MAXIM

High Voltage CMOS/DMOS Analog Switches

General Description

The MAX341/43/45/48 are CMOS/DMOS analog switches intended for high voltage use as well as high reliability general purpose applications. The operating supply range is ±20V to ±50V or +20V to +60V when using a single power supply. Signal handling capability extends from the negative to the positive supply voltage, i.e. over a 100V peak-to-peak range with ±50V power supplies.

The switch control inputs can be driven with CMOS or other high level logic signals. All switches are normally closed, i.e. an input "0" level turns the switch ON. The MAX341 and MAX348 are dual SPST switches, the MAX343 is a dual SPDT switch, and the MAX345's configuration is dual DPST. The MAX348 is a reduced R_{ON} version of the MAX341.

Positive supply current for all devices is less than 300μA and negative supply current is less than 100μA with ±50V power supplies. When using a single power supply and logic input levels equal to the supply value, the power supply currents are less than 20μA.

Applications

Medical Ultrasound Equipment
Automatic Test Equipment
Diagnostic Systems
48 Volt Telecom Systems
Stepper and DC Motor Drivers

Features

- ±20V to ±50V and Single Supply Operation
- R_{ON} Less than 55Ω (MAX348)
- -70dB Typical OFF Isolation at 1MHz
- Input Voltage Range Includes Power Supplies
- 100V peak-to-peak Signal Handling Capability
- Guaranteed Break-Before-Make Operation
- Completely Latchup-Proof Construction

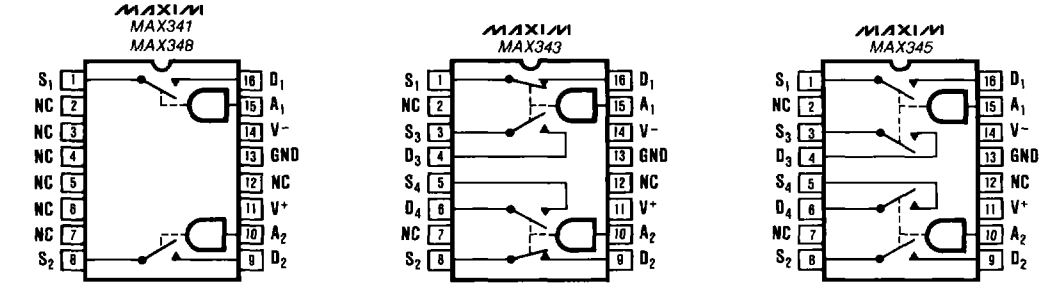
Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX341C/D	0°C to +70°C	Dice
MAX341CPE	0°C to +70°C	16 Lead Plastic DIP
MAX341CWE	0°C to +70°C	16 Lead Wide SO
MAX341EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX341EWE	-40°C to +85°C	16 Lead Wide SO
MAX341EJE	-40°C to +85°C	16 Lead CERDIP
MAX341MJE	-55°C to +125°C	16 Lead CERDIP
MAX343C/D	0°C to +70°C	Dice
MAX343CPE	0°C to +70°C	16 Lead Plastic DIP
MAX343CWE	0°C to +70°C	16 Lead Wide SO
MAX343EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX343EWE	-40°C to +85°C	16 Lead Wide SO
MAX343EJE	-40°C to +85°C	16 Lead CERDIP
MAX343MJE	-55°C to +125°C	16 Lead CERDIP

(Ordering Information Continued on Last Page)

Pin Configurations

Top Views



Dual SPST | Dual SPDT | Dual DPST

Switch States are for Logic "1" Input.

High Voltage CMOS/DMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V^+ to V^- Voltage ..... +120V
V^+ to GND Voltage ..... +65V
Digital Input Voltage ..... V^- to V^+
Input Current
S and D ..... +200mA
All pins except S and D ..... ±30mA
Lead Temperature (Soldering 10 sec) ..... +300°C
Storage Temperature ..... -65°C to +150°C

Operating Temperature Range
MAX34XC ..... 0°C to +70°C
MAX34XE ..... -40°C to +85°C
MAX34XM ..... -55°C to +125°C
Power Dissipation (16 pin packages)
CERDIP (derate 10mW/°C above +75°C) 750mW
Plastic DIP (derate 7.35mW/°C above +75°C) 550mW
Small Outline (derate 9mW/°C above +75°C) 680mW

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation at these or any other conditions above those indicated in the operations section of the specifications is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Over Temperature, V^+ = +50V, V^- = -50V, GND = 0V unless otherwise indicated)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Analog Signal Range	V_S, V_D		V^+		V^-	V
Channel ON Resistance MAX341/43/45 MAX341/43/45 MAX348 MAX348	R_{ON}	V_S = ±50V, I_S = 10mA T_A = +25°C Over Temp. T_A = +25°C Over Temp		 80 35 	 110 160 55 80	Ω
ON Resistance Match	ΔR_{ON}	V_S = ±50V, I_S = 10mA		7		%
OFF Leakage Current (Figure 7)	$I_{D(OFF)}$, $I_{S(OFF)}$	V_S = ±50V, V_D = ∓50V T_A = +25°C Over Temp.		 10 1000	 50 5000	nA
ON Output Leakage Current (Figure 8)	$I_{D(ON)}$, $I_{S(ON)}$	V_S = V_D = ±50V T_A = +25°C Over Temp.		 10 1000	 60 5000	nA
Input Low Threshold	V_{AL}				3.5	V
Input High Threshold	V_{AH}		12			V
Input Current (Logic)	I_A	V_A = 0V to +15V		0.1	10	µA
Turn-On Time (Figure 9)	t_{ON}	T_A = +25°C Over Temp.		0.5	1.0 1.5	µs
Turn-Off Time (Figure 9)	t_{OFF}	T_A = 25°C Over Temp.		0.4	0.75 1.0	µs
OFF Isolation (Figure 4)	ISO_{OFF}	T_A = +25°C, 1MHz, R_L = 75Ω		-70		dB
Channel-Channel Crosstalk (Figure 5)	ISO_X	T_A = +25°C, 1MHz, R_L = 75Ω		-75		dB
Channel Input Capacitance OFF State, C to Gnd OFF State, C to Out ON State, C to Gnd	$C_{S(OFF)}$ $C_{SD(OFF)}$ $C_{S(ON)}$	T_A = +25°C, V_S = 0V		 17 1 38		pF
Charge Injection (Figure 6)	Q	V_S = +50V V_S = 0V V_S = -50V		100 240 480		pC
Supply Current V^+ Current	I^+	T_A = +25°C Over Temp.		 200	300 600	µA
Supply Current V^- Current	I^-	T_A = +25°C Over Temp.		40 55	100 200	µA
Supply Voltage Range Split Supplies Single Supply		 GND = 0V V^- = GND = 0V	 ±20 +20		 ±50 +60	V

Detailed Description

Analog Signal Range

The MAX341 family's analog signal range is equal to the power supply value, up to ±50V with split power supplies and +60V with a single power supply (V^- connected to GND). An ON switch is also capable of passing up to 0.5A on a peak current basis. Maximum continuous current is limited only by the package power dissipation (see Absolute Maximum Ratings)

ON Resistance

The ON resistance of the MAX341 series switches is typically 40Ω. R_{ON} does, however increase as the switch voltage (V_S) approaches V^+. For example, with ±50V supplies and a +50V analog signal, R_{ON} will be typically less than 100Ω (50Ω for the MAX348), and 45Ω (25Ω for the MAX348) for -50V signals. With ±50V power supplies, and ±40V switch voltages, R_{ON} is about 40Ω for the +40V case and 30Ω for the -40V case. ON resistance can be reduced and current handling capacity can be increased by connecting switches in parallel. This is especially useful in power switching applications. Table 1 and the graph in the Typical Characteristics section further describe the relation between R_{ON} and V^+.

Table 1: ON Resistance

V^+/V^-	R_{ON} AT $V_S = V^+$	R_{ON} AT $V_S = V^-$
+20V/-20V	127Ω	39Ω
+30V/-30V	105Ω	36Ω
+40V/-40V	92Ω	32Ω
+50V/-50V	84Ω	30Ω
+40V/GND	127Ω	39Ω
+60V/GND	105Ω	36Ω

Note:
Typical R_{ON} for the MAX348 is approximately one half of the above values.

Power Supply Current

The maximum supply current for V^+ and V^- at 25°C is 300μA and 100μA respectively. However, the positive supply current (I^+) is partly dependent on the input logic level and can be reduced if control signals of a larger amplitude than 0V and +15V are used. If the control inputs swing to within 4V of V^+ and V^- then I^+ drops to a typical value of 20μA.

Control Inputs

15V logic level inputs are required to turn switches on or off, but the control inputs can also accept levels up to V^+ and V^-. A input greater than 12V constitutes a "1" state (switch OFF), and an input less than 3.5V will constitute a "0" state (switch ON).

Standard TTL logic can be used with MAX341 series switches if a level shifter such as the MC14504 is used to drive the control inputs as shown in in figure 1. Open collector drivers, with external pull-up resistors, can be used in a similar fashion as well.

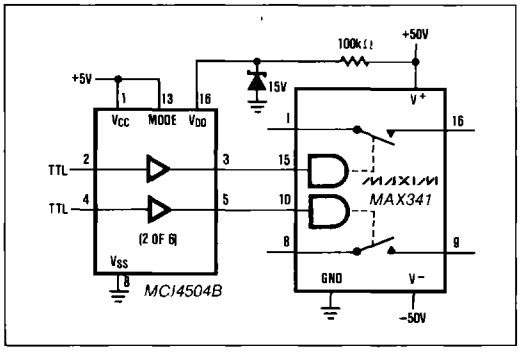


Figure 1. Using TTL Control Levels.

Applications

Flying Capacitor Input

A "flying capacitor" differential to single-ended converter takes advantage of the MAX343's wide input voltage range, which allows large common mode inputs to be rejected. As shown in Figure 2, a capacitor is alternately charged by the differential input signal and then is connected to an op-amp or A-to-D input. An instrumentation amplifier is not required since the output signal can be referenced to ground. Sample-hold operation is also built in to the design and the MAX343's break-before-make operation ensures that the output sees only the differential portion of the input signal. A similar approach can also be used for single-ended to differential signal conversion as well.

Parallel Switches

In designs where power switching ability is needed, any of the MAX341 series switches can be connected in parallel to increase current handling capability and reduce ON resistance. Applications such as ultrasonics, RF power, and DC motor drive are areas where this is often important. A MAX348 is shown in a parallel configuration in figure 3. The resulting SPST switch has a typical R_{ON} of 12Ω (5Ω for signals more than 10V below V^+) and can handle pulsed loads of up to 0.5 Amps. With ±50V power supplies, the peak-to-peak signal range is still 100V and 10MHz signals can be switched while maintaining typically -50dB of isolation.

High Voltage CMOS/DMOS Analog Switches

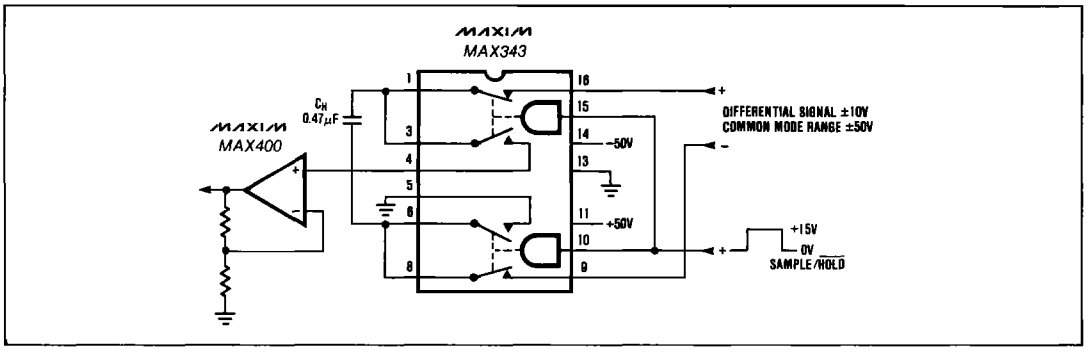


Figure 2. Flying Capacitor Differential to Single-Ended Converter with ±50V Common-Mode Range.

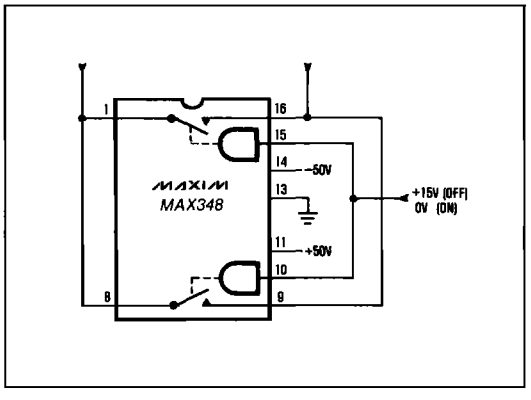


Figure 3. Minimum R_{ON} (5 to 10Ω typ.) High Voltage Switch.

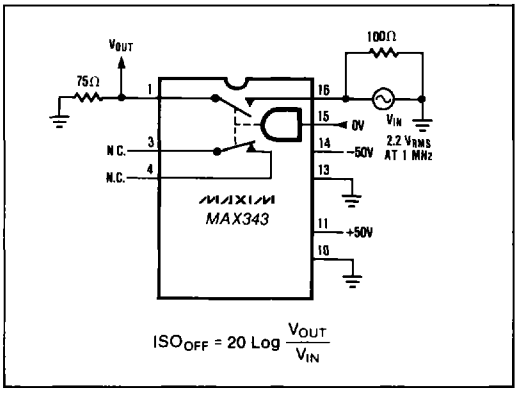


Figure 4. OFF Isolation Test Circuit.

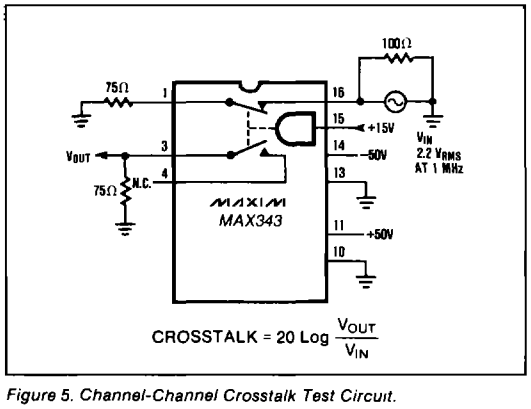


Figure 5. Channel-Channel Crosstalk Test Circuit.

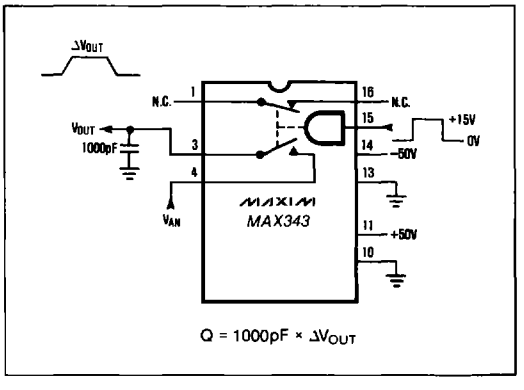
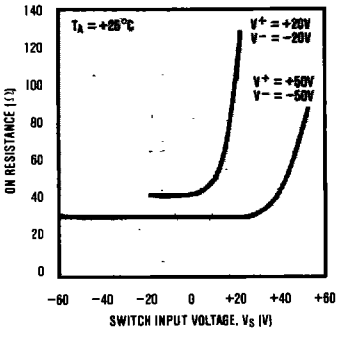


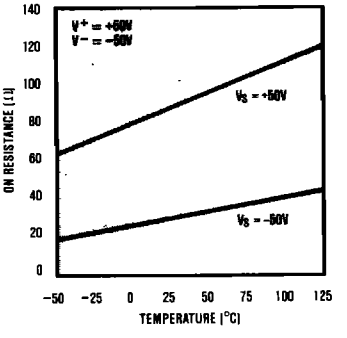
Figure 6. Charge Injection Test Circuit.

Typical Operating Characteristics

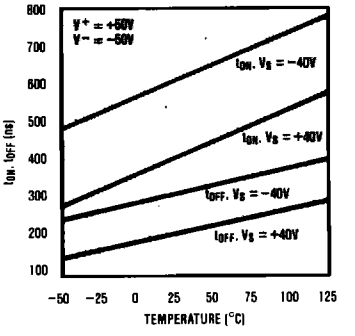
ON RESISTANCE vs. SWITCH INPUT VOLTAGE



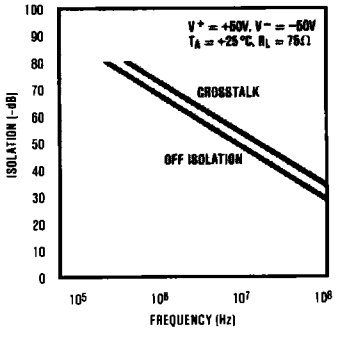
ON RESISTANCE vs. TEMPERATURE



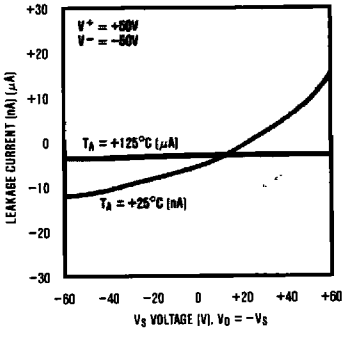
SWITCHING TIME vs. TEMPERATURE



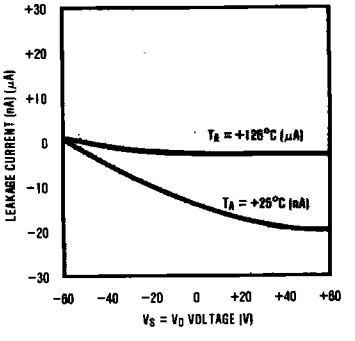
OFF ISOLATION AND CROSSTALK vs. FREQUENCY



OFF LEAKAGE vs. SWITCH VOLTAGE



ON LEAKAGE vs. SWITCH VOLTAGE



Test Circuits

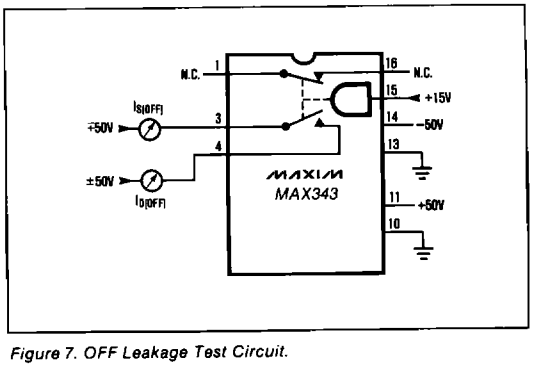


Figure 7. OFF Leakage Test Circuit.

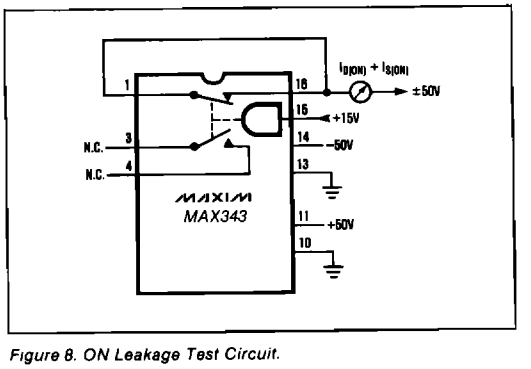


Figure 8. ON Leakage Test Circuit.

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Test Circuit

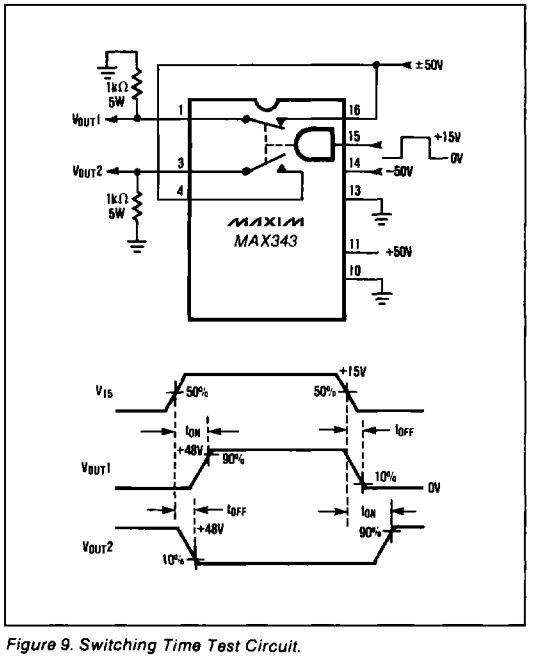
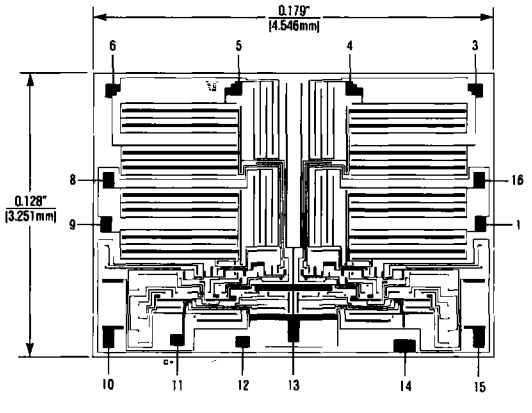


Figure 9. Switching Time Test Circuit.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
MAX345C/D	0°C to +70°C	Dice
MAX345CPE	0°C to +70°C	16 Lead Plastic DIP
MAX345CWE	0°C to +70°C	16 Lead Wide SO
MAX345EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX345EWE	-40°C to +85°C	16 Lead Wide SO
MAX345EJE	-40°C to +85°C	16 Lead CERDIP
MAX345MJE	-55°C to +125°C	16 Lead CERDIP
MAX348C/D	0°C to +70°C	Dice
MAX348CPE	0°C to +70°C	16 Lead Plastic DIP
MAX348CWE	0°C to +70°C	16 Lead Wide SO
MAX348EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX348EWE	-40°C to +85°C	16 Lead Wide SO
MAX348EJE	-40°C to +85°C	16 Lead CERDIP
MAX348MJE	-55°C to +125°C	16 Lead CERDIP

Chip Topography



See Pin Configurations for pin functions.