

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

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



RoHS*
Available

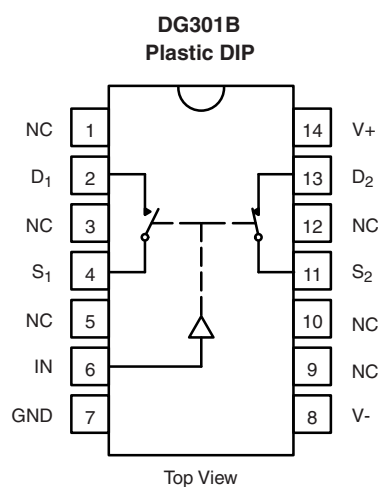
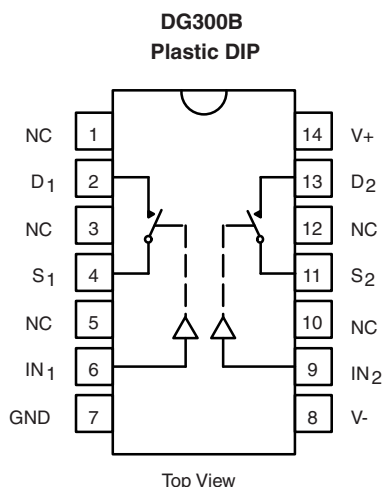
APPLICATIONS

- 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



TRUTH TABLE	
LOGIC	SWITCH
0	Off
1	On

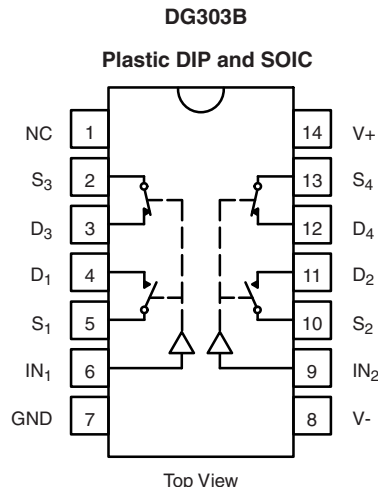
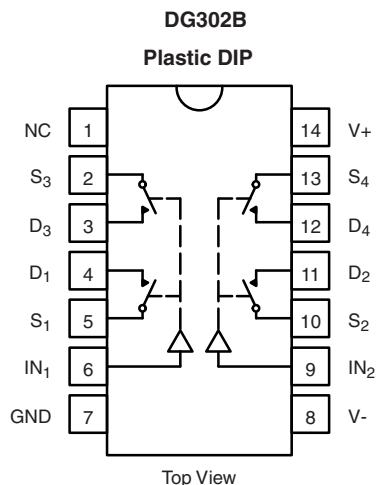
Note

- 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


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	mW
	SOIC-14 ^d	

Notes

- 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
- All leads welded or soldered to PC board
- Derate 6.5 mW/°C above 25 °C
- Derate 7.6 mW/°C above 75 °C

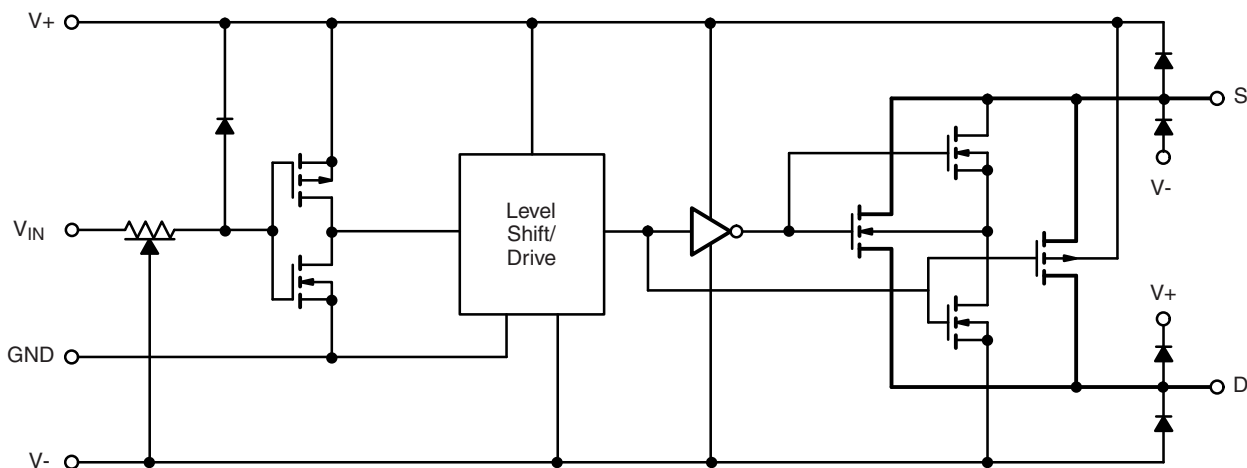
SCHEMATIC DIAGRAM (typical channel)


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			UNIT
				MIN. ^d	TYP. ^c	MAX. ^d	
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
Drain off leakage current	I _{D(off)}		Hot	-100	-	100	
			Room	-5	± 0.1	5	
			Hot	-100	-	100	
Drain on leakage current	I _{D(on)}	V _S = V _D = ± 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	-	
			Full	-	-	-	
Positive supply current	I+	V _{IN} = 0.8 V (all inputs)	Room	-	0.001	100	μA
			Full	-	-	-	
Negative supply current	I-		Room	-100	-0.001	-	
			Full	-	-	-	

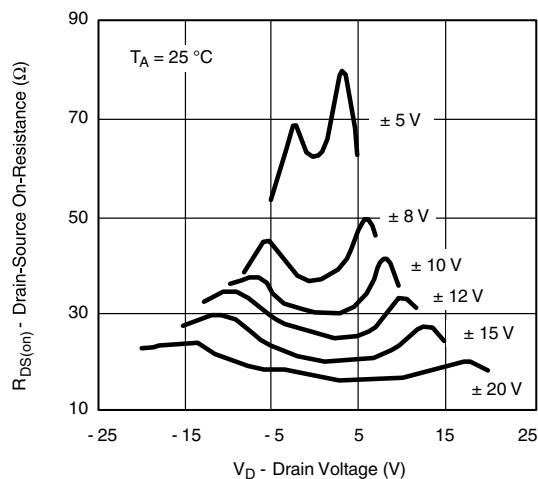
Notes

- 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

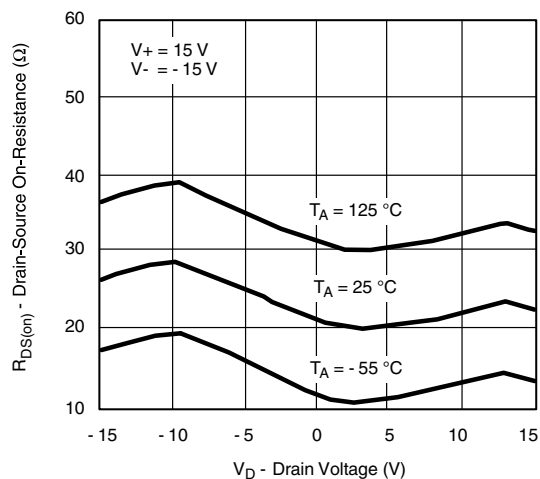
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



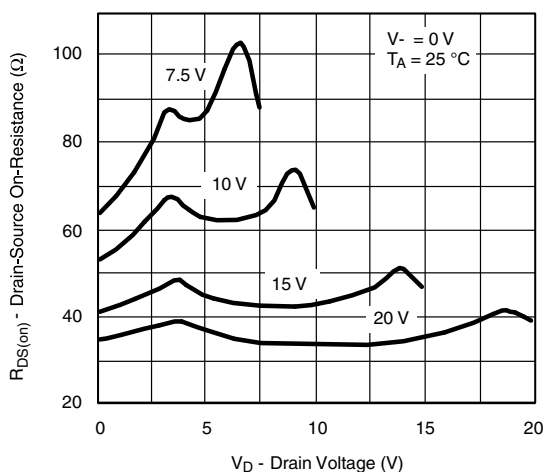
TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)



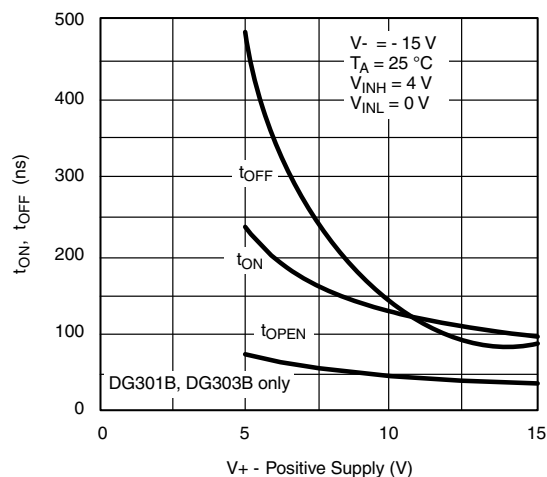
$R_{DS(on)}$ vs. V_D and Power Supply



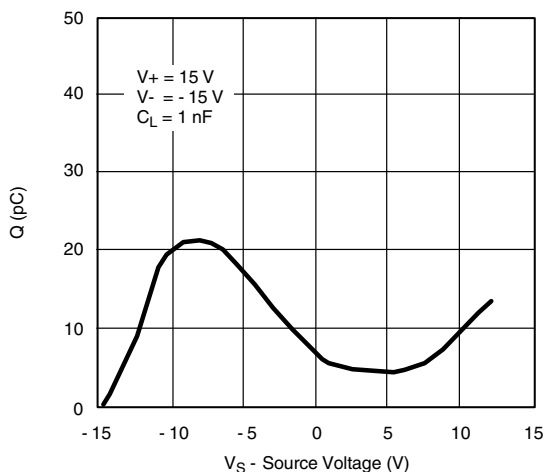
$R_{DS(on)}$ vs. V_D and Temperature



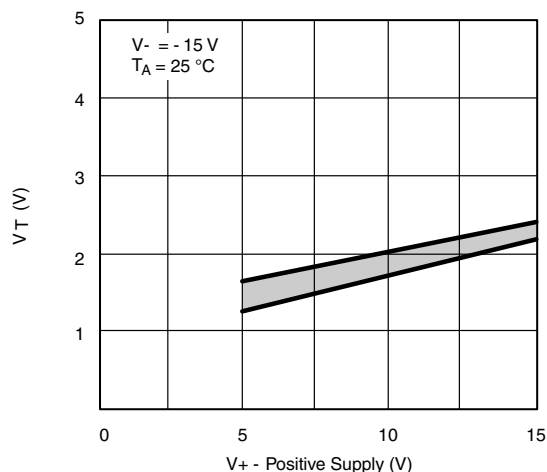
$R_{DS(on)}$ vs. V_D and Power Supply Voltage



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



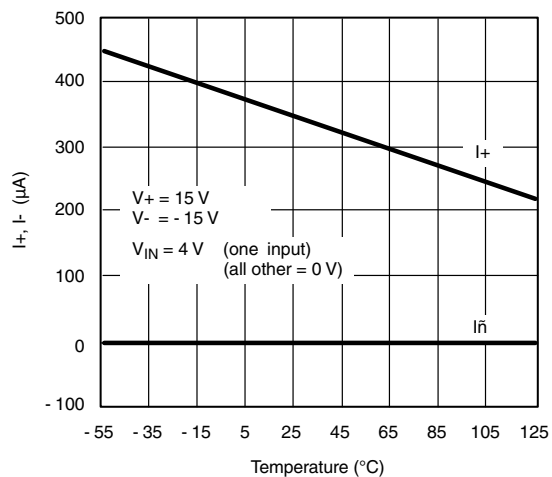
Charge Injection vs. Analog Voltage



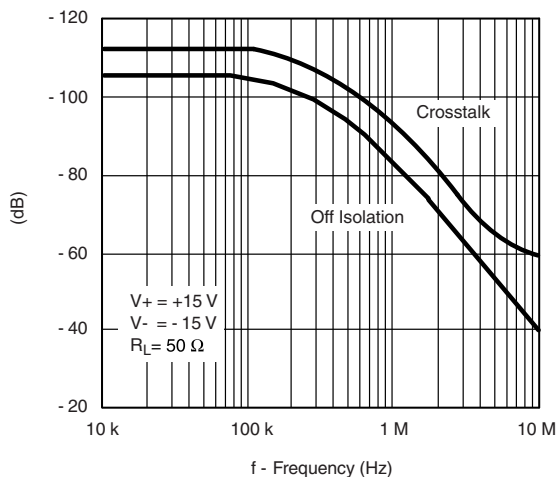
Input Switching Threshold vs. Positive Supply Voltage



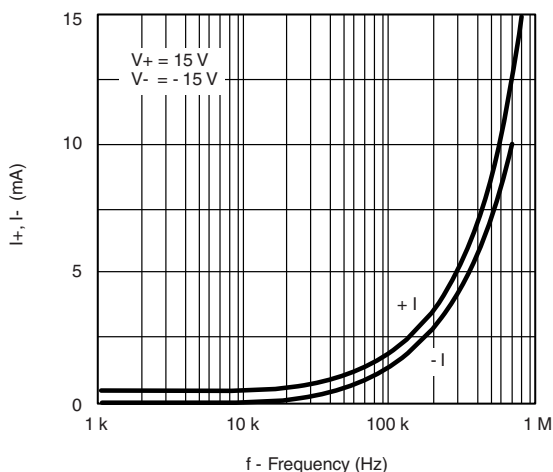
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^{\circ}\text{C}$, unless otherwise noted)



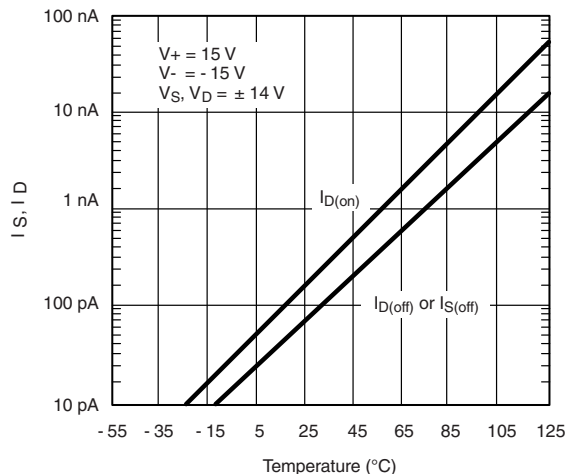
Supply Current vs. Temperature



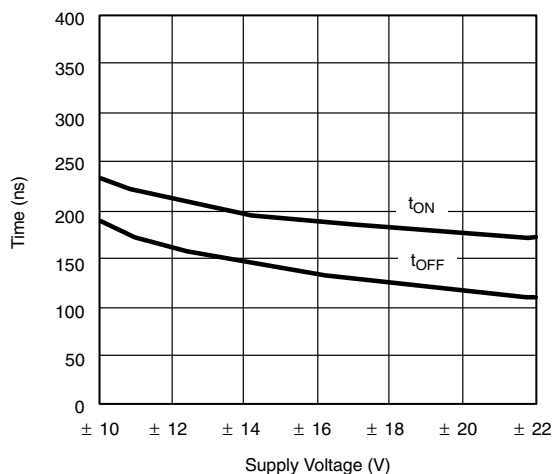
Off Isolation and Crosstalk vs. Frequency



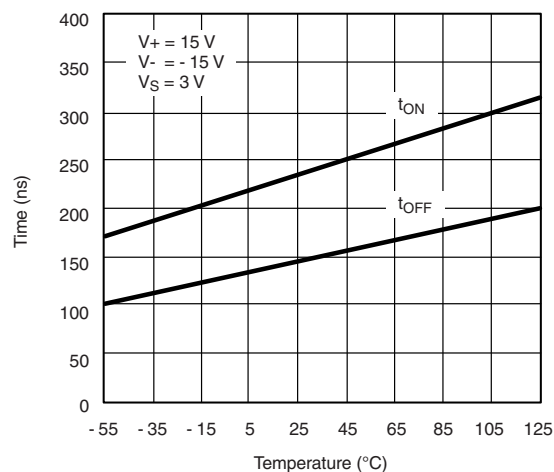
Supply Current vs. Switching Frequency



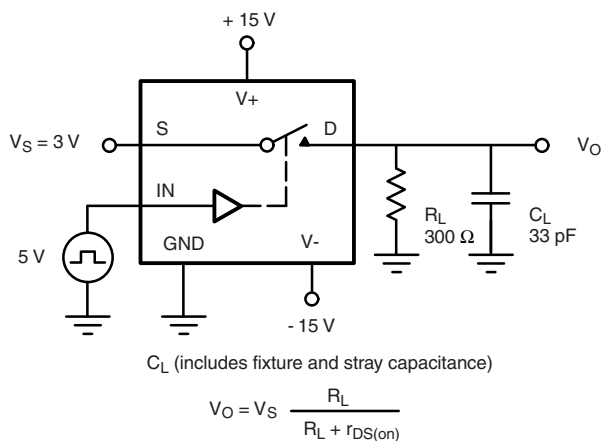
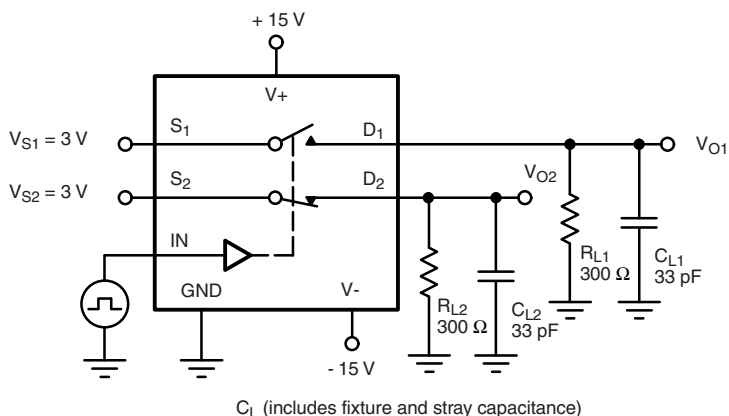
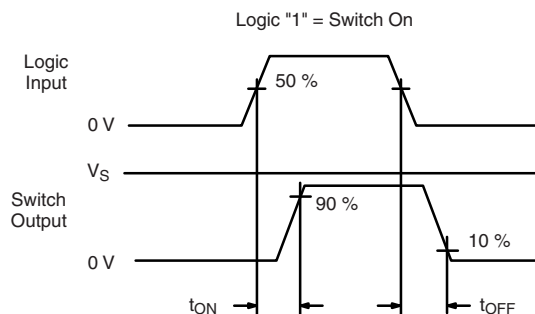
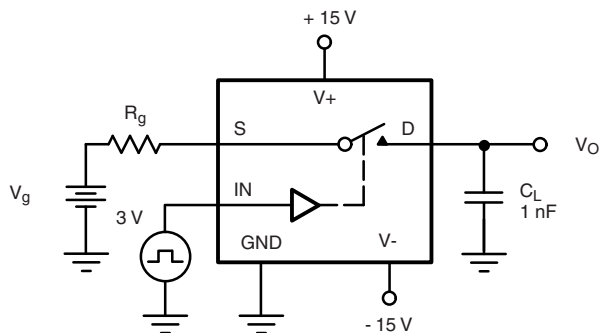
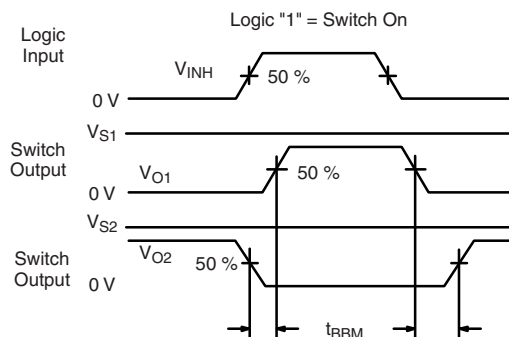
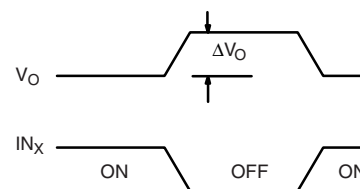
Leakage vs. Temperature



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")

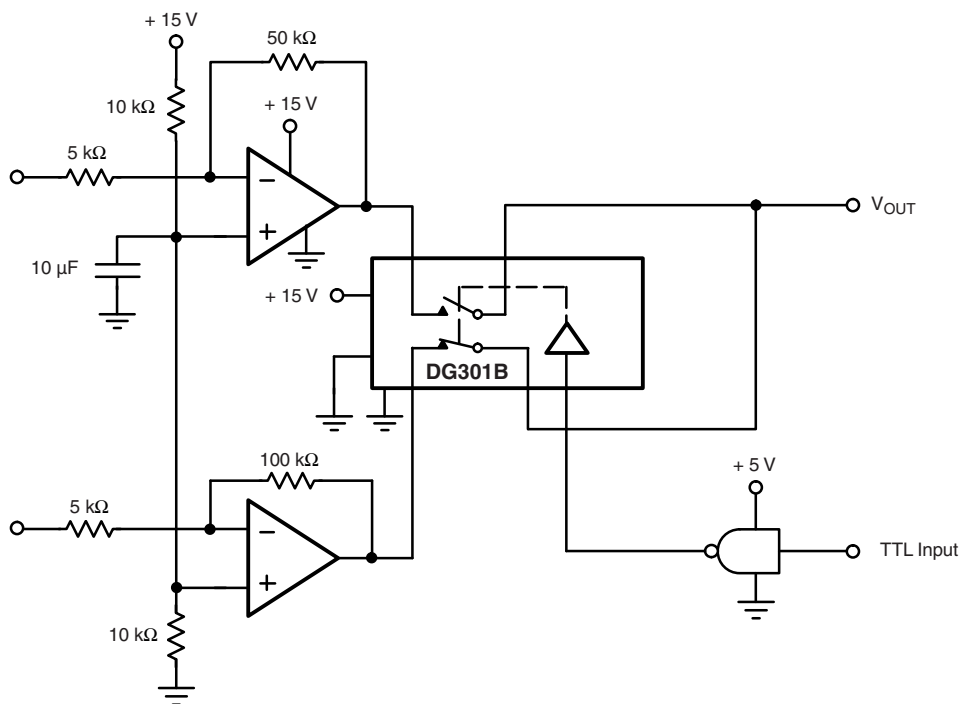


Fig. 5 - Single Supply Op. Amp. Switching

APPLICATIONS

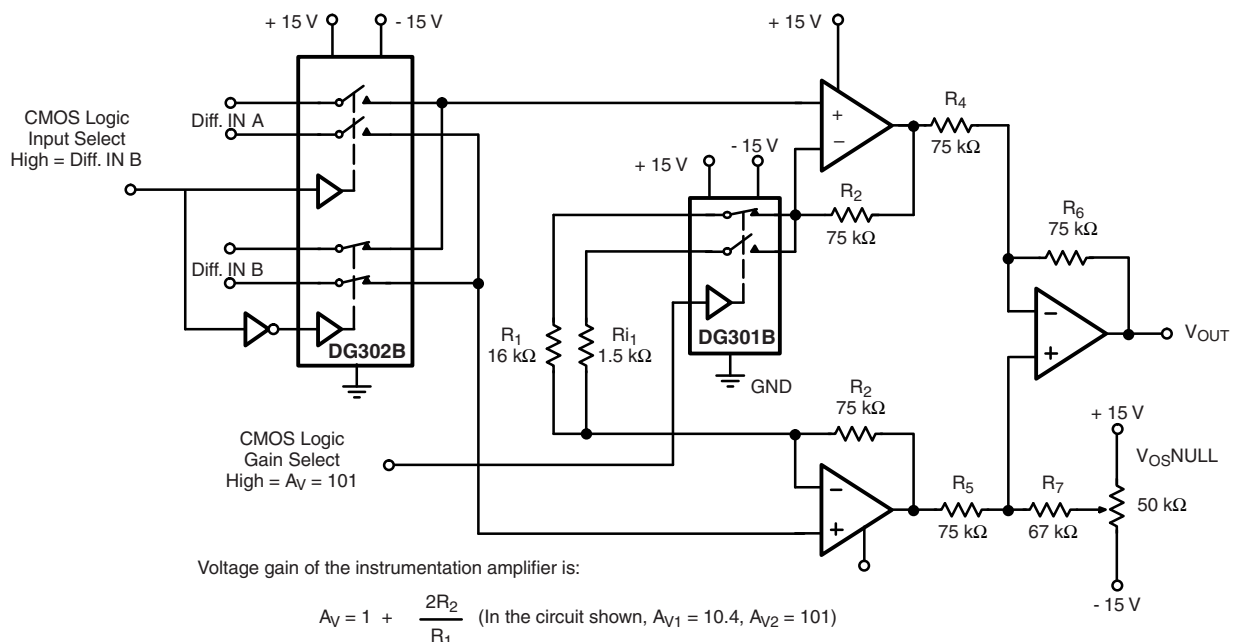


Fig. 6 - Low Power Instrumentation Amplifier with Digitally Selectable Inputs and Gain



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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