



Precision, Dual, High-Speed Analog Switches

MAX301/MAX303/MAX305

General Description

The MAX301/MAX303/MAX305 are precision, dual, high-speed analog switches. The single-pole single-throw (SPST) MAX301 and double-pole single-throw (DPST) MAX305 dualswitches are normally open (NO). The single-pole double-throw (SPDT) MAX303 has two NO and two normally closed (NC) poles. All three parts offer low on resistance (less than 35Ω), guaranteed to match to within 2Ω between channels and to remain flat over the full analog signal range (Δ3max). 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 150ns and turn-off time less than 100ns).

The MAX301/MAX303/MAX305 are fabricated with Maxim's new improved silicon-gate process for high system accuracy. Design improvements guarantee extremely low charge injection (15pC) and low power consumption (35μW). A 44V maximum breakdown voltage allows rail-to-rail analog signal capability.

These monolithic switches operate with a single positive supply (+10V to +30V) or with split supplies (±4.5V to ±20V) while retaining CMOS-logic input compatibility and fast switching. CMOS inputs provide reduced input loading.

Applications

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

Features

- ◆ Low On-Resistance < 22Ω Typical (35Ω Max)
- ◆ Guaranteed Matched On-Resistance Between Channels < 2Ω
- ◆ Guaranteed Flat On-Resistance over Full Analog Signal Range Δ3Ω Max
- ◆ Guaranteed Charge Injection < 15pC
- ◆ Guaranteed Off-Channel Leakage < 6nA at +85°C
- ◆ 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 | PKG CODE |
|-----------|-----------------|----------------|----------|
| MAX301CPE | 0°C to +70°C | 16 Plastic DIP | P16-1 |
| MAX301CSE | 0°C to +70°C | 16 Narrow SO | S16-2 |
| MAX301CJE | 0°C to +70°C | 16 CERDIP | J16-3 |
| MAX301C/D | 0°C to +70°C | Dice* | — |
| MAX301EPE | -40°C to +85°C | 16 Plastic DIP | P16-1 |
| MAX301ESE | -40°C to +85°C | 16 Narrow SO | S16-2 |
| MAX301EJE | -40°C to +85°C | 16 CERDIP | J16-3 |
| MAX301MJE | -55°C to +125°C | 16 CERDIP** | J16-3 |
| MAX301MLP | -55°C to +125°C | 20LCC* | L20-3 |

Ordering Information continued on last page.

*Contact factory for dice specifications.

**Contact factory for package availability.

Pin Configurations/Block Diagrams/Truth Tables

TOP VIEW

MAX301

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

LCC packages on last page.

MAX303

| LOGIC | SWITCHES 1, 2 | SWITCHES 3, 4 |
|-------|---------------|---------------|
| 0 | OFF | ON |
| 1 | ON | OFF |

SWITCHES SHOWN FOR LOGIC "0" INPUT

MAX305

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



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ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

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

Continuous Power Dissipation (T_A = +70°C) (Note 2)

| | |
|--|-------|
| 16-Pin Plastic DIP (derate 10.53mW/°C above +70°C) | 842mW |
| 16-Pin Narrow SO (derate 8.70mW/°C above +70°C) | 696mW |
| 16-Pin CERDIP (derate 10.00mW/°C above +70°C) | 800mW |
| 20-Pin LCC (derate 9.09mW/°C above +70°C) | 727mW |

Operating Temperature Ranges:

| | |
|----------------|-----------------|
| MAX30_C_ | 0°C to +70°C |
| MAX30_E_ | -40°C to +85°C |
| MAX30_M_ | -55°C to +125°C |

Storage Temperature Range

| | |
|---|--------|
| Lead Temperature (soldering, 10s) | +300°C |
|---|--------|

Note 1: Signals on NO₋, NC₋, or COM₋ beyond V+ or V- are clamped by internal diodes. Limit forward 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

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

| PARAMETER | SYMBOL | CONDITIONS | TEMP RANGE | MIN | TYP (Note 2) | MAX | UNITS | |
|---|--|--|---|---------|--------------|-------|-------|----|
| SWITCH | | | | | | | | |
| Analog-Signal Range | V _{ANA} | (Note 3) | | V- | | V+ | V | |
| On-Resistance | R _{ON} | I _(NC or NO) = -10mA, V _{COM-} = ±10V V _{INH} = 2.4V, V _{INL} = 0.8V | T _A = +25°C | C, E | 20 | 35 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | M | 20 | 30 | | |
| | | | T _A = +25°C | C, E | | 55 | | |
| | | | T _A = T _{MIN} to T _{MAX} | M | | 45 | | |
| On-Resistance Match Between Channels (Note 4) | R _{ON} | I _(NC or NO) = -10mA, V _{COM-} = ±10V V+ = 15V, V- = -15V | T _A = +25°C | C, E, M | 0.5 | 2 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E, M | | 3 | | |
| On-Resistance Flatness (Note 4) | R _{ON} | I _S = -10mA V _{COM-} = ±5V V+ = 15V, V- = -15V | T _A = +25°C | C, E, M | | 3 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | C, E, M | | 5 | | |
| NC or NO Off-Leakage Current | NC _(OFF) or NO _(OFF) | V _{COM-} = ±15.5V, V _{NC-} or V _{NO-} = ±15.5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | C, E | -0.50 | -0.01 | 0.50 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | M | -0.25 | -0.01 | 0.25 | |
| | | | T _A = +25°C | C, E | -6 | | 6 | |
| | | | T _A = T _{MIN} to T _{MAX} | M | -20 | | 20 | |
| COM Off-Leakage Current | COM _{OFF} | V _{COM-} = ±15.5V, V _{NC-} or V _{NO-} = ±15.5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | C, E | -0.50 | -0.01 | 0.50 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | M | -0.25 | -0.01 | 0.25 | |
| | | | T _A = +25°C | C, E | -6 | | 6 | |
| | | | T _A = T _{MIN} to T _{MAX} | M | -20 | | 20 | |
| COM On-Leakage Current | COM _{ON} | V _{COM-} = ±15.5V, V _{NC-} or V _{NO-} = ±15.5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | C, E | -1.0 | -0.04 | 1.0 | nA |
| | | | T _A = T _{MIN} to T _{MAX} | M | -0.4 | -0.04 | 0.4 | |
| | | | T _A = +25°C | C, E | -20 | | 20 | |
| | | | T _A = T _{MIN} to T _{MAX} | M | -40.0 | | 40.0 | |

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ELECTRICAL CHARACTERISTICS (continued)

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

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Note 2) | MAX | UNITS | |
|---------------------------------------|-----------------------|---|---|-----------------|-------|-------|----|
| INPUT | | | | | | | |
| Input Current with Input-Voltage High | I _{INH} | V _{INL} = 2.4V, all others = 0.8V | -1.000 | 0.005 | 1.000 | μA | |
| Input Current with Input-Voltage Low | I _{INH} | V _{INL} = 0.8V, all others = 2.4V | -1.000 | 0.005 | 1.000 | μA | |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | ±4.5 | | ±20 | V | |
| Positive Supply Current | I+ | All channels on or off, V _{IN} = 0V or 5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | -1.00 | 0.01 | 1.00 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5.00 | | 5.00 | |
| Negative Supply Current | I- | All channels on or off, V _{IN} = 0V or 5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | -1.00 | -0.01 | 1.00 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5.00 | | 5.00 | |
| Logic-Supply Current | I _L | All channels on or off, V _{IN} = 0V or 5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | -1.00 | 0.01 | 1.00 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5.00 | | 5.00 | |
| Ground Current | I _{GND} | All channels on or off, V _{IN} = 0V or 5V, V+ = 16.5V, V- = -16.5V | T _A = +25°C | -1.00 | -0.01 | 1.00 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5.00 | | 5.00 | |
| DYNAMIC | | | | | | | |
| Turn-On Time | t _{ON} | Figure 1 | | | 100 | 150 | ns |
| Turn-Off Time | t _{OFF} | Figure 1 | | | 60 | 100 | ns |
| Break-Before-Make Time Delay (Note 3) | t _D | MAX303 only, Figure 2 | | | 10 | 20 | ns |
| Charge Injection (Note 3) | Q | C _L = 10nF, V _{GEN} = 0V, R _{GEN} = 0Ω, Figure 3 | | | 10 | 15 | pC |
| Off-Isolation (Note 5) | OIRR | R _L = 100Ω, C _L = 5pF, f = 1MHz, Figure 4 | | | 72 | | dB |
| Crosstalk (Note 6) | | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 5 | | | 90 | | dB |
| Off-Capacitance | C _{OF} | f = 1MHz, Figure 6 | | | 12 | | pF |
| COM Off-Capacitance | C _{COM(OFF)} | f = 1MHz, Figure 6 | | | 12 | | pF |
| Channel-On Capacitance | C _{COM(ON)} | f = 1MHz, Figure 7 | | | 39 | | pF |

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used on this data sheet.

Note 3: Guaranteed by design.

Note 4: $\Delta R_{ON} = \Delta R_{ONMAX} - \Delta R_{ONMIN}$. On resistance match between channels and flatness are guaranteed only with specified voltages.

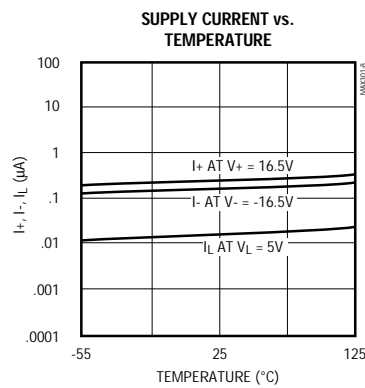
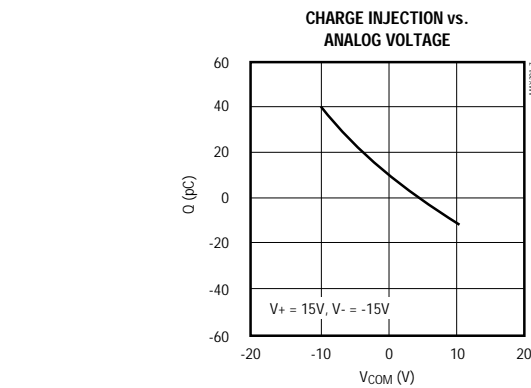
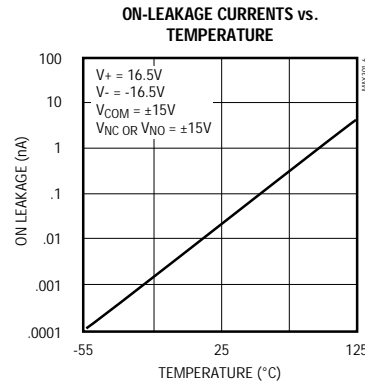
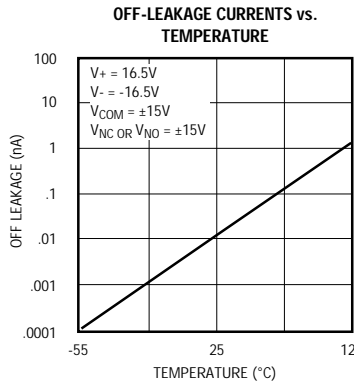
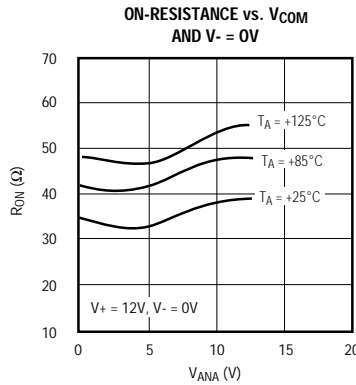
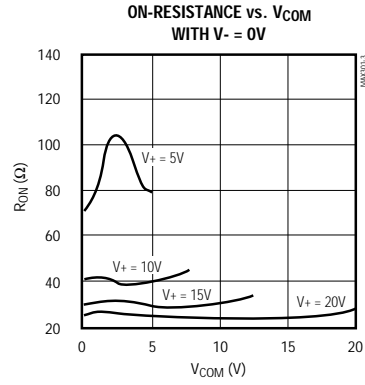
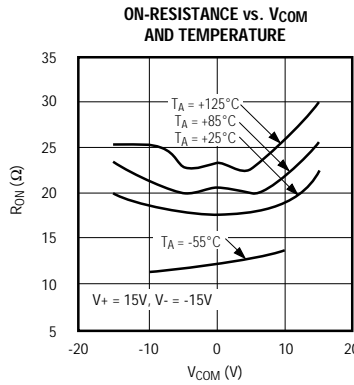
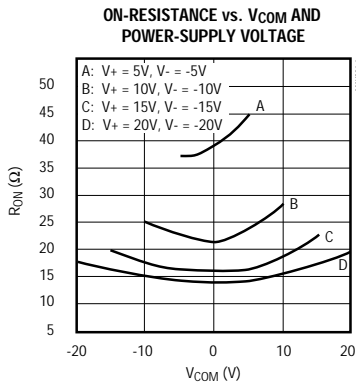
Note 5: See Figure 4. Off isolation = $20 \log_{10} V_{COM}/V_{NC}$ or V_{NO} . V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

Note 6: Between any two switches. See Figure 5.

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Typical Operating Characteristics

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



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MAX301/MAX303/MAX305

Pin Descriptions

| MAX301 PIN | | NAME | FUNCTION |
|-------------|--------------------|-----------------------------------|--|
| DIP/SO | LCC | | |
| 1, 8 | 2, 10 | COM1, COM2 | Drain (Analog Signal) |
| 2-7 | 1, 3-9, 11, 16 | N.C. | Not internally connected |
| 9, 16 | 5, 7, 12, 20 | NC1, NC2 | Source (Analog Signal) |
| 10, 15 | 13, 19 | IN2, IN1 | Digital Logic Inputs |
| 11 | 14 | V+ | Positive Supply-Voltage Input—connected to substrate |
| 12 | 15 | V _L | Logic Supply-Voltage Input |
| 13 | 17 | GND | Ground |
| 14 | 18 | V- | Negative Supply Voltage Input |
| MAX303 PIN | | NAME | FUNCTION |
| DIP/SO | LCC | | |
| 1, 8, 3, 6 | 2, 4, 8, 10 | COM ₋ | Drain (Analog Signal) |
| 2-7 | 1, 3, 6, 9, 11, 16 | N.C. | Not internally connected |
| 11 | 14 | V+ | Positive Supply-Voltage Input—connected to substrate |
| 12 | 15 | V _L | Logic Supply-Voltage Input |
| 13 | 17 | GND | Ground |
| 14 | 18 | V- | Negative Supply Voltage Input |
| 15, 10 | 19, 13 | IN1, IN2 | Digital Logic Inputs |
| 16, 9, 5, 4 | 5, 7, 12, 20 | NC ₋ , NO ₋ | Source (Analog Signal) |
| MAX305 PIN | | NAME | FUNCTION |
| DIP/SO | LCC | | |
| 1, 8, 3, 6 | 2, 4, 8, 10 | COM ₋ | Drain (Analog Signal) |
| 2-7 | 1, 3, 6, 9, 11, 16 | N.C. | Not internally connected |
| 11 | 14 | V+ | Positive Supply-Voltage Input—connected to substrate |
| 12 | 15 | V _L | Logic Supply-Voltage Input |
| 13 | 17 | GND | Ground |
| 14 | 18 | V- | Negative Supply Voltage Input |
| 15, 10 | 19, 13 | IN1, IN2 | Digital Logic Inputs |
| 16, 9, 5, 4 | 5, 7, 12, 20 | NO ₋ | Source (Analog Signal) |

Applications Information

Operation with Supply Voltages Other than ±15V

The MAX301/MAX303/MAX305 switches operate with ±4.5V to ±20V bipolar supplies and a +10V to +30V single supply. In either case, analog signals ranging from V+ to V- can be switched. The *Typical Operating Characteristics* graphs show the typical on-resistance variation with analog signal and supply voltage. The usual on-resistance temperature coefficient is 0.5%/°C (typ).

Logic Inputs

The MAX301/MAX303/MAX305 operate with a single positive supply or with bipolar supplies. The devices maintain TTL compatibility with supplies anywhere in the ±4.5V to ±20V range as long as V_L = +5V. If V_L is connected to V+ or another supply at voltages other than +5V, the devices will operate at CMOS-logic level inputs.

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 V_L, V-, and logic inputs. If power-supply sequencing is not possible, add two small signal diodes in series with the supply pins for overvoltage protection (Figure 1). Adding 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.

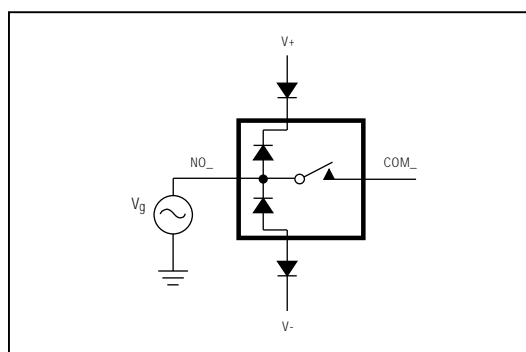


Figure 1. Overvoltage Protection Using Blocking Diodes

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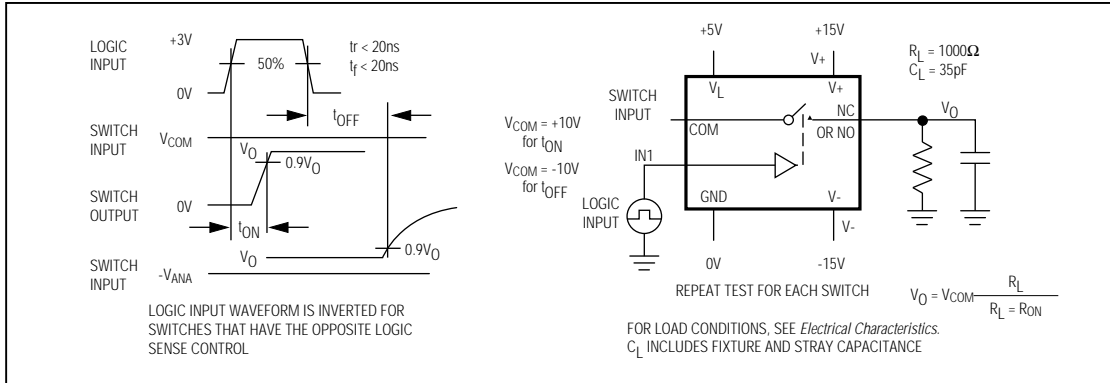


Figure 2. Switching-Time Test Circuit

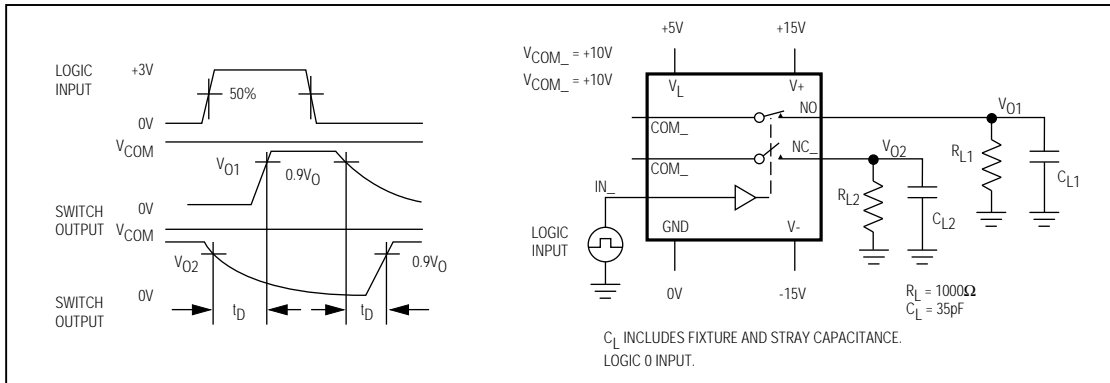


Figure 3. Break-Before-Make Test Circuit

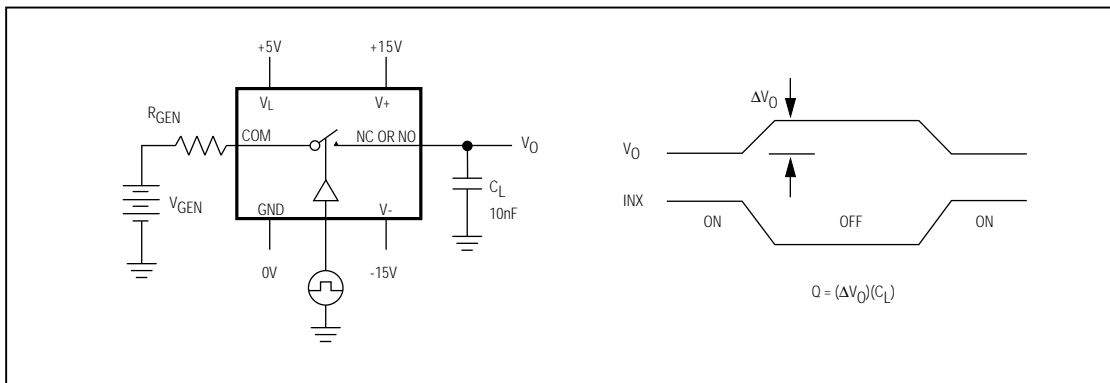


Figure 4. Charge-Injection Test Circuit

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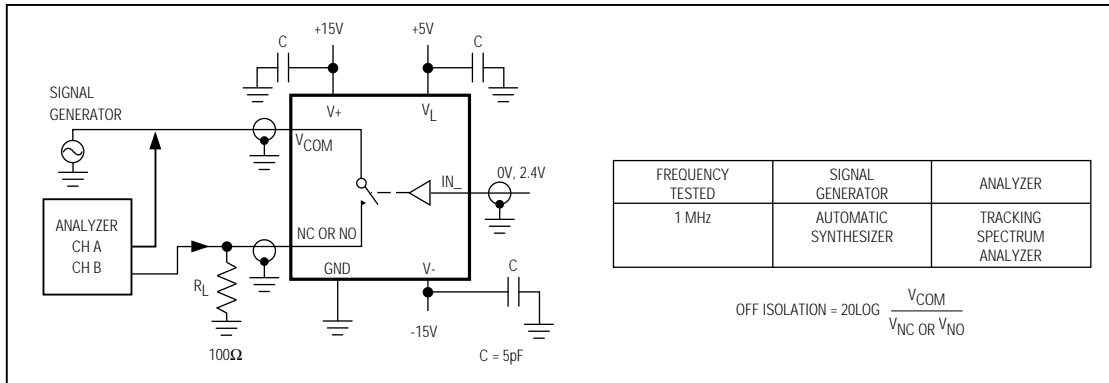


Figure 5. Off Isolation

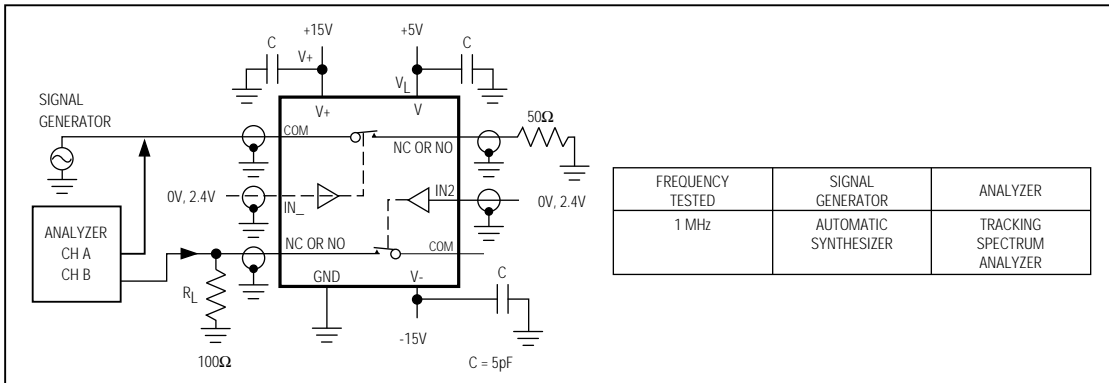


Figure 6. Crosstalk Test Circuit

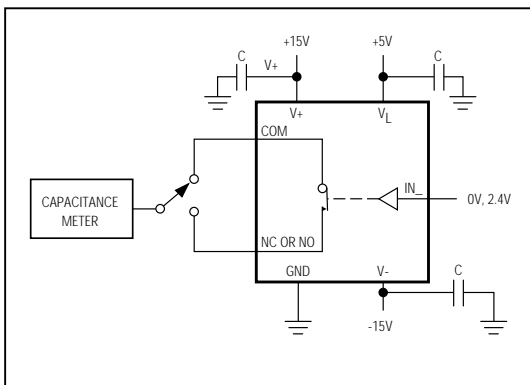


Figure 7. Channel On-Capacitance

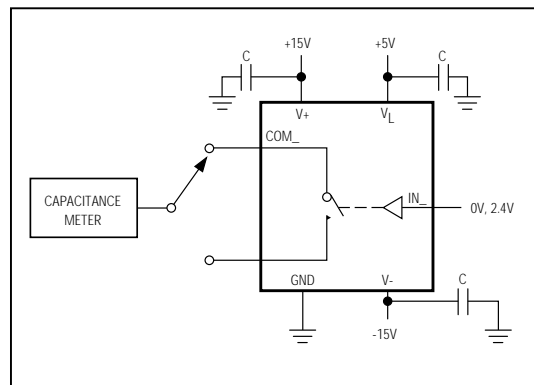


Figure 8. Channel Off-Capacitance

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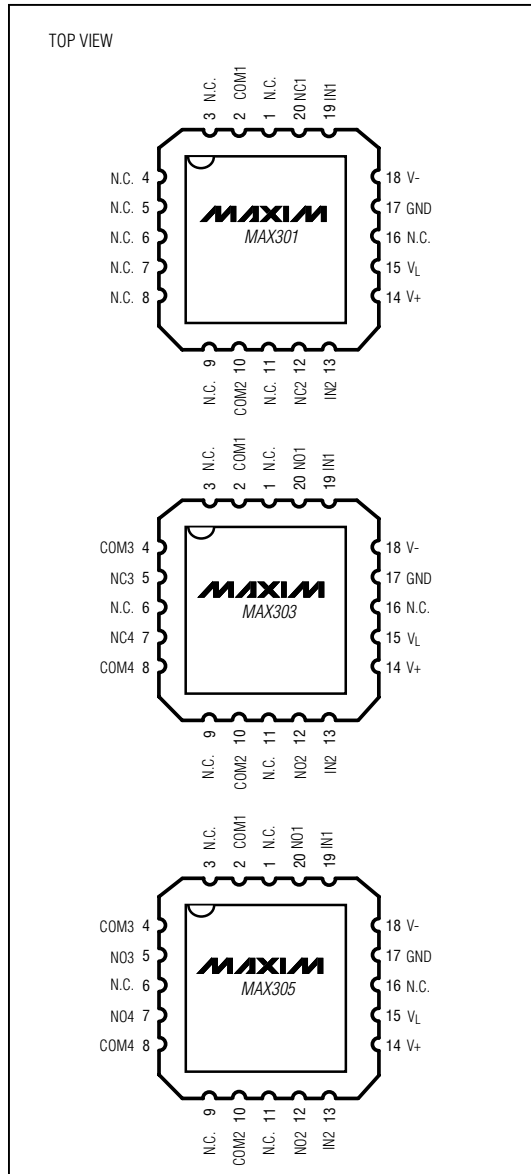
MAX301/MAX303/MAX305

Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE | PKG CODE |
|-----------|-----------------|----------------|----------|
| MAX303CPE | 0°C to +70°C | 16 Plastic DIP | P16-1 |
| MAX303CSE | 0°C to +70°C | 16 Narrow SO | S16-2 |
| MAX303CJE | 0°C to +70°C | 16 CERDIP | J16-3 |
| MAX303C/D | 0°C to +70°C | Dice* | — |
| MAX303EPE | -40°C to +85°C | 16 Plastic DIP | P16-1 |
| MAX303ESE | -40°C to +85°C | 16 Narrow SO | S16-2 |
| MAX303EJE | -40°C to +85°C | 16 CERDIP | J16-3 |
| MAX303MJE | -55°C to +125°C | 16 CERDIP | J16-3 |
| MAX303MLP | -55°C to +125°C | 20LCC* | L20-3 |
| MAX305CPE | 0°C to +70°C | 16 Plastic DIP | P16-1 |
| MAX305CSE | 0°C to +70°C | 16 Narrow SO | S16-2 |
| MAX305CJE | 0°C to +70°C | 16 CERDIP | J16-3 |
| MAX305C/D | 0°C to +70°C | Dice* | — |
| MAX305EPE | -40°C to +85°C | 16 Plastic DIP | P16-1 |
| MAX305ESE | -40°C to +85°C | 16 Narrow SO | S16-2 |
| MAX305EJE | -40°C to +85°C | 16 CERDIP | J16-3 |
| MAX305MJE | -55°C to +125°C | 16 CERDIP | J16-3 |
| MAX305MLP | -55°C to +125°C | 20LCC* | L20-3 |

* Dice are tested at $T_A = +25^\circ\text{C}$ only.
 ** Contact factory for availability.

Pin Configurations (continued)



Revision History

Pages changed at Rev 1: 1, 7, 8

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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