19-0181; Rev 0; 9/93

MAXIM

Precision, Quad, SPST Analog Switches

General Description

The MAX364/MAX365 are precision, quad, single-pole single-throw (SPST) analog switches. The MAX364 has four normally closed (NC), and the MAX365 has four normally open (NO) switches. Both parts offer low-channel on resistance (less than 85Ω), guaranteed to match within 2Ω between channels and to remain flat over the analog signal range (Δ9Ω max). Both parts also offer low leakage (less than 500pA at +25°C and less than 4nA at +85°C) and fast switching (turn-on time less than 250ns and turn-off time less than 170ns).

The MAX364/MAX365 are fabricated with Maxim's new improved 44V silicon-gate process. Design improvements guarantee extremely low charge injection (10pC), low power consumption (35µW), and electrostatic discharge (ESD) greater than 2000V. The 44V maximum breakdown voltage allows rail-to-rail analog signal handling 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	Communication Systems
Guidance and Control Systems	Battery-Operated Systems
Heads-Up Displays	PBX, PABX
Test Equipment	Military Radios

Features

- ♦ **Low On Resistance: < 45Ω Typical (85Ω Max)**
- ♦ **Guaranteed Matched On Resistance Between Channels: < 2Ω**
- ♦ **Guaranteed Flat On Resistance over Full Analog Signal Range: Δ9Ω Max**
- ♦ **Guaranteed Charge Injection: < 10pC**
- ♦ **Guaranteed Off-Channel Leakage: < 4nA at +85°C**
- ♦ **ESD Guaranteed > 2000V per Method 3015.7**
- ♦ **Single-Supply Operation (+10V to +30V) Bipolar-Supply Operation (±4.5V to ±20V)**
- ♦ **TTL-/CMOS-Logic Compatible**
- ♦ **Rail-to-Rail Analog Signal Handling Capability**

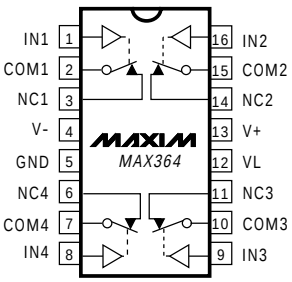
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX364CPE	0°C to +70°C	16 Plastic DIP
MAX364CSE	0°C to +70°C	16 Narrow SO
MAX364C/D	0°C to +70°C	Dice*
MAX364EPE	-40°C to +85°C	16 Plastic DIP
MAX364ESE	-40°C to +85°C	16 Narrow SO
MAX365CPE	0°C to +70°C	16 Plastic DIP
MAX365CSE	0°C to +70°C	16 Narrow SO
MAX365C/D	0°C to +70°C	Dice*
MAX365EPE	-40°C to +85°C	16 Plastic DIP
MAX365ESE	-40°C to +85°C	16 Narrow SO

** Contact factory for dice specifications.*

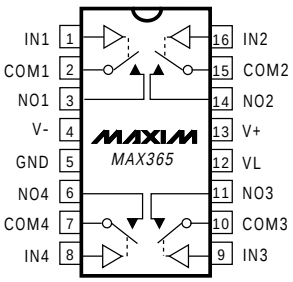
Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW



DIP/SO

MAX364	
LOGIC	SWITCH
0	ON
1	OFF



DIP/SO

MAX365	
LOGIC	SWITCH
0	OFF
1	ON

SWITCHES SHOWN FOR LOGIC "0" INPUT

Call toll free 1-800-998-8800 for free samples or literature.

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-
V+ 44V
GND 25V
VL ..... (GND - 0.3V) to (V+ + 0.3V)
IN_, COM_, NO_, or NC_ ..... (V- - 2V) to (V+ + 2V) or 30mA (whichever occurs first)
Continuous Current (any terminal) 30mA
Peak Current COM_, NO_, or NC_ (pulsed at 1ms, 10% duty cycle max) 100mA
ESD 2000V

Note 1: All leads are soldered or welded to PC board.

Continuous Power Dissipation (T_A = +70°C) (Note 1)
Plastic DIP (derate 10.53mW/°C above +70°C 842mW
Narrow SO (derate 8.70mW/°C above +70°C) 696mW
Operating Temperature Ranges:
MAX36_C_ _ ..... 0°C to +70°C
MAX36_E_ _ ..... -40°C to +85°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +300°C

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, VL = 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
ANALOG							
Analog-Signal Range	$V_{COM_}$, $V_{NO_}$, V_{NC}	(Note 3)		-15		15	V
On Resistance	R_{ON}	COM_ to NO_ or NC, I_{COM} = -10mA, V_{COM} = 8.5V or -8.5V, V+ = 13.5V, V- = -13.5V	T_A = +25°C		50	85	Ω
			T_A = T_{MIN} to T_{MAX}			100	
On Resistance Match Between Channels (Note 4)	R_{ON}	I_{COM} = -10mA, V_{COM} = 10V or -10V, V+ = 15V, V- = -15V	T_A = +25°C			2	Ω
			T_A = T_{MIN} to T_{MAX}			4	
On Resistance Flatness (Note 4)	R_{ON}	I_{COM} = -10mA, V_{COM} = 5V or -5V, V+ = 15V, V- = -15V	T_A = +25°C			9	Ω
			T_A = T_{MIN} to T_{MAX}			15	
NC_ or NO_ Leakage Current	$I_{NO_}$, I_{NC}	NO_ or NC_ terminal, V_{COM} = ±15.5V, V_{NO} or V_{NC} = ±15.5V, V+ = 16.5V, V- = -16.5V	T_A = +25°C	-0.50	0.01	0.50	nA
			T_A = T_{MIN} to T_{MAX}	-4		4	
COM_ Off Leakage Current	I_{NO}, I_{NC}	COM_ terminal, V_{NO} or V_{NC} = ±15.5V, V_{COM} = ±15.5V, V+ = 16.5V, V- = -16.5V	T_A = +25°C	-0.50	0.01	0.50	nA
			T_A = T_{MIN} to T_{MAX}	-4		4	
COM_, NC_ or NO_ On Leakage Current	I_{COM} or I_{NO}, I_{NC}	COM_ to NC_ or NO_ V_{COM} = ±15.5V, V_{NO} or V_{NC} = ±15.5V, V+ = 16.5V, V- = -16.5V	T_A = +25°C	-0.50	0.08	0.50	nA
			T_A = T_{MIN} to T_{MAX}	-6		6	
INPUT							
Input Current with Input Voltage High	I_{INH}	$V_{IN_}$ = 2.4V, all others = 0.8V		-0.5	-0.00001	0.5	µA
Input Current with Input Voltage Low	I_{INL}	$V_{IN_}$ = 0.8V, all others = 2.4V		-0.5	-0.00001	0.5	µA

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = 15V, V- = -15V, VL = 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
SUPPLY							
Power-Supply Range	V+, V-			±4.5		±20.0	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	0.001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
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	-0.0001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
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	0.001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
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	-0.0001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
DYNAMIC							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = ±10V, Figure 2	T_A = +25°C		150	250	ns
Turn-Off Time	t_{OFF}	MAX364, V_{NO} or V_{NC} = ±10V, Figure 2	T_A = +25°C		90	120	ns
		MAX365, V_{NO} or V_{NC} = ±10V, Figure 2	T_A = +25°C		110	170	ns
Charge Injection	Q	C_L = 1nF, V_{GEN} = 0V, R_{GEN} = 0Ω, Figure 3	T_A = +25°C		5	10	pC
Off Isolation (Note 5)	OIRR	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 4	T_A = +25°C		60		dB
Crosstalk (Note 6)		RL - 50Ω, CL = 5pF, f = 1MHz, Figure 5	T_A = +25°C		100		dB
NC_ or NO_ Off Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 6	T_A = +25°C		4		pF
COM_ Off Capacitance	$C_{COM(OFF)}$	f = 1MHz, Figure 6	T_A = +25°C		4		pF
Channel-On Capacitance	$C_{COM(ON)}$	f = 1MHz, Figure 6	T_A = +25°C		16		pF

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = 12V, V- = 0V, VL = 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
ANALOG							
Analog Signal Range	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$	(Note 3)		0		12	V
On Resistance	R_{ON}	COM_ to NO_ or NC_, I_{NC} or I_{NO} = -10mA, VL = 5.25V, V_{COM} = 3V, 8V, V+ = 10.8V	T_A = +25°C		100	160	Ω
			T_A = T_{MIN} to T_{MAX}			200	
SUPPLY							
Power-Supply Range	V+, V-			10.8		24.0	V
Power-Supply Current	I+	All channels on or off, V_{IN} = 0V or 5V	T_A = +25°C	-1	0.001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
Negative Supply Current	I-	All channels on or off, V_{IN} = 0V or 5V	T_A = +25°C	-1	-0.0001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
Logic Supply Current	I_L	All channels on or off, V_{IN} = 0V or 5V	T_A = +25°C	-1	0.001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
Ground Current	I_{GND}	All channels on or off, V_{IN} = 0V or 5V	T_A = +25°C	-1	-0.0001	1	µA
			T_A = T_{MIN} to T_{MAX}	-5		5	
DYNAMIC							
Turn-On Time	t_{ON}	V_{NC} or V_{NO}= 8V, Figure 2	T_A = +25°C		300	400	ns
Turn-Off Time	t_{OFF}	V_{NC} or V_{NO} = 8V, Figure 2	T_A = +25°C		60	200	ns
Charge Injection	Q	C_L = 1nF, V_{GEN} = 0V, R_{GEN} = 0Ω, Figure 3	T_A = +25°C		5	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: On resistance match between channels and flatness are guaranteed only with bipolar-supply operation.

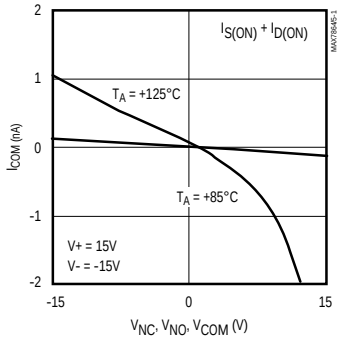
Note 5: See Figure 2. Off Isolation = $20 \log_{10} \left(\frac{V_{COM}}{V_{NC} \text{ or } V_{NO}} \right)$, V_{COM} = output, V_{NO} or V_{NC} = input to off switch.

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

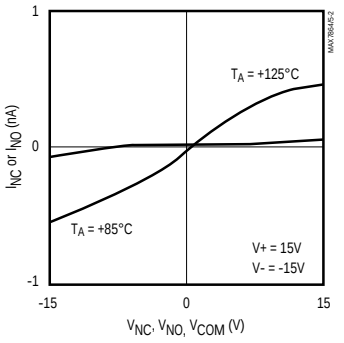
Typical Operating Characteristics

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

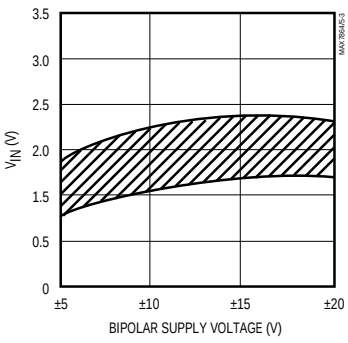
ON LEAKAGE CURRENTS



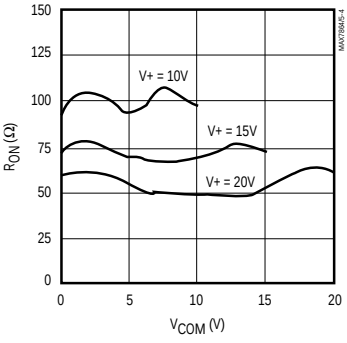
OFF LEAKAGE CURRENTS



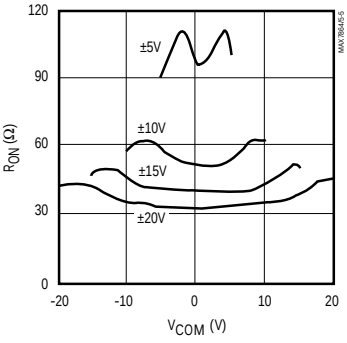
SWITCHING THRESHOLD vs. BIPOLAR SUPPLY VOLTAGE



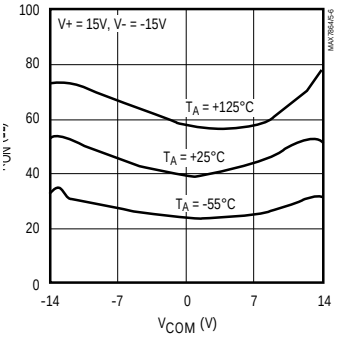
ON RESISTANCE vs. V_{COM} AND UNIPOLAR SUPPLY VOLTAGE



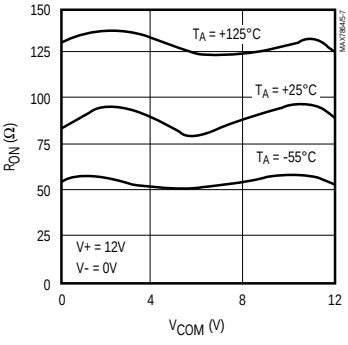
ON RESISTANCE vs. V_{COM} AND BIPOLAR SUPPLY VOLTAGE



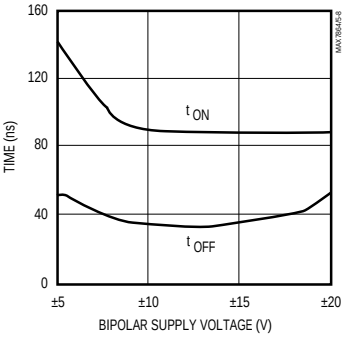
ON RESISTANCE vs. V_{COM}, BIPOLAR SUPPLY VOLTAGE AND TEMPERATURE



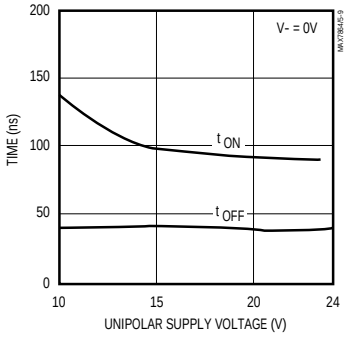
ON RESISTANCE vs. V_{COM}, UNIPOLAR SUPPLY VOLTAGE AND TEMPERATURE



SWITCHING TIME vs. BIPOLAR SUPPLY VOLTAGE

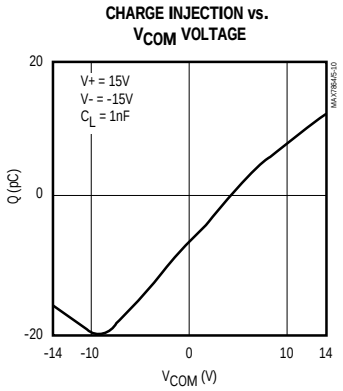


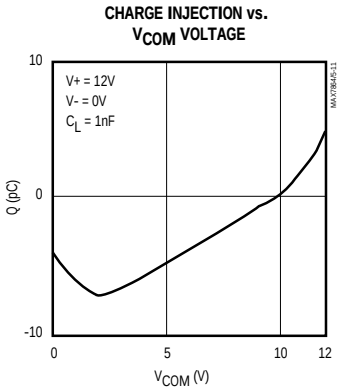
SWITCHING TIMES vs. UNIPOLAR SUPPLY VOLTAGE



Typical Operating Characteristics

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





Pin Description

PIN	NAME	FUNCTION
1, 16, 9, 8	IN1-IN4	Logic-Level Input
2, 15, 10, 7	COM1-COM4	Analog Switch Common Terminal
3, 14, 11, 6	NC1-NC4 (MAX364)	Normally Closed Analog Switch Terminal
	NO1-NO4 (MAX365)	Normally Open Analog Switch Terminal
4	V-	Negative Supply Voltage Input
5	GND	Ground
12	VL	Logic Supply Voltage Input
13	V+	Positive Supply Voltage Input—connected to substrate

Applications Information

Application Hints

1. Switches are open when power is off.
2. IN_, COM_, NO_, and NC_ should not exceed V+ or V-, even with the power off.
3. Switch leakage is from each analog switch terminal to V+ or V-, not to the other switch terminal.

Operation with Supply Voltages Other than ±15VO

The main limitation of supply voltages other than ±15V is reduction in the analog signal range. The MAX364/MAX365 switches operate with ±5V to ±20V bipolar supplies. The *Typical Operating Characteristics* graphs show typical on resistance for ±15V, ±10V, and ±5V supplies. Switching times increase by a factor of two or more for ±5V operation. The MAX364/MAX365 operate from unipolar supplies of +10V to +24V. Both parts 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. 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 those listed 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.

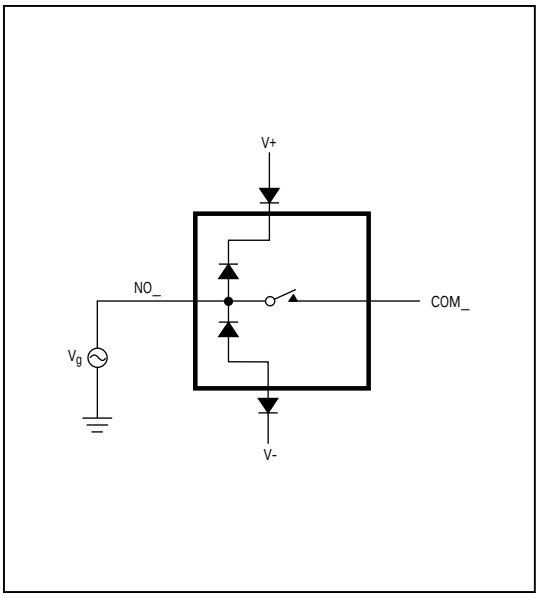


Figure 1. Overvoltage Protection Using Blocking Diodes

Test Circuits/Timing Diagrams

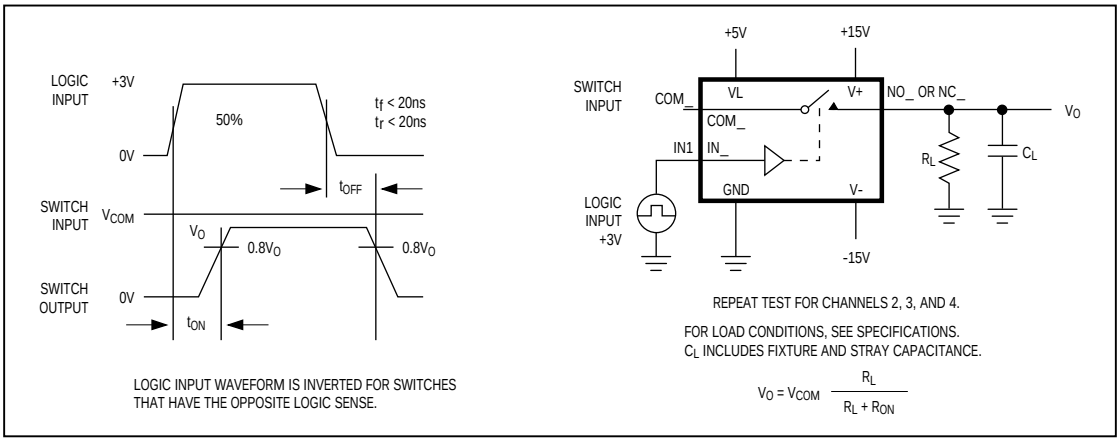


Figure 2. Switching-Time Test Circuit

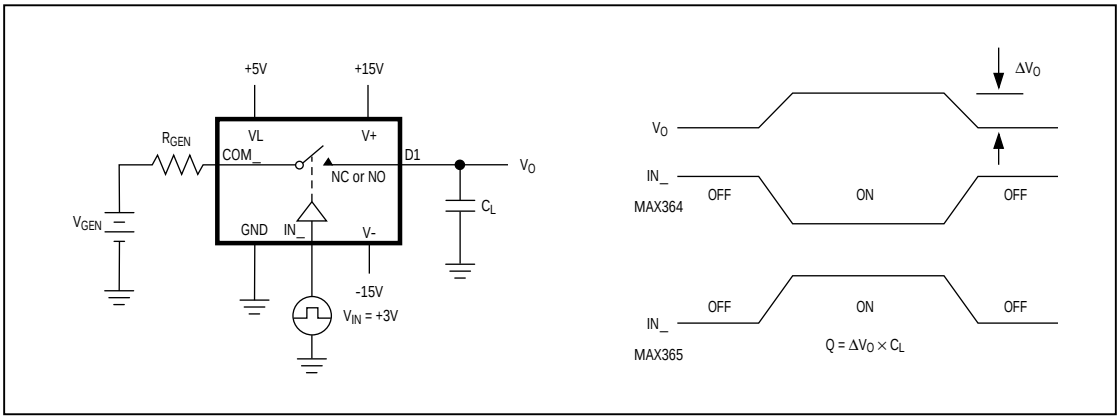


Figure 3. Charge-Injection Test Circuit

Test Circuits/Timing Diagrams (continued)

FREQUENCY TESTED	SIGNAL GENERATOR	ANALYZER
100Hz to 13MHz	AUTOMATIC SYNTHESIZER	SPECTRUM ANALYZER

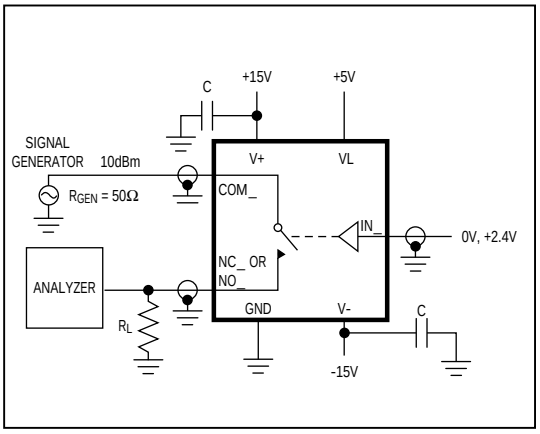


Figure 4. Off Isolation Test Circuit

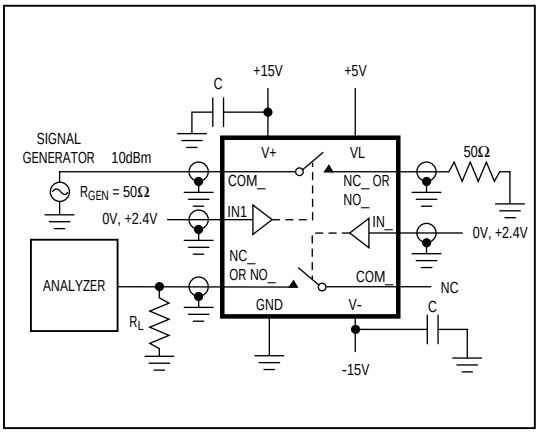


Figure 5. Crosstalk Test Circuit

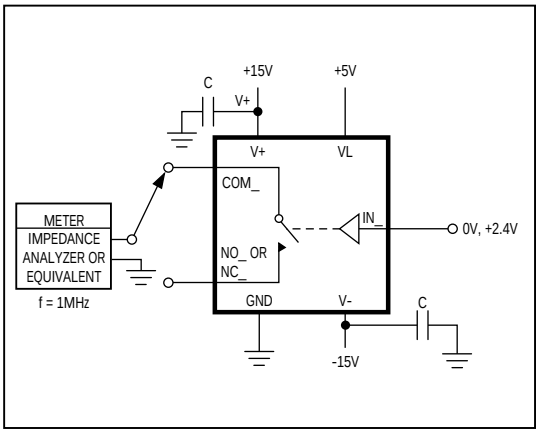


Figure 6. COM_, NC_, NO_ Off Capacitance

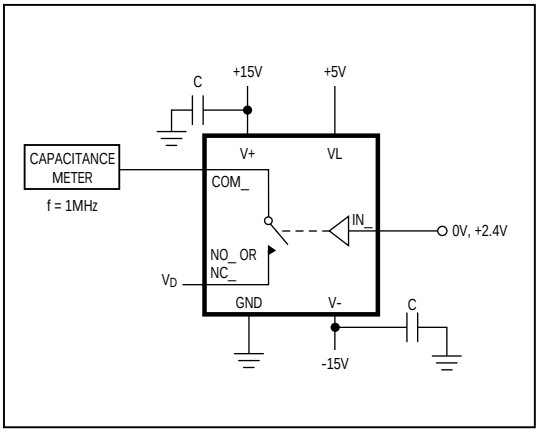
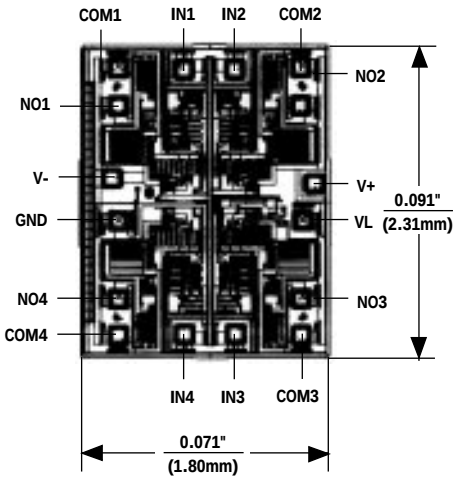


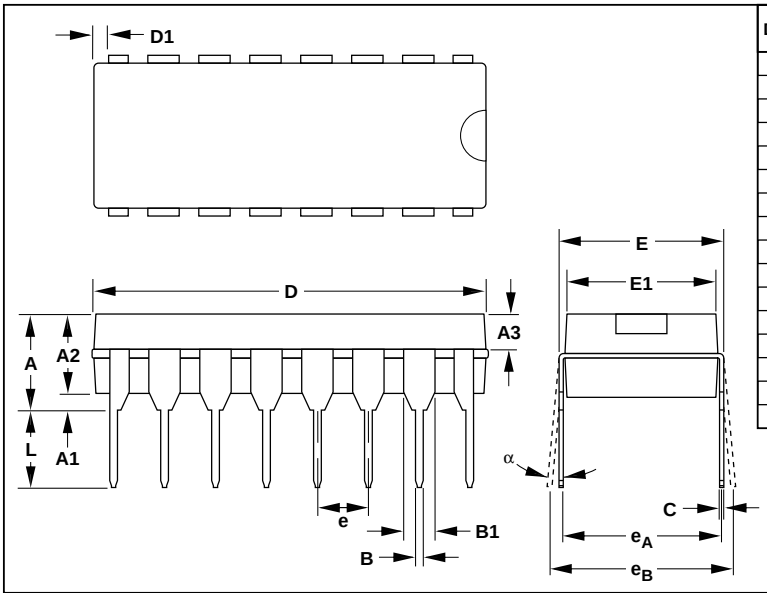
Figure 7. COM_, NC_, NO_ On Capacitance

Chip Topography



TRANSISTOR COUNT: 126;
SUBSTRATE CONNECTED TO V+.

Package Information

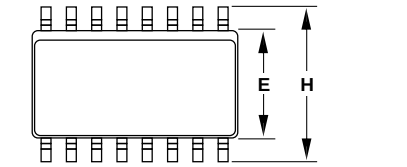


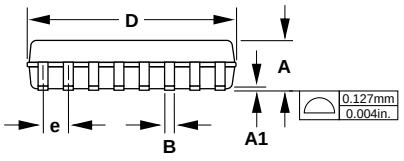
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
A1	0.015	–	0.38	–
A2	0.125	0.150	3.18	3.81
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.050	0.065	1.27	1.65
C	0.008	0.012	0.20	0.30
D	0.745	0.765	18.92	19.43
D1	0.005	0.030	0.13	0.76
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
e_A	0.300 BSC		7.62 BSC	
e_B	–	0.400	–	10.16
L	0.115	0.150	2.92	3.81
α	0°	15°	0°	15°

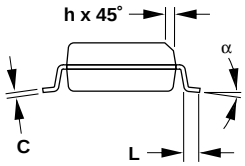
21-587A

16-PIN PLASTIC DUAL-IN-LINE PACKAGE

Package Information (continued)







DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
D	0.386	0.394	9.80	10.00
E	0.150	0.157	3.80	4.00
e	0.050 BSC		1.27 BSC	
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°

21-588B

16-PIN PLASTIC SMALL-OUTLINE (NARROW) PACKAGE

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