

MAXIM

2.5Ω, Quad, SPST, CMOS Analog Switches

MAX4661/MAX4662/MAX4663

General Description

The MAX4661/MAX4662/MAX4663 quad analog switches feature low on-resistance of 2.5Ω max. On-resistance is matched between switches to 0.5Ω max and is flat (0.5Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. Off-leakage current is only 5nA max at T_A = +85°C. These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have lower power requirements, use less board space, and are more reliable than mechanical relays.

The MAX4661 has four normally closed (NC) switches, and the MAX4662 has four normally open (NO) switches. The MAX4663 has two NC and two NO switches, and features guaranteed break-before-make switching.

These devices operate from a single +4.5V to +36V supply or from dual ±4.5V to ±20V supplies. A separate logic supply pin guarantees TTL/CMOS-logic compatibility when operating across the entire supply voltage range.

Applications

| | |
|------------------------|--------------------------|
| Reed Relay Replacement | Avionics |
| Test Equipment | ADC Systems |
| Communication Systems | Sample-and-Hold Circuits |
| PBX, PABX Systems | Data Acquisition Systems |
| Audio-Signal Routing | |

Features

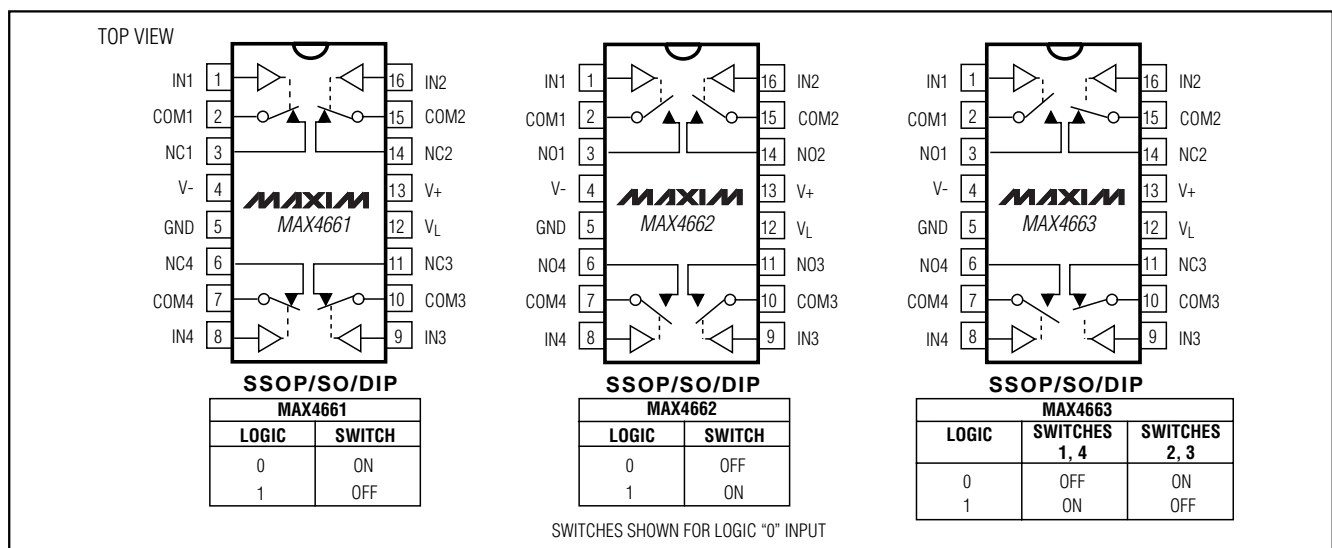
- ◆ Low On-Resistance (2.5Ω max)
- ◆ Guaranteed R_{ON} Match Between Channels (0.5Ω max)
- ◆ Guaranteed R_{ON} Flatness over Specified Signal Range (0.5Ω max)
- ◆ Rail-to-Rail Signal Handling
- ◆ Guaranteed Break-Before-Make (MAX4663)
- ◆ > 2kV ESD Protection per Method 3015.7
- ◆ +4.5V to +36V Single-Supply Operation
±4.5V to ±20V Dual-Supply Operation
- ◆ TTL/CMOS-Compatible Control Inputs

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|----------------|----------------|
| MAX4661CAE | 0°C to +70°C | 16 SSOP |
| MAX4661CWE | 0°C to +70°C | 16 Wide SO |
| MAX4661CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4661EAE | -40°C to +85°C | 16 SSOP |
| MAX4661EWE | -40°C to +85°C | 16 Wide SO |
| MAX4661EPE | -40°C to +85°C | 16 Plastic DIP |

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables



Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.



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ABSOLUTE MAXIMUM RATINGS

| | |
|---|-----------------------------|
| V+ to GND | -0.3V to +44V |
| V- to GND | +0.3V to -44V |
| V+ to V- | -0.3V to +44V |
| V _L to GND | (GND - 0.3V) to (V+ + 0.3V) |
| All Other Pins to GND (Note 1) | (V- - 0.3V) to (V+ + 0.3V) |
| Continuous Current (COM ₊ , NO ₊ , NC ₊) | ±200mA |
| Peak Current (COM ₊ , NO ₊ , NC ₊) (pulsed at 1ms, 10% duty cycle) | ±300mA |

| | |
|---|-----------------|
| Continuous Power Dissipation (T _A = +70°C) | |
| SSOP (derate 7.1mW/°C above +70°C) | 571mW |
| Wide SO (derate 9.52mW/°C above +70°C) | 762mW |
| Plastic DIP (derate 10.53mW/°C above +70°C) | 842mW |
| Operating Temperature Ranges | |
| MAX466_C_E | 0°C to +70°C |
| MAX466_E_E | -40°C to +85°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (soldering, 10sec) | +300°C |

Note 1: Signals on NC₊, NO₊, COM₊, or IN₊ exceeding V+ or V- will be 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—Dual Supplies

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|---|--|---|------|-------|-------|----|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range (Note 3) | V _{COM₊} , V _{NO₊} , V _{NC₊} | | V- | | V+ | V | |
| COM ₊ to NO ₊ or NC ₊ On-Resistance | R _{ON} | I _{COM₊} = 10mA, V _{NO₊} or V _{NC₊} = ±10V | | 1.7 | 2.5 | Ω | |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | 2.7 | | |
| COM ₊ to NO ₊ or NC ₊ On-Resistance Match Between Channels (Notes 3, 4) | ΔR _{ON} | I _{COM₊} = 10mA, V _{NO₊} or V _{NC₊} = ±10V | | 0.1 | 0.5 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.6 | | |
| COM ₊ to NO ₊ or NC ₊ On-Resistance Flatness (Notes 3, 5) | R _{FLAT(ON)} | I _{COM₊} = 10mA; V _{NO₊} or V _{NC₊} = -5V, 0, 5V | | 0.1 | 0.5 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.6 | | |
| Off-Leakage Current (NO ₊ or NC ₊) (Note 6) | I _{NO₊} , I _{NC₊} | V _{COM₊} = ±10V, V _{NO₊} or V _{NC₊} = ∓10V | | -0.5 | 0.01 | 0.5 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| COM Off-Leakage Current (Note 6) | I _{COM(OFF)} | V _{COM₊} = ±10V, V _{NO₊} or V _{NC₊} = ∓10V | | -0.5 | 0.01 | 0.5 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| COM On-Leakage Current (Note 6) | I _{COM(ON)} | V _{COM₊} = ±10V, V _{NO₊} or V _{NC₊} = ±10V or floating | | -1 | 0.01 | 1 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | -20 | | 20 | |
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | I _{IN_H} | IN ₊ = 2.4V, all others = 0.8V | | -0.5 | 0.001 | 0.5 | μA |
| Input Current with Input Voltage Low | I _{IN_L} | IN ₊ = 0.8V, all others = 2.4V | | -0.5 | 0.001 | 0.5 | μA |
| Logic Input Voltage High | V _{IN_H} | | | 2.4 | | | V |
| Logic Input Voltage Low | V _{IN_L} | | | | | 0.8 | V |

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ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V₊ = +15V, V₋ = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|-------------------|---|---|------|-------|-------|----|
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | ±4.5 | | ±20.0 | V | |
| Positive Supply Current | I ₊ | V _{IN} = 0 or 5V | T _A = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Negative Supply Current | I ₋ | V _{IN} = 0 or 5V | T _A = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Logic Supply Current | I _L | V _{IN} = 0 or 5V | T _A = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Ground Current | I _{GND} | V _{IN} = 0 or 5V | T _A = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | t _{ON} | V _{COM_} = ±10V, Figure 2 | T _A = +25°C | 130 | 275 | ns | |
| | | | T _A = T _{MIN} to T _{MAX} | | 400 | | |
| Turn-Off Time | t _{OFF} | V _{COM_} = ±10V, Figure 2 | T _A = +25°C | 100 | 175 | ns | |
| | | | T _A = T _{MIN} to T _{MAX} | | 300 | | |
| Break-Before-Make Time (MAX4663 only) | t _{OPEN} | V _{COM_} = ±10V, Figure 3, T _A = +25°C | 5 | 30 | | ns | |
| Charge Injection | Q | C _L = 1.0nF, V _{GEN} = 0, R _{GEN} = 0, Figure 4 | | 300 | | pC | |
| Off-Isolation (Note 7) | V _{ISO} | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 5 | | -56 | | dB | |
| Crosstalk (Note 8) | V _{CT} | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 6 | | -59 | | dB | |
| NC_ or NO_ Capacitance | C _{OFF} | f = 1MHz, Figure 7 | | 55 | | pF | |
| COM_ Off-Capacitance | C _{COM} | f = 1MHz, Figure 7 | | 55 | | pF | |
| On-Capacitance | C _{COM} | f = 1MHz, Figure 8 | | 250 | | pF | |

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ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0, VL = +5V, VIN_H = +2.4V, VIN_L = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|--|--------------------------------------|--|---------------------------------|------|-------|-------|-------|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range (Note 3) | VCOM_, VNO_, VNC_ | | | GND | | V+ | V |
| COM_ to NO_ or NC_ On-Resistance | RON | I _{COM_} = 10mA, V _{NO_} or V _{NC_} = 10V | TA = +25°C TA = TMIN to TMAX | | 3 | 4 | Ω |
| | | | | | | 5 | |
| COM_ to NO_ or NC_ On-Resistance Match Between Channels (Notes 3, 4) | ΔRON | I _{COM_} = 10mA, V _{NO_} or V _{NC_} = 10V | TA = +25°C TA = TMIN to TMAX | | 0.03 | 0.4 | Ω |
| | | | | | | 0.5 | |
| COM_ to NO_ or NC_ On-Resistance Flatness (Notes 3, 5) | R _{FLAT(ON)} | I _{COM_} = 10mA; V _{NO_} or V _{NC_} = 3V, 6V, 9V | TA = +25°C TA = TMIN to TMAX | | 0.1 | 0.7 | Ω |
| | | | | | | 0.8 | |
| Off-Leakage Current (NO_ or NC_) (Notes 6, 9) | I _{NO_} I _{NC_} | V _{COM_} = 1V, 10V; V _{NO_} or V _{NC_} = 10V, 1V | TA = +25°C TA = TMIN to TMAX | -0.5 | 0.01 | 0.5 | nA |
| | | | | -5 | | 5 | |
| COM Off-Leakage Current (Notes 6, 9) | I _{COM(OFF)} | V _{NO_} or V _{NC_} = 10V, 1V; V _{COM_} = 1V, 10V | TA = +25°C TA = TMIN to TMAX | -0.5 | 0.01 | 0.5 | nA |
| | | | | -5 | | 5 | |
| COM On-Leakage Current (Notes 6, 9) | I _{COM(ON)} | V _{COM_} = 1V, 10V; V _{NO_} or V _{NC_} = 1V, 10V, or floating | TA = +25°C TA = TMIN to TMAX | -1 | 0.01 | 1 | nA |
| | | | | -20 | | 20 | |
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | I _{IN_H} | IN_ = 2.4V, all others = 0.8V | | -0.5 | 0.001 | 0.5 | μA |
| Input Current with Input Voltage Low | I _{IN_L} | IN_ = 0.8V, all others = 2.4V | | -0.5 | 0.001 | 0.5 | μA |
| Logic Input Voltage High | V _{IN_H} | | | 2.4 | | | V |
| Logic Input Voltage Low | V _{IN_L} | | | | | | 0.8 |
| | | | | | | | V |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | | +4.5 | | +36.0 | V |
| Positive Supply Current | I+ | V _{IN} = 0 or 5V | TA = +25°C TA = TMIN to TMAX | -0.5 | 0.001 | 0.5 | μA |
| | | | | -5 | | 5 | |
| Logic Supply Current | I _L | V _{IN} = 0 or 5V | TA = +25°C TA = TMIN to TMAX | -0.5 | 0.001 | 0.5 | μA |
| | | | | -5 | | 5 | |
| Ground Current | I _{GND} | V _{IN} = 0 or 5V | TA = +25°C TA = TMIN to TMAX | -0.5 | 0.001 | 0.5 | μA |
| | | | | -5 | | 5 | |

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ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0, VL = +5V, VIN_H = +2.4V, VIN_L = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------|--|-------------------|-----|-----|-------|
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | |
| Turn-On Time (Note 3) | tON | VCOM_ = 10V, Figure 2 | TA = +25°C | 200 | 400 | ns |
| | | | TA = TMIN to TMAX | | 500 | |
| Turn-Off Time (Note 3) | tOFF | VCOM_ = 10V, Figure 2 | TA = +25°C | 100 | 250 | ns |
| | | | TA = TMIN to TMAX | | 350 | |
| Break-Before-Make Time (MAX4663 only) (Note 3) | tOPEN | VCOM_ = 10V, Figure 3, TA = +25°C | 5 | 125 | | ns |
| Charge Injection | Q | CL = 1.0nF, VGEN = 0, RGEN = 0, Figure 4 | | 20 | | pC |
| Crosstalk (Note 8) | VCT | RL = 50Ω, CL = 5pF, f = 1MHz, Figure 6 | | -60 | | dB |
| NC_ or NO_ Capacitance | COFF | f = 1MHz, Figure 7 | | 85 | | pF |
| COM Off-Capacitance | CCOM | f = 1MHz, Figure 7 | | 85 | | pF |
| On-Capacitance | CCOM | f = 1MHz, Figure 8 | | 140 | | pF |

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°C.

Note 7: Off-isolation = $20 \log_{10} [V_{COM} / (V_{NC} \text{ or } V_{NO})]$, VCOM = output, VNC or VNO = input to off switch.

Note 8: Between any two switches.

Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

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Typical Operating Characteristics

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



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Pin Description

MAX4661/MAX4662/MAX4663

| PIN | | | NAME | FUNCTION |
|--------------|--------------|--------------|------------------------|---|
| MAX4661 | MAX4662 | MAX4663 | | |
| 1, 16, 9, 8 | 1, 16, 9, 8 | 1, 16, 9, 8 | IN1, IN2, IN3, IN4 | Logic-Control Digital Inputs |
| 2, 15, 10, 7 | 2, 15, 10, 7 | 2, 15, 10, 7 | COM1, COM2, COM3, COM4 | Analog Switch Common Terminals |
| 3, 14, 11, 6 | — | — | NC1, NC2, NC3, NC4 | Analog Switch Normally Closed Terminals |
| — | 3, 14, 11, 6 | — | NO1, NO2, NO3, NO4 | Analog Switch Normally Open Terminals |
| — | — | 3, 6 | NO1, NO4 | Analog Switch Normally Open Terminals |
| — | — | 14, 11 | NC2, NC3 | Analog Switch Normally Closed Terminals |
| 4 | 4 | 4 | V- | Negative Analog Supply-Voltage Input. Connect to GND for single-supply operation. |
| 5 | 5 | 5 | GND | Ground |
| 12 | 12 | 12 | VL | Logic-Supply Input |
| 13 | 13 | 13 | V+ | Positive Analog Supply Input |

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 can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small-signal diodes (D1, D2) in series with the supply pins and a Schottky diode between V+ and VL for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V.

Off-Isolation at High Frequencies

In 50Ω systems, the high-frequency on-response of these parts extends from DC to above 100MHz with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor and off-isolation decreases with increasing frequency. (Above 300MHz, the switch actually passes more signal turned off than turned on.) This effect is more pronounced with higher source and load impedances.

Above 5MHz, circuit board layout becomes critical and it becomes difficult to characterize the response of the switch independent of the circuit. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors to a circuit board deemed "average"; that is, designed with isolation in mind, but not using stripline or other special RF circuit techniques. For critical applications above 5MHz, use the MAX440, MAX441, and MAX442, which are fully characterized up to 160MHz.

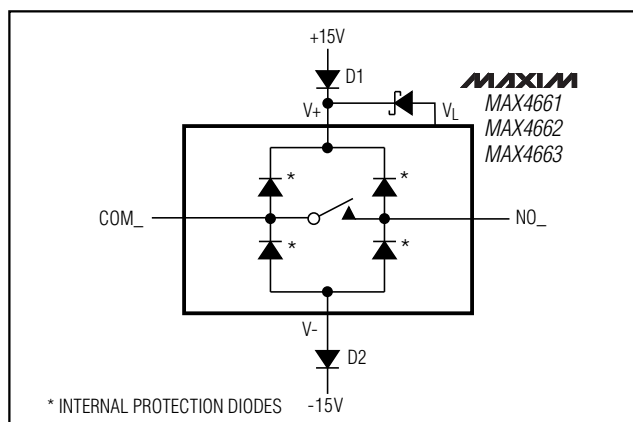


Figure 1. Overvoltage Protection Using External Blocking Diodes

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Figure 2. Switching-Time Test Circuit



Figure 3. Break-Before-Make Interval (MAX4663 only)

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Figure 4. Charge-Injection Test Circuit

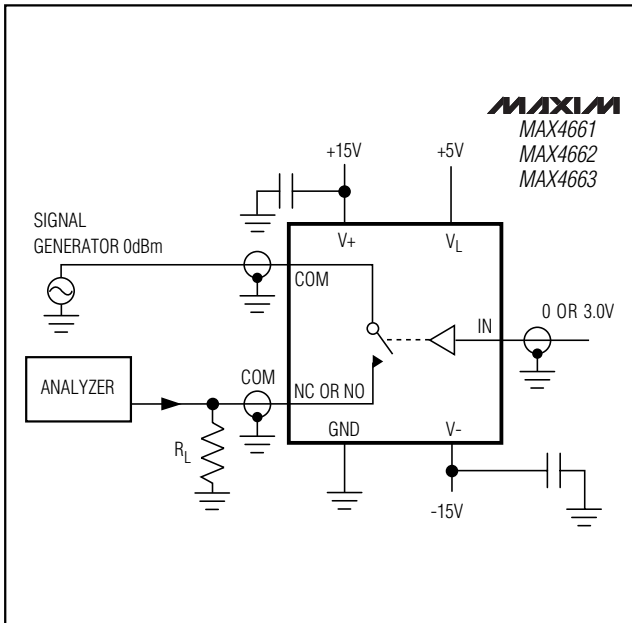


Figure 5. Off-Isolation Test Circuit



Figure 6. Crosstalk Test Circuit

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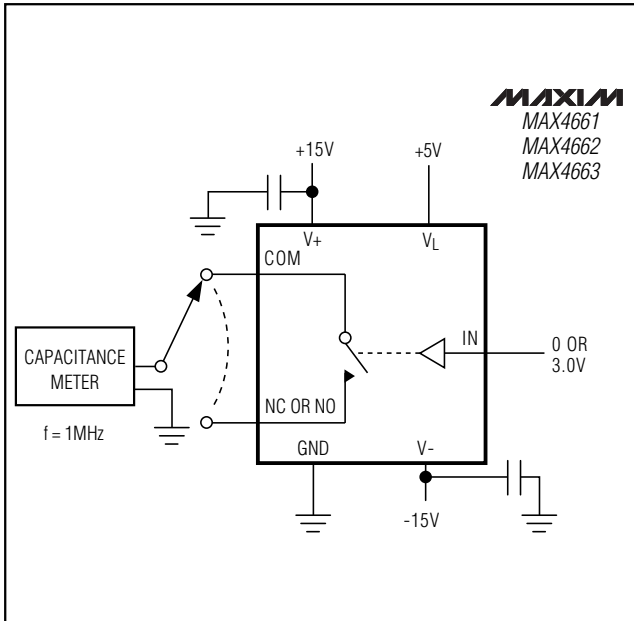


Figure 7. Switch Off-Capacitance Test Circuit

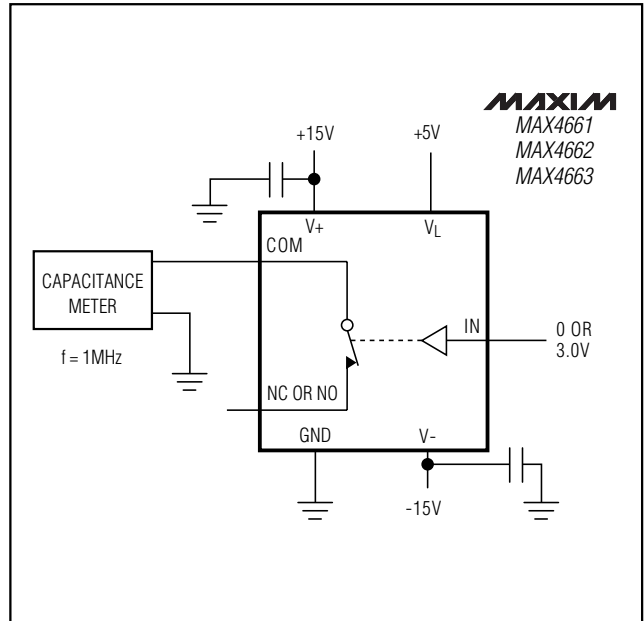


Figure 8. Switch On-Capacitance Test Circuit

Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|-------------------|----------------|----------------|
| MAX4662CAE | 0°C to +70°C | 16 SSOP |
| MAX4662CWE | 0°C to +70°C | 16 Wide SO |
| MAX4662CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4662EAE | -40°C to +85°C | 16 SSOP |
| MAX4662EWE | -40°C to +85°C | 16 Wide SO |
| MAX4662EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX4663CAE | 0°C to +70°C | 16 SSOP |
| MAX4663CWE | 0°C to +70°C | 16 Wide SO |
| MAX4663CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4663EAE | -40°C to +85°C | 16 SSOP |
| MAX4663EWE | -40°C to +85°C | 16 Wide SO |
| MAX4663EPE | -40°C to +85°C | 16 Plastic DIP |

Chip Information

TRANSISTOR COUNT: 108

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Package Information (continued)



| | INCHES | | MILLIMETERS | |
|----|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.093 | 0.104 | 2.35 | 2.65 |
| A1 | 0.004 | 0.012 | 0.10 | 0.30 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.009 | 0.013 | 0.23 | 0.32 |
| e | 0.050 | | 1.27 | |
| E | 0.291 | 0.299 | 7.40 | 7.60 |
| H | 0.394 | 0.419 | 10.00 | 10.65 |
| h | 0.010 | 0.030 | 0.25 | 0.75 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

| | INCHES | | MILLIMETERS | | N | MS013 |
|---|--------|-------|-------------|-------|----|-------|
| | MIN | MAX | MIN | MAX | | |
| D | 0.398 | 0.413 | 10.10 | 10.50 | 16 | AA |
| D | 0.447 | 0.463 | 11.35 | 11.75 | 18 | AB |
| D | 0.496 | 0.512 | 12.60 | 13.00 | 20 | AC |
| D | 0.598 | 0.614 | 15.20 | 15.60 | 24 | AD |
| D | 0.697 | 0.713 | 17.70 | 18.10 | 28 | AE |

- NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
 3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
 4. CONTROLLING DIMENSION: MILLIMETER
 5. MEETS JEDEC MS013-XX AS SHOWN IN ABOVE TABLE
 6. N = NUMBER OF PINS

| | | | |
|--|------------------------------------|--|----------------------|
| <small>120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737-7794</small> <small>PROPRIETARY INFORMATION</small> | PACKAGE FAMILY OUTLINE: SOIC .300" | | 21-0042 A |
| | | | <small>TITLE</small> |

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