LM139/LM239/LM339/LM2901/LM3302
Low Power Low Offset Voltage Quad Comparators

General Description
The LM139 series consists of four independent precision voltage comparators with an offset voltage specification as low as 2 mV max for all four comparators. These were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, squarewave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM139 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, they will directly interface with MOS logic — where the low power drain of the LM339 is a distinct advantage over standard comparators.

Advantages
- High precision comparators
- Reduced $V_{os}$ drift over temperature
- Eliminates need for dual supplies
- Allows sensing near GND
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features
- Wide supply voltage range
  - LM139/139A Series: 2 to 36 $V_{DC}$ or ±1 to ±18 $V_{DC}$
  - LM2901: 2 to 36 $V_{DC}$ or ±1 to ±18 $V_{DC}$
  - LM3302: 2 to 28 $V_{DC}$ or ±1 to ±14 $V_{DC}$
- Very low supply current drain (0.8 mA) — independent of supply voltage
- Low input biasing current: 25 nA
- Low input offset current: ±5 nA
- Offset voltage: ±3 mV
- Input common-mode voltage range includes GND
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage: 250 mV at 4 mA
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems

One-Shot Multivibrator with Input Lock Out
Absolute Maximum Ratings (Note 10)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th>LM239A, LM339A</th>
<th>LM3302</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage, $V^+$</td>
<td>$36 \text{ V}<em>{\text{DC}}$ or $\pm 18 \text{ V}</em>{\text{DC}}$</td>
<td>$28 \text{ V}<em>{\text{DC}}$ or $\pm 14 \text{ V}</em>{\text{DC}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Differential Input Voltage (Note 8)</td>
<td>$36 \text{ V}_{\text{DC}}$</td>
<td>$28 \text{ V}_{\text{DC}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>$-0.3 \text{ V}<em>{\text{DC}}$ to $+36 \text{ V}</em>{\text{DC}}$</td>
<td>$-0.3 \text{ V}<em>{\text{DC}}$ to $+28 \text{ V}</em>{\text{DC}}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Current ($V_{\text{IN}} &lt; -0.3 \text{ V}_{\text{DC}}$), (Note 3)</td>
<td>$50 \text{ mA}$</td>
<td>$50 \text{ mA}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Dissipation (Note 1)</td>
<td>Molding DIP</td>
<td>1050 mW</td>
<td>1050 mW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cavity DIP</td>
<td>1190 mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small Outline Package</td>
<td>760 mW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Short-Circuit to GND, (Note 2)</td>
<td>Continuous</td>
<td>Continuous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>$-65^\circ \text{C}$ to $+150^\circ \text{C}$</td>
<td>$-65^\circ \text{C}$ to $+150^\circ \text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead Temperature</td>
<td>(Soldering, 10 seconds)</td>
<td>$260^\circ \text{C}$</td>
<td>$260^\circ \text{C}$</td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>LM339/LM339A</td>
<td>0$^\circ \text{C}$ to $+70^\circ \text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LM239/LM239A</td>
<td>$-25^\circ \text{C}$ to $+85^\circ \text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LM2901</td>
<td>$-40^\circ \text{C}$ to $+85^\circ \text{C}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LM139/LM139A</td>
<td>$-55^\circ \text{C}$ to $+125^\circ \text{C}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Soldering Information

Dual-In-Line Package

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th>LM3302</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soldering (10 seconds)</td>
<td>Continuous</td>
<td>260$^\circ \text{C}$</td>
<td>260$^\circ \text{C}$</td>
</tr>
</tbody>
</table>

Small Outline Package

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th>LM3302</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vapor Phase (60 seconds)</td>
<td>Continuous</td>
<td>215$^\circ \text{C}$</td>
<td>215$^\circ \text{C}$</td>
</tr>
<tr>
<td>Infrared (15 seconds)</td>
<td>Continuous</td>
<td>220$^\circ \text{C}$</td>
<td>220$^\circ \text{C}$</td>
</tr>
</tbody>
</table>

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

ESD rating (1.5 kΩ in series with 100 pF) | 600V | 600V |

Electrical Characteristics

$(V^+ = 5 \text{ V}_{\text{DC}}, T_A = 25^\circ \text{C},$ unless otherwise stated)
### Electrical Characteristics (Continued)

(V\(^+\) = 5 V\(_{DC}\), \(T_A = 25^\circ\)C, unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th>LM239A, LM339A</th>
<th>LM139</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Output Sink Current</td>
<td>(V_{IN(-)}=1\ V_{DC}), (V_{IN(+)}=0), (V_C\leq1.5\ V_{DC})</td>
<td>6.0</td>
<td>16</td>
<td>6.0</td>
<td>16</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>(V_{IN(-)}=1\ V_{DC}), (V_{IN(+)}=0), (I_{SINK}\leq4\ mA)</td>
<td>250</td>
<td>400</td>
<td>250</td>
<td>400</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>(V_{IN(+)}=1\ V_{DC}), (V_{IN(-)}=0), (V_C=5\ V_{DC})</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>nA(_{DC})</td>
</tr>
</tbody>
</table>

### Electrical Characteristics

(V\(^+\) = 5 V\(_{DC}\), \(T_A = 25^\circ\)C, unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM239, LM339</th>
<th>LM2901</th>
<th>LM3302</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Input Offset Voltage</td>
<td>(Note 9)</td>
<td>2.0</td>
<td>5.0</td>
<td></td>
<td>2.0</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>(I_{IN(+)}) or (I_{IN(-)}) with Output in Linear Range, (Note 5), (V_{CM}=0)</td>
<td>25</td>
<td>250</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>(I_{IN(+)}=I_{IN(-)}), (V_{CM}=0)</td>
<td>5.0</td>
<td>50</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Input Common-Mode Voltage Range</td>
<td>(V^+=30\ V_{DC}), (V^+=28\ V_{DC}) (Note 6)</td>
<td>0</td>
<td>(V^+-1.5)</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Supply Current</td>
<td>(R_L=\infty) on all Comparators, (R_C=\infty, V^+=36V, (LM3302, V^+=28\ V_{DC}))</td>
<td>0.8</td>
<td>2.0</td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>Voltage Gain</td>
<td>(V_L\geq15\ k\Omega, V^+=15\ V_{DC})</td>
<td>80</td>
<td>200</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Large Signal Response Time</td>
<td>(V_{IN}=TTL\ Logic Swing, V_{REF}=1.4\ V_{DC}, V_{RL}=5\ V_{DC}, R_L=5.1\ k\Omega)</td>
<td>300</td>
<td></td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Response Time</td>
<td>(V_{RL}=5\ V_{DC}, R_L=5.1\ k\Omega) (Note 7)</td>
<td>1.3</td>
<td></td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td>Output Sink Current</td>
<td>(V_{IN(-)}=1\ V_{DC}, V_{IN(+)}=0, V_C\leq1.5\ V_{DC})</td>
<td>6.0</td>
<td>16</td>
<td></td>
<td>6.0</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>(V_{IN(-)}=1\ V_{DC}, V_{IN(+)}=0, I_{SINK}\leq4\ mA)</td>
<td>250</td>
<td>400</td>
<td></td>
<td>250</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>(V_{IN(+)}=1\ V_{DC}, V_{IN(-)}=0, V_C=5\ V_{DC})</td>
<td>0.1</td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Electrical Characteristics

(V\(^+\) = 5.0 V\(_{DC}\), (Note 4))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th>LM239A, LM339A</th>
<th>LM139</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Input Offset Voltage</td>
<td>(Note 9)</td>
<td>4.0</td>
<td>4.0</td>
<td></td>
<td>9.0</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>(I_{IN(+)}=I_{IN(-)}), (V_{CM}=0)</td>
<td>100</td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>(I_{IN(+)}) or (I_{IN(-)}) with Output in Linear Range, (V_{CM}=0) (Note 5)</td>
<td>300</td>
<td></td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Input Common-Mode Voltage Range</td>
<td>(V^+=30\ V_{DC}), (V^+=28\ V_{DC}) (Note 6)</td>
<td>0</td>
<td>(V^+-2.0)</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>(V_{IN(-)}=1\ V_{DC}, V_{IN(+)}=0, I_{SINK}\leq4\ mA)</td>
<td>700</td>
<td></td>
<td></td>
<td>700</td>
</tr>
</tbody>
</table>
### Electrical Characteristics (Continued)

(V<sup>+</sup> = 5.0 V<sub>DC</sub>, (Note 4))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM139A</th>
<th></th>
<th>LM239A, LM339A</th>
<th>LM139</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>(V_{IN(+)}, V_{IN(-)} = 0), (V_O = 30 \text{ V}<em>\text{DC}) (LM3302, (V_O = 28 \text{ V}</em>\text{DC}))</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0 (\mu\text{A}_\text{DC})</td>
<td></td>
</tr>
<tr>
<td>Differential Input Voltage</td>
<td>Keep all (V_{IN} \leq 0 \text{ V}_\text{DC}) (or (V^-), if used), (Note 8)</td>
<td>36</td>
<td>36</td>
<td>36 (\text{V}_\text{DC})</td>
<td></td>
</tr>
</tbody>
</table>

### Electrical Characteristics

(V<sup>+</sup> = 5.0 V<sub>DC</sub>, (Note 4))

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>LM239, LM339</th>
<th></th>
<th>LM2901</th>
<th>LM3302</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>Input Offset Voltage</td>
<td>(Note 9)</td>
<td>9.0</td>
<td>9</td>
<td>15</td>
<td>40</td>
<td>mV&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input Offset Current</td>
<td>(I_{IN(+)}, I_{IN(-)}, V_{CM} = 0\text{V})</td>
<td>150</td>
<td>50</td>
<td>200</td>
<td>300</td>
<td>nA&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input Bias Current</td>
<td>(I_{IN(+)}, I_{IN(-)}) with Output in Linear Range, (V_{CM} = 0\text{V}) (Note 5)</td>
<td>400</td>
<td>200</td>
<td>500</td>
<td>1000</td>
<td>nA&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Common-Mode Voltage Range</td>
<td>(V^+ = 30 \text{ V}<em>\text{DC}) (LM3302, (V^+ = 28 \text{ V}</em>\text{DC})) (\text{V}_\text{DC})</td>
<td>(V^- = 2.0)</td>
<td>0</td>
<td>(V^- = 2.0)</td>
<td>0</td>
<td>(V^- = 2.0)</td>
</tr>
<tr>
<td>Saturation Voltage</td>
<td>(V_{IN(+)}, V_{IN(-)} = 0), (I_{IN} &lt; 5\text{mA})</td>
<td>700</td>
<td>400</td>
<td>700</td>
<td>700</td>
<td>mV&lt;sub&gt;DC&lt;/sub&gt;</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>(V_{IN(+)}, V_{IN(-)} = 0), (V_O = 30 \text{ V}<em>\text{DC}), (LM3302, (V_O = 28 \text{ V}</em>\text{DC}))</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>(\mu\text{A}_\text{DC})</td>
<td></td>
</tr>
<tr>
<td>Differential Input Voltage</td>
<td>Keep all (V_{IN} \leq 0 \text{ V}_\text{DC}) (or (V^-), if used), (Note 8)</td>
<td>36</td>
<td>36</td>
<td>28</td>
<td>(\text{V}_\text{DC})</td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** For operating at high temperatures, the LM339/LM339A, LM2901, LM3302 must be derated based on a 125°C maximum junction temperature and a thermal resistance of 95°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM239 and LM139 must be derated based on a 150°C maximum junction temperature. The low bias dissipation and the “ON-OFF” characteristic of the outputs keeps the chip dissipation very small \(P_D \leq 100\text{mW}\), provided the output transistors are allowed to saturate.

**Note 2:** Short circuits from the output to \(V^+\) can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 20 mA independent of the magnitude of \(V^+\).

**Note 3:** This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the \(V^+\) voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than \(-0.3\text{ V}_\text{DC}\) (at 25°C).

**Note 4:** These specifications are limited to \(-55\text{°C} \leq T_A \leq 125\text{°C}\), for the LM139/LM139A. With the LM239/LM239A, all temperature specifications are limited to \(-25\text{°C} \leq T_A \leq 85\text{°C}\), the LM339/LM339A temperature specifications are limited to \(0\text{°C} \leq T_A \leq 70\text{°C}\), and the LM2901, LM3302 temperature range is \(-40\text{°C} \leq T_A \leq 85\text{°C}\).

**Note 5:** The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.

**Note 6:** The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is \(V^+\) \(-1.5\text{ V}_\text{DC}\) at 25°C, but either or both inputs can go to \(+30\text{ V}_\text{DC}\) without damage (25V for LM3302), independent of the magnitude of \(V^+\).

**Note 7:** The response time specified is a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained, see typical performance characteristics section.

**Note 8:** Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than \(-0.3 \text{ V}_\text{DC}\) (or 0.3 \text{ V}_\text{DC} below the magnitude of the negative power supply, if used) (at 25°C).

**Note 9:** At output switch point, \(V_O = 1.4 \text{ V}_\text{DC}\), \(R_S = 0\text{Ω}\) with \(V^+\) from \(5 \text{ V}_\text{DC}\) to 30 \text{ V}_\text{DC}\) and over the full input common-mode range (0 \text{ V}DC to \(V^+\) \(-1.5 \text{ V}_\text{DC}\)), at 25°C. For LM3302, \(V^+\) from 5 \text{ V}_\text{DC} to 28 \text{ V}_\text{DC}.

**Note 10:** Refer to RETS139AX for LM139A military specifications and to RETS139X for LM139 military specifications.

Supply Current

Input Current

Output Saturation Voltage

Response Time for Various Input Overdrives — Negative Transition

Response Time for Various Input Overdrives — Positive Transition

Typical Performance Characteristics LM2901

Supply Current

Input Current

Output Saturation Voltage
Application Hints

The LM139 series are high gain, wide bandwidth devices which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs via stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Power supply bypassing is not required to solve this problem. Standard PC board layout is helpful as it reduces stray input-output coupling. Reducing this input resistor to < 10 kΩ reduces the feedback signal levels and finally, adding even a small amount (1 to 10 mV) of positive feedback (hysteresis) causes such a rapid transition that oscillations due to stray feedback are not possible. Simply socketing the IC and attaching resistors to the pins will cause input-output oscillations during the small transition intervals unless hysteresis is used. If the input signal is a pulse waveform, with relatively fast rise and fall times, hysteresis is not required.

All pins of any unused comparators should be tied to the negative supply.

The bias network of the LM139 series establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2 VDC to 30 VDC. It is usually unnecessary to use a bypass capacitor across the power supply line.

Typical Applications \((V^+ = 5.0 \text{ V}_{\text{DC}})\)
Typical Applications \((V^+ = 5.0 \, V_{DC})\) (Continued)

AND Gate

\[
\begin{align*}
V^+ & \quad \text{"0"} \quad \text{"1"} \\
0 & \quad \text{"0"} \\
+0.375 & \\
39k & \\
1k & \\
100k & \\
\text{A} & \\
\text{B} & \\
\text{C} & \\
\text{1/4 LM139} & \\
f & \\
f = A \cdot B \cdot C
\end{align*}
\]

OR Gate

\[
\begin{align*}
V^+ & \quad \text{"0"} \quad \text{"1"} \\
0 & \quad \text{"0"} \\
+0.075V & \\
200k & \\
1k & \\
100k & \\
\text{A} & \\
\text{B} & \\
\text{C} & \\
\text{1/4 LM139} & \\
f & \\
f = A + B + C
\end{align*}
\]

Typical Applications \((V^+ = 15 \, V_{DC})\)

One-Shot Multivibrator

\[
\begin{align*}
V^+ & \quad \text{"0"} \\
\text{"1"} & \\
+V_{IN} & \\
100\, \mu F & \\
1M & \\
10k & \\
\text{1N914} & \\
\text{1/4 LM139} & \\
V_O & \\
0 & \\
1\, \text{ms} & \text{PW} & V^+
\end{align*}
\]

Bi-Stable Multivibrator

\[
\begin{align*}
V^+ & \\
\text{100k} & \\
\text{5k} & \\
\text{1/4 LM139} & \\
V_O & \\
0 & \\
S & +15V
\end{align*}
\]
Typical Applications \((V^*= 15 \text{ V}_{\text{DC}})\) (Continued)

One-Shot Multivibrator with Input Lock Out

![One-Shot Multivibrator Circuit](image1)

Pulse Generator

![Pulse Generator Circuit](image2)

* For large ratios of \(R1/R2\), \(D1\) can be omitted.
Typical Applications \((V^+ = 15 \, V_{DC})\) (Continued)

Large Fan-In AND Gate

\[ V_{OUT} = A \cdot B \cdot C \cdot D \]

ORing the Outputs

\[ V^+ \]

\[ V' \]

\[ V \]

\[ 3k \]

\[ 100k \]

\[ 10k \]

\[ 1/4 \text{ LM139} \]

\[ 1/4 \text{ LM139} \]

\[ 1/4 \text{ LM139} \]

\[ 1/4 \text{ LM139} \]

\[ V_D \]

\[ 3.0k \]

ALL DIODES 1N914
Typical Applications \((V^+ = 15\ V_{DC})\) (Continued)

Time Delay Generator

Non-Inverting Comparator with Hysteresis

Inverting Comparator with Hysteresis
**Typical Applications** \((V^* = 15 \text{ V}_{\text{DC}}\) (Continued)

**Squarewave Oscillator**

![Squarewave Oscillator Circuit](image)

**Basic Comparator**

![Basic Comparator Circuit](image)

**Limit Comparator**

![Limit Comparator Circuit](image)

**Comparing Input Voltages of Opposite Polarity**

![Comparing Input Voltages Circuit](image)
Typical Applications \( (V^* = 15 \ V_{DC}) \) (Continued)

**Output Strobing**

```
\[ \text{V}^* \]
\[ \begin{array}{c}
\text{0.2k} \\
\text{1/4 LM139} \\
\text{V_o} \\
\text{STROBE INPUT}
\end{array} \]
```

* Or open-collector logic gate without pull-up resistor

**Crystal Controlled Oscillator**

```
\[ \begin{array}{c}
\text{V}^* \\
\text{200k} \\
\text{100k} \\
\text{2.0k} \\
\text{0.1uF} \\
\text{1/4 LM139} \\
\text{CRystal} \\
f = 100 \ kHz
\end{array} \]
```

* Or open-collector logic gate without pull-up resistor
Two-Decade High-Frequency VCO

$V^+ = +30 \, V_{DC}$

$250 \, mV_{DC} \leq V_{DC} \leq 50 \, V_{DC}$

$700 \, Hz \leq f_0 \leq 100 \, kHz$

$V^+ = +15 \, V_{DC}$ (Continued)
Typical Applications \((V^+ = 15 \, V_{DC})\) (Continued)

**Transducer Amplifier**

**Zero Crossing Detector (Single Power Supply)**

Split-Supply Applications \((V^+ = +15 \, V_{DC} \text{ and } V^- = -15 \, V_{DC})\)

**MOS Clock Driver**
Split-Supply Applications \((V^+ = +15 \, V_{DC} \text{ and } V^- = -15 \, V_{DC})\) (Continued)

**Zero Crossing Detector**

![Zero Crossing Detector Schematic Diagram]

**Comparator With a Negative Reference**

![Comparator Schematic Diagram]

**Schematic Diagram**
Connection Diagrams

See NS Package Number J14A
Order Number LM339AM, LM339AMX, LM339M, LM339MX or LM2901M
See NS Package Number M14A
Order Number LM339N, LM339AN, LM2901N or LM3302N
See NS Package Number N14A

Order Number LM139AW/883 or LM139W/883 (Note 11)
See NS Package Number W14B,
LM139AWGRQMLV (Note 13)
See NS Package Number WG14A

Note 11: Available per JM38510/11201
Note 12: Available per SMD# 5962-8873901
Note 13: See STD Mil Dwg 5962R96738 for Radiation Tolerant Device
Physical Dimensions    inches (millimeters) unless otherwise noted

Ceramic Dual-In-Line Package (J)
Order Number LM139J, LM139J/883, LM139AJ,
NS Package Number J14A

S.O. Package (M)
Order Number LM339AM, LM339AMX, LM339M, LM339MX, LM2901M or LM2901MX
NS Package Number M14A
Physical Dimensions  inches (millimeters) unless otherwise noted  (Continued)

Molded Dual-In-Line Package (N)
Order Number LM339N, LM339AN, LM2901N or LM3302N
NS Package Number N14A

Order Number LM139AW/883, LM139W/883, LM139AWG/883 or LM139WG/883
NS Package Number W14B
LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.