

November 1996

### Features

- Operation from Single or Dual Supplies
- Common Mode Input Voltage Range to GND
- Output Voltage Compatible with TTL, DTL, ECL, MOS and CMOS
- Differential Input Voltage Range Equal to the Supply Voltage
- Maximum Input Offset Voltage ( $V_{IO}$ )
  - CA139A, CA239A, CA339A ..... 2mV
  - CA139, CA239, CA339 ..... 5mV
  - LM2901 ..... 7mV
  - LM3302 ..... 20mV
- Replacement for Industry Types 139, 239, 339, 139A, 239A, 339A, 2901, 3302

### Applications

- Square Wave Generator
- Time Delay Generators
- Pulse Generators
- Multivibrators
- High Voltage Digital Logic Gates
- A/D Converters
- MOS Clock Timers

### Description

The devices in this series consist of four independent single or dual supply voltage comparators on a single monolithic substrate. The common mode input voltage range includes ground even when operated from a single supply, and the low power supply current drain makes these comparators suitable for battery operation. These types were designed to directly interface with TTL and CMOS.

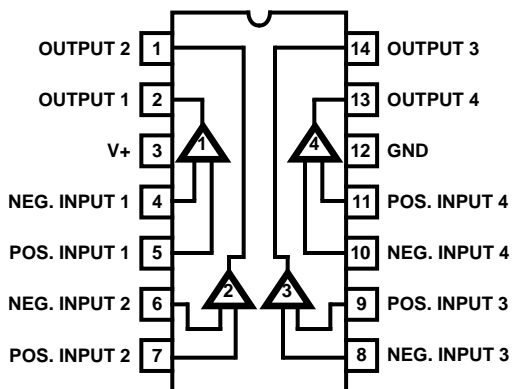
Types CA139A, CA239A, and CA339A have all the features and characteristics of their prototype counterparts CA139, CA239, and CA339 plus an even lower input offset voltage characteristic. All the SOIC parts are available on tape and reel. Replace the M suffix in the part number with M96 when ordering (e.g. CA0339AM96). The CA339 is also available in chip form (H suffix).

### Ordering Information

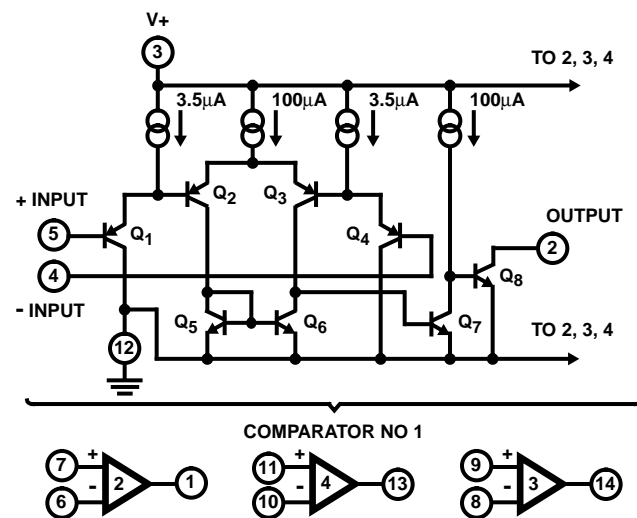
| PART NO. (BRAND)        | TEMP. RANGE (°C) | PACKAGE      | PKG. NO. |
|-------------------------|------------------|--------------|----------|
| CA0139E                 | -55 to 125       | 14 Ld PDIP   | E14.3    |
| CA0139F                 | -55 to 125       | 14 Ld Cerdip | E14.3    |
| CA0139M, AM (139, 139A) | -55 to 125       | 14 Ld SOIC   | M14.15   |
| CA0239E, AE             | -25 to 85        | 14 Ld PDIP   | E14.3    |
| CA0239F, AF             | -25 to 85        | 14 Ld Cerdip | E14.3    |
| CA0239M, (239)          | -25 to 85        | 14 Ld SOIC   | M14.15   |
| CA0339E, AE             | 0 to 70          | 14 Ld PDIP   | E14.3    |
| CA0339M, (339)          | 0 to 70          | 14 Ld SOIC   | M14.15   |
| LM339N, AN              | 0 to 70          | 14 Ld PDIP   | E14.3    |
| LM2901M (2901)          | -40 to 85        | 14 Ld SOIC   | M14.15   |
| LM2901N                 | -40 to 85        | 14 Ld PDIP   | E14.3    |
| LM3302M (3302)          | -40 to 85        | 14 Ld SOIC   | M14.15   |
| LM3302N                 | -40 to 85        | 14 Ld PDIP   | E14.3    |

### Pinout

CA139, CA239, CA239A (PDIP, Cerdip, SOIC)  
CA139A, CA339, CA339A, LM2901, LM3302 (PDIP, SOIC)  
LM339, LM339A (PDIP)  
TOP VIEW



### Schematic Diagram



**CA139, CA139A, CA239, CA239A, CA339, CA339A, LM339, LM339A, LM2901, LM3302**

**Absolute Maximum Ratings**

Supply Voltage . . . . . 36V or ±18V  
 Differential Input Voltage . . . . . 36V  
 Input Voltage . . . . . -0.3V to +36V  
 Input Current ( $V_I < -0.3V$ , Note 1) . . . . . 50mA  
 Output Short Circuit Duration (Single Supply, Note 2) . . Continuous

**Operating Conditions**

Temperature Range  
 CA139, CA139A . . . . . -55°C to 125°C  
 CA239, CA239A . . . . . -25°C to 80°C  
 CA339, CA339A, LM339, LM339A . . . . . 0°C to 70°C  
 LM2901, LM3302 . . . . . -40°C to 85°C

**Thermal Information**

Thermal Resistance (Typical, Note 3)  $\theta_{JA}$  (°C/W)  $\theta_{JC}$  (°C/W)  
 CERDIP Package . . . . . 90 30  
 PDIP Package . . . . . 100 N/A  
 SOIC Package . . . . . 175 N/A  
 Maximum Junction Temperature (Ceramic Package) . . . . . 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)

*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. Inputs must not go more negative than -0.3V.
2. Short circuits from the output to V+ can cause excessive heating and eventual destruction. The maximum output current independent of V+ is approximately 20mA.
3.  $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

**Electrical Specifications** V+ = 5V, Unless Otherwise Specified

| PARAMETER                       | SYMBOL    | TEST CONDITIONS   | TEMP (°C)  | CA139 |     |         | CA139A |     |         | UNITS   |
|---------------------------------|-----------|---|------------|-------|-----|---------|--------|-----|---------|---------|
|                                 |           |   |            | MIN   | TYP | MAX     | MIN    | TYP | MAX     |         |
| Input Offset Voltage            | $V_{IO}$  | $V_{REF} = 1.4V, R_S = 0,$<br>Output Switch Point<br>$V \cong 1.4V$ | $T_A = 25$ | -     | 2   | 5       | -      | 1   | 2       | mV      |
|                                 |           |   | Note 4     | -     | -   | 9       | -      | -   | 4       | mV      |
| Differential Input Voltage      | $V_{ID}$  | Keep All Inputs $\geq 0V$ , or<br>V- (if used), (Note 5)            | Note 4     | -     | -   | 36      | -      | -   | 36      | V       |
| Saturation Voltage              | $V_{SAT}$ | $V_{I-} = 1V, V_{I+} = 0V,$<br>$I_{SINK} \leq 4mA$                  | $T_A = 25$ | -     | 250 | 400     | -      | 250 | 400     | mV      |
|                                 |           |   | Note 4     | -     | -   | 700     | -      | -   | 700     | mV      |
| Common Mode Input Voltage Range | $V_{ICR}$ | Note 6  | $T_A = 25$ | 0     | -   | V+ -1.5 | 0      | -   | V+ -1.5 | V       |
|                                 |           |   | Note 4     | 0     | -   | V+ -2   | 0      | -   | V+ -2   | V       |
| Input Offset Current            | $I_{IO}$  | $I_{I+} - I_{I-}$   | $T_A = 25$ | -     | 3   | 25      | -      | 3   | 25      | nA      |
|                                 |           |   | Note 4     | -     | -   | 100     | -      | -   | 100     | nA      |
| Input Bias Current              | $I_{IB}$  | $I_{I+}$ or $I_{I-}$ with Output in<br>Linear Range                 | $T_A = 25$ | -     | 25  | 100     | -      | 25  | 100     | nA      |
|                                 |           |   | Note 4     | -     | -   | 300     | -      | -   | 300     | nA      |
| Total Supply Current            | $I_+$     | $R_L = \infty$ On All<br>Comparators                                | $T_A = 25$ | -     | 0.8 | 2       | -      | 0.8 | 2       | mA      |
| Output Leakage Current          |           | $V_{I+} \geq 1V, V_{I-} = 0V,$<br>$V_O = 5V$                        | $T_A = 25$ | -     | 0.1 | -       | -      | 0.1 | -       | nA      |
|                                 |           | $V_{I+} \geq 1V, V_{I-} = 0V,$<br>$V_O = 30V$                       | Note 4     | -     | -   | 1       | -      | -   | 1       | $\mu A$ |
| Output Sink Current             |           | $V_{I-} \geq 1V, V_{I+} = 0V, V_O$<br>$\leq 1.5V$                   | $T_A = 25$ | 6     | 16  | -       | 6      | 16  | -       | mA      |
| Voltage Gain                    | $A_{OL}$  | $R_L \geq 15k\Omega, V_+ = 15V$                                     | $T_A = 25$ | -     | 200 | -       | 50     | 200 | -       | V/mV    |

**CA139, CA139A, CA239, CA239A, CA339, CA339A, LM339, LM339A, LM2901, LM3302**

**Electrical Specifications**  $V_+ = 5V$ , Unless Otherwise Specified (Continued)

| PARAMETER                    | SYMBOL | TEST CONDITIONS  | TEMP (°C)  | CA139 |     |     | CA139A |     |     | UNITS   |
|------------------------------|--------|--|------------|-------|-----|-----|--------|-----|-----|---------|
|                              |        |  |            | MIN   | TYP | MAX | MIN    | TYP | MAX |         |
| Large Signal Response Time   |        | $V_I = \text{TTL Logic Swing}$ ,<br>$V_{REF} = 1.4V$ , $V_{RL} = 5V$ ,<br>$R_L = 5.1k\Omega$ | $T_A = 25$ | -     | 300 | -   | -      | 300 | -   | ns      |
| Response Time (Figures 3, 4) |        | $V_{RL} = 5V$ , $R_L = 5.1k\Omega$   | $T_A = 25$ | -     | 1.3 | -   | -      | 1.3 | -   | $\mu s$ |

**Electrical Specifications**  $V_+ = 5V$ , Unless Otherwise Specified

| PARAMETER                       | SYMBOL    | TEST CONDITIONS  | TEMP (°C)  | CA239, CA339, LM339 |     |             | CA239A, CA339A, LM339A |     |             | UNITS   |
|---------------------------------|-----------|--|------------|---------------------|-----|-------------|------------------------|-----|-------------|---------|
|                                 |           |  |            | MIN                 | TYP | MAX         | MIN                    | TYP | MAX         |         |
| Input Offset Voltage            | $V_{IO}$  | $V_{REF} = 1.4V$ , $R_S = 0$ ,<br>Output Switch Point<br>$V \cong 1.4V$                      | $T_A = 25$ | -                   | 2   | 5           | -                      | 1   | 2           | mV      |
|                                 |           |  | Note 4     | -                   | -   | 9           | -                      | -   | 4           | mV      |
| Differential Input Voltage      | $V_{ID}$  | Keep All Inputs $\geq 0V$ ,<br>or $V_-$ (if used),<br>(Note 5)                               | Note 4     | -                   | -   | 36          | -                      | -   | 36          | V       |
| Saturation Voltage              | $V_{SAT}$ | $V_{I-} = 1V$ , $V_{I+} = 0V$ ,<br>$I_{SINK} \leq 4mA$                                       | $T_A = 25$ | -                   | 250 | 400         | -                      | 250 | 400         | mV      |
|                                 |           |  | Note 4     | -                   | -   | 700         | -                      | -   | 700         | mV      |
| Common Mode Input Voltage Range | $V_{ICR}$ | Note 6   | $T_A = 25$ | 0                   | -   | $V_+ - 1.5$ | 0                      | -   | $V_+ - 1.5$ | V       |
|                                 |           |  | Note 4     | 0                   | -   | $V_+ - 2$   | 0                      | -   | $V_+ - 2$   | V       |
| Input Offset Current            | $I_{IO}$  | $I_{I+} - I_{I-}$  | $T_A = 25$ | -                   | 5   | 50          | -                      | 5   | 50          | nA      |
|                                 |           |  | Note 4     | -                   | -   | 150         | -                      | -   | 150         | nA      |
| Input Bias Current              | $I_{IB}$  | $I_{I+}$ or $I_{I-}$ with Output in<br>Linear Range  | $T_A = 25$ | -                   | 25  | 250         | -                      | 25  | 250         | nA      |
|                                 |           |  | Note 4     | -                   | -   | 400         | -                      | -   | 400         | nA      |
| Total Supply Current            | $I_+$     | $R_L = \infty$ on All<br>Comparators   | $T_A = 25$ | -                   | 0.8 | 2           | -                      | 0.8 | 2           | mA      |
| Output Leakage Current          |           | $V_{I+} \geq 1V$ , $V_{I-} = 0V$ ,<br>$V_O = 5V$   | $T_A = 25$ | -                   | 0.1 | -           | -                      | 0.1 | -           | nA      |
|                                 |           | $V_{I+} \geq 1V$ , $V_{I-} = 0V$ ,<br>$V_O = 30V$  | Note 4     | -                   | -   | 1           | -                      | -   | 1           | $\mu A$ |
| Output Sink Current             |           | $V_{I-} \geq 1V$ , $V_{I+} = 0V$ ,<br>$V_O \leq 1.5V$  | $T_A = 25$ | 6                   | 16  | -           | 6                      | 16  | -           | mA      |
| Voltage Gain                    | $A_{OL}$  | $R_L \geq 15k\Omega$ , $V_+ = 15V$   | $T_A = 25$ | 50                  | 200 | -           | 50                     | 200 | -           | V/mV    |
| Large Signal Response Time      |           | $V_I = \text{TTL Logic Swing}$ ,<br>$V_{REF} = 1.4V$ ,<br>$V_{RL} = 5V$ , $R_L = 5.1k\Omega$ | $T_A = 25$ | -                   | 300 | -           | -                      | 300 | -           | ns      |
| Response Time (Figures 3, 4)    |           | $V_{RL} = 5V$ , $R_L = 5.1k\Omega$   | $T_A = 25$ | -                   | 1.3 | -           | -                      | 1.3 | -           | $\mu s$ |

NOTES:

- Ambient Temperature ( $T_A$ ) applicable over operating temperature range as shown below.  
CA139, CA139A =  $-55^\circ C$  to  $125^\circ C$ ; CA239, CA239A =  $-25^\circ C$  to  $85^\circ C$ ; CA339, CA339A, LM339, LM339A =  $0^\circ C$  to  $70^\circ C$ ; LM2901, LM3302 =  $-40^\circ C$  to  $85^\circ C$ .
- The comparator will provide a proper output state even if the positive swing of the inputs exceeds the power supply voltage level, if the other input remains within the common mode voltage range. The low input voltage state must not be less than  $-0.3V$  (or  $0.3V$  below the magnitude of the negative power supply, if used).
- The upper end of the common mode voltage range is  $(V_+) - 1.5V$ , but either or both inputs can go to  $+30V$  without damage.

**CA139, CA139A, CA239, CA239A, CA339, CA339A, LM339, LM339A, LM2901, LM3302**

**Electrical Specifications**  $V_+ = 5V$ , Unless Otherwise Specified

| PARAMETER                       | SYMBOL    | TEST CONDITIONS  | TEMP (°C)  | LM2901 |     |             | LM3302 |     |             | UNITS   |
|---------------------------------|-----------|--|------------|--------|-----|-------------|--------|-----|-------------|---------|
|                                 |           |  |            | MIN    | TYP | MAX         | MIN    | TYP | MAX         |         |
| Input Offset Voltage            | $V_{IO}$  | $V_{REF} = 1.4V$ , $R_S = 0$ ,<br>Output Switch Point<br>$V \cong 1.4V$              | $T_A = 25$ | -      | 2   | 7           | -      | 1   | 20          | mV      |
|                                 |           |  | Note 4     | -      | -   | 15          | -      | -   | 40          | mV      |
| Differential Input Voltage      | $V_{ID}$  | Keep All Inputs $\geq 0V$ ,<br>or $V_-$ (if used), (Note 5)                          | Note 4     | -      | -   | 36          | -      | -   | 28          | V       |
| Saturation Voltage              | $V_{SAT}$ | $V_{I-} = 1V$ , $V_{I+} = 0V$ ,<br>$I_{SINK} \leq 4mA$                               | $T_A = 25$ | -      | 250 | 400         | -      | 250 | 500         | mV      |
|                                 |           |  | Note 4     | -      | -   | 700         | -      | -   | 700         | mV      |
| Common Mode Input Voltage Range | $V_{ICR}$ | Note 6   | $T_A = 25$ | 0      | -   | $V_+ - 1.5$ | 0      | -   | $V_+ - 1.5$ | V       |
|                                 |           |  | Note 4     | 0      | -   | $V_+ - 2$   | 0      | -   | $V_+ - 2$   | V       |
| Input Offset Current            | $I_{IO}$  | $I_{I+} - I_{I-}$  | $T_A = 25$ | -      | 5   | 50          | -      | 3   | 100         | nA      |
|                                 |           |  | Note 4     | -      | -   | 200         | -      | -   | 300         | nA      |
| Input Bias Current              | $I_{IB}$  | $I_{I+}$ or $I_{I-}$ with Output<br>in Linear Range                                  | $T_A = 25$ | -      | 25  | 250         | -      | 25  | 500         | nA      |
|                                 |           |  | Note 4     | -      | -   | 500         | -      | -   | 1000        | nA      |
| Total Supply Current            | $I_+$     | $R_L = \infty$ on All<br>Comparators   | $T_A = 25$ | -      | 0.8 | 2           | -      | 0.8 | 2           | mA      |
| Output Leakage Current          |           | $V_{I+} \geq 1V$ , $V_{I-} = 0V$ ,<br>$V_O = 5V$                                     | $T_A = 25$ | -      | 0.1 | -           | -      | 0.1 | -           | nA      |
|                                 |           | $V_{I+} \geq 1V$ , $V_{I-} = 0V$ ,<br>$V_O = 30V$                                    | Note 4     | -      | -   | 1           | -      | -   | 1           | $\mu A$ |
| Output Sink Current             |           | $V_{I-} \geq 1V$ , $V_{I+} = 0V$ ,<br>$V_O \leq 1.5V$                                | $T_A = 25$ | 6      | 16  | -           | 6      | 16  | -           | mA      |
| Voltage Gain                    | $A_{OL}$  | $R_L \geq 15k\Omega$ , $V_+ = 15V$   | $T_A = 25$ | 25     | 100 | -           | 2      | 30  | -           | V/mV    |
| Large Signal Response Time      |           | $V_I = TTL$ Logic<br>Swing, $V_{REF} = 1.4V$ ,<br>$V_{RL} = 5V$ , $R_L = 5.1k\Omega$ | $T_A = 25$ | -      | 300 | -           | -      | 300 | -           | ns      |
| Response Time<br>(Figures 3, 4) |           | $V_{RL} = 5V$ , $R_L = 5.1k\Omega$   | $T_A = 25$ | -      | 1.3 | -           | -      | 1.3 | -           | $\mu s$ |

Typical Performance Curves

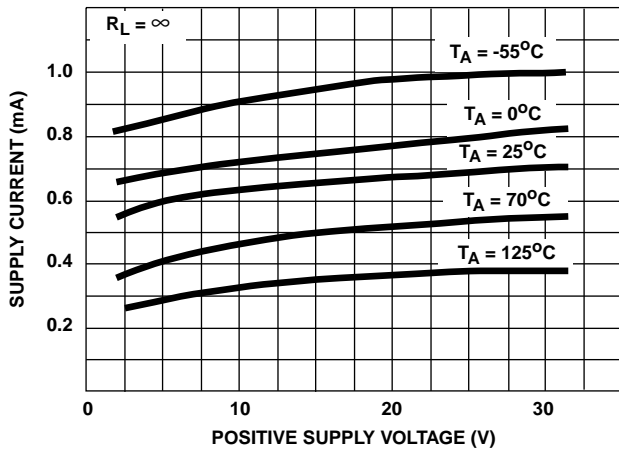


FIGURE 1. SUPPLY CURRENT vs SUPPLY VOLTAGE

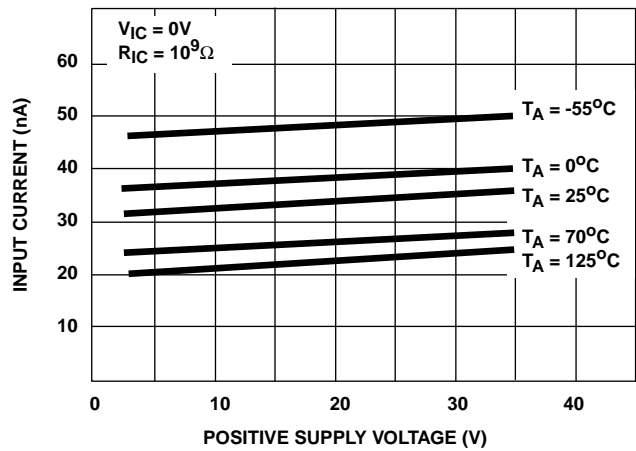


FIGURE 2. INPUT CURRENT vs SUPPLY VOLTAGE

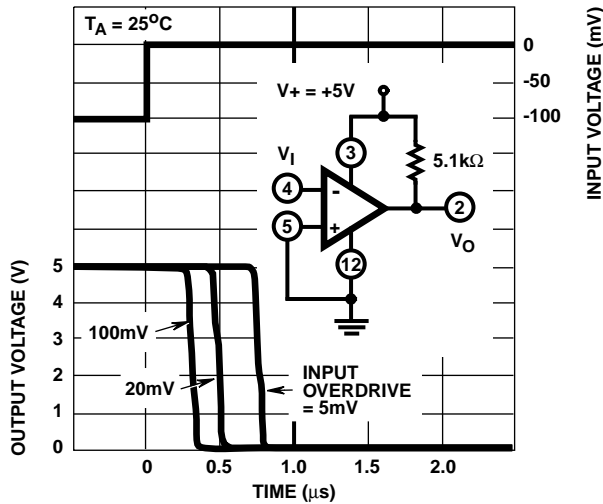


FIGURE 3. RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - NEGATIVE TRANSITION

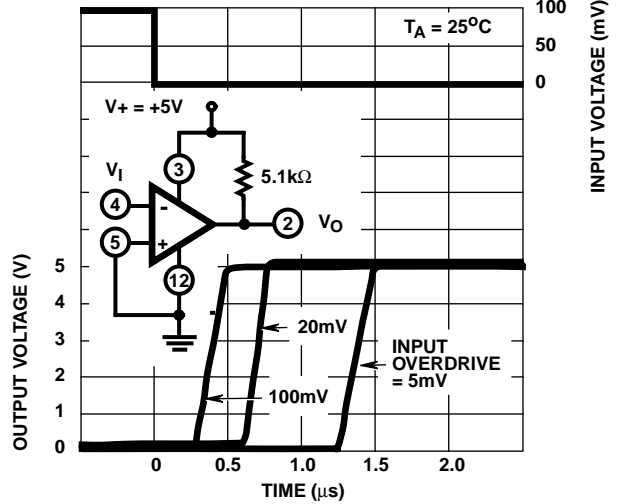


FIGURE 4. RESPONSE TIME FOR VARIOUS INPUT OVERDRIVES - POSITIVE TRANSITION

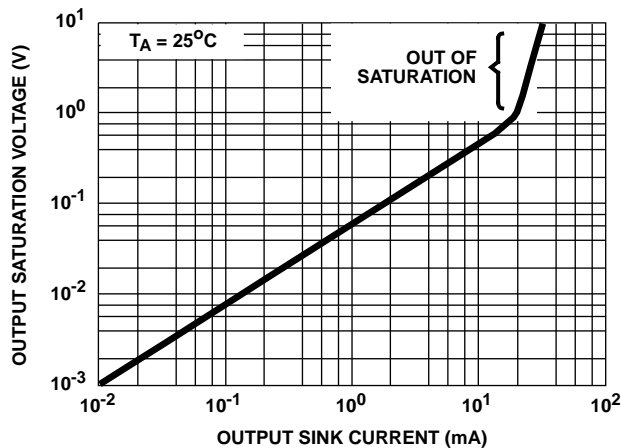
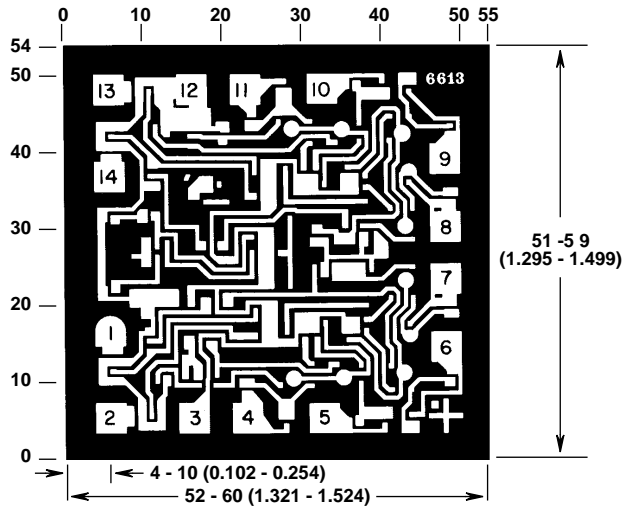


FIGURE 5. OUTPUT SATURATION VOLTAGE vs OUTPUT SINK CURRENT

### Metallization Mask Layout



NOTE: Dimensions in parentheses are in mm and are derived from the basic in. dimensions as indicated. Grid graduations are in mils ( $10^{-3}$  inch).

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