CMOS Analog Switches

DESCRIPTION

The DG300B, DG303B family of monolithic CMOS switches feature three switch configuration options (SPST, SPDT, and DPST) for precision applications in communications, instrumentation and process control, where low leakage switching combined with low power consumption are required.

Designed on the Vishay Siliconix PLUS-40 CMOS process, these switches are latch-up proof, and are designed to block up to 30 V peak-to-peak when off. An epitaxial layer prevents latchup.

In the on condition the switches conduct equally well in both directions (with no offset voltage) and minimize error conditions with their low on-resistance.

Featuring low power consumption (3.5 mW typ.) these switches are ideal for battery powered applications, without sacrificing switching speed. Designed for break-before-make switching action, these devices are CMOS and quasi TTL compatible. Single supply operation is allowed by connecting the V- rail to 0 V.

FEATURES

- Analog signal range: ± 15 V
- Fast switching - t_{on}: 150 ns
- Low on-resistance - $R_{DS(on)}$: 30 Ω
- Single supply operation
- Latch-up proof
- CMOS compatible
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS* Available

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

APPLICATIONS

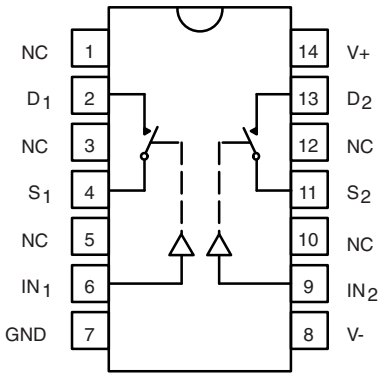
- Low level switching circuits
- Programmable gain amplifiers
- Portable and battery powered systems

BENEFITS

- Full rail-to-rail analog signal range
- Low signal error
- Low power dissipation

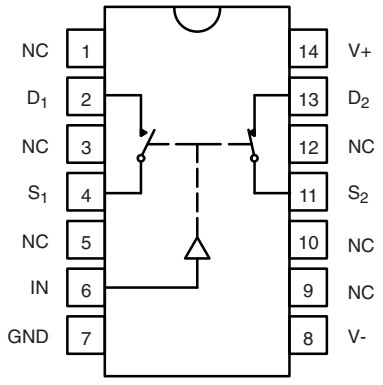
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG300B
Plastic DIP



Top View

DG301B
Plastic DIP



Top View

TRUTH TABLE	
LOGIC	**SWITCH**
0	Off
1	On

Note

- Logic “0” ≤ 0.8 V
  Logic “1” ≥ 4 V

TRUTH TABLE		
LOGIC	**SW_1**	**SW_2**
0	Off	On
1	On	Off

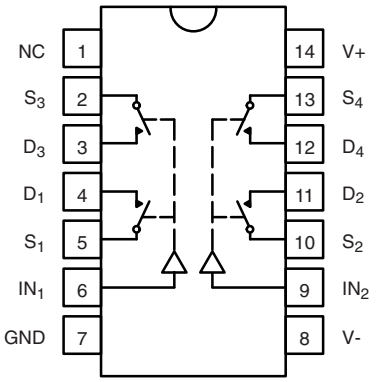
Note

- Logic “0” ≤ 0.8 V
  Logic “1” ≥ 4 V

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG302B

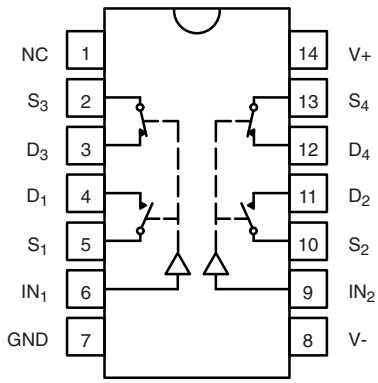
Plastic DIP



Top View

DG303B

Plastic DIP and SOIC



Top View

TRUTH TABLE	
LOGIC	**SWITCH**
0	Off
1	On

Note

- Logic “0” ≤ 0.8 V
  Logic “1” ≥ 4 V

TRUTH TABLE		
LOGIC	**SW_1, SW_2**	**SW_3, SW_4**
0	Off	On
1	On	Off

Note

- Logic “0” ≤ 0.8 V
  Logic “1” ≥ 4 V

ORDERING INFORMATION		
TEMP. RANGE	**STANDARD PACKAGE**	**PART NUMBER**
-40 °C to +85 °C	14-SOIC	DG303BDY-E3 DG303BDY-T1-E3

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)			
PARAMETER		**LIMIT**	**UNIT**
Voltages referenced V+ to V-		44	V
GND		25	
Digital inputs [a], V_S, V_D		(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first	
Current (any terminal)		30	mA
Continuous current, S or D (pulsed at 1 ms, 10 % duty cycle max.)		100	
Storage temperature		-65 to +150	°C
Power dissipation (package) [b]	14-pin plastic DIP [c]	470	mW
	SOIC-14 [d]	600	

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 6.5 mW/°C above 25 °C
d. Derate 7.6 mW/°C above 75 °C

SCHEMATIC DIAGRAM (typical channel)

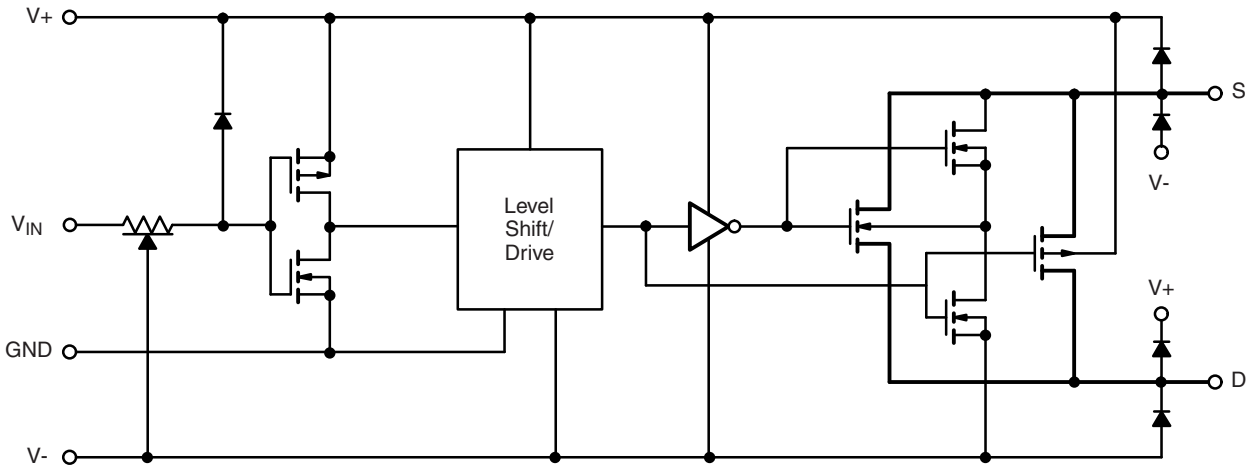


Fig. 1

SPECIFICATIONS [a]

PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 15 V, V- = -15 V V_{IN} = 0.8 V OR V_{IN} = 4 V [f]		TEMP.B	LIMITS -40 °C 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	-	30	50	Ω
				Full	-	-	75	
Source off leakage current	$I_{S(off)}$	V_S = ± 14 V, V_D = ± 14 V		Room	-5	± 0.1	5	nA
				Hot	-100	-	100	
Drain off leakage current	$I_{D(off)}$			Room	-5	± 0.1	5	
				Hot	-100	-	100	
Drain on leakage current	$I_{D(on)}$	VS = VD = ± 14 V		Room	-5	± 0.1	5	
				Hot	-100	-	100	
Digital Control								
Input current with input voltage high	I_{INH}	V_{IN} = 5 V		Room	-1	-0.001	-	µA
				Full	-	-	-	
		V_{IN} = 15 V		Room	-	0.001	1	
				Full	-	-	-	
Input current with input voltage low	I_{INL}	V_{IN} = 0 V		Room	-1	-0.001	-	
				Full	-	-	-	
Dynamic Characteristics								
Turn-on time	t_{on}	See Fig. 2		Room	-	150	-	ns
Turn-off time	t_{off}			Room	-	130	-	
Break-before-make time	t_{OPEN}	DG301B, DG303B only, Fig. 3		Room	-	50	-	
Charge injection	Q	C_L = 1 nF, R_{gen} = 0 Ω, V_{gen} = 0 V, Fig. 4		Room	-	8	-	pC
Source off capacitance	$C_{S(off)}$	V_S, V_D = 0 V, f = 1 MHz		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	-	
			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	-	

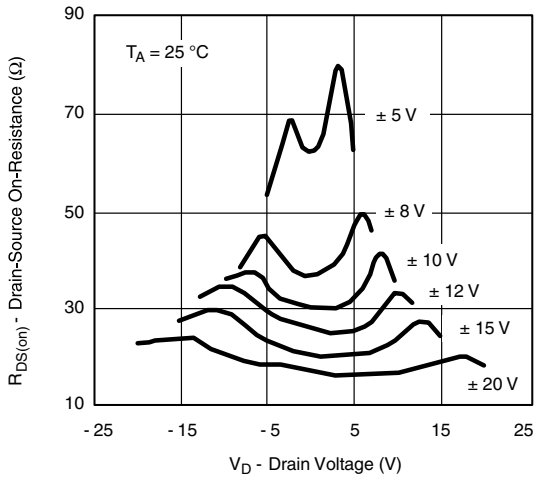
SPECIFICATIONS [a]							
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 15 V, V- = -15 V V_{IN} = 0.8 V OR V_{IN} = 4 V [f]	TEMP.B	LIMITS -40 °C TO +85 °C			UNIT
				MIN. [d]	TYP. [c]	MAX. [d]	
Power Supplies							
Positive supply current	I+	V_{IN} = 4 V (one input) all others = 0 V	Room	-	0.23	1	mA
			Full	-	-	-	
Negative supply current	I-		Room	-100	-0.001	-	µA
			Full	-	-	-	
Positive supply current	I+	V_{IN} = 0.8 V (all inputs)	Room	-	0.001	100	
			Full	-	-	-	
Negative supply current	I-		Room	-100	-0.001	-	
			Full	-	-	-	

Notes

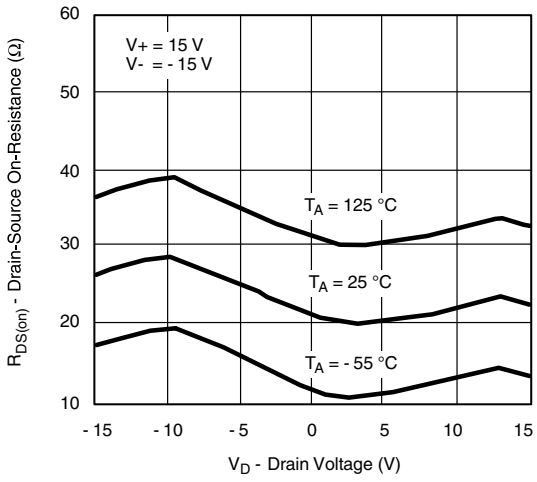
a. Refer to PROCESS OPTION FLOWCHART
b. Room = 25 °C, full = as determined by the operating temperature suffix
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum,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

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.

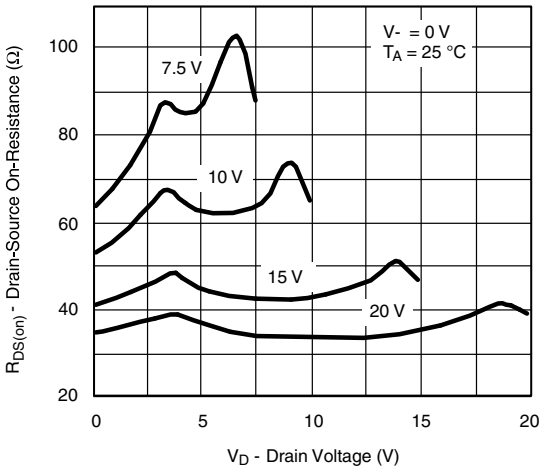
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



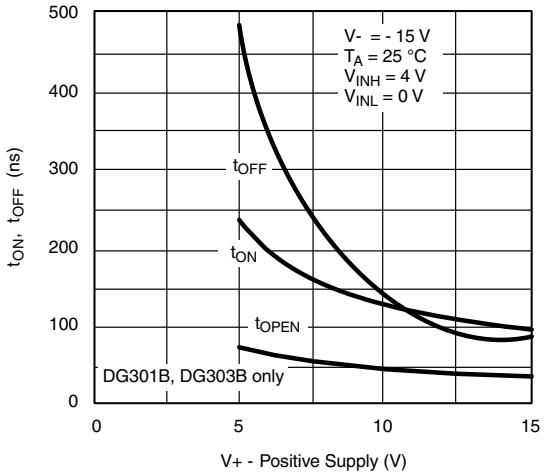
$R_{DS(on)}$ vs. V_D and Power Supply



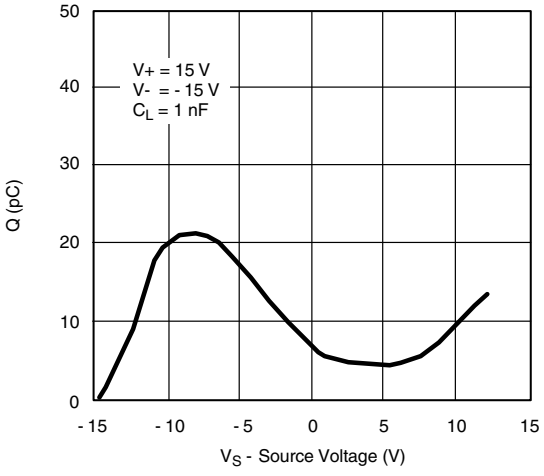
$R_{DS(on)}$ vs. V_D and Temperature



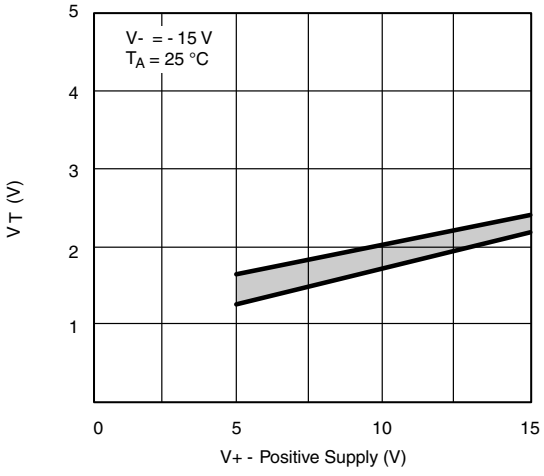
$R_{DS(on)}$ vs. V_D and Power Supply Voltage



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

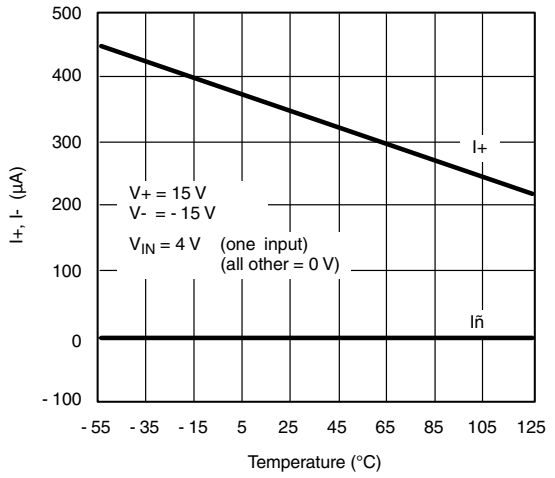


Charge Injection vs. Analog Voltage

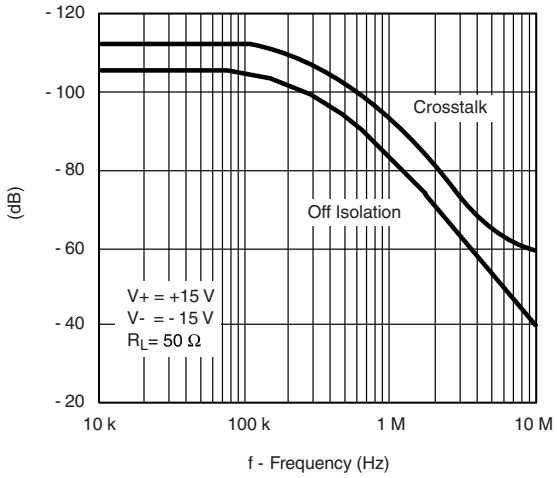


Input Switching Threshold vs. Positive Supply Voltage

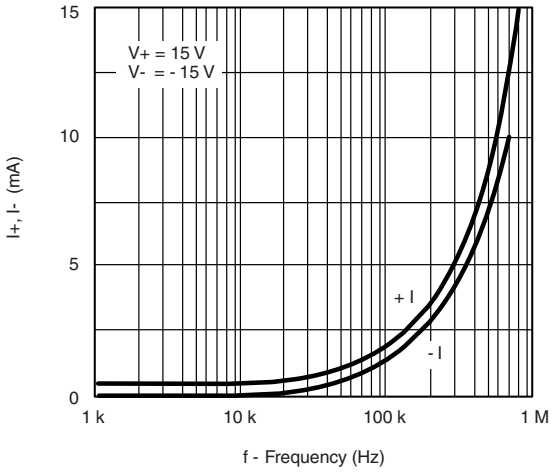
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



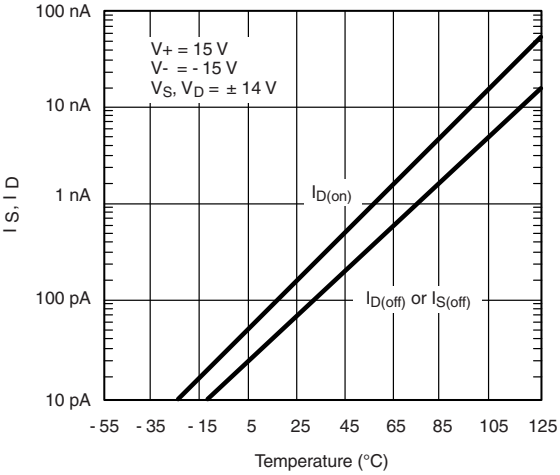
Supply Current vs. Temperature



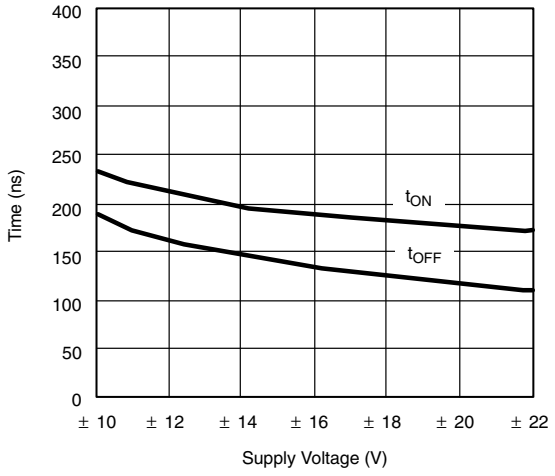
Off Isolation and Crosstalk vs. Frequency



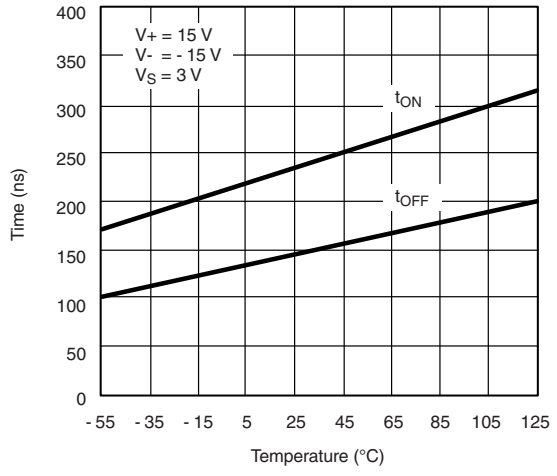
Supply Current vs. Switching Frequency



Leakage vs. Temperature

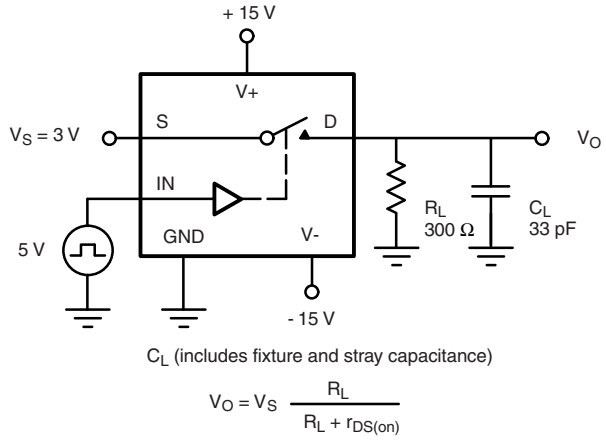


Switching Time vs. Power Supply Voltage



Switching Time vs. Temperature

TEST CIRCUITS



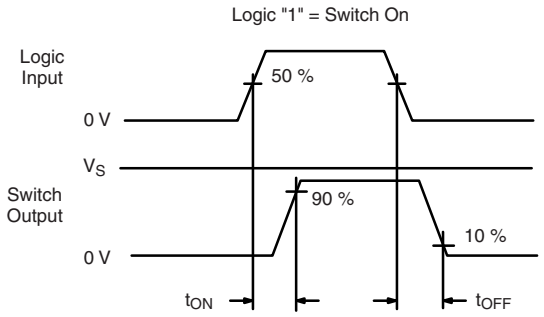
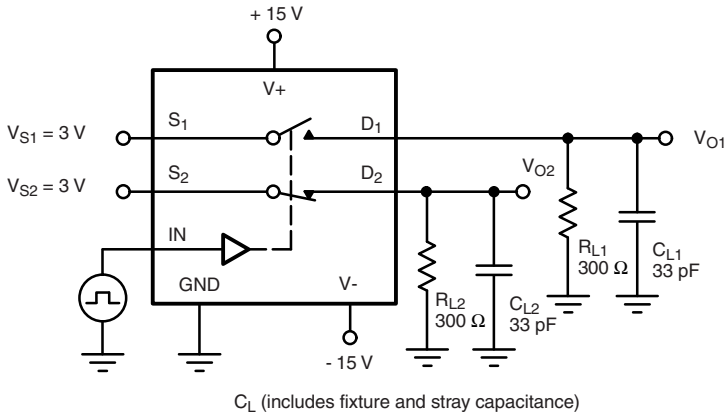


Fig. 2 - Switching Time



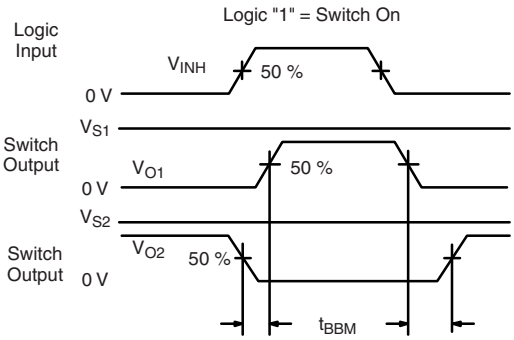
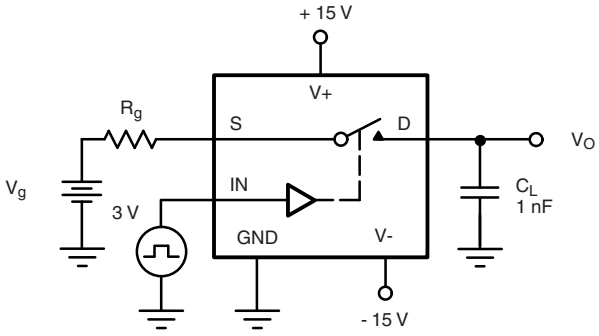


Fig. 3 - Break-Before-Make SPDT (DG301B, DG303B)



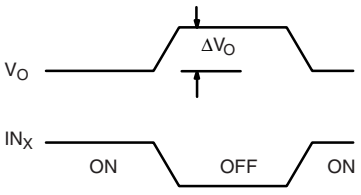


Fig. 4 - Charge Injection

APPLICATIONS HINTS [a]				
V+ POSITIVE SUPPLY VOLTAGE (V)	V- NEGATIVE SUPPLY VOLTAGE (V)	GND VOLTAGE (V)	V_{IN} LOGIC INPUT VOLTAGE $V_{INH(MIN.)}/V_{INL(MAX.)}$ (V)	V_S OR V_D ANALOG VOLTAGE RANGE (V)
15	-15	0	4/0.8	-15 to 15
20	-20	0	4/0.8	-20 to 20
15	0	0	4/0.8	0 to 15

Note

a. Application hints are for DESIGN AID ONLY, not guaranteed and not subject to production testing

APPLICATIONS

The DG300B series of analog switches will switch positive analog signals while using a single positive supply. This facilitates their use in applications where only one supply is available. The trade-offs of using single supplies are:

1. Increased $R_{DS(on)}$
2. Slower switching speed. The analog voltage should not go above or below the supply voltages which in single operation are V+ and 0 V. (See “Input Switching Threshold vs. Positive Supply Voltage Curve”)

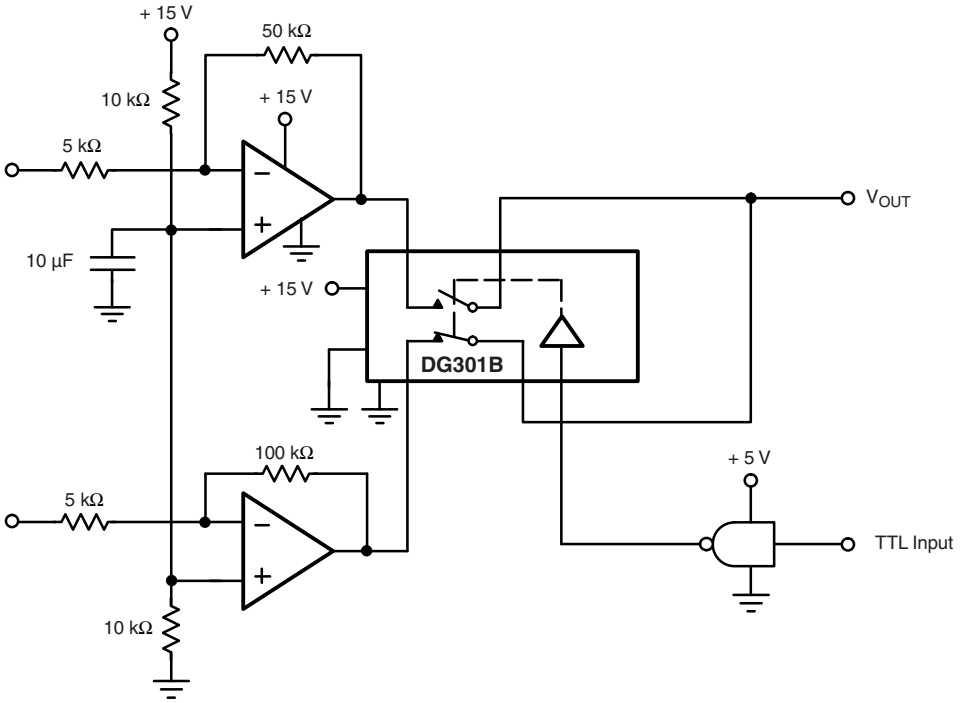
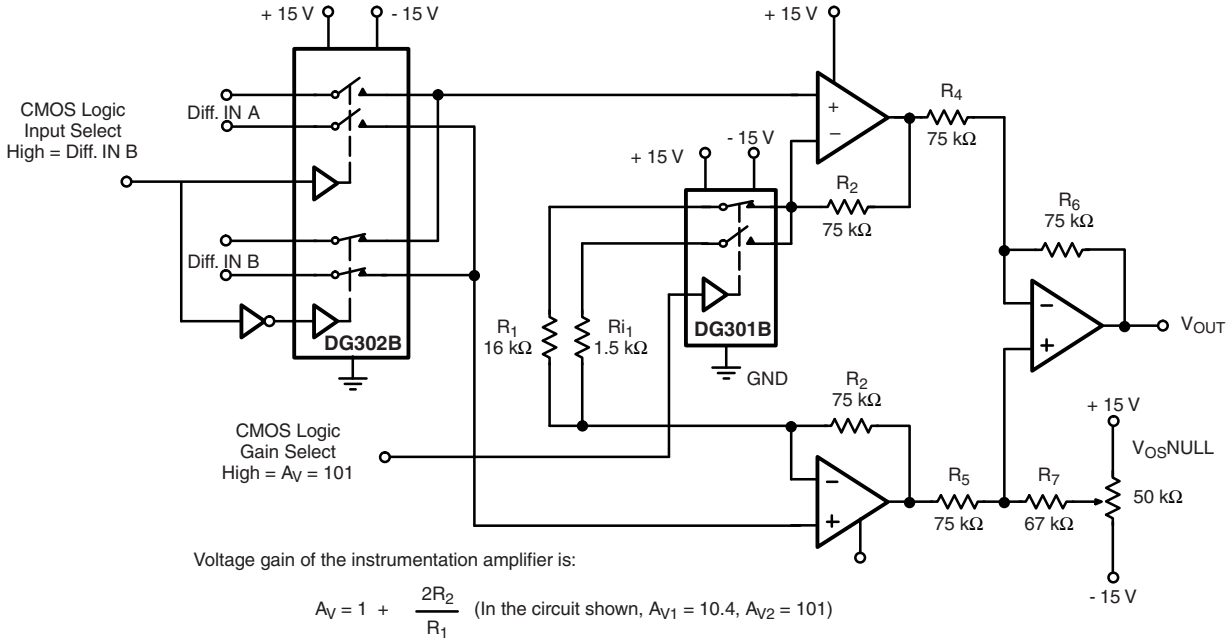


Fig. 5 - Single Supply Op. Amp. Switching

APPLICATIONS



Voltage gain of the instrumentation amplifier is:

$$A_V = 1 + \frac{2R_2}{R_1}$$ (In the circuit shown, $A_{V1} = 10.4$, $A_{V2} = 101$)

Fig. 6 - Low Power Instrumentation Amplifier with Digitally Selectable Inputs and Gain

PRODUCT SUMMARY					
Part number	DG300B	DG301B	DG302B	DG303B	DG303B
Status code	2	2	2	2	2
Configuration	SPST x 2, NO	DPST, comp	DPST x 2, NO	DPST x 2, comp	DPST x 2, comp
Single supply min. (V)	5	5	5	5	5
Single supply max. (V)	36	36	36	36	36
Dual supply min. (V)	5	5	5	5	5
Dual supply max. (V)	22	22	22	22	22
On-resistance (Ω)	15	15	15	15	15
Charge injection (pC)	8	8	8	8	8
Source on capacitance (pF)	40	40	40	40	40
Source off capacitance (pF)	14	14	14	14	14
Leakage switch on typ. (nA)	0.1	0.1	0.1	0.1	0.1
Leakage switch off max. (nA)	5	5	5	5	5
-3 dB bandwidth (MHz)	-	-	-	-	-
Package	Plastic DIP-14	Plastic DIP-14	Plastic DIP-14	Plastic DIP-14	SO-14 (narrow) AS
Functional circuit / applications	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare
Interface	Parallel	Parallel	Parallel	Parallel	Parallel
Single supply operation	Yes	Yes	Yes	Yes	Yes
Dual supply operation	Yes	Yes	Yes	Yes	Yes
Turn on time max. (ns)	150	150	150	150	150
Crosstalk and off isolation	-62	-62	-62	-62	-62

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