

**Monolithic, Quad SPST, CMOS Analog Switches**

The DG441 and DG442 monolithic CMOS analog switches are drop-in replacements for the popular DG201A and DG202 series devices. They include four independent single pole single throw (SPST) analog switches, TTL and CMOS compatible digital inputs, and a voltage reference for logic thresholds.

These switches feature lower analog ON resistance (<85Ω) and faster switch time ( $t_{ON} < 250ns$ ) compared to the DG201A and DG202. Charge injection has been reduced, simplifying sample and hold applications.

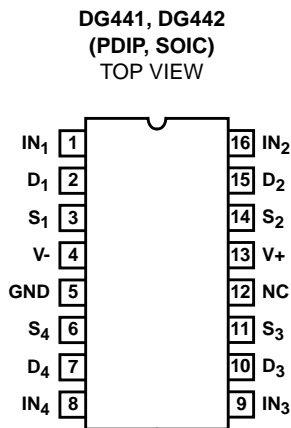
The improvements in the DG441 series are made possible by using a high voltage silicon-gate process. An epitaxial layer prevents the latch-up associated with older CMOS technologies. The 44V maximum voltage range permits controlling 40V<sub>P-P</sub> signals. Power supplies may be single-ended from +5V to +34V, or split from ±5V to ±20V.

The four switches are bilateral, equally matched for AC or bidirectional signals. The ON resistance variation with analog signals is quite low over a ±5V analog input range. The switches in the DG441 and DG442 are identical, differing only in the polarity of the selection logic.

**Ordering Information**

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE    | PKG. NO. |
|-------------|------------------|------------|----------|
| DG441DJ     | -40 to 85        | 16 Ld PDIP | E16.3    |
| DG441DY     | -40 to 85        | 16 Ld SOIC | M16.15   |
| DG442DJ     | -40 to 85        | 16 Ld PDIP | E16.3    |
| DG442DY     | -40 to 85        | 16 Ld SOIC | M16.15   |

**Pinout**



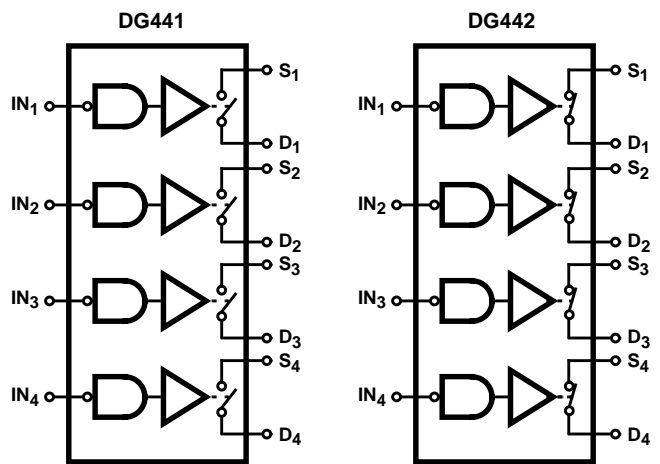
**Features**

- ON Resistance (Max) . . . . . 85Ω
- Low Power Consumption (P<sub>D</sub>) . . . . . <1.6mW
- Fast Switching Action
  - $t_{ON}$  (Max) . . . . . 250ns
  - $t_{OFF}$  (Max, DG441) . . . . . 120ns
- Low Charge Injection
- Upgrade from DG201A/DG202
- TTL, CMOS Compatible
- Single or Split Supply Operation

**Applications**

- Audio Switching
- Battery Operated Systems
- Data Acquisition
- Hi-Rel Systems
- Sample and Hold Circuits
- Communication Systems
- Automatic Test Equipment

**Functional Diagrams**

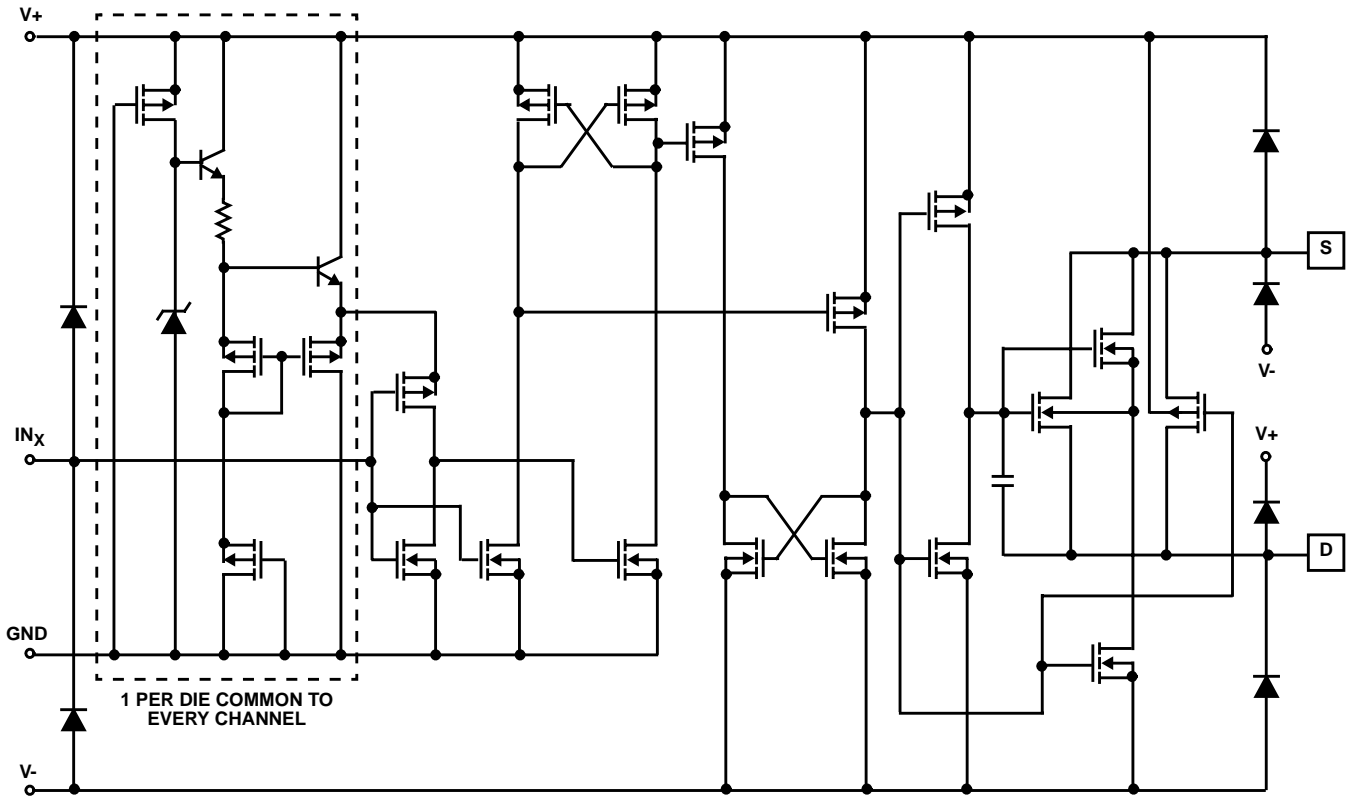


SWITCHES SHOWN FOR LOGIC "1" INPUT

TRUTH TABLE

| LOGIC | V <sub>IN</sub> | DG441 | DG442 |
|-------|-----------------|-------|-------|
| 0     | ≤0.8V           | ON    | OFF   |
| 1     | ≥2.4V           | OFF   | ON    |

**Schematic Diagram** (One Channel)



**Pin Descriptions**

| PIN | SYMBOL          | DESCRIPTION                                |
|-----|-----------------|--|
| 1   | IN <sub>1</sub> | Logic Control for Switch 1                 |
| 2   | D <sub>1</sub>  | Drain (Output) Terminal for Switch 1       |
| 3   | S <sub>1</sub>  | Source (Input) Terminal for Switch 1       |
| 4   | V-              | Negative Power Supply Terminal             |
| 5   | GND             | Ground Terminal (Logic Common)             |
| 6   | S <sub>4</sub>  | Source (Input) Terminal for Switch 4       |
| 7   | D <sub>4</sub>  | Drain (Output) Terminal for Switch 4       |
| 8   | IN <sub>4</sub> | Logic Control for Switch 4                 |
| 9   | IN <sub>3</sub> | Logic Control for Switch 3                 |
| 10  | D <sub>3</sub>  | Drain (Output) Terminal for Switch 3       |
| 11  | S <sub>3</sub>  | Source (Input) Terminal for Switch 3       |
| 12  | NC              | No Internal Connection                     |
| 13  | V+              | Positive Power Supply Terminal (Substrate) |
| 14  | S <sub>2</sub>  | Source (Input) Terminal for Switch 2       |
| 15  | D <sub>2</sub>  | Drain (Output) Terminal for Switch 2       |
| 16  | IN <sub>2</sub> | Logic Control for Switch 2                 |

# DG441, DG442

## Absolute Maximum Ratings

|  |  |
|--|--|
| V+ to V-   | 44.0V  |
| GND to V-  | 25V  |
| Digital Inputs, V <sub>S</sub> , V <sub>D</sub> (Note 1) | (V-) -2V to (V+) + 2V or 30mA,<br>Whichever Occurs First |
| Continuous Current (Any Terminal)                        | 30mA   |
| Peak Current, S or D (Pulsed 1ms, 10% Duty Cycle Max)    | 100mA  |

## Operating Conditions

|                          |               |
|--------------------------|---------------|
| Temperature Range        | -40°C to 85°C |
| Voltage Range            | ±20V (Max)    |
| Input Low Voltage        | 0.8V (Max)    |
| Input High Voltage       | 2.4V (Min)    |
| Input Rise and Fall Time | ≤20ns         |

## Thermal Information

|   |                                  |
|---|----------------------------------|
| Thermal Resistance (Typical, Note 2)            | θ <sub>JA</sub> (°C/W)           |
| PDIP Package                                    | 90                               |
| SOIC Package                                    | 115                              |
| Maximum Junction Temperature (Plastic Packages) | 150°C                            |
| Maximum Storage Temperature Range               | -65°C to 150°C                   |
| Maximum Lead Temperature (Soldering 10s)        | 300°C<br>(SOIC - Lead Tips Only) |

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### 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.
- θ<sub>JA</sub> is measured with the component mounted on an evaluation PC board in free air.

## Electrical Specifications (Dual Supply) Test Conditions: V+ = +15V, V- = -15V, V<sub>IN</sub> = 2.4V, 0.8V, V<sub>ANALOG</sub> = V<sub>S</sub>, V<sub>D</sub>, Unless Otherwise Specified

| PARAMETER   | TEST CONDITIONS  | TEMP (°C) | MIN  | (NOTE 3) TYP | MAX | UNITS |
|---|--|-----------|------|--------------|-----|-------|
| <b>DYNAMIC CHARACTERISTICS</b>                                      |  |           |      |              |     |       |
| Turn-ON Time, t <sub>ON</sub>                                       | R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF, V <sub>S</sub> = ±10V, (Figure 1) | 25        | -    | 150          | 250 | ns    |
| Turn-OFF Time, t <sub>OFF</sub>                                     |  | 25        | -    | 90           | 120 | ns    |
|   |  |           | -    | 110          | 210 | ns    |
| Charge Injection, Q (Figure 2)                                      | C <sub>L</sub> = 1nF, V <sub>G</sub> = 0V, R <sub>G</sub> = 0Ω                 | 25        | -    | -1           | -   | pC    |
| OFF Isolation (Figure 4)  | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz                           | 25        | -    | 60           | -   | dB    |
| Crosstalk (Channel-to-Channel) (Figure 3)                           |  | 25        | -    | -100         | -   | dB    |
| Source OFF Capacitance, C <sub>S(OFF)</sub>                         | f = 1MHz, V <sub>ANALOG</sub> = 0 (Figure 5)                                   | 25        | -    | 4            | -   | pF    |
| Drain OFF Capacitance, C <sub>D(OFF)</sub>                          |  | 25        | -    | 4            | -   | pF    |
| Channel ON Capacitance, C <sub>D(ON)</sub> + C <sub>S(ON)</sub>     |  | 25        | -    | 16           | -   | pF    |
| <b>DIGITAL INPUT CHARACTERISTICS</b>                                |  |           |      |              |     |       |
| Input Current V <sub>IN</sub> Low, I <sub>IL</sub>                  | V <sub>IN</sub> Under Test = 0.8V, All Others = 2.4V                           | Full      | -0.5 | -0.00001     | 0.5 | μA    |
| Input Current V <sub>IN</sub> High, I <sub>IH</sub>                 | V <sub>IN</sub> Under Test = 2.4V, All Others = 0.8V                           | Full      | -0.5 | 0.00001      | 0.5 | μA    |
| <b>ANALOG SWITCH CHARACTERISTICS</b>                                |  |           |      |              |     |       |
| Analog Signal Range, V <sub>ANALOG</sub>                            |  | Full      | -15  | -            | 15  | V     |
| Drain-Source ON Resistance, r <sub>DS(ON)</sub>                     | I <sub>S</sub> = ±10mA, V <sub>D</sub> = ±8.5V, V+ = 13.5V, V- = -13.5V        | 25        | -    | 50           | 85  | Ω     |
|   |  | 85        | -    | -            | 100 | Ω     |
| Source OFF Leakage Current, I <sub>S(OFF)</sub>                     | V+ = 16.5V, V- = -16.5V, V <sub>D</sub> = ±15.5V, V <sub>S</sub> = ±15.5V      | 25        | -0.5 | 0.01         | 0.5 | nA    |
|   |  | 85        | -5   | -            | 5   | nA    |
| Drain OFF Leakage Current, I <sub>D(OFF)</sub>                      |  | 25        | -0.5 | 0.01         | 0.5 | nA    |
|   |  | 85        | -5   | -            | 5   | nA    |
| Channel ON Leakage Current, I <sub>D(ON)</sub> + I <sub>S(ON)</sub> | V+ = 16.5V, V- = -16.5V, V <sub>S</sub> = V <sub>D</sub> = ±15.5V              | 25        | -0.5 | 0.08         | 0.5 | nA    |
|   |  | 85        | -10  | -            | 10  | nA    |
| <b>POWER SUPPLY CHARACTERISTICS</b>                                 |  |           |      |              |     |       |
| Positive Supply Current, I+   | V+ = 16.5V, V- = -16.5V, V <sub>IN</sub> = 0V or 5V                            | Full      | -    | 15           | 100 | μA    |
| Negative Supply Current, I-   |  | 25        | -1   | -0.0001      | -   | μA    |
|   |  | Full      | -5   | -            | -   | μA    |
| Ground Current, I <sub>GND</sub>                                    |  | Full      | -100 | -15          | -   | μA    |

**Electrical Specifications** (Single Supply) Test Conditions:  $V_+ = 12V$ ,  $V_- = 0V$ ,  $V_{IN} = 2.4V$ ,  $0.8V$ , Unless Otherwise Specified

| PARAMETER                                | TEST CONDITIONS   | TEMP (°C) | MIN  | (NOTE 3) TYP | MAX | UNITS    |
|--|---|-----------|------|--------------|-----|----------|
| <b>DYNAMIC CHARACTERISTICS</b>           |   |           |      |              |     |          |
| Turn-ON Time, $t_{ON}$                   | $R_L = 1k\Omega$ , $C_L = 35pF$ , $V_S = 8V$ , (Figure 1) | 25        | -    | 300          | 450 | ns       |
| Turn-OFF Time, $t_{OFF}$                 |   | 25        | -    | 60           | 200 | ns       |
| Charge Injection, Q (Figure 2)           | $C_L = 1nF$ , $V_G = 6V$ , $R_G = 0\Omega$                | 25        | -    | 2            | -   | pC       |
| <b>ANALOG SWITCH CHARACTERISTICS</b>     |   |           |      |              |     |          |
| Analog Signal Range, $V_{ANALOG}$        |   | Full      | 0    | -            | 12  | V        |
| Drain-Source ON Resistance, $r_{DS(ON)}$ | $I_S = 10mA$ , $V_D = 3V$ , $8V$ $V_+ = 10.8V$            | 25        | -    | 100          | 160 | $\Omega$ |
|  |   | Full      | -    | -            | 200 | $\Omega$ |
| <b>POWER SUPPLY CHARACTERISTICS</b>      |   |           |      |              |     |          |
| Positive Supply Current, $I_+$           | $V_+ = 13.2V$ , $V_- = 0V$ , $V_{IN} = 0V$ or $5V$        | Full      | -    | 15           | 100 | $\mu A$  |
| Negative Supply Current, $I_-$           |   | 25        | -1   | -0.0001      | -   | $\mu A$  |
|  |   | Full      | -100 | -0.0001      | -   | $\mu A$  |
| Ground Current, $I_{GND}$                |   | Full      | -100 | -15          | -   | $\mu A$  |

NOTES:

- 3. Typical values are for DESIGN AID ONLY, not guaranteed nor production tested.

**Test Circuits and Waveforms**

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

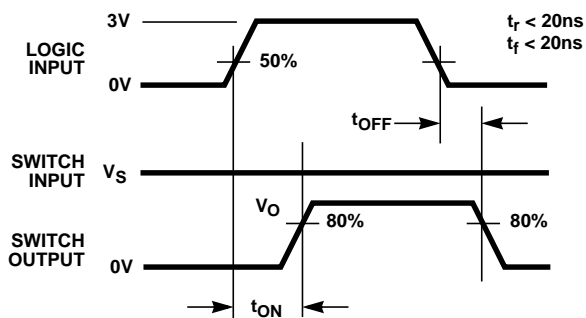
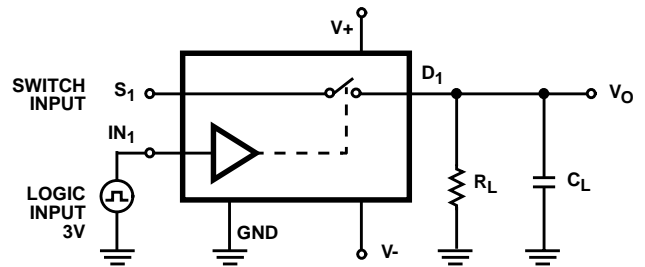


FIGURE 1A. MEASUREMENT POINTS



Repeat test for Channels 2, 3 and 4.  
For load conditions, see Specifications.  $C_L$  includes fixture and stray capacitance.

$$V_O = V_S \frac{R_L}{R_L + r_{DS(ON)}}$$

FIGURE 1B. TEST CIRCUIT

FIGURE 1. SWITCHING TIMES

NOTE: Logic input waveform is inverted for switches that have the opposite logic sense.

Test Circuits and Waveforms (Continued)

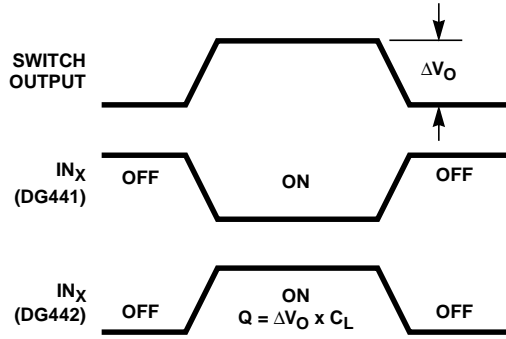


FIGURE 2A. MEASUREMENT POINTS

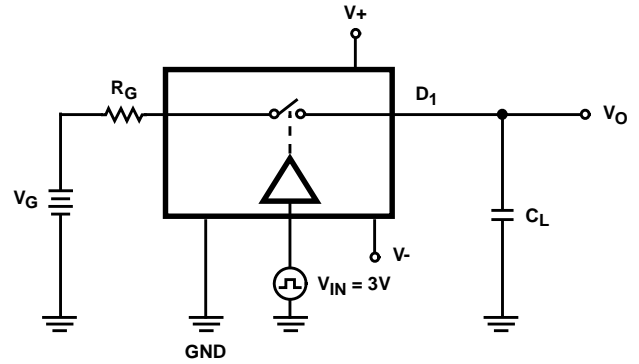


FIGURE 2B. TEST CIRCUIT

FIGURE 2. CHARGE INJECTION

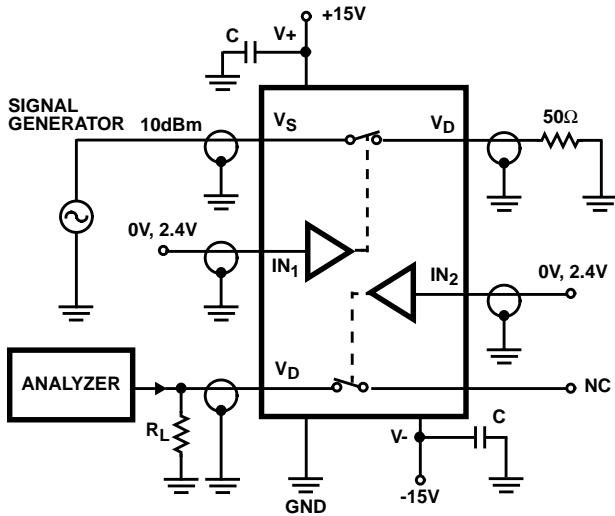


FIGURE 3. CROSTALK TEST CIRCUIT

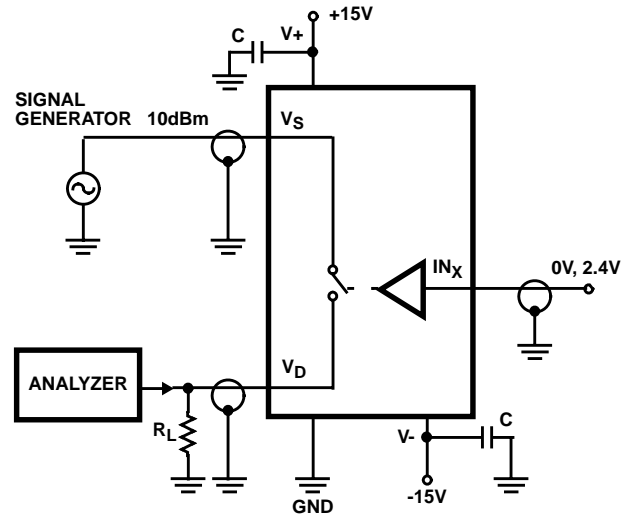


FIGURE 4. OFF ISOLATION TEST CIRCUIT

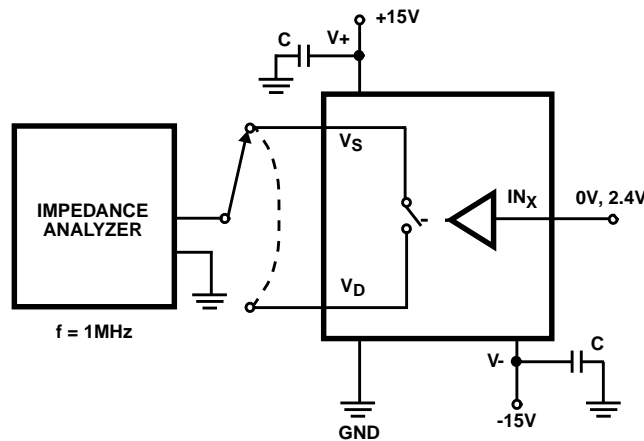
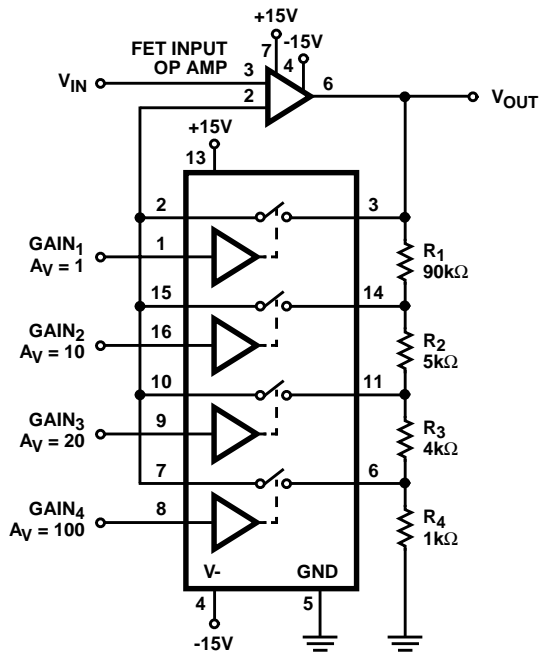


FIGURE 5. SOURCE/DRAIN CAPACITANCES TEST CIRCUIT

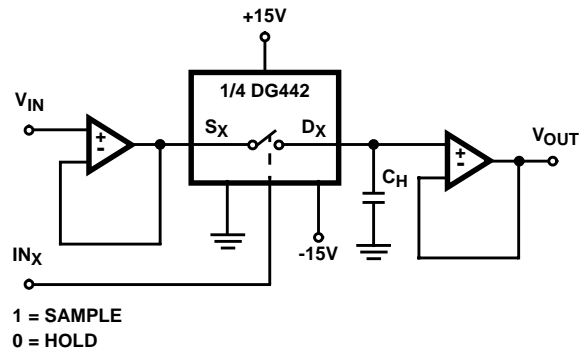
### Application Information

GAIN ERROR IS DETERMINED ONLY BY THE RESISTOR TOLERANCE. OP AMP OFFSET AND CMRR WILL LIMIT ACCURACY OF CIRCUIT.



$$\frac{V_{OUT}}{V_{IN}} = \frac{R_1 + R_2 + R_3 + R_4}{R_4} = 100 \text{ with SW}_4 \text{ closed}$$

FIGURE 6. PRECISION WEIGHTED RESISTOR PROGRAMMABLE GAIN AMPLIFIER



1 = SAMPLE  
0 = HOLD

FIGURE 7. OPEN LOOP SAMPLE AND HOLD

### Typical Performance Curves

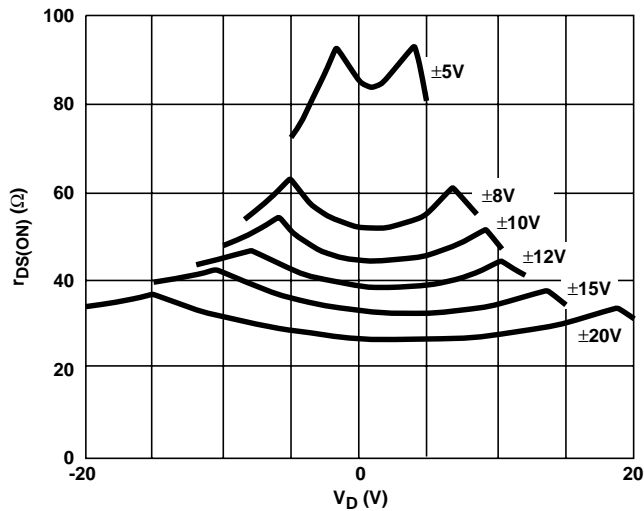


FIGURE 8.  $r_{DS(ON)}$  vs  $V_D$  AND POWER SUPPLY VOLTAGE

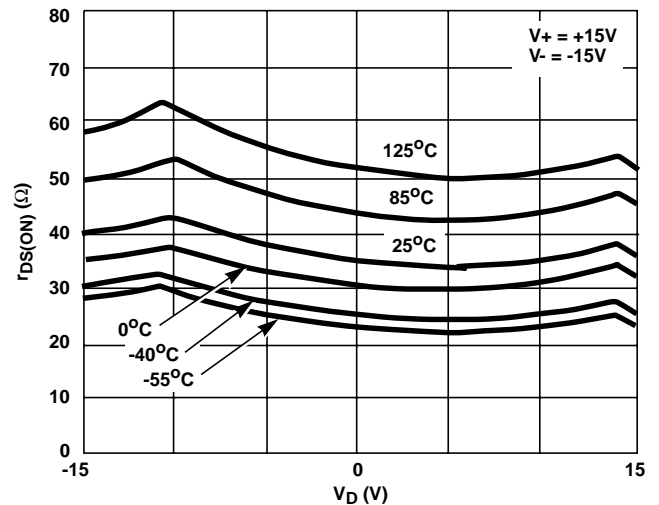


FIGURE 9.  $r_{DS(ON)}$  vs  $V_D$  AND TEMPERATURE

Typical Performance Curves (Continued)

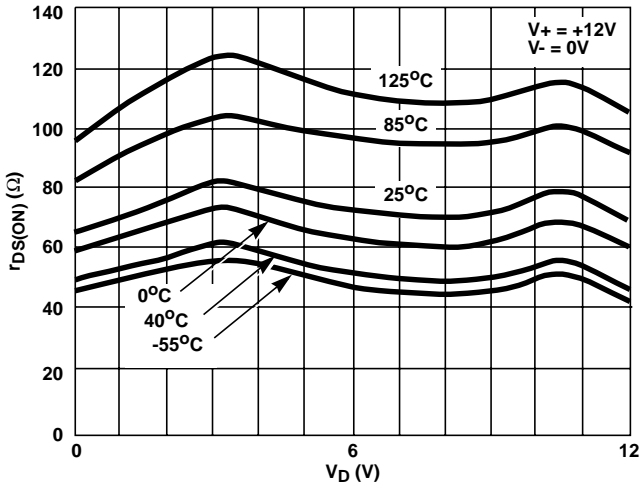


FIGURE 10.  $r_{DS(ON)}$  vs  $V_D$  AND TEMPERATURE (SINGLE 12V SUPPLY)

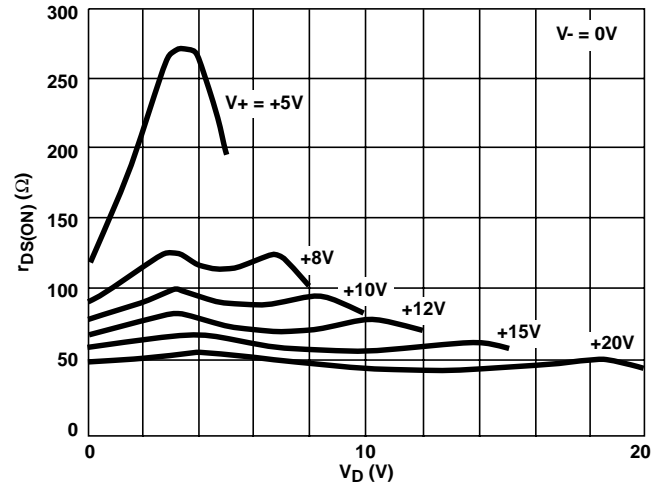


FIGURE 11.  $r_{DS(ON)}$  vs  $V_D$  AND SINGLE SUPPLY VOLTAGE

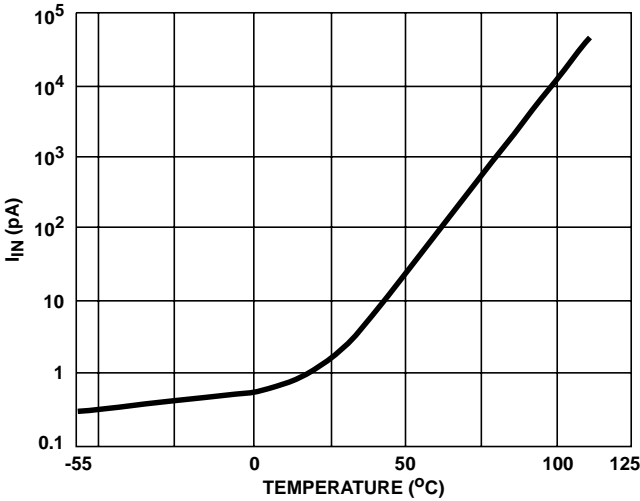


FIGURE 12. INPUT CURRENT vs TEMPERATURE

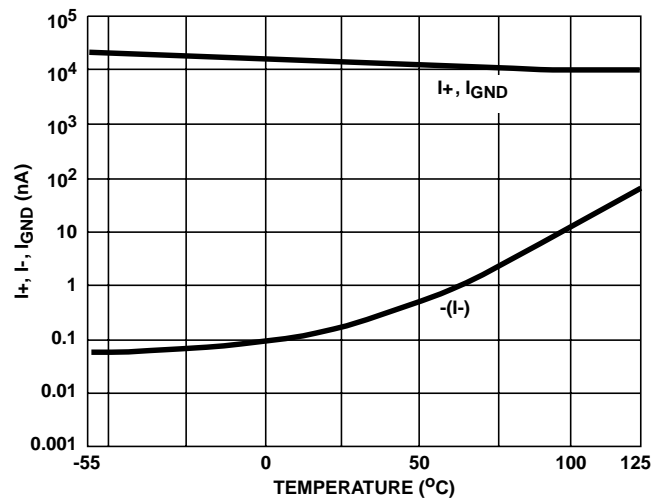


FIGURE 13. SUPPLY CURRENT vs TEMPERATURE

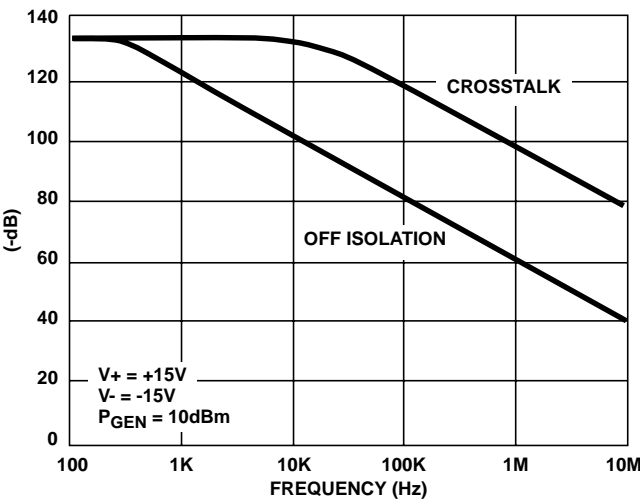


FIGURE 14. CROSSTALK AND OFF ISOLATION vs FREQUENCY

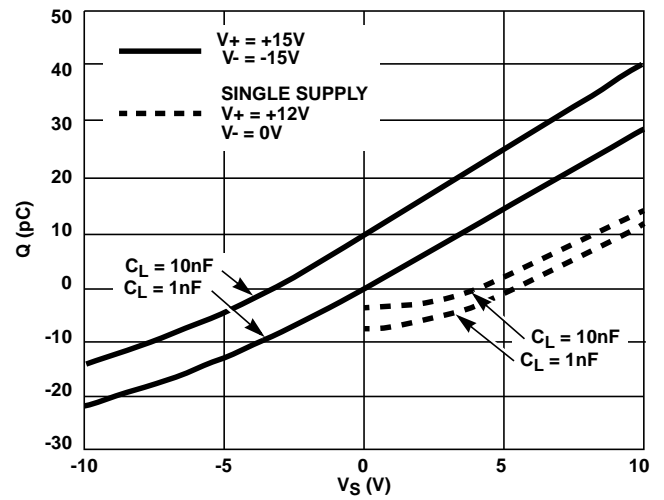


FIGURE 15. CHARGE INJECTION vs SOURCE VOLTAGE

Typical Performance Curves (Continued)

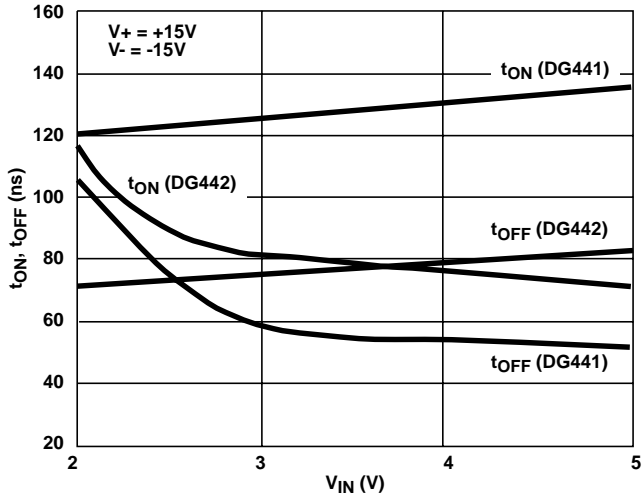


FIGURE 16. SWITCHING TIMES vs INPUT VOLTAGE

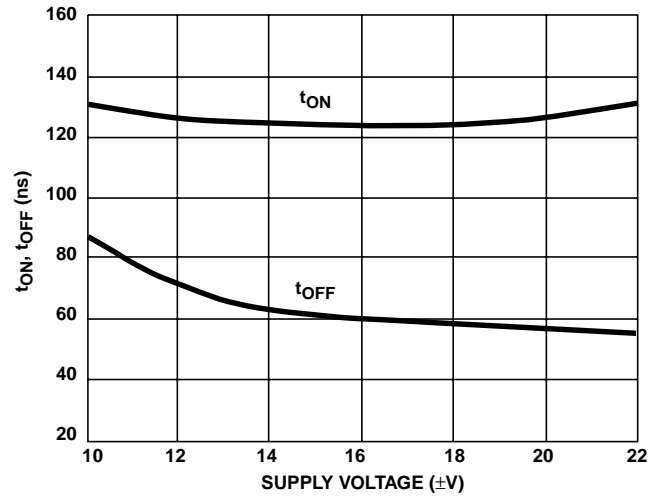


FIGURE 17. SWITCHING TIME vs POWER SUPPLY VOLTAGE (DG441)

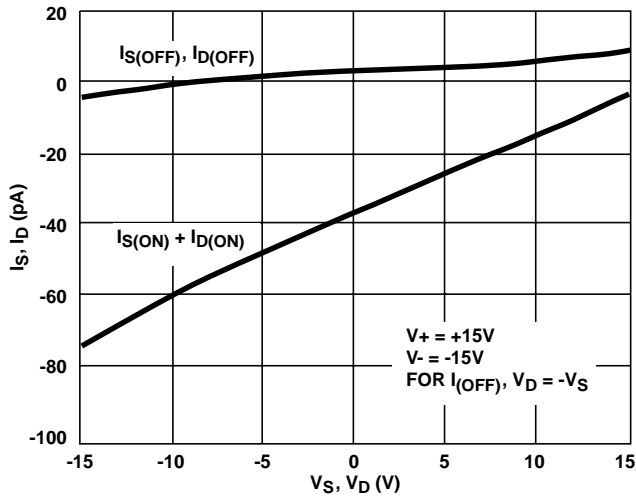


FIGURE 18. LEAKAGE CURRENT vs ANALOG VOLTAGE

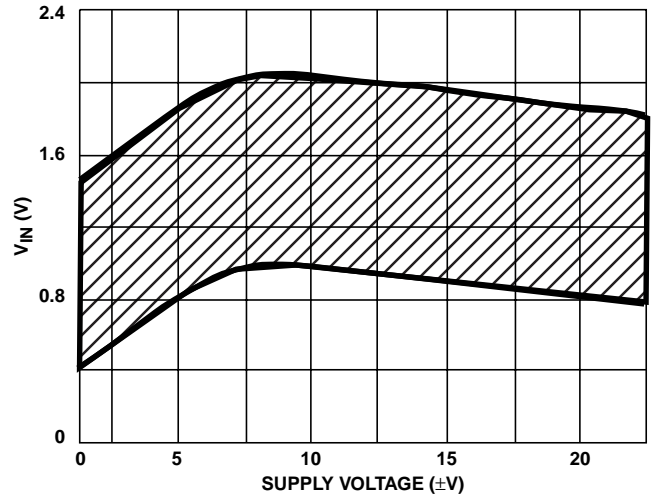


FIGURE 19. SWITCHING THRESHOLD vs SUPPLY VOLTAGE

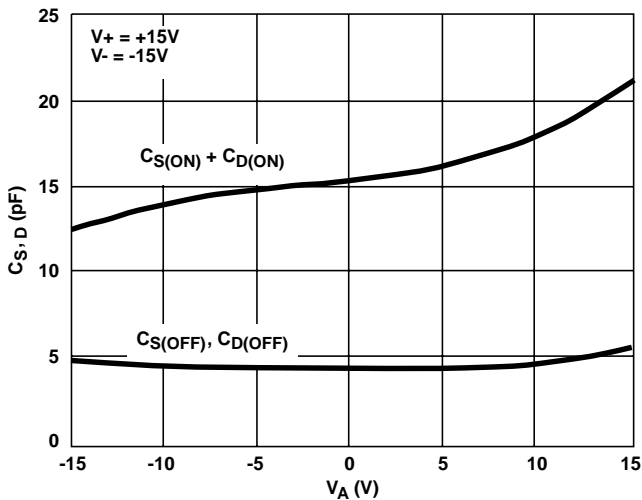


FIGURE 20. SOURCE/DRAIN CAPACITANCE vs ANALOG VOLTAGE

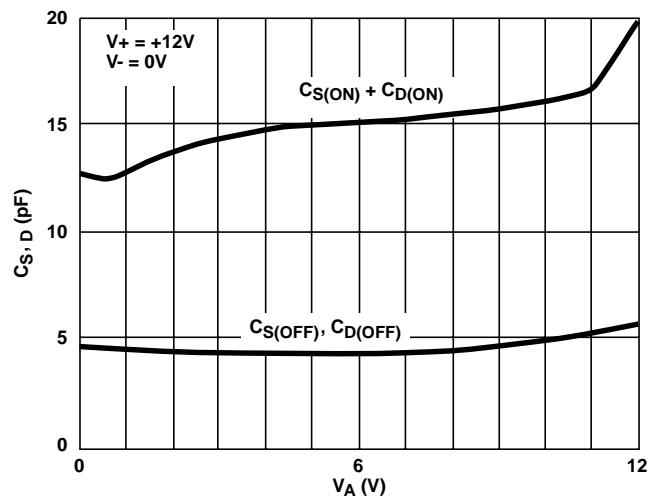


FIGURE 21. SOURCE/DRAIN CAPACITANCE vs ANALOG VOLTAGE (SINGLE 12V SUPPLY)



Typical Performance Curves (Continued)

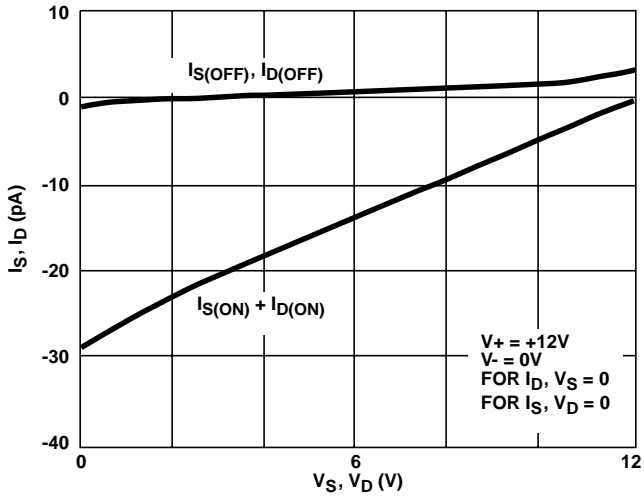


FIGURE 22. SOURCE/DRAIN LEAKAGE CURRENTS (SINGLE 12V SUPPLY)

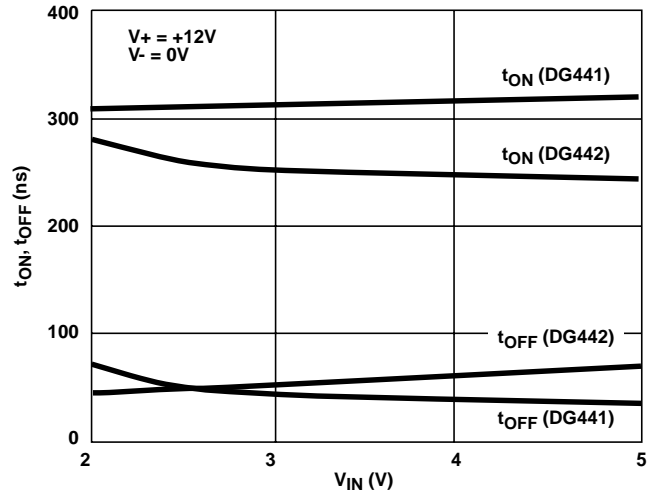


FIGURE 23. SWITCHING TIME vs INPUT VOLTAGE (SINGLE 12V SUPPLY)

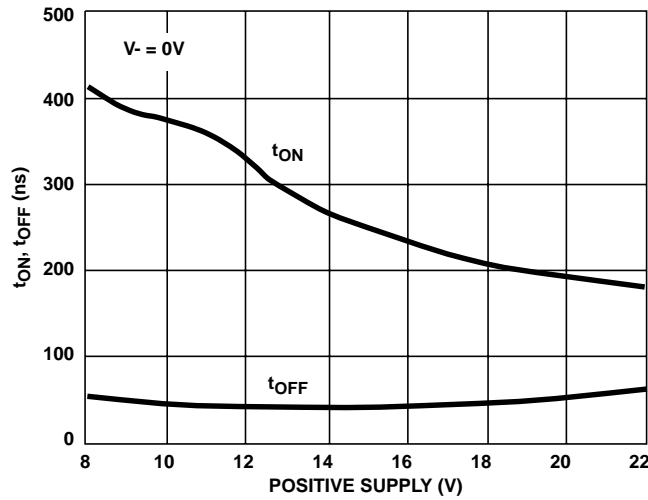


FIGURE 24. SWITCHING TIME vs SINGLE SUPPLY VOLTAGE (DG441)

**Die Characteristics**

**DIE DIMENSIONS:**

2160 $\mu$ m x 1760 $\mu$ m x 485 $\mu$ m

**METALLIZATION:**

Type: SiAl  
Thickness: 12k $\text{\AA}$   $\pm$  1k $\text{\AA}$

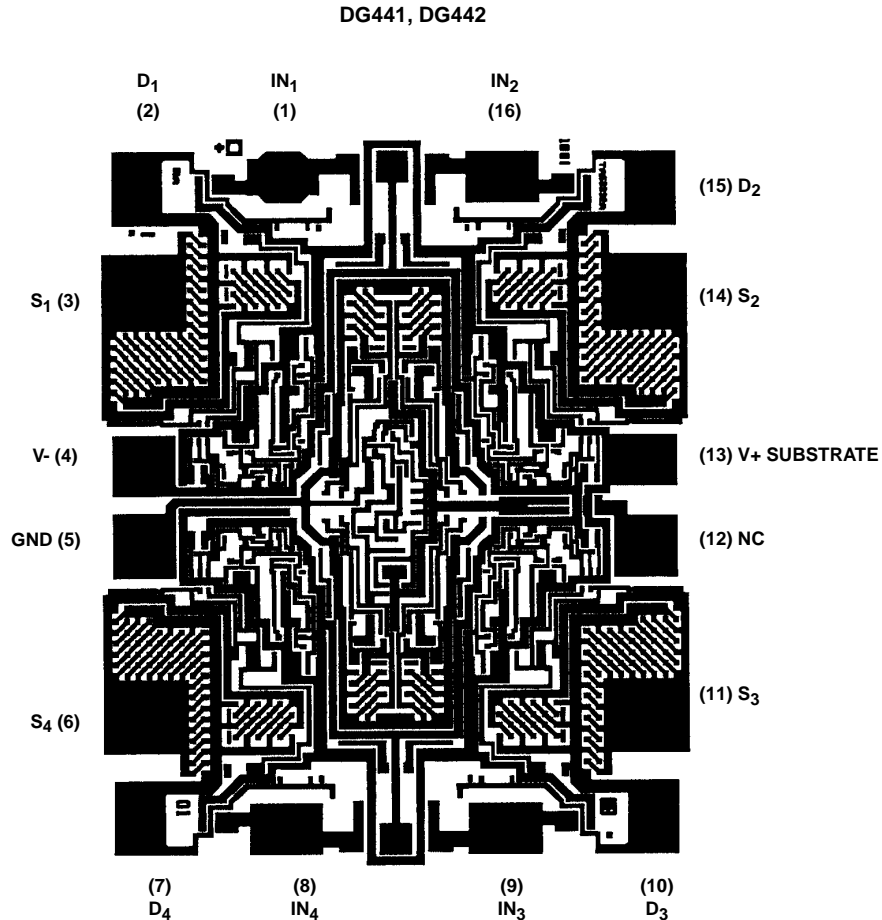
**PASSIVATION:**

Type: Nitride  
Thickness: 8k $\text{\AA}$   $\pm$  1k $\text{\AA}$

**WORST CASE CURRENT DENSITY:**

9.1 x 10<sup>4</sup> A/cm<sup>2</sup>

**Metallization Mask Layout**



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