

# Powered-off Protection, High Speed, 1.65 V to 5.5 V, SPDT Analog Switch (2:1 Multiplexer / Demultiplexer Bus Switch)

## DESCRIPTION

The DG3157E is a high speed single-pole double-throw analog switch designed for +1.65 V to +5.5 V single power rail operation.

Fabricated with high density CMOS technology, the DG3157E achieves low on-resistance, fast switching speed, and high bandwidth while maintains low power consumption.

The DG3157E can handle both analog and digital signals and permits signals with amplitudes of up to  $V+$  to be transmitted in either direction.

When the select pin is low,  $B_0$  is connected to the output A pin. When the select pin is high,  $B_1$  is connected to the output A pin. The path that is open will have a high impedance state with respect to the output. Break before make switching performance is guaranteed.

A powered-off protection circuit is built into the switch to prevent an abnormal current flow from COM pin to  $V+$  during the power-down condition. Each output pin can withstand greater than 7 kV (human body model).

Operation temperature is specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ . The DG3157E is available in the compact SC-70-6L package.

## FEATURES

- Direct cross to industry standard SN74LVC1G3157, NC7SB3157, NLASB3157, PI5A3157, and STG3157
- Low switch on-resistance (6  $\Omega$ )
- +1.65 V to +5.5 V single supply operation
- Powered-off protection
- Control logic inputs can go over  $V+$  up to 5.5 V
- Low parasitic capacitance, 7 pF at switch off
- Break before make switching
- Latch-up performance exceeds 200 mA per JESD 78
- High ESD rating
  - 7000 V human body model (JS-001)
  - 1000 V charge device model (JS-002)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

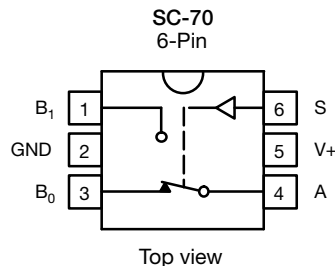


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

## APPLICATIONS

- Battery powered devices
- Consumer and computing
- Instrumentation
- Medical equipment
- Control and automation

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device marking: H0

TRUTH TABLE	
LOGIC INPUT (S)	FUNCTION
0	$B_0$ connected to A
1	$B_1$ connected to A

ORDERING INFORMATION		
TEMP. RANGE	PACKAGE	PART NUMBER
$-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$	SC-70-6	DG3157EDL-T1-GE3 (halogen-free)



ABSOLUTE MAXIMUM RATINGS			
PARAMETER		LIMIT	UNIT
V+, A, B <sub>0</sub> , B <sub>1</sub> , S reference to GND		-0.3 to 6	V
Continuous current (any terminal)		± 50	mA
Peak current (pulsed at 1 ms, 10 % duty cycle)		± 200	
Storage temperature	D suffix	-65 to +150	°C
Power dissipation (packages) <sup>a</sup>	6-pin SC-70 <sup>b</sup>	250	mW
ESD / HBM	JS-001	7000	V
ESD / CDM	JS-002	1000	
Latch up	Per JEDEC78 with 1.5 x V <sub>abs</sub> max. clamp	200	mA

**Notes**

- a. All leads welded or soldered to PC board
- b. Derate 3.1 mW/°C above 70 °C

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

SPECIFICATIONS								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V <sub>S</sub> = 0.25 V+ or 0.75 V+, V+ = 1.65 V to 1.95 V <sup>e</sup> V <sub>S</sub> = 0.2 V+ or 0.65 V+, V+ = 2.3 V to 5.5 V <sup>e</sup>		TEMP. <sup>a</sup>	LIMITS -40 °C to +85 °C			UNIT
					MIN. <sup>b</sup>	TYP. <sup>c</sup>	MAX. <sup>b</sup>	
<b>DC Characteristics</b>								
High level input voltage	V <sub>SH</sub>	V+ = 1.65 V to 1.95 V		Full	0.75 V+	-	-	V
		V+ = 2.3 V to 5.5 V		Full	0.65 V+	-	-	
Low level input voltage	V <sub>SL</sub>	V+ = 1.65 V to 1.95 V		Full	-	-	0.25 V+	V
		V+ = 2.3 V to 5.5 V		Full	-	-	0.2 V+	
On resistance	R <sub>ON</sub>	V+ = 4.5 V	V <sub>BN</sub> = 0 V, I <sub>A</sub> = 30 mA	Full	-	8	11	Ω
			V <sub>BN</sub> = 2.3 V, I <sub>A</sub> = -30 mA	Full	-	6	9	
			V <sub>BN</sub> = 4.5 V, I <sub>A</sub> = -30 mA	Full	-	7	9	
		V+ = 3 V	V <sub>BN</sub> = 0 V, I <sub>A</sub> = 24 mA	Full	-	10	14	
			V <sub>BN</sub> = 3 V, I <sub>A</sub> = -24 mA	Full	-	9	12	
		V+ = 2.3 V	V <sub>BN</sub> = 0 V, I <sub>A</sub> = 8 mA	Full	-	13	18	
			V <sub>BN</sub> = 2.3 V, I <sub>A</sub> = -8 mA	Full	-	12	16	
		V+ = 1.65 V	V <sub>BN</sub> = 0 V, I <sub>A</sub> = 4 mA	Full	-	20	26	
V <sub>BN</sub> = 1.65 V, I <sub>A</sub> = -4 mA	Full		-	18	23			
On resistance flatness	R <sub>FLAT</sub>	0 < V <sub>BN</sub> < V+	V+ = 4.5 V, I <sub>A</sub> = -30 mA	Room	-	2	-	Ω
			V+ = 3 V, I <sub>A</sub> = -24 mA	Room	-	4	-	
			V+ = 2.3 V, I <sub>A</sub> = -8 mA	Room	-	10	-	
			V+ = 1.65 V, I <sub>A</sub> = -4 mA	Room	-	58	-	
On resistance matching between channels	ΔR <sub>ON</sub>	V+ = 4.5 V, V <sub>BN</sub> = 3.15 V, I <sub>A</sub> = -30 mA	V+ = 4.5 V, V <sub>BN</sub> = 3.15 V, I <sub>A</sub> = -30 mA	Room	-	0.09	-	Ω
			V+ = 3 V, V <sub>BN</sub> = 2.1 V, I <sub>A</sub> = -24 mA	Room	-	0.13	-	
			V+ = 2.3 V, V <sub>BN</sub> = 1.6 V, I <sub>A</sub> = -8 mA	Room	-	0.15	-	
			V+ = 1.65 V, V <sub>BN</sub> = 1.15 V, I <sub>A</sub> = -4 mA	Room	-	0.16	-	
Input leakage current	I <sub>S</sub>	V+ = 5.5 V, V <sub>S</sub> = 5.5 V		Room	-0.1	-	0.1	μA
				Full	-1	-	1	
Off stage switch leakage	I <sub>BN(off)</sub>	V+ = 5.5 V, V <sub>A</sub> = 1 V / 4.5 V, V <sub>B</sub> = 4.5 V / 1 V		Room	-0.1	-	0.1	μA
				Full	-1	-	1	
On state switch leakage	I <sub>BN(on)</sub>	V+ = 5.5 V, V <sub>A</sub> = V <sub>B</sub> = 1 V or 4.5 V		Room	-0.1	-	0.1	μA
				Full	-1	-	1	
Power down leakage	I <sub>PD</sub>	V+ = 0 V, V <sub>A</sub> = 5 V, B <sub>0</sub> , B <sub>1</sub> open, V <sub>S</sub> = GND		Full	-	-	5	μA
		V+ = 0 V, V <sub>B0</sub> , V <sub>B1</sub> = 5 V, A open, V <sub>S</sub> = GND		Full	-	-	5	
<b>Power Supply</b>								
Power supply range	V+			Full	1.65	-	5.5	V
Quiescent supply current	I+	V+ = 5.5 V, V <sub>S</sub> = V+ or GND		Room	-	-	1	μA
				Full	-	-	5	



SPECIFICATIONS								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED $V_S = 0.25 V_+ \text{ or } 0.75 V_+, V_+ = 1.65 V \text{ to } 1.95 V^e$ $V_S = 0.2 V_+ \text{ or } 0.65 V_+, V_+ = 2.3 V \text{ to } 5.5 V^e$	TEMP. <sup>a</sup>	LIMITS -40 °C to +85 °C			UNIT	
				MIN. <sup>b</sup>	TYP. <sup>c</sup>	MAX. <sup>b</sup>		
<b>AC Electrical Characteristics <sup>e</sup></b>								
Prop delay time <sup>f</sup>	$t_{PHL}/t_{PLH}$	$V_A = 0 V$ , see Fig. 3	$V_+ = 1.65 V \text{ to } 1.95 V$	Full	-	4	-	ns
			$V_+ = 2.3 V \text{ to } 2.7 V$	Full	-	3	-	
			$V_+ = 3 V \text{ to } 3.6 V$	Full	-	2	-	
			$V_+ = 4.5 V \text{ to } 5.5 V$	Full	-	2	-	
Output enable time <sup>f</sup>	$t_{PZL}/t_{PZH}$	$V_{LOAD} = 2 \times V_+$ for $t_{PZL}$ , $V_{LOAD} = 0 V$ for $t_{PZH}$ , see Fig. 4	$V_+ = 1.65 V \text{ to } 1.95 V$	Room	-	32	-	
				Full	-	34	-	
			$V_+ = 2.3 V \text{ to } 2.7 V$	Room	-	22	-	
				Full	-	23	-	
			$V_+ = 3 V \text{ to } 3.6 V$	Room	-	19	-	
				Full	-	20	-	
			$V_+ = 4.5 V \text{ to } 5.5 V$	Room	-	16	-	
				Full	-	16	-	
Output disable time <sup>f</sup>	$t_{PLZ}/t_{PHZ}$	$V_{LOAD} = 2 \times V_+$ for $t_{PLZ}$ , $V_{LOAD} = 0 V$ for $t_{PHZ}$ , see Fig. 4	$V_+ = 1.65 V \text{ to } 1.95 V$	Room	-	22	-	
				Full	-	23	-	
			$V_+ = 2.3 V \text{ to } 2.7 V$	Room	-	18	-	
				Full	-	19	-	
			$V_+ = 3 V \text{ to } 3.6 V$	Room	-	16	-	
				Full	-	16	-	
			$V_+ = 4.5 V \text{ to } 5.5 V$	Room	-	13	-	
				Full	-	14	-	
Break-before-make time <sup>d</sup>	$t_{BBM}$		$V_+ = 1.65 V \text{ to } 1.95 V$	Full	0.5	-	-	
			$V_+ = 2.3 V \text{ to } 2.7 V$	Full	0.5	-	-	
			$V_+ = 3 V \text{ to } 3.65 V$	Full	0.5	-	-	
			$V_+ = 4.5 V \text{ to } 5.5 V$	Full	0.5	-	-	
Charge injection <sup>d</sup>	Q	$C_L = 0.1 \text{ nF}$ , $V_{GEN} = 0 V$ $R_{GEN} = 0 \Omega$	$V_+ = 5 V$	Room	-	1.3	-	
			$V_+ = 3.3 V$	Room	-	0.5	-	
<b>Analog Switch Characteristics</b>								
Off isolation <sup>d</sup>	OIRR	$R_L = 50 \Omega, f = 10 \text{ MHz}$	Room	-	-61	-	dB	
Crosstalk <sup>d</sup>	$X_{TALK}$		Room	-	-61	-		
-3 dB bandwidth <sup>d</sup>	BW	$R_L = 50 \Omega$	Room	-	580	-	MHz	
<b>Capacitance</b>								
Control pin capacitance <sup>d</sup>	$C_{IN}$	$V_+ = 0 V$	Room	-	6	-	pF	
B port off capacitance <sup>d</sup>	$C_{IO-B}$	$V_+ = 5 V$	Room	-	7	-		
A port capacitance when switch enable <sup>d</sup>	$C_{IO-A(on)}$		Room	-	12	-		

**Notes**

- a. Room = 25 °C, full = as determined by the operating suffix
- b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet
- c. Typical values are for design aid only, not guaranteed nor subject to production testing
- d. Guarantee by design, nor subjected to production test
- e.  $V_S$  = input voltage to perform proper function
- f. Guaranteed by design and not production tested. The bus switch propagation delay is a function of the RC time constant contributed by the on-resistance and the specified load capacitance with an ideal voltage source (zero output impedance) driving the switch

**LOGIC DIAGRAM POSITIVE LOGIC**

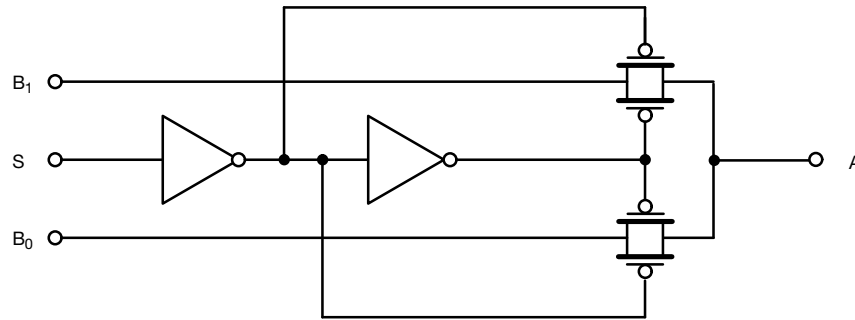
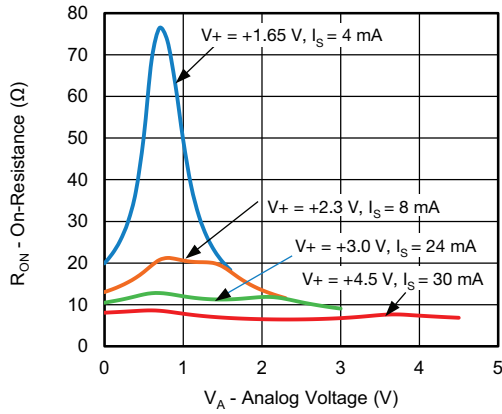
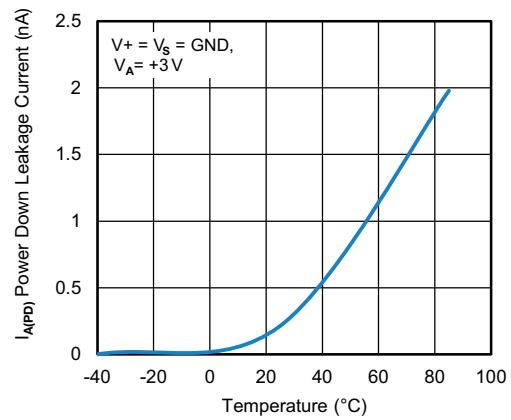


Fig. 1

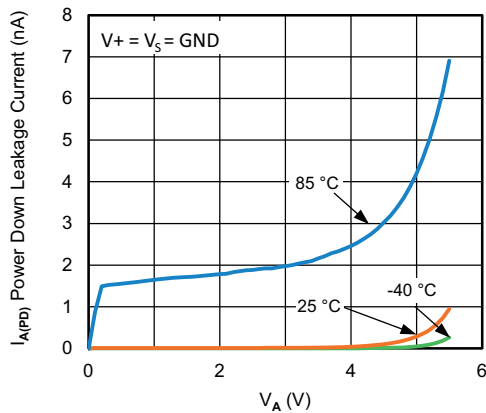
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



**R<sub>ON</sub> vs. V<sub>A</sub> vs. V+**

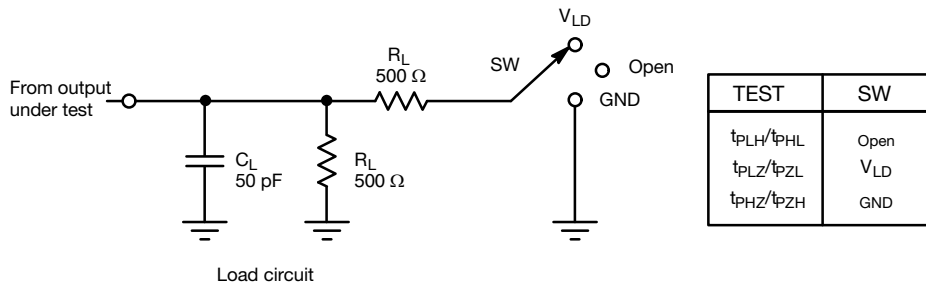


**Power Down Leakage Current vs. Temperature**

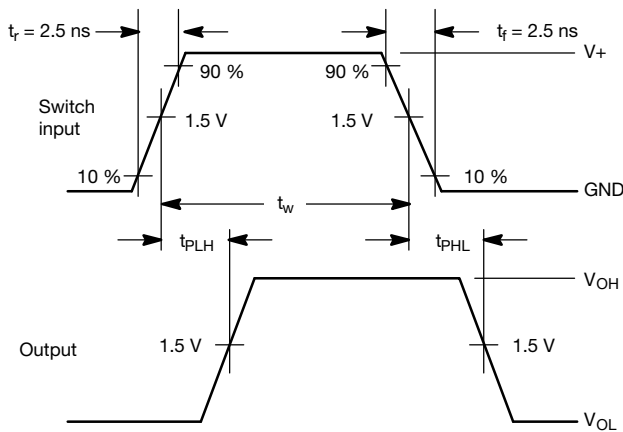


**Power Down Leakage Current vs. V<sub>A</sub>**

**AC LOADING AND WAVEFORMS**

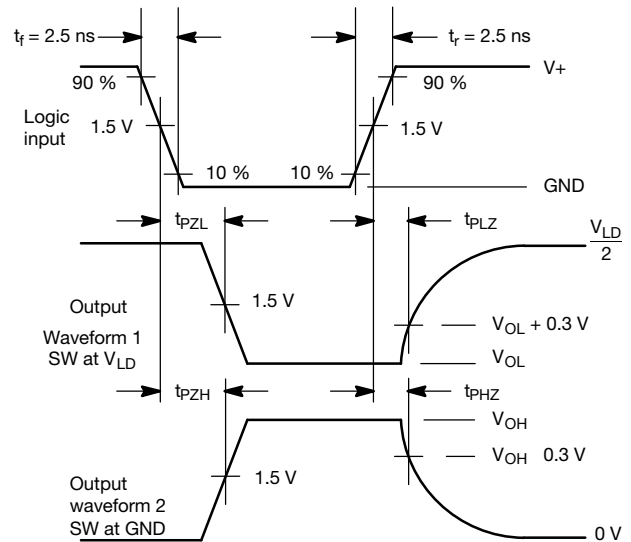


**Fig. 2 - AC Test Circuit**



Propagation delay times

**Fig. 3 - AC Waveforms**



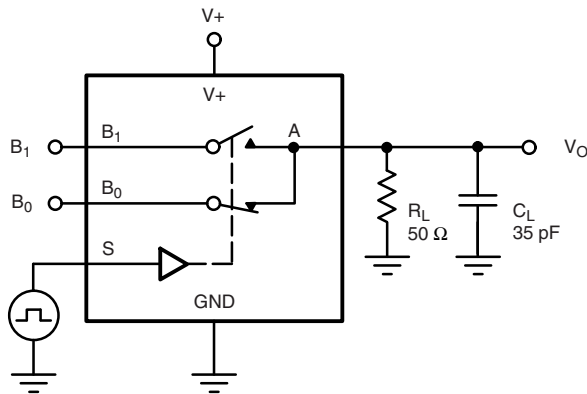
Enable and disable time-low- and high-level enabling

**Fig. 4 - AC Waveforms**

**Notes**

- $C_L$  includes probe and jig capacitance
- 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.
- All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$
- The outputs are measured one at a time with one transition per measurement
- $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$
- $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{dis}$
- $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{dis}$
- $V_{LD} = 2$  V+

TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)

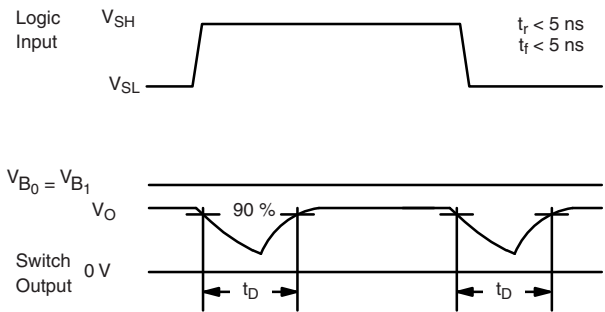
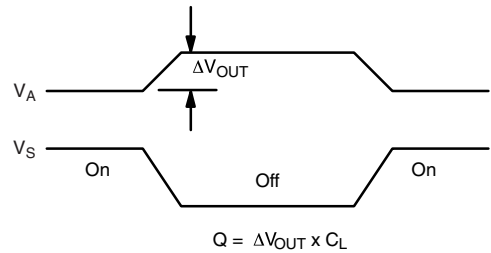
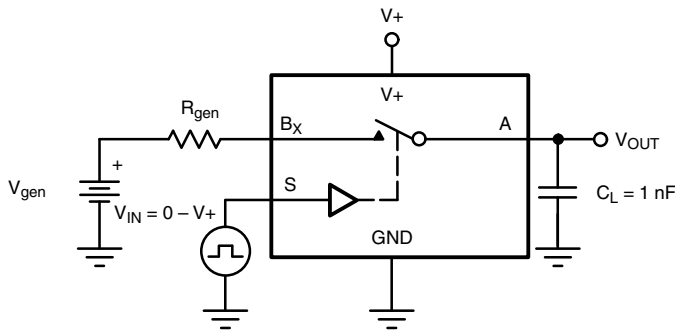


Fig. 5 - Break-Before-Make Interval



IN depends on switch configuration: input polarity determined by sense of switch.

Fig. 6 - Charge Injection

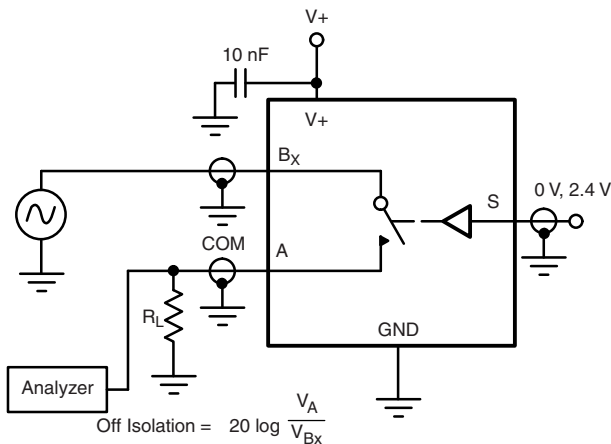


Fig. 7 - Off-Isolation

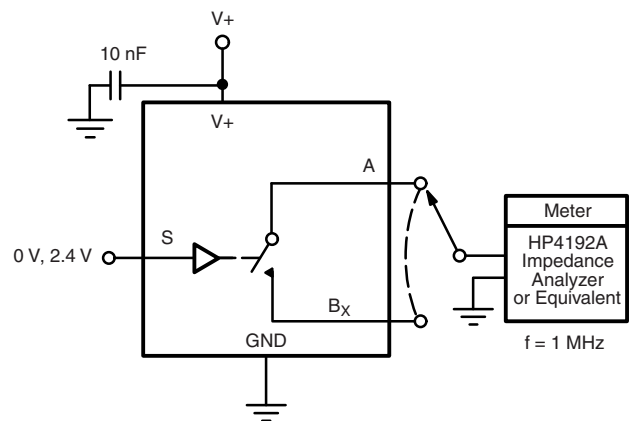


Fig. 8 - Channel Off/On Capacitance

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