HARRIS

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 ..... ±15V**
- **Access Time (Max.) 1.0μs**
- **Power Dissipation (Max.) 45mW**

Applications

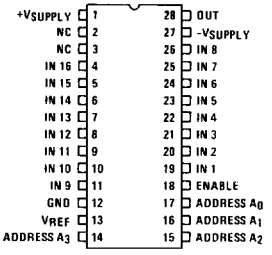
- **Data Acquisition Systems**
- **Control Systems**
- **Telemetry**

Description

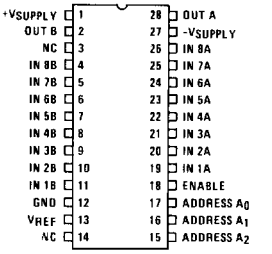
The HI-546/883 and HI-547/883 are analog multiplexers with Active Overvoltage Protection and guaranteed R_{ON} matching. Analog input levels may greatly exceed either power supply without damaging the device or disturbing the signal path of other channels. Active protection circuitry assures that signal fidelity is maintained even under fault conditions that would destroy other multiplexers. Analog inputs can withstand constant 70 volt peak-to-peak levels with ±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 1kΩ 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

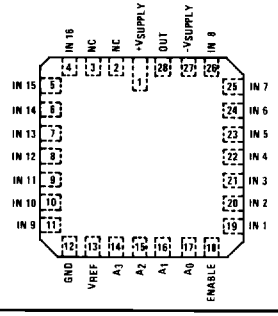
HI1-546/883 (CERAMIC DIP)
TOP VIEW



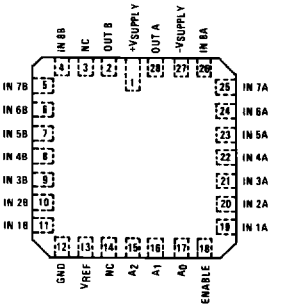
HI1-547/883 (CERAMIC DIP)
TOP VIEW



HI4-546/883 (CERAMIC LCC)
TOP VIEW



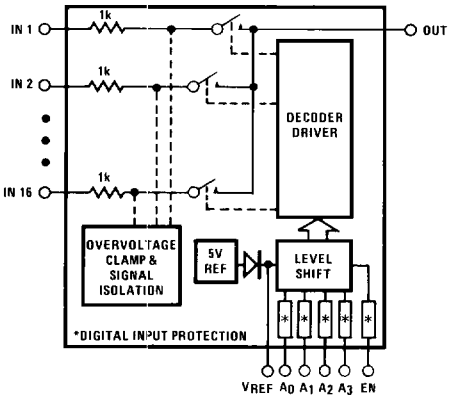
HI4-547/883 (CERAMIC LCC)
TOP VIEW



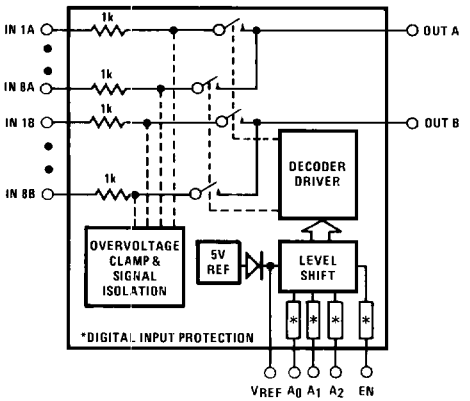
5 CMOS ANALOG MULTIPLEXERS

Functional Diagrams

HI-546/883



HI-547/883



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

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

Absolute Maximum Ratings

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

Recommended Operating Conditions

Operating Temperature Range ..... -55°C to +125°C
Operating Supply Voltage ($\pm V_{SUPPLY}$) ..... ±15V
Analog Input Voltage (V_S) ..... $\pm V_{SUPPLY}$
Logic Low Level (V_{AL}) ..... 0V to 0.8V
Logic High Level (V_{AH}) ..... +4V to $+V_{SUPPLY}$
Max RMS Current, S or D 8mA

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Devices Tested at $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, V_{EN} = 4.0V, V_{REF} (Pin 13) = OPEN, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Input Leakage Current	I_{IH}	Measure Inputs Sequentially,	1, 2, 3	+25°C, +125°C, -55°C	-1.0	1.0	µA
	I_{IL}	Connect All Unused Inputs to GND	1, 2, 3	+25°C, +125°C, -55°C	-1.0	1.0	µA
Leakage Current Into the Source Terminal of an "OFF" Switch	$+I_{S(OFF)}$	V_S = +10V, V_D = -10V, V_{EN} = 0.8V	1	+25°C	-10	+10	nA
		All Unused Inputs = -10V	2, 3	+125°C, -55°C	-50	+50	nA
	$-I_{S(OFF)}$	V_S = -10V, V_D = +10V, V_{EN} = 0.8V	1	+25°C	-10	+10	nA
		All Unused Inputs = +10V	2, 3	+125°C, -55°C	-50	+50	nA
Leakage Current Into the Drain Terminal of an "OFF" Switch	$+I_{D(OFF)}$	V_D = +10V, V_{EN} = 0.8V	1	+25°C	-10	+10	nA
		All Unused Inputs = -10V HI-546/883	2, 3	+125°C, -55°C	-300	+300	nA
		HI-547/883	2, 3	+25°C, -55°C	-200	+200	nA
	$-I_{D(OFF)}$	V_D = -10V, V_{EN} = 0.8V	1	+25°C	-10	+10	nA
		All Unused Inputs = +10V HI-546/883	2, 3	+25°C, -55°C	-300	+300	nA
		HI-547/883	2, 3	+125°C, -55°C	-200	+200	nA
Leakage Current From an "ON" Driver Into the Switch (Drain)	$+I_{D(ON)}$	V_{IN} (Selected Chan.) = V_D = +10V	1	+25°C	-10	+10	nA
		V_S = Unused Inputs = -10V HI-546/883	2, 3	+125°C, -55°C	-300	+300	nA
		HI-547/883	2, 3	+125°C, -55°C	-200	+200	nA
	$-I_{D(ON)}$	V_{IN} (Selected Chan.) = V_D = -10V	1	+25°C	-10	+10	nA
		V_S = Unused Inputs = +10V HI-546/883	2, 3	+125°C, -55°C	-300	+300	nA
		HI-547/883	2, 3	+125°C, -55°C	-200	+200	nA
Overvoltage Protected, Leakage Current Into the Drain Terminal of an "OFF" Switch	$I_{D(OFF)}$ Overvoltage	V_S = 33V, V_D = 0V, V_{EN} = 0.8V	1, 2, 3	+25°C, +125°C, -55°C	-2.0	+2.0	µA
		V_S applied at ≤ 25% duty cycle					
		V_S = -33V, V_D = 0V, V_{EN} = 0.8V	1, 2, 3	+25°C, +125°C, -55°C	-2.0	+2.0	µA
		V_S applied at ≤ 25% duty cycle					
Positive Supply Current	I(+)	V_A = 0V, V_{EN} = 4.0V	1, 2, 3	+25°C, +125°C, -55°C		2.0	mA
Negative Supply Current	I(-)	V_A = 0V, V_{EN} = 4.0V	1, 2, 3	+25°C, +125°C, -55°C	-1.0		mA
Standby Positive Supply Current	$+I_{SBY}$	V_A = 0V, V_{EN} = 0V	1, 2, 3	+25°C, +125°C, -55°C		2.0	mA
Standby Negative Supply Current	$-I_{SBY}$	V_A = 0V, V_{EN} = 0V	1, 2, 3	+25°C, +125°C, -55°C	-1.0		mA
Switch "ON" Resistance	$+R_{DS1}$	V_S = 10V	1	+25°C		1500	Ω
		I_D = 100µA	2, 3	+125°C, -55°C		1800	Ω
	$-R_{DS1}$	V_S = -10V	1	+25°C		1500	Ω
		I_D = -100µA	2, 3	+125°C, -55°C		1800	Ω
Logic Level Voltage	V_{AL1}	Notes 1, 2	1, 2, 3	+25°C, +125°C, -55°C		0.8	V
	V_{AH1}	Notes 1, 2	1, 2, 3	+25°C, +125°C, -55°C	4.0		V
	V_{AL2}	Note 3	1, 2, 3	+25°C, +125°C, -55°C		0.8	V
	V_{AH2}	Note 3	1, 2, 3	+25°C, +125°C, -55°C	6.0		V
Difference in switch "ON" Resistance Between Channels	$+\Delta R_{DS1}$	$\frac{(+R_{DS1}MAX) - (+R_{DS1}MIN) \times 100}{+R_{DS1}AVE}$	1	+25°C		7	%
	$-\Delta R_{DS1}$	$\frac{(-R_{DS1}MAX) - (-R_{DS1}MIN) \times 100}{-R_{DS1}AVE}$	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 $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, V_{EN} = 4.0V, V_{REF} (Pin 13) = OPEN, Unless Otherwise Specified.

A.C. PARAMETER	SYMBOL	CONDITIONS	SUBGROUP	TEMP	LIMITS MIN	LIMITS MAX	UNITS
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 $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, V_{EN} = 4.0V, V_{REF} (Pin 13) = OPEN, Unless Otherwise Specified.

PARAMETER	SYMBOL	CONDITIONS	NOTE	TEMP	LIMITS MIN	LIMITS MAX	UNITS
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 characterizec 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.

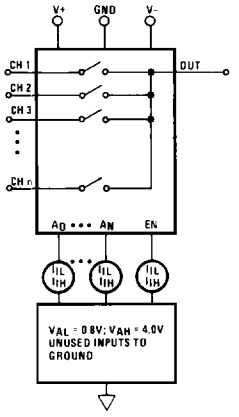
TABLE 4. ELECTRICAL TEST REQUIREMENTS

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

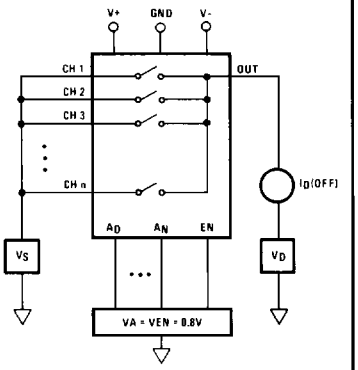
*PDA applies to Subgroup 1 only. No other subgroups are included in PDA.

Test Circuits

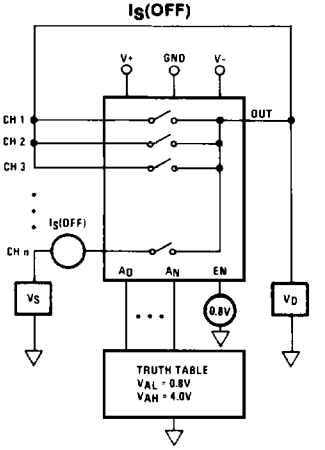
INPUT LEAKAGE CURRENT



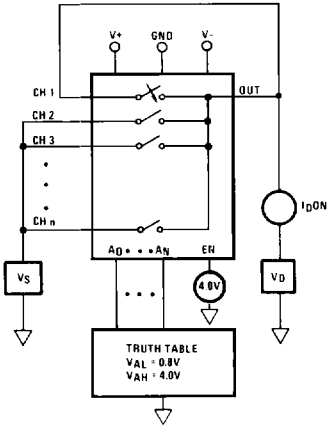
$I_{D(OFF)}$



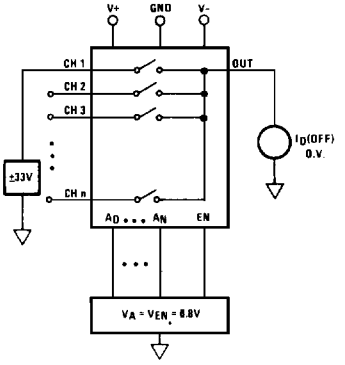
$I_{S(OFF)}$



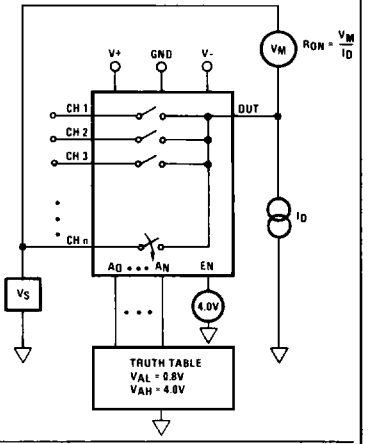
$I_{D(ON)}$



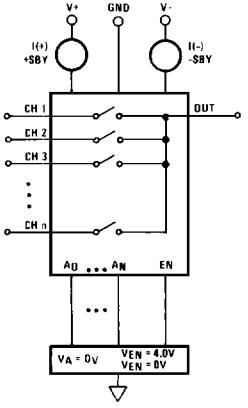
$I_{D(OFF)}$ OVERVOLTAGE



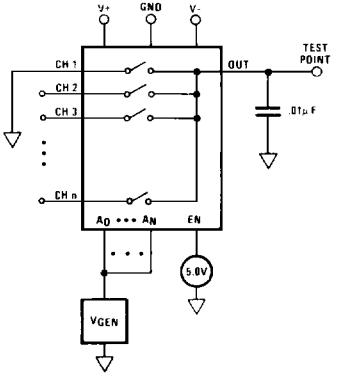
R_{DS}



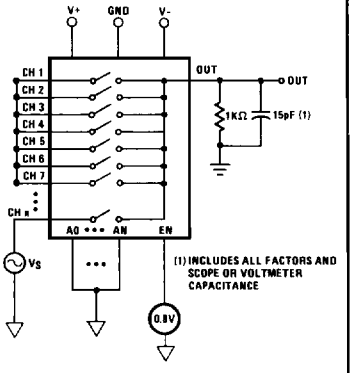
SUPPLY CURRENTS



CHARGE TRANSFER ERROR

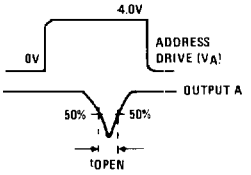


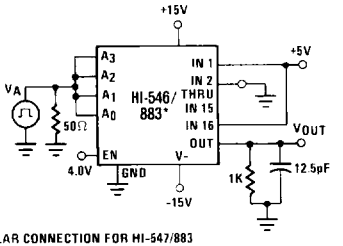
OFF CHANNEL ISOLATION



Switching Waveforms

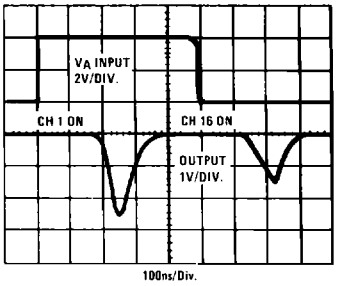
BREAK-BEFORE-MAKE DELAY (t_{OPEN})



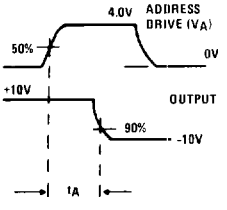


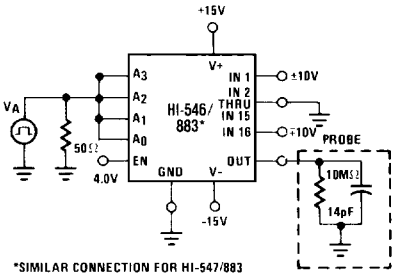
*SIMILAR CONNECTION FOR HI-547/883

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



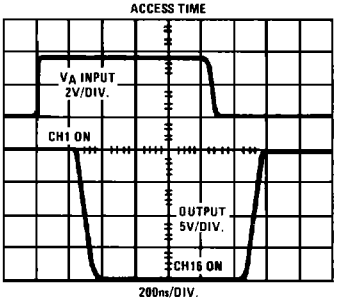
ACCESS TIME vs. LOGIC LEVEL (HIGH)



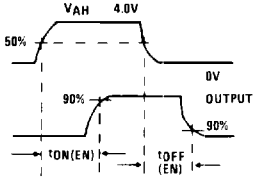


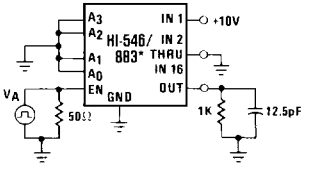
*SIMILAR CONNECTION FOR HI-547/883

ACCESS TIME



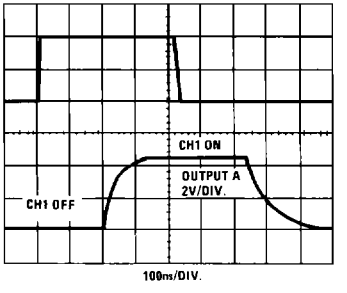
ENABLE DELAY $t_{ON(EN)}$, $t_{OFF(EN)}$





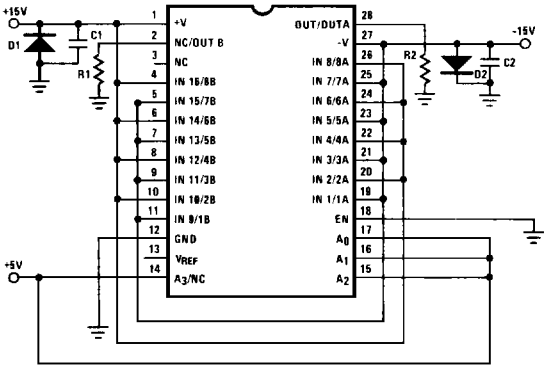
*SIMILAR CONNECTION FOR HI-547/883

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



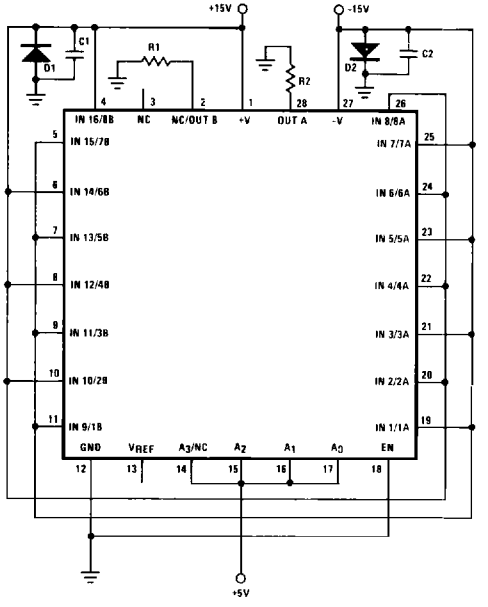
Burn-In Circuits

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)

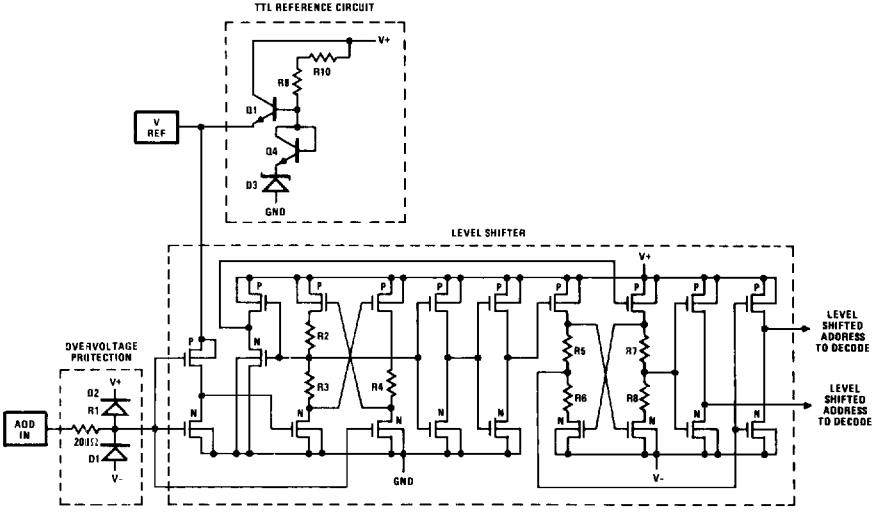
HI-546/883 HI-547/883 CERAMIC LCC



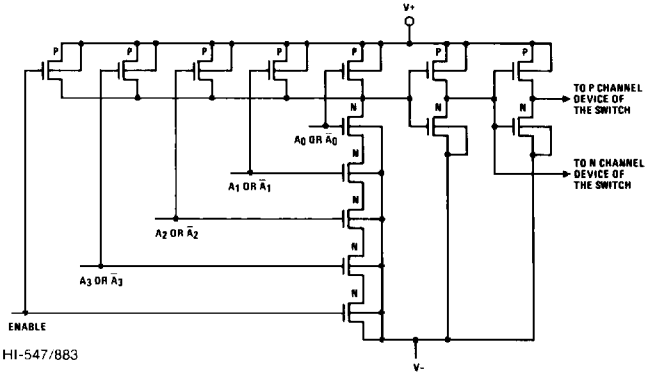
NOTES:
R1, R2 = 10kΩ ± 5% 1/2 or 1/4W (per socket)
C1, C2 = 0.01μF (per socket) or 0.1μF (per row)
D1, D2 = IN4002 (or equivalent) (per board)

Schematic Diagrams

ADDRESS INPUT BUFFER AND LEVER SHIFTER

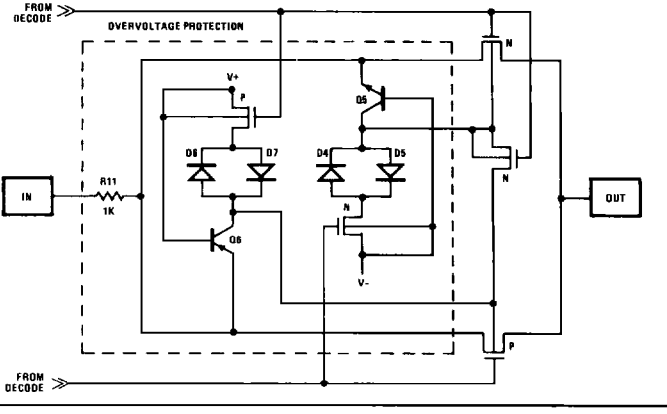


ADDRESS DECODER



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

MULTIPLEX SWITCH



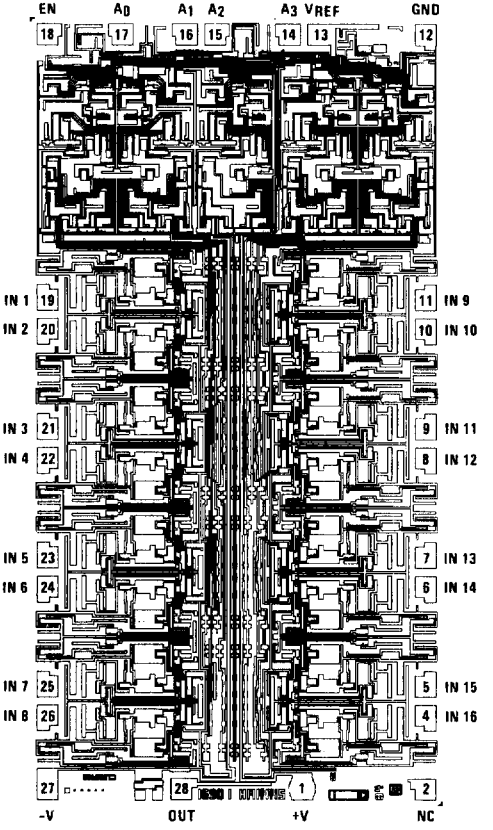
Die Characteristics

DIE DIMENSIONS: 83.9 x 159 x 19 mils
METALLIZATION
Type: Al
Thickness: 16kÅ ± 2kÅ
GLASSIVATION
Type: Nitride
Thickness: 7kÅ ± 0.7kÅ
WORST CASE CURRENT DENSITY: 1.4×10^5 A/cm^2

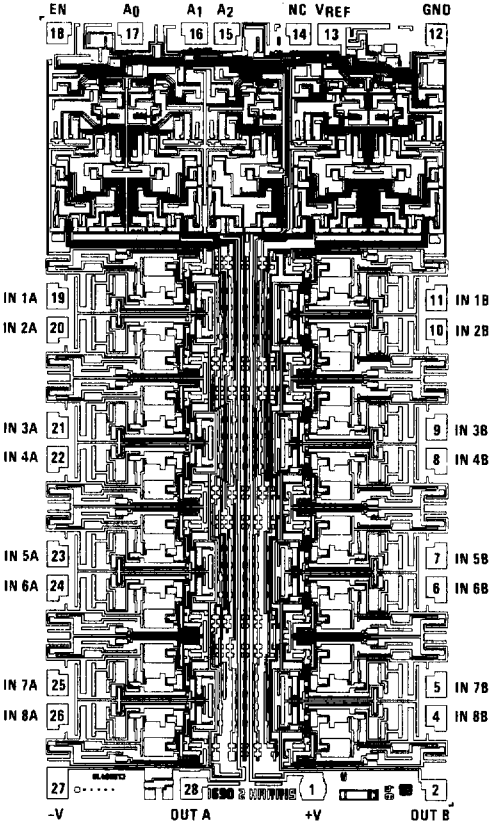
TRANSISTOR COUNT:
HI-546/883 485
HI-547/883 485
PROCESS: CMOS-DI
DIE ATTACH
Material: Gold Silicon Eutectic Alloy
Temperature: Ceramic DIP — 460°C (Max)
Ceramic LCC — 420°C (Max)

Metallization Mask Layout

HI-546/883



HI-547/883



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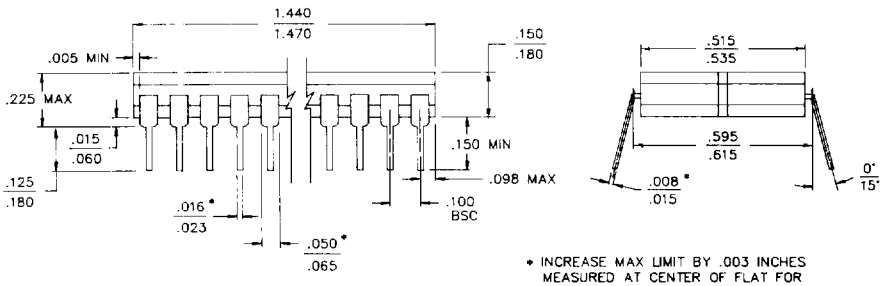
CMOS ANALOG MULTIPLEXERS

Packaging†

28 PIN CERAMIC DIP

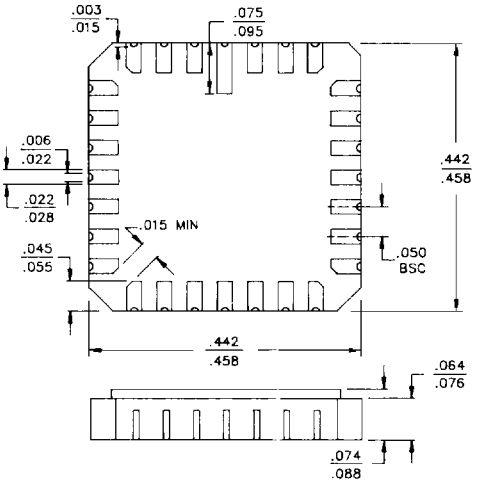


* INCREASE MAX LIMIT BY .003 INCHES MEASURED AT CENTER OF FLAT FOR SOLDER FINISH

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-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.

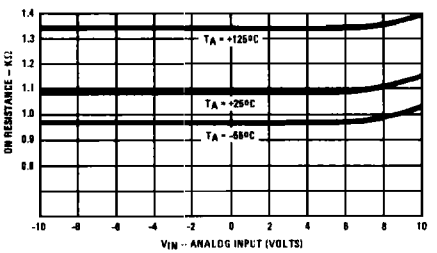
†Mil-M-38510 Compliant Materials, Finishes, and Dimensions.

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

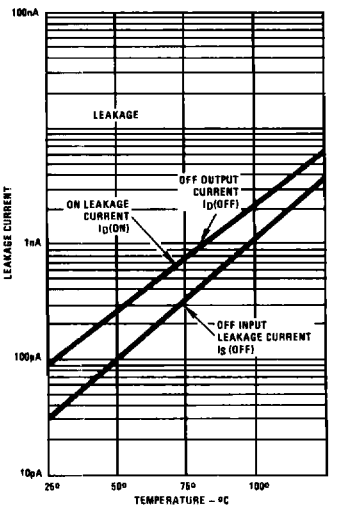
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design data only. No guarantee is implied.

Typical Performance Characteristics Unless Otherwise Specified: T_A = 25°C, V_{SUPPLY} = ±15V, V_{AH} = +4V, V_{AL} = 0.8V, V_{REF} = Open

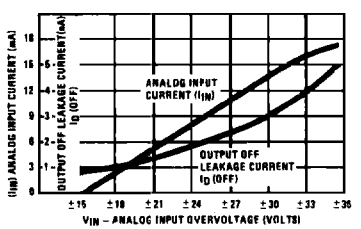
ON RESISTANCE vs. ANALOG INPUT VOLTAGE



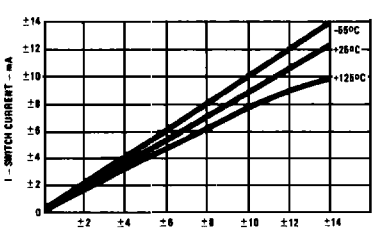
LEAKAGE CURRENT vs. TEMPERATURE



ANALOG INPUT OVERVOLTAGE CHARACTERISTICS



ON CHANNEL CURRENT vs. VOLTAGE



SUPPLY CURRENT vs. TOGGLE FREQUENCY