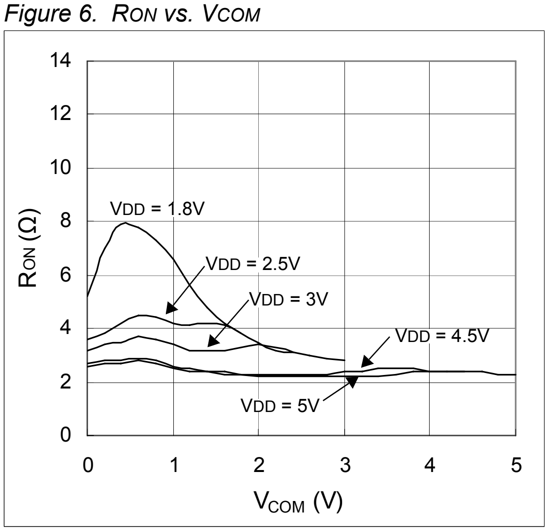


Figure 7. tON/tOFF vs. Temperature (V+ = 5V)

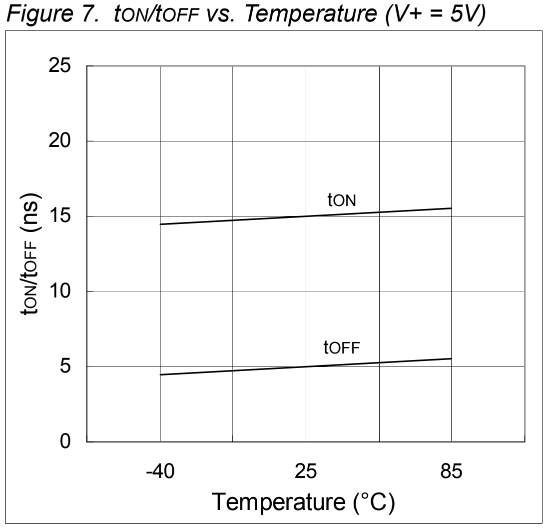


Figure 8. tON/tOFF vs. Supply Voltage

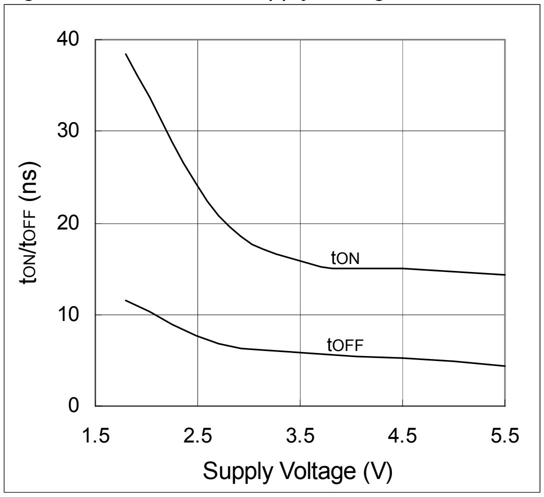
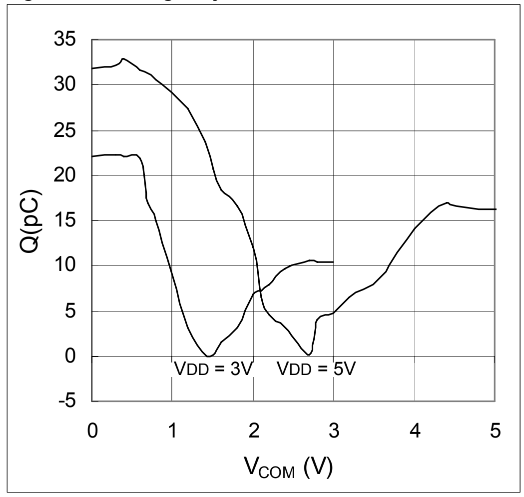


Figure 9. Charge Injection



7 Detailed Description

The AS1744/AS1745 are low ON-resistance, low-voltage, dual analog SPDT switches that operate from a single +1.8 to +5.5V supply.

CMOS process technology allows switching of analog signals that are within the supply voltage range (GND to V+).

ON-Resistance

When powered from a +5V supply, the low R_{ON} (4Ω max) allows high continuous currents to be switched in a wide range of applications. All devices have low R_{ON} flatness (1Ω, max) so they can meet or exceed the low-distortion audio requirements of modern portable audio devices.

Bi-Directional Switching

Pins NO*x*, NC*x*, and COM*x* are bi-directional, thus they can be used as inputs or outputs.

Analog Signal Levels

Analog signals ranging over the entire supply voltage (V+ to GND) can be passed with very little change in ON-resistance (see Typical Operating Characteristics on page 5).

Logic Inputs

The AS1744/AS1745 logic inputs (IN*x*) can be driven up to +5.5V regardless of the supply voltage value. For example, with a +3.3V supply, IN+ may be driven low to GND and high to +5.5V. This allows the devices to interface with +5V systems using a supply of less than 5V.

8 Application Information

Power-Supply Sequencing

Proper power-supply sequencing is critical for proper operation. The recommended sequence is as follows:

1. V+
2. NO*x*, NC*x*, COM*x*

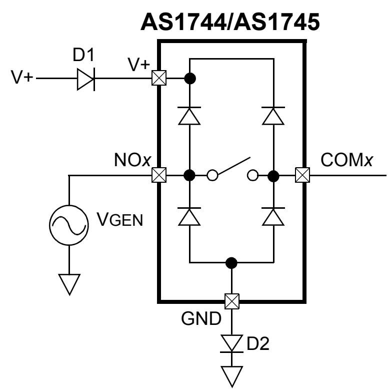
Always apply V+ before applying analog signals, especially if the analog signal is not current-limited. If the above sequence is not possible, and if the analog inputs are not current-limited to less than 30mA, add a small-signal diode as shown in Figure 10 (D1). If the analog signal can dip below GND, add diode D2. Adding these diodes will reduce the analog range to a diode-drop (about 0.7V) below V+ (for D1), and a diode-drop above ground (for D2).

Note: Operation beyond the absolute maximum ratings (see page 2) may permanently damage the devices.

Overvoltage Protection

ON-resistance increases slightly at lower supply voltages.

Figure 10. Overvoltage Protection Using 2 External Blocking Diodes



Adding diode D2 to the circuit shown in Figure 10 causes the logic threshold to be shifted relative to GND. Diodes D1 and D2 also protect against overvoltage conditions.

For example, in the circuit shown in Figure 10, if the supply voltage goes below the absolute maximum rating, and if a fault voltage up to the absolute maximum rating is applied to an analog signal pin, no damage will result.

Note: The supply voltage (V+) must not exceed the absolute maximum rating of +7V.

Power Supply Bypass

Power supply connections to the devices must maintain a low impedance to ground. This can be done using a bypass capacitor, which will also improve noise margin and prevent switching noise propagation from the V+ supply to other components.

Layout Considerations

High-speed switches require proper layout and design procedures for optimum performance.

- Reduce stray inductance and capacitance by keeping traces short and wide.
- Ensure that bypass capacitors are as close to the device as possible.
- Use large ground planes where possible.

Timing Diagrams and Test Setups

Figure 11. Switching Time

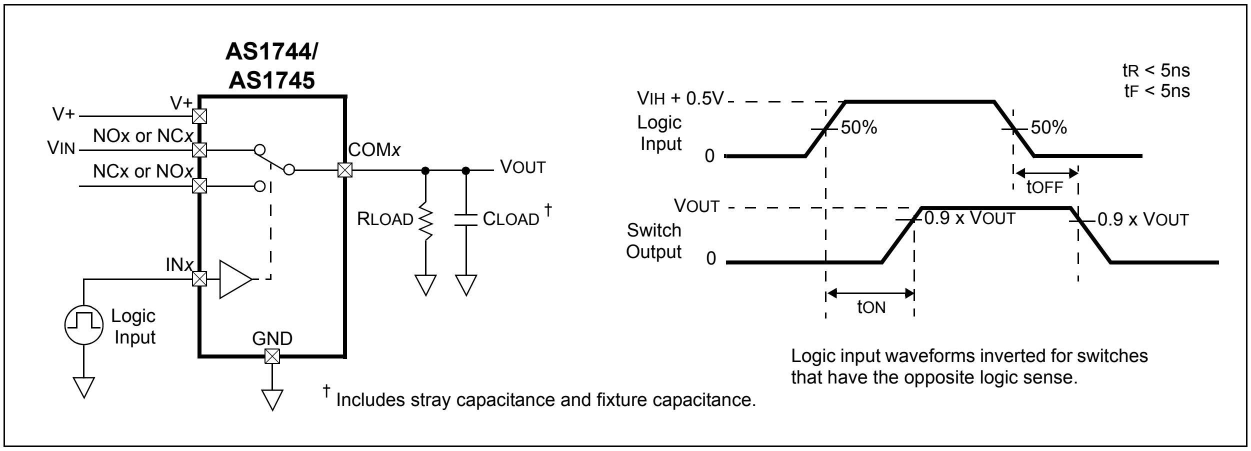


Figure 12. Break-Before-Make Interval

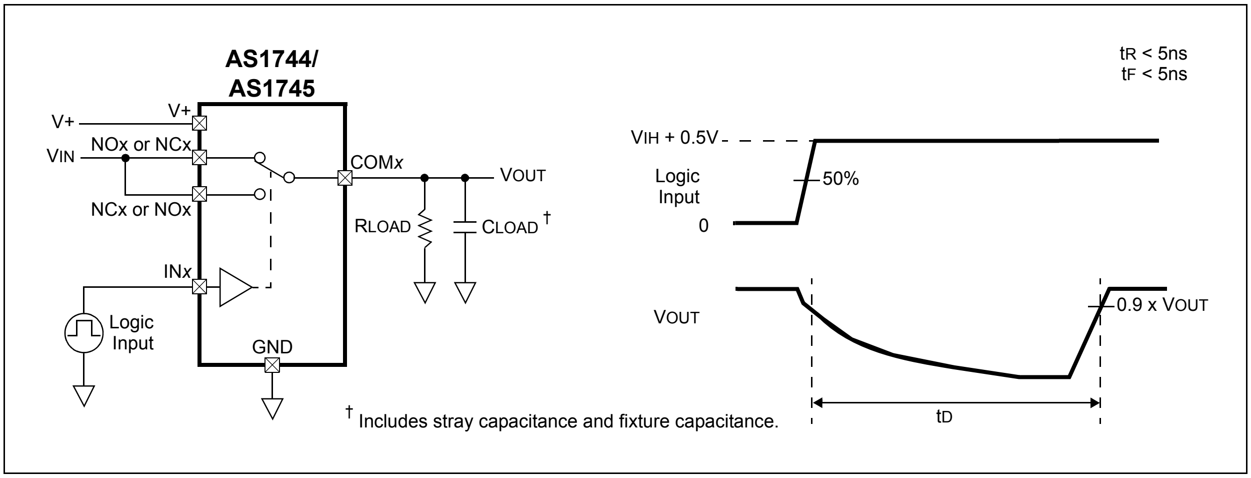


Figure 13. Charge Injection

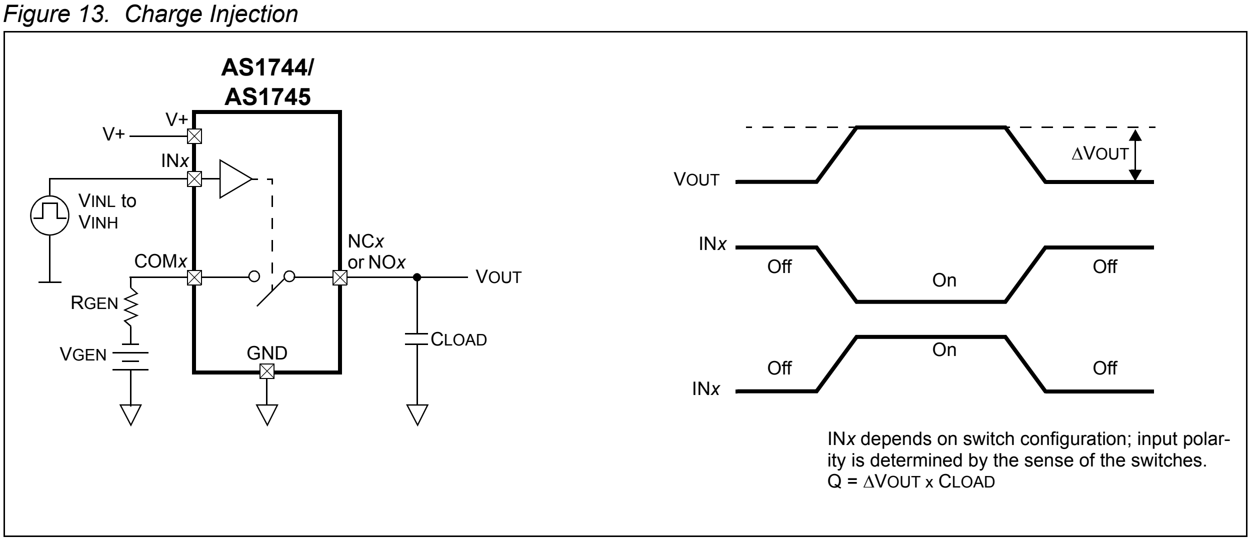


Figure 14. NOx, NCx, and COMx Capacitance

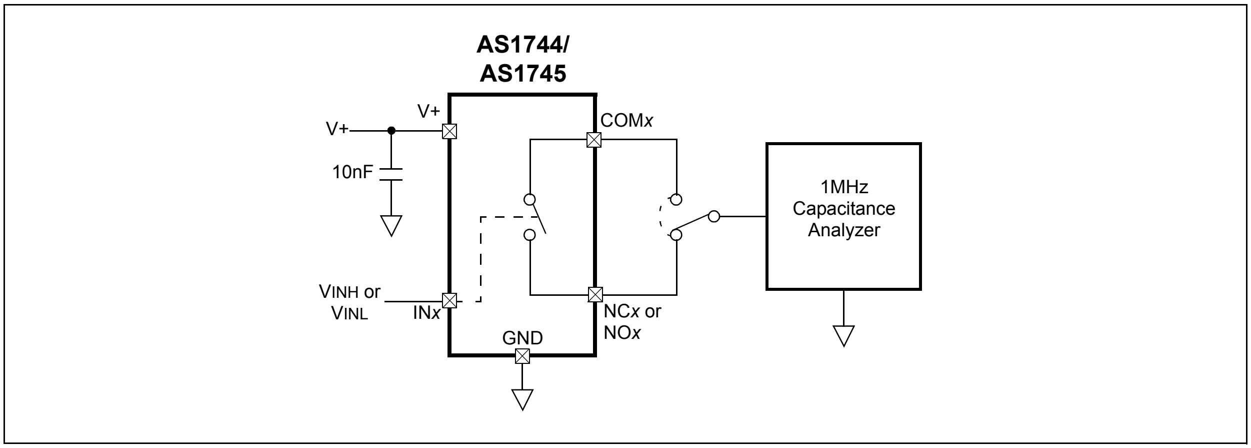
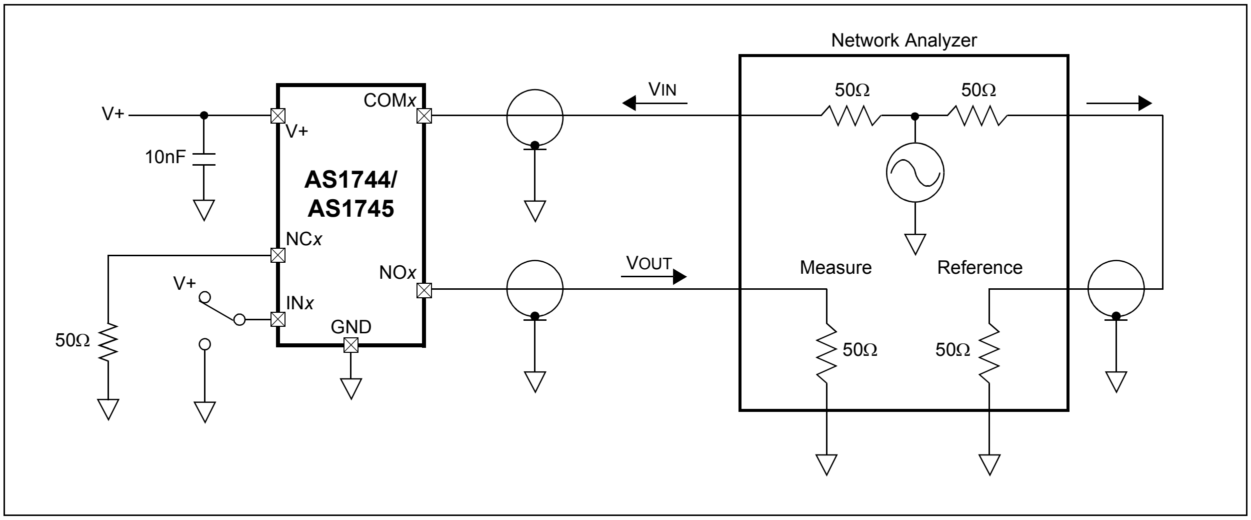


Figure 15. Off-Isolation, On-Loss, and Crosstalk



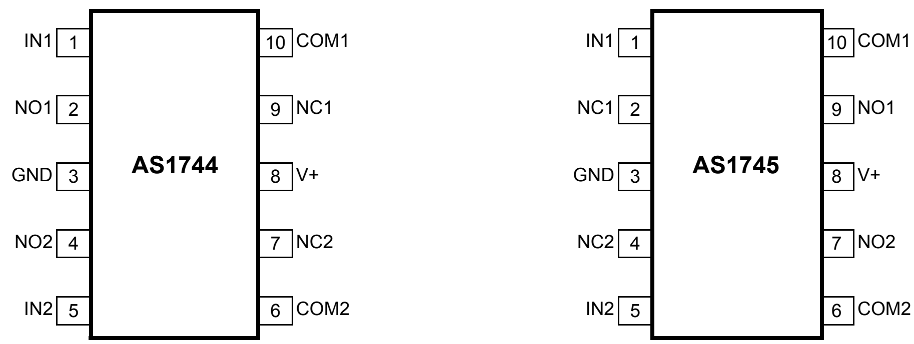
Notes:

1. Measurements are standardized against short-circuit at all terminals.
2. Off-isolation is measured between COM*x* and the off NC*x*/NO*x* terminal of each switch. Off-isolation = 20log(VOUT/VIN).
3. Crosstalk is measured from one channel to all other channels.
4. Signal direction through the switch is reversed; worst values are recorded.

9 Pinout and Packaging

Pin Assignments

Figure 16. Pin Assignments (Top View)



Pin Descriptions

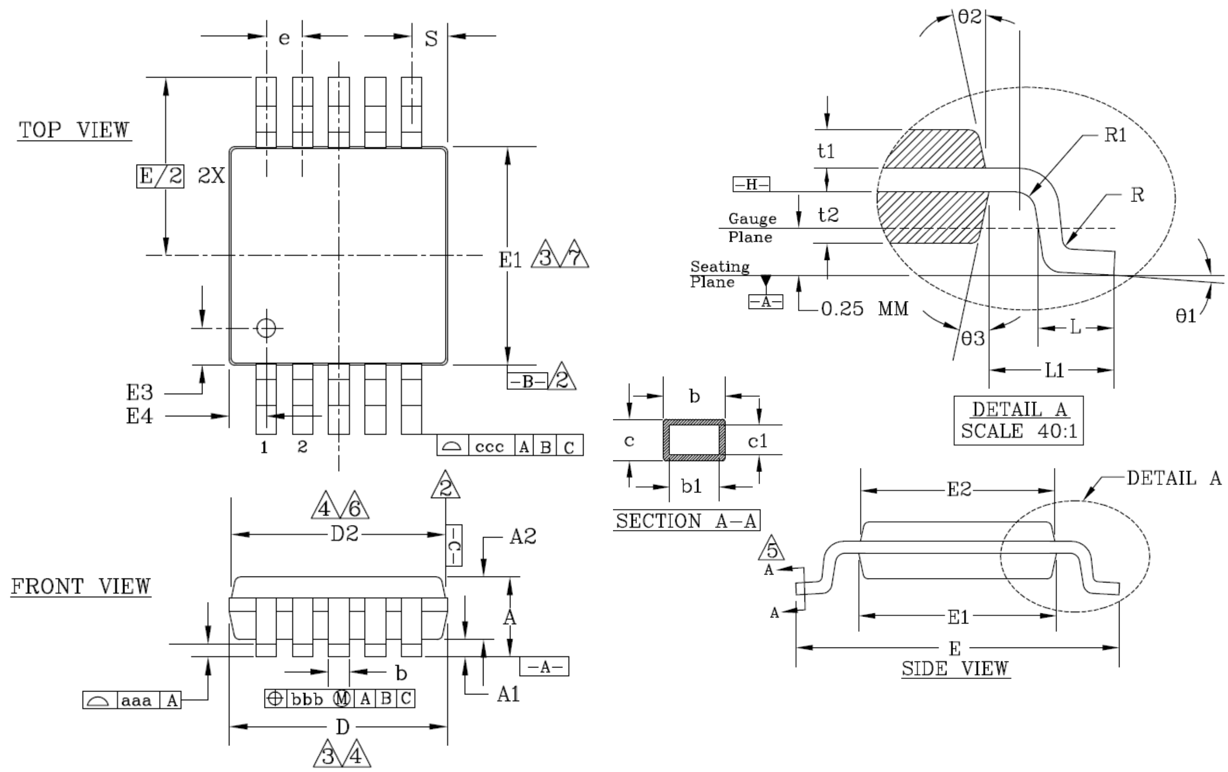
Table 4. Pin Descriptions

Pin Number		Pin Name	Description
AS1744	AS1745		
10	10	COM1	Analog Switch 1 Common
6	6	COM2	Analog Switch 2 Common
3	3	GND	Ground
1	1	IN1	Analog Switch 1 Logic Control Input
5	5	IN2	Analog Switch 2 Logic Control Input
9	2	NC1	Analog Switch 1 Normally Closed Terminal
7	4	NC2	Analog Switch 2 Normally Closed Terminal
2	9	NO1	Analog Switch 1 Normally Open Terminal
4	7	NO2	Analog Switch 2 Normally Open Terminal
8	8	V+	Input Supply Voltage, +1.8 to +5.5V

Package Drawings and Markings

The devices are available in a 10-pin MSOP package.

Figure 17. 10-pin MSOP Package



Symbol	Min	Max	Symbol	Min	Max
A	1.10	Max	R1	0.07	0.3
A1	0.05	0.15	t1	0.23	0.39
A2	0.78	0.94	t2	0.33	0.49
D	2.90	3.10	b	0.25	0.4
D2	2.85	3.05	b1	0.25	0.35
E	4.75	5.05	c	0.13	0.23
E1	2.90	3.10	c1	0.13	0.18
E2	2.85	3.05	Θ1	0º	6º
E3	0.38	0.64	Θ2	9º	15º
E4	0.38	0.64	Θ3	9º	15º
R	0.07	0.3	L	0.40	0.60

Symbol	Value
L1	0.95BSC
aaa	0.10
bbb	0.08
ccc	0.25
e	0.50 BSC
S	0.50 BSC

Notes:

1. All dimensions are in millimeters, angles in degrees, unless otherwise specified.
2. Datums B and C to be determined at datum plane H.
3. Dimensions D and E1 are to be determined at datum plane H.
4. Dimensions D2 and E2 are for top package; dimensions D and E1 are for bottom package.
5. Cross section A-A to be determined at 0.13 to 0.25mm from lead tip.
6. Dimensions D and D2 do not include mold flash, protrusion, or gate burrs.
7. Dimensions E1 and E2 do not include interlead flash or protrusion.

10 Ordering Information

The devices are available as the standard products shown in Table 5.

Table 5. Ordering Information

Type	Description	Delivery Form	Package
AS1744G	Dual SPDT Switch	Tube	MSOP10
AS1744G-T	Dual SPDT Switch	Tape and Reel	MSOP10
AS1745G †	Dual SPDT Switch	Tube	MSOP10
AS1745G-T †	Dual SPDT Switch	Tape and Reel	MSOP10

† Future Product

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