

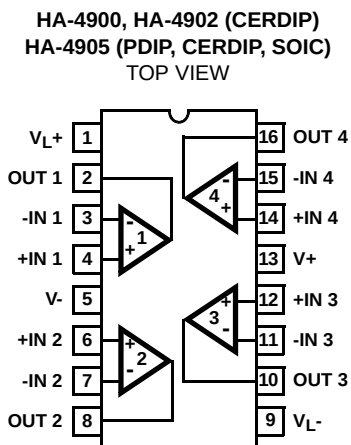
## Precision Quad Comparators

The HA-4900 series are monolithic, quad, precision comparators offering fast response time, low offset voltage, low offset current and virtually no channel-to-channel crosstalk for applications requiring accurate, high speed, signal level detection. These comparators can sense signals at ground level while being operated from either a single +5V supply (digital systems) or from dual supplies (analog networks) up to  $\pm 15V$ . The HA-4900 series contains a unique current driven output stage which can be connected to logic system supplies ( $V_{\text{LOGIC}+}$  and  $V_{\text{LOGIC}-}$ ) to make the output levels directly compatible (no external components needed) with any standard logic or special system logic levels. In combination analog/digital systems, the design employed in the HA-4900 series input and output stages prevents troublesome ground coupling of signals between analog and digital portions of the system.

These comparators' combination of features make them ideal components for signal detection and processing in data acquisition systems, test equipment and microprocessor/analog signal interface networks.

For military grade product, refer to the HA-4902/883 data sheet.

## Pinout



## Features

- Fast Response Time . . . . . 130ns
- Low Offset Voltage . . . . . 2.0mV
- Low Offset Current . . . . . 10nA
- Single or Dual Voltage Supply Operation
- Selectable Output Logic Levels
- Active Pull-Up/Pull-Down Output Circuit. No External Resistors Required
- Pb-Free Plus Anneal Available (RoHS Compliant)

## Applications

- Threshold Detector
- Zero Crossing Detector
- Window Detector
- Analog Interfaces for Microprocessors
- High Stability Oscillators
- Logic System Interfaces

## Ordering Information

| PART NUMBER            | PART MARKING | TEMP RANGE (°C) | PACKAGE              | PKG. DWG. # |
|------------------------|--------------|-----------------|----------------------|-------------|
| HA1-4900-2             | HA1-4900-2   | -55 to 125      | 16 Ld CERDIP         | F16.3       |
| HA1-4902-2             | HA1-4902-2   | -55 to 125      | 16 Ld CERDIP         | F16.3       |
| HA1-4905-5             | HA1-4905-5   | 0 to 75         | 16 Ld CERDIP         | F16.3       |
| HA3-4905-5             | HA3-4905-5   | 0 to 75         | 16 Ld PDIP           | E16.3       |
| HA9P4905-5             | HA9P4905-5   | 0 to 75         | 16 Ld SOIC           | M16.3       |
| HA9P4905-5Z (See Note) | HA9P4905-5Z  | 0 to 75         | 16 Ld SOIC (Pb-free) | M16.3       |

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.



**Electrical Specifications**  $V_{SUPPLY} = \pm 15V$ ,  $V_{LOGIC+} = 5V$ ,  $V_{LOGIC-} = GND$  (Continued)

| PARAMETER                                         | TEMP<br>(°C) | HA-4900-2<br>-55°C to 125°C |     |       | HA-4902-2<br>-55°C to 125°C |     |       | HA-4905-5<br>0°C to 75°C |     |       | UNITS |
|---------------------------------------------------|--------------|-----------------------------|-----|-------|-----------------------------|-----|-------|--------------------------|-----|-------|-------|
|                                                   |              | MIN                         | TYP | MAX   | MIN                         | TYP | MAX   | MIN                      | TYP | MAX   |       |
| OUTPUT CHARACTERISTICS                            |              |                             |     |       |                             |     |       |                          |     |       |       |
| Output Voltage Level                              |              |                             |     |       |                             |     |       |                          |     |       |       |
| Logic “Low State” (V <sub>OL</sub> )<br>(Note 8)  | Full         | -                           | 0.2 | 0.4   | -                           | 0.2 | 0.4   | -                        | 0.2 | 0.4   | V     |
| Logic “High State” (V <sub>OH</sub> )<br>(Note 8) | Full         | 3.5                         | 4.2 | -     | 3.5                         | 4.2 | -     | 3.5                      | 4.2 | -     | V     |
| Output Current                                    |              |                             |     |       |                             |     |       |                          |     |       |       |
| I <sub>SINK</sub>                                 | Full         | 3.0                         | -   | -     | 3.0                         | -   | -     | 3.0                      | -   | -     | mA    |
| I <sub>SOURCE</sub>                               | Full         | 3.0                         | -   | -     | 3.0                         | -   | -     | 3.0                      | -   | -     | mA    |
| POWER SUPPLY CHARACTERISTICS                      |              |                             |     |       |                             |     |       |                          |     |       |       |
| Supply Current, I <sub>PS</sub> (+)               | 25           | -                           | 6.5 | 20    | -                           | 6.5 | 20    | -                        | 7   | 20    | mA    |
| Supply Current, I <sub>PS</sub> (-)               | 25           | -                           | 4   | 8     | -                           | 4   | 8     | -                        | 5   | 8     | mA    |
| Supply Current, I <sub>PS</sub> (Logic)           | 25           | -                           | 3.5 | 4     | -                           | 3.5 | 4     | -                        | 3.5 | 4     | mA    |
| Supply Voltage Range                              |              |                             |     |       |                             |     |       |                          |     |       |       |
| V <sub>LOGIC+</sub> (Note 2)                      | Full         | 0                           | -   | +15.0 | 0                           | -   | +15.0 | 0                        | -   | +15.0 | V     |
| V <sub>LOGIC-</sub> (Note 2)                      | Full         | -15.0                       | -   | 0     | -15.0                       | -   | 0     | -15.0                    | -   | 0     | V     |

**NOTES:**

- Minimum differential input voltage required to ensure a defined output state.
- Input bias currents are essentially constant with differential input voltages up to  $\pm 9V$ . With differential input voltages from  $\pm 9V$  to  $\pm 15V$ , bias current on the more negative input can rise to approximately  $500\mu A$ . This will also cause higher supply currents.
- $V_{CM} = 0V$ . Input sensitivity is the worst case minimum differential input voltage required to guarantee a given output logic state. This parameter includes the effects of offset voltage and voltage gain.
- For  $t_{PD}(1)$ ; 100mV input step, -10mV overdrive. For  $t_{PD}(0)$ ; -100mV input step, 10mV overdrive. Frequency  $\approx 100Hz$ ; Duty Cycle  $\approx 50\%$ ; Inverting input driven. See Figure 1 for Test Circuit. All unused inverting inputs tied to +5V.
- For  $V_{OH}$  and  $V_{OL}$ :  $I_{SINK} = I_{SOURCE} = 3.0mA$ . For other values of  $V_{LOGIC}$ :  $V_{OH} (Min) = V_{LOGIC} + -1.5V$ .

**Test Circuit and Waveform**

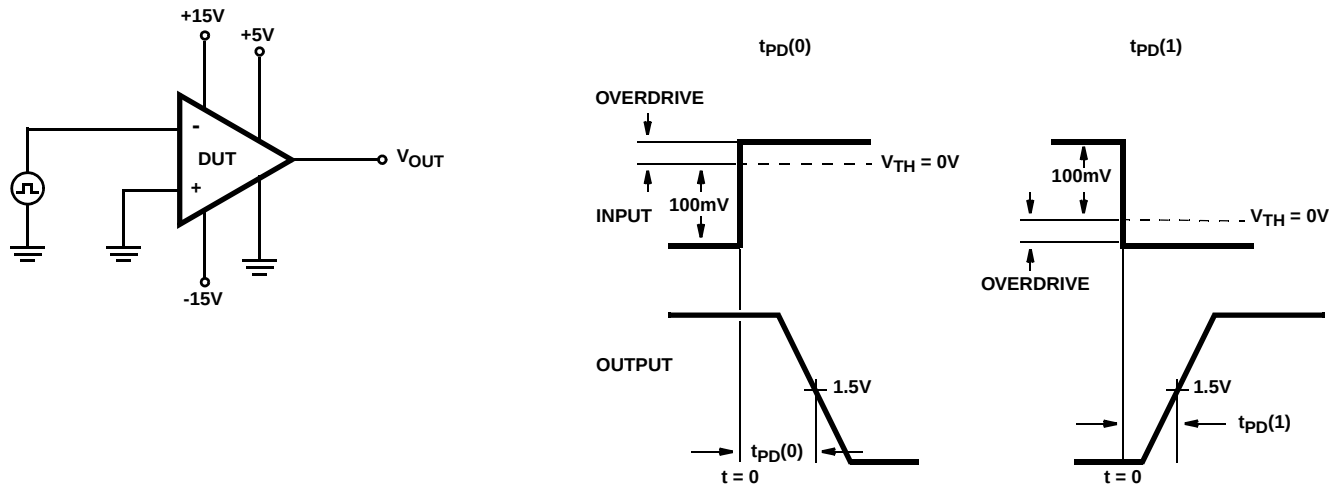
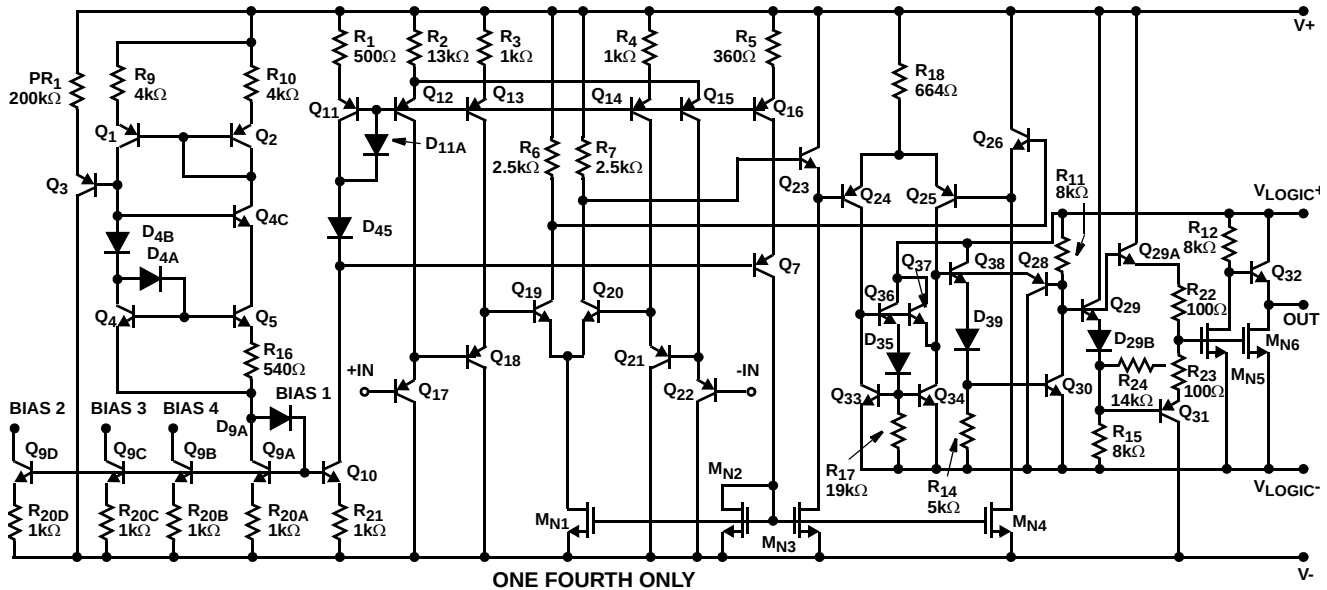


FIGURE 1.

## Schematic Diagram



## Applying the HA-4900 Series Comparators

### Supply Connections

This device is exceptionally versatile in working with most available power supplies. The voltage applied to the  $V_+$  and  $V_-$  terminals determines the allowable input signal range; while the voltage applied to the  $V_{L+}$  and  $V_{L-}$  determines the output swing. In systems where dual analog supplies are available, these would be connected to  $V_+$  and  $V_-$ , while the logic supply and return would be connected to  $V_{LOGIC+}$  and  $V_{LOGIC-}$ . The analog and logic supply commons can be connected together at one point in the system, since the comparator is immune to noise on the logic supply ground. A negative output swing may be obtained by connecting  $V_{L+}$  to ground and  $V_{L-}$  to a negative supply. Bipolar output swings ( $15V_{P-P}$  Max) may be obtained using dual supplies. In systems where only a single logic supply is available (+5V to 15V),  $V_+$  and  $V_{LOGIC+}$  may be connected together to the positive supply while  $V_-$  and  $V_{LOGIC-}$  are grounded. If an input signal could swing negative with respect to the  $V_-$  terminal, a resistor should be connected in series with the input to limit input current to  $< 5\text{mA}$  since the C-B junction of the input transistor would be forward biased.

### Unused Inputs

Inputs of unused comparator sections should be tied to a differential voltage source to prevent output "chatter."

### Crosstalk

Simultaneous high frequency operation of all other channels in the package will not affect the output logic state of a given channel, provided that its differential input voltage is sufficient to define a given logic state ( $\Delta V_{IN} \geq \pm V_{OS}$ ). Low level or high impedance input lines should be shielded from other signal sources to reduce crosstalk and interference.

### Power Supply Decoupling

Decouple all power supply lines with  $0.01\mu\text{F}$  ceramic capacitors to ground line located near the package to reduce coupling between channels or from external sources.

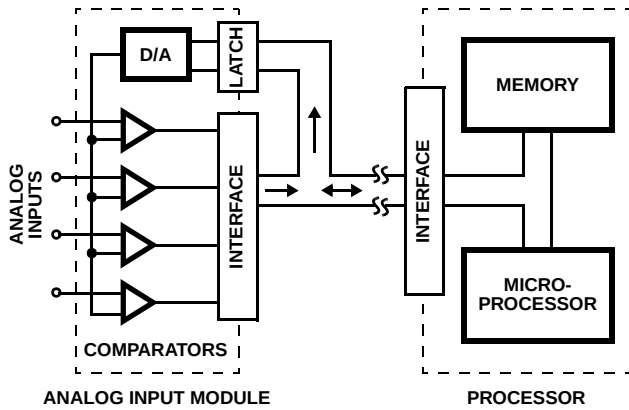
### Response Time

Fast rise time ( $< 200\text{ns}$ ) input pulses of several volts amplitude may result in delay times somewhat longer than those illustrated for  $100\text{mV}$  steps. Operating speed is optimized by limiting the maximum differential input voltage applied, with resistor-diode clamping networks.

## Typical Applications

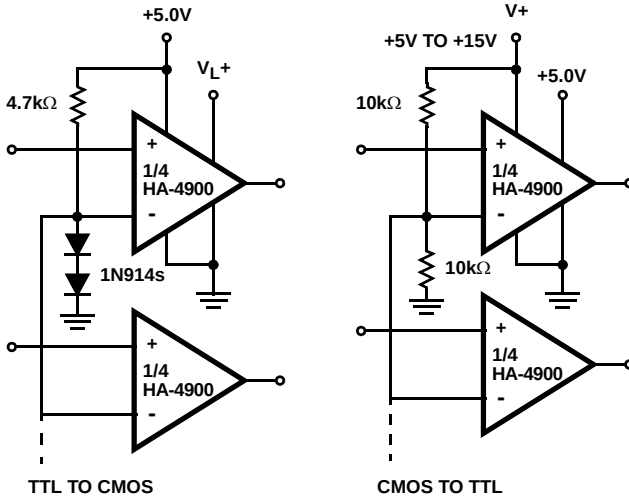
### Data Acquisition System

In this circuit the HA-4900 series is used in conjunction with a D to A converter to form a simple, versatile, multi-channel analog input for a data acquisition system. In operation the processor first sends an address to the D to A, then the processor reads the digital word generated by the comparator outputs. To perform a simple comparison, the processor sets the D to A to a given reference level, then examines one or more comparator outputs to determine if their inputs are above or below the reference. A window comparison consists of two such cycles with 2 reference levels set by the D to A. One way to digitize the inputs would be for the processor to increment the D to A in steps. The D to A address, as each comparator switches, is the digitized level of the input. While stairstepping the D to A is slower than successive approximation, all channels are digitized during one staircase ramp.



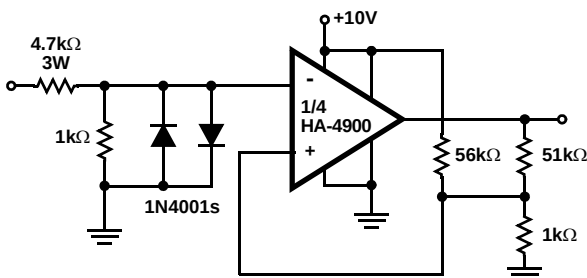
### Logic Level Translators

The HA-4900 series comparators can be used as versatile logic interface devices as shown in the circuits above. Negative logic devices may also be interfaced with appropriate supply connections. If separate supplies are used for  $V_-$  and  $V_{\text{LOGIC-}}$ , these logic level translators will tolerate several volts of ground line differential noise.



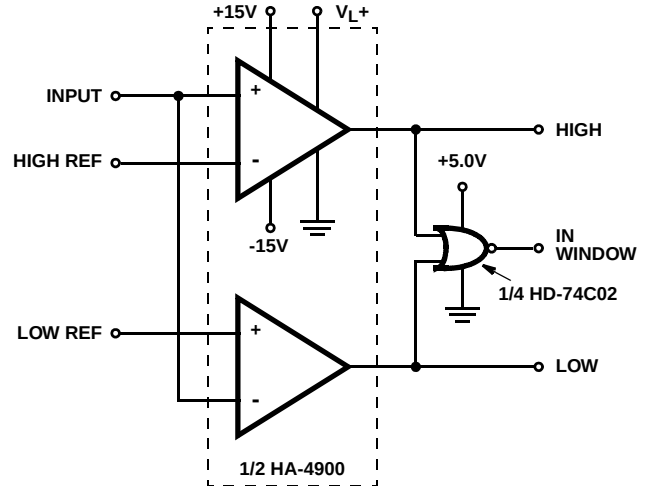
### RS-232 To CMOS Line Receiver

This RS-232 type line receiver to drive CMOS logic uses a Schmitt trigger feedback network to give about 1V input hysteresis for added noise immunity. A possible problem in an interface which connects two equipments, each plugged into a different AC receptacle, is that the power line voltage may appear at the receiver input when the interface connection is made or broken. The two diodes and a 3W input resistor will protect the inputs under these conditions.



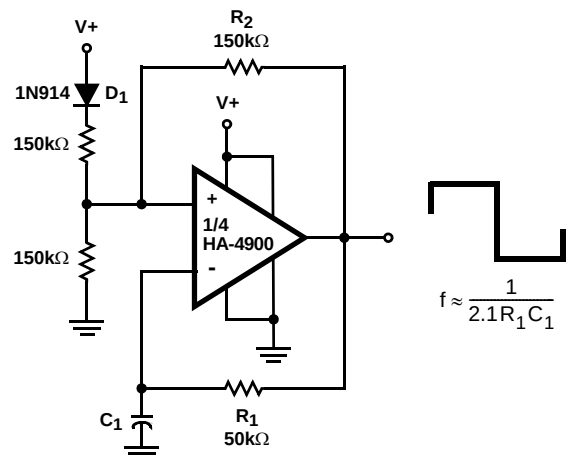
### Window Detector

The high switching speed, low offset current and low offset voltage of the HA-4900 series makes this window detector circuit extremely well suited to applications requiring fast, accurate, decision-making. The circuit above is ideal for industrial process system feedback controllers or "out-of-limit" alarm indicators.



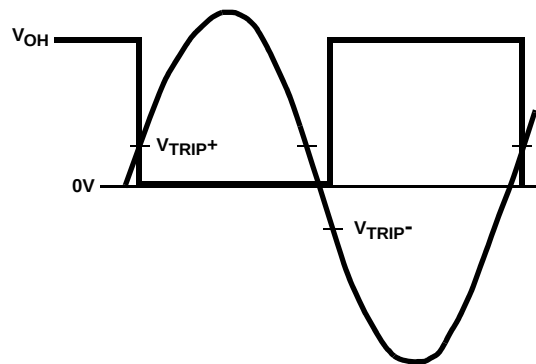
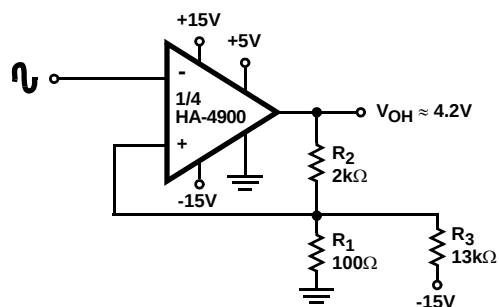
### Oscillator/Clock Generator

This self-starting fixed frequency oscillator circuit gives excellent frequency stability.  $R_1$  and  $C_1$  comprise the frequency determining network while  $R_2$  provides the regenerative feedback. Diode  $D_1$  enhances the stability by compensating for the difference between  $V_{OH}$  and  $V_{SUPPLY}$ . In applications where a precision clock generator up to 100kHz is required, such as in automatic test equipment,  $C_1$  may be replaced by a crystal.



### Schmitt Trigger (Zero Crossing Detector With Hysteresis)

This circuit has a 100mV hysteresis which can be used in applications where very fast transition times are required at the output even though the signal input is very slow. The hysteresis loop also reduces false triggering due to noise on the input. The waveforms below show the trip points developed by the hysteresis loop.



INPUT TO OUTPUT WAVEFORM SHOWING HYSTERESIS TRIP POINTS

**Typical Performance Curves**  $T_A = 25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $V_{\text{LOGIC}+} = 5\text{V}$ ,  $V_{\text{LOGIC}-} = 0\text{V}$ , Unless Otherwise Specified

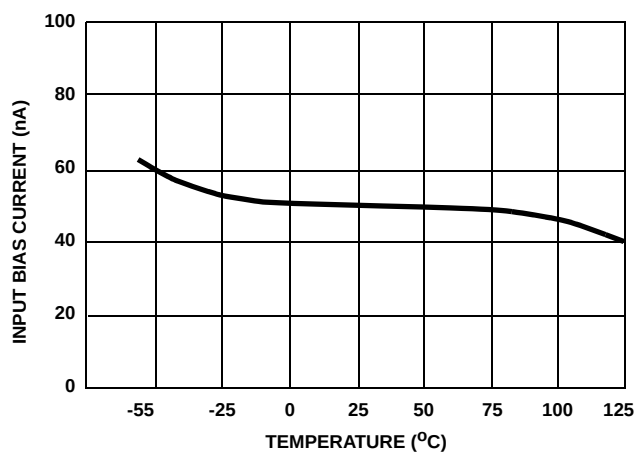


FIGURE 2. INPUT BIAS CURRENT vs TEMPERATURE

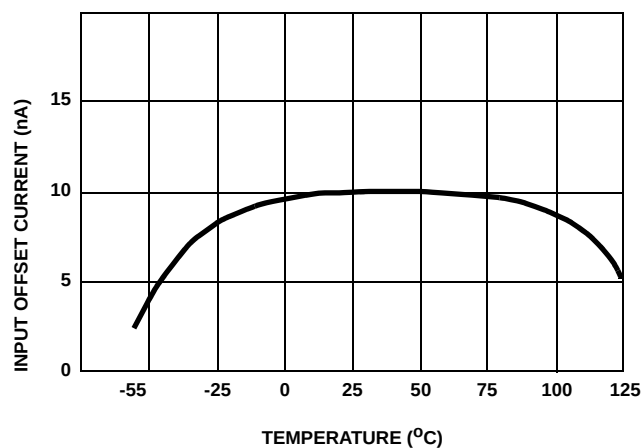


FIGURE 3. INPUT OFFSET CURRENT vs TEMPERATURE

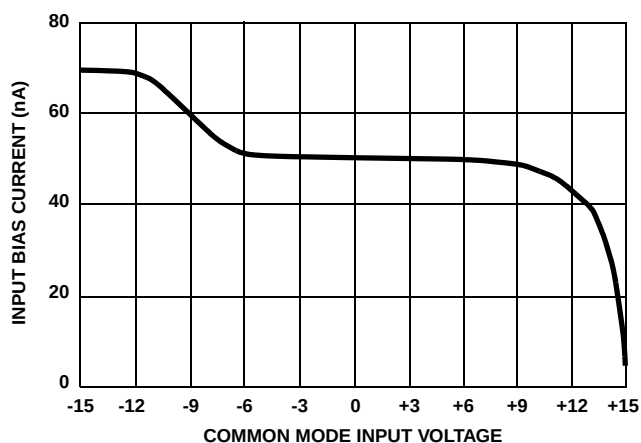


FIGURE 4. INPUT BIAS CURRENT vs COMMON MODE INPUT VOLTAGE ( $V_{\text{DIFF}} = 0\text{V}$ )

**Typical Performance Curves**  $T_A = 25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $V_{\text{LOGIC}+} = 5\text{V}$ ,  $V_{\text{LOGIC}-} = 0\text{V}$ , Unless Otherwise Specified (Continued)

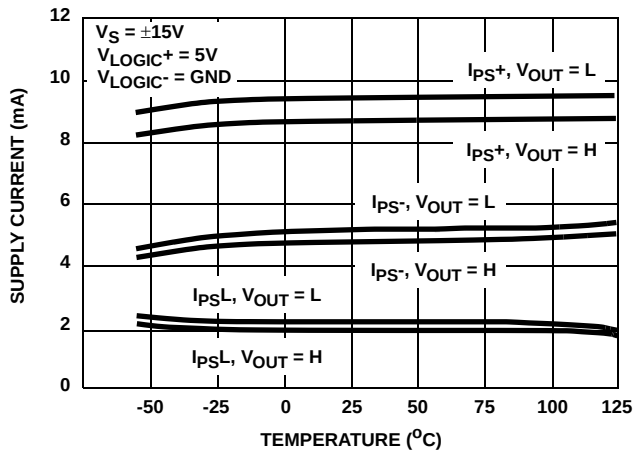


FIGURE 5. SUPPLY CURRENT vs TEMPERATURE (FOR  $\pm 15\text{V}$  SUPPLIES AND  $+5\text{V}$  LOGIC SUPPLY)

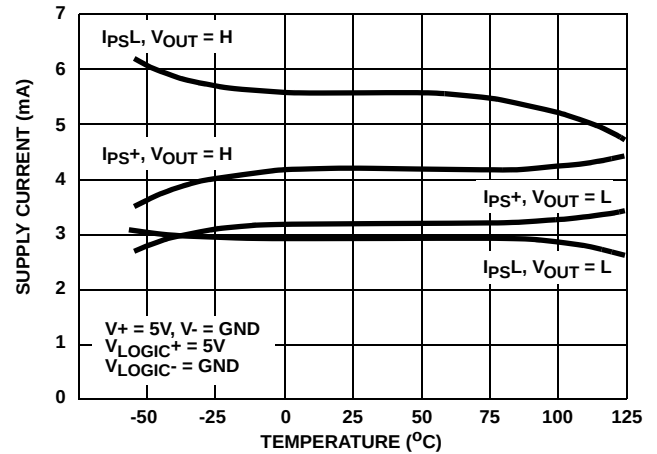


FIGURE 6. SUPPLY CURRENT vs TEMPERATURE (FOR SINGLE  $+5\text{V}$  OPERATION)

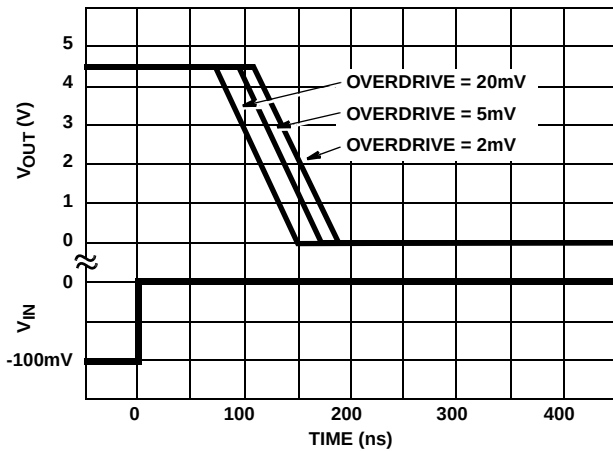


FIGURE 7. RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES

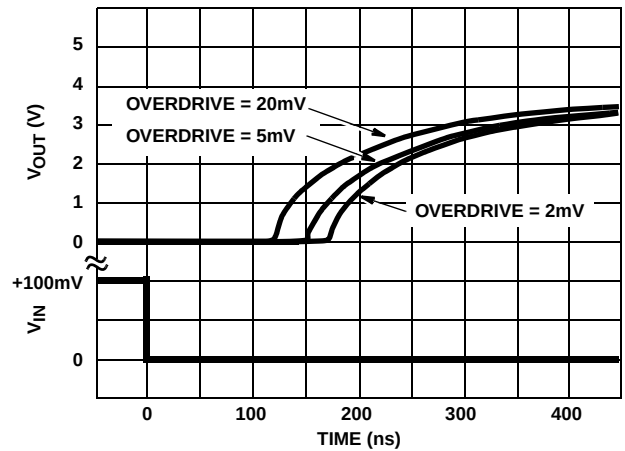


FIGURE 8. MAXIMUM PACKAGE DISSIPATION vs AMBIENT TEMPERATURE

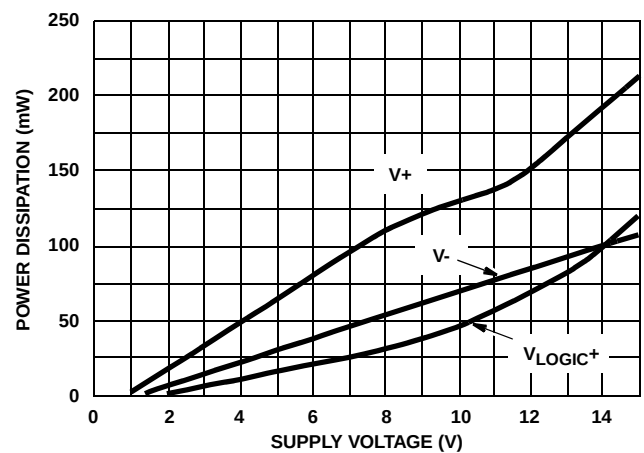


FIGURE 9. POWER DISSIPATION vs SUPPLY VOLTAGE (NO LOAD CONDITION)

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