

## Quad SPST CMOS Analog Switches

### FEATURES

- 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

### 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

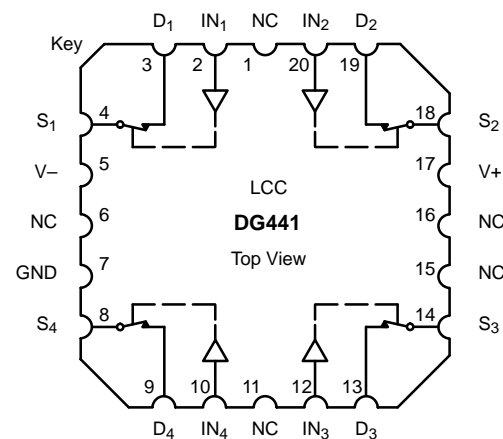
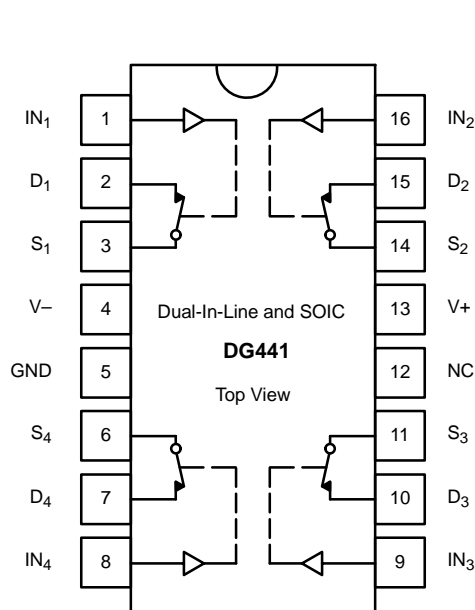
### DESCRIPTION

The DG441/442 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 DG441/442 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 DG441/442 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.

### 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 to 85°C          | 16-Pin Plastic DIP | DG441DJ         |
|                      |                    | DG442DJ         |
|                      | 16-Pin Narrow SOIC | DG441DY         |
|                      |                    | DG442DY         |
| -55 to 125°C         | 16-Pin CerDIP      | DG441AK         |
|                      |                    | DG441AK/883     |
|                      |                    | 5962-9204101MEA |
|                      |                    | DG442AK         |
|                      |                    | DG442AK/883     |
|                      |                    | 5962-9204102MEA |
|                      | LCC-20             | 5962-9204101M2A |
|                      |                    | 5962-9204102M2A |

**ABSOLUTE MAXIMUM RATINGS**

|   |  |
|---|--|
| V+ to V-  | 44 V   |
| GND to V-   | 25 V   |
| Digital Inputs <sup>a</sup> V <sub>S</sub> , V <sub>D</sub> | (V-) -2 V to (V+) +2 V<br>or 30 mA, whichever occurs first |
| Continuous Current (Any Terminal)                           | 30 mA  |
| Current, S or D (Pulsed 1 ms, 10% duty cycle)               | 100 mA   |
| Storage Temperature (AK Suffix)                             | -65 to 150°C   |
| (DJ, DY Suffix)   | -65 to 125°C   |

|  |         |
|--|---------|
| Power Dissipation (Package) <sup>b</sup> |         |
| 16-Pin Plastic DIP <sup>c</sup>          | 450 mW  |
| 16-Pin CerDIP <sup>d</sup>               | 900 mW  |
| 16-Pin Narrow Body SOIC <sup>d</sup>     | 900 mW  |
| LCC-20 <sup>d</sup>                      | 1200 mW |

- Notes:
- 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.
  - All leads welded or soldered to PC Board.
  - Derate 6 mW/°C above 75°C
  - Derate 12 mW/°C above 25°C

**SCHEMATIC DIAGRAM (TYPICAL CHANNEL)**

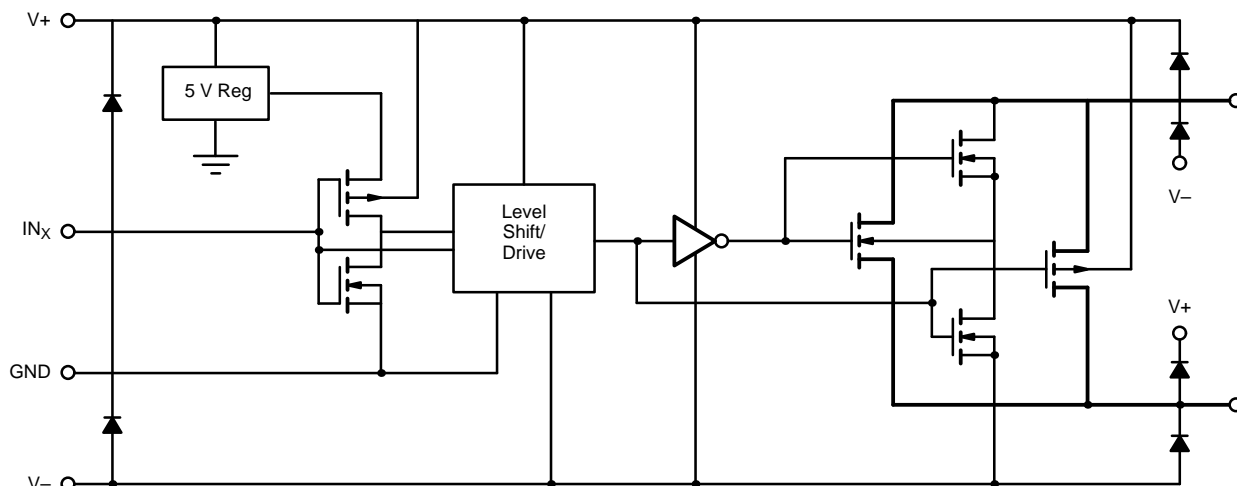


FIGURE 1.



| SPECIFICATIONS <sup>a</sup> FOR DUAL SUPPLIES     |                     |   |                   |                  |                          |                  |                         |                  |               |     |
|---|---------------------|---|-------------------|------------------|--------------------------|------------------|-------------------------|------------------|---------------|-----|
| Parameter   | Symbol              | Test Conditions<br>Unless Otherwise Specified<br>$V_+ = 15\text{ V}, V_- = -15\text{ V}, V_{IN} = 2.4\text{ V}, 0.8\text{ V}^f$ | Temp <sup>b</sup> | Typ <sup>c</sup> | A Suffix<br>-55 to 125°C |                  | D Suffix<br>-40 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<br>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<br>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>$V_D = \pm 15.5\text{ V}, V_S = \mp 15.5\text{ V}$                               | Room<br>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<br>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<br>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, 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, 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>$V_S = \pm 10\text{ V}$ , See Figure 2  | Room              | 150              |                          | 250              |                         | 250              | ns            |     |
| Turn-Off Time                                     | DG441               |   | $t_{OFF}$         | Room             | 90                       |                  | 120                     |                  |               | 120 |
|   | DG442               |   | $t_{OFF}$         | Room             | 110                      |                  | 210                     |                  |               | 210 |
| Charge Injection <sup>e</sup>                     | Q                   | $C_L = 1\text{ nF}, V_S = 0\text{ V}$<br>$V_{gen} = 0\text{ V}, R_{gen} = 0\text{ }\Omega$                                      | Room              | -1               |                          |                  |                         |                  | pC            |     |
| Off Isolation <sup>e</sup>                        | OIRR                | $R_L = 50\text{ }\Omega, C_L = 5\text{ pF}$<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>$V_{IN} = 0\text{ or }5\text{ V}$  | Full              | 15               |                          | 100              |                         | 100              | $\mu\text{A}$ |     |
| Negative Supply Current                           | $I_-$               |   | Room<br>Full      | -0.000<br>1      | -1<br>-5                 |                  | -1<br>-5                |                  |               |     |
| Ground Current                                    | $I_{GND}$           |   | Full              | -15              | -100                     |                  | -100                    |                  |               |     |

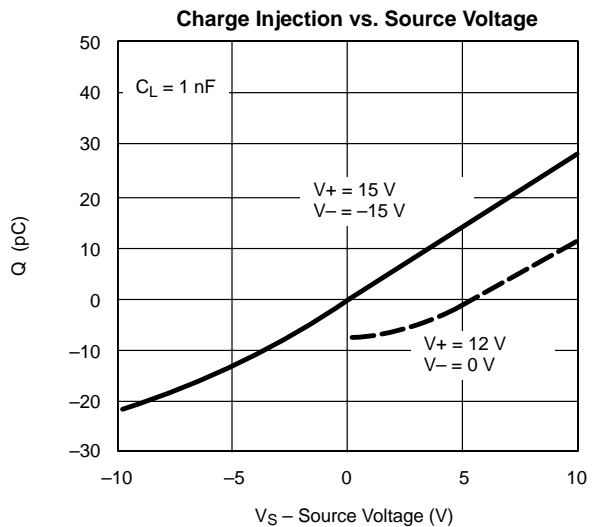
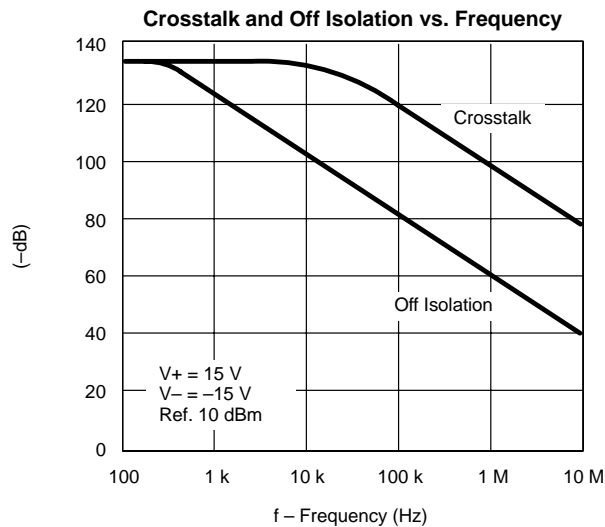
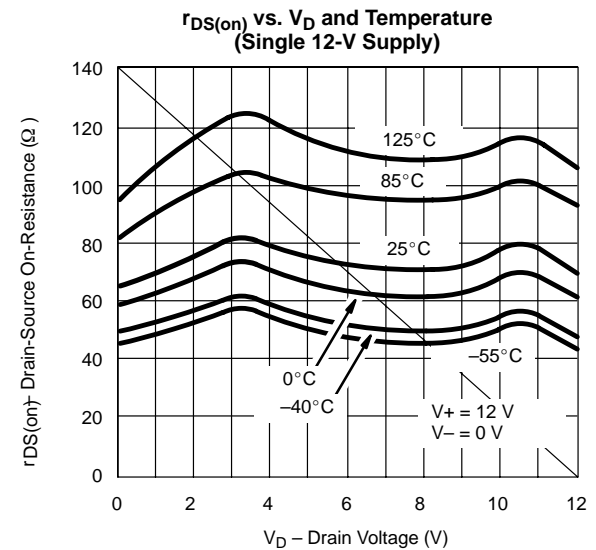
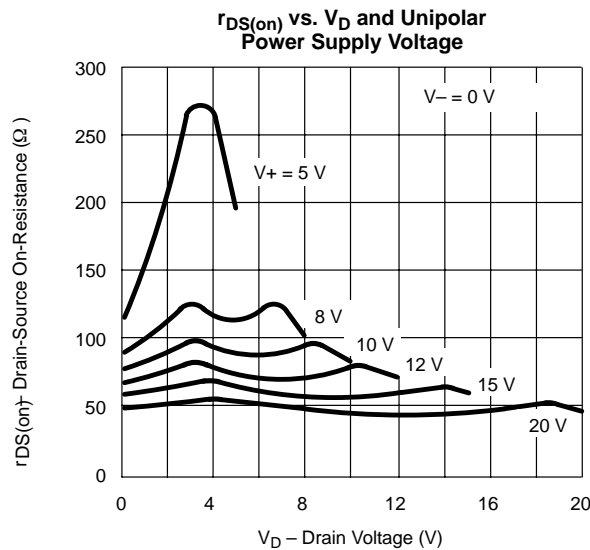
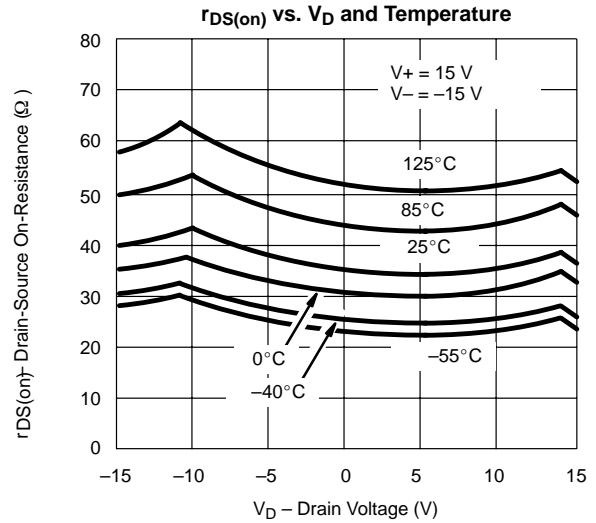
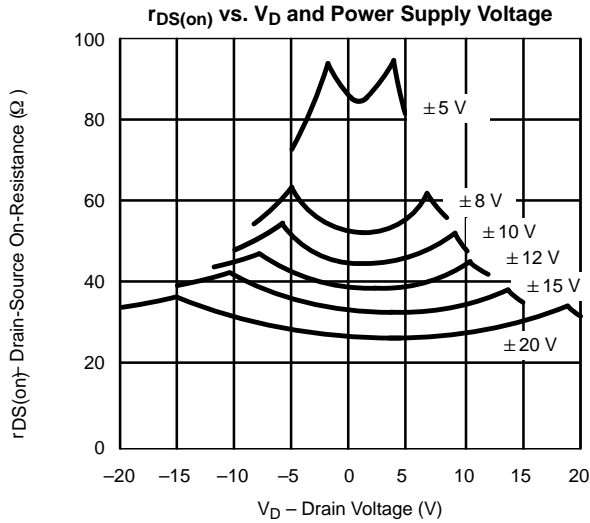


| SPECIFICATIONS <sup>a</sup> FOR SINGLE SUPPLY |              |   |                   |                  |                          |                  |                         |                  |               |
|---|--------------|---|-------------------|------------------|--------------------------|------------------|-------------------------|------------------|---------------|
| Parameter                                     | Symbol       | Test Conditions<br>Otherwise Unless Specified<br>$V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$ , $V_{IN} = 2.4\text{ V}$ ,<br>$0.8\text{ V}^f$ | Temp <sup>b</sup> | Typ <sup>c</sup> | A Suffix<br>-55 to 125°C |                  | D Suffix<br>-40 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>$V_S = 8\text{ V}$ , 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<br>Full      | -0.0001          | -1<br>-100               |                  | -1<br>-100              |                  |               |
| Ground Current                                | $I_{GND}$    |   | Full              | -15              | -100                     |                  | -100                    |                  |               |

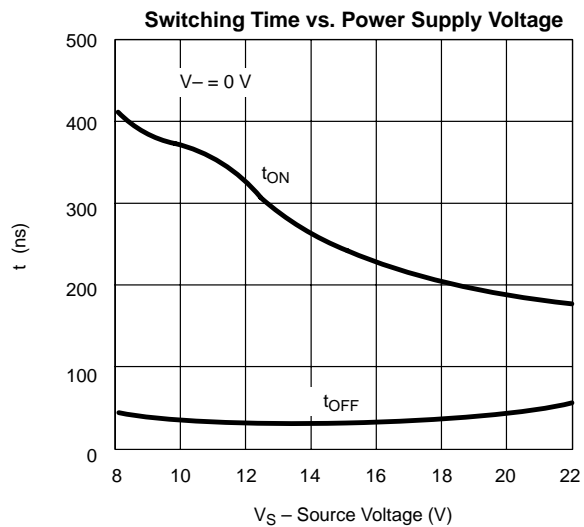
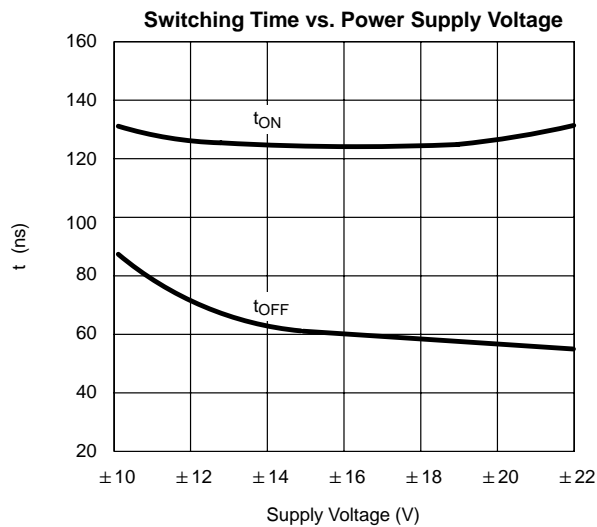
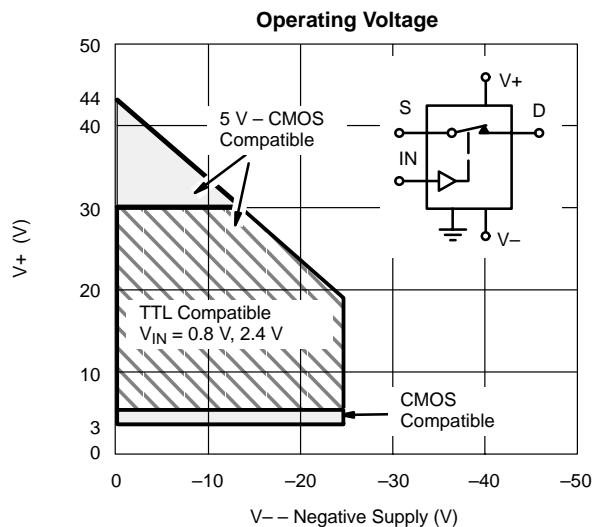
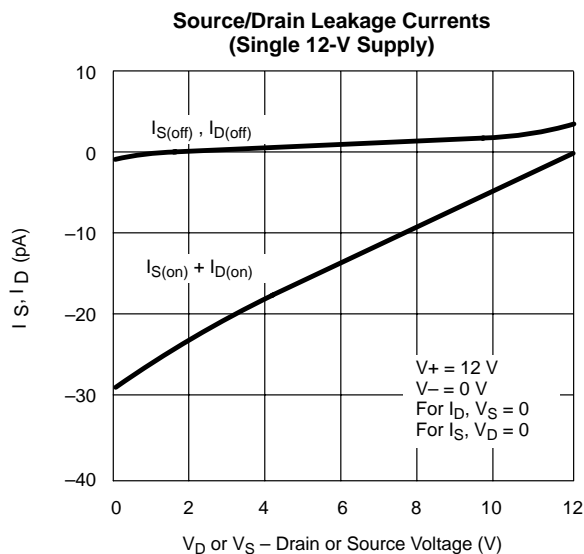
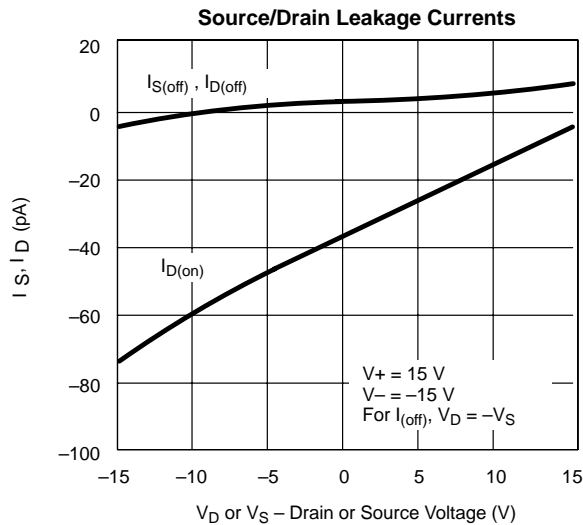
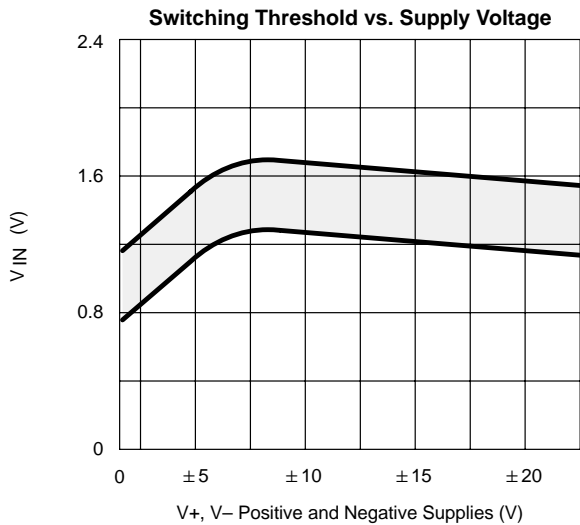
Notes:

- 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 data sheet.
- Guaranteed by design, not subject to production test.
- $V_{IN}$  = input voltage to perform proper function.

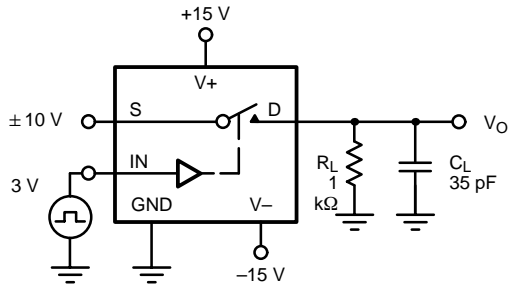
**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



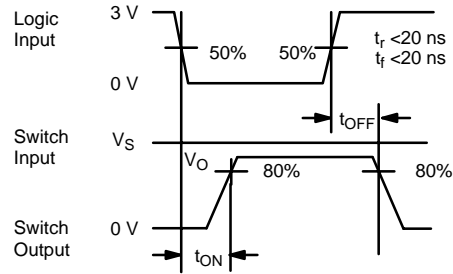
**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



**TEST CIRCUITS**

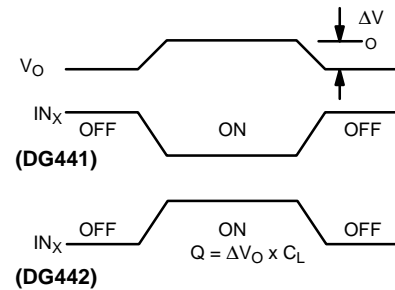
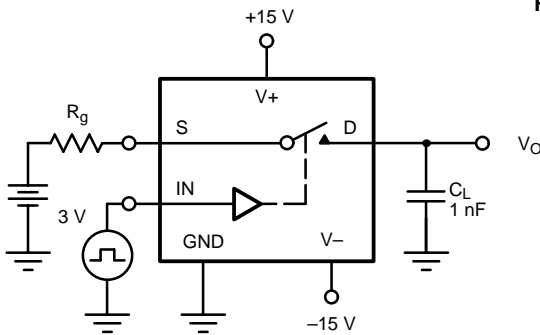


$C_L$  (includes fixture and stray capacitance)

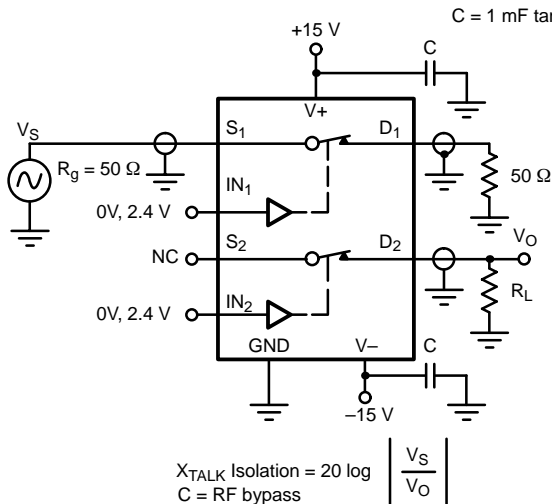


Note: Logic input waveform is inverted for DG442.

**FIGURE 2. Switching Time**



**FIGURE 3. Charge Injection**

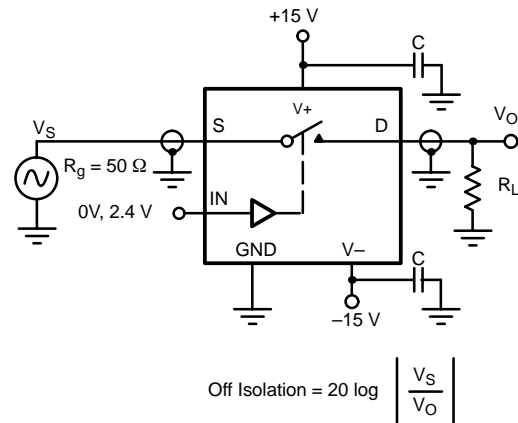


$C = 1 \text{ mF}$  tantalum in parallel with  $0.01 \text{ mF}$  ceramic

**FIGURE 4. Crosstalk**

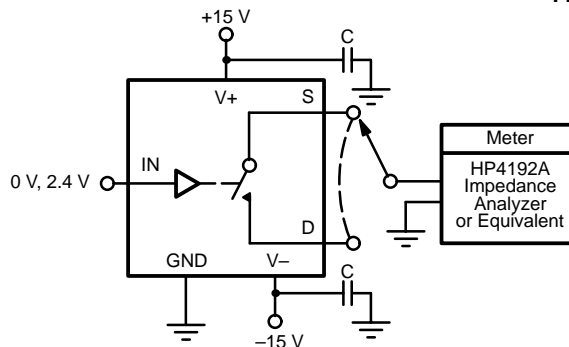
$$X_{\text{TALK Isolation}} = 20 \log \left| \frac{V_S}{V_O} \right|$$

$C = \text{RF bypass}$



**FIGURE 5. Off Isolation**

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



**FIGURE 6. Source/Drain Capacitances**

**APPLICATIONS**

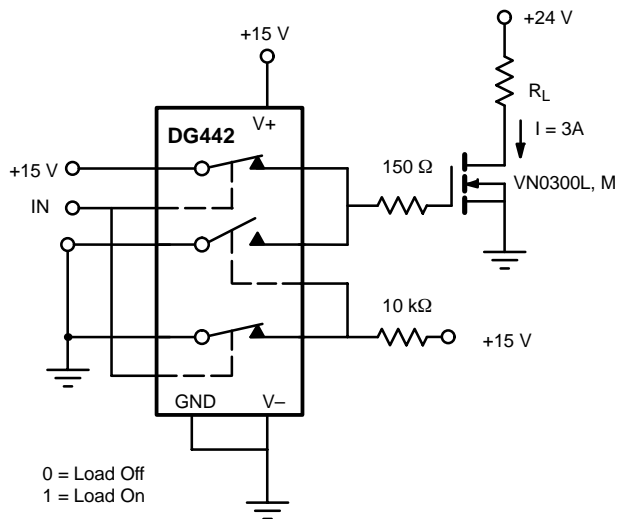


FIGURE 7. Power MOSFET Driver

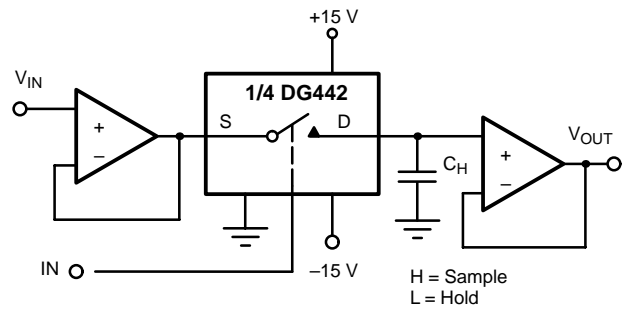
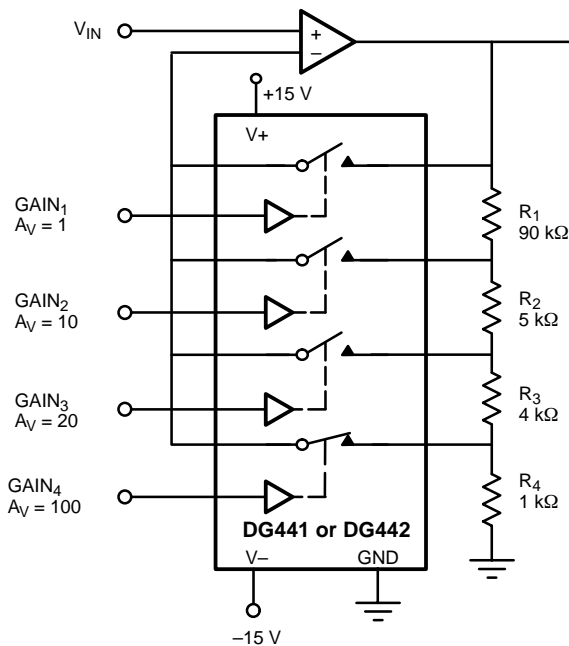


FIGURE 8. Open Loop Sample-and-Hold



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

With SW<sub>4</sub> Closed

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

FIGURE 9. Precision-Weighted Resistor Programmable-Gain Amplifier