Data Sheet | April 6, 2005 | FN3121.8

## Dual/Quad SPST, CMOS Analog Switches

HI-200/HI-201 (dual/quad) are monolithic devices comprising independently selectable SPST switches which feature fast switching speeds (HI-200 240ns, and HI-201 185ns) combined with low power dissipation (15mW at 25$^{O}$C). Each switch provides low "ON" resistance operation for input signal voltage up to the supply rails and for signal current up to 80mA. 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-200/HI-201 are ideal components for use in high frequency analog switching. Typical applications include signal path switching, sample and hold circuit, digital filters, and operational amplifier gain switching networks.

## Ordering Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE | PKG. DWG. # |
|---|---|---|---|
| HI3-0200-5Z (Note) | 0 to 75 | 14 Ld PDIP* (Pb-free) | E14.3 |
| HI1-0201-2 | -55 to 125 | 16 Ld CERDIP | F16.3 |
| HI1-0201-4 | -25 to 85 | 16 Ld CERDIP | F16.3 |
| HI1-0201-5 | 0 to 75 | 16 Ld CERDIP | F16.3 |
| HI3-0201-5 | 0 to 75 | 16 Ld PDIP | E16.3 |
| HI3-0201-5Z (Note) | 0 to 75 | 16 Ld PDIP* (Pb-free) | E16.3 |
| HI4P0201-5 | 0 to 75 | 20 Ld PLCC | N20.35 |
| HI4P0201-5Z (Note) | 0 to 75 | 20 Ld PLCC (Pb-free) | N20.35 |
| HI9P0201-5 | 0 to 75 | 16 Ld SOIC | M16.15 |
| HI9P0201-5Z (Note) | 0 to 75 | 16 Ld SOIC (Pb-free) | M16.15 |
| HI9P0201-9 | -40 to 85 | 16 Ld SOIC | M16.15 |
| HI9P0201-9Z (Note) | -40 to 85 | 16 Ld SOIC (Pb-free) | M16.15 |

*Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in Reflow solder processing applications.

NOTE: Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020. Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in Reflow solder processing applications.

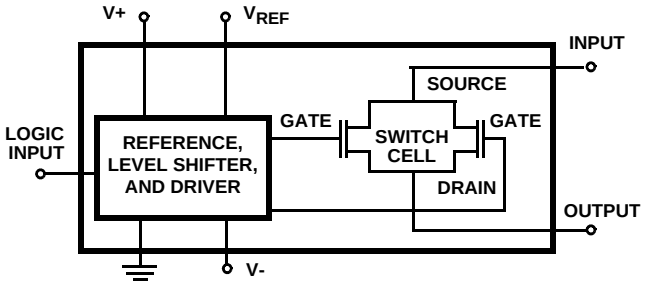
## Features

- Pb-Free Available (RoHS Compliant)
- Analog Voltage Range . . . . . ±15V
- Analog Current Range . . . . . 80mA
- Turn-On Time . . . . . 240ns
- Low $r_{ON}$ . . . . . 55Ω
- Low Power Dissipation . . . . . 15mW
- TTL/CMOS Compatible

## Applications

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

## Functional Diagram

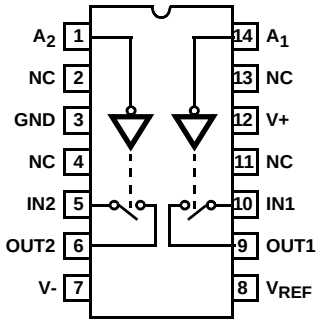



**TRUTH TABLE**

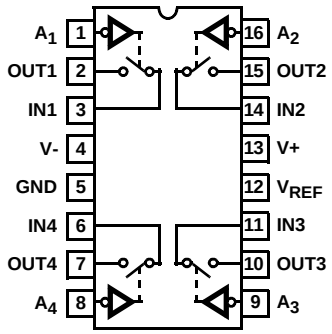
| LOGIC | HI-200 | HI-201 |
|---|---|---|
| 0 | ON | ON |
| 1 | OFF | OFF |

## Pinouts (Switches Shown For Logic “1” Input)

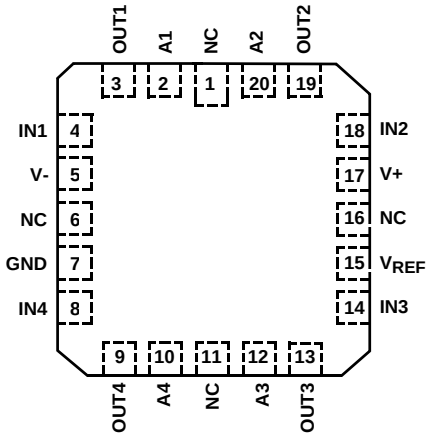
**HI-200 (PDIP)**
TOP VIEW




**HI-201 (CERDIP, PDIP, SOIC)**
TOP VIEW

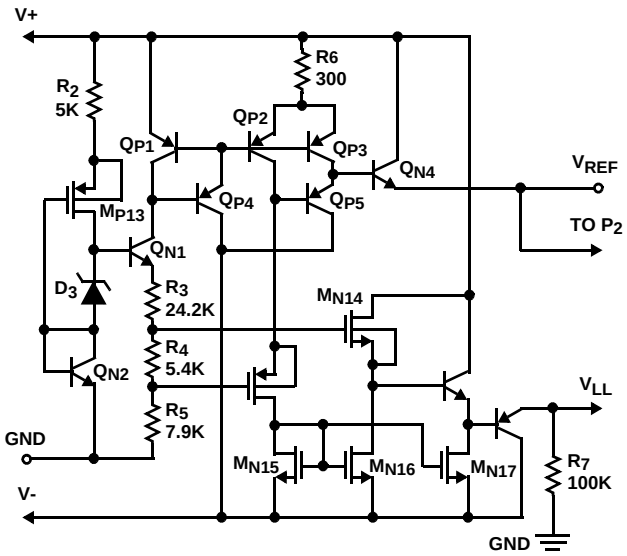



**HI-201 (PLCC)**
TOP VIEW

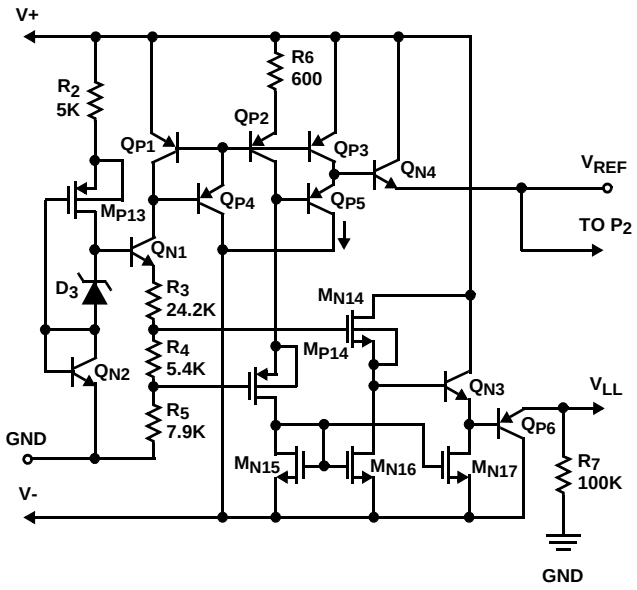



## Schematic Diagrams

**TTL/CMOS REFERENCE CIRCUIT $V_{REF}$ CELL**
**HI-200**

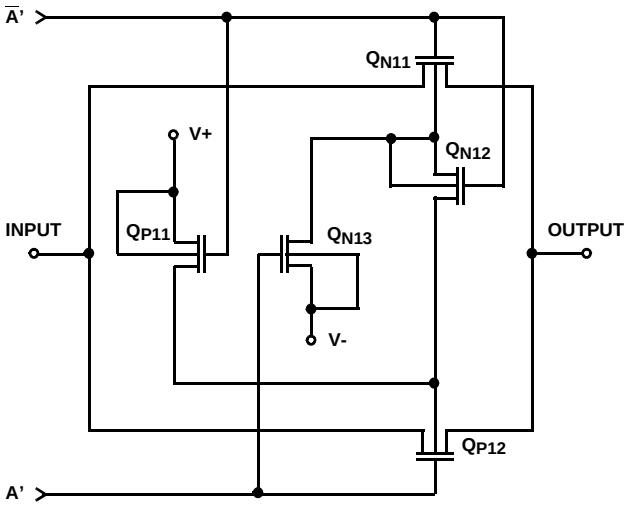



**TTL/CMOS REFERENCE CIRCUIT $V_{REF}$ CELL**
**HI-201**

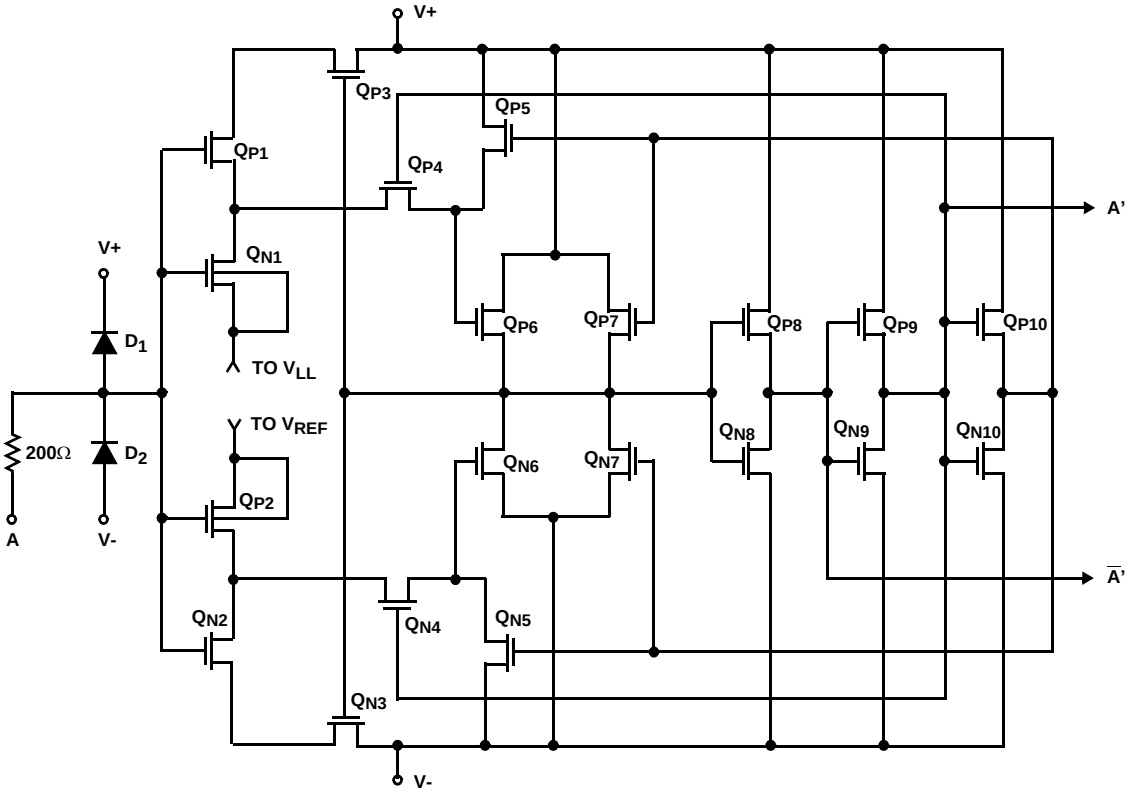


## Schematic Diagrams (Continued)

SWITCH CELL




DIGITAL INPUT BUFFER AND LEVEL SHIFTER



## Absolute Maximum Ratings

Supply Voltage (V+ to V-) . . . . . 44V (±22)
$V_{REF}$ to Ground . . . . . 20V, -5V
Digital Input Voltage . . . . . (V+) +4V to (V-) -4V
Analog Input Voltage (One Switch) . . . . . (V+) +2V to (V-) -2V

## Operating Conditions

Temperature Ranges
HI-201-2 . . . . . $-55^oC$ to $125^oC$
HI-201-4 . . . . . $-25^oC$ to $85^oC$
HI-200-5, HI-201-5 . . . . . $0^oC$ to $75^oC$
HI-201-9 . . . . . $-40^oC$ to $85^oC$

## Thermal Information

| Thermal Resistance (Typical, Note 1) | $\theta_{JA}$ ($^oC/W$) | $\theta_{JC}$ ($^oC/W$) |
|---|---|---|
| CERDIP Package | 75 | 20 |
| PLCC Package | 80 | N/A |
| PDIP Package* | 95 | N/A |
| SOIC Package | 110 | N/A |

Maximum Storage Temperature . . . . . $-65^oC$ to $150^oC$
Maximum Junction Temperature (Hermetic Packages) . . . . . $175^oC$
Maximum Junction Temperature (Plastic Packages) . . . . . $150^oC$
Maximum Lead Temperature (Soldering, 10s) . . . . . $300^oC$
(PLCC and SOIC - Lead Tips Only)

*Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in reflow solder processing applications.

*CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.*

NOTE:

1. $\theta_{JA}$ is measured with the component mounted on an evaluation PC board in free air.

## Electrical Specifications

Supplies = +15V, -15V; $V_{REF}$ = Open; $V_{AH}$ (Logic Level High) = 2.4V, VAL (Logic Level Low) = 0.8V

| PARAMETER | TEST CONDITIONS | TEMP ($^oC$) | -2 | | | -4, -5, -9 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| Switch ON Time, $t_{ON}$ | | | | | | | | | |
| HI-200 | | 25 | - | 240 | 500 | - | 240 | - | ns |
| HI-201 | | 25 | - | 185 | 500 | - | 185 | - | ns |
| | | Full | - | 1000 | - | - | 1000 | - | ns |
| Switch OFF Time, $t_{OFF}$ | | | | | | | | | |
| HI-200 | | 25 | - | 330 | 500 | - | 500 | - | ns |
| HI-201 | | 25 | - | 220 | 500 | - | 220 | - | ns |
| | | Full | - | 1000 | - | - | 1000 | - | ns |
| Off Isolation | (Note 4) | | | | | | | | |
| HI-200 | | 25 | - | 70 | - | - | 70 | - | dB |
| HI-201 | | 25 | - | 80 | - | - | 80 | - | dB |
| Input Switch Capacitance, $C_{S(OFF)}$ | | 25 | - | 5.5 | - | - | 5.5 | - | pF |
| Output Switch Capacitance, $C_{D(OFF)}$ | | 25 | - | 5.5 | - | - | 5.5 | - | pF |
| Output Switch Capacitance, $C_{D(ON)}$ | | 25 | - | 11 | - | - | 11 | - | pF |
| Digital Input Capacitance, $C_A$ | | 25 | - | 5 | - | - | 5 | - | pF |
| Drain-to-Source Capacitance, $C_{DS(OFF)}$ | | 25 | - | 0.5 | - | - | 0.5 | - | pF |
| **DIGITAL INPUT CHARACTERISTICS** | | | | | | | | | |
| Input Low Threshold, $V_{AL}$ | | Full | - | - | 0.8 | - | - | 0.8 | V |
| Input High Threshold, $V_{AH}$ | | Full | 2.4 | - | - | 2.4 | - | - | V |
| Input Leakage Current (High or Low), $I_A$ | (Note 3) | Full | - | - | 1.0 | - | - | 1.0 | µA |
| **ANALOG SWITCH CHARACTERISTICS** | | | | | | | | | |
| Analog Signal Range, $V_S$ | | Full | -15 | - | +15 | -15 | - | +15 | V |
| ON Resistance, $r_{ON}$ | (Note 2) | 25 | - | 55 | 70 | - | 55 | 80 | Ω |
| | | Full | - | 80 | 100 | - | 72 | 100 | Ω |

**Electrical Specifications** Supplies = +15V, -15V; $V_{REF}$ = Open; $V_{AH}$ (Logic Level High) = 2.4V, VAL (Logic Level Low) = 0.8V **(Continued)**

| PARAMETER | TEST CONDITIONS | TEMP ($^oC$) | -2 | | | -4, -5, -9 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| OFF Input Leakage Current, $I_{S(OFF)}$ | (Note 6) | 25 | - | 1 | 5 | - | 1 | 50 | nA |
| HI-200 | | Full | - | 100 | 500 | - | 10 | 500 | nA |
| HI-201 | | 25 | - | 2 | 5 | - | 2 | 50 | nA |
| | | Full | - | - | 500 | - | - | 250 | nA |
| OFF Output Leakage Current, $I_{D(OFF)}$ | (Note 6) | 25 | - | 1 | 5 | - | 1 | 50 | nA |
| HI-200 | | Full | - | 100 | 500 | - | 10 | 500 | nA |
| HI-201 | | 25 | - | 2 | 5 | - | 2 | 50 | nA |
| | | Full | - | 35 | 500 | - | 35 | 250 | nA |
| ON Leakage Current, $I_{D(ON)}$ | (Note 6) | 25 | - | 1 | 5 | - | 1 | 50 | nA |
| HI-200 | | Full | - | 100 | 500 | - | 10 | 500 | nA |
| HI-201 | | 25 | - | 2 | 5 | - | 2 | 50 | nA |
| | | Full | - | - | 500 | - | - | 250 | nA |
| **POWER SUPPLY CHARACTERISTICS** (Note 5) | | | | | | | | | |
| Power Dissipation, $P_D$ | | 25 | - | 15 | - | - | 15 | - | mW |
| | | Full | - | - | 60 | - | - | 60 | mW |
| Current, I+ | | 25 | - | 0.5 | - | - | 0.5 | - | mA |
| | | Full | - | - | 2.0 | - | - | 2.0 | mA |
| Current, I- | | 25 | - | 0.5 | - | - | 0.5 | - | mA |
| | | Full | - | - | 2.0 | - | - | 2.0 | mA |

NOTES:

2. $V_{OUT}$ = ±10V, $I_{OUT}$ = 1mA.
3. Digital Inputs are MOS gates: typical leakage is < 1nA.
4. $V_A$ = 5V, $R_L$ = 1kΩ, $C_L$ = 10pF, $V_S$ = $3V_{RMS}$, f = 100kHz.
5. $V_A$ = +3V or $V_A$ = 0V for Both Switches.
6. Refer to Leakage Current Measurements (Figure 2).

## *Test Circuits and Waveforms* $T_A$ = 25°C, $V_{SUPPLY}$ = ±±15V, $V_{AH}$ = 2.4V, $V_{AL}$ = 0.8V and $V_{REF}$ = Open

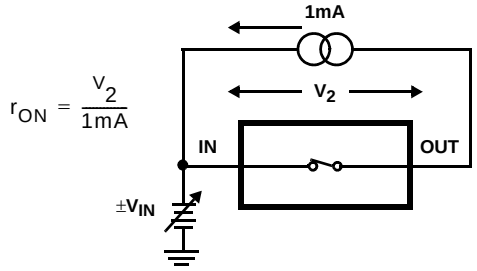



**FIGURE 1A. ON RESISTANCE TEST CIRCUIT**

## Test Circuits and Waveforms $T_A = 25^oC$, $V_{SUPPLY} = \pm\pm15V$, $V_{AH} = 2.4V$, $V_{AL} = 0.8V$ and $V_{REF}$ = Open **(Continued)**

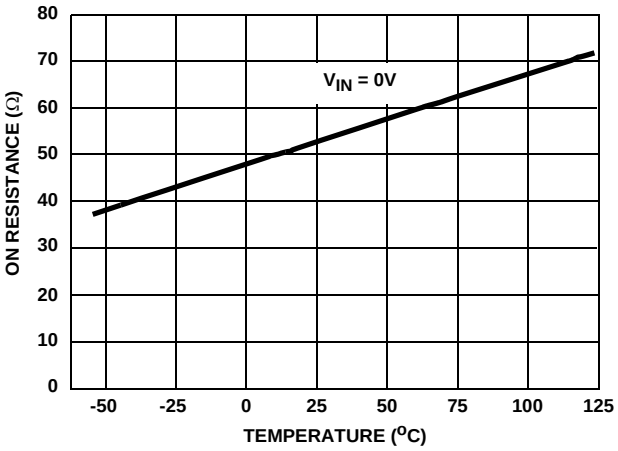



FIGURE 1B. ON RESISTANCE vs TEMPERATURE

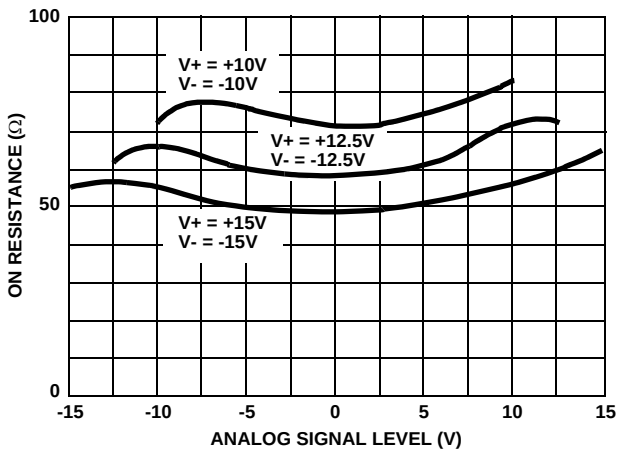



FIGURE 1C. HI-200 ON RESISTANCE vs ANALOG SIGNAL LEVEL

FIGURE 1. ON RESISTANCE

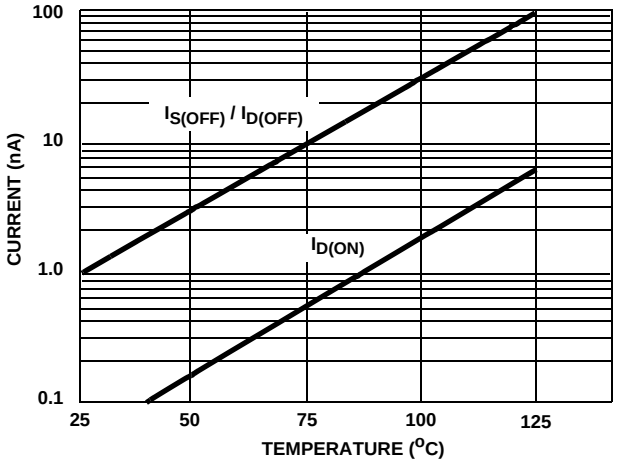



FIGURE 2A. LEAKAGE CURRENT vs TEMPERATURE

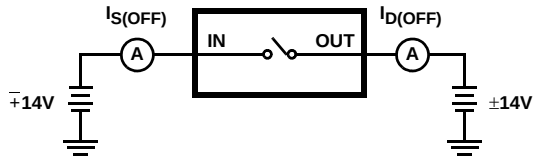



FIGURE 2B. OFF LEAKAGE CURRENT TEST CIRCUIT

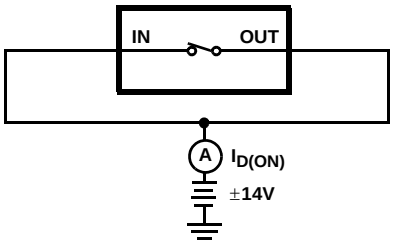



FIGURE 2C. ON LEAKAGE CURRENT TEST CIRCUIT

FIGURE 2. LEAKAGE CURRENTS

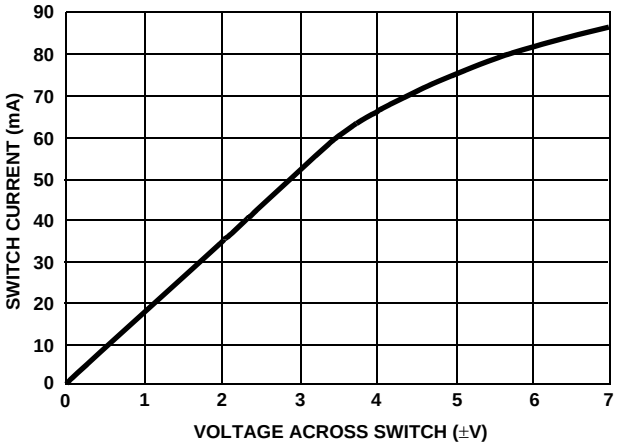



FIGURE 3A. SWITCH CURRENT vs VOLTAGE

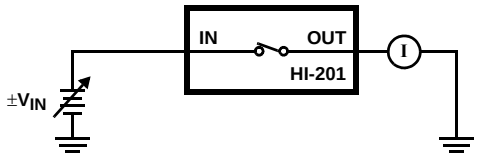



FIGURE 3B. TEST CIRCUIT

FIGURE 3. SWITCH CURRENT

## Test Circuits and Waveforms $T_A = 25^oC$, $V_{SUPPLY} = \pm\pm15V$, $V_{AH} = 2.4V$, $V_{AL} = 0.8V$ and $V_{REF}$ = Open **(Continued)**

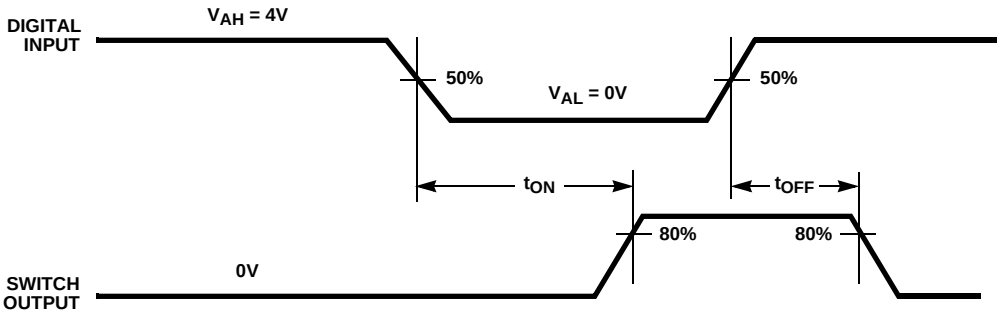
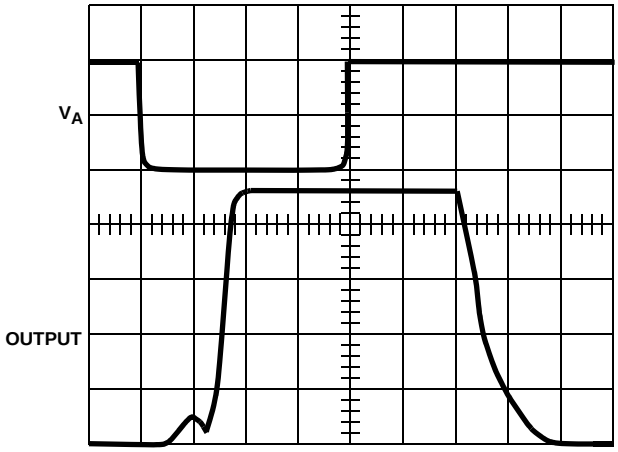
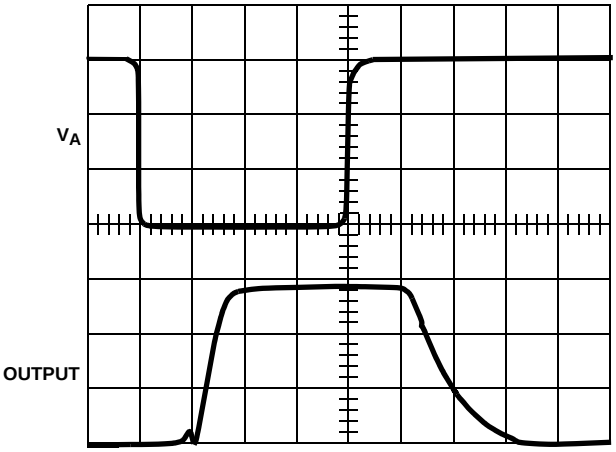



**FIGURE 4A. MEASUREMENT POINTS**




$V_A$ = 0 to 4V
Vertical: 2V/Div.
Horizontal: 100ns/Div.

**FIGURE 4B. WAVEFORMS WITH TTL COMPATIBLE LOGIC INPUT**




$V_A$ = 0 to 15V
Vertical: 5V/Div.
Horizontal: 100ns/Div.

**FIGURE 4C. WAVEFORMS WITH CMOS COMPATIBLE LOGIC INPUT**

**FIGURE 4. SWITCH $t_{ON}$ AND $t_{OFF}$**

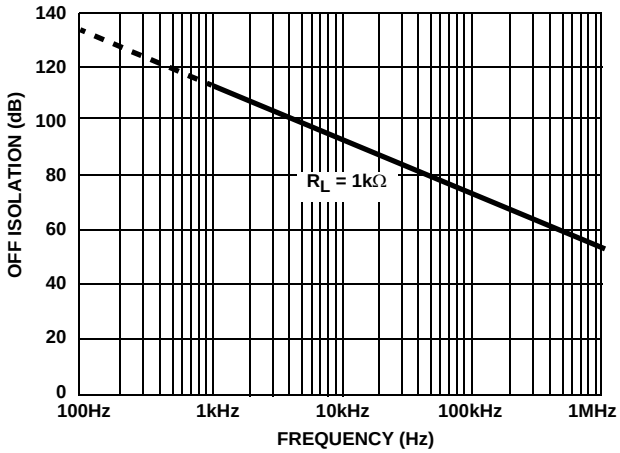



**FIGURE 5. HI-201 OFF ISOLATION vs FREQUENCY**

For more information see Application Notes AN520, AN521, AN531, AN532 and AN557.

## Application Information

### Single Supply Operation

The switch operation of the HI-200/201 is dependent upon an internally generated switching threshold voltage optimized for ±15V power supplies. The HI-200/201 does not provide the necessary internal switching threshold in a single supply system. Therefore, if single supply operation is required, the HI-300 series of switches is recommended. The HI-300 series will remain operational to a minimum +5V single supply.

Switch performance will degrade as power supply voltage is reduced from optimum levels (±15V). So it is recommended that a single supply design be thoroughly evaluated to ensure that the switch will meet the requirements of the application.

For further information see Application Notes AN520, AN557, AN1033 and AN1034.

## Die Characteristics

**METALLIZATION:**

Type: CuAl
Thickness: 16kÅ ±2kÅ

**PASSIVATION:**

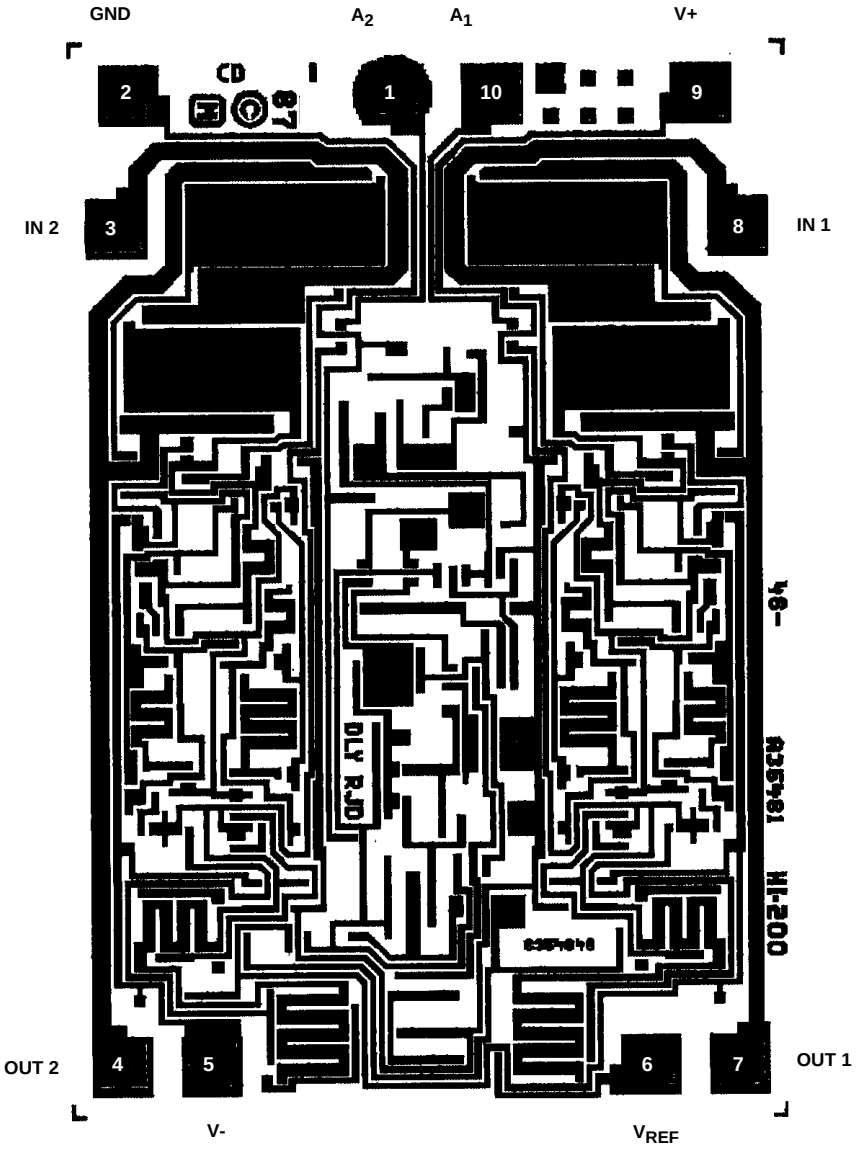
Type: Nitride over Silox
Nitride Thickness: 3.5kÅ ±1kÅ
Silox Thickness: 12kÅ ±2kÅ

**WORST CASE CURRENT DENSITY:**

$2 \times 10^5$ A/cm$^2$ at 25mA

## Metallization Mask Layout

**HI-200**



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