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19-3961; Rev 0; 1/99

2.5Ω, Quad, SPST, CMOS Analog Switches

MAX4601/MAX4602/MAX4603

General Description

The MAX4601/MAX4602/MAX4603 quad analog switches feature low on-resistance of 2.5Ω max. On-resistance is matched between switches to 0.5Ω max and is flat (0.5Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. The off-leakage current is only 2.5nA maximum at T_A = +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 MAX4601 has four normally closed (NC) switches, the MAX4602 has four normally open (NO) switches, and the MAX4603 has two NC and two NO switches.

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

Applications

Reed Relay Replacement

Test Equipment

Communication Systems

PBX, PABX Systems

Audio-Signal Routing

Avionics

Features

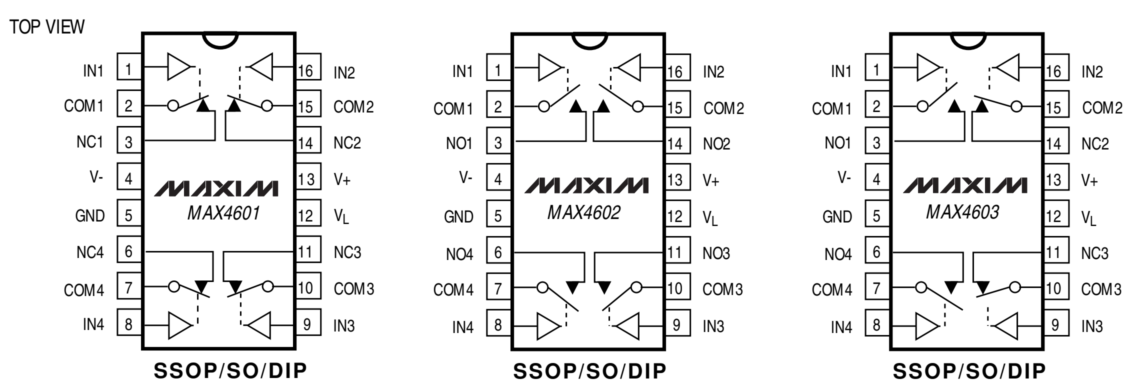
- ♦ **Low On-Resistance (2.5Ω max)**
- ♦ **Guaranteed R_{ON} Match Between Channels (0.5Ω max)**
- ♦ **Guaranteed R_{ON} Flatness over Specified Signal Range (0.5Ω max)**
- ♦ **Rail-to-Rail Signal Handling**
- ♦ **Guaranteed ESD Protection > 2000V per Method 3015.7**
- ♦ **Single-Supply Operation: +4.5V to +36V Dual-Supply Operation: ±4.5V to ±20V**
- ♦ **TTL/CMOS-Compatible Control Inputs**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4601CAE	0°C to +70°C	16 SSOP
MAX4601CWE	0°C to +70°C	16 Wide SO
MAX4601CPE	0°C to +70°C	16 Plastic DIP
MAX4601EAE	-40°C to +85°C	16 SSOP
MAX4601EWE	-40°C to +85°C	16 Wide SO
MAX4601EPE	-40°C to +85°C	16 Plastic DIP

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables



MAX4601	
LOGIC	SWITCH
0	ON
1	OFF

MAX4602	
LOGIC	SWITCH
0	OFF
1	ON

MAX4603		
LOGIC	SWITCHES 1, 4	SWITCHES 2, 3
0	OFF	ON
1	ON	OFF

SWITCHES SHOWN FOR LOGIC “0” INPUT

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

2.5Ω, Quad, 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 ....(GND - 0.3V) to (V+ + 0.3V)
All Other Pins to DGND (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
MAX460_C_E ....0°C to +70°C
MAX460_E_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- will be 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	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$	(Note 3)		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		1.7	2.5	Ω
			T_A = T_{MIN} to T_{MAX}			2.7	
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		0.1		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		0.1	0.4	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	0.2	1	nA
			T_A = T_{MIN} to T_{MAX}	-10		10	
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	µA
Logic Input High Voltage	V_{IN_H}			2.4	1.7		V
Logic Input Low Voltage	V_{IN_L}				1.7	0.8	V

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	MAX	UNITS
POWER SUPPLY							
Power-Supply Range				±4.5		±20.0	V
Positive Supply Current	I+	All channels on or off, 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	
Negative Supply Current	I-	All channels on or off, 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	All channels on or off, 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}	All channels on or off, 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	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	Figure 2, $V_{COM\_}$ = ±10V, T_A = +25°C			160	250	ns
Turn-Off Time	t_{OFF}	Figure 2, $V_{COM\_}$ = ±10V, T_A = +25°C			190	350	ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0, R_{GEN} = 0, Figure 3, T_A = +25°C			120		pC
Off-Isolation (Note 7)	V_{ISO}	R_L = 50Ω, C_L= 5pF, f = 1MHz, Figure 4, T_A = +25°C			-56		dB
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 5, T_A = +25°C			-59		dB
NC_ or NO_ Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 6, T_A = +25°C			55		pF
COM Off-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 6, T_A = +25°C			55		pF
On-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 7, T_A = +25°C			250		pF

ELECTRICAL CHARACTERISTICS—Single +12V Supply

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

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range	$V_{COM\_}$, $V_{NO\_}$, $V_{NC\_}$	(Note 3)		GND		V+	V
COM_ to NO or NC_ On-Resistance	R_{ON}	$I_{COM\_} = 10mA$, $V_{NO\_}$ or $V_{NC\_} = 10V$	$T_A = +25°C$		3	4	Ω
			$T_A = T_{MIN}$ to T_{MAX}			5	
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Note 4)	ΔR_{ON}	$I_{COM\_} = 10mA$, $V_{NO\_}$ or = $V_{NC\_} = 10V$	$T_A = +25°C$		0.03	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 $V_{NC\_} = 3V, 6V, 9V$	$T_A = +25°C$		0.1	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	0.01	1	nA
			$T_A = T_{MIN}$ to T_{MAX}	-10		10	
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	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+	All channels on or off, $V_{IN} = 0$ 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	All channels on or off, $V_{IN} = 0$ 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 +12V 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 (Note 2)	MAX	UNITS
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, $V_{COM\_} = 10V$, $T_A = +25°C$		170		ns
Charge Injection	Q	$C_L = 1.0nF$, $V_{GEN} = 0$, $R_{GEN} = 0$, Figure 3, $T_A = +25°C$		20		pC
Crosstalk (Note 8)	V_{CT}	$R_L = 50\Omega$, $C_L = 5pF$, f = 1MHz, Figure 5, $T_A = +25°C$		-60		dB
NC_ or NO_ Capacitance	$C_{(OFF)}$	f = 1MHz, Figure 6, $T_A = +25°C$		85		pF
COM Off-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 6, $T_A = +25°C$		85		pF
On-Capacitance	$C_{(COM)}$	f = 1MHz, Figure 7, $T_A = +25°C$		140		pF

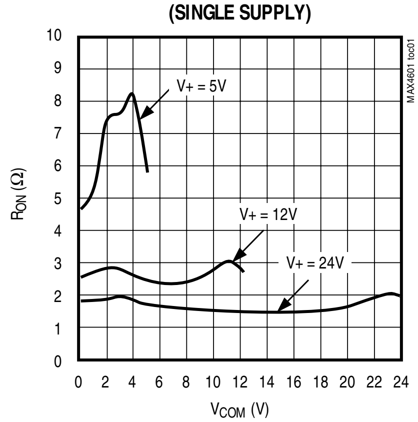
Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.
Note 3: Guaranteed by design.
Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 5: Flatness is defined as the difference between the maximum and minimum 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.

2.5Ω, Quad, SPST, CMOS Analog Switches

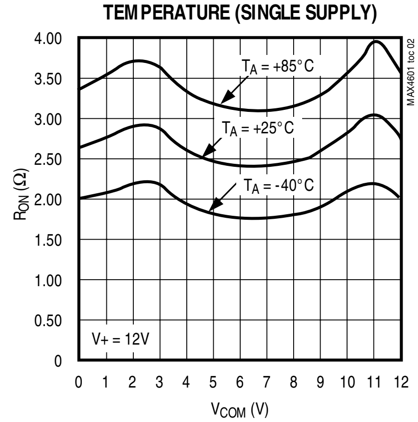
Typical Operating Characteristics

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

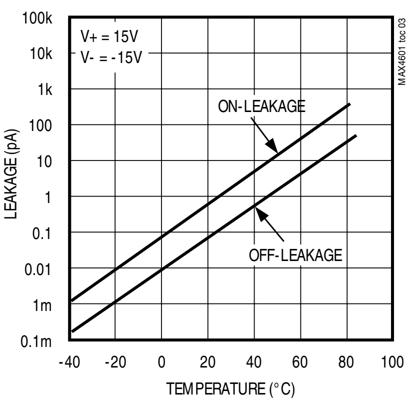
ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)



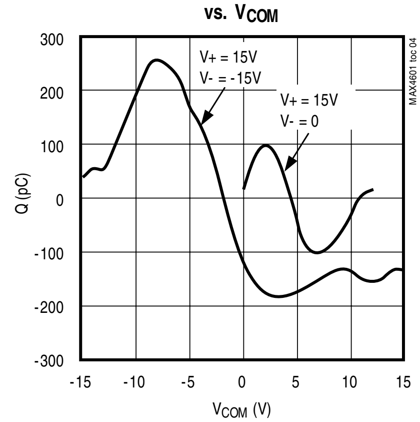
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



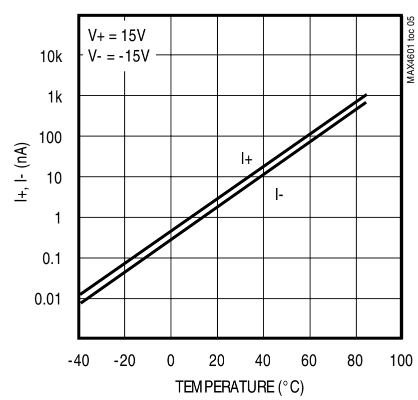
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



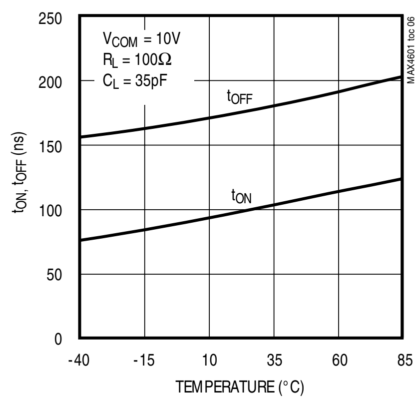
CHARGE INJECTION vs. V_{COM}



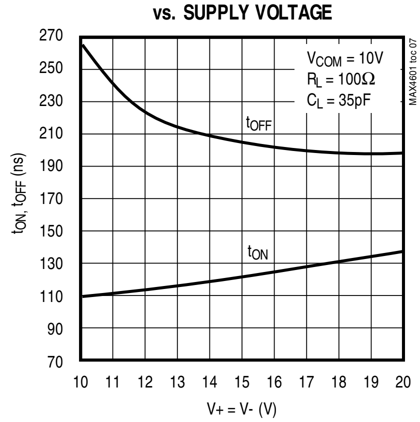
POWER-SUPPLY CURRENT vs. TEMPERATURE



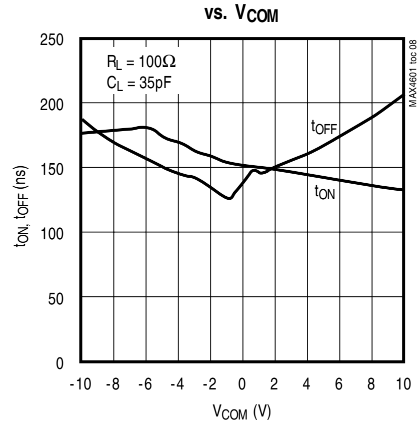
TURN-ON/OFF TIME vs. TEMPERATURE



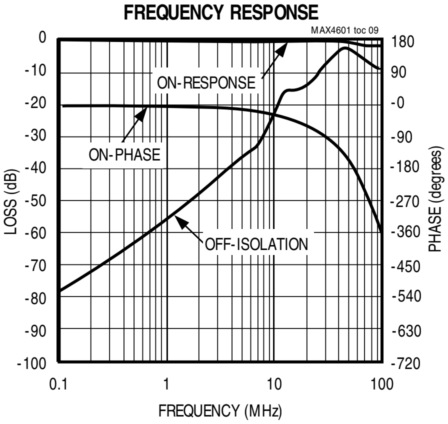
TURN-ON/OFF TIME vs. SUPPLY VOLTAGE



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



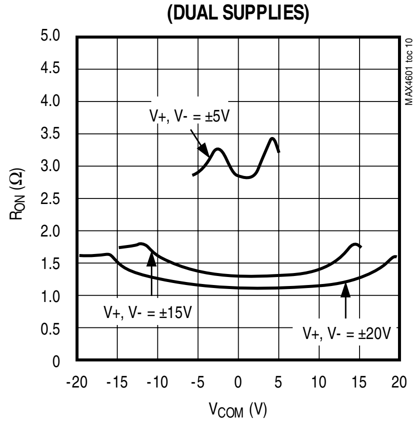
FREQUENCY RESPONSE



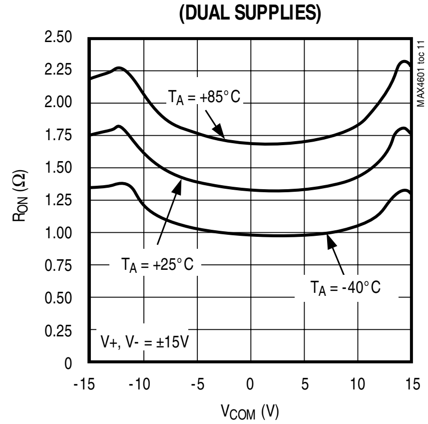
Typical Operating Characteristics (continued)

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

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



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



Pin Description

PIN			NAME	FUNCTION
MAX4601	MAX4602	MAX4603		
1, 16, 9, 8	1, 16, 9, 8	1, 16, 9, 8	IN1, IN2, IN3, IN4	Logic-Control Digital Inputs
2, 15, 10, 7	2, 15, 10, 7	2, 15, 10, 7	COM1, COM2, COM3, COM4	Analog Switch Common Terminals
3, 14, 11, 6	—	—	NC1, NC2, NC3, NC4	Analog Switch Normally Closed Terminals
—	3, 14, 11, 6	—	NO1, NO2, NO3, NO4	Analog Switch Normally Open Terminals
—	—	3, 6	NO1, NO4	Analog Switch Normally Open Terminals
—	—	14, 11	NC2, NC3	Analog Switch Normally Closed Terminals
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

2.5Ω, Quad, 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 the 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.

Off-Isolation at High Frequencies

In 50Ω systems, the high-frequency on-response of these parts extends from DC to above 100MHz with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor, and off-isolation decreases with increasing frequency. (Above 300MHz, the switch actually passes more signal turned off than turned on.) This effect is more pronounced with higher source and load impedances.

Above 5MHz, circuit board layout becomes critical, and it becomes difficult to characterize the response of the switch independent of the circuit. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors to a circuit board deemed "average;" that is, designed with isolation in mind, but not using strip-line or other special RF circuit techniques. For critical applications above 5MHz, use the MAX440, MAX441, and MAX442, which are fully characterized up to 160MHz.

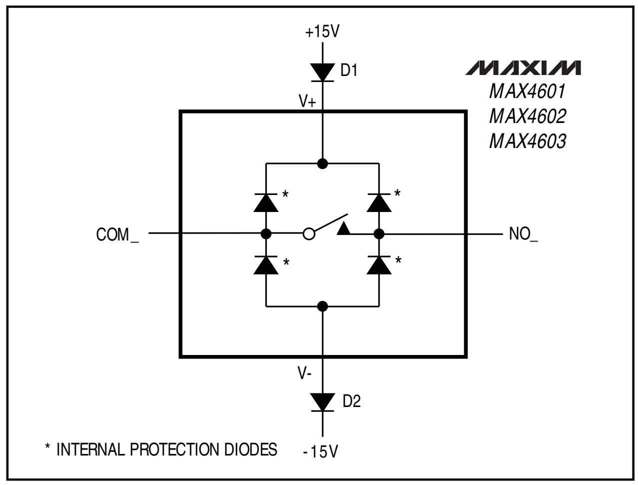


Figure 1. Overvoltage Protection Using External Blocking Diodes

Timing Diagrams/Test Circuits

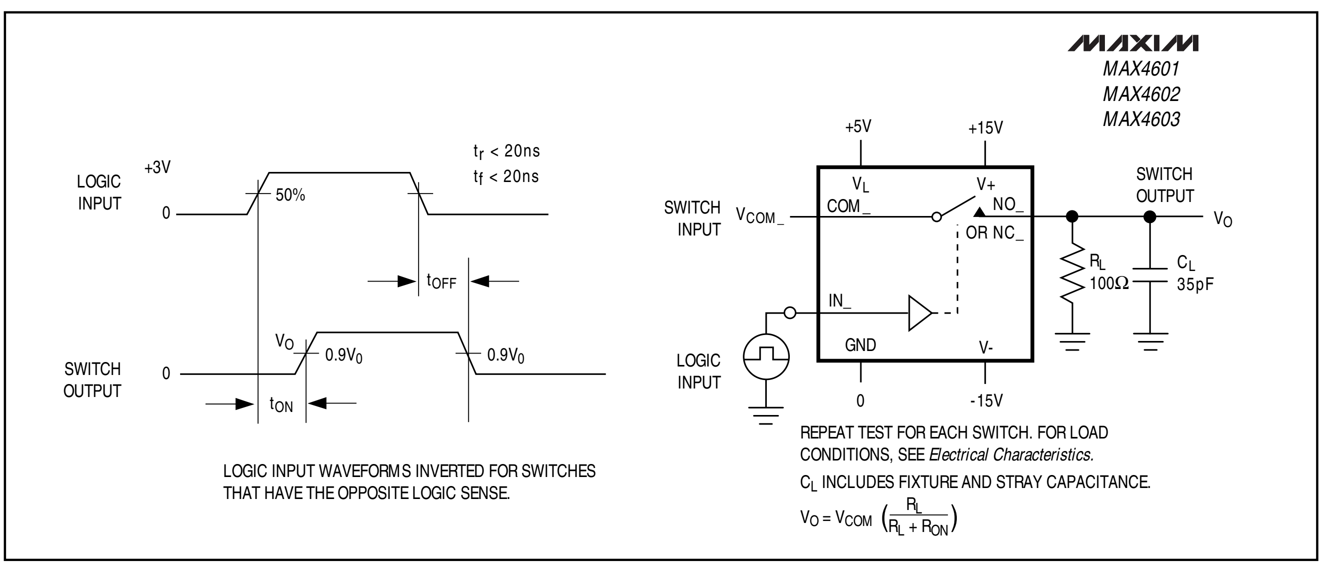


Figure 2. Switching-Time Test Circuit

Timing Diagrams/Test Circuits (continued)

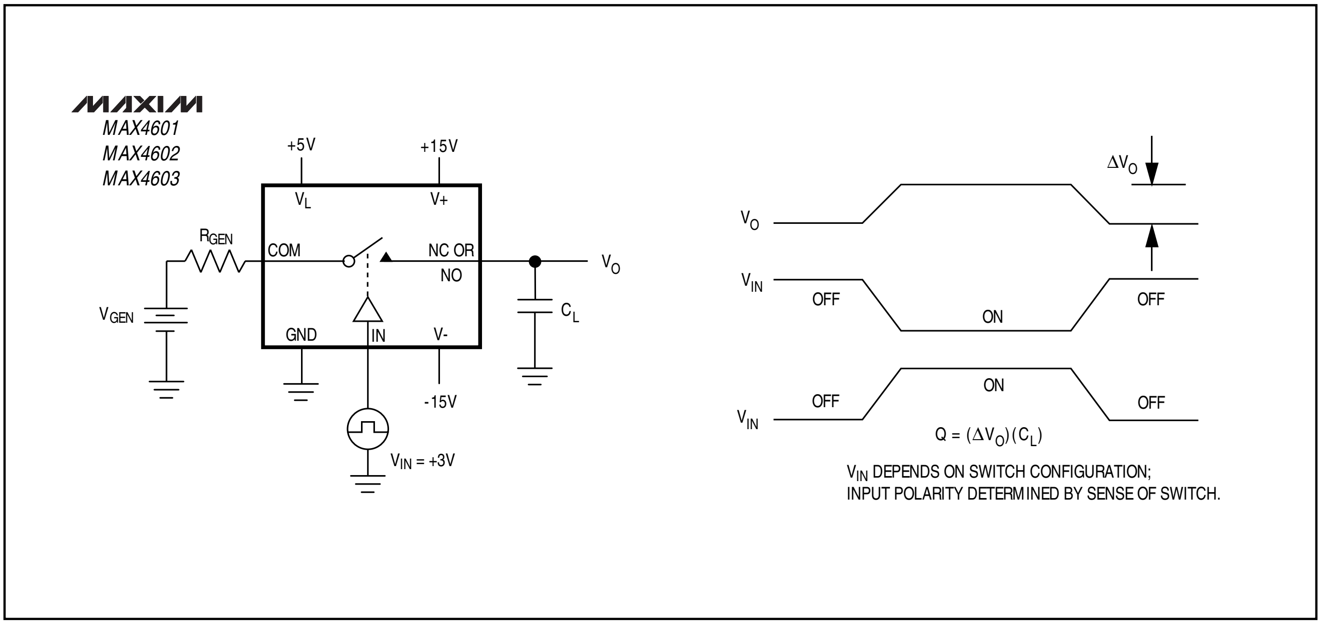


Figure 3. Charge-Injection Test Circuit

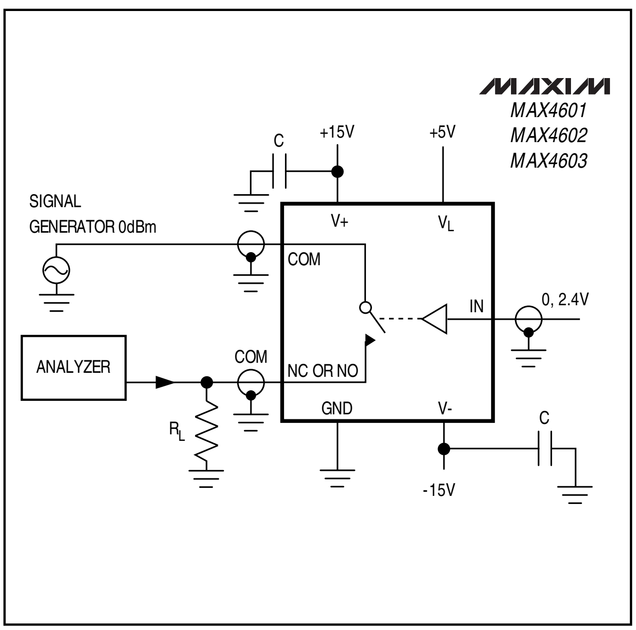


Figure 4. Off-Isolation Test Circuit

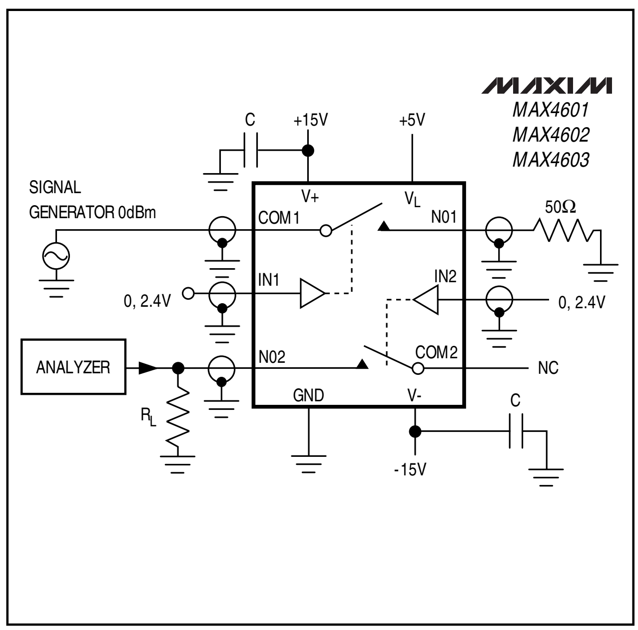


Figure 5. Crosstalk Test Circuit

Timing Diagrams/Test Circuits (continued)

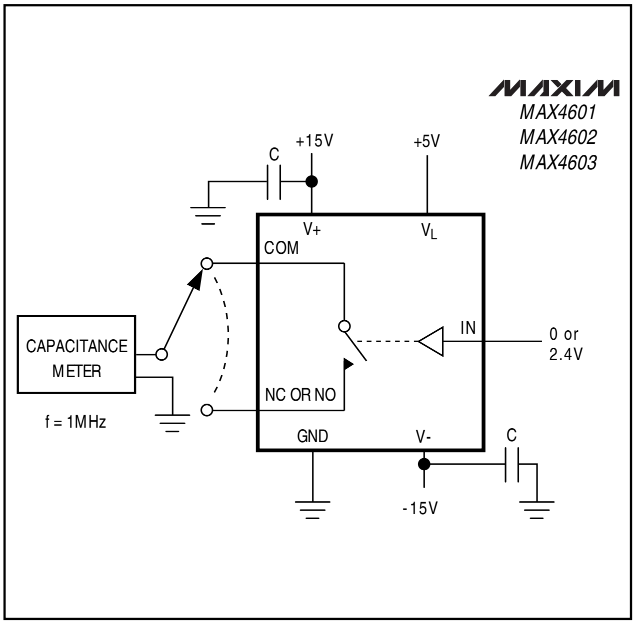


Figure 6. Switch Off-Capacitance Test Circuit

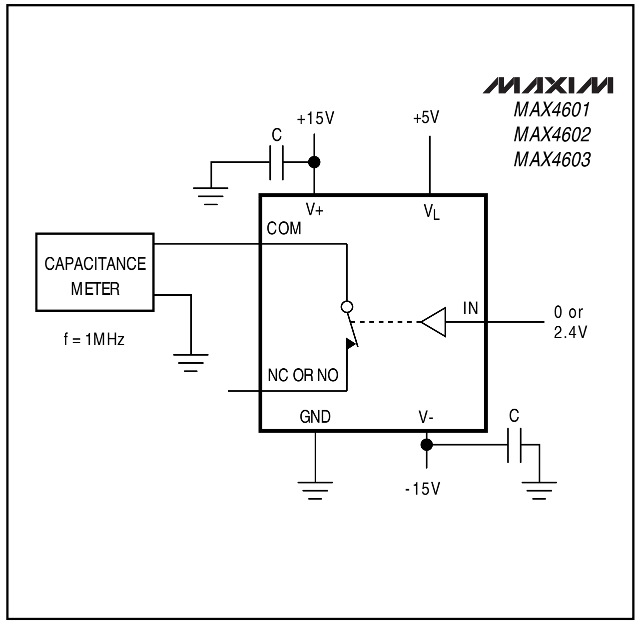


Figure 7. Switch On-Capacitance Test Circuit

Ordering Information (continued)

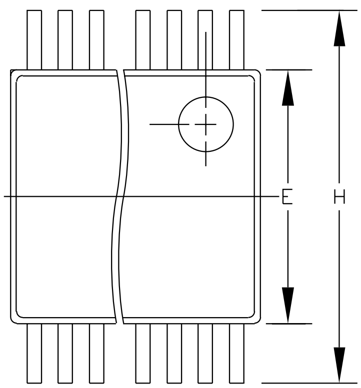
PART	TEMP. RANGE	PIN-PACKAGE
MAX4602CAE	0°C to +70°C	16 SSOP
MAX4602CWE	0°C to +70°C	16 Wide SO
MAX4602CPE	0°C to +70°C	16 Plastic DIP
MAX4602EAE	-40°C to +85°C	16 SSOP
MAX4602EWE	-40°C to +85°C	16 Wide SO
MAX4602EPE	-40°C to +85°C	16 Plastic DIP
MAX4603CAE	0°C to +70°C	16 SSOP
MAX4603CWE	0°C to +70°C	16 Wide SO
MAX4603CPE	0°C to +70°C	16 Plastic DIP
MAX4603EAE	-40°C to +85°C	16 SSOP
MAX4603EWE	-40°C to +85°C	16 Wide SO
MAX4603EPE	-40°C to +85°C	16 Plastic DIP

Chip Information

TRANSISTOR COUNT: 100

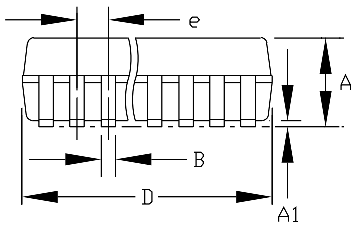
Package Information

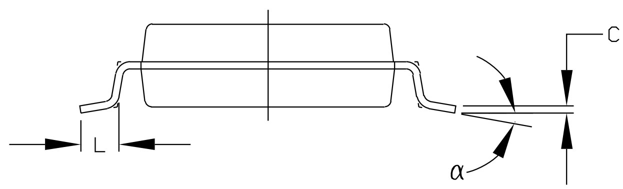
SSOP.EPS



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	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		MILLIMETERS		
	MIN	MAX	MIN	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





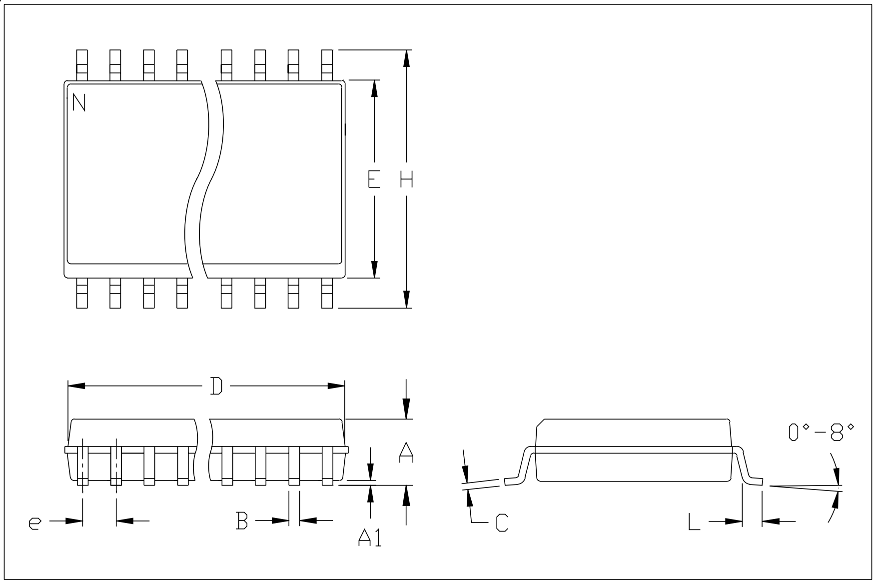
NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER

MAXIM
PROPRIETARY INFORMATION
TITLE:
PACKAGE OUTLINE, SSOP, 5.3X.65mm

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

2.5Ω, Quad, SPST, CMOS Analog Switches

Package Information



	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

TITLE: PACKAGE FAMILY OUTLINE: SOIC .300"

1/1

21-0042 A
DOCUMENT CONTROL NUMBER REV

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