

Single 4 x 1 and Dual 2 x 1 Multiplexers

DESCRIPTION

The DG9414, a single 4 to 1 multiplexer, and the DG9415, a dual 2 x 1 multiplexer, are monolithic CMOS analog devices designed for high performance low voltage operation. Combining low power, high speed, low on-resistance and small physical size, the DG9414 and DG9415 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

Both the DG9414 and DG9415 are built on Vishay Siliconix's low voltage BCD-15 process. Minimum ESD protection, per Method 3015.7, is 2000 V. An epitaxial layer prevents latchup. Break-before-make is guaranteed for DG9415.

FEATURES

- Low voltage operation (+ 2.7 V to + 12 V)
- Low on-resistance - $R_{DS(on)}$: 14 Ω
- Low power consumption
- TTL compatible
- ESD protection > 2000 V (method 3015.7)
- Available in TSSOP-10 (aka MSOP-10)
- **Compliant to RoHS Directive 2002/95/EC**


RoHS
COMPLIANT

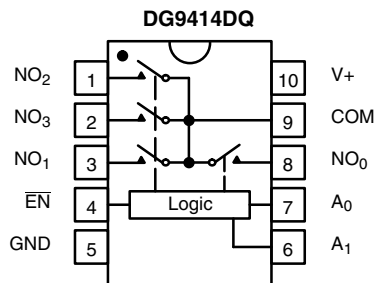
BENEFITS

- High accuracy
- Simple logic interface
- Reduce board space

APPLICATIONS

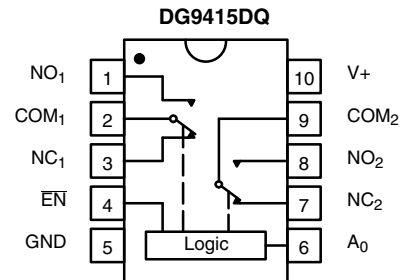
- Battery operated systems
- Portable test equipment
- Sample and hold circuits
- Cellular phones
- Communication systems
- Networking equipment

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| \overline{EN} | A_1 | A_0 | On Switch |
|-----------------|-------|-------|-----------|
| 1 | X | X | None |
| 0 | 0 | 0 | NO_0 |
| 0 | 0 | 1 | NO_1 |
| 0 | 1 | 0 | NO_2 |
| 0 | 1 | 1 | NO_3 |

X = Do not care



| \overline{EN} | A_0 | On Switch |
|-----------------|-------|------------------|
| 1 | X | None |
| 0 | 0 | NC_1 NC_2 |
| 0 | 1 | NO_1 NO_2 |

X = Do not care

ORDERING INFORMATION

| Temp Range | Package | Part Number |
|------------------|---------|----------------|
| - 40 °C to 85 °C | MSOP-10 | DG9414DQ-T1-E3 |
| | | DG9415DQ-T1-E3 |



| ABSOLUTE MAXIMUM RATINGS | | |
|--|---------------------|------|
| Parameter | Limit | Unit |
| Reference V+ to GND | - 0.3 to + 13 | V |
| IN, COM, NC, NO ^a | - 0.3 to (V+ + 0.3) | |
| Continuous Current (Any terminal) | ± 20 | mA |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle) | ± 40 | |
| ESD (Method 3015.7) | > 2000 | V |
| Storage Temperature (D Suffix) | - 65 to 150 | °C |

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 soldered or welded to PC board.

| SPECIFICATIONS (V+ = 3 V) | | | | | | | |
|---|--|--|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter | Symbol | Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, V _{IN} = 0.4 V or 2.4 V ^e | Temp. ^a | Limits - 40 °C to 85 °C | | | Unit |
| | | | | Min. ^c | Typ. ^b | Max. ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V _{ANALOG} | | Full | 0 | | V+ | V |
| On-Resistance | R _{ON} | V+ = 2.7 V, V _{COM} = 1 V/1.5 V/2 V I _{NO} or I _{NC} = 5 mA | Room Full | | 63 | 97 101 | Ω |
| R _{ON} Match ^d | ΔR _{ON} | | Room | | 3 | 11 | |
| R _{ON} Flatness ^{d,f} | R _{ON} Flatness | | Room | | 14 | 33 | |
| NO or NC Off Leakage Current ^g | I _{NO/NC(off)} | V+ = 3.3, V _{NO} or V _{NC} = 0.3 V/3 V V _{COM} = 3 V/0.3 V | Room Full | - 1 - 10 | | 1 10 | nA |
| COM Off Leakage Current ^g | I _{COM(off)} | | Room Full | - 1 - 10 | | 1 10 | |
| Channel-On Leakage Current ^g | I _{COM(on)} | V+ = 3.3 V V _{COM} = V _{NO} or V _{NC} = 0.3 V/3 V | Room Full | - 1 - 10 | | 1 10 | |
| Digital Control | | | | | | | |
| Input Current ^g | I _{INL} or I _{INH} | V _{IN} = 0 or V+ | Full | - 1 | | 1 | μA |
| Input High Voltage ^d | V _{INH} | | Full | 1.6 | | | V |
| Input Low Voltage ^d | V _{INL} | | Full | | | 0.4 | |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} or V _{NC} = 1.5 V | Room Full | | 102 | 125 142 | ns |
| Turn-Off Time | t _{OFF} | | Room Full | | 45 | 68 75 | |
| Break-Before-Make Time | t _D | | Room | 7 | 78 | | |
| Transition Time | t _{trans} | V _{NO} = 1.5 V/0 V, V _{NC} = 0 V/1.5 V | Room Full | | 81 | 128 144 | |
| Charge Injection ^d | Q _{INJ} | C _L = 1 nF, V _{gen} = 0 V, R _{gen} = 0 Ω | Room | | 3 | | pC |
| Off-Isolation | OIRR | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | | - 58 | | dB |
| Channel-to-Channel Crosstalk (DG9415) | X _{TALK} | R _L = 50 Ω, f = 1 MHz | Room | | - 64 | | |
| NO, NC Off Capacitance | C _{NO(off)} , C _{NC(off)} | f = 1 MHz | DG9414 Room | | 11 | | pF |
| | | | DG9415 Room | | 10 | | |
| COM Off Capacitance | C _{COM(off)} | | DG9414 Room | | 26 | | |
| | | | DG9415 Room | | 13 | | |
| COM On Capacitance | C _{COM(on)} | | DG9414 Room | | 43 | | |
| | | | DG9415 Room | | 25 | | |
| Power Supply | | | | | | | |
| Power Supply Range | V+ | | | 2.7 | | 3.3 | V |
| Power Supply Current ^h | I+ | V+ = 3.3 V, V _{IN} = 0 V or 3.3 V | Full | | | 1 | μA |



| SPECIFICATIONS (V ₊ = 5 V) | | | | | | | |
|---|--|--|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter | Symbol | Test Conditions Otherwise Unless Specified V ₊ = 5 V, ± 10 %, V _{IN} = 0.8 V or 2.4 V ^e | Temp. ^a | Limits - 40 °C to 85 °C | | | Unit |
| | | | | Min. ^c | Typ. ^b | Max. ^c | |
| Analog Switch | | | | | | | |
| Analog Signal Range ^d | V _{ANALOG} | | Full | 0 | | V ₊ | V |
| On-Resistance | R _{ON} | V ₊ = 4.5 V, V _{COM} = 1.5 V/2.5 V/3.5 V I _{NO} or I _{NC} = 10 mA | Room | | 33 | 56 | Ω |
| R _{ON} Match | ΔR _{ON} | | Room | | 2 | 10 | |
| R _{ON} Flatness ^f | R _{ON} Flatness | | Room | | 10 | 20 | |
| NO or NC Off Leakage Current ^g | I _{NO/NC(off)} | V ₊ = 5.5 V, V _{NO} or V _{NC} = 1 V/4.5 V V _{COM} = 4.5 V/1 V | Room | - 1 | | 1 | nA |
| COM Off Leakage Current ^g | I _{COM(off)} | | Room | - 1 | | 1 | |
| Channel-On Leakage Current ^g | I _{COM(on)} | V ₊ = 5.5 V V _{COM} = V _{NO} or V _{NC} = 1 V/4.5 V | Room | - 1 | | 1 | |
| Digital Control | | | | | | | |
| Input Current ^h | I _{INL} or I _{INH} | V _{IN} = 0 or V ₊ | Full | - 1 | | 1 | μA |
| Input High Voltage ^d | V _{INH} | | Full | 1.8 | | | V |
| Input Low Voltage ^d | V _{INL} | | Full | | | 0.6 | |
| Dynamic Characteristics | | | | | | | |
| Turn-On Time ^h | t _{ON} | V _{NO} or V _{NC} = 3 V | Room | | 56 | 77 | ns |
| Turn-Off Time ^h | t _{OFF} | | Room | | 25 | 46 | |
| Break-Before-Make Timet ^h | t _D | | Room | 7 | 34 | | |
| Transition Time | t _{trans} | V _{NO} = 3 V/ 0 V, V _{NC} = 0 V/3 V | Room | | 47 | 77 | dB |
| Off-Isolation | OIRR | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | | - 58 | | |
| Channel-to-Channel Crosstalk (DG9415) | X _{TALK} | R _L = 50 Ω, f = 1 MHz | Room | | - 64 | | |
| Charge Injection ^d | Q _{INJ} | C _L = 1 nF, V _{gen} = 0 V, R _{gen} = 0 Ω | Room | | 6 | | pC |
| NO, NC Off Capacitance | C _{NO(off)} , C _{NC(off)} | f = 1 MHz | DG9414 | Room | | 11 | pF |
| | | | DG9415 | Room | | 10 | |
| COM Off Capacitance | C _{COM(off)} | | DG9414 | Room | | 25 | |
| | | | DG9415 | Room | | 13 | |
| COM On Capacitance | C _{COM(on)} | | DG9414 | Room | | 42 | |
| | | | DG9415 | Room | | 24 | |
| Power Supply | | | | | | | |
| Power Supply Range | V ₊ | | | 4.5 | | 5.5 | V |
| Power Supply Current ^h | I ₊ | V ₊ = 5.5 V, V _{IN} = 0 V or 5.5 V | Full | | | 1 | μA |

Notes:

- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. Typical values are for design aid only, not guaranteed nor subject to production testing.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- d. Guarantee by design, nor subjected to production test.
- e. V_{IN} = input voltage to perform proper function.
- f. Difference of min and max values.
- g. Guaranteed by 12 V leakage testing, not production tested.
- h. Guaranteed by worst case test conditions and not subject to test.

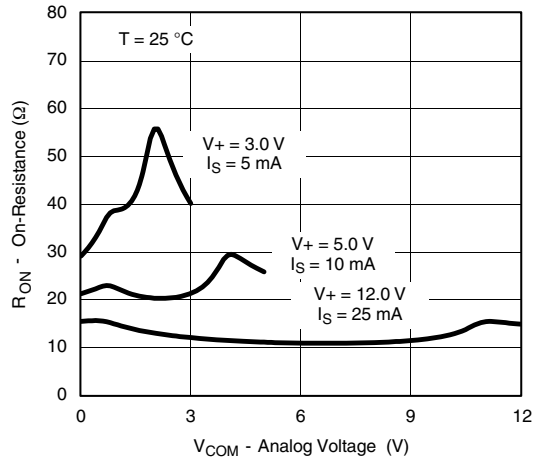
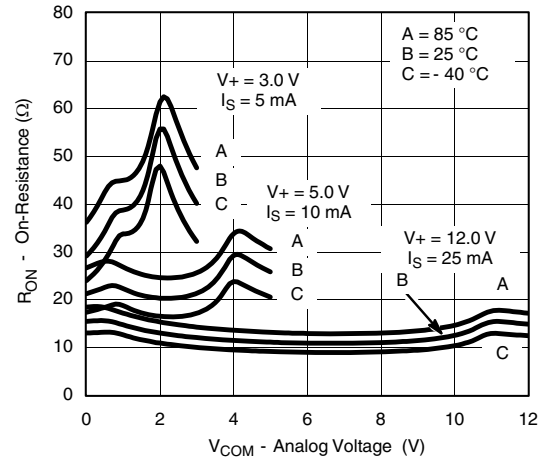
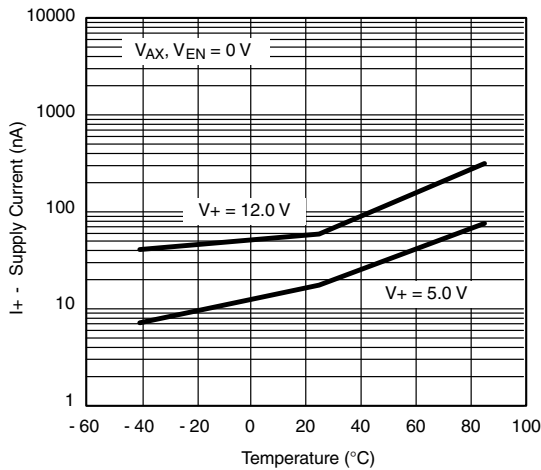
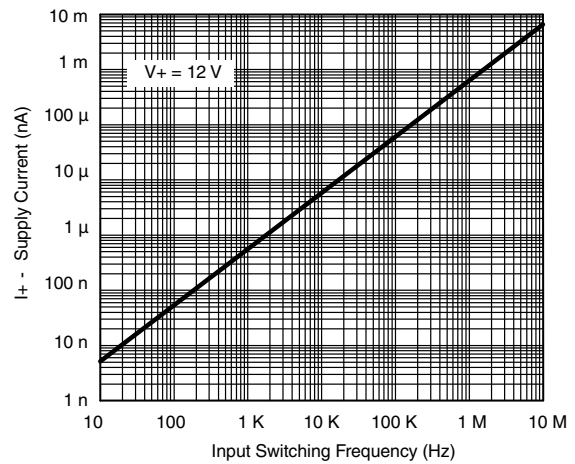
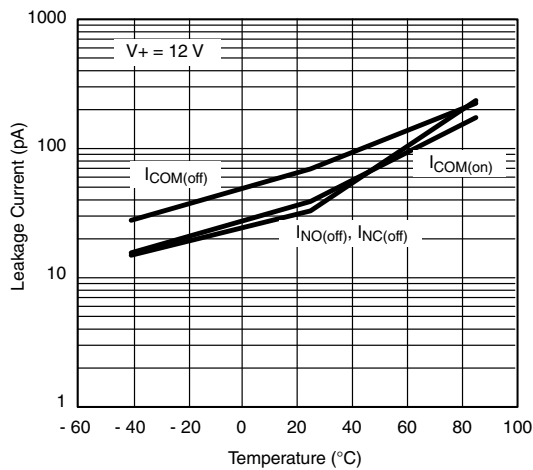
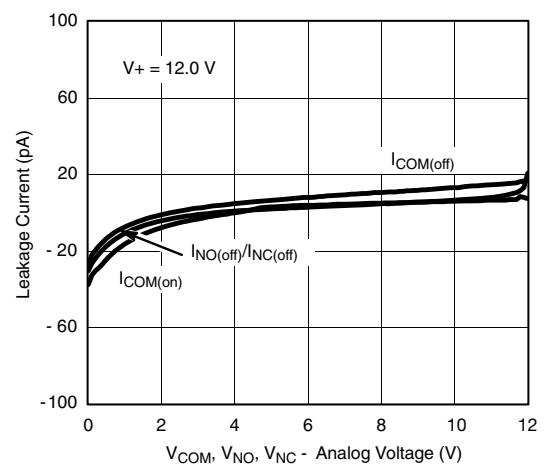


| SPECIFICATIONS ($V_+ = 12\text{ V}$) | | | | | | | | | |
|---|----------------------------------|---|--|----------------------------|-------------------|-------------------|------|----|----|
| Parameter | Symbol | Test Conditions Unless Specified $V_+ = 12\text{ V}$, $V_{IN} = 0.8\text{ V}$ or 2.4 V^e | Temp. ^a | Limits - 40 °C to 85 °C | | | Unit | | |
| | | | | Min. ^c | Typ. ^b | Max. ^c | | | |
| Analog Switch | | | | | | | | | |
| Analog Signal Range ^d | V_{ANALOG} | | Full | 0 | | 12 | V | | |
| R_{ON} Match | ΔR_{ON} | | Room | | 1 | 9 | Ω | | |
| R_{ON} Flatness ^{d,f} | R_{ON} Flatness | | Room | | 1 | 10 | | | |
| On-Resistance | R_{ON} | $V_+ = 10.8\text{ V}$, I_{NO} , $I_{NC} = 25\text{ mA}$ $V_{COM} = 2/9\text{ V}$ | Room Full | | 14 | 17 19 | | | |
| Switch Off Leakage Current | $I_{NO(off)}$ $I_{NC(off)}$ | $V_{COM} = 1/11\text{ V}$ V_{NO} , $V_{NC} = 11/1\text{ V}$ | Room Full | - 1 - 10 | | 1 10 | nA | | |
| | $I_{COM(off)}$ | | Room Full | - 1 - 10 | | 1 10 | | | |
| Channel On Leakage Current | $I_{COM(on)}$ | V_{NO} , $V_{NC} = V_{COM} = 11/1\text{ V}$ | Room Full | - 1 - 10 | | 1 10 | | | |
| Digital Control | | | | | | | | | |
| Input Current | I_{INL} or I_{INH} | $V_{IN} = 0$ or V_+ | Full | - 1 | | 1 | μA | | |
| Input High Voltage ^d | V_{INH} | | Full | 2.4 | | | V | | |
| Input Low Voltage ^d | V_{INL} | | Full | | | 0.8 | | | |
| Dynamic Characteristics | | | | | | | | | |
| Turn-On Time ^h | t_{ON} | $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ V_{NO} , $V_{NC} = 5\text{ V}$ See Figure 2 | Room Full | | 33 | 55 59 | ns | | |
| Turn-Off Time ^h | t_{OFF} | | Room Full | | 17 | 40 41 | | | |
| Break-Before-Make Time Delay ^h | t_D | DG419L Only, V_{NC} , $V_{NO} = 5\text{ V}$ $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ | Room | 2 | 24 | | | | |
| Transition Time | t_{trans} | $V_{NO} = 5\text{ V}/0\text{ V}$, $V_{NC} = 0\text{ V}/5\text{ V}$ | Room Full | | 29 | 56 59 | | | |
| Charge Injection ^d | Q_{INJ} | $V_g = 0\text{ V}$, $R_g = 0\ \Omega$, $C_L = 1\text{ nF}$ | Room | | 13 | | | pC | |
| Off Isolation ^d | OIRR | $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$ $f = 1\text{ MHz}$ | Room | | - 58 | | dB | | |
| Channel-to-Channel Crosstalk ^d | X_{TALK} | | Room | | - 64 | | | | |
| NO, NC Off Capacitance ^d | $C_{NO(off)}$, $C_{NC(off)}$ | $V_{IN} = 0$ or V_+ , $f = 1\text{ MHz}$ | DG9414 | Room | | 10 | | pF | |
| | | | DG9415 | Room | | 10 | | | |
| COM Off Capacitance | $C_{COM(off)}$ | | DG9414 | Room | | 24 | | | |
| | | | DG9415 | Room | | 13 | | | |
| COM On Capacitance ^d | $C_{COM(on)}$ | | DG9414 | Room | | 40 | | | |
| | | | DG9415 | Room | | 23 | | | |
| Power Supplies | | | | | | | | | |
| Positive Supply Current | I+ | | $V_{IN} = 0\text{ V}$ or 12 V | Full | | | 1 | | μA |

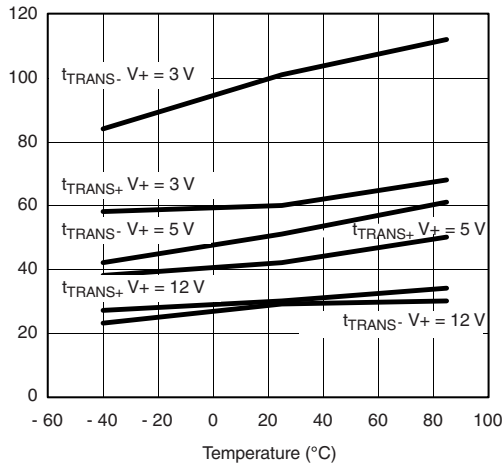
Notes:

- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. Typical values are for design aid only, not guaranteed nor subject to production testing.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- d. Guarantee by design, nor subjected to production test.
- e. V_{IN} = input voltage to perform proper function.
- f. Difference of min and max values.
- g. Guaranteed by 12 V leakage testing, not production tested.
- h. Guaranteed by worst case test conditions and not subject to test.

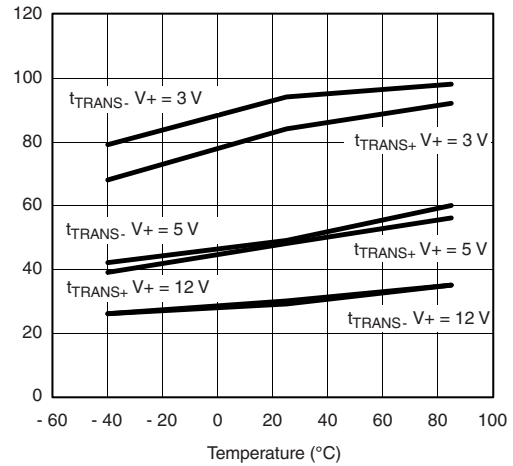
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

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

 R_{ON} vs. Analog Voltage and Temperature

Supply Current vs. Temperature

Supply Current vs. Input Switching Frequency

Leakage Current vs. Temperature

Leakage vs. Analog Voltage

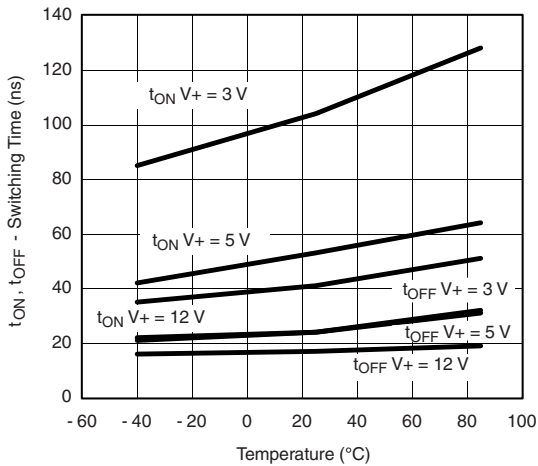
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



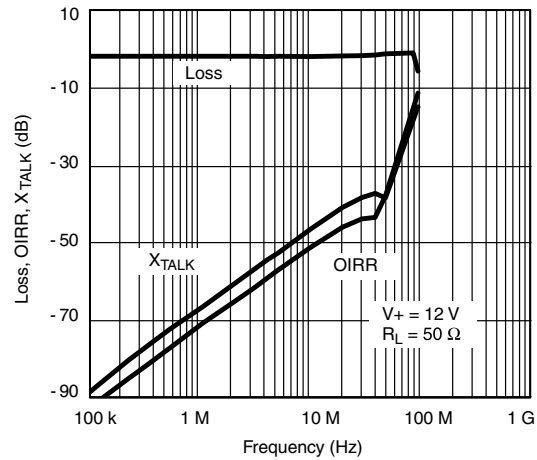
Transistion Time vs. Temperature (DG9414)



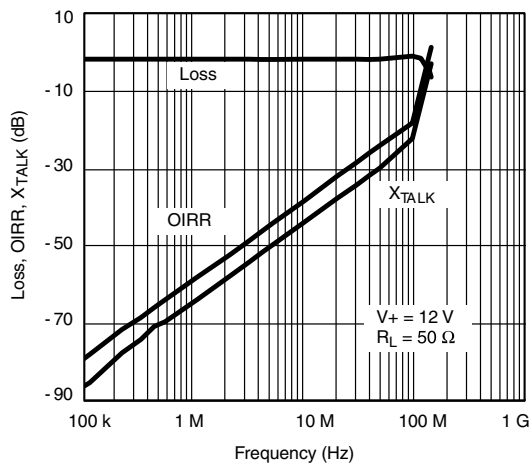
Transistion Time vs. Temperature (DG9415)



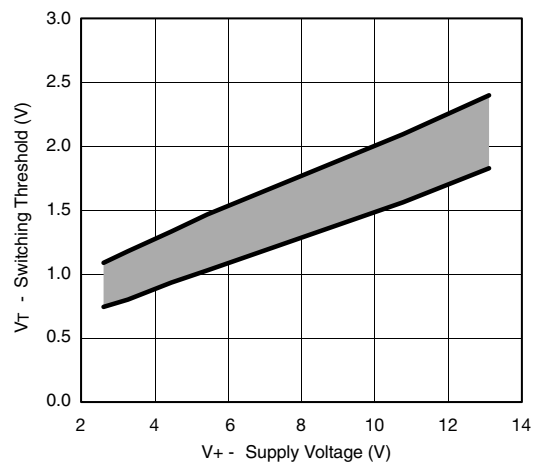
Switching Time vs. Temperature



Insertion Loss, Off-Isolation Crosstalk vs. Frequency (DG9414)

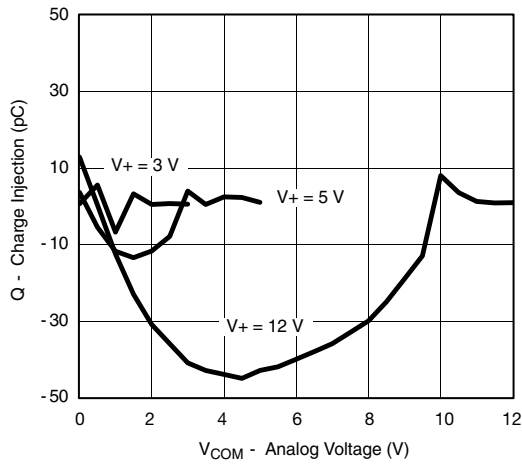


Insertion Loss, Off-Isolation Crosstalk vs. Frequency (DG9415)

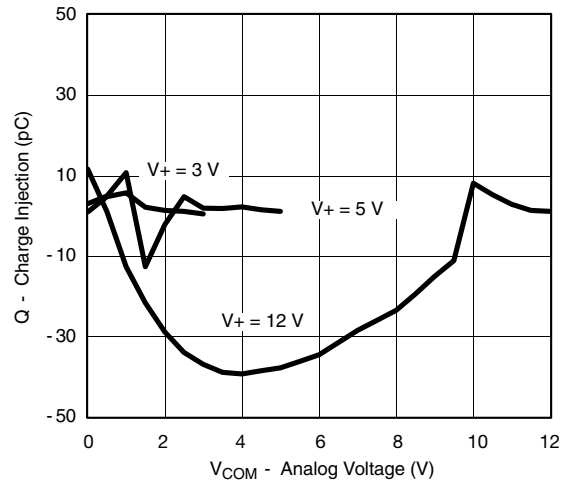


Switching Threshold vs. Supply Voltage

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Charge Injection vs. Analog Voltage (DG9414)



Charge Injection vs. Analog Voltage (DG9415)

SCHEMATIC DIAGRAM (Typical Channel)

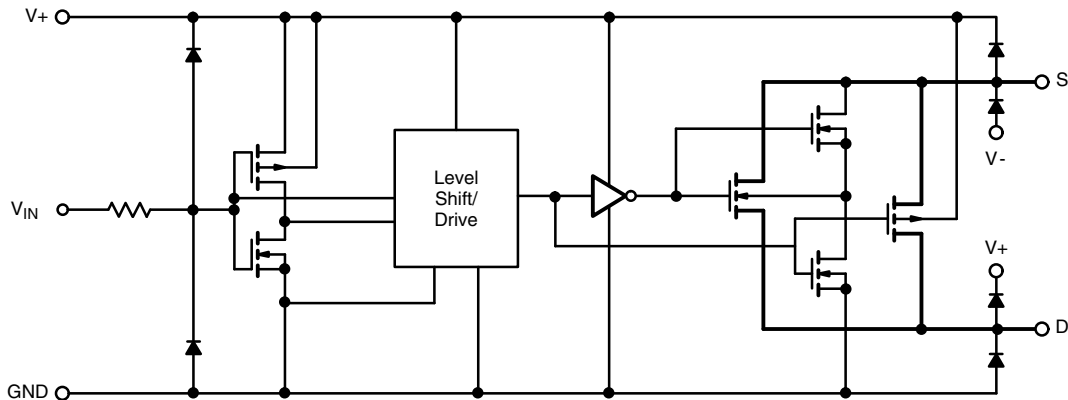
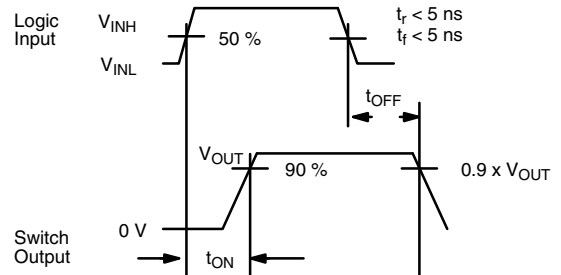
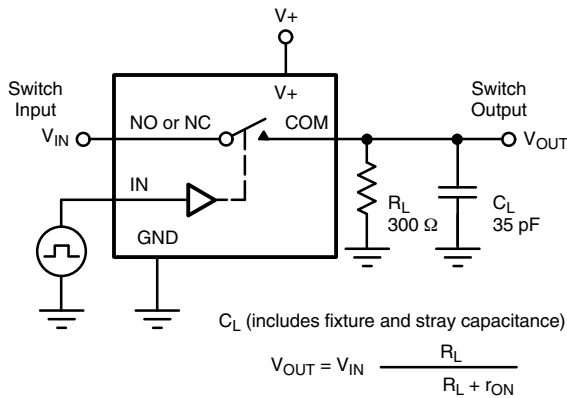


Figure 1.

TEST CIRCUITS



Note: Logic input waveform is inverted for switches that have the opposite logic sense control

Figure 2. Switching Time

TEST CIRCUITS

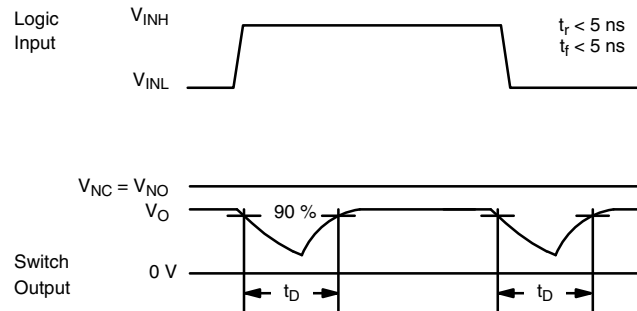
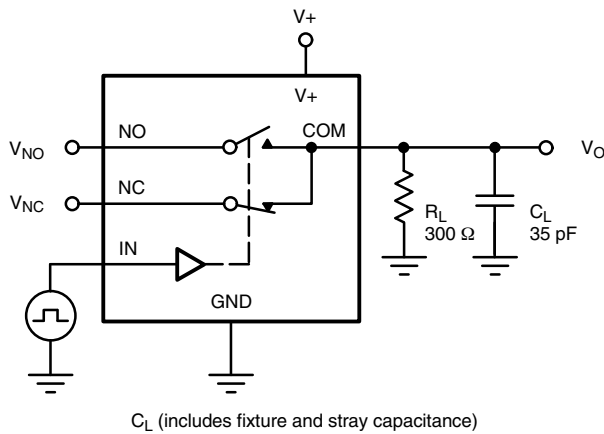


Figure 3. Break-Before-Make

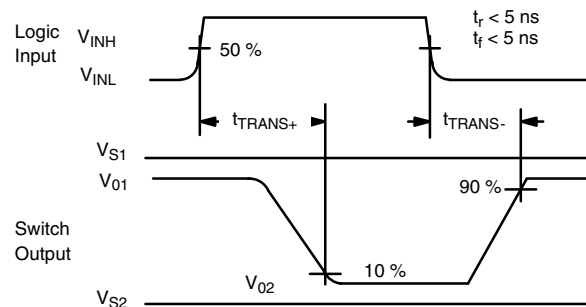
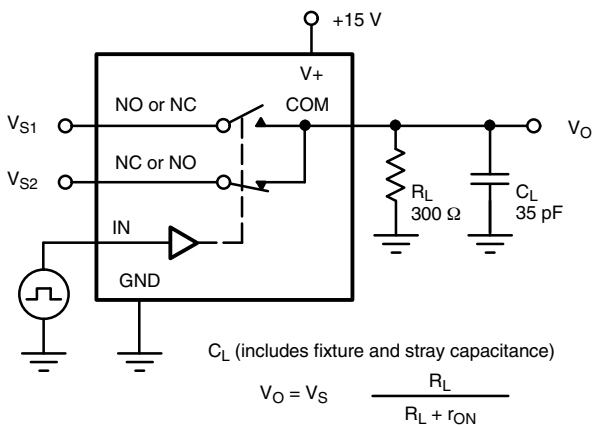
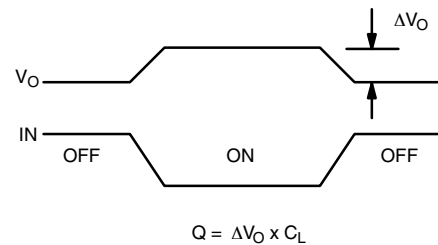
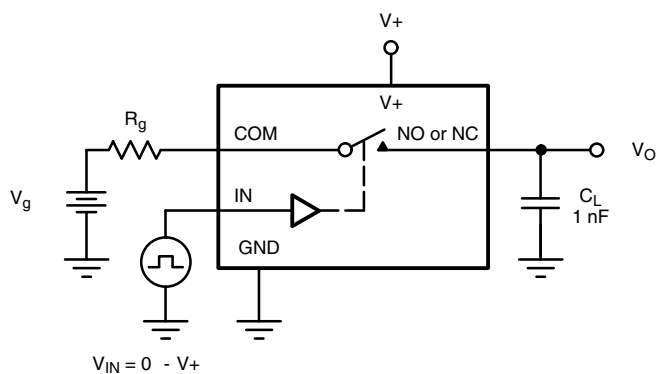
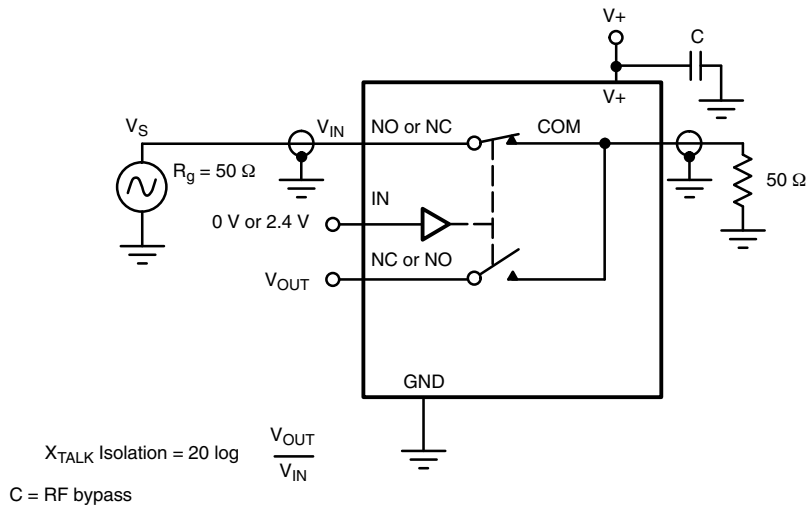
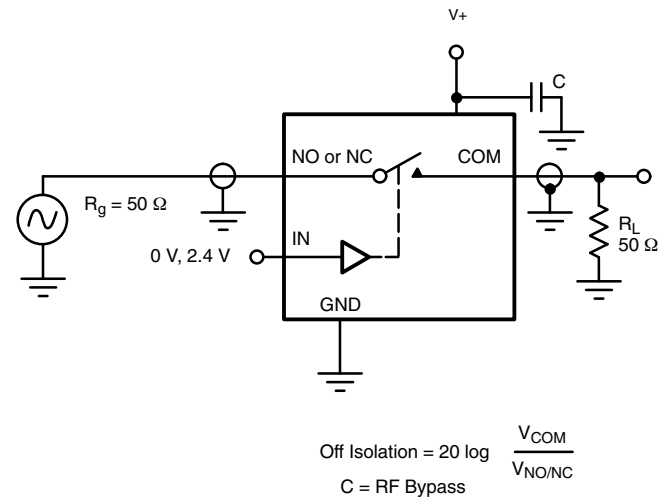
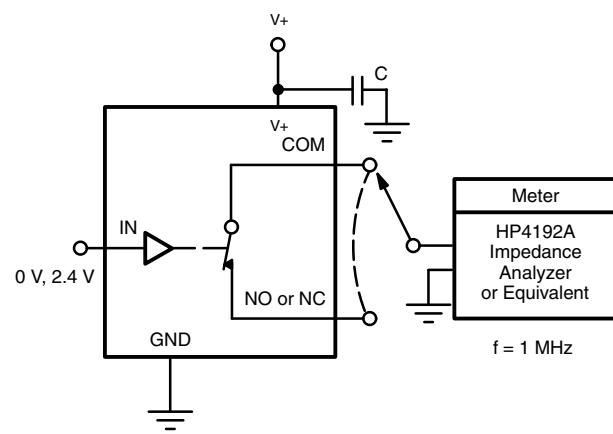


Figure 4. Transition Time



IN dependent on switch configuration Input polarity determined by sense of switch.

Figure 5. Charge Injection

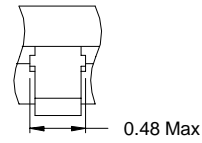
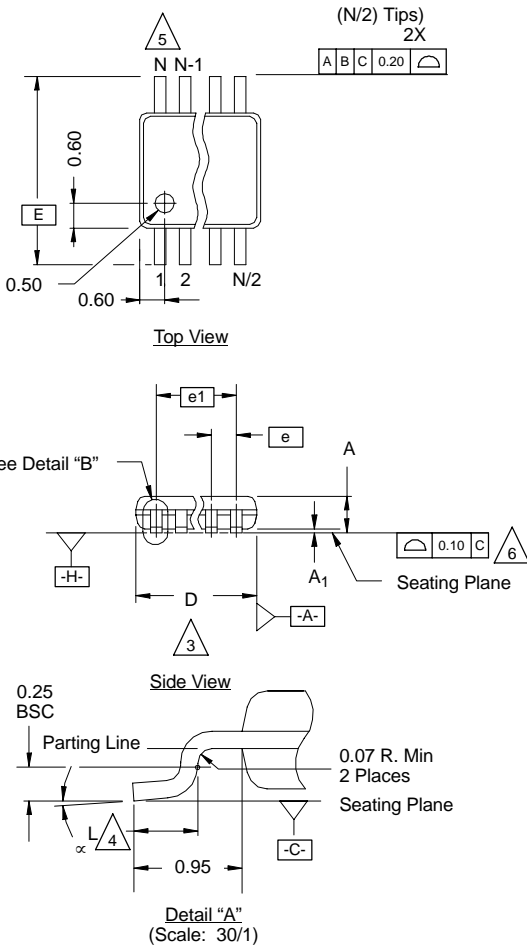
TEST CIRCUITS

Figure 6. Crosstalk

Figure 7. Off Isolation

Figure 8. Source/Drain Capacitances

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?71766.

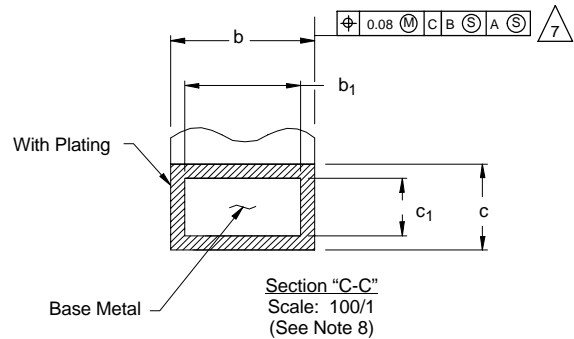


MSOP: 10-LEADS

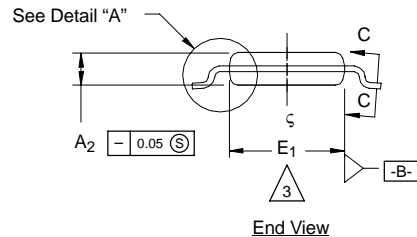
JEDEC Part Number: MO-187, (Variation AA and BA)



Detail "B"
(Scale: 30/1)
Dambar Protrusion



Section "C-C"
Scale: 100/1
(See Note 8)



End View

NOTES:

- Die thickness allowable is 0.203 ± 0.0127 .
- Dimensioning and tolerances per ANSI.Y14.5M-1994.
- Dimensions "D" and "E₁" do not include mold flash or protrusions, and are measured at Datum plane $\square\text{-H}\square$, mold flash or protrusions shall not exceed 0.15 mm per side.
- Dimension is the length of terminal for soldering to a substrate.
- Terminal positions are shown for reference only.
- Formed leads shall be planar with respect to one another within 0.10 mm at seating plane.
- The lead width dimension does not include Dambar protrusion. Allowable Dambar protrusion shall be 0.08 mm total in excess of the lead width dimension at maximum material condition. Dambar cannot be located on the lower radius or the lead foot. Minimum space between protrusions and an adjacent lead to be 0.14 mm. See detail "B" and Section "C-C".
- Section "C-C" to be determined at 0.10 mm to 0.25 mm from the lead tip.
- Controlling dimension: millimeters.
- This part is compliant with JEDEC registration MO-187, variation AA and BA.
- Datums $\square\text{-A}\square$ and $\square\text{-B}\square$ to be determined Datum plane $\square\text{-H}\square$.
- Exposed pad area in bottom side is the same as teh leadframe pad size.

N = 10L

| Dim | MILLIMETERS | | | Note |
|---|-------------|------|------|------|
| | Min | Nom | Max | |
| A | - | - | 1.10 | |
| A ₁ | 0.05 | 0.10 | 0.15 | |
| A ₂ | 0.75 | 0.85 | 0.95 | |
| b | 0.17 | - | 0.27 | 8 |
| b ₁ | 0.17 | 0.20 | 0.23 | 8 |
| c | 0.13 | - | 0.23 | |
| c ₁ | 0.13 | 0.15 | 0.18 | |
| D | 3.00 BSC | | | 3 |
| E | 4.90 BSC | | | |
| E ₁ | 2.90 | 3.00 | 3.10 | 3 |
| e | 0.50 BSC | | | |
| e ₁ | 2.00 BSC | | | |
| L | 0.40 | 0.55 | 0.70 | 4 |
| N | 10 | | | 5 |
| α | 0° | 4° | 6° | |
| ECN: T-02080—Rev. C, 15-Jul-02 DWG: 5867 | | | | |



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