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Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

General Description

The MAX4066/MAX4066A quad, SPST, CMOS analog switches are designed to provide superior performance over the industry-standard devices. These new switches feature guaranteed operation from +2.0V to +16V and are fully specified at 3V, 5V, and 12V. Both parts offer 45Ω on-resistance and 2Ω channel-to-channel matching at 12V, plus 4Ω flatness over the specified signal range.

Each device is controlled by TTL/CMOS input levels and can be used as a bilateral switch or multiplexer/demultiplexer.

Low off leakage current (100pA for the MAX4066A) and low power consumption (0.5μW) make the MAX4066/MAX4066A ideal for battery-operated equipment. These parts are also suitable for low-distortion audio applications. Both devices are available in 14-pin DIP and SO packages, as well as a 16-pin QSOP. ESD protection is greater than 2000V per Method 3015.7.

Applications

Battery-Operated Equipment
 Audio and Video Signal Routing
 Low-Voltage Data-Acquisition Systems
 Sample-and-Hold Circuits
 Communication Circuits

Features

- ♦ Pin Compatible with 74HC4066
- ♦ Guaranteed On-Resistance:
 170Ω max (3V supply)
 45Ω max (12V supply)
- ♦ Guaranteed Match Between Channels:
 4Ω max (MAX4066)
 2Ω max (MAX4066A)
- ♦ Guaranteed Low Leakage Currents:
 1nA at +25°C (MAX4066)
 100pA at +25°C (MAX4066A)
- ♦ Single-Supply Operation from +2.0V to +16V
- ♦ V+ to GND Signal Handling
- ♦ TTL/CMOS-Logic Compatible
- ♦ Low Power Consumption: 0.5μW
- ♦ Low Crosstalk: -86dB
- ♦ Low Off Isolation: -58dB
- ♦ Low Distortion: 0.03%
- ♦ Wide Bandwidth: > 100MHz

MAX4066/MAX4066A

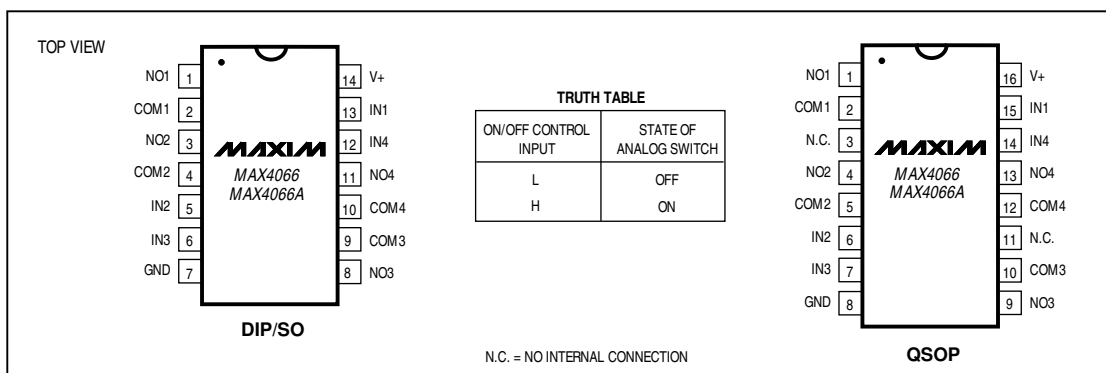
Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|--------------|----------------|
| MAX4066CPD | 0°C to +70°C | 14 Plastic DIP |
| MAX4066CSD | 0°C to +70°C | 14 Narrow SO |
| MAX4066CEE | 0°C to +70°C | 16 QSOP |
| MAX4066C/D | 0°C to +70°C | Dice* |

Ordering Information continued at end of data sheet.

* Contact factory for dice specifications.

Pin Configurations/Truth Table



Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND)

| | | |
|---|---------------------------|---|
| V+ |-0.3V to +17V | CERDIP (derate 9.09mW/°C above +70°C).....727mW |
| V _{IN} , V _{COM} , V _{NO} (Note 1) |-0.3V to (V+ + 0.3V) | Operating Temperature Ranges |
| Current (any terminal) |30mA | MAX4066C_/MAX4066AC_.....0°C to +70°C |
| Peak Current (any terminal) |100mA | MAX4066E_/MAX4066AE_.....-40°C to +85°C |
| ESD per Method 3015.7 |>2000V | MAX4066MJD/MAX4066AMJD.....-55°C to +125°C |
| Continuous Power Dissipation (T _A = +70°C) | | Storage Temperature Range.....-65°C to +150°C |
| Plastic DIP (derate 10.00mW/°C above +70°C) |800mW | Lead Temperature (soldering, 10sec).....+300°C |
| Narrow SO (derate 8.00mW/°C above +70°C) |640mW | |
| QSOP (derate 9.52mW/°C above +70°C) |762mW | |

Note 1: Signals on NO_, COM_, or IN_ exceeding V+ or GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.

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—Single +12V Supply

(V+ = 12V ±10%, GND = 0V, V_{INH} = 4.0V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS |
|--|---------------------------------------|---|--|----------|-----------------|-----|-------|
| ANALOG SWITCH | | | | | | | |
| Analog Signal Range | V _{COM} , V _{NO} | (Note 3) | | 0 | | V+ | V |
| On-Resistance | R _{ON} | V+ = 12V, I _{COM} = 2mA, V _{NO} = 10V | T _A = +25°C | | 16 | 45 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | | 55 | |
| | | | | M | | 75 | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = 12V, I _{COM} = 2mA, V _{NO} = 10V | T _A = +25°C | MAX4066 | 0.5 | 4 | Ω |
| | | | | MAX4066A | 0.5 | 2 | |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| On-Resistance Flatness (Note 5) | R _{FLAT(ON)} | V+ = 12V, I _{COM} = 2mA, V _{NO} = 10V, 5V, 1V | T _A = +25°C | | 2 | 4 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | | | |
| NO or NC Off Leakage Current (Note 6) | I _{NO(OFF)} | V+ = 12V, V _{COM} = 0V, V _{NO} = 10V | T _A = +25°C | MAX4066 | -1 | 1 | nA |
| | | | | MAX4066A | -0.1 | 0.1 | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -6 | 6 | |
| M | -100 | 100 | | | | | |
| COM Off Leakage Current (Note 6) | I _{COM(OFF)} | V+ = 12V, V _{COM} = 0V, V _{NO} = 10V | T _A = +25°C | MAX4066 | -1 | 1 | nA |
| | | | | MAX4066A | -0.1 | 0.1 | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -6 | 6 | |
| M | -100 | 100 | | | | | |
| COM On Leakage Current (Note 6) | I _{COM(ON)} | V+ = 12V, V _{COM} = 10V, V _{NO} = 10V | T _A = +25°C | MAX4066 | -2 | 2 | nA |
| | | | | MAX4066A | -0.2 | 0.2 | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -12 | 12 | |
| M | -200 | 200 | | | | | |

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ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

($V_+ = 12V \pm 10\%$, $GND = 0V$, $V_{INH} = 4.0V$, $V_{INL} = 0.8V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS | |
|---------------------------------------|----------------|--|------------------------------|-----------------|-------|---------|---------|
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | I_{INH} | $I_N = 5.0V$, all others = $0.8V$ | -0.5 | 0.005 | 0.5 | μA | |
| Input Current with Input Voltage Low | I_{INL} | $I_N = 0.8V$, all others = $5.0V$ | -0.5 | 0.005 | 0.5 | μA | |
| DYNAMIC | | | | | | | |
| Turn-On Time | t_{ON} | $V_{COM} = 10V$, Figure 2 | $T_A = +25^\circ C$ | 25 | 100 | ns | |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | 150 | | |
| Turn-Off Time | t_{OFF} | $V_{COM} = 10V$, Figure 2 | $T_A = +25^\circ C$ | 15 | 75 | ns | |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | 100 | | |
| On-Channel Bandwidth | BW | Signal = 0dbm , Figure 4, 50Ω in and out | $T_A = +25^\circ C$ | 100 | | MHz | |
| Charge Injection (Note 3) | V_{CTE} | $C_L = 1.0\text{nF}$, $V_{GEN} = 0V$, $R_{GEN} = 0\Omega$, Figure 3 | $T_A = +25^\circ C$ | 1 | 10 | pC | |
| Off Isolation (Note 7) | V_{ISO} | $R_L = 50\Omega$, $C_L = 5\text{pF}$, $f = 1\text{MHz}$, Figure 4 | $T_A = +25^\circ C$ | -58 | | dB | |
| Crosstalk (Note 8) | V_{CT} | $R_L = 50\Omega$, $C_L = 5\text{pF}$, $f = 1\text{MHz}$, Figure 5 | $T_A = +25^\circ C$ | -86 | | dB | |
| NO Capacitance | $C_{(OFF)}$ | $f = 1\text{MHz}$, Figure 6 | $T_A = +25^\circ C$ | 9 | | pF | |
| COM Off Capacitance | $C_{COM(OFF)}$ | $f = 1\text{MHz}$, Figure 6 | $T_A = +25^\circ C$ | 9 | | pF | |
| COM On Capacitance | $C_{COM(ON)}$ | $f = 1\text{MHz}$, Figure 6 | $T_A = +25^\circ C$ | 22 | | pF | |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | | | | V | |
| Supply Current | I_+ | $V_{IN} = 0V$ or V_+ , all channels on or off | $T_A = T_{MIN}$ to T_{MAX} | -1 | 0.001 | 1 | μA |
| Total Harmonic Distortion | THD | | $T_A = T_{MIN}$ to T_{MAX} | 0.03 | | % | |

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ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V₊ = 5V ± 10%, V₋ = 0V ± 10%, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS | |
|--|---------------------------------------|--|--|------------------------|-----------------|----------------|-------|--|
| ANALOG SWITCH | | | | | | | | |
| Analog Signal Range | V _{COM} , V _{NO} | (Note 3) | | 0 | | V ₊ | V | |
| On-Resistance | R _{ON} | V ₊ = 4.5V, I _{COM} = -1.0mA, V _{NO} = 3.5V | T _A = +25°C | 45 | 75 | | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | 52 | 100 | | |
| | | | | M | | 125 | | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V ₊ = 5V, I _{COM} = -1.0mA, V _{NO} = 3V | T _A = +25°C | 0.3 | 4 | | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 12 | | |
| On-Resistance Flatness (Notes 3, 5) | R _{FLAT(ON)} | V ₊ = 5V, I _{COM} = -1.0mA, V _{NO} = 1V, 3V | T _A = +25°C | 4 | 6 | | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 8 | | |
| NO Off Leakage Current (Note 6) | I _{NO(OFF)} | V ₊ = 5.5V, V _{COM} = 0V, V _{NO} = 4.5V | T _A = +25°C | MAX4066 | -1 | 1 | nA | |
| | | | | MAX4066A | -0.1 | 0.1 | | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -6 | 6 | | |
| | | | | M | -100 | 100 | | |
| COM Off Leakage Current (Note 6) | I _{COM(OFF)} | V ₊ = 5.5V, V _{COM} = 0V, V _{NO} = 4.5V | T _A = +25°C | MAX4066 | -1 | 1 | nA | |
| | | | | MAX4066A | -0.1 | 0.1 | | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -6 | 6 | | |
| | | | | M | -100 | 100 | | |
| COM On Leakage Current (Note 6) | I _{COM(ON)} | V ₊ = 5.5V, V _{COM} = 5V, V _{NO} = 4.5V | T _A = +25°C | MAX4066 | -2 | 2 | nA | |
| | | | | MAX4066A | -0.2 | 0.2 | | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E | -12 | 12 | | |
| | | | | M | -200 | 200 | | |
| DYNAMIC | | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO} = 3V | T _A = +25°C | 43 | 125 | | ns | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 175 | | |
| Turn-Off Time | t _{OFF} | V _{NO} = 3V | T _A = +25°C | 18 | 75 | | ns | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 125 | | |
| On-Channel Bandwidth | BW | Signal = 0dBm, 50Ω in and out, Figure 4 | | 100 | | | MHz | |
| Charge Injection (Note 3) | Q | V _{GEN} = 0V, R _{GEN} = 0V, C _L = 1.0nF, Figure 3 | | T _A = +25°C | 2 | 10 | pC | |
| SUPPLY | | | | | | | | |
| Positive Supply Current | I ₊ | V ₊ = 5.5V, V _{IN} = 0V or V ₊ , all channels on or off | | -1 | | 1 | μA | |

Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

MAX4066/MAX4066A

ELECTRICAL CHARACTERISTICS—Single +3V Supply

($V_+ = 2.7V$ to $3.3V \pm 10\%$, $GND = 0V$, $V_{INH} = 2.4V$, $V_{INL} = 0.8V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP (Note 2) | MAX | UNITS |
|---------------------------|-------------------------|--|------------------------------|-----|-----------------|-------|----------|
| ANALOG SWITCH | | | | | | | |
| Analog Signal Range | V_{COM} , V_{NO} | (Note 3) | | 0 | | V_+ | V |
| Channel On-Resistance | R_{ON} | $V_+ = 3V$, $I_{COM} = -1.0mA$, $V_{NO} = 1.5V$ | $T_A = +25^\circ C$ | | | 170 | Ω |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | 225 | |
| DYNAMIC | | | | | | | |
| Turn-On Time (Note 3) | t_{ON} | $V_+ = 3V$, V_{NO} or $V_{NC} = 1.5V$ | $T_A = +25^\circ C$ | 80 | 185 | | ns |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | | |
| Turn-Off Time (Note 3) | t_{OFF} | $V_+ = 3V$, V_{NO} or $V_{NC} = 1.5V$ | $T_A = +25^\circ C$ | 28 | 150 | | ns |
| | | | $T_A = T_{MIN}$ to T_{MAX} | | | | |
| Charge Injection (Note 3) | Q | $C_L = 1.0nF$, $V_{GEN} = 0V$, $R_{GEN} = 0V$ | $T_A = +25^\circ C$ | 2 | 10 | | pC |
| SUPPLY | | | | | | | |
| Positive Supply Current | I_+ | $V_+ = 3.6V$, $V_{IN} = 0V$ or V_+ , all channels on or off | | -1 | 0.001 | 1 | μA |

Note 2: 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: $\Delta R_{ON} = R_{ON}(\max) - R_{ON}(\min)$.

Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

Note 6: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at $+25^\circ C$.

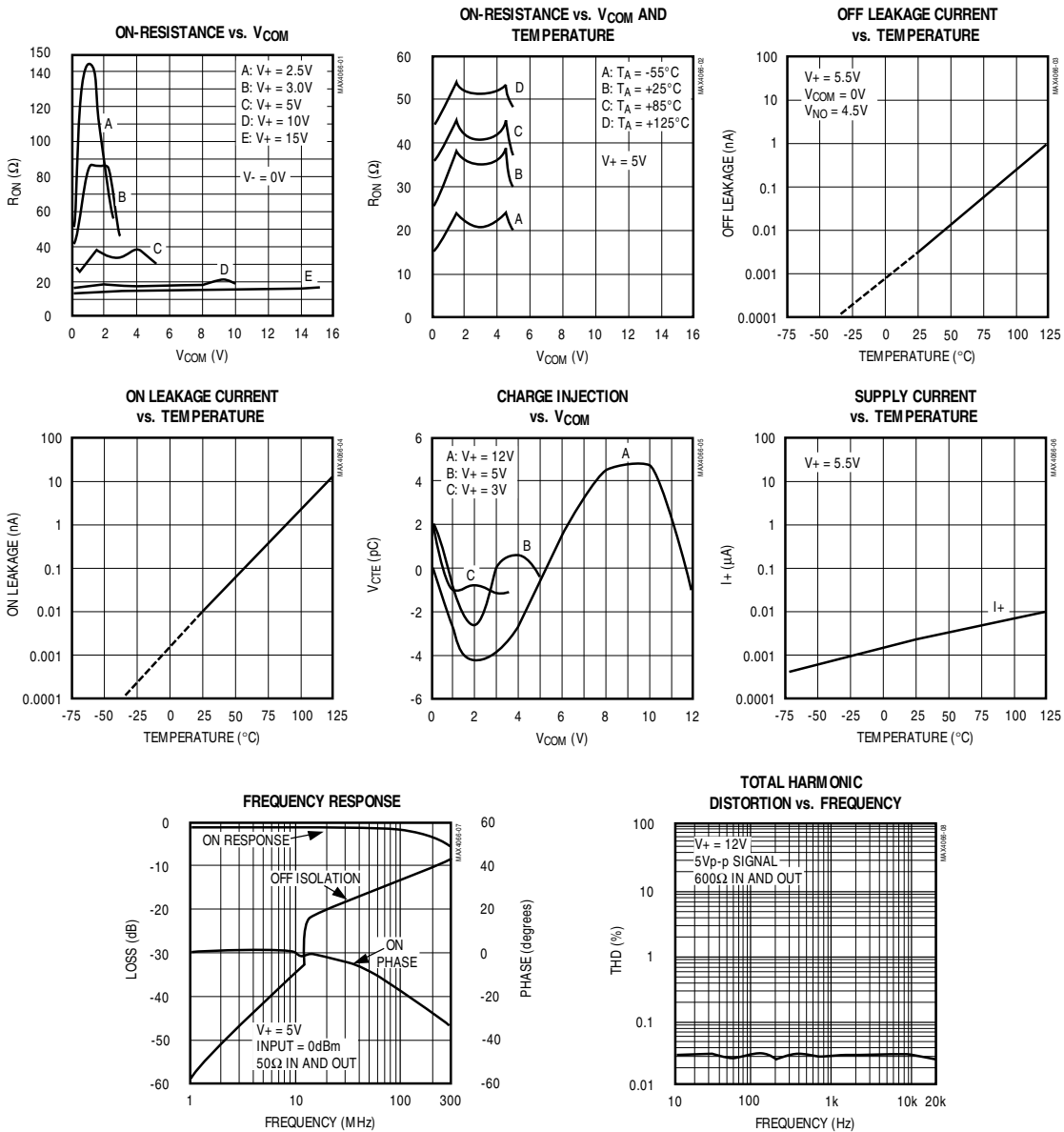
Note 7: Off Isolation = $20 \log_{10} (V_{COM} / V_{NO})$, V_{COM} = output, V_{NO} = input to off switch.

Note 8: Between any two switches.

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Typical Operating Characteristics

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



Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

Pin Description

| PIN | | NAME | FUNCTION |
|--------------|--------------|-----------|--|
| DIP/SO | QSOP | | |
| 1, 3, 8, 11 | 1, 4, 9, 13 | NO1–NO4 | Analog Switch Normally Open Terminal (bidirectional) |
| 2, 4, 9, 10 | 2, 5, 10, 12 | COM1–COM4 | Analog Switch Common Terminal (bidirectional) |
| — | 3, 11 | N.C. | Not internally connected |
| 13, 5, 6, 12 | 15, 6, 7, 14 | IN1–IN4 | Logic Control Inputs |
| 7 | 8 | GND | Ground |
| 14 | 16 | V+ | Positive Supply Voltage |

MAX4066/MAX4066A

Applications Information

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 the logic inputs. If power-supply sequencing is not possible, add two small signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V+ and 1V above GND, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ and GND should not exceed 17V.

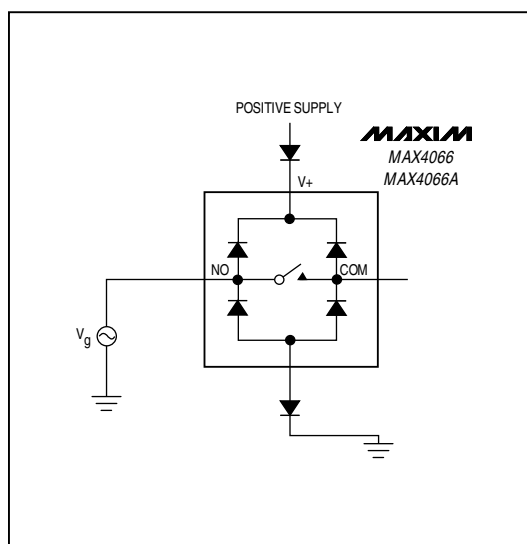


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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Test Circuits/Timing Diagrams

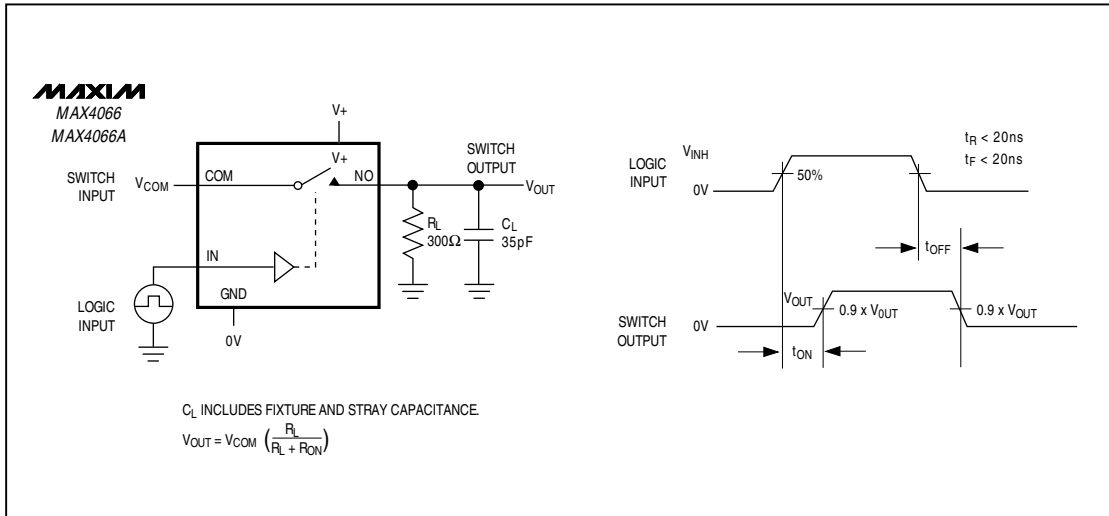


Figure 2. Switching Time

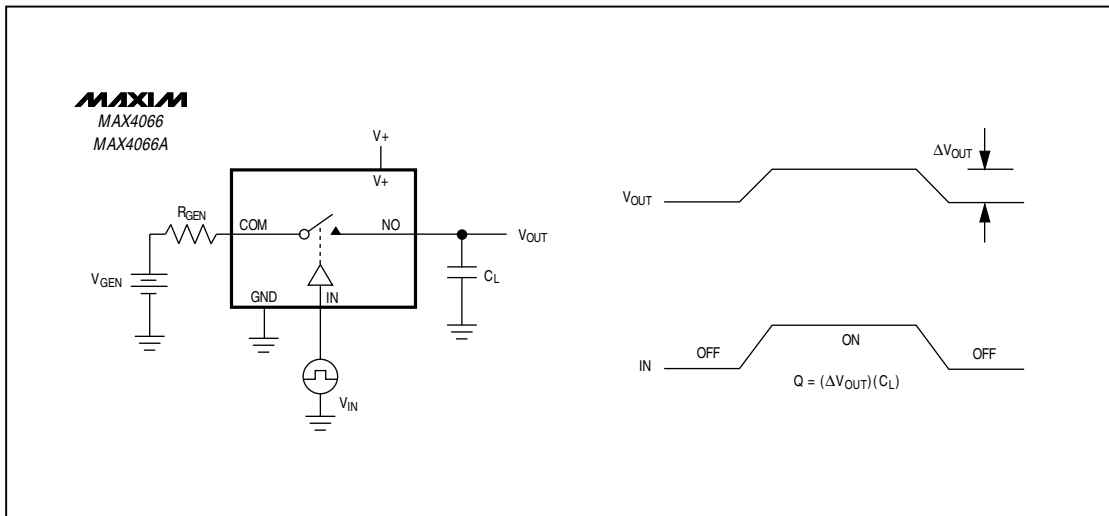


Figure 3. Charge Injection

Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

Test Circuits (continued)

MAX4066/MAX4066A

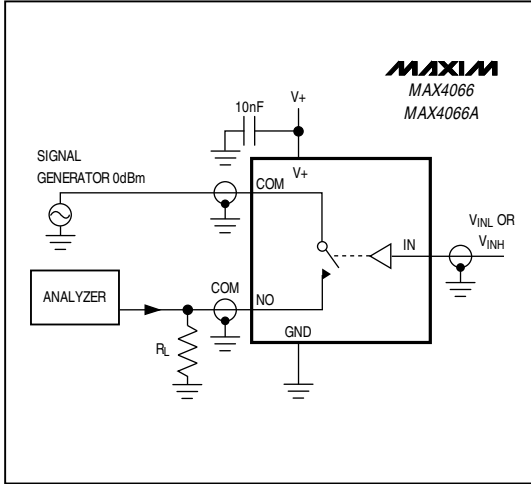


Figure 4. Off Isolation/On-Channel Bandwidth

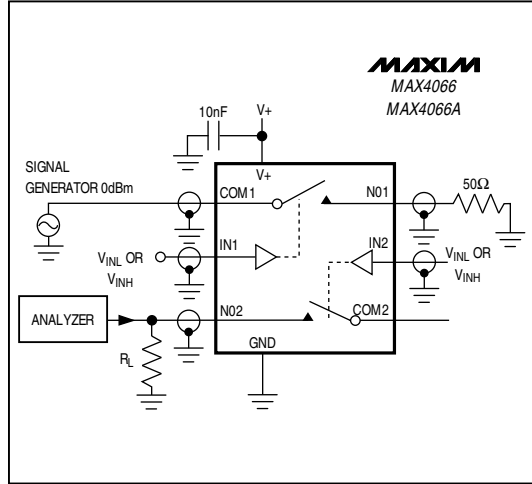


Figure 5. Crosstalk

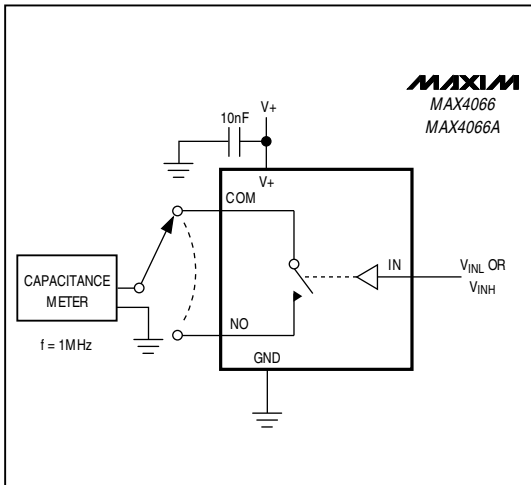


Figure 6. Channel Off/On Capacitance

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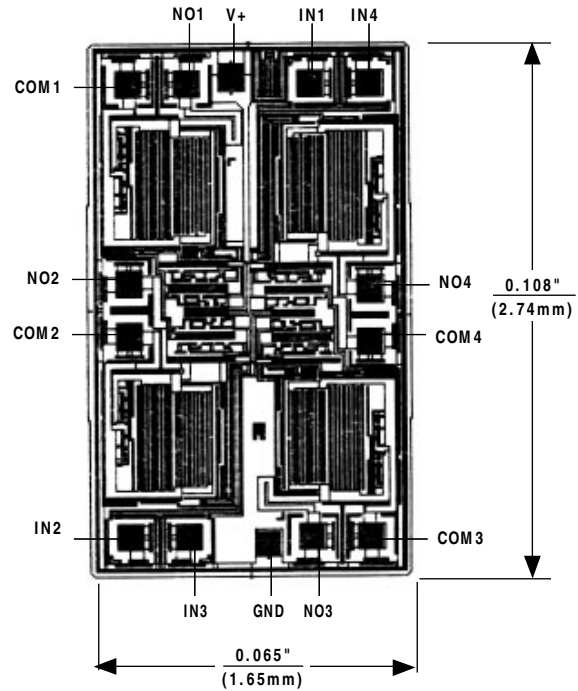
Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|--------------------|-----------------|----------------|
| MAX4066EPD | -40°C to +85°C | 14 Plastic DIP |
| MAX4066ESD | -40°C to +85°C | 14 Narrow SO |
| MAX4066MJD | -55°C to +125°C | 14 CERDIP** |
| MAX4066ACPD | 0°C to +70°C | 14 Plastic DIP |
| MAX4066ACSD | 0°C to +70°C | 14 Narrow SO |
| MAX4066ACEE | 0°C to +70°C | 16 QSOP |
| MAX4066AC/D | 0°C to +70°C | Dice* |
| MAX4066AEPD | -40°C to +85°C | 14 Plastic DIP |
| MAX4066AESD | -40°C to +85°C | 14 Narrow SO |
| MAX4066AEEE | -40°C to +85°C | 16 QSOP |
| MAX4066AMJD | -55°C to +125°C | 14 CERDIP** |

* Contact factory for dice specifications.

** Contact factory for availability.

Chip Topography



TRANSISTOR COUNT: 69
SUBSTRATE CONNECTED TO V+

Low-Cost, Low-Voltage, Quad, SPST, CMOS Analog Switches

Package Information

MAX4066/MAX4066A

**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 |

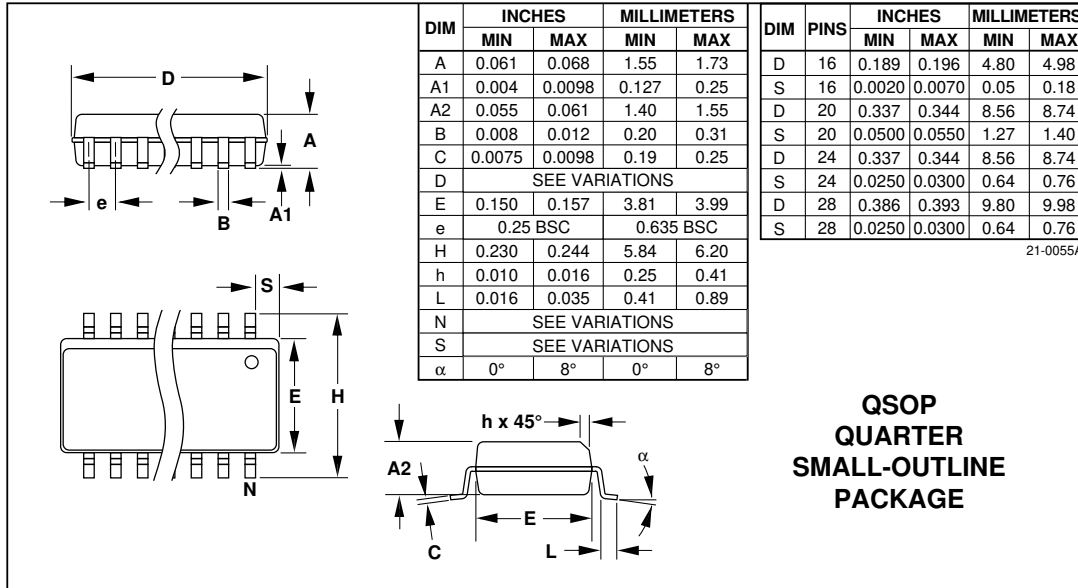
| DIM | PINS | INCHES | | MILLIMETERS | |
|-----|------|--------|-------|-------------|-------|
| | | MIN | MAX | MIN | MAX |
| D | 8 | 0.189 | 0.197 | 4.80 | 5.00 |
| D | 14 | 0.337 | 0.344 | 8.55 | 8.75 |
| D | 16 | 0.386 | 0.394 | 9.80 | 10.00 |

21-0041A

MAX4066/MAX4066A

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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.

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