

HI-546/883 HI-547/883

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

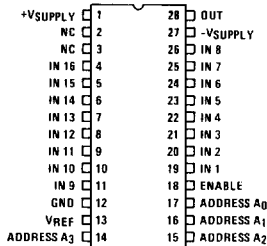
- Data Acquisition Systems
- Control Systems
- Telemetry

Description

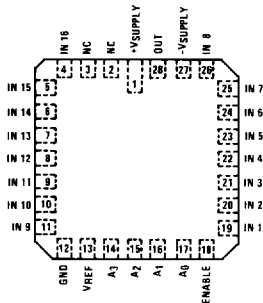
The HI-546/883 and HI-547/883 are analog multiplexers with Active Overvoltage Protection and guaranteed R_{ON} matching. Analog input levels may greatly exceed either power supply without damaging the device or disturbing the signal path of other channels. Active protection circuitry assures that signal 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 device. 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

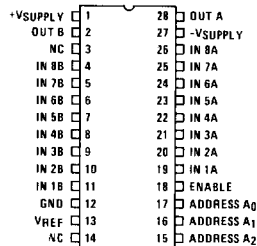
HI1-546/883 (CERAMIC DIP)
TOP VIEW



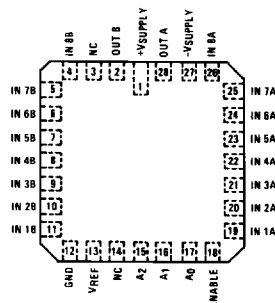
HI4-546/883 (CERAMIC LCC)
TOP VIEW



HI1-547/883 (CERAMIC DIP)
TOP VIEW

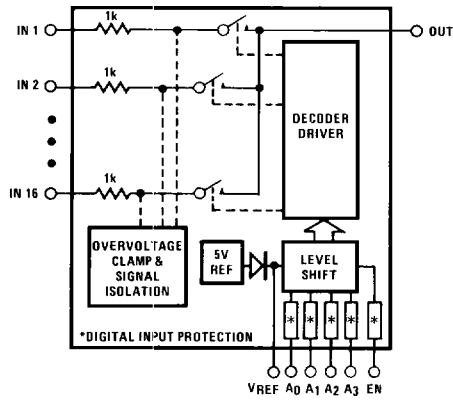


HI4-547/883 (CERAMIC LCC)
TOP VIEW



Functional Diagrams

HI-546/883

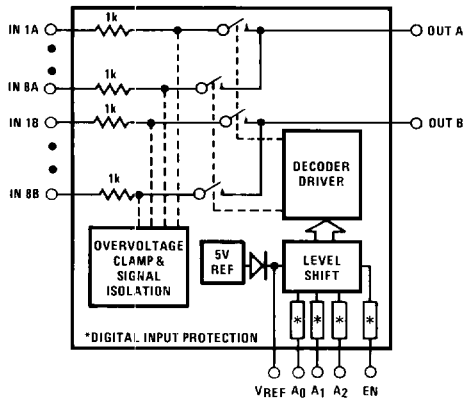


TRUTH TABLES

HI-546/883

A ₃	A ₂	A ₁	A ₀	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 ₂	A ₁	A ₀	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

Specifications HI-546/883 HI-547/883

Absolute Maximum Ratings

Voltage Between Supply Pins.....	44V	Junction Temperature.....	+175°C
+VSUPPLY to Ground.....	22V	Thermal Resistance, Junction-to-Case (θ_{JC})	
-VSUPPLY to Ground.....	25V	Ceramic DIP Package.....	18°C/W
Analog Input Voltage		Ceramic LCC Package.....	40°C/W
+VS.....	+VSUPPLY +20V	Thermal Resistance, Junction-to-Ambient (θ_{JA})	
-VS.....	-VSUPPLY -20V	Ceramic DIP Package.....	50°C/W
Digital Input Voltage		Ceramic LCC Package.....	81°C/W
+VEN, +VA.....	+VSUPPLY +4V	Power Dissipation	
-VEN, -VA.....	-VSUPPLY -4V	Ceramic DIP Package.....	2.0W
	or 20mA, whichever occurs first.	Ceramic LCC Package.....	1.23W
Continuous Current, S or D.....	20mA	Power Dissipation Derating Factor (Above +75°C)	
Peak Current, S or D		Ceramic DIP Package.....	20.0mW/°C
(Pulsed at 1ms, 10% Duty Cycle Max.).....	40mA	Ceramic LCC Package.....	12.3mW/°C
Storage Temperature Range.....	-65°C to +150°C	ESD Classification.....	≤2000V
Lead Temperature (Soldering 10 Seconds).....	275°C		

Recommended Operating Conditions

Operating Temperature Range.....	-55°C to +125°C	Logic Low Level (VAL).....	0V to 0.8V
Operating Supply Voltage (\pm VSUPPLY).....	\pm 15V	Logic High Level (VAH).....	+4V to +VSUPPLY
Analog Input Voltage (VS).....	\pm VSUPPLY	Max RMS Current, S or D.....	8mA

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

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

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Leakage Current	I _{IH}	Measure Inputs Sequentially, Connect All Unused Inputs to GND	1, 2, 3	+25°C, +125°C, -55°C	-1.0	1.0	μA
	I _{IL}		1, 2, 3	+25°C, +125°C, -55°C	-1.0	1.0	μA
Leakage Current Into the Source Terminal of an "OFF" Switch	+IS(OFF)	VS = +10V, VD = -10V, VEN = 0.8V All Unused Inputs = -10V	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-50	+50	nA
	-IS(OFF)	VS = -10V, VD = +10V, VEN = 0.8V All Unused Inputs = +10V	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-50	+50	nA
Leakage Current Into the Drain Terminal of an "OFF" Switch	+ID(OFF)	VD = +10V, VEN = 0.8V All Unused Inputs = -10V HI-546/883 HI-547/883	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-300	+300	nA
	-ID(OFF)	VD = -10V, VEN = 0.8V All Unused Inputs = +10V HI-546/883 HI-547/883	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-300	+300	nA
Leakage Current From an "ON" Driver Into the Switch (Drain)	+ID(ON)	VIN (Selected Chan.) = VD = +10V VS = Unused Inputs = -10V HI-546/883 HI-547/883	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-300	+300	nA
	-ID(ON)	VIN (Selected Chan.) = VD = -10V VS = Unused Inputs = +10V HI-546/883 HI-547/883	1	+25°C	-10	+10	nA
			2, 3	+125°C, -55°C	-300	+300	nA
Overvoltage Protected, Leakage Current Into the Drain Terminal of an "OFF" Switch	ID(OFF) Overvoltage	VS = 33V, VD = 0V, VEN = 0.8V VS applied at ≤ 25% duty cycle	1, 2, 3	+25°C, +125°C, -55°C	-2.0	+2.0	μA
		VS = -33V, VD = 0V, VEN = 0.8V VS applied at ≤ 25% duty cycle	1, 2, 3	+25°C, +125°C, -55°C	-2.0	+2.0	μA
Positive Supply Current	I(+)	VA = 0V, VEN = 4.0V	1, 2, 3	+25°C, +125°C, -55°C		2.0	mA
Negative Supply Current	I(-)	VA = 0V, VEN = 4.0V	1, 2, 3	+25°C, +125°C, -55°C	-1.0		mA
Standby Positive Supply Current	+ISBY	VA = 0V, VEN = 0V	1, 2, 3	+25°C, +125°C, -55°C		2.0	mA
Standby Negative Supply Current	-ISBY	VA = 0V, VEN = 0V	1, 2, 3	+25°C, +125°C, -55°C	-1.0		mA
Switch "ON" Resistance	+RDS1	VS = 10V ID = 100μA	1	+25°C		1500	Ω
			2, 3	+125°C, -55°C		1800	Ω
	-RDS1	VS = -10V ID = -100μA	1	+25°C		1500	Ω
			2, 3	+125°C, -55°C		1800	Ω
Logic Level Voltage	VAL1	Notes 1, 2	1, 2, 3	+25°C, +125°C, -55°C		0.8	V
	VAH1	Notes 1, 2	1, 2, 3	+25°C, +125°C, -55°C	4.0		V
	VAL2	Note 3	1, 2, 3	+25°C, +125°C, -55°C		0.8	V
	VAH2	Note 3	1, 2, 3	+25°C, +125°C, -55°C	6.0		V
Difference in switch "ON" Resistance Between Channels	+ΔRDS1	$\frac{(+RDS1MAX) - (+RDS1MIN) \times 100}{+RDS1AVE}$	1	+25°C		7	%
	-ΔRDS1	$\frac{(-RDS1MAX) - (-RDS1MIN) \times 100}{-RDS1AVE}$	1	+25°C		7	%

CAUTION: These devices are sensitive to electrostatic discharge. Proper IC handling procedures should be followed.

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 _D	R _L = 1kΩ, C _L = 12.5pF	9	+25°C	25		ns
Propagation Delay Times: Address Inputs to I/O Channel Times	t _A	R _L = 10MΩ, C _L = 14pF	9	+25°C		500	ns
			10, 11	+125°C, -55°C		1000	ns
Enable to I/O	t _{ON(EN)}	R _L = 1kΩ, C _L = 12.5pF	9	+25°C		500	ns
			10, 11	+125°C, -55°C		1000	ns
	t _{OFF(EN)}	R _L = 1kΩ, C _L = 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 _A	V ₊ = V ₋ = 0V f = 1MHz	4	+25°C		12	pF
Capacitance: Output Switch	C _{OS}	V ₊ = V ₋ = 0V HI-546/883	4	+25°C		85	pF
		f = 1MHz HI-547/883	4	+25°C		50	pF
Capacitance Input Switch	C _{IS}	V ₊ = V ₋ = 0V f = 1MHz	4	+25°C		15	pF
Charge Transfer Error	V _{CTE}	V _S = GND V _{GEN} = 0V to 5V	4	+25°C		10	mV
Off Isolation	V _{ISO}	V _{EN} = 0.8V, R _L = 1kΩ C _L = 15pF, V _S = 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. V_{REF} = +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.

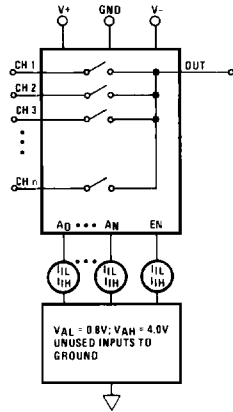
TABLE 4. ELECTRICAL TEST REQUIREMENTS

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

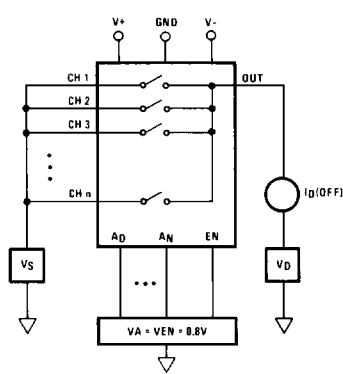
*PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

Test Circuits

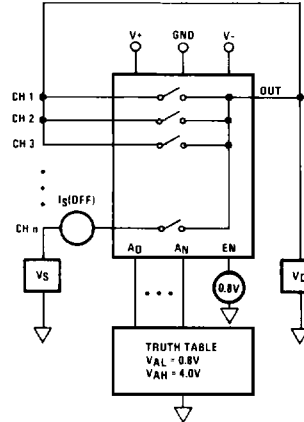
INPUT LEAKAGE CURRENT



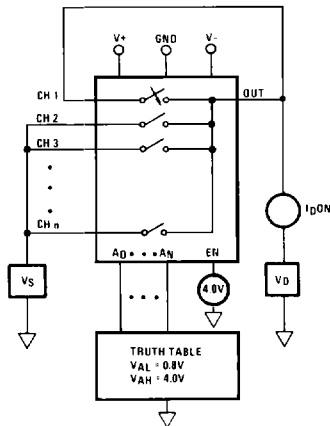
$I_D(OFF)$



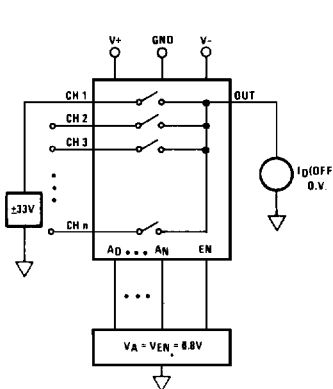
$I_S(OFF)$



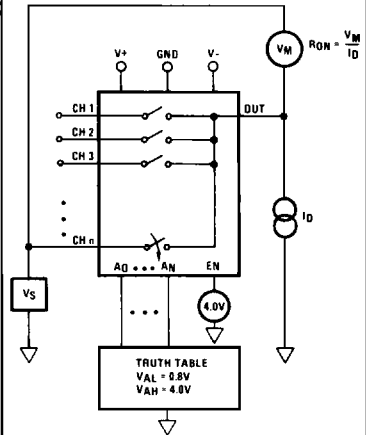
$I_D(ON)$



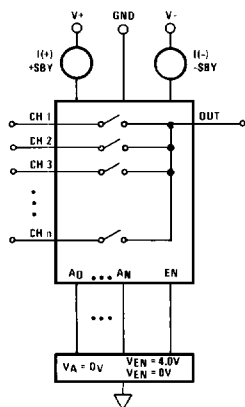
$I_D(OFF)$ OVERVOLTAGE



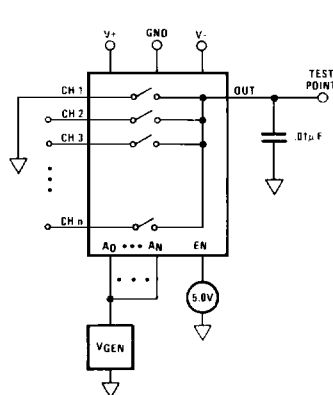
R_{DS}



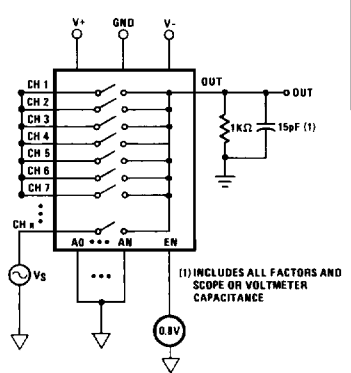
SUPPLY CURRENTS



CHARGE TRANSFER ERROR



OFF CHANNEL ISOLATION

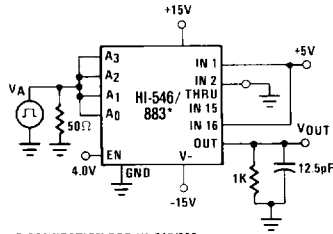
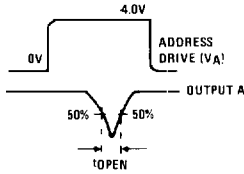


5

CMOS ANALOG
MULTIPLEXERS

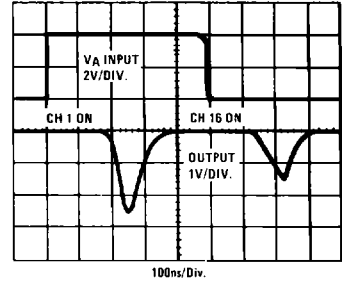
Switching Waveforms

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

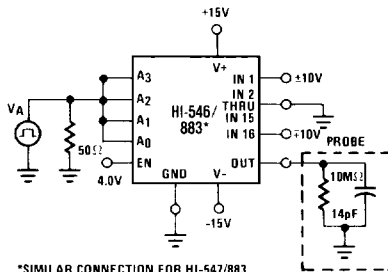
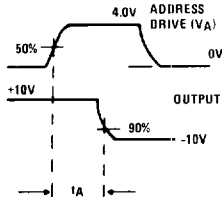


*SIMILAR CONNECTION FOR HI-547/883

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

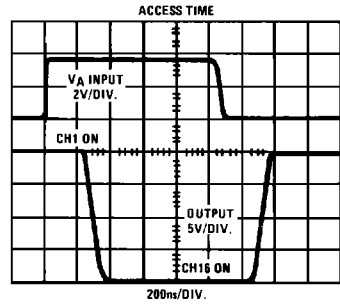


ACCESS TIME vs.
LOGIC LEVEL (HIGH)

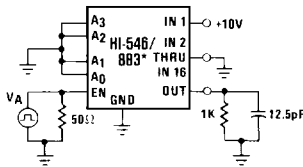
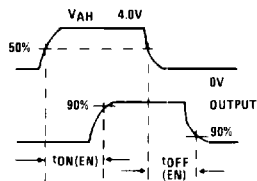


*SIMILAR CONNECTION FOR HI-547/883

ACCESS TIME

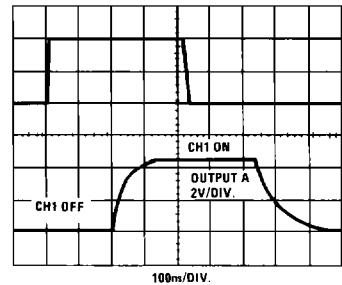


ENABLE DELAY
 $t_{ON}(EN)$, $t_{OFF}(EN)$



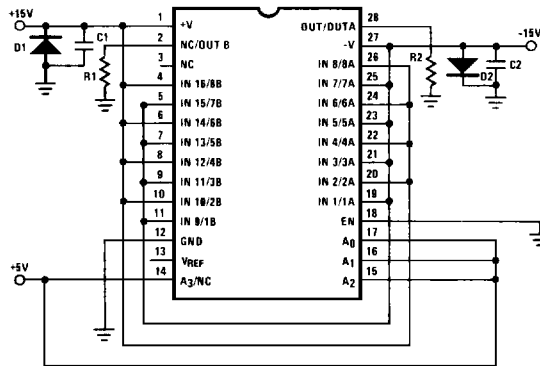
*SIMILAR CONNECTION FOR HI-547/883

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



Burn-In Circuits

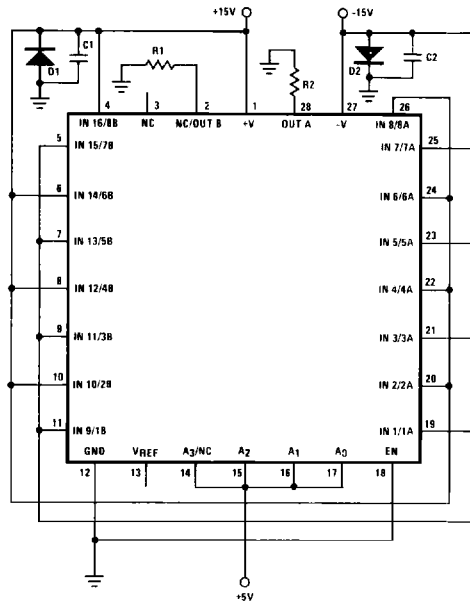
HI-546/883 HI-547/883 CERAMIC DIP



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

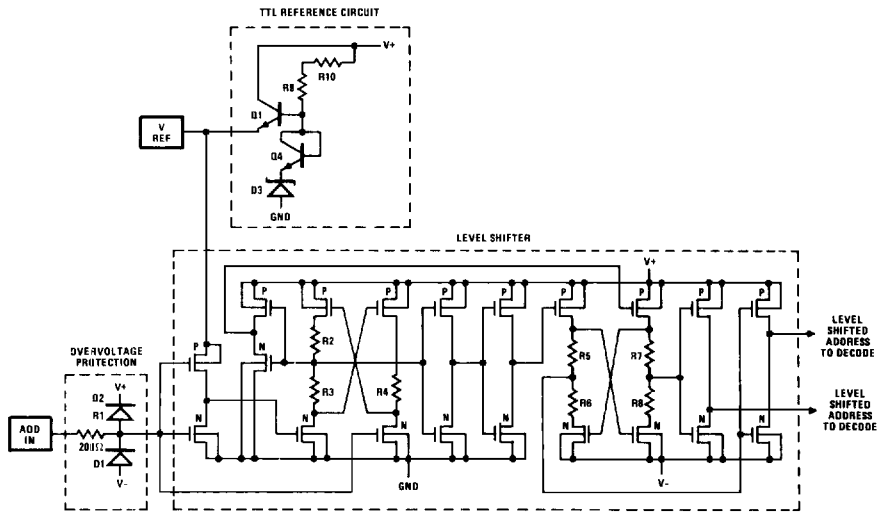


NOTES:

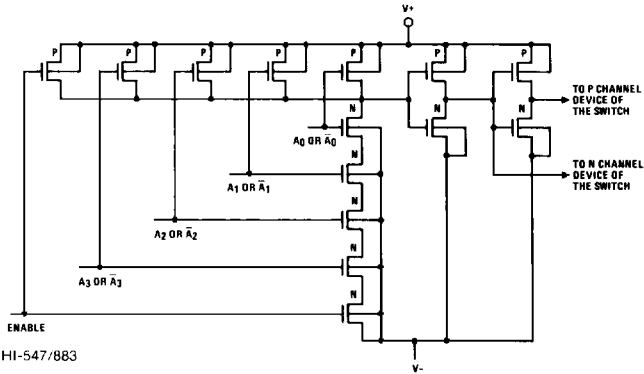
- R1, R2 = 10kΩ ± 5% 1/2 or 1/4W (per socket)
- C1, C2 = 0.01μF (per socket) or 0.1μF (per row)
- D1, D2 = IN4002 (or equivalent) (per board)

Schematic Diagrams

ADDRESS INPUT BUFFER AND LEVER SHIFTER

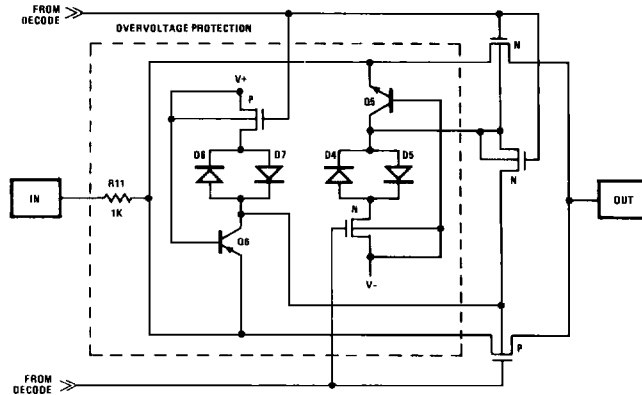


ADDRESS DECODER



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

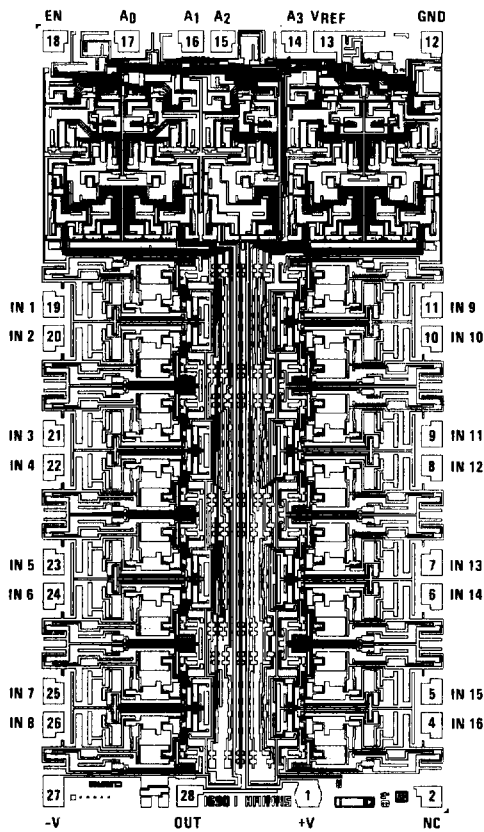
Material: Gold Silicon Eutectic Alloy

Temperature: Ceramic DIP — 460°C (Max)

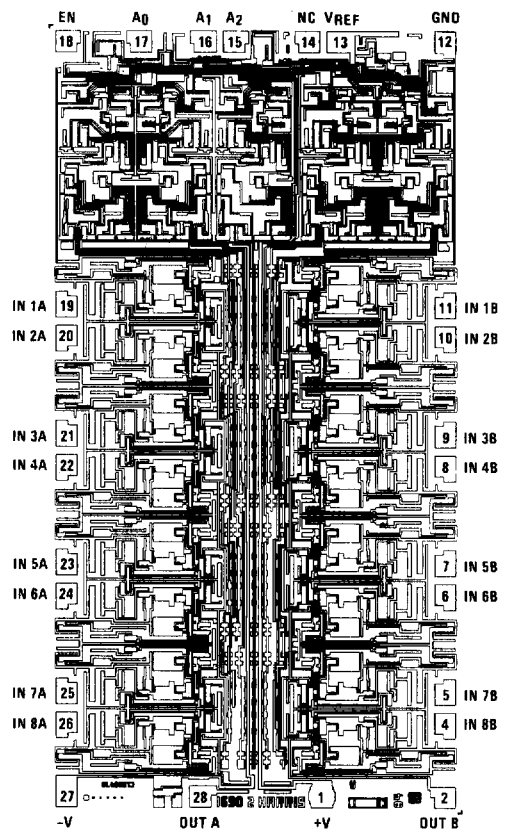
Ceramic LCC — 420°C (Max)

Metallization Mask Layout

HI-546/883

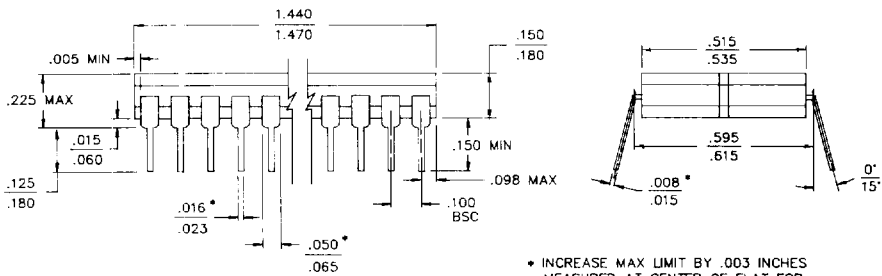


HI-547/883



Packaging†

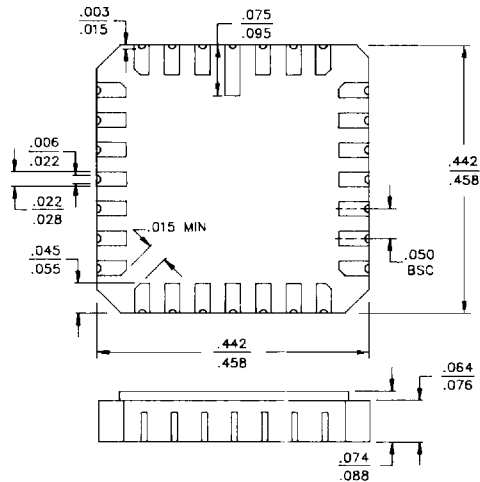
28 PIN CERAMIC DIP



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

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

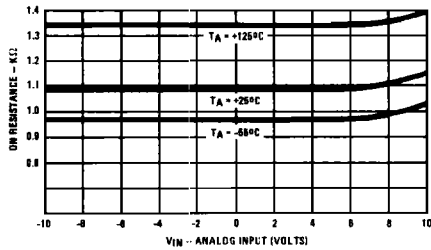
DESIGN INFORMATION

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

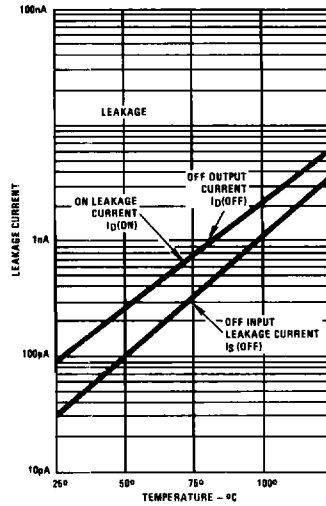
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design data only. No guarantee is implied.

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

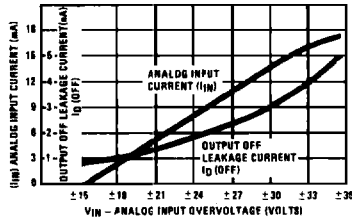
ON RESISTANCE vs. ANALOG INPUT VOLTAGE



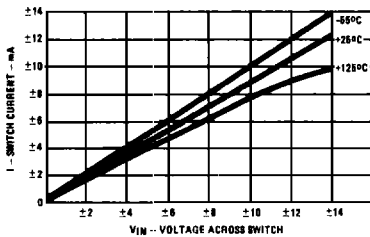
LEAKAGE CURRENT vs. TEMPERATURE



ANALOG INPUT OVERVOLTAGE CHARACTERISTICS



ON CHANNEL CURRENT vs. VOLTAGE



SUPPLY CURRENT vs. TOGGLE FREQUENCY

