19-0159; Rev 0; 9/93

MAXIM

Precision, Dual, High-Speed Analog Switches

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 dual switches 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 (Δ3Ω max). 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 Systems	PBX, PABX

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

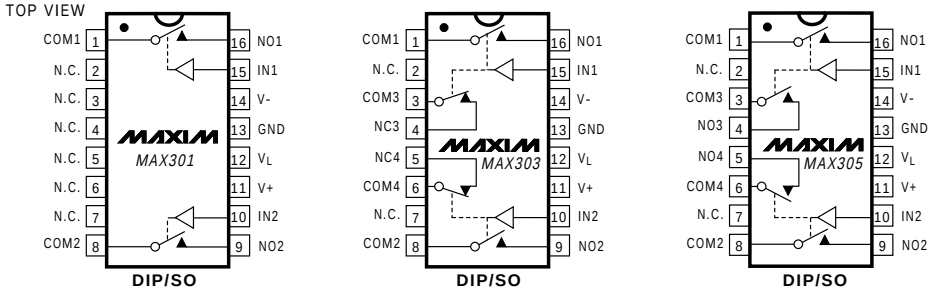
PART	TEMP. RANGE	PIN-PACKAGE
MAX301CPE	0°C to +70°C	16 Plastic DIP
MAX301CSE	0°C to +70°C	16 Narrow SO
MAX301CJE	0°C to +70°C	16 CERDIP
MAX301C/D	0°C to +70°C	Dice*
MAX301EPE	-40°C to +85°C	16 Plastic DIP
MAX301ESE	-40°C to +85°C	16 Narrow SO
MAX301EJE	-40°C to +85°C	16 CERDIP
MAX301MJE	-55°C to +125°C	16 CERDIP
MAX301MLP	-55°C to +125°C	20 LCC**

Ordering Information continued on last page.

** Contact factory for dice specifications.*

*** Contact factory for package availability.*

Pin Configurations/Block Diagrams/Truth Tables



MAX301	
LOGIC	SWITCH
0	OFF
1	ON

MAX303		
LOGIC	SWITCHES 1, 2	SWITCHES 3, 4
0	OFF	ON
1	ON	OFF

MAX305	
LOGIC	SWITCH
0	OFF
1	ON

LCC packages on last page.

SWITCHES SHOWN FOR LOGIC "0" INPUT

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 ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +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	MAX (Note 2)	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
				M		20	30	
			T_A = T_{MIN} to T_{MAX}	C, E			55	
				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
				M	-0.25	-0.01	0.25	
			T_A = T_{MIN} to T_{MAX}	C, E	-6		6	
				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
				M	-0.25	-0.01	0.25	
			T_A = T_{MIN} to T_{MAX}	C, E	-6		6	
				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
				M	-0.4	-0.04	0.4	
			T_A = T_{MIN} to T_{MAX}	C, E	-20		20	
				M	-40.0		40.0	

ELECTRICAL CHARACTERISTICS (continued)

(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		MIN	TYP (Note 2)	MAX	UNITS
INPUT							
Input Current with Input Voltage High	I_{INH}	$V_{IN\_}$ = 2.4V, all others = 0.8V		-1.000	0.005	1.000	µA
Input Current with Input Voltage Low	I_{INH}	$V_{IN\_}$ = 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}	Figure1	T_A = +25°C		100	150	ns
Turn-Off Time	t_{OFF}	Figure 1	T_A = +25°C		60	100	ns
Break-Before-Make Time Delay (Note 3)	t_D	MAX303 only, Figure 2	T_A = +25°C	10	20		ns
Charge Injection (Note 3)	Q	C_L = 10nF, V_{GEN} = 0V, R_{GEN} = 0Ω, Figure 3	T_A = +25°C		10	15	pC
Off Isolation (Note 5)	OIRR	R_L = 100Ω, C_L = 5pF, f = 1MHz, Figure 4	T_A = +25°C		72		dB
Crosstalk (Note 6)		R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5	T_A = +25°C		90		dB
Off Capacitance	C_{OFF}	f = 1MHz, Figure 6	T_A = +25°C		12		pF
COM Off Capacitance	$C_{COM(OFF)}$	f = 1MHz, Figure 6	T_A = +25°C		12		pF
Channel-On Capacitance	$C_{COM(ON)}$	f = 1MHz, Figure 7	T_A = +25°C		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: $\Delta R_{ON} = \Delta R_{ON}MAX - \Delta R_{ON}MIN$. On resistance match between channels and flatness are guaranteed only with specified voltages.

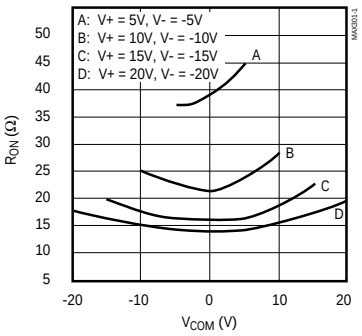
Note 5: See Figure 4. Off isolation = $20\log_{10} V_{COM}/V_{NC\ or}V_{NO}$, V_{COM} = output, $V_{NC\ or}$ V_{NO} = input to off switch.

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

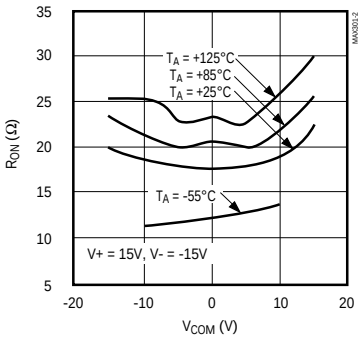
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted).

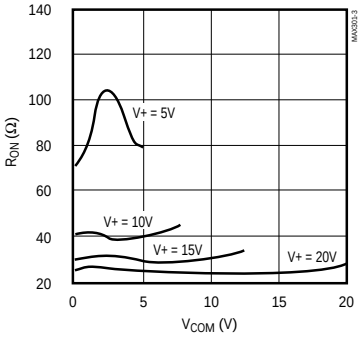
ON RESISTANCE vs. V_{COM} AND POWER-SUPPLY VOLTAGE



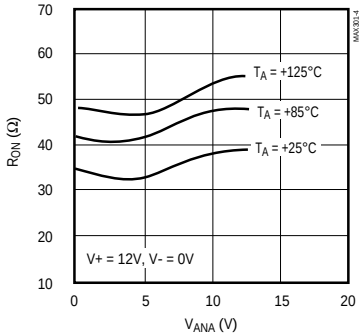
ON RESISTANCE vs. V_{COM} AND TEMPERATURE



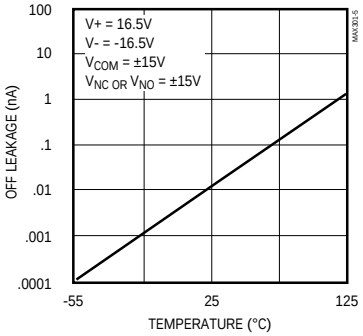
ON RESISTANCE vs. V_{COM} WITH V- = 0V



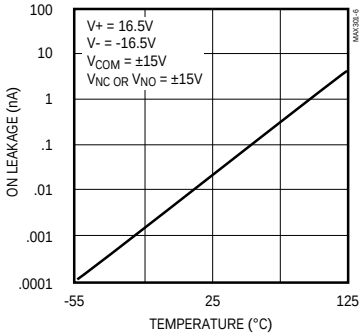
ON RESISTANCE vs. V_{COM} AND V- = 0V



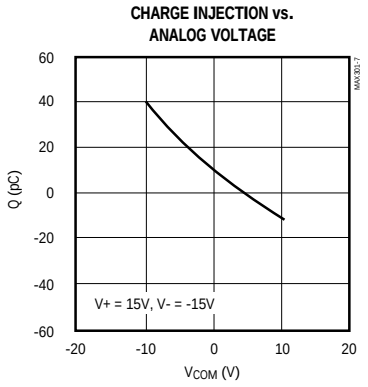
OFF LEAKAGE CURRENTS vs. TEMPERATURE



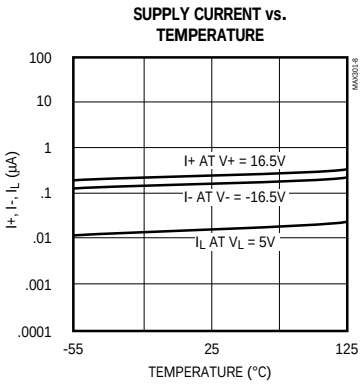
ON LEAKAGE CURRENTS vs. TEMPERATURE



CHARGE INJECTION vs. ANALOG VOLTAGE



SUPPLY CURRENT vs. TEMPERATURE



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
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 coefficent 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 VL, 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.

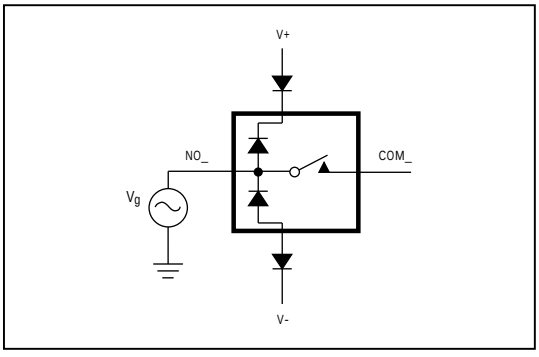


Figure 1. Overvoltage Protection Using Blocking Diodes

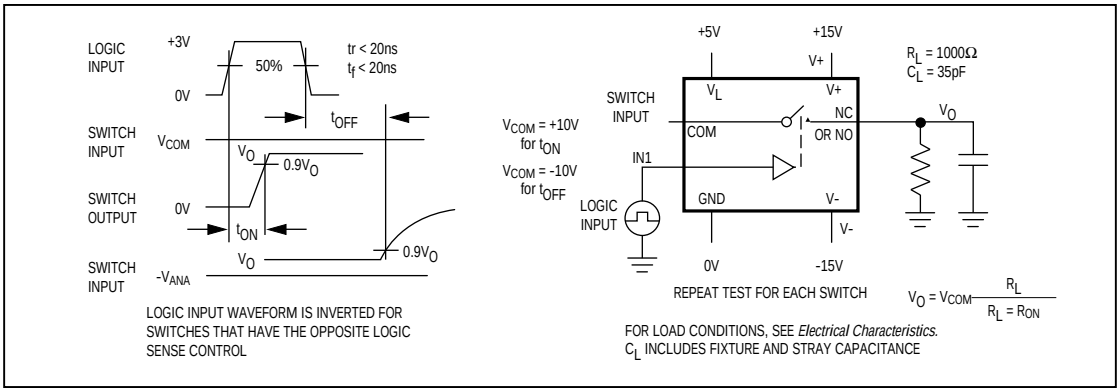


Figure 2. Switching-Time Test Circuit

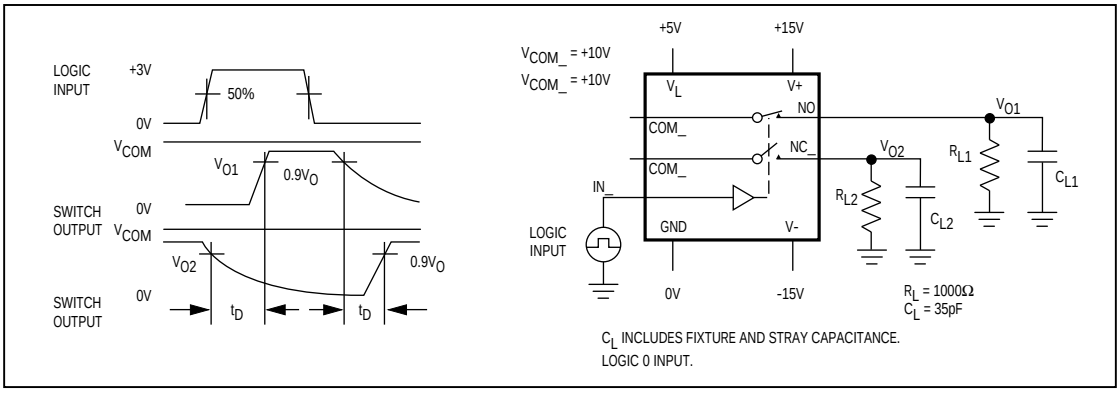


Figure 3. Break-Before-Make Test Circuit

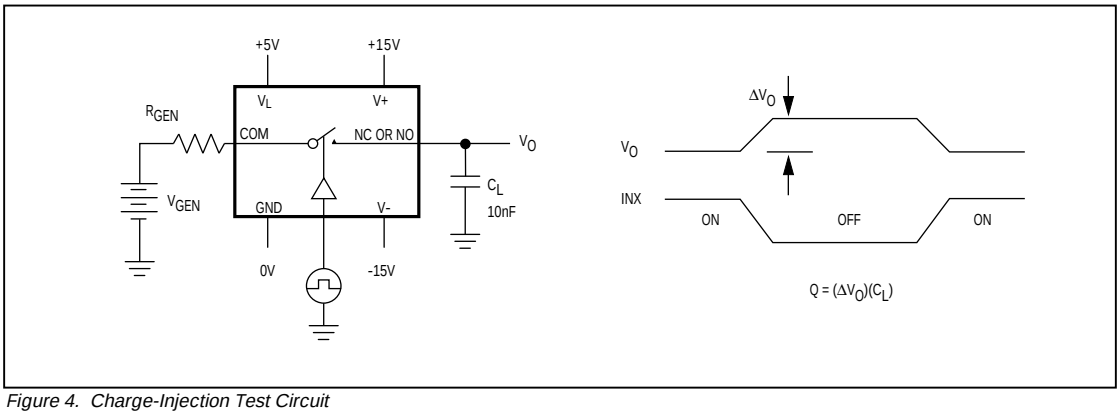
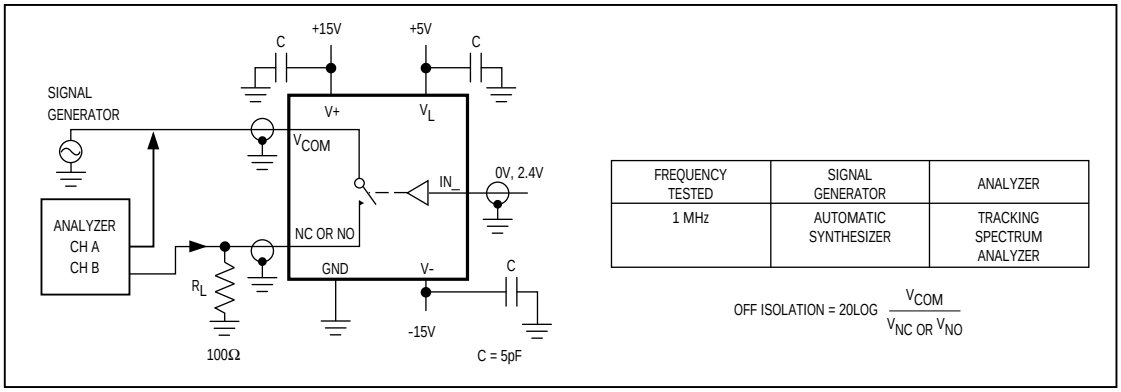


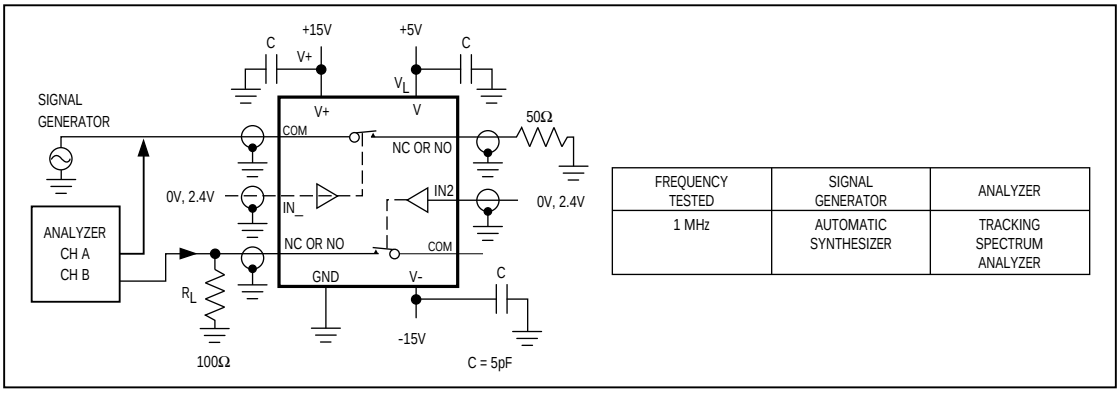
Figure 4. Charge-Injection Test Circuit



FREQUENCY TESTED	SIGNAL GENERATOR	ANALYZER
1 MHz	AUTOMATIC SYNTHESIZER	TRACKING SPECTRUM ANALYZER

$$\text{OFF ISOLATION} = 20\text{LOG}\ \frac{V_{COM}}{V_{NC\ OR\ V_{NO}}}$$

Figure 5. Off Isolation



FREQUENCY TESTED	SIGNAL GENERATOR	ANALYZER
1 MHz	AUTOMATIC SYNTHESIZER	TRACKING SPECTRUM ANALYZER

Figure 6. Crosstalk Test Circuit

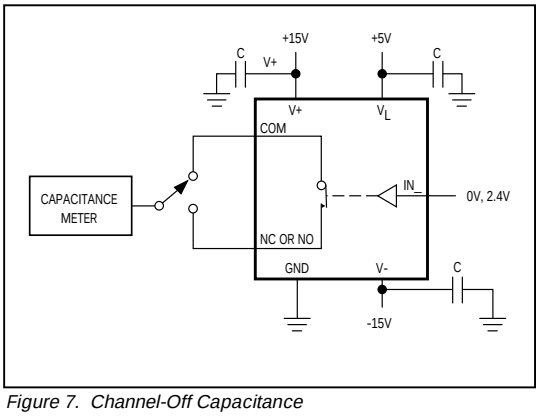


Figure 7. Channel-Off Capacitance

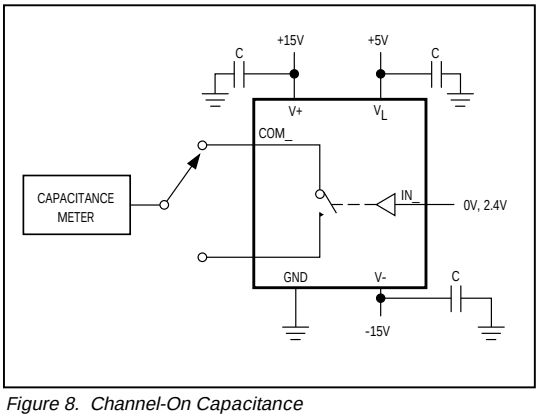


Figure 8. Channel-On Capacitance

Precision, Dual, High-Speed Analog Switches

Ordering Information (continued)

PART	TEMP.RANGE	PIN-PACKAGE
MAX303CPE	0°C to +70°C	16 Plastic DIP
MAX303CSE	0°C to +70°C	16 Narrow SO
MAX303CJE	0°C to +70°C	16 CERDIP
MAX303C/D	0°C to +70°C	Dice*
MAX303EPE	-40°C to +85°C	16 Plastic DIP
MAX303ESE	-40°C to +85°C	16 Narrow SO
MAX303EJE	-40°C to +85°C	16 CERDIP
MAX303MJE	-55°C to +125°C	16 CERDIP
MAX303MLP	-55°C to +125°C	20 LCC**
MAX305CPE	0°C to +70°C	16 Plastic DIP
MAX305CSE	0°C to +70°C	16 Narrow SO
MAX305CJE	0°C to +70°C	16 CERDIP
MAX305C/D	0°C to +70°C	Dice*
MAX305EPE	-40°C to +85°C	16 Plastic DIP
MAX305ESE	-40°C to +85°C	16 Narrow SO
MAX305EJE	-40°C to +85°C	16 CERDIP
MAX305MJE	-55°C to +125°C	16 CERDIP
MAX305MLP	-55°C to +125°C	20 LCC**

** Dice are tested at T_A = +25°C only.*

*** Contact factory for availability.*

Pin Configuration (continued)