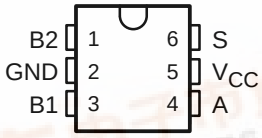
SINGLE-POLE, DOUBLE-THROW ANALOG SWITCH

SCES463 – JUNE 2003

- **Qualification in Accordance With AEC-Q100†**
- **Qualified for Automotive Applications**
- **Customer-Specific Configuration Control Can Be Supported Along With Major-Change Approval**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **1.65-V to 5.5-V V_{CC} Operation**
- **Useful for Both Analog and Digital Applications**
- **Specified Break-Before-Make Switching**
- **Rail-to-Rail Signal Handling**
- **High Degree of Linearity**
- **High Speed, Typically 0.5 ns (V_{CC} = 3 V, C_L = 50 pF)**
- **Low On-State Resistance, Typically ≈6 Ω (V_{CC} = 4.5 V)**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**

† Contact factory for details. Q100 qualification data available on request.

DCK PACKAGE
(TOP VIEW)



description/ordering information

This single-pole, double-throw (SPDT) analog switch is designed for 1.65-V to 5.5-V V_{CC} operation.

The SN74LVC1G3157 can handle both analog and digital signals. The device permits signals with amplitudes of up to V_{CC} (peak) to be transmitted in either direction.

Applications include signal gating, chopping, modulation or demodulation (modem), and signal multiplexing for analog-to-digital and digital-to-analog conversion systems.

ORDERING INFORMATION

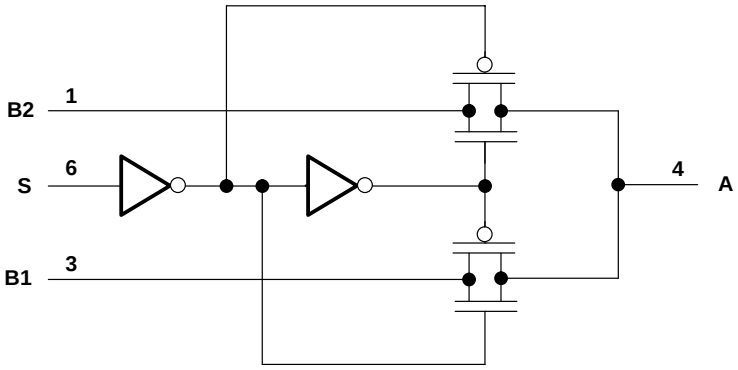
T_A	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOT (SC-70) – DCK	Tape and reel	1P1G3157QDCKRQ1	C5R

‡ Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

CONTROL INPUT S	ON CHANNEL
L	B1
H	B2

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} (see Note 1) . . . . . –0.5 V to 6.5 V
Control input voltage range, V_{IN} (see Notes 1 and 2) . . . . . –0.5 V to 6.5 V
Switch I/O voltage range, $V_{I/O}$ (see Notes 1, 2, 3, and 4) . . . . . –0.5 V to V_{CC} + 0.5 V
Control input clamp current, I_{IK} (V_{IN} < 0) . . . . . –50 mA
I/O port diode current, I_{IOK} ($V_{I/O}$ < 0 or $V_{I/O}$ > V_{CC}) . . . . . ±50 mA
On-state switch current, $I_{I/O}$ ($V_{I/O}$ = 0 to V_{CC}) (see Note 5) . . . . . ±128 mA
Continuous current through V_{CC} or GND . . . . . ±100 mA
Package thermal impedance, θ_{JA} (see Note 6) . . . . . 258°C/W
Storage temperature range, T_{stg} . . . . . –65°C to 150°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 under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltages are with respect to ground unless otherwise specified.
2. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
3. This value is limited to 5.5 V maximum.
4. V_I, V_O, V_A, and V_{Bn} are used to denote specific conditions for $V_{I/O}$.
5. I_I, I_O, I_A, and I_{Bn} are used to denote specific conditions for $I_{I/O}$.
6. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions (see Note 7)

			MIN	MAX	UNIT
V_{CC}			1.65	5.5	V
$V_{I/O}$			0	V_{CC}	V
V_{IN}			0	5.5	V
V_{IH}	High-level input voltage, control input	V_{CC} = 1.65 V to 1.95 V	$V_{CC} \times 0.75$		V
		V_{CC} = 2.3 V to 5.5 V	$V_{CC} \times 0.7$		
V_{IL}	Low-level input voltage, control input	V_{CC} = 1.65 V to 1.95 V		$V_{CC} \times 0.25$	V
		V_{CC} = 2.3 V to 5.5 V		$V_{CC} \times 0.3$	
$\Delta t/\Delta v$	Input transition rise/fall time	V_{CC} = 1.65 V to 1.95 V		20	ns/V
		V_{CC} = 2.3 V to 2.7 V		20	
		V_{CC} = 3 V to 3.6 V		10	
		V_{CC} = 4.5 V to 5.5 V		10	
T_A			–40	125	°C

NOTE 7: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS			V_{CC}	MIN	TYP†	MAX	UNIT
r_{on}	On-state switch resistance‡		See Figures 1 and 2	V_I = 0 V	I_O= 4 mA	1.65 V		11	20	Ω
				V_I = 1.65 V	I_O = –4 mA			15	50	
				V_I = 0 V	I_O = 8 mA	2.3 V		8	12	
				V_I = 2.3 V	I_O = –8 mA			11	30	
				V_I = 0 V	I_O = 24 mA	3 V		7	9.5	
				V_I = 3 V	I_O = –24 mA			9	20	
				V_I = 0 V	I_O = 30 mA	4.5 V		6	7.5	
				V_I = 2.4 V	I_O = –30 mA			7	12	
				V_I = 4.5 V	I_O = –30 mA			7	15	
r_{range}	On-state switch resistance over signal range‡§		$0 \le V_{Bn} \le V_{CC}$ (see Figures 1 and 2)		I_A = –4 mA	1.65 V			140	Ω
					I_A = –8 mA	2.3 V			45	
					I_A = –24 mA	3 V			18	
					I_A = –30 mA	4.5 V			10	
Δr_{on}	Difference of on-state resistance between switches‡¶#		See Figure 1	V_{Bn} = 1.15 V	I_A = –4 mA	1.65 V		0.5		Ω
				V_{Bn} = 1.6V	I_A = –8 mA	2.3 V		0.1		
				V_{Bn} = 2.1 V	I_A = –24 mA	3 V		0.1		
				V_{Bn} = 3.15 V	I_A = –30 mA	4.5 V		0.1		
$r_{on(flat)}$	ON resistance flatness‡¶‖		$0 \le V_{Bn} \le V_{CC}$		I_A = –4 mA	1.65 V		110		Ω
					I_A = –8 mA	2.3 V		26		
					I_A = –24 mA	3 V		9		
					I_A = –30 mA	4.5 V		4		
I_{off}☆	Off-state switch leakage current		$0 \le V_I, V_O \le V_{CC}$, (see Figure 3)			1.65 V to 5.5 V			±1	μA
								±0.05	±1†	
$I_{S(on)}$	On-state switch leakage current		$V_I = V_{CC}$ or GND, V_O = Open (see Figure 4)			5.5 V			±1	μA
									±0.1†	
I_{IN}	Control input current		$0 \le V_{IN} \le V_{CC}$			0 V to 5.5 V			±1	μA
								±0.05	±1†	
I_{CC}	Supply current		$V_{IN} = V_{CC}$ or GND			5.5 V		1	10	μA
ΔI_{CC}	Supply-current change		$V_{IN} = V_{CC}$ – 0.6 V			5.5 V			500	μA
C_{in}	Control input capacitance	S				5 V		2.7		pF
$C_{io(off)}$	Switch input/output capacitance	Bn				5 V		5.2		pF
$C_{io(on)}$	Switch input/output capacitance	Bn				5 V		17.3		pF
		A						17.3		

† T_A = 25°C
‡ Measured by the voltage drop between I/O pins at the indicated current through the switch. ON resistance is determined by the lower of the voltages on the two (A or B) ports.
§ Specified by design
¶ $\Delta r_{on} = r_{on(max)} - r_{on(min)}$ measured at identical V_{CC}, temperature, and voltage levels.
# This parameter is characterized, but not tested in production.
‖ Flatness is defined as the difference between the maximum and minimum values of ON resistance over the specified range of conditions.
☆ I_{off} is the same as $I_{S(off)}$ (off-state switch leakage current).

analog switch characteristics, T_A = 25°C

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	V_{CC}	TYP	UNIT
Frequency response (switch on)†	A or Bn	Bn or A	R_L = 50 Ω, f_{in} = sine wave (see Figure 6)	1.65 V	300	MHz
				2.3 V	300	
				3 V	300	
				4.5 V	300	
Crosstalk (between switches)‡	B1 or B2	B2 or B1	R_L = 50 Ω, f_{in} = 10 MHz (sine wave) (see Figure 7)	1.65 V	–54	dB
				2.3 V	–54	
				3 V	–54	
				4.5 V	–54	
Feed-through attenuation (switch off)‡	A or Bn	Bn or A	C_L = 5 pF, R_L = 50 Ω, f_{in} = 10 MHz (sine wave) (see Figure 8)	1.65 V	–57	dB
				2.3 V	–57	
				3 V	–57	
				4.5 V	–57	
Charge injection§	S	A	C_L = 0.1 nF, R_L = 1 MΩ, (see Figure 9)	3.3 V	3	pC
				5 V	7	
Total harmonic distortion	A or Bn	Bn or A	V_I = 0.5 V p-p, R_L = 600 Ω, f_{in} = 600 Hz to 20 kHz (sine wave) (see Figure 10)	1.65 V	0.1	%
				2.3 V	0.025	
				3 V	0.015	
				4.5 V	0.01	

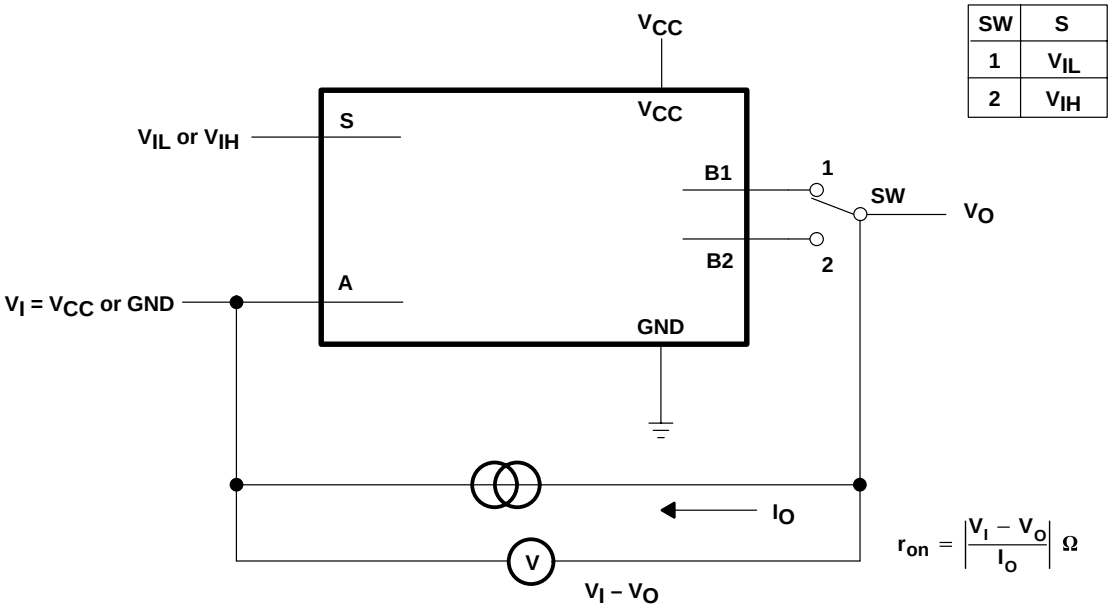
† Adjust f_{in} voltage to obtain 0 dBm at output. Increase f_{in} frequency until dB meter reads –3 dB.
‡ Adjust f_{in} voltage to obtain 0 dBm at input.
§ Specified by design

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 5 and 11)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 1.8 V ± 0.15 V		V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 5 V ± 0.5 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{pd}†	A or Bn	Bn or A		2		1.2		0.8		0.3	ns
t_{en}‡	S	Bn	7	24	3.5	14	2.5	7.6	1.7	5.7	ns
t_{dis}§			3	13	2	7.5	1.5	5.3	0.8	3.8	
t_{B-M}¶			0.5		0.5		0.5		0.5		ns

† t_{pd} is the slower of t_{PLH} or t_{PHL}. The propagation delay is calculated RC time constant of the typical on-state resistance of the switch and the specified load capacitance when driven by an ideal voltage source (zero output impedance).
‡ t_{en} is the slower of t_{PZL} or t_{PZH}.
§ t_{dis} is the slower of t_{PLZ} or t_{PHZ}.
¶ Specified by design

PARAMETER MEASUREMENT INFORMATION



SW	S
1	V_{IL}
2	V_{IH}

Figure 1. On-State Resistance Test Circuit

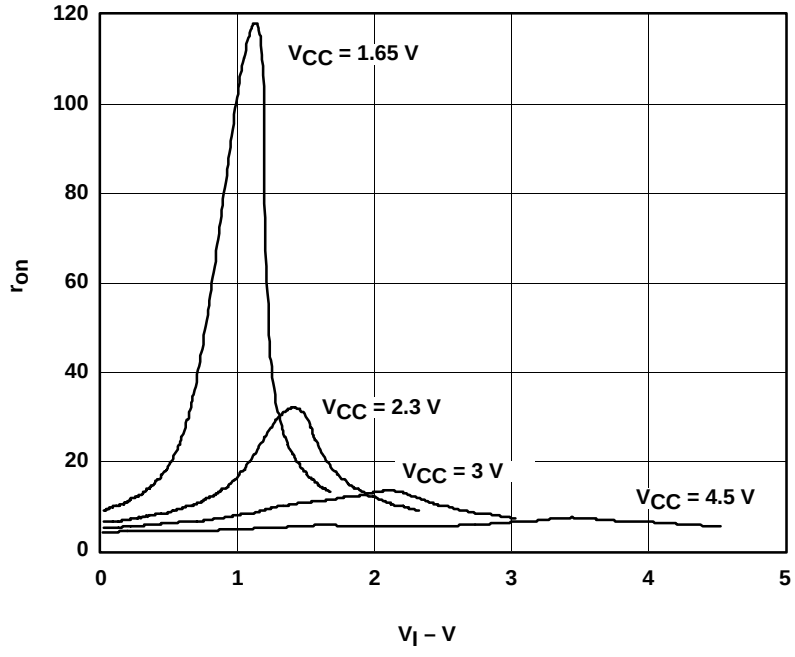
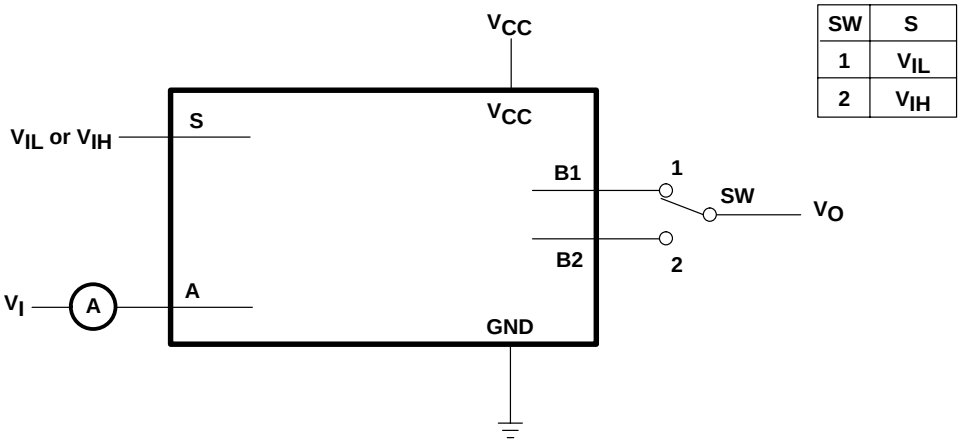


Figure 2. Typical r_{on} as a Function of Input Voltage (V_I) for V_I = 0 to V_{CC}

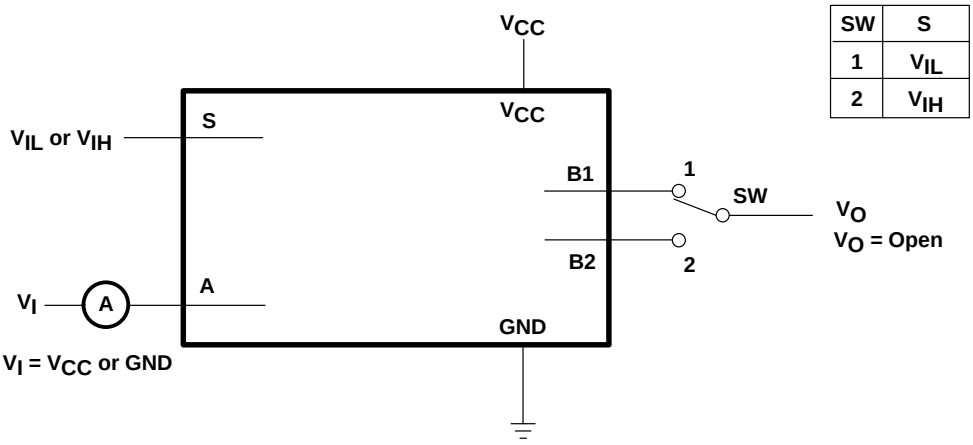
PARAMETER MEASUREMENT INFORMATION



SW	S
1	V_{IL}
2	V_{IH}

Condition 1: V_I = GND, V_O = V_{CC}
Condition 2: V_I = V_{CC}, V_O = GND

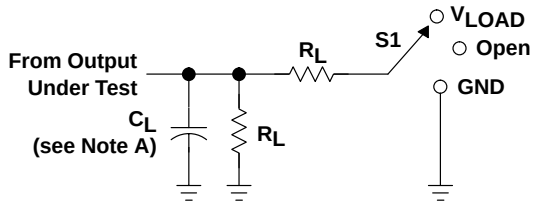
Figure 3. Off-State Switch Leakage-Current Test Circuit



SW	S
1	V_{IL}
2	V_{IH}

Figure 4. On-State Switch Leakage-Current Test Circuit

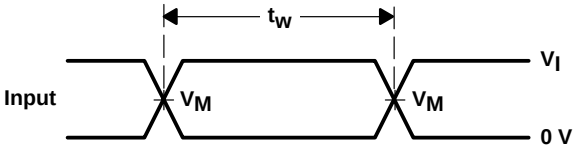
PARAMETER MEASUREMENT INFORMATION



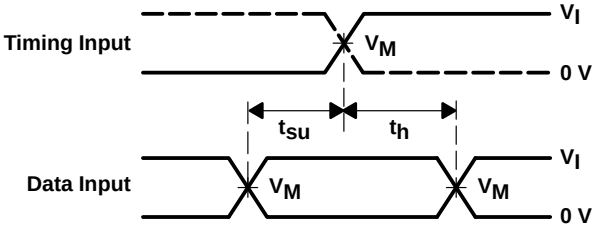
LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{LOAD}
t_{PHZ}/t_{PZH}	GND

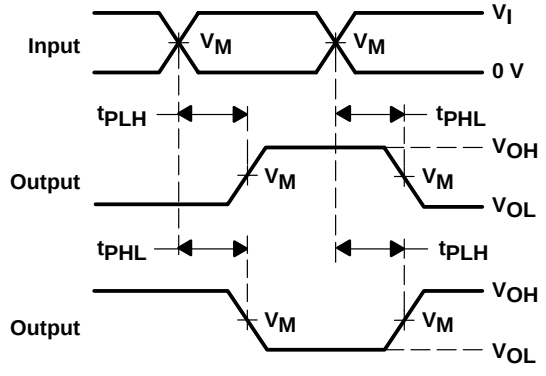
V_{CC}	INPUTS		V_M	V_{LOAD}	C_L	R_L	V_Δ
	V_I	t_r/t_f					
1.8 V ± 0.15 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	50 pF	500 Ω	0.3 V
2.5 V ± 0.2 V	V_{CC}	≤2 ns	$V_{CC}/2$	$2 \times V_{CC}$	50 pF	500 Ω	0.3 V
3.3 V ± 0.3 V	V_{CC}	≤2.5 ns	$V_{CC}/2$	$2 \times V_{CC}$	50 pF	500 Ω	0.3 V
5 V ± 0.5 V	V_{CC}	≤2.5 ns	$V_{CC}/2$	$2 \times V_{CC}$	50 pF	500 Ω	0.3 V



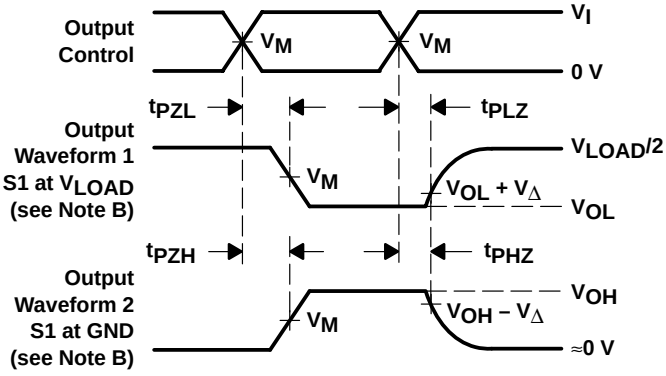
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

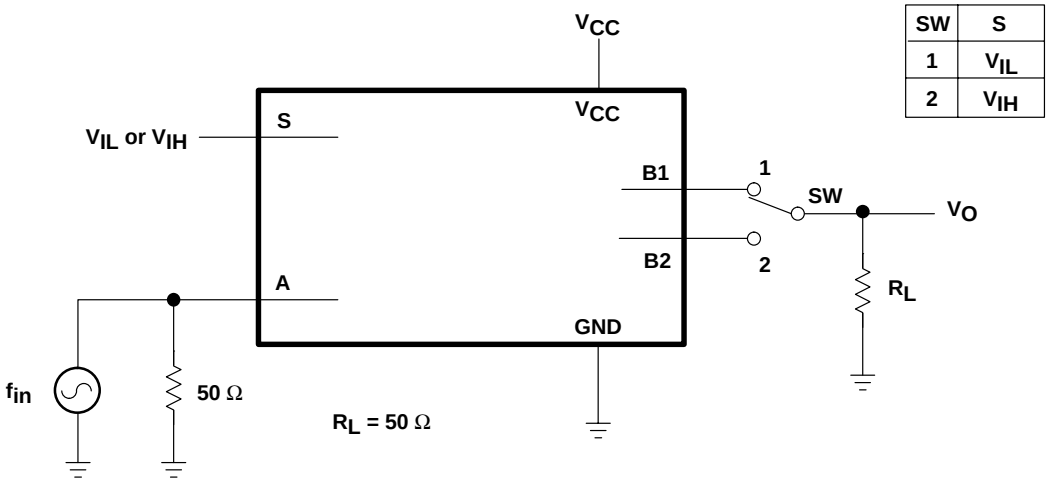


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

NOTES: A. C_L includes probe and jig capacitance.
B. 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.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω.
D. The outputs are measured one at a time with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. All parameters and waveforms are not applicable to all devices.

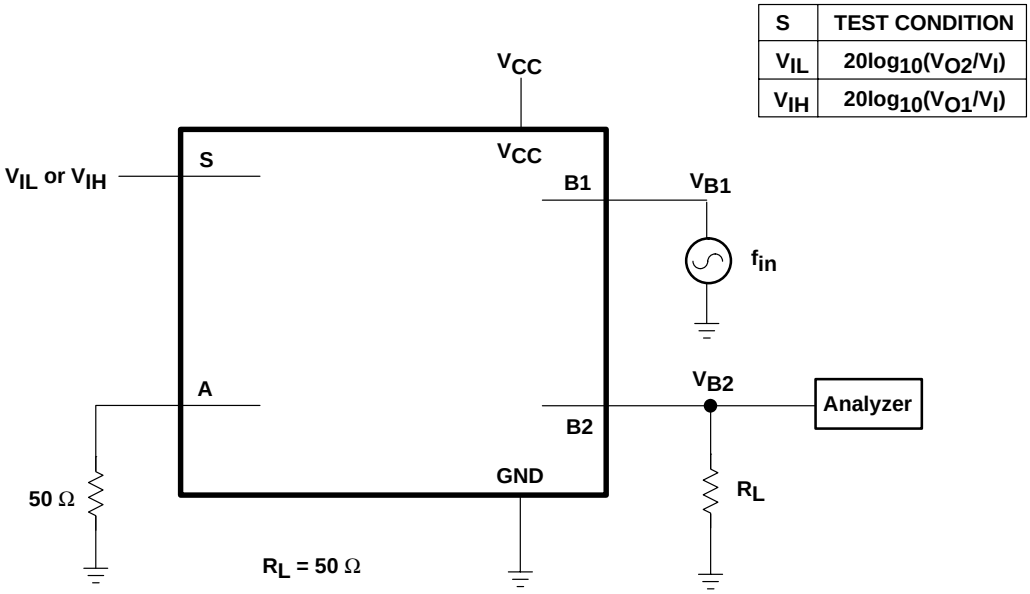
Figure 5. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION



SW	S
1	V_{IL}
2	V_{IH}

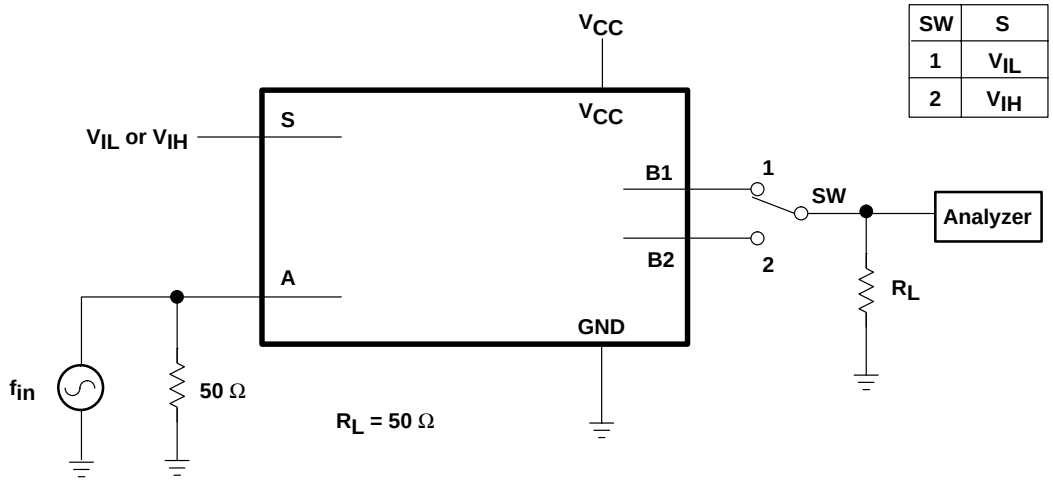
Figure 6. Frequency Response (Switch On)



S	TEST CONDITION
V_{IL}	$20\log_{10}(V_{O2}/V_I)$
V_{IH}	$20\log_{10}(V_{O1}/V_I)$

Figure 7. Crosstalk (Between Switches)

PARAMETER MEASUREMENT INFORMATION



SW	S
1	V_{IL}
2	V_{IH}

Figure 8. Feed Through

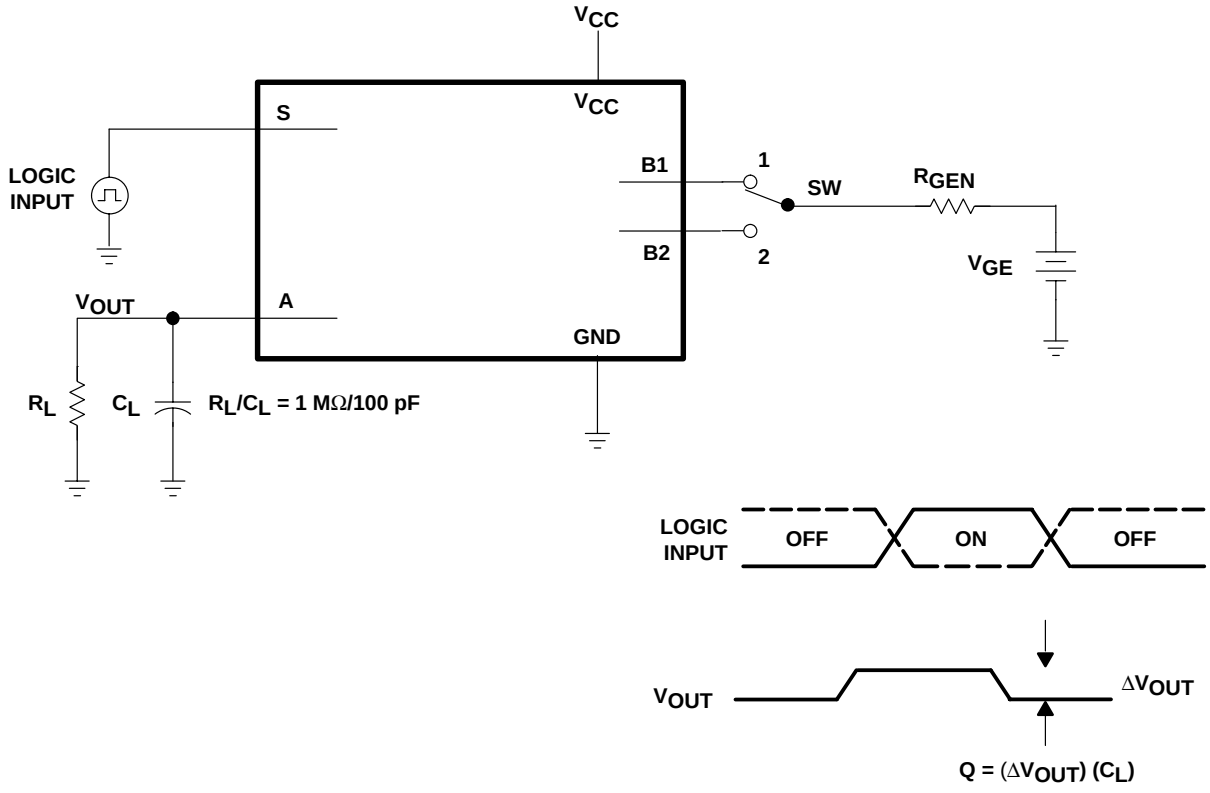
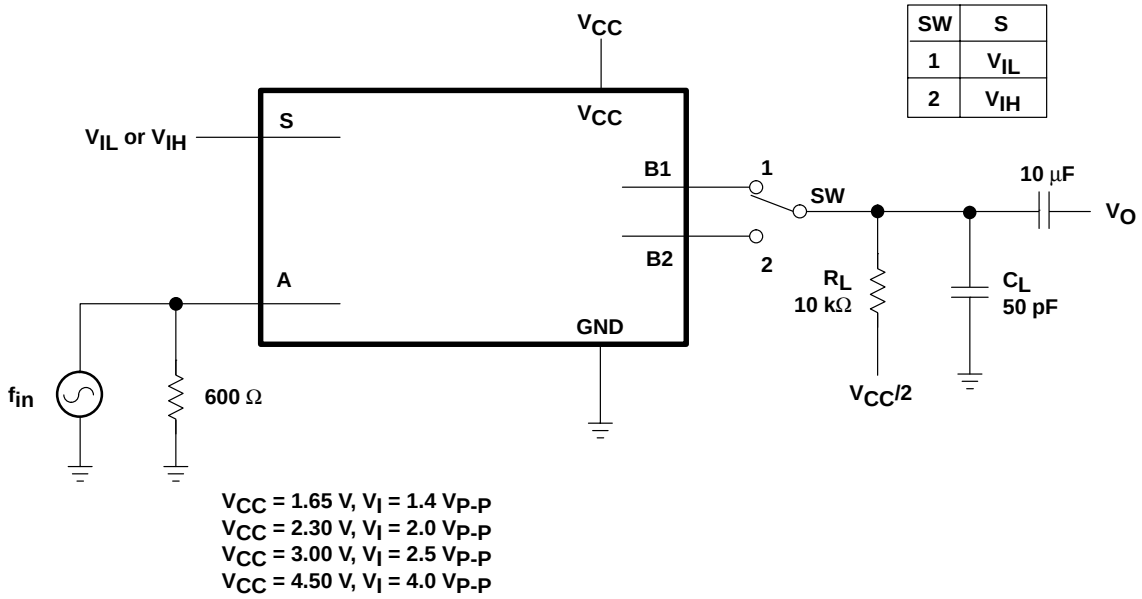


Figure 9. Charge-Injection Test

PARAMETER MEASUREMENT INFORMATION



SW	S
1	V_{IL}
2	V_{IH}

V_{CC} = 1.65 V, V_I = 1.4 V_{P-P}
V_{CC} = 2.30 V, V_I = 2.0 V_{P-P}
V_{CC} = 3.00 V, V_I = 2.5 V_{P-P}
V_{CC} = 4.50 V, V_I = 4.0 V_{P-P}

Figure 10. Total Harmonic Distortion

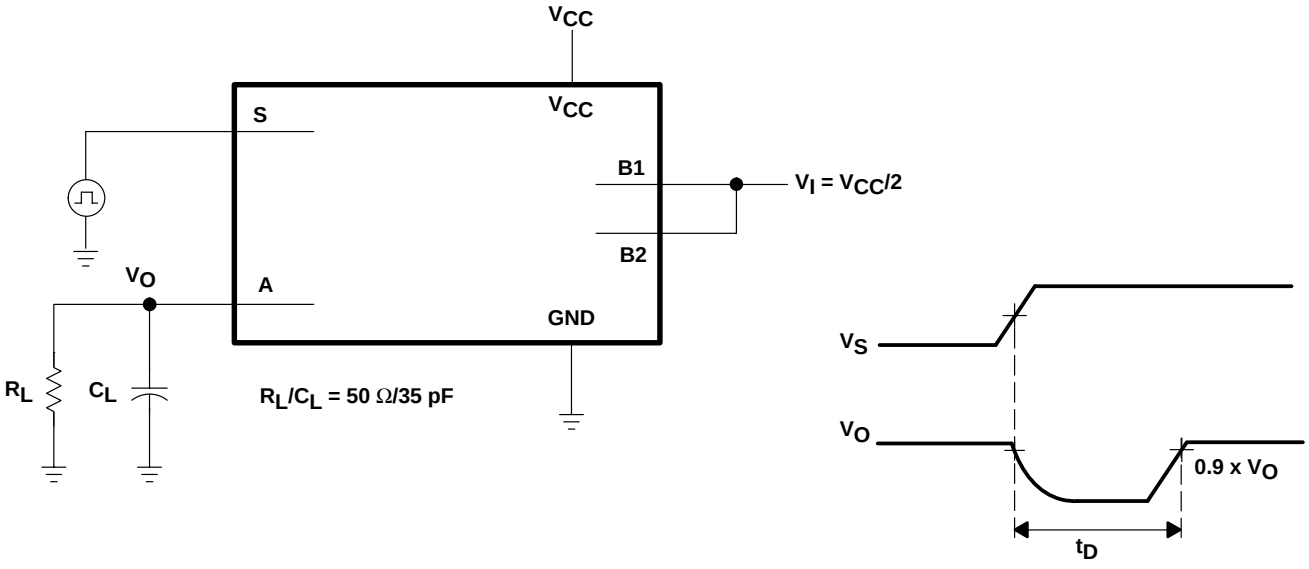
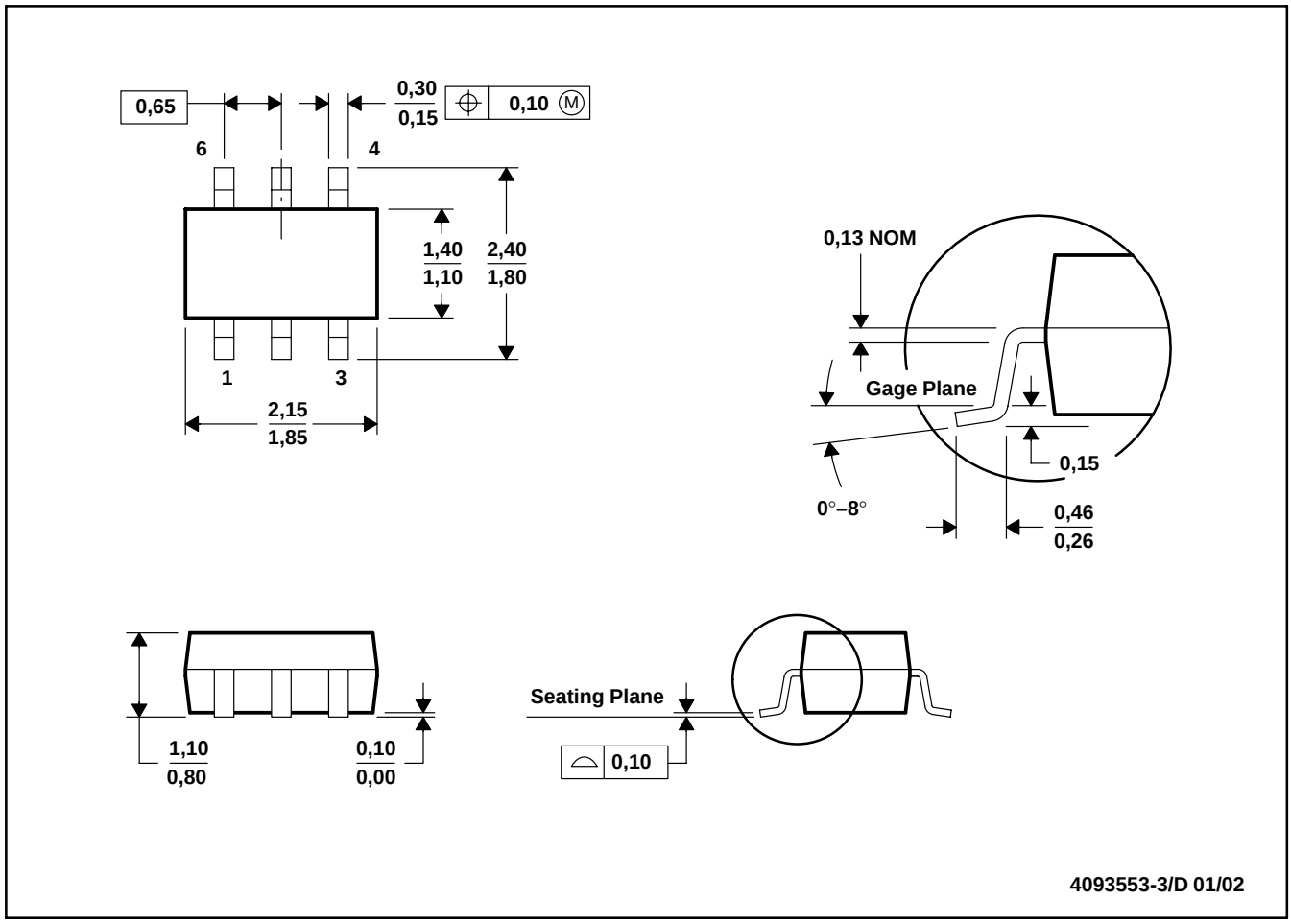


Figure 11. Break-Before-Make Internal Timing

MPDS114 – FEBRUARY 2002

DCK (R-PDSO-G6) **PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO-203

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