



Improved, SPST/SPDT Analog Switches

DG417/DG418/DG419

General Description

Maxim's redesigned DG417/DG418/DG419 precision, CMOS, monolithic analog switches now feature guaranteed on-resistance matching (3Ω max) between switches and guaranteed on-resistance flatness over the signal range (4Ω max). These switches conduct equally well in either direction and guarantee low charge injection, low power consumption, and an ESD tolerance of 2000V minimum per Method 3015.7. The new design offers low off-leakage current over temperature (less than 5nA at $+85^\circ\text{C}$).

The DG417/DG418 are single-pole/single-throw (SPST) switches. The DG417 is normally closed, and the DG418 is normally open. The DG419 is single-pole/double-throw (SPDT) with one normally closed switch and one normally open switch. Switching times are less than 175ns max for t_{ON} and less than 145ns max for t_{OFF} . Operation is from a single +10V to +30V supply, or bipolar $\pm 4.5\text{V}$ to $\pm 20\text{V}$ supplies. The improved DG417/DG418/DG419 are fabricated with a 44V silicon-gate process.

Applications

| | |
|------------------------------|--------------------------|
| Sample-and-Hold Circuits | Communications Systems |
| Test Equipment | Battery-Operated Systems |
| Modems | Fax Machines |
| Guidance and Control Systems | PBX, PABX |
| Audio Signal Routing | Military Radios |

New Features

- ◆ Plug-In Upgrades for Industry-Standard DG417/DG418/DG419
- ◆ Improved $R_{DS(ON)}$ Match Between Channels (3Ω max, DG419 only)
- ◆ Guaranteed $R_{FLAT(ON)}$ Over Signal Range (4Ω max)
- ◆ Improved Charge Injection (10pC max)
- ◆ Improved Off-Leakage Current Over Temperature ($<5\text{nA}$ at $+85^\circ\text{C}$)
- ◆ Withstand Electrostatic Discharge (2000V min) per Method 3015.7

Existing Features

- ◆ Low $R_{DS(ON)}$ (35Ω max)
- ◆ Single-Supply Operation +10V to +30V
Bipolar-Supply Operation $\pm 4.5\text{V}$ to $\pm 20\text{V}$
- ◆ Low Power Consumption ($35\mu\text{W}$ max)
- ◆ Rail-to-Rail Signal Handling
- ◆ TTL/CMOS-Logic Compatible

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|----------|--|---------------|
| DG417CJ | 0°C to $+70^\circ\text{C}$ | 8 Plastic DIP |
| DG417CY | 0°C to $+70^\circ\text{C}$ | 8 SO |
| DG417C/D | 0°C to $+70^\circ\text{C}$ | Dice* |
| DG417DJ | -40°C to $+85^\circ\text{C}$ | 8 Plastic DIP |
| DG417DY | -40°C to $+85^\circ\text{C}$ | 8 SO |

Ordering Information continued at end of data sheet.

* Contact factory for dice specifications.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

DIP/SO

| DG417 | |
|-------|--------|
| LOGIC | SWITCH |
| 0 | ON |
| 1 | OFF |

DIP/SO

| DG418 | |
|-------|--------|
| LOGIC | SWITCH |
| 0 | OFF |
| 1 | ON |

DIP/SO

| DG419 | | |
|-------|----------|----------|
| LOGIC | SWITCH 1 | SWITCH 2 |
| 0 | ON | OFF |
| 1 | OFF | ON |

N.C. = NO INTERNAL CONNECTION

SWITCHES SHOWN FOR LOGIC "0" INPUT



Improved, SPST/SPDT Analog Switches

DG417/DG418/DG419

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

| | |
|--------------------------------|--|
| V+ | 44V |
| GND | 25V |
| VL | (GND - 0.3V) to (V+ + 0.3V) |
| Digital Inputs VS, VD (Note 1) | (V- - 2V) to (V+ + 2V) or 30mA (whichever occurs first) |

Continuous Current (any terminal) (Note 1) 30mA

Peak Current, S or D (pulsed at 1ms, 10% duty cycle max) 100mA

Continuous Power Dissipation (TA = +70°C)

| | |
|--|-------|
| Plastic DIP (derate 9.09mW/°C above +70°C) | 727mW |
| SO (derate 5.88mW/°C above +70°C) | 471mW |
| CERDIP (derate 8.00mW/°C above +70°C) | 640mW |

Operating Temperature Ranges

| | |
|---------|-----------------|
| DG41_C_ | 0°C to +70°C |
| DG41_D_ | -40°C to +85°C |
| DG41_AK | -55°C to +125°C |

Storage Temperature Range -65°C to +150°C

Lead Temperature (soldering, 10sec) +300°C

Note 1: Signals on S, D, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

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.

ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +15V, V- = -15V, VL = 5V, GND = 0V, VINL = 0.8V, VINH = 2.4V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS | | |
|---|-----------|--|---|----------------------|--|-----------------|------------|------|------|
| SWITCH | | | | | | | | | |
| Analog Signal Range | VS, VD | (Note 3) | | -15 | | 15 | V | | |
| Drain-Source On-Resistance | RDS(ON) | V+ = 13.5V, V- = -13.5V, VD = ±10V, IS = -10mA | TA = +25°C | C, D | 20 | 35 | Ω | | |
| | | | | A | 20 | 30 | | | |
| | | | TA = TMIN to TMAX | | | 45 | | | |
| On-Resistance Match Between Channels (Note 4) | ΔRDS(ON) | V+ = 15V, V- = -15V, VD = ±10V, IS = -10mA | TA = +25°C | | | 3 | Ω | | |
| | | | TA = TMIN to TMAX | | | 4 | | | |
| On-Resistance Flatness (Note 4) | RFLAT(ON) | V+ = 15V, V- = -15V, VD = ±5V, IS = -10mA | TA = +25°C | | | 4 | Ω | | |
| | | | TA = TMIN to TMAX | | | 6 | | | |
| Source-Off Leakage Current (Note 5) | IS(OFF) | V+ = 16.5V, V- = -16.5V, VD = ±15.5V, VS = ±15.5V | TA = +25°C | | -0.25 | 0.25 | nA | | |
| | | | TA = TMIN to TMAX | C, D | -5 | 5 | | | |
| | | | | A | -20 | 20 | | | |
| Drain-Off Leakage Current (Note 5) | ID(OFF) | V+ = 16.5V, V- = -16.5V, VD = ±15.5V, VS = ±15.5V | DG417/ DG418 | TA = +25°C | | -0.25 | 0.1 | nA | |
| | | | | TA = TMIN to TMAX | C, D | -5 | 5 | | |
| | | | DG419 | | TA = +25°C | | -0.75 | | -0.1 |
| | | | | TA = TMIN to TMAX | C, D | -10 | 10 | | |
| | | | A | | -40 | 40 | | | |
| | | | Drain-On Leakage Current (Note 5) | ID(ON) | V+ = 16.5V, V- = -16.5V, VD = ±15.5V, VS = ±15.5V | DG417/ DG418 | TA = +25°C | | |
| TA = TMIN to TMAX | C, D | -10 | | | | | 10 | | |
| | DG419 | TA = +25°C | | | | | -0.75 | 0.75 | |
| TA = TMIN to TMAX | | C, D | | | | -10 | 10 | | |
| | A | -40 | | | | 40 | | | |

Improved, SPST/SPDT Analog Switches

DG417/DG418/DG419

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, VL = 5V, GND = 0V, VINL = 0.8V, VINH = 2.4V, TA = TMIN to TMAX, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS | |
|---|--|---|---|-----------------|---------|-------|----|
| LOGIC INPUT | | | | | | | |
| Logic Input Current with Input Voltage High | I _{INH} | V _{IN} = 2.4V | -0.5 | 0.005 | 0.5 | μA | |
| Logic Input Current with Input Voltage Low | I _{INL} | V _{IN} = 0.8V | -0.5 | 0.005 | 0.5 | μA | |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | DG417/DG418, V _D = ±10V, Figure 2 | TA = +25°C | 100 | 175 | ns | |
| | | | TA = T _{MIN} to T _{MAX} | | 250 | | |
| Turn-Off Time | t _{OFF} | DG417/DG418, V _D = ±10V, Figure 2 | TA = +25°C | 60 | 145 | ns | |
| | | | TA = T _{MIN} to T _{MAX} | | 210 | | |
| Transition Time | t _{TRANS} | DG419, V _S = ±10V, Figure 3 | TA = +25°C | | 175 | ns | |
| | | | TA = T _{MIN} to T _{MAX} | | 250 | | |
| Break-Before-Make Interval | t _D | DG419, V _{S1} = V _{S2} = ±10V, Figure 4, TA = +25°C | 5 | 13 | | ns | |
| Charge Injection (Note 3) | Q | V _{GEN} = 0V, Figure 5, TA = +25°C | | 3 | 10 | pC | |
| Off-Isolation Rejection Ratio (Note 6) | OIRR | R _L = 500Ω, C _L = 5pF, f = 1MHz, Figure 6, TA = +25°C | | 68 | | dB | |
| Crosstalk (Note 7) | | DG419, R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 7, TA = +25°C | | 85 | | dB | |
| Drain Off-Capacitance | C _{D (OFF)} | V _D = 0V, f = 1MHz, Figure 8, TA = +25°C | | 8 | | pF | |
| Source Off-Capacitance | C _{S (OFF)} | V _D = 0V, f = 1MHz, Figure 8, TA = +25°C | | 8 | | pF | |
| Drain-Source On-Capacitance | C _{D (ON)} or C _{S (ON)} | V _S = 0V, f = 1MHz, Figure 9, TA = +25°C | DG417/DG418 | 30 | | pF | |
| | | | DG419 | 35 | | | |
| SUPPLY | | | | | | | |
| Positive Supply Current | I ₊ | V ₊ = 16.5V, V ₋ = -16.5V, V _{IN} = 0V or 5V | TA = +25°C | -1 | -0.0001 | 1 | μA |
| | | | TA = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Negative Supply Current | I ₋ | V ₊ = 16.5V, V ₋ = -16.5V, V _{IN} = 0V or 5V | TA = +25°C | -1 | -0.0001 | 1 | μA |
| | | | TA = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Logic Supply Current | I _L | V ₊ = 16.5V, V ₋ = -16.5V, V _{IN} = 0V or 5V | TA = +25°C | -1 | -0.0001 | 1 | μA |
| | | | TA = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Ground Current | I _{GND} | V ₊ = 16.5V, V ₋ = -16.5V, V _{IN} = 0V or 5V | TA = +25°C | -1 | -0.0001 | 1 | μA |
| | | | TA = T _{MIN} to T _{MAX} | -5 | | 5 | |

Improved, SPST/SPDT Analog Switches

DG417/DG418/DG419

ELECTRICAL CHARACTERISTICS—Single Supply

($V_+ = +12V$, $V_- = 0V$, $V_L = 5V$, $GND = 0V$, $V_{INH} = 2.4V$, $V_{INL} = 0.8V$, $T_A = +25^\circ C$, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS |
|----------------------------|--------------|---|-----|-----------------|-----|----------|
| SWITCH | | | | | | |
| Analog Signal Range | V_{ANALOG} | (Note 3) | 0 | | 12 | V |
| Drain-Source On-Resistance | $R_{DS(ON)}$ | $I_S = -10mA$, $V_D = 3.8V$, $V_+ = 10.8V$ | | 40 | 100 | Ω |
| DYNAMIC | | | | | | |
| Turn-On Time | t_{ON} | DG417/DG418, $V_D = 8V$, Figure 2 | | 110 | | ns |
| Turn-Off Time | t_{OFF} | DG417/DG418, $V_D = 8V$, Figure 2 | | 40 | | ns |
| Break-Before-Make Interval | t_D | DG419, $R_L = 1000\Omega$, $C_L = 35pF$, Figure 4 | | 60 | | ns |
| Charge Injection (Note 3) | Q | $C_L = 10nF$, $V_{GEN} = 0V$, $R_{GEN} = 0V$, Figure 5 | | 2 | 10 | pC |
| SUPPLY | | | | | | |
| Positive Supply Current | I_+ | All channels on or off, $V_+ = 13.2V$, $V_L = 5.25V$, $V_{IN} = 0V$ or $5V$ | | -0.0001 | | μA |
| Negative Supply Current | I_- | All channels on or off, $V_+ = 13.2V$, $V_L = 5.25V$, $V_{IN} = 0V$ or $5V$ | | -0.0001 | | μA |
| Logic Supply Current | I_L | All channels on or off, $V_L = 5.25V$, $V_{IN} = 0V$ or $5V$ | | -0.0001 | | μA |
| Ground Current | I_{GND} | All channels on or off, $V_L = 5.25V$, $V_{IN} = 0V$ or $5V$ | | -0.0001 | | μA |

Note 2: Typical values are for **design aid only**, are not guaranteed, and are not subject to production testing. The algebraic convention where the most negative value is a minimum and the most positive value a maximum is used in this data sheet.

Note 3: Guaranteed by design.

Note 4: On-resistance match between channels and flatness is guaranteed only with bipolar-supply operation. Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured at the extremes of the specified analog range.

Note 5: Leakage parameters $I_{S(OFF)}$, $I_{D(OFF)}$, and $I_{D(ON)}$ are 100% tested at the maximum rated hot temperature and guaranteed by correlation at $+25^\circ C$.

Note 6: Off-Isolation Rejection Ratio = $20\log(V_D/V_S)$, V_D = output, V_S = input to off switch.

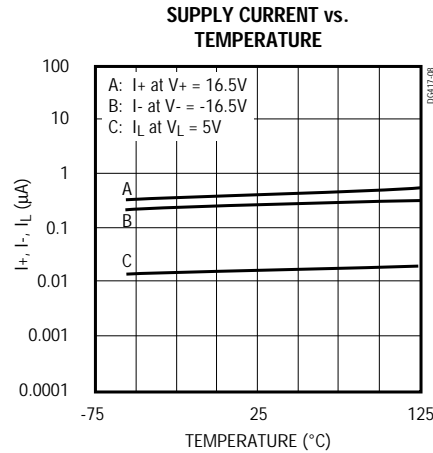
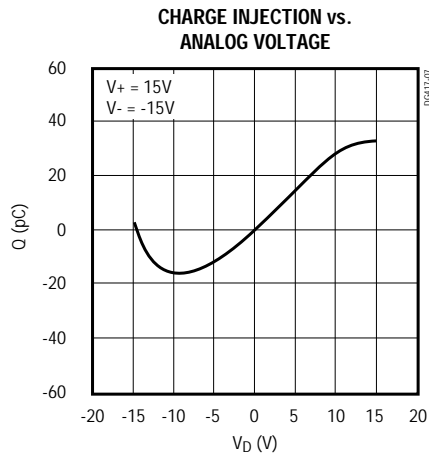
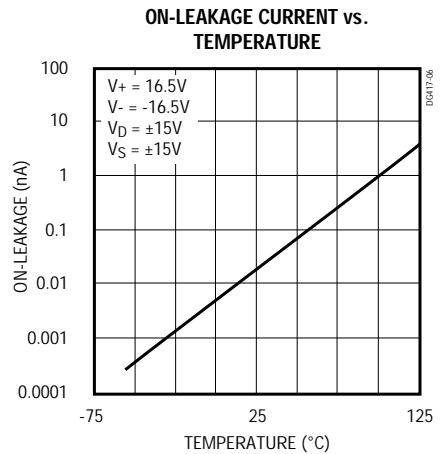
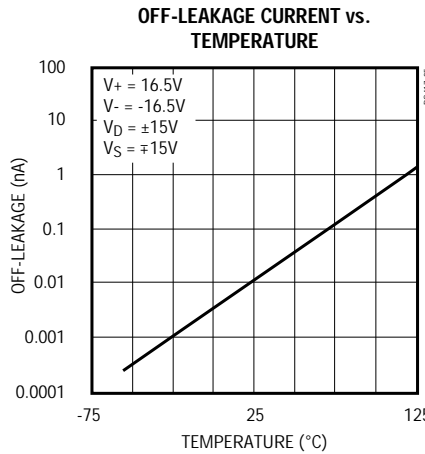
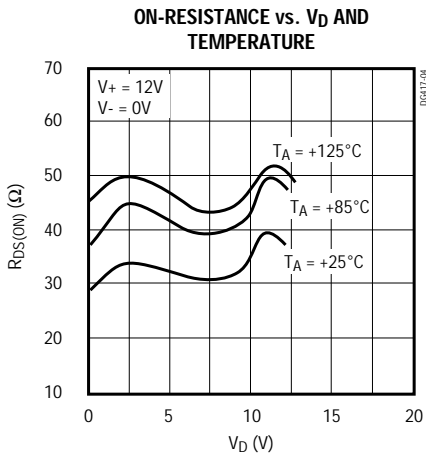
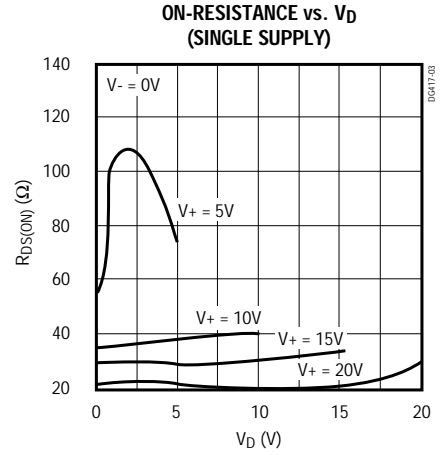
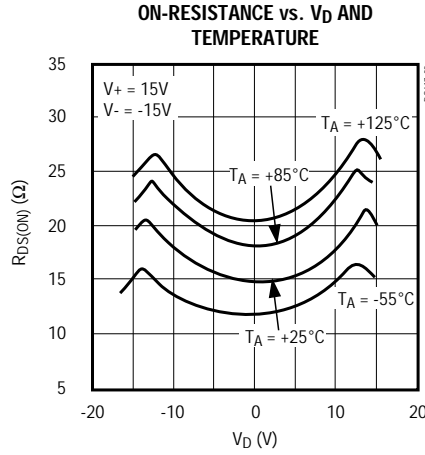
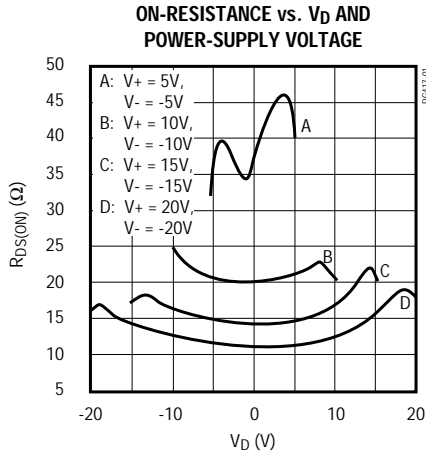
Note 7: Between any two switches.

Improved, SPST/SPDT Analog Switches

Typical Operating Characteristics

($T_A = +25^\circ\text{C}$, unless otherwise noted.)

DG417/DG418/DG419



Improved, SPST/SPDT Analog Switches

Pin Description

| PIN | | | NAME | FUNCTION |
|-------|-------|-------|------|---|
| DG417 | DG418 | DG419 | | |
| 1 | — | — | S | Analog-Switch Source Terminal (normally closed) |
| — | 1 | — | S | Analog-Switch Source Terminal (normally open) |
| — | — | 2 | S1 | Analog-Switch Source Terminal 1 (normally closed) |
| 2 | 2 | — | N.C. | No Internal Connection |
| 3 | 3 | 3 | GND | Logic Ground |
| 4 | 4 | 4 | V+ | Analog-Signal Positive Supply Input |
| 5 | 5 | 5 | VL | Logic-Level Positive Supply Input |
| 6 | 6 | 6 | IN | Logic-Level Input |
| 7 | 7 | 7 | V- | Analog-Signal Negative Supply Input |
| 8 | 8 | 1 | D | Analog-Switch Drain Terminal |
| — | — | 8 | S2 | Analog-Switch Source Terminal 2 (normally open) |

Applications Information

Operation with Supply Voltages Other than ±15V

Using supply voltages other than ±15V reduces the analog signal range. The DG417/DG418/DG419 switches operate with ±4.5V to ±20V bipolar supplies or with a +10V to +30V single supply; connect V- to 0V when operating with a single supply. Also, all device types can operate with unbalanced supplies, such as +24V and -5V. VL must be connected to +5V to be TTL compatible, or to V+ for CMOS-logic level inputs. The *Typical Operating Characteristics* graphs show typical on-resistance with ±20V, ±15V, ±10V, and ±5V supplies. (Switching times increase by a factor of two or more for operation at ±5V.)

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V+ on first, followed by VL, V-, and logic inputs. If power-supply sequencing is not possible, add two small, external signal diodes in series with the supply pins for overvoltage protection (Figure 1).

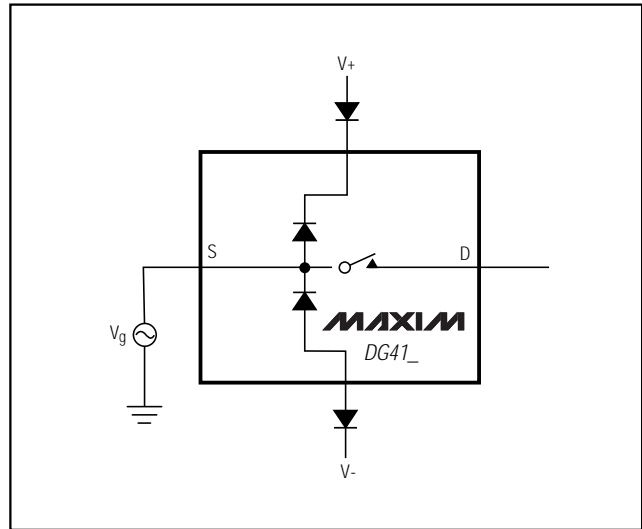


Figure 1. Overvoltage Protection Using External Blocking Diodes

Adding diodes reduces the analog signal range to 1V below V+ and 1V above V-, without affecting low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed +44V.

Improved, SPST/SPDT Analog Switches

Test Circuits/Timing Diagrams

DG417/DG418/DG419

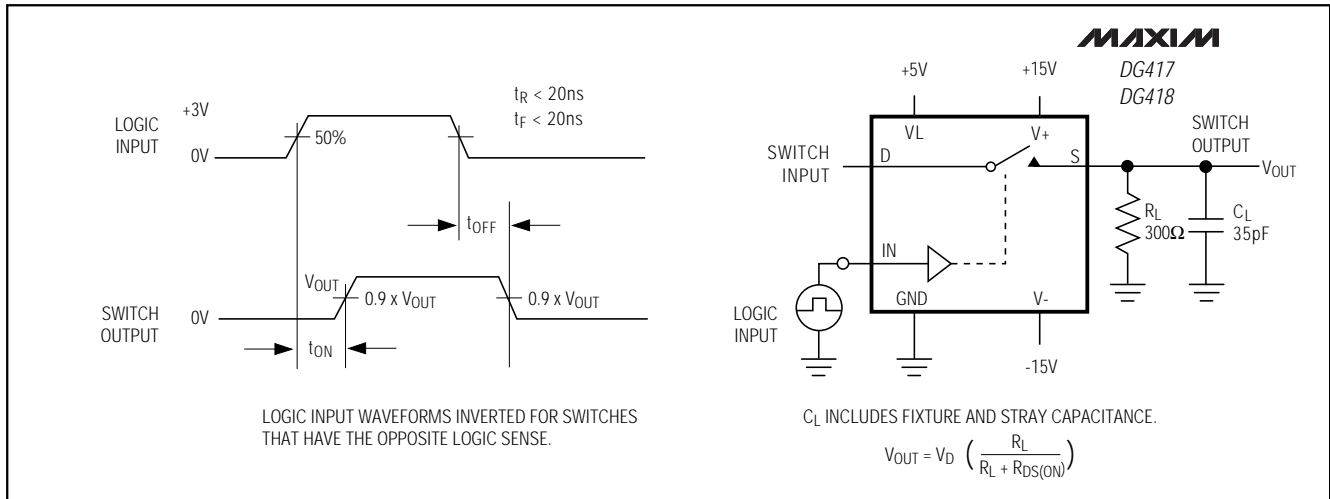


Figure 2. DG417/DG418 Switching Time

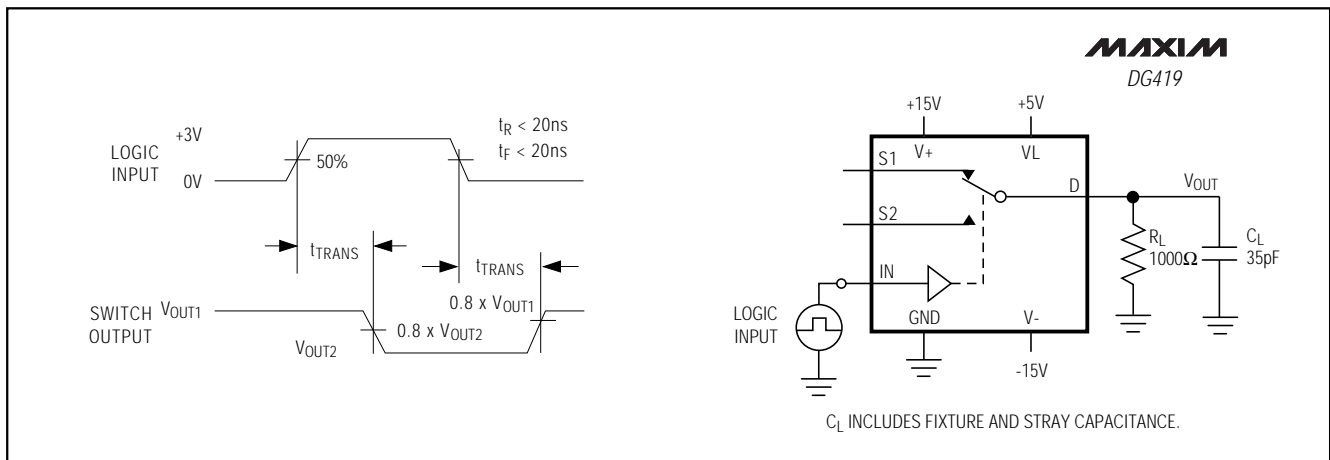


Figure 3. DG419 Transition Time

Improved, SPST/SPDT Analog Switches

DG417/DG418/DG419

Test Circuits/Timing Diagrams (continued)

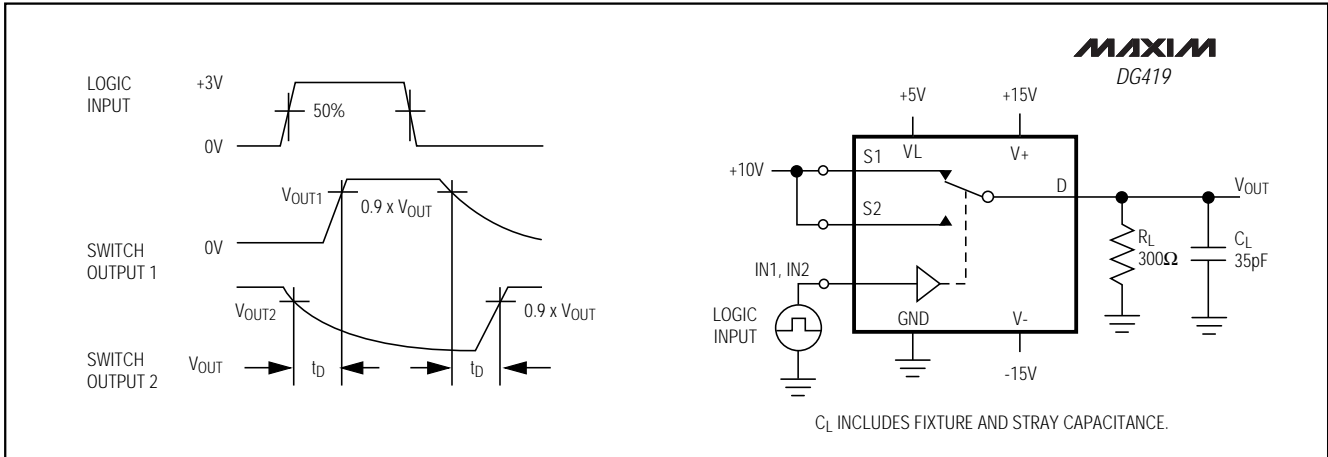


Figure 4. DG419 Break-Before-Make Interval

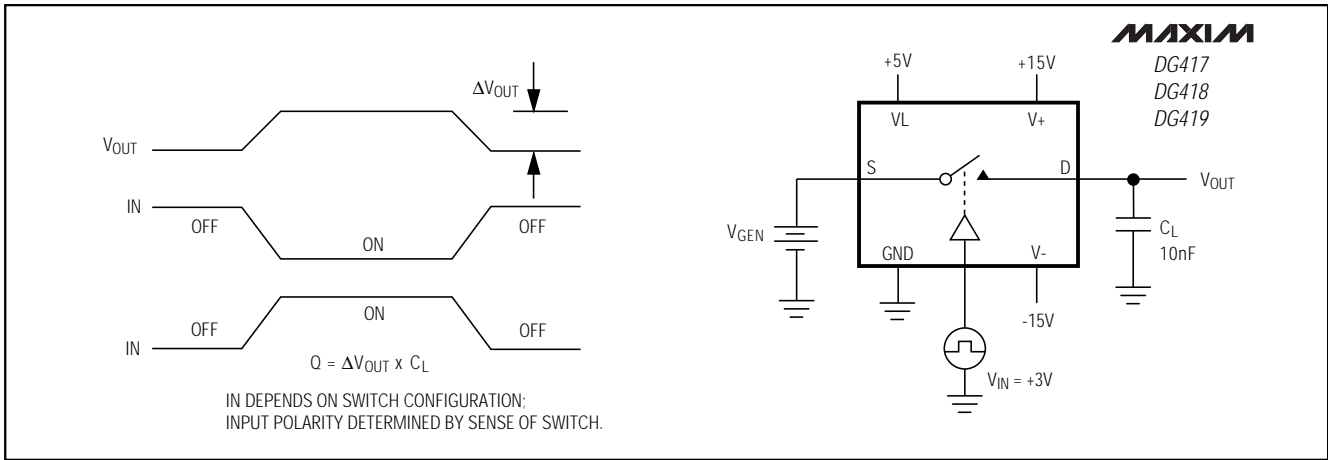


Figure 5. Charge Injection

Improved, SPST/SPDT Analog Switches

Test Circuits/Timing Diagrams (continued)

DG417/DG418/DG419

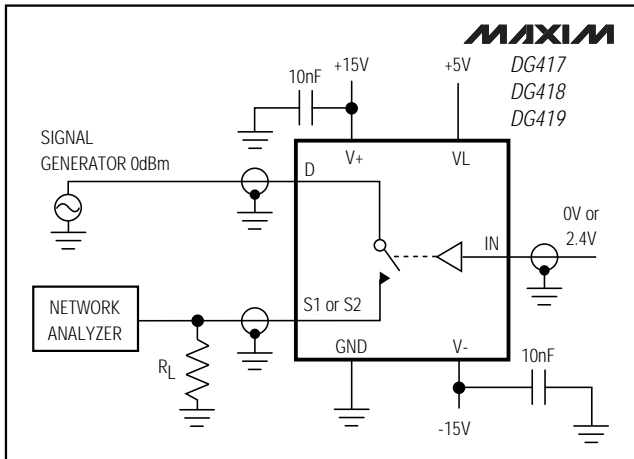


Figure 6. Off-Isolation Rejection Ratio

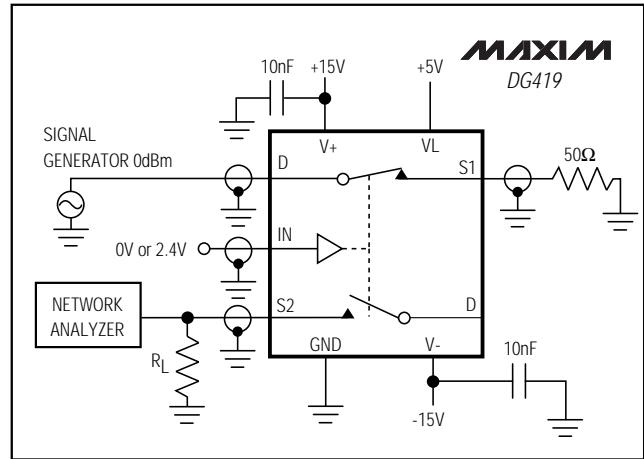


Figure 7. DG419 Crosstalk

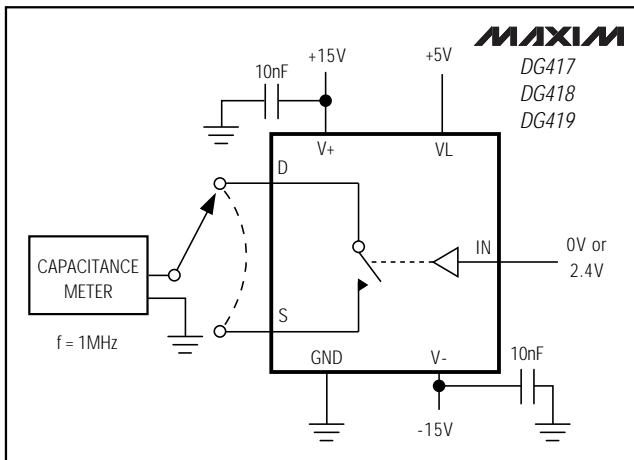


Figure 8. Drain-Source Off-Capacitance

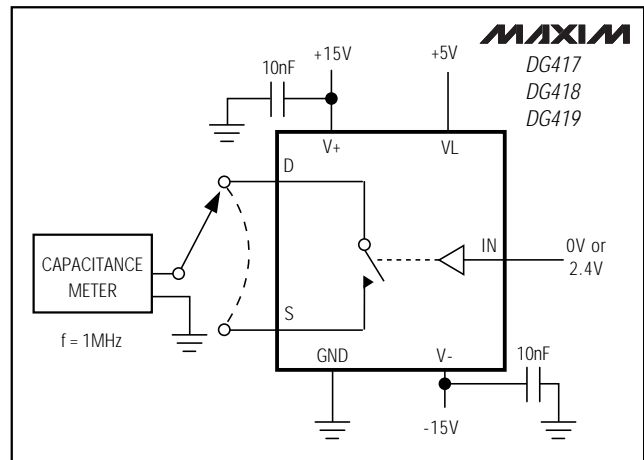


Figure 9. Drain-Source On-Capacitance

Improved, SPST/SPDT Analog Switches

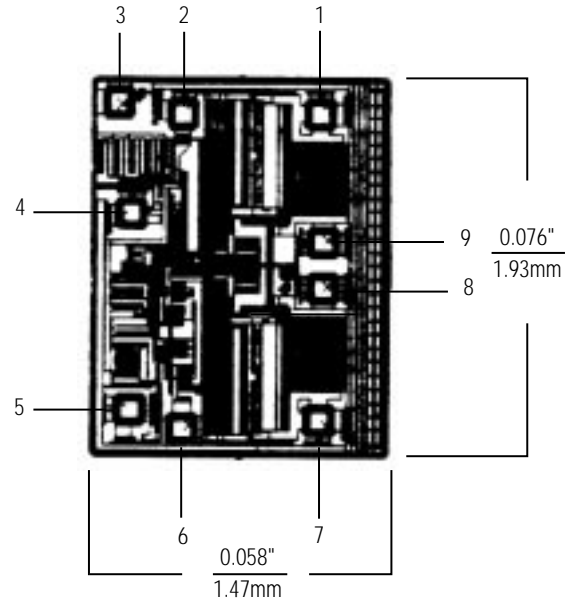
Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|----------------|-----------------|---------------|
| DG417DK | -40°C to +85°C | 8 CERDIP |
| DG417AK | -55°C to +125°C | 8 CERDIP** |
| DG418CJ | 0°C to +70°C | 8 Plastic DIP |
| DG418CY | 0°C to +70°C | 8 SO |
| DG418C/D | 0°C to +70°C | Dice* |
| DG418DJ | -40°C to +85°C | 8 Plastic DIP |
| DG418DY | -40°C to +85°C | 8 SO |
| DG418DK | -40°C to +85°C | 8 CERDIP |
| DG418AK | -55°C to +125°C | 8 CERDIP** |
| DG419CJ | 0°C to +70°C | 8 Plastic DIP |
| DG419CY | 0°C to +70°C | 8 SO |
| DG419C/D | 0°C to +70°C | Dice* |
| DG419DJ | -40°C to +85°C | 8 Plastic DIP |
| DG419DY | -40°C to +85°C | 8 SO |
| DG419DK | -40°C to +85°C | 8 CERDIP |
| DG419AK | -55°C to +125°C | 8 CERDIP** |

* Contact factory for dice specifications.

**Contact factory for availability and processing to MIL-STD-883B.

Chip Topography



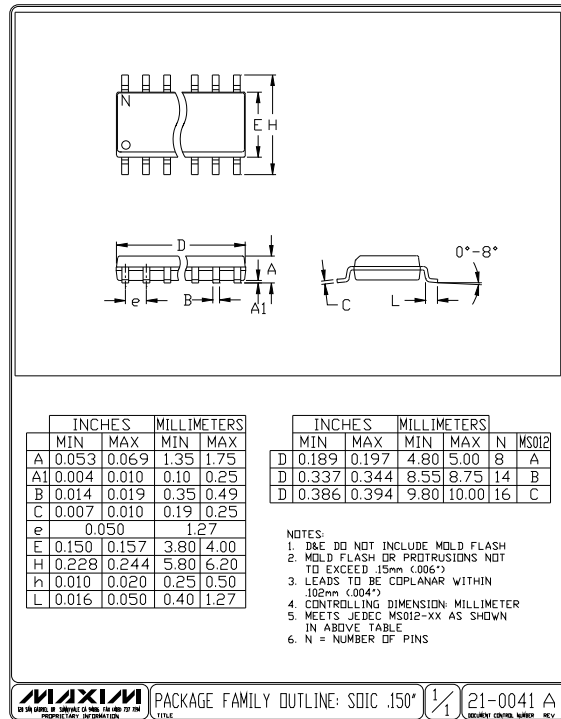
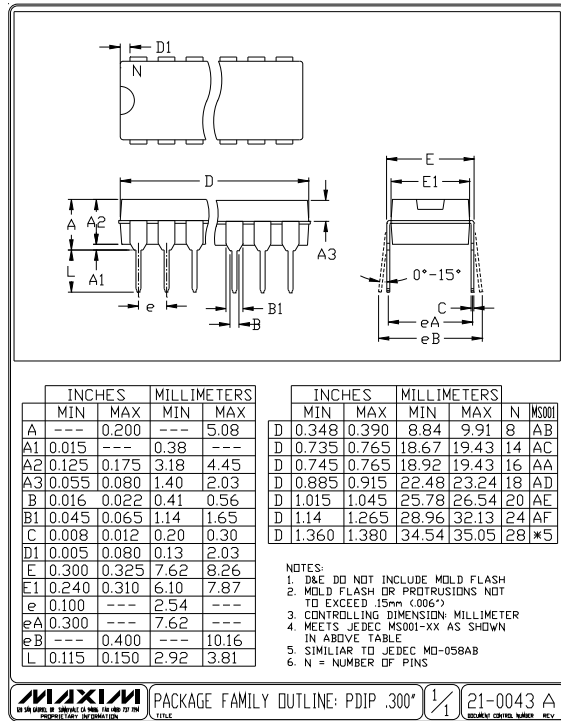
TRANSISTOR COUNT: 32
SUBSTRATE CONNECTED TO V+

| DIE PAD | DG417 | DG418 | DG419 |
|---------|-------|-------|-------|
| 1 | D | N.C. | S |
| 2 | GND | GND | GND |
| 3 | V+ | V+ | V+ |
| 4 | VL | VL | VL |
| 5 | IN | IN | IN |
| 6 | V- | V- | V- |
| 7 | N.C. | S | S |
| 8 | N.C. | D | D |
| 9 | S | N.C. | D |

Improved, SPST/SPDT Analog Switches

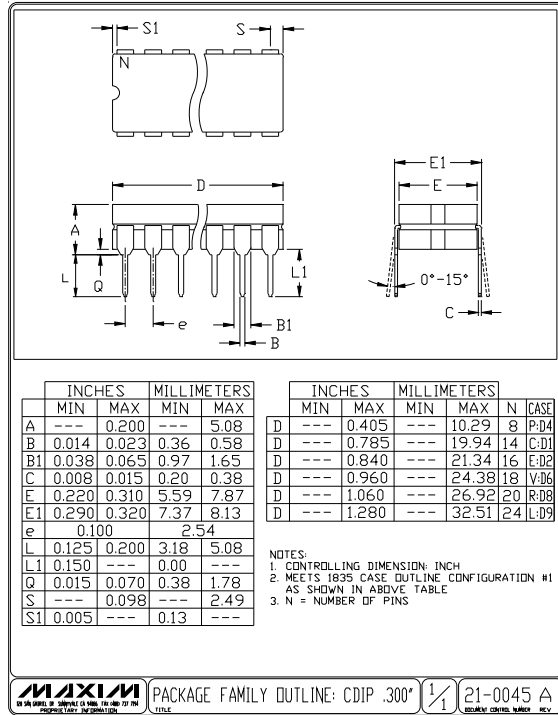
Package Information

DG417/DG418/DG419



Improved, SPST/SPDT Analog Switches

Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

12 _____ Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 (408) 737-7600

© 1996 Maxim Integrated Products

Printed USA

MAXIM is a registered trademark of Maxim Integrated Products.