



# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

MAX306/MAX307

## General Description

The MAX306/MAX307 precision, monolithic, CMOS analog multiplexers (muxes) offer low on-resistance (less than 100Ω), which is matched to within 5Ω between channels and remains flat over the specified analog signal range (7Ω max). They also offer low leakage over temperature (I<sub>NO(OFF)</sub> less than 2.5nA at +85°C) and fast switching speeds (t<sub>TRANS</sub> less than 250ns). The MAX306 is a single-ended 1-of-16 device, and the MAX307 is a differential 2-of-8 device.

The MAX306/MAX307 are fabricated with Maxim's improved 44V silicon-gate process. Design improvements yield extremely low charge injection (less than 10pC) and guarantee electrostatic discharge (ESD) protection greater than 2000V.

These muxes operate with a single +4.5V to +30V supply, or bipolar ±4.5V to ±20V supplies, while retaining TTL/CMOS-logic input compatibility and fast switching. CMOS inputs provide reduced input loading. These improved parts are plug-in upgrades for the industry-standard DG406, DG407, DG506A, and DG507A.

## Applications

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

## Features

- ♦ **Guaranteed On-Resistance Match Between Channels, <5Ω Max**
- ♦ **Low On-Resistance, <100Ω Max**
- ♦ **Guaranteed Flat On-Resistance over Specified Signal Range, 7Ω Max**
- ♦ **Guaranteed Charge Injection, <10pC**
- ♦ **I<sub>NO(OFF)</sub> Leakage <2.5nA at +85°C**
- ♦ **I<sub>COM(OFF)</sub> Leakage <20nA at +85°C**
- ♦ **ESD Protection >2000V**
- ♦ **Plug-In Upgrade for Industry-Standard DG406/DG407/DG506A/DG507A**
- ♦ **Single-Supply Operation (+4.5V to +30V) Bipolar-Supply Operation (±4.5V to ±20V)**
- ♦ **Low Power Consumption, <1.25mW**
- ♦ **Rail-to-Rail Signal Handling**
- ♦ **TTL/CMOS-Logic Compatible**

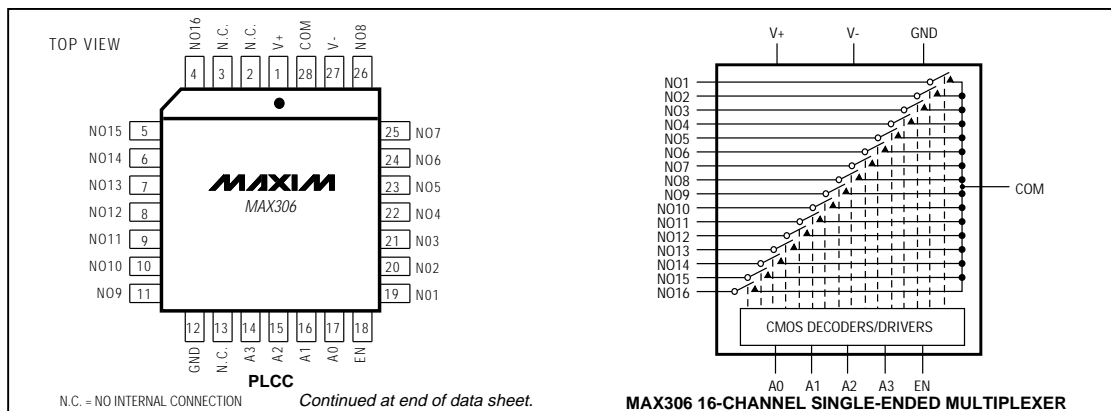
## Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX306CPI	0°C to +70°C	28 Plastic DIP
MAX306CWI	0°C to +70°C	28 Wide SO
MAX306C/D	0°C to +70°C	Dice*
MAX306EPI	-40°C to +85°C	28 Plastic DIP
MAX306EWI	-40°C to +85°C	28 Wide SO
MAX306EQI	-40°C to +85°C	28 PLCC
MAX306MJI	-55°C to +125°C	28 CERDIP

Ordering Information continued at end of data sheet.

\* Contact factory for dice specifications.

## Pin Configurations/Functional Diagrams/Truth Tables



# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-	Wide SO (derate 12.50mW/°C above +70°C).....1000mW
V+ .....-0.3V, 44V	PLCC (derate 10.53mW/°C above +70°C) .....842mW
GND .....-0.3V, 25V	CERDIP (derate 16.67mW/°C above +70°C).....1333mW
Digital Inputs, NO, COM (Note 1).....(V- - 2V) to (V+ + 2V) or 30mA (whichever occurs first)	Operating Temperature Ranges
Continuous Current (any terminal) .....30mA	MAX30_C_ _ .....0°C to +70°C
Peak Current, NO or COM (pulsed at 1ms, 10% duty cycle max) .....100mA	MAX30_E_ _ .....-40°C to +85°C
Continuous Power Dissipation (TA = +70°C)	MAX30_MJL.....-55°C to +125°C
Plastic DIP (derate 9.09mW/°C above +70°C) .....727mW	Storage Temperature Range .....-65°C to +150°C
	Lead Temperature (soldering, 10sec) .....+300°C

**Note 1:** Signals on NO, COM, A0, A1, A2, A3, or EN exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

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, GND = 0V, VAH = +2.4V, VAL = +0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS	
<b>SWITCH</b>								
Analog Signal Range	VNO, VCOM	(Note 3)		-15		15	V	
On-Resistance	RON	I <sub>NO</sub> = -1.0mA, VCOM = ±10V	TA = +25°C		60	100	Ω	
			TA = TMIN to TMAX			125		
On-Resistance Matching Between Channels	ΔRON	I <sub>NO</sub> = -1.0mA, VCOM = ±10V (Note 4)	TA = +25°C		1.5	5	Ω	
			TA = TMIN to TMAX			8		
On-Resistance Flatness	RFLAT	I <sub>NO</sub> = -1.0mA, VCOM = ±5V or 0V	TA = +25°C		1.8	7	Ω	
			TA = TMIN to TMAX			10		
NO-Off Leakage Current (Note 5)	I <sub>NO(OFF)</sub>	VCOM = ∓10V, VNO = ±10V, VEN = 0V	TA = +25°C	-0.5	0.01	0.5	nA	
			TA = TMIN to TMAX	C, E	-2.5	2.5		
				M	-5.0	5.0		
COM-Off Leakage Current (Note 5)	I <sub>COM(OFF)</sub>	VNO = ±10V, VCOM = ∓10V, VEN = 0V	MAX306	TA = +25°C	-0.75	0.02	0.75	nA
				TA = TMIN to TMAX	C, E	-20	20	
			M	-40	40			
		TA = +25°C	-0.75	0.02	0.75			
		VNO = ∓10V, VCOM = ±10V, VEN = 0V	MAX307	TA = TMIN to TMAX	C, E	-10	10	
				M	-20	20		
COM-On Leakage Current (Note 5)	I <sub>COM(ON)</sub>	VCOM = ±10V, VNO = ±10V, sequence each switch on	MAX306	TA = +25°C	-0.75	0.02	0.75	nA
				TA = TMIN to TMAX	C, E	-25	25	
			M	-50	50			
		TA = +25°C	-0.75	0.02	0.75			
			MAX307	TA = TMIN to TMAX	C, E	-12.5	12.5	
				M	-25	25		

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## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, GND = 0V, VAH = +2.4V, VAL = +0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>INPUT</b>							
Input Current with Input Voltage High	IAH	VA = 2.4V or 15V		-1.0		1.0	μA
Input Current with Input Voltage Low	I <sub>AL</sub>	VEN = 0V or 2.4V, VA = 0V		-1.0		1.0	μA
<b>SUPPLY</b>							
Power-Supply Range				±4.5		±20	V
Positive Supply Current	I+	VEN = VA = 0V or 4.5V	TA = +25°C		16	30	μA
			TA = TMIN to TMAX			75	
Positive Supply Current	I+	VEN = 2.4V, VA(ALL) = 0V or 2.4V	TA = +25°C		0.075	0.5	mA
			TA = TMIN to TMAX			1	
Negative Supply Current	I-	VEN = 2.4V, VA(ALL) = 0V or 2.4V	TA = +25°C		-1	1	μA
			TA = TMIN to TMAX		-10	10	
<b>DYNAMIC</b>							
Transition Time	tTRANS	Figure 2	TA = +25°C		110	300	ns
			TA = TMIN to TMAX			400	
Break-Before-Make Interval	tOPEN	Figure 4	TA = +25°C		10	40	ns
Enable Turn-On Time	ton(EN)	Figure 3	TA = +25°C		130	200	ns
			TA = TMIN to TMAX			400	
Enable Turn-Off Time	toff(EN)	Figure 3	TA = +25°C		55	150	ns
			TA = TMIN to TMAX			300	
Charge Injection (Note 3)	Q	CL = 1.0nF, VNO = 0V, RS = 0Ω, Figure 5	TA = +25°C		2	10	pC
Off Isolation (Note 6)	VISO	VEN = 0V, RL = 1kΩ, f = 100kHz, Figure 6	TA = +25°C		-69		dB
Crosstalk Between Channels	VCT	VEN = 2.4V, f = 100kHz, VGEN = 1Vp-p, RL = 1kΩ, Figure 7	TA = +25°C		-92		dB
Logic Input Capacitance	CIN	f = 1MHz	TA = +25°C		8		pF
NO-Off Capacitance	CNO(OFF)	f = 1MHz, VEN = VNO = 0V, Figure 8	TA = +25°C		8		pF
COM-Off Capacitance	CCOM(OFF)	f = 1MHz, VEN = 0.8V, VCOM = 0V, Figure 8	MAX306	TA = +25°C		130	pF
			MAX307			65	
COM-On Capacitance	CCOM(ON)	f = 1MHz, VEN = 2.4V, VCOM = 0V, Figure 8	MAX306	TA = +25°C		140	pF
			MAX307			70	

## Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

### ELECTRICAL CHARACTERISTICS—Single Supply

( $V_+ = +12V$ ,  $V_- = 0V$ ,  $GND = 0V$ ,  $V_{AH} = +2.4V$ ,  $V_{AL} = +0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>SWITCH</b>							
Analog Signal Range	$V_{NO}$ , $V_{COM}$	(Note 3)		0		12	V
On-Resistance	$R_{ON}$	$I_{NO} = -1.0mA$ $V_{COM} = 3V$ or $10V$	$T_A = +25^\circ C$		120	175	$\Omega$
<b>DYNAMIC</b>							
Transition Time (Note 3)	$t_{TRANS}$	$V_{NO1} = 8V$ , $V_{NO8} = 0V$ , $V_{IN} = 2.4V$ , Figure 1	$T_A = +25^\circ C$		130	450	ns
Enable Turn-On Time (Note 3)	$t_{ON(EN)}$	$V_{INH} = 2.4V$ , $V_{INL} = 0V$ , $V_{NO1} = 5V$ , Figure 3	$T_A = +25^\circ C$		105	600	ns
Enable Turn-Off Time (Note 3)	$t_{OFF(EN)}$	$V_{INH} = 2.4V$ , $V_{INL} = 0V$ , $V_{NO1} = 5V$ , Figure 3	$T_A = +25^\circ C$		80	300	ns
Charge Injection (Note 3)	Q	$C_L = 1.0nF$ , $V_{NO} = 0V$ , $R_S = 0\Omega$	$T_A = +25^\circ C$		2	10	pC

**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:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ . On-resistance match between channels and flatness are guaranteed only with specified voltages. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured at the extremes of the specified analog signal range.

**Note 5:** Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at  $+25^\circ C$ .

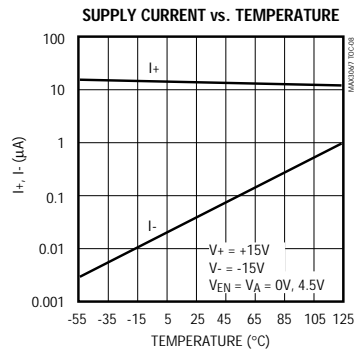
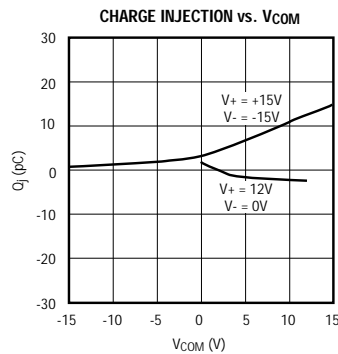
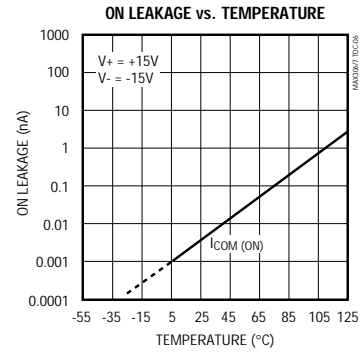
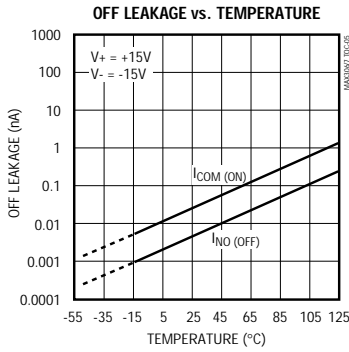
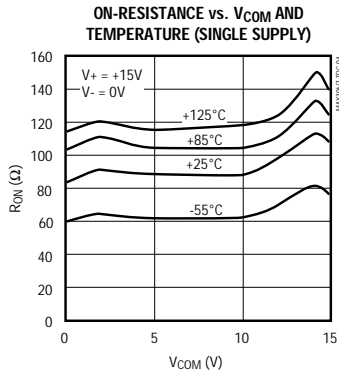
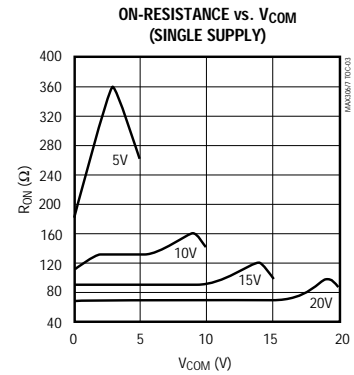
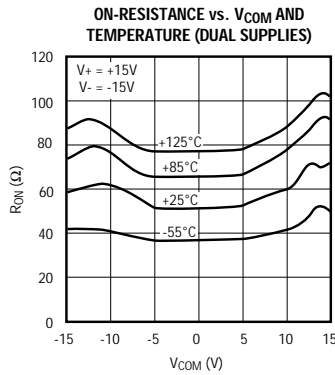
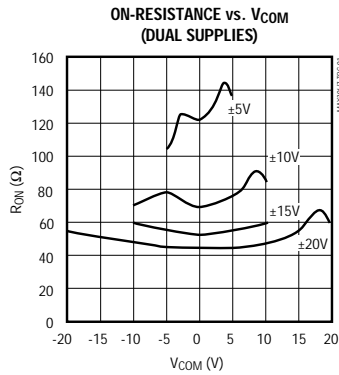
**Note 6:** Off isolation =  $20\log V_{COM}/V_{NO}$ , where  $V_{COM}$  = output and  $V_{NO}$  = input to off switch.

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## Typical Operating Characteristics

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

MAX306/MAX307



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## Pin Descriptions

MAX306 PIN	NAME	FUNCTION
1	V+	Positive Supply Voltage Input
2, 3, 13	N.C.	No Internal Connections
4–11	NO16–NO9	Analog Inputs–bidirectional
12	GND	Ground
14–17	A3–A0	Address Inputs
18	EN	Enable Inputs
19–26	NO1–NO8	Analog Inputs–bidirectional
27	V-	Negative Supply Voltage Input
28	COM	Output–bidirectional

MAX307 PIN	NAME	FUNCTION
1	V+	Positive Supply Voltage Input
2	COMB	Output B–bidirectional
3, 13, 14	N.C.	No Internal Connection
4–11	NO8B–NO1B	Analog Inputs–bidirectional
12	GND	Ground
15, 16, 17	A2, A1, A0	Address Inputs
18	EN	Enable Input
19–26	NO1A–NO8A	Analog Inputs–bidirectional
27	V-	Negative Supply Voltage Input
28	COMA	Output A–bidirectional

## Applications Information

### Operation with Supply Voltages Other than $\pm 15\text{V}$

Using supply voltages other than  $\pm 15\text{V}$  will reduce the analog signal range. The MAX306/MAX307 switches operate with  $\pm 4.5\text{V}$  to  $\pm 20\text{V}$  bipolar supplies or with a  $+4.5\text{V}$  to  $+30\text{V}$  single supply; connect V- to GND when operating with a single supply. Also, both device types can operate with unbalanced supplies such as  $+24\text{V}$  and  $-5\text{V}$ . The *Typical Operating Characteristics* graphs show typical on-resistance with 20V, 15V, 10V, and 5V supplies. (Switching times increase by a factor of two or more for operation at 5V.)

### 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, then V-, followed by either the logic inputs, NO, or COM. 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 above V+ and 1V below V-, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ and V- should not exceed +44V.

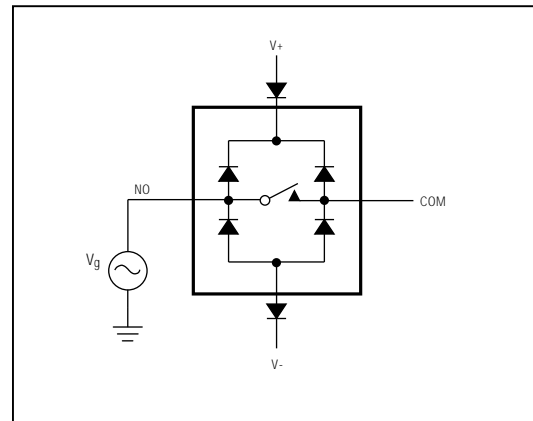


Figure 1. Overvoltage Protection Using External Blocking Diodes

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams

MAX306/MAX307

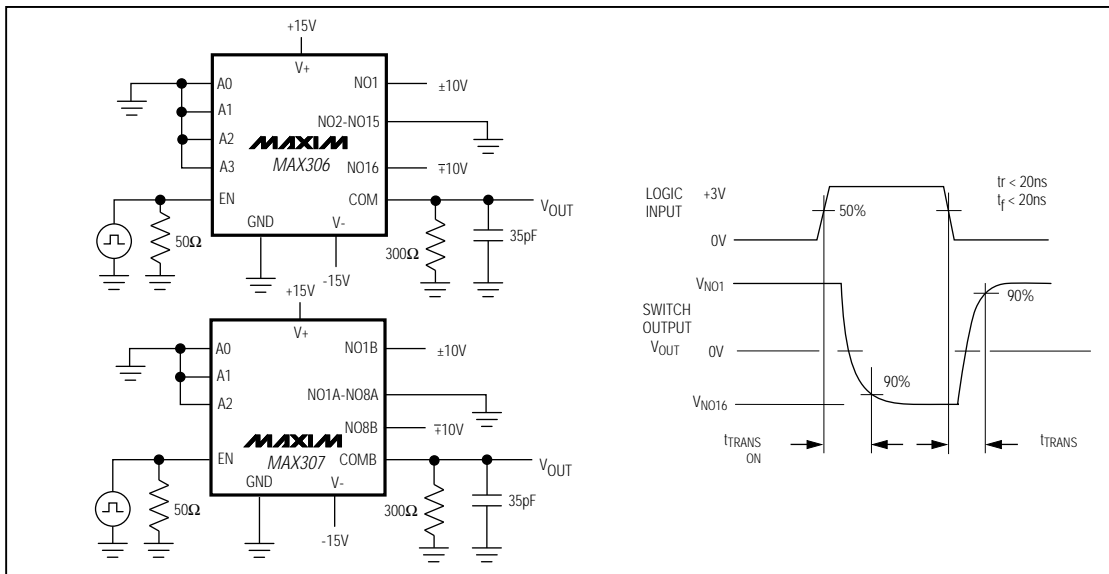


Figure 2. Transition Time

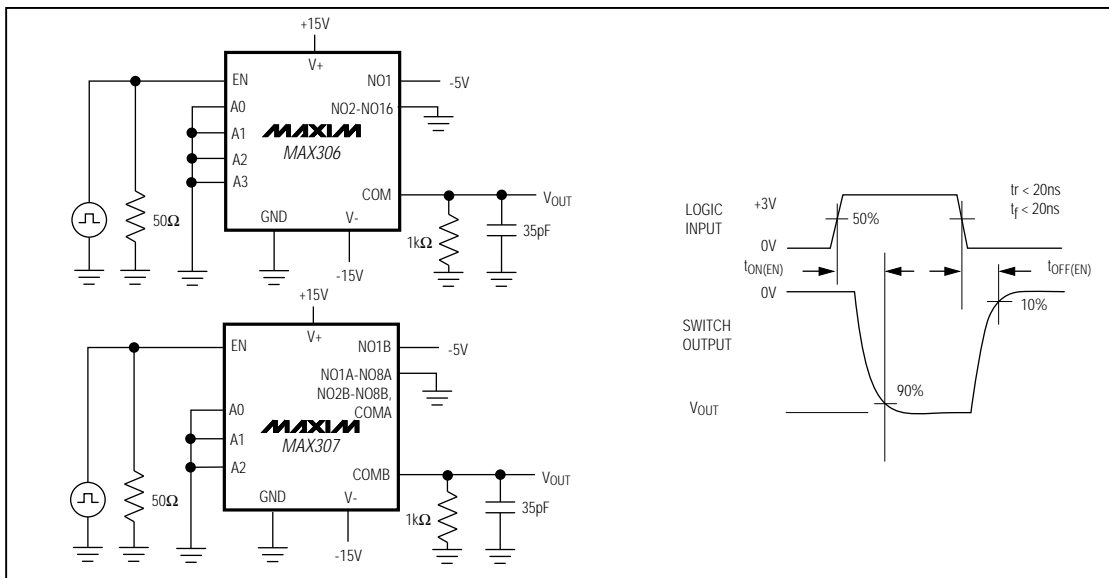


Figure 3. Enable Switching Time

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams (continued)

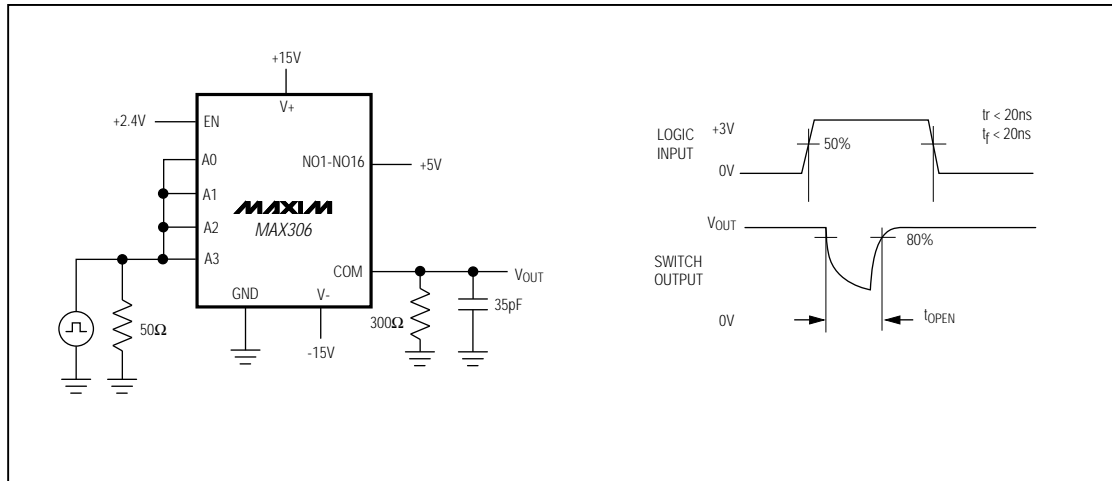


Figure 4. Break-Before-Make Interval

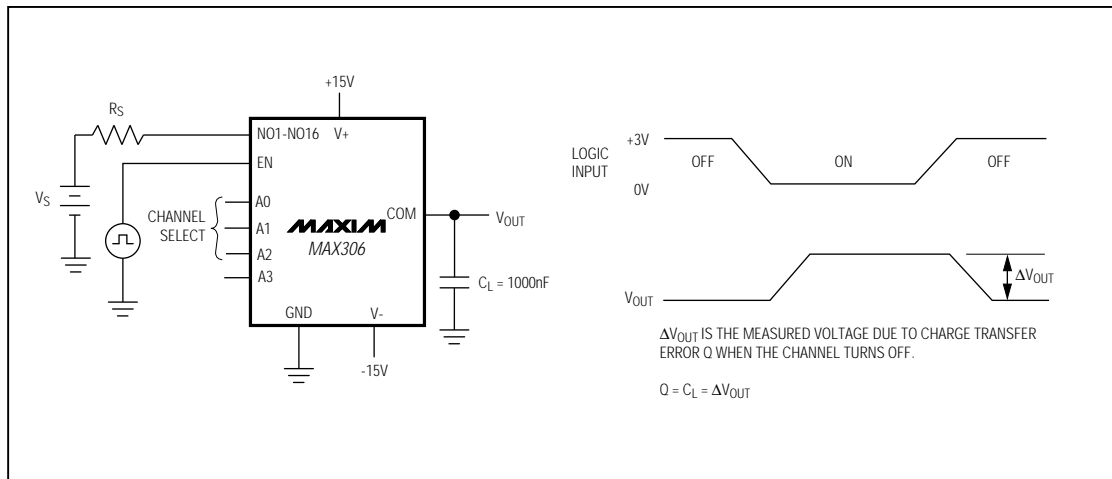


Figure 5. Charge Injection



# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams (continued)

MAX306/MAX307

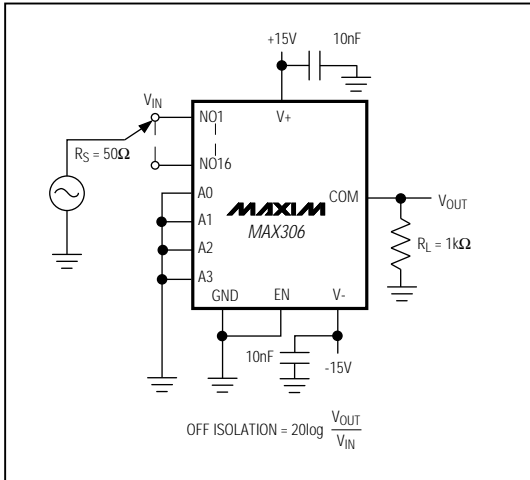


Figure 6. Off Isolation

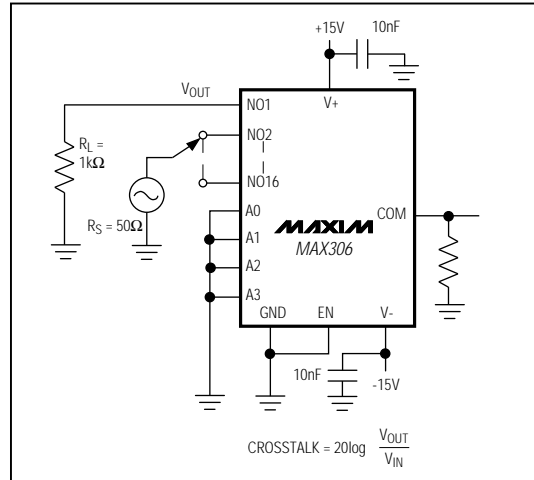


Figure 7. Crosstalk

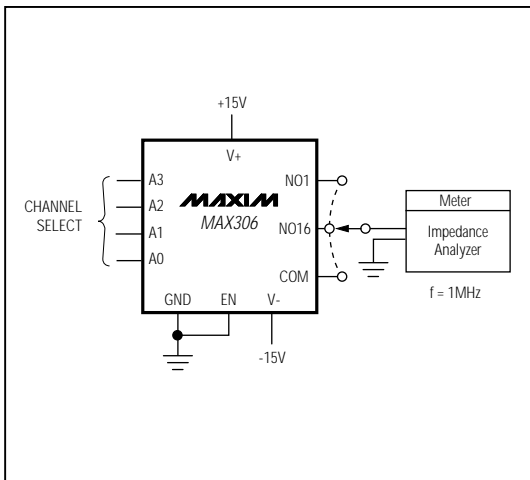
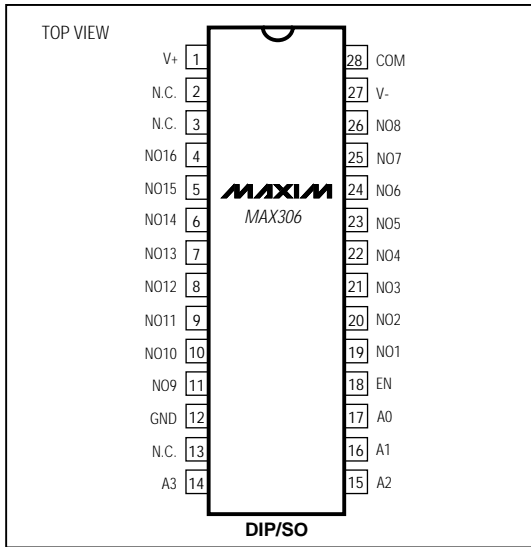


Figure 8. NO/COM Capacitance

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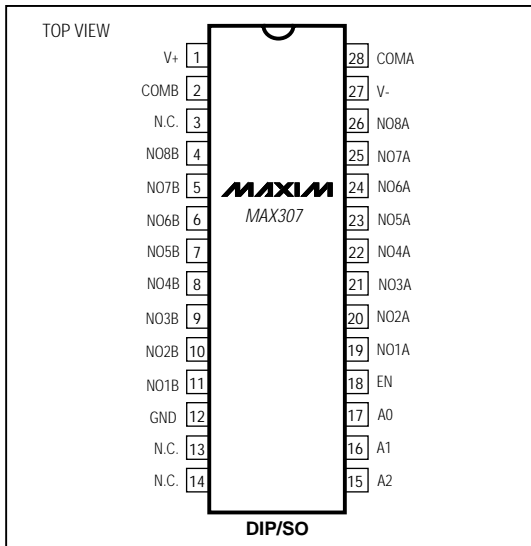
Pin Configurations/Functional Diagrams/Truth Tables (continued)



A3	A2	A1	A0	EN	ON Switch
X	X	X	X	0	None
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

MAX306

LOGIC "0"  $V_{AL} \leq 0.8V$ , LOGIC "1" =  $V_{AH} \geq 2.4V$



A2	A1	A0	EN	ON Switch
X	X	X	0	None
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

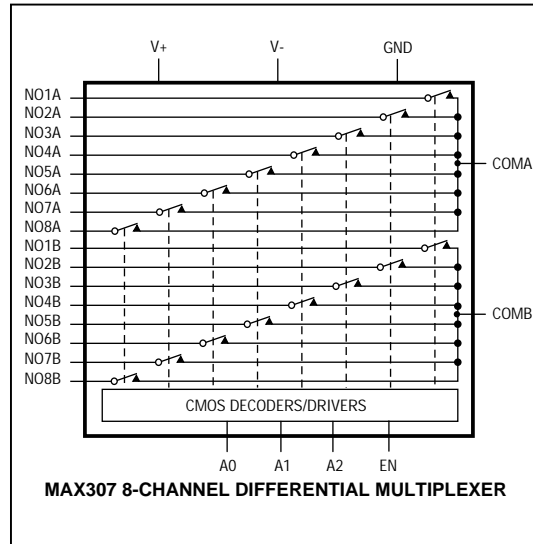
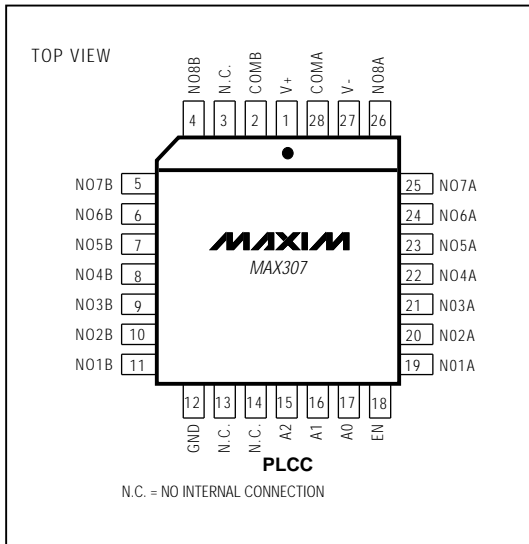
MAX307

LOGIC "0"  $V_{AL} \leq 0.8V$ , LOGIC "1" =  $V_{AH} \geq 2.4V$

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

\_\_\_\_\_Pin Configurations/Functional Diagrams/Truth Tables (continued)

MAX306/MAX307



\_\_\_\_\_Ordering Information (continued)

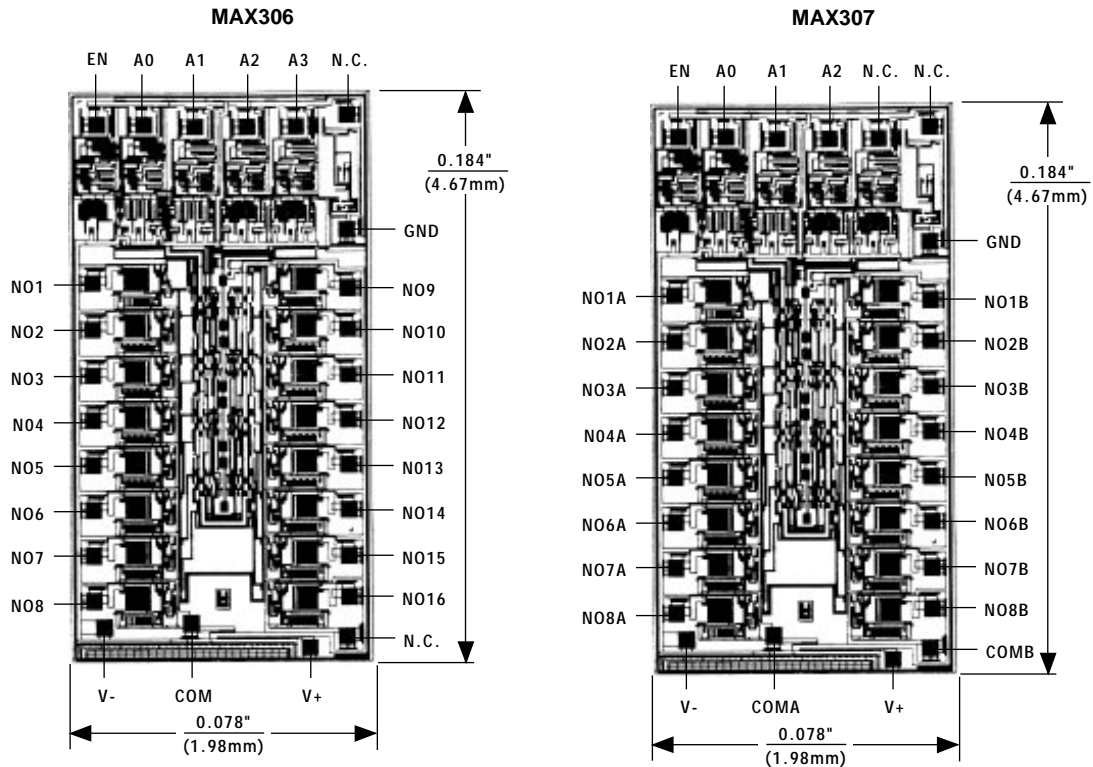
PART	TEMP. RANGE	PIN-PACKAGE
MAX307CPI	0°C to +70°C	28 Plastic DIP
MAX307CWI	0°C to +70°C	28 Wide SO
MAX307C/D	0°C to +70°C	Dice*
MAX307EPI	-40°C to +85°C	28 Plastic DIP
MAX307EWI	-40°C to +85°C	28 Wide SO
MAX307EQI	-40°C to +85°C	28 PLCC
MAX307MJI	-55°C to +125°C	28 CERDIP

\* Contact factory for dice specifications.

# Precision, 16-Channel/Dual 8-Channel, High-Performance, CMOS Analog Multiplexers

Chip Topographies

MAX306/MAX307



N.C. = NO INTERNAL CONNECTION

TRANSISTOR COUNT: 269  
SUBSTRATE IS INTERNALLY CONNECTED TO V+

TRANSISTOR COUNT: 269  
SUBSTRATE IS INTERNALLY CONNECTED TO V+

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