



Precision, Quad, SPDT, CMOS Analog Switch

MAX3333A

General Description

The MAX3333A is a precision, quad, single-pole double-throw (SPDT) analog switch. The four independent switches operate with bipolar supplies ranging from $\pm 4.5V$ to $\pm 20V$, or with a single-ended supply between $+10V$ and $+30V$. The MAX3333A offers low on resistance (less than 35Ω), guaranteed to match within 2Ω between channels and to remain flat over the analog signal range ($\Delta 3\Omega$ max). It also offers break-before-make switching (10ns typical), with turn-off times less than 145ns and turn-on times less than 175ns. The MAX3333A is ideal for portable operation since quiescent current runs less than $50\mu A$ with all inputs high or low.

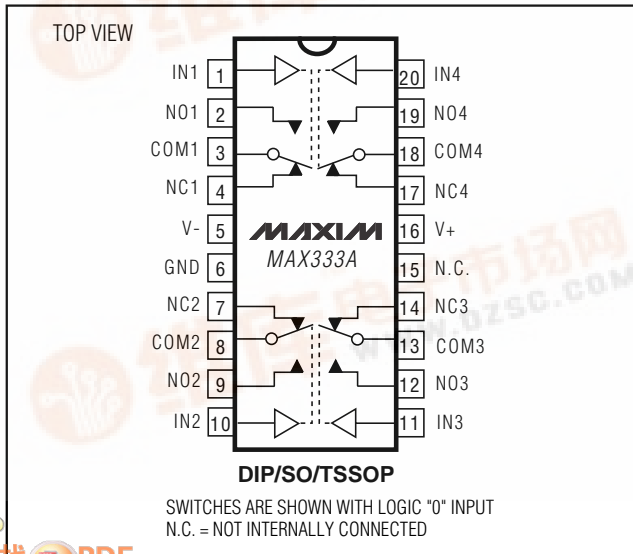
This monolithic, quad switch is fabricated with Maxim's new improved silicon-gate process. Design improvements guarantee extremely low charge injection (10pC), low power consumption (3.75mW), and electrostatic discharge (ESD) greater than 2000V.

Logic inputs are TTL and CMOS compatible and guaranteed over a $+0.8V$ to $+2.4V$ range—regardless of supply voltage. Logic inputs and switched analog signals can range anywhere between the supply voltages without damage.

Applications

- Test Equipment
- Communications Systems
- PBX, PABX
- Heads-Up Displays
- Portable Instruments

Pin Configuration



Features

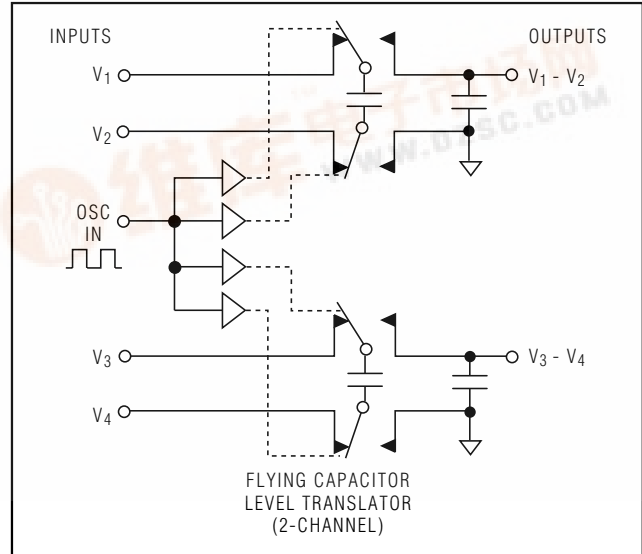
- ◆ Upgraded Replacement for a DG211/DG212 Pair or Two DG403s
- ◆ Low On Resistance $< 17\Omega$ Typical (35Ω Max)
- ◆ Guaranteed Matched On Resistance Between Channels $< 2\Omega$
- ◆ Guaranteed Flat On Resistance over Analog Signal Range $\Delta 3\Omega$ Max
- ◆ Guaranteed Charge Injection $< 10pC$
- ◆ Guaranteed Off-Channel Leakage $< 6nA$ at $+85^\circ C$
- ◆ ESD Guaranteed $> 2000V$ per Method 3015.7
- ◆ Single-Supply Operation ($+10V$ to $+30V$)
- ◆ Bipolar-Supply Operation ($\pm 4.5V$ to $\pm 20V$)
- ◆ TTL-/CMOS-Logic Compatibility
- ◆ Rail-to-Rail Analog Signal Handling Capability

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|-------------|---------------------------------|----------------|
| MAX3333ACPP | $0^\circ C$ to $+70^\circ C$ | 20 Plastic DIP |
| MAX3333ACWP | $0^\circ C$ to $+70^\circ C$ | 20 Wide SO |
| MAX3333ACUP | $0^\circ C$ to $+70^\circ C$ | 20 TSSOP |
| MAX3333AC/D | $0^\circ C$ to $+70^\circ C$ | Dice* |
| MAX3333AEPP | $-40^\circ C$ to $+85^\circ C$ | 20 Plastic DIP |
| MAX3333AEWP | $-40^\circ C$ to $+85^\circ C$ | 20 Wide SO |
| MAX3333AEUP | $-40^\circ C$ to $+85^\circ C$ | 20 TSSOP |
| MAX3333AMJP | $-55^\circ C$ to $+125^\circ C$ | 20 CERDIP |

* Contact factory for dice specifications.

Typical Operating Circuit



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ABSOLUTE MAXIMUM RATINGS

| | |
|--|----------|
| V+ to V- | 44V |
| VIN, VCOM, VNO, VNC | V- to V+ |
| (VNO - VNC) | 32V |
| V+ to Ground | 30V |
| V- to Ground | -30V |
| Current, Any Terminal Except VCOM, VNO, or VNC | 30mA |
| Continuous Current, VCOM, VNO, or VNC | 20mA |
| Peak Current, VCOM, VNO, or VNC (Pulsed at 1ms, 10% duty cycle max) | 70mA |
| ESD | 2000V |

| | |
|--|-----------------|
| Continuous Power Dissipation (TA = +70°C) (Note 1) | |
| Plastic DIP (derate above +70°C by 11.11mW/°C) | 889mW |
| SO (derate above +70°C by 10.00mW/°C) | 800mW |
| CERDIP (derate above +70°C by 11.11mW/°C) | 889mW |
| TSSOP (derate above +70°C by 7mW/°C) | 559mW |
| Operating Temperature Ranges: | |
| MAX333AC | 0°C to +70°C |
| MAX333AE | -40°C to +85°C |
| MAX333AMJP | -55°C to +125°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (soldering, 10sec) | +300°C |

Note 1: Device mounted with all leads soldered 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

(GND = 0V, V+ = +15V, V- = -15V, TA = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Notes 2, 3) | MAX | UNITS | |
|--|----------------|---|-------------------|---------------------|------|-------|------|
| POWER REQUIREMENTS | | | | | | | |
| Positive Supply Current | I+ | VIN = 0V/5V, V+ = 16.5V, V- = -16.5V | | 0.05 | 0.25 | mA | |
| Supply Voltage Range | V+/V- | Dual supply, V+ = V- | ±4.5V | | ±20 | V | |
| | V+ | Single supply, V- = GND | 10 | | 30 | | |
| Negative Supply Current | I- | VIN = 0V/5V, V+ = 16.5V, V- = -16.5V | | 0.01 | 1 | µA | |
| LOGIC INPUT | | | | | | | |
| Input Voltage Low | VIL | | V- | | 0.8 | V | |
| Input Voltage High | VIH | | 2.4 | | V+ | V | |
| Input Current | IIN | VIN = V-, V+ | -1.0 | 0.0001 | 1.0 | µA | |
| SWITCH | | | | | | | |
| Analog Signal Range | VCOM, VNO, VNC | | V- | | V+ | V | |
| On Circuit Resistance | RON | VCOM = +10V, I(NC or NO) = 1mA; VCOM = -10V, I(NC or NO) = 1mA | M | 20 | 35 | Ω | |
| | | | C, E | | 45 | | |
| On Resistance Match Between Channels (Note 4) | RON | I(NC or NO) = -10mA, VD = 10V or -10V, V+ = 15V, V- = -15V | TA = +25°C | | 2 | Ω | |
| | | | TA = TMIN to TMAX | | 4 | | |
| On Resistance Flatness (Note 4) | RON | I(NC or NO) = -10mA, VD = 5V or -5V, V+ = 15V, V- = -15V | TA = +25°C | | 3 | Ω | |
| | | | TA = TMIN to TMAX | | 5 | | |
| On Circuit Leakage Current | ICOM | VCOM = ±15.5V, VNC or VNO = +15.5V, V+ = 16.5V, V- = -16.5V | M | -0.75 | 0.75 | nA | |
| | | | C, E | -1.00 | 0.20 | | 1.00 |
| Off Circuit Leakage Current | INC or INO | VCOM = ±15.5V VNC or VNO = ±15.5V, V+ = 16.5V, V- = -16.5V | M | -0.25 | 0.01 | 0.25 | |
| | | | C, E | -0.50 | 0.02 | 0.05 | |
| DYNAMIC | | | | | | | |
| Turn-Off Time | tOFF | Figure 1 | | | 145 | ns | |
| Turn-On Time | tON | | | | 175 | ns | |
| Break-Before-Make Time | tOPEN | | 10 | | | ns | |
| Off Capacitance | COFF | | | 5 | | pF | |
| On Capacitance | CON | | | 5 | | pF | |
| Charge Injection | Q | CL = 10nF, VGEN = 0V, RGEN = 0Ω, Figure 6 | TA = +25°C | | 2 | 10 | pC |
| Off Isolation | OIRR | f = 1MHz, RL = 75Ω, VCOM = 2.3VRMS | | | 72 | | dB |
| Crosstalk | CCRR | | | | 78 | | dB |

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ELECTRICAL CHARACTERISTICS—DUAL SUPPLIES (continued)

(GND = 0V, V+ = +15V, V- = -15V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Notes 2, 3) | MAX | UNITS |
|----------------------------|------------------------------------|--|------|---------------------|-----|-------|
| LOGIC INPUT | | | | | | |
| Input Voltage Low | V _{IL} | | V- | | 0.8 | V |
| Input Voltage High | V _{IH} | | 2.4 | | V+ | V |
| Input Current | I _{IN} | V _{IN} = V-, V+ | -1.0 | 0.0001 | 1.0 | μA |
| SWITCH | | | | | | |
| Analog Signal Range | V _{COM} | | V- | | V+ | V |
| On Circuit Resistance | R _{ON} | V _{COM} = 10V, I _(NC or NO) = 1mA; V _{COM} = -10V, I _(NC or NO) = 1mA | C, E | | 45 | Ω |
| | | | M | | 45 | |
| On Circuit Leakage Current | I _{COM} | V _{COM} = ±15V, V _{NC} or V _{NO} = -15V, V+ = 16.5V, V- = -16.5V | C, E | -10 | 10 | nA |
| | | | M | -60 | 60 | |
| On Circuit Leakage Current | I _{NC} or I _{NO} | V _{COM} = ±15V, V _{NC} or V _{NO} = -15V, V+ = 16.5V, V- = -16.5V | C, E | -6 | 6 | nA |
| | | | M | | | |

ELECTRICAL CHARACTERISTICS—Single Supply

(GND = 0V, V+ = +12V, V- = 0V, T_A = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP (Notes 2, 3) | MAX | UNITS |
|-----------------------------|---|---|-----|---------------------|------|-------|
| SUPPLY | | | | | | |
| Supply Voltage Range | V+ | Single supply, V- = GND | 10 | | 30 | V |
| Positive Supply Current | I+ | | | | 0.25 | mA |
| INPUT | | | | | | |
| Input Voltage Low | V _{INLO} | | 0 | | 0.8 | V |
| Input Voltage High | V _{INH} | | 2.4 | | V+ | V |
| Input Current | I _{IN} | V _{IN} = V+, 0V | | | 1 | μA |
| SWITCH | | | | | | |
| Analog Signal Range | V _{COM} , V _{NO} , V _{NC} | | V- | | V+ | V |
| On Circuit Resistance | r _{ON} | V _{COM} = 10V, I _(NC or NO) = 1mA, V _{COM} = 1V, I _(NC or NO) = 1mA | | 35 | 75 | Ω |
| On Circuit Leakage Current | I _{COM} | V _{COM} = 11V, V _{NC} or V _{NO} = 0V V _{COM} = 1V, V _{NC} or V _{NO} = V+ | | | 0.75 | nA |
| Off Circuit Leakage Current | I _{NC} or I _{NO} | V _{COM} = 11V V _{NC} or V _{NO} = 1V | | | 0.25 | nA |
| DYNAMIC | | | | | | |
| Turn-Off Time | t _{OFF} | Figure 1 | | 45 | | ns |
| Turn-On Time | t _{ON} | | | 90 | | ns |
| Break-Before-Make Time | t _{OPEN} | | 5 | 10 | | ns |
| Off Isolation | OIRR | f = 1MHz, R _L = 75Ω, V _{COM} = 2.3V _{RMS} | | 70 | | dB |
| Crosstalk | CCRR | | | 72 | | dB |

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

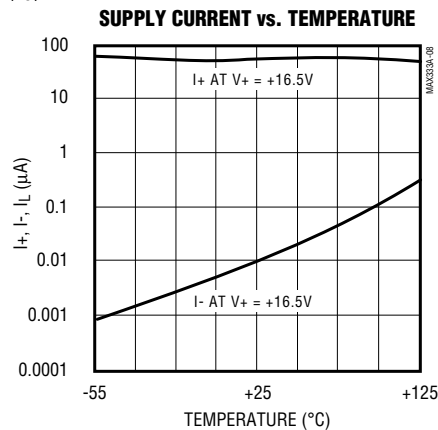
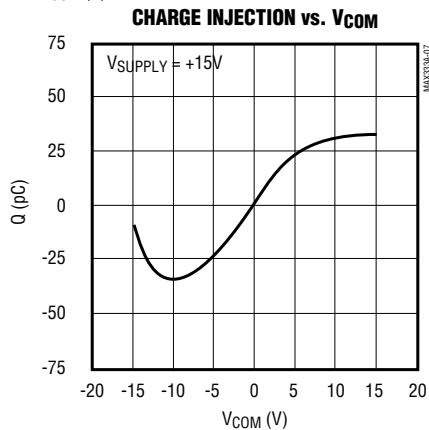
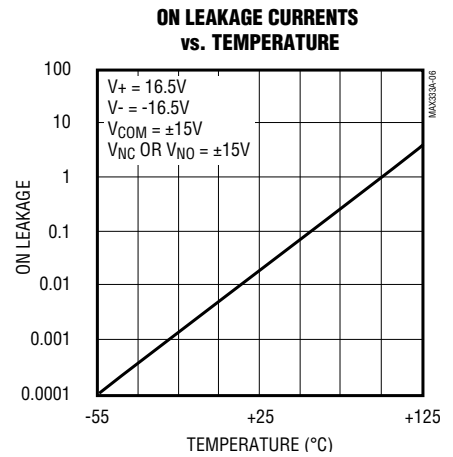
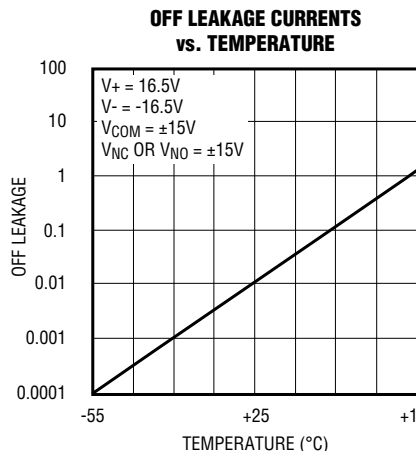
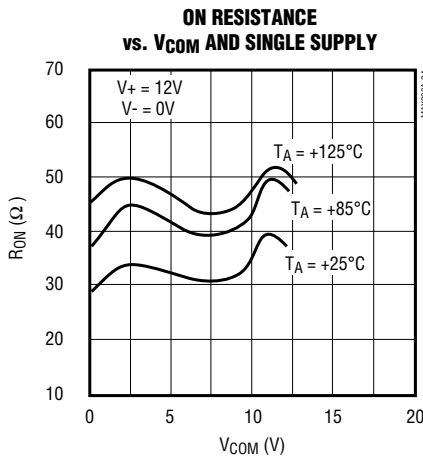
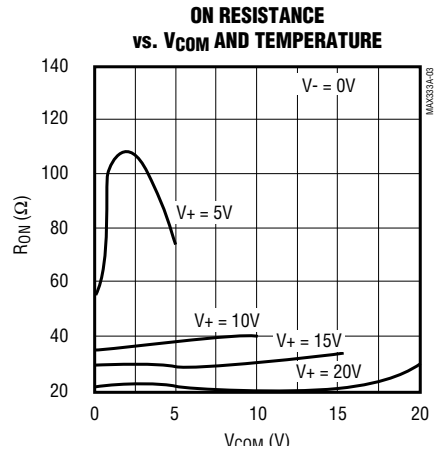
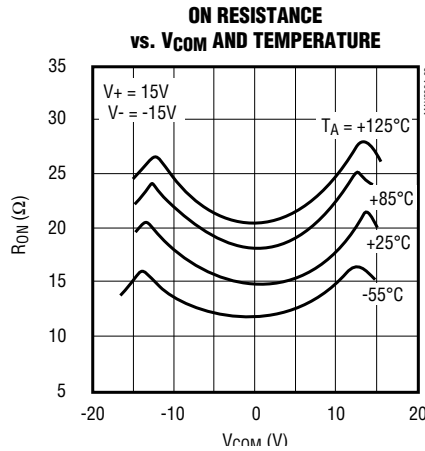
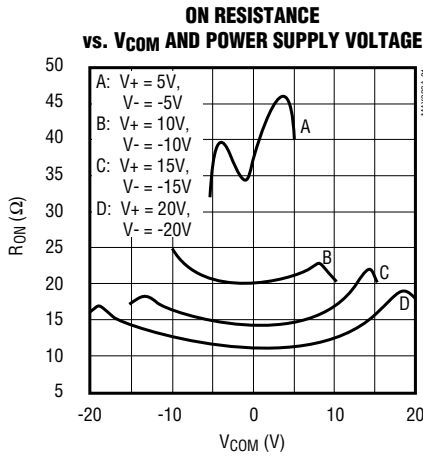
Note 3: Typical values are for design aid only, not guaranteed or subject to production testing.

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

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Typical Operating Characteristics

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



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Pin Description

| PIN | NAME | FUNCTION |
|---------------|-----------|--------------------------|
| 1, 10, 11, 20 | IN1-IN4 | Logic-Level Inputs |
| 2, 9, 12, 19 | NO1-NO4 | Normally Open Switches |
| 3, 8, 13, 18 | COM1-COM4 | Common Switch Poles |
| 4, 7, 14, 17 | NC1-NC4 | Normally Closed Switches |
| 5 | V- | Negative Power Supply |
| 6 | GND | Ground |
| 15 | N.C. | Not Internally Connected |
| 16 | V+ | Positive Power Supply |

Applications Information

Operation with Supply Voltages Other than $\pm 15V_0$

The main limitation of supply voltages other than $\pm 15V$ is a reduction in the analog signal range. The MAX333A operates with $\pm 5V$ to $\pm 20V$ bipolar supplies. The *Typical Operating Characteristics* and graphs show typical on resistance for $\pm 15V$, $\pm 10V$, ± 5 supplies. Switching times increase by a factor of two or more for $\pm 5V$ operation. The MAX333A can operate from $+10V$ to $+24V$ unipolar supplies. It can be powered from a single $+10V$ to $+24V$ supply, as well as from unbalanced supplies such as $+24V$ and $-5V$. Connect V- to $0V$ when operating with a single supply.

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, add 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.

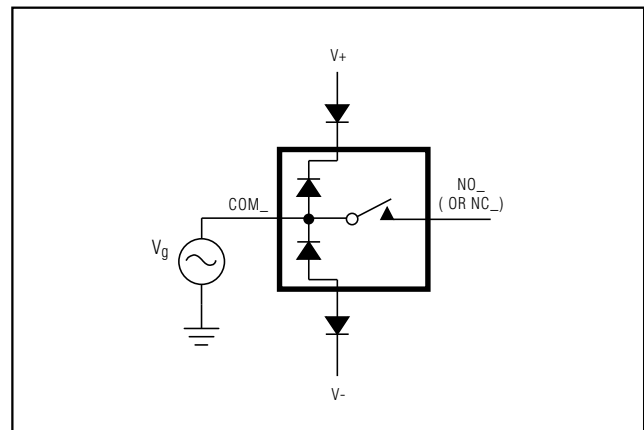


Figure 1. Overvoltage Protection Using Blocking Diodes

Test Circuits/Timing Diagrams

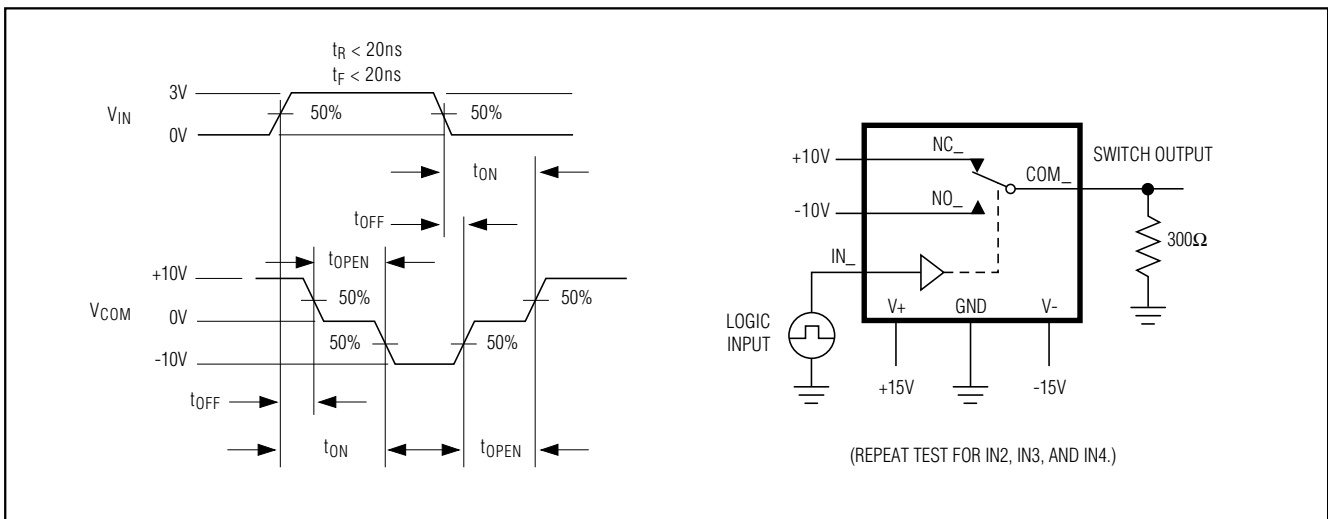


Figure 2. Switching-Time Test Circuit

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Test Circuits/Timing Diagrams

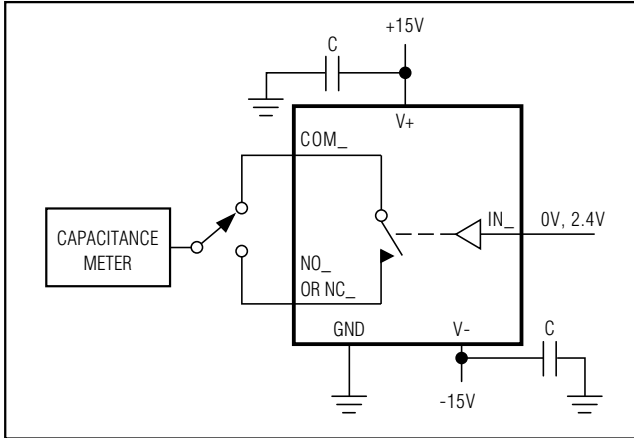


Figure 3. Channel-Off Capacitance

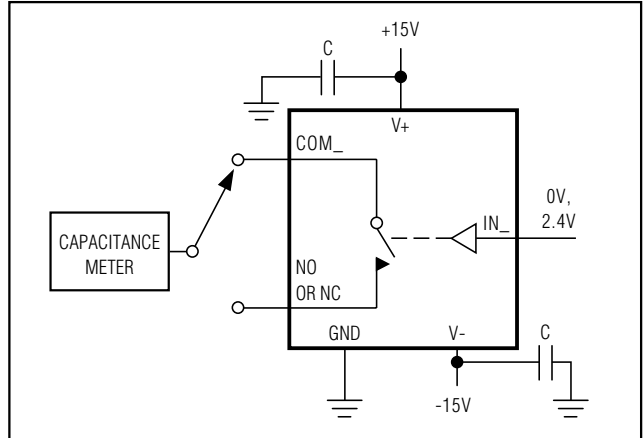


Figure 4. Channel-On Capacitance

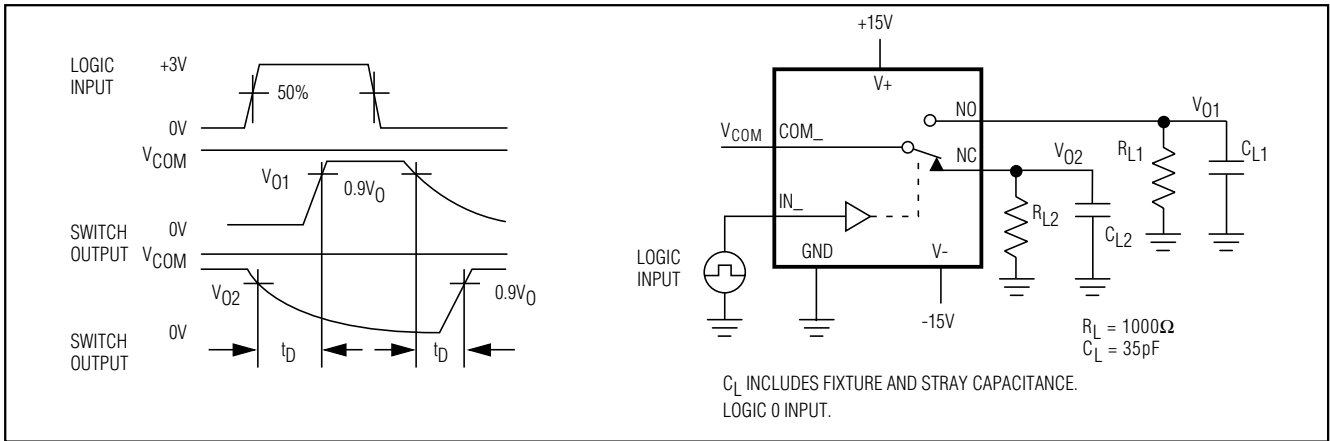


Figure 5. Break-Before-Make

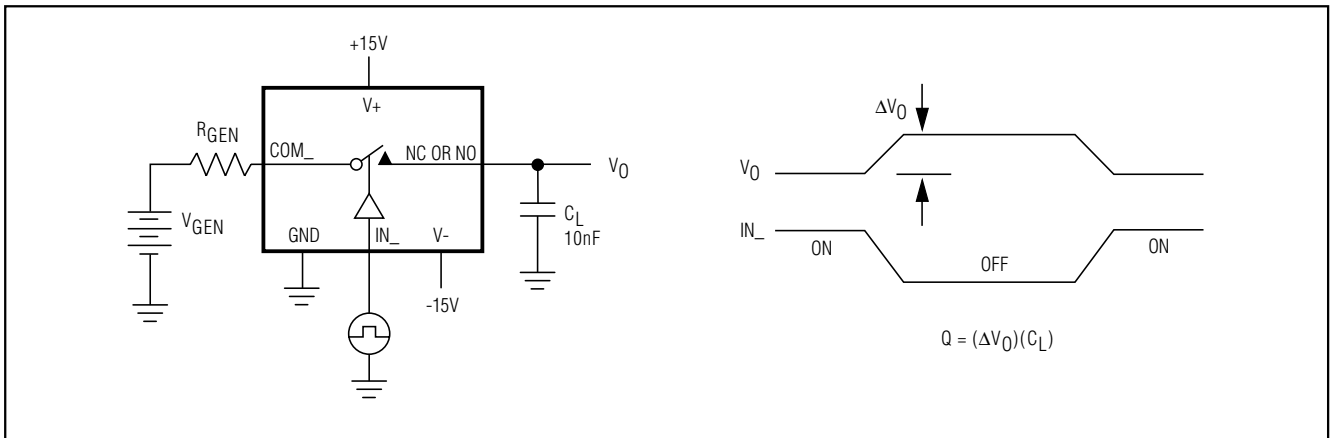


Figure 6. Charge Injection

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Test Circuits/Timing Diagrams (continued)

MAX333A

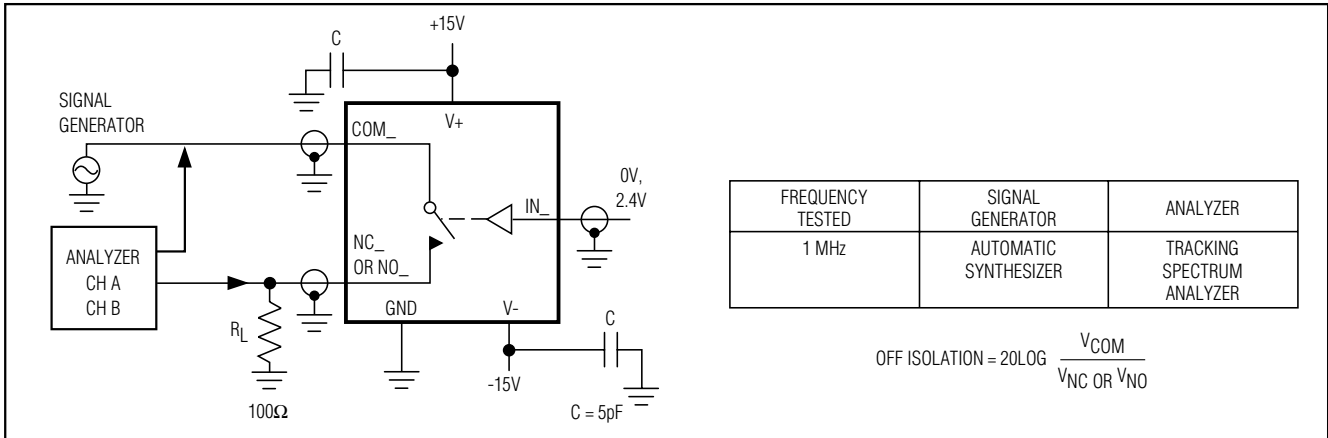


Figure 7. Off-Isolation

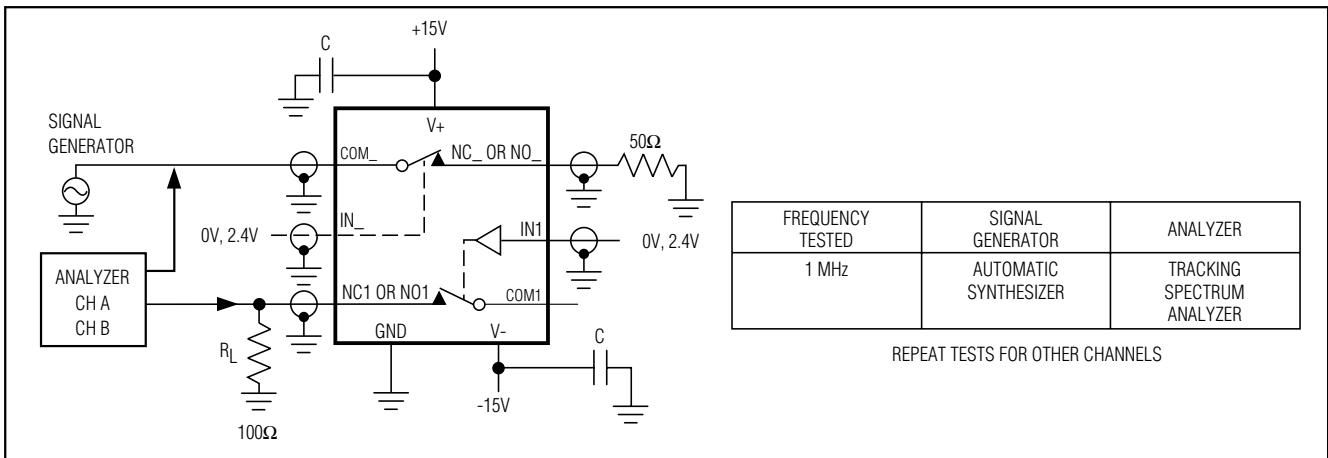
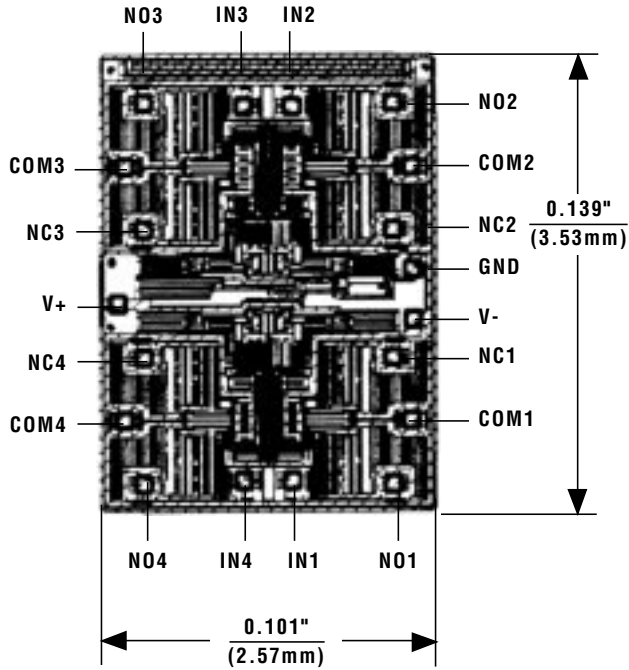


Figure 8. Crosstalk

MAX333A

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Chip Topography



TRANSISTOR COUNT: 145;
SUBSTRATE CONNECTED TO V+.

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