Monolithic Quad SPST CMOS Analog Switches

Features
- ±15-V Input Range
- Low Off Leakage—$I_{D(on)}$: 0.1 nA
- Low On-Resistance—$r_DSS(on)$: 115 Ω
- 44-V Maximum Supply Ratings
- TTL and CMOS Compatible

Benefits
- Wide Input Range
- Low Distortion Switching
- Can Be Driven from Comparators or Op Amps Without Limiting Resistors

Applications
- Disk Drives
- Radar Systems
- Communications Systems
- Sample-and-Hold

Description
The DG201A and DG202 are quad SPST analog switches designed to provide accurate switching over a wide range of input signals. When combining a low on-resistance and a wide signal range (±15 V) with low charge-transfer these devices are well suited for industrial and military applications.

Built on Siliconix’ high voltage metal gate process to achieve optimum switch performance, each switch conducts equally well in both directions when on. When off these switches will block up to 30 V peak-to-peak and have a 44-V absolute maximum power supply rating.

These two devices are differentiated by the type of switch actions (See Truth Table).

The DG201B/DG202B upgrades are recommended for new designs.

Functional Block Diagram and Pin Configuration

DG201A

Truth Table

<table>
<thead>
<tr>
<th>Logic</th>
<th>DG201A</th>
<th>DG202</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
<td>ON</td>
</tr>
</tbody>
</table>

Logic “0” ≤ 0.8 V
Logic “1” ≥ 2.4 V

Updates to this data sheet may be obtained via facsimile by calling Siliconix FaxBack, 1-408-970-5600. Please request FaxBack document #70036.
### Ordering Information

<table>
<thead>
<tr>
<th>Temp Range</th>
<th>Package</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 70°C</td>
<td>16-Pin Plastic DIP</td>
<td>DG201ACJ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG202CJ</td>
</tr>
<tr>
<td>-25 to 85°C</td>
<td>16-Pin CerDIP</td>
<td>DG201ABK</td>
</tr>
<tr>
<td>-40 to 85°C</td>
<td>16-Pin Narrow SOIC</td>
<td>DG201ADY</td>
</tr>
<tr>
<td>-55 to 125°C</td>
<td>16-Pin CerDIP</td>
<td>DG201AAK, JM38510/12302BEA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7705301EA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG202AK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DG202AK/883</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7705301EC</td>
</tr>
<tr>
<td>-55 to 125°C</td>
<td>16-Pin Sidebraze</td>
<td>JM38510/12302BEC</td>
</tr>
<tr>
<td></td>
<td>LCC-20</td>
<td>77053012A</td>
</tr>
</tbody>
</table>

### Absolute Maximum Ratings

- **Voltages Referenced to V–**
  - V+ ........................................ 44 V
  - GND ...................................... 25 V
  - Digital Inputs\( V_S, V_D \) (\( V– \) – 2 V to (V+) + 2 V or 20 mA, whichever occurs first)

- **Current, Any Terminal Except S or D** .......................... 30 mA
- **Continuous Current, S or D** ................................. 20 mA
- **Peak Current, S or D** (Pulsed at 1 ms, 10% duty cycle max) ....................... 70 mA
- **Storage Temperature**  
  - (K, Z Suffix) .............................. –65 to 150°C
  - (J, Y Suffix) .............................. –65 to 125°C

- **Power Dissipation (Package)b**
  - 16-Pin Plastic DIP\(c\) .............................. 470 mW
  - 16-Pin SOIC\(d\) .............................. 640 mW
  - 16-Pin CerDIP and Sidebraze\(e\) .................... 900 mW
  - LCC-20\(f\) .............................. 750 mW

**Notes:**
- a. Signals on \( S_X, D_X, \) or \( I N_X \) 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
- e. Derate 12 mW/°C above 75°C
- f. Derate 10 mW/°C above 75°C

### Schematic Diagram (Typical Channel)

![Schematic Diagram](image-url)
### Specifications

#### Analog Switch

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>Temp</th>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Signal Range</td>
<td>$V_{ANALOG}$</td>
<td>$V_+ = 15, V, V_- = -15, V$</td>
<td>Room</td>
<td>115</td>
<td>175</td>
<td>175</td>
<td>室温</td>
<td>250</td>
<td>$\Omega$</td>
</tr>
<tr>
<td>Drain-Source On-Resistance</td>
<td>$r_{DS(on)}$</td>
<td>$V_D = \pm 10, V, I_S = 1, mA$</td>
<td>Full</td>
<td>250</td>
<td>100</td>
<td>100</td>
<td>室温</td>
<td>5</td>
<td>nA</td>
</tr>
<tr>
<td>Source Off Leakage Current</td>
<td>$I_{S(\text{off})}$</td>
<td>$V_S = \pm 14, V, V_D = \mp 14, V$</td>
<td>Room</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>室温</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Drain Off Leakage Current</td>
<td>$I_{D(\text{off})}$</td>
<td>$V_D = \pm 14, V, V_S = \mp 14, V$</td>
<td>Room</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>室温</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Drain On Leakage Current</td>
<td>$I_{D(\text{on})}$</td>
<td>$V_S = V_D = \pm 14, V$</td>
<td>Room</td>
<td>0.15</td>
<td>200</td>
<td>200</td>
<td>室温</td>
<td>5</td>
<td>100</td>
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#### Digital Control

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>Temp</th>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current with Input Voltage High</td>
<td>$I_{INH}$</td>
<td>$V_{IN} = 2.4, V$</td>
<td>Room</td>
<td>-0.0004</td>
<td>-1</td>
<td>-1</td>
<td>-1</td>
<td>-10</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{IN} = 15, V$</td>
<td>Room</td>
<td>0.003</td>
<td>1</td>
<td>0.5</td>
<td>1</td>
<td>0.5</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Input Current with Input Voltage Low</td>
<td>$I_{INL}$</td>
<td>$V_{IN} = 0, V$</td>
<td>Room</td>
<td>-0.0004</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
<td>$\mu A$</td>
<td></td>
</tr>
</tbody>
</table>

#### Dynamic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>Temp</th>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn-On Time</td>
<td>$t_{ON}$</td>
<td>See Switching Time Test Circuit</td>
<td>Room</td>
<td>480</td>
<td>600</td>
<td>600</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-Off Time</td>
<td>$t_{OFF}$</td>
<td></td>
<td>Room</td>
<td>370</td>
<td>450</td>
<td>450</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge Injection</td>
<td>$Q$</td>
<td>$C_L = 1000, pF, V_{IN} = 0, V$</td>
<td>Room</td>
<td>20</td>
<td>pC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source-Off Capacitance</td>
<td>$C_{S(\text{off})}$</td>
<td>$V_S = 0, V, V_{IN} = 5, V, f = 1, MHz$</td>
<td>Room</td>
<td>5</td>
<td>pF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain-Off Capacitance</td>
<td>$C_{D(\text{off})}$</td>
<td>$V_D = V_S = 0, V, V_{IN} = 0, V$</td>
<td>Room</td>
<td>5</td>
<td>pF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel On Capacitance</td>
<td>$C_{D(on)} + C_{S(on)}$</td>
<td>$V_D = V_S = 0, V, V_{IN} = 0, V$</td>
<td>Room</td>
<td>16</td>
<td>pF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Off Isolation</td>
<td>$OIRR$</td>
<td>$V_{IN} = 5, V, R_L = 75, \Omega$</td>
<td>Room</td>
<td>70</td>
<td>dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Channel-to-Channel Crosstalk</td>
<td>$X_{TALK}$</td>
<td>$V_{IN} = 5, V, f = 100, kHz$</td>
<td>Room</td>
<td>90</td>
<td>dB</td>
<td></td>
<td></td>
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</table>

#### Power Supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>Temp</th>
<th>Typ</th>
<th>Min</th>
<th>Max</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Supply Current</td>
<td>$I_+$</td>
<td>All Channels On or Off</td>
<td>Room</td>
<td>0.9</td>
<td>2</td>
<td>2</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>$I_-$</td>
<td></td>
<td>Room</td>
<td>-0.3</td>
<td>-1</td>
<td>-1</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

**Charge Injection vs. Analog Voltage**

- $V_{+} = 15 \text{ V}$, $V_{-} = -15 \text{ V}$
- $T_{A} = 25^\circ \text{C}$

- $Q_{D}$ vs. $V_{\text{ANALOG}}$
- $Q_{S}$ vs. $V_{\text{ANALOG}}$

**$r_{\text{DS(on)}}$ vs. $V_{D}$ and Power Supply Voltage**

- $T_{A} = 25^\circ \text{C}$
- $\pm 5 \text{ V}$
- $\pm 8 \text{ V}$
- $\pm 10 \text{ V}$
- $\pm 12 \text{ V}$
- $\pm 15 \text{ V}$

**$r_{\text{DS(on)}}$ vs. $V_{D}$ and Temperature**

- $V_{+} = 15 \text{ V}$, $V_{-} = -15 \text{ V}$

- $125^\circ \text{C}$
- $85^\circ \text{C}$
- $25^\circ \text{C}$
- $0^\circ \text{C}$
- $-55^\circ \text{C}$
- $-40^\circ \text{C}$

**Leakage vs. Temperature**

- $I_{S(off)}$, $I_{D(off)}$, $I_{D(on)}$

- $V_{+} = 15 \text{ V}$, $V_{-} = -15 \text{ V}$

- $V_{D} = \pm 14 \text{ V}$

**Supply Current vs. Switching Frequency**

- $V_{+} = 15 \text{ V}$
- $V_{-} = -15 \text{ V}$

**Insertion Loss vs. Frequency**

- $V_{+} = 15 \text{ V}$
- $V_{-} = -15 \text{ V}$
- $1 \text{ M}\Omega$

- $1 \text{ k}\Omega$

- Ref. 0.0 dBm

- $R_{L} = 50 \text{ }\Omega$

See Figures 3 and 4
Typical Characteristics (Cont’d)

Crosstalk and Off Isolation vs. Frequency

Leakage Current vs. Analog Voltage

Switching Time vs. Temperature

Switching Time vs. Power Supply Voltage

See Figures 3 and 4.
Test Circuits

$V_O$ is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

**Figure 2.** Switching Time

$V_S$ = +2 V

$V_O$ = $V_S$ $R_L$ $+ r_{DS(on)}$

$V_{IN}$ = 0V, 2.4 V

$V_{O}$ = measured voltage error due to charge injection

The charge injection in coulombs is $\Delta Q = C_L \times \Delta V_O$

**Figure 3.** Off Isolation

**Figure 4.** Channel-to-Channel Crosstalk

**Figure 5.** Charge Injection
Application Hints\(^a\)

<table>
<thead>
<tr>
<th>V+ Positive Supply Voltage (V)</th>
<th>V− Negative Supply Voltage (V)</th>
<th>(V_{IN}) Logic Input Voltage (V_{INH(\text{min})/V_{INL(\text{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>2.4/0.8</td>
<td>−15 to 15</td>
</tr>
<tr>
<td>10</td>
<td>−12</td>
<td>2.4/0.8</td>
<td>−12 to 12</td>
</tr>
<tr>
<td>12</td>
<td>−10</td>
<td>2.2/0.6</td>
<td>−10 to 10</td>
</tr>
<tr>
<td>(g_b)</td>
<td>−8</td>
<td>2.0/0.5</td>
<td>−8 to 8</td>
</tr>
</tbody>
</table>

Notes:
\(a\). Application Hints are for DESIGN AID ONLY, not guaranteed and not subject to production testing.
\(b\). Operation below ±8 V is not recommended.

Applications

![Sample-and-Hold Circuit Diagram](image)

Acquisition Time = 25 \(\mu\)s
Aperature Time = 1 \(\mu\)s
Sample to Hold Offset = 5 mV
Droop Rate = 5 mV/s

**Figure 6.** Sample-and-Hold
Applications (Cont’d)

Figure 7. Active Low Pass Filter with Digitally Selected Break Frequency

Figure 8. A Precision Amplifier with Digitally Programable Input and Gains