19-1394; Rev 0; 10/98

MAXIM

1.25Ω, Dual SPST, CMOS Analog Switches

General Description

The MAX4580/MAX4590/MAX4600 dual analog switches feature low on-resistance of 1.25Ω max. On-resistance is matched between switches to 0.25Ω max and is flat (0.3Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. The off-leakage current is only 2.5nA max at +85°C. These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have low power requirements, require less board space, and are more reliable than mechanical relays.

The MAX4580 has two NC (normally closed) switches, the MAX4590 has two NO (normally open) switches, and the MAX4600 has one NC (normally closed) and one NO (normally open) switch.

These switches operate from a +4.5V to +36V single supply or from ±4.5V to ±20V dual supplies. All digital inputs have +0.8V and +2.4V logic thresholds, ensuring TTL/CMOS-logic compatibility when using a +12V single supply or ±15V dual supplies.

Applications

Reed Relay Replacement

Test Equipment

Communication Systems

PBX, PABX Systems

Features

- **Low On-Resistance (1.25Ω max)**
- **Guaranteed R_{ON} Match Between Channels (0.25Ω max)**
- **Guaranteed R_{ON} Flatness Over Specified Signal Range (0.3Ω max)**
- **Rail-to-Rail Signal Handling**
- **Guaranteed ESD Protection >2kV per Method 3015.7**
- **Single-Supply Operation: +4.5V to +36V Dual-Supply Operation: ±4.5V to ±20V**
- **TTL/CMOS-Compatible Control Inputs**

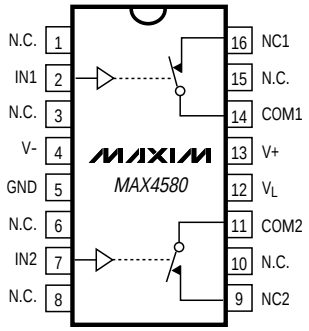
Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4580CAE	0°C to +70°C	16 SSOP
MAX4580CWE	0°C to +70°C	16 Wide SO
MAX4580CPE	0°C to +70°C	16 Plastic DIP
MAX4580EAE	-40°C to +85°C	16 SSOP
MAX4580EWE	-40°C to +85°C	16 Wide SO
MAX4580EPE	-40°C to +85°C	16 Plastic DIP

Ordering Information continued at end of data sheet.

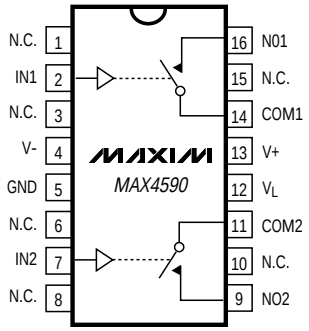
Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW



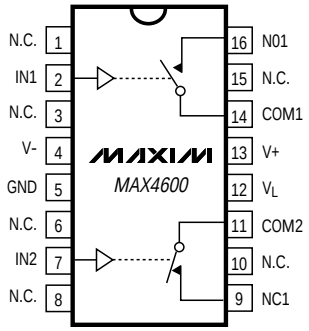
SSOP/SO/DIP

LOGIC	SWITCH
0	ON
1	OFF



SSOP/SO/DIP

LOGIC	SWITCH
0	OFF
1	ON



SSOP/SO/DIP

LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

N.C. = NOT INTERNALLY CONNECTED

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

1.25Ω, Dual SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V+ to GND .....-0.3V to +44V
V- to GND .....+0.3V to -44V
V+ to V- .....-0.3V to +44V
V_L to GND ..... -0.3V to (V+ + 0.3V)
All Other Pins to GND (Note 1) ..... (V- - 0.3V) to (V+ + 0.3V)
Continuous Current (COM_, NO_, NC_) ..... ±200mA
Peak Current (COM_, NO_, NC_)
(pulsed at 1ms, 10% duty cycle) ..... ±300mA

Continuous Power Dissipation (T_A = +70°C)
16 SSOP (derate 7.1mW/°C above +70°C) 571mW
16 Wide SO (derate 9.52mW/°C above +70°C) 762mW
16 Plastic DIP (derate 10.53mW/°C above +70°C) 842mW
Operating Temperature Ranges
MAX4_ _0C_E .....0°C to +70°C
MAX4_ _0E_E .....-40°C to +85°C
Storage Temperature Range ..... -65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Note 1: Signals on NC_, NO_, COM_, or IN_ exceeding V+ or V- are clamped by internal diodes. Limit forward diode 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–Dual Supplies

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range (Note 3)	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			V-		V+	V
COM_ to NO or NC_ On-Resistance	R_{ON}	$I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = ±10V,	T_A = +25°C		0.9	1.25	Ω
			T_A = T_{MIN} to T_{MAX}			1.5	
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = ±10V	T_A = +25°C		0.05	0.25	Ω
			T_A = T_{MIN} to T_{MAX}			0.5	
COM_ to NO_ or NC_ On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	$I_{COM\_}$ = 10mA; $V_{NO\_}$ or $V_{NC\_}$ = -5V, 0, +5V	T_A = +25°C		0.06	0.3	Ω
			T_A = T_{MIN} to T_{MAX}			0.5	
Off-Leakage Current (NO_ or NC_) (Note 6)	$I_{NO\_}$, $I_{NC\_}$	$V_{COM\_}$ = ±10V, $V_{NO\_}$ or $V_{NC\_}$ = ∓10V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		2.5	
COM_ Off-Leakage Current (Note 6)	$I_{COM\_(OFF)}$	$V_{COM\_}$ = ±10V, $V_{NO\_}$ or $V_{NC\_}$ = ∓10V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		2.5	
COM_ On-Leakage Current (Note 6)	$I_{COM\_(ON)}$	$V_{COM\_}$ = ±10V, $V_{NO\_}$ or $V_{NC\_}$ = ±10V, or floating	T_A = +25°C	-1	0.01	1	nA
			T_A = T_{MIN} to T_{MAX}	-5		5	
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_H}	IN_ = 2.4V, all others = 0.8V		-0.500	0.001	0.500	µA
Input Current with Input Voltage Low	I_{IN_L}	IN_ = 0.8V, all others = 2.4V		-0.500	0.001	0.500	

ELECTRICAL CHARACTERISTICS–Dual Supplies (continued)

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
Logic Input High Voltage	V_{IN_H}			2.4	1.7		V
Logic Input Low Voltage	V_{IN_L}				1.7	0.8	V
POWER SUPPLY							
Power-Supply Range				±4.5		±20.0	V
Positive Supply Current	I+	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.01	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
Negative Supply Current	I-	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.01	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
Logic Supply Current	I_L	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.01	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
Ground Current	I_{GND}	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.01	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	Figure 2, $V_{COM\_}$ = ±10V, T_A = +25°C			160		ns
Turn-Off Time	t_{OFF}	Figure 2, $V_{COM\_}$ = ±10V, T_A = +25°C			210		ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0, R_{GEN} = 0, Figure 3, T_A = +25°C			-60		pC
Off-Isolation (Note 7)	V_{ISO}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 4, T_A = +25°C			-53		dB
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5, T_A = +25°C			-65		dB
NC_ or NO_ Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 6, T_A = +25°C			115		pF
COM Off-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 6, T_A = +25°C			115		pF
On-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 7, T_A = +25°C			520		pF

1.25Ω, Dual SPST, CMOS Analog Switches

ELECTRICAL CHARACTERISTICS–Single Supply

(V+ = +12V, V- = 0, V_L = +5V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range (Note 3)	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$			GND		V+	V
COM_ to NO_ or NC_ On-Resistance	R_{ON}	$I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = +10V, V+ = 12V	T_A = +25°C		1.6	3	Ω
			T_A = T_{MIN} to T_{MAX}			3.5	
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM\_}$ = 10mA, $V_{NO\_}$ or $V_{NC\_}$ = +10V	T_A = +25°C			0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.5	
COM_ to NO_ or NC_ On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	$I_{COM\_}$ = 10mA; $V_{NO\_}$ or $V_{NC\_}$ = +3V, +6V, +9V	T_A = +25°C			0.4	Ω
			T_A = T_{MIN} to T_{MAX}			0.5	
Off-Leakage Current (NO_ or NC_) (Notes 6, 9)	$I_{NO\_}$, $I_{NC\_}$	$V_{COM\_}$ = 1V, +10V; $V_{NO\_}$ or $V_{NC\_}$ = +10V, +1V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		2.5	
COM_ Off-Leakage Current (Notes 6, 9)	$I_{COM\_(OFF)}$	$V_{NO\_}$ or $V_{NC\_}$ = +10V, +1V; $V_{COM\_}$ = +1V, +10V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-2.5		2.5	
COM_ On-Leakage Current (Notes 6, 9)	$I_{COM\_(ON)}$	$V_{COM\_}$ = +1V, +10V; $V_{NO\_}$ or $V_{NC\_}$ = +1V, +10V, or floating	T_A = +25°C	-1	0.02	1	nA
			T_A = T_{MIN} to T_{MAX}	-10		10	
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_L}	IN_ = 0.8V, all others = 2.4V		-0.500	0.001	0.500	µA
Input Current with Input Voltage Low	I_{IN_H}	IN_ = 2.4V, all others = 0.8V		-0.500	0.001	0.500	µA
Logic Input High Voltage	V_{IN_H}			2.4			V
Logic Input Low Voltage	V_{IN_L}					0.8	V
POWER SUPPLY							
Power-Supply Range				+4.5		+36.0	V
Positive Supply Current	I+	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.001	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
Logic Supply Current	I_L	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.001	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	
Ground Current	I_{GND}	$V_{IN\_}$ = 0 or +5V	T_A = +25°C	-0.5	0.001	0.5	µA
			T_A = T_{MIN} to T_{MAX}	5		5	

ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0, V_L = +5V, V_{IN_H} = 2.4V, V_{IN_L} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

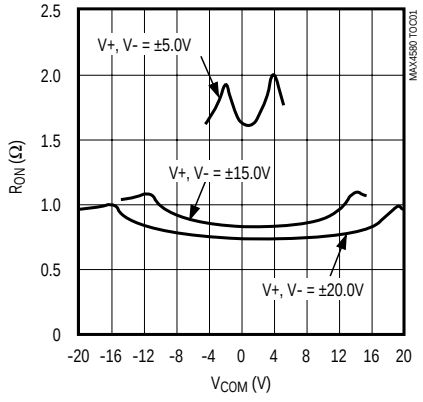
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX (Note 2)	UNITS
SWITCH DYNAMIC CHARACTERISTICS						
Turn-On Time	t_{ON}	$V_{COM\_}$ = +10V, Figure 2, T_A = +25°C		150		ns
Turn-Off Time	t_{OFF}	$V_{COM\_}$ = +10V, Figure 2, T_A = +25°C		200		ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0, R_{GEN} = 0, Figure 3, T_A = +25°C		40		pC
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5, T_A = +25°C		-65		dB
NC_ or NO_ Capacitance	$C_{(OFF)\_}$	f = 1MHz, Figure 6, T_A = +25°C		175		pF
COM Off-Capacitance	$C_{(COM)\_}$	f = 1MHz, Figure 6, T_A = +25°C		175		pF
On-Capacitance	$C_{(COM)\_}$	f = 1MHz, Figure 7, T_A = +25°C		275		pF

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: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
Note 6: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at +25°C.
Note 7: 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 8: Between any two switches.
Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

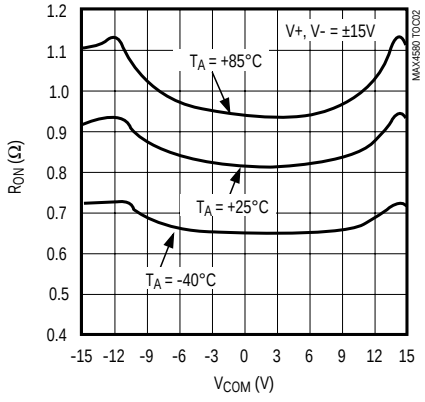
Typical Operating Characteristics

(Circuit of Figure 1, T_A = +25°C, unless otherwise noted.)

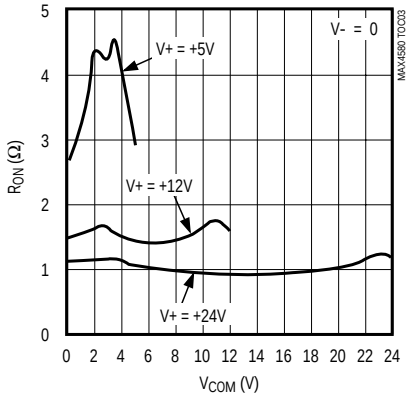
ON-RESISTANCE vs. V_{COM} (DUAL SUPPLIES)



ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (DUAL SUPPLIES)



ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)

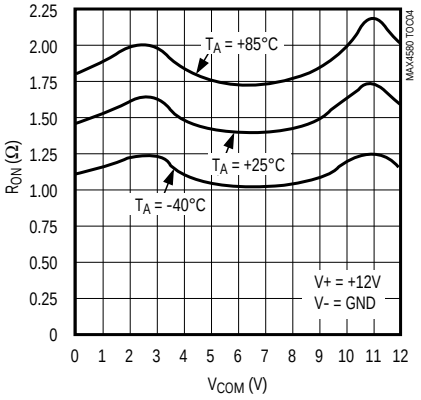


1.25Ω, Dual SPST, CMOS Analog Switches

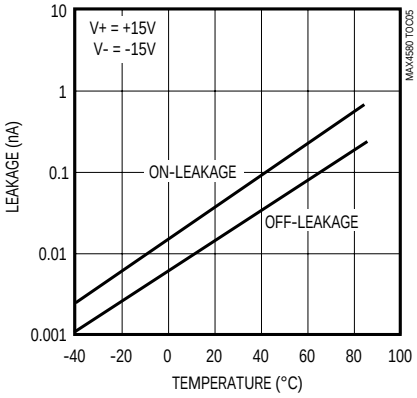
Typical Operating Characteristics (continued)

(Circuit of Figure 1, T_A = +25°C, unless otherwise noted.)

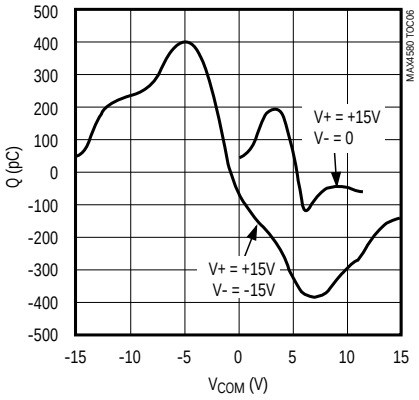
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



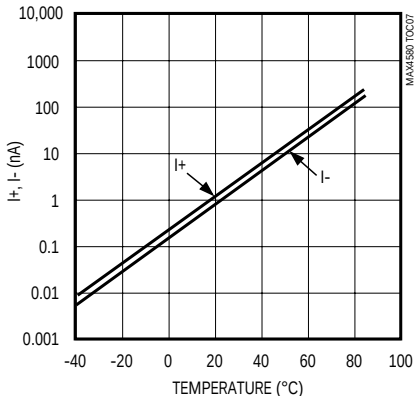
ON/OFF-LEAKAGE vs. TEMPERATURE



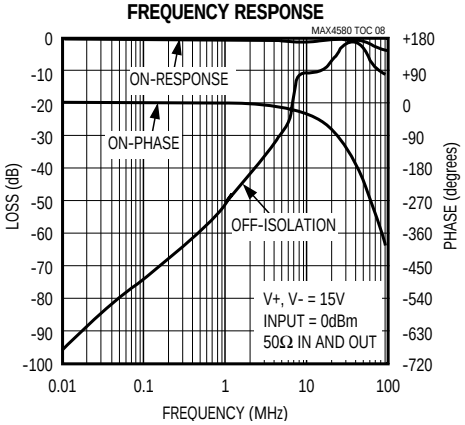
CHARGE INJECTION vs. V_{COM}



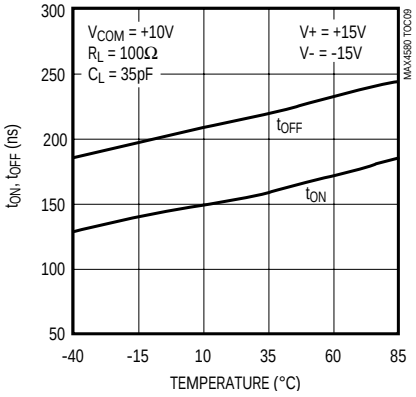
POWER-SUPPLY CURRENT vs. TEMPERATURE



FREQUENCY RESPONSE



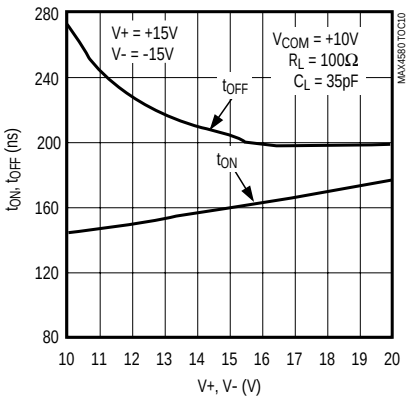
TURN-ON/TURN-OFF TIME vs. TEMPERATURE



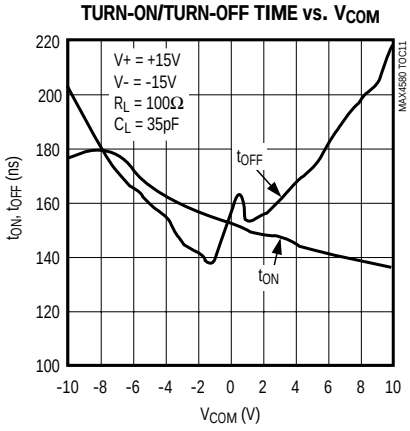
Typical Operating Characteristics (continued)

(Circuit of Figure 1, T_A = +25°C, unless otherwise noted.)

TURN-ON/TURN-OFF TIME vs. SUPPLY VOLTAGE



TURN-ON/TURN-OFF TIME vs. V_{COM}



Pin Description

PIN			NAME	FUNCTION
MAX4580	MAX4590	MAX4600		
1, 3, 6, 8, 10, 15	1, 3, 6, 8, 10, 15	1, 3, 6, 8, 10, 15	N.C.	No connection. Not internally connected. Connect to GND or low-impedance point to improve on/off-isolation.
2, 7	2, 7	2, 7	IN1, IN2	Logic-Control Digital Inputs
4	4	4	V-	Negative Analog Supply Voltage Input. Connect to GND for single-supply operation.
5	5	5	GND	Ground
12	12	12	V_L	Logic Supply Input
13	13	13	V+	Positive Analog Supply Input
14, 11	14, 11	14, 11	COM1, COM2	Analog Switch Common Terminals
16, 9	–	–	NC1, NC2	Analog Switch Normally Closed Terminals
–	16, 9	–	NO1, NO2	Analog Switch Normally Open Terminals
–	–	9	NC1	Analog Switch Normally Closed Terminal
–	–	16	NO1	Analog Switch Normally Open Terminal

1.25Ω, Dual SPST, CMOS Analog Switches

Applications Information

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 can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V. These protection diodes are not recommended when using a single supply.

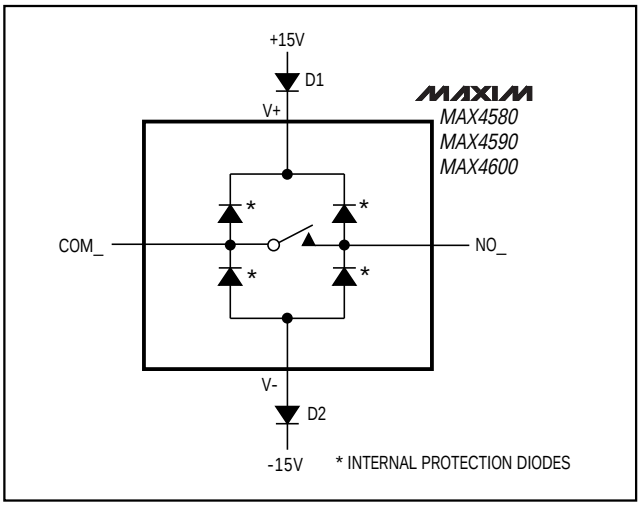


Figure 1. Overvoltage Protection Using External Blocking Diodes

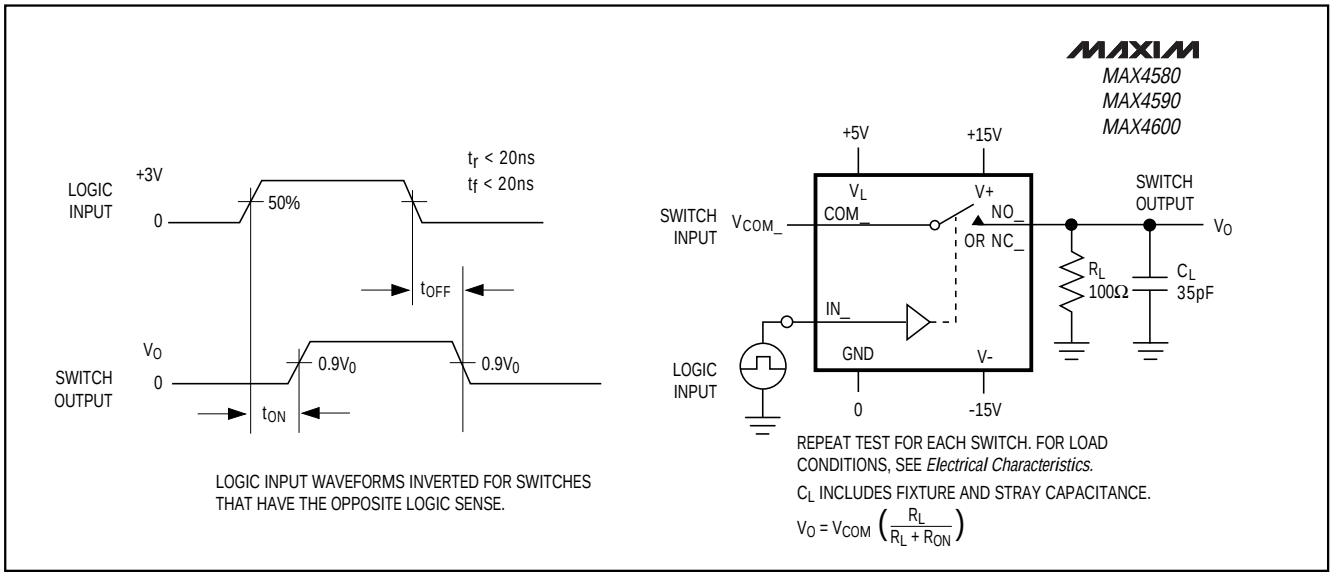


Figure 2. Switching-Time Test Circuit

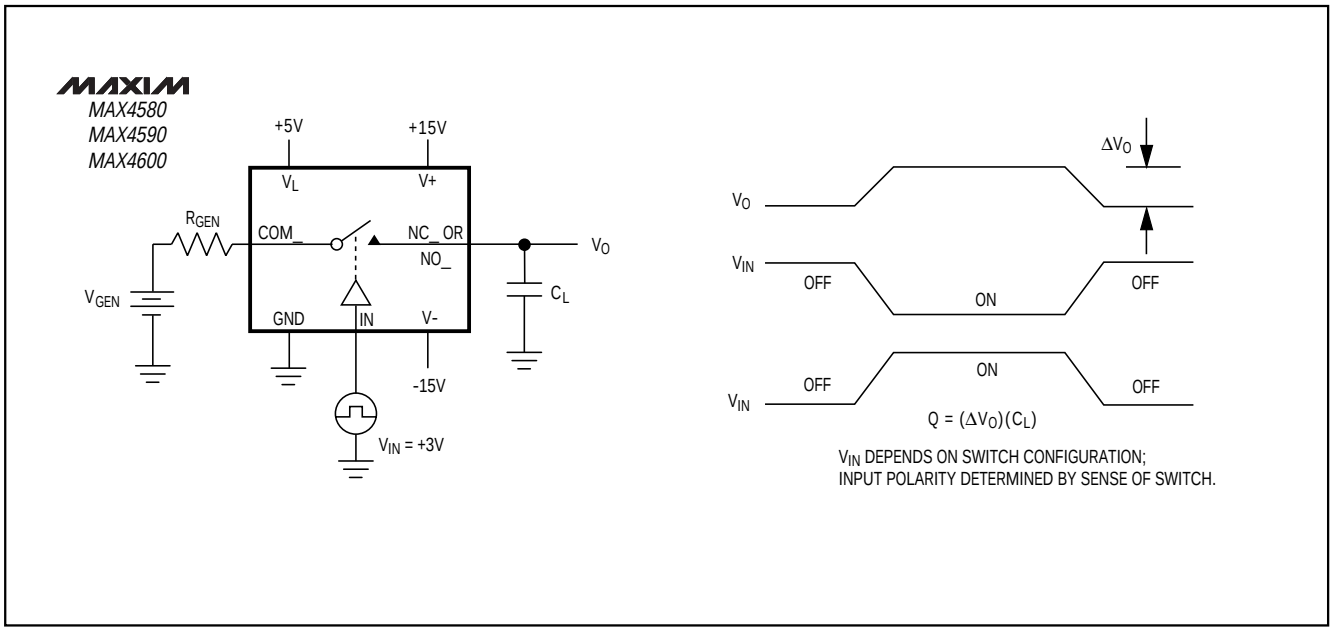


Figure 3. Charge-Injection Test Circuit

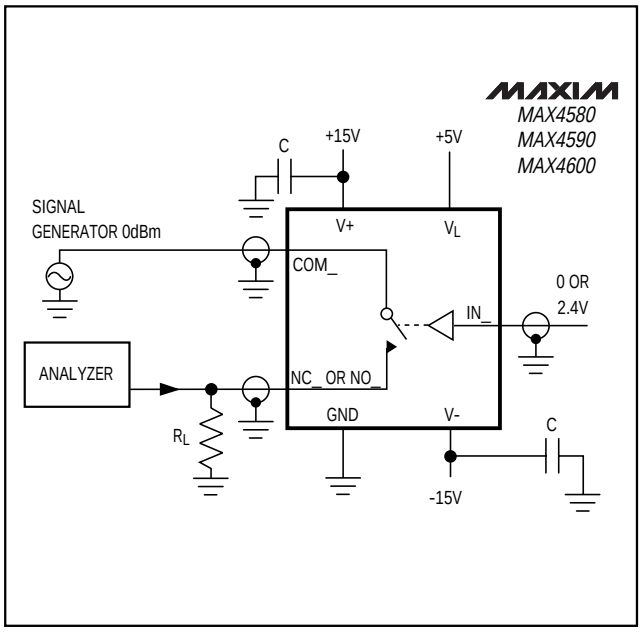


Figure 4. Off-Isolation Test Circuit

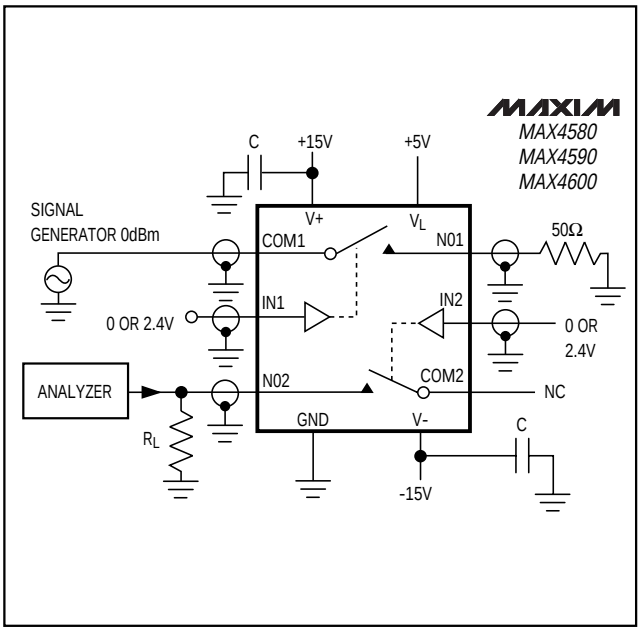


Figure 5. Crosstalk Test Circuit

1.25Ω, Dual SPST, CMOS Analog Switches

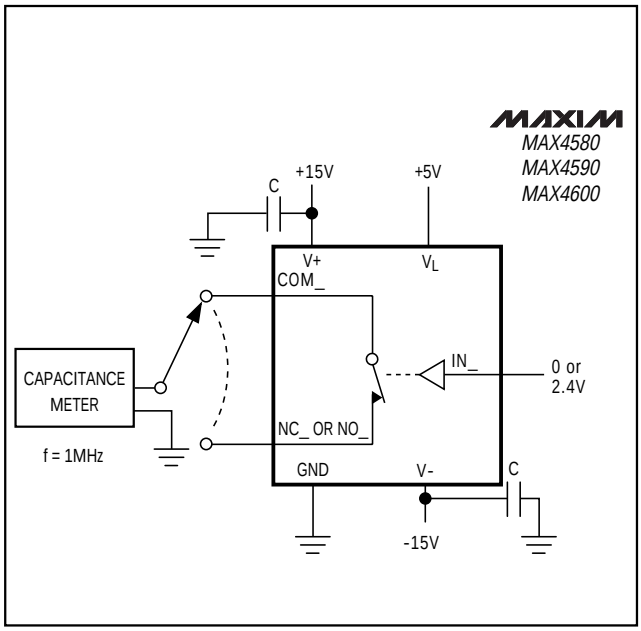


Figure 6. Switch Off-Capacitance Test Circuit

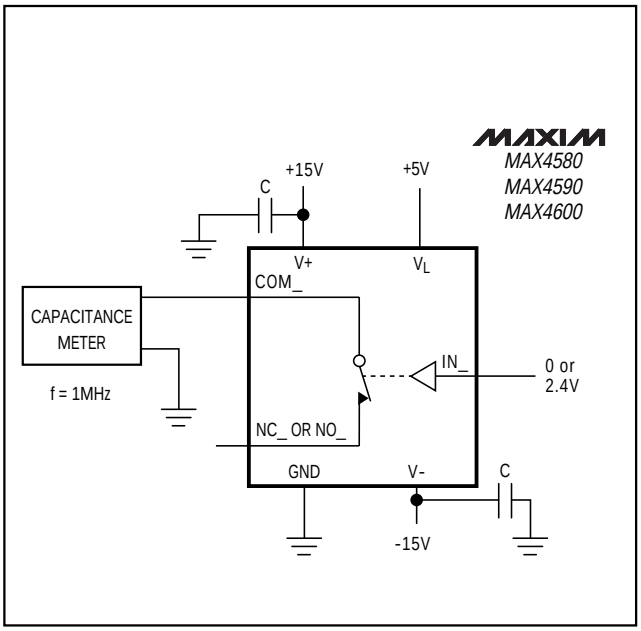


Figure 7. Switch On-Capacitance Test Circuit

Ordering Information (continued)

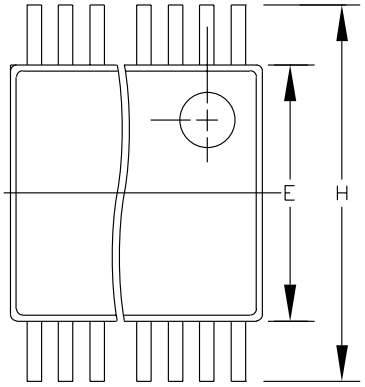
PART	TEMP. RANGE	PIN-PACKAGE
MAX4590CAE	0°C to +70°C	16 SSOP
MAX4590CWE	0°C to +70°C	16 Wide SO
MAX4590CPE	0°C to +70°C	16 Plastic DIP
MAX4590EAE	-40°C to +85°C	16 SSOP
MAX4590EWE	-40°C to +85°C	16 Wide SO
MAX4590EPE	-40°C to +85°C	16 Plastic DIP
MAX4600CAE	0°C to +70°C	16 SSOP
MAX4600CWE	0°C to +70°C	16 Plastic DIP
MAX4600CPE	0°C to +70°C	16 Wide SO
MAX4600EAE	-40°C to +85°C	16 SSOP
MAX4600EWE	-40°C to +85°C	16 Wide SO
MAX4600EPE	-40°C to +85°C	16 Plastic DIP

Chip Information

TRANSISTOR COUNT: 100

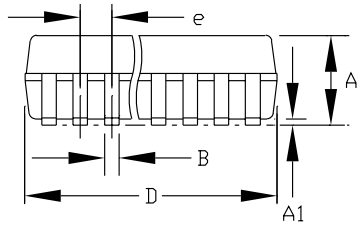
Package Information

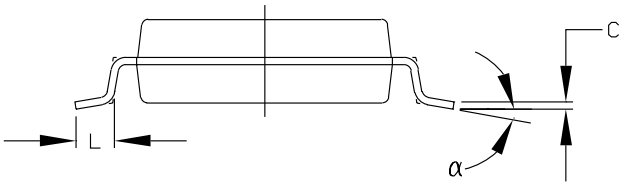
SSOP.EPS



DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.068	0.078	1.73	1.99
A1	0.002	0.008	0.05	0.21
B	0.010	0.015	0.25	0.38
C	0.004	0.008	0.09	0.20
D	SEE VARIATIONS			
E	0.205	0.209	5.20	5.38
e	0.0256 BSC		0.65 BSC	
H	0.301	0.311	7.65	7.90
L	0.025	0.037	0.63	0.95
α	0°	8°	0°	8°

	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX	
D	0.239	0.249	6.07	6.33	14L
D	0.239	0.249	6.07	6.33	16L
D	0.278	0.289	7.07	7.33	20L
D	0.317	0.328	8.07	8.33	24L
D	0.397	0.407	10.07	10.33	28L





NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER

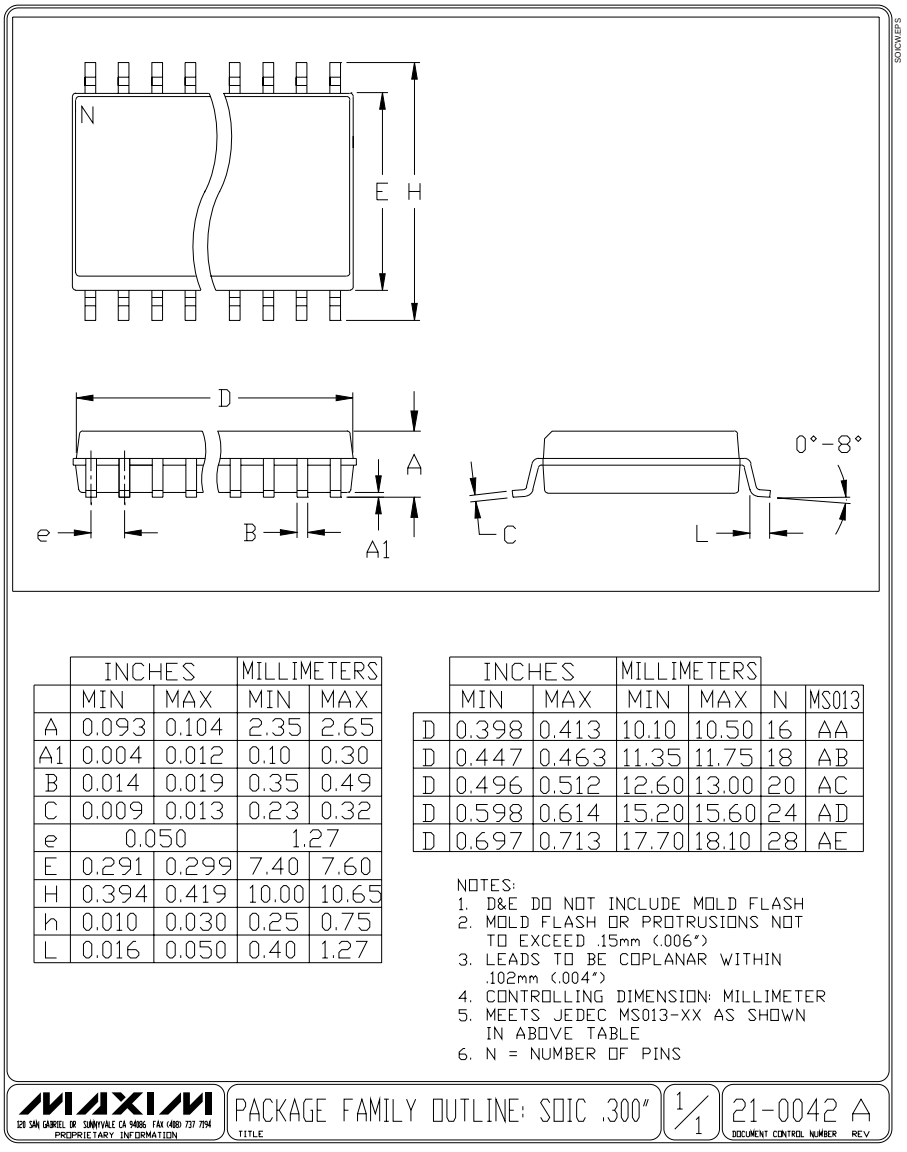
MAXIM
PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, SSOP, 5.3X.65mm

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0056	A	1/1

1.25Ω, Dual SPST, CMOS Analog Switches

Package Information (continued)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
e	0.050		1.27	
E	0.291	0.299	7.40	7.60
H	0.394	0.419	10.00	10.65
h	0.010	0.030	0.25	0.75
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS013
D	0.398	0.413	10.10	10.50	16	AA
D	0.447	0.463	11.35	11.75	18	AB
D	0.496	0.512	12.60	13.00	20	AC
D	0.598	0.614	15.20	15.60	24	AD
D	0.697	0.713	17.70	18.10	28	AE

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS013-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

PACKAGE FAMILY OUTLINE: SOIC .300"
TITLE

1/1

21-0042 A
DOCUMENT CONTROL NUMBER REV.