19-1984; Rev 1; 10/01

MAXIM

High-Current, 10Ω, SPST, CMOS Analog Switches

General Description

Maxim's MAX4655–MAX4658 are medium-voltage CMOS analog switches with low on-resistance of 10Ω max, specifically designed to handle large switch currents. With a switch capability of up to 400mA peak current and 300mA continuous current (MAX4655/MAX4656), and up to 300mA peak current and 150mA continuous current (MAX4657/MAX4658), these parts can switch loads as low as 25Ω. They can replace reed relays with a million times the speed and virtually unlimited number of lifetime cycles. Normal power consumption is only 3mW, whether the switch is on or off. These parts are TTL/CMOS compatible and will switch any voltage within its power-supply range.

These are SPST (single-pole/single-throw) switches. The MAX4655/MAX4657 are normally closed (NC), while the MAX4656/MAX4658 are normally open (NO). The difference between the MAX4655/MAX4656 and the MAX4657/MAX4658 is in the power dissipation of their packages. Refer to the *Absolute Maximum Ratings* and the *Electrical Characteristics*.

The MAX4655–MAX4658 power-supply range is from ±4.5V to ±20V for dual supply operation and +9V to +40V for single supply operation. These switches can operate from any combination of supplies, within a 40V V+ to V- range. They conduct equally well in either direction and can handle Rail-to-Rail® analog signals. The off-leakage current is only 1nA max at T_A = +25°C. They are available in 8-pin µMAX, QFN, and SO packages, with exposed pad options for high-power applications.

Applications

Relay Replacement
Test Equipment
Communication Systems
xDSL Modems
PBX, PABX Systems
Audio Signal Routing
Audio Systems
PC Multimedia Boards
Redundant/Backup Systems

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

Features

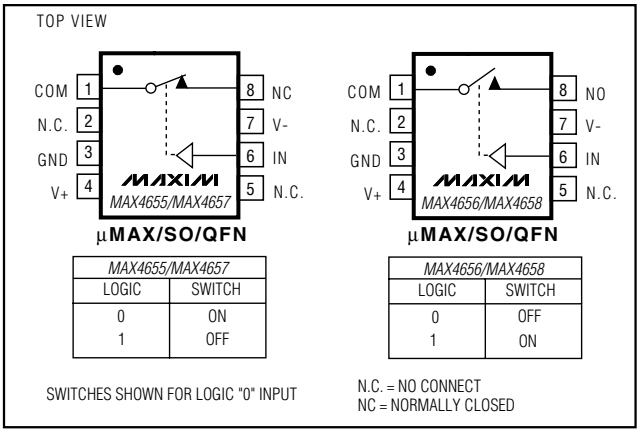
- **High Continuous Current Handling**
  300mA (MAX4655/MAX4656)
  150mA (MAX4657/MAX4658)
- **High Peak Current Handling**
  400mA (MAX4655/MAX4656)
  300mA (MAX4657/MAX4658)
- **10Ω max On-Resistance (±15V supplies)**
- **V_L not Required**
- **1Ω max R_{ON} Flatness over Specified Signal Range**
- **Rail-to-Rail Signal Handling**
- **+12V Single Supply or ±15V Dual Supply Operation**
- **Pin Compatible with DG417, DG418**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4655EGA	-40°C to +85°C	8 QFN
MAX4655EUA	-40°C to +85°C	8 µMAX-EP*
MAX4655ESA	-40°C to +85°C	8 SO-EP*
MAX4656EGA	-40°C to +85°C	8 QFN
MAX4656EUA	-40°C to +85°C	8 µMAX-EP*
MAX4656ESA	-40°C to +85°C	8 SO-EP*
MAX4657EGA	-40°C to +85°C	8 QFN
MAX4657EUA	-40°C to +85°C	8 µMAX
MAX4657ESA	-40°C to +85°C	8 SO
MAX4658EGA	-40°C to +85°C	8 QFN
MAX4658EUA	-40°C to +85°C	8 µMAX
MAX4658ESA	-40°C to +85°C	8 SO

**EP = exposed pad*

Pin Configurations/ Functional Diagrams/Truth Tables



MAX4655/MAX4657	
LOGIC	SWITCH
0	ON
1	OFF

MAX4656/MAX4658	
LOGIC	SWITCH
0	OFF
1	ON

SWITCHES SHOWN FOR LOGIC "0" INPUT

N.C. = NO CONNECT
NC = NORMALLY CLOSED

High-Current, 10Ω, SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V+ to GND .....-0.3V to +44V
V- to GND .....-44V to +0.3V
V+ to V- .....-0.3V to +44V
All Other Pins to GND (Note 1) .....V- - 0.3V to V+ + 0.3V
Continuous Current, COM, NO, NC
(MAX4655/MAX4656) .....±300mA
Continuous Current, COM, NO, NC
(MAX4657/MAX4658) .....±150mA
Continuous Current, IN .....±30mA
Peak Current, COM, NO, NC
(pulsed at 1ms, 10% duty cycle)
MAX4655/MAX4656 .....±400mA
(pulsed at 1ms, 10% duty cycle)
MAX4657/MAX4658 .....±300mA

Continuous Power Dissipation (T_A = +70°C)
8-Pin QFN (derate 24.4mW/°C above +70°C) 195mW
8-Pin µMAX-EP (derate 10.3mW/°C above +70°C)
MAX4655/MAX4656 .....825mW
8-Pin µMAX (derate 4.50mW/°C above +70°C)
MAX4657/MAX4658 .....362mW
8-Pin SO-EP (derate 18.9mW/°C above +70°C)
MAX4655/MAX4656 .....1509mW
8-Pin SO (derate 5.88mW/°C above +70°C)
MAX4657/MAX4658 .....471mW
Operating Temperature Ranges
MAX4655–MAX4658 .....-40°C to +85°C
Junction Temperature .....+150°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- 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_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 7)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{NO}, V_{NC}, V_{COM}			V-		V+	V
On-Resistance	R_{ON}	I_{COM} = 100mA; V_{NO} or V_{NC} = ±10V	+25°C		7	10	Ω
			T_{MIN} to T_{MAX}			15	
On-Resistance Flatness (Note 3)	$R_{FLAT(ON)}$	I_{COM} = 100mA; V_{NO} or V_{NC} = -5V, 0, +5V	+25°C		0.3	1	Ω
			T_{MIN} to T_{MAX}			1.5	
NO or NC Off-Leakage Current (Note 4)	$I_{NO(OFF)}$ or $I_{NC(OFF)}$	V_{COM} = +14.5V, -14.5V; V_{NO} or V_{NC} = -14.5V, +14.5V	+25°C	-1	0.01	1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM Off-Leakage Current (Note 4)	$I_{COM(OFF)}$	V_{COM} = +14.5V, -14.5V; V_{NO} or V_{NC} = -14.5V, +14.5V	+25°C	-1	0.01	1	nA
			T_{MIN} to T_{MAX}	-10		10	
COM On-Leakage Current (Note 4)	$I_{COM(ON)}$	V_{COM} = +14.5V, -14.5V; V_{NO} or V_{NC} = +14.5V, -14.5V, or floating	+25°C	-2		2	nA
			T_{MIN} to T_{MAX}	-20		20	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 10V; R_L = 50Ω; MAX4655/4656, R_L = 100Ω; MAX4657/4658, C_L = 35pF; Figure 3	+25°C		110	200	ns
			T_{MIN} to T_{MAX}			300	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 10V; R_L = 50Ω; MAX4655/4656, R_L = 100Ω; MAX4657/4658, C_L = 35pF; Figure 3	+25°C		75	100	ns
			T_{MIN} to T_{MAX}			150	

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 7)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
Charge Injection	Q	V_{GEN} = 0; R_{GEN} = 0; C_L = 1nF; Figure 4	+25°C		23		pC
-3dB Bandwidth	BW		+25°C		210		MHz
Off-Isolation (Note 5)	V_{ISO}	f = 1MHz; R_L = 50Ω; Figure 5	+25°C		-77		dB
Total Harmonic Distortion	THD	f = 20Hz to 20kHz, $V_{N\_}$ = $5V_{p-p}$; R_L = 600Ω	+25°C		0.007		%
NO or NC Off-Capacitance	$C_{NO(OFF)}$, $C_{NC(OFF)}$	f = 1MHz; Figure 6	+25°C		25		pF
COM Off-Capacitance	$C_{COM(OFF)}$	f = 1MHz; Figure 6	+25°C		25		pF
COM On-Capacitance	$C_{COM(ON)}$	f = 1MHz; Figure 7	+25°C		67		pF
DIGITAL I/O							
Input Logic High	V_{IH}		T_{MIN} to T_{MAX}	2.4			V
Input Logic Low	V_{IL}		T_{MIN} to T_{MAX}			0.8	V
Input Leakage Current	I_{IN}	V_{IN} = 0.8V or 2.4V	T_{MIN} to T_{MAX}	-1		1	µA
POWER SUPPLY							
Power-Supply Range			T_{MIN} to T_{MAX}	±4.5		±20	V
Positive Supply Current	I+	V_{IN} = 0 or 5V, $V_{N\_}$ = 3V; I_{SWITCH} = 200mA, MAX4655/4656; I_{SWITCH} = 100mA, MAX4657/4658	+25°C		90	150	µA
			T_{MIN} to T_{MAX}			300	
Negative Supply Current	I-	V_{IN} = 0 or 5V, $V_{N\_}$ = 3V; I_{SWITCH} = 200mA, MAX4655/4656; I_{SWITCH} = 100mA, MAX4657/4658	+25°C		10	50	µA
			T_{MIN} to T_{MAX}			100	
Ground Current	I_{GND}	V_{IN} = 0 or 5V, $V_{N\_}$ = 3V; I_{SWITCH} = 200mA, MAX4655/4656; I_{SWITCH} = 100mA, MAX4657/4658	+25°C		80	130	µA
			T_{MIN} to T_{MAX}			260	

High-Current, 10Ω, SPST, CMOS Analog Switches

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

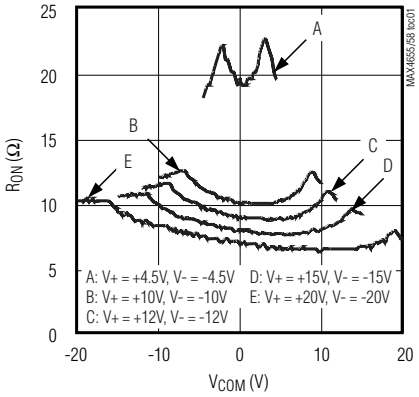
PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Analog Signal Range	V_{IN}		T_{MIN} to T_{MAX}	0		V+	V
On-Resistance	R_{ON}	I_{COM} = 50mA, V_{NO} or V_{NC} = 10V	+25°C		15	22	Ω
			T_{MIN} to T_{MAX}			33	
On-Resistance Flatness (Note 3)	$R_{FLAT (ON)}$	I_{COM} = 50mA, V_{NO} or V_{NC} = 2V, 6V, 10V	+25°C		2.2	4	Ω
			T_{MIN} to T_{MAX}			5	
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{NO} or V_{NC} = 10V; R_L = 100Ω MAX4655/4656, R_L = 200Ω MAX4657/4658, C_L = 35pF; Figure 3	+25°C		140	200	ns
			T_{MIN} to T_{MAX}			300	
Turn-Off Time	t_{OFF}	V_{NO} or V_{NC} = 10V; R_L = 100Ω MAX4655/4656, R_L = 200Ω MAX4657/4658, C_L = 35pF; Figure 3	+25°C		65	125	ns
			T_{MIN} to T_{MAX}			200	
Charge Injection	Q	V_{GEN} = 0; R_{GEN} = 0; C_L = 1nF; Figure 4	+25°C		1		pC
POWER SUPPLY							
Power-Supply Range	V+			9		40	V
Positive Supply Current (Note 6)	I+	V_{IN} = 0 or 12V, I_{SWITCH} = 100mA, MAX4655/4656; I_{SWITCH} = 50mA, MAX4657/4658	+25°C		25	100	µA
			T_{MIN} to T_{MAX}			200	
		V_{IN} = 0 or 5V, I_{SWITCH} = 100mA, MAX4655/4656; I_{SWITCH} = 50mA, MAX4657/4658	+25°C		46	125	
			T_{MIN} to T_{MAX}			200	

Note 2: The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.
Note 3: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
Note 4: Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at T_A = +25°C.
Note 5: 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 6: Guaranteed by testing with dual supplies.
Note 7: -40°C specifications are guaranteed by design.

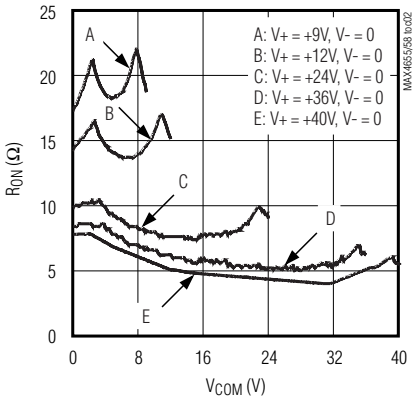
Typical Operating Characteristics

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

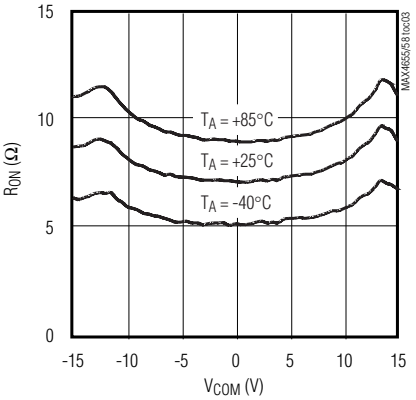
ON-RESISTANCE vs. V_{COM} (DUAL SUPPLIES)



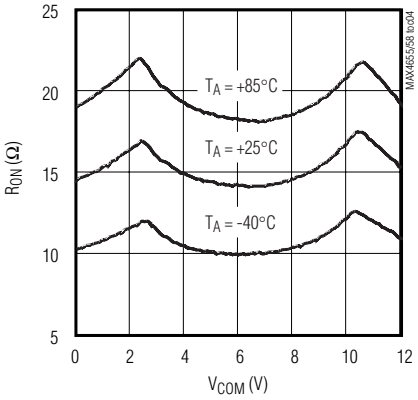
ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)



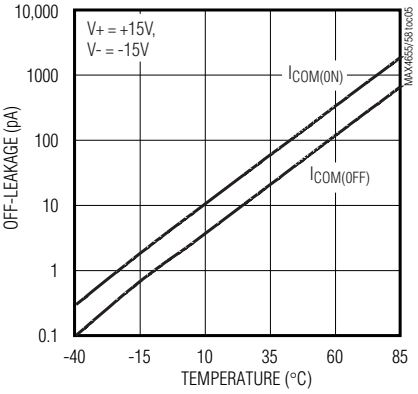
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (DUAL SUPPLIES)



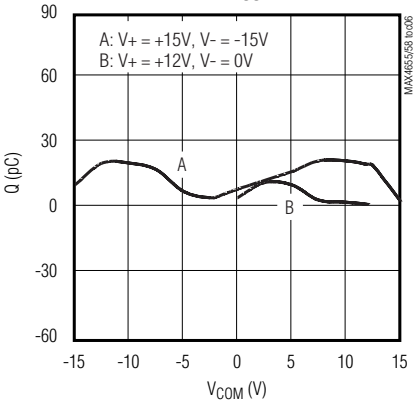
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



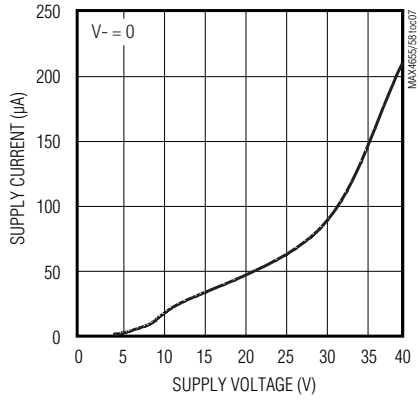
LEAKAGE CURRENT vs. TEMPERATURE



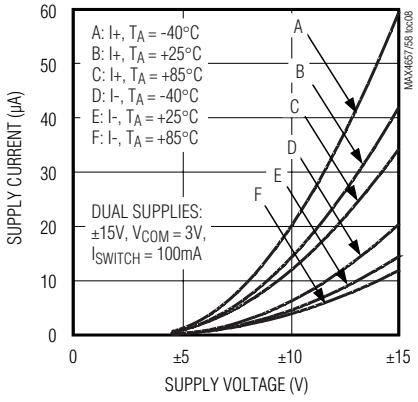
CHARGE INJECTION vs. V_{COM}



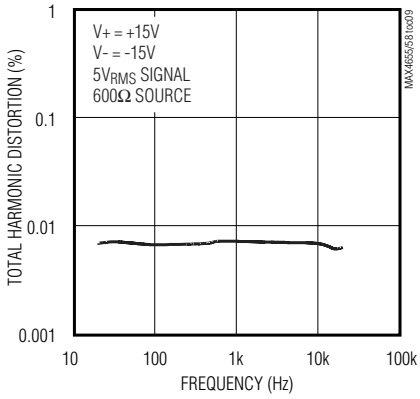
SUPPLY CURRENT vs. SUPPLY VOLTAGE (SINGLE SUPPLY)



SUPPLY CURRENT vs. SUPPLY VOLTAGE AND TEMPERATURE



TOTAL HARMONIC DISTORTION vs. FREQUENCY

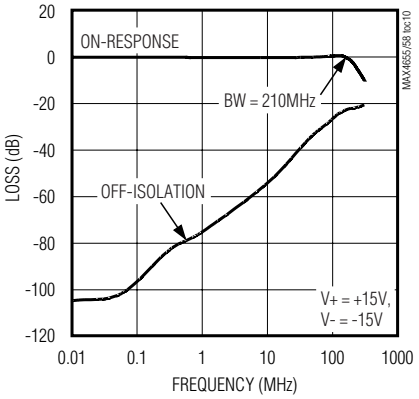


High-Current, 10Ω, SPST, CMOS Analog Switches

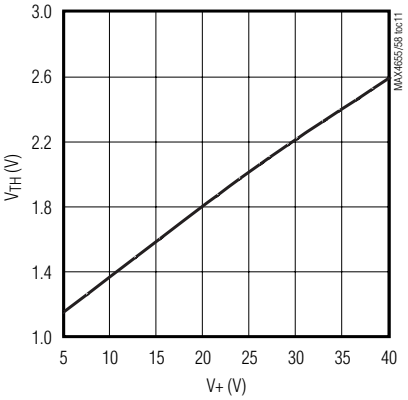
Typical Operating Characteristics (continued)

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

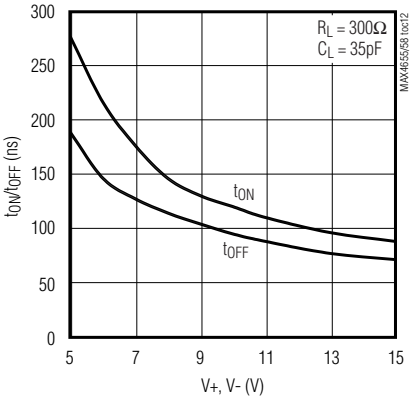
ON-RESPONSE, OFF-ISOLATION vs. FREQUENCY



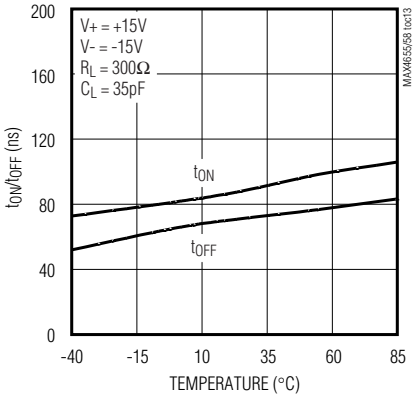
LOGIC LEVEL THRESHOLD VOLTAGE vs. SUPPLY VOLTAGE



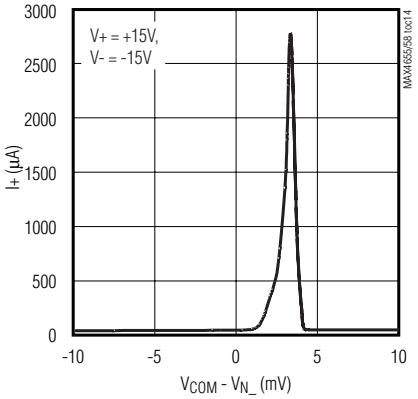
TURN-ON/TURN-OFF TIME vs. SUPPLY VOLTAGE (DUAL SUPPLIES)



TURN-ON/TURN-OFF TIME vs. TEMPERATURE



SUPPLY CURRENT vs. VOLTAGE ACROSS SWITCH



Pin Description

PIN		NAME	FUNCTION
MAX4655/ MAX4657	MAX4656/ MAX4658		
1	1	COM	Analog Switch Common
2, 5	2, 5	N.C.	No Internal Connection
3	3	GND	Ground
4	4	V+	Positive Supply Voltage Input
6	6	IN	Digital Control Input
7	7	V-	Negative Supply Voltage Input
—	8	NO	Analog Switch Normally Open
8	—	NC	Analog Switch Normally Closed

Detailed Description

The MAX4655–MAX4658 are single SPST CMOS analog switches. The CMOS switch construction provides rail-to-rail signal handling while consuming very little power. The switch is controlled by a TTL/CMOS level compatible digital input. The MAX4655/MAX4657 are normally closed switches, and the MAX4656/MAX4658 are normally open switches.

These devices can be operated with either single power supplies or dual power supplies. Operation at up to ±20V supplies allows users a wide switching dynamic range. Additionally, asymmetrical operation is possible to tailor performance to a particular application.

These switches have been specifically designed to handle high switch currents, up to 400mA peak current and 300mA continuous currents. In order to do this, a new technique is used to drive the body of the output N-channel device. (Note: the basic switch between the input NC/NO terminal, and the output common terminal consists of an N-channel MOSFET and a P-channel MOSFET in parallel.) The standard method limits operation to approximately a 600mV drop across the switch. More than 600mV causes an increase in Id_{ON} leakage current (due to the turn-on of on-chip parasitic diodes) and an increase in V+ supply current. With the new sensing method, there is no limitation to the voltage drop across the switch. Current and voltage are limited only by the power dissipation rating of the package and the absolute maximum ratings of the switch.

When the analog input to output voltage drop is approximately 7mV there is an increase in power supply current from typically 90µA to 2mA within a 1mV to 7mV range, caused by the new sensing/driving circuitry.

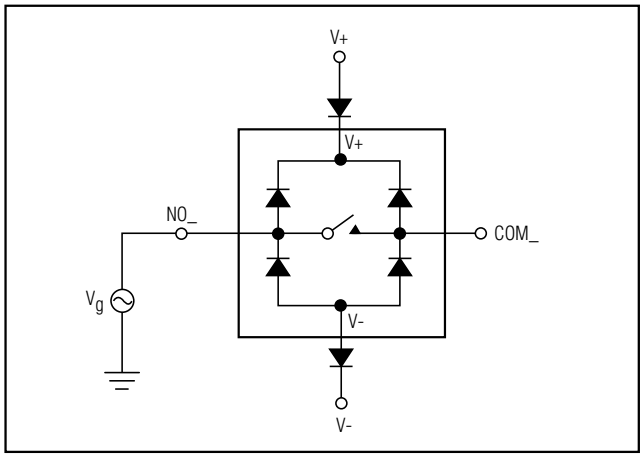


Figure 1. Overvoltage Protection Using Blocking Diodes

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. First, connect GND, followed by V+, V-, and the remaining pins. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins (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. The protection diode for the negative supply is not required when V- is connected to GND.

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. This effect is more pronounced with higher source and load impedances. Above 5MHz, circuit board layout becomes critical. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors.

High-Current, 10Ω, SPST, CMOS Analog Switches

Test Circuits/Timing Diagrams

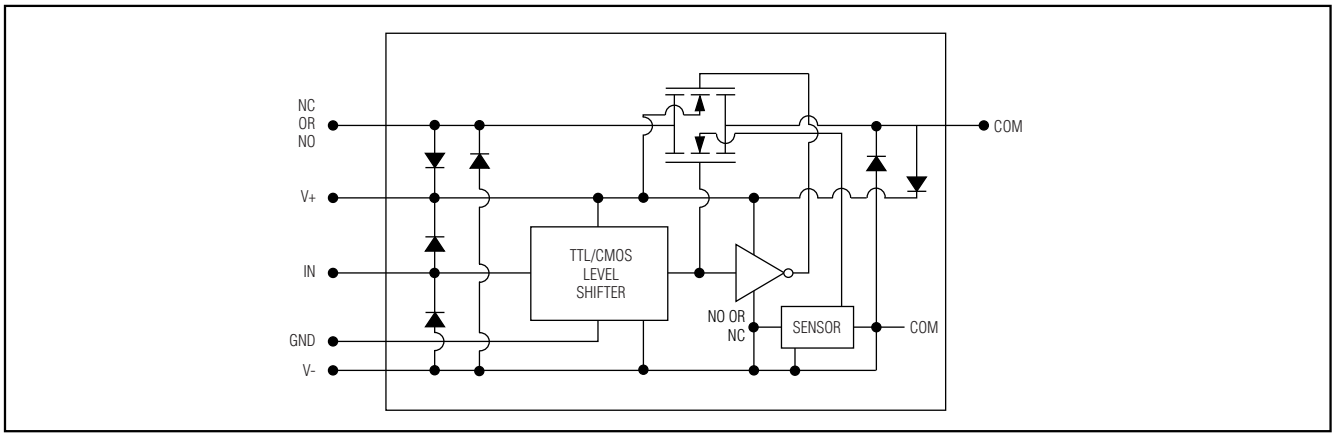


Figure 2. Block Diagram

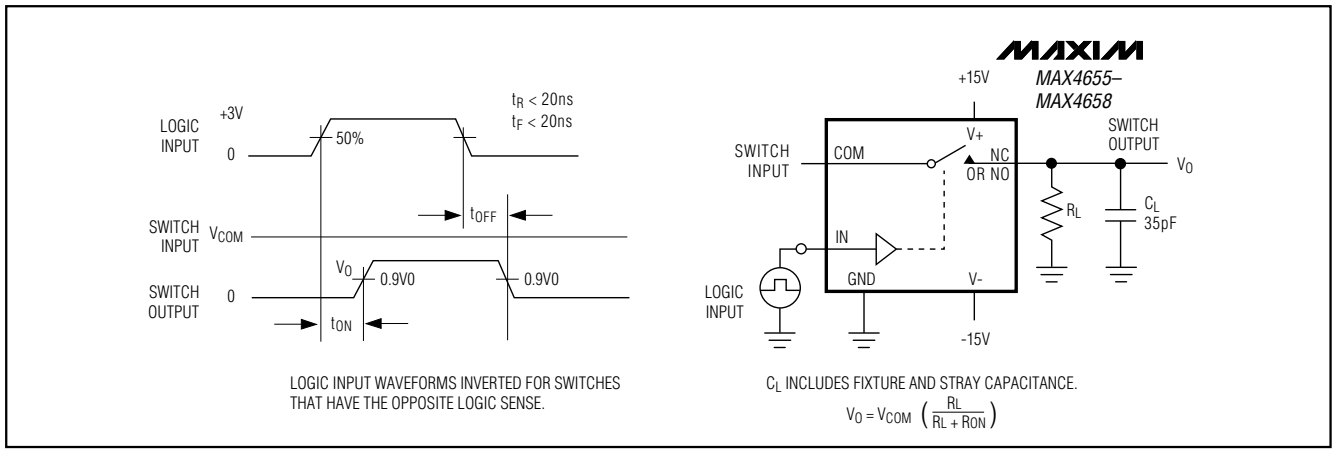


Figure 3. Switching Time

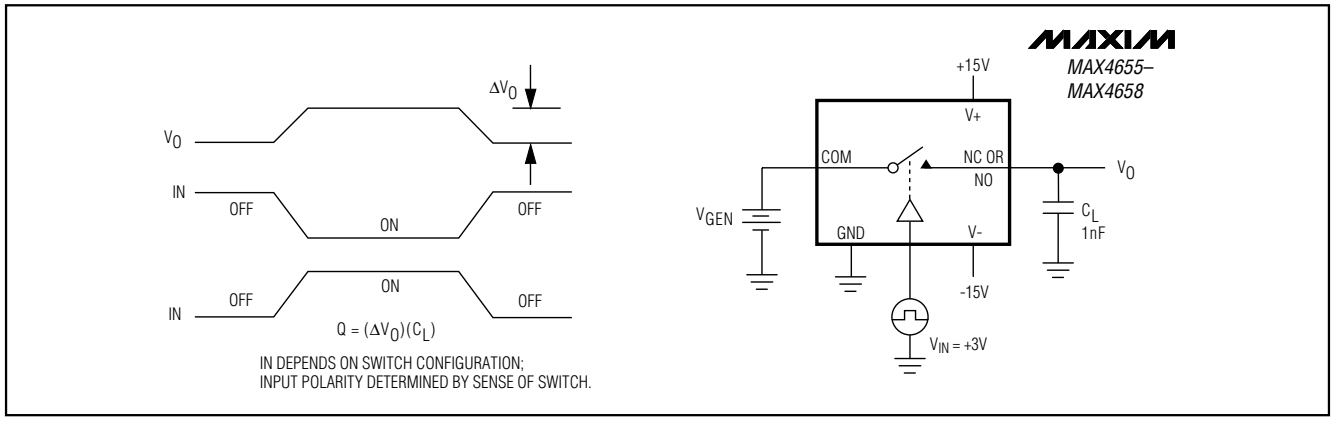


Figure 4. Charge Injection

MAXIM

Test Circuits/Timing Diagrams (continued)

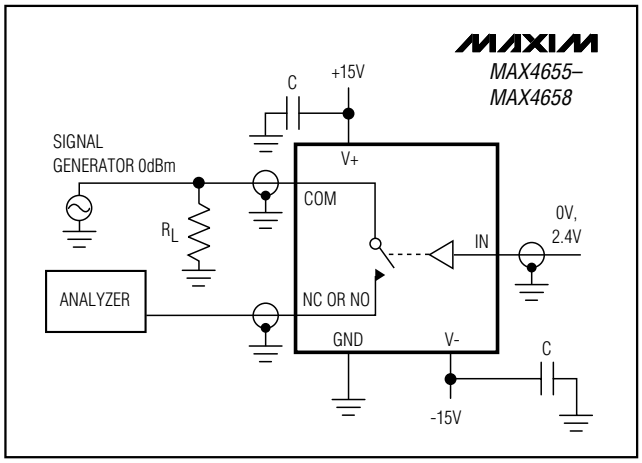


Figure 5. Off-Isolation

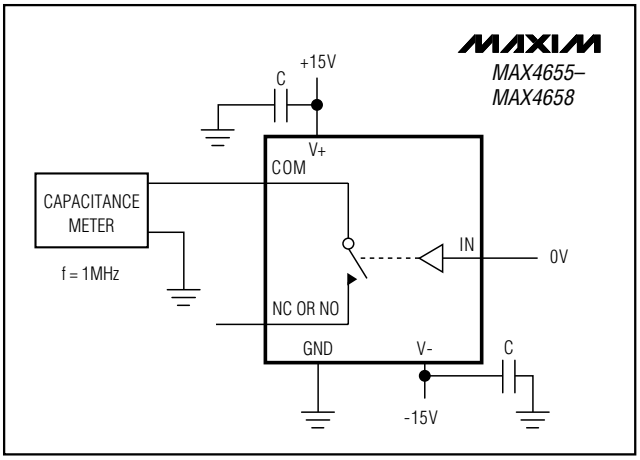


Figure 7. Channel On-Capacitance

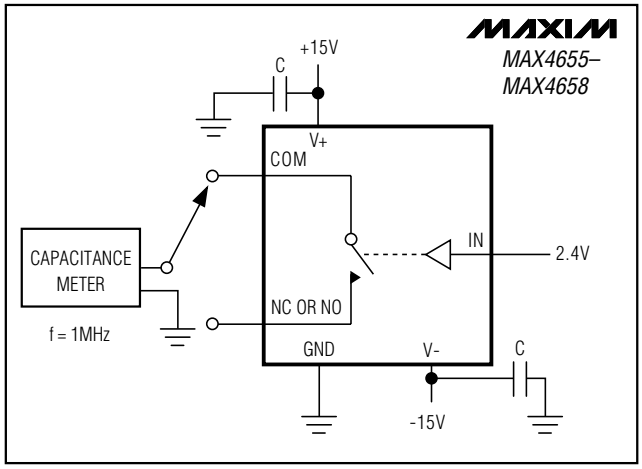


Figure 6. Channel Off-Capacitance

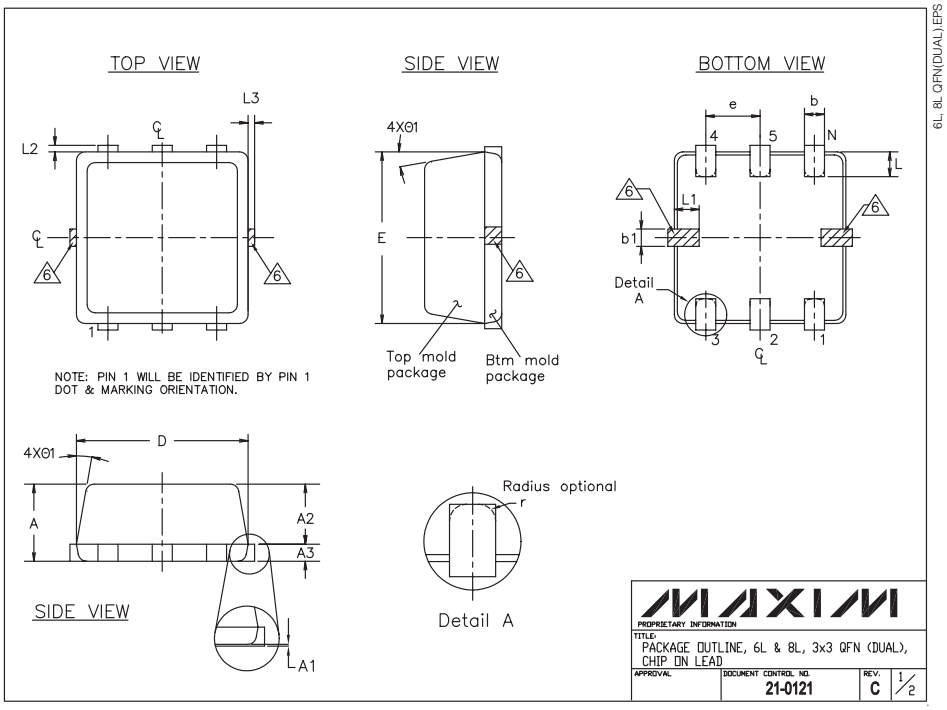
Chip Information

TRANSISTOR COUNT: 45

PROCESS: CMOS

High Current, 10Ω, SPST, CMOS Analog Switches

Package Information



COMMON DIMENSIONS		
SYMBOL	MIN	MAX
A	0.80	1.00
A1	0	0.05
A2	0.65	0.90
A3	0.15	0.25
L2	0	0.10
L3	0	0.10
b1	0.17	0.30
θ1	0°	12°

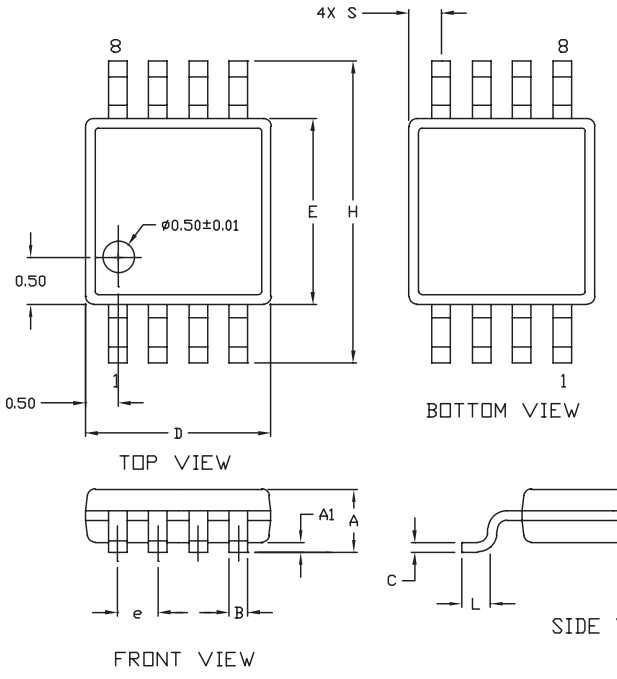
VARIATIONS				
SYMBOL	MIN	MAX	MIN	MAX
D	2.90	3.10	2.90	3.10
E	2.90	3.10	2.90	3.10
N	6		8	
e	0.95 BSC		0.65 BSC	
b	0.27	0.43	0.25	0.40
L	0.21	0.44	0.21	0.44
L1	0.21	0.37	0.21	0.37
JEDEC SPEC	———		MO–220 VARIATION EEC–2	

Note:
1. All dimensions are in mm.
2. Package outline exclusive of mold flash & metal burr.
3. Package outline inclusive of plating.
4. N is the total number of terminals.
5. Package surface finishing of Ra0.4µm max.
6. Shaded areas are not leads. Do not make electrical contact in this area. Use numbered leads for electrical contact.

PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, 6L & 8L, 3x3 QFN (DUAL), CHIP ON LEAD
APPROVAL
DOCUMENT CONTROL NO. 21-0121
REV. C
2/2

Package Information (continued)

8LUMAXD.EPS



	INCHES		MILLIMETERS		JEDEC INCHES		JEDEC MILLIMETERS	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10	---	0.043	---	1.10
A1	0.002	0.006	0.05	0.15	0.002	0.006	0.05	0.15
B	0.010	0.014	0.25	0.36	0.010	0.016	0.25	0.40
C	0.005	0.007	0.13	0.18	0.005	0.009	0.13	0.23
D	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
e	0.0256 BSC		0.65 BSC		0.0256 BSC		0.64 BSC	
E	0.116	0.120	2.95	3.05	0.114	0.122	2.9	3.1
H	0.188	0.198	4.78	5.03	0.193 BSC		4.9 BSC	
L	0.016	0.026	0.41	0.66	0.016	0.027	0.40	0.70
α	0°	6°	0°	6°	0°	6°	0°	6°
S	0.0207 BSC		0.5250 BSC					

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15MM (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.
4. MEETS JEDEC MO-187.

MAXIM
PROPRIETARY INFORMATION

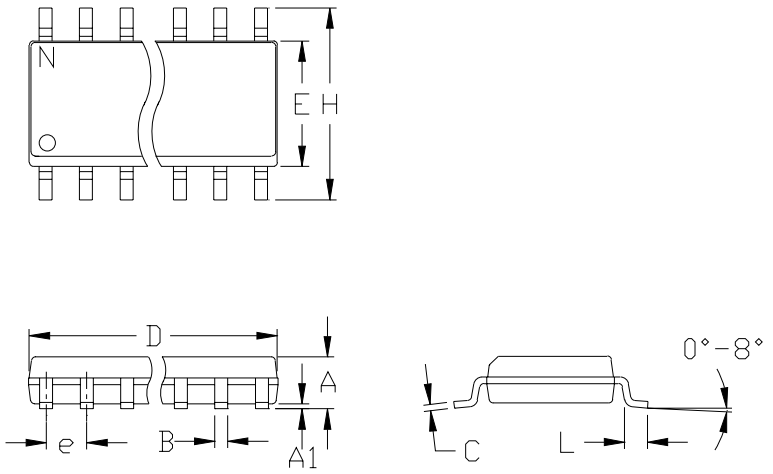
TITLE: PACKAGE OUTLINE, 8L uMAX

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0036	I	1/1

High Current, 10Ω, SPST, CMOS Analog Switches

Package Information (continued)

SOICN.EPS



	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			
	MIN	MAX	MIN	MAX	N	MS012
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
120 SAN GABRIEL DR SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION	TITLE		DOCUMENT CONTROL NUMBER REV

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