# HI-201/883

January 1989

## Quad SPST 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.**
- **Low "On" Resistance ..... 100Ω Max**
- **Wide Analog Signal Range ..... ±15V**
- **TTL/CMOS Compatible ..... 2.4V (Logic "1")**
- **Turn-On Time ..... 500ns**
- **Analog Current Range (Continuous) ..... 25mA**
- **No Latch-Up**
- **Replaces DG201**

### Applications

- **High Frequency Analog Switching**
- **Sample and Hold Circuits**
- **Digital Filters**
- **Op Amp Gain Switching Networks**

### Description

HI-201/883 is a monolithic device comprising four independently selectable SPST switches which feature fast switching speeds (185ns typical) combined with low power dissipation (15mW typical @ +25°C).

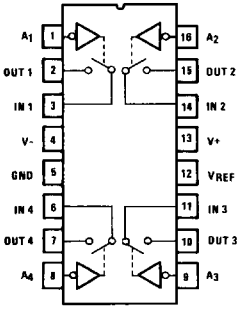
Each switch provides low "ON" resistance operation for input signal voltages up to the supply rails and for signal currents up to 25mA continuous. Rugged DI construction eliminates latch-up and substrate SCR failure modes.

All devices provide break-before-make switching and are TTL and CMOS compatible for maximum application versatility. HI-201/883 is an ideal component for use in high frequency analog switching. Typical applications include signal path switching, sample and hold circuits, digital filters, and op amp gain switching networks.

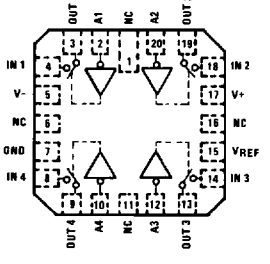
HI-201/883 is available in a 16 pin Ceramic DIP package and a 20 pin LCC package.

### Pinouts

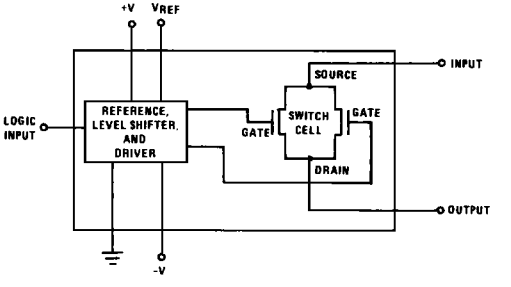
**HI-201/883 (CERAMIC DIP)**
TOP VIEW




**HI-201/883 (CERAMIC LCC)**
TOP VIEW




### Functional Diagram

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CMOS ANALOG SWITCHES

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals ..... 40V
$\pm V_{SUPPLY}$ to Ground (V+, V-) ..... ±20V
Analog Input Voltage $+V_S$ ..... $+V_{SUPPLY}$ +2V
$-V_S$ ..... $-V_{SUPPLY}$ -2V
Digital Input Voltage $+V_A$ ..... $+V_{SUPPLY}$ +4V
$-V_A$ ..... $-V_{SUPPLY}$ -4V
Peak Current (S or D)
(Pulse at 1ms, 10% Duty Cycle Max) ..... 40mA
Continuous Current Any Terminal (Except S or D) ..... 25mA
Junction Temperature ..... +175°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering 10 sec) ..... ≤275°C

## Thermal Information

| Thermal Resistance | $\theta_{ja}$ | $\theta_{jc}$ |
|---|---|---|
| Ceramic DIP Package | 86°C/W | 22°C/W |
| Ceramic LCC Package | 84°C/W | 24°C/W |

Package Power Dissipation at +75°C
Ceramic DIP Package ..... 0.88W
Ceramic LCC Package ..... 0.9W
Package Power Dissipation Derating Factor Above +75°C
Ceramic DIP Package ..... 11.76mW/°C
Ceramic LCC Package ..... 12.0mW/°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
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 ($V_{AH}$) ..... 2.4V to $+V_{SUPPLY}$

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

Device Tested at: $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, $V_{REF}$ = OPEN, GND = 0V, Unless Otherwise Specified

| D.C. PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Switch "ON" Resistance | $R_{DS}$ | $V_A$ = 0.8V, $V_S$ = 10V, $I_D$ = -1mA All Unused Channels $V_A$ = 2.4V | 1 | +25°C | - | 70 | Ω |
| | | | 2, 3 | -55°C to +125°C | - | 100 | Ω |
| | | $V_A$ = 0.8V, $V_S$ = -10V, $I_D$ = 1mA All Unused Channels $V_A$ = 2.4V | 1 | +25°C | - | 70 | Ω |
| | | | 2, 3 | -55°C to +125°C | - | 100 | Ω |
| Source "OFF" Leakage Current | $I_{S(OFF)}$ | $V_S$ = +14V, $V_D$ = -14V, $V_A$ = 2.4V All Unused Channels $V_A$ = 2.4V, $V_D$ = +14V, $V_S$ = -14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -100 | 100 | nA |
| | | $V_S$ = -14V, $V_D$ = +14V, $V_A$ = 2.4V All Unused Channels $V_A$ = 2.4V, $V_D$ = -14V, $V_S$ = +14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -100 | 100 | nA |
| Drain "OFF" Leakage Current | $I_{D(OFF)}$ | $V_D$ = -14V, $V_S$ = +14V, $V_A$ = 2.4V All Unused Channels $V_A$ = 2.4V, $V_D$ = +14V, $V_S$ = -14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -100 | 100 | nA |
| | | $V_D$ = +14V, $V_S$ = -14V, $V_A$ = 2.4V All Unused Channels $V_A$ = 2.4V, $V_D$ = -14V, $V_S$ = +14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -100 | 100 | nA |
| Channel "ON" Leakage Current | $I_{D(ON)}$ | $V_D$ = $V_S$ = +14V, $V_A$ = 0.8V All Unused Channels $V_A$ = 0.8V, $V_D$ = $V_S$ = -14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -100 | 100 | nA |
| | | $V_D$ = $V_S$ = -14V, $V_A$ = 0.8V All Unused Channels $V_A$ = 0.8V, $V_D$ = $V_S$ = +14V | 1 | +25°C | -2 | 2 | nA |
| | | | 2, 3 | -55°C to +125°C | -200 | 200 | nA |
| Low Level Input Current | $I_{AL}$ | $V_{AL}$ = 0.8V All Unused Channels $V_A$ = 2.4V | 1 | +25°C | -0.5 | 0.5 | µA |
| | | | 2, 3 | -55°C to +125°C | -1.0 | 1.0 | µA |
| High Level Input Current | $I_{AH}$ | $V_{AH}$ = 2.4V and 15V All Unused Channels $V_A$ = 2.4V | 1 | +25°C | -0.5 | 0.5 | µA |
| | | | 2, 3 | -55°C to +125°C | -1.0 | 1.0 | µA |
| Supply Current | $+I_{CC}$ | All Channels $V_A$ = 0.8V | 1, 2 | +25°C, +125°C | - | 1.5 | mA |
| | | | 3 | -55°C | - | 2.0 | mA |
| | | All Channels $V_A$ = 2.4V | 1, 2 | +25°C, +125°C | - | 1.5 | mA |
| | | | 3 | -55°C | - | 2.0 | mA |
| Supply Current | $-I_{CC}$ | All Channels $V_A$ = 0.8V | 1, 2 | +25°C, +125°C | -1.5 | - | mA |
| | | | 3 | -55°C | -2.0 | - | mA |
| | | All Channels $V_A$ = 2.4V | 1, 2 | +25°C, +125°C | -1.5 | - | mA |
| | | | 3 | -55°C | -2.0 | - | mA |

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

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

Device Tested at: $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, $V_{REF}$ = OPEN, GND = 0V, Unless Otherwise Specified

| PARAMETERS | SYMBOL | CONDITIONS | GROUP A SUBGROUPS | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Turn "ON" Time | $t_{(ON)}$ | $C_L$ = 100pF, $R_L$ = 1kΩ | 9 | +25°C | - | 600 | ns |
| | | | 10, 11 | -55°C, +125°C | - | 800 | ns |
| Turn "OFF" Time | $t_{(OFF)}$ | $C_L$ = 100pF, $R_L$ = 1kΩ | 9 | +25°C | - | 500 | ns |
| | | | 10, 11 | -55°C, +125°C | - | 650 | ns |

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

Device Characterized at: $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, $V_{REF}$ = OPEN, GND = 0V

| PARAMETERS | SYMBOL | CONDITIONS | NOTE | TEMPERATURE | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Address Capacitance | $C_A$ | f= 1MHz, $V_{AL}$ = 0V | 1 | +25°C | - | 15 | pF |
| Switch Input Capacitance | $C_{S(OFF)}$ | f = 1MHz, $V_{AH}$ = 5V Measure Input to Ground | 1 | +25°C | - | 15 | pF |
| Switch Output Capacitance | $C_{D(OFF)}$ | f = 1MHz, $V_{AH}$ = 5V Measure Output to Ground | 1 | +25°C | - | 20 | pF |
| | $C_{D(ON)}$ | f = 1MHz, $V_{AL}$ = 0V Measure Output to Ground | 1 | +25°C | - | 30 | pF |
| Drain to Source Capacitance | $C_{DS}$ | f = 1MHz, $V_{AH}$ = 5V | 1 | +25°C | - | 2.0 | pF |
| Off Isolation | $V_{ISO}$ | f = 200kHz, $V_A$ = 2.4, $R_L$ = 1K $V_{GEN}$ = $1V_{p-p}$, $C_L$ = 10pF | 1 | +25°C | 55 | - | dB |
| Crosstalk | $V_{CT}$ | f = 200kHz, $V_A$ = 2.4, $R_L$ = 1K $V_{GEN}$ = $1V_{p-p}$, $C_L$ = 10pF | 1 | +25°C | 60 | - | dB |
| Charge Transfer Error | $V_{CTE}$ | f = 200kHz, $V_A$ = 0 to 4V $C_L$ = 0.01µF | 1 | +25°C | -10 | 10 | 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.

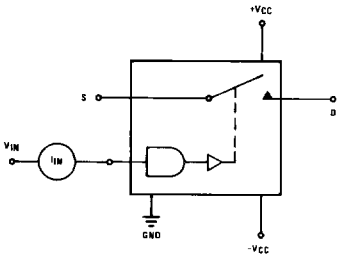
**TABLE 4. ELECTRICAL TEST REQUIREMENTS**

| 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 |

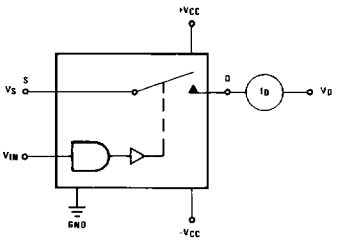
* PDA applies to Subgroup 1 only.

## Test Circuits

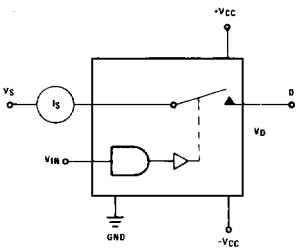
### INPUT LEAKAGE CURRENT



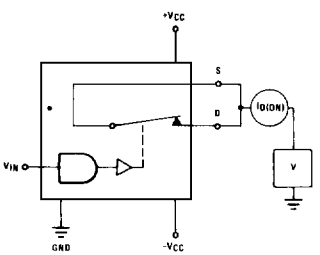

### $I_{D(OFF)}$



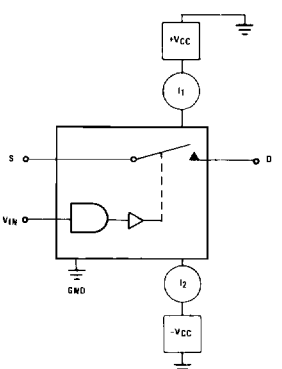

### $I_{S(OFF)}$



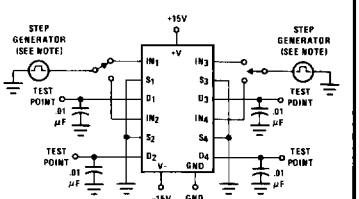

### $I_{D(ON)}$



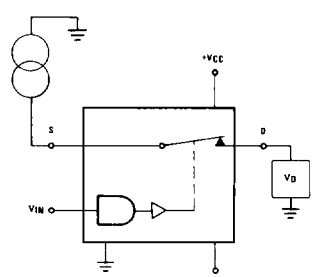

### SUPPLY CURRENTS



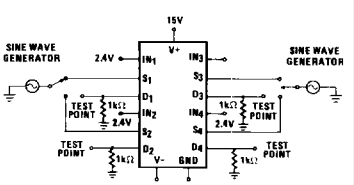

### CHARGE TRANSFER ERROR



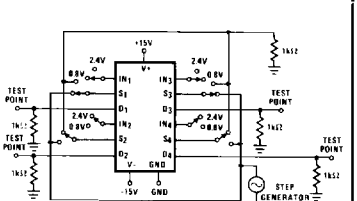

### $R_{DS}$




### OFF CHANNEL ISOLATION

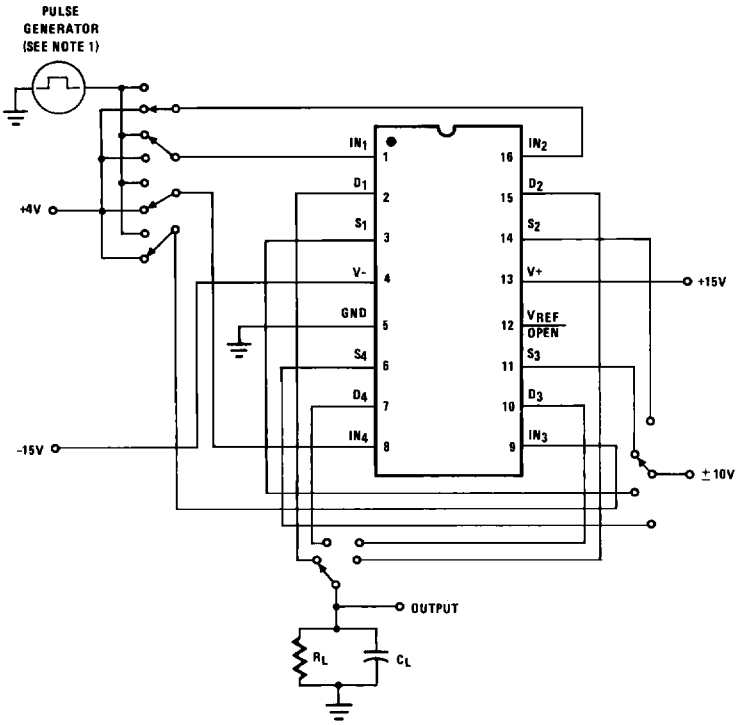


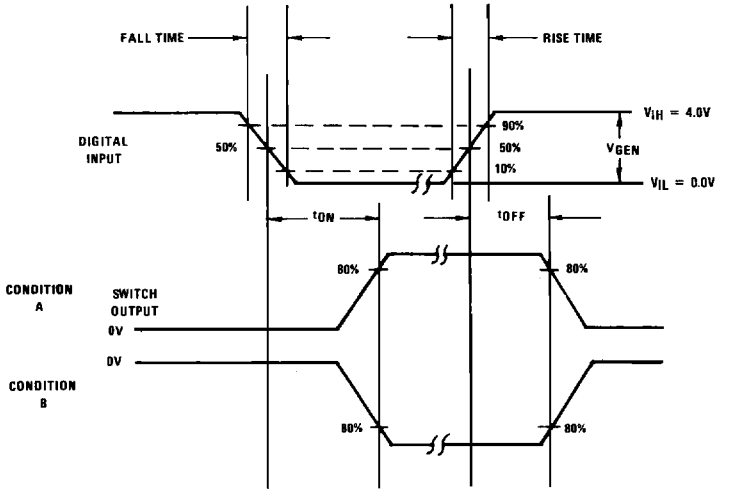

### CROSSTALK BETWEEN CHANNELS




For Detail Information Refer to HI-201/883 Test Tech Brief

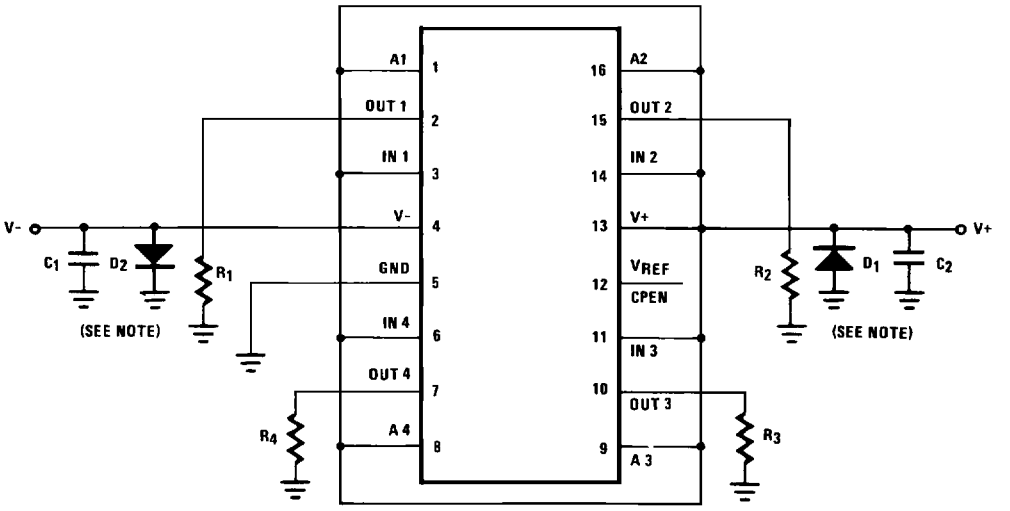
## Switching Waveforms



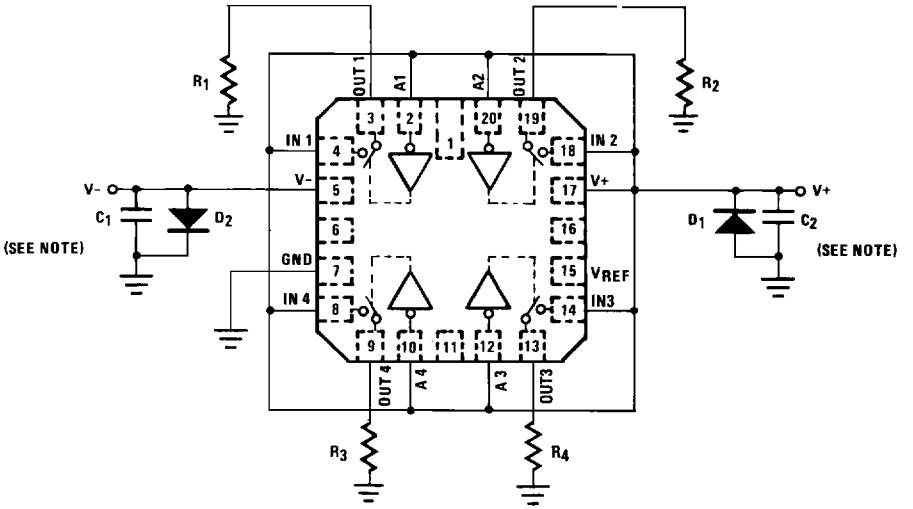



## Burn-In Circuits

HI-201/883 CERAMIC DIP




HI-201/883 CERAMIC LCC




NOTES:

$R_1 = R_2 = R_3 = R_4 = 10k\Omega$

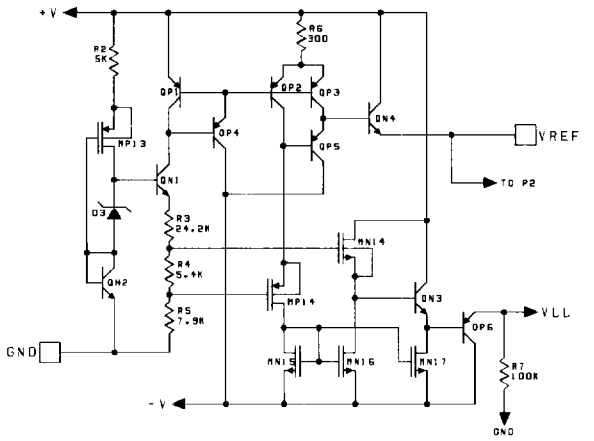
$C_1 = C_2 = 0.01\mu F$ (per socket) or $0.1\mu F$ (per row)

$D_1 = D_2$ = IN4002 or Equivalent/Board

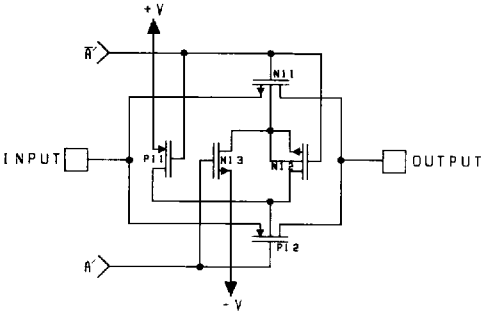
$|(V+) + (V-)| = 30V$

## Schematic Diagrams

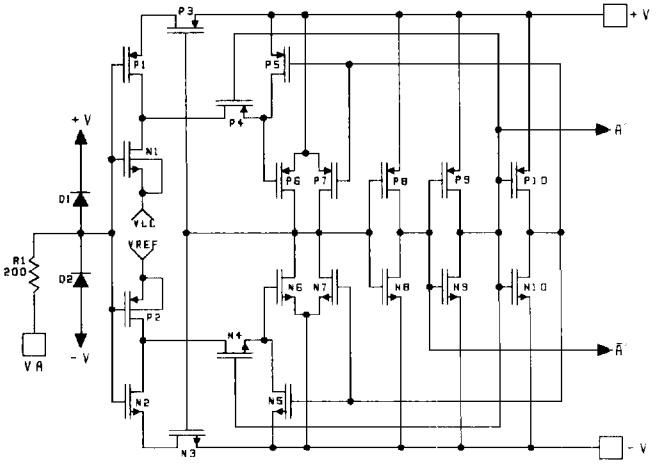
### TTL/CMOS REFERENCE CIRCUIT




### SWITCH CELL




### DIGITAL INPUT BUFFER AND LEVEL SHIFTER



## Die Characteristics

**DIE DIMENSIONS:**
81 x 85 x 19 mils

**METALLIZATION:**
Type: Aluminum
Thickness: 16kÅ ± 2kÅ

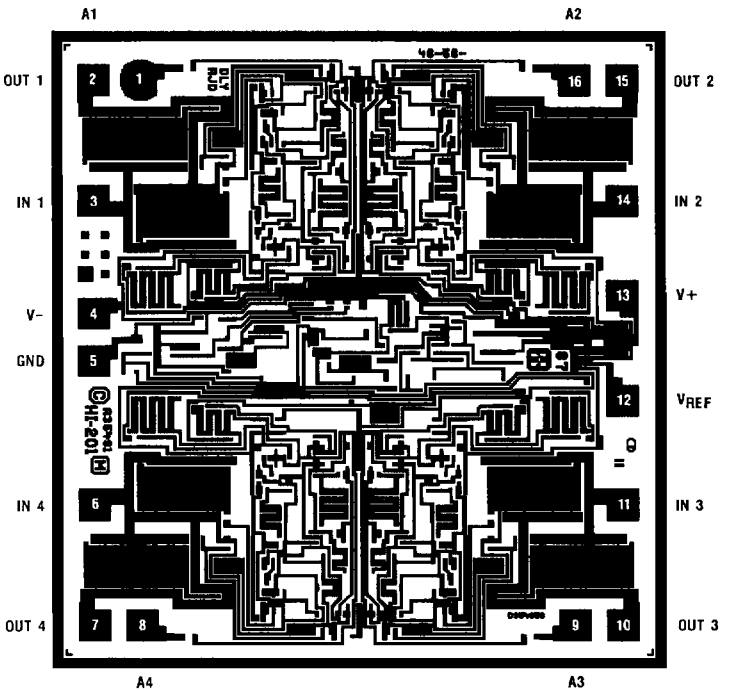
**GLASSIVATION:**
Type: Nitride over Silox
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1kÅ

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

**WORST CASE CURRENT DENSITY:**
$2 \times 10^5 A/cm^2$ at 25mA

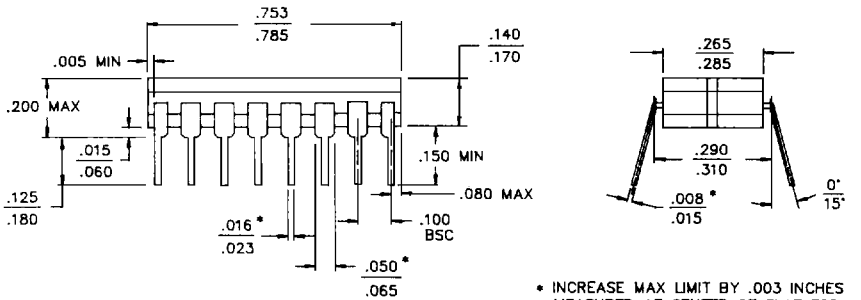
## Metallization Mask Layout

H1-201/883



## Packaging†

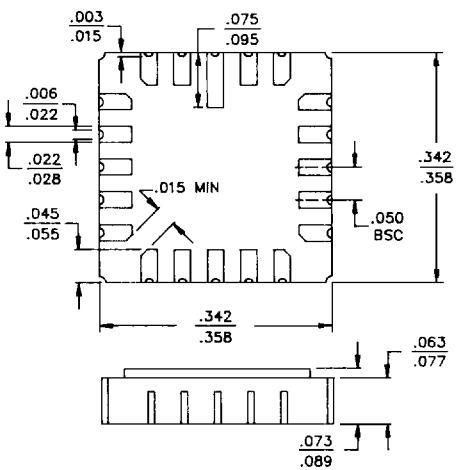
**16 PIN CERAMIC DIP**




**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-2

**20 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-2

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

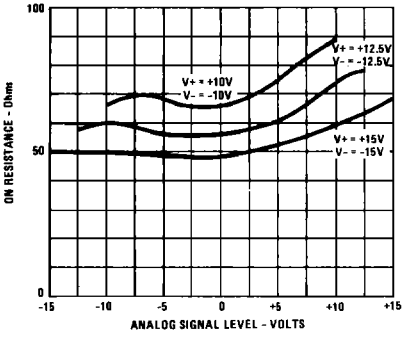
†Mil-M-38510 Compliant Materials, Finishes, and Dimensions.

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

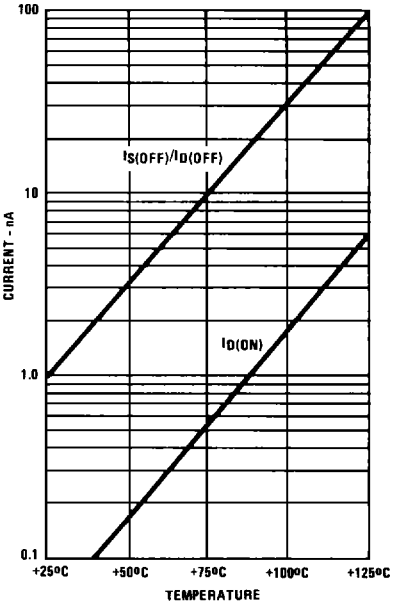
## *Typical Performance Characteristics*

Unless Otherwise Specified: $T_A = +25^oC$, $V_{SUPPLY} = \pm15V$ $V_{AH} = 2.4V$, $V_{AL} = 0.8V$, $V_{REF}$ = Open

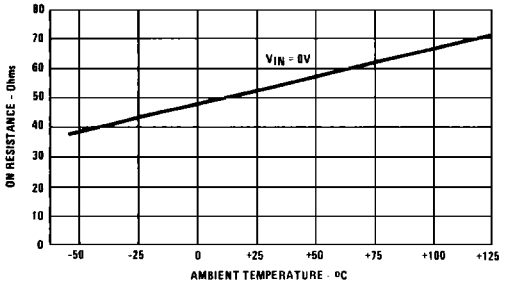
**ON RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE**



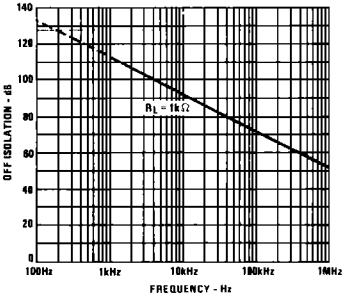

**LEAKAGE CURRENT vs. TEMPERATURE**




**ON RESISTANCE vs. TEMPERATURE**




**OFF ISOLATION vs. FREQUENCY**




**SWITCH CURRENT vs. VOLAGE**