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 - tON: 150 ns
• Low on-resistance - RDS(on): 30 Ω
• Single supply operation
• Latch-up proof
• CMOS compatible

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

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

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

TRUTH TABLE

<table>
<thead>
<tr>
<th>Logic</th>
<th>Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
</tr>
</tbody>
</table>

Logic “0” ≤ 0.8 V
Logic “1” ≥ 4 V

* Pb containing terminations are not RoHS compliant, exemptions may apply.
DG300B, DG301B, DG302B, DG303B
Vishay Siliconix

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

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<table>
<thead>
<tr>
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</tr>
</tbody>
</table>

Logic “0” ≤ 0.8 V
Logic “1” ≥ 4 V

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Temp. Range</th>
<th>Standard Package</th>
<th>Standard Part Number</th>
<th>Lead (Pb)-free Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40 °C to 85 °C</td>
<td>14-Pin Plastic DIP</td>
<td>DG300BDJ</td>
<td>DG300BDJ-E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG301BDJ</td>
<td>DG301BDJ-E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG302BDJ</td>
<td>DG302BDJ-E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG303BDJ</td>
<td>DG303BDJ-E3</td>
</tr>
<tr>
<td></td>
<td>14-SOIC</td>
<td>DG303BDY</td>
<td>DG303BDY-T1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DG303BDY-E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DG303BDY-T1-E3</td>
</tr>
</tbody>
</table>
### ABSOLUTE MAXIMUM RATINGS (TA = 25 °C, unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltages Referenced V+ to V-</td>
<td>44</td>
<td>V</td>
</tr>
<tr>
<td>GND</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Digital Inputs(^a), VS, VD</td>
<td>(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first</td>
<td>mA</td>
</tr>
<tr>
<td>Current (Any Terminal)</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>Continuous Current, S or D (Pulsed at 1 ms, 10 % duty cycle max.)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-65 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>Power Dissipation (Package)(^b)</td>
<td>14-Pin PlasticDIP(^c)</td>
<td>470</td>
</tr>
<tr>
<td></td>
<td>SOIC-14(^d)</td>
<td>600</td>
</tr>
</tbody>
</table>

Notes:
- a. Signals on SX, DX, or INX 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)

![Schematic Diagram](image-url)
**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Limits</th>
<th>Temp.</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analog Switch</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog Signal Range</td>
<td>( V_{ANALOG} )</td>
<td>( V_+ = 15 \text{ V}, V_- = -15 \text{ V} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{IN} = 0.8 \text{ V or } V_{IN} = 4 \text{ V} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain-Source On-Resistance</td>
<td>( R_{DS(on)} )</td>
<td>( V_D = \pm 10 \text{ V}, I_S = -10 \text{ mA} )</td>
<td>Room</td>
<td>- 5</td>
<td>5</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Full</td>
<td>- 100</td>
<td>± 0.1</td>
<td>5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Source Off Leakage Current</td>
<td>( I_{S(off)} )</td>
<td>( V_S = \pm 14 \text{ V}, V_D = \pm 14 \text{ V} )</td>
<td>Room</td>
<td>- 5</td>
<td>5</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hot</td>
<td>- 100</td>
<td>± 0.1</td>
<td>5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Drain Off Leakage Current</td>
<td>( I_{D(off)} )</td>
<td>( V_S = V_D = \pm 14 \text{ V} )</td>
<td>Room</td>
<td>- 5</td>
<td>5</td>
<td>100</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hot</td>
<td>- 100</td>
<td>± 0.1</td>
<td>5</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

| **Digital Control** | | | | | | | | |
| Input Current with Input Voltage High | \( I_{INH} \) | \( V_{IN} = 5 \text{ V} \) | Room | - 1 | - 0.001 | | µA |
| | | | Full | | | | | |
| Input Current with Input Voltage Low | \( I_{INL} \) | \( V_{IN} = 0 \text{ V} \) | Room | - 1 | - 0.001 | | µA |
| | | | Full | | | | | |

| **Dynamic Characteristics** | | | | | | | | |
| Turn-On Time | \( t_{ON} \) | | Room | 150 | | | ns |
| Turn-Off Time | \( t_{OFF} \) | | Room | 130 | | | | |
| Break-Before-Make Time | \( t_{OPEN} \) | | DG301B, DG303B Only | 50 | | | | |
| Charge Injection | \( Q \) | \( C_L = 1 \text{ nF}, R_{gen} = 0 \text{ Ω}, V_{gen} = 0 \text{ V} \) | Room | 8 | | | pC |
| Source Off Capacitance | \( C_{S(off)} \) | \( V_S, V_D = 0 \text{ V, } f = 1 \text{ MHz} \) | Room | 14 | | | pF |
| Drain Off Capacitance | \( C_{D(off)} \) | | Room | 14 | | | | |
| Channel-On Capacitance | \( C_{D(on)} \) | | Room | 40 | | | | |
| Input Capacitance | \( C_{in} \) | \( f = 1 \text{ MHz} \) | Room | 6 | | | | |
| | | \( V_{IN} = 0 \text{ V} \) | Room | 7 | | | | |
| | | \( V_{IN} = 15 \text{ V} \) | Room | 7 | | | | |
| Off Isolation | OIRR | \( V_{IN} = 0 \text{ V, } R_L = 1 \text{ kΩ} \) | Room | 62 | | | dB |
| Crosstalk (Channel-to-Channel) | \( XTALK \) | \( V_S = 1 \text{ V}_{imp}, f = 500 \text{ kHz} \) | Room | 74 | | | | |

| **Power Supplies** | | | | | | | | |
| Positive Supply Current | \( I^+ \) | \( V_{IN} = 4 \text{ V (one input) all others = 0 V} \) | Room | 0.23 | 1 | | mA |
| | | | Full | | | | | |
| Negative Supply Current | \( I^- \) | | Room | - 100 | - 0.001 | | µA |
| | | | Full | | | | | |
| Positive Supply Current | \( I^+ \) | \( V_{IN} = 0.8 \text{ V (all inputs)} \) | Room | 0.001 | 100 | | µA |
| | | | 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 data sheet.
- 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 \( (T_A = 25 \, ^\circ C, \text{unless otherwise noted}) \)

- **RDS(on) vs. \( V_D \) and Power Supply Voltage**
  - \( V_D \) vs. \( R_{DS(on)} \) at different power supply voltages.
  - Power supply voltages include \( \pm 5 \, V \), \( \pm 8 \, V \), \( \pm 10 \, V \), \( \pm 12 \, V \), \( \pm 15 \, V \), and \( \pm 20 \, V \).

- **RDS(on) vs. \( V_D \) and Temperature**
  - \( V_D \) vs. \( R_{DS(on)} \) at different temperatures.
  - Temperatures include \( T_A = 125 \, ^\circ C \), \( T_A = 25 \, ^\circ C \), and \( T_A = -55 \, ^\circ C \).

- **Charge Injection vs. Analog Voltage**
  - \( V_S \) vs. \( Q \) at different \( V_D \) voltages.
  - \( V_D = 7.5 \, V \), \( V_D = 10 \, V \), \( V_D = 15 \, V \), and \( V_D = 20 \, V \).

- **Switching Time and Break-Before-Make Time**
  - \( V_D \) vs. \( t_{ON}, t_{OFF}, t_{OPEN} \) at positive supply voltage.
  - Positive supply voltages include \( V_+ = 15 \, V \), \( V_- = -15 \, V \), \( V_{INH} = 4 \, V \), and \( V_{INK} = 0 \, V \).

- **Input Switching Threshold**
  - \( V_D \) vs. \( V_T \) at \( V_+ = 15 \, V \) and \( T_A = 25 \, ^\circ C \).
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)

Supply Current vs. Temperature

Supply Currents vs. Switching Frequency

Switching Time vs. Power Supply Voltage

Off Isolation and Crosstalk vs. Frequency

Leakage vs. Temperature

Switching Time vs. Temperature
Vishay Siliconix

**TEST CIRCUITS**

**Figure 2. Switching Time**

\[ V_O = V_S \frac{R_L}{R_L + r_{DS(on)}} \]

**Vs = 3 V**

**RL**

\[ RL + r_{DS(on)} \]

\[ VO = VS \]

\[ CL \text{ (includes fixture and stray capacitance)} \]

**V-**

\[ V+ \]

**IN**

**S**

**D**

**V-**

**CL**

33 pF

**Logic**

**Input**

\[ Logic \ "1\" = Switch On \]

**Switch Output**

\[ t_{ON} \]

\[ t_{OFF} \]

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

**Vs1 = 3 V**

**Vs2 = 3 V**

**S1**

\[ S_1 \]

**D1**

\[ D_1 \]

\[ VO1 \]

\[ V_O \]

\[ CL \text{ (includes fixture and stray capacitance)} \]

**S2**

\[ S_2 \]

**D2**

\[ D_2 \]

\[ VO2 \]

\[ VO2 \]

\[ CL1 \text{ 33 pF} \]

\[ CL2 \text{ 33 pF} \]

\[ RL1 \text{ 300 } \Omega \]

\[ RL2 \text{ 300 } \Omega \]

\[ IN \]

\[ V_S \]

\[ GND \]

\[ +15 V \]

\[ -15 V \]

**Logic**

**Input**

\[ Logic \ "1\" = Switch On \]

**Switch Output**

\[ V_{INH} \]

\[ V_{S1} \]

\[ V_{S2} \]

\[ VO1 \]

\[ VO2 \]

\[ 50 \% \]

\[ 50 \% \]

\[ 50 \% \]

\[ 0 \% \]

\[ 50 \% \]

\[ 10 \% \]

\[ t_{BBM} \]

**Figure 4. Charge Injection**

\[ \Delta V_O \]

\[ V_O \]

\[ IN_X \]

\[ ON \]

\[ OFF \]

\[ ON \]

\[ 1 \text{ nF} \]

\[ CL \text{ 1 nF} \]

\[ RL \text{ 300 } \Omega \]

\[ GND \]

\[ +15 V \]

\[ -15 V \]
DG300B, DG301B, DG302B, DG303B
Vishay Siliconix

**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.)

---

**APPLICATIONS HINTS**

<table>
<thead>
<tr>
<th>V+ Positive Supply Voltage (V)</th>
<th>V- Negative Supply Voltage (V)</th>
<th>GND Voltage (V)</th>
<th>$V_{IN}$ Logic Input Voltage $V_{INH(min)}$/$V_{INL(max)}$ (V)</th>
<th>$V_S$ or $V_D$ Analog Voltage Range (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>- 15</td>
<td>0</td>
<td>4/0.8</td>
<td>- 15 to 15</td>
</tr>
<tr>
<td>20</td>
<td>- 20</td>
<td>0</td>
<td>4/0.8</td>
<td>- 20 to 20</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0</td>
<td>4/0.8</td>
<td>0 to 15</td>
</tr>
</tbody>
</table>

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

---

Figure 5. Single Supply Op. Amp. Switching
Figure 6. Low Power Instrumentation Amplifier with Digitally Selectable Inputs and Gain
SOIC (NARROW): 14-LEAD

### Package Information

<table>
<thead>
<tr>
<th>Dim</th>
<th>MILLIMETERS</th>
<th>INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.35</td>
<td>0.053</td>
</tr>
<tr>
<td>B</td>
<td>0.10</td>
<td>0.004</td>
</tr>
<tr>
<td>C</td>
<td>0.38</td>
<td>0.015</td>
</tr>
<tr>
<td>D</td>
<td>0.18</td>
<td>0.007</td>
</tr>
<tr>
<td>e</td>
<td>8.55</td>
<td>0.336</td>
</tr>
<tr>
<td>H</td>
<td>1.27 BSC</td>
<td>0.050 BSC</td>
</tr>
<tr>
<td>L</td>
<td>3.8</td>
<td>0.149</td>
</tr>
<tr>
<td>Ø</td>
<td>0.050 BSC</td>
<td>0.037</td>
</tr>
</tbody>
</table>

ECN: T-05766—Rev. F, 19-Sep-05

DWG: 54999

Vishay Siliconix
Document Number: 71193
19-Sep-05

www.vishay.com
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PDIP: 14-LEAD

Package Information
Vishay Siliconix

Dim | MILLIMETERS | INCHES
--- | --------- | -----
A | 3.81 - 5.08 | 0.150 - 0.200 |
A_1 | 0.38 - 1.27 | 0.015 - 0.050 |
B | 0.38 - 0.51 | 0.015 - 0.020 |
B_1 | 0.89 - 1.85 | 0.035 - 0.065 |
C | 0.20 - 0.30 | 0.008 - 0.012 |
D | 17.27 - 19.30 | 0.680 - 0.760 |
E | 7.62 - 8.26 | 0.300 - 0.325 |
E_1 | 5.59 - 7.11 | 0.220 - 0.280 |
e_1 | 2.29 - 2.79 | 0.090 - 0.110 |
e_A | 7.37 - 7.87 | 0.290 - 0.310 |
L | 2.79 - 3.81 | 0.110 - 0.150 |
Q_1 | 1.27 - 2.03 | 0.050 - 0.080 |
S | 1.02 - 2.03 | 0.040 - 0.080 |

ECN: S-03946—Rev. C, 09-Jul-01
DWG: 5481
RECOMMENDED MINIMUM PADS FOR SO-14

Recommended Minimum Pads
Dimensions in Inches/(mm)

0.047 (1.194)
0.022 (0.559)
0.050 (1.270)
0.028 (0.711)

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