

Monolithic CMOS Analog Switches



designed for . . .

- **Portable, Battery Operated Circuits**
- **Low Leakage Switching**
i.e. Sample and Hold Circuits
- **Communication Systems**
- **Low Level Switching Circuits**
- **Fast Switching Circuits**
such as Multiplexers
- **Standard Linear Dual Supply Voltages or Single Supply Systems**

BENEFITS

- **Low Standby Power**
 - 0.06 μ W Typical
- **Minimizes Signal Error**
 - 0.1 nA Typical Leakage
- **Low Operating Power**
 - 0.06 μ W Typical for DG304-407
- **Reduced Voltage Drop Across Switch in ON Condition**
 - $r_{ds(on)} < 50 \Omega$
- **Minimizes Switching Time**
 - Typ t_{on} & $t_{off} < 200$ ns
- **Minimizes System Power Requirements**
 - Single Supply Operation Capabilities
- **Easily Interfaced**
 - TTL, DTL and CMOS Input Compatible
- **Reduces External Component Requirements**
 - Logic Input Overvoltage Protection

DESCRIPTION

The DG300 through DG307 switch family features four switching functions using CMOS technology for low and nearly constant ON resistance (less than 50 Ω) over the full analog signal range. In the ON condition the switches will conduct current in either direction with no offset voltage. With low power dissipation, (a few milliwatts for the DG300-303, a few hundred microwatts for the DG304-307), this series of switches becomes an ideal candidate for battery-powered or remote switching applications. The switching speed is among the fastest available with the low quiescent power dissipation. In the OFF condition, the switches will block voltages up to 30 V peak-to-peak. A logic input driver controls the ON/OFF state of the switches. (See the "Pin Configuration" for switch status with a logic "1" input.) The DG300-303 switches are TTL and CMOS input compatible and have a logic "0" state with an input less than 0.8 V and a logic "1" state with an input greater than 4.0 V. A pull-up resistor should be added for totem pole TTL outputs. The DG304-307 switches are CMOS input compatible and have a logic "0" state with an input less than 3.5 V and a logic "1" state with an input greater than 11 V (for 15 V positive supply). The logic inputs are protected against overvoltage up to 18 V above and 36 V below the positive supply. The combination of low cost, low power, low resistance and fast speed optimizes system design.

PIN CONFIGURATIONS

DUAL SPST DG300 or DG304

Metal Can Package Dual-In-Line and Flat Package

V+ (SUBSTRATE AND CASE)

ORDER NUMBERS:
 DG300AP OR DG300BP
 DG304AP OR DG304BP
 SEE PACKAGE 11
 DG300CJ
 DG304CJ
 SEE PACKAGE 7
 DG300AL OR DG304AL
 SEE PACKAGE 16

LOGIC	SWITCH
0	OFF
1	ON

SPDT DG301 or DG305

Dual-In-Line and Flat Package Metal Can Package

V+ (SUBSTRATE AND CASE)

ORDER NUMBERS:
 DG301AP OR DG301BP
 DG305AP OR DG305BP
 SEE PACKAGE 11
 DG301CJ
 DG305CJ
 SEE PACKAGE 7
 DG301AL OR DG305AL
 SEE PACKAGE 16

LOGIC	SW 1	SW 2
0	OFF	ON
1	ON	OFF

DUAL DPST DG302 or DG306

Dual-In-Line and Flat Package

V+ (SUBSTRATE AND CASE)

ORDER NUMBERS:
 DG302AP OR DG302BP
 DG306AP OR DG306BP
 SEE PACKAGE 11
 DG302CJ
 DG306CJ
 SEE PACKAGE 7
 DG302AL OR DG306AL
 SEE PACKAGE 16

LOGIC	SWITCH
0	OFF
1	ON

DUAL SPDT DG303 or DG307

Dual-In-Line and Flat Package

V+ (SUBSTRATE AND CASE)

ORDER NUMBERS:
 DG303AP OR DG303BP
 DG307AP OR DG307BP
 SEE PACKAGE 11
 DG303CJ
 DG307CJ
 SEE PACKAGE 7
 DG303AL OR DG307AL
 SEE PACKAGE 16

LOGIC	SW 1	SW 2	SW 3	SW 4
0	OFF	ON	ON	OFF
1	ON	OFF	OFF	ON

SWITCH STATES ARE FOR LOGIC "1" INPUTS (POSITIVE LOGIC)

DG300 DG301 DG302 DG303
 DG304 DG305 DG306 DG307

Analog Switches



Siliconix

ABSOLUTE MAXIMUM RATINGS

V_{IN} to Ground	$V^+ +18\text{ V}, V^- -36\text{ V}$
V_S or V_D	V^+ to V^-
V^+ to Ground	+36 V
V^+ to V^-	+36 V
Current, Any Terminal (Except S or D)	30 mA
Current, S or D, Continuous	30 mA
Pulsed 1 ms 10% Duty Cycle	100 mA
Operating Temperature (A Suffix)	-55 to +125°C
(B Suffix)	-20 to +85°C
(C Suffix)	0 to +70°C
Storage Temperature (A & B Suffix)	-65 to +150°C
(C Suffix)	-65 to +125°C

Power Dissipation*

14 Pin Sidebrazed DIP (P)**	825 mW
14 Pin Plastic DIP (J)***	470 mW
Metal Can (A)****	450 mW
Flat Package (L)*****	750 mW

* Device mounted with all leads welded or soldered to PC board.

** Derate 11 mW/°C above 75°C

*** Derate 6.5 mW/°C above 25°C

**** Derate 6 mW/°C above 75°C

***** Derate 10 mW/°C above 75°C

ELECTRICAL CHARACTERISTICS

All DC parameters are 100% tested at 25°C. Lots are sample tested for AC parameters and high and low temperature limits to assure conformance with specifications.

Characteristics		Typ ¹ 25°C	Max Limits						Unit	Test Conditions $V^+ = +15\text{ V}, V^- = -15\text{ V}, Gnd = 0\text{ V}$	
			A/B Suffix			C Suffix					
			-55°C/ -20°C	25°C	125°C/ 85°C	0°C	25°C	70°C			
SWITCH	$t_{DS(on)}$ Drain Source ON Resistance	30	50	50	75	50	50	75	Ω	$V_D = +10\text{ V}, I_S = -10\text{ mA}$ $V_D = -10\text{ V}, I_S = +10\text{ mA}$	Note 2
		30	50	50	75	50	50	75			
	$I_{S(off)}$ Source OFF Leakage Current	0.1		1	100		5	100	nA	$V_S = +14\text{ V}, V_D = -14\text{ V}$ $V_S = -14\text{ V}, V_D = +14\text{ V}$	Note 2
		-0.1		-1	-100		-5	-100			
	$I_{D(off)}$ Drain OFF Leakage Current	0.1		1	100		5	100	nA	$V_D = +14\text{ V}, V_S = -14\text{ V}$ $V_D = -14\text{ V}, V_S = +14\text{ V}$	Note 2
		-0.1		-1	-100		-5	-100			
	$I_{D(on)}$ Channel ON Leakage Current	0.1		1	100		5	100	nA	$V_D = V_S = +14\text{ V}$ $V_D = V_S = -14\text{ V}$	Note 2
		-0.1		-2	-200		-5	-200			
INPUTS	I_{INH} Input Current	DG300-303 Only	-0.001	-1	-1	-1	-1		μA	$V_{IN} = +5\text{ V}$	
	I_{INH} Input Voltage High	DG300-307	0.001	1	1	1	1			$V_{IN} = +15\text{ V}$	
	I_{INL} Input Current Input Voltage Low		-0.001	-1	-1	-1	-1			$V_{IN} = 0$	
DYNAMIC	t_{on} Turn ON Time	DG300-303 Only	150	300					nS	See Switching Time Test Circuit	
	t_{off} Turn OFF Time	Only	130	250							
	t_{on} Turn ON Time	DG304-307 Only	110	250							
	t_{off} Turn OFF Time	Only	70	150							
	$t_{on} - t_{off}$ Break-Before-Make Interval	DG301/303 DG305/307 Only	50								See Break-Before-Make Time Test Circuit
CAPACITANCE	$C_{S(off)}$ Source OFF Capacitance		14						pF	$V_S = 0$, Note 2 $V_D = 0$, Note 2 $V_D = V_S = 0$, Note 2 $V_{IN} = 0$ $V_{IN} = +15\text{ V}$	f = 1 MHz
	$C_{D(off)}$ Drain OFF Capacitance		14								
	$C_{D(on)} + C_{S(on)}$ Channel ON Capacitance		40								
	C_{IN} Input Capacitance		6								
			3.5								
	OFF Isolation ³		62						dB	$V_{IN} = 0, R_L = 1\text{ K}\Omega, C_L = +15\text{ pF}$ $V_S = 1\text{ V}_{RMS}, f = 500\text{ kHz}$	
SUPPLY	I^+ Positive Supply Current	DG300-303 Only	0.23	1	0.5	0.5		1		μA	$V_{IN} = 4\text{ V}$ (One Input) (All Other Inputs = 0) $V_{IN} = 0.8\text{ V}$ (All Inputs) $V_{IN} = +15\text{ V}$ (All Inputs) $V_{IN} = 0$ (All Inputs)
	I^- Negative Supply Current		-0.001	-10	-10	-100		-100			
	I^+ Positive Supply Current		0.001	10	10	100		100			
	I^- Negative Supply Current		-0.001	-10	-10	-100		-100			
	I^+ Positive Supply Current		0.001	10	10	100		100			
	I^- Negative Supply Current		-0.001	-10	-10	-100		-100			
	I^+ Positive Supply Current		0.001	10	10	100		100			
	I^- Negative Supply Current		-0.001	-10	-10	-100		-100			

NOTES:

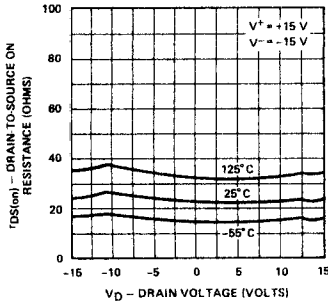
- Typical values are for DESIGN AID ONLY, not guaranteed and not subject to production testing.
- V_{IN} = Input voltage to perform proper function, DG300-303: V_{IN} - For logic "1" = 4 V, for logic "0" = 0.8 V
DG304-307: V_{IN} - For logic "1" = 11 V, for logic "0" = 3.5 V
- "OFF" Isolation $\geq 20 \log V_S/V_D$, V_S = Input to OFF switch, V_D = Output

DG300 ICMA-A	DG302 ICMB-A
DG301 ICMA-B	DG303 ICMB-B
DG304 ICMA-C	DG306 ICMB-C
DG305 ICMA-D	DG307 ICMB-D

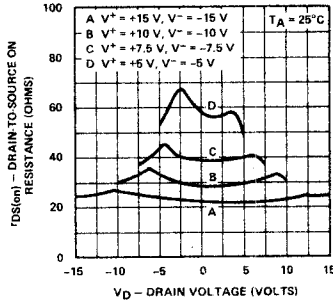


TYPICAL CHARACTERISTICS

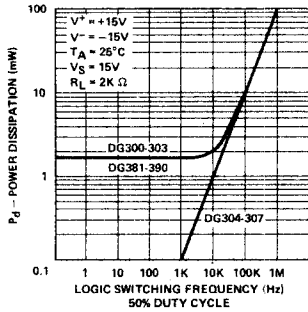
$r_{DS(on)}$ vs V_D and Temperature



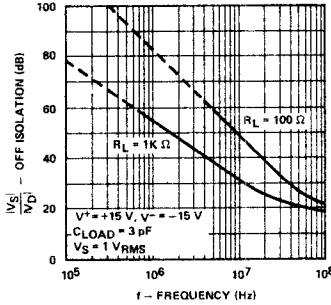
$r_{DS(on)}$ vs V_D and Power Supply Voltage



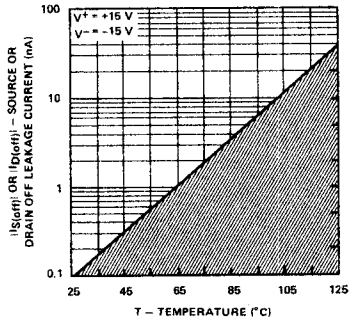
Device Power Dissipation vs Switching Frequency
 Single Logic Input



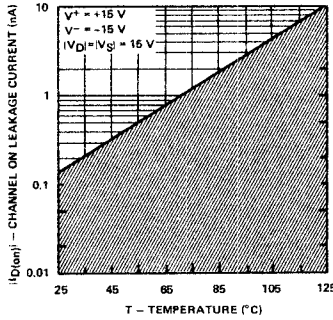
OFF Isolation vs Frequency



$I_S(off)$ or $I_D(off)$ vs Temperature*

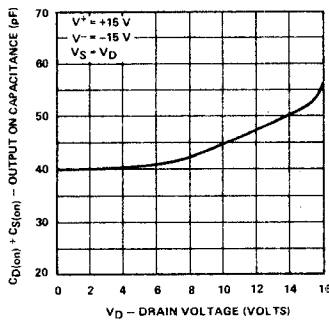


$I_D(on)$ vs Temperature*

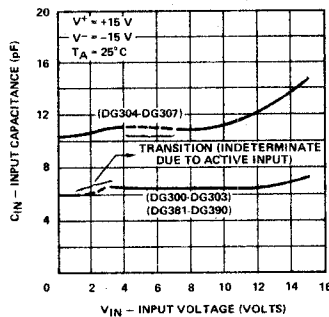


*The net leakage into the source or drain is the n-channel leakage minus the p-channel leakage. This difference can be positive, negative, or zero depending on the analog voltage and temperature, and will vary greatly from unit to unit.

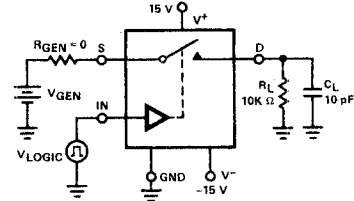
Output ON Capacitance vs Drain Voltage



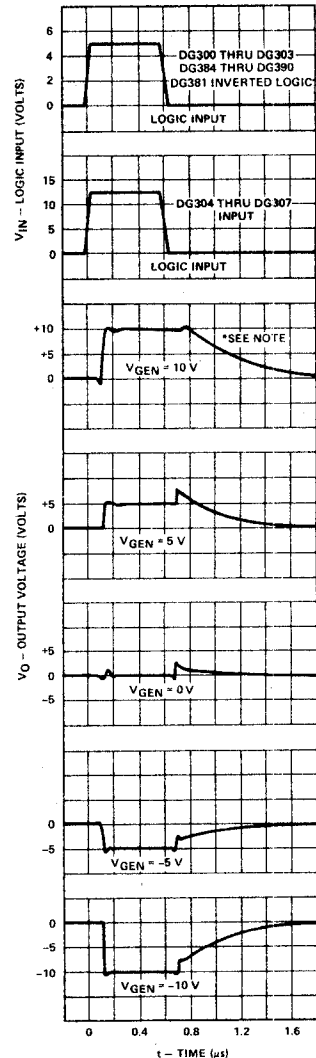
Input Capacitance vs Input Voltage



Typical delay, rise, fall, settling times, and switching transients in this circuit.

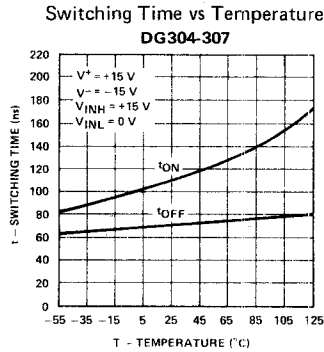
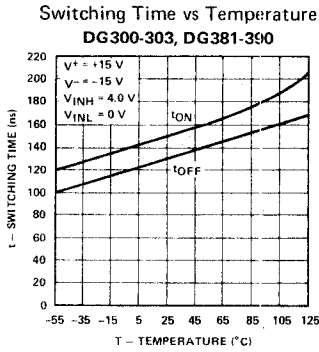


If R_{GEN} , R_L or C_L is increased, there will be proportional increases in rise and/or fall RC times. Applying V_{GEN} to D rather than S results in much greater spikes.

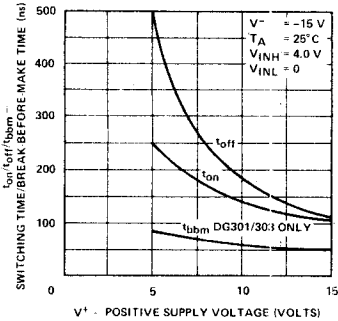


*Note: The turn-off time is primarily limited here by the RC time constant (100 ns) of the load.

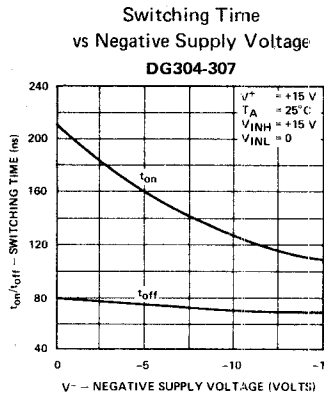
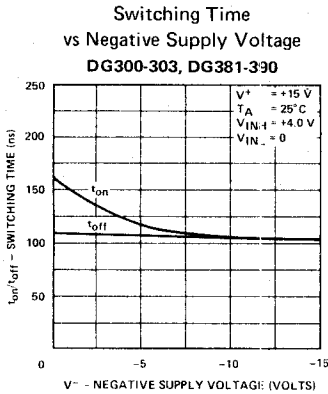
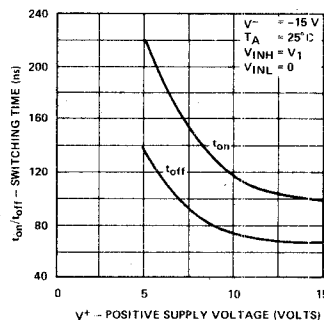
TYPICAL CHARACTERISTICS (Cont'd)



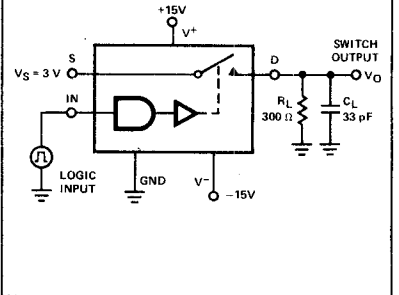
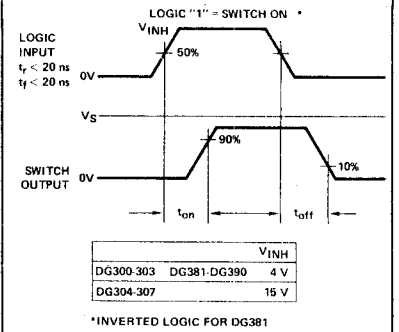
Switching Time and Break-Before-Make Time vs Positive Supply Voltage
 DG300-303, DG381-390



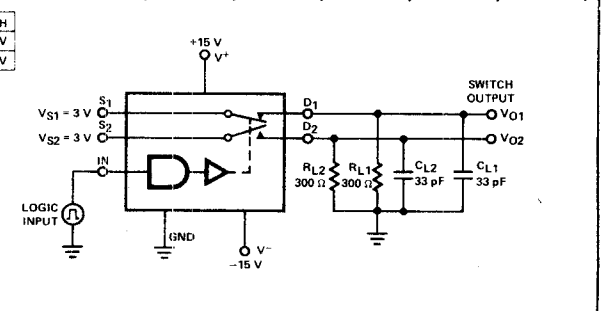
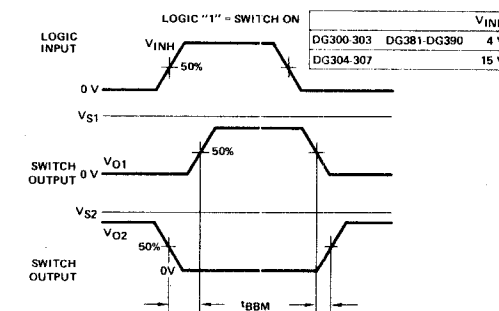
Switching Time vs Positive Supply Voltage
 DG304-307



**SWITCHING TIME TEST CIRCUIT
 (DG300-307 DG381-390)**

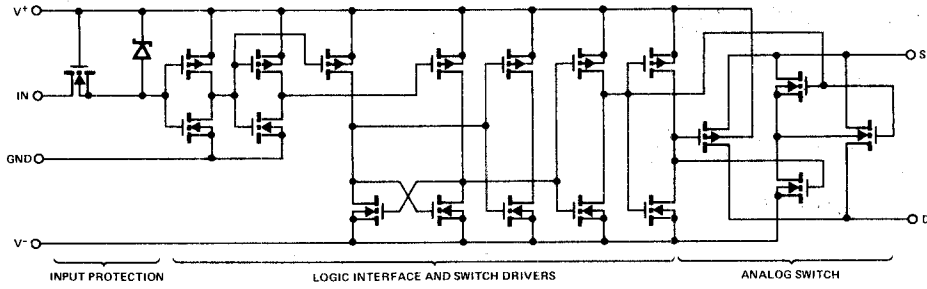


BREAK-BEFORE-MAKE TIME TEST CIRCUIT SPDT (DG301, DG303, DG305, DG307, DG384, DG390)





PARTIAL SCHEMATIC OF TYPICAL SWITCH (DG300-307, DG381-390)

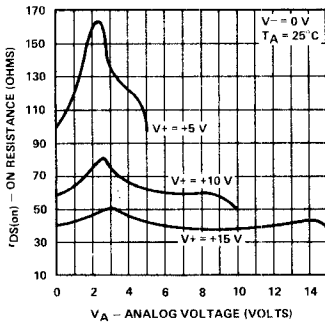


APPLICATIONS

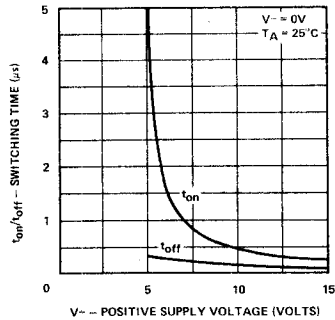
Single Supply Operation

The DG300 series of analog switches will switch positive analog signals while using a single positive supply. This will allow use in many 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 in the Figures below. As stated in the absolute maximum ratings section of the data sheet, the analog voltage should not go above or below the supply voltages which in single operation are V+ and 0 volts.

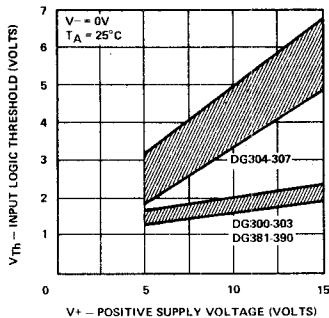
$R_{DS(on)}$ vs Analog and Positive Supply Voltage
 With $V_- = 0V$



Switching Time vs V_- – Positive Supply Voltage



Input Threshold Voltage vs Positive Supply



Single Supply Range:
 (V_- and GND Tied Together)
 $V_+ : +5V$ to $+25V$

Analog Signal Range:
 $V_- \leq V_{ANALOG} \leq V_+$