



1.6 Ω On Resistance, ± 5 V, +12 V, and +3 V Quad SPST Switches

DESCRIPTION

The DG9424E, DG9425E, DG9426E are monolithic quad single-pole-single-throw analog switches. The G9424E and DG9425E differ only in that they respond to opposite logic levels. The DG9426E has two normally open and two normally closed switches. It can be given various configurations, including four SPST, two SPDT, and one DPDT.

Using BiCMOS wafer fabrication technology allows the DG9424E, DG9425E, and DG9426E to operate on single and dual supplies. Single supply voltage ranges from 3 V to 16 V while dual supply operation is recommended with ± 3 V to ± 8 V. Each switch conducts equally well in both direction when on, and blocks input voltages up to the supply levels when off.

The low and flat on resistance over the full input signal voltage rang bring excellent linearity, reduce insertion loss and signal distortion, make them ideal for data acquisition and programmable gain control applications. These switch characters also make them ideal fit for audio signal switch and reed relay replacement.

The DG9424E, DG9425E, DG9426E feature low power dissipation, fast switching speed, and low voltage logic control threshold. Proprietary design enables the low charge injection that minimize the switching transient.

Operation temperature is specified from -40 °C to +85 °C. The DG9424E, DG9425E, DG9426E are available in 16 lead TSSOP packages.

FEATURES

- 3 V to 16 V single supply or ± 3 V thru ± 8 V dual supply operation
- 1.6 Ω typical on resistance
- 3 V logic compatible for control
- Bidirectional rail to rail signal switching
- Fast switching speed
- < 0.2 nA switch on leakage
- Break-before-make switching - DG9426

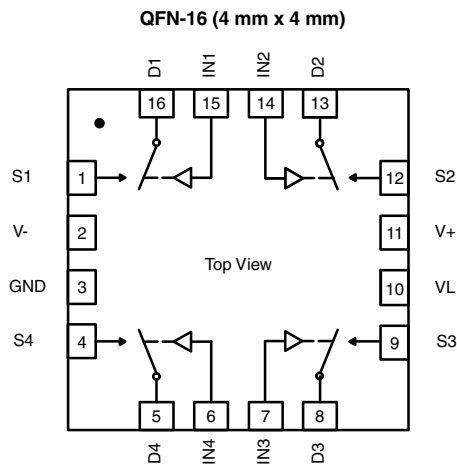
BENEFITS

- Wide operation voltage range
- Low signal errors and distortion
- Fast switching time
- Simple interfacing

APPLICATIONS

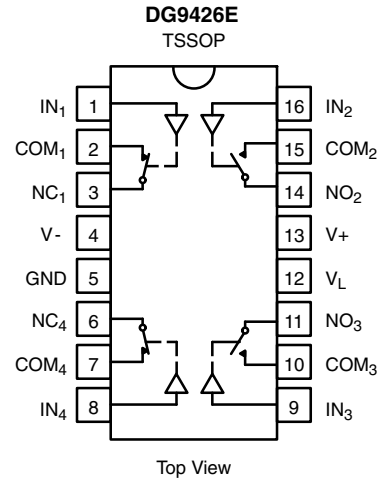
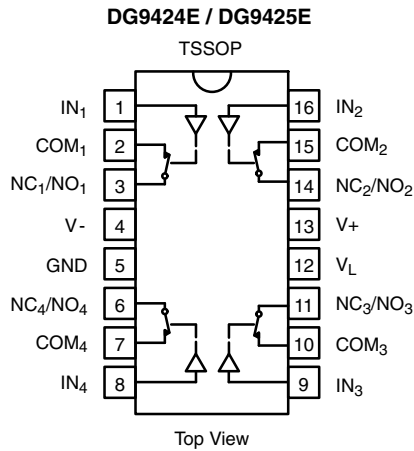
- Automatic test equipment
- Data acquisition systems
- Meters and instruments
- Medical and healthcare systems
- Communication systems
- Audio and video signal routing
- Relay replacement
- Battery powered systems
- Computer peripherals
- Audio and video signal routing

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Note

- QFN exposed pad can either be tied to V- or left floating

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION


| TRUTH TABLE | | |
|-------------|---------|---------|
| LOGIC | DG9424E | DG9425E |
| 0 | Off | On |
| 1 | On | Off |

| TRUTH TABLE | | |
|-------------|-----------------------------------|-----------------------------------|
| LOGIC | SW ₁ , SW ₄ | SW ₂ , SW ₃ |
| 0 | On | Off |
| 1 | Off | On |

| ORDERING INFORMATION | | | | |
|----------------------|-------------------------------------|------------------|--------------|--------------------------|
| TEMP. RANGE | PACKAGE | PART NUMBER | PART MARKING | STD PACK QUANTITY |
| -40 °C to +85 °C | 16-pin TSSOP | DG9424EDQ-T1-GE3 | 9424E | Tape and reel 3000 units |
| | | DG9425EDQ-T1-GE3 | 9425E | Tape and reel 3000 units |
| | | DG9426EDQ-T1-GE3 | 9426E | Tape and reel 3000 units |
| | QFN (4 mm x 4 mm) 16L (variation 2) | DG9424EDN-T1-GE4 | 9424E | Tape and reel 2500 units |
| | | DG9425EDN-T1-GE4 | 9425E | Tape and reel 2500 units |
| | | DG9426EDN-T1-GE4 | 9426E | Tape and reel 2500 units |

| ABSOLUTE MAXIMUM RATINGS | | | |
|---|--|------|------|
| PARAMETER | LIMIT | UNIT | |
| V ₊ to V ₋ | -0.3 to +18 | V | |
| GND to V ₋ | 18 | | |
| V _L | (GND - 0.3) to (V ₊) + 0.3 | | |
| IN, COM, NC, NO ^a | (V ₋) - 0.3 to (V ₊) + 0.3 | | |
| Continuous current (NO, NC, COM pins) | 100 | mA | |
| Peak current, S or D (pulsed 1 ms, 10 % duty cycle) | 200 | | |
| Storage temperature | -65 to +150 | °C | |
| Power dissipation (package) ^b | 16-pin TSSOP ^c | 450 | mW |
| Thermal resistance ^b | | 178 | °C/W |
| ESD human body model (HBM); per ANSI / ESDA / JEDEC® JS-001 | >1500 | V | |
| Latch up current, per JESD78D | 400 | mA | |

Notes

- Signals on NC, NO, COM or IN 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 7 mW/°C above 25 °C

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.



| SPECIFICATIONS ^a Single Supply 12 V | | | | | | | |
|--|--------------------------------------|--|--------------------|----------------------------|-------------------|-------------------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 12 V, V ₋ = 0 V V _L = 5 V, V _{IN} = 2.4 V, 0.8 V ^f | TEMP. ^b | LIMITS -40 °C to +85 °C | | | UNIT |
| | | | | MIN. ^d | TYP. ^c | MAX. ^d | |
| Analog Switch | | | | | | | |
| Analog signal range ^e | V _{ANALOG} | | Full | 0 | - | 12 | V |
| On-resistance | R _{ON} | V ₊ = 10.8 V, V ₋ = 0 V, I _{NO} , I _{NC} = 50 mA, V _{COM} = 2/9 V | Room | - | 1.6 | 3 | Ω |
| | | | Full | - | - | 4 | |
| Digital Control | | | | | | | |
| Input current | I _{INL} or I _{INH} | | Full | -1 | 0.01 | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-on time ^e | t _{ON} | R _L = 300 Ω, C _L = 35 pF, V _{NO} , V _{NC} = 5 V, see Fig. 2 | Room | - | 36 | 51 | ns |
| | | | Full | - | - | 65 | |
| Turn-off time ^e | t _{OFF} | | Room | - | 20 | 35 | |
| | | | Full | - | - | 44 | |
| Break-before-make time delay ^e | t _D | DG9426E only, V _{NO} , V _{NC} = 5 V, R _L = 300 Ω, C _L = 35 pF | Room | 2 | - | - | |
| Charge injection ^e | Q _{INJ} | V _g = 0 V, R _g = 0 Ω, C _L = 1 nF | Room | - | 38 | - | pC |
| Off-isolation ^e | OIRR | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | - | -56 | - | dB |
| Channel-to-channel crosstalk ^e | X _{TALK} | | Room | - | -77 | - | |
| NO, NC off capacitance ^e | C _{NO(off)} | f = 1 MHz | Room | - | 49 | - | pF |
| | C _{NC(off)} | | | | | | |
| COM off capacitance ^e | C _{COM(off)} | | Room | - | 37 | - | |
| Channel on capacitance ^e | C _{COM(on)} | | Room | - | 89 | - | |
| Power Supplies | | | | | | | |
| Positive supply current | I ₊ | V _{IN} = 0 or V _L | Room | - | 0.02 | 1 | μA |
| | | | Full | - | - | 5 | |
| Negative supply current | I ₋ | | Room | -1 | -0.002 | - | |
| | | | Full | -5 | - | - | |
| Logic supply current | I _L | | Room | - | 0.002 | 1 | |
| | | | Full | - | - | 5 | |
| Ground current | I _{GND} | | Room | -1 | -0.002 | - | |
| | | | Full | -5 | - | - | |



| SPECIFICATIONS ^a Dual Supply ± 5 V | | | | | | | |
|---|--------------------------------|---|--------------------|----------------------------|-------------------|-------------------|----------|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED $V_+ = 5$ V, $V_- = 5$ V $V_L = 5$ V, $V_{IN} = 2.4$ V, 0.8 V ^f | TEMP. ^b | LIMITS -40 °C to +85 °C | | | UNIT |
| | | | | MIN. ^d | TYP. ^c | MAX. ^d | |
| Analog Switch | | | | | | | |
| Analog signal range ^e | V_{ANALOG} | | Full | -5 | | 5 | V |
| On-resistance | R_{ON} | $V_+ = 4.5$ V, $V_- = -4.5$ V, $I_{NO}, I_{NC} = 50$ mA | Room | - | 1.9 | 3.3 | Ω |
| | | | Full | - | - | 4.3 | |
| Switch off leakage current | $I_{NO(off)}$ | $V_+ = 5.5$ V, $V_- = -5.5$ V, $V_{COM} = \pm 4.5$ V, $V_{NO}, V_{NC} = \pm 4.5$ V | Room | -1 | - | 1 | nA |
| | $I_{NC(off)}$ | | Full | -10 | - | 10 | |
| | $I_{COM(off)}$ | | Room | -1 | - | 1 | |
| | | | Full | -10 | - | 10 | |
| Channel on leakage current | $I_{COM(on)}$ | $V_+ = 5.5$ V, $V_- = -5.5$ V, $V_{NO}, V_{NC} = V_{COM} = \pm 4.5$ V | Room | -1 | - | 1 | |
| | | | Full | -10 | - | 10 | |
| Digital Control | | | | | | | |
| Input current ^a | I_{INL} or I_{INH} | | Full | -1 | 0.05 | 1 | μ A |
| Dynamic Characteristics | | | | | | | |
| Turn-on time ^e | t_{ON} | $R_L = 300 \Omega$, $C_L = 35$ pF, $V_{NO}, V_{NC} = \pm 3.5$ V, see Fig. 2 | Room | - | 48 | 67 | ns |
| | | | Full | - | - | 81 | |
| Turn-off time ^e | t_{OFF} | | Room | - | 34 | 57 | |
| | | | Full | - | - | 67 | |
| Break-before-make time delay ^e | t_D | DG9426E only, $V_{NO}, V_{NC} = 3.5$ V, $R_L = 300 \Omega$, $C_L = 35$ pF | Room | 2 | - | - | |
| Charge injection ^e | Q_{INJ} | $V_g = 0$ V, $R_g = 0 \Omega$, $C_L = 1$ nF | Room | - | 112 | - | pC |
| Off isolation ^e | OIRR | $R_L = 50 \Omega$, $C_L = 5$ pF, $f = 1$ MHz | Room | - | -56 | - | dB |
| Channel-to-channel crosstalk ^e | X_{TALK} | | Room | - | -82 | - | |
| Source off capacitance ^e | $C_{NO(off)}$ $C_{NC(off)}$ | $f = 1$ MHz | Room | - | 38 | - | pF |
| Drain off capacitance ^e | $C_{COM(off)}$ | | Room | - | 38 | - | |
| Channel on capacitance ^e | $C_{COM(on)}$ | | Room | - | 89 | - | |
| Power Supplies | | | | | | | |
| Positive supply current ^e | I_+ | $V_{IN} = 0$ or V_L | Room | - | 0.03 | 1 | μ A |
| | | | Full | - | - | 5 | |
| Negative supply current ^e | I_- | | Room | -1 | -0.002 | - | |
| | | | Full | -5 | - | - | |
| Logic supply current ^e | I_L | | Room | - | 0.002 | 1 | |
| | | | Full | - | - | 5 | |
| Ground current ^e | I_{GND} | | Room | -1 | -0.002 | - | |
| | | | Full | -5 | - | - | |



| SPECIFICATIONS ^a Single Supply 5 V | | | | | | | |
|---|---------------------|---|--------------------|----------------------------|-------------------|-------------------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 5 V, V ₋ = 0 V V _L = 5 V, V _{IN} = 2.4 V, 0.8 V ^f | TEMP. ^b | LIMITS -40 °C to +85 °C | | | UNIT |
| | | | | MIN. ^d | TYP. ^c | MAX. ^d | |
| Analog Switch | | | | | | | |
| Analog signal range ^e | V _{ANALOG} | | Full | - | - | 5 | V |
| On-resistance ^e | R _{ON} | V ₊ = 4.5 V, I _{NO} , I _{NC} = 50 mA | Room | - | 3.1 | 4.8 | Ω |
| | | | Full | - | - | 5.8 | |
| Dynamic Characteristics | | | | | | | |
| Turn-on time ^e | t _{ON} | R _L = 300 Ω, C _L = 35 pF, V _{NO} , V _{NC} = 3.5 V, see Fig. 2 | Room | - | 62 | 78 | ns |
| | | | Hot | - | - | 106 | |
| Turn-off time ^e | t _{OFF} | | Room | - | 29 | 44 | |
| | | | Hot | - | - | 56 | |
| Break-before-make time delay ^e | t _D | DG9426E only, V _{NO} , V _{NC} = 3.5 V, R _L = 300 Ω, C _L = 35 pF | Room | 5 | - | - | |
| Charge injection ^e | Q _{INJ} | V _g = 0 V, R _g = 0 Ω, C _L = 1 nF | Room | - | 10 | - | pC |
| Power Supplies | | | | | | | |
| Positive supply current ^e | I ₊ | V _{IN} = 0 or V _L | Room | - | 0.02 | 1 | μA |
| | | | Hot | - | - | 5 | |
| Negative supply current ^e | I ₋ | | Room | -1 | -0.002 | - | |
| | | | Hot | -5 | - | - | |
| Logic supply current ^e | I _L | | Room | - | 0.002 | 1 | |
| | | | Hot | - | - | 5 | |
| Ground current ^e | I _{GND} | | Room | -1 | -0.002 | - | |
| | | | Hot | -5 | - | - | |

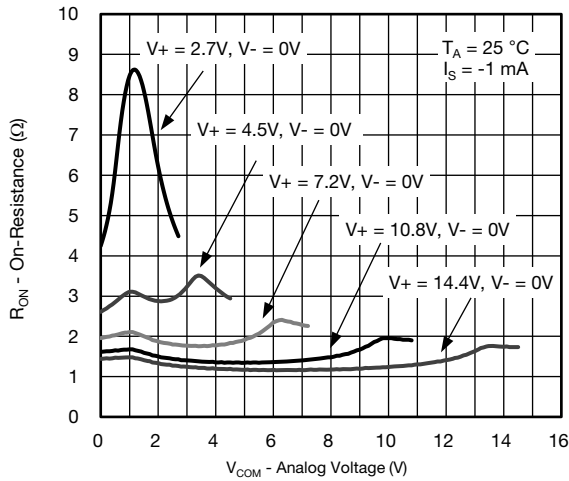


| SPECIFICATIONS ^a Single Supply 3 V | | | | | | | |
|---|--------------------------------------|---|--------------------|----------------------------|-------------------|-------------------|------|
| PARAMETER | SYMBOL | TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 3 V, V ₋ = 0 V V _L = 3 V, V _{IN} = 2.4 V, 0.4 V ^f | TEMP. ^b | LIMITS -40 °C to +85 °C | | | UNIT |
| | | | | MIN. ^d | TYP. ^c | MAX. ^d | |
| Analog Switch | | | | | | | |
| Analog signal range ^e | V _{ANALOG} | | Full | 0 | - | 3 | V |
| On-resistance | R _{ON} | V ₊ = 2.7 V, V ₋ = 0 V. I _{NO} , I _{NC} = 5 mA, V _{COM} = 0.5, 2.2 V | Room | - | 6 | - | Ω |
| | | | Full | - | - | - | |
| Switch off leakage current ^a | I _{NO(off)} | V ₊ = 3.3 V, V ₋ = 0 V. V _{COM} = 0.3, 3 V, V _{NO} , V _{NC} = 3, 0.3 V | Room | -1 | - | 1 | nA |
| | I _{NC(off)} | | Full | -10 | - | 10 | |
| | I _{COM(off)} | | Room | -1 | - | 1 | |
| | | | Full | -10 | - | 10 | |
| Channel on leakage current ^a | I _{COM(on)} | V ₊ = 3.3 V, V ₋ = 0 V, V _{NO} , V _{NC} = V _{COM} = 0.3, 3 V | Room | -1 | - | 1 | |
| | | | Full | -10 | - | 10 | |
| Digital Control ^e | | | | | | | |
| Input current | I _{INL} or I _{INH} | | Full | -1 | 0.005 | 1 | μA |
| Dynamic Characteristics | | | | | | | |
| Turn-on time | t _{ON} | R _L = 300 Ω, C _L = 35 pF. V _{NO} , V _{NC} = 1.5 V, see Fig. 2 | Room | - | 140 | - | ns |
| | | | Full | - | - | 193 | |
| Turn-off time | t _{OFF} | | Room | - | 65 | - | |
| | | | Full | - | - | 89 | |
| Break-before-make time delay | t _D | DG9426E only, V _{NO} , V _{NC} = 1.5 V, R _L = 300 Ω, C _L = 35 pF | Room | 5 | | | |
| Charge injection ^e | Q _{INJ} | V _g = 0 V, R _g = 0 Ω, C _L = 1 nF | Room | - | 15 | - | pC |
| Off isolation ^e | OIRR | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz | Room | - | -56 | - | dB |
| Channel-to-channel crosstalk ^e | X _{TALK} | | Room | - | -80 | - | |
| Source off capacitance ^e | C _{NO(off)} | f = 1 MHz | Room | - | 53 | - | pF |
| | C _{NC(off)} | | Room | - | 42 | - | |
| Drain off capacitance ^e | C _{COM(off)} | | Room | - | 92 | - | |
| Channel on capacitance ^e | C _{COM(on)} | | Room | - | 92 | - | |

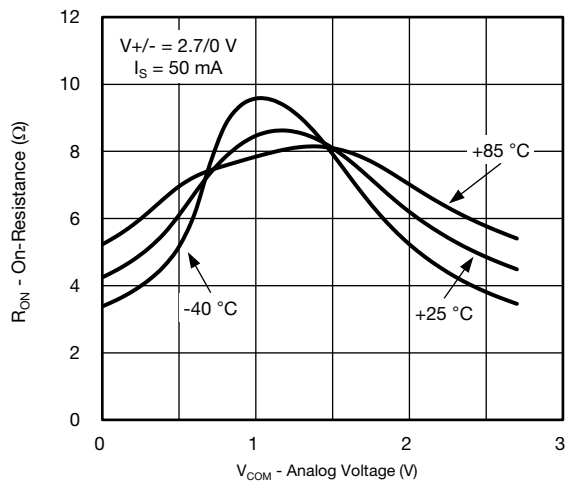
Notes

- a. Leakage parameters are guaranteed by worst case test conditions and not subject to production test
- b. Room = 25 °C, Full = As determined by the operating temperature suffix
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
- d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet
- e. Guaranteed by design, not subject to production test
- f. V_{IN} = Input voltage to perform proper function

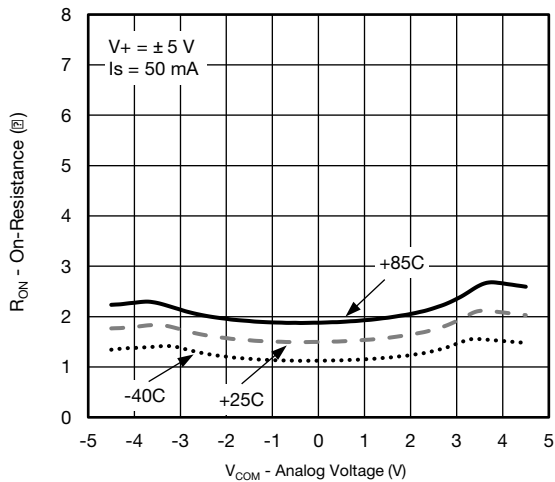
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



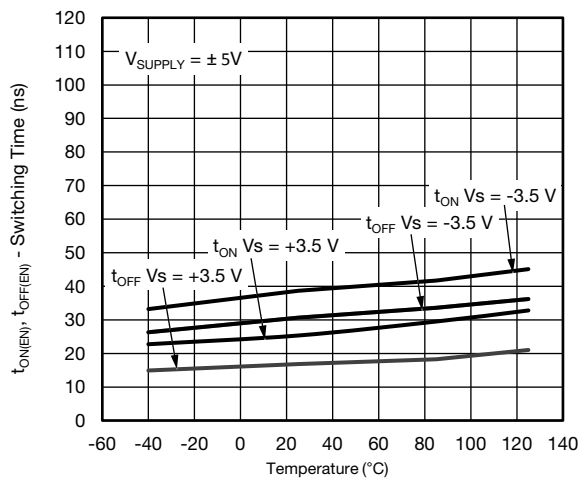
RON vs. VCOM and Supply Voltage



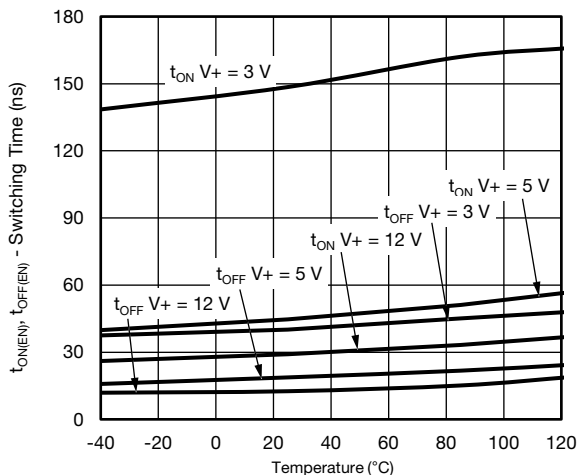
RON vs. Analog Voltage and Temperature



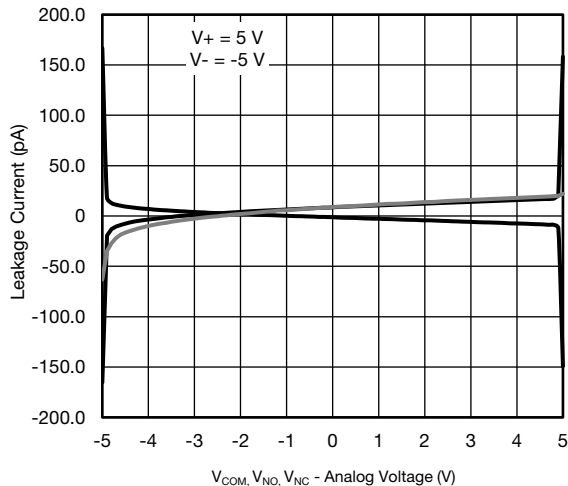
RON vs. Analog Voltage and Temperature



Switching Time vs. Temperature and Dual Supply Voltage



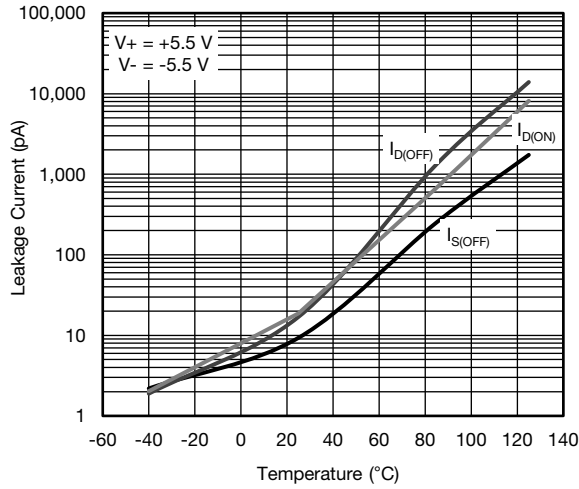
Switching Time vs. Temperature and Single Supply Voltage



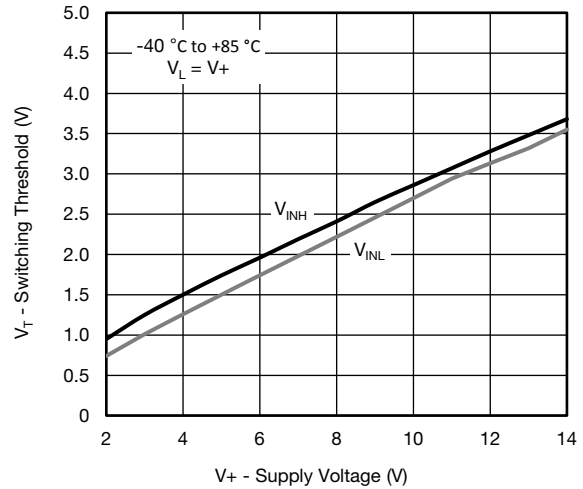
Leakage Current vs. Analog Voltage



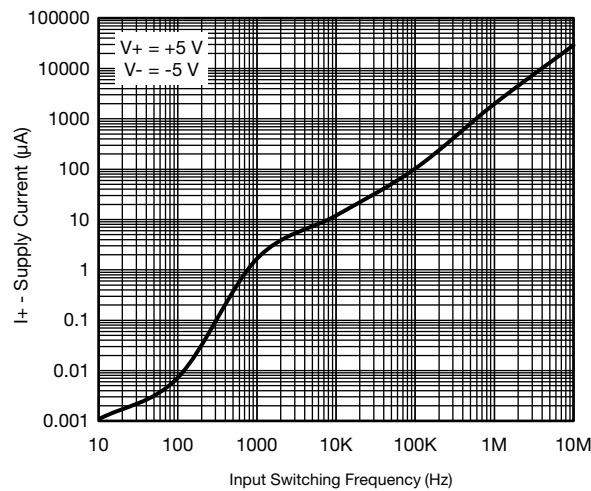
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



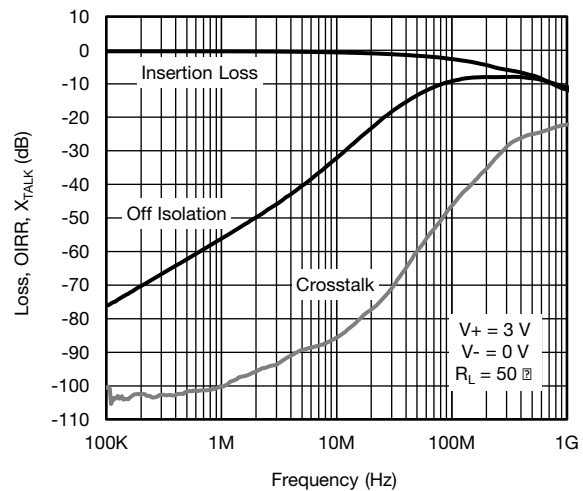
Leakage Current vs. Temperature



Switching Threshold vs. Supply Voltage



Switching Current vs. Input Switching Frequency



Insertion Loss, Off Isolation and Crosstalk vs. Frequency

SCHEMATIC DIAGRAM (typical channel)

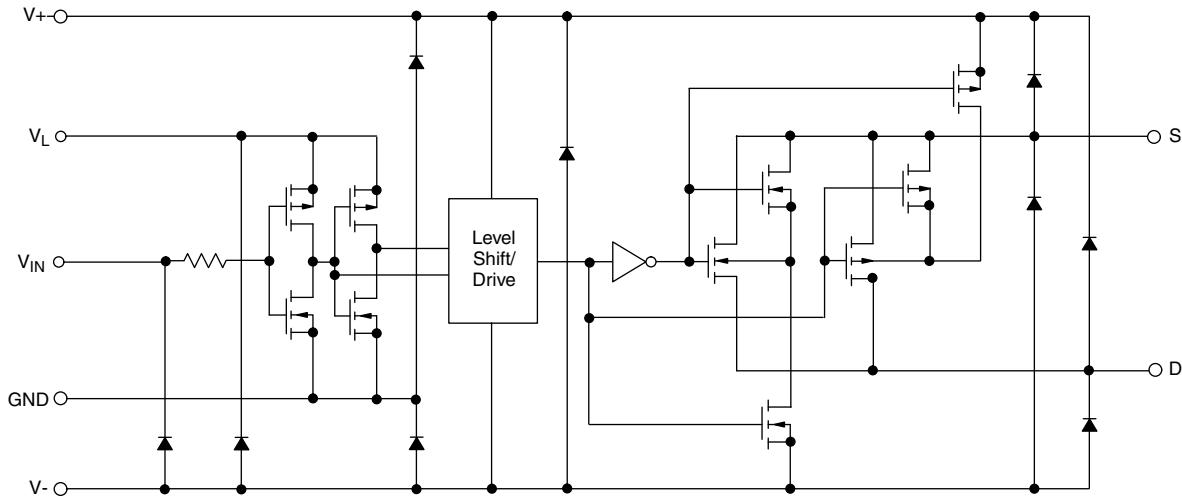
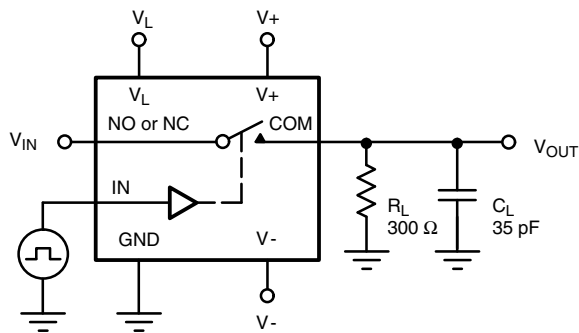


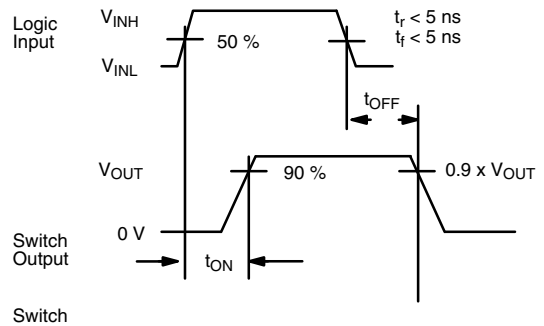
Fig. 1

TEST CIRCUITS



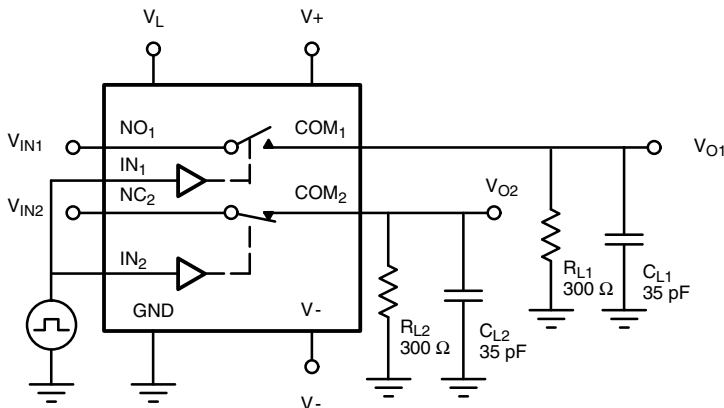
C_L (includes fixture and stray capacitance)

$$V_{OUT} = V_{IN} \frac{R_L}{R_L + r_{ON}}$$



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

Fig. 2 - Switching Time



C_L (includes fixture and stray capacitance)

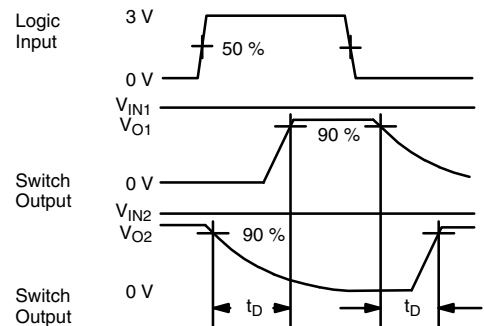


Fig. 3 - Break-Before-Make (DG9426E)

TEST CIRCUITS

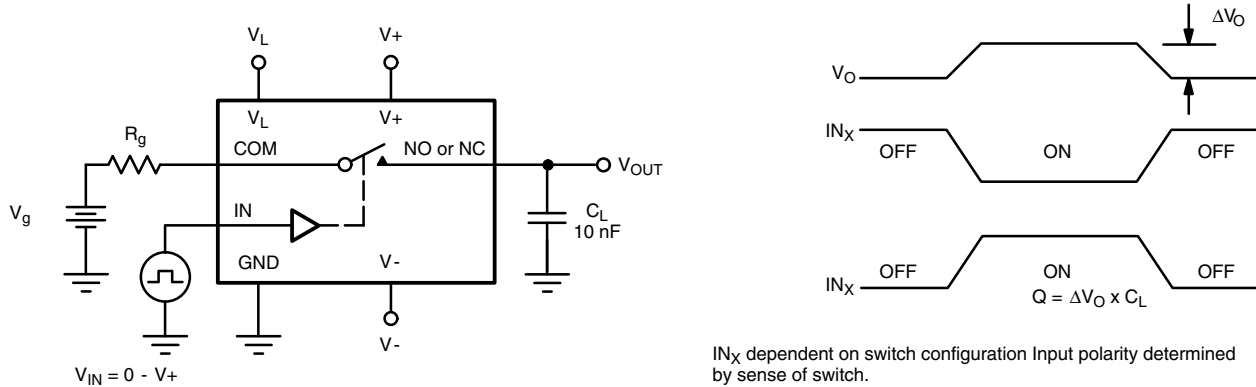


Fig. 4 - Charge Injection

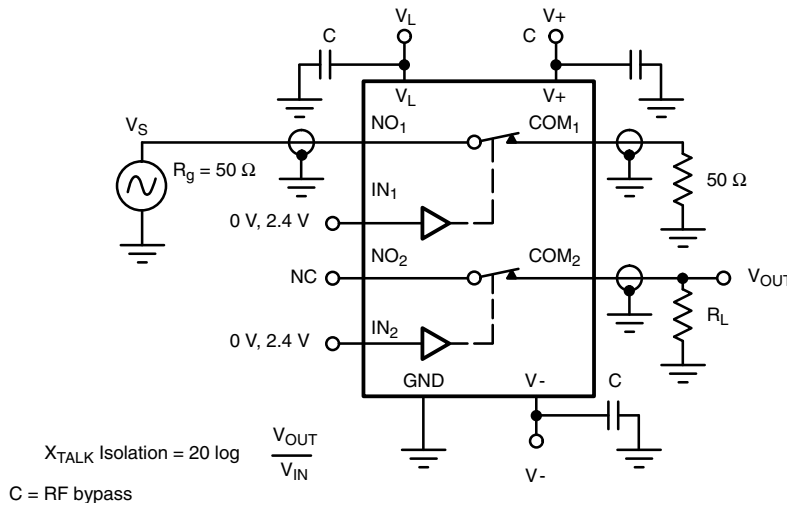


Fig. 5 - Crosstalk

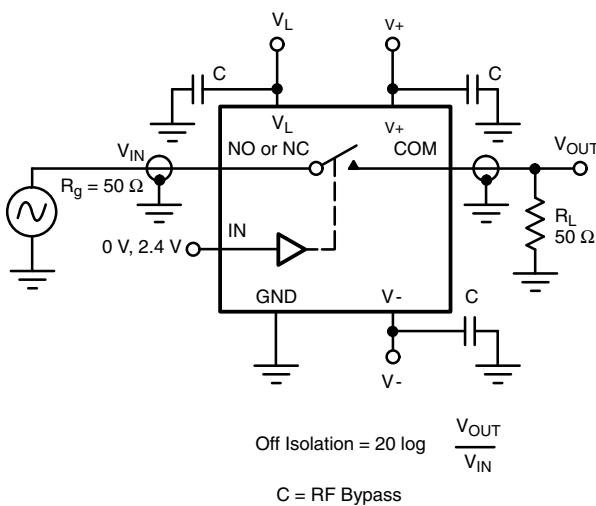


Fig. 6 - Off-Isolation

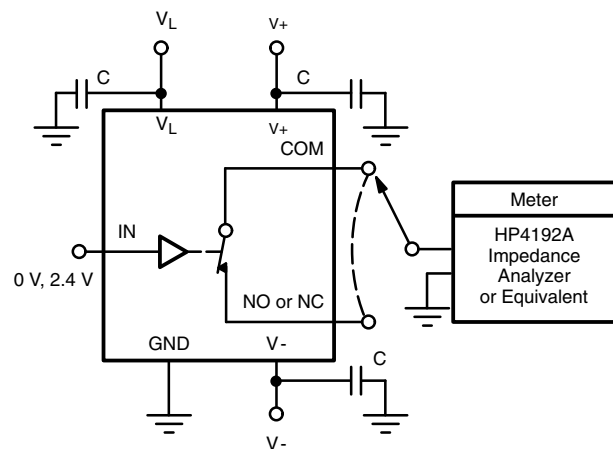


Fig. 7 - Source/Drain Capacitances

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?75770.

QFN 4x4-16L Case Outline



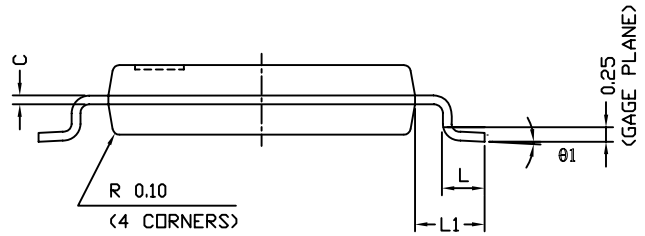
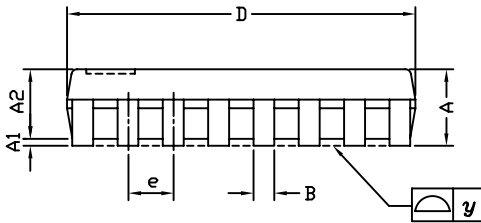
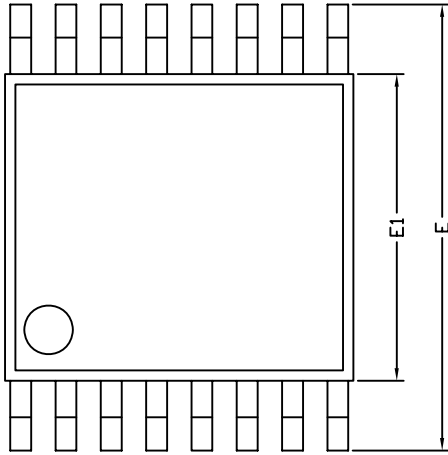
| DIM | VARIATION 1 | | | | | | VARIATION 2 | | | | | |
|-------------------|----------------------------|------|------|------------|-------|-------|----------------------------|------|------|------------|-------|-------|
| | MILLIMETERS ⁽¹⁾ | | | INCHES | | | MILLIMETERS ⁽¹⁾ | | | INCHES | | |
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.75 | 0.85 | 0.95 | 0.029 | 0.033 | 0.037 | 0.75 | 0.85 | 0.95 | 0.029 | 0.033 | 0.037 |
| A1 | 0 | - | 0.05 | 0 | - | 0.002 | 0 | - | 0.05 | 0 | - | 0.002 |
| A3 | 0.20 ref. | | | 0.008 ref. | | | 0.20 ref. | | | 0.008 ref. | | |
| b | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 | 0.25 | 0.30 | 0.35 | 0.010 | 0.012 | 0.014 |
| D | 4.00 BSC | | | 0.157 BSC | | | 4.00 BSC | | | 0.157 BSC | | |
| D2 | 2.0 | 2.1 | 2.2 | 0.079 | 0.083 | 0.087 | 2.5 | 2.6 | 2.7 | 0.098 | 0.102 | 0.106 |
| e | 0.65 BSC | | | 0.026 BSC | | | 0.65 BSC | | | 0.026 BSC | | |
| E | 4.00 BSC | | | 0.157 BSC | | | 4.00 BSC | | | 0.157 BSC | | |
| E2 | 2.0 | 2.1 | 2.2 | 0.079 | 0.083 | 0.087 | 2.5 | 2.6 | 2.7 | 0.098 | 0.102 | 0.106 |
| K | 0.20 min. | | | 0.008 min. | | | 0.20 min. | | | 0.008 min. | | |
| L | 0.5 | 0.6 | 0.7 | 0.020 | 0.024 | 0.028 | 0.3 | 0.4 | 0.5 | 0.012 | 0.016 | 0.020 |
| N ⁽³⁾ | 16 | | | 16 | | | 16 | | | 16 | | |
| Nd ⁽³⁾ | 4 | | | 4 | | | 4 | | | 4 | | |
| Ne ⁽³⁾ | 4 | | | 4 | | | 4 | | | 4 | | |

Notes

- (1) Use millimeters as the primary measurement.
- (2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
- (3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
- (4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.
- (5) The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.
- (6) Package warpage max. 0.05 mm.

ECN: S13-0893-Rev. B, 22-Apr-13
DWG: 5890

TSSOP: 16-LEAD



| Symbols | DIMENSIONS IN MILLIMETERS | | |
|---------|---------------------------|-------|------|
| | Min | Nom | Max |
| A | - | 1.10 | 1.20 |
| A1 | 0.05 | 0.10 | 0.15 |
| A2 | - | 1.00 | 1.05 |
| B | 0.22 | 0.28 | 0.38 |
| C | - | 0.127 | - |
| D | 4.90 | 5.00 | 5.10 |
| E | 6.10 | 6.40 | 6.70 |
| E1 | 4.30 | 4.40 | 4.50 |
| e | - | 0.65 | - |
| L | 0.50 | 0.60 | 0.70 |
| L1 | 0.90 | 1.00 | 1.10 |
| y | - | - | 0.10 |
| theta 1 | 0° | 3° | 6° |

ECN: S-61920-Rev. D, 23-Oct-06
DWG: 5624



RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads
Dimensions in inches (mm)



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