

# HI-200, HI-201

Dual/Quad SPST, CMOS Analog Switches

FN3121

Rev 9.00

September 15, 2015

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°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<br>(Note) (No longer available or supported) | 0 to 75          | 14 Ld PDIP* (Pb-free) | E14.3       |
| HI1-0201-2                                               | -55 to 125       | 16 Ld Cerdip          | F16.3       |
| HI3-0201-5Z<br>(Note)                                    | 0 to 75          | 16 Ld PDIP* (Pb-free) | E16.3       |
| HI4P0201-5Z<br>(Note) (No longer available or supported) | 0 to 75          | 20 Ld PLCC (Pb-free)  | N20.35      |
| HI9P0201-5Z<br>(Note)                                    | 0 to 75          | 16 Ld SOIC (Pb-free)  | M16.15      |
| HI9P0201-9Z<br>(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.

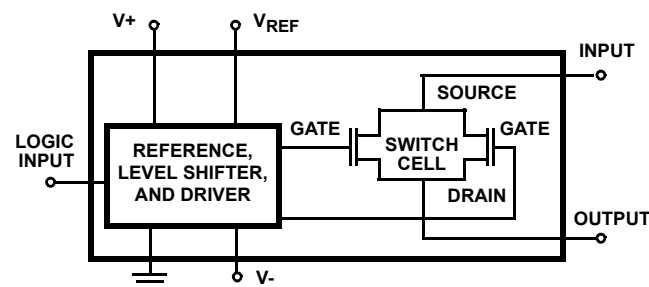
## Features

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

## Applications

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

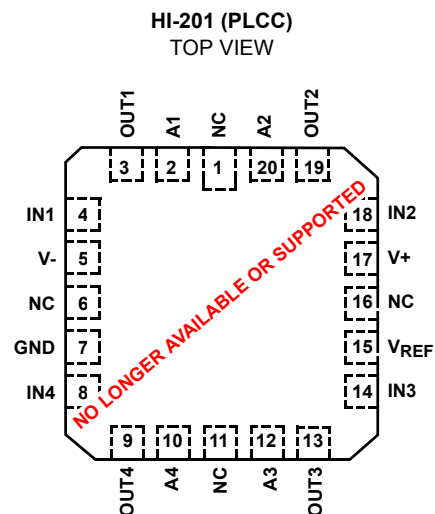
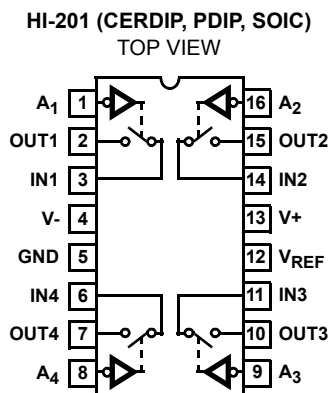
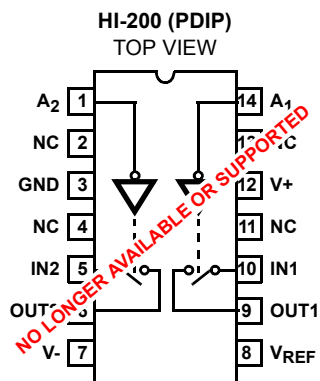
## Functional Diagram



TRUTH TABLE

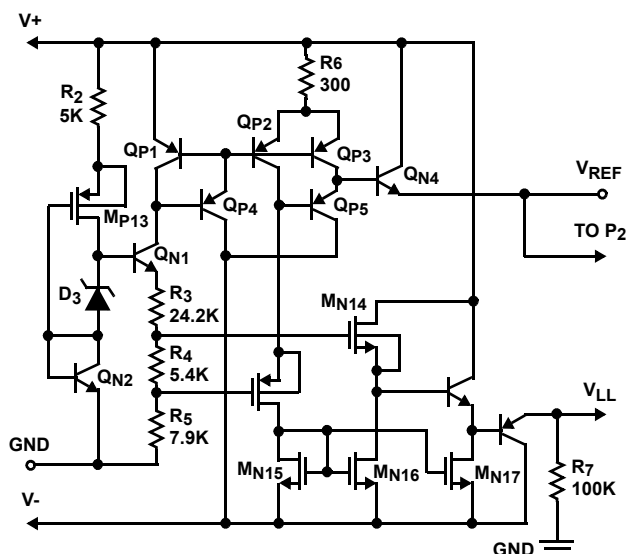
| LOGIC | HI-200 | HI-201 |
|-------|--------|--------|
| 0     | ON     | ON     |
| 1     | OFF    | OFF    |

## Pinouts (Switches Shown For Logic "1" Input)

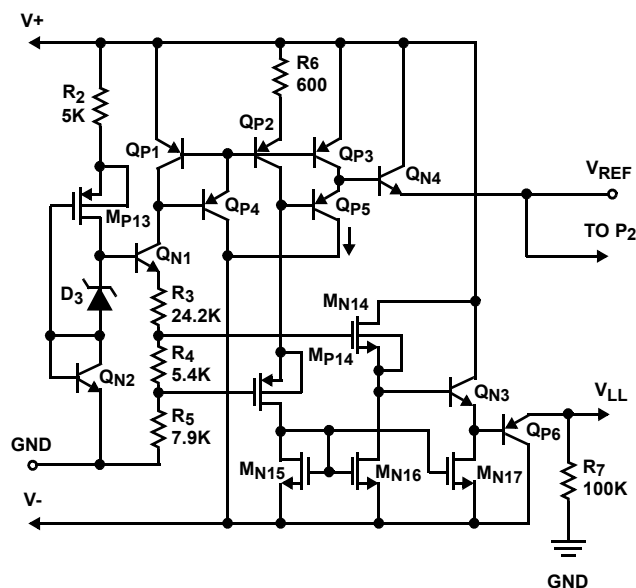


## Schematic Diagrams

TTL/CMOS REFERENCE CIRCUIT V<sub>REF</sub> CELL  
HI-200



TTL/CMOS REFERENCE CIRCUIT V<sub>REF</sub> CELL  
HI-201



The diagram shows a CMOS inverter circuit. The PMOS network consists of two parallel branches: one with transistor Q<sub>p11</sub> connected to V<sub>+</sub>, and another with transistor Q<sub>p12</sub> connected to A'. The NMOS network consists of two parallel branches: one with transistor Q<sub>n13</sub> connected to V<sub>-</sub>, and another with transistors Q<sub>n11</sub> and Q<sub>n12</sub> in series, connected to A'. The input of the inverter is connected to the gates of Q<sub>p11</sub> and Q<sub>n13</sub>. The output is taken from the common drain connection of Q<sub>p12</sub> and Q<sub>n12</sub>.

The circuit diagram illustrates a 10-bit DAC implemented using a 256-unit R-2R ladder network. The input signal  $V_{in}$  is connected to the top of the ladder through a  $200\Omega$  resistor. The ladder network consists of a series of resistors forming a binary-weighted structure. The output of the ladder is connected to a 10-bit digital-to-analog converter (DAC) core, which is a modified R-2R ladder. This core includes 10 operational amplifiers (op-amps) and 10 comparators. The op-amps are configured as voltage followers, and the comparators are configured as differential amplifiers. The output of the DAC core is a 10-bit digital signal, labeled  $A'$  and  $\bar{A}'$ . The circuit is powered by a  $V_{+}$  supply and a  $V_{-}$  supply. The input signal  $V_{in}$  is also connected to the  $V_{+}$  supply through a  $200\Omega$  resistor. The output of the DAC core is connected to the  $V_{-}$  supply through a  $200\Omega$  resistor. The circuit is labeled with various components:  $V_{in}$ ,  $200\Omega$ ,  $V_{+}$ ,  $V_{-}$ ,  $A'$ ,  $\bar{A}'$ , and 10 op-amps (labeled 1 through 10).

**Absolute Maximum Ratings**

Supply Voltage (V+ to V-)..... 44V ( $\pm 22$ )  
 V<sub>REF</sub> 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°C to 125°C  
 HI-201-4..... -25°C to 85°C  
 HI-200-5, HI-201-5..... 0°C to 75°C  
 HI-201-9..... -40°C to 85°C

**Thermal Information**

Thermal Resistance (Typical, Note 1)       $\theta_{JA}$  (°C/W)     $\theta_{JC}$  (°C/W)  
 Cerdip Package..... 75                      20  
 PLCC Package..... 80                      N/A  
 PDIP Package\* ..... 95                      N/A  
 SOIC Package..... 110                      N/A  
 Maximum Storage Temperature..... -65°C to 150°C  
 Maximum Junction Temperature (Hermetic Packages)..... 175°C  
 Maximum Junction Temperature (Plastic Packages)..... 150°C  
 Maximum Lead Temperature (Soldering, 10s)..... 300°C  
 (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<sub>REF</sub> = Open; V<sub>AH</sub> (Logic Level High) = 2.4V, V<sub>AL</sub> (Logic Level Low) = 0.8V

| PARAMETER                                           | TEST CONDITIONS | TEMP (°C) | -2  |      |     | -4, -5, -9 |      |     | UNITS |
|-----------------------------------------------------|-----------------|-----------|-----|------|-----|------------|------|-----|-------|
|                                                     |                 |           | MIN | TYP  | MAX | MIN        | TYP  | MAX |       |
| DYNAMIC CHARACTERISTICS                             |                 |           |     |      |     |            |      |     |       |
| Switch ON Time, t <sub>ON</sub>                     |                 |           |     |      |     |            |      |     |       |
| HI-200                                              |                 | 25        | -   | 240  | 500 | -          | 240  | -   | ns    |
| HI-201                                              |                 | 25        | -   | 185  | 500 | -          | 185  | -   | ns    |
|                                                     |                 | Full      | -   | 1000 | -   | -          | 1000 | -   | ns    |
| Switch OFF Time, t <sub>OFF</sub>                   |                 |           |     |      |     |            |      |     |       |
| 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 <sub>S</sub> (OFF)      |                 | 25        | -   | 5.5  | -   | -          | 5.5  | -   | pF    |
| Output Switch Capacitance, C <sub>D</sub> (OFF)     |                 | 25        | -   | 5.5  | -   | -          | 5.5  | -   | pF    |
| Output Switch Capacitance, C <sub>D</sub> (ON)      |                 | 25        | -   | 11   | -   | -          | 11   | -   | pF    |
| Digital Input Capacitance, C <sub>A</sub>           |                 | 25        | -   | 5    | -   | -          | 5    | -   | pF    |
| Drain-to-Source Capacitance, C <sub>DS</sub> (OFF)  |                 | 25        | -   | 0.5  | -   | -          | 0.5  | -   | pF    |
| DIGITAL INPUT CHARACTERISTICS                       |                 |           |     |      |     |            |      |     |       |
| Input Low Threshold, V <sub>AL</sub>                |                 | Full      | -   | -    | 0.8 | -          | -    | 0.8 | V     |
| Input High Threshold, V <sub>AH</sub>               |                 | Full      | 2.4 | -    | -   | 2.4        | -    | -   | V     |
| Input Leakage Current (High or Low), I <sub>A</sub> | (Note 3)        | Full      | -   | -    | 1.0 | -          | -    | 1.0 | μA    |
| ANALOG SWITCH CHARACTERISTICS                       |                 |           |     |      |     |            |      |     |       |
| Analog Signal Range, V <sub>S</sub>                 |                 | Full      | -15 | -    | +15 | -15        | -    | +15 | V     |
| ON Resistance, r <sub>ON</sub>                      | (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,  $V_{AL}$  (Logic Level Low) = 0.8V (Continued)

| PARAMETER                                       | TEST CONDITIONS | TEMP (°C) | -2  |     |     | -4, -5, -9 |     |     | UNITS |
|-------------------------------------------------|-----------------|-----------|-----|-----|-----|------------|-----|-----|-------|
|                                                 |                 |           | MIN | TYP | MAX | MIN        | TYP | MAX |       |
| OFF Input Leakage Current, I <sub>S(OFF)</sub>  | (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 <sub>D(OFF)</sub> | (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 <sub>D(ON)</sub>          | (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 <sub>D</sub>               |                 | 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:

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

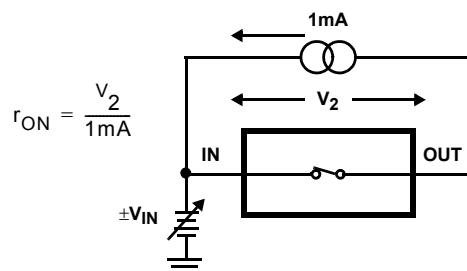
**Test Circuits and Waveforms**  $T_A = 25^\circ C$ ,  $V_{SUPPLY} = \pm 15V$ ,  $V_{AH} = 2.4V$ ,  $V_{AL} = 0.8V$  and  $V_{REF} = \text{Open}$ 

FIGURE 1A. ON RESISTANCE TEST CIRCUIT

# Test Circuits and Waveforms $T_A = 25^\circ\text{C}$ , $V_{\text{SUPPLY}} = \pm 15\text{V}$ , $V_{\text{AH}} = 2.4\text{V}$ , $V_{\text{AL}} = 0.8\text{V}$ and $V_{\text{REF}} = \text{Open}$ (Continued)

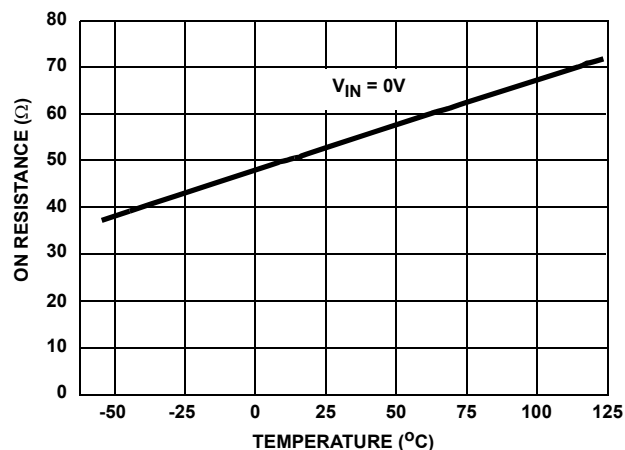


FIGURE 1B. ON RESISTANCE vs TEMPERATURE

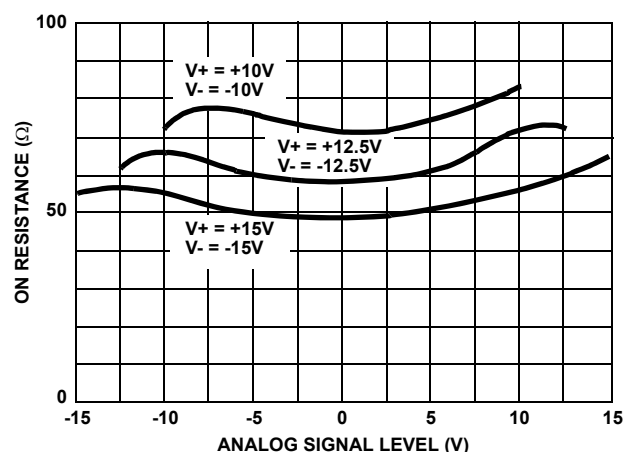


FIGURE 1C. HI-200 ON RESISTANCE vs ANALOG SIGNAL LEVEL

FIGURE 1. ON RESISTANCE

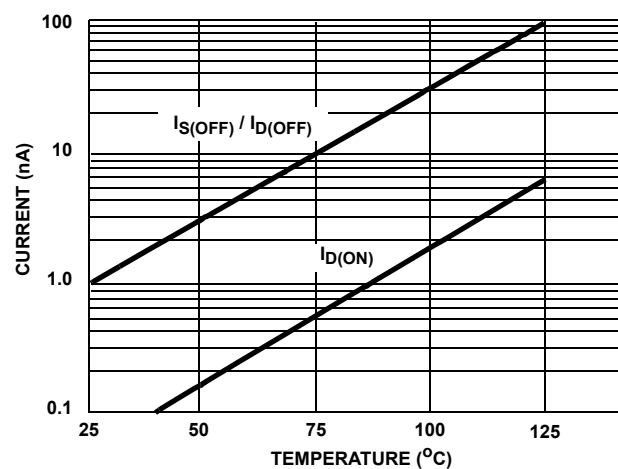


FIGURE 2A. LEAKAGE CURRENT vs TEMPERATURE

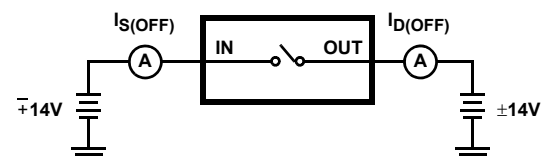


FIGURE 2B. OFF LEAKAGE CURRENT TEST CIRCUIT

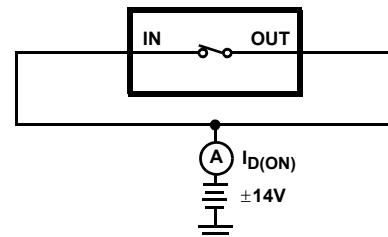


FIGURE 2C. ON LEAKAGE CURRENT TEST CIRCUIT

FIGURE 2. LEAKAGE CURRENTS

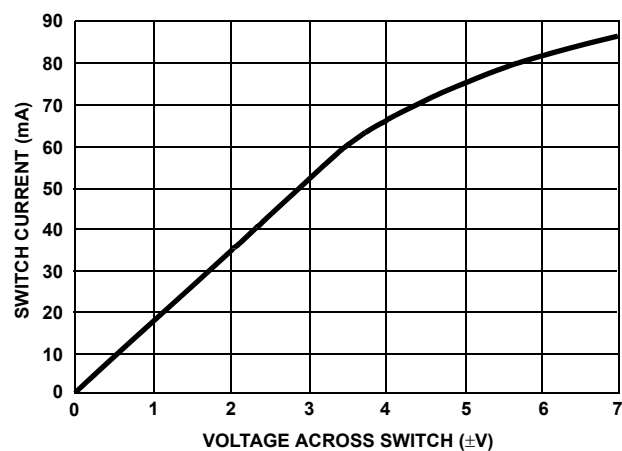


FIGURE 3A. SWITCH CURRENT vs VOLTAGE

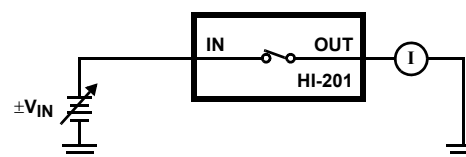


FIGURE 3B. TEST CIRCUIT

FIGURE 3. SWITCH CURRENT

# Test Circuits and Waveforms $T_A = 25^{\circ}\text{C}$ , $V_{\text{SUPPLY}} = \pm 15\text{V}$ , $V_{\text{AH}} = 2.4\text{V}$ , $V_{\text{AL}} = 0.8\text{V}$ and $V_{\text{REF}} = \text{Open}$ (Continued)

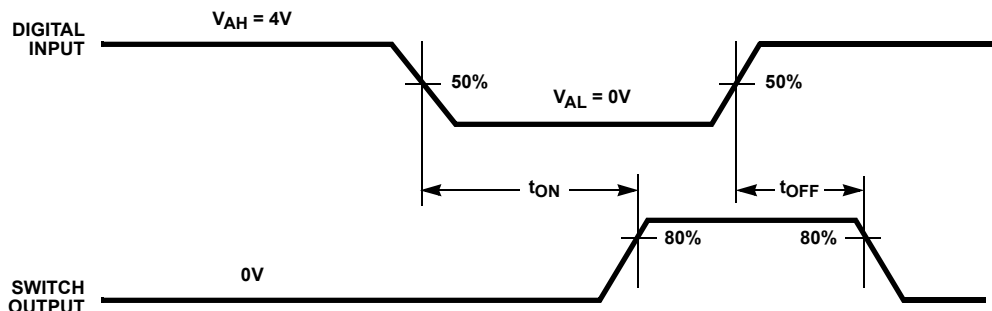
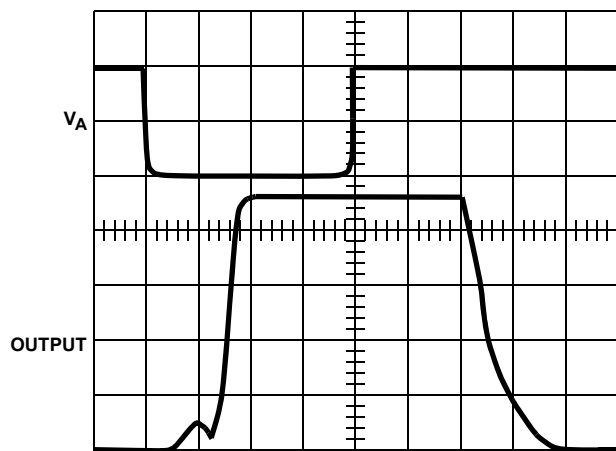
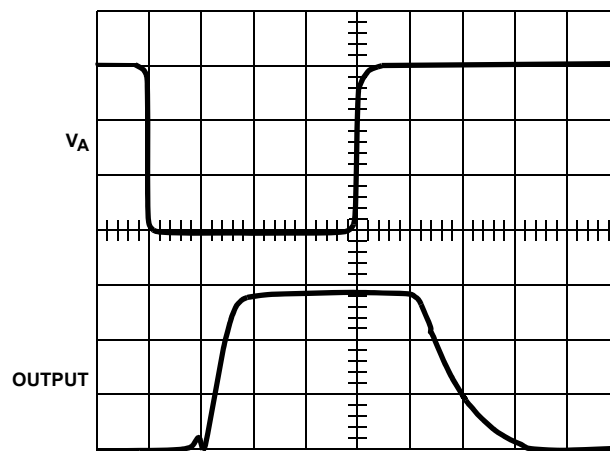


FIGURE 4A. MEASUREMENT POINTS



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

FIGURE 4B. WAVEFORMS WITH TTL COMPATIBLE LOGIC INPUT



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

FIGURE 4C. WAVEFORMS WITH CMOS COMPATIBLE LOGIC INPUT

FIGURE 4. SWITCH  $t_{\text{ON}}$  AND  $t_{\text{OFF}}$

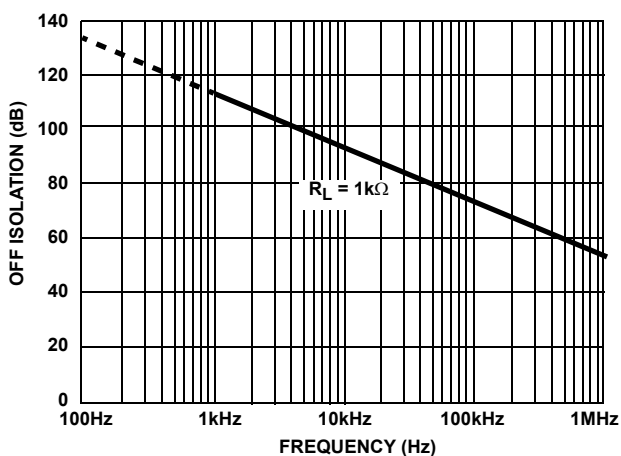


FIGURE 5. HI-201 OFF ISOLATION vs FREQUENCY

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  $\pm 15\text{V}$  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  $+5\text{V}$  single supply.

Switch performance will degrade as power supply voltage is reduced from optimum levels ( $\pm 15\text{V}$ ). 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:  $16\text{k}\text{\AA} \pm 2\text{k}\text{\AA}$

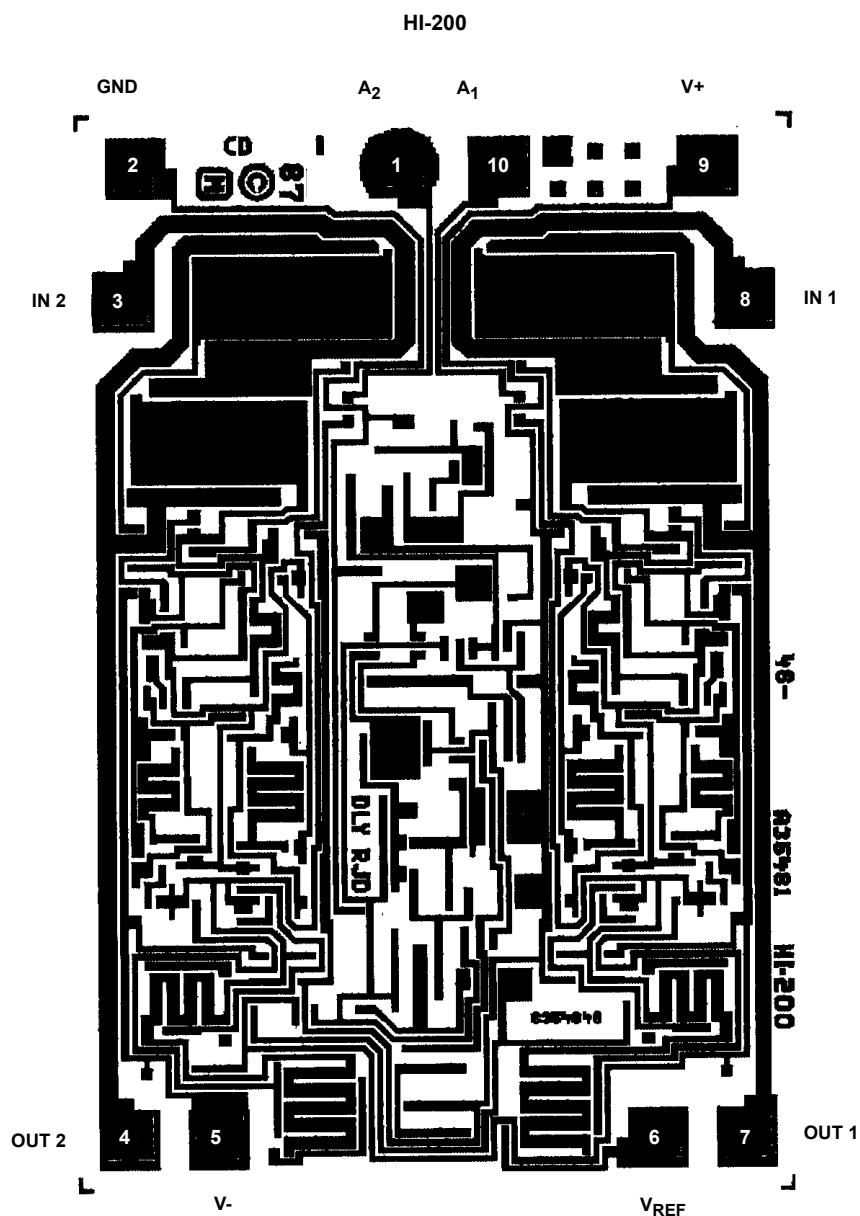
### PASSIVATION:

Type: Nitride over Silox  
Nitride Thickness:  $3.5\text{k}\text{\AA} \pm 1\text{k}\text{\AA}$   
Silox Thickness:  $12\text{k}\text{\AA} \pm 2\text{k}\text{\AA}$

### WORST CASE CURRENT DENSITY:

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

## Metallization Mask Layout



## Die Characteristics

### METALLIZATION:

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

### PASSIVATION:

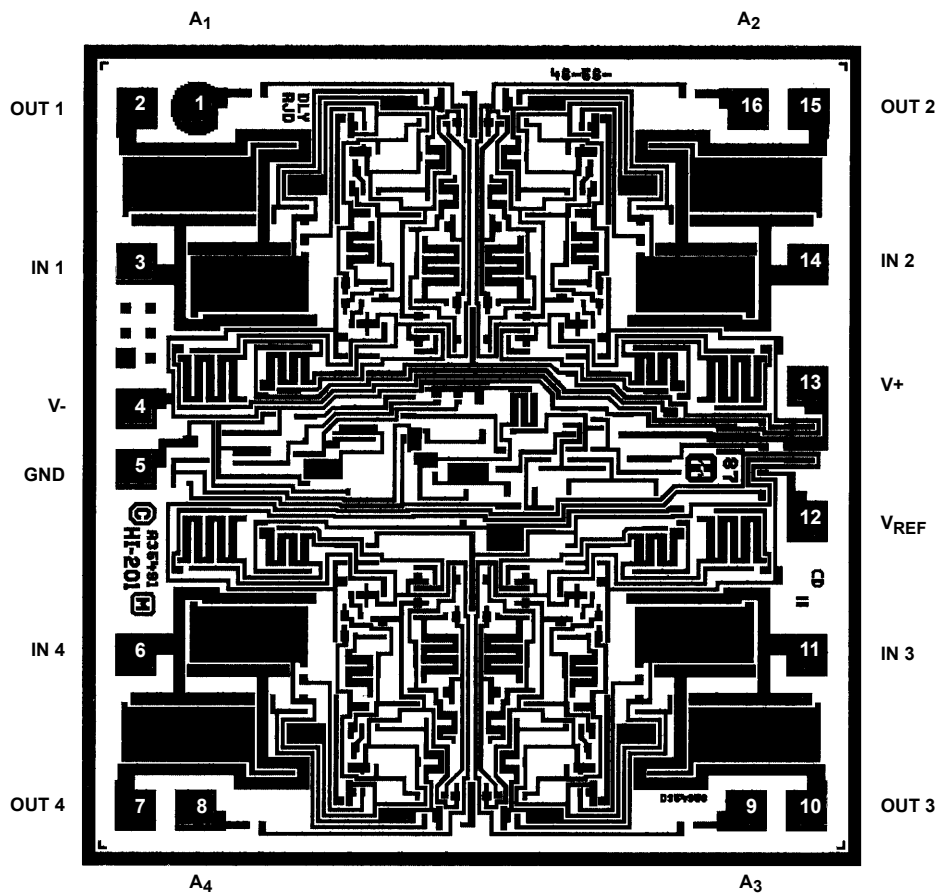
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### WORST CASE CURRENT DENSITY:

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

## Metallization Mask Layout

HI-201



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## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to the web to make sure that you have the latest revision.

| DATE               | REVISION | CHANGE                                                                                                           |
|--------------------|----------|------------------------------------------------------------------------------------------------------------------|
| September 15, 2015 | FN3121.9 | - Updated Ordering Information Table on page 1.<br>- Added Revision History.<br>- Added About Intersil Verbiage. |

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## About Intersil

Intersil Corporation is a leading provider of innovative power management and precision analog solutions. The company's products address some of the largest markets within the industrial and infrastructure, mobile computing and high-end consumer markets.

For the most updated datasheet, application notes, related documentation and related parts, please see the respective product information page found at [www.intersil.com](http://www.intersil.com).

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