

January 1989

## 4PST CMOS Analog Switch

### Features

- This Circuit is Processed in Accordance to Mil-Std-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Wide Analog Signal Range .....  $\pm 15V$
- Low "ON" Resistance
  - ▶ HI-5047 .....  $50\Omega$  (Typ)  $150\Omega$  (Max)
  - ▶ HI-5047A .....  $25\Omega$  (Typ)  $50\Omega$  (Max)
- High Current Capability .....  $70mA$  (Max)
- Break-Before-Make Switching
  - ▶ Turn-On Time .....  $370ns$  (Typ)  $800ns$  (Max)
  - ▶ Turn-Off Time .....  $280ns$  (Typ)  $400ns$  (Max)
- No Latch-Up
- Input MOS Gates Are Protected From Electrostatic Discharge
- DTL, TTL, CMOS, PMOS Compatible

### Applications

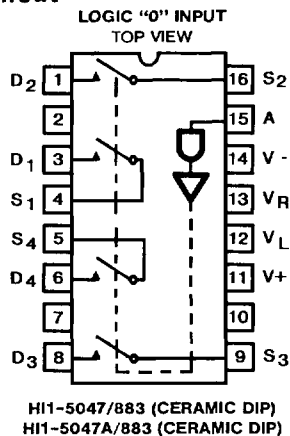
- High Frequency Switching
- Sample and Hold
- Digital Filters
- Operational Amplifier Gain Switching

### Description

These CMOS analog switches offer low-resistance switching performance for analog voltages up to the supply rails and for signal currents up to  $70mA$ . "ON" resistance is low and stays reasonably constant over the full range of operating signal voltage and current.  $R_{ON}$  remains exceptionally constant for input voltages between  $+5V$  and  $-5V$  and currents up to  $50mA$ . Switch impedance also changes very little over temperature, particularly between  $0^\circ C$  and  $+75^\circ C$ .  $R_{ON}$  is nominally  $50\Omega$  for the HI-5047/883 and  $25\Omega$  for the HI-5047A/883.

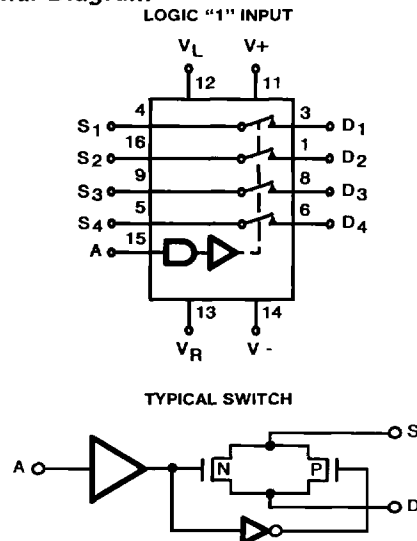
These devices provide break-before-make switching and are TTL and CMOS compatible for maximum application versatility. Performance is further enhanced by Dielectric Isolation processing which insures latch-free operation with very low input and output leakage currents ( $0.8nA$  at  $+25^\circ C$ ). They also feature very low power operation ( $1.5mW$  at  $+25^\circ C$ ). The HI-5047/883 and HI-5047A/883 are available in a 16 pin Ceramic DIP and operate over the  $-55^\circ C$  to  $+125^\circ C$  temperature range.

### Pinout



NOTE: Unused pins may be internally connected. Ground all unused pins.

### Functional Diagram



NOTE: Source and Drain are arbitrarily depicted as Analog Input and Output respectively. They may be interchanged without affecting performance.

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CMOS ANALOG SWITCHES

## Specifications HI-5047/883 HI-5047A/883

### Absolute Maximum Ratings

Voltage Between V+ and V- Terminals .....	36V
±V <sub>SUPPLY</sub> to Ground (V+, V-) .....	±18V
V <sub>R</sub> to Ground .....	-V <sub>SUPPLY</sub>
V <sub>L</sub> to Ground .....	+V <sub>SUPPLY</sub>
Digital and Analog Input Voltage (V <sub>A</sub> , V <sub>S</sub> , V <sub>D</sub> ) .....	+V <sub>SUPPLY</sub> +4V -V <sub>SUPPLY</sub> -4V
Peak Current (Source to Drain) (Pulse at 1 ms, 10% Duty Cycle Max) .....	70mA
Continuous Current (Any Pin) .....	20mA
Junction Temperature .....	+175°C
Storage Temperature Range .....	-65°C to +150°C
ESD Rating .....	<2000V
Lead Temperature (Soldering 10 sec) .....	300°C

### Thermal Information

Thermal Resistance	$\theta_{ja}$	$\theta_{jc}$
Ceramic DIP Package	82°C/W	20°C/W
Package Power Dissipation at +75°C		
Ceramic DIP Package		1.0W
Package Power Dissipation Derating Factor Above +75°C		
Ceramic DIP Package		12.3mW/°C

*CAUTION: Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.*

### Recommended Operating Conditions

Operating Temperature Range .....	-55°C to +125°C	Analog Input Voltage (V <sub>S</sub> ) .....	±V <sub>SUPPLY</sub>
Operating Supply Voltage .....	±15V	Address Low Level (V <sub>AL</sub> ) .....	0V to 0.8V
Logic Supply Voltage (V <sub>L</sub> ) .....	+5.0V	Address High Level (V <sub>AH</sub> ) .....	2.4V to +5.0V
Logic Reference Voltage (V <sub>R</sub> ) .....	0.0V		

**TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage = ±15V, V<sub>L</sub> = +5.0V, V<sub>R</sub> = 0.0V, V<sub>AH</sub> = 2.4V, V<sub>AL</sub> = +0.8V, Unused Pins are Grounded, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Switch "ON" Resistance For HI-5047/883	R <sub>DS1</sub>	V <sub>D</sub> = -10V, I <sub>S</sub> = 10mA S1/S2/S3/S4	1	+25°C	-	75	Ω
			2, 3	-55°C to +125°C	-	150	Ω
		V <sub>D</sub> = 10V, I <sub>S</sub> = -10mA S1/S2/S3/S4	1	+25°C	-	75	Ω
			2, 3	-55°C to +125°C	-	150	Ω
Switch "ON" Resistance For HI-5047A/883	R <sub>DS2</sub>	V <sub>D</sub> = -10V, I <sub>S</sub> = 10mA S1/S2/S3/S4	1	+25°C	-	45	Ω
			2, 3	-55°C to +125°C	-	50	Ω
		V <sub>D</sub> = 10V, I <sub>S</sub> = -10mA S1/S2/S3/S4	1	+25°C	-	45	Ω
			2, 3	-55°C to +125°C	-	50	Ω
Source "OFF" Leakage Current	I <sub>S(OFF)</sub>	V <sub>S</sub> = -10V, V <sub>D</sub> = 10V S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		V <sub>S</sub> = 10V, V <sub>D</sub> = -10V S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Drain "OFF" Leakage Current	I <sub>D(OFF)</sub>	V <sub>D</sub> = -10V, V <sub>S</sub> = 10V S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		V <sub>D</sub> = 10V, V <sub>S</sub> = -10V S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Channel "ON" Leakage Current	I <sub>D(ON)</sub>	V <sub>D</sub> = V <sub>S</sub> = 10V S1/S2/S3/S4	1	+25°C	-2	2	nA
			2, 3	-55°C to +125°C	-200	200	nA
		V <sub>D</sub> = V <sub>S</sub> = -10V S1/S2/S3/S4	1	+25°C	-2	2	nA
			2, 3	-55°C to +125°C	-200	200	nA

CAUTION: This device is sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

**TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at: Supply Voltage =  $\pm 15V$ ,  $V_L = +5.0V$ ,  $V_R = 0.0V$ ,  $V_{AH} = 2.4V$ ,  $V_{AL} = +0.8V$ , Unused Pins are Grounded, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Low Level Address Current	$I_{AL}$	$V_A = 0V$	1	+25°C	-1	1	$\mu A$
			2, 3	-55°C to +125°C	-10	1	$\mu A$
High Level Address Current	$I_{AH}$	$V_A = 2.4V, 5V$	1	+25°C	-1	1	$\mu A$
			2, 3	-55°C to +125°C	-1	10	$\mu A$
Positive Supply Current	$+I_{CC}$	$V_A = 0V, 5V$	1	+25°C	-	200	$\mu A$
			2, 3	-55°C to +125°C	-	300	$\mu A$
Negative Supply Current	$-I_{CC}$	$V_A = 0V, 5V$	1	+25°C	-200	-	$\mu A$
			2, 3	-55°C to +125°C	-300	-	$\mu A$
Logic Supply Current	$+I_L$	$V_A = 0V, 5V$	1	+25°C	-	200	$\mu A$
			2, 3	-55°C to +125°C	-	300	$\mu A$
Reference Supply Current	$+I_R$	$V_A = 0V, 5V$	1	+25°C	-200	-	$\mu A$
			2, 3	-55°C to +125°C	-300	-	$\mu A$

**TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: Supply Voltage =  $\pm 15V$ ,  $V_L = +5.0V$ ,  $V_R = 0.0V$ ,  $V_{AH} = +5.0V$ ,  $V_{AL} = +0.0V$ , Unused Pins are Grounded, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Turn "ON" Time	$t_{ON}$	$V_S = 10V, -10V$ $C_L = 10pF$ $R_L = 1k\Omega$	11	-55°C	-	450	ns
			9	+25°C	-	500	ns
			10	+125°C	-	800	ns
Turn "OFF" Time	$t_{OFF}$	$V_S = 10V, -10V$ $C_L = 10pF$ $R_L = 1k\Omega$	11	-55°C	-	350	ns
			9	+25°C	-	450	ns
			10	+125°C	-	600	ns

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**HI-5047/883 HI-5047A/883**

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)**

Device Characterized at: Supply Voltage =  $\pm 15V$ ,  $V_L = +5.0V$ ,  $V_R = 0.0V$ ,  $V_{AH} = 4.0V$ ,  $V_{AL} = 0.8V$ , Unused Pins are Grounded, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
"On" Resistance Match (Channel to Channel) for HI-5047/883	R <sub>ON1</sub> Match	V <sub>D</sub> = $\pm 10V$ I <sub>D</sub> = 10mA	1	+25°C	-	10	$\Omega$
"On" Resistance Match (Channel to Channel) for HI-5047A/883	R <sub>ON2</sub> Match	V <sub>D</sub> = $\pm 10V$ I <sub>D</sub> = 10mA	1	+25°C	-	10	$\Omega$
Address Capacitance	C <sub>A</sub>	V <sub>A</sub> = 0V, 5V	1	+25°C	-	45	pF
Switch Input Capacitance	C <sub>S(OFF)</sub>	Switch Off: V <sub>A</sub> = 0V	1	+25°C	-	60	pF
Switch Output Capacitance	C <sub>D(OFF)</sub>	Switch Off: V <sub>A</sub> = 0V	1	+25°C	-	60	pF
	C <sub>D(ON)</sub>	Switch On: V <sub>A</sub> = 5V	1	+25°C	-	60	pF
Drain to Source Capacitance	C <sub>DS(OFF)</sub>	Switch Off: V <sub>A</sub> = 0V	1	+25°C	-	10	pF
Off Isolation	V <sub>ISO</sub>	V <sub>S</sub> = 2V <sub>p-p</sub> @ f = 100kHz R <sub>L</sub> = 100 $\Omega$	1	+25°C	-	60	dB
Charge Transfer Error	V <sub>CTE</sub>	V <sub>S</sub> = GND, C <sub>L</sub> = 10,000pF V <sub>A</sub> = 0 to 4V @ f = 200kHz	1	+25°C	-	30	mV

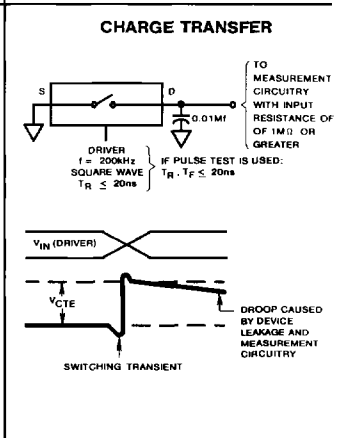
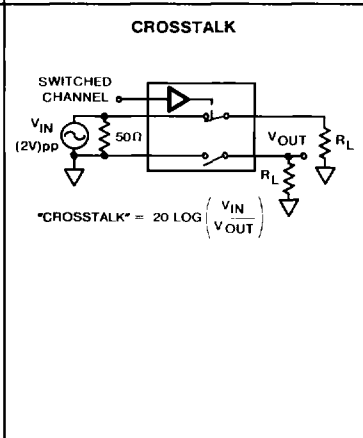
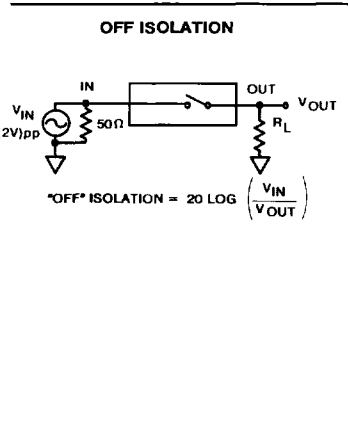
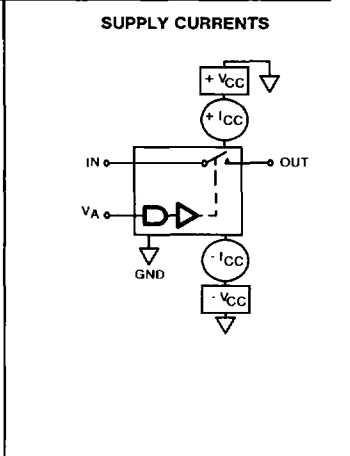
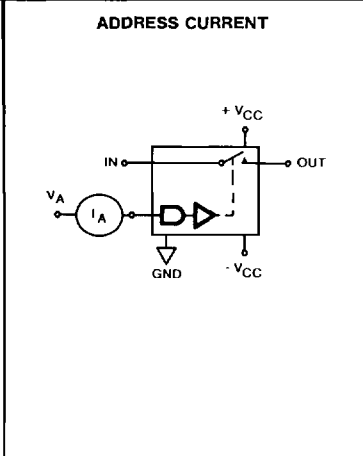
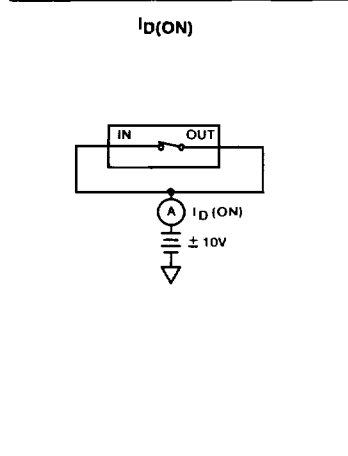
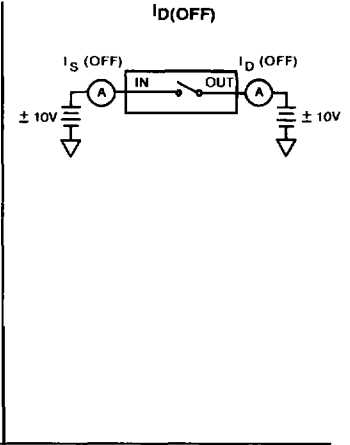
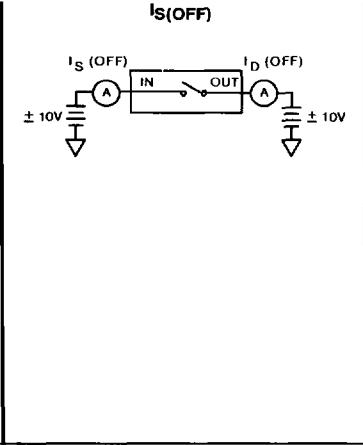
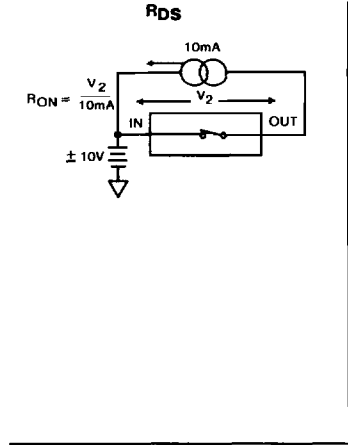
NOTE 1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1 & 2)
Interim Electrical Parameters (Pre Burn-in)	1
Final Electrical Test Parameters	1*, 2, 3, 9, 10, 11
Group A Test Requirements	1, 2, 3, 9, 10, 11
Groups C & D Endpoints	1

\* PDA applies to Subgroup 1 only.

**Test Circuits**

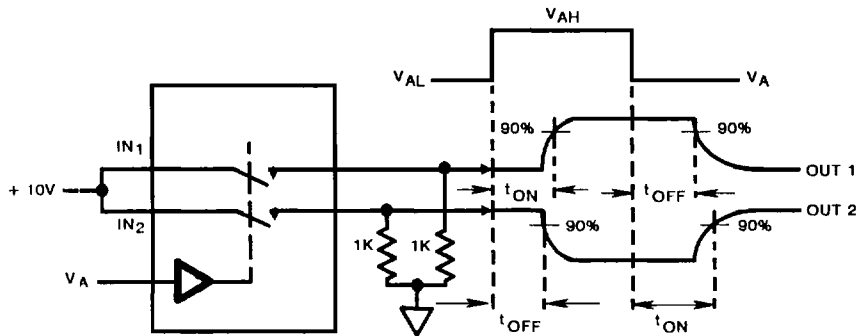


NOTE: Applies only to DUAL or DOUBLE THROW switches.

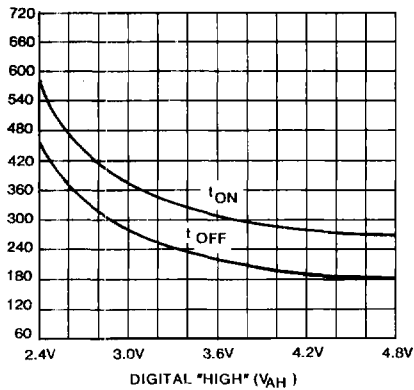
NOTE:  $V_{CTE}$  may be a positive or negative value.

**Test Characteristics**

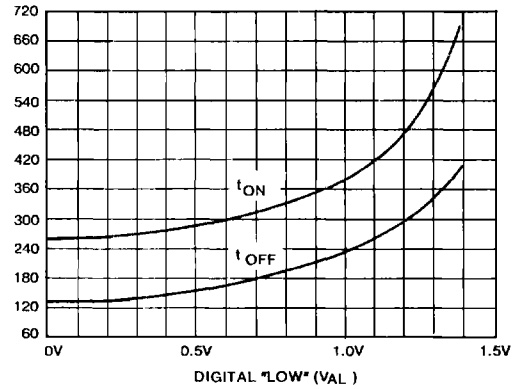
**ON/OFF SWITCH TIME ( $t_{ON}$ ,  $t_{OFF}$ )**



**SWITCHING TIMES FOR POSITIVE DIGITAL TRANSITION**



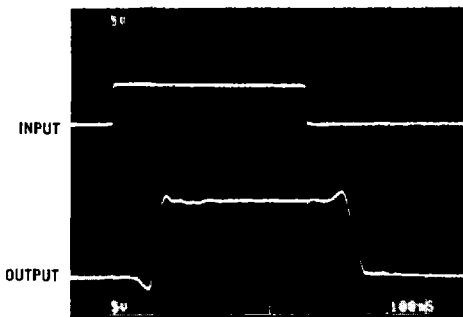
**SWITCHING TIMES FOR NEGATIVE DIGITAL TRANSITION**



**Test Waveforms**

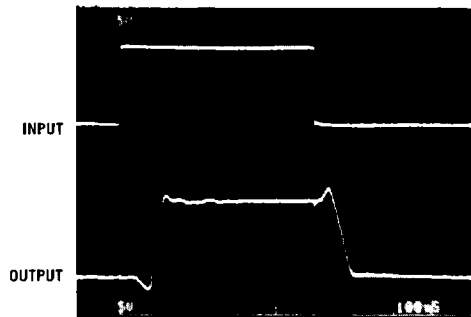
Vertical Scale: Input = 5V/Div., (TTL;  $V_{AH} = 5V$ ,  $V_{AL} = 0V$ )  
Output = 5V/Div.

Horizontal Scale: 100ns/Div.



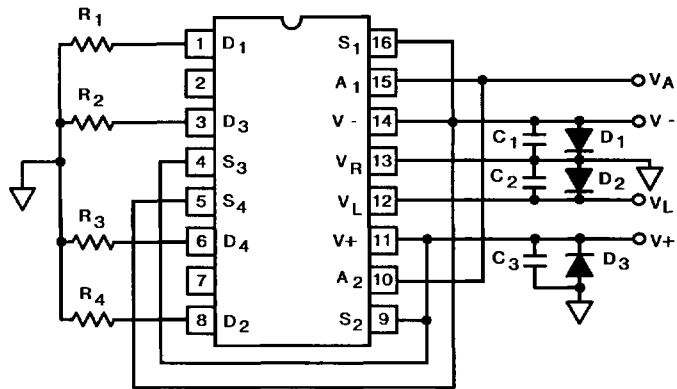
Vertical Scale: Input = 5V/Div., (CMOS;  $V_{AH} = 10V$ ,  $V_{AL} = 0V$ )  
Output = 5V/Div.

Horizontal Scale: 100ns/Div.



**Burn-In Circuit**

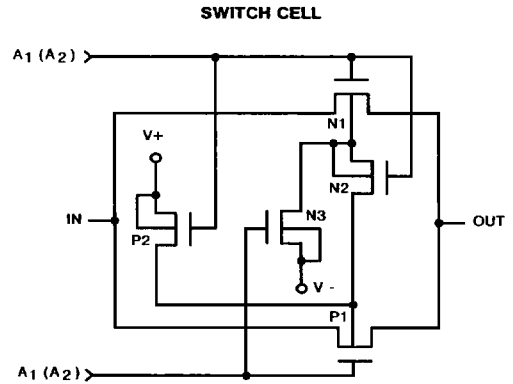
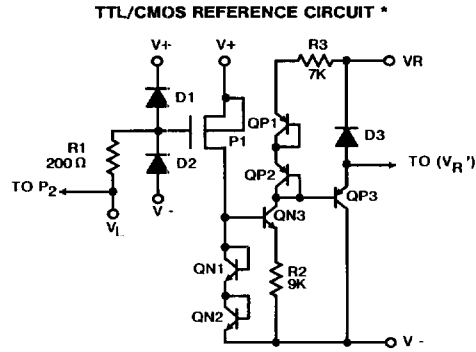
HI-5047/883 HI-5047A/883 CERAMIC DIP



**NOTES:**

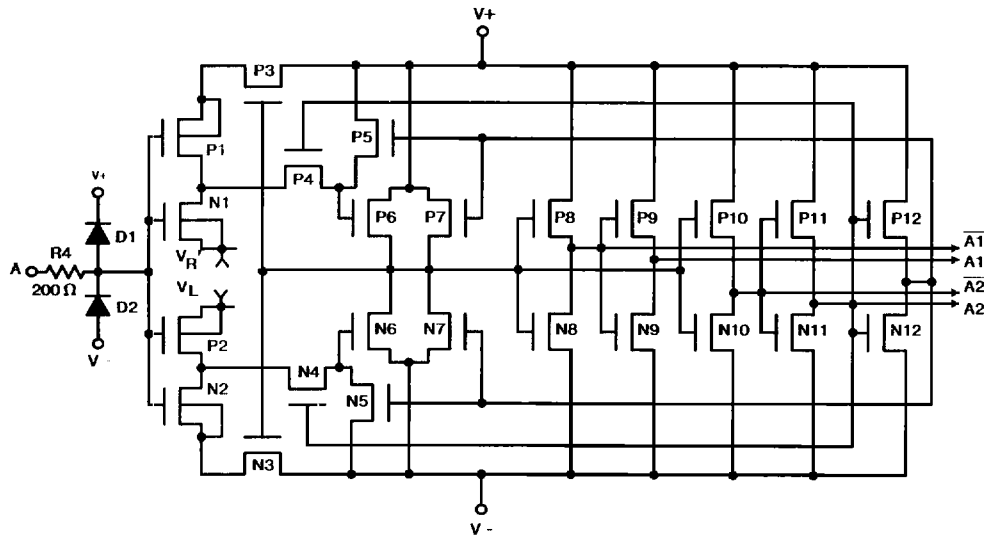
- R<sub>1</sub> thru R<sub>4</sub> = 10kΩ, ±5%, 1/4W (Min)
- C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub> = 0.01μF/Socket (Min) or 0.1μF/Row, (Min)
- D<sub>1</sub>, D<sub>2</sub>, D<sub>3</sub> = IN4002 or Equivalent/Board
- V<sub>L</sub> = 5.5 ± 0.5V
- A<sub>1</sub> = A<sub>2</sub> = 5.5 ± 0.5V
- |V<sub>+</sub> - V<sub>-</sub>| = 30V

**Schematic Diagram**



\* Connect V+ to V<sub>L</sub> for minimizing power consumption when driving from CMOS circuits.

**DIGITAL INPUT BUFFER AND LEVEL SHIFTER**



All N-Channel Bodies to V-  
 All P-Channel Bodies to V+  
 Except as Shown



**Die Characteristics**

**DIE DIMENSIONS:**

96 x 81 x 19mils  
(2430 x 2050 x 480μm)

**METALLIZATION:**

Type: Aluminum  
Thickness: 16kÅ ± 2kÅ

**GLASSIVATION:**

Type: Nitride over Silox  
Silox Thickness: 12kÅ ± 2kÅ  
Nitride Thickness: 3.5kÅ ± 1kÅ

**SUBSTRATE POTENTIAL (Powered-up):** V-

**DEVICE COUNT:** 82

**DIE ATTACH:**

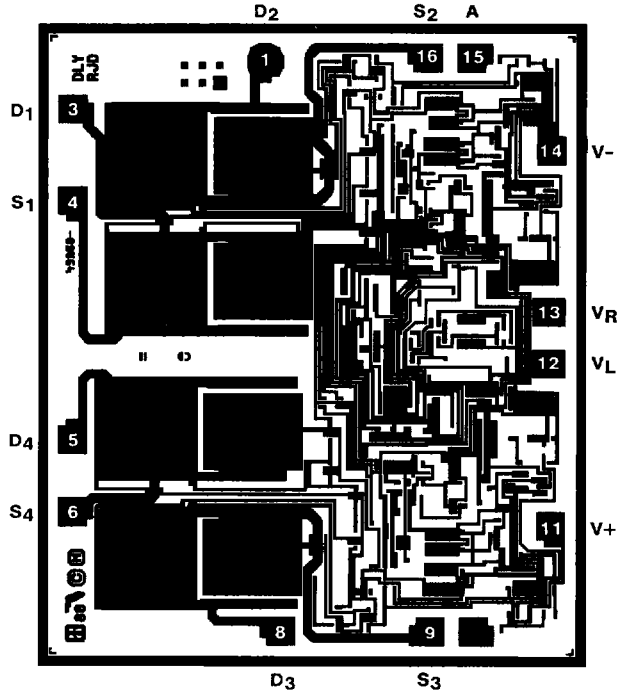
Material: Gold/Silicon Eutectic Alloy  
Temperature: Ceramic DIP — 480°C (Max)

**WORST CASE CURRENT DENSITY:**

1.0 x 10<sup>5</sup>A/cm<sup>2</sup> @ 20mA

**Metallization Mask Layout**

HI-5047/883 HI-5047A/883

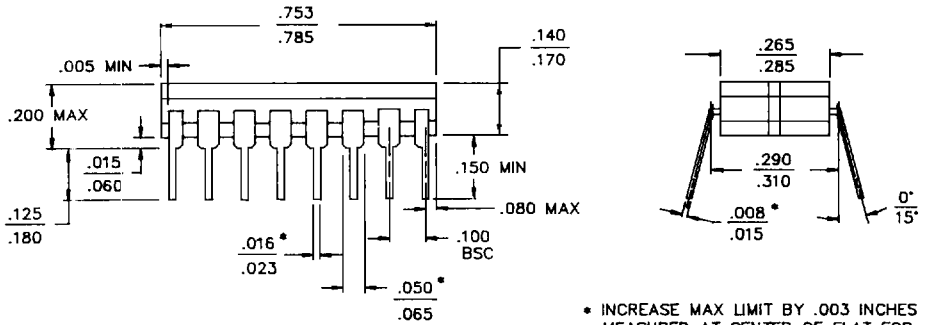


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NOTE: Pin Numbers Correspond to DIP Package Only. Unused Pins May Be Connected. Ground All Unused Pins.

**Packaging†**

**16 PIN CERAMIC DIP**



\* INCREASE MAX LIMIT BY .003 INCHES MEASURED AT CENTER OF FLAT FOR SOLDER FINISH

**LEAD MATERIAL:** Type B  
**LEAD FINISH:** Type A  
**PACKAGE MATERIAL:** Ceramic, 90% Alumina  
**PACKAGE SEAL:**  
 Material: Glass Frit  
 Temperature: 450°C ± 10°C  
 Method: Furnace Seal

**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic  
**COMPLIANT OUTLINE:** 38510 D-2

NOTE: All Dimensions are  $\frac{\text{Min}}{\text{Max}}$ , Dimensions are in inches.

† Mil-M-38510 Compliant Materials, Finishes, and Dimensions.

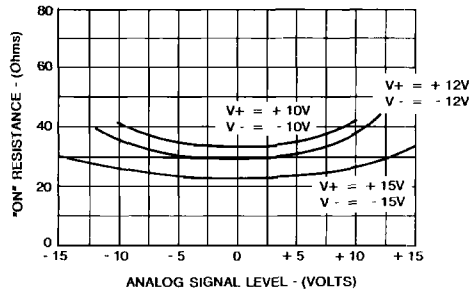
## DESIGN INFORMATION

## 4PST CMOS Analog Switch

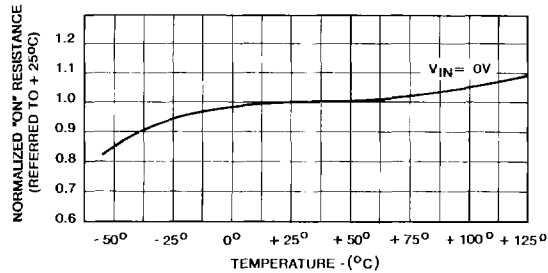
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

**Typical Performance Curves** Unless Otherwise Specified:  $T_A = +25^\circ\text{C}$ ,  $V_{\text{SUPPLY}} = \pm 15\text{V}$

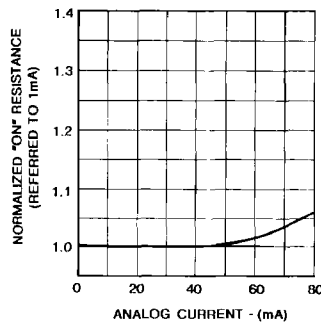
**"ON" RESISTANCE vs. ANALOG SIGNAL LEVEL  
AND POWER SUPPLY VOLTAGE**



**NORMALIZED "ON" RESISTANCE vs. TEMPERATURE**



**NORMALIZED "ON" RESISTANCE vs. ANALOG CURRENT**

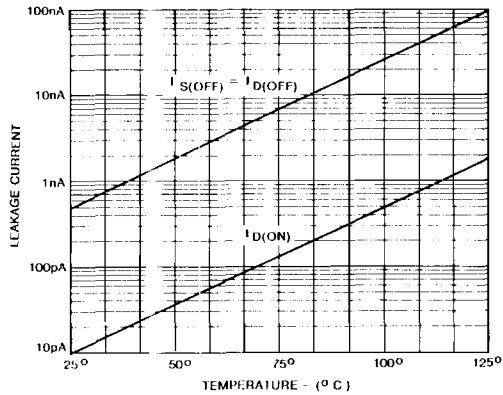


**DESIGN INFORMATION** (Continued)

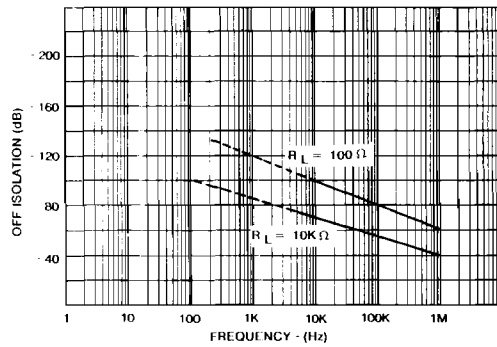
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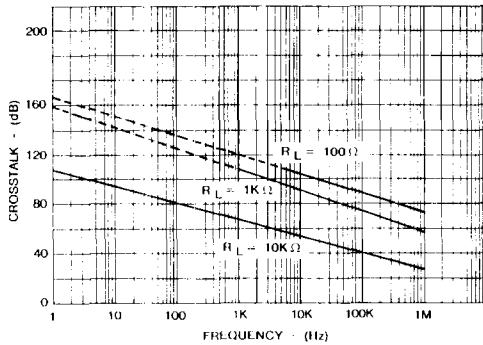
**ON/OFF LEAKAGE CURRENT vs. TEMPERATURE**



**"OFF" ISOLATION vs. FREQUENCY**



**CROSSTALK vs. FREQUENCY**



**POWER CONSUMPTION vs. FREQUENCY**

