



# CMOS Analog Switches

## FEATURES

- ±15-V Input Range
- Low  $r_{DS(on)}$ : 30  $\Omega$
- Single Supply Operation
- Pin and Function Compatible with the JFET DG180 Family

## BENEFITS

- Full Rail-to-Rail Analog Signal Range
- Minimizes Signal Error
- Low Power Dissipation

## APPLICATIONS

- Low Level Switching Circuits
- Programmable Gain Amplifiers
- Portable and Battery Powered Systems

## DESCRIPTION

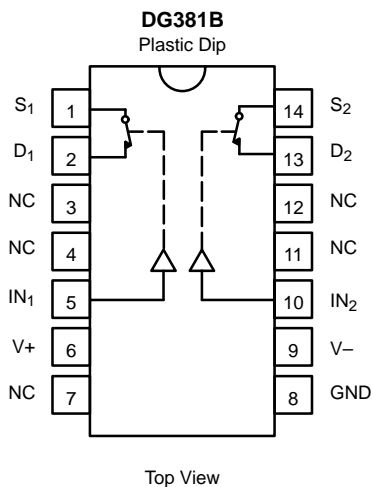
The DG381B–DG390B series of monolithic CMOS analog switches was designed for applications in instrumentation, communications, and process control. This series is suited for applications requiring fast switching and nearly flat on-resistance over the entire voltage range.

switches are ideal for battery powered applications, without sacrificing switching speed. Break-before-make switching action is guaranteed, and an epitaxial layer prevents latchup. Single supply operation is allowed by connecting the V– rail to 0 V.

Designed on Vishay Siliconix' PLUS-40 CMOS process, these devices achieve low power consumption (3.5 mW typical) and excellent on/off switch performance. These

Each switch conducts equally well in both directions when on, and blocks up to the supply voltage when off. These switches are CMOS and quasi TTL logic compatible.

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



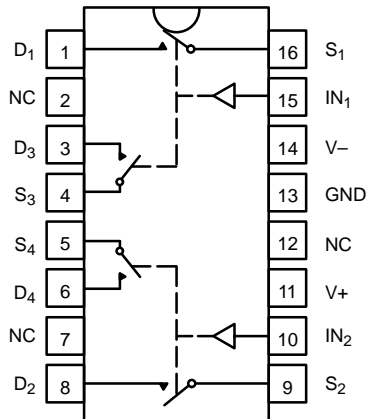
TRUTH TABLE	
Logic	Switch
0	ON
1	OFF

Logic "0"  $\leq$  0.8 V  
Logic "1"  $\geq$  4 V

**FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION**

**DG384B**

Dual-In-Line



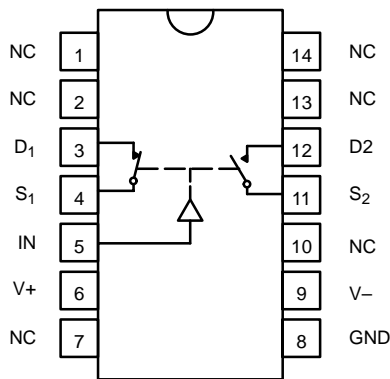
Top View

TRUTH TABLE	
Logic	Switch
0	OFF
1	ON

Logic "0"  $\leq 0.8$  V  
 Logic "1"  $\geq 4$  V

**DG387B**

Dual-In-Line



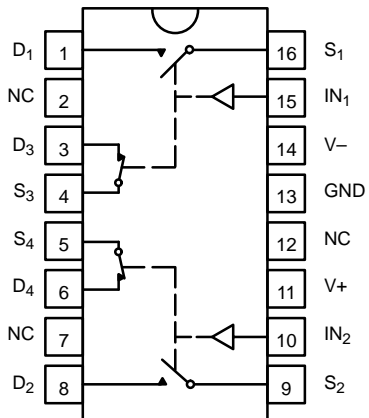
Top View

TRUTH TABLE		
Logic	SW <sub>1</sub>	SW <sub>2</sub>
0	ON	OFF
1	OFF	ON

Logic "0"  $\leq 0.8$  V  
 Logic "1"  $\geq 4$  V

**DG390B**

Dual-In-Line



Top View

TRUTH TABLE		
Logic	SW <sub>1</sub> , SW <sub>2</sub>	SW <sub>3</sub> , SW <sub>4</sub>
0	OFF	ON
1	ON	OFF

Logic "0"  $\leq 0.8$  V  
 Logic "1"  $\geq 4$  V

ORDERING INFORMATION		
Temp Range	Package	Part Number
<b>DG381B</b>		
-40 to 85°C	14-Pin Plastic DIP	DG381BDJ
<b>DG384B</b>		
-40 to 85°C	16-Pin Plastic DIP	DG384BDJ
<b>DG387B</b>		
-40 to 85°C	14-Pin Plastic DIP	DG387BDJ
<b>DG390B</b>		
-40 to 85°C	16-Pin Plastic DIP	DG390BDJ

**ABSOLUTE MAXIMUM RATINGS**

Voltages Referenced to V-

V+ ..... 44 V

GND ..... 25 V

Digital Inputs<sup>a</sup>, V<sub>S</sub>, V<sub>D</sub> ..... (V-) -2 V to (V+) +2V or  
30 mA, whichever occurs first

Current, Any Terminal Except S or D ..... 30 mA

Continuous Current, S or D ..... 30 mA

(Pulsed at 1 ms, 10% duty cycle max) ..... 100 mA

Storage Temperature ..... -65 to 150°C

Power Dissipation<sup>b</sup>

14-Pin Plastic DIP<sup>d</sup> ..... 470 mW

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads welded or soldered to PC Board.
- c. Derate 11 mW/°C above 75°C
- d. Derate 6.5 mW/°C above 25°C

**SCHEMATIC DIAGRAM (TYPICAL CHANNEL)**

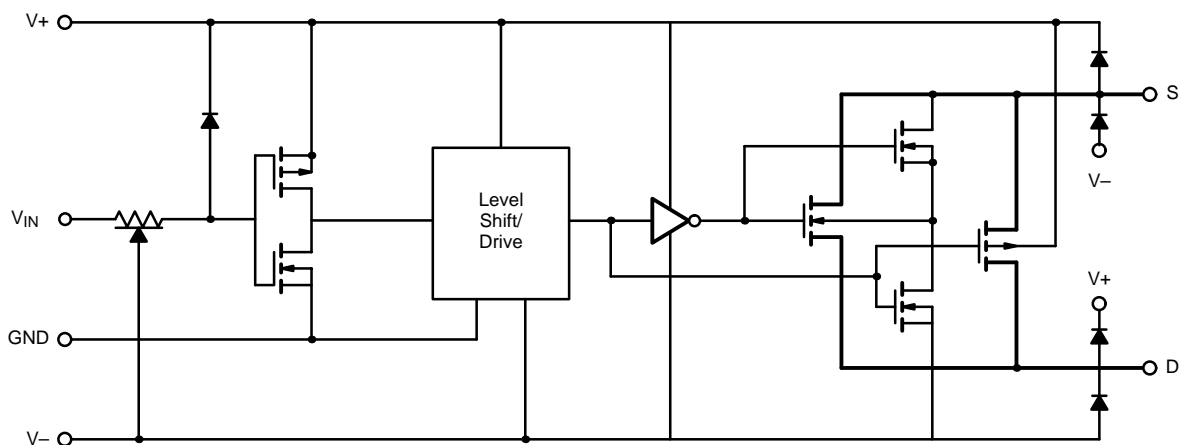


FIGURE 1.

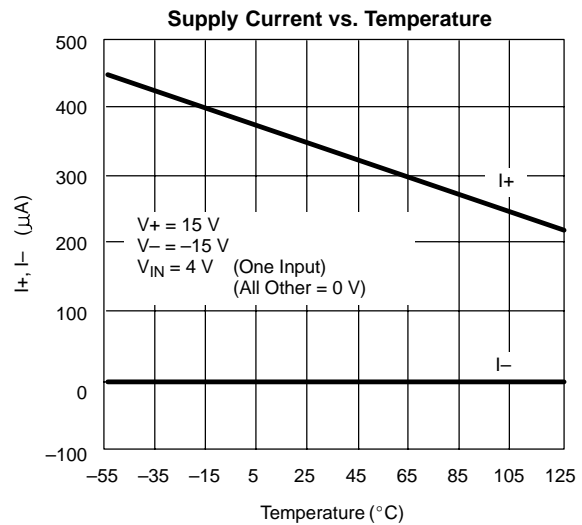
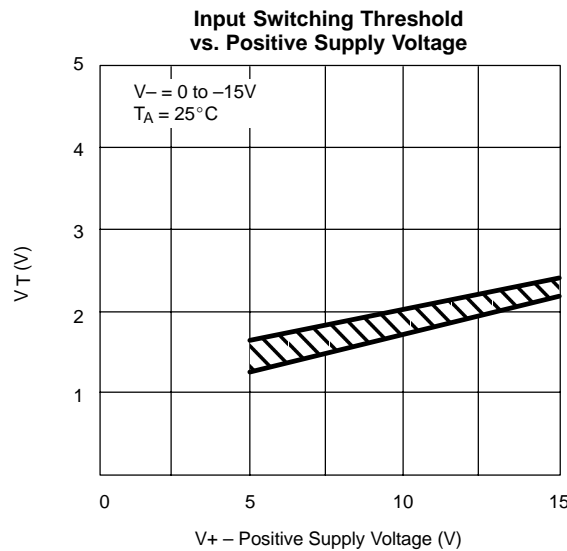
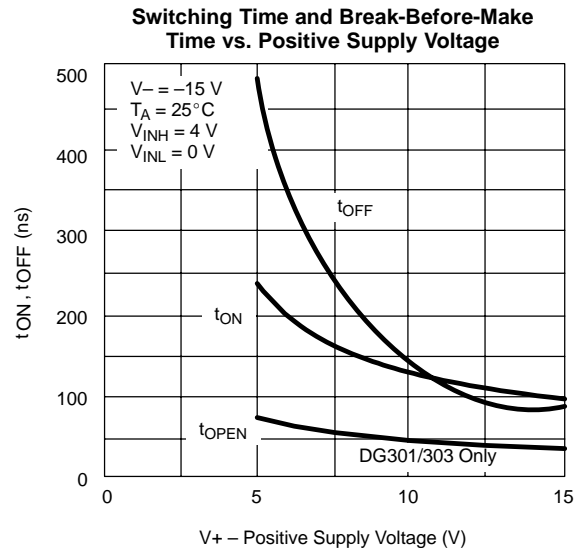
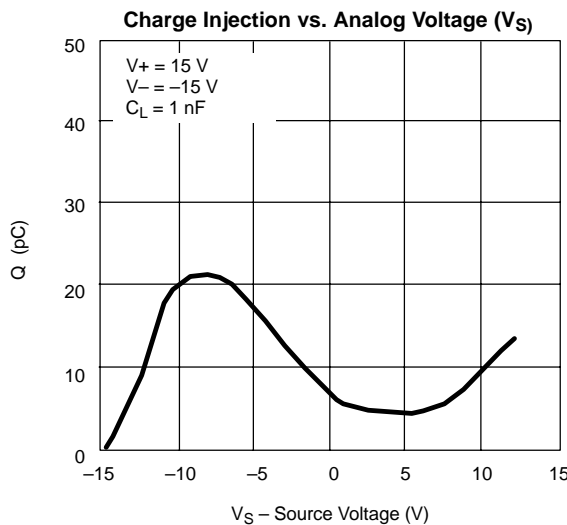
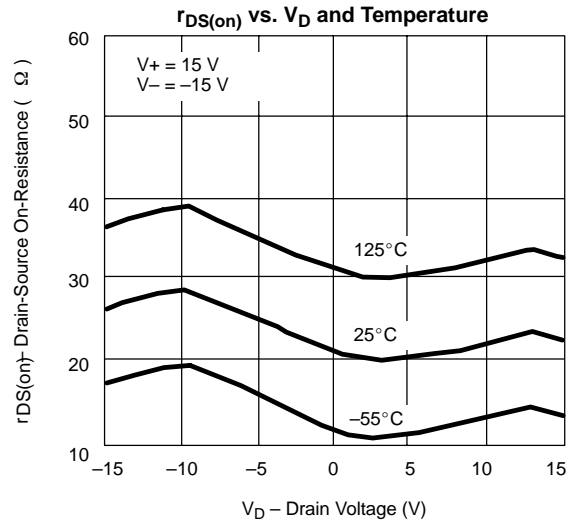
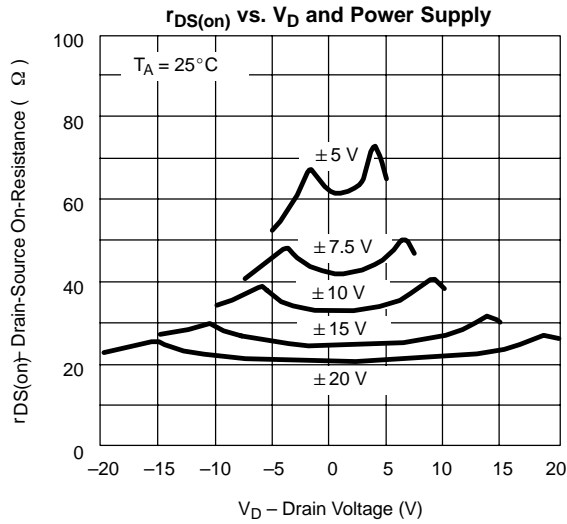
SPECIFICATIONS <sup>a</sup>							
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_{IN} = 0.8\text{ V}$ or $4\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full	-15		15	V
Drain-Source On-Resistance	$r_{DS(on)}$	$V_D = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$	Room Full		30	50 75	$\Omega$
Source Off Leakage Current	$I_{S(off)}$	$V_S = \pm 14\text{ V}$ , $V_D = \mp 14\text{ V}$	Room Hot	-5 -100	$\pm 0.1$	5 100	nA
Drain Off Leakage Current	$I_{D(off)}$	$V_S = \pm 14\text{ V}$ , $V_D = \mp 14\text{ V}$	Room Hot	-5 -100	$\pm 0.1$	5 100	
Drain On Leakage Current	$I_{D(on)}$	$V_D = V_S = \pm 14\text{ V}$	Room Hot	-5 -100	$\pm 0.1$	5 100	
<b>Digital Control</b>							
Input Current with Input Voltage High	$I_{INH}$	$V_{IN} = 5\text{ V}$	Room Full	-1	-0.001		$\mu\text{A}$
		$V_{IN} = 15\text{ V}$	Room Full		0.001	1	
Input Current with Input Voltage Low	$I_{INL}$	$V_{IN} = 0\text{ V}$	Room Full	-1	-0.001		
<b>Dynamic Characteristics</b>							
Turn-On Time	$t_{ON}$	See Figure 2	Room		150		ns
Turn-Off Time	$t_{OFF}$		Room		130		
Break-Before-Make Time	$t_{OPEN}$		Room		50		
Charge Injection	Q	$C_L = 0.01\ \mu\text{F}$ , $R_{gen} = 0\ \Omega$ , $V_{gen} = 0\text{ V}$	Room		10		pC
Source-Off Capacitance	$C_{S(off)}$	$f = 1\text{ MHz}$ ; $V_S$ , $V_D = 0\text{ V}$	Room		14		pF
Drain-Off Capacitance	$C_{D(off)}$		Room		14		
Channel-On Capacitance	$C_{D(on)}$		Room		40		
Input Capacitance	$C_{IN}$		$f = 1\text{ MHz}$	$V_{IN} = 0\text{ V}$	Room		
		$V_{IN} = 15\text{ V}$		Room		7	
Off-Isolation	OIRR	$V_{IN} = 0\text{ V}$ , $R_L = 1\text{ k}\Omega$ $V_S = 1\text{ V}_{rms}$ , $f = 500\text{ kHz}$	Room		62		dB
Crosstalk (Channel-to-Channel)	$X_{TALK}$		Room		74		
<b>Power Supplies</b>							
Positive Supply Current	$I_+$	$V_{IN} = 4\text{ V}$ (One Input) (All Others = 0)	Room Full		0.23	1	mA
Negative Supply Current	$I_-$		Room Full	-100	-0.001		
Positive Supply Current	$I_+$	$V_{IN} = 0.8\text{ V}$ (All Inputs)	Room Full		0.001	100	$\mu\text{A}$
Negative Supply Current	$I_-$		Room Full	-100	-0.001		

Notes:

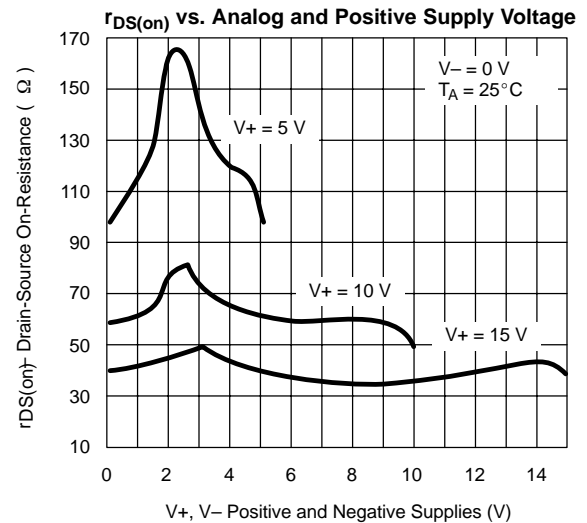
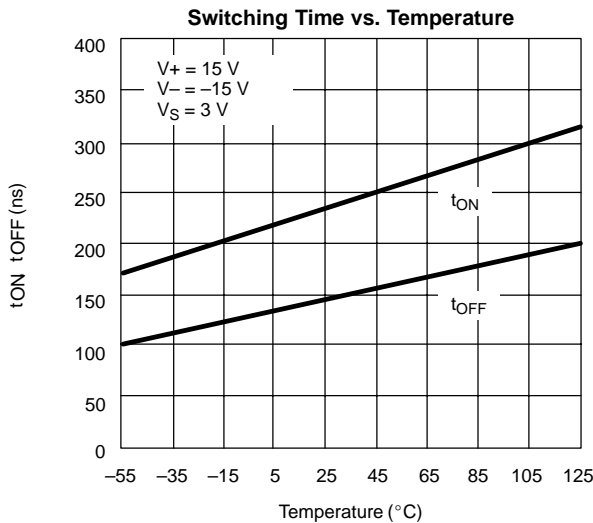
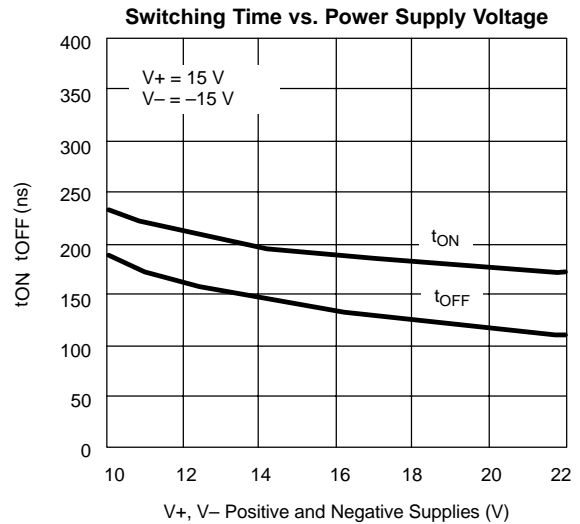
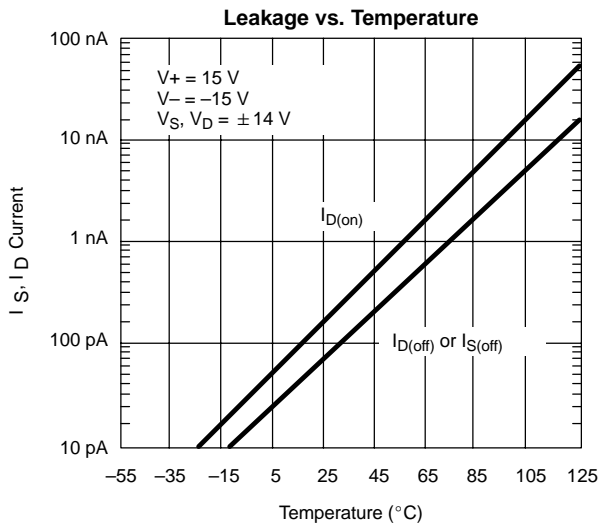
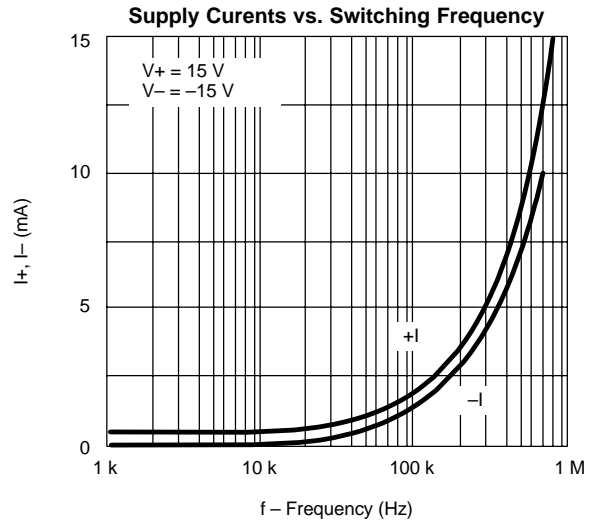
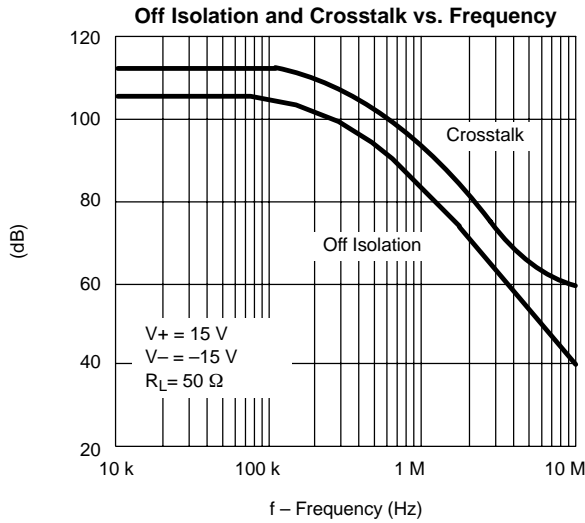
- Refer to PROCESS OPTION FLOWCHART.
- Room = 25°C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- $V_{IN}$  = input voltage to perform proper function.



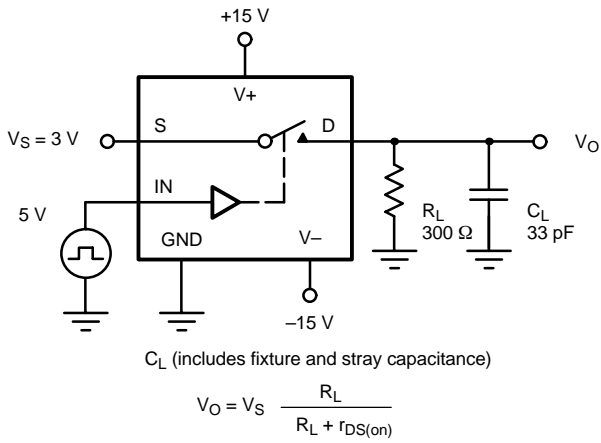
**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



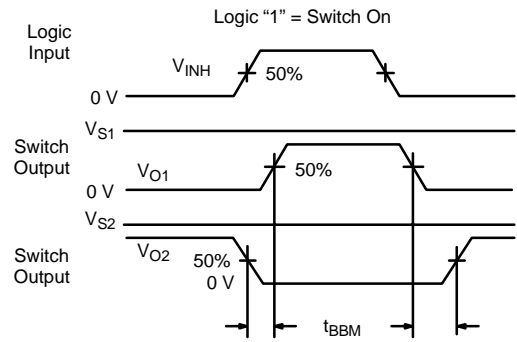
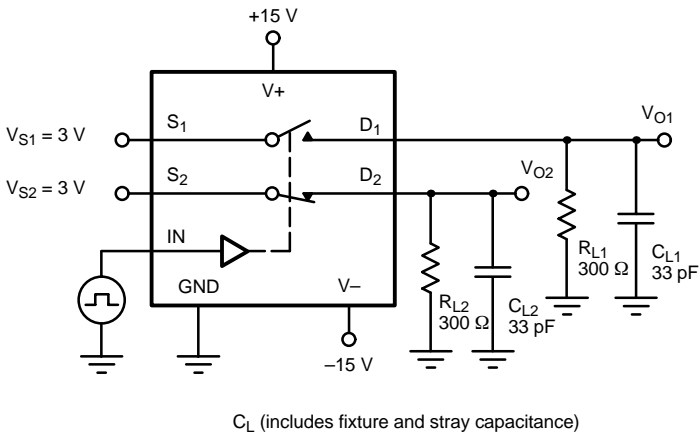
**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



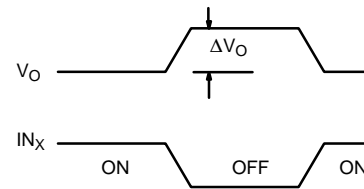
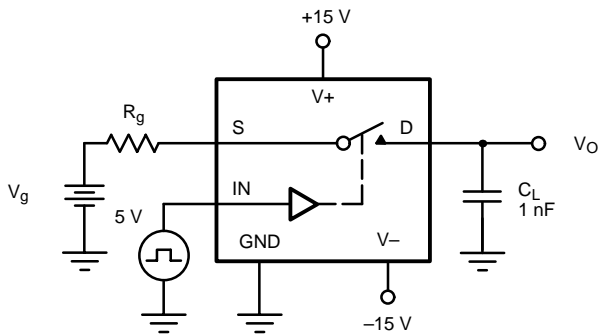
### TEST CIRCUITS



**FIGURE 2. Switching Time**



**FIGURE 3. Break-Before-Make SPDT (DG387B, DG390B)**



**FIGURE 4. Charge Injection**

### APPLICATIONS

The DG381B series of analog switches will switch positive analog signals while using a single positive supply. This allows their use in applications where only one supply is available. The trade-offs or performance given up while using single supplies are: 1) increased  $r_{DS(on)}$ , 2) slower switching speed. Typical curves for aid in designing with single supplies are supplied (see Typical Characteristics). The analog voltage should not go above or below the supply voltages which in single operation are  $V+$  and 0 V.

In the integrator of Figure 4,  $R_D$  controls the discharge rate of the capacitor so that the pulsed or continuous current ratings are not exceeded. During reset  $SW_1$  is closed and  $SW_2$  is open. Opening  $SW_2$  with  $SW_1$  also open will hold the integrator output at its present value.

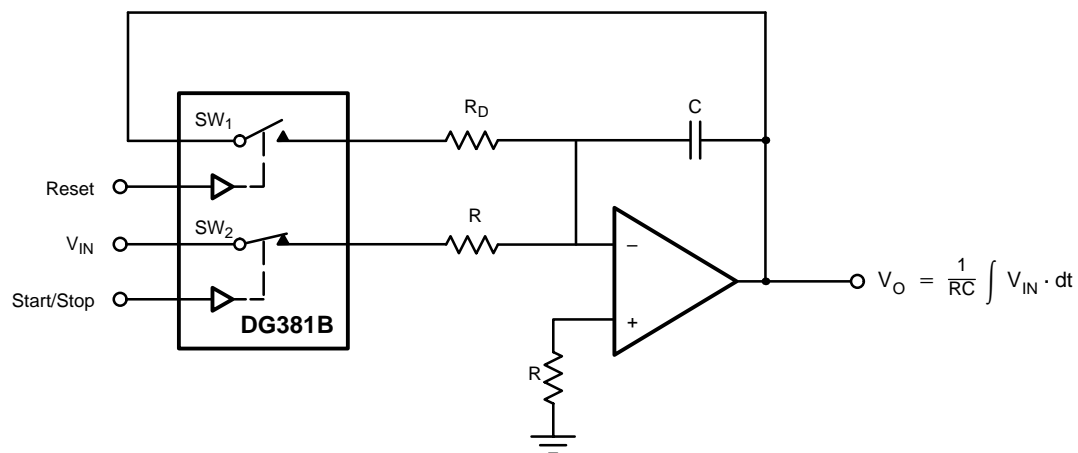


FIGURE 5. Integrator with Reset and Start/Stop





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