



# HARRIS

## HI-508L/HI-509L

### Single 8/Differential 4 Channel CMOS Analog Multiplexers With Latches And Overvoltage Protection

#### FEATURES

- Analog Overvoltage protection
- Resettable Latches ( $\overline{RS}$ )
- TTL/DTL and CMOS Compatible
- Failsafe for conditions of Overvoltage & Loss of Power
- No SCR Latch-up
- Break-before-make switching
- Microprocessor Bus compatible
- Very low leakage -  $I_{D(off)} \leq 4nA$  (typ) over full temp range
- Access time -  $t_A = 500nS$  (typ)
- Minimum write pulse width ( $\overline{WR}$ ) = 300 nS
- OFF isolation = -100dB, typ @ 10kHz

#### DESCRIPTION

These monolithic CMOS multiplexers feature on-board address latches, plus overvoltage protection for the analog inputs and the output as well. Each model includes digital inputs for channel selection and an Enable input for device selection under program control. In addition, Write (WR) and Reset (RS) inputs allow the program to store or clear the channel address.

The overvoltage performance of these multiplexers is particularly useful in redundant systems, where the inputs and output must present a high impedance when power is off. This is achieved by a switch cell with three MOSFET's in series, rather than the conventional transmission gate design.

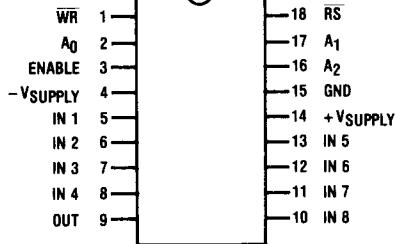
Each channel can withstand overvoltage to +25VDC with respect to ground with power ON or OFF. An OFF channel remains OFF in the presence of overvoltage. If the channel is ON, output voltage is clamped below the supply rail, which protects the load circuit.

The HI-508L offers 8 single-ended channels, and the HI-509L is a 4 channel differential version. The recommended supply voltages are 15V, though operation at reduced levels or with a single supply may also be implemented. The package is a 18 pin ceramic or plastic DIP.

Each product is specified for the commercial temperature range (0°C to 75°C, -5 suffix) and the military range (-55°C to +125°C, -2 suffix). Military high reliability burned-in product is available as a "-8" suffix.

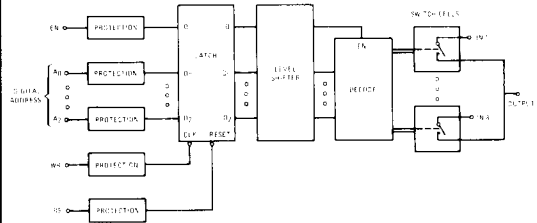
#### PINOUT

##### HI-508L

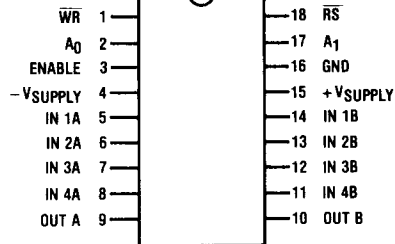


#### FUNCTIONAL DIAGRAM

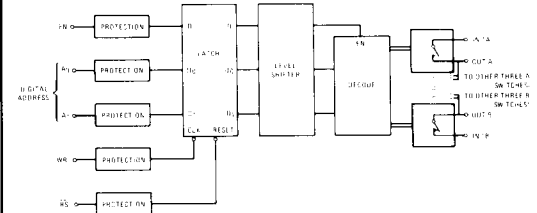
##### HI-508L



##### HI-509L



##### HI-509L



CAUTION: Electronic devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

# SPECIFICATIONS

HI-508L/509L

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage Between Pins 4 and 14 (15)	44V	Operating Temperature	
Digital Input Overvoltage, $V_A$ , $V_{EN}$ , $V_{RS}$ , $V_{WR}$ :			
V supply (+)	+4V	HI-508L/509L-2	-55°C to 125°C
V supply (-)	-4V	HI-508L/509L-5	0°C to 75°C
Analog Overvoltage		Storage Temperature	-65°C to +150°C
Input to Ground	±25VDC		
Total Power Dissipation* (Package)	1200mW	*Derate-8mW/°C above $T_A = +75°C$	

## ELECTRICAL CHARACTERISTICS (Unless otherwise specified)

+V supply = 15V, -V supply = -15V,  $V_{AH}$  (Logic High) = 2.0V,  $V_{AL}$  (Logic Low) = 0.8V

PARAMETER	HI-508L/509L-2 -55°C to +125°C			HI-508L/509L-5 0°C to +75°C			UNITS
	TEMP	MIN	TYP	MAX	MIN	TYP	
<b>ANALOG CHANNEL CHARACTERISTICS</b>							
$V_S$ Analog Signal Range	Full		±10			±10	V
$R_{ON}$ , ON Resistance (Note 2)	+25°C			1.2			1.5
	Full			1.8			1.8
$\Delta R_{ON}$ , Change in $R_{ON}$ (Note 3) between channels	+25°C		5			5	%
$I_{S(off)}$ , OFF input leakage current	+25°C			10			10
	Full		5	50		5	50
$I_{D(off)}$ , OFF output leakage current	+25°C			10			10
	Full		4	100		4	100
	HI-508L		2	50		2	50
	HI-509L		2	50		2	50
$I_{D(on)}$ , ON Channel leakage current	+25°C			10			10
	Full		5	100		5	100
	HI-508L		2	50		2	50
	HI-509L		2	50		2	50
<b>FAULT CHARACTERISTICS</b>							
$I_{S(off)}$ , with Power OFF	Full		10	1000		10	5000
$I_{S(off)}$ , overvoltage (Note 4)	Full		10	750		10	2500
$I_{D(off)}$ , with input over- voltage applied (Note 4)	+25°C		5	5		5	5
	Full		10	750		10	2500
<b>DIGITAL INPUT CHARACTERISTICS</b>							
$V_{AL}$ , Input Low Threshold	Full			1.4		1.4	0.8
$V_{AH}$ , Input High Threshold	Full	2.0	1.4		2.0	1.4	
$I_{AH}$ , Input High Current (Note 5)	Full		10	40		10	40
$I_{AL}$ , Input Low Current (Note 5)	Full		40	200		40	200
<b>DYNAMIC SWITCHING CHARACTERISTICS (Note 6)</b>							
$t_a$ , Access Time	+25°C		0.5	1.0		0.5	1.0
$t_{OPEN}$ , Break-Before-Make	+25°C	.025	0.1		.025	0.1	
$t_{ON}$ , (EN), Enable Delay (ON)	+25°C		0.5	1.0		0.5	1.0
$t_{OFF}$ , (EN), Enable Delay (OFF)	+25°C		0.5	1.0		0.5	1.0
Settling Time ( $\pm 0.1\%$ )	+25°C		1.0			1.0	
	+25°C		1.75			1.75	
OFF Isolation (Note 7)	+25°C	50	68		50	68	dB
OFF Isolation POWER OFF (Note 8)	+25°C		56			56	dB
$C_{S(off)}$ , Channel Input Cap.	+25°C		5			5	pF
$C_{D(off)}$ , Channel Output Cap.							
	+25°C		25			25	pF
	+25°C		12			12	pF
$C_A$ , Digital Input Capacitance	+25°C		5			5	pF
$C_{PS(off)}$ , Input to Output capacitance	+25°C		0.1			0.1	pF
<b>POWER REQUIREMENTS</b>							
$P_D$ , Power Dissipation (Note 9)	Full		60	100		60	100
$I_+$ , Current Pin 14 (Note 9)	Full		3.7	6.0		3.7	6.0
$I_-$ , Current Pin 4 (Note 9)	Full		0.3	0.6		0.3	0.6

NOTES 1. Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied.  
2.  $V_{OUT} = \pm 10V$ ,  $I_{OUT} = -100\mu A$   
3.  $\Delta R_{ON} = R_{ON}(MAX) - R_{ON}(MIN)$ ,  $V_{IN} = \pm 10V$   
 $R_{ON}(AVG)$   
4. Analog Overvoltage = ± 25V

5.  $I_{AH}$  and  $I_{AL}$  tested at 2.4V and 0.4V respectively  
6. For measurements in this section, input logic levels are 3.0V (High) and 0V (Low)  
7.  $V_{CM} = 0.8V$ ,  $R_L = 1K\Omega$ ,  $C_L = 15pF$ ,  
 $V_S = 70mV$ ,  $f = 500kHz$   
Off isolation = 20 log  $\left| \frac{V_{D1}}{V_S} \right|$   
[V<sub>S</sub>]

8.  $V_+ = V_- = 0V$ ,  $R_L = 1K\Omega$   
 $C_L = 50pF$ ,  $V_S = 3Vrms$ ,  $f = 500kHz$   
9. See Test Circuit #8 for high logic frequency applications

Worst case isolation on channel 4 due to proximity of the output pin(s)

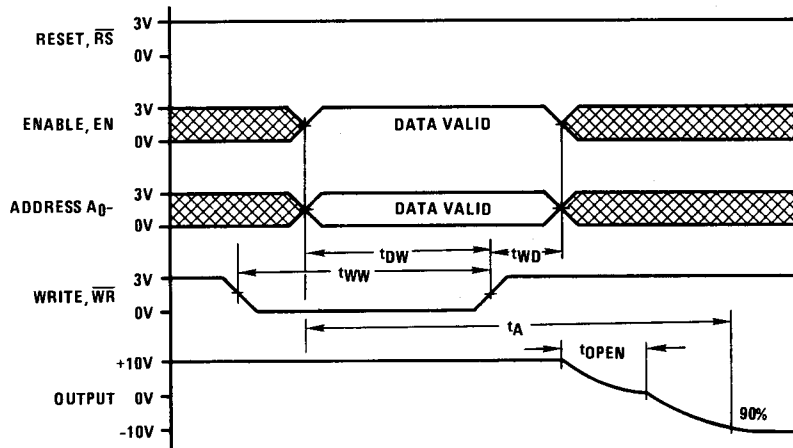
4

MULTIPLEXERS

## MINIMUM TIMING REQUIREMENTS

PARAMETER	MIN LIMITS FULL TEMP RANGE	UNITS
$t_{WW}$ , Write Pulse Width	300	nS
$t_{DW}$ , A. EN Data Valid To WRITE (Stabilization Time)	225	nS
$t_{WD}$ , A. EN Data Valid After Write (hold Time)	100	nS
$t_{RS}$ , RESET pulse width	400	nS
$t_{OFF}$ (RS) Reset Delay	1000	nS
$t_{ON}$ (WR) Write Turn-on Time	1000	nS

## TIMING REQUIREMENTS



1.  $+V_{SUPPLY} = +15V$ ;  $-V_{SUPPLY} = -15V$ .
2. Logic Levels:  $V_{AL} = 0V$ ;  $V_{AH} = +3.0V$ .
3. Time intervals are measured between 50% levels unless otherwise noted.
4. Minimum values for  $t_{RS}$ ,  $t_{DW}$ ,  $t_{WW}$  and  $t_{WD}$  are guaranteed separately but not simultaneously.

Figure 1

## SCHEMATIC DIAGRAM

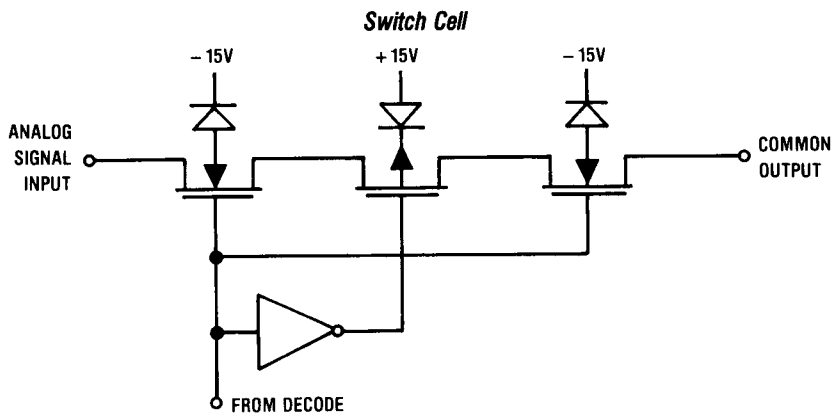


Figure 2

508L

A2	A1	A0	EN	$\overline{WR}$	$\overline{RS}$	OUTPUT - ON CHANNEL
X	X	X	L	L	H	None
X	X	X	X		H	Previous ON Channel.
X	X	X	X	X	L	None (latches cleared)
L	L	L	H	L	H	Channel 1
L	L	H	H	L	H	Channel 2
L	H	L	H	L	H	Channel 3
L	H	H	H	L	H	Channel 4
H	L	L	H	L	H	Channel 5
H	L	H	H	L	H	Channel 6
H	H	L	H	L	H	Channel 7
H	H	H	H	L	H	Channel 8

509L

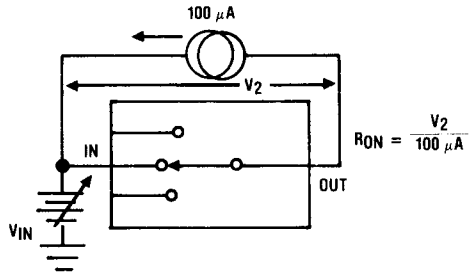
A1	A0	EN	$\overline{WR}$	$\overline{RS}$	OUTPUT - ON CHANNEL PAIR
X	X	L	L	H	None
X	X	X		H	Previous ON Channel.
X	X	X	X	L	None (latches cleared)
L	L	H	L	H	Channel 1A and 1B
L	H	H	L	H	Channel 2A and 2B
H	L	H	L	H	Channel 3A and 3B
H	H	H	L	H	Channel 4A and 4B

**DESCRIPTION AND APPLICATION**

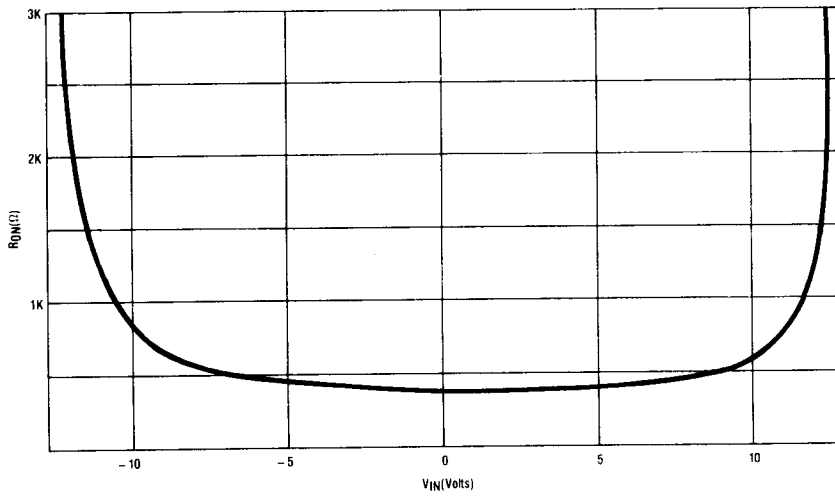
The switch cell of HI-508L/509L has a different structure than earlier Harris designs (HI-508, HI508A). The new switch (Figure 2) consists of an N-channel, P-channel and N-channel MOSFET in series, as opposed to the transmission gate configuration with an N and P-channel device in parallel. The series N-P-N switch offers higher Off isolation with power off, and better fault performance. Channel overvoltage protection is inherent since one of the three MOSFETs turn off in the presence of overvoltage. This turn-off process begins well below the supply rail so the  $V_{IN}$  range is less than the power supply range. Electrical performance is guaranteed to  $\pm 10V$  for each channel, and the usable range extends above  $\pm 11$  Volts.

The address inputs  $A_0$ ,  $A_1$ ,  $A_2$ , and ENABLE are latched into an internal buffer when  $\overline{WR}$  goes high. Each latch output is level shifted into the decode section, which activates the appropriate channel. The device may be reset (all channels OFF) by taking  $\overline{RS}$  low. Usually,  $\overline{RS}$  is tied to the system RESET line, to assure that all channels are OFF following a turn-on of power. The reset function overrides all others, just as  $\overline{WR}$  overrides the address inputs ( $A_0$ - $A_2$  and EN are ignored when  $\overline{WR}$  is high). With  $\overline{WR}$  low and  $\overline{RS}$  high, the switches respond immediately to a change in channel address; i.e., the latches are "transparent". Refer to Figure 1. For additional Applications information please see AN 545.

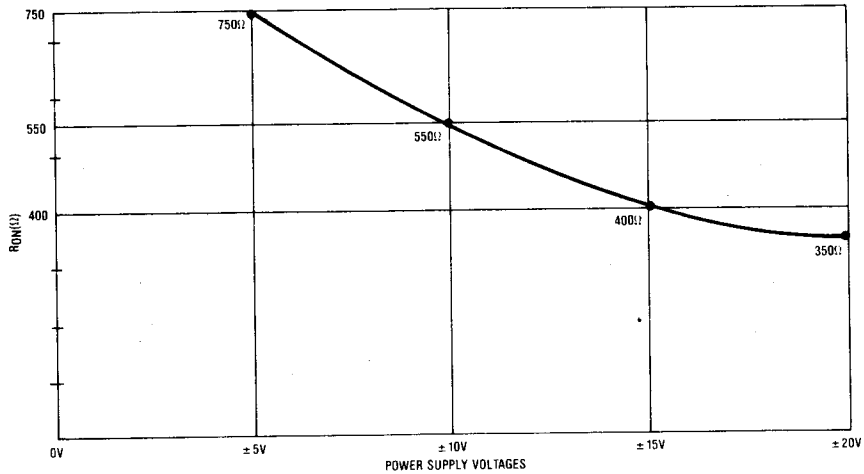
TEST CIRCUIT NO. 1  
ON RESISTANCE vs.  
INPUT SIGNAL LEVEL



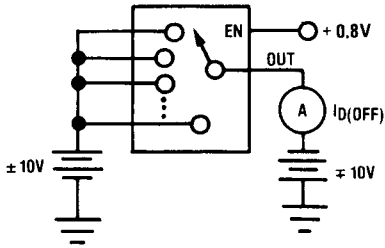
$V_{IN}$  vs.  $R_{ON}$



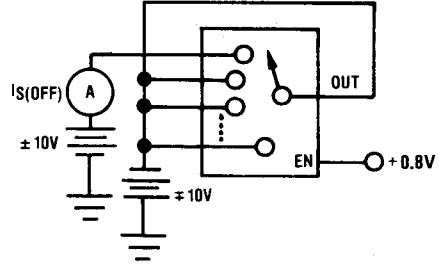
$R_{ON}$  vs. POWER SUPPLY VOLTAGES  
INPUT = 0V



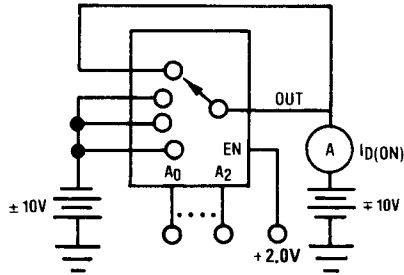
TEST CIRCUIT NO. 2\*



TEST CIRCUIT NO. 3\*



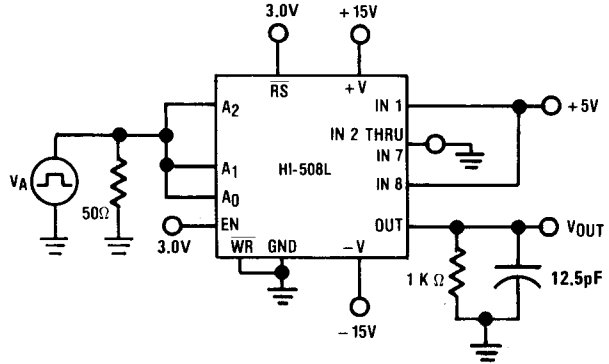
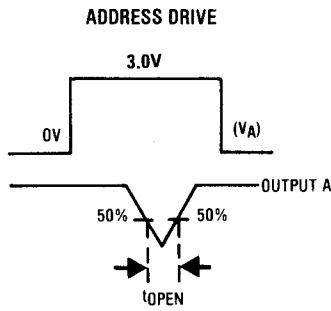
TEST CIRCUIT NO. 4\*



\*Two measurements per channel:  
+10V/-10V and -10V/+10V.  
(Two measurements per device for  $I_D(OFF)$   
+10V/-10V and -10V/+10V.)

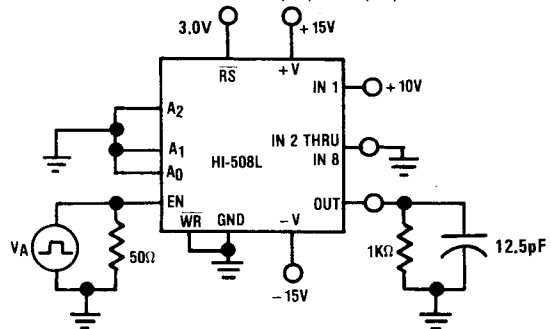
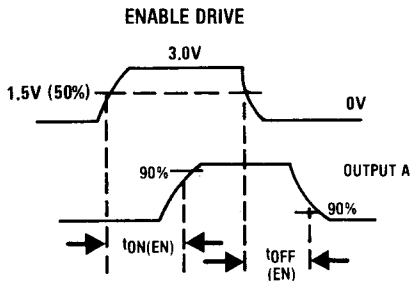
TEST CIRCUIT NO. 5

BREAK-BEFORE-MAKE DELAY ( $t_{OPEN}$ )



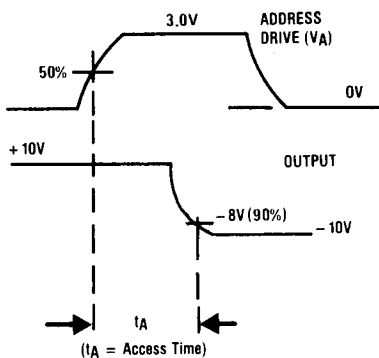
TEST CIRCUIT NO. 6

ENABLE DELAY ( $t_{ON(EN)}$ ,  $t_{OFF(EN)}$ )

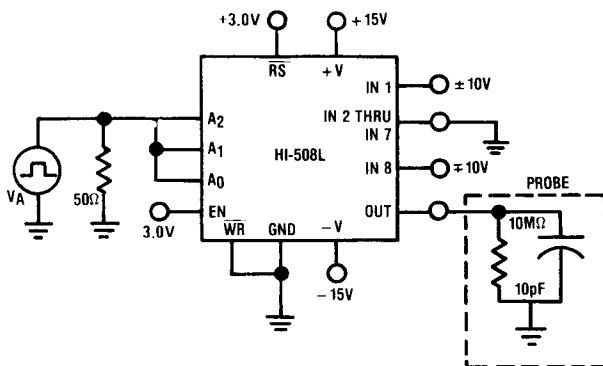


# HI-508L TEST CIRCUITS

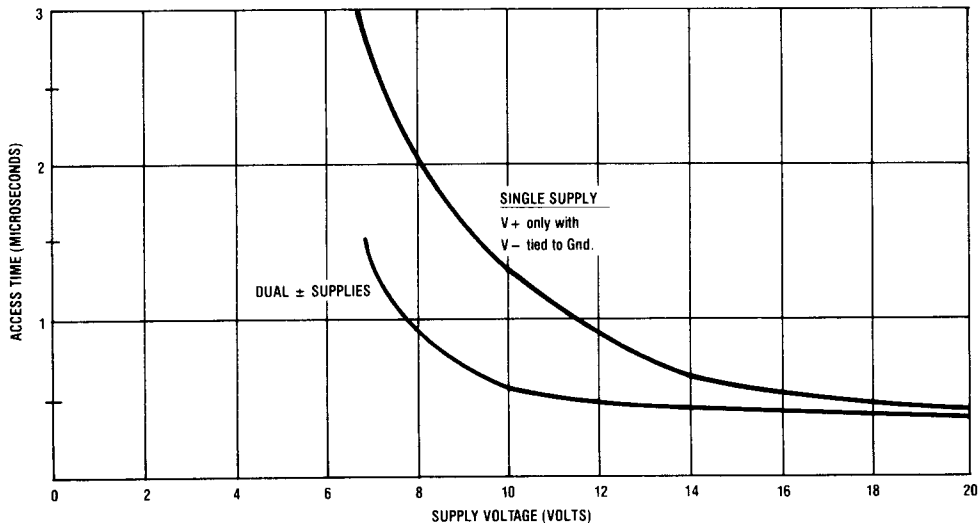
## TEST CIRCUIT NO. 7



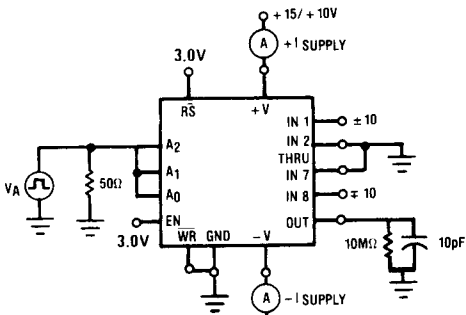
## ACCESS TIME



## ACCESS TIME vs. SUPPLY VOLTAGE

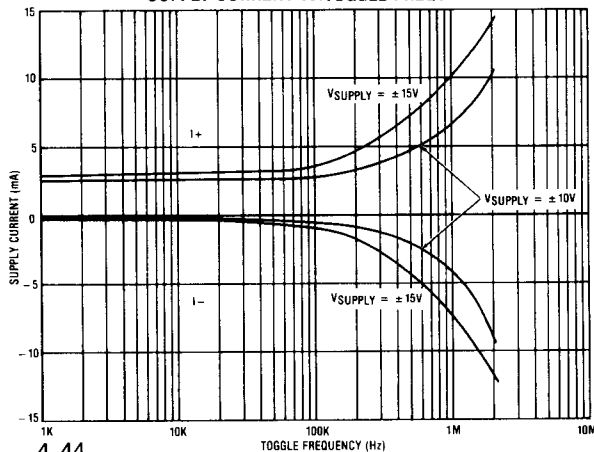


## TEST CIRCUIT NO. 8 SUPPLY CURRENTS vs. TOGGLE FREQUENCY

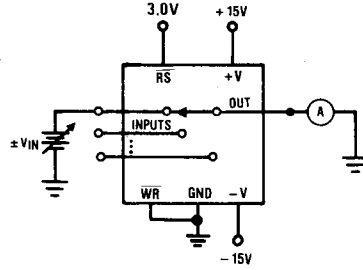
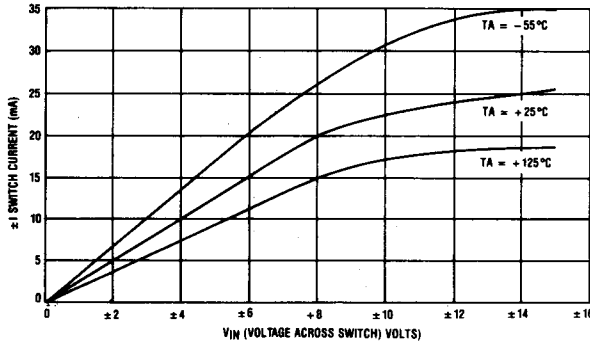


SIMILAR CONNECTION FOR HI-509L

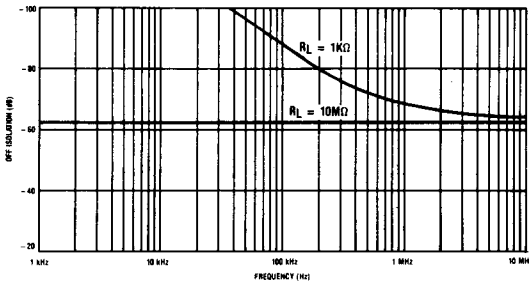
## SUPPLY CURRENT vs. TOGGLE FREQUENCY



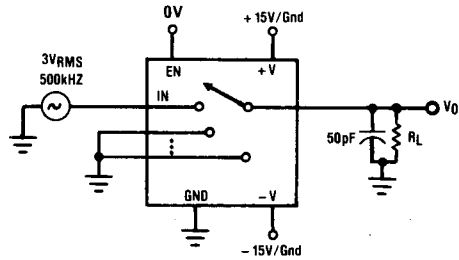
TEST CIRCUIT NO. 9  
ON CHANNEL CURRENT vs. INPUT VOLTAGE



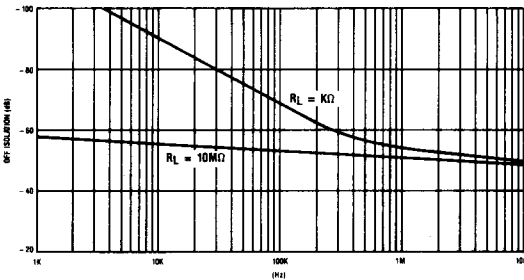
OFF ISOLATION vs. FREQUENCY POWER ON



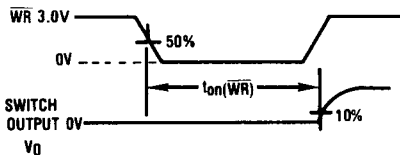
TEST CIRCUIT NO. 10  
OFF ISOLATION



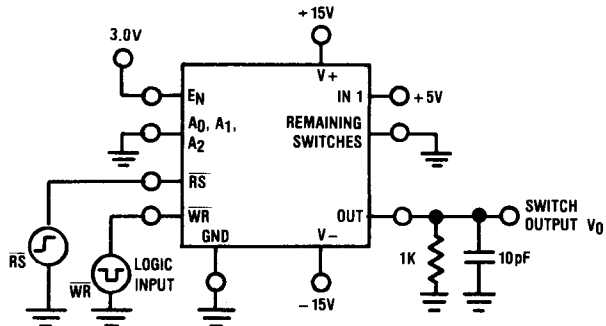
OFF ISOLATION vs. FREQUENCY (POWER OFF)



TEST CIRCUIT 11  
WRITE TURN-ON TIME  $t_{on}(\overline{WR})$



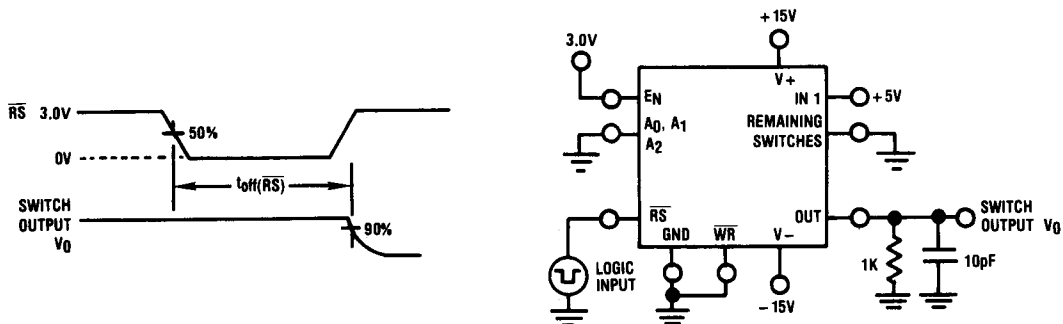
DEVICE MUST BE RESET PRIOR TO  
APPLYING WR PULSE



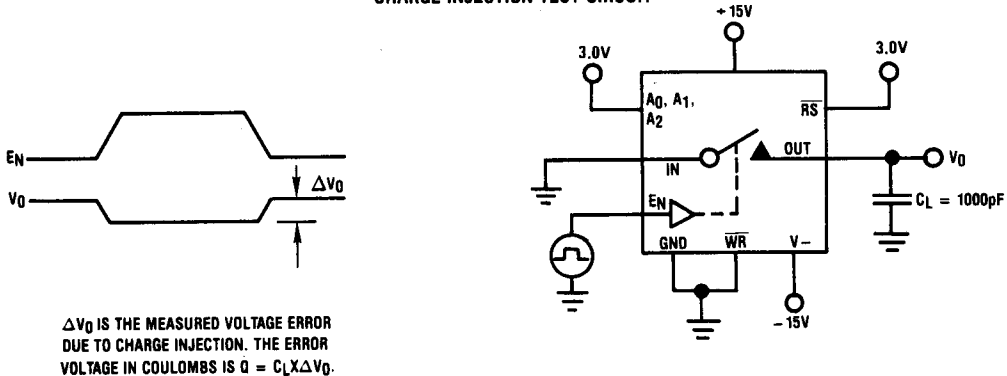


## HI-508L TEST CIRCUITS

**TEST CIRCUIT 12**  
RESET TURN-OFF TIME  $t_{off}(RS)$



**TEST CIRCUIT 13**  
CHARGE INJECTION TEST CIRCUIT



## DIE CHARACTERISTICS

Transistor Count	397
Die Size	124x114mils.
Thermal Impedance	
$\theta_{JA}$	80°C/W
$\theta_{JC}$	22°C/W
Tie Substrate to:	-V Supply
Process	CMOS-DI