High Voltage Analog Switches

Ordering Information

Function			Dual SPST	Dual SPDT	Dual DPST	Dual SPST
Analog Signal Range			V_{NN} to V_{PP}	V_{NN} to V_{PP}	V_{NN} to V_{PP}	V_{NN} to V_{PP}
$RDS_{(ON)}$			100 ohms	100 ohms	100 ohms	55 ohms
Order No. and Part Type	Package Type	Temp Range				
	16-lead CERDIP, Hi-Rel	-55°C to +125°C	RBHV341D	RBHV343D	RBHV345D	RBHV348D
	16-lead CERDIP, Mil-Temp	-55°C to +125°C	HV341D	HV343D	HV345D	HV348D
	16-lead CERDIP	-20°C to + 85°C	HV341MD	HV343MD	HV345MD	HV348MD
	16-lead small outline*	-20°C to + 85°C	HV341MWG	HV343MWG	HV345MWG	HV348MWG
	16-lead small outline*	0°C to + 70°C	HV341WG	HV343WG	HV345WG	HV348WG
	16-lead plastic DIP	0°C to + 70°C	HV341P	HV343P	HV345P	HV348P
	Die in waffle pack	0°C to + 70°C	HV341X	HV343X	HV345X	HV348X

*300 mil wide SO package

Features

- ☐ ±20V to ±50V single and dual supply operation
- ☐ R_{ON} less than 55Ω (HV348)
- ☐ Signal switching from positive to negative rail
- ☐ -50db OFF isolation at 5MHz
- ☐ Withstand +80V to -100 spikes
- ☐ Withstand V_{SIG} with power supply off

Applications

- ☐ Test Equipment and Instruments
- ☐ Diagnostic Systems
- ☐ 48 Volt Telecom Systems
- ☐ Military Electronics

Absolute Maximum Ratings[1]

Supply voltage, V_{DD}		-0.3V to +65V
Supply voltage, V_{NN}		+0.3V to -65V
Data input voltage		V_{NN} to V_{PP}
Input current	Switches	±200mA
	Logic inputs	±30mA
Continuous total power dissipation[2]	Plastic Packages	500mW
	Ceramic Packages	750mW
Storage temperature range		-65°C to +150°C

Notes: 1. All voltages are referenced to V_{SS}.
2. For operation above 25°C ambient, derate linearly to 85°C at 8mW/°C.

General Description

These CMOS/DMOS high voltage analog switches are designed to handle high voltage analog signals. They may be used when analog voltages are low and high voltage immunity is desired. The signal handling capability extends from positive to negative supply voltage; i.e., 100V peak to peak with ±50V power supplies.

Inputs are compatible with CMOS logic, with a zero level turning the switches ON.

Operating supply voltage ranges from ±20V to ±50V with dual output power supplies, with the positive supply current below 300μA and negative supply not exceeding 100μA.

When a single output power supply is used, operating voltage ranges from +20V to +50V, with less than 20μA operating current when logic input signal equals the supply voltage.

With the addition of series diodes on the power supply and ground inputs, the HV341 series drivers will withstand +80V to -100V excursion on the inputs or switch pins without damage, or will withstand signal input with the power supplies OFF.

Electrical Characteristics (over recommended operating conditions unless noted)

DC Characteristics

Symbol	Parameter		Min	Typ	Max	Units	Conditions
V_{SIG}	Analog signal range		V_{NN}		V_{PP}	V	
R_{ON}	HV341/343/345	25°C		40	75	Ω	V_{SIG} = ±50V I_{SIG} = 10mA
		Over temp			100	Ω	
	HV348	25°C		25	50	Ω	
		Over temp			75	Ω	
R_{ON}	ON-Resistance matching			7		%	
V_{IL}	Input low threshold				3.5	V	
V_{IH}	Input high threshold		12			V	
I_{SOL}	Switch OFF leakage	25°C		10	60	nA	V_{SIG} = ±50V
		Over temp		1	5	µA	
I_{PP}	V_{PP} quiescent current			200	600	µA	
I_{NN}	V_{NN} quiescent current			15	100	µA	
I_{IN}	Logic input current			0.1	10	µA	V_{IN} = 0 to 15V
I_{SON}	Switch ON leakage	25°C		10	60	nA	V_{SIG} = ±50V
		Over temp		1	5	µA	

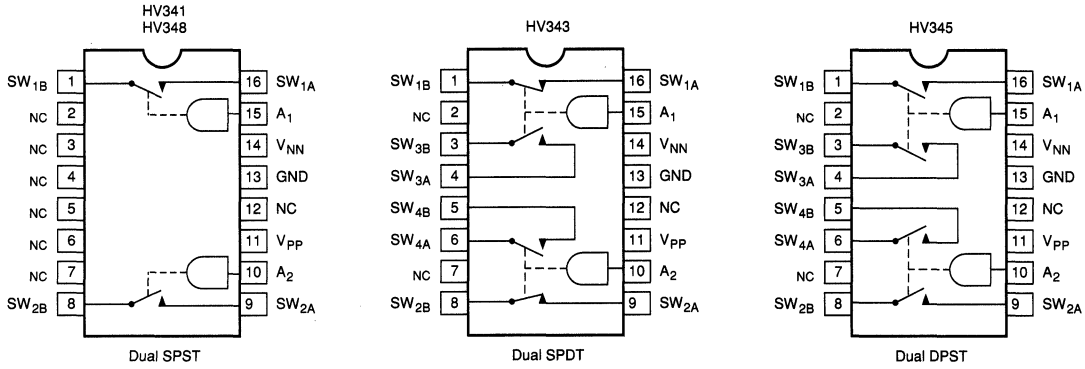
AC Characteristics (@ V_{DD} = 12V, V_{PP} = 60V, T_C = 25°C)

Symbol	Parameter		Min	Typ	Max	Units	Conditions
t_{ON}	Turn-ON time	25°C		0.5	1.0	µs	Figure 7
		Over temp			1.5	µs	
t_{OFF}	Turn-OFF time	25°C		0.4	0.75	µs	
		Over temp			1.0	µs	
K_O	OFF isolation			-70		dB	25°C, 1MHz
K_{CR}	Switch crosstalk			-75		dB	25°C, 1MHz
$C_{SW(OFF)}$	OFF capacitance across switch			1		pF	T_A = 25°C, V_S = 0V
$C_{SG(OFF)}$	OFF capacitance SW to GND			17		pF	
$C_{SG(ON)}$	ON capacitance SW to GND			38		pF	
Q	Charge injection			100		pC	V_{SIG} = +50V
				240		pC	V_{SIG} = 0V
				480		pC	V_{SIG} = -50V

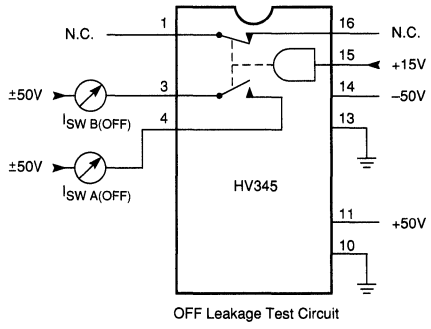
Recommended Operating Conditions

Symbol	Parameter		Min	Typ	Max	Units
V_{NN}	Negative high voltage supply		-50		0	V
V_{PP}	High voltage supply		+20		+50	V
V_{IH}	High-level input voltage		+12		+50	V
V_{IL}	Low-level input voltage		-50		+3.5	V
Operating temperature range		Commercial	0		+70	°C
		Military Hi-Rel (RB)	-55		+125	°C

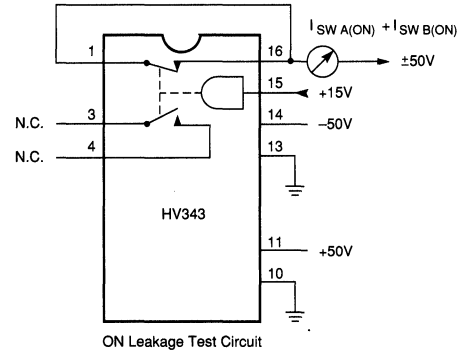
Functional Block Diagrams and Pin Configurations



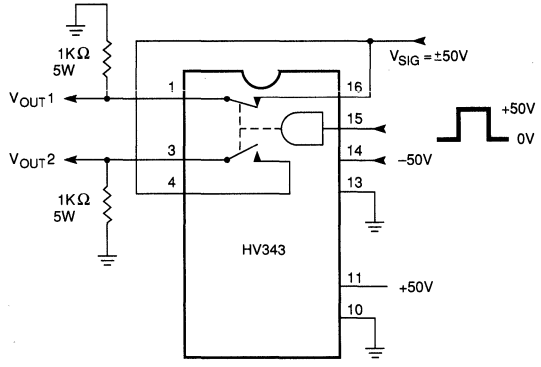
Test Circuits

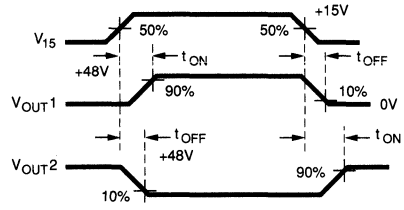


OFF Leakage Test Circuit

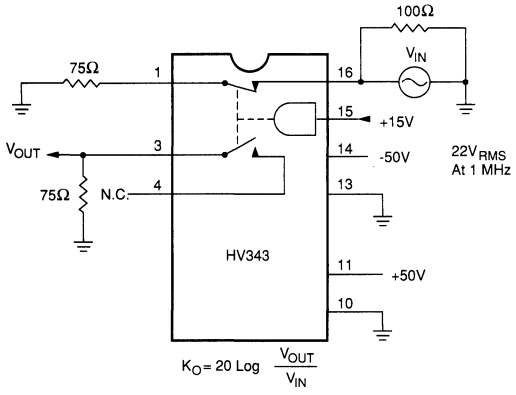


ON Leakage Test Circuit

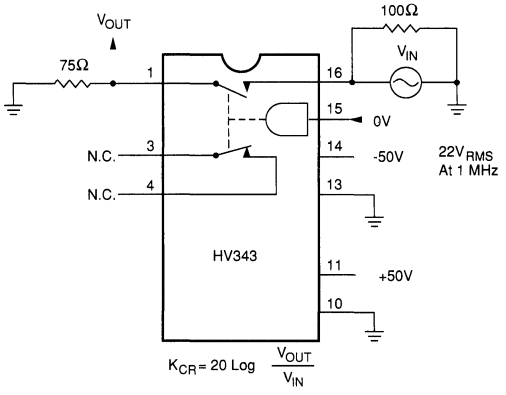




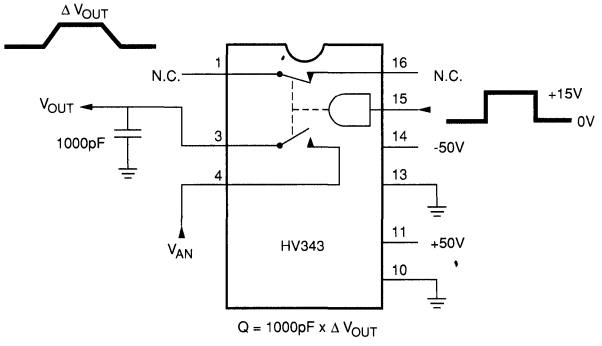
Switching Time Test Circuit



OFF Isolation Test Circuit



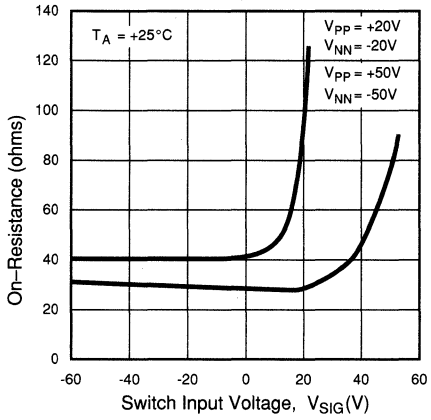
Channel–Channel Crosstalk Test Circuit



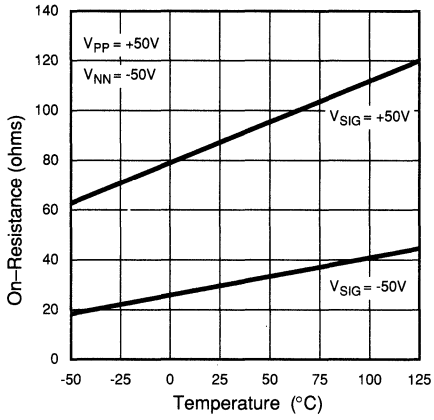
Charge Injection Test Circuit

Typical Operating Characteristics

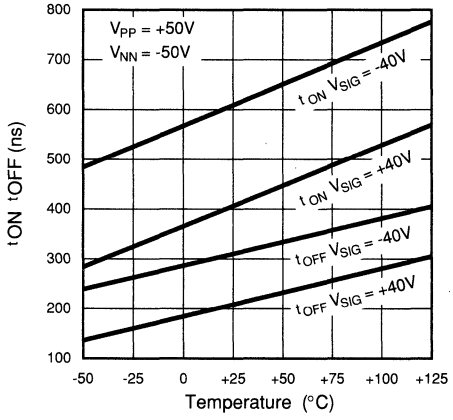
On–Resistance vs. Switch Input Voltage



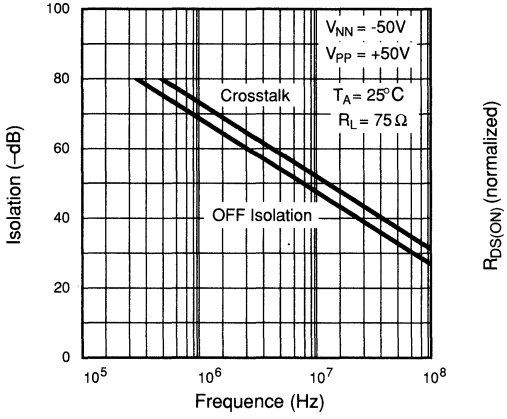
On-Resistance vs. Temperature



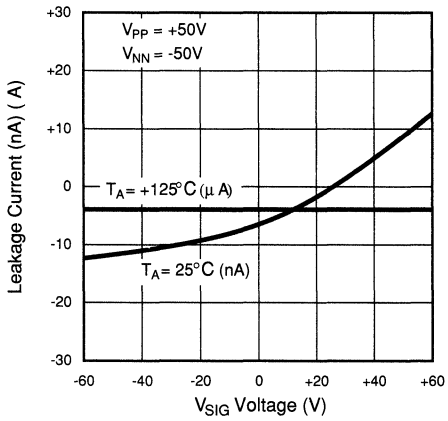
Switching Time vs. Temperature



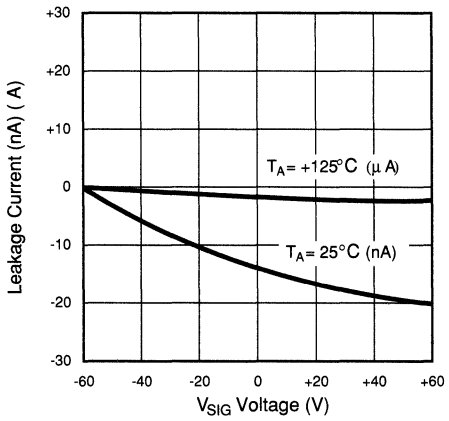
OFF Isolation And Crosstalk vs. Frequency



OFF Leakage vs. Switch Voltage



ON Leakage vs. Switch Voltage



Applications Information

Analog Signal Range

The HV341 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_{NN} 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 (VSIG) approaches V_{PP}. For example, with ±50V supplies and a +50V analog signal, R_{ON} will be typically less than 100Ω (50Ω for the HV348), and 45Ω (25Ω for the HV348 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_{PP}.

Power Supply Current

The maximum supply current for V_{PP} and V_{NN} at 25°C is 300µA and 100µA, respectively. However, the positive supply current (1+) 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_{PP} and V_{NN} then 1+ drops to a typical value of 200µA.

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_{PP} and V_{NN}. An 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 HV341 series switches if a level shifter such as the MC14504 is used to drive the control inputs as shown in Figure 1. Open collector drivers, with external pull-up resistors, can be used in a similar fashion as well.

Table 1: ON Resistance

V_{PP}/V_{NN}	R_{ON} at $V_{SIG} = V_{PP}$	R_{ON} at $V_{SIG} = V_{NN}$
+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 HV348 is approximately one half of the above values.

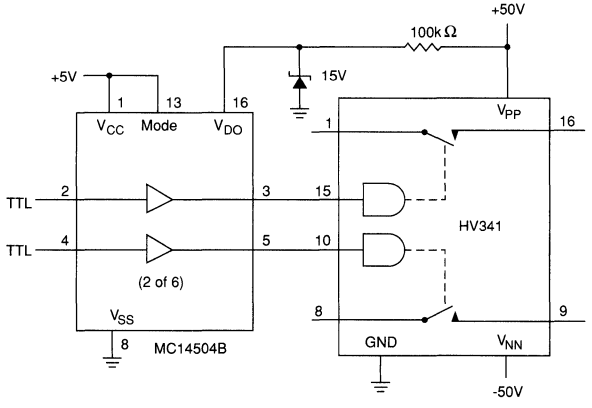


Figure 1. Using TTL Control Levels

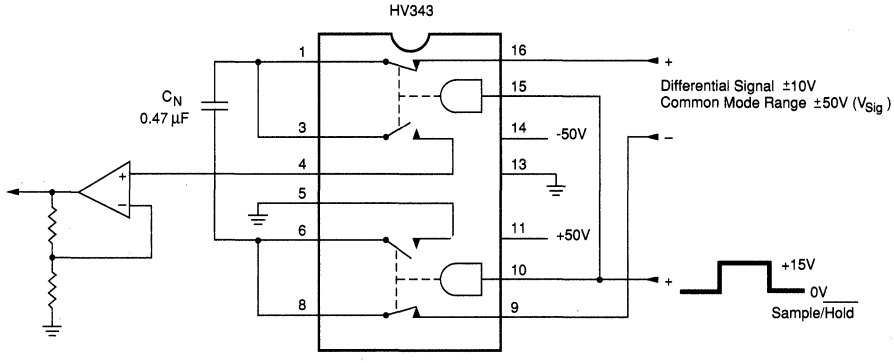


Figure 2. Flying Capacitor Differential to Single-Ended Converter With ±50V Common-Mode Range.

Flying Capacitor Input

A "flying capacitor" differential to single-ended converter takes advantage of the HV343'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 into the design and the HV343'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 HV 341 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. An HV348 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_{PP}) 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.

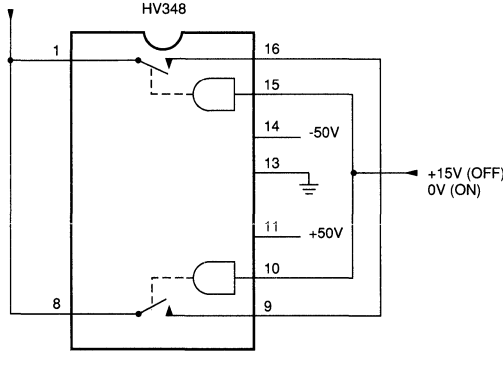


Figure 3. Minimum R_{ON} (5 to 10Ω typ.) High Voltage Switch.