

MAXIM

Precision, CMOS Analog Switches

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 ($\Delta 3\Omega$ max). They also offer low leakage (less than 250pA at $+25^\circ\text{C}$ and less than 6nA at $+85^\circ\text{C}$) 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 ($35\mu\text{W}$), and electrostatic discharge (ESD) greater than $\pm 2000\text{V}$. 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

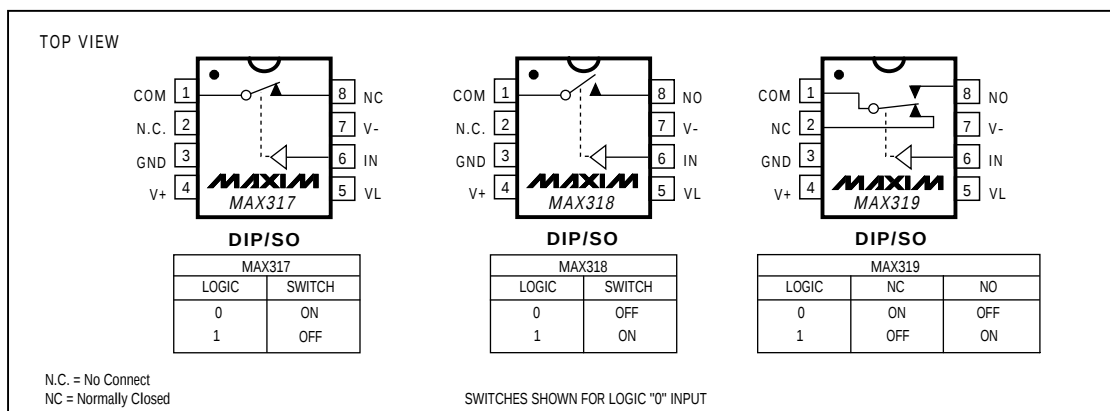
- ♦ Low On Resistance $< 20\Omega$ Typical (35Ω Max)
- ♦ Guaranteed Matched On Resistance Between Channels $< 2\Omega$
- ♦ Guaranteed Flat On Resistance over Analog Signal Range $\Delta 3\Omega$ Max
- ♦ Guaranteed Charge Injection $< 10\text{pC}$
- ♦ Guaranteed Off-Channel Leakage $< 6\text{nA}$ at $+85^\circ\text{C}$
- ♦ ESD Guaranteed $> 2000\text{V}$ per Method 3015.7
- ♦ Single-Supply Operation ($+10\text{V}$ to $+30\text{V}$)
Bipolar-Supply Operation ($\pm 4.5\text{V}$ to $\pm 20\text{V}$)
- ♦ TTL-/CMOS-Logic Compatible
- ♦ Rail-to-Rail Analog Signal Handling Capability

Ordering Information

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

Ordering Information continued on last page.
* Contact factory for dice specifications.

Pin Configurations/Functional Diagrams/Truth Tables



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MAX317/MAX318/MAX319

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-		Continuous Power Dissipation ($T_A = +70^\circ\text{C}$) (Note 1)
V+	+44V	Plastic DIP (derate 9.09mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$).....727mW
GND	+25V	SO (derate 5.88mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)471mW
V _L	(GND - 0.3V) to (V+ + 0.3V)	CERDIP (derate 8.00mW/ $^\circ\text{C}$ above $+70^\circ\text{C}$)640mW
I _N , COM, NC, NO	(V- - 2V) to (V+ + 2V) or 30mA, whichever occurs first	Operating Temperature Ranges:
Continuous Current (any terminal)	30mA	MAX31_C0°C to $+70^\circ\text{C}$
Peak Current, NC, NO, COM		MAX31_E-40°C to $+85^\circ\text{C}$
(pulsed at 1ms, 10% duty cycle max)	100mA	MAX31_MJA-55°C to $+125^\circ\text{C}$
ESD	$\pm 2000\text{V}$	Storage Temperature Range-55°C to $+150^\circ\text{C}$
		Lead Temperature (soldering, 10sec) $+300^\circ\text{C}$

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, $T_A = T_{\text{MIN}}$ 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} = $\pm 12.5\text{V}$, I _(NC OR NO) = -10mA, V+ = 13.5V, V- = -13.5V	T _A = $+25^\circ\text{C}$ C, E M		20 30	35	Ω
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 = $+25^\circ\text{C}$ T _A = T_{MIN} to T_{MAX}			2 3	Ω
On Resistance Flatness (Note 4)	R _{ON}	I _(NC OR NO) = -10mA, V _{COM} = 5V or -5V, V+ = 15V, V- = -15V	T _A = $+25^\circ\text{C}$ T _A = T_{MIN} to T_{MAX}			3 5	Ω
NO or NC Off Leakage Current	I _{NC(OFF)} or I _{NO(OFF)}	V+ = 16.5V, V- = -16.5V, V _{COM} = $\pm 15.5\text{V}$, V _{NC} or V _{NO} = $\pm 15.5\text{V}$	T _A = $+25^\circ\text{C}$ C, E M	-0.25 -6 -20		0.25 6 20	nA
COM Off Leakage Current	I _{COM(OFF)}	V+ = 16.5V, V- = -16.5V, V _{COM} = $\pm 15.5\text{V}$, V _{NC} or V _{NO} = $\pm 15.5\text{V}$	T _A = $+25^\circ\text{C}$ C, E M T _A = $+25^\circ\text{C}$ C, E M	-0.25 -6 -20 -0.75 -10 -60	-0.1 -0.1	0.25 6 20 0.75 10 60	nA
COM On Leakage Current	I _{COM(ON)}	V+ = 16.5V, V- = -16.5V, V _{NC} or V _{NO} = V _D = $\pm 15.5\text{V}$	T _A = $+25^\circ\text{C}$ C, E M T _A = $+25^\circ\text{C}$ C, E M	-0.4 -10 -40 -0.75 -10 -60		0.4 10 40 0.75 10 60	nA

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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} = ±10V		T _A = +25°C	100	175	ns	
				T _A = T _{MIN} to T _{MAX}		250		
Turn-Off Time	t _{OFF}	MAX317, MAX318, Figure 2, V _{COM} = ±10V		T _A = +25°C	60	145	ns	
				T _A = T _{MIN} to T _{MAX}		210		
Transition Time	t _{TRANS}	MAX319, Figure 3, V _{NO} = ±10V, V _{NC} = ±10V		T _A = +25°C		175	ns	
				T _A = T _{MIN} to T _{MAX}		250		
Break-Before-Make Interval	t _D	MAX319, Figure 4, V _{NO} = V _{NC} = ±10V		T _A = +25°C	5	13	ns	
Charge Injection	Q	V _{GEN} = 0V, Figure 5		T _A = +25°C		3	10	pC
Off Isolation (Note 5)	OIRR	R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 7		T _A = +25°C		68		dB
Crosstalk (Note 6)		R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 8		T _A = +25°C		85		dB
COM Off Capacitance	C _{COM(OFF)}	V _{COM} = 0V, f = 1MHz, Figure 8		T _A = +25°C		8		pF
Off Capacitance NC or NO	C _(OFF)	V _{COM} = 0V, f = 1MHz, Figure 8		T _A = +25°C		8		pF
Channel-On Capacitance COM Terminal	C _{COM(ON)}	V _S = 0V, f = 1MHz, Figure 9	MAX317, MAX318	T _A = +25°C		30	pF	
			MAX319			35		
SUPPLY								
Positive Supply Current	I ⁺	V _{IN} = 0V or 5V, V ⁺ = 16.5V, V ⁻ = -16.5V		T _A = +25°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°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°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°C	-1	-0.0001	1	μA
				T _A = T _{MIN} to T _{MAX}	-5		5	

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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.

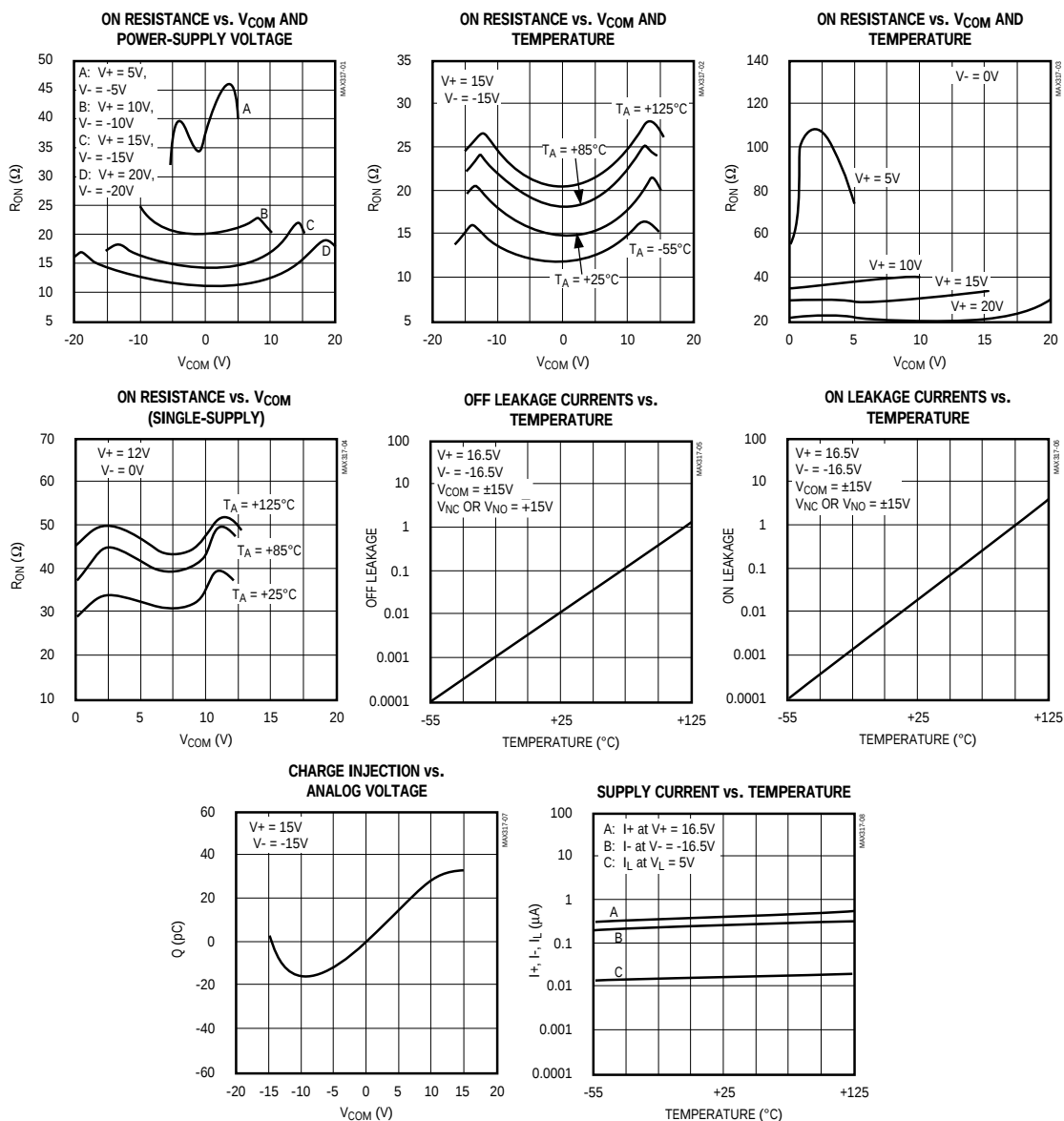
Note 5: Off Isolation = $20\log_{10} \left(\frac{V_{COM}}{V_{NC} \text{ or } V_{NO}} \right)$, V_{COM} = output, V_{NC} or V_{NO} = input to off switch.

Note 6: Between any two switches.

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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
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 $+44V$.

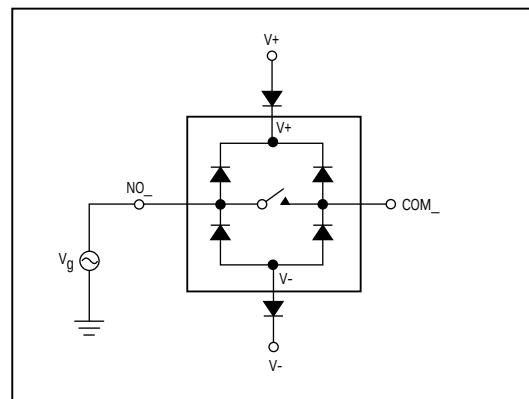


Figure 1. Overvoltage Protection Using Blocking Diodes

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Test Circuits/Timing Diagrams

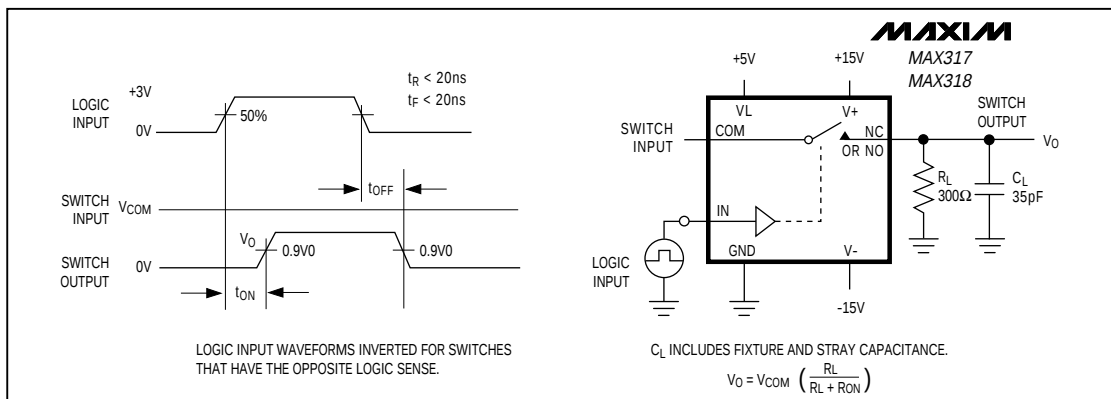


Figure 2. MAX317/MAX318 Switching-Time Test Circuit

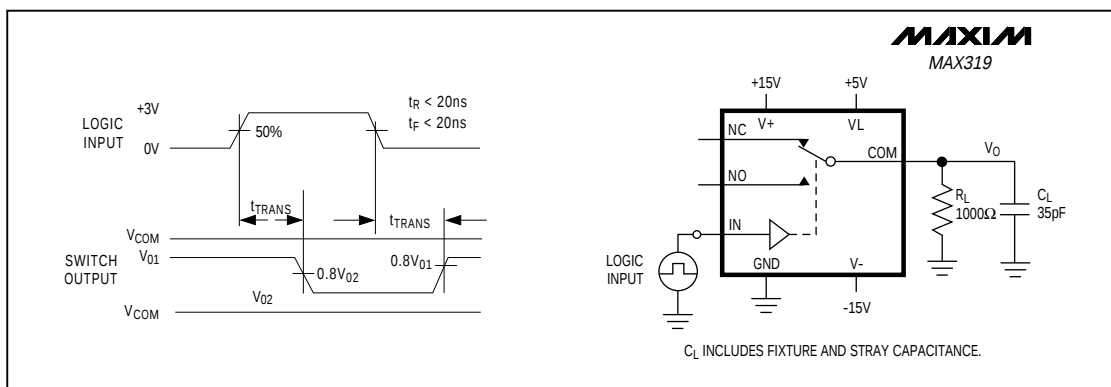


Figure 3. MAX319 Transition Time

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MAX317/MAX318/MAX319

Test Circuits/Timing Diagrams (continued)

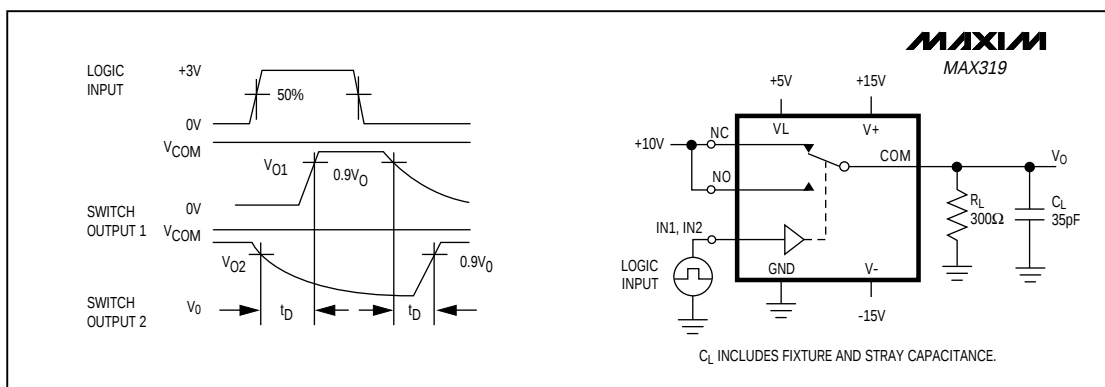


Figure 4. MAX319 Break-Before-Make Test Circuit

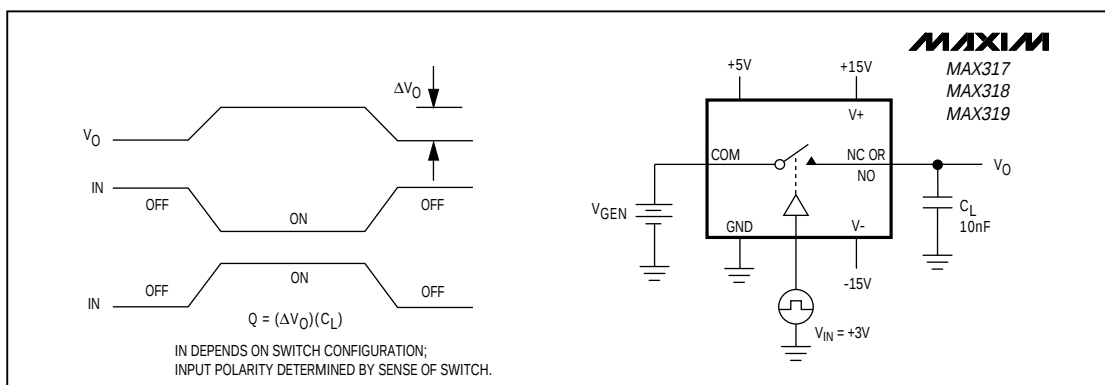


Figure 5. Charge-Injection Test Circuit

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Test Circuits/Timing Diagrams (continued)

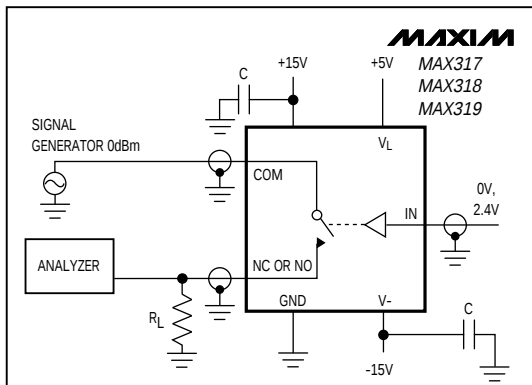


Figure 6. Off-Isolation Test Circuit

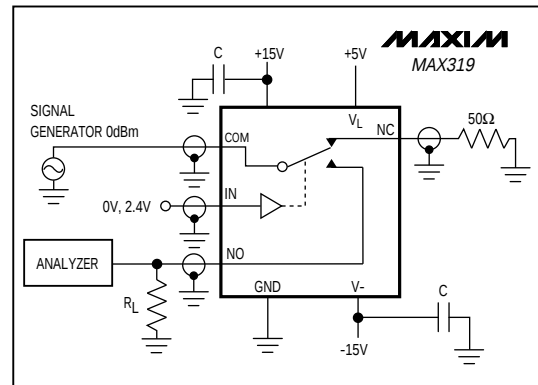


Figure 7. MAX319 Crosstalk Test Circuit

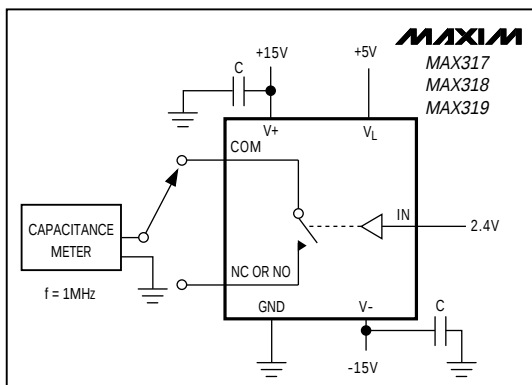


Figure 8. Channel-Off Capacitance Test Circuit

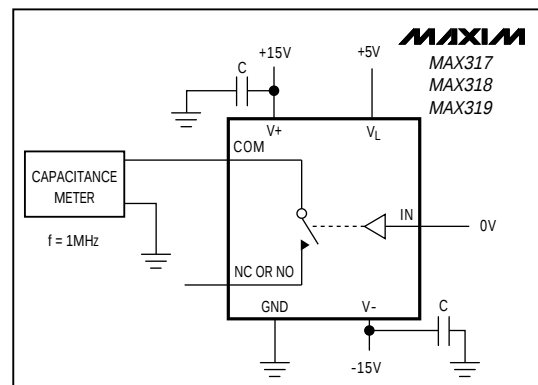


Figure 9. Channel-On Capacitance Test Circuit

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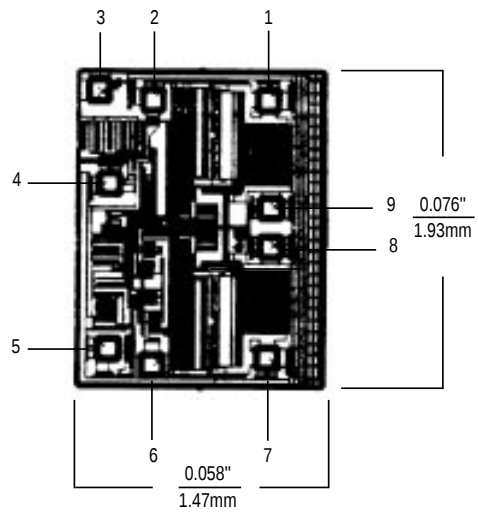
MAX317/MAX318/MAX319

Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MAX318CPA	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
MAX318 EJA	-40°C to +85°C	8 CERDIP
MAX318MJA	-55°C to +125°C	8 CERDIP**
MAX319CPA	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



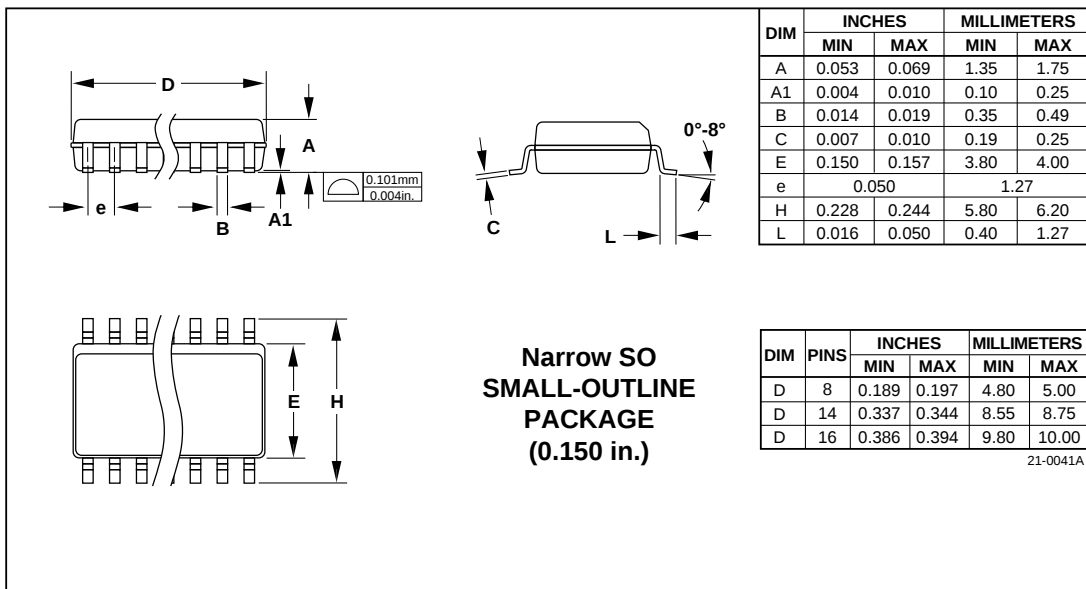
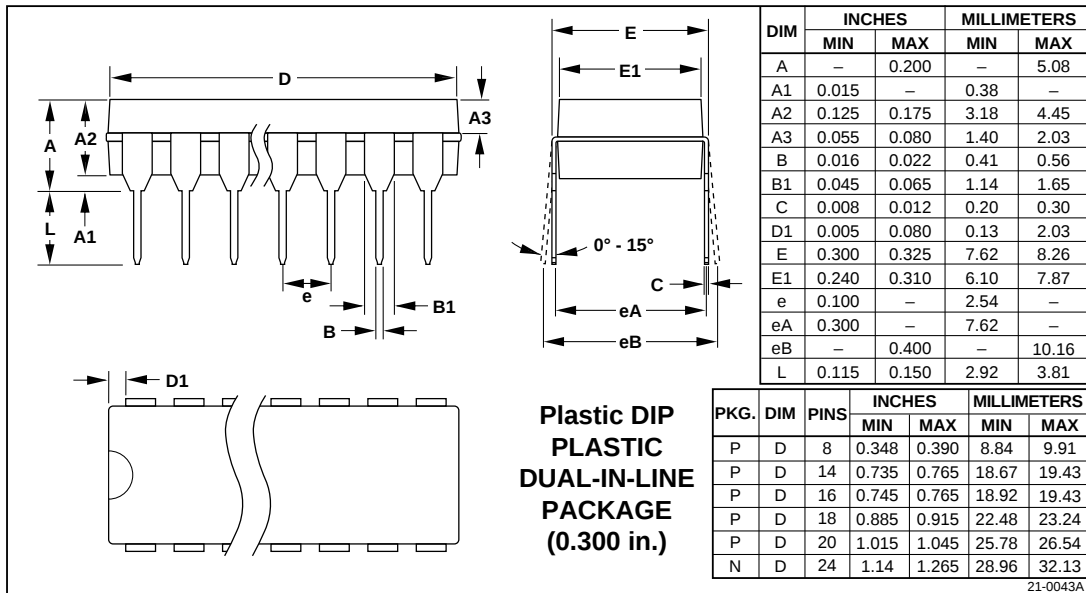
TRANSISTOR COUNT: 32;
 SUBSTRATE CONNECTED TO V+.

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

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Package Information

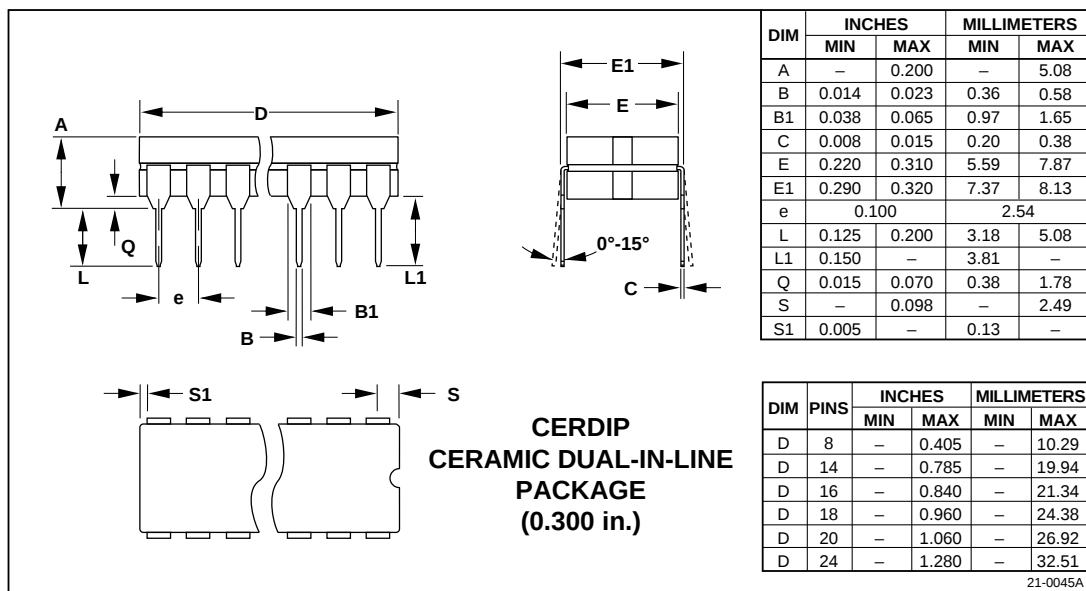
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Package Information



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