

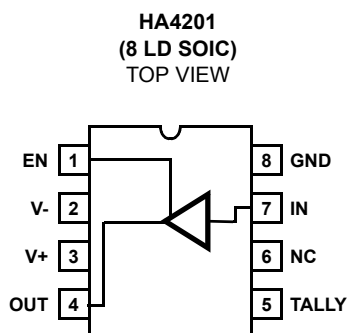
## 480MHz, 1x1 Video Crosspoint Switch with Tally Output

The HA4201 is a very wide bandwidth 1x1 crosspoint switch ideal for professional video switching, HDTV, computer monitor routing, and other high performance applications. The circuit features very low power dissipation (105mW Enabled, 1mW Disabled), excellent differential gain and phase, and very high off isolation. When disabled, the output is switched to a high impedance state, making the HA4201 ideal for routing matrix equipment.

The HA4201 requires no external current source, and features fast switching and symmetric slew rates. The tally output is an open collector PNP transistor to  $V_{CC}$ , and is activated whenever EN = 1 to provide an indication of crosspoint selection.

For applications which don't require a TALLY output, please refer to the HA4600 data sheet.

## Pinout



## Truth Table

| EN | OUT    | TALLY |
|----|--------|-------|
| 0  | High Z | Off   |
| 1  | Active | On    |

## Features

- Low Power Dissipation . . . . . 105mW
- Symmetrical Slew Rates . . . . . 1700V/ $\mu$ s
- 0.1dB Gain Flatness . . . . . 250MHz
- Off Isolation (100MHz) . . . . . 85dB
- Differential Gain . . . . . 0.01%
- Differential Phase . . . . . 0.01 Degrees
- High ESD Rating . . . . . >1800V
- TTL Compatible Enable Input
- Open Collector Tally Output
- Improved Replacement for GX4201
- Pb-Free Plus Anneal Available (RoHS Compliant)

## Applications

- Professional Video Switching and Routing
- Video Multiplexers
- HDTV
- Computer Graphics
- RF Switching and Routing
- PCM Data Routing

## Ordering Information

| PART NUMBER           | PART MARKING | TEMP. RANGE (°C) | PACKAGE                    | PKG. DWG. # |
|-----------------------|--------------|------------------|----------------------------|-------------|
| HA4201CB96            | 4201C B      | 0 to +70         | 8 Ld SOIC<br>Tape and Reel | M8.15       |
| HA4201CBZ96<br>(Note) | 4201C BZ     | 0 to +70         | 8 Ld SOIC<br>(Pb-free)     | M8.15       |

NOTE: Intersil Pb-free plus anneal 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.

**Absolute Maximum Ratings**

|                                                          |                   |
|----------------------------------------------------------|-------------------|
| Voltage Between V+ and V- . . . . .                      | 12V               |
| Input Voltage . . . . .                                  | $V_{SUPPLY}$      |
| Digital Input Current (Note 2) . . . . .                 | $\pm 25\text{mA}$ |
| Output Current . . . . .                                 | 20mA              |
| ESD Rating                                               |                   |
| Human Body Model (Per MIL-STD-883 Method 3015.7) . . . . | 1800V             |

**Operating Conditions**

|                             |              |
|-----------------------------|--------------|
| Temperature Range . . . . . | 0°C to +70°C |
|-----------------------------|--------------|

**Thermal Information**

|                                                                                                                 |                                |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------|
| Thermal Resistance (Typical, Note 1)                                                                            | $\theta_{JA}$ (°C/W)           |
| SOIC Package . . . . .                                                                                          | 170                            |
| Maximum Junction Temperature (Die) . . . . .                                                                    | +175°C                         |
| Maximum Junction Temperature (Plastic Package) . . . . .                                                        | +150°C                         |
| Maximum Storage Temperature Range . . . . .                                                                     | -65°C to +150°C                |
| Maximum Lead Temperature (Soldering 10s) . . . . .                                                              | +300°C (SOIC - Lead Tips Only) |
| Pb-free reflow profile . . . . .                                                                                | see link below                 |
| <a href="http://www.intersil.com/pbfree/Pb-FreeReflow.asp">http://www.intersil.com/pbfree/Pb-FreeReflow.asp</a> |                                |

**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.

**NOTES:**

1.  $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.
2. If an input signal is applied before the supplies are powered up, the input current must be limited to this maximum value.

**Electrical Specifications**  $V_{SUPPLY} = \pm 5\text{V}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_{EN} = 2.0\text{V}$ , Unless Otherwise Specified

| PARAMETER                                | TEST CONDITIONS                               | TEMP.<br>(°C) | MIN       | TYP       | MAX       | UNITS                        |
|------------------------------------------|-----------------------------------------------|---------------|-----------|-----------|-----------|------------------------------|
| <b>DC SUPPLY CHARACTERISTICS</b>         |                                               |               |           |           |           |                              |
| Supply Voltage                           |                                               | Full          | $\pm 4.5$ | $\pm 5.0$ | $\pm 5.5$ | V                            |
| Supply Current ( $V_{OUT} = 0\text{V}$ ) | $V_{EN} = 2.0\text{V}$                        | 25, 70        | -         | 10.5      | 13        | mA                           |
|                                          | $V_{EN} = 2.0\text{V}$                        | 0             | -         | -         | 14.5      | mA                           |
|                                          | $V_{EN} = 0.8\text{V}$                        | 25, 70        | -         | 100       | 115       | $\mu\text{A}$                |
|                                          | $V_{EN} = 0.8\text{V}$                        | 0             | -         | 100       | 125       | $\mu\text{A}$                |
| <b>ANALOG DC CHARACTERISTICS</b>         |                                               |               |           |           |           |                              |
| Output Voltage Swing without Clipping    | $V_{OUT} = V_{IN} \pm V_{IO} \pm 20\text{mV}$ | 25, 70        | $\pm 2.7$ | $\pm 2.8$ | -         | V                            |
|                                          |                                               | 0             | $\pm 2.4$ | $\pm 2.5$ | -         | V                            |
| Output Current                           |                                               | Full          | 15        | 20        | -         | mA                           |
| Input Bias Current                       |                                               | Full          | -         | 30        | 50        | $\mu\text{A}$                |
| Output Offset Voltage                    |                                               | 25            | -10       | -         | 10        | mV                           |
| Output Offset Voltage Drift (Note 3)     |                                               | Full          | -         | 25        | 50        | $\mu\text{V}/^\circ\text{C}$ |
| <b>SWITCHING CHARACTERISTICS</b>         |                                               |               |           |           |           |                              |
| Turn-On Time                             |                                               | 25            | -         | 160       | -         | ns                           |
| Turn-Off Time                            |                                               | 25            | -         | 320       | -         | ns                           |
| <b>DIGITAL DC CHARACTERISTICS</b>        |                                               |               |           |           |           |                              |
| Input Logic High Voltage                 |                                               | Full          | 2         | -         | -         | V                            |
| Input Logic Low Voltage                  |                                               | Full          | -         | -         | 0.8       | V                            |
| EN Input Current                         | $V_{EN} = 0$ to 4V                            | Full          | -2        | -         | 2         | $\mu\text{A}$                |
| Tally Output High Voltage                | $I_{OH} = 1\text{mA}$                         | Full          | 4.7       | 4.8       | -         | V                            |
| Tally Off Leakage Current                | $V_{TALLY} = 0\text{V}, -5\text{V}$           | Full          | -20       | -         | 20        | $\mu\text{A}$                |
| <b>AC CHARACTERISTICS</b>                |                                               |               |           |           |           |                              |
| Insertion Loss                           | $1V_{P-P}$                                    | Full          | -         | 0.04      | 0.05      | dB                           |
| -3dB Bandwidth                           | $R_S = 82\Omega$ , $C_L = 10\text{pF}$        |               | -         | 480       | -         | MHz                          |
|                                          | $R_S = 43\Omega$ , $C_L = 15\text{pF}$        | 25            | -         | 380       | -         | MHz                          |
|                                          | $R_S = 36\Omega$ , $C_L = 21\text{pF}$        | 25            | -         | 370       | -         | MHz                          |

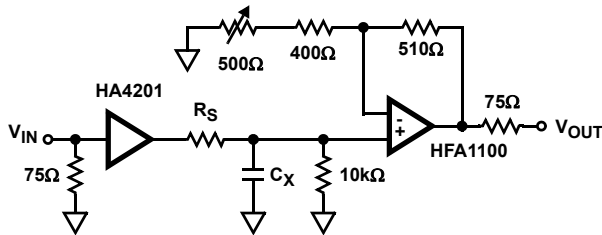
**Electrical Specifications**  $V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $R_L = 10\text{k}\Omega$ ,  $V_{\text{EN}} = 2.0\text{V}$ , Unless Otherwise Specified **(Continued)**

| PARAMETER                                     | TEST CONDITIONS                                                              | TEMP.<br>(°C) | MIN | TYP       | MAX  | UNITS                  |
|-----------------------------------------------|------------------------------------------------------------------------------|---------------|-----|-----------|------|------------------------|
| $\pm 0.1\text{dB}$ Flat Bandwidth             | $R_S = 82\Omega$ , $C_L = 10\text{pF}$                                       | 25            | -   | 250       | -    | MHz                    |
|                                               | $R_S = 43\Omega$ , $C_L = 15\text{pF}$                                       | 25            | -   | 175       | -    | MHz                    |
|                                               | $R_S = 36\Omega$ , $C_L = 21\text{pF}$                                       | 25            | -   | 170       | -    | MHz                    |
| Input Resistance                              |                                                                              | Full          | 200 | 400       | -    | $\text{k}\Omega$       |
| Input Capacitance                             |                                                                              | Full          | -   | 1.0       | -    | $\text{pF}$            |
| Enabled Output Resistance                     |                                                                              | Full          | -   | 15        | -    | $\Omega$               |
| Disabled Output Capacitance                   | $V_{\text{EN}} = 0.8\text{V}$                                                | Full          | -   | 2.0       | -    | $\text{pF}$            |
| Differential Gain                             | 4.43MHz, (Note 3)                                                            | 25            | -   | 0.01      | 0.02 | %                      |
| Differential Phase                            | 4.43MHz, (Note 3)                                                            | 25            | -   | 0.01      | 0.02 | Degrees                |
| Off Isolation                                 | $1V_{\text{P-P}}$ , 100MHz, $V_{\text{EN}} = 0.8\text{V}$ , $R_L = 10\Omega$ | Full          | -   | 85        | -    | dB                     |
| Slew Rate<br>( $1.5V_{\text{P-P}}$ , +SR/-SR) | $R_S = 82\Omega$ , $C_L = 10\text{pF}$                                       | 25            | -   | 1750/1770 | -    | $\text{V}/\mu\text{s}$ |
|                                               | $R_S = 43\Omega$ , $C_L = 15\text{pF}$                                       | 25            | -   | 1460/1360 | -    | $\text{V}/\mu\text{s}$ |
|                                               | $R_S = 36\Omega$ , $C_L = 21\text{pF}$                                       | 25            | -   | 1410/1360 | -    | $\text{V}/\mu\text{s}$ |
| Total Harmonic Distortion (Note 3)            |                                                                              | Full          | -   | 0.01      | 0.1  | %                      |
| Disabled Output Resistance                    |                                                                              | Full          | -   | 12        | -    | $\text{M}\Omega$       |

NOTE:

- This parameter is not tested. The limits are guaranteed based on lab characterization, and reflect lot-to-lot variation.

## AC Test Circuit



NOTE:  $C_L = C_X + \text{Test Fixture Capacitance}$ .

## PC Board Layout

The frequency response of this circuit depends greatly on the care taken in designing the PC board. **The use of low inductance components such as chip resistors and chip capacitors is strongly recommended, while a solid ground plane is a must!**

Attention should be given to decoupling the power supplies. A large value ( $10\mu\text{F}$ ) tantalum in parallel with a small value ( $0.1\mu\text{F}$ ) chip capacitor works well in most cases.

Keep input and output traces as short as possible, because trace inductance and capacitance can easily become the performance limiting items.

## Application Information

### General

The HA4201 is a 1x1 crosspoint switch that is ideal for the matrix element in small, high input-to-output isolation switchers and routers. It also excels as an input buffer for routers with a large number of outputs (i.e. each input must connect to a large number of outputs) and delivers performance superior to most video amplifiers at a fraction of the cost. As an input buffer, the HA4201's low input capacitance and high input resistance provide excellent video terminations when used with an external  $75\Omega$  resistor. This crosspoint contains no feedback or gain setting resistors, so the output is a true high impedance load when the IC is disabled ( $\text{EN} = 0$ ).

### Frequency Response

Most applications utilizing the HA4201 require a series output resistor,  $R_S$ , to tune the response for the specific load capacitance,  $C_L$ , driven. Bandwidth and slew rate degrade as  $C_L$  increases (as shown in the Electrical Specification table on page 2), so give careful consideration to component placement to minimize trace length. As an example, -3dB bandwidth decreases to 160MHz for  $C_L = 100\text{pF}$ ,  $R_S = 0\Omega$ . In big matrix configurations where  $C_L$  is large, better frequency response is obtained by cascading two levels of crosspoints in the case of multiplexed outputs (see Figure 2), or distributing the load between two drivers if  $C_L$  is due to bussing and subsequent stage input capacitance.

### Control Signals

**EN** - The ENABLE input is a TTL/CMOS compatible, active high input. When driven low this input forces the output to a true high impedance state and reduces the power dissipation by two orders of magnitude. The EN input has no on-chip pull-up resistor, so it must be connected to a logic high (recommend V+) if the enable function isn't utilized.

**Tally** - The Tally output is an open collector PNP transistor connected to V+. When EN = 1, the PNP transistor is enabled and current is delivered to the load. When the crosspoint is disabled, the Tally output presents a very high impedance to the external circuitry. Several Tally outputs may be wire OR'd together to generate complex control signals, as shown with the HA4404 in the application circuits below. The Tally load may be terminated to GND or to V- as long as the continuous output current doesn't exceed 3mA (6mA at 50% duty cycle, etc.).

### Switcher/Router Applications

Figure 1 illustrates one possible implementation of a wideband, low-power, 4x4 switcher/router. A 4x4 switcher/router allows any of the four outputs to be driven by any one of the four inputs (e.g. each of the four inputs may connect to a different output, or an input may connect to multiple outputs). This application utilizes the HA4201 for the input buffer, the HA4404 (4x1 crosspoint switch) as the switch

matrix, and the HFA1112 (programmable gain buffer) as the gain of two output driver. Figure 2 details a 16x1 switcher (basically a 16:1 mux) which uses the HA4201 in a cascaded stage configuration to minimize capacitive loading at each output node, thus increasing system bandwidth.

### Power Up Considerations

No signals should be applied to the analog or digital inputs before the power supplies are activated. Latch-up may occur if the inputs are driven at the time of power up. To prevent latch-up, the input currents during power up must not exceed the values listed in the Absolute Maximum Ratings.

### Intersil's Crosspoint Family

Intersil offers a variety of 1x1 and 4x1 crosspoint switches. In addition to the HA4201, the 1x1 family includes the HA4600 which is an essentially similar device but without the Tally output. The 4x1 family is comprised of the HA4314, HA4404, and HA4344. The HA4314 is a 14 lead basic 4x1 crosspoint. The HA4404 is a 16 Ld device with Tally outputs to indicate the selected channel. The HA4344 is a 16 Ld crosspoint with synchronized control lines (A0, A1,  $\overline{CS}$ ). With synchronization, the control information for the next channel switch can be loaded into the crosspoint without affecting the current state. On a subsequent clock edge the stored control state effects the desired channel switch.

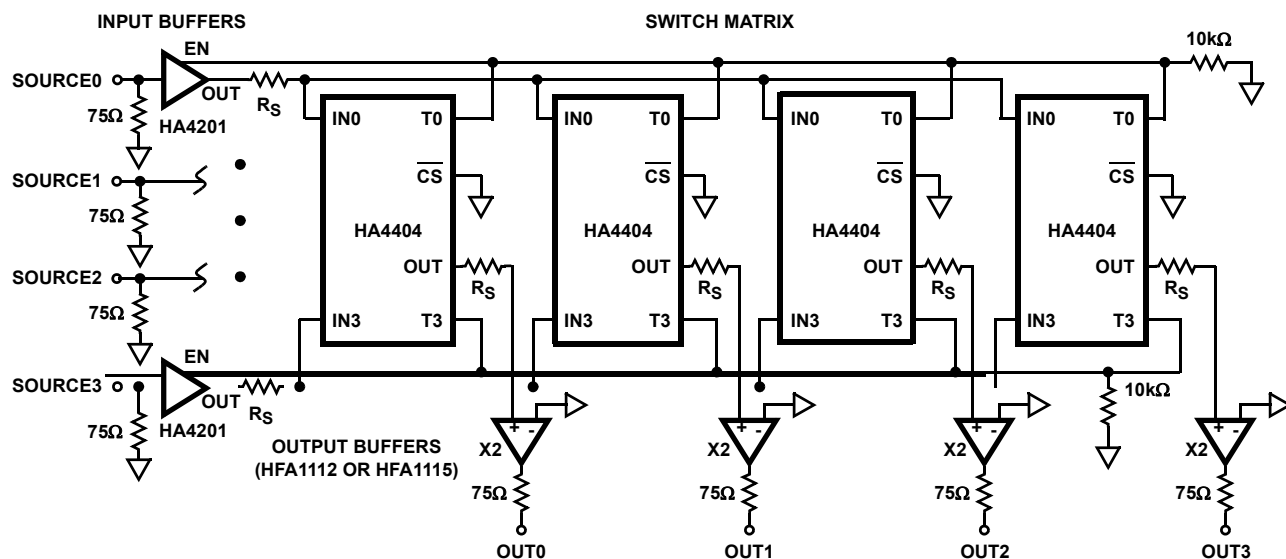


FIGURE 1. 4x4 SWITCHER/ROUTER APPLICATION

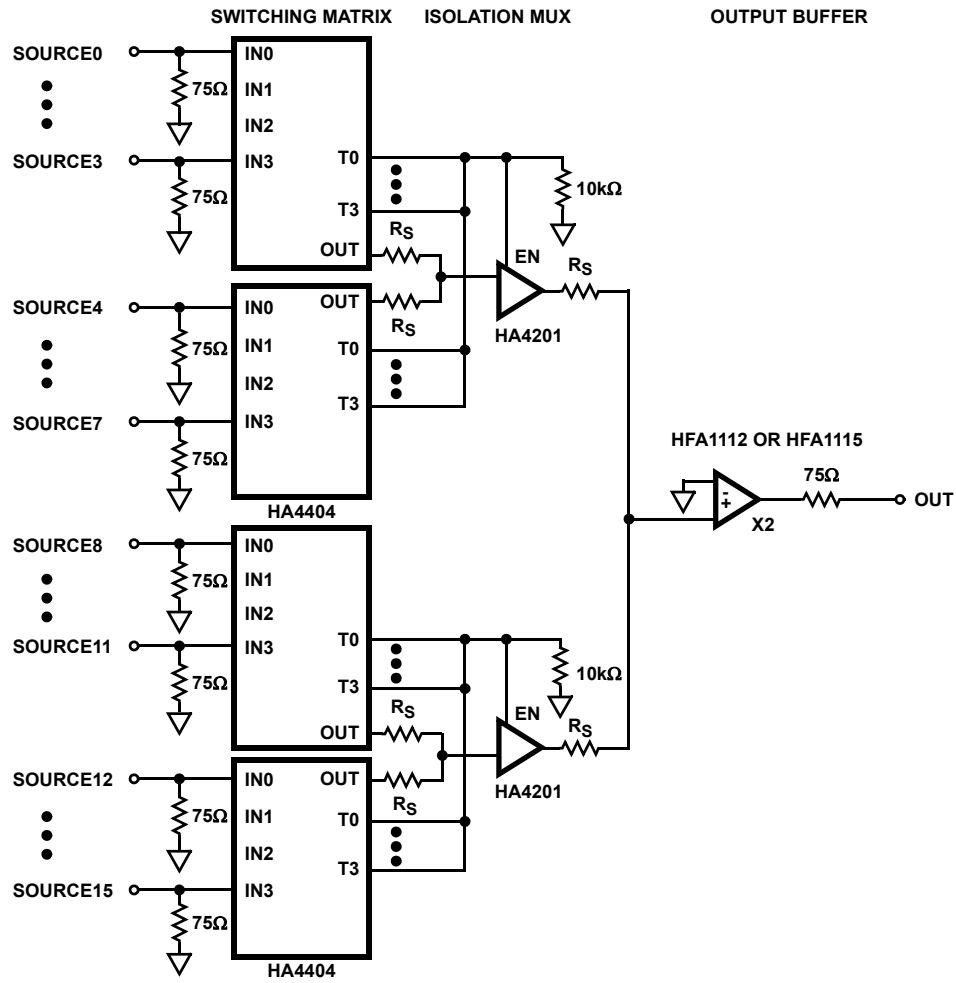


FIGURE 2. 16x1 SWITCHER APPLICATION

# Typical Performance Curves

$V_{\text{SUPPLY}} = \pm 5\text{V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{k}\Omega$ , Unless Otherwise Specified

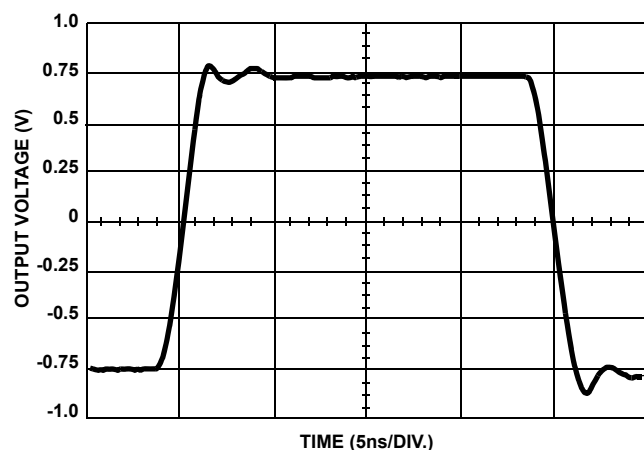


FIGURE 3. LARGE SIGNAL PULSE RESPONSE

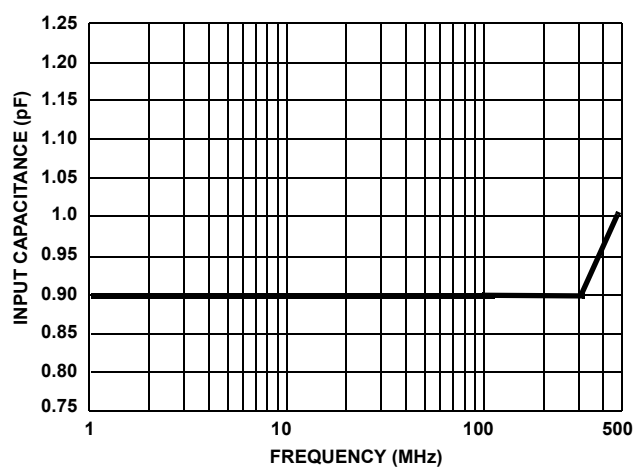


FIGURE 4. INPUT CAPACITANCE vs FREQUENCY

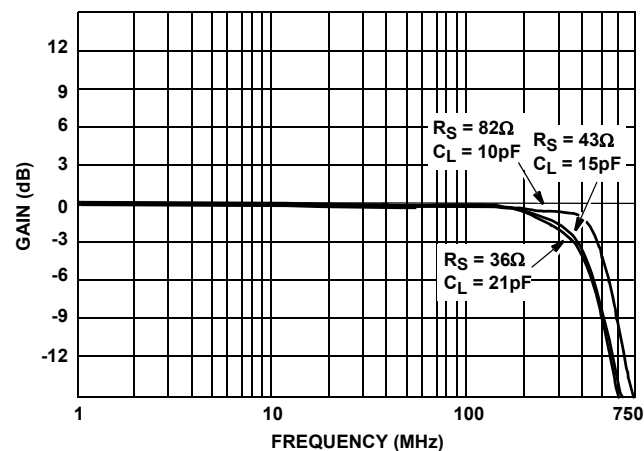


FIGURE 5. FREQUENCY RESPONSE

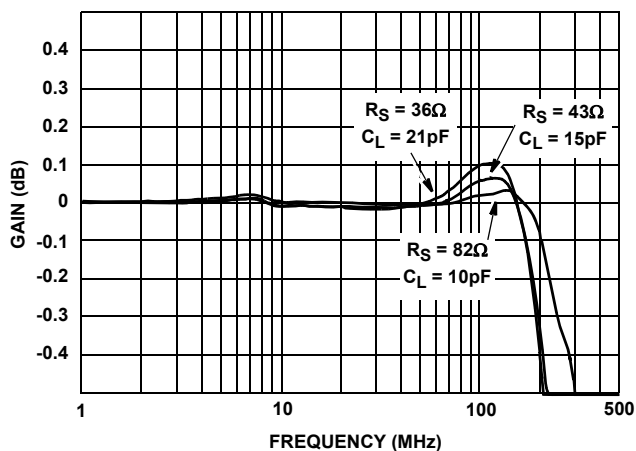


FIGURE 6. GAIN FLATNESS

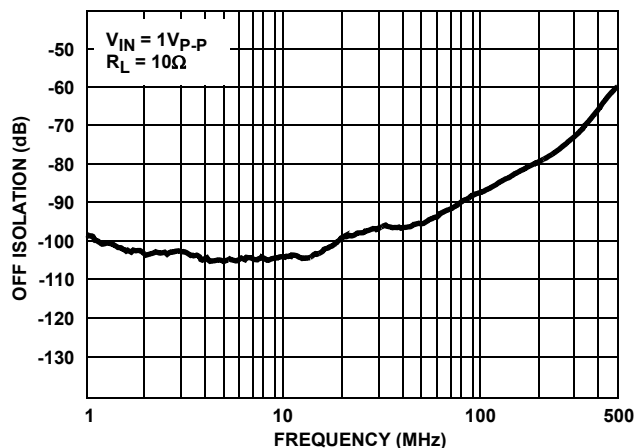


FIGURE 7. OFF ISOLATION

## Die Characteristics

### DIE DIMENSIONS:

51 mils x 36 mils x 19 mils  
 1290 $\mu$ m x 910 $\mu$ m x 483 $\mu$ m

### METALLIZATION:

Type: Metal 1: AlCu (1%)/TiW  
 Thickness: Metal 1: 6k $\text{\AA}$   $\pm$  0.8k $\text{\AA}$   
 Type: Metal 2: AlCu (1%)  
 Thickness: Metal 2: 16k $\text{\AA}$   $\pm$  1.1k $\text{\AA}$

### PASSIVATION:

Type: Nitride  
 Thickness: 4k $\text{\AA}$   $\pm$  0.5k $\text{\AA}$

### TRANSISTOR COUNT:

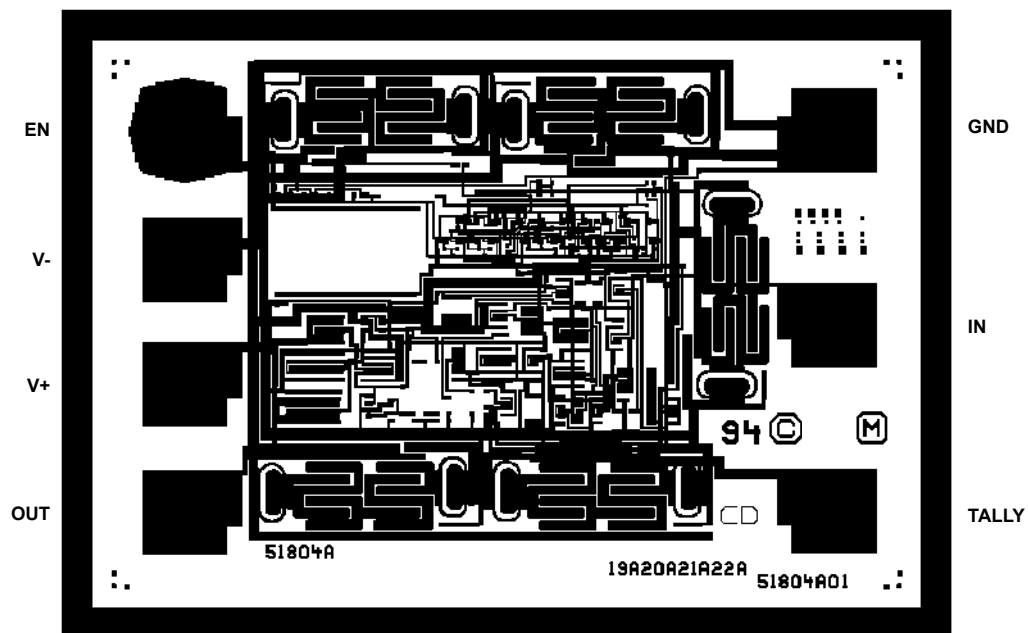
53

### SUBSTRATE POTENTIAL (Powered Up):

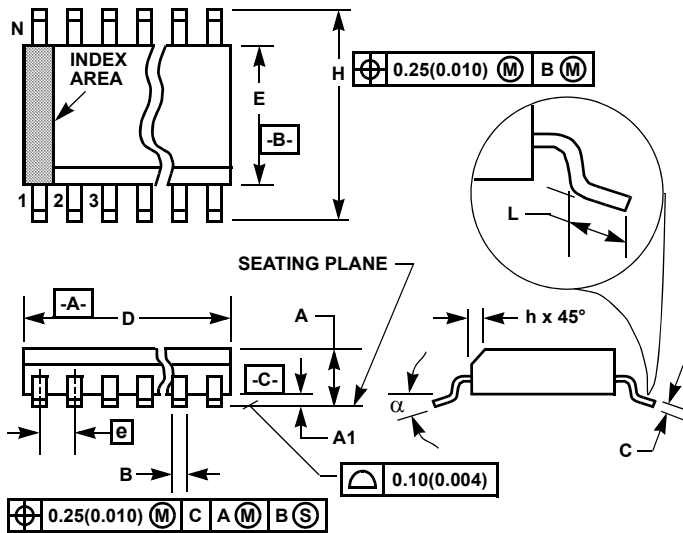
V-

## Metallization Mask Layout

HA4201



## Small Outline Plastic Packages (SOIC)



### NOTES:

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

### M8.15 (JEDEC MS-012-AA ISSUE C)

#### 8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE

| SYMBOL   | INCHES    |        | MILLIMETERS |      | NOTES |
|----------|-----------|--------|-------------|------|-------|
|          | MIN       | MAX    | MIN         | MAX  |       |
| A        | 0.0532    | 0.0688 | 1.35        | 1.75 | -     |
| A1       | 0.0040    | 0.0098 | 0.10        | 0.25 | -     |
| B        | 0.013     | 0.020  | 0.33        | 0.51 | 9     |
| C        | 0.0075    | 0.0098 | 0.19        | 0.25 | -     |
| D        | 0.1890    | 0.1968 | 4.80        | 5.00 | 3     |
| E        | 0.1497    | 0.1574 | 3.80        | 4.00 | 4     |
| e        | 0.050 BSC |        | 1.27 BSC    |      | -     |
| H        | 0.2284    | 0.2440 | 5.80        | 6.20 | -     |
| h        | 0.0099    | 0.0196 | 0.25        | 0.50 | 5     |
| L        | 0.016     | 0.050  | 0.40        | 1.27 | 6     |
| N        | 8         |        | 8           |      | 7     |
| $\alpha$ | 0°        | 8°     | 0°          | 8°   | -     |

Rev. 1 6/05

All Intersil U.S. products are manufactured, assembled and tested utilizing ISO9001 quality systems.

Intersil Corporation's quality certifications can be viewed at [www.intersil.com/design/quality](http://www.intersil.com/design/quality)

*Intersil products are sold by description only. Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that data sheets are current before placing orders. Information furnished by Intersil is believed to be accurate and reliable. However, no responsibility is assumed by Intersil or its subsidiaries for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Intersil or its subsidiaries.*

For information regarding Intersil Corporation and its products, see [www.intersil.com](http://www.intersil.com)