



NOT RECOMMENDED FOR NEW DESIGNS

IH5108

8-Channel Fault Protected CMOS Analog Multiplexer

October 1997

GENERAL DESCRIPTION

The IH5108 is a dielectrically isolated CMOS monolithic analog multiplexer, designed as a plug-in replacement for the HI548 and similar devices, but adds fault protection to the standard performance. A unique serial MOSFET switch ensures that an OFF channel will remain OFF when the input exceeds the supply rails by up to $\pm 25V$, even with the supply voltage at zero. Further, an ON channel will be limited to a throughput of about 1.5V less than the supply rails, thus affording protection to any following circuitry such as op amps, D/A converters, etc.

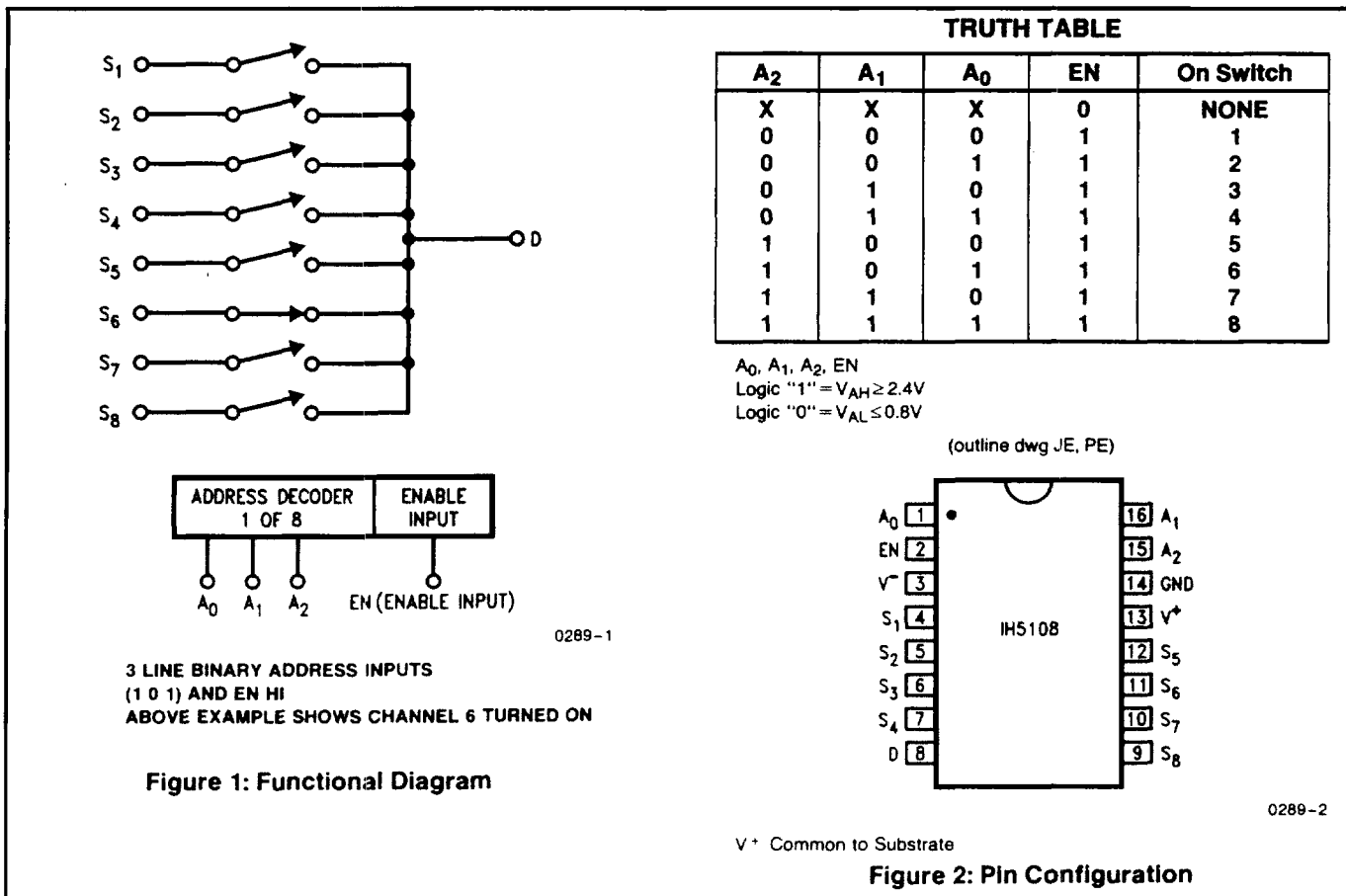
A binary 3-bit address code together with the ENable input allows selection of any one channel, or none at all. These 4 inputs are all TTL compatible for easy logic interface; the ENable input also facilitates MUX expansion and cascading.

ORDERING INFORMATION

Part Number	Temperature Range	Package
IH5108MJE	-55°C to +125°C	16 pin Cerdip
IH5108IJE	-25°C to +85°C	16 pin Cerdip
IH5108CPE	0°C to 70°C	16 pin plastic DIP

FEATURES

- All Channels OFF When Power OFF, for Analog Signals up to $\pm 25V$
- Power Supply Quiescent Current Less Than 1mA
- $\pm 13V$ Analog Signal Range
- No SCR Latchup
- Break-Before-Make Switching
- Pin Compatible With HI-548
- Any Channel Turns OFF if Input Exceeds Supply Rails by Up to $\pm 25V$
- TTL and CMOS Compatible Binary Address and ENable Inputs



File Number 3152.1

HARRIS SEMICONDUCTOR'S SOLE AND EXCLUSIVE WARRANTY OBLIGATION WITH RESPECT TO THIS PRODUCT SHALL BE THAT STATED IN THE WARRANTY ARTICLE OF THE CONDITION OF SALE. THE WARRANTY SHALL BE EXCLUSIVE AND SHALL BE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR USE.

304200-004

NOTE: All typical values have been characterized but are not tested.

8-108

ABSOLUTE MAXIMUM RATINGS

$V_{IN}(A, EN)$ to Ground	-15V to 15V
V_S or V_D to V^+	+25V, -40V
V_S or V_D to V^-	-25V, +40V
V^+ to Ground	20V
V^- to Ground	-20V
Current (Any Terminal)	20mA
Operating Temperature	
C Suffix	0°C to +70°C
I Suffix	-25°C to +85°C
M Suffix	-55°C to +125°C

Storage Temperature

C Suffix	-65°C to +125°C
I & M Suffix	-65°C to +150°C
Lead Temperature (Soldering, 10 sec)	300°C
Power Dissipation*	
CERDIP Package**	900 mW
Plastic Package***	470 mW

*Device mounted with all leads soldered or welded to PC board.

**Derate 12 mW/°C above 75°C

***Derate 6.3 mW/°C above 75°C

NOTE: Stresses above 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 above 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 ($V^+ = 15V, V^- = -15V, V_{EN} = 2.4V$, unless otherwise specified.)

Characteristic	Measured Terminal	No Tests Per Temp	Test Conditions	Typ 25°C	Max Limits						Units	
					M Suffix			C Suffix				
					-55°C	25°C	125°C	-25°C/ 0°C	25°C	85°C/ 70°C		
SWITCH												
$R_{DS(ON)}$	S to D	8	$V_D = 10V, I_S = -100\mu A$	Sequence each switch on	900	1200	1200	1800	1500	1500	2000	Ω
		8	$V_D = -10V, I_S = -100\mu A$	$V_{AL} = 0.8V, V_{AH} = 2.4V$	900	1200	1200	1800	1500	1500	2000	
$\Delta R_{DS(ON)}$			$\Delta R_{DS(on)} = \frac{R_{DS(on)max} - R_{DS(on)min}}{R_{DS(on)avg.}}$ $V_S = \pm 10V$		5							%
$I_{S(off)}$	S	8	$V_S = 10V, V_D = -10V$	$V_{EN} = 0.8V$	± 0.02		± 0.5	± 50		± 1.0	± 50	nA
		8	$V_S = -10V, V_D = 10V$		± 0.02		± 0.5	± 50		± 1.0	± 50	
$I_{D(off)}$	D	1	$V_D = 10V, V_S = -10V$		± 0.02		± 1.0	± 100		± 2.0	± 100	
		1	$V_D = -10V, V_S = 10V$		± 0.05		± 1.0	± 100		± 2.0	± 100	
$I_{D(on)}$	D	8	$V_{S(All)} = V_D = 10V$	Sequence each switch on	± 0.1		± 2.0	± 100		± 5	± 100	
		8	$V_{S(All)} = V_D = -10V$	$V_{AL} = 0.8V, V_{AH} = 2.4V, V_{EN} = 2.4V$	± 0.1		± 2.0	± 100		± 5	± 100	
FAULT												
I_S with Power OFF	S	8	$V_{SUPP} = 0V, V_{IN} = \pm 25V, V_{EN} = V_O = 0V, A_0, A_1, A_2 = 0V$		± 1.0		± 2.0			± 5.0		μA
$I_{S(off)}$ with Overvoltage	S	8	$V_{IN} = \pm 25V, V_O = \pm 10V$		± 1.0		± 5.0			± 10		μA



ELECTRICAL CHARACTERISTICS

($V^+ = 15V$, $V^- = -15V$, $V_{EN} = 2.4V$, unless otherwise specified.) (Continued)

Characteristic	Measured Terminal	No Tests Per Temp	Test Conditions	Typ 25°C	Max Limits						Units
					M Suffix			C Suffix			
					-55°C	25°C	125°C	-25°C/0°C	25°C	85°C/70°C	
INPUT											
$I_{EN(on)}$ $I_{A(on)}$ or $I_{EN(off)}$ $I_{A(off)}$	A ₀ , A ₁ , A ₂ or EN	4	$V_A = 0V$	0.01		-10	-30		-10	-30	μA
		4	$V_A = 15V$	0.01		10	30		10	30	
DYNAMIC											
$t_{transition}$	D		See Figure 3	0.3		1					μs
t_{open}	D		See Figure 4	0.2							
$t_{on(EN)}$	D		See Figure 5	0.6		1.5					
$t_{off(EN)}$	D			0.4		1					
$t_{on-t_{off}}$ Break-Before-Make Delay Settling Time	D	6	$V_{EN} = +5V$, A ₀ , A ₁ , A ₂ Strobed $V_{IN} = \pm 10V$, see Figure 6	10							ns
"OFF" Isolation	D		$V_{EN} = 0V$, $R_L = 200\Omega$, $C_L = 3pF$, $V_S = 3 VRMS$, $f = 500kHz$	60							dB
$C_{s(off)}$	S		$V_S = 0V$	5							pF
$C_{D(off)}$	D		$V_D = 0V$		25						
$C_{DS(off)}$	D to S		$V_S = 0V$, $V_D = 0V$			1					
SUPPLY											
Supply Current	I+	1	$V_{EN} = 5V$ All $V_A = 0V/5V$	0.5	0.7	0.6	0.5		1.0		mA
	I-	1		0.02	0.7	0.6	0.5		1.0		

Note 1. Readings taken 400ms after the overvoltage occurs.

SWITCHING TIME TEST CIRCUITS

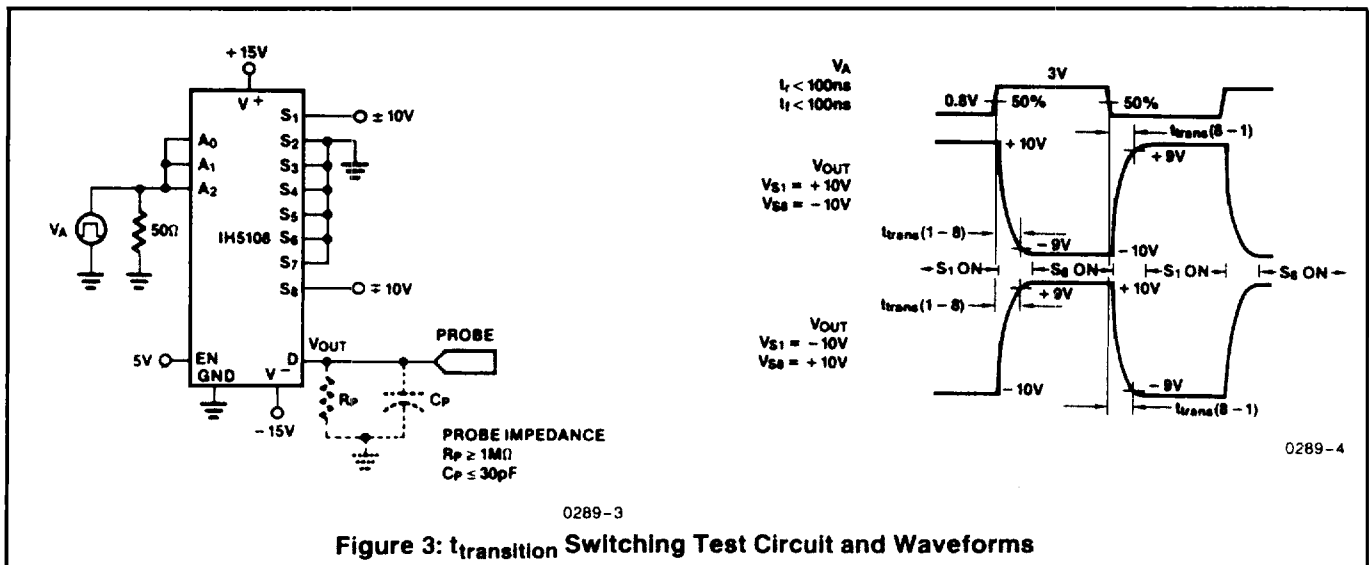
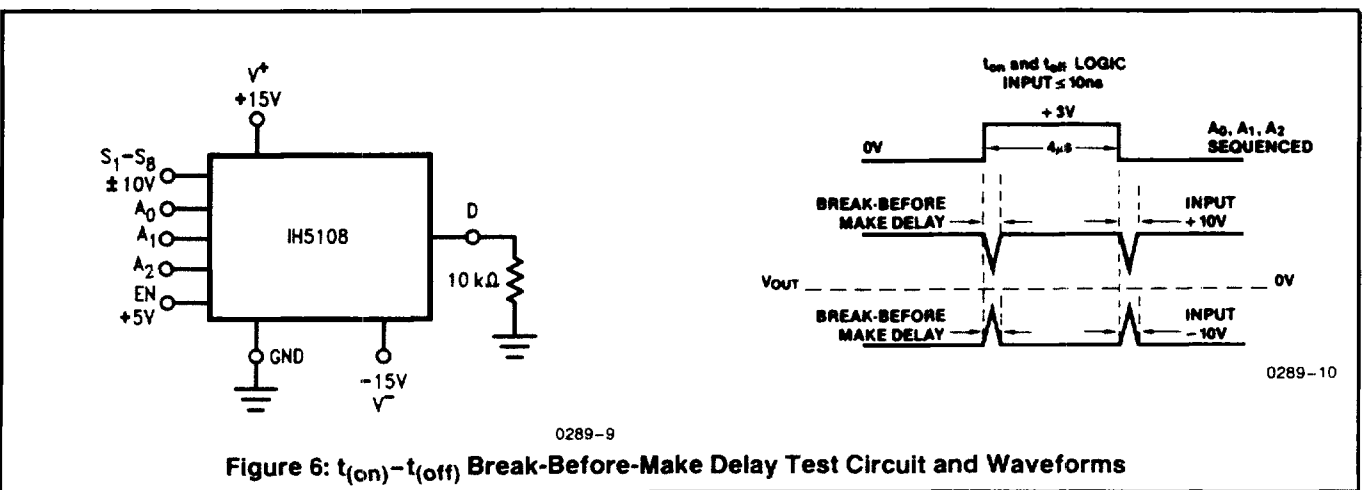
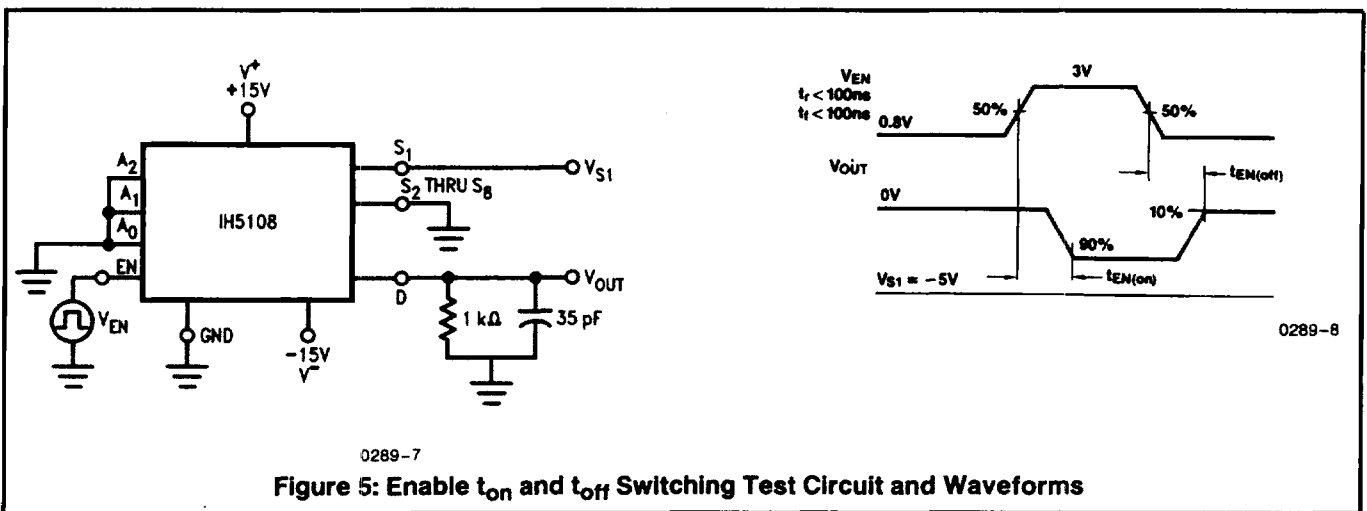
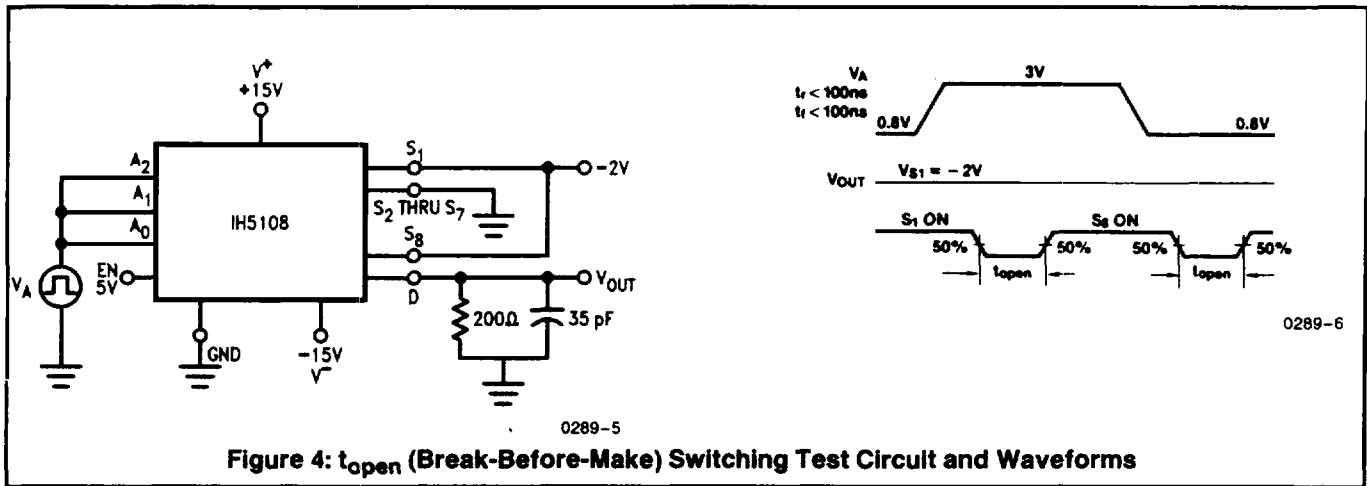


Figure 3: $t_{transition}$ Switching Test Circuit and Waveforms

NOTE: All typical values have been characterized but are not tested

SWITCHING TIME TEST CIRCUITS (Continued)



NOTE All typical values have been characterized but are not tested

DETAILED DESCRIPTION

The IH5108, like all Harris multiplexers, contains a set of CMOS switches that form the channels, and driver and decoder circuitry to control which channel turns ON, if any. In addition, the IH5108 contains an internal regulator which provides a fully TTL compatible ENable input that is identical in operation to the Address inputs. This does away with the special conditions that many multiplexer enable inputs require for proper logic swings. The identical circuit conditions of the ENable and Address lines also helps ensure the extension of break-before-make switching to wider multiplexer systems (see applications section).

Another, and more important difference lies in the switching channel. Previous devices have used parallel n- and p-channel MOSFET switches. While this scheme yields reasonably good ON resistance characteristics and allows the switching of rail-to-rail input signals, it also has a number of drawbacks. The sources and drains of the switch transistors will conduct to the substrate if the input goes outside the supply rails, and even careful use of diodes cannot avoid channel-to-output and channel-to-channel coupling in cases of input overrange. The IH5108 uses a novel series arrangement of the p- and n-channel switches (Figure 7) combined with a dielectrically isolated process to eliminate these problems.

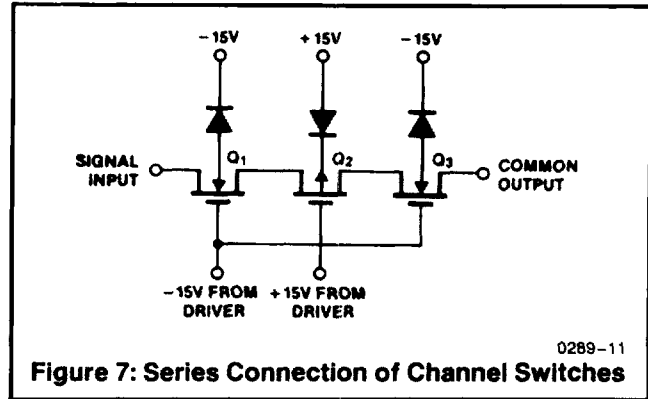
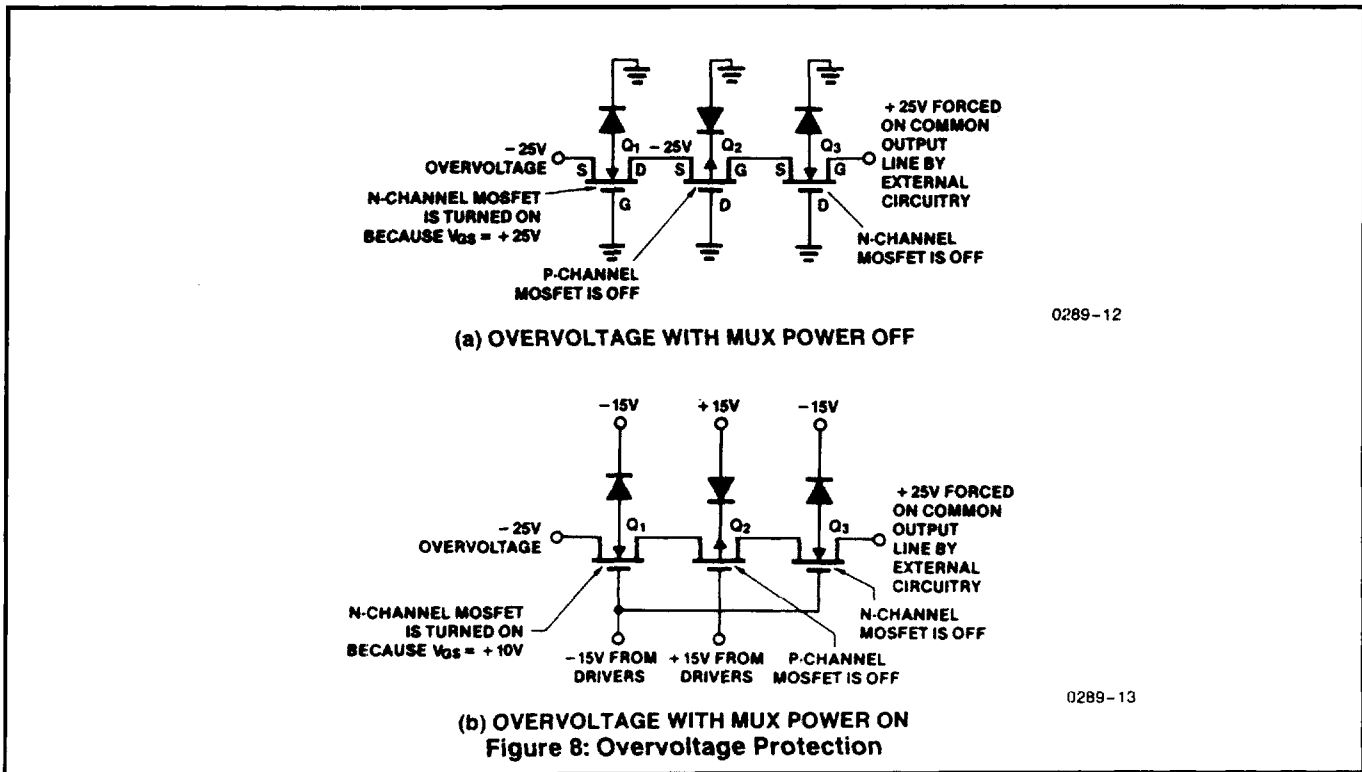


Figure 7: Series Connection of Channel Switches

Within the normal analog signal range, the inherent variation of switch ON resistance will balance out almost as well as the customary parallel configuration, but as the analog signal approaches either supply rail, even for an ON channel, either the p- or the n-channel will become a source follower, disconnecting the channel (Figure 8). Thus protection is provided for any input or output channel against overvoltage, even in the absence of multiplexer supply voltages. This applies up to the breakdown voltage of the respective switches. Figure 9 shows a more detailed schematic of the channel switches, including the back-gate driver devices which ensure optimum channel ON resistances and breakdown voltage under the various conditions.



(a) OVERVOLTAGE WITH MUX POWER OFF

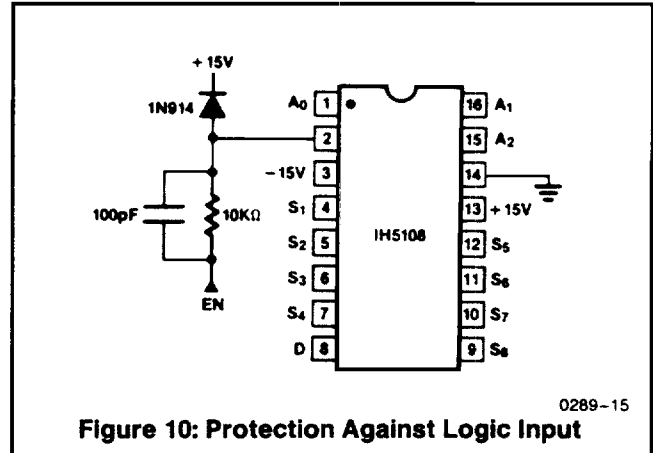
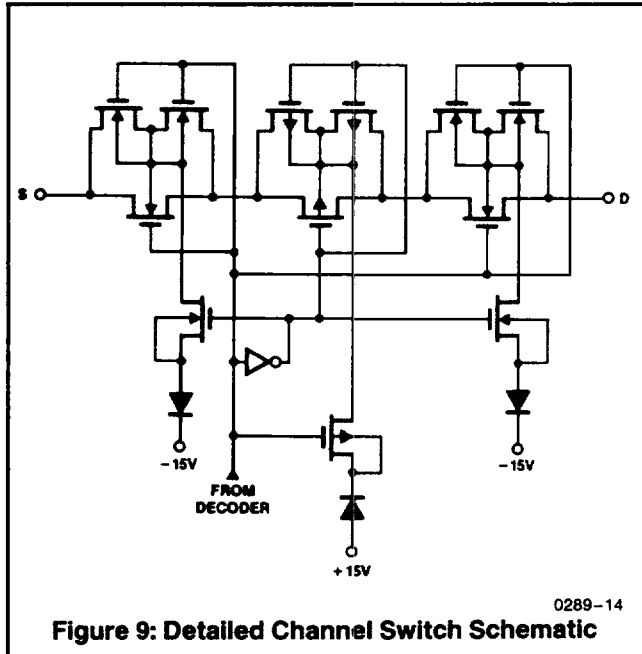
0289-12

(b) OVERVOLTAGE WITH MUX POWER ON
Figure 8: Overvoltage Protection

0289-13

DETAILED DESCRIPTION (Continued)

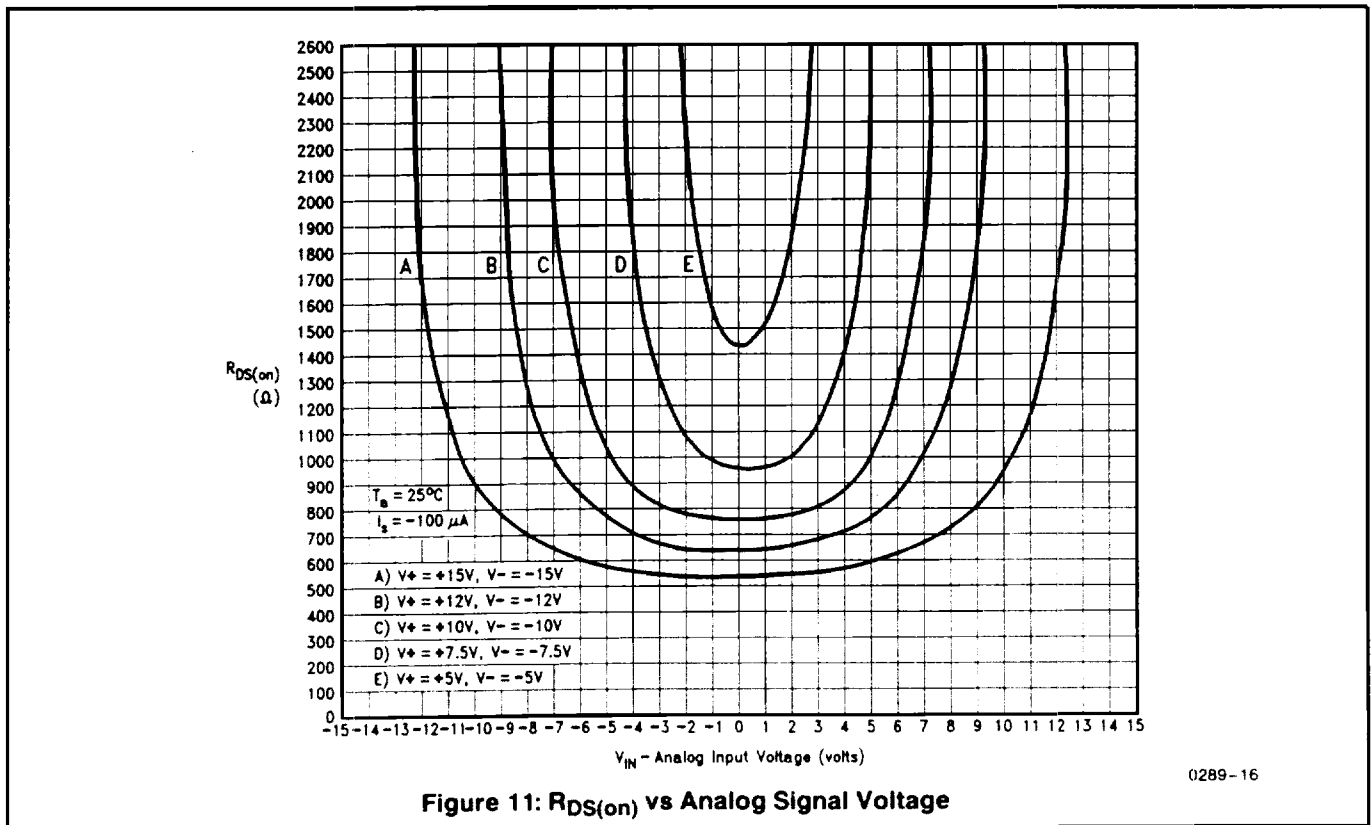
Under some circumstances, if the logic inputs are present but the multiplexer supplies are not, the circuit will use the logic inputs as a sort of phantom supply; this could result in an output up to that logic level. To prevent this from occurring, simply ensure that the ENable pin is LOW any time the multiplexer supply voltages are missing (Figure 10).



MAXIMUM SIGNAL HANDLING CAPABILITY

The IH5108 is designed to handle signals in the $\pm 10V$ range, with a typical $r_{DS(on)}$ of 900Ω ; it can successfully handle signals up to $\pm 12V$, however, $r_{DS(on)}$ will increase to about $1.8k\Omega$. Beyond $\pm 12V$ the device approaches an open circuit, and thus $\pm 12V$ is about the practical limit, see Figure 11.

Figure 12 shows the input/output characteristics of an ON channel, illustrating the inherent limiting action of the series switch connection (see Detailed Description), while Figure 13 gives the ON resistance variation with temperature.



NOTE All typical values have been characterized but are not tested

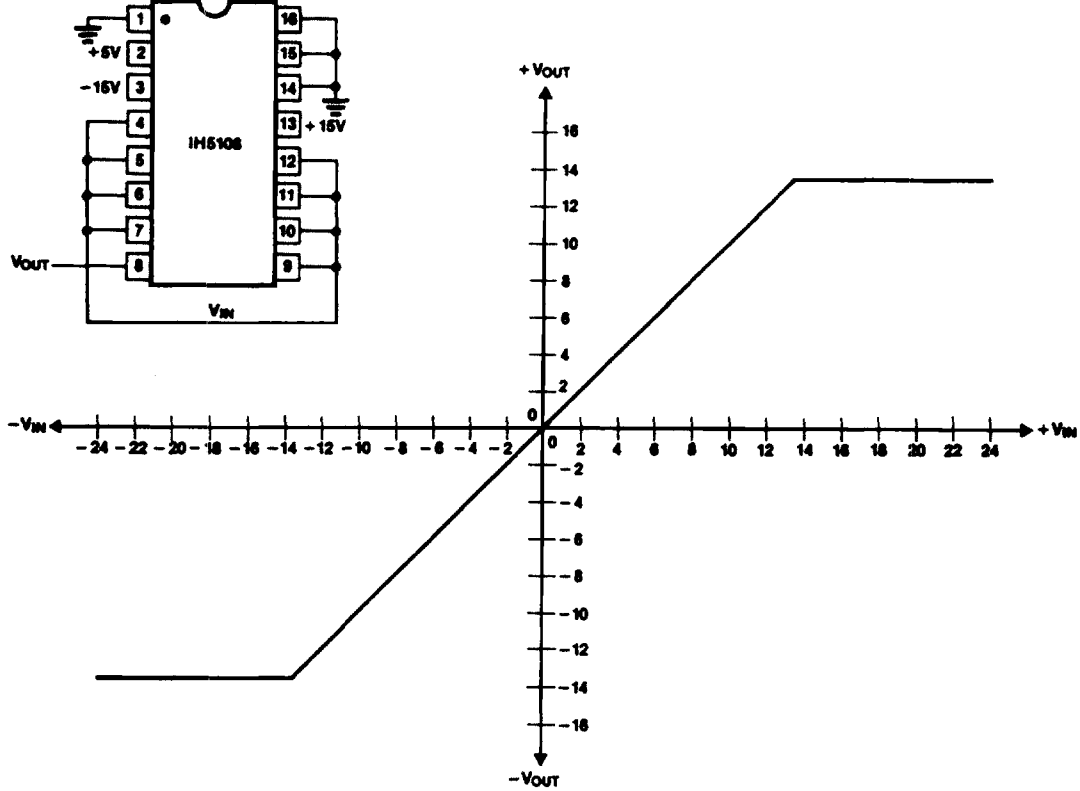


Figure 12: MUX Output Voltage vs Input Voltage (Channel 1 Shown; All Channels Similar)

0289-17

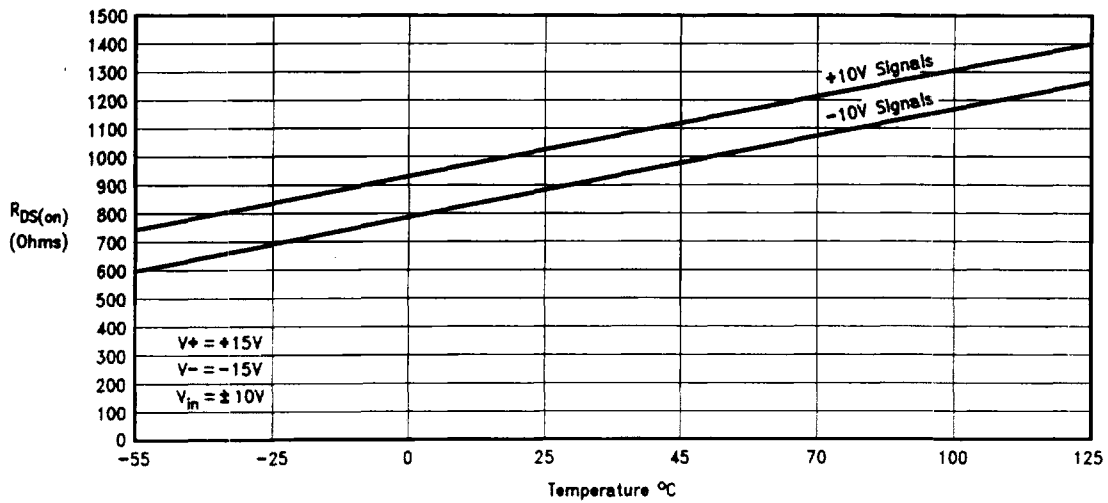


Figure 13: Typical $r_{DS(on)}$ Variation With Temperature

0289-18

USING THE IH5108 WITH SUPPLIES OTHER THAN $\pm 15V$

The IH5108 will operate successfully with supply voltages from $\pm 5V$ to $\pm 15V$, however $r_{DS(on)}$ increases as supply voltage decreases, as shown in Figure 11. Leakage currents, on the other hand, decrease with a lowering of supply voltage, and therefore the error term product of $r_{DS(on)}$ and leakage current remains reasonably constant. $r_{DS(on)}$ also decreases as signal levels decrease. For high system accuracy [acceptable levels of $r_{DS(on)}$] the maximum input signal should be 3V less than the supply voltages. The logic levels remain TTL compatible.

APPLICATION NOTES

Further information may be found in:

- A003** "Understanding and Applying the Analog Switch"
- A006** "A New CMOS Analog Gate Technology"
- A020** "A Cookbook Approach to High Speed Data Acquisition and Microprocessor Interfacing"

IH5108 APPLICATIONS INFORMATION

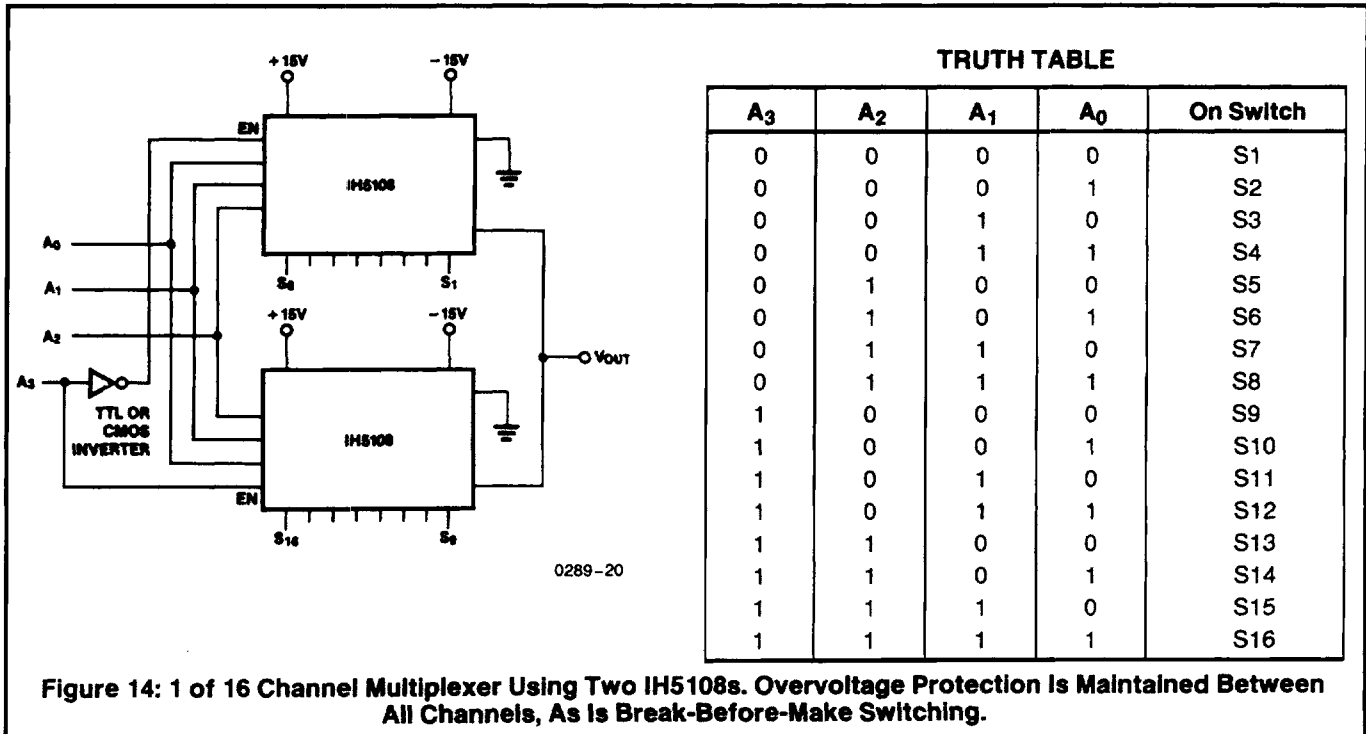
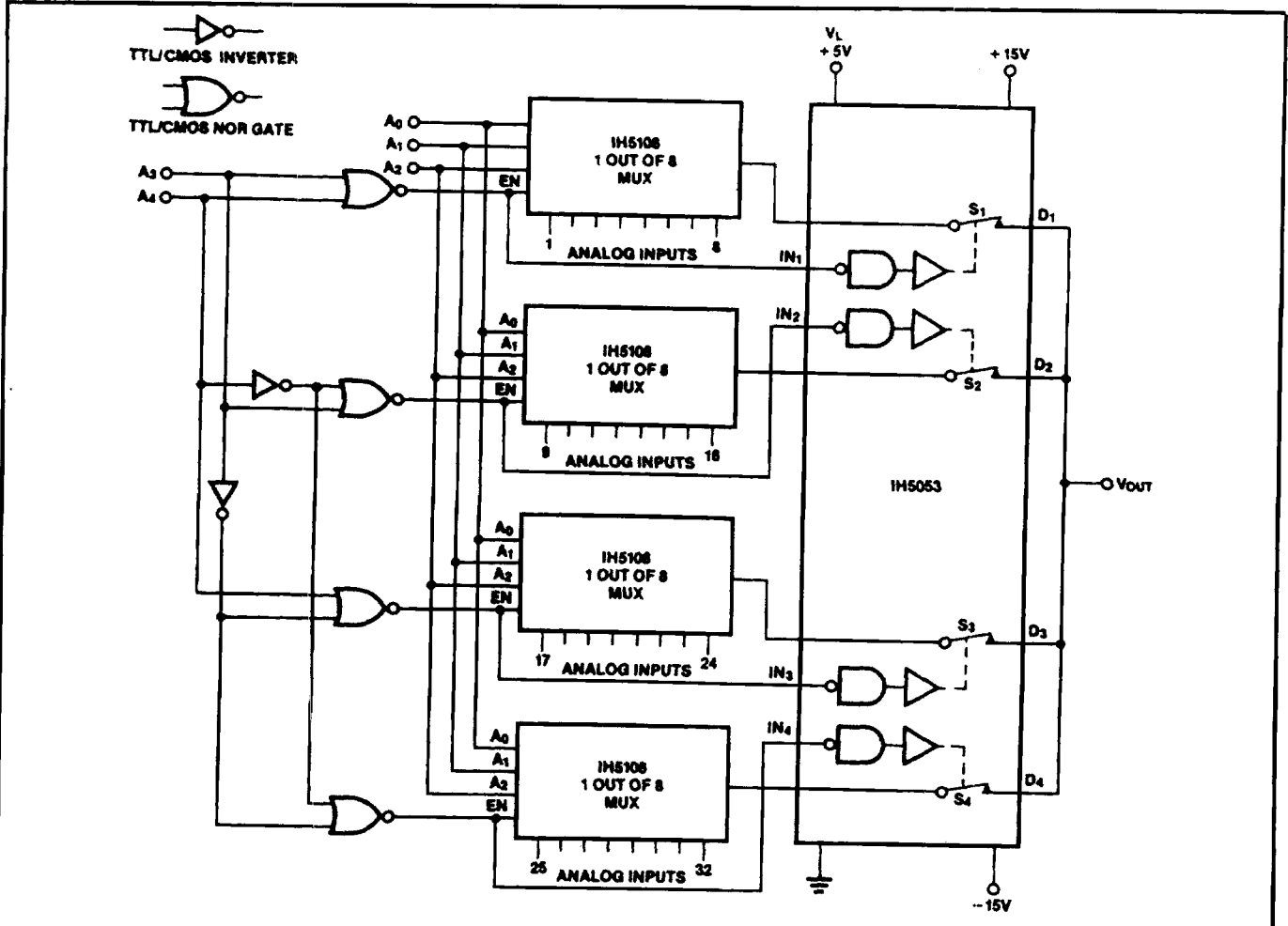


Figure 14: 1 of 16 Channel Multiplexer Using Two IH5108s. Overvoltage Protection Is Maintained Between All Channels, As is Break-Before-Make Switching.

IH5108 APPLICATIONS INFORMATION (Continued)



0289-21

TRUTH TABLE

A ₄	A ₃	A ₂	A ₁	A ₀	On Switch
0	0	0	0	0	S1
0	0	0	0	1	S2
0	0	0	1	0	S3
0	0	0	1	1	S4
0	0	1	0	0	S5
0	0	1	0	1	S6
0	0	1	1	0	S7
0	0	1	1	1	S8
0	1	0	0	0	S9
0	1	0	0	1	S10
0	1	0	1	0	S11
0	1	0	1	1	S12
0	1	1	0	0	S13
0	1	1	0	1	S14
0	1	1	1	0	S15
0	1	1	1	1	S16

TRUTH TABLE

A ₄	A ₃	A ₂	A ₁	A ₀	On Switch
1	0	0	0	0	S17
1	0	0	0	1	S18
1	0	0	1	0	S19
1	0	0	1	1	S20
1	0	1	0	0	S21
1	0	1	0	1	S22
1	0	1	1	0	S23
1	0	1	1	1	S24
1	1	0	0	0	S25
1	1	0	0	1	S26
1	1	0	1	0	S27
1	1	0	1	1	S28
1	1	1	0	0	S29
1	1	1	0	1	S30
1	1	1	1	0	S31
1	1	1	1	1	S32

Figure 15: 1 Of 32 Multiplexer Using 4 IH5108s and An IH5053 As A Submultiplexer. Note That The IH5053 Is Protected Against Overvoltages By The IH5108s. Submultiplexing Reduces Output Leakage and Capacitance.