

Precision 8-Ch/Dual 4-Ch/Triple 2-Ch Low Voltage Analog Switches/Multiplexers

DESCRIPTION

The DG9051/9052/9053 are low-voltage monolithic CMOS analog switches and multiplexers. DG9051 is an 8-channel multiplexer; DG9052 is a dual 4-channel multiplexer; and DG9053 is a triple single-pole/double throw (SPDT) switch.

They are designed to operate from a +2.7 to +12-V single supply or ± 2.7 to ± 6 -V dual power supplies. All control logic inputs have guaranteed 2-V logic high/0.8-V logic low when operating from a single 5 V or dual ± 5 -V supplies, and 2.4-V logic high/0.8-V logic low when $V_{+} = 12$ V.

Built on Vishay Siliconix's proprietary high-density process, the DG9051/9052/9053 offer the advantage of bi-directional signal, rail to rail analog signal handling.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the Lead (Pb)-Free device terminations. For analog switching products manufactured with 100 % matte tin device termination, the Lead (Pb)-Free "-E3" suffix is being used as a designator.

FEATURES

- 2.7 to 12-V Single Supply or ± 2.7 to ± 6 -V Dual Supply Operation
- Guaranteed Ron Matching
- Low Voltage CMOS Logic Compatible

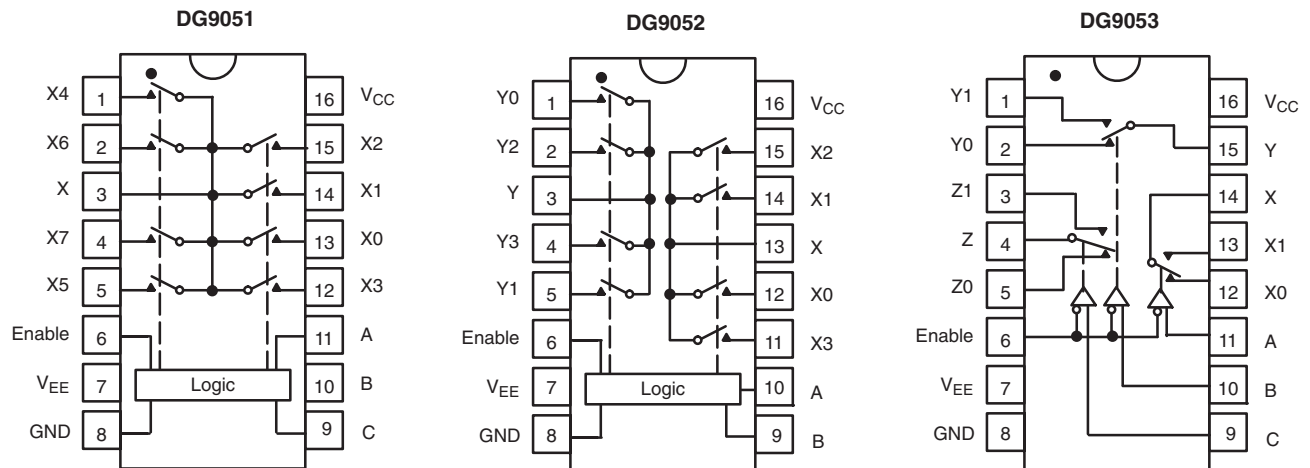

RoHS
COMPLIANT

BENEFITS

- Wide Operation Voltage Range
- Pin Compatible with 74HC4051/2/5
- Guaranteed Low Leakage

APPLICATIONS

- Battery Powered Equipment
- Test Process Equipment
- Communication Systems
- A/V and Mixed Signal Routing
- Automotive

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

ORDERING INFORMATION

| Temp Range | Package | Part Number |
|-------------|----------|----------------|
| -40 to 85°C | TSSOP-16 | DG9051DQ-T1-E3 |
| | | DG9052DQ-T1-E3 |
| | | DG9053DQ-T1-E3 |

The information shown here is a preliminary product proposal, not a commercial product data sheet. Siliconix is not committed to produce this or any similar product. This information should not be used for design purposes, nor construed as an offer to furnish or sell such products

| TRUTH TABLE | | | | | | |
|--------------|---------------|---|---|-------------------|-------------------|------------------------------|
| Enable Input | Select Inputs | | | On Switches | | |
| | C* | B | A | DG9051 | DG9052 | DG9053 |
| H | X | X | X | All switches open | All switches open | All switches open |
| L | L | L | L | X – X0 | X – X0, Y – Y0 | X – X0, Y – Y0, Z – Z0 |
| L | L | L | H | X – X1 | X – X1, Y – Y1 | X – X1, Y – Y0, Z – Z0 |
| L | L | H | L | X – X2 | X – X2, Y – Y2 | X – X0, Y – Y1, Z – Z0 |
| L | L | H | H | X – X3 | X – X3, Y – Y3 | X – X1, Y – Y1, Z – Z0 |
| L | H | L | L | X – X4 | X – X0, Y – Y0 | X – X0, Y – Y0, Z – Z1 |
| L | H | L | H | X – X5 | X – X1, Y – Y1 | X – X1, Y – Y0, Z – Z1 |
| L | H | H | L | X – X6 | X – X2, Y – Y2 | X – X0, Y – Y1, Z – Z1 |
| L | H | H | H | X – X7 | X – X3, Y – Y3 | X – X1, Y – Y1, Z – Z1 |

X = Don't care

| ABSOLUTE MAXIMUM RATINGS $T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted | | | | |
|--|--|--------|------------------------|------|
| Parameter | | Symbol | Limit | Unit |
| Voltage Referenced to V– | V+ | | 13.5 | V |
| | GND | | 7 | |
| Digital Inputs ^a | V _S , V _D | | (V–) –0.3 to (V+) +0.3 | |
| Current (Any Terminal Except S or D) | | | 30 | mA |
| Continuous Current, S or D | | | 100 | |
| Peak Current, S or D (Pulsed at 1 ms, 10 % Duty Cycle Max) | | | 200 | |
| Package Solder Reflow Conditions ^b | IR/Convection | | 260 | °C |
| Storage Temperature | | | –65 to 150 | |
| Power Dissipation (Packages) ^c | $T_A = 70\text{ }^\circ\text{C}$, TSSOP-16 ^d | | 925 | mW |



| SPECIFICATIONS (SINGLE SUPPLY 12 V) | | | | | | | |
|---|----------------------|--|-------------------|-----------------------|------------------|------------------|------|
| Parameter | Symbol | Test Condition Otherwise Unless Specified V ₊ = 12 V, ±10 %, V ₋ = 0 V V _A , V _{EN} = 0.8 V or 2.4 V ^f | Temp ^b | Limits -40 to 85°C | | | Unit |
| | | | | Min ^c | Typ ^d | Max ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^e | V _{ANALOG} | | Full | 0 | | 12 | V |
| On-Resistance | r _{ON} | V _D = 3.5 V, I _S = 1 mA Sequence Each Switch On | Room Full | | 30 | 40 50 | Ω |
| r _{ON} Match Between Channels ⁹ | Δr _{ON} | V _D = 3.5 V, I _S = 1 mA | Room | | | 5 | |
| Switch Off Leakage Current | I _{S(off)} | V _{EN} = 2.4 V, V _D = 11 V or 1 V, V _S = 1 V or 11 V | Room Full | -1 -20 | | 1 20 | nA |
| | I _{D(off)} | | Room Full | -1 -20 | | 1 20 | |
| Channel On Leakage Current | I _{D(on)} | V _{EN} = 0 V, V _S = V _D = 1 V or 11 V | Room Full | -2 -10 | | 2 10 | |
| Digital Control | | | | | | | |
| Logic High Input Voltage | V _{INH} | | Full | 2.4 | | | V |
| Logic Low Input Voltage | V _{INL} | | Full | | | 0.8 | |
| Input Current | I _{IN} | V _{AX} = V _{EN} = 2.4 V or 0.8 V | Full | -1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Transition Time | t _{TRANS} | V _{NO} /V _{NC} = 8 V/0 V, 0 V/8 V R _L = 300 Ω, C _L = 35 pF | Room Full | | | 26 35 55 | ns |
| Break-Before-Make Time | t _{BBM} | V _{X,Y,Z} = 5 V, V _S = 0 V, R _L = 306 Ω, C _L = 35 pF | Room Full | 3 | | 10 | |
| Enable Turn-On Time | t _{ON(EN)} | | Room Full | | | 20 35 45 | |
| Enable Turn-Off Time | t _{OFF(EN)} | | Room Full | | | 16 30 40 | |
| Charge Injection ^e | Q | C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω | Room | | | 38 | pC |
| Off-Isolation ^{e,h} | OIRR | f = 1 MHz, R _L = 50 Ω | Room | | | -78 | dB |
| Crosstalk ^e | X _{TALK} | | Room | | | -83 | |
| Source Off Capacitance ^e | C _{S(off)} | f = 1 MHz, V _S = 0 V, V _{EN} = 2.4 V | Room | | | 4 | pF |
| Drain Off Capacitance ^e | C _{D(off)} | f = 1 MHz, V _D = 0 V, V _{EN} = 2.4 V | Room | | | 8 | |
| Drain On Capacitance ^e | C _{D(on)} | f = 1 MHz, V _D = 0 V, V _{EN} = 0 V | Room | | | 15 | |
| Power Supply | | | | | | | |
| Power Supply Current | I ₊ | V _{EN} = V _A = 0 V or V ₊ | Room | | | 1.0 | μA |

| SPECIFICATIONS (DUAL SUPPLY $V_+ = 5\text{ V}$, $V_- = -5\text{ V}$) | | | | | | | |
|--|--|---|-------------------|-----------------------|------------------|------------------|------|
| Parameter | Symbol | Test Condition Otherwise Unless Specified $V_+ = 5\text{ V}$, $V_- = -5\text{ V} \pm 10\%$ V_A , $V_{\overline{EN}} = 0.8\text{ V}$ or 2.0 V^f | Temp ^b | Limits -40 to 85°C | | | Unit |
| | | | | Min ^c | Typ ^d | Max ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^e | V_{ANALOG} | | Full | -5 | | 5 | V |
| On-Resistance | r_{ON} | $V_+ = 4.5\text{ V}$, $V_- = -4.5\text{ V}$, $V_D = \pm 3\text{ V}$, $I_S = 1\text{ mA}$ Sequence Each Switch On | Room Full | | 35 | 55 60 | Ω |
| r_{ON} Match Between Channels ^g | Δr_{ON} | | Room | | | 5 | |
| On-Resistance Flatness ⁱ | r_{ON} Flatness | $V_+ = 4.5\text{ V}$, $V_- = -4.5\text{ V}$, $V_D = \pm 3.0\text{ V}$, $I_S = 1\text{ mA}$ | Room | | 7 | 10 | |
| Switch Off Leakage Current ^a | $I_{\text{S(off)}}$ | $V_+ = 5.5\text{ V}$, $V_- = -5.5\text{ V}$ $V_{\overline{EN}} = 2.0\text{ V}$, $V_D = \pm 4.5\text{ V}$, $V_S = \pm 4.5\text{ V}$ | Room Full | -1 -20 | | 1 20 | nA |
| | $I_{\text{D(off)}}$ | | Room Full | -1 -20 | | 1 20 | |
| Channel On Leakage Current ^a | $I_{\text{D(on)}}$ | $V_+ = 5.5\text{ V}$, $V_- = -5.5\text{ V}$ $V_{\overline{EN}} = 0\text{ V}$, $V_D = \pm 4.5\text{ V}$, $V_S = \pm 4.5\text{ V}$ | Room Full | -2 -10 | | 2 10 | |
| Digital Control | | | | | | | |
| Logic High Input Voltage | V_{INH} | | Full | 2.0 | | | V |
| Logic Low Input Voltage | V_{INL} | | Full | | | 0.8 | |
| Input Current ^a | I_{IN} | $V_{\text{AX}} = V_{\text{EN}} = 2.0\text{ V}$ or 0.8 V | Full | -1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Transition Time ^e | t_{TRANS} | $V_+ = 4.5\text{ V}$, $V_- = -4.5\text{ V}$, $V_{\text{NO/NC}} = \pm 3\text{ V}$, $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ | Room Full | | | 35 50 65 | ns |
| Break-Before-Make Time ^e | t_{BBM} | $V_{X,Y,Z} = +/ -3\text{ V}$, $V_S = 0\text{ V}$, $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ | Room Full | 5 | | 12 | |
| Enable Turn-On Time ^e | $t_{\text{ON}(\overline{\text{EN}})}$ | | Room Full | | | 38 55 70 | |
| Enable Turn-Off Time ^e | $t_{\text{OFF}(\overline{\text{EN}})}$ | | Room Full | | | 22 35 50 | |
| Source Off Capacitance ^e | $C_{\text{S(off)}}$ | $f = 1\text{ MHz}$, $V_S = 0\text{ V}$, $V_{\overline{\text{EN}}} = 2.0\text{ V}$ | Room | | | 5 | pF |
| Drain Off Capacitance ^e | $C_{\text{D(off)}}$ | $f = 1\text{ MHz}$, $V_D = 0\text{ V}$, $V_{\overline{\text{EN}}} = 2.0\text{ V}$ | Room | | | 9 | |
| Drain On Capacitance ^e | $C_{\text{D(on)}}$ | $f = 1\text{ MHz}$, $V_D = 0\text{ V}$, $V_{\overline{\text{EN}}} = 0\text{ V}$ | Room | | | 13 | |
| Power Supply | | | | | | | |
| Power Supply Current | I_+ | $V_{\overline{\text{EN}}} = V_A = 0\text{ V}$ or V_+ | Room | | | 1.0 | μA |
| | I_- | | Room | -1.0 | | | |



| SPECIFICATIONS (SINGLE SUPPLY 5 V) | | | | | | | |
|---|--|--|-------------------|-----------------------|------------------|------------------|---------------|
| Parameter | Symbol | Test Condition Otherwise Unless Specified $V_+ = 5\text{ V}, \pm 10\%$, $V_- = 0\text{ V}$ $V_A, V_{\overline{EN}} = 0.8\text{ V}$ or 2.0 V^f | Temp ^b | Limits -40 to 85°C | | | Unit |
| | | | | Min ^c | Typ ^d | Max ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^e | V_{ANALOG} | | Full | 0 | | 5 | V |
| On-Resistance | r_{ON} | $V_+ = 4.5\text{ V}, V_D$ or $V_S = 3\text{ V}$ or $3.5\text{ V}, I_S = 1\text{ mA}$ | Room Full | | 80 | 100 120 | Ω |
| r_{ON} Match Between Channels ^g | Δr_{ON} | $V_+ = 4.5\text{ V}, V_D = 3\text{ V}, I_S = 1\text{ mA}$ | Room | | | 8.0 | |
| Switch Off Leakage Current ^a | $I_{\text{S(off)}}$ | $V_+ = 5.5\text{ V}, V_{\overline{EN}} = 2\text{ V}$ $V_S = 1\text{ V}$ or $4.5\text{ V}, V_D = 4.5\text{ V}$ or 1 V | Room Full | -1 -20 | | 1 20 | nA |
| | $I_{\text{D(off)}}$ | | Room Full | -1 -20 | | 1 20 | |
| Channel On Leakage Current ^a | $I_{\text{D(on)}}$ | $V_+ = 5.5\text{ V}, V_{\overline{EN}} = 0\text{ V}$ $V_D = V_S = 1\text{ V}$ or 4.5 V | Room Full | -2 -10 | | 2 10 | |
| Digital Control | | | | | | | |
| Logic High Input Voltage | V_{INH} | | Full | 2.0 | | | V |
| Logic Low Input Voltage | V_{INL} | | Full | | | 0.8 | |
| Input Current ^a | I_{IN} | $V_{\text{AX}} = V_{\overline{EN}} = 2.0\text{ V}$ or 0.8 V | Full | -1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Transition Time | t_{TRANS} | $V_+ = 4.5\text{ V}, V_- = 0\text{ V}, V_{\text{NO/NC}} = 3\text{ V} / 0\text{ V},$ $0\text{ V} / 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$ | Room | | 40 | | ns |
| Break-Before-Make Time | t_{BBM} | $V_+ = 4.5\text{ V}, V_{\text{X,Y,Z}} = 3\text{ V}, V_S = 0\text{ V},$ $R_L = 300\ \Omega, C_L = 35\text{ pF}$ | Room | | 15 | | |
| Enable Turn-On Time | $t_{\text{ON}(\overline{\text{EN}})}$ | | Room | | 40 | | |
| Enable Turn-Off Time | $t_{\text{OFF}(\overline{\text{EN}})}$ | | Room | | 20 | | |
| Charge Injection ^e | Q | $C_L = 1\text{ nF}, V_{\text{GEN}} = 0\text{ V}, R_{\text{GEN}} = 0\ \Omega$ | Room | | 20 | | pC |
| Off-Isolation ^{e,h} | OIRR | $f = 1\text{ MHz}, R_L = 50\ \Omega$ | Room | | -79 | | dB |
| Crosstalk ^e | X_{TALK} | | Room | | -83 | | |
| Source Off Capacitance ^e | $C_{\text{S(off)}}$ | $f = 1\text{ MHz}, V_S = 0\text{ V}, V_{\overline{EN}} = 0\text{ V}$ | Room | | 4 | | pF |
| Drain Off Capacitance ^e | $C_{\text{D(off)}}$ | $f = 1\text{ MHz}, V_D = 0\text{ V}, V_{\overline{EN}} = 2.0\text{ V}$ | Room | | 8 | | |
| Drain On Capacitance ^e | $C_{\text{D(on)}}$ | $f = 1\text{ MHz}, V_D = 0\text{ V}, V_{\overline{EN}} = 0\text{ V}$ | Room | | 15 | | |
| Power Supply | | | | | | | |
| Power Supply Current | I_+ | $V_{\overline{EN}} = V_A = 0\text{ V}$ or V_+ | Room | | | 1.0 | μA |

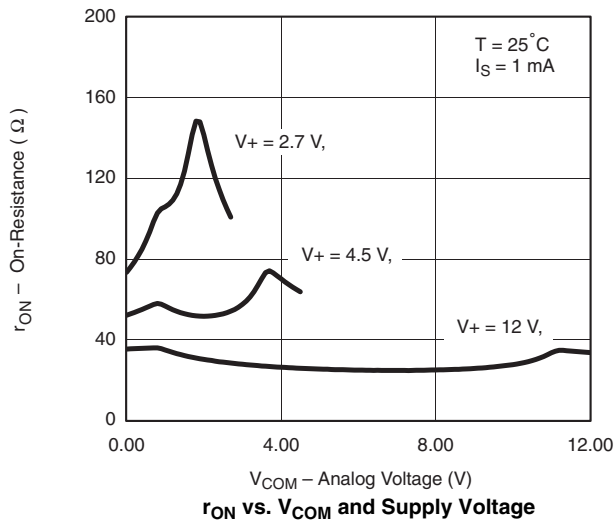
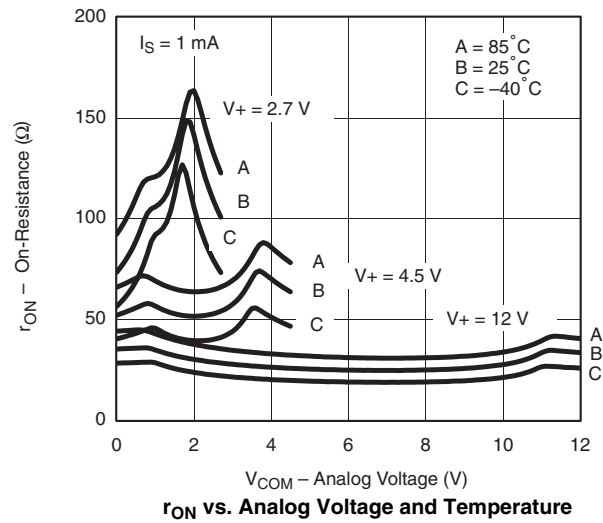
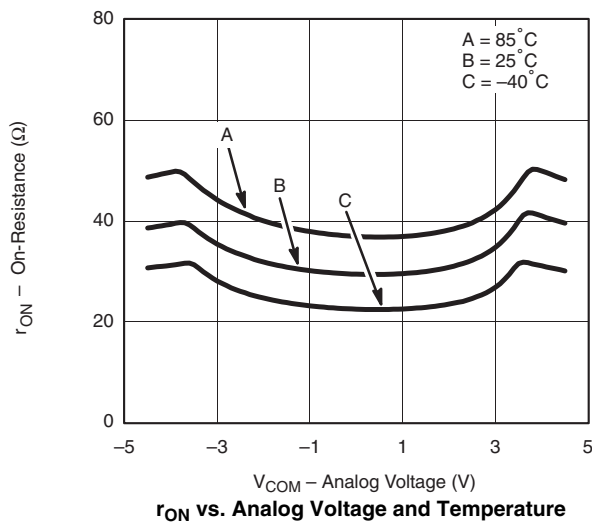
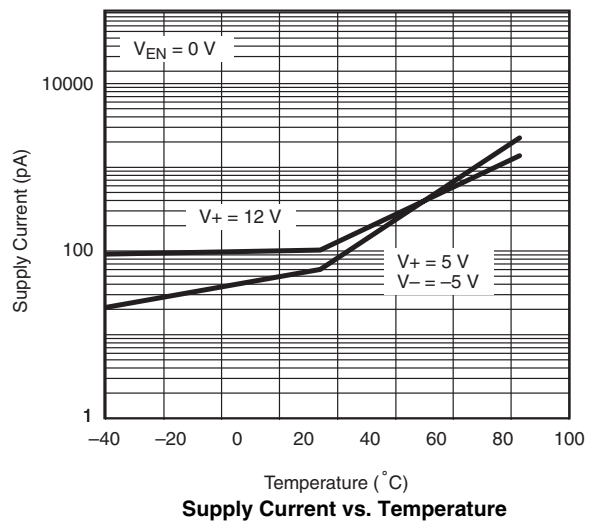
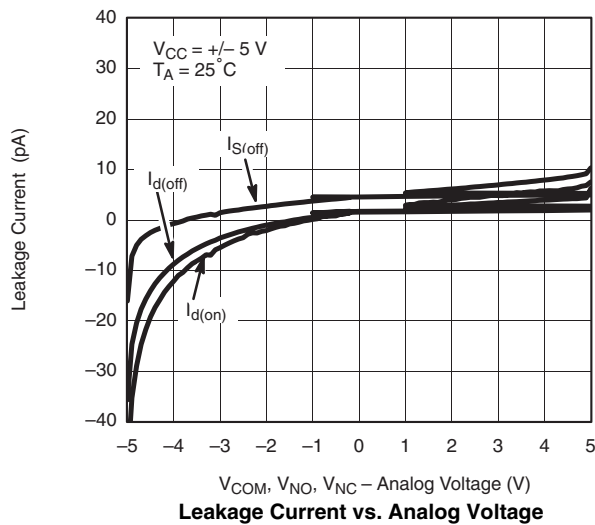
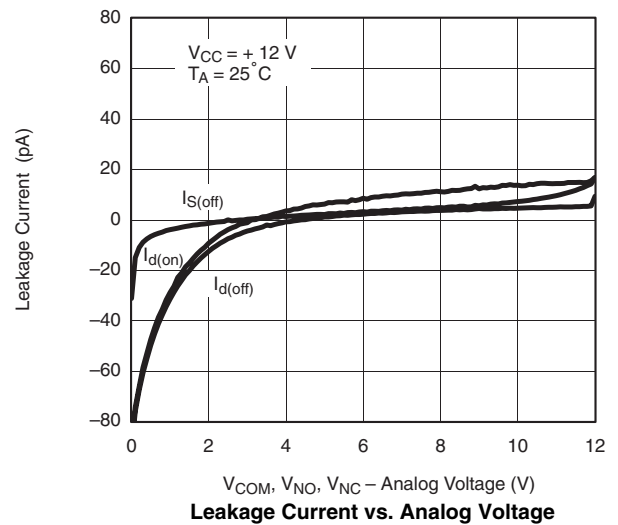


| SPECIFICATIONS (SINGLE SUPPLY 3 V) | | | | | | | |
|---|----------------------|---|-------------------|-----------------------|------------------|------------------|------|
| Parameter | Symbol | Test Condition Otherwise Unless Specified V+ = 3 V, ±10 %, V- = 0 V V _{EN} = 0.4 V or 2.0 V | Temp ^b | Limits -40 to 85°C | | | Unit |
| | | | | Min ^c | Typ ^d | Max ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^e | V _{ANALOG} | | Full | 0 | | 3 | V |
| On-Resistance | r _{ON} | V+ = 2.7 V, V _D = 1.5 V, I _S = 0.1 mA | Room | | 130 | | Ω |
| r _{ON} Match Between Channels ^g | Δr _{ON} | V+ = 2.7 V, V _D = 1.5 V, I _S = 0.1 mA | Room | | | 12 | |
| Switch Off Leakage Current ^a | I _{S(off)} | V+ = 3.3 V, V _{EN} = 2.0 V V _S = 3 or 0.3 V, V _D = 0.3 or 3 V | Room | -1 | | 1 | nA |
| | I _{D(off)} | | Full | -20 | | 20 | |
| Channel On Leakage Current ^a | I _{D(on)} | V+ = 3.3 V, V _{EN} = 0 V V _S = 3 or 0.3 V, V _D = 0.3 or 3 V | Room | -2 | | 2 | |
| | | | Full | -10 | | 10 | |
| Digital Control | | | | | | | |
| Logic High Input Voltage | V _{INH} | | Full | 2.0 | | | V |
| Logic Low Input Voltage | V _{INL} | | Full | | | 0.4 | |
| Input Current ^a | I _{IN} | V _{AX} = V _{EN} = 2.0 V or 0.4 V | Full | -1 | | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Transition Time | t _{TRANS} | V+ = 2.7 V, V _{NO/NC} = 1.5 V/0 V, 0 V/1.5 V R _L = 300 Ω, C _L = 35 pF | Room | | 80 | | ns |
| Break-Before-Make Time | t _{BBM} | V+ = 2.7 V, V _{X,Y,Z} = 1.5 V, V _S = 0 V, R _L = 300 Ω, C _L = 35 pF | Room | 5 | 25 | | |
| Enable Turn-On Time | t _{ON(EN)} | | Full | | 90 | | |
| Enable Turn-Off Time | t _{OFF(EN)} | | Room | 30 | | | |
| Charge Injection ^e | Q | C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω | Room | | 9 | | pC |
| Off-Isolation ^{e,h} | OIRR | f = 1 MHz, R _L = 50 Ω | Room | | -78 | | dB |
| Crosstalk ^e | X _{TALK} | | Room | | -83 | | |
| Source Off Capacitance ^e | C _{S(off)} | f = 1 MHz, V _S = 0 V, V _{EN} = 1.8 V | Room | | 5 | | pF |
| Drain Off Capacitance ^e | C _{D(off)} | f = 1 MHz, V _D = 0 V, V _{EN} = 1.8 V | Room | | 10 | | |
| Drain On Capacitance ^e | C _{D(on)} | f = 1 MHz, V _D = 0 V, V _{EN} = 0 V | Room | | 15 | | |
| Power Supply | | | | | | | |
| Power Supply Current | I+ | V _{EN} = V _A = 0 V or V+ | Room | | | 1.0 | μA |

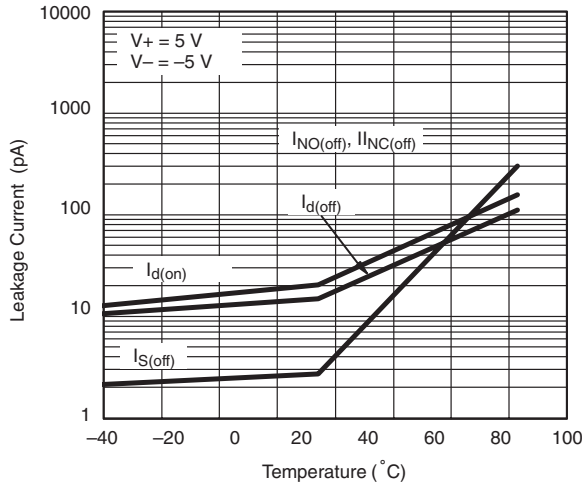
Notes

- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25°C, Full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f. V_{IN} = input voltage to perform proper function.
- g. Δr_{DON} = r_{DON} Max - r_{DON} Min.
- h. Worst case isolation occurs on Channel 4 due to proximity to the drain pin.
- i. r_{DON} flatness is measured as the difference between the minimum and maximum measured values across a defined Analog signal.

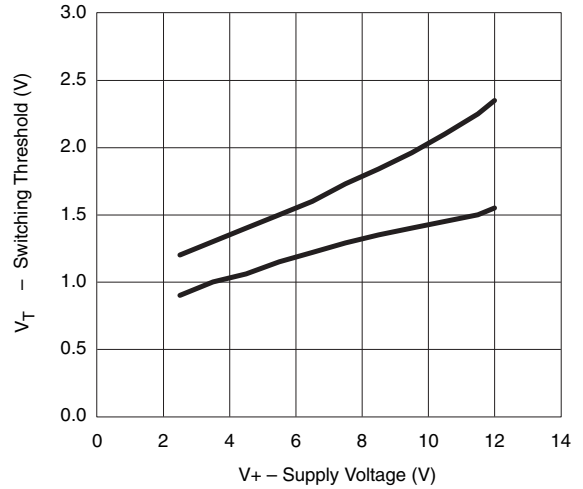
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

TYPICAL CHARACTERISTICS $T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted

 r_{ON} vs. V_{COM} and Supply Voltage

 r_{ON} vs. Analog Voltage and Temperature

 r_{ON} vs. Analog Voltage and Temperature

Supply Current vs. Temperature

Leakage Current vs. Analog Voltage

Leakage Current vs. Analog Voltage

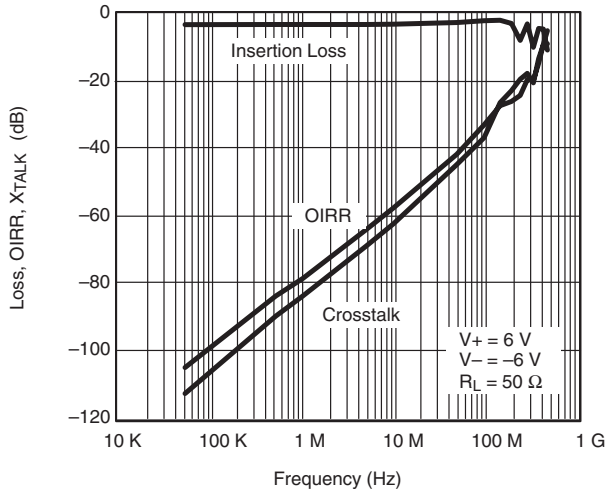
TYPICAL CHARACTERISTICS $T_A = 25\text{ }^\circ\text{C}$, unless otherwise noted



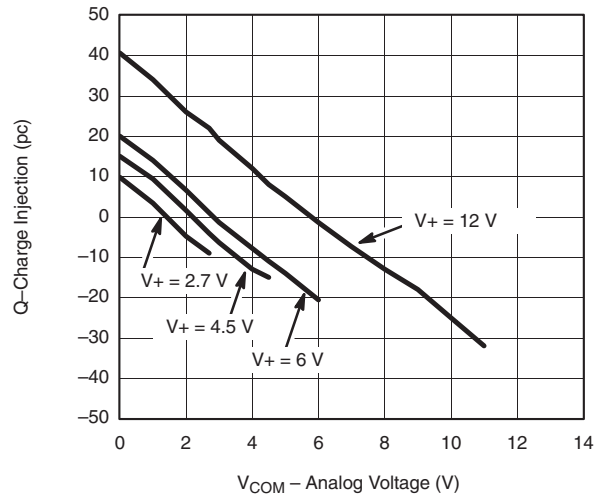
Leakage Current vs. Temperature



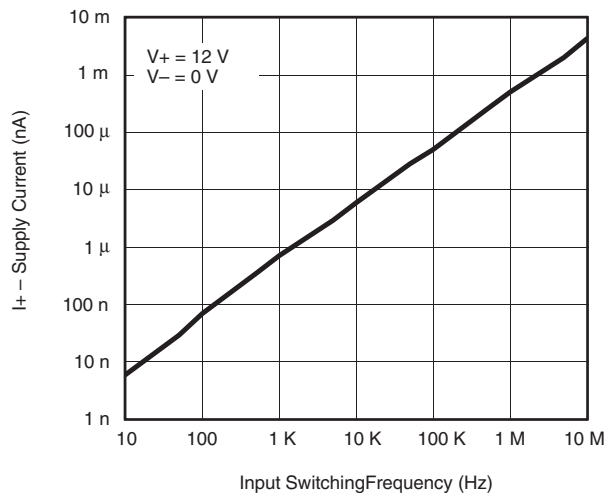
Switching Threshold vs. Supply Voltage



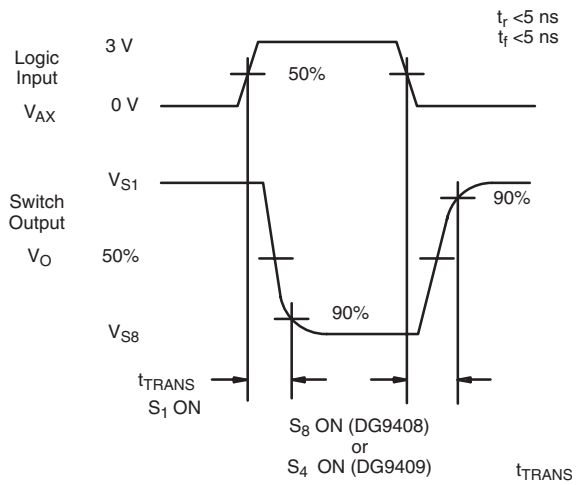
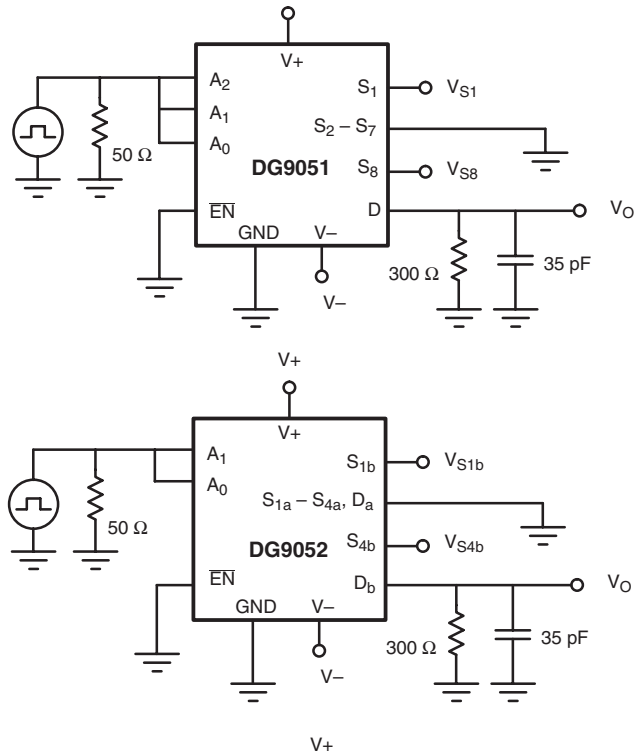
Insertion Loss, Off-Isolation Crosstalk vs. Frequency



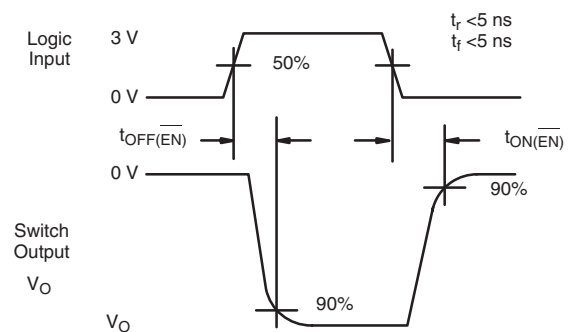
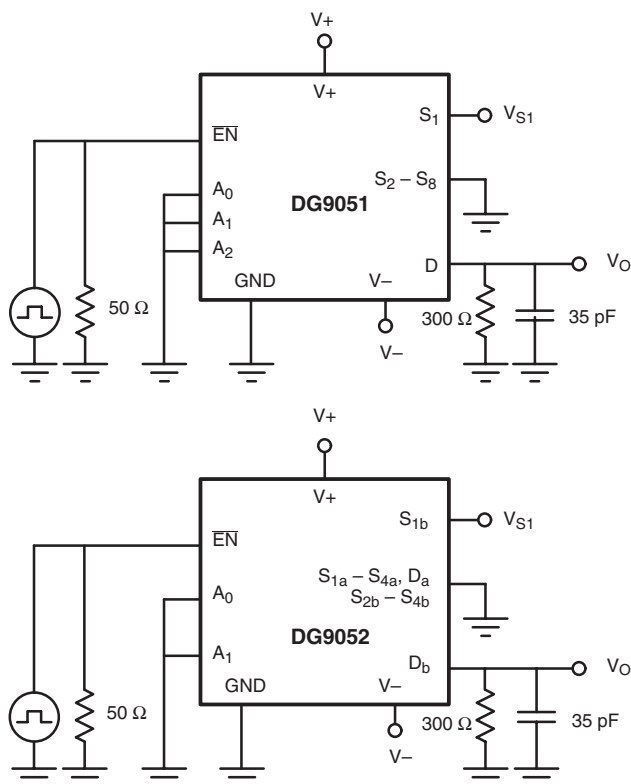
Charge Injection vs. Analog Voltage



Supply Current vs. Input Switching Frequency

TEST CIRCUITS


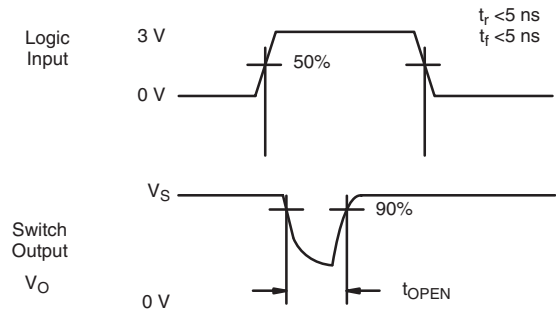
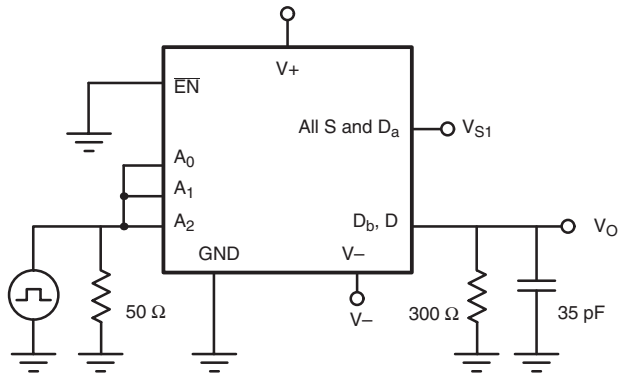
Return to Specifications:
 Single Supply 12 V
 Dual Supply $V_+ = 5 \text{ V}$, $V_- = -5 \text{ V}$
 Single Supply 5 V
 Single Supply 3 V

Figure 1. Transition Time


Return to Specifications:
 Single Supply 12 V
 Dual Supply $V_+ = 5 \text{ V}$, $V_- = -5 \text{ V}$
 Single Supply 5 V
 Single Supply 3 V

Figure 2. Enable Switching Time

TEST CIRCUITS



Return to Specifications:
 Single Supply 12 V
 Dual Supply $V_+ = 5\text{ V}$, $V_- = -5\text{ V}$
 Single Supply 5 V
 Single Supply 3 V

Figure 3. Break-Before-Make Interval

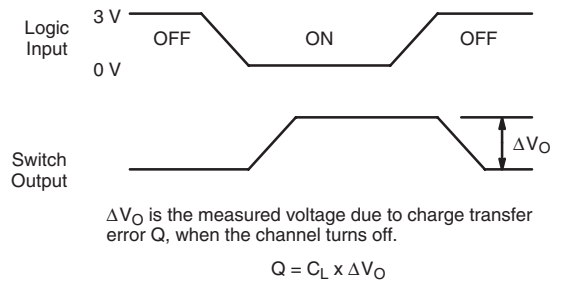
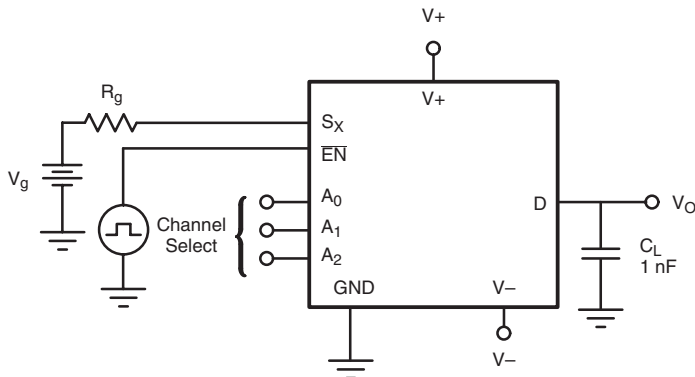


Figure 4. Charge Injection

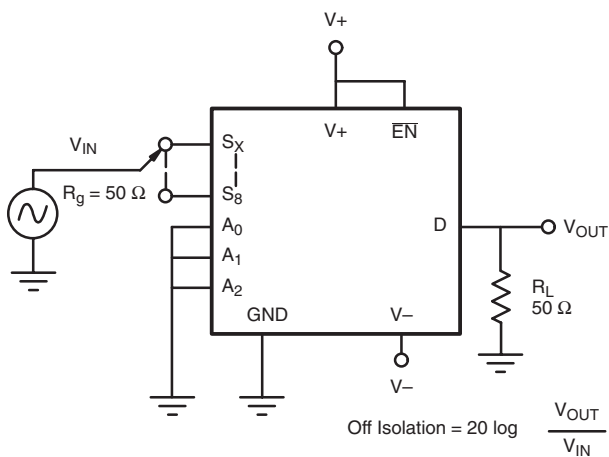


Figure 5. Off Isolation

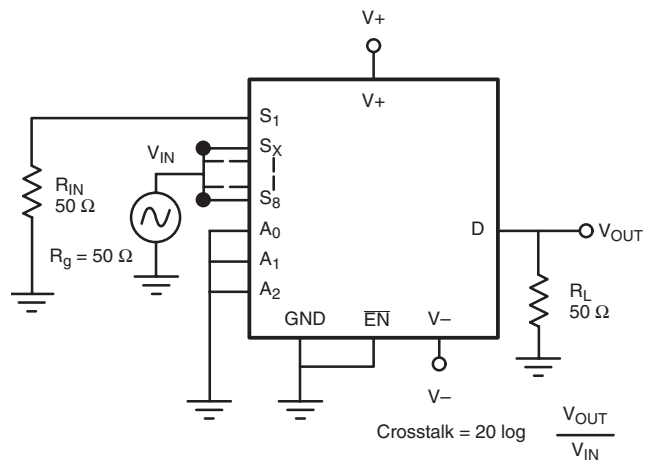
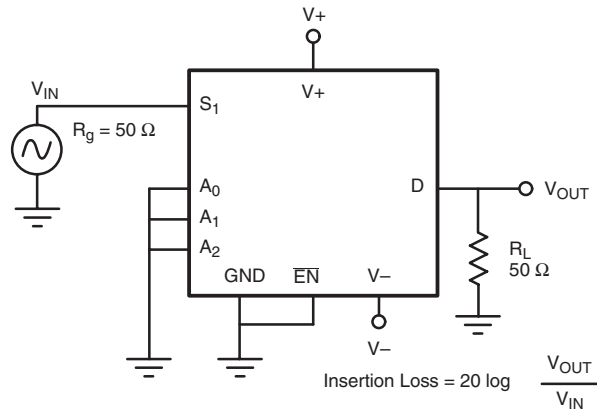
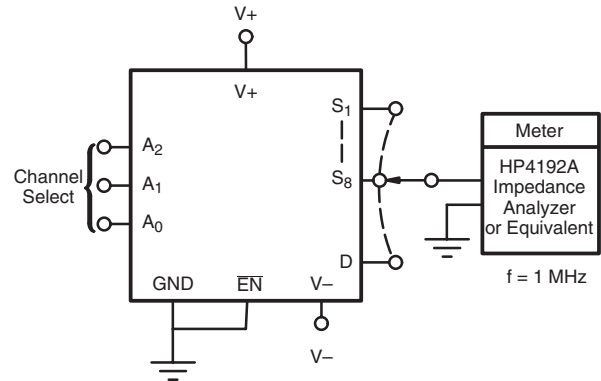


Figure 6. Crosstalk

TEST CIRCUITS

Figure 7. Insertion Loss

Figure 8. Source Drain Capacitance

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