



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

MAX4591/MAX4592/MAX4593

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

TOP VIEW

TSSOP/SO/DIP

MAX4591	
LOGIC	SWITCH
0	ON
1	OFF

N.C. = NO CONNECTION

TSSOP/SO/DIP

MAX4592	
LOGIC	SWITCH
0	OFF
1	ON

SWITCHES SHOWN FOR LOGIC "0" INPUT

TSSOP/SO/DIP

MAX4593		
LOGIC	SWITCHES 1, 4	SWITCHES 2, 3
0	OFF	ON
1	ON	OFF



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

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_E	0°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 20	24	Ω
On-Resistance Match Between Channels (Note 4)	ΔRON	ICOM_ = -10mA, VNO_ or VNC_ = 10V	TA = +25°C C, E	0.5	1 1.5	Ω
On-Resistance Flatness (Note 5)	RFLAT(ON)	ICOM_ = -10mA; VNO_ or VNC_ = 3V, 6V, 9V	TA = +25°C C, E	1	1.75 2	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

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

MAX4591/MAX4592/MAX4593

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	IINH	IN_ = V+, all others = 0.8V		-0.5	0.005	0.5	μA
Input Current with Input Voltage Low	IINL	IN_ = 0.8V, all others = V+		-0.5	0.005	0.5	μA
DYNAMIC							
Turn-On Time	tON	VCOM_ = 10V, Figure 2	TA = +25°C	50	80		ns
			C, E		90		
Turn-Off Time	tOFF	VCOM_ = 10V, Figure 2	TA = +25°C	30	45		ns
			C, E		50		
Break-Before-Make Time Delay (Note 3)	tD	MAX4593 only, RL = 300Ω, CL = 35pF, Figure 3		5	20		ns
Charge Injection (Note 3)	Q	CL = 1nF, VGEN = 0, RGEN = 0Ω, Figure 4	TA = +25°C		2	5	pC
Off-Isolation (Note 7)	OIRR	RL = 50Ω, CL = 5pF, f = 10MHz, Figure 5	TA = +25°C		72		dB
Crosstalk (Note 8)		RL = 50Ω, CL = 5pF, f = 10MHz, Figure 6	TA = +25°C		85		dB
NC_ or NO_ Capacitance	C(OFF)	f = 1MHz, Figure 7	TA = +25°C		9		pF
COM_ Off-Capacitance	CCOM_(OFF)	f = 1MHz, Figure 7	TA = +25°C		9		pF
COM_ On-Capacitance	CCOM_(ON)	f = 1MHz, Figure 8	TA = +25°C		22		pF
SUPPLY							
Power-Supply Range				3		16	V
Positive Supply Current	I+	V+ = 15V, VIN_ = 0 or V+, all channels on or off	C, E	-1	0.001	1	μA

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

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	VCOM ₋ , VNO ₋ , VNC ₋	(Note 3)	0		V+	V
On-Resistance	RON	ICOM ₋ = -10mA, VNO ₋ or VNC ₋ = 10V		12	16	Ω
		TA = +25°C C, E			2.0	
On-Resistance Match Between Channels (Notes 3, 4)	ΔRON	ICOM ₋ = -10mA, VNO ₋ or VNC ₋ = 10V		0.5	1.5	Ω
		TA = +25°C C, E			2.0	
On-Resistance Flatness (Notes 3, 5)	RFLAT(ON)	ICOM ₋ = -10mA; VNO ₋ or VNC ₋ = 3V, 6V, 9V		0.7	1.5	Ω
		TA = +25°C C, E			2.0	
NO ₋ or NC ₋ Off-Leakage Current (Note 6)	INO ₋ (OFF) or INC ₋ (OFF)	V+ = 15.5V; VCOM ₋ = 14V, 1V; VNO ₋ or VNC ₋ = 1V, 14V		-0.1	0.01	nA
		TA = +25°C C, E		-5	5	
COM ₋ Off-Leakage Current (Note 6)	ICOM ₋ (OFF)	V+ = 15.5V; VCOM ₋ = 14V, 1V; VNO ₋ or VNC ₋ = 1V, 14V		-0.1	0.01	nA
		TA = +25°C C, E		-5	5	
COM ₋ On-Leakage Current (Note 6)	ICOM ₋ (ON)	V+ = 15.5V; VCOM ₋ = 14V, 1V; VNO ₋ or VNC ₋ = 14V, 1V, or floating		-0.2	0.02	nA
		TA = +25°C C, E		-10	10	
DYNAMIC						
Turn-On Time	tON	VNO ₋ or VNC ₋ = 10V, Figure 2		60	80	ns
		TA = +25°C C, E			90	
Turn-Off Time	tOFF	VNO ₋ or VNC ₋ = 10V, Figure 2		30	40	ns
		TA = +25°C C, E			50	
Break-Before-Make Time Delay (Note 3)	tD	MAX4593 only, RL = 300Ω, CL = 35pF	5	20		ns
Charge Injection (Note 3)	Q	CL = 1nF, VGEN = 0, RGEN = 0Ω, Figure 4		2	5	pC
SUPPLY						
Positive Supply Current	I+	V+ = 15V, VINL = 0 or V+, all channels on or off	-1	0.001	1	μA
Negative Supply Current	I-	V+ = 15V, VINL = 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.

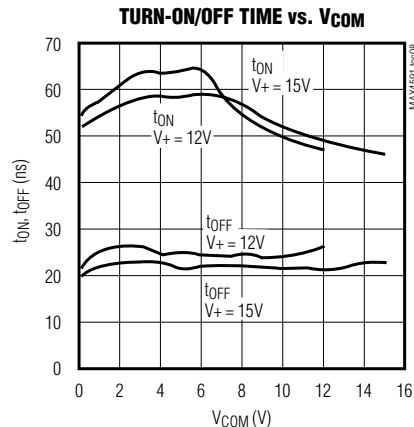
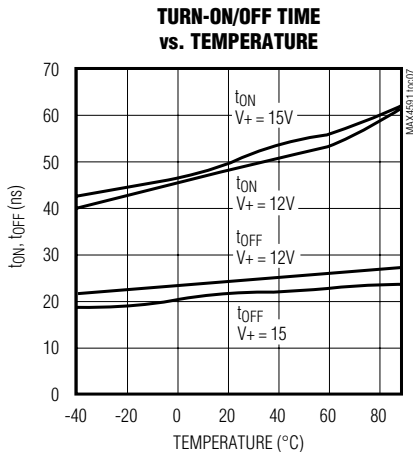
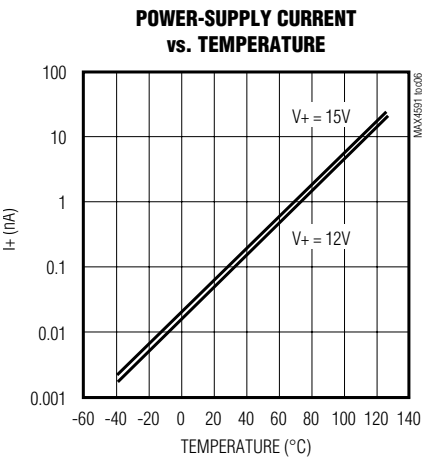
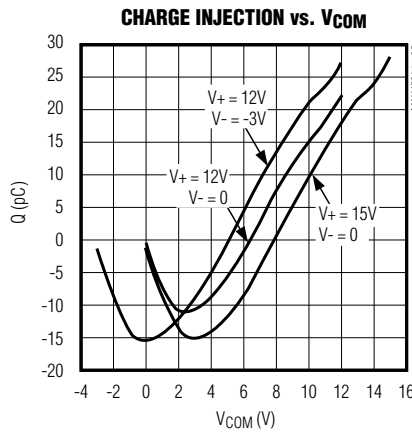
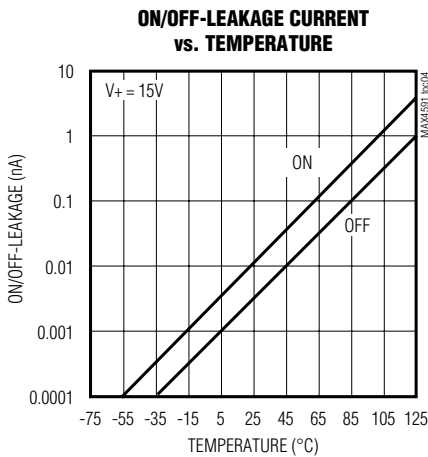
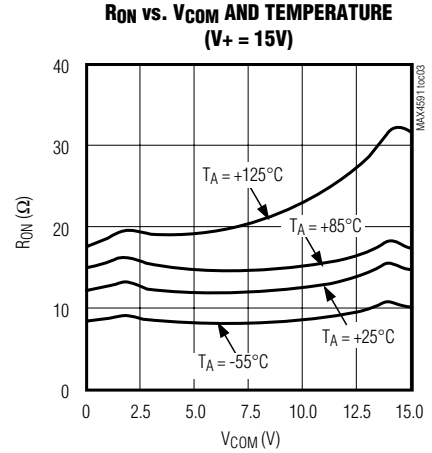
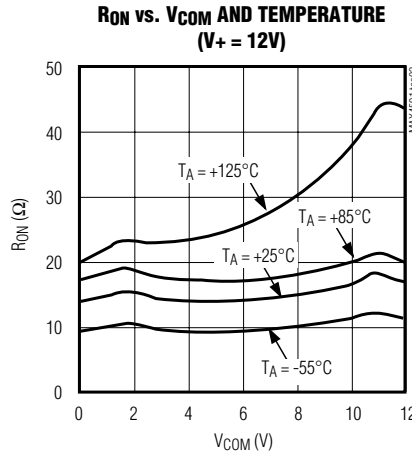
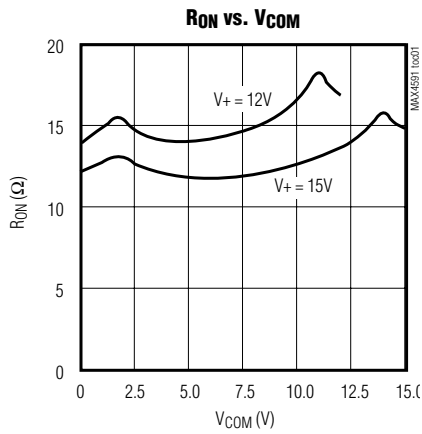
Note 8: Between any two switches.

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

Typical Operating Characteristics

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

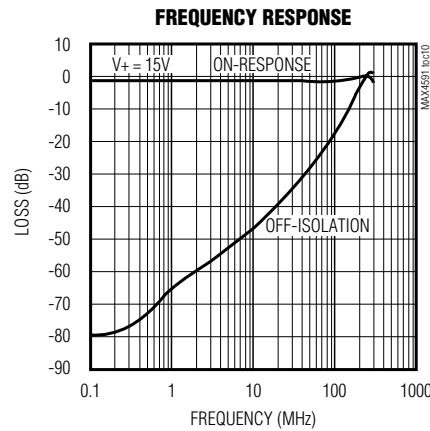
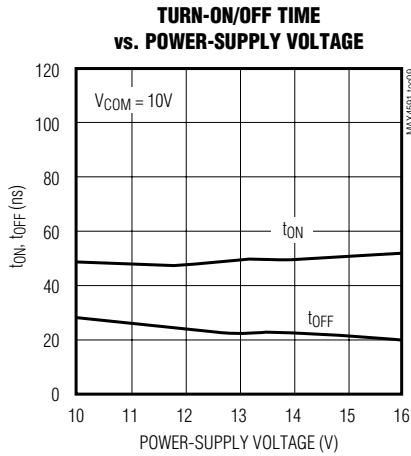
MAX4591/MAX4592/MAX4593



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

Typical Operating Characteristics (continued)

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



Pin Description

PIN	NAME	FUNCTION
1, 16, 9, 8	IN1–IN4	Switch Input Terminals. Drive ≤ 0.8V for logic “0”; drive ≥ 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.

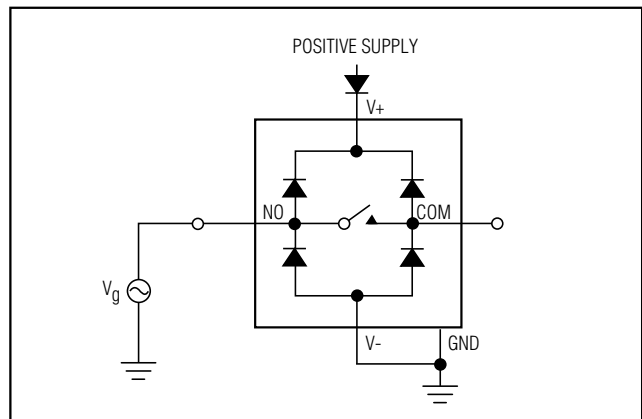


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

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

Test Circuits/Timing Diagrams

MAX4591/MAX4592/MAX4593

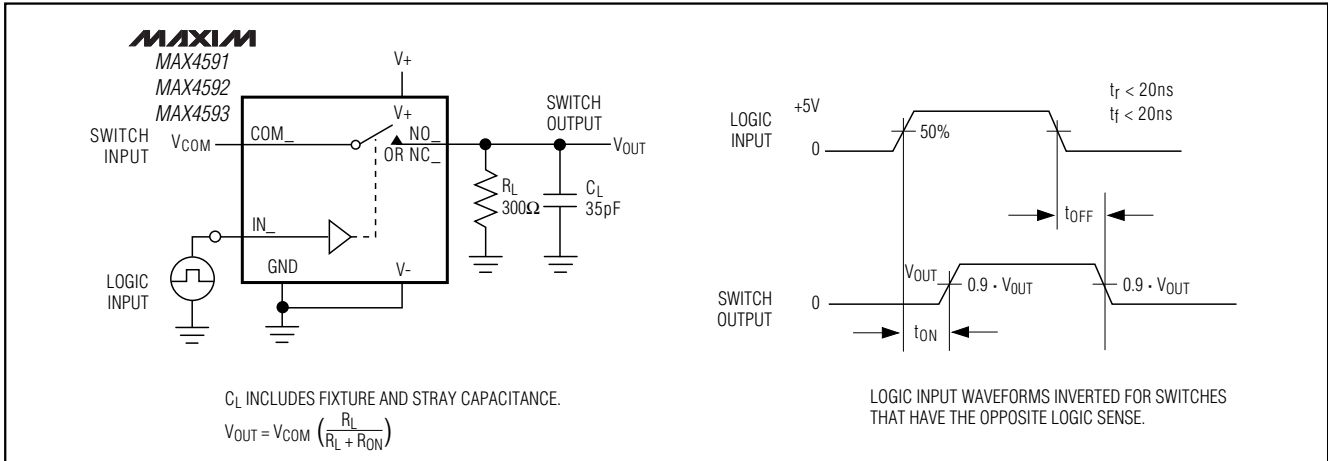


Figure 2. Switching Time

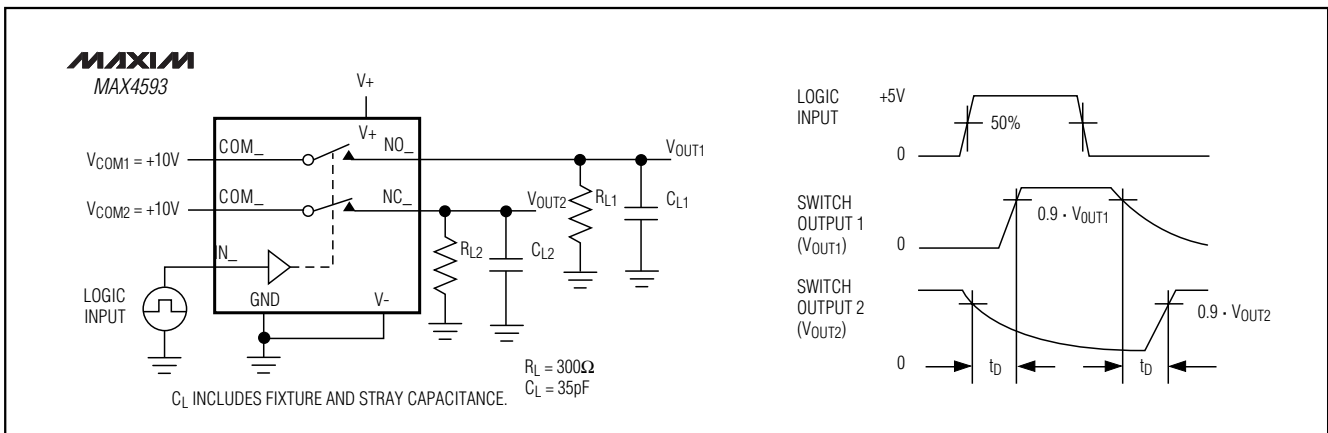


Figure 3. Break-Before-Make Interval (MAX4593 Only)

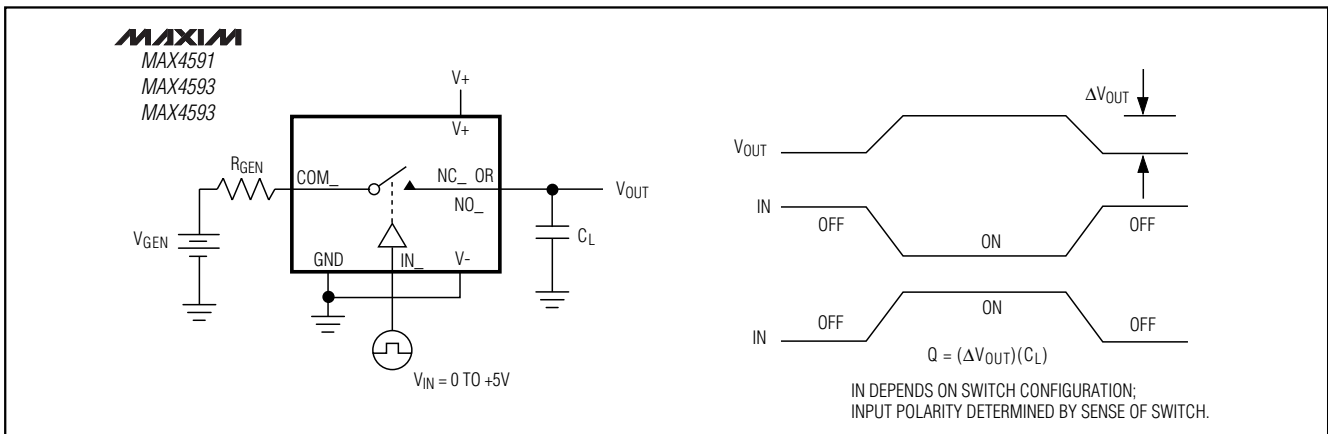


Figure 4. Charge Injection

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

Test Circuits/Timing Diagrams (continued)

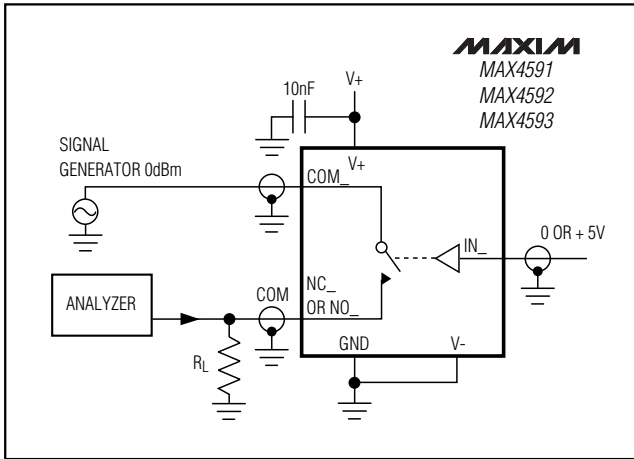


Figure 5. Off-Isolation

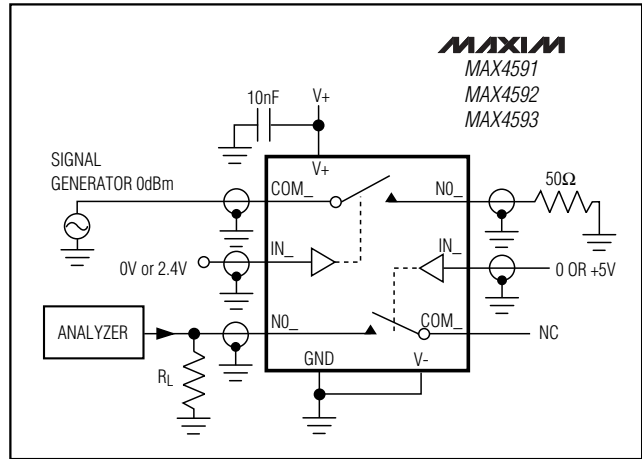


Figure 6. Crosstalk

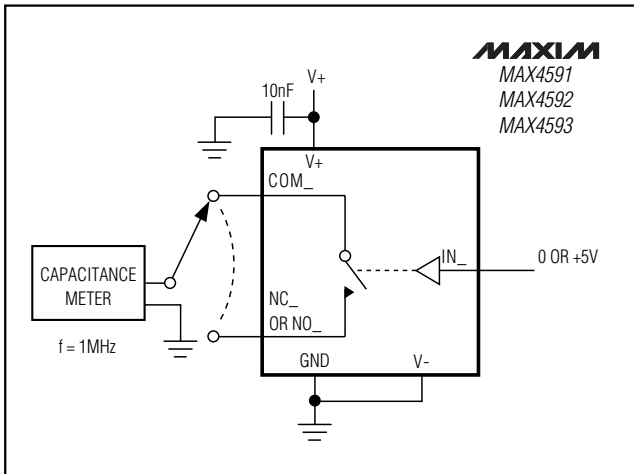


Figure 7. Channel Off-Capacitance

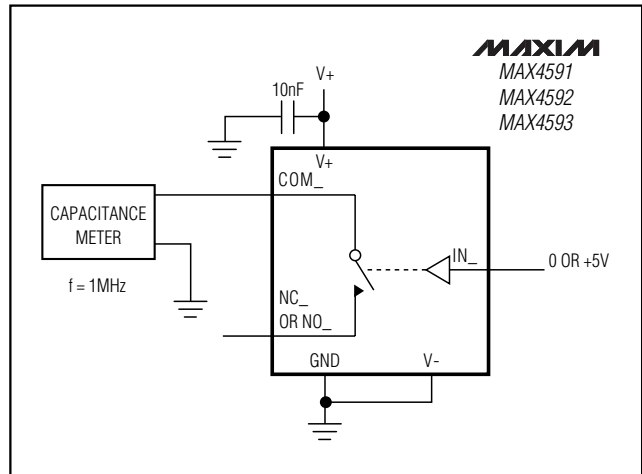


Figure 8. Channel On-Capacitance

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

Ordering Information (continued)

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

Chip Information

TRANSISTOR COUNT: 76

MAX4591/MAX4592/MAX4593

Package Information

DIMENSION				SYMBOL			
UNIT	MILS	MILLIMETERS	UNIT	MILS	MILLIMETERS	UNIT	MILS
MAXIMUM	0.004	0.101	MINIMUM	0.002	0.051	MINIMUM	0.002
MINIMUM	0.002	0.051	MAXIMUM	0.004	0.101	MAXIMUM	0.004

SYMBOL	DIMENSION	VARIATIONS	
		MILLIMETERS	INCHES
A1	W	0.254	0.010
A2	W	0.254	0.010
A3	W	0.254	0.010
A4	W	0.254	0.010
A5	W	0.254	0.010
A6	W	0.254	0.010
A7	W	0.254	0.010
A8	W	0.254	0.010
A9	W	0.254	0.010
A10	W	0.254	0.010
A11	W	0.254	0.010
A12	W	0.254	0.010
A13	W	0.254	0.010
A14	W	0.254	0.010
A15	W	0.254	0.010
A16	W	0.254	0.010
A17	W	0.254	0.010
A18	W	0.254	0.010
A19	W	0.254	0.010
A20	W	0.254	0.010
A21	W	0.254	0.010
A22	W	0.254	0.010
A23	W	0.254	0.010
A24	W	0.254	0.010
A25	W	0.254	0.010
A26	W	0.254	0.010
A27	W	0.254	0.010
A28	W	0.254	0.010
A29	W	0.254	0.010
A30	W	0.254	0.010
A31	W	0.254	0.010
A32	W	0.254	0.010
A33	W	0.254	0.010
A34	W	0.254	0.010
A35	W	0.254	0.010
A36	W	0.254	0.010
A37	W	0.254	0.010
A38	W	0.254	0.010
A39	W	0.254	0.010
A40	W	0.254	0.010
A41	W	0.254	0.010
A42	W	0.254	0.010
A43	W	0.254	0.010
A44	W	0.254	0.010
A45	W	0.254	0.010
A46	W	0.254	0.010
A47	W	0.254	0.010
A48	W	0.254	0.010
A49	W	0.254	0.010
A50	W	0.254	0.010
A51	W	0.254	0.010
A52	W	0.254	0.010
A53	W	0.254	0.010
A54	W	0.254	0.010
A55	W	0.254	0.010
A56	W	0.254	0.010
A57	W	0.254	0.010
A58	W	0.254	0.010
A59	W	0.254	0.010
A60	W	0.254	0.010
A61	W	0.254	0.010
A62	W	0.254	0.010
A63	W	0.254	0.010
A64	W	0.254	0.010
A65	W	0.254	0.010
A66	W	0.254	0.010
A67	W	0.254	0.010
A68	W	0.254	0.010
A69	W	0.254	0.010
A70	W	0.254	0.010
A71	W	0.254	0.010
A72	W	0.254	0.010
A73	W	0.254	0.010
A74	W	0.254	0.010
A75	W	0.254	0.010
A76	W	0.254	0.010
A77	W	0.254	0.010
A78	W	0.254	0.010
A79	W	0.254	0.010
A80	W	0.254	0.010
A81	W	0.254	0.010
A82	W	0.254	0.010
A83	W	0.254	0.010
A84	W	0.254	0.010
A85	W	0.254	0.010
A86	W	0.254	0.010
A87	W	0.254	0.010
A88	W	0.254	0.010
A89	W	0.254	0.010
A90	W	0.254	0.010
A91	W	0.254	0.010
A92	W	0.254	0.010
A93	W	0.254	0.010
A94	W	0.254	0.010
A95	W	0.254	0.010
A96	W	0.254	0.010
A97	W	0.254	0.010
A98	W	0.254	0.010
A99	W	0.254	0.010
A100	W	0.254	0.010

NOTES:

- DIMENSIONS B AND C DO NOT INCLUDE FLASH.
- MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 25 μm PER SIDE.
- CONTROLLING DIMENSION MILLIMETER.
- LEADS JEDED OUTLINE M0-139 VARIATIONS FOR M0, M1, M2, M3.
- DIMENSIONS M AND Y APPLY TO EXPOSED PAD DIPS VERSIONS ONLY.
- EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN 50μm.

MAXIM
 CORPORATION
 1305 N. SHILOH ROAD
 FOLSOM, CA 95630
 (916) 905-0000
 FAX (916) 905-0001
 WWW.MAXIM-IC.COM

PACKAGE OUTLINE, TSSOP, 64mm BODY, 16mm PITCH
 DATE: 01-06-06
 REV: G

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

Package Information (continued)

	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
e	0.050		1.27	
E	0.150	0.157	3.80	4.00
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

	INCHES		MILLIMETERS		N	MS012
	MIN	MAX	MIN	MAX		
D	0.189	0.197	4.80	5.00	8	A
D	0.337	0.344	8.55	8.75	14	B
D	0.386	0.394	9.80	10.00	16	C

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 MS012-XX AS SHOWN IN ABOVE TABLE
 6. N = NUMBER OF PINS

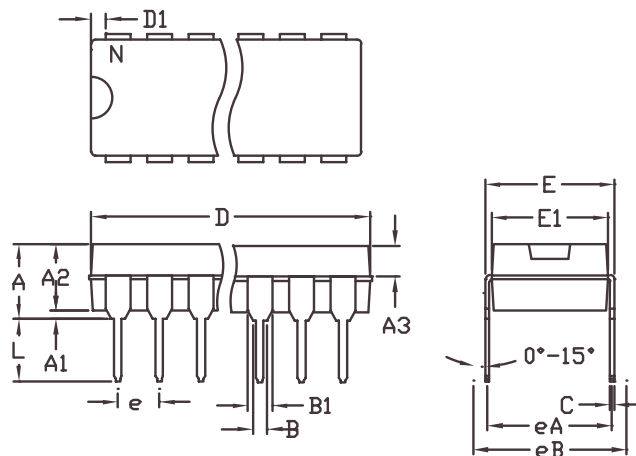
MAXIM PACKAGE FAMILY OUTLINE: SOIC .150° 1/1 21-0041 A
MAXIM IS A REGISTERED TRADEMARK OF MAXIM INTEGRATED PRODUCTS TITLE REVISION CONTROL NUMBER REV.

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

Package Information (continued)

MAX4591/MAX4592/MAX4593

PDIPN:EPS



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.180	---	4.572
A1	0.020	---	0.508	---
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.015	0.021	0.381	0.533
B1	0.045	0.060	1.14	1.524
C	0.009	0.014	0.229	0.355
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.255
E1	0.275	0.295	6.985	7.493
e	0.100	---	2.54	---
eA	0.300	---	7.62	---
eB	---	0.400	---	10.16
L	0.115	0.150	2.921	3.81

	INCHES		MILLIMETERS		N	MS001
	MIN	MAX	MIN	MAX		
D	0.348	0.390	8.84	9.91	8	AB
D	0.735	0.765	18.67	19.43	14	AC
D	0.745	0.765	18.92	19.43	16	AA
D	0.885	0.915	22.48	23.24	18	AD
D	1.015	1.045	25.78	26.54	20	AE
D	1.14	1.265	28.96	32.13	24	AF
D	1.360	1.380	34.54	35.05	28	*5

NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
5. SIMILAR TO JEDEC MS-095-AH
6. N = NUMBER OF PINS



PACKAGE FAMILY OUTLINE: PDIP .300'



21-0043 B

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

NOTES

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.

12 _____ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600**