

# Precision, Low-Voltage Analog Switches

## ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to GND

V+	.....-0.3V to +17V
V-	.....+0.3V to -17V
V+ to V-	.....-0.3V to +17V
COM <sub>-</sub> , NO <sub>-</sub> , NC <sub>-</sub> , IN <sub>-</sub>	.....(V <sub>-</sub> - 2V) to (V <sub>+</sub> + 2V) or 30mA, whichever occurs first
Continuous Current, any pin	.....30mA
Peak Current, any pin (pulsed at 1ms, 10% duty cycle max)	.....100mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

Plastic DIP (derate 10.53mW/°C above +70°C)	.....842mW
Narrow SO (derate 8.70mW/°C above +70°C)	.....696mW
CERDIP (derate 10.00mW/°C above +70°C)	.....800mW
Operating Temperature Ranges	
MAX38_C_E	.....0°C to +70°C
MAX38_E_E	.....-40°C to +85°C
MAX38_MJE	.....-55°C to +125°C
Storage Temperature Range	.....-65°C to +150°C
Lead Temperature (soldering, 10sec)	.....+300°C

**Note 1:** Signals on NC, NO, COM, or IN exceeding V<sub>+</sub> or V<sub>-</sub> 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—Dual Supplies

(V<sub>+</sub> = +5V ±10%, V<sub>-</sub> = -5V ±10%, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP. RANGE	MIN	TYP (Note 2)	MAX	UNITS	
<b>SWITCH</b>								
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	(Note 3)		V-		V+	V	
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = 4.5V, V <sub>-</sub> = -4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±3.5V, I <sub>COM</sub> = -10mA, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0.8V	T <sub>A</sub> = +25°C	C, E	20	35	Ω	
			M		20	30		
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V <sub>NC</sub> or V <sub>NO</sub> = ±3V, I <sub>COM</sub> = -10mA, V <sub>+</sub> = 5V, V <sub>-</sub> = -5V	T <sub>A</sub> = +25°C	C, E, M	0.5	2	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E, M		4		
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V <sub>NC</sub> or V <sub>NO</sub> = 3V, 0V, -3V; I <sub>COM</sub> = -10mA, V <sub>+</sub> = 5V; V <sub>-</sub> = -5V	T <sub>A</sub> = +25°C	C, E, M		4	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E, M		6		
NC or NO Off Leakage Current (Note 5)	I <sub>NC(OFF)</sub> or I <sub>NO(OFF)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = +25°C	C, E	-0.2	-0.01	0.2	nA
			M		-0.1	-0.01	0.1	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
COM Off Leakage Current (Note 5)	I <sub>COM(OFF)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = +25°C	C, E	-0.2	-0.01	0.2	nA
			M		-0.1	-0.01	0.1	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
COM On Leakage Current (Note 5)	I <sub>COM(ON)</sub>	V <sub>COM</sub> = ±4.5V, V <sub>NC</sub> or V <sub>NO</sub> = ±4.5V, V <sub>+</sub> = 5.5V, V <sub>-</sub> = -5.5V	T <sub>A</sub> = +25°C	C, E	-0.4	-0.04	0.4	nA
			M		-0.2	-0.04	0.2	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5.0		5.0	
				M		-20.0	20.0	

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>DIGITAL LOGIC INPUT</b>							
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V		-1.0	0.005	1.0	μA
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V		-1.0	0.005	1.0	μA
Logic High Input Voltage	V <sub>AH</sub>		TA = T <sub>MIN</sub> to T <sub>MAX</sub>	2.4			V
Logic Low Input Voltage	V <sub>AL</sub>		TA = T <sub>MIN</sub> to T <sub>MAX</sub>			0.8	V
<b>DYNAMIC</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>COM</sub> = 3V, Figure 2	TA = +25°C	100	175		ns
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>			225	
Turn-Off Time	t <sub>OFF</sub>	V <sub>COM</sub> = 3V, Figure 2	TA = +25°C	60	100		ns
			TA = T <sub>MIN</sub> to T <sub>MAX</sub>			150	
Break-Before-Make Time Delay (Note 3)	t <sub>D</sub>	MAX383 only, Figure 3	TA = +25°C	10	20		ns
Charge Injection (Note 3)	V <sub>CTE</sub>	CL = 1.0nF, V <sub>GEN</sub> = 0V, R <sub>GEN</sub> = 0Ω, Figure 4	TA = +25°C		2	5	pC
Off Isolation (Note 6)	V <sub>ISO</sub>	RL = 100Ω, CL = 5pF, f = 1MHz, Figure 5	TA = +25°C		72		dB
Crosstalk (Note 7)	V <sub>CT</sub>	RL = 50Ω, CL = 5pF, f = 1MHz, Figure 6	TA = +25°C		90		dB
Off Capacitance	C <sub>OFF</sub>	f = 1MHz, Figure 7	TA = +25°C		12		pF
COM Off Capacitance	C <sub>COM(OFF)</sub>	f = 1MHz, Figure 7	TA = +25°C		12		pF
Channel On Capacitance	C <sub>COM(ON)</sub>	f = 1MHz, Figure 8	TA = +25°C		39		pF
<b>SUPPLY</b>							
Power-Supply Range				±3		±8	V
Positive Supply Current	I+	All channels on or off, V+ = 5.5V, V- = -5.5V, VIN = 0V or V+		-1.0	0.06	1.0	μA
Negative Supply Current	I-	All channels on or off, V+ = 5.5V, V- = -5.5V, VIN = 0V or V+		-1.0	-0.01	1.0	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:**  $\Delta R_{ON} = \Delta R_{ON(max)} - \Delta R_{ON(min)}$ . On-resistance match between channels and flatness are guaranteed only with specified voltages. Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

**Note 5:** Leakage parameters are 100% tested at maximum rated hot temperature and guaranteed by correlation at room temperature.

**Note 6:** See Figure 4. Off isolation =  $20 \log_{10} V_{COM}/V_{NC}$  or  $V_{NO}$ . V<sub>COM</sub> = output, V<sub>NC</sub> or V<sub>NO</sub> = input to off switch.

**Note 7:** Between any two switches. See Figure 5.

**Note 8:** Leakage testing at single supply is guaranteed by testing with dual supplies.

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +5V ±10%, V- = 0V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP. RANGE	MIN	TYP (Note 2)	MAX	UNITS	
<b>SWITCH</b>								
Analog Signal Range	V <sub>COM</sub> , V <sub>NO</sub> , V <sub>NC</sub>	(Note 3)		0V		V+	V	
On-Resistance	R <sub>ON</sub>	V+ = 5.0V, V- = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 3.5V, I <sub>COM</sub> = 1.0mA, V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0.8V	T <sub>A</sub> = +25°C	C, E	25	65	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E, M		60		75
On-Resistance Match Between Channels (Note 4)	ΔR <sub>ON</sub>	V <sub>NC</sub> or V <sub>NO</sub> = 3V, I <sub>COM</sub> = 1.0mA, V+ = 5V	T <sub>A</sub> = +25°C	C, E, M	0.5	2	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E, M				4
On-Resistance Flatness (Note 4)	R <sub>FLAT(ON)</sub>	V <sub>NC</sub> or V <sub>NO</sub> = 3V, 2V, 1V; I <sub>COM</sub> = 1.0mA; V+ = 5V; V- = 0V	T <sub>A</sub> = +25°C	C, E, M		6	Ω	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E, M				8
NC or NO Off Leakage Current (Note 8)	I <sub>NC(OFF)</sub> or I <sub>NO(OFF)</sub>	V <sub>COM</sub> = 0V, V <sub>NC</sub> or V <sub>NO</sub> = 4.5V, V+ = 5.5V, V- = 0V	T <sub>A</sub> = +25°C	C, E	-0.2	-0.01	0.2	nA
				M	-0.1	-0.01	0.1	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
				M	-5.0		5.0	
COM Off Leakage Current (Note 8)	I <sub>COM(OFF)</sub>	V <sub>COM</sub> = 4.5V, V <sub>NC</sub> or V <sub>NO</sub> = 0V, V+ = 5.5V, V- = 0V	T <sub>A</sub> = +25°C	C, E	-0.2	-0.01	0.2	nA
				M	-0.1	-0.01	0.1	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-2.5		2.5	
				M	-5.0		5.0	
COM On Leakage Current (Note 8)	I <sub>COM(ON)</sub>	V <sub>COM</sub> = 4.5V, V <sub>NC</sub> or V <sub>NO</sub> = 4.5V, V+ = 5.5V, V- = 0V	T <sub>A</sub> = +25°C	C, E	-0.4	-0.04	0.4	nA
				M	-0.2	-0.04	0.2	
			T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	C, E	-5.0		5.0	
				M	-20.0		20.0	
<b>DIGITAL LOGIC INPUT</b>								
Input Current with Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4V, all others = 0.8V		-1.0	0.005	1.0	μA	
Input Current with Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0.8V, all others = 2.4V		-1.0	0.005	1.0	μA	

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +5V ±10%, V- = 0V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS
<b>DYNAMIC</b>						
Turn-On Time	tON	VCOM = 3V, Figure 2	TA = +25°C	160	250	ns
			TA = TMIN to TMAX		300	
Turn-Off Time	tOFF	VCOM = 3V, Figure 2	TA = +25°C	60	125	ns
			TA = TMIN to TMAX		175	
Break-Before-Make Time Delay (Note 3)	tD	MAX383 only	TA = +25°C	10	20	ns
Charge Injection (Note 3)	VCTE	CL = 1.0nF, VGEN = 0V, RGEN = 0Ω	TA = +25°C	2	5	pC
<b>SUPPLY</b>						
Power-Supply Range	V+		2.7		16	V
Positive Supply Current	I+	All channels on or off, VIN = 0V or V+, V+ = 5.5V, V- = 0V	-1.0	0.01	1.0	μA
Negative Supply Current	I-	All channels on or off, VIN = 0V or V+, V+ = 5.5V, V- = 0V	-1.0	-0.01	1.0	μA

## ELECTRICAL CHARACTERISTICS—Single +3.3V Supply

(V+ = 3.0V to 3.6V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP. RANGE	MIN	TYP (Note 2)	MAX	UNITS	
<b>SWITCH</b>								
Analog Signal Range	VCOM, VNO, VNC	(Note 3)		0V		V+	V	
On-Resistance	RON	V+ = 3V, V- = 0V, VNC or VNO = 1.5V, ICOM = 1.0mA, VINH = 2.4V, VINL = 0.8V	TA = +25°C	C, E	75	185	Ω	
			TA = TMIN to TMAX	M		175		
NC or NO Off Leakage Current (Note 8)	INC(OFF) or INO(OFF)	VCOM = 0V, VNC or VNO = 3V, V+ = 3.6V, V- = 0V	TA = +25°C	C, E	-0.2	-0.01	0.2	nA
			TA = TMIN to TMAX	M	-0.1	-0.01	0.1	
				C, E	-2.5		2.5	
				M	-5.0		5.0	
COM Off Leakage Current (Note 8)	ICOM(OFF)	VCOM = 3V, VNC or VNO = 0V, V+ = 3.6V, V- = 0V	TA = +25°C	C, E	-0.2	-0.01	0.2	nA
			TA = TMIN to TMAX	M	-0.1	-0.01	0.1	
				C, E	-2.5		2.5	
				M	-5.0		5.0	
COM On Leakage Current (Note 8)	ICOM(ON)	VCOM = 3V, VNC or VNO = 3V, V+ = 3.6V, V- = 0V	TA = +25°C	C, E	-0.4	-0.04	0.4	nA
			TA = TMIN to TMAX	M	-0.2	-0.04	0.2	
				C, E	-5.0		5.0	
				M	-20.0		20.0	

# Precision, Low-Voltage Analog Switches

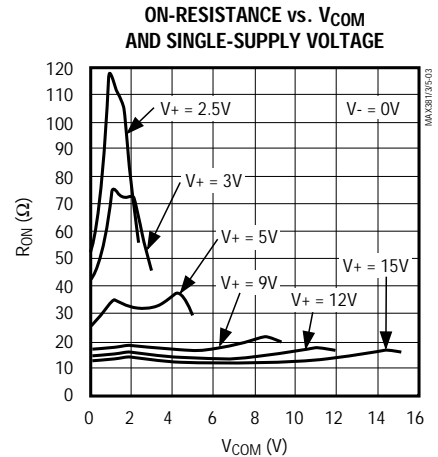
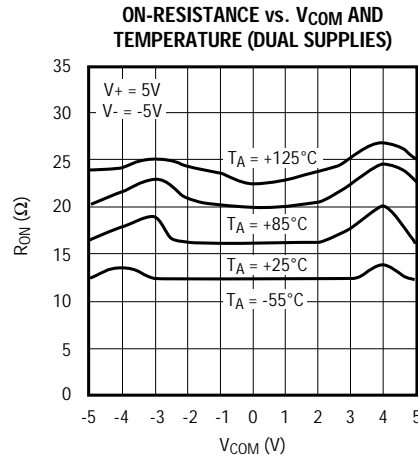
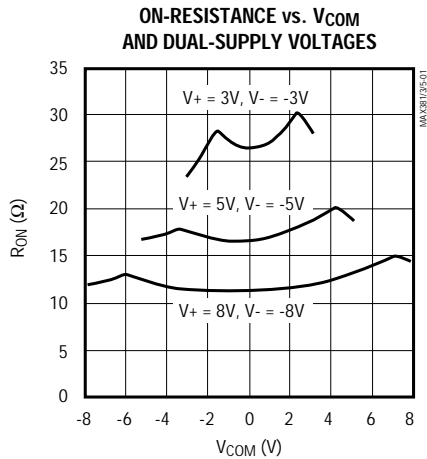
## ELECTRICAL CHARACTERISTICS—Single +3.3V Supply (continued)

( $V_+ = 3.0V$  to  $3.6V$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
<b>DIGITAL LOGIC INPUT</b>							
Input Current with Input Voltage High	$I_{INH}$	$V_{IN} = 2.4V$ , all others = $0.8V$		-1.0	0.005	1.0	$\mu A$
Input Current with Input Voltage Low	$I_{INL}$	$V_{IN} = 0.8V$ , all others = $2.4V$		-1.0	0.005	1.0	$\mu A$
<b>DYNAMIC</b>							
Turn-On Time (Note 3)	$t_{ON}$	$V_{COM} = 1.5V$ , Figure 2	$T_A = +25^\circ C$			400	ns
Turn-Off Time (Note 3)	$t_{OFF}$	$V_{COM} = 1.5V$ , Figure 2	$T_A = +25^\circ C$			150	ns
Break-Before-Make Time Delay (Note 3)	$t_D$	MAX383 only	$T_A = +25^\circ C$	10	20		ns
Charge Injection (Note 3)	$V_{CTE}$	$C_L = 1.0nF$ , $V_{GEN} = 0V$ , $R_{GEN} = 0\Omega$	$T_A = +25^\circ C$		1	5	pC
<b>SUPPLY</b>							
Power-Supply Range	$V_+$			2.7		16	V
Positive Supply Current	$I_+$	All channels on or off, $V_{IN} = 0V$ or $V_+$ , $V_+ = 3.6V$ , $V_- = 0V$		-1.0	0.01	1.0	$\mu A$
Negative Supply Current	$I_-$	All channels on or off, $V_{IN} = 0V$ or $V_+$ , $V_+ = 3.6V$ , $V_- = 0V$		-1.0	-0.01	1.0	$\mu A$

## Typical Operating Characteristics

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

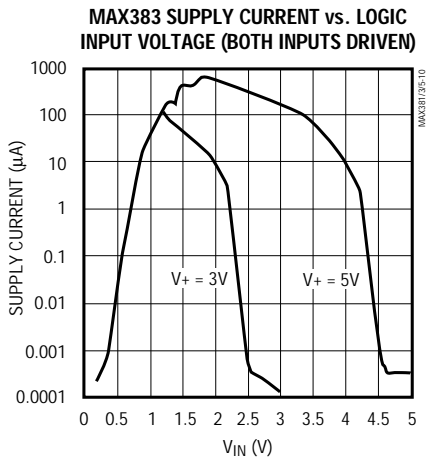
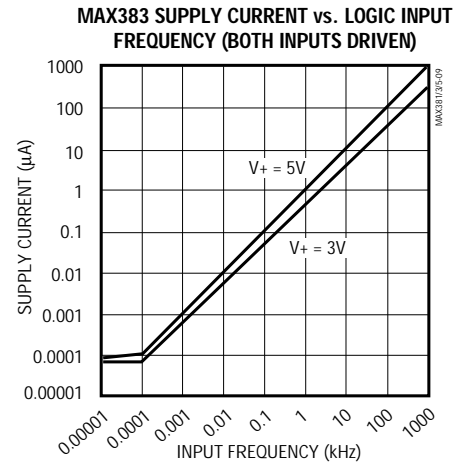
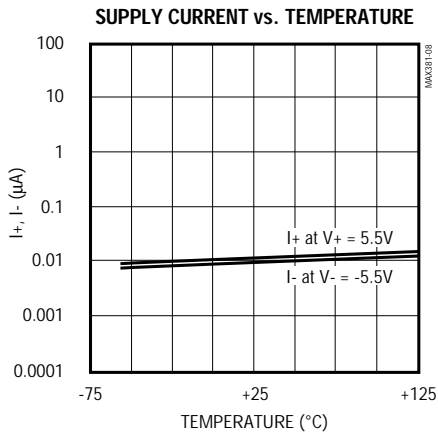
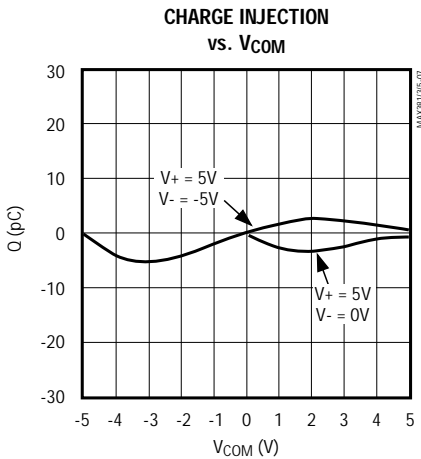
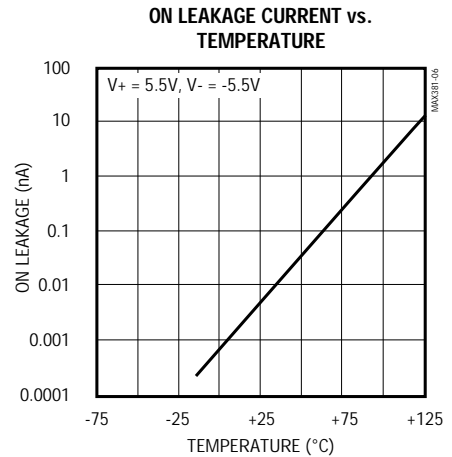
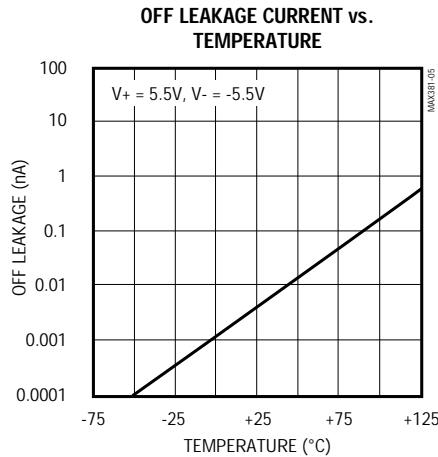
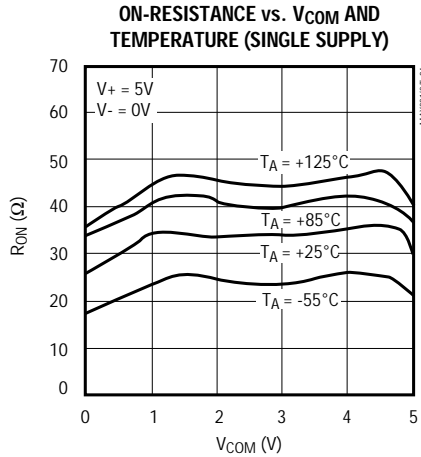


# Precision, Low-Voltage Analog Switches

## Typical Operating Characteristics (continued)

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

MAX381/MAX383/MAX385



# Precision, Low-Voltage Analog Switches

## Pin Description

PIN			NAME	FUNCTION
MAX381	MAX383	MAX385		
1, 8	1, 3, 6, 8	1, 3, 6, 8	COM_	Analog Switch Common Terminal
2-7, 12	2, 7, 12	2, 7, 12	N.C.	Not Internally Connected
9, 16	9, 16	4, 5, 9, 16	NO_	Analog Switch Normally Open Terminal
—	4, 5	—	NC_	Analog Switch Normally Closed Terminal
10, 15	10, 15	10, 15	IN_*	Logic Level Input (Normally Low)
11	11	11	V+	Analog Signal and Logic Positive Supply Input
13	13	13	GND	Logic Negative Supply Input (Ground)
14	14	14	V-	Analog Signal Negative Supply Input

\* IN1 controls COM1 and COM3; IN2 controls COM2 and COM4.

## Applications Information

### Operation with Supply Voltages Other than $\pm 5V$

The MAX381/MAX383/MAX385 switches operate with  $\pm 3.0V$  to  $\pm 8V$  bipolar supplies and a  $+3V$  to  $+15V$  single supply. In either case, analog signals ranging from  $V+$  to  $V-$  can be switched. The *Typical Operating Characteristics* graphs show the typical on-resistance variation with analog signal and supply voltage. The usual on-resistance temperature coefficient is  $0.5\%/^{\circ}C$  (typ).

### 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 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  $17V$ . These protection diodes are not recommended when using a single  $3V$  supply.

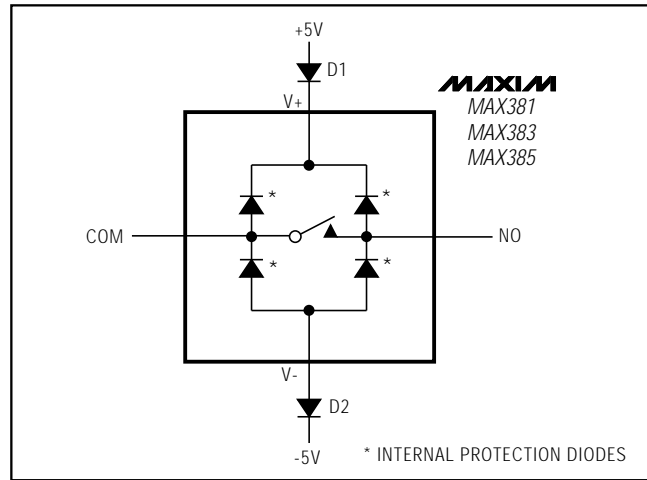


Figure 1. Overvoltage Protection Using Two External Blocking Diodes

# Precision, Low-Voltage Analog Switches

## Test Circuits/Timing Diagrams

MAX3871/MAX383/MAX385

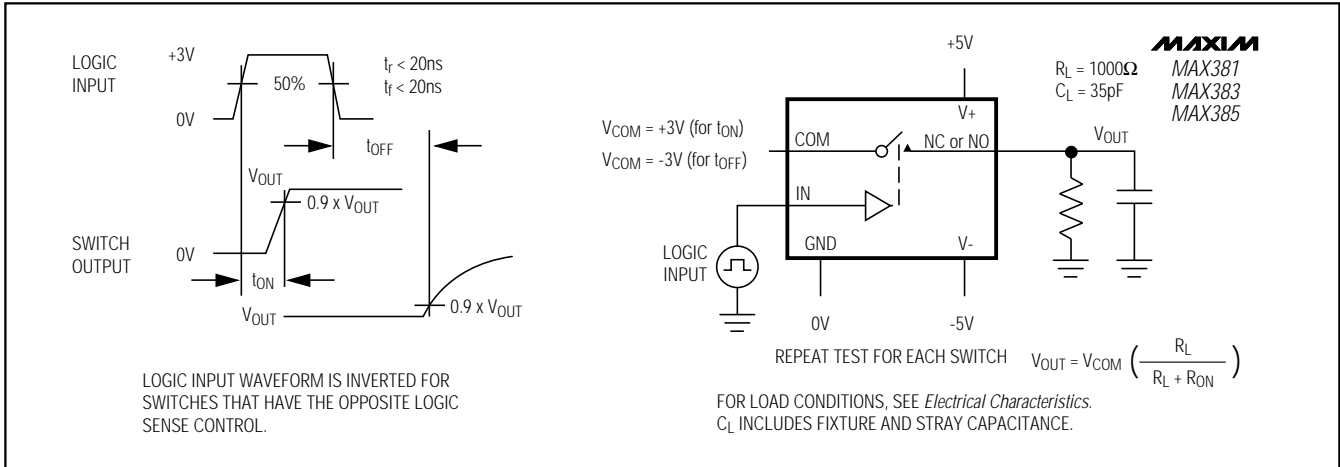


Figure 2. Switching-Time Test Circuit

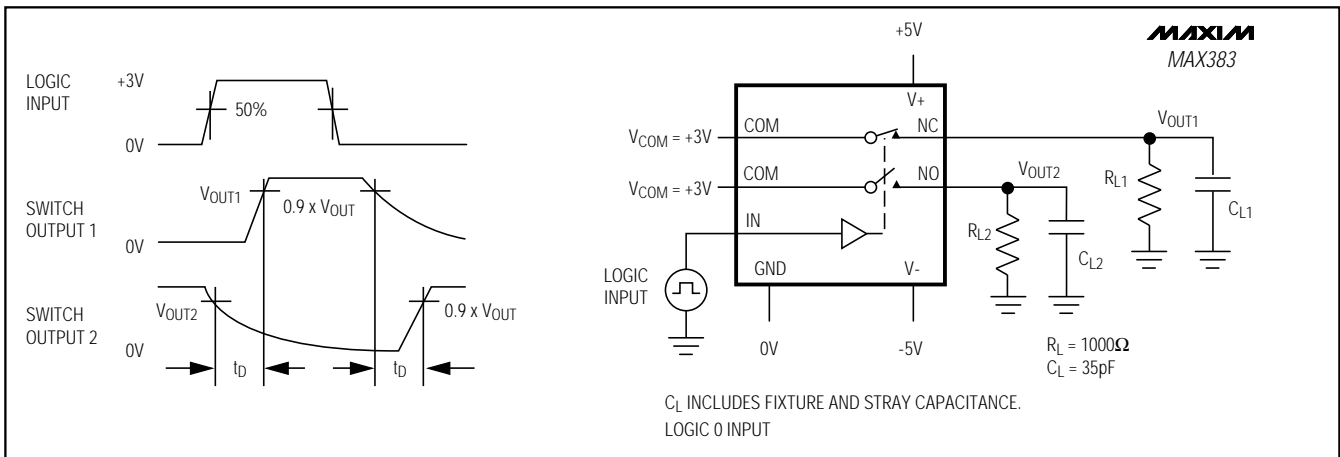


Figure 3. Break-Before-Make Test Circuit (MAX383 only)

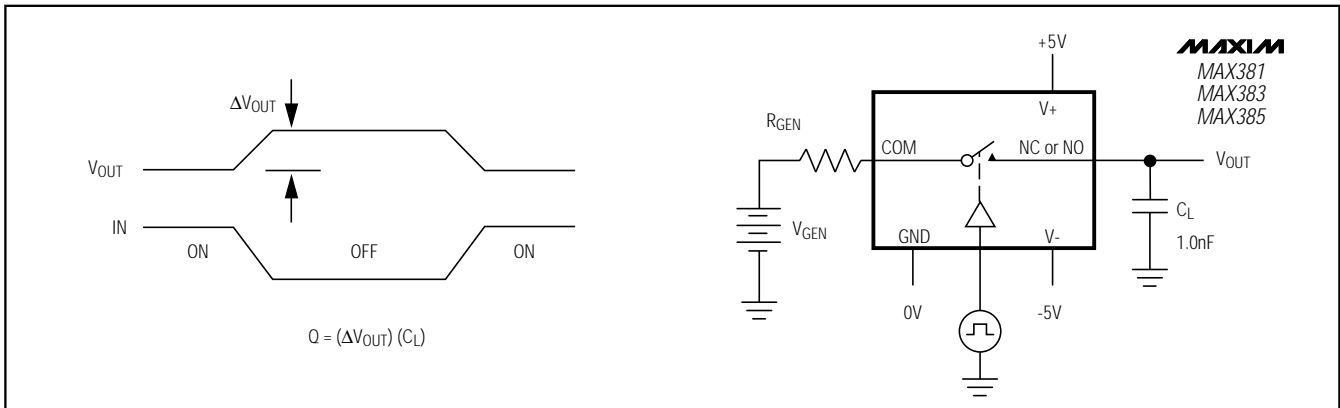


Figure 4. Charge-Injection Test Circuit



# Precision, Low-Voltage Analog Switches

## Test Circuits/Timing Diagrams (continued)

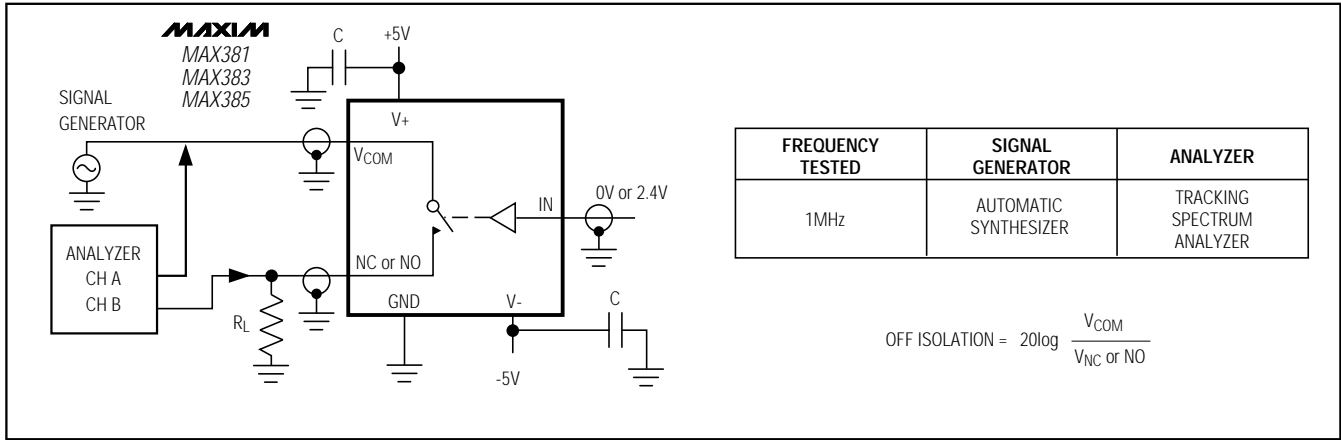


Figure 5. Off Isolation

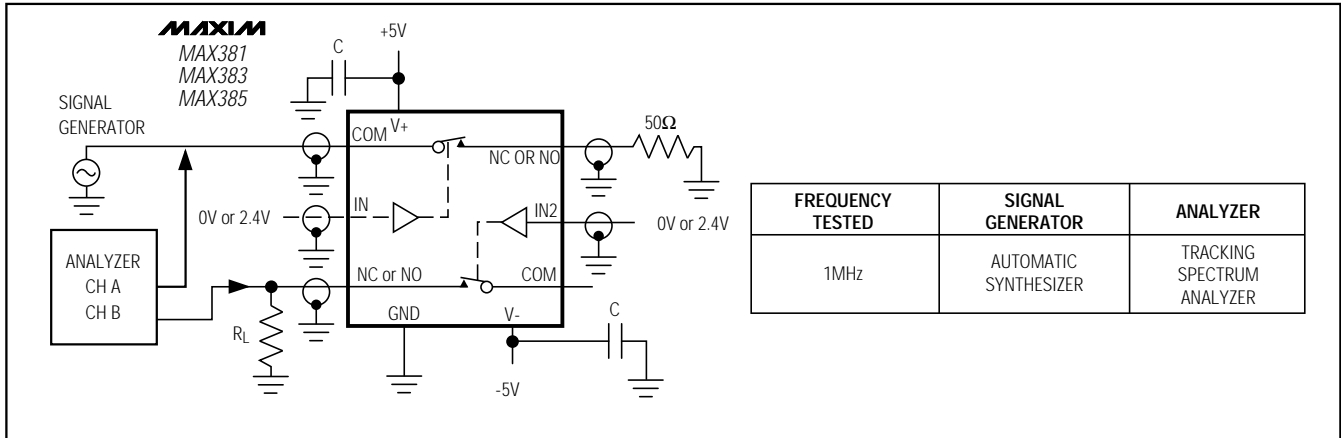


Figure 6. Crosstalk Test Circuit

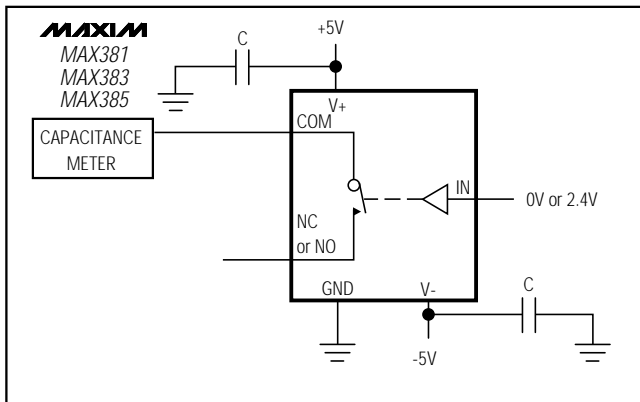


Figure 7. Channel-Off Capacitance

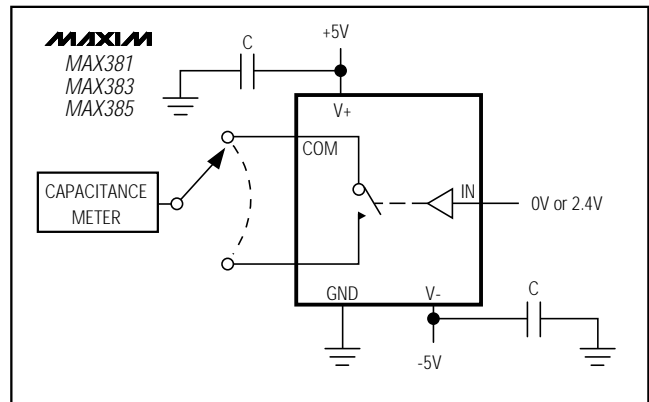


Figure 8. Channel-On Capacitance

# Precision, Low-Voltage Analog Switches

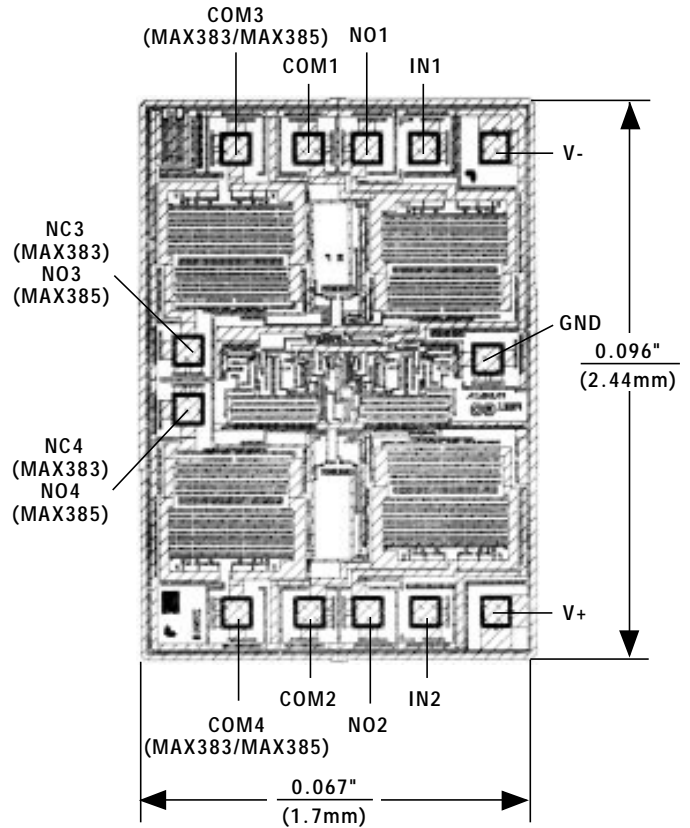
## Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
<b>MAX383</b> CPE	0°C to +70°C	16 Plastic DIP
MAX383CSE	0°C to +70°C	16 Narrow SO
MAX383C/D	0°C to +70°C	Dice*
MAX383EPE	-40°C to +85°C	16 Plastic DIP
MAX383ESE	-40°C to +85°C	16 Narrow SO
MAX383EJE	-40°C to +85°C	16 CERDIP**
MAX383MJE	-55°C to +125°C	16 CERDIP**
<b>MAX385</b> CPE	0°C to +70°C	16 Plastic DIP
MAX385CSE	0°C to +70°C	16 Narrow SO
MAX385C/D	0°C to +70°C	Dice*
MAX385EPE	-40°C to +85°C	16 Plastic DIP
MAX385ESE	-40°C to +85°C	16 Narrow SO
MAX385EJE	-40°C to +85°C	16 CERDIP**
MAX385MJE	-55°C to +125°C	16 CERDIP**

\* Dice are tested at  $T_A = +25^\circ\text{C}$  only.

\*\* Contact factory for package availability.

## Chip Topography

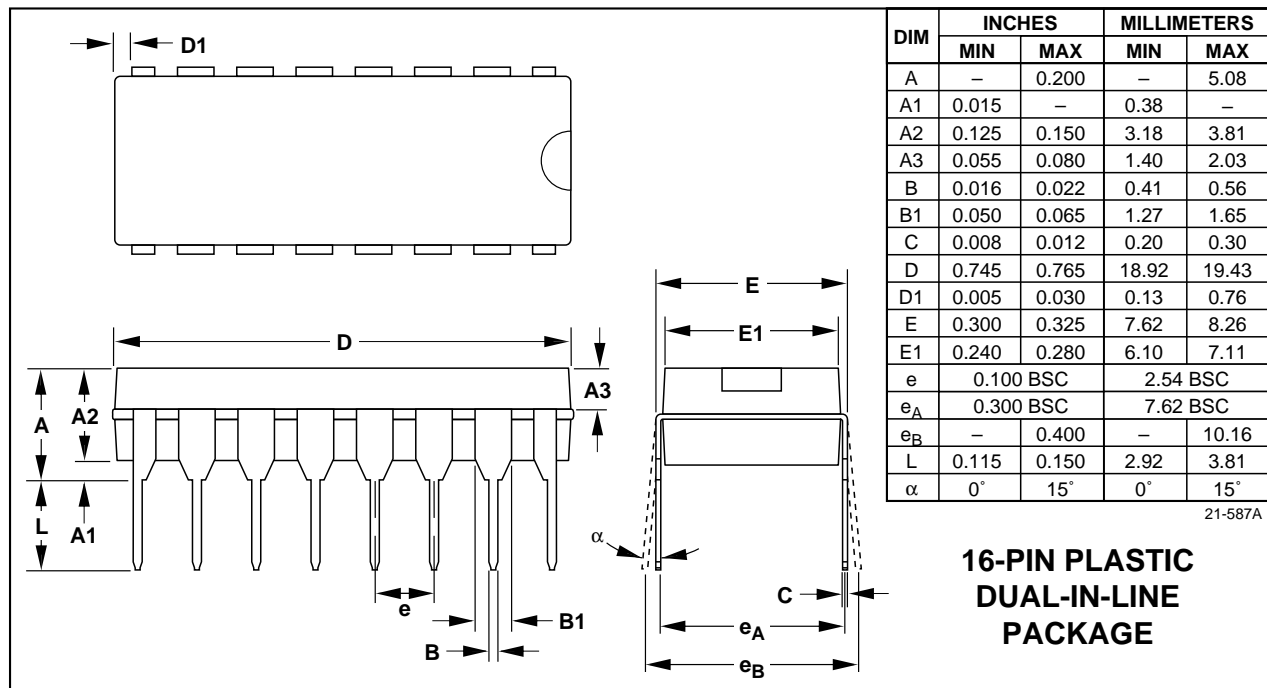
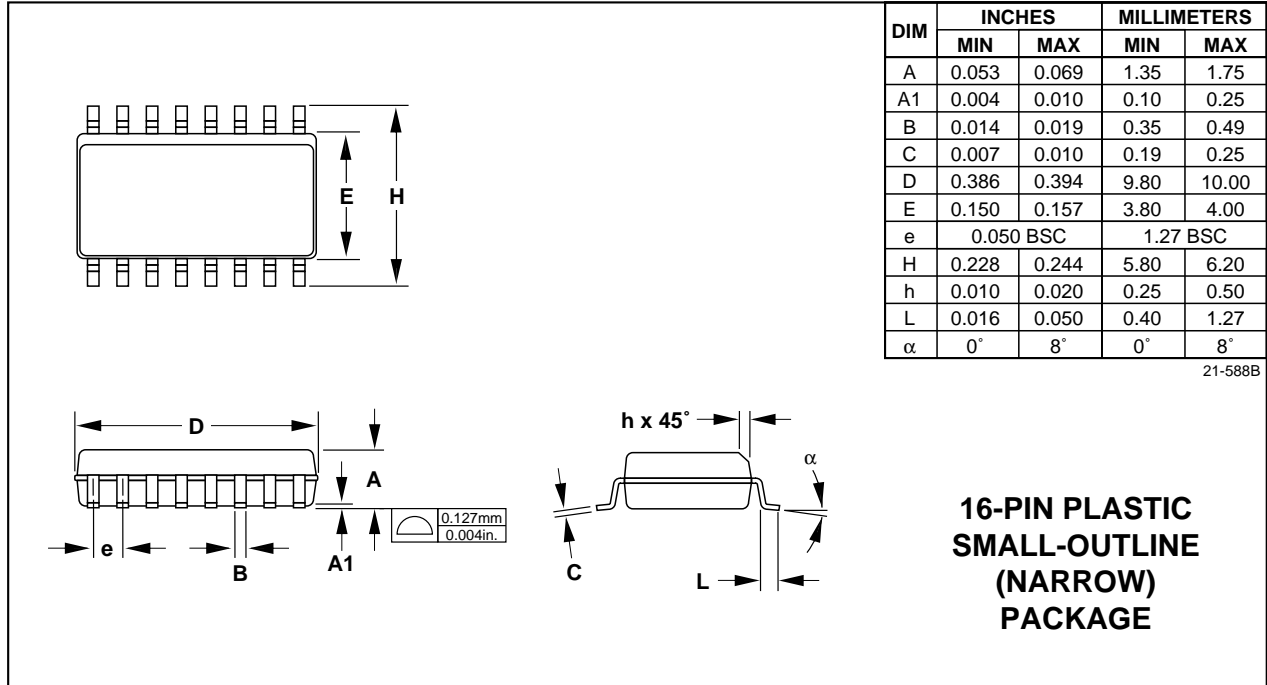


TRANSISTOR COUNT: 57  
SUBSTRATE CONNECTED TO V+

# Precision, Low-Voltage Analog Switches

MAX381/MAX383/MAX385

## Package Information



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.

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