



Precision, CMOS Analog Switches

MAX317/MAX318/MAX319

General Description

The MAX317/MAX318/MAX319 are precision, CMOS, monolithic analog switches. The single-pole single-throw (SPST) MAX317 is normally closed (NC), the SPST MAX318 is normally open (NO), and the single-pole double-throw (SPDT) MAX319 has one normally open and one normally closed switch. All three parts offer low on resistance (less than 35Ω), guaranteed to match within 2Ω between channels and to remain flat over the analog signal range (Δ3Ω max). They also offer low leakage (less than 250pA at +25°C and less than 6nA at +85°C) and fast switching (turn-on time less than 175ns and turn-off time less than 145ns).

The MAX317/MAX318/MAX319 are fabricated with Maxim's new improved silicon-gate process. Design improvements guarantee extremely low charge injection (10pC), low power consumption (35μW), and electrostatic discharge (ESD) greater than ±2000V. The 44V maximum breakdown voltage allows rail-to-rail analog signal handling capability.

Applications

- Sample-and-Hold Circuits
- Guidance and Control Systems
- Heads-Up Displays
- Test Equipment
- Military Radios
- Communications Systems
- Battery-Powered Systems
- PBX, PABX

Features

- ♦ Low On Resistance <20Ω Typical (35Ω Max)
- ♦ Guaranteed Matched On Resistance Between Channels <2Ω
- ♦ Guaranteed Flat On Resistance over Analog Signal Range Δ3Ω Max
- ♦ Guaranteed Charge Injection <10pC
- ♦ Guaranteed Off-Channel Leakage <6nA at +85°C
- ♦ ESD Guaranteed > 2000V per Method 3015.7
- ♦ Single-Supply Operation (+10V to +30V)
Bipolar-Supply Operation (±4.5V to ±20V)
- ♦ TTL-/CMOS-Logic Compatible
- ♦ Rail-to-Rail Analog Signal Handling Capability

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|-----------|-----------------|---------------|
| MAX317CPA | 0°C to +70°C | 8 Plastic DIP |
| MAX317CSA | 0°C to +70°C | 8 SO |
| MAX317CJA | 0°C to +70°C | 8 CERDIP |
| MAX317C/D | 0°C to +70°C | Dice* |
| MAX317EPA | -40°C to +85°C | 8 Plastic DIP |
| MAX317ESA | -40°C to +85°C | 8 SO |
| MAX317EJA | -40°C to +85°C | 8 CERDIP |
| MAX317MJA | -55°C to +125°C | 8 CERDIP |

Ordering Information continued on last page.

* Contact factory for dice specifications.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

DIP/SO

| MAX317 | |
|--------|--------|
| LOGIC | SWITCH |
| 0 | ON |
| 1 | OFF |

DIP/SO

| MAX318 | |
|--------|--------|
| LOGIC | SWITCH |
| 0 | OFF |
| 1 | ON |

DIP/SO

| MAX319 | | |
|--------|-----|-----|
| LOGIC | NC | NO |
| 0 | ON | OFF |
| 1 | OFF | ON |

SWITCHES SHOWN FOR LOGIC "0" INPUT

N.C. = No Connect
NC = Normally Closed



Precision, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

| | |
|---|---|
| V+ |+44V |
| GND |+25V |
| V _L |(GND - 0.3V) to (V+ + 0.3V) |
| I _N , COM, NC, NO |(V- - 2V) to (V+ + 2V) or 30mA, whichever occurs first |
| Continuous Current (any terminal) |30mA |
| Peak Current, NC, NO, COM |30mA |
| Peak Current, NC, NO, COM (pulsed at 1ms, 10% duty cycle max) |100mA |
| ESD |±2000V |

Continuous Power Dissipation (T_A = +70°C) (Note 1)

| | |
|--|------------|
| 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:

| | |
|-------------------------------------|----------------------|
| MAX31_C_ |0°C to +70°C |
| MAX31_E_ |-40°C to +85°C |
| MAX31_MJA |-55°C to +125°C |
| Storage Temperature Range |-55°C to +150°C |
| Lead Temperature (soldering, 10sec) |+300°C |

Note 1: All leads are soldered or welded to PC board.

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, V_L = 5V, GND = 0V, V_{INL} = 0.8V, V_{INH} = 2.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | TEMP. | MIN | TYP (Note 2) | MAX | UNITS | | | |
|---|---|--|---|------|------------------------|------|-------|-------|------|------|
| Analog-Signal Range | V _{COM} , V _{NO} , V _{NC} | (Note 3) | | -15 | | 15 | V | | | |
| On Resistance | R _{ON} | V _{COM} = ±12.5V, I _(NC OR NO) = -10mA, V+ = 13.5V, V- = -13.5V | T _A = +25°C | | 20 | 35 | Ω | | | |
| | | | | C, E | | | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 45 | | | | |
| On Resistance Match Between Channels (Note 4) | R _{ON} | I _(NC OR NO) = -10mA, V _{COM} = 10V or -10V, V+ = 15V, V- = -15V | T _A = +25°C | | | 2 | Ω | | | |
| | | | | | | | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 3 | | | | |
| On Resistance Flatness (Note 4) | R _{ON} | I _(NC OR NO) = -10mA, V _{COM} = 5V or -5V, V+ = 15V, V- = -15V | T _A = +25°C | | | 3 | Ω | | | |
| | | | | | | | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 5 | | | | |
| NO or NC Off Leakage Current | I _{NC(OFF)} or I _{NO(OFF)} | V+ = 16.5V, V- = -16.5V, V _{COM} = ±15.5V, V _{NC} or V _{NO} = ±15.5V | T _A = +25°C | | -0.25 | 0.25 | nA | | | |
| | | | | C, E | | -6 | | 6 | | |
| | | | | M | | -20 | | 20 | | |
| COM Off Leakage Current | I _{COM(OFF)} | V+ = 16.5V, V- = -16.5V, V _{COM} = ±15.5V, V _{NC} or V _{NO} = ±15.5V | T _A = +25°C | | -0.25 | -0.1 | 0.25 | nA | | |
| | | | | C, E | | -6 | 6 | | | |
| | | | | M | | -20 | 20 | | | |
| | | | | | T _A = +25°C | | -0.75 | | -0.1 | 0.75 |
| | | | | C, E | | -10 | 10 | | | |
| | | | | M | | -60 | 60 | | | |
| COM On Leakage Current | I _{COM(ON)} | V+ = 16.5V, V- = -16.5V, V _{NC} or V _{NO} = V _D = ±15.5V | T _A = +25°C | | -0.4 | 0.4 | nA | | | |
| | | | | C, E | | -10 | | 10 | | |
| | | | | M | | -40 | | 40 | | |
| | | | | | T _A = +25°C | | | -0.75 | 0.75 | |
| | | | | C, E | | -10 | | 10 | | |
| | | | | M | | -60 | | 60 | | |

Precision, CMOS Analog Switches

MAX317/MAX318/MAX319

ELECTRICAL CHARACTERISTICS — Dual Supplies (continued)

($V_+ = 15V$, $V_- = -15V$, $V_L = 5V$, $GND = 0V$, $V_{INL} = 0.8V$, $V_{INH} = 2.4V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | TEMP. | MIN | TYP (Note 2) | MAX | UNITS |
|---|----------------|--|------------------------------|---------------------|-----------------|-----|---------|
| LOGIC INPUT | | | | | | | |
| Logic Input Current (Input Voltage High) | I_{IH} | $V_{IN} = 2.4V$ | | -0.5 | 0.005 | 0.5 | μA |
| Logic Input Current (Input Voltage Low) | I_{IL} | $V_{IN} = 0.8V$ | | -0.5 | 0.005 | 0.5 | μA |
| DYNAMIC | | | | | | | |
| Turn-On Time | t_{ON} | MAX317, MAX318, Figure 2, $V_{COM} = \pm 10V$ | $T_A = +25^\circ C$ | 100 | 175 | | ns |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | 250 | |
| Turn-Off Time | t_{OFF} | MAX317, MAX318, Figure 2, $V_{COM} = \pm 10V$ | $T_A = +25^\circ C$ | 60 | 145 | | ns |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | 210 | |
| Transition Time | t_{TRANS} | MAX319, Figure 3, $V_{NO} = \pm 10V$, $V_{NC} = \pm 10V$ | $T_A = +25^\circ C$ | | | 175 | ns |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | 250 | |
| Break-Before-Make Interval | t_D | MAX319, Figure 4, $V_{NO} = V_{NC} = \pm 10V$ | $T_A = +25^\circ C$ | 5 | 13 | | ns |
| Charge Injection | Q | $V_{GEN} = 0V$, Figure 5 | $T_A = +25^\circ C$ | | 3 | 10 | pC |
| Off Isolation (Note 5) | OIRR | $R_L = 50\Omega$, $C_L = 5pF$, $f = 1MHz$, Figure 7 | $T_A = +25^\circ C$ | | 68 | | dB |
| Crosstalk (Note 6) | | $R_L = 50\Omega$, $C_L = 5pF$, $f = 1MHz$, Figure 8 | $T_A = +25^\circ C$ | | 85 | | dB |
| COM Off Capacitance | $C_{COM(OFF)}$ | $V_{COM} = 0V$, $f = 1MHz$, Figure 8 | $T_A = +25^\circ C$ | | 8 | | pF |
| Off Capacitance NC or NO | $C_{(OFF)}$ | $V_{COM} = 0V$, $f = 1MHz$, Figure 8 | $T_A = +25^\circ C$ | | 8 | | pF |
| Channel-On Capacitance COM Terminal | $C_{COM(ON)}$ | $V_S = 0V$, $f = 1MHz$, Figure 9 | MAX317, MAX318 | $T_A = +25^\circ C$ | 30 | | pF |
| | | | MAX319 | | 35 | | |
| SUPPLY | | | | | | | |
| Positive Supply Current | I_+ | $V_{IN} = 0V$ or $5V$, $V_+ = 16.5V$, $V_- = -16.5V$ | $T_A = +25^\circ C$ | -1 | 0.0001 | 1 | μA |
| | | | $T_A = T_{MIN}$ to T_{MAX} | -5 | | 5 | |
| Negative Supply Current | I_- | $V_{IN} = 0V$ or $5V$, $V_+ = 16.5V$, $V_- = -16.5V$ | $T_A = +25^\circ C$ | -1 | -0.0001 | 1 | μA |
| | | | $T_A = T_{MIN}$ to T_{MAX} | -5 | | 5 | |
| Logic Supply Current | I_L | $V_{IN} = 0V$ or $5V$, $V_+ = 16.5V$, $V_- = -16.5V$ | $T_A = +25^\circ C$ | -1 | 0.0001 | 1 | μA |
| | | | $T_A = T_{MIN}$ to T_{MAX} | -5 | | 5 | |
| Ground Current | I_{GND} | $V_{IN} = 0V$ or $5V$, $V_+ = 16.5V$, $V_- = -16.5V$ | $T_A = +25^\circ C$ | -1 | -0.0001 | 1 | μA |
| | | | $T_A = T_{MIN}$ to T_{MAX} | -5 | | 5 | |

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MAX317/MAX318/MAX319

ELECTRICAL CHARACTERISTICS — Single Supply

(V₊ = 12V, V₋ = 0V, V_L = 5V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS |
|---------------------------------|---|---|-----|-----------------|-----|-------|
| SWITCH | | | | | | |
| Analog-Signal Range | V _{COM} , V _{NO} , V _{NC} | (Note 3) | 0 | | 12 | V |
| Drain-Source On Resistance | R _(ON) | I _(NC or NO) = -10mA, V _{COM} = 3.8V, V ₊ = 10.8V | | 40 | 100 | Ω |
| DYNAMIC | | | | | | |
| Turn-On Time | t _{ON} | V _{COM} = 8V, Figure 2 | | 110 | | ns |
| Turn-Off Time | t _{OFF} | V _{COM} = 8V, Figure 2 | | 40 | | ns |
| Break-Before-Make Time Delay | t _D | MAX319, R _L = 1000Ω, C _L = 35pF, Figure 4 | | 60 | | ns |
| Charge Injection | Q | C _L = 10nF, V _{GEN} = 0V, R _{GEN} = 0V, Figure 5 | | 2 | 10 | pC |
| SUPPLY | | | | | | |
| Positive Supply Current | I ₊ | V ₊ = 13.2V, all channels on or off, V _{IN} = 0V or 5V, V _L = 5.25V | | 0.0001 | | μA |
| Negative Supply Current | I ₋ | V ₊ = 13.2V, all channels on or off, V _{IN} = 0V or 5V, V _L = 5.25V | | 0.0001 | | μA |
| Logic Supply Current | I _L | V _L = 5.25V, all channels on or off, V _{IN} = 0V or 5V | | 0.0001 | | μA |
| Ground Current | I _{GND} | V _L = 5.25V, all channels on or off, V _{IN} = 0V or 5V | | -0.0001 | | μA |

Note 2: Typical values are for **design aid only**, not guaranteed, not subject to production testing.

Note 3: Guaranteed by design.

Note 4: On resistance match between channels and flatness are guaranteed only with bipolar-supply operation.

Note 5: Off Isolation = $20\log_{10} \left(\frac{V_{COM}}{V_{NC} \text{ or } V_{NO}} \right)$, V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

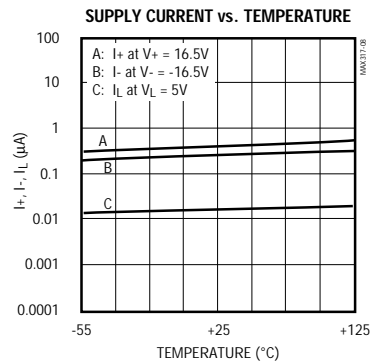
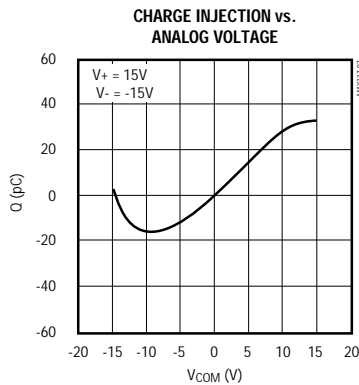
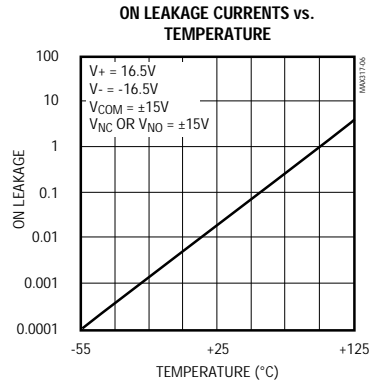
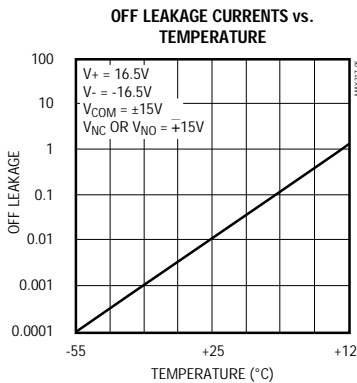
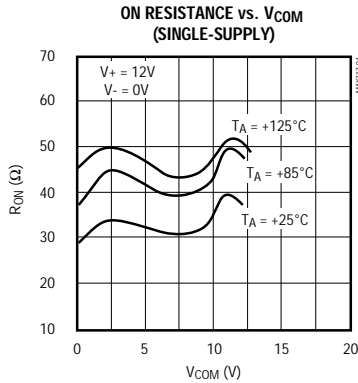
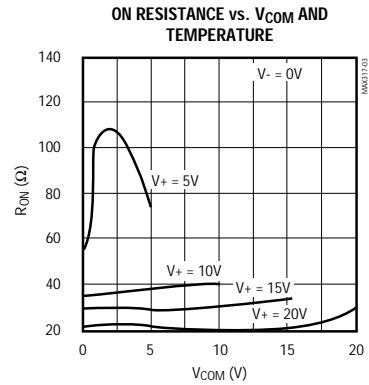
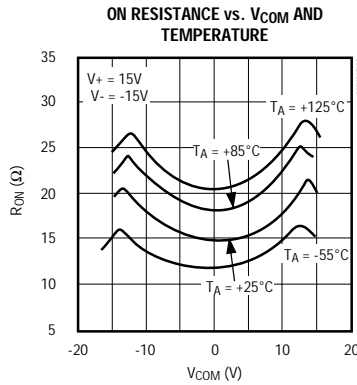
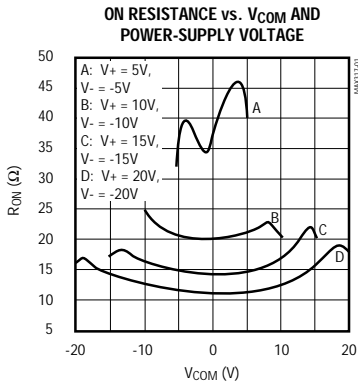
Note 6: Between any two switches.

Precision, CMOS Analog Switches

Typical Operating Characteristics

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

MAX317/MAX318/MAX319



Precision, CMOS Analog Switches

Pin Description

| PIN | | | NAME | FUNCTION |
|--------|--------|--------|------|--|
| MAX317 | MAX318 | MAX319 | | |
| 1 | 1 | 1 | COM | Analog-switch common terminal |
| 2 | 2 | — | N.C. | No connect — not internally connected |
| — | — | 8 | NO | Analog-switch normally open terminal |
| 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 | — | 2 | NC | Analog-switch normally closed terminal |
| — | 8 | — | NO | Analog-switch normally open terminal |

Applications Information

Operation with Supply Voltages Other Than $\pm 15V$

The main limitation of supply voltages other than $\pm 15V$ is analog signal range reduction. The MAX317/MAX318/MAX319 switches operate with bipolar supplies of $\pm 5V$ to $\pm 20V$. Typical Operating Characteristics graphs show typical on resistance for $\pm 15V$, $\pm 10V$, and $\pm 5V$ supplies. Switching times increase by a factor of two or more for operation at $\pm 5V$. The MAX317/MAX318/MAX319 can operate from unipolar supplies of $+10V$ to $+30V$. Both parts can also operate from unbalanced supplies such as $+24V$ and $-5V$.

Connect V- to 0V when operating with a single supply. This means that VL must be connected to $+5V$ to be TTL compatible, or to V+ for CMOS logic input levels.

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. It is important not to 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, protect the devices from overvoltage by

adding two small signal diodes in series with the supply pins (Figure 1). Adding the diodes reduces the analog signal range to 1V below V+ and 1V below V-, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ to V- should not exceed $+44V$.

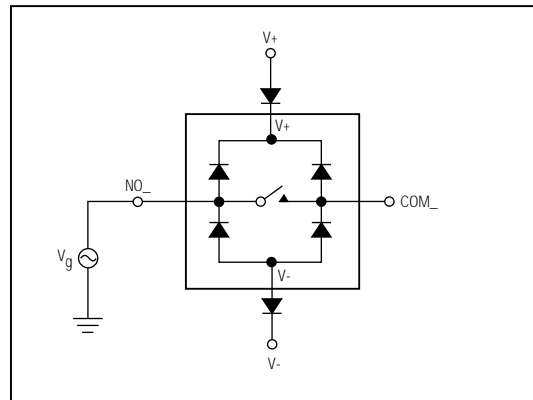


Figure 1. Overvoltage Protection Using Blocking Diodes

Precision, CMOS Analog Switches

Test Circuits/Timing Diagrams

MAX317/MAX318/MAX319

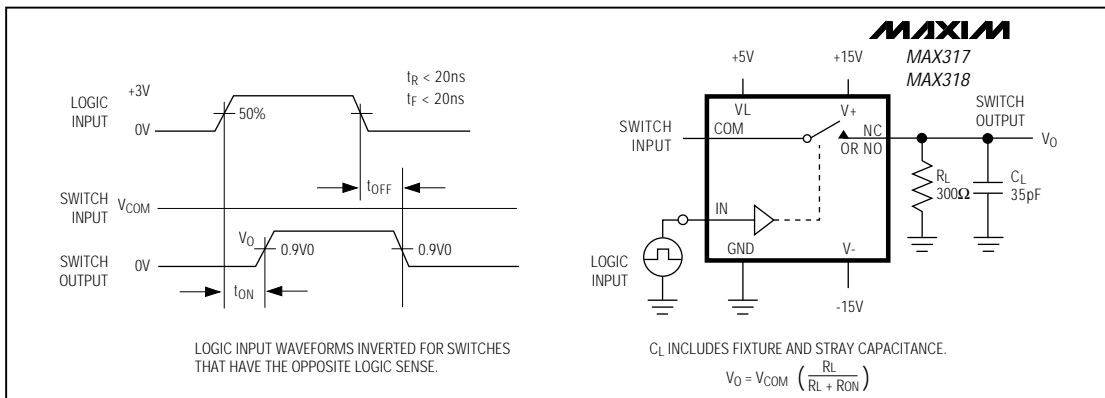


Figure 2. MAX317/MAX318 Switching-Time Test Circuit

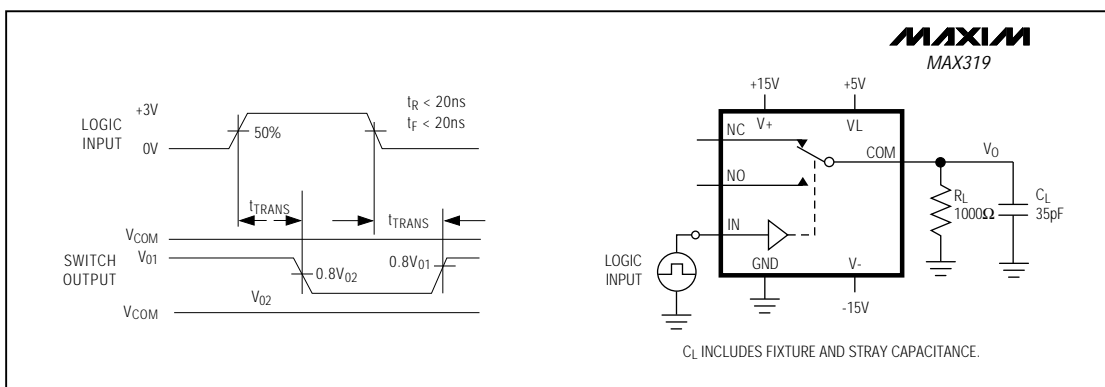


Figure 3. MAX319 Transition Time

Precision, CMOS Analog Switches

MAX317/MAX318/MAX319

Test Circuits/Timing Diagrams (continued)

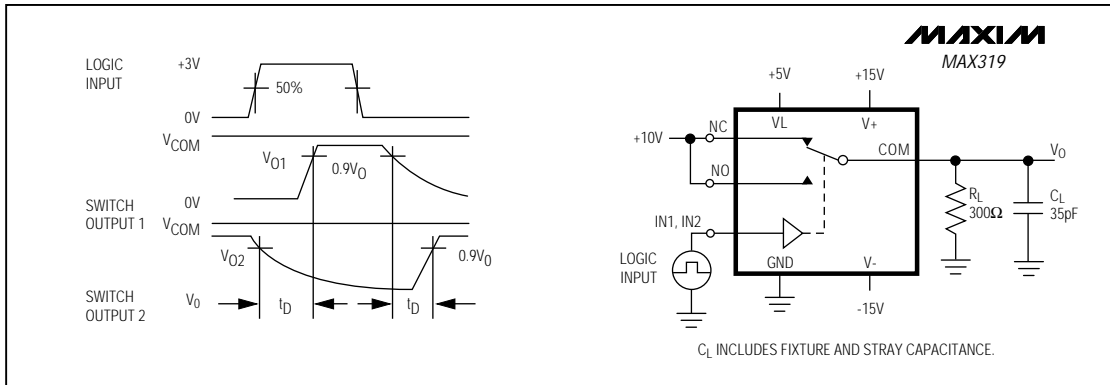


Figure 4. MAX319 Break-Before-Make Test Circuit

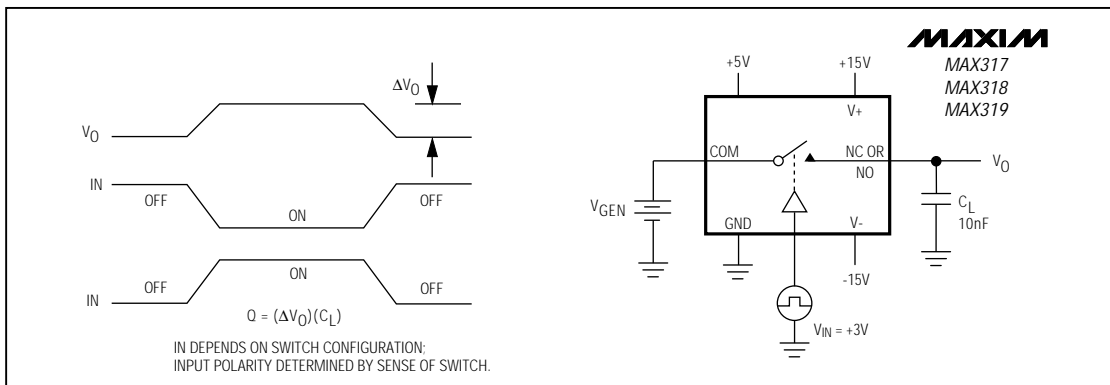


Figure 5. Charge-Injection Test Circuit

Precision, CMOS Analog Switches

Test Circuits/Timing Diagrams (continued)

MAX317/MAX318/MAX319

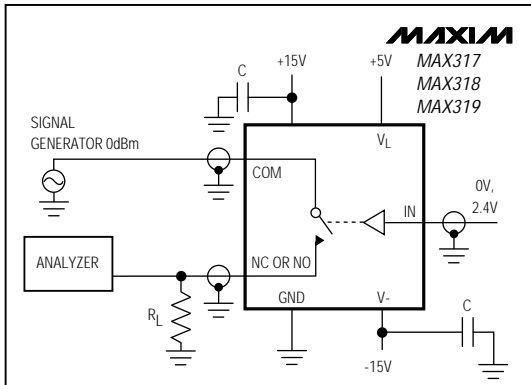


Figure 6. Off-Isolation Test Circuit

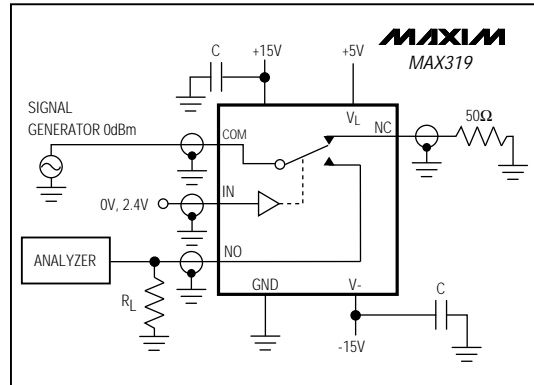


Figure 7. MAX319 Crosstalk Test Circuit

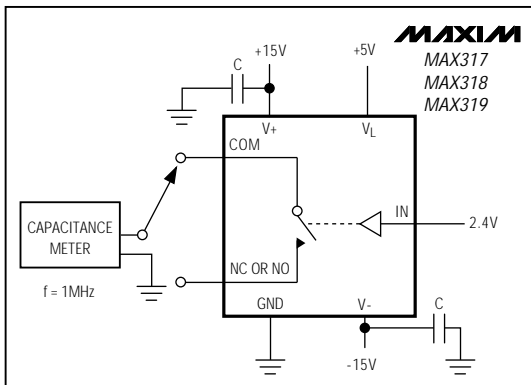


Figure 8. Channel-Off Capacitance Test Circuit

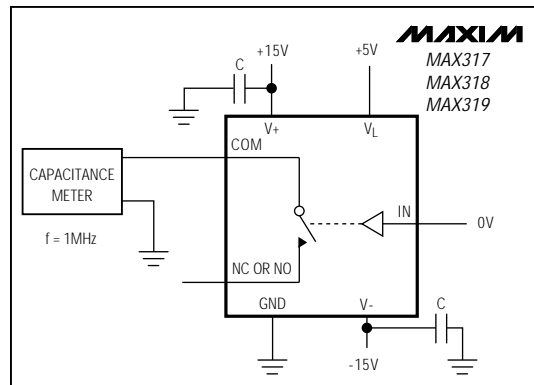


Figure 9. Channel-On Capacitance Test Circuit

Precision, CMOS Analog Switches

MAX317/MAX318/MAX319

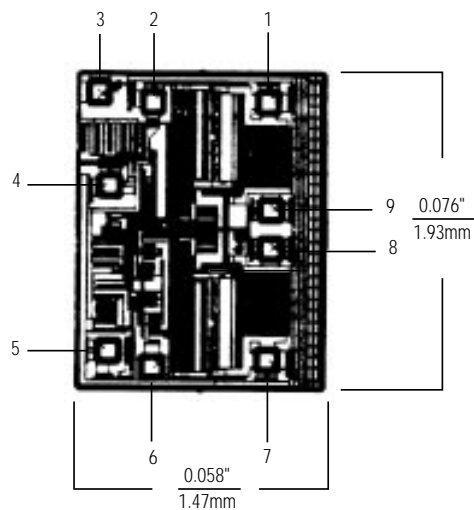
Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|-------------------|-----------------|---------------|
| MAX318 CPA | 0°C to +70°C | 8 Plastic DIP |
| MAX318CSA | 0°C to +70°C | 8 SO |
| MAX318CJA | 0°C to +70°C | 8 CERDIP |
| MAX318C/D | 0°C to +70°C | Dice* |
| MAX318EPA | -40°C to +85°C | 8 Plastic DIP |
| MAX318ESA | -40°C to +85°C | 8 SO |
| MAX318EJA | -40°C to +85°C | 8 CERDIP |
| MAX318MJA | -55°C to +125°C | 8 CERDIP** |
| MAX319 CPA | 0°C to +70°C | 8 Plastic DIP |
| MAX319CSA | 0°C to +70°C | 8 SO |
| MAX319CJA | 0°C to +70°C | 8 CERDIP |
| MAX319C/D | 0°C to +70°C | Dice* |
| MAX319EPA | -40°C to +85°C | 8 Plastic DIP |
| MAX319ESA | -40°C to +85°C | 8 SO |
| MAX319EJA | -40°C to +85°C | 8 CERDIP |
| MAX319MJA | -55°C to +125°C | 8 CERDIP** |

* Contact factory for dice specifications.

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

Chip Topography



TRANSISTOR COUNT: 32;

SUBSTRATE CONNECTED TO V+.

| DIE PAD | MAX317 | MAX318 | MAX319 |
|---------|--------|--------|--------|
| 1 | COM | NC | NC |
| 2 | GND | GND | GND |
| 3 | V+ | V+ | V+ |
| 4 | VL | VL | VL |
| 5 | IN | IN | IN |
| 6 | V- | V- | V- |
| 7 | N.C. | NO | NO |
| 8 | N.C. | COM | COM |
| 9 | NC | NC | COM |

Precision, CMOS Analog Switches

Package Information

MAX317/MAX318/MAX319

**Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)**

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | — | 0.200 | — | 5.08 |
| A1 | 0.015 | — | 0.38 | — |
| A2 | 0.125 | 0.175 | 3.18 | 4.45 |
| A3 | 0.055 | 0.080 | 1.40 | 2.03 |
| B | 0.016 | 0.022 | 0.41 | 0.56 |
| B1 | 0.045 | 0.065 | 1.14 | 1.65 |
| C | 0.008 | 0.012 | 0.20 | 0.30 |
| D1 | 0.005 | 0.080 | 0.13 | 2.03 |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.310 | 6.10 | 7.87 |
| e | 0.100 | — | 2.54 | — |
| eA | 0.300 | — | 7.62 | — |
| eB | — | 0.400 | — | 10.16 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |

| PKG. | DIM | PINS | INCHES | | MILLIMETERS | |
|------|-----|------|--------|-------|-------------|-------|
| | | | MIN | MAX | MIN | MAX |
| P | D | 8 | 0.348 | 0.390 | 8.84 | 9.91 |
| P | D | 14 | 0.735 | 0.765 | 18.67 | 19.43 |
| P | D | 16 | 0.745 | 0.765 | 18.92 | 19.43 |
| P | D | 18 | 0.885 | 0.915 | 22.48 | 23.24 |
| P | D | 20 | 1.015 | 1.045 | 25.78 | 26.54 |
| N | D | 24 | 1.14 | 1.265 | 28.96 | 32.13 |

21-0043A

**Narrow SO
SMALL-OUTLINE
PACKAGE
(0.150 in.)**

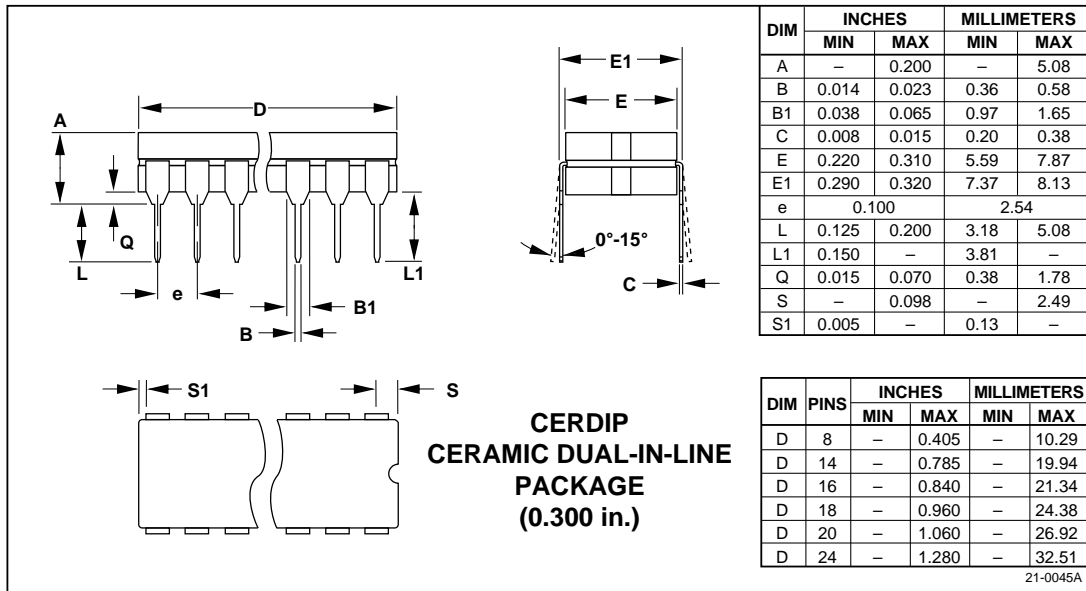
| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|------|
| | MIN | MAX | MIN | MAX |
| A | 0.053 | 0.069 | 1.35 | 1.75 |
| A1 | 0.004 | 0.010 | 0.10 | 0.25 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.007 | 0.010 | 0.19 | 0.25 |
| E | 0.150 | 0.157 | 3.80 | 4.00 |
| e | 0.050 | | 1.27 | |
| H | 0.228 | 0.244 | 5.80 | 6.20 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

| DIM | PINS | INCHES | | MILLIMETERS | |
|-----|------|--------|-------|-------------|-------|
| | | MIN | MAX | MIN | MAX |
| D | 8 | 0.189 | 0.197 | 4.80 | 5.00 |
| D | 14 | 0.337 | 0.344 | 8.55 | 8.75 |
| D | 16 | 0.386 | 0.394 | 9.80 | 10.00 |

21-0041A

Precision, CMOS Analog Switches

Package Information



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.

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