

MAXIM

1.25 Ω , Dual SPST, CMOS Analog Switches

General Description

The MAX4580/MAX4590/MAX4600 dual analog switches feature low on-resistance of 1.25 Ω max. On-resistance is matched between switches to 0.25 Ω max and is flat (0.3 Ω 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 $\pm 4.5V$ to $\pm 20V$ 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 $\pm 15V$ dual supplies.

Applications

Reed Relay Replacement
Test Equipment
Communication Systems
PBX, PABX Systems

Features

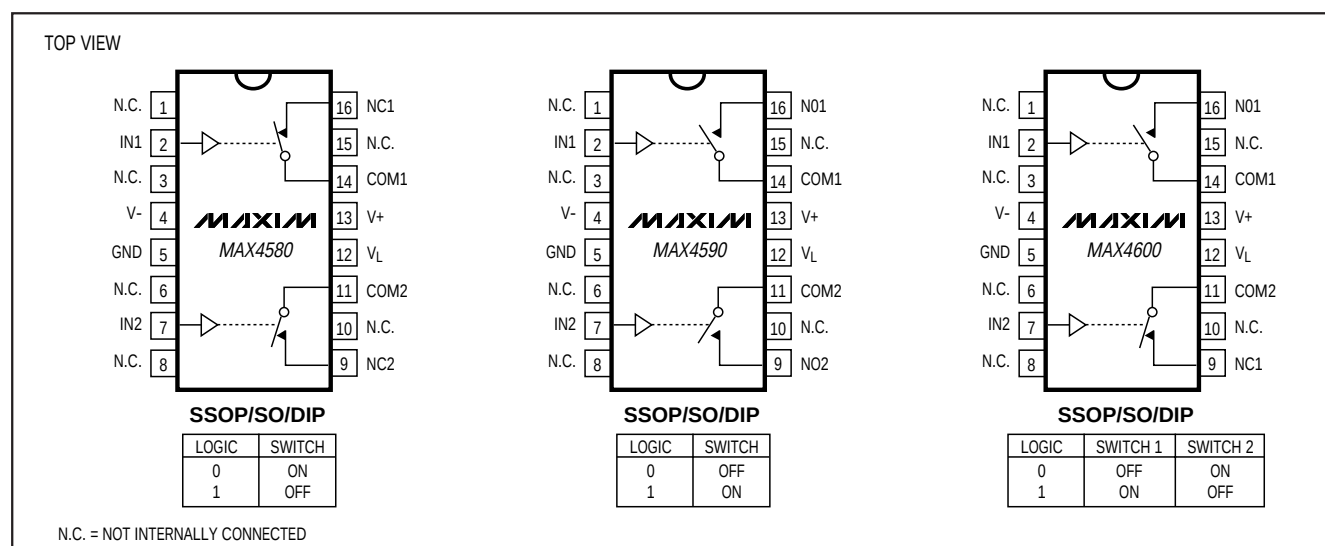
- ♦ Low On-Resistance (1.25 Ω max)
- ♦ Guaranteed R_{ON} Match Between Channels (0.25 Ω max)
- ♦ Guaranteed R_{ON} Flatness Over Specified Signal Range (0.3 Ω max)
- ♦ Rail-to-Rail Signal Handling
- ♦ Guaranteed ESD Protection >2kV per Method 3015.7
- ♦ Single-Supply Operation: +4.5V to +36V
Dual-Supply Operation: $\pm 4.5V$ to $\pm 20V$
- ♦ 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



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



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For small orders, phone 1-800-835-8769.

MAX4580/MAX4590/MAX4600

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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}	$I_{COM_} = 10\text{mA}$, $V_{NO_}$ or $V_{NC_} = \pm 10\text{V}$,	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	0.9	1.25		Ω
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM_} = 10\text{mA}$, $V_{NO_}$ or $V_{NC_} = \pm 10\text{V}$	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	0.05	0.25		Ω
COM_ to NO_ or NC_ On-Resistance Flatness (Note 5)	$R_{FLAT(ON)}$	$I_{COM_} = 10\text{mA}$; $V_{NO_}$ or $V_{NC_} = -5\text{V}, 0, +5\text{V}$	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	0.06	0.3		Ω
Off-Leakage Current (NO_ or NC_) (Note 6)	$I_{NO_}$, $I_{NC_}$	$V_{COM_} = \pm 10\text{V}$, $V_{NO_}$ or $V_{NC_} = \mp 10\text{V}$	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	-0.5	0.01	0.5	nA
COM_ Off-Leakage Current (Note 6)	$I_{COM_ (OFF)}$	$V_{COM_} = \pm 10\text{V}$, $V_{NO_}$ or $V_{NC_} = \mp 10\text{V}$	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	-0.5	0.01	0.5	nA
COM_ On-Leakage Current (Note 6)	$I_{COM_ (ON)}$	$V_{COM_} = \pm 10\text{V}$, $V_{NO_}$ or $V_{NC_} = \pm 10\text{V}$, or floating	$T_A = +25^{\circ}\text{C}$ $T_A = T_{MIN}$ to T_{MAX}	-1	0.01	1	nA
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_H}	$IN_ = 2.4\text{V}$, all others = 0.8V		-0.500	0.001	0.500	μA
Input Current with Input Voltage Low	I_{IN_L}	$IN_ = 0.8\text{V}$, all others = 2.4V		-0.500	0.001	0.500	

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ELECTRICAL CHARACTERISTICS–Dual Supplies (continued)

(V+ = +15V, V- = -15V, VL = +5V, VIN_H = +2.4V, VIN_L = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +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

MAX4580/MAX4590/MAX4600

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ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0, VL = +5V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +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		

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ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0, VL = +5V, VIN_H = 2.4V, VIN_L = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS						
Turn-On Time	tON	VCOM_ = +10V, Figure 2, TA = +25°C		150		ns
Turn-Off Time	tOFF	VCOM_ = +10V, Figure 2, TA = +25°C		200		ns
Charge Injection	Q	CL = 1.0nF, VGEN = 0, RGEN = 0, Figure 3, TA = +25°C		40		pC
Crosstalk (Note 8)	VCT	RL = 50Ω, CL = 5pF, f = 1MHz, Figure 5, TA = +25°C		-65		dB
NC_ or NO_ Capacitance	C(OFF)_	f = 1MHz, Figure 6, TA = +25°C		175		pF
COM Off-Capacitance	C(COM)_	f = 1MHz, Figure 6, TA = +25°C		175		pF
On-Capacitance	C(COM)_	f = 1MHz, Figure 7, TA = +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.

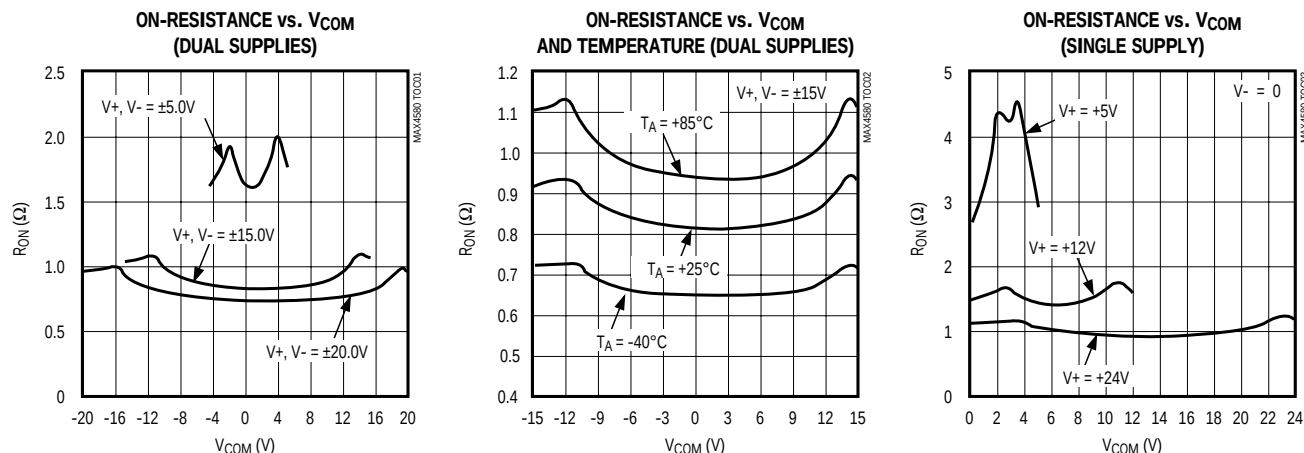
Note 7: Off-isolation = $20 \log_{10} [V_{COM} / (V_{NC} \text{ or } V_{NO})]$, VCOM = output, VNC or VNO = input to off switch.

Note 8: Between any two switches.

Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

Typical Operating Characteristics

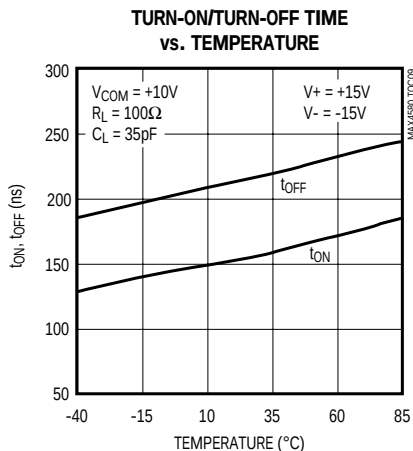
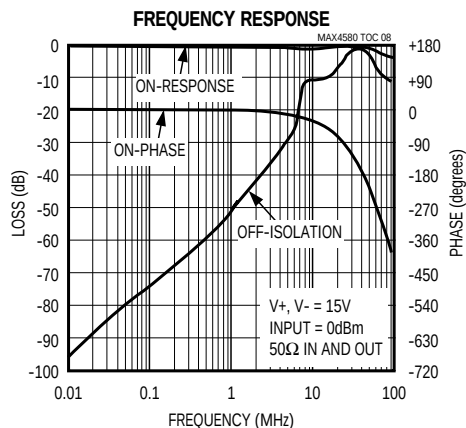
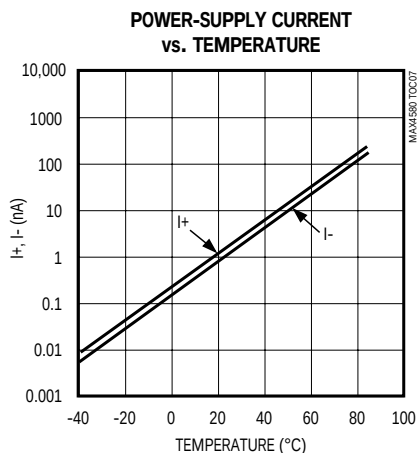
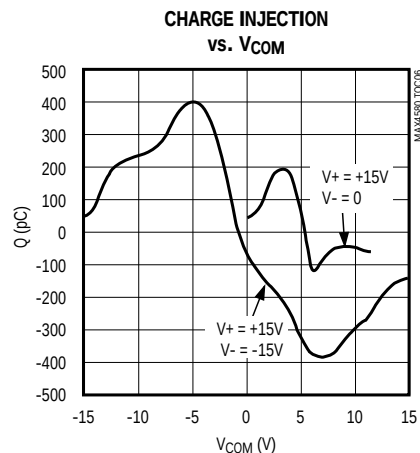
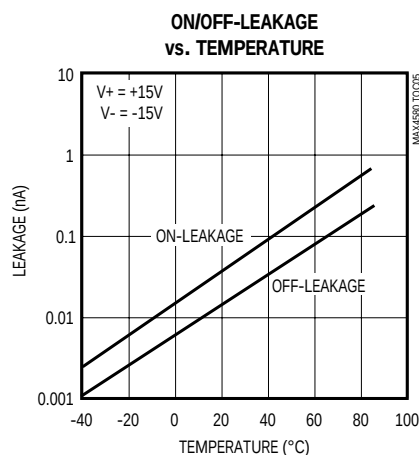
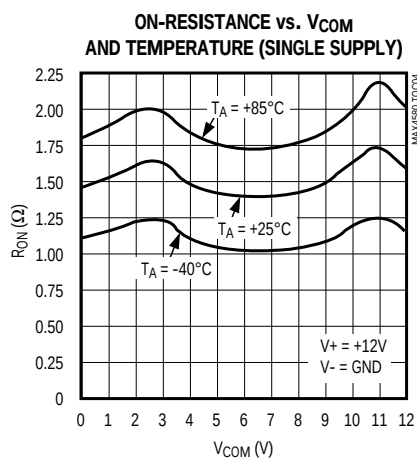
(Circuit of Figure 1, TA = +25°C, unless otherwise noted.)



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Typical Operating Characteristics (continued)

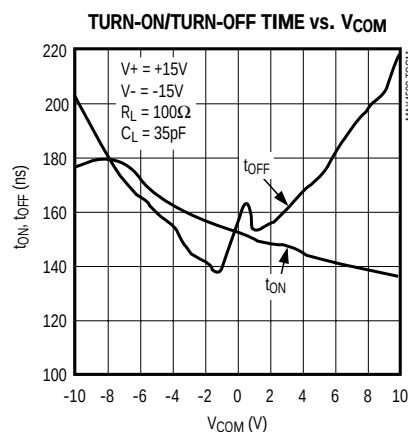
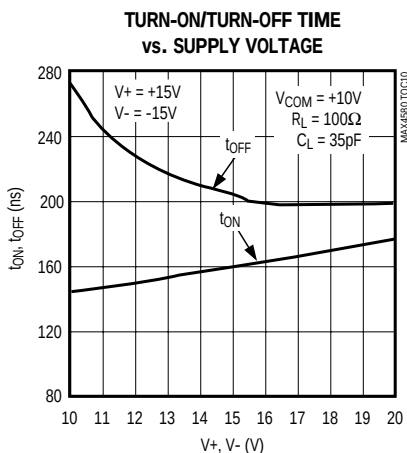
(Circuit of Figure 1, $T_A = +25^\circ\text{C}$, unless otherwise noted.)



1.25Ω, Dual SPST, CMOS Analog Switches

Typical Operating Characteristics (continued)

(Circuit of Figure 1, $T_A = +25^\circ\text{C}$, unless otherwise noted.)



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

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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.

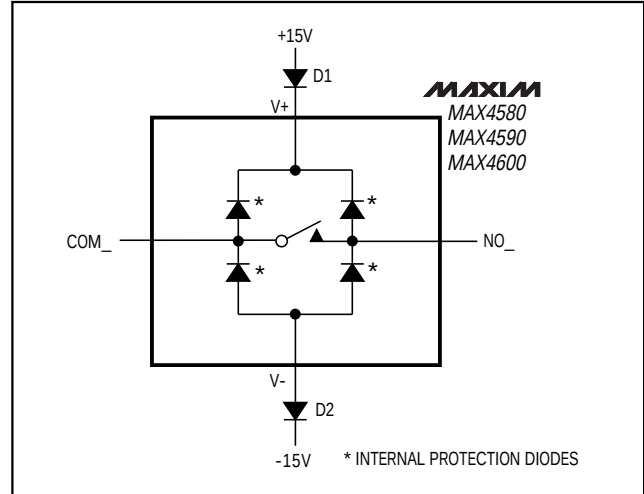


Figure 1. Overvoltage Protection Using External Blocking Diodes

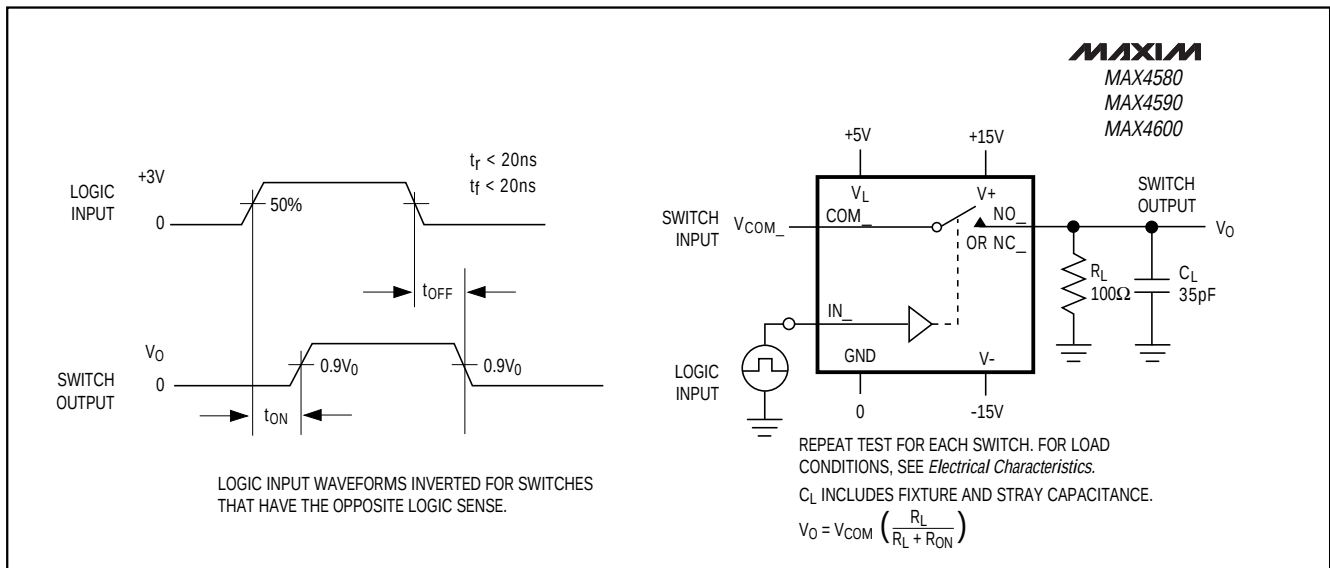


Figure 2. Switching-Time Test Circuit

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MAX4580/MAX4590/MAX4600

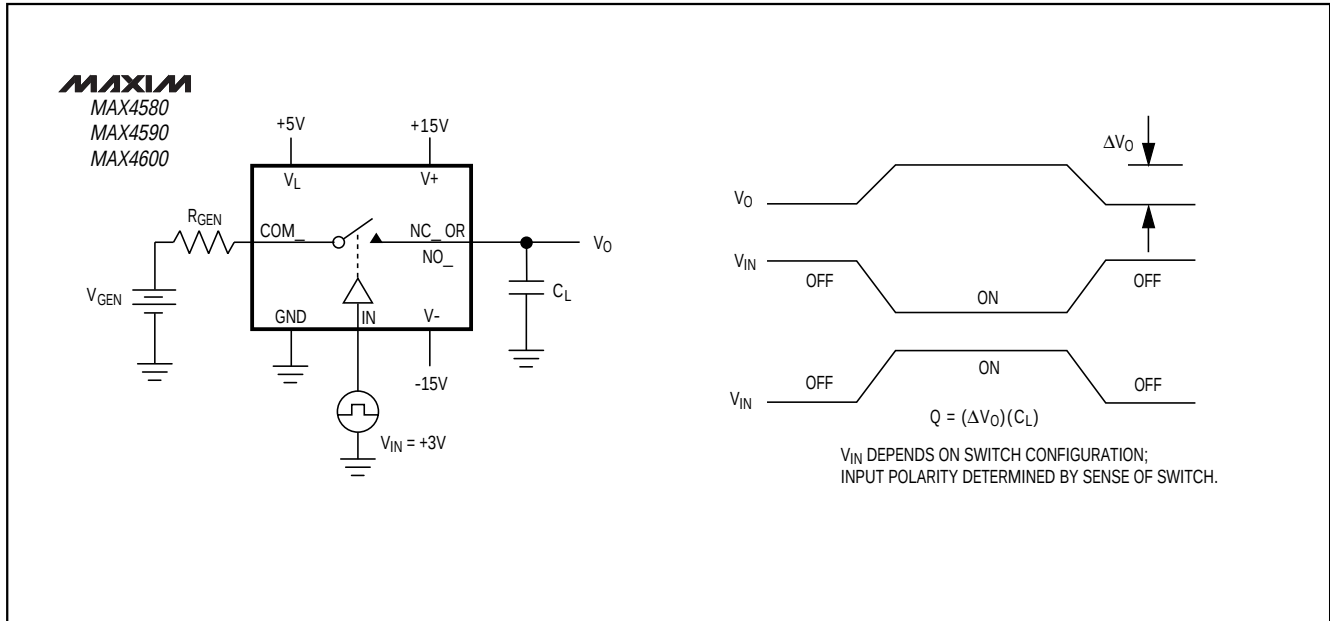


Figure 3. Charge-Injection Test Circuit

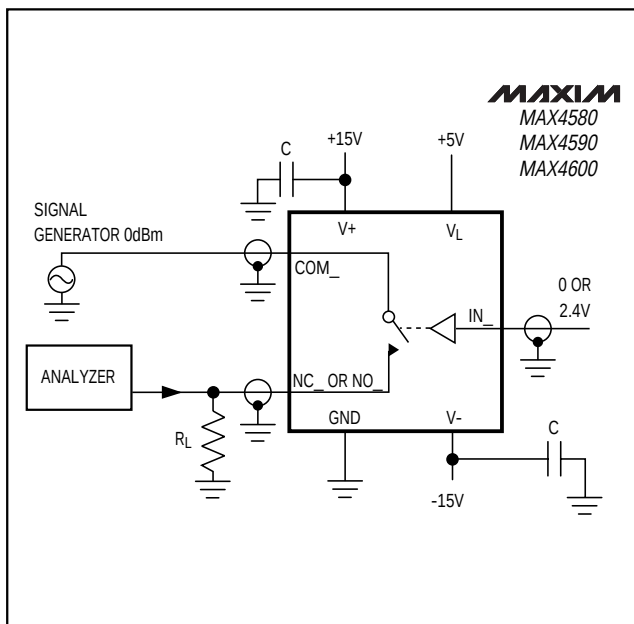


Figure 4. Off-Isolation Test Circuit

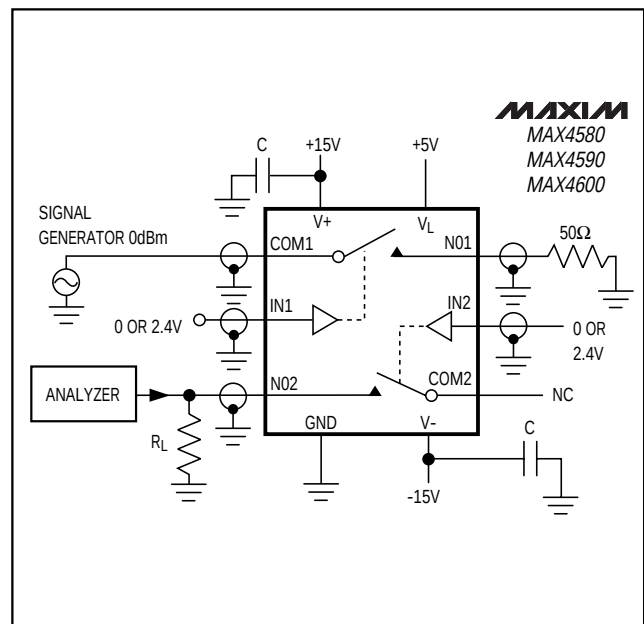


Figure 5. Crosstalk Test Circuit

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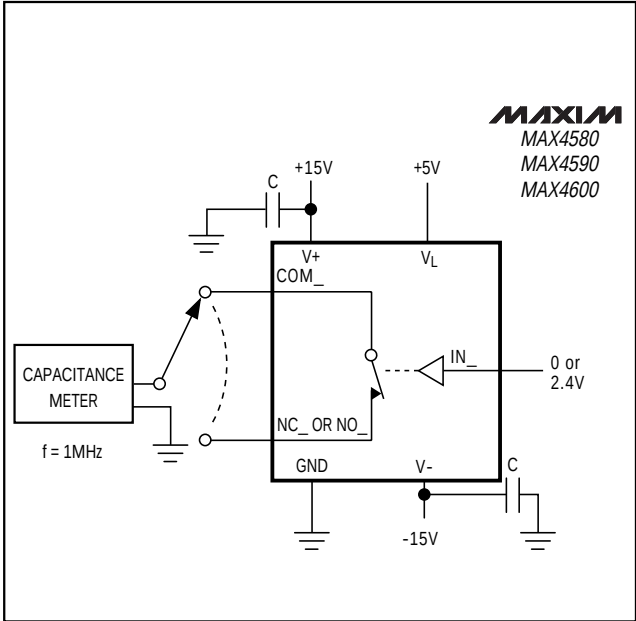


Figure 6. Switch Off-Capacitance Test Circuit

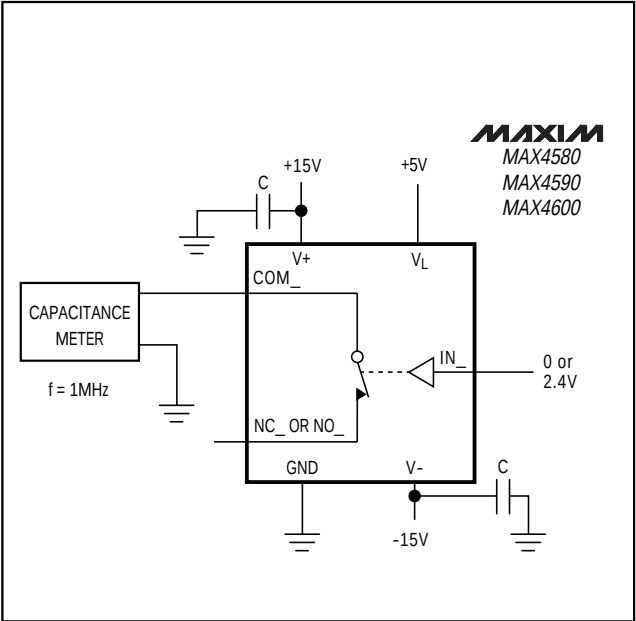


Figure 7. Switch On-Capacitance Test Circuit

Ordering Information (continued)

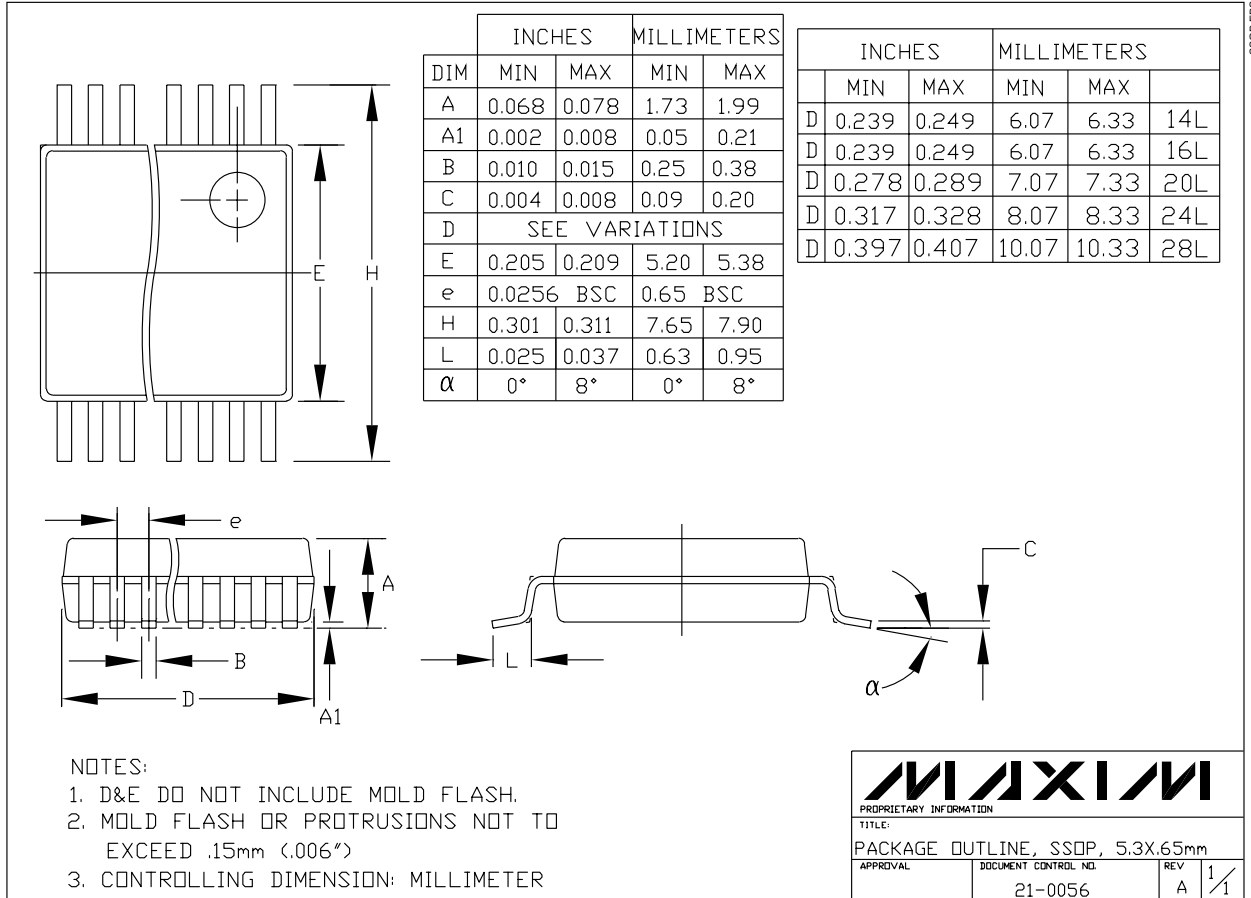
PART	TEMP. RANGE	PIN-PACKAGE
MAX4590 CAE	0°C to +70°C	16 SSOP
MAX4590CWE	0°C to +70°C	16 Wide SO
MAX4590CPE	0°C to +70°C	16 Plastic DIP
MAX4590EAE	-40°C to +85°C	16 SSOP
MAX4590EWE	-40°C to +85°C	16 Wide SO
MAX4590EPE	-40°C to +85°C	16 Plastic DIP
MAX4600 CAE	0°C to +70°C	16 SSOP
MAX4600CWE	0°C to +70°C	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

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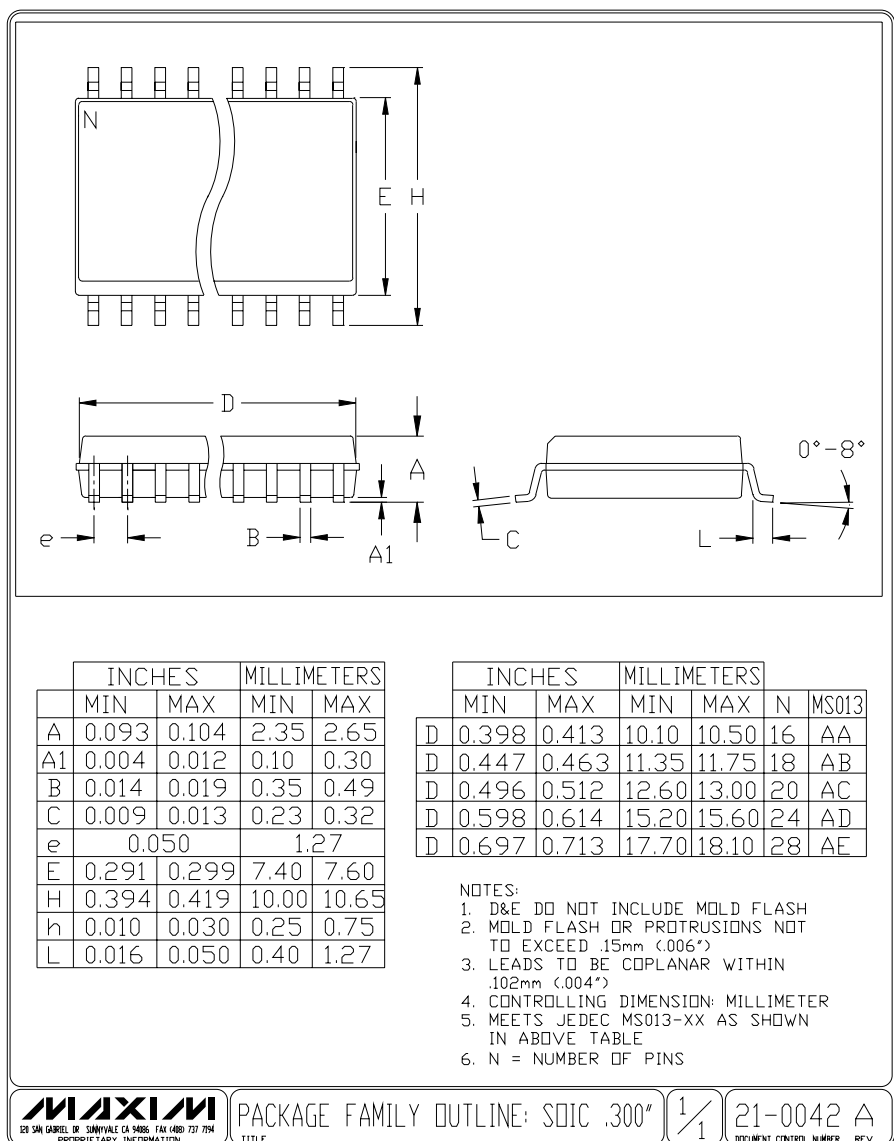
Package Information



MAX4580/MAX4590/MAX4600

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Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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