



High-Speed, Single-Supply, Quad, SPST Analog Switches

General Description

The MAX4591/MAX4592/MAX4593 are high-speed, precision, quad, single-pole/single-throw (SPST) analog switches designed to operate at +12V or +15V. The MAX4591 has four normally closed (NC) switches, and the MAX4592 has four normally open (NO) switches. The MAX4593 has two NO and two NC switches. All three devices offer low leakage (100pA max) and fast switching speeds ($t_{ON} \leq 80ns$, $t_{OFF} \leq 45ns$).

With a +12V supply, the MAX4591/MAX4592/MAX4593 offer guaranteed 1Ω max channel-to-channel matching, 20Ω max on-resistance (R_{ON}), and 1.75Ω max R_{ON} flatness over the specified range.

These switches are also fully specified for single +15V operation, with 16Ω max R_{ON} , 1.5Ω max R_{ON} match, and 1.5Ω max flatness. For low-voltage or dual-supply operation, refer to the MAX391 data sheet.

These low-voltage switches also offer 5pC max charge injection, and electrostatic discharge (ESD) protection is greater than 2000V, per Method 3015.7.

Applications

Test Equipment	Sample-and-Hold Circuits
Disk Drives	Guidance and Control Systems
Tape Drives	Military Radios
Audio and Video	Communications Systems
Switching	PBX, PABX
Heads-Up Displays	

Features

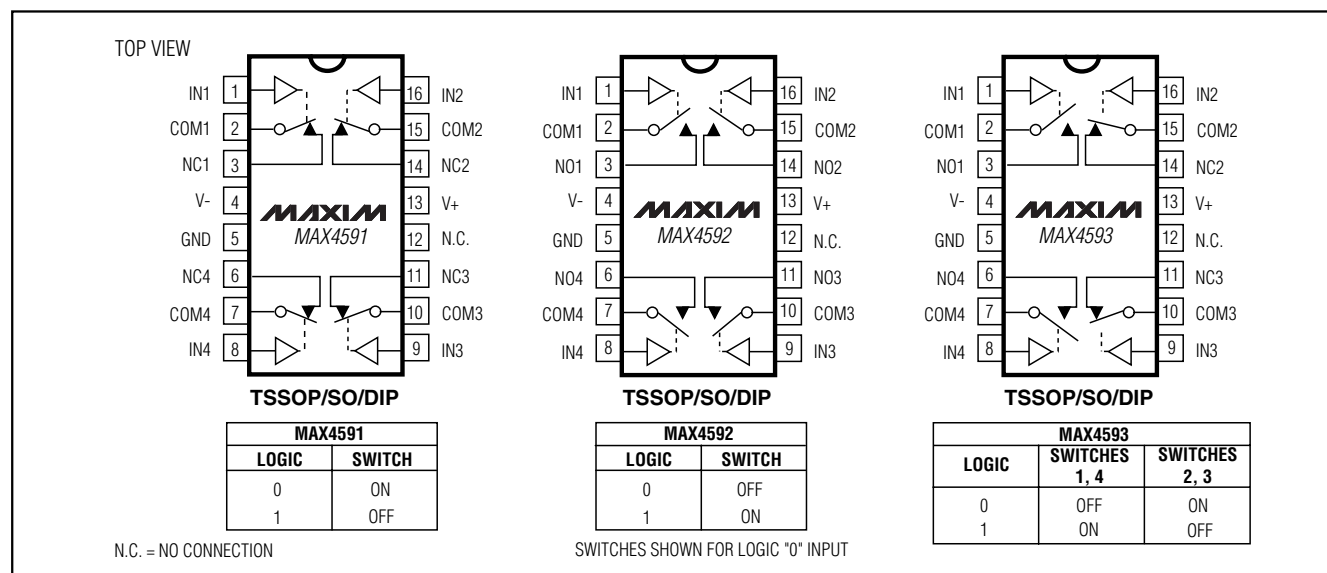
- ◆ Low 16Ω On-Resistance
- ◆ Fast Switching Times: $t_{ON} = 50ns$, $t_{OFF} = 30ns$
- ◆ Guaranteed 1Ω max On-Resistance Match Between Channels
- ◆ Guaranteed 1.75Ω max On-Resistance Flatness over Signal Range
- ◆ Guaranteed 5pC max Charge Injection
- ◆ Improved Leakage over Temperature: 5nA max at +85°C
- ◆ ESD >2000V per Method 3015.7
- ◆ +12V or +15V Single-Supply Operation
- ◆ Pin Compatible with DG611/DG612/DG613, DG211/DG212/DG213

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4591CUE	0°C to +70°C	16 TSSOP
MAX4591CSE	0°C to +70°C	16 Narrow SO
MAX4591CPE	0°C to +70°C	16 Plastic DIP
MAX4591EUE	-40°C to +85°C	16 TSSOP
MAX4591ESE	-40°C to +85°C	16 Narrow SO
MAX4591EPE	-40°C to +85°C	16 Plastic DIP

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables



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ABSOLUTE MAXIMUM RATINGS

V+ to GND-0.3V to +17V
 VIN_, VCOM_, VNC_, VNO_ (Note 1)V- to V+
 Current (any terminal)30mA
 Peak Current, COM_, NO_, NC_
 (pulsed at 1ms, 10% duty cycle max)100mA
 ESD per Method 3015.7>2000V
 Continuous Power Dissipation (TA = +70°C)
 16-Pin TSSOP (derate 5.70mW/°C above +70°C)457mW

16-Pin Narrow SO (derate 8.70mW/°C above +70°C)696mW
 16-Pin Plastic DIP (derate 10.53mW/°C above +70°C) ...842mW
 Operating Temperature Ranges
 MAX459_C_E0°C to +70°C
 MAX459_E_E-40°C to +85°C
 Storage Temperature Range-65°C to +150°C
 Lead Temperature (soldering, 10s)+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—Single +12V Supply

(V+ = +12V, V- = GND = 0, VINH = 5V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
ANALOG SWITCH						
Analog Signal Range	VCOM_, VNO_, VNC_	(Note 3)	C, E	V-	V+	V
On-Resistance	RON	ICOM_ = -10mA, VNO_ or VNC_ = 10V	TA = +25°C C, E	16 24	20	Ω
On-Resistance Match Between Channels (Note 4)	ΔRON	ICOM_ = -10mA, VNO_ or VNC_ = 10V	TA = +25°C C, E	0.5 1.5	1	Ω
On-Resistance Flatness (Note 5)	RFLAT(ON)	ICOM_ = -10mA; VNO_ or VNC_ = 3V, 6V, 9V	TA = +25°C C, E	1 2	1.75	Ω
NO or NC Off-Leakage Current (Note 6)	INO_(OFF) or INC_(OFF)	V+ = 15.5V; VCOM_ = 14V, 1V; VNO_ or VNC_ = 1V, 14V	TA = +25°C C, E	-0.1 -5	0.01 5	0.1 nA
COM Off-Leakage Current (Note 6)	ICOM_(OFF)	V+ = 15.5V; VCOM_ = 14V, 1V; VNO_ or VNC_ = 1V, 14V	TA = +25°C C, E	-0.1 -5	0.01 5	0.1 nA
COM On-Leakage Current (Note 6)	ICOM_(ON)	V+ = 15.5V; VCOM_ = 14V, 1V; VNO_ or VNC_ = 14V, 1V, or floating	TA = +25°C C, E	-0.2 -10	0.01 10	0.2 nA

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ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

(V+ = +12V, V- = GND = 0, VINH = 5V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
LOGIC INPUT							
Input Current with Input Voltage High	I _{INH}	IN ₋ = V+, all others = 0.8V		-0.5	0.005	0.5	μA
Input Current with Input Voltage Low	I _{INL}	IN ₋ = 0.8V, all others = V+		-0.5	0.005	0.5	μA
DYNAMIC							
Turn-On Time	t _{ON}	V _{COM-} = 10V, Figure 2	T _A = +25°C	50		80	ns
			C, E	90			
Turn-Off Time	t _{OFF}	V _{COM-} = 10V, Figure 2	T _A = +25°C	30		45	ns
			C, E	50			
Break-Before-Make Time Delay (Note 3)	t _D	MAX4593 only, R _L = 300Ω, C _L = 35pF, Figure 3		5	20		ns
Charge Injection (Note 3)	Q	C _L = 1nF, V _{GEN} = 0, R _{GEN} = 0Ω, Figure 4	T _A = +25°C	2		5	pC
Off-Isolation (Note 7)	OIRR	R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 5	T _A = +25°C	72			dB
Crosstalk (Note 8)		R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 6	T _A = +25°C	85			dB
NC ₋ or NO ₋ Capacitance	C _(OFF)	f = 1MHz, Figure 7	T _A = +25°C	9			pF
COM ₋ Off-Capacitance	C _{COM-(OFF)}	f = 1MHz, Figure 7	T _A = +25°C	9			pF
COM ₋ On-Capacitance	C _{COM-(ON)}	f = 1MHz, Figure 8	T _A = +25°C	22			pF
SUPPLY							
Power-Supply Range				3	16		V
Positive Supply Current	I ₊	V ₊ = 15V, V _{IN-} = 0 or V ₊ , all channels on or off	C, E	-1	0.001	1	μA

MAX4591/MAX4592/MAX4593

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ELECTRICAL CHARACTERISTICS—Single +15V Supply

(V+ = +15V, V- = GND = 0, VINH = 5V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.)
(Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V _{COM-} , V _{NO-} , V _{NC-}	(Note 3)		0		V+	V
On-Resistance	R _{ON}	I _{COM-} = -10mA, V _{NO-} or V _{NC-} = 10V	T _A = +25°C	12	16		Ω
			C, E		2.0		
On-Resistance Match Between Channels (Notes 3, 4)	ΔR _{ON}	I _{COM-} = -10mA, V _{NO-} or V _{NC-} = 10V	T _A = +25°C	0.5	1.5		Ω
			C, E		2.0		
On-Resistance Flatness (Notes 3, 5)	R _{FLAT(ON)}	I _{COM-} = -10mA; V _{NO-} or V _{NC-} = 3V, 6V, 9V	T _A = +25°C	0.7	1.5		Ω
			C, E		2.0		
NO_ or NC_ Off-Leakage Current (Note 6)	I _{NO-(OFF)} or I _{NC-(OFF)}	V+ = 15.5V; V _{COM-} = 14V, 1V; V _{NO-} or V _{NC-} = 1V, 14V	T _A = +25°C	-0.1	0.01	0.1	nA
			C, E	-5		5	
COM_ Off-Leakage Current (Note 6)	I _{COM-(OFF)}	V+ = 15.5V; V _{COM-} = 14V, 1V; V _{NO-} or V _{NC-} = 1V, 14V	T _A = +25°C	-0.1	0.01	0.1	nA
			C, E	-5		5	
COM_ On-Leakage Current (Note 6)	I _{COM-(ON)}	V+ = 15.5V; V _{COM-} = 14V, 1V; V _{NO-} or V _{NC-} = 14V, 1V, or floating	T _A = +25°C	-0.2	0.02	0.2	nA
			C, E	-10		10	
DYNAMIC							
Turn-On Time	t _{ON}	V _{NO-} or V _{NC-} = 10V, Figure 2	T _A = +25°C	60	80		ns
			C, E		90		
Turn-Off Time	t _{OFF}	V _{NO-} or V _{NC-} = 10V, Figure 2	T _A = +25°C	30	40		ns
			C, E		50		
Break-Before-Make Time Delay (Note 3)	t _D	MAX4593 only, R _L = 300Ω, C _L = 35pF		5	20		ns
Charge Injection (Note 3)	Q	C _L = 1nF, V _{GEN} = 0, R _{GEN} = 0Ω, Figure 4	T _A = +25°C	2	5		pC
SUPPLY							
Positive Supply Current	I+	V+ = 15V, V _{IN-} = 0 or V+, all channels on or off		-1	0.001	1	μA
Negative Supply Current	I-	V+ = 15V, V _{IN-} = 0 or V+, all channels on or off		-1	0.001	1	μA

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: ΔRON = ΔRON max - ΔRON 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 = 20log₁₀ [VCOM / (VNC or VNO)], VCOM = output, VNC or VNO = input to off switch.

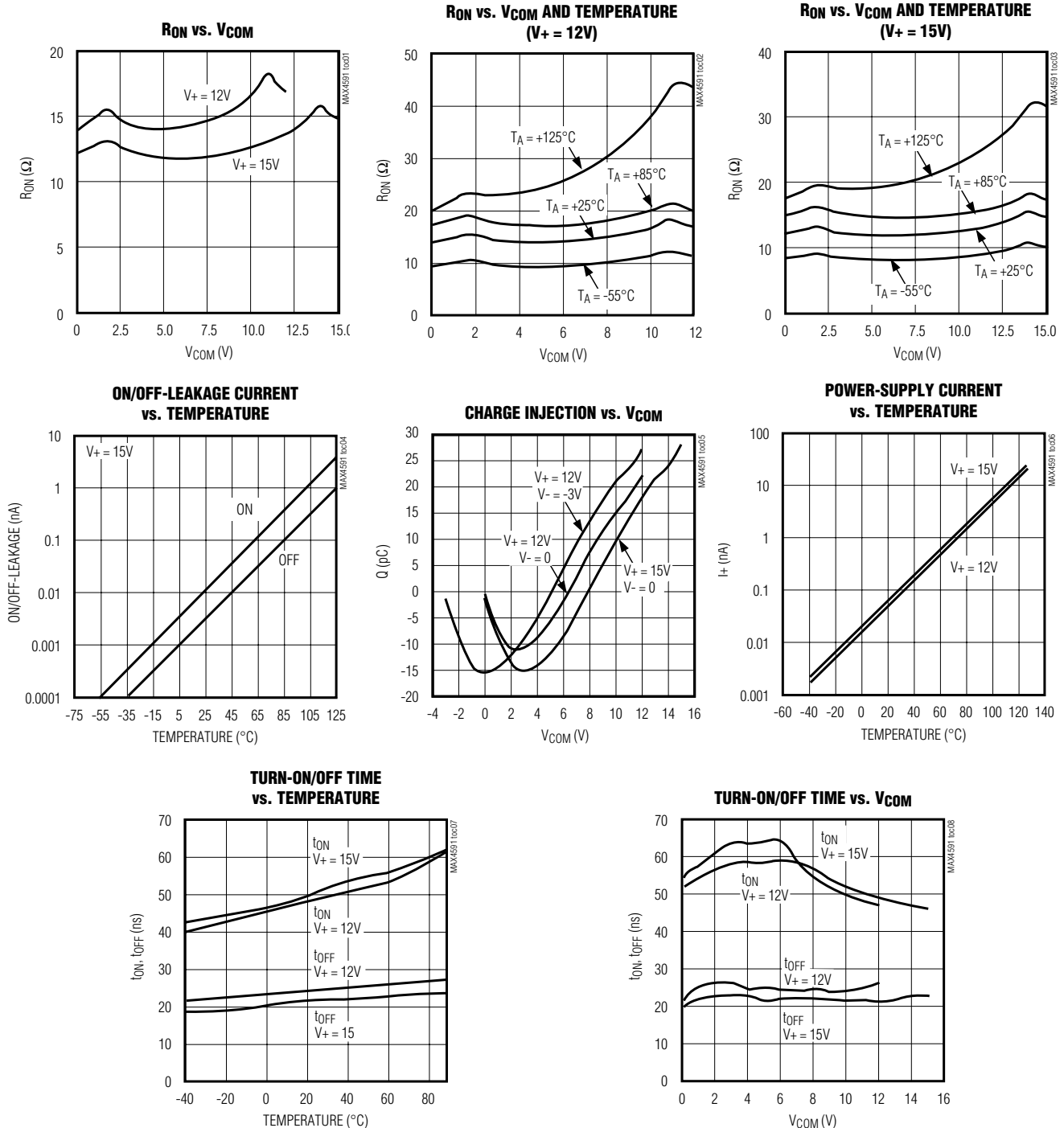
Note 8: Between any two switches.

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Typical Operating Characteristics

($V_- = \text{GND} = 0$, $I_{IN} = 0$ or V_+ , $T_A = +25^\circ\text{C}$, unless otherwise noted.)

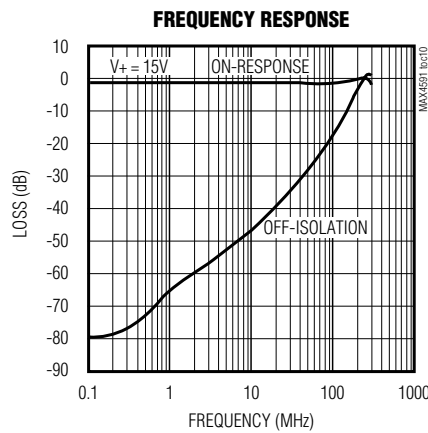
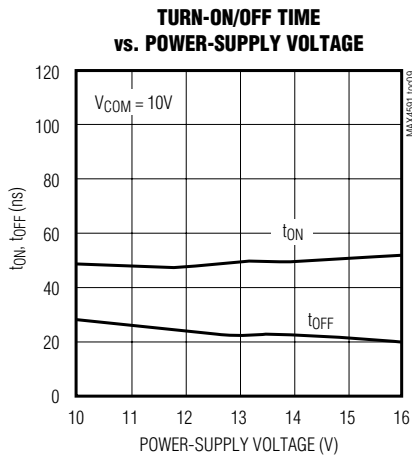
MAX4591/MAX4592/MAX4593



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Typical Operating Characteristics (continued)

(V- = GND = 0, IN- = 0 or V+, TA = +25°C, unless otherwise noted.)



Pin Description

PIN	NAME	FUNCTION
1, 16, 9, 8	IN1-IN4	Switch Input Terminals. Drive $\leq 0.8V$ for logic "0"; drive $\geq 5V$ for logic "1".
2, 15, 10, 7	COM1-COM4	Analog Switch Common Terminal
3, 14, 11, 6	NO1-NO4 or NC1-NC4	Switch Inputs
4	V-	Negative Supply Voltage Input. Normally connected to ground.
5	GND	Ground
12	N.C.	No Connection. Not internally connected.
13	V+	Positive Supply Voltage Input. Connected to substrate.

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 may cause permanent damage to the devices. Always sequence V+ on first, followed by the logic inputs. If power-supply sequencing is not possible, add a small signal diode in series with V+ for overvoltage protection (Figure 1). Adding a diode reduces the analog signal range to 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 17V.

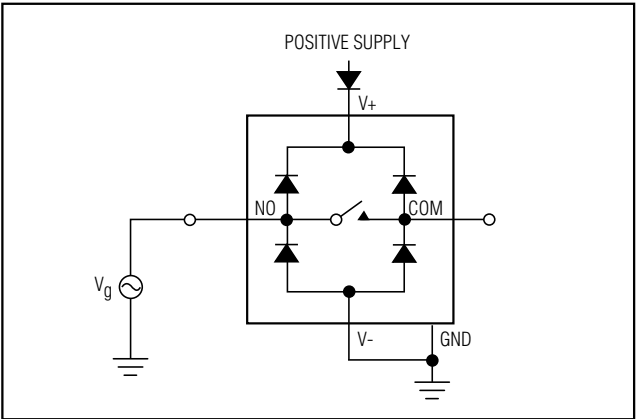


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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Test Circuits/Timing Diagrams

MAX4591/MAX4592/MAX4593

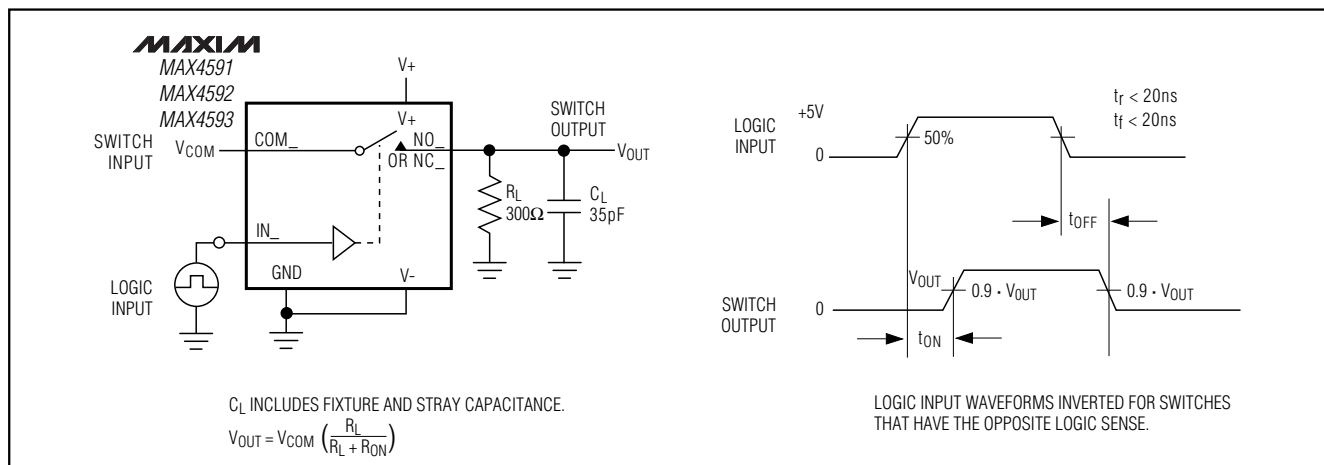


Figure 2. Switching Time

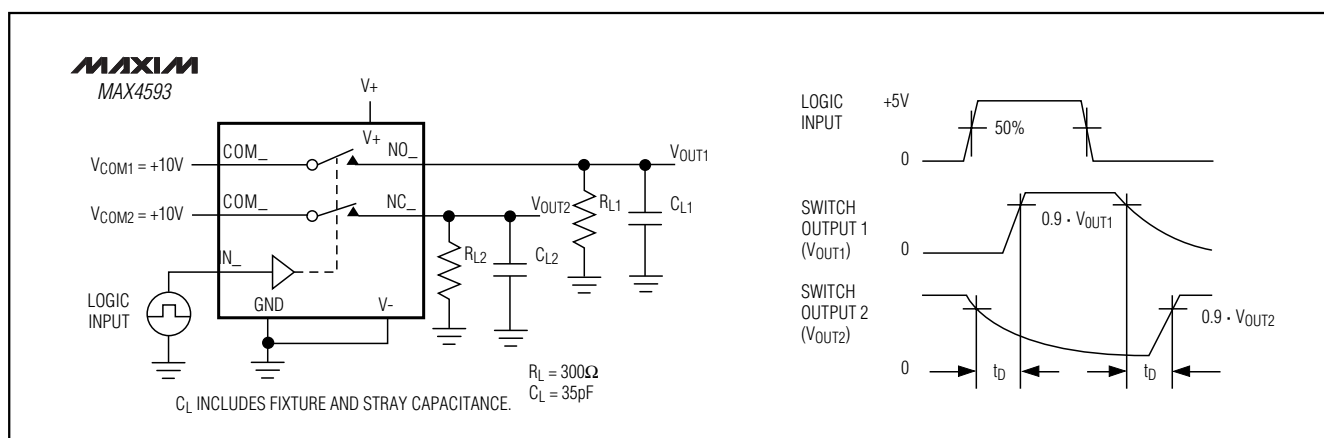


Figure 3. Break-Before-Make Interval (MAX4593 Only)

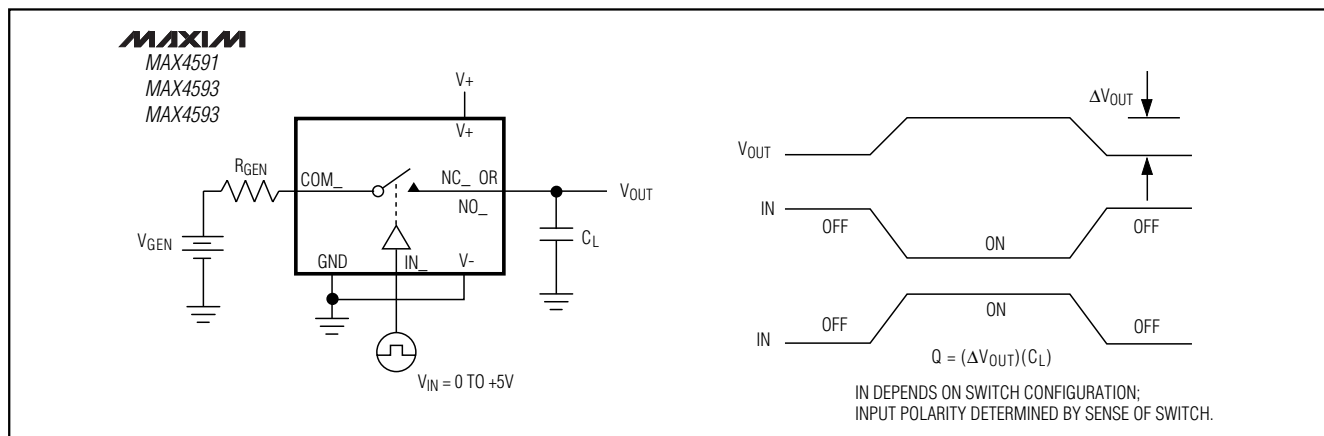


Figure 4. Charge Injection

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Test Circuits/Timing Diagrams (continued)

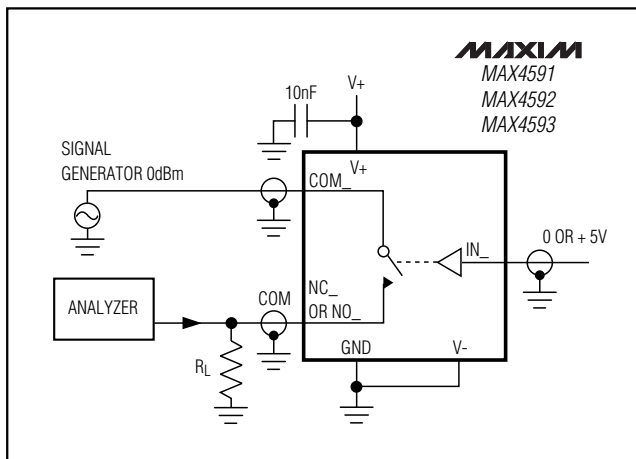


Figure 5. Off-Isolation

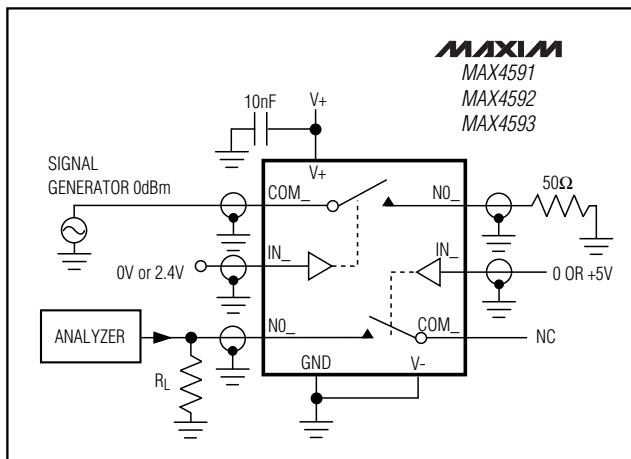


Figure 6. Crosstalk

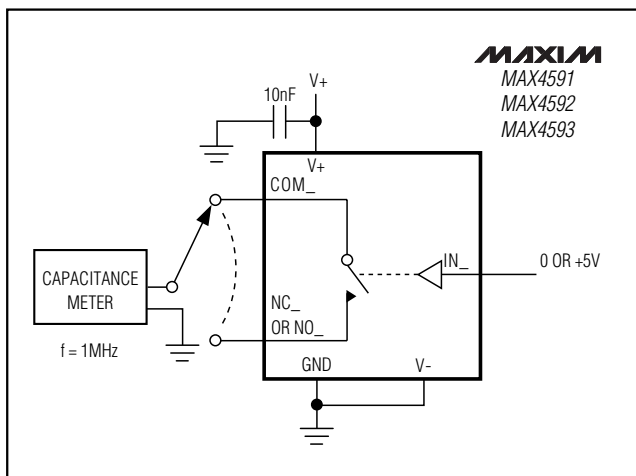


Figure 7. Channel Off-Capacitance

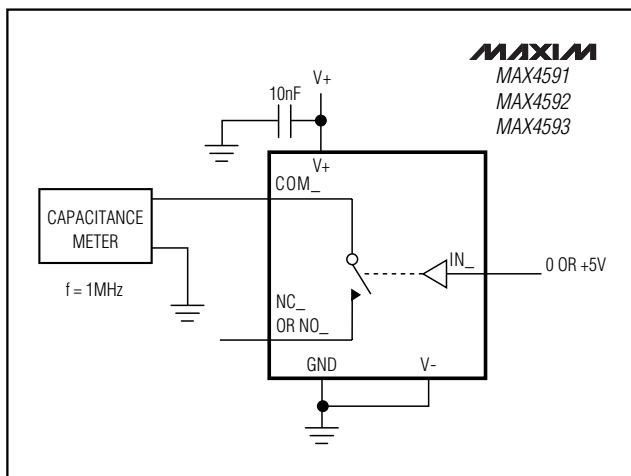


Figure 8. Channel On-Capacitance

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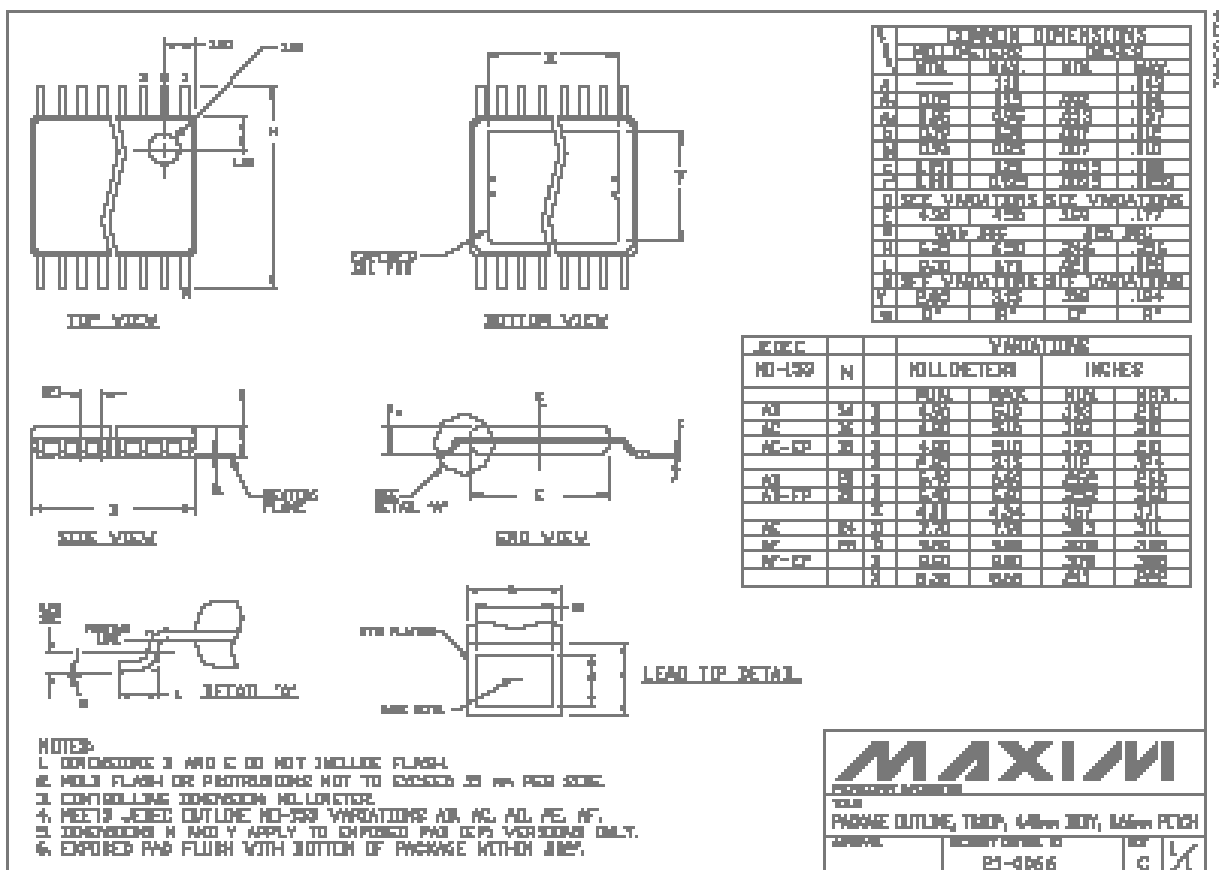
Ordering Information (continued)

Chip Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4592CUE	0°C to +70°C	16 TSSOP
MAX4592CSE	0°C to +70°C	16 Narrow SO
MAX4592CPE	0°C to +70°C	16 Plastic DIP
MAX4592EUE	-40°C to +85°C	16 TSSOP
MAX4592ESE	-40°C to +85°C	16 Narrow SO
MAX4592EPE	-40°C to +85°C	16 Plastic DIP
MAX4593CUE	0°C to +70°C	16 TSSOP
MAX4593CSE	0°C to +70°C	16 Narrow SO
MAX4593CPE	0°C to +70°C	16 Plastic DIP
MAX4593EUE	-40°C to +85°C	16 TSSOP
MAX4593ESE	-40°C to +85°C	16 Narrow SO
MAX4593EPE	-40°C to +85°C	16 Plastic DIP

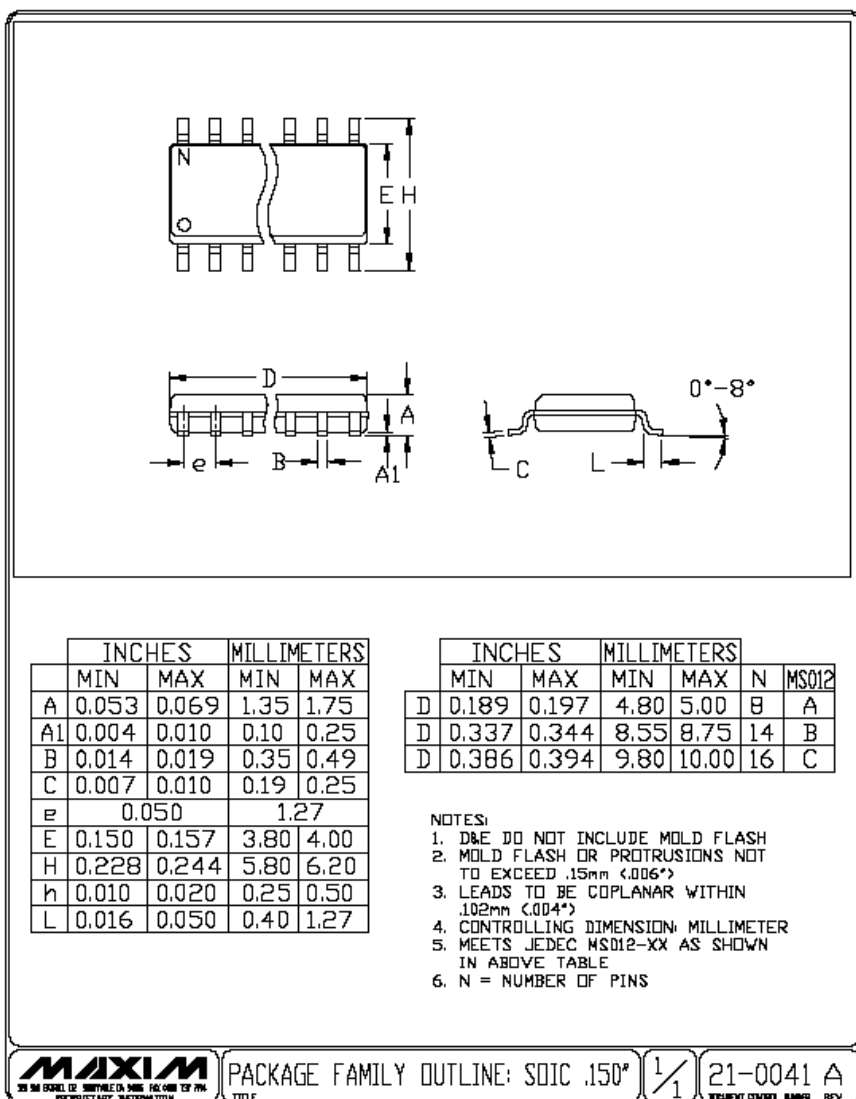
TRANSISTOR COUNT: 76

Package Information



High-Speed, Single-Supply, Quad, SPST Analog Switches

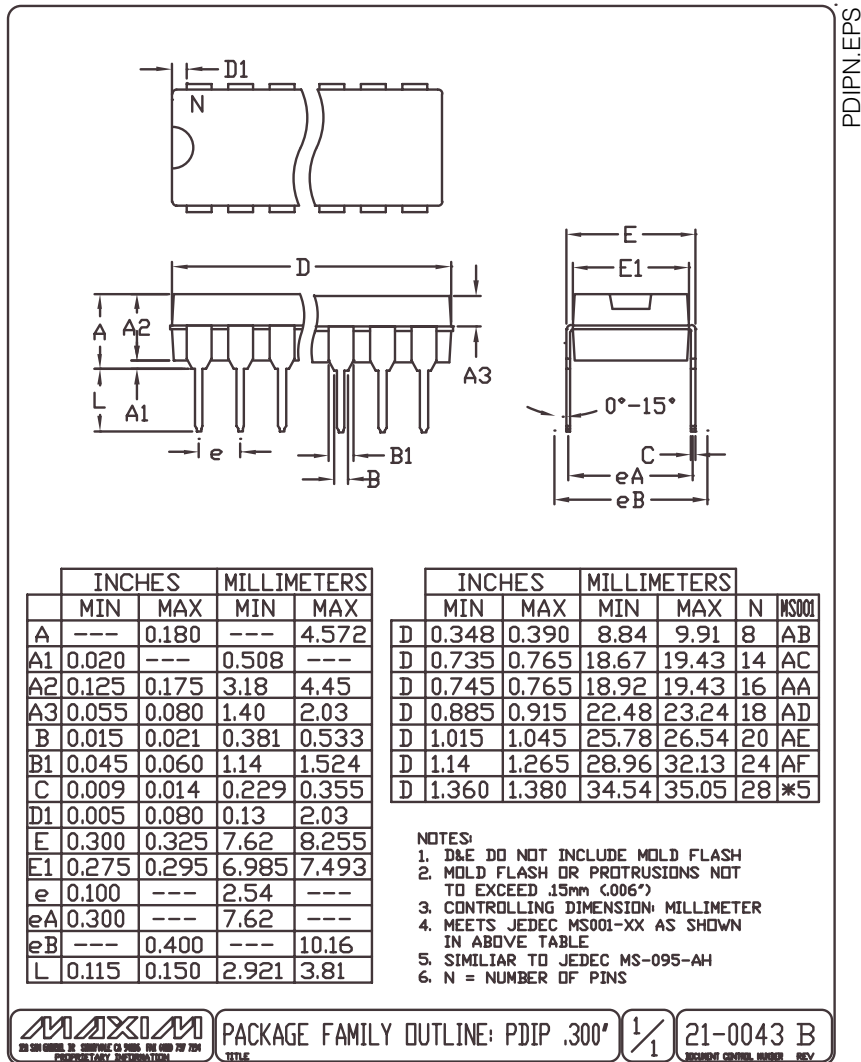
Package Information (continued)



High-Speed, Single-Supply, Quad, SPST Analog Switches

Package Information (continued)

MAX4591/MAX4592/MAX4593



High-Speed, Single-Supply, Quad, SPST Analog Switches

NOTES

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