Quad SPST CMOS Analog Switches

DESCRIPTION
The DG441, DG442 monolithic quad analog switches are designed to provide high speed, low error switching of analog and audio signals. The DG441 has a normally closed function. The DG442 has a normally open function. Combining low on-resistance (50 Ω, typ.) with high speed (tON 150 ns, typ.), the DG441, DG442 are ideally suited for upgrading DG201A/202 sockets. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

To achieve high voltage ratings and superior switching performance, the DG441, DG442 are built on Vishay Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks input voltages to the supply levels when off.

FEATURES
- Halogen-free according to IEC 61249-2-21 Definition
- Low on-resistance: 50 Ω
- Low leakage: 80 pA
- Low power consumption: 0.2 mW
- Fast switching action - tON: 150 ns
- Low charge injection - Q: -1 pC
- DG201A/DG202 upgrades
- TTL/CMOS-compatible logic
- Single supply capability
- Compliant to RoHS Directive 2002/95/EC

BENEFITS
- Less signal errors and distortion
- Reduced power supply requirements
- Faster throughput
- Improved reliability
- Reduced pedestal errors
- Simplifies retrofit
- Simple interfacing

APPLICATIONS
- Audio switching
- Battery powered systems
- Data acquisition
- Hi-Rel systems
- Sample-and-hold circuits
- Communication systems
- Automatic test equipment
- Medical instruments

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

<table>
<thead>
<tr>
<th>Logic</th>
<th>DG441</th>
<th>DG442</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
**DG441, DG442**

Vishay Siliconix

### Ordering Information

<table>
<thead>
<tr>
<th>Temp. Range</th>
<th>Package</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40 °C to 85 °C</td>
<td>16-pin plastic DIP</td>
<td>DG441DJ, DG441DJ-E3, DG442DJ, DG442DJ-E3</td>
</tr>
<tr>
<td></td>
<td>16-pin narrow SOIC</td>
<td>DG441DY, DG441DY-E3, DG441DY-T1, DG441DY-T1-E3, DG442DY, DG442DY-E3, DG442DY-T1, DG442DY-T1-E3</td>
</tr>
</tbody>
</table>

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V+ to V-</td>
<td>44</td>
<td>V</td>
</tr>
<tr>
<td>GND to V-</td>
<td>25</td>
<td>V</td>
</tr>
<tr>
<td>Digital Inputsa, V_S, V_D</td>
<td>(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first</td>
<td>mA</td>
</tr>
<tr>
<td>Continuous Current (any terminal)</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>Storage Temperature (AK suffix)</td>
<td>- 65 to 150</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature (DJ, DY suffix)</td>
<td>- 65 to 125</td>
<td>°C</td>
</tr>
<tr>
<td>Power Dissipation (Package)b</td>
<td></td>
<td>kW</td>
</tr>
<tr>
<td>16-pin plastic DIPc</td>
<td>450</td>
<td>kW</td>
</tr>
<tr>
<td>16-pin CerDIPd</td>
<td>900</td>
<td>kW</td>
</tr>
<tr>
<td>16-pin narrow SOICd</td>
<td>900</td>
<td>kW</td>
</tr>
<tr>
<td>LCC-20d</td>
<td>1200</td>
<td>kW</td>
</tr>
</tbody>
</table>

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 mW/°C above 75 °C.
d. Derate 12 mW/°C above 75 °C.

### Schematic Diagram

Typical Channel

![Figure 1.](image-url)
## SPECIFICATIONS (Dual Supplies)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>Temp.</th>
<th>A Suffix</th>
<th>D Suffix</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog Switch</td>
<td></td>
<td>V+ = 15 V, V- = -15 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V IN = 2.4 V, 0.8 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Analog Switch</strong></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></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drain-Source On-Resistance</strong></td>
<td>R DS(on)</td>
<td>I S = -10 mA, V D = ±8.5 V</td>
<td>Room</td>
<td>50</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V+ = 13.5 V, V- = -13.5 V</td>
<td>Full</td>
<td>100</td>
<td>100</td>
<td>Ω</td>
</tr>
<tr>
<td><strong>On-Resistance Match Between Channels</strong></td>
<td>∆R DS(on)</td>
<td>I S = -10 mA, V D = ±10 V</td>
<td>Room</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>V+ = 15 V, V- = -15 V</td>
<td>Full</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Switch Off Leakage Current</strong></td>
<td>I S(off)</td>
<td>V+ = 16.5 V, V- = -16.5 V</td>
<td>Room</td>
<td>0.01</td>
<td>0.01</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V D = ±15.5 V, VS = ±15.5 V</td>
<td>Full</td>
<td>- 5</td>
<td>- 5</td>
<td></td>
</tr>
<tr>
<td><strong>Switch On Leakage Current</strong></td>
<td>I D(on)</td>
<td>V+ = 16.5 V, V- = -16.5 V</td>
<td>Room</td>
<td>0.08</td>
<td>0.08</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V S = V D = ±15.5 V</td>
<td>Full</td>
<td>- 40</td>
<td>- 40</td>
<td></td>
</tr>
<tr>
<td><strong>Digital Control</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Current V IN Low</td>
<td>I IL</td>
<td>V IN under test = 0.8 V, All Other = 2.4 V</td>
<td>Full</td>
<td>- 0.01</td>
<td>- 500</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>Input Current V IN High</td>
<td>I IH</td>
<td>V IN under test = 2.4 V</td>
<td>Full</td>
<td>0.01</td>
<td>- 500</td>
<td>500</td>
</tr>
<tr>
<td><strong>Dynamic Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn-On Time</td>
<td>t ON</td>
<td>R L = 1 kΩ, C L = 35 pF</td>
<td>Room</td>
<td>150</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td><strong>Turn-Off Time</strong></td>
<td>t OFF</td>
<td>V S = ±10 V</td>
<td>Room</td>
<td>90</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See Figure 2</td>
<td>Room</td>
<td>110</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td><strong>Charge Injection</strong></td>
<td>Q</td>
<td>C L = 1 nF, V S = 0 V</td>
<td>Room</td>
<td>- 1</td>
<td></td>
<td>pC</td>
</tr>
<tr>
<td><strong>Off Isolation</strong></td>
<td>O IRR</td>
<td>V gen = 0 V, R gen = 0 Ω</td>
<td>Room</td>
<td>60</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td><strong>Crosstalk (Channel-to-Channel)</strong></td>
<td>X TALK</td>
<td>R L = 50 Ω, C L = 5 pF</td>
<td>Room</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Source Off Capacitance</strong></td>
<td>C S(off)</td>
<td>f = 1 MHz</td>
<td>Room</td>
<td>4</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td><strong>Drain Off Capacitance</strong></td>
<td>C D(off)</td>
<td>f = 1 MHz</td>
<td>Room</td>
<td>4</td>
<td></td>
<td>pF</td>
</tr>
<tr>
<td><strong>Channel On Capacitance</strong></td>
<td>C D(on)</td>
<td>V ANALOG = 0 V</td>
<td>Room</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power Supplies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Positive Supply Current</td>
<td>I+</td>
<td>V+ = 16.5 V, V- = -16.5 V</td>
<td>Full</td>
<td>15</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>I-</td>
<td>V+ = 15 V, V- = -15 V</td>
<td>Room</td>
<td>- 0.0001</td>
<td>- 1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Ground Current</strong></td>
<td>I GND</td>
<td>V IN = 0 or 5 V</td>
<td>Full</td>
<td>- 15</td>
<td>- 100</td>
<td>100</td>
</tr>
</tbody>
</table>

- **A Suffix**: -55 °C to 125 °C
- **D Suffix**: -40 °C to 85 °C
- **Unit**: V
- **Test Conditions**: Unless Otherwise Specified
- **Temp.**: Room
- **Min.d**: -15
- **Max. d**: 15

*Not applicable in all cases.*

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DG441, DG442
Vishay Siliconix

### SPECIFICATIONS (Single Supply)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions Unless Otherwise Specified</th>
<th>A Suffix -55 °C to 125 °C</th>
<th>D Suffix -40 °C to 85 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>V+ = 12 V, V- = 0 V V\text{IN} = 2.4 V, 0.8 V\text{f}</td>
<td>Temp.\text{b}</td>
<td>Min.\text{d}</td>
</tr>
<tr>
<td>Analog Switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog Signal Range</td>
<td>V\text{ANALOG}</td>
<td>Full</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Drain-Source On-Resistance</td>
<td>R\text{DS(on)}</td>
<td>I\text{S} = -10 mA, V\text{D} = 3 V, 8 V V+ = 10.8 V</td>
<td>Room</td>
<td>100</td>
</tr>
</tbody>
</table>

### Dynamic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Temperature</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\text{ON}</td>
<td>R\text{L} = 1 kΩ, C\text{L} = 35 pF V\text{S} = 8 V</td>
<td>Room</td>
<td>300</td>
<td>450</td>
<td>450</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Turn-Off Time</td>
<td>t\text{OFF}</td>
<td>C\text{L} = 1 nF, V\text{gen} = 6 V, R\text{gen} = 0 Ω</td>
<td>Room</td>
<td>60</td>
<td>200</td>
<td>200</td>
<td>pC</td>
<td></td>
</tr>
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</table>

### Power Supplies

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Room</th>
<th>Full</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>V+ = 13.2 V, V- = 0 V V\text{IN} = 0 or 5 V</td>
<td>- 0.0001</td>
<td>- 100</td>
<td>- 1</td>
<td>- 100</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Supply Current</td>
<td>I-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Current</td>
<td>I\text{GND}</td>
<td></td>
<td></td>
<td></td>
<td>- 15</td>
<td>- 100</td>
<td>- 100</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 datasheet.
e. Guaranteed by design, not subject to production test.
f. V\text{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** (25 °C, unless otherwise noted)

- **R<sub>DS(on)</sub> vs. V<sub>D</sub> and Power Supply Voltage**
  - Graph showing R<sub>DS(on)</sub> vs. V<sub>D</sub> for different power supply voltages (±5 V, ±8 V, ±10 V, ±12 V, ±15 V, ±20 V).
  - V<sub>D</sub> ranges from -20 to 20 V.

- **R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature**
  - Graph showing R<sub>DS(on)</sub> vs. V<sub>D</sub> for different temperatures (0 °C, 25 °C, 85 °C, 125 °C, -40 °C, -55 °C).
  - V<sub>D</sub> ranges from -10 to 20 V.

- **Crosstalk and Off Isolation vs. Frequency**
  - Graph showing crosstalk and off-isolation vs. frequency for different power supply voltages (V<sub>+</sub> = 15 V, V<sub>-</sub> = -15 V, V<sub>+</sub> = 12 V, V<sub>-</sub> = 0 V).
  - Frequency range from 100 Hz to 100 MHz.

- **Charge Injection vs. Source Voltage**
  - Graph showing charge injection vs. source voltage for different power supply voltages (V<sub>+</sub> = 15 V, V<sub>-</sub> = -15 V, V<sub>+</sub> = 12 V, V<sub>-</sub> = 0 V).
  - Source voltage range from 0 V to 10 V.
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

1. **Switching Threshold vs. Supply Voltage**
   - Graph showing the switching threshold for positive and negative supplies.
   - Supply Voltage (V+) and (V-) vs. Switching Voltage (VSW).

2. **Source/Drain Leakage Currents (Single 12 V Supply)**
   - Graph illustrating the leakage currents for different supply voltages.

3. **Source/Drain Leakage Currents**
   - Graph depicting the leakage currents for positive and negative supply voltages.

4. **Operating Voltage**
   - Graph showing the operating voltage characteristics for CMOS and TTL compatibility.

5. **Switching Time vs. Power Supply Voltage**
   - Graph displaying the switching times for various supply voltages.
TEST CIRCUITS

**Figure 2. Switching Time**

<table>
<thead>
<tr>
<th>Logic Input</th>
<th>Switch Input</th>
<th>Switch Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V</td>
<td>3 V</td>
<td>0 V</td>
</tr>
<tr>
<td>50 %</td>
<td>50 %</td>
<td>80 %</td>
</tr>
<tr>
<td>tf &lt; 20 ns</td>
<td>t&lt;sub&gt;ON&lt;/sub&gt;</td>
<td>t&lt;sub&gt;OFF&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Logic input waveform is inverted for DG442.

**Figure 3. Charge Injection**

C<sub>L</sub> (includes fixture and stray capacitance)

```
+ 15 V

S

V+

IN

GND

V-

- 15 V

R<sub>L</sub> 1 kΩ

C<sub>L</sub> 35 pF

D

V<sub>O</sub>

3 V

50 %

0 V

80 %
```

Figure 4. Crosstalk

```
+ 15 V

S

V+

D

C

V-

- 15 V

R<sub>g</sub> = 50 Ω

S<sub>1</sub>

I<sub>N</sub><sub>1</sub>

V<sub>+</sub>

NC

0 V, 2.4 V

S<sub>2</sub>

I<sub>N</sub><sub>2</sub>

GND

V<sub>−</sub>

0 V, 2.4 V

C = 1 nF

S<sub>1</sub>

S<sub>2</sub>

D<sub>1</sub>

D<sub>2</sub>

V<sub>O</sub>

R<sub>g</sub> = 50 Ω

C = RF bypass

S<sub>,D</sub> = 20 log |V<sub>S</sub>|/|V<sub>D</sub>|

Figure 5. Off Isolation

```
+ 15 V

S

V+

D

C

V-

- 15 V

R<sub>g</sub> = 50 Ω

S<sub>1</sub>

IN

GND

V<sub>−</sub>

0 V, 2.4 V

R<sub>L</sub>

C

S<sub>1</sub>

S<sub>2</sub>

D<sub>1</sub>

D<sub>2</sub>

V<sub>O</sub>

R<sub>g</sub> = 50 Ω

S<sub>,D</sub> = 20 log |V<sub>S</sub>|/|V<sub>D</sub>|

Figure 6. Source/Drain Capacitances

```
+ 15 V

S

V+

IN

D

C

GND

V−

- 15 V

0 V, 2.4 V

IN

D

C

Figure 6. Source/Drain Capacitances

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DG441, DG442

Vishay Siliconix

APPLICATIONS

Figure 7. Power MOSFET Driver

Figure 8. Open Loop Sample-and-Hold

Figure 9. Precision-Weighted Resistor Programmable-Gain Amplifier

Gain error is determined only by the resistor tolerance. Op amp offset and CMRR will limit accuracy of circuit.

With SW4 Closed

\[
\frac{V_{OUT}}{V_{IN}} = \frac{R_1 + R_2 + R_3 + R_4}{R_4} = 100
\]

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SOIC (NARROW): 16-LEAD
JEDEC Part Number: MS-012

<table>
<thead>
<tr>
<th>Dim</th>
<th>MILLIMETERS</th>
<th>INCHES</th>
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<tbody>
<tr>
<td>A</td>
<td>1.35</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>1.75</td>
<td>0.069</td>
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ECN: S-03946—Rev. F, 09-Jul-01
DWG: 5300
## Package Information

**Vishay Siliconix**

**PDIP: 16-LEAD**

![Diagram of PDIP 16-lead package](image)

### Dimensional Information

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**ECN:** S-03946—Rev. D, 09-Jul-01

**DWG:** 5482
RECOMMENDED MINIMUM PADS FOR SO-16

Recommended Minimum Pads
Dimensions in Inches/(mm)

0.246
(6.248)

0.152
(3.861)

0.047
(1.194)

0.372
(9.449)

0.050
(1.270)

0.152
(3.861)

0.028
(0.711)
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