

## Single 16/Differential 8 Channel CMOS Analog Multiplexers With Active Overvoltage Protection

January 1989

### Features

- This Circuit Is Processed in Accordance to Mil-Std-883 and Is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- No Channel Interaction During Overvoltage
- Guaranteed  $R_{ON}$  Matching
- 44V Maximum Power Supply
- Break-Before-Make Switching
- Analog Signal Range.....  $\pm 15V$
- Access Time (Max.) .....  $1.0\mu s$
- Power Dissipation (Max.) .....  $45mW$

### Applications

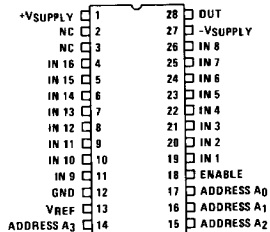
- Data Acquisition Systems
- Control Systems
- Telemetry

### Description

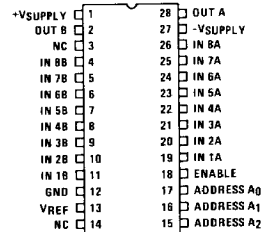
The HI-546/883 and HI-547/883 are analog multiplexers with Active Overvoltage Protection and guaranteed  $R_{ON}$  matching. Analog input levels may greatly exceed either power supply without damaging the device or disturbing the signal path of other channels. Active protection circuitry assures that signal fidelity is maintained even under fault conditions that would destroy other multiplexers. Analog inputs can withstand constant 70 volt peak-to-peak levels with  $\pm 15V$  supplies and digital inputs will sustain continuous faults up to 4 volts greater than either supply. In addition, signal sources are protected from short circuiting should multiplexer supply loss occur; each input presents  $1k\Omega$  of resistance under this condition. These features make the HI-546/883 and HI-547/883 ideal for use in systems where the analog inputs originate from external equipment or separately powered circuitry. Both devices are fabricated with 44 volt dielectrically isolated CMOS technology. The HI-546/883 is a 16 channel device and the HI-547/883 is an 8 channel differential version. If input overvoltage protection is not needed, the HI-506/883 and HI-507/883 multiplexers are recommended. For further information see Application Notes 520 and 521.

### Pinouts

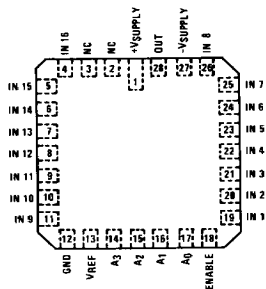
HI1-546/883 (CERAMIC DIP)  
TOP VIEW



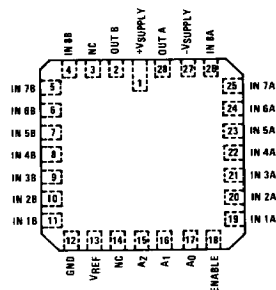
HI1-547/883 (CERAMIC DIP)  
TOP VIEW



HI4-546/883 (CERAMIC LCC)  
TOP VIEW

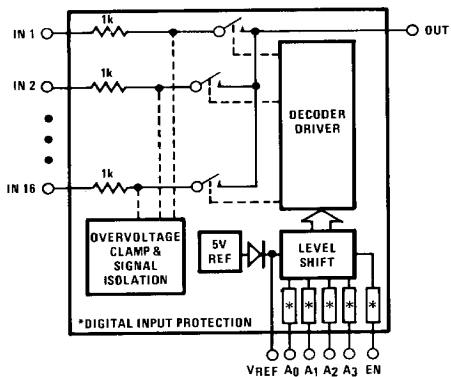


HI4-547/883 (CERAMIC LCC)  
TOP VIEW



Functional Diagrams

HI-546/883

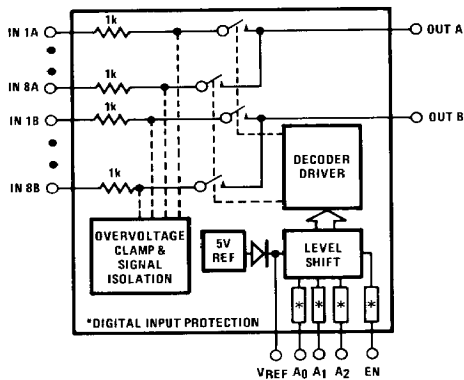


TRUTH TABLES

HI-546/883

A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	EN	"ON" CHANNEL
X	X	X	X	L	None
L	L	L	L	H	1
L	L	L	H	H	2
L	L	H	L	H	3
L	L	H	H	H	4
L	H	L	L	H	5
L	H	L	H	H	6
L	H	H	L	H	7
L	H	H	H	H	8
H	L	L	L	H	9
H	L	L	H	H	10
H	L	H	L	H	11
H	L	H	H	H	12
H	H	L	L	H	13
H	H	L	H	H	14
H	H	H	L	H	15
H	H	H	H	H	16

HI-547/883



HI-547/883

A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	EN	"ON" CHANNEL PAIR
X	X	X	L	None
L	L	L	H	1
L	L	H	H	2
L	H	L	H	3
L	H	H	H	4
H	L	L	H	5
H	L	H	H	6
H	H	L	H	7
H	H	H	H	8



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

Devices Tested at +VSUPPLY = +15V, -VSUPPLY = -15V, VEN = 4.0V, VREF (Pin 13) = OPEN, Unless Otherwise Specified.

A.C. PARAMETER	SYMBOL	CONDITIONS	SUBGROUP	TEMP	LIMITS		UNITS
					MIN	MAX	
Break-Before-Make Time Delay	t <sub>D</sub>	R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 12.5pF	9	+25°C	25		ns
Propagation Delay Times: Address Inputs to I/O Channel Times	t <sub>A</sub>	R <sub>L</sub> = 10MΩ, C <sub>L</sub> = 14pF	9	+25°C		500	ns
			10, 11	+125°C, -55°C		1000	ns
Enable to I/O	t <sub>ON(EN)</sub>	R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 12.5pF	9	+25°C		500	ns
			10, 11	+125°C, -55°C		1000	ns
	t <sub>OFF(EN)</sub>	R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 12.5pF	9	+25°C		500	ns
			10, 11	+125°C, -55°C		1000	ns

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Characterized at +VSUPPLY = +15V, -VSUPPLY = -15V, VEN = 4.0V, VREF (Pin 13) = OPEN, Unless Otherwise Specified.

PARAMETER	SYMBOL	CONDITIONS	NOTE	TEMP	LIMITS		UNITS
					MIN	MAX	
Capacitance: Address Input	C <sub>A</sub>	V <sub>+</sub> = V <sub>-</sub> = 0V f = 1MHz	4	+25°C		12	pF
Capacitance: Output Switch	C <sub>OS</sub>	V <sub>+</sub> = V <sub>-</sub> = 0V HI-546/883	4	+25°C		85	pF
		f = 1MHz HI-547/883	4	+25°C		50	pF
Capacitance Input Switch	C <sub>IS</sub>	V <sub>+</sub> = V <sub>-</sub> + 0V f = 1MHz	4	+25°C		15	pF
Charge Transfer Error	V <sub>CTE</sub>	V <sub>S</sub> = GND V <sub>GEN</sub> = 0V to 5V	4	+25°C		10	mV
Off Isolation	V <sub>ISO</sub>	V <sub>EN</sub> = 0.8V, R <sub>L</sub> = 1kΩ C <sub>L</sub> = 15pF, V <sub>S</sub> = 7VRMS f = 100kHz	4, 5	+25°C	-50		dB

- NOTES: 1. Used for forcing conditions for all DC Tests, unless otherwise specified.  
 2. To drive from DTL/TTL circuits, 1kΩ pull-up resistors to +5.0V supply are recommended.  
 3. VREF = +10V.  
 4. The parameters listed in this table are controlled via design or process parameters and are not directly tested. These parameters are characterized upon initial design release and upon design changes which would affect these characteristics.  
 5. Worst case isolation occurs on channel 8B due to proximity of the output pins.

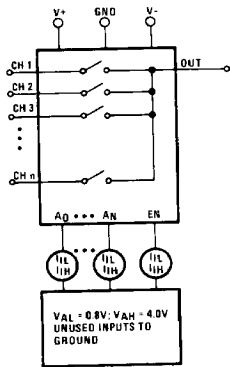
**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1, 2 & 3)
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

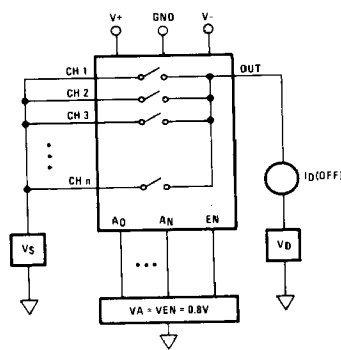
\*PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

**Test Circuits**

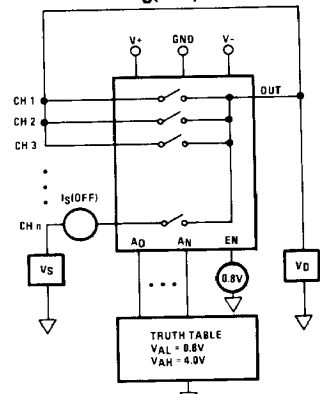
**INPUT LEAKAGE CURRENT**



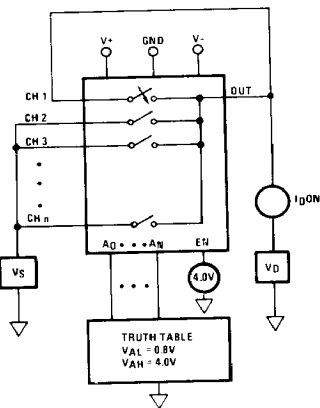
**$I_D(OFF)$**



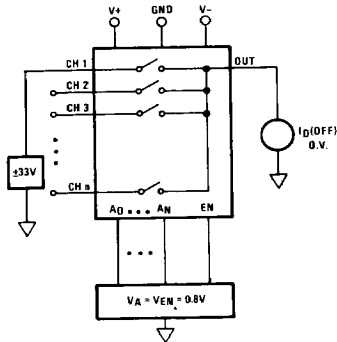
**$I_S(OFF)$**



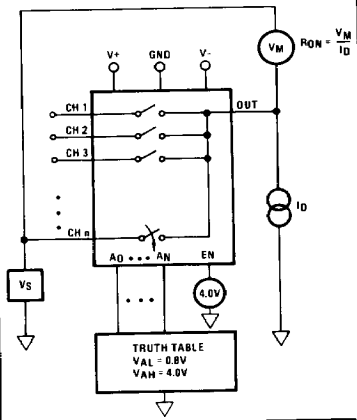
**$I_D(ON)$**



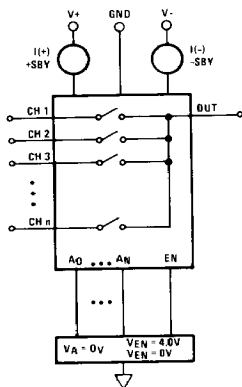
**$I_D(OFF)$  OVERVOLTAGE**



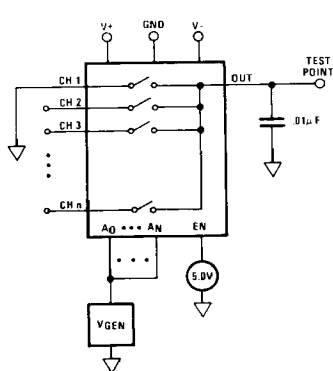
**$R_{ps}$**



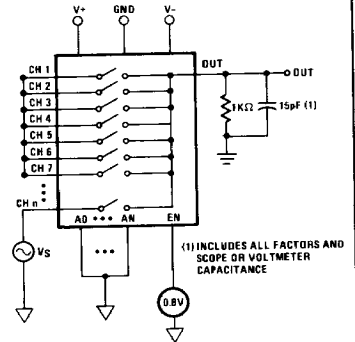
**SUPPLY CURRENTS**



**CHARGE TRANSFER ERROR**



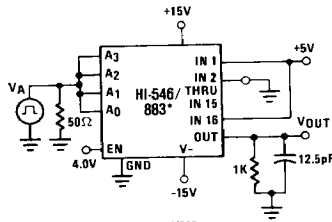
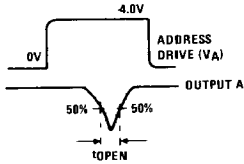
**OFF CHANNEL ISOLATION**



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CMOS ANALOG  
MULTIPLEXERS

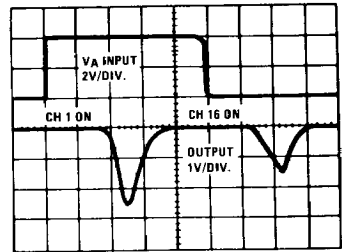
Switching Waveforms

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



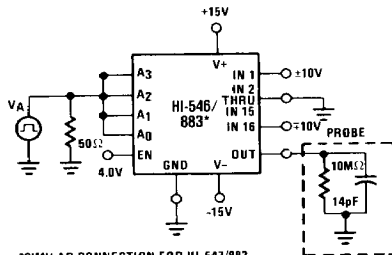
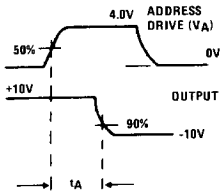
\*SIMILAR CONNECTION FOR HI-547/883

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



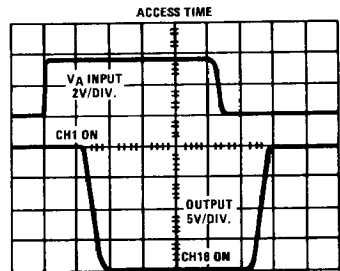
100ns/DIV.

ACCESS TIME vs.  
LOGIC LEVEL (HIGH)



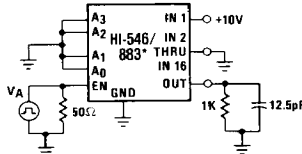
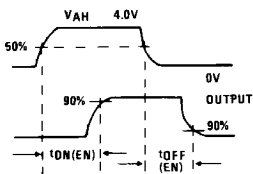
\*SIMILAR CONNECTION FOR HI-547/883

ACCESS TIME



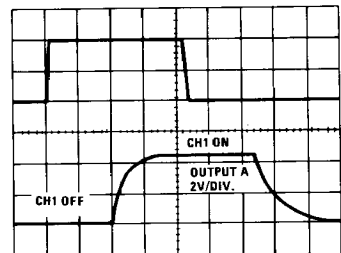
200ns/DIV.

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



\*SIMILAR CONNECTION FOR HI-547/883

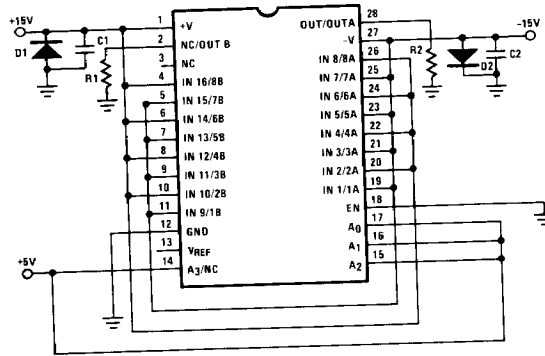
ENABLE DELAY  
 $t_{ON}(EN)$ ,  $t_{OFF}(EN)$



100ns/DIV.

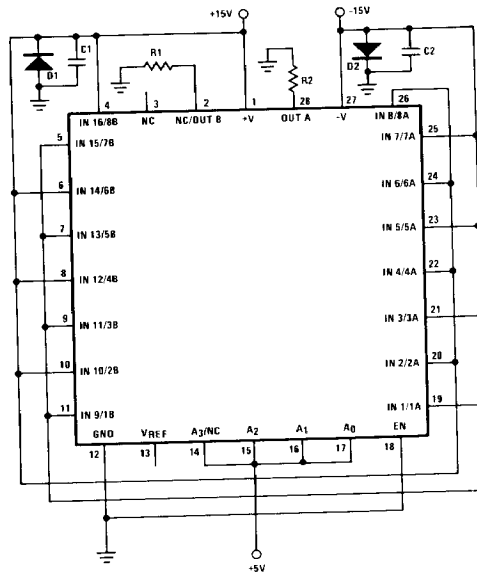
**Burn-In Circuits**

HI-546/883 HI-547/883 CERAMIC DIP



NOTES:  
 R1, R2 = 10kΩ ± 5% 1/2 or 1/4W (per socket)  
 C1, C2 = 0.01μF (per socket) or 0.1μF (per row)  
 D1, D2 = IN4002 (or equivalent) (per board)

HI-546/883 HI-547/883 CERAMIC LCC

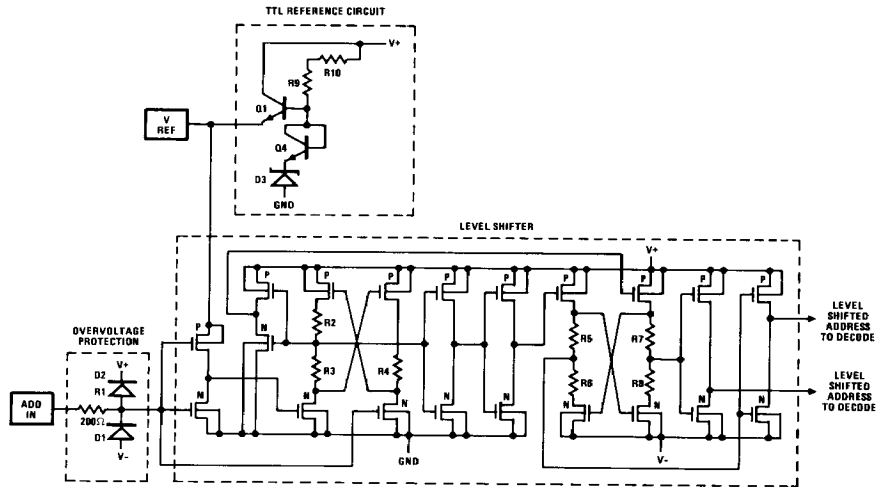


NOTES:  
 R1, R2 = 10kΩ ± 5% 1/2 or 1/4W (per socket)  
 C1, C2 = 0.01μF (per socket) or 0.1μF (per row)  
 D1, D2 = IN4002 (or equivalent) (per board)

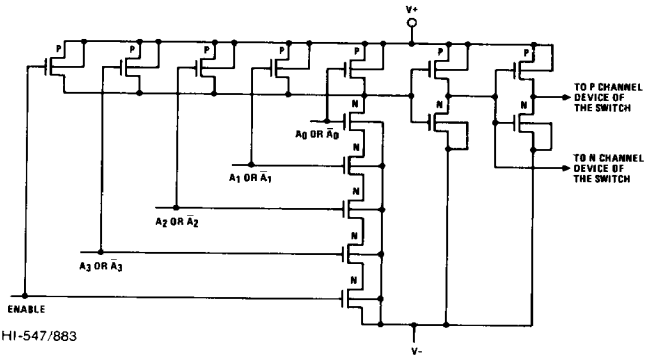
5  
 CMOS ANALOG  
 MULTIPLEXERS

**Schematic Diagrams**

**ADDRESS INPUT BUFFER AND LEVEL SHIFTER**

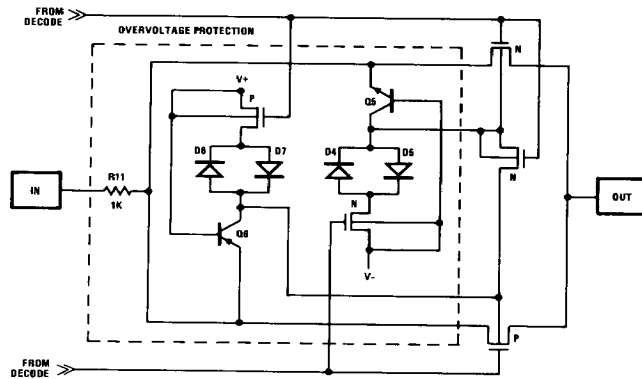


**ADDRESS DECODER**



Delete  $A_3$  or  $\bar{A}_3$  Inputs for HI-547/883

**MULTIPLEX SWITCH**





**Die Characteristics**

**DIE DIMENSIONS:** 83.9 x 159 x 19 mils

**METALLIZATION**

Type: Al  
Thickness:  $16\text{k}\text{\AA} \pm 2\text{k}\text{\AA}$

**GLASSIVATION**

Type: Nitride  
Thickness:  $7\text{k}\text{\AA} \pm 0.7\text{k}\text{\AA}$

**WORST CASE CURRENT DENSITY:**  $1.4 \times 10^5 \text{ A/cm}^2$

**TRANSISTOR COUNT:**

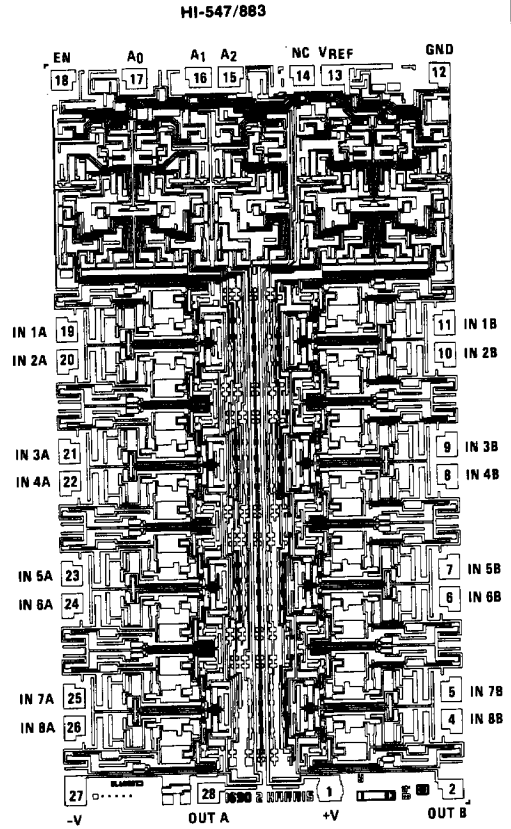
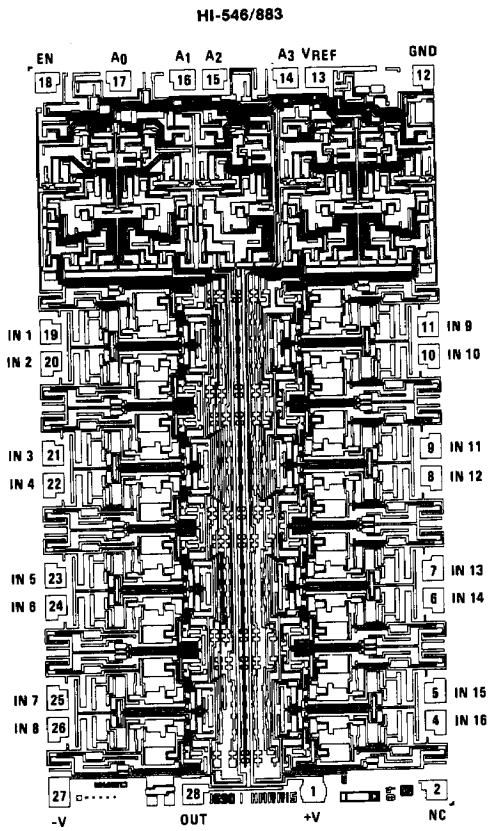
HI-546/883 485  
HI-547/883 485

**PROCESS:** CMOS-DI

**DIE ATTACH**

Material: Gold Silicon Eutectic Alloy  
Temperature: Ceramic DIP — 460°C (Max)  
Ceramic LCC — 420°C (Max)

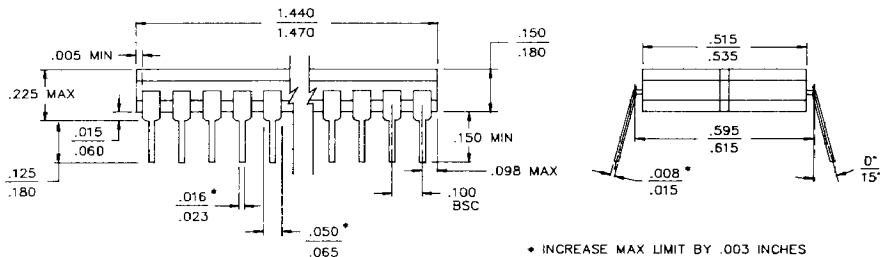
**Metallization Mask Layout**



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CMOS ANALOG  
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**Packaging†**

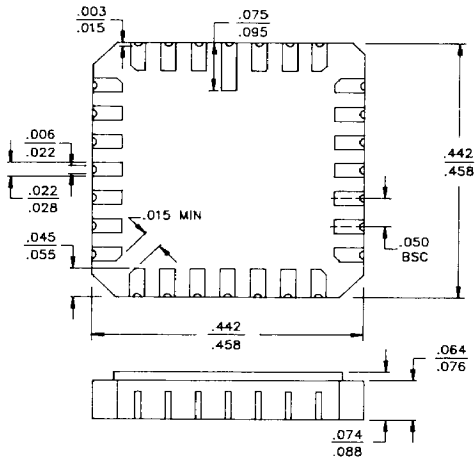
**28 PIN CERAMIC DIP**



**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-10

**28 PAD CERAMIC LCC**



**PAD MATERIAL:** Type C  
**PAD FINISH:** Type A  
**FINISH DIMENSION:** Type A  
**PACKAGE MATERIAL:** Multilayer Ceramic, 90% Alumina  
**PACKAGE SEAL:**  
 Material: Gold/Tin (80/20)  
 Temperature: 320°C ± 10°C  
 Method: Furnace Braze

**INTERNAL LEAD WIRE:**  
 Material: Aluminum  
 Diameter: 1.25 Mil  
 Bonding Method: Ultrasonic  
**COMPLIANT OUTLINE:** 38510 C-4

NOTE: All Dimensions are Min/Max. Dimensions are in inches.

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

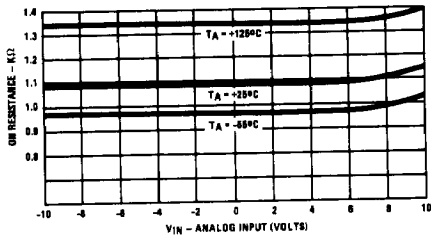
## DESIGN INFORMATION

## Single 16/Differential 8 Channel CMOS Analog Multiplexers With Active Overvoltage Protection

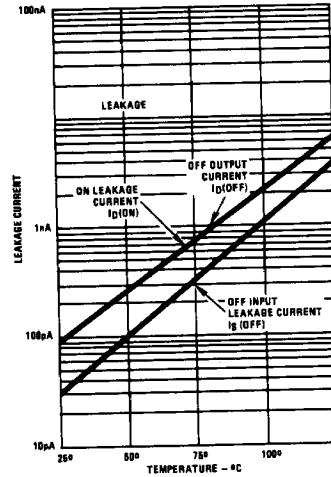
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design data only. No guarantee is implied.

**Typical Performance Characteristics** Unless Otherwise Specified:  $T_A = 25^\circ\text{C}$ ,  $V_{\text{SUPPLY}} = \pm 15\text{V}$ ,  $V_{\text{AH}} = +4\text{V}$ ,  $V_{\text{AL}} = 0.8\text{V}$ ,  $V_{\text{REF}} = \text{Open}$

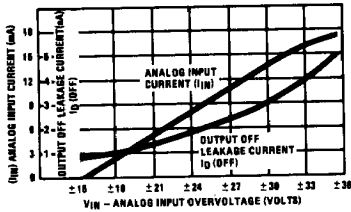
**ON RESISTANCE vs. ANALOG INPUT VOLTAGE**



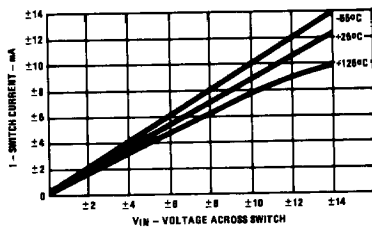
**LEAKAGE CURRENT vs. TEMPERATURE**



**ANALOG INPUT OVERVOLTAGE CHARACTERISTICS**



**ON CHANNEL CURRENT vs. VOLTAGE**



**SUPPLY CURRENT vs. TOGGLE FREQUENCY**

