CMOS Analog Switches

FEATURES

- ±15-V Input Range
- Low $r_{DS(on)}$: 30 Ω
- 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 Sytems

DESCRIPTION

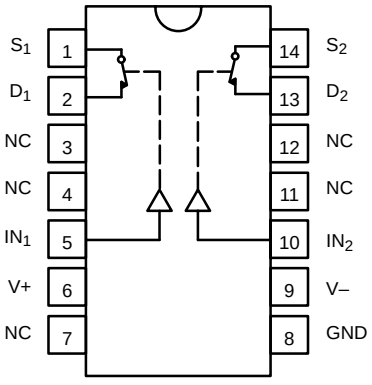
The DG381B–DG390B series of monolithic CMOS analog switches was designed for applications in instrumentation, communications, and process control. This series is suited for applications requiring fast switching and nearly flat on-resistance over the entire voltage range.

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 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.

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

DG381B
Plastic Dip



Top View

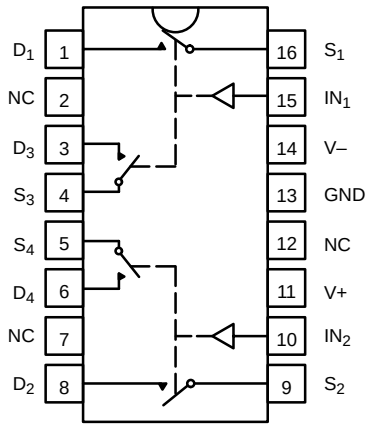
TRUTH TABLE	
Logic	**Switch**
0	ON
1	OFF

Logic "0" ≤ 0.8 V
Logic "1" ≥ 4 V

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG384B

Dual-In-Line



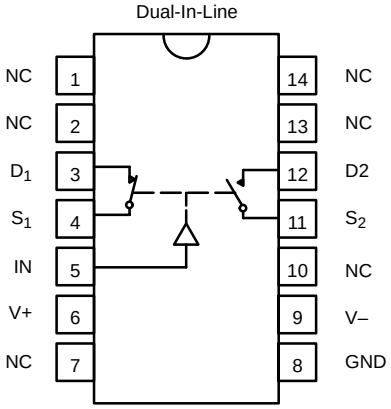
Top View

TRUTH TABLE	
Logic	**Switch**
0	OFF
1	ON

Logic “0” ≤ 0.8 V
Logic “1” ≥ 4 V

DG387B

Dual-In-Line



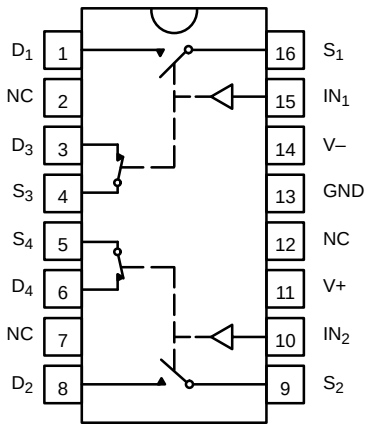
Top View

TRUTH TABLE		
Logic	**SW_1**	**SW_2**
0	ON	OFF
1	OFF	ON

Logic “0” ≤ 0.8 V
Logic “1” ≥ 4 V

DG390B

Dual-In-Line



Top View

TRUTH TABLE		
Logic	**SW_1, SW_2**	**SW_3, SW_4**
0	OFF	ON
1	ON	OFF

Logic “0” ≤ 0.8 V
Logic “1” ≥ 4 V

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

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V–

V+ . . . . . 44 V

GND . . . . . 25 V

Digital Inputs[a], V_S, V_D . . . . . (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[b]

14-Pin Plastic DIP[d] . . . . . 470 mW

Notes:

a. Signals on S_X, D_X, or IN_X 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)

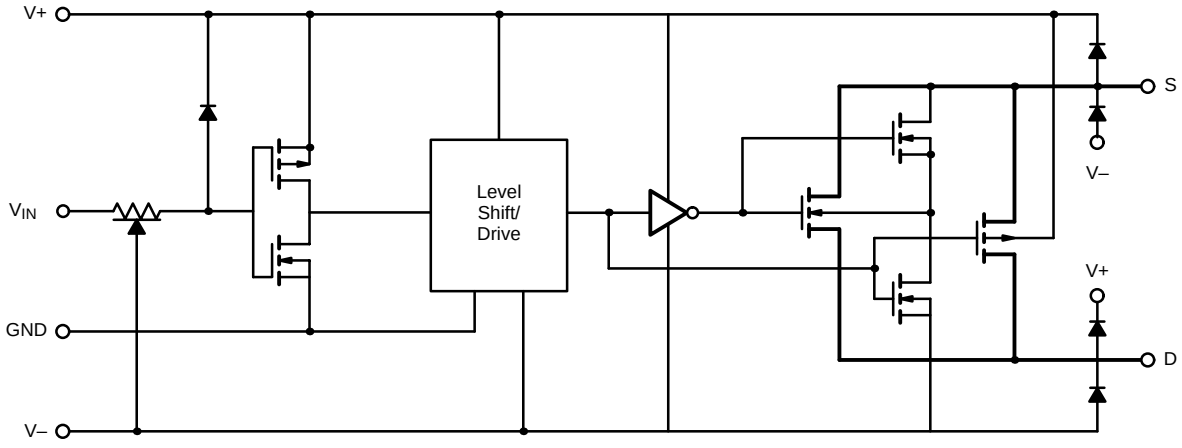


FIGURE 1.

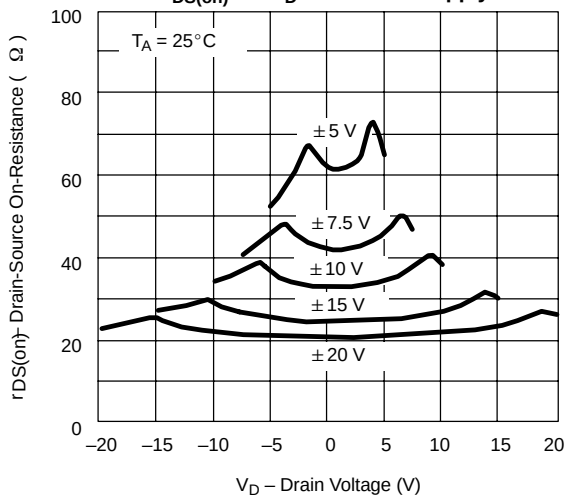
SPECIFICATIONS[a]

Parameter	Symbol	Test Conditions Unless Specified V+ = 15 V, V– = –15 V V_{IN} = 0.8 V or 4 V[f]	Temp[b]	Limits –40 to 85°C Min[d]	Typ[c]	Max[d]	Unit
Analog Switch							
Analog Signal Range[e]	V_{ANALOG}		Full	–15		15	V
Drain-Source On-Resistance	$r_{DS(on)}$	V_D = ±10 V, I_S = –10 mA	Room Full		30	50 75	Ω
Source Off Leakage Current	$I_{S(off)}$	V_S = ±14 V, V_D = ∓14 V	Room Hot	–5 –100	±0.1	5 100	nA
Drain Off Leakage Current	$I_{D(off)}$	V_S = ±14 V, V_D = ∓14 V	Room Hot	–5 –100	±0.1	5 100	
Drain On Leakage Current	$I_{D(on)}$	V_D = V_S = ±14 V	Room Hot	–5 –100	±0.1	5 100	
Digital Control							
Input Current with Input Voltage High	I_{INH}	V_{IN} = 5 V	Room Full	–1	–0.001		µA
		V_{IN} = 15 V	Room Full		0.001	1	
Input Current with Input Voltage Low	I_{INL}	V_{IN} = 0 V	Room Full	–1	–0.001		
Dynamic Characteristics							
Turn-On Time	t_{ON}	See Figure 2	Room		150		ns
Turn-Off Time	t_{OFF}		Room		130		
Break-Before-Make Time	t_{OPEN}	See Figure 3	Room		50		
Charge Injection	Q	C_L = 0.01 µF, R_{gen} = 0 Ω V_{gen} = 0 V	Room		10		pC
Source-Off Capacitance	$C_{S(off)}$	f = 1 MHz; V_S, V_D = 0 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 MHz; V_{IN} = 0 V	Room		6		
		f = 1 MHz; V_{IN} = 15 V	Room		7		
Off-Isolation	OIRR	V_{IN} = 0 V, R_L = 1 kΩ V_S = 1 V_{rms}, f = 500 kHz	Room		62		dB
Crosstalk (Channel-to-Channel)	X_{TALK}		Room		74		
Power Supplies							
Positive Supply Current	I+	V_{IN} = 4 V (One Input) (All Others = 0)	Room Full		0.23	1	mA
Negative Supply Current	I–		Room Full	–100	–0.001		µA
Positive Supply Current	I+	V_{IN} = 0.8 V (All Inputs)	Room Full		0.001	100	
Negative Supply Current	I–		Room Full	–100	–0.001		

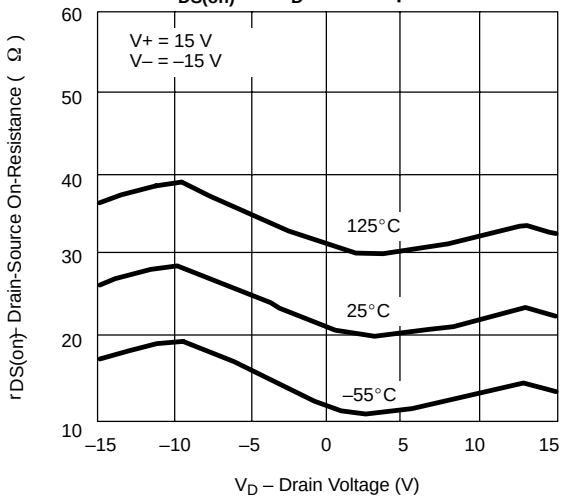
Notes:
a. Refer to PROCESS OPTION FLOWCHART.
b. Room = 25°C, Full = as determined by the operating temperature suffix.
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
d. The algebraic convention whereby the most negative value is a minimum and the most positive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

TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

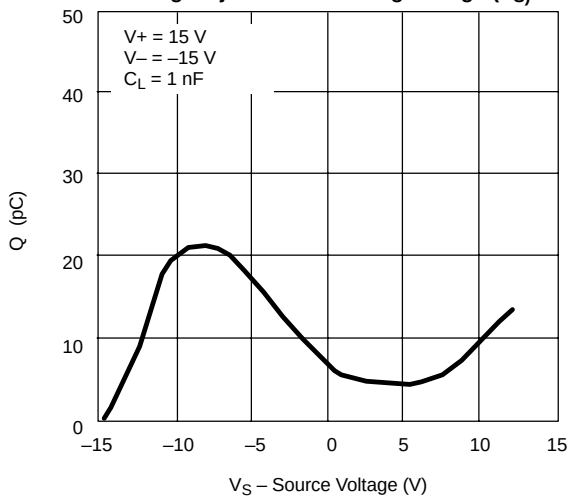
$r_{DS(on)}$ vs. V_D and Power Supply



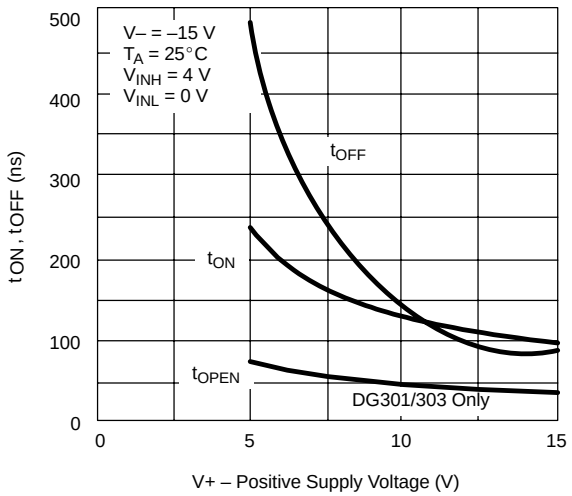
$r_{DS(on)}$ vs. V_D and Temperature



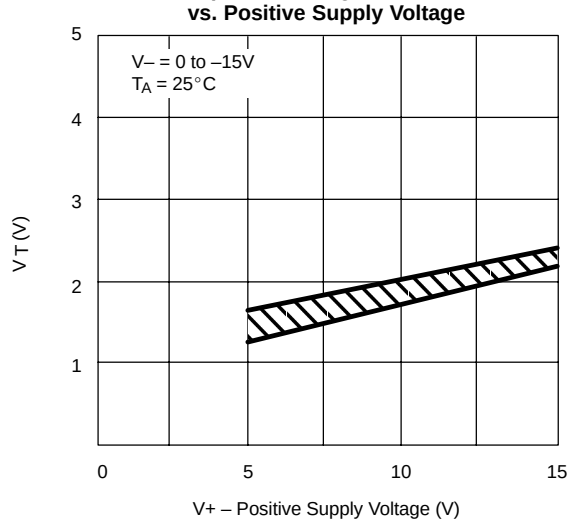
Charge Injection vs. Analog Voltage (V_S)



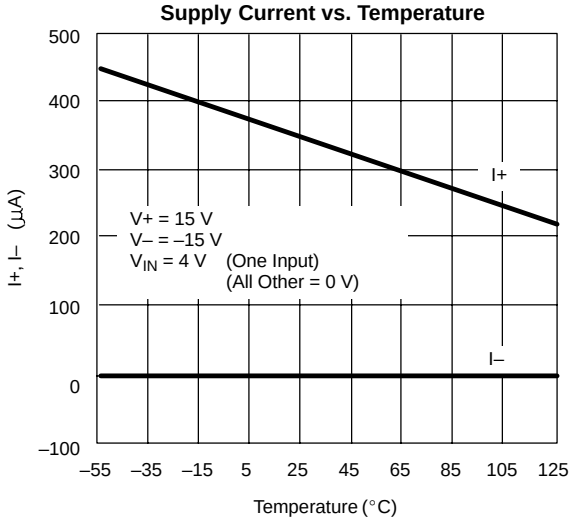
Switching Time and Break-Before-Make Time vs. Positive Supply Voltage



Input Switching Threshold vs. Positive Supply Voltage

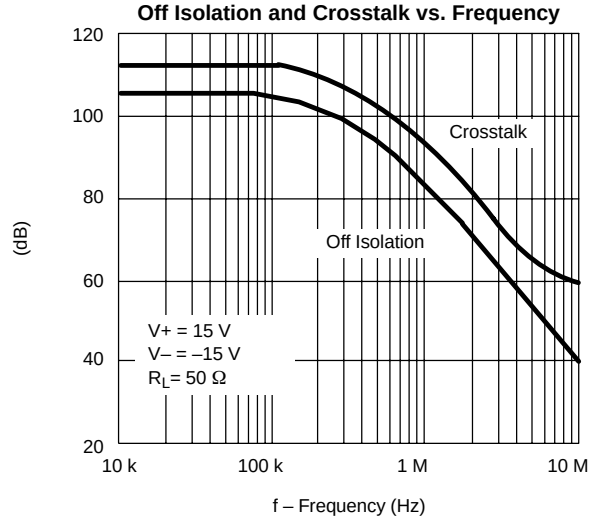


Supply Current vs. Temperature

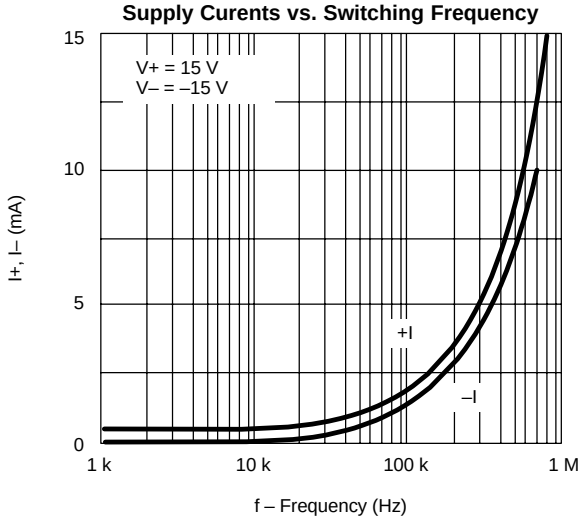


TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

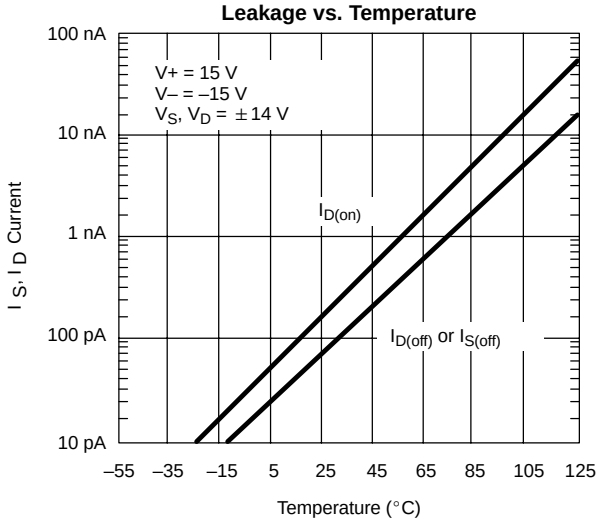
Off Isolation and Crosstalk vs. Frequency



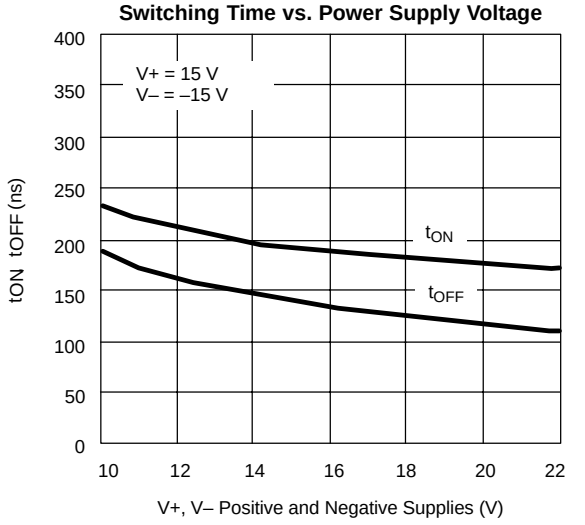
Supply Curents vs. Switching Frequency



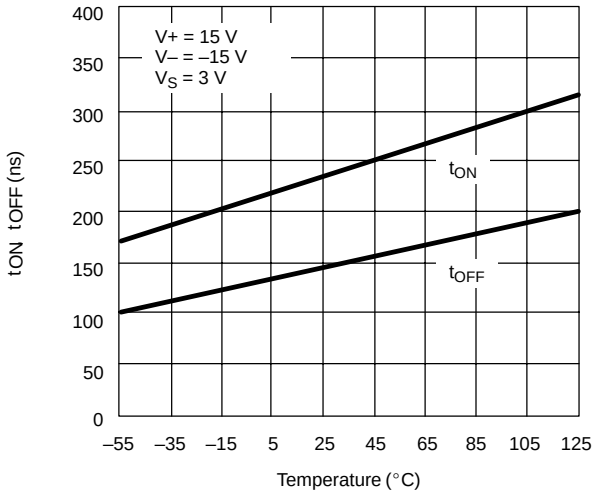
Leakage vs. Temperature



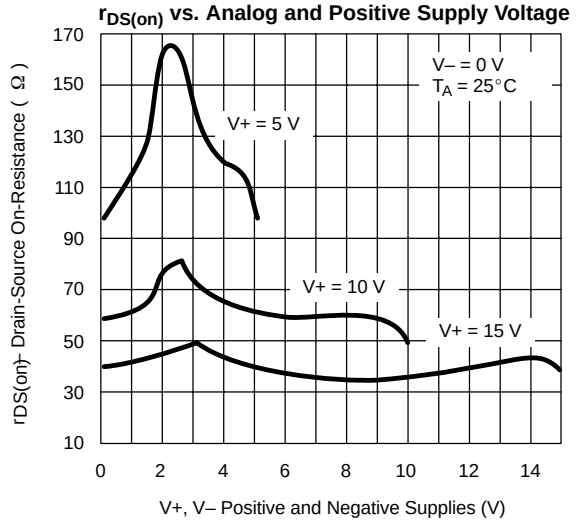
Switching Time vs. Power Supply Voltage



Switching Time vs. Temperature



$r_{DS(on)}$ vs. Analog and Positive Supply Voltage



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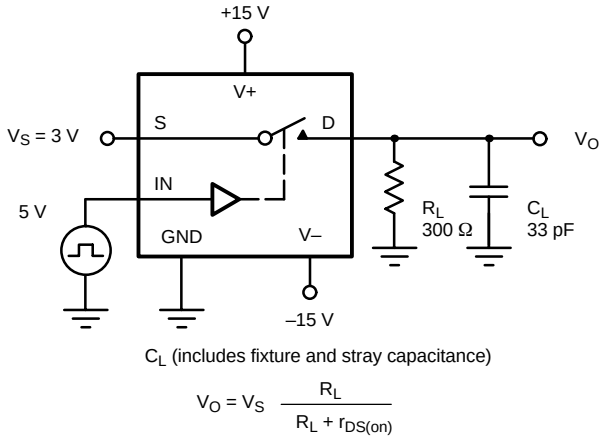
TEST CIRCUITS



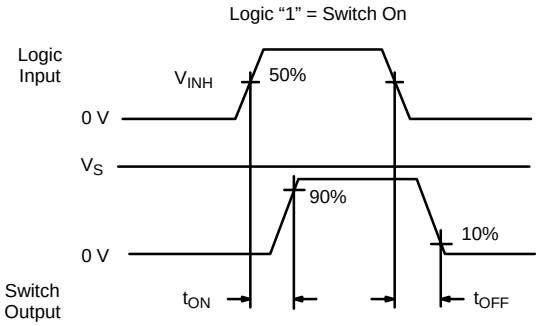
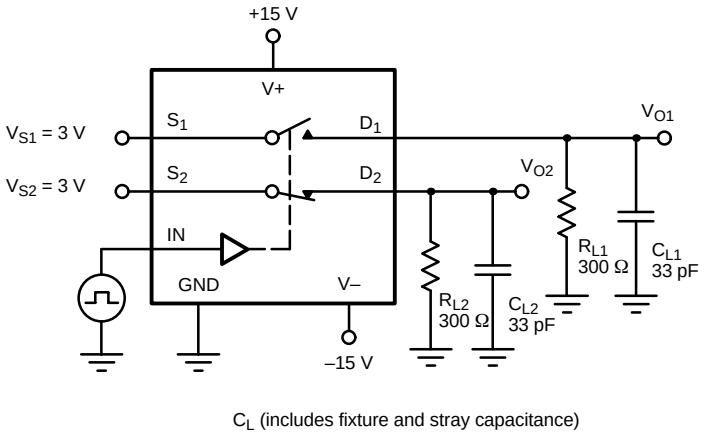


FIGURE 2. Switching Time



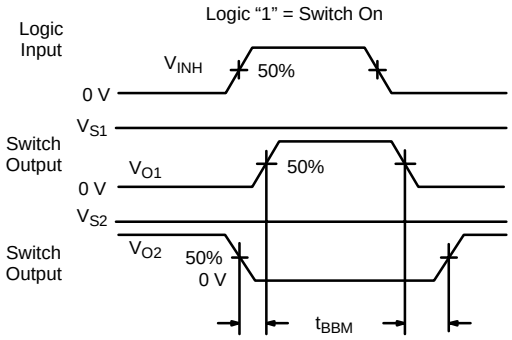
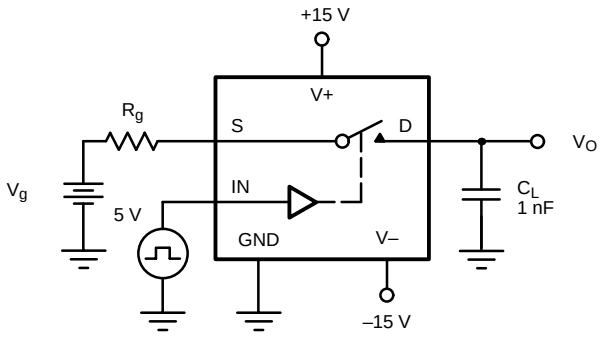


FIGURE 3. Break-Before-Make SPDT (DG387B, DG390B)



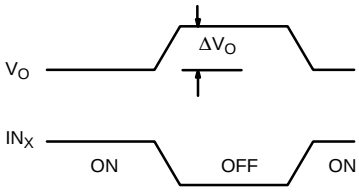


FIGURE 4. Charge Injection

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.

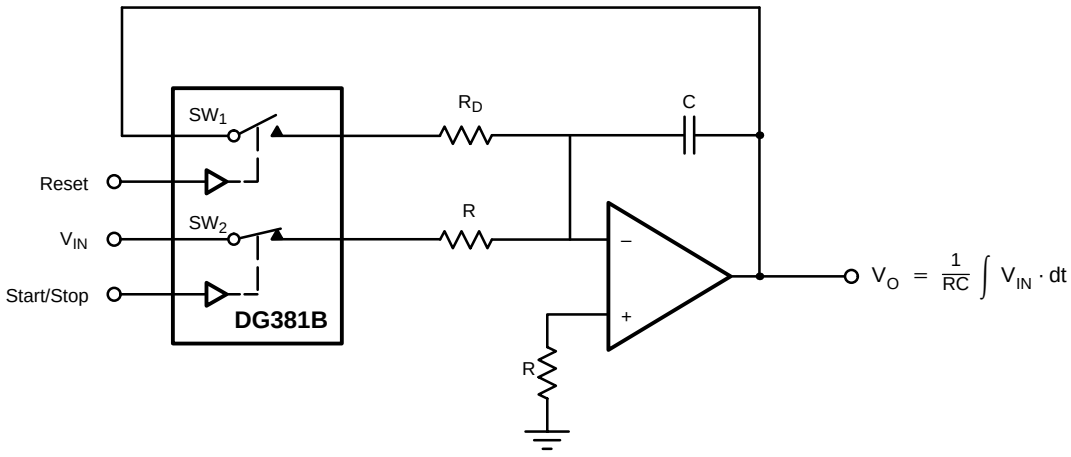


FIGURE 5. Integrator with Reset and Start/Stop

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