

## 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  $\Omega$ , typ.) with high speed ( $t_{ON}$  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  $\Omega$
- Low leakage: 80 pA
- Low power consumption: 0.2 mW
- Fast switching action -  $t_{ON}$ : 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**



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### 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



### TRUTH TABLE

| Logic | DG441 | DG442 |
|-------|-------|-------|
| 0     | On    | Off   |
| 1     | Off   | On    |

Logic "0"  $\leq$  0.8 V

Logic "1"  $\geq$  2.4 V

| ORDERING INFORMATION |                    |  |
|----------------------|--------------------|--|
| Temp. Range          | Package            | Part Number  |
| - 40 °C to 85 °C     | 16-pin plastic DIP | DG441DJ<br>DG441DJ-E3                                |
|                      |                    | DG442DJ<br>DG442DJ-E3                                |
|                      | 16-pin narrow SOIC | DG441DY<br>DG441DY-E3<br>DG441DY-T1<br>DG441DY-T1-E3 |
|                      |                    | DG442DY<br>DG442DY-E3<br>DG442DY-T1<br>DG442DY-T1-E3 |

| ABSOLUTE MAXIMUM RATINGS                                      |                                 |  |      |
|---|---------------------------------|--|------|
| Parameter   |                                 | Limit  | Unit |
| V+ to V-  |                                 | 44   | V    |
| GND to V-   |                                 | 25   |      |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub> |                                 | (V-) - 2 to (V+) + 2<br>or 30 mA, whichever occurs first |      |
| Continuous Current (any terminal)                             |                                 | 30   | mA   |
| Current, S or D (pulsed at 1 ms, 10 % duty cycle)             |                                 | 100  |      |
| Storage Temperature   | (AK suffix)                     | - 65 to 150  | °C   |
|   | (DJ, DY suffix)                 | - 65 to 125  |      |
| Power Dissipation (Package) <sup>b</sup>                      | 16-pin plastic DIP <sup>c</sup> | 450  | mW   |
|   | 16-pin CerDIP <sup>d</sup>      | 900  |      |
|   | 16-pin narrow SOIC <sup>d</sup> | 900  |      |
|   | LCC-20 <sup>d</sup>             | 1200   |      |

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> 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.



| SPECIFICATIONS <sup>a</sup> (Dual Supplies)       |                     |   |                           |                   |                               |                   |                              |                   |               |     |
|---|---------------------|---|---------------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|---------------|-----|
| Parameter   | Symbol              | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$<br>$V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^f$ | Temp. <sup>b</sup>        | Typ. <sup>c</sup> | A Suffix<br>- 55 °C to 125 °C |                   | D Suffix<br>- 40 °C to 85 °C |                   | Unit          |     |
|   |                     |   |                           |                   | Min. <sup>d</sup>             | Max. <sup>d</sup> | Min. <sup>d</sup>            | Max. <sup>d</sup> |               |     |
| <b>Analog Switch</b>                              |                     |   |                           |                   |                               |                   |                              |                   |               |     |
| Analog Signal Range <sup>e</sup>                  | $V_{ANALOG}$        |   | Full                      |                   | - 15                          | 15                | - 15                         | 15                | V             |     |
| Drain-Source On-Resistance                        | $R_{DS(on)}$        | $I_S = -10\text{ mA}$ , $V_D = \pm 8.5\text{ V}$<br>$V_+ = 13.5\text{ V}$ , $V_- = -13.5\text{ V}$  | Room Full                 | 50                |                               | 85<br>100         |                              | 85<br>100         | $\Omega$      |     |
| On-Resistance Match Between Channels <sup>e</sup> | $\Delta R_{DS(on)}$ | $I_S = -10\text{ mA}$ , $V_D = \pm 10\text{ V}$<br>$V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$   | Room Full                 |                   |                               | 4<br>5            |                              | 4<br>5            |               |     |
| Switch Off Leakage Current                        | $I_{S(off)}$        | $V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$<br>$V_D = \pm 15.5\text{ V}$ , $V_S = \pm 15.5\text{ V}$                                   | Room Full                 | $\pm 0.01$        | - 0.5<br>- 20                 | 0.5<br>20         | - 0.5<br>- 5                 | 0.5<br>5          | nA            |     |
|   | $I_{D(off)}$        |   | Room Full                 | $\pm 0.01$        | - 0.5<br>- 20                 | 0.5<br>20         | - 0.5<br>- 5                 | 0.5<br>5          |               |     |
| Channel On Leakage Current                        | $I_{D(on)}$         | $V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$<br>$V_S = V_D = \pm 15.5\text{ V}$   | Room Full                 | $\pm 0.08$        | - 0.5<br>- 40                 | 0.5<br>40         | - 0.5<br>- 10                | 0.5<br>10         |               |     |
| <b>Digital Control</b>                            |                     |   |                           |                   |                               |                   |                              |                   |               |     |
| Input Current $V_{IN}$ Low                        | $I_{IL}$            | $V_{IN}$ under test = 0.8 V,<br>All Other = 2.4 V   | Full                      | - 0.01            | - 500                         | 500               | - 500                        | 500               | nA            |     |
| Input Current $V_{IN}$ High                       | $I_{IH}$            | $V_{IN}$ under test = 2.4 V<br>All Other = 0.8 V  | Full                      | 0.01              | - 500                         | 500               | - 500                        | 500               |               |     |
| <b>Dynamic Characteristics</b>                    |                     |   |                           |                   |                               |                   |                              |                   |               |     |
| Turn-On Time                                      | $t_{ON}$            | $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$<br>$V_S = \pm 10\text{ V}$<br>See Figure 2  | Room                      | 150               |                               | 250               |                              | 250               | ns            |     |
| Turn-Off Time                                     | DG441<br>DG442      |   | $t_{OFF}$                 | Room              | 90                            |                   | 120                          |                   |               | 120 |
|   |                     |   |                           | Room              | 110                           |                   | 210                          |                   |               | 210 |
| Charge Injection <sup>e</sup>                     | Q                   | $C_L = 1\text{ nF}$ , $V_S = 0\text{ V}$<br>$V_{gen} = 0\text{ V}$ , $R_{gen} = 0\ \Omega$  | Room                      | - 1               |                               |                   |                              |                   | pC            |     |
| Off Isolation <sup>e</sup>                        | OIRR                | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$<br>$f = 1\text{ MHz}$  | Room                      | 60                |                               |                   |                              |                   | dB            |     |
| Crosstalk (Channel-to-Channel)                    | $X_{TALK}$          |   | Room                      | 100               |                               |                   |                              |                   |               |     |
| Source Off Capacitance <sup>e</sup>               | $C_{S(off)}$        | $f = 1\text{ MHz}$  | Room                      | 4                 |                               |                   |                              |                   | pF            |     |
| Drain Off Capacitance <sup>e</sup>                | $C_{D(off)}$        |   | Room                      | 4                 |                               |                   |                              |                   |               |     |
| Channel On Capacitance <sup>e</sup>               | $C_{D(on)}$         |   | $V_{ANALOG} = 0\text{ V}$ | Room              | 16                            |                   |                              |                   |               |     |
| <b>Power Supplies</b>                             |                     |   |                           |                   |                               |                   |                              |                   |               |     |
| Positive Supply Current                           | $I_+$               | $V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$<br>$V_{IN} = 0$ or $5\text{ V}$  | Full                      | 15                |                               | 100               |                              | 100               | $\mu\text{A}$ |     |
| Negative Supply Current                           | $I_-$               |   | Room                      | - 0.0001          | - 1                           |                   | - 1                          |                   |               |     |
|   |                     |   | Full                      |                   | - 5                           |                   | - 5                          |                   |               |     |
| Ground Current                                    | $I_{GND}$           |   | Full                      | - 15              | - 100                         |                   | - 100                        |                   |               |     |



| <b>SPECIFICATIONS<sup>a</sup></b> (Single Supply) |              |   |                    |                   |                               |                   |                              |                   |               |
|---|--------------|---|--------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|---------------|
| Parameter   | Symbol       | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 12\text{ V}, V_- = 0\text{ V}$<br>$V_{IN} = 2.4\text{ V}, 0.8\text{ V}^f$ | Temp. <sup>b</sup> | Typ. <sup>c</sup> | A Suffix<br>- 55 °C to 125 °C |                   | D Suffix<br>- 40 °C to 85 °C |                   | Unit          |
|   |              |   |                    |                   | Min. <sup>d</sup>             | Max. <sup>d</sup> | Min. <sup>d</sup>            | Max. <sup>d</sup> |               |
| <b>Analog Switch</b>                              |              |   |                    |                   |                               |                   |                              |                   |               |
| Analog Signal Range <sup>e</sup>                  | $V_{ANALOG}$ |   | Full               |                   | 0                             | 12                | 0                            | 12                | V             |
| Drain-Source On-Resistance                        | $R_{DS(on)}$ | $I_S = -10\text{ mA}, V_D = 3\text{ V}, 8\text{ V}$<br>$V_+ = 10.8\text{ V}$  | Room<br>Full       | 100               |                               | 160<br>200        |                              | 160<br>200        | $\Omega$      |
| <b>Dynamic Characteristics</b>                    |              |   |                    |                   |                               |                   |                              |                   |               |
| Turn-On Time                                      | $t_{ON}$     | $R_L = 1\text{ k}\Omega, C_L = 35\text{ pF}$<br>$V_S = 8\text{ V}$<br>See Figure 2  | Room               | 300               |                               | 450               |                              | 450               | ns            |
| Turn-Off Time                                     | $t_{OFF}$    |   | Room               | 60                |                               | 200               |                              | 200               |               |
| Charge Injection                                  | Q            | $C_L = 1\text{ nF}, V_{gen} = 6\text{ V}, R_{gen} = 0\ \Omega$  | Room               | 2                 |                               |                   |                              |                   | pC            |
| <b>Power Supplies</b>                             |              |   |                    |                   |                               |                   |                              |                   |               |
| Positive Supply Current                           | $I_+$        | $V_+ = 13.2\text{ V}, V_- = 0\text{ V}$<br>$V_{IN} = 0\text{ or }5\text{ V}$  | Full               | 15                |                               | 100               |                              | 100               | $\mu\text{A}$ |
| Negative Supply Current                           | $I_-$        |   | Room               | - 0.0001          | - 1                           |                   | - 1                          |                   |               |
|   |              |   | Full               |                   | - 100                         |                   | - 100                        |                   |               |
| Ground Current                                    | $I_{GND}$    |   | Full               | - 15              | - 100                         |                   | - 100                        |                   |               |

Notes:

- Refer to PROCESS OPTION FLOWCHART.
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- Guaranteed by design, not subject to production test.
- $V_{IN}$  = 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** (25 °C, unless otherwise noted)



**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Power Supply Voltage**



**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature**



**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Unipolar Power Supply Voltage**



**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature (Single 12-V Supply)**

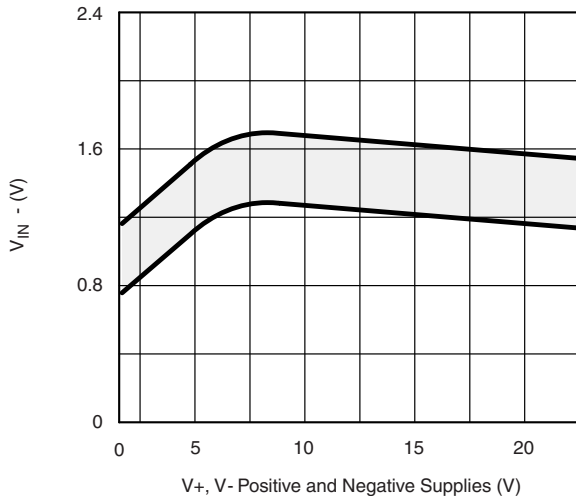


**Crosstalk and Off Isolation vs. Frequency**



**Charge Injection vs. Source Voltage**

### TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Switching Threshold vs. Supply Voltage



Source/Drain Leakage Currents



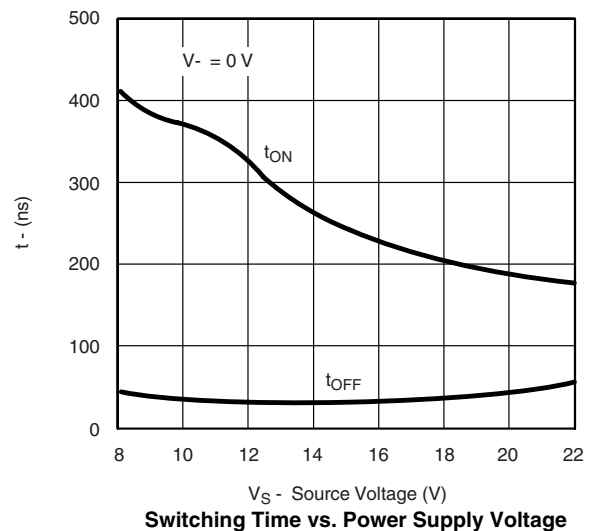
Source/Drain Leakage Currents (Single 12 V Supply)



Operating Voltage



Switching Time vs. Power Supply Voltage



Switching Time vs. Power Supply Voltage

## TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)

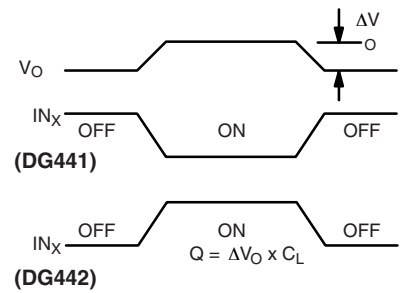


Note: Logic input waveform is inverted for DG442.

**Figure 2. Switching Time**



**Figure 3. Charge Injection**



$C = 1 \text{ mF}$  tantalum in parallel with  $0.01 \text{ mF}$  ceramic



$$X_{\text{TALK Isolation}} = 20 \log \left| \frac{V_S}{V_O} \right|$$

$C = \text{RF bypass}$

**Figure 4. Crosstalk**



$$\text{Off Isolation} = 20 \log \left| \frac{V_S}{V_O} \right|$$

**Figure 5. Off Isolation**



**Figure 6. Source/Drain Capacitances**

## APPLICATIONS

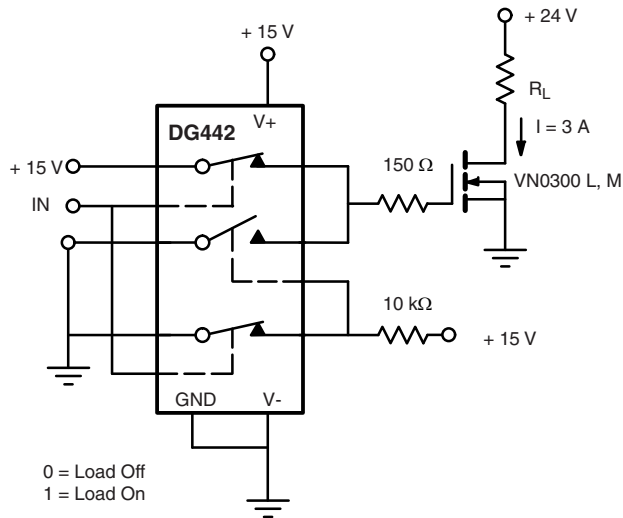


Figure 7. Power MOSFET Driver



Figure 8. Open Loop Sample-and-Hold



Figure 9. Precision-Weighted Resistor Programmable-Gain Amplifier

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



| Dim            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.20  | 0.004     | 0.008 |
| B              | 0.38        | 0.51  | 0.015     | 0.020 |
| C              | 0.18        | 0.23  | 0.007     | 0.009 |
| D              | 9.80        | 10.00 | 0.385     | 0.393 |
| E              | 3.80        | 4.00  | 0.149     | 0.157 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H              | 5.80        | 6.20  | 0.228     | 0.244 |
| L              | 0.50        | 0.93  | 0.020     | 0.037 |
| ∅              | 0°          | 8°    | 0°        | 8°    |

ECN: S-03946—Rev. F, 09-Jul-01  
DWG: 5300



### PDIP: 16-LEAD



| Dim                  | MILLIMETERS |       | INCHES |       |
|----------------------|-------------|-------|--------|-------|
|                      | Min         | Max   | Min    | Max   |
| <b>A</b>             | 3.81        | 5.08  | 0.150  | 0.200 |
| <b>A<sub>1</sub></b> | 0.38        | 1.27  | 0.015  | 0.050 |
| <b>B</b>             | 0.38        | 0.51  | 0.015  | 0.020 |
| <b>B<sub>1</sub></b> | 0.89        | 1.65  | 0.035  | 0.065 |
| <b>C</b>             | 0.20        | 0.30  | 0.008  | 0.012 |
| <b>D</b>             | 18.93       | 21.33 | 0.745  | 0.840 |
| <b>E</b>             | 7.62        | 8.26  | 0.300  | 0.325 |
| <b>E<sub>1</sub></b> | 5.59        | 7.11  | 0.220  | 0.280 |
| <b>e<sub>1</sub></b> | 2.29        | 2.79  | 0.090  | 0.110 |
| <b>e<sub>A</sub></b> | 7.37        | 7.87  | 0.290  | 0.310 |
| <b>L</b>             | 2.79        | 3.81  | 0.110  | 0.150 |
| <b>Q<sub>1</sub></b> | 1.27        | 2.03  | 0.050  | 0.080 |
| <b>S</b>             | 0.38        | 1.52  | .015   | 0.060 |

ECN: S-03946—Rev. D, 09-Jul-01  
DWG: 5482

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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