

**Precision, Quad, SPDT, 17V Analog Switch**
**Features**

- Low On-Resistance (17 Ohm typ.) Minimizes Distortion and Error Voltages
- Low Glitching Reduces Step Errors and Improves Settling Times. Charge Injection: <10pC
- Dual-Supply Operation ( $\pm 2.7V$  to  $\pm 8V$ )
- Single-Supply Operation (+2.7V to +15V)
- Improved Second Sources for MAX394
- On-Resistance Matching Between Channels: <2 Ohm
- On-Resistance Flatness: 4 Ohm (Max.)
- Low Off-Channel Leakage,  $I_{NO(OFF)} < 2.5nA @ +85^{\circ}C$
- TTL/CMOS Logic Compatible (w/ +5V or  $\pm 5V$  supplies)
- Break-Before-Make action eliminates momentary crosstalk
- Rail-to-Rail Analog Signal Range
- Narrow SOIC and QSOP Packages Minimize Board Area

**Applications**

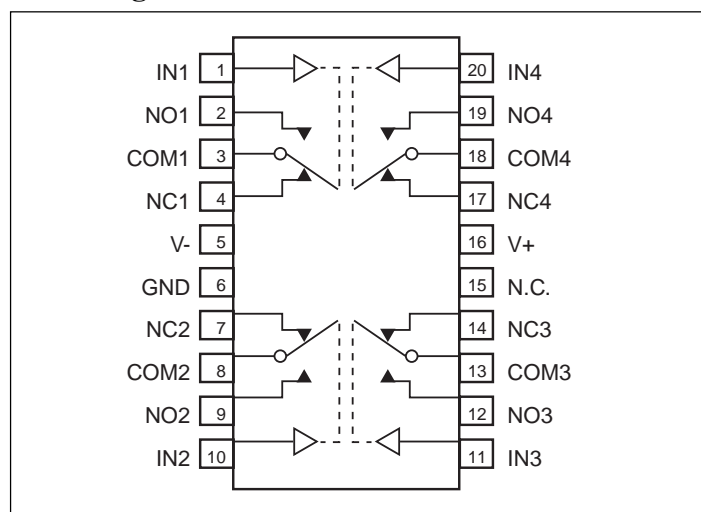
- Data Acquisition Systems
- Audio Switching and Routing
- Test Equipment
- PBX, PABX
- Telecommunication Systems
- Battery-Powered Systems

**Description**

The PS394 is a precision, low-voltage, quad, single-pole/double-throw (SPDT) analog switch. The four independent switches operate with bipolar supplies ranging from  $\pm 2.7V$  to  $\pm 8V$ , or with a single supply of +2.7V to +15V. The PS394 offers low On-resistance (less than 35 Ohm), guaranteed to match within 2 Ohm between channels and to remain flat over the analog signal range (4 Ohm Max.). It also offers break-before-make switching (10ns typical), with turn-off times less than 75ns and turn-on times less than 130ns. The PS394 is ideal for portable operation since quiescent current runs less than 1 $\mu A$  with all inputs high or low.

This monolithic, quad switch is fabricated using Pericom's 17V silicon-gate process. Design improvements guarantee extremely low charge injection (10pC), low power consumption (10 $\mu W$ ), and electrostatic discharge (ESD) greater than 2000V.

Logic Inputs are TTL and CMOS compatible and guaranteed over a +0.8V to +2.4V range. Logic inputs and switched analog signals can range anywhere between the supply voltages without damage.

**Pin Configuration**

**Pin Description**

Name	Function
IN1 - IN4	Logic-Levels Inputs
NO1 - NO4	Normally Open Switches
COM1 - COM4	Common Switch Poles
NC1 - NC4	Normally Closed Switches
V-	Negative Power Supply
GND	Ground
N.C.	Not Internally Connected
V+	Positive Power Supply

### Absolute Maximum Ratings

Voltages Referenced to GND	
V+	-0.3V to +17V
V-	+0.3V to -17V
V+ to V-	-0.3V to +17V
COM, NO, NC, IN <sup>(1)</sup>	(V--2V) to (V++2V) or 30mA, whichever occurs first
Continuous Current, Any Pin	30mA
Peak Current, Any Pin (pulsed at 1ms, 10% duty cycle max.)	100mA
Continuous power Dissipation (T <sub>A</sub> = +70°C)	
Plastic DIP (derate 10.53mW/°C above +70°C)	842mW
Narrow SO (derate 8.70mW/°C above +70°C)	696mW
Operating Temperature Ranges	
PS394C_P	0°C to +70°C
PS394E_P	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10sec)	+300°C

**Note 1:**

Signals on NC, NO, COM, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

**CAUTION**

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied.

### Applications Information

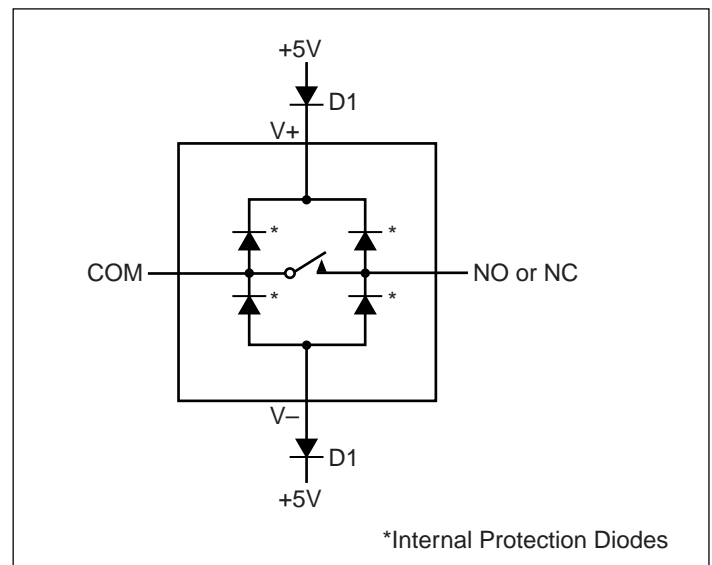
**Operation with Supply Voltages Other than ±5V**

The PS394 switch operates with ±2.7V to ±8V bipolar supplies and a +2.7V to +15V single supply. In either case, analog signals ranging from V+ to V- can be switched. The *Typical Operating Characteristics* graphs show the typical on-resistance variation with analog signal and supply voltage. The usual on-resistance temperature coefficient is 0.5%/°C (typ).

**Power-Supply Sequencing and Overvoltage Protection**

Do not exceed the absolute maximum ratings, because 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+, followed by V- (when using split supplies) before applying analog signals or logic inputs, especially if the analog or logic signals are not current-limited. If this sequencing is not possible and if the analog or logic inputs are not current limited to less than 30mA, add a single diode (D1) for single-supply operation (Figure 1). If using dual supplies or if the analog signal can dip below ground in single-supply operation, add two small signal diodes (D1, D2), as shown in Figure 1. Adding protection diodes reduces the analog signal range to a diode drop above V- for D2. Leakage is not affected by adding the diodes. On-resistance increases by a small amount at low supply voltages. Maximum supply voltage (V- to V+) must not exceed 17V.

Adding diodes D1 and D2 also protects against some overvoltage situations. With the circuit of Figure 1, if the supply voltage is 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. For example, with ±5V supplies, analog signals up to ±8.5V will not damage the circuit of Figure 1. If only a single fault signal is present, the fault voltage can go to +12V or -12V without damage.



**Figure 1. Overvoltage Protection using Blocking Diodes**

### Electrical Characteristics—Dual Supplies

(V+ = 5V ± 10%, V- = -5V ± 10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

Parameter	Symbol	Conditions	Temp. Range	Min. <sup>(2)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(2)</sup>	Units	
<b>Switch</b>								
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	(note 3)		V-		V+	V	
On-Resistance	R <sub>ON</sub>	V+ = 4.5V, V- = -4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±3.5V, I <sub>COM</sub> = 10mA, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0.8V	TA = +25°C	C, E	20	35	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		45		
On-Resistance Match Between Channels <sup>(4)</sup>	ΔR <sub>ON</sub>	V <sub>NC</sub> or V <sub>NO</sub> = ±3V, I <sub>COM</sub> = 10mA, V+ = 5V, V- = -5V	TA = +25°C	C, E	0.5	2	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		4		
On-Resistance Flatness <sup>(4)</sup>	R <sub>FLAT(ON)</sub>	V <sub>NC</sub> or V <sub>NO</sub> = +3V, 0V, -3V; I <sub>COM</sub> = 10mA, V+ = 5V; V- = -5V	TA = +25°C	C, E		4	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		6		
NC or NO Off Leakage Current <sup>(5)</sup>	I <sub>NC(OFF)</sub> or I <sub>NO(OFF)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V, V+ = 5.5V, V- = -5.5V	TA = +25°C	C, E	-0.2	-0.01	0.2	nA
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
COM Leakage Current <sup>(5)</sup>	I <sub>COM(ON)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V, V+ = 5.5V, V- = -5.5V	TA = +25°C	C, E	-0.4	-0.04	0.4	nA
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5.0		5.0	
<b>Digital Logic Input</b>								
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V			-1.0	0.005	1.0	μA
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V			-1.0	0.005	1.0	
Logic High Input Voltage	V <sub>A_H</sub>		TA = T <sub>MIN</sub> to T <sub>MAX</sub>		2.4			V
Logic Low Input Voltage	V <sub>A_L</sub>		TA = T <sub>MIN</sub> to T <sub>MAX</sub>				0.8	

**Electrical Characteristics — Dual Supplies (continued)**

( $V_+ = 5V \pm 10\%$ ,  $V_- = -5V \pm 10\%$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

Parameter	Symbol	Conditions	Temp. Range	Min. <sup>(2)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(2)</sup>	Units
<b>Dynamic</b>							
Turn-On-Time	$t_{ON}$	$V_{COM} = 3V$ , Figure 2	$T_A = +25^\circ C$			82	130
			$T_A = T_{MIN}$ to $T_{MAX}$				175
Turn-off-Time	$t_{OFF}$	$V_{COM} = 3V$ , Figure 2	$T_A = +25^\circ C$			57	75
			$T_A = T_{MIN}$ to $T_{MAX}$				100
Break-Before-Make Time Delay <sup>(3)</sup>	$t_D$	Figure 5	$T_A = +25^\circ C$		2	10	
Charge Injection <sup>(3)</sup>	$V_{CTE}$	$C_L = 1.0nF$ , $V_{GEN} = 0V$ , $R_{GEN} = 0\text{ Ohm}$ , Figure 6	$T_A = +25^\circ C$			5	10
Off Isolation <sup>(6)</sup>	$V_{ISO}$	$R_L = 50\text{ Ohm}$ , $C_L = 5pF$ , $f = 1\text{ MHz}$ , Figure 3	$T_A = +25^\circ C$			66	
Crosstalk <sup>(7)</sup>	$V_{CT}$	$R_L = 50\text{ Ohm}$ , $C_L = 5pF$ , $f = 1\text{ MHz}$ , Figure 8	$T_A = +25^\circ C$			88	
Off Capacitance	$C_{OFF}$	$f = 1\text{ MHz}$ , Figure 3	$T_A = +25^\circ C$			12	
COM Off Capacitance	$C_{COM(OFF)}$	$f = 1\text{ MHz}$ , Figure 3	$T_A = +25^\circ C$			12	
Channel On Capacitance	$C_{COM(ON)}$	$f = 1\text{ MHz}$ , Figure 4	$T_A = +25^\circ C$			39	
<b>Supply</b>							
Power-Supply Range				$\pm 2.4$		$\pm 8$	V
Positive Supply Current	I+	All channels on or off, $V_+ = 5.5V$ , $V_- = -5.5V$ , $V_{IN} = 0V$ or $V_+$		-1.0	0.06	1.0	$\mu A$
Negative Supply Current	I-	All channels on or off, $V_+ = 5.5V$ , $V_- = -5.5V$ , $V_{IN} = 0V$ or $V_+$		-1.0	-0.01	1.0	

**Electrical Characteristics — Single +5V Supply**

(V+ = 5V ± 10%, V- = 0V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

Parameter	Symbol	Conditions	Temp. Range	Min. <sup>(2)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(2)</sup>	Units	
<b>Switch</b>								
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	(note 3)		0V		V+	V	
On-Resistance	R <sub>ON</sub>	V+ = 5.0V, V- = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 3.5V, I <sub>COM</sub> = 1.0mA, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0.8V	TA = +25°C	C, E	25	65	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		75		
On-Resistance Match Between Channels <sup>(4)</sup>	ΔR <sub>ON</sub>	V <sub>NC</sub> or V <sub>NO</sub> = 3V, I <sub>COM</sub> = 1.0mA, V+ = 5V	TA = +25°C	C, E	0.5	2	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		4		
On-Resistance Flatness <sup>(4)</sup>	R <sub>FLAT(ON)</sub>	V <sub>NC</sub> or V <sub>NO</sub> = 3V, 2V, 1V, I <sub>COM</sub> = 1.0mA, V+ = 5V, V- = 0V	TA = +25°C	C, E		6	Ohm	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		8		
NC or NO Off Leakage Current <sup>(8)</sup>	I <sub>NC(OFF)</sub> or I <sub>NO(OFF)</sub>	V <sub>COM</sub> = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 4.5V, V+ = 5.5V, V- = 0V	TA = +25°C	C, E	-0.2	-0.01	nA	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5			2.5
COM Leakage Current <sup>(8)</sup>	I <sub>COM(ON)</sub>	V <sub>COM</sub> = 4.5V, V <sub>NC</sub> or V <sub>NO</sub> = 4.5V, V+ = 5.5V, V- = 0V	TA = +25°C	C, E	-0.4	-0.04	nA	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5.0			5.0
<b>Digital Logic Input</b>								
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V			-1.0	0.005	μA	
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V			-1.0	0.005		
<b>Dynamic</b>								
Turn-On-Time <sup>(3)</sup>	t <sub>ON</sub>	V <sub>COM</sub> = 3V, Figure 2	TA = +25°C			160	ns	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>					300
Turn-off-Time <sup>(3)</sup>	t <sub>OFF</sub>	V <sub>COM</sub> = 3V, Figure 2	TA = +25°C			60	ns	
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>					175
Break-Before-Make Time Delay <sup>(3)</sup>	t <sub>D</sub>		TA = +25°C		5	20		
Charge Injection <sup>(3)</sup>	V <sub>CTE</sub>	CL = 1.0nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0 Ohm	TA = +25°C			3	5	pC
<b>Supply</b>								
Power-Supply Range	V+			2.4		16	V	
Positive Supply Current	I+	All channels on or off, V <sub>IN</sub> = 0V or V+, V+ = 5.5V, V- = 0V		-1.0	0.01	1.0	μA	
Negative Supply Current	I-	All channels on or off, V <sub>IN</sub> = 0V or V+, V+ = 5.5V, V- = 0V		-1.0	-0.01	1.0		

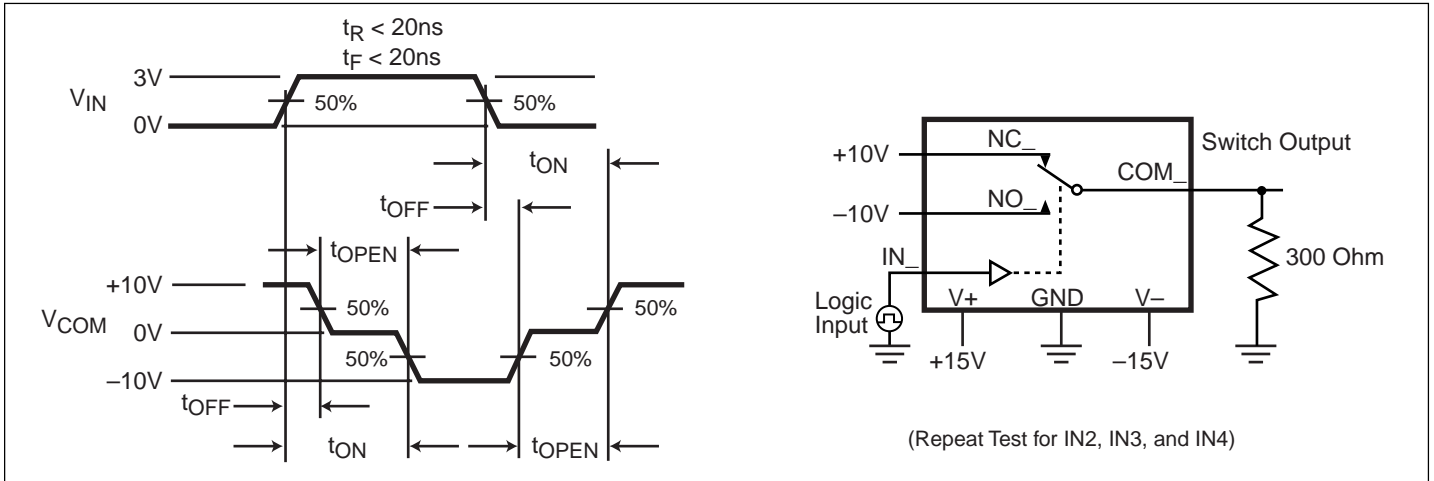
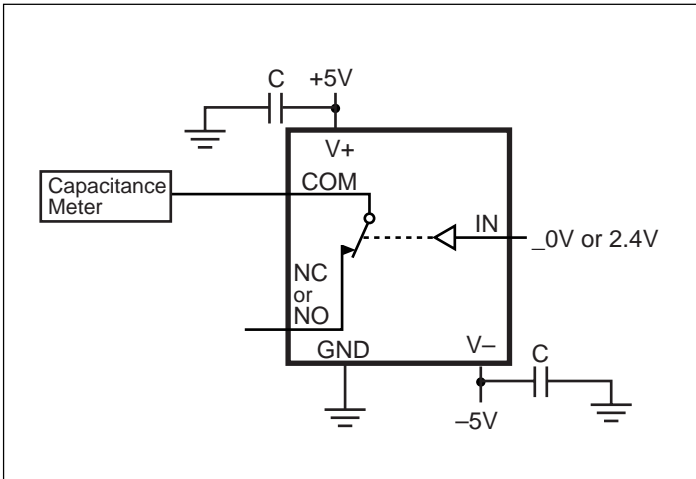
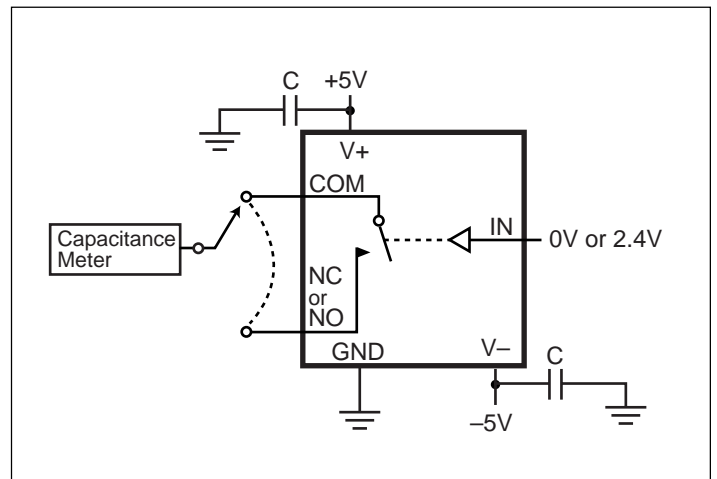
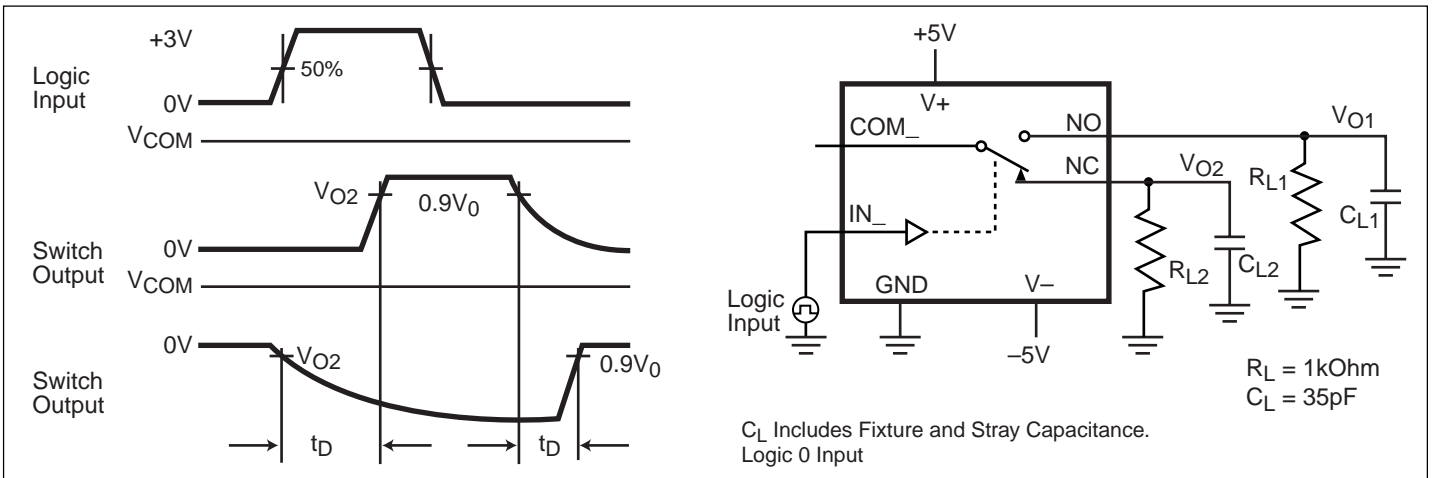
### Electrical Characteristics — Single +3.3V Supply

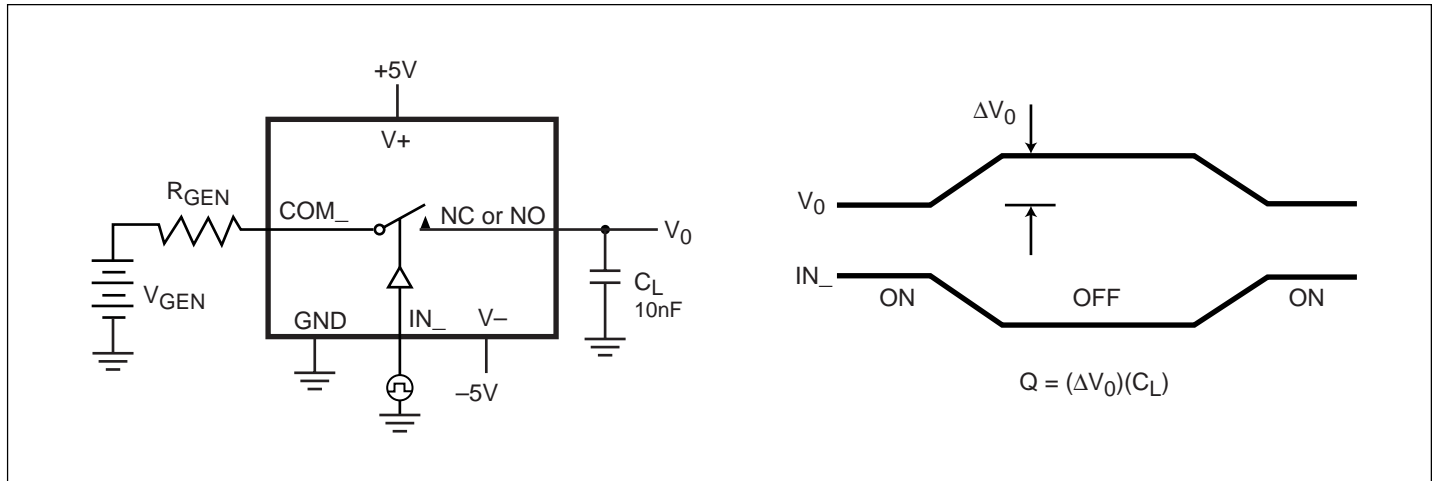
(V+ = 3.0V to 3.6V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

Parameter	Symbol	Conditions	Temp. Range	Min. <sup>(2)</sup>	Typ. <sup>(2)</sup>	Max. <sup>(2)</sup>	Units
<b>Switch</b>							
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	(note 3)		0V		V+	V
On-Resistance	R <sub>ON</sub>	V+ = 3V, V- = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 1.5V, I <sub>COM</sub> = 1.0mA, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0.8V	T <sub>A</sub> = +25°C	C, E	75	185	Ohm
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E		250	
NC or NO Off Leakage Current <sup>(8)</sup>	I <sub>NC(OFF)</sub> or I <sub>NO(OFF)</sub>	V <sub>COM</sub> = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 3V, V+ = 3.6V, V- = 0V	T <sub>A</sub> = +25°C	C, E	-0.2	-0.01	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5	2.5	
COM Leakage Current <sup>(8)</sup>	I <sub>COM(ON)</sub>	V <sub>COM</sub> = 3V, V <sub>NC</sub> or V <sub>NO</sub> = 3V, V+ = 3.6V, V- = 0V	T <sub>A</sub> = +25°C	C, E	-0.4	-0.04	nA
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5.0	5.0	
<b>Digital Logic Input</b>							
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V			-1.0	0.005	μA
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V			-1.0	0.005	
<b>Dynamic</b>							
Turn-On-Time <sup>(3)</sup>	t <sub>ON</sub>	V <sub>COM</sub> = 1.5V, Figure 2	T <sub>A</sub> = +25°C			400	ns
Turn-off-Time <sup>(3)</sup>	t <sub>OFF</sub>	V <sub>COM</sub> = 1.5V, Figure 2	T <sub>A</sub> = +25°C			150	
Break-Before-Make Time Delay <sup>(3)</sup>	t <sub>D</sub>	Figure 5	T <sub>A</sub> = +25°C		5	20	
Charge Injection <sup>(3)</sup>	V <sub>CTE</sub>	C <sub>L</sub> = 1.0nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0 Ohm Figure 6	T <sub>A</sub> = +25°C			1	pC
<b>Supply</b>							
Power-Supply Range	V+			2.7		16	V
Positive Supply Current	I+	All channels on or off, V <sub>IN</sub> = 0V or V+, V+ = 3.6V, V- = 0V		-1.0	0.01	1.0	μA
Negative Supply Current	I-	All channels on or off, V <sub>IN</sub> = 0V or V+, V+ = 3.6V, V- = 0V		-1.0	-0.01	1.0	

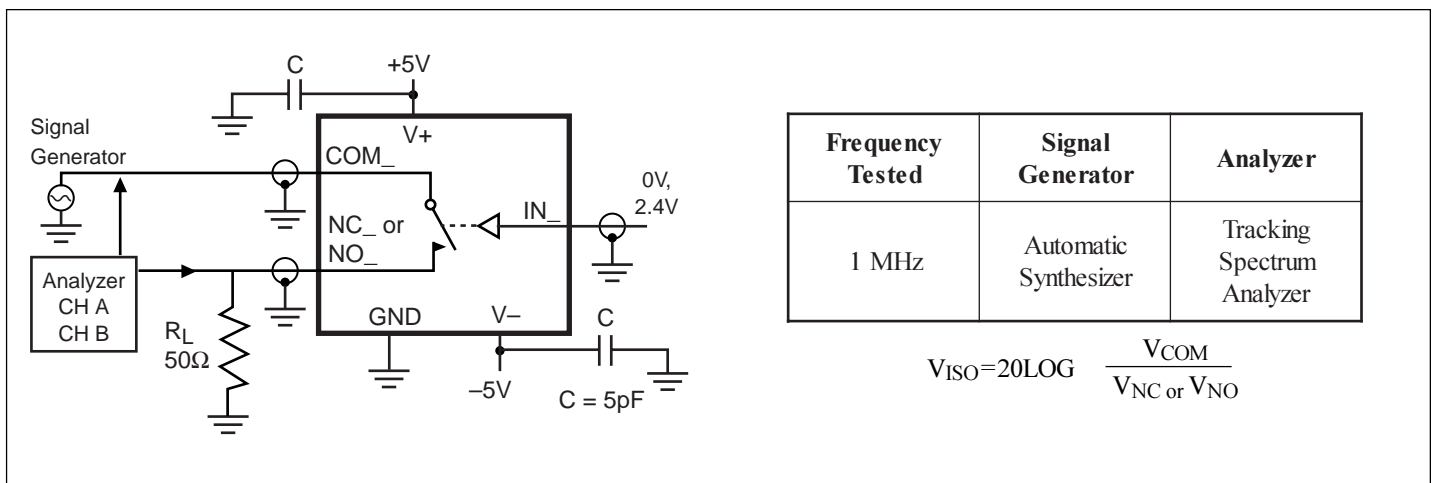
**Notes:**

2. The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.
3. Guaranteed by design
4. ΔR<sub>ON</sub> = ΔR<sub>ON(MAX)</sub>. On-resistance match between channels and flatness are guaranteed only with specified voltages. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
5. Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at room temperature.
6. See Figure 6. Off isolation = 20log<sub>10</sub> V<sub>COM</sub>/V<sub>NC</sub> or V<sub>NO</sub>, V<sub>COM</sub> = output, V<sub>NC</sub> or V<sub>NO</sub> = input to off switch
7. Between any two switches. See Figure 3.
8. Leakage testing at single supply is guaranteed by testing with dual supplies.

**Test Circuits/Timing Diagrams**

**Figure 2. Switching-Time Circuit**

**Figure 3. Channel Off Capacitance**

**Figure 4. Channel On Capacitance**

**Figure 5. Break-Before-Make Delay**



**Figure 6. Charge Injection**



**Figure 7. Off Isolation**

**Ordering Information**

Part Number	Temperature Range	Pin - Package
PS394CPP	0°C to +70°C	20-pin Plastic DIP
PS394CWP	0°C to +70°C	20-pin Wide SO
PS394EPP	-40°C to +85°C	20-pin Plastic DIP
PS394EWP	-40°C to +85°C	20-pin Wide SO