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# 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<sub>A</sub> = +25°C. They are available in 8-pin μMAX®, TDFN, and SO packages, with exposed paddle 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

## Features

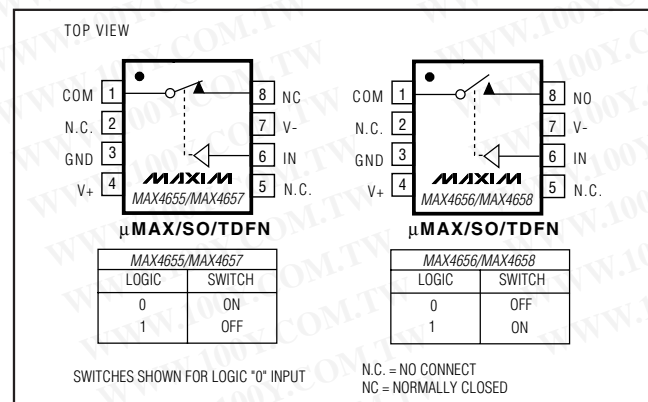
- ◆ High Continuous Current Handling  
 300mA (MAX4655/MAX4656)  
 150mA (MAX4657/MAX4658)
- ◆ High Peak Current Handling  
 400mA (MAX4655/MAX4656)  
 300mA (MAX4657/MAX4658)
- ◆ 10Ω (max) On-Resistance (±15V supplies)
- ◆ V<sub>L</sub> Not Required
- ◆ 1Ω (max) R<sub>ON</sub> Flatness over Specified 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	TOP MARK
MAX4655ETA	-40°C to +85°C	8 TDFN-EP*	AKT
MAX4655EUA	-40°C to +85°C	8 μMAX	AAAL
MAX4655ESA	-40°C to +85°C	8 SO	—
MAX4656ETA	-40°C to +85°C	8 TDFN-EP*	AKU
MAX4656EUA	-40°C to +85°C	8 μMAX	AAAM
MAX4656ESA	-40°C to +85°C	8 SO	—
MAX4657EUA	-40°C to +85°C	8 μMAX	—
MAX4657ESA	-40°C to +85°C	8 SO	—
MAX4658EUA	-40°C to +85°C	8 μMAX	—
MAX4658ESA	-40°C to +85°C	8 SO	—

\*EP = Exposed paddle.

## Pin Configurations/ Functional Diagrams/Truth Tables



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For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim's website at [www.maxim-ic.com](http://www.maxim-ic.com).

MAX4655-MAX4658

# High-Current, 10 $\Omega$ , SPST, CMOS Analog Switches

## ABSOLUTE MAXIMUM RATINGS

V+ to GND .....	-0.3V to +44V	Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
V- to GND .....	-44V to +0.3V	8-Pin TDFN (derate 24.4mW/°C above +70°C) .....	1951mW
V+ to V- .....	-0.3V to +44V	8-Pin $\mu$ MAX-EP (derate 10.3mW/°C above +70°C)	
All Other Pins to GND (Note 1) .....	V- - 0.3V to V+ + 0.3V	MAX4655/MAX4656 .....	825mW
Continuous Current, COM, NO, NC (MAX4655/MAX4656) .....	$\pm$ 300mA	8-Pin $\mu$ MAX (derate 4.50mW/°C above +70°C)	
Continuous Current, COM, NO, NC (MAX4657/MAX4658) .....	$\pm$ 150mA	MAX4657/MAX4658 .....	362mW
Continuous Current, IN .....	$\pm$ 30mA	8-Pin SO-EP (derate 18.9mW/°C above +70°C)	
Peak Current, COM, NO, NC (pulsed at 1ms, 10% duty cycle)		MAX4655/MAX4656 .....	1509mW
MAX4655/MAX4656 .....	$\pm$ 400mA	8-Pin SO (derate 5.88mW/°C above +70°C)	
MAX4657/MAX4658 .....	$\pm$ 300mA	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<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.)  
(Notes 2, 7, 8)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub>			V-		V+	V
On-Resistance	R <sub>ON</sub>	I <sub>COM</sub> = 100mA; V <sub>NO</sub> or V <sub>NC</sub> = $\pm$ 10V	+25°C		7	10	$\Omega$
			T <sub>MIN</sub> to T <sub>MAX</sub>			15	
On-Resistance Flatness (Note 3)	R <sub>FLAT(ON)</sub>	I <sub>COM</sub> = 100mA; V <sub>NO</sub> or V <sub>NC</sub> = -5V, 0, +5V	+25°C		0.3	1	$\Omega$
			T <sub>MIN</sub> to T <sub>MAX</sub>			1.5	
NO or NC Off-Leakage Current (Note 4)	I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub>	V <sub>COM</sub> = +14.5V, -14.5V; V <sub>NO</sub> or V <sub>NC</sub> = -14.5V, +14.5V	+25°C	-1	0.01	+1	nA
			T <sub>MIN</sub> to T <sub>MAX</sub>	-10		10	
COM Off-Leakage Current (Note 4)	I <sub>COM(OFF)</sub>	V <sub>COM</sub> = +14.5V, -14.5V; V <sub>NO</sub> or V <sub>NC</sub> = -14.5V, +14.5V	+25°C	-1	0.01	+1	nA
			T <sub>MIN</sub> to T <sub>MAX</sub>	-10		+10	
COM On-Leakage Current (Note 4)	I <sub>COM(ON)</sub>	V <sub>COM</sub> = +14.5V, -14.5V; V <sub>NO</sub> or V <sub>NC</sub> = +14.5V, -14.5V, or floating	+25°C	-2		+2	nA
			T <sub>MIN</sub> to T <sub>MAX</sub>	-20		+20	
<b>DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 10V; R <sub>L</sub> = 50 $\Omega$ ; MAX4655/4656, R <sub>L</sub> = 100 $\Omega$ ; MAX4657/4658, C <sub>L</sub> = 35pF; Figure 3	+25°C		110	200	ns
			T <sub>MIN</sub> to T <sub>MAX</sub>			300	
Turn-Off Time	t <sub>OFF</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 10V; R <sub>L</sub> = 50 $\Omega$ ; MAX4655/4656, R <sub>L</sub> = 100 $\Omega$ ; MAX4657/4658, C <sub>L</sub> = 35pF; Figure 3	+25°C		75	100	ns
			T <sub>MIN</sub> to T <sub>MAX</sub>			150	

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

MAX4655-MAX4658

## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V<sub>+</sub> = +15V, V<sub>-</sub> = -15V, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.)  
(Notes 2, 7, 8)

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

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## ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>IN</sub>		T <sub>MIN</sub> to T <sub>MAX</sub>	0		V+	V
On-Resistance	R <sub>ON</sub>	I <sub>COM</sub> = 50mA, V <sub>NO</sub> or V <sub>NC</sub> = 10V	+25°C		15	22	$\Omega$
			T <sub>MIN</sub> to T <sub>MAX</sub>			33	
On-Resistance Flatness (Note 3)	R <sub>FLAT</sub> (ON)	I <sub>COM</sub> = 50mA, V <sub>NO</sub> or V <sub>NC</sub> = 2V, 6V, 10V	+25°C		2.2	4	$\Omega$
			T <sub>MIN</sub> to T <sub>MAX</sub>			5	
<b>DYNAMIC CHARACTERISTICS</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 10V; R <sub>L</sub> = 100 $\Omega$ MAX4655/4656, R <sub>L</sub> = 200 $\Omega$ MAX4657/4658, C <sub>L</sub> = 35pF; Figure 3	+25°C		140	200	ns
			T <sub>MIN</sub> to T <sub>MAX</sub>			300	
Turn-Off Time	t <sub>OFF</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 10V; R <sub>L</sub> = 100 $\Omega$ MAX4655/4656, R <sub>L</sub> = 200 $\Omega$ MAX4657/4658, C <sub>L</sub> = 35pF; Figure 3	+25°C		65	125	ns
			T <sub>MIN</sub> to T <sub>MAX</sub>			200	
Charge Injection	Q	V <sub>GEN</sub> = 0; R <sub>GEN</sub> = 0; C <sub>L</sub> = 1nF; Figure 4	+25°C		1		pC
<b>POWER SUPPLY</b>							
Power-Supply Range	V+				9	40	V
Positive Supply Current (Note 6)	I+	V <sub>IN</sub> = 0 or 12V, I <sub>SWITCH</sub> = 100mA, MAX4655/4656; I <sub>SWITCH</sub> = 50mA, MAX4657/4658	+25°C		25	100	$\mu$ A
			T <sub>MIN</sub> to T <sub>MAX</sub>			200	
		V <sub>IN</sub> = 0 or 5V, I <sub>SWITCH</sub> = 100mA, MAX4655/4656; I <sub>SWITCH</sub> = 50mA, MAX4657/4658	+25°C		46	125	
			T <sub>MIN</sub> to T <sub>MAX</sub>			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<sub>A</sub> = +25°C.

**Note 5:** Off-isolation = 20log<sub>10</sub> [V<sub>COM</sub> / (V<sub>NC</sub> or V<sub>NO</sub>)], V<sub>COM</sub> = output, V<sub>NC</sub> or V<sub>NO</sub> = input to off switch.

**Note 6:** Guaranteed by testing with dual supplies.

**Note 7:** -40°C specifications are guaranteed by design.

**Note 8:** TDFN parts are tested at +25°C and guaranteed by design over the entire temperature range.

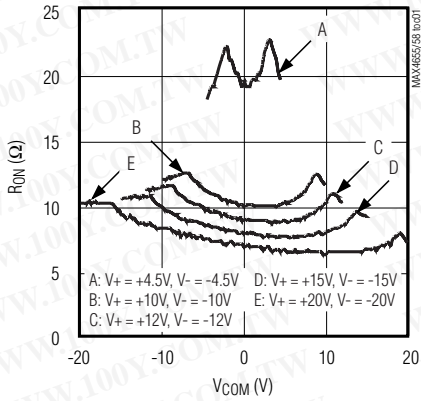
# High-Current, 10Ω, SPST, CMOS Analog Switches

## Typical Operating Characteristics

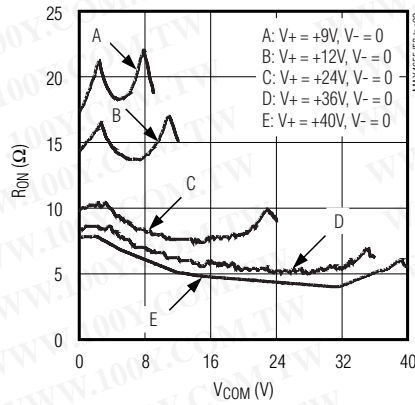
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

MAX4655-MAX4658

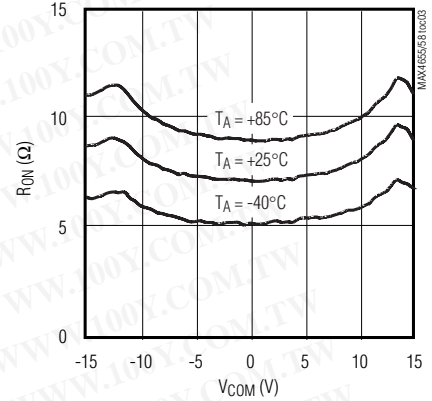
**ON-RESISTANCE vs.  $V_{COM}$  (DUAL SUPPLIES)**



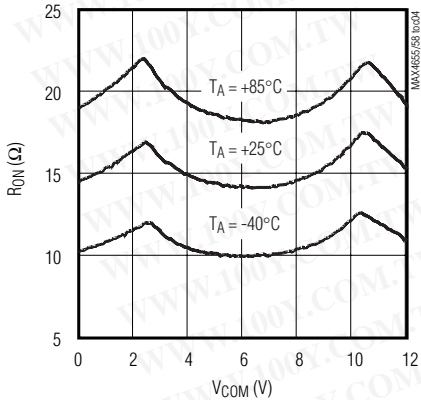
**ON-RESISTANCE vs.  $V_{COM}$  (SINGLE SUPPLY)**



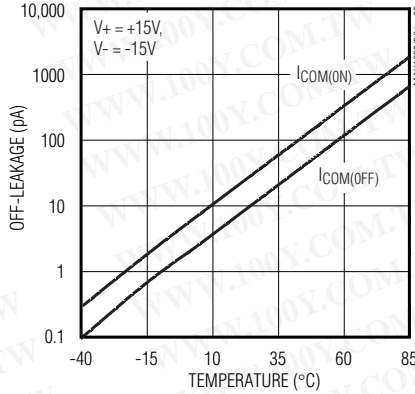
**ON-RESISTANCE vs.  $V_{COM}$  AND TEMPERATURE (DUAL SUPPLIES)**



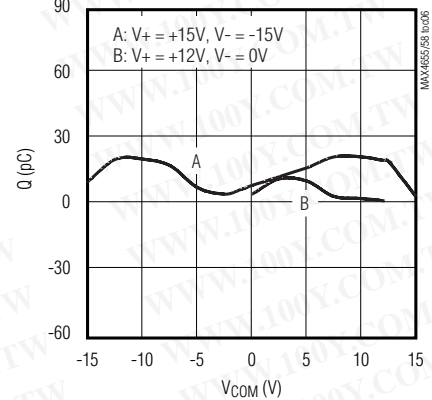
**ON-RESISTANCE vs.  $V_{COM}$  AND TEMPERATURE (SINGLE SUPPLY)**



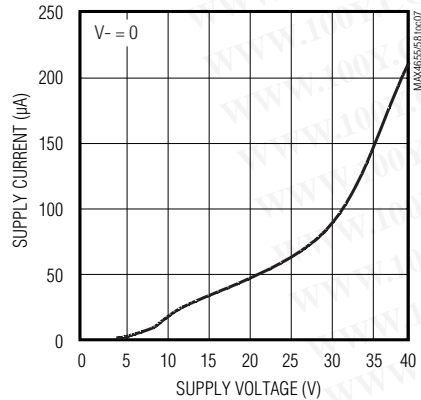
**LEAKAGE CURRENT vs. TEMPERATURE**



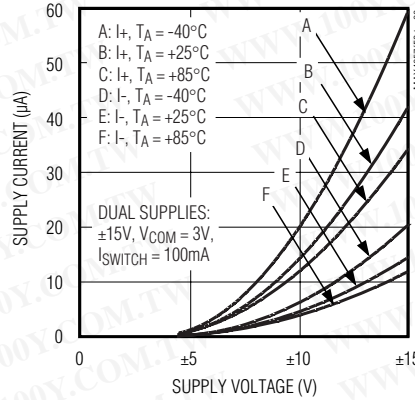
**CHARGE INJECTION vs.  $V_{COM}$**



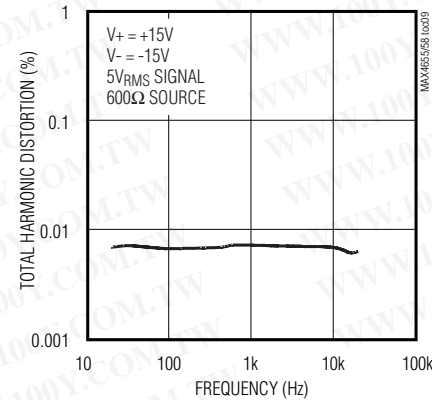
**SUPPLY CURRENT vs. SUPPLY VOLTAGE (SINGLE SUPPLY)**



**SUPPLY CURRENT vs. SUPPLY VOLTAGE AND TEMPERATURE**



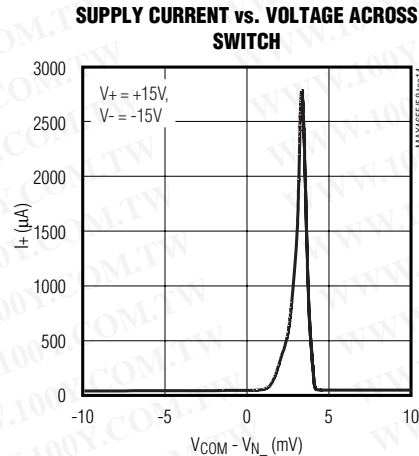
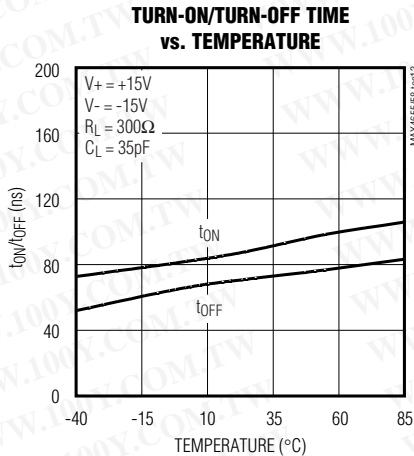
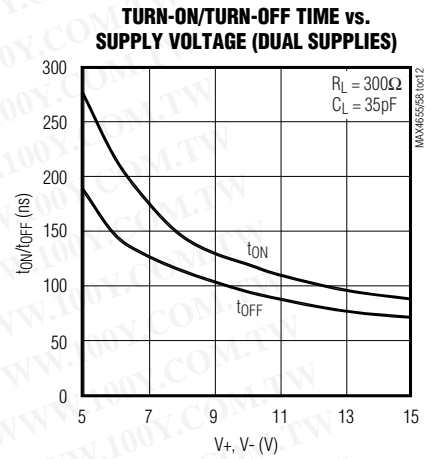
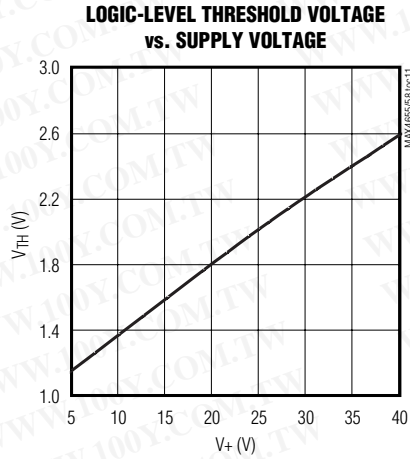
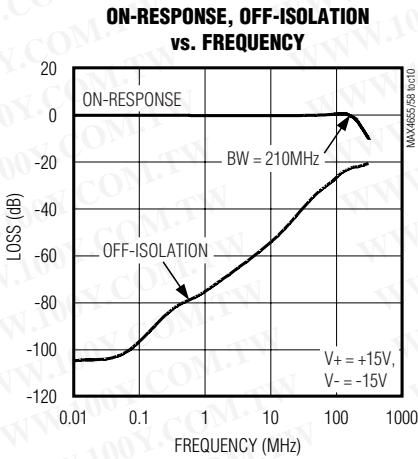
**TOTAL HARMONIC DISTORTION vs. FREQUENCY**



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

## Typical Operating Characteristics (continued)

(T<sub>A</sub> = +25°C, unless otherwise noted.)



## 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 <sub>+</sub>	Positive Supply Voltage Input
6	6	IN	Digital Control Input
7	7	V <sub>-</sub>	Negative Supply Voltage Input
—	8	NO	Analog Switch Normally Open
8	—	NC	Analog Switch Normally Closed
EP	—	EP	Exposed Paddle. Connect EP to V <sub>+</sub> .



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

## Test Circuits/Timing Diagrams

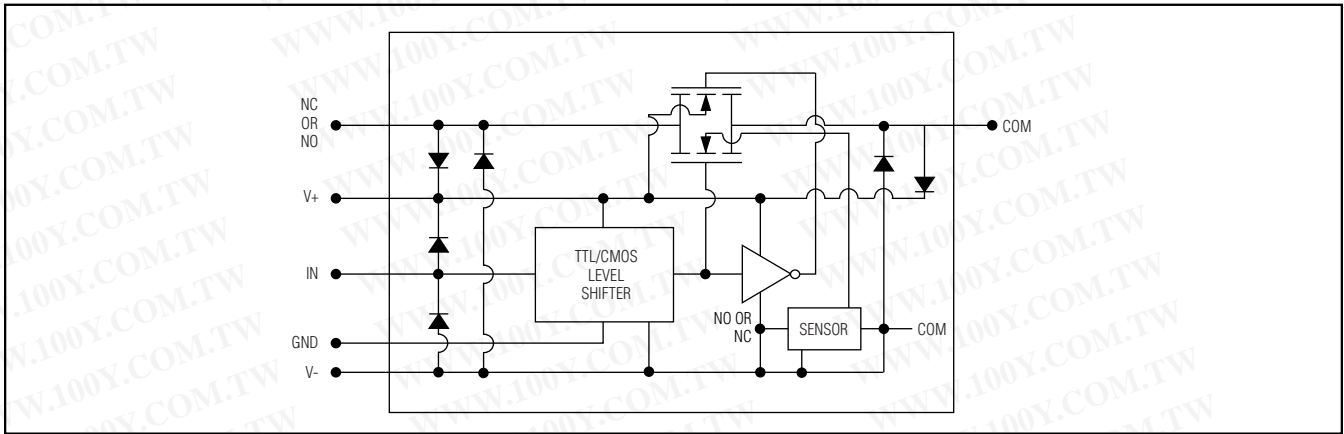


Figure 2. Block Diagram

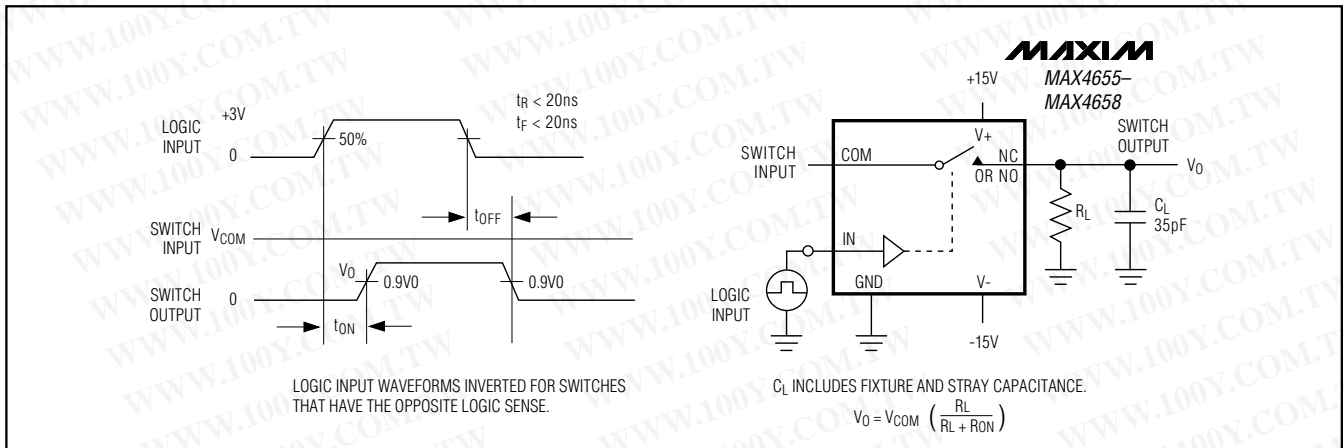


Figure 3. Switching Time

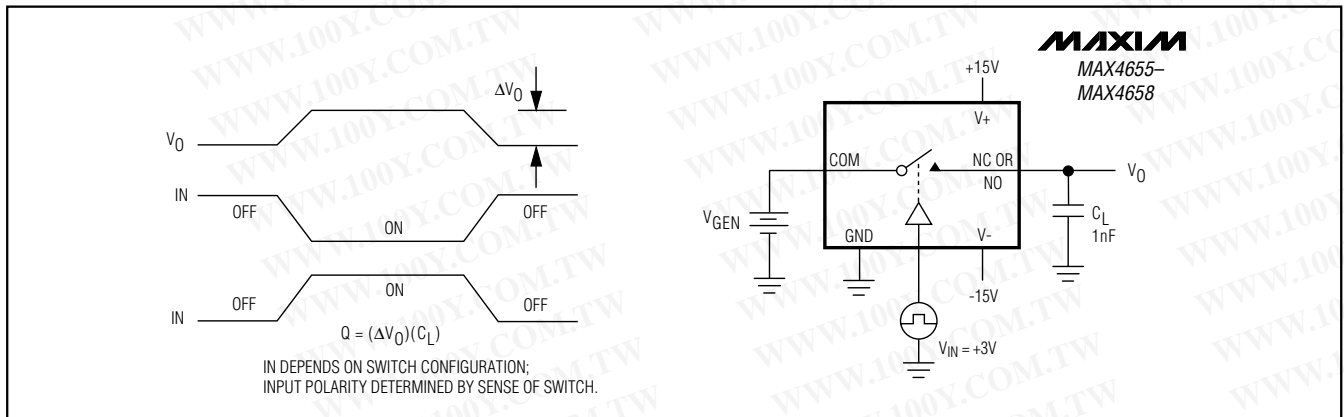


Figure 4. Charge Injection

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

## Test Circuits/Timing Diagrams (continued)

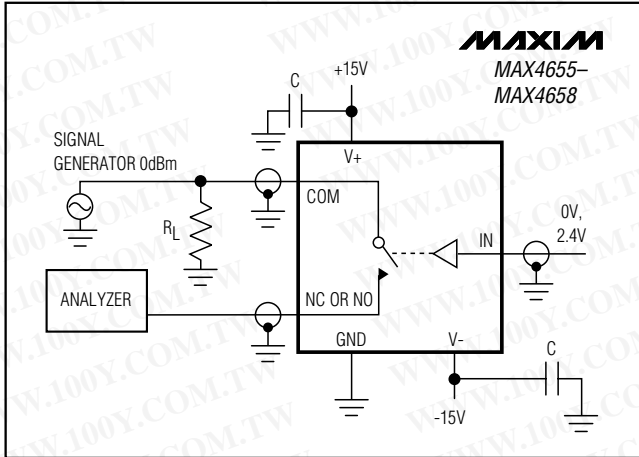


Figure 5. Off-Isolation

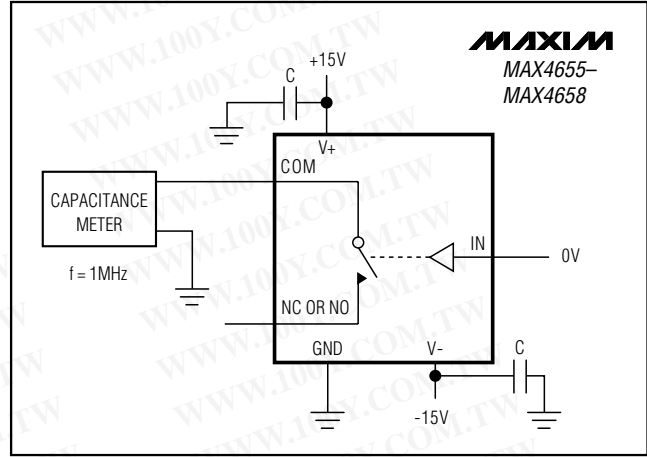


Figure 7. Channel On-Capacitance

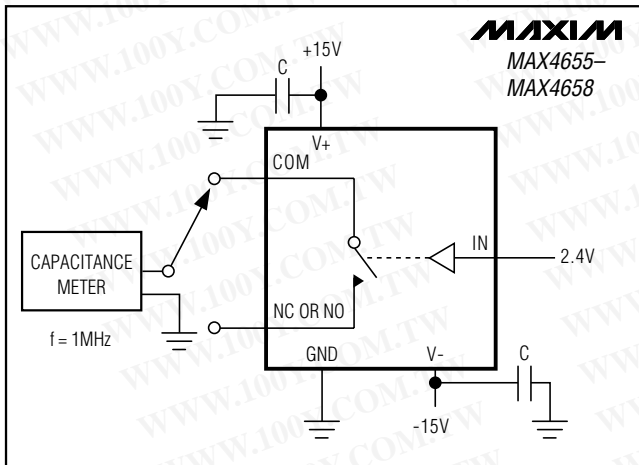


Figure 6. Channel Off-Capacitance

## Chip Information

TRANSISTOR COUNT: 45

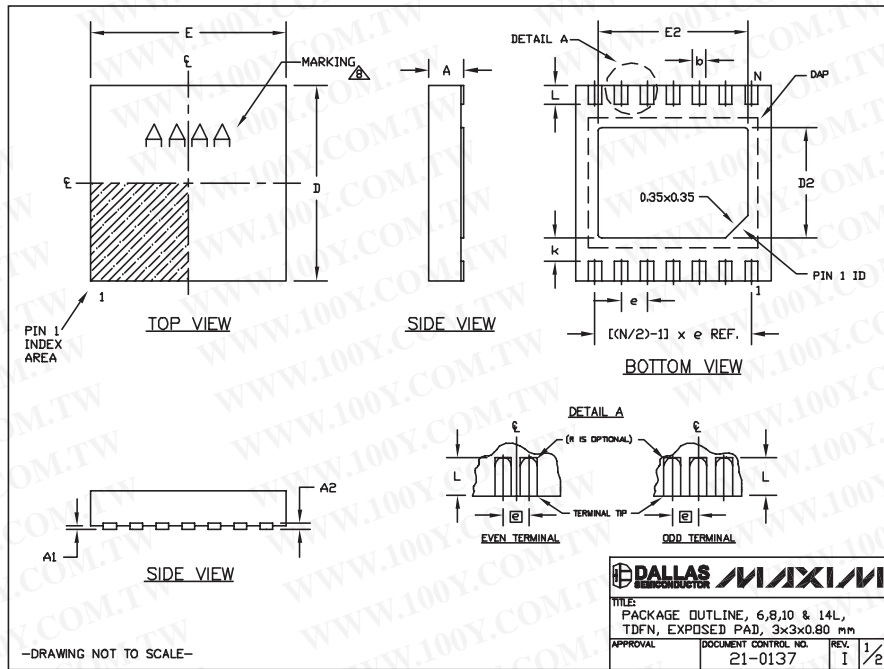
PROCESS: CMOS

MAX4655-MAX4658

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

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



6, 8, & 10L, DFN THIN EPS

COMMON DIMENSIONS			PACKAGE VARIATIONS							
SYMBOL	MIN.	MAX.	PKG. CODE	N	D2	E2	e	JEDEC SPEC	b	[(N/2)-1] x e
A	0.70	0.80	T633-2	6	1.50±0.10	2.30±0.10	0.95 BSC	MO229 / WEEA	0.40±0.05	1.90 REF
D	2.90	3.10	T833-2	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
E	2.90	3.10	T833-3	8	1.50±0.10	2.30±0.10	0.65 BSC	MO229 / WEEC	0.30±0.05	1.95 REF
A1	0.00	0.05	T1033-1	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
L	0.20	0.40	T1033-2	10	1.50±0.10	2.30±0.10	0.50 BSC	MO229 / WEED-3	0.25±0.05	2.00 REF
k	0.25 MIN.		T1433-1	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF
A2	0.20 REF.		T1433-2	14	1.70±0.10	2.30±0.10	0.40 BSC	----	0.20±0.05	2.40 REF

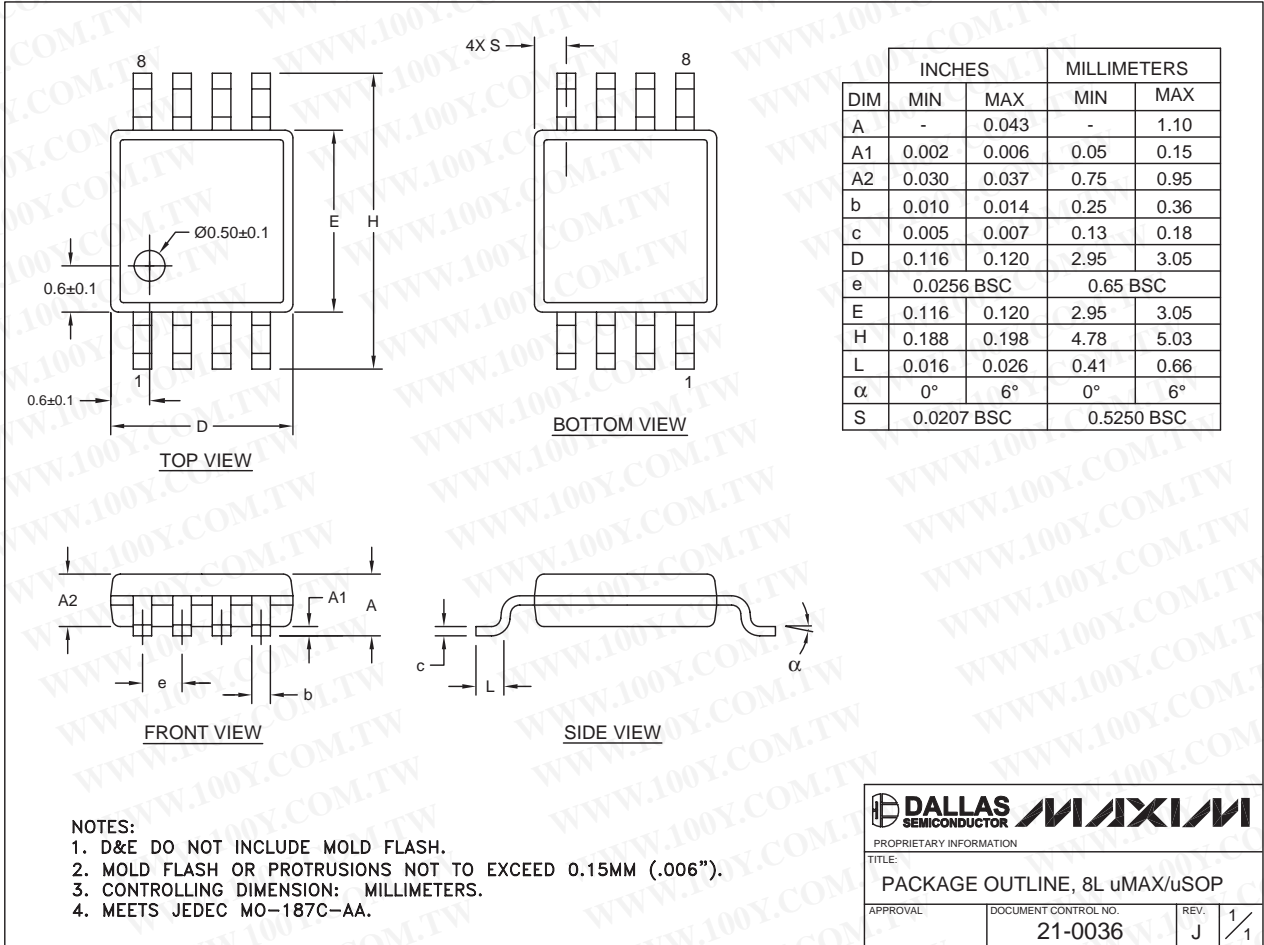
NOTES:  
 1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.  
 2. COPLANARITY SHALL NOT EXCEED 0.08 mm.  
 3. WARPAGE SHALL NOT EXCEED 0.10 mm.  
 4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).  
 5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.  
 6. "N" IS THE TOTAL NUMBER OF LEADS.  
 7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.  
 MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.

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

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



8LUMAXD.EPS

MAX4655-MAX4658

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

勝特力材料 886-3-5753170  
 勝特力电子(上海) 86-21-34970699  
 勝特力电子(深圳) 86-755-83298787  
 Http://www.100y.com.tw

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

**TOP VIEW**

**FRONT VIEW**

**SIDE VIEW**

**NOTES:**

1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

DIM	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 BSC		1.27 BSC	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

VARIATIONS:

DIM	INCHES		MILLIMETERS		N	MS012
	MIN	MAX	MIN	MAX		
D	0.189	0.197	4.80	5.00	8	AA
D	0.337	0.344	8.55	8.75	14	AB
D	0.386	0.394	9.80	10.00	16	AC

SOICN EP5

<b>DALLAS SEMICONDUCTOR</b>		<b>MAXIM</b>	
<small>PROPRIETARY INFORMATION</small>			
TITLE: <b>PACKAGE OUTLINE, .150" SOIC</b>			
<small>APPROVAL</small>	<small>DOCUMENT CONTROL NO.</small> 21-0041	<small>REV.</small> B	<small>REV.</small> 1/1

## Revision History

Pages changed at Rev 4: 1, 2, 3, 6, 12

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